How do flow rates on the regulated Columbia River system between Hugh Keenleyside Dam and Trail, in the West Kootenay region of British Columbia affect Recreational Fishing catch rates for Rainbow Trout (*Oncorhynchus mykiss*)?

Ty Tarvyd
November 12, 2019
RFW271
Recreation, Fish and Wildlife
Selkirk College
Faculty Advisor: Pier Van Dishoeck
Project Manager: Brenda Beckwith
Completed: April 4, 2020

Disclaimer

The contents provided on the following pages are student work produced as part of the written evaluation in the diploma program in the School of Environment and Geomatics, Selkirk College, Castlegar, British Columbia, Canada. This work obtained a minimum assessment grade of "C" (60%) and met the requirements of the assignment for which it was completed.

ENVIRONMENT & GEOMATICS
Selkirk College

Abstract

The Columbia River in the West Kootenay area of British Columbia is heavily damned which has had significant long-lasting effects of species in the area. The tailwater ecosystem on the Columbia River below Hugh Keenleyside dam near Robson, BC is home to spectacular fishing for a healthy population of Rainbow Trout (Oncorhynchus mykiss). Thousands annually come to the greater Castlegar area to target these sport fish which has contributed a lot to the local economy, however rapidly changing flow rates from dam management has given anglers headaches for years trying to understand where the fish are in constantly shifting conditions. This report is part of a joint project with Brady Ward to look at a range of factors which affect the feeding habits of the Columbia River Rainbow Trout to determine the best conditions to target large numbers of fish during the fall season. I focused on looking at the flow rates within the area and other factors affected by flow rate to understand more about the prime conditions to catch Rainbow Trout in the Columbia River. The goal was to create a set of conditions that produced more Rainbow Trout for the benefit of anglers in the Castlegar area to have a higher success rate on the water. Through the use of fly-fishing, Brady and myself caught a total of 7 Rainbow Trout over the 5 sampling days in the fall and winter season. Upon analyzing the data, I found that during lower flow rates larger Rainbow Trout were caught during these later months of the year. There also was no direct link with the increased catch rates of Rainbow Trout and certain ranges of flow rates. Little definitive claims can be made about the data due to more data needing to be collected to understand trends and truly understand the effects of rapidly changing flow rates on the feeding habits of Rainbow Trout on the Columbia River.

Acknowledgements

I would like to thank my research partner Brady Ward for the constant support and help throughout the entirety of this project, especially his help in data collection. I would also like to express gratitude to Pier Van Dishoeck (RP Bio) for his timely help in designing and overseeing the project. Lastly, but definitely not least, I would like to recognize Brenda Beckwith (PhD) for managing the project and provide persistent support and feedback to guide the study.

Introduction

Background information

Across the globe recreational fishing accounts for billions of dollars to the world's economy. Over the last decade, there has been a continuous upward trend in popularity by as much as 20% in 2016 (Fishing Tackle Retailer 2016). The increase in popularity of recreational angling sparks concern for how anthropogenic factors are contributing to fisheries, especially regulated rivers (Post el al.2002). The Columbia River that flows through Castlegar, British Columbia (BC), is known for some of the world's greatest Rainbow Trout

(*Oncorhynchus mykiss*) fishing and brings in thousands of dollars in revenue each year courtesy of recreational anglers (Zavaduk 2019).

Numerous dams used for hydroelectric power on the Columbia River system have impacted fish and fish habitat within the West Kootenay region. Dams, like Hugh Keenleyside in Robson, have altered much of the riparian and littoral ecosystems downstream with constantly changing flow rates and hydropeaking events (Cushman 1985). Recreational anglers and biologists alike speculate that dam management affects recreational fisheries leading biologists to measure the effects that regulated rivers have on recreational catch rates (Post et al. 2002). Many recreational anglers within the fishing community feel that there is a relationship between a decrease in catch rates and rapid changing flows in regulated rivers (Zavaduk 2019). Recreational anglers also feel put off by the effects of changes in flows because, certain areas are inaccessible or completely dewatered. Tailwaters, or rivers below dams, have been known to produce prolific macroinvertebrate life causing fish, particularly salmonids, to grow larger than fish in naturally flowing rivers (Dibble et al. 2015). Hydropeaking can cause large amounts of sediment to be forced into the river system, which will dislodge many invertebrates and keep fish moving to habitats to stay in the main current flow instead of backwater areas where oxygen can be depleted quickly (Korman et al. 2009; (Freeman et al. 2001; Cushman 1985). The constant change in habitat could cause stress in salmonids leading them to decrease feeding, because of unfamiliar habitats which can be a useful piece of information to recreational fisherman everywhere (Cushman 1985). The increase or decrease in flow could dislodge more macro invertebrates leading to an increase in feeding activity creating a healthier population of salmonids such as Rainbow Trout (*Oncorhynchus mykiss*) (Dibble et al. 2015).

Research Goal

My research goal was to determine if there is a relationship between the change in rapidly changing water levels in regulated rivers and decreased recreational catch rates of Rainbow Trout for the purpose of providing anglers with ideal conditions to catch Rainbow Trout in the Columbia River. This research follows similar research by John Fallows (2019) and Ian Chrystal (2019) on the environmental factors that affect Rainbow Trout feeding habits on the Columbia River between Hugh Keenleyside Dam in Robson and Trail, British Columbia. The partners caught only two Rainbow Trout through their study period marked by high flow rates and a colder than average fall season (Fallows 2019; Chrystal 2019). This work provides scientific information about the prime flows to catch increased numbers and size of Rainbow Trout in the Columbia River during the fall months. This study was designed to provide valuable information to help anglers in the community have a more successful day on the water and potentially bring in new anglers to the area to support the local economy provided through the information about the Rainbow Trout fishery on the Columbia.

To address my research goal, I created the following objectives:

- Collect changing flow rate data from Birchbank flow station on the Columbia River
- Sample Rainbow Trout using fly fishing methods
- Determine how access, safety, and water clarity “affect an angler’s day” on a regulated river.

- Analyze the change in water temperatures caused by the shifting flows in the Columbia River to understand the potential effects on Rainbow Trout.
- Give recreational anglers recommendations on the peak conditions to target Rainbow Trout in the fall period on the Columbia River.

Methods

Study Area

My research area is a 38.4 kilometer stretch of the Columbia River between Hugh Keenleyside Dam in Robson and the Highway 3B bridge in Trail, located in the West Kootenay region of British Columbia (Figure 1). The Kootenay River flows into the Columbia River downstream of the Hugh Keenleyside Dam in Castlegar. The entire section of the sampling area is in the Interior Cedar Hemlock very dry warm (ICHxw) Biogeoclimatic Ecosystem Classification (BEC) Unit (Mackillop & Ehman 2016). The study area is home to many flora and fauna such as Whitetail Deer *(Odocoileus virginianus)*, Black Bears (*Ursus americanus*), Walleye (*Sander vitreus*), and White Sturgeon (*Acipenser transmontanus*)].

Castlegar is home to 9023 people which includes a large number of Doukhobours who are responsible for a large growth in the population in the area (Statistics Canada 2016). Trail has a population of 12,643 and is a centre for the workers at Teck Resources smelter plant which contributes much to the local economy (Statistics Canada 2016).

The greater Castlegar area is used recreationally as a tourist destination in all seasons and is home to guided fly fishing on much of the river below Hugh Keenleyside Dam down to the United States border. Hydroelectric dams have been placed on many parts of the river and contribute to a large portion of the energy generated for the Province of British Columbia.

Decisions for which location was sampled each time was based on the choice of the anglers partaking in the study and the current flow rates for that day, as some spots were not accessible due to high or low flow rates. Five locations spread throughout the study area were used for data collection, they included Selkirk College Campus, Waldie Island, Genelle, Millennium Park, and the Highway 3 Bridge in Trail.

Project Design and Data Collection

Through fly fishing, data was collected at random based on samplers scheduling. To create as little bias as possible no specific dates were selected for sampling. Data was collected by my research partner Brady Ward and I throughout the fall and winter months.

Flies in use for the project varied a lot, as there are many fly patterns available for anglers. Flies were chosen and used based on macroinvertebrates observed in the field and the individual angler's decisions. Anglers fished with a range of fly rods from four to seven weights depending on the rod needed for the fly and presentation. Fly lines that were used consisted of floating or sinking tip fly lines.

First aid kits, waders, and boots were required for each angler to carry with them when on the water. All data collectors will possess a valid fishing license and follow the rules and regulations set out by the provincial government.

The study began by conducting background research for the project from public resources such as similar studies to guide my research, different styles of data analysis or techniques to improve the study. After understanding the types of data that need to be collected, a site card was created using a Microsoft Excel spreadsheet which could be filled out in the field on an iPad with GPS capability or on a paper copy of the spreadsheet which was later collected by myself or Brady. On the data card one angler recorded daily information, then site information and lastly fish data.

The daily information allowed for tracking of location data which was used in linkage with the fish and site data to understand more about how the flows affected the catch rates in the study. The daily data includes:

- Date
- General location name
- UTM Coordinates using a Garmin 62s GPS
- Current flow rate at Birchbank flow station (Using River App on iPad)
- Previous days flow rate at Birchbank flow station (using River App on iPad)
- Water and Air Temperature using basic thermometer
- Barometric Pressure at the Castlegar airport for that day using Environment Canada's website
- A comment section is provided for important notes pertaining to that day

The fish data allowed for numbers of Rainbow Trout to be recorded and to be compared and linked with other the data gathered throughout the study. The length, girth and weight was used to described the overall health of the fish caught in the study to generally estimate the health of the Rainbow Trout in the Columbia River system. A digital scale, and a 100-centimeter flexible measuring tape will be used to collect data from individual fish. The fish data includes:

- Date
- Start Time
- End Time
- Total Hours fished by all data collectors combined
- Number of Anglers
- Category for Walking or Floating
- Length (cm) of Rainbow Trout caught
- Girth (cm) of Rainbow Trout caught
- Weight (g) of Rainbow Trout caught

Access, safety, and water clarity helped define the effects of rapidly changing flow rates effects on angler's day on the Columbia River. The site information includes:

- Date

- Access (Rated on a scale from 1-5, with 1 being not able to access the site you wished to fish and 5 being able to access any site you wanted to sample with ease)
- Safety (Rated on a scale from 1-5, with 1 being dangerous to fish because of flow rates or weather, and 5 being an angler's ideal day on the water)
- Water Clarity (Rated on a scale from 1-5, a one was visibility <10cm, a two was 11-20cm, three being 21-30cm, a four being 31-40cm, and a five being >41cm
- Number of other visible anglers on the river other than the crew you were working in
- Weather observations about cloud cover and precipitation
- General Insect observations from on or underneath the water

Analysis

For my project, the main focus was to compare certain ranges of flow rates to the numbers and size of Rainbow Trout caught to create an ideal list of conditions for anglers of when it is best to target large and numbers of Rainbow Trout on the Columbia River. To do this, I created a list of ranges of flow rates and compared them in excel tables to the number of fish caught per day. This allowed me to understand if a specific flow rate range was best to fish in. I then went on to calculate the number of fish caught per day and compare it with the number of other anglers on the river that day to see the effects of other angling pressure on the fish. Upon doing so, I also compared the collected water temperatures to the number of fish caught per day to understand the effects of water temperatures on fish feeding behaviour. The analysis produced a generalized set of conditions of when to target Rainbow Trout on the Columbia River for recreational anglers. The peak period described the ideal conditions for targeting Rainbow Trout on the Columbia River in the fall. All the data was organized and analyzed using Microsoft Excel.

Schedule

- Project start: October 1, 2019
- Project planning: September 1 – October 1, 2019
- Background research: September 15, 2019 – December 1, 2019
- Data Collection: October 1, 2019 – February 15, 2020
- Data analysis: January 1, 2020 – March 15, 2020
- Final Report: April 6, 2020
- Final Report Presentation: April 9, 2020
- Project completion: April 9, 2020

Results

Site Data

The sampling in the Columbia river took place from October 15, 2019 to February 3, 2020 and a total of 7 Rainbow Trout (Oncorhynchus Mykiss) were caught during the study. Three sampling locations were used during the study – Genelle, Selkirk College, and Waldie Island – to collect data. Flow rates ranged from 787 m3/s (meters cubed per second) to 1790 m3/s during the study which created a lot of variability in the data. The

changes in the flow rates from the previous day to the day of sampling varied little. The largest change in flow rates from the previous day was 169 m3/s with the lowest being 8.6 m3/s (Table 1). The water clarity remained consistent on sampling days ranging between a 3 to 4 on a scale of 1-5 even with a large variability in the Columbia River flow rates. All angling was done by walking and fly fishing on the Columbia River. The total time allotted on the Columbia River for sampling was 14.83 hours between multiple anglers. During sampling multiple different bugs were observed the most of which being Caddis (*Trichoperta*), Midges (*Chaoboridae),* and Bloodworms (*Glycera*). All data was collected through the use of fly-fishing methods by Brady Ward and myself.

Rainbow Trout Data

In terms of the Rainbow Trout caught during sampling, the most fish caught were when flow rates were between 801-1000 m3/s (Table 2). The least amount of Rainbow Trout caught during sampling were when flows were at their lowest or highest specified ranges. There was little correlation between the number of fish caught per day and the number of other anglers on the river. The number of days where the same flow range of flow rates were consistently even showing no major differences (Table 3).Whether there were no other anglers or if there were multiple it did little to change the numbers of fish caught per day on the Columbia River (Table 4). Water temperatures had a similar effect on the catch rates on Rainbow Trout in the Columbia River (Table 5). The surface water temperatures ranged only between 5^0C and 8^0C which had minimal effect on the number of Rainbow Trout caught in the Columbia River during the time of sampling. Regardless of warmer or colder water temperatures it did little to affect the catch rates of Rainbow Trout. The longest Rainbow Trout caught during sampling was 50 centimeters (cm) long, meanwhile the shortest Rainbow Trout was 42cm. The thickest Rainbow Trout caught was 24cm around the thickest portion of the body, and the skinniest Rainbow Trout was 19cm thick. The heaviest Rainbow Trout caught during sampling was 1814 grams (g), meanwhile the lightest Rainbow caught was 581 g. The largest Rainbow Trout caught in the study, were caught during the periods of the lower flow rates sampled on the Columbia River (Figure 2).

Discussion

Site Data

After combing through the data extensively, little trends can be made in the data, however there are key points that the study brought to the attention of Brady Ward and myself. Based on the lower total angler hours than what we would have liked to have found for the study, no major conclusions can be drawn from the study. Flow rates ranged drastically from site to site not because of the location, rather because of the timing of the year (Freeman et al 2001). When more power is needed for the local city of Castlegar; BC Hydro releases more water through the dams at Hugh Keenleyside and Brilliant to generate more power during the late fall and winter months. Flows were relatively low for the Columbia River on average of the sampling period based on previous years observations not included in the study. Flows increased as the study continued into the winter.

The higher flow rates did not seem to affect the number of fish caught during each sample day, but did seem to impact the overall size of the fish caught. Heavier fish were caught during lower flow rates during sampling. This is likely due to two factors. The first being access, low flow rates allowed anglers more access to fish areas that are most often under water during high flow rates(Korman & Campana 2009). The second being the timing of the year in relation to water temperature. The smaller Rainbow Trout were caught during the colder months of the sampling period. Colder water in the winter slows the metabolism of trout and causes them less to feed which is likely why the larger fish are likely in different water then the sampling areas later in the sampling period. The earlier fall produced warmer water due to warmer air temperatures and low flow rates on the Columbia River which produced larger Rainbows in the month of October. As the study carried on, water temperatures dropped into November to February. Through the use of fly-fishing as the only method to catching fish does lead to some conclusions about the data. The data is only from fish that were eating the flies chosen by anglers and the skill of the anglers potentially created flaws in the data, because more fish could have been caught instead of fish being lost due to errors made by the anglers (ex: bad hooksets and lost fish). Angler inexperience potential created lost data in terms of losing Rainbow Trout while trying to catch the fish. Another potential error in the data was the sampling dates, no consistent dates were established to ensure that the data was collected on consistent dates to collect data in a range of environmental differences. All the data was collected on days that were convenient to the anglers and not on pre-determined sampling dates because of balancing a work schedule with a full course load of classes. All insect's observed were consistent with the species of bugs that should be hatching in the fall and winter seasons within the sample area.

Rainbow Trout Data

In terms of Rainbow Trout data, the most Rainbow Trout were caught when flow rates were between 801-1000 m3/s and this is likely due to access and water temperatures. When lower flow rates occur due to dam management, the flow rates slow down, and water levels drop increasing water temperature due to warming from the air temperature and sunlight penetrating into areas of usually deeper water. This warming of the water increases fish metabolism and increases them to feed more. Also, areas that are inaccessible by walking or structures under water that are too deep to fish are exposed due to low flows in the Columbia River. The lower flows allowed researchers to walk to areas that are not exposed during periods of high flow rates. Also, because of constantly fluctuating river flows, the low flow rates allowed Brady and myself to fish areas that do not see a lot of pressure from other anglers due to areas being inaccessible during high flows. Also, the largest and smallest Rainbow Trout caught in terms of length and girth in centimeters were not that far apart in size during the study. However, the weight of the heaviest and lightest Rainbow Trout caught during sampling varied a lot. This is likely due to the timing of the year and the feed available to the fish. Certain areas sampled like Genelle produced heavier Rainbow Trout in comparison to other spots fished. Another important point from the data

was that the water temperatures varied little despite the constantly changing river flows, this is likely because of the timing of the year. Sampling during a different time of the year in warmer weather like late spring or the middle of summer may produce results that show that river flows have a greater effect on water temperatures which could affect fish feeding habits.

Conclusions

In conclusion, a lot of valuable information can be drawn from this study. The first thing being for any angler looking to catch a large Columbia River Rainbow Trout in the fall, there first step would be to pick a day to fish with flow rates between 801 - 1000m3/s. The second would be finding a day with warmer than usual water temperatures for that specific time of year to increase the likeliness of insect hatches causing the fish to feed more. These conditions based off of the data would produce increased likelihood of catching numbers of large Rainbow Trout on the Columbia River in the fall season within the area sampled. There are many things that could be changed with this project, the first and most primary would be sampling during all four seasons to gain a better understanding of the best time of the year to fish. Another important addition to a study looking to follow this one would be to collect other data factors like light intensity and dissolved oxygen to understand all of the effects on Rainbow Trout feeding habits in the Columbia River (Fallows & Chrystal 2019). All in all, the study provided a huge learning opportunity for developing a study, collecting data, sorting the data, and interpreting the results to draw minor conclusions from it. With the conclusions drawn from this study anglers should have a good understanding of the conditions needed to increase their chances of catching a big Rainbow Trout on the Columbia River.

Table 1. Columbia River flow rates the day off and day before sampling, February 2020. (N/A means not recorded)

Date	Flow rate (m3/s) present	Flow rate previous day (m3/s)
15-Oct-19	832.4	N/A
16-Oct-19	841	832.4
20-Oct-19	787	796
08-Nov-19	1400	1322
03-Feb-20	1790	1621

Table 2. Flow rate ranges comparison between number of Rainbow Trout caught by angling per day by the flow rate range during sampling, February 2020.

Date	# of fish per day	Flow rate range (m3/s)	ranges for flow rates (m3/s)
15-Oct-19	1	801-1000	<800
16-Oct-19	2	801-1000	801-1000
20-Oct-19	1	<800	1001-1200
08-Nov-19	2	1201-1400	1201-1400
03-Feb-20	1	1601-1800	1401-1600
			1601-1800
			>1801

Table 3. Number of angling days with the same flow rate range in the Columbia River, February 2020.

# of days with same flow rate range	Flow rate range
2	801-1000
1	<800

1	1201-1400
1	1601-1800

Table 4. A comparison of the number of other anglers on the Columbia River compared to the number of fish caught per day on the sampling dates, February 2020.

Date	# Of Other Anglers on The River	# of Fish per Day
15-Oct-19	0	1
16-Oct-19	0	2
20-Oct-19	4	1
08-Nov-19	3	2
03-Feb-20	0	1

Table 5. A comparison of the number of Rainbow Trout caught per day by the sampled surface water temperature in degrees celsius on the Columbia River, February 2020.

Date	# of Fish Per Day	Water temp (oC)
15-Oct-19	1	7
16-Oct-19	2	8
20-Oct-19	1	6
08-Nov-19	2	5
03-Feb-20	1	5

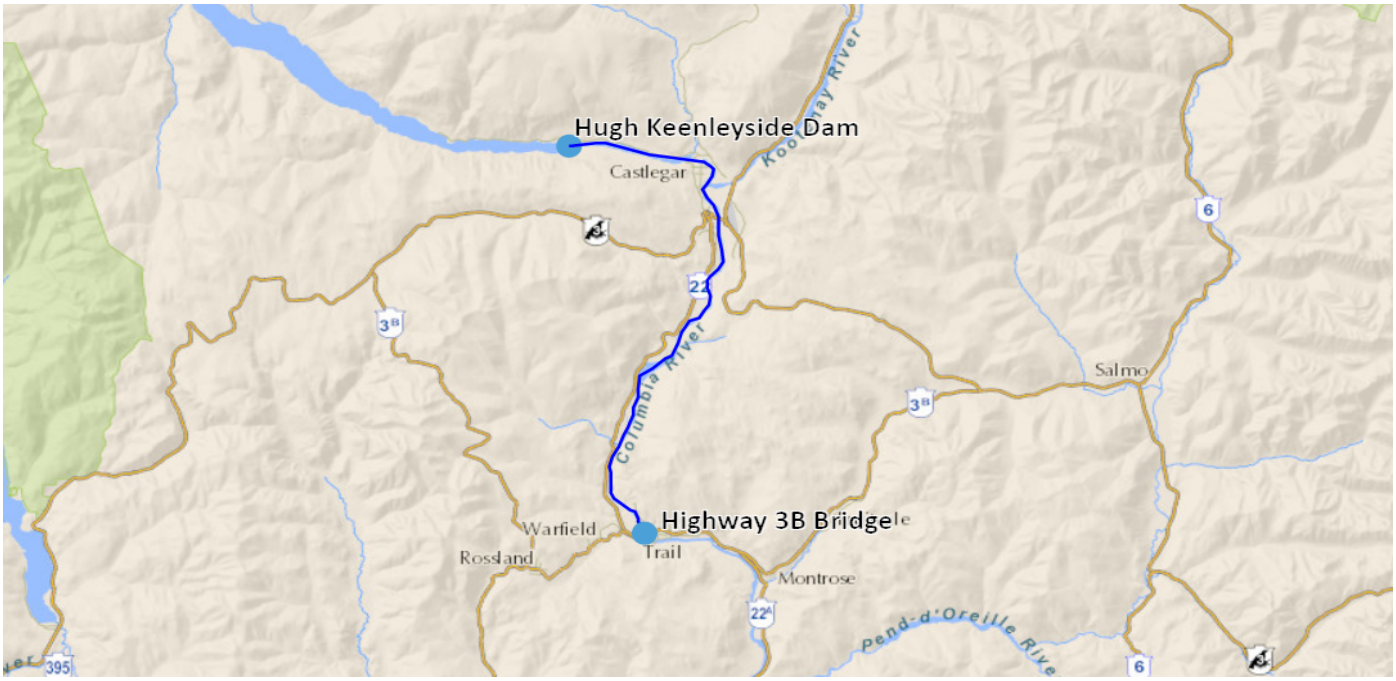

Figure 1. Map of the study area on the Columbia River between Hugh Keenleyside Dam and the Highway 3B bridge in Trail, British Columbia, November 2019 (Imap BC).

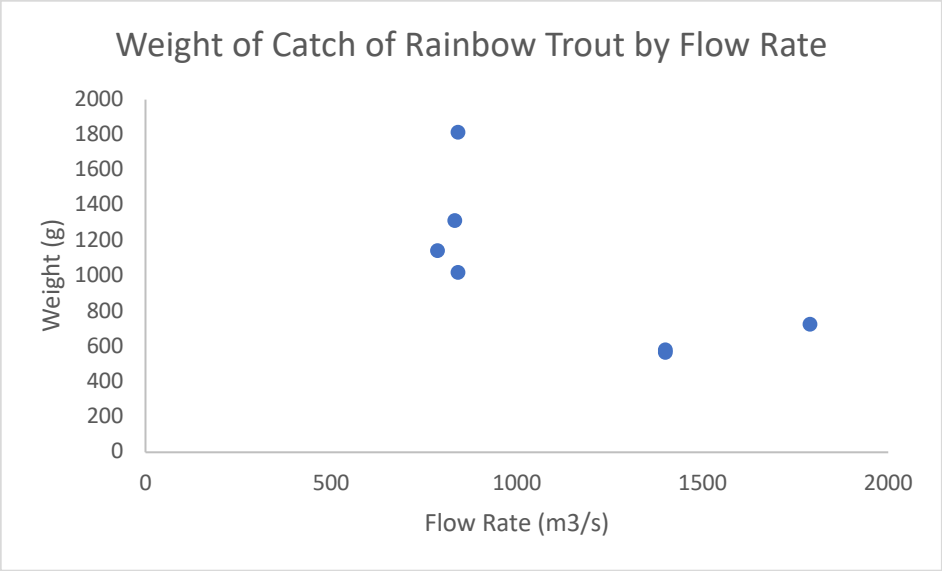

Figure 2. Scatter plot graph representing Rainbow Trout weight by the Columbia River flow rate, February 2020.

Literature Cited

J Korman, SE Campana. 2009. Effects of hydropeaking on nearshore habitat use and growth of 0-age Rainbow Trout in a large regulated river. Transactions of the American fisheries society. [Updated February 5, 2009, accessed October 24, 2019]. 138:76-87. https://www.researchgate.net/profile/Steven_Campana/publication/241652808_Effects_of_Hydropeaking_on_Nearshore_Habitat_Use_and_Growth_of_Age0_Rainbow_Trout_in_a_Large_Regulated_River/links/54525f6d0cf2bccc49093fa9/Effects-of-Hydropeaking-on-Nearshore-Habitat-Use-and-Growth-of-Age0-Rainbow-Trout-in-a-Large-Regulated-River.pdf

Freeman, M. C., Z. H. Bowen, K. D. Bovee, and E. R. Irwin. 2001. Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes. Ecological applications. 11: 179-180.

R M. Cushman. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American journal of fisheries management.5: 330-339. Oak ridge, Tennessee. https://www.tu.org/wp-content/uploads/2019/05/Ecological-Effects-of-Rapidly-Varying-Flows-Downstream-from-Hydroelectric-Facilities-American-Fisheries-Society-1985.pdf

K L. Dibble, C B Yackulic, TA Kennedy, P Budy. 2015. Flow management and fish density regulate salmonid recruitment and adult size in tailwaters across western North America. Ecological applications. Ecological society of America. [accessed 2019 Oct 19); 25(8):2168-2179. https://pdfs.semanticscholar.org/67bd/efac6f0dc9aa41774c5ed1e5a22931011f2c.pdf

J R. Post, M Sullivan, S Cox, N P. Lester, C J. Walters, E A. Parkinson, A J. Paul, L Jackson, B J. Shuter (2002) Canada's Recreational Fisheries: The Invisible Collapse?, Fisheries, 27:1, 6-17, DOI: 10.1577/1548-8446(2002)027<0006:CRF>2.0.CO;2

J Fallows. 2019. Environmental factors affecting Rainbow Trout feeding habits on the Columbia River between Hugh Keenleyside Dam and Trail, British Columbia. Selkirk College. Pages 1-11.

I Chrystal. 2019. Environmental factors that affect trout feeding habits on the Columbia river between Trail and Castlegar, B.C. Selkirk College. Pages 1-11.

MacKillop, D.J. and A.J. Ehman. 2016. A field guide to site classification and identification for southeast British Columbia: the south-central Columbia Mountains. Prov. B.C., Victoria, B.C. Land Manag. Handb. 70.

Fishing Tackle Retailer. "Recreational Fishing Participation Increased Nearly 20 Percent Over the Past 10 Years," September 13, 2017. https://fishingtackleretailer.com/recreational-fishing-participation-increased-nearly-20-percent-past-10-years/.

"IMapBC." Accessed November 14, 2019. https://maps.gov.bc.ca/ess/hm/imap4m/.

Government of Canada, Statistics Canada. "Census Profile, 2016 Census - Castlegar [Population Centre], British Columbia and British Columbia [Province]," February 8, 2017. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=POPC&Code1=0146&Geo2=PR&Code2=59&SearchText=Castlegar&SearchType=Begins&SearchPR=01&B1=All&TABID=1&type=0.

Government of Canada, Statistics Canada. "Census Profile, 2016 Census - Trail - Fruitvale [Population Centre], British Columbia and British Columbia [Province]," February 8, 2017. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=POPC&Code1=1569&Geo2=PR&Code2=59&SearchText=Trail&SearchType=Begins&SearchPR=01&B1=All&TABID=1&type=0.

Mickle, Bearcave Web Services-RD Monrad- Johanna. "Fly Fishing Guides." Castlegar Sports Centre and Fly shop - Castlegar, British Columbia, Canada. Accessed November 30, 2019. https://www.castlegarflyshop.ca/.
(Rod Zavaduk (2019, personal interview)