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Haslam Lake Lang Creek Water Quality and Quantity Monitoring Program for 2014

Photo by Alex Dober taken near peak flow for 2014

Prepared for
Powell River Salmonid Enhancement Society
Funded by BC Timber Sales and
the Powell River Community Forest

February 2015

Brian Carson, P.Geo.

Summary

British Columbia Timber Sales and the Powell River Community Forest provide funds to the Powell River Salmonid Enhancement Society for monitoring water quality throughout the Haslam Lang Community Watershed. This report presents 2014 data collected (as well as selected historic data to demonstrate trends) and discusses results generated by the water quality monitoring program to date.

During 2014, the automated monitoring station located at the Salmon Enhancement Society Counting Station at the mouth of Lang Creek continued to record stage, rainfall, and water and air temperature on a continuous basis.

The stage -discharge calibration curve from 2012 was used to develop the 2014 hydrograph. While the hydrograph followed the normal overall trends of past years, the Dec 2014 storm was one of the largest recorded instantaneous discharges on Lang Creek (instantaneous peak flow of 64.2 m^3/sec) since the automated recorder began measurements in 1998. The fish gates were threatened but remained undamaged from this flood. Summer low flow appears to have been pretty well regulated in 2014 (at 0.7 m^3/sec) by management of the weir. Neither the Salmon Enhancement Society nor the Brew Bay Water Users Association expressed concerns about problematic low flows on lower Lang Creek.

Bi-monthly, on-site sampling conducted by Salmon Enhancement Society staff has continued at six strategic locations within the watershed throughout the 2014 season. This data has been evaluated taking into account all of the 1998 to 2014 data and provides an excellent historic record of variability of water quality parameters. It is recognized that the Haslam Lake Intake collection site does not reflect the actual water quality of the intake itself but does indicate problems with shoreline wave action that may need to be addressed.

In addition to bi-monthly monitoring, continuous water temperature recorders have been employed in 2014 on Anderson Creek, Blackwater Creek and at the hatchery on upper Lang Creek. This data is also of high quality and records minor temperature fluctuations during the critical maximum water temperatures of midsummer. Supplementary monitoring of water temperatures during low flow on small tributaries on lower Lang Creek might be considered. Such data would be useful to guide forest operations managing riparian leave strips along non-fish streams in the area.

The tables and figures presented in this report represent just a small portion of the total data set collected under this monitoring program. All digital data is archived at the office of the Powell River Salmonid Enhancement Society and is freely available.

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I. INTRODUCTION

British Columbia Timber Sales and the Powell River Community Forest have provided on going support to the Powell River Salmon Enhancement Society in 2014 with funds to monitor water quality within the Haslam Lang Community Watershed. The purpose of water quality monitoring is to:

- provide information for resource management planning and decision making at the community and regional level;
- establish baseline levels in support of specific criteria/objectives development and attainment reporting;
- provide information on the status, health, trends and uses of water resources;
- specifically address wild fish health and habitat in relation to the above; and
- employ and train persons from local communities to foster interest and involvement in community watersheds.

This report presents a range of data collected during the 2014 monitoring season, makes some comparisons with historic data, comments on management significance of data and provides recommendations for ongoing monitoring.

II. BACKGROUND

The watershed being monitored lies immediately east of Powell River. It is confined to the drainages associated with Haslam Lake and Lang Creek, comprising a total area of around 12,800 ha. Elevations range from sea level at the mouth of Lang Creek to 1,103 meters on Tin Hat Mountain. Most of the area falls within the Coastal Western Hemlock Biogeoclimatic zone. Douglas fir, red cedar, western hemlock and alder are the most common tree species found. Along the highest ridges on the north east portion of the watershed, one encounters the Mountain Hemlock Biogeoclimatic Zone. Most of the watershed has either been logged or burned in the last 80 years although small isolated patches of old growth remain. A network of forest roads is maintained within the watershed. An even more extensive network of old skid trails occurs at lower elevations throughout the watersheds and these are now used extensively for recreation activities.

Most of the watershed (excepting land immediately adjacent to lower Lang Creek) is comprised of crown land. Forestry for timber extraction is likely to be the major industrial use of the watershed for the foreseeable future. Forest Development Plans have been drawn up, indicating future cutblocks and required access roads. The Ministry of Environment, Lands and Parks, completed the first Coastal Watershed Assessment Procedure (CWAP) in 1997. The results from this study indicated that the forest harvesting activities planned was conservative, and unlikely to influence hydrological characteristics of the watershed. Mining does not play much of a role on the area. Small rock quarries are used for the extraction of road ballast. While signs of mineralization of rock within some of these quarries has been noted, problems with acid drainage have not been documented. Agriculture is restricted to a few small hobby farms along lower Lang Creek. Settlement (low density) is likewise confined to the southern strip adjacent to Lang Creek and even less so along the southern slopes of Haslam Lake. Being close to the population center of Powell River, the Haslam Lang area is popular with recreationists for riding ATVs, hiking, and non-motorized boating. Fisheries resources are substantial, particularly in the lower

watershed. A large salmon population is supported along the course of Lang Creek within the lower 8 km of channel and adjacent tributaries. Salmon returns are being accurately recorded by the Salmonid Enhancement Society and show variable returns but overall stable salmon populations. Major investment has been made in a fish hatchery, a counting station and an artificial spawning channel on Lang Creek. In 2000, Lang Creek was classified as a sensitive stream because of its high fisheries values. In the summer of 2000, a second CWAP was carried out which supported the conclusions of the first CWAP. It also stressed that good management would be more important to the continued health of the watershed than the actual amount of watershed logged or roaded. The Community Forest, which is a major licensee, conducted an assessment of their roads positioned within the watershed area in 2009 that showed that the great majority of roads were being well managed. No substantial sediment sources from these roads or cutblocks had impacted water quality at the Powell River Water Intake or on Lang Creek itself. Rigorous road sediment management was also observed while conducting the 2014 field evaluation. The Licensees have also invested considerable resources protecting the water quality at the Haslam Intake by relocating the Duck Lake Forest Service Road away from the land draining immediately adjacent to the Haslam Lake Intake. This action was important to minimize the chance of a catastrophic hydrocarbon spill that would almost certainly impact the Powell River Water supply. On a smaller scale, a major portion of the human generated sediment adjacent to the outlet of Duck Lake will be curtailed by the repositioning of the informal picnic site, boat launch and a road segment along the southern shore of Duck Lake. These actions, performed with close cooperation of major watershed users, reflect the informed decision making processes underlying the watersheds' present management.

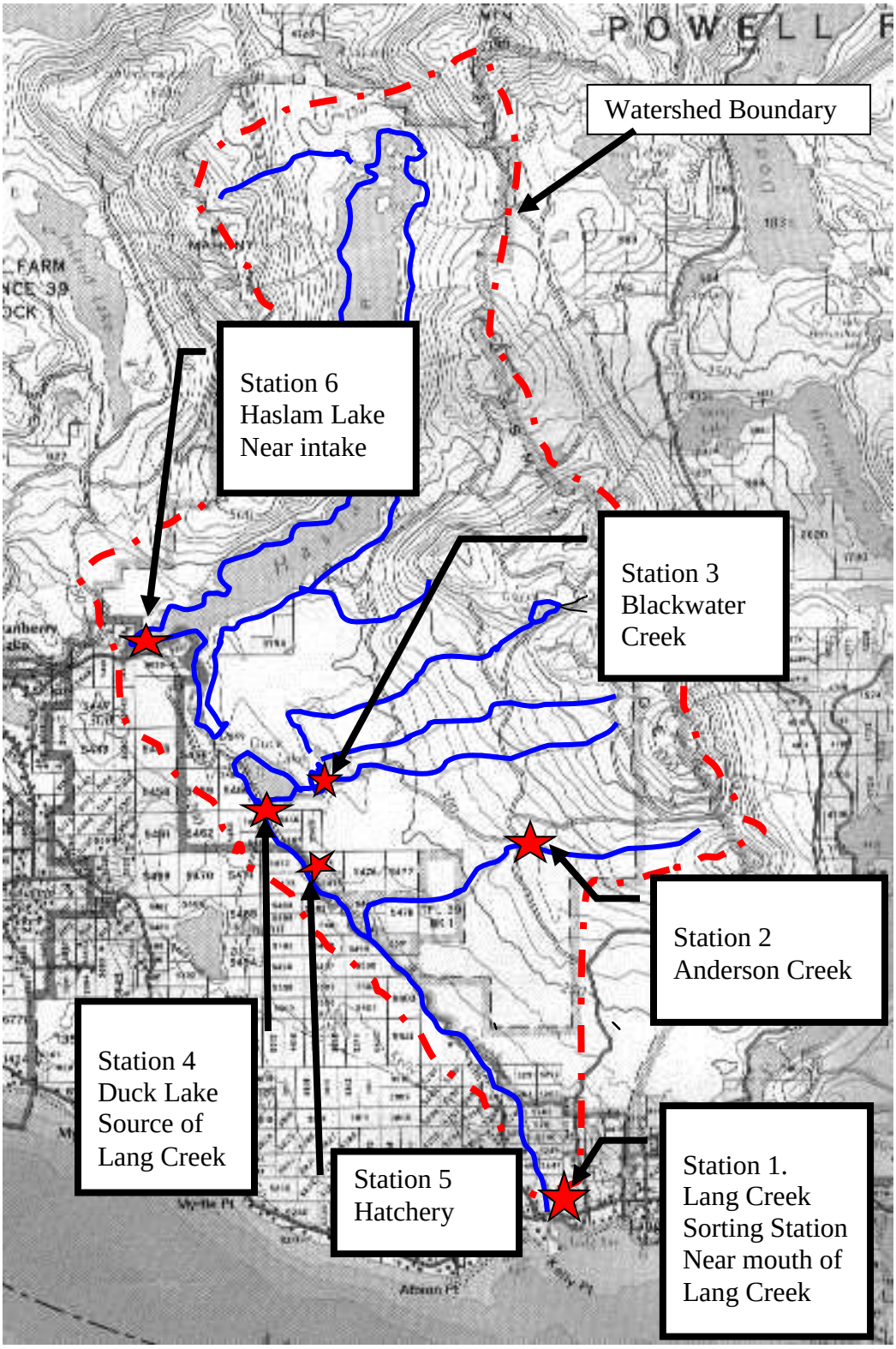
III. METHODOLOGY

The sites chosen for water sampling (as listed in Table 1) are similar to those developed in the original program and are located on the map on Figure 1.

Table 1. Schedule for Monitoring Sites

Station	Sampling Interval	Sampling For
Station 1 Lang Creek Sorting Station Provincial Identification Number E220912	Continuous Bi-monthly	Water temperature, stage, air temperature, and rainfall. Portable meter to check on continuous recorders.
Station 2 Anderson Creek Provincial Identification Number (4 km upstream of E220913)	Continuous Bi-monthly	Water temperature. Portable meter for turbidity, pH, specific conductivity, temperature and stage.
Station 3 Black Water Creek Provincial Identification Number E220914	Continuous Bi-monthly	Water temperature. Portable meter for turbidity, pH, specific conductivity, temperature and stage.
Station 4 Outlet of Duck Lake Provincial Identification Number E220915	Bi-monthly	Portable meter for turbidity, pH, specific conductivity, temperature, and lake level.
Station 5 Upper Lang Creek Hatchery	Continuous	Water temperature.
Station 6 Haslam Lake (near intake)	Bi-monthly	Portable meter for turbidity, pH, specific conductivity, temperature and lake level.

Figure 1. Location of Monitoring Stations within Haslam Lang Community Watershed



IV. SAMPLING PROCEDURES

A. Water sampling for laboratory analyses

No water chemistry laboratory analyses were conducted in 2014.

B. Analysis using portable meters

Bi-monthly analysis of water temperature, pH, turbidity and salinity were conducted using portable meters. Before sampling, the meters were calibrated with standard solutions following directions supplied by the meter manufacturers.

C. Automated samplers

Automated stage, temperature and rainfall recorders are located at the mouth of Lang Creek (Sorting Station). Automatic temperature recorders are located at the Hatchery and on Anderson Creek.

V. RESULTS AND DISCUSSION

Results and discussion of data collected during the course of the monitoring program are presented below. Some water temperature data was collected at 15 minute intervals, others hourly, over the whole year. All of the original digital information used to develop these figures and tables is available on Excel spread sheets at the Powell River Salmon Enhancement Society office.

A. Water Quality

1. Turbidity measurements with portable meter

Turbidity events throughout the Haslam Lang Watershed are episodic and easily missed with spot sampling. However, given the technical difficulties of acquiring good continuous turbidity data, a sufficient number of spot recordings provide an indication of the range of turbidity events that can be expected at any given location. Now that we have more than 2,400 samples taken at 6 sites over 17 years we are able to characterize water quality characteristics of these sites much better than previously.

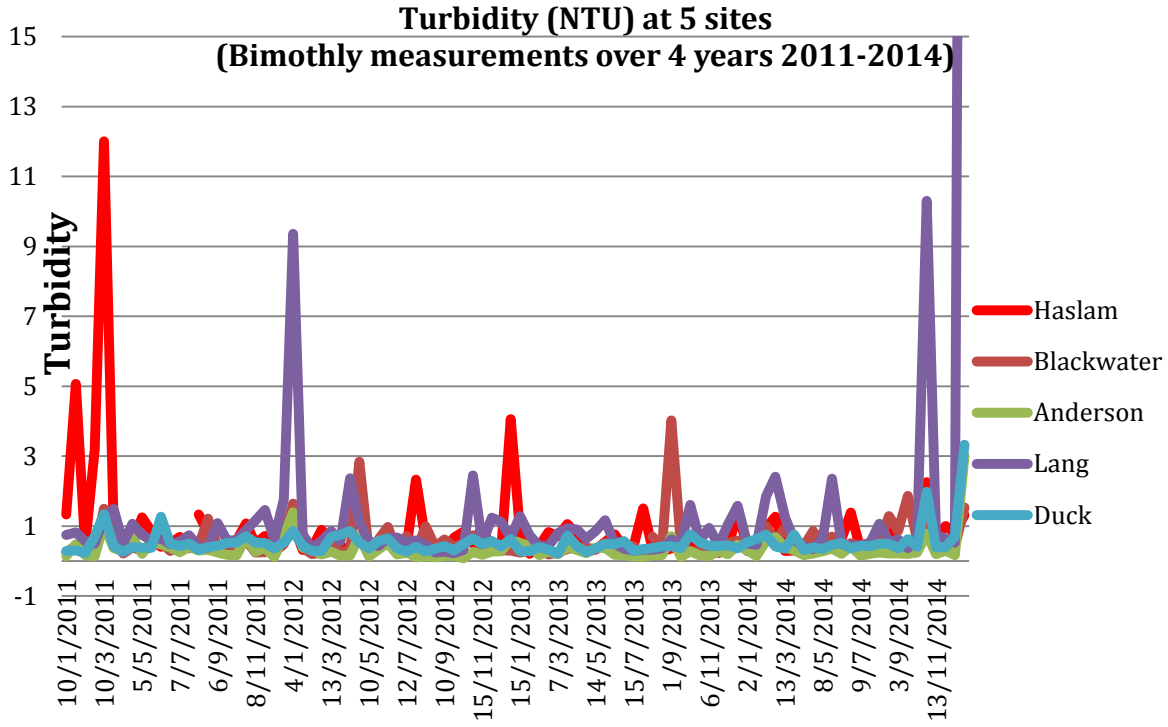
Table 2 shows turbidity data collected in 2014 at 5 sites and flags those with a turbidity in excess of 1 NTU. Turbidities in excess of 1 occurred 8 times out of 25 samples on lower Lang Creek whereas they occurred only 2 times at the outlet of Duck Lake. The Dec 12 storm resulted in higher levels of turbidity at all sampled sites and a record of 57 NTU at the Sorting Station. This turbidity even was almost certainly the result of bank collapse and scouring along yhe main channel of Lang Creek. Anderson, the primary tributary flowing directly into the Lower Lang Creek had only 1 turbidity event over 2014 and was not responsible for any significant increase in turbidity of the main Lang Creek channel. This is in spite of the fact that this catchment has encountered considerable harvesting over the previous few years.

Table 2. Turbidity Values for Bi-monthly samples taken in 2014 (>1 NTU highlighted in yellow)

Date	Haslam	Blackwater	Anderson	Lang	Duck
20/12/2014	1.42	0.58	0.46	1.58	0.36
2/1/2014	0.41	0.29	0.31	0.5	0.54
21/1/2014	0.34	0.23	0.14	0.46	0.63
12/2/2014	0.95	0.99	0.58	1.85	0.76
19/2/2014	1.27	0.56	0.68	2.41	0.42
13/3/2014	0.29	0.95	0.4	1.26	0.35
27/3/2014	0.3	0.51	0.31	0.6	0.76
10/4/2014	0.51	0.43	0.17	0.42	0.32
23/4/2014	0.61	0.86	0.22	0.34	0.39
8/5/2014	0.78	0.33	0.28	0.66	0.34
27/5/2014	0.53	0.7	0.35	2.36	0.46
3/6/2014	0.64	0.38	0.21	0.49	0.52
16/6/2014	1.39	0.51	0.43	0.44	0.36
9/7/2014	0.33	0.41	0.15	0.45	0.44
21/7/2014	0.54	0.51	0.21	0.52	0.43
5/8/2014	0.67	0.54	0.24	1.07	0.5
15/8/2014	0.89	1.29	0.22	0.55	0.49
3/9/2014	0.41	0.87	0.22	0.62	0.36
18/9/2014	0.55	1.86	0.21	0.37	0.63
6/10/2014	0.53	0.59	0.24	0.65	0.41
24/10/2014	2.26	0.98	0.78	10.3	1.98
13/11/2014	0.68	0.37	0.2	0.75	0.39
24/11/2014	1	0.41	0.3	0.65	0.4
5/12/2014	0.81	0.41	0.17	0.53	0.7
11/12/2014	1.31	1.53	3.01	57.3	3.33
Average	.78	.68	.42	3.19	.65

On Figure 2 spot turbidities are provided for the period 2011 through 2014. At all stations, turbidity events are most common between November and March and are usually associated with heavy precipitation, overland flow and an order of magnitude greater discharge. Turbidities rarely exceed 2 NTU for all sites between Spring and Autumn equinox. The samples collected at the Haslam Lake site were taken immediately adjacent to the intake along the shoreline. These periods of elevated turbidity were associated with wave action along an unprotected shoreline during times of high lake levels. The turbidity levels at the intake itself, in spite of its proximity to the sample location, do not exhibit these elevated levels. For the years under observation by the Powell River Engineering Department of water drawn at the intake, there has not been a single turbidity level measured in excess of 1 NTU.

Figure 2.



On Table 3 all bi-monthly turbidity samples are compiled since the sampling program began in 1998. Of the total of 2,407 samples taken at the 5 sites over the previous 17 years, <0.5% of the 5 sites exceeded 10 NTU, 1% fell between 5 and 9.99 NTU, 3% of samples fell between 2 and 5 NTU, 10% of samples fell between 1 and 2 NTU and more than 89% of the samples were below 1 NTU. The great majority of turbidity events recorded were considered to be natural, i.e. not generated by human activities.

This same data, presented in Figure 3 and 4 illustrates the nature of turbidity events at these 5 sites.

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Table 3 Summary of all turbidity measurements taken over 18 years at 5 sites in Haslam Watershed

Sites	Lang		Anderson		Bl'kwater		Duck		Haslam		All sites combined	
Turbidity range	# of sites in range	% of sites within range	# of sites in range	% of sites within range	# of sites in range	% of sites within range	# of sites in range	% of sites within range	# of sites in range	% of sites within range	# of sites in range	% of sites in sample
0 to 1 NTU	342	70.9%	443	93.6%	370	76.4%	456	93.63%	439	91.2%	2050	85.2%
1 to 1.99 NTU	91	18.8%	19	4.0%	90	18.6%	25	5.13%	27	5.6%	252	10.5%
2 to 5 NTU	32	6.6%	7	1.4%	19	3.9%	4	0.82%	11	2.2%	73	3.0%
5 to 10 NTU	10	2.0%	3	0.6%	5	1.0%	2	0.41%	3	0.6%	23	1.0%
>10 NTU	7	1.4%	1	0.2%	0	0.0%	0	0.00%	1	0.2%	9	0.4%
Total	482		473		484		487		481		2407	

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Figure 3

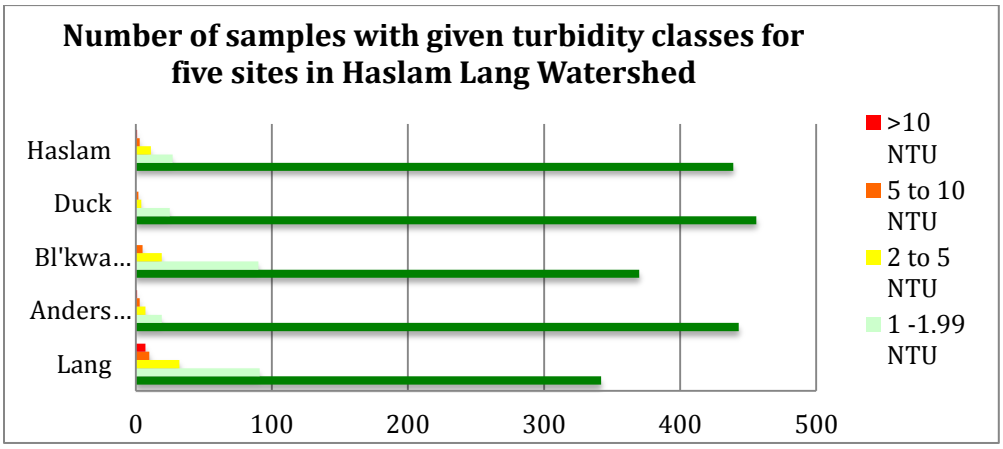
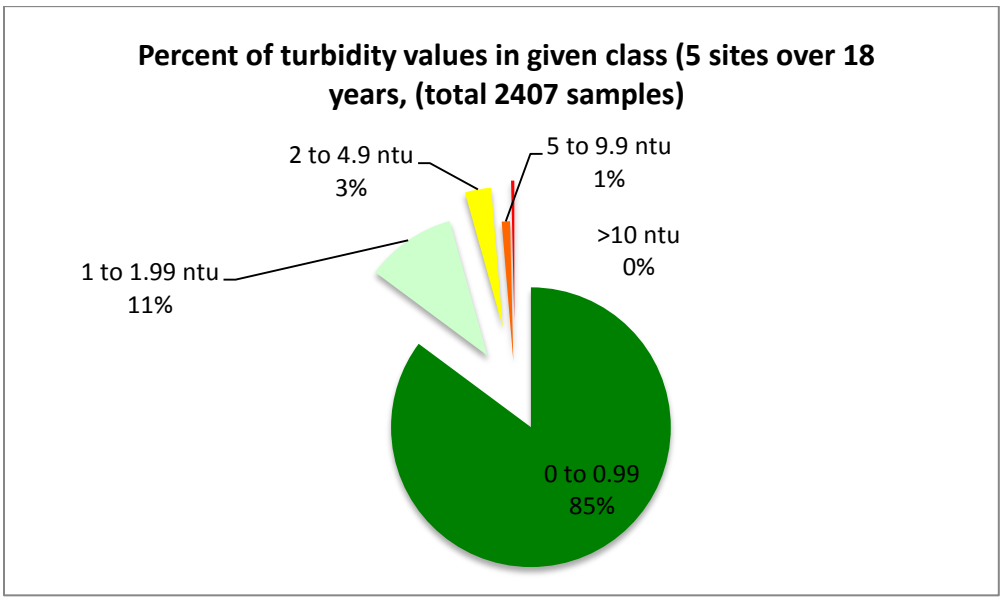


Figure 4



Figures 5, 7 and 9 show the complete bi-monthly turbidity sampling while Figures 6, 8 and 10 provide the range of turbidities experienced at each station. Comparing turbidities collected at these sites shows Anderson Creek, the major tributary of Lang Creek, almost always had a lower

turbidity value that the main stem of Lang Creek. The Duck Lake site always had lower levels of turbidity than Lower Lang Creek site. When sources of turbidity affecting these stations were noted, they were almost always resulting from natural stream sedimentation processes.

Figure 5

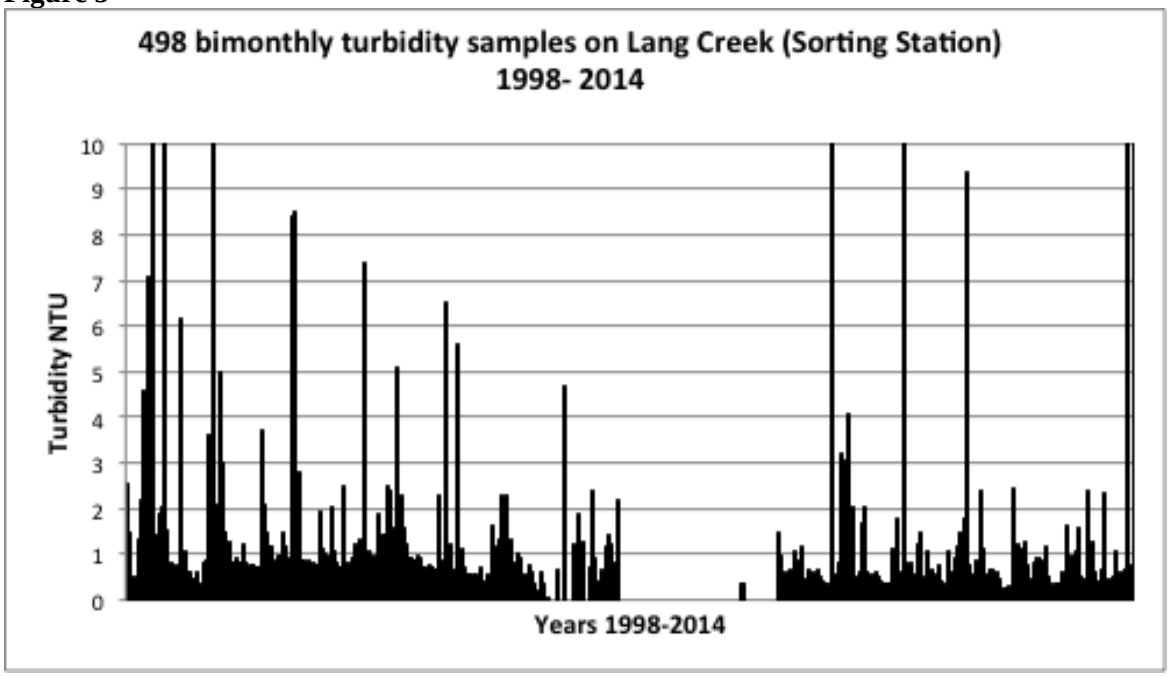


Figure 6

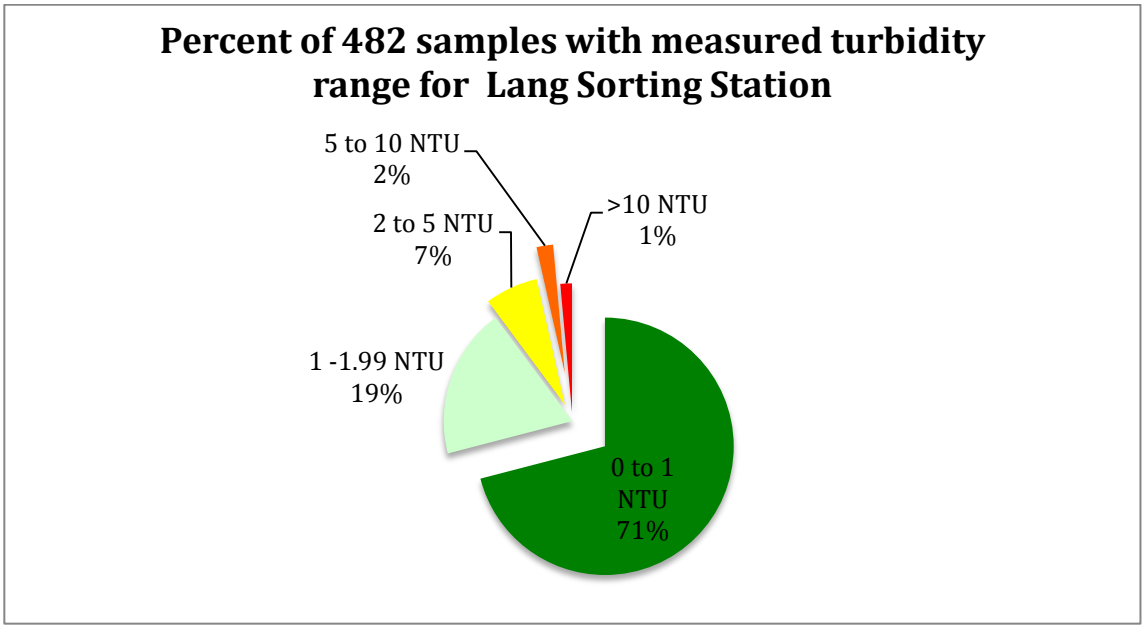


Figure 7

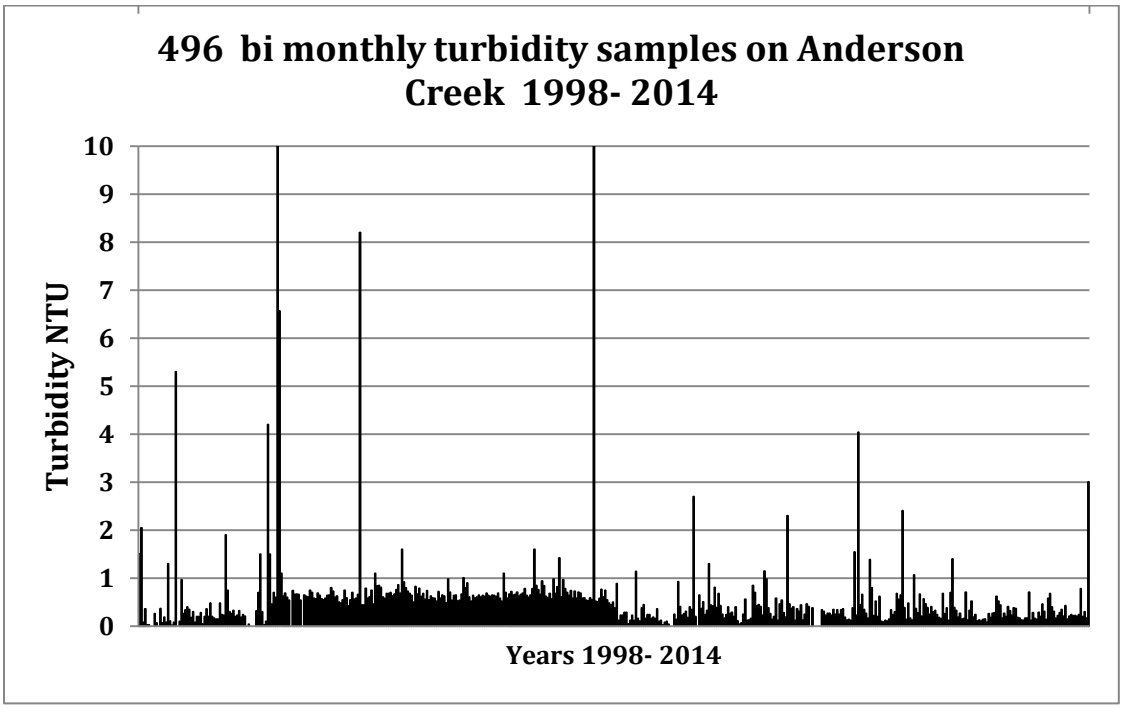


Figure 8

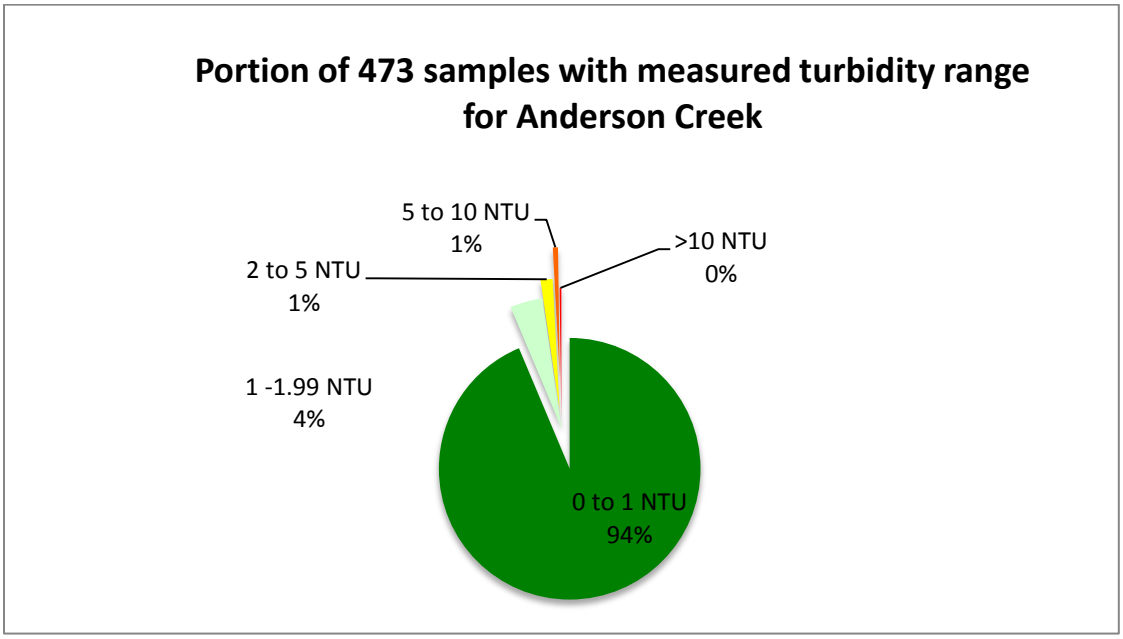


Figure 9

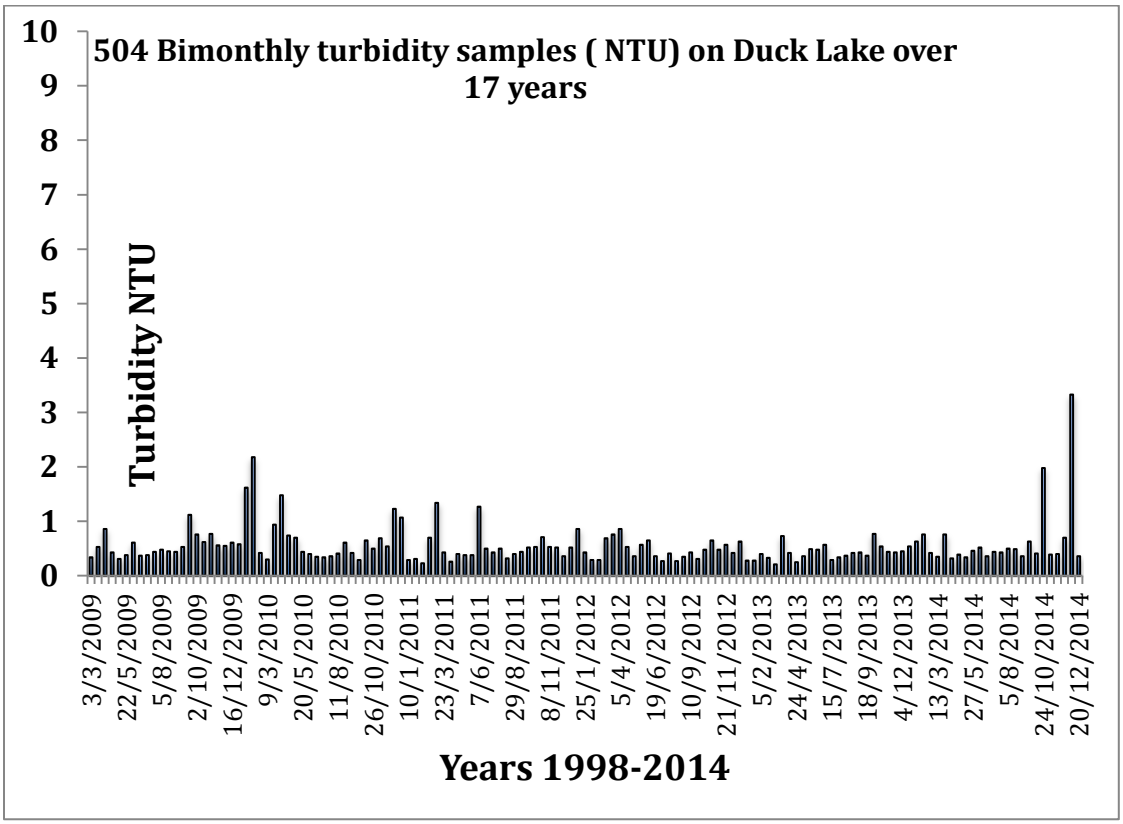
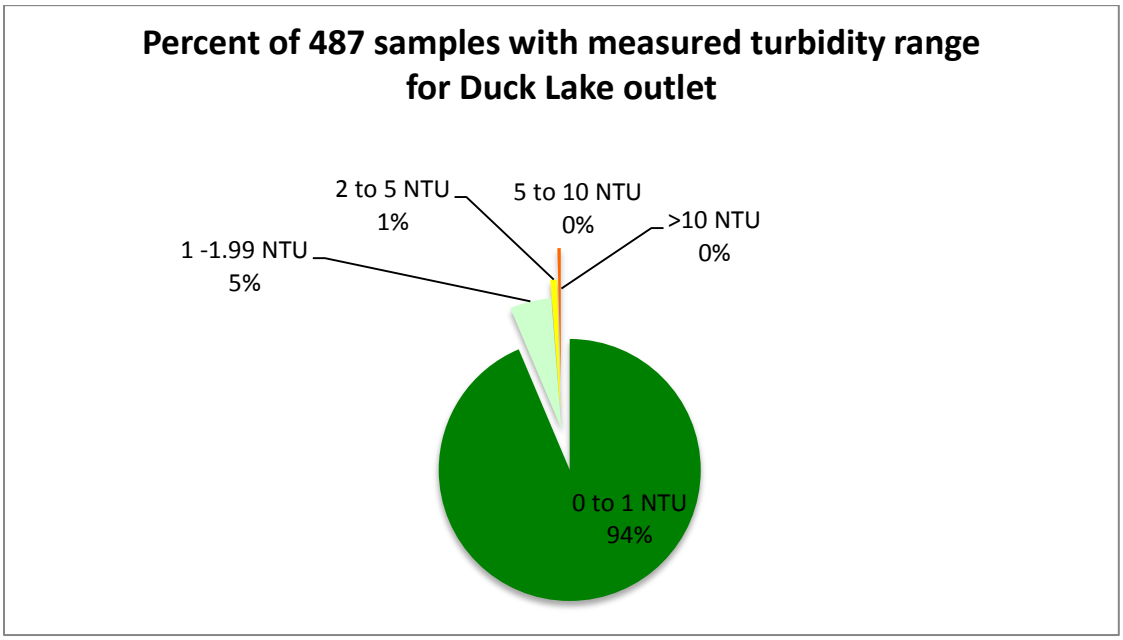


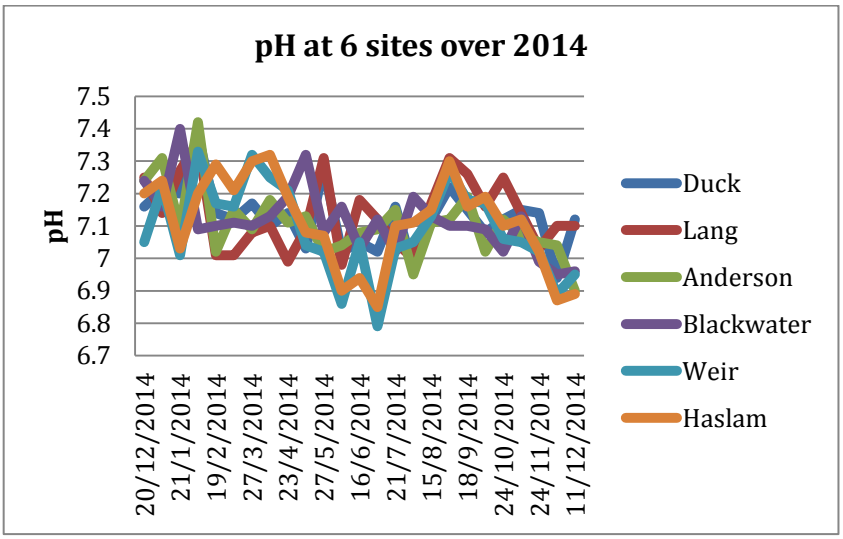
Figure 10



2. pH with Portable Meter

Figure 11 shows the variability of pH over 2014 for the 6 sampling sites within the watershed. The pH is found to be near neutral for most recorded measurements. There is a possiblity that the the pH meter is no longer providing consistently accurate readings as historic trends have shown a slight increase in pH over the summer months rather than the reverse which is shown here.

Figure 11



3. Electrical Conductivity

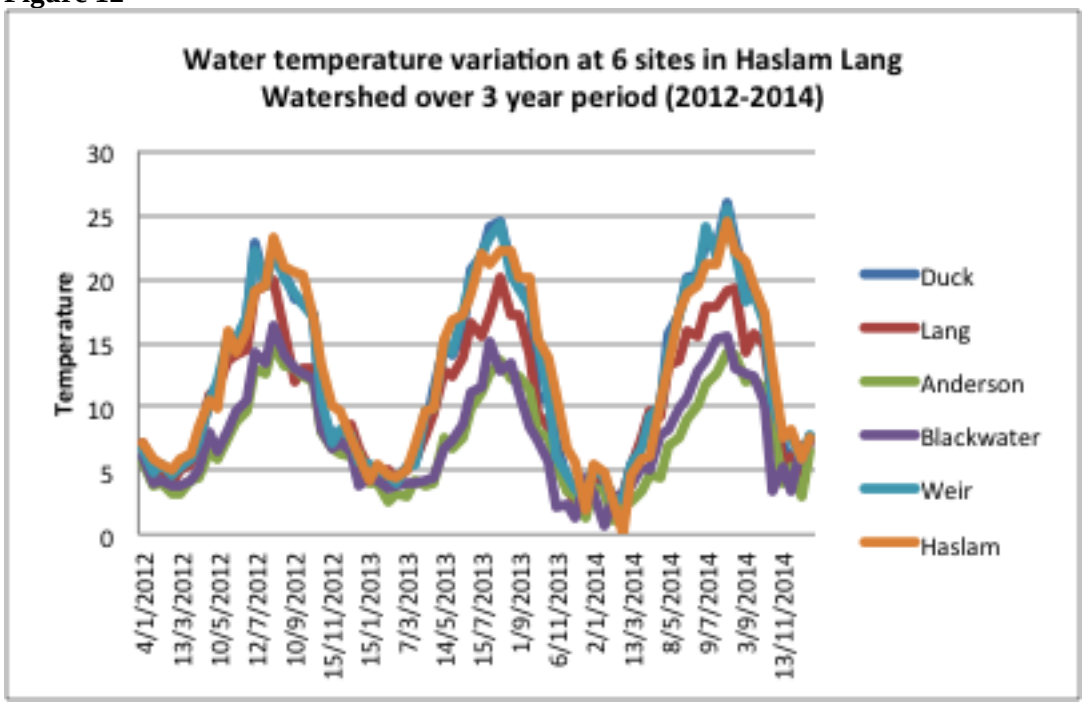
In all sampling to date, the data indicates extremely low electrical conductivity meaning that dissolved salts are available in only very low concentrations throughout the watershed. There is an indication that the sensor probe used may not accurately measure variability at these low concentrations.

B. Water Temperature Monitoring Results

1. Bi-monthly Manual collection from 6 sites within the watershed

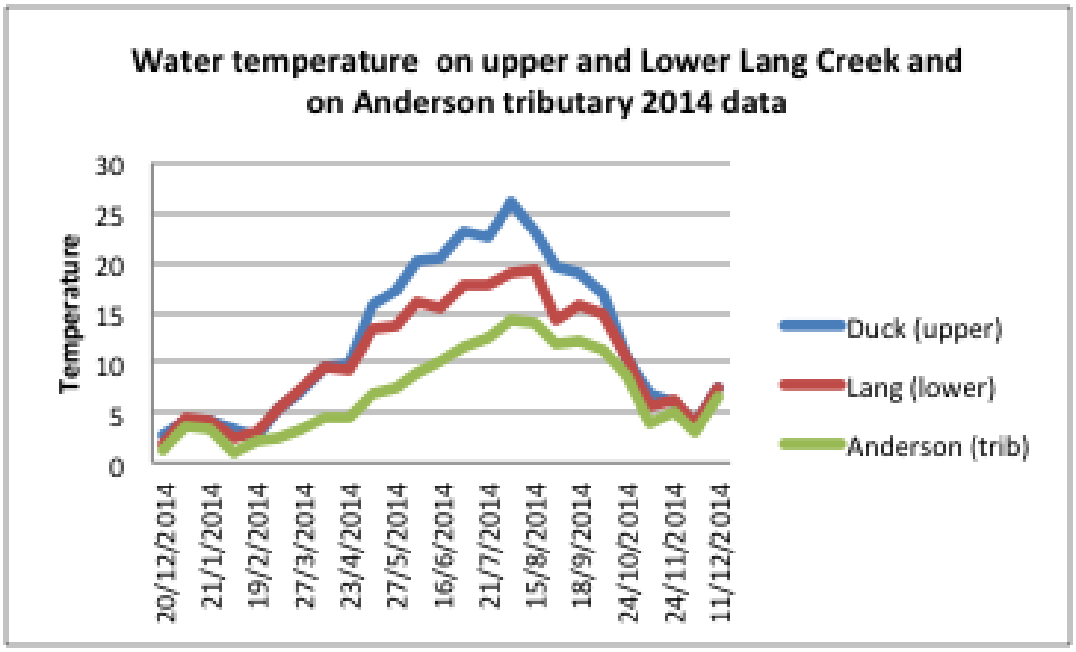
Figure 12 shows the range of, and variability between water temperatures of the major sampling sites from 2012-2014. The three years of data reflect the same pattern. Highest summer temperatures (>22 ^{o} C) are recorded at the surface of lakes, (Haslam, Slough, Duck) lowest summer temperatures from small streams under forest cover (Anderson and Blackwater Creek) and intermediate summer temperatures on streams where warmer lake water is cooled as it flows through forested riparian zone (Lang).

Figure 12



On Figure 13 the cooling effect of Lang Creek water passing from Duck Lake to the mouth is portrayed. During the hottest period in the summer, Lang Creek can be cooled as much as 4 degrees centigrade along its passage. Evapotranspiration and direct shading from riparian vegetation likely assist in this cooling effect as well as additions of cooler water from Anderson Creek. Unnamed creeks east of Anderson Creek and ground water seeping directly into the channel may also be important.

Figure 13



2. Continuous water temperature records

On Figure 14 daily max min water temperature data for Lang Creek Sorting Station is provided for 2014. Note that for the warmest period of the summer, there is a diurnal fluctuation of more than 2 degrees C at the mouth whereas there is very little or no diurnal fluctuation in winter months.

Figure 14

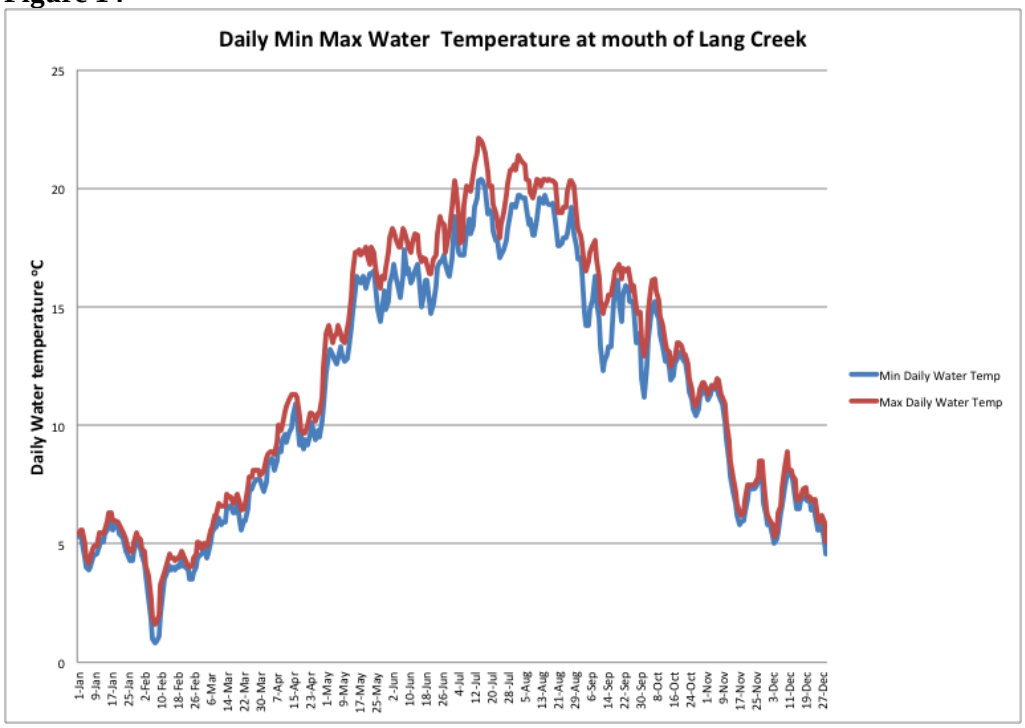


Figure 15 provides water temperatures on Lower Lang Creek for the hottest 10 day interval of the year, peaking on July 14, 2014 with a temperature of 22 ^{0}C.

Figure 15

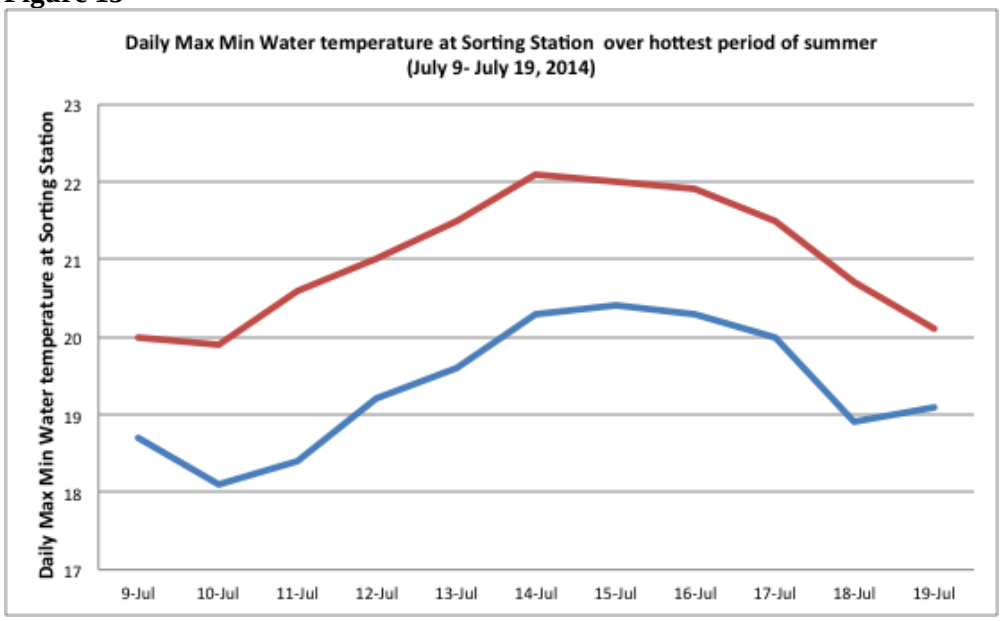


Figure 16 is a compilation of all ¼ hourly water temperature data collected over the summer of 2014. The graph clearly shows the two major warm spells over the summer superimposed onto the daily oscillations.

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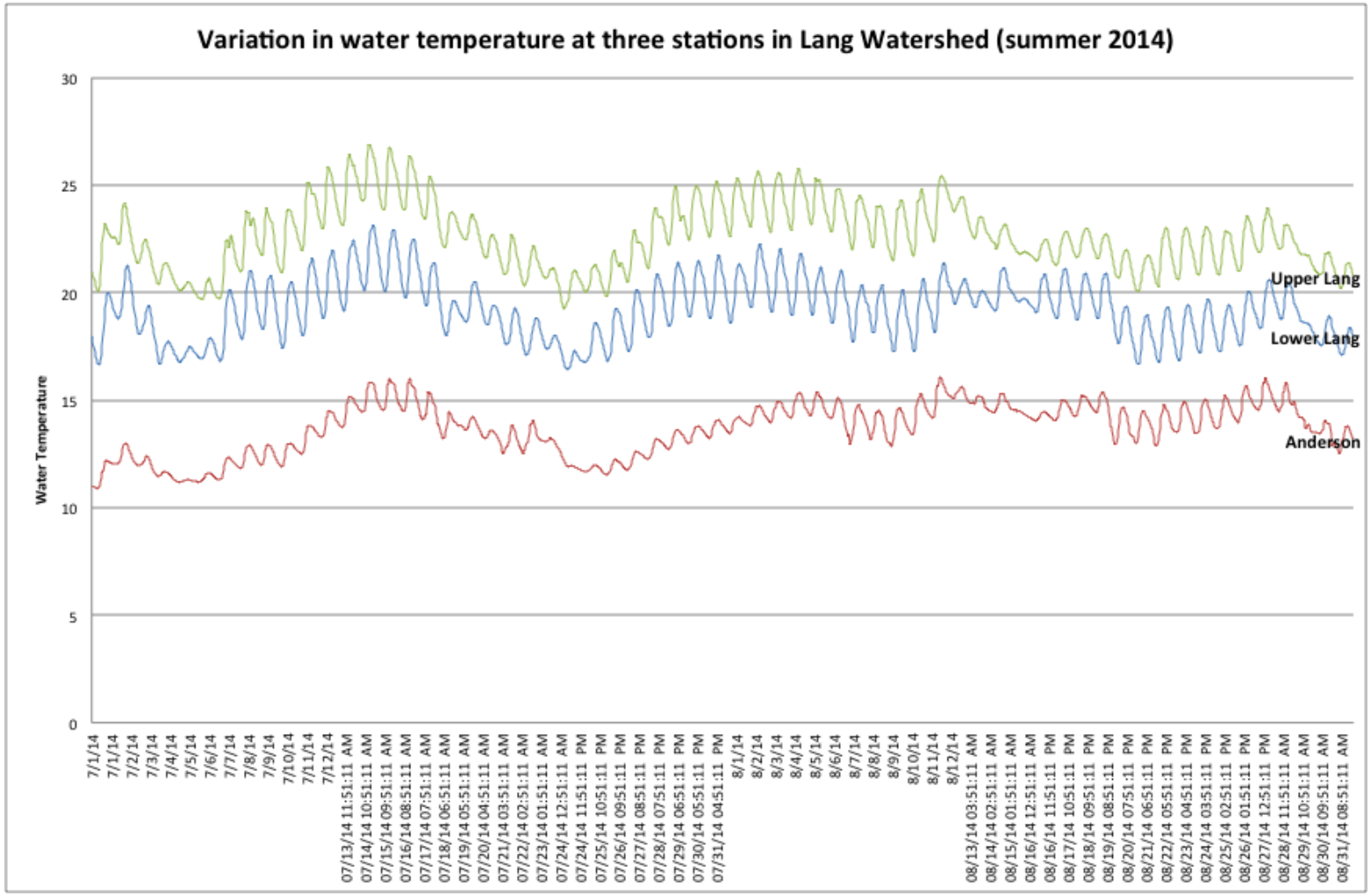
Figure 16



On Figure 17 the hottest 5 day interval over the summer of 2014 was recorded. Survival strategies of resident Coho may depend on the both the diurnal cooling and the much cooler tributary streams. Note that the warmest temperature on lower Lang is staggered by approximately 4 hours from that measured on upper Lang Creek, mirroring the duration of passage (and cooling) down the Lang Creek channel.

Figure 17

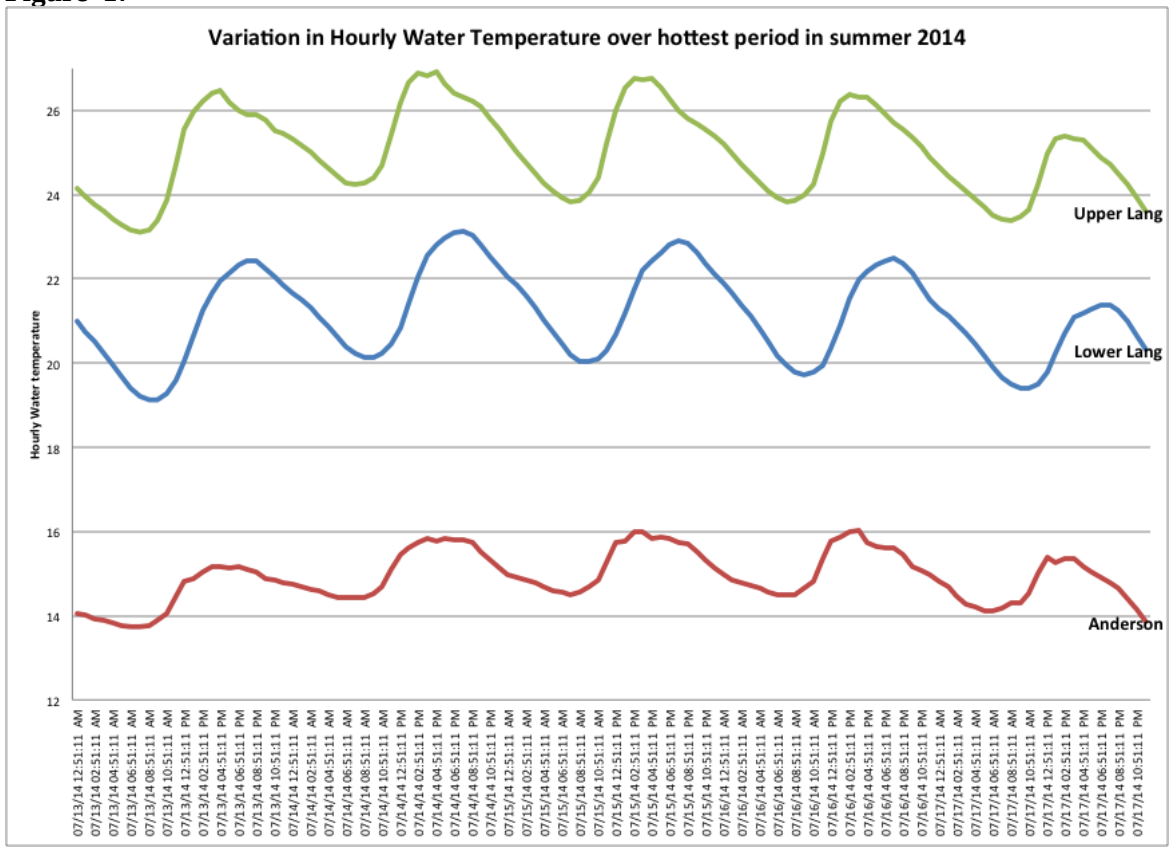


Figure 18 and 19 show the variation in water temperature from Duck Lake and Anderson Lake from bi monthly samples taken since 1997. Annual fluctuations are fairly consistent and no obvious long term trend in warming or cooling of water is noted over this time interval.

Figure 18

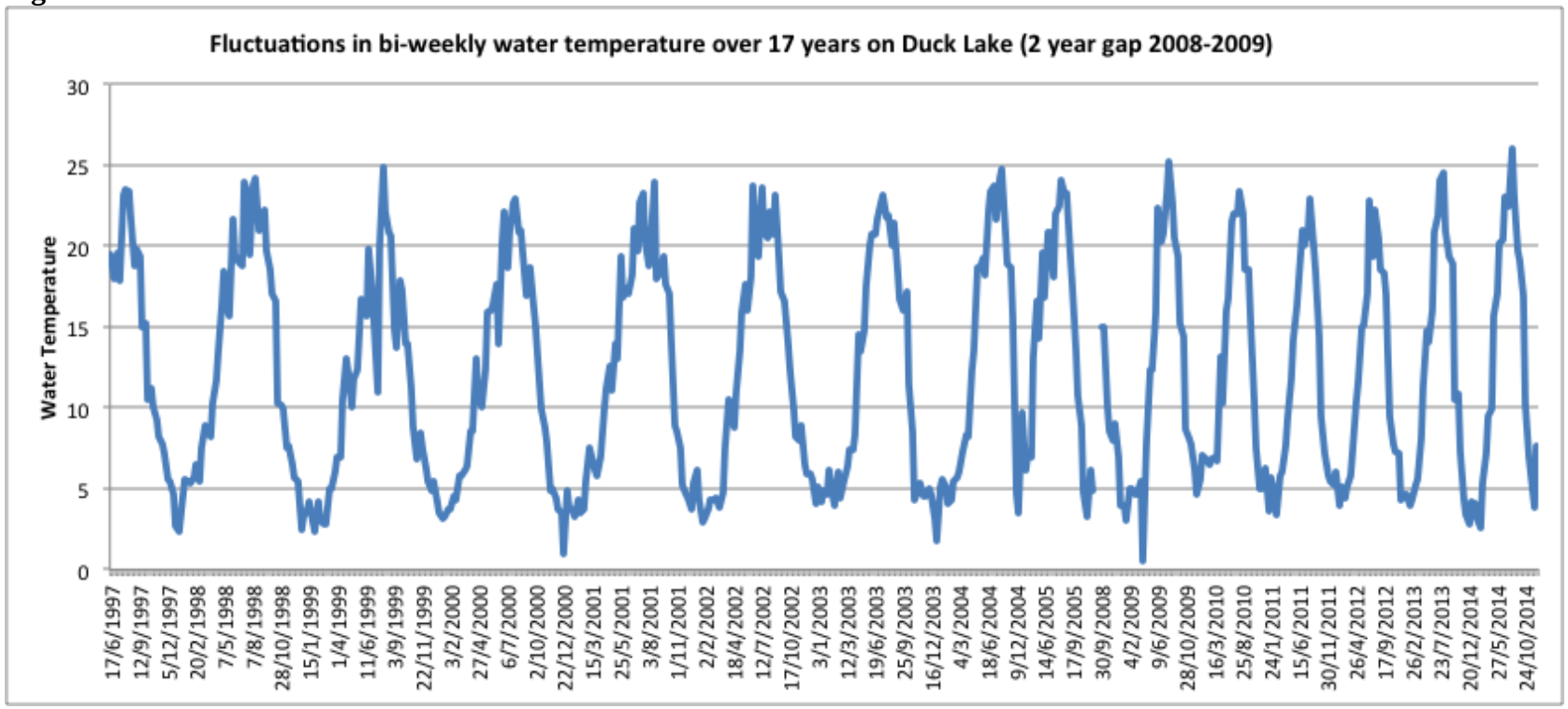
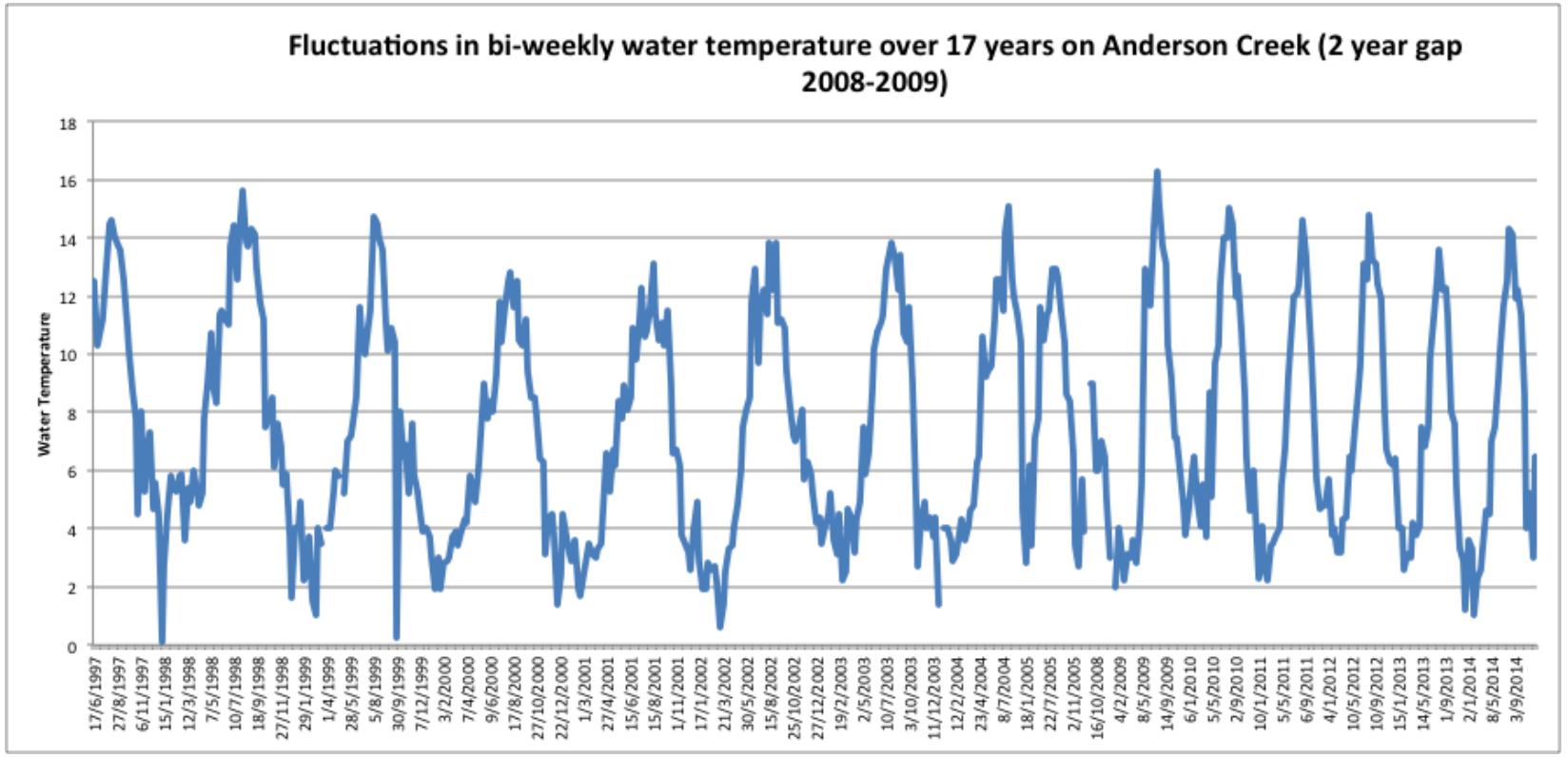


Figure 19


Fluctuations in bi-weekly water temperature over 17 years on Anderson Creek (2 year gap 2008-2009)
Water Temperature
0
2
4
6
8
10
12
14
16
18
17/6/1997
27/8/1997
6/11/1997
15/1/1998
12/3/1998
7/5/1998
10/7/1998
18/9/1998
27/11/1998
29/1/1999
1/4/1999
28/5/1999
5/8/1999
30/9/1999
7/12/1999
3/2/2000
7/4/2000
9/6/2000
17/8/2000
27/10/2000
22/12/2000
1/3/2001
27/4/2001
15/6/2001
15/8/2001
1/11/2001
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21/3/2002
30/5/2002
15/8/2002
25/10/2002
27/12/2002
19/2/2003
2/5/2003
10/7/2003
3/10/2003
11/12/2003
12/2/2004
23/4/2004
8/7/2004
18/1/2005
22/7/2005
2/11/2005
16/10/2008
4/2/2009
8/5/2009
14/9/2009
6/1/2010
5/5/2010
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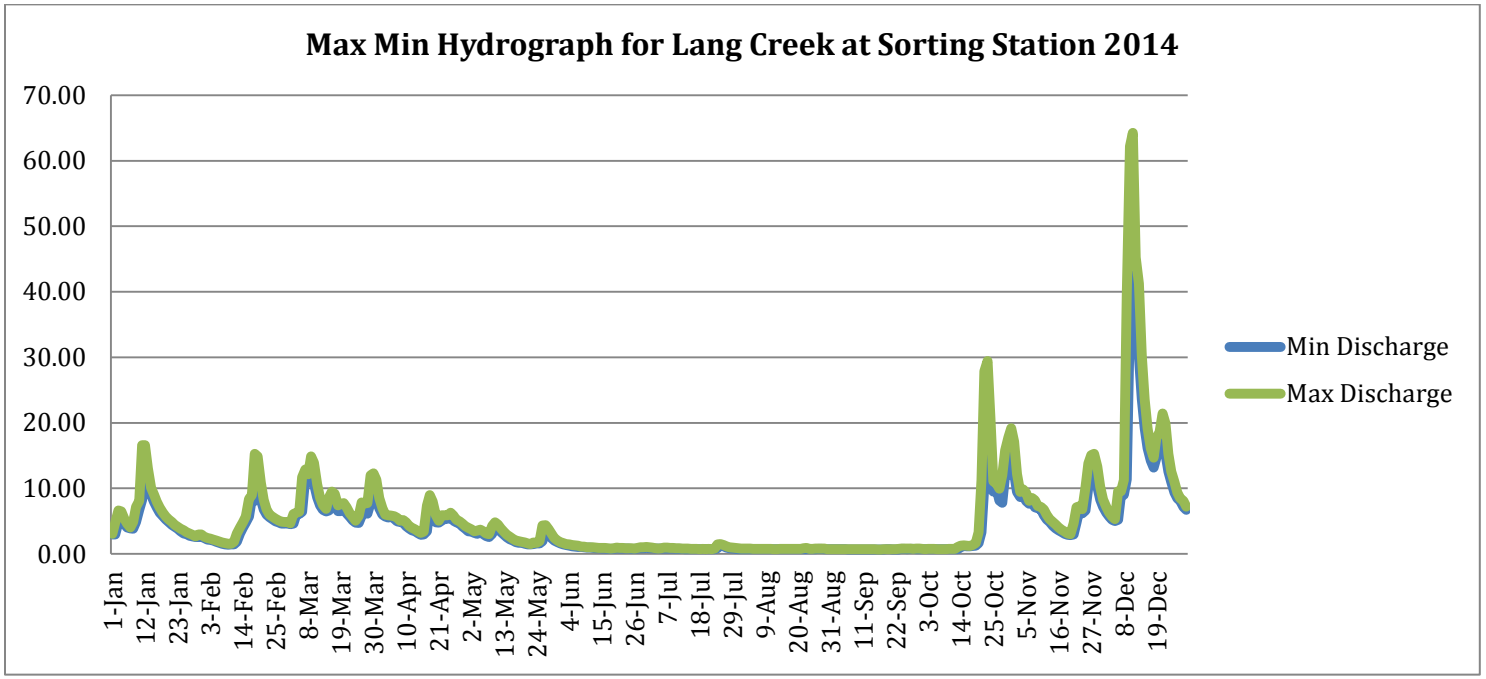
10/5/2012
10/9/2012
15/1/2013
14/5/2013
1/9/2013
2/1/2014
8/5/2014
3/9/2014

C. Water Quantity and Timing of Flows

On Figure 20 the max min hydrograph for 2014[1] is presented. Daily changes in discharge of more than 100% are commonly recorded during winter storms. As has been discussed in previous reports, the lakes create a major hydrological and water quality buffer for the majority of the watershed. Anderson Creek, being unbuffered, is a major storm water contributor during peak flows on lower Lang Creek. Looking back on turbidity data that shows Anderson Creek to always have much lower turbidity levels than Lang Creek we can infer that a disproportionate amount of the turbidity measured at the mouth of Lang Creek is generated within Lang Creek Channel itself.

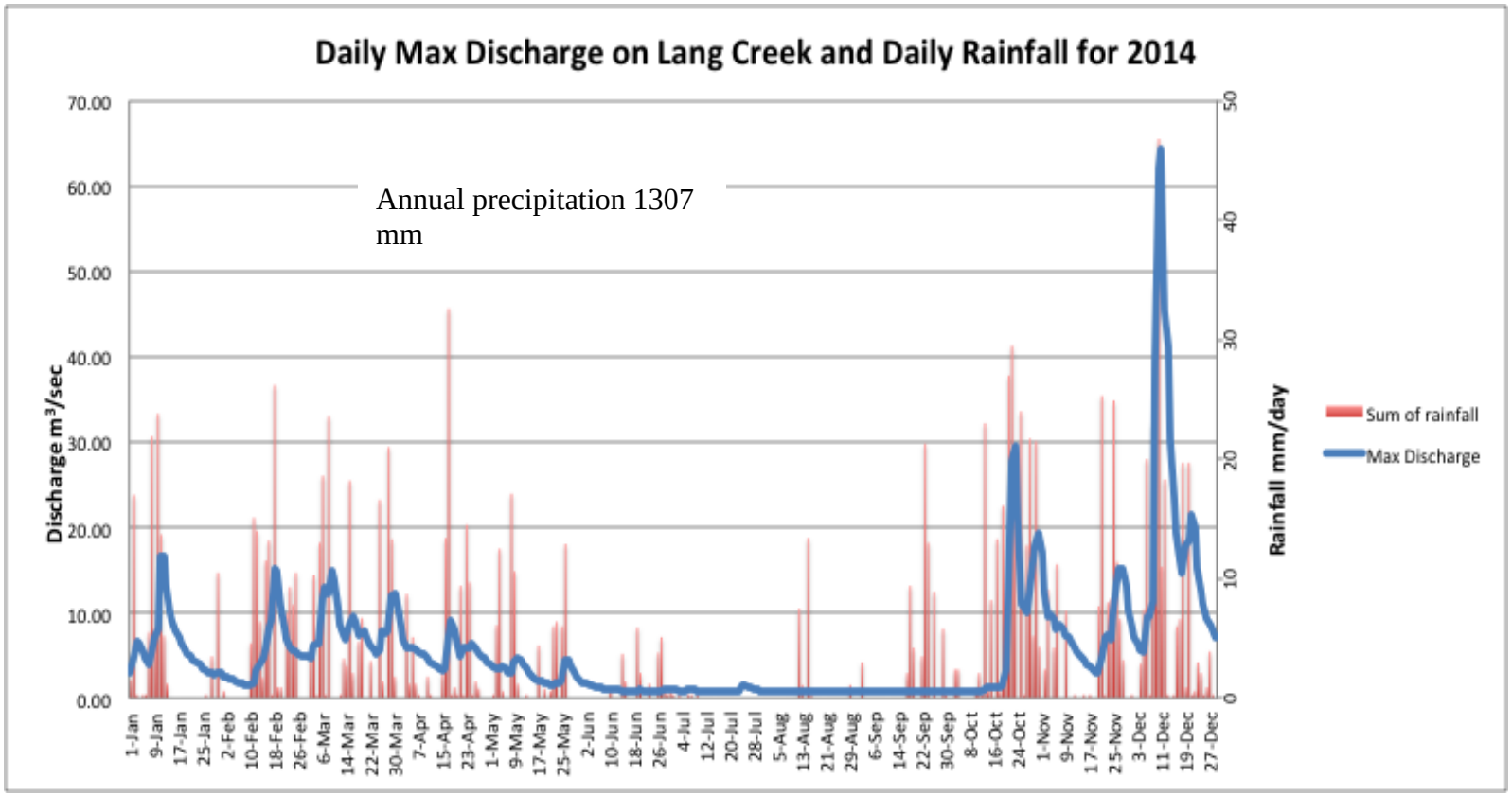
Figure 20



[1] The Stage discharge curve ($y=28.01x^2-18.193x+3.638$) developed in 2012 was used to develop this hydrograph. Because there were no actual measurements taken at these very high stage levels, (1.81 m) actual discharge values reflect considerable uncertainty.

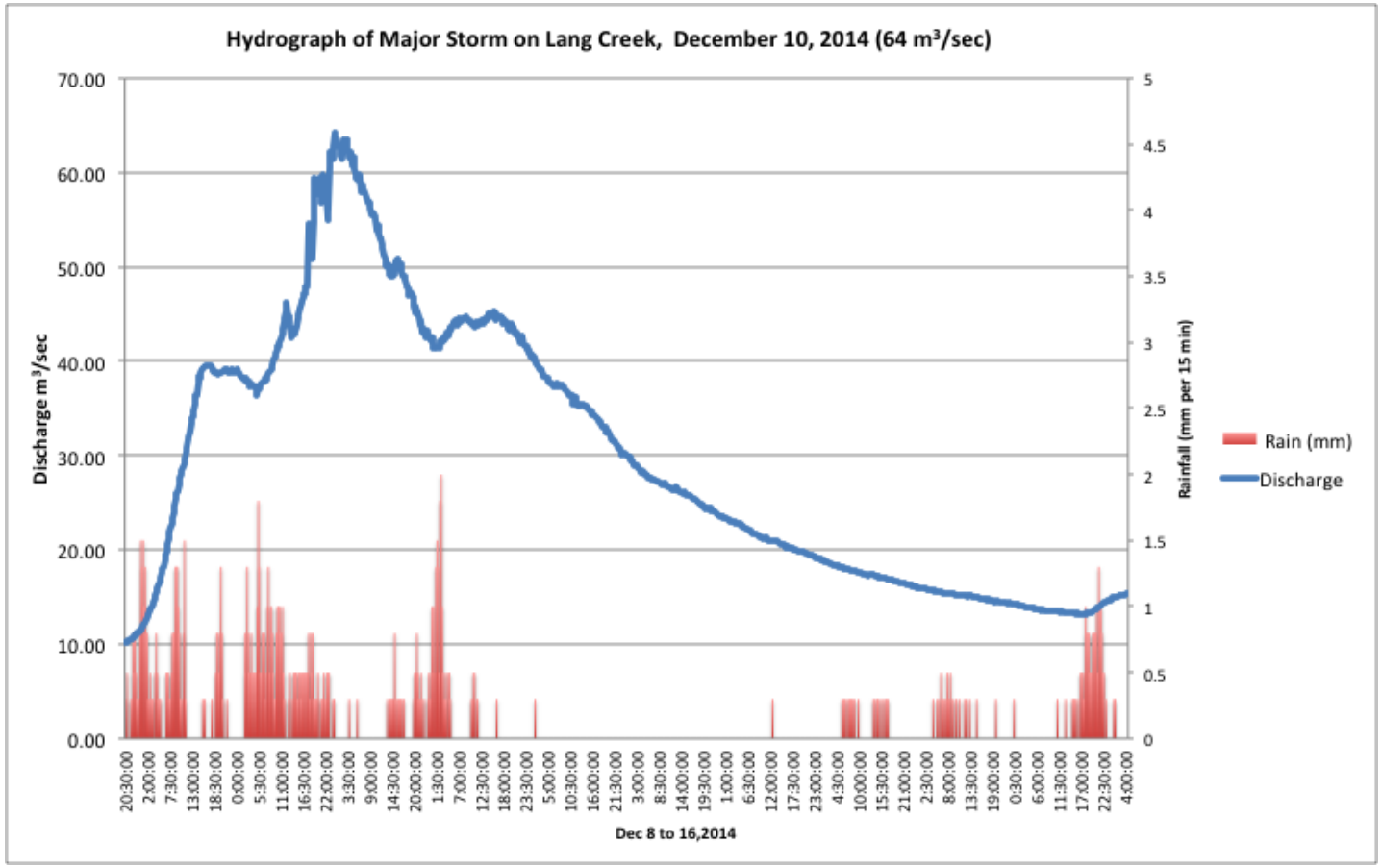
On Figure 21 we see the daily rainfall overlain with the hydrograph. The highest recorded instantaneous flow in 2014 was 64 m^3/sec. (using the stage discharge curve based on equation $y=28.01x^2-18.193x+3.638$) This discharge is the highest measured since 1998. There is considerable uncertainty of actual discharge levels at these higher stages because the highest stages have been extrapolated from measurements made only at lower stages. Total rainfall at the sorting station was 1,307 mm in 2014, 30% above average annual rainfall.

Figure 21



On Figure 22 the hydrograph of the December 10, 2014 storm is recorded including the 15 min interval precipitation totals.

Figure 22



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VI. CONCLUSIONS AND RECOMMENDATIONS

The data collected by the Salmon Enhancement Society supports a general conclusion that neither water quantity nor quality has been adversely impacted by forest industry operations in 2014. A CWAP analysis under way mirrors that conclusion. By re-evaluation of historic data collected over the last 17 years within the Haslam Drainage we conclude there is an ongoing ability to supply raw water of sufficient quantity and good quality at the Haslam Lake Intake. The Brew Bay Water Users Group and the Powell River Salmon Enhancement Society, holding the two water licenses on Lang Creek, have adapted to the periodic natural turbidity events that characterize that stream channel irrespective of potential land use impacts. All three water users are dependent on the weir for summer storage on Haslam Lake and maintaining summer low flow on Lang Creek.

Some monitoring recommendations include:

1. Basic water chemistry analysis including TTS, turbidity, CaCO3 equivalent, TOC, colour, faecal coliform, total metals should be considered for the 2015 field season. This might be done concurrently under the auspices of another government ministry involved in the original Integrated Watershed Management Plan.

2. The pH/ Salinity Meter is not producing consistent results and either needs replacing or refurbishing of its electrodes.

3. The Salmon Enhancement Society might consider re-establishing the stage discharge curve on Anderson Creek considering the importance of that drainage to peak flows on the main Lang Creek Channel.

4. With the going concerns of climate change and possible increases to water temperature and its effect on fish populations, the temperature monitoring portion of the program is likely going to be of even more importance than in the past. In particular, the discharge and temperature of the small drainages flowing into lower Lang Creek (below the confluence with Anderson Creek) should be measured during the time of highest temperatures on Lang Creek. This data would help to establish whether riparian vegetation of small non-fish streams is providing any useful cooling effect during periods of high temperature. The actual day or days of observation could be conducted by volunteers of the Salmon Enhancement Society and would be triggered by temperatures in excess of 21 degrees centigrade at the Sorting Station.

5. The Powell River Community Forest has acquired LIDAR mapping for much of the watershed. This data should be made available to the Powell River Salmon Enhancement Society for accurately locating small streams under forest cover, particularly in the lower Lang Creek area.

Annex

Salmon returns on Lang Creek between 1990 and 2014 (Data provided by Powell River Salmon Enahancment Society). While there is considerable variability in annual returns, overall the salmon populations are considered to be healthy. Reasons for peaks and troughs are often difficult or impossible to assess.

Figure A (Chum returns)

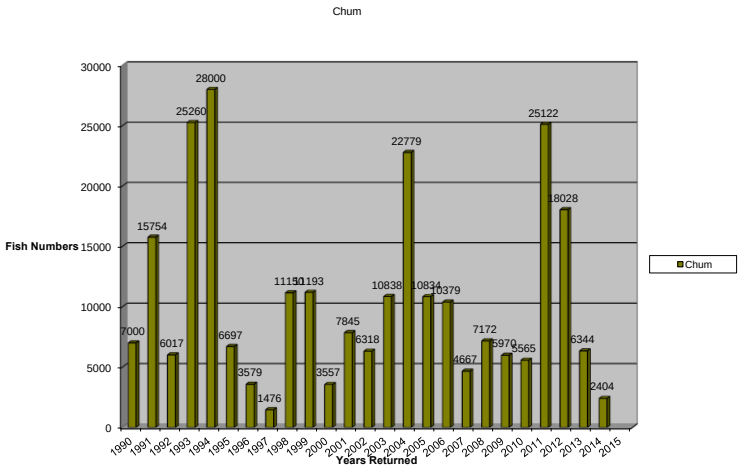

Figure B Coho returns

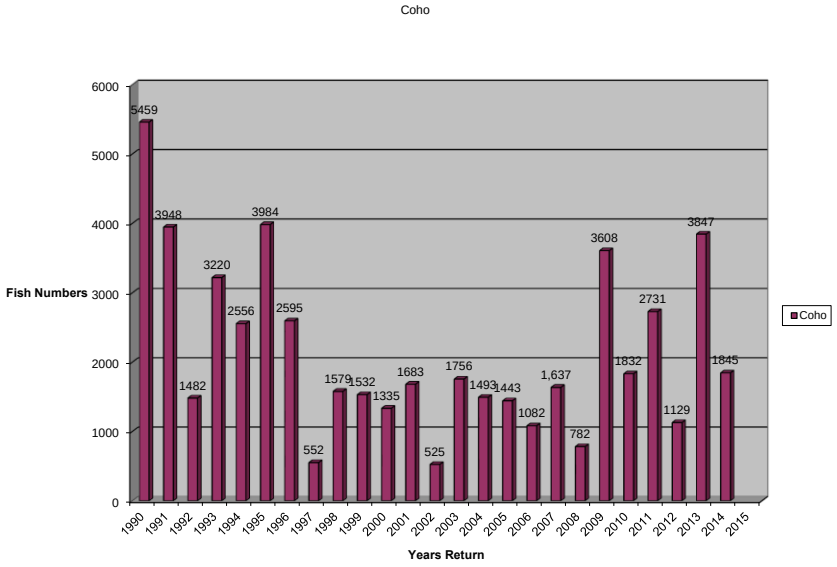

Figure C. Chinook Returns

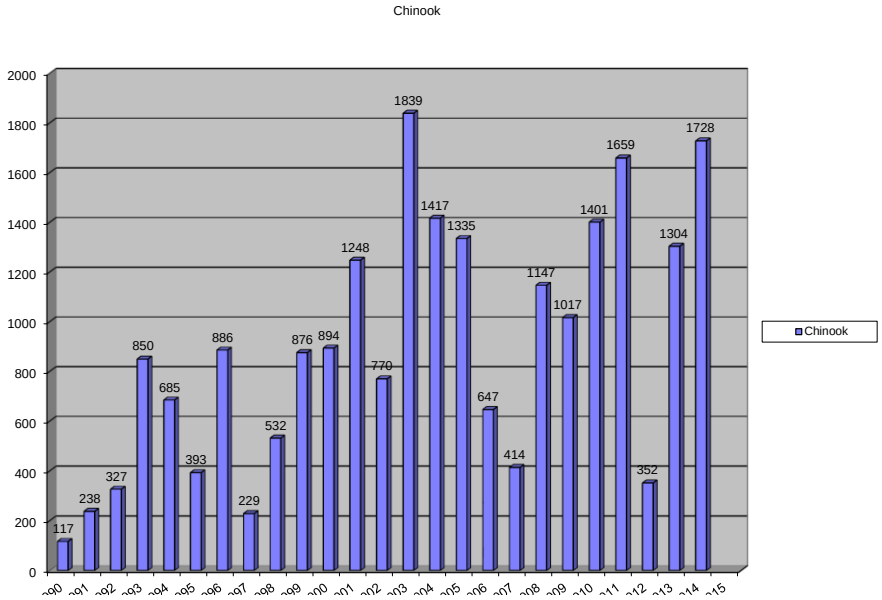

Figure D. Pink returns.