Bow River Basin Council

Preserving Our Lifeline

working together to nurture, renew and protect the waters of the bow river basin

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The BRBC Welcomes its New Program Coordinator, Brooke Kapeller, to the team!

Brooke's passions lie in land and water conservation, landscape management, geospatial tools, and utilizing collaborative tools to achieve common goals. She grew up in southern Alberta and has lived in all three cities within the region.

Prior to taking this position, Brooke was Conservation Program Coordinator with the Canadian Parks and Wilderness Society (CPAWS), Southern Alberta Chapter.

Brooke takes a dual-pronged approach to her work in conservation, combining her scientific and technical skills with her passion for community building. She will soon defend her Masters thesis, investigating local-scale environmental stewardship initiatives. She also holds a BSc in Geography with a concentration in GIS, and a diploma in Renewable Resource Management.

Brooke is excited to bring her GIS skills and experience working in conservation to the role at BRBC.

In her free time, Brooke loves to get out and explore the landscapes of southern Alberta with her dog. Brooke is excited to bring her GIS skills and experience working in conservation to the role at BRBC. Welcome aboard Brooke!

IN THIS Issue

BRBC 2021 Science Forum Re-imagined

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This year, the BRBC Science Forum ran as a webinar series! Due to the pandemic, the forum could not be held in person and the Science Committee had to re-imagine how to host this annual gathering. A monthly online webinar series was chosen as the best method to share information and keep the community informed of the latest research happening within the Bow River Basin.

Each session had a designated theme: Monitoring for a Changing Environment (February), State of the Watershed (March), Exploring Methods of Environmental Assessment (April), and Connecting Science to Action (May). Over these four sessions, there were a total of 11 presentations featuring research and projects across academia, government, watershed stewardship groups, and consulting.

In the February session, Cuauhtémoc Tonatiuh Vidrio Sahagún (University of Calgary) presented his research on the hydrological response of the Elbow River under a changing climate. Chris Spence (Environment and Climate Change Canada) also presented on a watershed model developed for understanding the sensitivity of prairie hydrology to changes in climate. Both showcased timely research on climate impacts in the Bow Basin and stimulated engaging discussion.

For the March session, Nilo Sinnatamby (University of Calgary) presented on how human threats and natural variability impact ecological processes in the Bow River. Jennifer Janzen (Alberta Tomorrow) also presented, providing a deep dive into the impressive Alberta Tomorrow online educational tool on land use planning in the Bow River Basin. Bill Berzins (H3M Environmental) rounded off the webinar with his discussion on how seasonality impacts Calgary runoff water quality. These three presentations gave a diverse perspective on the state of the basin.

In the April session, Kelly Munkittrick and Fred Wrona (both from the University of Calgary) presented on the development of a Bow River cumulative effects management framework. Also presenting was Brian Maude (City of Calgary) who discussed the results of the City's continuous in-situ monitoring program of rivers and creeks from 2007 to present. Finally, Tobin Benedict (University of Calgary) presented the monitoring and research she conducted for the Bighill Creek Preservation Society on benthic invertebrates in Bighill Creek. These works highlighted some of the innovative and thorough methods employed for water monitoring in the region.

For the final session in May, Jon Fennell (SAIT Integrated Water Management Program) presented on a flooding and climate change case study for Redwood Meadows. Mike Gallant (Kerr Wood Leidal) and Norma Posada (City of Calgary) presented on long-term monitoring for improved soil bioengineering in Calgary. The session concluded with Jacqueline Noga (University of Alberta) presenting the Water and Resource Recovery Roadmap, a guide for the challenges we face with climate change and increasing water scarcity in southern Alberta. These topics provided participants with a great overview of the current challenges in water management and the solutions being developed.

This virtual series highlighted some of the new and emerging research in the Bow River Basin and it was encouraging to see the breadth of work presented. The virtual format created a more accessible event and allowed presenters and attendees not local to Calgary to participate in the forum. While we hope to meet again in person for the 2022 Science Forum, the success of the virtual format was a sign that the BRBC and its community members are adaptive and shows there is a potential for knowledge sharing in new ways.

The BRBC Science Committee would like to extend a huge thanks to all those who participated in the series to make it a success. We especially thank the presenters for taking the time to present and share their work: the BRBC Science Webinar planning committee for their organization of the forum; the session facilitators (Mary Kruk, Cecilia Chung and Mike Murray); the session chairs (Brandi Newton, David Barrett and Nilo Sinnatamby); BRBC Executive Director Mike Murray for providing opening and closing comments; and finally, all of the attendees who engaged with and supported the new format for this annual forum.

Introducing the Fish Creek Watershed Association

David Swann, President
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Board members and volunteers of the Fish Creek Watershed Association. Photo: Sandi Riemersma.

Over 45 people met at the Priddis Hall in the summer of 2019 to discuss concerns about the state of the Fish, Priddis and Whiskey creeks.

These concerns included perceptions of declining flows, poor water quality, loss of fish and fish habitat, and adverse impacts of climate warming in the future. A decision was made to formally organize and register with the province as a stewardship organization: the Fish Creek Watershed Association (FCWA).

The upper Fish Creek watershed has a population of about 2600 people, and a multitude of land uses are represented in this headwater, from forestry and high impact recreation activity in the McLean Creek PLUZ to country-residential, agricultural, commercial and industrial activities. The upper Fish Creek headwater is also an important supply of water to the Tsuut'ina Nation, Calgary and communities to the east. The FCWA was officially registered in Alberta in late 2020 and quickly retained Palliser Environmental Services Ltd. to assist in assessing the state of the watershed; this report should be complete this summer.

Other organizations participated this past year both in educating the FCWA Board and volunteers and in providing data measurements to establish the threats and opportunities to our goal of protecting water quantity and quality for human and ecosystem health in perpetuity.

Alberta Environment and Parks, Cows and Fish, Trout Unlimited, Brad Stelfox (ALCES) and Foothills County have contributed significantly to the study so far. FCWA's volunteers are also participating in Alberta Creekwatch and have learned to sample water quality. Groundwater mapping in a few wells will begin soon, thanks to Dr. Masaki Hayashi at the University of Calgary.

This is a very timely educational, monitoring and planning process for all who depend upon and want to preserve this critical watershed. As in most areas of human population growth and urban and industrial development, declines in water quantity and quality have occurred. We therefore need more information on water use, flows and quality, especially in the late summer and fall. We must also carefully monitor current land use to assess the limits to growth in the watershed. There is a growing interest and support for our first State of the Watershed Report and subsequent planning for ways in which residents can learn and work together to ensure no further degradation of the watershed and to rehabilitate damaged riparian areas; it's an exciting time for landowners. The FCWA looks forward to collaborating with residents, landowners and stakeholders in assessing watershed conditions and planning for the management and stewardship of watershed resources in the Upper Fish Creek watershed.

The FCWA thanks the Bow River Basin Council, Alberta EcoTrust, the Watershed Resiliency and Restoration Program, and the Land Stewardship Centre of Canada for their generous donations that support this important work.

Microplastics Partitioning between Biosolids and Final Effluent in a Tertiary Wastewater Treatment Plant

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The Problem of Plastics

Plastic manufacturing, aimed at improving our quality of life, has significantly increased since the introduction of mass production in the 1950s. However, plastic often ends up in landfills and aquatic environments, and according to a special report of National Geographic, 8.18×10^9 kg of plastic pollution enters our oceans annually (Daly, 2018).

Plastic used in daily life can produce microplastics, operationally defined as plastic pieces that are 250 µm - 5 mm in length (Edo et al. 2019), which are now an emerging contaminant of concern. Primary microplastics are pieces of plastic that are manufactured to be small, such as microbeads, while secondary microplastics are plastics that have fragmented or broken down from a larger piece through physical, chemical, or biological processes (Ma et al. 2019).

While the fate and environmental consequences of microplastics in freshwater have been studied far less than in marine systems, especially in Canadian contexts (Anderson et al. 2016), what is known is that microplastics may act as contaminants and endocrine disruptors and lead to alterations in feeding and reproductive behaviour in aquatic organisms following ingestion (Qu et al. 2018). Chemicals used in the production of plastics, such as phthalates, also have the potential to alter endocrine function once ingested (Gallo et al. 2018; Verla et al. 2019).

Microplastics can enter freshwater through runoff, leaching (Li et al. 2018) and human use of plastic materials such as grocery bags and textile fibres that enter municipal and industrial wastewater through plastics used in our daily lives and industrial manufacturing (Kang et al. 2018). Wastewater treatment plants have been identified as a major point of concentration of microplastics to receiving waterbodies from industrial and municipal sources and are one of the largest sources of loading into the freshwater environment (Murphy et al. 2016; Sun et al. 2019).

Due to the continuous release of effluent from wastewater treatment systems, unremoved microplastics have the potential to accumulate in receiving environments. The objective of my study was to quantify the microplastic abundance and polymer types entering and exiting a tertiary wastewater treatment plant (WWTP) in Alberta, in the influent, final effluent and processed biosolids.

How Were Microplastics Measured?

Grab samples of post coarse-screened influent and post UV-radiated final effluent wastewater and biosolid samples were collected weekly for eight weeks and frozen until processing. There is no standard method to sample, quantify and analyse microplastics. Therefore, a method was devised that used aspects from previously published methods appropriate for wastewater samples (Conley et al. 2019; Kang et al. 2018; Li et al. 2018; Mahon et al. 2016).

Three samples of Milli-Q water were collected as methodological controls to determine if any contamination resulted from the method. Glassware was used where possible but was not always an option. Frozen samples were thawed in a refrigerator, then sieved through a 250 µm sieve to obtain the 250 µm + size fraction. The collected material underwent a wet peroxide digestion with 50% H_2O_2 to digest all organic matter in the samples. Following digestion, samples were vacuum filtered onto glass fibre filters (47 mm, 1.2 µm pore size) and dried. A dissecting microscope, fitted with a filter holder and counting grid,

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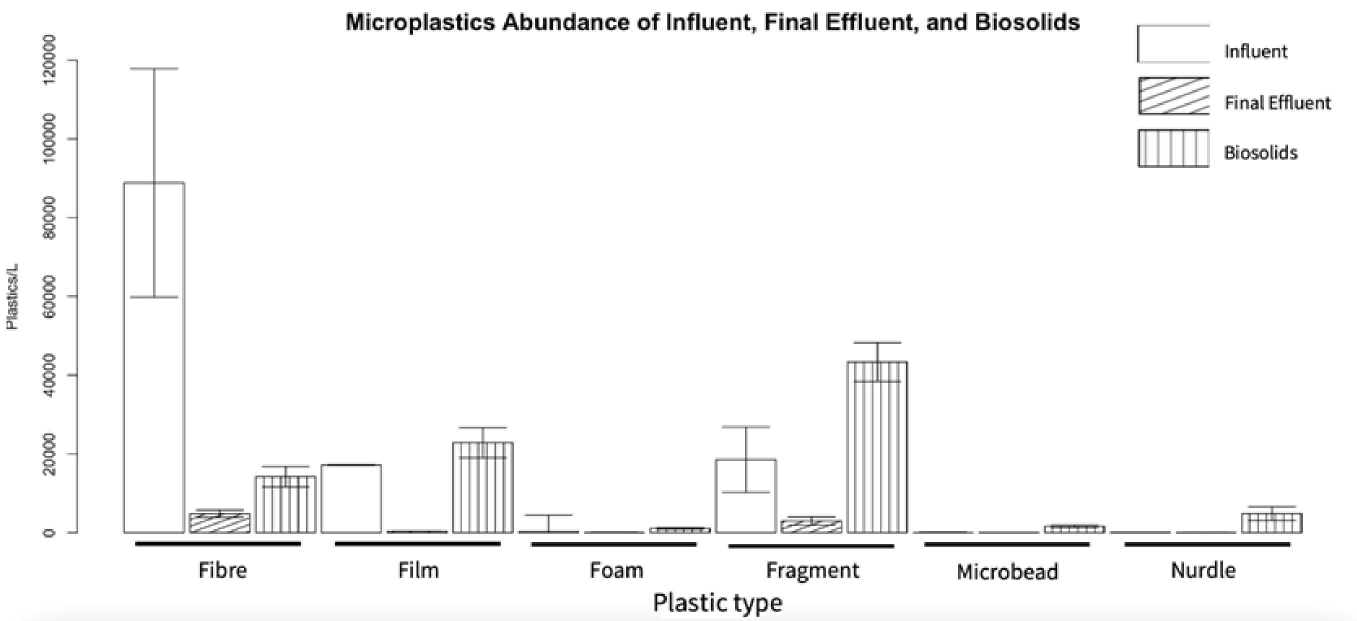

Figure 1. Mean microplastics abundance in six common categories from influent, final effluent, and biosolids (n = 8 for all cases). Error bars represent 1 standard error of the mean. In some cases error bars are too small to be visible. Note that final effluent is multiplied by 100 to allow plotting on the same scale. Details of statistically significant abundances between plastic types and source is summarized in the findings.

was used to count and categorize the microplastics. Pearson's Chi-Squared test for homogeneity was performed to determine any difference in the proportions of plastics among influent, final effluent and biosolids. An analysis of variance (ANOVA) was performed to determine differences in the plastic categories between the sampling locations, with significant ANOVA results followed by a Tukey's Honestly Significant Differences to determine the location of significance.

What were the Findings?

Of the microplastics identified in the influent, 70.5% were identified leaving the treatment plant in the final effluent and biosolids (Figure 1). A mass balance analysis revealed 29.5% of the microplastics measured in influent were removed elsewhere in the wastewater treatment process as they were not present in the final effluent plus biosolids. Of the microplastics leaving the plant, 99% were found in the biosolids and less than 1% were found in the final effluent. Influent and final effluent samples were dominated by fibres (88,820 +/- 29,008 pieces/L in influent; 48 +/- 9 pieces/L in final effluent) followed by fragments (18,550 +/- 8,297 pieces/L in influent; 30 +/- 10 pieces/L in final effluent). Biosolid samples were dominated by fragments (43,322 +/- 4,933 pieces/L) followed by films (22,861 +/- 3,836 pieces/L) (Figure 2). All Chi-Squared comparisons were significant, indicating high sample heterogeneity. All ANOVA comparisons were significant, with the exception of the final effluent-biosolid comparison for fibres.

What do the Findings Mean?

Based on my calculations during the eight week study period, an average of 6.23x10^{12} microplastic pieces left the WWTP daily. The influent and final effluent had similar patterns of relative plastic abundance, with the sources being dominated by fibres, followed by fragments and lastly films (Figure 1). This relative abundance of

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microplastics differed in the biosolids, which were dominated by fragments, followed by films and lastly fibres. The change in the relative abundance of plastic categories between the three sampling locations indicates that there is microplastic removal somewhere throughout the treatment process. Most of the plastics identified in the fragment, foam, and nurdle category fell within a 250 µm – 2 mm size range, while fibres and films mostly fell within the 1 – 3 mm size range and microbeads fell in the < 1 mm size range (Figure 2).

The findings of my project show that >99% of microplastics that are unremoved during wastewater treatment end up in the biosolids, which is consistent with previous studies (Edo et al. 2019, Li et al. 2018, and Sun et al. 2019). Of the microplastics quantified in influent, very little (< 1%) is discharged from the WWTP in final effluent, since only 82 +/- 8 pieces/L were identified in the final effluent compared to 124,790 +/- 37,760 pieces/L in influent. 70.4% of influent microplastics from the WWTP leave in biosolids and 29.5% are removed elsewhere during treatment. However, in general, and depending on further processing once biosolids leave a wastewater treatment facility, some proportion of microplastics may eventually end up in the terrestrial environment (this is due to biosolids being used in agricultural settings as fertilizers).

Implications to Receiving Environments

Biosolids are used to fertilize agricultural fields (City of Calgary, 2021); therefore, the application of biosolids to agricultural fields likely increases the overall distribution of microplastics in these landscapes (O'Kelly et al. 2021). In subsurface injected systems, microplastics still have the potential to be incorporated into terrestrial food webs via burrowing organisms such as earthworms (O'Kelly et al. 2021). Some studies have estimated that in surface applications, greater than 99% of microplastics applied to fields that originated from biosolids are returned to the aquatic environment, with fibres more likely to be incorporated into the soil and fragments likely to be distributed further in the terrestrial environment (Crossman et al. 2020).

Recent evidence indicates that biofilms that grow on microplastics in wastewater treatment plants can be 'hotspots' for transfer of antimicrobial resistance genes (Martinez-Campos et al. 2021). Antimicrobial resistance genes may not only be shared between bacteria present on the surface of microplastics, but may also be transferred to terrestrial landscapes due to biosolids application (Chen and Xia, 2017). This is an emerging area of research that needs more study to determine its full impact.

Figure 2. Images illustrating the diversity of size and types of microplastics in biosolids following wet peroxide digestion with 50% H_2O_2. Left filter – 16 x magnification; right filter – 32 x magnification.

Acknowledgements

I thank my project supervisors (Drs. Sean Rogers and Lee Jackson) for providing guidance, knowledge and support for my thesis project. I thank Matthew Saowapon for help sampling Advancing Canadian Wastewater Assets (ACWA), and ACWA for access to their facility. I also thank The City of Calgary for on-going support and commitment to advancing wastewater research. This research was partially funded by NSERC.

Please contact the author at paige.jackson@ucalgary.ca for a complete list of literature cited.

The Bow River Basin in Pictures

The past 18 months have been a challege for everyone. More than ever, we have been reminded of the joy and inspiration nature provides us. In that spirit, please enjoy these photos taken in the Elbow, Nose and Fish Creek watersheds.

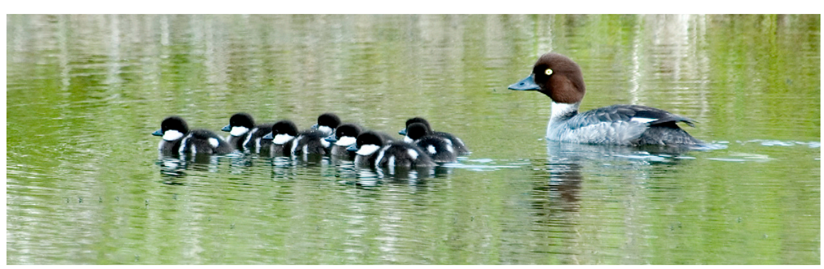
Upper Elbow River. Photo: Robert Lee.

Glenmore Reservoir at sunset. Photo: Robert Lee.

West Nose Creek. Photo: Sandi Riemersma.

Upper Fish Creek, June. Photo: Sandi Riemersma.

Elbow River at downtown Calgary. Photo: Robert Lee.



Our fellow Bow Basin residents. Photo: Robert Lee.

The United Nations World Water Development Report 2021

How should we value water? The 2021 World Water Development Report focuses on this crucial issue. The report explains various approaches to valuing water for environmental considerations, water-related infrastructure, drinking water, sanitation and hygiene. It looks at valuation issues in food and agriculture, business, industry, energy and financing. And it highlights the perspectives of different value systems and cultures, and associated social and gender-based considerations.

Download the report at this link: https://unesdoc.unesco.org/ark:/48223/pf0000375724

BRBC Quarterly Educational and Networking Forum (Microsoft Teams)

September 8th, 9:30 - 12:30

Debris Management: Carseland Diversion and Irrigation Canals
Richard Phillips
Bow River Irrigation District

Elbow State of the Basin Report
Flora Giesbrecht
Elbow River Watershed Partnership

Water Re-Use
Kelsey S. Sostar
SAIT Capstone Student

For details and to register, visit:
https://www.eventbrite.ca/e/brbc-september-8th-quarterly-educational-forum-tickets-166864721875

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Bow River Basin Council

The next BRBC newsletter will be released in December.

If you would like to submit an article, please contact Andrea Czarnecki at: andreacz@shaw.ca