Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

August 3 to September 2, 2011

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division

Real-Time Water Quality Deployment Report

Lower Churchill River and Lake Melville Stations

August 3 to September 2, 2011

Contents

General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at stations on the Lower Churchill River at English Point and Lake Melville East of Little River.
- On August 3, 2011, real-time water quality monitoring instruments were deployed at stations on the Lower Churchill River at English Point and Lake Melville East of Little River. Instruments were deployed for a period of 28-29 days. Instruments were removed on September 1 and 2.

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
  - ► At deployment and removal, a QA/QC Sonde is temporarily deployed along side the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (oC)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

- Deployment and removal comparison rankings for the English Point and Lake Melville stations deployed between August 3 and September 1-2, 2011 are summarized in Table 2.

Table 2: Comparison rankings for English Point and Lake Melville stations, August 3- September 1-2, 2011

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
English Point	Aug 3, 2011	Deployment	Good	Excellent	Excellent	Good	Good
	Sep 1, 2011	Removal	Good	Excellent	Good	Excellent	Fair
Lake Melville	Aug 3, 2011	Deployment	Good	Excellent	Good	Excellent	Excellent
	Sep 2, 2011	Removal	Fair	Good	Excellent	Excellent	Poor

- At Churchill River at English Point, all parameters ranked 'good' or 'excellent' at deployment. At removal, temperature, pH, specific conductivity, and dissolved oxygen all ranked either 'good' or excellent' while turbidity ranked 'fair' The field instrument read a value of 5.8NTU and the QA/QC instrument read a value of 12.4NTU. The median turbidity reading at this station during the deployment period is 5.8NTU indicating that the field instrument was most likely correct at this moment. This discrepancy is likely caused by a calibration error with the QA/QC instrument which resulted in higher than expected values for turbidity throughout the day at numerous sampling stations.
- At Lake Melville East of Little River, all parameters ranked 'good' or 'excellent' at deployment. At removal, pH, specific conductivity, and dissolved oxygen all ranked either 'good' or excellent' while temperature ranked 'fair' and turbidity ranked 'poor'. For temperature, the field instrument read a value of 15.77°C and the QA/QC instrument read a value of 16.38°C. The water was exceptionally wavy that day and the field instrument could not be seen before it was pulled from the water body. Therefore, there may have been a difference in instrument location significant enough to cause such a discrepancy in temperature. For turbidity, the field instrument read a value of 53.0NTU and the QA/QC instrument read a value of 74.0NTU. This discrepancy is likely caused by a calibration error with the QA/QC instrument which resulted in higher than expected values for turbidity throughout the day at numerous sampling stations. In addition to a calibration error, the conditions at the site were not ideal for obtaining a stable comparison reading (high surf) and therefore this could also contribute to the discrepancy in turbidity values.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from August 3 to September 1-2 at the stations on the Churchill River at English Point and Lake Melville East of Little River.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Churchill River at English Point

- Water temperature ranged from 15.20 to 21.40^{o}C during this deployment period (Figure 1).
- Water temperature is generally stable throughout the deployment period. This trend is expected due to the consistent ambient air temperatures in the summer season (Figure 2). Water temperature fluctuates diurnally and with tidal influences.

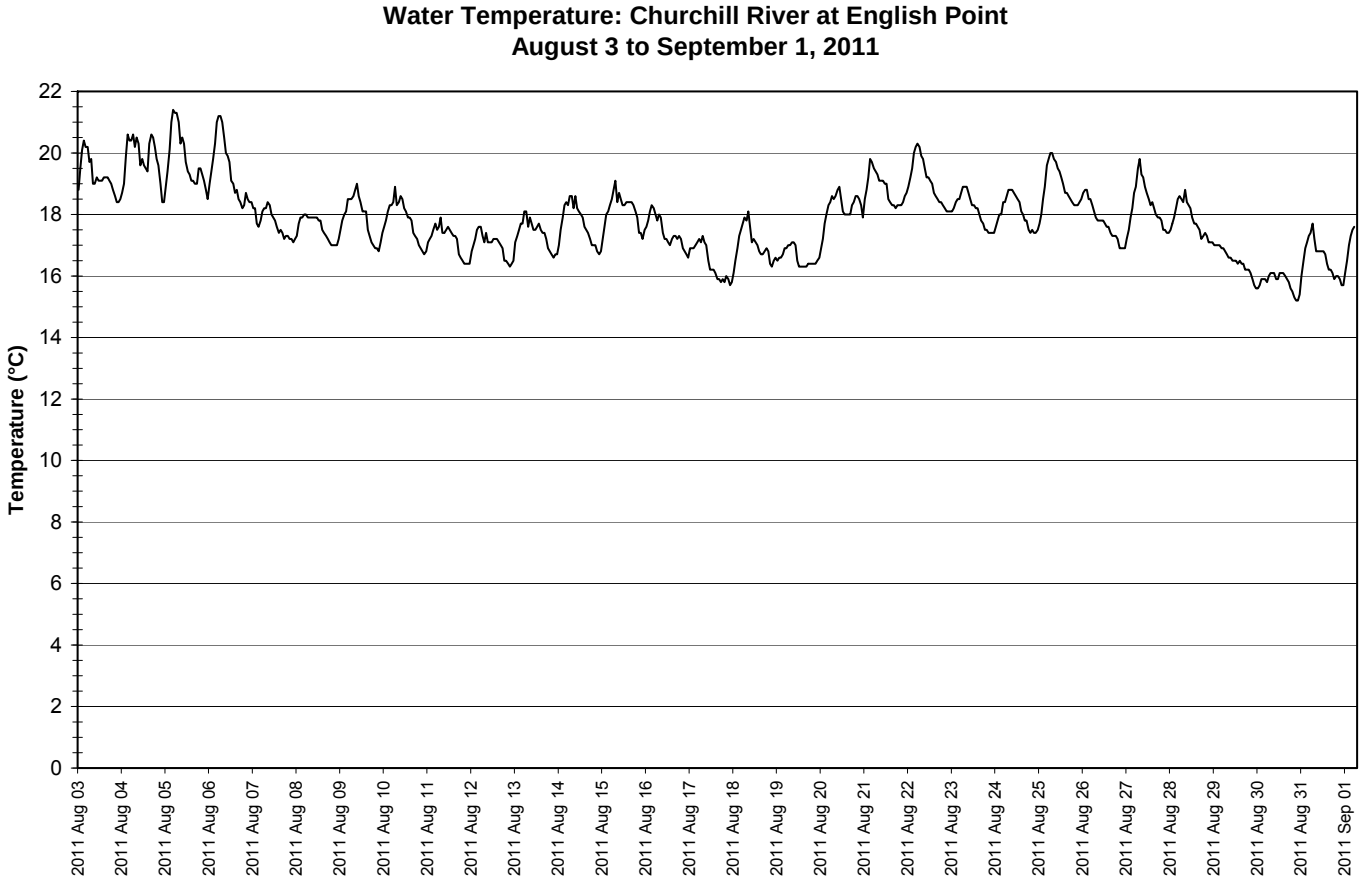

Figure 1: Water temperature at Churchill River at English Point

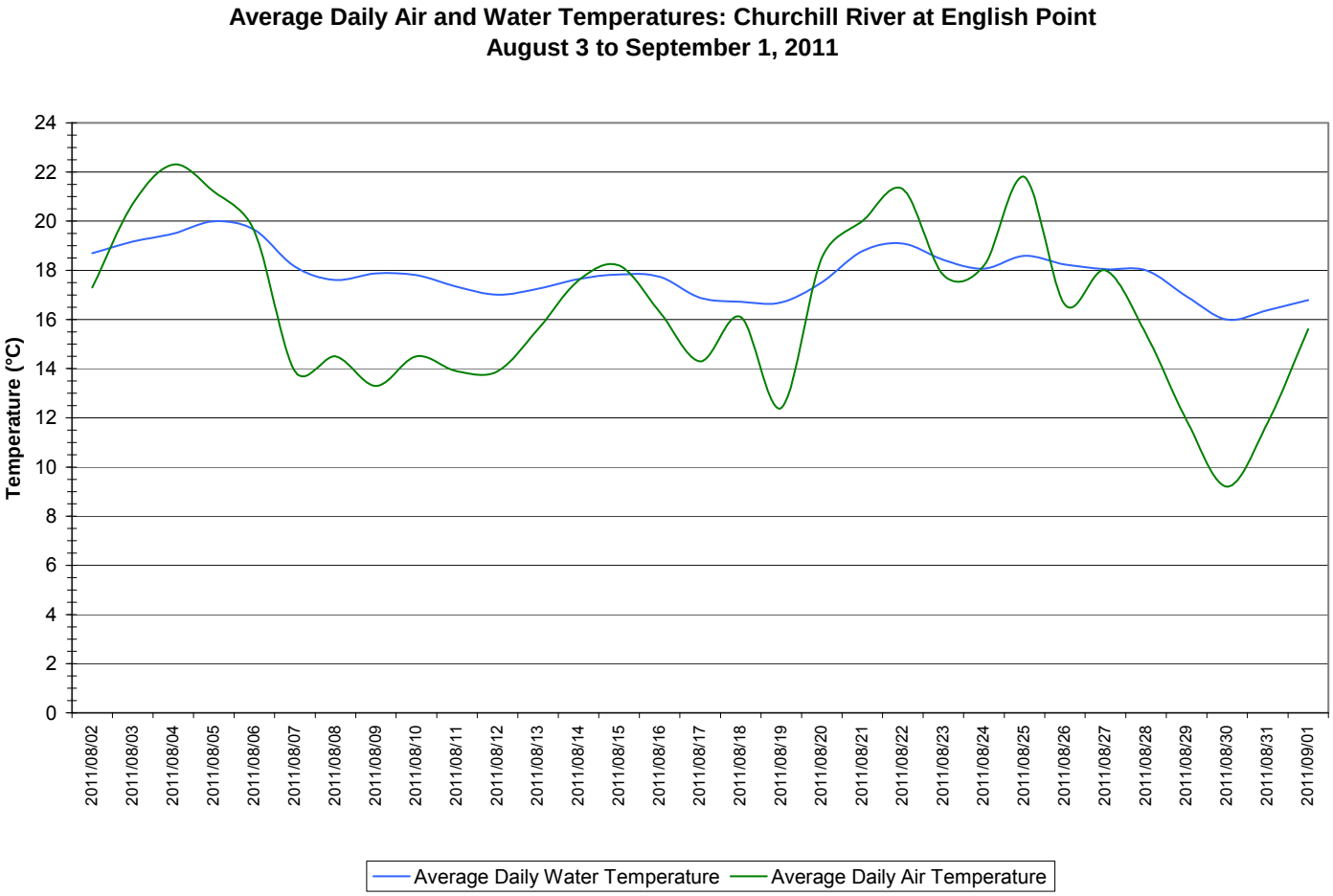

Figure 2: Average daily air and water temperatures at Churchill River at English Point (weather data collected at Goose Bay)

- pH ranges between 7.01 and 7.53 pH units and are consistent throughout the deployment period (Figure 3). pH values fluctuate diurnally and with tidal influences.
- All values during the deployment are within the minimum and maximum CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.5).

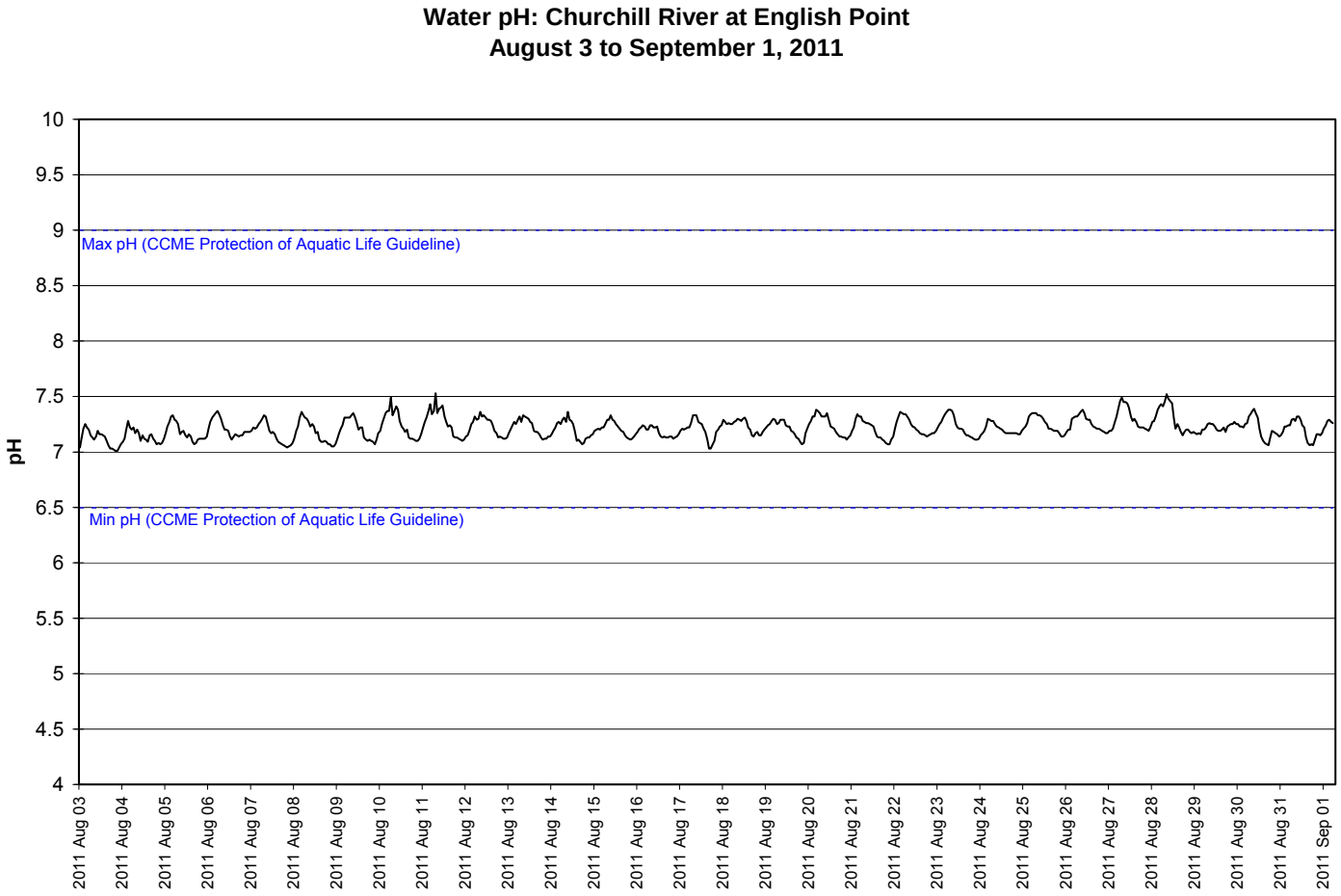

Figure 3: pH at Churchill River at English Point

- Specific conductivity typically ranges between 23.1 to 55.9µS/cm during the deployment period, averaging 34.7µS/cm (Figure 4).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the specific conductivity increases as the dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is consistent throughout the deployment period.

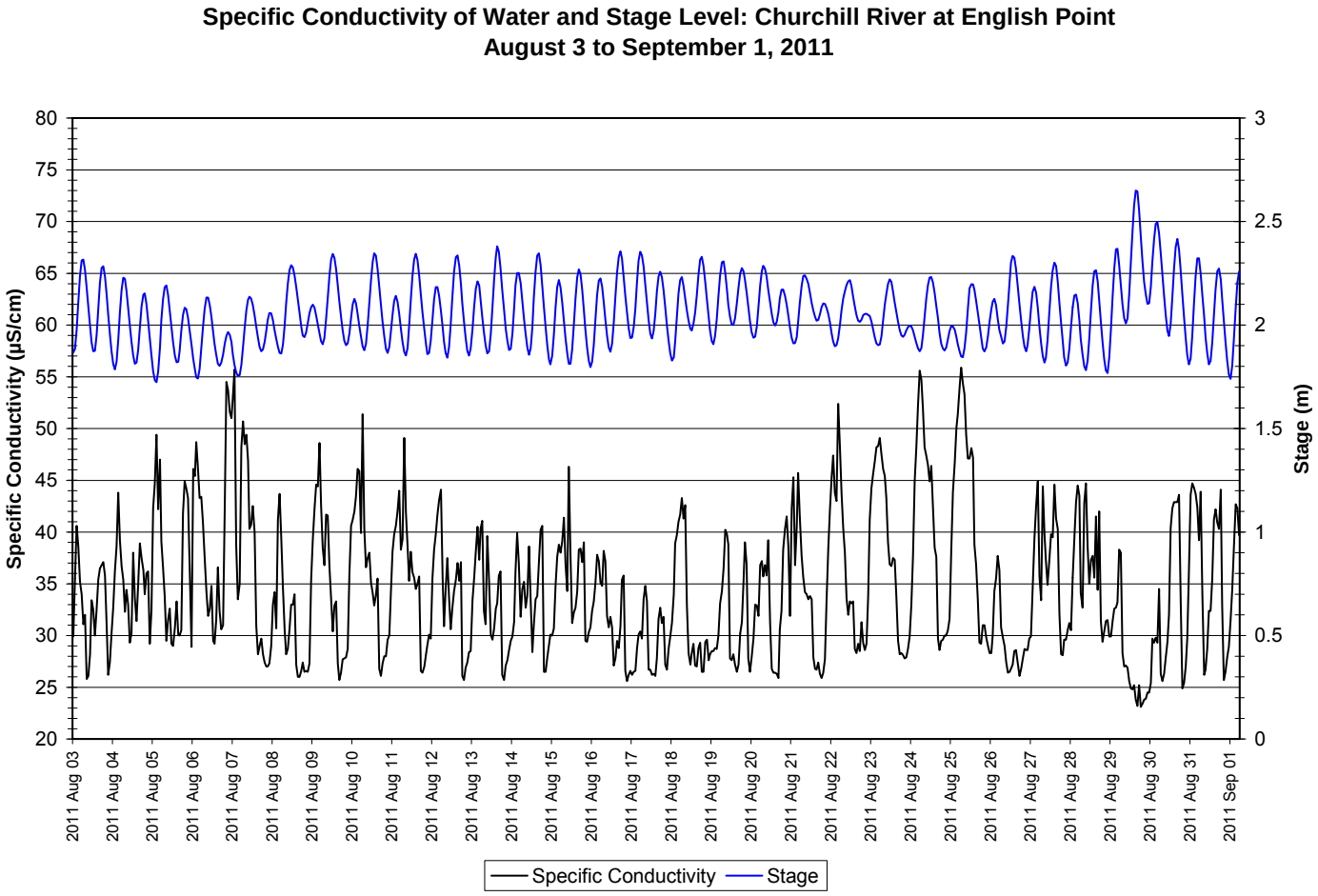

Figure 4: Specific conductivity and stage level at Churchill River at English Point

- The saturation of dissolved oxygen ranged from 89.0 to 108.8% and a range of 8.72 to 10.09mg/l was found in the concentration of dissolved oxygen with a median value of 9.43mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. Dissolved oxygen content was generally around the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is consistent throughout the deployment period and clearly fluctuates diurnally, displaying the inverse relationship to water temperature during the day and night. Dissolved oxygen content is lower than deployments earlier in the season however this trend is expected given the consistent warm air and water temperatures in the summer season (Figure 1 & 2).

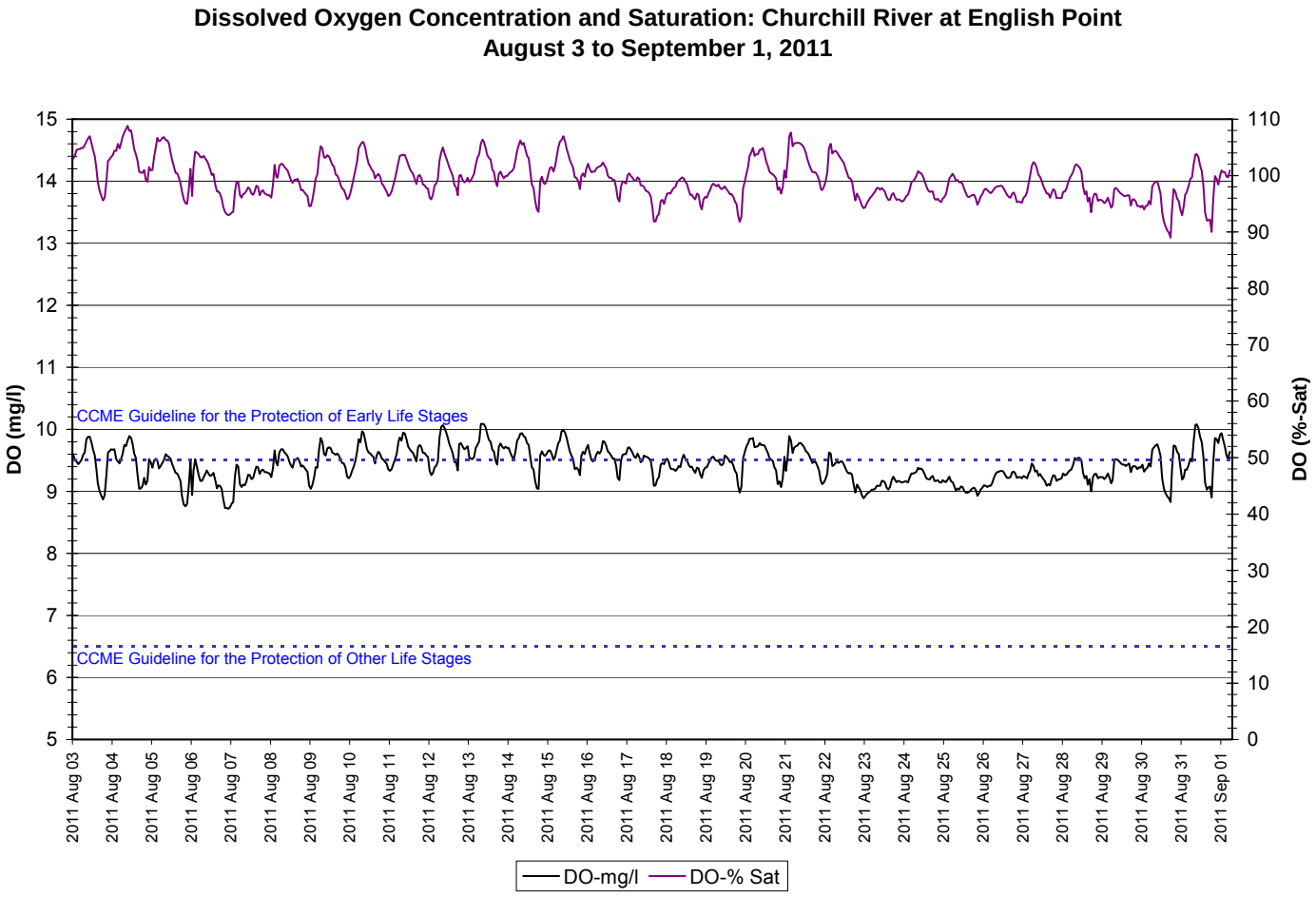

Figure 5: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity values ranged between 0.0 and 732.0NTU (Figure 6). A median value of 5.1 NTU indicates there is a natural background turbidity value at this station.
- Over a period of 2 days (August 16, 22-23), turbidity values rise considerably peaking at 3000NTU. This reading is an error reading by the instrument and it often caused when there is something blocking the sensor. These values were not considered in the range or median value calculation and have been removed from the dataset. This site is prone to biofouling, especially in warm temperatures which can affect the sensors' performance, causing the error readings.
- Rainfall events do not correspond well with the turbidity increases recorded between August 18 and 26. Turbidity values fluctuate significantly during this time period up to over 700NTU. It is unknown what caused this disturbance.

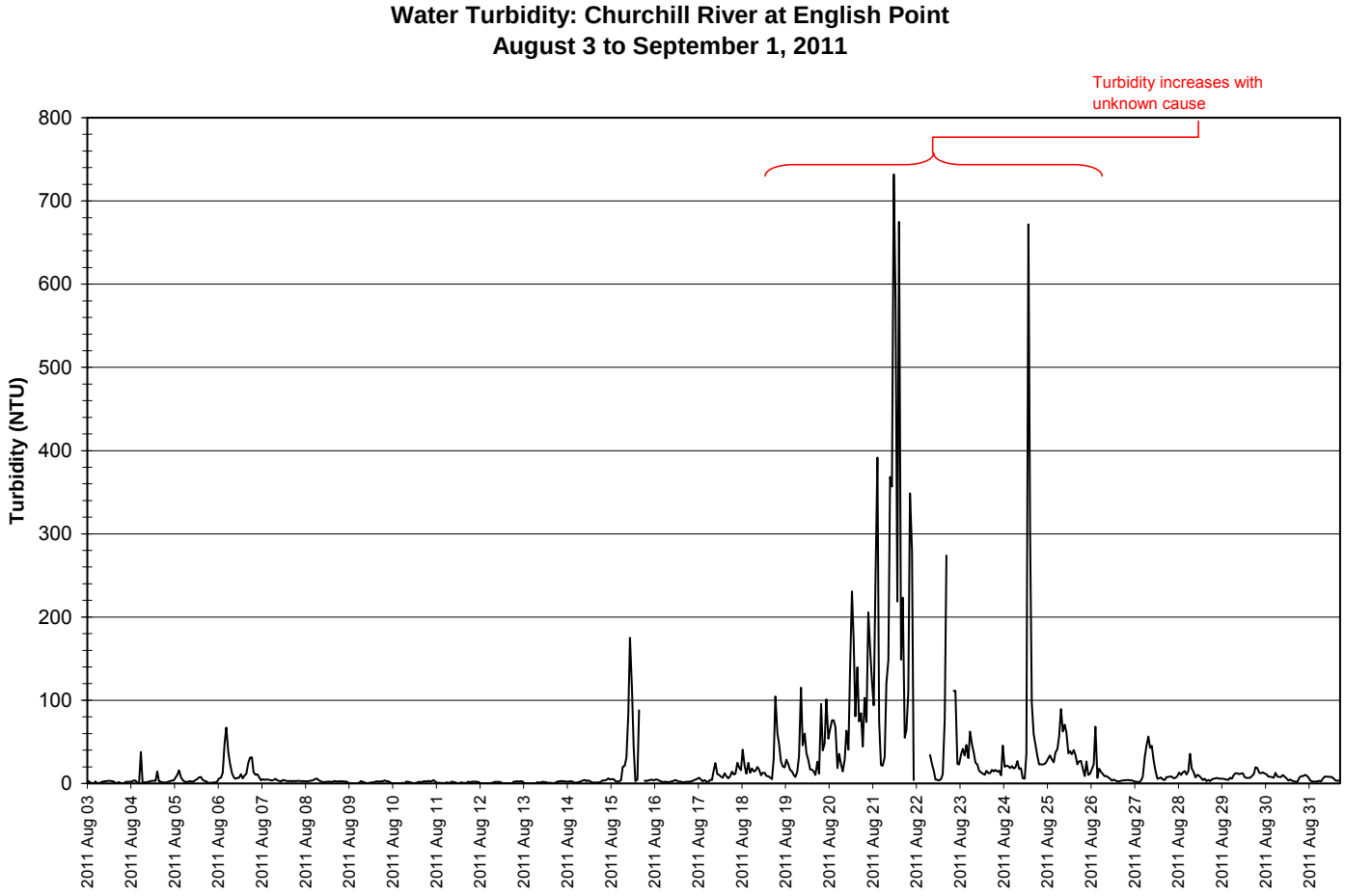

Figure 6: Turbidity and stage level at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage fluctuates throughout the deployment period with varying precipitation records. Averaging stage over 24 hour period reduces the appearance of diurnal variability caused by the tides in the hourly data.

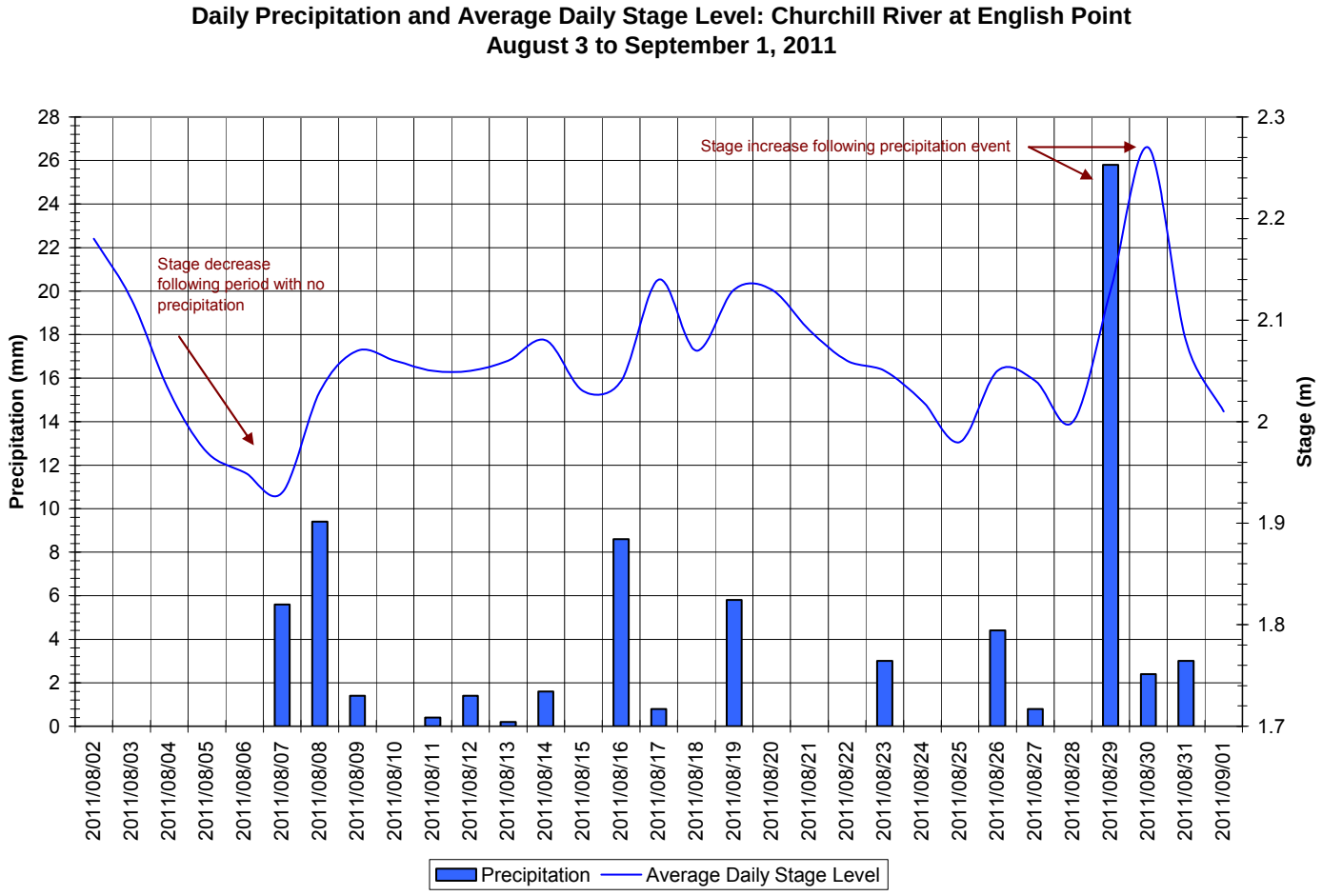

Figure 7: Stage and precipitation at Churchill River at English Point

Lake Melville East of Little River

- Water temperature ranges from 3.90 to 20.50°C during this deployment period (Figure 8).
- Water temperature is generally consistent throughout the deployment period with the exception of very cool temperatures experienced near the middle and end of the deployment period. These decreases correspond with cold air temperatures and rainfall events. Water temperature fluctuates significantly on a daily basis.

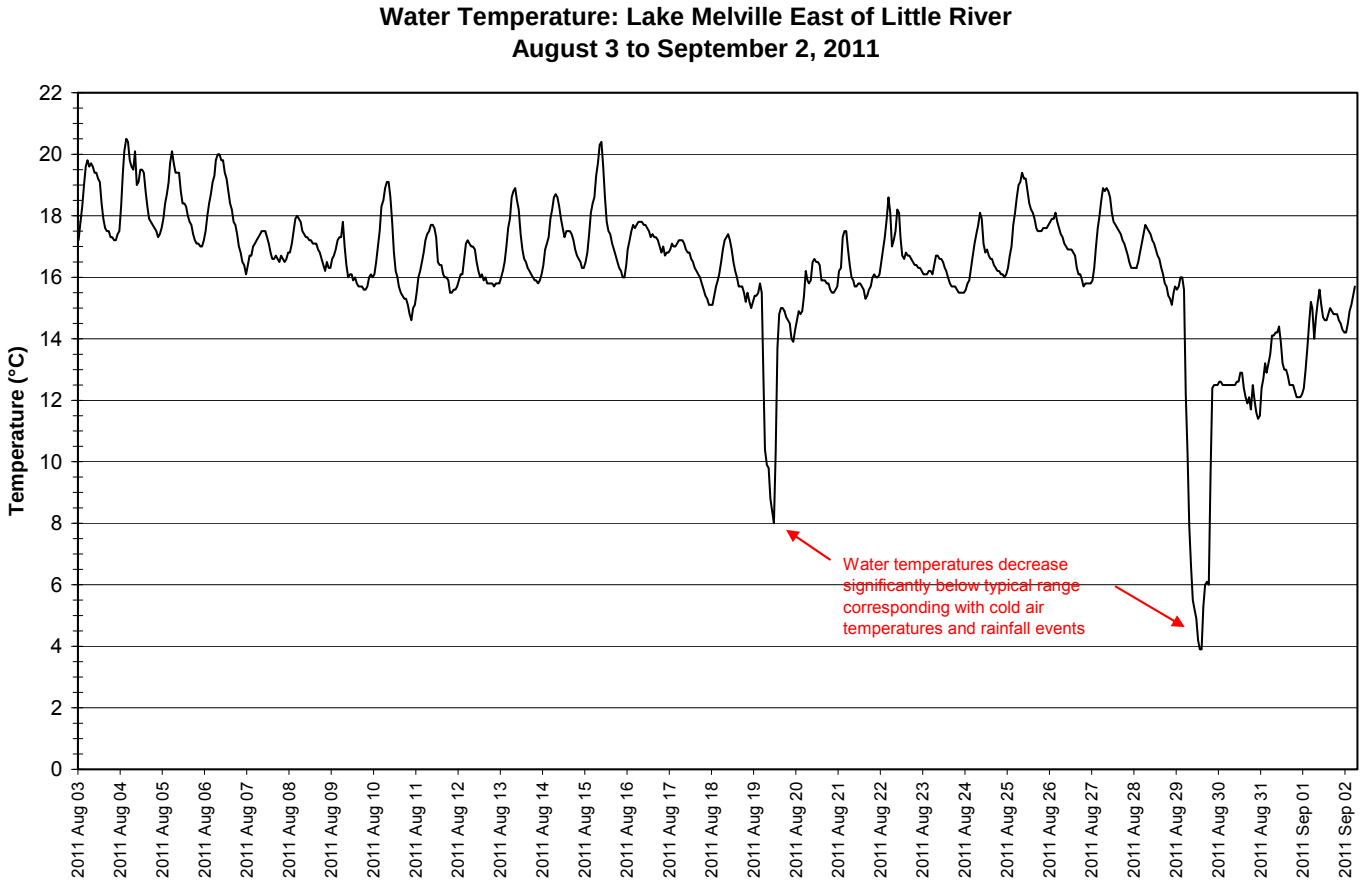

Figure 8: Water temperature at Lake Melville East of Little River

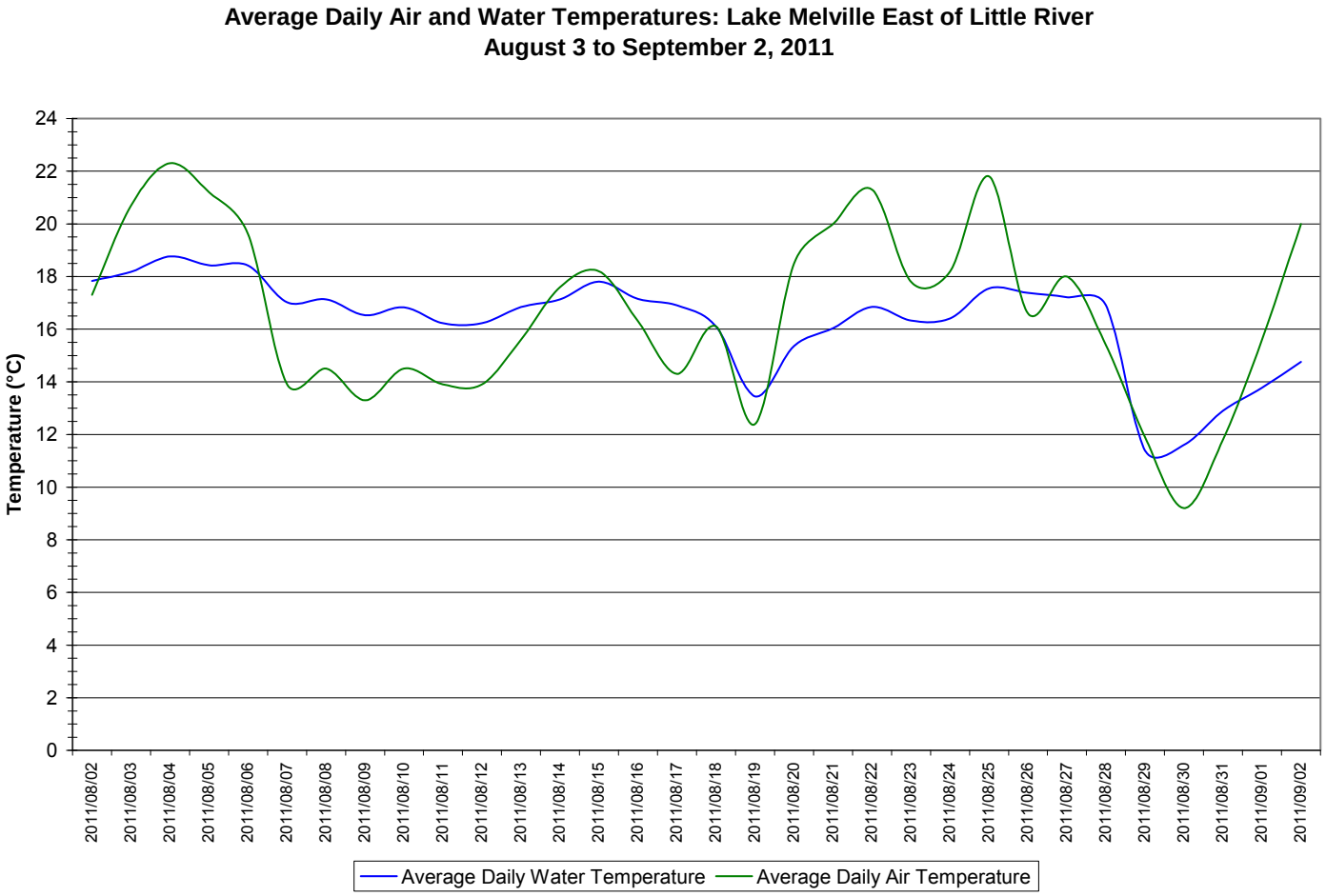

Figure 9: Average daily air and water temperatures at Lake Melville East of Little River (weather data collected at Goose Bay)

- pH ranges between 7.29 and 9.12 pH units (Figure 10). pH fluctuates daily.
- The consistent diurnal fluctuations in pH are disrupted near the middle and end of the deployment period. These trend changes correspond with periods of cold air and water temperatures and rainfall events (indicated by red arrows on Figure 10).
- Most values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10). These guidelines however, are for 'freshwater ' environments. If we consider this to be a 'marine' environment, the minimum and maximum pH guidelines would be then 7.0 and 8.7 respectively (indicated in green on Figure 10). The maximum guideline for pH in marine environments is exceeded at different times throughout the deployment period but only for short periods of time.

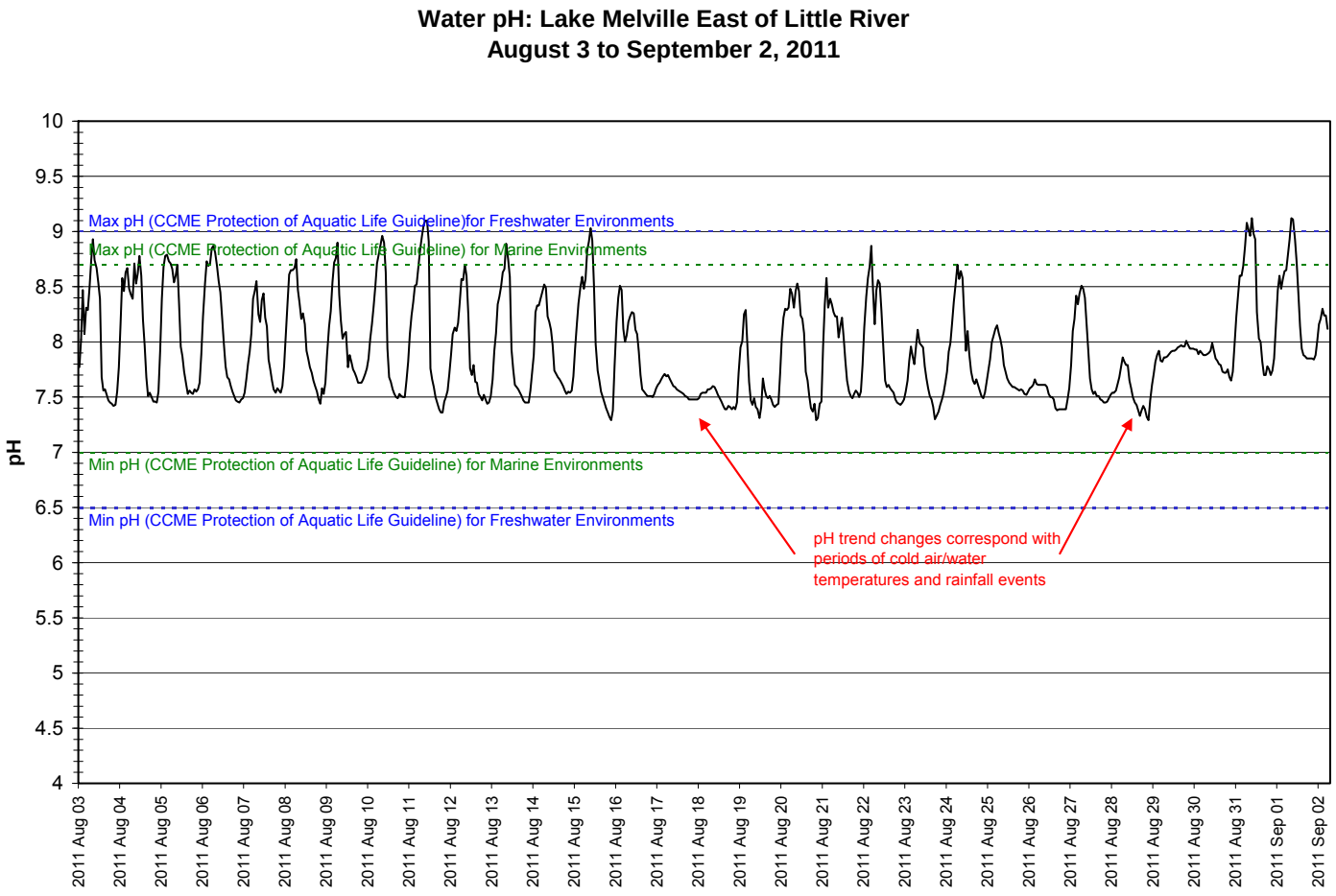

Figure 10: pH at Lake Melville East of Little River

- Specific conductivity typically ranges between 7500 and 19000µS/cm and fluctuates throughout the deployment period (Figure 11).
- There are two occasions near the middle and end of the deployment period where specific conductivity increases beyond the typical range to over 30000µS/cm. These events correspond with periods of cold air temperatures and rainfall events. These events are noticeable in several other water quality parameters (pH, dissolved oxygen and turbidity).

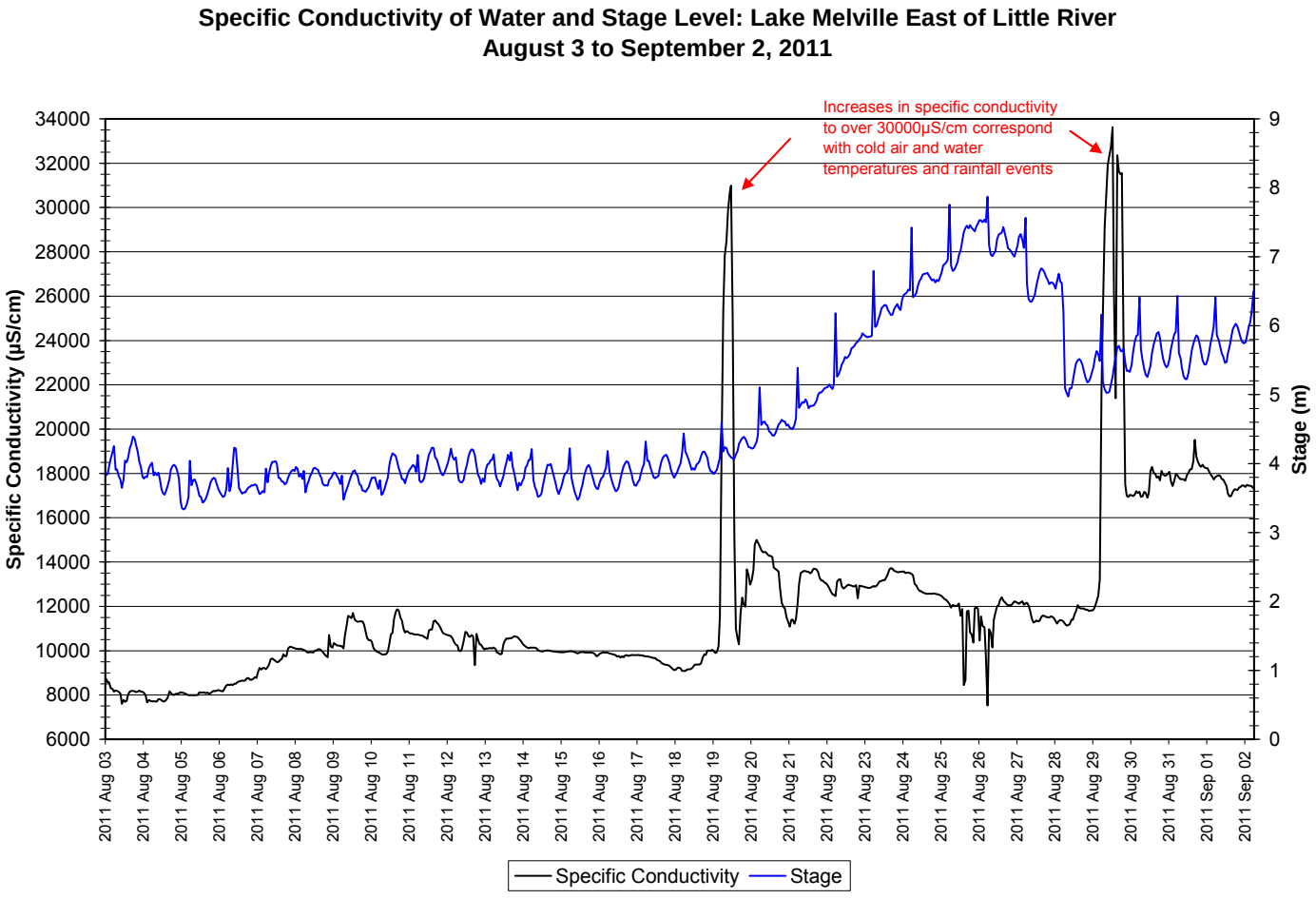

Figure 11: Specific conductivity at Lake Melville East of Little River

- The saturation of dissolved oxygen ranged from 71.9 to 168.6% and a range of 6.88 to 16.20mg/l was found in the concentration of dissolved oxygen with a median value of 9.31mg/l (Figure 12). Dissolved oxygen content is relatively stable throughout the deployment period with significant daily fluctuations reflecting the inverse relationship with water temperature.
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. Dissolved oxygen content fluctuates above and below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l during day and night (indicated in blue on Figure 12). It is important to note that these guidelines are for 'freshwater' environments. If this environment is considered a 'marine' environment, the minimum CCME Guideline for the Protection of Aquatic Life is 8.0mg/l (indicated in green on Figure 12). Most values are above this minimum guideline.
- On August 16-18, dissolved oxygen and percent saturation do not fluctuate regularly as seen in the trend for the first two weeks of the deployment period. This change corresponds with a decrease in water and air temperatures and a rainfall event. Other water quality parameters are affected at this time as well (pH, specific conductivity and turbidity). Similarly, near the end of the deployment period (August 25-30), dissolved oxygen does not fluctuate as significantly on a diurnal interval. This event also corresponds with cooler water and air temperatures, a rainfall event and changes in other water quality parameters.
- From August 31 to September 1, dissolved oxygen and percent saturation increase significantly, spiking to over 16.0mg/l and 165% respectively. This increase is likely the result of windy conditions causing high surf at the lake side station.

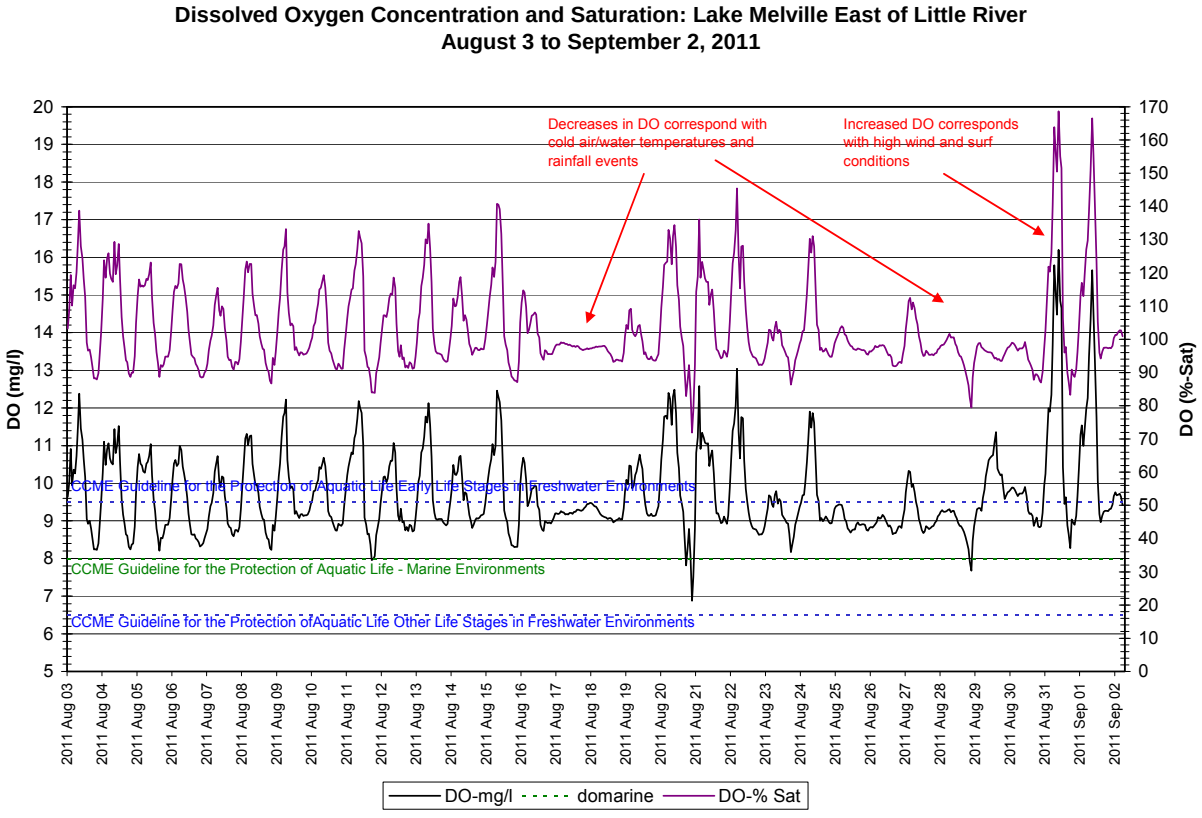

Figure 12: Dissolved oxygen and percent saturation at Lake Melville East of Little River

- A range of 0.0 to 559.0NTU was recorded for turbidity for this deployment period (Figure 13). A median value of 0.8 NTU indicates there is often natural background turbidity value at this station.
- A significant turbidity event occurring from August 17-19, with values reaching >550NTU, corresponds with decrease air and water temperatures, a rainfall event and changes in other water quality parameters monitored at the site (pH, specific conductivity, and dissolved oxygen). Other increases in turbidity occur near the end of the deployment between August 25-30 which also correspond with cold water and air temperatures, rainfall events and other changes in water quality parameters.
- This station is particularly susceptible to high winds because the lake environment can cause extreme surf conditions affecting the turbidity and stability of the readings by the instrument.

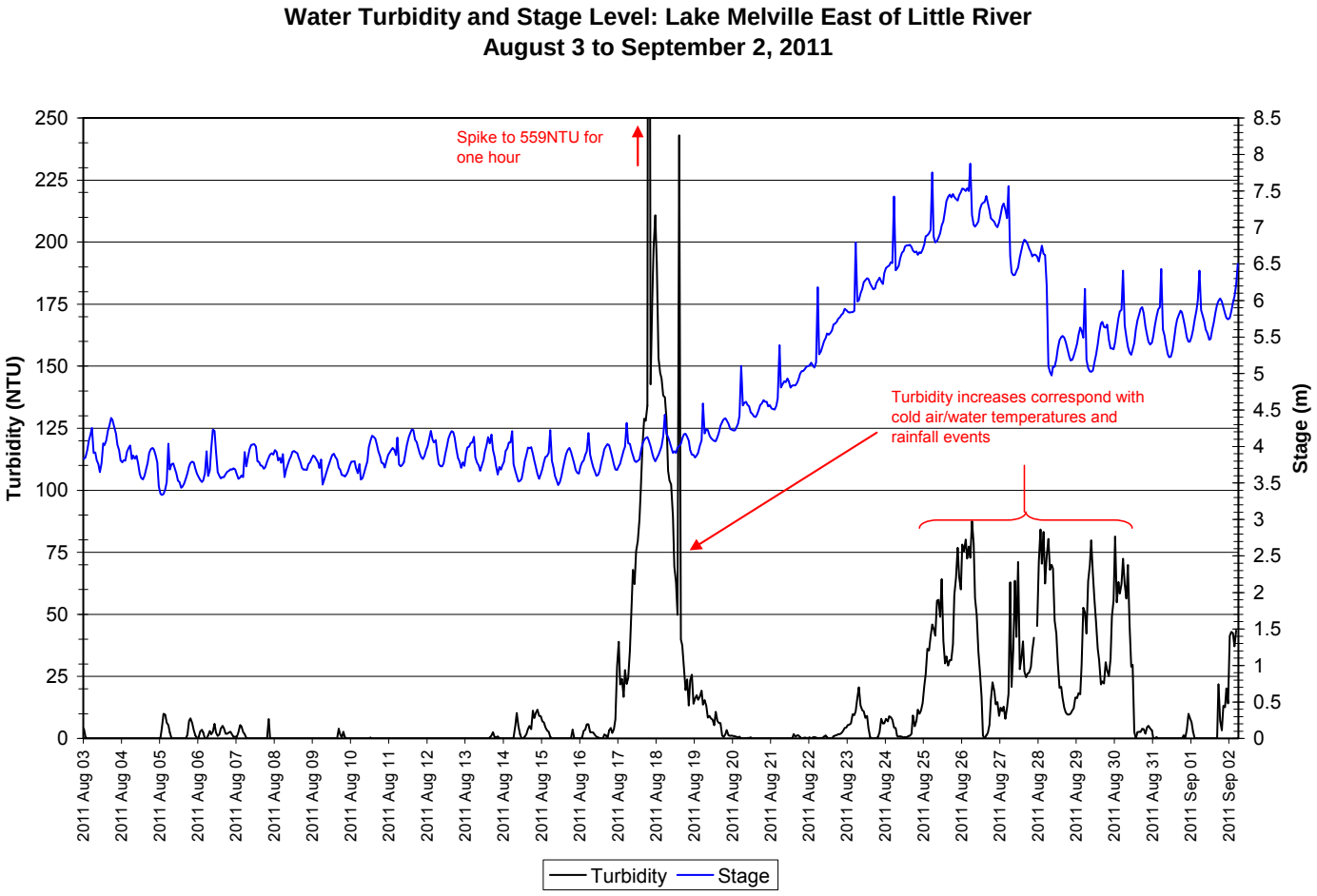

Figure 13: Turbidity at Lake Melville East of Little River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Precipitation events vary throughout the deployment period.
- There is no significant correlation between precipitation and water level in such a small period of time for such a large lake (3000sq km).

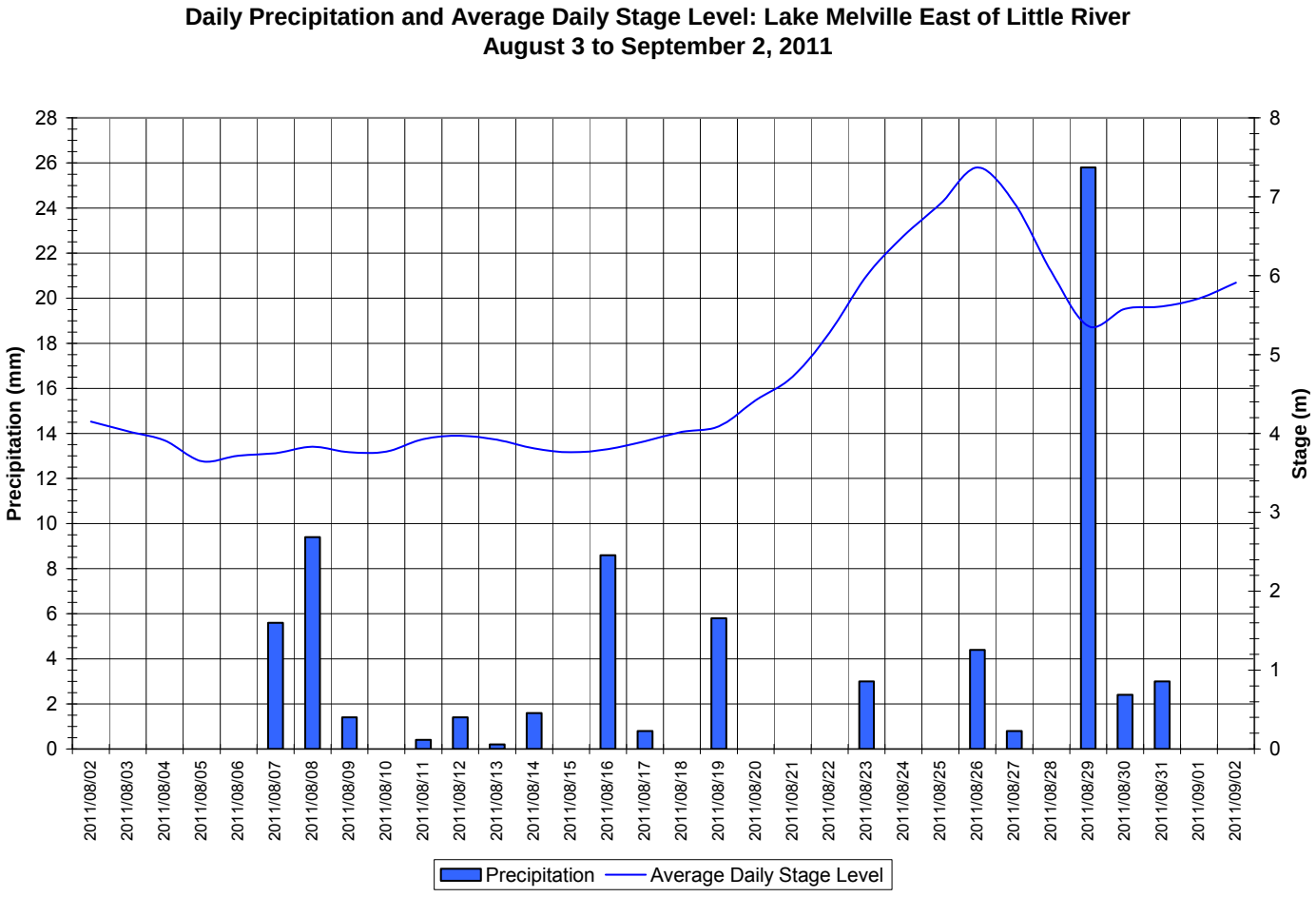

Figure 14: Stage and precipitation at Lake Melville East of Little River

Conclusions

- Instruments at water quality monitoring stations on the Lower Churchill River at English Point and on Lake Melville East of Little River were deployed on August 3 and removed on September 1-2.
- These stations are an extension of the existing RTWQ Network on the Lower Churchill River, established to protect ambient water resources and catch emerging water quality issues. The data from these 2 stations augment the data collected from the existing stations on the Lower Churchill River.
- In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations. In some cases, the cause of the disturbance remains unknown.
- Most values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen. Events which exceeded the CCME Guidelines were for the most part short lived and not of great magnitude beyond the guideline.
- Water temperature was generally stable at both stations due to the consistent warm ambient air temperatures in the region. During the summer season.
- pH values were generally within the recommended CCME Guidelines for the Protection of Aquatic Life for either freshwater or marine environments depending on the station. Events which exceeded the CCME Guidelines were for the most part short lived and not of great magnitude beyond the guideline. pH values fluctuated at a greater magnitude at the Lake Melville station on a daily basis.
- Specific conductance fluctuated diurnally with the tides at both stations. Specific conductive is 300-400 times greater at the station on Lake Melville due to the influence from the Atlantic Ocean and experiences much more variability throughout the deployment period than the station at the mouth of the Churchill River.
- Dissolved oxygen content fluctuated inversely to water temperature. Dissolved oxygen content is generally stable throughout the deployment period at both stations as the water temperature was consistent. Dissolved oxygen is at a seasonal low during this period due to the warm air and water temperatures.
- There is a natural background turbidity values at both of these stations. These stations are susceptible to turbidity increases during rainfall and weather events. Recovery periods for turbidity events range depending on the size of the disturbance and vary throughout the deployment period.

Prepared by:
Grace Gillis
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.896.5542
Fax: 709.896.9566

Appendix 1

Average Daily Air Temperature and Daily Precipitation: Happy Valley Goose Bay, NL
August 2 to September 1, 2011