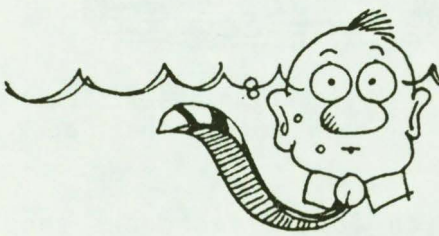
MN SEA GRANT EXTENSION

University of Minnesota

LACUSTRINE LESSONS

Aquatic Topics for Grades K-12

SEPTEMBER/OCTOBER 1985



HIGH WATER

by Karen Plass
UW Sea Grant Advisory Services

Lake Superior's high water levels this summer have caused increased shore erosion and some flooding as well. During an August 15 storm, northeasterly winds caused a temporary storm surge increase in water level that flooded low-lying areas in Superior/Duluth, including the bay side of Minnesota Point.

For the first 26 days of August, Lake Superior's water level averaged 601 feet, 9 inches -- 5.5 inches higher than its August 1984 average and 9.4 inches higher than its 1900-1983 August average. Meanwhile, Lake Michigan was also 5.5 inches above its August 1984 average and 22 inches above its 1900-1983 August average.

Lake Superior's discharge at Sault Ste. Marie has been adjusted four times this summer by the International Joint Commission (IJC). It was reduced to 64 percent of its normal flow of 108,000 cubic feet per second on June 7, and then increased to 69 percent of normal on Aug. 8, 76 percent on Aug. 16, and 87 percent on Aug. 23. The original reduction was designed to lower extremely high water levels on the lower Great Lakes. Outflow was subsequently increased to ensure that Lake Superior does not exceed a daily average of 602 feet, according to Sally Ayers, Public Affairs Director for the IJC. The 602 foot level is the regulatory maximum level allowed for Lake Superior.

On Aug. 15, Lake Superior had an average elevation of 601 feet, 10 inches. But at the gauge in Duluth it rose a foot above that level at 1:00 p.m. during a storm surge, according to the Corps of Engineers office in Duluth.

The 602 foot regulatory maximum applies to the average elevation, according to Richard Thomas, Hydraulic Engineer with the Corps of Engineers Detroit office. The lake can sometimes officially remain below 602 feet even though water levels are exceeding that height on the downwind shore.

"Wind causes the surface of the lake to tilt," Thomas said. "When the water comes up in Superior/Duluth, it goes down in Marquette." The average daily lake levels at the gauge in Duluth exceeded 602 feet on 19 out of the first 26 days in August due to the local effect of northeasterly winds, but the lake as a whole has not exceeded 602 feet on any day, Thomas said.

Lake Superior is expected to peak just below the 602-foot level in early September. Such a peak would be 7.9 inches above the 1984 peak that occurred last September 1, and 2 inches below the all-time record high for September set in 1916.

Lake level predictions are based on past temperature and precipitation trends and the 30-day weather forecast, according to Phil Keillor, Coastal Engineer with the UWS Sea Grant Institute in Madison. But precipitation patterns have varied so erratically during the last few years that there may not be any trends, he said.

Precipitation in the Lake Superior basin last June dropped below normal after six consecutive months of much greater-than-normal precipitation, according to Keillor.

"More recently it has been wet again. If it stays
wet, we could get a rise in water level that would be hard to keep below 602 feet," Keillor said. "There is quite a lag between recognizing a period of heavy rainfall, opening the gates at Sault St. Marie, and then getting corrective action."

Even if the fall peak is just under 602 feet, storms blowing from the northeast will raise lake levels on western Lake Superior well above 602 feet in those places where surface water is pushed by wind into confined areas like bays, Keillor said. Fall storms could cause water levels in such confined areas to reach 100-year flood levels for one to two days at a time. Such temporary increases could be 1.5 feet in Superior/Duluth and 3 feet in Wisconsin's Chequamegon Bay. Any flooding would be confined to designated flood-plain zones, which in most cases are either undeveloped or contain few structures, Keillor said.

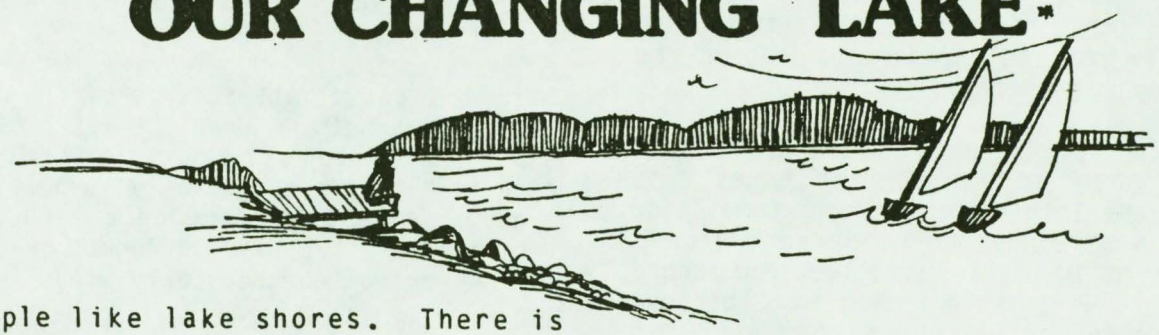
There are several ways for property owners to protect flood-threatened structures, according to Keillor. "The first thing would be to get things off their basement floors. They might be able to keep most of the water out of their basement wrapping plastic around the base of their house and sandbagging the foundation, like people do along the banks of flooding rivers. In low backyards along the bay side of Duluth's Minnesota Point, people could help

reduce wave damage by putting a semicircle of sandbags facing the bay around their deck or toolshed."

People with low, fixed docks should consider raising them, according to Keillor. "The problem with high water at docks is that the waves tend to work at the boards and knock them loose," Keillor said.

For more ways to create temporary protection from damaging wave action, Keillor recommends the Corps of Engineers' booklet, "Low Cost Shore Protection," which is available free of charge from MN Sea Grant Extension, 208 Washburn Hall/UMD, Duluth, MN 55812 (phone 726-8106).

OUR CHANGING LAKE



People like lake shores. There is something about the movement of waves against the beach, the sight of a sailboat on a clear day, the ability to plunge into the water on a hot summer day, that attracts people to the lake. Shores tend to become highly developed. Property values are high. Lakes, however, can be unpredictable. Storm driven waves can destroy houses, especially if the level of the lake has risen since the houses were built.

In this activity middle school students will determine if the water levels in Lake Superior change. This is accomplished by examining graphs of Lake Superior's water levels. Their attention is drawn to the nature of lake level changes and the damage that can occur when the lake level rises. The effect of seiches on lake levels is also explored.

Objectives

1. To determine whether lake levels on Lake Superior change.
2. To identify patterns on lake level graphs.
3. To identify possible causes of changes in lake levels.

Materials

- copies of the water level graphs
- copies of the student questions

Prerequisite

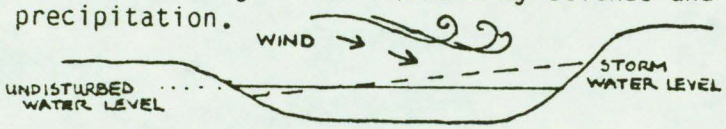
Students should be able to read graphs.

*Adapted from "Lake Erie and Changing Lake Levels", by Carolyn Farnsworth and Dr. Victor Mayer, an Ohio Sea Grant publication.

Background

Lake levels change. It's a fact of nature. It can also be a result of human manipulation. Changes in lake levels can be dramatic(measureable in inches or feet in less than an hour), or nearly imperceptible.

This activity looks at lake levels for Lake Superior and its Duluth/Superior Harbor. Water level measurements taken in the harbor show hourly and daily fluctuations that can occur at a site. Note the graph for Figure 1. These changes are created by seiches and precipitation.



A form of seiche is created by wind . Persistent wind blowing in a single direction causes water to "pile up" at the downwind end of the lake. Wind has its maximum effect on lake levels for only a short period of time. When the wind subsides, the water levels rock back and forth in the lake basin until they return to the undisturbed water level.

Lake Superior also goes through monthly lake level cycles. Note Figure 2. The average lake levels are calculated from measurements taken around the lake. Changes in these averages reflect cycles which correspond to weather trends throughout the year. Some periods have lots of precipitation, others are more conducive to evaporation. There can be greater than normal precipitation for several years in a row. Then the average annual lake level starts to increase. We've seen this type of increase in lake Superior during the last few years.

Man attempts to affect lake levels by regulating the outflow of water from Lake Superior into the St. Mary's River. Regulations are established by the International Joint Commission which is comprised of Canadian and American scientists and citizens. Outflow is usually restricted if the lower great lakes have excessively high water levels.

Regulating the outflow of Lake Superior can have an impact on the lake's water level. But has been estimated by a representative of the US Army Corps of Engineers(one of the regulating bodies) that a severly restricted outflow would probably result in only 1 inch or less of increase in the average lake level during a month of high precipitation. The major controlling factor in Lake Superior's water level over the months and years is weather.

Procedure

1. Introduce the investigation by discussing points raised in the introduction and background. Additional information can be obtained from the references and the high water article in this issue.
2. Distribute copies of the graphs and assign the worksheets. Ask a few sample questions to be sure all students can read their graphs correctly.
3. When the students have completed the assignment conclude with a post-investigation discussion. Be sure that the students understand that the lake level effects in this activity are not unique to Lake Superior. Other lakes, from small lakes to the Great Lakes, may experience similar fluctuations.

The film "Not Man's to Command" is available through the Public Relations Unit, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6. It deals with many of the problems in trying to regulate the Great Lakes. If available, it should be shown as a follow-up to the Investigation.

Figure 1. Water levels recorded in Duluth, MN harbor between noon August 9, 1985 and noon August 10, 1985.

Figure 2. Lake Superior water levels. Extracted from US Army Corps of Engineers' Monthly Bulletin of Lake Levels for the Great Lakes.

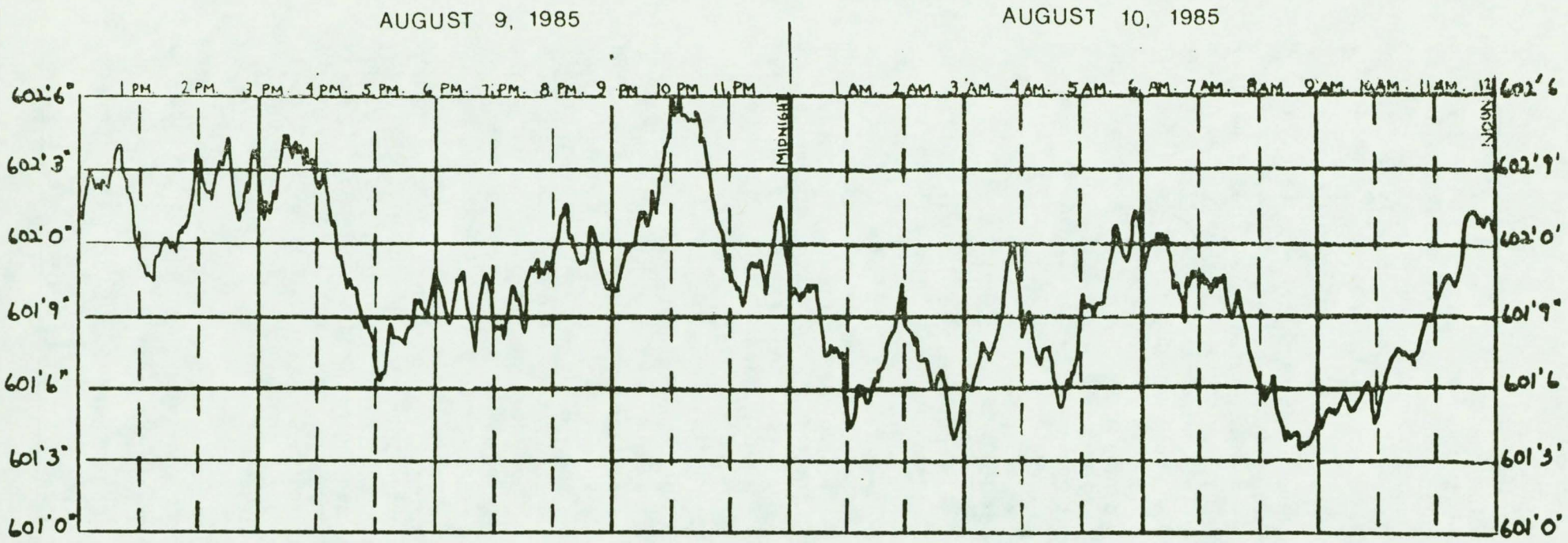

AUGUST 9, 1985
AUGUST 10, 1985
602'6"
602'3"
602'0"
601'9"
601'6"
601'3"
601'0"
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
10 PM
11 PM
MIDNIGHT
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
NOON
602'6
602'9'
602'0'
601'9"
601'6
601'3'
601'0'

FIGURE 1.

Worksheet

To answer questions 1-5 use Figure 1. Give swers to the nearest inch.

1. What was the highest water level recorded during this 24 hour period?

2. What was the lowest water level recorded?

3. What was the difference in inches between the highest and lowest water levels during the 24 hours?

4. What hour had the greatest difference between highest and lowest recorded water levels?

5. What was the greatest change in water levels during a one hour period?

To answer questions 6-15 use Figure 2.

6. According to the average water level curve, during what month is Lake Superior normally at its highest level?

7. During what month is Lake Superior usually at its lowest level?

8. Based on the average monthly levels, about how much difference is there between Lake Superior's highest and lowest levels?

9. How much higher was the water level in August 1985 compared to the average water level for that month?

10. Which was higher, the water level in August 1985 or August 1984?

11. During what month and year was the lowest water level recorded?

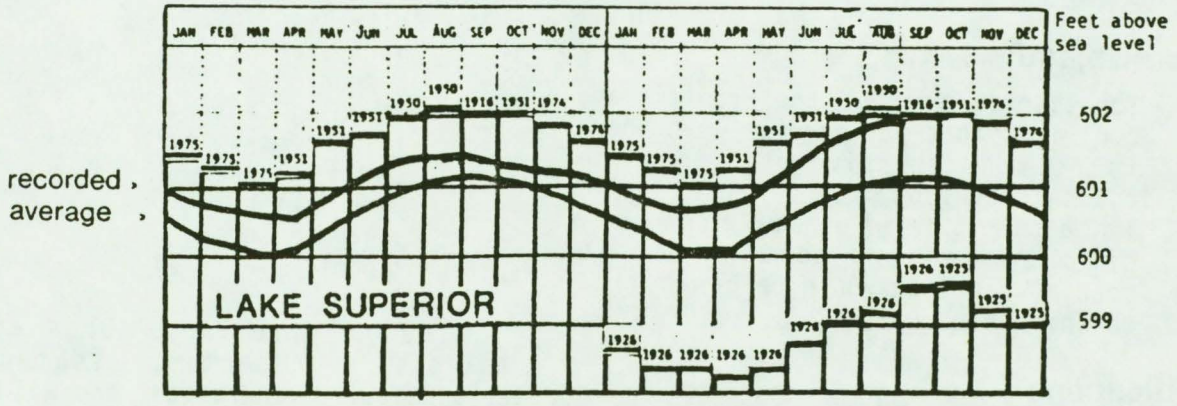
12. What was the lowest recorded water level between 1900-1984?

13. During what month and year was the highest water level recorded?

14. What was the highest water level recorded between 1900-1984?

15. Based on the average monthly levels would you expect to have lake levels in September which are higher than the highest August level?

FIGURE 2.



Answers :

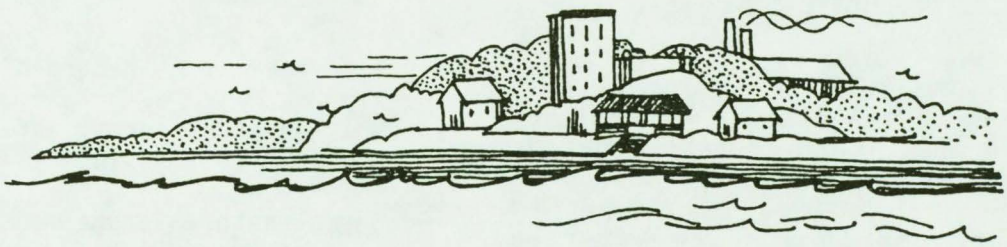
1.602' 6"
2.601' 4"
3.14"
4.from 4-5pm
5.about 8-9"
6.September
7.March(or April)
8.about 1 foot
9.about 10"
10.August 1985
11.April 1986
12.about 598.2' (598' 2.4")
13.August 1950
14.602.1'(602' 1")
15.yes

References

Department of the Army, "Monthly Bulletin of Lake Levels for the Great Lakes," Detroit District, Corps of Engineers, P.O. Box 102 Detroit, Michigan 48231.

International Joint Commission,1976, Further Regulations of the Great Lakes. Great Lakes Regional Office, Windsor, Ontario. Canada.

Building a Coastal City



By the end of this decade three quarters of the American people will be living and working within 50 miles of our oceans and Great Lakes. Historically, development along coastal areas has often been haphazard. Increased use of the American coast will very likely lead to increased conflict between the various user groups.

The following activity demonstrates how coastal cities have usually developed. It also provides an opportunity for the participants to plan a community with foresight.

Lesson Objectives

1. To describe some of the problems and conflicts that may develop when there is no comprehensive plan to guide coastal development.
2. To demonstrate some of the compromises and adjustments in coastal use that would be beneficial to the whole community.

Specifications

Age group: 10 years and older
Activity time: 1/2 hour to 1 hour
Group size: 20 to 30 people
Group leader: A senior high school or college student, a teacher or adult leader.

Equipment

A. 23 large cards representing land uses (minimum size 9" x 12" poster board).

Use	Number of cards
homes	3
golf course	3
hunting	3
park	2
cropland	2
cattle feedlot	1
city dump	1
junkyard	1
factory	1
shopping center	1
fishing	1
swimming beach	1
water skiing	1
sewage discharge	1
school	1

B. 20 or more large cards and 4-foot stakes to represent an assumed original terrain, soil, vegetation, and wildlife. See sample townsite for example.

C. A box of large paper clips (2 dozen).

Preparatory discussion

1. Give examples of how people use land and open space:

places to live
places to work
places to recreate, exercise
places to farm
places for forestry
places to learn
places to shop
locations for recycling and disposing of wastes
places for mining

2. Give examples of uses for available water resources:

drinking water
power
economical transporation
transporting and purifying wastes
production
industrial heating and cooling
recreation

3. When an industry, factory, feedlot, housing sub-division or freeway is built, the environment is changed. These changes are irreversible. The results may be undesirable. There may be odors, traffic congestion, air pollution, noise, or a decrease in property values. Which of the following uses of land and water resources conflict? How do they conflict?

farming -- wildlife
farming -- forestry
homes -- airports
homes -- highways
homes -- feedlots
homes -- meat-packing factories
homes -- factories
homes -- junkyards
swimming -- boating
fishing -- waterskiing
swimming - sewage disposal
cattle feedlot -- swimming
homes -- sewage disposal sites

4. Comprehensive planning takes advantage of compatible uses of resources. Discuss how the following uses of land and water resources may be compatible.

feedlots -- farming
homes -- farming
homes -- parks
swimming -- fishing
timber production -- wildlife
fishing -- golf course
feedlots -- meat packing
homes -- shopping centers
homes -- swimming
swimming -- parks
airports -- farming

5. When planning the use of water frontage or land, all of the resources of the area should be considered:

. The suitability of the soil for various uses should be one of the primary considerations. The slope, texture, seasonal wetness, depth, water holding capacity, and erodibility are all factors that need to be evaluated. How do these factors affect streets, lawns, forests, homes, waste treatment, wildlife habitats, or farms?

. What are the scenic qualities of the area? Should they be improved or preserved or disregarded?

. Which land uses will make the best use of available water resources? Which land uses may pollute the water resources through run-off or direct use?

. What about the vegetation -- the forest, marshes, and prairies? Is it of value to the community? Should it be improved, preserved or disregarded?

. Should the wildlife and its habitat be preserved?

Preparation

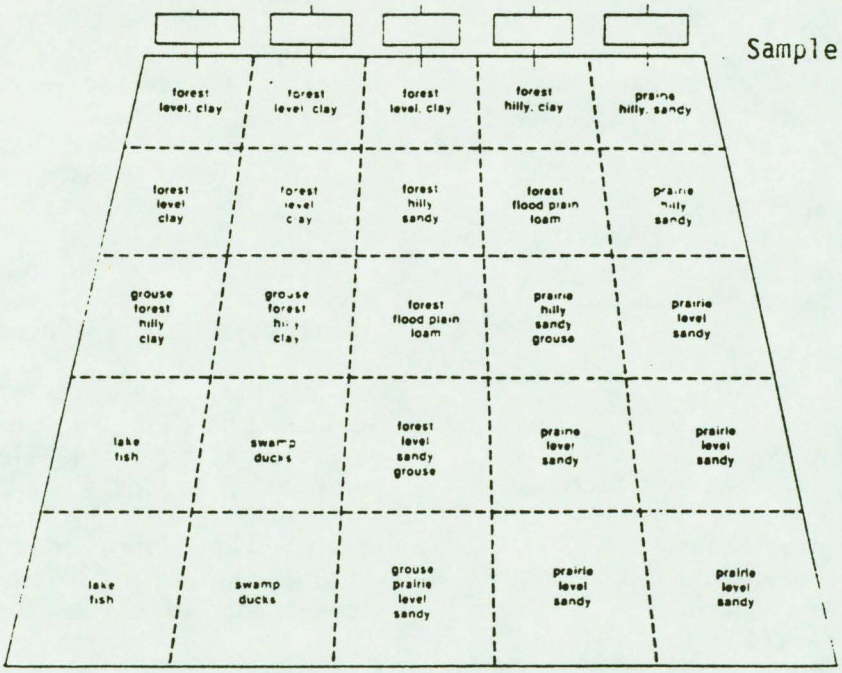
Indoors

Using the signs, label 20 or more blocks in a checkerboard design. Prop the signs up on the floor against wood blocks, books, etc. Leave walking room between the cards for students.

Outdoors

Using the stakes and signs, label 20 or more blocks and spread them out in checkerboard fashion. Set the stakes about four feet apart to make the entire townsite approximately 16 feet by 20 feet. Select the site for the town on a slope, if possible, so the class can observe it from a somewhat lower elevation.

Select the initial terrain, soil, and vegetation for the townsite beforehand. Use some of the surrounding observable landscape as a pattern and for class reference later if practical. Make additional cards if you wish but remember KISS (Keep it Simple, Sir or Sis).



Sample Townsite

Teaching Outline

"You are a group of pioneers who have come to this undeveloped coastal area to create a new community.

You have traveled in pickup campers, houseboats, travel trailers, and motorcycles. This is the area you've chosen for your new city.

First, we'll see what our townsite consists of. Then we'll decide how we want to use it. Finally we'll see how we can improve our new community."

Creating townsite (5 minutes)

Briefly describe each labeled area, including the topography, soil, vegetation, and wildlife. Explain that these are the original natural resources on the townsite.

If outdoors, relate to the surrounding observable landscape if possible so the settlers get a good idea of the actual situation.

Developing townsite (10 to 20 minutes)

Ask individual people to "develop" the town. Give them "use" cards and have them (1) pick out an area they think is best for that use. (2) Clip the land use activity card to the plot description card.

Select uses in the following order:

cropland (2 selections)
factory
sewage
homes (2 or 3 selections)
(sewage outlet and dump must be used)
school
city dump

The following are optional, let the settlers decide:

golf course (must be used in 3 adjoining sections in a row or L-shaped)
park (with baseball diamonds, tennis courts, picnic area, etc. - must occupy 2 adjoining sections)
hunting (waterfall, upland game in forest and prairie)
fishing
swimming beach
water skiing
shopping center

Note: When "uses" are selected by settlers, have them to discuss whether or not tr[illegible] will be cut or the environment changed so that fish and game will decrease or become extinct.

Consider what has been done (3-5 minutes

Get the settlers involved in discussing among themselves how their choices affect neighboring plots. Consider odors, pollution, erosion, aesthetics, etc.

Focus on the use of the coastal area. Was the coast used for public, private or commercial developments? How does this compare with what the settlers have observed in their communities? What would happen to these coastal developments if the water level of the lake changed? How could their planning compensate for the possible changes in lake levels?

Let's start over (5-20 minutes)

Retrieve the land use activity cards.

Ask the settlers to form a circle holding their cards so all can see them. then using the cards in the same order as before, have the group decide where the various uses should be located. (Majority rules).

Have each activity card clipped to the designated plot card.

Permit them to shift around to make adjustments as planning progresses.

Continue until time is used or they lose interest.

Summary (5 minutes)

What do we need to know when we plan a community?

1. Many things about the land we want to use.
2. The kind of community we want to live in.
3. How our land use may affect our water uses.
4. How to make what we want fit with what we have.
5. How everything affects other things.

Key Concepts (not to read to settlers)

Characteristics and components of the soil, water, air, and sunlight vary in many ways and combine to form numerous different environments or habitats for living things.

Air, water, and/or land provide homes for all living things.

Living things are interdependent with one another and their environment.

The interrelationships between the plant and animal members of an ecosystem and their environment determine the characteristics of a particular ecosystem.

Living things are normally adapted by structure and function to living in a particular environment, habitat, or set of conditions. As the characteristics of the plan and animals species inhabiting the area may change, or the species may change.

As the living and nonliving things common to an area or community influence one another, they reach a relatively stable relationship with one another called "the balance of nature."

When one kind of plant or animal is destroyed or reduced in numbers or becomes too numerous for the environment to support, other plants or animals are affected.

Some plants and animals tolerate a wide range of environmental conditions and may thrive as a result of change. Others can tolerate very little change and may disappear from the community.

Every community, no matter how large, has a definite limit in its capacity to provide food, water, and living space to animals.

Man manipulates components of the environment (manages resources) to better satisfy his desires for shelter, food, pleasure, etc. He also partially adapts himself to the environment.

Man's manipulation of the environment creates new environments.

Man, like animals and plants, uses the environment to dispose of his wastes.

Man's disposal of wastes causes changes in the environment that affect him and other living things. Disposing of wastes in a way that causes undesirable changes in the environment is called pollution.

Often resources are not used for the greatest good for the greatest number of people because of conflicts among public and private interests, and the inability of individuals to adequately foresee the results of their actions or care about effects on others.

Resources

An Introduction to City and Regional Planning, Munzer, Martha, New York 1964.

Man's Habitat - The City, Minnesota Environmental Sciences Foundation, National Wildlife Federation.

"A Case for Land and Water Use Policies", Isberg, Gunnar, Minnesota Volunteer, May-June 1974, pp. 49-58.

"Where and How We Grow" Hill, Gladwin, Natural History, April 1974, pp. 76-78.

***Adapted From:**

"Building a New Town" Halsey, Clifton, Minnesota Agricultural Extension Service, Environmental Education Activity Sheet No. 5.

This lesson has been reprinted from the September/October 1980 issue of Lacustrine Lessons because of its relevance to the other topics in this issue.

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Illustrations/layout

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lacustrine/lə'kəs·trən/adj (prob. from French or Italian lacustre, from Latin lacus lake): of, relating to, or growing in lakes." *Webster's New Collegiate Dictionary*

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