

Observations of Grizzly Bear (*Ursus arctos*) associated with abundance of spawning Kokanee (*Oncorhynchus nerka*) at an inland river, British Columbia, Canada

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Abstract

Salmon (*Oncorhynchus* spp.) are an important food source for Grizzly Bear (*Ursus arctos*), but many salmon populations are declining. While most research on Grizzly Bear–salmon interactions occurs in coastal ecosystems, declining salmon may also affect Grizzly Bears in inland ecosystems where salmon are also an important part of their diet. We document changes in the number and distribution of observations of Grizzly Bears and changing Kokanee (i.e., landlocked Sockeye Salmon, *Oncorhynchus nerka*) abundance at an inland river. We hypothesized that reduced abundance of Kokanee would limit the number of Grizzly Bear observations at the river. We compared Kokanee abundance and Grizzly Bear observations ($n = 535$) between 2012 and 2019 at the Lardeau River, British Columbia, Canada. We used a generalized linear mixed model to test if the number of bear observations changed as a function of Kokanee abundance among four river reaches during eight consecutive years of study. Kokanee abundance was a strong statistical predictor of Grizzly Bear observations ($\beta = 0.52$, $P = 0.001$, $CI = 0.12–0.87$), and Kokanee abundance and reach explained 73% of the variance. Our results suggest that reduced Kokanee abundance also reduces Grizzly Bear presence, likely because bears seek out other, more available food sources, away from Kokanee spawning habitat. This pattern could limit ecosystem services provided by Grizzly Bears adjacent to spawning areas and it could have implications for bear management and conservation.

Key words: Grizzly Bear; *Ursus arctos*; Kokanee; *Oncorhynchus nerka*; community science; animal behaviour; dietary plasticity; optimal foraging theory

Introduction

Pacific salmon (*Oncorhynchus* spp.) represent an important food source for some subpopulations of Grizzly Bear (*Ursus arctos*; e.g., Hilderbrand *et al.* 1999; Mowat and Heard 2006). Grizzly Bears that access salmon are larger and occur at higher densities (Hilderbrand *et al.* 2018). Dietary salmon also increases litter size (Hilderbrand *et al.* 1999), decreases cortisol levels (Bryan *et al.* 2013), and is important for individual and population fitness (Mowat and Heard 2006; Bryan *et al.* 2013). Unfortunately, many Pacific salmon stocks are declining (Irvine and Fukuwaka 2011), with some runs becoming extinct (Gustafson *et al.* 2007). A major contributor to salmon declines is ongoing climate change (e.g., Irvine and Fukuwaka 2011; Isaak *et al.* 2011; Ward *et al.* 2015; Schoen *et al.* 2017; Crozier *et al.* 2021) via increased water temperature (e.g., Martins *et al.* 2012; Atlas

et al. 2021) and low water levels associated with limited rainfall (e.g., Tillotson and Quinn 2017). Low salmon density may affect the distribution of salmon within spawning areas, for example, via decreased intraspecific competition for spawning sites (Adkison *et al.* 2014; Falcy 2015). Changes in abundance or distribution of salmon in spawning areas may affect the presence and distribution of Grizzly Bears that use them as food (e.g., Quinn *et al.* 2003, 2016; Deacy *et al.* 2016, 2019).

Grizzly Bears exhibit considerable dietary plasticity (e.g., Cristecu *et al.* 2015). Diverse diets that rely on seasonally available foods require Grizzly Bears to travel among habitats (Hamer and Herrero 1987; MacHutchon and Wellwood 2003; Mowat and Heard 2006; Fortin *et al.* 2013). For example, in Banff National Park, Alberta, Canada, seasonal changes in habitat use were related to changes in the phenology

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of forage species, with more use of higher elevations and slopes with a northern aspect as the growing season progressed and snow receded (Hamer and Herrero 1987). They may also change their diet and location annually in response to changing food availability (Schwartz *et al.* 2013; Costello *et al.* 2014). Schwartz *et al.* (2013) found that autumn fat levels in Grizzly Bears did not depend on the quality of Whitebark Pine (*Pinus albicaulis* Englemann) seed production because bears accessed more meat in years when seed crops were poor. Grizzly Bears also respond to temporal changes in food availability. For example, bears follow resource waves by relocating to areas with abundant spawning salmon, even though the phenology of salmon runs changes among years (Deacy *et al.* 2016, 2019). Selectivity extends even to individual prey items, with Grizzly Bears consuming a larger proportion of each fish captured and targeting the most energy-rich fish in years with limited salmon abundance. By contrast, in years when salmon are abundant, they consume only the most energy-rich parts of the fish (e.g., eggs, brains; Gende *et al.* 2001). Dietary changes reflect optimal foraging, which predicts foraging that maximizes energetic intake by selecting foods that provide the greatest energetic reward relative to energy invested (MacArthur and Pianka 1966; Charnov and Orians 1973); this strategy has been observed in Grizzly Bears (e.g., Hamilton and Bunnell 1987; Edwards *et al.* 2011). For Grizzly Bears, the optimal food may change depending on its abundance and accessibility. For example, when salmon abundance is low, the energetic expenditure of finding and catching fish increases (e.g., Cunningham *et al.* 2013) and may exceed the energetic benefit of its consumption. The theory of ideal despotic distribution, which postulates that more competitive individuals occupy high-quality habitat with denser resources (Calsbeek and Sinervo 2002), could also affect Grizzly Bear presence in spawning areas. Dominant males would be expected to occupy river sections with abundant and accessible salmon (i.e., high-quality habitat), which could encourage more vulnerable demographics (e.g., mothers with cubs) to seek other food sources (e.g., Nevin and Gilbert 2005). Finally, bears may select mixed diets because consumption of a variety of different foods is nutritionally beneficial (Rode and Robbins 2000; Erlenbach *et al.* 2014), even if a single food item is most energetically efficient.

While most studies of Grizzly Bear and salmon interactions have occurred in coastal areas, salmon are also an important food source for interior bear populations. Belant *et al.* (2006) found that salmon comprised a large proportion of Grizzly Bear diet and was important for body condition at a site in southcentral

Alaska, over 200 km from the coast. Salmon is also an important food source for interior, montane Grizzly Bears in the low Arctic (Sorum *et al.* 2019; Mangipane *et al.* 2020). In central British Columbia (BC), landlocked Sockeye Salmon (*Oncorhynchus nerka*), known as Kokanee, represent an important food source for Grizzly Bears (Mowat and Heard 2006; Herbison 2008). In the Kootenay Lake system of BC, Kokanee have spawned in the Lardeau River since the end of the last ice age (Gayton 2002). Spawning Kokanee in the Lardeau River have been counted annually since 1979 (excepting 1985; Bassett *et al.* 2018). The number of spawning Kokanee declined dramatically from ~500 000 in 2012 (Neufeld 2012) to ~6000 in 2017 (Neufeld 2017). The decline was attributed to increased abundance of piscivorous salmonid predators (Redfish Consulting Ltd. 2016; Bassett *et al.* 2018), but the impacts of the decline on Grizzly Bear presence and distribution has not been explored.

Our aim was to examine changes in the number and distribution of Grizzly Bear observations in response to changing abundance of Kokanee at an inland river. We hypothesized that reduced Kokanee abundance would decrease the attractiveness of this food source for Grizzly Bears and predicted a positive relationship between the number of Kokanee and the number of Grizzly Bear observations. Understanding density dependent changes in salmon distribution and how Grizzly Bears respond to these changes could be valuable for management, conservation, and bear-viewing operations, especially as climate change progresses and salmon populations decline.

Methods

The Lardeau Valley (50.457°N, 117.194°W) is a sparsely human-populated valley in the Selkirk Mountains of southeastern BC (Figure 1). The Lardeau River spans roughly 46 km from the outlet of Trout Lake to the confluence with the Duncan River at the north end of Kootenay Lake. Because the Lardeau River has no flow control structures or dams, its width and depth vary considerably along its length and its numerous side channels and logjams represent excellent spawning habitat (Slaney and Andusak 2003). Along with the Meadow Creek spawning channel, located 6.5 km south of reach 1, the Lardeau River is one of the primary spawning locations for Kootenay Lake Kokanee (Redfish Consulting Ltd. 2016). Riverside ecosystems are classified as the Interior-Cedar-Hemlock biogeoclimatic zone (Herbison 2008). Our study area overlaps the boundaries of both the North Purcells and Central Selkirk Grizzly Bear population units, both of which have been assigned a conservation ranking of 'moderate' by the

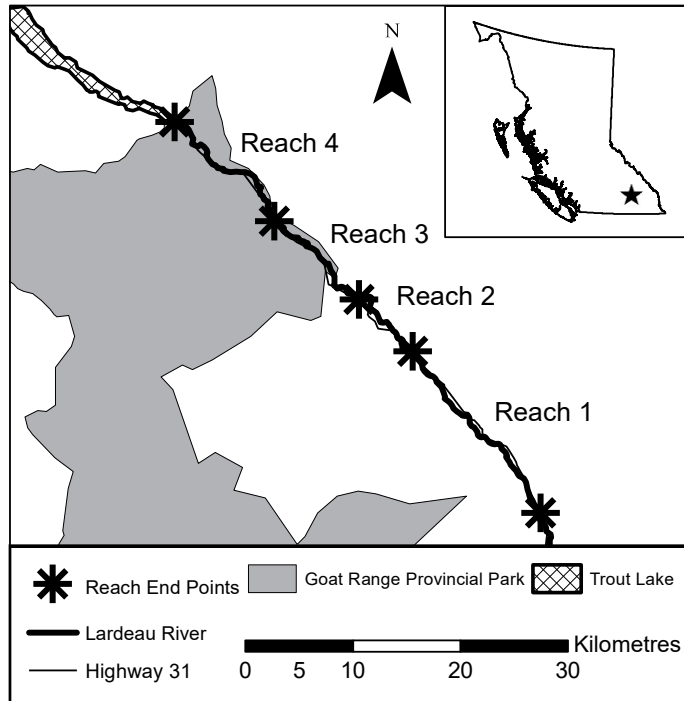


FIGURE 1. The study area in the Selkirk Mountains of southeastern British Columbia, Canada. The Lardeau River was divided into four reaches that were used for analysis. Reaches 1 and 4 are the furthest downstream and upstream reaches, respectively. The Meadow Creek spawning channel is located 6.5 km south of reach 1.

province (Environmental Reporting BC 2020). In the study area, Grizzly Bears typically consume vegetation and Yellow Glacier Lily (*Erythronium grandiflorum* Pursh) bulbs upon emerging from hibernation, followed by Mountain Huckleberry (*Vaccinium membranaceum* Douglas ex Torrey) in the subalpine during the summer, moving to valley bottoms to feed on Kokanee prior to hibernating (Mowat and Heard 2006; Herbison 2008).

Salmon abundance

We retrieved spawning Kokanee count data from the BC Ministry of Environment's Ecological Reports Catalogue (<https://a100.gov.bc.ca/pub/acat/public/welcome.do>). Briefly, from 2012 through 2014, Kokanee were counted once, with a single overland flight resulting in a peak count (Neufeld 2012, 2014a,b). In 2015 (Neufeld 2016a) and 2017 (Neufeld 2017), three counts occurred, and in 2016 (Neufeld 2016b), 2018 (Neufeld 2018), and 2019 (Bassett 2019) fish were counted twice. Flight dates were selected to represent peak Kokanee activity based on observations at the Meadow Creek spawning channel (Bassett *et al.* 2018). Provincial government personnel counted all fish between the Duncan River's outflow into Kootenay Lake and the headwaters of the Lardeau River

at Gerrard, BC. They counted fish in six discrete reaches, four of which we used in our study (Figure 1). Reaches were unequal in length and we used ArcGIS Version 10.7 to determine the length of each reach. Counts were not meant to represent absolute abundance of Kokanee, but they provided an index of abundance that allowed comparison among years and locations (Bassett *et al.* 2018). For brevity, we use the term abundance in our study. Although the number of flights and the complement and number of surveyors varied and may have affected abundance accuracy among years, we used the maximum Kokanee abundance provided in government reports for analysis. Government reports included inflation factors meant to adjust Kokanee counts for factors that affected count accuracy (e.g., shading, water surface conditions, height/speed of aircraft, etc.). We applied this correction factor equally across counts in all reaches.

Bear observations

We compiled records of bear observations from Wild Bear Lodge, a commercial bear viewing company that operates tours along the Lardeau River when Grizzly Bears congregate along the river to consume spawning Kokanee (J.S. unpubl. data). As part of their operational program and to comply with

Provincial Park Permits, lodge employees, i.e., ‘surveyors’, recorded bear observations, including location, time, date, the number of bears, the platform from which the observation occurred (i.e., foot, raft, vehicle), and the bear’s response to viewing. We collected records that occurred between 2012 and 2019 during the Kokanee spawning period, which we defined as 1 September to 31 October. Start dates for data collection ranged from 1 to 4 September and end dates ranged from 25 to 31 October. We excluded observations of Black Bear (*Ursus americanus*), observations that occurred >500 m from the Lardeau River’s banks, and any records lacking clear location information, or when bear species was unknown. Overall, we omitted 42 observations, 35 of which occurred in 2012. We omitted between zero and three observations from all other years. We considered family groups (i.e., mother with offspring) as single observations. If surveyors lost sight of a bear and then detected a bear within half an hour and 1 km of where the first bear had been located, we considered it a single observation. Given a lodge policy to leave an area if a bear entered cover or appeared disturbed, such occurrences were rare ($n = 11$). Surveyors recorded bear locations based on familiar landmarks and kilometre markers along the highway. To facilitate analysis, we reclassified the location of each observation as occurring in one of the four reaches used for Kokanee abundance estimation (Figure 1). If a bear moved among reaches during a viewing, we recorded it as a single observation occurring in the reach where it was originally detected, which rarely occurred ($n = 4$). We used work logs to calculate daily effort spent searching for bears annually, defining a day of effort as one surveyor spending all daylight hours searching for bears, with or without commercial guests. Surveyors all received the same training and used similar search methods, which involved walking or sitting in high-quality habitat, scanning riverbanks with binoculars, and rafting down the Lardeau River, but some search time was spent in vehicles (typically in transit to a trailhead). Although search methods varied, they were approximately consistent among years and reaches. Surveyors spent time approximately equally along the river’s length, however private property adjacent to reaches 1 and 2 somewhat reduced effort in these sections.

Analyses

We used Chi-square goodness-of-fit tests to compare Kokanee abundance among years (assuming equal counts annually) and to compare Kokanee distribution among reaches within years (assuming distribution was proportional to reach length). We also used Chi-square goodness-of-fit tests to compare

the number of bear observations among years (with expected values based on effort) and within years but among reaches (assuming observations would be proportional to reach length).

To determine the predictive capacity of Kokanee abundance on bear observations, we used a generalized linear mixed effects model (GLMM) to test the number of bear observations in each reach during each year of the study ($n = 32$) in relation to annual local Kokanee abundance divided by reach length. Human presence (Gibeau *et al.* 2002; Schwartz *et al.* 2010a), spawning habitat (Adkison *et al.* 2014), and high-quality fishing locations (Luque and Stokes 1976; Gende and Quinn 2004) can affect bear presence and varied along the river’s length, so we included reach as a covariate in the model. To address inter-annual variation, we included year as a random effect and included an offset term for the number of days of search effort. We used a negative binomial distribution to accommodate overdispersion in the data (Coxe *et al.* 2009). We scaled (by 1 SD) and mean-centred Kokanee abundance prior to modelling. To assess model fit and the value of including Kokanee abundance as a covariate, we used AIC weights adjusted for small sample sizes (AICc) and likelihood ratio tests. We assessed the amount of variance explained by the model using an adjusted r^2 metric suitable for GLMMs following negative binomial distributions (Nakagawa *et al.* 2017). Lastly, we confirmed the absence of collinearity among variables using variance inflation factors. We completed all statistical analyses using R Studio Version 4.2.2. We report averages as mean \pm SD and use a significance level of $P = 0.05$.

Results

The mean annual abundance of Kokanee summed across the four reaches was 95634 ± 144239 and ranged between 399929 in 2012 and 5210 in 2017 (Table S1). Abundance varied significantly among years ($\chi^2 = 1522878$, $P < 0.001$). In each year, the distribution among the four reaches differed significantly from what would be expected based on distribution proportional to reach length (χ^2 ranging from 4906 to 118925, $P < 0.001$ for all years). Over time, Kokanee abundance in reaches 1 and 2 was relatively constant (Figure 2a). With the exceptions of 2012 and 2019, when the proportion of Kokanee was similar in reaches 3 and 4, most fish were in reach 4 until 2014, after which the greatest proportion of fish was found in reach 3.

There were 535 bear observations that occurred during 487 days of search effort with sufficient information to include in our analysis (Table S2). The number of Grizzly Bear observations/day ranged

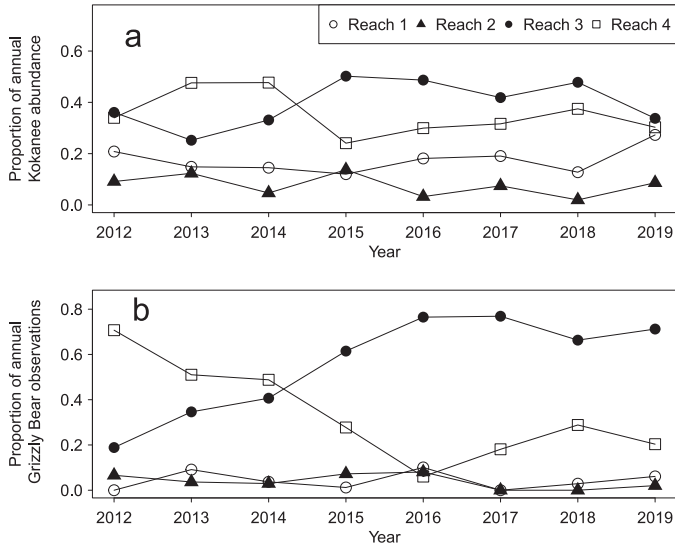


FIGURE 2. Distribution of spawning Kokanee (*Oncorhynchus nerka*) and Grizzly Bear (*Ursus arctos*) observations among four reaches of the Lardeau River, British Columbia, 2012–2019.

from 0.33 in 2017 to 3.03 in 2012. Compared to what would be expected based on survey effort, the number of observations varied significantly among years ($\chi^2_7 = 208$, $P < 0.001$), and distribution of observations among reaches differed significantly from what would be expected based on distribution proportional to reach length for each year (χ^2_3 , range 40–143, $P < 0.001$ for each test). The proportion of observations in reaches 1 and 2 was relatively stable over the study period, and most bear observations occurred in reach 4 until 2014, after which most observations occurred in reach 3 (Figure 2b).

The mean rate of Grizzly Bear observations (i.e., number corrected by effort) roughly paralleled annual Kokanee abundance (Figure 3). Model results indicated that local fish abundance was a significant predictor of the number of bear observations ($\beta = 0.52$, $P = 0.001$, $CI = 0.12$ – 0.87). To confirm that Kokanee abundance was an important predictor of bear observations, we conducted a likelihood ratio test between models including and excluding Kokanee abundance as a predictor; the model including Kokanee abundance fit the data significantly better ($P = 0.02$). Fixed effects (i.e., Kokanee abundance and reach) accounted for 72.7% of the variance in bear observations, while random terms (i.e., year) accounted for only 0.9 % of variance. The $\Delta AICc$ between the null model and our top model was 27.3 AICc points, and likelihood ratio testing indicated the final model had significantly better fit ($P < 0.001$). Variance inflation factors confirmed the absence of collinearity among variables ($VIF \leq 1.18$).

Discussion

Consistent with our predictions, Grizzly Bear observations were strongly predicted by Kokanee abundance, suggesting that bears modified their distribution based on food availability, potentially seeking other food sources when Kokanee were limited. Distribution of Kokanee within the Lardeau River appeared to change over time, which is consistent with observations of density-dependent changes in salmon distribution in spawning areas elsewhere (Adkison *et al.* 2014; Falcy 2015). The observed shift towards reaches further downstream (i.e., from reach 4 to reach 3) in years of low abundance could relate to reduced competition for spawning sites during years with few fish (Adkison *et al.* 2014; Falcy 2015), with individuals conserving energy by occupying the first suitable site they encounter (Adkison *et al.* 2014).

The frequency of Grizzly Bear observations was temporally (i.e., among years) and spatially (i.e., among reaches) predicted by Kokanee abundance. This observation is consistent with findings that suggest Grizzly Bears shift their distribution to accommodate the geographic location of food sources (Hamer and Herrero 1987; MacHutchon and Wellwood 2003; Mowat and Heard 2006; Fortin *et al.* 2013). For example, in the Greater Yellowstone Ecosystem, Grizzly Bears moved into Whitebark Pine habitat as seed crops became available (Costello *et al.* 2014), and Grizzly Bears followed resource waves of spawning salmon (Deacy *et al.* 2016, 2019). The predictive capacity of Kokanee abundance on bear observations was also consistent with the work of others who have

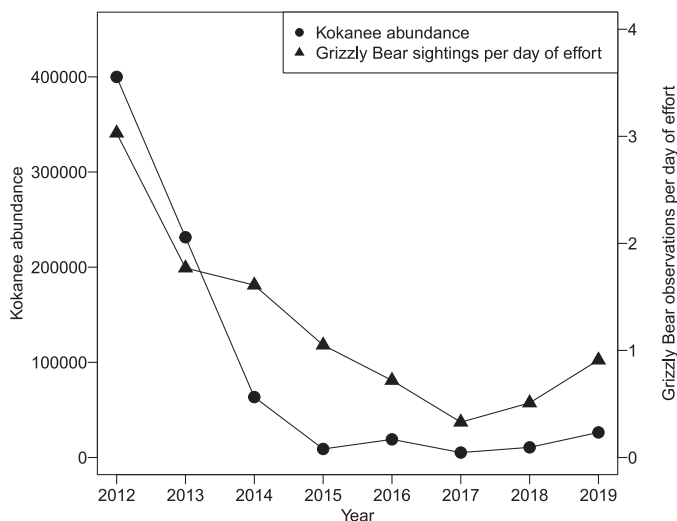


FIGURE 3. Kokanee (*Oncorhynchus nerka*) abundance and Grizzly Bear (*Ursus arctos*) observations/day of effort at the Lardeau River, British Columbia, 2012–2019.

found that salmon predation by bears increases with increasing salmon density (Quinn *et al.* 2003, 2016).

Besides reduced bear presence, an explanation for fewer observations in years of Kokanee scarcity could be that reduced Kokanee density promotes behaviour that affected bear detectability. When fish are scarce, bears may become more selective when fishing to compensate for the high energetic cost of locating fish. For example, Cunningham *et al.* (2013) found that Grizzly Bears selectively caught large fish when salmon density was low and Gende *et al.* (2001) observed selection of the most energy-rich fish when salmon were scarce. Because fishing success is higher at night (e.g., Klinka and Reimchen 2002), bears may have selectively fished at night during years of salmon scarcity, reducing detections during daytime surveys.

Lastly, when resources are sparse, individual animals may occupy and defend larger areas to meet resource requirements (Calsbeek and Sinervo 2002). If the most dominant male bears, which are largely nocturnal, occupied larger areas of the river corridor in years of Kokanee scarcity, they may have limited the presence of more vulnerable demographics, such as mothers with cubs, which are more diurnal and therefore easier to detect using our methods (Nevin and Gilbert 2005). In other systems, intraspecific competition and risk of infanticide have been proposed as reasons some Grizzly Bears fail to consume salmon despite its availability in their home ranges (Gende *et al.* 2001; Deacy *et al.* 2016), and this effect could increase in years when resources are limited, and competition therefore increases.

When Kokanee were scarce and Grizzly Bears

were largely absent from the Lardeau River, individuals may have switched to other food sources, which has occurred following declines of historically available foods in other ecosystems (e.g., Schwartz *et al.* 2013; Costello *et al.* 2014; Cristecu *et al.* 2015). Although we did not attempt to test if a dietary change occurred, Wild Bear Lodge staff anecdotally observed bears using the subalpine and scats containing Mountain Huckleberry later than average in years of Kokanee scarcity (J.S. unpubl. data). At low fish densities, the energetic cost of fishing may exceed the energetic rewards (Quinn *et al.* 2003, 2016), even when bears become more selective about the individual salmon they target (Gende *et al.* 2001; Cunningham *et al.* 2013). Optimal foraging theory (MacArthur and Pianka 1966; Charnov and Orians 1973) would predict selection of other food sources. In our study area, the primary alternate food source in years of Kokanee scarcity may have been Mountain Huckleberry in the subalpine (e.g., Mowat and Heard 2006), which, given favourable weather, can persist well into the autumn (Minore and Smart 1978). Finding, handling, and consuming berries represents an energetic investment, and the energetic benefits of berry consumption decline if berry density or size is low, or if berry bushes are sparse (Welch *et al.* 1997). The attractiveness of huckleberries compared to Kokanee could therefore vary among years depending on the quality of the berry crop. Compared to Kokanee, berries are high in carbohydrates and low in protein and lipids (Rode and Robbins 2000; Erlenbach *et al.* 2014), and the latter may be especially important in the fall prior to hibernation (Erlenbach

et al. 2014). Nutritionally, the optimal Grizzly Bear diet would be mixed (Erlenbach *et al.* 2014), which would likely mean consumption of both Kokanee and huckleberries. In our study area, the distance and elevation change between the Lardeau River where Kokanee spawn and the subalpine where huckleberries can be found in autumn is considerable, and the energetic investment of travelling between these ecosystems could influence food selection. An important next step in this system could be to better understand the role of Kokanee in the diets of bears and what foods bears use when Kokanee are limited.

Various factors limited the strength of our findings. Multi-year studies can be affected by inter-annual variation. We controlled for such variation in our models by including year as a random effect; however, inter-annual changes may have affected our results, and we did not study the sources of this variation (e.g., quality of berry crop). We failed to account for the myriad factors besides Kokanee abundance that may have affected Grizzly Bear distribution, such as land cover (e.g., Milakovic *et al.* 2012) and human presence (e.g., Gibeau *et al.* 2002; Schwartz *et al.* 2010a). These factors varied among reaches. For example, reach 4 occurred primarily within Goat Range Provincial Park, where human presence was lower. Spawning habitat (Adkison *et al.* 2014) and good fishing sites (Luque and Stokes 1976; Gende and Quinn 2004) likely varied among reaches and affected bear presence. We accounted for these factors in our modelling approach by using reach as a covariate. Additionally, we used the number of Grizzly Bear observations as a metric for bear presence, but we did not survey at night, and Grizzly Bears increase nocturnality in response to human presence (Olson 1998; Rode *et al.* 2006; Ordiz *et al.* 2011, 2014). Finally, there were several limitations associated with using community science data. Inconsistent data collection in 2012 resulted in the omission of many ($n = 35$) observations from analysis, but this omission would not have changed the direction of the effects we observed. Surveyors were different among years, and, although they received the same training, their abilities to detect bears could have differed. Upon observing a bear, surveyors typically stopped searching for additional bears, so bears in other reaches may have gone unnoticed. This effect is likely small because most bear observations lasted less than an hour. Although individual bears tolerate human viewers to different extents (e.g., Olson *et al.* 1998; Nevin and Gilbert 2005), surveyors could not reliably distinguish among individual bears, which may have affected results. For example, the presence of a habituated individual in some years but not others could have inflated viewing rate in some years.

Similarly, Kokanee abundance accuracy may have varied among years given variation in the number of flights and the number and complement of surveyors.

Despite these sources of error, our data provide valuable information about the Kokanee–Grizzly Bear dynamics of a system for which there was no existing monitoring, and we made use of publicly available and community-sourced data, which increases efficiencies, democratizes science, and promotes valuable conservation and research outcomes (De Sherbinin *et al.* 2021).

Conclusions

Community science data provided considerable support that changes in Kokanee abundance and distribution was linked to changes in Grizzly Bear observations adjacent to an inland, salmon-bearing river in southeastern British Columbia. These findings are consistent with research from coastal ecosystems, but these principles had not previously been examined in a system with landlocked salmon. The dietary flexibility exhibited by Grizzly Bears may promote resilience as climate change and other factors alter seasonally available foods (e.g., Schwartz *et al.* 2013; Costello *et al.* 2014; Cristecu *et al.* 2015), and this flexibility may be especially valuable given widespread salmon declines (Gustafson *et al.* 2007; Irvine and Fukuwaka 2011). However, the amount of dietary salmon is functionally related to fitness (Mowat and Heard 2006) and, in coastal systems, bear–salmon interactions culminate in complex and beneficial ecosystem services (Levi *et al.* 2020). Declines in food sources may promote increased human–bear conflict; for example, in years of Whitebark Pine seed scarcity, Grizzly Bears in the Greater Yellowstone Ecosystem increased use of low-elevation habitat (Mattson *et al.* 1992), where risk of human-associated mortality increases (Schwartz *et al.* 2010b). It follows that declines in Kokanee abundance may limit bear fitness and provision of ecosystem services, and could increase human–bear conflict. Lastly, ecotourism businesses that centre operations around salmon-bearing streams (e.g., Rode *et al.* 2006) may encounter financial difficulties as salmon populations decline and bear distributions change, which could limit the conservation outcomes of wildlife viewing (e.g., Tisdell and Wilson 2001). We recommend future research on how salmon declines affect Grizzly Bear populations, especially as climate change progresses, as well as better understanding the role of Kokanee in the diets of Grizzly Bears.

Author Contributions

Writing – Original Draft: S.R.; Writing – Review & Editing: N.F. and S.R.; Conceptualization: J.S. and

S.R.; Investigation: S.R.; Methodology: S.R.; Formal Analysis: S.R.; Funding Acquisition: N.F. and S.R.

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SUPPLEMENTARY MATERIALS:

TABLE S1. Spawning Kokanee (*Oncorhynchus nerka*) abundance observed by British Columbia provincial government personnel in the Lardeau River, British Columbia, 2012–2019.

TABLE S2. Number of Grizzly Bear (*Ursus arctos*) observations adjacent to four river reaches, effort spent searching for bears, and observations/day of effort at the Lardeau River, British Columbia, 2012–2019.