Nova Scotia Environment and Labour
Automated Surface Water Quality Monitoring Network

Real-time Water Quality Monitoring Workshop

June 4th and 5th , 2007

St. John's, NFLD

NOVA SCOTIA
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Outline

- NSEL Automated Surface Water Quality Monitoring Network Overview
- Current Water Monitoring Stations
- NSEL's Field Verification and Sonde Maintenance
- Data Management
- Data Analysis and Interpretation Report
- Future Work
- Lessons learned from 5 years of monitoring
- Questions?

Program Overview

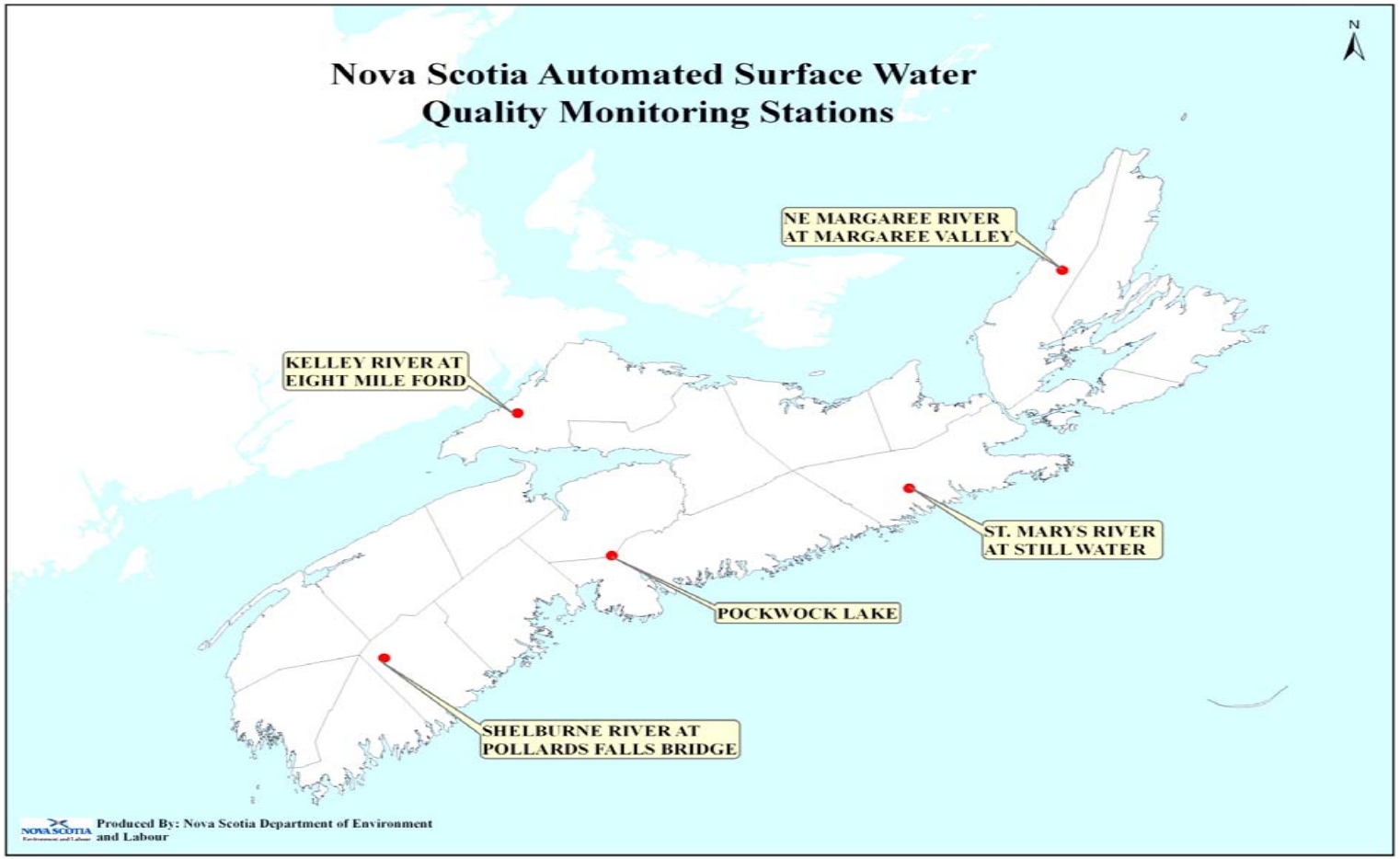
- The NSEL's Automated Water Quality Monitoring Program is intended to determine baseline water quality in lakes and streams throughout the province
- This program measures long term-trends in water quality
- Monitoring stations are located in areas of provincial significance
- The Automated Water Quality Monitoring Network consist of 5 automated stations throughout Nova Scotia

Program Overview

- Monitoring stations are typically co-located with Hydrometric Monitoring stations to allow : 1) program delivery efficiencies, 2) capabilities for real-time reporting, and 3) calculations of loadings of contaminants or other water quality constituents.

- Site Selection has been based on:
  - Heritage River status or nomination
  - Protected Area status
  - Existing Hydrometric infrastructure
  - Largely unimpacted site
  - WQ Index potential
  - Existing long term water quality dataset

Active Monitoring Stations



Active Monitoring Stations

- All of our stations have shoreline deployment
- Shelburne and North East Margaree are designated Heritage Rivers
- QAQC data has been collect since 2002 at Shelburne River, Pockwock Lake, Northeast Margaree
- Kelley River was added in 2004
- St. Mary's River was added in 2006
- All data from 2002 to 2005 has been collected, verified, shifted, and graded for release to the public.

NSEL's Field Verification and Sonde Maintenance

- The QAQC data collection program was implemented in 2002
- Verified the sondes Turbidity, pH and Sp Conductance with grab samples
- Verified the sondes Temperature and DO with freshly calibrated hand held YSI probe
- During the 2002 field season the sondes were verified, then removed from the site and maintained remotely
- After sonde cleaning and servicing they were allowed to stabilize over night and calibrated the next morning
- Then returned to the site and verification was performed

NSEL's Field Verification and Sonde Maintenance

- NSEL purchased a spare sonde for the network in 2003
- The spare unit was cleaned, serviced and calibrated at the Halifax lab prior to the field maintenance trip
- Once arriving at the monitoring station the seasoned sonde was verified by taking grab samples and using the handheld YSI probe
- The seasoned sonde was removed and the freshly calibrated sonde deployed
- Verification was preformed on the freshly calibrated sonde again with grab samples and handheld YSI probe
- The seasoned sonde was taken back to the Halifax lab for maintenance and calibration

NSEL's Field Verification and Sonde Maintenance

- NSEL purchase a handheld unit that monitors the same parameters as the sondes in 2004
- The spare unit and new handheld unit were cleaned, serviced and calibrated at the Halifax lab prior to the field maintenance trip
- Once arriving at the monitoring station the seasoned sonde was verified with the freshly calibrated handheld unit and grab samples were taken as a back up
- The seasoned sonde was removed and the freshly calibrated sonde deployed
- Verification was preformed on the freshly calibrated sonde with the handheld unit and grab samples were taken as a back up
- The seasoned sonde and handheld unit was taken back to the Halifax lab for maintenance and calibration
- This is the current procedure that is followed today

Data Management

- SOP's and Guidelines used
- Removal of Outliers
- Data Rejection
- Criteria for Water Quality Data Shift
- Data Rating
- Supporting Documents
  - Monitoring Station Description
  - Data Quality Analysis

Data Management – SOPs and Guidelines

- The bases for NSEL's Data Management comes from Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S. Geological Survey Water Resources Investigations Report 00-4252

Data Management – Removal of Outliers

- The first step in Data Management is to removed outliers
- This is preformed by comparing the outliers to stage data, precipitation data, and other monitoring parameters
- Also, professional judgement and knowledge of the monitoring site plays a key role in deciding when outliners are removed

Data Management – Data Rejection

- The decision to reject data is based on comparing the difference between the field verification value and the sonde's value for each parameter
- The difference between the two values is then compared to the Data Rejection Criteria Table
- If the difference falls outside of the Rejection value for a parameter then a decision has to be made on how much of the deployment data will be rejected.
- Profession judgement is to be used when rejecting partial data

Data Management – Data Rejection

Data Rejection Criteria. Maximum allowable limits for continuous water-quality monitoring sensors.

Measured physical property	Maximum allowable limits for water-quality Sensor values
Temperature	+/- 2.0 °C
Specific conductance	+/- 30 percent
Dissolved oxygen	The greater of +/- 2.0 mg/L or 20 percent
pH	+/- 2 pH units
Turbidity	The greater of 15 NTUs or 30 percent

Data Management - Criteria for Water Quality Data Shifts

- The decision to shift data is based on comparing the difference between the field verification value and the sonde's value for each parameter
- The difference between the two values is then compared to the Criteria for Water Quality Data Shifts Table
- If the difference falls outside of the Criteria for Water Quality Data Shifts value for a parameter, then the data for that parameter is shifted to reflect the field verification value

Data Management - Criteria for Water Quality Data Shifts

Measured physical property	USGS Shift Criteria (apply shift when deviation exceeds this value)
Temperature	+/- 0.2 Degrees Celsius
pH	+/- 0.2 units
Specific Conductance	The greater of +/- 5 uS/cm or +/- 3 percent of the measured value
Dissolved Oxygen	+/- 0.3 mg/l
Turbidity	The greater of +/- 2 NTU or +/- 5 percent of the measured value

Data Management - Criteria for Water Quality Data Shifts

- Once the decision to adjust data has been reached, the adjustment is preformed in Excel
- The difference between the field verification value and sonde value is determined for the installation and removal period of the sonde (deployment period)
- In Excel those two points are highlighted then the Series/Linear/Trend function is used to create a linear rate over the deployment period between the two verification points
- This linear rate is then used to adjust the sonde's values to the field verification values, if necessary

Data Management – Data Rating

- The final step in Data Management is Data Rating
- This is performed by comparing the difference between the field verification and sonde's value for each parameter to the Data Quality Rating table
- After comparing the value to the table for a deployment period, the data is given a rating of Excellent, Good, Fair or Poor

Data Management – Data Rating

Data Quality Rating. Rating continuous water-quality records

Measured physical property	Excellent	Good	Fair	Poor
Water temperature	≤ +/- 0.20 °C	> +/- 0.2 to 0.5 °C	> +/- 0.5 to 0.8 °C	> +/- 0.8 °C
Specific conductance	The greater of ≤ +/- 3% or ≤ +/- 5 uS/cm	The greater of > +/- 3 to 10 % or > +/- 5 to 15 uS/cm	The greater of > +/- 10 to 15 % or > +/- 15 to 25 uS/cm	The greater of > +/- 15 % or 25 uS/cm
Dissolved oxygen	≤ +/- 0.3 mg/L	> +/- 0.3 to 0.5 mg/L	> +/- 0.5 to 0.8 mg/L	> +/- 0.8 mg/L
pH	≤ +/- 0.2 units	> +/- 0.2 to 0.5 units	> +/- 0.5 to 0.8 units	> +/- 0.8 units
Turbidity	The greater of ≤ +/- 5% or ≤ +/- 2 NTUs	The greater of > +/- 5 to 10% or > +/- 2 to 5 NTUs	The greater of > +/- 10 to 15% or > +/- 5 to 8 NTUs	The greater of > +/- 15% or > +/- 8 NTUs

Data Management – Data Quality Analysis Document

- Produced for each year of data
- Equipment Description
- Primary Records
- Channel Characteristics
- Field verification description and dates
- Data Rating table for collected data
- Data Correction procedures
- Missing Data

Data Management – Data Quality Analysis- Example Data Rating Table

Data Rating:

Period from	Period to	Temperature	pH	Conductivity	DO	Turbidity
12/15/2004	05/11/2005	Excellent	Good	Excellent	Fair	Rejected
05/11/2005	06/29/2005	Excellent	Excellent	Excellent	Fair	Excellent
06/29/2005	09/14/2005	Excellent	Poor	Fair	Good	Poor
09/14/2005	12/01/2005	Excellent	Good	Good	Excellent	Poor

Data Management – Monitoring Station Description Document

- Produced for each year of data
- Location
- Gross Drainage Area
- Hydrometric Record Length
- Hydrometric Measurement
- Hydrometric Real-Time Data Available
- Water Quality Record Length
- Water Quality Parameters Recorded

Data Management – Monitoring Station Description

- Water Quality Real-Time Data Available
- USGS SOP's were followed excluding: cross-section measurement and adjustments, modification to Data Rejection Criteria table and Data Quality Rating table

Data Analysis and Interpretation Report

- In the spring of 2007 NSEL released a report on the Automated Water Quality Monitoring program
- This report describes the water quality of 4 monitoring sites from 2002 to 2005
- The validated hourly data was used to create daily, monthly and annual data for statistical analyses

Future Work

- Setting up Real-time Monitoring Network with Environment Canada
- Explore different options for data verification and management
  - Working with EC and NFLD on using calibration solutions for evaluating sensor fouling and drift
  - Exchanging ideas and information regarding data analysis and reporting
- Using Aquarius Software for data shifting and statistical analysis of data

Lessons learned in 5 years of monitoring

- The use of existing Hydrometric Network infrastructure
- Environment Canada's Hydrometric field staff experience
- Having a spare sonde for equipment rotation and equipment repair to minimize data gaps
- Using the USGS SOP's as a guideline for NSEL's SOPs
- Advancements in sensor technology.
  - Turbidity wiper sensor and the LDO sensor

Questions?

- Thank you

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