Teacher's Guide

Comparing Current Chemical Water Quality Measurements with Past Measurements At A Stream Site

Lesson Description

In this lesson, students will compare their most recent water quality measurements with their past measurements at the same stream site. Samples are usually taken during the spring and fall seasons of the year, and to avoid seasonal variations, the spring measurements should be compared only to spring measurements from the past. The same protocol should be followed when comparing the fall measurements to those from the past.

Samples collected from the most recent stream surveys can be measured and converted to Q values. (Mitchell and Stapp). The averaged measurements from the same site collected for the same season of the year should also be converted to Q values. The Q values, as illustrated in the aforementioned reference, assign a value between zero and one hundred for each measurement conducted.

By using a Q value, the amount of a substance present can be compared to the ideal amount of that substance. The Q value allows us to compare the measured levels of phosphates, nitrates, turbidity and all the other measurements to the ideal values for the stream sample. The use of Q values provides a level playing field, and instead of comparing apples to oranges we can compare, for instance, the ripeness of apples to the ripeness of oranges. The measurement of ripeness for apples and oranges can be assessed by Q values, and this analogy can be applied to any of the water quality measurements for comparison.

There are several other methods to evaluate and analyze the water quality data, but they require the use of statistics that may be outside the scope of this investigation or beyond the expertise of the students. Keeping with the data conversion to Q values, our comparisons will be simply how far is our sample or our database average below the ideal amount for each measurement. Any difference in value that is greater than 10 Q values is considered worthy of closer inspection and further investigation.

Science Concepts Introduced

- Compare current data collected from a stream site to accumulated data at that stream site.
- Evaluation of recently collected data to an on-line database.

Process Skills Emphasized

- Accessing web based information.
- Downloading data to a spreadsheet.
- Comparing recently collected data to the database average
- Preparing a class presentation

Technology Used:

- Computer
- Analytical software such as MS Excel
- Internet

MST Standards

Standard 1: Key idea 1 - Performance indicators 1, 2, 3
Standard 2: Key idea 2 - Performance indicators 1, 2, 3
Standard 3: Key idea 1 - Performance indicator 2
              Key idea 6 - Performance indicator 1
Standard 7: Key idea 1 - Performance indicators 1 and 4
              Key idea 2 - Performance indicators 1, 2, 3, 4, 5, 6

Learning Outcomes
Students will be able to:
1. Use a spreadsheet to find the averages for a set of chemical values.
2. Manipulate data in MS Excel.
3. Convert data into graphs in MS Excel
4. Compare and evaluate a recent collection with past collections of data.
5. Communicate group results in a class presentation

Time Requirement
4 Class periods or 2 double periods (block)
Collection and analysis
Comparisons and class presentations

Instructional Strategies
Learning and communicating through group work

Background
- Input a new column (monthly) in the downloaded database, allowing students to cancel out seasonal differences.
- Assist groups on the spreadsheet manipulation. If possible, arrange to have a technophile in each group capable of performing, or better yet, teaching the spreadsheet functions to the other group members.
- If students do not have computer access, the teachers may have to sort the database to obtain average values for comparison.
- Use the Q values to make the comparisons. Values usually deviate from the number (+ or –) by two or three Q values.
- A good estimation for a significant number will be a difference of ten or more Q values between chemical measurements.

Assessment
- Q value results will be quantified and compared in a group presentation.
- A written report will be submitted following the oral report.
- Both reports will be evaluated to see how students determined the Q values.

Extensions/Options
1. Students plot spring/fall variation for each chemical test.
2. Each group graphically displays seasonal variations.
3. Compare two samples from different stream sites from the same stream (collected on the same day). These comparisons should be relatively simple because the same weather and precipitation conditions will be present at both sites.

Key Terms
Q values, upstream site, downstream site, database, chemical v non-chemical measurements

Prerequisite Knowledge
1. All participants will understand how to find optimum results for water chemistry tests using the Q values tables from the references. (Mitchell and Stapp).
2. The water quality chemistry tests include: dissolved oxygen (DO), pH, nitrates, phosphates, total dissolved solids, chlorides, biochemical oxygen demand (BOD).
3. The non-chemical water quality tests include: turbidity, and fecal Coliform

Equipment Needed
Computer with MS Excel and MS Word
Printer
Internet Access

References

M.K. Mitchell and W.B. Stapp 1997 <u>Field Manual for Water Quality Monitoring,</u> GREEN/Earth
    Force, Alexandria, VA
<u>Web sites:</u>
http://wow.nrri.umn.edu/wow/data/pplotter/index_ice.html
http://wow.nrri.umn.edu/wow/overview.html

FYI

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May 10, 2005

Dear Ms. O'Brien:

Since 1995, Project Watershed Central New York participants have used your publication, Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools by M.K. Mitchell, W.B. Stapp and Earth Force Inc. (0-7872-6801-1). Project Watershed provides stream monitoring experiences for 23 high schools and 6 adult volunteer teams in five Central New York counties.

non-exclusive

The intent of this letter is to request permission to copyright the nine weighting curve charts in Chapter 4, Calculating the Results, for reference on our web site at < http://projectwatershed.org/>.   Since these charts have served as the basis of our chemical/physical monitoring protocol, they would be very useful to our teachers, students and adult volunteers on the Internet, as they review and interpret their collected water quality data at the Project Watershed database.

Project Watershed is a totally volunteer, not-for-profit environmental education organization. The organization's supplies, equipment and web site are funded through contributions and grants.

I can be reached at 315-677-5194 or leggbill@dreamscape.com or the address above.

I look forward to your reply to this request. Thank you for your consideration.

Sincerely,

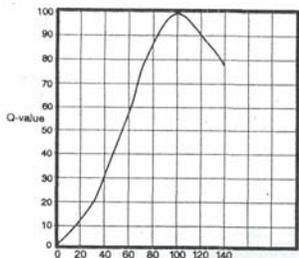Bill Legg, Director
Project Watershed Central New York

WEIGHTING CURVE CHART

Dissolved Oxygen (DO) Test Results

Q-value vs. DO: % saturation

Note: if DO % saturation > 140.0, Q=50.0

Fecal Coliform (FC) Test Results

Q-value vs. FC: colonies/100 ml

Note: if FC > 10⁵, Q=2.0

pH Test Results

Q-value vs. pH: units
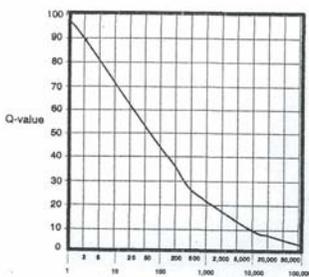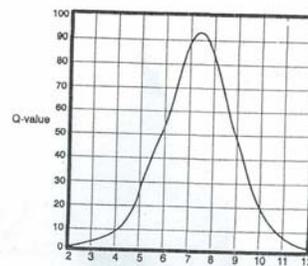
Note: if pH < 2.0, Q=0.0; if pH > 12.0, Q=0.0

5-Day Biochemical Oxygen Demand (BOD) Test Results

Q-value vs. BOD₅: mg/l
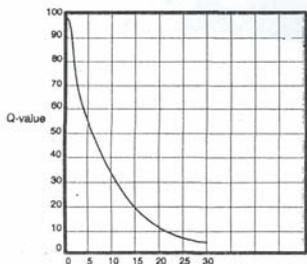
Note: if BOD₅ > 30.0, Q=2.0

Phosphate (as PO₄-P) Test Results
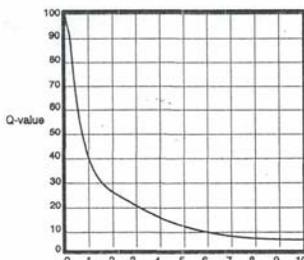
Q-value vs. PO₄-P: mg/l

Note: if PO₄-P > 10.0, Q=2.0

Nitrate (as NO₃) Test Results

Q-value vs. NO₃: mg/l
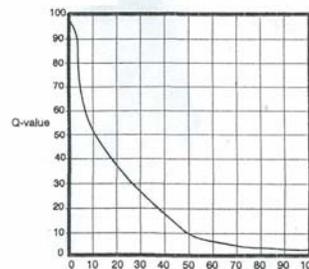
Note: if NO₃ > 100.0, Q=1.0

WEIGHTING CURVE CHART

Chloride (as Cl⁻) Test Results
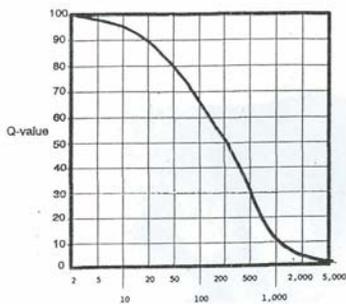
Q-value vs. Chloride: mg/l

Note: if Cl⁻ < 2.0, Q = 100; if Cl⁻ > 5,000, Q = 0.0

Turbidity Test Results
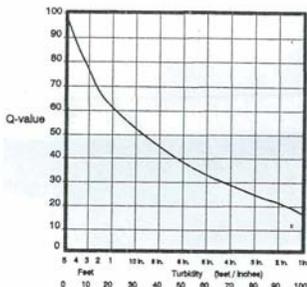
Q-value vs. Turbidity: NTU's/JTU's or feet/inches

Note: if Turbidity > 100.0, Q=5.0

Total Solids (TS) Test Results
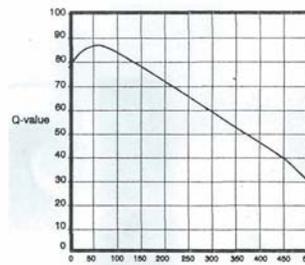
Q-value vs. TS: mg/l

Note: if TS > 500.0, Q=20.0

Comparing Current Chemical Water Quality Measurements with Past Measurements At A Stream Site

Introduction

Once water quality measurements obtained from a stream study are available, there must be an investigation to see if those measurements are accurate. The most recent stream study will be compared to the averaged test results from the database. If these results are similar in Q value to the samples collected in the past, they will tell us no significant pollution has occurred recently (the last several days) upstream from the collection site.

Pollution can enter the watershed in many forms. Project Watershed's nine tests are specific to the most probable types of pollution. If differences between your sample and the average from the database are found in significant numbers, it would signal pollution is entering the watershed somewhere upstream. The water quality chemistry tests include: dissolved oxygen (DO), pH, nitrates, phosphates, total dissolved solids, chlorides, biochemical oxygen demand (BOD). The non-chemical water quality tests include: turbidity, and fecal coliform. Your instructor will present a simple method for comparing test results using Q values (Mitchell and Stapp).

Learning Outcomes

Students will be able to:
- Use a spreadsheet to find the averages for a set of chemical values.
- Manipulate data in MS Excel.
- Convert data into graphs in MS Excel
- Compare and evaluate a recent collection with past collections of data.
- Communicate group results in a class presentation

Skills Required
- Use of computers and software
- Sort information from the database
- Compare data from various sites and times
- Public speaking

New Terms

Q values, chemical physical and biological parameters.

Quest

You are an investigator searching for traveling midnight polluter (s) who has been releasing illegal chemicals into our local streams. We know that there have been large amounts of certain chemicals released at various times of the year. The problem is that we only monitor the stream twice a year. Realizing that once the chemicals are released, they can be washed away by the stream flow. We have to almost catch the polluter(s) in the act. Your task is to compare recently collected samples to the Project Watershed database and determine if the polluter(s) has made an illegal release into your stream.

Materials

A set of data from your most recent stream study
Computer with MS Excel and a word processing program
Access to the Internet

Procedure

1. Download all the water chemistry data at the selected stream site.
2. Sort the data by month to avoid seasonal influences.
3. Compute and evaluate the mean for each of the nine parameters of water quality from the database.
4. Convert each mean to a Q value from the established reference.
5. Convert the current data collected from the recently measured stream site into Q values using the reference (Mitchell and Stapp).

6. Compare the Q values for each of the chemical parameters to see if there are what you would consider to be significant differences.
7. Find any deviation between current and past values. Explain the differences and why they would be considered highly significant.
8. Develop an Excel bar graph to show the current and past Q values for visual comparison of the investigation results.
9. Present the results of your investigation to the class.

Extension/Options
1. Students plot the monthly values for each of their chemical tests.
2. Identify variations in the spring/fall period. Expect wide variations.
3. Graphically display any seasonal variation.
4. If your stream fails to show expected variations, choose another stream (available on the website) with a larger database.
5. Compare two samples from different stream sites from the same stream collected on the same day. These comparisons should be relatively simple because the same weather and precipitation conditions were present at both sites. Expect minimal variations.

References
M.K. Mitchell and W.B. Stapp 1997 <u>Field Manual for Water Quality Monitoring,</u> GREEN/Earth Force, Alexandria, VA.

Websites:
- http://www.projectwatershed.org
- http://wow.nrri.umn.edu/wow/under/parameters/turbidity.html
- http://wow.nrri.umn.edu/wow/under/parameters/oxygen.html
- http://h2osparc.wq.ncsu.edu/info/do.html
- http://bcn.boulder.co.us/basin/data/NUTRIENTS/info/TP.html
- http://www.epa.gov/volunteer/stream/vms56.html
- http://oregonstate.edu/instruction/bi301/eutrophi.htm
- http://bcn.boulder.co.us/basin/data/NUTRIENTS/info/NO3+NO2.html
- http://www.campbellsci.ca/CampbellScientific/Catalogue/Hydrolab_Chloride.pdf
- http://wilkes.edu/~eqc/tds.htm
- http://bcn.boulder.co.us/basin/data/NUTRIENTS/info/TDS.html
- http://www.ncsu.edu/~ajclevel/pHeffects.htm
- http://www.dec.state.ny.us/website/dow/stream/orderpageone.htm
- http://www.people.virginia.edu/~sosiwla/Stream-Study/Key/MacroKeyIntro.HTML
- http://bcn.boulder.co.us/basin/data/NUTRIENTS/info/index.html
- http://www4.ncsu.edu/~ajclevel/macroinvert.html
- See websites (above) to research why the Q values vary by a significant amount.

Assessment
Rubric
- Work effectively by following directions for analysis of water quality parameters using Q values.
- Demonstrate the ability to gather and process information by downloading the appropriate data.
- Demonstrate the ability to calculate all parameters into seasonal averages using a spreadsheet for comparison.
- Generate Q values from the processed data.
- Demonstrate ability to analyze Q values (present to past).
- Demonstrate significant differences in Q values and offers a hypothesis for the variations.
- Present results and interpretation in a clear, concise and informative manner.

Handouts