Final Report delivered to the Okanagan Basin Water Board (OBWB) for the Water Conservation and Quality Improvement Grant Program (WCQI)

May 31, 2022

MICROPLASTICS IN OKANAGAN LAKE

A scoping study to evaluate the presence of microplastics in Okanagan Lake and Kelowna's municipal wastewater

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Executive Summary

The evaluation of *Microplastics in Okanagan Lake* project (OBWB WCQI 2021-2022) was initiated in the Spring of 2021 with the grant commitment from the Okanagan Basin Water Board (OBWB) to FreshWater Life. The overarching goal of this project was to better understand microplastics in Okanagan Lake and inform potential mitigation solutions. This project was set as a scoping study that may inform future monitoring in addition to looking to quantify and *possibly* qualify the presence of microplastics in Okanagan Lake and Kelowna's municipal wastewater.

The core partners of FreshWater Life, Seven in the Ocean and Copper Sky Productions have been actively working with the City of Kelowna, local educational and research institutions of the University of British Columbia Okanagan and Okanagan College (OC), the Okanagan Nation Alliance (ONA), and Fresh Outlook Foundation (collectively the "Partnership"). Under this grant agreement with the OBWB, we have:

1. Confirmed the presence of microplastics in both wastewater and freshwater samples from Okanagan Lake.
2. Established a freshwater and wastewater sampling protocol in alignment with the project goals.
3. Conducted the Okanagan Lake surface water sampling at 5 locations per the grant agreement.
4. Collected both inbound and outbound wastewater samples at the City of Kelowna Wastewater Treatment plan.
5. Collaborated with Okanagan College to develop two capstone projects where students developed analysis protocols for extracting and identifying microplastics from freshwater and wastewater samples.
6. Initiated analysis of samples for microplastics in partnership with Okanagan College.
7. Collected video footage at each of the above steps of the process for the purpose of building the 10-minute video documentary.
8. Secured various social media channels and communicated widely through local and regional media about the results.
9. Produced a 2-minute "project trailer" video.
10. Received final data from Okanagan College.

Final analysis from the Okanagan College WET capstone students confirm that microplastics were present in all five sampled sites on Okanagan Lake, as well as both influent and effluent wastewater from Kelowna's Wastewater Treatment Facility.

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1.0 Introduction

Plastics have transformed the world for humanity: from the goods we consume to the utility and protection of foodstuffs, to healthcare and clothing, to transportation and beauty products and beyond. It can be difficult, if not impossible, to live a truly plastic-free lifestyle, and plastics have become a part of our everyday lives. It is likely that the vast majority of people on the planet have had access to or utilize plastic in their daily lives. Both single-use and recycled plastics are in use globally, and industry is producing and people are consuming it much faster than the environment can break it down.

Unfortunately, most plastics end up in landfills or are inadvertently released into the environment where they can sit for hundreds of years or longer before they are broken down; simply put, plastic is accumulating in the environment. While there are variants of plastics, the most pervasive plastics do not magically disappear, they simply break down into smaller and smaller fragments through biological and photodegradation processes. The smallest of the fragments are designated as microplastics (<5mm in diameter) and can be invisible to the human eye, mistaken for organic debris, or even food for aquatic organisms from invertebrates such as zooplankton, to fish and birds. Functionally, some of the plastic we consume and dispose of today will be present and likely will be detectable in the environment for multiple human generations.

The global evidence and pervasiveness of macro and microplastics in all the world's oceans and freshwater systems indicates that the majority are anthropogenic in origin. We expect that plastic use in the Okanagan follows global patterns of use and disposal, and any plastic pollution in the Okanagan environment would be due to the human population living, working, and visiting the Valley. With the bulk of the population in the Okanagan Valley residing on or close to the Okanagan Lake, and the communities of Vernon at the north end (Kelowna, West Kelowna, Peachland, Summerland and Penticton/Naramata at the south) constituting approximately 250,000 residents that at least partially rely on the Okanagan Lake for their daily water use including the release of wastewater, we hypothesized that plastics have been and are possibly being inadvertently discharged into the Okanagan Lake with uncertain consequences in the short term and long term.

The first step in understanding the consequences of plastics in our environment is confirming that it is indeed present, and if so at what concentration.

1.1 Goals and Objectives

The goal of this project was to quantify and if possible, qualify, the presence of microplastics in Okanagan Lake and the City of Kelowna wastewater.

The objectives of this project were:

1. to determine if microplastics are present and can be detected in Okanagan Lake;
2. if wastewater is a potential source of contamination; and
3. if microplastics are present, determining solutions to mitigating microplastics entering waterways that are achievable and community-oriented.

2.0 Partners and Collaborators

This small scoping study garnered considerable attention on discussion with various active and potential collaborators and partners. The core partners of FreshWater Life, Seven in the Ocean, and CopperSky Productions have been actively working with collaborators from FreshOutlook Foundation, UBCO and the City of Kelowna to meet the terms of the grant agreement.

Since the initiation of the project, we have expanded the Partnership and added additional collaborators that are now involved with the project. The City of Kelowna facilitated safe access to wastewater samples despite the challenges that COVID-19 had created with how the samples are both collected and handled.

The Okanagan Nation Alliance (ONA) Fisheries Program, with ongoing monitoring of fisheries in the Lake, offered their rigid-hull inflatable fisheries vessel and crew to conduct the open water manta trawl.

UBCO was active in the first quarter of this grant cycle, assisting with sampling design, testing the laboratory analyses, and facilitating access to laboratory facilities. However, the graduate student we were working closely with could not delay his departure for his graduate studies to Alberta and became unavailable for the freshwater sample analysis. Additional new, inbound graduate students at UBCO were offered, however, due to onboarding and training delays, we could not guarantee the analysis of water samples before the end of the grant period. Thus, we pivoted to work with Okanagan College to conduct both the wastewater and freshwater sample analysis.

The Okanagan College Water Engineering Technology (WET) program led both the wastewater and freshwater laboratory sample analysis for microplastic through the Fall Term 2021. Two groups of four (4) students, divided into the wastewater and freshwater teams, cooperated with the Partnership to process the samples, and concurrently meet their requirements as a capstone project in compliance with their degree requirements. These eight (8) students completed the sample analyses and reported their findings on the presence of microplastics in both freshwater and wastewater in November 2021 (Figure 1).

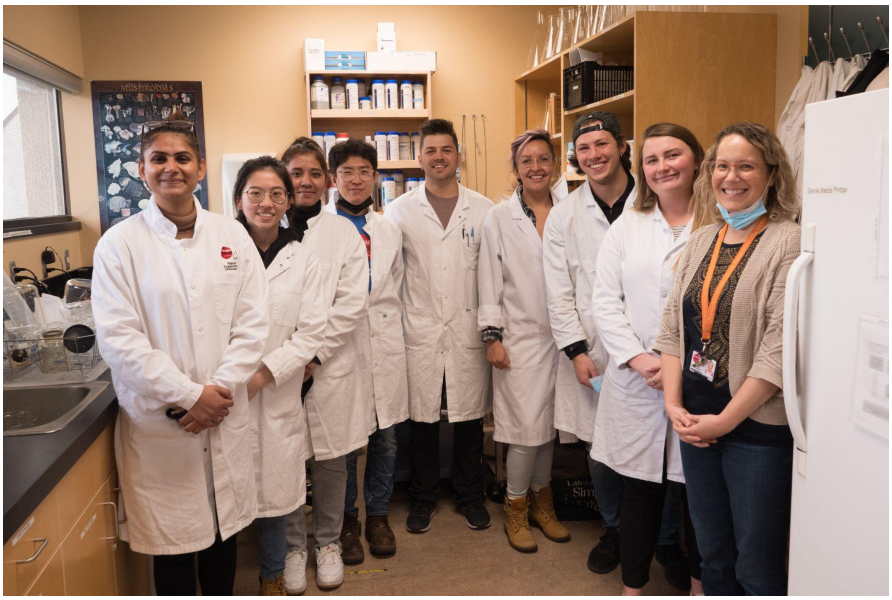

Figure 1. Okanagan College WET Capstone Students focus on Microplastics assessment in Okanagan Lake freshwater and City of Kelowna wastewater. Erin Radomske, OC (right) provided guidance and support.

3.0 Okanagan Lake Microplastics Assessment

3.1 Objectives

We have hypothesized that microplastics of anthropogenic origin have been discharged into Okanagan Lake most likely transported mostly through surface water runoff and from plastics released into the lake via wastewater from daily household activity including dishwashing, laundry, and cosmetics used in daily hygiene care, and other sources. Should microplastics be extant in the lake, we endeavoured to determine if they were detectable in surface water in Okanagan Lake, and focused our sampling in areas where they might predictably be detected if present.

3.2 Methods

Okanagan Lake surface water sampling occurred twice over the month of August 2021: August 5 to test gear and sampling protocols and again on August 25, to collect the official samples. On the first sampling trip, both UBCO (Ryland Giebelhaus) and OC (Erin Radomske) were present to assist with the collection. Following the first trip, all samples were brought to UBCO for analysis and evaluation of methods. No other details will be provided here.

Official samples were stored at OC until capstone students were identified, trained, and initiated sampling in the laboratory.

Figure 2: Manta trawl being towed in Okanagan Lake.

Surface water sampling was completed using a surface manta tow with a 0.335mm mesh net, fitted with a mesh collection bag to collect samples, generally following the 5 Gyres Manta Trawl Protocol (Figure 2). Prior to deploying, the net was checked that all hardware was fastened and secured. The net was towed next to the research vessel for ~30 minutes, on 1 km long transects, with the vessel travelling at a target rate of ~2 knots. Transect length was confirmed by handheld GPS, following test sampling vial checks that showed no more than a 50% visible collection of surface debris in the sample vial.

The collection bag contents were rinsed into a stainless steel bucket, and poured into pre labelled 1-3 glass mason/sample jar.. Each jar was labeled with sample #, time, date, transect #, and location. To prevent bacterial/algae growth, ethanol was added (>10% volume), and the jar placed into a cooler, stored at ambient temperature for transport to Okanagan College.

Each transect sieved ~31,000 litres and reduced the volume of material to fit into 2-3 1L glass mason jars. Total water filtered across all five sample sites was ~ 155,000 litres.

Okanagan Lake Freshwater Sampling Points

We identified five sampling transect points (Figure 3), three of which were hypothesized to have likely higher concentration of microplastics based on their likely origin (wastewater, mouth of Mission Creek), or were concentrating due to natural constriction (W.R. Bennett bridge). Two additional samples were collected at the widest points of the lake south and north of the bridge as general reference sampling points.

Specifically, we sampled at:

a) **Central lake at its widest point, north of the bridg**e: North of the bridge on Okanagan Lake there are numerous commercial ventures including the construction of residential properties and the decommissioning of the Tolko sawmill at the base of Knox Mountain.
b) South side of the **William R. Bennett bridge-crossing**: This represents a natural constriction and likely concentration point of any microplastics that may have been moving with the currents.
c) **Downstream of the Kelowna Wastewater Treatment Facility** near the outfall pipe where micropolastics may have been released.
d) **Mouth of Mission Creek**: Mission Creek is the largest freshwater input flowing into Okanagan lake. Additionally, Mission Creek flows through mixed-use recreational land, parks, farms, and residential neighbourhoods.
e) **Central lake at its widest point, south of the bridge**.

Figure 3: Approximate freshwater sampling locations in Okanagan Lake and at the Kelowna Wastewater Treatment Facility. August/October 2021.

3.3 Summary of Sample Analysis - Okanagan Lake

The freshwater capstone team at Okanagan College developed sampling and analysis protocols for the detection of microplastics based on NOAA's 'Laboratory Methods for the Analysis of Microplastics in the Marine Environment: Recommendations for quantifying synthetic particles in waters and sediments' (NOAA Marine Debris Program 2015) and adapted for the freshwater environment (Figure 4). They concluded that microplastics were present in all five sampled sites on Okanagan Lake. However, their relative concentrations were highly variable. Relative to other freshwater samples, microplastics in Okanagan Lake are quite low (as compared to Lake Superior, Cox et al. 2021). Similarly, relative to marine environments, Okanagan Lake is relatively low as compared to Pacific Ocean and Great Lakes datasets (Eriksen et al. 2013, Moore et al. 2001, Driedger et al. 2015.)

Figure 4: Okanagan Lake freshwater sample at Okanagan College during processing.

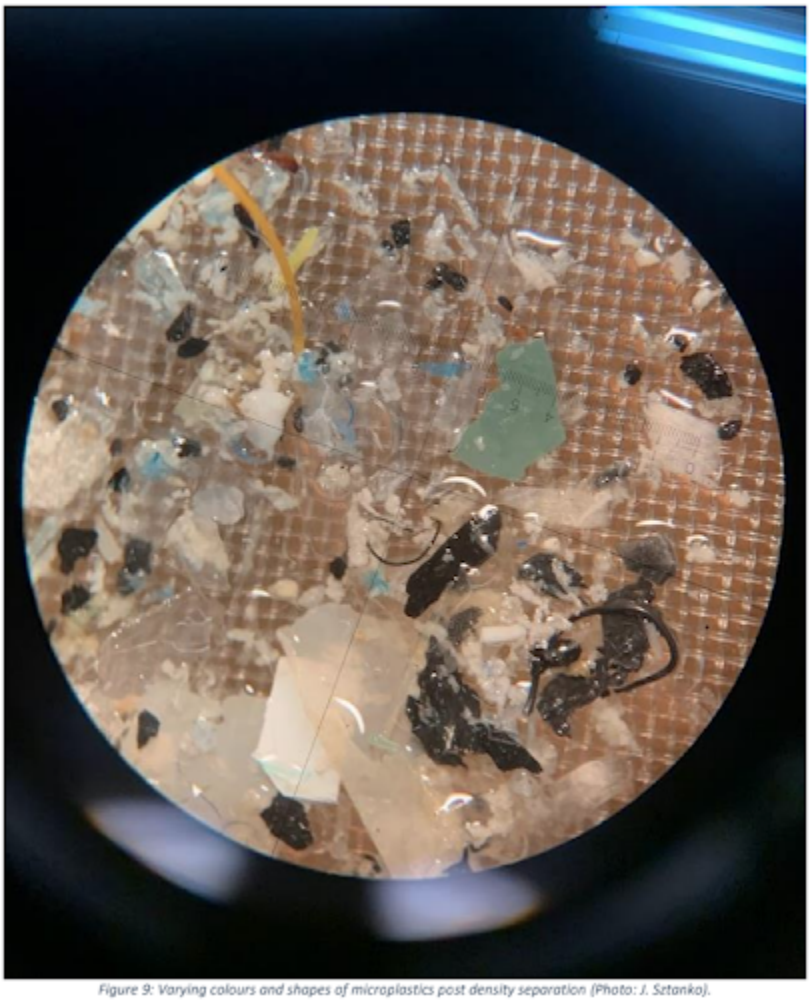

Figure 9: Varying colours and shapes of microplastics post density separation (Photo: J. Sztanko).

Figure 5: Okanagan Lake freshwater sample (Bennett Bridge) post-processing to reveal microplastic particles and suspected tire wear particles in addition to carbon particles from forest fires.

In total, about 2.75 grams of plastic were collected across all five sample locations *(out of a total of 155,000L water filtered across all sample sites).* The greatest concentration of microplastics was collected below the William R. Bennett bridge and yielded 1.1009g.

Microplastic morphology (fragments, fibres, and films) was highly varied, randomized, and did not follow a distinct pattern. However, visual analysis revealed that fragments were the most abundant morphology of microplastic collected, although some fragments mimicked the appearance of fibres. Film-type plastic was the most distinguishable of the samples but least commonly found due to the ease of degradation and resultant varying sizes. Fragments were collected at four of five locations, with abundance being greatest in the area south of the William R. Bennett Bridge. Fibres were collected at all locations, with the greatest abundance appearing in the region of the lake south of the Mission Creek outflow. Films were collected at three of five locations, with the area north of the William R. Bennett Bridge and the area south of it yielding the greatest number of films (Figure 5).

See Appendix A for further details on Okanagan Lake microplastics results.

3.4 Final Deliverables

The Partnership is delivering the following as part of its grant obligations:

1. A succinct, analysis protocol for the collection of and detection of microplastics in lake water samples.
2. Sample results, including the abundance of microplastics per sample and morphology breakdown (i.e., fibres, fragments, and films) (Appendix A and B).

4.0 City of Kelowna Wastewater Microplastics Assessment

4.1 Objective

The City of Kelowna - with the largest concentration of residents in the valley, and its wastewater treatment facility concentrating a large proportion of the resident population's wastewater – was predicted to represent the area with the highest probability of detecting microplastics. Thus, our sampling focused on influent wastewater at the treatment facility (pre-treatment) and effluent wastewater (post-treatment) before discharge into Okanagan Lake.

4.2 Methods

In cooperation with the City of Kelowna, sampling was timed to correspond with daily high water inputs into the treatment facility. This time period was chosen based on when residents were more likely to be at home and using water for laundry, dishwashing, and using hygiene products that may be washed into the sewer system.

The specific step-by-step sampling and analysis protocols were developed in collaboration with the Okanagan College WET program as outlined in Figure 6 and Appendix B.

4.3 Summary of Results- Wastewater

Following similar analysis protocols to the freshwater team, the wastewater team discovered that microplastics were present in both influent and effluent wastewater samples. The wastewater sample analysis was potentially more complex than freshwater samples, with the potential for contamination and false positives (see Appendix B). Regardless of contamination, microplastics were discovered to be extant in both inbound and outbound wastewater samples.

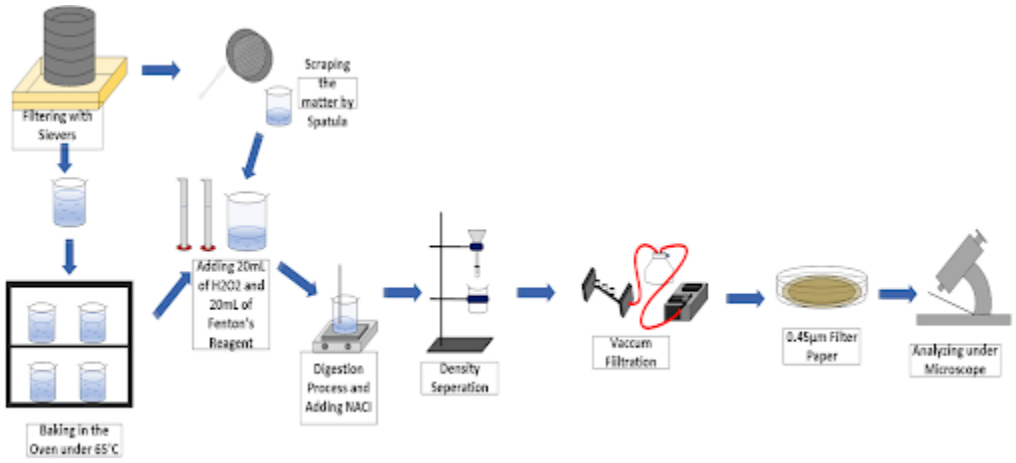

Figure 6: Graphic depiction of sample analysis procedure followed.

Most of the particles recovered in wastewater samples (based on visual observation) appeared to be microfibres (Figure 7). Some plastic films, fragments, and particles that appeared like microbeads were also observed. The most identified colours of the particles were red, blue, black and clear. Other colours observed included yellow, purple, green and pink colours (Appendix B).

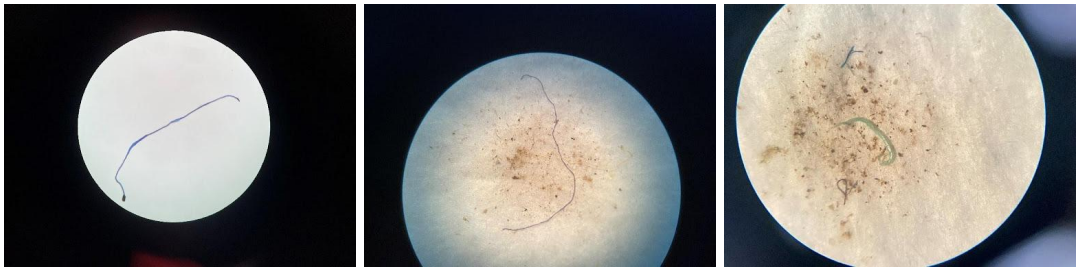

Figure 7: Kelowna municipal wastewater sample, post-processing revealed an abundance of fibres suspected to be microplastics.

4.4 Final Deliverables

The Partnership is delivering the following as part of its grant obligations:

1. A succinct, sampling technique for the collection of wastewater for microplastics; and an analysis protocol for the detection of microplastics (both abundance and morphologies)
2. Sample results, including the abundance of microplastics per sample and morphology breakdown (i.e., fibres, fragments, and films)

5.0 Communications

5.1 Objectives

The purpose of developing communication materials is to raise awareness about the project and generally, to shed light on the topic of microplastics in the Okanagan. These communication materials intend to connect the community with the larger, global context of plastic pollution in a way that is inclusive, transparent and invites inquiry and dialogue (and that does not stoke fear).

5.2 Communication Channels

A project website has been established (https://microplasticsokanagan.com/) to house information about the project, the project team, findings, and related research that ties this work to the global issue of microplastics. Similarly, social media channels have been set up on Facebook, Instagram, and Twitter, to engage with the general public through creative infographics, photos, and written stories. Through these channels, the team can report on project findings, connect with similar groups and interested individuals, and cross-post similar content from project partners and others.

Channel URLs:
Facebook: https://www.facebook.com/microplasticsokanagan
Twitter: https://twitter.com/MicroplasticOK
Instagram: https://www.instagram.com/microplasticsokanagan/

Video and still photography footage were captured along the way for use in the project trailer and forthcoming documentary film that will summarize this project's story. The still photography has been used on the website and has also been used across social media platforms and in press releases by both the project team, its partners, and media outlets. This effectively stretches the use of visual media across multiple channels and sectors.

In conjunction with World Water Day on March 22, the project team and its partners launched a joint press release about the project and its initial findings to the public. The release attracted a sizeable amount of media attention, including:

Interviews

- Daybreak South with Chris Walker: A group of researchers in the Okanagan have found microplastics in Okanagan lake

News Articles

- Global News: Microplastics found in Okanagan Lake, researchers say
- OC News: Community collaboration studies microplastics in Okanagan Lake
- Castanet: Relatively low levels of microplastics detected in Okanagan Lake, Kelowna wastewater
- Kelowna Capital News: Microplastics research being conducted in Okanagan Lake
- Infotel: iN VIDEO: Warning issued about microplastics found in Okanagan Lake
- The Golden Star: Microplastics research being conducted in Okanagan Lake

- Kelowna Daily Courier: Microplastics found in Okanagan Lake
- Kelowna Now: Research reveals presence of microplastics in Okanagan Lake

Videos

- Kelowna10: WATCH: Do microplastics pose a risk to Okanagan Lake?

The Partnership produced a short, two-minute trailer to promote the project and raise interest in and awareness of microplastic pollution in freshwater ecosystems - specifically in Okanagan Lake. As of this writing, the video has received 925 views on Vimeo, 57 views on the Okanagan College YouTube channel, and 4,131 views on Instagram with 21 shares on the platform.

The project trailer can be viewed here: https://vimeo.com/641263640

5.5 Final Deliverables

The Partnership is delivering the following as part of its grant obligations:

1. An online presence.
2. Digital infographics
3. Digital assets include press releases, newsletters, blogs, and social media posts.

The communication aspect of this project will likely be ongoing into the future as it continues into the next and future phases.

6.0 Budget

The project was budgeted at approximately $56,000, with $22,000 committed from the OBWB. To date we have secured approximately $37,000 of in-kind support from UBCO, Okanagan College, the Okanagan Nation Alliance, and FreshWater Life. No additional cash commitments were identified.

The expenses were spent on project management, supplies (sample collection and laboratory analysis), and equipment (the Manta Trawl, see Sampling Details).

The Partnership will continue to secure outside funding from a variety of supporters to produce a finished video product for use as an educational tool and inspirational piece of content. The format for this video product is to be determined (i.e., mini-documentary; docu-series; feature-length documentary, etc).

A detailed summary of the budget and expenses was provided to the OBWB in line with their reporting requirements, and available on request.

7.0 Future Activities

We anticipate that the Okanagan College WET students will complete and report out on the water sample analyses by mid-December 2021. Inevitably we expect the results of the analyses will catalyze additional questions about the significance of the results, the limits of the sampling, in addition to making recommendations to overcome the challenges faced in the laboratory analysis.

In 2022, the Partnership proposes to:

1. Form a Technical Advisory Group (TAG) that can advise the Partnership on the significance of the results, offer guidance on improving both field sampling and laboratory analysis, and potential future water sampling such as in the water column, sediment layer, and potentially in other lakes in the Okanagan Valley.
2. Based on input from the TAG, finalize protocols for future sampling and analysis.
3. Complete the 10-minute video production.
4. Coordinate with the OBWB and other partners in media outreach and communication with the people of the Okanagan Valley writ large.
5. Initiate a longer communication strategy.

8.0 Literature Cited

Cox, K., E. Brocious, S. C. Courtenay, M. R. Vinson, S.A. Mason. 2021. Distribution, abundance and spatial variability of microplastic pollution on the surface of Lake Superior. Journal of Great Lakes Research. Volume 47:5: 1358-1364.

Driedger, A.G.J., H.H. Dürr, K. Mitchell, P. Van Cappellen. 2015. Plastic debris in the Laurentian Great Lakes: A review. Journal of Great Lakes Research. Volume 41:1:9-19.

Eriksen,M., N. Maximenko, M.Thiel, A. Cummins, G. Lattin, S.Wilson, J. Hafner, A. Zellers, S.Rifman. 2013. Plastic pollution in the South Pacific subtropical gyre. Marine Pollution Bulletin. Volume 68: 1–2: 71-76.

Masura, J., J. Baker, G. Foster, C. Arthur and C. Herring. 2015. Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48.

Moore, C.J., S.L Moore, M.K Leecaster, S.B Weisberg. 2001. A Comparison of Plastic and Plankton in the North Pacific Central Gyre. Marine Pollution Bulletin. Volume 42:12:1297-1300.

5 Gyres Manta Trawl Protocol - ‘Manta Trawl Trawlshare Protocols’ (no date).

9.0 Acknowledgements

The Project team wishes to thank the following organizations and individuals for their time, commitments, and energies to date:

Okanagan Basin Water Board & the WCQI Grant Program
Okanagan Nation Alliance: Sam Pham, Dave Tom (Vessel Operator)
City of Kelowna: Ed Hoppe, Jen Anderson
Okanagan College: Erin Radomske, Allison O'Neill, David Teasdale, Frank Carey, and WET Capstone Students & Lab Techs:

Wanda Cosford
Quinn Dartnell
Megahan McCreight
Joshua Sztanko
Tejveer Kaur
Harjit Kaur
Jongsun Park
Shu Ying Sai
Cascade Tong and Isabelle Curyk (Bio/Chem lab tech)
Michelle Toftland (WET lab tech)

UBCO PlantSMART Lab: Dr. Susan Murch, Ryland Giebelhaus
Fresh Outlook Foundation: Joanne De Vries
5 Gyres: Dr. Marcus Eriksen
Institute for Underwater Research (IFUR): Raphael Nowak

10.0 Appendices

Two Appendices follow:

Appendix A: Microplastics in Okanagan Lake: A Qualitative and Quantitative Analysis (freshwater results)

Appendix B: Microplastics in wastewater capstone project report