Fish Habitat Management System (FHMS)
14-Year Water Quality Monitoring Review

Prepared for:

Government of Yukon
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EXECUTIVE SUMMARY

Hemmera was requested by the Government of Yukon to complete a summary and analysis of water quality monitoring data that are regularly collected as part of the Adaptive Management Framework (AMF) and the Fish Habitat Management System for Yukon Placer Mining (FHMS). This was intended to support the Yukon Government and Fisheries and Oceans Canada (DFO) with their evaluation of the effectiveness of AMF and FHMS, toward the larger goal of protecting and conserving fish and fish habitat in Yukon watersheds where placer mining activities occur, and continued improvements in water quality monitoring in the Yukon.

This report provides an update to the March 3rd 2020 draft report (Draft 1.0 completed under Contract C00053203) through inclusion of Water Quality Objectives Monitoring (WQOM) data collected in 2019 and 2020. We provide herein a summary and analysis of water quality monitoring data obtained from 2007 through 2020, over the first fourteen years of the AMF, for sixteen Yukon watersheds and the habitat suitability classes therein.

This Work was performed in accordance with Contract C00055556 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and Government of Yukon (Client), dated July 21st, 2020 (Contract). This Report has been prepared by Hemmera, based on desktop data review and analysis conducted by Hemmera, for sole benefit and use by Government of Yukon. In performing this Work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced.

A major focus of the monitoring of water quality in streams staked for placer mining is to evaluate whether the existing water quality objectives implemented under the FHMS generally are being met. The focus of the existing water quality monitoring program is monitoring of total suspended solids (TSS) with respect to the water quality objectives (TSS_{WQO}) that vary between watershed categories and habitat.

The data synthesis includes statistical summaries, spatial analyses, and temporal analyses (*e.g.,* time series plots) for TSS. The frequency and magnitude of exceedances of the TSS_{WQO} is summarized for each monitoring site and watershed, and spatially presented in map form. Similar statistical and spatiotemporal summaries are provided for other key indicators for aquatic health (*i.e.,* pH, electrical conductivity, temperature, dissolved oxygen).

This Executive Summary is not intended to be a stand–alone document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
AMF	Adaptive Management Framework
CV	Co–efficient of variation
DFO	Department of Fisheries and Oceans
DO	Dissolved oxygen
EC	Electrical conductivity
FHMS	Fish Habitat Monitoring System for Yukon Placer Mining
PRQ	Preliminary Risk Quotient
TSS	Total Suspended Solids
TSS_{WQO}	Water quality objective for total suspended solids
WQO	Water quality objectives

1.0 INTRODUCTION

Hemmera Envirochem Inc. (Hemmera) was engaged by the Yukon Government and Department of Fisheries and Oceans (DFO) to complete a desktop review of water quality data obtained from 2007 through 2020 for streams in 16 watersheds in the Yukon. The purpose of this data review is to support the Yukon Government and DFO in their evaluation of the existing Aquatic Management Framework (AMF) and Fish Habitat Monitoring System for Yukon Placer Mining (FHMS).

1.1 Adaptive Management Framework and FHMS

The Government of Yukon and Fisheries and Oceans Canada, in consultation with the Intergovernmental Management Group (IMG), jointly implemented the "Fish Habitat Management System for Yukon Placer Mining." This was intended to achieve the appropriate statutory and desired protection and conservation of fish and fish habitat in balance with supporting a sustainable Yukon placer mining industry. The FHMS is supported by the Adaptive Management Framework (AMF: YPAHWG 2010)[1].

There are three monitoring programs and associated protocols within the AMF, including the following:

- Aquatic Health Monitoring (AHM);
- Water Quality Objectives Monitoring (WQOM), and
- Economic Health Monitoring (EHM).

The objective of WQOM is to ascertain whether water quality objectives defined within the FHMS are being achieved, and whether any exceedances are attributable to placer mining or other causes. The WQOM protocols focus on total suspended solids (TSS).

1.2 Project Objectives

The Government of Yukon Placer Secretariat, Fisheries and Oceans Canada, and the Government of Yukon seek to understand the effectiveness of the Program and especially WQOM to achieve the desired level of environmental protection in watersheds that may be influenced by placer mining. Such information is of direct relevance to the AMF, for ensuring the effectiveness of the FHMS in achieving its intended objectives.

The overall objective of this water quality monitoring data review is to determine if the existing TSS water quality objectives are being met. A further objective is to provide a synthesis of water quality conditions and trends in streams with placer activity, and provide information that will aid in subsequent evaluation of the effectiveness of the existing FHMS and AMF. This review is intended to:

- provide an overview of water quality conditions, trends, and issues from 2007 through 2020,
- generate information that will inform aquatic health and water quality objectives monitoring protocols,
- generate information that will inform potential future changes to the AMF and effects monitoring protocols.

[1] Yukon Placer Aquatic Health Working Group (YPAHWG). 2010. Fish habitat management system for Yukon placer mining: Adaptive management framework. (https://yukon.ca/en/fish–habitat–management–system–yukon–placer–mining–adaptive–management–framework; Accessed February 24, 2020)

1.3 Scope of Work

The focus of this review is on monitoring data for total suspended solids (TSS), since placer mining activities have the potential to introduce additional suspended solids to streams either directly in discharges from sluicing and other activities, or indirectly from the disturbance of alluvial deposits and riparian areas. Other important stream variables evaluated to assess aquatic health were included in the review, such as electrical conductivity (EC), pH, dissolved oxygen (DO), temperature and turbidity.

The scope of the data review includes the following:

- Time series plots of all water quality attributes (TSS, turbidity, temperature, pH, EC).
- Evaluation of the data distribution for TSS (e.g., normal, log–normal, gamma), since this is relevant to statistical point estimates for various subsets of data, and the particulars of spatial comparisons and trend analyses using numerical procedures associated with General Linear Model (GLM) statistical approaches.
- Summary statistics (mean, median, minimum, maximum, standard deviation and standard error) after accounting for data distributions and non–detect values, for water quality attributes (TSS, temperature, pH, EC) for all watersheds and Fish Habitat Suitability Classes therein, and then (to the extent supported by the data), by season.
- Comparison of TSS exceedance frequency across watershed monitoring areas including, in order importance: Category A/B watersheds, fish habitat suitability class, and seasons.
- Magnitude of TSS exceedance; expressed as Preliminary Risk Quotients (PRQ); *where* –

  PRQ1 = maximum observed TSS / TSS_{WQO}

  and

  PRQ2 =90^{th} %ile TSS / TSS_{WQO}.

- Ranking of individual sampling sites by PRQs.
- Comparison of the magnitude of TSS exceedances across watersheds, habitat suitability categories and individual sample stations.

2.0 DATA ANALYSIS AND REVIEW

2.1 Data Summary

The water quality dataset includes data from 14 years of monitoring from 2007 through 2020. Routinely obtained data consisted of the following:

- *In situ* measurements of stream or river elevation (stage) using level–logger pressure transducers installed in stilling wells, which are then converted to instantaneous stream flow estimates using stage curves developed through less frequent concurrent acquisition of direct flow measurements using a doppler flow meter or similar.
- Field-collected data on physical parameters using a portable field meter.
- Stream water physical and chemical characteristics, including TSS concentrations, based on laboratory analyses.

Water samples were collected from various watercourses either as discrete 'grab' samples or as an integrated (i.e., continuous) sample collected by an ISCO automated sampler[2]. Integrated samples reflected pooling of individual samples collected at specified intervals through a 24-hour period, with the sampling interval adapted to specific stream conditions and experience with draw down of power from the solar–powered ISCO samplers.

The water quality dataset is stored and organized in a Microsoft Office Access™ database. The database includes three key tables for this data review. These contain -

- Analytical data for integrated and grab samples (TSS, EC, pH, and turbidity),
- Field measurement data for a measurement event (instantaneous temperature, DO, pH and EC),
- Qualitative meta–data for each monitoring location (watershed category, watershed, TSS_{WQO}, watercourse, stream reach, habitat suitability classification and site coordinates).

The organization of water quality data by sampling unit follows a hierarchical approach:

Watershed Category (A or B) → Watershed → Habitat Suitability Classification →

Watercourse → Monitoring Station.

Watershed categories (A or B) were assigned by the Yukon Placer Secretariat (YPS) to denote the relative sensitivity of a watershed to anthropogenic influence, as outlined in the YPS (2015) Watershed Sensitivity and Habitat Classification Methodology Report:

> *"The use of a Watershed sensitivity designation process provides an indication of the possibility of an ecological response within an individual watershed as a whole, resulting from a human-induced or anthropogenic stressor (placer mining). The sensitivity of a watershed is classified into one of two possible categories based on an assessment of both physical and biological characteristics. The goal of this process is to designate watersheds as either more likely, or less likely to display a response to a set of specific anthropogenic stressors attributable to placer mining activities."*

[2] Detailed sampling methods are provided in Appendix A of Yukon Placer Water Quality Working Group (YPWQWG). 2016. Yukon Placer Mining Industry Water Quality Objectives Monitoring Protocol

The classification process considers the degree of development, watershed water quality (with respect to productive capacity of aquatic systems), and presence of valued ecosystem components (e.g., salmon). Watersheds classified as Category A are considered more sensitive to anthropogenic impacts than Category B Watersheds.

The overall 14-year monitoring dataset encompasses 16 watersheds, 148 watercourses, 328 monitoring stations and thousands of individual samples. The six habitat suitability classes are shown in **Table 2.1** with the associated TSS_{WQO}. A summary of the number of stations and number of discrete sample results per watershed is provided in **Table 2.2** and **Table 2.3,** respectively.

Over 18,000 TSS samples have been analyzed over the 14-year period as part of the monitoring program, with laboratory pH, EC and turbidity recorded for nearly all the grab and integrated samples. There are also more than 1000 field measurements for pH, EC, and DO.

Table 2.1 Habitat suitability classes and associated TSS water quality objectives

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

The ability to detect deleterious changes in water quality over time, for the purpose of guiding management actions, is influenced by the following three factors:

- The size of the change deemed to be meaningful from a fish health and habitat perspective (*e.g.,* the minimum change in TSS over background concentrations expected to lead to subtle adverse effects).
- Sources of variation in the monitored parameter in addition to the longer-term monotonic variation; i.e. a generalized increase or decrease through time or along the watershed, whether linear on non-linear. Such variations typically include variations between seasons and within seasons arising from responses to specific rainfall and snowmelt events, variations across years based on cyclic and apparently random climatic variations, variations over smaller distances as a result of channel morphology and flow variations, sampling and observer induced variability, etcetera.
- The number of observations (total number of sample results: *n*) across the period of interest and their distribution (e.g. randomly distributed, having an orderly distribution along prescribed increments, or non-randomly distributed in a manner that can introduce bias).

In general, it will be challenging to detect temporal changes in water quality at a specific sampling location over a decadal time span based on the true power to detect such changes for stations with 20 to 30 data points or fewer, given sources of 'confounding' variability. Thus, there are limited TSS or other monitoring data from the 14-year monitoring period to support robust statistical analyses of temporal trends for several of the watersheds and monitoring stations. Limited numbers of sampling results for a subset of stations will also reduce the robustness of some of the statistical point estimates provided herein such as 95% upper confidence limits of the means (95% UCLMs) for log–transformed TSS data, or various percentile estimates. Those statistical point estimates based on fewer than 10 to 20 data points, in particular, should be treated with an appropriate degree of skepticism.

Given the spatial scale of the monitoring program, it may not be possible to sample every station annually. An alternative approach is to prioritize annual sampling efforts to Moderate–High to High habitat suitability classes, and conduct less frequent sampling (e.g. once every two to three years) for the lower habitat suitability classes. Another possible approach is to identify areas with high frequency and magnitude of exceedances to support investigation of root causes of high TSS in areas of note. Frequency and magnitude of exceedances per station is discussed below.

Table 2.2 Number of stations sampled for TSS in each watershed and habitat suitability classification therein (2007–2020)

Watershed Category	Watershed	No. Watercourses	Number of Stations						
			Area of Special Consideration	High	Moderate High	Moderate–Moderate	Moderate–Low	Low	All Habitat Classes
A	Big Creek	9		2	3	6	1	8	20
	Big Salmon River	5		1	2	5		2	10
	Klondike River	13	2	6			9	34	51
	Laird River	11	*No habitat suitability classification*						18
	McQuesten River	5	1	6		5	2	1	15
	Nisutlin River	3		2	1				3
	Pelly River	1		1					1
	Stewart River	5		5	3	2	2	2	14
	Yukon River South	10	6	15	4		1		26
B	Fortymile River	3	4					1	5
	Indian River	24				1	1	43	45
	Mayo River	5		1				6	7
	Sixty Mile River	10	3			1	4	14	22
	White River	16		2	2	2	1	14	22
	Yukon River North	27	17	25	13	1	2		58
None	Alsek River	2		1			3		4

Note:
Station counts are of monitoring stations with TSS data. Stations that have been established but have not yet been sampled are not included.

Table 2.3 Number of samples collected in each watershed and habitat suitability classification therein (2007–2020)

Watershed Category	Watershed	No. Watercourses	Number of TSS Samples						
			Area of Special Consideration	High	Moderate High	Moderate–Moderate	Moderate–Low	Low	All Habitat Classes
A	Big Creek	9		604	362	566	171	356	2059
	Big Salmon River	5		191	295	410		10	906
	Klondike River	13	999	1161			3353	2107	7620
	Laird River	11	No habitat suitability classification						365
	McQuesten River	5	3	240	0	47	2	6	298
	Nisutlin River	3		199	89				288
	Pelly River	1		6	0				6
	Stewart River	5		76	171	191	73	85	595
	Yukon River South	10	94	139	283		112		628
B	Fortymile River	3	22	0				2	24
	Indian River	24		0		540	6	1247	1793
	Mayo River	5		72				412	484
	Sixty Mile River	10	388			1	346	560	1295
	White River	16		9	21	94	11	623	758
	Yukon River North	27	176	200	184	19	33		614
None	Alsek River	2		132			344		476

Table 2.4 Number of samples collected in each watershed by year (2007–2020)

Watershed	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2007 to 2020
Klondike River	180	367	482	543	901	533	1203	621	389	773	689	61	839	39	7620
Big Creek		440	362	10	27			141	611	468					2059
Indian River	74	155	374	213	2	1	143				733	98			1793
Sixty Mile River	76	85	418	162	2	1	1			550					1295
Big Salmon River									510		4	392			906
White River	15	9	9	117	148	83	50		5	322					758
Yukon River South	177	27	15	45	48	90	114					112			628
Yukon River North	157	41	17	142	108	55	36				54			4	614
Stewart River	1	241	239	53	6	1	54							1	596
Mayo River	152	104	2		1	225									484
Alsek River											476				476
Liard River				346											346
McQuesten River	84	55	10	7	2	140									298
Nisutlin River											288				288
Fortymile River	1	15		2	2	1	1				2				24
Pelly River			1	2	2	1									6
All Watersheds	917	1539	1929	1642	1249	1131	1602	762	1515	2113	2246	663	839	44	18191

Note:
Watersheds are listed by order of greatest number of samples collected from 2007–2020.

2.2 Data Analysis and Statistical Summary

2.2.1 Data Distribution

For the purpose of comparing TSS concentrations across sampling locations over time, the distribution of TSS data was evaluated using ProUCL software. When interpreting indicators of central tendency or spread (e.g. as confidence limits) and using these to compare across data sets, it is important to recognize how departures from a normal distribution will bias the indicators, such as occurs for a left-skewed data distribution. The three watersheds with the largest population of samples were evaluated: (i) Klondike River, (ii) Big Creek and (iii) Indian River watersheds. Statistical outputs and Q–Q test plots for the three watersheds are provided in **Appendix A**.

The TSS data were not normally distributed (Lillefors goodness of fit test; α=0.05). Nor was the data set consistent with a normal distribution following a gamma distribution transformation (Anderson Darling and Kolmogorov–Smirnoff test; α=0.05), or logarithmic transformation (Lillefors; α=0.05). The departures from normality, especially for log-transformed TSS data, were generally attributed to a small subset of anomalously high TSS readings, the drivers of which are not known. While the overall data do not follow a discernible distribution, Q–Q test plots show that the monitoring data distribution more closely resembles a natural logarithmic distribution relative to normal or gamma Q–Q plots (**Appendix A**). Thus, we conclude that the TSS data distributions for the three watershed are sufficiently consistent with a log(*e*)-normal data distribution (or L*n*–normal data distribution) that parametric statistical point estimates, regression type and analysis of variance (ANOVA) type approaches that rely on data normality will provide robust interpretations of the water quality monitoring data after log(e) transformation.

2.2.2 Water Sampling Methodology (Grab versus ISCO)

Two monitoring approaches have been used to monitor TSS in streams: (i) through collection of discrete, or 'grab' water samples, or (ii) through collection and combination of multiple water samples within a 24-hour period using an ISCO automated sampler. Data from grab samples and time integrated samples should provide very similar estimates of the central tendency in TSS concentrations over extended time periods, provided that there are a reasonably large number of samples. From a theoretical perspective, the time integrated samples could provide a range of TSS concentrations through time that is narrower than the range obtained from grab samples. This is because the integration of samples in itself results in averaging of TSS fluctuations within a 24-hour period.

To evaluate whether TSS monitoring data from grab samples and integrated samples are adequately comparable, we evaluated the central tendency of TSS distributions for an entire watershed, and in particular, the relative spread in the TSS data through examination of the co–efficient of variation (CV, where CV = sample standard deviation / mean). The available TSS data obtained from either grab or integrated sample acquisition do not reflect either a paired sampling approach, nor true random sampling of the overall TSS levels in the larger watershed, and there may be other drivers of departures in TSS central tendency or variability between the two monitoring approaches. Nonetheless, a comparison between monitoring approaches of TSS mean concentrations and the CV was deemed useful to assess major, consistent differences in the collated data from the two approaches.

The TSS data are not normally distributed, but after a natural logarithmic (Ln) transformation more closely approximate normality. Thus, the data means and CV values were estimated following Ln transformation of TSS data from each watershed. Non–detected TSS values are assigned a value of zero ('0') in the database. These values were replaced with an assumed value of 0.001 mg/L to enable their log-transformation.

Table 2.5 provides a comparison of CV's for time integrated and grab sampling based on the Ln-transformed TSS data. The higher of the two CV's is shaded grey. The CV is quite low for several of the watersheds for both types of monitoring approaches (e.g., Indian River, Klondike River, Stewart River, White River, Yukon River South). No trend in higher CV for either approach is observed across the watersheds.

The central tendency in the TSS data, by monitoring approach, is provided in **Table 2.6**. The log-transformed means of both sampling methods are comparable, and it is reasonable to conclude that sample acquisition method has relatively small influence on TSS data distribution, based on the central tendency variation, compared with other potential influences such as spatial variation between sampling sites used during either method.

Table 2.5 Variability of Ln-transformed TSS data by sample collection methodology (ISCO integrated samples versus discrete grab samples)

Watershed	ISCO Co-efficient of Variation	Grab Co-efficient of Variation
Alsek River	1.3	0.7
Big Creek	2.2	1.3
Big Salmon River	1.0	1.1
Indian River	0.5	0.5
Klondike River	0.6	0.6
Liard River	11.6	4.5
Mayo River	1.0	0.7
McQuesten River	0.8	1.0
Nisutlin River	1.4	0.7
Sixty Mile River	0.9	1.1
Stewart River	0.6	0.5
White River	0.5	0.8
Yukon River South	0.4	0.6

Table 2.6 Central tendency of TSS data(mg/L) by sample collection methodology (ISCO integrated samples versus discrete grab samples)

Watershed	Time–integrated (ISCO) Samples			Grab Samples		
	No. Samples	Ln-transformed Mean TSS	Back-transformed Mean TSS	No. Samples	Ln-transformed Mean TSS	Back-transformed Mean TSS
Alsek River	448	1.4	4.1	28	2.1	8.1
Big Creek	1835	1.0	2.8	224	1.7	5.4
Big Salmon River	827	1.7	5.3	79	1.1	2.9
Indian River	1380	2.8	17.2	413	2.9	18.8
Klondike River	5089	2.9	18.3	1652	2.8	17.0
Liard River	234	–0.2	0.9	112	0.3	1.4
Mayo River	280	2.0	7.1	204	2.4	10.9
McQuesten River	157	1.3	3.8	141	1.6	5.0
Nisutlin River	270	0.9	2.5	18	1.3	3.8
Sixty Mile River	1032	2.1	8.0	263	2.0	7.1
Stewart River	438	3.1	21.6	157	3.1	23.1
White River	601	3.4	29.2	152	3.4	29.0
Yukon River South	237	2.3	10.4	391	2.4	11.0

Note: For log–transformation, all zero data values were replaced with 0.001 mg/L

2.2.3 Summary Statistics

Summary statistics of field measurements (pH, conductivity, temperature and DO) for each watershed were not calculated due to the small number of sample results in the data base (~1,000 discrete results). The summary statistics by watershed and habitat suitability class are in most instances not amenable to calculation or are strongly influenced by very high variance.

Summary statistics for analytical results (TSS, turbidity, EC and pH) for the habitat suitability classes in each watershed are provided in **Appendix B**, with sample counts and number of TSS_{WQO} exceedances.

To evaluate potential seasonal trends in TSS, monthly statistics are also presented per watershed over the course of the May to October sampling season (**Appendix B**). Historical flow data and hydrographs for major Yukon watersheds, show that freshet generally starts in mid-April to May, peak flows are in early summer, and flows diminish by late-October[3,4]. Although onset of freshet varies slightly across watersheds and with elevation in a specific watershed, the following sub-seasons can be considered for seasonal analysis:

- April – May (Spring high flow/Freshet)

[3] Halm, D.R., and Dornblaser, M.M., 2007, Water and sediment quality in the Yukon River and its tributaries between Atlin, British Columbia, Canada, and Eagle, Alaska, USA, 2004: U.S. Geological Survey OpenFile Report 2007-1197, 120 p.

[4] Anthony Lapp, Ian D. Clark, Andrew L. Macumber & R. Timothy Patterson (2017) Hydrology of the North Klondike River: carbon export, water balance and inter-annual climate influences within a sub-alpine permafrost catchment, Isotopes in Environmental and Health Studies, 53:5, 500–517, DOI: 10.1080/10256016.2017.1355795

- June – July (Early Summer)
- August – September (Late Summer)
- October – March (Low Flow)

In a subset of watersheds (*e.g.,* Klondike River Watershed), TSS exceedances of their respective water quality objectives were higher in the spring and early summer months than later in the summer. Spring freshet is often accompanied by higher TSS and turbidity. In many of the watersheds, however, such TSS exceedances generally have been infrequent and have not varied appreciably across seasons (*e.g.,* based on WQOM results for Big Creek and Mayo River watersheds). The preliminary analysis may be useful in identifying watersheds where the seasonal flows may impact the TSS levels in the stream; however, further analysis of the flow data is required to confirm whether seasonal fluctuations in flow correlate with increased TSS levels and TSS_{WQO} exceedances. Additional analysis of flows at each station and refining of calculations per site may provide insight into cause and effect of trends in TSS in the various watercourses but is outside the scope of this study.

2.2.4 Frequency and Magnitude of TSS_{WQO} Exceedances

Overall, the frequency of TSS exceedance is slightly higher in category A watersheds (19%) than category B (10%) watersheds (**Table 2.7**), potentially due to the generally more stringent TSS_{WQO} for the more sensitive category. The frequency and magnitude of TSS_{WQO} exceedances are tabulated in **Appendix C**, per monitoring site, and per habitat suitability class in each watershed. Magnitude of exceedance is expressed as a Preliminary Risk Quotient (**PRQ)** where PRQ1 = maximum observed TSS / TSS_{WQO} and PRQ2 = 90th percentile TSS / TSS_{WQO}).

Table 2.7 Frequency of TSS_{WQO} exceedances in Category A and Category B watersheds

Watershed Category	Number of Sample Results	Number of TSS_{WQO} Exceedances	% Exceeding
A	12,749	2427	19%
B	4968	560	11%

Spatial coverage of water quality sampling sites and relative frequency of exceedance for each watershed is provided in **Appendix D**. Monitoring sites with <10% samples exceeding the TSS_{WQO} for that site are represented by a small green symbol, sites with 20 – 40% samples exceeding by a yellow symbol, and >40% by a red symbol.

2.3 Time Series Analysis

Time series plots of grab and integrated TSS data are presented in **Appendix E** for each habitat suitability class for each watershed. Note that not all six habitat suitability classes occur in all watersheds.

Grab samples (blue symbols) are differentiated from integrated ISCO samples (black symbols) in the plots, with no obvious difference between the data types that would indicate an effect of sample methodology on the elucidation of water quality trends.

3.0 DISCUSSION AND RECOMMENDATIONS

3.1 Summary of WQOM Sampling Efforts, 2007 Through 2020

The collated WQOM data for the last fourteen years is summarized in **Appendix C** for a total of 324 individual sites, including 161 Category A Watershed sites, 159 Category B Watershed sites, and four unclassified sites in the Jarvis River and Fourth of July Creek. There are five or fewer TSS results for 111 of 324 sites (35% of all WQOM sites). Such sites nonetheless provide useful information, especially about spatial trends of TSS along specific sub-watersheds.

The relative level of sampling effort across the individual WQOM sites, based on the acquisition of TSS concentration data from grab or integrated samples, is illustrated in **Figure 3.1** for Category A Watersheds and **Figure 3.2** for Category B Watersheds. **Figure 1** lists the sixteen Category A Watershed sites for which 200 or more TSS results are available from 2007 through 2020, in order of sampling effort.

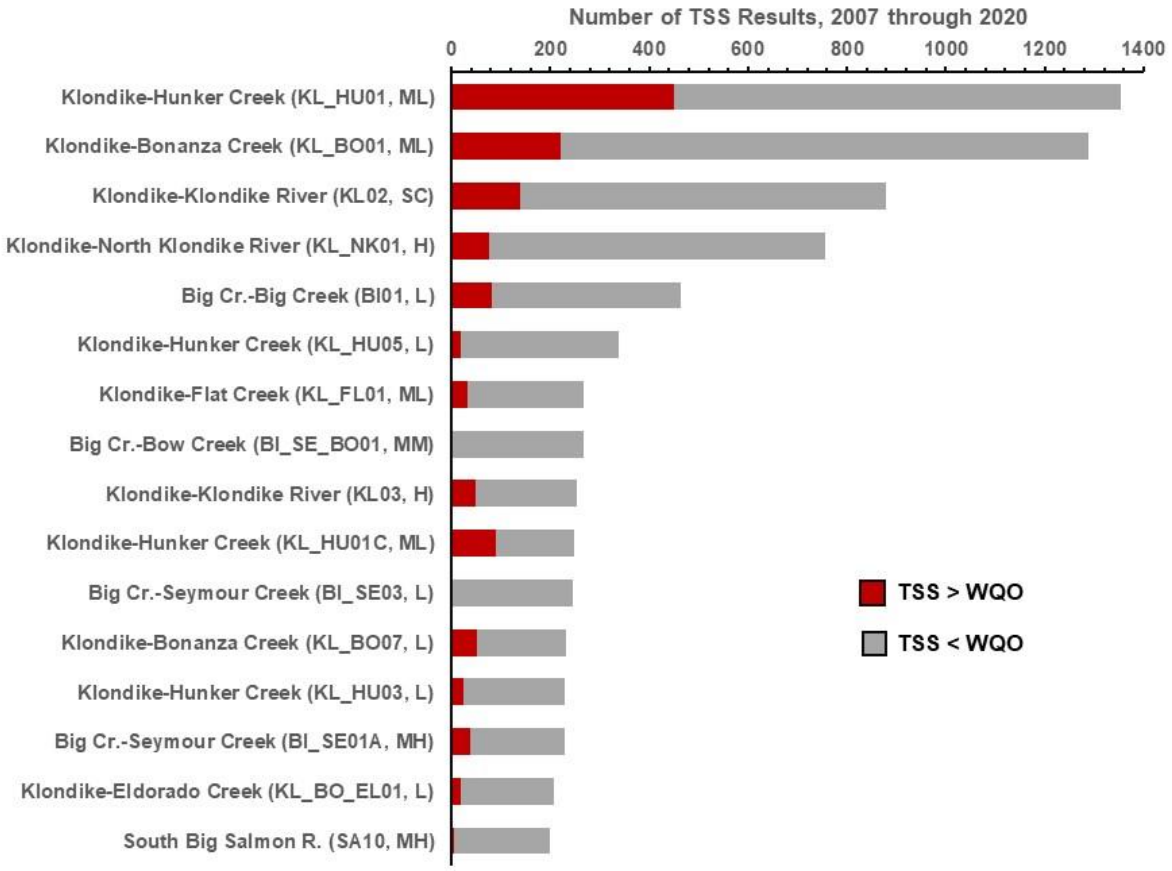

Figure 3.1 Relative level of WQOM sampling effort for Category A watersheds, 2007 through 2020

A high degree of WQO sampling effort has occurred in Klondike River and its tributaries, especially Hunker Creek and Bonanza Creek. **Figure 3.1** also provides the number of all TSS results that exceeded their respective WQO, based in turn on their sensitivity rating. Note that the major portion of most frequently sampled Category A Watershed sites are categorized as Low (L) of Moderate-Low (ML) habitat suitability. The relative sampling effort applied to different catchments and sites is probably a reflection of the level of active placer mining, and associated management needs.

Figure 3.2 similarly lists the ten Category B Watershed sites for which there are 150 or more individual TSS results in the 2007 through 2020 WQOM data collation. A lower level of TSS characterization effort has been applied to Category B Watershed sites over the 14 year period.

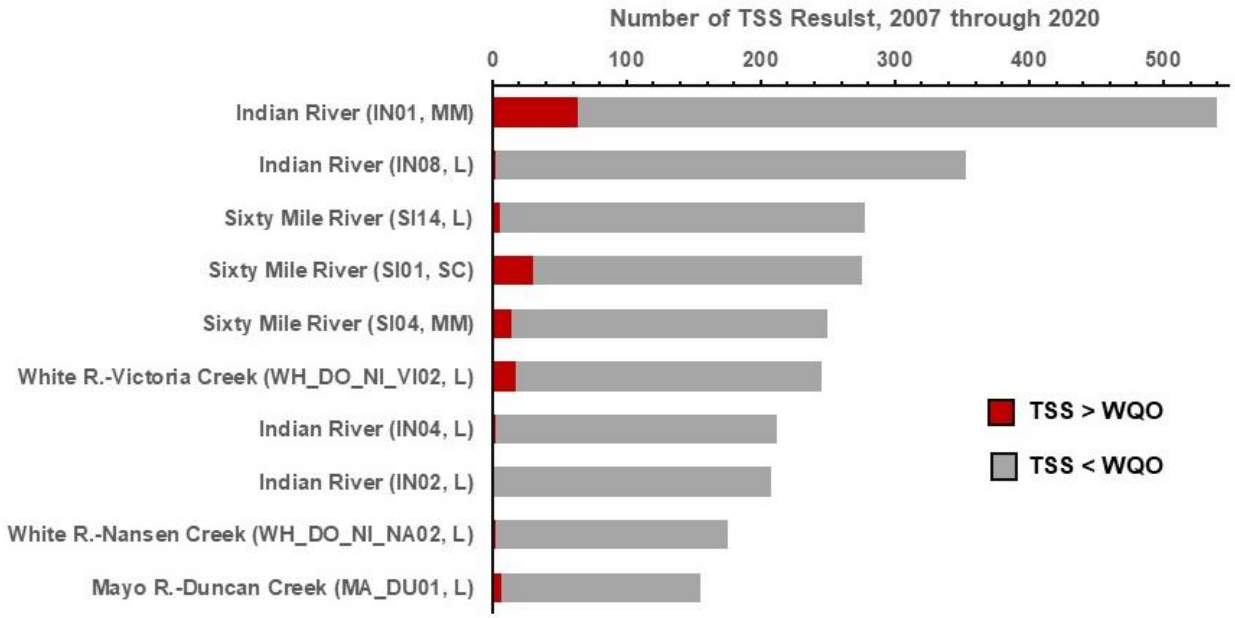

Figure 3.2 Relative level of WQOM sampling effort for Category B watersheds, 2007 through 2020

Rivers and tributaries that have been sampled more frequently and intensively in Category B Watersheds from 2007 through 2014 include especially the Indian River and Sixty Mile River. Seven of the ten most frequently sampled Category B Watershed sites are classified as having Low suitability, while two are Moderate-Moderate suitability, and one site is designated as an Area of Special Concern (Sixty Mile River, SI01).

3.2 Ranking of WQOM Sites Based on the Frequency and Magnitude Exceedances of Water Quality Objectives

A possible indicator of comparative pressures from placer mining activities on different catchments is the percentage of TSS results that exceeded their respective TSS_{WQO} (**Table 2.1**), as illustrated in **Figure 3.3** for Category A watershed sampling sites and **Figure 3.4** for Category B watershed sites. In both figures, the total number of TSS results that have been obtained under the WQOM program are indicated on the bar adjacent to the WQOM site name. Sites that had 5 or fewer TSS results in the 2007 though 2020 WQOM data were not assigned a ranking.

Those sites for which 40% or more of TSS sample results have exceeded their respective TSS_{WQO} are shown in **Figure 3.3**, ordered from the highest percentage (Hunker Creek, KL_HU1B: 100% of results exceeded TSS_{WQO}) to the lower percent. Sites for which fewer than 40% of TSS results exceeded their TSS_{WQO} are not shown.

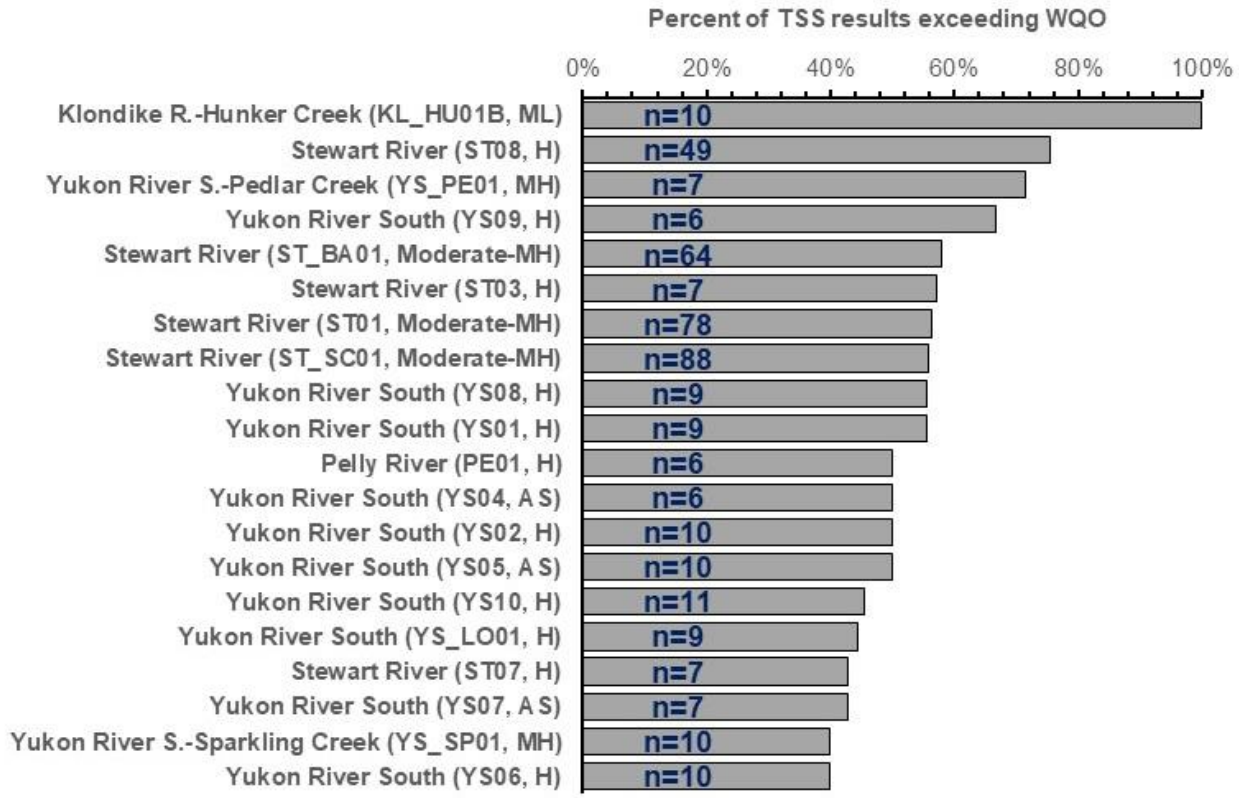

Figure 3.3 Ranking of Category A watershed sites based on percent of sample TSS results that exceeded their respective water quality objective

For both the Category A and Category B Watersheds, the major portion of sites exhibiting TSS results greater than their TSS_{WQO} in more than 40% of the samples collected from 2007 through 2020 were located on the mainstem of major rivers rather than tributary sub-watersheds. For example, TSS has been routinely observed at levels greater than the TSS_{WQO} for sites on the Stewart River (Figure 3: ST08, ST03, ST01, ST07), Yukon River South (YS09, YS08, YS01, YS04, YS02, YS05, YS10, YS07, YS06), and Pelly River (PE-01). Many of these sites are rated as high suitability.

The extent to which higher TSS in mainstem flows of Category A Watersheds is attributable to placer mining activity, versus naturally elevated TSS or other suspended sediment contributions is not known.

Sites with greater than 40% TSS results exceeding their TSS_{WQO} that have been sampled more extensively from 2007 through 2020 (49 or more TSS results over the 14 year period) include the following:

- Stewart River: ST08
- Stewart River, Barker Creek: ST_BA01
- Stewart River: ST01
- Stewart River, Scroggie Creek: ST_SC01

Similarly, the major portion of Category B Watershed sites located on the mainstem of major rivers consistently exhibited TSS concentrations that were greater than their TSS_{WQO} (**Figure 3.4**). This included especially sites on the Yukon River North, in contrast to its tributaries. The TSS exceedances are related, in part, to the categorization of these sites as either an Area of Special Concern or High suitability, both with a TSS_{WQO} of 25 mg/L.

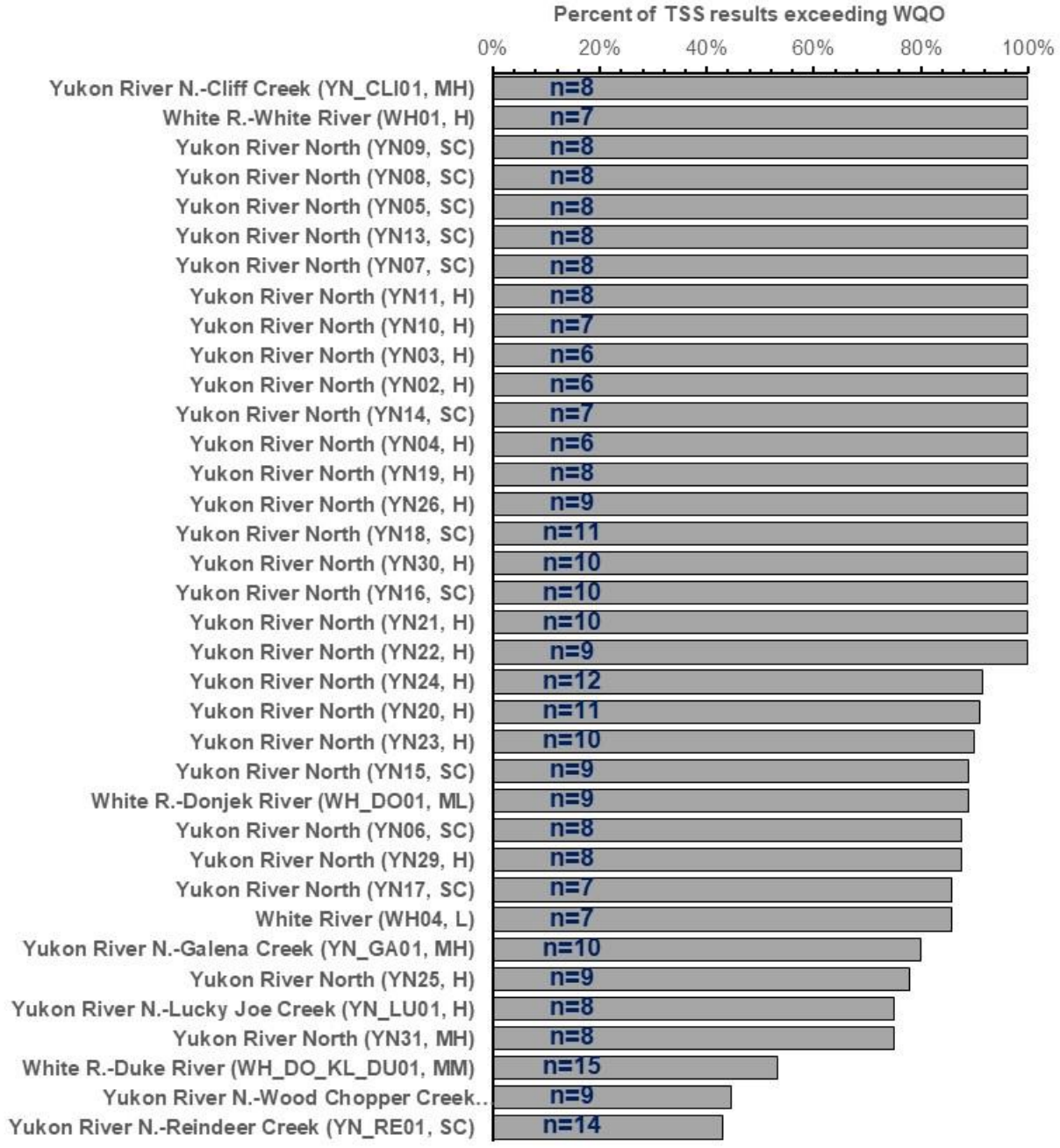

Figure 3.4 Ranking of Category B watershed sites based on percent of sample TSS results that exceeded their respective water quality objective

The frequency with which TSS results exceeded their respective TSS_{WQO} may be a reflection in many instances of an observed TSS concentration that was only marginally higher than the WQO. The degree to which a set of TSS results for a specific site are greater than the TSS_{WQO} was estimated herein as a preliminary risk quotient (PRQ2):

PRQ2 = 90th percentile TSS / TSS_{WQO}

Those WQOM sites with the highest PRQ2 values are listed (from higher to lower PRQ2 values) in **Figure 3.5** for Category A Watersheds and **Figure 3.6** for Category B Watersheds. For Stewart River, Barker Creek site ST_BA01 (Moderate-Low suitability) a PRQ2 value of 18.8 (**Figure 3.5**) signifies that the 90th percentile TSS concentration of 64 samples obtained from 2007 through 2020 exceeds the TSS_{WQO} of 80 mg/L by a factor of 18.8. The frequency of TSS_{WQO} exceedance for this site through the 14 year time span was 58%.

Note that **Figures 3.5** and **3.6** exclude those sites with a PRQ2 less than 2.0.

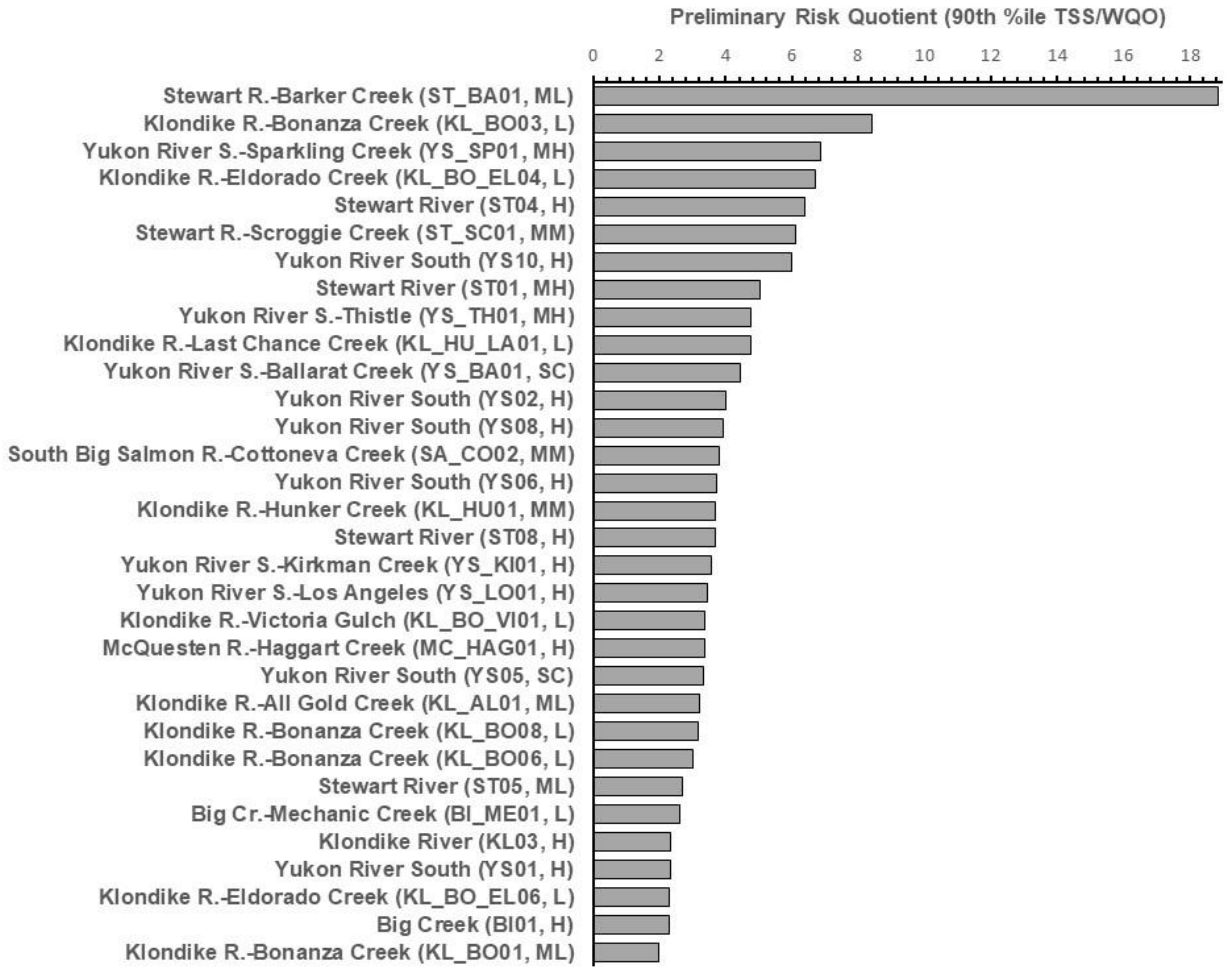

Figure 3.5 Rank order of Category A WQOM sites based on the magnitude of TSS concentrations (90th percentile value for all data obtained from 2007 through 2020) relative to the TSS_{WQO}

Those creeks that have exhibited highly elevated TSS for Category A Watersheds include –

- Stewart River watershed: Barker Creek and Scroggie Creek
- Klondike River watershed: Bonanza Creek, Eldorado Creek, Last Chance Creek, and Hunker Creek
- Yukon River South watershed: Sparkling Creek, Thistle Creek, Ballarat Creek
- South Big Salmon River: Cottoneva Creek

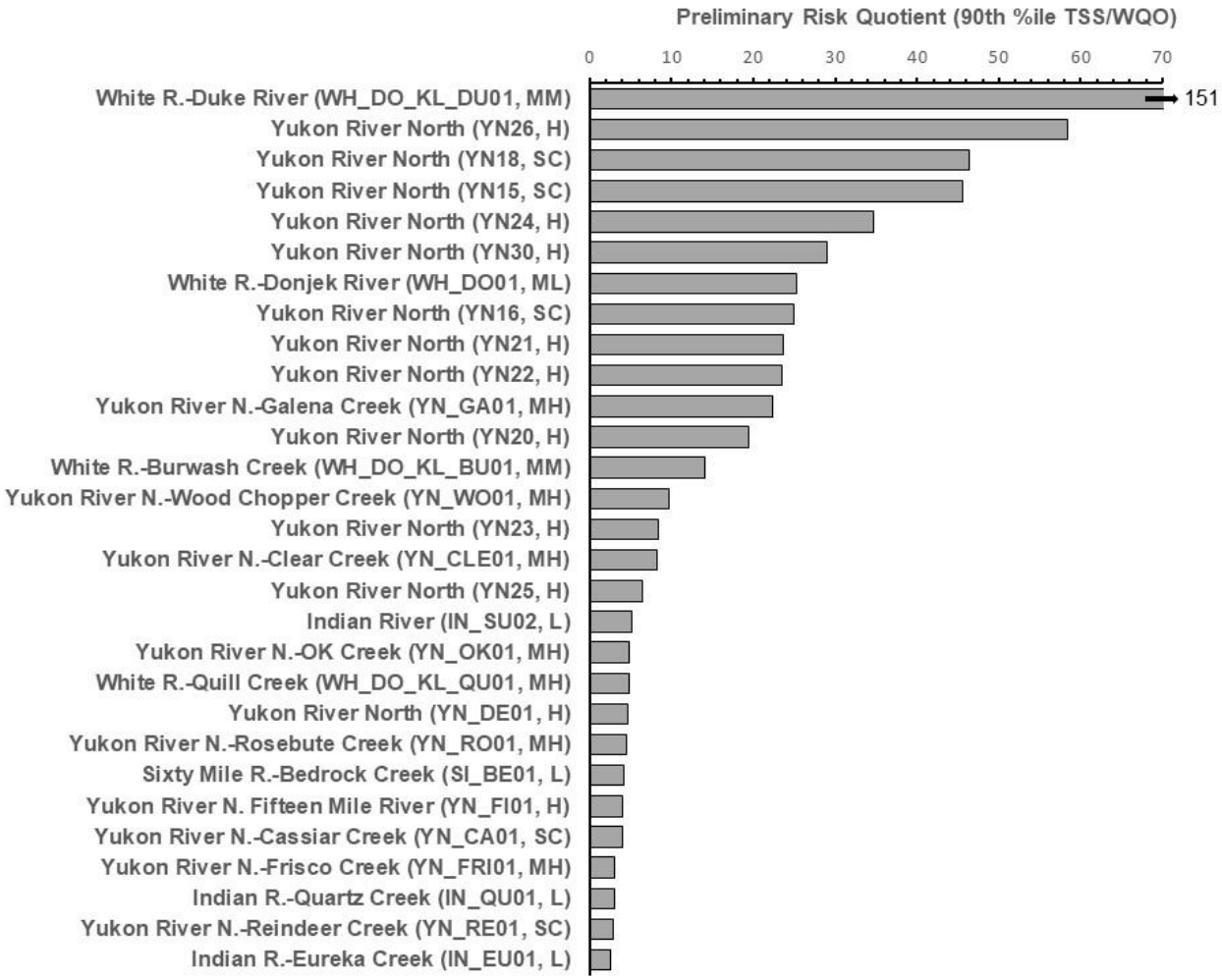

Figure 3.6 Rank order of Category B WQOM sites based on the magnitude of TSS concentrations (90th percentile value for all data obtained from 2007 through 2020) relative to the TSS_{WQO}

In Category B Watershed areas, those creeks that have exhibited highly elevated TSS include the following:

- White River watershed: Duke River, Donjek River, Burwash Creek, Quill Creek
- Yukon River North watershed: Galena Creek, Wood Chopper Creek, Clear Creek, OK Creek, Rosebute Creek

Note the scale of the x-axis (Preliminary Risk Quotient) for Category B sites (**Figure 3.6**) in comparison with Category A sites (**Figure 3.5**).

An examination of the magnitude of TSS exceedances in the WQOM in contrast to percent of sample results that exceed their TSS_{WQO} tends to de-emphasize TSS monitoring results in mainstem flows, and helps to highlight smaller tributary catchments that may be heavily influenced by placer activity or other types of disturbances and discharges.

The water quality of some Yukon watersheds, with respect to TSS, is very good as indicated by low percentage of samples exceeding the TSS_{WQO} and/or low magnitudes of exceedance (PRQ1 and PRQ2). For example, less than 20% of samples collected over the fourteen years exceeded their TSS_{WQO}, or had a PRQ2 >2 for the Alsek River, Fortymile River, Liard River, Mayo River, and Nisutlin River watersheds.

In most watersheds, only a small subset of monitoring sites exhibited a higher frequency of TSS_{WQO} exceedances, while TSS_{WQO} exceedances were not observed for the majority of the sites in the watershed. For example, the monitoring stations in the Indian River, Big Salmon River, and McQuesten River watersheds exceeded the TSS_{WQO} and have PRQ2 >2 only infrequently, with the exception of one to three stations that exhibited frequent and/or large exceedances of the TSS_{WQO}. In a watershed with most watercourses frequently meeting the TSS_{WQO}, these sites might be indicative of increased disturbance in the watercourse due to placer mining activity.

The Yukon River (North and South) and Klondike River stations exhibited a high frequency of exceedances at most stations, with up to 100% exceedances at some sites. The magnitude of exceedance was often very high, with PQR1 >10 and PQR2 >4. This may partially be an artifact of the high number of sites with low TSS_{WQO} in these watersheds (*i.e.,* Areas of Special Concern, High habitat suitability, and Moderate-High habitat suitability), in combination with the location of these sites along mainstem flows of relatively large and naturally turbid rivers.

3.3 Temporal Trends

With respect to seasonal trends, some watersheds, such as the Klondike River and Indian River watersheds, exhibited a higher frequency of TSS_{WQO} exceedances in April to July during freshet and close to the time of peak discharge. In watersheds such as the Mayo River, however, exceedances of TSS_{WQO} have been observed to be low (0–5%) throughout the sampling season. To better understand how flow and seasonality affects TSS levels in these watersheds, flow in various reaches, watersheds and individual watercourses could be evaluated using site-specific hydrometric data and flow measurements. Such an evaluation is beyond the scope of this report.

Trends and conditions are further discussed below for individual Category A and Category B watersheds.

3.4 TSS Conditions and Trends for Category A Watersheds

3.4.1 Big Creek Watershed

Big Creek is a major tributary of the Yukon River and drains an area of approximately 1,750 km^2. The drainage basin is centrally located west-south-west of Minto and south-west of Carmacks. Twenty monitoring stations, comprising all habitat suitability types, are established on Big Creek and its tributaries, with 2,059 samples collected between 2008 – 2011 and 2014 – 2016.

The observed concentrations of TSS have generally been below the TSS_{WQO} in the watershed: greater than 80% of all 2007 through 2020 WQOM results are lower than their objective. Exceedances were limited to three stations (Boliden Creek, Seymour Creek and Whirlwind Creek, with 25-33% of sample results exceeding TSS_{WQO} in the Moderate-Moderate and Low habitat suitability areas). The overall water quality, with respect to suspended solids, is considered very good in the watershed.

3.4.2 South Big Salmon River Watershed

The Big Salmon Range is a remote mountainous range in south-central Yukon with the elevations ranging from 600 – 2,400 m asl. Due to the mountainous terrain, streams are likely to produce a streamflow response that tends to be rapid and flashy[5].

The South Big Salmon River, with a drainage basin of approximately 515 km^2, drains into the larger Big Salmon River to the north. A total of 906 samples were collected in 2015, 2017 and 2018 from the South Big Salmon at the ten established monitoring stations. The observed TSS concentrations were routinely below the TSS_{WQO} (with fewer than 20% of sample results exceeding TSS_{WQO}), except for samples collected from Cottoneva Creek (SA_CO02) where 37% of historical samples were above the TSS_{WQO} of 50 mg/L TSS in a Moderate-Moderate habitat suitability zone. The max and 90^{th} percentile TSS levels at the SA_CO02 station are considerably higher than most other stations in the watershed (maximum = 5,932 mg/L, n = 192). The second highest TSS concentrations were observed in Livingstone Creek (SA_Ll01 maximum = 2,263 mg/L), with all other stations reporting very low TSS ranging from below detection to 295 mg/L.

Additional investigations may be warranted to discern why high TSS is observed at SA_CO02 and SA_Ll01 in contrast to observations for other tributaries and stations in the watershed (e.g., in relation to placer activity and intensity, stream gradient and discharge, or local to regional lithologies). The overall conditions in the South Big Salmon River watershed are considered good considering the few TSS_{WQO} exceedances observed through the historical monitoring program.

3.4.3 Klondike River Watershed

The Klondike River, a major tributary to the Yukon River, drains an area of approximately 7,800 km^2 and has an overall channel length of approximately 160 km [5]. The Klondike River and Dawson City are historically significant and central to the Klondike Gold Rush; with watercourses such as Hunker Creek, Bonanza Creek, and Allgold Creek that have been rerouted and reworked by both historical and ongoing placer activity.

The Klondike River has been a key area of focus of the WQOM program to date, due to the region's historical and cultural significance, extensive historical and on-going placer development, select areas of interest in the watershed by the local First Nations, and ease of access due to the network of access roads. The Klondike River Watershed has been monitored every year since the initiation of the program, with 7620 samples collected at 44 different WQOM stations.

[5] Yukon Placer Secretariat. 2019. Water Quality Objectives Monitoring Report (2018) – Fish Habitat Management System for Yukon Placer Mining.

Water quality (with respect to TSS) is variable within the watershed and it is difficult to discern from the overall dataset whether WQOM exceedances are due to placer activities (which are often intermittent, seasonally variable, and the amount of activity per operation may vary year to year) or natural conditions. In other reports (YG 2019, Hemmera 2021), a subset of watercourses within the watershed have been examined more closely using a case study approach to try and discern if elevated TSS is due to natural or anthropogenic influence.

Most TSS_{WQO} exceedances in the Klondike River Watershed are observed in areas classified as Moderate-Low habitat suitability, with 25% of samples exceeding the TSS_{WQO}. Overall, 19% of samples collected from 2007 through 2020 exhibited TSS levels that were greater than the TSS_{WQO}. Generally, TSS concentrations have been in the range from approximately 3 to 160 mg/L (10^{th} and 90^{th} percentiles).

3.4.4 Liard River Watershed

The Laird River Watershed was the focus of a targeted study in 2010, with 234 samples collected from 18 WQOM stations. Water quality, with respect to TSS, was very good in 2010 with only two (2) samples exceeding the site-specific objective of of 25 mg/L TSS[6]. TSS concentrations were generally observed to be in the range from 0.2 to 6.4 mg/L (10^{th} and 90^{th} percentile).

3.4.5 McQuesten River Watershed

The McQuesten River flows into the Stewart River which eventually joins the Yukon River south of Dawson. Flows are low in February, with high runoff and flows reported in May and June in response to snowmelt [7].

Water quality monitoring was conducted from 2007 – 2012 in the drainage basin, with 298 grab and integrated samples collected at 15 stations; most WQOM stations are located on the South McQuesten River, or on Haggart Creek, which has experienced considerable placer mining. The TSS_{WQO} were generally met in the watershed with 94% of measured TSS below the TSS_{WQO} for the various habitat suitability classes (Low, Moderate-Low, Moderate-Moderate, High and Areas of Special Consideration).

Placer mining occurs in the watershed (largely Haggart Creek) as early as March and in some areas continues as late as November. Prior to mining development, during spring melt in early May, sediment concentrations in Haggart Creek have been observed to be elevated[7]. Most observed TSS_{WQO} exceedances in the watershed for the period 2007-2013 have been associated with monitoring events conducted during the month of May, coinciding with spring freshet and high flows.

The most frequent exceedance and highest magnitude of exceedances (**Appendix C.1 and C.2**) were observed in Murphy's Pup, a tributary to Haggart Creek; however, there have been only a limited number of WQOM samples collected since the initiation of the program (3 of 4 samples were above the TSS_{WQO} of 50 mg/L TSS).

6 Laird River and tributaries in the Laird River Watershed has not been assigned a habitat suitability classification.

7 Yukon Placer Secretariat. 2009. Water Quality Objectives Monitoring Report (2008) – Fish Habitat Management System for Yukon Placer Mining.

3.4.6 Nitsultin River Watershed

Three (3) samples were collected in the Nitsultin River watershed in 2017 at three stations; the TSS results for all samples were below their TSS_{WQO}.

3.4.7 Pelly River Watershed

Six (6) samples were collected from one station classified as High habitat suitability on the Pelly River between 2009 and 2012. Three of the six samples exceeded the WQO of 25 mg/L TSS; all results ranged from 6.1 to 62 mg/L.

3.4.8 Stewart River Watershed

The Stewart River, a major tributary to the Yukon River, drains an area of approximately 51,000 km^2 and has an overall channel length of approximately 533 km [7]. The river stretches from the headwaters in the Mackenzie Mountains, joining the Yukon River approximately 112 km upstream from Dawson City.

Almost 600 samples were collected at 14 stations from 2008 through 2013 in the Stewart River Watershed with one sample collected in Clear Creek in 2020 to investigate high visible turbidity noted by residents of the area. The sample collected in Clear Creek exhibited a TSS level below the TSS_{WQO} for the Moderate-Moderate habitat suitability class station (ST_CL02).

Concentrations of TSS in the Stewart River and its tributaries are frequently higher than their respective TSS_{WQO}, with 35% of samples exhibiting TSS at a concentration higher than the TSS_{WQO}. In High habitat suitability areas with the most stringent TSS_{WQO} for the drainage basin, 60% of samples exhibited TSS concentrations that were above the TSS_{WQO} (n = 76). The highest TSS concentrations were measured in the Low, Moderate-Low and Moderate-Moderate habitat suitability classes (TSS_{WQO}), with a maximum TSS concentration of up to 3,714 mg/L in Barker Creek (ST_BA01).

Measured TSS generally ranged from 0.1 to 220 mg/L (10^{th} and 90^{th} percentile).

3.4.9 Yukon River South Watershed

The Yukon River is a major watercourse of north western North America. Over half of the river course occurs within Alaska, with most of the other portion lying in Yukon. A small portion of the watershed, in higher elevation headwater areas, is located in British Columbia. The river is 3,700 km long, making it the third longest river in North America, and empties into the Bering Sea at the Yukon-Kuskokwim Delta. The average flow is 6,430 m^3/s. The total drainage area is 832,700 km^2 of which 323,800 km^2 is in Canada[7]. This is the fourth largest drainage basin in North America. By comparison, the total area is more than 25% larger than the province of Alberta. Many large tributary rivers and streams flow into the catchment area of the Yukon River basin.

In Yukon, this river is divided into two sections, the North Yukon section, downstream from the Yukon River's confluence with the White River, and the South Yukon section, upstream from its confluence with the White River. The average water quality of the North Yukon River is much more turbid and higher in suspended solids concentrations than that of the South Yukon River due to the huge contribution of sediment and glacial material entering the Yukon River from the White River. Total suspended solids concentrations in the North Yukon can be 10 to 25 times higher than those found in the South Yukon.

Water quality monitoring was conducted from 2007 – 2013 and 2018, with 628 samples collected at 26 WQOM stations in the Yukon River and it's tributaries south of the confluence with White River. The frequency of TSS_{WQO} exceedances was similar in Areas of Special Consideration, High habitat suitability and Moderate-High suitability: 26 – 35% of samples collected in each of these classes exhibited TSS concentrations that were higher than their $TSS_{WQO.}$ No TSS_{WQO} exceedances were observed for the 112 samples collected in Moderate-Low habitat suitability areas.

Monthly statistics (**Appendix B.16**) show TSS concentrations increase toward the period of peak river discharge, typically in July, and then decrease thereafter. For WQOM samples collected from May to October, 24 – 66% of TSS concentrations exceeded the TSS_{WQO}.

TSS concentrations in the Yukon River South Watershed typically occur within a range from 2.0 – 53.0 mg/L (10^{th} and 90^{th} percentile). The highest TSS concentrations have been observed in the Thistle Creek tributary (maximum = 1,579 mg/L TSS, 90^{th} percentile = 119 mg/L TSS).

3.5 TSS Conditions and Trends for Category B Watersheds

3.5.1 Fortymile River Watershed

The Fortymile River, a major tributary to the Yukon River, drains an area of approximately 16,600 km^2 and has an overall channel length of approximately 97 km [7]. The drainage basin is located northwest of Dawson, with the headwaters originating in Alaska.

Twenty-four (24) grab samples were collected from five WQOM stations in 2007 – 2008, 2010 – 2013 and 2017. Nearly all samples exhibited TSS concentrations that were below the TSS_{WQO}; only one sample of 22 exceeded its TSS_{WQO} at the four stations monitored in Areas of Special Consideration, and no exceedances were observed in the two samples collected the one station in a Low habitat suitability area. The TSS concentrations observed in WQOM samples from the Fortymile River were in the range from 0.6 – 1,900 mg/L, and this watershed is considered to be in good condition with respect to suspended solids inputs and transport.

3.5.2 Indian River Watershed

The Indian River, a major tributary to the Yukon River, drains an area of approximately 2,220 km^2 and has an overall channel length of approximately 120 km. The Indian River Watershed lies within the Klondike Plateau, a gently sloping upland south of Tintina Trench. The present flood plain descends about 53 m over a distance of 33 km with an overall gradient of about 1.6 m/km between the confluences of Dominion Creek and Ruby Creek.

The Indian River Watershed was monitored from 2007 – 2011, 2013 and 2017 – 2018 with 1,793 integrated and grab samples collected from 45 stations on the Indian River and it's tributaries. Monitoring stations in the watershed generally are located in Low habitat suitability areas with a few stations located in Moderate-Moderate habitat suitability areas. Reported TSS levels range from 3.6 – 92 mg/L (10^{th} and 90^{th} percentile) with only 5% of samples overall exceeding the TSS_{WQO}. Exceedances were not observed in Indian River, but rather it's tributaries, including Dominion Creek, Jenson Creek, Quartz Creek and Sulphur Creek tributaries. The highest TSS levels were observed in Sulphur Creek.

3.5.3 Mayo River/Lake Watershed

The Mayo River Watershed (also known as Mayo Lake Watershed) is a relatively small basin; the Mayo River is an outlet of Mayo Lake, and drains into the Stewart River (a major tributary to the Yukon River). A total of 484 integrated and grab samples were collected from seven stations in the watershed: six stations in Low habitat suitability areas and one station a High habitat suitability area. Monitoring in the Mayo River/Lake Watershed was completed in 2007-2009 and 2011-2012.

All 68 samples collected from the High habitat suitability area at stations on the Mayo River exhibited TSS concentrations that were below the TSS_{WQO}, and only 2% of samples in the Low habitat suitability areas exhibited a TSS concentration above the TSS_{WQO}, primarily on the Duncan Creek tributary. Overall, reported TSS levels were low, ranging from 1.7 – 100 mg/L (10^{th} and 90^{th} percentile).

3.5.4 Sixty Mile River Watershed

The Sixty Mile River is a major tributary of the Yukon River, with the headwaters originating in Alaska. The Sixty Mile River Watershed includes vast areas of active mining as well as inactive, reclaimed and partially reclaimed areas. Placer gold was discovered in the Sixty Mile River area in late 1800s: the principle creeks mined were Miller, Glacier, Big Gold, Little Gold and Bedrock creeks[7].

The watershed has been a key area of focus of water quality monitoring due to the high level of placer mining activity in the Sixty Mile River and tributaries. A total of 1,295 integrated and grab samples have been collected at 22 sampling stations between 2007 – 2013 and in 2016. Monitoring stations are located in areas of special consideration, Moderate-Moderate, Moderate-Low and Low habitat suitability class designated sections of the watercourses.

Overall, TSS levels generally ranged from 0.9 – 72 mg/L (10^{th} and 90^{th} percentile) with 4% of all samples exhibiting TSS concentrations higher then the TSS_{WQO} for a given station. Of the habitat suitability classes, stations in the Areas of Special Consideration exceeded the TSS_{WQO} most frequently (6% of samples). The range of TSS concentrations observed for this sensitive class is similar or the range of other WQOM stations in the Sixty Mile River Watershed, but TSS_{WQO} exceedances have been observed more frequently due to the more stringent TSS_{WQO} of 25 mg/L relative to the higher TSS_{WQO} of 200 – 300 mg/L TSS for stations the lower habitat suitability classes in the watershed.

3.5.5 White River Watershed

The White River, with a drainage area of about 50,504 km^2, contributes large amounts of silt and sediment from glacier and mountain runoff into Yukon River[7]. Many large tributary rivers and streams flow into the catchment area of the White River watershed. The confluence of the White River with the Yukon River creates the point that delineates the Yukon River North Watershed from the Yukon River South Watershed.

The White River and its tributaries were monitored from 2007 – 2013 and 2015 – 2016 with 758 integrated and grab samples collected at 22 stations within Low to High habitat suitability areas. Water quality generally met the TSS_{WQO}, with 11% of total samples exhibiting a TSS concentration greater than the TSS_{WQO}. The highest frequency of exceedances was observed in the High habitat suitability and Low habitat suitability stations; however, it is important to note fewer than 10 samples have been collected at these locations from 2007 to the present time, and acquisition of a greater number of water samples would provide more confidence in the data.

Reported TSS generally ranged from approximately 3 – 279 mg/L (10th and 90th percentile) with the highest TSS levels and most frequent exceedances recorded in Burwash Creek, Donjek Creek, Duke River, and White River at stations WH01 and WH04.

3.5.6 Yukon River North Watershed

The Yukon River is divided into two sections, with the North Yukon Watershed being downstream from the Yukon River's confluence with the White River. The North Yukon River is much more turbid and higher in suspended solids concentrations than that of the South Yukon River due to the contribution of sediment and glacial material entering the Yukon River from the White River Watershed. TSS concentrations in the North Yukon River Watershed can be 10 – 25 times higher than those found in the South Yukon River Watershed. Many large tributary rivers and streams flow into the catchment area of the Yukon River basin.

TSS concentrations observed in North Yukon River Watershed WQOM samples are quite high, with reported concentrations typically between 1.0 and 520 mg/L (10th and 90th percentile) and a mean value of 137 mg/L TSS for the 610 samples collected from the 58 stations in the drainage basin. WQOM samples have frequently exceeded the TSS_{WQO} throughout the monitoring program (2007 – 2013, 2017), in part due to the High habitat suitability classification of many of the stations. Fifty-five of the 58 stations have a stringent TSS_{WQO} of 25 mg/L due to classification as an Area of Special Consideration, High habitat suitability or Moderate-High habitat suitability. Overall, 51% of samples collected over the annual monitoring program exhibited a TSS concentration that was higher than the TSS_{WQO} for a given station.

3.6 TSS Conditions and Trends for Uncategorized Watersheds (Alsek Watershed)

The Alsek River Watershed was the focus of a targeted study in 2017 with 448 samples collected from four WQOM stations, primarily using the ISCO integrated sampling methodology. Water quality was considered very good in 2017; no samples were above TSS_{WQO} at the one station in a High habitat suitability area, with 21 of 344 samples exceeding the TSS_{WQO} at the three Moderate-Low habitat suitability sites.

3.7 Recommendations

A review of the existing discrete and integrated sampling procedures[2] showed no major issues with the existing methodology. Comparison of the data variability (*e.g.,* based on the co-efficient of variation) and central tendencies for TSS data obtained from discrete (grab) water samples and integrated (ISCO) sample data indicates that the two water sampling methods provide comparable data. Thus, the ability to understand spatial or temporal trends in suspended sediment loads should not be compromised based on acquisition of the TSS data using two different approaches. Either or both of these methods are recommended for continued monitoring.

We conclude that the general approach to monitoring efforts is reasonable; i.e., the level of monitoring devoted to each watershed and station is based on several factors, including overall habitat sensitivity, the amount of historical and current mining activity, any outstanding questions or concerns arising from previous monitoring efforts, and changes in environmental conditions in the watershed. The data summaries, statistics and time series summaries provided in **Appendix C** to this report are intended to support the planning and prioritization of future WQOM annual programs.

This review of 2007 through 2020 WQOM data provides an overview of water quality conditions in Yukon watersheds. It does not, however, attribute the cause of any highlighted systematic exceedances of TSS_{WQO}. In fact, the WQOM Protocol is not well-equipped to elucidate the root causes of specific cases where TSS concentrations have been observed to exceed TSS_{WQO}, or for any observed spatial or temporal trends in TSS concentrations.

The ability to confidently determine whether elevated TSS is attributable to one or more placer mining operations is tied to either (i) an ability to concretely document changes from the reference state resulting from placer mining activities (e.g. based on a before-after, or upstream-downstream set of contrasts), or (ii) an ability to rule out other possible causes or contributory factors when higher concentrations of TSS are observed.

Before-after and upstream-downstream contrasts are undermined by the fact that placer-related inputs of TSS tend to occur without prior notification, resulting in insufficient time to plan and acquire water quality data with sufficient spatial or temporal resolution to confidently detect the relevant patterns. Such contrasts are also undermined by the degree to which placer-related inputs of TSS to a local stream reach are typically highly variable within a single day and between days when the placer mine is operating. Evidence of a pulse-type sediment discharge will diminish rapidly as the stream water is conveyed downstream and is mixed with the larger conveyed volume of water. This limits the ability to detect an anomalously high input of sediments to a stream after the fact.

Amongst the other contributory factors that could theoretically alter TSS in a catchment or portion thereof, are the following:

- Position of a sampling location within a watershed, from higher elevation headwater areas to the mouth.
- Local gradient (steepness) of the streambed or riverbed
- Local to regional lithologies (soil and sediment characteristics; bedrock characteristics), including differences between areas within and outside of glacial refugia.
- Average stream/river discharge, which increases progressively from the upper to lower reaches of a gaining head water course.
- Seasonal and shorter-term variations in stream/river discharge in association with snow melt and rainfall.
- Interannual variations in climatic conditions, especially based on snowpack accumulation and peak rainfall events.
- Vegetated status of the surrounding landscape, and influence of forest fires.

Some of the root causes of confounding (or natural) variation in TSS loads are addressed in the WQOM Protocol; for example, streamflow data and stream channel cross-sectional area are routinely collected. To the present time, however, it appears that no attempt has been made to develop a predictive model of suspended sediment loads and transport in Yukon River watersheds based on natural drivers, and the additional anthropogenic contributions.

We recommend further work on the basic conceptual models from a hydrological perspective, towards achieving a better understanding of anthropogenically influenced and unperturbed suspended sediment loads in Yukon watersheds. An improvement of the detailed conceptual understanding of how suspended sediments enter and are conveyed through watercourses could help advance the larger understanding of differences in sensitivities between sites and between catchments to human-caused sediment inputs.

It is a daunting task to advance the conceptual model for suspended sediment inputs and transport for the larger set of FHMS watersheds; however, focused case studies of various smaller watersheds that encompass systems under very limited to very severe placer mining pressures will be useful for developing a better understanding of the relevant system dynamics and drivers.

In addition, there is an increased importance from the upper to lower end of watercourses of the integrated influence of multiple-point and non-point suspended sediment inputs on the observed TSS concentrations. The circulating load of sediments within the watershed includes both the TSS entrained in actively flowing water and transient bed sediments prone to scour and re-settlement downstream. It is recommended that the WQOM include two major focuses: (i) evaluation of the aquatic environmental implications of a specific placer mine; and (ii) evaluation of the cumulative influences of placer mining within a specific catchment.

An investigative approach or case study evaluation on a site-by-site or watercourse-by-watercourse basis is the next recommended phase in evaluating if TSS_{WQO} are due to natural variations in suspended solids in the stream, or the direct result of placer mining activity. This subsequent analysis may involve evaluating the type of placer activity noted in the watercourse by field personnel at the time of the sampling event, using geomatics analysis to map the footprint of placer mining activity in the watercourses using satellite imagery, and an analysis of the flow regime in the watershed and it's watercourses relative to timing of TSS_{WQO} exceedances.

A key to success in these detailed investigations and tracking is continued acquisition of TSS data for long-term trend analysis, and good record keeping of site conditions and placer activity in watercourses whenever possible. We recommend that two to four watercourses are selected as case studies to use the qualitative and quantitative data to evaluate potential cause-and-effect of TSS_{WQO} exceedances in particularly sensitive and/or frequently exceeding locations.

4.0 CLOSURE

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

Report prepared by:
Hemmera Envirochem Inc.

Nicole Marsh, MSc, GIT
Environmental Scientist

Report reviewed by:
Hemmera Envirochem Inc.

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Practice Lead – Environmental Risk Assessment

APPENDIX A
ProUCL Outputs

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options

Date/Time of Computation	22/05/2020 3:21:46 PM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	0.95

TSS_all

Raw Statistics

Number of Valid Observations	2059
Number of Distinct Observations	457
Minimum	0.001
Maximum	66820
Mean of Raw Data	54.78
Standard Deviation of Raw Data	1477
Khat	0.246
Theta hat	222.9
Kstar	0.246
Theta star	223
Mean of Log Transformed Data	1.104
Standard Deviation of Log Transformed Data	2.254

Normal GOF Test Results

Correlation Coefficient R	0.105
Lilliefors Test Statistic	0.485
Lilliefors Critical (0.05) Value	0.0195

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.294
A-D Test Statistic	4.857E+27
A-D Critical (0.05) Value	0.901
K-S Test Statistic	0.266
K-S Critical(0.05) Value	0.0233

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.929
Lilliefors Test Statistic	0.135
Lilliefors Critical (0.05) Value	0.0195

Data not Lognormal at (0.05) Significance Level

TSS_grab

Raw Statistics

Number of Valid Observations	1634
Number of Distinct Observations	286

Minimum	0.001
Maximum	418.7
Mean of Raw Data	9.615
Standard Deviation of Raw Data	23.55
Khat	0.475
Theta hat	20.23
Kstar	0.475
Theta star	20.24
Mean of Log Transformed Data	0.917
Standard Deviation of Log Transformed Data	2.207

Normal GOF Test Results

Correlation Coefficient R	0.602
Approximate Shapiro Wilk Test Statistic	0.39
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.342
Lilliefors Critical (0.05) Value	0.0219

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.896
A-D Test Statistic	45.3
A-D Critical (0.05) Value	0.829
K-S Test Statistic	0.118
K-S Critical(0.05) Value	0.0257

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.894
Approximate Shapiro Wilk Test Statistic	0.79
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.166
Lilliefors Critical (0.05) Value	0.0219

Data not Lognormal at (0.05) Significance Level

TSS_isco

Raw Statistics

Number of Valid Observations	224
Number of Distinct Observations	131
Minimum	0.001
Maximum	66820
Mean of Raw Data	361.8
Standard Deviation of Raw Data	4469
Khat	0.178
Theta hat	2033
Kstar	0.179
Theta star	2026
Mean of Log Transformed Data	1.68
Standard Deviation of Log Transformed Data	2.157

Normal GOF Test Results

Correlation Coefficient R	0.214
Approximate Shapiro Wilk Test Statistic	0.0809
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.468
Lilliefors Critical (0.05) Value	0.0592

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

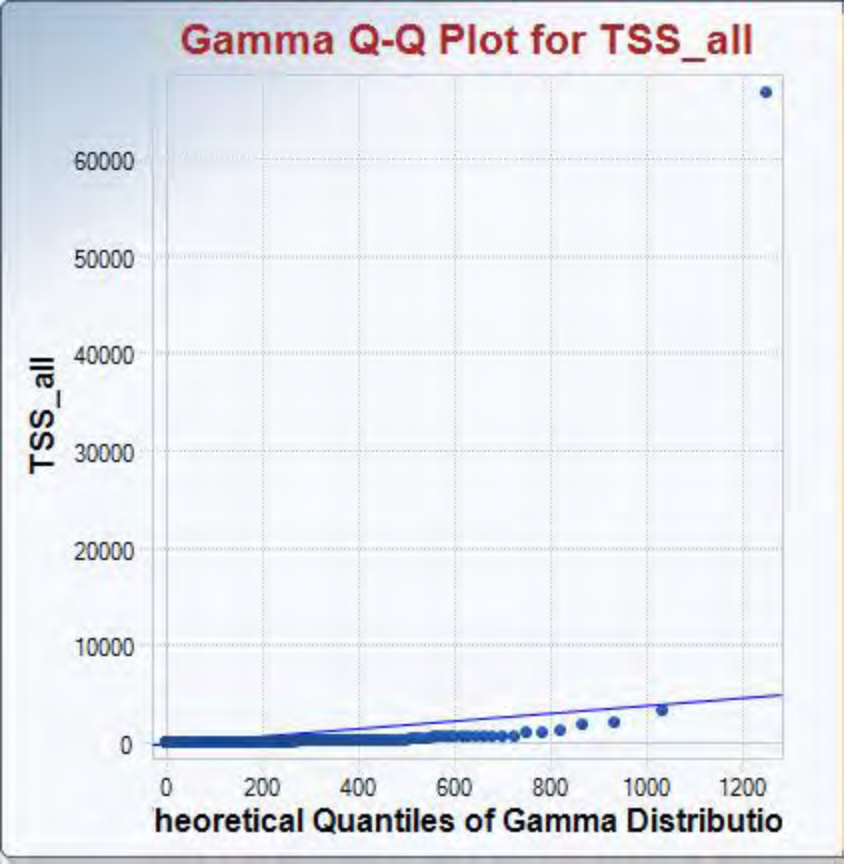
Correlation Coefficient R	0.555
A-D Test Statistic	40.08
A-D Critical (0.05) Value	0.942
K-S Test Statistic	0.307
K-S Critical(0.05) Value	0.0682

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.97
Approximate Shapiro Wilk Test Statistic	0.96
Approximate Shapiro Wilk P Value	5.9976E-5
Lilliefors Test Statistic	0.0918
Lilliefors Critical (0.05) Value	0.0592

Data not Lognormal at (0.05) Significance Level



TSS_all

N = 2059

Mean = 54.7759

k hat = 0.2457

theta hat = 222.9359

Slope = 3.9493

Intercept = -161.4152

Correlation, R = 0.2944

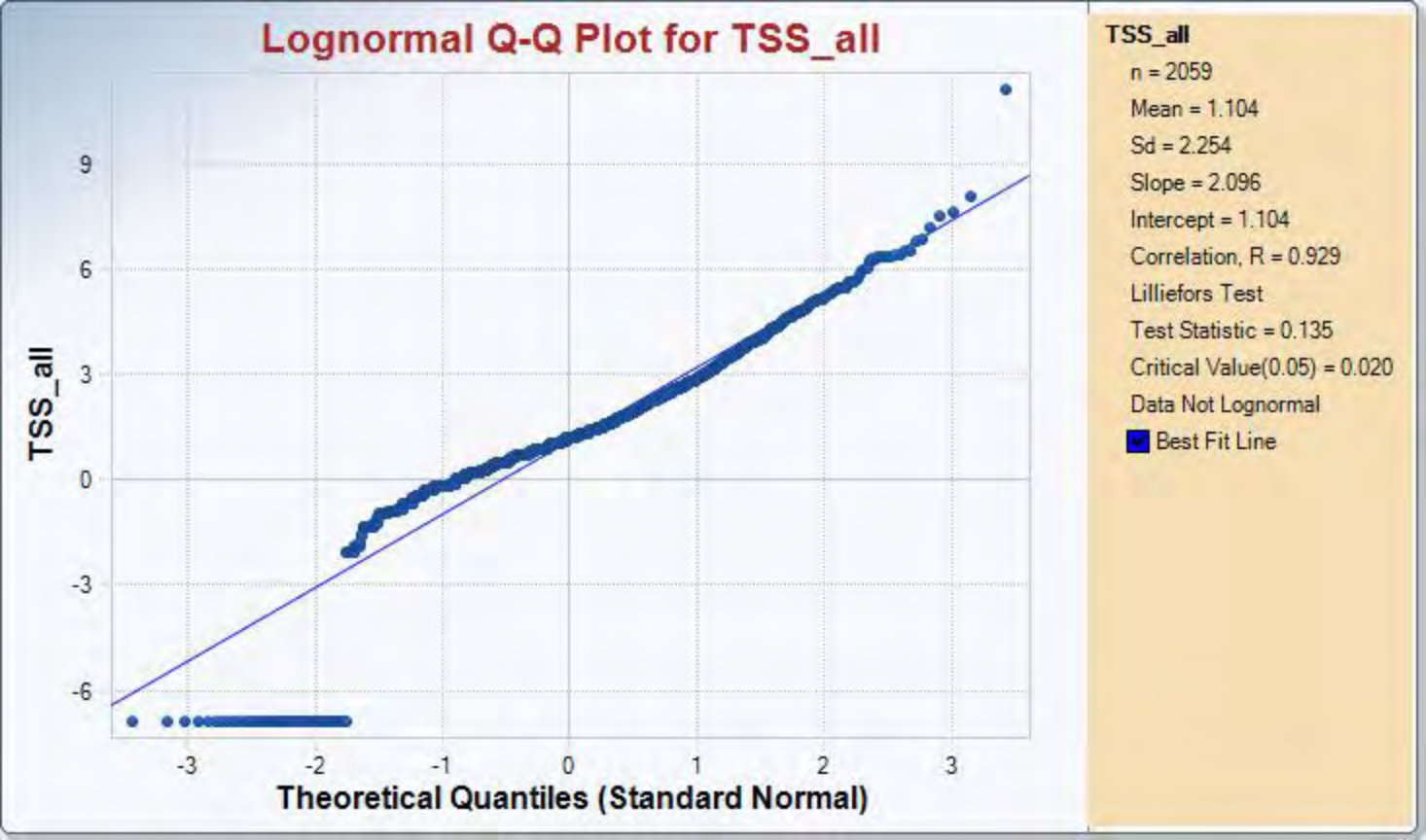
Anderson-Darling Test

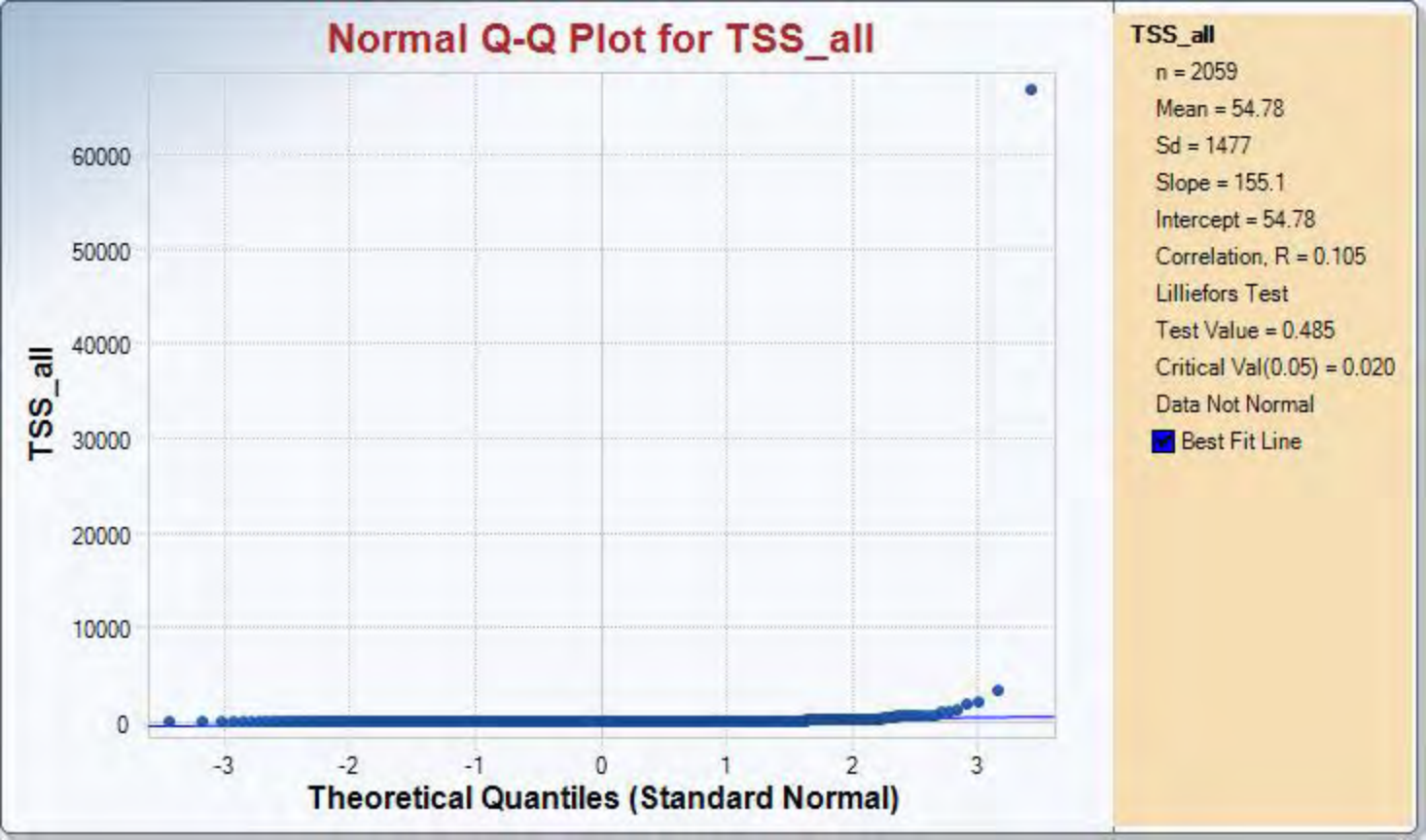
Test Statistic = 485672656629432000000000000.000

Critical Value(0.05) = 0.901

Data not Gamma Distributed

Best Fit Line


Lognormal Q-Q Plot for TSS_all
TSS_all
Theoretical Quantiles (Standard Normal)
9
6
3
0
-3
-6
-3
-2
-1
0
1
2
3
TSS_all
n = 2059
Mean = 1.104
Sd = 2.254
Slope = 2.096
Intercept = 1.104
Correlation, R = 0.929
Lilliefors Test
Test Statistic = 0.135
Critical Value(0.05) = 0.020
Data Not Lognormal
Best Fit Line


Normal Q-Q Plot for TSS_all
TSS_all
60000
50000
40000
30000
20000
10000
0
-3
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
TSS_all
n = 2059
Mean = 54.78
Sd = 1477
Slope = 155.1
Intercept = 54.78
Correlation, R = 0.105
Lilliefors Test
Test Value = 0.485
Critical Val(0.05) = 0.020
Data Not Normal
Best Fit Line

INDIAN RIVER

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options

Date/Time of Computation	22/05/2020 3:25:40 PM
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	0.95

TSS_all

Raw Statistics

Number of Valid Observations	1790
Number of Distinct Observations	751
Minimum	0.001
Maximum	10615
Mean of Raw Data	54.2
Standard Deviation of Raw Data	306.1
Khat	0.554
Theta hat	97.77
Kstar	0.554
Theta star	97.86
Mean of Log Transformed Data	2.865
Standard Deviation of Log Transformed Data	1.373

Normal GOF Test Results

Correlation Coefficient R	0.306
Approximate Shapiro Wilk Test Statistic	0.131
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.43
Lilliefors Critical (0.05) Value	0.0209

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.537
A-D Test Statistic	5.587E+27
A-D Critical (0.05) Value	0.818
K-S Test Statistic	0.159
K-S Critical(0.05) Value	0.0244

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.983
Approximate Shapiro Wilk Test Statistic	0.973
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.0301
Lilliefors Critical (0.05) Value	0.0209

Data not Lognormal at (0.05) Significance Level

TSS_grab

Raw Statistics

Number of Valid Observations	1130
Number of Distinct Observations	385
Minimum	0.001
Maximum	352
Mean of Raw Data	24.28
Standard Deviation of Raw Data	29.04
Khat	0.98
Theta hat	24.78
Kstar	0.978
Theta star	24.83
Mean of Log Transformed Data	2.599
Standard Deviation of Log Transformed Data	1.237

Normal GOF Test Results

Correlation Coefficient R	0.832
Approximate Shapiro Wilk Test Statistic	0.709
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.203
Lilliefors Critical (0.05) Value	0.0264

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.981
A-D Test Statistic	6.302
A-D Critical (0.05) Value	0.786
K-S Test Statistic	0.0492
K-S Critical(0.05) Value	0.0286

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.963
Approximate Shapiro Wilk Test Statistic	0.934
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.0463
Lilliefors Critical (0.05) Value	0.0264

Data not Lognormal at (0.05) Significance Level

TSS_isco

Raw Statistics

Number of Valid Observations	412
Number of Distinct Observations	308
Minimum	0.625
Maximum	10615
Mean of Raw Data	109.3
Standard Deviation of Raw Data	624.7
Khat	0.377
Theta hat	290.2

Kstar	0.375
Theta star	291.1
Mean of Log Transformed Data	2.929
Standard Deviation of Log Transformed Data	1.508

Normal GOF Test Results

Correlation Coefficient R	0.359
Approximate Shapiro Wilk Test Statistic	0.172
Approximate Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.431
Lilliefors Critical (0.05) Value	0.0437

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

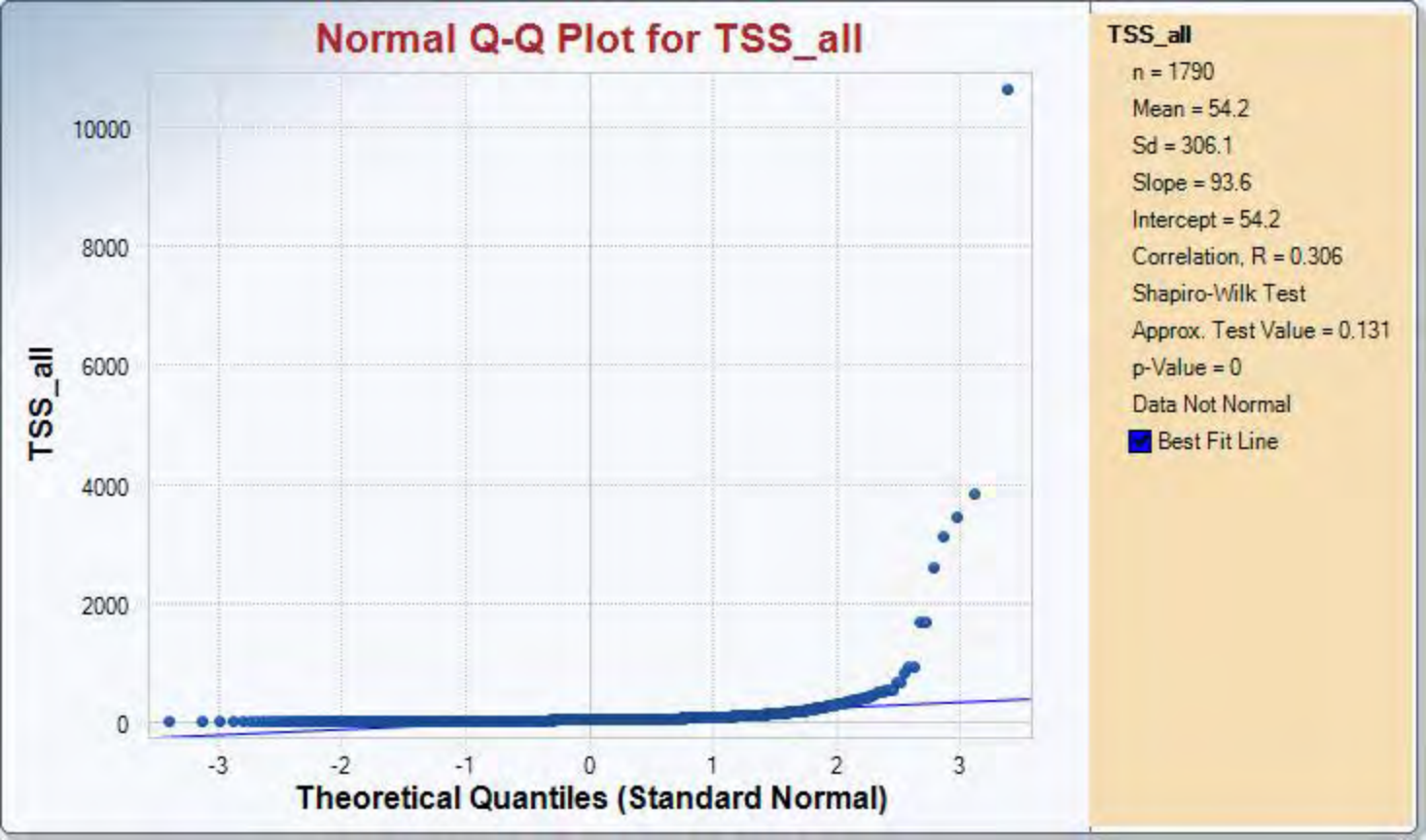
Correlation Coefficient R	0.684
A-D Test Statistic	2.427E+28
A-D Critical (0.05) Value	0.853
K-S Test Statistic	0.229
K-S Critical(0.05) Value	0.048

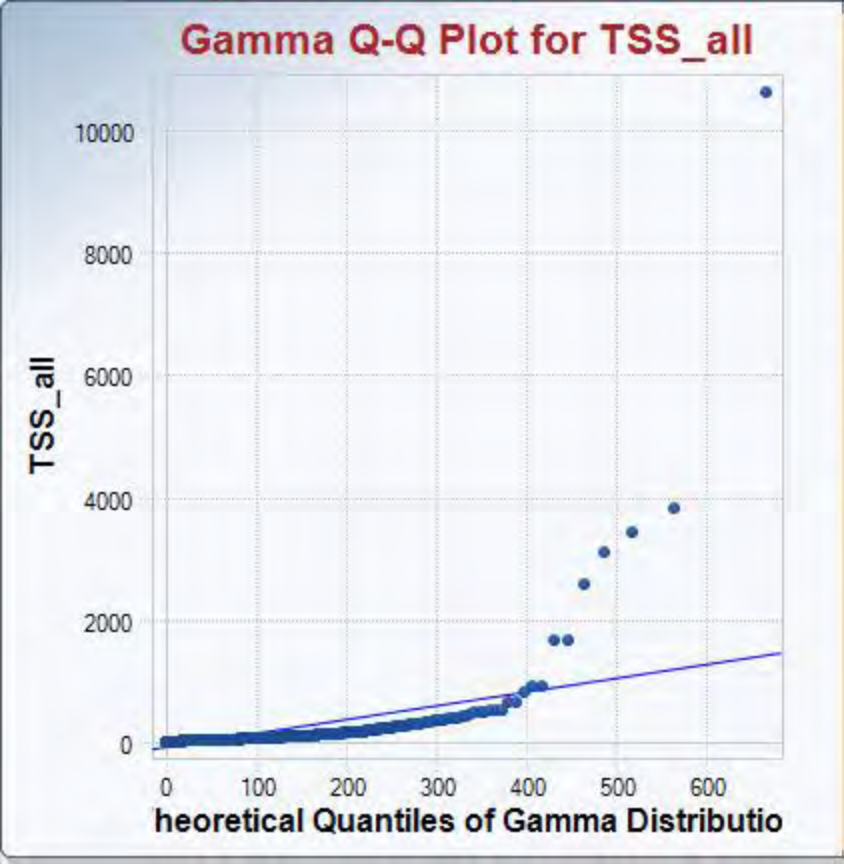
Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.987
Approximate Shapiro Wilk Test Statistic	0.966
Approximate Shapiro Wilk P Value	2.3780E-6
Lilliefors Test Statistic	0.0551
Lilliefors Critical (0.05) Value	0.0437

Data not Lognormal at (0.05) Significance Level


Normal Q-Q Plot for TSS_all
TSS_all
10000
8000
6000
4000
2000
0
-3
-2
-1
0
1
2
3
Theoretical Quantiles (Standard Normal)
TSS_all
n = 1790
Mean = 54.2
Sd = 306.1
Slope = 93.6
Intercept = 54.2
Correlation, R = 0.306
Shapiro-Wilk Test
Approx. Test Value = 0.131
p-Value = 0
Data Not Normal
Best Fit Line



TSS_all

N = 1790

Mean = 54.2018

k hat = 0.5544

theta hat = 97.7660

Slope = 2.2608

Intercept = -68.2993

Correlation, R = 0.5368

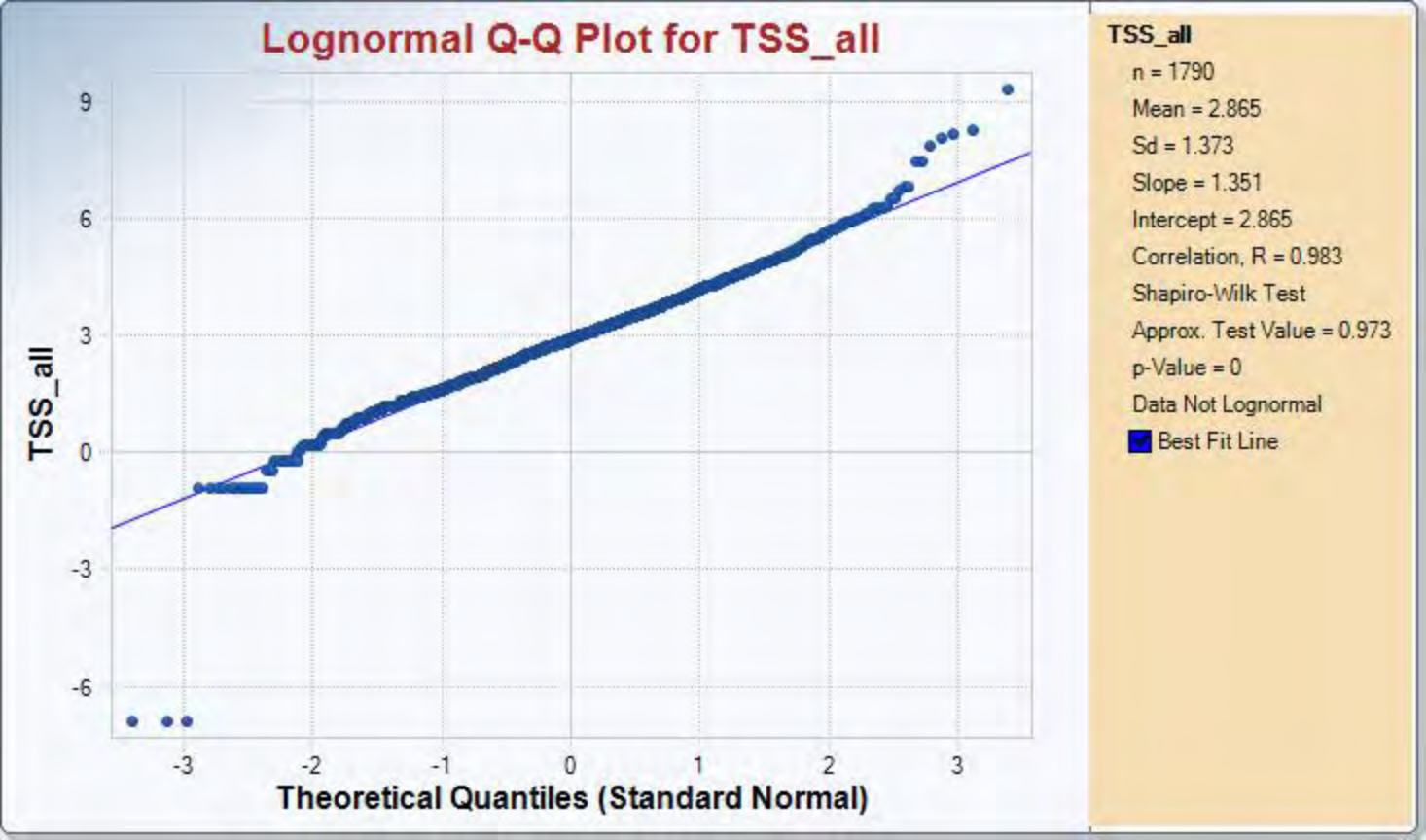
Anderson-Darling Test

Test Statistic = 55865921787709500000000000000.000

Critical Value(0.05) = 0.818

Data not Gamma Distributed

Best Fit Line


Lognormal Q-Q Plot for TSS_all
TSS_all
Theoretical Quantiles (Standard Normal)
9
6
3
0
-3
-6
-3
-2
-1
0
1
2
3
TSS_all
n = 1790
Mean = 2.865
Sd = 1.373
Slope = 1.351
Intercept = 2.865
Correlation, R = 0.983
Shapiro-Wilk Test
Approx. Test Value = 0.973
p-Value = 0
Data Not Lognormal
Best Fit Line

Goodness-of-Fit Test Statistics for Uncensored Full Data Sets without Non-Detects

User Selected Options

Date/Time of Computation	13/04/2021 3:53:06 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

TSS_all

Raw Statistics

Number of Valid Observations	18193
Number of Distinct Observations	2971
Minimum	0.001
Maximum	66820
Mean of Raw Data	75.22
Standard Deviation of Raw Data	649.2
Khat	0.355
Theta hat	211.8
Kstar	0.355
Theta star	211.8
Mean of Log Transformed Data	2.431
Standard Deviation of Log Transformed Data	1.948

Normal GOF Test Results

Correlation Coefficient R	0.237
Lilliefors Test Statistic	0.454
Lilliefors Critical (0.05) Value	0.00657

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

Correlation Coefficient R	0.472
A-D Test Statistic	5.497E+26
A-D Critical (0.05) Value	0.859
K-S Test Statistic	0.167
K-S Critical(0.05) Value	0.0196

Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.977
Lilliefors Test Statistic	0.0467
Lilliefors Critical (0.05) Value	0.00657

Data not Lognormal at (0.05) Significance Level

TSS_grab

Raw Statistics

Number of Valid Observations	4613
Number of Missing Observations	1
Number of Distinct Observations	1607

Minimum	0
Maximum	66820
Mean of Raw Data	123.4
Standard Deviation of Raw Data	1177

Normal GOF Test Results

Correlation Coefficient R	0.228
Lilliefors Test Statistic	0.458
Lilliefors Critical (0.05) Value	0.013

Data not Normal at (0.05) Significance Level

TSS_isco

Raw Statistics

Number of Valid Observations	13612
Number of Distinct Observations	2247
Minimum	0.001
Maximum	15670
Mean of Raw Data	59.65
Standard Deviation of Raw Data	307.6
Khat	0.384
Theta hat	155.5
Kstar	0.383
Theta star	155.6
Mean of Log Transformed Data	2.361
Standard Deviation of Log Transformed Data	1.945

Normal GOF Test Results

Correlation Coefficient R	0.365
Lilliefors Test Statistic	0.423
Lilliefors Critical (0.05) Value	0.00759

Data not Normal at (0.05) Significance Level

Gamma GOF Test Results

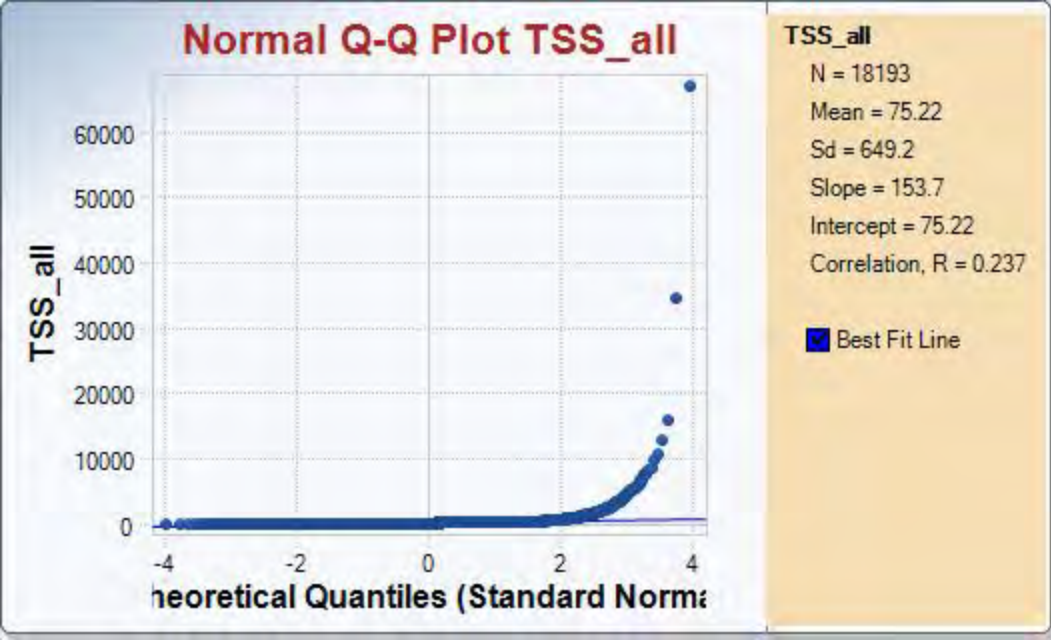
Correlation Coefficient R	0.666
A-D Test Statistic	7.346E+26
A-D Critical (0.05) Value	0.852
K-S Test Statistic	0.148
K-S Critical(0.05) Value	0.0195

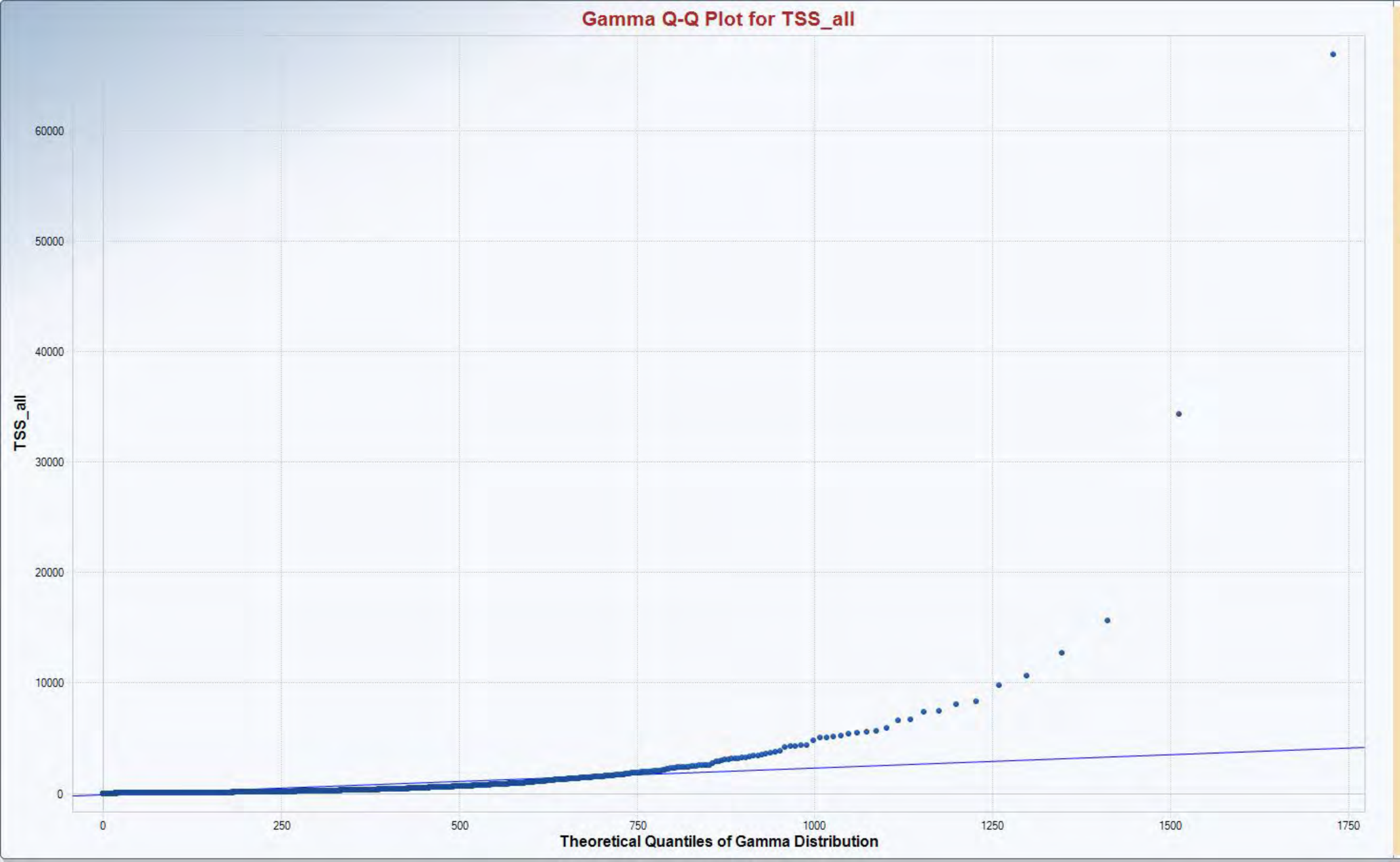
Data not Gamma Distributed at (0.05) Significance Level

Lognormal GOF Test Results

Correlation Coefficient R	0.971
Lilliefors Test Statistic	0.0517
Lilliefors Critical (0.05) Value	0.00759

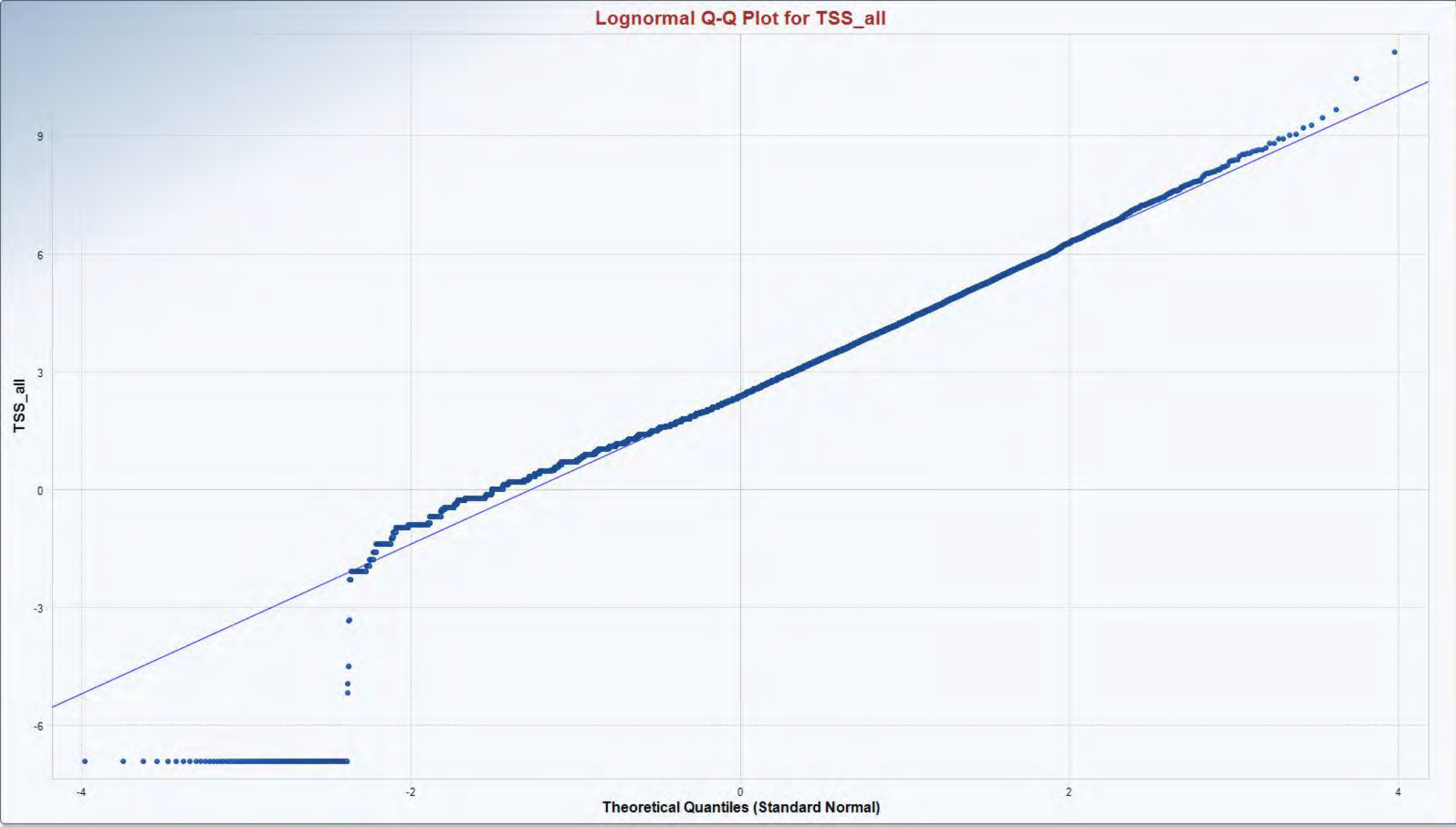
Data not Lognormal at (0.05) Significance Level


Normal Q-Q Plot TSS_all
TSS_all
60000
50000
40000
30000
20000
10000
0
-4
-2
0
2
4
heoretical Quantiles (Standard Norma
TSS_all
N = 18193
Mean = 75.22
Sd = 649.2
Slope = 153.7
Intercept = 75.22
Correlation, R = 0.237
Best Fit Line



TSS_all

N = 18193
Mean = 75.2188
k hat = 0.3551
theta hat = 211.8131
Slope = 2.4275
Intercept = -107.3647
Correlation, R = 0.4718
Anderson-Darling Test
Test Statistic = 5496619578958940000000000000.000
Critical Value(0.05) = 0.859
Data not Gamma Distributed
Best Fit Line


Lognormal Q-Q Plot for TSS_all
TSS_all
9
6
3
0
-3
-6
-4
-2
0
2
4
Theoretical Quantiles (Standard Normal)
TSS_all
n = 18193
Mean = 2.431
Sd = 1.948
Slope = 1.903
Intercept = 2.431
Correlation, R = 0.977
Lilliefors Test
Test Statistic = 0.047
Critical Value(0.05) = 0.007
Data Not Lognormal
Best Fit Line

APPENDIX B

Summary Statistics (in excel format)

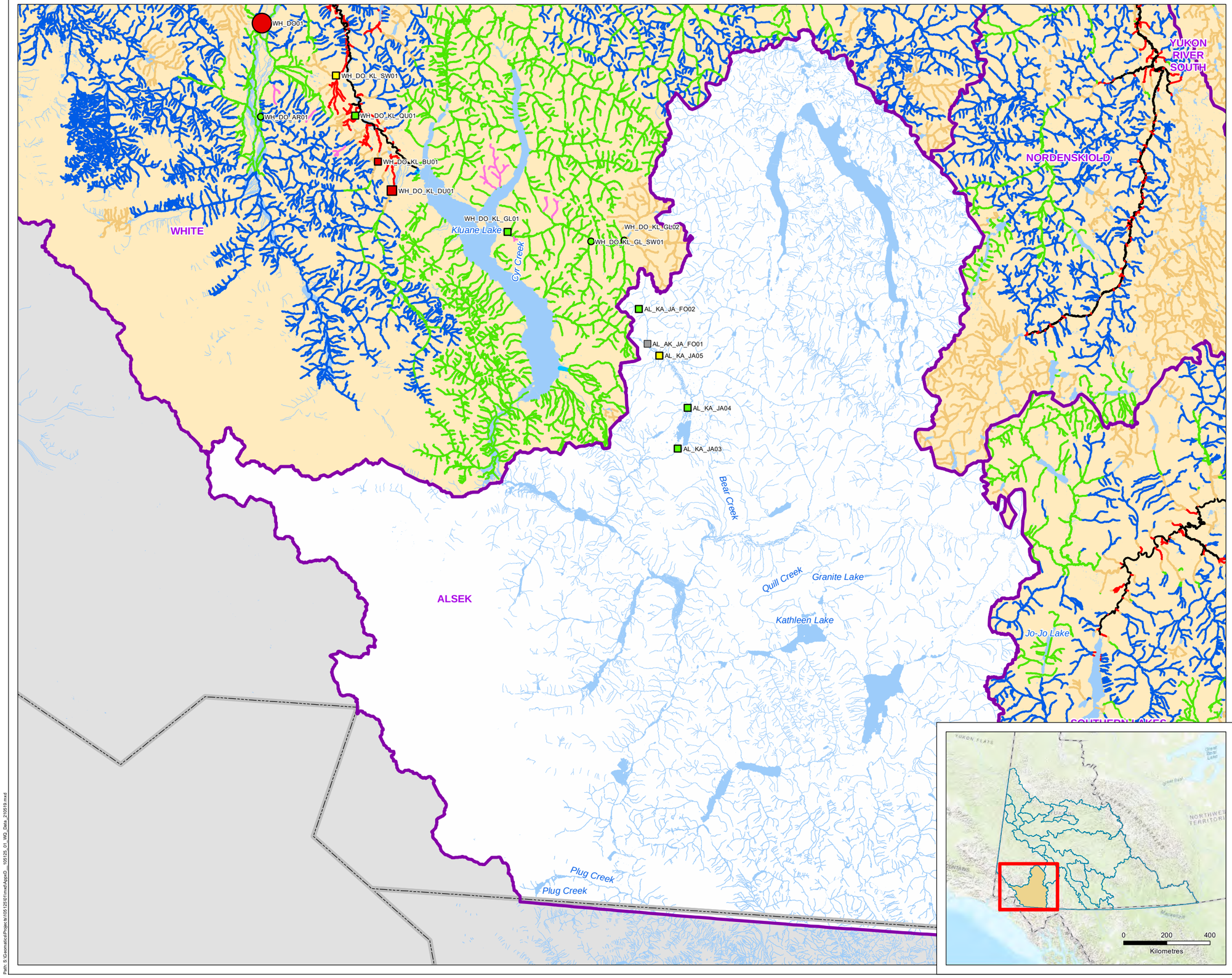
APPENDIX C

Frequency and Magnitude of Exceedances (in excel format)

APPENDIX D
Maps

Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Alsek River Watershed



Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - Yukon
- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:810,000

0 6 12 18 24
Kilometres

NAD 1983 Yukon Albers

Page Size: 11" x 17"

105125-01	Production Date: May 19, 2021	Appendix D

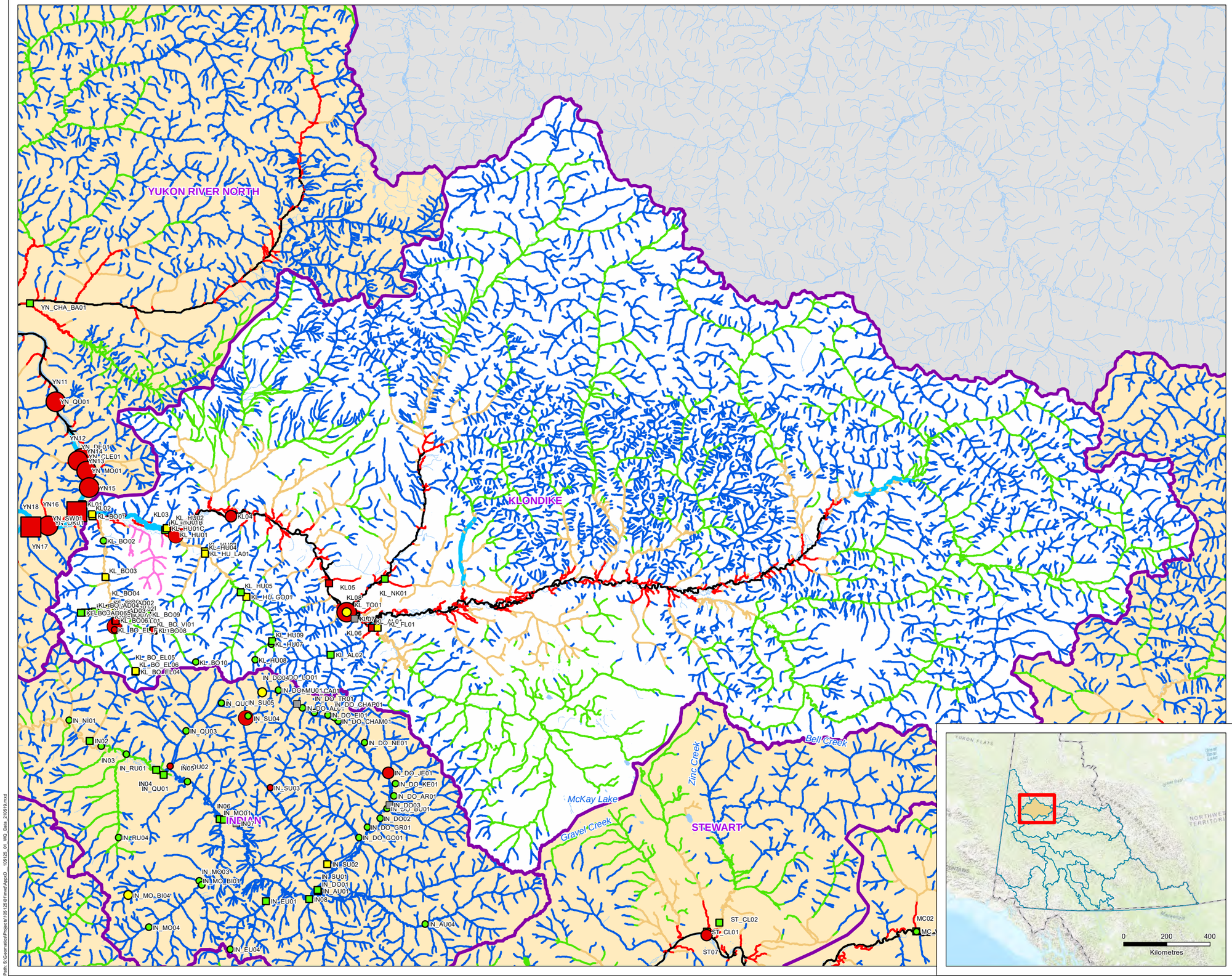
Hemmera
An Ausenco Company

Yukon

Path: S:\Geomatics\Projects\105125\01\mxd\AppxD_ 105125_01_WQ_Data_210519.mxd

Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Klondike River Watershed



Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - Yukon
- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:490,000

0 3.5 7 10.5 14
Kilometres

NAD 1983 Yukon Albers

Page Size: 11" x 17"

105125-01	Production Date: May 19, 2021	Appendix D

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Yukon

Path: S:\Geomatics\Projects\105125\01\mxd\Appx\D__105125_01_WQ_Data_210519.mxd

Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Mayo River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
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Sources

- Contains information licensed under the Open Government Licence(s) - Yukon
- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:370,000

0 2.5 5 7.5 10
Kilometres

NAD 1983 Yukon Albers

Page Size: 11" x 17"

105125-01	Production Date: May 19, 2021	Appendix D

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Yukon

0 200 400
Kilometres

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in McQuesten River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

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- Inset Basemap: ESRI World Topographic Map

N

1:400,000

0 3 6 9 12
Kilometres

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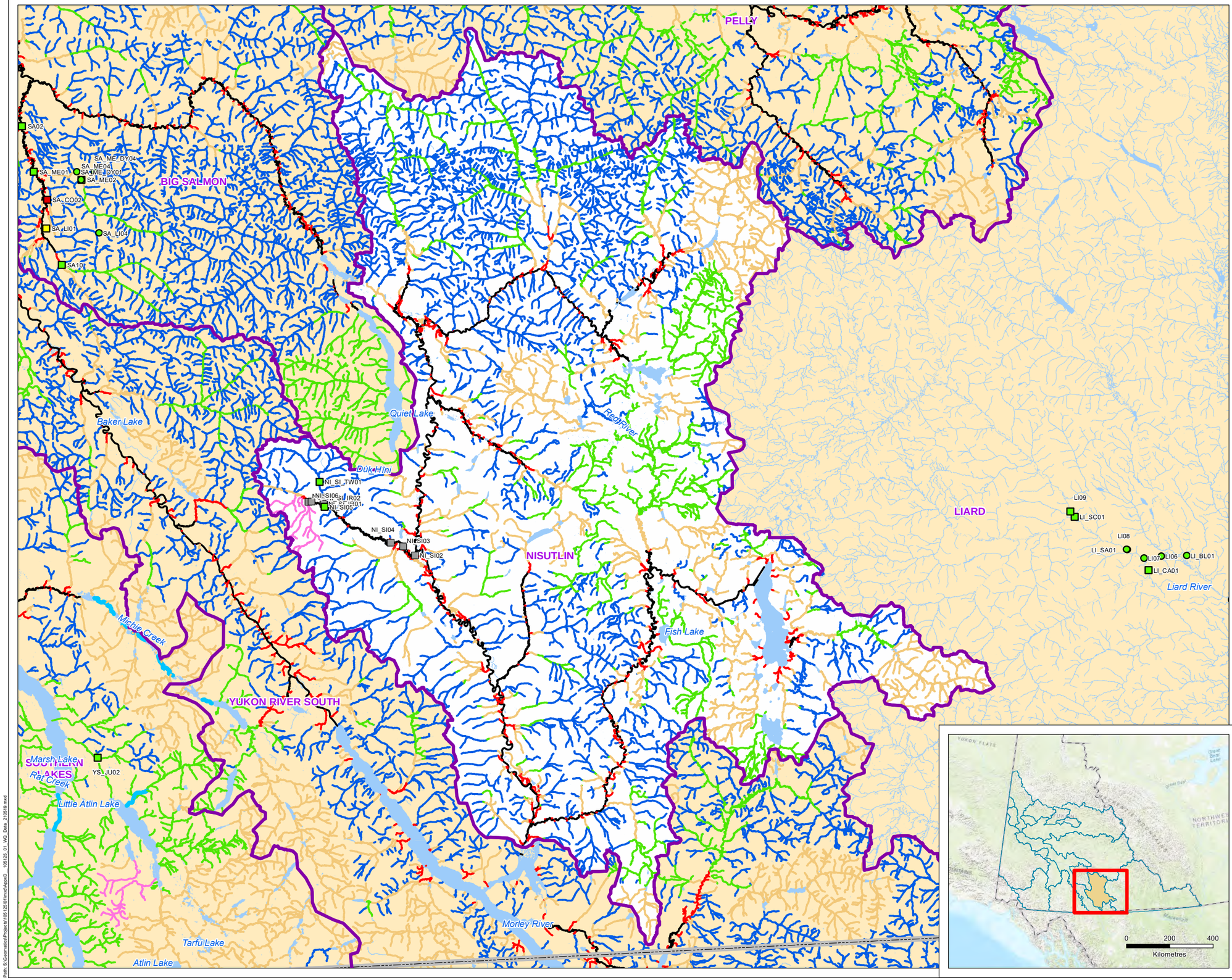
Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Nisutlin River Watershed



Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

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- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:740,000

0 5.5 11 16.5 22
Kilometres

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Yukon

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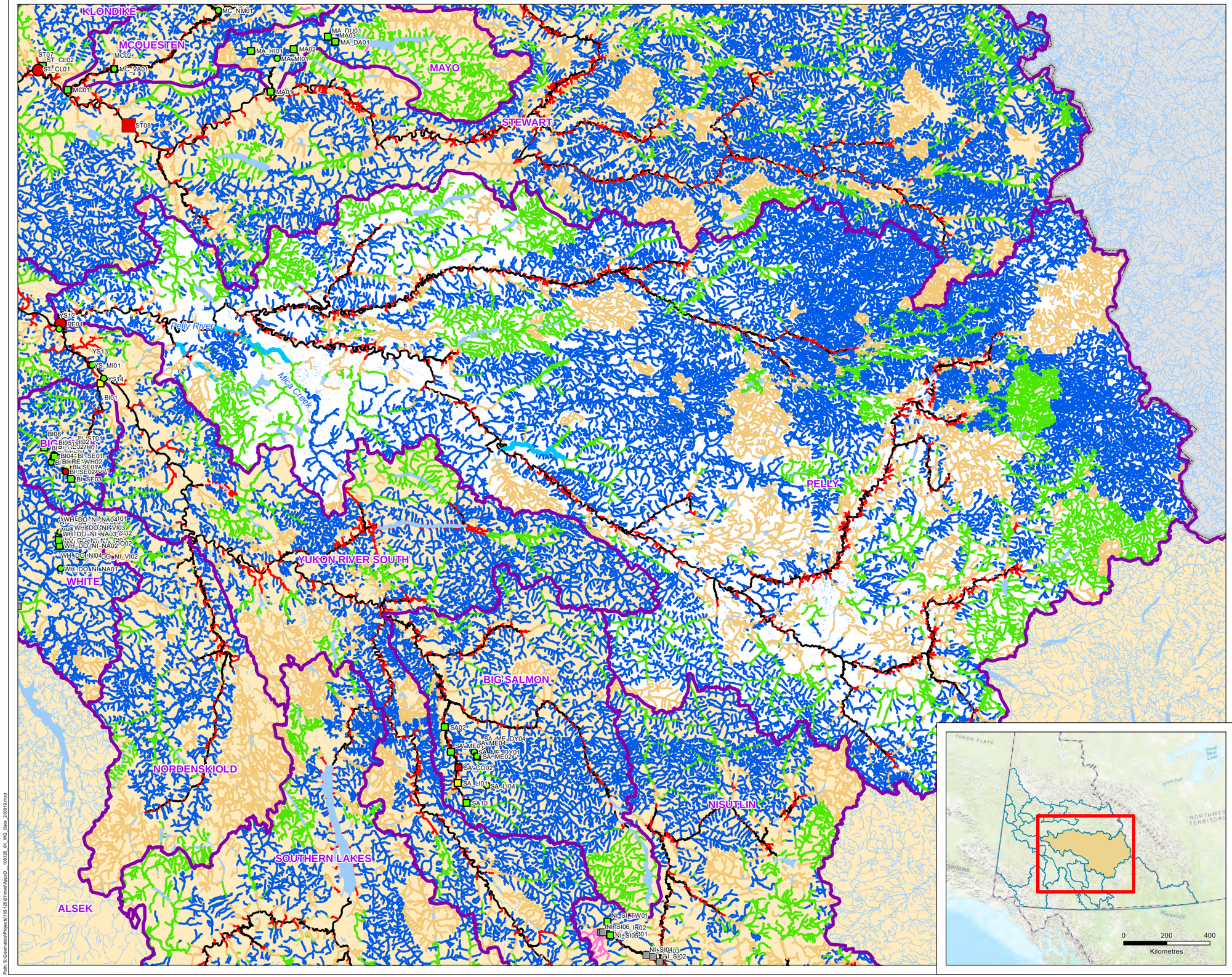

Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Pelly River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

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- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
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- Inset Basemap: ESRI World Topographic Map

N

1:1,350,000

0 10 20 30 40
Kilometres

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Yukon

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Sixty Mile River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
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- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:380,000

0 2.5 5 7.5 10
Kilometres

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Yukon

0 200 400
Kilometres

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Indian River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
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N

1:260,000

0 2 4 6 8
Kilometres

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Yukon

0 200 400
Kilometres

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Forty Mile River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
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- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:240,000

0 1.5 3 4.5 6
Kilometres

NAD 1983 Yukon Albers

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Yukon

0 200 400
Kilometres

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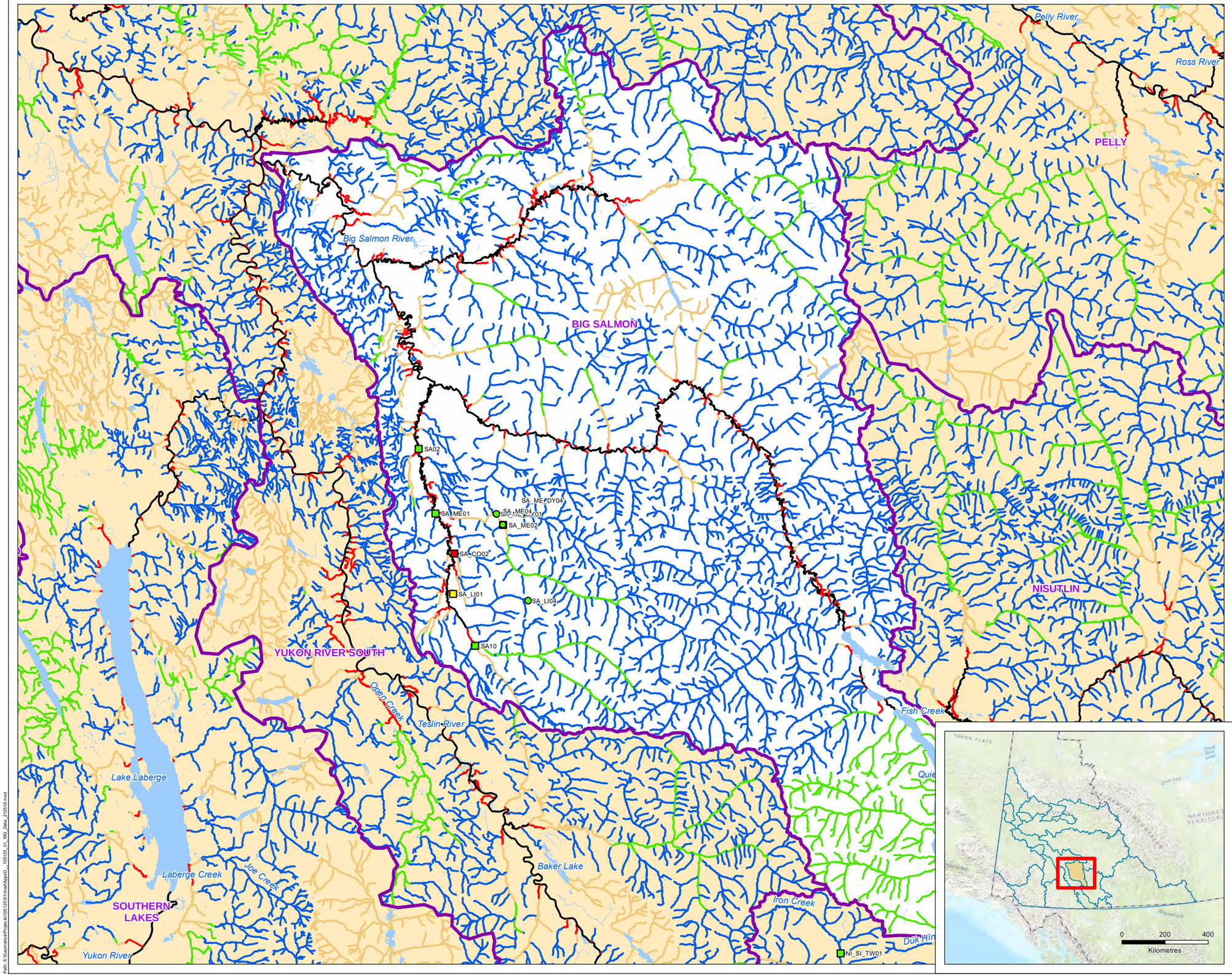
Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Big Salmon River Watershed



Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

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- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:520,000

0 4 8 12 16
Kilometres

NAD 1983 Yukon Albers

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Yukon

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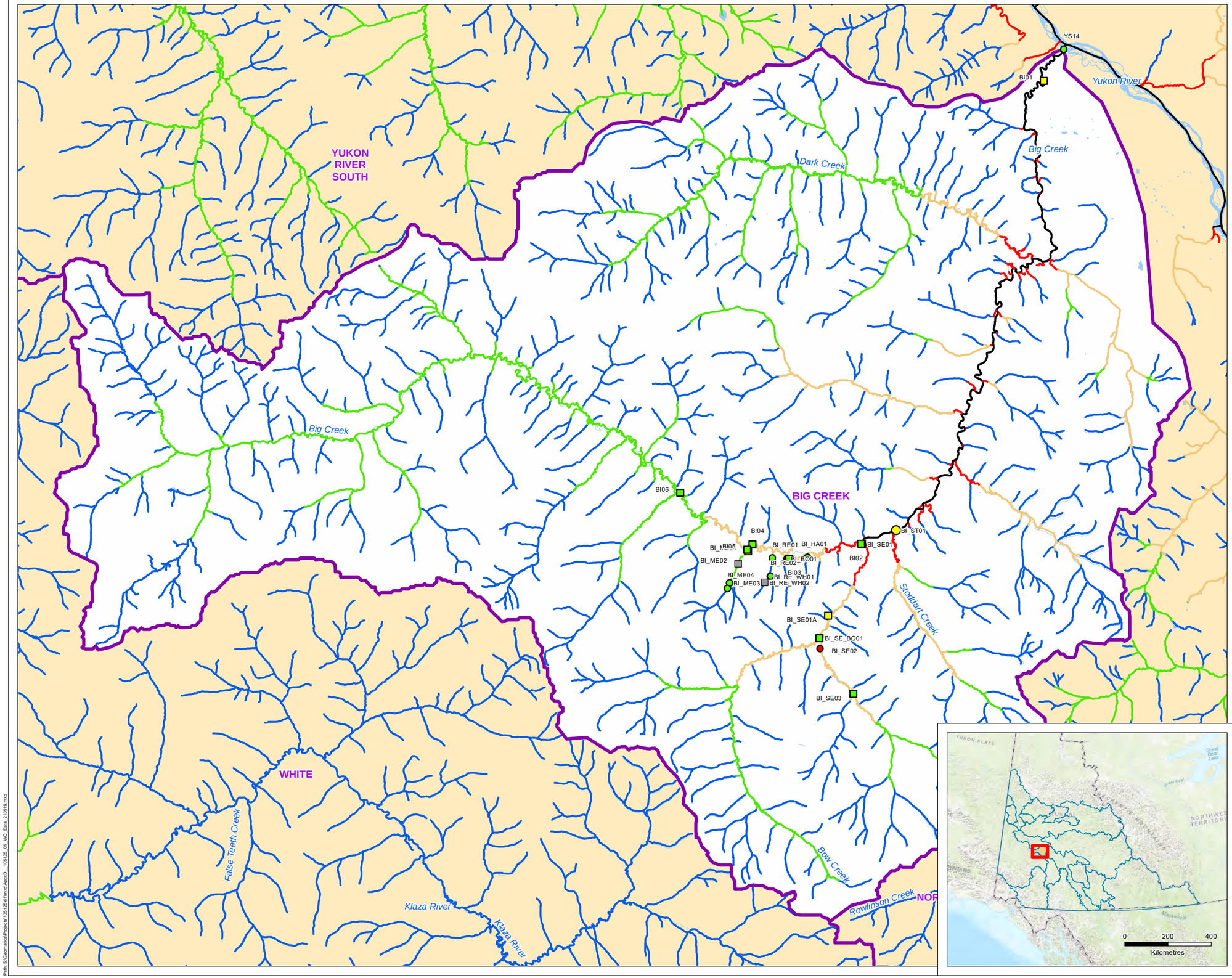
Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Big Creek Watershed



Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

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- Inset Basemap: ESRI World Topographic Map

N

1:210,000

0 1.5 3 4.5 6
Kilometres

NAD 1983 Yukon Albers

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Stewart River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

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- Inset Basemap: ESRI World Topographic Map

N

1:1,530,000

0 10 20 30 40
Kilometres

NAD 1983 Yukon Albers

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Yukon

0 200 400
Kilometres

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in White River Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
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- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:1,430,000

0 10 20 30 40
Kilometres

NAD 1983 Yukon Albers

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Yukon

0 200 400
Kilometres

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Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Yukon River South Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - Yukon
- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:1,500,000

0 10 20 30 40
Kilometres

NAD 1983 Yukon Albers

Page Size: 11" x 17"

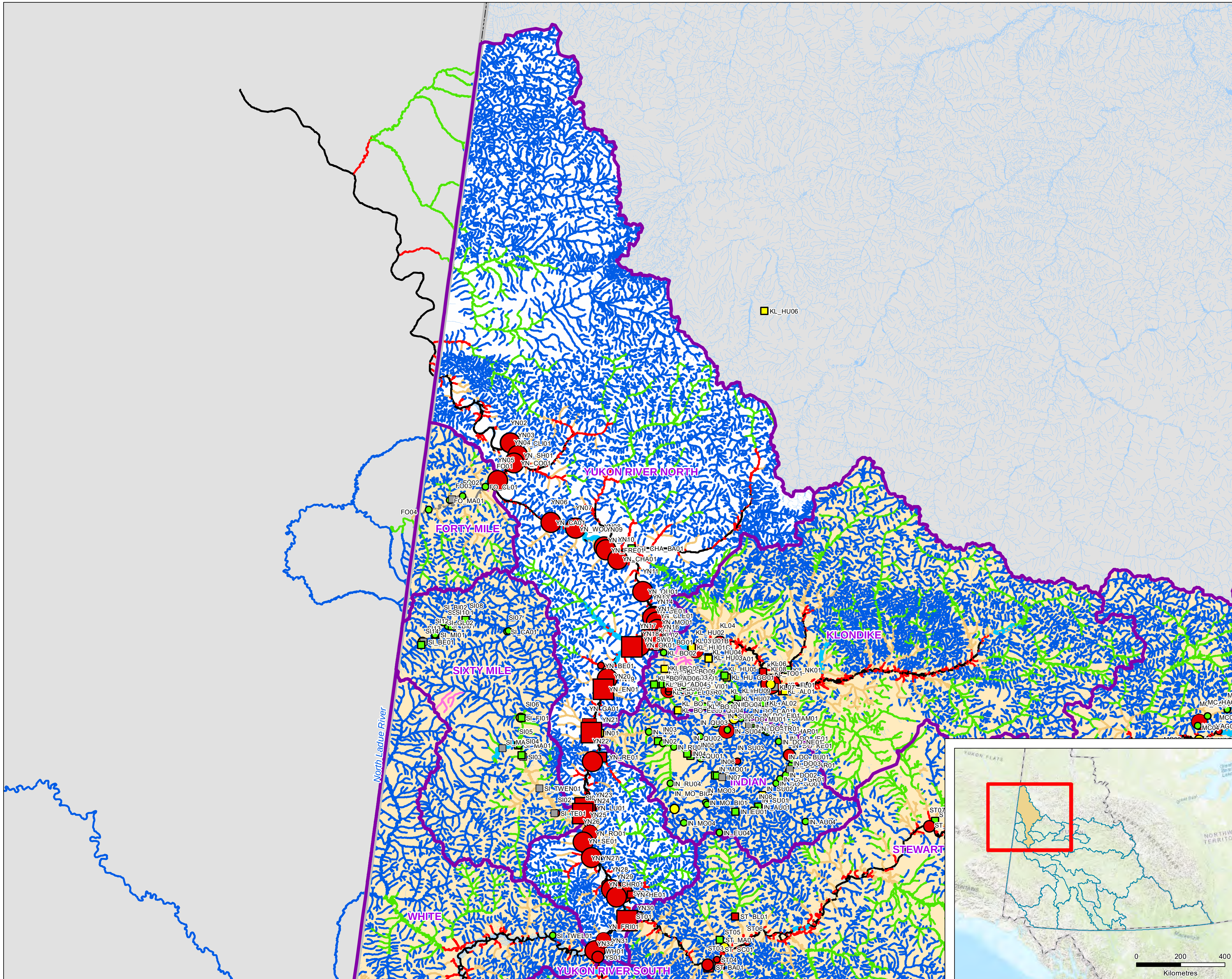
105125-01	Production Date: May 19, 2021	Appendix D

Hemmera
An Ausenco Company

Yukon

0 200 400
Kilometres

Path: S:\Geomatics\Projects\105125\01\mxd\AppxD_ 105125_01_WQ_Data_210519.mxd



Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Yukon River North Watershed

Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data
- Low Suitability
- Moderate-Low Suitability
- Moderate-Moderate Suitability
- Moderate-High Suitability
- High Suitability
- Areas of Special Consideration (Ecological)
- Areas of Special Consideration (Cultural)
- Unclassified

Notes

1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:1,140,000

0 8.5 17 25.5 34

Kilometres

NAD 1983 Yukon Albers

Page Size: 11" x 17"

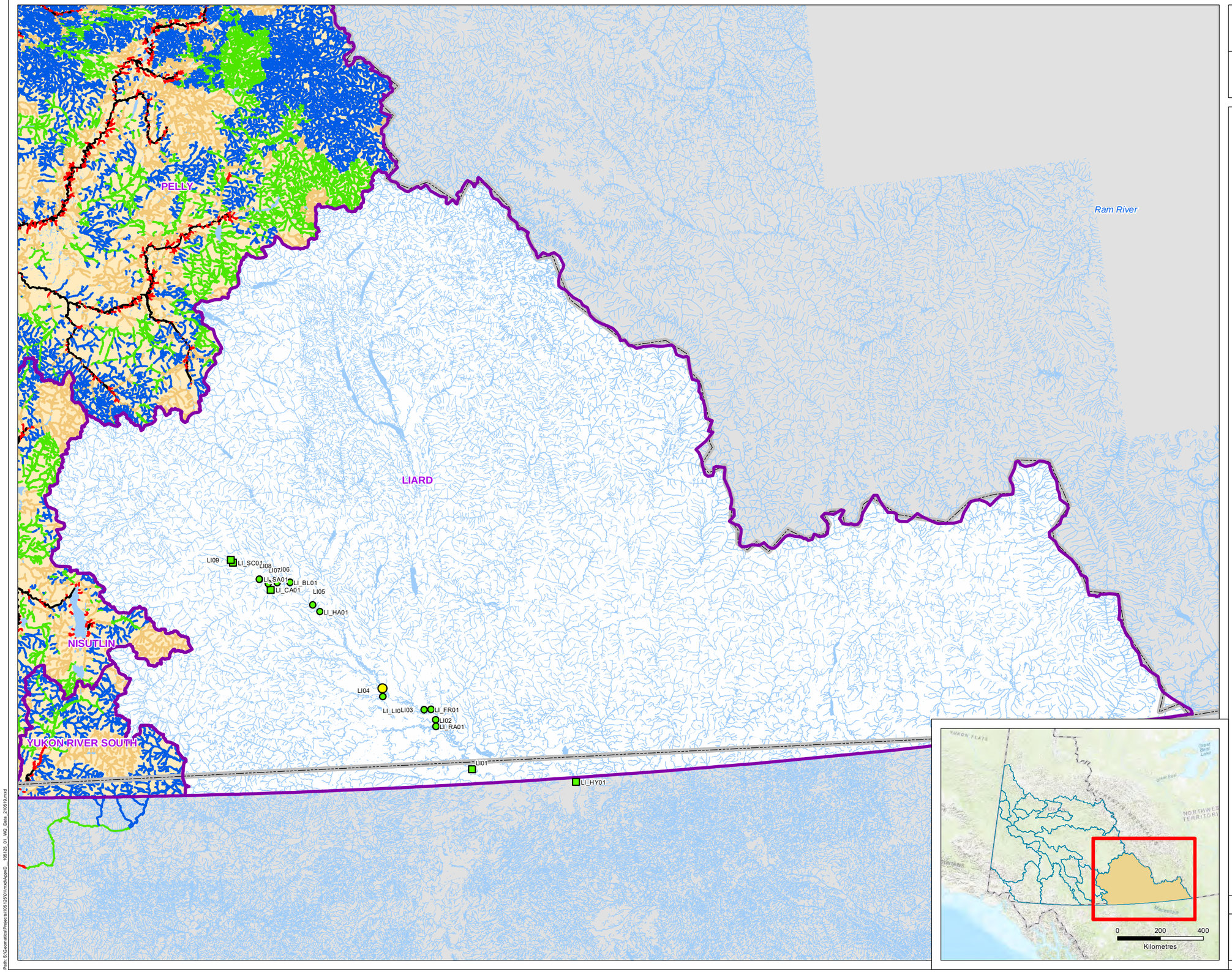
105125-01	Production Date: May 19, 2021	Appendix D

Hemmera
An Ausenco Company

Yukon

Yukon Territory WQ Sampling
Yukon Territory, Canada

Water Quality Stations in Liard River Watershed



Legend

- 0% to 10% samples exceeding TSS-WQO (n => 10)
- 0% to 10% samples exceeding TSS-WQO (n < 10)
- >10% to 20% samples exceeding TSS-WQO (n => 10)
- >10% to 20% samples exceeding TSS-WQO (n < 10)
- >20% to 40% samples exceeding TSS-WQO (n => 10)
- >20% to 40% samples exceeding TSS-WQO (n < 10)
- >40% to 60% samples exceeding TSS-WQO (n => 10)
- >40% to 60% samples exceeding TSS-WQO (n < 10)
- >60% to 80% samples exceeding TSS-WQO (n => 10)
- >60% to 80% samples exceeding TSS-WQO (n < 10)
- >80% samples exceeding TSS-WQO (n => 10)
- >80% samples exceeding TSS-WQO (n < 10)
- No TSS data

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

Notes

1. n = number of TSS samples
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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- Layer Name: Watersheds, placer streams, water-quality sampling locations - Fisheries and Oceans Canada (DFO)
- Basemap Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

N

1:1,440,000

0 10 20 30 40
Kilometres

NAD 1983 Yukon Albers

Page Size: 11" x 17"

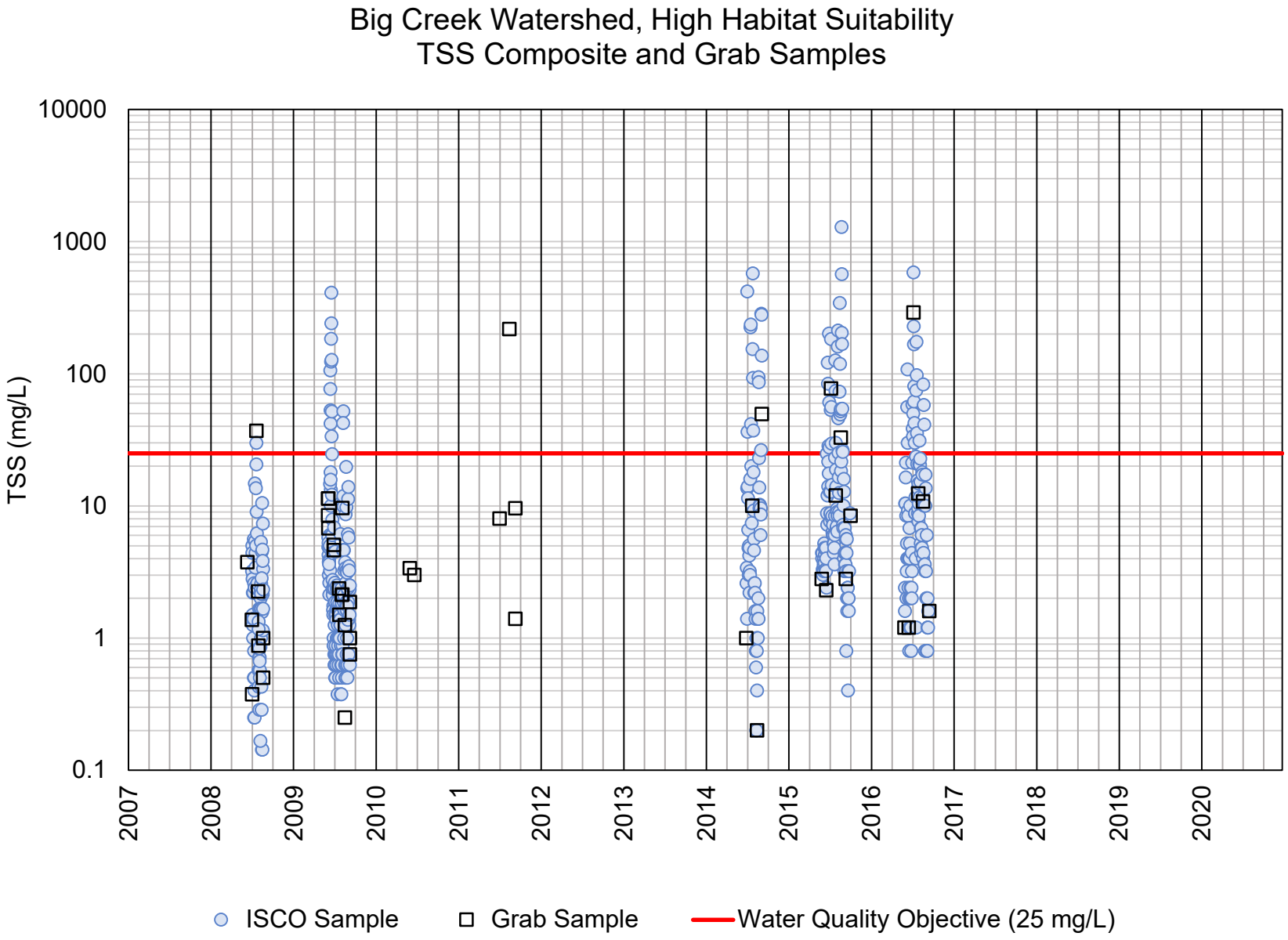
105125-01	Production Date: May 19, 2021	Appendix D

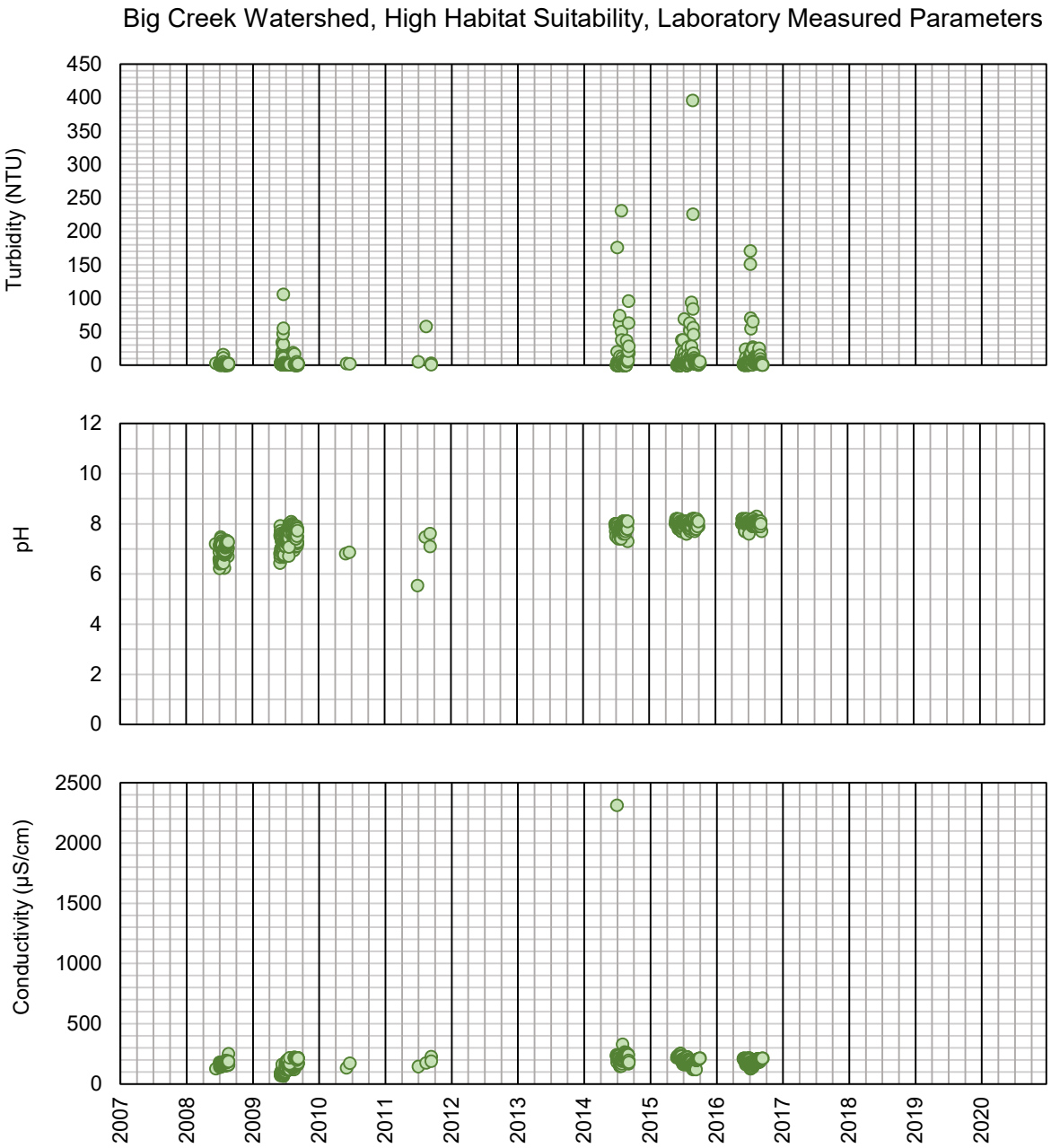
Hemmera
An Ausenco Company

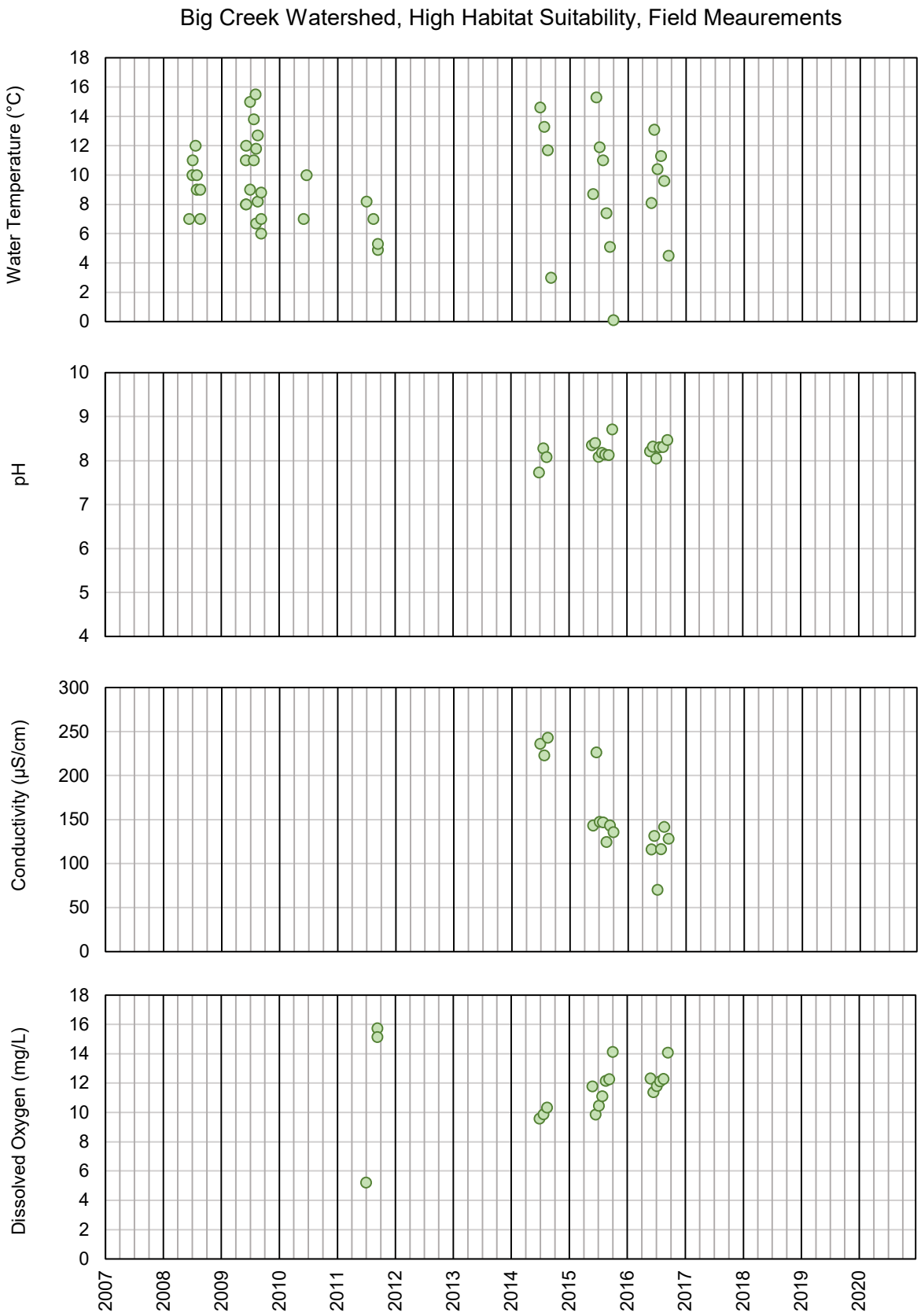
Yukon

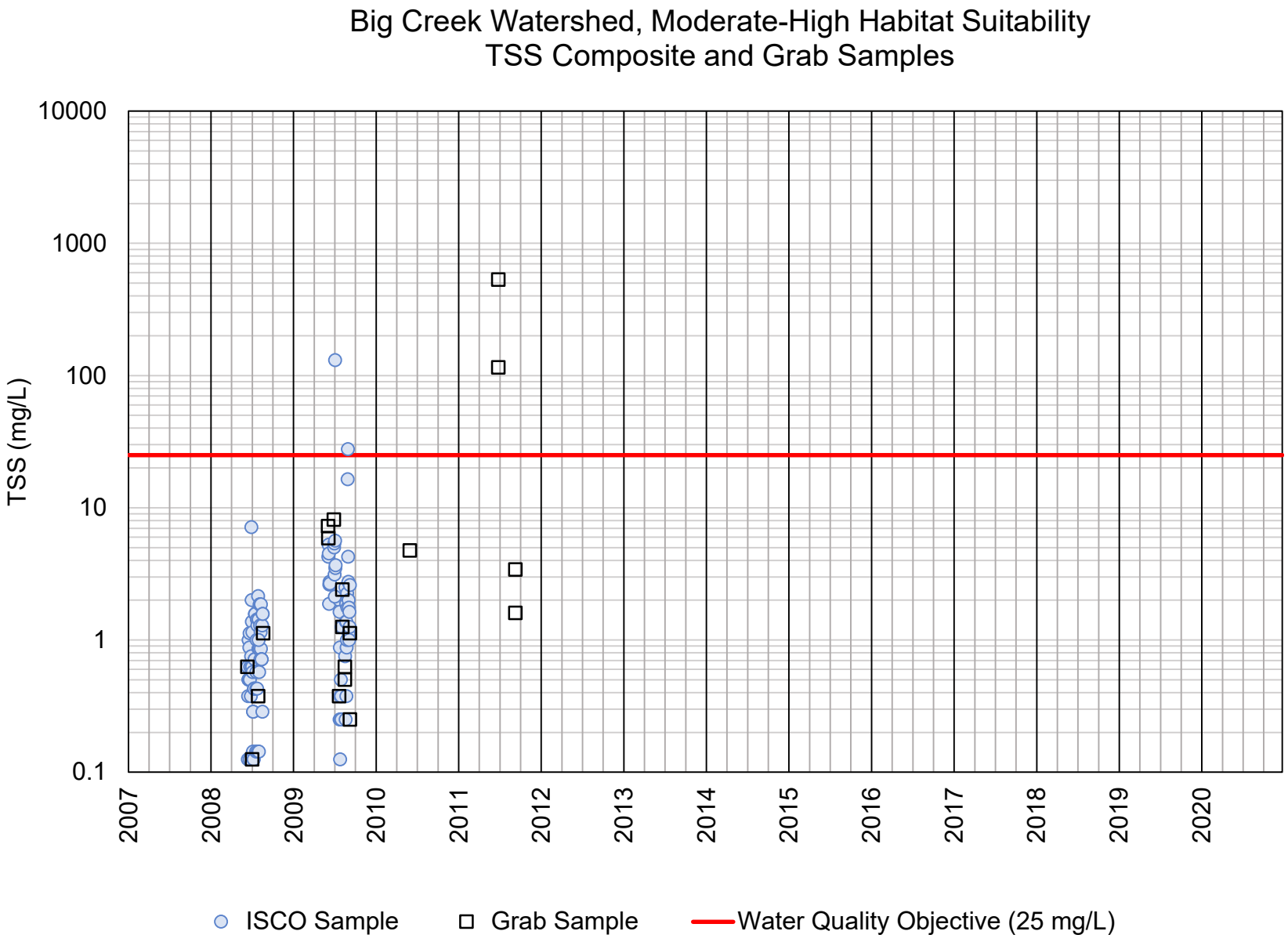
Path: S:\Geomatics\Projects\105125\01\mxd\AppxD_ 105125_01_WQ_Data_210519.mxd

APPENDIX E
Time Series Plots

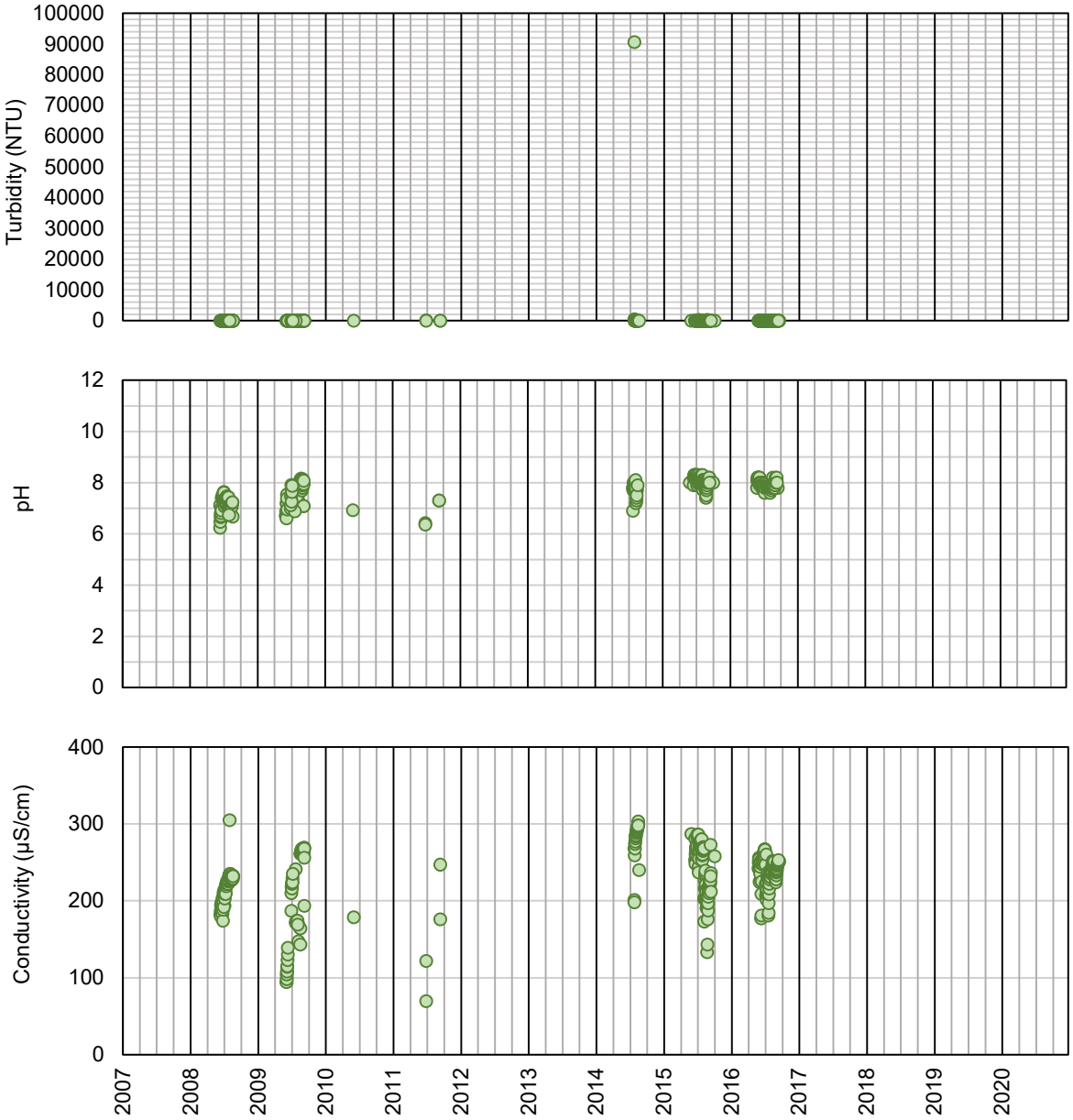

Big Creek Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

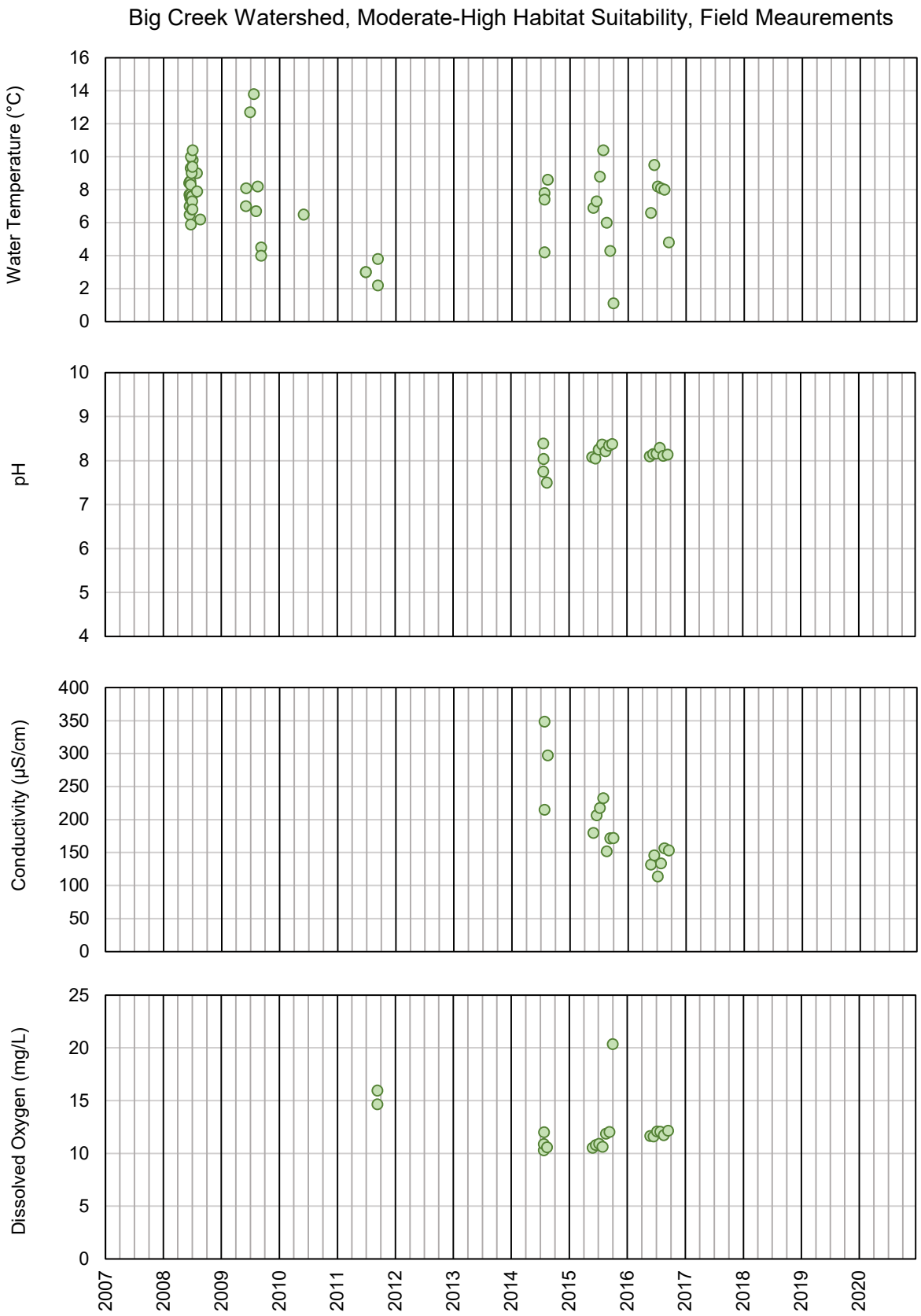

Big Creek Watershed, High Habitat Suitability, Laboratory Measured Parameters
Turbidity (NTU)
450
400
350
300
250
200
150
100
50
0
pH
12
10
8
6
4
2
0
Conductivity (µS/cm)
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

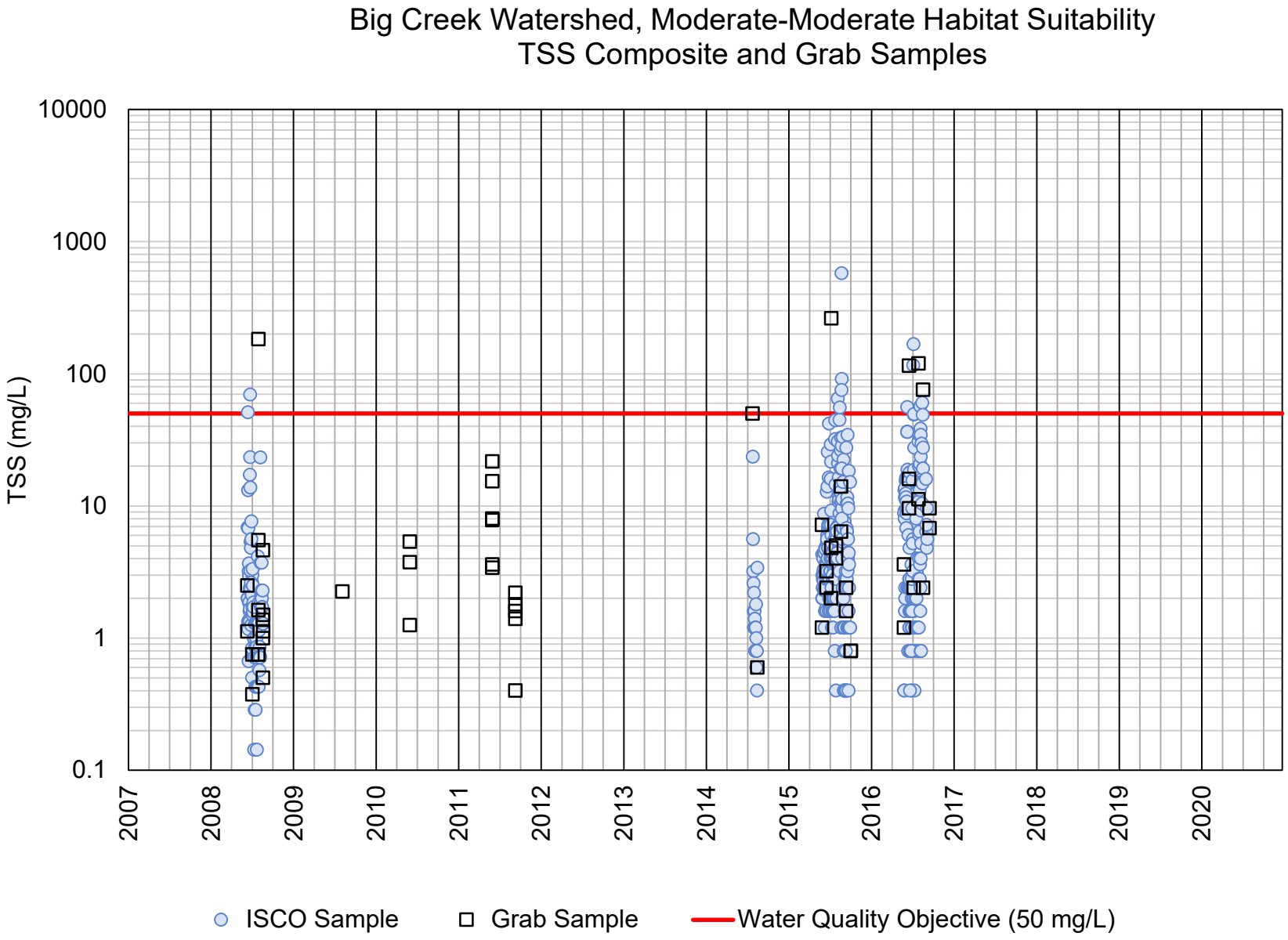

Big Creek Watershed, High Habitat Suitability, Field Meaurements
Water Temperature (°C)
pH
Conductivity (µS/cm)
Dissolved Oxygen (mg/L)
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Big Creek Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

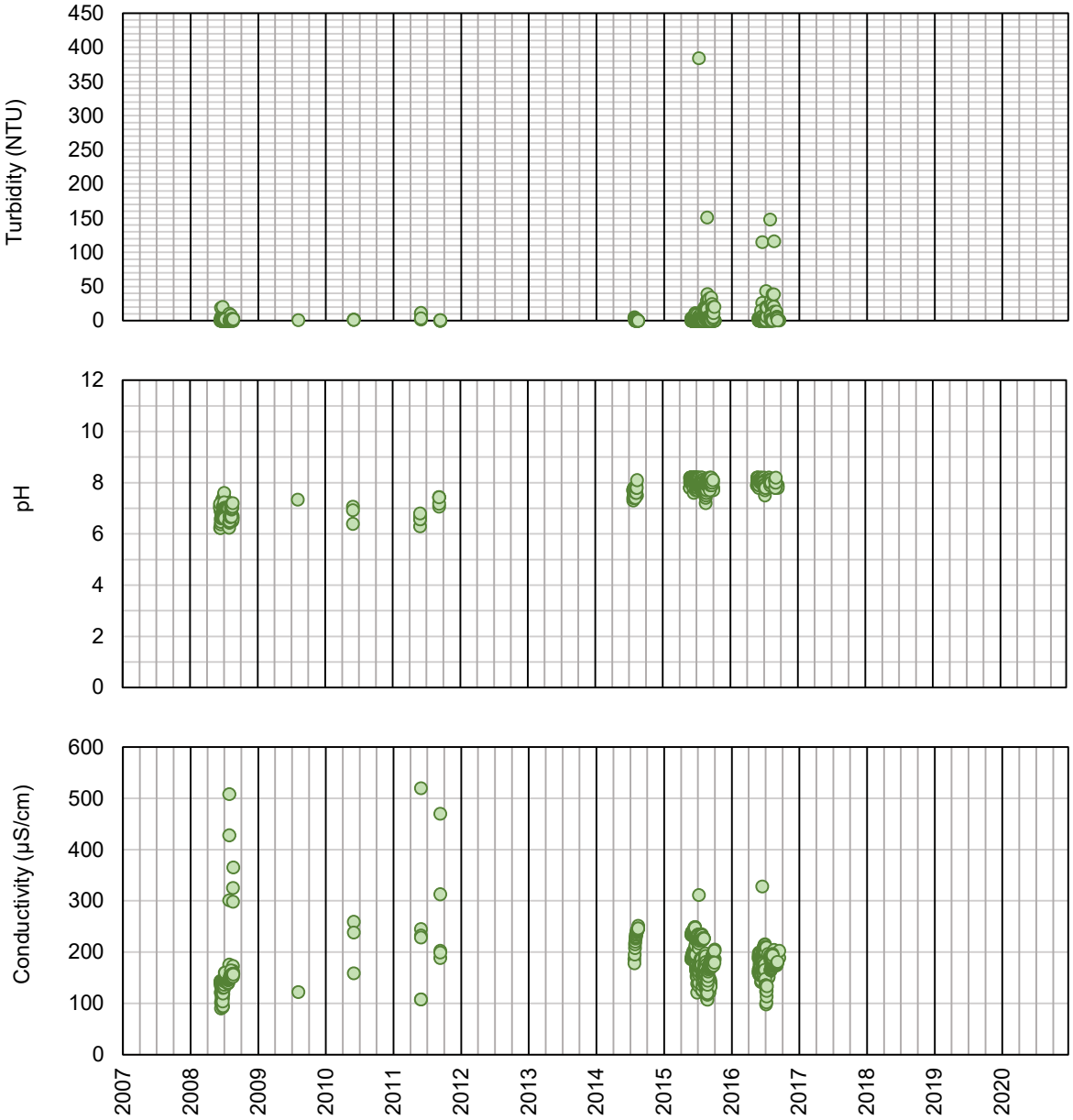
Big Creek Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters

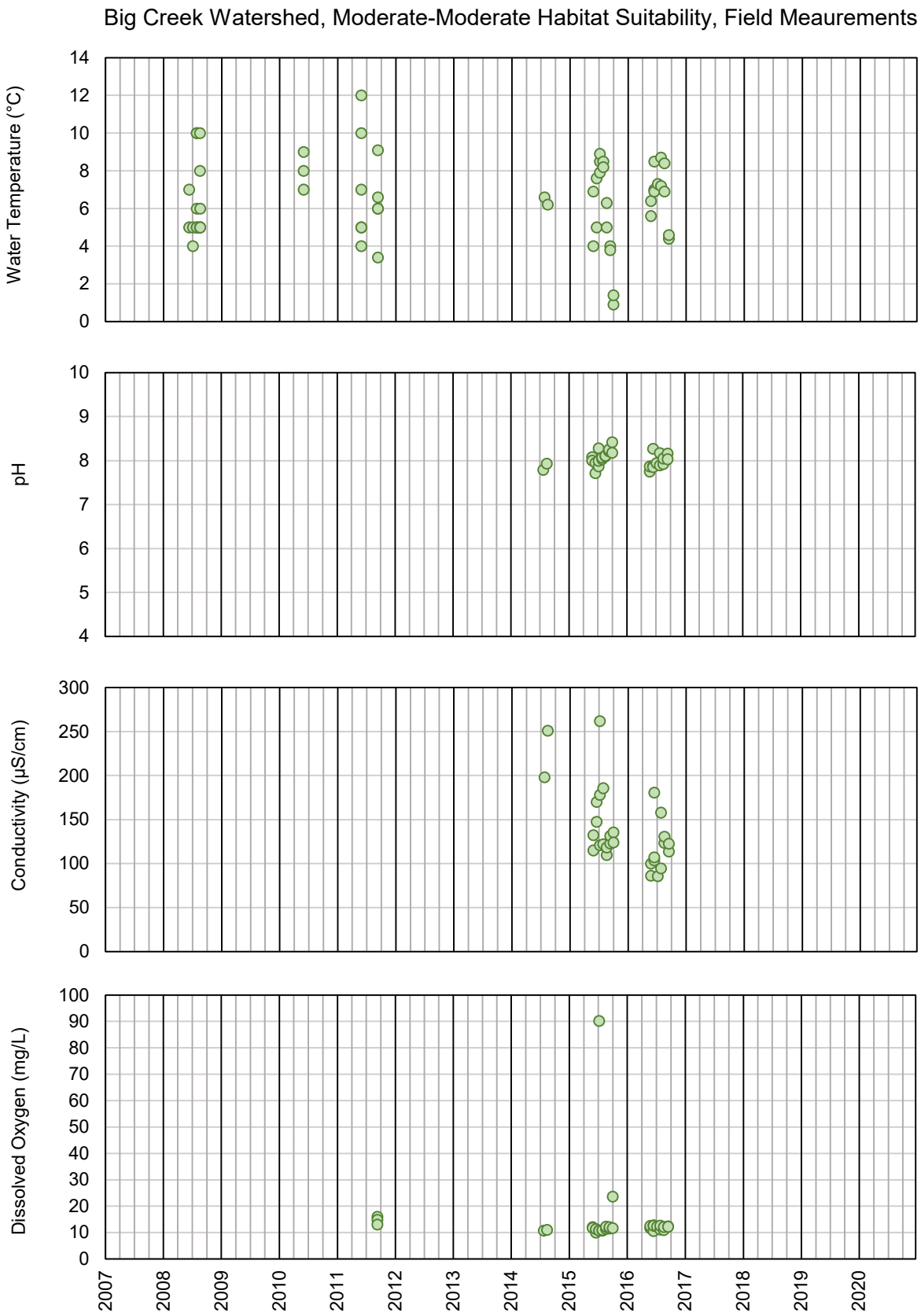


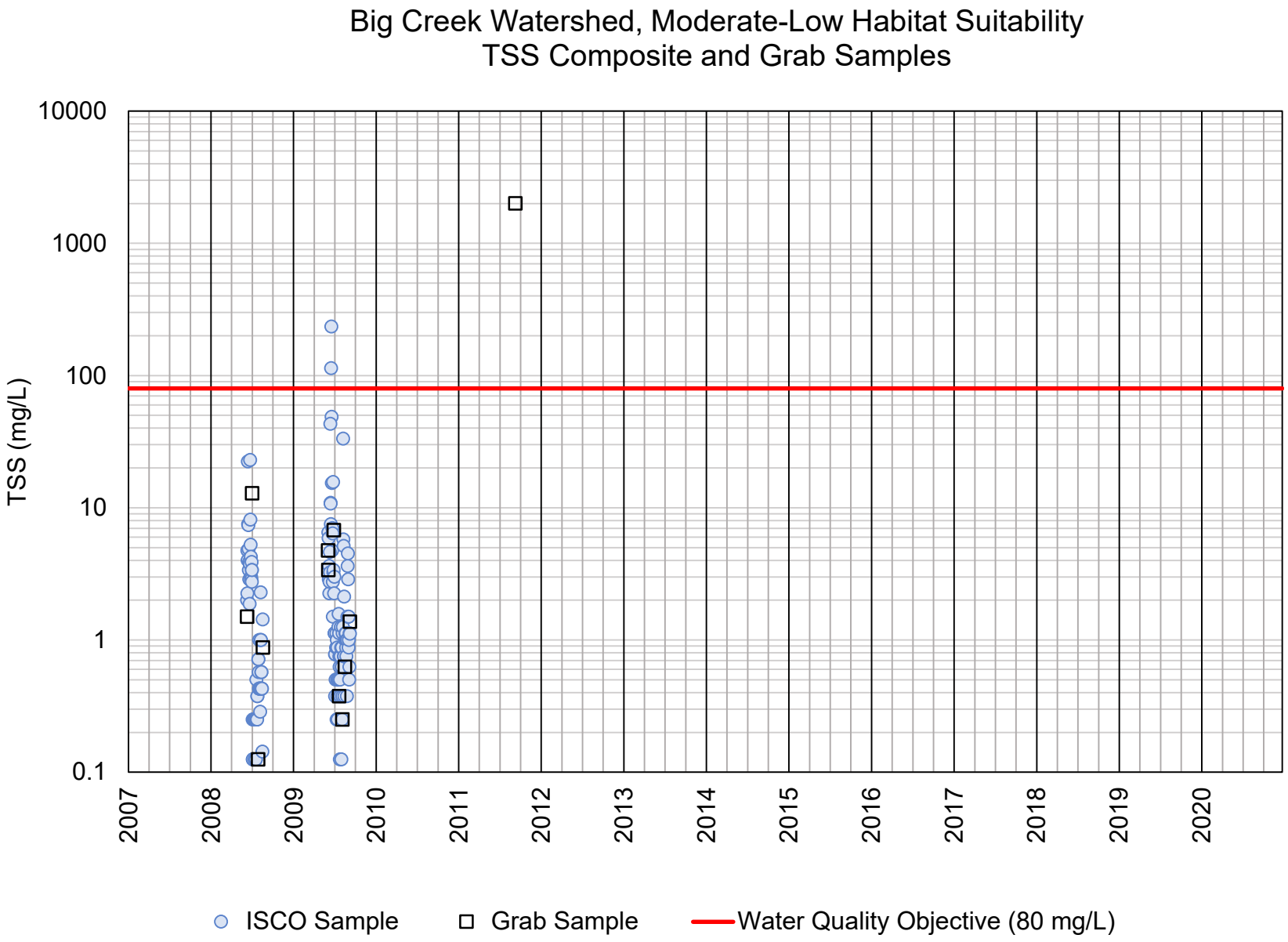

Big Creek Watershed, Moderate-High Habitat Suitability, Field Meaurements
Water Temperature (°C)
0
2
4
6
8
10
12
14
16
pH
4
5
6
7
8
9
10
Conductivity (µS/cm)
0
50
100
150
200
250
300
350
400
Dissolved Oxygen (mg/L)
0
5
10
15
20
25
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Big Creek Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (50 mg/L)

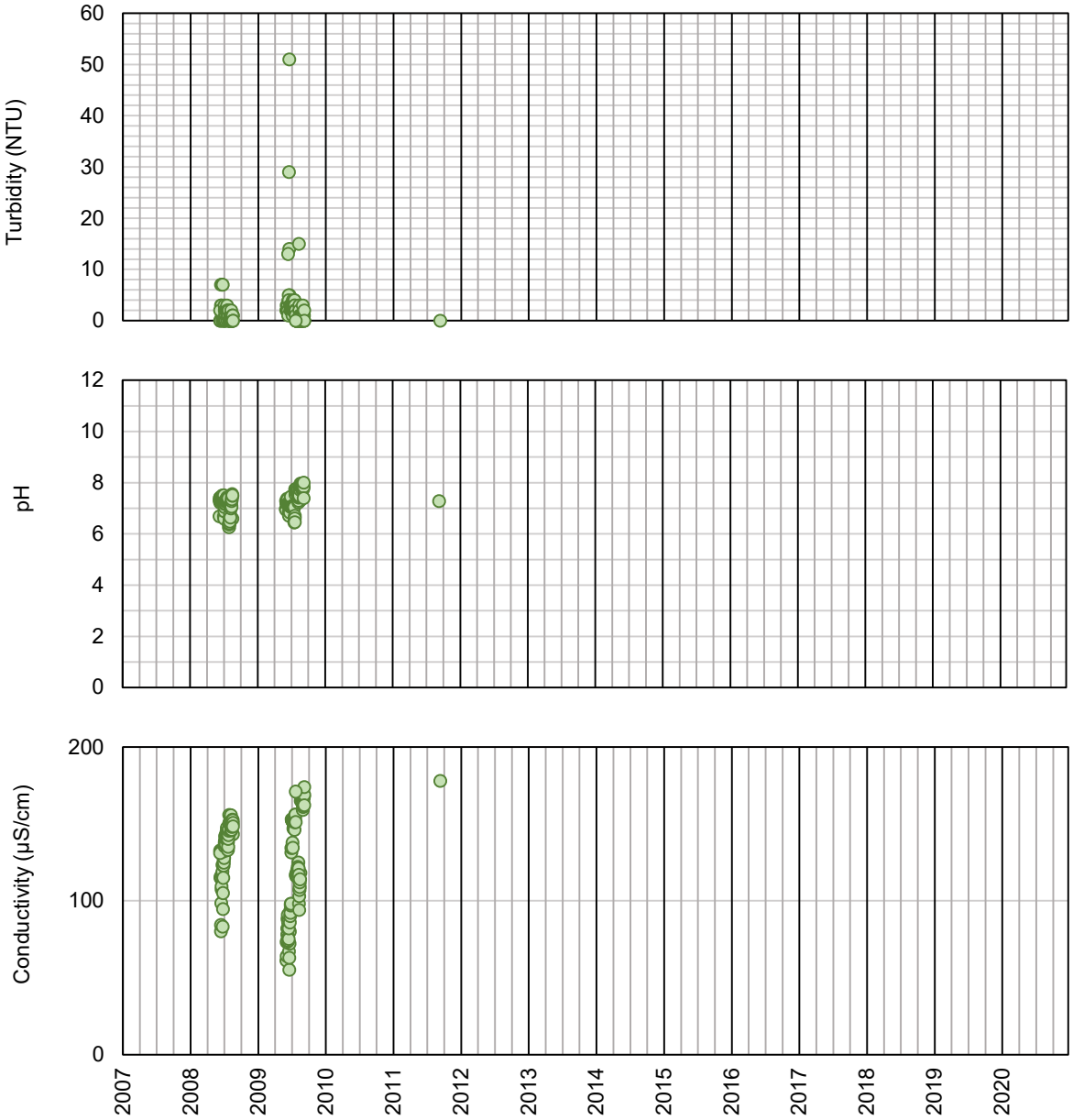
Big Creek Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters



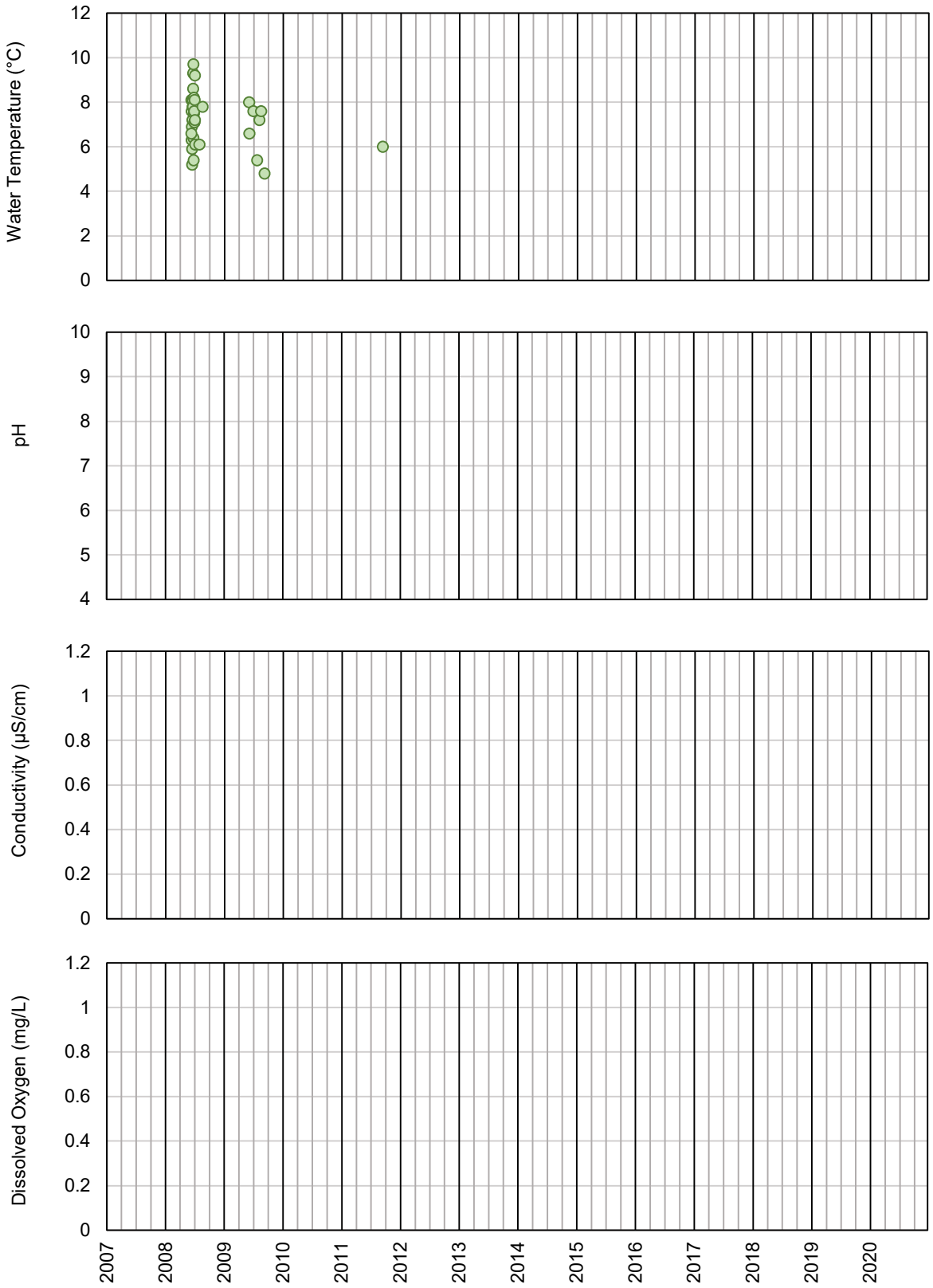

Big Creek Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements
Water Temperature (°C)
0
2
4
6
8
10
12
14
pH
4
5
6
7
8
9
10
Conductivity (µS/cm)
0
50
100
150
200
250
300
Dissolved Oxygen (mg/L)
0
10
20
30
40
50
60
70
80
90
100
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

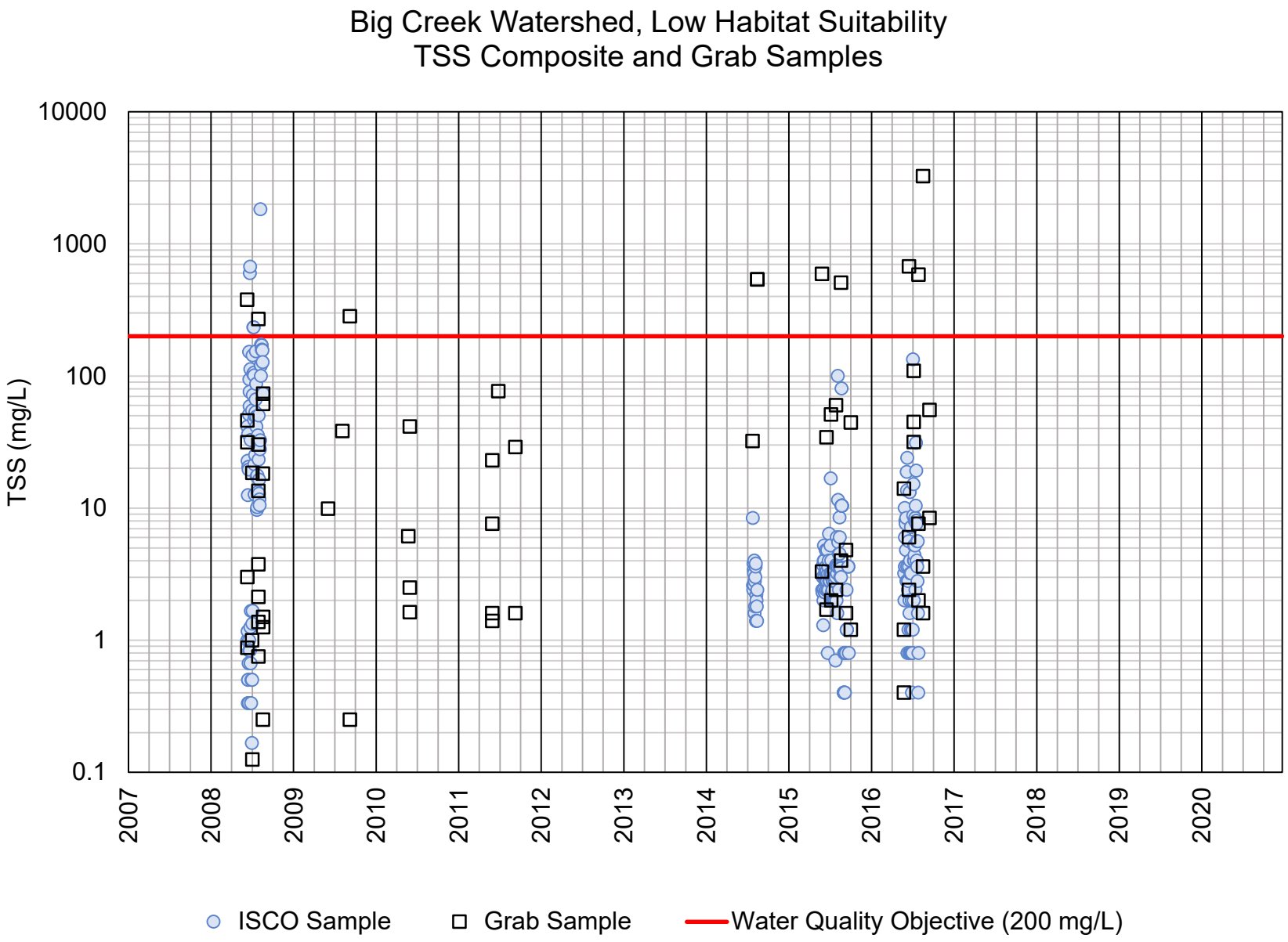

Big Creek Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (80 mg/L)

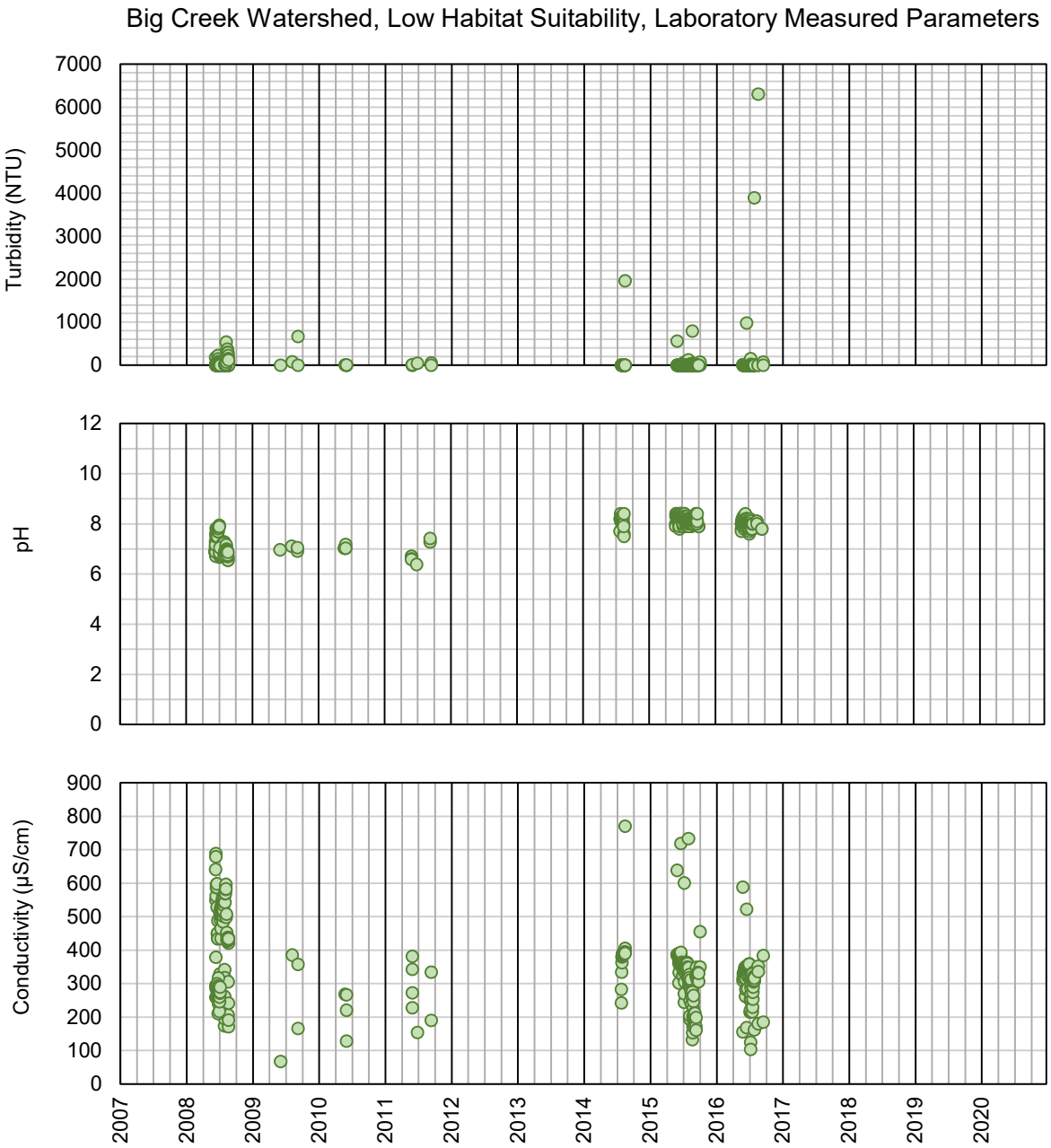
Big Creek Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters



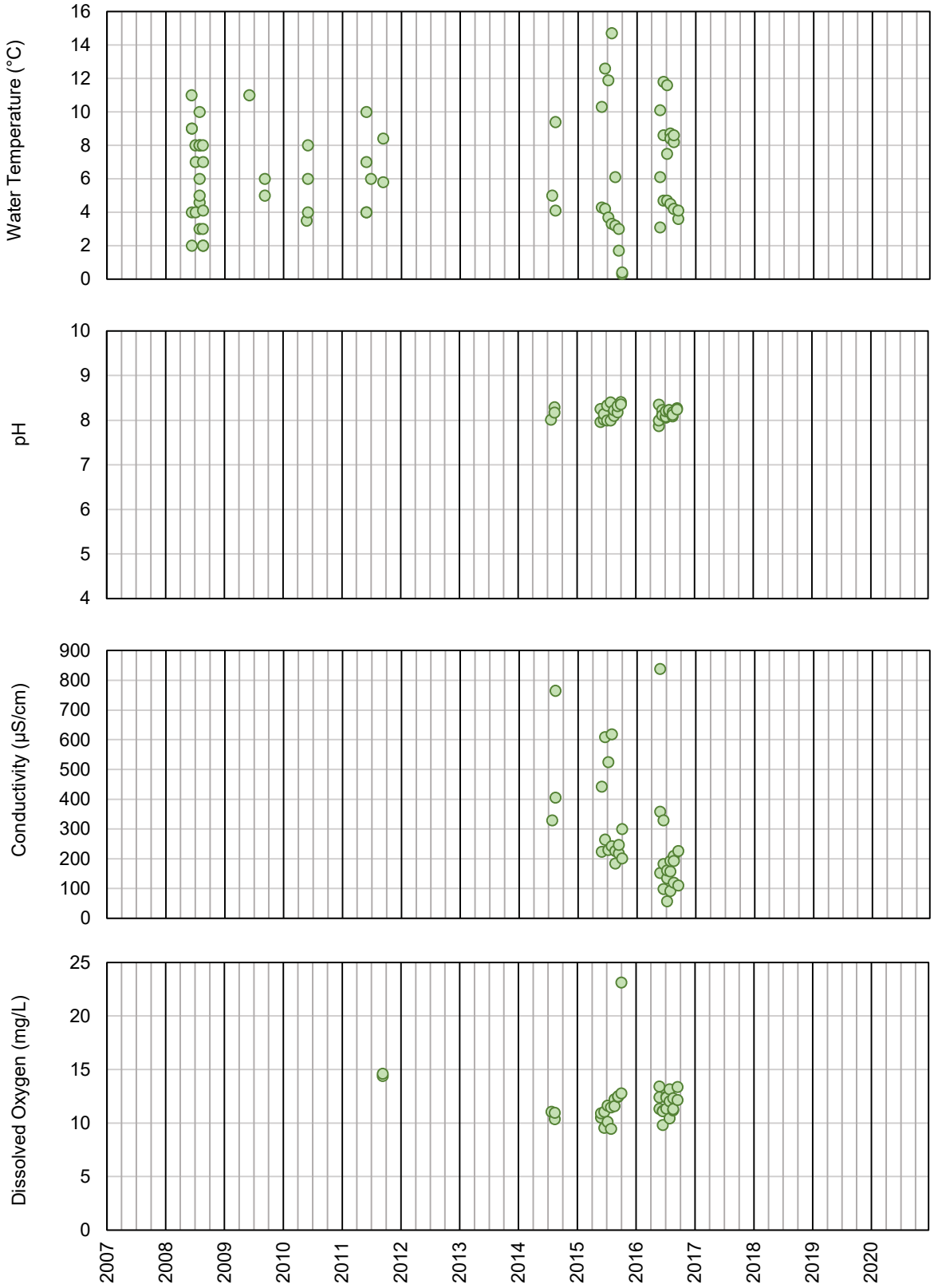
Big Creek Watershed, Moderate-Low Habitat Suitability, Field Meaurements

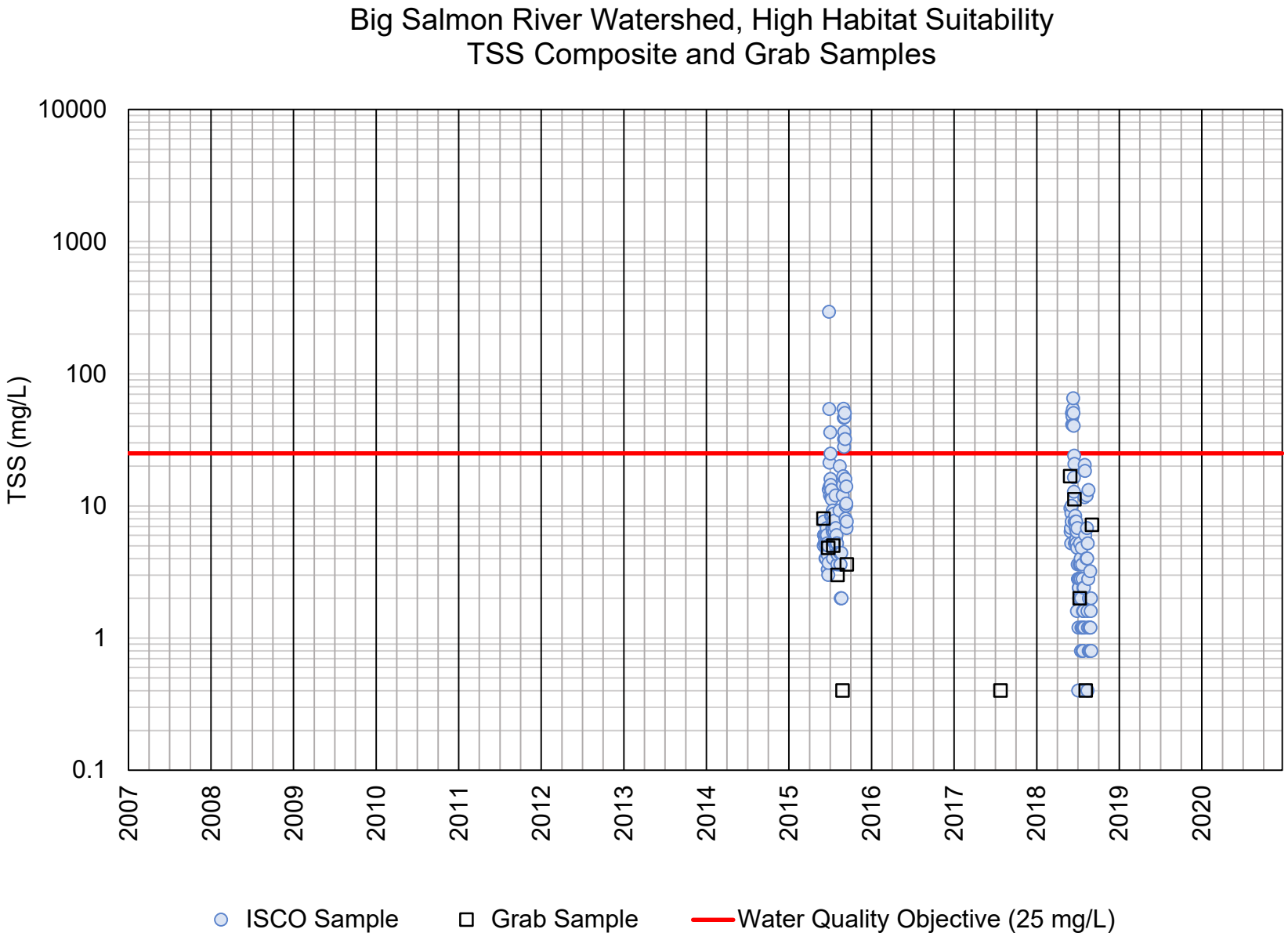



Big Creek Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

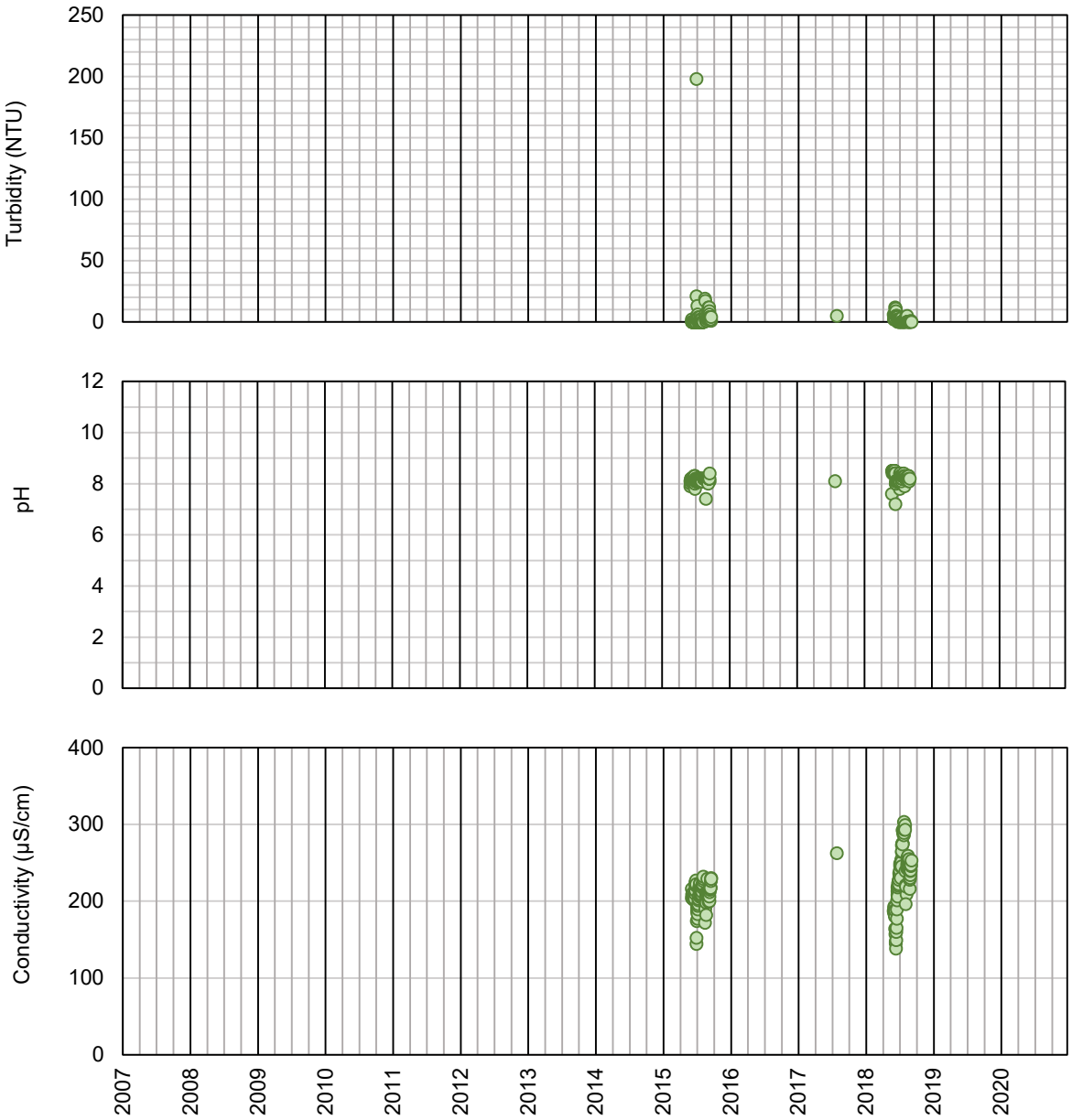

Big Creek Watershed, Low Habitat Suitability, Laboratory Measured Parameters
Turbidity (NTU)
7000
6000
5000
4000
3000
2000
1000
0
pH
12
10
8
6
4
2
0
Conductivity (µS/cm)
900
800
700
600
500
400
300
200
100
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

Big Creek Watershed, Low Habitat Suitability, Field Meaurements

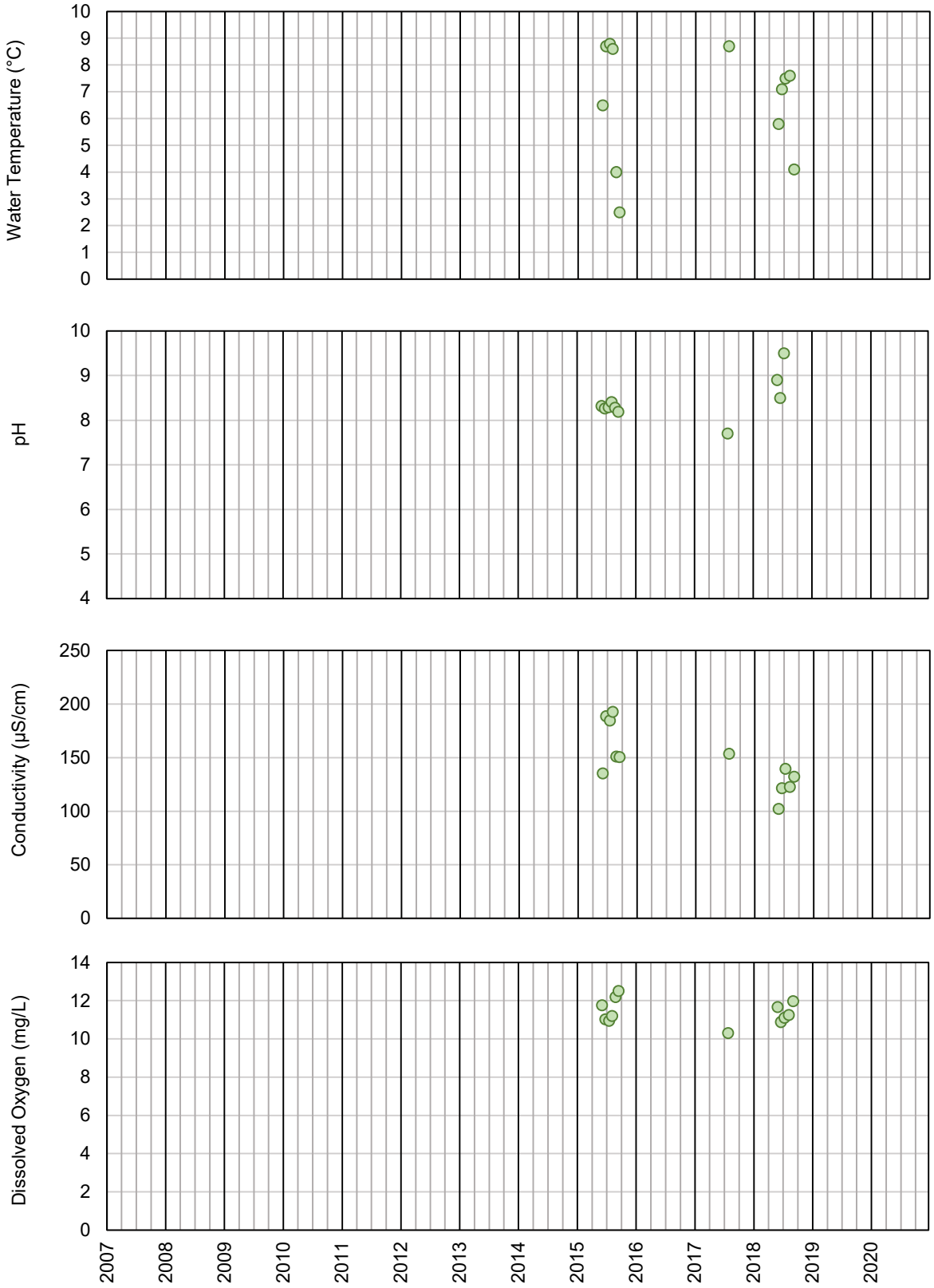


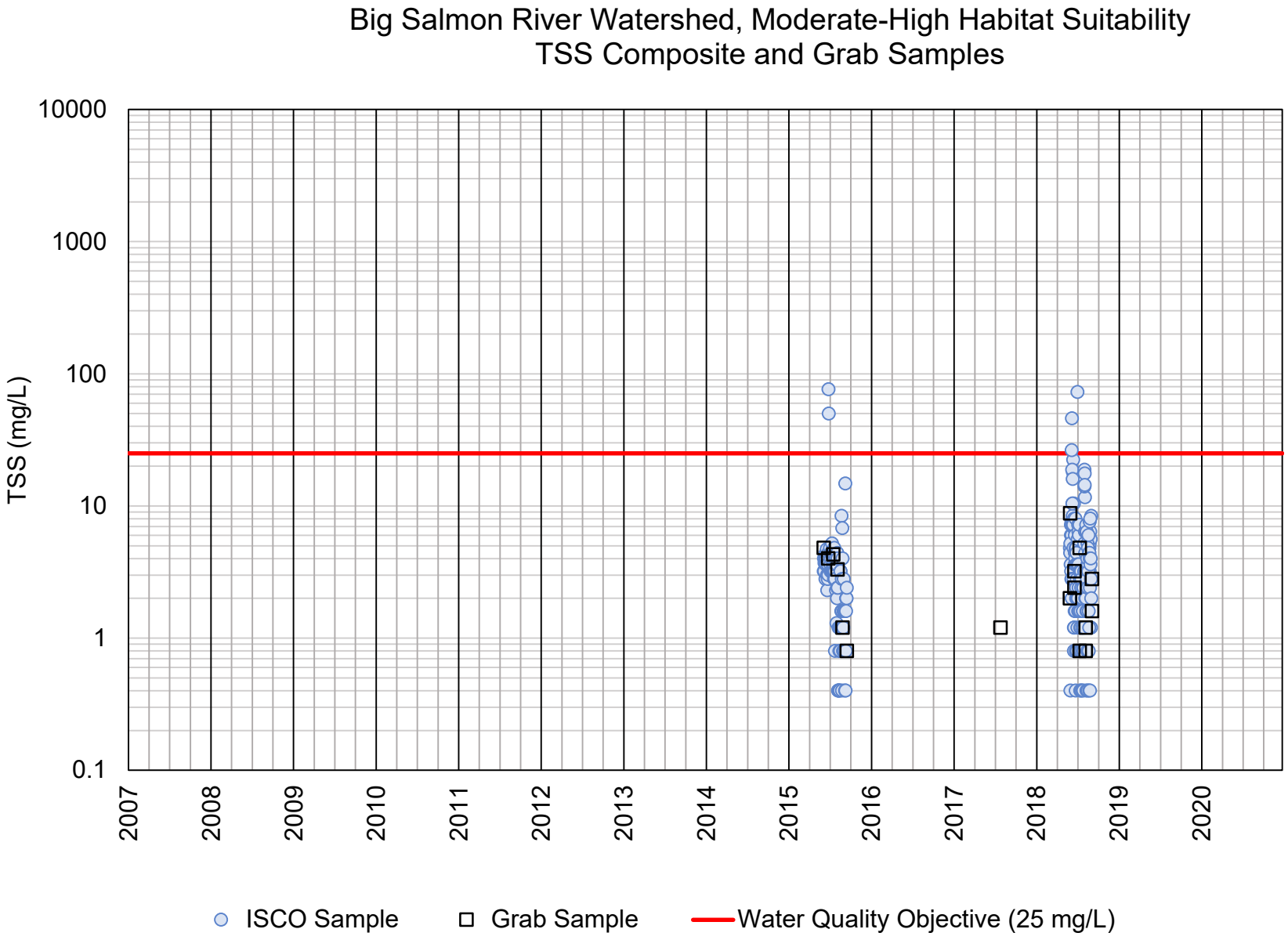

Big Salmon River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Big Salmon River Watershed, High Habitat Suitability, Laboratory Measured Parameters

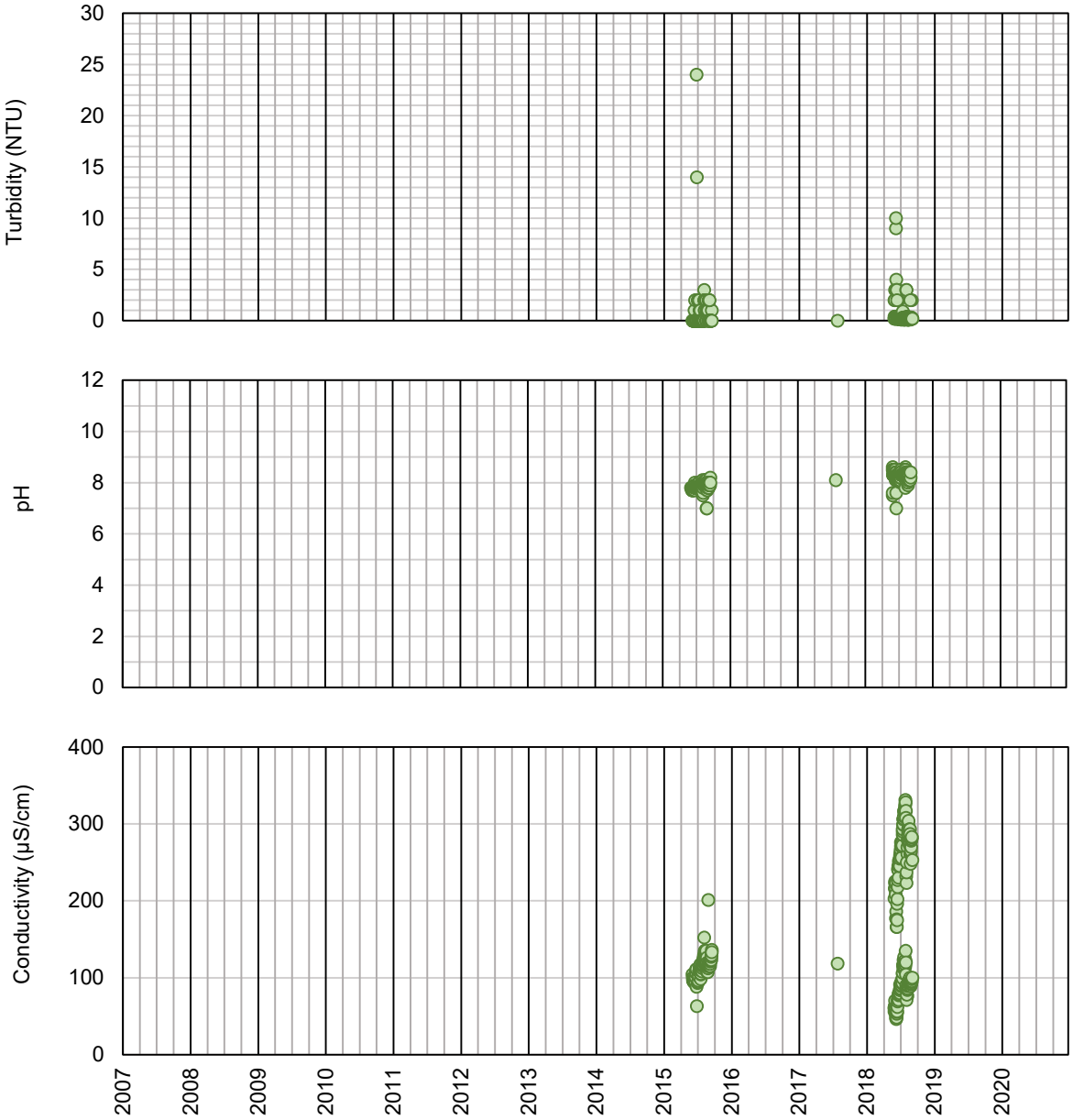


Big Salmon River Watershed, High Habitat Suitability, Field Meaurements

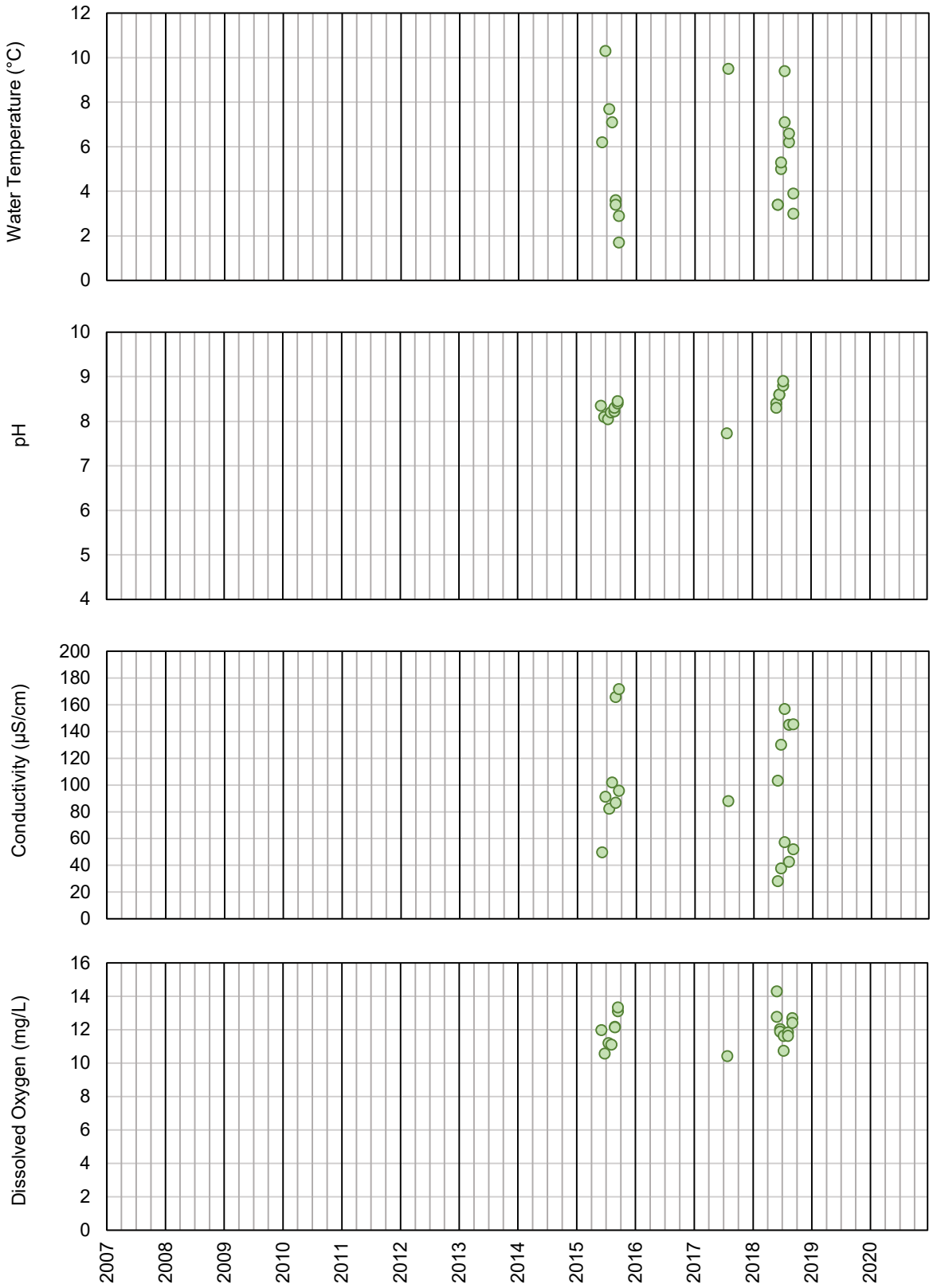


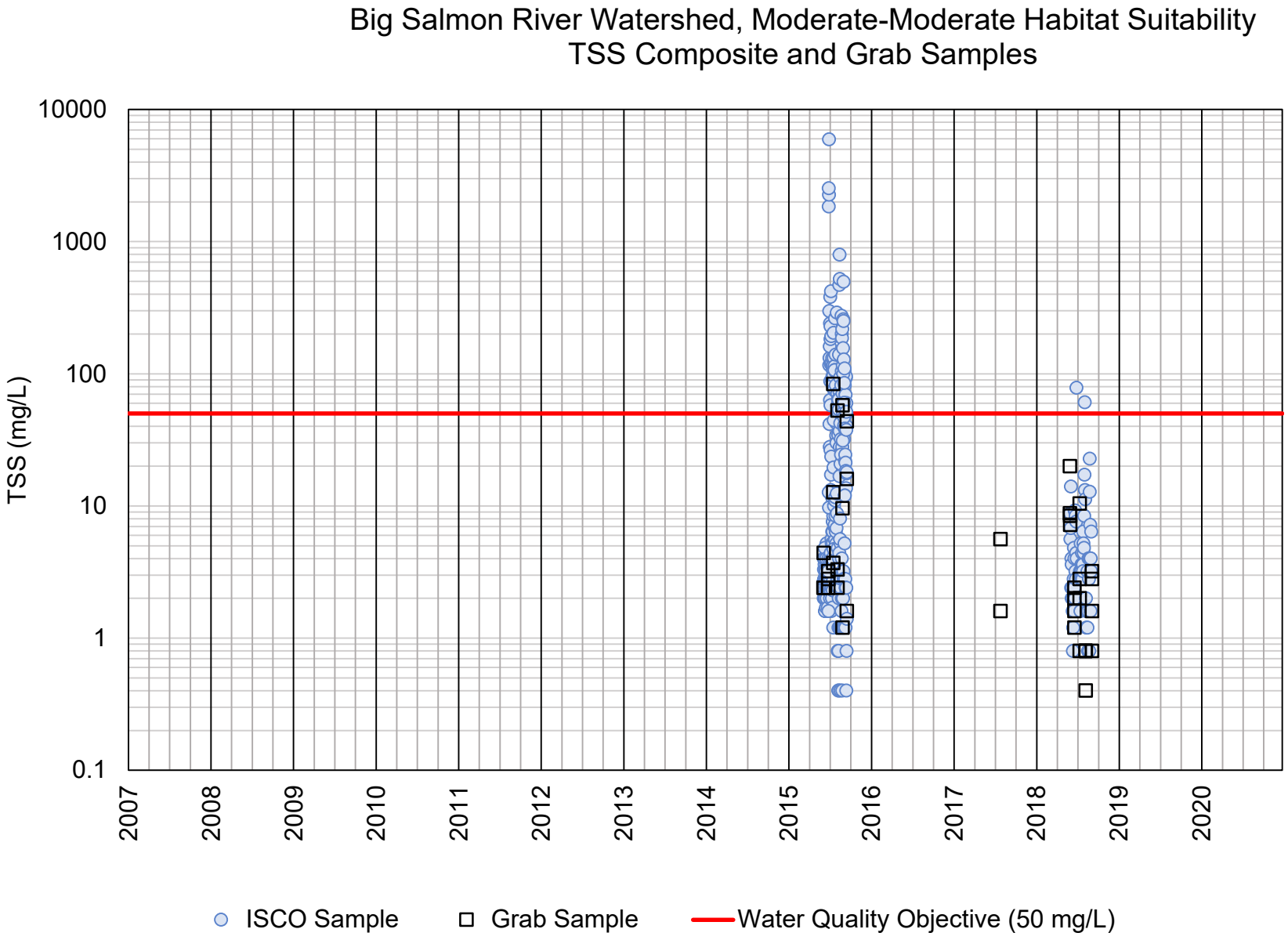

Big Salmon River Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Big Salmon River Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters

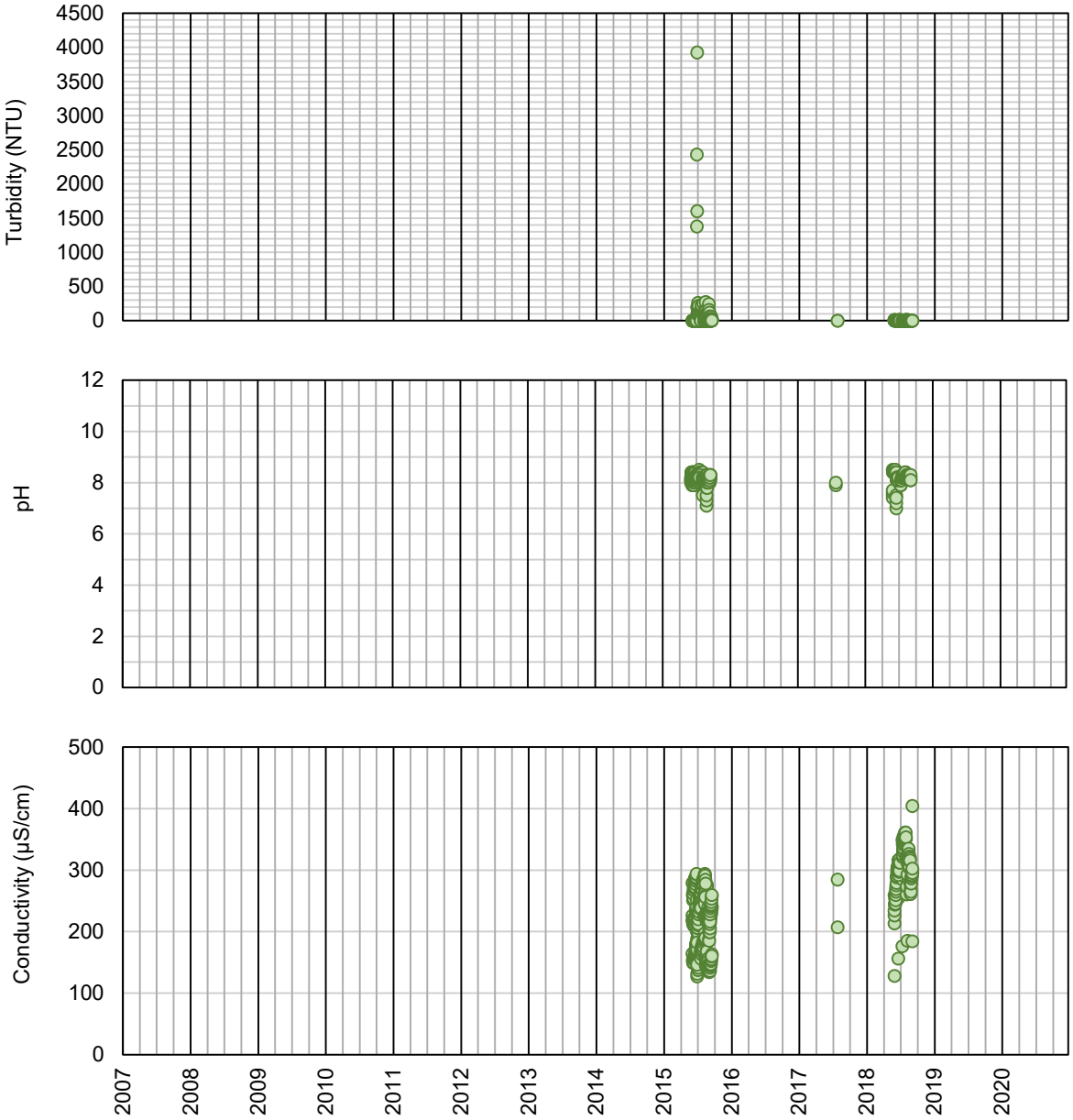


Big Salmon River Watershed, Moderate-High Habitat Suitability, Field Meaurements

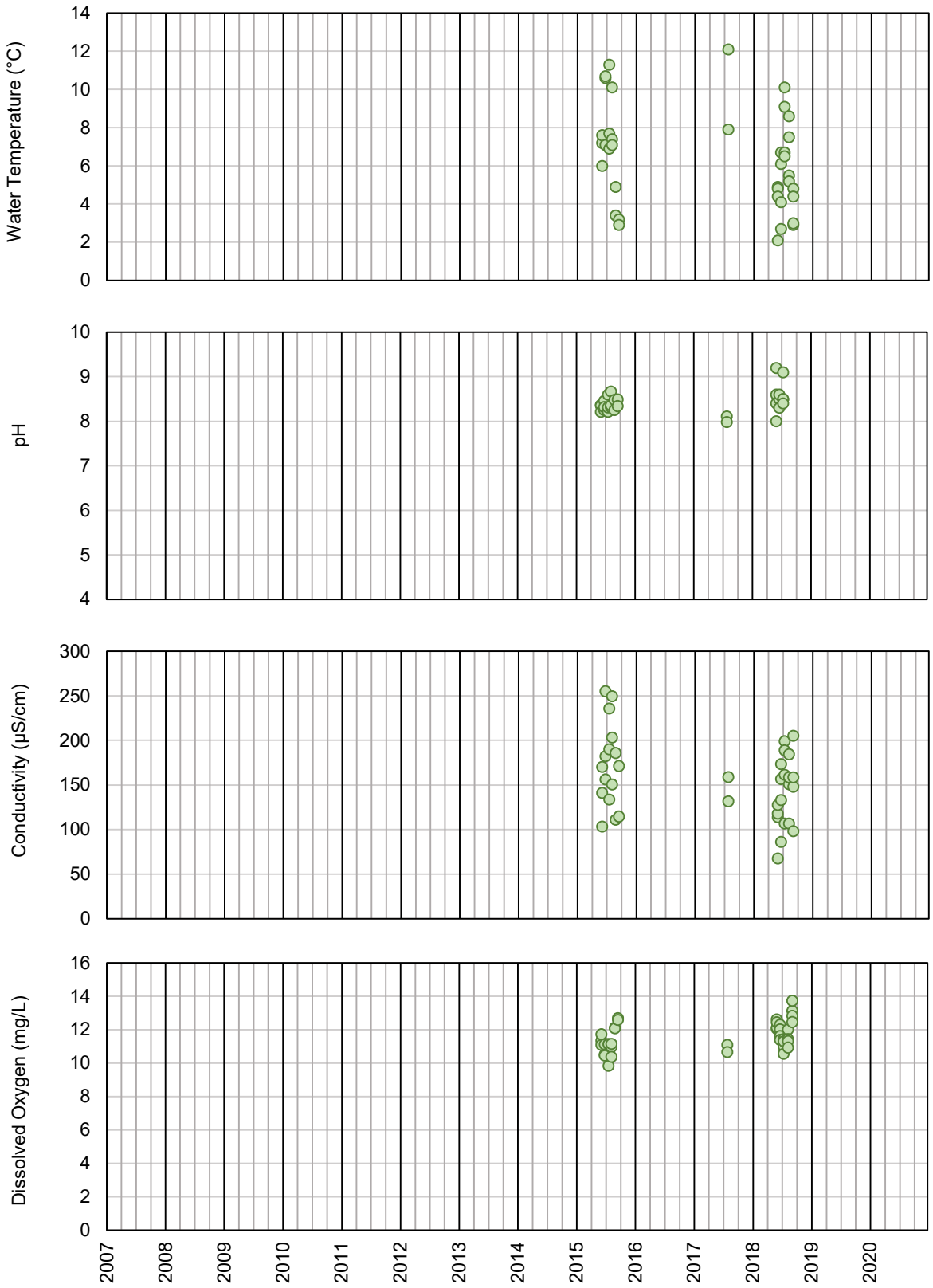


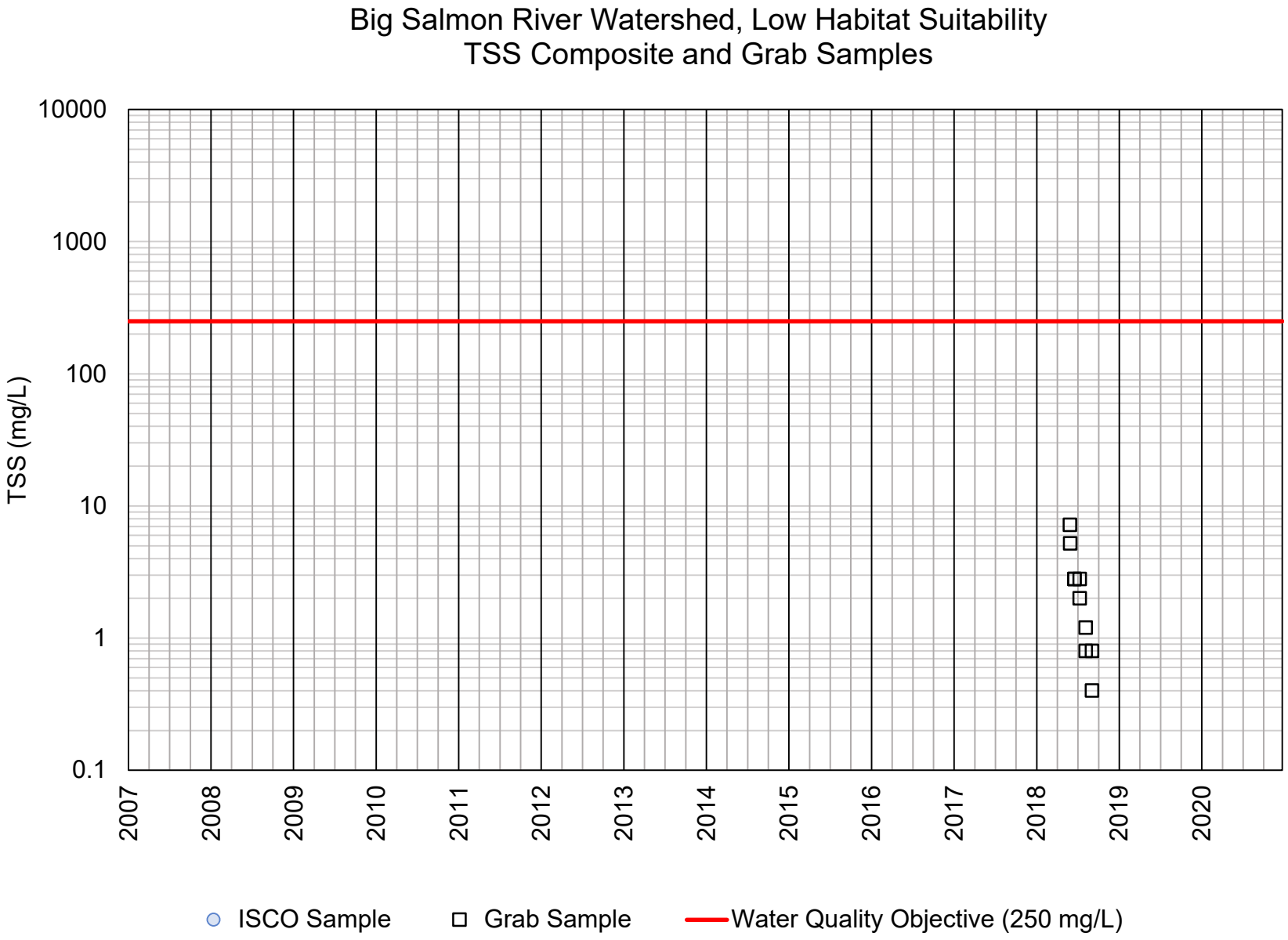

Big Salmon River Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (50 mg/L)

Big Salmon River Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters

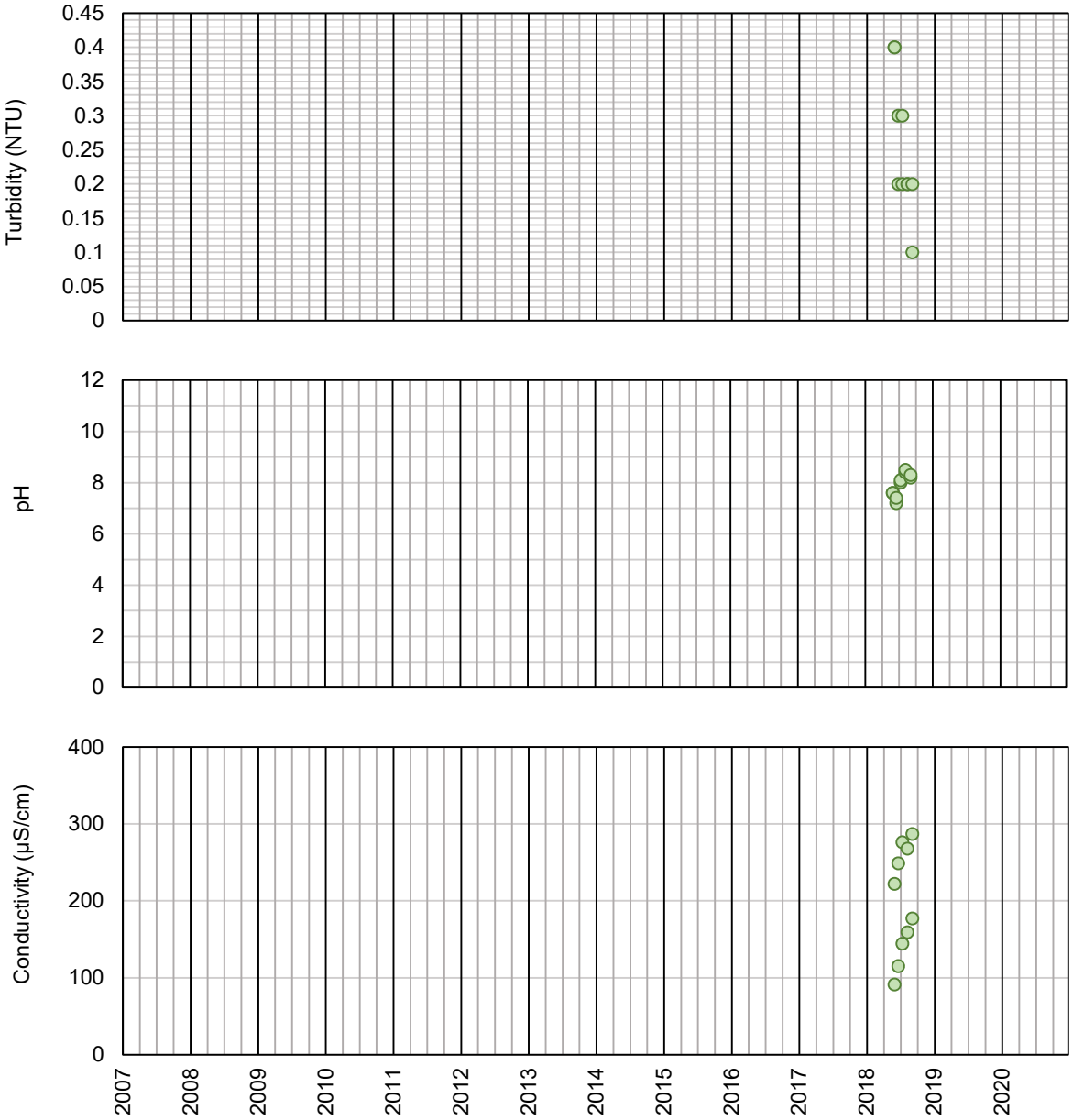


Big Salmon River Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements

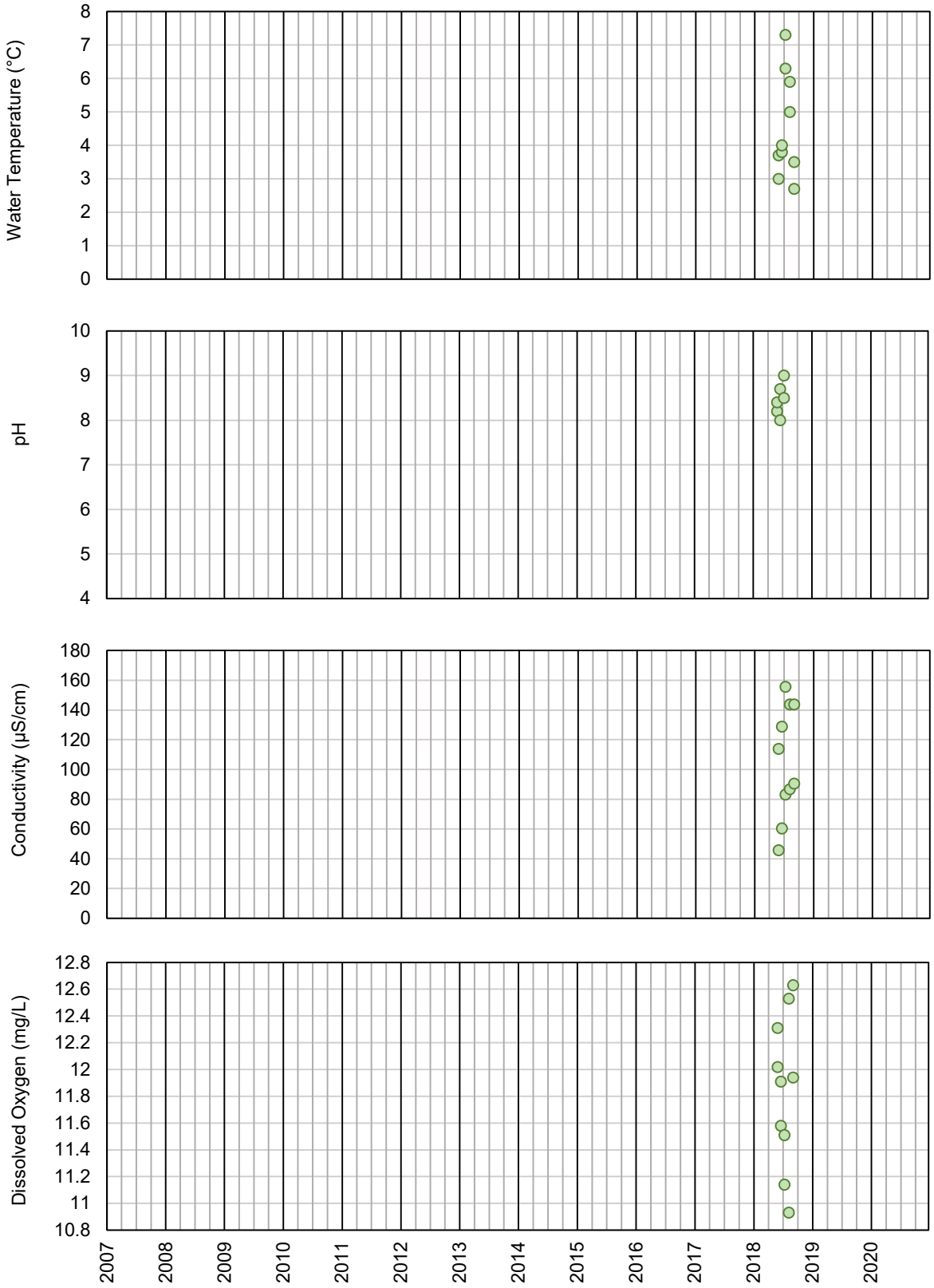


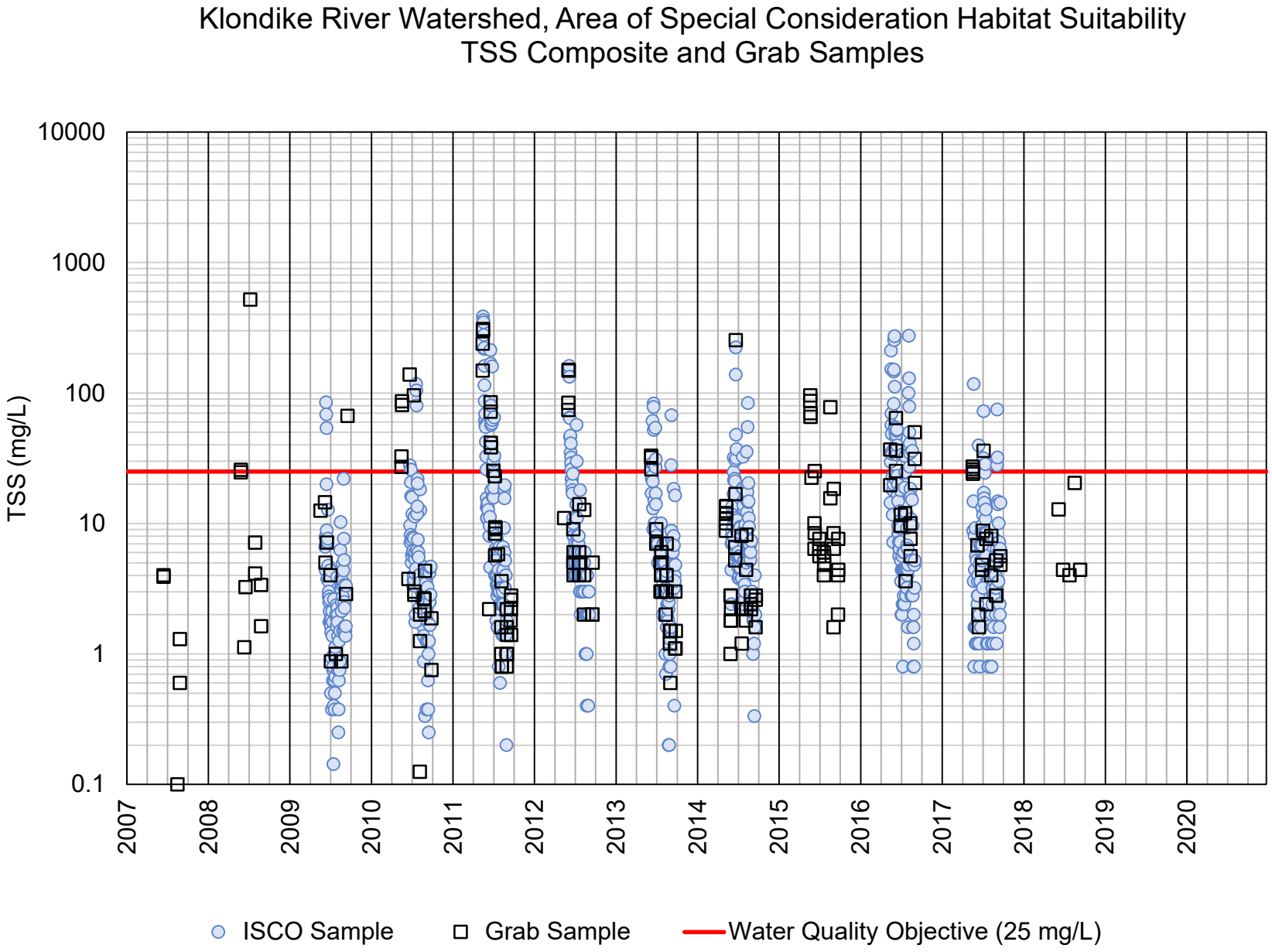

Big Salmon River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (250 mg/L)

Big Salmon River Watershed, Low Habitat Suitability, Laboratory Measured Parameters

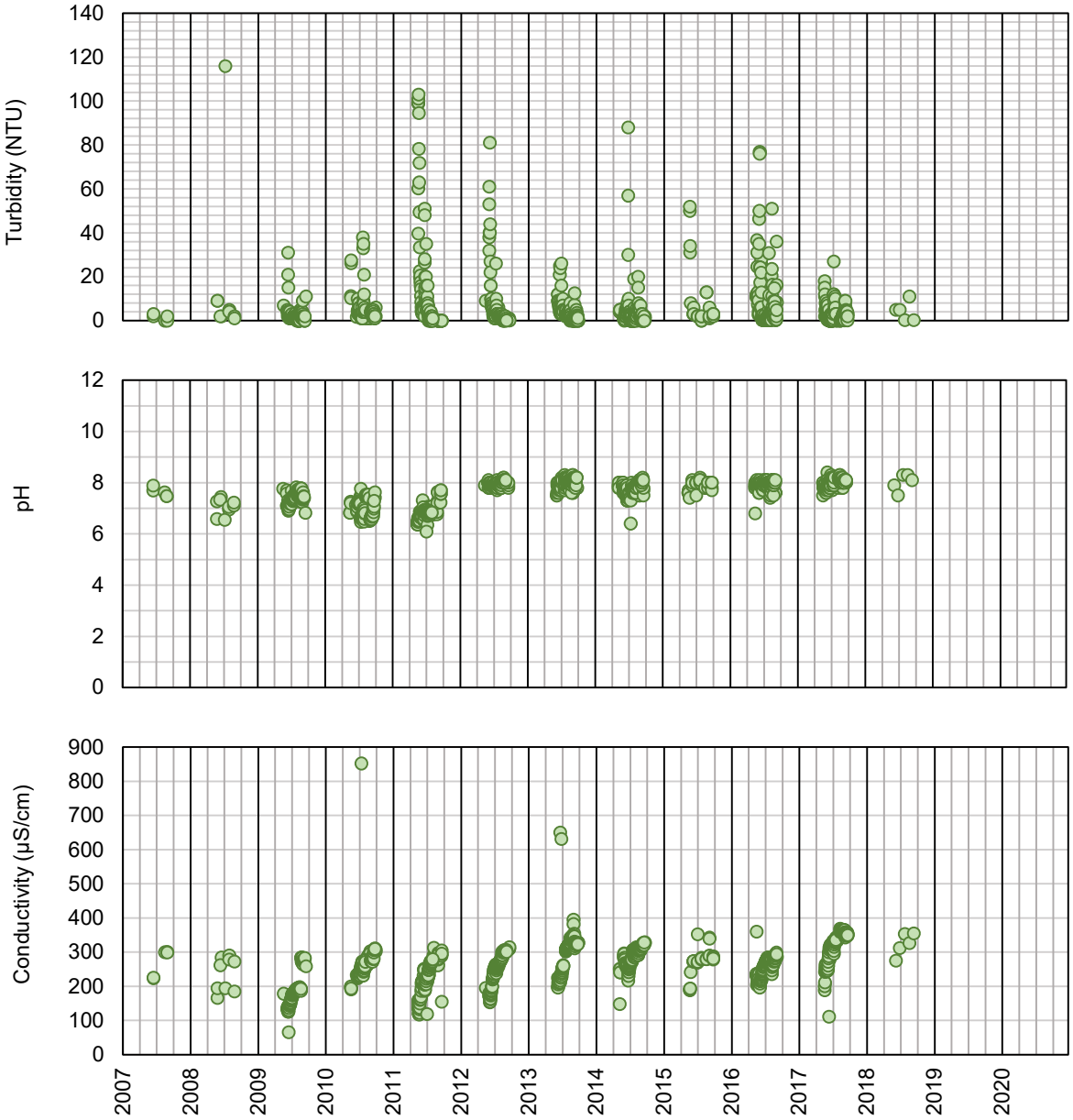


Big Salmon River Watershed, Low Habitat Suitability, Field Meaurements

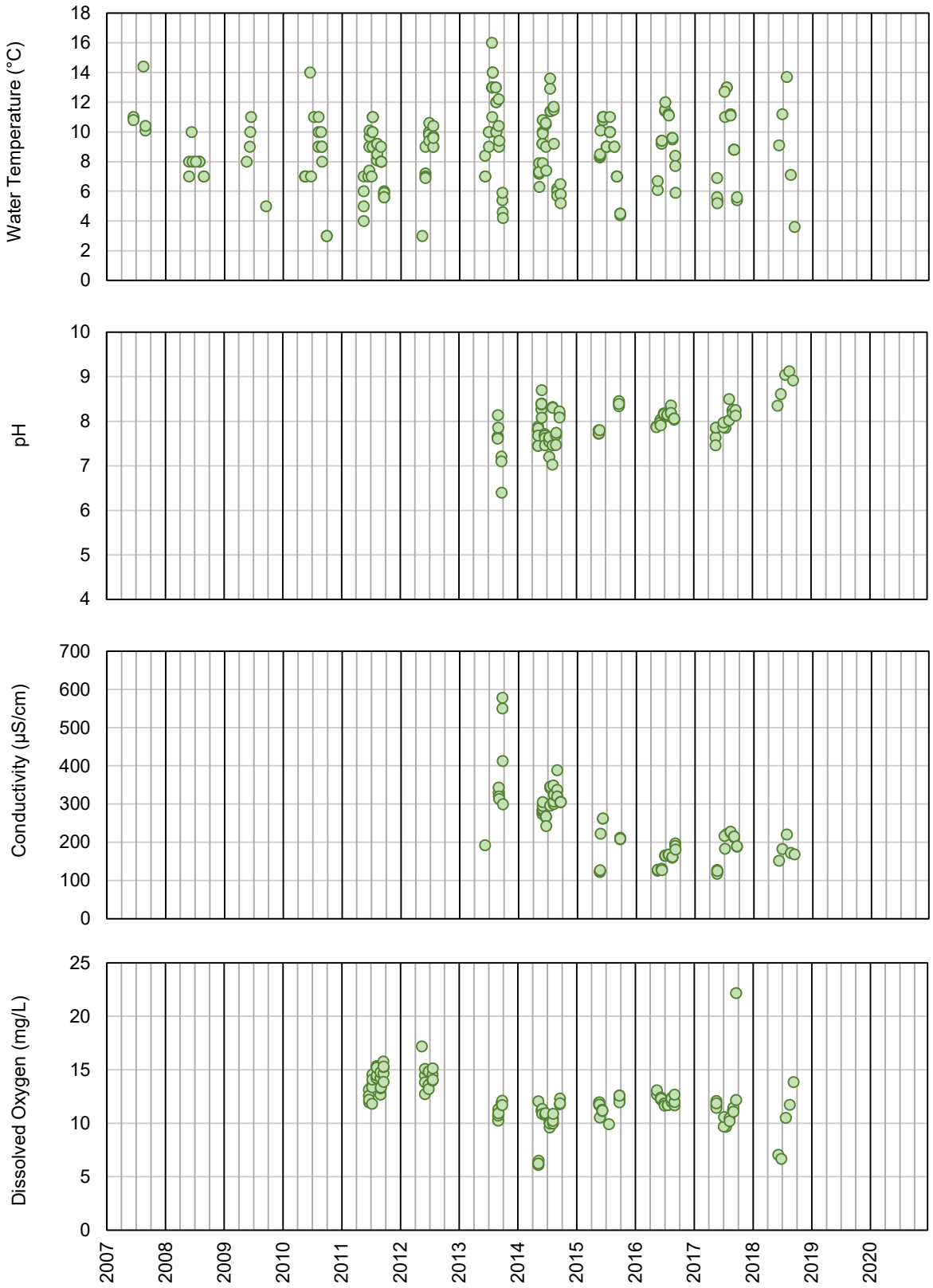


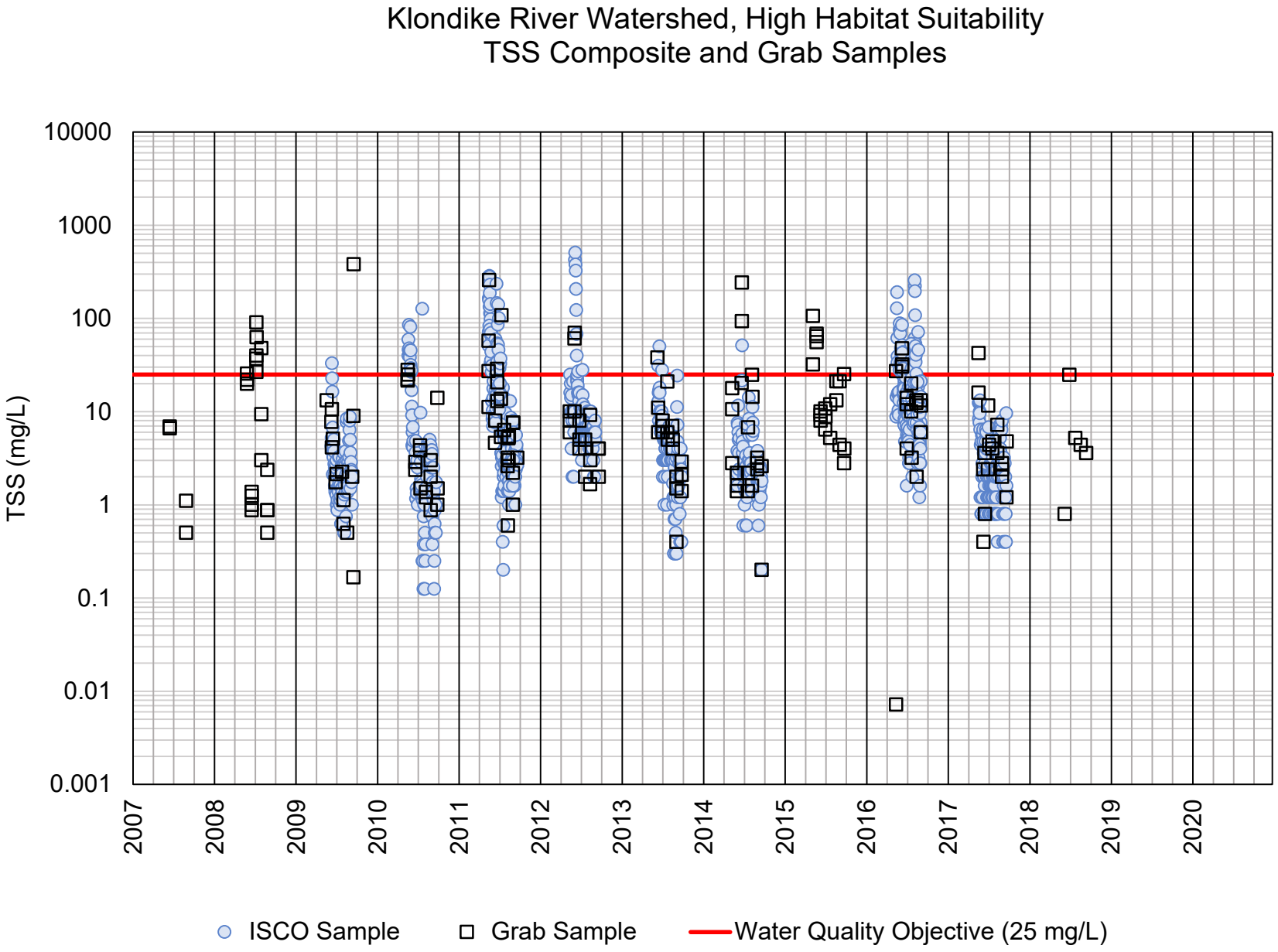

Klondike River Watershed, Area of Special Consideration Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Klondike River Watershed, Area of Special Consideration Habitat Suitability, Laboratory Measured Parameters

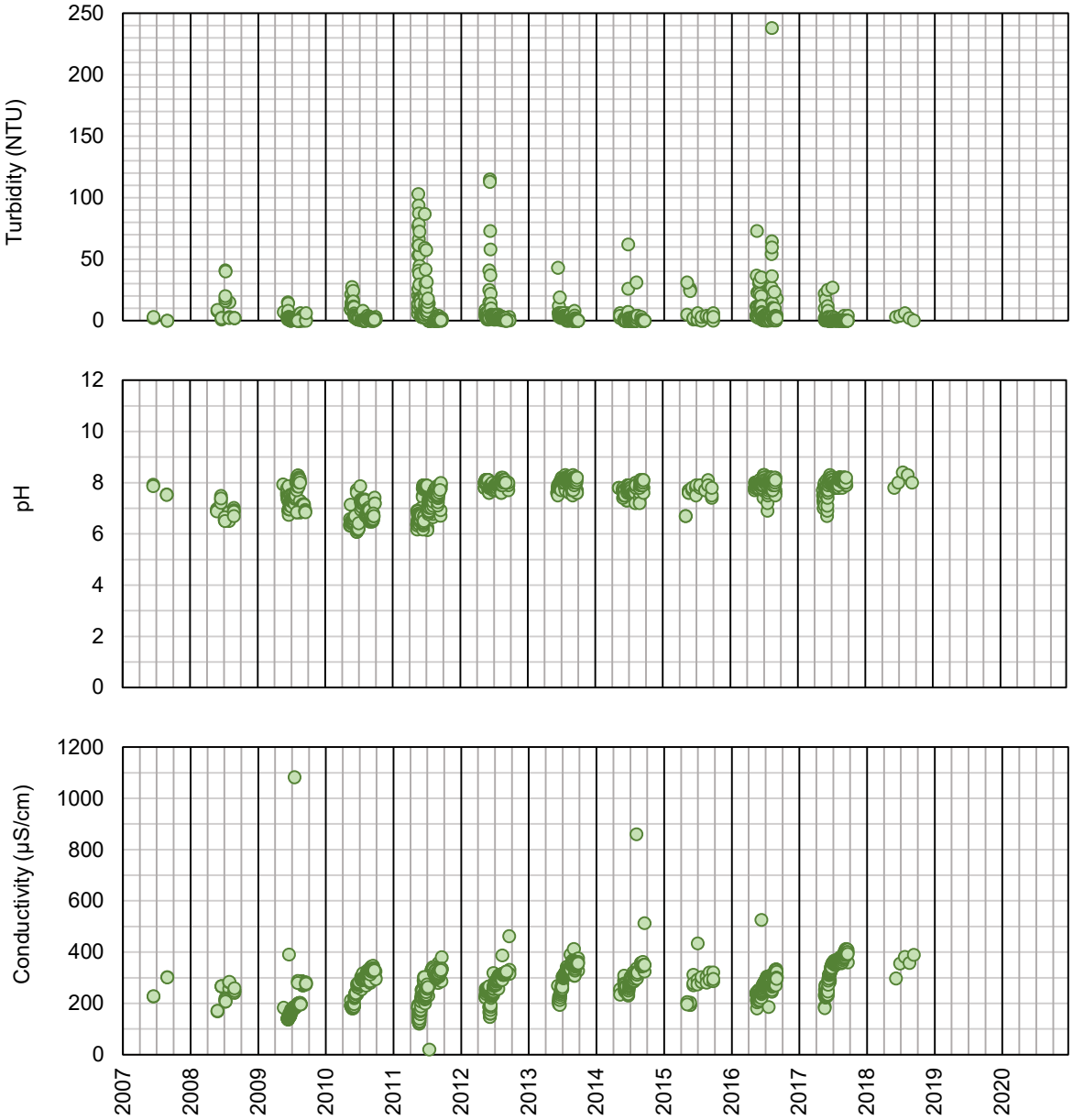


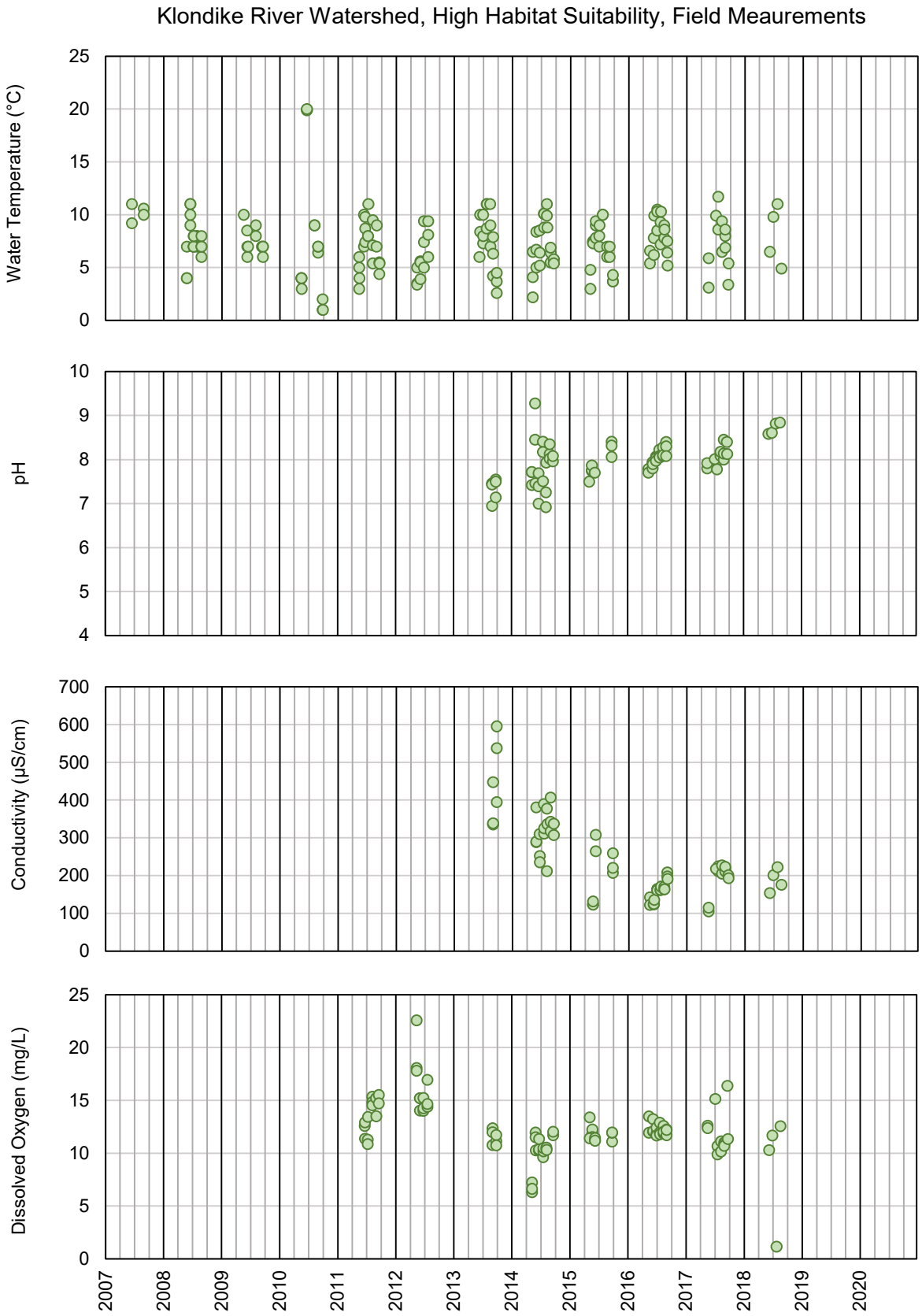
Klondike River Watershed, Area of Special Consideration Habitat Suitability, Field Meaurements

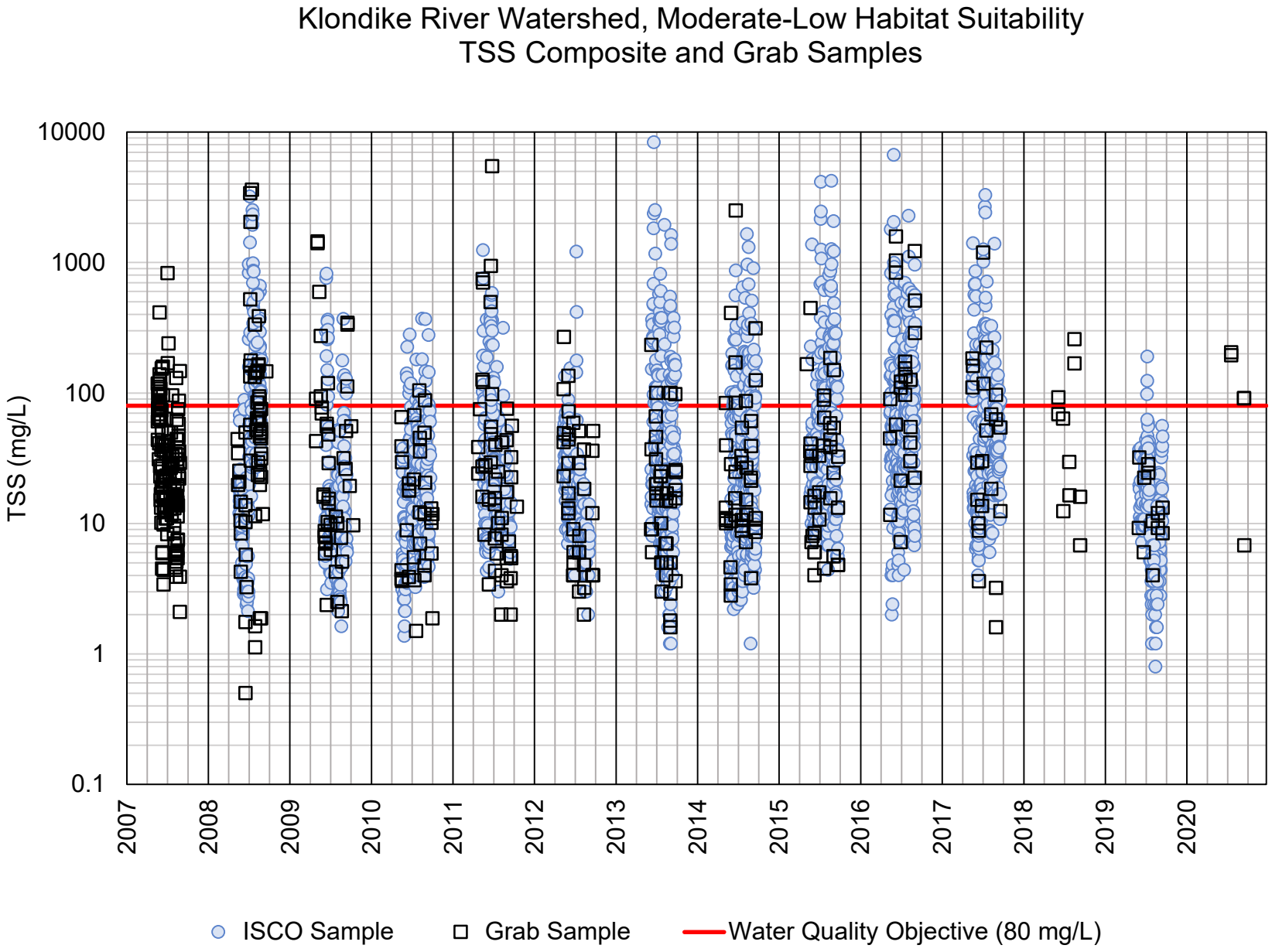



Klondike River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
0.01
0.001
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

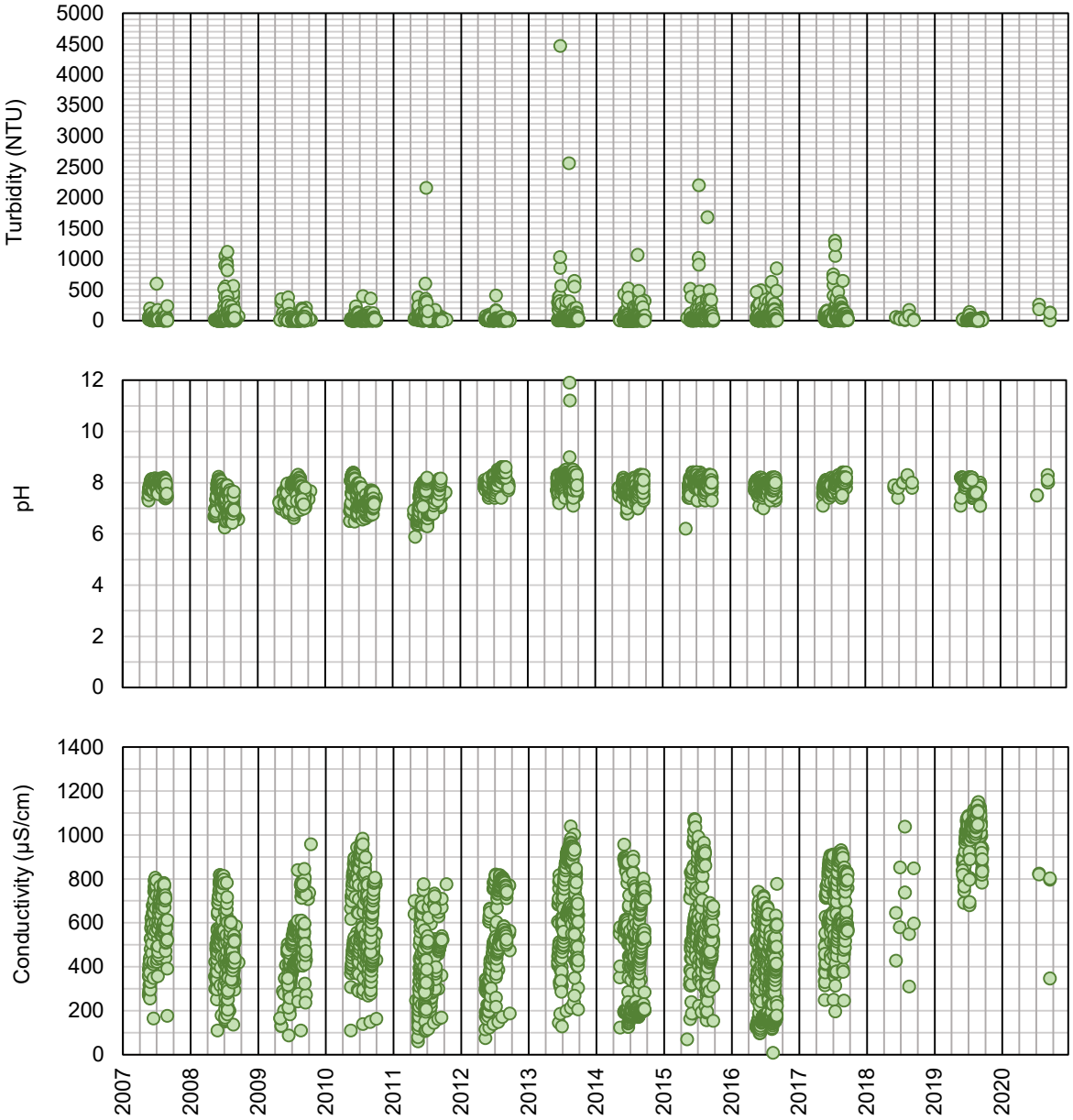
Klondike River Watershed, High Habitat Suitability, Laboratory Measured Parameters

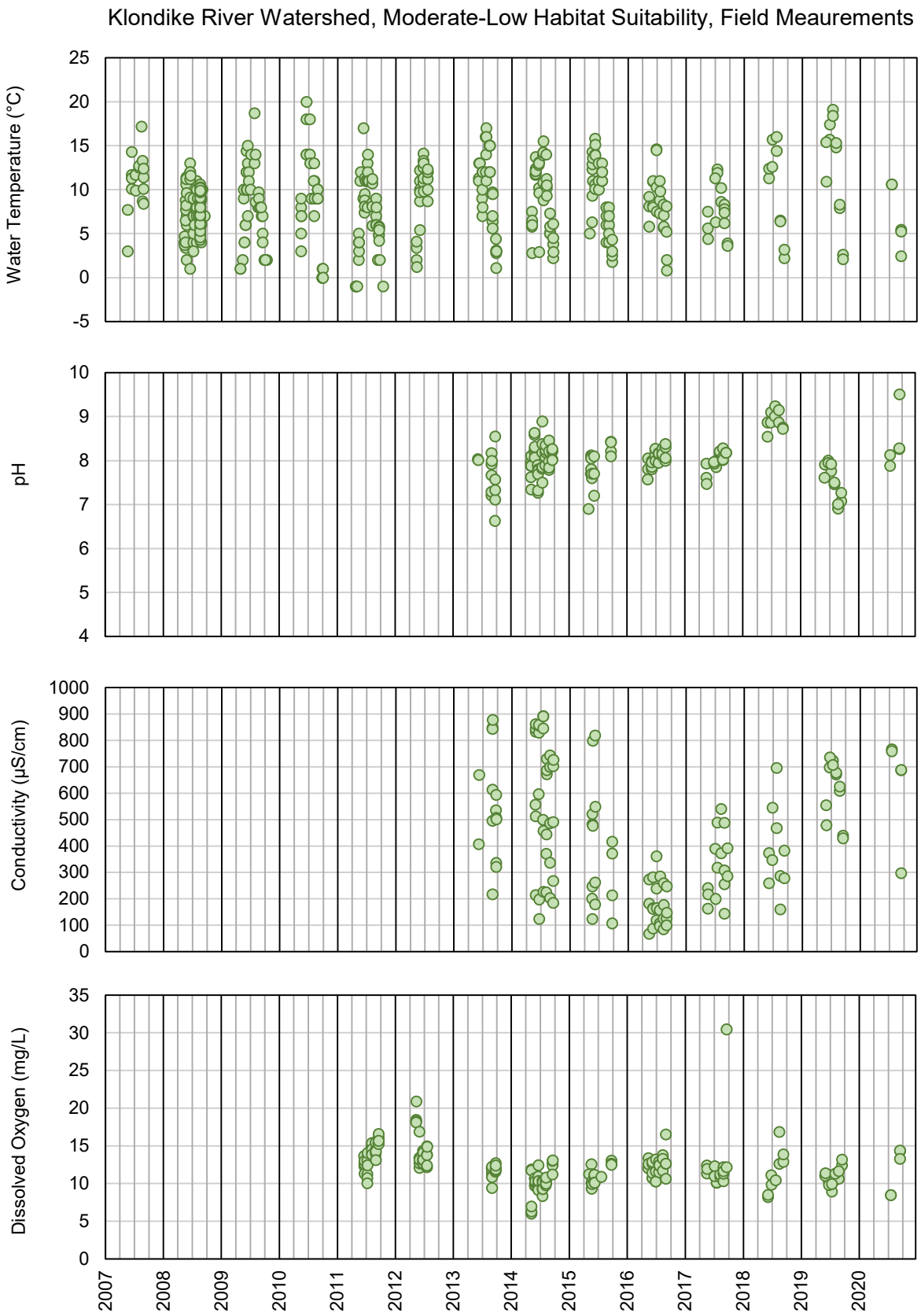


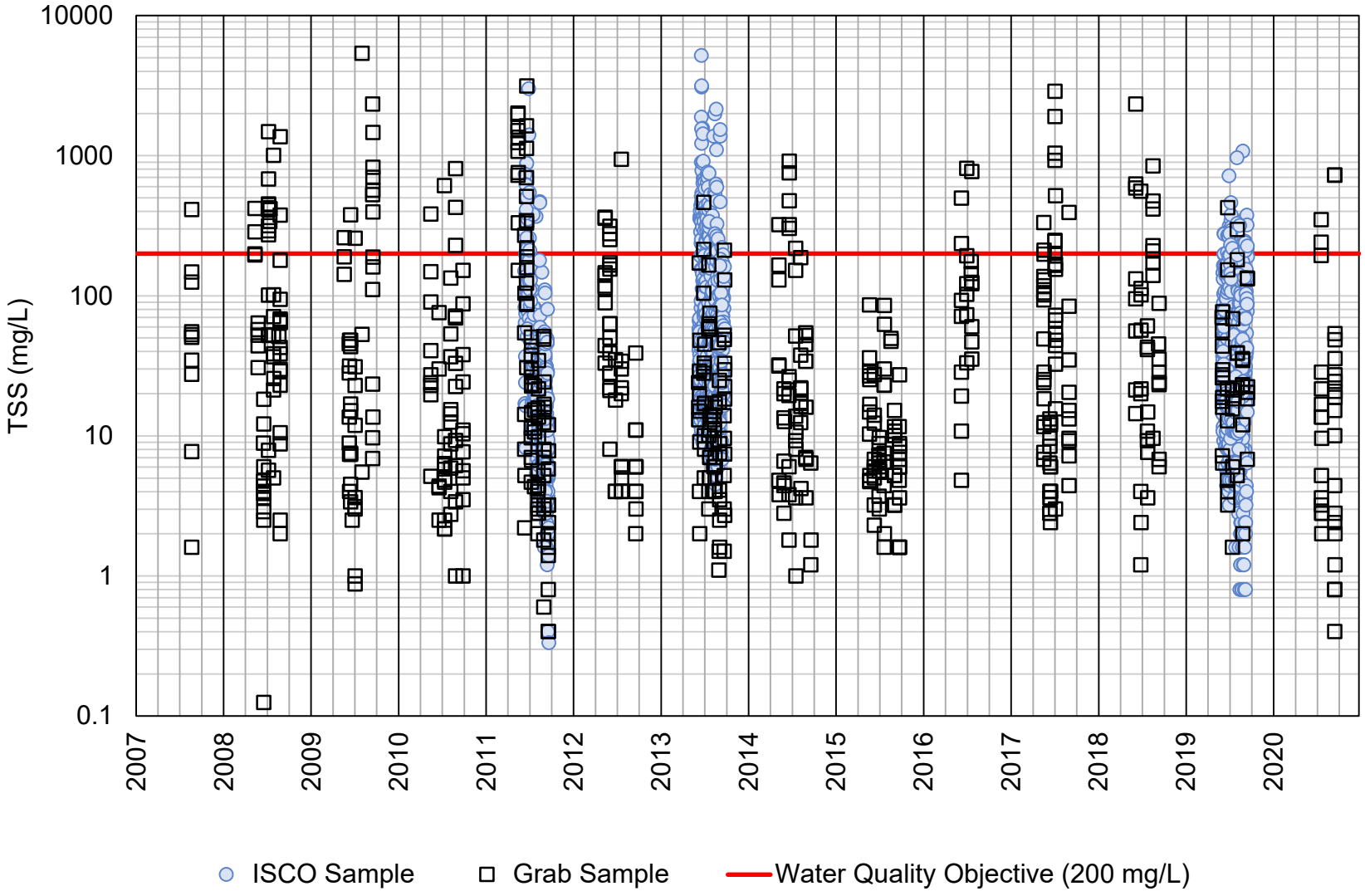

Klondike River Watershed, High Habitat Suitability, Field Meaurements
Water Temperature (°C)
0
5
10
15
20
25
pH
4
5
6
7
8
9
10
Conductivity (µS/cm)
0
100
200
300
400
500
600
700
Dissolved Oxygen (mg/L)
0
5
10
15
20
25
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


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

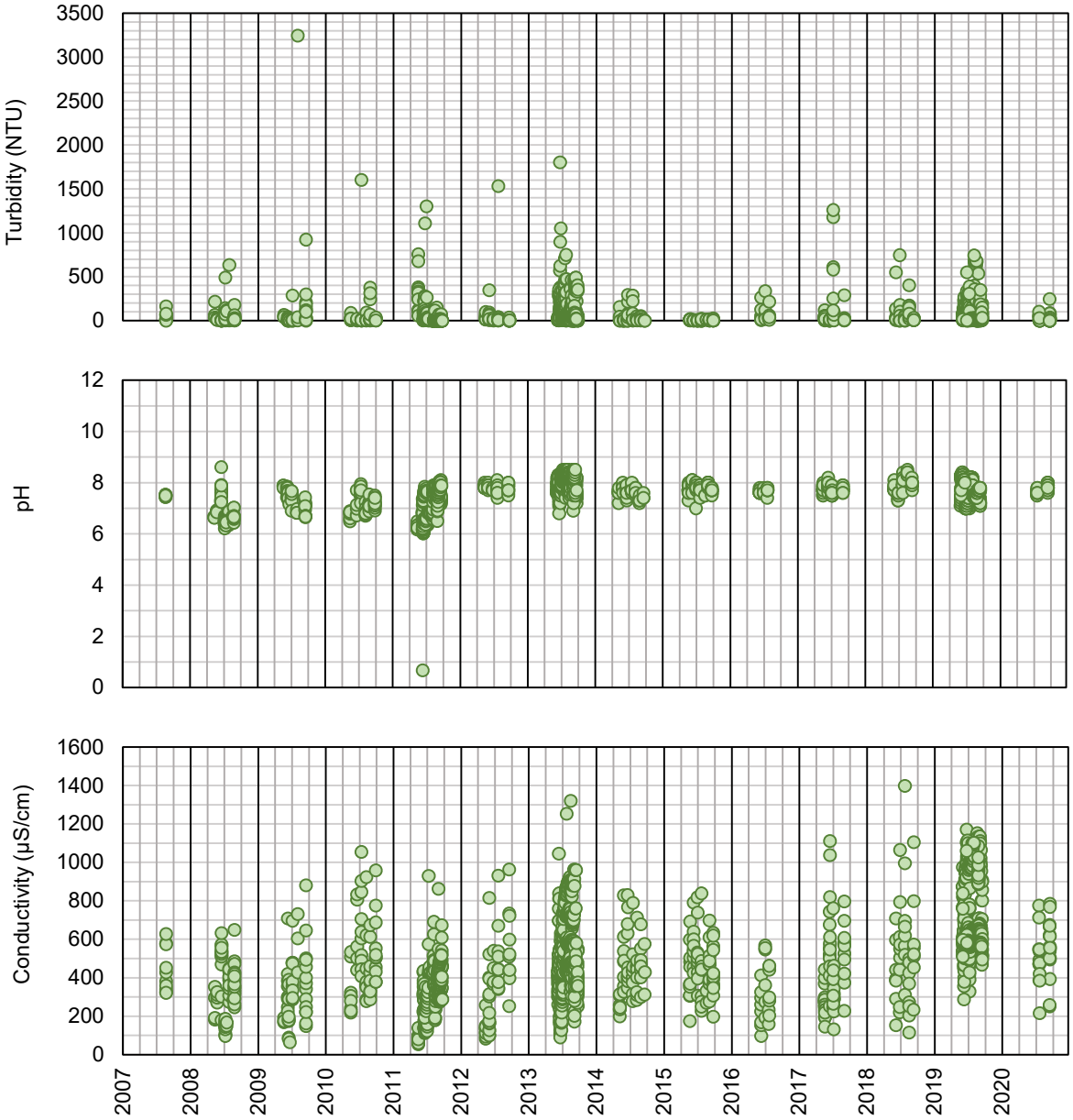
Klondike River Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters

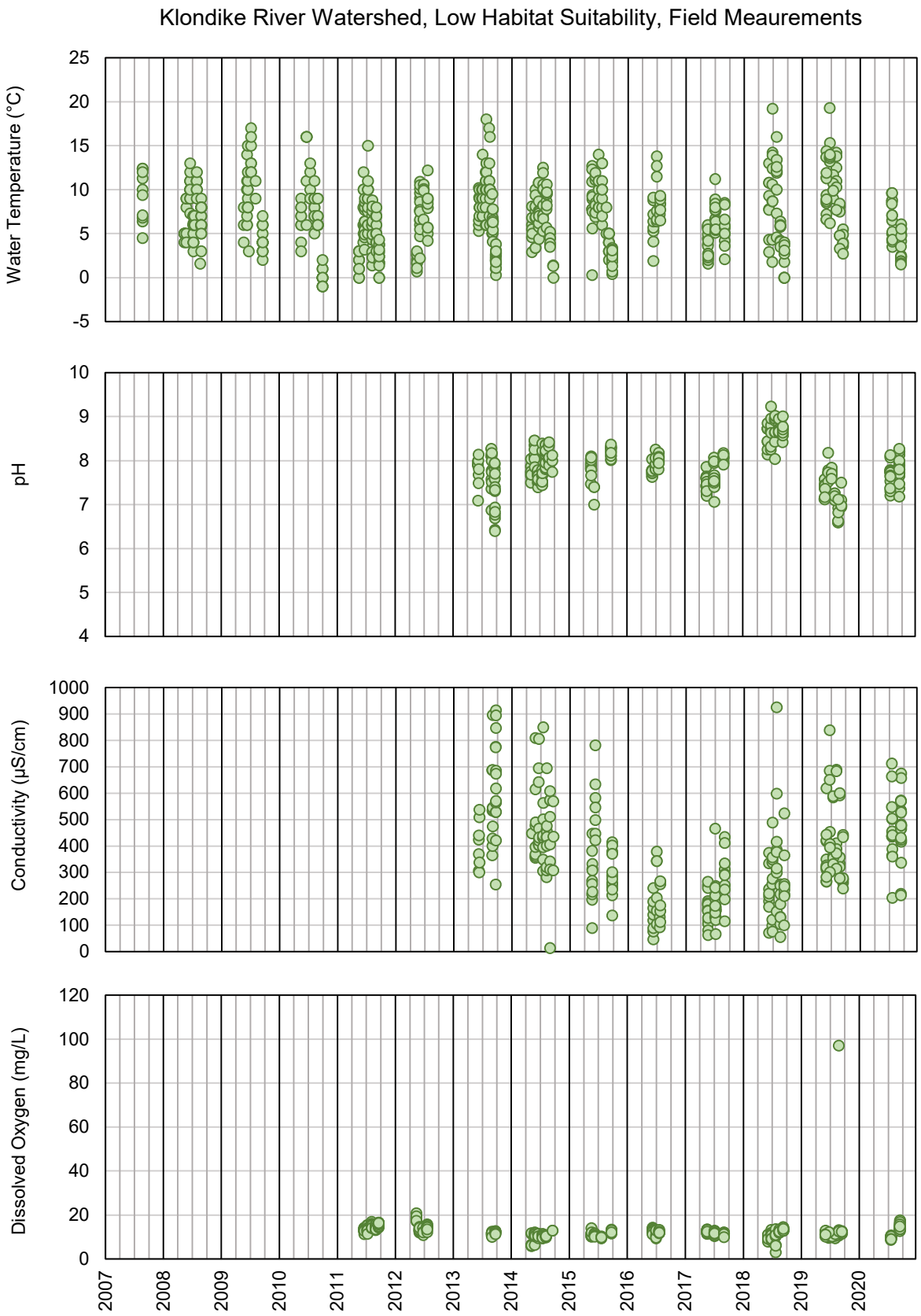


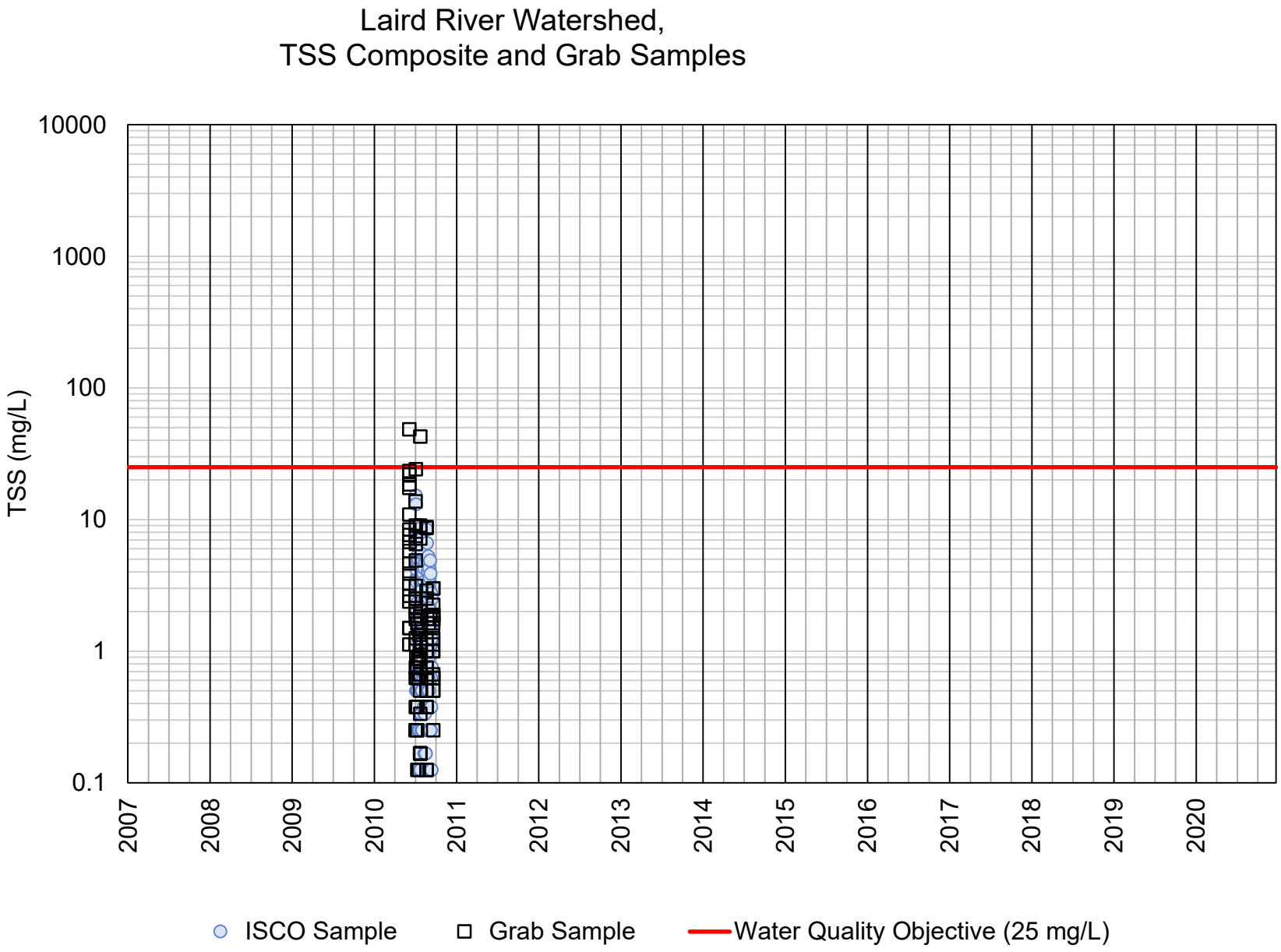

Klondike River Watershed, Moderate-Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
25
20
15
10
5
0
-5
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1000
900
800
700
600
500
400
300
200
100
0
Dissolved Oxygen (mg/L)
35
30
25
20
15
10
5
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

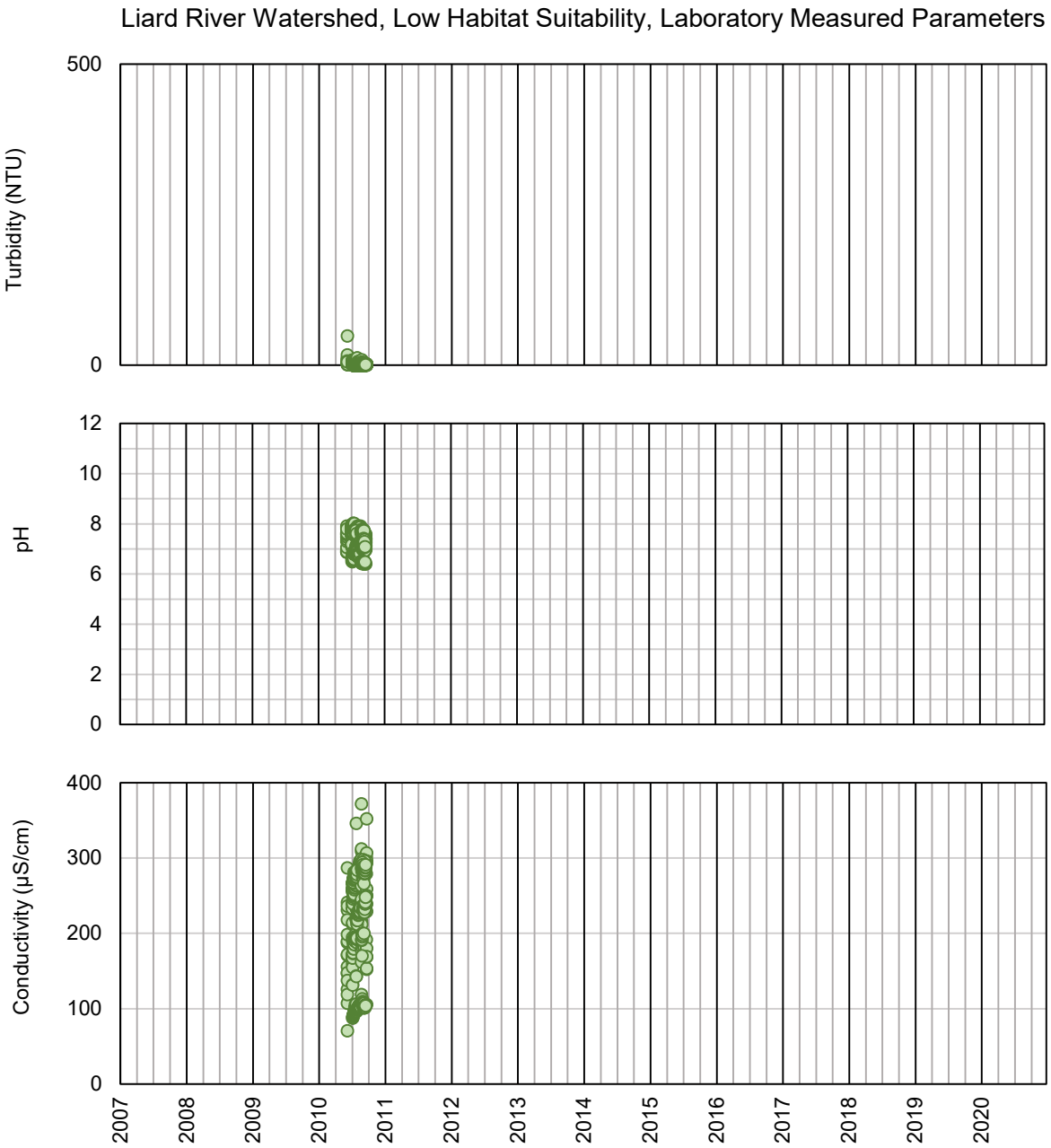

Klondike River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

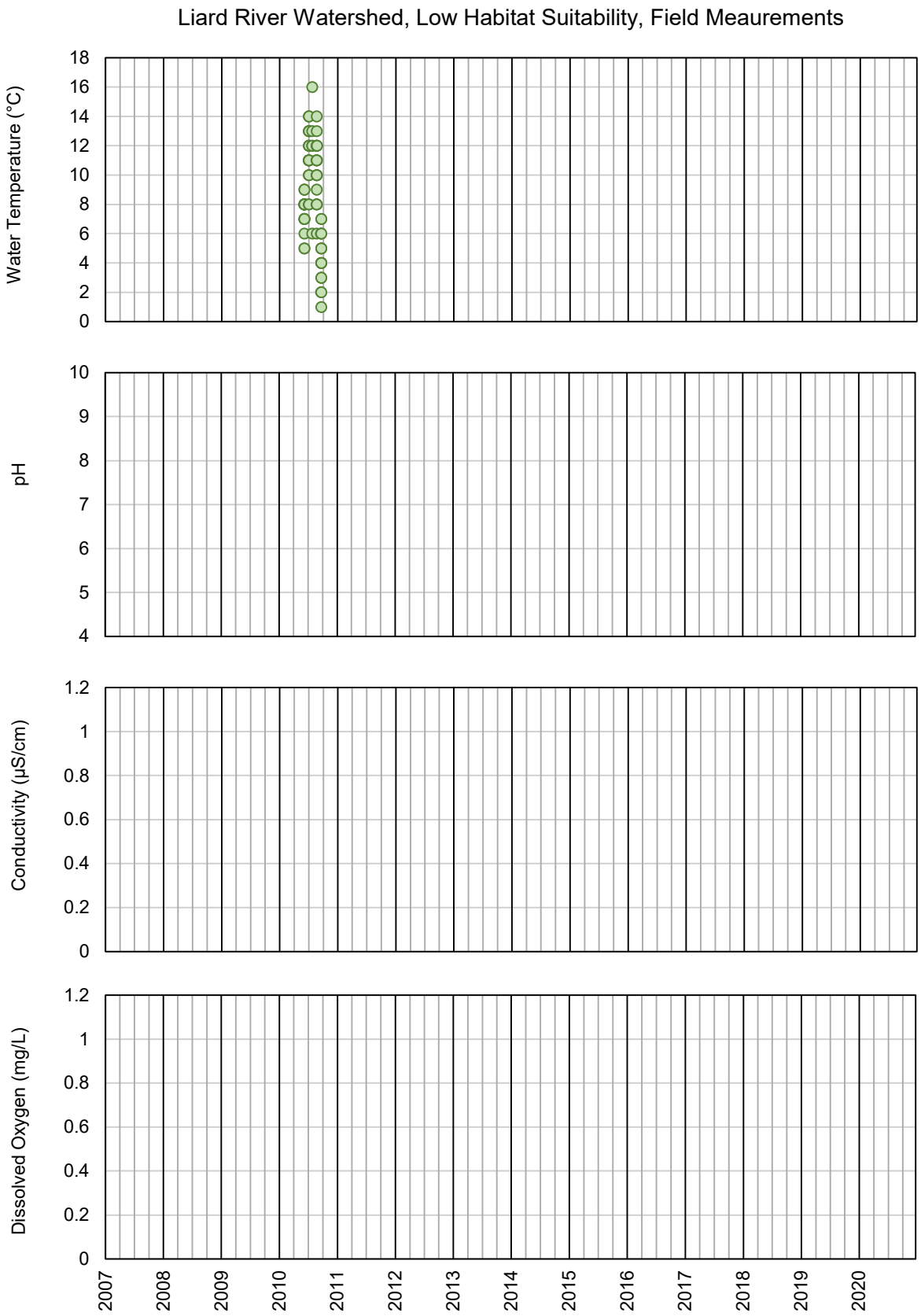
Klondike River Watershed, Low Habitat Suitability, Laboratory Measured Parameters

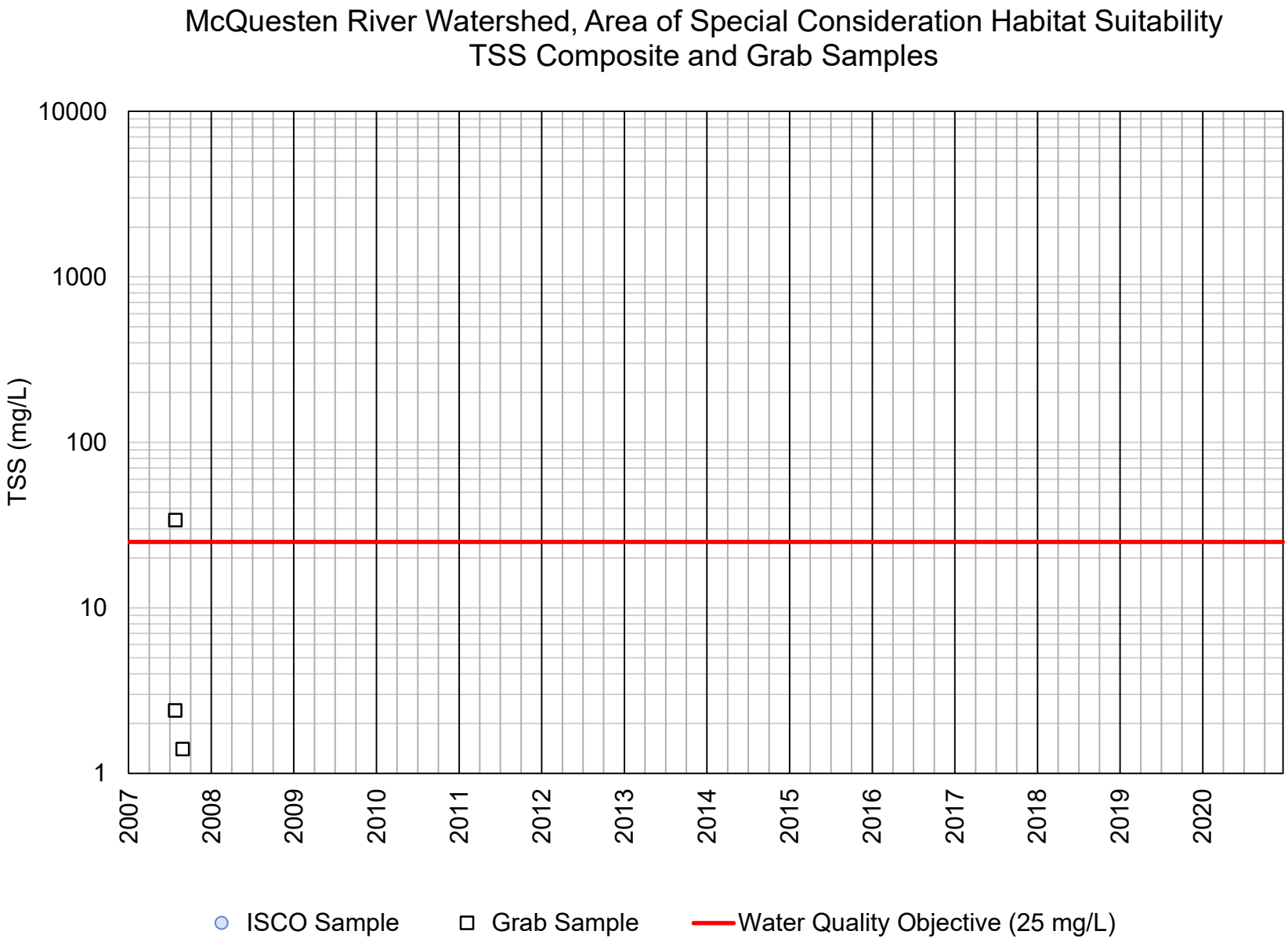



Klondike River Watershed, Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
25
20
15
10
5
0
-5
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1000
900
800
700
600
500
400
300
200
100
0
Dissolved Oxygen (mg/L)
120
100
80
60
40
20
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

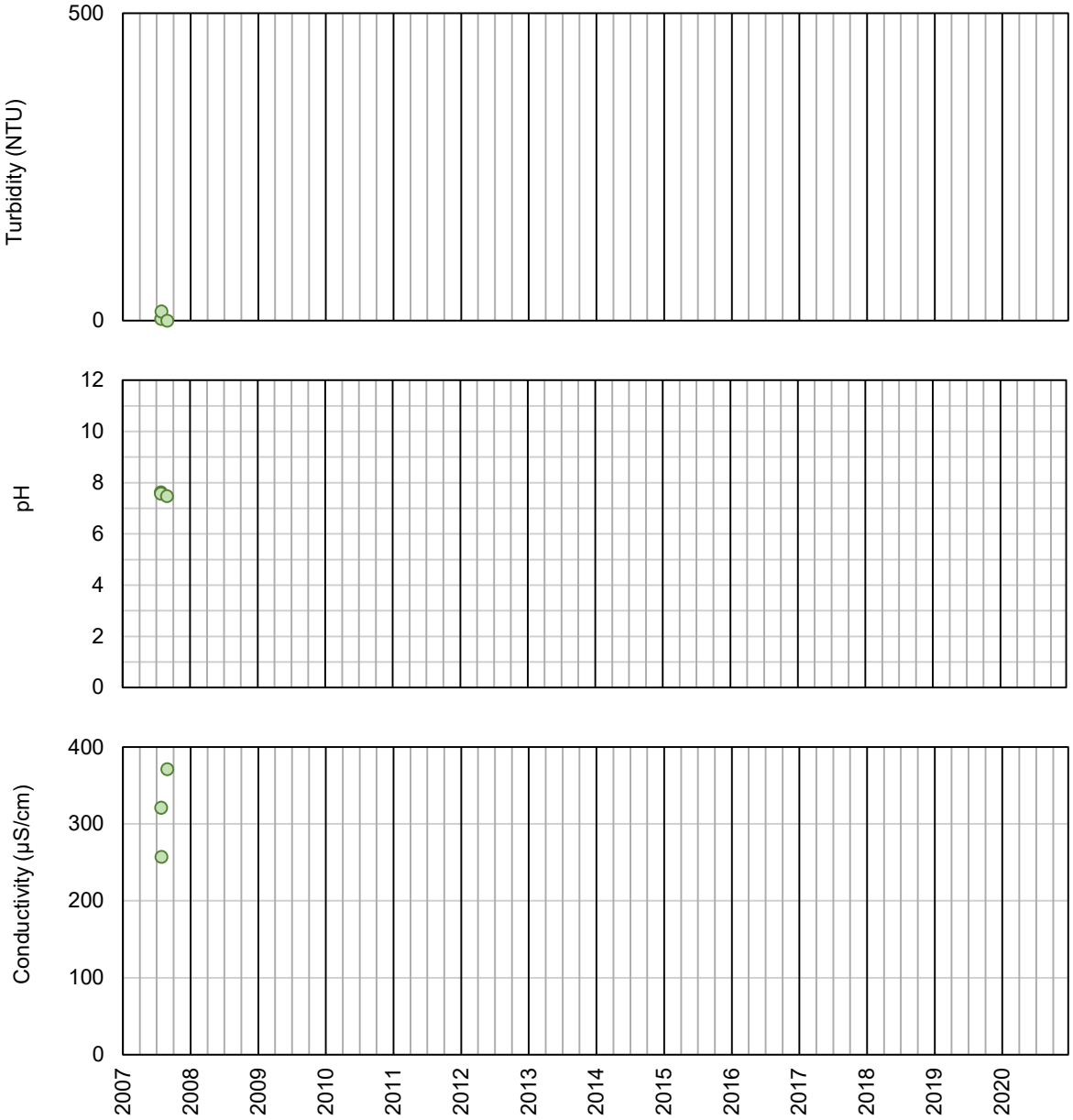

Laird River Watershed,
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)


Liard River Watershed, Low Habitat Suitability, Laboratory Measured Parameters
Turbidity (NTU)
500
0
pH
12
10
8
6
4
2
0
Conductivity (µS/cm)
400
300
200
100
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

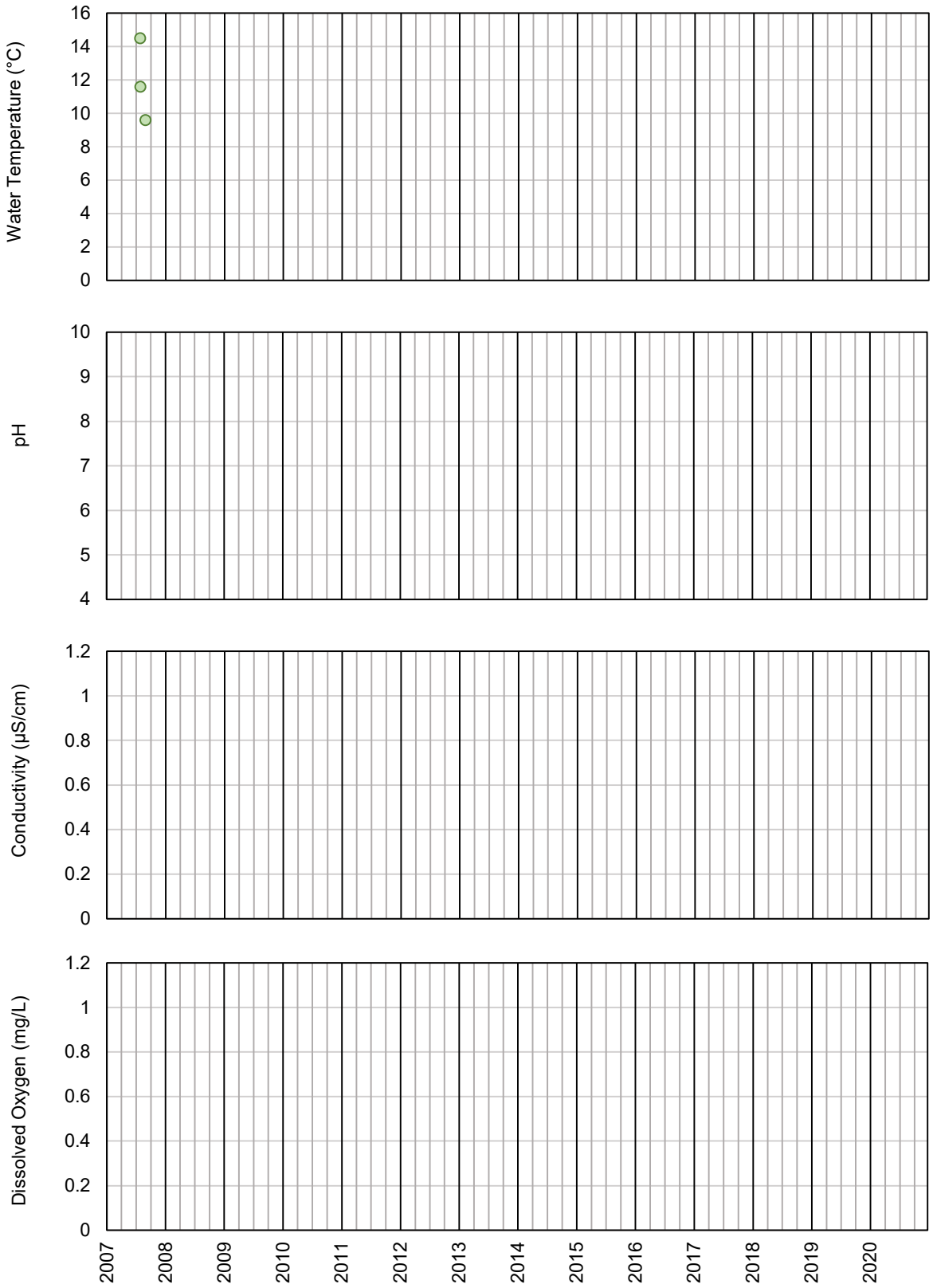

Liard River Watershed, Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
18
16
14
12
10
8
6
4
2
0
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
Dissolved Oxygen (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


McQuesten River Watershed, Area of Special Consideration Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

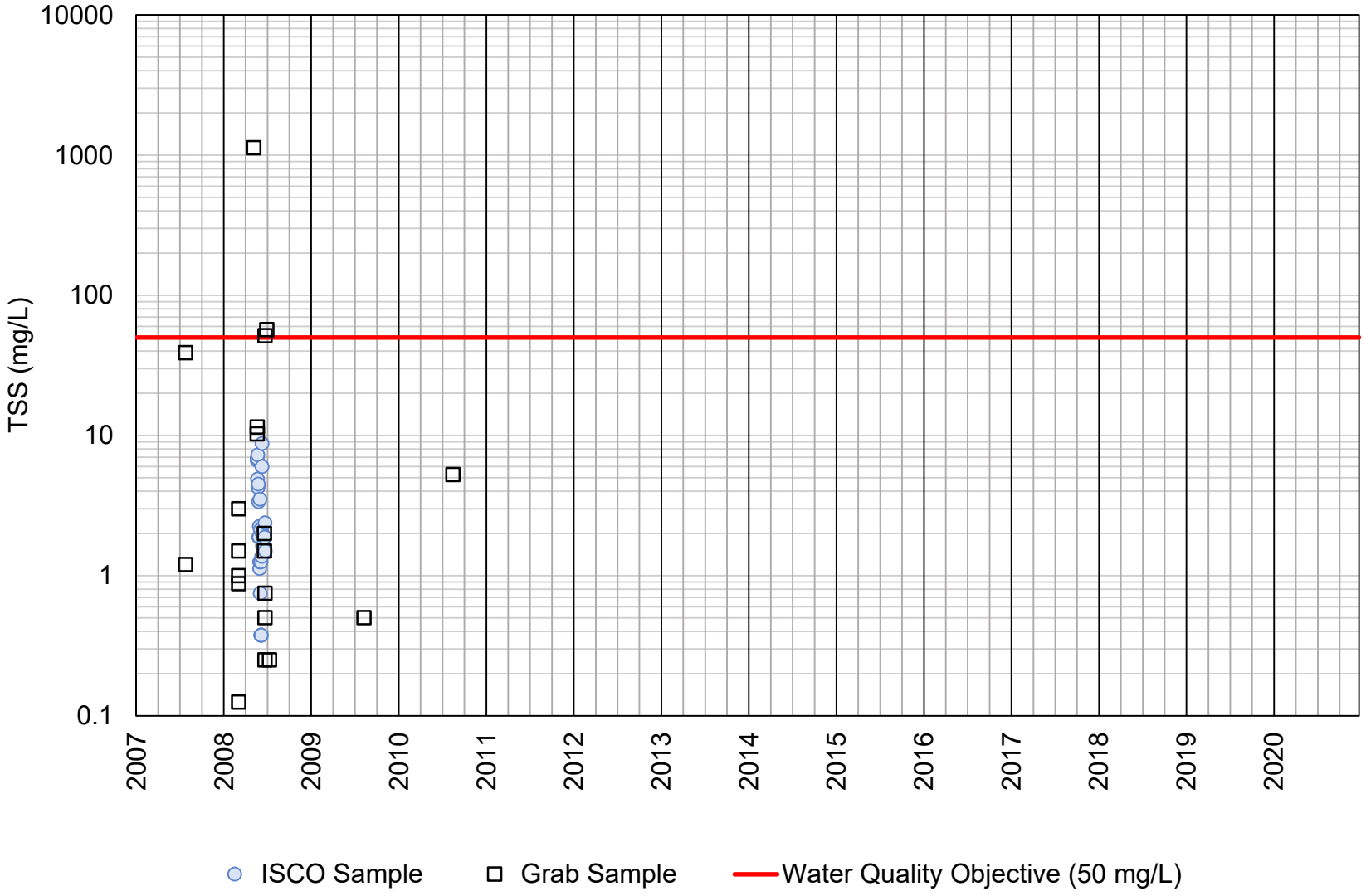
McQuesten River Watershed, Area of Special Consideration Habitat Suitability, Laboratory Measured Parameters



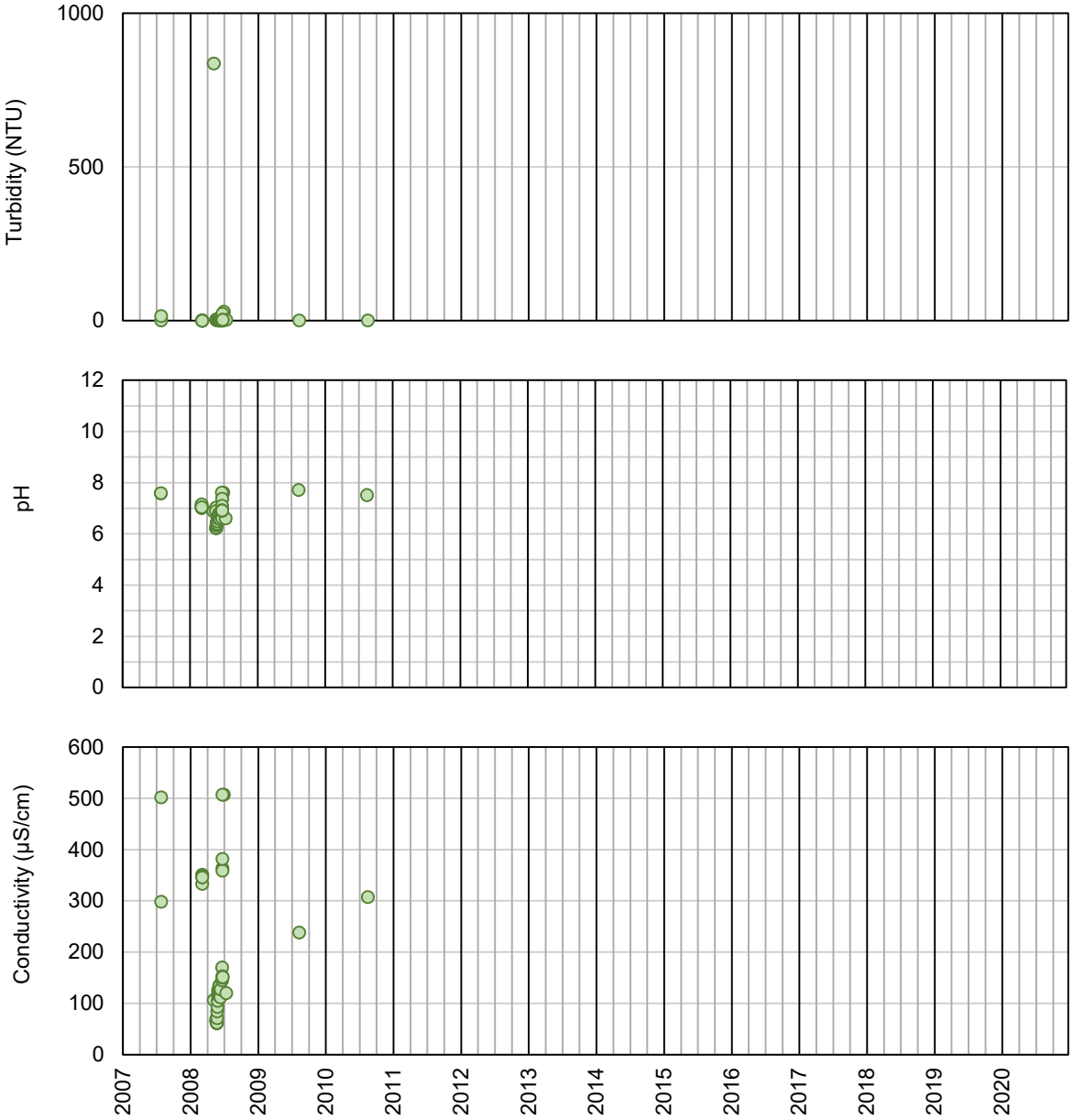
McQuesten River Watershed, Area of Special Consideration Habitat Suitability, Field Meaurements



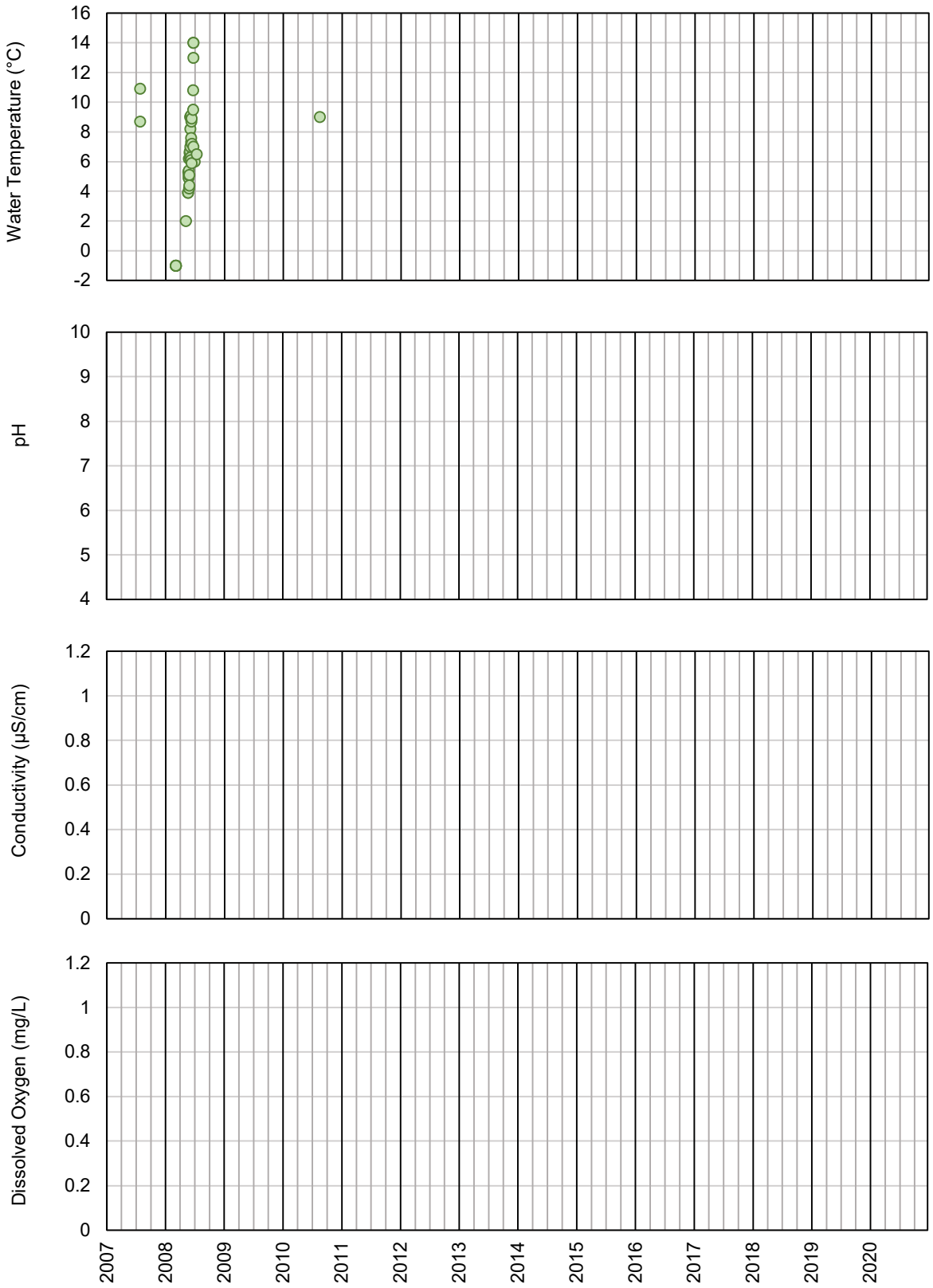
McQuesten River Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples

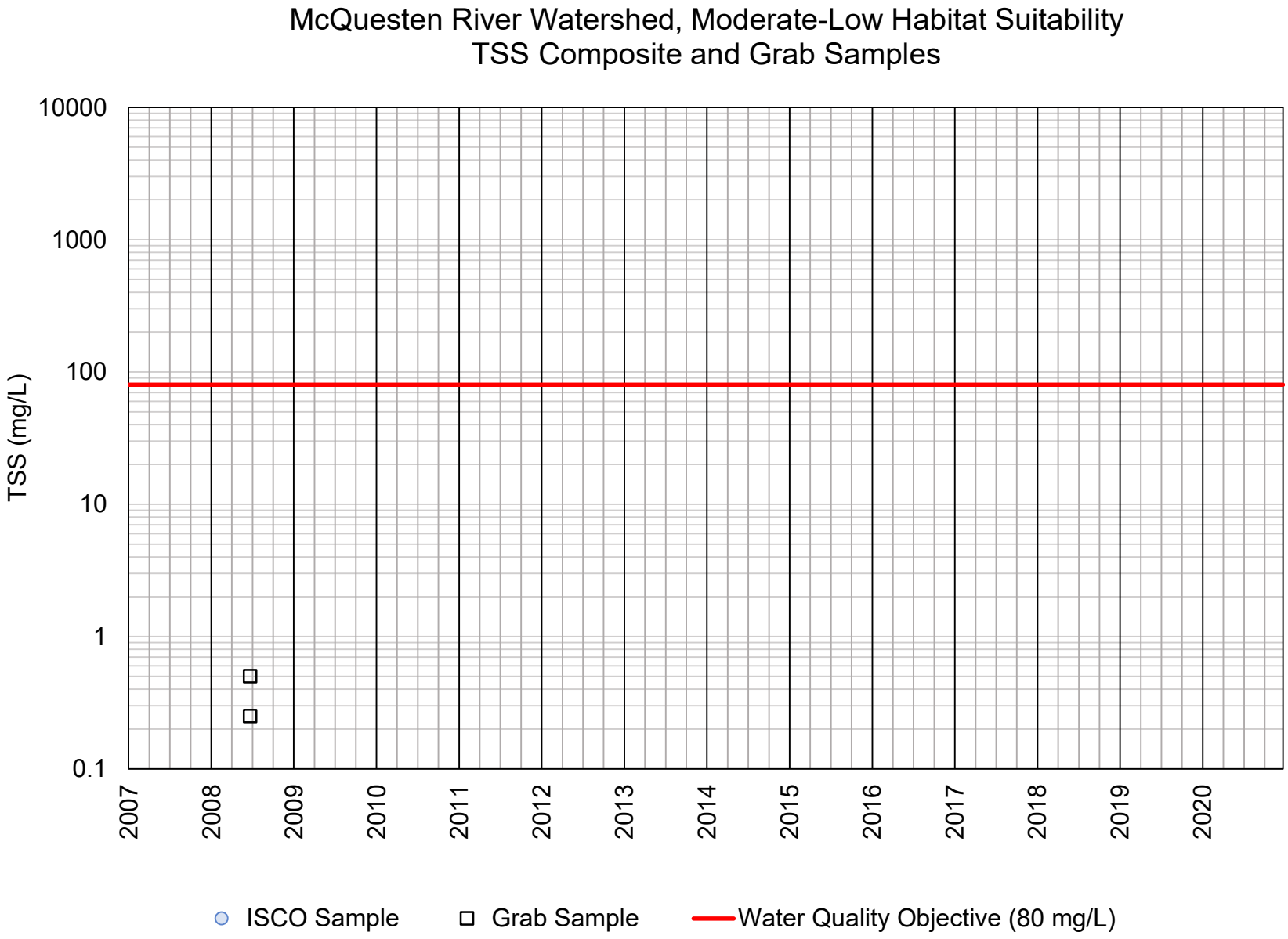


McQuesten River Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters

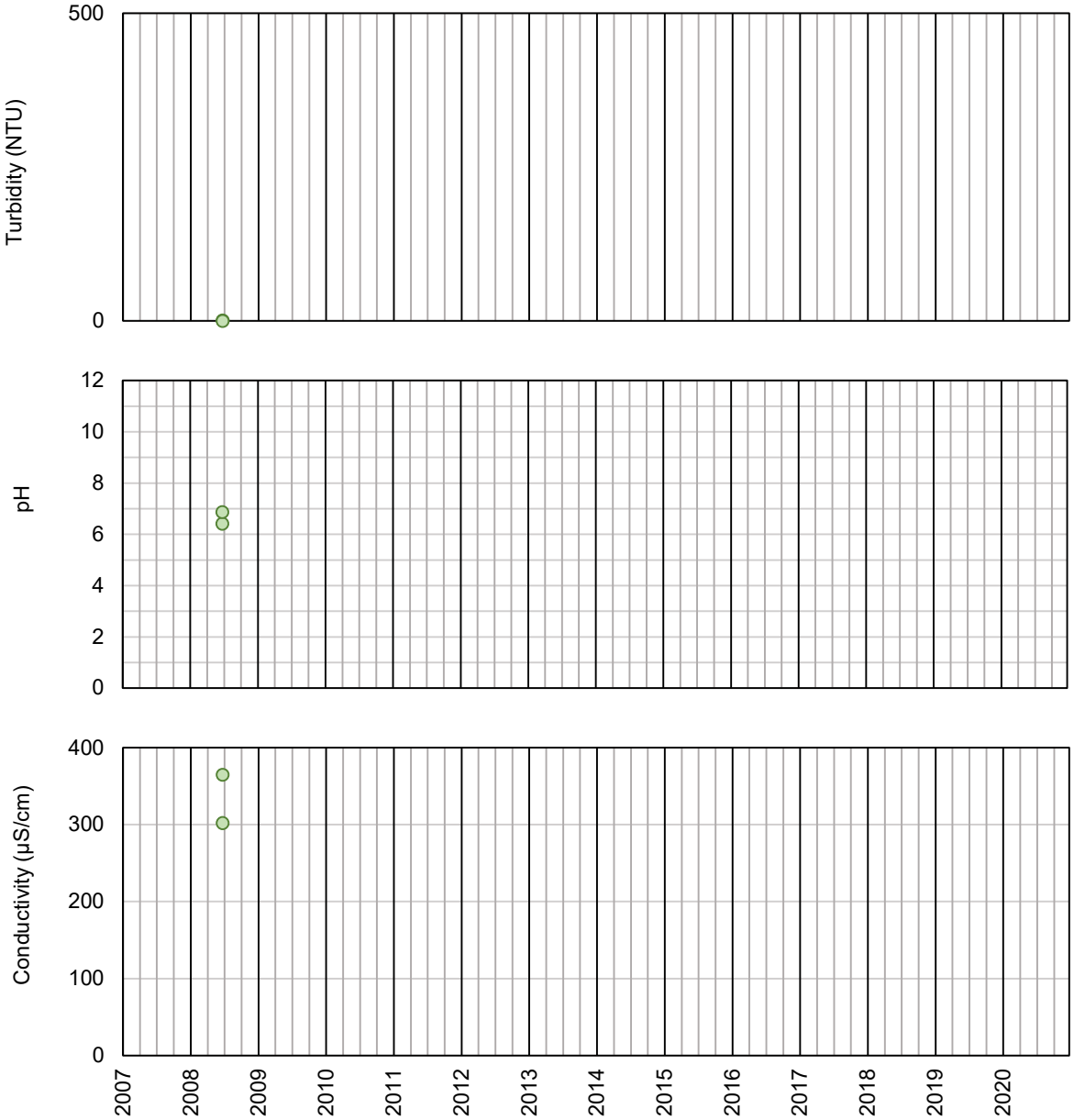


McQuesten River Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements

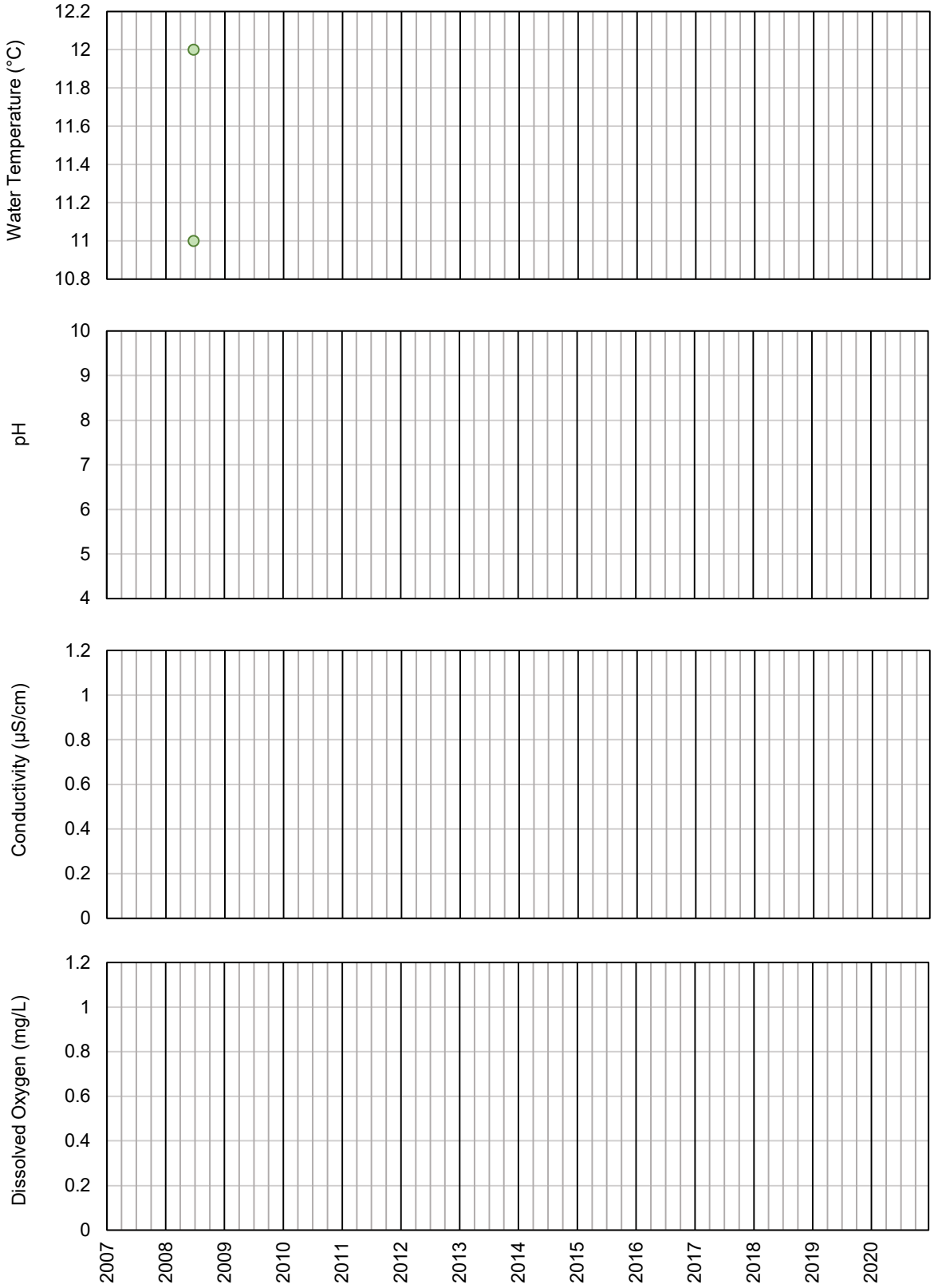


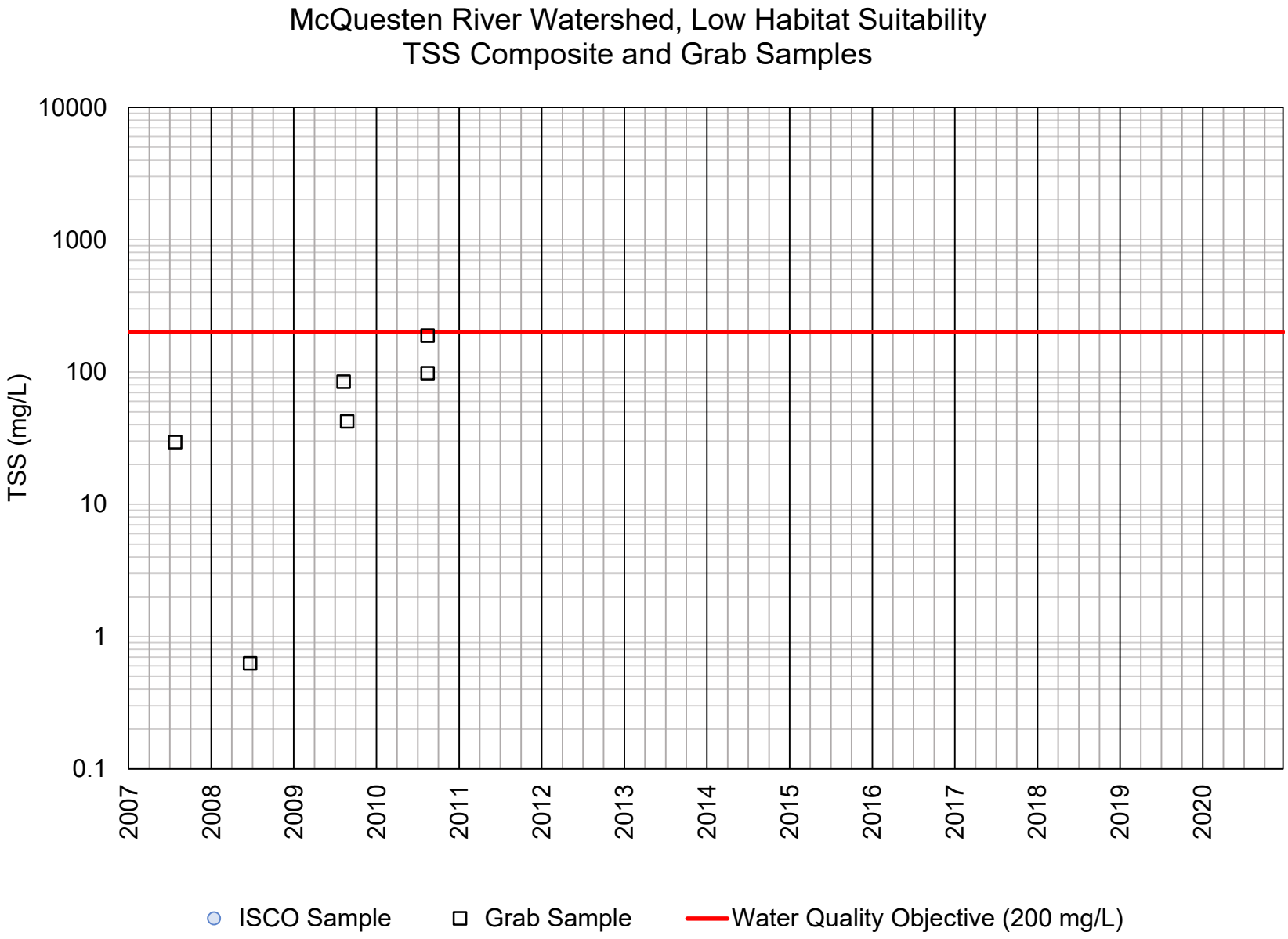

McQuesten River Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (80 mg/L)

McQuesten River Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters

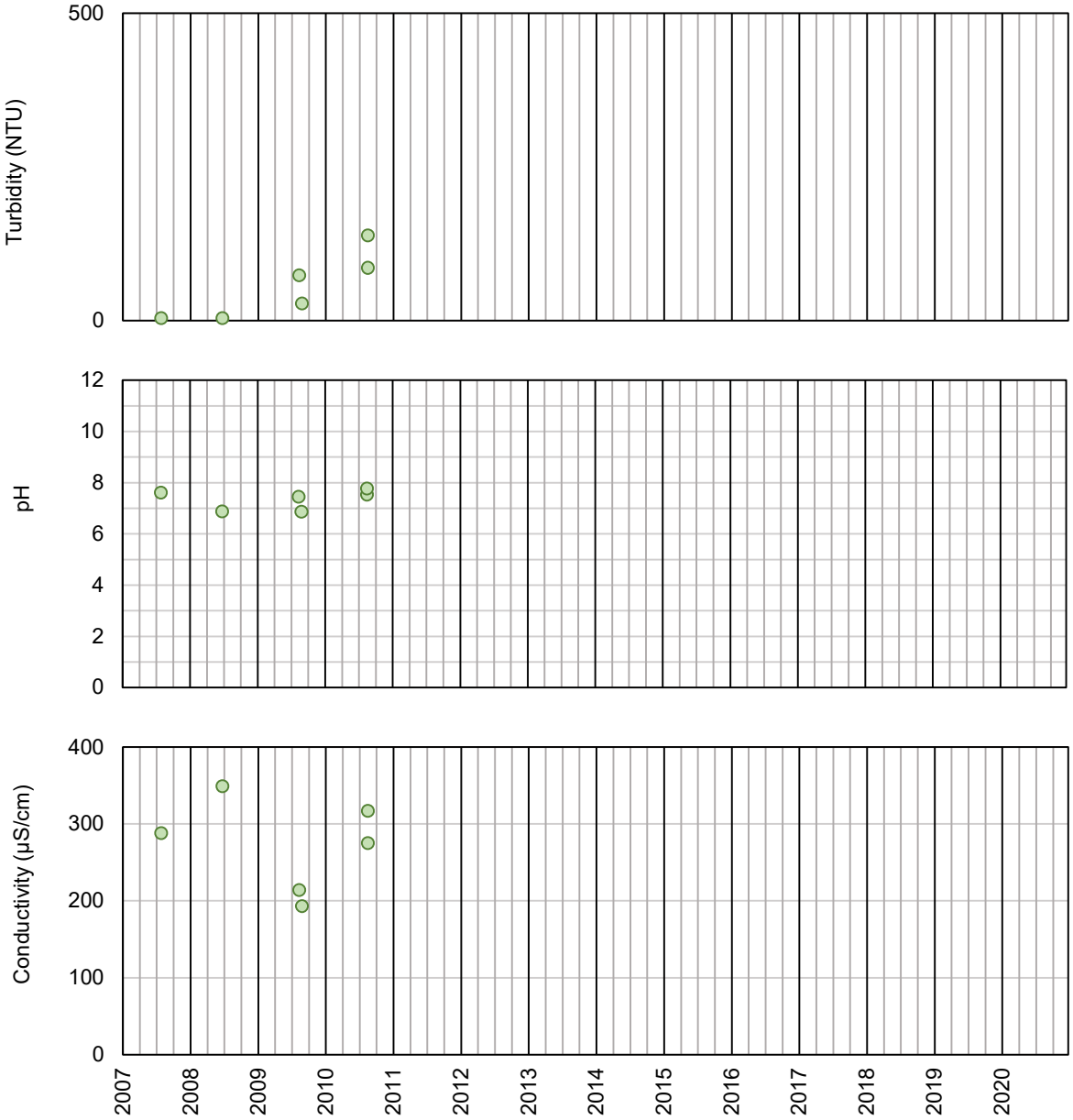


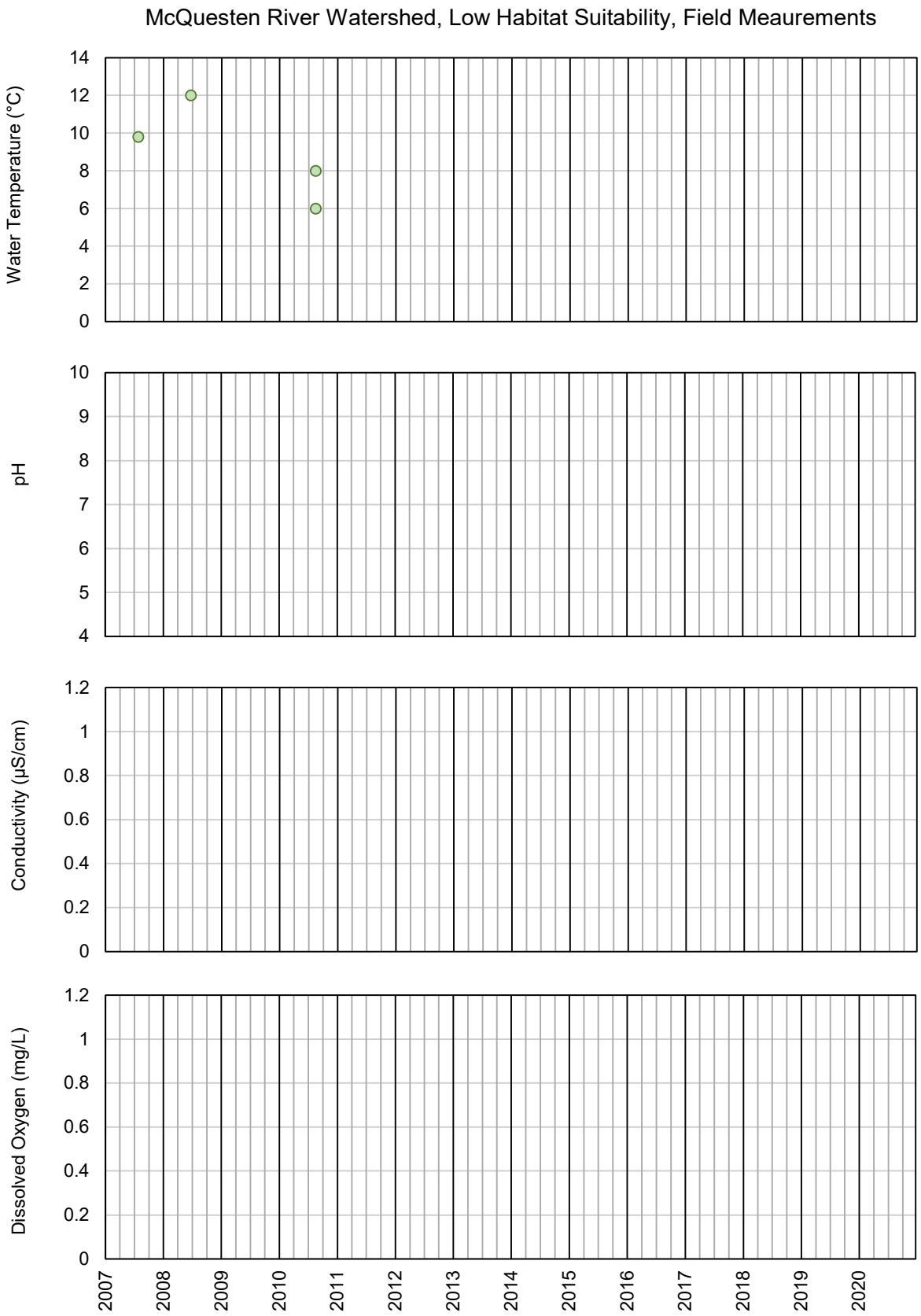
McQuesten River Watershed, Moderate-Low Habitat Suitability, Field Meaurements

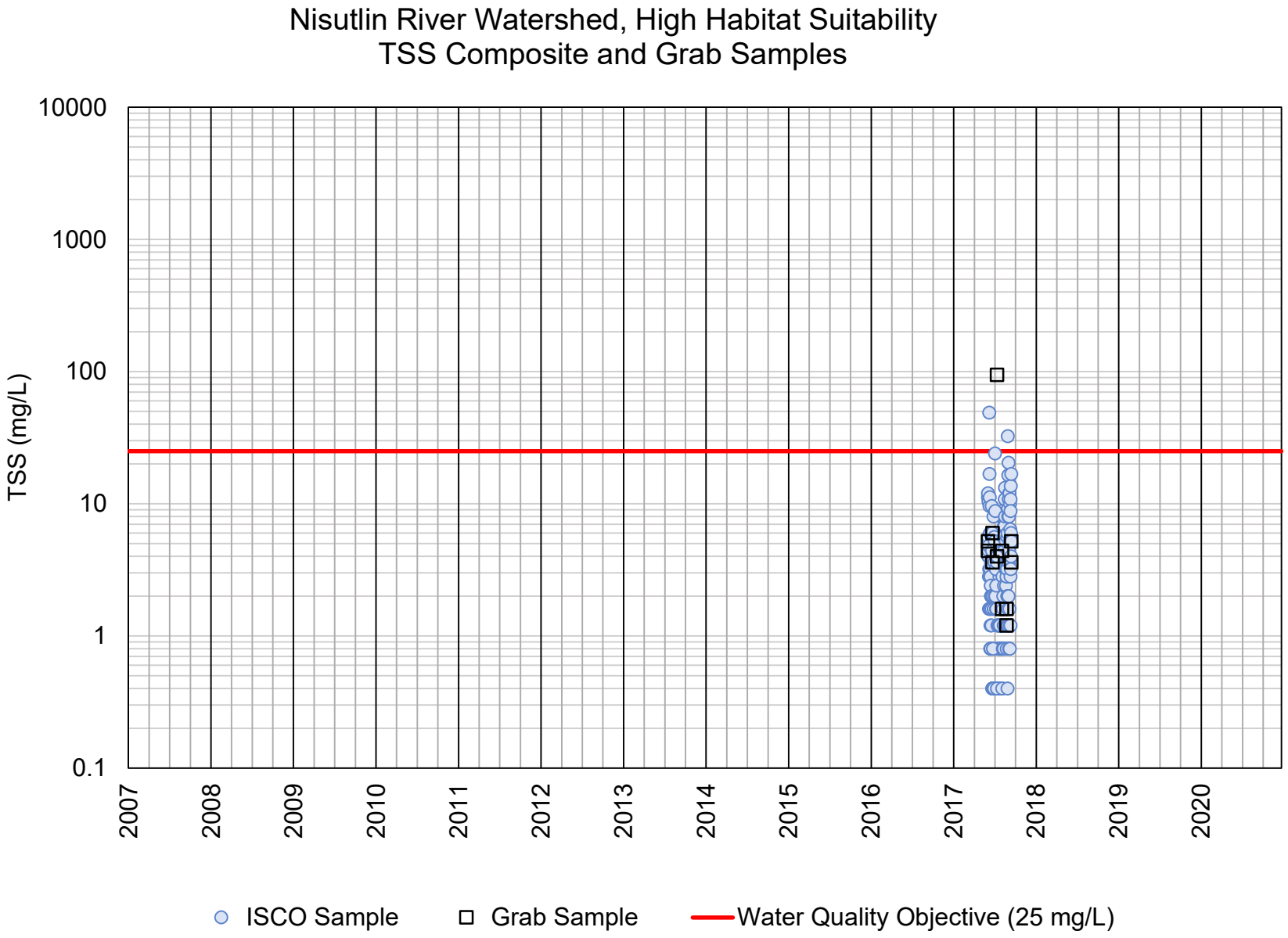



McQuesten River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

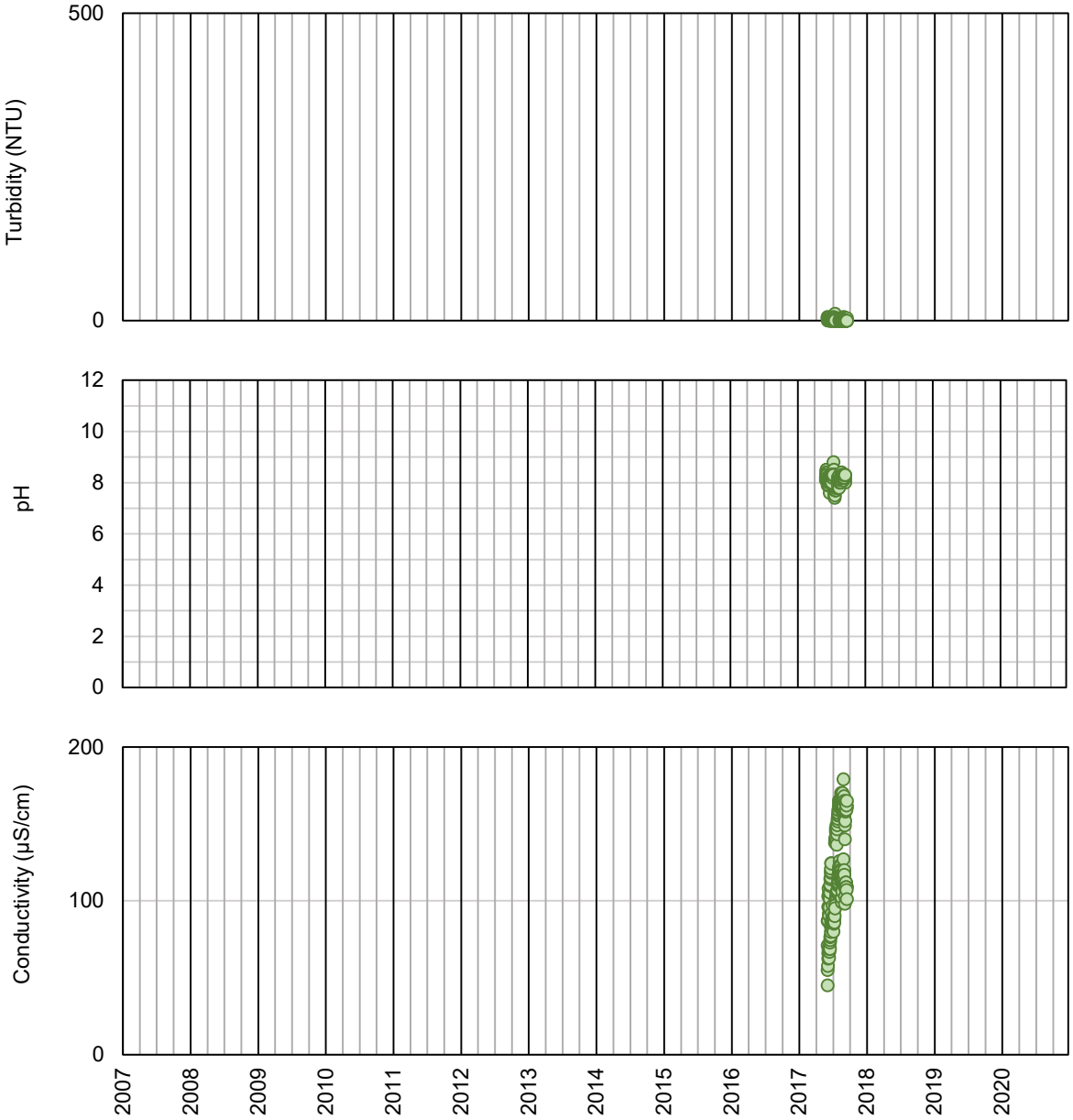
McQuesten River Watershed, Low Habitat Suitability, Laboratory Measured Parameters

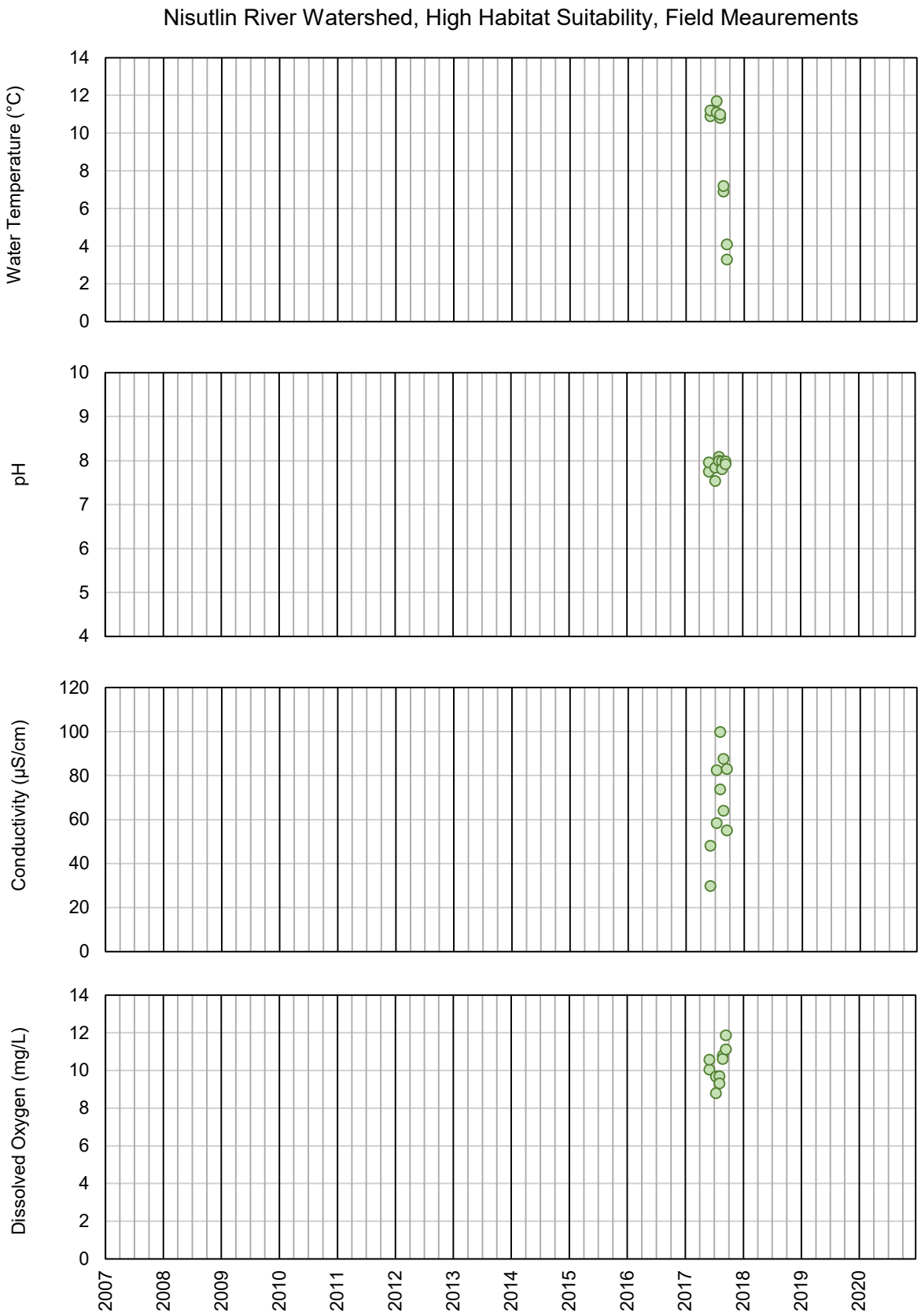


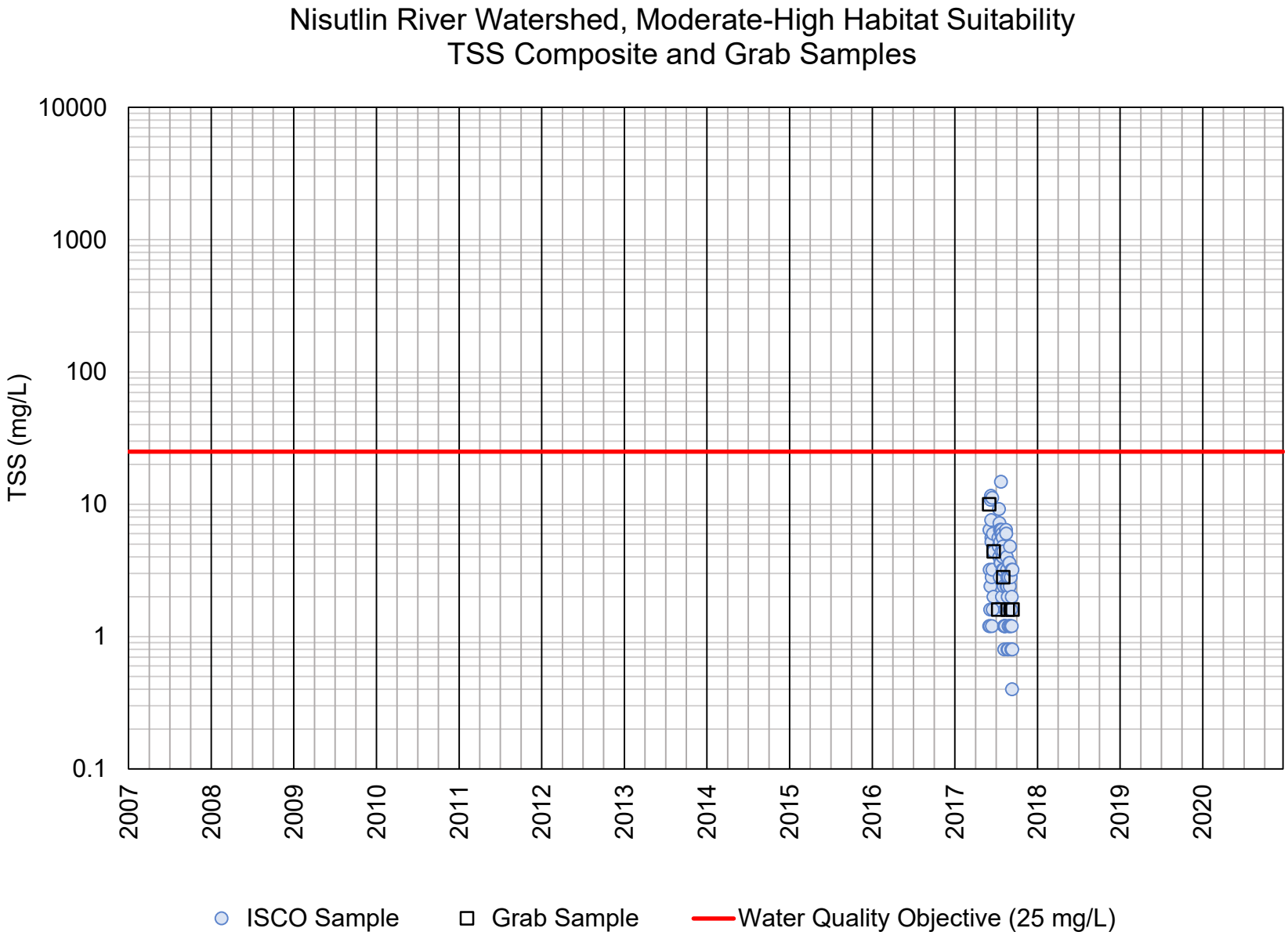

McQuesten River Watershed, Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
14
12
10
8
6
4
2
0
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
Dissolved Oxygen (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Nisutlin River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

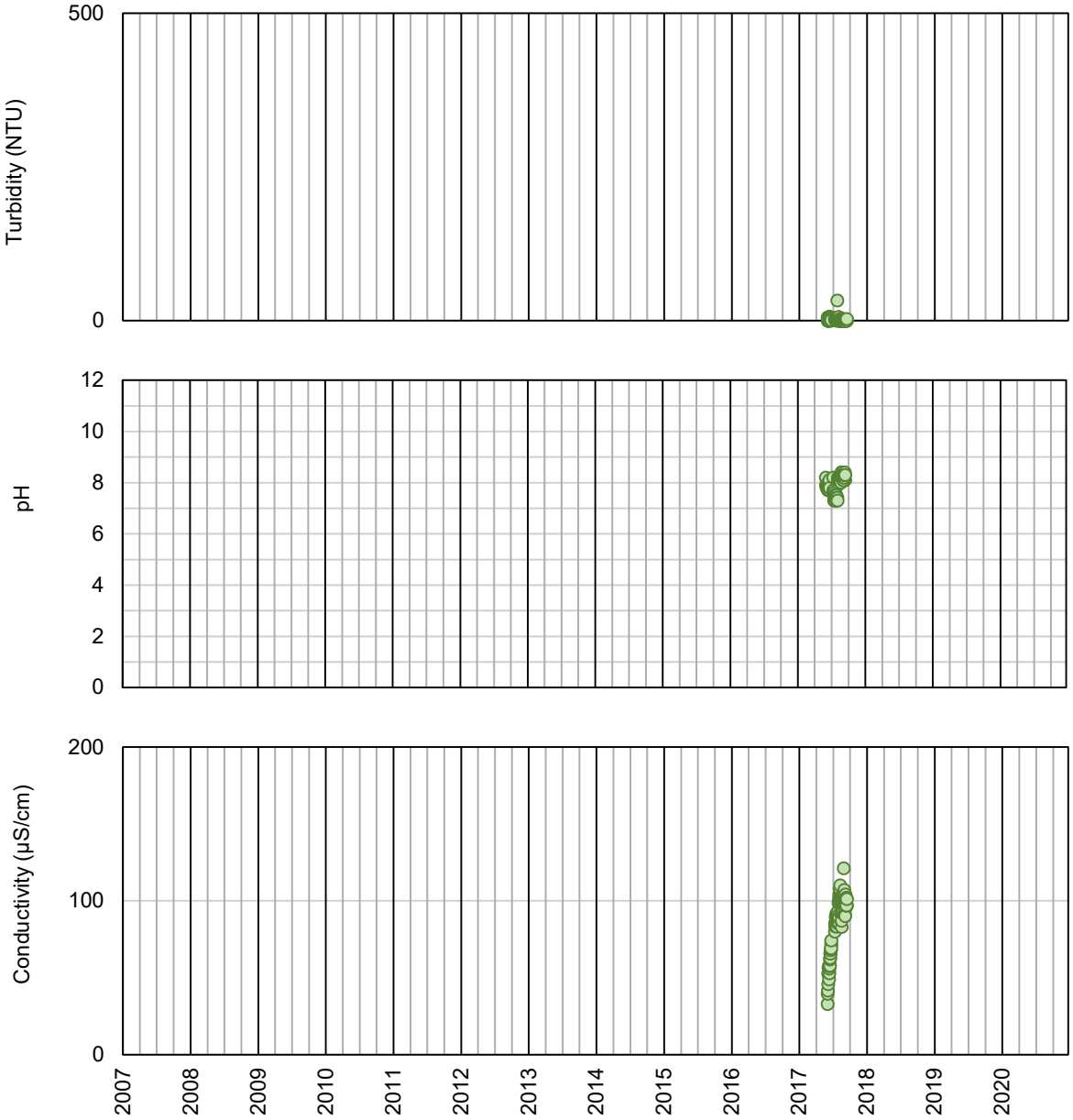
Nisutlin River Watershed, High Habitat Suitability, Laboratory Measured Parameters



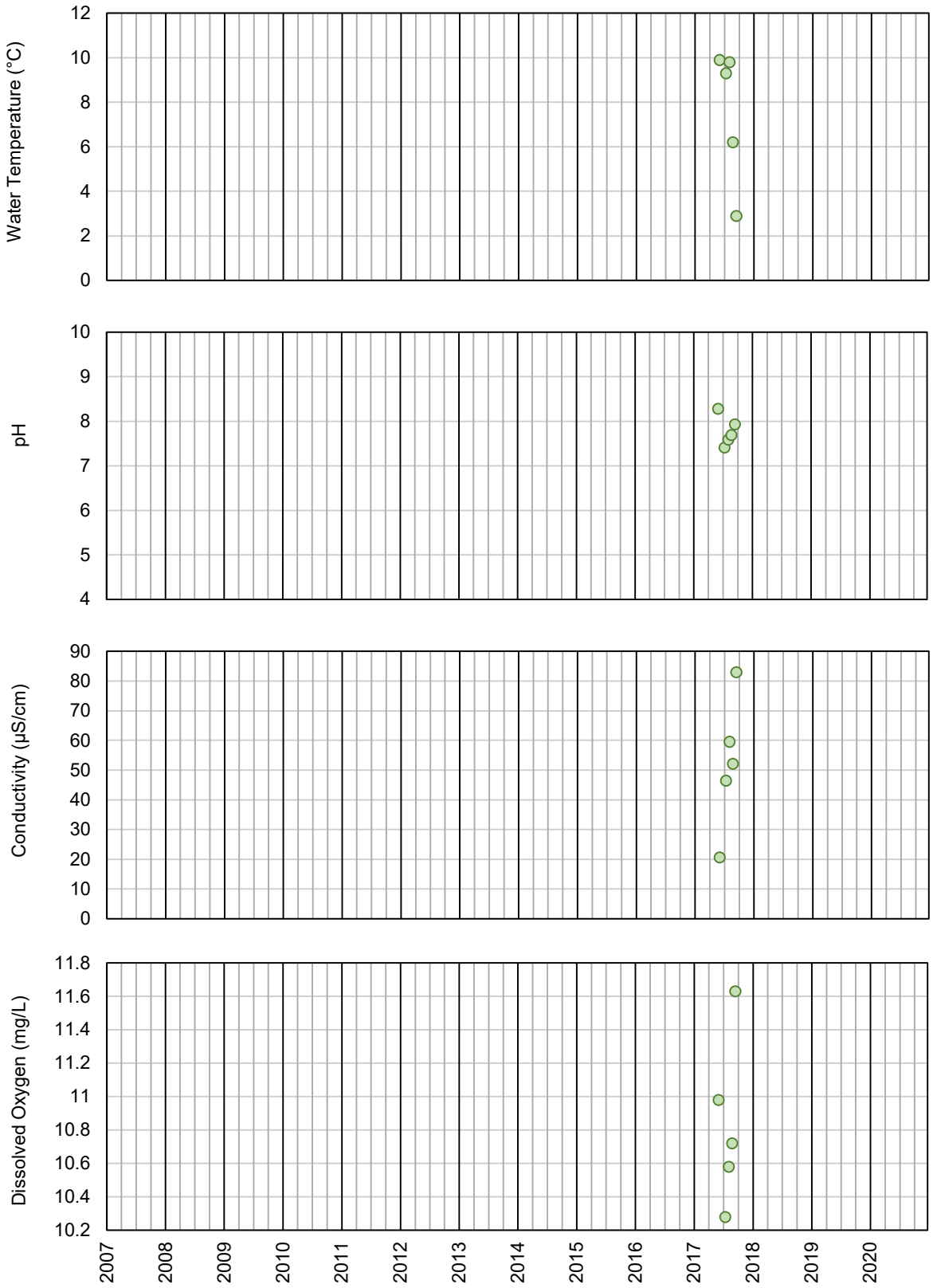

Nisutlin River Watershed, High Habitat Suitability, Field Meaurements
Water Temperature (°C)
0
2
4
6
8
10
12
14
pH
4
5
6
7
8
9
10
Conductivity (µS/cm)
0
20
40
60
80
100
120
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

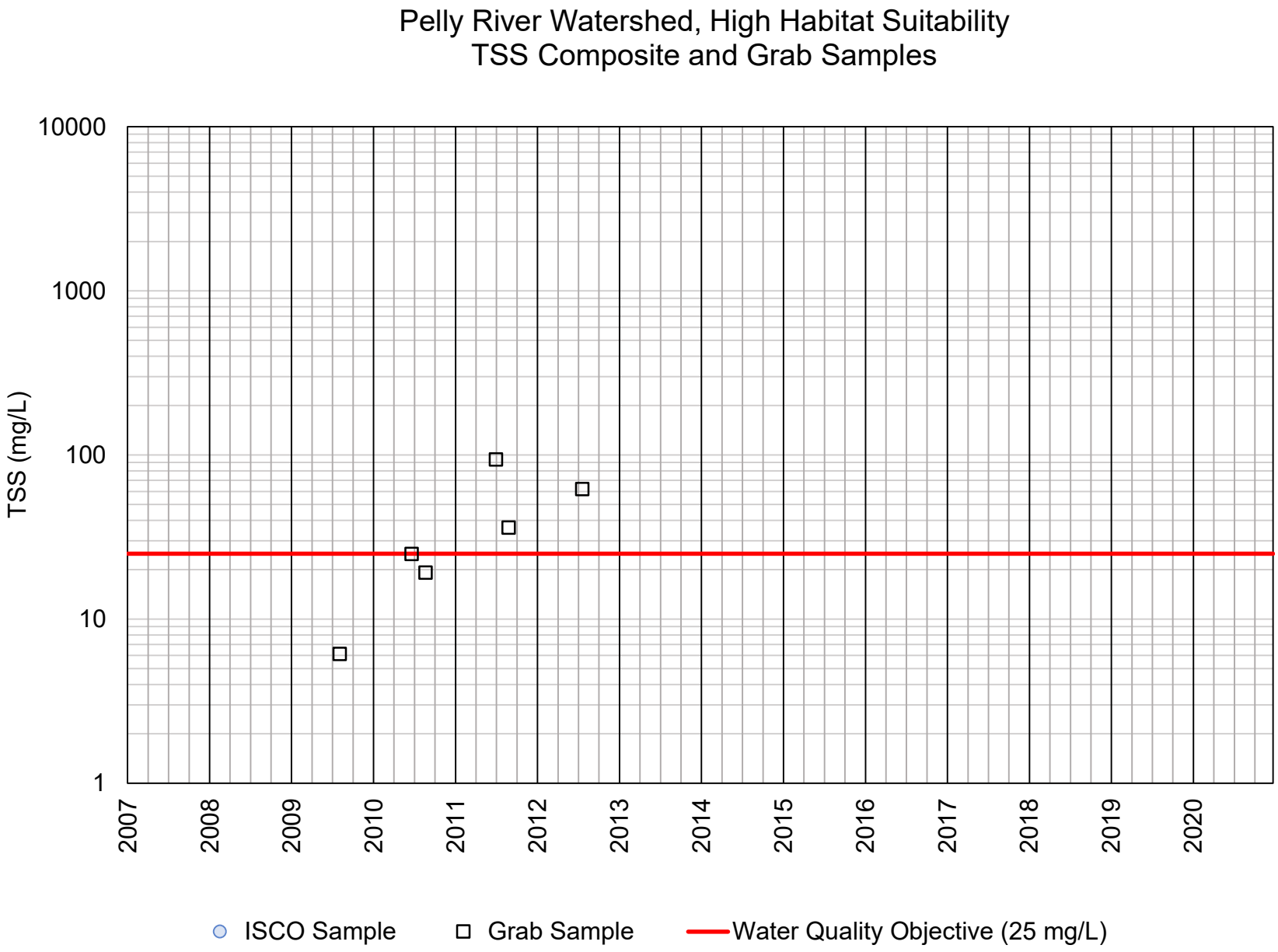

Nisutlin River Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

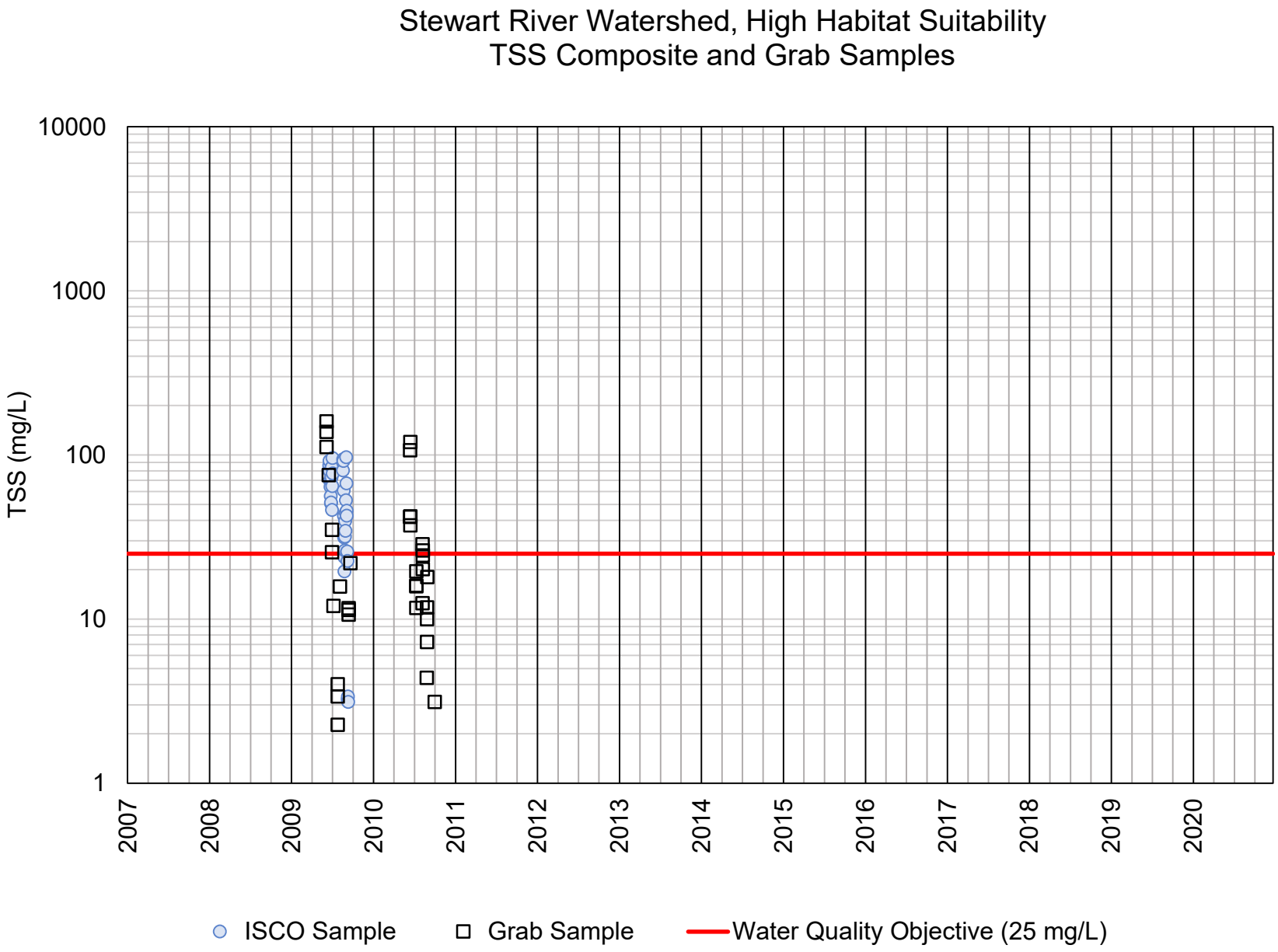
Nisutlin River Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters



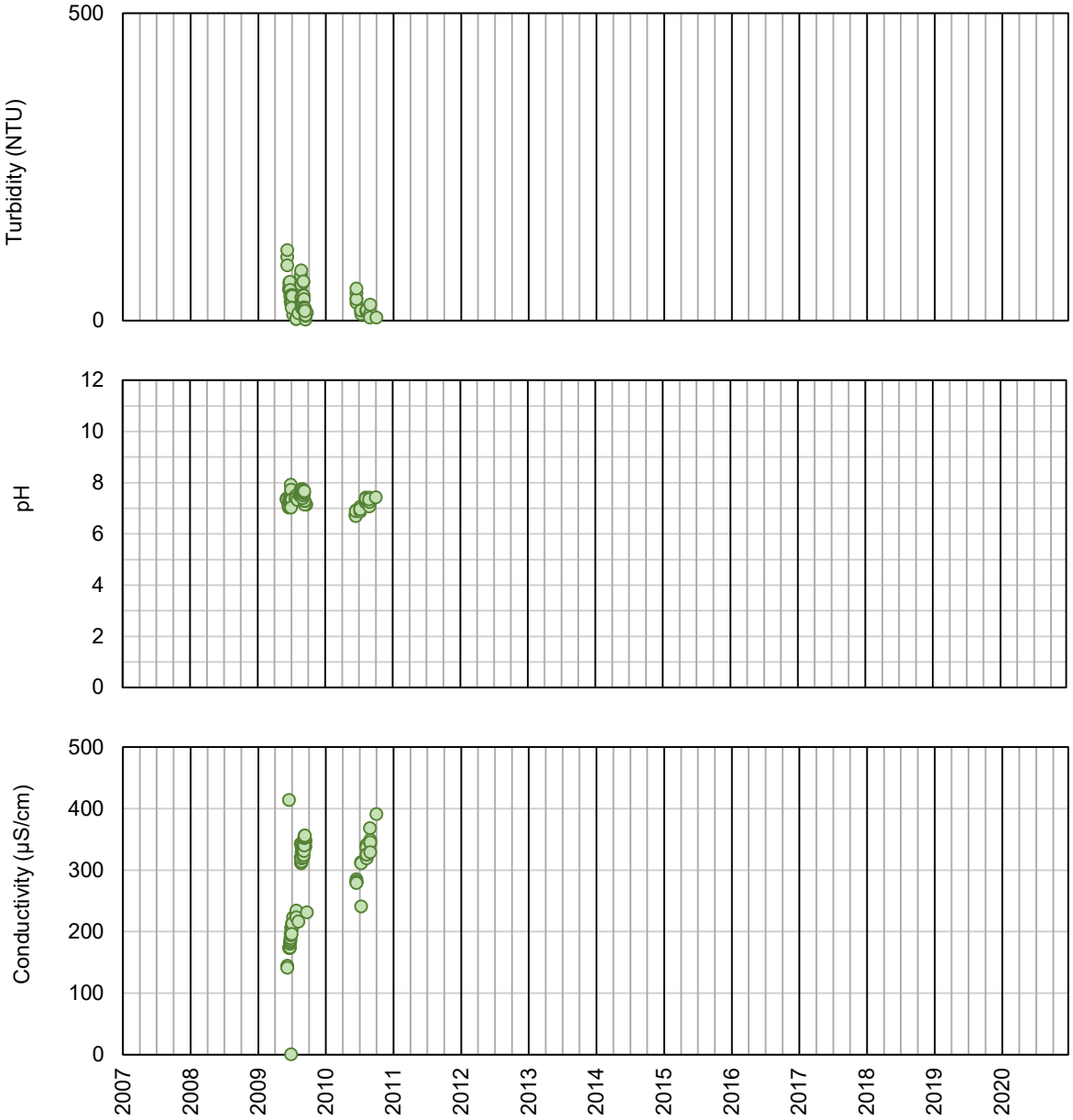
Nisutlin River Watershed, Moderate-High Habitat Suitability, Field Meaurements

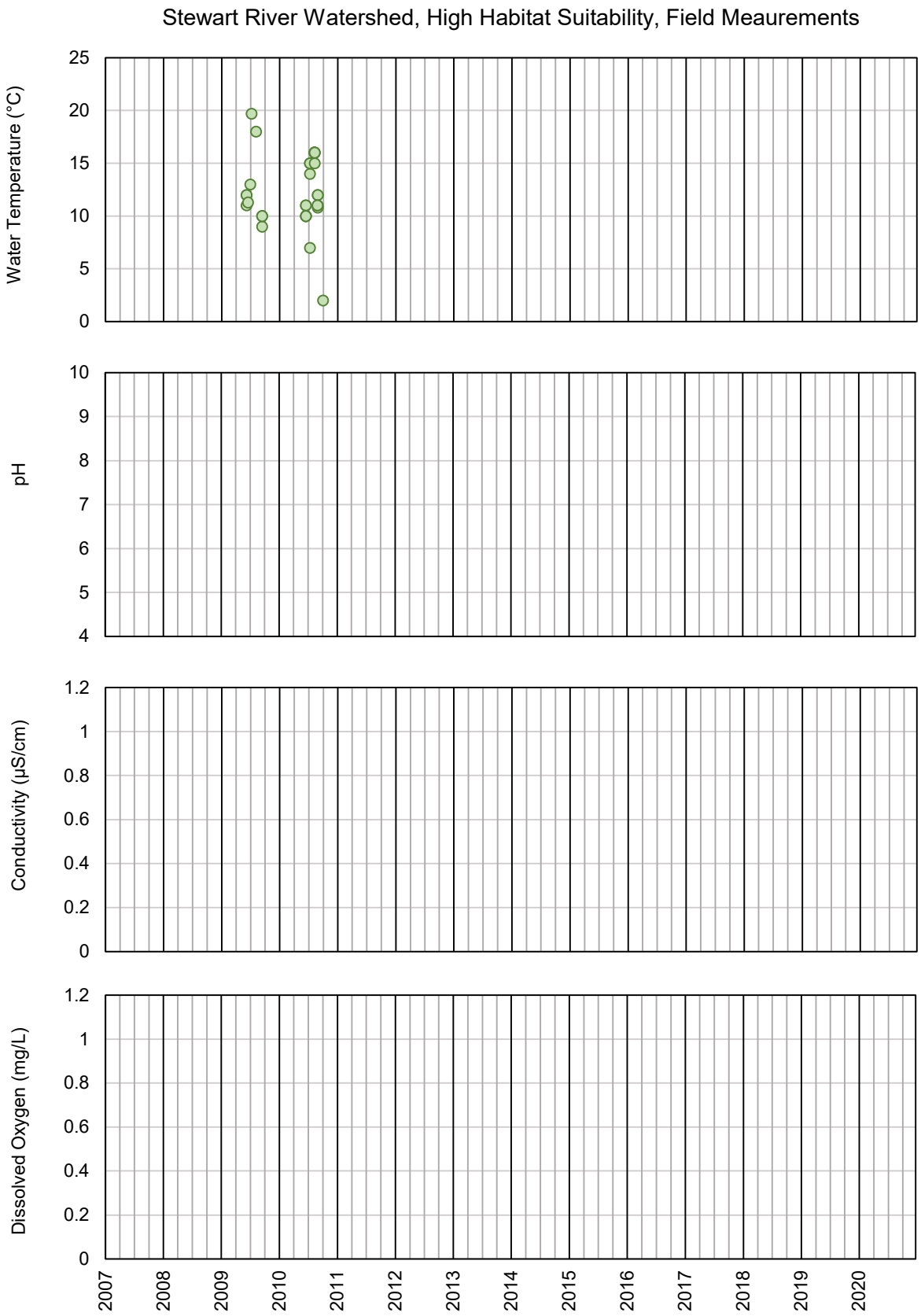


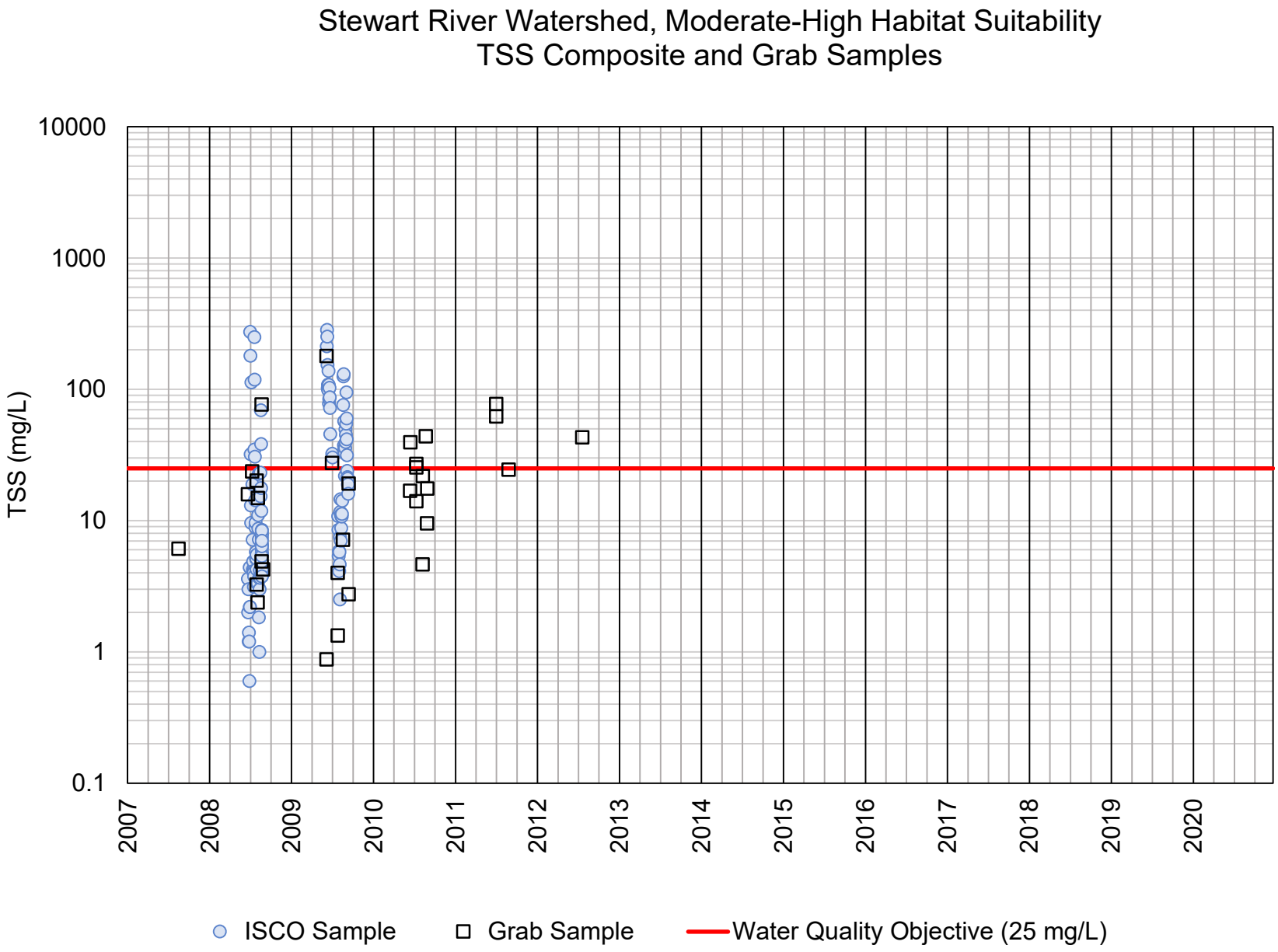

Pelly River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)


Stewart River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

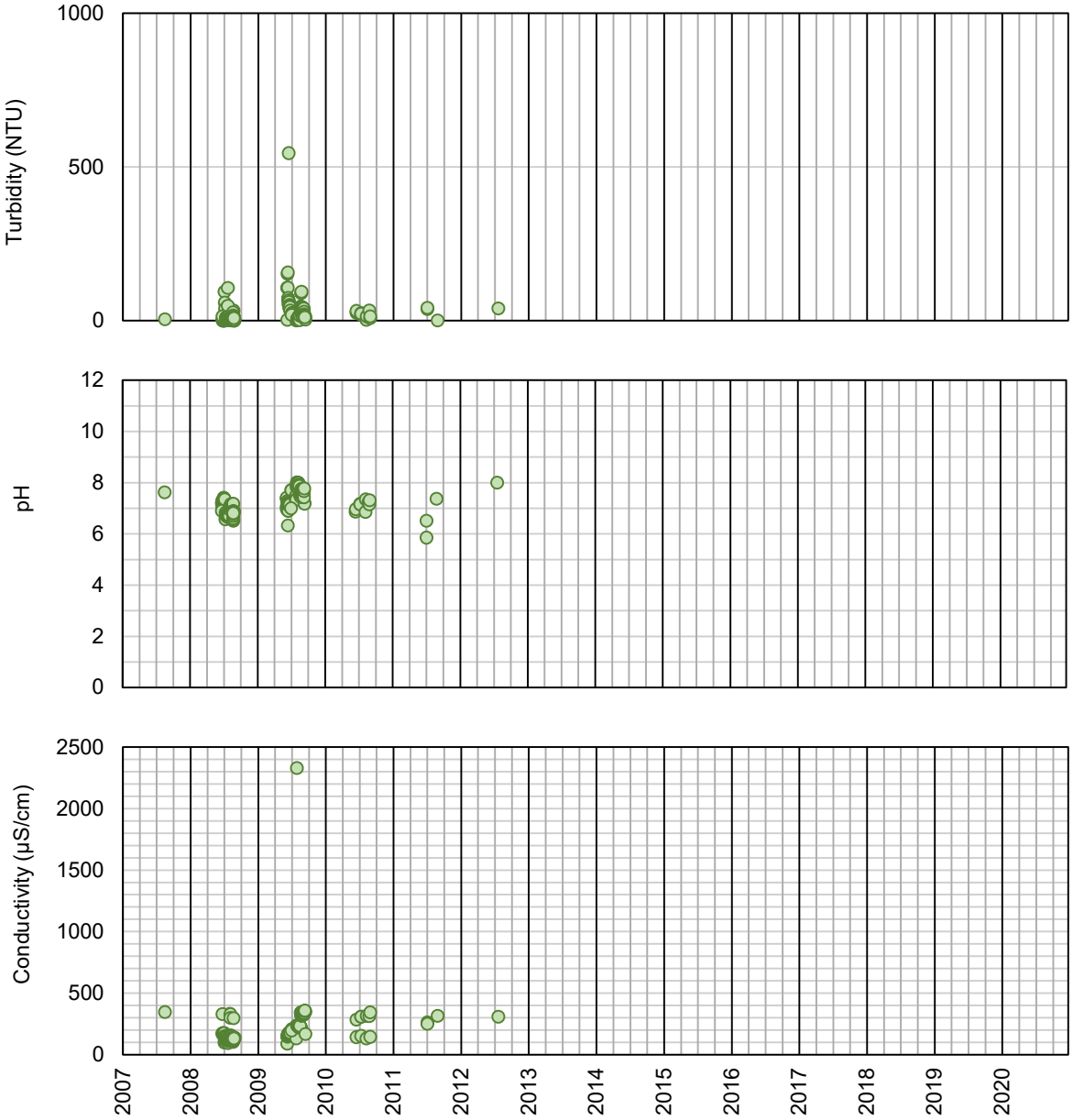
Stewart River Watershed, High Habitat Suitability, Laboratory Measured Parameters



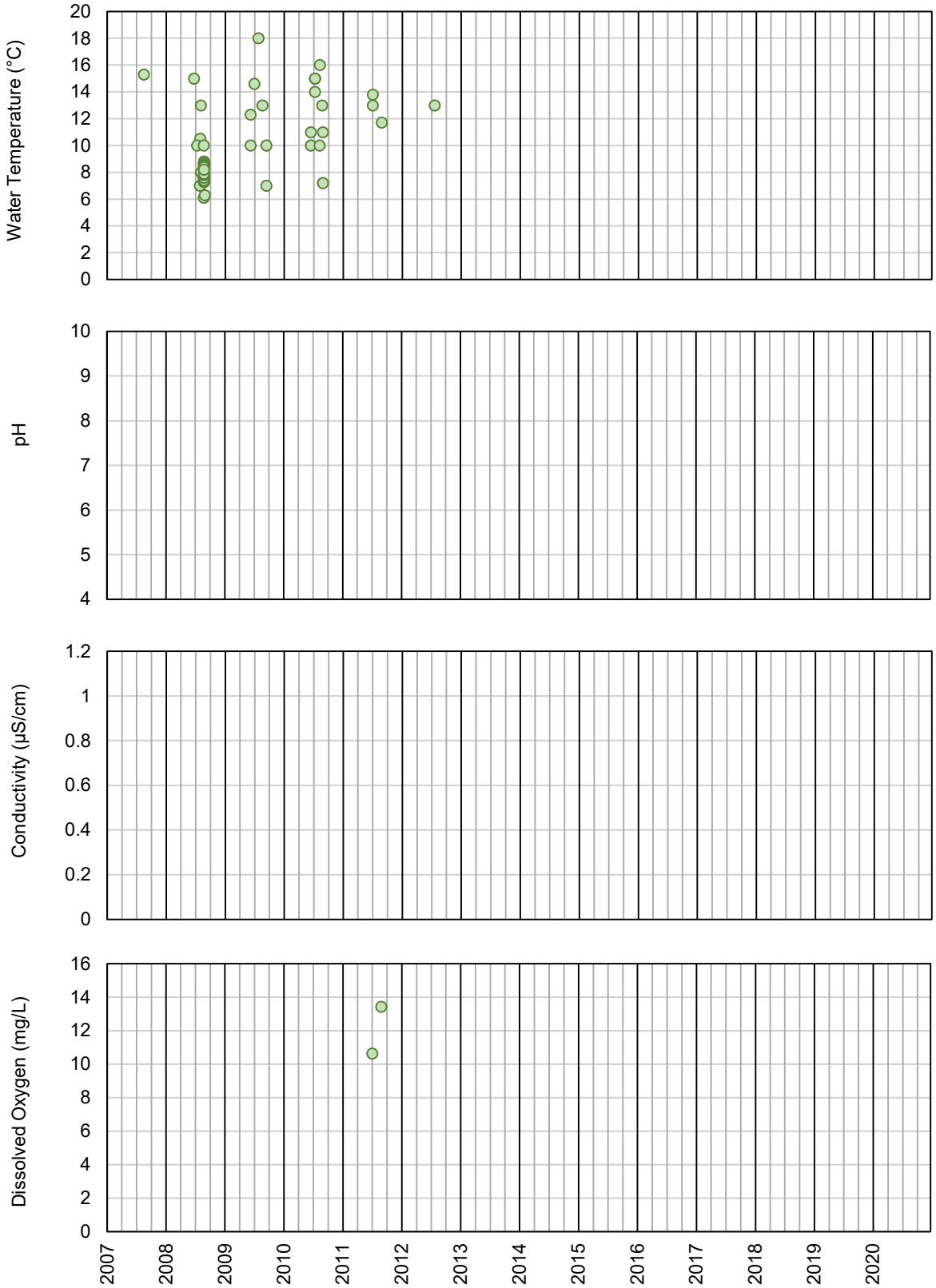

Stewart River Watershed, High Habitat Suitability, Field Meaurements
Water Temperature (°C)
25
20
15
10
5
0
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
Dissolved Oxygen (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

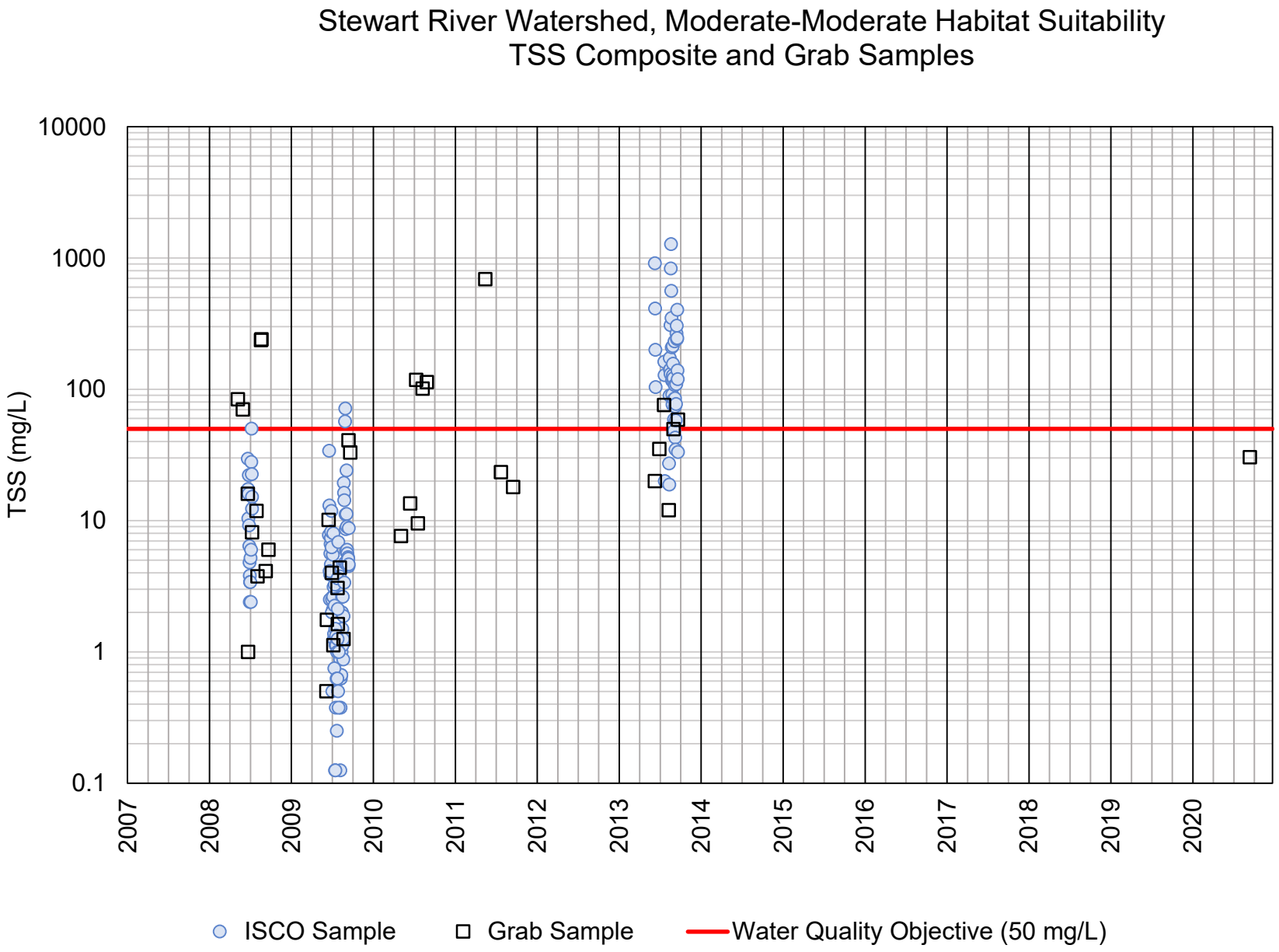

Stewart River Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Stewart River Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters

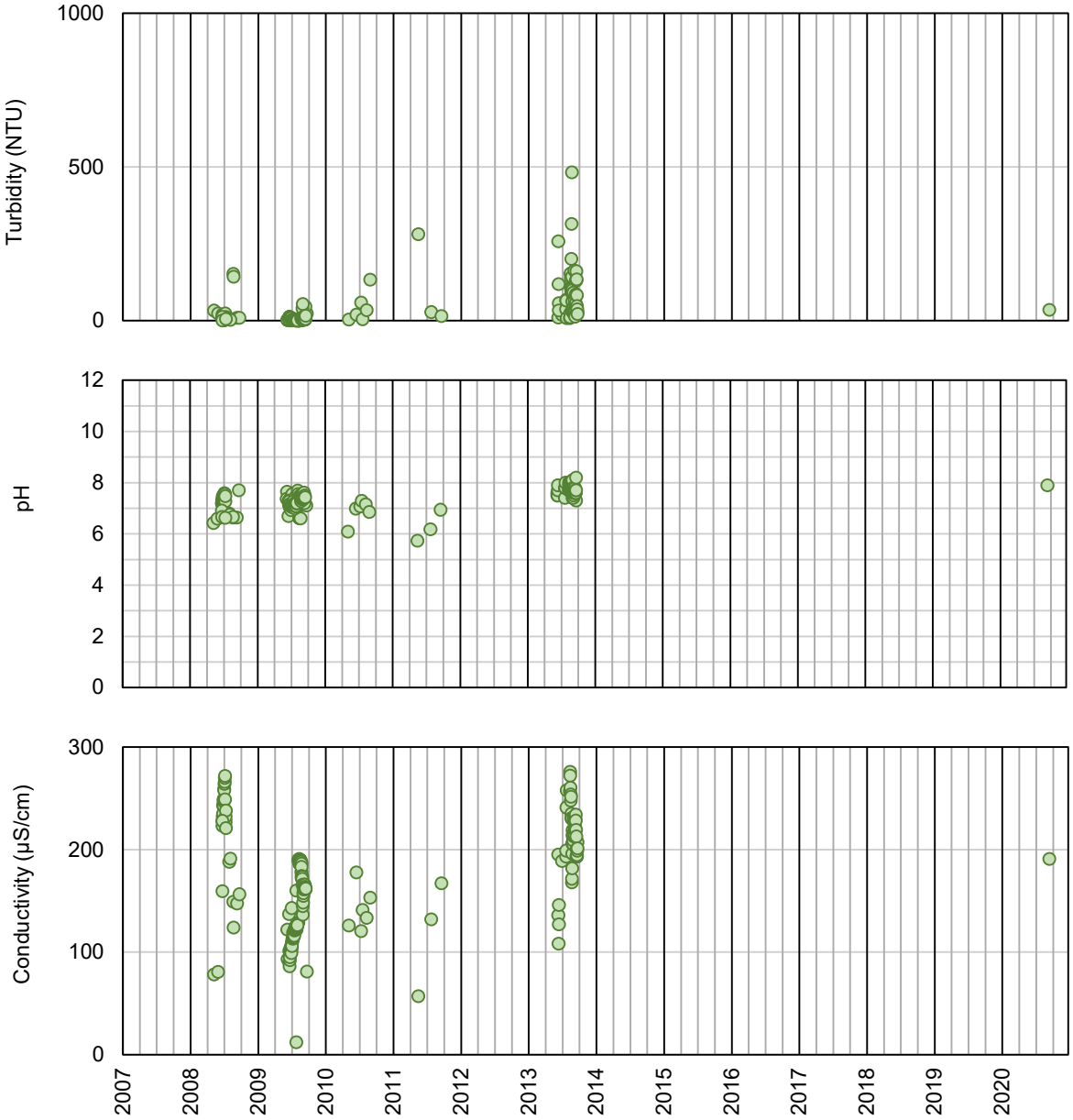


Stewart River Watershed, Moderate-High Habitat Suitability, Field Meaurements

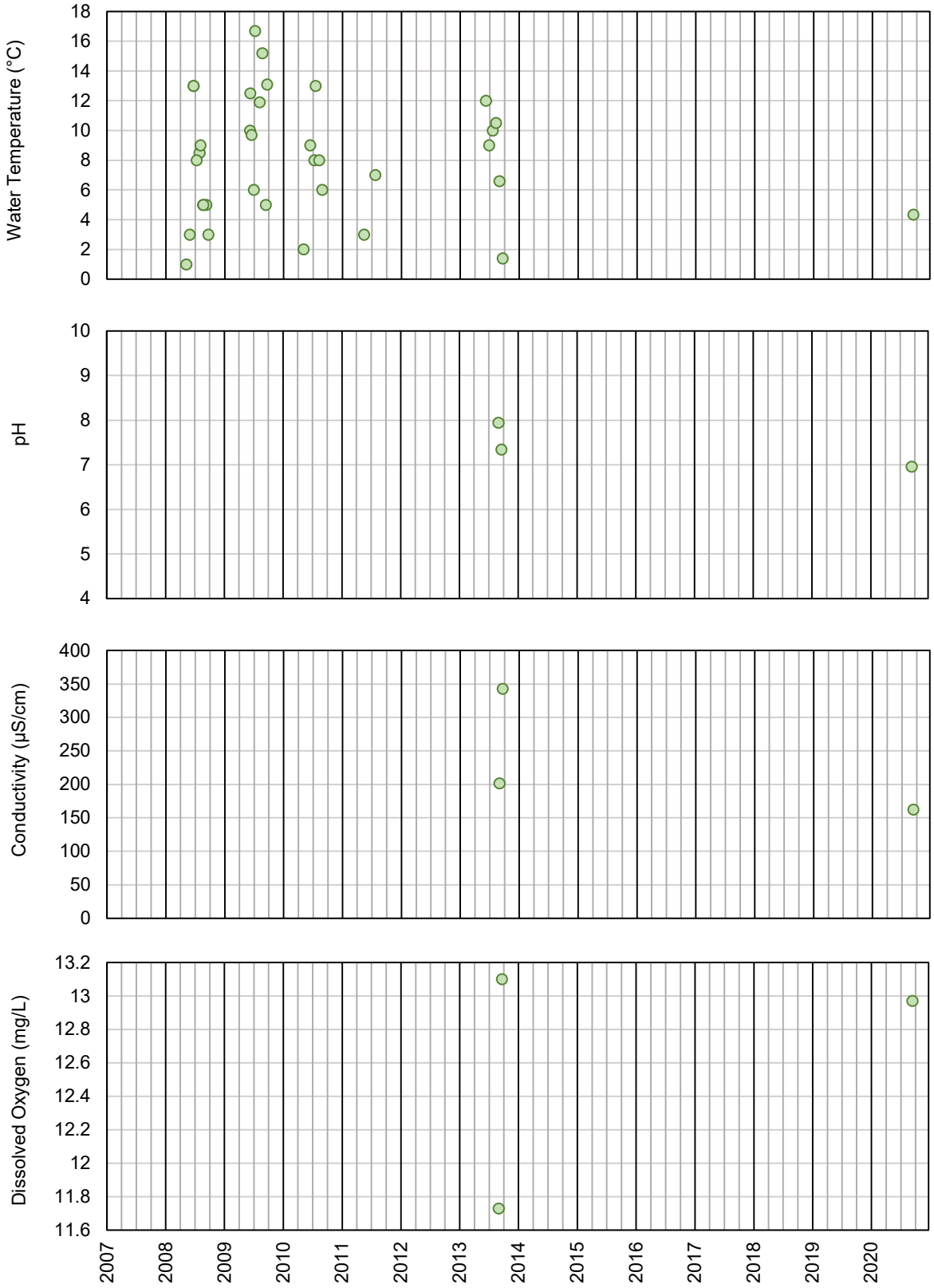


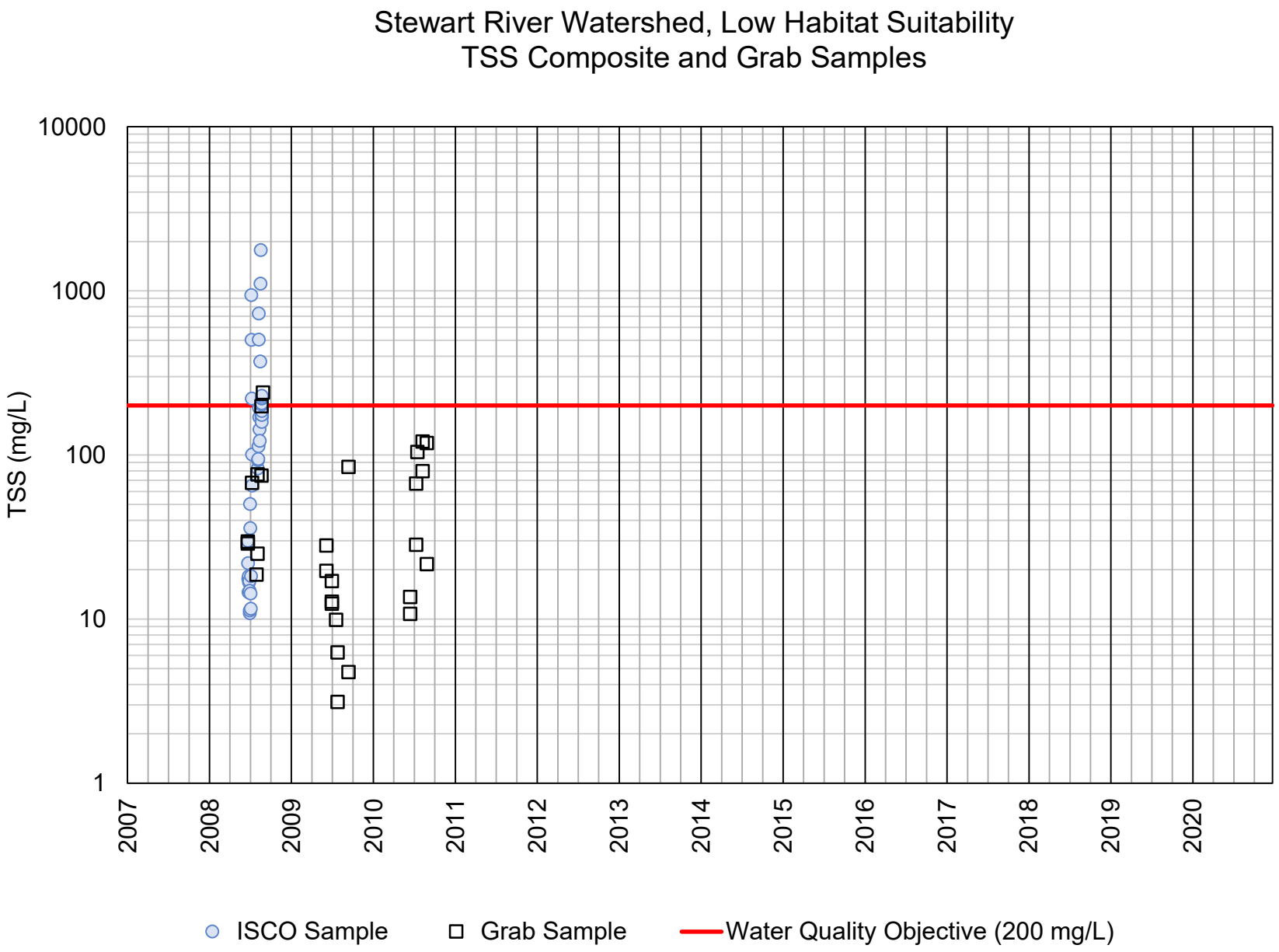

Stewart River Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (50 mg/L)

Stewart River Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters

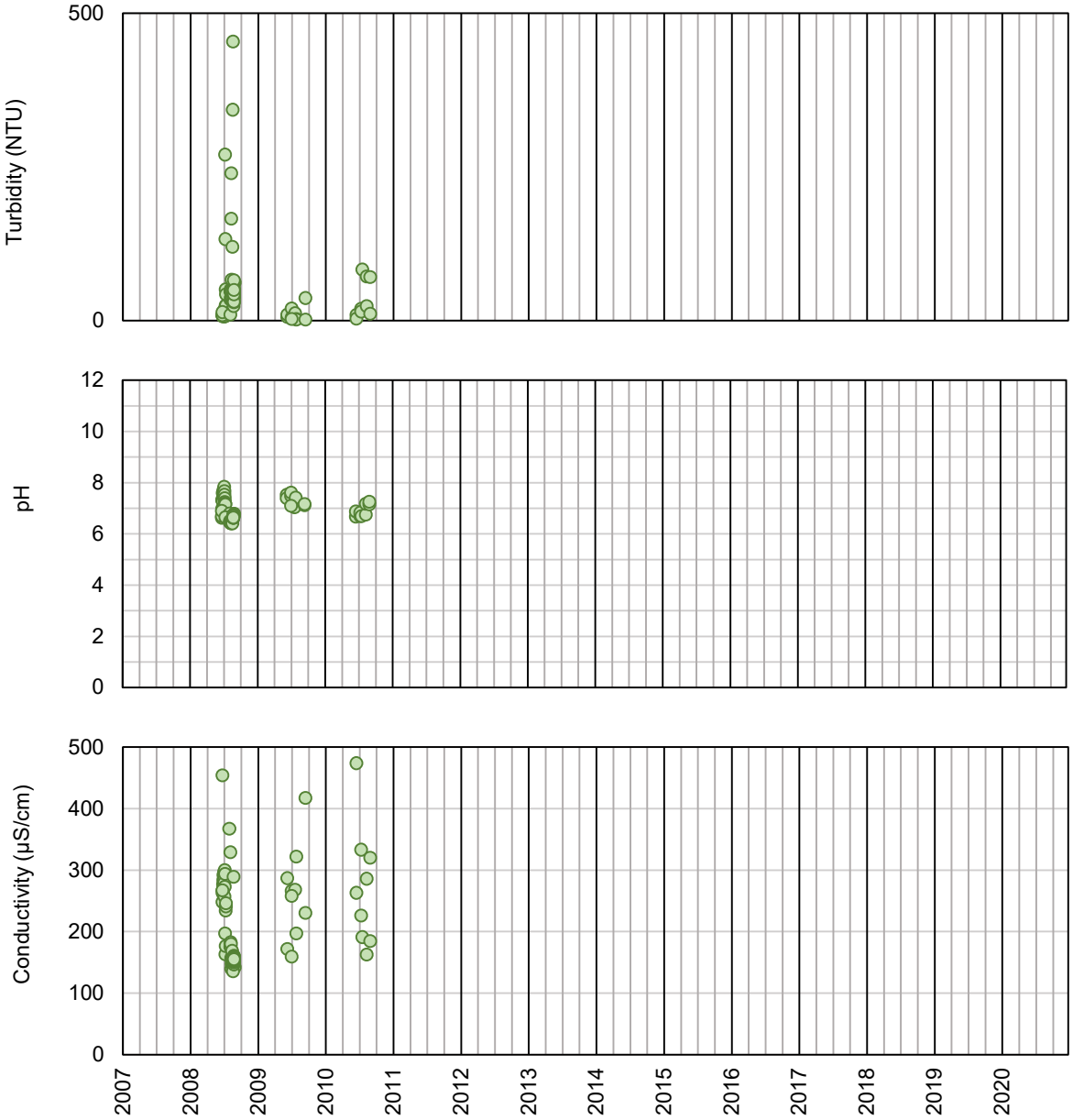


Stewart River Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements

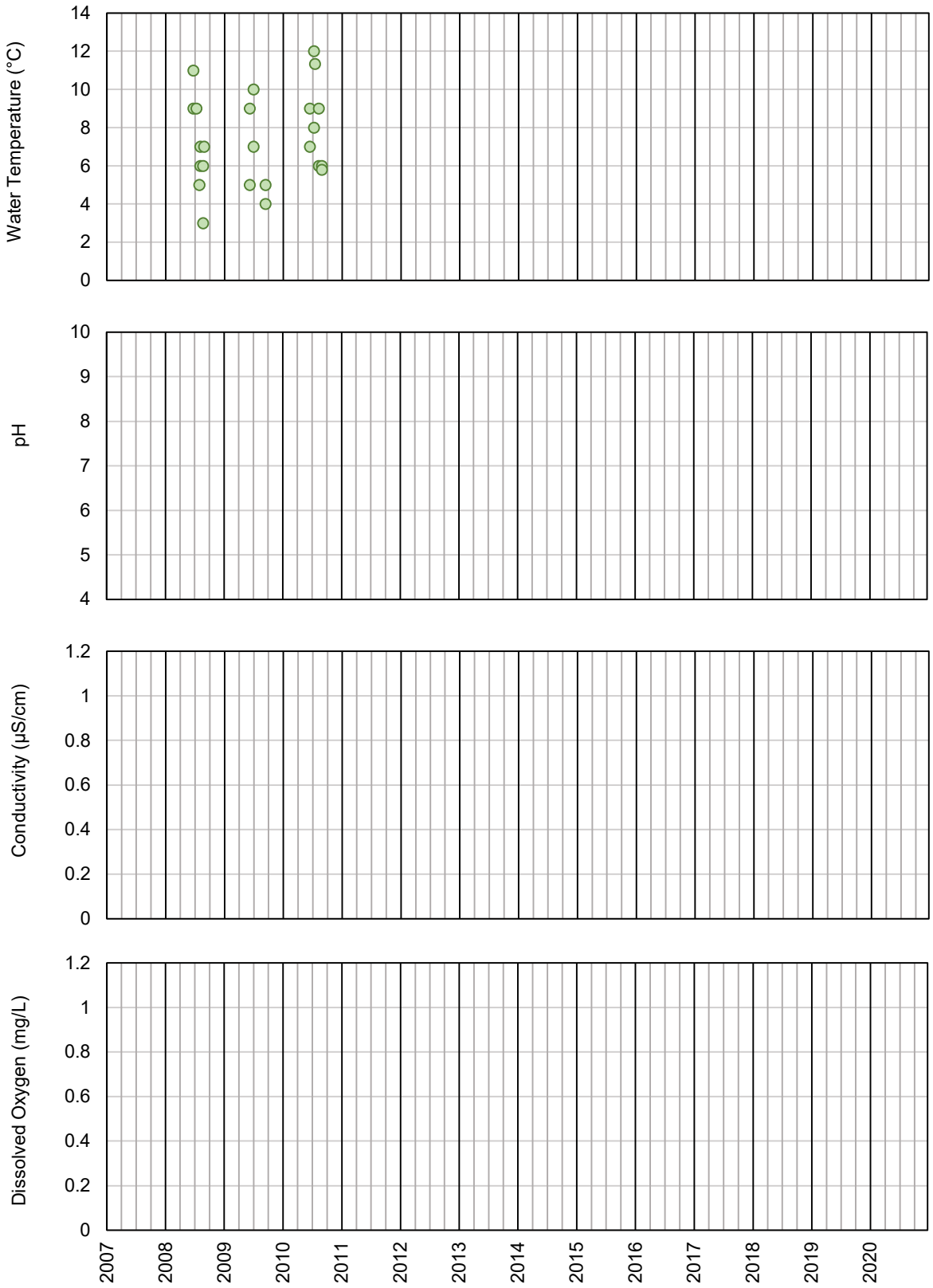



Stewart River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

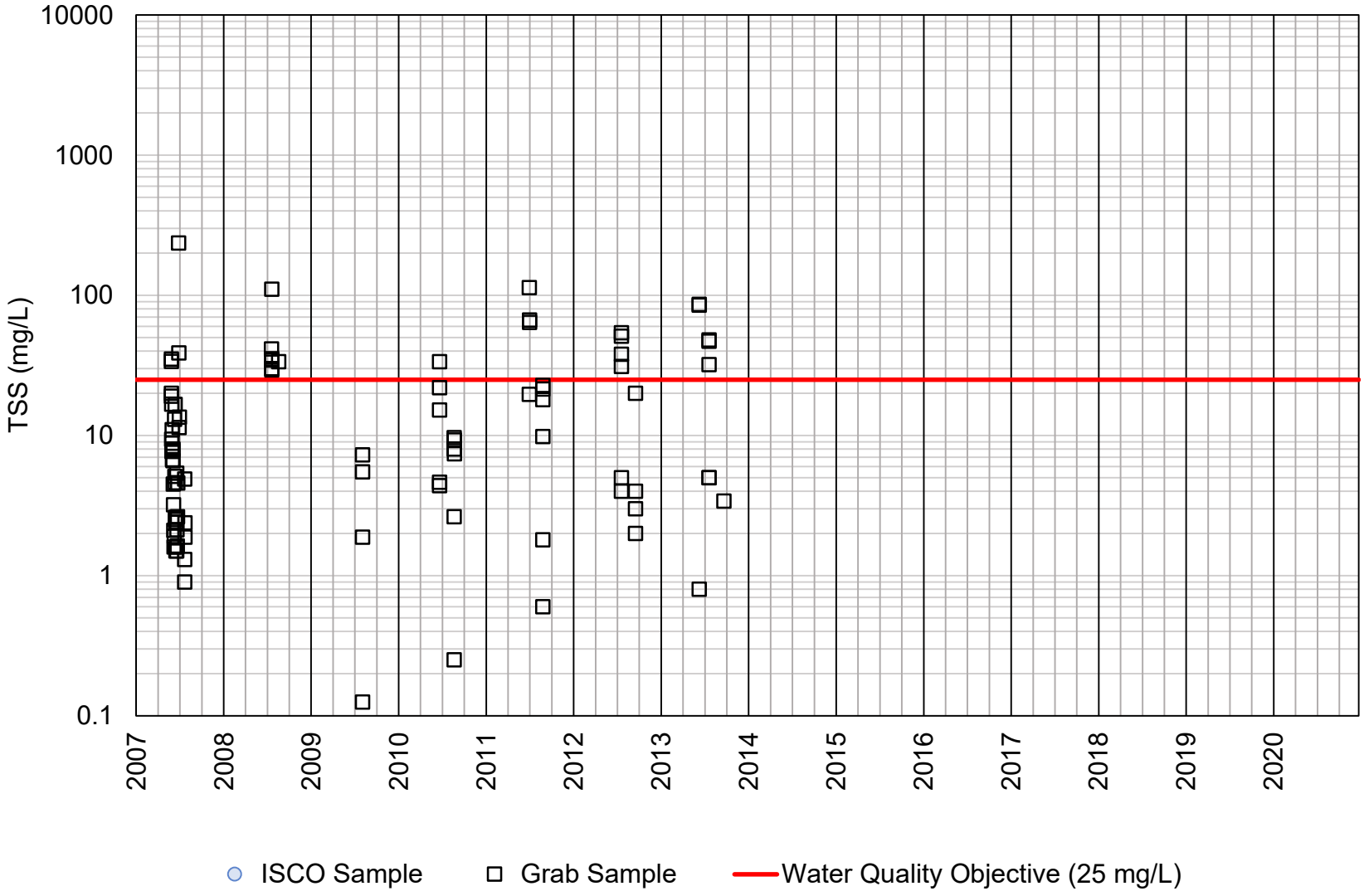
Stewart River Watershed, Low Habitat Suitability, Laboratory Measured Parameters



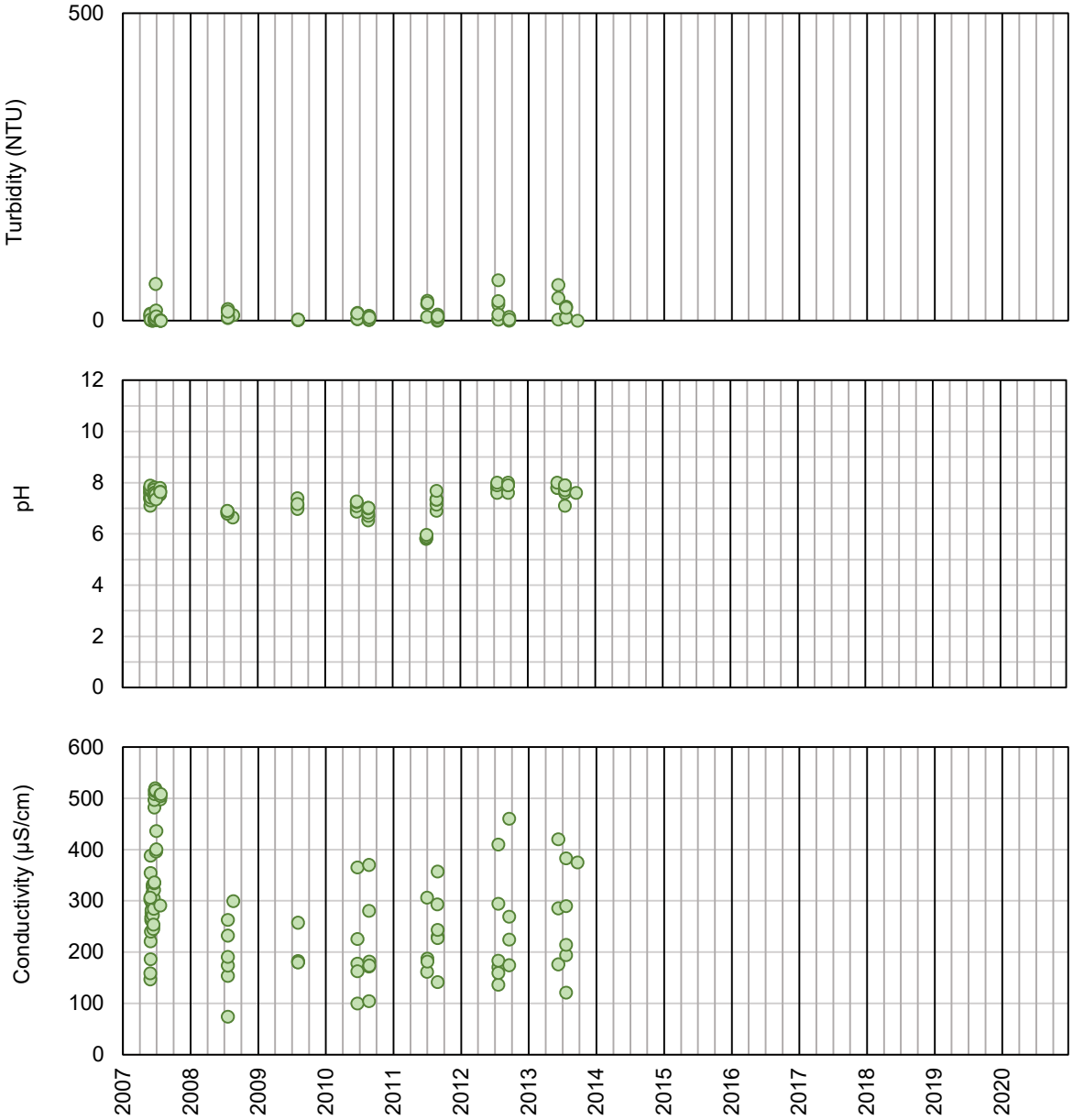
Stewart River Watershed, Low Habitat Suitability, Field Meaurements



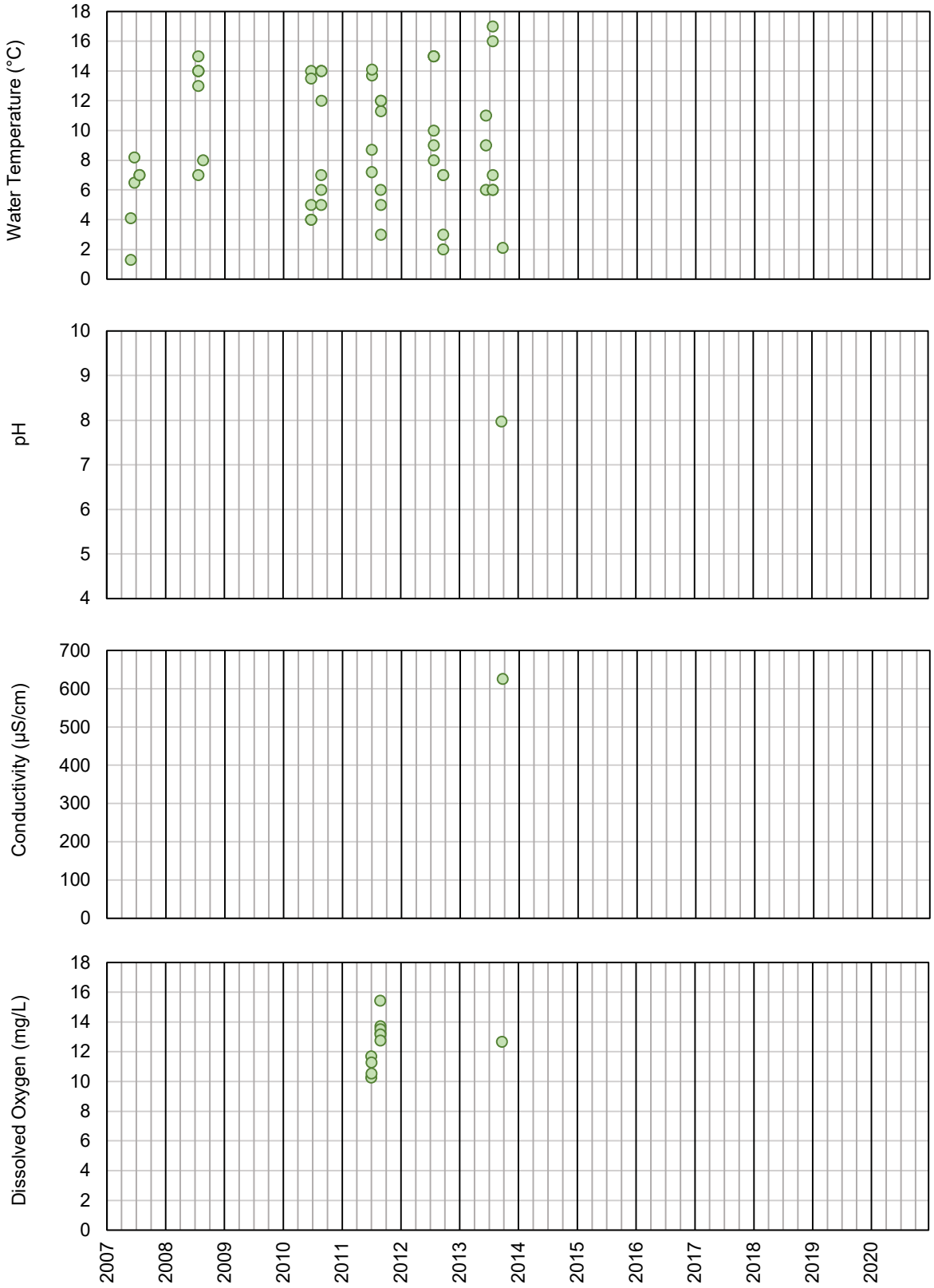
Yukon River South Watershed, Area of Special Consideration Habitat Suitability
TSS Composite and Grab Samples

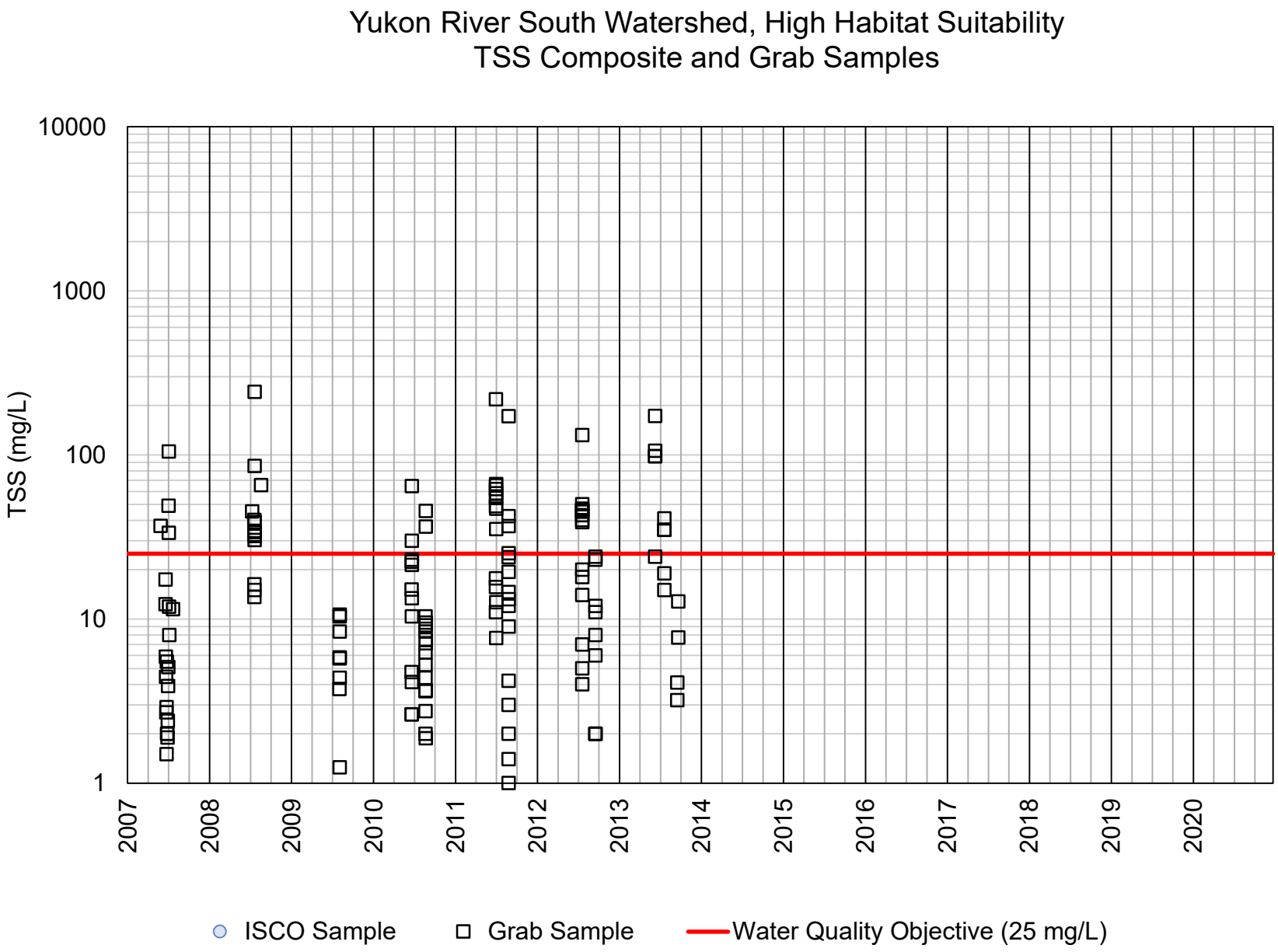


Yukon River South Watershed, Area of Special Consideration Habitat Suitability, Laboratory Measured Parameters

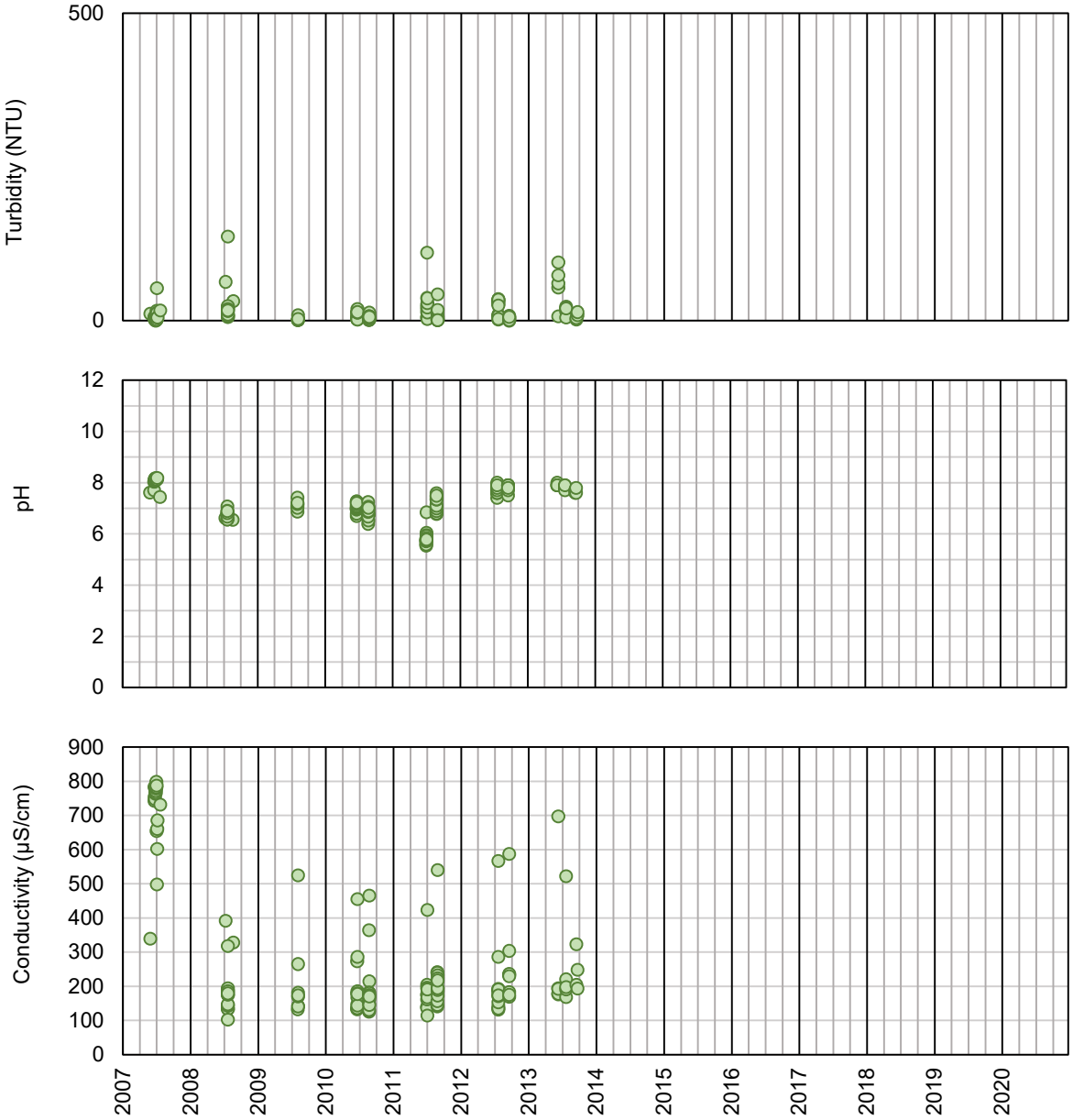


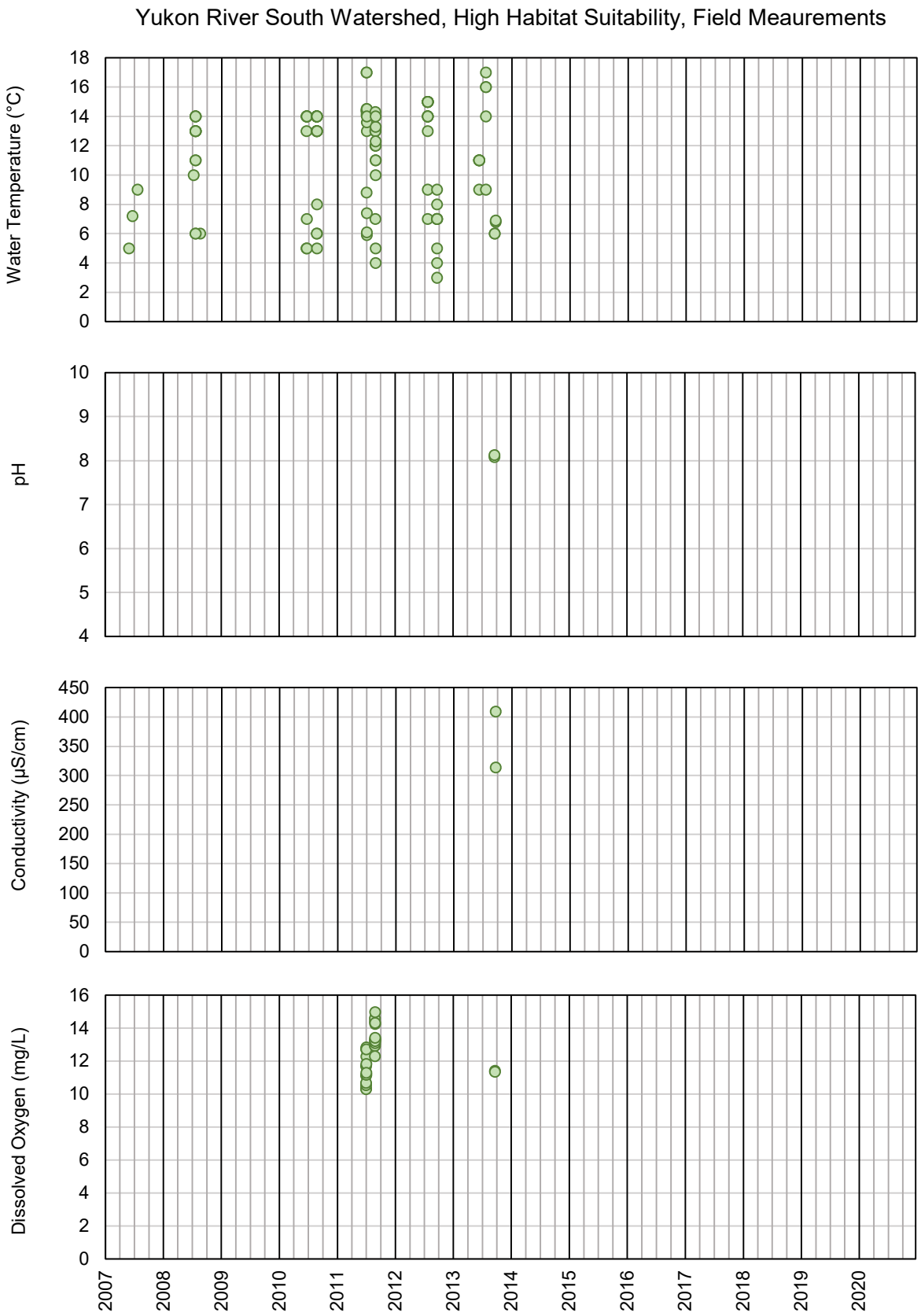
Yukon River South Watershed, Area of Special Consideration Habitat Suitability, Field Meaurements

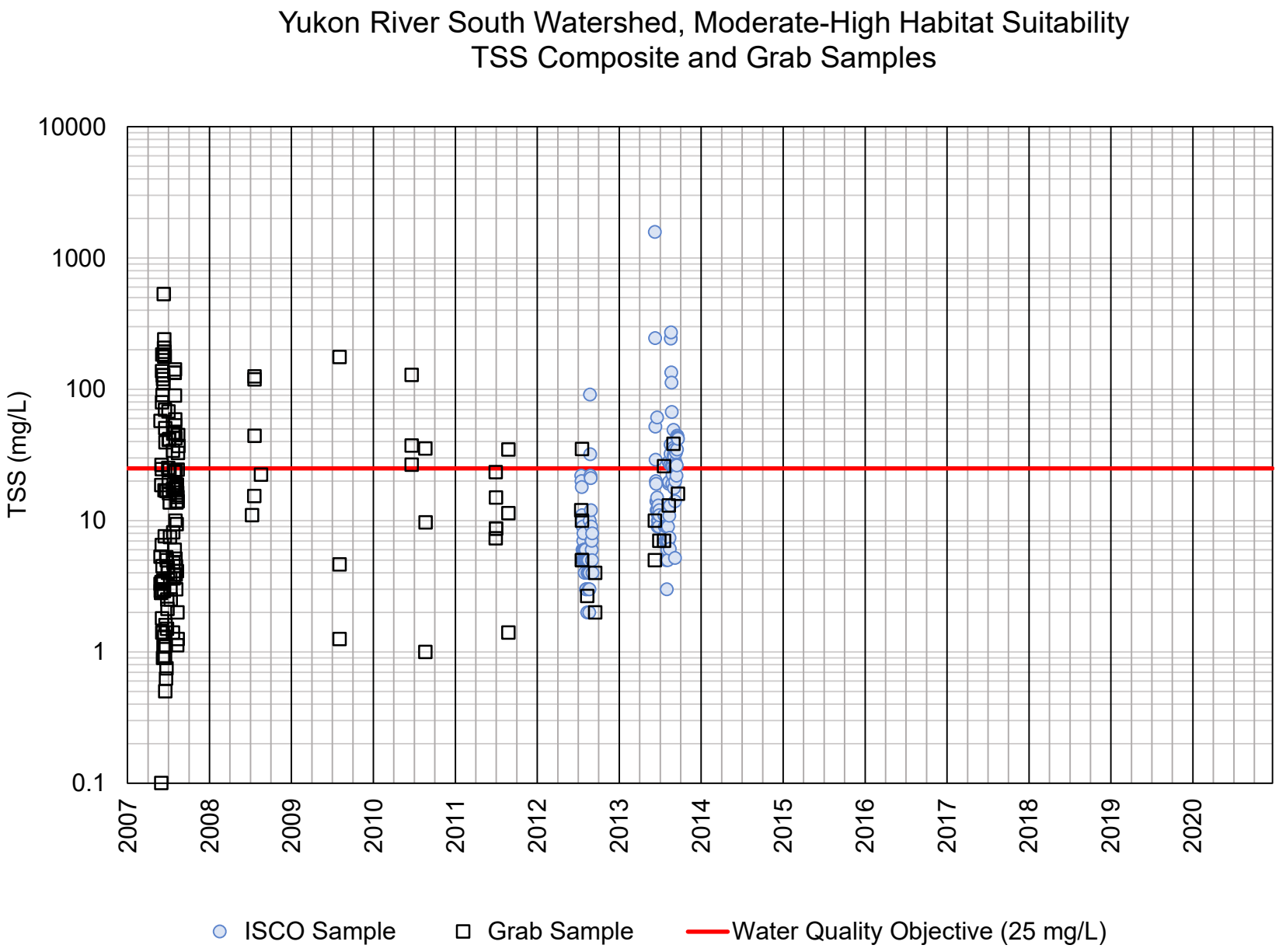



Yukon River South Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

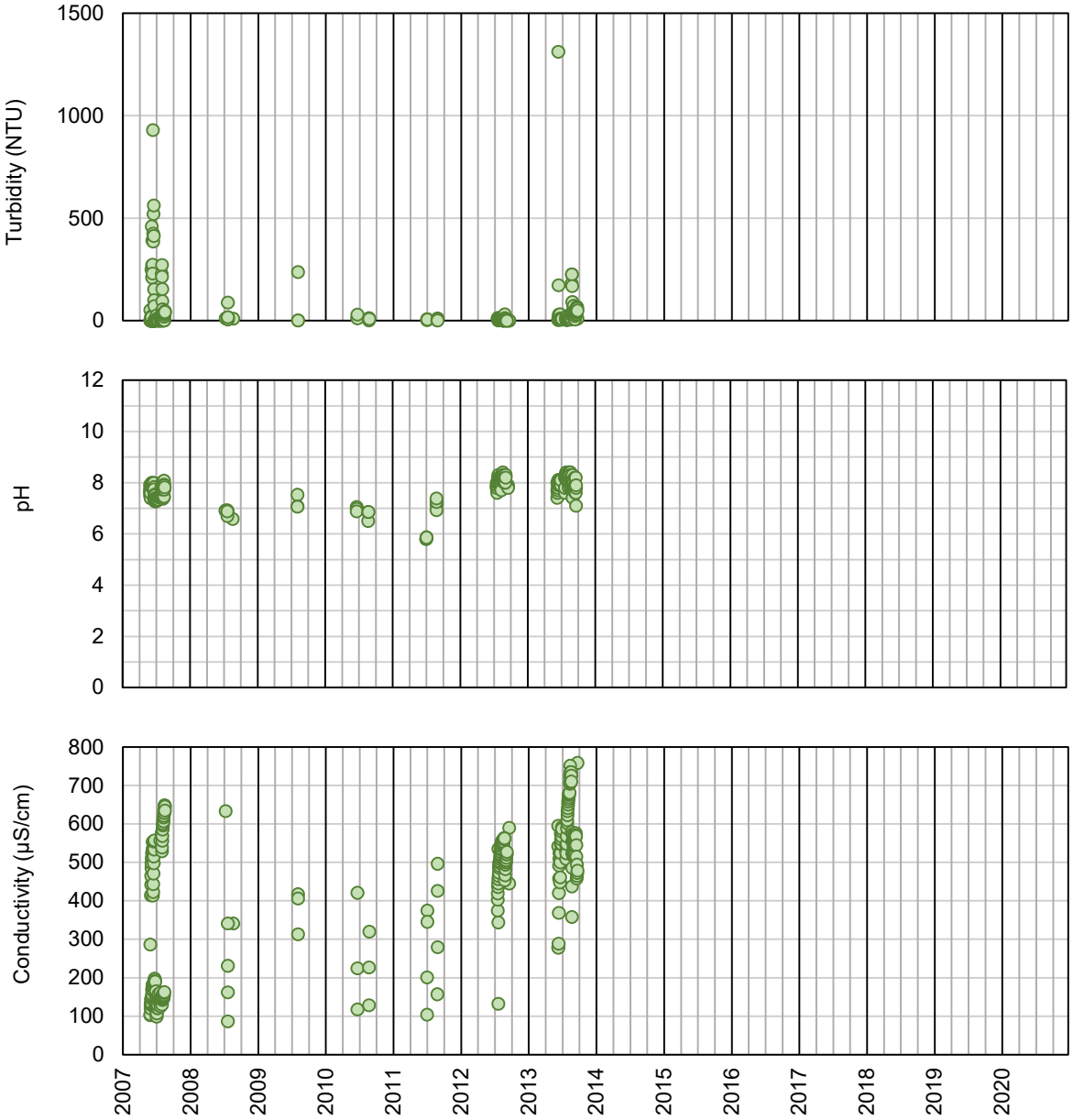
Yukon River South Watershed, High Habitat Suitability, Laboratory Measured Parameters



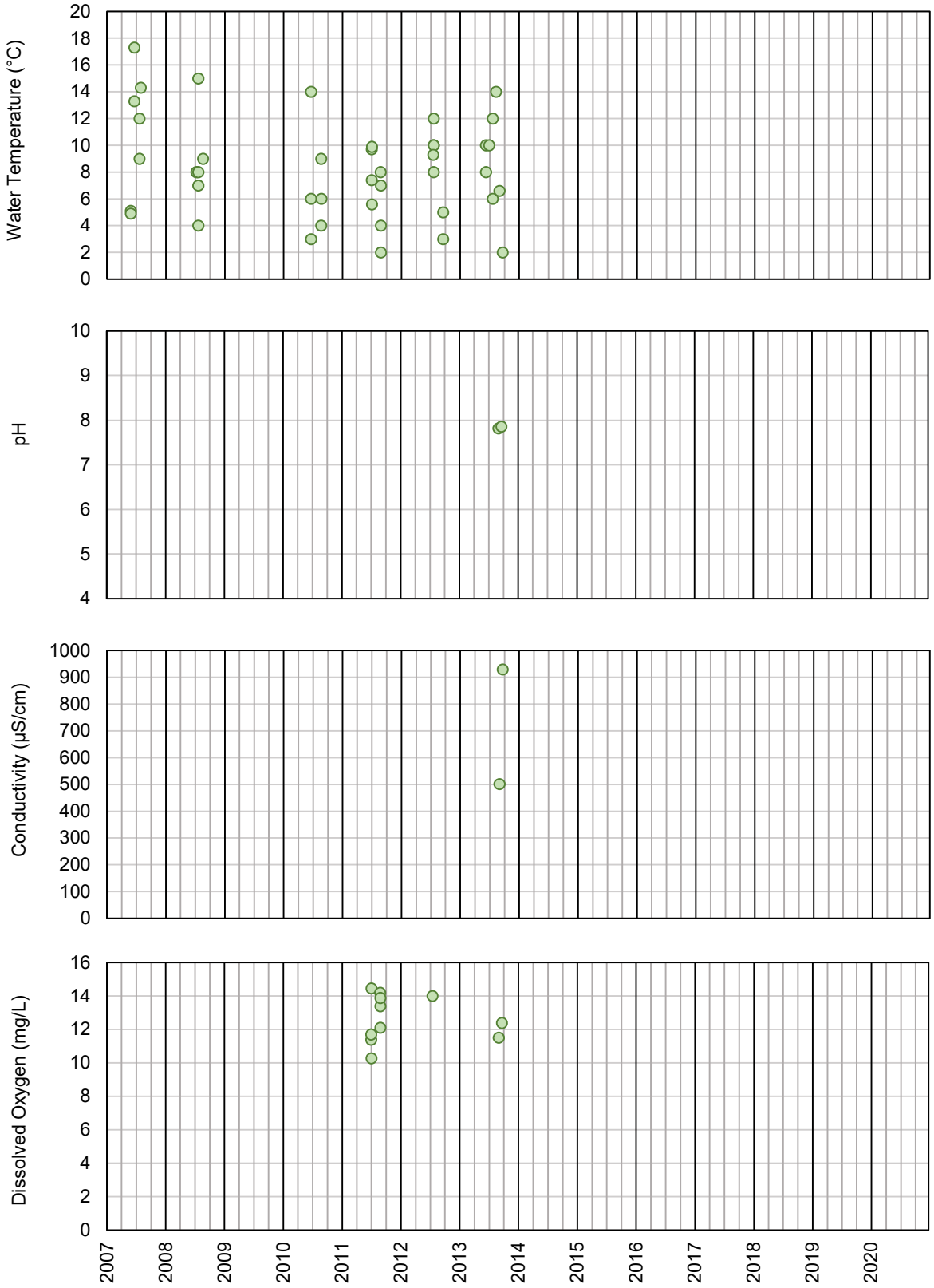

Yukon River South Watershed, High Habitat Suitability, Field Meaurements
Water Temperature (°C)
0
2
4
6
8
10
12
14
16
18
pH
4
5
6
7
8
9
10
Conductivity (µS/cm)
0
50
100
150
200
250
300
350
400
450
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
16
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

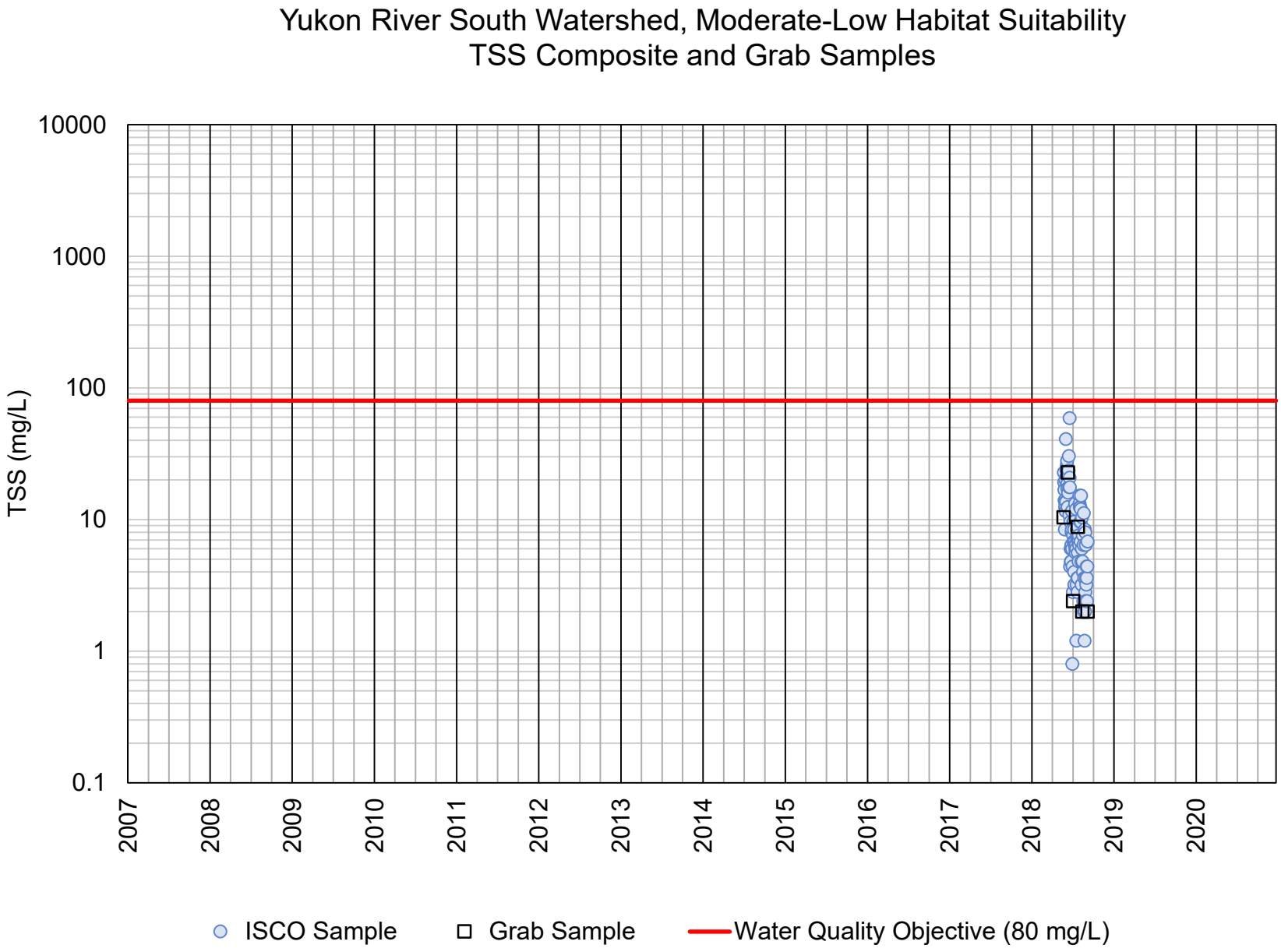

Yukon River South Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Yukon River South Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters

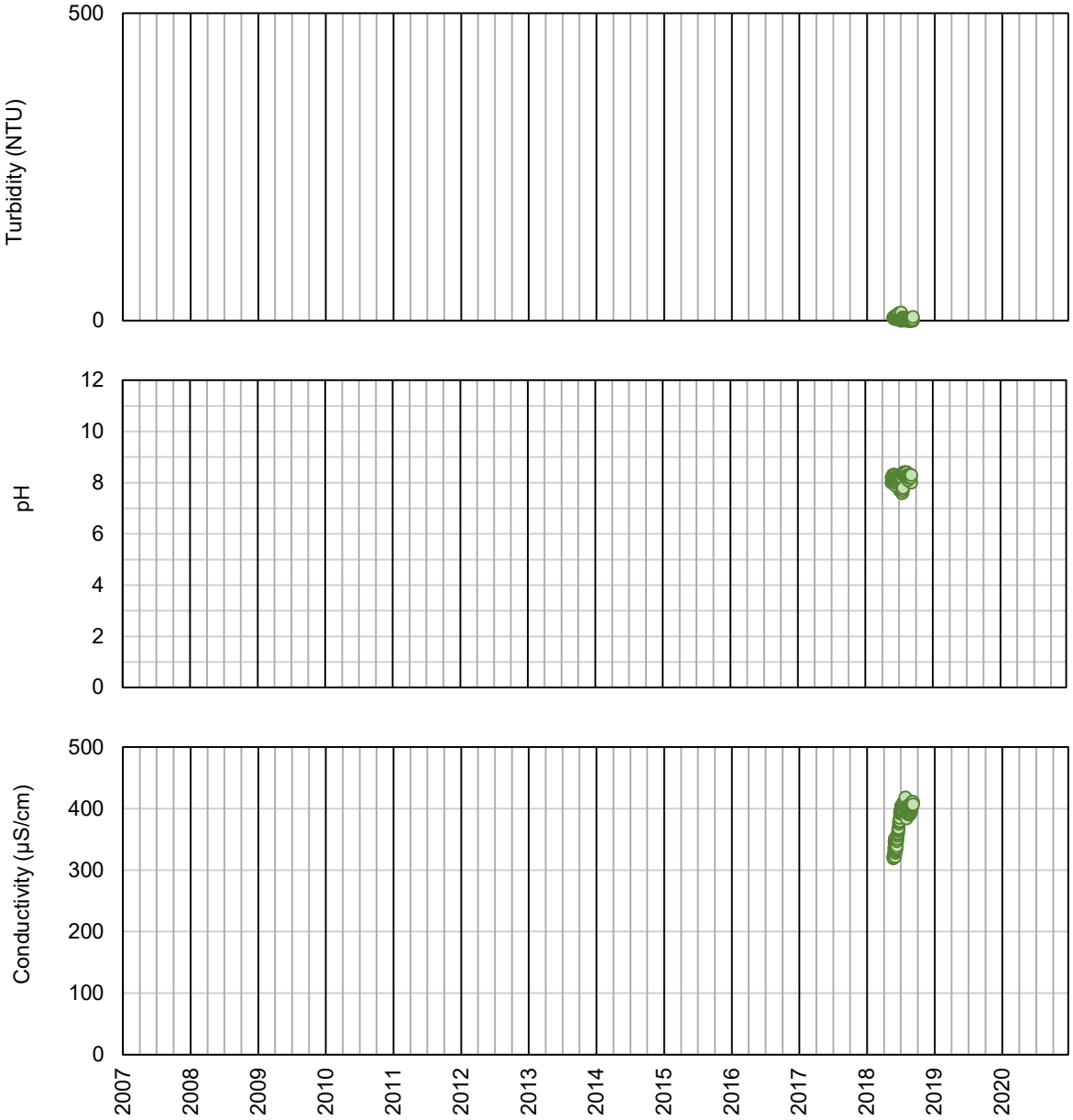


Yukon River South Watershed, Moderate-High Habitat Suitability, Field Meaurements

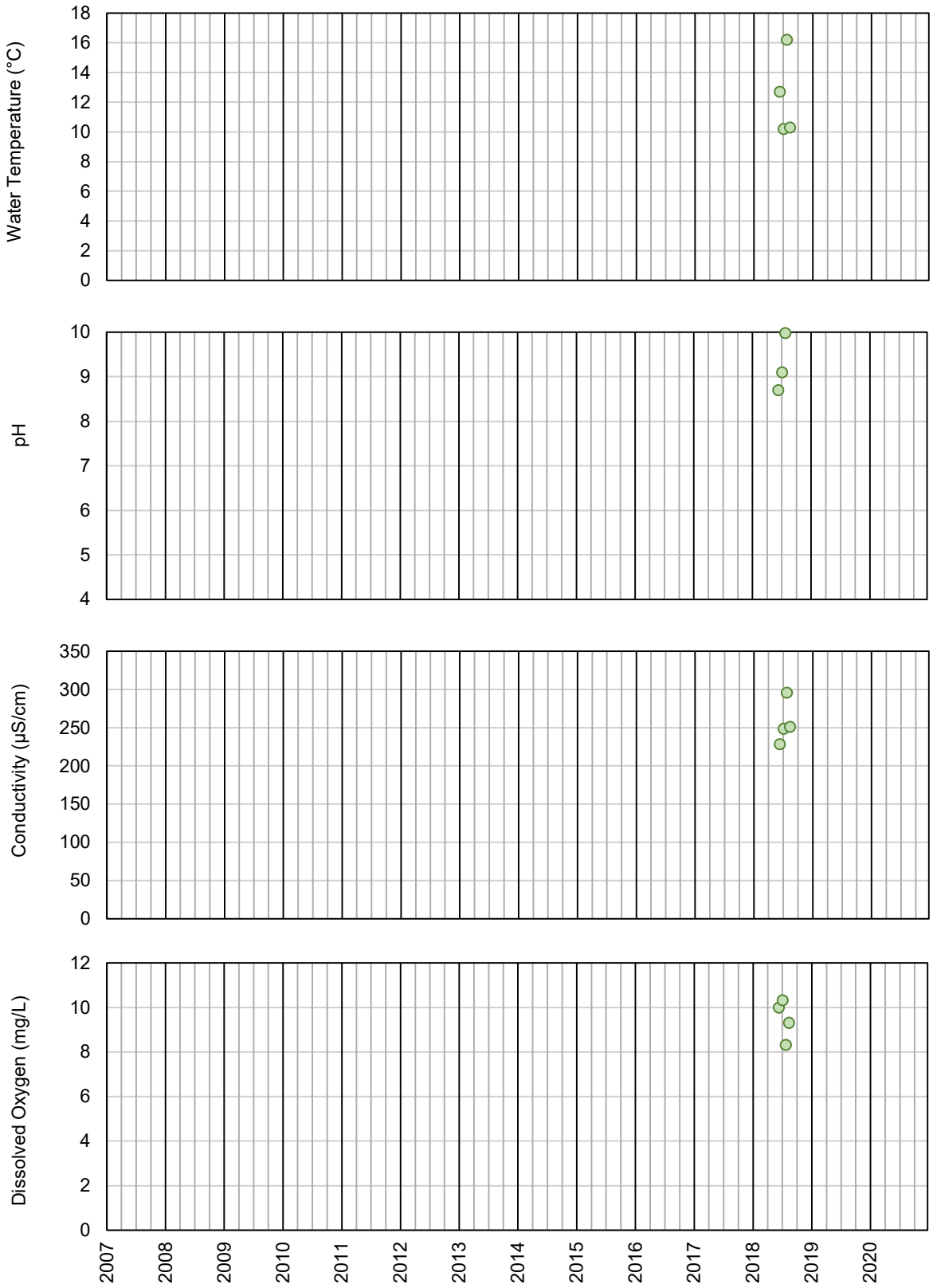



Yukon River South Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (80 mg/L)

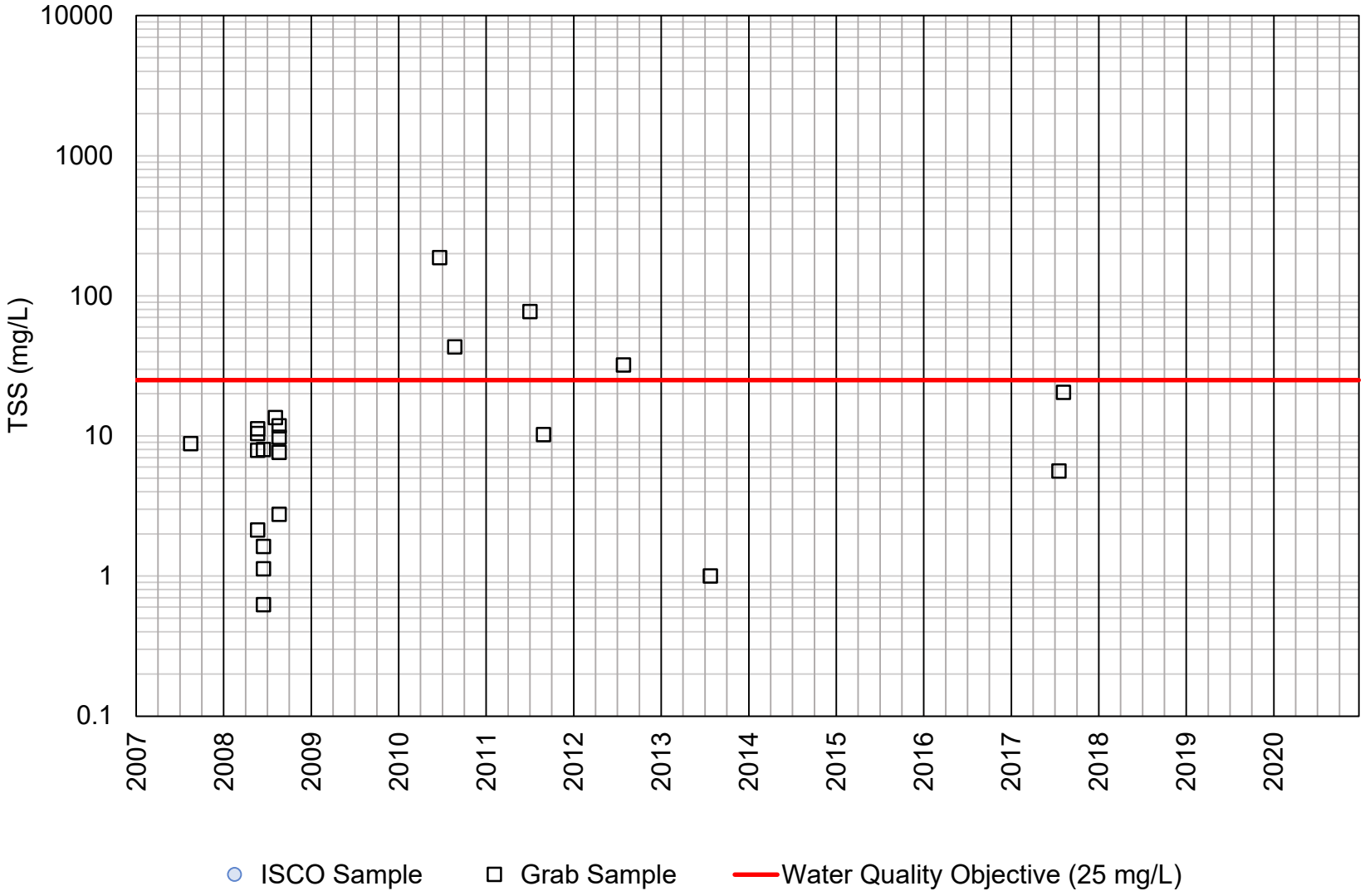
Yukon River South Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters



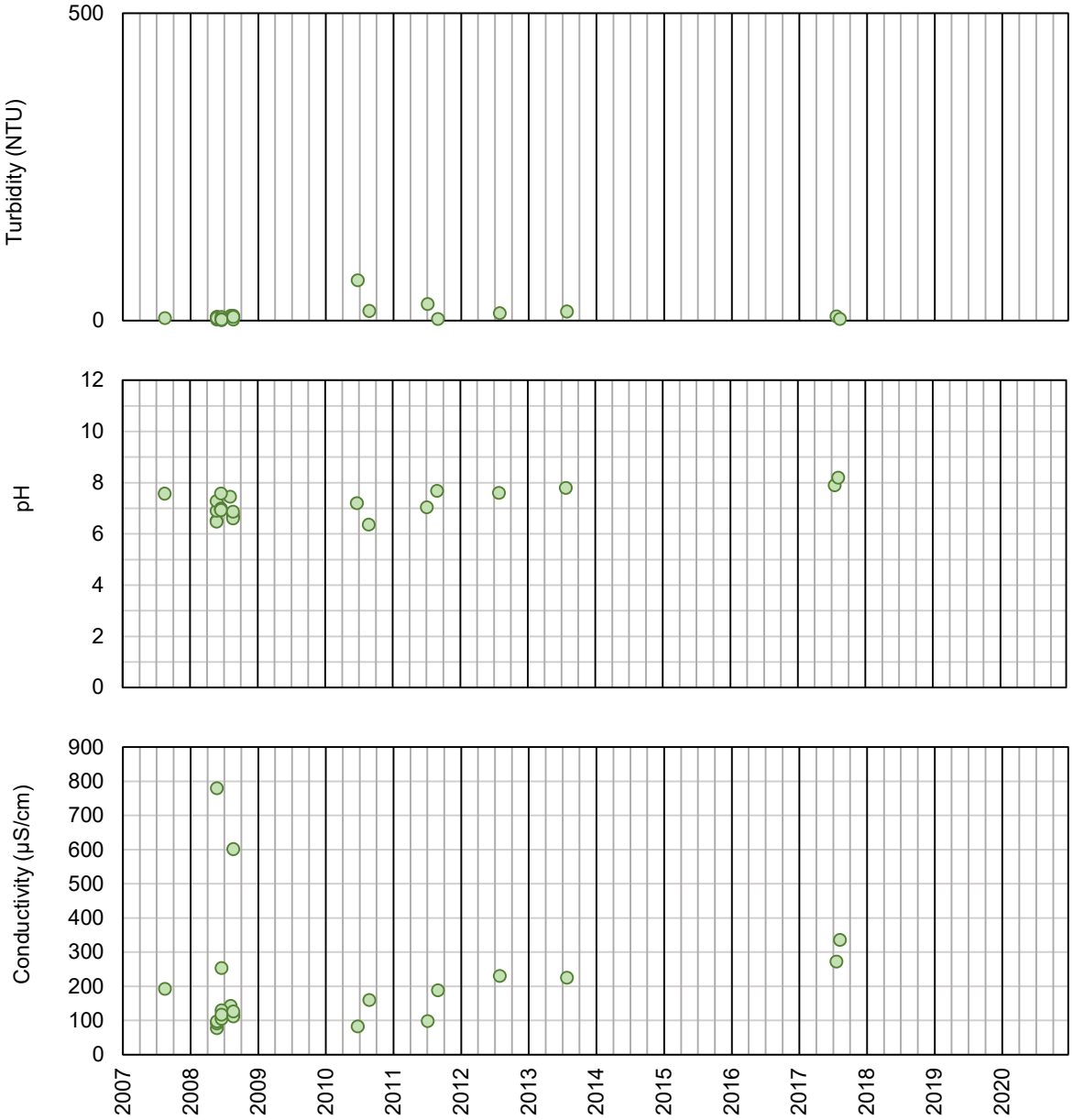
Yukon River South Watershed, Moderate-Low Habitat Suitability, Field Meaurements



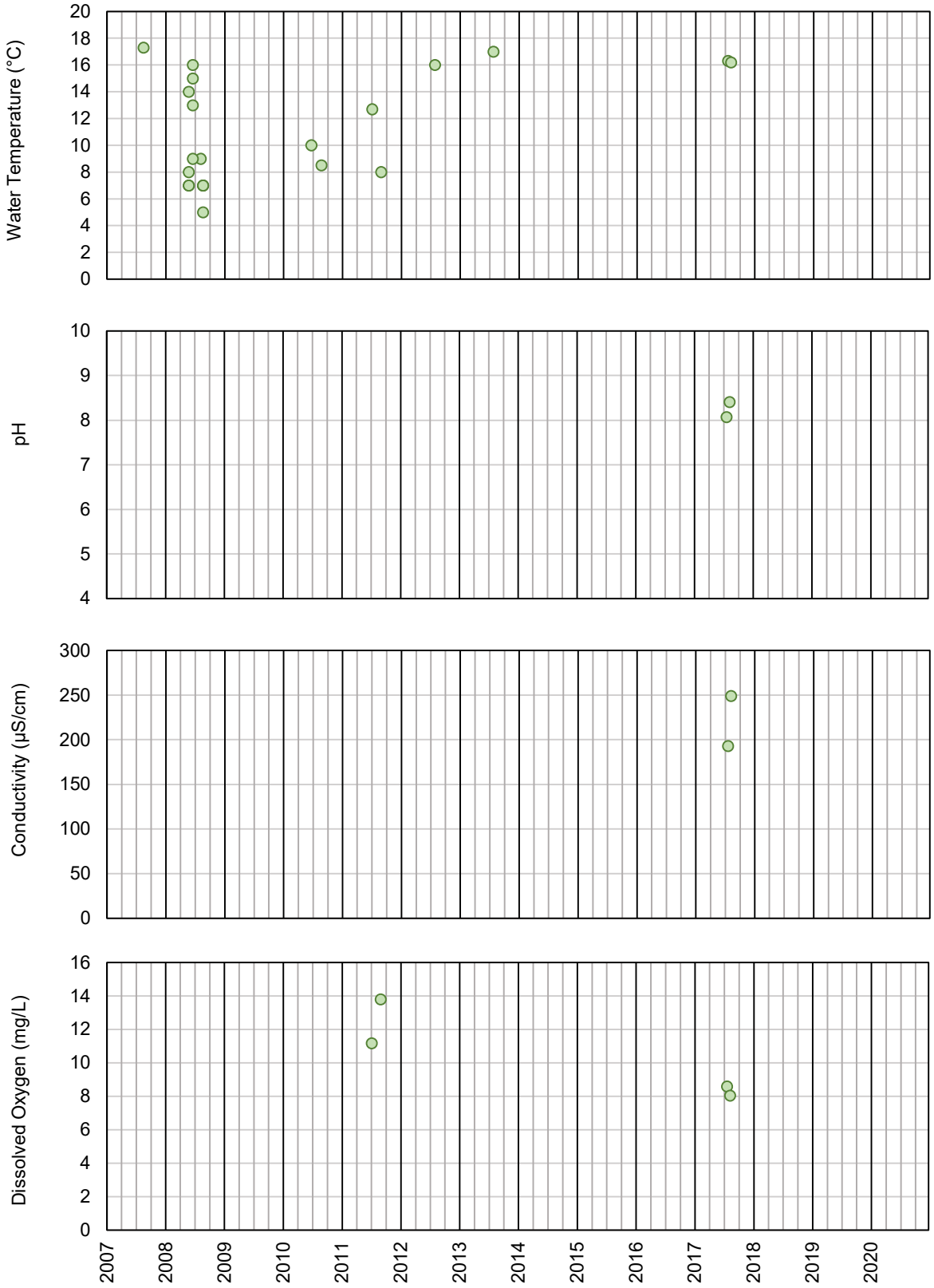
Forty Mile River Watershed, Area of Special Consideration Habitat Suitability
TSS Composite and Grab Samples

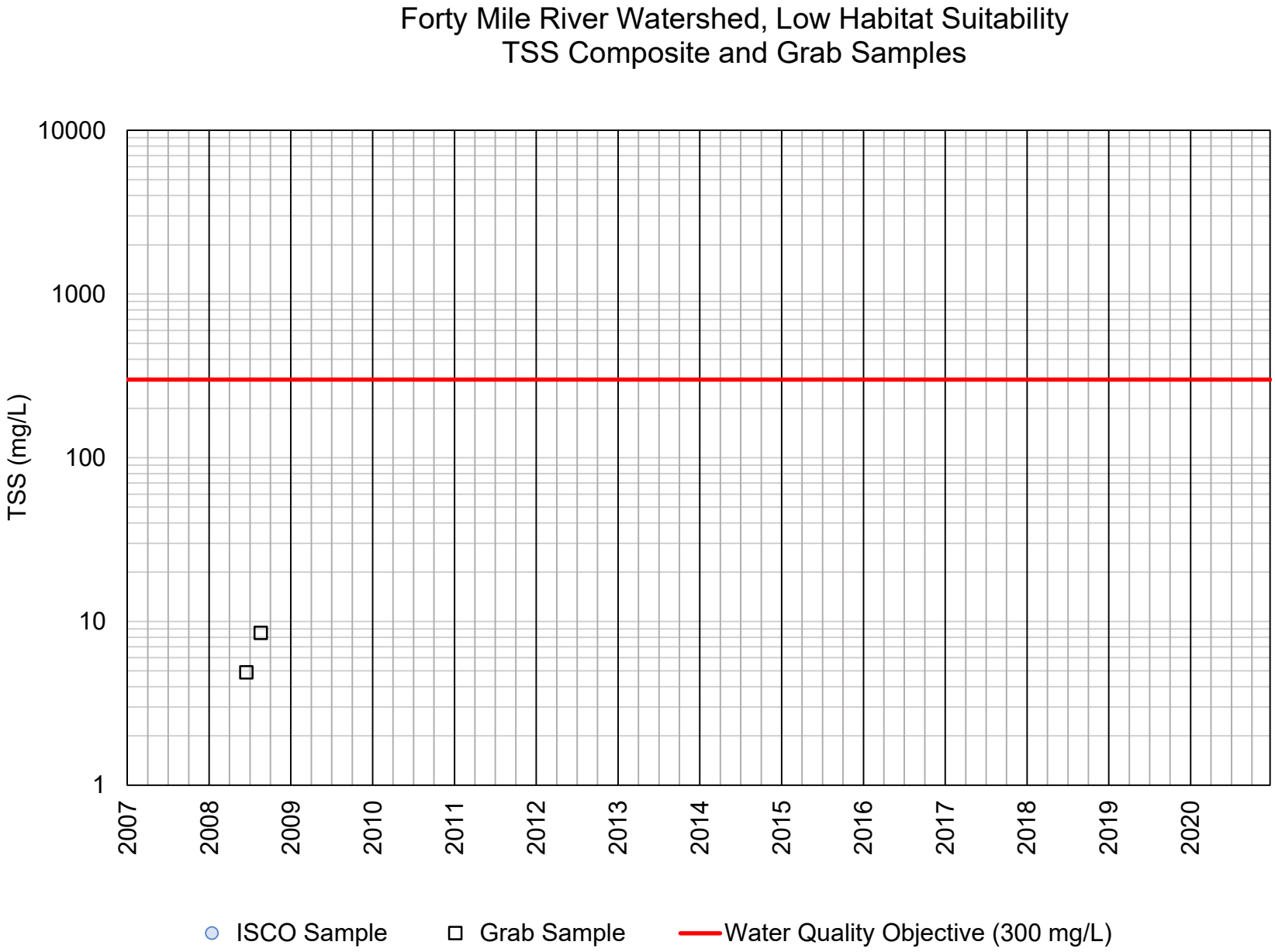


Forty Mile River Watershed, Area of Special Consideration Habitat Suitability, Laboratory Measured Parameters

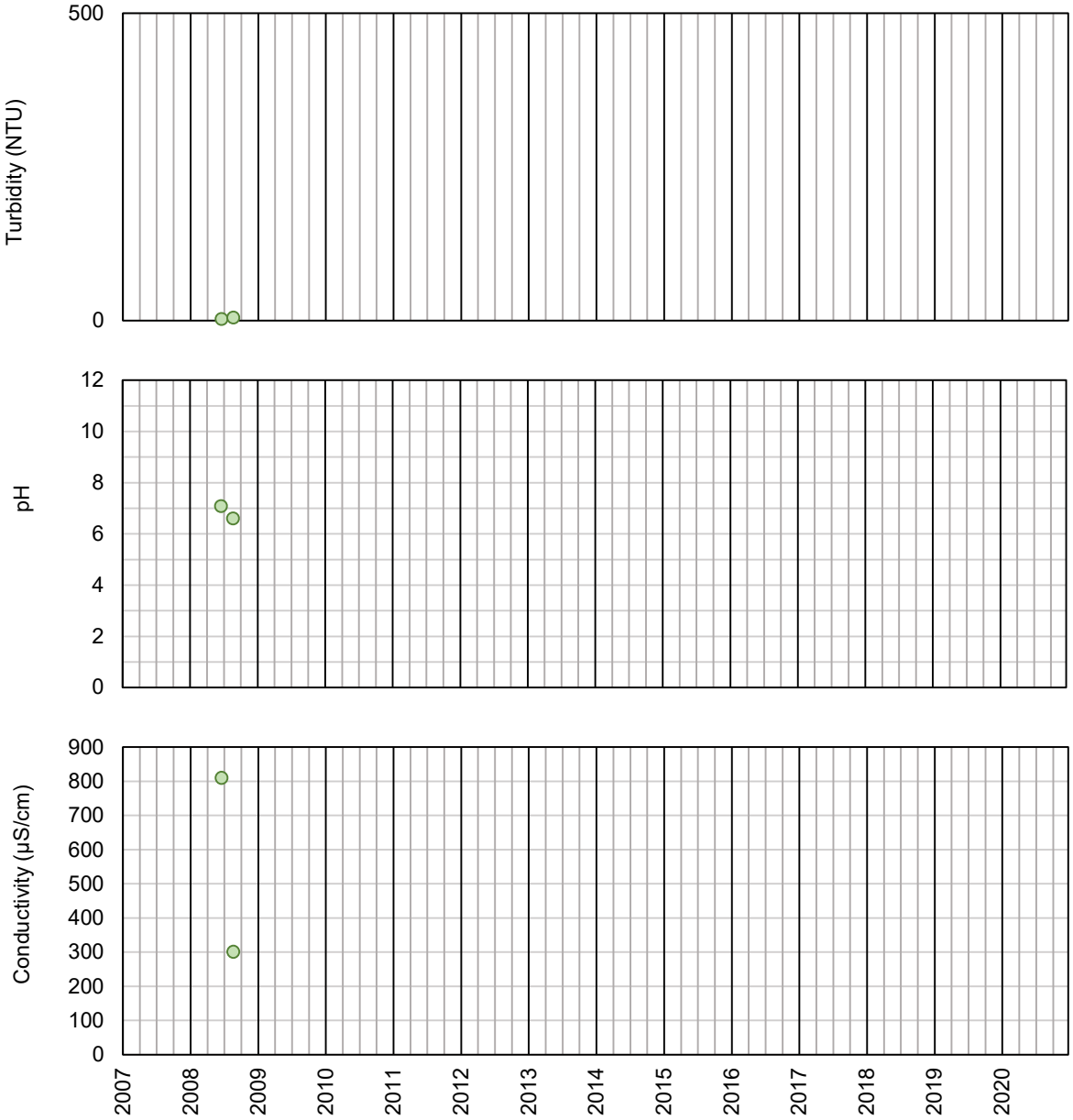


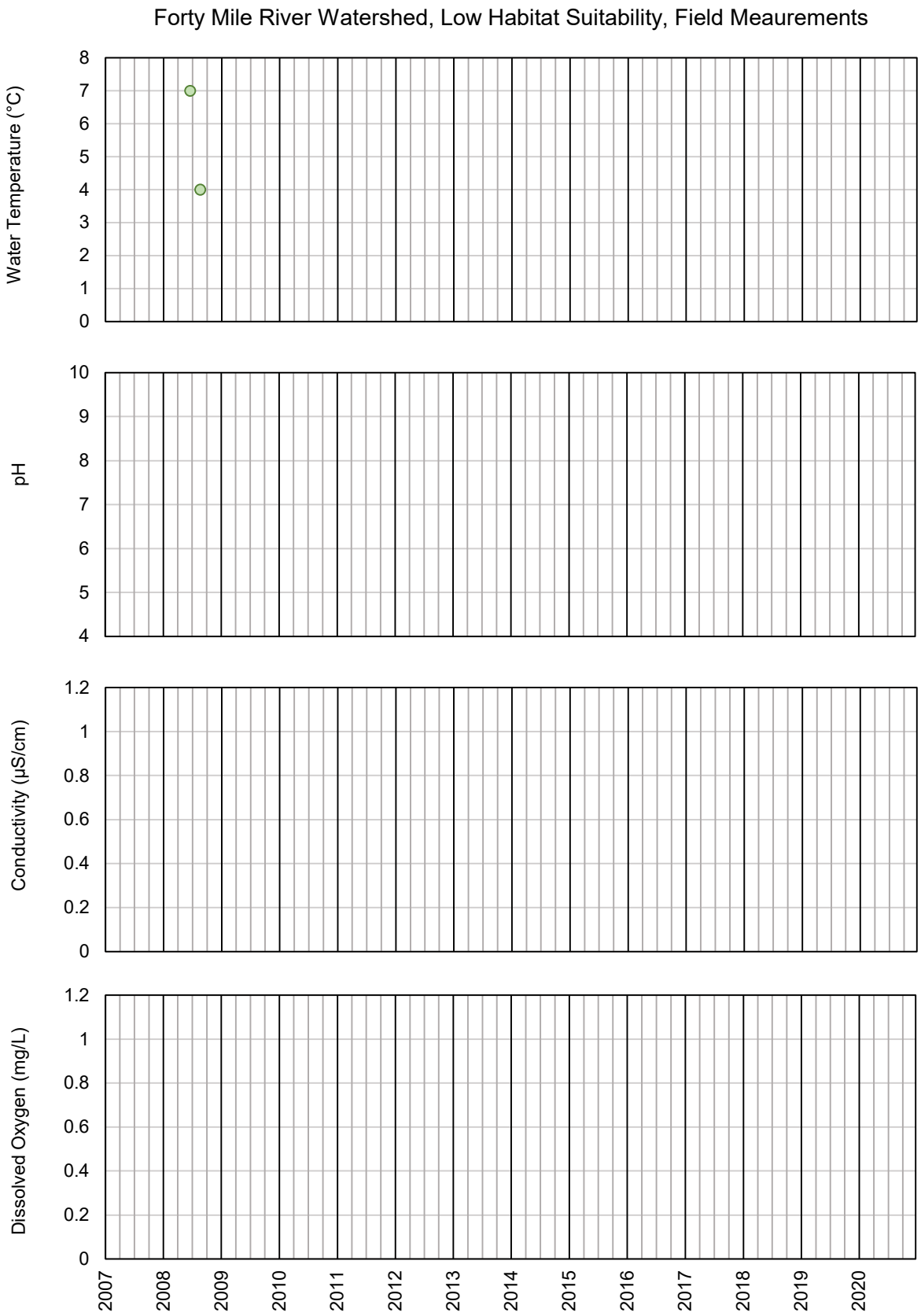
Forty Mile River Watershed, Area of Special Consideration Habitat Suitability, Field Meaurements

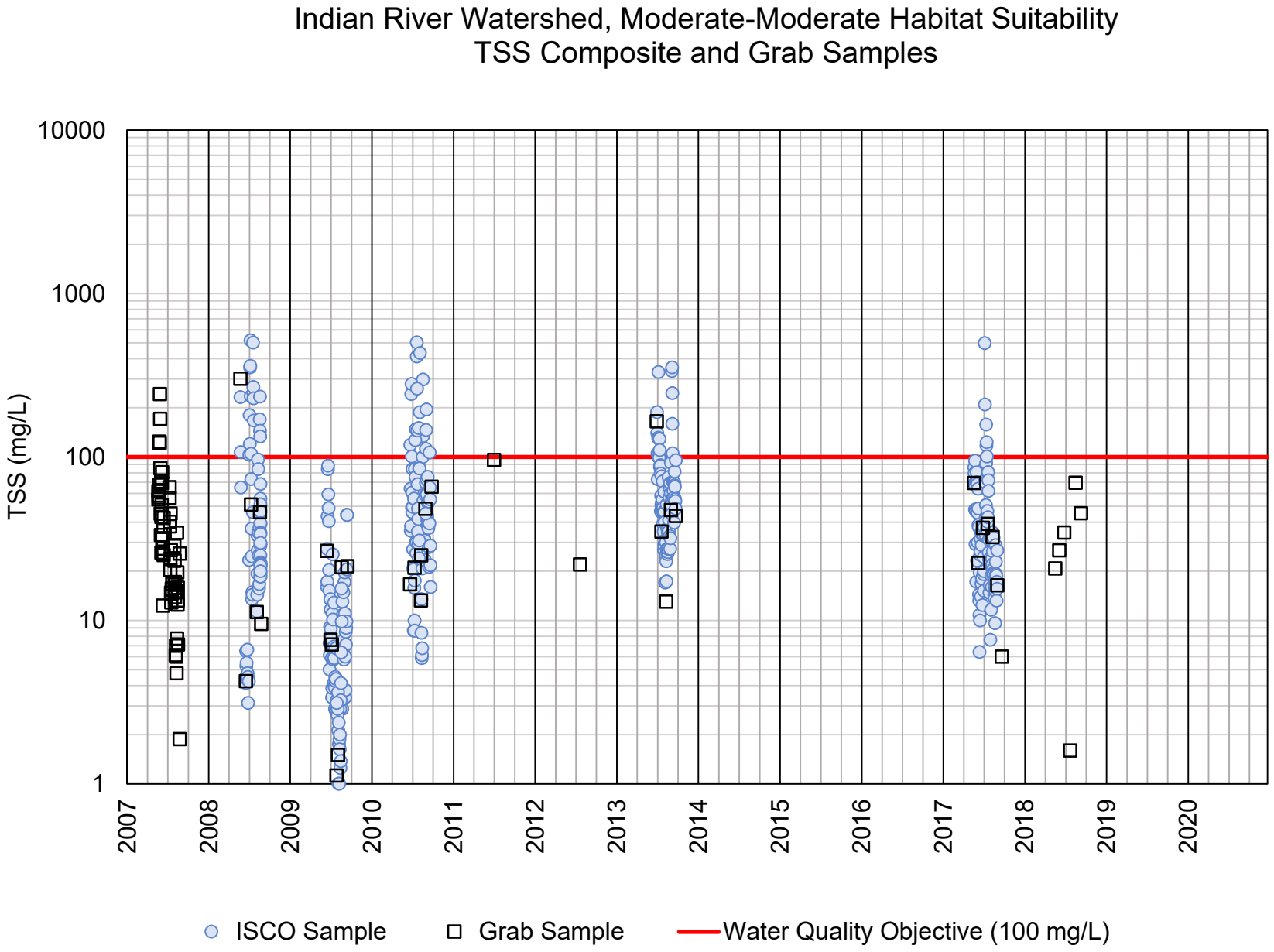



Forty Mile River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (300 mg/L)

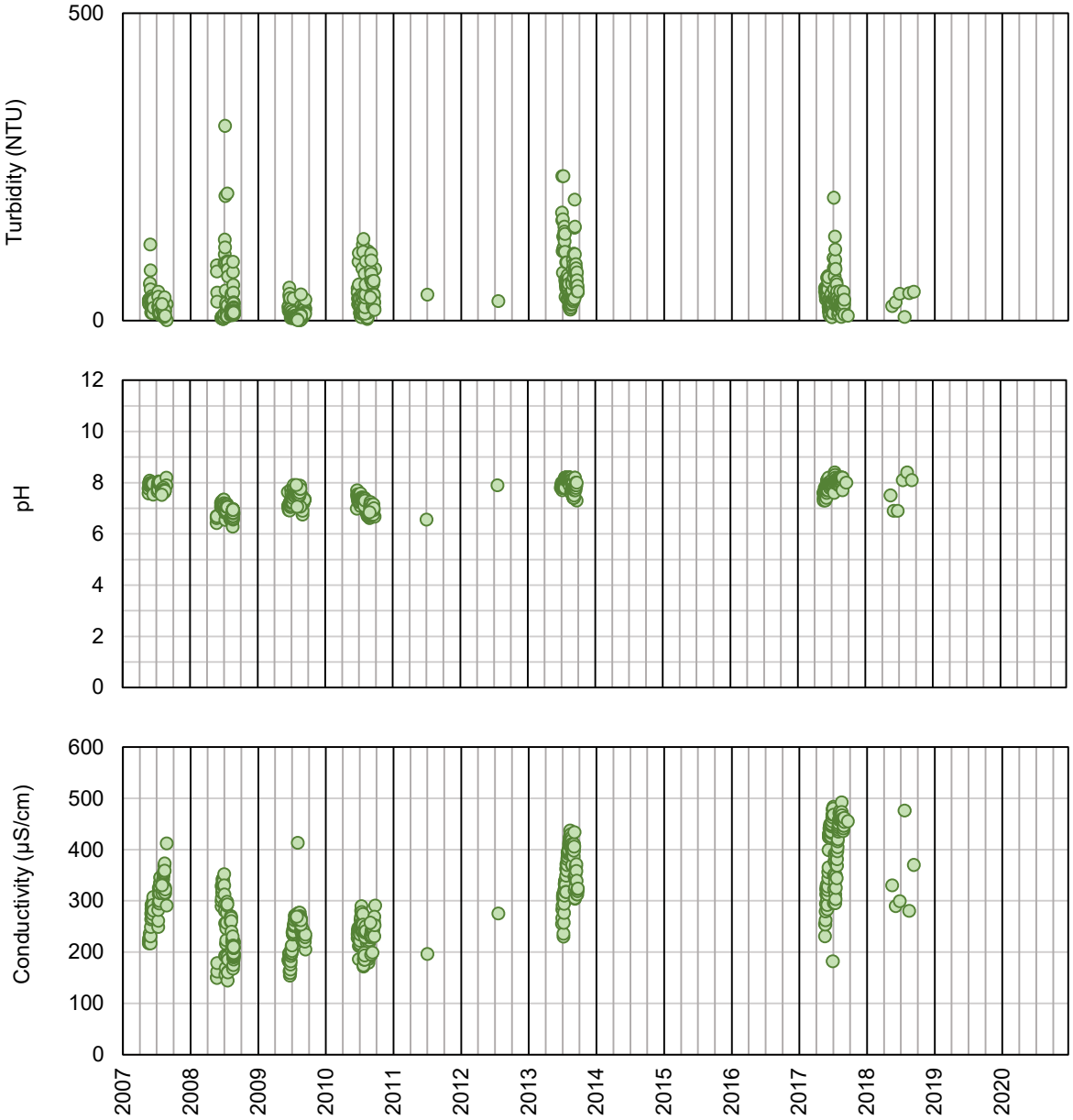
Forty Mile River Watershed, Low Habitat Suitability, Laboratory Measured Parameters



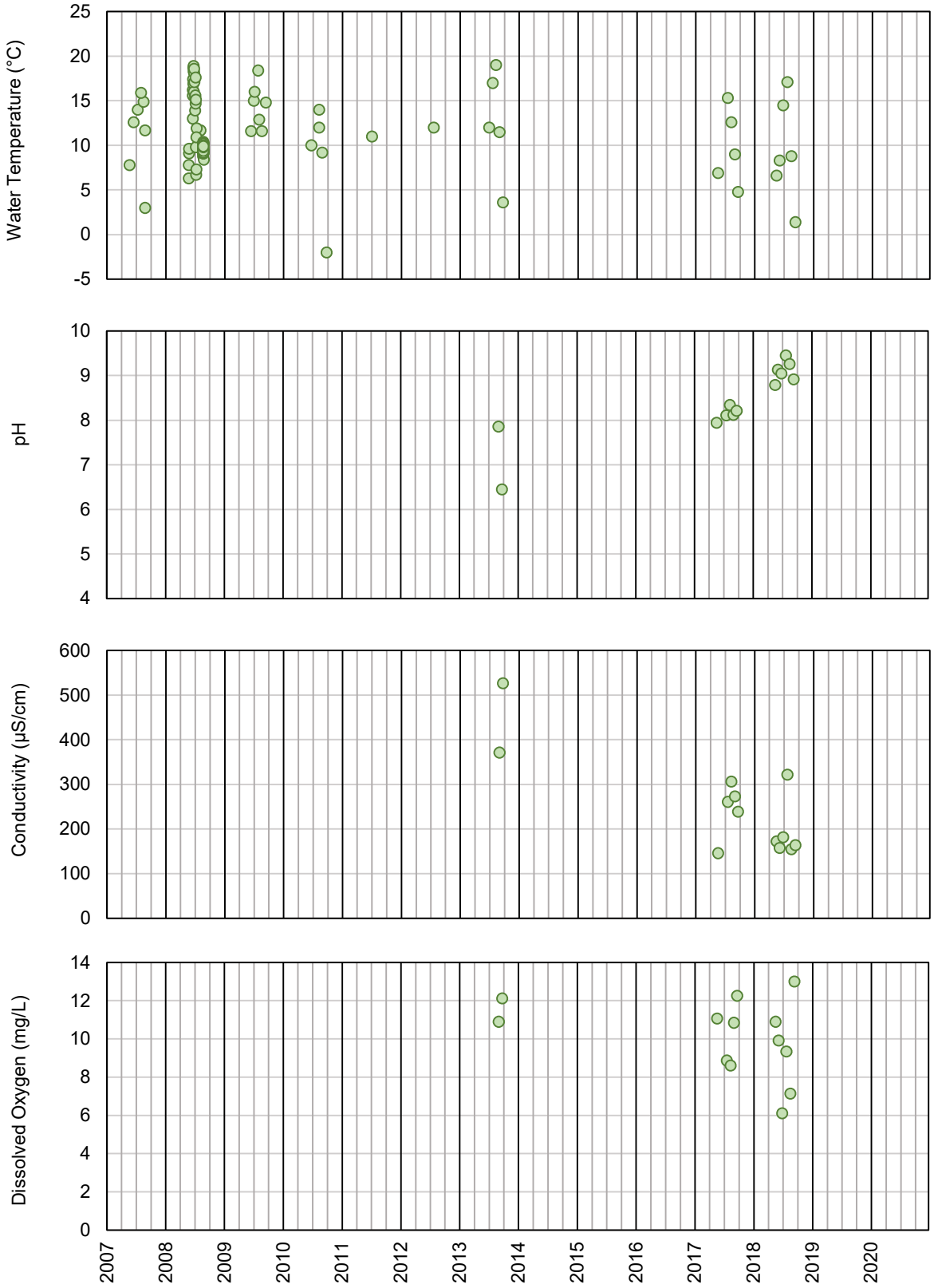

Forty Mile River Watershed, Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
8
7
6
5
4
3
2
1
0
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
Dissolved Oxygen (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

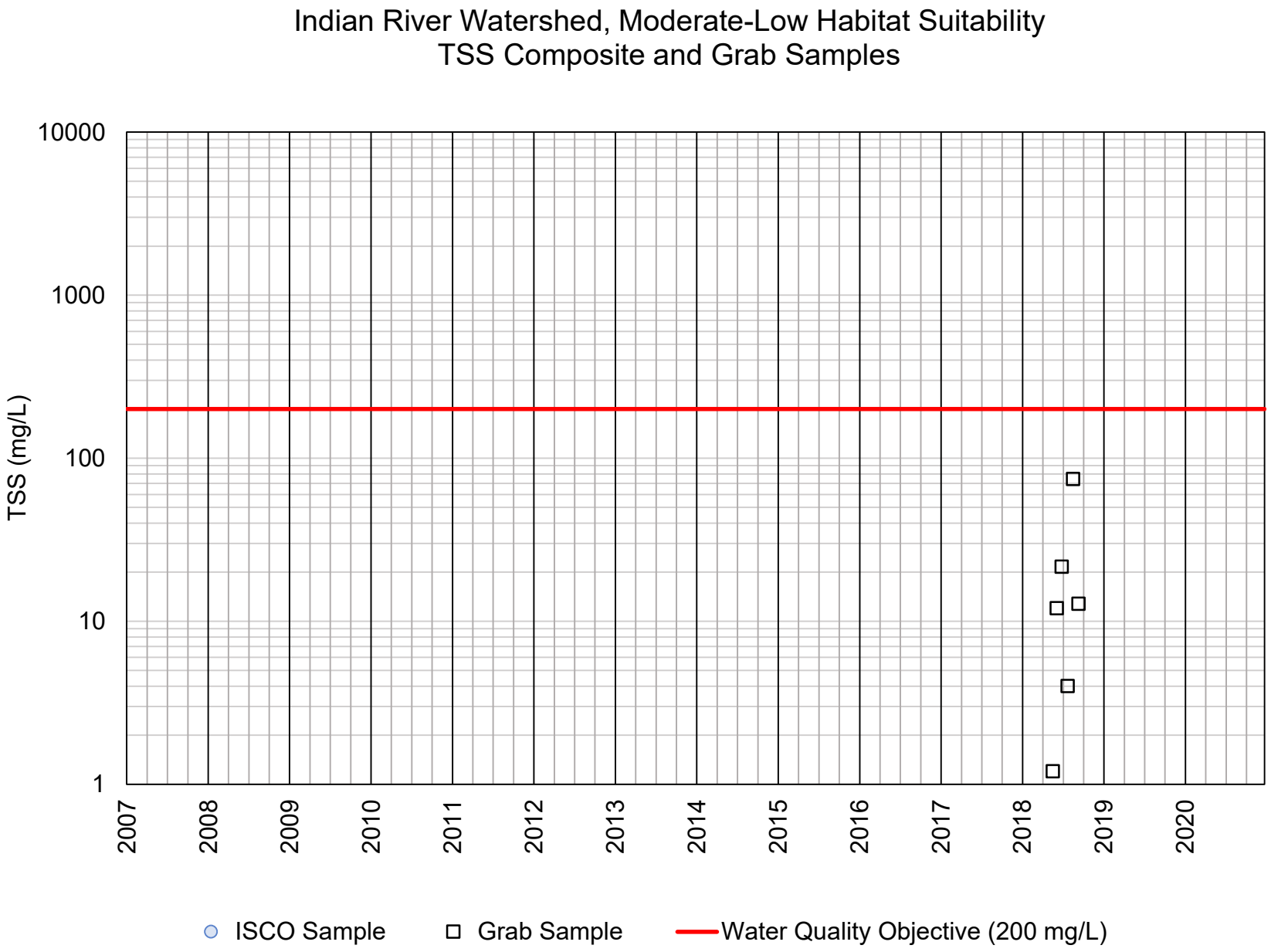

Indian River Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (100 mg/L)

Indian River Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters

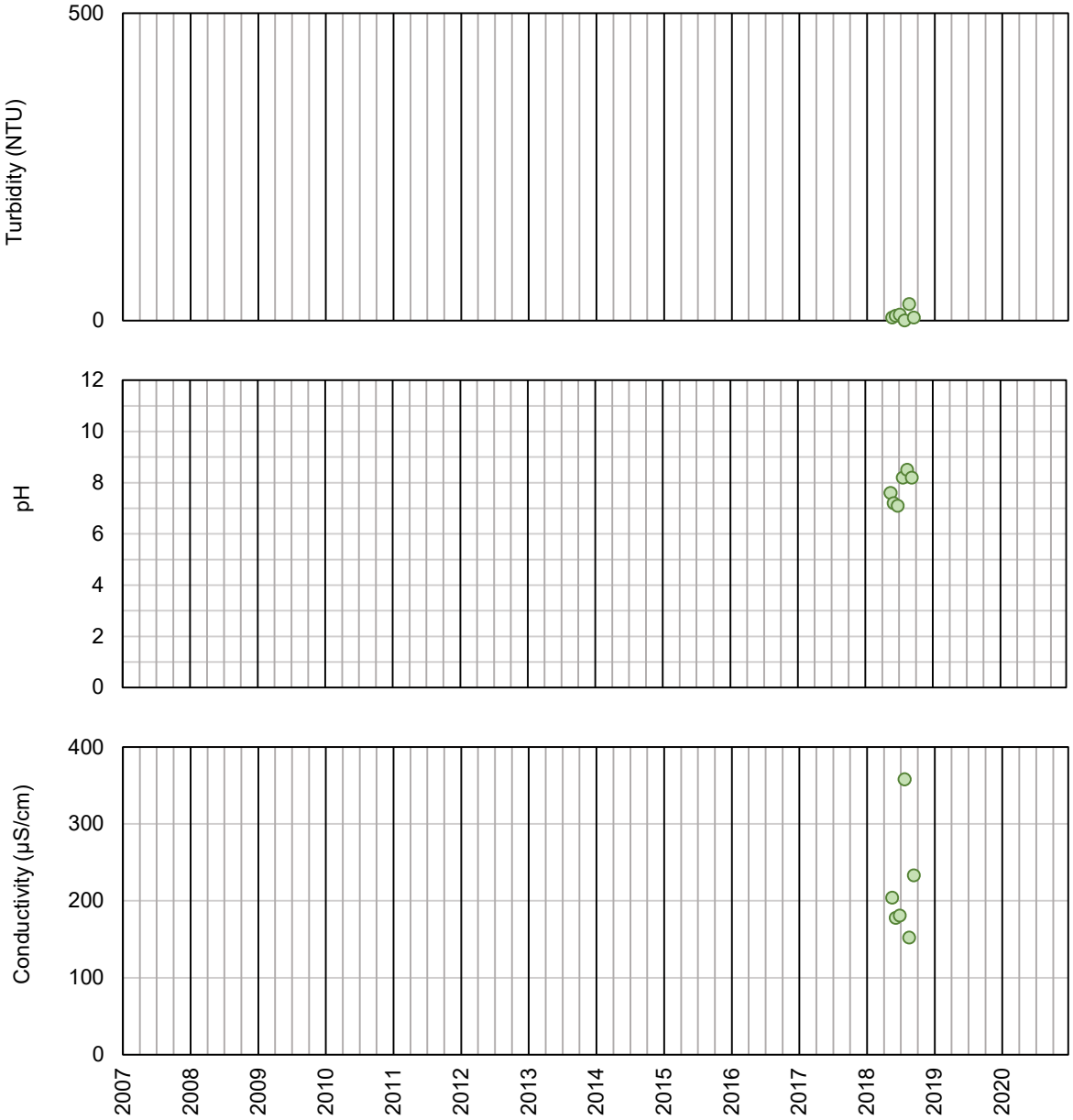


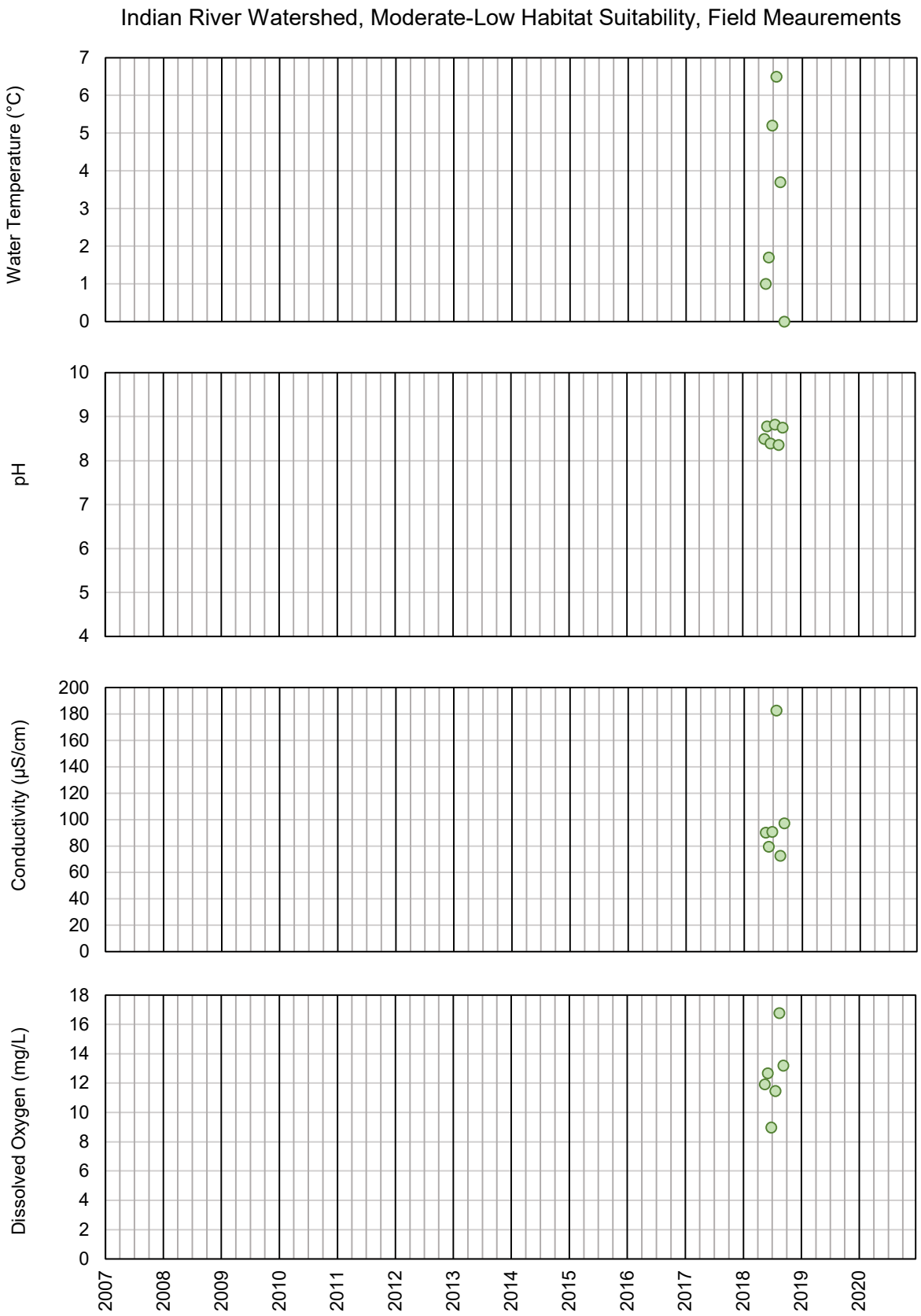
Indian River Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements

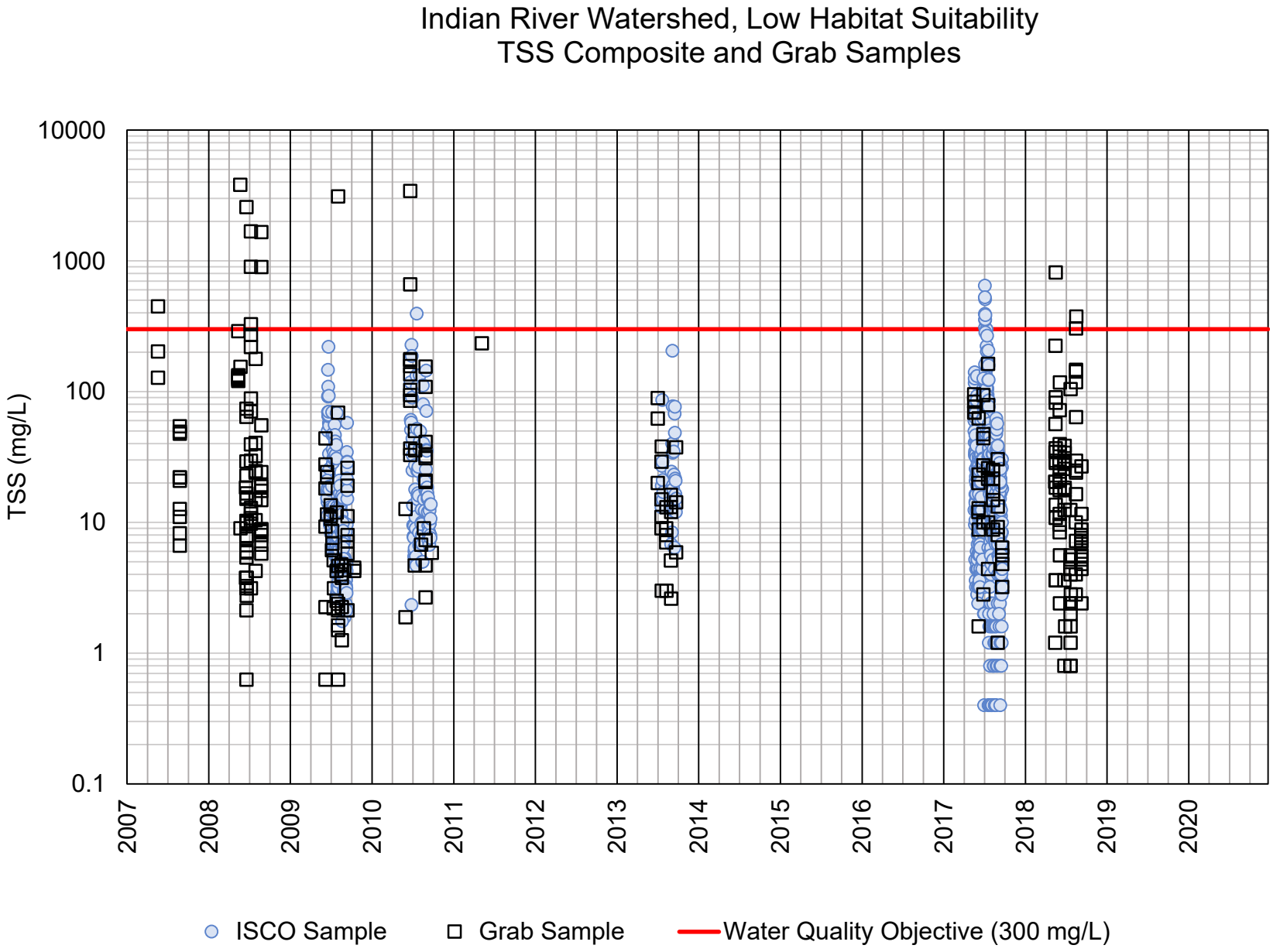



Indian River Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

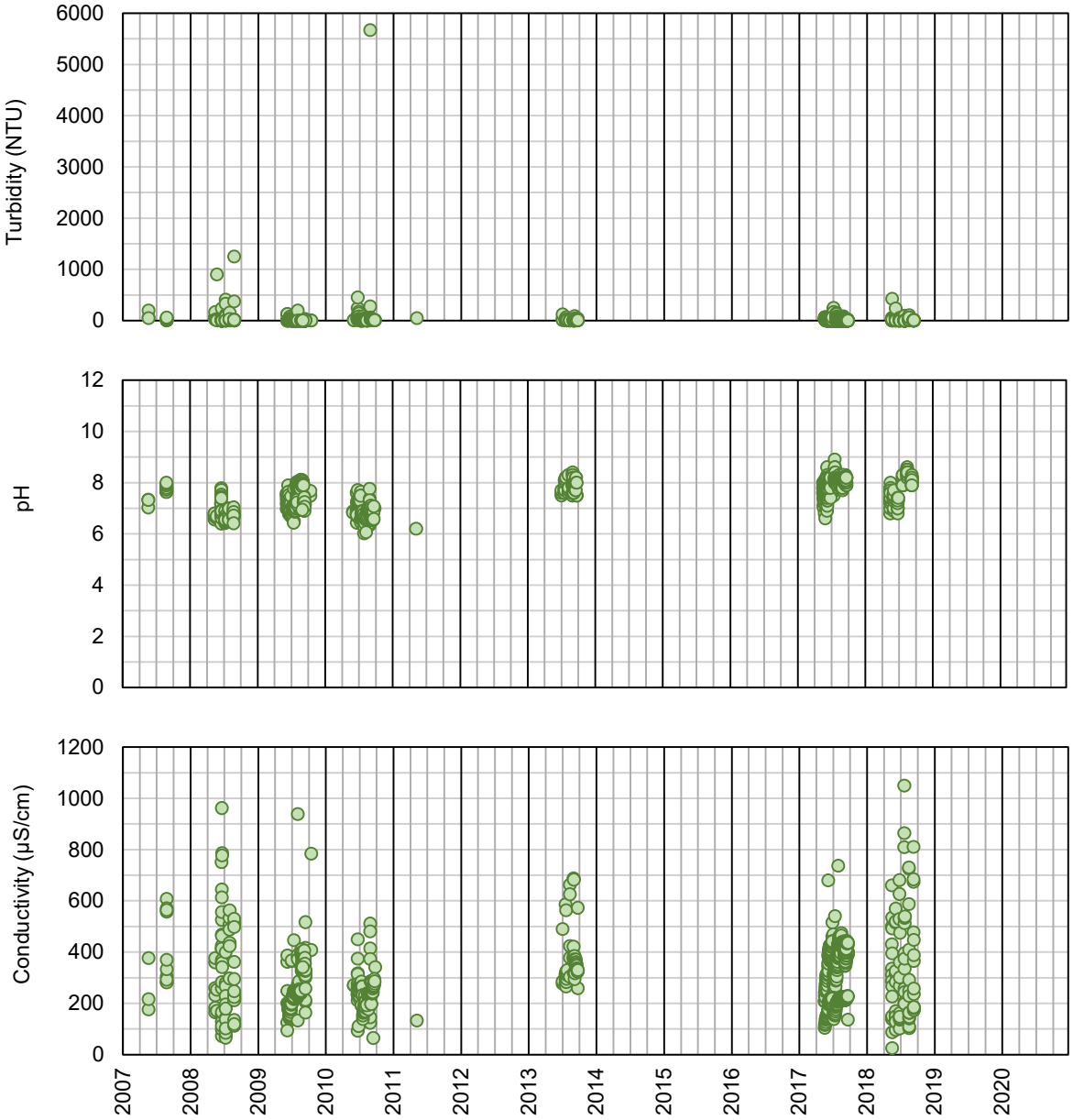
Indian River Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters

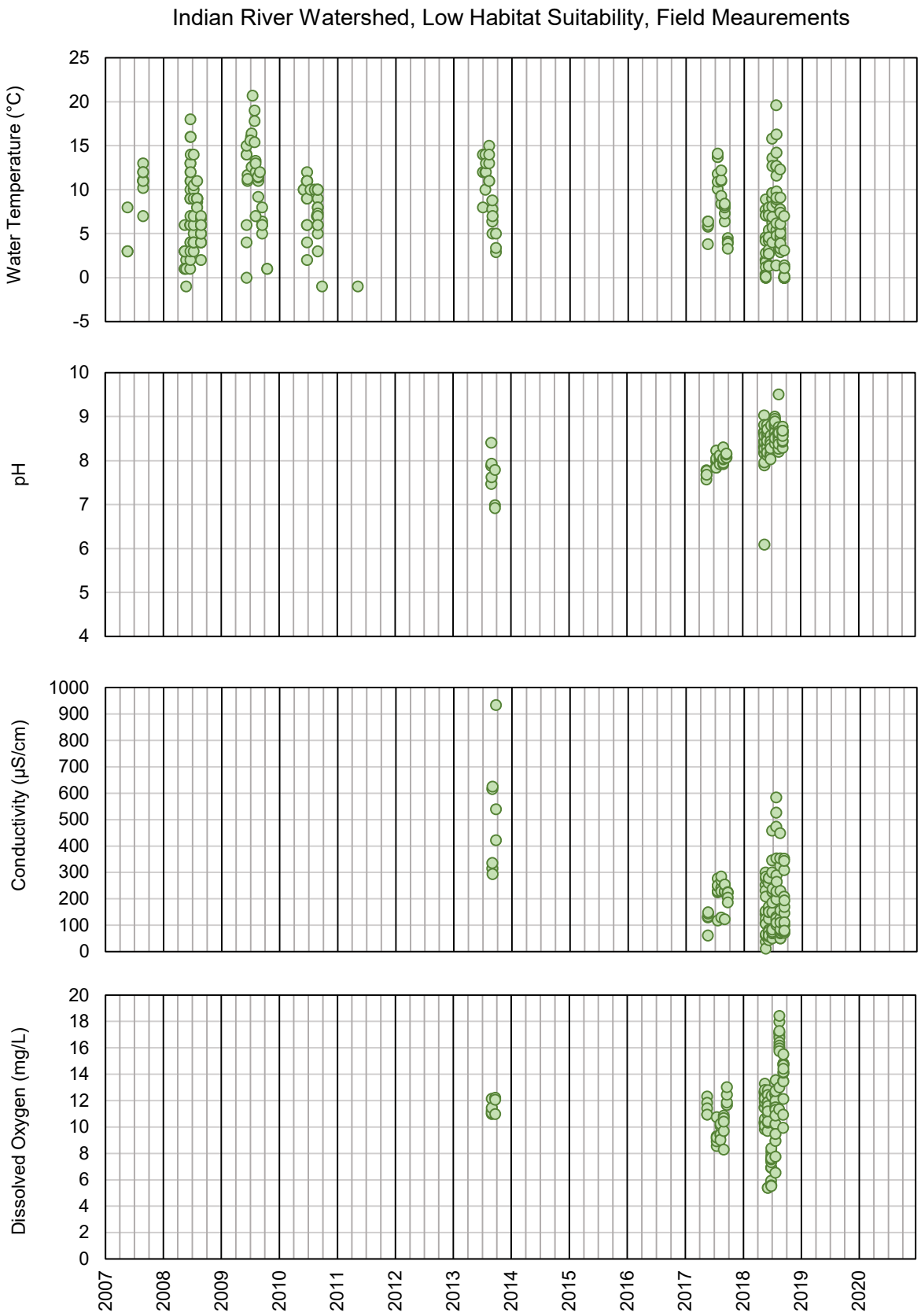


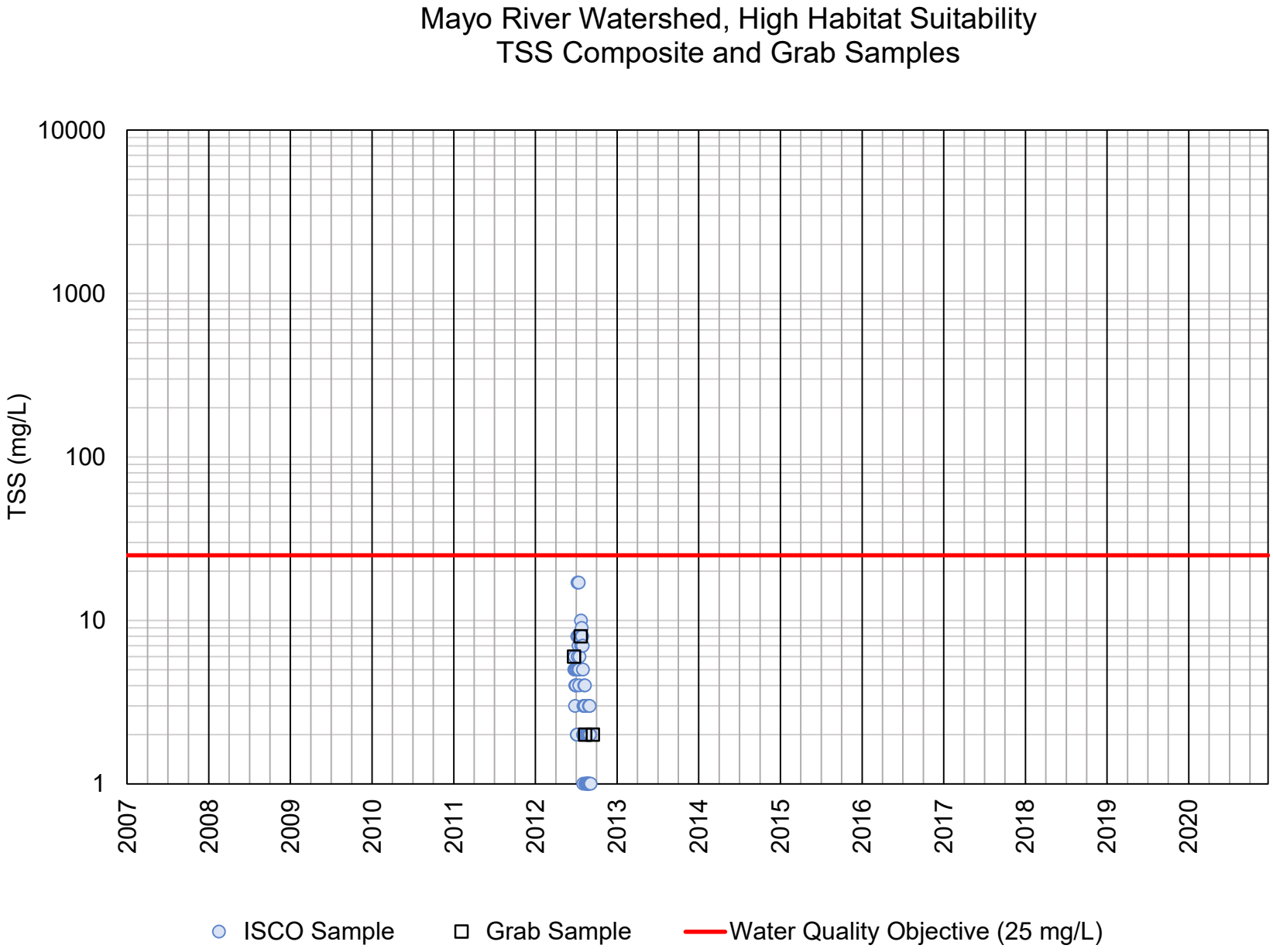

Indian River Watershed, Moderate-Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
0
1
2
3
4
5
6
7
pH
4
5
6
7
8
9
10
Conductivity (µS/cm)
0
20
40
60
80
100
120
140
160
180
200
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
16
18
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Indian River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (300 mg/L)

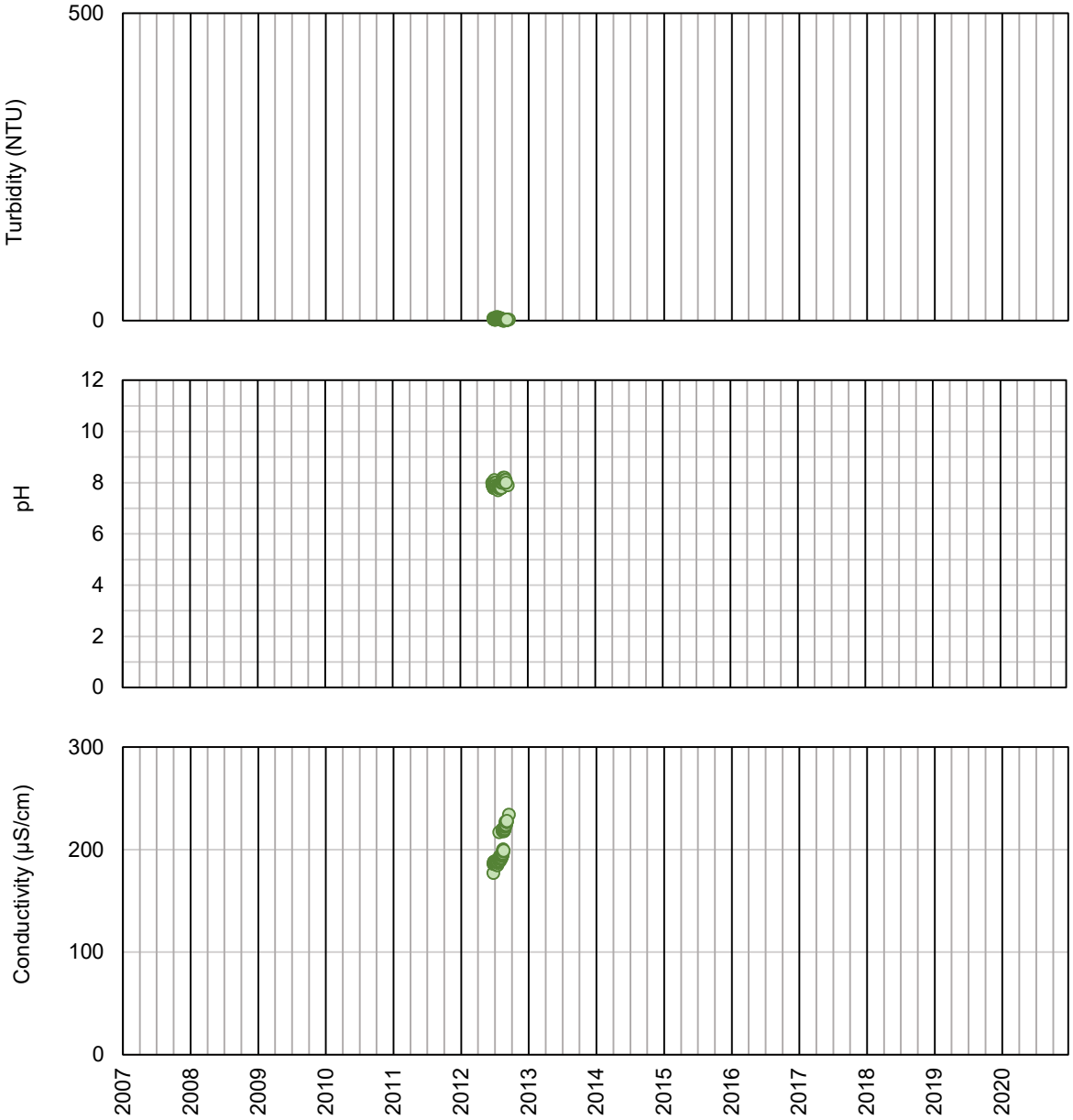
Indian River Watershed, Low Habitat Suitability, Laboratory Measured Parameters



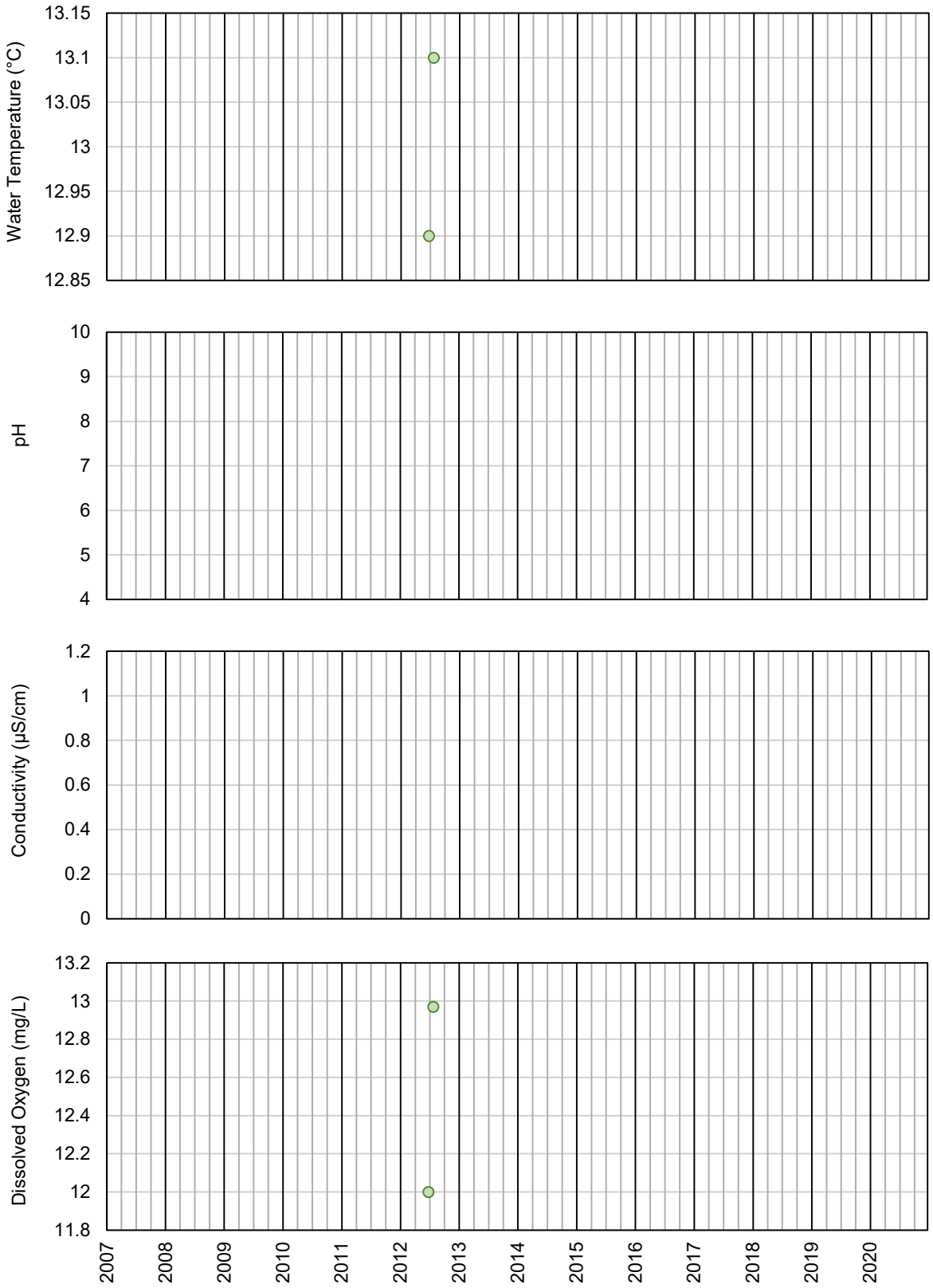

Indian River Watershed, Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
25
20
15
10
5
0
-5
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1000
900
800
700
600
500
400
300
200
100
0
Dissolved Oxygen (mg/L)
20
18
16
14
12
10
8
6
4
2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

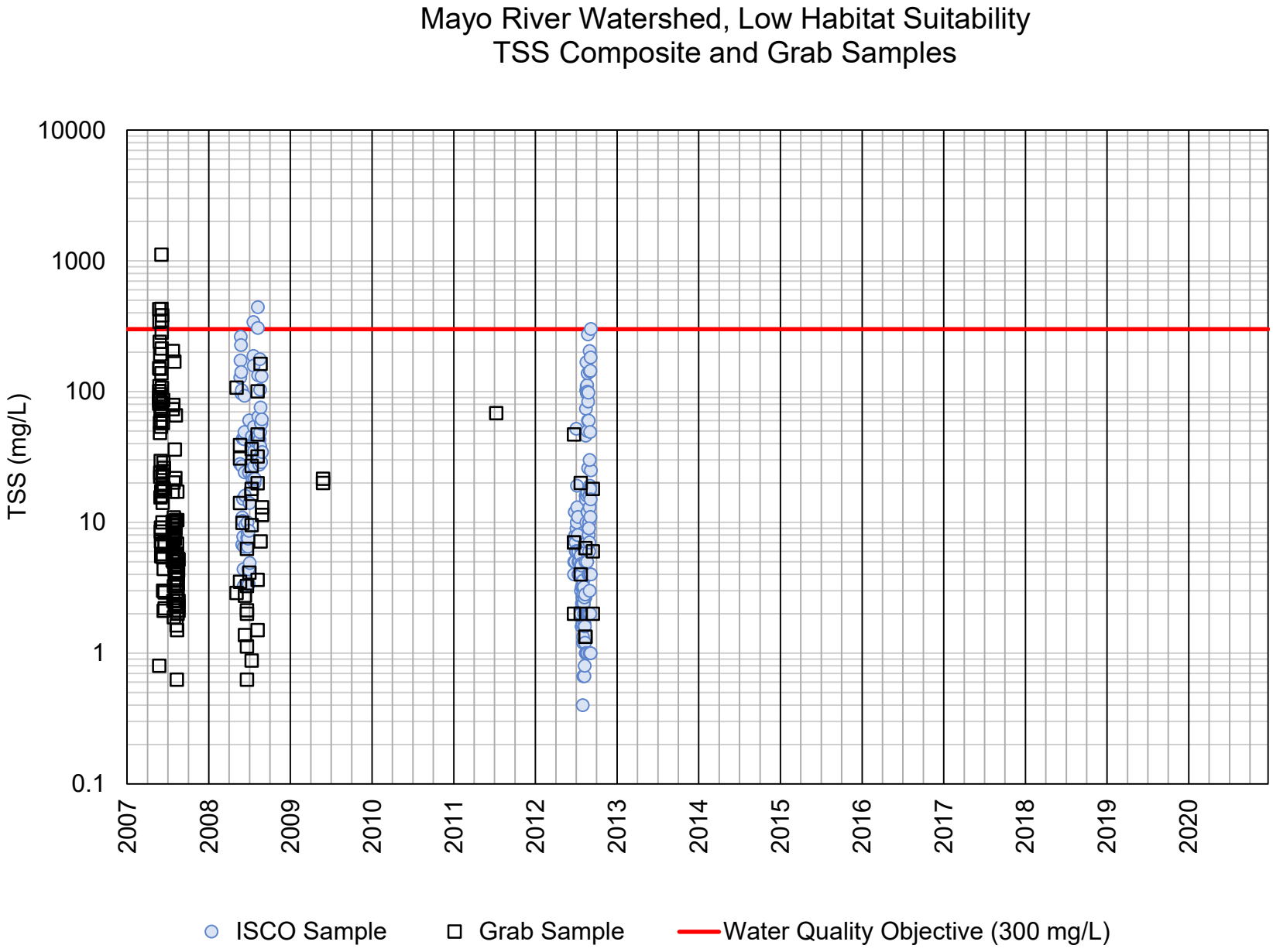

Mayo River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Mayo River Watershed, High Habitat Suitability, Laboratory Measured Parameters

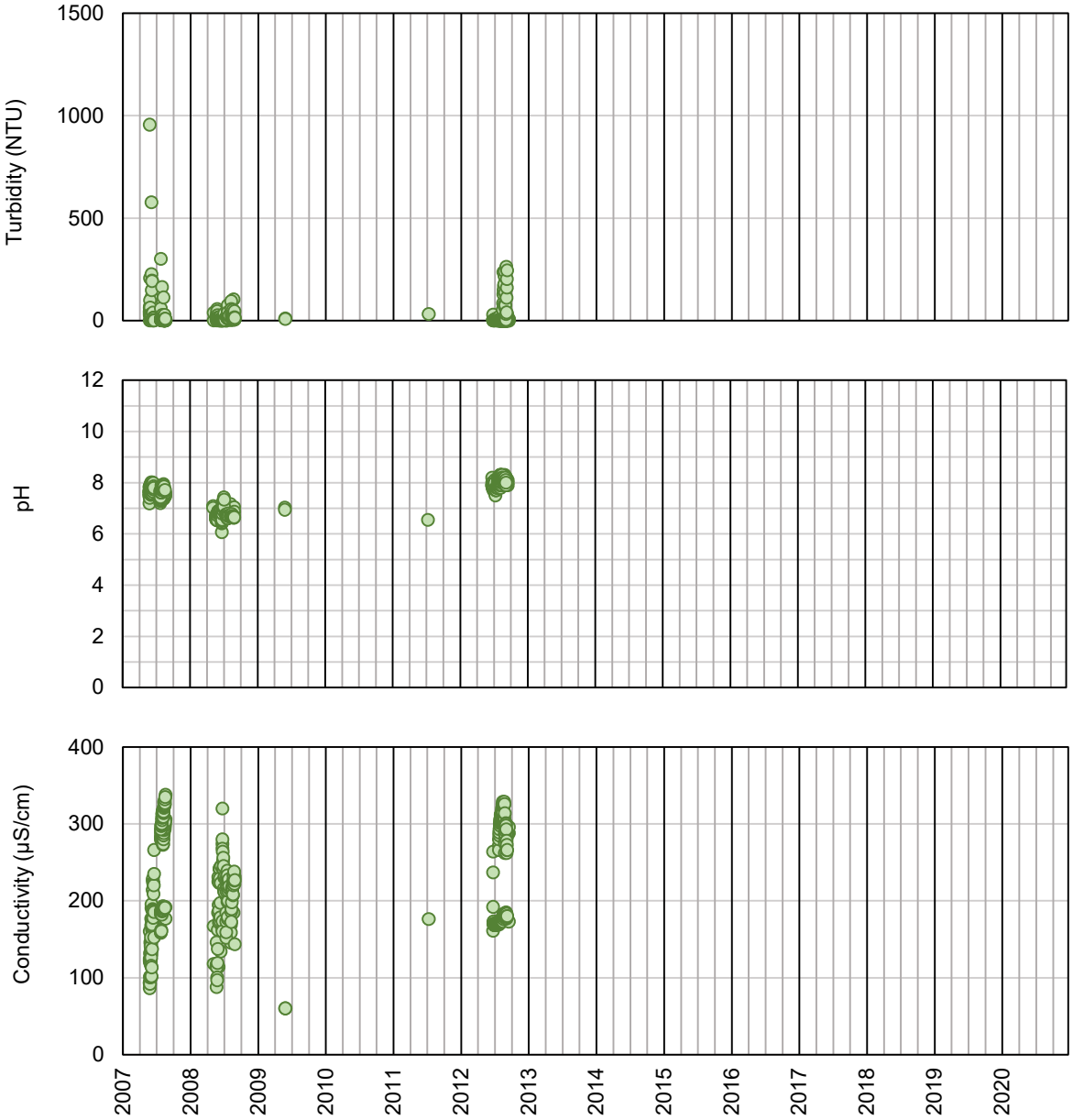


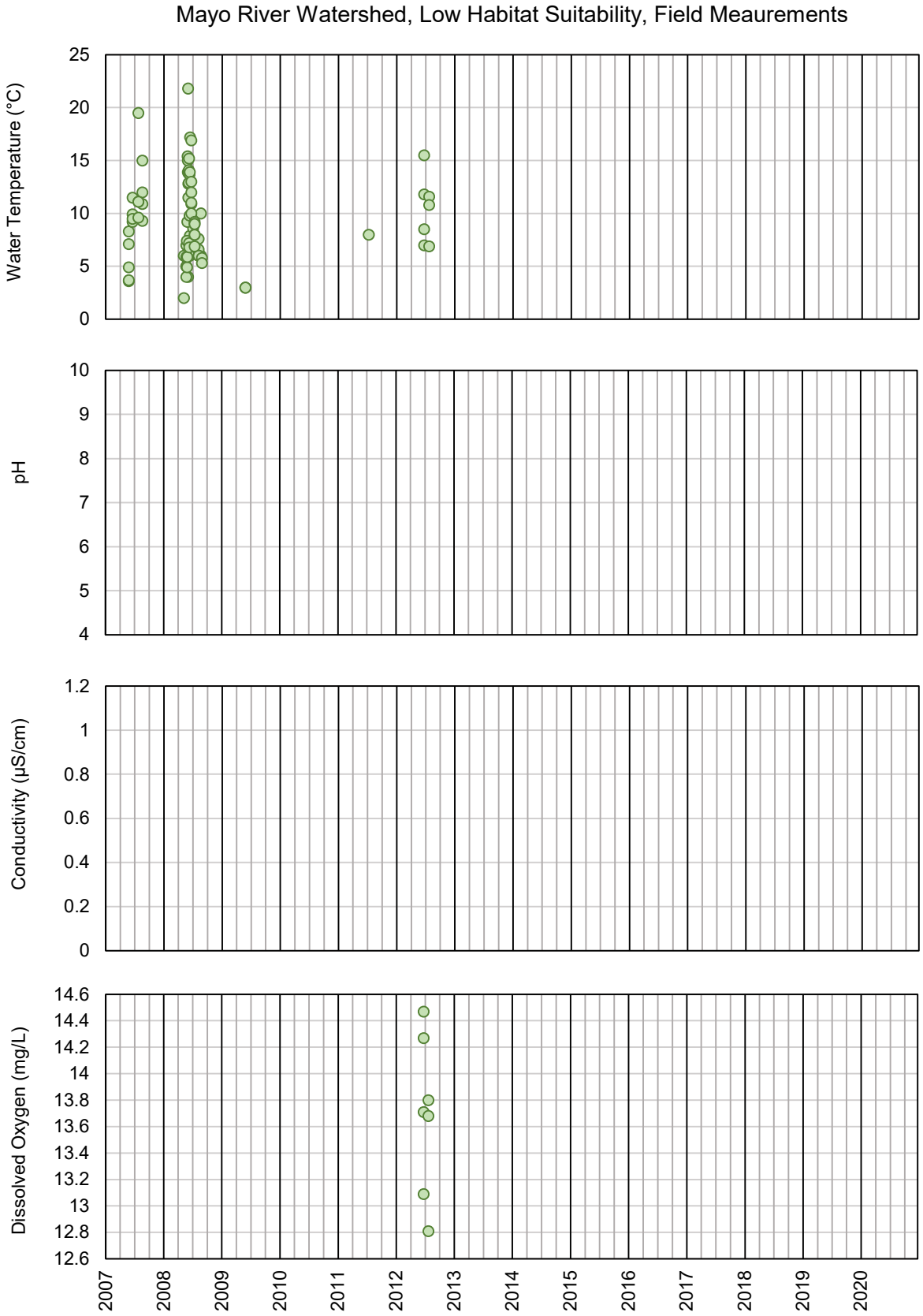
Mayo River Watershed, High Habitat Suitability, Field Meaurements



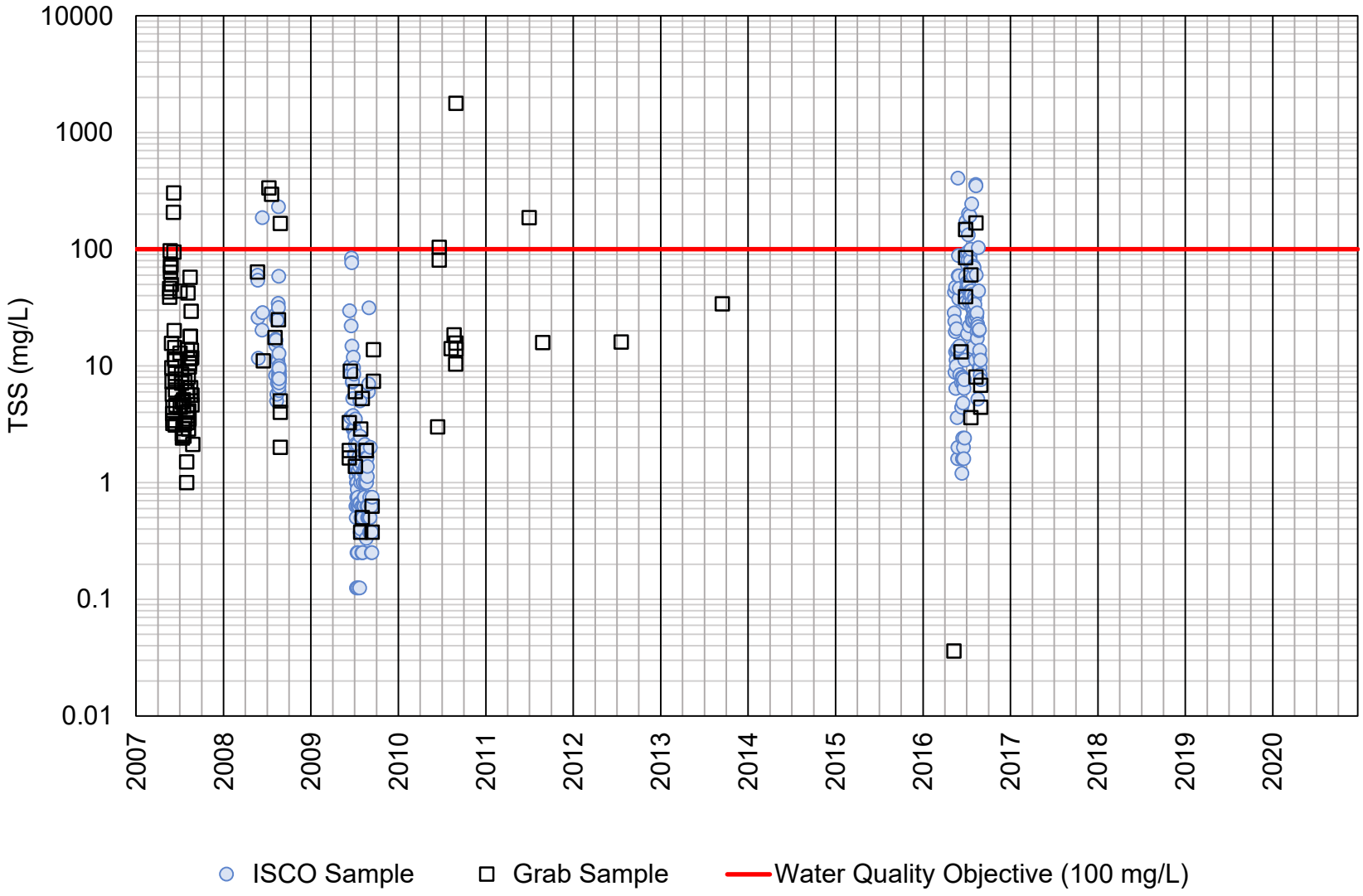

Mayo River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (300 mg/L)

Mayo River Watershed, Low Habitat Suitability, Laboratory Measured Parameters

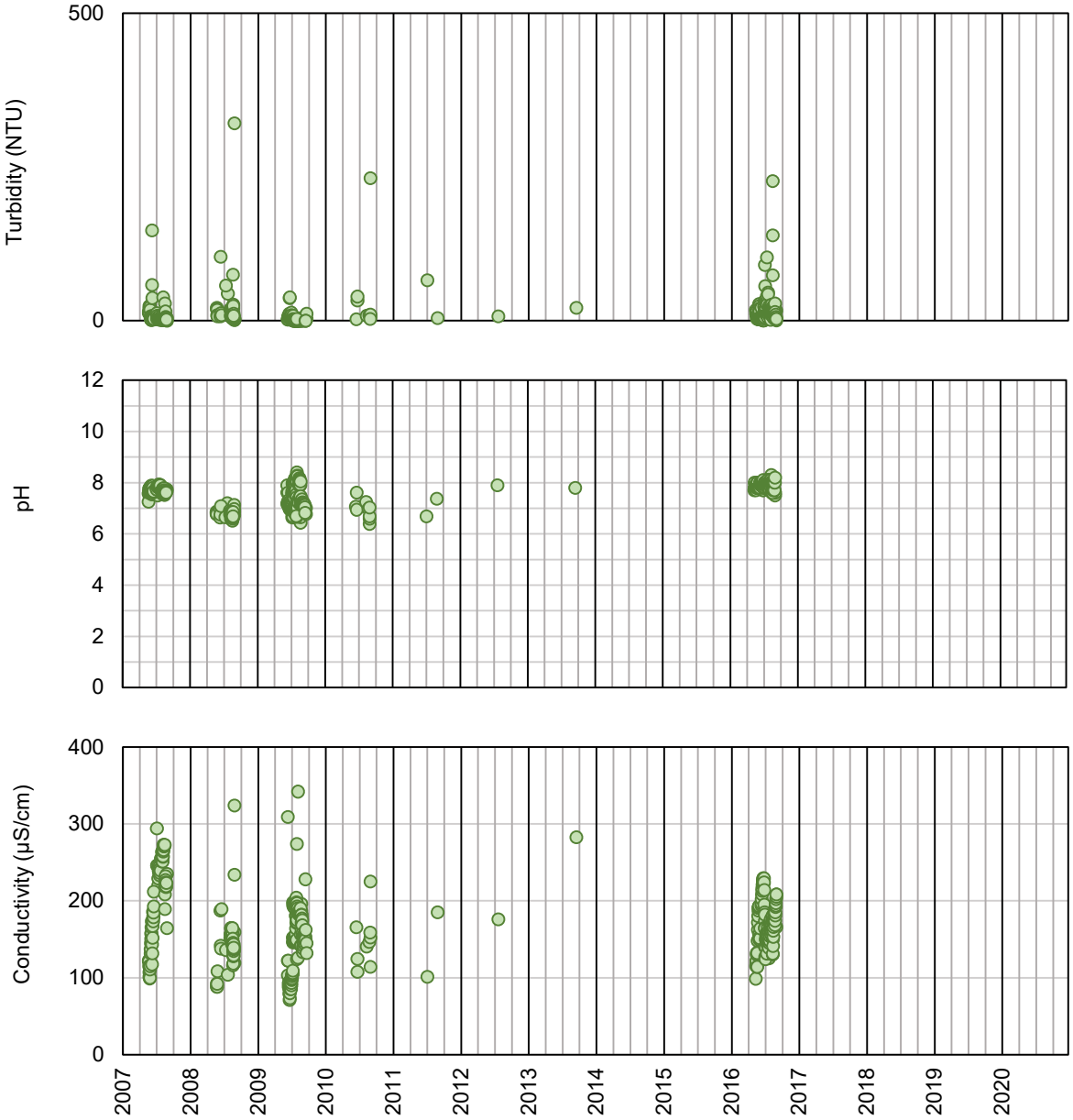



Mayo River Watershed, Low Habitat Suitability, Field Meaurements
Water Temperature (°C)
25
20
15
10
5
0
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
Dissolved Oxygen (mg/L)
14.6
14.4
14.2
14
13.8
13.6
13.4
13.2
13
12.8
12.6
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

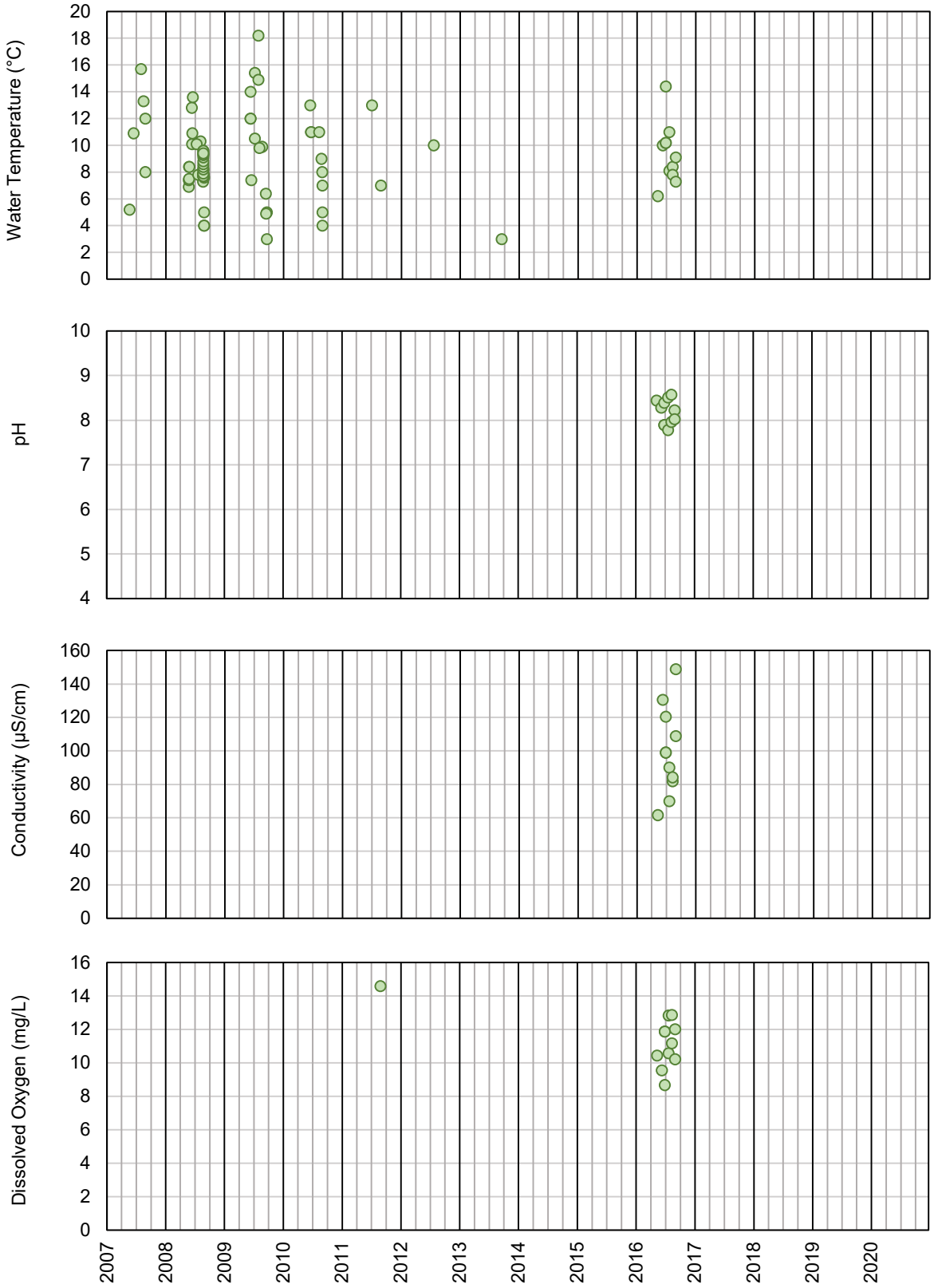
Sixty Mile River Watershed, Area of Special Consideration Habitat Suitability
TSS Composite and Grab Samples



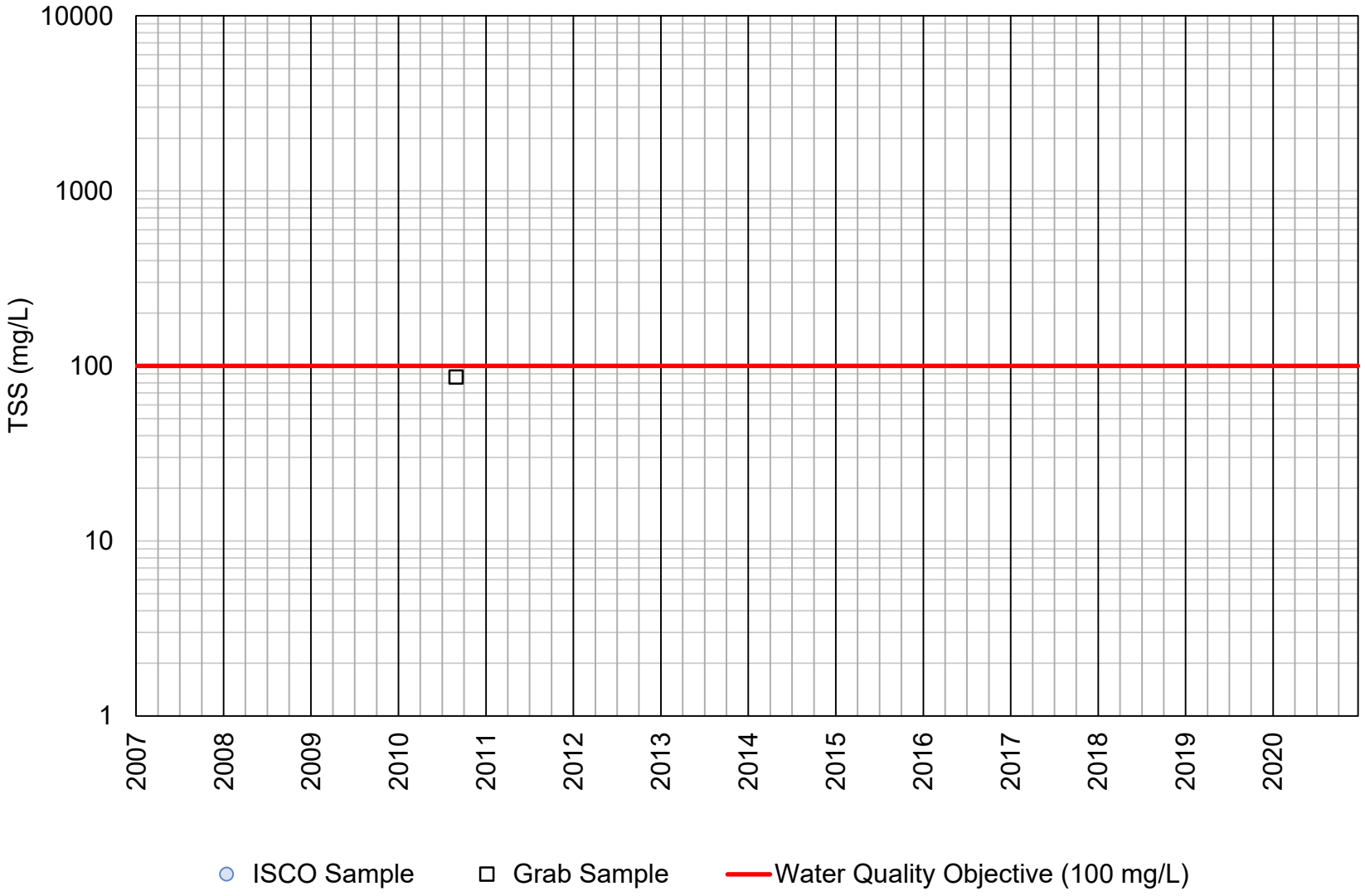
Sixty Mile River Watershed, Area of Special Consideration Habitat Suitability, Laboratory Measured Parameters



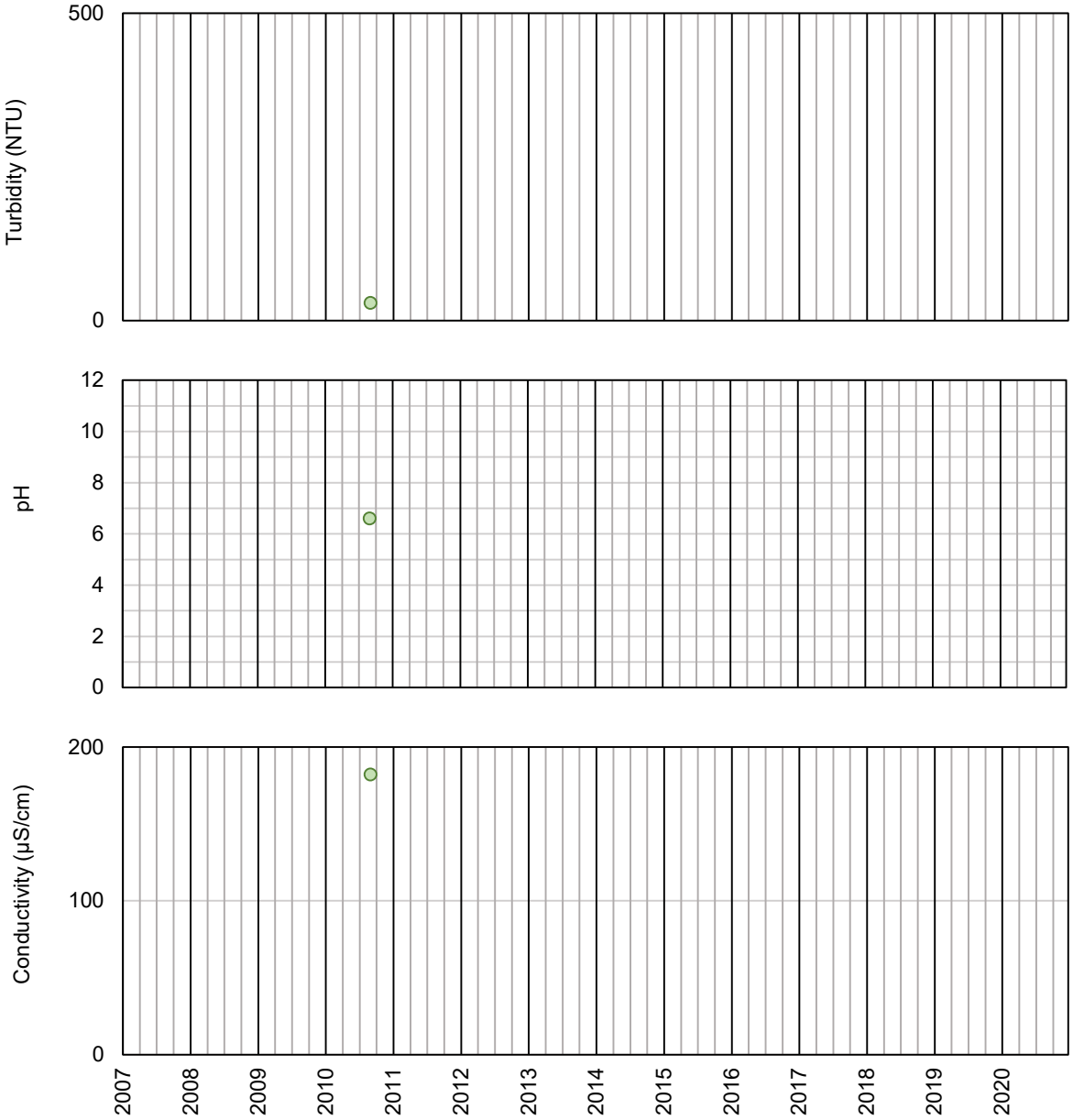
Sixty Mile River Watershed, Area of Special Consideration Habitat Suitability, Field Meaurements



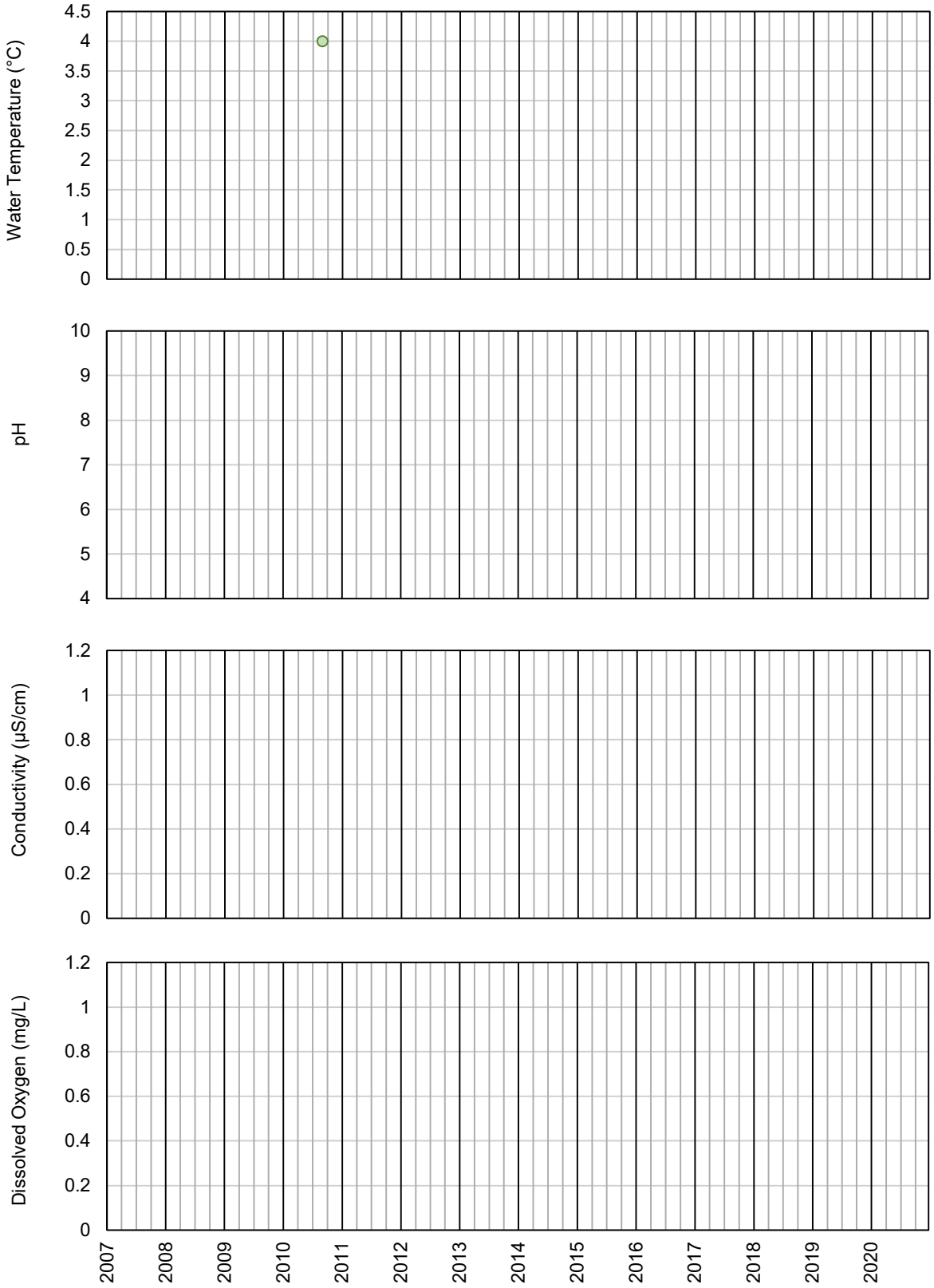
Sixty Mile River Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples

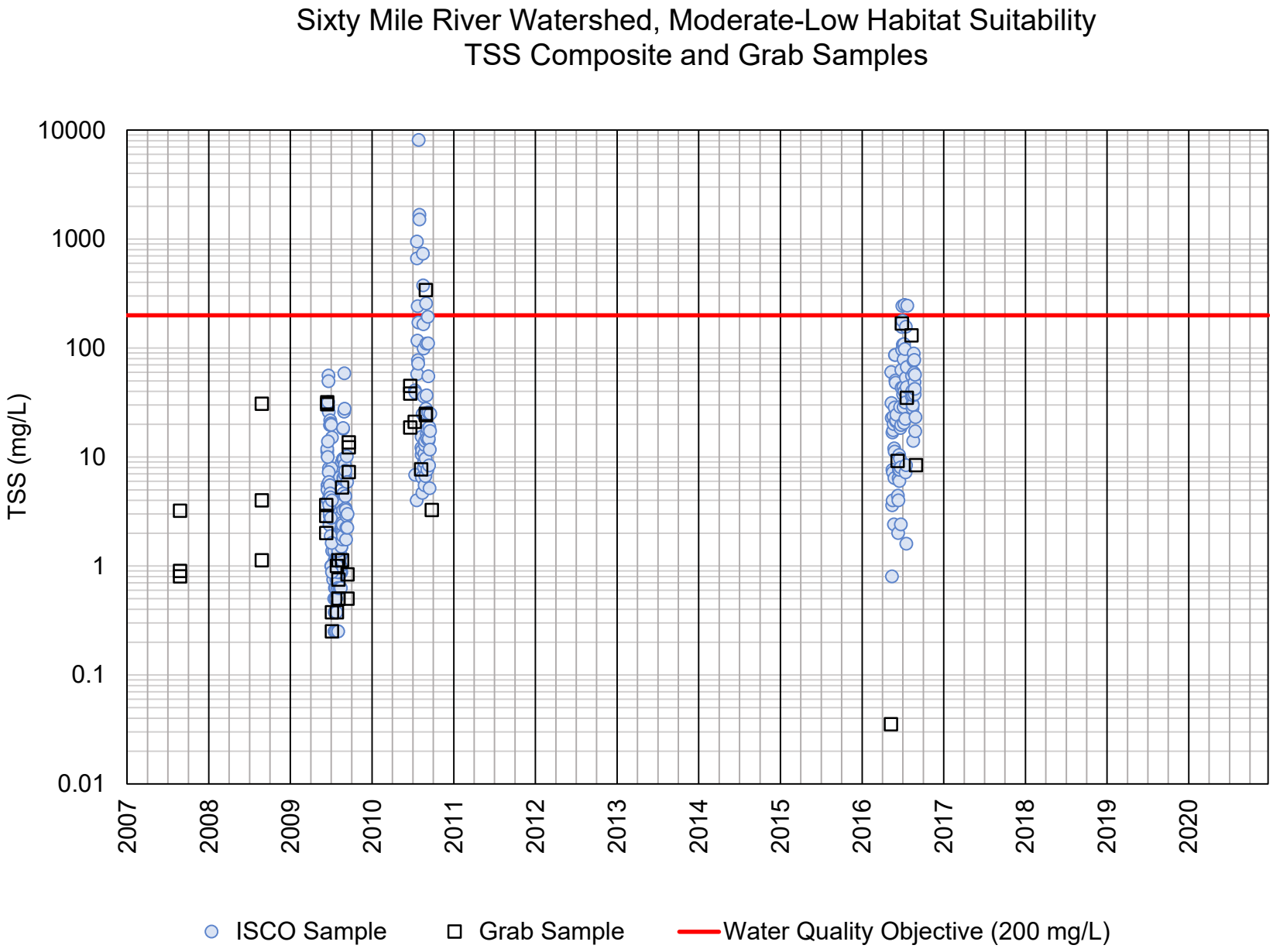


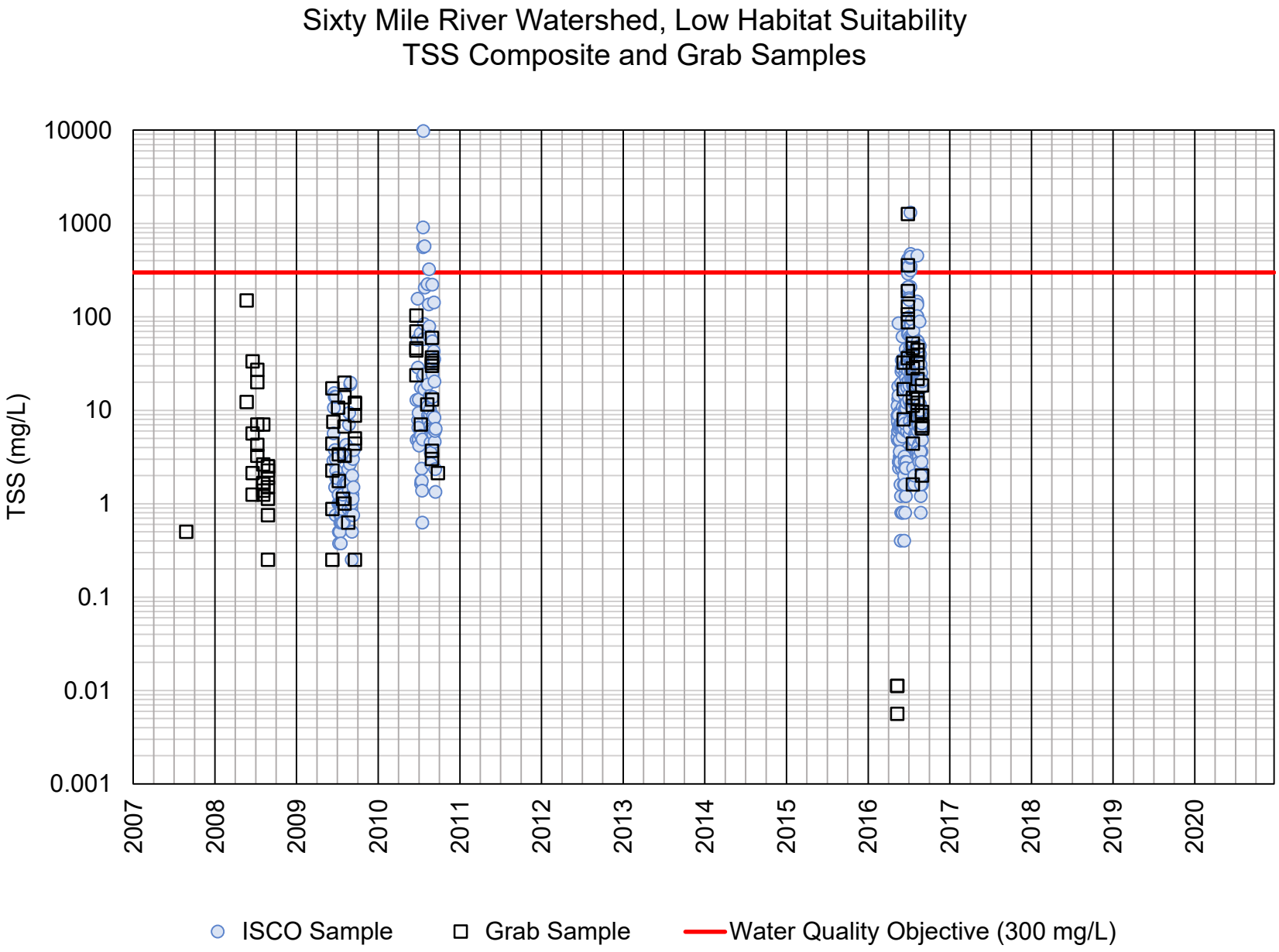
Sixty Mile River Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters



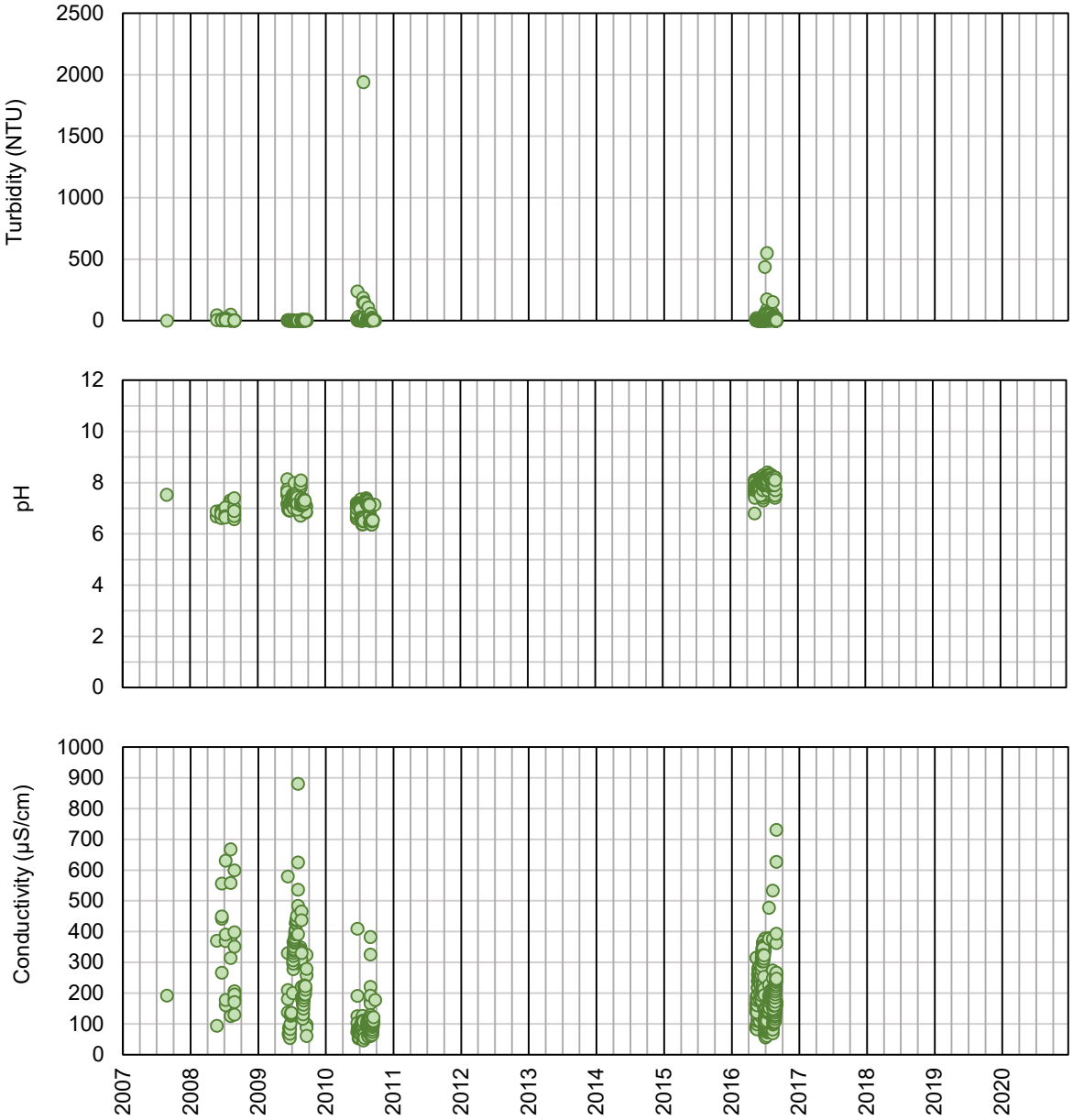
Sixty Mile River Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements



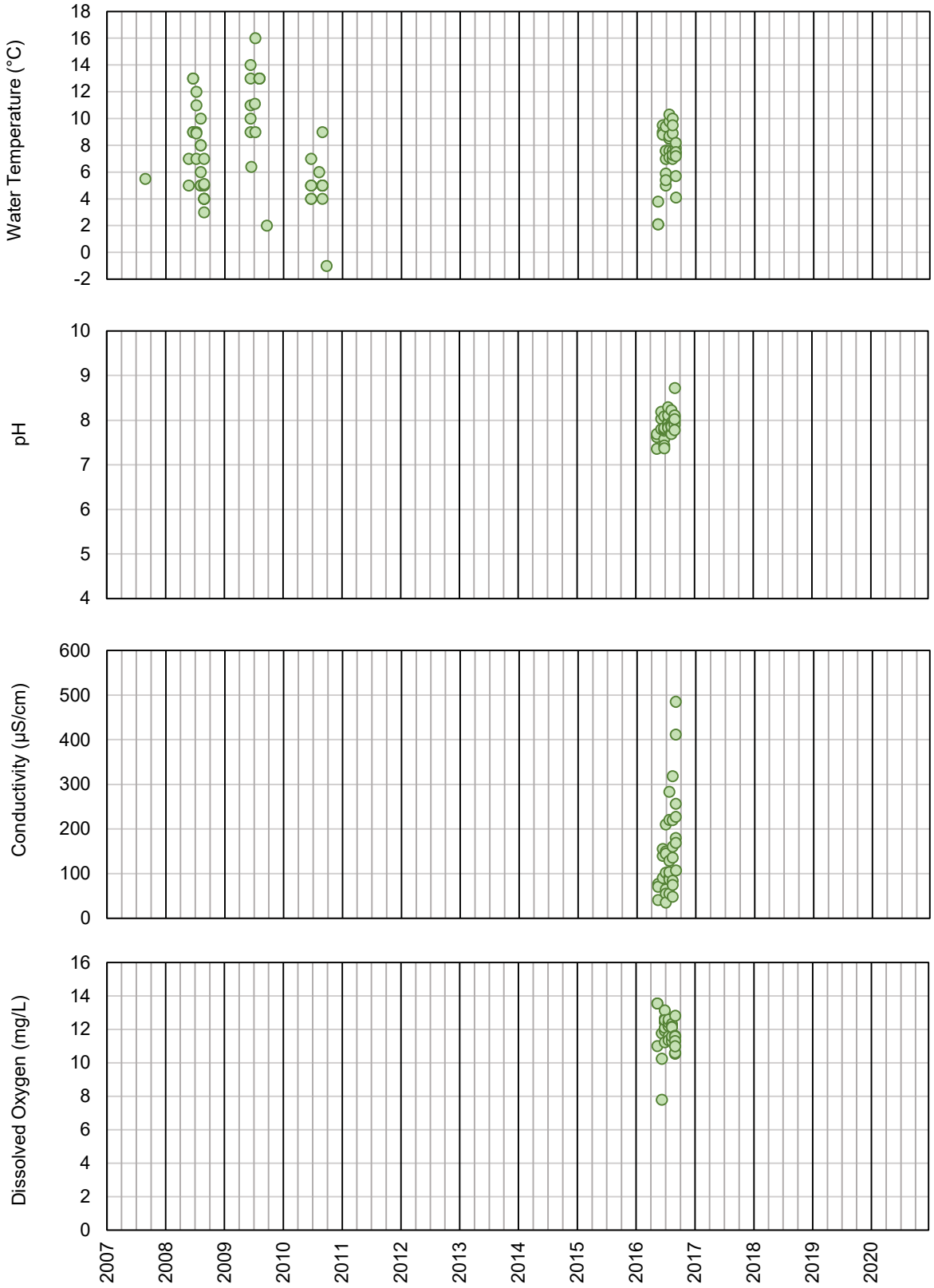

Sixty Mile River Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
0.01
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

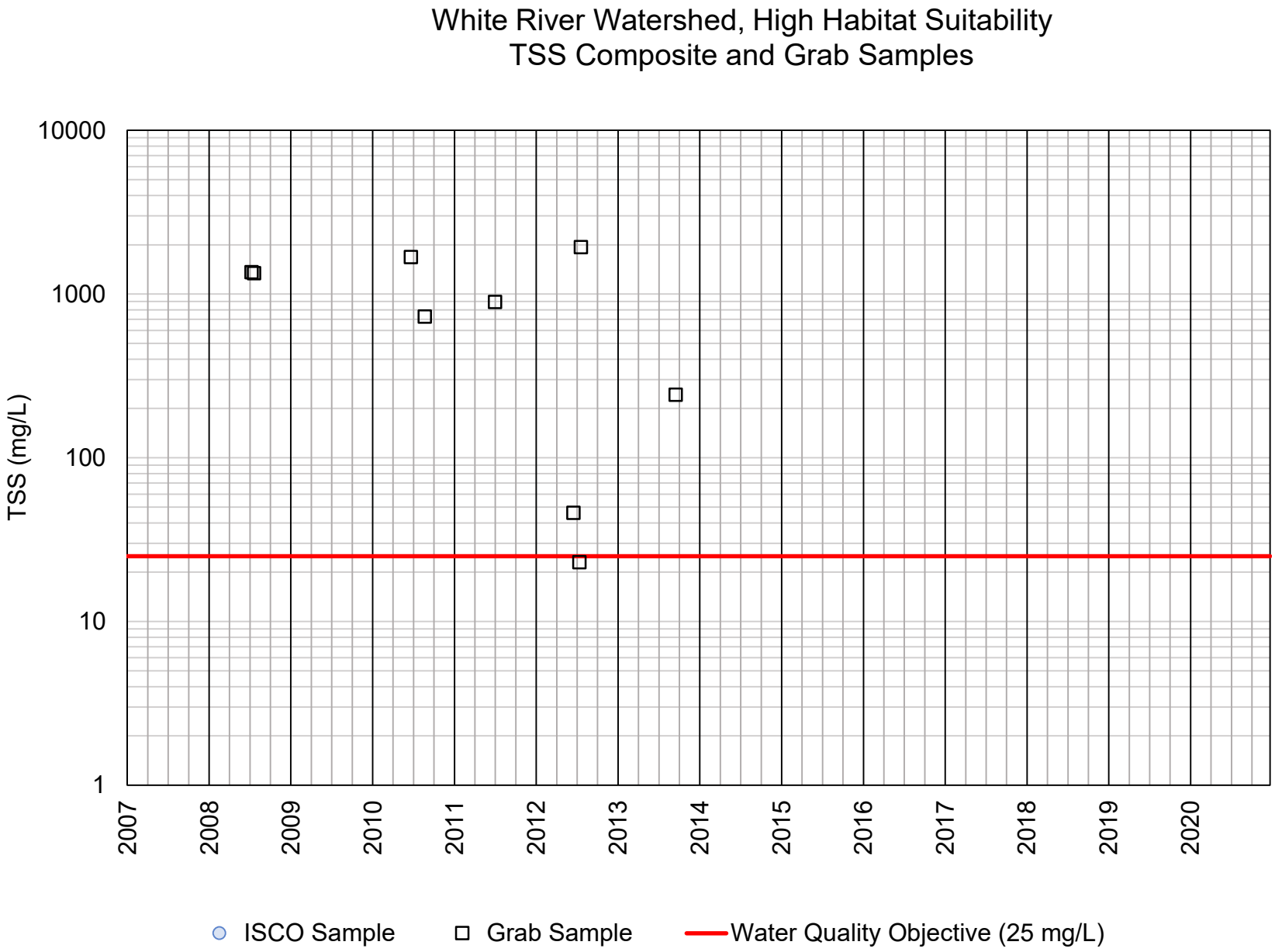

Sixty Mile River Watershed, Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
0.01
0.001
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (300 mg/L)

Sixty Mile River Watershed, Low Habitat Suitability, Laboratory Measured Parameters

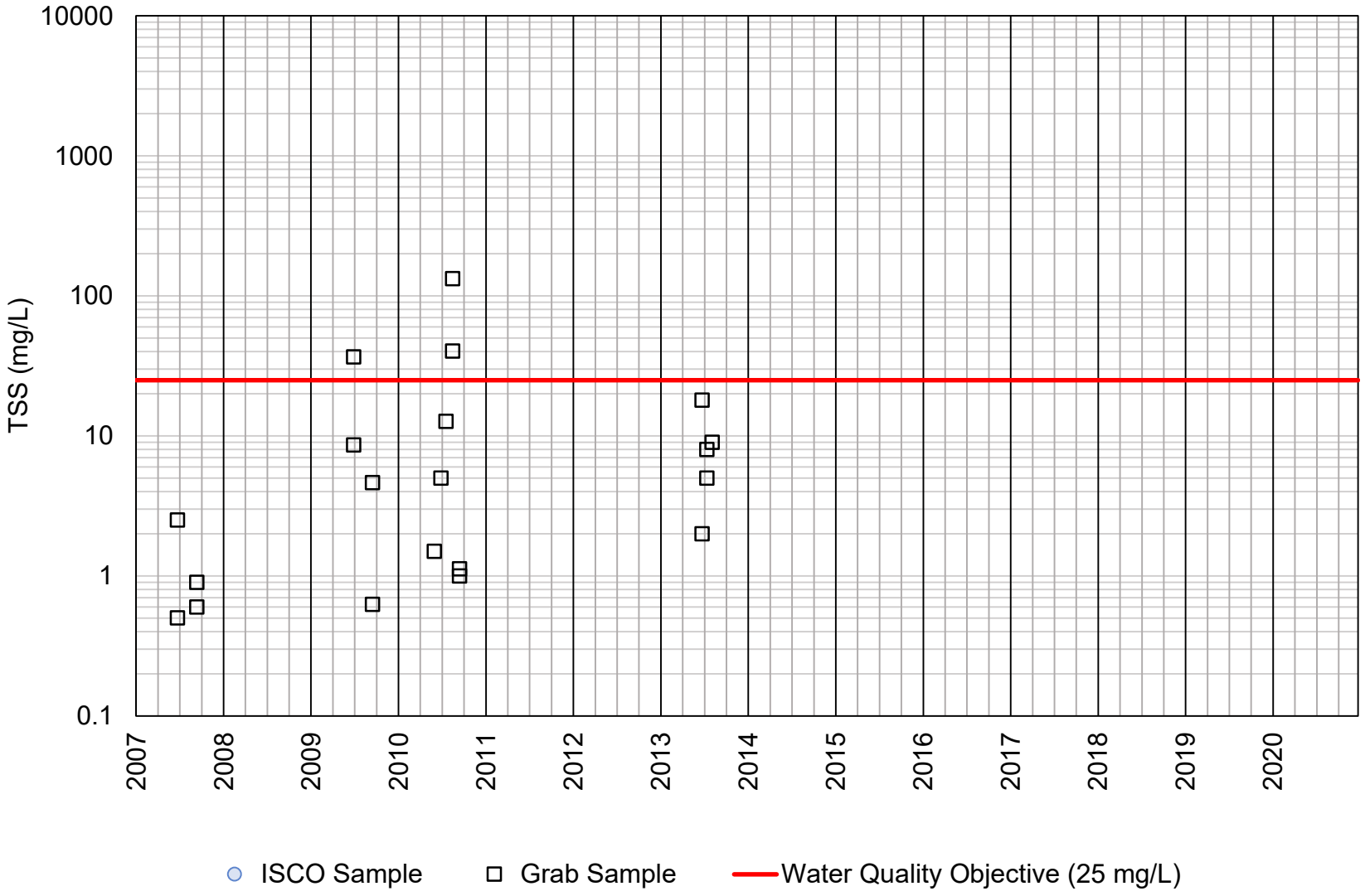


Sixty Mile River Watershed, Low Habitat Suitability, Field Meaurements

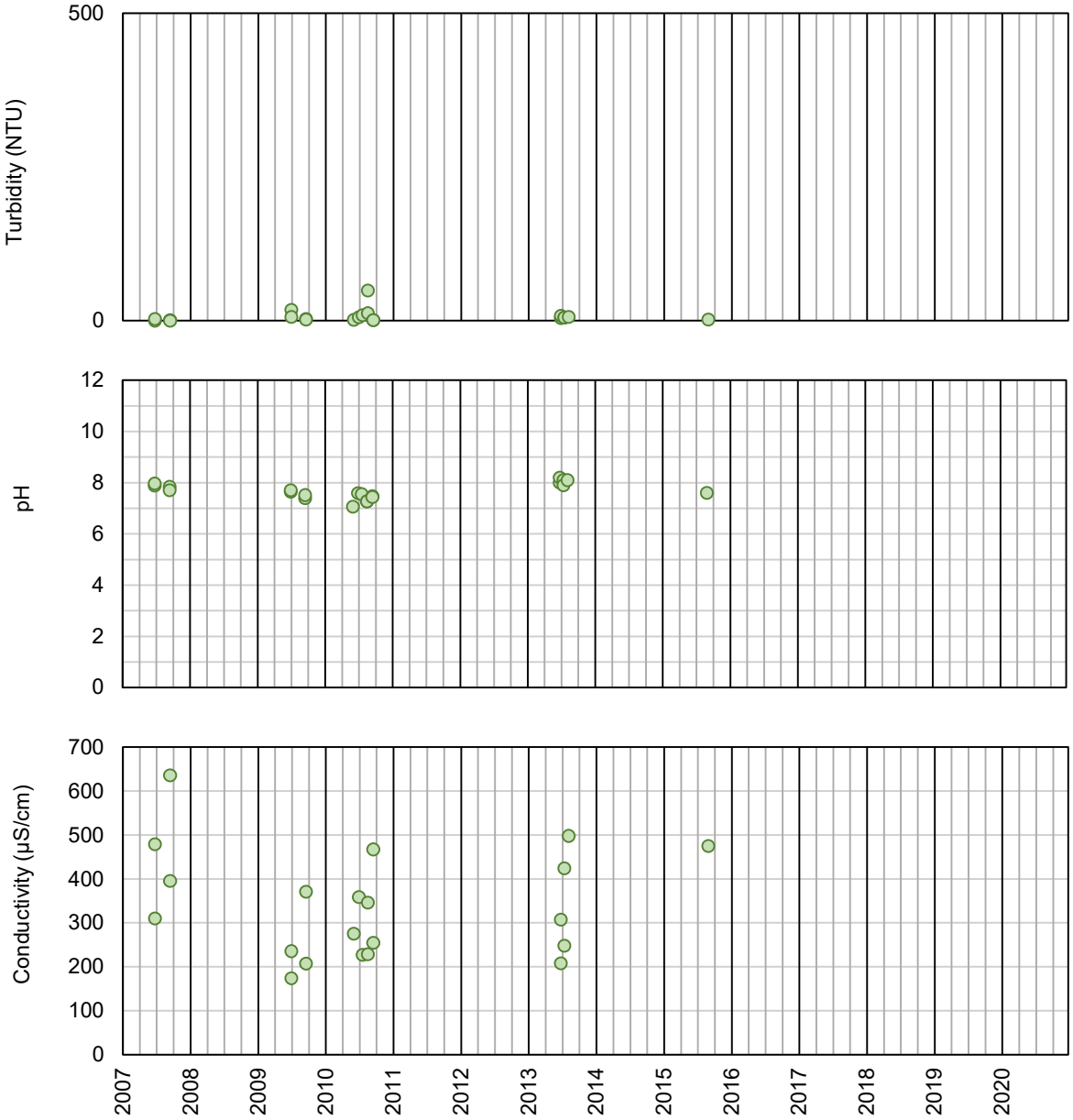



White River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

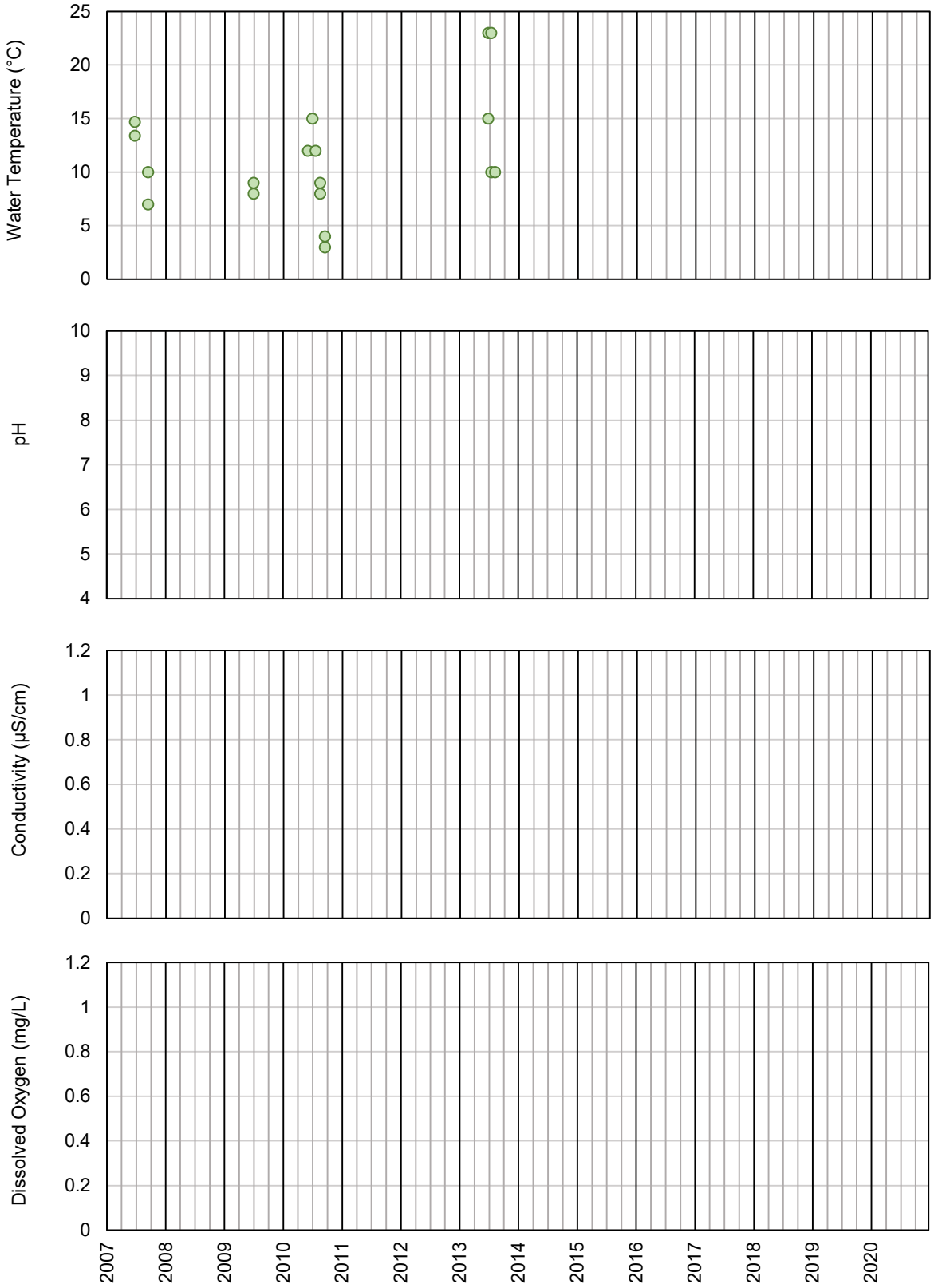
White River Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples

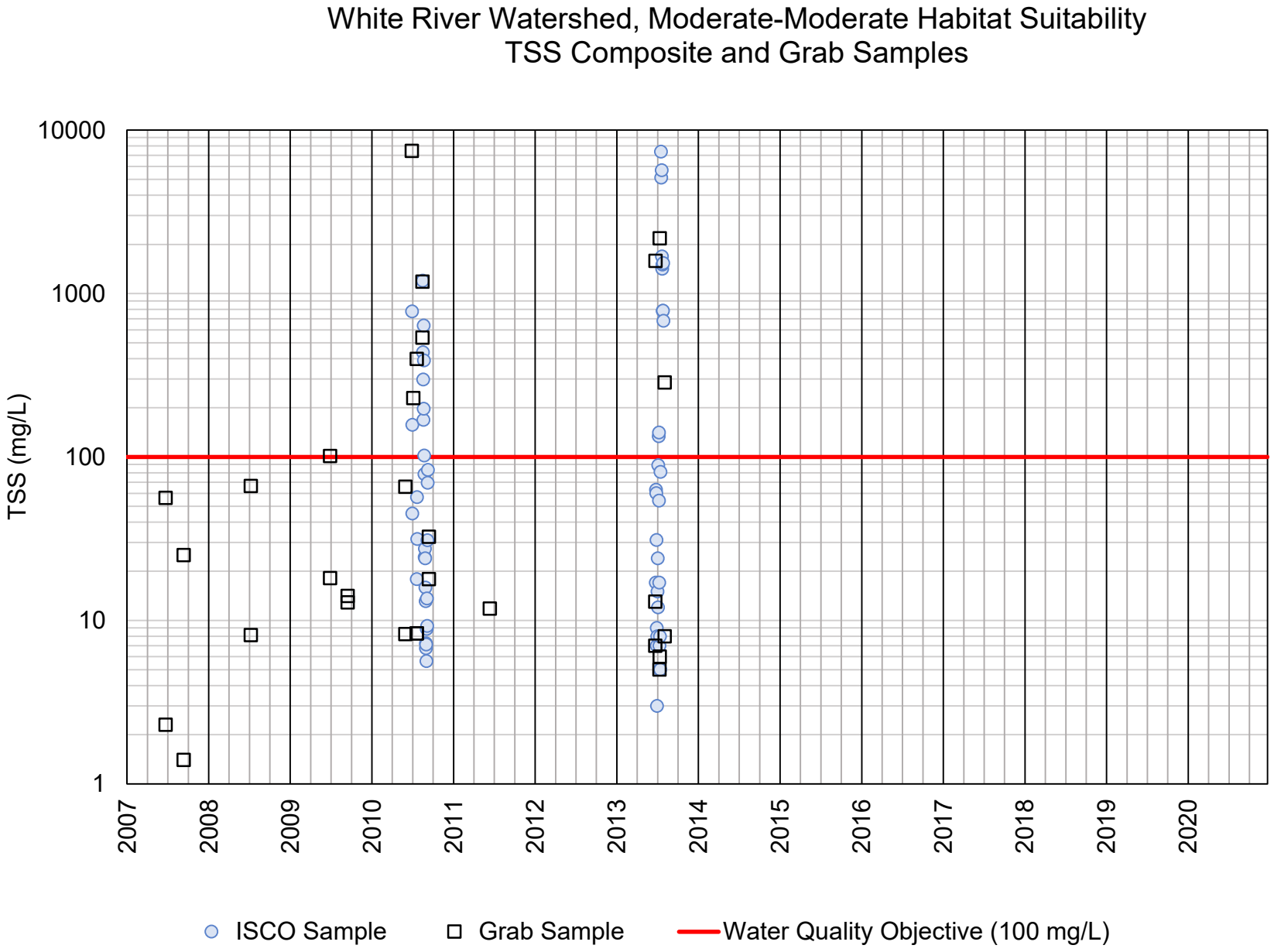


White River Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters

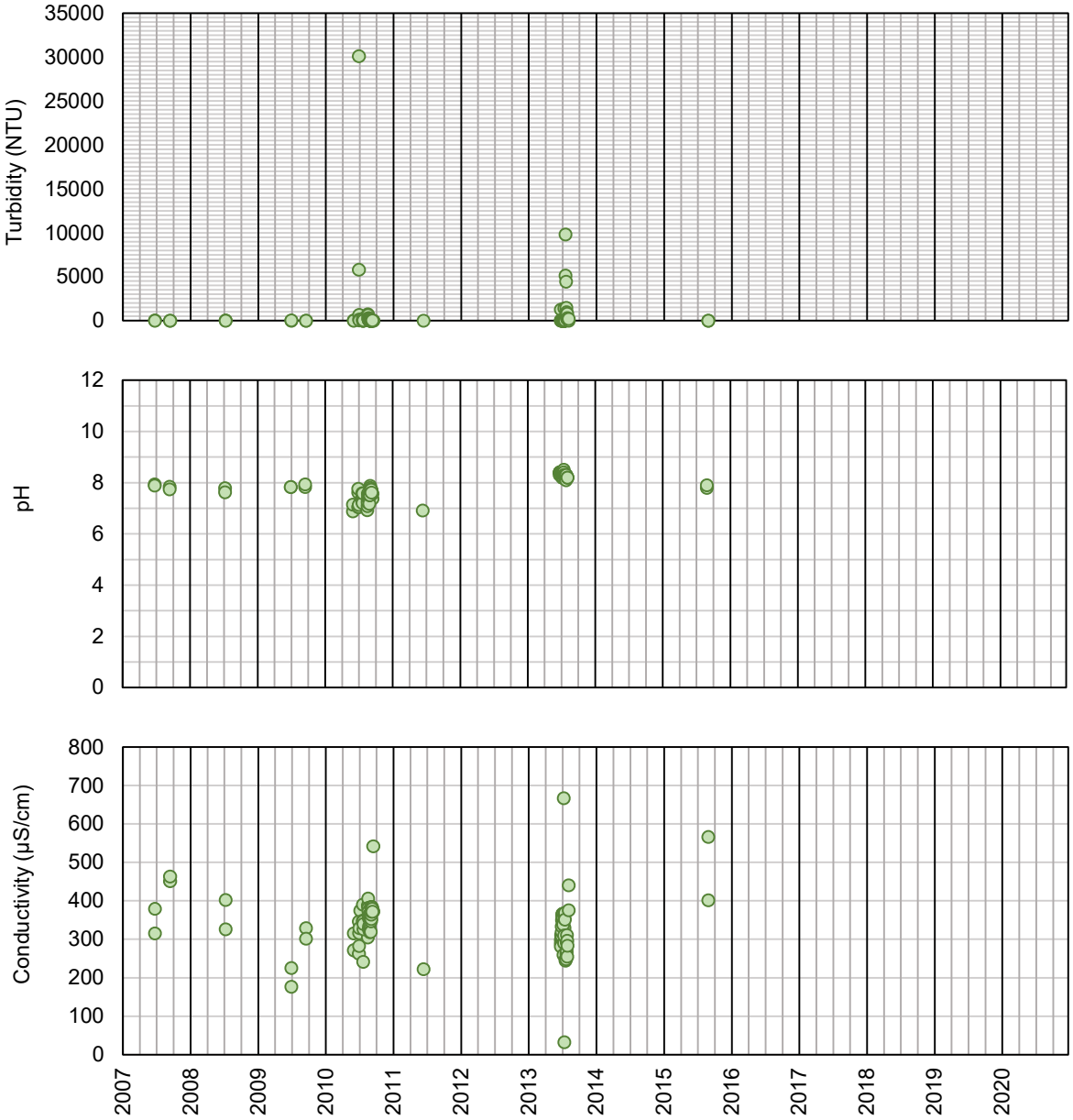


White River Watershed, Moderate-High Habitat Suitability, Field Meaurements

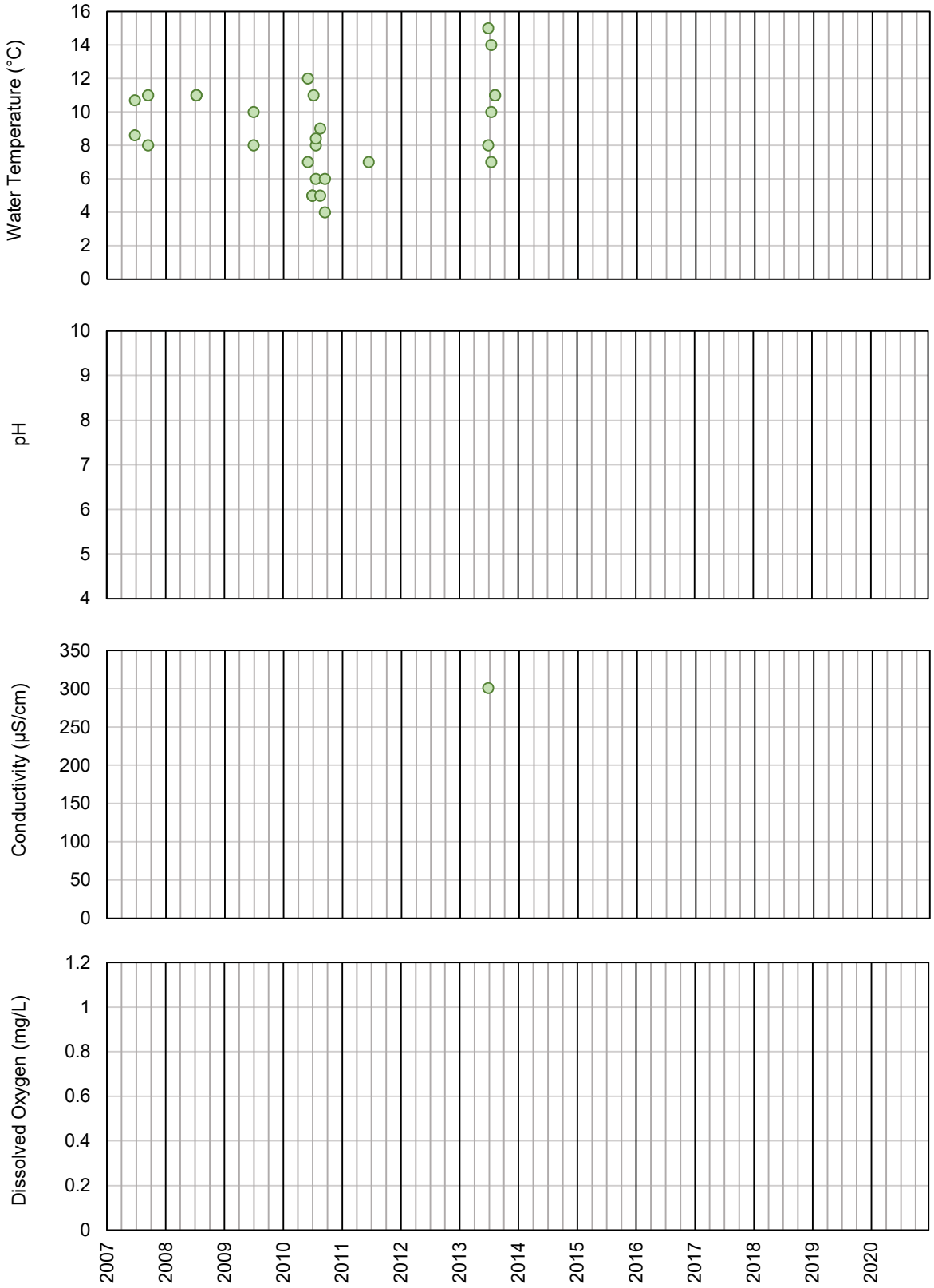


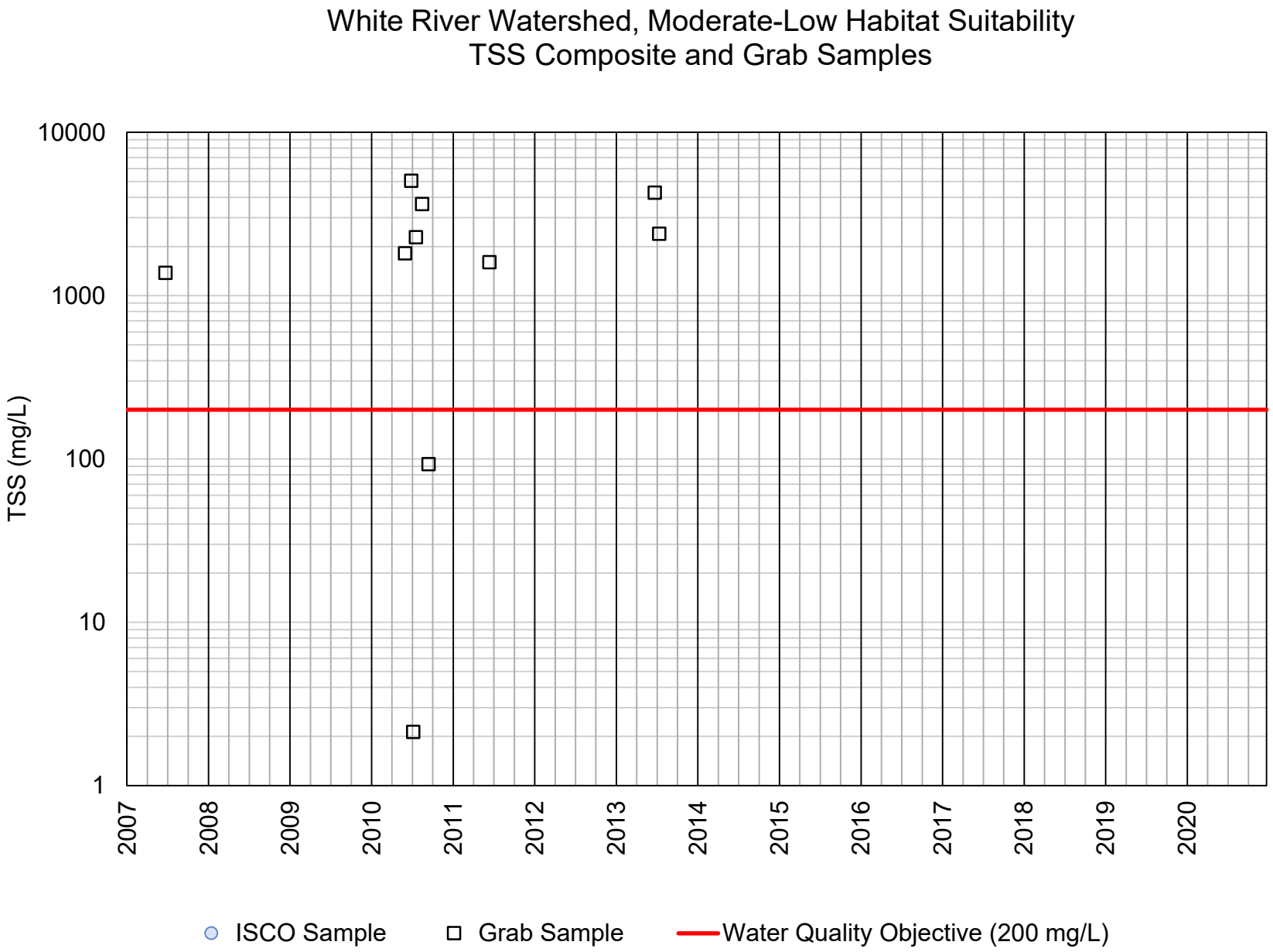

White River Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (100 mg/L)

White River Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters

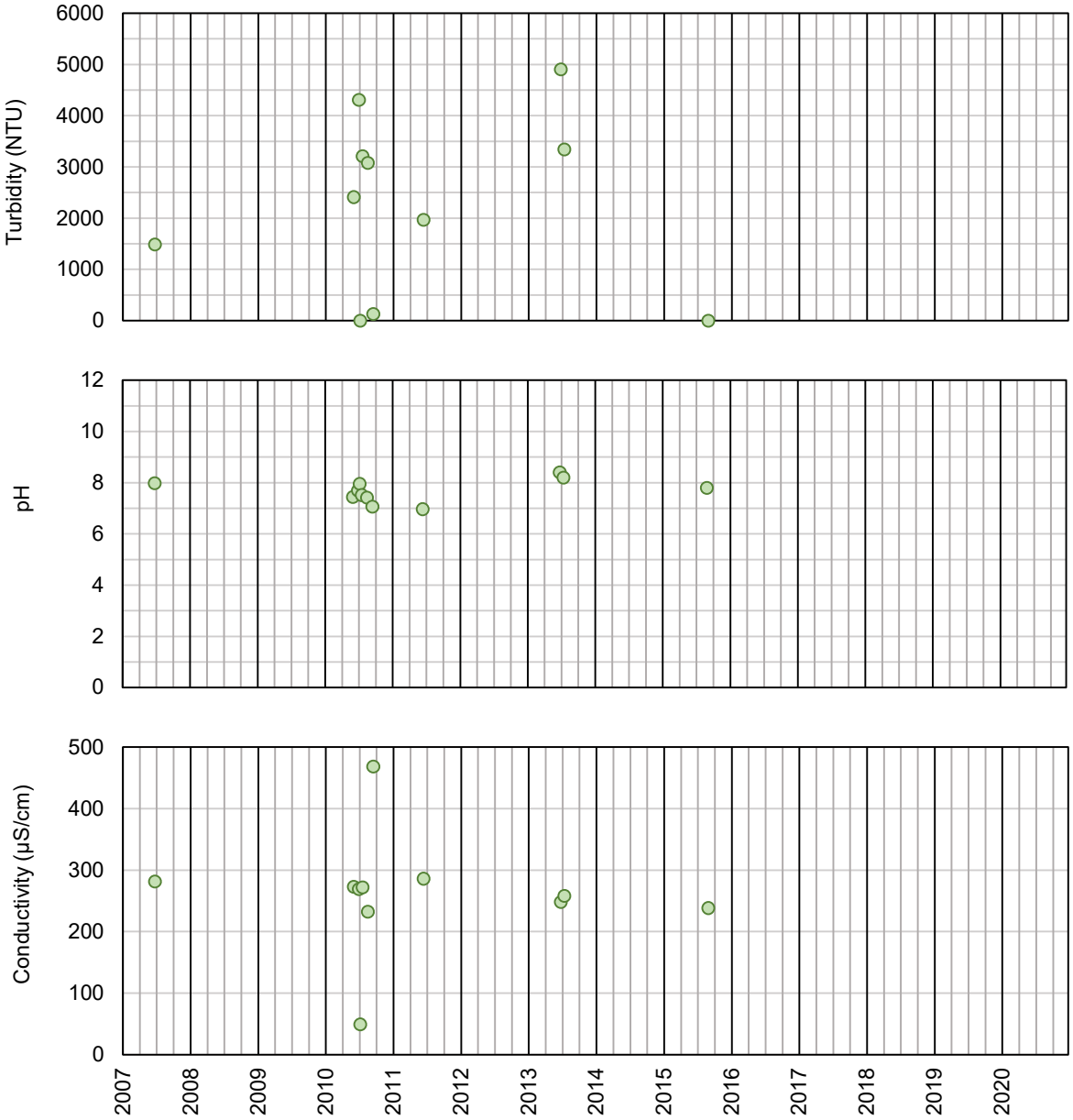


White River Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements

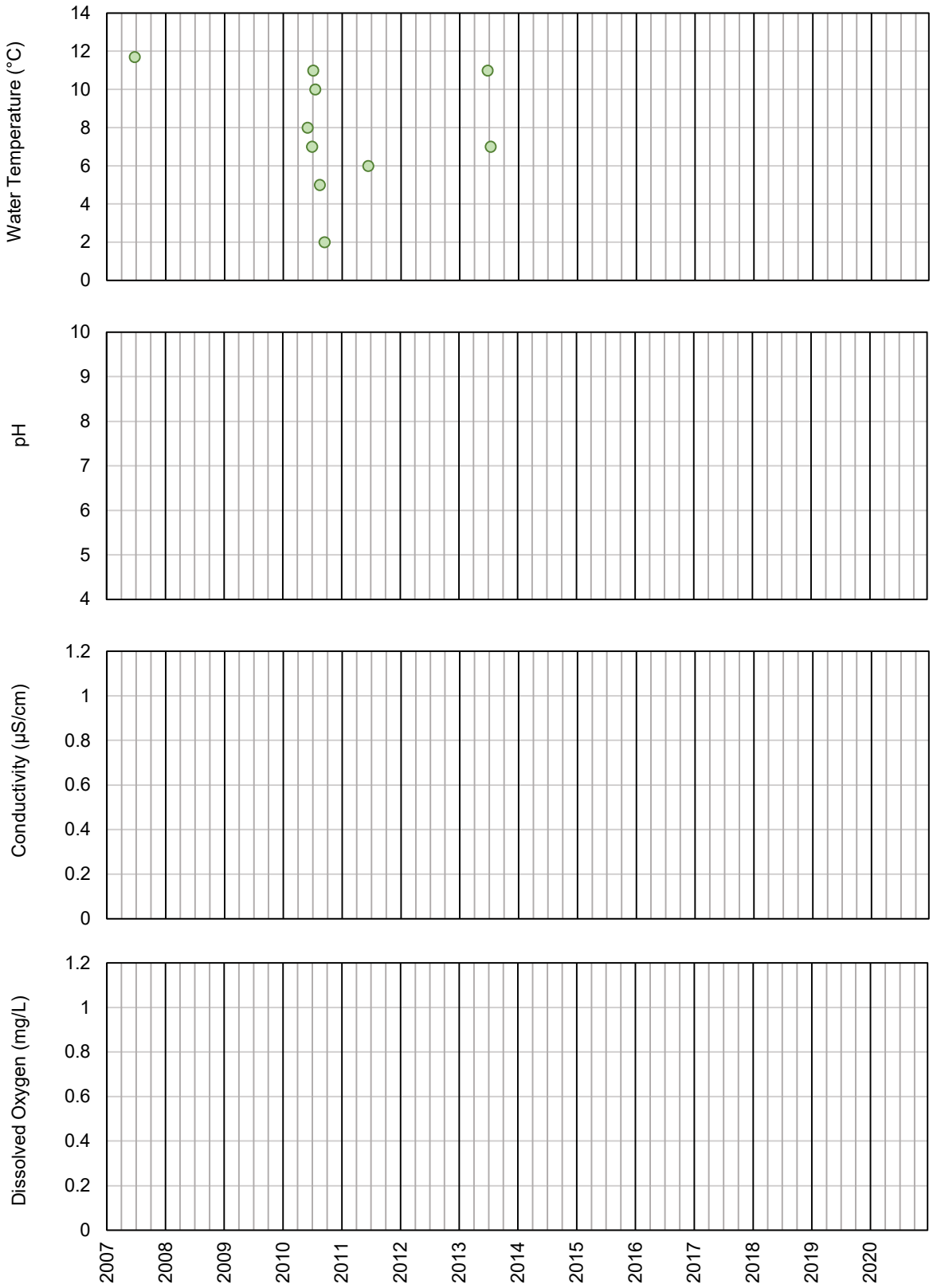



White River Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

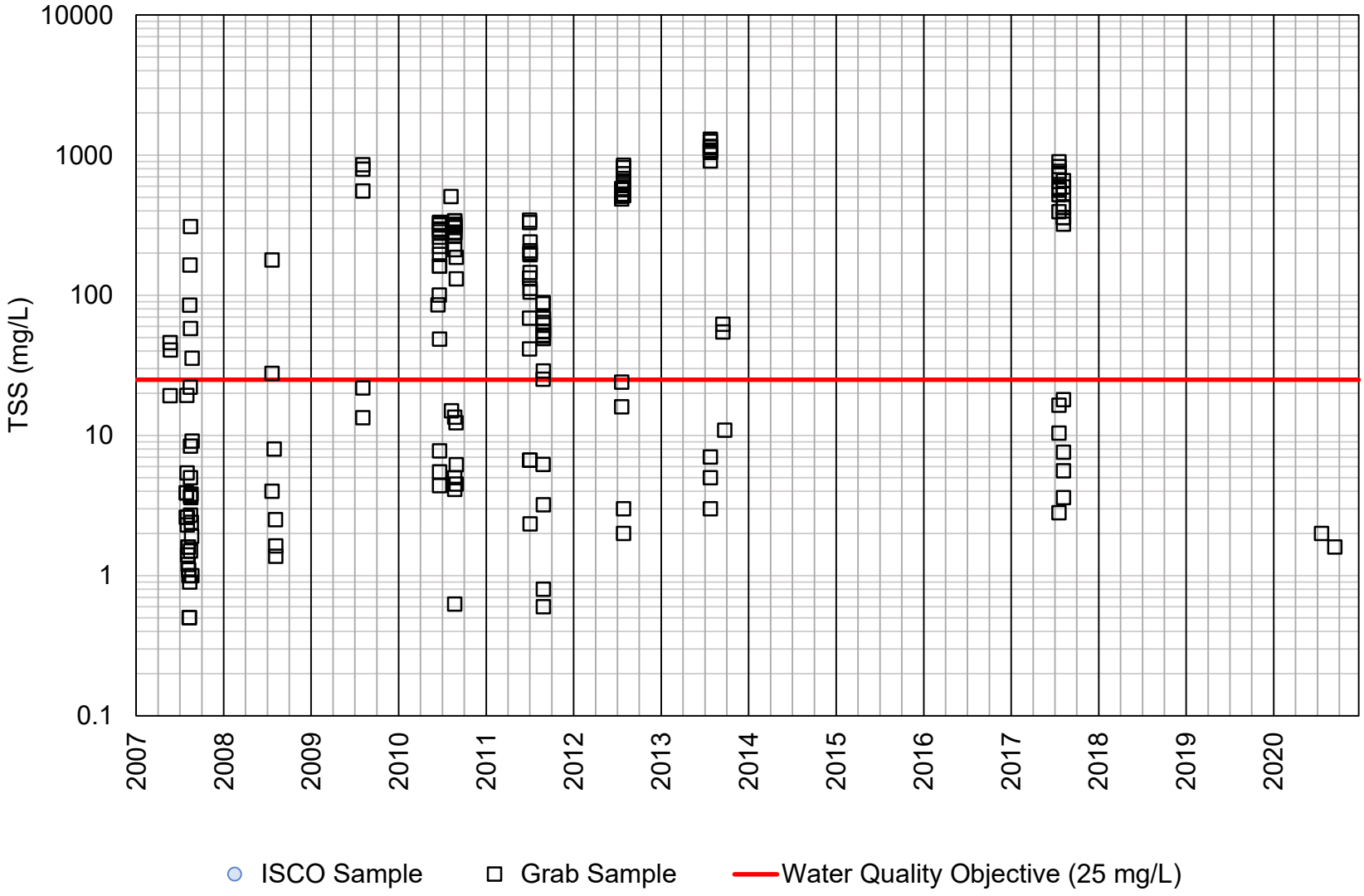
White River Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters



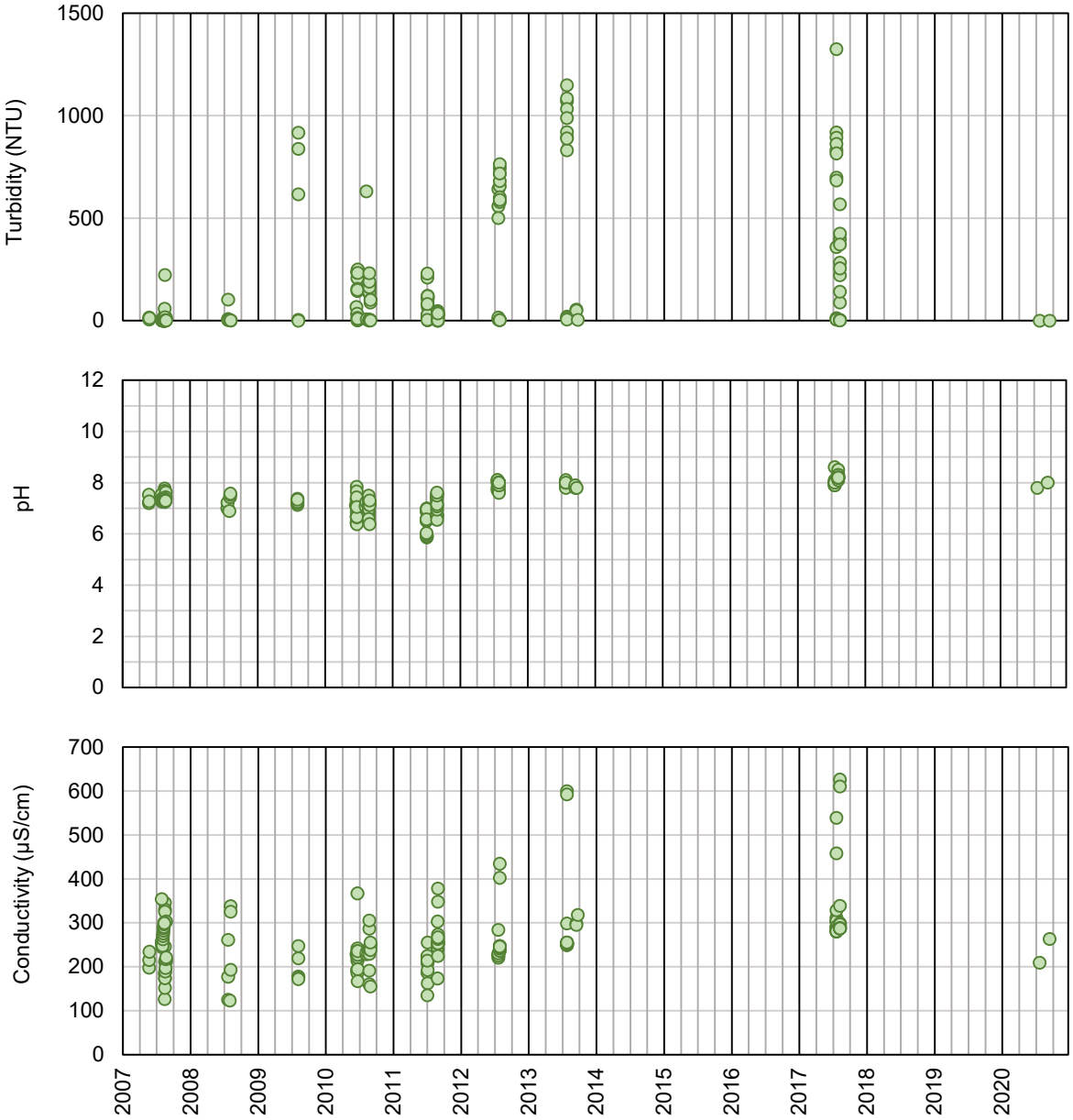
White River Watershed, Moderate-Low Habitat Suitability, Field Meaurements



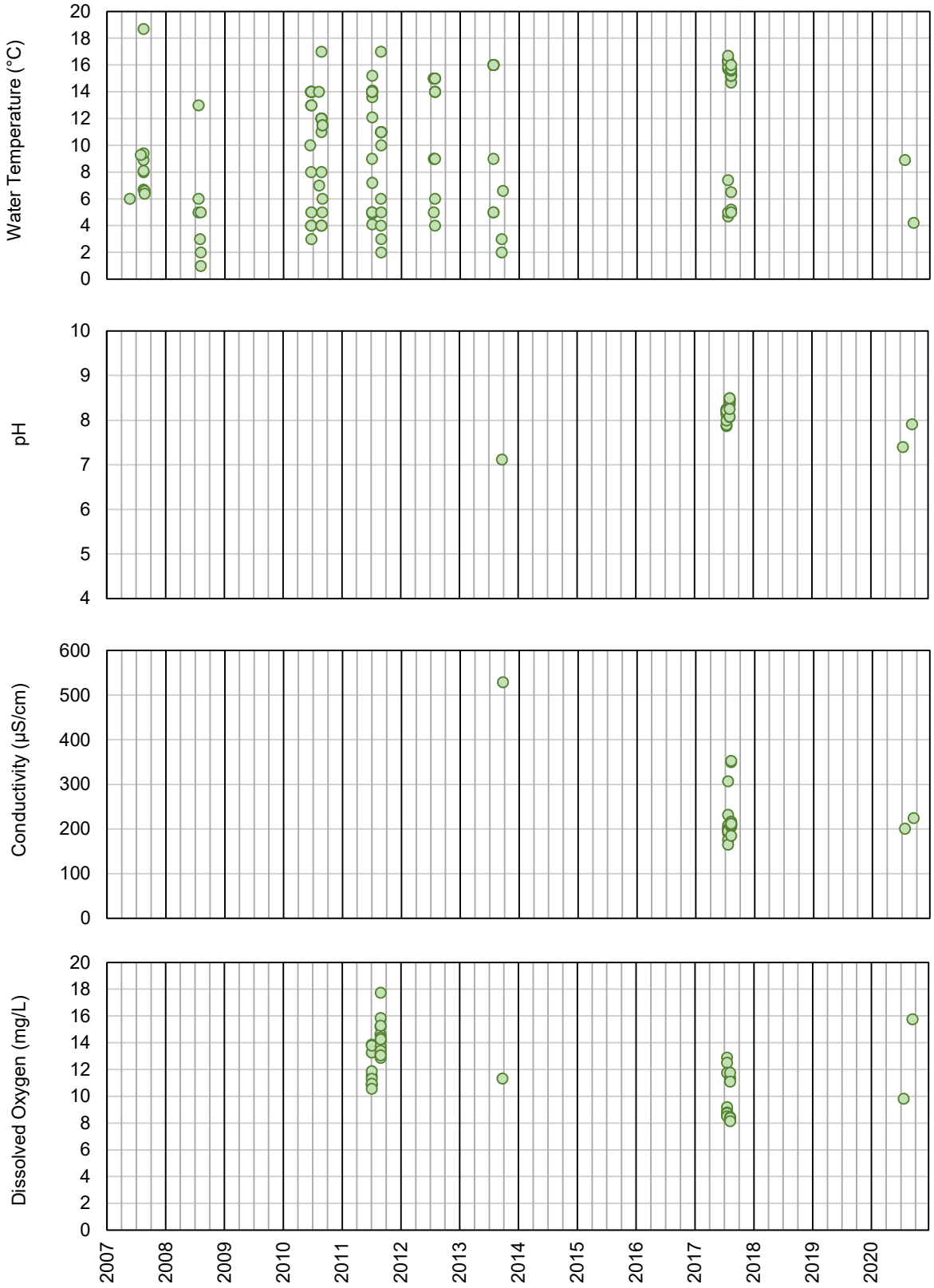
Yukon River North Watershed, Area of Special Consideration Habitat Suitability
TSS Composite and Grab Samples

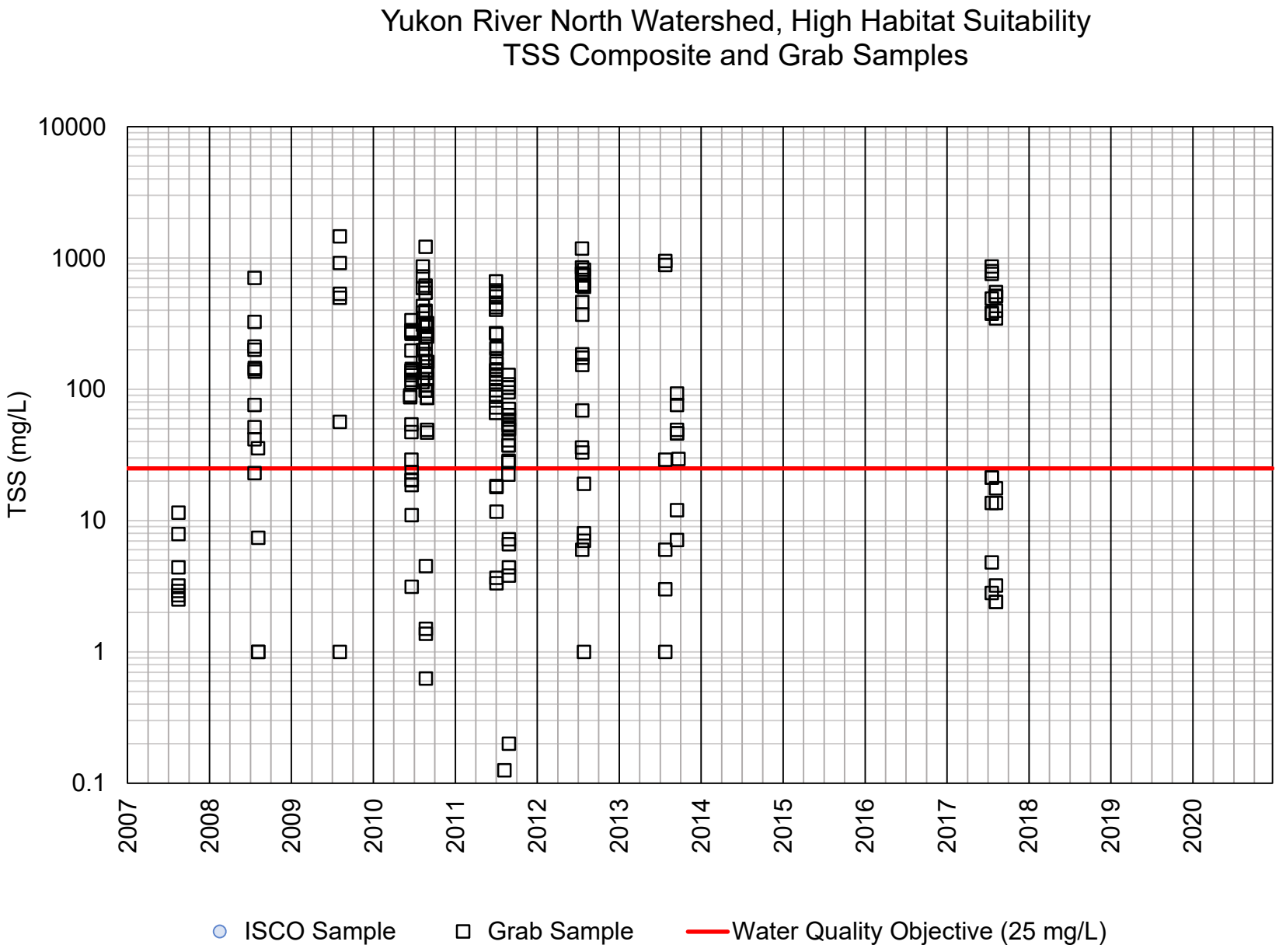


Yukon River North Watershed, Area of Special Consideration Habitat Suitability, Laboratory Measured Parameters

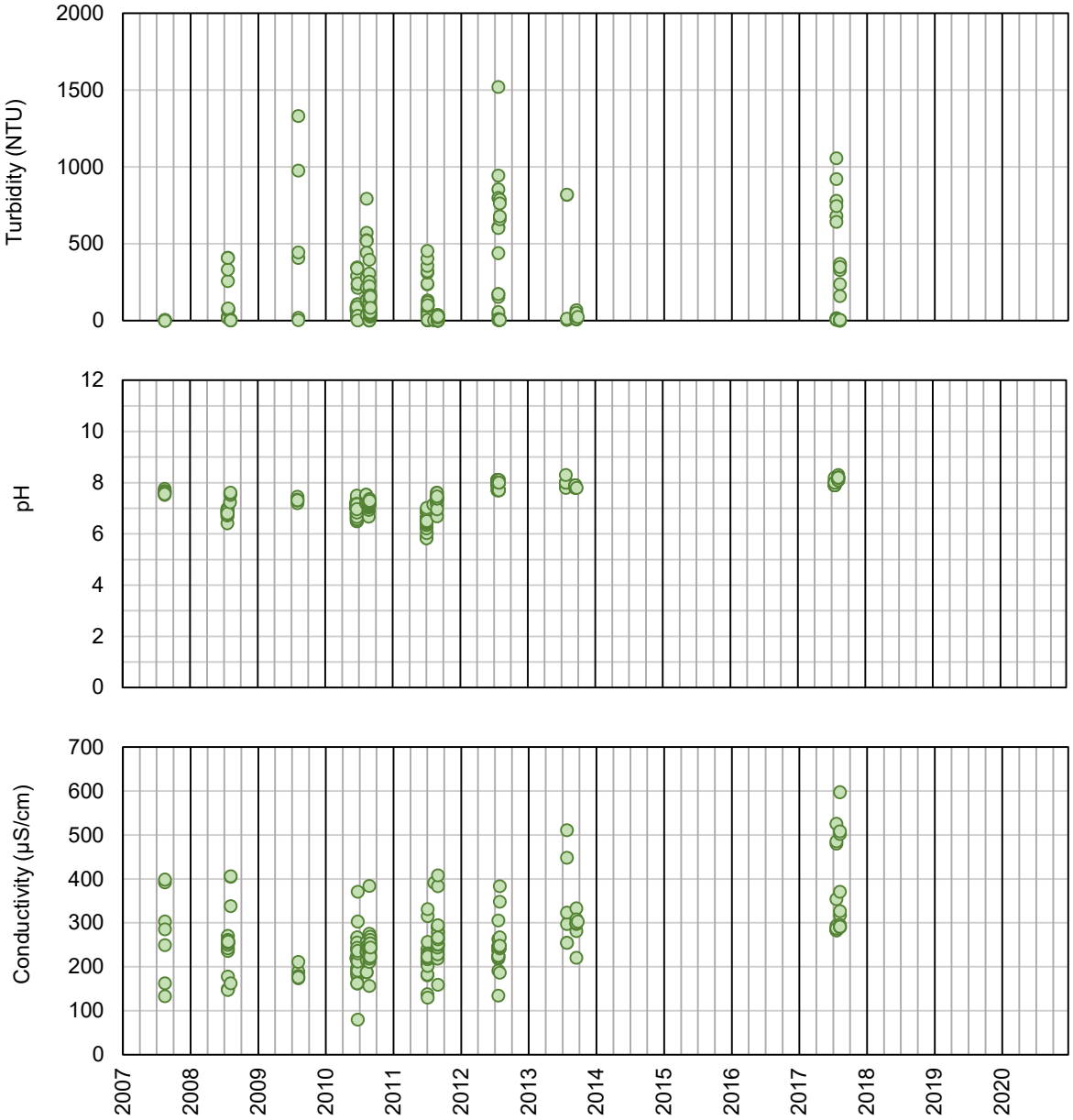


Yukon River North Watershed, Area of Special Consideration Habitat Suitability, Field Meaurements

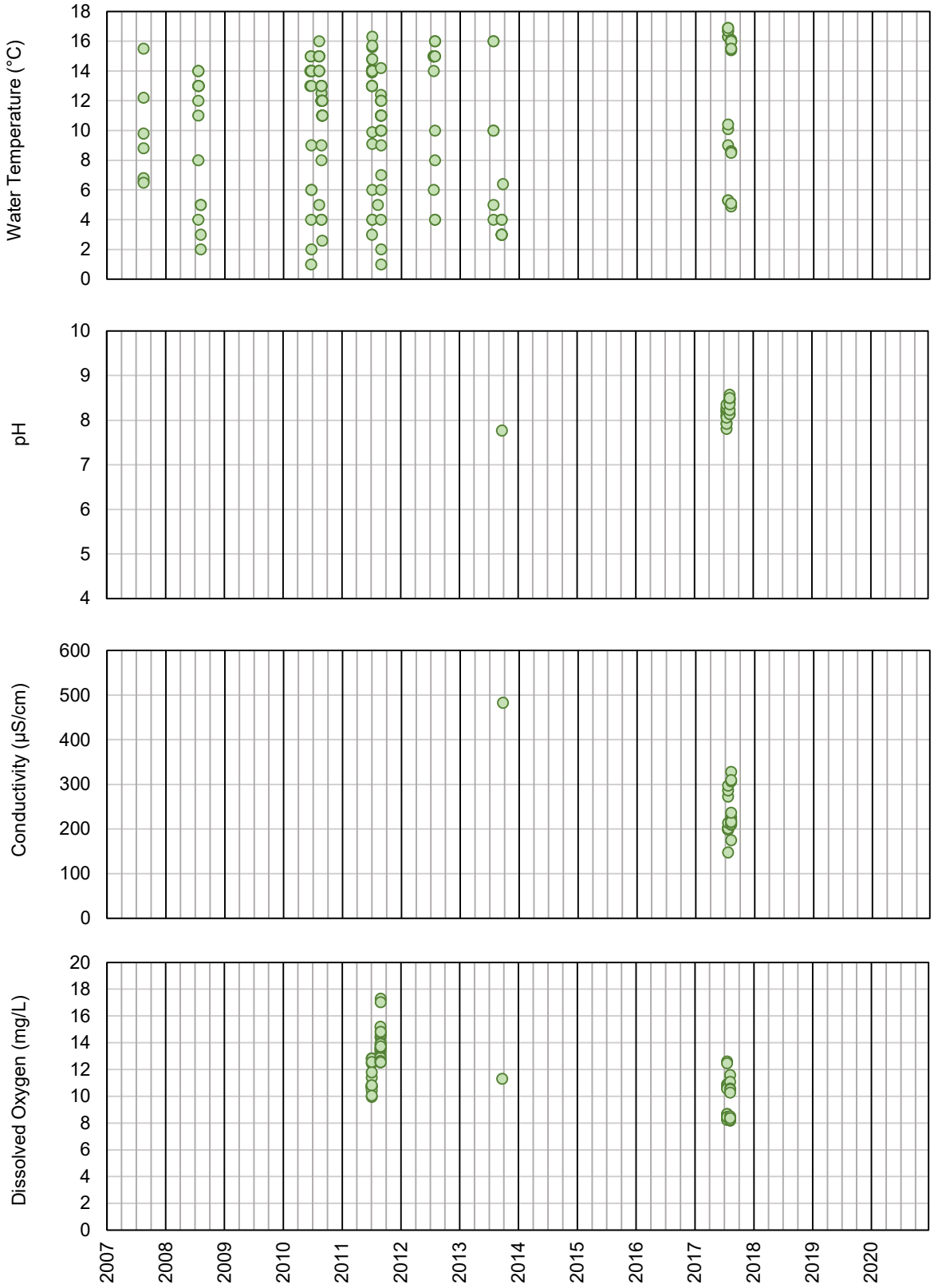


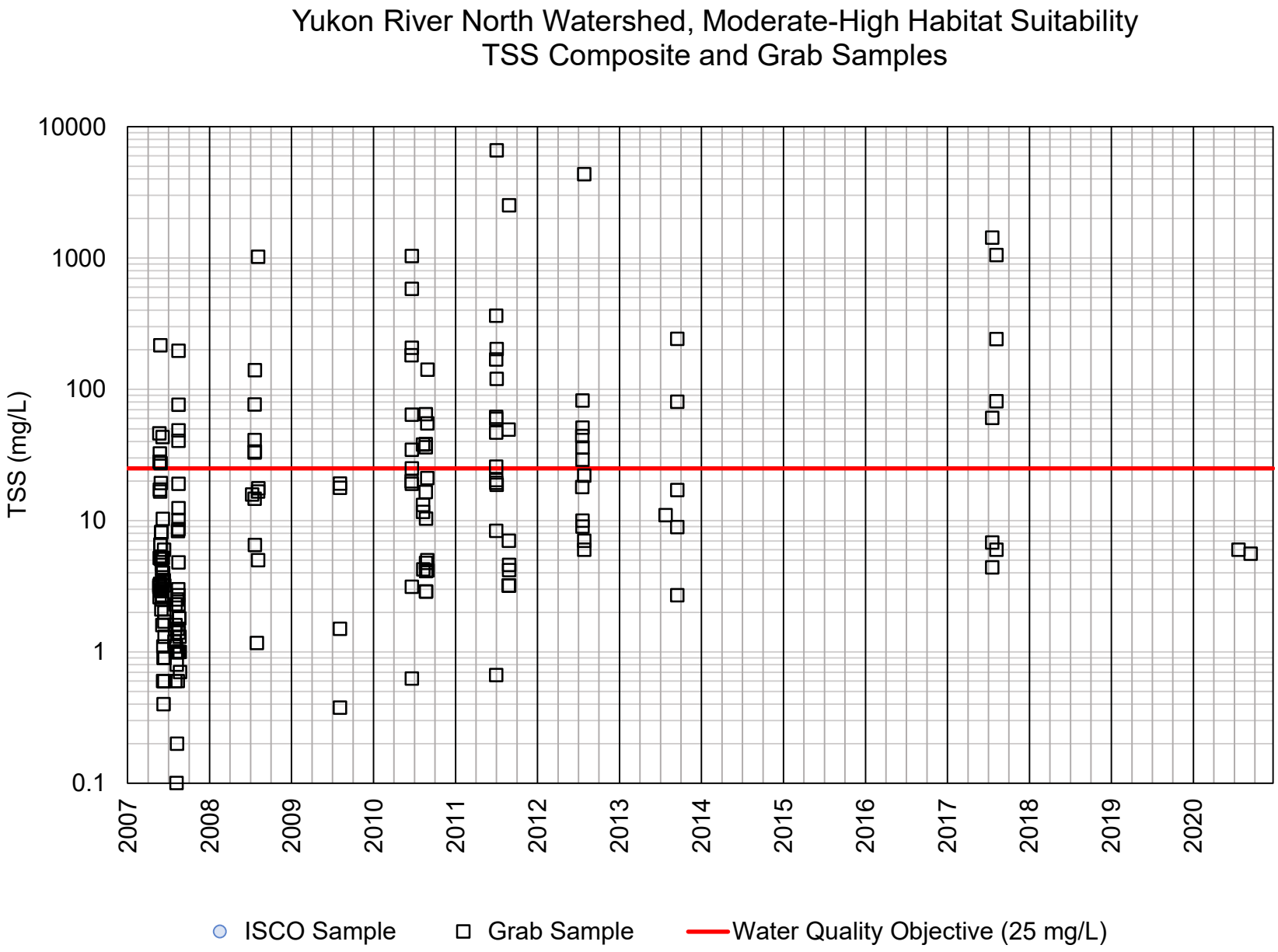

Yukon River North Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Yukon River North Watershed, High Habitat Suitability, Laboratory Measured Parameters

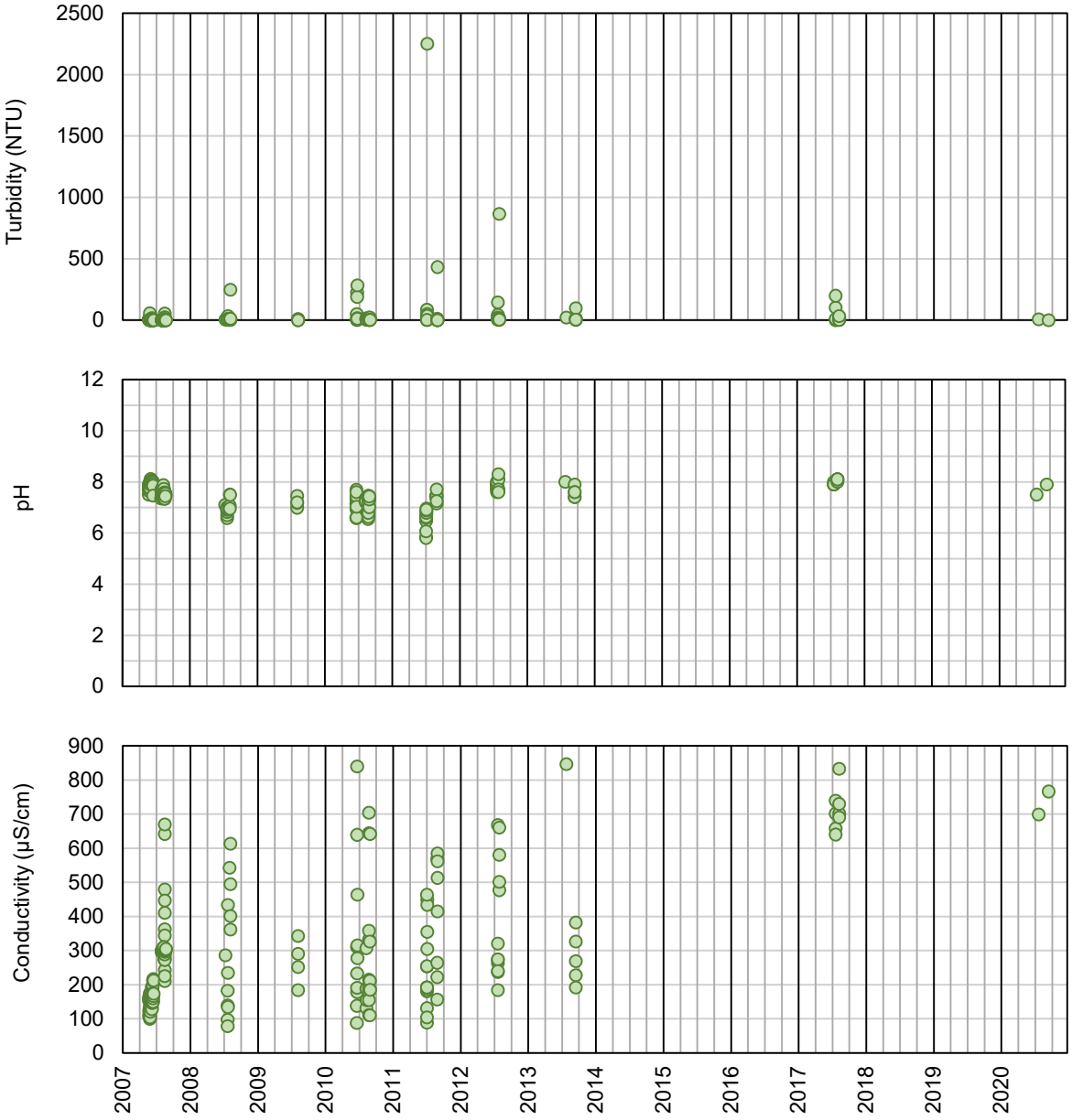


Yukon River North Watershed, High Habitat Suitability, Field Meaurements

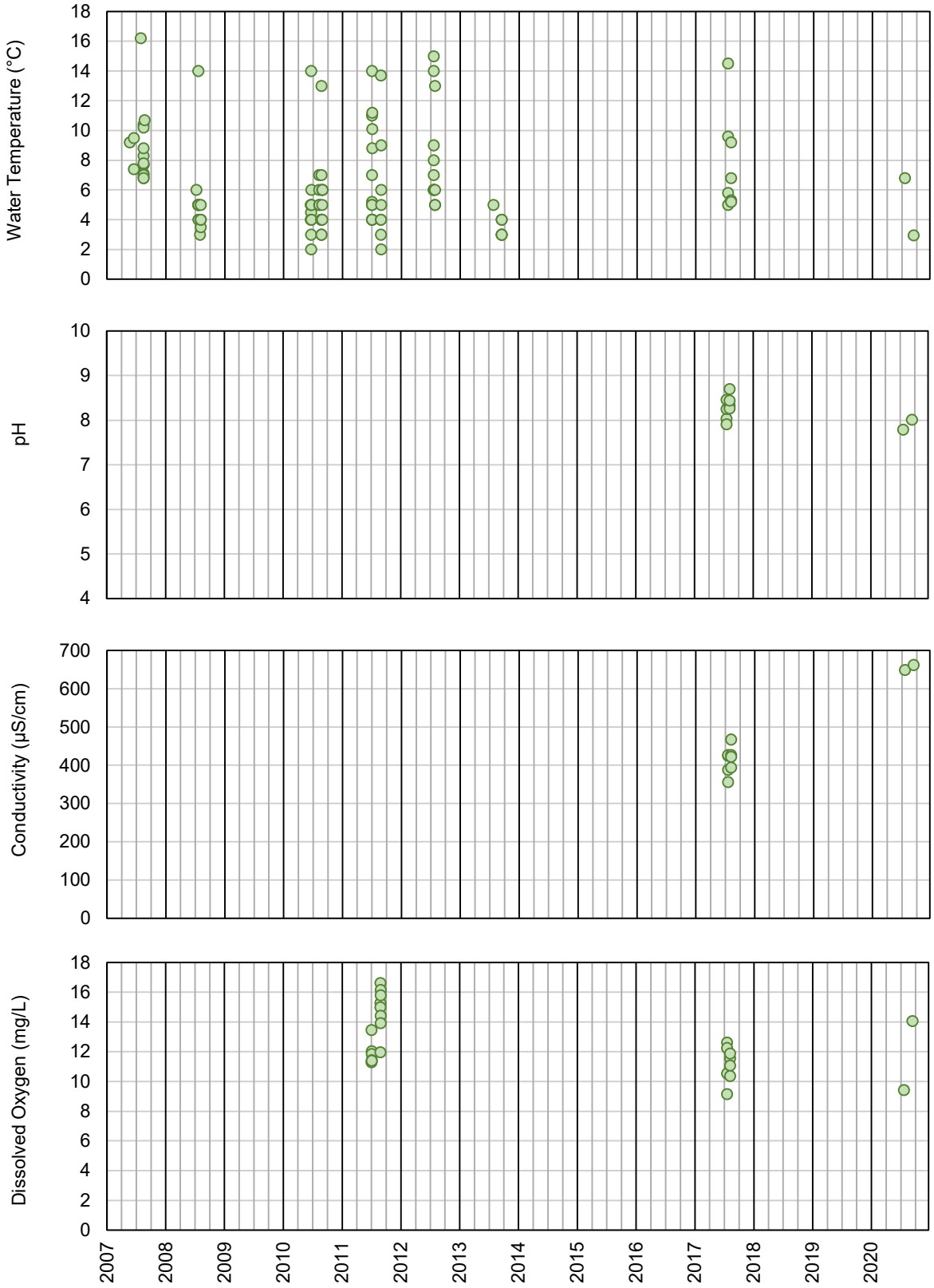


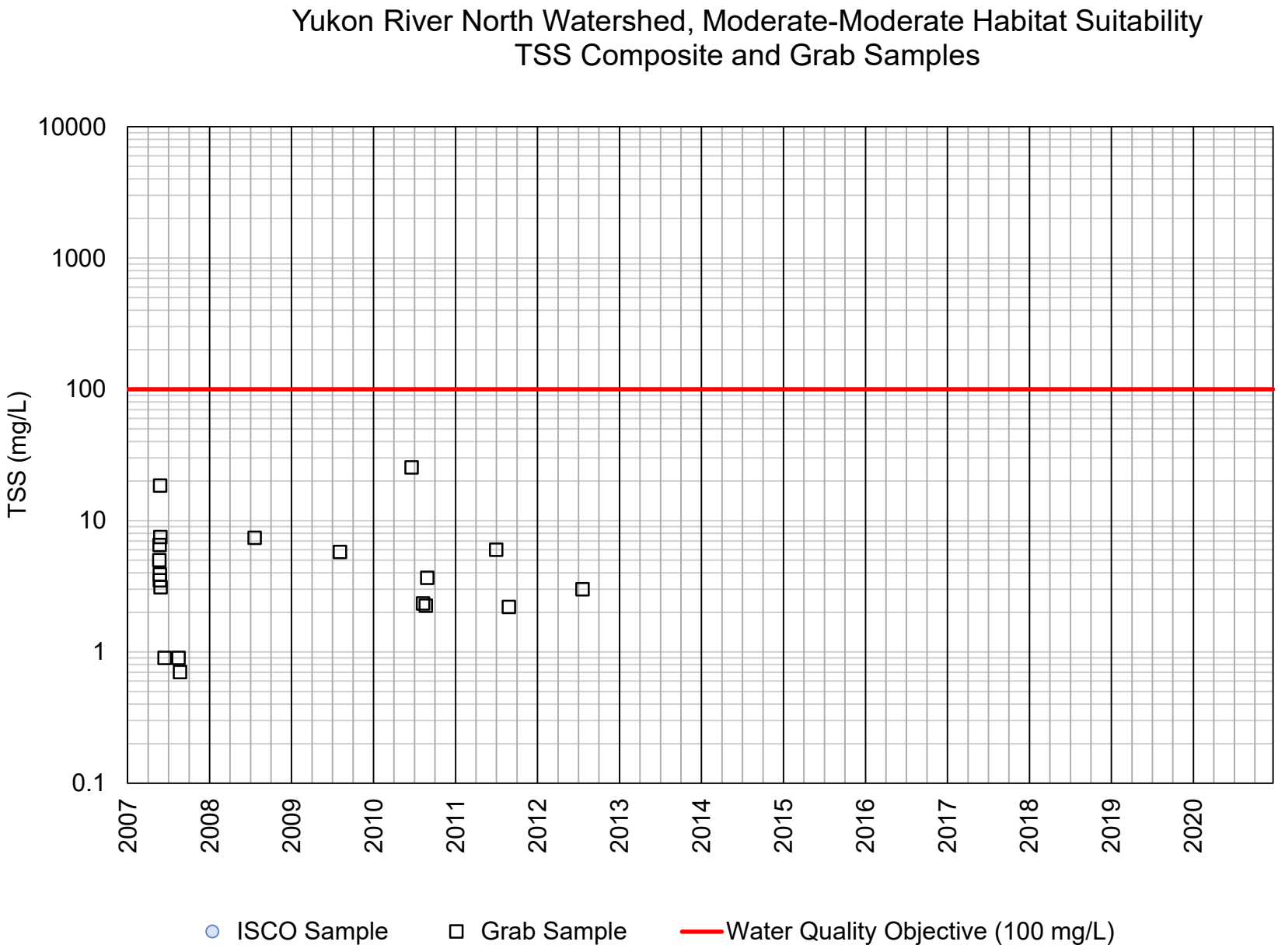

Yukon River North Watershed, Moderate-High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

Yukon River North Watershed, Moderate-High Habitat Suitability, Laboratory Measured Parameters

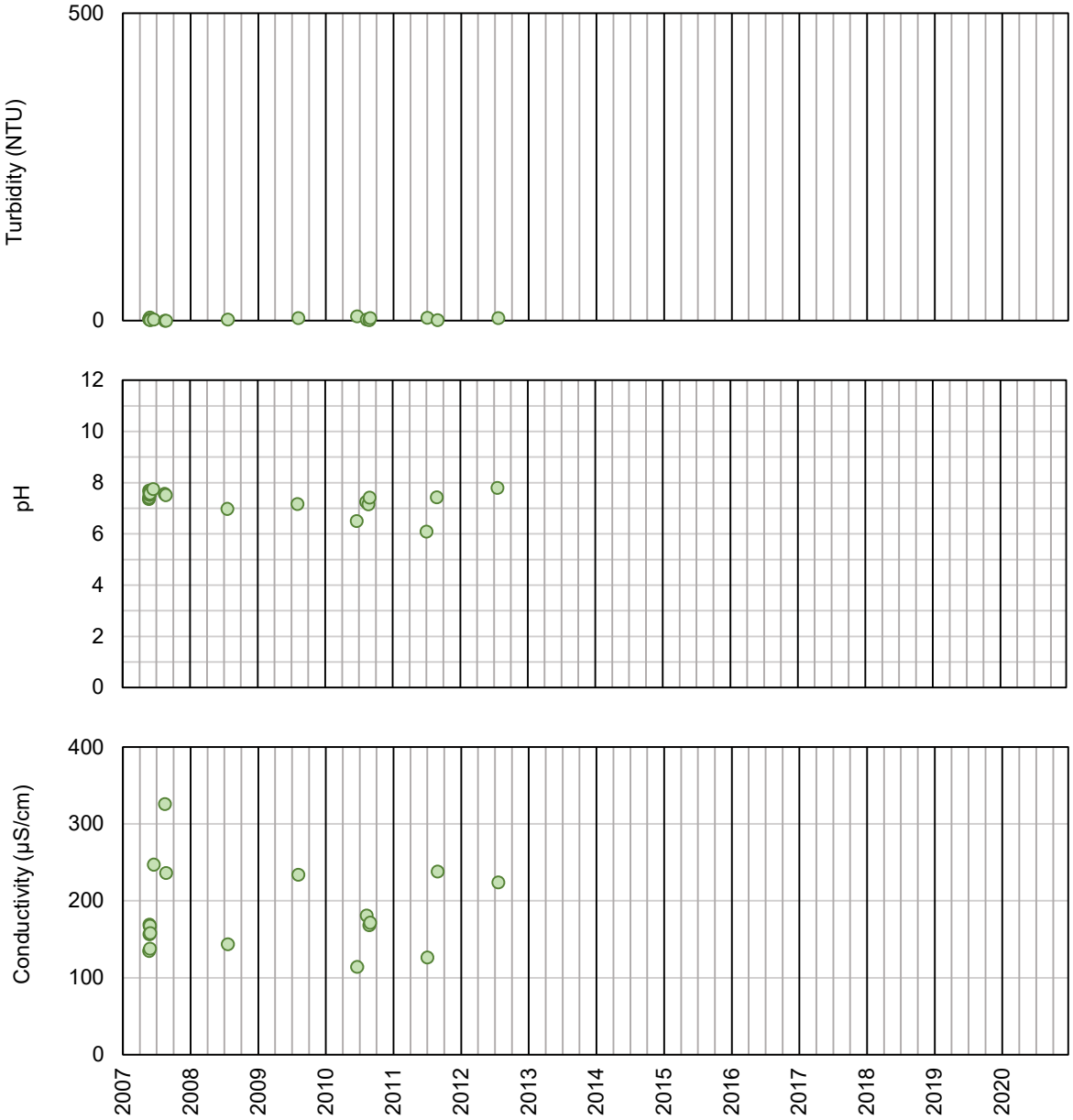


Yukon River North Watershed, Moderate-High Habitat Suitability, Field Meaurements

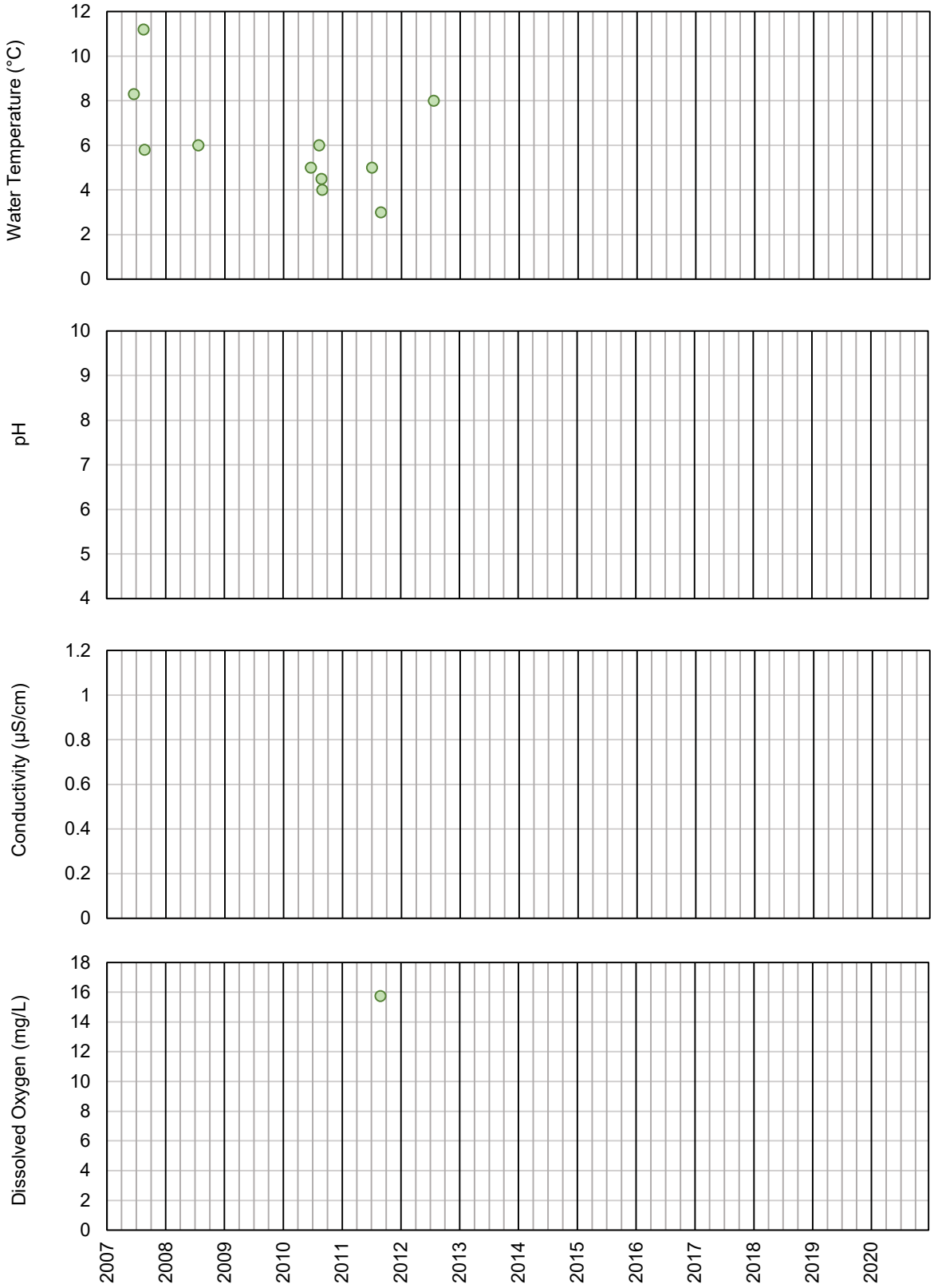


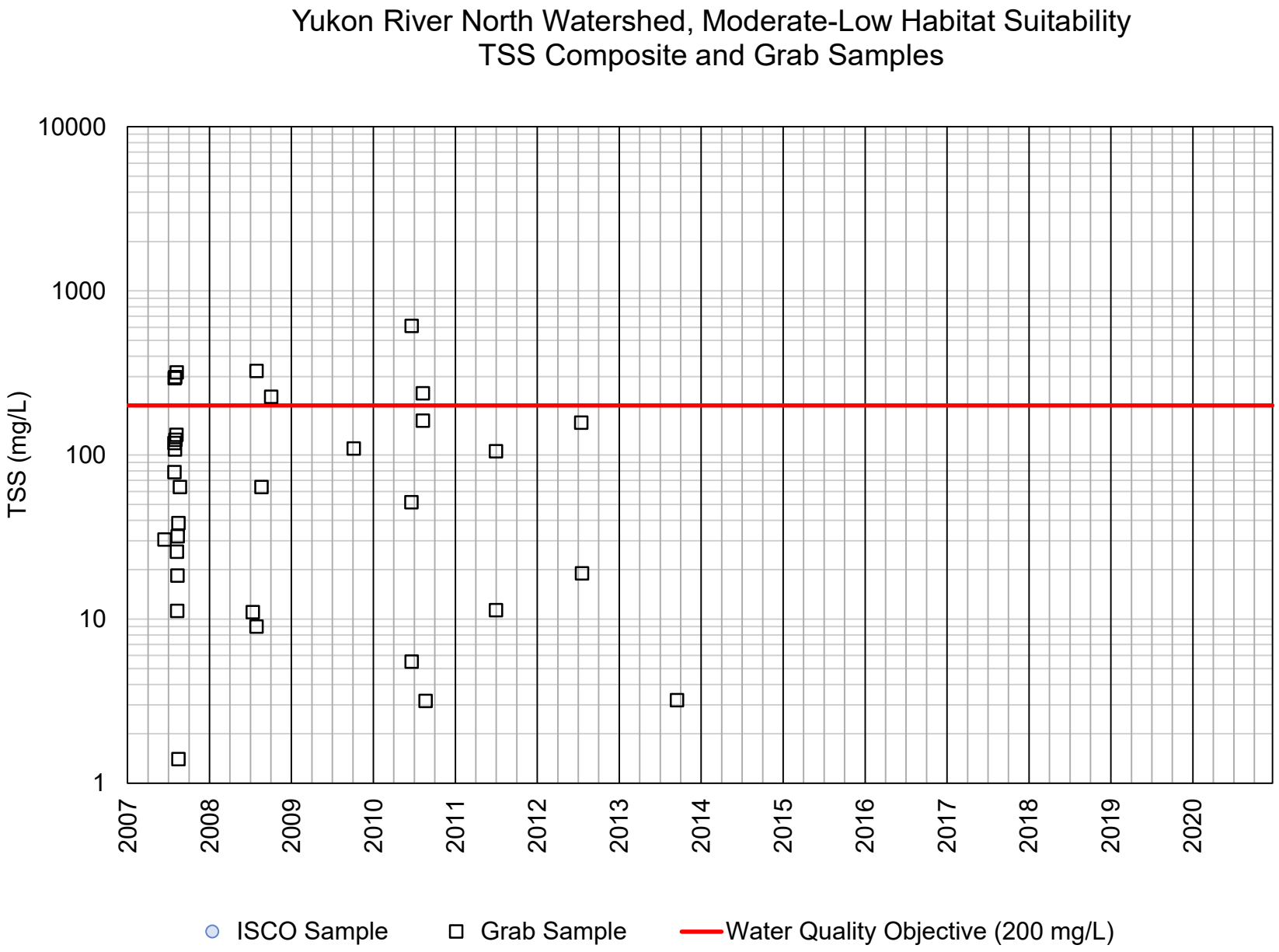

Yukon River North Watershed, Moderate-Moderate Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (100 mg/L)

Yukon River North Watershed, Moderate-Moderate Habitat Suitability, Laboratory Measured Parameters

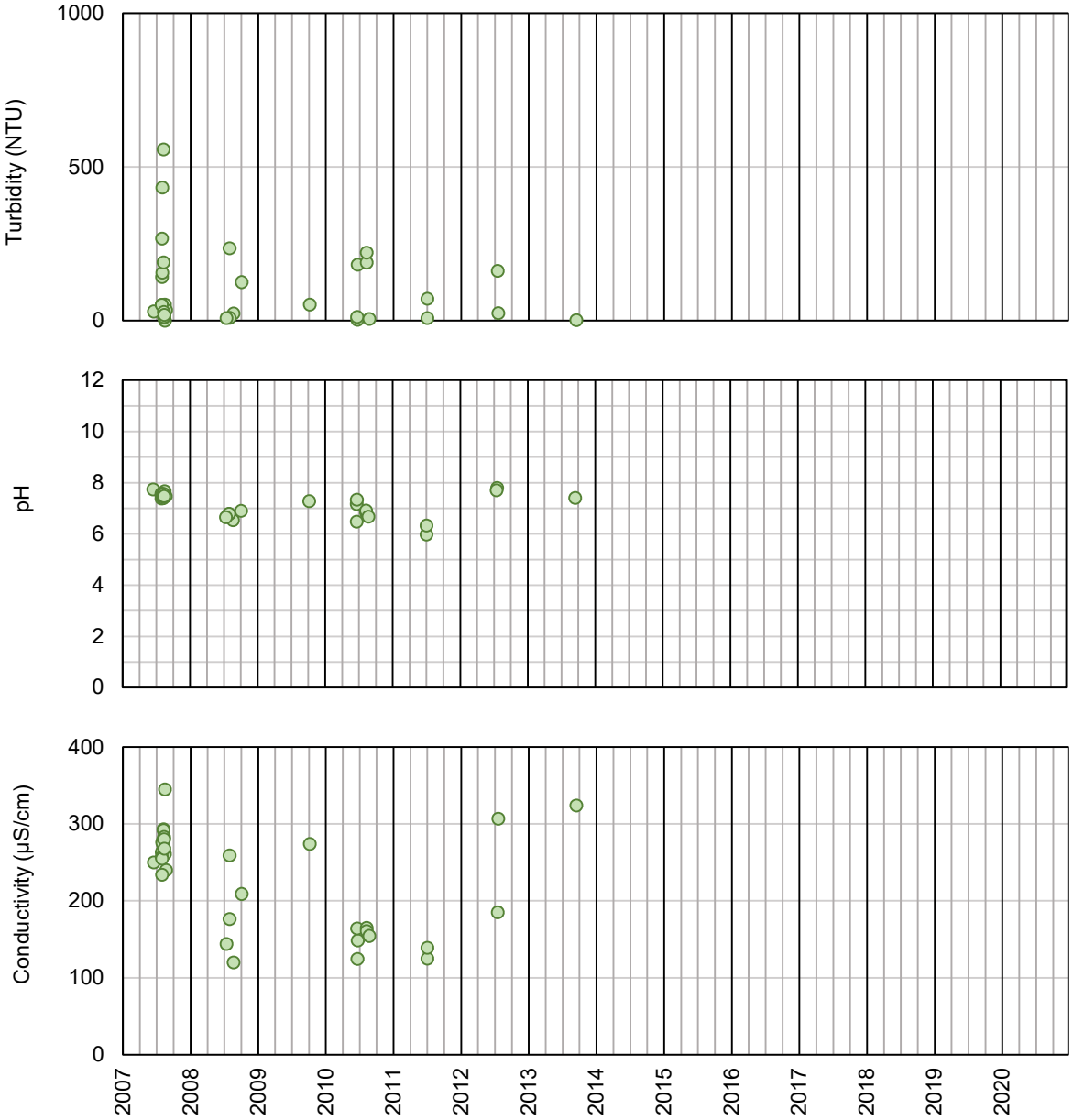


Yukon River North Watershed, Moderate-Moderate Habitat Suitability, Field Meaurements

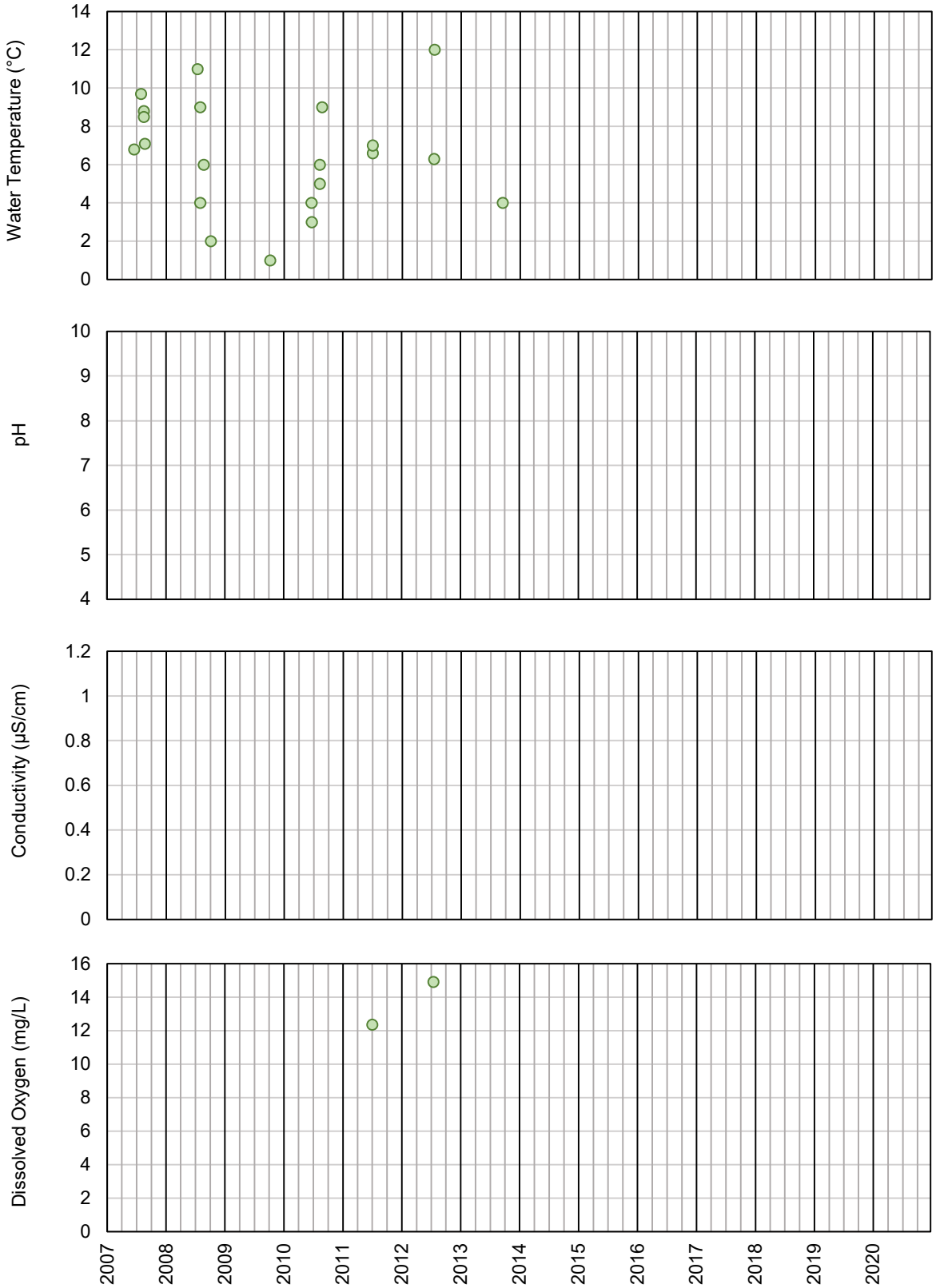


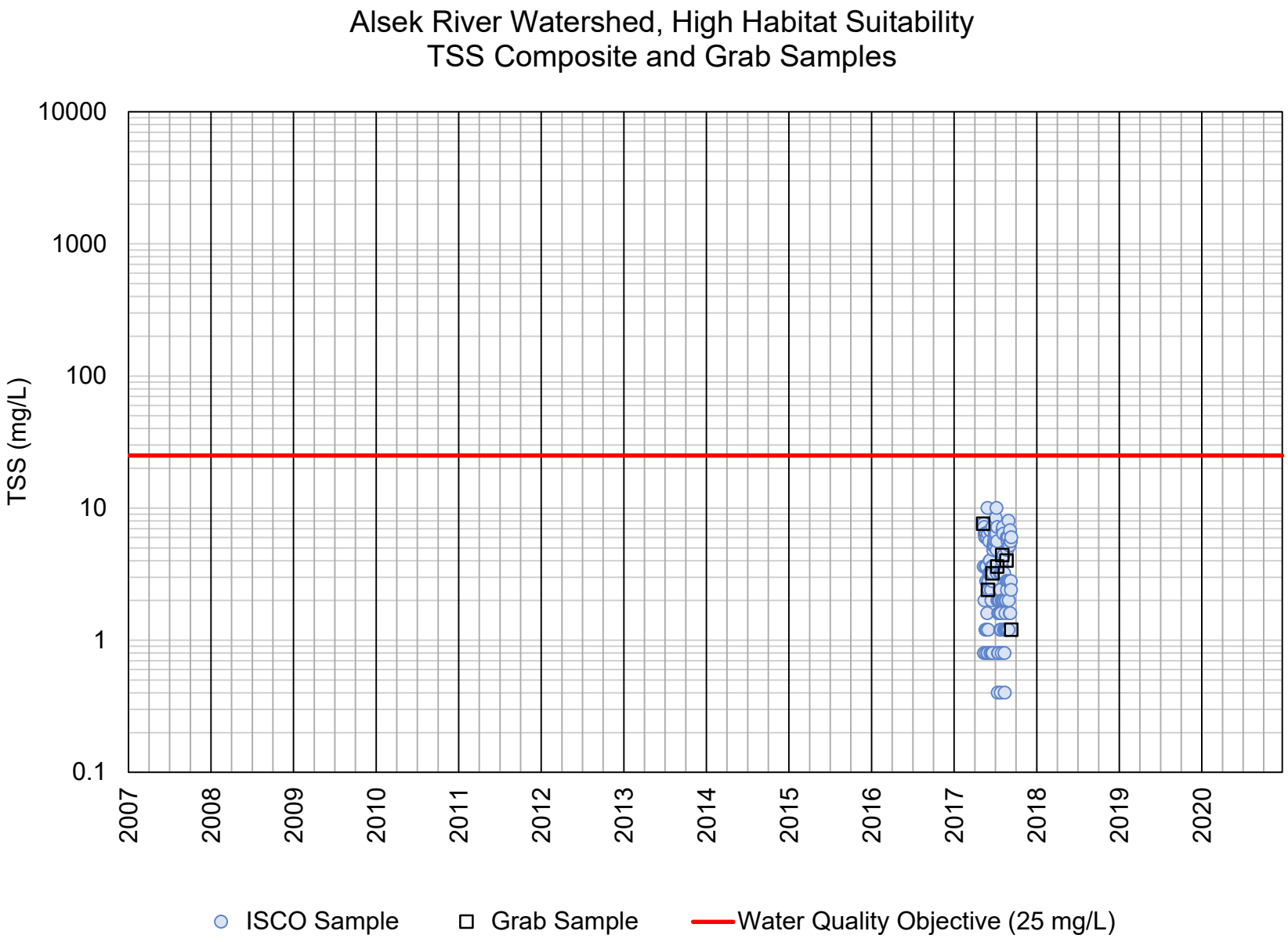

Yukon River North Watershed, Moderate-Low Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (200 mg/L)

Yukon River North Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters

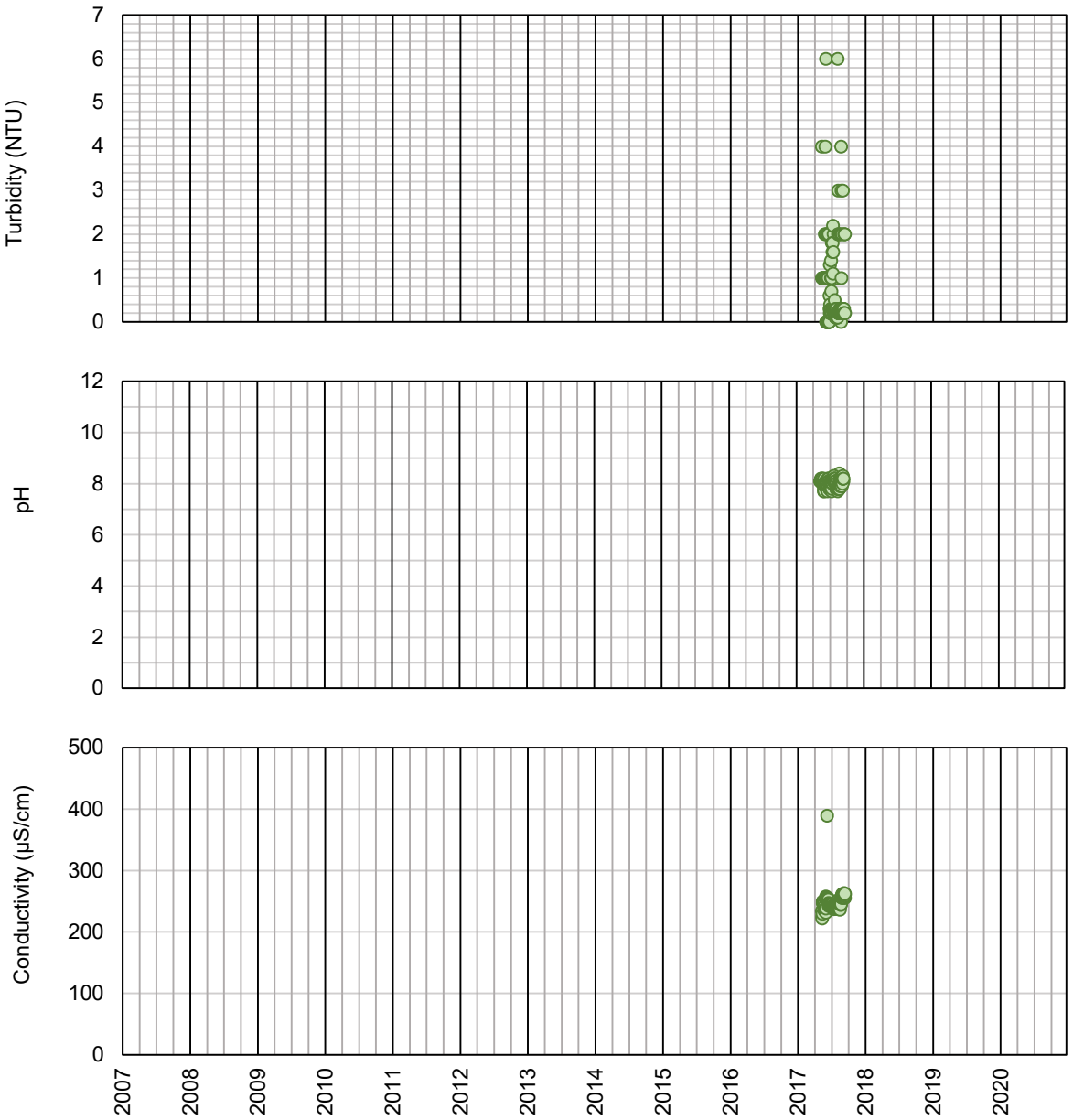


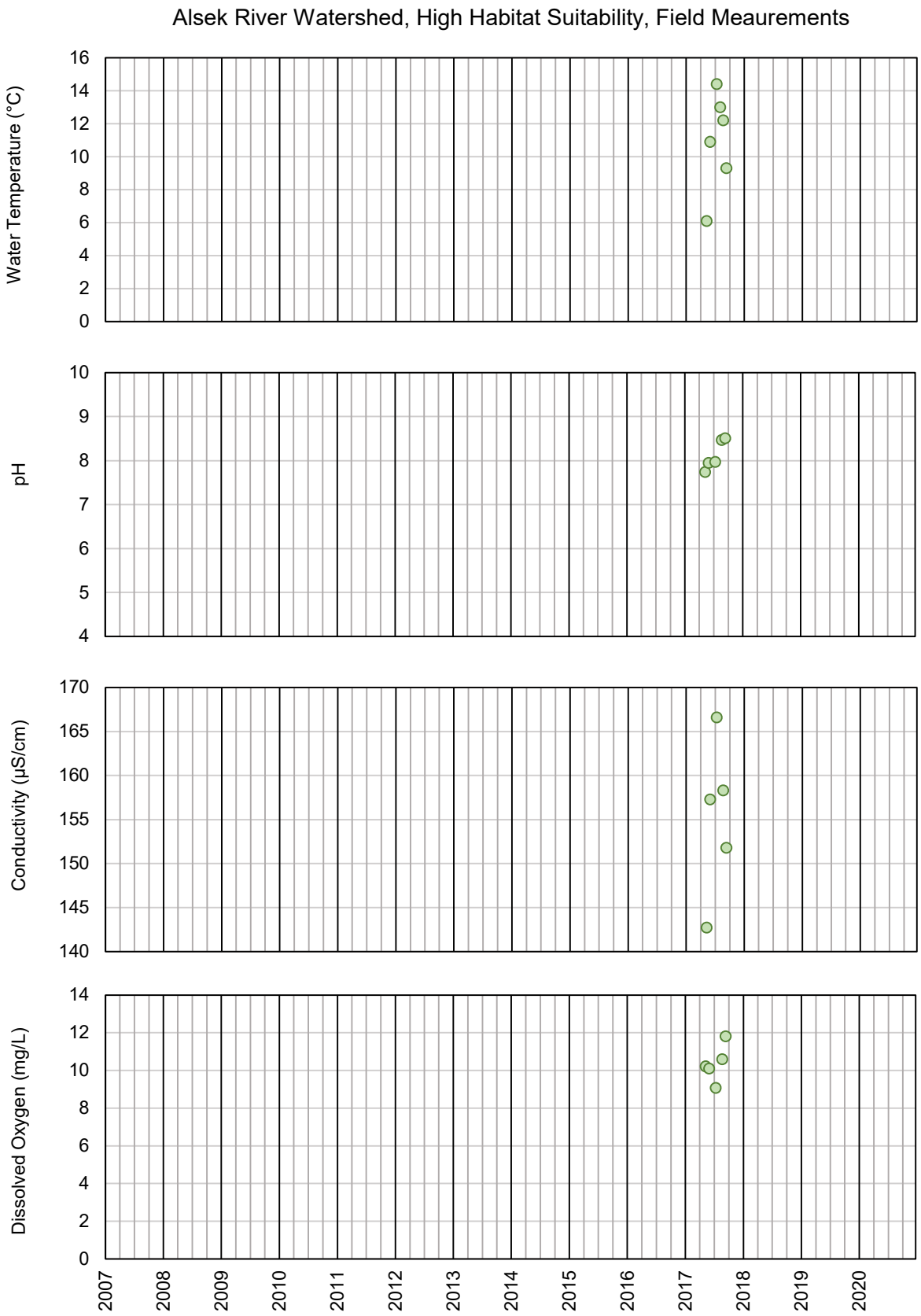
Yukon River North Watershed, Moderate-Low Habitat Suitability, Field Meaurements

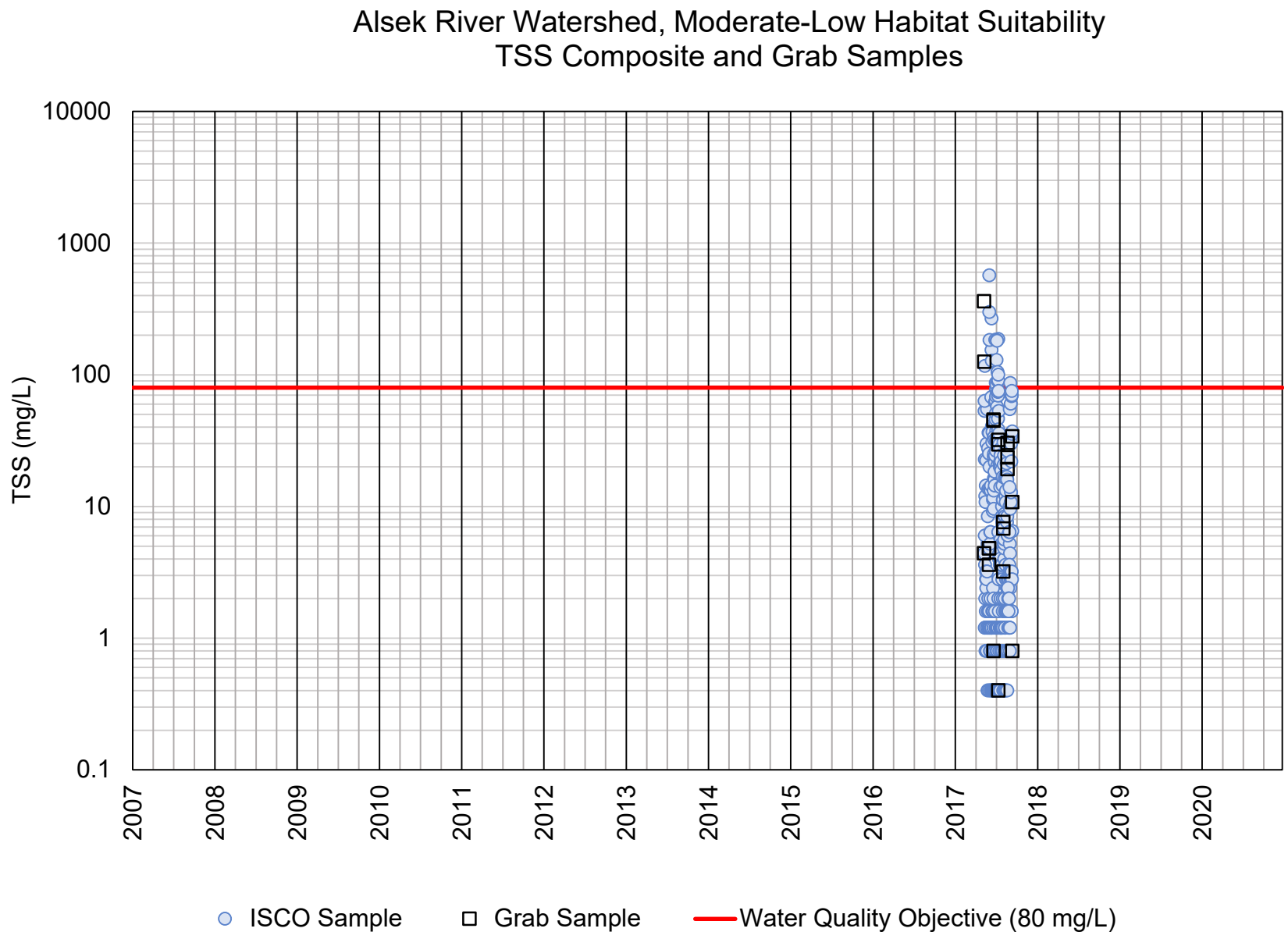



Alsek River Watershed, High Habitat Suitability
TSS Composite and Grab Samples
TSS (mg/L)
10000
1000
100
10
1
0.1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
ISCO Sample
Grab Sample
Water Quality Objective (25 mg/L)

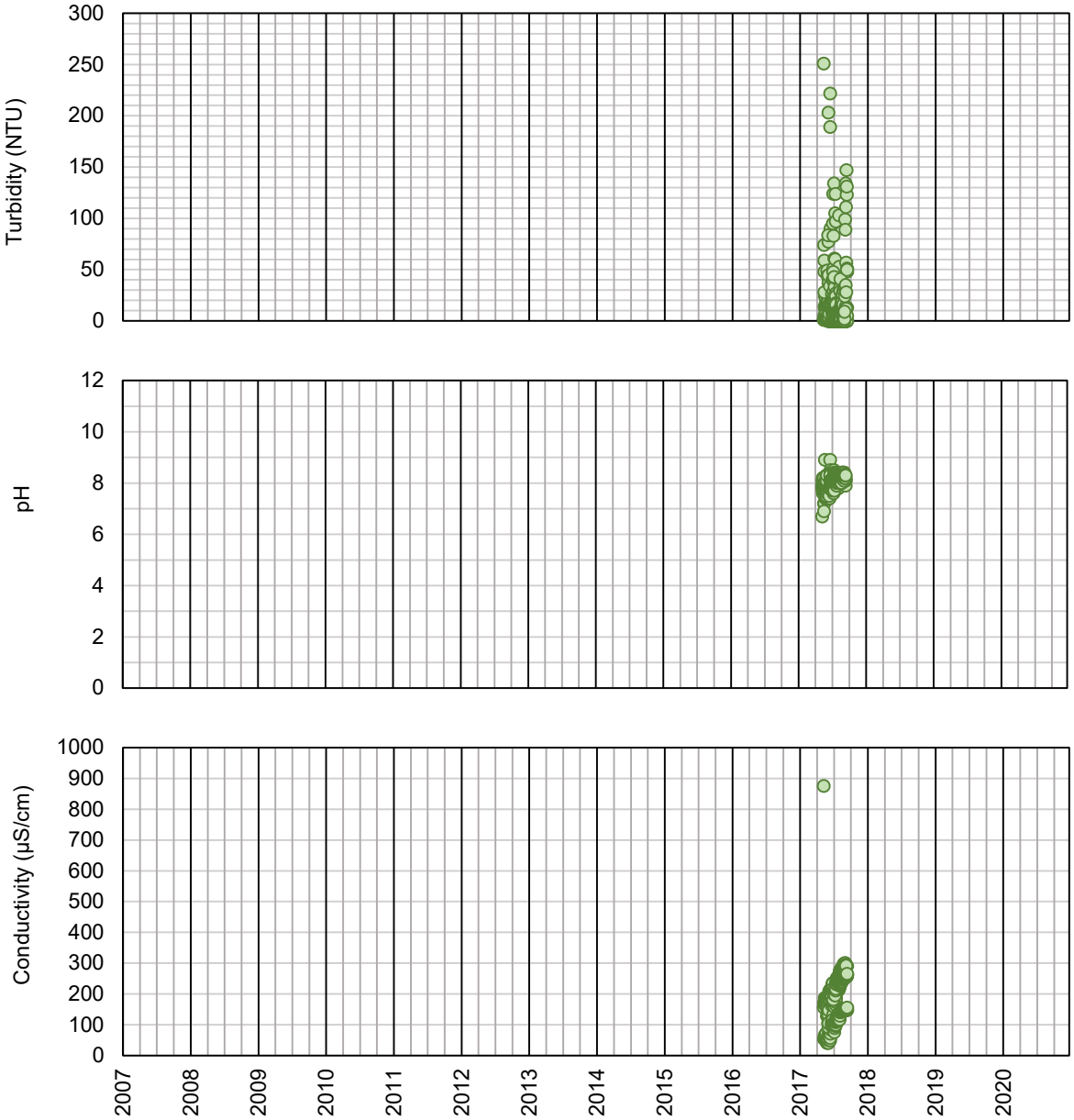
Alsek River Watershed, High Habitat Suitability, Laboratory Measured Parameters




Alsek River Watershed, High Habitat Suitability, Field Meaurements
Water Temperature (°C)
16
14
12
10
8
6
4
2
0
pH
10
9
8
7
6
5
4
Conductivity (µS/cm)
170
165
160
155
150
145
140
Dissolved Oxygen (mg/L)
14
12
10
8
6
4
2
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


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

Alsek River Watershed, Moderate-Low Habitat Suitability, Laboratory Measured Parameters



Alsek River Watershed, Moderate-Low Habitat Suitability, Field Meaurements