



# The River Mile Water Quality

## Lesson # 5

## Water Quality: Temperature



Developed by the Lake Roosevelt Forum to support "The River Mile" National Park Service Program

**Suggested duration:**

90 minutes to  
optional multi day

**Inquiry Question:**

How does temperature  
impact water quality?

**Inquiry Process:**

Interpreting data to  
understand implications

**Standards:**

PS3 – energy & heat

**Formative Assessment:**

Analysis based on  
comparing Ecology  
temperature data for  
Grand Coulee, Hawk Creek  
and North Port

**Materials:**

Thermometers, beakers,  
water samples of varying  
temperatures  
Or trip to water body  
location for testing

**Handouts:**

Student science journal  
L5 Student Handout  
Canary in the Coal Mine  
Optional  
GLOBE Temperature Lab  
Project Introduction:  
Water Footprint Intro:  
Lesson 10

**Credits/Citations:**

<http://www.bpa.gov/corporate/education/kidsinthecreek/water.cfm>

Globe Temperature Lab

**LESSON # 5****Water Quality: Temperature****INTRODUCTION:**

**Temperature** - Certain types of fish, like rainbow trout, kokanee salmon and other aquatic organisms need cold water temperatures to thrive. Temperature is monitored to observe changes from month to month, season to season, and overall trends from year to year. Temperature may also directly affect the amount and location of aquatic plant growth.

Scientists studied the Columbia and Snake River systems to understand what causes increased temperatures. They analyzed everything from climate change to paper mills. They found that the biggest influence on temperature is hydroelectric reservoirs. Scientists estimate that the reservoir (Lake Roosevelt) behind Grand Coulee can increase water temperature in the Columbia River by as much as 3-5 degrees Celsius above natural conditions. Logging practices and the removal of shading vegetation next to waterways can also have a major impact on water temperatures. Global climate changes have and will continue to alter temperatures. In general it is not the temperature itself that kills fish, it is low dissolved oxygen caused by high temps. As temperature increases, less oxygen can be dissolved in the water.

**STUDENT WORK AND ASSESSMENT**

Student formative assessment is based on teacher observation, student reflection, and evidence of accurate data analysis and interpretation.

**QUESTIONS TO EXPLORE/INSTRUCTIONS/PROCEDURE**

1. Introduce Temperature Investigation by using the power point provided. Students first write their ideas in the handout provided and then add information from the presentation
2. Mini lesson 1: Students use graphed pH data from 4 Columbia River & Lake Roosevelt locations and reflect their experience in Lesson 4 of testing pH
3. Compare, analyze and present temperature data using data tables, line, bar & radar graphs
4. Activity: The Canary in the Coal Mine - Analyze Department of Ecology WQ Data for CR & LR and determine which fish will die first when water temperature increases.
5. Option: test water of different temperatures for dissolved oxygen. A basic test kit would work well for this. How do these values compare to what they saw in Lake Roosevelt during the field trip? GLOBE Temperature Lab: **Note: Full details are provided in the unit appendices.**

**HOMEWORK: (15 m)**

Introduce Lesson 10: Water Footprint. Students begin recording data over the weekend and continue for 3-5 days with 2 days to implement their water reduction plan before Lesson 10 results analysis.

# WATER QUALITY: TEMPERATURE

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**Essential Questions:**

How does temperature impact water quality?

**Inquiry Questions:**

How can temperature data predict species survival in Lake Roosevelt and its tributaries?

**Objective:**

You will:

- Make and record accurate temperature readings
- Analyze Ecology temperature data and predict the impact on aquatic species
- Understand natural and human factors that impact water temperatures
- Explore solutions to reduce water temperature

**Preparation from Lesson 4:**

Think about your experience in Lesson 4 of measuring the pH of water samples and common household substances. Today we will explore the impact of temperature on water quality and some of the factors that can cause temperature to change.

**Think Time:** Things I already know about temperature and some questions running around in my mind....

**Notes: Identify key points about temperature**

Why is water temperature important?

How is temperature measured?

In what ways are aquatic organisms impacted by temperature?

What are some of the ways water temperature changes?

What is the relationship between air and water temperatures?

How do temperatures differ between various locations along the Columbia River and throughout Lake Roosevelt?

**Suggestions for Selecting Water Samples:**

- Identify one water body and one location. Measure the temperature at regular intervals over a period of time (e.g., daily, weekly, monthly) at the same time of day and at the same depth.
- Identify one water body and multiple locations. Measure the temperature at each location (e.g., shaded or open and sunny, slow or fast water flow, water near banks with and without plants and natural vegetation). Measurements are taken at the same time of day and at the same water depth.
- Identify one water body and one location (from a boat, dock or bridge and test multiple depths

**Temperature Measurement Procedure:**

1. Measure and record both air and water temperatures using a °Celsius thermometer
2. Use a °Celsius temperature probe to repeat the water temperature measurement.
3. If possible, record temperature data using both methods. Use an excel spreadsheet to create charts and graphs that can help you identify patterns between air and water temperatures and explain any discrepancies between the thermometer and probe readings in water temperature data.

Water Sample	Thermometer °C	Temperature probe °C	+/-Results Explain any large differences	Air Temp °C

Water Sample	Thermometer °C	Temperature probe °C	+/-Results Explain any large differences	Air Temp °C





## Canary in the Coal Mine or Fish in Hot Water!

Compare the Lake Roosevelt water temperature data for Grand Coulee, Hawk Creek and North Port with the highest 7 DAD Maximum temperatures for fish survival. Fill in the chart provided. Identify the months and location when recorded temperatures exceed the survival temperature for each species. Analyze the data and answer the questions below. [2008-09 data is from www.ecy.gov](http://www.ecy.gov)

Aquatic Life Temperature Criteria	Highest 7-DAD Max °C	Mark each month below with the locations (GHN) in which the fish would die due to temperature. The first 3 for Char Spawning are done for you.											
		Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
Char Spawning	9	GHN	G N	G									
Char Spawning & Rearing	12												
Salmon & Trout Spawning	13												
Core Summer Salmonid Habitat	16												
Salmonid Spawning, Rearing & Migration	17.5												
Salmonid Rearing & Migration Only	17.5												
Non-Anadromous Interior Redband Trout	18												
Indigenous Warm Water Species	20												

WQ Data Collection Location	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
2008-09 Grand Coulee (G) TEMP °C	18.3	14.6	11.3	4.9	5.3	6.8	6	7.2	12	15.9	17.5	19.2
2008-09 Hawk Creek (H) TEMP °C	11.3	8.6	7.4	1.2	7.3	7.1	12.2	12.6	17.7	16.2	18.9	15
2008-09 North Port (N) TEMP °C	14.8	9.7	6.9		3.1	7.9		12.9	16.7	20.1	18.7	

1. Which location provides the best water temperature for the most fish?
2. Which water location has the worst temperatures for fish survival?
3. Which fish is the “Canary in the Coal Mine” and will die first?
4. Which fish have the highest survival potential?
5. Which month(s) are the temperatures best for fish survival?

**More Aquatic Species and Survival Temperatures:**

- Compare** 2008-2009 water temperatures at Grand Coulee (GC), Hawk Creek (HC) and North Port (NP) with maximum average temperatures for growth and short-term maximum temperatures for the non-indigenous fish species below.
- Analyze** the information and decide if the non-indigenous species will **die (D)**, **maintain a small population** compared to the native species **(M)** or **thrive (T)** at each location.
- Mark** your analysis in the chart below with a **D, M or T** for each species and at each location. Be prepared to explain your decisions.

Non-Indigenous Species	Max. weekly average temp. for growth (juveniles)	Max. temp. for survival of short exposure (juveniles)	Max. weekly average temp. for spawning <sup>a</sup>	Max. temp. for embryo spawning <sup>b</sup>	GC	HC	NP
Common carp	---	---	21 °C	33 °C			
Channel catfish	32 °C	35 °C	27 °C	29 °C			
Largemouth bass	32 °C	34 °C	21 °C	27 °C			
Smallmouth bass	29 °C	---	17 °C	23 °C			

(Brungs and Jones 1977)

- Upper temperature for successful incubation and hatching reported for the species
- Optimum or mean of the range of spawning temperatures reported for the species

- Optional: Research** the survival temperatures for other aquatic species such as the macroinvertebrates that fish depend on for food.

- Back Swimmer
- Bivalves
- Caddisfly Larva
- Cranefly Nymphs
- Crayfish
- Damselfly Nymphs
- Dobsonfly Larva



- Dragonfly Nymph
- Leeches
- Mayfly Nymphs
- Midge
- Mosquito Larva
- Penny Beetle Larva
- Riffle Beetle
- Salmonfly Nymph

- Scuds
- Side Swimmer
- Snail
- Sow Bugs
- Stonefly Nymphs
- Water Bugs
- Water Strider
- Worms

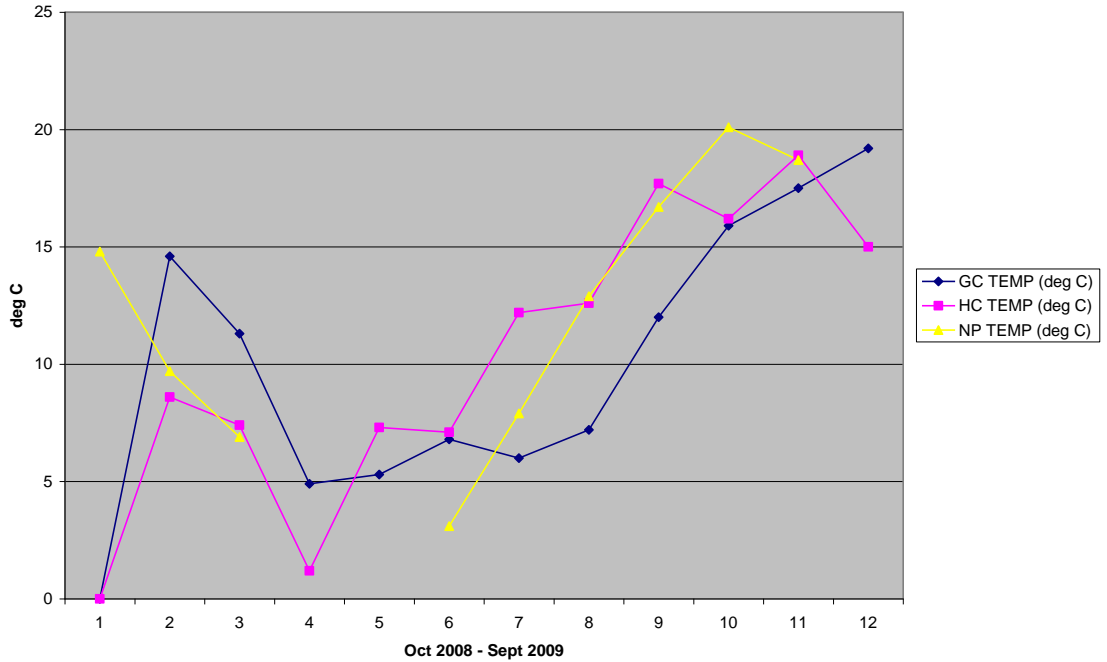


**Data Presentation:**

View and analyze a variety of data formats (e.g., data table, bar, line, and radar graphs).

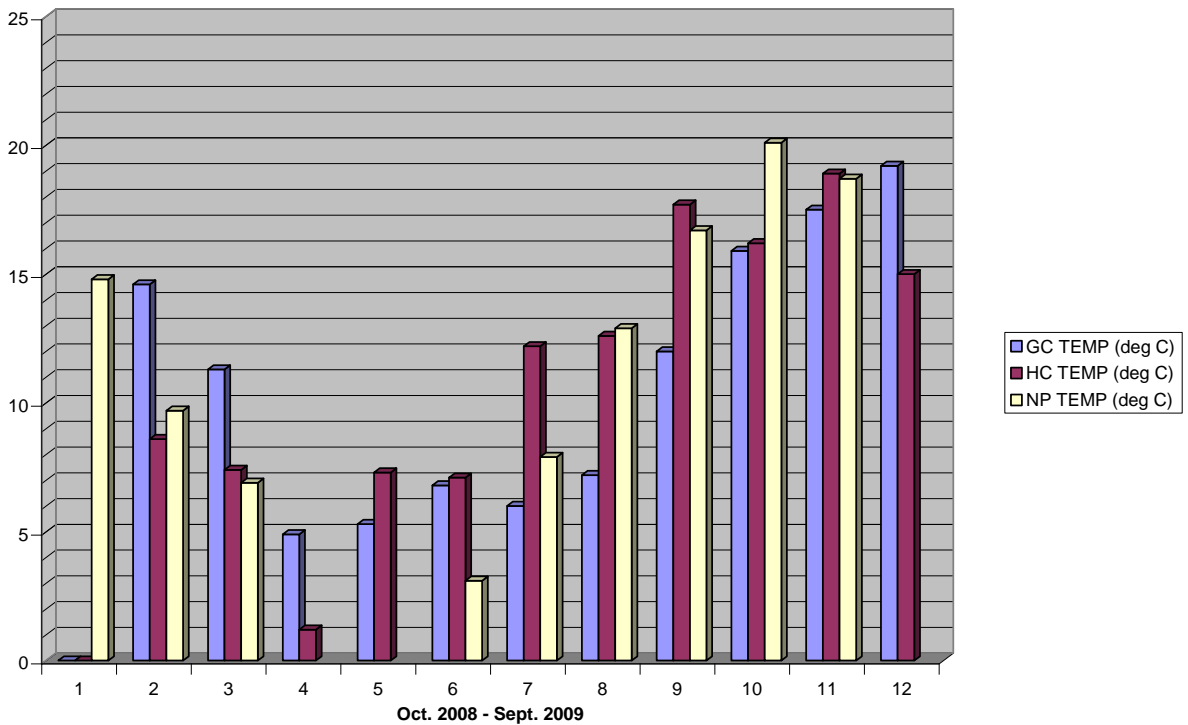
**Line Graph**

Grand Coulee Hawk Creek North Port Temperatures



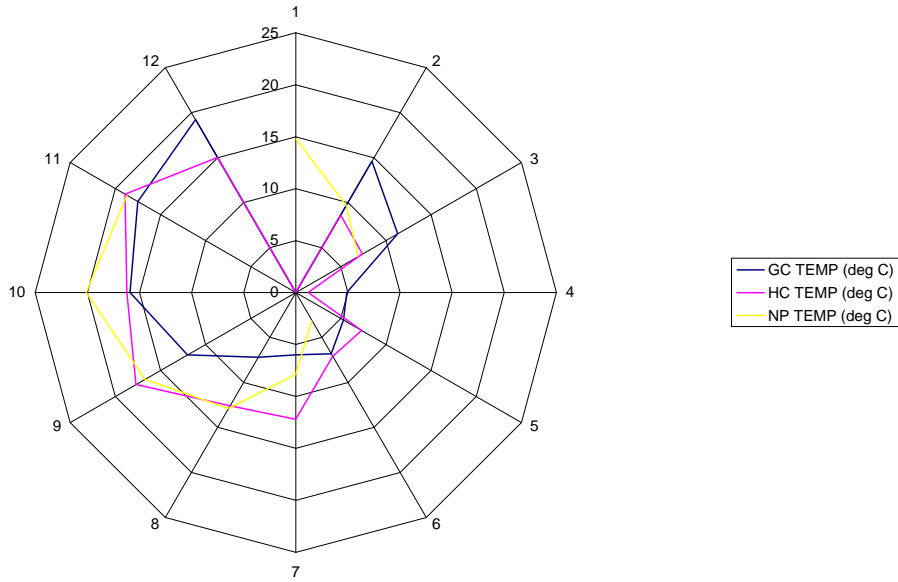
**Bar Graph**

Grand Coulee - Hawk Creek - North Port Temperatures



Grand Coulee Hawk Creek North Port Oct 2008 - Sept 2009 Temperatures

**Radar Graph**



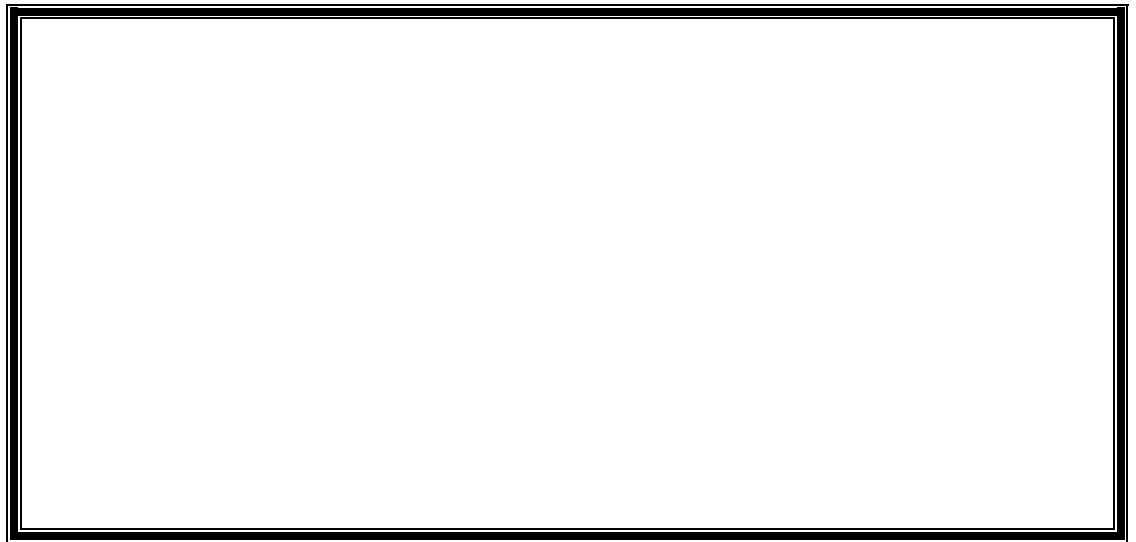
**Explain** the strengths & weaknesses of each presentation format. What does each format about temperature and water quality? If possible use excel to test additional graphs and charts

<p style="text-align: center;"><b>DATA TABLE:</b></p> <p>Strengths</p> <p>Weaknesses</p>	<p style="text-align: center;"><b>RADAR GRAPH:</b></p> <p>Strengths</p> <p>Weaknesses</p>
<p style="text-align: center;"><b>LINE GRAPH:</b></p> <p>Strengths</p> <p>Weaknesses</p>	<p style="text-align: center;"><b>BAR GRAPH:</b></p> <p>Strengths</p> <p>Weaknesses</p>

**Reflections, thoughts, and new questions about the role of temperature in water quality**



**What can we do to help maintain healthy water temperature for aquatic organisms?**



Resources

WQ temperature data for Grand Coulee, Hawk Creek and North Port  
[http://www.ecy.wa.gov/programs/eap/fw\\_riv/rv\\_main.html](http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html)

Microsoft clip art

**Water Quality: Temperature**

How is water quality affected by temperature?

### Why is water temperature important?

- Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. The rates of biological and chemical processes depend on temperature.
- Temperature also affects the oxygen content of the water (oxygen levels become lower as temperature increases). The rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases are all affected by temperature.

### How is temperature measured?

Thermometer °C/°F

Hand Held multi-meter probe

**Water temperature is measured using a thermometer or probe. It is read using a scale of degrees.**

- Celsius (°C) is a temperature scale that defines the freezing point of water as 0 degrees and the boiling point of water as 100 degrees. This is the scale scientists use.
- Fahrenheit (°F) is a temperature scale that defines the freezing point of water as 32° and the boiling point as 212° at one atmosphere of pressure.

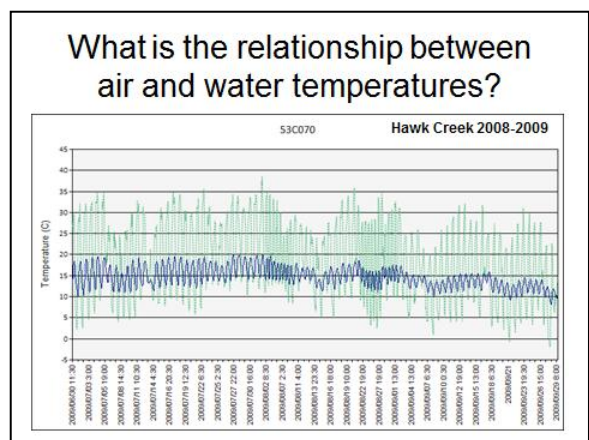
### In what ways are aquatic organisms impacted by temperature?

- **Temperature** - Certain types of fish like rainbow trout, kokanee salmon and aquatic organisms need cold water temperatures to thrive. Temperature is monitored to observe changes from month to month, season to season, and overall trends from year to year. Temperature may also directly affect the amount and location of aquatic plant growth.

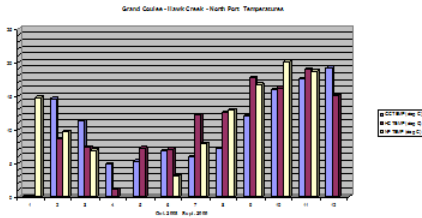
Photo by Lake Roosevelt Forum

### What are some of the ways water temperature changes?

- Causes include weather, logging and removal of shading streambank vegetation; impoundments (a body of water confined by a barrier, such as a dam); dis-charge of cooling water from factories; waste water treatment facilities; urban storm water; and groundwater inflows to the stream.
- Global climate changes have historically and will continue to alter temperatures.



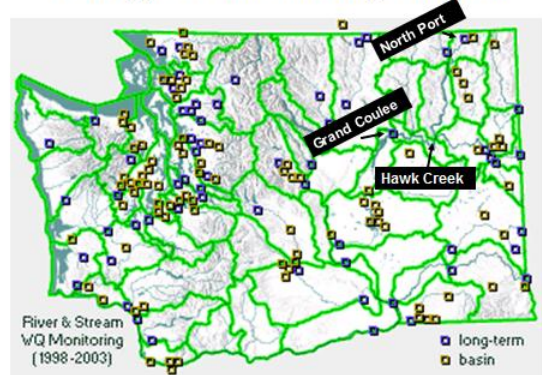
How do temperatures differ between various locations along the Columbia River and throughout Lake Roosevelt?



Let's find out by analyzing the data?

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### Ecology WQ Monitoring Stations



Columbia River @ Grand Coulee  
Hawk Creek @ Creston  
Kettle River near Barstow  
Columbia River @ North Port

[http://www.ecy.wa.gov/programs/eap/fw\\_riv/rv\\_main.html](http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html)

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### 61A070 - Columbia R @ Northport



LOCATED AT THE BRIDGE CROSSING THE COLUMBIA RIVER ON STATE HIGHWAY 25, IMMEDIATELY NORTHEAST OF NORTHPORT

Overall water quality at this station is of moderate concern. (72/100 based on water-year 2008 summary)

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### North Port 2008 -2009 WQ Data

date	time	FLOW (CFS)	OXYGEN (mg/L)	PH (pH)	TEMP (deg C)
10/7/2008	11:45	69400	9.3	8.23	14.8
11/4/2008	12:30	70300	9.9	8.14	9.7
12/2/2008	11:00	78600	10.9	7.96	6.9
1/6/2009	11:30	112000			
2/3/2009	11:45	77800			
3/3/2009	11:55	79300	13.46	8.07	3.1
5/5/2009	12:00	80100	11.65	8.15	7.9
6/2/2009	12:10	174000	11.9	8.18	12.9
7/7/2009	12:15	125000	9.8	8.27	16.7
8/4/2009	11:15	84800	8.8	8.49	20.1
9/15/2009	11:45	75600	8.6	8.45	18.7

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### 53C070 - Hawk Creek @ Miles-Creston Rd.



Location: From Grand Coulee: Head southwest on Hwy 174 towards Wilbur. Turn left onto Hwy 2 heading towards Wilbur/Creston. After traveling past Creston ~6 miles, turn left onto Miles-Creston Rd. Follow until the road crosses Hawk Creek. Park on the near side of the bridge on the left hand side of the road.

Overall water quality at this station did not meet expectations and is of highest concern. (18/100 based on water-year 2009 summary)

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## 14 Water Quality Indicators

- COND (umhos/cm)
- FC - Fecal Coliform bacteria (#/100ml)
- FLOW - Velocity of river (CFS) cubic feet /second
- NH3\_N - Ammonia (mg/L)
- NO2\_NO3 - Nitrate plus nitrite (mg/L)
- OP\_DIS - Soluble reactive phosphorus (mg/L)
- OXYGEN (mg/L)
- PH (pH)
- PRESS Barometric Pressure (mm/Hg)
- SUSSOL Suspended solids (mg/L)
- TEMP Temperature (deg C)
- TP\_P Total Phosphorus (mg/L)
- TPN (mg/L)
- TURB Turbidity (NTU)

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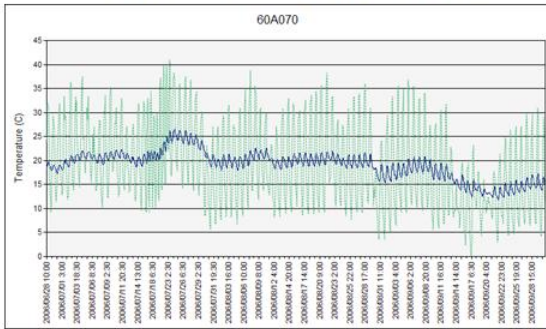
## 60A070 - Kettle R nr Barstow



LOCATED 10.9 MILES FROM THE MOUTH OF THE KETTLE RIVER, .75 MILES EAST OF BARSTOW ON THE FERRY-STEVENS COUNTY LINE

Overall water quality at this station is of moderate concern. (64/100 based on water-year 2008 summary)

## Kettle at Barstow 2006 Air and Water Temperatures



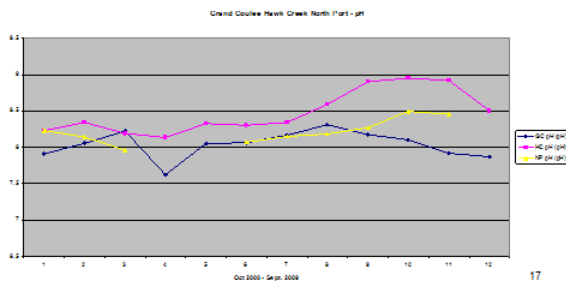
## 53A070 - Columbia River @ Grand Coulee



LOCATED AT THE COULEE DAM BRIDGE .5 MILES BELOW GRAND COULEE DAM

Overall water quality at this station met or exceeded expectations and is of lowest concern. (85/100 based on water-year 2009 summary)

## 2008-2009 pH Comparison Grand Coulee Hawk Creek & North Port



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## Want more information?

If you have questions about a particular waterbody or monitoring station, you can contact our Eastern Washington specialist

- [Dan Sherratt](#)
- [509.329.3420](tel:509.329.3420)



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Aquatic Life Temperature Criteria	Highest 7-DAD Max °C	Mark each month below with the locations (GHN) in which the fish would die due to temperature											
		Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
Char Spawning	9	GH N	GH N	GH N				H	HN	GH N	GH N	GH N	GH
Char Spawning & Rearing	12	G N	G	G				H	HN	GH N	GH N	GH N	GH
Salmon & Trout Spawning	13	G N	G							HN	GH N	GH N	GH
Core Summer Salmonid Habitat	16	G								HN	HN	GH N	G
Salmonid Spawning, Rearing & Migration	17.5	G									N	HN	G
Salmonid Rearing & Migration Only	17.5	G									N	HN	G
Non-Anadromous Interior Redband Trout	18	G									N	HN	G
Indigenous Warm Water Species	20										N		

WQ Data Collection Location	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
Grand Coulee (G) TEMP °C	18.3	14.6	11.3	4.9	5.3	6.8	6	7.2	12	15.9	17.5	19.2
Hawk Creek (H) TEMP °C	11.3	8.6	7.4	1.2	7.3	7.1	12.2	12.6	17.7	16.2	18.9	15
North Port (N) TEMP °C	14.8	9.7	6.9		3.1	7.9		12.9	16.7	20.1	18.7	

Which location provides the best water temperature for the most fish? **Hawk Creek and North Port are somewhat better than Grand Coulee**

Which water location has the worst temperatures for fish survival? **High Temperature occurrences (G-28) (H-25) (N-25)**

Which fish will die first? **Char Spawning**

Which Fish have the highest survival potential? **Warm Water Indigenous**

Which month(s) are the temperatures best for fish survival? **January thru March however we don't know the Minimum temperatures.**

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Which location provides the best water temperature for the most fish?

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Which fish will die first?

Which Fish have the highest survival potential?

Which month(s) are the temperatures best for fish survival?



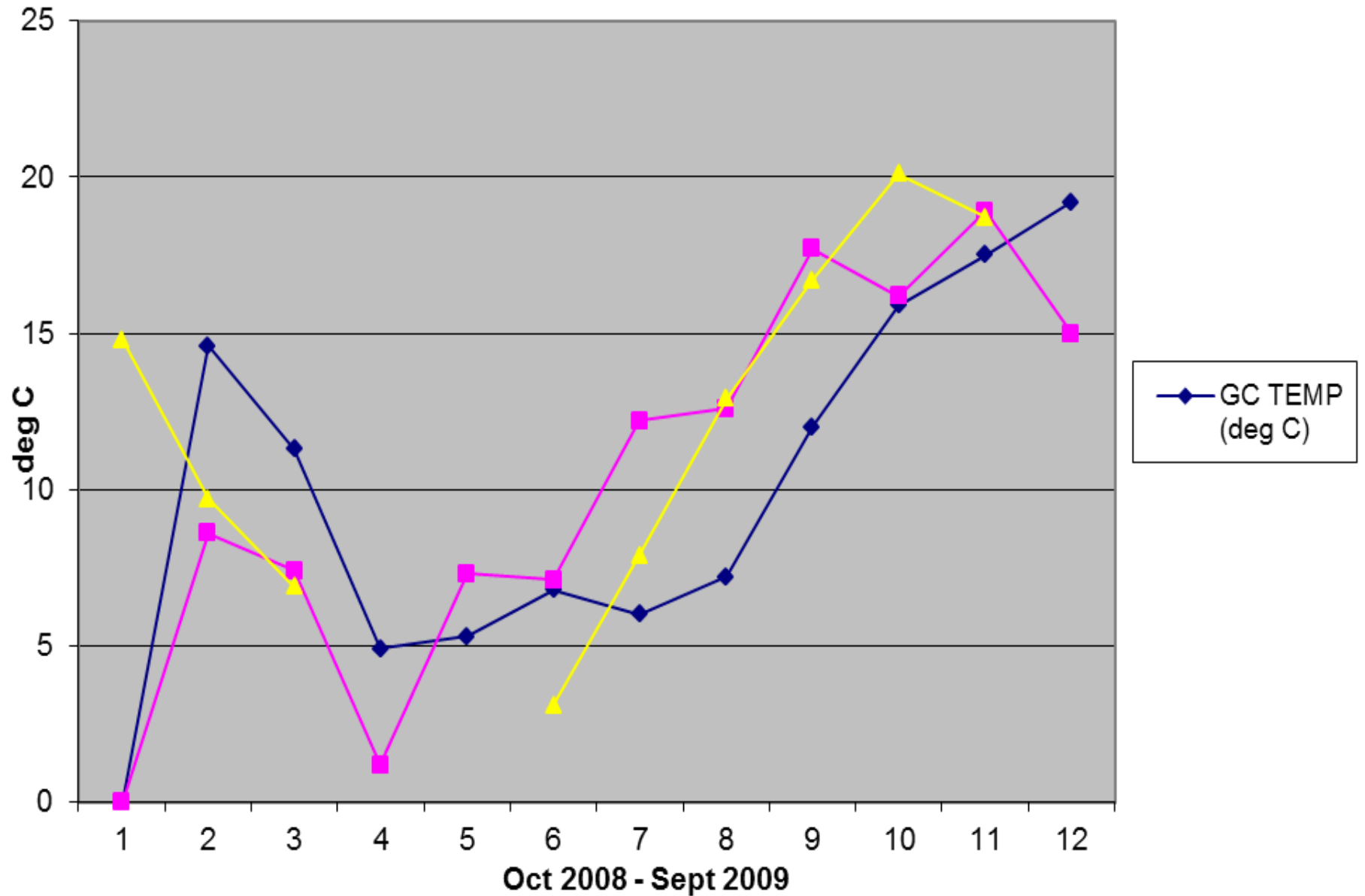
Grand Coulee Data

Aquatic Organisms		MAX. weekly average temp for growth juveniles	Max. Temp for survival of short exposure (juveniles)	Max weekly average temp for spawning	Max. Temp for embryo Spawning		
Bluegill		32	35	25	34		
Carp				21	33		
Catfish		32	35	27	29		
Kokanee							
Largemouth Bass		32	34	21	27		
Rainbow Trout		19	24	9	13		
Small Mouth bass		29		17	23		
Sockeye Salmon		18	22	10	13		
Walleye							

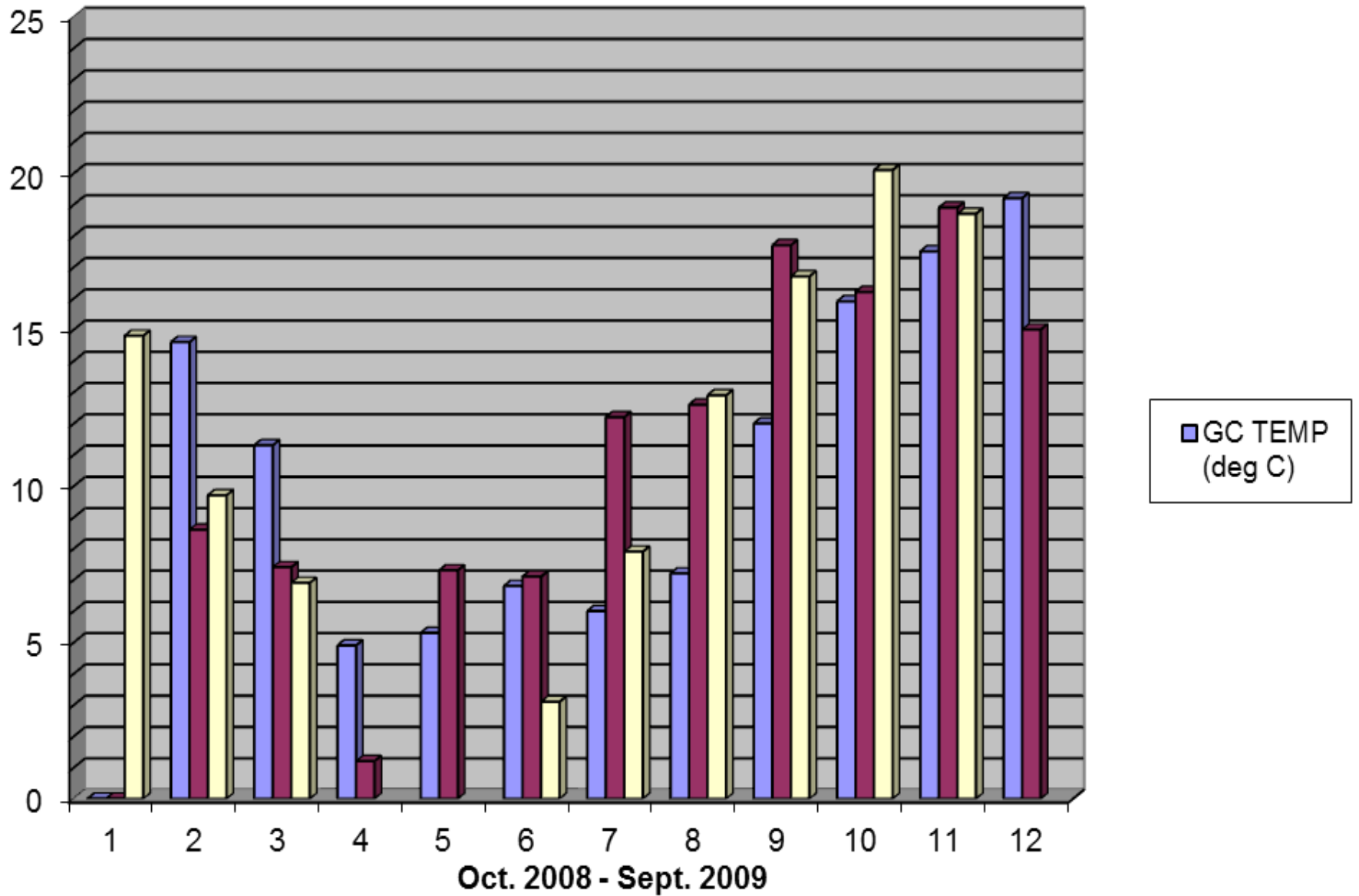
Aquatic Organisms							
Back Swimmer							
Bivalves							
Caddisfly Larva							
Crane fly Nymphs							
Crayfish							
Damselfly Nymphs							
Dobsonfly Larva							
Dragonfly Nymph							
Leech							
Leeches							
Mayfly Nymphs							
Midge							
Mosquito Larva							
Penny Beetle Larva							
Riffle Beetle							
Salmonfly Nymph							
scuds							
Side Swimmer							
Snail							
Sow Bugs							
Stonefly Nymphs							
Water Bugs							
Water Strider							
Worms							

date	GC pH (pH)	HC pH (pH)	NP pH (pH)	GC TEMP (deg C)	HC TEMP (deg C)	NP TEMP (deg C)	GC DO (mg/L)	HC DO (mg/L)	NP DO (mg/L)
10/6/2008	7.91	8.23	8.23	18.3*	11.3*	14.8	7.9	10.1	9.3
11/3/2008	8.05	8.34	8.14	14.6	8.6	9.7	8.8	10.8	9.9
12/1/2008	8.22	8.19	7.96	11.3	7.4	6.9	9.69	11.9	10.9
1/5/2009	7.62	8.13		4.9	1.2		11.4	11.9	
2/2/2009	8.05	8.32		5.3	7.3		12.76	12.46	
3/2/2009	8.06	8.3	8.07	6.8	7.1	3.1	13.36	11.55	13.46
4/6/2009	8.16	8.34	8.15	6	12.2	7.9	13.1	10.19	11.65
5/4/2009	8.31	8.59	8.18	7.2	12.6	12.9	12.7	10.04	11.9
6/1/2009	8.17	8.9	8.27	12	17.7	16.7	11	9.5	9.8
7/6/2009	8.1	8.95	8.49	15.9	16.2	20.1	10	9.3	8.8
8/3/2009	7.92	8.92	8.45	17.5	18.9	18.7	8.3	9	8.6
9/14/2009	7.87	8.5		19.2	15		7.8	9	

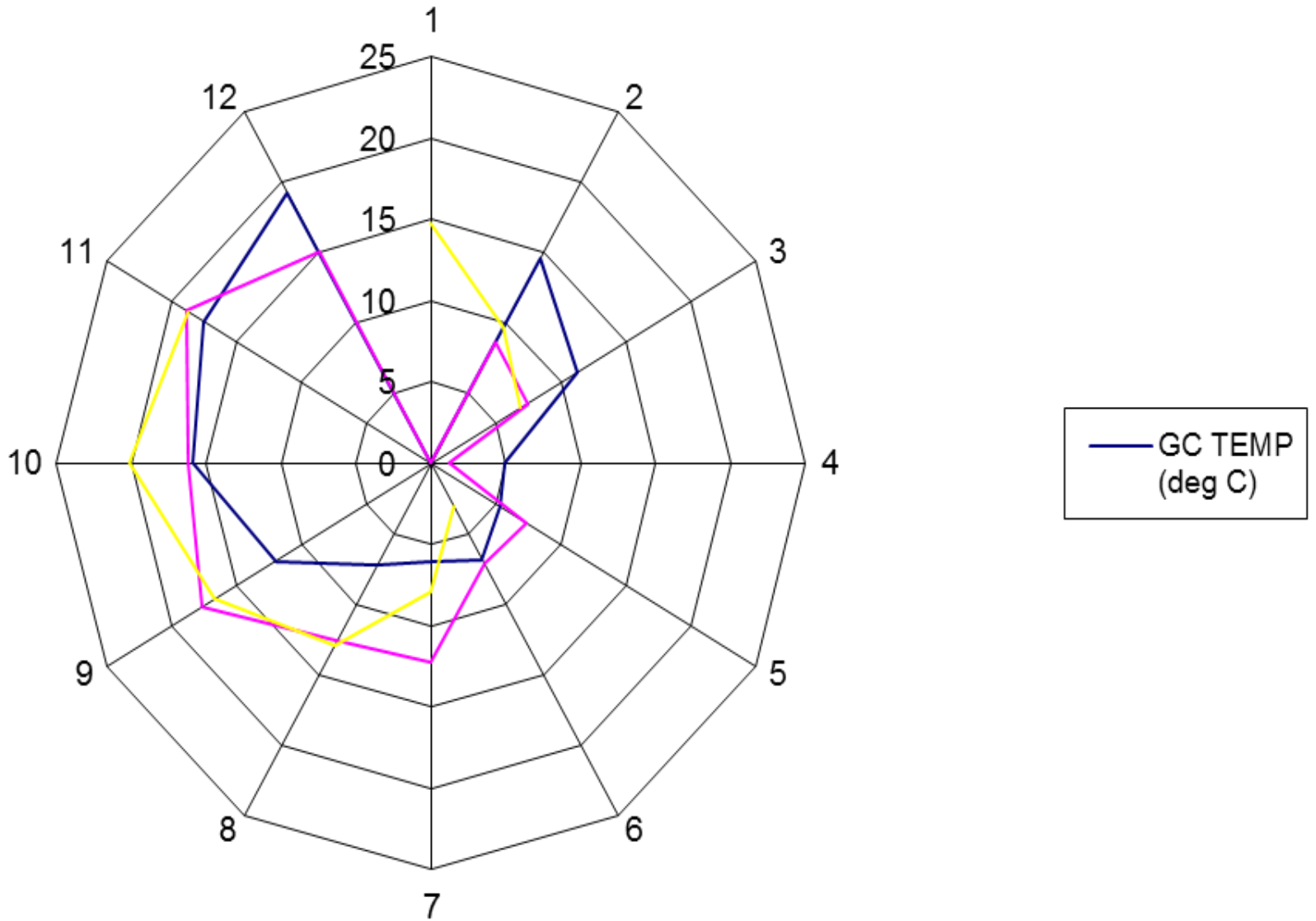
### Grand Coulee Hawk Creek North Port Temperatures



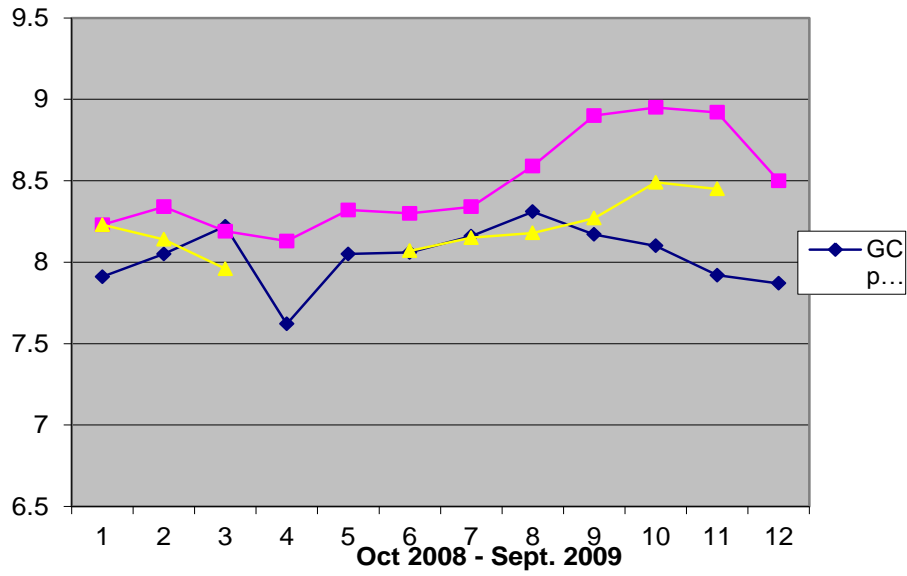
## Grand Coulee - Hawk Creek - North Port Temperatures



# Grand Coulee Hawk Creek North Port Oct 2008 - Sept 2009 Temperatures



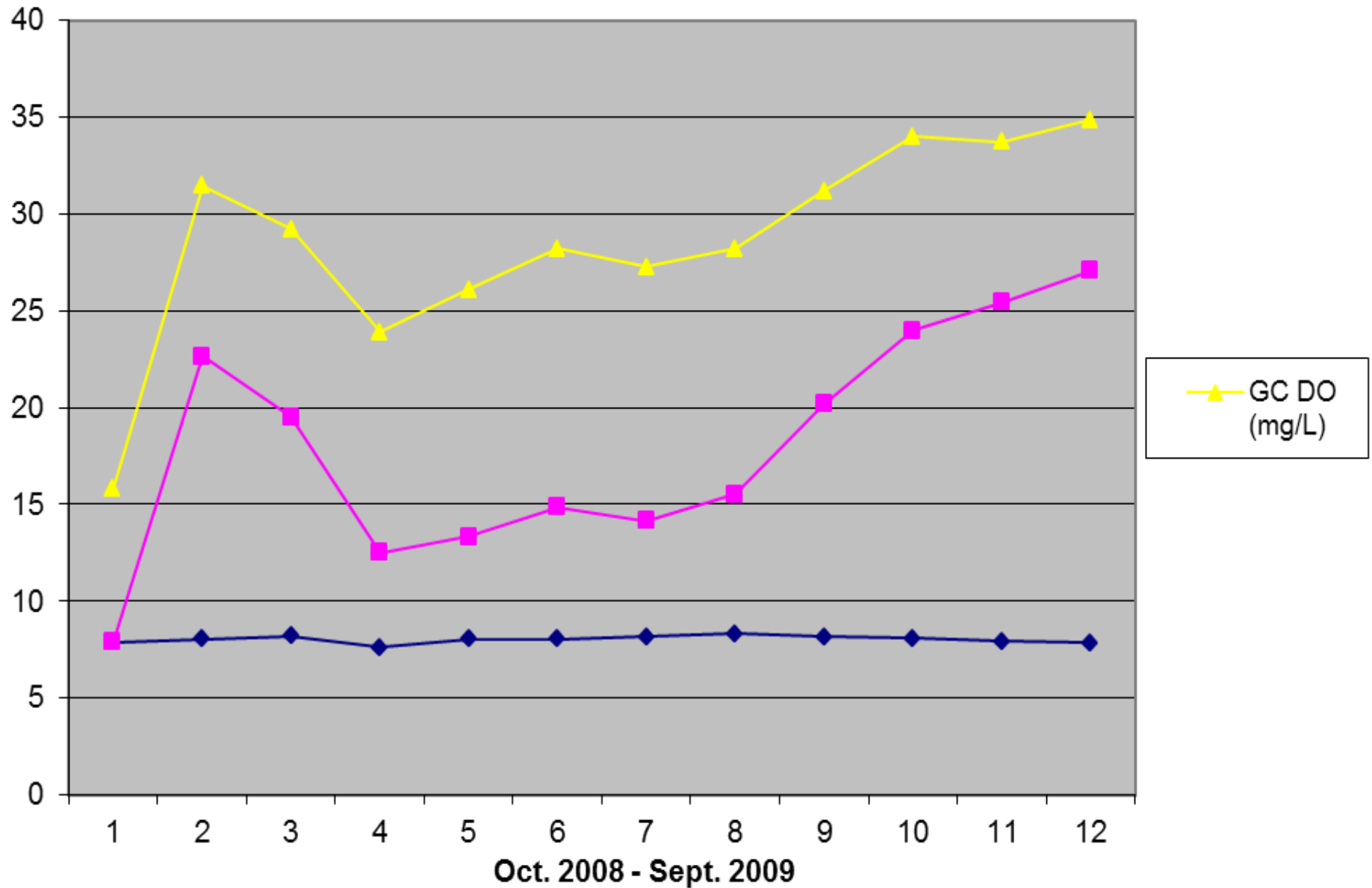
### Grand Coulee Hawk Creek North Port - pH



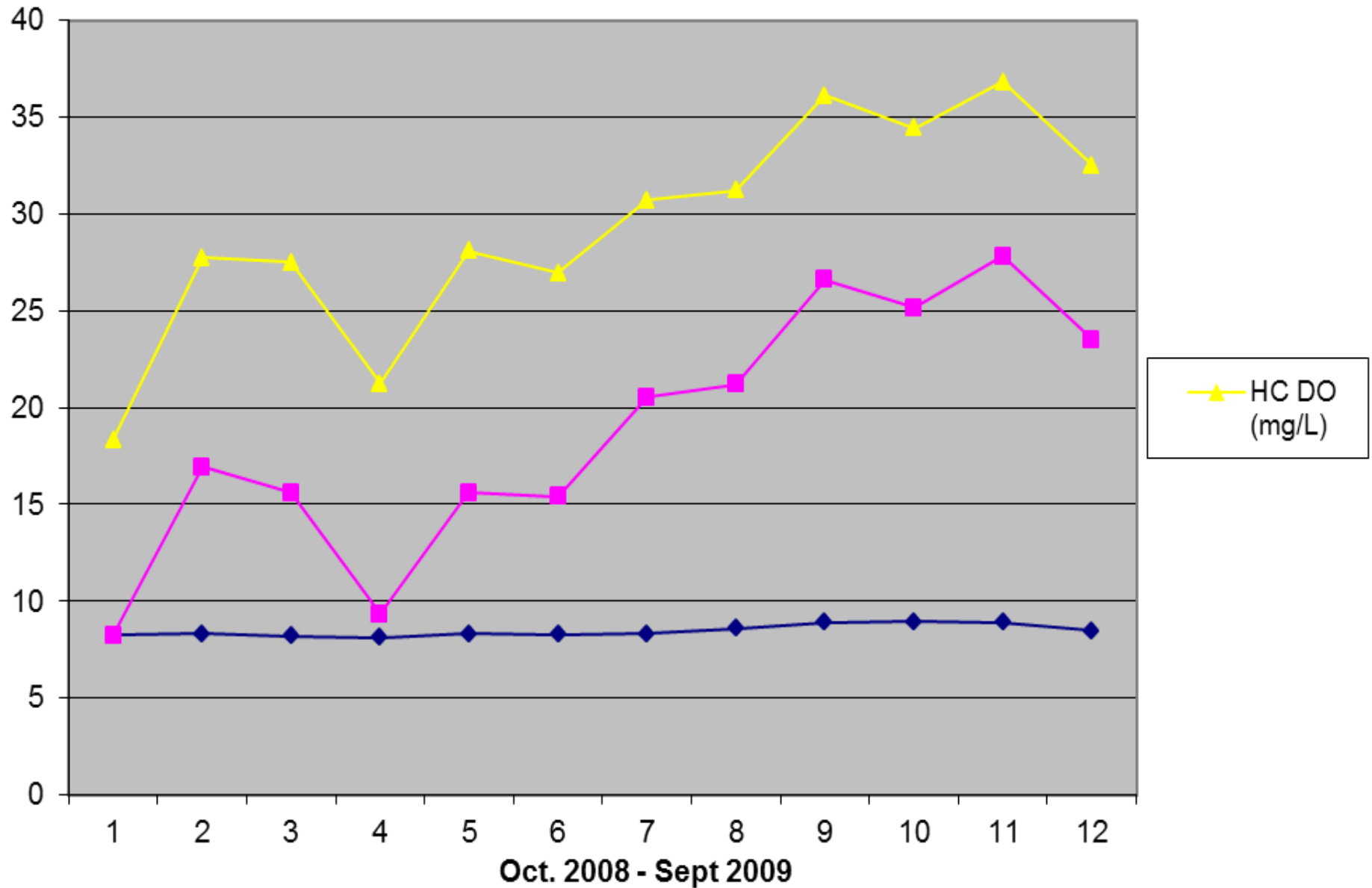
date	GC pH (pH)	GC TEMP (deg C)	GC DO (mg/L)	HC pH (pH)	HC TEMP (deg C)	HC DO (mg/L)	NP pH (pH)	NP TEMP (deg C)	NP DO (mg/L)
10/6/2008	7.91	18.3*	7.9	8.23	11.3*	10.1	8.23	14.8	9.3
11/3/2008	8.05	14.6	8.8	8.34	8.6	10.8	8.14	9.7	9.9
12/1/2008	8.22	11.3	9.69	8.19	7.4	11.9	7.96	6.9	10.9
1/5/2009	7.62	4.9	11.4	8.13	1.2	11.9			
2/2/2009	8.05	5.3	12.76	8.32	7.3	12.46			
3/2/2009	8.06	6.8	13.36	8.3	7.1	11.55	8.07	3.1	13.46
4/6/2009	8.16	6	13.1	8.34	12.2	10.19	8.15	7.9	11.65
5/4/2009	8.31	7.2	12.7	8.59	12.6	10.04	8.18	12.9	11.9
6/1/2009	8.17	12	11	8.9	17.7	9.5	8.27	16.7	9.8
7/6/2009	8.1	15.9	10	8.95	16.2	9.3	8.49	20.1	8.8
8/3/2009	7.92	17.5	8.3	8.92	18.9	9	8.45	18.7	8.6
9/14/2009	7.87	19.2	7.8	8.5	15	9			



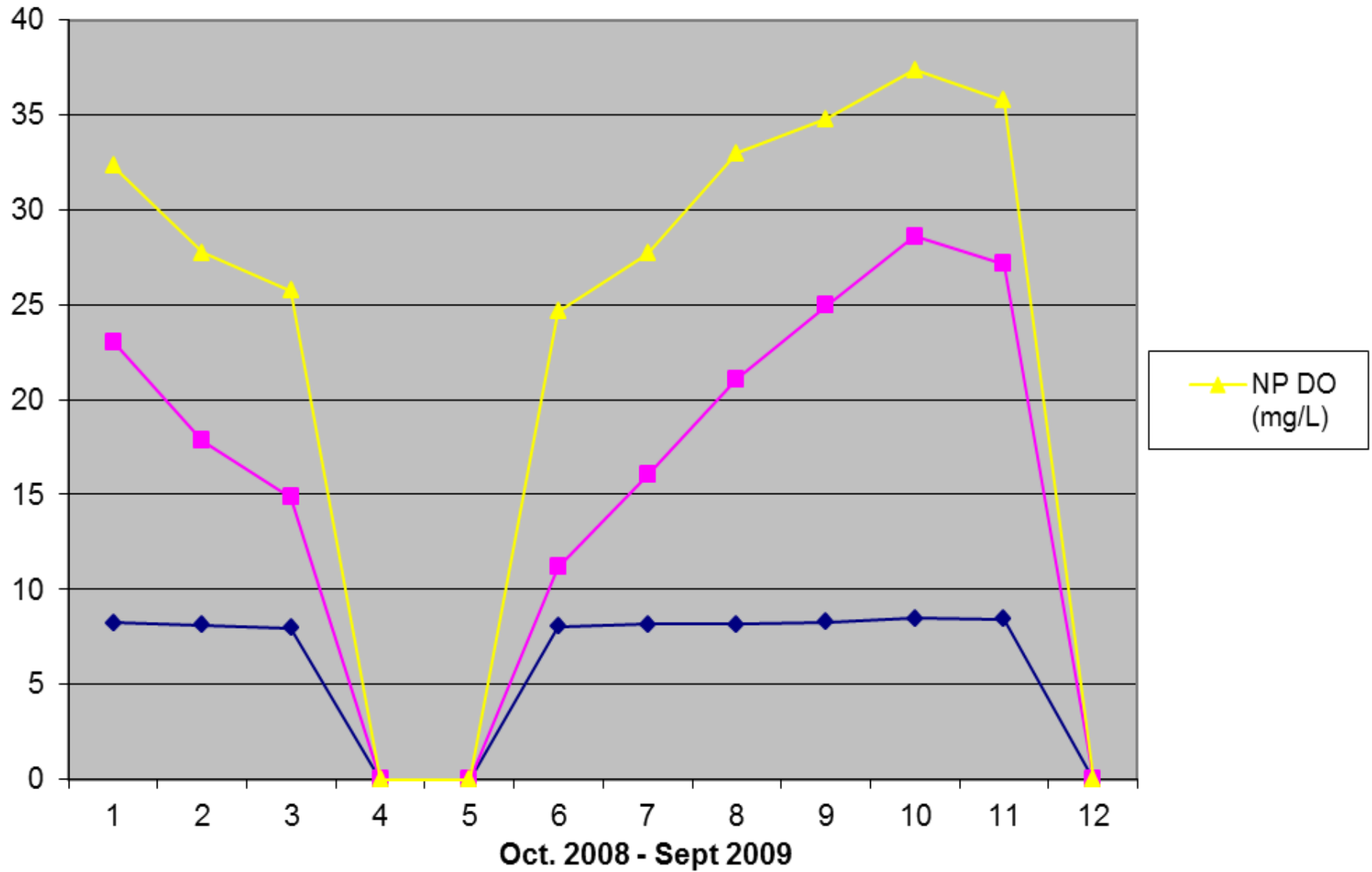
### Grand Coulee pH/Temperature/Dissolved Oxygen



### Hawk Creek pH Temperature Dissolved Oxygen



### North Port pH Temperature Dissolved Oxygen



## Grand Coulee Hawk Creek North Port - Dissolved Oxygen

