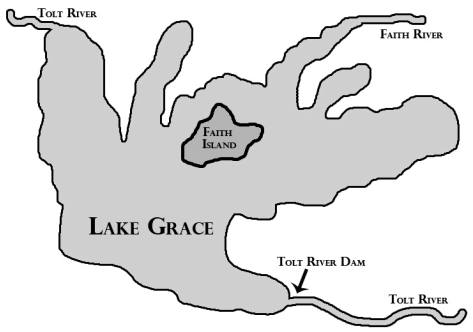
Lab 14. Interdependence of Organisms: Why Is the Sport Fish Population of Lake Grace Decreasing in Size?

Introduction

Lake Grace (see the figure to the right) is known as one of the best lakes for sport fishing in the United States. The Tolt and Faith rivers feed the lake, and extensive stump and grass beds provide a great habitat for sport fish, such as largemouth bass, white bass, and bluegill. Sizable populations of other fish, such as catfish, crappie, and bream, are also present. In fact, over 79 different species of fish have been found in the lake. Over the last five years, however, anglers have been catching fewer and fewer of the large sport fish that once made Lake Grace so famous.

Lake Grace



The low numbers of sport fish in the lake have led to a decrease in the number of anglers that come to the lake to fish on weekends or for a fishing vacation. As a result, there has been a downturn in the economy of the nearby town of Aidanville, and many local stores and hotels that depended on tourism have gone out of business.

Your Task

Conduct an investigation of the water quality of Lake Grace and develop an explanation for the decline in the populations of sport fish.

The guiding question of this investigation is, **Why is the sport fish population of Lake Grace decreasing in size?**

Materials

You may use any of the following materials during your investigation:

- Samples of water from Lake Grace (three different locations)
- Water quality test kit (pH, nitrates, phosphates, dissolved oxygen, turbidity)
- Information packet

Safety Precautions

1. Safety goggles, vinyl gloves, and aprons are required for this activity.
2. Wash hands with soap and water upon completing this lab.
3. Follow all normal lab safety rules.

Getting Started

To answer the guiding question, you will need to analyze an existing data set and then determine the overall quality of a water sample from Lake Grace. To accomplish this task, you must first determine what type of data you will need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect,* think about the following questions:

- What type of information do I need to collect from the existing data set found in the information packet?
- What type of tests will I need to determine the quality of the water in Lake Grace? (*Hint*: Be sure to follow all directions as given in the water quality test kits.)
- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data,* think about the following questions:

- What will serve as a control (or comparison) condition?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data,* think about the following questions:

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Investigation Proposal Required? ☐ Yes ☐ No

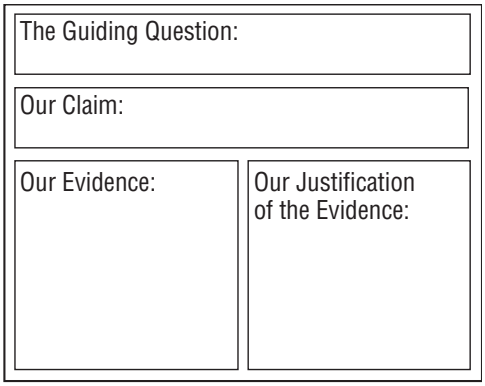
Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- the importance of identifying the underlying cause for observations;
- why it is important to determine what is relevant at a particular scale or over a specific time frame;
- how energy and matter flow into, out of, within, and through a system;
- how the method scientists use depends on the topic under investigation and the research question; and
- how social and cultural issues influence the work of scientists.

Argumentation Session

Argument presentation on a whiteboard



Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure to the right.

To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- How did you collect your data? Why did you use that method? Why did you collect those data?
- What did you do to make sure the data you collected are reliable? What did you do to decrease measurement error?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

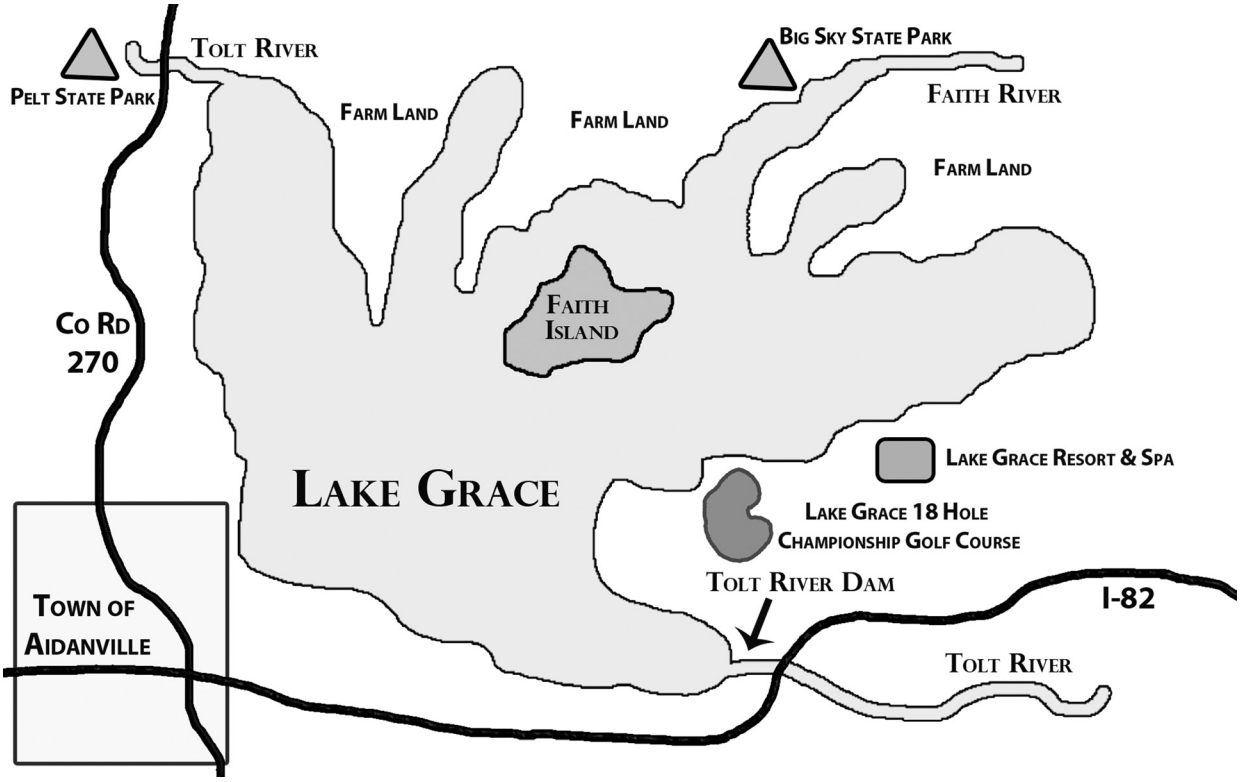
Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!

Lake Grace Information Packet

Lake Grace and the Town of Aidanville

Lake Grace is located in the southeastern United States and covers an area of 37,500 acres. Extending up the Tolt River 30 miles and up the Faith River 35 miles, Lake Grace has 376 miles of shoreline. The lake was created in 1957 when the Tolt River Dam was built. The dam produces hydroelectric power that is used by both homes and industry in the area. Aidanville was founded in 1897 and is located on the southwest side of Lake Grace (see the figure below).

Lake Grace and environs



Major events in the history of Lake Grace and the town of Aidanville

Date	Event
1940	The population of Aidanville reaches 1,587, according to U.S. census data.
1947	Money to build the Tolt River Dam is authorized, and construction begins.
1952	The Tolt River Dam is completed.
1957	Lake Grace opens for public use.
1958	Pelt State Park and Big Sky State Park are completed and open for public use.
1980	The population of Aidanville reaches 2,016, according to U.S. census data.
1981	Two Rivers State Park is completed and opens for use. The park includes a public boat launch, which was built in response to the large number of anglers coming to the lake to fish.
1985	Three new hotels are built in Aidanville.
1989	Two more hotels and five more restaurants are built in Aidanville.
1990	The population of Aidanville reaches 3,287, according to U.S. census data.
1995	Aidanville City Council begins a program to monitor the water quality of Lake Grace.
1996	Lake Grace Resort and Spa completed
1998	Invasive species of water plants, such as hydrilla and water hyacinth, are found in Lake Grace for the first time.
1999	Lake Grace 18-hole championship golf course is completed and open for public use.
2000	The population of Aidanville reaches 3,824, according to U.S. census data.
2001	The farmers who own the farmland near Big Sky State Park stop raising crops, sell off part of their land to developers, and begin operating a large hog farm.
2004	The Aidanville City Council begins to use herbicides to slow the spread of invasive water plants in Lake Grace.
2011	Three hotels and four restaurants go out of business in Aidanville.

Number and size of sport fish caught annually in Lake Grace, 1995–2011

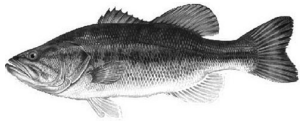
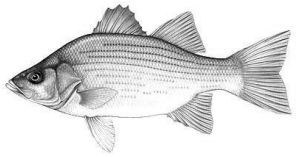
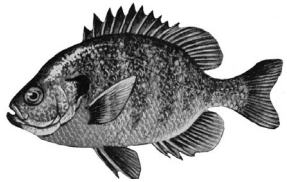
Year	Number caught			Average size of fish caught (cm)		
	Largemouth bass	White bass	Bluegill	Largemouth bass*	White bass†	Bluegill‡
2011	1,152	1,705	952	31	39	17
2010	1,287	1,830	975	29	38	19
2009	1,213	1,819	1,012	30	38	16
2008	1,284	1,962	1,204	32	39	19
2007	1,406	1,993	1,432	31	42	20
2006	1,517	2,003	1,616	30	43	21
2005	1,872	1,894	2,203	33	41	22
2004	2,411	1,752	2,106	32	45	24
2003	1,310	1,385	1,910	33	49	25
2002	1,504	1,206	1,867	34	48	23
2001	1,692	1,197	1,992	33	43	28
2000	1,825	1,151	1,845	36	45	27
1999	1,714	1,302	1,791	38	47	31
1998	1,535	1,207	1,603	39	49	29
1997	2,387	1,234	1,375	40	43	27
1996	1,747	1,750	1,402	43	48	32
1995	2,422	1,344	1,208	41	46	33

* The legal size limit for largemouth bass is 30 cm.

† The legal size limit for white bass is 40 cm.

‡ There is no legal size limit for bluegill.

Information about some of the organisms found in Lake Grace

Name	Appearance	Habitat	Size	Diet	Reproduction	Ecological importance
Largemouth bass		Shallow lakes, ponds, or rivers	Adults range in size from 26 cm to 46 cm	Young fish feed on daphnia, gammarus amphipods, and invertebrates; adults feed on small fish, frogs, and aquatic invertebrates	Male fish build nests in sand or gravel in shallow areas and attract a female to the nest. The female lays a few hundred eggs and then the male fertilizes them. The male guards the eggs until they hatch, which takes 7–10 days.	Largemouth bass are important predators in freshwater ecosystems and help maintain the population size of other primary consumers such as aquatic invertebrates and secondary consumers (such as amphibians and small fish). They are also one of the species most sought after by recreational anglers.
White bass		Deep, clear lakes and large rivers.	Adults range in size from 38 cm to 50 cm	Mostly daphnia, crustaceans, and other aquatic invertebrates; larger individuals feed on small fish	They only spawn in water ranging from 12 to 20°C. Females lay eggs in moving water such as a tributary stream or river. Females release 200,000 eggs, which stick to the surface of plants, submerged logs, gravel, or rocks.	White bass are important predators in freshwater ecosystems and help maintain the population size of other primary consumers such as aquatic invertebrates and secondary consumers (such as amphibians and small fish). They are also one of the species most sought after by recreational anglers.
Bluegill		Weedy, shallow, waters; does not tolerate high turbidity well	Adults range in size from 15 cm to 35 cm	Daphnia, gammarus amphipods, insects, and crustaceans	They spawn early in the spring. Females release their eggs and males then fertilize them. Eggs hatch about eight days later.	Bluegills are important aquatic predators. They also provide food for larger fish. Numerous organisms eat their eggs. For anglers, the bluegill provides considerable sport, and the flesh is firm, flaky and well flavored. Bluegills are often stocked in artificial ponds as forage for largemouth bass.
Daphnia		Lakes with temperatures below 20°C	1 mm long	Bacteria, protists, and algae	They produce eggs that develop without fertilization. An adult female can produce 10–15 eggs.	Daphnia are a principal food staple for fish and an important link in the food chain (fish stomach can contain 95% daphnia by volume). Daphnia also help maintain water quality by cleaning up algae blooms in lakes (daphnia can reduce the amount of algae in a lake by half in a small amount of time).

Name	Appearance	Habitat	Size	Diet	Reproduction	Ecological importance
Gammarus amphipod		Floors of lakes and rivers that are well oxygenated and below 20°C	21 mm long	Algae and dead organic matter	Occurs during winter—females only produce one brood during their life (which lasts 1–1.5 years)	Gammarus amphipods are a main source of food for larger freshwater organisms. Gammarus amphipods are sensitive to changes in the environment—low pH levels or warm temperatures kill them.
Algae		Anywhere there is a body of water or a sufficient quantity of moisture	Can live as single cells, in colonies (groups), or as strands of attached cells (called filaments)	Photosynthetic organism	Asexual	When the concentrations of nitrates and phosphates increase in a lake, the algae population increases. The massive amount of algae gives the water a pea-green color and produces a funny smell (called an algae bloom). Many of the algae begin to die off as the population increases. Oxygen-using decomposer bacteria then increase in number, which drops the oxygen levels of the lake. As result, many fish can suffocate.
Pickerelweed		Lakes, ponds, ditches, and streams	60–90 cm tall	Photosynthetic organism	Seeds	Submerged portions of aquatic plants provide habitats for many invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g., amphibians, reptiles, ducks). After aquatic plants die, their decomposition by bacteria and fungi provides food for many aquatic invertebrates.
Hydrilla		Lakes, ponds, ditches, and streams	Up to 760 cm tall	Photosynthetic organism	Seeds and fragmentation	Grows into dense stands extending from the shoreline to a depth of 10 ft. Dense strands can (1) prevent light from penetrating to deeper water, (2) reduce dissolved oxygen, and (3) displace native plants and reduce biodiversity.
Water hyacinth		Lakes, ponds, ditches, and streams; floats above the water surface	Leaves are 10–20 cm and can be up to 1 m above the surface	Photosynthetic organism	Seeds	Water hyacinth will cover lakes and ponds entirely; this has a dramatic impact on water flow, blocks sunlight from reaching native aquatic plants, and starves the water of oxygen. The plants also create a prime habitat for mosquitoes.

Water quality in Lake Grace

The following table provides data from a program that was started in 1995 by the Aidanville City Council to monitor the water quality in Lake Grace. Unfortunately, the program was cut in 2005 because the city lacked the funds necessary to sustain it.

Year	pH	Dissolved oxygen (mg/L)	Nitrates* (ppm)	Phosphate† (mg/L)	Coliform bacteria	Triclopyr‡ (ppb)	Algal bloom§ observed
2005	5.8	9.5	36	0.12	Yes	11	No
2004	5.9	9.5	35	0.13	Yes	8	No
2003	5.9	9.6	33	0.12	Yes	1	No
2002	6.0	9.6	30	0.11	Yes	2	Yes
2001	6.0	9.7	12	0.12	No	2	No
2000	6.0	9.6	13	0.1	No	2	Yes
1999	6.2	9.8	12	0.09	No	2	No
1998	6.4	10.3	14	0.02	No	1	No
1997	6.6	10.2	13	0.01	No	1	No
1996	6.5	10.2	14	0.02	No	2	No
1995	6.7	10.2	12	0.01	No	1	No

* Nitrate levels over 30 ppm can inhibit growth of fish and some aquatic invertebrates and stimulate the growth of algae and other aquatic plants

† Phosphate levels of 0.01–0.03 mg/L in lake water are considered normal. Plant growth is stimulated at levels of 0.025– 0.1 mg/L.

‡ Triclopyr is a weed killer (herbicide) that targets broadleaf plants and has often been used in in lakes. Levels of triclopyr, however, must be below 2 ppb for the water to be safe for irrigation; higher doses of the chemical can be toxic to aquatic organisms. Small organisms such as gammarus amphipods, daphnia, and freshwater shrimp often ingest tiny amounts of the chemical into their bodies or absorb small amounts of it through their gills, but the small dose of the chemical usually does little harm to these organisms (although the chemical often stays in their system for long periods of time).

§ An algal bloom is a rapid increase or accumulation in the population of algae. Although there is no officially recognized threshold level, algae can be considered to be blooming at concentrations of hundreds to thousands of cells per milliliter of water. Algal bloom concentrations may reach millions of cells per milliliter of water. Algal blooms are the result of an excess of nutrients, particularly phosphorus and nitrates. The excess of nutrients may originate from fertilizers that are applied to land for agricultural or recreational purposes (such as keeping the grass on fairways healthy). These nutrients can then enter rivers and lakes through water runoff. When phosphates and nitrates are introduced into water systems, higher concentrations cause increased growth of algae and plants. Algae tend to grow very quickly under high nutrient availability, but each alga is short-lived, and the result is a high concentration of dead organic matter, which starts to decay. The decay process consumes dissolved oxygen in the water.

Average water temperature in Lake Grace