ACWA

Advancing Canadian Water Assets

An Urban Alliance initiative

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Development of an Adaptive Monitoring and Management Framework for Environmental Substances of Concern (ESOCs) in Wastewater; a Collaborative Research and Innovation demonstration.

What is ACWA: Advancing Canadian Water Assets

- Globally-unique **technology test bed** and **research facility**, where researchers, municipalities and industry can de-risk water technologies and management approaches.
- Embedded within City of Calgary's Pine Creek Wastewater Treatment Centre.

- Themes:
  - Technology Development and Demonstration (municipal + industrial)
  - Environmental Effects
  - Public Health

What is ACWA?


Experimental Creeks
Analytical Lab
Treatment Modules
PC WWTP = 100,000 m³/d
ACWA tertiary = 510 m³/d
ACWA streams ea. 1,200 m³/d

ACWA Infrastructure: Treatment Modules

- Tertiary treatment modules (UF, RO, UV, O_3)
- Piloting and tech demonstration

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ACWA Infrastructure: Experimental Creeks

- 12 replicated creeks: receiving environment testing
- Controlled area for mesocosms & pilot testing

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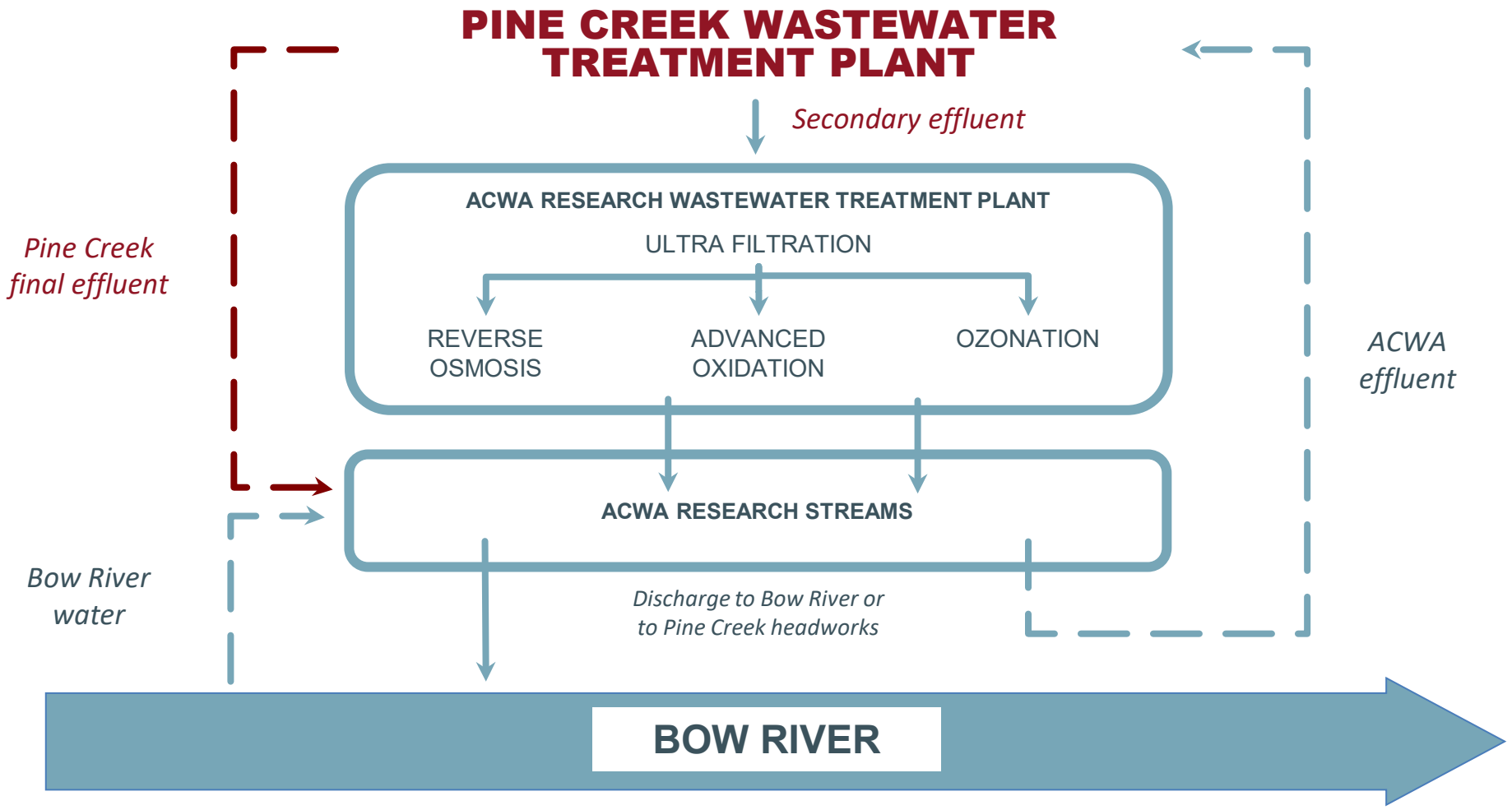
ACWA is integrated into a full-scale municipal WWTP



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ACWA Infrastructure: Laboratories, on-site + on-campus

- **Analytical chemistry** *(on-site)*
  - Develop cutting-edge analytical methods
  - Measure contaminants of emerging concern
- **Aquatic ecotoxicology** *(with BioScience)*
  - Measure effects of individual contaminants and mixtures with exposure studies
- **Microbiology & gene sequencing** *(with Medicine + Vet Med)*
  - Sequence bacteria and viruses (determine mechanisms of antimicrobial resistance and monitor pathogens)
- **Stable isotopes** *(with GeoScience)*
  - Trace nutrient and contaminant fluxes

ACWA is more than a place – it's an approach

- Innovation-driven approach.
- More than a facility – **greatest asset** is the broad **network of specialists** that we bring to projects.
- We are here to help unlock key advancements in water, wherever those occur:
  - Large and small
  - Physical and digital
  - Local and international
  - Knowledge creation and mobilization

ACWA Project Examples

1. COVID-in-wastewater monitoring with AHS.
2. Adaptive monitoring for environmental substances of concern.
3. Alberta's first potable reuse water (with Village Brewery & Xylem).
4. Helping Shell improve industrial treatment efficiency & reduce costs.
5. Optimization of RO using artificial intelligence.
6. New lab methods for cannabinoids, pthalates, antibiotics, hormones, etc.

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How we help: Our offerings

Researchers & Universities

- *Access a world-class facility to do leading-edge research.*

Municipalities & Industry (technology end users)

- *Get better solutions for your key water challenges.*

Technology developers & vendors

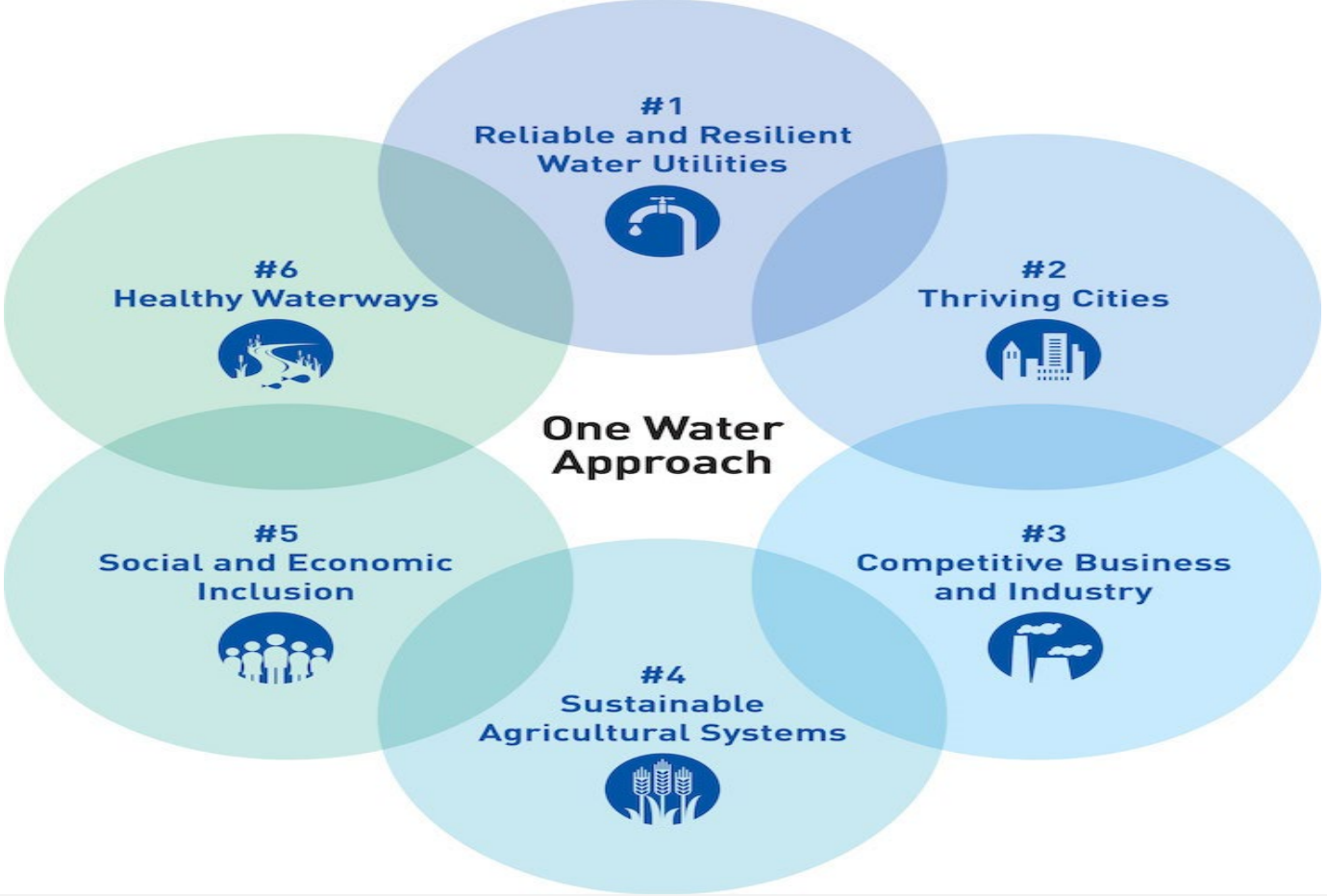
- *De-risk and demonstrate your tech at a unique test bed.*

Regulators

- *Pilot test policies, guidance docs & regs before finalizing / releasing them.*

NGOs

- *Access a network of researchers & wealth of knowledge.*



https//research.ucalgary.ca/acwa

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Researchers & universities,

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Bow River Ecosystem Health Assessment (BREHA)

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National Water and Wastewater Conference

Patricija Marjan
Department of Biological Sciences
University of Calgary

November 8th, 2022

BREHA Project Objectives

- Better understand the impacts of Calgary's municipal effluents
- Differentiate the relative importance of municipal effluents and storm waters, identify priority areas of concern in the Bow River, and in the long term, integrate with the South Saskatchewan regional monitoring system
- Integrate research with the development of a provincial Environmental Effects Monitoring (EEM) approach for Alberta's wastewater facilities

Pine Creek Wastewater Treatment Plant - Calgary

Dale Hodges Park storm water pond/wetlands - Calgary

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Knowledge and Technology Objectives

1. Identification of key responses to wastewater/stormwater at multiple levels of biological organization from primary productivity to fish responses through a set of semi-controlled, field-based exposures or field-based surveys to develop thresholds that can be used to guide optimization of water/wastewater treatment by the City
2. Identified key indicators and associated monitoring triggers will be used to identify areas of potential concern in the Bow River Watershed within the City, and
3. Engagement with the City, stakeholders and local Indigenous communities to develop knowledge translation and communication tools and approaches specific to evaluating ecosystem changes in the presence of wastewater.

BREHA Team and Network

- Collaboration with research groups at University of Calgary and other universities in Canada (and the United States)
  - 11 HQPs and 3 PIs at University of Calgary (UofC) and 3 PIs from other Universities (+HQPs)
- Partnership with the City of Calgary and Advancing Canadian Water Assets (ACWA)
- Additional partnerships:
  - Alberta Innovates, NSERC, Bow River Basin Board, Indigenous communities, the River Watch (Institute of Alberta), Bow River Trout Foundation, Alberta Environment and Parks, Environment and Climate Change Canada

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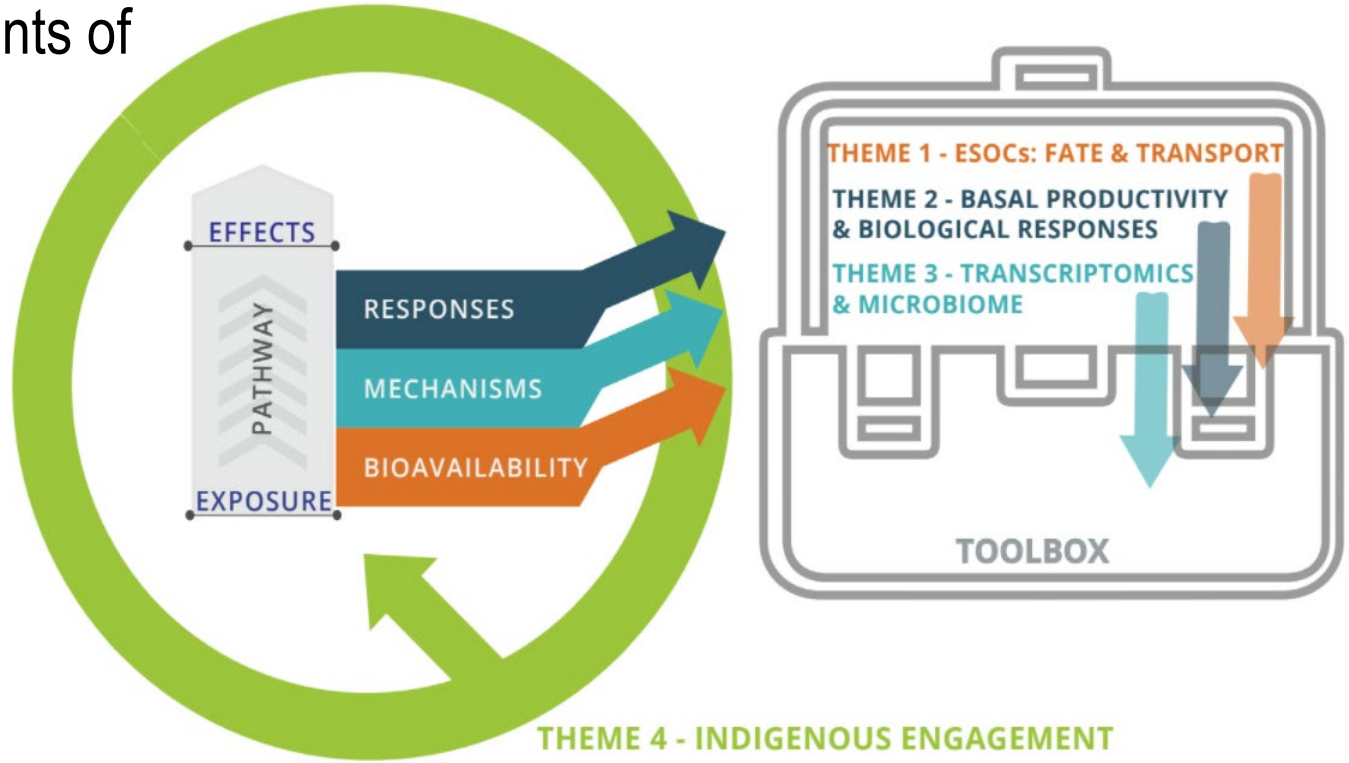
Scientific Objectives

- BREHA seeks to develop a comprehensive and integrated assessment of the following components of the Bow River system:
  - Physio-chemical parameters (Environmental Substances of Concern; ESOCs)
  - Basal productivity
  - Fish health and responses
  - Indigenous knowledge



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Theme 1 (T1): Emerging Substances of Concern (ESOCs)
Fate and Transport

- Develop fate and transport models for ESOCs chemistry
- Incorporate ESOC concentrations with fate/transport assessments in water and soil/sediments to associate exposures with biological effects (identified in T2 and T3).
- Couple toxico-kinetics results with a river hydrological model to identify significant processes that contribute to ESOCs fate/transport and effects

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Theme 2 (T2): Basal Productivity & Biological Responses

- Examine changes in changes in periphyton, macroinvertebrates, and microbial communities in the ACWA streams and in the Bow River

1) improving our understanding of nutrient-contaminant interactions on autotrophic and heterotrophic energy pathways
2) quantify benthic food web response and the relative importance of contaminant transfer pathways
3) understanding responses with traditional EEM endpoints for benthic macroinvertebrates, biofilm primary producers, and fish

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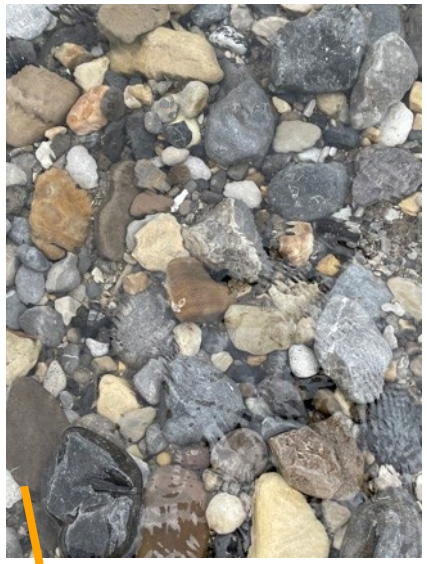
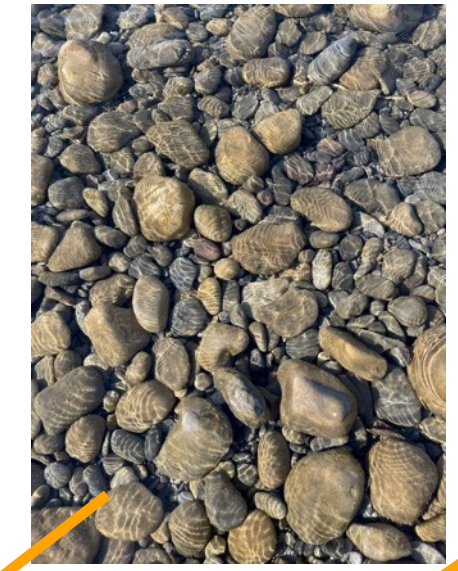


Upstream Canmore
MWWE

Downstream Canmore
MWWE



Bowmont

Downstream Nose Creek

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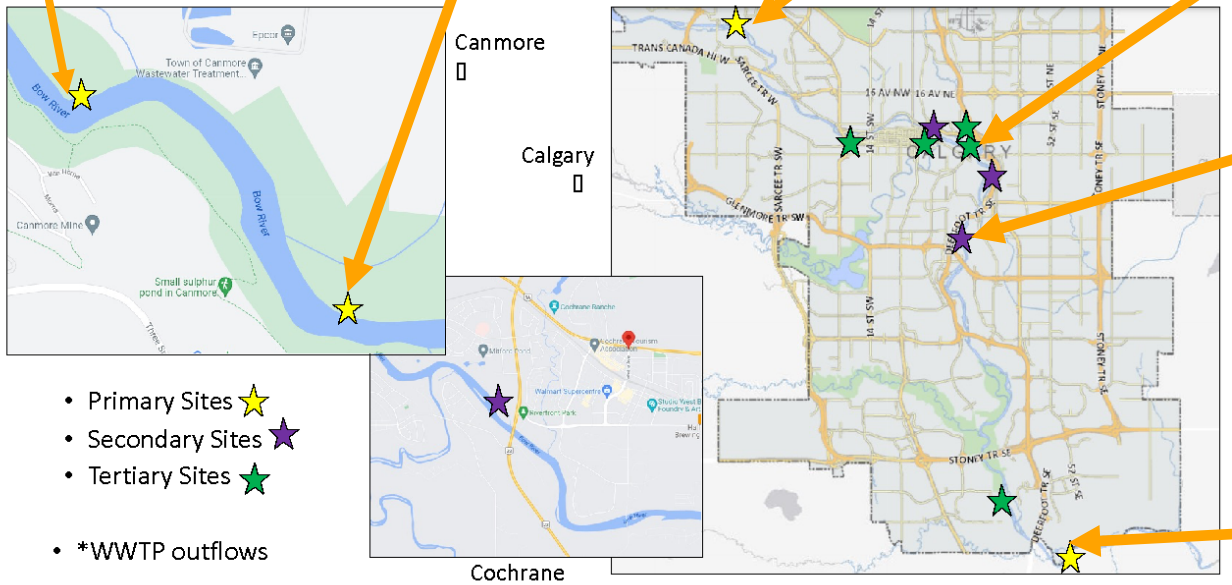
SAMPLING DESIGN- SITES



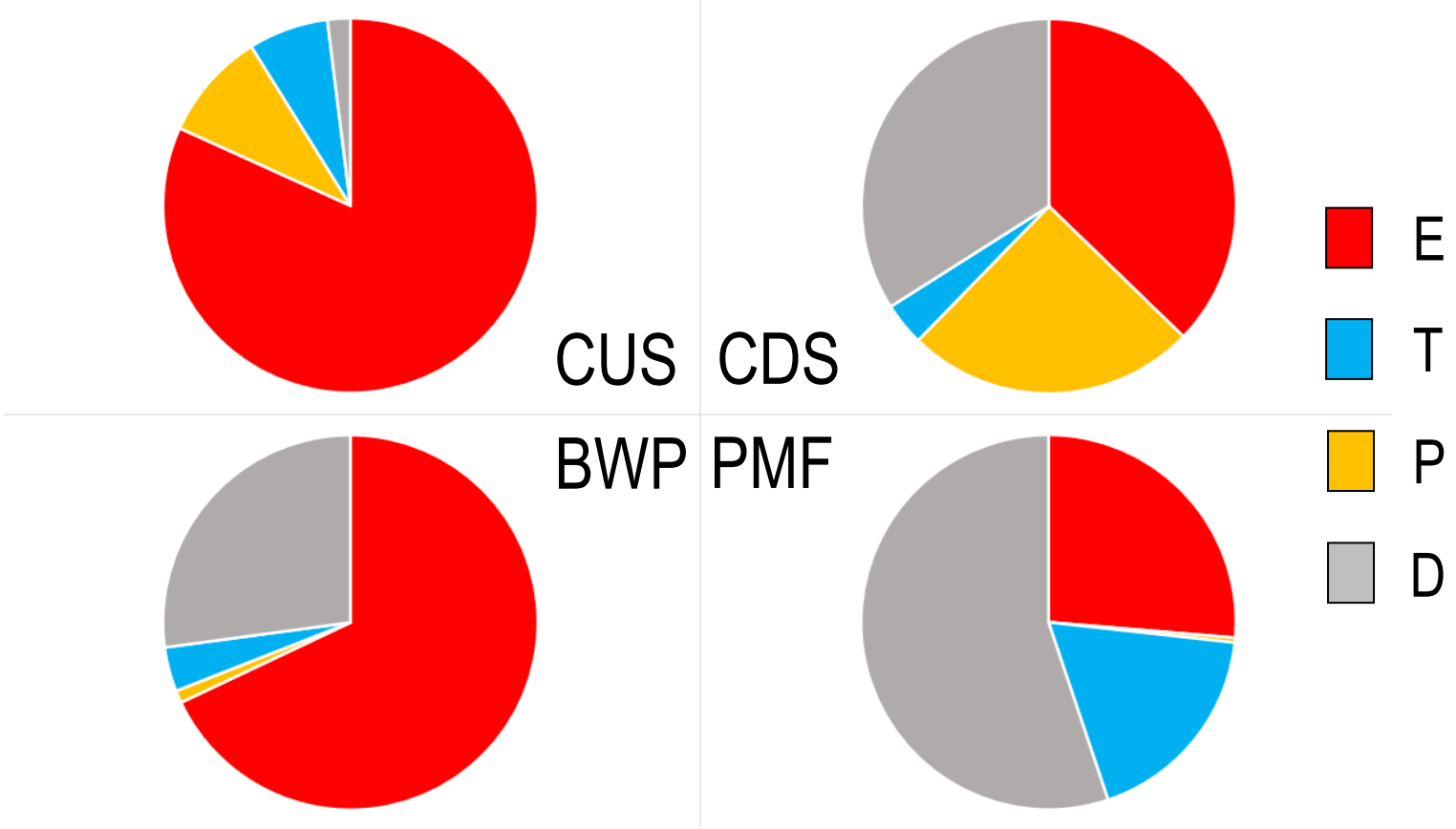
- Primary Sites
- Secondary Sites
- Tertiary Sites

- *WWTP outflows

Downstream BonnyBrook
MWWE

Downstream Pine Creek
MWWE

Kicknet Community Metrics

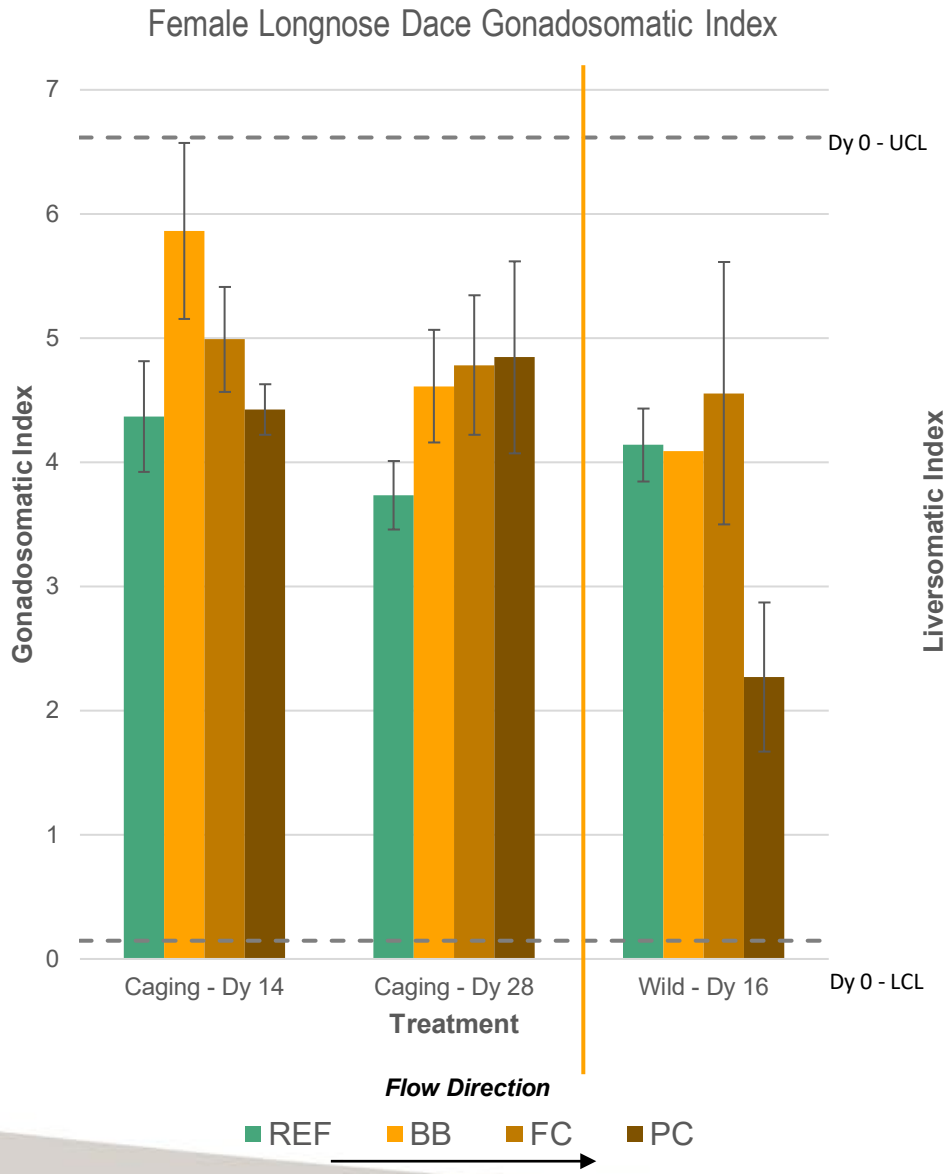


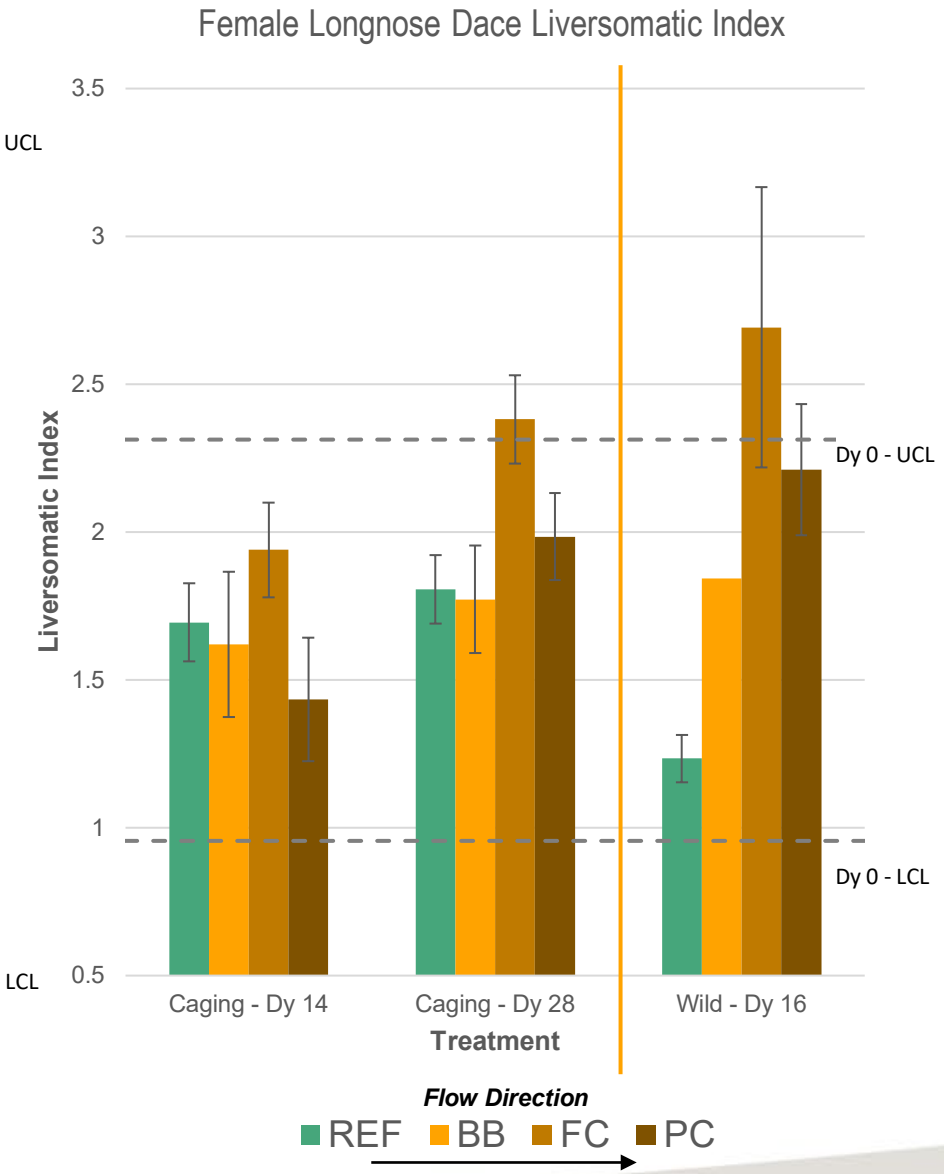
CUS – Canmore Upstream
CDS – Canmore Downstream
BWP – Bonnybrook Wastewater
PMF – Policeman's Flats

Relative abundance: Ephemeroptera (E), Plecoptera (P) and Trichoptera (T) (sensitive to stress) to Diptera (tolerant of stress)

by A. Sutherland

FISH EEM: Fall 2021 MWW effluent effects on caged longnose dace vs. wild





by Rajiv Tanna

Theme 3 (T3) Transcriptomics & Microbiomics

- Caged exposures of fish in ACWA streams and in stormwater ponds to characterize transcriptome changes to identify markers of exposure
- Compare gene expression responses and microbiome responses in the Bow River and ACWA to discern molecular and microbiological responses in fish, aquatic macroinvertebrates and riparian spiders
- Evaluate utility of these responses and their potential roles in environmental assessments of MWWE effects and the broader EEM program

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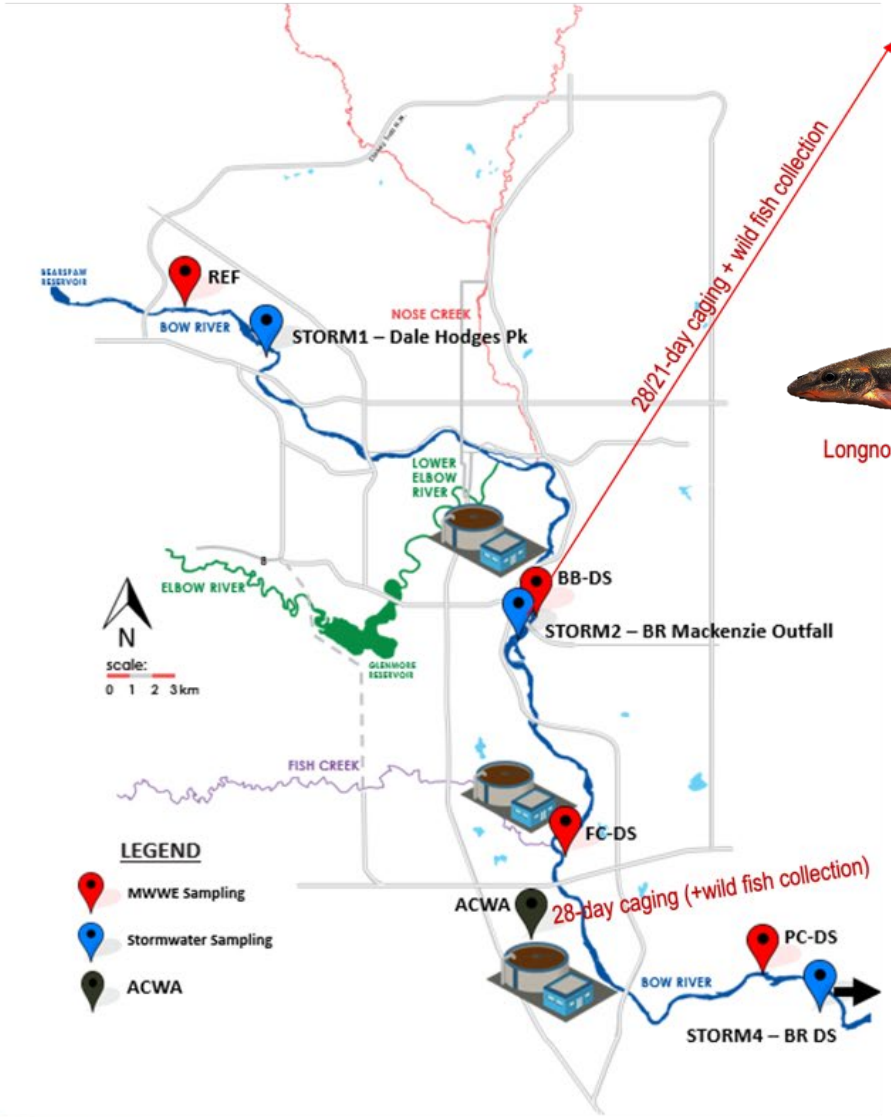
Transcriptomics Caging Experiments



Longnose dace (*Rhinichtys cataractae*)

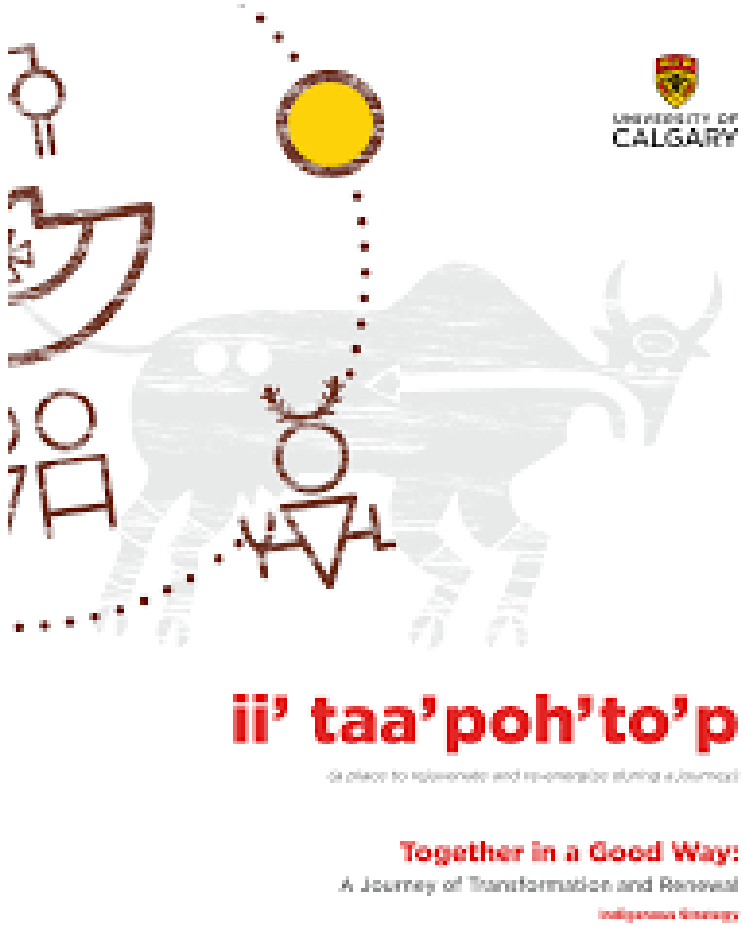
Trout perch (*Percopsis omiscomaycus*)

Spoonhead sculpin (*Cottus ricei*)

Theme 4 (T4) Indigenous Engagement

- Inclusion of community members, including leadership, administration, elders and youth, will help support the development of conceptual models for practical integration of traditional and scientific knowledge

- Inclusion of Community-based researcher and a graduate student will be used to bridge the gap between traditional and technical knowledge and will aid in developing toolkits for successful engagement, as well as highlighting the role of land-based reconnection activities in enhancing community participation in decision-making



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Future work - 2022

- Nose Creek
- Recovery caging
- Targeted assessments of fish/ macroinvertebrate/biofilm responses to increased MWWE exposure (15% effluent caging)
- Initiate Indigenous collaborations
- Modelling start-up
- Broadening stakeholder involvement

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Benefits to Alberta

- Creates opportunities
  - proactive identification of environmental degradation
  - treatment technology development
- Leverages the full potential of globally unique stream mesocosm infrastructure to simulate current and future climate change scenarios
  - allow for more robust risk assessment of complex organic pollutants in these conditions
- Assessment tools developed relevant for policy makers and end-users alike

Learnings from the 1st Milestone

ESOCs Fate and Transport

- Extraction methods for biological tissues need to be improved to get better detection limits
- Working closely with the City of Calgary allowed for mutually beneficial collaborations
- Interdisciplinary group broadens training for HQP

Basal Productivity

- Glass slides less viable for biofilm biomass & chl-a measures compared to ceramic briquettes and river rocks

Biological Responses

- Invertebrate community composition and abundance change by orders of magnitude from Canmore to below Calgary
- Benthic macroinvertebrate communities differ between ACWA streams and Bow River sampling locations
- Preliminary RNA sequencing results suggest that the longnose dace hepatic transcriptomic responses are indicative of urban effluent exposure in both treatments (Bow River and 5% Pine Creek effluent raceways) and the number of transcripts that are significantly different increases with the duration of exposure (7d<14d<28d)
- Fish sex did not majorly contribute to the differences observed in the quantitative or the qualitative changes of the hepatic transcriptome. It is of great importance to complete RNA sequencing for all 3 fish species to understand species-specific differences which will further contribute to selecting candidate gene markers of effluent exposure

Program Performance Metrics

Clean Resources Metrics (target in brackets)

Use of new and unique Alberta infrastructure (Increase use of ACWA facility due to characterization of stream mesocosm infrastructure): **We have conducted three sets of fish caging studies in the ACWA raceways, as well as one set of benthic invertebrate natural and artificial substrate studies, and completed chemical characterizations for ESOCs**

Developing foundation for innovative use of unique Alberta infrastructure (establish basis for technology developers to quantify benefits): **Streams are being characterized in terms of chemistry, basal productivity, benthic invertebrate communities and responses of fish placed in cages**

Federal wastewater regulations (knowledge generated from work in natural and artificial systems will generate practical guidance): **Basal productivity, benthic communities and the response of caged fish are being characterized at ACWA and benthic communities and wild and caged fish are being characterized in the Bow River**

5+ scientific publications (program designed for practical guidance as well as scientific publications: **Publications are starting to be developed**

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HQP

PhD Students

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  - Kyle Paradis (Biological Sciences)
  - Angela Burk (Biological Sciences)
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Thank you!

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