Bridge River Project Water Use Plan

Lower Bridge River Riverine Wildlife Monitoring

Implementation Year 6

Reference: BRGMON-11B

Study Period: 2020

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BRGMON-11B - LOWER BRIDGE RIVER RIVERINE WILDLIFE MONITORING:
2020 Report

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Cover photo: Lower Bridge River, Harlequin Duck female with three young. Photo © Russ Walton, Wildtech Biological Services.

EXECUTIVE SUMMARY

The completion of the Terzaghi Dam in 1960 diverted water from the Bridge River to powerhouses located on the Seton Reservoir, leaving over 3 km of dry river bed below the dam. In August 2000, BC Hydro initiated an average annual release of 3 cms, converting the section of formerly dry river bed into potentially usable habitat and increasing the flow of water in the Lower Bridge River. The average annual release was increased to 6 cms in May 2011. Due to seismic concerns on a storage reservoir upstream, the flow regime changed dramatically in 2016, with peak flows nearing 100 cms, more than a six-fold increase from the previous freshets (but still a third of the original flow prior to regulation). This Modified Operation is expected to continue for several more years.

As part of the Water License Requirements associated with the adoption of the 2011 Water Use Plan, BC Hydro commissioned the BRGMON-11 project to monitor the impact of river regulation on riparian vegetation and riverine birds on the Lower Bridge River. In 2018, the Terms of Reference for this project was separated into a vegetation component (BRGMON-11A) and a wildlife component (BRGMON-11B). Here we report results from 2020 monitoring for BRGMON-11B.

BRGMON-11B has 6 Management Questions (MQ):

1) How has the population of Harlequin Ducks in Reaches 3 and 4 of the Lower Bridge River (as enumerated prior to the nesting period with 'pair surveys') varied over time, and is this population index related to flow regime?

2) Are Harlequin Duck brood counts, monitored in Reaches 3 and 4 of the Lower Bridge River, influenced by flow regime?

3) Are other riverine bird species likely to be influenced by flow regime; if so, how?

4) How many active beaver lodges are there in Reaches 2, 3 and 4 of the Lower Bridge River in fall, how are they distributed, and how do these data vary among years?

5) Is the distribution of beavers in the Lower Bridge River influenced by river morphology or possibly by flows (see Walton and Heinrich 2020)?

6) Which riparian bird populations are most vulnerable to being impacted by changes to riparian habitat along the Lower Bridge River, and what ramifications do vegetation monitoring results have for riparian birds at the regional scale (see Walton and Heinrich 2020)?

Riverine Bird Monitoring
In 2020 we conducted riverine bird surveys during the breeding season on 14.9 km of the Lower Bridge River to contribute towards addressing MQ-1, MQ-2 and MQ-3. Survey methods were identical to previous surveys that began in 1999 (see Walton and Heinrich (2015, 2019a, 2020) for a summary of earlier surveys). Several species of riverine birds used the Lower Bridge River

during the breeding season but we focused our efforts on Common Mergansers (*Mergus merganser*), Spotted Sandpipers (*Actitus maculatus*), Harlequin Ducks (*Histrionicus histrionicus*), American Dippers (*Cinclus mexicanus*) and Belted Kingfishers (*Ceryle alcyon*).

No merganser broods were seen in 2020 for the third consecutive year. Adult mergansers numbers also remained low, continuing a trend that began in 2016. Harlequin Duck numbers during pair surveys were again low in 2020, but we observed two harlequin broods, although only three young were observed on the final brood survey. Dippers, sandpipers and kingfishers appeared less affected by recent flow changes, falling more in line with counts seen in previous survey years. Other waterfowl species that typically stopped on the Lower Bridge River in early May during migration were completely absent for the second consecutive year, suggesting that the Lower Bridge River is no longer suitable habitat for waterfowl adapted to slower moving water during the breeding season.

In 2020, the timing and intensity of flows closely approximated the 6 cms flow regime. Despite this return to lower flows, waterfowl numbers continued to remain low in 2020, following the decline observed since the initiation of the Modified Operations. This decline suggests that habitat quality for waterfowl, especially, was negatively affected by the Modified Operations compared with the 3 cms and 6 cms regimes, and that there may be a delayed lag effect from these impacts. Because there were few years of monitoring under the various flow regimes, additional years of monitoring would allow greater confidence interpreting the strength of trends present in the multi-year dataset.

Monitoring Beaver Abundance

Since the controlled release began in August 2000, beaver (*Castor canadensis*) numbers have probably increased along the Lower Bridge River, and there is concern about their effect on black cottonwood trees (*Populus trichocarpa*), an important resource for riparian biodiversity. We conducted a survey of active beaver lodges in late autumn in 2016, 2018, 2019 and 2020 to address MQ-5 for Reaches 3 and 4. In all years we found a stable number of five or six active lodges present. These counts are considerably higher than the single active lodge observed on these reaches prior to the return of water. We additionally performed a second survey along Reach 2 in 2020, recording 4 active lodges. Because dedicated beaver lodge surveys only commenced during Modified Operations, it is unclear how flows affect beaver distribution in the study area. Additional survey data in years of differing operations are likely required before the relationship between flow regime and beaver distribution can be assessed with confidence. These surveys have the added benefit of providing an extra riverine bird survey in late autumn-early winter. We believe the number of dippers, in particular, is a useful indicator of ecosystem health on the Lower Bridge River in winter, and dipper numbers provide some indication of the influence of dipper feeding on salmon eggs and alevin.

KEYWORDS

Lower Bridge River, riverine bird surveys, Harlequin Duck, Common Merganser, American Dipper, Belted Kingfisher, Spotted Sandpiper, beaver, beaver lodge.

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Vella Dan, Gilda Davis, Roxx Ledoux and Bryony Fowler (St'át'imc Eco-Resources Ltd.) provided essential project support and encouragement. We owe a debt of gratitude to the St'át'imc Eco-Resources Ltd. technicians in 2020: Trevor Dunn and Mercedes Adolph. Funding for this study was provided by BC Hydro's Bridge River Water Use Planning Monitoring Program.

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1.0 INTRODUCTION

Hydroelectric development on the Bridge River system began in 1927 with work on the first diversion through Mission Mountain. The river first became regulated when the Mission Dam was completed in 1948, followed by completion of the La Joie Dam upstream in the early 1950s, and culminated with an enlargement of the Mission Dam to what became the Terzaghi Dam, completed in 1960. Prior to damming, the Bridge River hydrograph, measured at the site of the Terzaghi Dam, had annual maximum flows of over 300 cms during spring freshet, sometimes reaching ~900 cms (Hall et al. 2009). Following completion of the Terzaghi Dam, all upstream water was diverted from the Lower Bridge River to powerhouses located on the Seton Reservoir, leaving over 3 km of dry river bed below the dam. Groundwater and unregulated tributaries downstream of the Terzaghi Dam contributed some water to the Lower Bridge River, the most notable being the Yalakom River.

In August 2000, BC Hydro initiated a permanent flow release at Terzaghi Dam designed to create a peak in summer and an enhanced winter flow in the Lower Bridge River (Bradford et al. 2011). Initially, a regime was adopted where flows ranged from a base flow in winter of ~1.5 cms to a maximal flow of 5.0 cms during the summer freshet, resulting in an average annual release of 3 cms (Wright 2004). This regime was modified in early May 2011 to produce an average annual discharge rate of 6 cms, where maximal flows reached ~15 cms during freshet and dropped to ~ 1.5 cms during winter. This 6 cms regime continued until the spring of 2016, when unforeseen circumstances elsewhere in the Bridge system required a Modified Operation. The Modified Operation increased peak flows during freshet, reaching 97 cms in early June, more than a 6-fold increase over the peak flow levels under the 6 cms regime. Winter flows remained unchanged (~1.5 cms) and an average annual flow rate of 21.9 cms was realized. Since then, the Modified Operation regime has continued. In 2018 flows peaked at 102 cms in early July, but in 2019 and 2020 the average flow rate more closely matched the 6 cms flow regime, peaking at ~16 cms.

Prior to the reintroduction of flows through the Terzaghi Dam, it was recognized that passing water down the Lower Bridge River could have considerable consequences on riverine birds. Baseline monitoring was implemented in 1999 and 2000 with a focus on Harlequin Duck, *Histrionicus histrionicus*, in Reach 3 and 4 between the Terzaghi Dam and the Yalakom River (Wright 1998; Wright and Walton 2001a, b). Very few Harlequin Ducks were found (Walton and Heinrich 2015); other riverine bird species recorded included American Dipper (*Cinclus mexicanus*), Common Merganser (*Mergus merganser*), Spotted Sandpiper (*Actitus maculatus*) and Belted Kingfisher (*Ceryle alcyon*). Following these baseline surveys, monitoring in Reaches 3 and 4 has been implemented in most years following similar methods so that the response of riverine birds to flow regime can be assessed (Walton and Heinrich 2015). Since 2012, monitoring been administered as a BC Hydro's Water Licence Requirements riparian vegetation and wildlife monitoring program (BRGMON-11). In 2019, a revision was made to the Terms of Reference for the wildlife component (BRGMON-11B).

In 2015, following three years of monitoring under BRGMON-11 and incorporating data back to 1999, we produced a synthesis report on the response of riverine birds to the various flow regimes in the 14.9 km section below the Terzaghi Dam (Walton and Heinrich 2015). We tested

the original management hypothesis that the population increase of riverine birds in on Reaches 3 and 4 of the Lower Bridge River is directly related to the instream flow release from Terzaghi Dam. We also considered whether species had shifted their distributions upstream or downstream with changing flow conditions. Results indicated that the five resident riverine bird species responded differently to the three flow regimes, and that one flow rate will not equally benefit all species. Therefore, the recommendation was made to use Harlequin Ducks as the main indicator species for riverine bird management. Both the 3 cms and the 6 cms flow regimes appeared to increase usage by Harlequin Duck compared with baseline conditions, and the increased flows appeared to be associated with increased productivity of this species (Walton and Heinrich 2015).

Starting in 2016, the Modified Operations created new conditions for riverine birds by increasing freshet flows above the previous 6 cms regime, but still well below historic levels prior to the regulation of the river (Hall et al. 2009). Riverine birds were monitored during Modified Operations in 2016, 2018, 2019 and 2020 using methods consistent with previous years. This report describes the 2020 survey results from the BRGMON-11B wildlife monitoring program. For riverine birds, the 2020 data are used to update a multi-year analysis.

BRGMON-11 is broadly concerned with how flow regime affects the riverine and riparian ecology for plants and wildlife. During early years, a concern developed that the flows released since 2000 have allowed beavers (*Castor canadensis*) to colonize the Lower Bridge River and to cut down many large black cottonwood trees (*Populus trichocarpa*), an important resource for biodiversity (Polzin and Rood 2000; Rood et al. 2003; Naiman et al. 2005). Because construction of the Terzaghi Dam disrupted cottonwood recruitment (Hall et al. 2009), the recent pressure by beavers on cottonwoods may be negatively impacting riparian habitat; consequently, autumn beaver surveys were conducted in 2016, 2018 and 2019 along Reaches 3 and 4 in order to track beaver distribution over time (Walton and Heinrich 2018a, 2019a, 2020). In 2019, autumn beaver surveys were expanded to include Reach 2. We report results from the 2020 survey of Reach 2 in this report.

2.0 STUDY AREA

The study area is located on the east side of the Coast Mountains in southwestern BC. In this region, moisture is delivered by Pacific frontal systems, which create sizable snowpack in winter, especially near the headwaters of the Bridge River. The Bridge River is approximately 120 km long and flows into the Fraser River, just upstream of Lillooet, BC. It is regulated by two dams: the LaJoie Dam and, approximately 60 km downstream, the Terzaghi Dam, which impounds the Carpenter Lake reservoir. The two dams partition the Bridge River into three main sections: the Upper Bridge River (above LaJoie Dam), the Middle Bridge River (between the dams), and the Lower Bridge River.

The Lower Bridge River has a relatively steep gradient (0.7-3 %) and passes through a long canyon for approximately 41 km until it joins the Fraser River (Bradford et al. 2011). The unregulated Yalakom River flows into the Lower Bridge River 15 km below Terzaghi Dam, adding an average of 4.4 cms of water (Bradford et al. 2011).

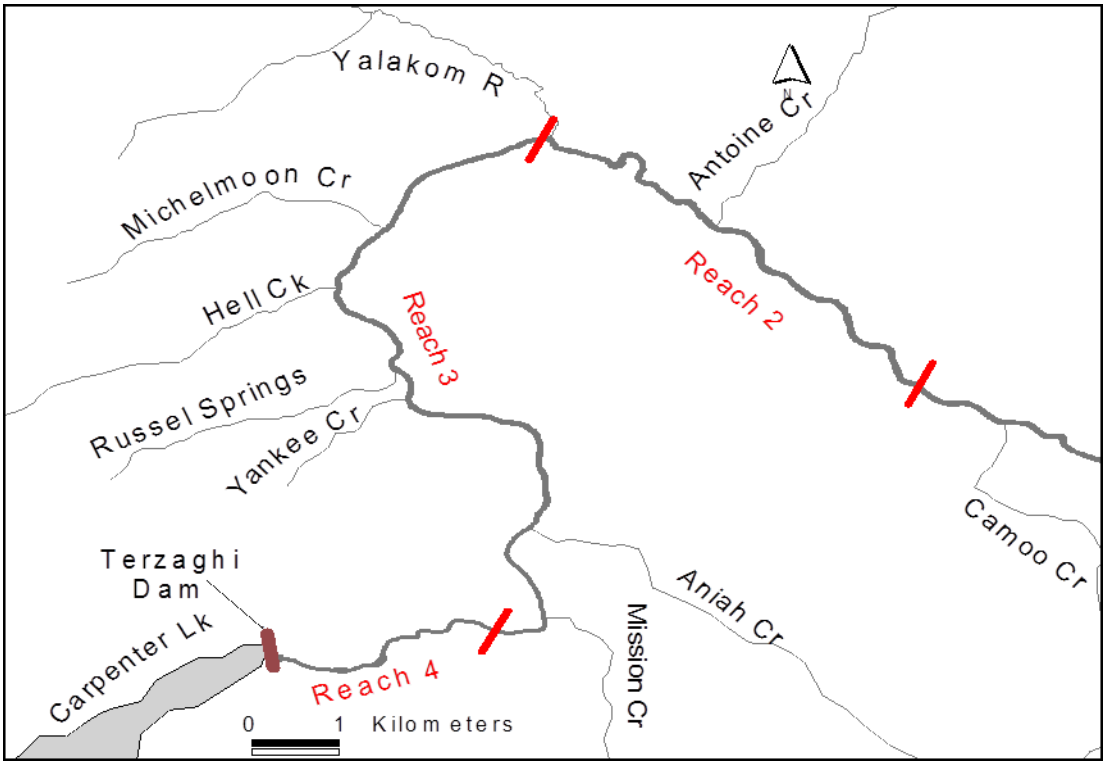

Figure 1. Map of the Main Study Area. Faint lines indicate major creeks. Red lines and text show locations of reaches.

Positioned in the rain shadow of the Coast Mountains, the Lower Bridge River occurs in the IDFxc (Interior Douglas-fir very dry cold zone) biogeoclimatic zone (Meidinger and Pojar 1991).

Riverine bird surveys were conducted from the confluence of the Yalakom River to the base of the Terzaghi Dam, a distance of 14.9 km along the Bridge River (Figure 1). Prior to the controlled release in August 2000, the 3.3 km section below the dam was essentially dry river bed (Reach 4: Bradford et al. 2011). For the next 11.6 km downstream to the Yalakom River confluence (Reach 3: Bradford et al. 2011), the Bridge River was fed by ground water and minor tributaries, averaging a mean annual discharge of 0.7 cms (Bradford et al. 2011). The 2.2 km section from Reach 4 to Aniah Creek (Figure 1) had especially low water levels. Water from the initial flow release in 2000 created pools, riffles and islands, and it flooded much of the river bank vegetation, especially clusters of Sitka alder (*Alnus viridis*), making hiking along the river bank difficult in places. Riffle area increased in Reach 3 by over 25 % at the 3 cms and 6 cms flow regimes and added over 25,000 m^2 of riffle area to the previously dewatered section (Jeff Sneep, *unpubl. data*). More area was flooded at the peak of the large flow increases in 2016 and 2018. In 2019 and 2020, we extended surveys for beavers into Reach 2 (7 km; Bradford et al. 2011) which extends from the Yalakom River to the Camoo bridge (Figure 1).

The release of water through Terzaghi Dam was designed to approximate the timing of the natural spring freshet with some important differences across years (Figure 2). At the 3 cms regime, flow gradually increased for the spring and summer “freshet” beginning in mid-March

until it peaked by mid-June, gradually declining to winter levels by late October. Flows at 6 cms followed the same general pattern, increasing in mid-March to a sustained peak in early June, then declining in early August to winter levels.

After 2015 peak freshet flow rate increased dramatically, peaking at 97 cms and 102 cms in 2016 and 2018, respectively, compared to peak flows of 5 and 15 cms in earlier regimes. By early August both Modified Operations flows had subsided to earlier regime levels. In 2019 and 2020, the flow regime more closely resembled the 6 cms flow, peaking at 15.7 cms on July 24 (Figure 2). In all years, flows increased throughout the Harlequin nesting period. With the exception of the Modified Operation flows in 2016 and 2018, large increases in flow were finished before Harlequins began incubating eggs (Figure 2).

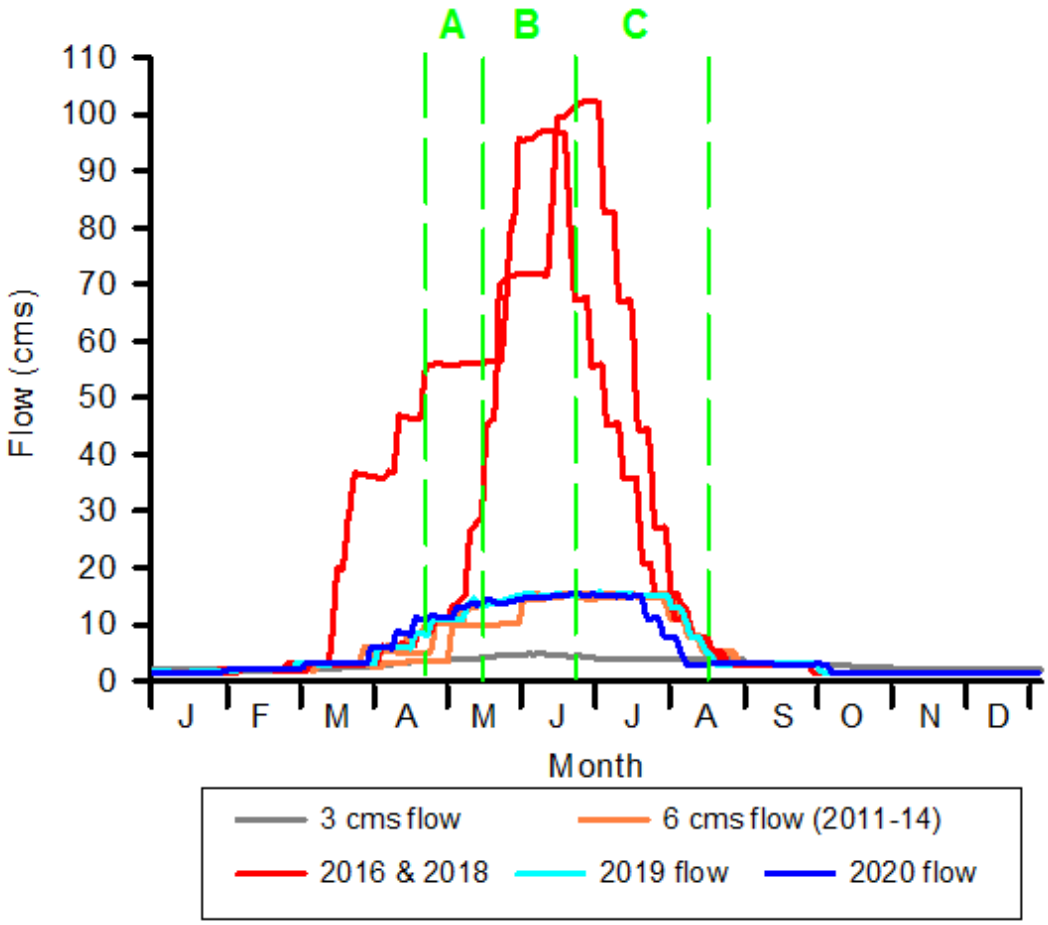

Figure 2. Flow release from the Terzaghi Dam. The grey line is the average 3 cms flow from 2000 to 2004. The 6 cms flow regime began on May 3, 2011 and individual years from 2011-14 are represented by orange lines. Vertical dashed green lines indicate approximate timing for breeding stages for the Harlequin Duck: A = arrival, nest-building and egg-laying; B = incubation; C = brood-rearing.

3.0 METHODS

3.1 Riverine Bird Surveys

3.1.1 Survey Timing

We performed five riverine bird surveys in 2020: two breeding pair surveys and three brood surveys. These surveys began between 8:00 – 9:30 a.m. and finished by 3:00 p.m. Pair surveys were conducted on May 8 and May 20, and brood surveys were done on June 29, July 13 and 27. The seasonal timing of surveys coincided with breeding phenology of Harlequin Ducks (Figure 3) and typically allowed detections of newly hatched broods; however, all riverine species were monitored. Spotted Sandpipers are the last species to arrive on the river and are not usually seen until the final pair survey (Figure 3), therefore we focused our analysis on brood survey numbers for sandpipers.

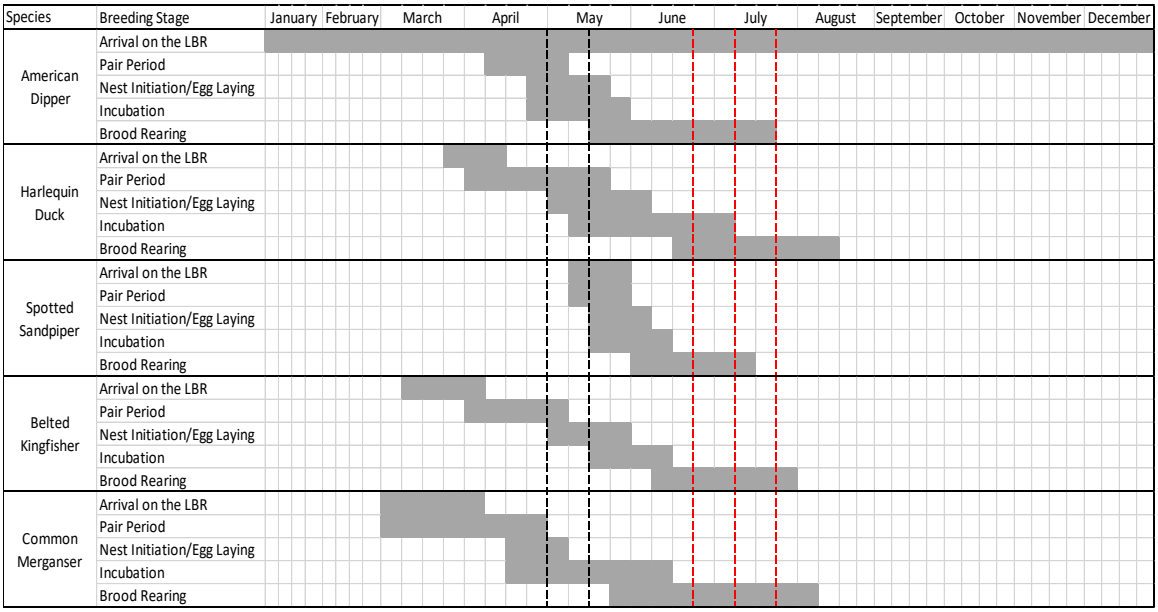

Figure 3. General breeding phenology (based on literature and local knowledge) for the five focal species of riverine birds. The black dashed lines represent the pair surveys and the red dashed lines represent the brood surveys. Some mergansers and kingfishers may be present year-round. (Sources: Robertson and Goudie 1999, Kelly et al. 2009, Willson and Kingery 2011, Reed et al. 2013, Pearce et al. 2015)

3.1.2 Survey Methods

Surveys in 2020 were conducted by two biologists hiking separately in an upstream direction along the western river bank to maximize bird detections. In previous years a technician accompanied each biologist but, due to COVID precautions, no technicians walked the river in 2020. The first biologist began walking upriver at the Yalakom River confluence (Figure 1) and

the second biologist began walking upstream approximately halfway between the Yalakom River and Terzaghi Dam (N 5629418, E 558150 UTM 10). Starting locations for the two biologists (RW and RH) were rotated among surveys to guard against observer bias. Each biologist carried binoculars (10 power) to assist with identification. Survey techniques followed those proposed by the Resources Inventory Committee (RIC 1998).

In 2020, visual coverage was complete except for portions of back-channels on the opposite side of four small islands (approximately 250 m). Initial bird locations were fixed by handheld GPS (Garmin Colorado 300 and Garmin GPSMap64s, accuracies ranged from ± 3m to ± 35m) and later mapped to correspond with Digital Terrain Inventory Mapping (TRIM) features. Since handheld GPS accuracies ranged widely due to steep canyon terrain, TRIM features were used to ensure that field locations were mapped within a reasonable range of known features (e.g., major tributaries). Final bird locations are presented in Appendix 1. Documentation of all mammals, birds, and herptiles observed during the surveys are appended to this report (see Appendix 2), including locations of Northern Alligator Lizards (*Elgaria coerulea principis*) seen incidentally during surveys (Appendix 3; Heinrich and Walton 2018b).

When a bird was spotted, it was kept in sight until the bird moved downstream, the biologist passed it while moving upstream, or the bird flew out of sight upstream. If the bird flew upstream we used two approaches to avoid double-counting. For dippers and sandpipers with relatively short territories, we did not record a new sighting for a species if we saw a single bird within 100 m upstream of the last location; in other words, we would have to see two birds within a 100 m section simultaneously to record two birds. For more mobile species like waterfowl, we noted the age and sex of birds that flew upstream and avoided recording these birds again if we encountered them further upriver. We found birds generally landed within 1-2 km of their last location and, because they were restricted to the river, it was rare not to see the same group again. In practice, most birds flew downstream after being disturbed a couple of times rather than flying upstream beyond Terzaghi Dam. If birds flew upstream or downstream towards the other survey team, we communicated by radio to avoid double-counting.

3.1.3 Analysis of Riverine Bird Data

For analyses, we compared riverine bird numbers as a function of flow regime for Reaches 3 and 4 combined and for Reach 4 by itself (the previously dewatered section). We calculated average numbers of birds observed during pair and brood periods for each survey year. For waterfowl, we also presented the maximum number of pairs and broods seen during pair or brood surveys, respectively. We chose the maximum value rather than presenting averages within a breeding stage because we believe the maximum value better indicates the total number of birds resident on these reaches. We did not present pair and brood counts for other riverine species because these counts are less reliable for species not restricted to the water like waterfowl. It should be noted, however, that not all waterfowl pairs we observed may have remained on the Lower Bridge River to breed. Especially in the first May survey, some waterfowl pairs may have been passing through during migration. Similarly, the maximum number of broods observed during the brood-raising period is not necessarily indicative of the number of broods successfully fledged by the end of the breeding season.

Although complete surveys of Reaches 3 and 4 were done from 2005-2020, this section was not surveyed in its entirety in all years. In the pre-release period in 1999 and 2000, pair and brood surveys only covered the 11.6 km of Reach 3 because Reach 4 was mostly dry river bed (Wright and Walton 2001a, b). For analyses of Reaches 3 and 4 combined, we compared data from these surveys directly to the survey results from 2005 to 2014, including the extra 3.3 km (Reach 4) of previously dry river bed below Terzaghi Dam. We assumed that no riverine birds used Reach 4 prior to the release in August 2000 and that numbers could safely be interpreted as zeros. Surveys of the dewatered section on July 27 and August 3, 1999 supported this assumption (Ken Wright, *unpubl. data*), although 2-3 Spotted Sandpipers may have been using this area. In 2004, we conducted truncated surveys from Aniah Creek to the Terzaghi Dam (Figure 1), primarily to assess riverine bird use of the previously dewatered section (Walton and Heinrich 2004). Walton and Heinrich (2015) provide dates and distances for earlier surveys.

We restricted the riverine bird study to Reaches 3 and 4 of the Lower Bridge River. We did not extend surveys up the Yalakom River, partly due to logistical reasons, but also because the Yalakom River is unregulated and it is not directly influenced by flow release decisions made at the Terzaghi Dam. While smaller tributaries are also present, the Yalakom River is the largest tributary that enters the survey route along the Lower Bridge River (Figure 1). For territorial birds like Belted Kingfisher, Spotted Sandpiper and American Dipper, the surveyed population can be considered "closed," although dippers, especially, may nest short distances away from the river up streams in canyons. Not all dippers may have been present on the river during our surveys.

The "closed" population assumption is not necessarily true for Harlequin Duck and Common Merganser, however. Both species are highly mobile, particularly during brood-rearing, and can potentially enter or leave the study area (e.g., up the Yalakom River or downstream of its confluence with the Lower Bridge River). For example, in 1999 and 2000, when 17 km of the Yalakom River was routinely surveyed, harlequins tended to nest on the Yalakom River and rear their broods on the Lower Bridge River. One banded female routinely flew more than 12 km during incubation breaks from her nest on the Yalakom River to the Lower Bridge River to feed (Wright and Walton 2001a). Although the Yalakom River was most likely used by more mobile species during our surveys, especially during nesting, we believe the numbers of birds we detected on the Lower Bridge River represent the population using the river. This is supported by the consistent number of broods we observed in most years between the first and third brood surveys. However, the "openness" of the system should be considered when interpreting survey results for these species.

3.2 Beavers

3.2.1 Fall Beaver Surveys

On December 6, 2020, two biologists walked the western shoreline between the Yalakom River confluence and Terzaghi Dam (14.9 km) using the same route and approach as that used during summer riverine bird surveys in 2020. On December 7, we used the same methods to survey Reach 2 (7.0 km).

We recorded the number of active beaver lodges based upon the presence of food caches (clumps of freshly cut branches and saplings piled nearby in the water). The presence of a food cache in late autumn is considered the best indicator that a beaver colony is actively using a lodge (MELP 1998).

Bank lodges on both sides of the river were counted. Only beaver lodges with a cache of freshly cut branches and saplings were recorded as being active. Locations of active lodges were fixed by GPS (Garmin handheld receivers, accuracies ranged from ± 3m to ± 35m) and later mapped to correspond with digital TRIM coverage for the Bridge River to compensate for small inaccuracies in location. We additionally documented observations of riverine birds along Reaches 3 and 4. Riverine bird observations followed the same procedures used during breeding season surveys.

4.0 RESULTS

4.1 Riverine Birds

Numbers of focal riverine species observed during the five surveys in 2020 are presented in Table 1. Detailed data and location coordinates for each observation are documented in Appendix 1. No other waterfowl species was observed during any of the five surveys in 2020. One resident Bald Eagle (*Haliaeetus leucocephalus*) was seen on the first two pair surveys, and a single Osprey (*Pandion haliaetus*) was observed on each of the brood surveys.

Numerically, Spotted Sandpiper was the most abundant species, followed by Harlequin Duck, American Dipper, Common Merganser and Belted Kingfisher. No Harlequin Duck pairs were observed during pair surveys in 2020. One harlequin brood was spotted with a female on the June 29th and July 27th surveys, and two broods were seen with females on the July 13th survey. A single pair of Common Mergansers was observed in each of the May surveys but we did not find merganser broods later in the summer.

Table 1. Number of individuals of major riverine bird species observed on the 14.9 km survey route from the Yalakom River confluence to Terzaghi Dam in 2020.

Survey Type	American Dipper	Harlequin Duck	Spotted Sandpiper	Belted Kingfisher	Common Merganser	**Total**
Pair						
May 08	5	0	0	0	5	*10*
May 20	1	1	12	2	3	*19*
Brood						
June 29	4 (1)	9 (7)	8 (2)	2 (0)	1 (0)	*24 (10)*
July 13	5 (0)	8 (4)	11 (0)	0	0	*24 (4)*
July 27	4 (2)	5 (3)	1 (0)	0	0	*10 (5)*
Total	*19 (3)*	*23 (14)*	*32 (2)*	*4 (0)*	*9 (0)*	*87 (19)*

Values are totals of adults and juveniles combined. Numbers in parentheses indicate the number of juveniles observed.

4.1.1 Harlequin Duck Response

Adult Harlequin Duck numbers during pair surveys were variable across years (Figure 4a). Despite this variability, adult harlequin numbers have generally increased since the release in 2000, with a tendency for more harlequins to be seen at the 6 cms flow regime than at the 3 cms flow (Figure 4a). Since higher flows began with the Modified Operations, harlequin numbers have declined compared with results obtained during the 6 cms flow. This relative decline continued in 2020, despite this being the second consecutive year in which flow rates were similar to the 6 cms flow regime (Figure 2).

During the brood-raising period, the number of harlequins increased almost linearly from pre-release levels until 2008, when overall numbers appeared to plateau at approximately 10 birds per survey, with the exception of a dip in numbers in 2013 (Figure 4b). This translates to approximately 2-4 harlequin females raising young on this section of river each year. This pattern continued in the first high flow survey in 2016. The total number of harlequins dropped in 2018 during our second high flow brood survey, and declined even further in 2019 when flows were more similar to the 6 cms flow regime. In 2020, overall harlequin numbers more closely resembled numbers from previous survey years (Figure 4b).

The maximum number of harlequin pairs observed on a pair survey was highly variable over the years, ranging from no observations to a maximum of 6 pairs (Figure 4c). In 2020, for the first time since 2006, we did not observe any harlequin pairs during our May surveys. However, we found two harlequin broods in 2020 (Figure 4d). These brood observations followed two consecutive years in which broods were not detected on the Lower Bridge River.

Harlequin Ducks have used the previously dewatered section of Reach 4 during both the pair and brood-rearing periods. While harlequin numbers appeared to increase during the 6 cms flow on Reach 4 during the pair period (Figure 4e), the numbers are highly variable among years, probably reflecting the relatively small (3.3 km) length of this reach on which to find birds. No harlequins were observed on Reach 4 during May surveys in 2020. For the fourth consecutive survey year, Harlequins used Reach 4 during the brood-rearing period in 2020 (Figure 4f).

Harlequins are not present on the Lower Bridge River during late autumn beaver surveys.

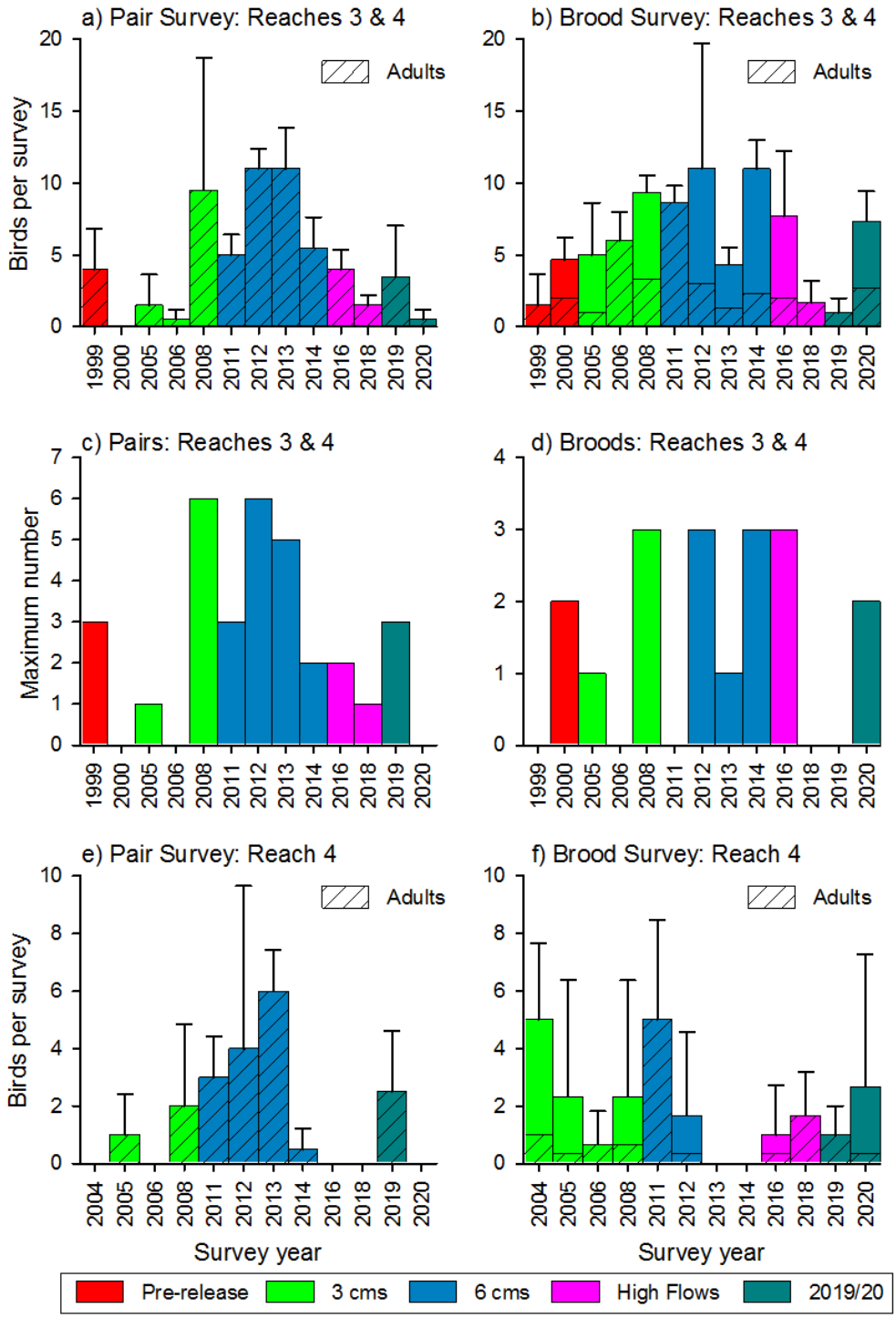

Figure 4. Average number (4a,b) of Harlequin Ducks per survey (± 1 SD) and maximum number of pairs and broods observed (4c,d) in Reaches 3 and 4 combined during pair and brood surveys. Average number (4e,f) of Harlequin Ducks per survey (± 1 SD) in Reach 4 only during pair and brood surveys. Modified Operations occurred from 2016 through 2020.

4.1.2 American Dipper Response

Dipper numbers are highly variable during the pair period (Figure 5a). Although no overall trend or pattern is apparent across all years, dipper numbers in three of the last four survey years have been among the lowest numbers recorded since surveys began in 1999. Dipper numbers in 2020 matched numbers seen during pair surveys in 2019.

Dippers are the only resident riverine bird species studied with at least one juvenile observed in all survey years, and this trend continued in 2020. Juvenile production was similar in 2020 to other survey years across all flow regimes (Figure 5b).

Dippers used Reach 4 in both the pair and brood periods (Figures 5c, d). Dipper numbers are especially consistent in Reach 4 during the brood-raising period (Figure 5d). Juvenile dippers have been observed in this reach in all survey years except 2008 and 2020.

On the December 6^{h} beaver food cache survey, we observed 25 dippers along Reaches 3 and 4. This number was a substantial decline from the 41, 40 and 46 dippers we counted during late autumn surveys in 2016, 2018 and 2019, respectively.

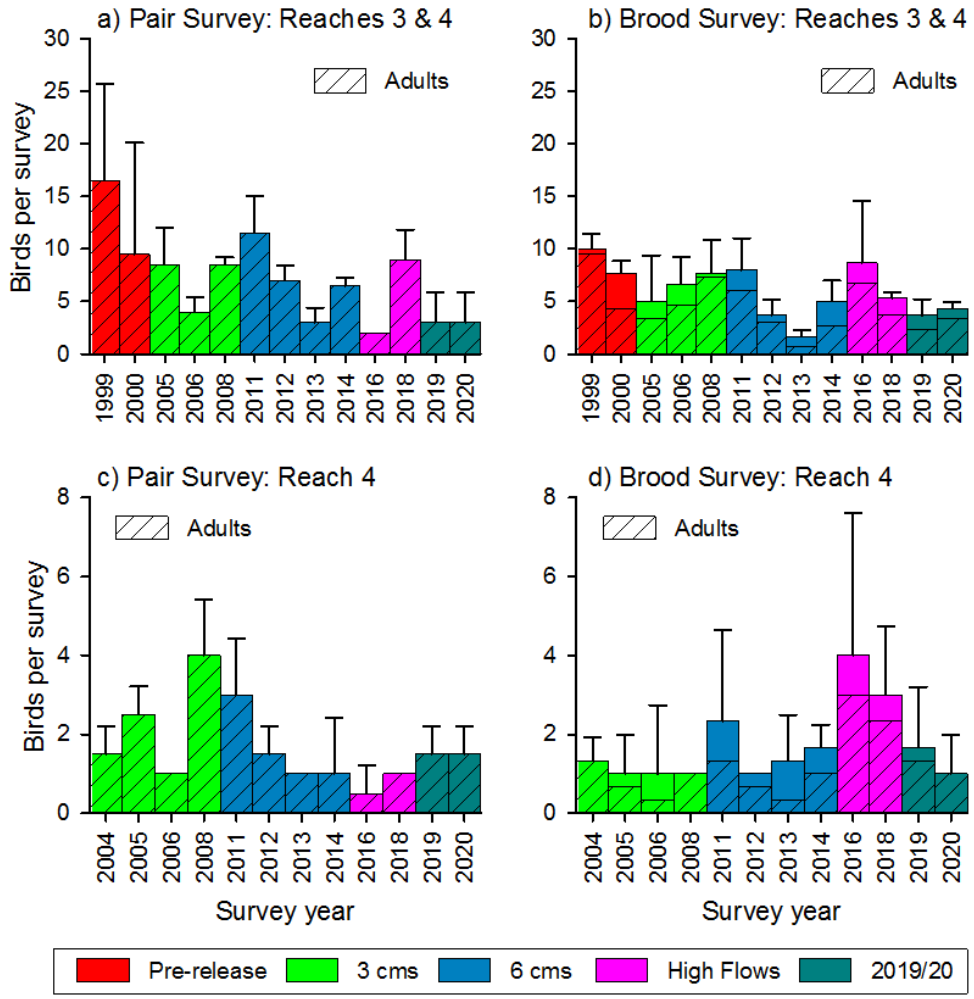

Figure 5. Average number of American Dippers per survey (± 1 SD) in Reaches 3 and 4 combined (4a, b) and in Reach 4 only (4c, d) for pair and brood surveys.

4.1.3 Common Merganser Response

At the 3 cms and 6 cms flow regimes, the number of Common Mergansers observed remained stable during the pair survey period (Figure 6a). In 2016, the first year of Modified Operations, we observed a historically low count of mergansers (8.5 mergansers per survey). This count dropped to 5.5 birds per survey during the pair period in 2018. In 2019 we only observed a total of one merganser across both pair surveys, but merganser numbers rebounded somewhat in 2020, although average numbers were still unusually low (Table 1; Figure 6a). Since surveys began in 1999, adult mergansers have been observed during the brood-rearing period in all years except 2018 and 2019, continuing an apparent decline beginning with the onset of the Modified Operations (Figure 6b). In 2020, we observed one female merganser during our first brood survey.

For the third consecutive survey year, we found no juvenile mergansers in 2020 (Figure 6b). Since Modified Operations began, we have only seen one young merganser (2016) being raised on the Lower Bridge River. While we acknowledge the high variability in merganser brood production among years (no broods were found in 1999 and 2013 as well), we have found exceptionally low numbers of young mergansers on surveys since Modified Operations began. Lack of juvenile production, combined with low numbers for adult mergansers during the pair and brood survey periods since 2014, suggests that high flows may be adversely affecting merganser use of the Lower Bridge River during breeding season, despite flows more closely resembling the 6 cms flow regime in 2019 and 2020.

In most years, we found 2-4 pairs of mergansers during pair surveys (Figure 6c). Pair numbers remained relatively stable until 2016, but were lower in 2018, 2019 and 2020. Brood counts of mergansers can be difficult because mergansers are known to crèche their young, and a single female can watch over a large number of young from multiple broods (Pearce et al. 2015). In 2004, for instance, we observed a female merganser with a brood of 19 young. Despite this, we have consistently observed at least one or two merganser broods along Reaches 3 and 4 during brood surveys prior to 2018 (Figure 6d). Since the first Modified Operations brood surveys in 2016, no merganser broods have been found.

Prior to 2019, adult mergansers had been observed using Reach 4 every survey year consistently. In 2020, for the second consecutive year, we did not detect any mergansers using Reach 4 during the pair surveys (Figure 6e). Use of Reach 4 during the brood-rearing period has been more variable historically (Figure 6f). In 2020, we found a single female merganser using Reach 4 on the first brood survey, the first observation during this time brood-rearing period since 2016 (Figure 6f).

During autumn beaver food cache surveys on December 6th, we saw a single female merganser. Late autumn merganser numbers appear to be highly variable on the Lower Bridge River. During 2016, 2018 and 2019 autumn surveys, we saw 5, 0 and 25 mergansers, respectively.

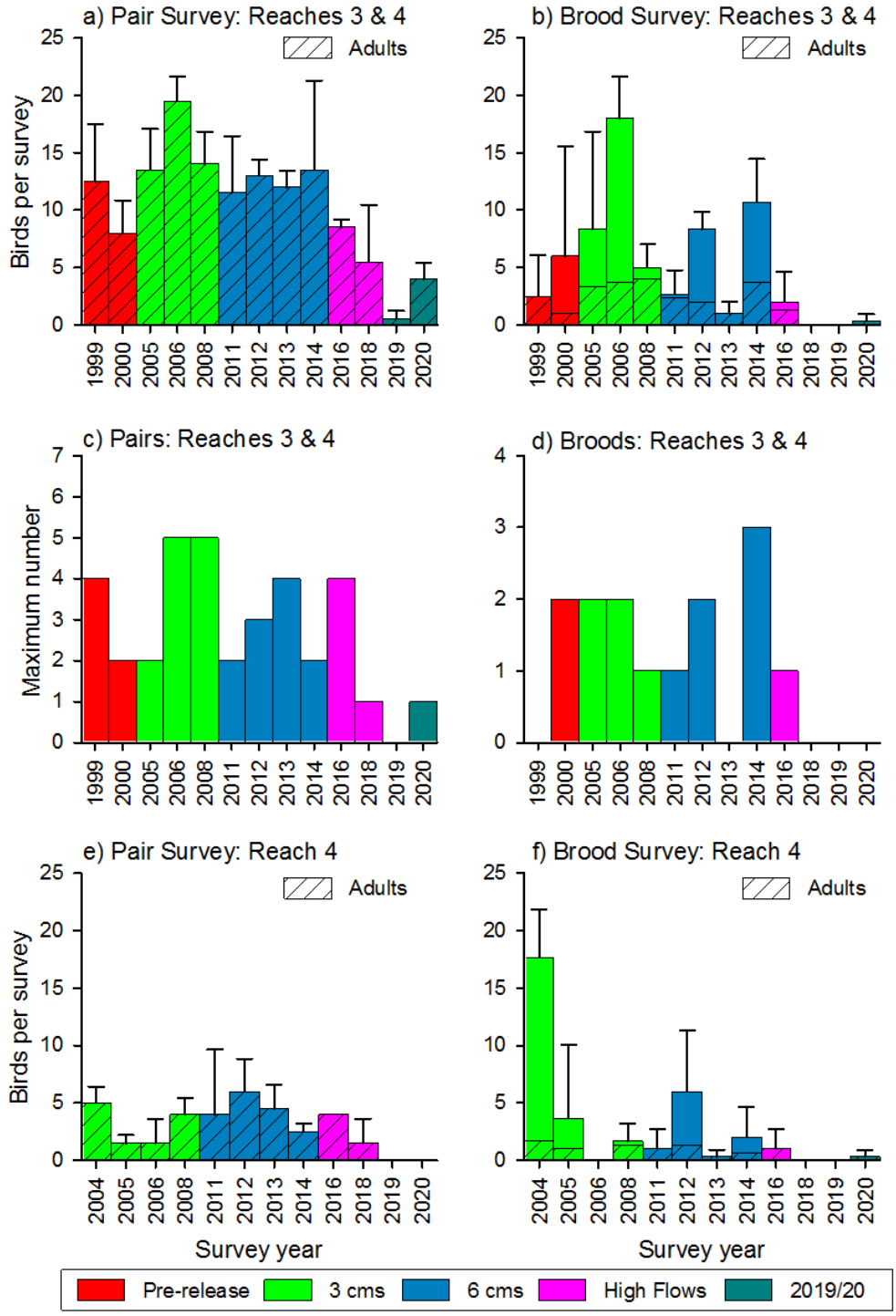

Figure 6. Average number (6a,b) of Common Mergansers per survey (± 1 SD) and maximum number of pairs and broods observed (4c,d) in Reaches 3 and 4 combined during pair and brood surveys. Average number (6e,f) of Common Mergansers per survey (± 1 SD) in Reach 4 only during pair and brood surveys.

4.1.4 Spotted Sandpiper Response

Spotted Sandpipers more than doubled their numbers in 2005 and their numbers remained elevated during the 3 cms flow regime (Figure 7b). When the 3 cms flow regime ended, the time series suggest that Spotted Sandpiper numbers became reset at a lower population size. Sandpiper numbers do not appear to have been affected by flows of the Modified Operations, although sandpiper numbers are the lowest since surveys began in 1999 in two of the last three survey years.

Sandpiper use of Reach 4 mirrors the trend observed for Reaches 3 and 4 combined, with higher numbers of sandpipers being found on Reach 4 at the 3 cms flow than at other flow regimes (Figure 7d). In 2019 and 2020, when the flow was similar to the 6 cms flow regime (Figure 2), sandpiper numbers were similar to numbers observed from 2011 to 2014.

Sandpipers are not present on the Lower Bridge River during late autumn beaver food cache surveys.

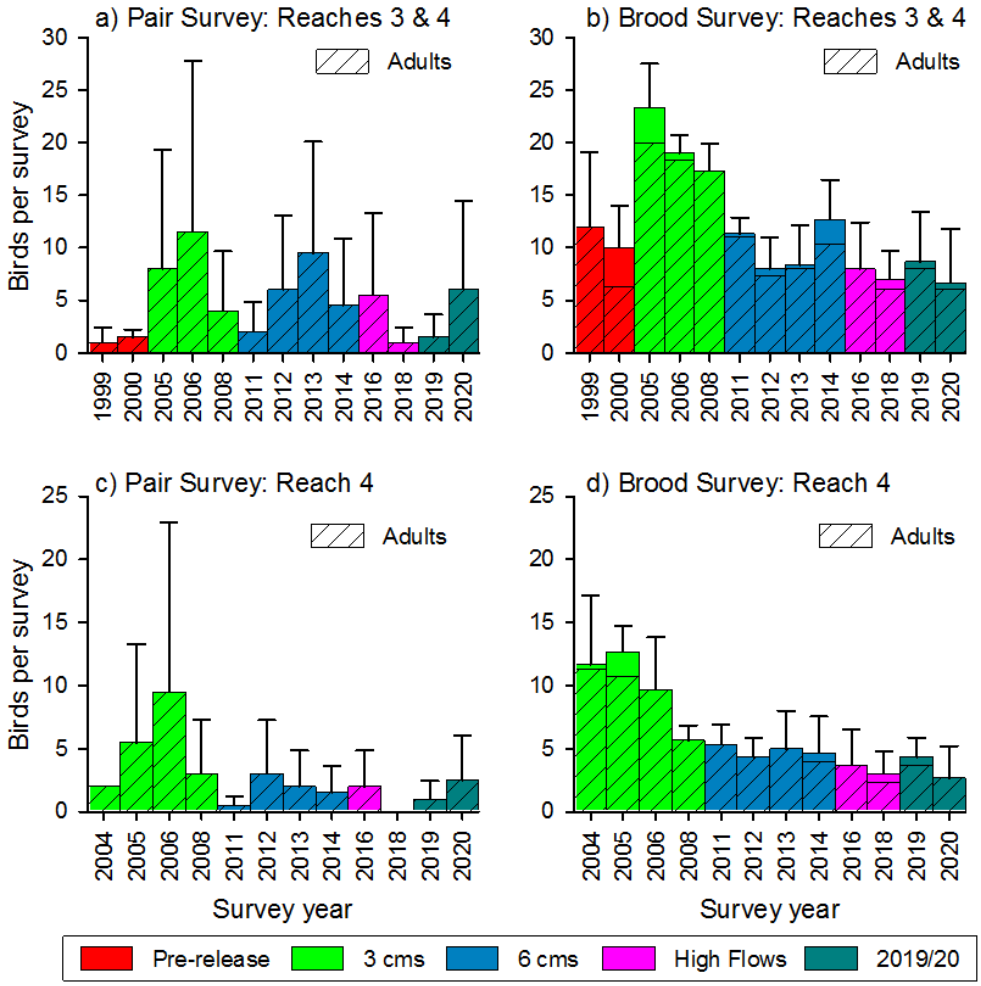

Figure 7. Average number of Spotted Sandpipers per survey (± 1 SD) in Reaches 3 and 4 combined (4a, b) and in Reach 4 only (4c, d) for pair and brood surveys.

4.1.5 Belted Kingfishers

We observed two Belted Kingfishers during pair and brood surveys in 2020 (Table 1). Kingfisher observations are highly variable among survey years during both breeding stages (Figure 8a,b), but kingfisher numbers in 2020 appear to be more similar to numbers observed during the 6 cms flow from 2011-2014.

In all years, kingfisher use of Reach 4 was highly variable (Figure 8c,d). Kingfishers were observed in Reach 4 during both breeding periods.

We saw one kingfisher during the December 6th beaver food cache survey. This is similar to our results from similar surveys when we observed 2 kingfishers in 2016 but no kingfishers in 2018 and 2019.

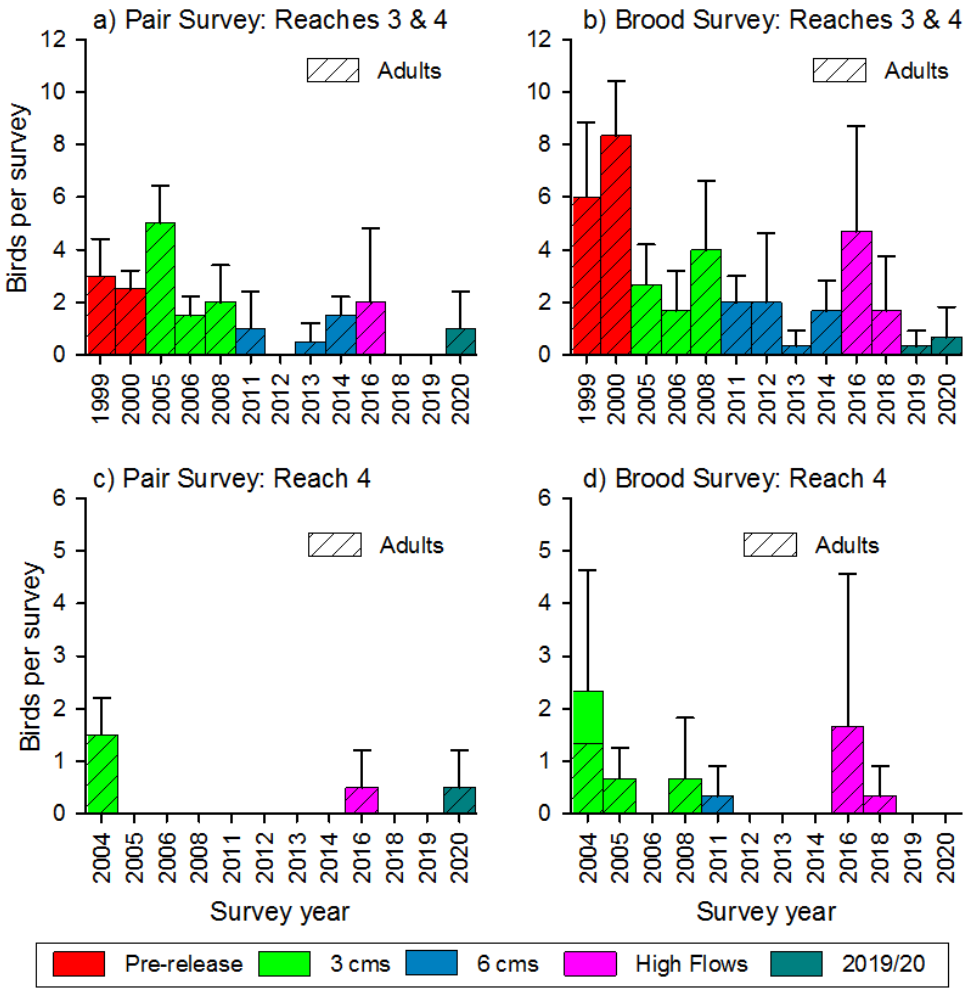

Figure 8. Average number of Belted Kingfishers per survey (± 1 SD) in Reaches 3 and 4 combined (4a, b) and in Reach 4 only (4c, d) for pair and brood surveys.

4.2 Beavers

4.2.1 Number of Active Beaver Colonies

We found five active beaver lodges with food caches along Reaches 3 and 4 during our December 6th shoreline survey, giving a linear density of 0.34 beaver colonies per km of river (Figure 9). This count was consistent with the six active lodges we found in 2016 and 2019 and the five active lodges in 2018. Only one of the six lodges was located in Reach 4 in 2020. Two of the lodges had also been occupied in 2019.

On December 7th, we conducted a shoreline survey along Reach 2 for the second year. We found four active beaver lodges, giving a linear density of 0.57 beaver colonies per km of river (Figure 9). Three of these lodges were also active in the previous winter. An example of a larger lodge and food cache is shown in Figure 10.

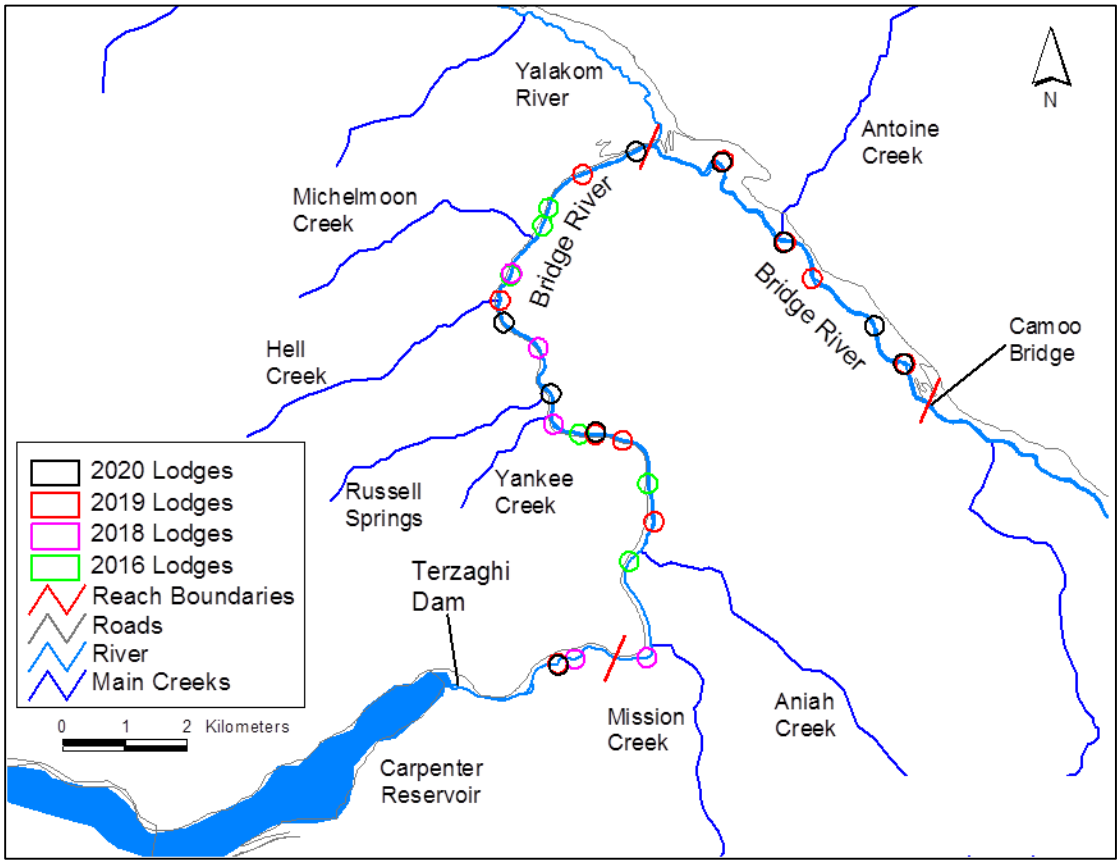

Figure 9. Location of active beaver lodges in late autumn surveys in 2016, 2018, 2019 and 2020.

Figure 10. Beaver lodge and food cache in Reach 2. Fresh mud is visible on the lodge.

5.0 DISCUSSION

5.1 Riverine Birds

All five resident riverine bird species used the 14.9 km section below Terzaghi Dam to the Yalakom River confluence for at least part of their breeding stages throughout all years of the study. Sandpiper and dipper nests were occasionally detected along this section. Although harlequin nests were found on the Lower Bridge River after the release in 2000 (Ken Wright, *pers. comm.*), previous work (Wright and Goudie 2000; Wright and Walton 2001a) suggested that some harlequins nested on the Yalakom River and moved their young to the Lower Bridge River for brood-rearing. Common Mergansers, a cavity-nesting species, probably nests along our survey route where trees with appropriate cavities were available, and their numbers may be limited by this availability. In autumn 2019, 10 nest boxes for Common Mergansers were installed along Reaches 2, 3 and 4 (Fowler 2020). No merganser broods were observed on Reaches 3 and 4 in 2020 which suggests that, in the first year at least, the addition of nest boxes

did not affect merganser use. In future years, however, as birds discover the nest boxes, the breeding population may be affected.

The high flow regime from Modified Operations may have had a negative effect on habitat suitability for both resident waterfowl species. Numbers for both harlequins and mergansers declined in 2016 and 2018 during pair surveys under extremely different operations, and this decline persisted in 2019 and 2020, despite flows being similar to the 6 cms flow regime in both years. Adult mergansers were absent from brood surveys in 2018 and 2019, and we found only a single female merganser in 2020. The absence of adult mergansers during the brood-rearing period and the lack of broods for three consecutive summers suggest that habitat conditions may have deteriorated for mergansers on the Lower Bridge River during the breeding season. Harlequin numbers rebounded somewhat during pair surveys in 2019 but were still unusually low in 2020. For the first time in three summers, however, harlequin broods were detected in 2020, although only one brood of three harlequin young were found on the last brood survey. It is unlikely that nest flooding from rapidly increasing flows alone can explain the recent decline in overall waterfowl numbers. Mergansers nest in tree cavities and harlequins, although ground nesters, experienced earlier peak flows and lower flow levels in the last two breeding seasons compared with conditions in 2016 and 2018. Walton and Heinrich (2020) expressed concern that there could be a lag effect for waterfowl after Modified Operations whereby recovery could take several years following a return to previous conditions. After two years with more typical flows, this concern remains for mergansers but the presence of harlequin broods in 2020 is encouraging.

Rapidly rising and dropping water levels during the breeding season may have affected the production of aquatic macroinvertebrates that harlequins and dippers largely prey upon (Kingery 1996, Robertson and Goudie 1999). Harlequin densities tend to depend on the availability of aquatic invertebrates (LeBourdais et al. 2009) although this relationship can be weak (e.g., Esler et al. 2007) or non-existent (Cassirer and Groves 1994). Prior to the high flows of the Modified Operations, the response by the aquatic invertebrate community to increased flows was variable in Reach 3, with most differences coming between pre-release levels and the 3 cms and 6 cms flows (Jeff Sneep, *pers. comm.*). Sampling with fall baskets suggested a tendency for the total abundance of benthic invertebrates to decline on Reach 3 at higher flow levels, although this was compensated to some degree by their colonization of Reach 4 (Jeff Sneep, *pers. comm.*). Compared to other local rivers, aquatic invertebrate numbers were exceptionally high during the 3 cms flow period (LeBourdais et al. 2009), suggesting that aquatic invertebrates were likely not limiting harlequins or dippers during either period prior to the Modified Operations.

In 2016 we expressed concern about the effect of the timing of flow changes on aquatic invertebrate abundance (Walton and Heinrich 2018a). The last large increase in flow began during the incubation period, peaked for approximately three weeks, and then declined precipitously in mid-June as young birds appeared on the river. A similar pattern occurred in 2018. Since aquatic invertebrate abundance is negatively affected by high variability in flow (LeBourdais et al. 2009) and the unusually high water levels were expected to scour previously unflooded shoreline, increasing sedimentation, it was unclear if aquatic invertebrates would be available for young riverine birds. To study this, we sampled aquatic invertebrates at the beginning of the brood-rearing period in Reaches 3 and 4 in 2016 and found that invertebrate density was similar to that studied by LeBourdais et al. (2009) during the 3 cms flow (Walton

and Heinrich 2018a). Three Harlequin Duck females raised a total of nine young in 2016 on Reaches 3 and 4, suggesting that invertebrate availability was not an important limitation. However, the absence of harlequin broods in 2018 and 2019 raised the possibility that there may have been a delayed lag effect in the response of aquatic invertebrates to the increasing flows in 2016 and 2018 (Walton and Heinrich 2020). The presence of two harlequin broods in 2020 suggests that if there was a negative lag effect for aquatic invertebrates in response to Modified Operations, its effects may be waning after two summers with more typical flows. A negative lag effect on fish for mergansers may explain declining merganser numbers. Of course, reasons unrelated to flow changes may also be affecting brood numbers for waterfowl. With only two years of high flow surveys and two subsequent years at more typical flows, the sample is too small to draw strong conclusions.

Dippers appear to be relatively insensitive to different flow regimes on the Lower Bridge River. We often saw dippers flying up tributaries from the river, particularly at Hell Creek and Aniah Creek, presumably returning to nests on the canyon walls. Because dippers nest on rock faces, both on the Lower Bridge River and along tributaries, their nests are generally immune from flooding at high flow levels. Where their territories encompass tributaries along the river, tributaries also provide an alternative source of aquatic invertebrates for feeding. Adult dippers will continue to feed young after fledging (Willson and Kingery 2011), and we routinely witnessed adults feeding young at the end of July. Unlike harlequin young that are self-feeding after hatching (Robertson and Goudie 1999), extended parental care gives young dippers the advantage of being fed by more experienced adults when foraging conditions are difficult. It is also possible that flow regime changes differentially affected harlequin and dipper brood-rearing habitat. Although we can only hypothesize about the reasons, dippers appear to be more resilient than other riverine birds to potential negative effects from changing flow regimes.

Spotted Sandpiper numbers were highest at the 3 cms flow regime. Although there are minor fluctuations, sandpiper numbers were similar at all other flow regimes experienced during this study, suggesting that, like dippers, sandpipers are relatively insensitive to flow changes along the Lower Bridge River. Sandpipers nest on the ground and, as the last of the major riverine species to arrive on the Lower Bridge River, sandpipers could be vulnerable to nest flooding during any steep flow increases between late May and early July. Unlike harlequins that generally nest within 10 m of water on low-lying islands (Robertson and Goudie 1999), however, sandpiper nests are usually built within 100 m of water (Reed et al. 2013), offering them more locations to nest and potentially making them less vulnerable to nest flooding. Sandpipers feed on a wide variety of terrestrial and aquatic animals along the shoreline (Reed et al. 2013), suggesting that food availability is not as limiting for sandpipers as it is for riverine birds restricted to feeding in water. Reed et al. (2013) note, however, that dense shoreline vegetation can inhibit foraging by young sandpipers, and this may be an issue where flows have recently flooded the shoreline.

In 2016, we did not see other waterfowl species during pair surveys for the first time since surveys began in 1999 (Heinrich and Walton 2018a). Typically, goldeneye (*Bucephela spp)*, scaups (*Athya spp*), bufflehead and other waterfowl are seen in May, presumably stopping during migration on their way to nesting areas. Since 2016, we have only observed a single female bufflehead during breeding seasons surveys in 2018, 2019 and 2020. Recent stream

modifications made by recent high flows may have made conditions less desirable for waterfowl adapted to calmer lakes and ponds. This is unlikely to have a significant effect on other waterfowl populations, however, since the Lower Bridge River was not used for nesting by these species in previous years.

Of the five main riverine species studied, kingfishers are the most difficult to survey. Most often we saw kingfishers while they were flying from a tree perch along the river. As a result of these fleeting glimpses, juveniles were difficult to identify and their numbers should be treated cautiously in this study. Kingfisher numbers were relatively low in 2018, 2019 and 2020, but within the range of high variability experienced at other flow regimes. Kelly et al. (2009) note that high turbidity can interfere with the kingfisher's ability to hunt prey, causing birds to abandon fishing areas. The increase in turbidity accompanying the flow release may explain why we saw kingfishers more often before 2000 than after, although difficulty in monitoring kingfishers precludes any strong statements.

One caveat for our study is that higher flows inundate the shoreline, making it more difficult to spot birds, and this may have created a bias towards underestimating bird numbers during 2016 and 2018 especially. While we cannot discount this possibility, repeated surveys during each breeding stage provide some protection against this bias. Surveys were also conducted across a wide range of flow rates, not just at times of peak shoreline flooding. However, at all flow rates, numbers of juvenile sandpipers, kingfishers and, to some extent, dippers, are likely underestimated during brood surveys. These birds were often observed very briefly, not allowing enough time for positive age identification. Kingfishers, in particular, were usually observed in flight and their juvenile (and probably adult) count will be underrepresented.

Unlike in natural river systems, the timing and rate of flow of water through the Lower Bridge River is artificially controlled. Under the high flow regime of Modified Operations, flows increased steeply in mid-May and declined quickly in early July, generally mimicking the hydrograph for Reach 3 generated by small tributaries prior to the controlled release in 2000 (Bradford et al. 2011). In 2019 and 2020, peak flow plateaued by early June and stayed level throughout July. For ground-nesting birds, the timing of flow increases can influence the possibility of nest flooding, as we witnessed for harlequins in 1999 (Wright and Walton 2001a). However, nesting strategies of all five riverine species have evolved under natural hydrographs with high annual variability, and ground-nesting birds like harlequins should be able to adapt to the high flow regime. Immediate and lag effect-caused declines in food availability following Modified Operation flows may be more limiting to riverine birds. Regular monitoring of all riverine birds, especially waterfowl, will be important to determine if the general decline in birds observed since 2016 continues.

In winter, dippers are the most prevalent riverine bird species on the Lower Bridge River, being found at much higher densities than during the breeding season (Heinrich and Walton 2018c). In 2019, we recorded similar numbers of dippers as we had recorded in 2016 and 2018, suggesting that winter conditions for dippers are stable across multiple flow regimes. These consistent dipper counts argue against the presence of negative lag effects on aquatic invertebrate populations from the 2016 and 2018 high flows, at least for invertebrate species preyed upon by dippers in winter. In 2020, however, winter dipper numbers were almost half of the number of

dippers observed in previous survey years. Unusually mild temperatures in autumn 2020 may have contributed to the decline in dipper numbers, but it may be prudent to do a conduct another late autumn survey in 2021 to rule out a shift in the overwintering dipper population.

Because there were few years of monitoring under the various flow regimes, additional years of monitoring would allow greater confidence interpreting the strength of trends present in the multi-year dataset.

5.2 Beavers

5.2.1 Number of Active Beaver Colonies

Since we began surveys in 2016, the number of active winter beaver lodges on Reaches 3 and 4 of the Lower Bridge River has alternated between five and six lodges. The number of active lodges, however, does not always reflect the number of beavers in the population (Hay 1958, MELP 1998). For example, we suspect that at least one of the lodges in 2020 housed a solitary beaver. This small lodge in Reach 4 was built in the crack along the edge of a large boulder on shore and was also occupied in 2019 (see Figure 10 in Walton and Heinrich 2020). Without using mark-recapture techniques or conducting more intensive observations, it is difficult to speculate on the actual number of overwintering beavers on Reaches 3 and 4. Based on the consistency of the number of active lodges among surveys, however, the population appears to be stable on these two reaches.

In 2020 we conducted a second survey of active beaver lodges along Reach 2, following the initial baseline survey done in 2019. We found four active lodges in both years. Lodge densities on Reach 2 were similar to those found on Reaches 3 and 4 (approximately one beaver lodge every 2 km). The most upstream lodge was located outside of the main river channel, in an adjacent backchannel pond in the Horseshoe area; this lodge was also occupied in 2019.

Because dedicated beaver lodge surveys only commenced during Modified Operations, it is unclear how flows affect beaver distribution in the study area. Additional survey data in years of differing operations are likely required before the relationship between flow regime and beaver distribution can be assessed with confidence. These surveys have the added benefit of providing an extra riverine bird survey in late autumn-early winter. We believe the number of dippers, in particular, is a useful indicator of ecosystem health on the Lower Bridge River in winter, and dipper numbers provide some indication of the influence of dipper feeding on salmon eggs and alevin.

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APPENDIX 1

Appendix 1. Detailed riverine bird observations from the 2020 survey.

Coordinates are UTM Zone 10, NAD 83. Species codes: AMDI = American Dipper; BAEA = Bald Eagle; BEKI = Belted Kingfisher; COME = Common Merganser; HADU = Harlequin Duck; OSPR = Osprey; SPSA = Spotted Sandpiper.

Date	Survey	Species	M	F	Unknown Sex	Adult Group Size	Brood Size	Easting	Northing
08-May-20	1st Pair	BAEA	0	0	1	1	0	558217	5629115
08-May-20	1st Pair	AMDI	0	0	1	1	0	557995	5628596
08-May-20	1st Pair	COME	0	2	0	2	0	557796	5628373
08-May-20	1st Pair	COME	2	1	0	3	0	557750	5628208
08-May-20	1st Pair	AMDI	0	0	1	1	0	558184	5627120
08-May-20	1st Pair	AMDI	0	0	1	1	0	557034	5626941
08-May-20	1st Pair	AMDI	0	0	1	1	0	555109	5626471
08-May-20	1st Pair	AMDI	0	0	1	1	0	556346	5631842
08-May-20	1st Pair	COME	2	0	0	2	0	556439	5631401
20-May-20	2nd Pair	BAEA	0	0	1	1	0	558145	5634958
20-May-20	2nd Pair	HADU	0	1	0	1	0	556800	5634373
20-May-20	2nd Pair	COME	0	1	0	1	0	556567	5634043
20-May-20	2nd Pair	SPSA	0	0	1	1	0	556322	5633492
20-May-20	2nd Pair	SPSA	0	0	1	1	0	555757	5632501
20-May-20	2nd Pair	BEKI	1	0	0	1	0	556587	5630763
20-May-20	2nd Pair	SPSA	0	0	1	1	0	558206	5629202
20-May-20	2nd Pair	SPSA	0	0	1	1	0	558223	5629037
20-May-20	2nd Pair	SPSA	0	0	1	1	0	557834	5628441
20-May-20	2nd Pair	SPSA	0	0	1	1	0	557839	5628012
20-May-20	2nd Pair	COME	1	1	0	2	0	558192	5627085
20-May-20	2nd Pair	SPSA	0	0	1	1	0	558118	5626947
20-May-20	2nd Pair	BEKI	0	0	1	1	0	557359	5627074
20-May-20	2nd Pair	SPSA	1	1	0	2	0	555981	5626330
20-May-20	2nd Pair	AMDI	0	0	1	1	0	555582	5626309
20-May-20	2nd Pair	SPSA	0	0	1	1	0	555268	5626423
20-May-20	2nd Pair	SPSA	1	1	0	2	0	555026	5626468
29-Jun-20	1st Brood	HADU	0	1	0	1	0	558202	5629391
29-Jun-20	1st Brood	AMDI	0	0	0	0	1	557872	5626915
29-Jun-20	1st Brood	HADU	0	1	0	1	7	557379	5627072
29-Jun-20	1st Brood	COME	0	1	0	1	0	557176	5627104
29-Jun-20	1st Brood	SPSA	0	0	1	1	0	556717	5626921
29-Jun-20	1st Brood	AMDI	0	0	2	2	0	556708	5626913
29-Jun-20	1st Brood	SPSA	0	0	1	1	0	556219	5626397

Date	Survey	Species	M	F	Unknown Sex	Adult Group Size	Brood Size	Easting	Northing
29-Jun-20	1st Brood	OSPR	0	0	1	1	0	555789	5626279
29-Jun-20	1st Brood	SPSA	0	0	1	1	0	555389	5626346
29-Jun-20	1st Brood	SPSA	0	0	1	1	0	558210	5634962
29-Jun-20	1st Brood	SPSA	0	0	1	1	0	557966	5634901
29-Jun-20	1st Brood	BEKI	1	0	0	1	0	557646	5634730
29-Jun-20	1st Brood	SPSA	0	0	1	1	0	557572	5634708
29-Jun-20	1st Brood	BEKI	0	0	1	1	0	556826	5634388
29-Jun-20	1st Brood	AMDI	0	0	1	1	0	555761	5632584
29-Jun-20	1st Brood	SPSA	1	1	0	2	2	556437	5631403
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	558210	5634962
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	557627	5634721
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	557427	5634651
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	557101	5634519
13-Jul-20	2nd Brood	HADU	0	1	0	1	1	556808	5634380
13-Jul-20	2nd Brood	HADU	0	2	0	2	0	556798	5634369
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	556072	5633240
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	555949	5632963
13-Jul-20	2nd Brood	AMDI	0	0	1	1	0	555755	5632489
13-Jul-20	2nd Brood	HADU	0	1	0	1	3	556860	5630470
13-Jul-20	2nd Brood	AMDI	0	0	1	1	0	558179	5628934
13-Jul-20	2nd Brood	OSPR	0	0	1	1	0	557754	5628132
13-Jul-20	2nd Brood	AMDI	0	0	1	1	0	558142	5626946
13-Jul-20	2nd Brood	AMDI	0	0	1	1	0	557942	5626922
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	556702	5626886
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	556275	5626505
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	556213	5626402
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	555954	5626318
13-Jul-20	2nd Brood	AMDI	0	0	1	1	0	555953	5626317
13-Jul-20	2nd Brood	SPSA	0	0	1	1	0	555049	5626505
27-Jul-20	3rd Brood	HADU	0	1	0	1	0	558207	5629327
27-Jul-20	3rd Brood	AMDI	0	0	1	1	2	558207	5629305
27-Jul-20	3rd Brood	OSPR	0	0	1	1	0	555854	5626288
27-Jul-20	3rd Brood	AMDI	0	0	1	1	0	555768	5632533
27-Jul-20	3rd Brood	HADU	0	1	0	1	3	556481	5631541
27-Jul-20	3rd Brood	SPSA	0	0	1	1	0	556482	5631495

APPENDIX 2

Appendix 2. List of wildlife species encountered during riverine bird surveys conducted between May 8th and July 27th, 2020.

Mammals (Eder and Pattie 2001)

Common Name	Latin Name	Provincial List	COSEWIC[1]	Identified Wildlife	Bridge R. Status
Mule Deer	*Odocoileus hemionus*	Yellow	N/A	No	Resident
Red Squirrel	*Tamiasciurus hudsonicus*	Yellow	N/A	No	Resident
Yellow Pine Chipmunk	*Tamias amoenus*	Yellow	N/A	No	Resident
American Beaver	*Castor canadensis*	Yellow	N/A	No	Resident
Black Bear	*Ursus americanus*	Yellow	N/A	No	Resident
Mountain Goat	*Oreamnos americanus*	Blue	N/A		Resident
Myotis Bats	*Myotis spp*	Species dependent	T	No	Resident

Birds (Alsop 2002, Campbell *et* al 1997a, 1997b and 1997c, and Ehrlich *et al* 1988)

Common Name	Latin Name	Provincial List	COSEWIC[1]	Identified Wildlife	Bridge R. Status
Harlequin Duck	*Histrionicus histrionicus*	Yellow	N/A	No	Breeding Migrant
Common Merganser	*Mergus merganser*	Yellow	N/A	No	Resident
Hawks, Eagles and Ospreys (Acipitridae)					
Osprey	*Pandion haliaetus*	Yellow	NAR	No	Breeding Migrant
Bald Eagle	*Halieaeetus leucocephalus*	Yellow	NAR	No	Resident
Grouse, partridges and pheasants (Phasianidae)					
Ruffed Grouse	*Bonansa umbellus*	Yellow	N/A	No	Resident
Sandpipers and Phalaropes (Scolopacidae)					
Spotted Sandpiper	*Actitis macularius*	Yellow	N/A	No	Breeding Migrant
Hummingbirds (Trochilidae)					
Rufous Hummingbird	*Selasphorus rufus*	Yellow	N/A	No	Breeding Migrant
Kingfishers (Alcedinidae)					
Belted Kingfisher	*Ceryle alcyon*	Yellow	N/A	No	Resident
Flycatchers (Tyranidae)					
Dusky Flycatcher	*Empidonax oberholseri*	Yellow	N/A	No	Breeding Migrant

Common Name	Latin Name	Provincial List	COSEWIC[1]	Identified Wildlife	Bridge R. Status
Vireos (Vireonidae)					
Warbling Vireo	*Vireo gilvus*	Yellow	N/A	No	Breeding Migrant
Jays, Crows and Ravens (Corvidae)					
Common Raven	*Corvus corax*	Yellow	N/A	No	Resident
Swallows (Hirundinidae)					
Violet-green Swallow	*Tachycineta thalassina*	Yellow	N/A	No	Breeding Migrant
Northern Rough-winged Swallow	*Stelgidopteryx serripensis*	Yellow	N/A	No	Breeding Migrant
Chickadees (Paridae)					
Chestnut-backed Chickadee	*Poecile rufescens*	Yellow	N/A	No	Resident
Nuthatches (Sittidae)					
Red-breasted Nuthatch	*Sitta canadensis*	Yellow	N/A	No	Resident
Wrens (Troglodytidae)					
Pacific Wren	*Troglodytes pacificus*	Yellow	N/A	No	Resident
Dippers (Cinclidae)					
American Dipper	*Cinclus mexicanus*	Yellow	N/A	No	Resident
Bluebirds, Solitaires and Thrushes (Turdidae)					
Townsend's Solitaire	*Myadestes townsendi*	Yellow	N/A	No	Common Breeding Migrant
Swainson's Thrush	*Catharus ustulatus*	Yellow	N/A	No	Common Breeding Migrant
American Robin	*Turdus migratorius*	Yellow	N/A	No	Common Breeding Migrant
Waxwings (Bombycillidae)					
Cedar Waxwing	*Bombycilla cedrorum*	Yellow	N/A	No	Breeding Migrant
Wood-Warblers (Parulidae)					
Yellow Warbler	*Dendroica petechia*	Yellow	N/A	No	Common Breeding Migrant
Yellow-rumped Warbler	*Dendroica coronata*	Yellow	N/A	No	Common Breeding Migrant
MacGillivray's Warbler	*Oporornis tolmiei*	Yellow	N/A	No	Breeding Migrant

Common Name	Latin Name	Provincial List	COSEWIC[1]	Identified Wildlife	Bridge R. Status
Tanagers (Thraupidae)					
Western Tanager	*Piranga ludoviciana*	Yellow	N/A	No	Common Breeding Migrant
Tohees, Sparrows and Buntings (Emberizidae)					
Song Sparrow	*Melospiza melodia*	Yellow	N/A	No	Common Breeding Migrant
Dark-eyed Junco (Oregon Race)	*Junco hyemalis*	Yellow	N/A	No	Common Breeding Migrant
Finches (Fringillidae)					
Pine Siskin	*Spinus pinus*	Yellw	N/A	No	Resident

Reptiles (St John 2002 and Gregory and Campbell 1984)

Common Name	Latin Name	Provincial List	COSEWIC[1]	Identified Wildlife	Bridge R. Status
Northern Alligator Lizard (Northwestern)	*Elgaria coerulea principis*	Yellow	NAR	No	Common Resident
Common Garter Snake (Valley Garter Snake)	*Thamnophis sirtalis fitchi*	Yellow	N/A	No	Common Resident
Western Terrestrial Garter Snake (Wandering Garter snake)	*Thamnohpis elegans vagrans*	Yellow	N/A	No	Common Resident

Sources for Provincial and Federal rankings:

- B.C. Conservation Data Centre. 2017. BC Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Jan 2, 2019). provincial endangered species tracking database;
- https://www.registrelep-sararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1 Species at Risk Public Registry; and
- Province of BC. 2004. Identified Wildlife Management Strategy: Species at Risk and the Forest Practices Code. Ministry of Forests and Ministry of Water, Land and Air Protection. 180pp. Also see: http://www.env.gov.bc.ca/wld/frpa/iwms/iwms.html

APPENDIX 3

Appendix 3. Locations of Northern Alligator Lizards incidentally observed during riverine bird surveys in 2020.

Date	Survey	Number of Individuals	Easting	Northing
20-May-20	2nd Pair	1	557706	5634762
27-July-20	3rd Brood	1	557846	5628486
27-July-20	3rd Brood	1	558038	5626998