FY17 HERC Undergraduate Research: *Institution Name*

Student(s)	Major(s)	Project Summary	Project Amount	Stipend(s)	Supplies	Travel	Faculty Mentor	Dissemination
Mari Carillo	Biology/Social Sciences:Anthropology Emphasis	Medical Pluralism: Shifts in traditional knowledge and practice amoung Sobadores and medical practitioners	3,039	2,460		579	Kerensa Allison	Presented at the ICUR virtural conference.
Rhiana Fox	Math & Psychology	Using Data Analytics to study the psychological effects due to long-term illness.	3,510	3,510			Heather Moon	Presented at the ICUR virtural conference.
Gary McEwen	Exercise Science	Effects of Bio-Electro-Magnetic-Energy-Regulation (BEMER) on recovery and performance in Anaerobic Exercise Tests	1,000	1,000			Collin Fehr	Presented at the ICUR virtural conference and the ACSM meeting in Boise, Idaho.
Tristan Olsen	Mathematics and Chemistry	Using Parametric Linear Programming to approximate phase state curves	3,510	3,510			Heather Moon	Presented at the ICUR virtural conference and the ACSM meeting in Boise, Idaho.
Abbey Roy	Biology	Studying long-term biological consequences of Blm-deficient embryonic development in Drosophila.	2,560	2,560			Eric Stoffregen	Presented at the ICUR virtural conference.
Judy Boozer	Biology	Use of Amphioxus as a model for Regenerative Medicine.	1,624	1,176	448		Leigh Latta	Presented at the ICUR virtural conference.
Dylan Miller	Biology, Chemistry	Method Development for the Determination of Uptake Rates used in Passive Sorbent Tube-Type Sampling.	1,440	1,440			Nancy Johnston	Presented at the ICUR virtural conference.
Eli Moser	GeoChemistry	Collection and analysis of mobile sulfer compound data around a pulp papermill in northern-central Idaho.	1,440	1,440			Nancy Johnston	Presented at the ICUR virtural conference.
Elias Pukkila	Chemistry/Biology	Analysis of multiple anions in the water supply and surrounding natural water deposites of North Idaho.	1,480	1,080	400		Nancy Johnston	Presented at the ICUR virtural conference.
Ryan Glimp and McKenzie Malm	Kinesiologgy:Exercise Science (Glimp) Kinesiology:Health & Fitness (Malm)	Body Dysmorphia Occurrence in College Athletes versus College Students	1,482	1,344	138		Clay Robinson	
Totals		**Payments**	**21,085**	**19,520**	**986**	**579**		
		FY21 HERC Undergraduate funding received	**20,000**					
		# undergrads participating in research	11					

8/5/2020

Dear Provost Stinson:

Hello, my name is Eli Moser. This summer I had the privilege to be funded by the State Board of Education Higher Education Resource Council and Provost Stinson to conduct research on sulfur dioxide (SO_2) in the air in the Lewis-Clark Valley. Sulfur dioxide in our valley is partially responsible for the noxious odor that hangs in the valley. It is emitted by industry such as the local paper mill. SO_2 is a criteria pollutant monitored by the EPA but has never been monitored constantly for a significant amount of time in the area. SO_2 is known to cause irritation of the skin and respiratory system and increases the symptoms in people with preexisting respiratory issues. SO_2 also has corrosive environmental effects such as acid rain and the reduction on growth in foliage existing in high concentration areas.

My project goals were to measure SO_2 constantly and find trends temporally, spatially, and seasonally. To achieve this, we sampled 24 hours a day since June 2019, and continue to sample from the lab and on a mobile platform. We analyzed the data and found that temporally there was a spike in concentration through the morning and has been a constant increase in concentration for the past year. Spatially, from the few sampling runs we have done agree that there is an increase in concentration with an increase in elevation. The title of my project was *Collection and analysis of mobile sulfur compound data around a pulp papermill in northern-central Idaho.* As the project developed the final poster title that was presented at the Idaho Conference of Undergraduate Research (ICUR) was *Analysis of Sulfur Dioxide Emissions in the Lewis-Clark Valley.*

Similar to the project itself, I developed as a scientist and a person over the course of this project. I have learned more of the chemistry of SO_2 in the atmosphere and instrumentation than I previously had exposure to in classes or normal lab procedures. I had the opportunity to be exposed to the grant writing process as well as method development and all of its trial and error. Perseverance is an essential element of conducting research and has taught me many lessons like better communication and time management. I believe that future projects will be vastly improved by the experience that I have gained while taking on this project. I am very thankful for the opportunity and hope to assist more students in the future to have a similar research experience.

Sincerely,

Elijah Moser

Analysis of Sulfur Dioxide Emissions in the Lewis-Clark Valley

Moser, E.P.; McGarry J.K; Johnston, N.A.C. Ph.D.
Division of Natural Sciences and Mathematics
Lewis-Clark State College

Introduction

- Sulfur dioxide (SO_2) is produced as a byproduct of burning fossil fuels or chemical reactions used by industries such as kraft paper mill production.
- A kraft paper mill is a major industrial pollution source in the Lewis-Clark Valley; a community that rests at the confluence between the Snake and Clearwater Rivers and includes parts of Southeastern Washington and North central Idaho.
- SO_2 is a criteria pollutant that is monitored by the EPA because in the atmosphere because it is an indicator of other sulfur species SOx concentration and
  - It creates acid rain and while gaseous can damage plant growth and foliage
  - accelerates respiratory issues such as asthma
- The goal of this study is to discover:
  - How SO_2 pollution varies in a water gap valley
  - Diurnal variation of concentrations including
  - Plume movement throughout the day morning to noon versus noon to dusk
  - Daily / weekly / monthly averages or seasonal variation
  - Spatial variation of concentrations throughout the valley
- SO_2 was monitored using a Teledyne T102, UV fluorescence-total reduced sulfur analyzer.
- Sampling was done in both a stationary location (LCSC instrument lab) and on a mobile platform that was driven around the valley

Methods and Materials

- A Teledyne T102, UV fluorescence-total reduced sulfur analyzer was used in SO_2 mode during mobile operation and in SO_2 and TRS (Total Reduced Sulfur) mode switching every 10 minutes during stationary operation.
- While conducting stationary sampling the analyzer was calibrated with NIST traceable 5.0 ppm +/- 10% sulfur dioxide gas cylinders as standards controlled via a T700 dilution calibrator and a T701 zero air generator.
- Calibration checks were conducted while sampling in the field with a Metronics Dynacal 140 ng/min +/- 25% wafer permeation tube.
- Sampling sites seen in Figure 1 were chosen to bisect the paper mill and explore different elevation gradients.
- SO_2 was sampled continuously from the LCSC instrument lab from June 2019 to present, while Mobile operations took place in a Chevy Volt on 7/1-7/1/2020.
- During mobile sampling the relative humidity, atmospheric pressure, temperature, wind speed and direction both locally and on a valley wide average as well as times were recorded while in the field.
- Data analysis of raw 1-minute data was streamlined by using Python to create data files and statistics.

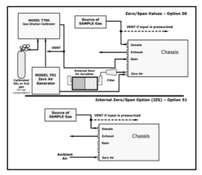


Figure 1. diagram of the setup that was used to calibrate and sample SO_2 in the lab. [1]

Figure 2. Eli Moser calibrating the T102 sulfur analyzer.

Figure 3. Chevy Volt housing the sulfur analyzer and sampling via an intake tube out of the back window.

Results

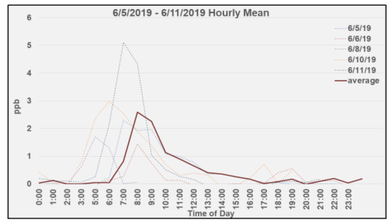


Figure 4. The hourly average measured in ppb for 7 days in June and the average of all the days in series displaying a peak from hours of 6:00 to 12:00 at LCSC site.

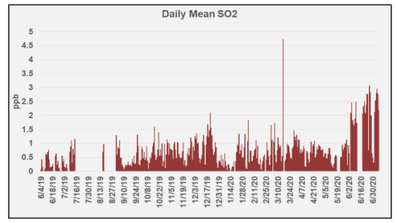


Figure 5. The daily average SO_2 for June at LCSC site 2019-2020 with concentrations in ppb.

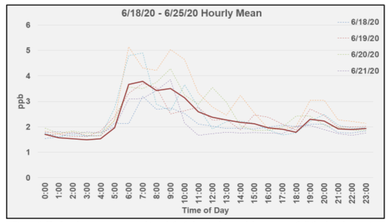


Figure 6. The hourly average measured in ppb for 8 days in June and the average of all the days from series displaying a peak from 7:00 to 12:00 at LCSC site.

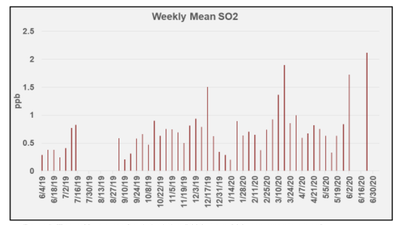


Figure 7. The weekly average for 2019-2020 at LCSC site and SO_2 concentrations in ppb.

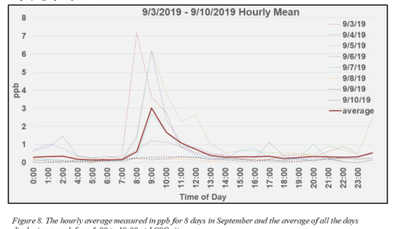


Figure 8. The hourly average measured in ppb for 8 days in September and the average of all the days displaying a peak from 5:00 to 18:00 at LCSC site.

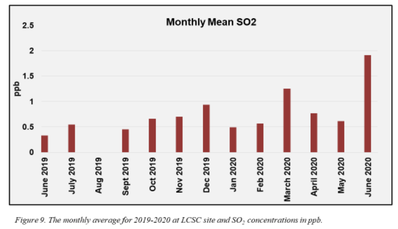


Figure 9. The monthly average for 2019-2020 at LCSC site and SO_2 concentrations in ppb.

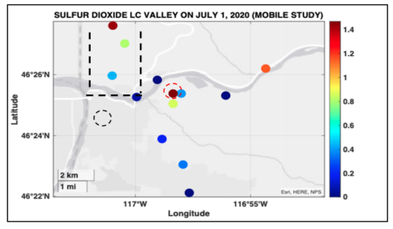


Figure 10. Mobile sample sites in the Lewis-Clark valley and SO_2 concentration in ppb on July 1, 2020. Red circle marks the Paper Mill location. The black circle indicates the stationary site at LCSC.

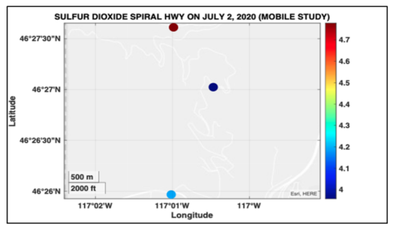


Figure 11. Mobile sample sites in the Lewis-Clark Valley and SO_2 concentration in ppb. These sites are from insert on Figure 10.

Conclusions

- There is a consistent peak SO_2 from about 6:00 AM to 12:00 PM during the day and otherwise the days and nights are low.
- SO_2 appears to be rising throughout the year at a slow rate. This could be coincidence, weather related or increased emissions.
- There may be certain months that have higher concentrations however more data is needed to confirm.
- Although data is limited (two sample runs on 7/1/20-7/2/20), the mobile sampling suggests an increase in SO_2 concentration with an increase in elevation. This could be from the heat released causing the SO_2 to rise in a column and then disperse with the inversion layer.
- We also see low concentrations of SO_2 directly beside the mill although the smell is distinctly stronger meaning the odor may be other compounds in addition to SO_2
- In the future we plan to sample in a stationary position at different locations and attempt to track plume movement as it correlates to temperature and elevation.
- SO_2 levels in LC Valley are considered at or below attainment.[2]

Figure 12. A photo of the Clearwater Paper Mill on the Clearwater River. Photo taken by Nancy Johnston.

References

1. Teledyne API. (2012, June 11). Model T102 Total Reduced Sulfur Analyzer with Model 501 TRS Thermal Analyzer. San Diego, CA.
1. United States Environmental Protection Agency. (2017, January 19). *Sulfur Dioxide (SO2) Pollution*. Retrieved from EPA.gov: https://www.epa.gov/so2-pollution

Acknowledgements

- This research was sponsored by a Higher Education Research Council Grant, Idaho State Board of Education's Higher Education Research Council, This publication was made possible by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under Grant #P20GM103408 and Lewis-Clark State College.
- Additional assistance that made this research possible was provided by Gabrielle Dickenson and Timbre Durbin.
- Contact: Elijah Moser (epmoser@lcmail.lcsc.edu)

Idaho State Board of Education

IDAHO INBRE
IDeA Network of Biomedical Research Excellence

30-Jul-20

Provost Lori Stinson, Ph.D., RN
Lewis-Clark State College
c/o Office of the Provost
500 8th Avenue
Lewiston, ID 83501

Dear Dr. Stinson,

I want to thank you for facilitating my Summer 2020 Idaho HERC award. As this component of my project comes to a close, I reflect on the results we have achieved from a very positive outlook. The HERC grant I received was instrumental in initiating our study of diffusive uptake rates for use with passive air sampling. I'm so grateful for the steps forward these funds have allowed me to take as a student researcher and critical thinker.

At the Idaho Conference on Undergraduate Research this month, I presented the poster entitled "Determination of Diffusive Uptake Rates for VOCs on Passive Thermal Desorption Air Samplers". This was the first public sharing of my work with uptake rates. Our preliminary results indicated confidence in the method conducted and relevant literature comparison showed commensurate data with derived uptake rates. Attached is a copy of the presented material. For the remainder of the summer and throughout the coming academic year, our goals for the project will include the expansion of our data sets including uptake rates of up to two weeks working toward eventual publication in a scientific journal.

Again, thank you so much for your support of this research!

With Gratitude,

Dylan Miller

Determination of Diffusive Uptake Rates for VOCs on Passive Thermal Desorption Air Samplers

Dylan D. Miller and Nancy A.C. Johnston, Ph.D.
Division of Natural Sciences and Mathematics, Lewis-Clark State College, Lewiston, ID

LEWIS CLARK STATE COLLEGE
NATURAL SCIENCES & MATHEMATICS

Background

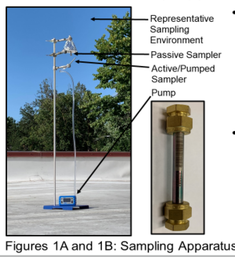
- The LCSC VOC air research group is conducting ongoing studies on air pollutants and wildfire emissions with pertinence to human heath risk.
- Thermal desorption tube-type samplers are a common method for air sampling. This can be done actively by pumping air through the sampler or passively by the diffusion of compounds onto sorbent.[1]
- Sampling passively offers an average concentration of compounds over the sample period, which is important in human health risk assessment.[2]

Introduction

- Passive sampling requires the use of an uptake rate (UTR), the rate at which compounds diffuse into the sampler and onto the sorbent.[3]
- UTRs published in the scientific literature are lacking. [4]
- The purpose of this research is to expand the literature of established UTRs via a synchronized active/passive sampling technique.

Methods

- Necessary components of UTR calculations were obtained by parallel active and passive samples.
- Two sampling trials of 24-hour duration with one duplicate were conducted using this technique.
- Experimentation was performed in outdoor ambient environments.
- Active samples were taken for 4 hours with a flow of 20 mL/min to accompany passive sampling.



Figures 1A and 1B: Sampling Apparatus and Sorbent Tube.

- Blank correction was accomplished by the subtraction of all trials' averaged field blanks from both passive and active samples.
- All Samples were analyzed using TD-GC-MS and chromatograms were individually verified for quality.

Methods (cont.)

Thermal Desorption - Removes compounds of interest from the sampler with high temperatures → Gas Chromatography – Separates sampled compounds into pure species by their physical properties → Mass Spectrometry – Identifies compounds based on the mass of their fragments after ionization

Calculations

- Algebraic manipulation of a concentration equation for passive samplers derives the equation for uptake rate calculation.

$$C = \frac{(m_{passive\ sampler} - m_{blank}) \times 1000}{UTR \times t}$$

$$UTR = \frac{(m_{passive\ sampler} - m_{blank}) \times 1000}{C_{active\ sampler} \times t}$$

- To calculate uptake rates (UTR), $C_{active\ sampler}$ (concentration) was provided by active samplers, m (sorbed mass on sample) was provided by passive samplers, and t (time) is duration of the sample.
- Active sample concentrations were averaged to provide the mean concentration over the sample period (24-hr).

Sample Calculation: Benzene (24-hr UTR)

Active Sampler (Avg.) → 0.3199 ng/L = $C_{active\ sampler}$
Passive Sampler → 0.2454 ng = $m_{passive\ sampler}$
Field Blank → 0.1040 ng = $m_{field\ blank}$
Pump
Sampling Duration = 1440 min.

$C_{active\ sampler}$ calculated with: ($m_{active\ sampler}$ – $m_{field\ blank}$)/ Volume Sampled

$$UTR = \frac{(0.2454\ ng\ -\ 0.1040\ ng) \times 1000\ \frac{mL}{L}}{0.3199\ \frac{ng}{L} \times 1440\ min}$$

$$= \frac{141.4\ ng\ mL}{460.7\ ng\ min}$$

$$UTR = 0.3060\ \frac{mL}{min}$$

Results

Compound	24-hr Trial 1 UTR (mL/min)	24-hr Trial 1 Duplicate UTR (mL/min)	24-hr Trial 2 UTR (mL/min)	24-hr Trial Averages (mL/min)	Literature comparison (7-day period)[2] (mL/min)
Benzene	0.31	0.21	0.80	0.44 (+/- 0.26)	0.30
Toluene	0.25	0.22	0.74	0.40 (+/- 0.24)	0.35
Ethylbenzene	0.29	0.27	0.81	0.46 (+/- 0.25)	0.35
m,p-Xylene	0.21	0.19	0.70	0.37 (+/- 0.24)	0.39

Figure 2: 24-hour uptake rates (mL/min) averaged from all trials and compared to related literature data (1-week rates). There are no directly comparable 24-hour rates in the published literature.

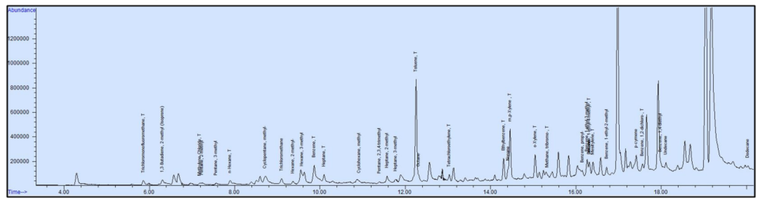


Figure 3: Chromatogram showing a normal response for actively sampled air samplers.

Conclusions

- Agreement between experimental data and comparable published uptake rates is observed.
- Preliminary data suggests confidence in the method due to these agreements.
- Fewer uptake rates than expected were calculated. This is due to the fact that compounds whose uptake rates are derived are quantified on both active and passive samplers. This experimentation yielded a phenomenon in which many more compounds were quantified on active samplers in comparison to passive samplers. This may be resolved with longer sample durations.
- With the measurement of additional uptake rates, LCSC VOC 2019 data set from our participation in NASA/NOAA FIREX-AQ will be retrospectively evaluated for human health risk.


Credit: Colorado State Forest Service

References

1. US EPA. (2019). Method 325A—Volatile Organic Compounds from Fugitive and Area Sources. Retrieved from https://www.epa.gov/sites/production/files/2019-08/documents/method_325a.pdf.
2. Walgraeve, Christophe, et al. "Diffusive sampling of 25 volatile organic compounds in indoor air: Uptake rate determination and application in Flemish homes for the elderly." Atmospheric environment 45.32 (2011): 5828-5836.
3. Walgraeve, Christophe, et al. "Uptake rate behavior of tube-type passive samplers for volatile organic compounds under controlled atmospheric conditions." Atmospheric environment 45.32 (2011): 5872-5879. (2).
4. Brown, V.M., et al., Long term diffusive sampling of volatile organic compounds in indoor air, Environmental Technology,(1993), 14: 771–777, http://dx.doi.org/10.1080/09593339309385348.

Acknowledgements

- This research was supported by an Idaho Higher Education Research Council Grant and an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under Grant #P20GM103408, Idaho State Board of Education's Higher Education Research Council and Lewis-Clark State College.
- This research was assisted by Gabrielle Dickinson, Elias Pukkila, Timbre Durbin, Elijah Moser, Aakriti Bajracharya, and William Bruchard.

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Analysis of Nitrate and Other Anions in Natural Water Sources of North Central Idaho

Elias J. Pukkila and Nancy A. C. Johnston

Division of Natural Sciences and Mathematics, Lewis Clark State College, Lewiston, Idaho

Abstract

Nitrates in the water supply may cause cancer and birth defects when ingested. Nitrates are introduced to the water supply when farmers use fertilizer for their crops. The fertilizer contains high concentrations of nitrates. These nitrates are then able to enter various water sources via runoff from rain. Water samples from various water sources in North Central Idaho during early summer were collected. Nitrates and six other anions (Fluoride, Chloride, Nitrite, Bromide, Phosphate, and Sulfate) were analyzed using ion chromatography. Only Fluoride, Chloride, Nitrate, and Sulfate were detected in any of the samples. No amounts of nitrate analyzed exceeded the EPA MCL (maximum contaminant level) except for one site located in a small creek located in a valley between two farms. Therefore, analysis shows little risk of health danger for most water sources in North Central Idaho.

Introduction

- Runoff from farmland can cause high concentrations of nitrate to flow into different water sources which can be harmful to biological systems when ingested.
- Sites were chosen based on the EPA's nitrate priority areas. These are areas which have had high nitrate levels that need to be monitored.[1]
- One of these areas is located to the east of the Lewis-Clark valley. Sites were picked along the river to observe any change in anions as creeks located in these nitrate priority areas were deposited into the river.
- Two samples were taken from each site on different days during the beginning of Summer.

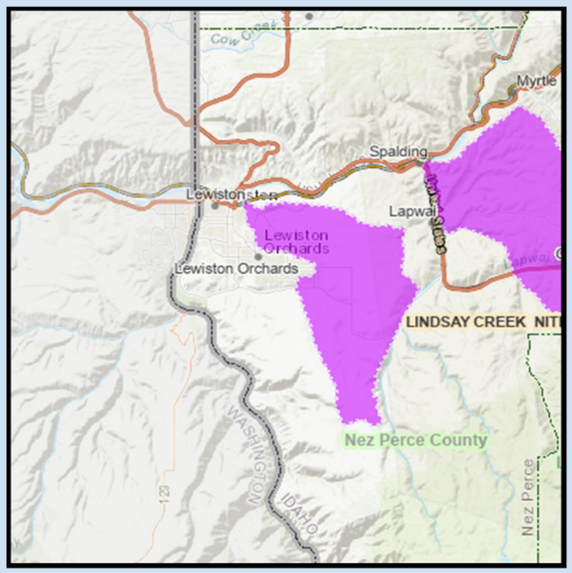

Figure 1: EPA Nitrate Priority Map

Results/Discussion

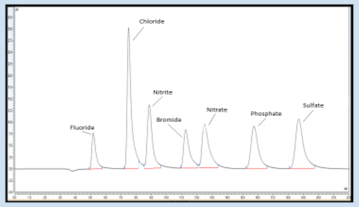

Figure 2: 50 ppm 7 Anion Standard Chromatogram

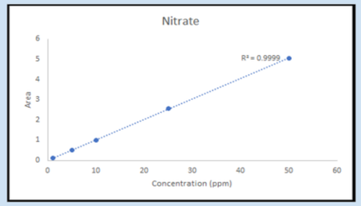

Figure 3: Nitrate Calibration Curve

Day 1 - Day 2 -

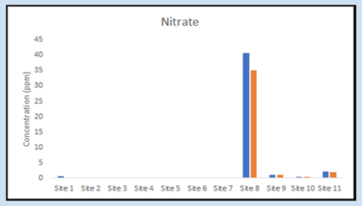

Figure 4: Source Water Nitrate Concentrations

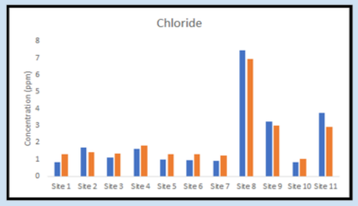

Figure 5: Source Water Chloride Concentrations

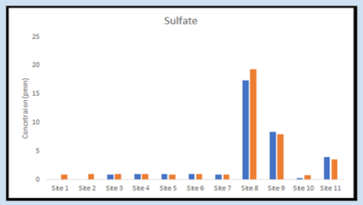

Figure 6: Source Water Sulfate Concentrations

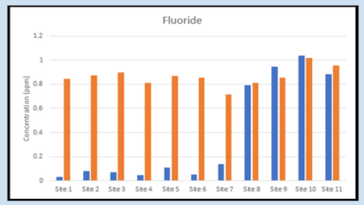

Figure 7: Source Water Fluoride Concentrations

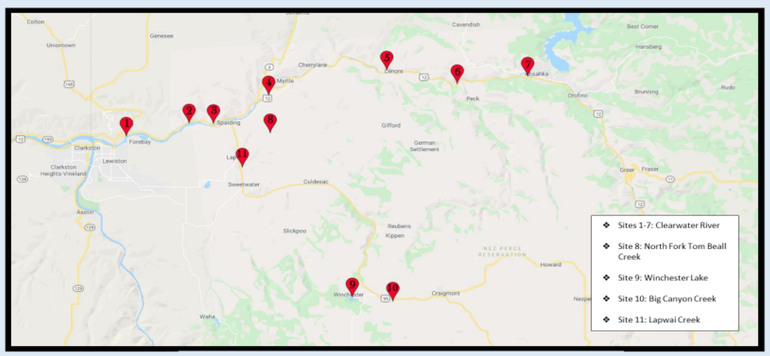

Figure 8: Map of Source Water Sampling Sites

Methods

- Water samples were retrieved from the several locations provided in *Figure 2*. 500 mL PTFE bottles were used to store the liquid before analysis.
- The samples were analyzed no later than 48 hours after they were extracted and were syringed through 0.46 um filter before injection into the ion chromatogram.
- Standards were prepared using a Thermo standard stock solution containing the 7 anions being analysed. 5 different concentration levels were made to create a calibration curve (50 ppm, 25 ppm, 10 ppm, 5 ppm, and 1 ppm)

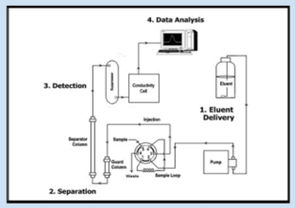

Figure 9: Ion Analysis Process

IC Parameters

- Column: Dionex IonPac AS 14A
- Suppressor: Dionex AERS 500 14mm
- Flow: 0.7 mL/min
- Current: 30 mA
- Eluent: 8 mM Carbonate/ 1mM Bicarbonate
- Run time: 22 min

Conclusions

- No amounts of Nitrite, Bromide, or Phosphate were detected in any source water sample. Concentrations for these anions may have been under the LOD for the experiment.
- Chloride and Sulfate concentrations of all samples stayed well below the EPA's set MCL of drinking water of 250 ppm.[2]
- The source of the Fluoride in the drinking water is possibly from the addition of fluoride to drinking water.
- Sampling site 8 was the only site to show Nitrate concentrations exceeding the EPA's established MCL of 10 ppm.[3] This is possibly due to the farmland to both sides of the creek.
- All other sampling sites were well below the MCL for nitrate.

References

1. Idaho Department of Environmental Quality, 2014 Nitrate Priority Areas, retrieved from https://mapcase.deq.idaho.gov/npa/
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