Subjects/Target Grades

Science and Social Studies
Grades 7-12

Duration/ Location

2- 3 50-60 minute class periods
Classroom setting

Materials

*Per small group*

- Plan for Action: Subwatershed Research Project student resource
- Exploratory Data Analysis student activity
- Locations of Subwatershed Management Units student resource
- Lower Grand River Watershed Management Plan student resource
- Supplies to make visual representations

# Lesson Four Explain: Managing Excess Nutrients- page 10 from lesson 4

## Activity Overview

Students explore the patterns of nitrogen and phosphorus inputs in the Lower Grand River Watershed by looking at the nitrogen and phosphorus loadings in selected subwatersheds and drawing conclusions about which sites are critical areas for action to reduce nutrient inputs.

## Lesson Procedure

1) Divide students into small groups. Pass out the *Plan for Action: Subwatershed Research Project* student resource. Provide groups of students with the *Exploratory Data Analysis* student activity, the *Locations of Subwatershed Management Units* student resource, and the *Lower Grand River Watershed Management Plan* student resource.

2) Once all groups have finished creating their visual representations to persuade the class why or why not their subwatershed should be a priority for nutrient reduction, have the small groups present their visuals to the class

3) Once all presentations are complete, have the class vote to prioritize the subwatersheds for nutrient reduction action.

## Vocabulary Terms

**Subwatershed-** A watershed is all of the land and water areas that drain toward a particular lake or river segment. Watersheds can be identified on different scales. Large scale watersheds are composed of smaller areas called subwatersheds.

# Exploratory Data Analysis

Below is information from the Subwatershed Management Unit Summaries for the Lower Grand River Watershed. See the *Locations of Subwatershed Management Units* maps for their locations. Taking into account the information below, your group's task is to:

- Look at the information that is currently in the Nutrient Load table, determine the **top four** management units that should be priorities for nutrient reduction, and explain in detail why you have made your selections.

- Calculate the missing columns in the table and re-visit your selection for the **top four** management units.

## Nutrient Load

| Management Unit | Acres | Phosphorus lbs/year | Phosphorus lbs/acre | Nitrogen lbs/year | Nitrogen lbs/acre | Agri-culture % | Urban % |
|---|---|---|---|---|---|---|---|
| Bear Creek | 20,332 | 3,690 | | 21,600 | | 34 | 12 |
| Buck Creek | 32,392 | 28,061 | | 153,436 | | 18 | 64 |
| Deer Creek | 22,374 | 3,600 | | 20,913 | | 79 | 8 |
| Indian Mill Creek | 10,979 | 7,545 | | 42,689 | | 39 | 43 |
| Rogue River | 139,522 | 50,936 | | 291,252 | | 42-45 | 5-19 |
| Rush Creek | 38,041 | 18,330 | | 103,000 | | 38 | 46 |
| Sand Creek | 35,085 | 12,620 | | 75,200 | | 64 | 14 |
| Lower Thornapple River | 93,534 | 22,890 | | 133,690 | | 43 | 14 |

1. How did calculating the loads in lbs/acre influence your choices?

2. What influenced your discussion about the sources of the nutrient loads?

ANSWER KEY

# Exploratory Data Analysis

Below is information from the Subwatershed Management Unit Summaries for the Lower Grand River Watershed. See the *Locations of Subwatershed Management Units* maps for their locations. Taking into account the information below, your group's task is to:

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- Calculate the missing columns in the table and re-visit your selection for the **top four** management units.

## Nutrient Load

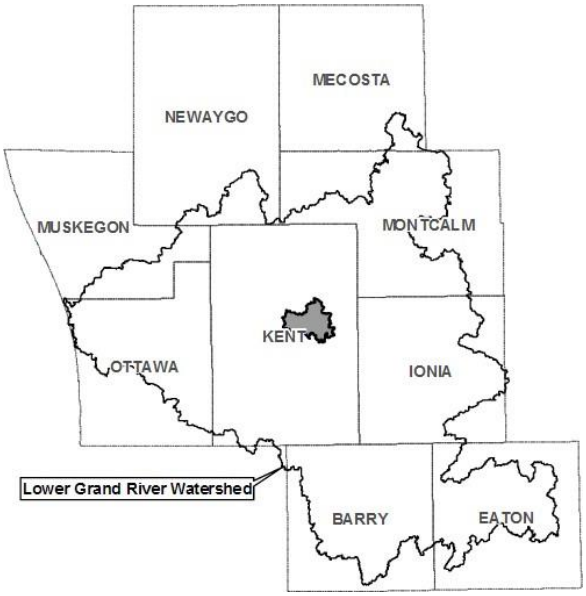
| **Management Unit, *(Rank)*** | **Acres** | **Phosphorus lbs/year** | **Phosphorus lbs/year/acre** | **Nitrogen lbs/year** | **Nitrogen lbs/year/ acre** | **Agri-culture %** | **Urban %** |
|---|---|---|---|---|---|---|---|
| Bear Creek *22* | 20,332 | 3,690 | *0.18* | 21,600 | *1.06* | 34 | 12 |
| Buck Creek *1* | 32,392 | 28,061 | *0.87* | 153,436 | *4.74* | 18 | 64 |
| Deer Creek *27* | 22,374 | 3,600 | *0.16* | 20,913 | *0.93* | 79 | 8 |
| Indian Mill Creek *4* | 10,979 | 7,545 | *0.69* | 42,689 | *3.89* | 39 | 43 |
| Rogue River 2 | 139,522 | 50,936 | *0.37* | 291,252 | *2.09* | 42-45 | 5-19 |
| Rush Creek *6* | 38,041 | 18,330 | *0.48* | 103,000 | *2.71* | 38 | 46 |
| Sand Creek *10* | 35,085 | 12,620 | *0.36* | 75,200 | *2.14* | 64 | 14 |
| Lower Thornapple River *11* | 93,534 | 22,890 | *0.24* | 133,690 | *1.43* | 43 | 14 |

1. How did calculating the loads in lbs/year/acre influence your choices?

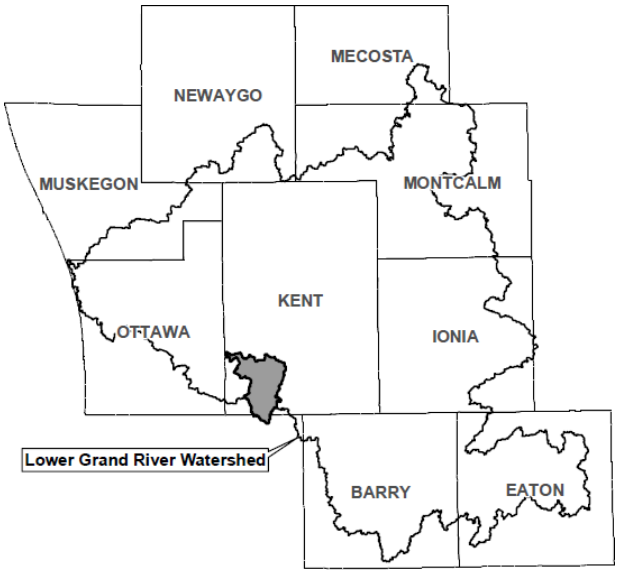
2. What influenced your discussion about the sources of the nutrient loads?

# Locations of Subwatershed Management Units

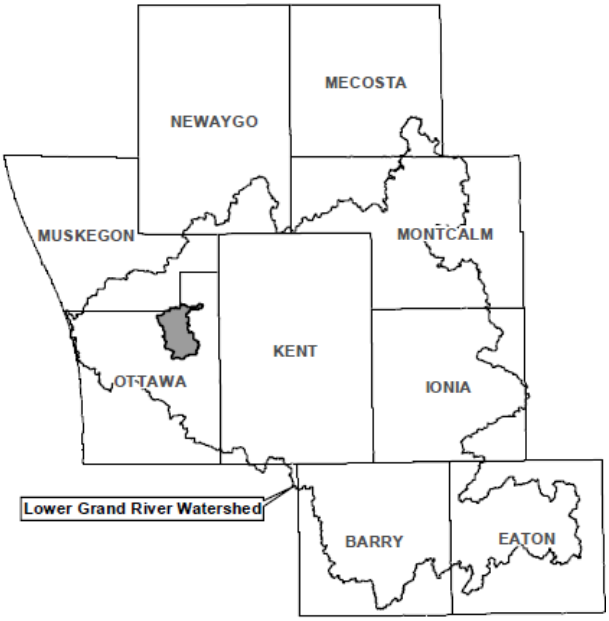
Bear Creek



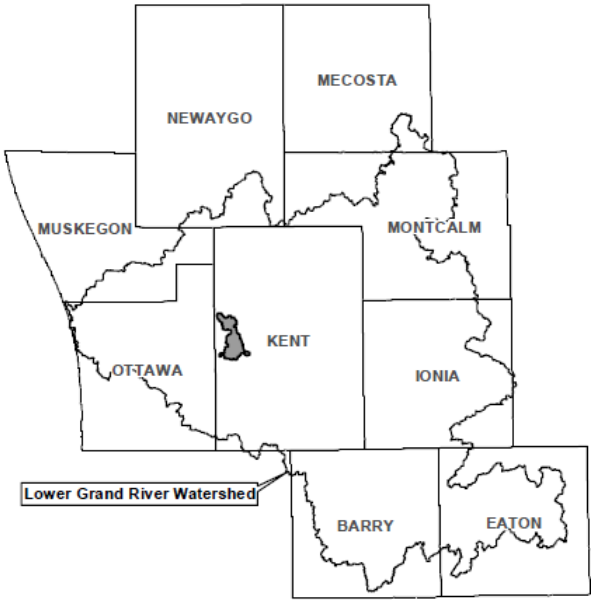

Buck Creek



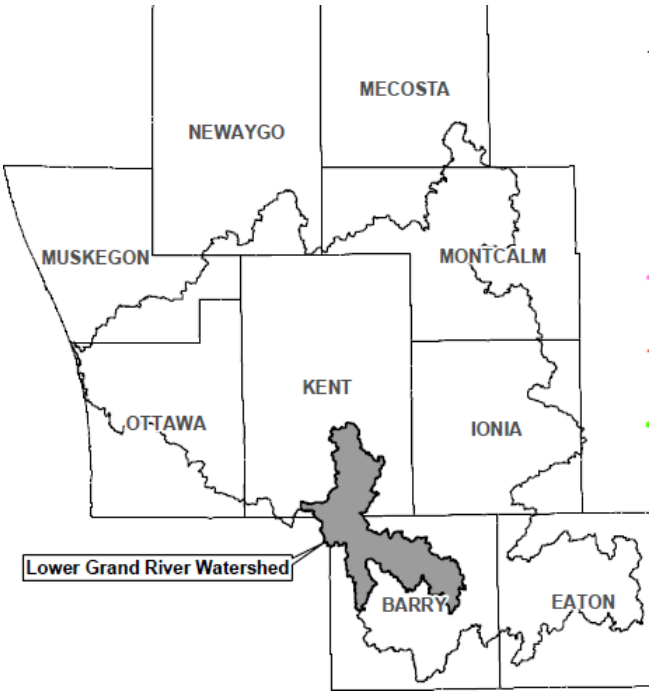

Deer Creek



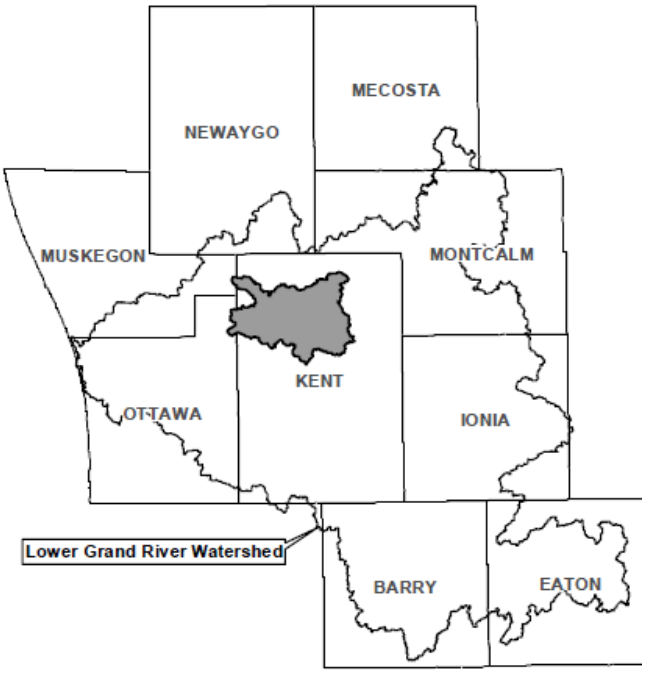

Indian Mill Creek



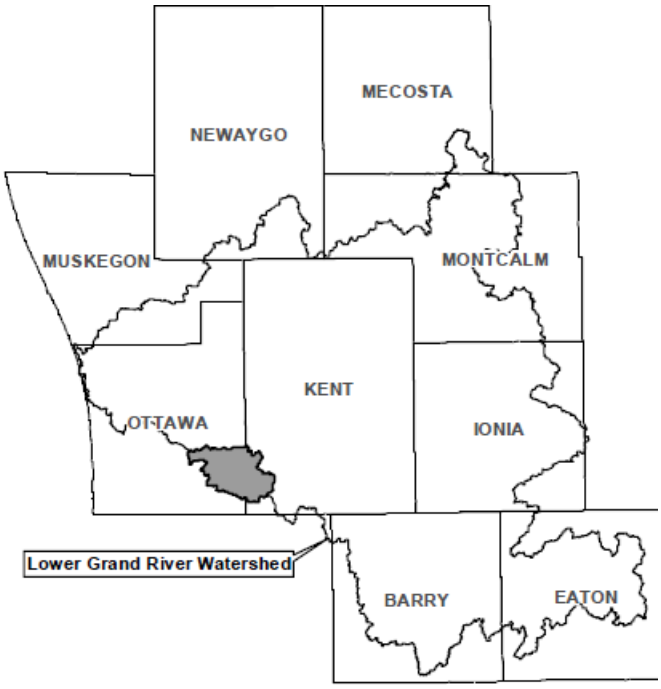
Lower Thornapple River



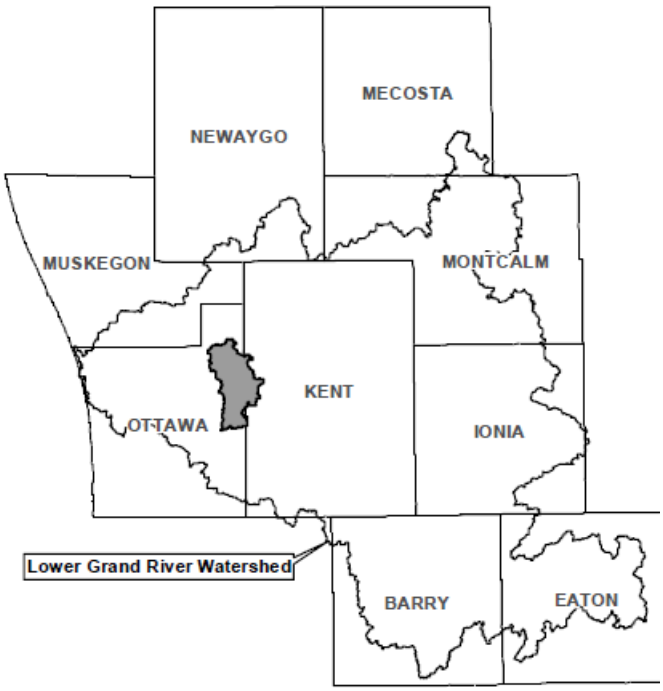

Lower Rogue River




Rush Creek




Sand Creek



# Lower Grand River Watershed Management Plan

Below are excerpts from the Lower Grand River Watershed Management Plan. You can find the entire report at https://www.gvsu.edu/wri/isc/lower-grand-river-watershed-management-plan-312.htm.

## 2.1 CULTURAL HISTORY

The Lower Grand River Watershed (LGRW or Watershed), home to the mound-building Hopewell Indian Tribe and later to the European settlers, is a region rich in cultural history and natural resources. Native Americans and European settlers alike depended on the Grand River for food, transportation, and recreation.

By the mid 1960s, the Grand River needed a massive cleanup effort. Using funds from the 1968 Clean Water Bond, many municipal wastewater treatment plants were able to upgrade technologies, and volunteers had supplies they needed to clean up trash and debris and plant trees along the river's banks.

An ambitious project called the Grand River Salmon Plan began in 1977, and brought salmon and other sport fish all the way to the state capitol by constructing a series of fish ladders over the six dams that obstructed fish passage upstream of Grand Rapids.

In the 1990s, the City of Grand Rapids began a massive undertaking of removing combined sewers. The combined sewers delivered both sanitary and storm water to the City of Grand Rapid's Wastewater Treatment Plant. During periods of heavy rainfall, the sewers would overflow into the Grand River. Occasionally, this would result in bacteria counts that warranted beach closures downstream.

## 2.2 GEOGRAPHIC SCOPE AND BOUNDARIES

The LGRW encompasses 1,861,468 acres (2,909 square miles) and encompasses large portions of Ottawa, Muskegon, Kent, Montcalm, Ionia, Barry, and Eaton Counties. The main branch of the LGR is 51 miles long, and the major tributaries flow for a total of 209 miles.

## 2.3 GEOLOGY AND TOPOGRAPHY

The topography within the LGRW is influenced by glacial deposition of sediment and the effect of water deposition and drainage over time. The elevations in the Watershed range from 780 feet, at the most eastern edge of the Watershed, to 571 feet at its confluence with Lake Michigan at the City of Grand Haven.

## 2.6 NATURAL RESOURCES

### *Wetlands*

Wetlands are a critical component to watershed health, as they improve water quality by trapping pollutants and serving as natural detention areas. The Watershed is home to numerous types of wetlands. Wetlands are invaluable for a variety of water quality functions they naturally perform. These include, but are not limited, to the following:

- Denitrification: Studies show that in certain instances, wetlands can remove from 70 to 90 percent of nitrates.
- Trapping sediments can keep large amounts of phosphorous from entering adjacent rivers and reduces sedimentation.

### *Fish and Wildlife*

A diversity of aquatic and terrestrial habitat types are found throughout the Watershed that harbors various amphibian, reptile, avian, mammal, and fish species. Many of these species are important from a recreational and economical perspective.

### *Protected Species*

Michigan has a number of significant natural features located across the state. These natural features can provide public benefits that may include bird watching, hunting, fishing, camping, hiking, off-roading, and water sports. However, these areas also include critical habitat for different species of plants, mammal, amphibians, reptiles, birds, fish, and macroinvertebrates.

## 3.3.4 Stream Inventory

**Table 3.3 – NPS Inventory Summary**

| Pollutant Source | Number of Sites per Subwatershed Management Unit | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plaster Creek[1] | Buck Creek[2] | Coldwater River[3] | Indian Mill Creek[4] | Sand Creek[5] | Upper and Lower Rogue River[6] | Upper and Lower Thornapple River[7] | Spring Lake[8] | Deer Creek[9] | Bass River[9] | Total |
| Nonpoint Agriculture Source | 2 | | 1 | 9 | 3 | 9 | 127 | | 9 | 16 | **176** |
| Streambank Erosion | 8 | 16 | 1 | 16 | 19 | 1 | 42 | 7 | 2 | | **112** |
| Tile Outlet | 2 | 2 | | 5 | 3 | | | 62 | 4 | 2 | **80** |
| Livestock Access | | 1 | 15 | 1 | 5 | 7 | 14 | | 4 | | **47** |
| Debris/Trash/Obstructions | 41 | 60 | 60 | 37 | 6 | | 122 | | | | **326** |
| Urban/Residential | 14 | 12 | 2 | 59 | 39 | | 42 | | 7 | 19 | **194** |
| Construction | 6 | 4 | | 1 | | | | | 2 | | **13** |
| Other | 4 | | | | | 6 | | | | | **10** |
| Gully Erosion | 1 | 3 | 4 | 1 | 6 | | | | | | **15** |
| Rill Erosion | | | | 3 | | | | | | | **3** |
| Downcutting | | | | | 1 | 4 | | | | | **5** |
| Stream Crossing/Road Stream Crossing | 6 | 1 | | | 13 | 5 | 170 | 13 | 2 | 1 | **211** |
| **Total NPS Sites** | **84** | **99** | **83** | **132** | **95** | **32** | **517** | **82** | **30** | **38** | **1,192** |

[1] Grand Valley Metropolitan Council (GVMC), Plaster Creek Watershed Management Plan, 2008

[2] GVMC, Buck Creek Watershed Management Plan, 2004.

[3] GVMC, Coldwater River Watershed Management Plan, April 2009.

[4] Sievert, Mary & Janice Tompkins. 2010. Summary of Indian Mill Creek Watershed Assessment. MNDRE, Field Operation Section, Water Division, Grand Rapids, MI.

[5] GVMC, Sand Creek Watershed Management Plan, July 2004.

[6] Annis Water Resources Institute, Rogue River Watershed Management Plan, December 2000.

[7] Barry Conservation District, Thornapple River Watershed Management Plan Draft, July 2009.

[8] Progressive AE. *Spring Lake Watershed Management Plan*. 2001

[9] Inventory of main branches of Deer Creek and Bass River was completed for this project.

## 4.1 IDENTIFYING SOURCES AND CAUSES

Once specific pollutants were identified, the focus of investigation turned to possible sources. In order to reduce the pollutants impairing the designated uses of the Watershed, it was necessary to determine where the pollutants originate as well as why the pollutant is impairing the Watershed. By identifying the cause of the pollutant source, implementation efforts can be directed to correct the condition that is generating the pollutant. This helps to ensure the most appropriate designs and successful control measures are implemented or installed.

**Table 4.1a – Sediment and Nutrient Loadings by Source - NPS Sites**

| Subwatershed | Sediment Loading (tons/yr) | | | | | | Phosphorus Content (lbs/yr) | Nitrogen Content (lbs/yr) |
|---|---|---|---|---|---|---|---|---|
| | Streambank Erosion | Gully Erosion | Tile Outlet | Road/Stream Crossing | Livestock Access | Total (tons/yr) | | |
| Rogue River (Lower & Upper Rogue) | 556 | | | 1,491 | 99 | 2,146 | 1,826 | 3,652 |
| Coldwater River | 453 | | | | 30 | 483 | 427 | 854 |
| Plaster Creek | 13.5 | 1.1 | 0.2 | 15.8 | | 31 | 27 | 54 |
| Buck Creek | 18 | 0.3 | | | 6.6 | 25 | 21 | 36 |
| Bass River | | | 0.1 | 0.6 | | 0.7 | 0.6 | 1 |
| Indian Mill Creek | 110.9 | 2.1 | | | 0.3 | 113 | 95 | 189 |
| Deer Creek | 0.1 | | 1 | 0.1 | 6 | 7 | 6 | 13 |
| **TOTAL** | **1,151.5** | **3.5** | **1.3** | **1507.5** | **141.9** | **2,806** | **2,396** | **4,798** |

# Plan for Action: Subwatershed Research Project

**Instructions:**

A Lower Grand River Watershed meeting will be held in your classroom. You and your team members will represent one of the subwatersheds of the Lower Grand River. You need to create a visual (poster, PowerPoint, brochure, etc.) to explain why or why not your subwatershed should be a priority for nutrient reduction. Your group will present this visual representation to the class. The class will then vote prioritize all of the subwatersheds for nutrient reduction from #1 (high priority) to #8 (lower priority).

There are many factors to consider when making watershed management decisions. To learn more about the subwatershed you are representing, complete the following:

- Calculate the missing values in the *Exploratory Data Analysis* (Student Activity)
- Examine the *Locations of Subwatershed Management Units* (Student Resource)
- Read the *Lower Grand River Watershed Management Plan* (Student Resource)
- Visit the LGROW website at http://www.lgrow.org/ and click on your subwatershed under the watersheds heading to read more about the subwatershed you are representing.

Once you have completed the above tasks, begin your visual representation. You need to make sure that everyone in your group has a role in creating and presenting your visual.

**Subwatershed:**

_____

**Group Members:**

_____

_____