Fish Habitat Management System for Yukon Placer Mining

Annual Adaptive Management Meeting

May 21, 2021, 10am – 3 pm

Online Meeting

Yukon

Welcome

- House-Keeping
  - Zoom functions & cameras
  - State your name and affiliation when speaking
  - Questions during and after each presentation
  - Technical problems: text Chris Madden 867-333-4575, or dial in (idetails n meeting invitation)
  - Permission to Record
- Facilitated Introductions

Agenda Review

1. Welcome
2. Agenda Review
3. Introduction and Status of the Adaptive Management Program
4. Monitoring Results
   a) Aquatic Health Monitoring
      - Program Status
      - 2019-2020 Monitoring Results and Focal Studies
   b) Water Quality Objective Monitoring
      - 2019-2020 Monitoring Results
      - 14-Year Data Roll-Up

Lunch Break (approximately 12-1pm)

   c) Economic Health Monitoring
   d) Traditional Knowledge
   e) Summary
5. Monitoring Plans 2021
6. Other Updates
   a) Final Sediment Discharge Standards
   b) Conformity Checks
   c) IMG-First Nations Engagement
   d) Collaborative Stewardship Initiative
7. Closing

Annual Adaptive Management Meeting

Introduction to the Adaptive Management Program and Program Status

Meeting Purpose

FHMS Components	Assess	Design	Implement	Monitor	Evaluate	Adjust
Consultation process	X					
Placer mining claims	X					
Yukon Habitat Suitability Model with determinations of watershed sensitivity and fish habitat suitability	X					
Watershed authorizations	X	X				
Operational and reclamation standards		X	X			
Aquatic health, water quality, and socio-economic monitoring protocols				X		
Compliance monitoring and inspections				X	X	
Adaptive management reports					X	
Adaptive management framework	X	X	X	X	X	X
Traditional and local knowledge	X	X	X	X	X	X
Governance structure	X	X	X	X	X	X

Table: components of the FHMS and their alignment with the Adaptive Management Cycle (Olson et al. 2020, page 13)

First Nation Governments' role in Adaptive Management process

- Helped with development
- Inform fish habitat suitability maps
- Participate in monitoring
- Share Traditional Knowledge
- Review reports and recommendations
- Consulted during changes
- Participating in governance structure

Intergovernmental Management Group

- Created to facilitate development of the system in 2005
- Addresses issues with the FHMS and helps implement AM
- Representatives of Fisheries and Oceans Canada, Yukon government, and Council of Yukon First Nations/First Nations governments
- Joint Placer Implementation Committee (JPIC) is the decision making entity

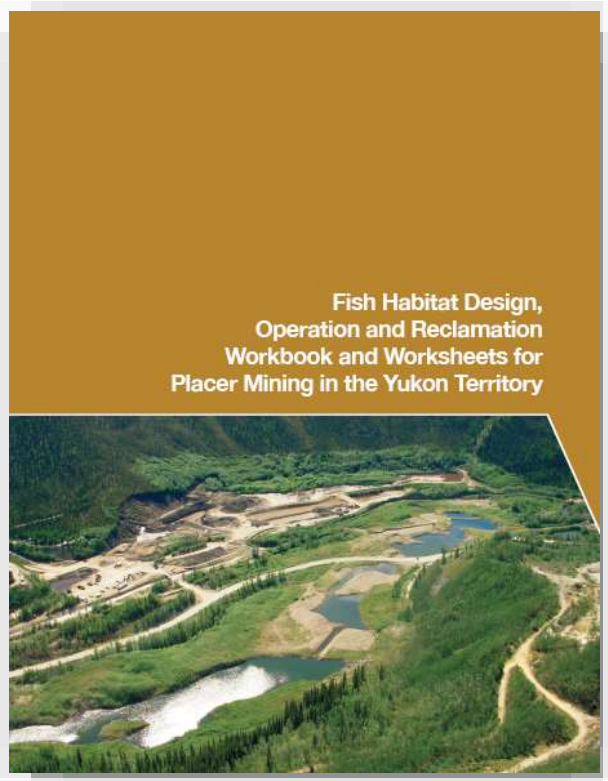
Fish Habitat Management System for Yukon Placer Mining (FHMS)

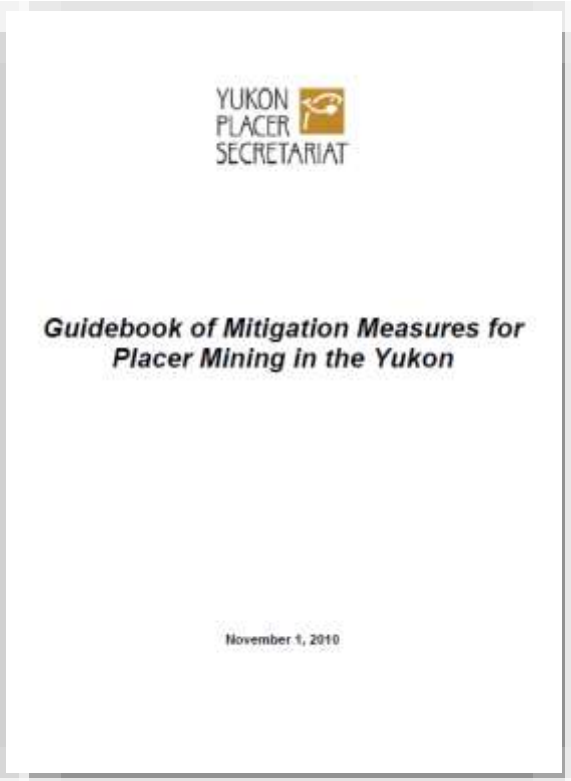
- Placer mining occurs in and around streams
- Can cause harmful alteration, disruption or destruction of fish habitat
- FHMS is an integrated system for managing the effects of placer mining under the *Fisheries Act*
- Developed 2003-2008


Chinook salmon by Paul Vecsei

FHMS Management Objectives

- Management objectives:
  1) sustaining the **placer mining industry**, and
  2) protecting **fish and fish habitat** supporting fisheries
- FHMS standards and requirements for placer mining designed to meet objectives





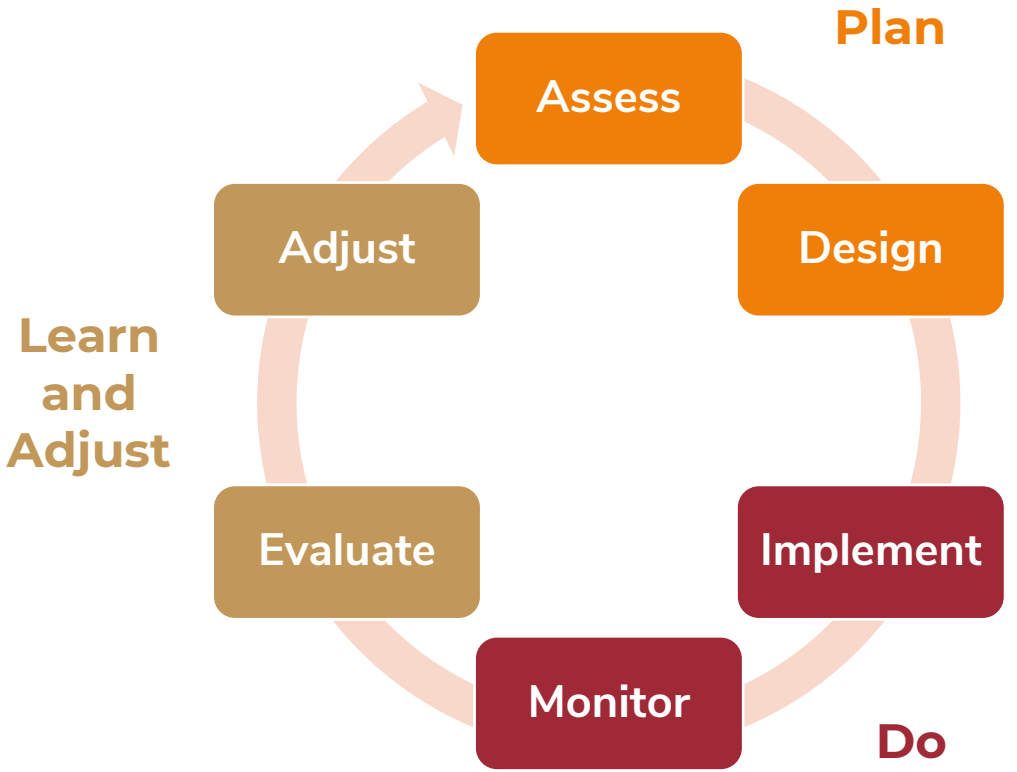
FHMS and Adaptive Management

- Uncertainty whether requirements will balance the two management objectives or shift the system towards one at the expense of the other
- Adaptive management (AM) supports the FHMS
- Parties agreed to in 2005

What is Adaptive Management?

structured approach to **'learning by doing'**
(Williams et al. 2009; Williams and Brown 2012; Murray et al. 2015)

"a rigorous approach for designing and implementing management actions to maximize learning about critical uncertainties that affect decisions, while simultaneously striving to meet multiple management objectives"
(Marmorek, 2016, p 375)



Phases of AM Cycle

- Management objectives
- Management problem, uncertainties

Assess

Design

- Identify and select strategies and actions to achieve objectives

Implement

- Apply management strategies

Monitor

- Monitor outcomes & status of valued components

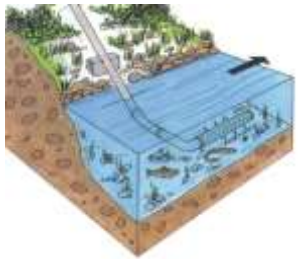
Evaluate

- Did management work? Compare monitoring results to the objectives

WQO	AH	EH
✓	✓	✓
✓	✓	×
✓	×	✓
✓	×	×
×	✓	✓
×	✓	×

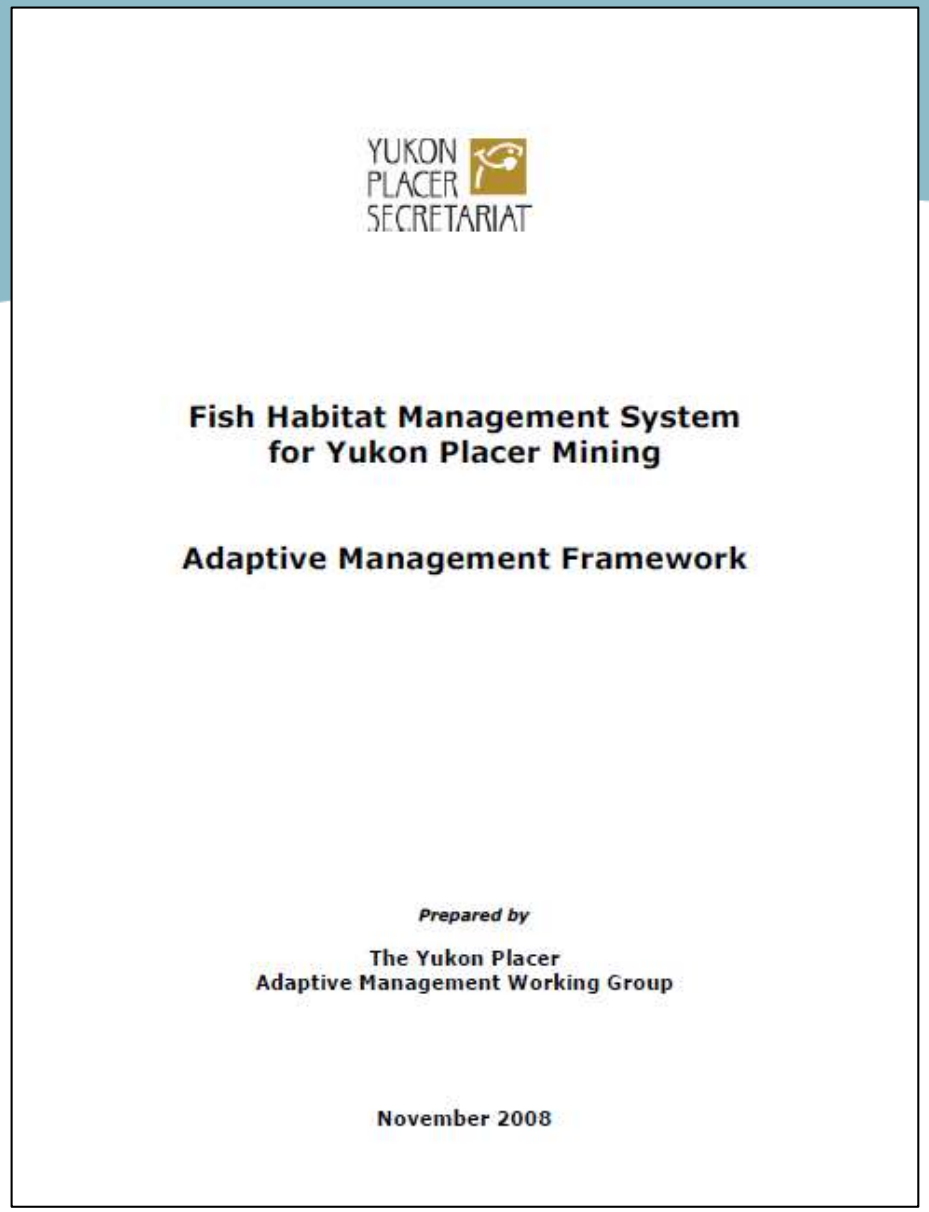
Adjust

- What was learnt?
- Adjust actions based on what was learned



Adaptive Management Framework

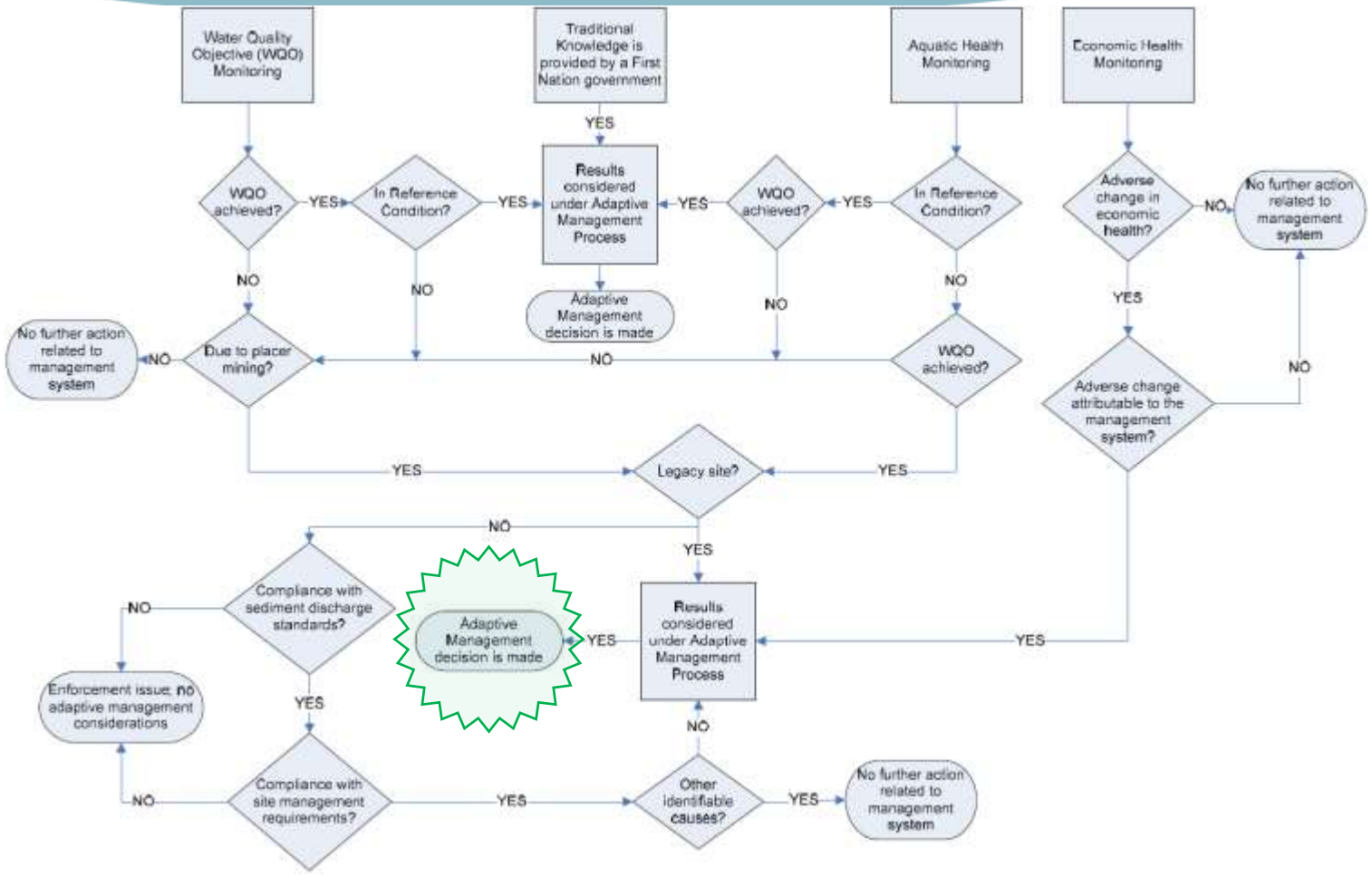
- Supports learning about outcomes of the FHMS
- What information will be collected, how to evaluate the results, what management responses are appropriate



Information Collected for AM

- Monitoring Programs
  - Aquatic Health Monitoring
  - Water Quality Objective Monitoring
  - Economic Health Monitoring
  - Traditional Knowledge
  - Compliance Monitoring
- Provides information on whether the FHMS:
  - effectively conserves and protects fish and fish habitat supporting fisheries
  - Provides opportunity to maintain the viability of placer mining
- Are water quality, aquatic health, and economic health within acceptable limits

Evaluation and Management Responses



WQO	AH	EH	Possible Management Response after Each Year of Monitoring.
✓	✓	✓	No change necessary. Improvements to monitoring may be considered.
✓	✓	✗	Intensify EHM, emphasis on factors identified in panel survey. After 3 years, may consider relaxing some requirements of W.A.
✓	✗	✓	Intensify AHM in areas with unacceptable results. WQOM and compliance monitoring will focus on same areas to determine if result attributed to placer mining. After 3 years, if results attributed to placer mining, may consider making the relevant requirements more stringent in W.A.
✓	✗	✗	Intensify AHM in areas with unacceptable results. WQOM and compliance monitoring will focus on same areas to determine if result attributed to placer mining. Intensify EHM, emphasis on factors identified in panel survey. After 3 years, if AHM results is attributed to placer mining, may consider making the relevant requirements more stringent in W.A. If unacceptable AH is observed, but not attributed to placer mining, do not relax requirements until acceptable AH is achieved.
✗	✓	✓	WQOM will address the reason for unacceptable results. Attention will be given to the relationship between WQO and AH. After 3 years, WQOM and AHM results suggests that the WQO might be too stringent. May consider amending this element of the W.A.
✗	✓	✗	WQOM will address the reason for unacceptable results. Attention will be given to the relationship between the WQO and AH. Intensify EHM, emphasis on factors identified in panel survey. After 3 years, the outcome for WQ and AHM suggests that the WQO might be unnecessarily stringent. May consider amending this element and other elements of the W.A.
✗	✗	✓	Intensify AHM and WQOM in areas with unacceptable results, compliance monitoring will focus on same areas to determine if result attributed to placer mining. After 3 years, if unacceptable results are related to placer mining, may consider making the relevant requirements more stringent in W.A.
✗	✗	✗	Intensify AHM and WQOM in areas with unacceptable results, compliance monitoring will focus on same areas to determine if result attributed to placer mining. Intensify EHM, emphasis on factors identified in panel survey. After 3 years, results could suggest that both management action and redesign of the management regime might be necessary.

Program Status

- AMF implemented since 2008
- Extensive data collection
- No management recommendations through AMF process
- Improvements to FHMS have occurred
  - Fish habitat suitability classification maps
  - Finalized the Interim Sediment Discharge Standards

Review of the AMF

- Examined the implementation and design of the AMF to understand obstacles to decision making
  - Implementation Status Review for the FHMS (YPS, 2018)
  - Evaluation of the Reference Condition Approach for the AHM program (CSAS, 2019)
  - Review and Evaluation of Adaptive Management in the FHMS (Olson et al., 2020)

Implementation Status Review

- Status and effectiveness of the implementation of FHMS including AMF
- Designed consistently with original vision but work required to achieve full implementation
- 54 recommendations, 14 apply to AMF

YPS, 2018, p 11 (hyperlink)

12.3 Recommendations

Adaptive management involves a long-term commitment to monitoring and reporting. The following is a list of the recommended actions IMG should continue to take in order to improve the delivery of adaptive management and the monitoring programs.

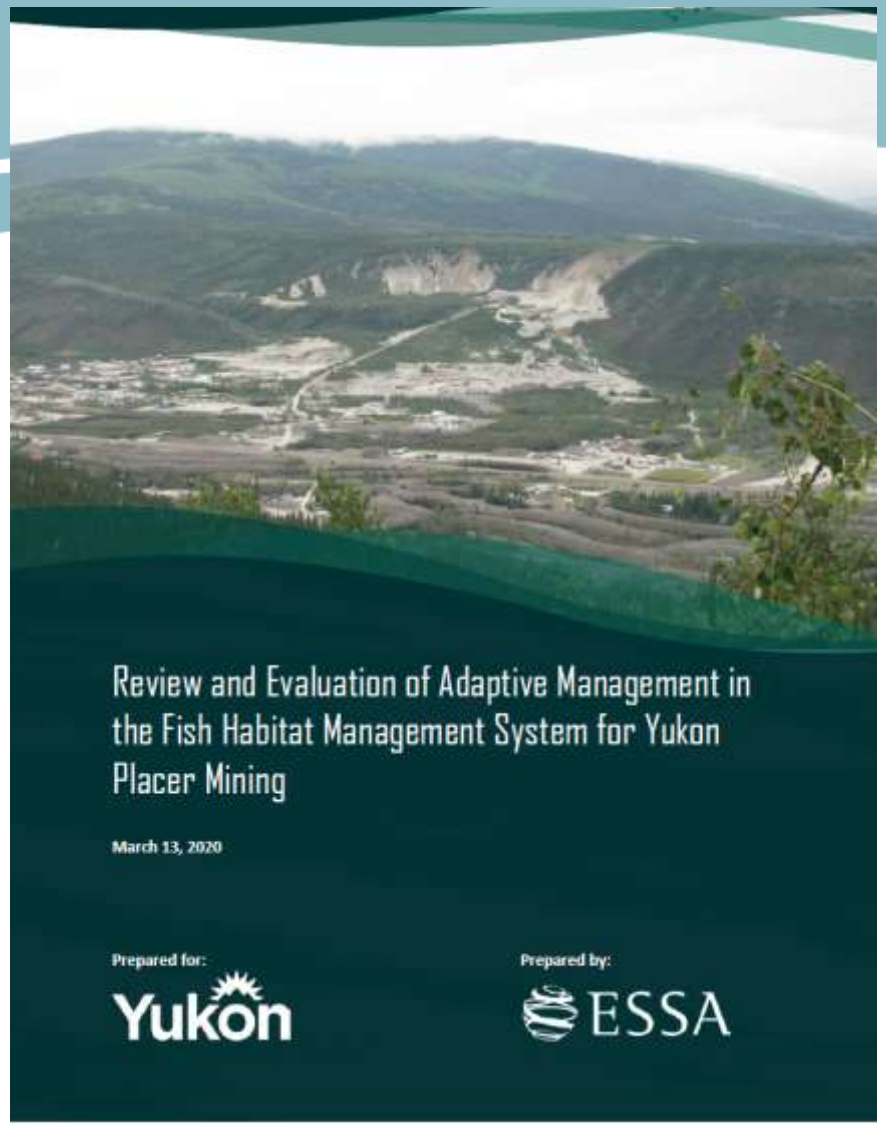
41. Consider the current structure and duties of the YPS to determine if it has the capacity to effectively coordinate adaptive management, including compiling and analyzing monitoring data.
42. Consideration should be given to the merit and feasibility of adjusting the aquatic health monitoring program as recommended by the scientific consultants who reviewed the aquatic health monitoring data in 2015.
43. Develop a system to integrate information regarding all placer mining activity with monitoring data to inform interpretation of monitoring results.
44. Develop a method for tracking restored areas and removal of Previous Development designation.
45. Develop a definition for historically mined streams in the context of adaptive management.
46. Consider monitoring options to identify and quantify non-point source contributions of sediment from placer mines to inform appropriate action.
47. Develop methods to carry out follow-up assessments for sites that have been found to be out of reference.
48. Consider methods to assess the aquatic health in large rivers.
49. Consider methods to assess aquatic health in lakes supporting lake trout.
50. Establish criteria to make conclusions as to whether or not monitoring results can be attributed to placer mining.
51. Determine if criteria can be developed to draw conclusions about aquatic health at the watershed scale using the reference condition approach.
52. A performance evaluation should be completed after all the new standards have been fully implemented and there is sufficient data available to support an evaluation.
53. Revisit the Step 1 indicators in the Economic Health Monitoring Protocol to examine the rationale for utilizing both the number of mines in production and the number of mines with active water use licences; consideration may be given to replacing one indicator.
54. Determine whether to continue proceeding automatically to Step 2 of the Economic Health Monitoring Protocol (i.e. a Panel Survey of operators) regardless of the outcome of Step 1.

Protocol Reviews

- Aquatic Health Monitoring Evaluation of the Reference Condition Approach for the AHM program (CSAS, 2019)

Review and Evaluation of AM in the FHMS

- Examined the design and implementation of AM
- Literature review and interviews
- Evaluation based on
  - AM Steps
  - Context and Enabling Factors
- Identified opportunities for improvement and strengths



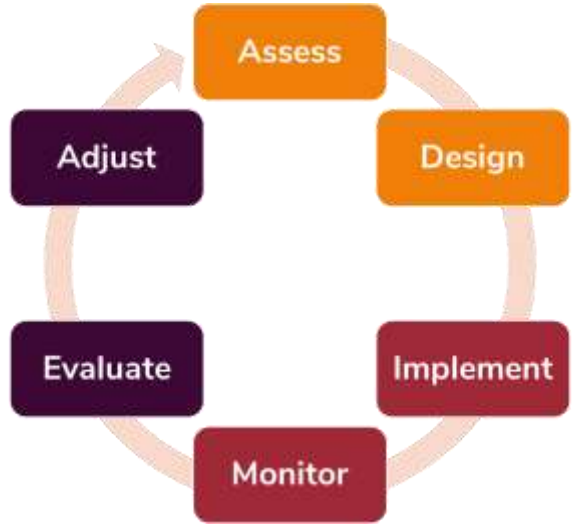
Olson et al., 2020 (hyperlink)

Overarching Findings

- FHMS is complex
- Beneficial to continue to apply AM
- Initial design has many of the key components
- Long term commitment and support for AM
- Changes can be made to improve functioning
- Good foundation to build on

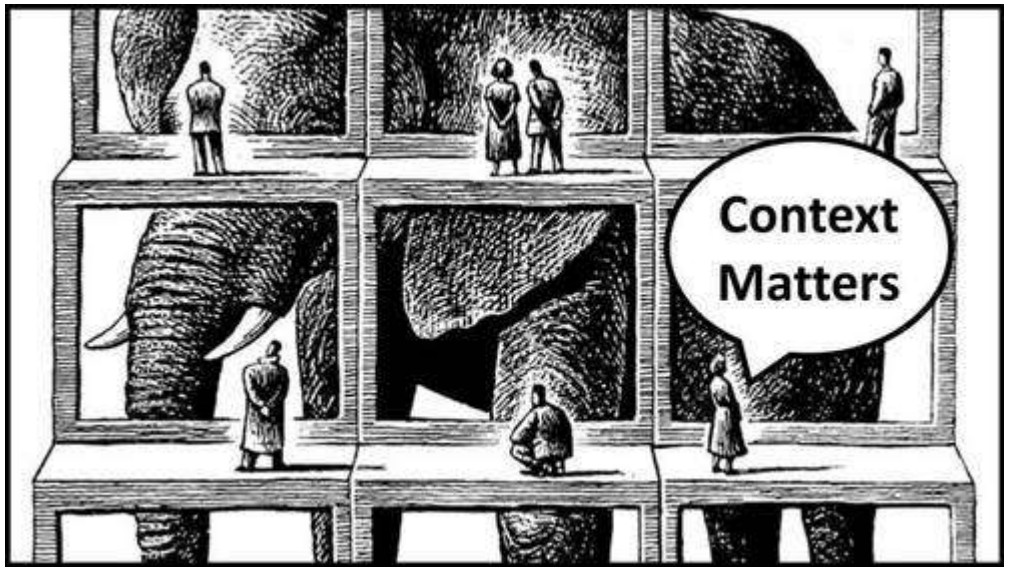
Detailed Findings: AM Steps

- Lack of clarity around management objectives and decisions, narrow focus on pathway of effects
- Rationale and scope and scale of management actions
- Design of monitoring (protocols, Traditional Knowledge, coordination)
- Implementation schedule
- Monitoring implemented but limitations in data analysis
- Evaluation challenges (different datasets, confounding factors, lack of inclusion of Traditional Knowledge)
- Lack of clarity in decision criteria



Detailed Findings: Context and Enabling Factors

- **Context** is appropriate as there is control and uncertainty
- **Trust** among key parties but may be vulnerable
- **Leadership** and decision authority, reorganization and employee turn over having effect
- **Organizational structure** exists but missing voices and lack of clarity of roles and responsibilities
- **Communication** internally vs externally
- Allocation of **funding and capacity**



Recommendations

1. Clarify foundational elements for AM
2. Synthesize and evaluate existing data
3. Review the monitoring design and evaluation process
4. Clarify roles/responsibilities and reinvigorate the organizational structure

Recommendation 1:
Clarify foundational elements for AM

- Revisit and “unpack” management objectives
- Clarify pathways of effect
- Identify critical management uncertainties
- Revisit range of management actions available

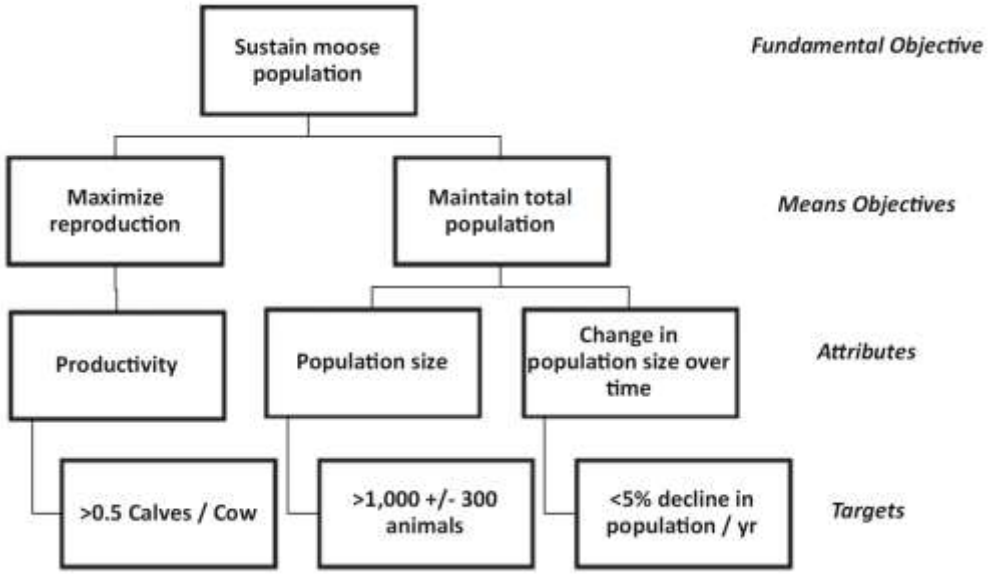


Figure: Example of an objectives hierarchy
(Reynolds et al. 2016, pg 5)

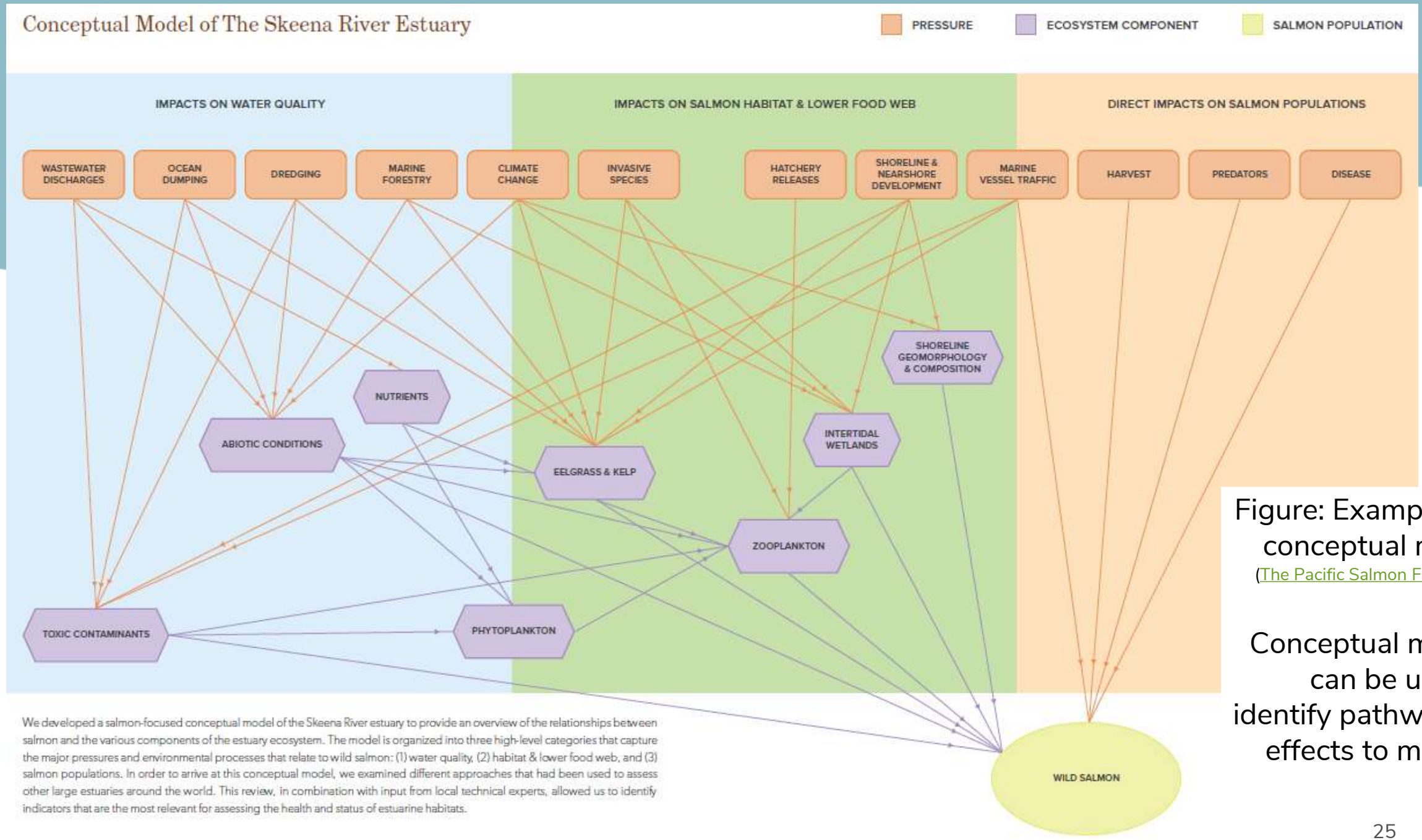


Figure: Example of a conceptual model. (The Pacific Salmon Foundation, 2015, p 5)

Conceptual models can be used to identify pathways of effects to manage

Recommendation 2: Synthesize and evaluate existing data

- Abundance of data
- Greater emphasis on evaluation step
- Comprehensive synthesis of existing data
- Begin with reviewing analytical methods and identifying supplementary datasets

Recommendation 3:
Review the monitoring design and evaluation process

- Monitoring often requires adjustment after starting
- Leverage insights from previous reviews and recommendations
- Develop process for coordinating sampling, data sharing, and analyses

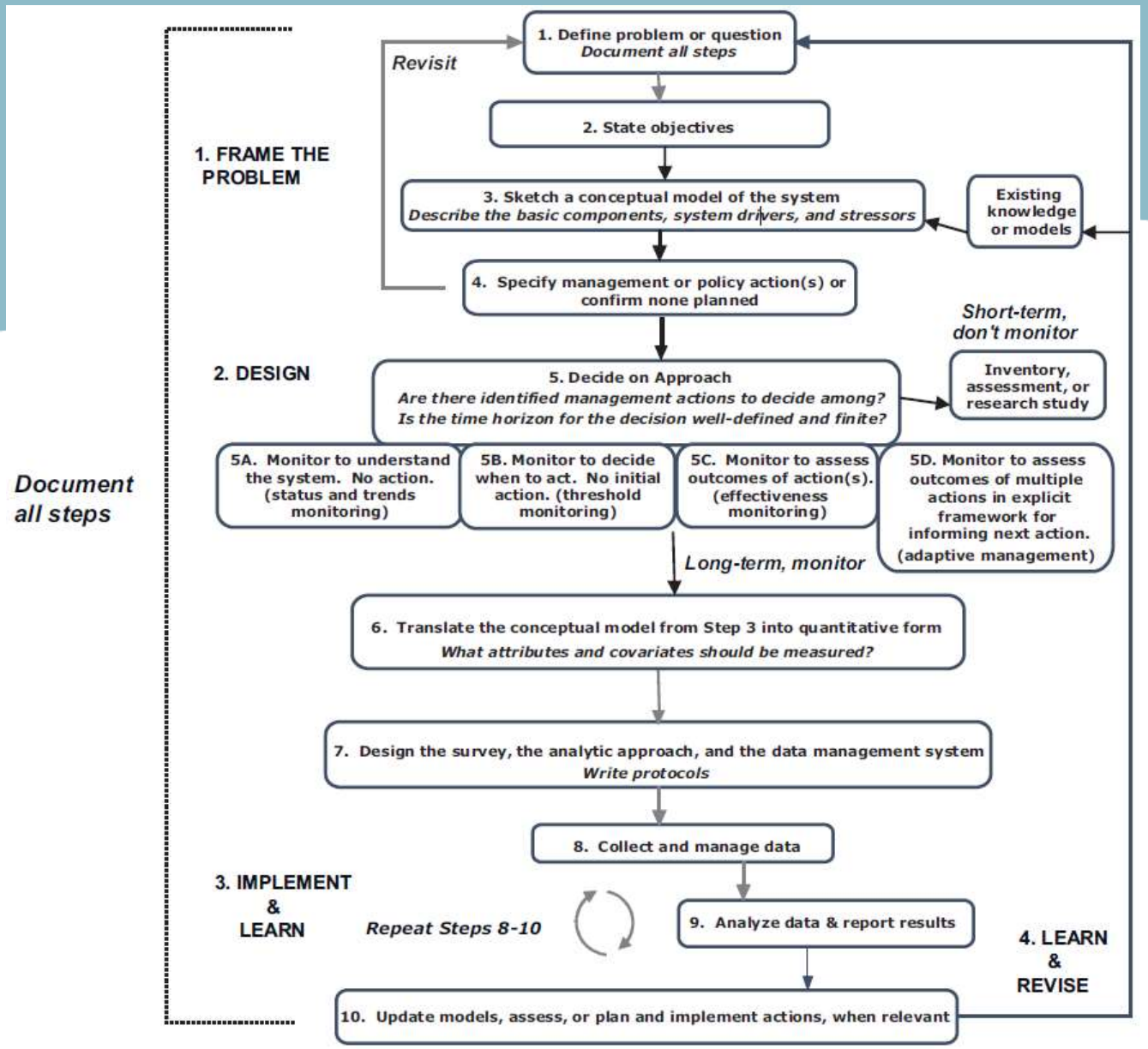


Figure: Road map for designing and implementing monitoring (Reynolds et al. 2016, pg 3)

Recommendation 4:
Clarify roles/responsibilities and reinvigorate the organizational structure

- Near term:
  - Roles/responsibilities have evolved.
  - Examine current roles/responsibilities & make adjustments
- Medium term:
  - reinvigorate the organizational structure
  - Special focus on working with First Nations

Figure: example of generic governance structure
(Marc Nelitz, pers comm, 04-08-2020)

Next Steps

- Current
  - Working with existing data
  - Reviewing analytical methods
  - Improving monitoring protocols
  - Roles and responsibilities
  - Communication and relationship building

- Upcoming: Update AMF by implement recommendations
  - Engagement with First Nations, management partners, stakeholders

Interim Adaptive Management Process

- Continue collecting data
- Pilot monitoring protocols
- Respond to and investigate monitoring results
- Continue focal studies and data analyses

Questions or Comments?

Annual Adaptive Management Meeting

Aquatic Health Monitoring

Aquatic Health Monitoring Program

Adaptive Management Meeting

May 21, 2021

Presentation Overview

- Aquatic Health Monitoring Program Purpose & Status
- Update on Science Review
- Path Forward
  - RCA model
  - Targeted studies
  - Interim Approach

Aquatic Health Monitoring Program

Purpose:

- To assess the effectiveness of the Fish Habitat Management System (FHMS) in maintaining aquatic health for fish and fish habitat in placer mining watersheds.
- Information from aquatic health monitoring is used to inform adaptive management.

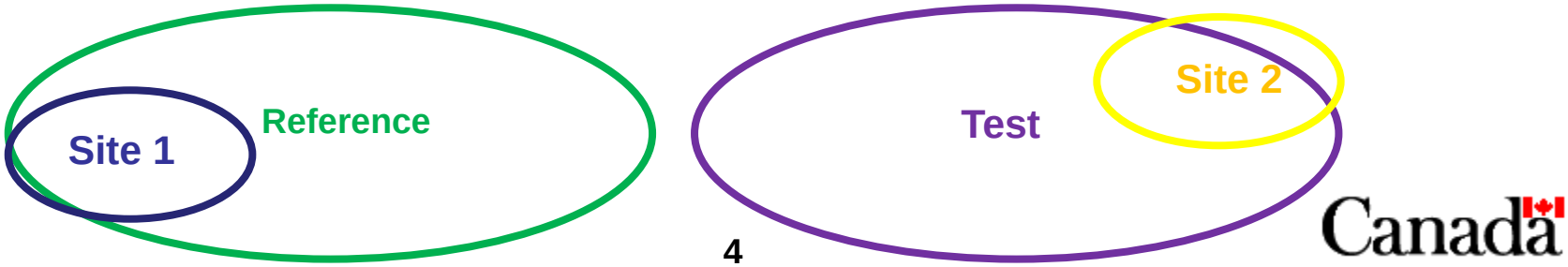
Status:

- *Fish Habitat Management System for Yukon Placer Mining Aquatic Health Monitoring Protocol* (November 2008)
- Recommendation to review this protocol through the 2015 Implementation Status Review of FHMS
- 2018 Science (CSAS) review identified several challenges with the protocol

Update on Science Review

Background on 2008 Monitoring Protocol:

- Uses benthic invertebrate community as monitoring tool
- Relies on Reference Condition Approach (RCA)
- Regional reference groups were developed with data collected from 2004 to 2013
- Habitat variables were used to assign the test sites to one of the reference groups based on predictor variables
- Probability ellipses are then used to assess the status of the test site



Key Issues with Existing Protocol

- Assessment of broader spatial and temporal scales can be problematic using RCA
- Review of reference model indicated high degree of temporal and spatial variability
- Issues with model error rates
- Issues with predictor variables
- Inability to link divergence from reference condition to placer mining activity

Path Forward

- ECCC responded to CSAS review of RCA method
- ECCC is considering building a new Yukon RCA model
  - Updated model would follow new CABIN Science Team model building and review criteria
  - Updated model could include larger rivers

Path Forward

Targeted studies to examine issues raised by Science Review

- Replication study → To assess within site variability in invertebrate community composition
  - Comparison of triplicate invertebrate samples
    - Results from 2019 & 2020 indicate more data is needed to identify number of replicates required.

- Analysis of substrate composition methods
  - Previous protocol relies on 10 substrate samples
  - Data analysis compared mean substrate values between sample sizes of 10 - 100
  - Results from 2019 study recommend 100 substrate samples be taken to accurately describe instream substrate

Targeted Studies (continued)

- In situ sediment sampling → How does the benthic invertebrate community respond to varying sediment parameters?
  - Instream samples were collected and sediment parameters (e.g. particle size, total carbon, total nitrogen) were compared to invertebrate community metrics
  - Results from 2019 & 2020 indicate more data needed to explore relationship between invertebrate community metrics and sediment parameters
  - Recommend exploring other invertebrate community metrics to evaluate sensitivities of specific invertebrate taxa

Interim Approach

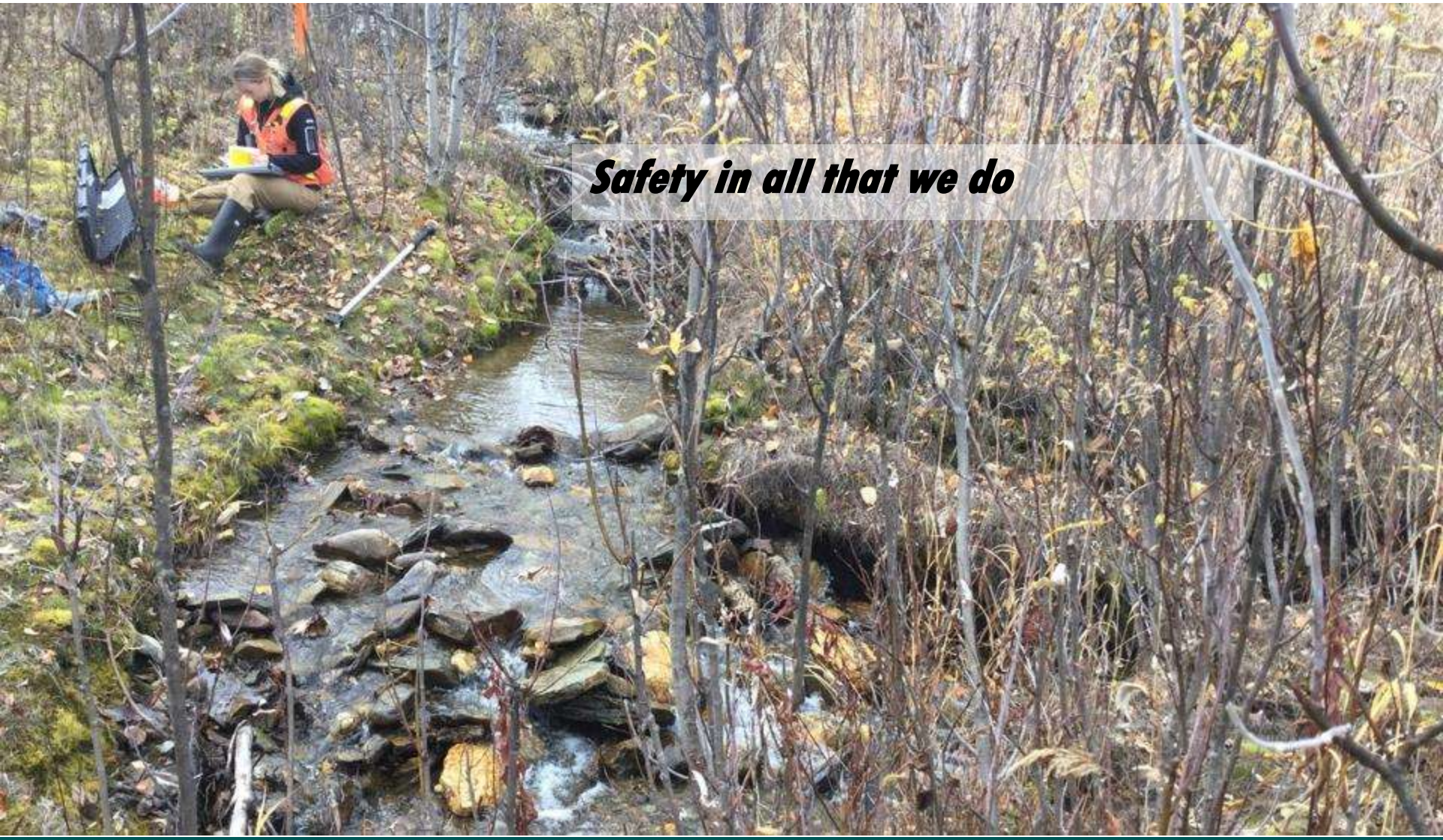
- Followed since 2018
- Field sampling consistent with previous years (CABIN protocol)
- Reference site sampling
  - Paired reference – test sites where possible
- Physical habitat characterization (e.g., canopy coverage, slope, channel width, velocity, depth, and substrate characteristics)
- Documentation of degree of placer mining development
- Evaluation of invertebrate community metrics (e.g. relative abundance of major taxonomic groups, family level taxonomic richness etc)
- Comparison of invertebrate community composition to local reference sites

Hemmera
An Ausenco Company

2019 and 2020 Aquatic Health Results

1. Safety and Values Moment
2. Introductions
3. Definitions
4. AHM Purpose/Objectives
5. Methodology
6. 2019 Aquatic Health Monitoring Results
7. 2019 Focal Study Results
8. 2020 Aquatic Health Monitoring Results
9. 2020 Focal Study Results
10. Conclusion/Recommendations

Safety and values moment



Introductions

- **Andrew MacPhail, Biologist**
- **Nicole Marsh, Environmental Scientist**
- **Doug Bright, Environmental Toxicologist**

AHM Purpose/Objectives

- **Provide information that informs the adaptive management process.**
- **Helps evaluate how effective is the FHMS at protecting fish and fish habitat:**
    - **Assess if aquatic health is being maintained in streams exposed to placer mining and if historically mined sites are improving over time.**
- **2019 and 2020 AHM goals included:**
    - **Taking an interim approach to data analysis given the CSAS review findings.**
    - **Attempt to better align WQO sampling with AHM sampling.**
    - **Focal/Targeted Studies to inform protocol redesign including:**
        - **Replicate study to better characterize within site variability in benthic invertebrate community composition to evaluate the need to incorporate site replication into the study design.**
        - **Analysis of substrate composition to evaluate the potential effects of sample size on variability of mean substrate diameter.**
        - **In-situ sediment sampling to explore benthic invertebrate community response to selected sediment parameters.**
        - **Inclusion of monitoring in areas of interest to Tr'ondëk Hwëch'in and collaboration for sampling (specific to 2020).**

Field Sampling

- **Benthic invertebrate community sampling (i.e. kick-net sampling) and habitat characterization conducted according to CABIN protocols, consistent with previous years.**
- **Collection of TSS and water chemistry to supplement benthic community data and in-situ sediment data.**

Additional focal study tasks

- **An analysis of substrate composition characterization methods (2019).**
- **Addition of replicate sampling (i.e. three kicks per site) (2019 and 2020).**
- **In-situ sediment sampling (2019 and 2020).**

Sampling Date (D/M/Y): Site Code:

PRIMARY SITE DATA

CABIN Study name: Basin:
River/Stream name: ☐ Test ☐ Reference

Site Location Description:

GPS Datum: WGS84 or GPS Altitude (max) or last):
*Latitude: Stream Order (1-10 max):
*Longitude: Ecoregion:
(*use decimal degrees)

Photos taken:
☐ Field sheet ☐ Upstream ☐ Downstream ☐ Across channel ☐ Dry substrate ☐ Aquatic substrate ☐ Aerial substrate

REACH DATA (Represent 5 x bankfull width)

1. Habitat Types Present/Flow State Reach (check those present)
☐ hydraulic jump ☐ riffle ☐ rapids ☐ straight run ☐ pool/back eddy
2. Canopy Coverage (check one)
☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%
3. Macrophyte Coverage (check one)
☐ 0% ☐ 1-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%
4. Riparian Zone (check those present)
☐ 1 - forbs/grasses ☐ 2 - shrubs ☐ 3 - deciduous trees ☐ 4 - coniferous trees
5. Periphyton Coverage on Substrate (benthic algae, not moss) (check one)
☐ 1 – Not slippery, no colour (<0.5mm)
☐ 2 – Slightly slippery, yellow-brown to light green (0.5-1mm)
☐ 3 – Noticeably slippery, patches of thicker green to brown (1.0-5mm)
☐ 4 – Very slippery, numerous large clumps of green to dark brown (5.0-20mm)
☐ 5 - Rocks mostly obscured, extensive green, brown to black mass may have long strands (> 20mm)

WATER CHEMISTRY

Air Temp (C): Water T (C): Cond.: DO (mg/L):
pH: Turbidity: sp Cond. (us/cm): DO %:
Water Samples Collected: ☐ TSS (500ml) ☐ General (500 ml) ☐ Total metals (250 ml) ☐ Nutrients (250 ml) ☐ Other

Sampling Date (D/M/Y): Site Code:

SUBSTRATE COMPOSITION IN RIFFLE (kicking area)

1. 100 Pebble Count & Substrate Embeddedness
+ Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embeddedness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

	Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E		Diameter (cm)	E
1			26			51			76		
2			27			52			77		
3			28			53			78		
4			29			54			79		
5			30			55			80		
6			31			56			81		
7			32			57			82		
8			33			58			83		
9			34			59			84		
10			35			60			85		
11			36			61			86		
12			37			62			87		
13			38			63			88		
14			39			64			89		
15			40			65			90		
16			41			66			91		
17			42			67			92		
18			43			68			93		
19			44			69			94		
20			45			70			95		
21			46			71			96		
22			47			72			97		
23			48			73			98		
24			49			74			99		
25			50			75			100		

Note: The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.

2. Surrounding/Interstitial Material - check the substrate size category for the surrounding material.
☐ 0 organic cover (>50% cover)
☐ 1 (silt) <0.1 cm
☐ 2 (sand) 0.1 – 0.2 cm
☐ 3 (gravel) 0.2 – 1.6 cm
☐ 4 (pebble) 1.6 – 3.2 cm
☐ 5 (pebble) 3.2 – 6.4 cm
☐ 6 (cobble) 6.4 – 12.8 cm
☐ 7 (cobble) 12.8 – 25.6 cm
☐ 8 (boulder) > 25.6 cm
☐ 9 - Bedrock

Sampling Date (D/M/Y): Site Code:

3. Sediment Samples Collected: ☐ (300-500g)

Depth of easily penetrable sediments (cm): Depth of sediment sampled (cm):
Sediment texture and colour:
Check those present: ☐ woody debris ☐ Leaf litter ☐ macrophytes ☐ biofilms ☐ periphyton ☐ odour ☐ oily sheen ☐ invertebrates
Comments:

BIOLOGICAL: BENTHIC INVERTEBRATE SAMPLES

1. Kicknet Sample (location): ☐ riffle ☐ rapid ☐ straight run ☐ pool/back eddy

500 µm mesh Kicknet**	Riffle 1	Riffle 2	Riffle 3
Operator:			
Time of Day:			
Sampling time (i.e. 3 min)			
No. of sample jars			
Typical depth (in kick area)			

CHANNEL DATA

1. Channel

Slope/Gradient (%)		Flow Stage: ☐ Low/ ☐ Moderate/ ☐ High/ ☐ Flood	
Bankfull Width (m)		Wetted Stream Width (m)	
Bankfull Wetted Depth (distance between water level and top of bank) (cm)			
Location in site (note where in sample site taken i.e. d/s of kick area)			

2. Channel Transect

Velocity/Depth	1	2	3	4	5	AVG
Distance from shore (m)						
Depth (cm)						
Velocity (m/s)						

Definitions

- **EPT –Ephemeroptera (mayflies), plecoptera (stoneflies) and trichoptera (caddisflies). Generally associated with low organic pollution.**

- **Chironomidae (non-biting midges) – Generally associated with high organic pollution.**

- **Abundance – total # of organisms counted in a sample.**

- **Relative Abundance – evenness of distribution of individuals among species in a sample.**

Ephemeroptera (mayflies)

https://thecatchandthehatch.com/mayflies/

Plecoptera (stoneflies)

https://www.flickr.com/photos/51646491@N00/8497757419

Trichoptera (caddisflies)

https://www.ncpedia.org/media/caddisfly-larva-water

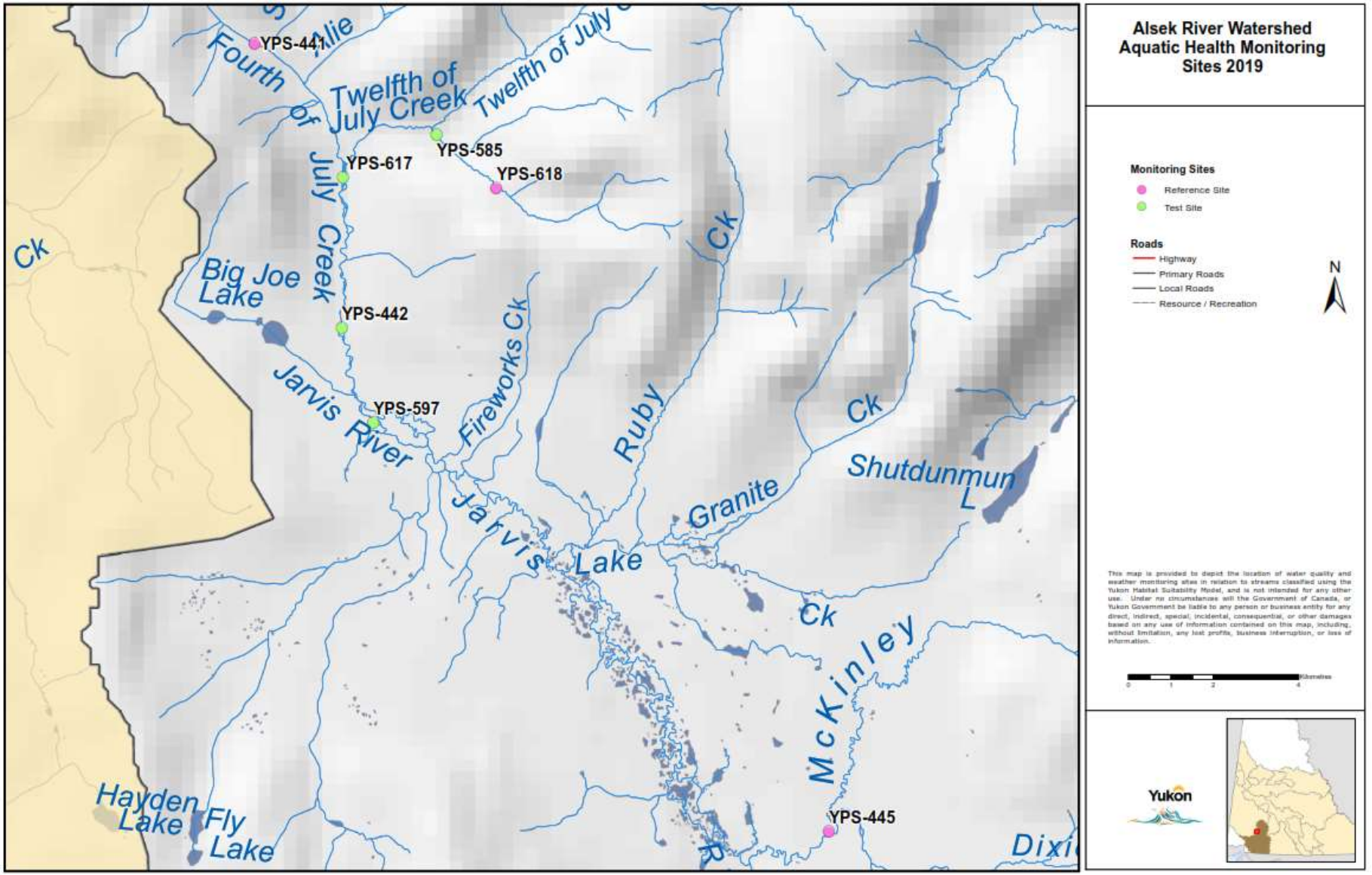
Chironomidae (Non-biting Midges)

https://collections.museumsvictoria.com.au/species/8488

2019 Aquatic Health Monitoring

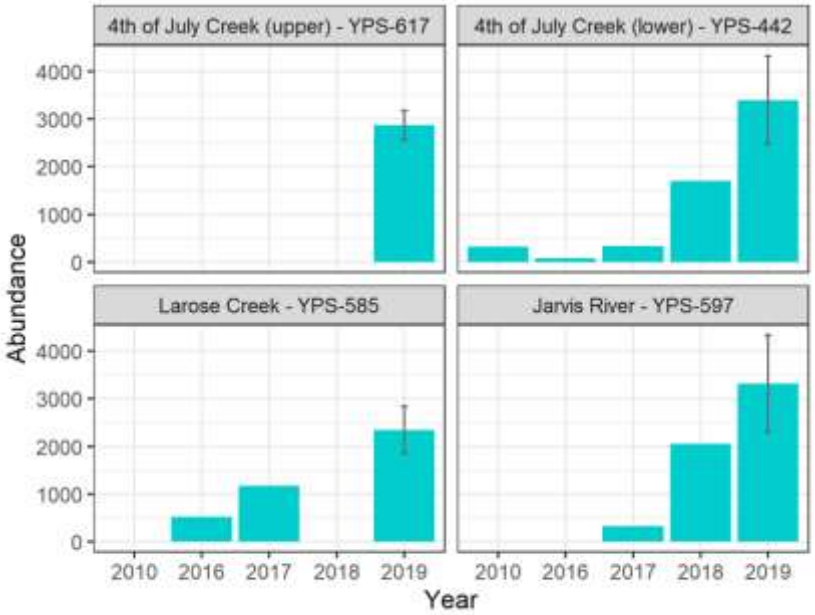
YPS-078, Hunker Creek, looking upstream

Alsek River Watershed

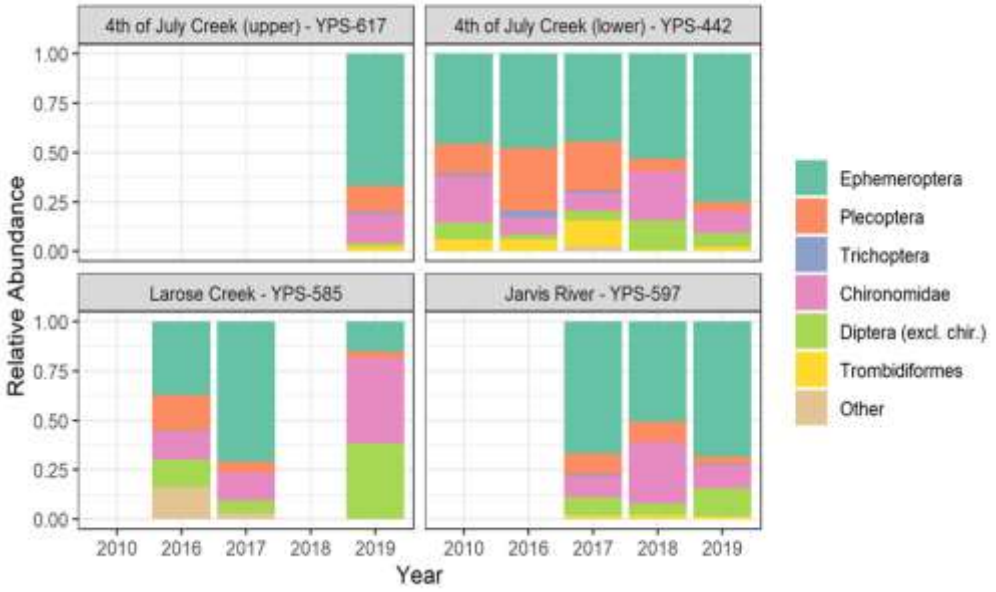


Alsek River Watershed – Test Sites

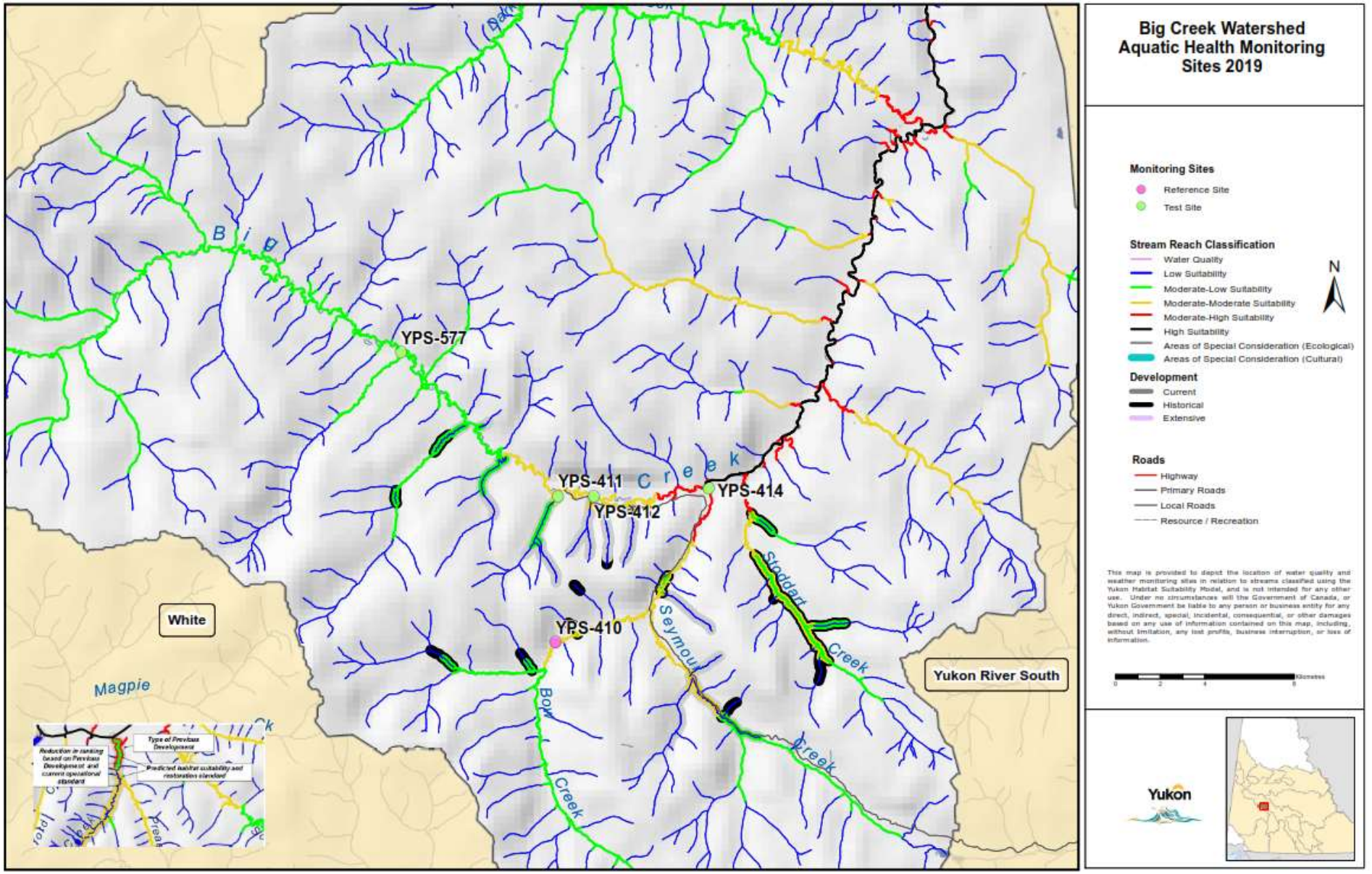
- **Placer mining development characterized as low-moderate at YPS-585 (Larose Creek), YPS-442 (4th of July Creek (lower)), YPS-597 (Jarvis River) and moderate at YPS-617 (4th of July).**
- **Invertebrate communities generally dominated by Ephemeroptera, Plecoptera, and Chironomidae which was similar to observations at the reference sites.**
- **Abundance at YPS-422 and YPS-597 showed increasing trend overtime.**



Note: error bars show standard deviation from triplicate samples collected in 2019

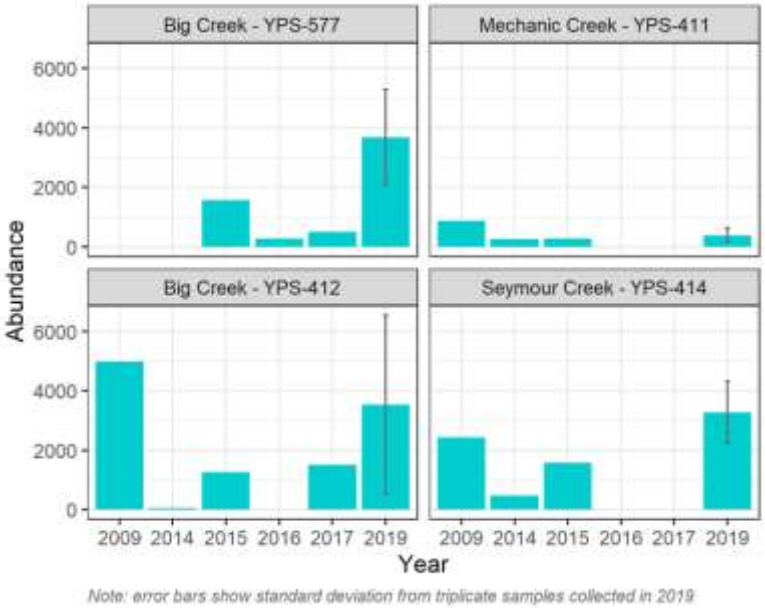


Big Creek Watershed

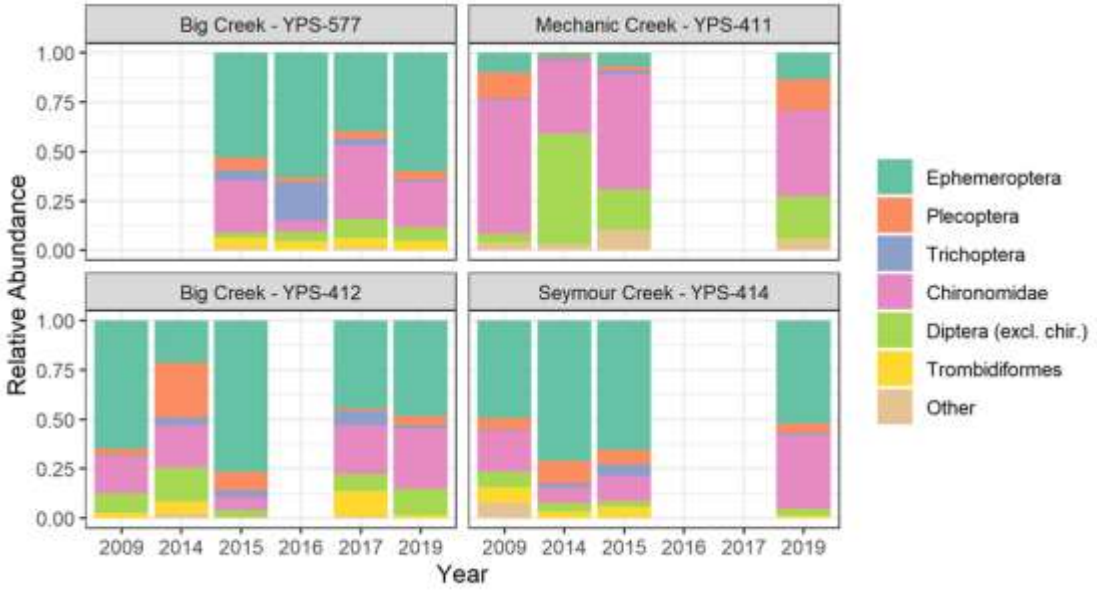


Big Creek Watershed – Test Sites

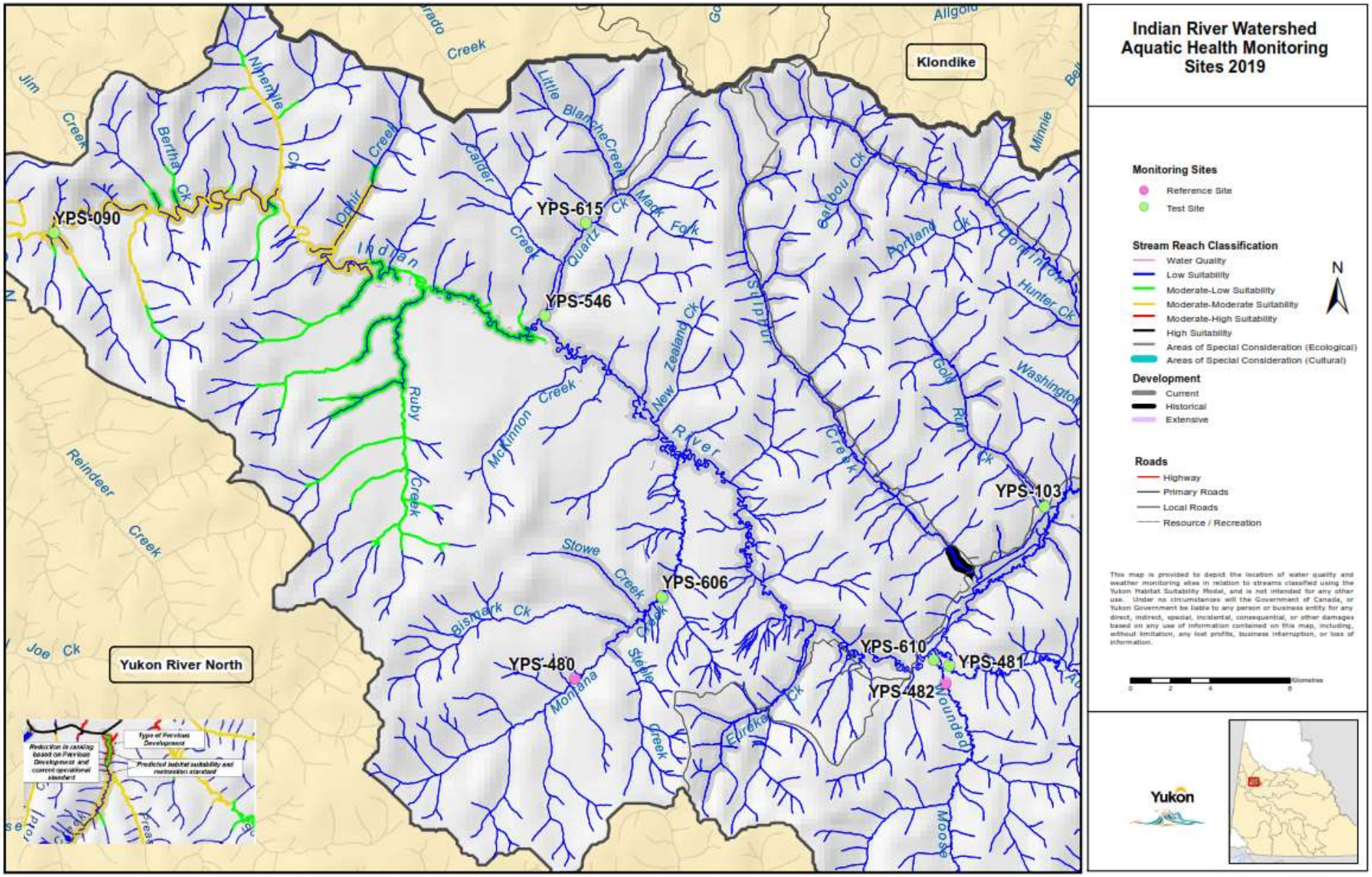
- **Placer mining development characterized as low at YPS-577 (Big Creek) to high at YPS-411 (Mechanic Creek).**
- **With the exception of YPS-411, invertebrate communities at the test sites were generally dominated by Ephemeroptera, Plecoptera, and Chironomidae. A similar community composition was observed at the Big Creek reference site (YPS-410).**
- **No discernable trends in abundance at any of the sites.**



Note: error bars show standard deviation from triplicate samples collected in 2019

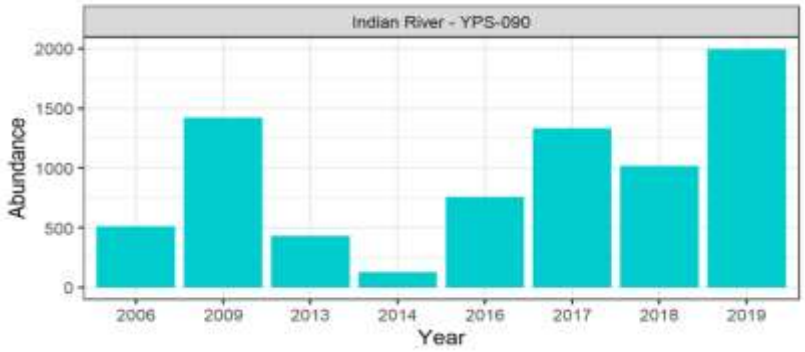


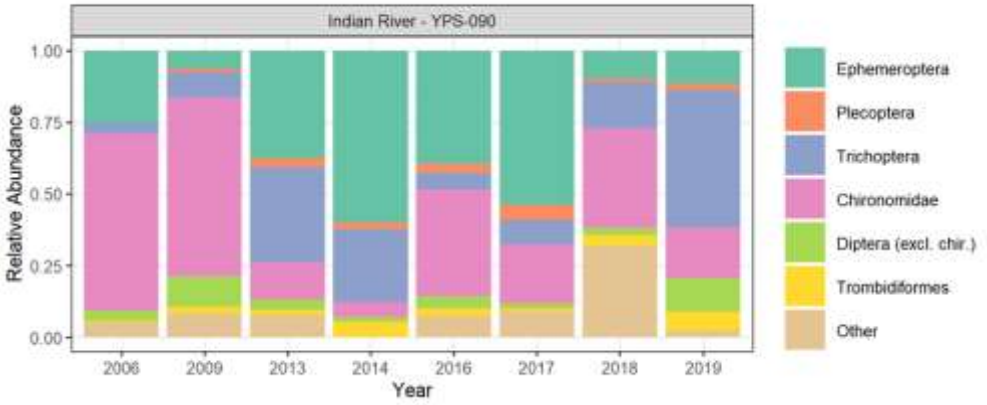
Indian River Watershed



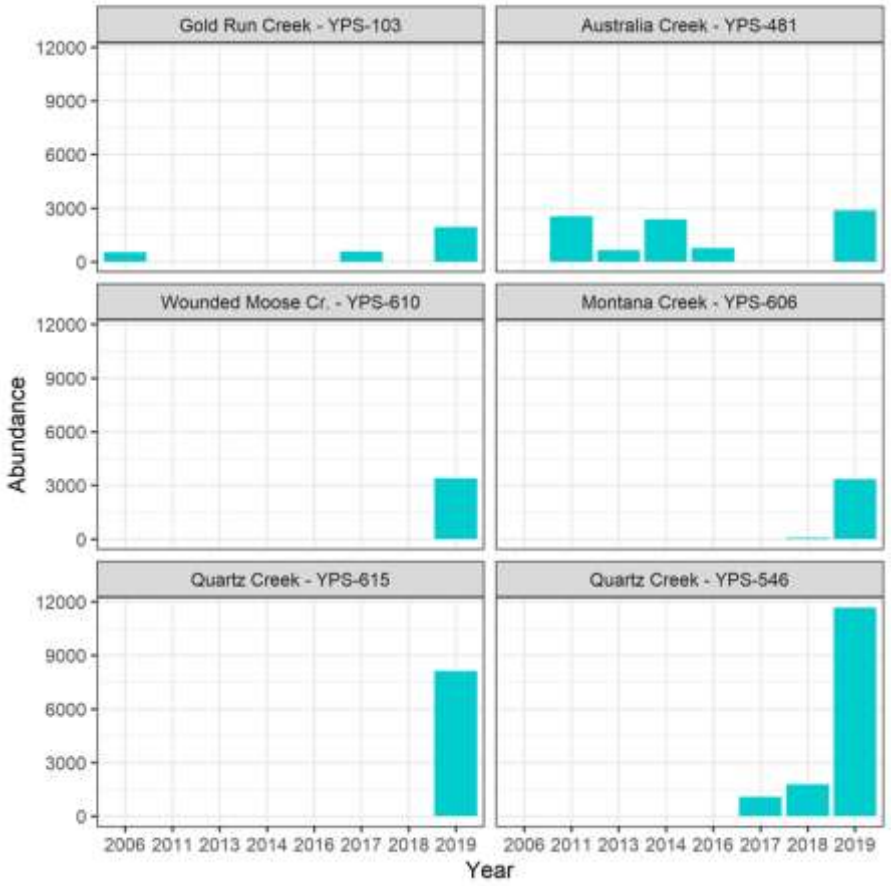
Indian River Watershed – Test Sites

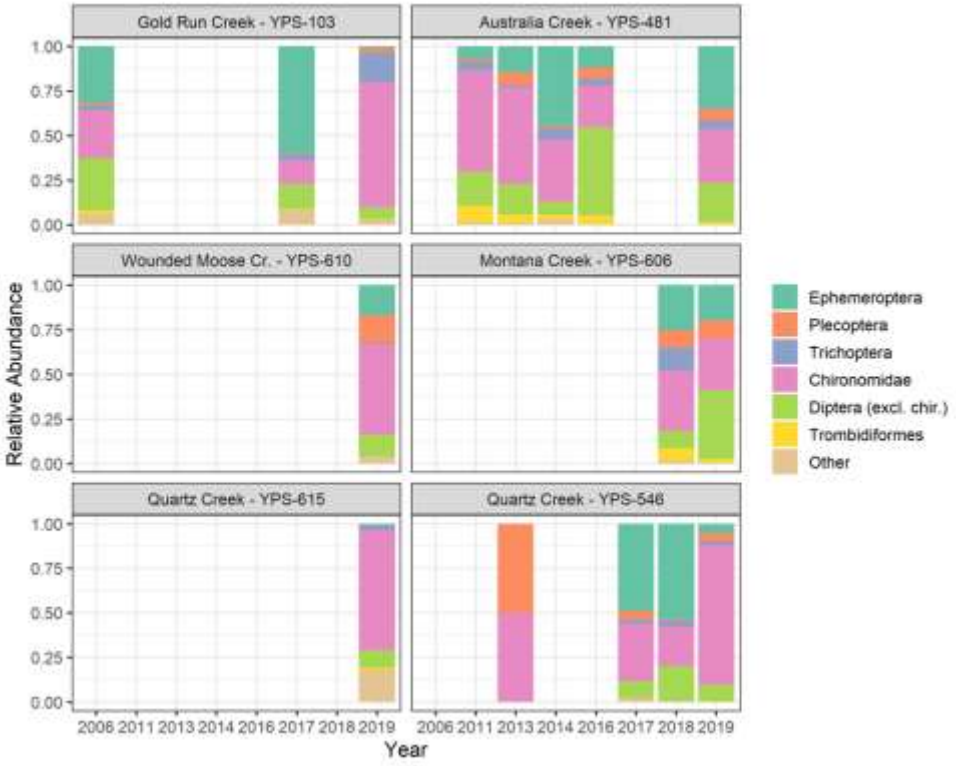
- **Placer mining development characterized as low at YPS-481(Australia Creek), YPS-606 (Montana Creek), and YPS-610 (Wounded Moose Creek) and High at YPS-546 and YPS-615 (Quartz Creek), YPS-090 (Indian River) and at YPS-103 (Gold Run Creek).**
- **Invertebrate communities at the test sites were generally dominated by Ephemeroptera, Plectopera and Chironomidae.**
- **No discernable trends in community composition or abundance at any of the sites sampled.**



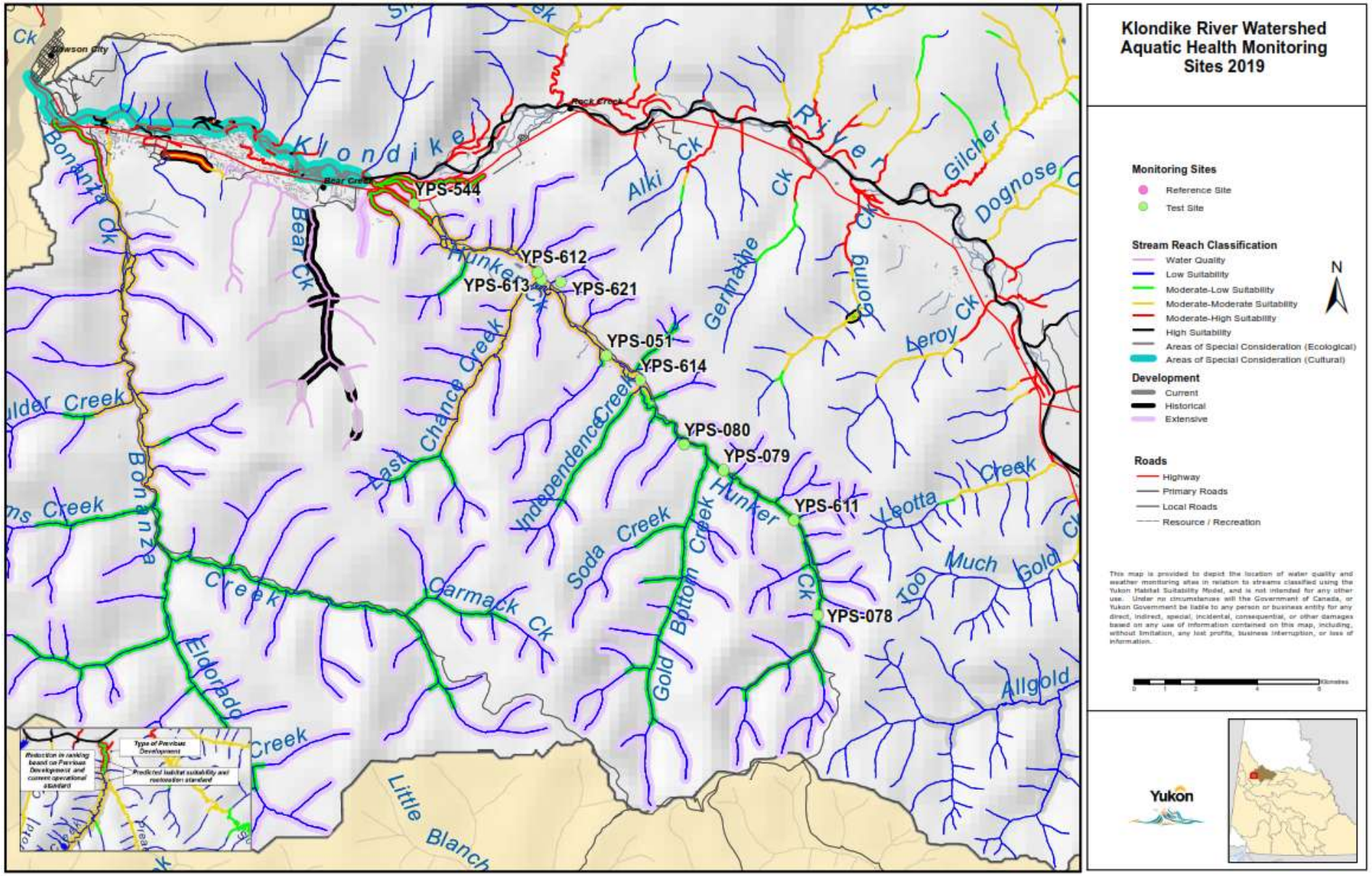


Indian River Watershed – Test Sites



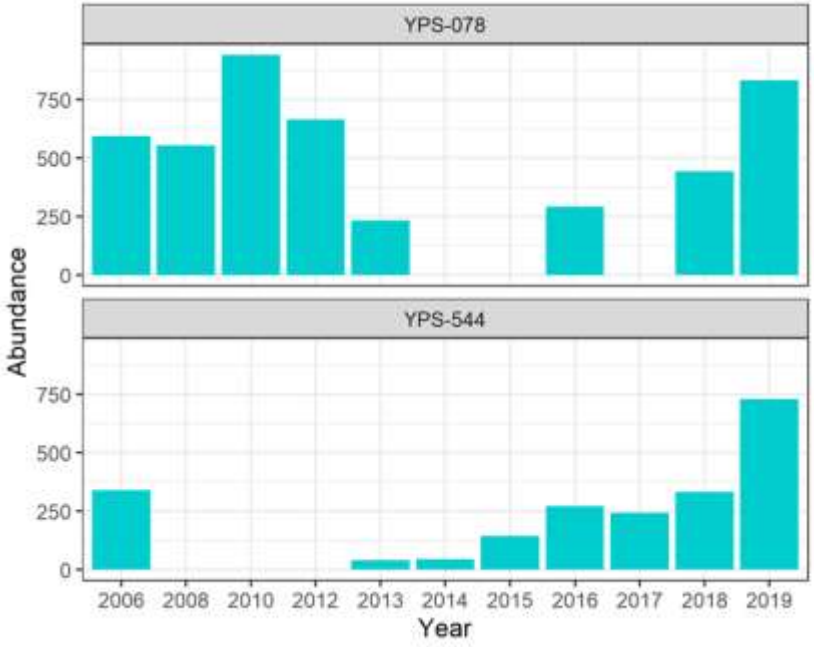


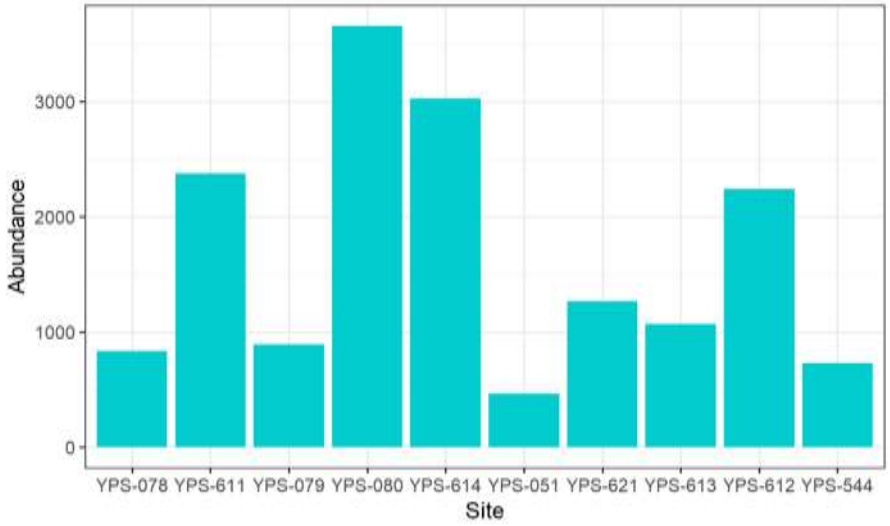
Klondike River Watershed



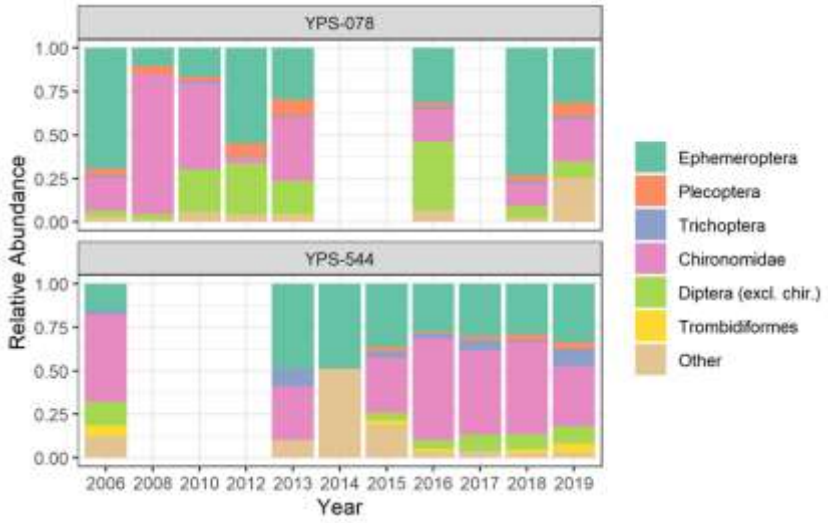
Klondike River Watershed – Test Sites

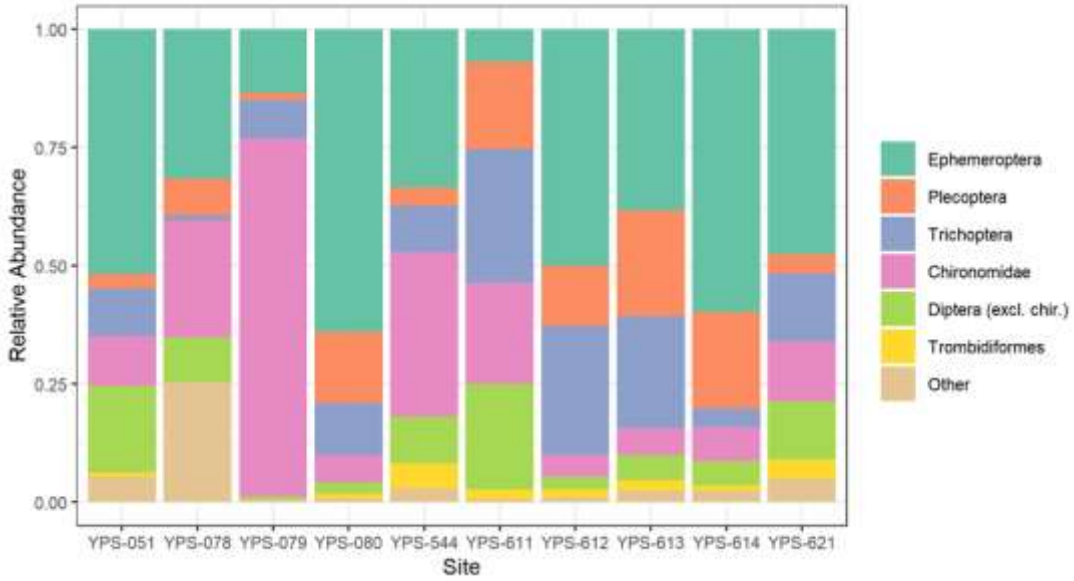
- **Placer mining development characterized as high with the exception of YPS-078 (Hunker Creek upstream of Ontario Creek).**
- **Invertebrate community at YPS-078 has varied over time, with the dominant taxon shifting among Ephemeroptera, Chironomidae, and other Diptera. At YPS-544, community was generally dominated by Ephemeroptera and Chironomidae.**
- **Appears to be increasing trend in abundance at YPS-544 (most downstream site). No similar trend at most upstream site (YPS-708).**



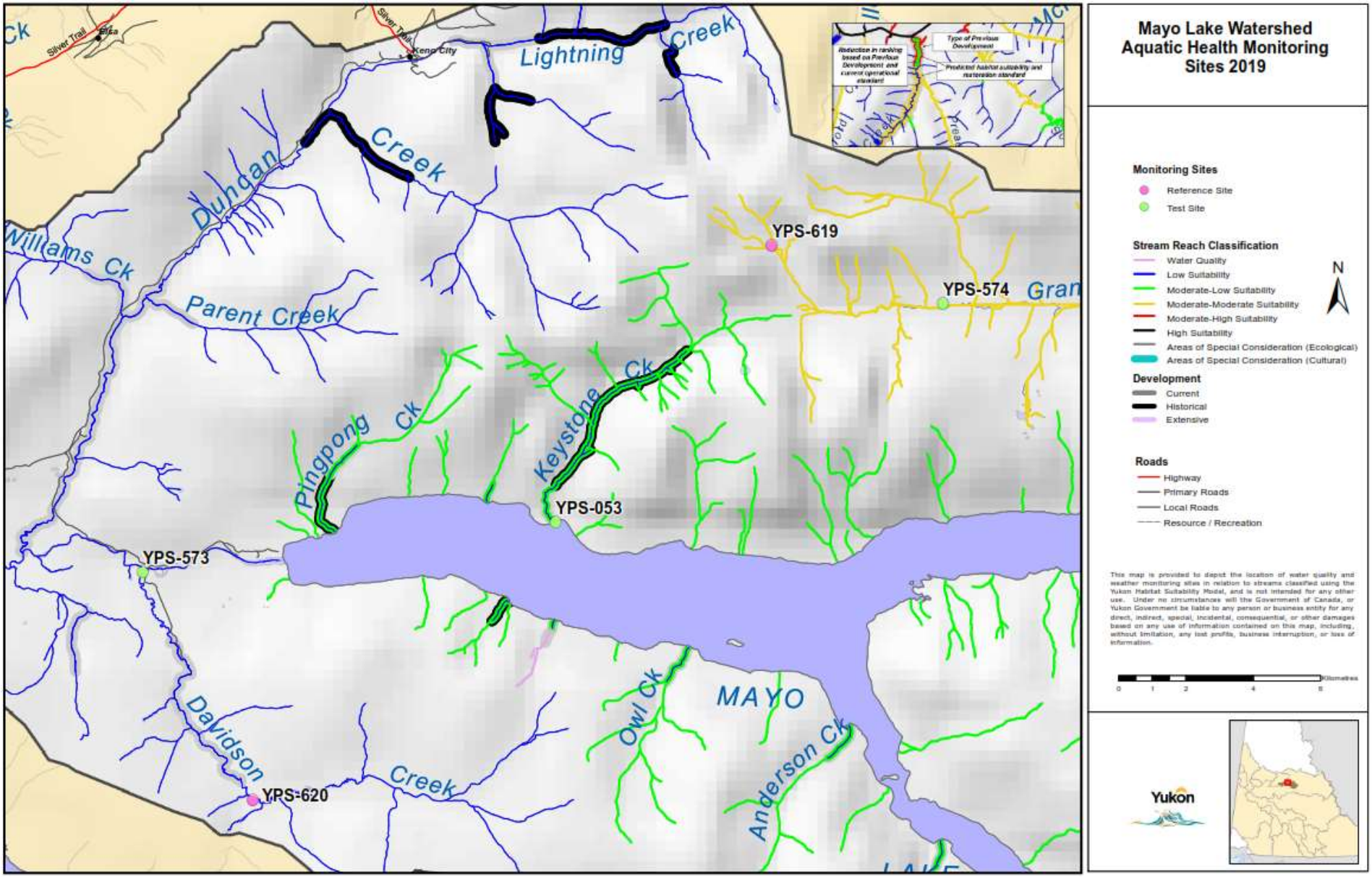


Klondike River Watershed – Test Sites



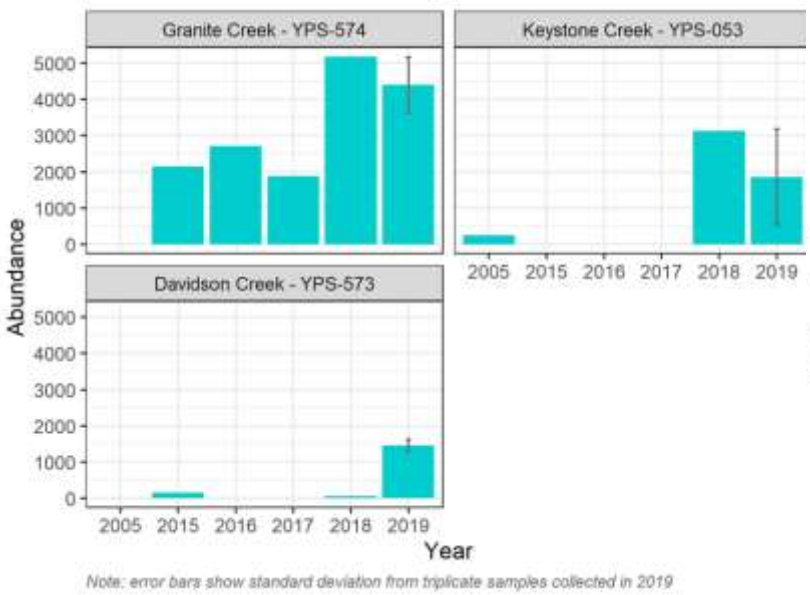


Mayo River Watershed

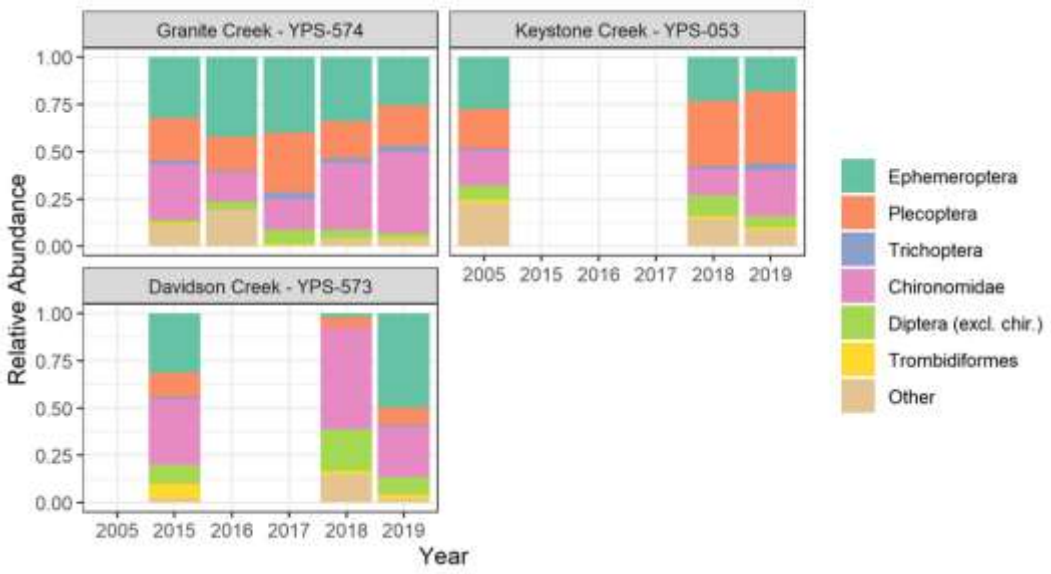


Mayo River Watershed – Test Sites

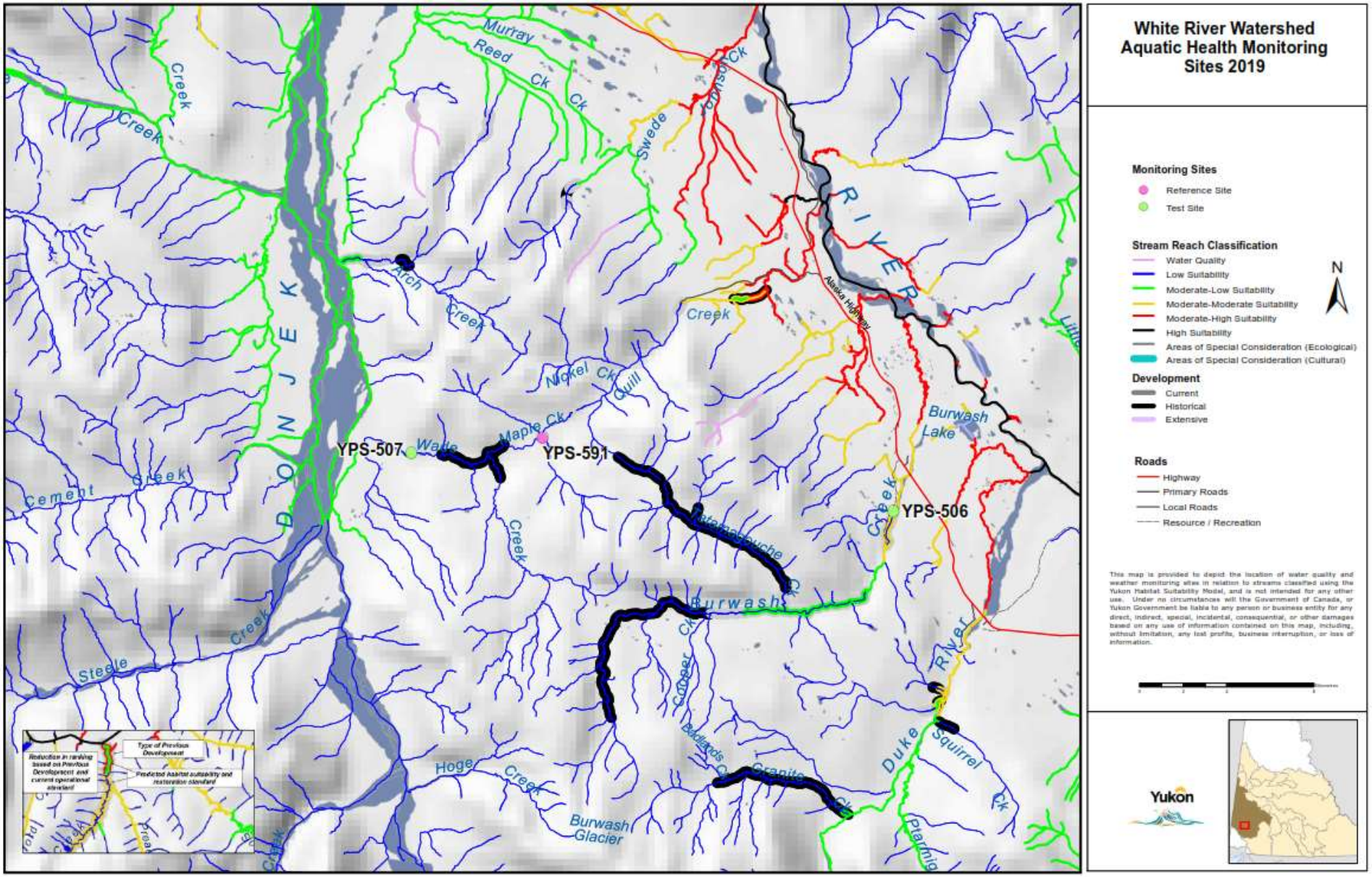
- **Placer mining development characterized as low at YPS-574 (Granite Creek), high at YPS-573 (Davidson Creek) and no indication of placer activity was indicated at YPS-053 (Keystone Creek).**
- **Invertebrate community generally dominated by Ephemeroptera, Plecoptera, and Chironomidae.**
- **No discernable trends in abundance at test sites.**



Note: error bars show standard deviation from triplicate samples collected in 2019

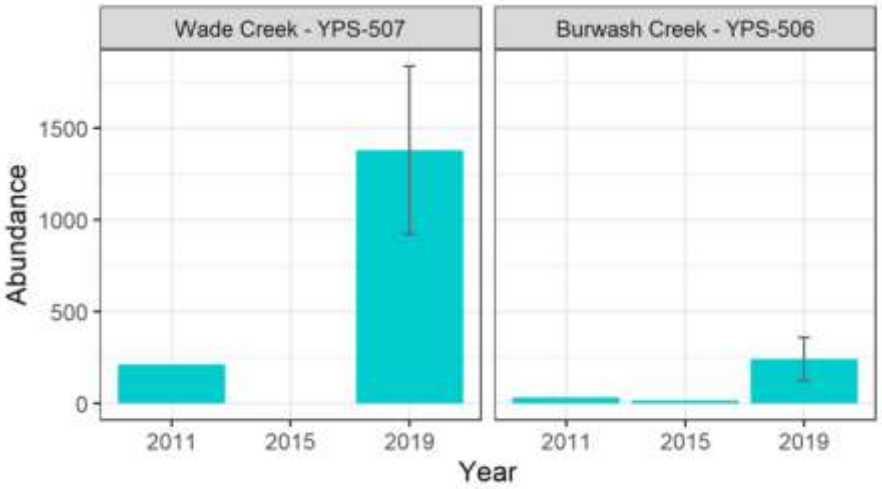


White River Watershed – Test Sites

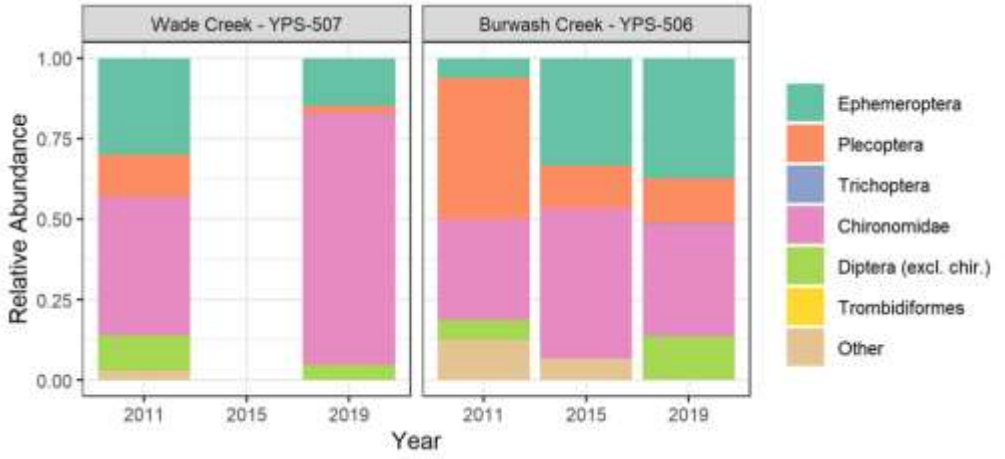


White River Watershed – Test Sites

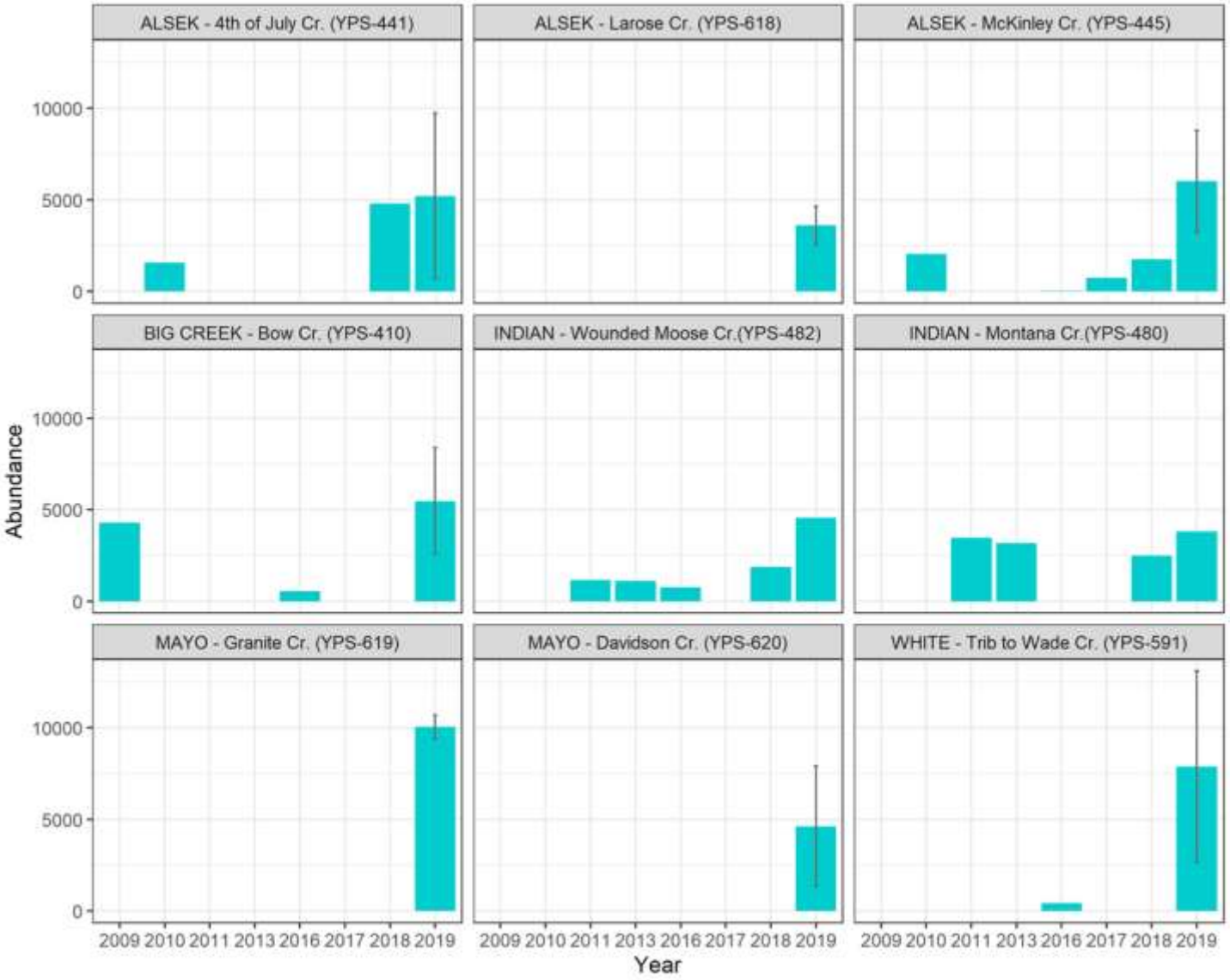
- **Placer mining characterized as low at YPS-507 (Wade Creek) and high at YPS-506 (Burwash Creek).**
- **Invertebrate communities generally dominated by Ephemeroptera, Plecoptera, and Chironomidae at the test site.**
- **There was a greater relative abundance of Chironomidae than observed at the reference site (YPS-591), where Ephemeroptera was the dominant taxon.**
- **Abundance was low in Burwash Creek and saw increase from 2011 to 2019 in Wade Creek.**



Note: error bars show standard deviation from triplicate samples collected in 2019

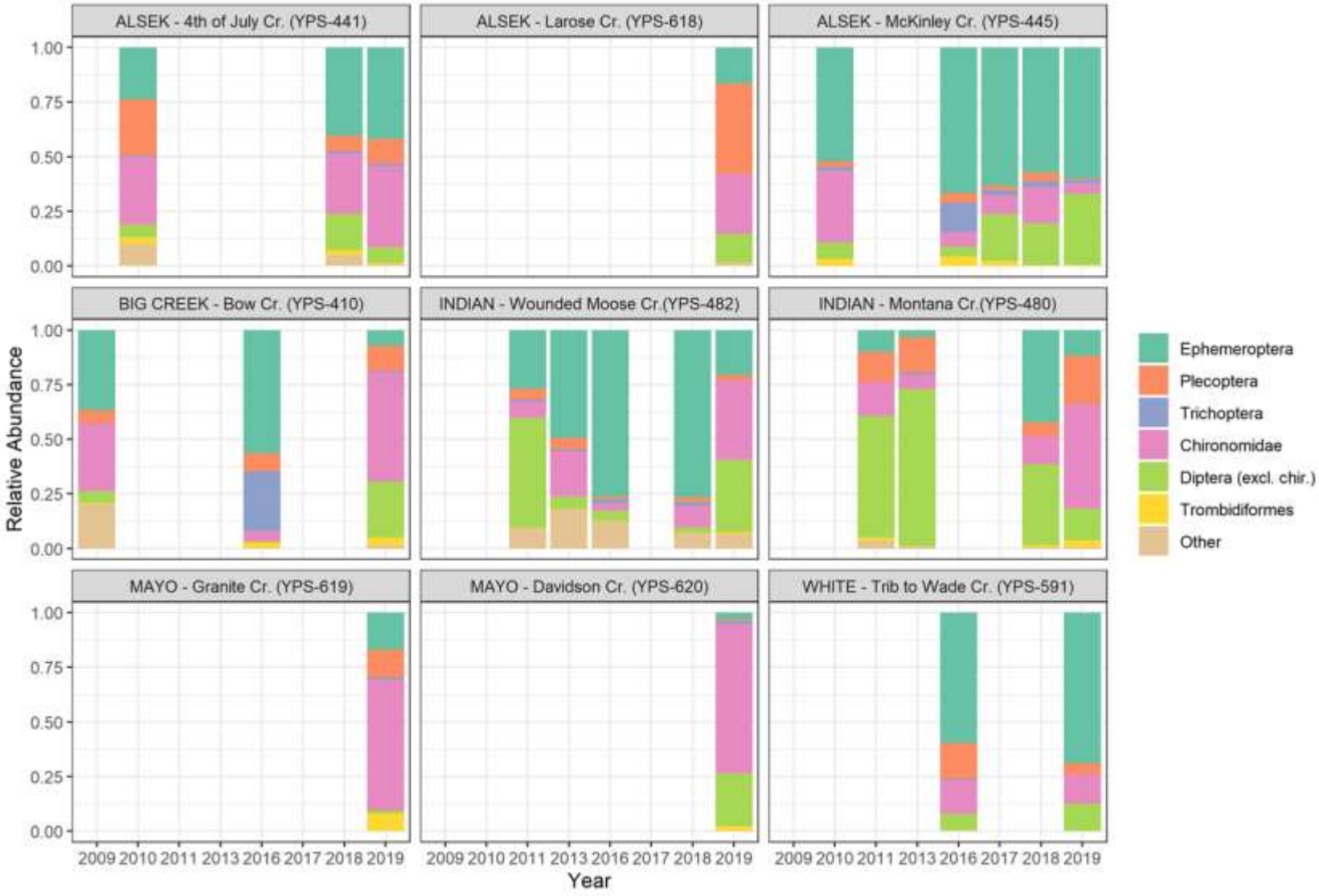


Reference Sites – All Watersheds



Note: error bars show standard deviation from triplicate samples collected in 2019

Reference Sites – All Watersheds

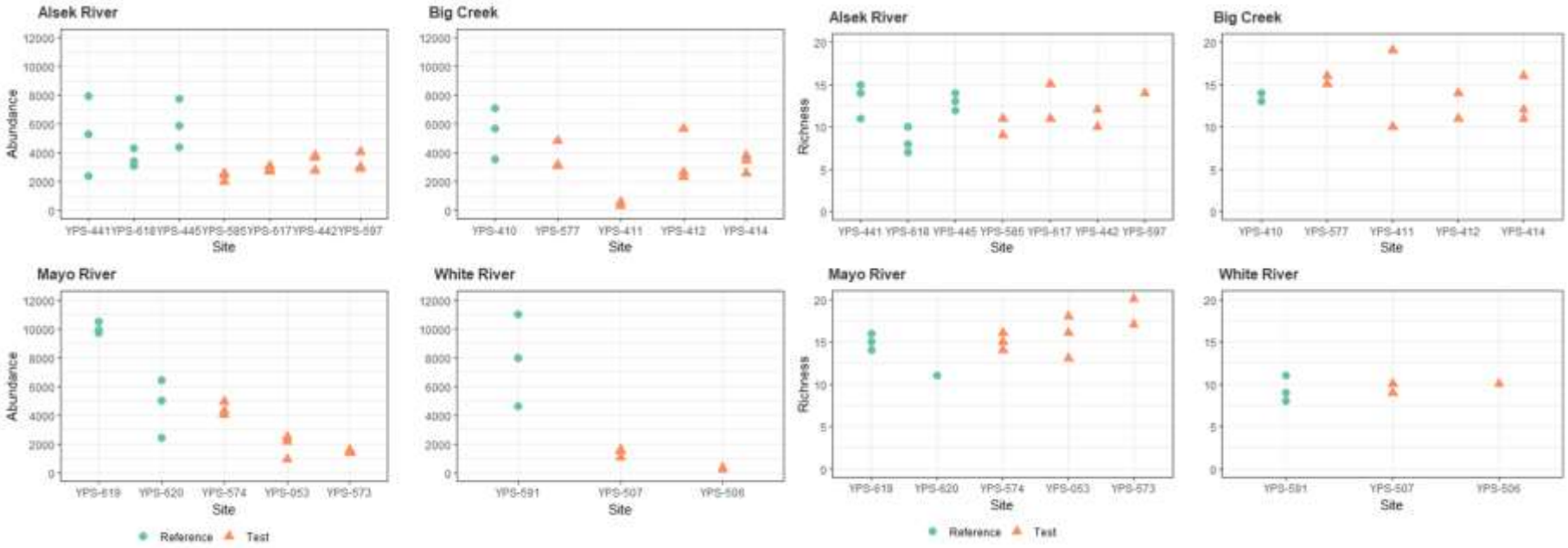


Replicate Study

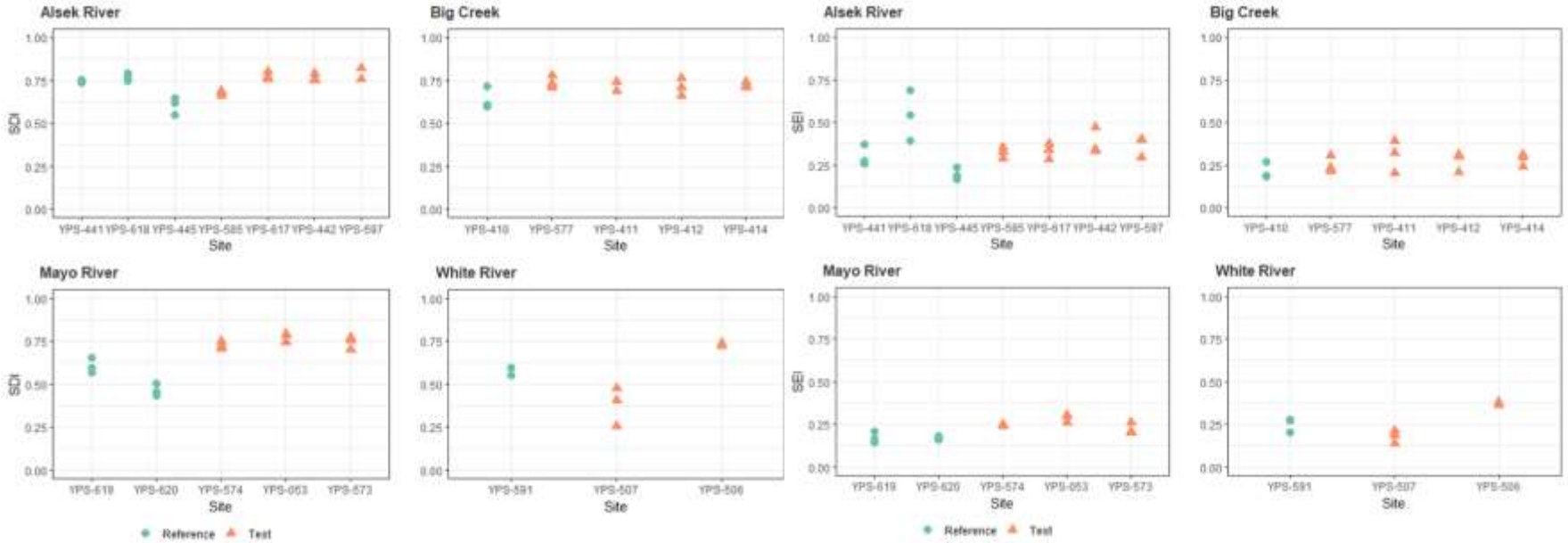
- **A study to evaluate variability in replicates of benthic invertebrate community samples was carried out to answer the following key question:**

  - ***Should AHM protocols incorporate replication into the study design?***

- **Field work included collection of three replicate invertebrate samples from consecutive riffles at 20 sites.**
- **Of the four benthic metrics (i.e., total abundance, richness, Simpsons Diversity Index, and Simpsons Evenness Index), abundance exhibited the greatest within-site variability based on comparison of the coefficients of variation.**



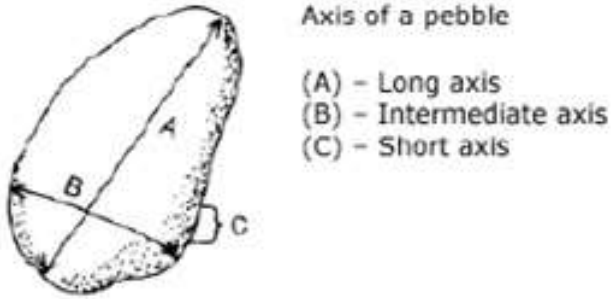
Replicate Study



Analysis of substrate composition methods

- **An analysis of substrate composition methods was carried out to answer the following key questions:**
  - ***How comparable are substrate composition values between sample sizes of 10 and 100 substrate measurements?***
  - ***What is the recommended sample size to provide an accurate representation of in-stream substrate composition?***
- **The analysis showed that substantial variation in calculated geometric mean substrate size can occur when sample sizes are less than 75. Therefore a sample size of 100 substrate measurements is recommended to characterize substrate composition at aquatic health monitoring sites.**

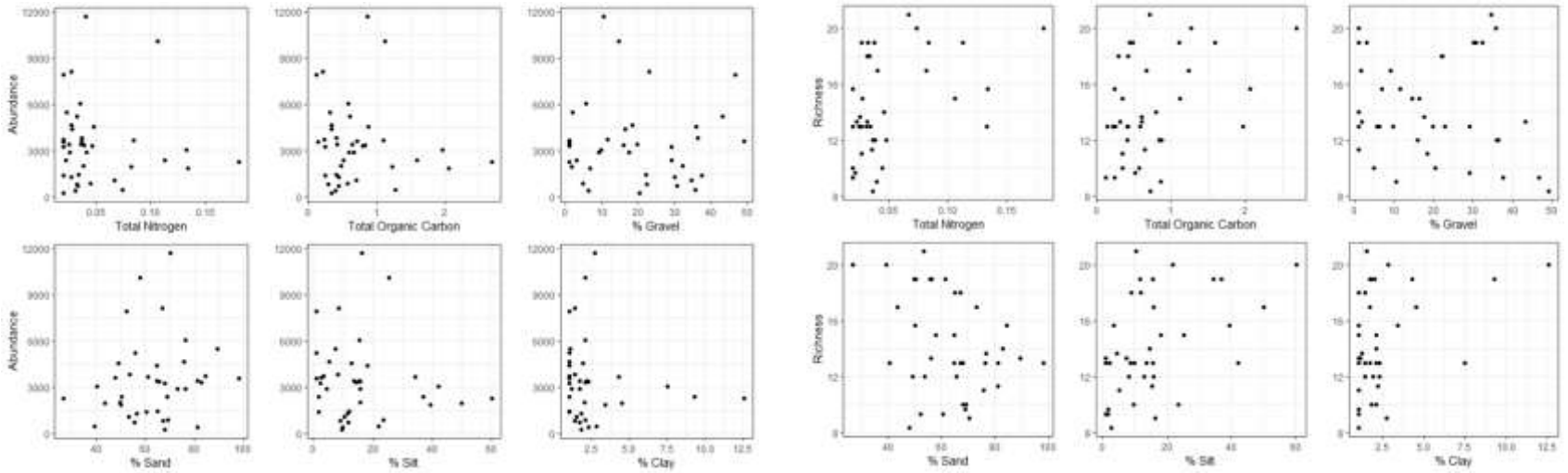
https://www.youtube.com/watch?v=B7S3RJ6XLvA



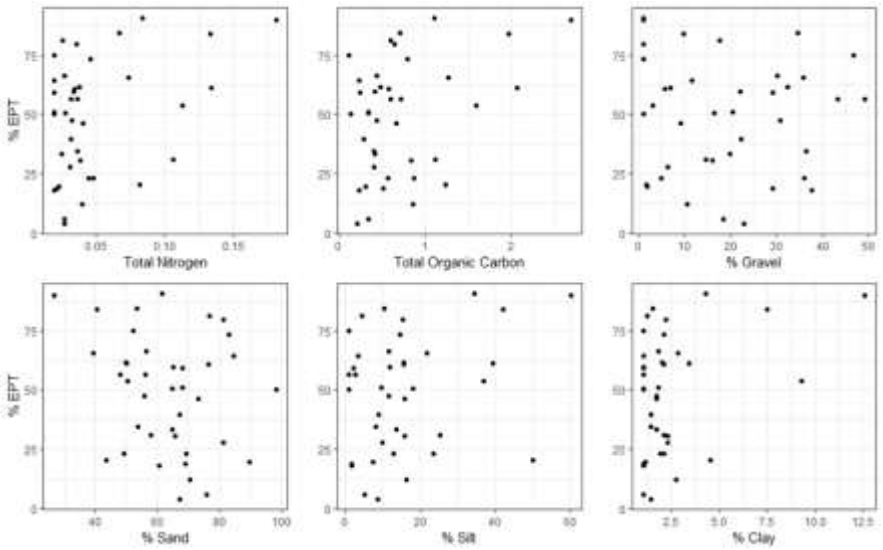
https://dep.wv.gov/WWE/getinvolved/sos/Pages/SOPpebble.aspx

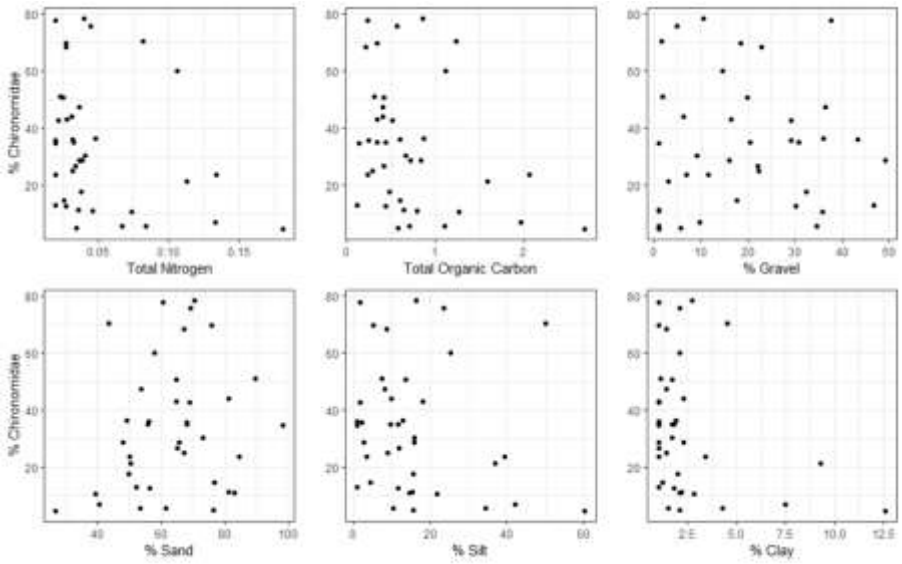
In-situ sediment sampling

- **Collection of in-situ sediment samples was carried out to answer the following key questions:**
  - **How does the benthic invertebrate community respond to varying sediment parameters?**
- **Sediment parameters analyzed in the laboratory were used to support the interpretation of the invertebrate community results. Total abundance, richness, % EPT, and % C were plotted against the sediment parameters to visually explore potential relationships.**
- **There were no distinct relationships between selected invertebrate community metrics (total abundance, richness, % EPT, and % C) and the laboratory-analyzed sediment parameters.**



In-situ sediment sampling

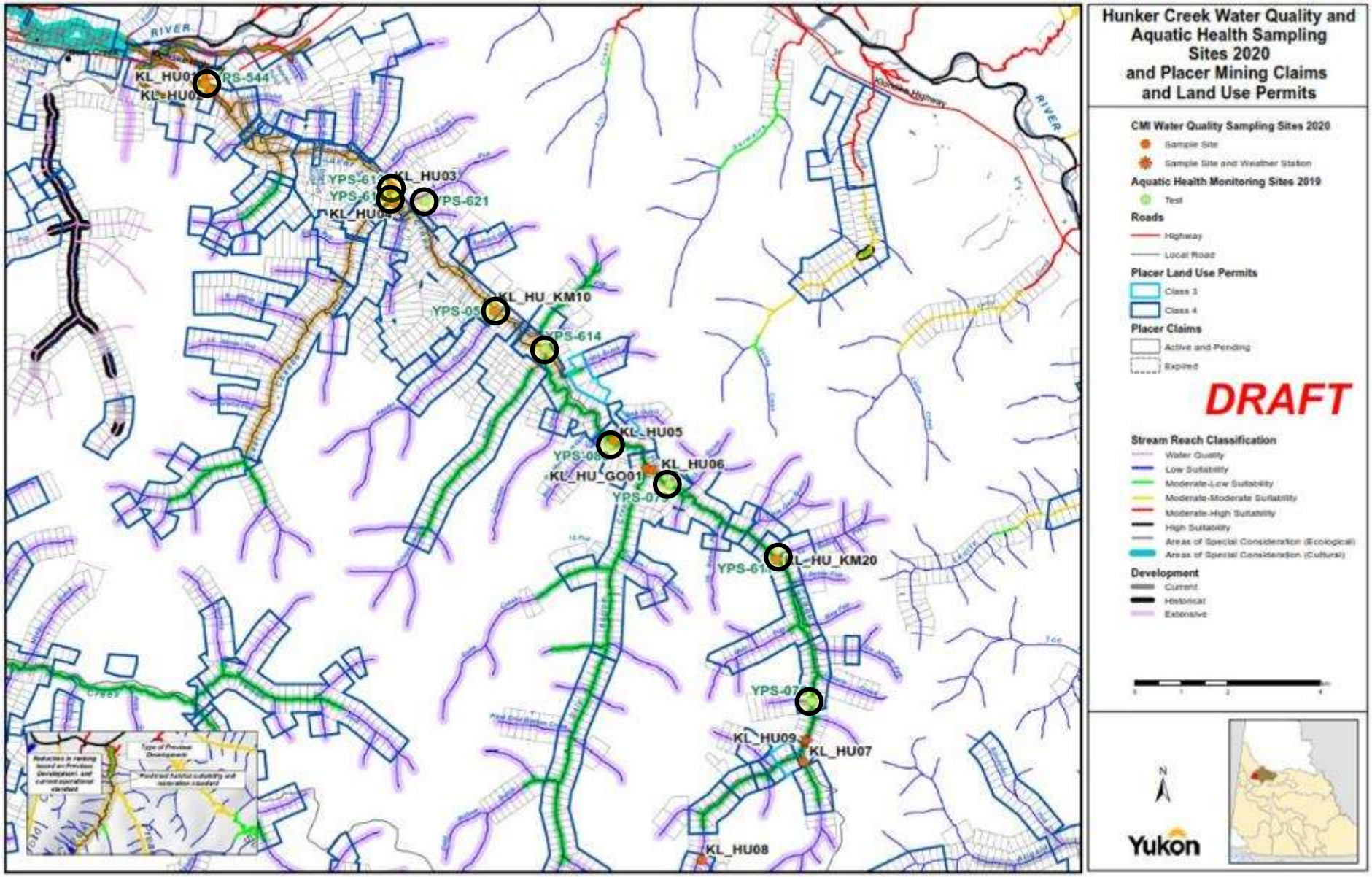




2020 Aquatic Health Monitoring

YPS-078, Hunker Creek, looking downstream

Hunker Creek



Hunker Creek

- **Community composition dominated by Chironomidae (non-biting midges) at all sites with the exception of YPS-078.**
- **Orthocladius complex was the dominant taxon at all sites sampled with the exception of YPS-078.**
- **Of EPT taxa, presence of Ephemeroptera (mayflies) is generally higher than Plecoptera (stoneflies) and Trichoptera (caddisflies).**

YPS-612, Hunker Creek, looking downstream

YPS-051, Hunker Creek, looking downstream

Hunker Creek

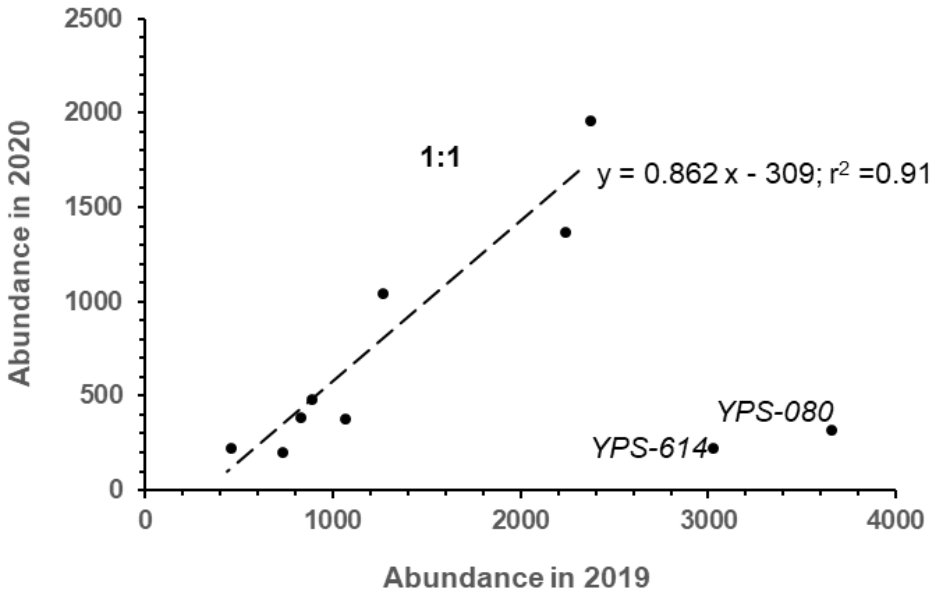
- **Evidence of current and historical placer mining at all sites sampled.**
- **Turbidity was highest at YPS-544 (most downstream) and lowest at YPS-078 (most upstream).**
- **Very little periphyton observed at all sites.**

YPS-079, Hunker Creek, aquatic substrate.

YPS-544, Hunker Creek, looking upstream

Hunker Creek

- **Stream invertebrates were collected at the 10 Hunker Creek sites in both 2019 and 2020.**



Total abundance was very similar between years for 8 of the 10 sites.

- **The community composition and biodiversity measures were not similar between years, however. No statistically significant relationship between 2020 and 2019 for these measures. Far more dipterans in 2020.**
- **Evaluation of turbidity and discharge relationship with benthic invertebrate community metrics did not reveal any significant relationships on Hunker Creek.**

Adams Creek


Adams Creek Water Quality and Aquatic Health Sampling Sites 2020
CMI Water Quality Sampling Sites 2020
Sample Site
Aquatic Health Monitoring Sites 2020
Test
Roads
Local Road
Placer Land Use Permits
Class 4
Placer Claims
Active and Pending
DRAFT
Stream Reach Classification
Water Quality
Low Suitability
Moderate-Low Suitability
Moderate-Moderate Suitability
Moderate-High Suitability
High Suitability
Areas of Special Consideration (Ecological)
Areas of Special Consideration (Cultural)
Development
Current
Historical
Extensive
KL_BO_AD01
YPS-622
KL_BO_AD02
YPS-623
KL_BO_AD03
YPS-624
KL_BO_AD04
YPS-625
KL_BO_AD05
YPS-626
KL_BO_AD06
Stampede
Adams
Hawley Gulch
Stampede Gulch
Monte Cristo Gulch
Fox Gulch
American Gulch
Magnet Gulch
Boulder
Varuah Gulch
Dahlgreen Gulch
Mosquito
Queen
Skookum Gulch
Irish
French
Glacier
Yukon

Adams Creek

- **Established four test sites (YPS-622, YPS-623, YPS-624 and YPS-625) and one potential reference site (YPS-626) in 2020.**
- **Generally low percent EPT in all sites sampled.**
- **Lack of Trichoptera (caddisflies) taxa with only 1% representation at YPS-626**
- **Increasing trend of total abundance and family richness (apart from YPS-624) as you move from the most downstream site to the most upstream site.**
- **Chironomidae (non-biting midges) dominated community composition at all sites.**

YPS-623, Adams Creek, looking upstream

YPS-624, Adams Creek, looking upstream

Adams Creek

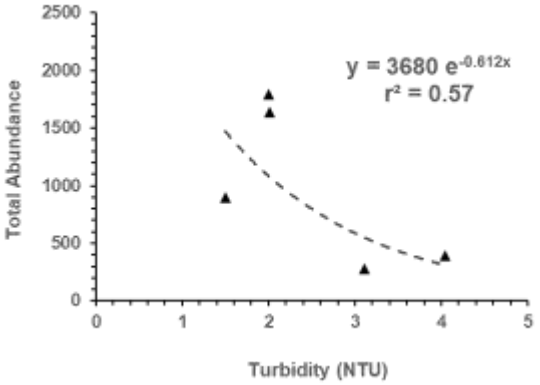
- **Evidence of current or historical placer mining at all sites apart from YPS-626 (most upstream site).**
- **Little evidence of fine sediment accumulation in riffle areas.**
- **Low turbidity observed at all sites. Placer crews were moving dirt but no active sluicing at time of sampling.**

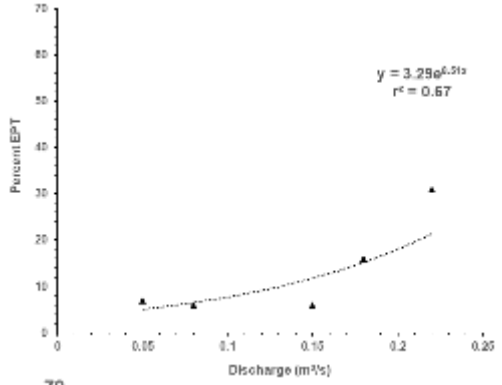
YPS-622, Adams Creek, looking downstream

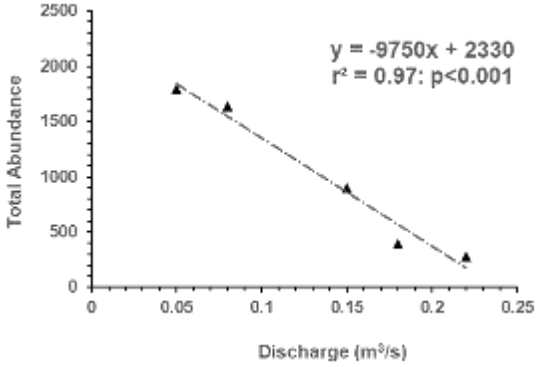
YPS-626, Adams Creek, looking downstream

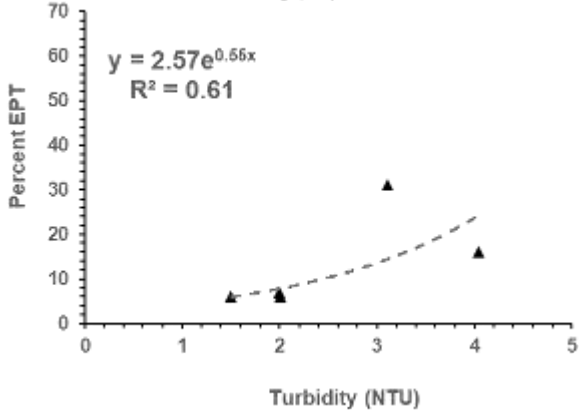
Adams Creek

- **Total abundance decreased significantly with increasing turbidity and increasing streamflow**
- **Percent EPT increased significantly with increasing turbidity and increasing streamflow**

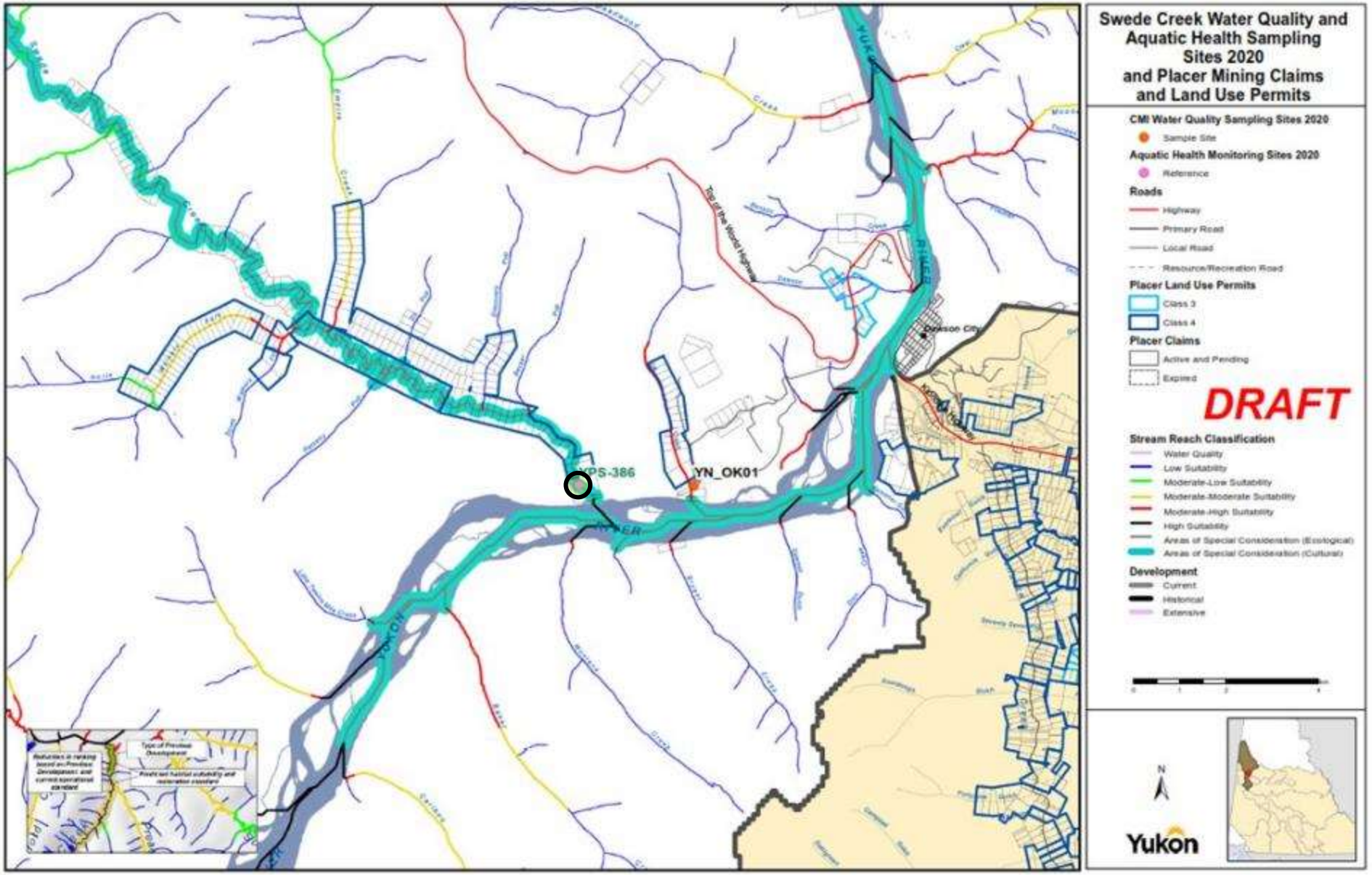








Swede Creek


Swede Creek Water Quality and Aquatic Health Sampling Sites 2020 and Placer Mining Claims and Land Use Permits
CMI Water Quality Sampling Sites 2020
Sample Site
Aquatic Health Monitoring Sites 2020
Reference
Roads
Highway
Primary Road
Local Road
Resource/Recreation Road
Placer Land Use Permits
Class 3
Class 4
Placer Claims
Active and Pending
Expired
DRAFT
Stream Reach Classification
Water Quality
Low Suitability
Moderate-Low Suitability
Moderate-Moderate Suitability
Moderate-High Suitability
High Suitability
Areas of Special Consideration (Ecological)
Areas of Special Consideration (Cultural)
Development
Current
Historical
Extensive
YN_OK01
Dawson City
Yukon

Swede Creek

- **Only one site sampled, YPS-386, Swede Creek near the Mouth of Yukon River**
- **Results are generally consistent with 2009 and 2016.**
- **Appears to be a decreasing trend in percent Chironomidae and increasing trend in percent EPT and total abundance.**
- **Consistent lack of Trichoptera (caddisflies) taxa, similar to Adams Creek.**

YPS-386, Swede Creek, looking across

YPS-386, Swede Creek, substrate dry

Swede Creek

- **Habitat at the site indicates little to no recent or historical placer mining development.**
- **One of the few sites monitored in 2020 with the presence of periphyton.**
- **Low turbidity (1.8 NTU) and little evidence of sediment accumulation within riffle substrates.**

YPS-386, Swede Creek, looking upstream

YPS-386, Swede Creek, aquatic substrate

Targeted Studies – Benthic Invertebrate Community Composition and Relationship with In-situ Sediment

- **Primary environmental issue associated with placer mining is the potential to increase suspended sediment concentrations (TSS).**
- Extensive body of science that clearly demonstrates the potential for adverse effects of increased TSS on aquatic life.
- Two types of observations within the AHM to capture substrates conditions in the stream reach.

YPS-624, Adams Creek, substrate (dry)

YPS-624, Adams Creek, substrate (aquatic)

Targeted Studies – Benthic Invertebrate Community Composition and Relationship with In-situ Sediment

- For Hunker Creek in 2019, the abundance of stream invertebrates significantly co-varied with the fines content of sediment samples (silt-clay fraction;<63 µm).
- The remaining benthic community metrics for Hunker Creek in 2019 and 2020 as well as Adams Creek in 2020 did not significantly covary with any qualitative measure of substrate conditions (Both CABIN and analytical results).

Variables	Hunker Creek - 2019		Hunker Creek - 2020		Adams Creek - 2020	
	r^2	p value	r^2	p value	r^2	p value
Abundance vs Percent Fines	0.51	0.02	0.05	0.53	0.44	0.22
Abundance vs Pebble/Cobble	0.08	0.41	0.1	0.36	0.38	0.27
Abundance vs %TOC	0.33	0.08	0.0004	0.95	0.4	0.25
Richness vs Percent Fines	0.04	0.58	0.03	0.62	0.01	0.87
Richness vs Pebble:Cobble ratio	0.04	0.58	0.42	0.04	0.00005	0.99
Richness vs %TOC	0.003	0.87	0.0001	0.97	0.17	0.49
%EPT vs Percent Fines	0.24	0.16	0.02	0.71	0.49	0.19
%EPT vs Pebble/Cobble	0.09	0.39	0.11	0.35	0.003	0.92
%EPT vs %TOC	0.35	0.06	0.0005	0.95	0.25	0.39
%C vs Percent Fines	0.08	0.42	0.01	0.76	0.42	0.23
%C vs Pebble/Cobble	0.08	0.43	0.07	0.45	0.01	0.9
%C vs %TOC	0.21	0.19	0.003	0.88	0.57	0.14

Focal Studies – Replicate Study

- Three replicates were collected at YPS-612, YPS-622 and YPS-626 in 2020 to further the work in 2019 to better characterize within site variability in benthic invertebrate community composition to evaluate the need to incorporate site replication into the study design. To improve the statistical confidence and results the evaluating the site variability a larger data set will be utilized and published in an upcoming report.

Conclusions

- **Difficult to make any conclusions about whether watersheds exposed to placer mining are not being maintained in reference condition.**
- It is important to note the relatively poor agreement in community metrics such as family richness, % EPT and % C for Hunker Creek AHM sites between 2020 and 2019 and very high degree of inter-annual variability for several Hunker Creek site across multiple monitoring years.

YPS-621, Hunker Creek, looking across

YPS-622, Adams Creek, looking across

Conclusions

- Benthic invertebrate data for both Hunker Creek and Adams Creek show that the numerically dominant families include especially dipteral insects, with very low abundance of ephemeroptera (mayflies) and very low abundances of plectoptera (stoneflies) and trichopteran (caddisflies).
- A better understanding of community compositional differences across watersheds, and along natural gradients from headwater areas to valley bottom confluences with mainstem flows will be useful for re-evaluation of AHM metrics and approaches that reflect ecological responses to anthropogenically increased suspended sediment loads and inventories.

Recommendations

- **Alter in-situ sediment sampling methodology.**
- **Further refinement to descriptors to capture the intensity of assessing placer mining activities.**
- **Investigate the proliferation of certain Chironomidae taxa.**
- **Add the collection of periphyton to AHM program.**

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Annual Adaptive Management Meeting

Water Quality Objective Monitoring

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Water Quality Objective Monitoring Program

Our Team:

Andrew McPhail, B.Sc., R.P.Bio., P.Biol., Biologist,

Nicole Marsh, M.Sc., GIT, Environmental Scientist

Doug Bright, Ph.D., R.P.Bio., P.Biol., Environ. Toxicologist

Agenda

1. Introduction
2. Water Quality Objective Monitoring Protocols
3. 2019-2020 Water Quality Monitoring Results
4. 14-Year Data Roll-Up
5. Recommendations
6. Questions & Answers/ Discussion

Introduction

- Hemmera provided assistance with execution of the 2020 Water Quality Objectives Monitoring (AQOM) and Aquatic Health Monitoring (AHM) programs.

- Hemmera conducted data "roll-up" of 14 years of monitoring data, including a data inventory, statistical summaries and data visualization (plots, maps).

- Supported the larger interest in evaluating the effectiveness of the Adaptive Management Framework (AMF).

Water Quality Objective (WQO) Monitoring Protocols

- Protocols for monitoring program design, sample collection and data-analysis.

- Primary objectives:
  - Provide ongoing information on the water quality in the various watersheds.
  - Provide the data on total suspended solids (TSS) used to determine whether the WQO set within the regime are being achieved.
  - Describe how WQO will be monitored.
  - Align the water quality information with the adaptive management process.

Water Quality Objective Monitoring Protocols

- Water quality objectives (WQO) for total-suspended solids (TSS) developed specifically for Yukon placer mining with reference to Canadian Federal guidelines and European criteria.

Habitat Suitability Classification	Watershed Category A TSS_{WQO} (mg/L)	Watershed Category B TSS_{WQO} (mg/L)
Area of Special Concern	25	25
High	25	25
Moderate–High	25	25
Moderate–Moderate	50	100
Moderate–Low	80	200
Low	200	300

2019-2020 WQOM

KL_BO_AD03, Adams Creek, looking downstream

2019-2020 WQOM

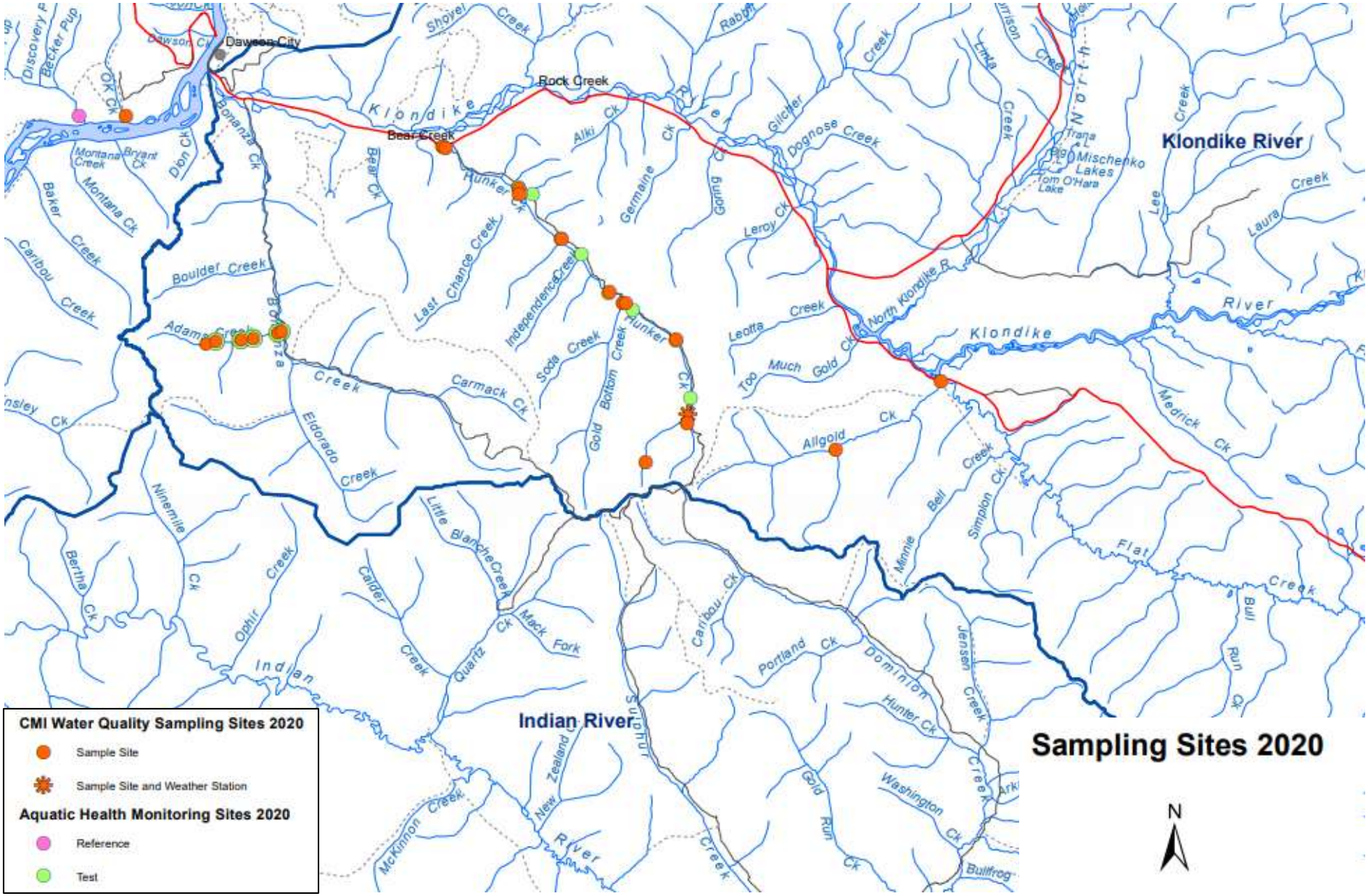
2019 monitoring completed by CMI

- Focal study on Hunker Creek (Klondike River Watershed)

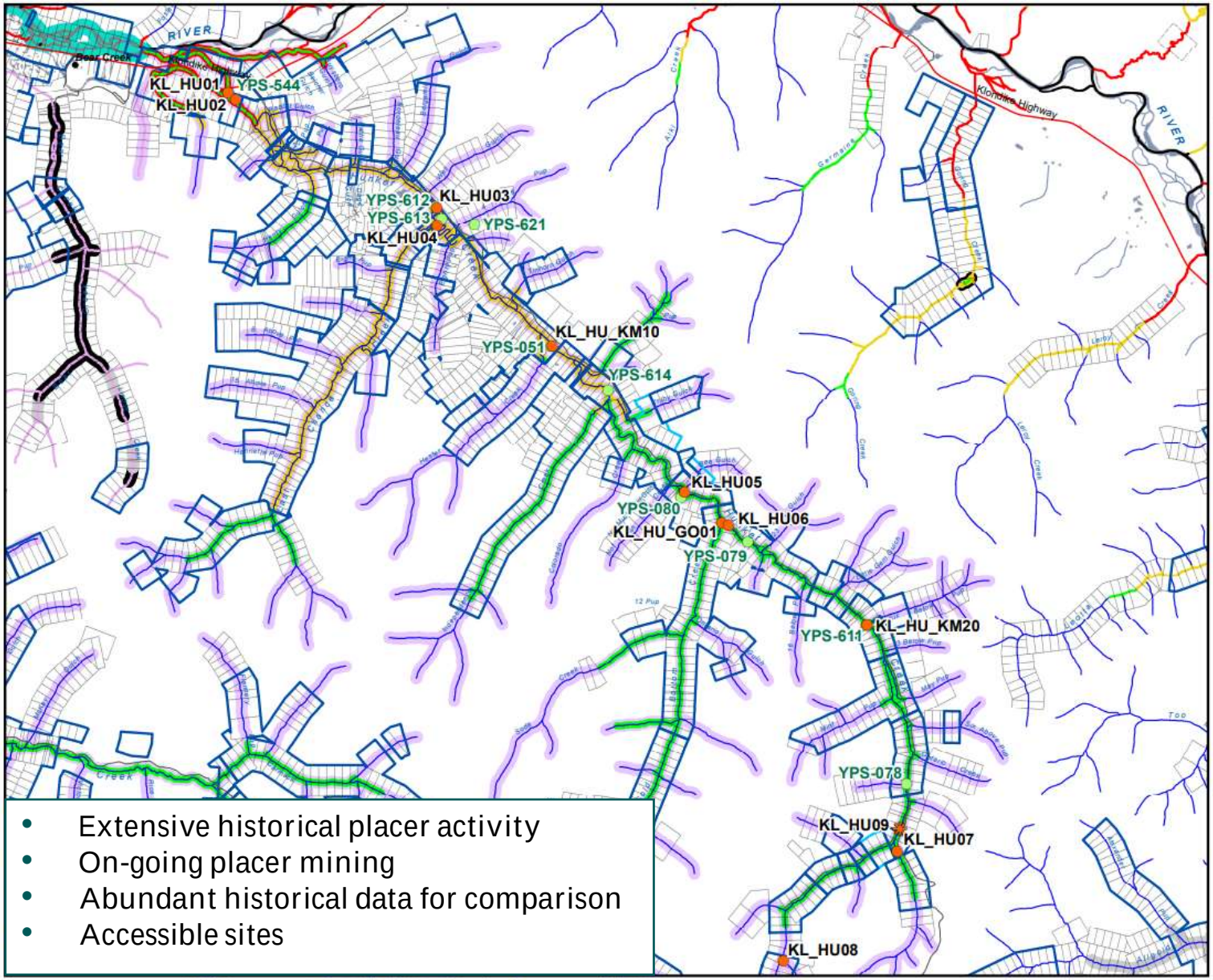
2020 monitoring completed by Hemmera

- Tied closely with AHM program
- Focal study approach:

1. Hunker Creek
2. Adams Creek
3. Swede Creek
4. All Gold Creek


Dawson City
Rock Creek
Bear Creek
Klondike River
Indian River
Sampling Sites 2020
N
CMI Water Quality Sampling Sites 2020
Sample Site
Sample Site and Weather Station
Aquatic Health Monitoring Sites 2020
Reference
Test

Hunker Creek



- Extensive historical placer activity
- On-going placer mining
- Abundant historical data for comparison
- Accessible sites

Hunker Creek Water Quality and Aquatic Health Sampling Sites 2020 and Placer Mining Claims and Land Use Permits

CMI Water Quality Sampling Sites 2020
- Sample Site
- Sample Site and Weather Station

Aquatic Health Monitoring Sites 2019
- Test

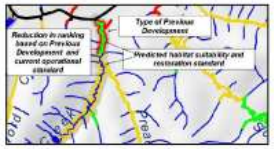
Roads
- Highway
- Local Road

Placer Land Use Permits
- Class 3
- Class 4

Placer Claims
- Active and Pending
- Expired

Stream Reach Classification
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)

Development
- Current
- Historical
- Extensive

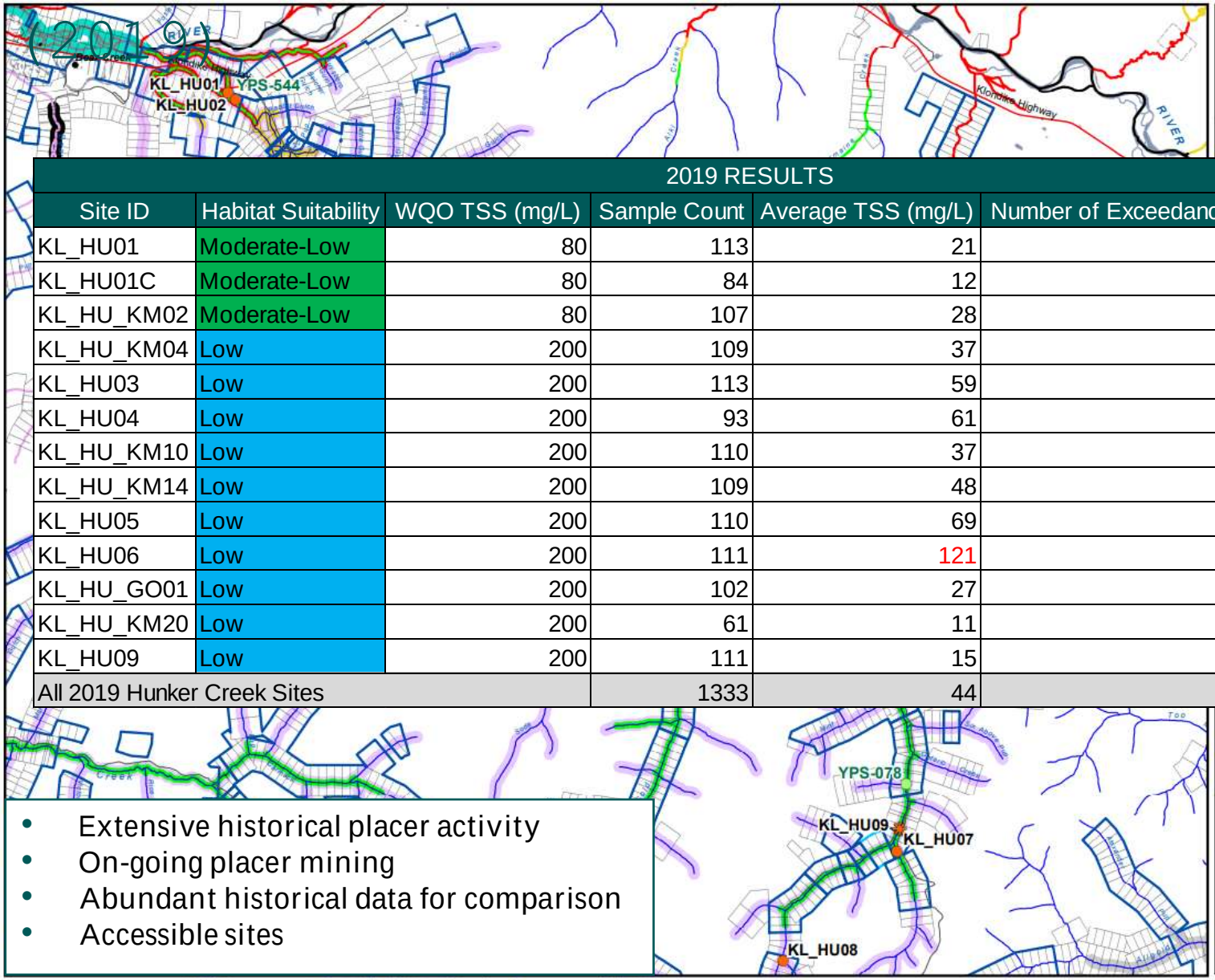


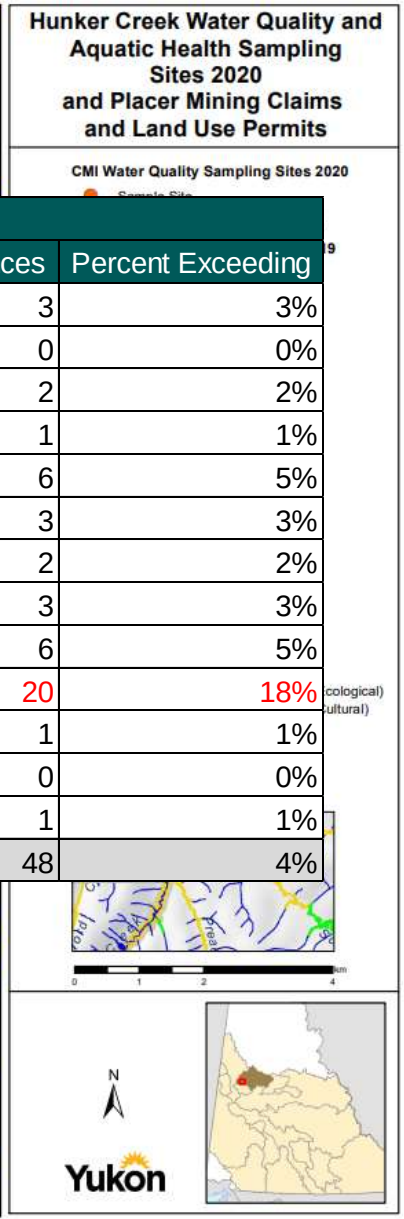
N

Yukon

Hunker Creek (2019)

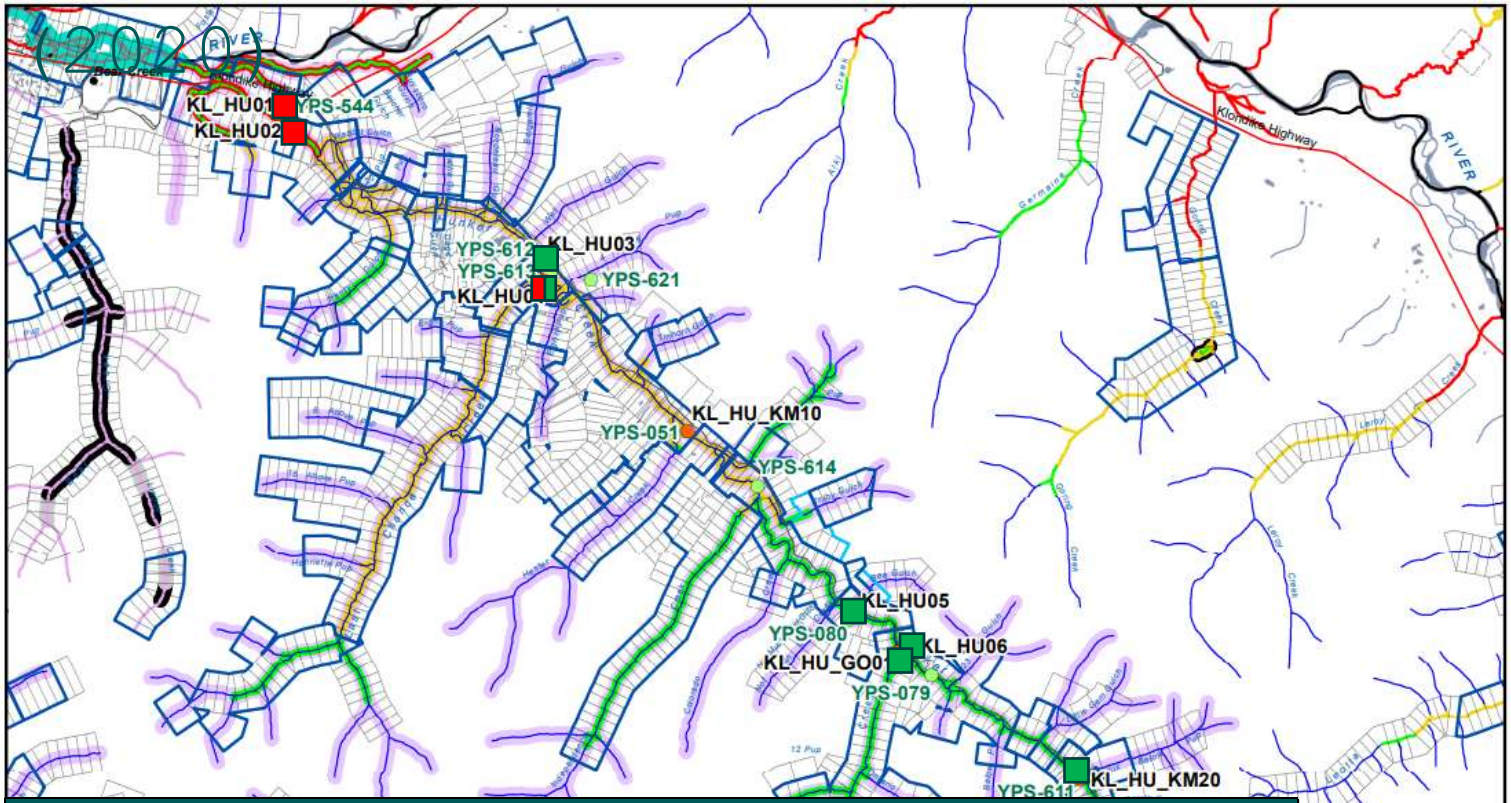
2019 RESULTS						
Site ID	Habitat Suitability	WQO TSS (mg/L)	Sample Count	Average TSS (mg/L)	Number of Exceedances	Percent Exceeding
KL_HU01	Moderate-Low	80	113	21	3	3%
KL_HU01C	Moderate-Low	80	84	12	0	0%
KL_HU_KM02	Moderate-Low	80	107	28	2	2%
KL_HU_KM04	Low	200	109	37	1	1%
KL_HU03	Low	200	113	59	6	5%
KL_HU04	Low	200	93	61	3	3%
KL_HU_KM10	Low	200	110	37	2	2%
KL_HU_KM14	Low	200	109	48	3	3%
KL_HU05	Low	200	110	69	6	5%
KL_HU06	Low	200	111	121	20	18%
KL_HU_GO01	Low	200	102	27	1	1%
KL_HU_KM20	Low	200	61	11	0	0%
KL_HU09	Low	200	111	15	1	1%
All 2019 Hunker Creek Sites			1333	44	48	4%

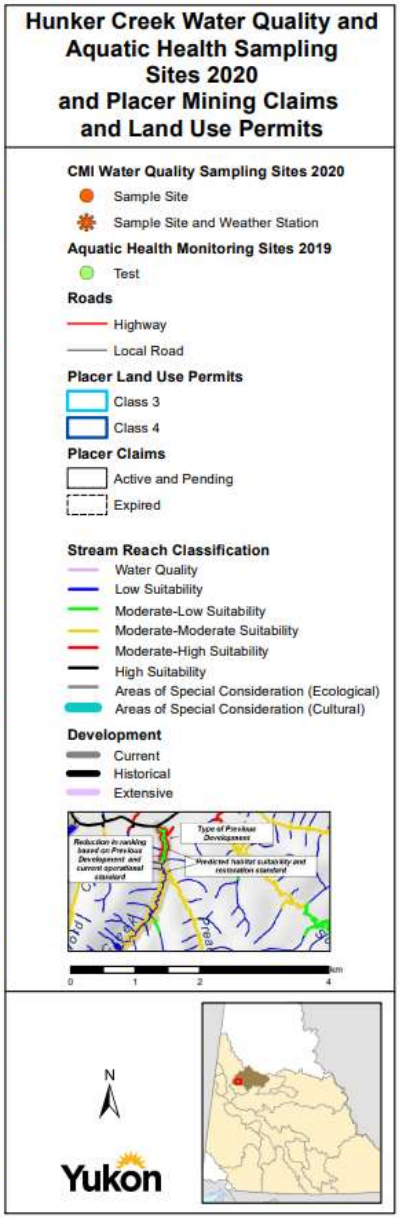




- Extensive historical placer activity
- On-going placer mining
- Abundant historical data for comparison
- Accessible sites

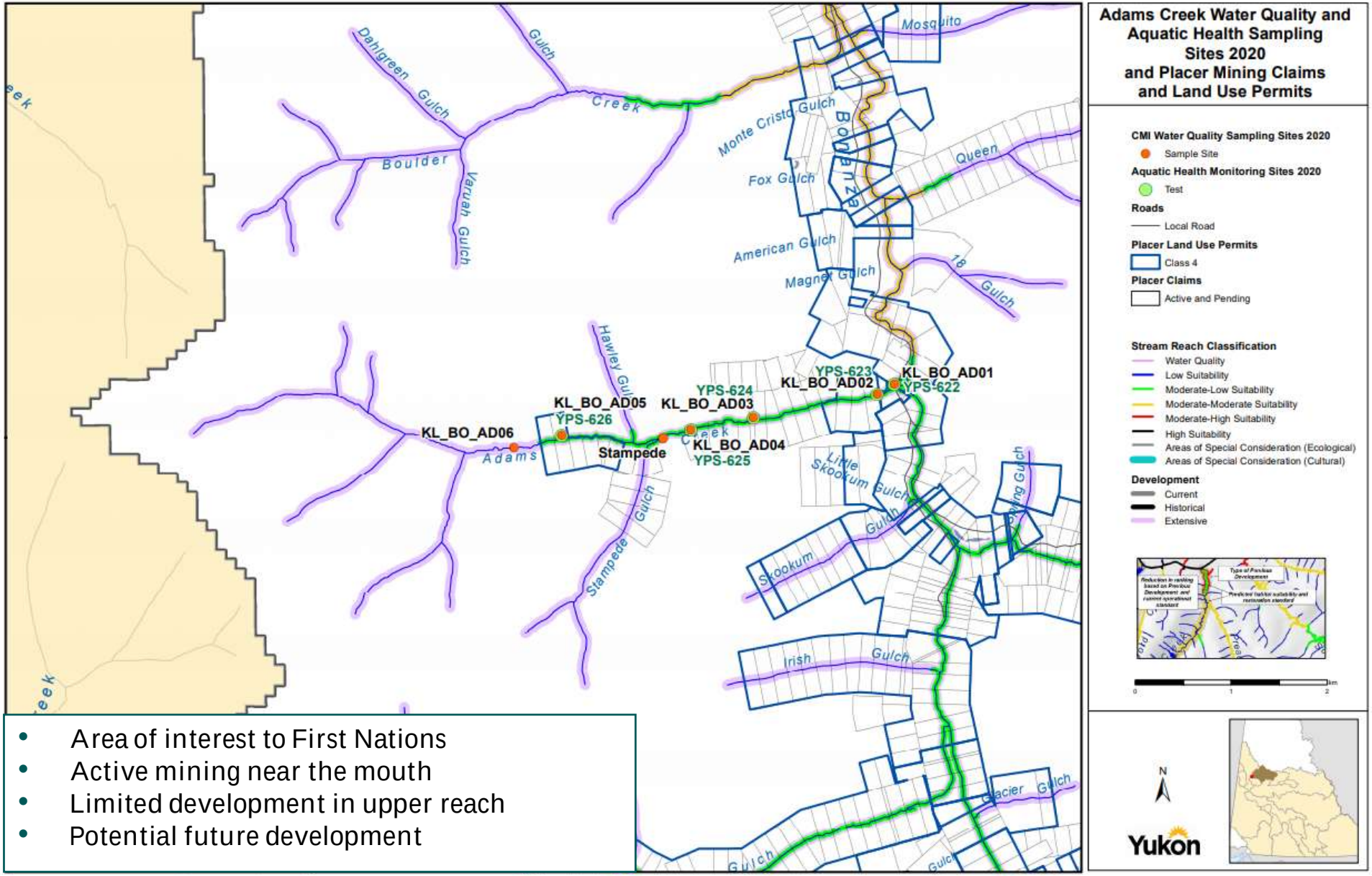
Hunker Creek (2020)





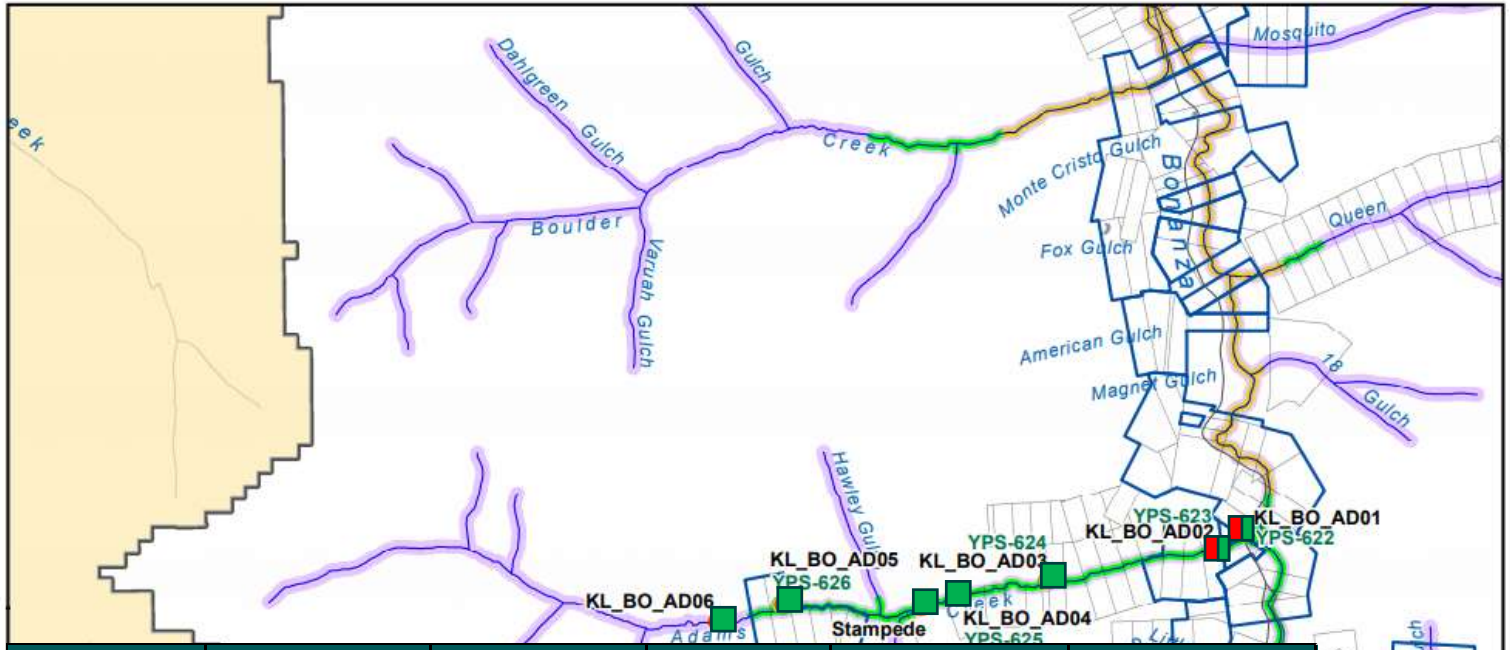
2020 Results					
Site ID	Habitat Classification	WQO (TSS in mg/L)	Sample Date	Measured TSS (mg/L)	Above or Below WQO?
KL_HU01	Moderate-Low	80	28-Jul-20	204.4	*Above*
			24-Sep-20	90.8	*Above*
KL_HU02	Moderate-Low	80	28-Jul-20	194.4	*Above*
			24-Sep-20	91.2	*Above*
KL_HU03	Low	200	28-Jul-20	193.2	Below
			24-Sep-20	48.4	Below
KL_HU_KM10	Low	200	28-Jul-20	349.6	*Above*
			24-Sep-20	24.4	Below
KL_HU04	Low	200	28-Jul-20	240.4	*Above*
			24-Sep-20	53.6	Below

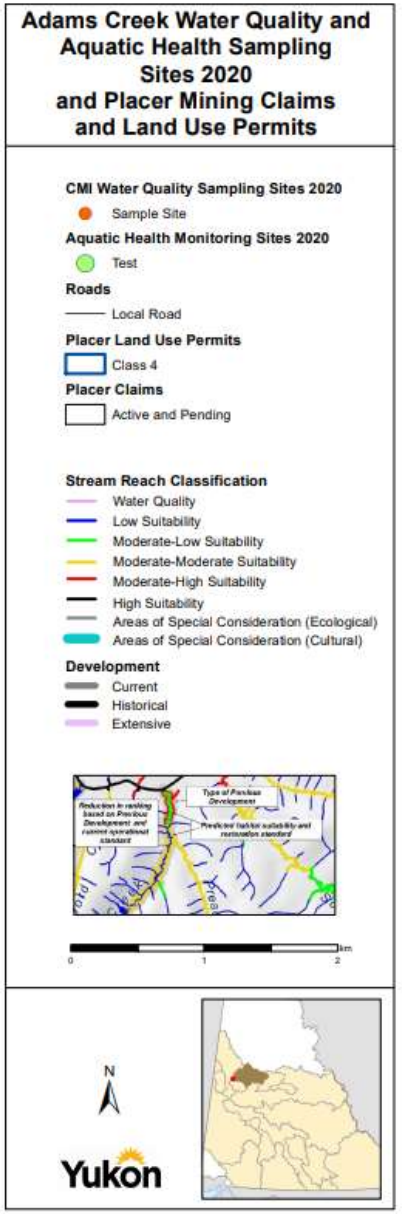
Adams Creek (2020)



- Area of interest to First Nations
- Active mining near the mouth
- Limited development in upper reach
- Potential future development

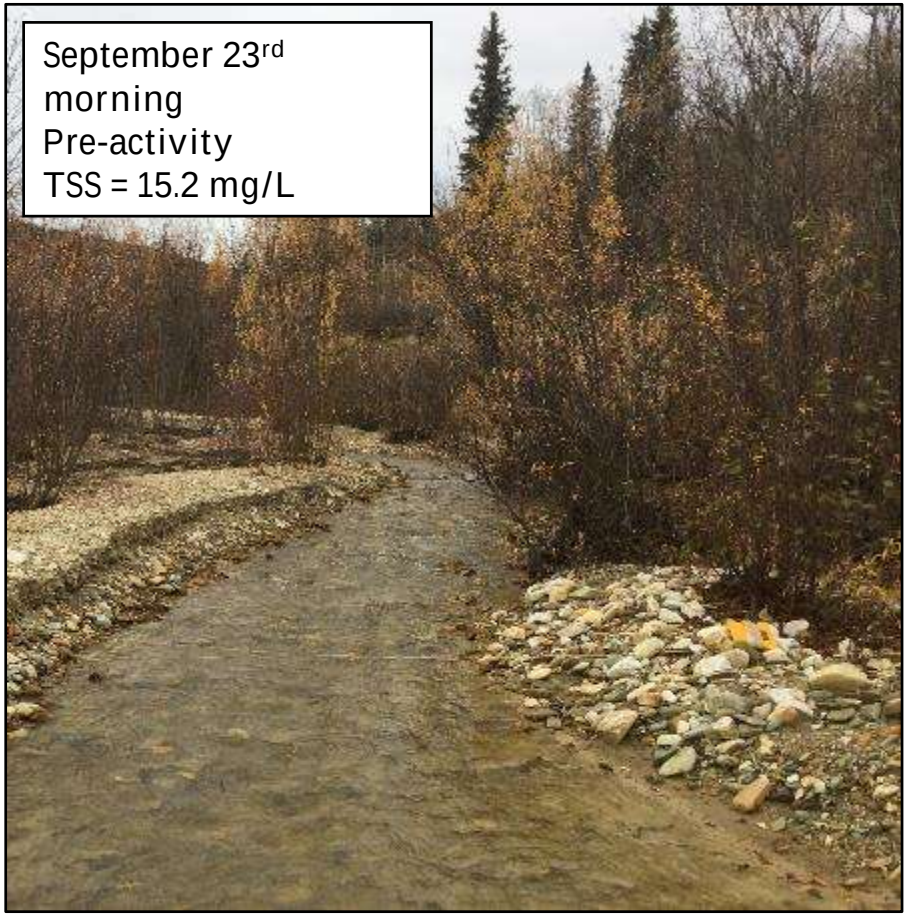
Adams Creek (2020)





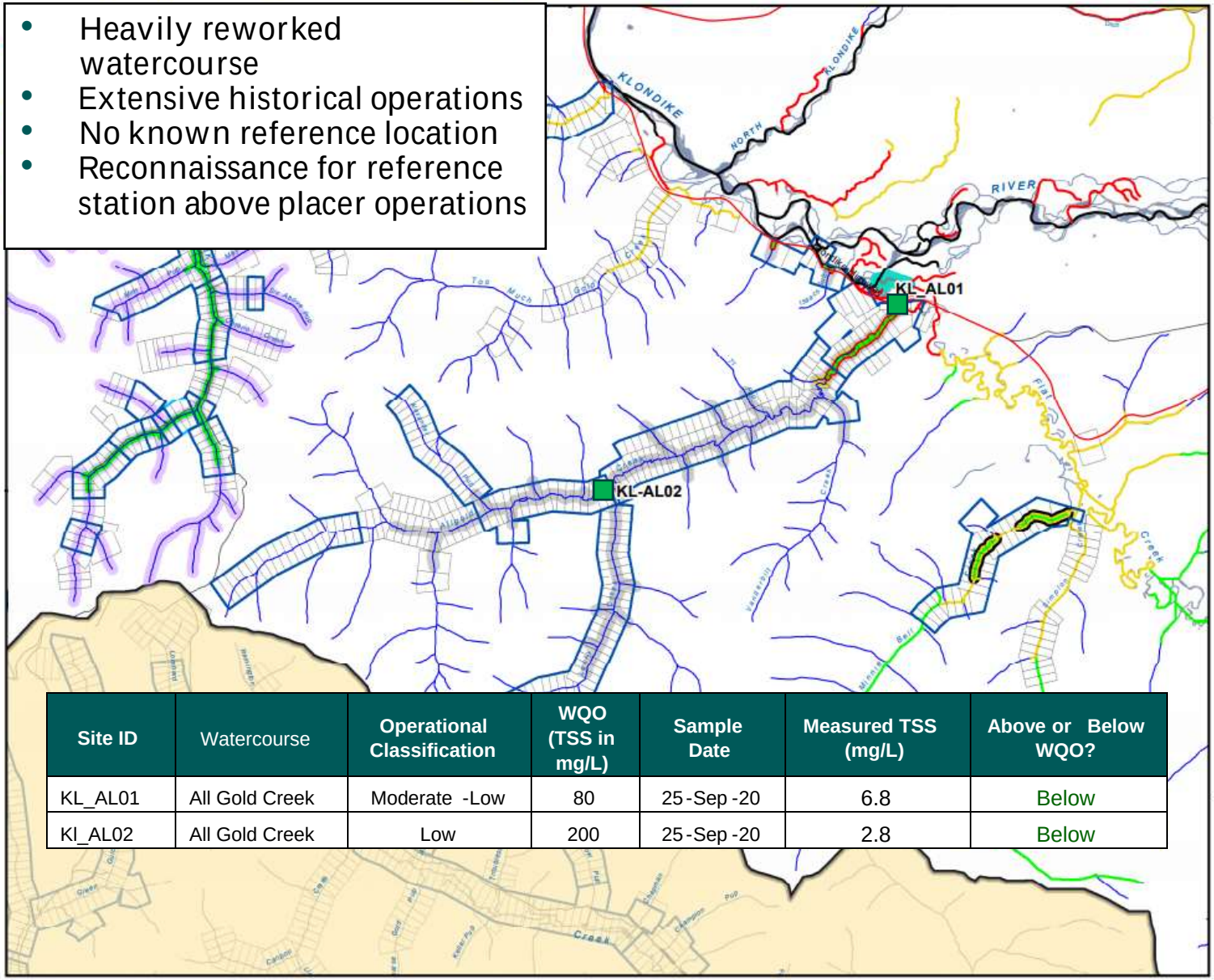
Site ID	Habitat Classification	WQO (TSS in mg/L)	Sample Date	Measured TSS (mg/L)	Above or Below WQO?
KL_BO_AD_SG01	Low	200	23-Sep-20	0.8	Below
KL_BO_AD01	Low	200	30-Jul-20	13.6	Below
			23-Sep-20 **(AM)***	15.2	Below
			23-Sep-20 **(PM)***	725	Above
KL_BO_AD02	Low	200	30-Jul-20	9.6	Below
			23-Sep-20 **(AM)***	10	Below
			23-Sep-20 **(PM)***	728	Above
KL_BO_AD03	Low	200	30-Jul-20	2.8	Below
			23-Sep-20	2.4	Below
KL_BO_AD04	Low	200	30-Jul-20	2.8	Below
			23-Sep-20	0.4	Below
KL_BO_AD05	Low	200	30-Jul-20	2	Below
			23-Sep-20	4.4	Below
KL_BO_AD06	Low	200	23-Sep-20	0.8	Below

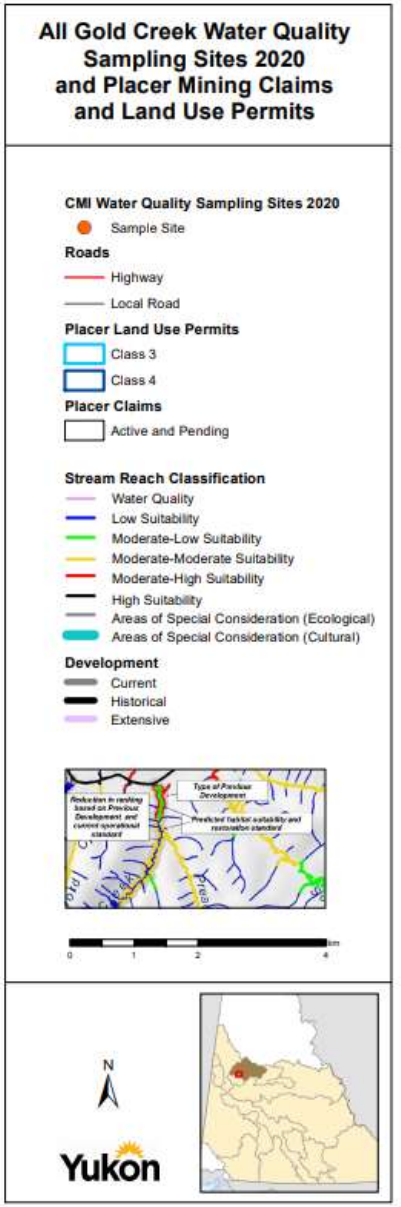
Adams Creek (2020)



All Gold Creek (2020)

- Heavily reworked watercourse
- Extensive historical operations
- No known reference location
- Reconnaissance for reference station above placer operations

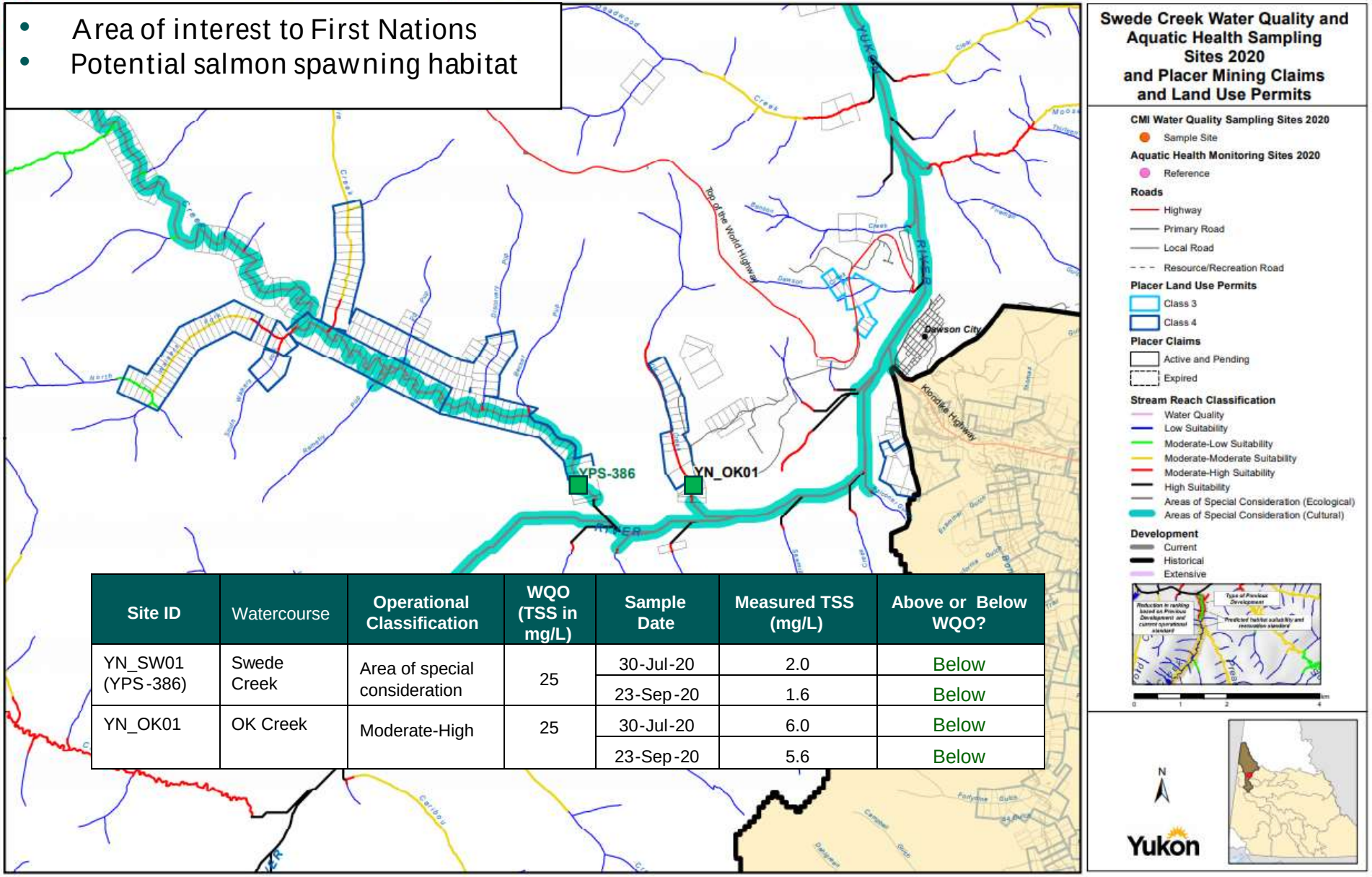




Site ID	Watercourse	Operational Classification	WQO (TSS in mg/L)	Sample Date	Measured TSS (mg/L)	Above or Below WQO?
KL_AL01	All Gold Creek	Moderate -Low	80	25-Sep-20	6.8	Below
Kl_AL02	All Gold Creek	Low	200	25-Sep-20	2.8	Below

Swede Creek (2020)

- Area of interest to First Nations
- Potential salmon spawning habitat



Site ID	Watercourse	Operational Classification	WQO (TSS in mg/L)	Sample Date	Measured TSS (mg/L)	Above or Below WQO?
YN_SW01 (YPS-386)	Swede Creek	Area of special consideration	25	30-Jul-20	2.0	Below
				23-Sep-20	1.6	Below
YN_OK01	OK Creek	Moderate-High	25	30-Jul-20	6.0	Below
				23-Sep-20	5.6	Below

Swede Creek Water Quality and Aquatic Health Sampling Sites 2020 and Placer Mining Claims and Land Use Permits

CMI Water Quality Sampling Sites 2020
- Sample Site

Aquatic Health Monitoring Sites 2020
- Reference

Roads
- Highway
- Primary Road
- Local Road
- Resource/Recreation Road

Placer Land Use Permits
- Class 3
- Class 4

Placer Claims
- Active and Pending
- Expired

Stream Reach Classification
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)

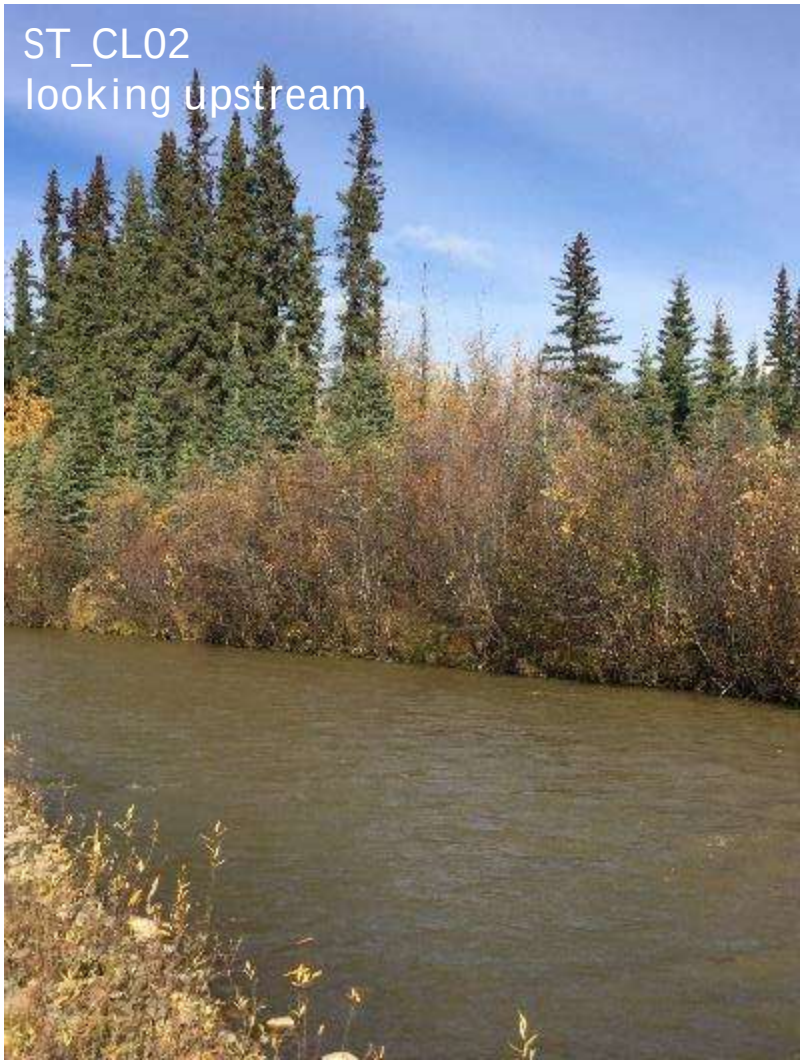
Development
- Current
- Historical
- Extensive

N

Yukon

Clear Water Creek (2020)

Moderate-Moderate Habitat Suitability
Sampled September 23, 2020
TSS = 30.4 mg/L
BELOW WQO (50 mg/L TSS)



2019-2020 WQOM Summary and Conclusions

2019

- Majority of samples collected using ISCO automated sampler.
- Majority of WQO were met (only 4% of samples exceeded WQO).
- Exceedances most frequently observed at KL_HU06, with seasonal TSS above WQO. Causation not known.

2020

- Samples collected by grab method.
- Majority of WQO were met.
- Klondike watershed exceedances generally at mouth of watercourse where WQO are more stringent. No exceedances recorded at KL_HU06 in 2020.
- Two exceedances at mouth of Adams Creek due to observed placer activity.
- No exceedances recorded on Swede Creek, OK Creek, Clear Creek or All Gold Creek.

14-Year WQOM Data Roll-Up

Scope of Work

Synthesis of 14-years of water-quality monitoring data:

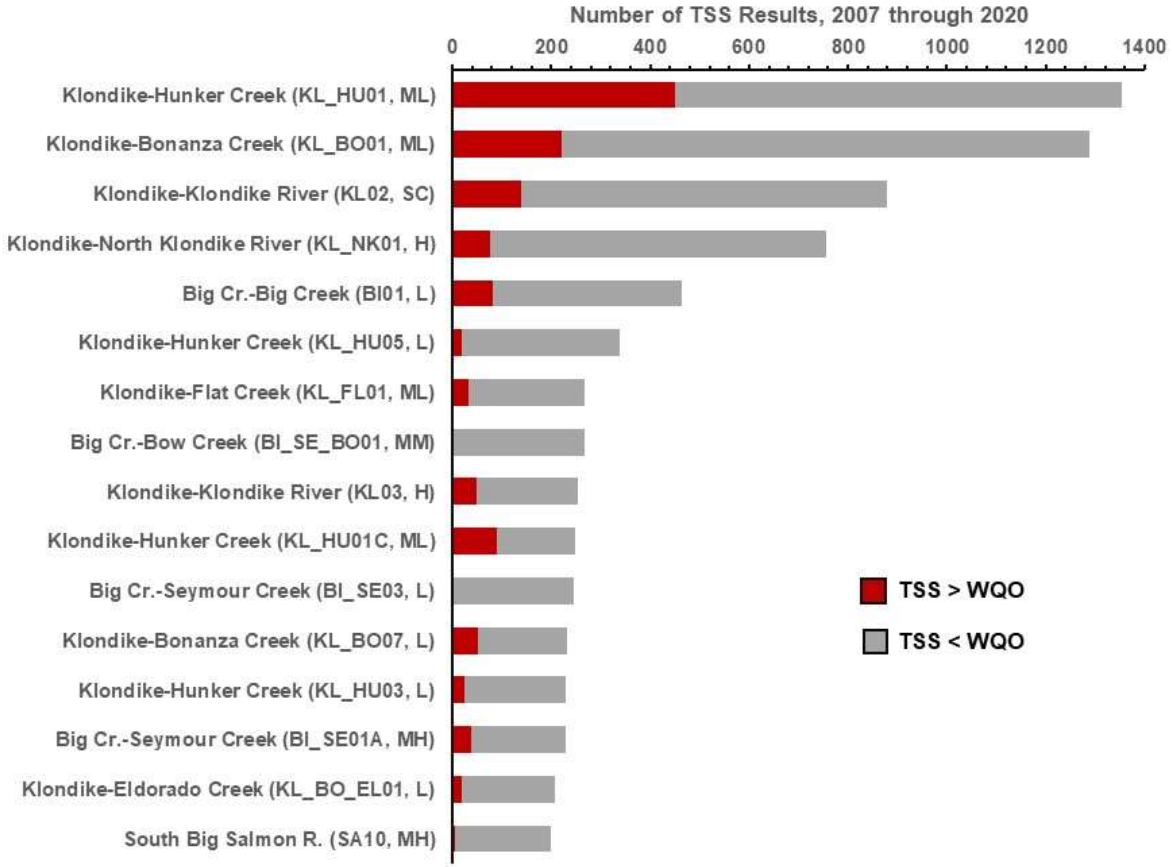
- Summary of available data
- Summary statistics for all parameters
  - total suspended solids (TSS), dissolved oxygen, pH and electrical conductivity
- Time series plots
- Comparison of TSS exceedance frequency and magnitude across watersheds, habitat suitability categories and individual sample stations

Data summary

- Over 18,000 water-quality objective monitoring samples (WQOM) samples collected from 2007-2020
  - 16 watersheds, 148 watercourses, 300+ stations
- Analytical data: TSS, EC, pH, and turbidity
- Field data: instantaneous temperature, DO, pH and EC

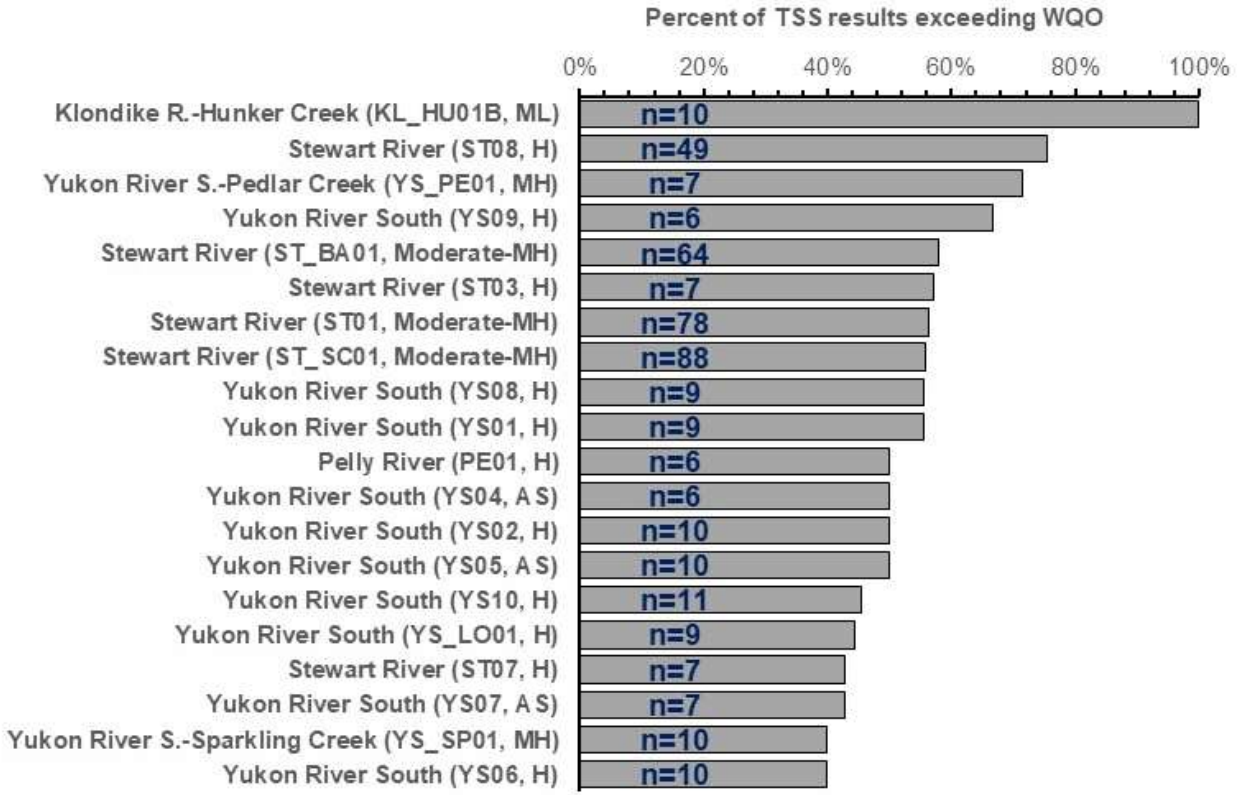
Watershed Category A

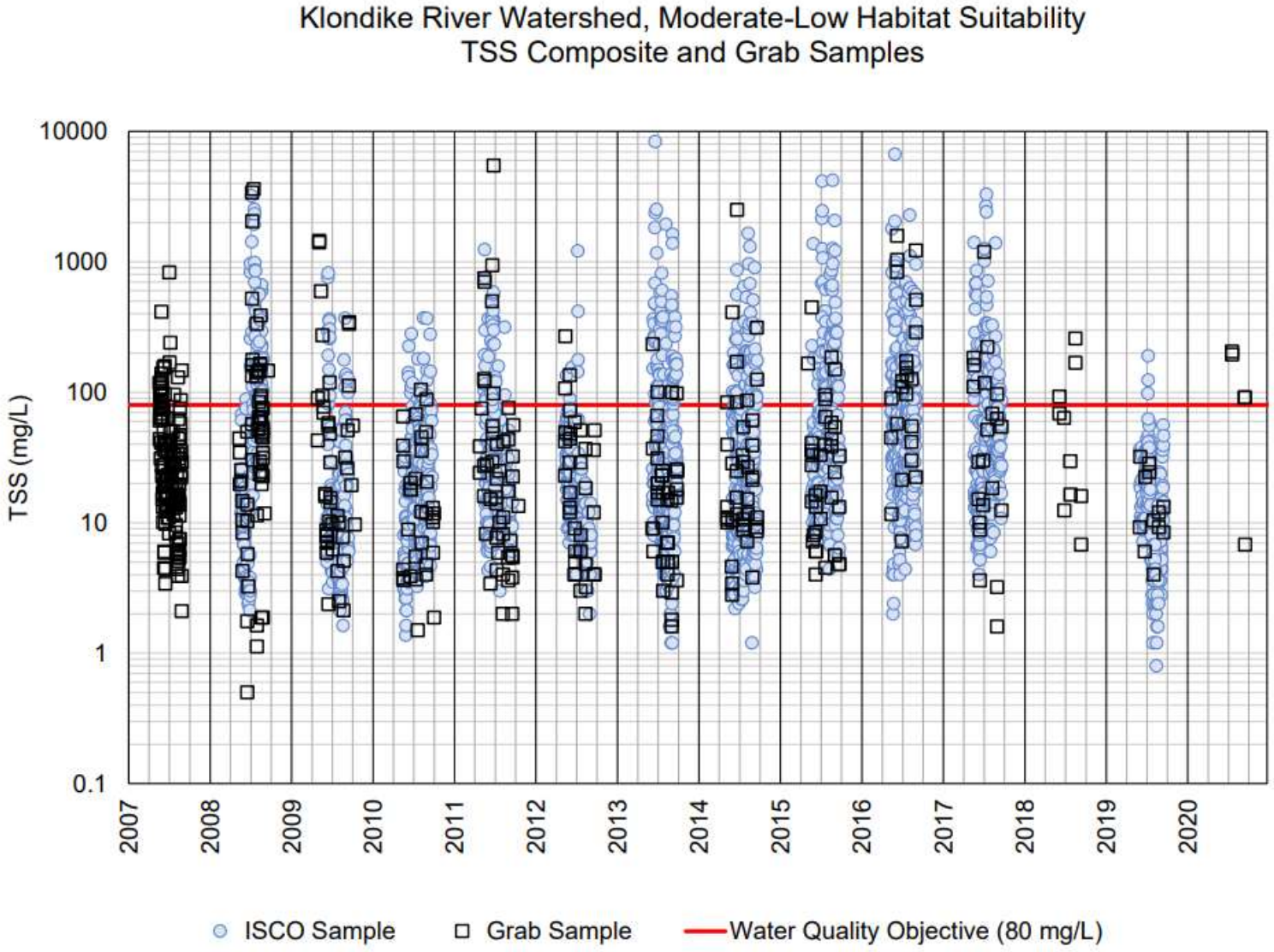
Sites with >150 individual TSS results



Watershed Category A

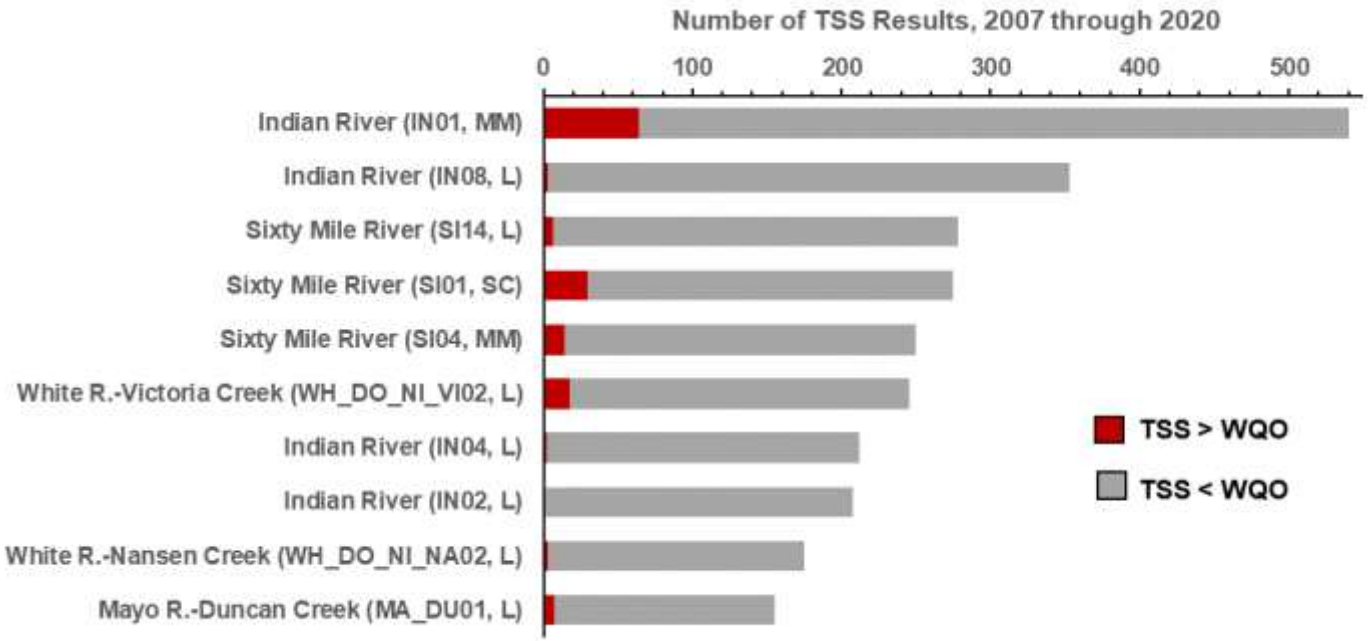
Sites with >40% individual TSS results exceeding the WQO




Klondike River Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (80 mg/L)

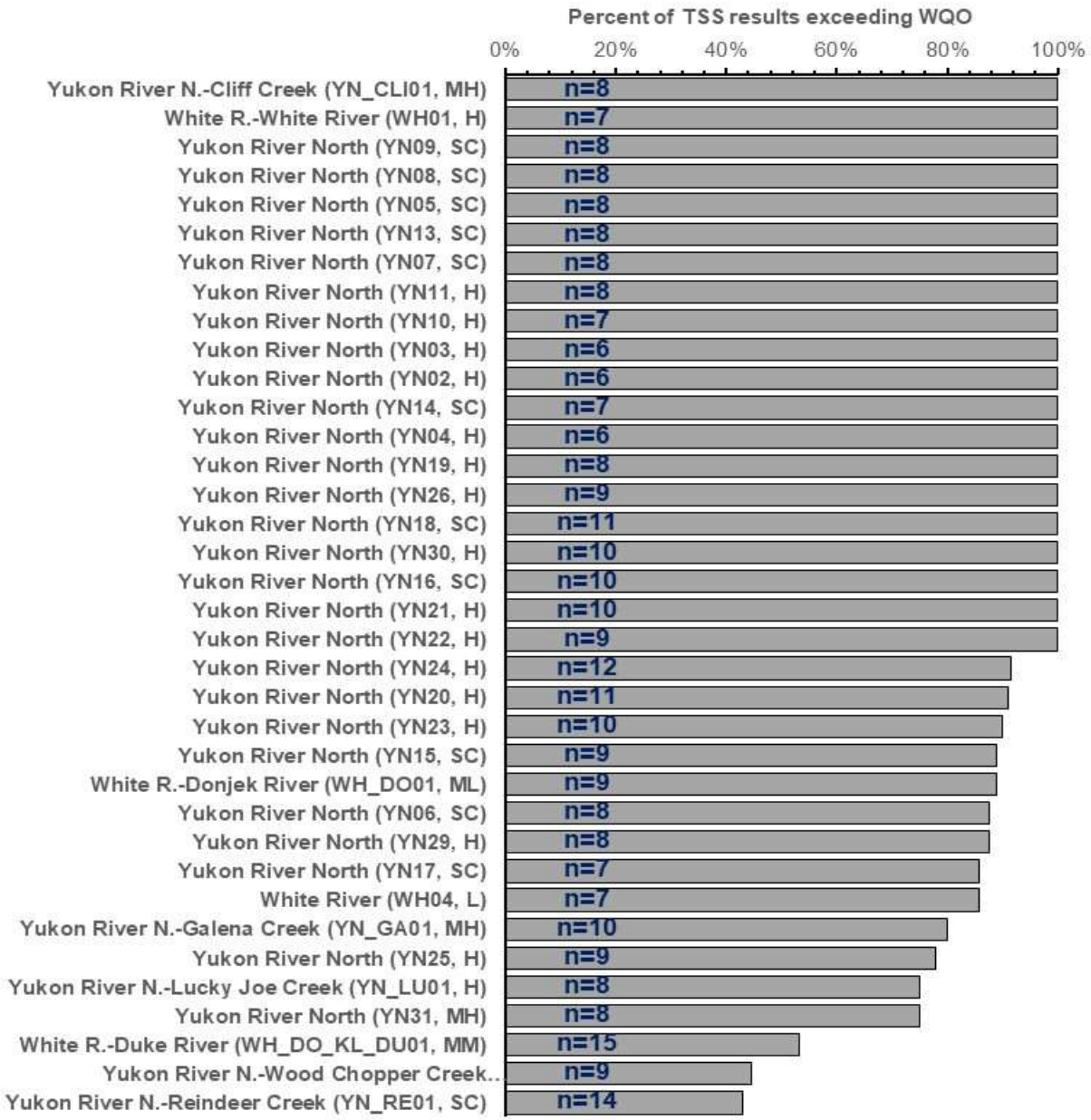
Watershed Category B

Sites with >150 individual TSS results

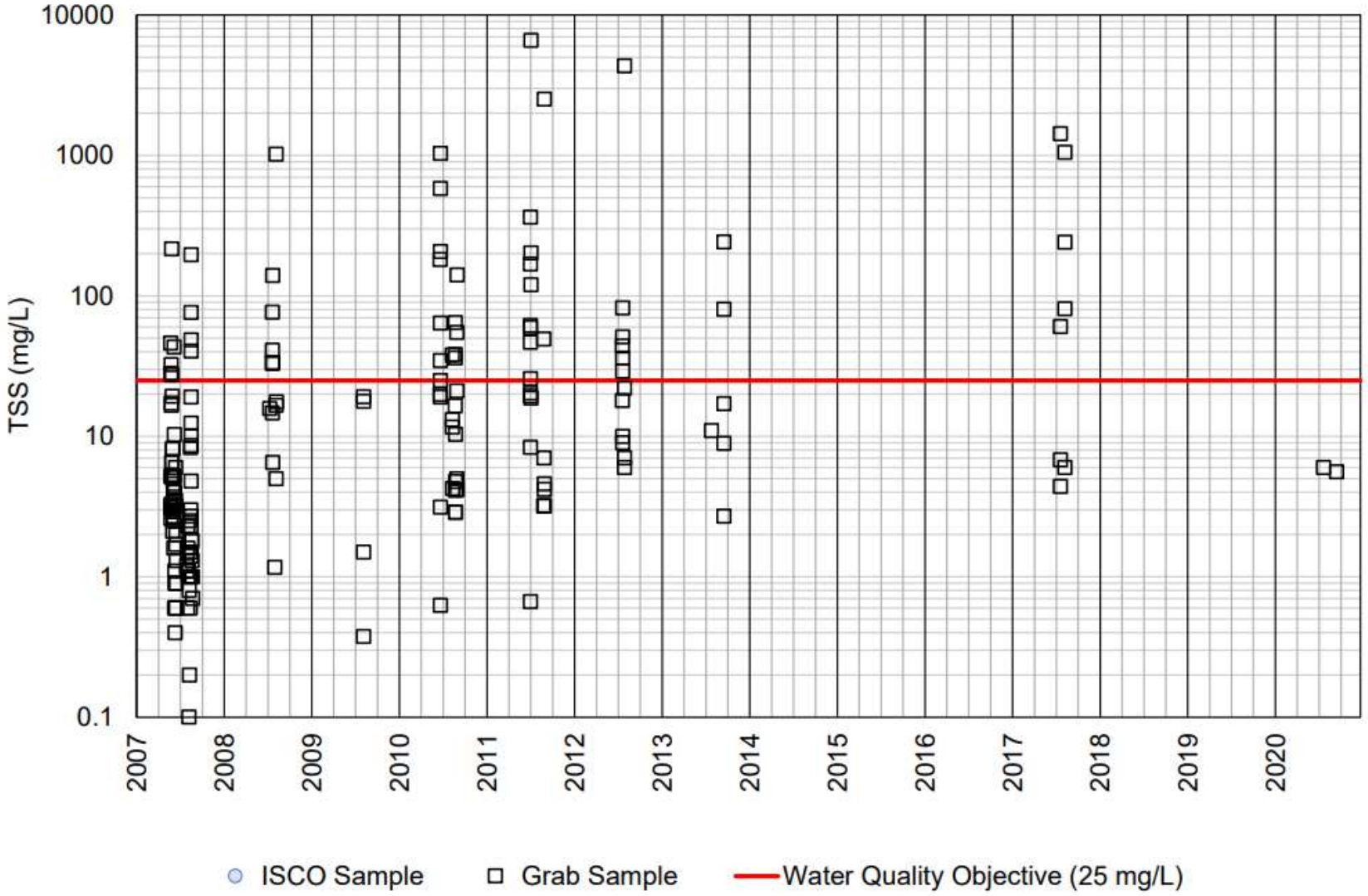


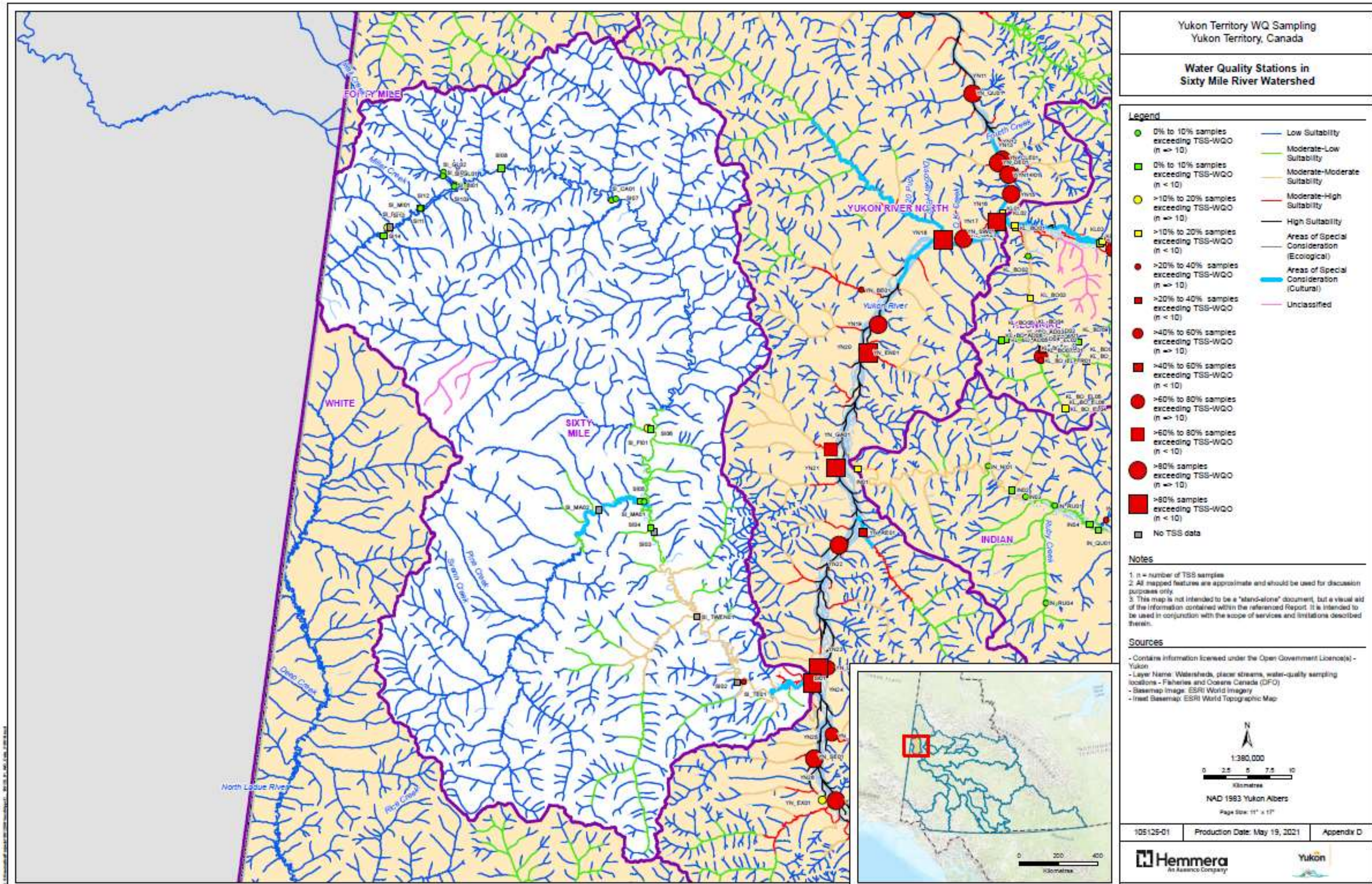
Watershed Category B

Sites with >40% individual TSS results exceeding the WQO



Yukon River North Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples




Yukon Territory WQ Sampling
Yukon Territory, Canada
Water Quality Stations in Sixty Mile River Watershed
Legend
0% to 10% samples exceeding TSS-WQO (n => 10)
0% to 10% samples exceeding TSS-WQO (n < 10)
>10% to 20% samples exceeding TSS-WQO (n => 10)
>10% to 20% samples exceeding TSS-WQO (n < 10)
>20% to 40% samples exceeding TSS-WQO (n => 10)
>20% to 40% samples exceeding TSS-WQO (n < 10)
>40% to 60% samples exceeding TSS-WQO (n => 10)
>40% to 60% samples exceeding TSS-WQO (n < 10)
>60% to 80% samples exceeding TSS-WQO (n => 10)
>60% to 80% samples exceeding TSS-WQO (n < 10)
>80% samples exceeding TSS-WQO (n => 10)
>80% samples exceeding TSS-WQO (n < 10)
No TSS data
Low Suitability
Moderate-Low Suitability
Moderate-Moderate Suitability
Moderate-High Suitability
High Suitability
Areas of Special Consideration (Ecological)
Areas of Special Consideration (Cultural)
Unclassified
Notes
1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
Sources
- Contains information licensed under the Open Government Licence(s) - Yukon
- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map
1:380,000
0 2.5 5 7.5 10
Kilometres
NAD 1983 Yukon Albers
Page Size: 11" x 17"
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Production Date: May 19, 2021
Appendix D
Hemmera
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Yukon
FORTYMILE
WHITE
SIXTY MILE
YUKON RIVER NORTH
INDIAN
Yukon River
Miller Creek
Pine Creek
Swarm Creek
Deep Creek
North Ladue River
Ruby Creek
Fourth Creek
0 200 400
Kilometres

Recommendations

Continue to implement focal studies

- Investigative approach
- Use roll-up report to identify sites and watercourses with frequent exceedances
- Utilize automatic samplers where long-term and/or daily measurements would be helpful for investigating causation of frequent TSS exceedances
- Collection of qualitative (placer activity) and quantitative data (TSS)

2021-2022: implement 2+ focal studies on site-site or watercourse-watercourse basis into WQOM program.

Recommendations (cont.)

Development of hydrological conceptual model(s)

- Large-scale model likely resource prohibitive.
- Focus on various smaller watersheds that encompass systems under very limited to very severe placer mining pressures.
- Useful for developing a better understanding of the relevant system dynamics and drivers.

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Thank you

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Nova Scotia | Yukon | Northwest Territories

Annual Adaptive Management Meeting

Economic Health Monitoring

Overview of the Economic Health Monitoring Program

- Protocol for collecting and analyzing economic health information
- Results are considered alongside the results of the other monitoring programs
- Results are used to make changes to the FHMS through adaptive management.
- Program is delivered by Government of Yukon

Questions of the EHMP

Addresses the questions:

- Are there changes in industry viability?
- If so, can the changes be attributed to the FHMS?

Viability refers to the placer mining industry's ability to exist and/or grow in the regulatory environment.

Methodology

Economic Health Monitoring Protocol consists of two parts:

- Part 1: Assessment of placer industry viability
- Part 2: Panel survey of placer mine operators (only if triggered by Part 1).

Methods Part 1: Monitoring of Placer Industry Viability

Evaluate a series of economic health indicators to establish if a trend exists

- For each indicator determine if there was a change from 2018-2019 and 2019-2020
- Overall adverse changes defined as:
  - Unfavourable change of ≥15% in two or more of the indicators
  - Unfavourable change of ≥10% in four or more of the indicators

Type A.1 Viability Indicator	Adverse if indicator goes…
Active licenses	↓
Gold royalty collected	↓
Number of person days of employment	↓
Level of non-compliance (# of "inspectors directions")	↑
Total placer claims staked in reporting period - Sept to Oct	↓
Total fuel consumption	↓
Number of claims in good standing per type of stream classification	↓
Number of water licenses (>40,000 cubic yards washed per year)	↓

Methods Part 2: Panel Survey

- Triggered when adverse changes are detected in Part 1
- Used to determine any trend can be attributed to the FHMS or if they are the result of independent causes (e.g. global prices of gold)

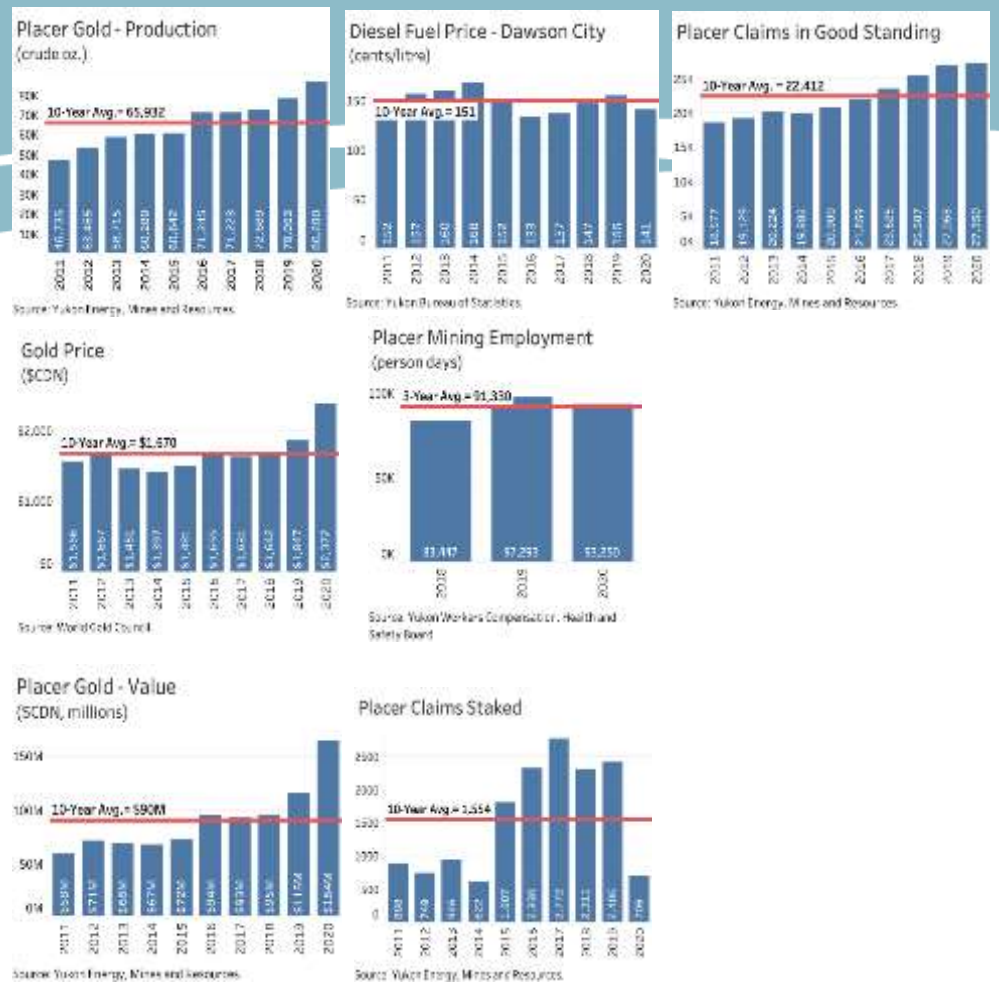
Results

- Part 1: Adverse changes not detected
- Part 2: Panel Survey not triggered*

	Type A.1 Viability Indicator	Potential adverse change if...	2018	2019	% change 2018 to 2019	2019	2020	% change 2019 to 2020
Top Four Indicators	Active licenses	↓	160	160	0%	160	150	-6%
	Gold royalty collected	↓	$ 27,207	$30,167	11%	$30,167	$30,700	2%
	Number of person days of employment	↓	83,447	97,293	17%	97,293	93,250	-4%
	Level of non-compliance (# of "NRO directions")	↑	6	2	-67%	2	3	50%
	TOP FOUR INDICATOR ANALYSIS: Was there an adverse change of ≥15% in two or more of the Top Four Indicators?		**No**			**No**		
Bottom Four Indicators	Total placer claims staked in reporting period - Sept to Oct	↓	2,311	2,406	4 %	2,406	705	-71%
	Total fuel consumption	↓	Not available					
	Number of claims in good standing per type of stream classification	↓	25,507	27,068	6%	27,068	27,350	1%
	Number of water licenses (>40,000 cubic yards washed per year)	↓	Indicator under review					
	TOP AND BOTTOM FOUR INDICATOR ANALYSIS: Was there an adverse change of ≥10% in four or more of the eight Indicators		**No**			**No**		

COVID-19 and Placer Mining Economic Health

- Economic Health 2020 Snapshot
  - Gold production increased
  - Value of gold increased
  - Fuel prices lower
  - Labor down 4%
  - Drop in claims staked could be ground available
- Other changes may not be reflected



Conclusion for 2019 and 2020

- Adverse changes in the viability of Yukon's placer mining industry were not detected in 2019 or 2020
- Demonstrated through the monitoring and analysis of the placer viability indicators
- No further action is required at this time

Questions or Comments?

Annual Adaptive Management Meeting

Traditional Knowledge

Traditional Knowledge in the AMF

Table: Traditional knowledge in the Adaptive Management cycle for the FHMS (Olson et al. 2020, page 13)

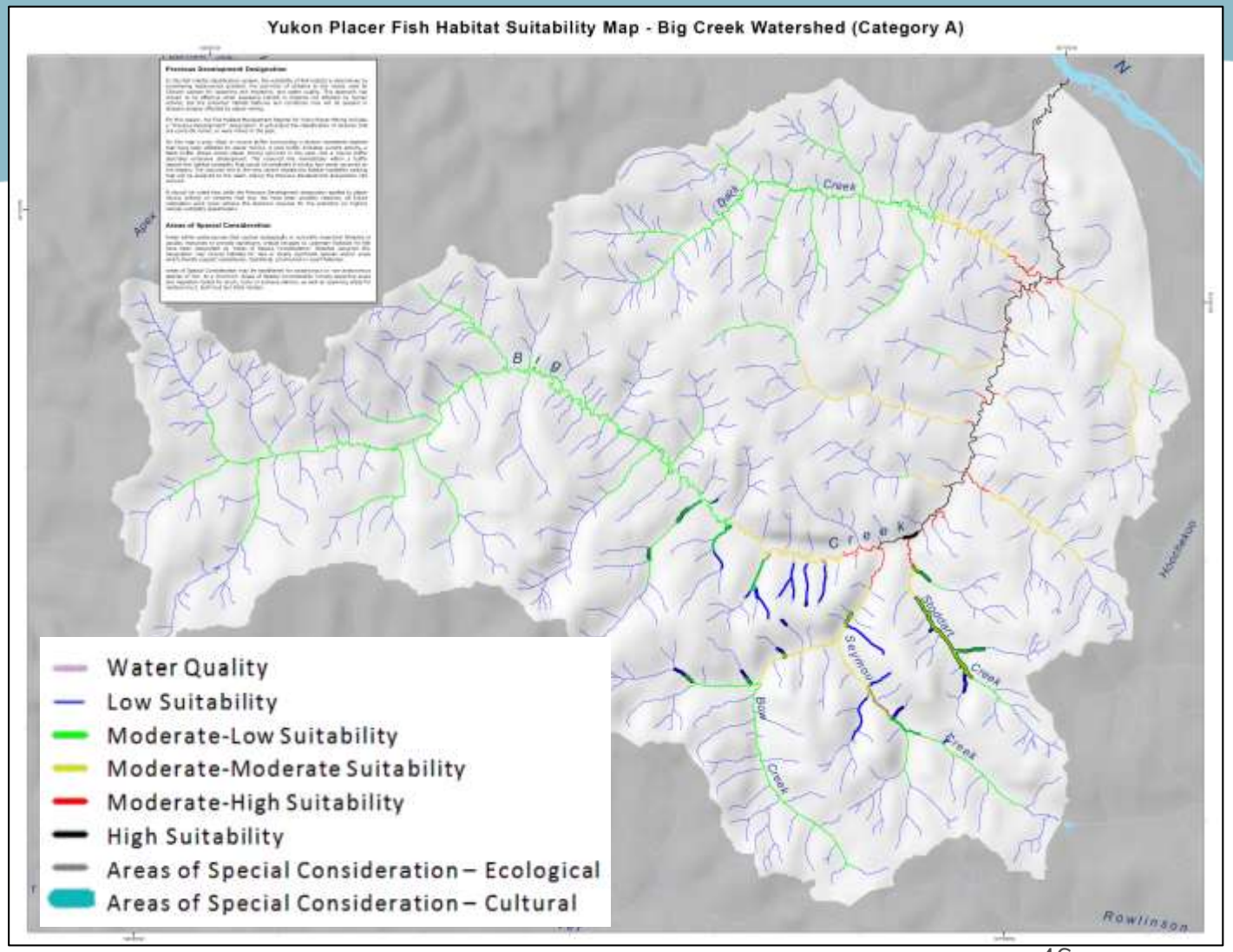
FHMS Components	Assess	Design	Implement	Monitor	Evaluate	Adjust
Traditional and local knowledge	X	X	X	X	X	X

Traditional important in the development and administration of the FHMS

"First Nations will be provided the opportunity to report on traditional knowledge prior to the annual evaluation of monitoring results for watersheds in their traditional territories. This opportunity may be facilitated through a survey form soliciting information on what a First Nation may have observed about the management system and its effects on fish habitat and fisheries." (Adaptive Management Framework, YPS, 2008, p 13)

Traditional Knowledge and Fish Habitat Suitability Classification of Streams

- Every stream reach is assigned a Fish Habitat Suitability classification
- Classification based on
  - Physical Indicators (Watercourse Gradient, Proximity to Chinook Salmon Production Areas, Water Quality)
  - Biological Indicators (Presence of Chinook Salmon Production Areas, Areas of Special Consideration)
- Determines what placer mining standards apply in the reach
- Traditional Knowledge informs the maps



Questions or Comments?

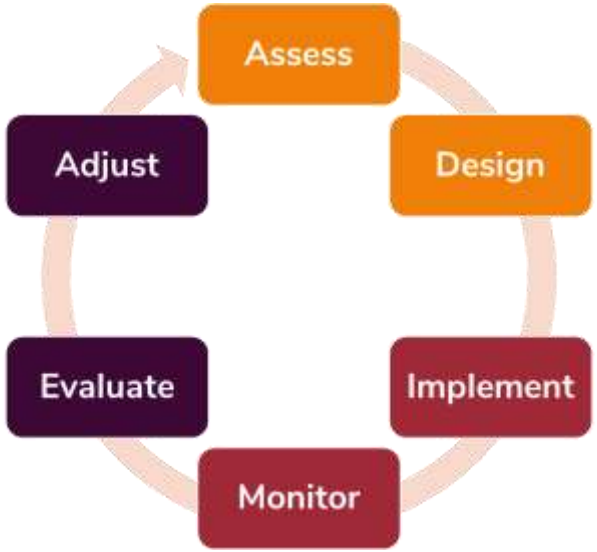
Annual Adaptive Management Meeting

2019 & 2020 Summary

Monitoring Program	2019 Result	2020 Results
Economic Health	• **Adverse changes not detected** in industry viability • Placer Survey not triggered but still done	• Downward trends but **significant adverse changes not detected** in industry viability • Panel survey not triggered and not done • Snapshot during COVID-19
Water Quality Objective	• On average **Water Quality Objectives were met.** • Follow-up recommended KL_HU06	• On average **Water Quality Objectives were met.** • Exceedances not detected at KL_HU06 • Exceedances at habitat suitability change points
Aquatic Health	• Interim approach • Focal studies	• Interim approach • Focal studies
Traditional Knowledge	• Not solicited or shared.	• Not solicited or shared

Outcomes & Next Steps

- Learnings from 2019-20 (e.g. benthic community composition, WQO exceedances at habitat suitability change points)
- Benthic invertebrate data analysis (historic data)
- Continue with protocol redesign
- Interpret and investigate 14-Year WQO Results
- Implement recommendations to improve AMF!!



Questions or Comments?

Annual Adaptive Management Meeting

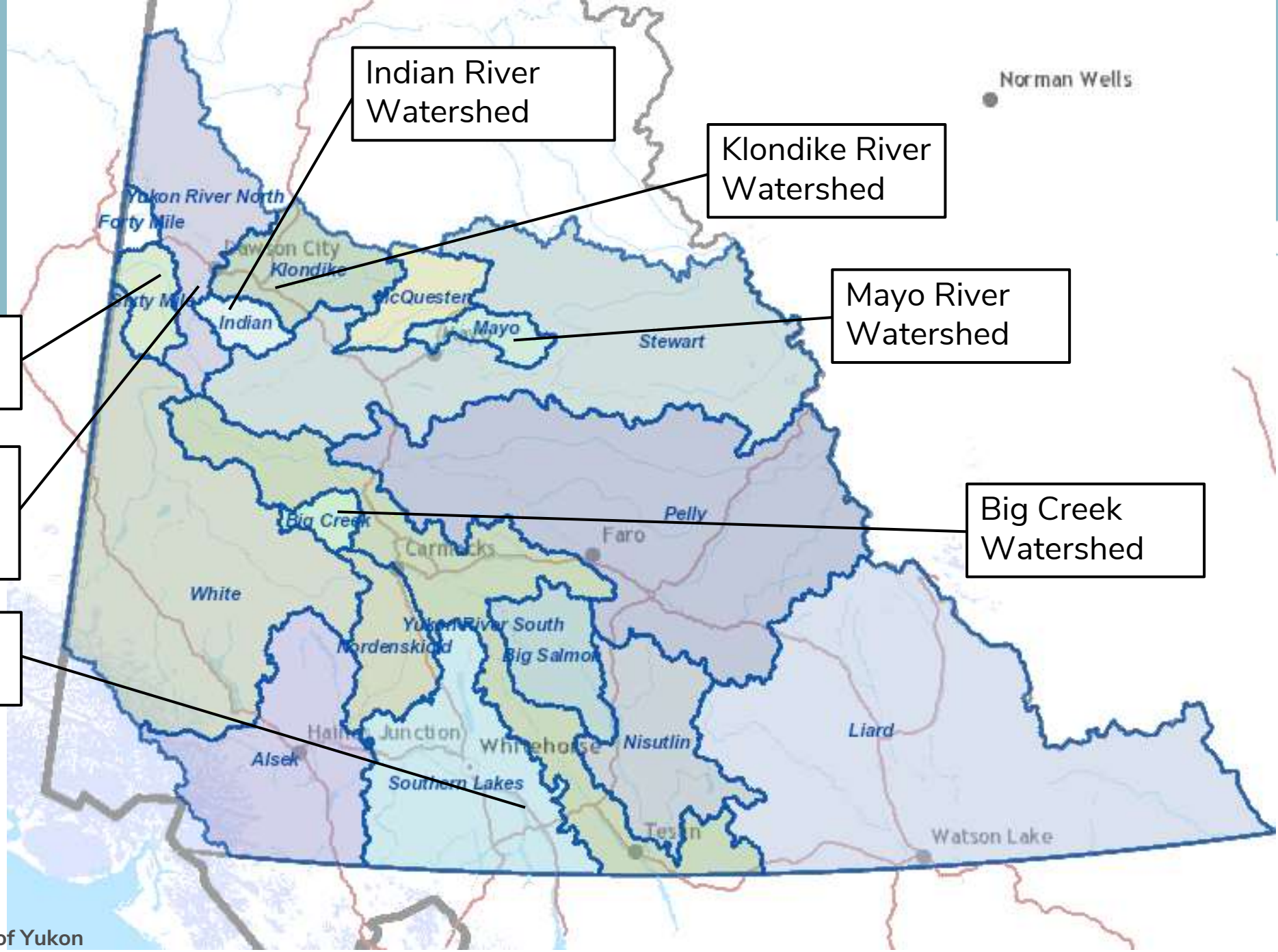
2021 Field Monitoring Planning

2021 Field Monitoring

- Water Quality Objective and Aquatic Health Monitoring
- Apply existing knowledge and recommendations
- Focal studies
- Intensive automated sampling

2021 Field Monitoring

- Working with First Nations
- Working with other Yukon government departments
- Sharing data and supporting one another's projects and priorities


Indian River Watershed
Klondike River Watershed
Mayo River Watershed
Sixty Mile Watershed
Yukon River North Watershed
Big Creek Watershed
Southern Lakes Watershed
Norman Wells
Yukon River North
Forty Mile
Dawson City
Klondike
Sixty Mile
Indian
McQuester
Mayo
Stewart
Pelly
Faro
Big Creek
Carmacks
White
Yukon River South
Nordenskiold
Big Salmon
Haines Junction
Whitehorse
Nisutlin
Liard
Alsek
Southern Lakes
Teslin
Watson Lake

Questions or Comments?

Other Updates

Final Sediment Discharge Standards

- FHMS had a phase in schedule for sediment discharge standards
- Effective June 30, 2021, transition from Interim to Final Standards in 6 watersheds
  - Fortymile River
  - Indian River
  - Klondike River
  - Sixty Mile
  - White River
  - Yukon River North
- Transition will ensure consistency across Watershed Authorizations

Fisheries and Oceans Canada | Pêches et Océans Canada

Schedule 2

Sediment Discharge Standards for Placer Mine Effluent – Indian River Watershed (Category B)

Habitat Suitability	Water Quality Objective[1]	Sediment Discharge Standard for Mine Discharge
Moderate-High	<25 mg/L[1]	<200 mg/L
Moderate-Moderate	<100 mg/L[1]	Design Target: 0.2 ml/L Action Level: 0.4 ml/L Compliance Level: 0.8 ml/L
Moderate-Low	<200 mg/L[1]	Design Target: 0.2 ml/L Action Level: 1.0 ml/L Compliance Level: 2.0 ml/L 2.0ml/L is an interim standard with transition to 1.5ml/L within 3 years subject to monitoring and adaptive management.
Low	<300 mg/L[1]	Design Target: 0.2 ml/L Action Level: 1.0 ml/L Compliance Level: 2.5 ml/L 2.5ml/L is an interim standard with transition to 2.0ml/L within 3 years subject to monitoring and adaptive management.
Water Quality Zones	Downstream WQO mg/L[1]	None identified to date. Consult Fisheries and Oceans Canada for guidance where you believe a natural barrier to fish exists
Areas of Special Consideration *Lower Indian River (From confluence with the Yukon River upstream to 63° 47' 6.46"N 139° 43' 44.35"W)*	<100 mg/L[1]	To be determined by Fisheries and Oceans Canada if locations are identified other than those listed below Design Target: 0.2 ml/L Action Level: 0.4 ml/L Compliance Level: 0.8 ml/L

[1] The water quality objective is established for management and effectiveness monitoring purposes. The placer mine operator is not required to monitor or report on this objective for compliance purposes.

Watershed	Habitat Suitability	Previous Interim Sediment Discharge Standards	Final Sediment Discharge Standards Now in Effect***
Fortymile River	Mod-Low	Compliance Level: 2.0 ml/L	Compliance Level: 1.5 ml/L
	Low	Compliance Level: 2.5 ml/L	Compliance Level: 2.0 ml/L
Indian River	Mod-Low	Compliance Level: 2.0 ml/L	Compliance Level: 1.5 ml/L
	Low	Compliance Level: 2.5 ml/L	Compliance Level: 2.0 ml/L
Klondike River	Extensive Development Zones (previously developed areas in Hunker and Bonanza Creek only)	Compliance Level: 2.5 ml/L	Compliance Level: 2.0 ml/L
Sixty Mile River	Mod-Low	Compliance Level: 2.0 ml/L	Compliance Level: 1.5 ml/L
	Area of Special Consideration (Matson Creek)	Compliance Level: 2.0 ml/L	Compliance Level: 1.5 ml/L
White River	Mod-Low	Compliance Level: 2.0 ml/L	Compliance Level: 1.5 ml/L
	Low (Not contributing to Lake Trout Lakes)	Compliance Level: 2.5 ml/L	Compliance Level: 2.0 ml/L
Yukon River North	Mod-Low	Compliance Level: 2.0 ml/L	Compliance Level: 1.5 ml/L
	Low	Compliance Level: 2.5 ml/L	Compliance Level: 2.0 ml/L

Conformity Checks

- DFO conducting conformity checks during YESAB assessment phase and Yukon Water Board regulatory review phase
- Conformity checks ensure proponent mine plans are consistent with requirements of Watershed Authorization
- Identified issues are corrected prior to issuing water licence

Other Updates

- Intergovernmental Management Group (IMG) and First Nations Engagement
    - Triannual Meetings (fall, winter, spring)
    - Participation in IMG
    - Additional meetings as needed/requested

Other Updates

- Collaborative Stewardship Initiative with Compliance Monitoring and Inspections (CMI)

Questions or Comments?

Annual Adaptive Management Meeting

Closing

Closing

- Open floor Q&A / Discussion
- Meeting summary distribution
- Future format (Online or In Person)
- Contact for follow-up

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Annual Adaptive Management Meeting

Thank You!

Yukon