UNDERSTANDING YOUR ESTUARY
Level IA- ESTUARY SEARCH

Kakagon/Bad River Sloughs, a Lake Superior estuary located on the Bad River Reservation near Ashland, WI.

GOAL
Select one Wisconsin estuary to study and adoption through the Wisconsin Coastal Management's Adopt-An-Estuary Program

OBJECTIVES, students will…

1) Understand the four characteristics of Wisconsin's freshwater estuaries and the importance of each in creating an estuary

2) Understand the concept of watershed and give examples of how land use within a watershed affects an estuary

SETTING
Classroom

MATERIALS
Wisconsin map showing rivers
Wisconsin watershed map (below)
List of Wisconsin's Great Lakes Coastal Wetlands (included in this unit)

BACKGROUND
Traditionally an estuary is defined as a special wetland environment where a freshwater river meets and mixes with the saltwater of sea, and water levels are controlled by tides.

There are also freshwater estuaries. They are unique aquatic environments to the Great Lakes. Here water level, sedimentation, erosion, and biological processes are not controlled by tides, but by weather-related changes in the Lake's water level.

Example of a "barred freshwater estuary" named for the large sand bar forms at the estuary's mouth.
Photo by John Griebsch 1990

Estuaries Are Special Coastal Wetlands

Just like their salt-water cousins, Wisconsin's freshwater estuaries are special. They are found where a tributary river combines with waters of Lake Superior or Lake Michigan in a coastal wetland. When the waters of the Lake and a river mix in the estuary, a third type of water chemically different than either one is formed. This water creates a new environment different than either the river or lake.

Changing Water Levels Make Estuaries Dynamic

Estuaries are different from other Wisconsin coastal wetlands. These aquatic systems are influenced by weather-caused changes in Great Lakes water levels. Year-to-year water level fluctuations can range from 3.5 to 6.5 feet (1.3-2.5 m). Unlike a tide, they do not occur on any schedule and can persist for several years as climatic conditions change. Changing water levels that make estuaries dynamic ecosystems include:

- **Daily changes** caused by winds or changes in barometric pressure
- **Seasonal changes** caused by variations in rainfall and evaporation
- **Yearly changes** caused by longer year-to-year variations in precipitation

Changing water levels can cause sedimentation and submerge estuary plants.

Only plants and animals that can tolerate change will thrive. They must adapt to changes in water levels, water currents, wave action, turbidity (clarity or light penetration), nutrient content or availability, temperature, ice scour, and sediment.

Estuary systems are adapted to and need periodic water level fluctuations to remain healthy. As water levels rise and fall, plant communities within an estuary shift: moving landward during high-water years, and lakeward during low-water years.

Attempts to control an estuary's natural fluctuations disrupt the natural cycle that favors estuary plants and animals that are tolerant of change. This can lead to a reduction of species diversity. A predominance of cattails, a plant intolerant of significant water level change, is one indicator that natural water-level fluctuations of an estuary have been altered.

What Gives An Estuary Its Personality?

The Lake Superior Watershed is an example of a major Watershed or "Basin". Smaller or "sub-watersheds" lie within its boundaries. All of the water that falls on the land within the light tan boundary (which is not evaporated or used in industrial processes) will eventually flow to Lake Superior.

Not all coastal wetlands are estuaries. Estuaries are only those coastal wetlands where where the waters of a river and Great Lake mix. Wisconsin's estuaries have four general characteristics that give them their individual "personality":

1) **A Watershed**

A watershed is a geographical area of where all of the water falling on the land eventually drains to a common point—either a river or a lake. A watershed includes all of the humans, plants, and animals that live in it and all the non-living parts

such as rocks, soil, and even the air above it. Water connects all of these parts together.

In an "estuarine watershed", water drains off the land into a tributary river which flows into the estuary, and finally merge and flow into a Great Lake. The types of land use within the watershed influences the quality of the water draining off the land and the estuary's water quality.

Whatever happens upstream in the watershed eventually washes downstream to larger water bodies. Whatever we put on the land, affects the quality of water we use for drinking and recreation.

2) **An "Estuarine" River System**
Not all rivers flowing into Lake Superior or Lake Michigan form estuaries. The key is the river and Lake waters must mix together first in a coastal wetland before flowing to the Lake. These are called "estuarine" rivers.

The Fish Creek Estuary is formed where Fish Creek, an estuarine river, flows into the estuary wetlands, and mixes with the waters of Lake Superior (left). US Highway 2, west of Ashland WI, bisects the mouth of the estuary.

3) **A Special Coastal Wetland called an "Estuary"**
To understand how Wisconsin's estuaries were formed, we need to go back to the Ice Age! Glaciers covered most of Wisconsin. As these mile thick sheets of ice moved over the landscape, they scooped and gouged out what we know as the Great Lakes. The glaciers weighed so much that they compressed the earth.

About 10,000 years ago the glaciers began to melt and "retreat" back to the Artic. Rivers carried glacial melt water and rainwater downstream to the Great Lakes. The water flow carved rivers valleys into the land's surface.

The land surrounding the Great Lakes has been slowly "rebounding" or rising since the heavy glacial ice left. The Canadian shoreline is rising the fastest. Like a bowl with one side tipped up more than the other, more Great Lakes water is spilling toward Wisconsin's shoreline causing water to flood the mouths of some Wisconsin tributary rivers. The flooded or "drowned" river mouth forms a freshwater estuary. Here the flow of the river water slows and warms before it mixes with Lake water. This environment supports an entirely different cast of plants and animals that live in either the river or Lake.

4) **A Great Lake**

The water quality characteristics of Lake Superior and Lake Michigan are different than the estuarine rivers that flow into them. The exchange of water between the estuary and the Lake is a two-way street. While water carried by the estuarine river eventually flows to Lake, water from the Lake is also flows back into estuary.

Wind and waves push Lake water into the estuary. "Seiches", a unique Great Lakes phenomena caused by changing barometric pressure, push and pull water in estuary. The action resembles a lunar tide, but is not as predictable or strong. Like a bowl of soup that is sloshed from side to side, an "on-shore" seiche can push colder Lake water back up into the estuary while an "off-shore" seiche can pull water from the estuary out into Lake.

The "see-saw" action of water flowing out of the estuary's river into the Lake and the inflow of Lake water back up into the estuary makes this a dynamic environment. Seiches can significantly change water levels and water chemistry. They can scour out new water channels or dry up old ones. Plants and animals living in the estuary must be able to survive these changes.

ACTIVITIES

Students should examine both a Wisconsin state map and a Wisconsin watershed Map and locate their local watershed. Identify a major river(s) draining this watershed. Does this watershed drain into one of Wisconsin's Great Lakes?

Have students brainstorm which of Wisconsin's watersheds have the characteristics to form an estuary, which do not, and why.

Give students the list of Wisconsin's Great Lake Coastal wetlands included in this unit. The list includes some, but not all of Wisconsin's estuaries.

Students should select one estuary to adopt. Students should be able to list the following characteristics of the estuary:

- **Name of the estuary**
- **Location: county, nearest city/town, general region of Wisconsin**
- **Name of the watershed that drains into the estuary**
- **Name of the estuarine river that drains the watershed and flows through the estuary to the Lake**

Field tours to this estuary will be part of student-conducted research in Level II.

LEVEL I-A WISCONSIN WATERSHED MAP

To learn more about Wisconsin's Watersheds visit:
http://dnr.wi.gov/org/water/wm/programs.html

Level 1-A: Classification and Ranking of Wisconsin's Great Lakes Coastal Wetlands

Marsh[a]	Aquatic System	State	Site Type	Location		Size[b] (ha)
				Latitude	Longitude	
Lake Superior						
Bad River B*	Lake Superior	WI	Barrier-beach lagoon	46.92	90.34	1600
Bark Bay A&B	Lake Superior	WI	Barrier-beach lagoon	47.15	90.68	270
Honest John	Lake Superior	WI	Barrier-beach lagoon	46.85	90.22	260
Raspberry Bay A*	Lake Superior	WI	Barrier-beach lagoon	47.18	90.33	60
Siskewit Bay	Lake Superior	WI	Barrier-beach lagoon	47.18	90.61	100
Stockton Island	Lake Superior	WI	Barrier-beach lagoon	47.14	90.12	90
Pokegama A&B	Lake Superior	WI	Open lacustrine estuary	47.04	91.54	80
Bad River Mouth	Lake Superior	WI	Barred lacustrine estuary	46.92	90.34	1600
Kakagon Slough	Lake Superior	WI	Barred lacustrine estuary	46.94	90.36	2500
Long Island	Lake Superior	WI	Sandspit swale	46.90	90.41	80
Raspberry Bay B*	Lake Superior	WI	Barred lacustrine estuary	47.18	90.33	60
Lake Michigan						
Mink River	Lake Michigan	WI	Open lacust. Estuary & Delta	45.32	86.91	260
Dead Horse Bay	Lake Michigan	WI	Sandspit embayment	44.75	87.88	128
Little Tail Pt.	Lake Michigan	WI	Sandspit embayment	44.80	87.85	84
Oconto River	Lake Michigan	WI	Tributary delta	45.00	87.71	700
Peshtigo River	Lake Michigan	WI	Tributary delta	45.13	87.50	1100
West Twin River	Lake Michigan	WI	Barred lacustrine estuary	44.23	87.56	200

Source: Great Lakes Coastal Wetlands, Biotic and Abiotic Characteristics, EPA, http://www.epa.gov/glnpo/ecopage/wetlands/index.html