



Adaptive Management Report

Fish Habitat Management System for Yukon Placer Mining

Appendix B – Aquatic Health Monitoring Program 2018 Report





Aquatic Health Monitoring Program 2018 Report

Fish Habitat Management System for Yukon Placer Mining

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Acronyms

AHM	Aquatic Health Monitoring
ANOVA	Analysis of Variance
BEAST	Benthic Assessment of Sediment
C	Chironomidae
CABIN	Canadian Aquatic Biomonitoring Network
CRI	Canadian Rivers Institute
CSAS	Canadian Science Advisory Secretariat
DFO	Fisheries and Oceans Canada
E	Ephemeroptera
ECCE	Environment and Climate Change Canada
FHMS	Fish Habitat Management System
IMG	Intergovernmental Management Group
P	Plecoptera
PERMANOVA	Permutational multivariate analysis of variance
RCA	Reference Condition Approach
SDI	Simpson's Diversity Index
SEI	Simpson's Evenness Index
UNB	University of New Brunswick
YG	Yukon Government

Table of Contents

Document Contributors.....	i
Acronyms.....	ii
Table of Contents.....	iii
1 Introduction	1
2 Methods.....	3
2.1 Aquatic Health Monitoring Protocol.....	3
2.2 CABIN Sampling.....	3
2.3 Reference Condition Approach and Model Review.....	4
2.3.1 Evaluation of Reference Condition Approach.....	4
2.3.2 Performance of Current Regional Reference Model.....	4
2.3.3 Sampling Design and Protocol.....	5
2.3.4 Predictor Variables:.....	6
2.3.5 Recommendations and Conclusions	6
2.4 Annual Aquatic Health Monitoring	7
2.4.1 Study Area.....	7
2.4.2 Site Selection	7
2.4.3 Field Sampling.....	8
2.4.4 Invertebrate Classification	9
2.5 Data Analysis.....	9
2.5.1 Reference Site Characterization	10
2.5.2 Habitat Characterization	10
2.5.3 Placer Mining Development Assessment	10
2.5.4 Benthic Invertebrate Community Composition.....	11

3	Results – 2018 Aquatic Health	13
3.1	Study Area.....	13
3.2	Sample Sites	14
3.3	2018 Results by Watershed.....	17
3.3.1	Reference Sites	17
3.3.2	Alsek River Watershed.....	21
3.3.3	Indian River Watershed.....	23
3.3.4	Klondike River Watershed.....	27
3.3.5	Mayo River Watershed.....	35
3.3.6	McQuesten River Watershed	39
3.3.7	Nisutlin River Watershed.....	41
3.3.8	Sixty Mile River Watershed.....	44
3.3.9	Stewart River Watershed.....	48
3.3.10	Yukon River North Watershed	52
3.3.11	Yukon River South Watershed.....	55
4	Next Steps	59

List of Tables and Figures

FIGURE 1. PLACER WATERSHEDS AND THE 2018 AQUATIC HEALTH MONITORING SAMPLING SITES.....	13
FIGURE 2. RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT REFERENCE SITES SAMPLED FROM 2006 TO 2018.....	20
FIGURE 3. RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE ALSEK RIVER WATERSHED	22
FIGURE 4. RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE INDIAN RIVER WATERSHED	25

FIGURE 6. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED IN THE
DOWNSTREAM SITES OF THE KLONDIKE RIVER WATERSHED 30

FIGURE 7. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED IN THE
UPSTREAM SITES OF THE KLONDIKE RIVER WATERSHED..... 31

FIGURE 8. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN
MAYO RIVER AND MCQUESTEN RIVER WATERSHEDS 37

FIGURE 8. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE
NISUTLIN RIVER WATERSHED..... 42

FIGURE 9. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE
SIXTY MILE RIVER WATERSHED..... 46

FIGURE 10. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE
STEWART RIVER WATERSHED..... 50

FIGURE 11. RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE
YUKON RIVER NORTH WATERSHED..... 54

FIGURE 12. . RELATIVE ABUNDANCE OF MAJOR TAXONOMIC GROUPS IDENTIFIED AT SITES IN THE
YUKON RIVER SOUTH WATERSHED 57

TABLE 1. SUMMARY OF SITE SELECTION CRITERIA AND CONDITIONS THAT WERE USED TO
SELECT SAMPLING SITES FOR ANNUAL MONITORING IN 2018..... 7

TABLE 2. NUMBER OF SAMPLE SITES BY WATERSHED SAMPLED IN 2018..... 14

TABLE 3. SAMPLING SINCE 2005 FOR SITES SAMPLED IN 2018..... 15

TABLE 4. BENTHIC INVERTEBRATE COMMUNITY METRICS AT REFERENCE SITES..... 19

TABLE 5. DEGREE OF PLACER MINING DEVELOPMENT AT, OR UPSTREAM OF, SITES SAMPLED IN
THE ALSEK RIVER WATERSHED. 21

TABLE 6. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE ALSEK RIVER WATERSHED..... 21

TABLE 7. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE INDIAN RIVER
WATERSHED. 24

TABLE 8. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE INDIAN RIVER WATERSHED..... 24

TABLE 9. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE KLONDIKE RIVER
WATERSHED. 27

TABLE 10. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE KLONDIKE RIVER WATERSHED.
..... 28

TABLE 11. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE MAYO RIVER
WATERSHED. 35

TABLE 12. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE MAYO RIVER WATERSHED. 36

TABLE 13. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE MCQUESTEN
RIVER WATERSHED..... 40

TABLE 14. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE MCQUESTEN RIVER
WATERSHED. 40

TABLE 15. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE NISUTLIN
RIVER WATERSHED..... 41

TABLE 16. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE NISUTLIN RIVER WATERSHED.
..... 41

TABLE 17. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE SIXTY MILE
RIVER WATERSHED..... 44

TABLE 18. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE SIXTY MILE RIVER WATERSHED.
..... 45

TABLE 17. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE STEWART
RIVER WATERSHED..... 48

TABLE 20. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE STEWART RIVER WATERSHED.
..... 49

TABLE 21. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE YUKON RIVER
NORTH WATERSHED..... 52

TABLE 22. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE YUKON RIVER NORTH
WATERSHED. 53

TABLE 19. DEGREE OF PLACER MINING DEVELOPMENT AT SITES SAMPLED IN THE YUKON RIVER
SOUTH WATERSHED. 56

TABLE 24. BENTHIC INVERTEBRATE COMMUNITY METRICS IN THE YUKON RIVER SOUTH
WATERSHED. 56



List of Appendices

Appendix B1: Maps of Monitoring Locations by Watershed

Appendix B2: CABIN Reports for 2018 Sampling

Appendix B3: Stream Habitat Characteristics

1 Introduction

The Fish Habitat Management System for Yukon Placer Mining (FHMS) is intended to balance the objectives of a sustainable Yukon placer mining industry with the conservation and protection of fish and fish habitat supporting fisheries. Within the FHMS there are three effects-monitoring programs and associated protocols including Aquatic Health, Water Quality Objectives and Economic Health. All three programs help to verify the effectiveness of the FHMS in meeting its objectives.

The Aquatic Health Monitoring Program (AHMP) is intended to assess how effective the Fish Habitat Management System (FHMS) is in maintaining aquatic health for fish and fish habitat in placer mining watersheds. Information is then used to make changes to the FHMS, if necessary, through adaptive management. The annual AHM program is jointly delivered by Fisheries and Oceans Canada (DFO) and the Yukon Government Department of Environment (YG).

The Yukon Placer Secretariat was established to coordinate the implementation of the Fish Habitat Management System for Yukon Placer Mining. The Compliance Monitoring and Inspections Branch of Energy Mines and Resources delivers the duties and functions of the Yukon Placer Secretariat and as such is responsible for producing this report.

The Yukon Placer Secretariat carried out an implementation status review of the FHMS in 2015, which identified the need for additional methodology and data to enable monitors to determine relationships between the level of placer development and the condition of the watercourse. As part of the implementation status review, several high priority recommendations were made that were relevant to the aquatic health monitoring program. One of these recommendations was to determine if criteria can be developed to draw conclusions about aquatic health at the watershed scale using the current monitoring approach (the reference condition approach [RCA]). As a follow-up from these recommendations, the Canadian Science Advisory Secretariat (CSAS) undertook an evaluation of the suitability of the Yukon Regional Reference Model and provided guidance regarding the adequacy of RCA for informing regulatory decisions

for placer mining in the Yukon. CSAS is a Secretariat within DFO, that addresses scientific questions related to the conservation of marine and freshwater resources.

The CSAS Report identified some significant challenges with the current monitoring approach for evaluating the effects of placer activity on the aquatic health of fish and fish habitat. The report provided several recommendations for consideration to support the long term goal of developing a statistically defensible approach that meets the needs of the monitoring protocol within the adaptive management framework. As such, the Intergovernmental Management Group (IMG) is currently in the planning phase of a study redesign. DFO and Yukon government and will carry out targeted studies in 2019 to answer several key questions that will be used to inform a revised approach to aquatic health monitoring. An interim approach to evaluating aquatic health will be used while the new program is being developed.

This report presents the results of the 2018 monitoring but does not provide detailed analysis and comparisons to the regional reference model using RCA that has been done in previous years.

2 Methods

2.1 Aquatic Health Monitoring Protocol

The Aquatic Health Monitoring (AHM) program is governed by the Aquatic Health Monitoring Protocol. The AHM Protocol describes the objectives and key questions to be addressed in monitoring, and guides sampling design (locations, timing, frequency, and methods employed). The 2018 field sampling program was carried out according to the AHM Protocol. Due to challenges identified in previous programs with using the regional reference model comparisons, an interim approach to data analysis was used for the 2018 sampling results as described below. A revised Aquatic Health Monitoring Protocol will be developed during the study redesign phase.

2.2 CABIN Sampling

Data gathered under the AHM program is housed, managed, and analyzed online through the [Canadian Aquatic Biomonitoring Network \(CABIN\)](#), a website administered and maintained by Environment and Climate Change Canada (ECCC) to support the collection, assessment, reporting and distribution of biological monitoring information across Canada. CABIN is an aquatic biomonitoring network for assessing the health of freshwater ecosystems in Canada. CABIN is based on the network of networks approach that promotes inter-agency collaboration and data-sharing to achieve consistent and comparable reporting on freshwater quality and aquatic ecosystem conditions in Canada. CABIN allows for a formalized scientific assessment using nationally comparable standards overseen by a National Science Team.

A training program for the application of CABIN protocols is provided by ECCC in partnership with the Canadian Rivers Institute (CRI) at the University of New Brunswick (UNB). Training ensures that practitioners of CABIN fieldwork, laboratory analysis and data entry and interpretation are operating under a nationally standardized methodology. Certified personnel can then reduce the work required in building their own biomonitoring program, benefit from the collective research efforts by practitioners across Canada and contribute consistent data to the national database.

In turn, this data can be shared for building more accurate and up-to-date assessment models.

2.3 Reference Condition Approach and Model Review

Given the inherent challenges identified in previous years with the reliability of the Yukon reference model, the Canadian Science Advisory Secretariat (CSAS) was asked to evaluate the suitability of the Reference Condition Approach (RCA) for informing regulatory decisions for placer mining in the Yukon. The advice arising from the CSAS evaluation will be used to inform the IMG on the effectiveness of the RCA model in detecting changes in aquatic health in streams exposed to placer mining activity.

The main objectives of the CSAS review were as follows:

- Evaluate the RCA method for evaluating potential effects from placer mining
- Evaluate the performance of the current Yukon 2013 regional reference model
- Evaluate the current aquatic health sampling design and protocol
- Evaluate the current predictor variables used in the Yukon reference model and statistical procedures for selecting predictor variables

2.3.1 Evaluation of Reference Condition Approach

The following key challenges were identified with the current reference condition approach:

- Assessment of broader spatial and temporal scales is problematic with the current approach
- Inability to link divergence from reference condition to biological significance
- Inability to link divergence from reference condition to placer mining activity
- Challenges in extrapolating the current site assessment results to the broader watershed health

2.3.2 Performance of Current Regional Reference Model

To evaluate the current performance of the model, Type I and Type II error rates were evaluated. Type I error rates were similar to what was expected. However, higher rates

of Type II error were found in the model indicating that the power to detect a statistical change are low. Issues with model error rates could be improved through increased replication in space and time.

Alternative modelling approaches were also mentioned including use of non parametric multivariate tools such as PERMANOVA (multivariate adaptation of ANOVA) or the use of invertebrate community metrics to develop indices to estimate the strength of stressor effects on aquatic health.

2.3.3 Sampling Design and Protocol

Analysis of spatial and temporal variation was carried out on invertebrate community data collected from 2004 to 2017. The following trends in variability were noted:

- Temporal variability was high and shifts among years were observed in total abundance and relative abundance of taxonomic groups
- Sample variability was observed to be more variable using abundance-based metrics compared to taxa-presence metrics
- Site variability was generally low
- Stream variability indicated that sites within streams are more similar based on family level richness and total abundance
- High degree of variability was observed at the regional scale and abundance appeared to be the primary driver in determining model groups in the Yukon reference model.

Several potential areas that could introduce sampling error and bias were noted:

- Variation among sampler
- Lack of replication
- Appropriateness of sampling habitat
- Range of variability of habitat conditions

A further challenge in the current approach includes providing updates to the model as new reference sites are sampled. There are currently 33 reference samples collected since 2012 that cannot be used until a new multivariate model is built

2.3.4 Predictor Variables:

The following issues were identified related to the predictor variables used to define the 2013 Yukon CABIN reference model:

- A strong reliance on variables with no clear biological linkages to invertebrate communities.
- The inclusion of highly correlated variables, which can increase the potential for Type II errors and lead to an increased likelihood of finding a test site to be in reference condition when it is actually divergent.
- Sites are not always being assigned to the optimal reference group, which could lead to inaccurate prediction results.

2.3.5 Recommendations and Conclusions

The conclusions from the Science Report indicated some significant challenges with the current monitoring approach for evaluating the effects of placer activity on the aquatic health of fish and fish habitat. Several recommendations were provided in the CSAS report that will be considered during the study redesign process.

Recommendations included:

- Potential refinements to the regional reference model – this could include consideration of a statistic transformation of the data (e.g., fourth root or $\log(X+1)$) to reduce the weighting of the analysis by the most abundant taxa and improve model performance, and consideration of a revised approach to the selection of habitat variables used to assign test sites to a reference group.
- Changes to sampling protocol – considering spatially and temporally balanced sampling design.
- Implementation of alternative sampling approaches - including development of multimetric indices and using other multivariate analyses (e.g., PERMANOVA).
- Maintain the CABIN legacy – continue to use CABIN sampling field protocols and the online CABIN database.

The long term goal during the redesign phase will be to develop a practical and statistically defensible approach that meets the needs of the aquatic health monitoring protocol within the adaptive management framework.

The full science report was published on the CSAS website in January and can be accessed at the link below:

- DFO. 2019. Evaluation of the reference condition approach for Yukon placer mining monitoring. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/053.
http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ScR-RS/2018/2018_053-eng.pdf

2.4 Annual Aquatic Health Monitoring

2.4.1 Study Area

The Fish Habitat Management System for Yukon placer mining governs mining activities in 16 watersheds within the Yukon River Basin including: Big Creek, Big Salmon River, Fortymile River, Indian River, Klondike River, Mayo River, McQuesten River, Nisutlin River, Nordenskiold River, Pelly River, Sixty Mile River, Southern Lakes, Stewart River, White River, Yukon River North and Yukon River South. Placer mining occurs at different intensities among these watersheds and as such sampling is not carried out equally in each watershed.

2.4.2 Site Selection

Approximately 40 sites are sampled each year by Fisheries and Oceans Canada and Yukon Government. The selection of priority reference and test sites for sampling/re-sampling was based on several factors outlined in the Aquatic Health Monitoring Protocol and the Adaptive Management Framework. Several of these factors are summarized in Table 1 below.

Table 1. Summary of Site Selection Criteria and Conditions that were Used to Select Sampling Sites for Annual Monitoring in 2018.

Site Selection Criteria	Condition
Watershed Sensitivity Category	Equal representation of A and B.

Habitat Suitability	Higher priority on high habitat suitability types if found to be out of reference during previous site visits.
	Otherwise equal representation of habitat suitability types.
Habitat suitability	1: High to Moderate-High and out of reference: resample at site level
	2: Low to Moderate and out of reference: determine at watershed level
New placer operations on reference/un-impacted streams	If new operations are active on previously un-impacted streams, these sites are considered a high priority for sampling.
Chronic compliance issues	These sites may not be sampled until issues are addressed because the sample results may not reflect the FHMS.
Sites with improving/declining trends in site assessment results	Higher priority for re-sampling in order to track improvement/decline over time in order to pinpoint reasons for change.
Site has shown declining trend in assessment result over multiple samples	1st sample: high priority to resample (intensify monitoring)
	2nd sample: medium priority to resample (continue monitoring)
	3 rd + sample: low priority to resample until there is a change to standards or another cause of decline is determined.
Known natural disturbance with influence on site (forest fire, landslide etc.)	If significant and can be tied to site/watershed may not re-sample. It may not be possible to differentiate natural impacts from placer impacts.
Long term trend sites	Some sites are sampled each year regardless of previous site assessment results in order to monitor long term trends and maintain continuity of sample years.
Reference sites	1 in 5 annual site visits are done on repeat reference sites to monitor natural variation.
Points of Interest	Sites of interest to Indigenous groups, industry, government agencies, non-governmental organizations may be a priority.

2.4.3 Field Sampling

Annual sampling is carried out over a three-week period beginning no earlier than the second week of July and extending no later than the start of the second week of August of each year. Repeat site visits are sampled at the same location each visit while new site locations are chosen based on ease of access as well as representation of the sample stream. Data collected during site visits includes a three minute travelling 500µm kick net (benthic invertebrate samples collected for laboratory identification and counting), basic water chemistry (YSI Probe: pH, temperature, conductivity, dissolved oxygen), detailed water chemistry (laboratory analysis: nutrients, physical and chemical properties and metals), and environmental variables (stream width, depth and velocity, riparian vegetation and site characteristics), and electrofishing (fish species, length,



weight and count). All information is recorded on a standard field form and several standardized photos are taken of each site while on the ground and from the air, when possible. More information regarding field sampling procedures can be found in the CABIN field sampling protocol (<http://www.ec.gc.ca/rcba-cabin/default.asp?lang=en&n=74876ADD-1>) as well as in the AHM Protocol.

2.4.4 Invertebrate Classification

All benthic invertebrate samples are classified by a certified taxonomist. Each organization and laboratory participating in the CABIN program is required to implement stringent quality assurance and quality control procedures. For more information regarding laboratory methods see documentation on the CABIN website (<http://www.ec.gc.ca/rcba-cabin/default.asp?lang=en&n=74876ADD-1>).

2.5 Data Analysis

Several challenges have been identified with using the applicable regional reference model developed by CABIN for the Yukon region (CSAS 2019). Previous comparisons of benthic invertebrate community using the BEAST (Benthic Assessment of Sediment) assessment provided by CABIN yielded inconsistent site assessment results and an inability to link divergence from the reference condition to anthropogenic stresses from placer mining activity.

For this reason, results from the 2018 monitoring program were not compared to the regional reference model. An interim assessment approach has been used for the 2018 samples, which relies on characterization of physical habitat, degree of placer mining development, evaluation of several invertebrate community metrics and a qualitative description of the invertebrate community in comparison to multiple local reference sites.

All data collected in 2018 were entered into the Canadian Aquatic Biomonitoring Network (CABIN) online database.

2.5.1 Reference Site Characterization

To support the 2018 assessment, habitat and community data from 26 reference sites were provided for comparison. Habitat characteristics measured as part of the CABIN sampling protocols are presented to provide an indication of the habitat similarities between reference and test sites. Using multiple reference locations in comparable stream habitats serves to bound the variability inherent in the streams. Summary statistics, including mean, standard deviation, minimum, and maximum, were calculated for metrics at selected reference sites.

The use of multiple reference locations for comparison will be further explored and expanded during the study redesign phase.

2.5.2 Habitat Characterization

Environmental variables can provide explanatory information for data interpretation. Stream habitat characteristics were measured during field sampling and are used to inform potential differences observed in the stream invertebrate communities that could be due to environmental factors rather than anthropogenic influences.

A habitat assessment was conducted at each site following CABIN field sampling protocols. Habitat variables included canopy coverage, slope, channel width, velocity, depth, and substrate characteristics. In addition to the field habitat assessment, several environmental variables were determined from site maps, including altitude and stream order.

2.5.3 Placer Mining Development Assessment

The degree of placer mining at each site was estimated using the following approach. When possible during 2016, 2017 and 2018 field sampling, streams were flown upstream of sampling locations and photographs were taken along with notes about placer activity. Based on the information collected, the proximity of recent (<2 years) placer mining development as well as older (>2 years) placer mining development was compiled.

The intensity of placer mining development (low, moderate, high) was estimated from aerial photographs taken during field sampling, as well as from aerial photographs available on the Yukon Placer Watershed Atlas. The intensity of placer mining presented in this report is based on a visual estimate of placer mining development within the watershed upstream of each sample location and may not reflect actual placer mining activities that would be expected to affect aquatic health. In the future, additional sources of information will be incorporated from Yukon Government databases, mining inspection reports, and GIS mapping exercises.

2.5.4 Benthic Invertebrate Community Composition

The following variables were calculated to characterize benthic invertebrate communities:

- Community metrics including total abundance, family level taxonomic richness, Simpson's Evenness Index (SEI), Simpson's Diversity Index (SDI), % Chironomidae (C), % Ephemeroptera (E), % Plecoptera (P), % EPT (Ephemeroptera, Plecoptera, Trichoptera) individuals
- Relative abundance of major taxonomic groups (e.g., Ephemeroptera, Plecoptera, Trichoptera, Diptera)

Invertebrate community metrics were calculated using the on-line CABIN tools based on family-level taxonomic identification.

The metrics are described as follows:

- Total abundance – absolute number of individuals standardized by time per CABIN sampling protocols
- Family level taxonomic richness – total number of taxonomic families identified at a site
- Simpson's Diversity Index – measures the proportional distribution of organisms in the community, which takes into account the number of species present and how evenly the abundance is distributed among these taxa. Values range from 0 to 1; values closer to 1 indicate that a higher diversity of taxa compared to sites with values closer to 0.

- Simpson's Evenness Index – is a measure of how evenly the abundance is distributed among the taxa present at a site. Values range from 0 to 1; values closer to 1 indicate equal numbers of all taxa present in a sample and values closer to zero indicate a high degree of dominance by one or a few organisms.

Relative abundances of major taxonomic groups were also summarized and presented graphically to provide a visual representation of broad level taxonomic composition and total invertebrate abundance at each site.

3 Results – 2018 Aquatic Health

3.1 Study Area

Watersheds sampled in 2018 included: Alsek River, Indian River, Klondike River, Mayo River, McQuesten River, Nisutlin River, Sixty Mile River, Stewart River, Yukon River South, and Yukon River North (Figure 1). Maps showing sampling sites in each watershed are provided in Appendix B1.

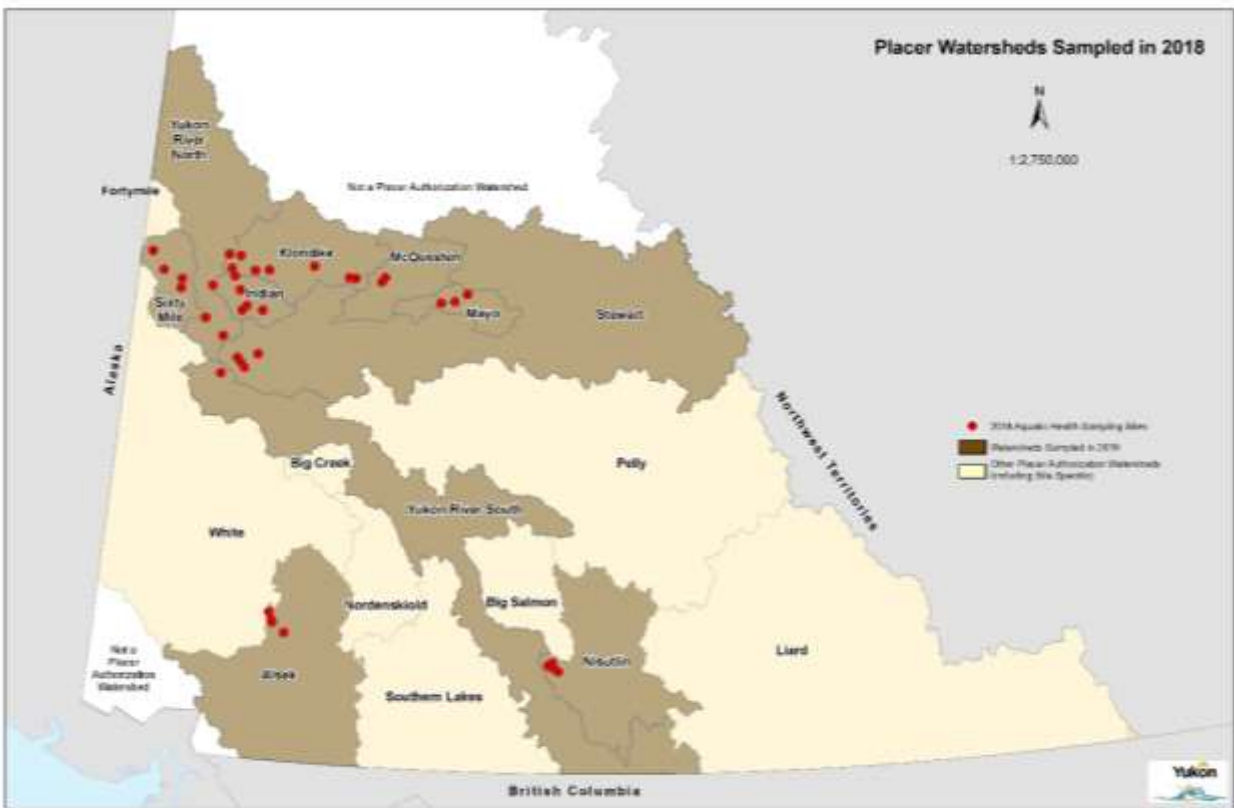


Figure 1. Placer Watersheds and the 2018 Aquatic Health Monitoring Sampling Sites

3.2 Sample Sites

Site visits were carried out from July 17 to July 27, 2018. A total of 39 sites were sampled among 10 watersheds (Table 2). Sampling was carried out at 10 reference sites and 29 test sites. For sites that were sampled in 2018, all available years of data were included in the analysis (Table 3).

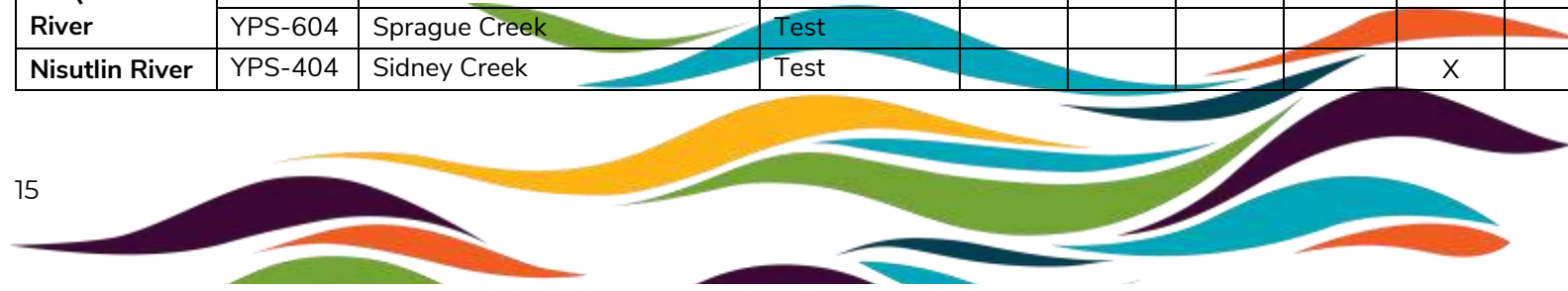
Table 2. Number of Sample Sites by Watershed Sampled in 2018.

Watershed	Reference	Test	Grand Total
Alsek River	2	2	4
Indian River	2	3	5
Klondike River	1	8	9
Mayo River	0	3	3
McQuesten River	1	1	2
Nisutlin River	2	3	5
Sixty Mile River	1	3	4
Stewart River	1	3	4
Yukon River North	0	2	2
Yukon River South	0	1	1
Total	10	29	39



Table 3. Sampling since 2005 for Sites Sampled in 2018.

Watershed	Site	Creek Name	Sample Type	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Alsek River	YPS-441	4th of July Creek	Reference						X								X	
	YPS-442	4th of July Creek (lower)	Test						X						X	X	X	
	YPS-445	McKinley Creek	Reference						X						X	X	X	
	YPS-597	Jarvis River	Test													X	X	
Indian River	YPS-090	Indian River at Water Resources Station	Test		X			X				X	X		X	X	X	
	YPS-480	Montana Creek	Reference							X		X					X	
	YPS-482	Wounded Moose Creek	Reference							X		X			X		X	
	YPS-546	Quartz Creek	Test									X				X	X	
	YPS-606	Montana Creek	Test														X	
Klondike River	YPS-078	Hunker Creek upstream of Ontario Cr.	Test		X		X		X		X	X			X		X	
	YPS-081	Bonanza Creek at Highway	Test		X		X		X		X	X			X	X	X	
	YPS-084	Bonanza Creek upstream of Eldorado inflow	Test		X				X					X		X	X	
	YPS-107	Eldorado Creek top	Test		X		X					X	X		X	X	X	
	YPS-489	Gates Creek	Reference							X							X	
	YPS-544	Hunker Creek	Test		X ^a								X	X	X	X	X	X
	YPS-569	Allgold Creek	Test			X ^b						X		X	X	X	X	
	YPS-607	Big Creek (Klondike)	Test														X	
Mayo River	YPS-053	Keystone Creek inflow to Mayo Lake	Test	X													X	
	YPS-573	Davidson Creek	Test											X			X	
	YPS-574	Granite Creek	Test											X	X	X	X	
McQuesten River	YPS-144	Ballard Creek	Reference		X												X	
	YPS-604	Sprague Creek	Test														X	
Nisutlin River	YPS-404	Sidney Creek	Test					X								X	X	



Watershed	Site	Creek Name	Sample Type	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	YPS-405	Sidney Creek	Reference					X								X	X
	YPS-406	Iron Creek	Reference					X									X
	YPS-598	Iron Creek	Test													X	X
	YPS-605	Sidney Creek	Test														X
Sixty Mile River	YPS-099	60-Mile River at Miller Creek	Test		X												X
	YPS-115	Matson Creek at 60-Mile River	Test		X									X	X		X
	YPS-117	50-Mile Creek at 60-Mile River	Test		X												X
	YPS-381	Fifty Mile Creek	Reference					X									X
Stewart River	YPS-209	Simmons Creek	Reference			X											X
	YPS-428	Black Hills Creek	Test						X			X	X	X		X	X
	YPS-432	Barker Creek	Test						X	X		X					X
	YPS-433	Brewer Creek	Test						X			X	X			X	X
Yukon River North	YPS-153	Henderson Creek	Test		X			X	X				X				X
	YPS-159	Rosebute Creek	Test		X												X
Yukon River South	YPS-164	Thistle Creek	Test		X						X	X	X	X	X	X	X

Notes:

- a. formerly YPS-077 moved due to dry channel
- b. formerly YPS-214 located 800m downstream from current location



3.3 2018 Results by Watershed

The results of the reference site characterization, test site habitat characteristics, degree of placer mining development by watershed, and invertebrate community composition are provided below. Information for the current year as well as previous years were analysed to provide an indication of inter-annual variability within a test site. Comparison to reference sites are also provided where appropriate.

A summary of the 2018 test site results by watershed provides an overview of the sampling results and identifies sites with potentially impaired communities and the priority for re-sampling based on current information.

Site description, map location, site photos, and metrics are provided for each site in Appendix B2 – CABIN Summary Reports for 2018 Sampling Sites. Raw data for all aquatic monitoring sites can be found through the CABIN open data portal (<https://open.canada.ca/data/en/dataset/13564ca4-e330-40a5-9521-bfb1be767147>).

3.3.1 Reference Sites

Habitat and invertebrate community data for reference sites sampled in each watershed are provided below. Direct comparisons of reference sites to test sites are not possible at this time but the local reference site data can be used to characterize the natural variability in invertebrate community composition under reference conditions. Data for reference sites that were sampled in 2018 and historical data for these locations are provided. A total of 26 reference sites were included to support the 2018 analysis. This information can be used to provide useful context to support the evaluation of potential effects of placer mining at the test sites.

3.3.1.1 *Habitat Characterization*

Habitat characteristics measured at reference sites are provided in Appendix B3, Table 3-1. Reference sites generally appeared to be variable in habitat type. Sites were typically in third and fourth order streams and no reference sites in large river systems were sampled. Wetted stream width varied from 1.5 to 12.2 metres. Depth and velocity were also variable. Dominant substrate type was variable but generally dominated by pebble or cobble substrate. Simmons Creek (YPS-209) in the Stewart Watershed had

finer substrate compared to other reference locations with silt/sand substrate dominant at this site. Embeddedness of coarse substrate at the sites was also variable and ranged from unembedded to 75% embedded.

Stream slope was generally low gradient at the majority of reference sites with the exception of Fourth of July Creek and Iron Creek, which appeared to be steeper than the other creeks sampled (Table 3-1). These two creeks were also sampled at the highest altitude of all the reference sites included in this comparison.

Habitat characteristics at reference sites generally encompassed the same type of habitat variability observed at test sites with the exception of large river systems where a comparable reference site was not sampled.

3.3.1.2 *Benthic Invertebrate Community Composition*

Invertebrate community metrics measured at reference sites are provided in Table 4. The relative abundance of major taxonomic groups are shown on Figure 2.

Abundance and richness were observed to be highly variable at reference sites. Abundance ranged from 15 to 4,814 individuals with a mean value of 1,808. Three sites with less than 100 individuals (McKinley Creek: YPS-445 in 2016, Simmons Creek: YPS-209 in 2007 and YPS-209 in 2018) were notably lower in abundance compared to other locations. Low richness was also observed at these sites. Simmons Creek was observed to have silt/sand as the dominant substrate type indicating that habitat differences may help to explain the different invertebrate community at this site.

SDI suggest that reference site communities are reasonably diverse (average SDI = 0.73) and SEI indicates generally low evenness among sites (average SEI = 0.33).

The majority of the invertebrate communities at reference sites was made up of families from the Orders Ephemeroptera (mayflies) and Plecoptera (stoneflies) and the family Chironomidae (non-biting midges) (Table 4, Figure 2).

A large relative abundance of the family Simuliidae (black flies, Order Diptera) was identified in all three years of sampling on Montana Creek. Fifty Mile Creek had high abundance of Oligochaete worms from the family Lumbriculidae in 2009 and a high

abundance of Oligochaete worms from the family Naididae (formerly known as Tubificidae) in 2018.

Table 4. Benthic Invertebrate Community Metrics at Reference Sites.

Watershed	Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Alsek	4th of July Creek	YPS-441	2010	1562	15	0.84	0.41	31	24	26
			2018	4814	12	0.81	0.43	28	40	7
	McKinley Creek	YPS-445	2010	2060	18	0.80	0.27	33	52	3
			2016	45	11	0.79	0.42	7	67	4
			2017	746	17	0.82	0.33	9	63	2
			2018	1745	13	0.79	0.36	17	57	4
Indian	Montana Creek	YPS-480	2011	3478	9	0.64	0.31	16	10	14
			2013	3170	10	0.46	0.18	7	3	16
			2018	2487	8	0.67	0.38	13	42	6
	Wounded Moose Creek	YPS-482	2011	1166	12	0.71	0.29	8	27	5
			2013	1118	15	0.72	0.24	21	49	5
			2016	771	14	0.69	0.23	3	76	1
			2018	1878	9	0.40	0.18	10	77	2
Klondike	Gates Creek	YPS-489	2011	1493	14	0.72	0.26	26	50	11
			2018	346	16	0.81	0.33	12	61	13
McQuesten	Ballard Creek	YPS-144	2006	982	14	0.86	0.49	8	28	35
			2018	1710	20	0.83	0.29	14	47	15
Nisutlin	Sidney Creek	YPS-405	2009	4200	22	0.78	0.20	16	67	4
			2017	2892	22	0.84	0.28	25	47	6
			2018	680	13	0.49	0.15	15	0	3
	Iron Creek	YPS-406	2009	1590	15	0.75	0.27	7	62	25
			2018	1805	14	0.81	0.38	20	58	18
Sixty Mile	Fifty Mile Creek	YPS-381	2009	3610	20	0.75	0.20	42	14	8
			2018	2577	13	0.83	0.45	15	50	5
Stewart	Simmons Creek	YPS-209	2007	15	4	0.67	0.77	23	0	0
			2018	63	6	0.65	0.48	49	2	19
Summary Statistics	Arithmetic Mean			1808	14	0.73	0.33	18	41	10
	Standard Deviation			1292	5	0.12	0.13	11	24	9
	Minimum			15	4	0.40	0.15	3	0	0
	Maximum			4814	22	0.86	0.77	49	77	35

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)



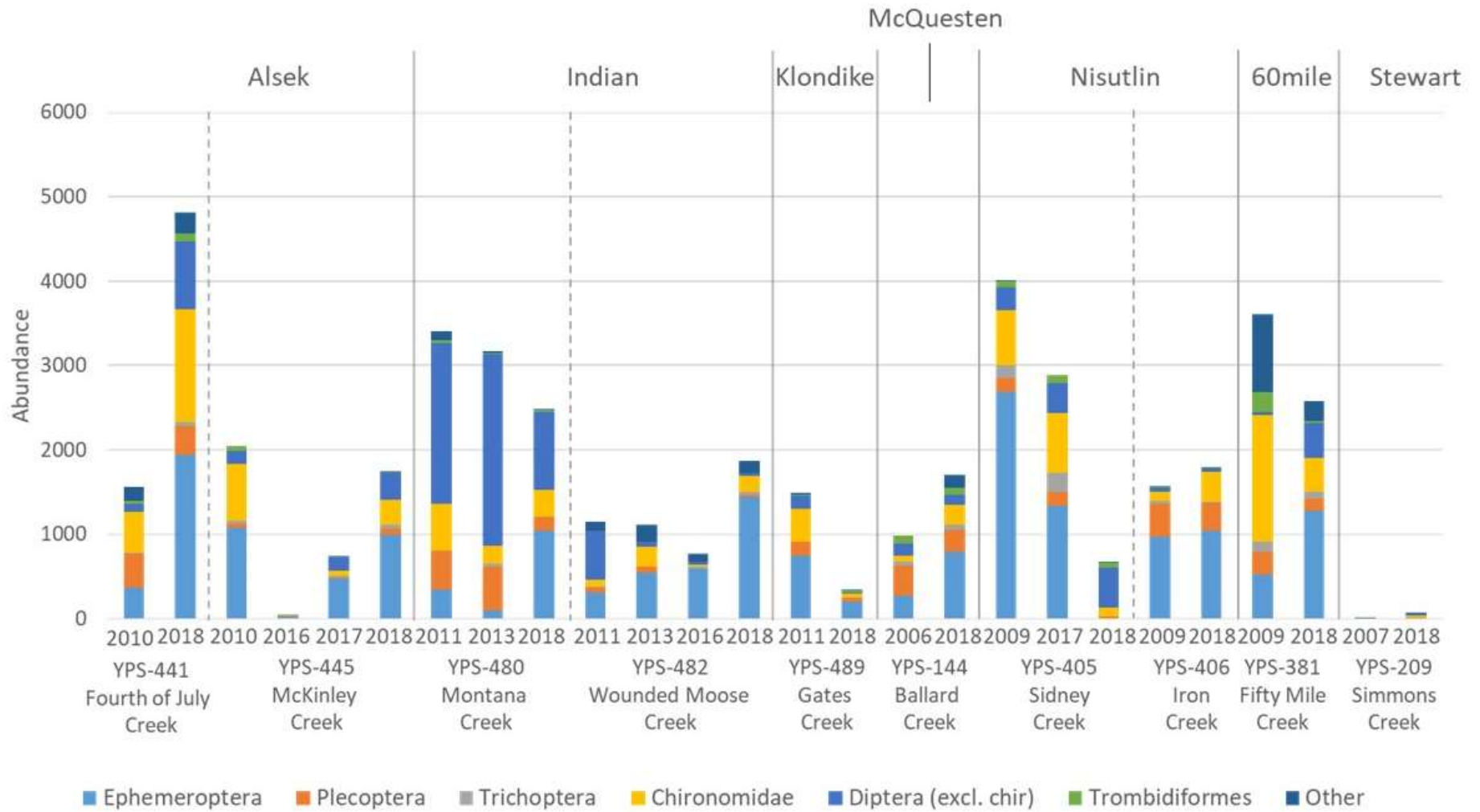


Figure 2. Relative Abundance of Major Taxonomic Groups Identified at Reference Sites Sampled from 2006 to 2018.

3.3.2 Alsek River Watershed

The following section presents the site assessment results for the two sites sampled in the Alsek River Watershed. Four years of data were available for YPS-442 on the Fourth of July Creek and two years of data were available for the Jarvis River. The test site evaluation was focused on the 2018 sampling results.

3.3.2.1 Habitat Characterization

Habitat characteristics measured on two creeks in the Alsek River Watershed are provided in Appendix B3, Table 3-2. Average depth was lower in 2018 compared to past years. Wetted width ranged from 5 m to 9.5 m with no consistent trends observed among years. Stream substrate was dominated by gravel, pebble, or cobble substrate. Embeddedness ranged from 0 to 50%.

3.3.2.2 Degree of Placer Mining

Placer mining development upstream of sites sampled in the Alsek Watershed in 2018 was generally estimated to be low to moderately low (Table 5).

Table 5. Degree of Placer Mining Development at Sites Sampled in the Alsek River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
4th of July Creek (lower)	YPS-442	Moderate-Low	4.0	7.5	Active fords 200 m to 5 km u/s.
Jarvis River	YPS-597	Moderate-Low	10.0	6.5	

3.3.2.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 6. Relative abundance of major taxonomic groups is provided in Figure 3.

Table 6. Benthic Invertebrate Community Metrics in the Alsek River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
4th of July Creek (lower)	YPS-442	2010	327	17	0.83	0.34	24	46	15
		2016	82	10	0.80	0.51	9	48	32
		2017	338	17	0.87	0.45	9	45	25

		2018	1705	11	0.73	0.33	25	53	6
Jarvis River	YPS-597	2017	326	17	0.77	0.26	10	67	10
		2018	2056	13	0.74	0.29	31	51	10

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)

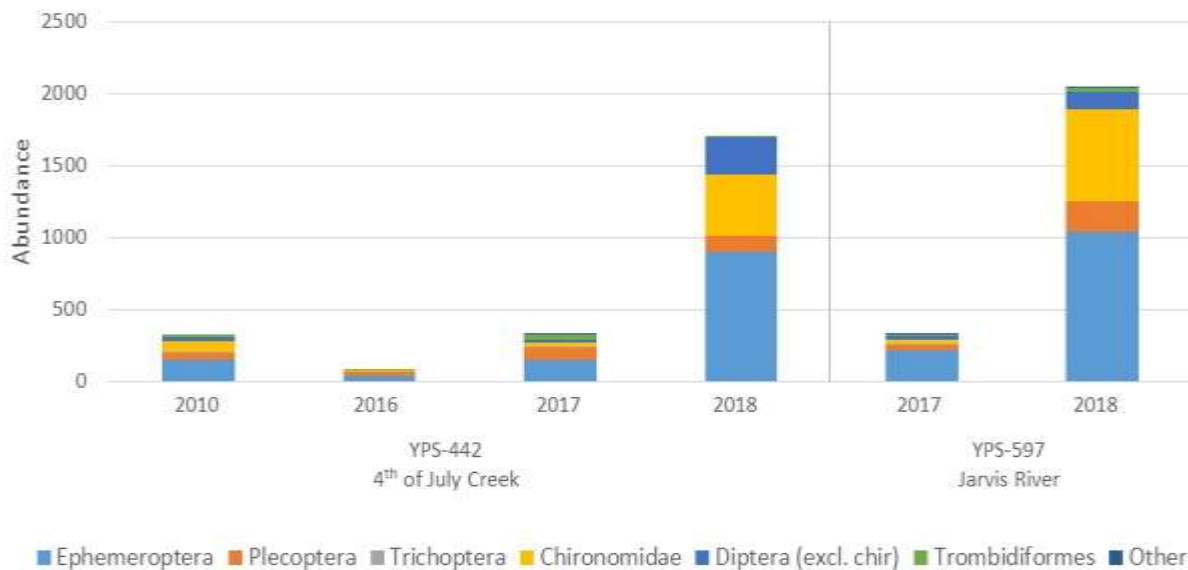


Figure 3 Relative Abundance of Major Taxonomic Groups Identified at Sites in the Alsek River Watershed

3.3.2.4 Alsek River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below. Currently there is no habitat suitability model for the Alsek River drainage and as such no habitat suitability classification information has been provided for the Alsek test sites below.

YPS-442 – Fourth of July Creek

This site is located on the main channel of Fourth of July Creek approximately two kilometres upstream of the confluence with the Jarvis River. Abundance and richness were higher in 2018 compared to previous years. The majority of the community was made up of Ephemeroptera and Chironomidae and overall community composition is typical of what is observed in other locations including nearby reference sites.

There is the potential for increased placer development in this watershed; therefore, this site is considered a high priority for re-sampling.

YPS-597 – Jarvis River

This site is located on the Jarvis River approximately 700 meters downstream of the mouth of Fourth of July Creek and well downstream of placer activity. Abundance was higher in 2018 compared to 2017. Richness was lower than 2017 although still within the range of normal variability observed at reference sites. The majority of the community was made up of Ephemeroptera and Chironomidae and overall community composition is typical of what is observed in other locations including nearby reference sites.

There is the potential for increased placer development in this watershed; therefore, this site is considered a high priority for re-sampling.

3.3.3 Indian River Watershed

The following section presents the site assessment results for three sites sampled in the Indian River Watershed. Seven years of data were available at YPS-090 on the Indian River at the Water Resources Station. Quartz Creek (YPS-546) has been sampled for three years and Montana Creek (YPS-606) was sampled for the first time in 2018. The test site evaluation focused on the 2018 sampling results.

3.3.3.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Indian River Watershed are provided in Appendix B3 Table, 3-3. Habitat characteristics at the Indian River site are notably different compared to sites on Quartz Creek and Montana Creek. The Indian River is a sixth order stream with large wetted and bankfull widths. Stream depths in the Indian River are higher than the other creeks as well. Visual assessment of bottom substrate typically identified pebble or cobble substrate at sampling sites.

3.3.3.2 Degree of Placer Mining

Placer mining development was generally estimated to be high in the Indian River Watershed with the exception of Montana Creek where development is currently estimated to be moderate but is expected to increase in the future (Table 10).

Table 7. Degree of Placer Mining Development at Sites Sampled in the Indian River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Indian River at Water Resources Station	YPS-090	High	9.0	10.0	
Quartz Creek	YPS-546	High	0.2	0.0	
Montana Creek	YPS-606	Moderate	1.0	0.5	

3.3.3.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 8. Relative abundance of major taxonomic groups is provided in Figure 4.

Table 8. Benthic Invertebrate Community Metrics in the Indian River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Indian River at Water Resources Station	YPS-090	2006	513	16	0.57	0.15	62	25	0
		2009	1391	20	0.57	0.12	64	6	1
		2013	429	22	0.85	0.31	15	45	4
		2014	130	8	0.71	0.43	5	60	2
		2016	760	26	0.78	0.18	37	39	3
		2017	1332	15	0.78	0.31	20	54	5
		2018	1016	15	0.76	0.28	35	10	1
Quartz Creek	YPS-546	2013	2	2	0.50	1.00	50	0	50
		2017	1091	11	0.64	0.25	33	49	5
		2018	1779	9	0.64	0.31	22	53	1
Montana Creek	YPS-606	2018	71	9	0.77	0.49	36	27	7

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)



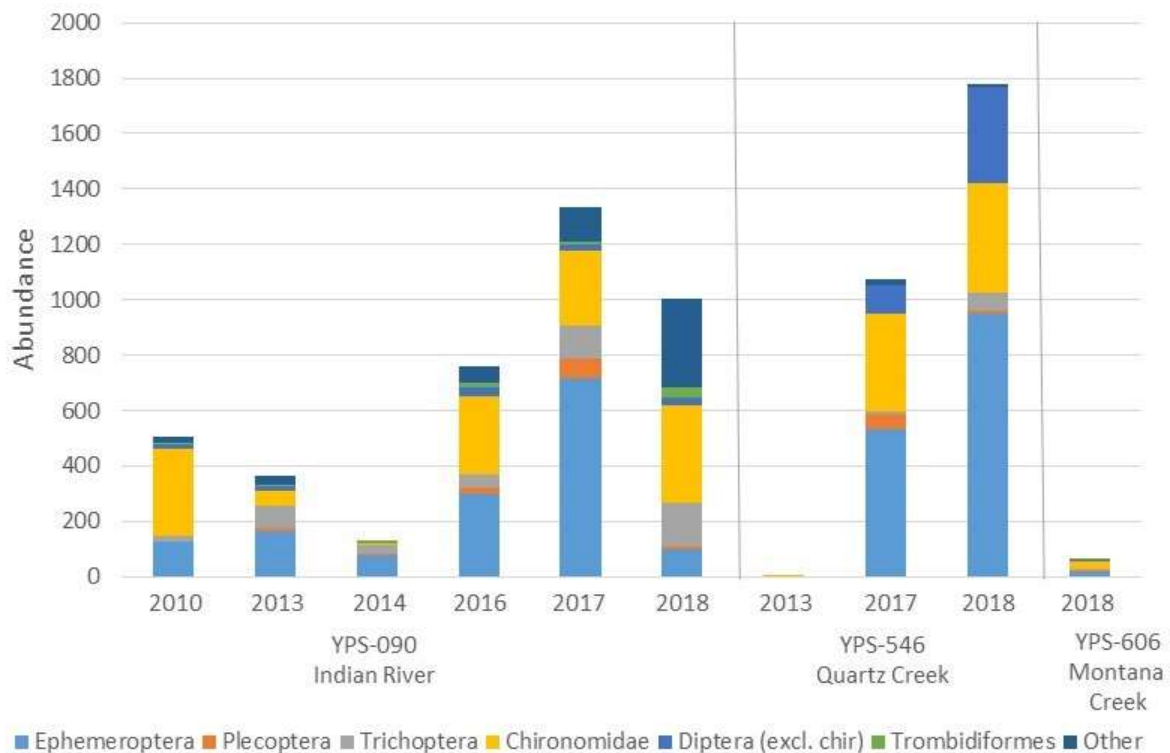


Figure 4. Relative Abundance of Major Taxonomic Groups Identified at Sites in the Indian River Watershed

3.3.3.4 Indian River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-090 – Indian River

This moderate-moderate suitability site is located approximately 10 km upstream of the mouth of the Indian River and 9 km downstream of active placer mining. Some variability in abundance has been observed over the six years of sampling. No consistent upwards or downwards trends were noted. In 2018, a decrease in relative abundance of Ephemeroptera was noted. High abundance of Tubificidae were identified at YPS-090 in 2018 compared to previous years.

Habitat characteristics in the Indian River are different compared to selected reference sites. Therefore, tracking long-term trends over time will be important for monitoring the aquatic health at this location.

Given the long term monitoring already undertaken at this location and the difficulty in finding a comparable reference site, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-546 – Quartz Creek

This site is located near the mouth of Quartz Creek in low suitability habitat and immediately downstream of active placer mining. Abundance in 2018 is higher compared to past year and suggests an increasing trend. Abundance in 2013 was extremely low with only two individuals collected. Richness in 2018 (9 families) was lower than the reference mean (14 families) but was within the range of variability observed at reference sites. Community composition is typical of what is observed in other locations with the majority of individuals from the Order Ephemeroptera and the family Chironomidae. In 2018, a large number of individuals from the family Simuliidae (black flies) were identified.

Given the high degree of placer mining development upstream of this site, additional sampling at this location is recommended to build on the long term data set for this creek.

YPS-606 – Montana Creek

This site is located in an area of low habitat suitability and immediately downstream of a moderate amount of historic placer development. The invertebrate community in 2018 was low in total abundance of individuals and low in richness. This site had not been sampled previously so there are no past years for comparison. The upstream reference site on this creek was characterized by higher total abundance and a high relative abundance of individuals from the Order Ephemeroptera.

Given the potential for increase placer mining activity on this creek, additional data on this creek would be useful to form a baseline to understand the typical invertebrate community at this site. This site is considered a high priority for re-sampling.

3.3.4 Klondike River Watershed

The following section presents the site assessment results for eight sites sampled in the Klondike River Watershed. Long term historical data sets (up to seven years of data) are available for two sites on Hunker Creek (YPS-078 and YPS-544), two sites on Bonanza Creek (YPS-081 and YPS-084), and one site on Eldorado Creek (YPS-1070). Five years of data are also available on Allgold Creek (YPS-569), a tributary to the Klondike River located further upstream. YPS-607 on Big Creek and YPS-608 on Little South Klondike Creek were sampled for the first time in 2018. The test site evaluation focused on the 2018 sampling results.

3.3.4.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Klondike River Watershed are provided in Appendix B3 Table, 3-4.

A range of streams were sampled in the Klondike Watershed including Eldorado Creek (YPS-107), a small second order creek that is fairly narrow in width to Little South Klondike (YPS-608), a large fifth order creek with wide stream widths and abundant periphyton coverage. The dominant substrate type was typically pebble or cobble at the majority of sites; however, some years of sampling indicated the dominant substrate was predominantly fines (sand/silt/clay).

3.3.4.2 Degree of Placer Mining

Placer mining development in the Klondike River Watershed was estimated to range from low to high depending on the creek (Table 9).

Table 9. Degree of Placer Mining Development at Sites Sampled in the Klondike River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Hunker Creek upstream of Ontario Creek	YPS-078	Moderate	0.2	0.0	
Bonanza Creek at Highway	YPS-081	High	0.0	0.0	Difficult to tell where active mining is located. Extensive development

					throughout watershed immediately upstream.
Bonanza Creek upstream of Eldorado inflow	YPS-084	Moderate	2.0	0.2	
Eldorado Creek top	YPS-107	Low	None	0.0	
Hunker Creek	YPS-544	High	0.2	0.2	
Allgold Creek	YPS-569	Moderate	0.0	0.0	
Big Creek (Klondike)	YPS-607	Moderate	1.5	10.0	
Little South Klondike	YPS-608	Moderate	7.5	16.0	

3.3.4.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 10. Relative abundance of major taxonomic groups is provided in Figures 5 and 6.

Table 10. Benthic Invertebrate Community Metrics in the Klondike River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Hunker Creek upstream of Ontario Cr.	YPS-078	2006	596	12	0.53	0.18	19	69	4
		2008	555	15	0.35	0.10	80	10	5
		2010	943	16	0.69	0.20	51	17	2
		2012	665	19	0.75	0.21	4	55	7
		2013	234	14	0.79	0.33	37	30	10
		2016	294	19	0.85	0.35	21	34	3
		2018	443	16	0.61	0.16	13	74	3
Bonanza Creek at Highway	YPS-081	2006	698	14	0.58	0.17	58	28	0
		2008	148	9	0.52	0.23	28	64	1
		2010	1435	12	0.69	0.27	24	49	1
		2012	1607	18	0.61	0.14	19	59	1
		2013	301	10	0.64	0.28	56	18	2
		2016	769	9	0.52	0.23	64	26	2
		2017	159	14	0.64	0.20	39	47	2
		2018	2538	8	0.59	0.31	39	51	7
Bonanza Creek upstream of Eldorado inflow	YPS-084	2006	132	7	0.48	0.27	9	70	12
		2010	2567	16	0.57	0.15	59	29	1
		2015	76	9	0.69	0.36	50	19	5
		2017	74	11	0.65	0.26	50	37	6
		2018	1527	8	0.43	0.22	17	74	5
Eldorado Creek top	YPS-107	2006	3804	8	0.67	0.38	5	68	3
		2008	347	13	0.84	0.49	20	33	26
		2013	462	12	0.80	0.42	9	56	21

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
		2014	260	11	0.61	0.23	59	30	10
		2016	379	14	0.81	0.37	27	25	11
		2017	1315	11	0.82	0.51	21	30	14
		2018	1882	13	0.79	0.37	32	32	15
Hunker Creek	YPS-544	2006 ^a	340	15	0.77	0.29	36	11	0
		2013	40	6	0.67	0.51	31	49	0
		2014	45	4	0.64	0.70	0	49	0
		2015	143	12	0.73	0.31	32	37	3
		2016	270	15	0.58	0.16	59	28	1
		2017	242	15	0.67	0.20	48	30	2
		2018	332	13	0.62	0.20	54	30	2
Allgold Creek	YPS-569	2007 ^b	125	11	0.83	0.54	27	20	7
		2013	108	7	0.37	0.23	79	9	0
		2015	99	4	0.20	0.31	89	9	0
		2016	172	9	0.22	0.14	88	4	1
		2017	355	10	0.33	0.15	81	13	1
		2018	532	16	0.63	0.17	49	33	2
Big Creek (Klondike)	YPS-607	2018	3058	19	0.76	0.22	43	31	5
Little South Klondike	YPS-608	2018	2369	15	0.85	0.43	27	36	12

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)

a. Collected at site YPS-077

b. Collected at site YPS-214



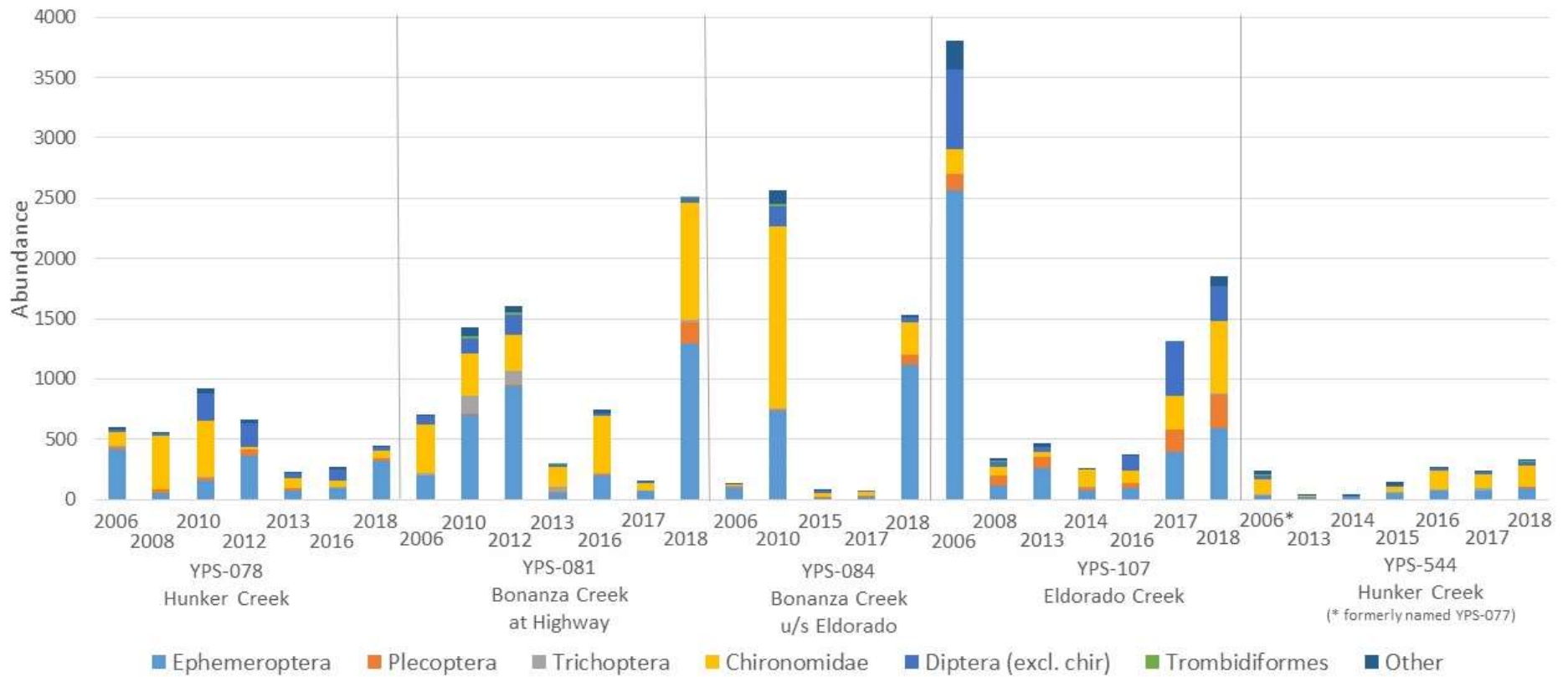


Figure 5. Relative Abundance of Major Taxonomic Groups Identified in the Downstream Sites of the Klondike River Watershed



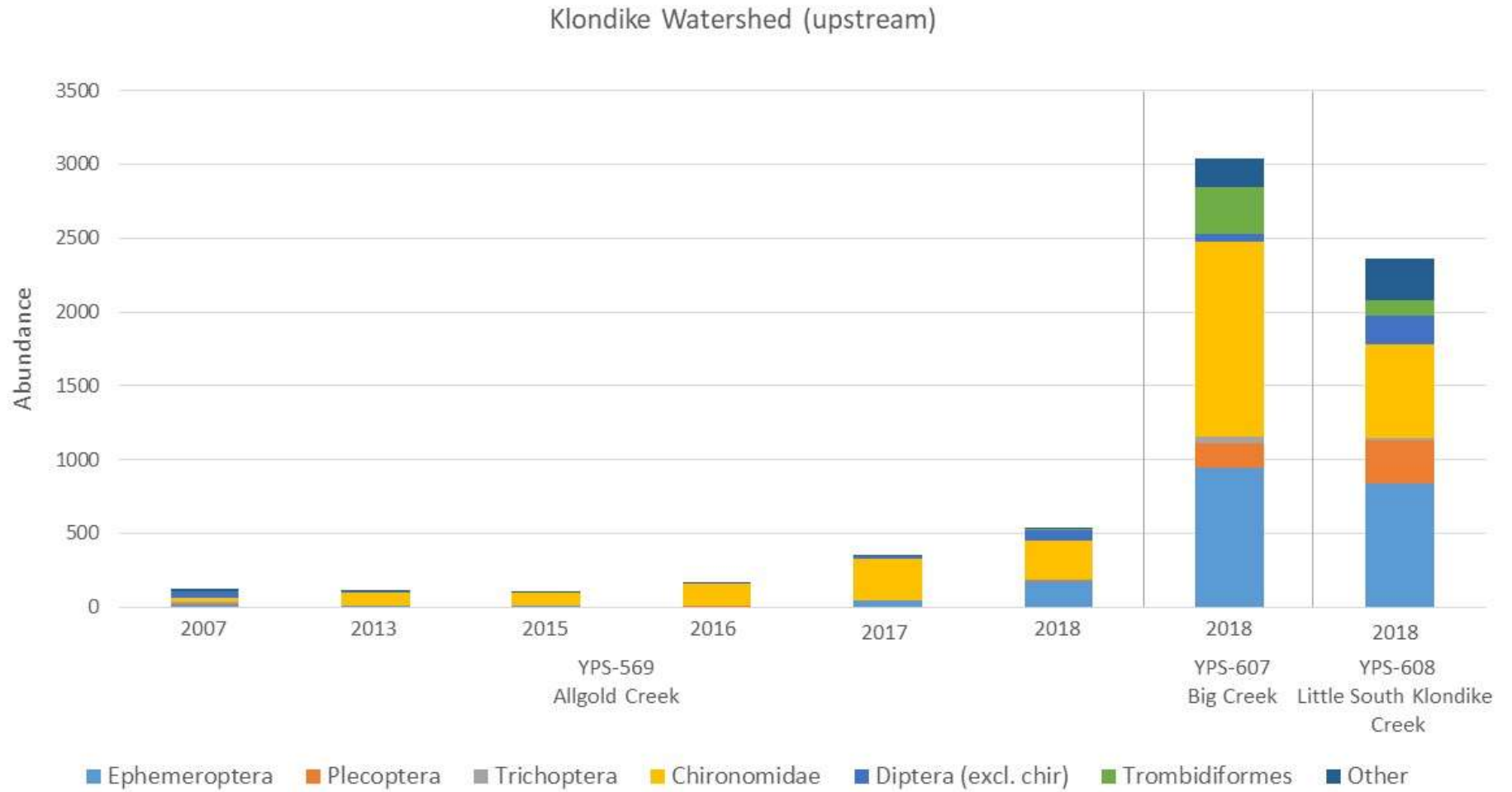


Figure 6. Relative Abundance of Major Taxonomic Groups Identified in the Upstream Sites of the Klondike River Watershed



3.3.4.4 Klondike River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-078 – Hunker Creek

This site is located in moderate-low suitability habitat immediately downstream of recent placer mining on the upper reaches of Hunker Creek and has seven years of sampling data. Low invertebrate abundance has typically been observed at this site compared to reference sites. In 2018, invertebrate abundance and richness was similar to past sampling. The majority of the invertebrate community was made up of Ephemeroptera.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-081 – Bonanza Creek at Highway

This moderate-high suitability site is located in the lower third of the drainage and has seven years of sampling data, with historic and active placer mining upstream and in close proximity. An increase in abundance was observed in the 2018 sampling event compared to past years. Lower richness was also observed in 2018 compared to what has previously been observed at this site; however, taxa that were present included the major taxonomic groups (Ephemeroptera and Chironomidae), which are typical in the area.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-084 – Bonanza Creek upstream of Eldorado

This moderate-low suitability site is located in the middle of the Bonanza Creek drainage within historic workings with historic and active placer mining upstream and in close proximity to the site. In 2018, abundance was much higher compared to the

last two years of sampling; however, richness and SDI were lower compared to previous years. Relative abundance of Ephemeroptera was high.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-107 – Eldorado Creek

This moderate-low suitability site is located in the upper third of the drainage with very little placer development upstream. The site has seven years of sample data.

Abundance increased in 2018 compared to past years. The majority of individuals were made up of Chironomidae and Ephemeroptera. Richness and SDI were similar to previous years.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-544 – Hunker Creek

This moderate-high suitability site is located near the mouth of Hunker Creek and has seven years of sample data. There is active and historical placer mining upstream and in close proximity to this site. A slight increase in abundance has been observed over the last six years with 2018 having the highest abundance of 332 individuals. This is low compared to the mean abundance of 1808 individuals at local reference sites. The community was made up primarily of Chironomidae and Ephemeroptera, which is consistent with past years.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-569 – Allgold Creek

This moderate-high suitability site is located in the lower reaches of Allgold Creek and has six years of sample data. There is active and historical placer mining upstream and in close proximity to this site. A generally increasing trend in abundance is observed although an abundance of 532 individuals is still quite low compared to the mean abundance of 1808 individuals at local reference sites. Richness and SDI were higher in 2018 and a higher relative abundance of Ephemeroptera was observed compared to past years.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-607 – Big Creek

This moderate-low suitability site on Big Creek upstream of the confluence with the Little South Klondike River and there is active placer activity upstream and in close proximity to this site. A single year of sampling has been carried out at this location. The 2018 sampling indicated high abundance, richness and SDI at this location. This site was observed to have high periphyton growth based on visual observations indicating the potential for higher productivity in this creek. The community was predominantly Chironomidae and Ephemeroptera, which is typical of sites in the area.

The 2018 provides a baseline for invertebrate communities in this creek but further sampling in this creek is not proposed. This site is considered a low priority for re-sampling.

YPS-608 – Little South Klondike Creek

This moderate-low suitability site on the Little South Klondike River downstream of the confluence with Big Creek. A single year of sampling has been carried out at this location. The 2018 sampling indicated high abundance, richness and SDI at this location. This site was observed to have high periphyton growth based on visual observations indicating the potential for higher productivity in this creek. The community was predominantly Chironomidae and Ephemeroptera, which is typical of sites in the area.

The 2018 provides a baseline for invertebrate communities in this creek but further sampling in this creek is not proposed. This site is considered a low priority for re-sampling.

3.3.5 Mayo River Watershed

The following section presents the site assessment results for three sites sampled in the Mayo River Watershed. Two years of data were available for Keystone Creek (YPS-053) and Davidson Creek (YPS-573) and three years of data were available for Granite Creek (YPS-574). The test site evaluation focused on the 2018 sampling results.

3.3.5.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Mayo River Watershed are provided in Appendix B3 Table, 3-5.

Davidson and Granite creeks were both third order streams with coarse cobble substrate. The creeks were similar in physical habitat characteristics and were comparable to several of the reference sites. Keystone Creek is a fourth order stream located near the inflow to Mayo Lake.

3.3.5.2 Degree of Placer Mining Development

Placer mining development in the Mayo River Watershed was estimated to range from no development to high depending on the creek (Table 11).

Table 11. Degree of Placer Mining Development at Sites Sampled in the Mayo River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Keystone Creek inflow to Mayo Lake	YPS-053	None	None	None	New road near channel starts 8km upstream. Development proposed.
Davidson Creek	YPS-573	High	3.0	3.0	Road runs directly beside much of this stream
Granite Creek	YPS-574	Low	4.0	None	

3.3.5.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 12. Relative abundance of major taxonomic groups is provided in Figure 7.

Table 12. Benthic Invertebrate Community Metrics in the Mayo River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Keystone Creek inflow to Mayo Lake	YPS-053	2005	255	12	0.83	0.49	18	27	21
		2018	3130	15	0.81	0.36	14	23	35
Davidson Creek	YPS-573	2015	150	19	0.82	0.29	35	31	13
		2018	54	9	0.66	0.32	54	2	6
Granite Creek	YPS-574	2015	2147	16	0.80	0.31	30	32	22
		2016	2717	14	0.76	0.29	16	42	18
		2017	1883	14	0.77	0.30	16	40	32
		2018	5186	16	0.78	0.29	35	34	19

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)



Mayo/McQuesten River Watershed

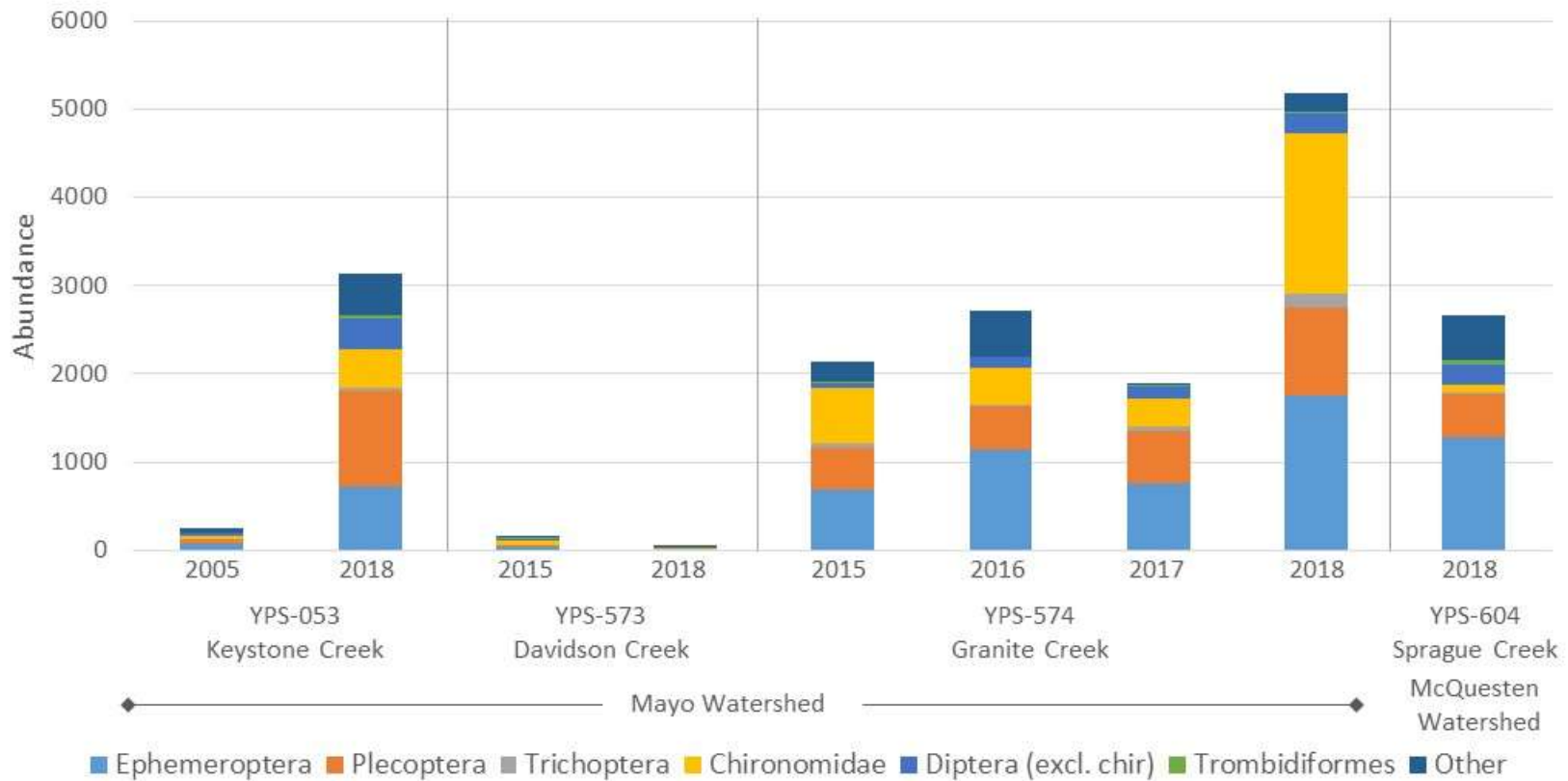


Figure 7. Relative Abundance of Major Taxonomic Groups Identified at Sites in Mayo River and McQuesten River Watersheds



3.3.5.4 Mayo River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-053 – Keystone Creek

This moderate-low suitability site is located at the mouth of Keystone Creek where it discharges into Mayo Lake. Higher abundance in 2018 was observed compared to last sampling in 2005. The dominant taxonomic group was Plecoptera but individuals from the family Chironomidae and the order Ephemeroptera were also present in fairly large relative abundance. It is possible that the proximity of this site to Mayo Lake may influence the invertebrate community composition at this location.

This site is not considered a high priority for re-sampling until such time as there is an increase in placer activity.

YPS-573 – Davidson Creek

This low habitat suitability site is located near the mouth of Davidson Creek. Low abundance, richness and SDI has been observed in both years of sampling. An extremely low relative abundance of Ephemeroptera were observed in 2018. Based on the invertebrate metrics and community composition, and the high level of placer activity known to occur at this site, there is evidence for some potential impairment of the invertebrate community at this site. This site is considered a moderate priority for re-sampling to confirm the results from the 2018 sampling event. However, a re-visit in 2019 is not currently planned.

YPS-574 – Granite Creek

This moderate-moderate suitability site is located in the upper reaches of Granite Creek with recently developed and active placer activity upstream. Abundance was higher in 2018 compared to past years. Richness and SDI were similar to what has been observed previously at the site. Relative composition of major taxonomic groups was also similar to past year and the community was primarily composed of Chironomidae and Ephemeroptera.

The invertebrate community is similar to what would be expected for the site; therefore, this site is considered a low priority for re-sampling.

3.3.6 McQuesten River Watershed

The following section presents the site assessment results for three sites sampled in the McQuesten River Watershed. Sprague Creek (YPS-604) was the only test site sampled in this watershed. It was sampled for the first time in 2018.

3.3.6.1 *Habitat Characteristics*

Habitat characteristics measured on Sprague Creek are provided in Appendix B3 Table, 3-6.

Sprague Creek is a third order stream with coarse cobble substrate as the dominant substrate type.

3.3.6.2 *Degree of Placer Mining Development*

No existing significant development was observed at the time of the 2018 site visit on Sprague Creek in the McQuesten Watershed (Table 13). However, it is anticipated that placer development may increase in the future.

Table 13. Degree of Placer Mining Development at Sites Sampled in the McQuesten River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Sprague Creek	YPS-604	None	2.5	None	Small test pits only,

3.3.6.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 14. Relative abundance of major taxonomic groups is provided in Figure 7.

Table 14. Benthic Invertebrate Community Metrics in the McQuesten River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Sprague Creek	YPS-604	2018	2669	16	0.80	0.31	4	48	18

Notes: SDI = Simpson’s Diversity Index; SEI = Simpson’s Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)

3.3.6.4 McQuesten River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-604 – Sprague Creek

This moderate-moderate suitability site was sampled for the first time in 2018. Placer developments is currently limited to small test pits upstream of this site. Invertebrate abundance and richness were high and were similar to reference mean. The invertebrate community was made up primarily of Ephemeroptera and Plecoptera. Relative abundance of Chironomidae was lower than at other sites.

This site is not considered a high priority for re-sampling at this time; however if placer activity in the area increases, it will likely be re-sampled.

3.3.7 Nisutlin River Watershed

The following section presents the site assessment results for two sites sampled in the Nisutlin River Watershed. Two years of data were available for Iron Creek (YPS-598) and three years of data were available for Sidney Creek (YPS-404). The test site evaluation focused on the 2018 sampling results.

3.3.7.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Nisutlin River Watershed are provided in Appendix B3 Table, 3-7.

Large cobble substrate was observed to be the dominant substrate type in Iron Creek. Otherwise, both Iron and Sydney creeks appeared to be fairly similar in physical habitat characteristics.

3.3.7.2 Degree of Placer Mining Development

Placer mining development at sites sampled in the Nisutlin River Watershed was estimated to be low (Table 15).

Table 15. Degree of Placer Mining Development at Sites Sampled in the Nisutlin River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Iron Creek	YPS-598	Low	0.5	2.0	0.5km is out of stream operation
Sidney Creek	YPS-404	Low	0.7	2.2	Mining on Iron Creek only
Sidney Creek	YPS-605	Low	9.0	11.0	Mining on Iron creek only. 0.7km is out of stream operation

3.3.7.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 16. Relative abundance of major taxonomic groups is provided in Figure 8.

Table 16. Benthic Invertebrate Community Metrics in the Nisutlin River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Sidney Creek	YPS-404	2009	3767	16	0.74	0.24	7	73	13
		2017	1608	21	0.83	0.28	32	35	5

		2018	1625	19	0.82	0.30	24	58	5
	YPS-605	2018	2224	19	0.86	0.37	22	51	3
Iron Creek	YPS-598	2017	1700	17	0.81	0.31	13	68	11
		2018	3042	18	0.78	0.25	21	61	9

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)

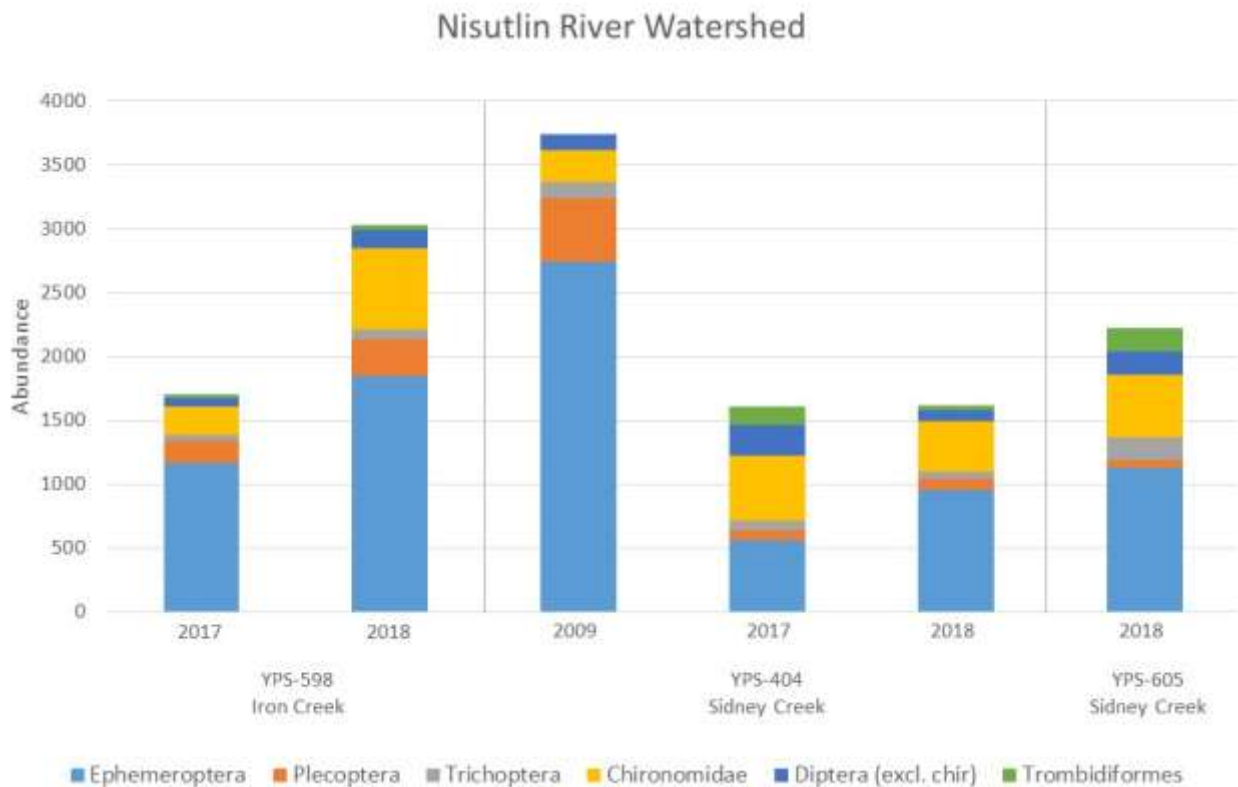


Figure 8. Relative Abundance of Major Taxonomic Groups Identified at Sites in the Nisutlin River Watershed

3.3.7.4 Nisutlin River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-598 – Iron Creek

This high suitability site is located near the mouth of Iron Creek. The site is located just downstream of a small placer mining camp and active placer mining, although no direct

discharge to the creek is expected at this location (i.e., total recirculation methods are used). This was the second year of sampling at this location.

The site was characterized by high abundance, high richness, and a high relative abundance of Ephemeroptera in both years sampled. Invertebrate community composition in 2018 was similar to the upstream reference site on Iron Creek (YPS-406). Abundance and richness were higher at the test site compared to the reference site.

This site is located in an area of active placer mining in high suitability habitat where juvenile Chinook salmon are known to utilize this site and the adjacent stream channel. As such, this site is considered a high priority for re-sampling in order to build a long term data set for this location.

YPS-404 – Sidney Creek

This high habitat suitability site is located on Sidney Creek just downstream of the mouth of Iron Creek, which has active placer mining activity (with no direct discharge) just upstream.

Invertebrate abundance and richness in 2018 was similar to 2017. The order Ephemeroptera made up the majority of the community based on relative abundance.

This site is located in an area of active placer mining in high suitability habitat where juvenile Chinook salmon are known to utilize this site and the adjacent stream channel. As such, this site is considered a high priority for re-sampling in order to build a long term data set for this location

YPS-605 – Sidney Creek

This site is located in high suitability habitat further downstream on Sidney Creek. The invertebrate abundance of 2224 individuals at this site was higher than the reference mean for all sites and much higher than the abundance measured at the upstream reference location (YPS-405) on this creek. Taxonomic richness was also high and the community was made up primarily of Chironomidae and Ephemeroptera.

This site is located in high suitability habitat where juvenile Chinook salmon are known to utilize this site and the adjacent stream channel. As such, this site is considered a high priority for re-sampling in order to establish a baseline dataset for the Sidney Creek Watershed.

3.3.8 Sixty Mile River Watershed

The following section presents the site assessment results for two sites sampled in the Sixty Mile River Watershed. Four years of data were available for Matson Creek (YPS-115). Two years of data were available for Sixty Mile River (YPS-099) and Fifty Mile Creek (YPS-117). The test site evaluation focused on the 2018 sampling results.

3.3.8.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Sixty Mile River Watershed are provided in Appendix B3 Table, 3-8.

The Sixty Mile River is a fifth order stream characterized by wider bankfull and wetted widths typical of a larger river system. Matson and Fifty Mile creeks are fourth order streams with physical habitat characteristics similar to the range of reference sites sampled in 2018.

3.3.8.2 Degree of Placer Mining Development

Placer mining development at sites sampled in the Sixty Mile River Watershed was estimated to range from low to moderate depending on the creek (Table 17).

Table 17. Degree of Placer Mining Development at Sites Sampled in the Sixty Mile River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
60-Mile River at Miller Creek	YPS-099	Moderate	unknown	0.0	No known recent work upstream. 5km of intense old workings then no development.
Matson Creek at 60-Mile River	YPS-115	Low	None	10.0	Very little old disturbance
50-Mile Creek at 60-Mile River	YPS-117	Low	12.0	unknown	Limited information

3.3.8.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 18. Relative abundance of major taxonomic groups is provided in Figure 9.

Table 18. Benthic Invertebrate Community Metrics in the Sixty Mile River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Sixty Mile River at Miller Creek	YPS-099	2006	292	12	0.74	0.32	7	68	11
		2018	2593	14	0.76	0.29	15	42	3
Matson Creek at Sixty Mile River	YPS-115	2006	1192	15	0.70	0.22	49	34	0
		2015	556	22	0.84	0.29	18	47	11
		2016	1084	19	0.86	0.37	18	37	5
		2018	1119	17	0.80	0.29	33	40	5
Fifty Mile Creek at Sixty Mile River	YPS-117	2006	1192	16	0.80	0.32	31	37	6
		2018	1076	19	0.83	0.31	21	49	14

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)

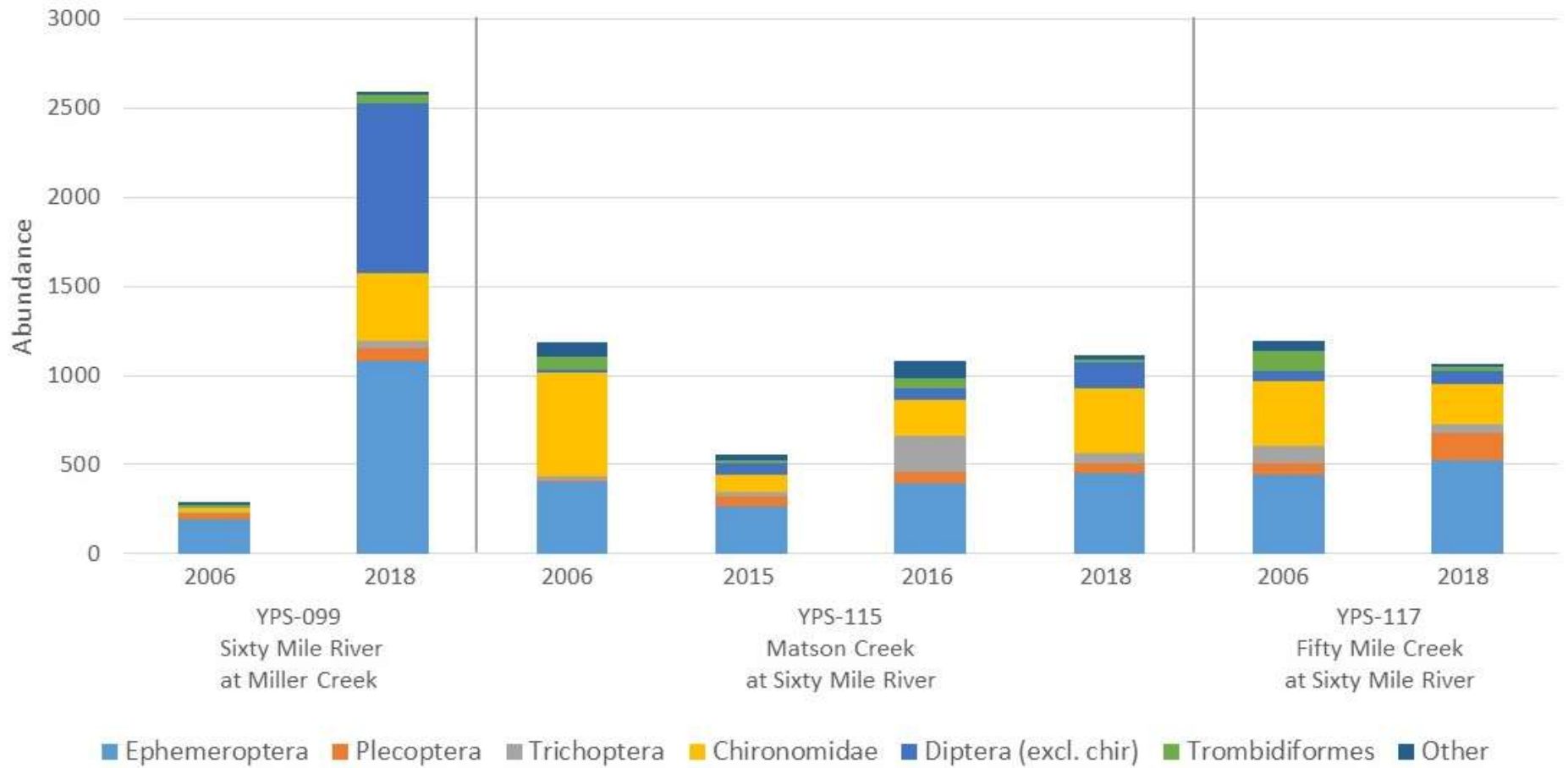


Figure 9. Relative Abundance of Major Taxonomic Groups Identified at Sites in the Sixty Mile River Watershed



3.3.8.4 Sixty Mile River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-099 – Sixty Mile River

This site is located in low suitability habitat and in close proximity to upstream active and historic placer mining.

High abundance was observed at this site in 2018 compared to sampling in 2006. Richness was similar to the mean richness from reference sites. The community was primarily composed of ephemeropterans; however there were large number of dipterans from the family Simuliidae (black flies) identified in 2018 as well.

This site is not considered a high priority for re-sampling.

YPS-115 – Matson Creek

This site is located in an area of special consideration for cultural reasons and is well downstream of placer activity.

Similar abundance, richness and relative abundance of major taxonomic groups were observed in 2018 compared to past years at this site.

This site has been identified as an area of special consideration and is considered a high priority for re-sampling.

YPS-117 – Fifty Mile Creek

This site is located in moderate-low suitability habitat and approximately 12 km downstream of active placer mining.

Invertebrate abundance in 2018 was similar to the past sampling event in 2006. Richness was fairly high and the community was made up of primarily Ephemeroptera and Chironomidae.

This site is considered a high priority for re-sampling given the increase in placer mining in this watershed, the habitat suitability, and the limited number of existing samples for this site.

3.3.9 Stewart River Watershed

The following section presents the site assessment results for three sites sampled in the Stewart River Watershed. Six years of data were available for Black Hills Creek (YPS-428). Four years of data were available for Barker Creek (YPS-432) and five years of data were available for Brewer Creek (YPS-433). The test site evaluation focused on the 2018 sampling results.

3.3.9.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Stewart River Watershed are provided in Appendix B3 Table, 3-9.

Brewer Creek is a fourth order stream with an enclosed canopy cover (76 to 100% enclosed). Dominant substrate in Brewer Creek is pebble and the substrate is generally 50 to 75 % embedded in the streambed. Black Hills Creek is also a fourth order stream with a more open canopy coverage and silt or sand dominant substrate. Barker Creek is a fifth order stream with generally coarser substrate (cobble/pebble dominant).

3.3.9.2 Degree of Placer Mining Development

Placer mining development at sites sampled in the Stewart River Watershed was estimated to range from low to high depending on the creek (Table 17).

Table 19. Degree of Placer Mining Development at Sites Sampled in the Stewart River Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Black Hills Creek	YPS-428	High	15.0	12.0	
Barker Creek	YPS-432	High	6.0	0.0	Old working
Brewer Creek	YPS-433	Low	2.0	1.5	Single operation. Limited old workings.

3.3.9.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 20. Relative abundance of major taxonomic groups is provided in Figure 10.

Table 20. Benthic Invertebrate Community Metrics in the Stewart River Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Black Hills Creek	YPS-428	2010	11	2	0.48	0.96	40	60	0
		2013	13	2	0.14	0.58	92	8	0
		2014	72	8	0.66	0.37	31	54	10
		2015	26	6	0.71	0.58	36	52	8
		2017	24	5	0.64	0.56	54	42	4
		2018	27	4	0.63	0.68	52	20	0
Barker Creek	YPS-432	2010	16	6	0.75	0.66	40	7	20
		2011	226	9	0.71	0.39	48	10	30
		2013	390	10	0.71	0.34	11	42	40
		2018	1995	13	0.52	0.16	2	63	3
Brewer Creek	YPS-433	2010	224	6	0.64	0.46	13	54	25
		2013	227	9	0.64	0.31	10	57	20
		2014	166	10	0.74	0.39	34	20	36
		2017	189	9	0.70	0.37	26	44	24
		2018	71	10	0.69	0.33	16	23	5

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)



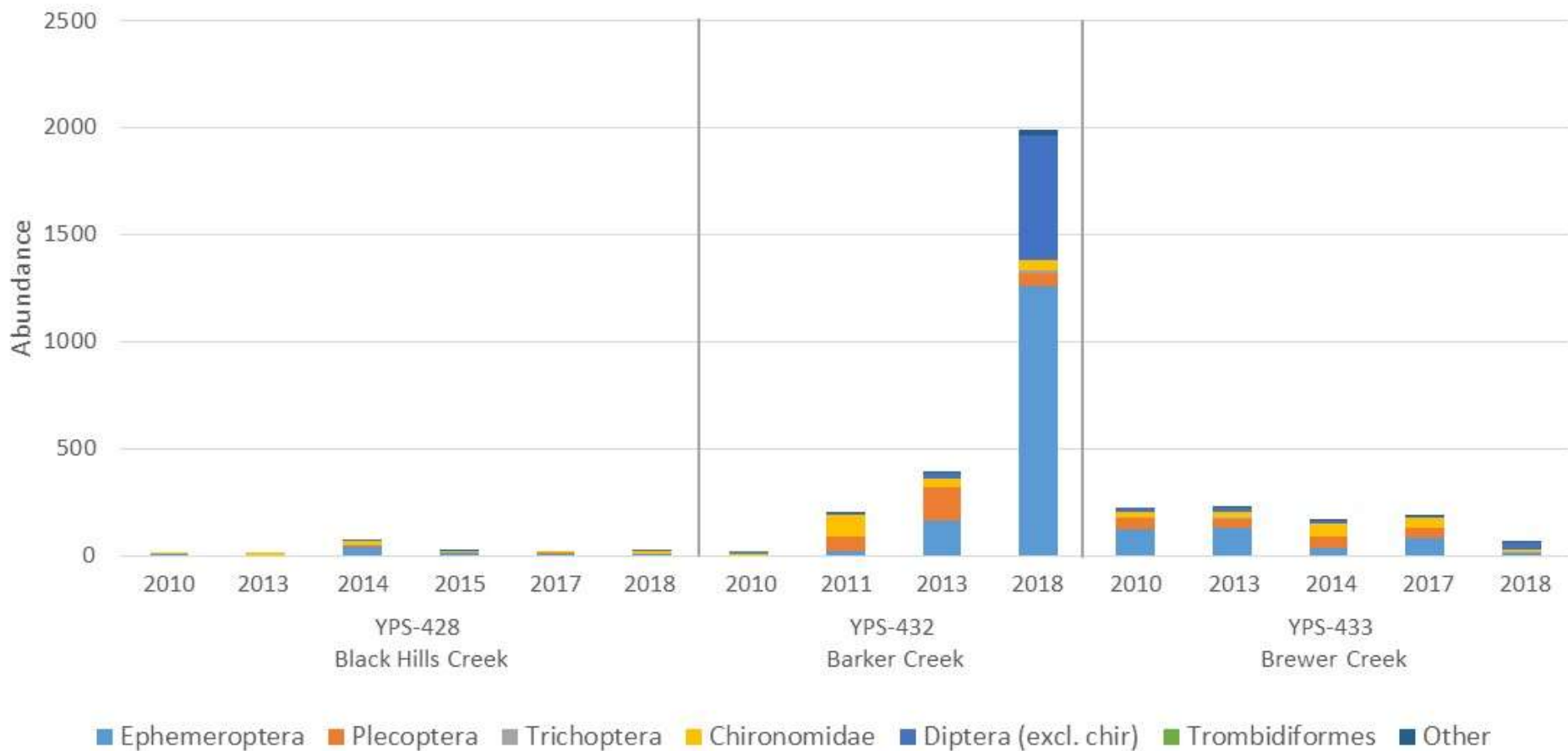


Figure 10. . Relative Abundance of Major Taxonomic Groups Identified at Sites in the Stewart River Watershed



3.3.9.4 Stewart River Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-428 – Black Hills Creek

This moderate-high suitability site is located at the mouth of Black Hills Creek and is downstream of both historic and active placer mining.

Abundance and richness have been consistently low in all sampling years at this location. The majority of the community is made up of Chironomidae. The community composition in Black Hills Creek is different compared to what is typically observed at reference sites in the area. Differences could be related to the dominant substrate type, which is made up primarily of fines and could contribute to differences in invertebrate community composition at this site.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-432 – Barker Creek

This site is located in moderate-moderate suitability habitat and immediately downstream of historic placer mining.

A large increase in abundance was observed in 2018 compared to past years. The community was made up primarily of families from the Order Ephemeroptera. A large number of dipterans from the family Simuliidae (black flies) were also identified.

This site was visited in 2018 due to an anticipated increase in placer activity and therefore provides a baseline for future monitoring. Until such time as activity increases this site is considered a low priority for re-sampling.

YPS-433 – Brewer Creek

This moderate-moderate habitat suitability site is located at the mouth of Brewer Creek and downstream of active placer mining. In 2018, invertebrate abundance was lower

compared to past years with only 71 individuals identified. Richness was similar to past years.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

3.3.10 Yukon River North Watershed

The following section presents the site assessment results for two sites sampled in the Yukon River North Watershed. Five years of data were available for Henderson Creek (YPS-153). Two years of data were available for Rosebute Creek (YPS-159). The test site evaluation focused on the 2018 sampling results.

3.3.10.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Yukon River North Watershed are provided in Appendix B3 Table, 3-10.

Henderson and Rosebute creeks were generally similar in habitat characteristics. Henderson Creek is a fifth order stream with gravel and pebble as the dominant streambed substrate. Rosebute Creek is a fourth order stream and the dominant substrate type was variable between the two years (ranging from sand to cobble dominant).

3.3.10.2 Degree of Placer Mining Development

Placer mining development at sites sampled in the Yukon River North Watershed was estimated to range from low to high depending on the creek (Table 21).

Table 21. Degree of Placer Mining Development at Sites Sampled in the Yukon River North Watershed

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Henderson Creek	YPS-153	High	0.0	unknown	Site is within developed area. Intense development immediately upstream. Old and new development upstream of that.
Rosebute Creek	YPS-159	Low	9.0	unknown	

3.3.10.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 22. Relative abundance of major taxonomic groups is provided in Figure 11.

Table 22. Benthic Invertebrate Community Metrics in the Yukon River North Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Henderson Creek	YPS-153	2006	92	6	0.66	0.49	0	50	34
		2009	155	11	0.71	0.31	28	48	10
		2010	245	13	0.82	0.43	21	28	20
		2014	94	11	0.66	0.27	8	53	28
		2018	228	11	0.56	0.21	25	63	6
Rosebute Creek	YPS-159	2006	316	10	0.79	0.48	11	27	2
		2018	2147	11	0.47	0.17	16	72	1

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)



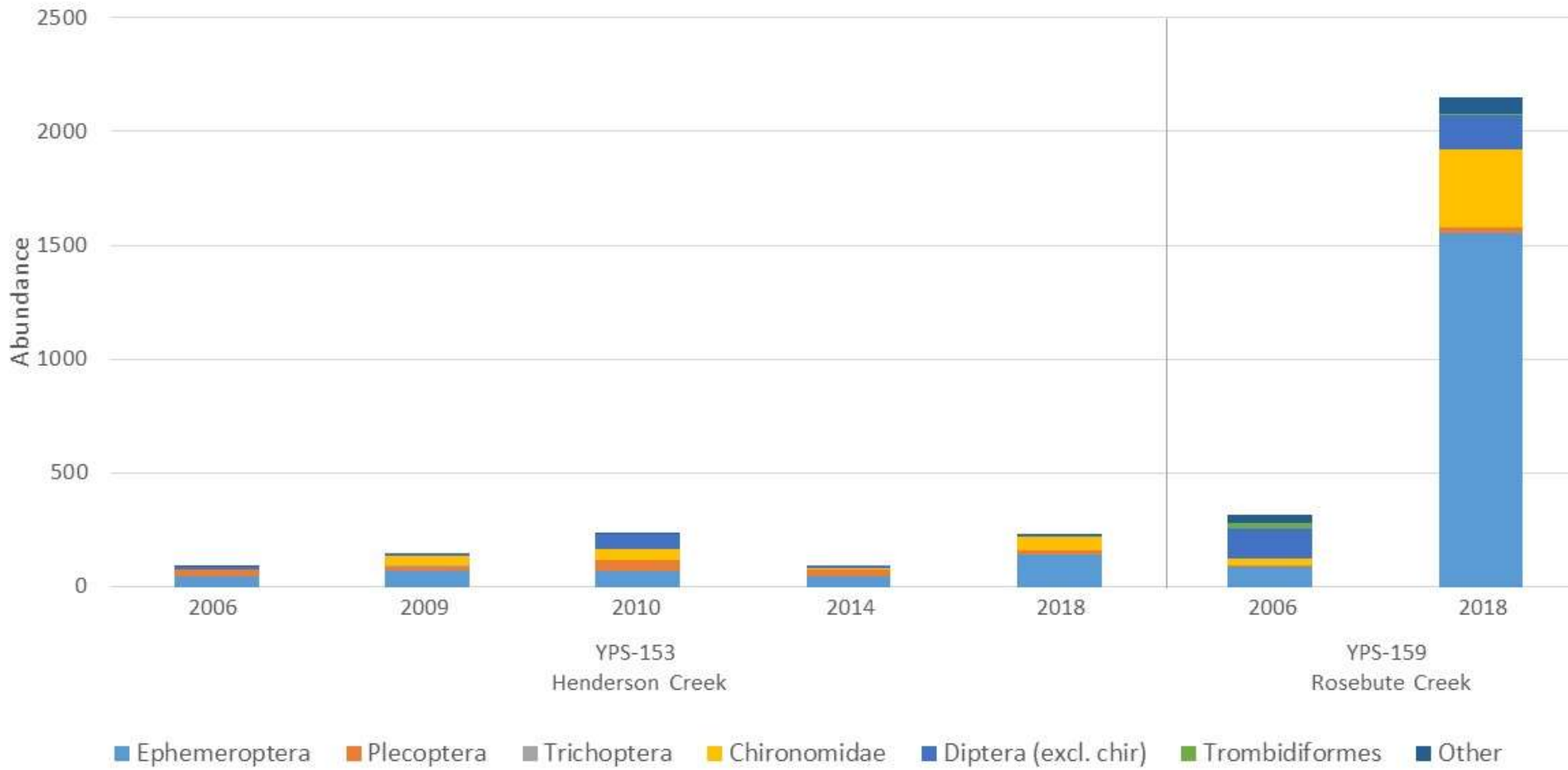


Figure 11. Relative Abundance of Major Taxonomic Groups Identified at Sites in the Yukon River North Watershed



3.3.10.4 Yukon River North Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below.

YPS-153 – Henderson Creek

This moderate-high habitat suitability site is located in an area of high placer mining activity.

The site has low invertebrate abundance compared to reference sites but abundance in 2018 is generally similar to what has been observed during past years. Richness was also similar to past years and the site had a high relative abundance of Ephemeroptera.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

YPS-159 – Rosebute Creek

This moderate-high suitability site is located near the mouth of Rosebute Creek just upstream from the confluence with the Yukon River.

A large increase in abundance was observed in 2018 compared to past sampling event in 2006. Richness was similar to past years. The site had a high relative abundance of families from the order Ephemeroptera.

This site is considered a high priority for re-sampling given the placer mining activity in this watershed, the habitat suitability, and the limited number of existing samples for this site.

3.3.11 Yukon River South Watershed

The following section presents the site assessment results for two sites sampled in the Yukon River South Watershed. Eight years of long term monitoring data were available

for Thistle Creek (YPS-164). The test site evaluation focused on the 2018 sampling results.

3.3.11.1 Habitat Characteristics

Habitat characteristics measured on creeks in the Yukon River South Watershed are provided in Appendix B3 Table, 3-11.

Thistle Creek is a fifth order stream with dominant substrate type generally made up of cobble or pebble.

3.3.11.2 Degree of Placer Mining Development

Placer mining development at the site sampled in the Yukon River South Watershed was estimated be high (Table 19).

Table 23. Degree of Placer Mining Development at Sites Sampled in the Yukon River South Watershed.

Name	Site	Degree of Placer Mining (low, mod, high)	Upstream Distance to Active (within 2 years) Mining Development (km)	Upstream Distance to old (older than 2 years) Mining Development (km)	Comments
Thistle Creek	YPS-164	High	8.0	0.0	Not active at the time of 2018 site visit

3.3.11.3 Benthic Invertebrate Community Composition

Benthic invertebrate community metrics are provided in Table 24. Relative abundance of major taxonomic groups is provided in Figure 12.

Table 24. Benthic Invertebrate Community Metrics in the Yukon River South Watershed.

Creek Name	Site	Year	Total Abundance	Family Richness	SDI	SEI	% C	% E	% P
Thistle Creek	YPS-164	2006	220	8	0.68	0.39	49	28	10
		2012	136	13	0.56	0.17	64	18	7
		2013	55	6	0.55	0.37	62	24	2
		2014	517	15	0.43	0.12	18	73	2
		2015	303	11	0.22	0.12	3	89	4
		2016	273	14	0.61	0.19	32	55	3
		2017	636	9	0.63	0.30	49	37	1
		2018	726	12	0.30	0.12	3	90	2

Notes: SDI = Simpson's Diversity Index; SEI = Simpson's Evenness; C = Chironomidae (non-biting midges); E = Ephemeroptera (Mayflies); P = Plecoptera (stoneflies)



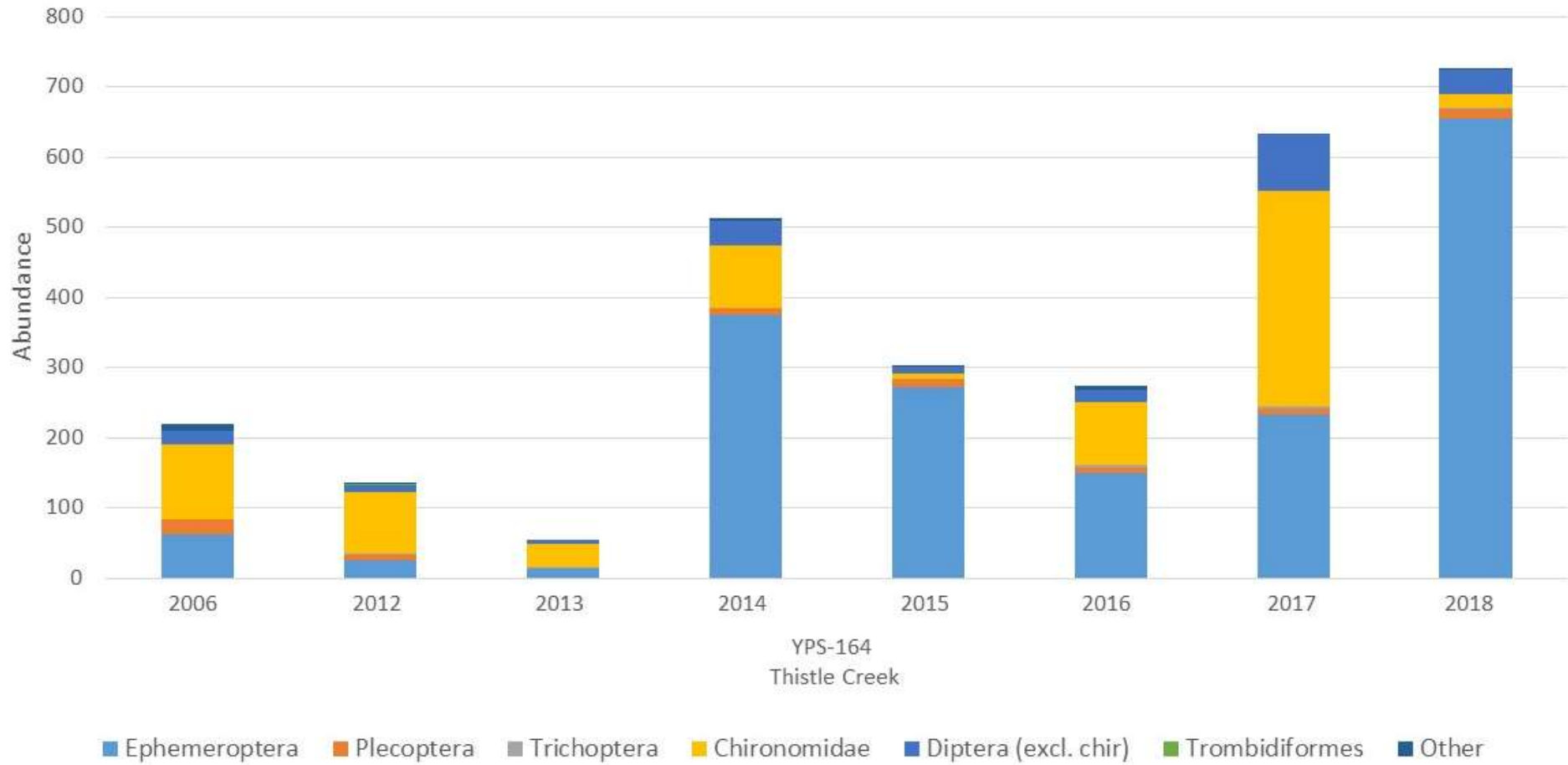


Figure 12. . Relative Abundance of Major Taxonomic Groups Identified at Sites in the Yukon River South Watershed



3.3.11.4 Yukon River South Test Site Discussion

An assessment of the overall site results and the priority for re-sampling the site is provided below

YPS-164 – Thistle Creek

This moderate-high suitability site is located at the mouth of Thistle Creek and downstream of both historic and current placer mining.

The highest total abundance was observed in 2018 and there appears to be an increasing trend in abundance over the last four years. Taxonomic richness in 2018 is similar to past years and similar to the mean richness from the local reference sites.

Given the long term monitoring already undertaken at this location, this site is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time.

4 Next Steps

Aquatic health monitoring is being carried out to obtain data to evaluate aquatic health in streams affected by placer mining and to inform sound adaptive management decisions. IMG is currently in the planning phases of a revised aquatic health study design. The updated approach will consider the recommendations provided in the CSAS report. An interim approach to monitoring will be implemented for the 2019 field program until an updated study design is in place.

In order to inform the study design, targeted studies will be carried out to answer key questions to inform a revised study design. The following initiatives are planned:

- Additional replication to assess within site variability
- Improved characterization of stream sediment
- Evaluation of comparability of reference sites based on community composition and physical habitat variables
- Evaluate the suitability of stream periphyton biomass as another potential indicator of placer mining effects.

The long term goal will be to develop a statistically defensible approach to inform the adaptive management process.

•

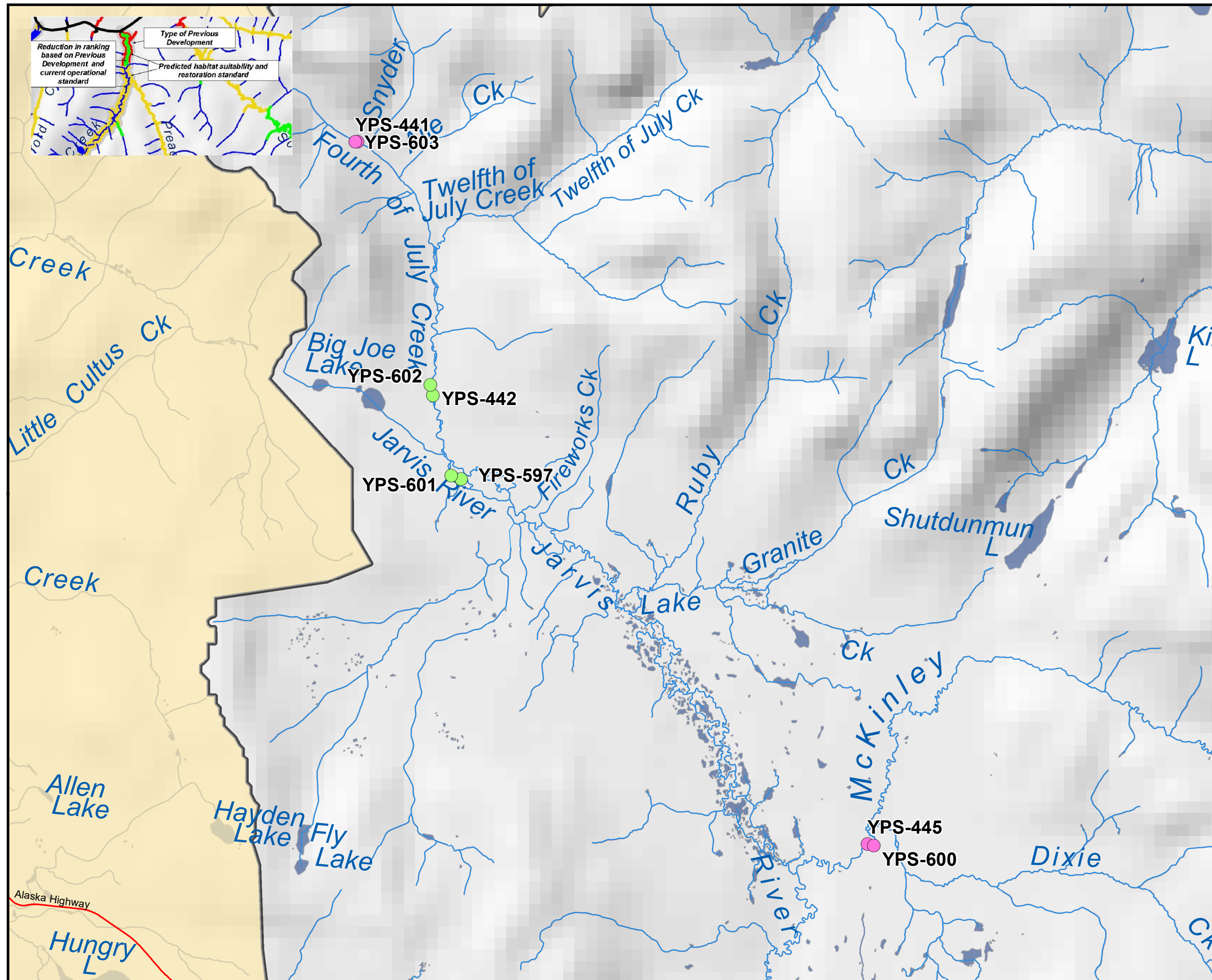
Fish Habitat Management System for Yukon Placer Mining
Aquatic Health Monitoring Program. 2018 Report.

Appendix B1

Maps of Monitoring Locations by Watershed



Alsek River Watershed Aquatic Health Monitoring Sites 2018



Monitoring Sites

- Reference Site
- Test Site

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

Roads

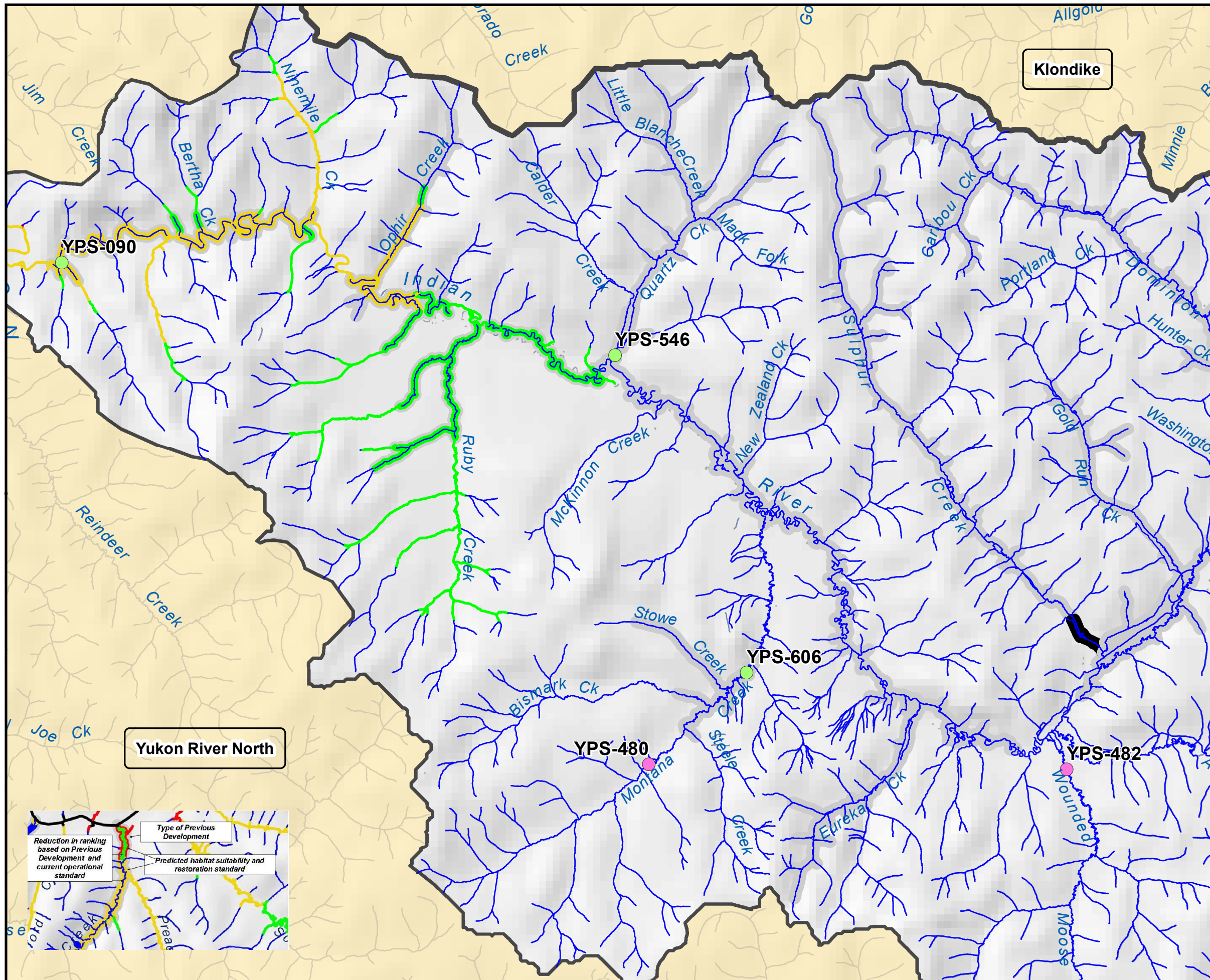
- Highway
- Primary Roads
- Local Roads
- - - Resource / Recreation



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Indian River Watershed Aquatic Health Monitoring Sites 2018



Klondike

Yukon River North

Monitoring Sites

- Reference Site
- Test Site

Stream Reach Classification

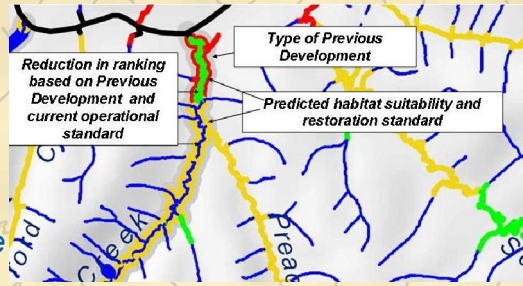
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)



Development

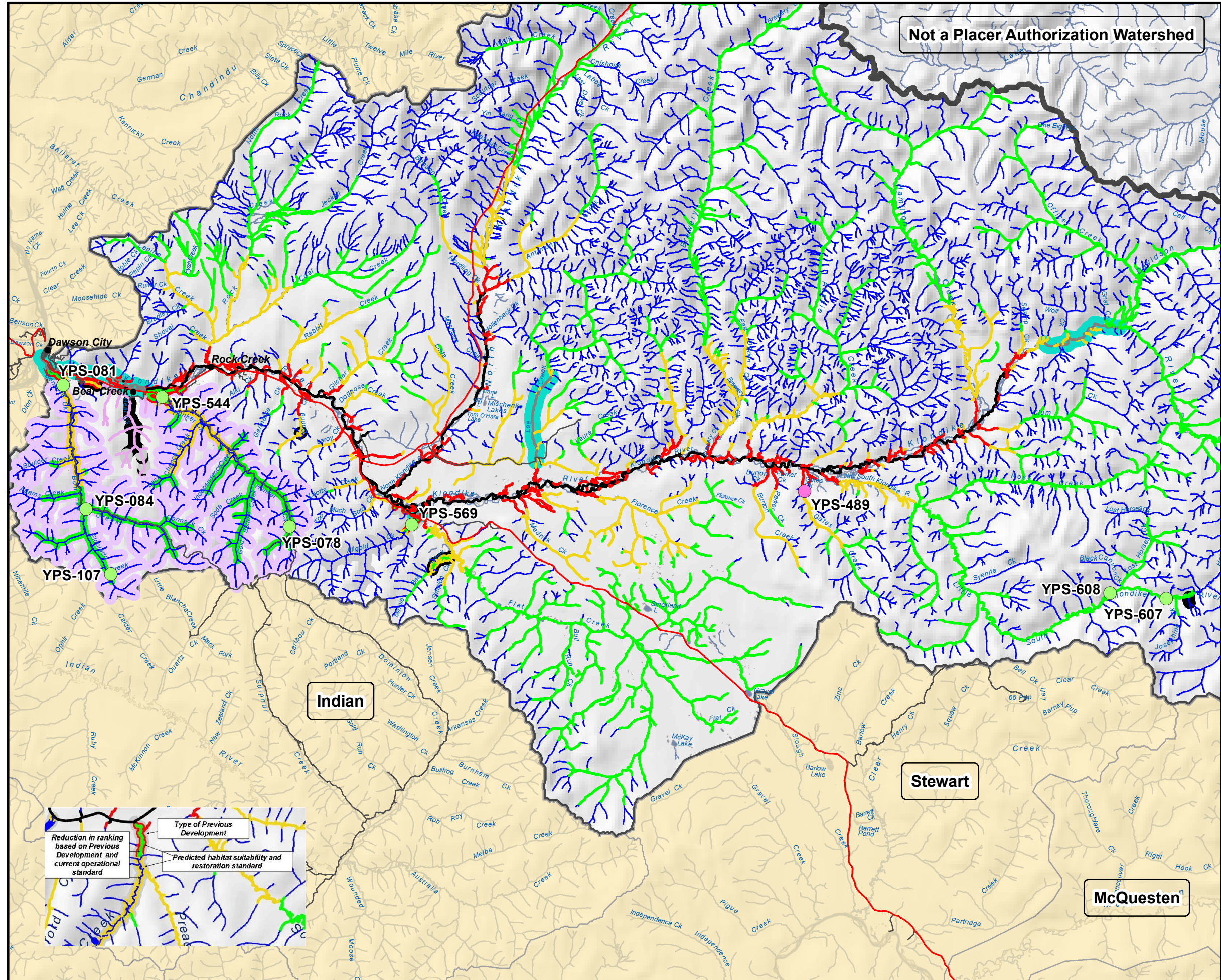
- Current
- Historical
- Extensive

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Klondike River Watershed Aquatic Health Monitoring Sites 2018

Not a Placer Authorization Watershed



Monitoring Sites

- Reference Site
- Test Site

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

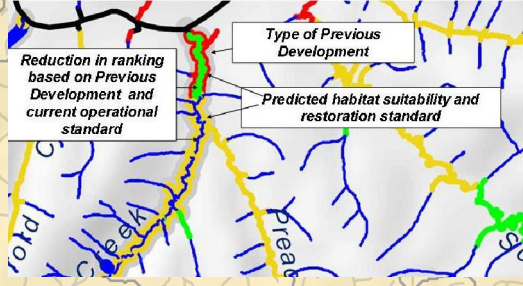
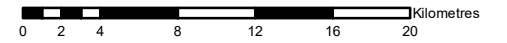
- Current
- Historical
- Extensive

Roads

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

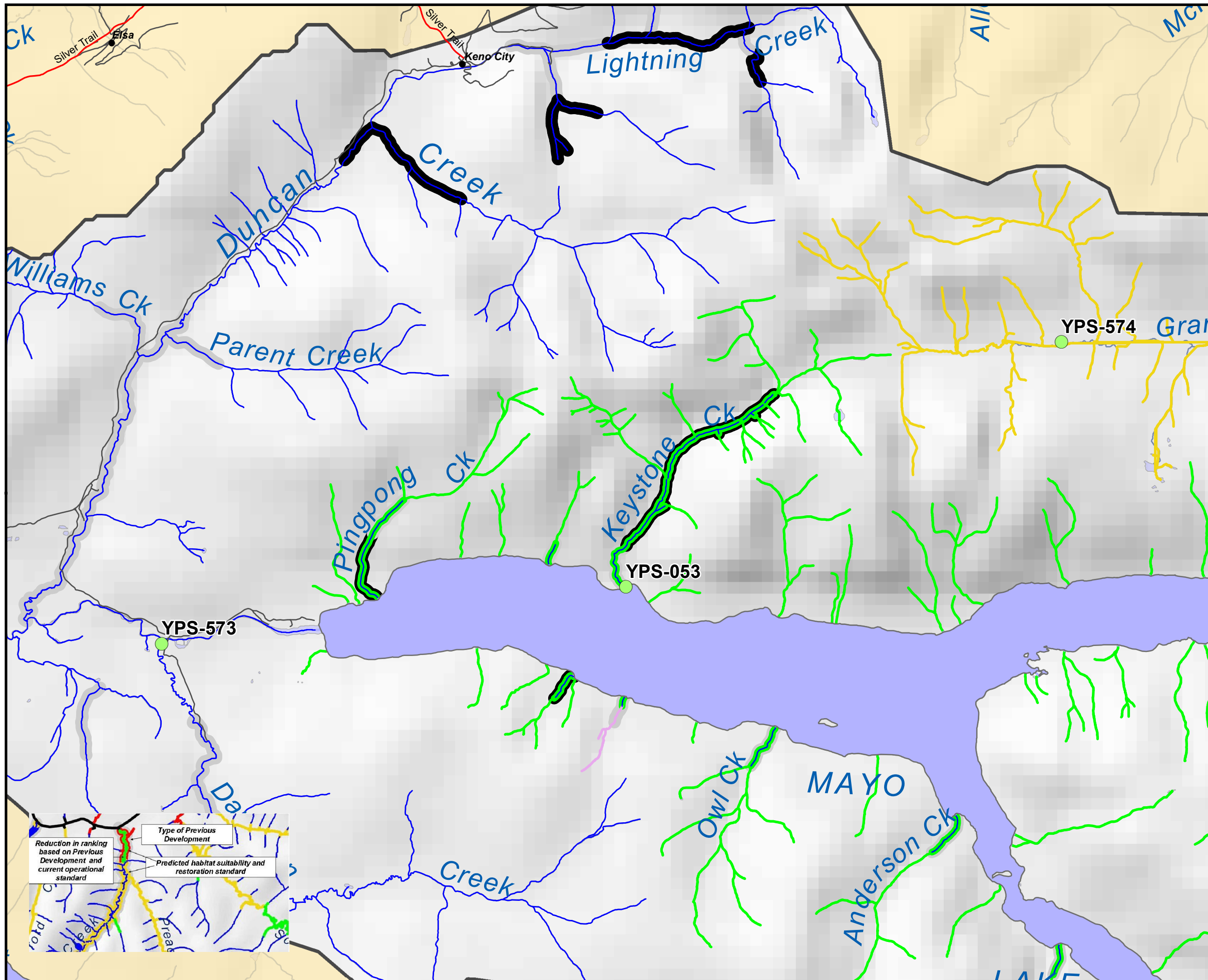


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McQuesten

Mayo Lake Watershed Aquatic Health Monitoring Sites 2018



Monitoring Sites

- Reference Site
- Test Site

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

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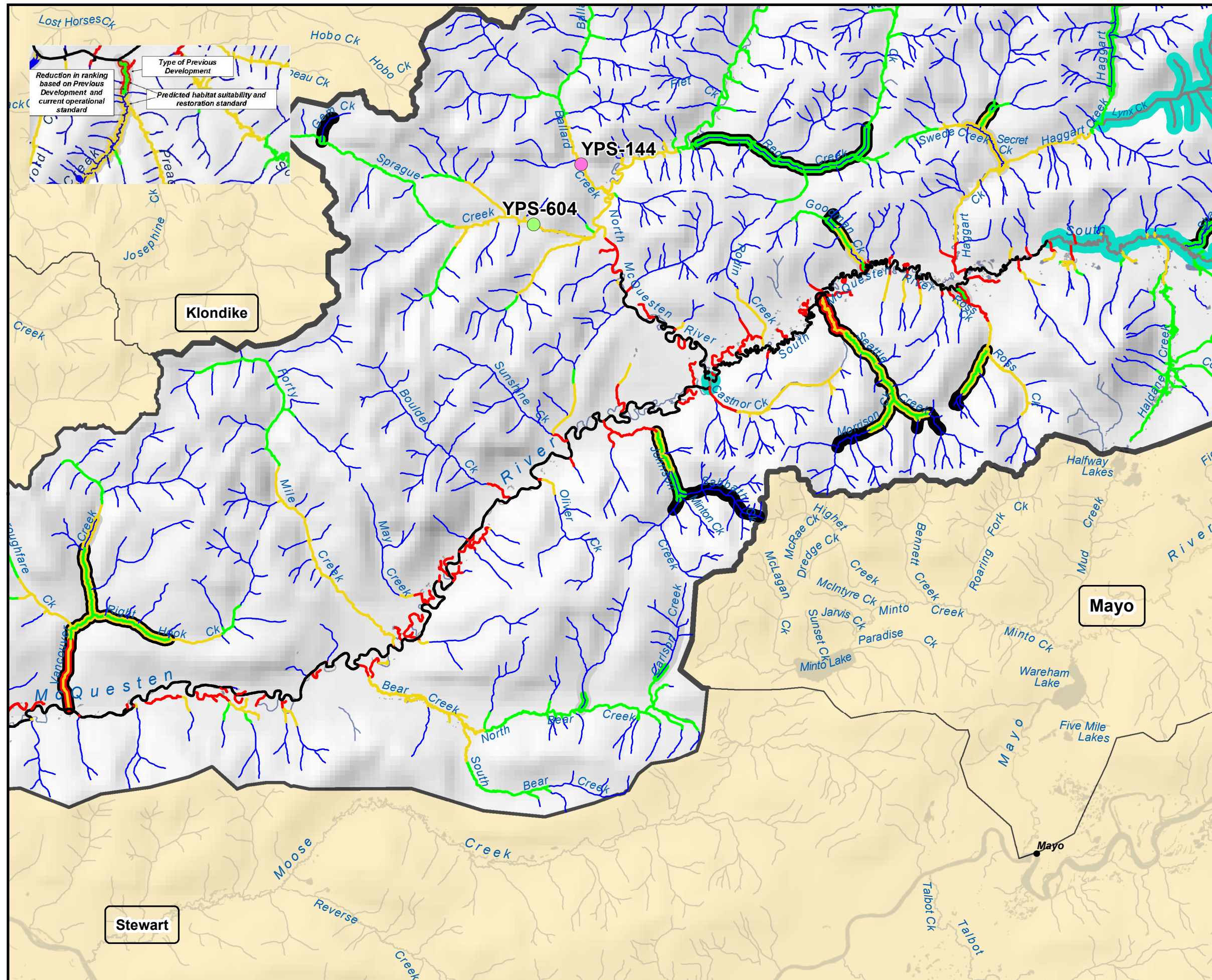
Reduction in ranking based on Previous Development and current operational standard

Type of Previous Development

Predicted habitat suitability and restoration standard



McQuesten River Watershed Aquatic Health Monitoring Sites 2018



Reduction in ranking based on Previous Development and current operational standard

Type of Previous Development

Predicted habitat suitability and restoration standard

Monitoring Sites

- Reference Site
- Test Site

Stream Reach Classification

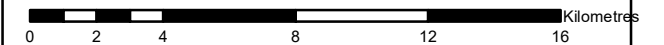
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)



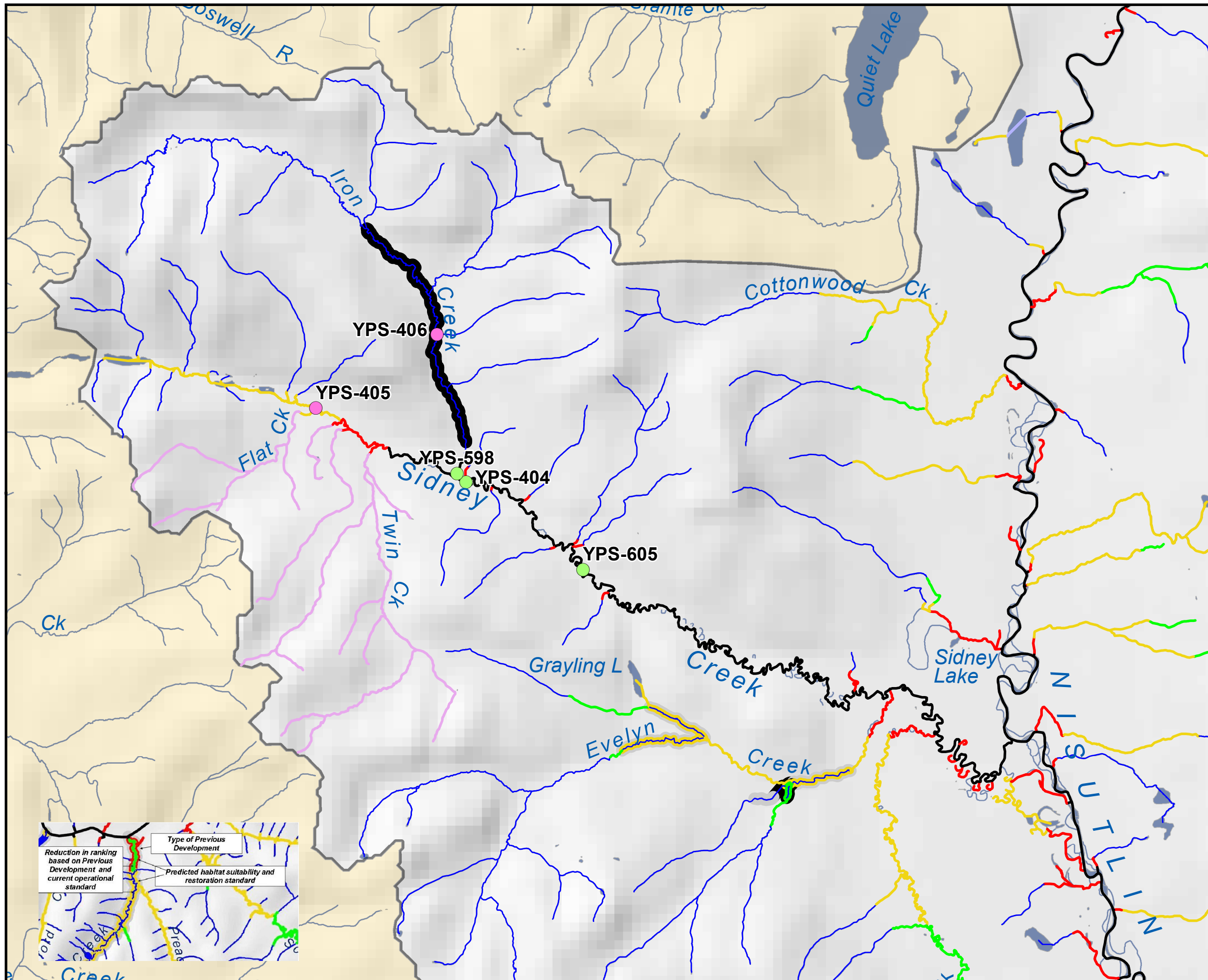
Development

- Current
- Historical
- Extensive

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Nisutlin River Watershed Aquatic Health Monitoring Sites 2018



Monitoring Sites

- Reference Site
- Test Site

Stream Reach Classification

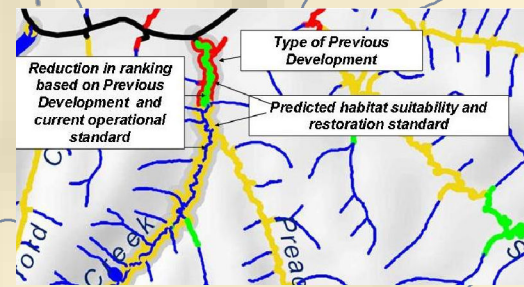
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)



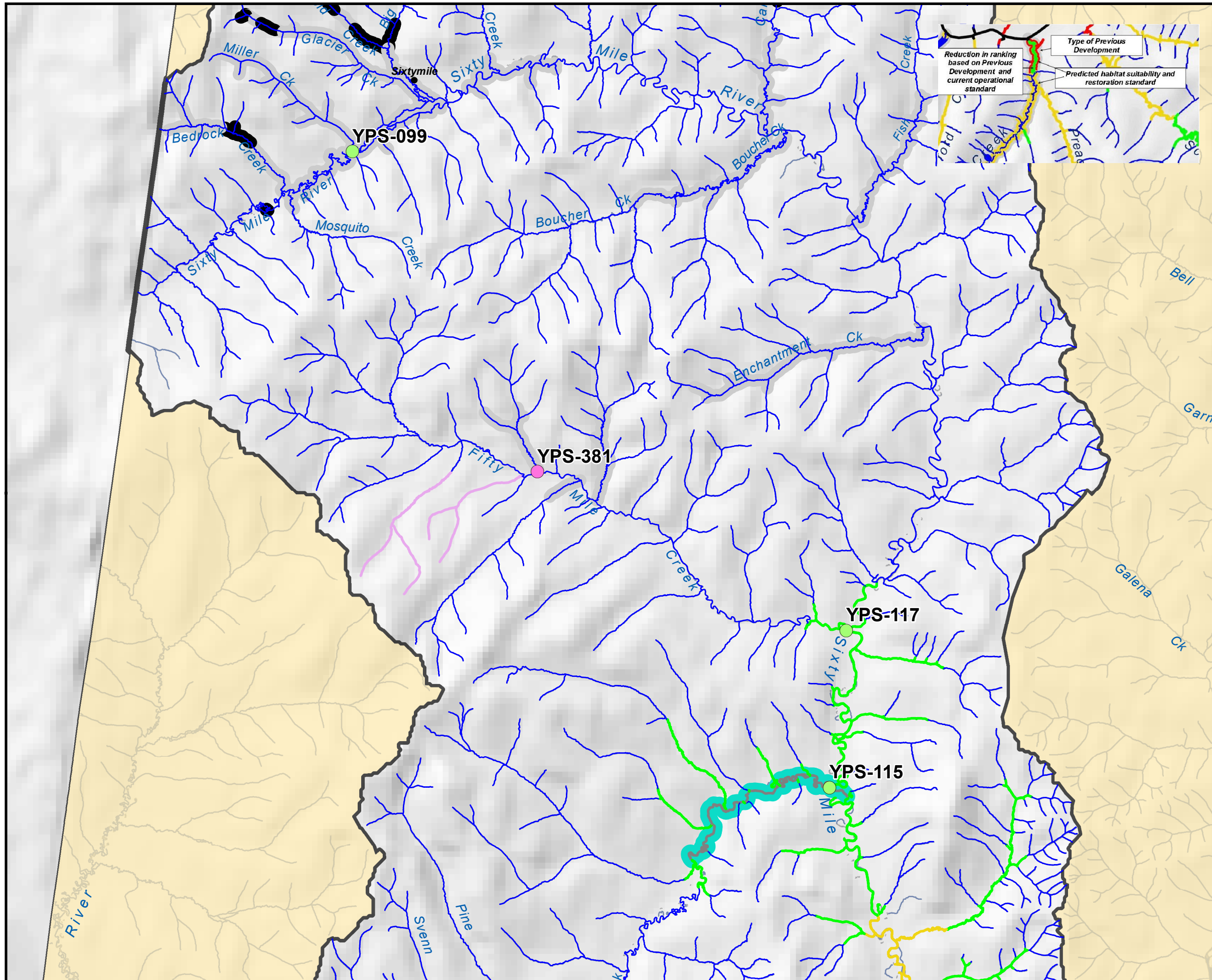
Development

- Current
- Historical
- Extensive

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Sixty Mile River Watershed Aquatic Health Monitoring Sites 2018



Monitoring Sites

- Reference Site
- Test Site

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)

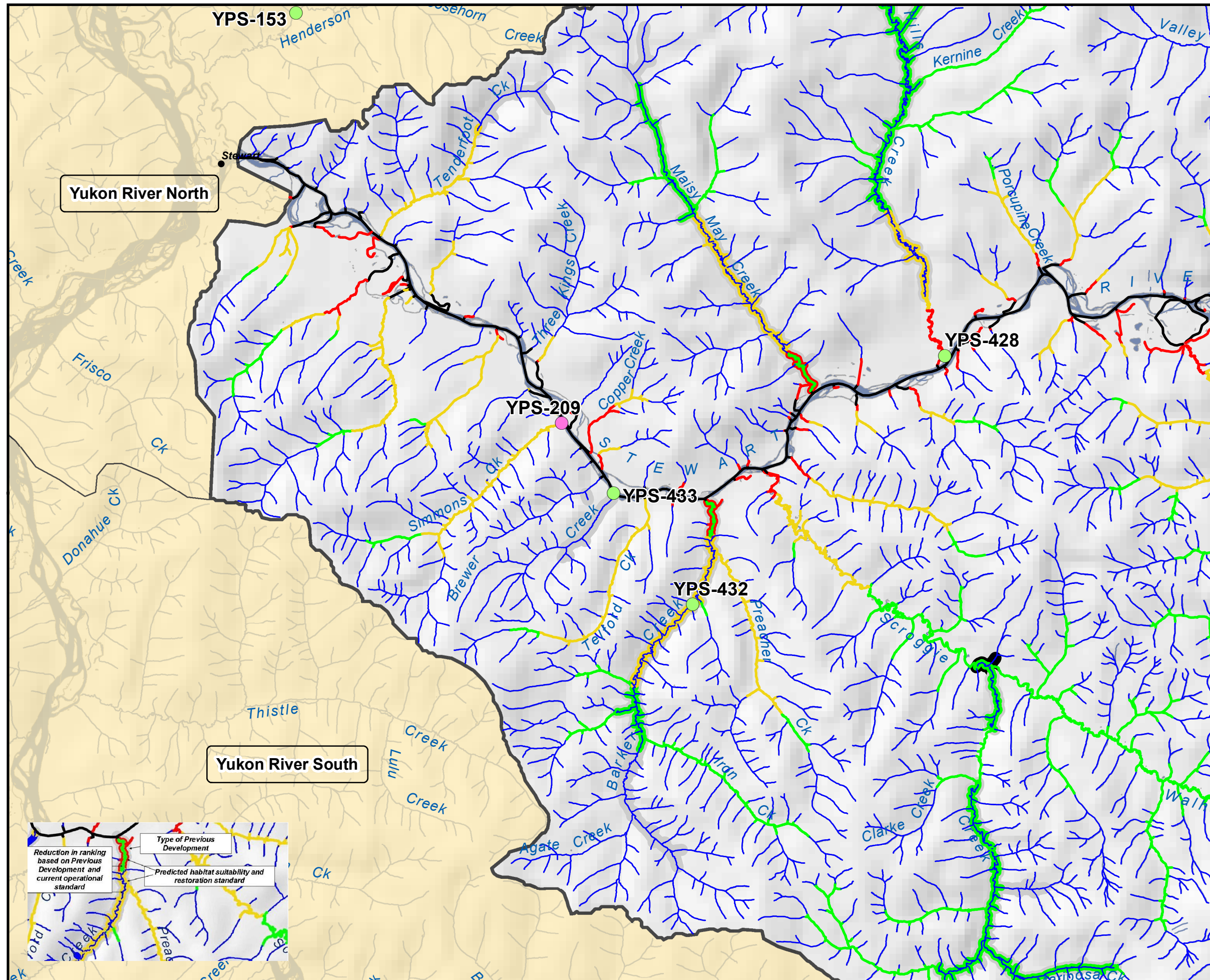
Development

- Current
- Historical
- Extensive

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Stewart River Watershed Aquatic Health Monitoring Sites 2018



Monitoring Sites

- Reference Site
- Test Site

Stream Reach Classification

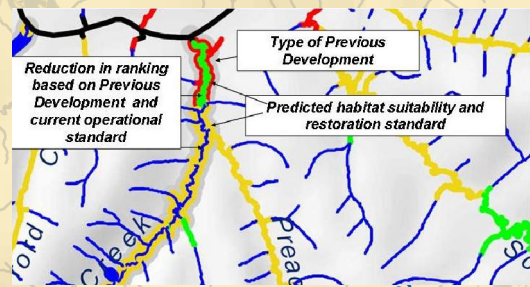
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)



Development

- Current
- Historical
- Extensive

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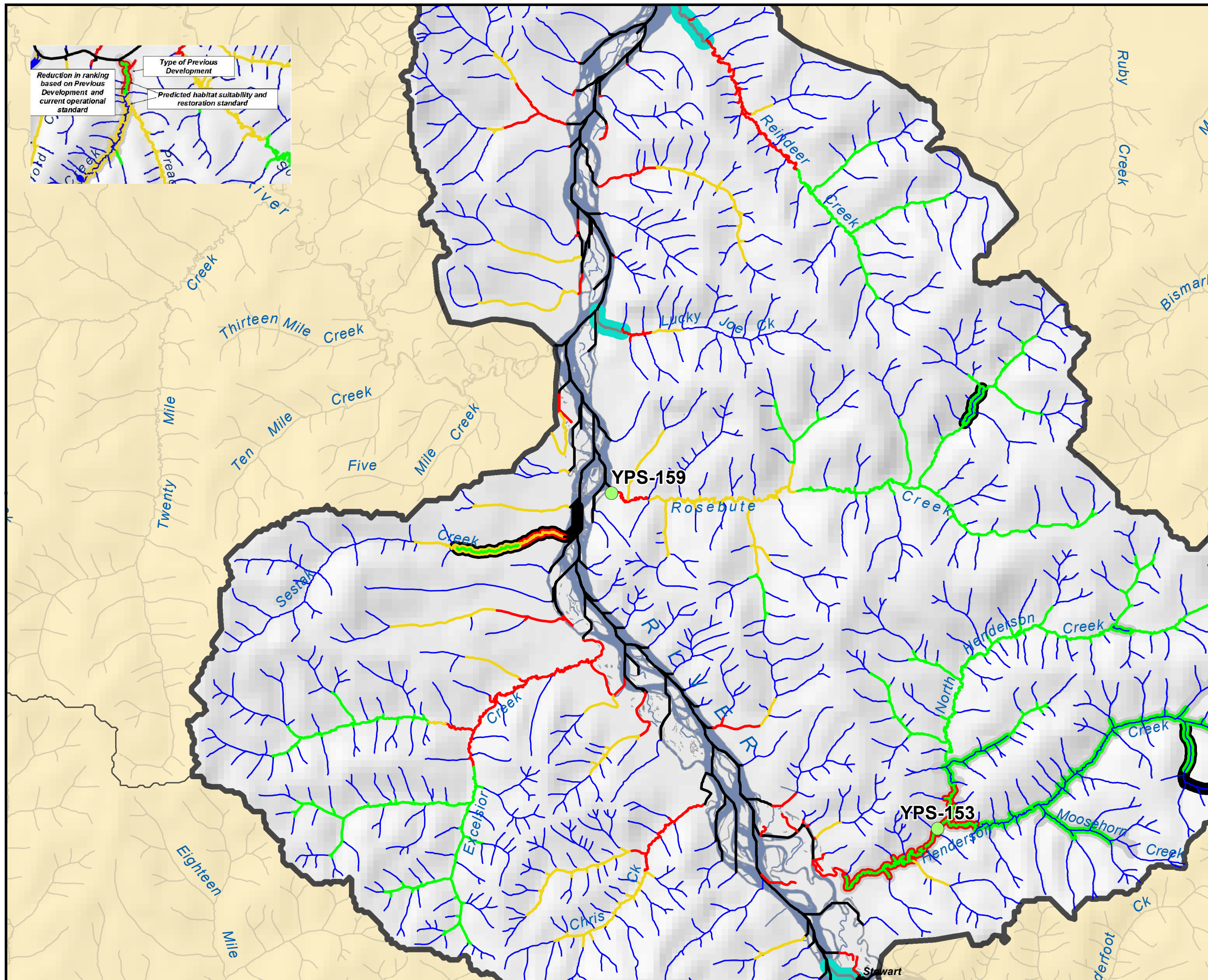


Yukon River North Watershed Aquatic Health Monitoring Sites 2018

Reduction in ranking based on Previous Development and current operational standard

Type of Previous Development

Predicted habitat suitability and restoration standard



Monitoring Sites

- Reference Site
- Test Site

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)



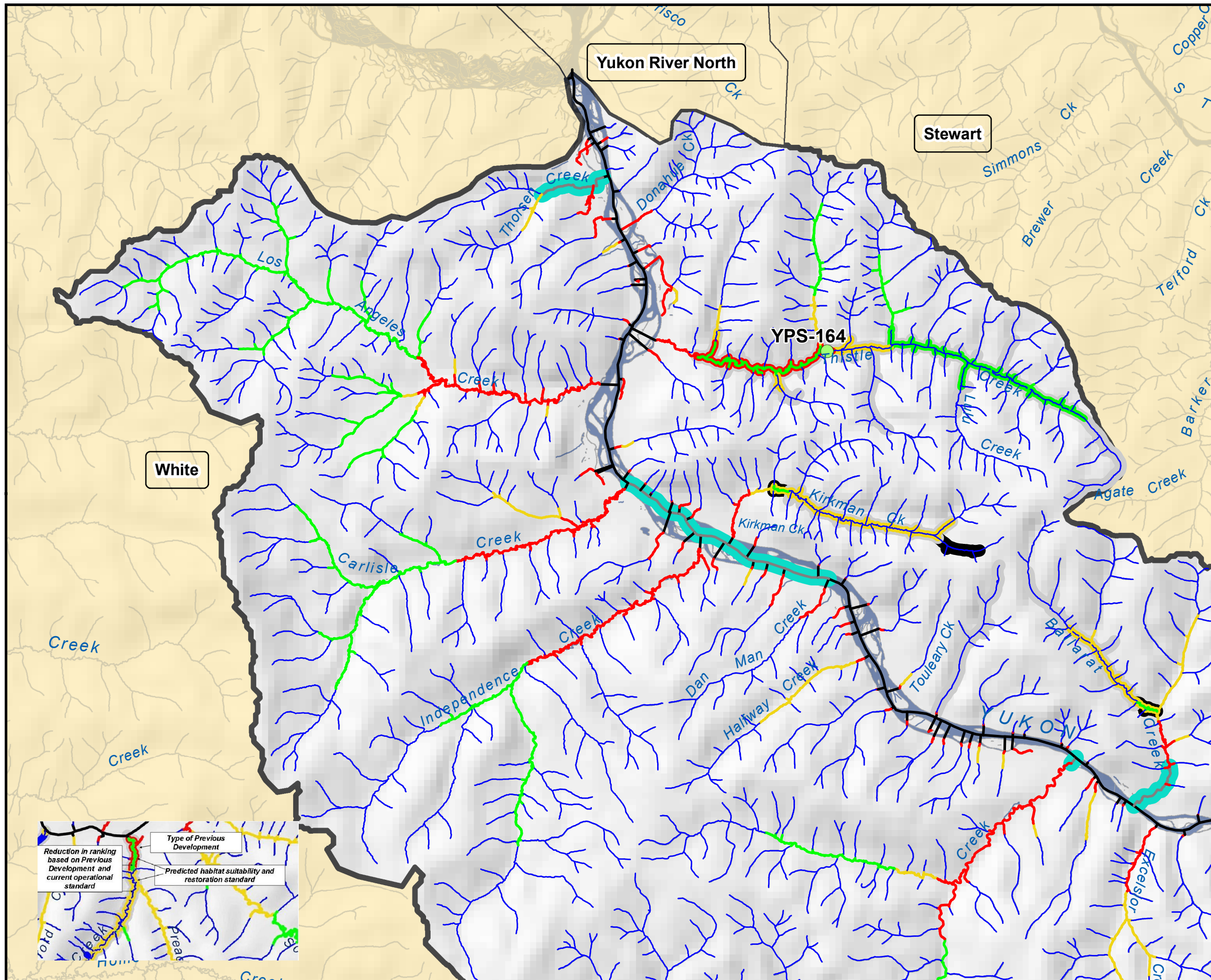
Development

- Current
- Historical
- Extensive

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Yukon River South Watershed Aquatic Health Monitoring Sites 2018



Monitoring Sites

- Reference Site
- Test Site

Stream Reach Classification

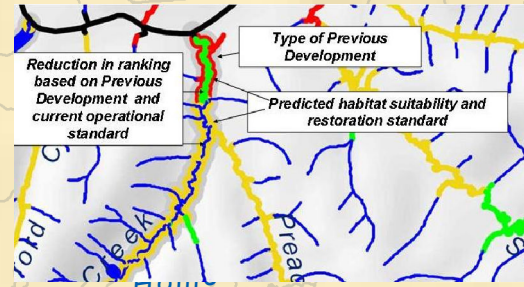
- Water Quality
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)



Development

- Current
- Historical
- Extensive

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Fish Habitat Management System for Yukon Placer Mining
Aquatic Heath Monitoring Program. 2018 Report.

Appendix B2

CABIN Reports for 2018 Sampling



Site Description

Study Name	Yukon Territory - AHM
Site	YPS-441
Sampling Date	Jul 17 2018
Know Your Watershed Basin	Alsek
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Ruby Ranges EcoRegion
Coordinates (decimal degrees)	61.19205 N, 138.09311 W
Altitude	1161
Local Basin Name	4th of July Creek
	Alsek
Stream Order	3



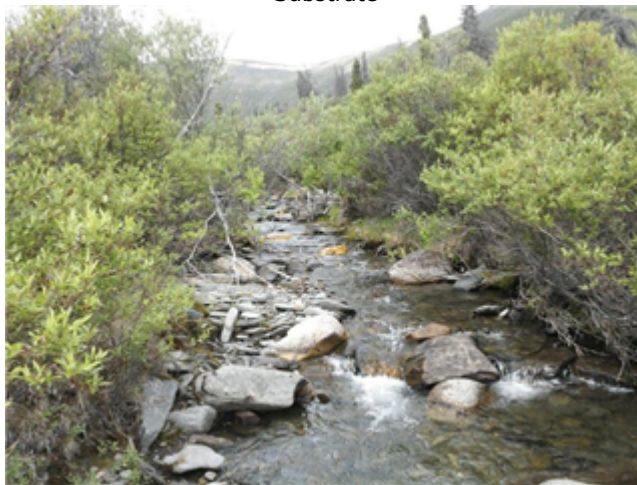
Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-441	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	27.9	
% Ephemeroptera	40.4	
% Plecoptera	7.1	
Total Abundance	4814.3	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.4	
Total No. of Taxa	12.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-442
Sampling Date	Jul 17 2018
Know Your Watershed Basin	Alsek
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Ruby Ranges EcoRegion
Coordinates (decimal degrees)	61.13369 N, 138.04436 W
Altitude	956
Local Basin Name	4th of July Creek (lower)
	Alsek
Stream Order	3



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-442	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	24.7	
% Ephemeroptera	53.2	
% Plecoptera	6.5	
Total Abundance	1705.0	
Richness		
Simpson's Diversity	0.7	
Simpson's Evenness	0.3	
Total No. of Taxa	11.0	

Site Description

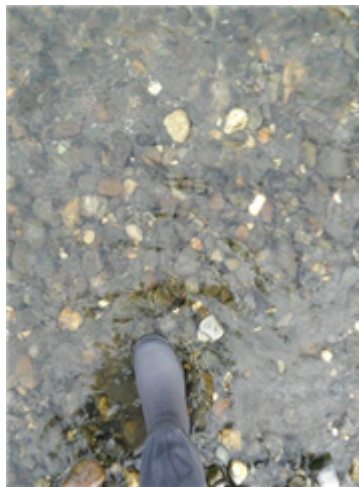
Study Name	Yukon Territory - AHM
Site	YPS-445
Sampling Date	Jul 17 2018
Know Your Watershed Basin	Alsek
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Ruby Ranges EcoRegion
Coordinates (decimal degrees)	61.03664 N, 137.81393 W
Altitude	878
Local Basin Name	McKinley Creek
	Alsek
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-445	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	16.6	
% Ephemeroptera	57.3	
% Plecoptera	4.0	
Total Abundance	1745.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.4	
Total No. of Taxa	13.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-597
Sampling Date	Jul 17 2018
Know Your Watershed Basin	Alsek
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Ruby Ranges EcoRegion
Coordinates (decimal degrees)	61.11447 N, 138.02698 W
Altitude	931
Local Basin Name	Jarvis River
	Alsek
Stream Order	5



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-597	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	31.4	
% Ephemeroptera	50.9	
% Plecoptera	10.1	
Total Abundance	2056.3	
Richness		
Simpson's Diversity	0.7	
Simpson's Evenness	0.3	
Total No. of Taxa	13.0	

Site Description

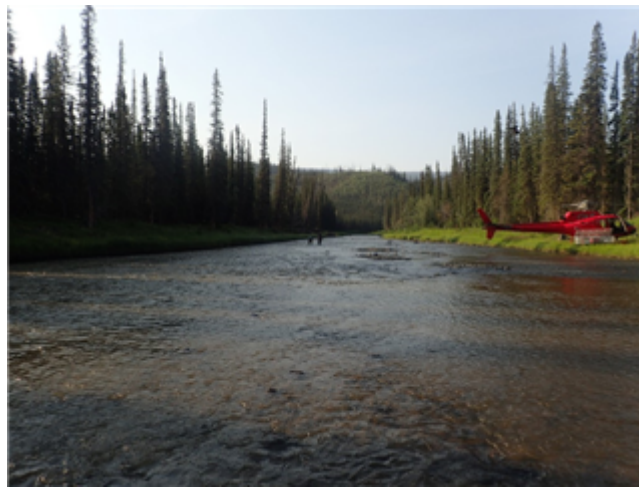
Study Name	Yukon Territory - AHM
Site	YPS-090
Sampling Date	Jul 25 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.76944 N, 139.63000 W
Altitude	366
Local Basin Name	Indian Rive at Water Resources Station
	Indian River
Stream Order	6



Across Reach



Aerial



Down Stream



Substrate



Up Stream

Metrics

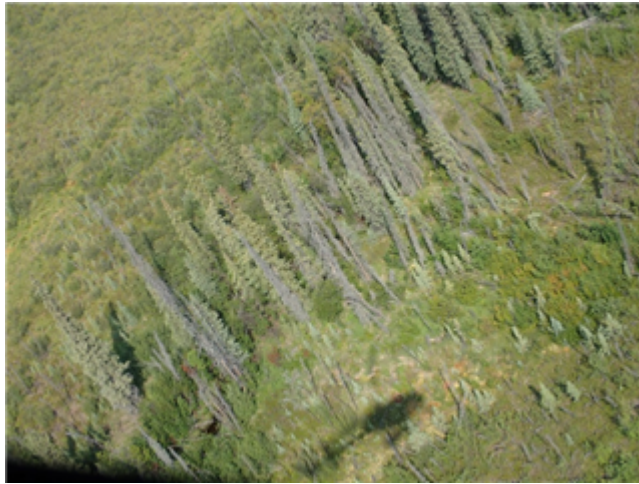
Name	YPS-090	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	35.1	
% Ephemeroptera	9.9	
% EPT Individuals	26.7	
% Plecoptera	1.2	

Metrics

Name	YPS-090	Predicted Group Reference Mean \pmSD
Total Abundance	1015.6	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	15.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-480
Sampling Date	Jul 25 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.59319 N, 139.05441 W
Altitude	568
Local Basin Name	Montana Creek
	Indian River
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-480	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	12.9	
% Ephemeroptera	42.1	
% Plecoptera	6.4	
Total Abundance	2486.7	
Richness		
Simpson's Diversity	0.7	
Simpson's Evenness	0.4	
Total No. of Taxa	8.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-482
Sampling Date	Jul 25 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.60792 N, 138.68036 W
Altitude	537
Local Basin Name	Wounded Moose Creek
	Indian River
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-482	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	9.8	
% Ephemeroptera	76.9	
% Plecoptera	1.8	
Total Abundance	1877.8	
Richness		
Simpson's Diversity	0.4	
Simpson's Evenness	0.2	
Total No. of Taxa	9.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-546
Sampling Date	Jul 27 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.75424 N, 139.12285 W
Altitude	441
Local Basin Name	Quartz Creek Indian River
Stream Order	4



Aerial



Down Stream



Substrate



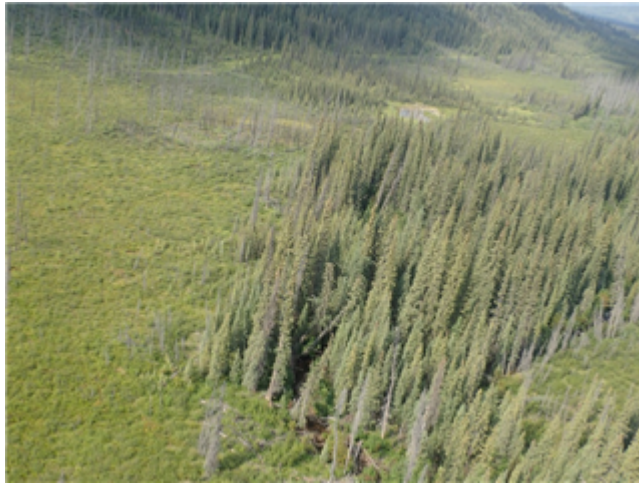
Up Stream

Metrics

Name	YPS-546	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	22.2	
% Ephemeroptera	53.3	
% Plecoptera	0.9	
Total Abundance	1778.9	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.3	
Total No. of Taxa	9.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-606
Sampling Date	Jul 25 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.63361 N, 138.97520 W
Altitude	499
Local Basin Name	Montana Creek
	Indian River
Stream Order	



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-606	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	35.8	
% Ephemeroptera	26.9	
% Plecoptera	7.5	
Total Abundance	71.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.5	
Total No. of Taxa	9.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-078
Sampling Date	Jul 27 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.92250 N, 138.88390 W
Altitude	586
Local Basin Name	Hunker Creek upstream of Ontario Cr.
	Klondike River
Stream Order	3



Down Stream



Up Stream

Metrics

Name	YPS-078	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	12.7	
% Ephemeroptera	73.8	
% Plecoptera	3.4	
Total Abundance	443.0	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.2	

Metrics

Name	YPS-078	Predicted Group Reference Mean \pm SD
Total No. of Taxa	16.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-081
Sampling Date	Jul 24 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	64.03056 N, 139.38861 W
Altitude	332
Local Basin Name	Bonanza Creek at Highway
	Klondike River
Stream Order	4



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-081	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	38.5	
% Ephemeroptera	51.4	
% Plecoptera	7.0	
Total Abundance	2538.5	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.3	
Total No. of Taxa	8.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-084
Sampling Date	Jul 24 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.91972 N, 139.31334 W
Altitude	480
Local Basin Name	Bonanza Creek upstream of Eldorado inflow
	Klondike River
Stream Order	3



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-084	Predicted Group Reference Mean \pmSD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	17.3	
% Ephemeroptera	73.5	
% Plecoptera	5.4	
Total Abundance	1527.3	
Richness		
Simpson's Diversity	0.4	
Simpson's Evenness	0.2	
Total No. of Taxa	8.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-107
Sampling Date	Jul 24 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.86222 N, 139.24667 W
Altitude	616
Local Basin Name	Eldorado Creek top
	Klondike River
Stream Order	2



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-107	Predicted Group Reference Mean \pmSD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	32.5	
% Ephemeroptera	31.8	
% Plecoptera	15.3	
Total Abundance	1882.4	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.4	
Total No. of Taxa	13.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-489
Sampling Date	Jul 27 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.99900 N, 137.81285 W
Altitude	625
Local Basin Name	Gates Creek
	Klondike River
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-489	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	12.2	
% Ephemeroptera	60.8	
% Plecoptera	13.1	
Total Abundance	346.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	16.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-544
Sampling Date	Jul 24 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	64.02940 N, 139.17841 W
Altitude	359
Local Basin Name	Hunker Creek
	Klondike River
Stream Order	4



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-544	Predicted Group Reference Mean \pmSD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	53.8	
% Ephemeroptera	29.8	
% Plecoptera	1.8	
Total Abundance	332.0	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.2	
Total No. of Taxa	13.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-569
Sampling Date	Jul 24 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.93566 N, 138.62846 W
Altitude	475
Local Basin Name	Allgold Creek
	Klondike River
Stream Order	4



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-569	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	49.4	
% Ephemeroptera	33.4	
% Plecoptera	1.7	
Total Abundance	532.0	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.2	
Total No. of Taxa	16.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-607
Sampling Date	Jul 26 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.92635 N, 137.03642 W
Altitude	895
Local Basin Name	Big Creek (Klondike)
	Klondike River
Stream Order	



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-607	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	43.3	
% Ephemeroptera	31.0	
% Plecoptera	5.5	
Total Abundance	3058.3	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.2	
Total No. of Taxa	19.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-608
Sampling Date	Jul 27 2018
Know Your Watershed Basin	Klondike
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.92789 N, 137.15529 W
Altitude	849
Local Basin Name	Little South Klondike
	Klondike River
Stream Order	



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-608	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	27.0	
% Ephemeroptera	35.5	
% Plecoptera	12.4	
Total Abundance	2369.2	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.4	
Total No. of Taxa	15.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-053
Sampling Date	Jul 19 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.78611 N, 135.20278 W
Altitude	671
Local Basin Name	Keystone Creek inflow to Mayo Lake
	Mayo Lake
Stream Order	4



Across Reach



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-053	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	13.7	
% Ephemeroptera	23.0	
% EPT Individuals	59.1	
% Plecoptera	34.5	

Metrics

Name	YPS-053	Predicted Group Reference Mean \pmSD
Total Abundance	3130.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.4	
Total No. of Taxa	15.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-573
Sampling Date	Jul 19 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.76778 N, 135.45047 W
Altitude	659
Local Basin Name	Davidson Creek Mayo River
Stream Order	3



Across Reach



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-573	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	53.7	
% Ephemeroptera	1.9	
% EPT Individuals	7.4	
% Plecoptera	5.6	

Metrics

Name	YPS-573	Predicted Group Reference Mean \pmSD
Total Abundance	54.0	
Richness		
Simpson's Diversity	0.7	
Simpson's Evenness	0.3	
Total No. of Taxa	9.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-574
Sampling Date	Jul 19 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.84809 N, 134.97409 W
Altitude	1079
Local Basin Name	Granite Creek
	Mayo River
Stream Order	3



Across Reach



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-574	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	35.3	
% Ephemeroptera	33.9	
% EPT Individuals	55.9	
% Plecoptera	19.3	

Metrics

Name	YPS-574	Predicted Group Reference Mean \pmSD
Total Abundance	5185.7	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	16.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-144
Sampling Date	Jul 19 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.94722 N, 136.49889 W
Altitude	648
Local Basin Name	Ballard Creek
	McQuesten River
Stream Order	4



Aerial



Down Stream



Substrate



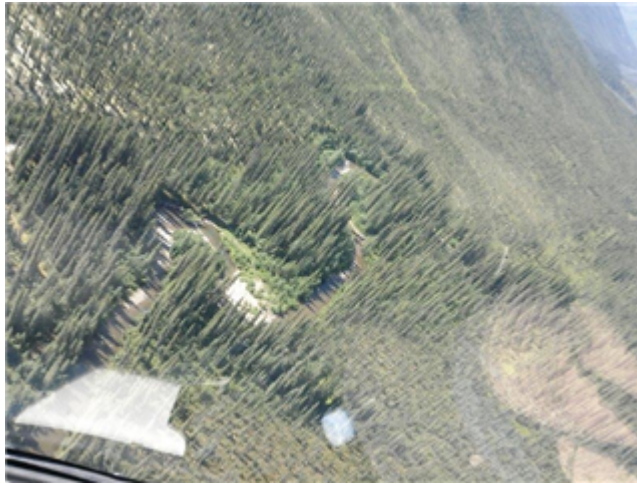
Up Stream

Metrics

Name	YPS-144	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	13.8	
% Ephemeroptera	46.9	
% Plecoptera	15.2	
Total Abundance	1710.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	20.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-604
Sampling Date	Jul 19 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.91335 N, 136.55261 W
Altitude	718
Local Basin Name	Sprague Creek McQuesten River
Stream Order	



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-604	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	3.7	
% Ephemeroptera	48.1	
% Plecoptera	18.2	
Total Abundance	2669.2	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	16.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-404
Sampling Date	Jul 20 2018
Know Your Watershed Basin	Teslin
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Pelly Mountains EcoRegion
Coordinates (decimal degrees)	60.85028 N, 133.31250 W
Altitude	810
Local Basin Name	Sidney Creek
	Nisutlin River
Stream Order	5



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-404	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	24.0	
% Ephemeroptera	58.5	
% Plecoptera	5.2	
Total Abundance	1625.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	19.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-405
Sampling Date	Jul 20 2018
Know Your Watershed Basin	Teslin
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Pelly Mountains EcoRegion
Coordinates (decimal degrees)	60.87222 N, 133.40694 W
Altitude	899
Local Basin Name	Sidney Creek
	Nisutlin River
Stream Order	3



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-405	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	15.1	
% Ephemeroptera	0.3	
% Plecoptera	3.0	
Total Abundance	680.0	
Richness		
Simpson's Diversity	0.5	
Simpson's Evenness	0.2	
Total No. of Taxa	13.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-406
Sampling Date	Jul 20 2018
Know Your Watershed Basin	Teslin
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Pelly Mountains EcoRegion
Coordinates (decimal degrees)	60.89528 N, 133.33194 W
Altitude	994
Local Basin Name	Iron Creek
	Nisutlin River
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-406	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	19.7	
% Ephemeroptera	57.9	
% Plecoptera	18.0	
Total Abundance	1805.0	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.4	
Total No. of Taxa	14.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-598
Sampling Date	Jul 20 2018
Know Your Watershed Basin	Teslin
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Pelly Mountains EcoRegion
Coordinates (decimal degrees)	60.85291 N, 133.31819 W
Altitude	831
Local Basin Name	Iron Creek
	Nisutlin
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-598	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	21.2	
% Ephemeroptera	61.0	
% Plecoptera	9.3	
Total Abundance	3041.7	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	18.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-605
Sampling Date	Jul 20 2018
Know Your Watershed Basin	Teslin
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Southern Lakes EcoRegion
Coordinates (decimal degrees)	60.82392 N, 133.23875 W
Altitude	682
Local Basin Name	Sidney Creek
	Nisutlin River
Stream Order	



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-605	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	21.7	
% Ephemeroptera	50.5	
% Plecoptera	2.9	
Total Abundance	2223.5	
Richness		
Simpson's Diversity	0.9	
Simpson's Evenness	0.4	
Total No. of Taxa	19.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-099
Sampling Date	Jul 26 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Ruby Ranges EcoRegion
Coordinates (decimal degrees)	63.98667 N, 140.79222 W
Altitude	701
Local Basin Name	60-Mile Rive at Miller Creek
	Sixty Mile River
Stream Order	5



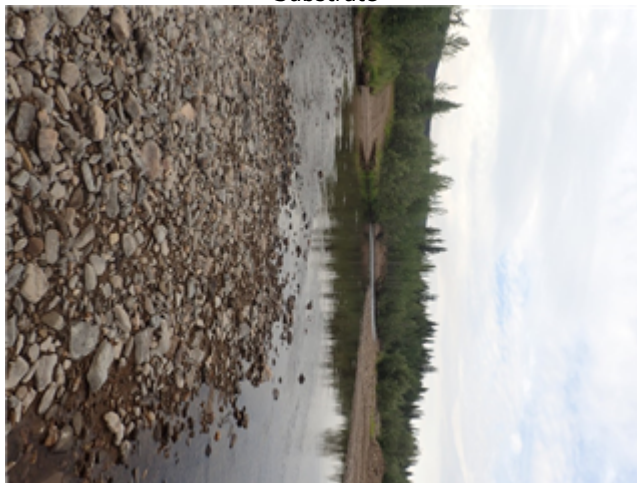
Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-099	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	14.7	
% Ephemeroptera	41.6	
% Plecoptera	2.8	
Total Abundance	2593.3	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	14.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-115
Sampling Date	Jul 26 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.71756 N, 140.19611 W
Altitude	437
Local Basin Name	Matson Creek at 60-Mile Rive
	Sixty Mile River
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-115	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	33.0	
% Ephemeroptera	40.3	
% Plecoptera	5.0	
Total Abundance	1118.5	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	17.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-117
Sampling Date	Jul 26 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -North EcoRegion
Coordinates (decimal degrees)	63.79167 N, 140.20084 W
Altitude	457
Local Basin Name	50-Mile Creek at 60-Mile River Sixty Mile River
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-117	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	21.1	
% Ephemeroptera	49.3	
% Plecoptera	14.2	
Total Abundance	1075.8	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.3	
Total No. of Taxa	19.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-381
Sampling Date	Jul 26 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.84806 N, 140.55028 W
Altitude	654
Local Basin Name	Fifty Mile Creek
	Sixtymile
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-381	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	15.2	
% Ephemeroptera	49.6	
% Plecoptera	5.4	
Total Abundance	2576.9	
Richness		
Simpson's Diversity	0.8	
Simpson's Evenness	0.5	
Total No. of Taxa	13.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-209
Sampling Date	Jul 18 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.21092 N, 139.05097 W
Altitude	369
Local Basin Name	SIMMONS CREEK
	STEWART RIVER
Stream Order	4



Across Reach



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-209	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	49.2	
% Ephemeroptera	1.7	
% EPT Individuals	22.0	
% Plecoptera	18.6	
Total Abundance	63.0	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.5	
Total No. of Taxa	6.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-428
Sampling Date	Jul 18 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Yukon Plateau -Central EcoRegion
Coordinates (decimal degrees)	63.25575 N, 138.69150 W
Altitude	432
Local Basin Name	Black Hills Creek
	Stewart
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-428	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	52.0	
% Ephemeroptera	20.0	
% Plecoptera	0.0	
Total Abundance	27.0	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.7	

Site Description

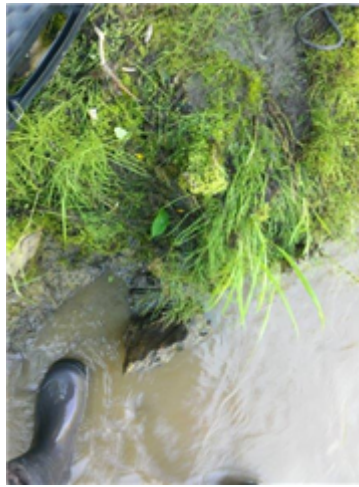
Study Name	Yukon Territory - AHM
Site	YPS-432
Sampling Date	Jul 18 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.13722 N, 138.90694 W
Altitude	415
Local Basin Name	Barker Creek
	Stewart
Stream Order	5



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-432	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	2.1	
% Ephemeroptera	63.2	
% Plecoptera	3.2	
Total Abundance	1994.7	
Richness		
Simpson's Diversity	0.5	
Simpson's Evenness	0.2	

Site Description

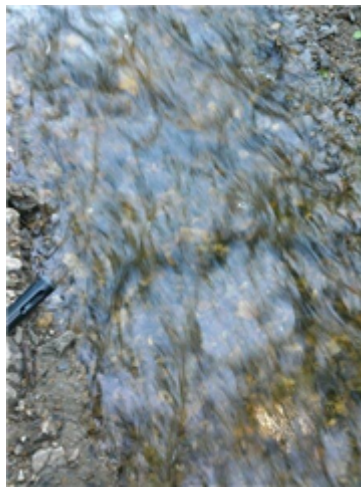
Study Name	Yukon Territory - AHM
Site	YPS-433
Sampling Date	Jul 18 2018
Know Your Watershed Basin	Stewart
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.18176 N, 138.99315 W
Altitude	397
Local Basin Name	Brewer Creek
	Stewart
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-433	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	16.1	
% Ephemeroptera	22.6	
% Plecoptera	4.8	
Total Abundance	71.0	
Richness		
Simpson's Diversity	0.7	
Simpson's Evenness	0.3	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-153
Sampling Date	Jul 25 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.36458 N, 139.35458 W
Altitude	391
Local Basin Name	Henderson Creek
	Yukon River North
Stream Order	5



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-153	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	25.0	
% Ephemeroptera	63.2	
% Plecoptera	6.1	
Total Abundance	228.0	
Richness		
Simpson's Diversity	0.6	
Simpson's Evenness	0.2	
Total No. of Taxa	11.0	

Site Description

Study Name	Yukon Territory - AHM
Site	YPS-159
Sampling Date	Jul 26 2018
Know Your Watershed Basin	Central Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.50195 N, 139.69417 W
Altitude	386
Local Basin Name	Rosebute Creek
	Yukon River North
Stream Order	4



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-159	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	15.8	
% Ephemeroptera	72.4	
% Plecoptera	1.2	
Total Abundance	2146.7	
Richness		
Simpson's Diversity	0.5	
Simpson's Evenness	0.2	
Total No. of Taxa	11.0	

Site Description

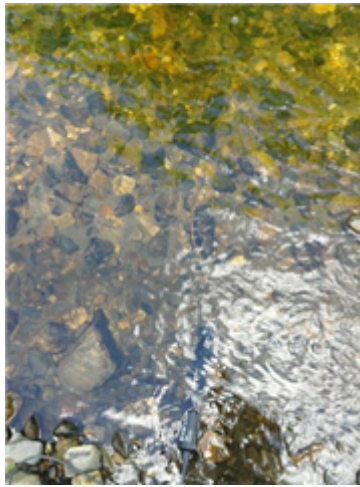
Study Name	Yukon Territory - AHM
Site	YPS-164
Sampling Date	Jul 18 2018
Know Your Watershed Basin	Upper Yukon
Province / Territory	Yukon Territories
Terrestrial Ecological Classification	Boreal Cordillera EcoZone Klondike Plateau EcoRegion
Coordinates (decimal degrees)	63.07472 N, 139.31555 W
Altitude	467
Local Basin Name	Thistle Creek
	Yukon River South
Stream Order	5



Aerial



Down Stream



Substrate



Up Stream

Metrics

Name	YPS-164	Predicted Group Reference Mean \pm SD
Bray-Curtis Distance	--	--
Number Of Individuals		
% Chironomidae	2.7	
% Ephemeroptera	90.1	
% Plecoptera	1.8	
Total Abundance	726.1	
Richness		
Simpson's Diversity	0.3	
Simpson's Evenness	0.1	
Total No. of Taxa	12.0	

Fish Habitat Management System for Yukon Placer Mining
Aquatic Health Monitoring Program. 2018 Report.

Appendix B3

Stream Habitat Characteristics



Appendix 3

Table 3-1: Reference Sites Physical Habitat Characteristics

Watershed	Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Alsek	4th of July Creek	YPS-441	2010	1161	3	20	29	1	0.05	0.48	1.1	7.1	4	6	4	nr
			2018	1161	3	8.3	14	1	0.04	0.2	0.4	3.7	3.3	6	4	2
	McKinley Creek	YPS-445	2010	878	4	22.2	30	1	0.015	0.59	0.92	12.5	9.2	7	4	nr
			2016	878	4	25.5	43	1	0.012	0.74	1.2	11.5	10.8	5	5	3
			2017	878	4	27.2	47	1	0.005	0.8	1.3	15.2	10.9	3	3	3
2018	878	4	17.8	26.5	1	0.015	0.42	0.7	12.2	9.1	5	4	1			
Indian	Montana Creek	YPS-480	2011	568	4	33	39	3	0.01	0.97	1.48	11.7	2.2	7	4	nr
			2013	568	4	60	65	3	0.01	0.29	0.34	2.6	2.4	6	5	nr
			2018	568	4	33	37	4	0.01	0.2	0.3	2.5	1.7	6	3	1
	Wounded Moose Cre	YPS-482	2011	537	4	39.6	49	1	0.01	0.71	0.87	5.4	3.5	7	5	nr
			2013	537	4	26.2	28	1	0.0025	0.4	0.4	3.9	3.9	7	4	nr
			2016	537	4	56.8	71	2	0.005	0.62	0.8	4.5	4.5	6	3	2
2018	537	4	34.8	39	2	0.005	0.3	0.4	3.5	3.3	6	4	2			
Klondike	Gates Creek	YPS-489	2011	625	4	40	47	1	0.015	0.57	0.63	8.4	4.4	3	4	nr
			2018	625	4	33.7	36	2	0.01	0.37	0.4	5.4	3.6	5	4	1
McQuesten	Ballard Creek	YPS-144	2006	648	4	54.6	nr	0	0.015	0.87	1.91	nr	11.5	7	5	nr
			2018	648	4	22.4	34.5	1	0.015	0.62	0.8	11.4	10.8	7	3	2
Nisutlin	Sidney Creek	YPS-405	2009	899	3	41	52	1	0.015	0.25	0.28	9.6	6.4	5	3	nr
			2017	899	3	19.9	29.5	2	0.005	0.9	1.3	9.7	4.6	4	3	3
			2018	899	3	43	61.5	1	0.005	0.09	0.1	12.2	12.2	3	4	3
	Iron Creek	YPS-406	2009	994	4	37.4	61	1	0.03	0.35	0.47	18	7	6	4	nr
			2018	994	4	25.5	43	1	0.05	0.74	1.4	14.2	10.5	7	3	3
Sixty Mile	Fifty Mile Creek	YPS-381	2009	654	4	36	44	1	0.01	0.18	0.22	18.5	6.7	7	5	nr
			2018	654	4	20.8	28	1	0.015	0.44	0.8	13.6	8.9	6	4	3
Stewart	Simmons Creek	YPS-209	2007	369	4	30	30	2	0.01	0.2	0.2	5	1.5	1	2	nr
			2018	369	4	18.7	26	2	0.015	0.33	0.4	9.4	3.1	2	5	1

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 75% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5mm - 20 mm thick)

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3-2: Asek Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
4th of July Creek (lower)	YPS-442	2010	956	3	40.2	65	1	0.02	0.4	0.87	17.4	5	3	4	nr
		2016	956	3	36	58	1	0.013	1.18	1.6	22.5	9.5	4	4	1
		2017	956	3	46	51	1	0.025	1	1.2	21.6	6.1	4	5	1
		2018	956	3	15.8	25	1	0.025	0.62	1.4	20.1	5.1	6	3	2
Jarvis River	YPS-597	2017	931	5	30.9	47	1	0.015	0.9	1.4	19.6	7.6	4	4	1
		2018	931	5	11.8	18	1	0.02	0.68	1	13.2	6.2	5	4	2

Notes: *nr* = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5mm - 20 mm thick)

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3-3: Indian Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Indian River at Water Resources Station	YPS-090	2006	366	6	51.4	nr	0	0.01	1.18	nr	36.7	nr	3	2	nr
		2009	366	6	19	28	0	0.01	0.52	0.84	31.8	19.6	7	3	nr
		2013	366	6	39.2	42	1	0.01	1.01	1.01	34.3	19.5	6	5	nr
		2014	366	6	39	45	0	0.01	0.44	0.5	30	30	6	3	nr
		2016	366	6	63.5	83	0	0.005	1.35	1.6	37	28	7	5	2
		2017	366	6	29	39.5	1	0.0075	1	1.6	41	27.7	6	3	2
		2018	366	6	19.5	28.5	1	0.0075	0.48	0.7	46	37	5	4	3
Quartz Creek	YPS-546	2013	441	4	13.6	15	1	0.01	0.48	0.6	6	4.5	1	2	nr
		2017	441	4	13.2	23	1	0.005	0.5	0.8	9.3	9.1	6	3	1
		2018	441	4	10.6	14	2	0.005	0.24	0.3	7.6	6	5	4	2
Montana Creek	YPS-606	2018	499	4	23.2	29	3	0.005	0.2	0.2	6.6	5	6	4	1

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5mm - 20 mm thick)

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.4: Klondike Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Hunker Creek upstream of Ontario Cr.	YPS-078	2006	585	3	20.4	nr	nr	0.03	0.51	nr	nr	2.5	6	5	nr
		2008	585	3	8.7	12	2	0.03	0.32	0.44	9.2	3.8	1	3	nr
		2010	586	3	6	12	3	0.02	0.36	0.75	3.8	2.3	1	4	nr
		2012	585	3	8.7	13	2	0.03	0.48	0.53	6.4	3.6	7	4	nr
		2013	585	3	10	16	1	0.03	0.19	0.4	6.7	3.2	6	4	nr
		2016	586	3	20.6	23	1	0.03	0.62	0.8	4.4	3.4	6	3	1
		2018	586	3	7.3	9	1	0.02	0.3	0.5	8.7	3.3	4	4	1
Bonanza Creek at Highway	YPS-081	2006	340	4	28.9	nr	nr	0.01	0.55	nr	nr	8.6	6	4	nr
		2008	345	4	16.6	30	1	0.01	0.58	0.78	38	13.4	2	3	nr
		2010	344	4	18.6	23	1	0.01	0.48	0.78	19.6	4.3	5	5	nr
		2012	340	4	22	29	1	0.01	0.44	0.69	29.2	7.7	5	4	nr
		2013	332	4	11.8	16	1	0.01	0.29	0.41	31	8.5	4	4	nr
		2016	332	4	45.8	86	1	0.01	1.1	1.5	15.8	14.4	6	3	1
		2017	332	4	27.2	38	1	0.02	0.78	1	22.5	6.4	4	4	1
2018	332	4	13.4	17.5	2	0.01	0.53	0.9	24.6	13.9	6	4	1		
Bonanza Creek upstream of Eldorado inflow	YPS-084	2006	480	3	28.9	nr	nr	0.008	0.43	nr	nr	3.7	3	2	nr
		2010	511	3	18	30	2	0.01	0.14	0.16	7.1	4.3	5	3	nr
		2015	480	3	31.2	44	1	0.005	0.7	0.8	7.4	5	6	3	1
		2017	480	3	40.8	45	1	0.01	0.26	0.3	7.5	4.9	2	4	1
		2018	480	3	15.3	18.5	2	0.005	0.43	0.5	8.1	4.3	4	4	1
Eldorado Creek top	YPS-107	2006	628	2	13.4	nr	nr	0.02	0.42	nr	nr	3.4	6	5	nr
		2008	620	2	6.3	8	1	0.02	0.51	0.65	10.9	2.6	1	3	nr
		2013	616	2	6.7	7	1	0.02	0.34	0.4	10.5	1.8	5	2	nr
		2014	616	2	9.4	16	1	0.02	0.22	0.3	12.3	2.5	6	4	nr
		2016	616	2	22	34	1	0.02	0.7	1	7.4	3.2	6	4	1
		2017	616	2	9.3	14	1	0.02	0.37	0.5	6.1	2.8	4	3	1
		2018	616	2	8.3	12.5	1	0.02	0.7	0.7	8.6	3.9	5	5	2
Hunker Creek	YPS-544	2013	359	4	19	31	1	0.005	0.42	0.63	8.9	5.8	1	3	nr
		2014	360	4	24.8	31	1	0.005	0.3	0.4	8.7	8.1	3	3	nr
		2015	359	4	18.2	25	1	0.005	0.62	0.9	8.8	6.7	5	3	1
		2016	359	4	47	72	2	0.005	0.62	0.8	9.1	8.2	1	1	1
		2017	359	4	23.4	34	2	0.0075	0.54	0.8	8.9	7.2	5	2	1
		2018	359	4	10.8	15	3	0.005	0.46	0.5	9	6.4	5	4	1
Allgold Creek	YPS-569	2013	475	4	17.3	19.5	1	0.01	0.23	0.29	14.2	6.5	3	2	nr
		2015	475	4	20.4	34	0	0.015	0.98	1.8	11.8	6.2	7	3	1
		2016	475	4	29.6	47	0	0.005	0.96	1.3	10.4	5.7	6	3	1
		2017	475	4	14.4	18	0	0.015	0.48	0.7	8.2	5.5	5	3	1
		2018	475	4	11.6	19	0	0.005	0.38	0.5	10.4	4.8	5	3	1
Big Creek (Klondike)	YPS-607	2018	895	4	24.5	30	1	0.02	0.78	0.9	17.5	14.8	6	4	3
Little South Klondike	YPS-608	2018	849	5	30.4	50	1	0.0125	0.68	0.8	21.5	19.6	6	3	4

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5mm - 20 mm thick)

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.5: Mayo Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Keystone Creek inflow to Mayo	YPS-053	2005	671	4	23	nr	nr	nr	0.74	nr	nr	7	6	5	nr
		2018	671	4	21.7	36	1	0.025	0.72	1.1	8.7	5.5	6	3	1
Davidson Creek	YPS-573	2015	659	3	25.2	39	1	0.01	0.68	1	10.7	7	7	4	1
		2018	659	3	28.6	54	2	0.015	0.78	1.2	10	6.8	6	3	2
Granite Creek	YPS-574	2015	1079	3	37	52	1	0.015	0.72	0.9	6.7	5.7	7	4	1
		2016	1079	3	33.2	43	1	0.015	0.5	0.7	7.1	56	7	4	2
		2017	1079	3	24.4	38	0	0.0175	0.52	0.8	8	5.1	7	2	3
		2018	1079	3	26	35	1	0.025	0.66	1.3	6.3	6.3	7	3	3

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.6: McQuesten Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Sprague Creek	YPS-604	2018	718	3	41	62	1	0.015	0.74	1.2	11.3	5.7	6	4	2

Notes: *nr* = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.7: Nisutlin Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Iron Creek	YPS-598	2017	831	4	22.4	33.5	2	0.02	0.5	1.1	10.7	10.7	7	4	3
		2018	831	4	19.9	23.5	1	0.03	0.58	1	14.5	13.5	7	5	1
	YPS-406	2018	994	4	25.5	43	1	0.05	0.74	1.4	14.2	10.5	7	3	3
Sidney Creek	YPS-404	2009	810	5	55	79	1	0.01	0.76	1.03	40.4	8.2	7	4	nr
		2017	810	5	27.8	59	1	0.0075	0.6	0.8	18.1	16.8	5	3	2
		2018	810	5	29.4	57.5	1	0.01	0.7	0.9	18.2	16.4	6	4	2
	YPS-405	2017	899	3	19.9	29.5	2	0.005	0.9	1.3	9.7	4.6	4	3	3
		2018	899	3	43	61.5	1	0.005	0.09	0.1	12.2	12.2	3	4	3
	YPS-605	2018	682	5	22.8	38.5	1	0.015	0.8	1.1	22.5	16.6	5	4	3

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm t

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown a

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.8: Sixty Mile Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
60-Mile River at Miller Creek	YPS-099	2006	701	5	55.6	nr	nr	0.005	0.63	nr	nr	18.3	5	4	nr
		2018	701	5	16.1	30	1	0.005	0.22	0.5	49.4	21.7	6	3	4
Matson Creek at 60-Mile River	YPS-115	2006	427	4	60	nr	nr	0.01	0.81	nr	nr	14.1	7	5	nr
		2015	437	4	42.2	57	1	0.01	1.38	1.6	27.3	12.7	6	5	2
		2016	437	4	70	nr	1	0.01	1.5	nr	23	20	5	5	1
		2018	437	4	35.9	50	1	0.01	0.52	0.9	26.6	9.4	5	3	2
50-Mile Creek at 60-Mile River	YPS-117	2006	457	4	29.7	nr	nr	0.005	0.69	nr	nr	18.9	7	5	nr
		2018	457	4	22.8	31	1	0.005	0.5	0.9	17.4	13.2	6	4	3
Fifty Mile Creek	YPS-381	2018	654	4	20.8	28	1	0.015	0.44	0.8	13.6	8.9	6	4	3

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5m)

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.9: Stewart Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Black Hills Creek	YPS-428	2010	380	4	74.4	83	1	0.005	0.28	0.39	12.5	9	1	1	nr
		2013	380	4	69.8	78	1	0.005	0.18	0.26	11	9.1	1	1	nr
		2014	380	4	61.2	74	1	0.005	0.38	0.5	10	9.7	1	1	nr
		2015	432	4	37.4	72	2	0.005	0.36	0.5	13.1	12.1	2	2	1
		2017	432	4	38.9	43	1	0.005	0.32	0.4	9.7	9.2	2	5	1
		2018	432	4	24.6	35.5	2	0.005	0.46	0.6	14.4	10	2	3	1
Barker Creek	YPS-432	2010	416	5	38.4	43	1	0.02	0.58	0.73	nr	7.8	5	4	nr
		2011	416	5	36.8	67	1	0.02	0.62	0.76	8.8	6.3	5	3	nr
		2013	415	5	25.4	32	1	0.02	0.61	0.77	24.9	6.8	4	5	nr
		2018	415	5	19.5	30	2	0.02	0.62	1	6.3	6.3	6	2	1
Brewer Creek	YPS-433	2010	397	4	20.4	23	2	0.023	0.46	0.62	3.3	3.3	7	4	nr
		2013	375	4	8	11	2	0.015	0.37	0.41	3.7	3.2	4	4	nr
		2014	375	4	9	13	3	0.02	0.33	0.4	3.9	2.8	6	3	nr
		2017	375	4	9.3	13	4	0.03	0.3	0.4	4	2.1	5	3	1
		2018	397	4	8.7	10.5	4	0.025	0.7	1.2	3.9	1.4	4	4	1
Simmons Creek	YPS-209	2018	369	4	18.7	26	2	0.015	0.33	0.4	9.4	3.1	2	5	1

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5mm)

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.10: Yukon River North Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Henderson Creek	YPS-153	2006	397	5	42	nr	0	0.01	0.49	0.75	nr	6.6	5	4	nr
		2009	397	5	12	14	2	0.01	0.45	0.52	nr	6.7	1	2	nr
		2010	385	5	31.8	42	2	0.01	0.5	0.75	7	7	5	4	nr
		2014	391	5	36	40	1	0.01	1	1.1	11.2	7.6	3	3	nr
		2018	391	5	22.6	29.5	0	0.015	0.74	1.1	9.7	5.6	5	4	1
Rosebute Creek	YPS-159	2006	386	4	nr	nr	nr	0.005	nr	nr	nr	9.1	2	3	nr
		2018	386	4	23.1	32	2	0.005	0.38	0.5	10.5	6.5	6	4	1

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)

Appendix 3

Table 3.11: Yukon River South Watershed Physical Habitat Characteristics

Creek Name	Site	Year	Altitude	Stream Order	Average Depth (cm)	Maximum Depth (cm)	Canopy Coverage	Slope (m/m)	Average Velocity (m/s)	Maximum Velocity (m/s)	Bankfull Width (m)	Wetted Width (m)	Dominant Substrate	Embeddedness	Periphyton Coverage
Thistle Creek	YPS-164	2006	467	5	25.4	nr	0	0.013	0.52	nr	nr	19	2	3	nr
		2012	467	5	18.2	21	1	0.015	0.61	0.73	10.2	8.3	5	4	nr
		2013	467	5	16.2	22	1	0.01	0.31	0.34	18.7	8.9	2	2	nr
		2014	475	5	29.8	43	1	0.015	0.48	0.7	12.3	10.9	6	4	nr
		2015	462	5	18.7	28.5	2	0.015	0.84	1.1	9.8	8.6	5	3	1
		2016	462	5	18	27	2	0.015	0.6	0.9	9.3	9.3	5	3	2
		2017	462	5	22.6	34	1	0.015	0.46	0.6	9.4	4.6	6	4	1
		2018	467	5	17.8	25.5	1	0.015	0.36	0.6	7.5	5.1	6	3	2

Notes: nr = not reported

CABIN protocol canopy coverage: 0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%

CABIN protocol embeddedness scoring: 1 - completely embedded; 2 - 75% embedded; 3 - 50% embedded; 4 - 25% - embedded; 5 - unembedded

Substrate size classes: 0 - organic cover; 1 - sand/silt/clay; 2 - sand; 3 - gravel; 4 - small pebble; 5 - large pebble; 6 - small cobble; 7 - large cobble; 8 - boulder; 9 - bedrock

CABIN protocol periphyton scoring:

1 - rocks not slippery, no obvious colour (thin layer < 0.5mm thick)

2 - rocks slightly slippery, yellow-brown to light green colour (0.5-1mm thick)

3 - rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)

4 - rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5r

5 - rock mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (>20 mm thick)