**Nutrient Loads Module**

**Instructor's Handout**

**MODULE DESCRIPTION:**

**Instructors Overview:**

**Intended Audience and Background Skills:**

This module is intended for introductory to mid-level, Earth Science, Biological Science and Environmental Science students. It is helpful if students have a little knowledge of chemistry. It will also be useful for the students to understand the fundamentals of the hydrological cycle prior to this module as runoff plays a key role in the interpretation of the results. The Excel skills used in this activity involve using equations, summations and averages.

**Location within course:**

This module is designed to address the following core-concepts within the course curriculum:

* The Nitrogen Cycle
* Impact of nutrients on downstream lake health, and coastal “dead zones.”
* The Clean Water Act and federal management of water quality in the United States

**Prior to using this module, students should be familiar with the following concepts:**

* Components of the Hydrologic Cycle
* Stream discharge and its measurement
* Hydrographs
* Nutrient cycling
* Rudimentary operation of Microsoft Excel

**Learning Objectives:**

* Analyze and interpret data to deepen knowledge and increase understanding of hydrogeological concepts and nitrogen cycling in aquatic systems in the context of increased nutrient availability.
* Explore advantages and disadvantages of different ways to investigate, sample, and quantify nutrients in aquatic systems.
* Develop skills for critical data analysis, graphing, and statistics.

**Duration:**

This module is designed for two 50-minute lecture periods and two 1-hour-and-50-minute lab period. The instructor may complete as many of the activities as practical during this time. The activities are listed in order of increasing difficulty from A to E.

**Overview and Timing**

***Part A (Lecture and background - 1 hour)***

Students will learn background of nutrient issues in surface waters and learn about concentration, discharge, their relationship and the calculation of load from their multiplication.

***Part B (Calculations and Graphing - Concentration Discharge -1 hour)***

Students will learn to access USGS data sets using either NWIS or CUAHSI’s Hydro Client and learn to combine concentration and discharge data to investigate nutrients loads from agricultural systems in Iowa. They will learn to graph the data as time -series and X-Y plots as well as investigate calculations that can be made with these data.

***Part C (Calculations and Graphing - Concentration Discharge - 1 hour)***

Students will learn to quantify correlations between the two variables at different time scales and in different ways using both graphs and statistical correlations.

***Part D (Calculations of load - 1 hour)***

Students will learn to calculate loads of nutrients exported from a catchment and compare an upstream and a downstream catchment to see how concentration and discharge change along with nutrient load with distance downstream.

***Part E (Sample Frequency- 1 hour)***

Students will learn to calculate loads of nutrients exported from a catchment with varying sample frequency. It is rare to have high frequency data like the ones used in the earlier parts of this module. In this exercise students will work with desampled data to investigate the effects of sample frequency on the calculation of nutrient loads.

**Nitrate Loading Module:**

**Pre-Reading:**

To engage the students, the instructor should assign the class a few background readings from the “Background Readings” folder the week prior to running the module. At the minimum, we recommend assigning Articles 1 and 2, as these discuss the cyanotoxin crisis in Toledo, Ohio in 2014, as well as Article 3 which discusses nitrate sources along the Mississippi River and the content closely parallels our activities. Article 4 provides additional information on the Gulf of Mexico Dead Zone. Article 5 discusses phosphate as a pollutant. Article 6 explores lake eutrophication in a tropical lake in Guatemala which has impacted tourism, and the health and livelihood of indigenous Mayan communities.

The following background reading articles are available:

(1) Wines, M. (2014). Behind Toledo’s Water Crisis - a Long-Troubled Lake Erie, *New York Times*, August 4: 4 pages.

(2) Zimmer, C. (2014). Cyanobacteria are far from just Toledo’s problem. *New York Times*, August 7: 3 pages.

(3) Shipley-Hiles, S. (2012). Dead zone pollutant grows despite decades of work. *Scientific American*, July 9: 6 pages.

**Introduction PowerPoint:**

The PowerPoint presentation introduces the key concepts and terminology referenced in this module. This presentation includes 45 slides with relevant figures. Short-duration, classroom demonstrations/activities are described within the PowerPoint. The instructor may choose to:

a) show the entire presentation during one, 50 minute class period at the beginning of the module;

b) break the presentation into smaller components, and show these components between the activities; c) assign the PowerPoint along with the pre-reading.

**Useful Web Pages**

We have provided a Word Document that lists useful web pages. These are supplemental resources which the students or faculty member may wish to explore during the module.

**ACTIVITIES**

The assignment will take students from a general understanding of why loads are important, to a qualitative understanding of the connection of discharge to nitrate concentrations, to focused correlation analyses of the connection between discharge and nitrate concentrations, to estimating nutrient loads at a site and along a river network, and finally to develop an understanding of the influence of sampling frequency on robustness of load estimates. See the student hand out for the details of the assignment.