Teaching with Great Lakes Data

Great Lakes Waves and Water Safety Lesson
Activity 1: The Path of the Edmund Fitzgerald

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Summary:
Students will learn about how to analyze wind and wave data as a decision-support tool in the context of the famous historical wreck of the *Edmund Fitzgerald*. This lesson provides the opportunity for students to perform a retrospective investigation of the meteorological conditions that led to the shipwreck and explore how modern data sources could help prevent such a disaster. Additionally, students will use weather maps to plan a "safe route" for the ship to navigate through the storm.

Key concepts:

- Historically, weather agencies did not have the continuous monitoring equipment and advanced computing necessary to develop sophisticated predictive models of wind and waves on the Great Lakes
- The existence of these models could have prevented this tragic shipwreck
- Wave heights are strongly dependent on constant wind speed and direction, as well as the distance over which the wind travels (un-interrupted by land forms)

Learning Objective:

- Use modeled historical data showing wind speed, wind direction, and wave height as a decision-support tool in a hypothetical route-planning exercise

Subject Areas: Earth Science/Physical Science

Grade Level: 6-12

Wisconsin Science Education Standards:
A.8.4
Collect evidence to show that models developed as explanations for events were (and are) based on the evidence available to scientists at the time.
Based on historical and/or current scientific data and evidence, design a model to explain an event. *Examples: geocentric theory, flat earth, medical techniques, simulations; such as, wind tunnels, stream tables…*

A.8.6
Use models and explanations to predict actions and events in the natural world. Emphasize the themes of change, models, explanation, and systems to employ conceptual and/or physical models and explanations to predict actions and events in the natural world. *Examples: Plate tectonics, succession, weather data/maps and weather events…*

A.8.7
Design real or thought investigations to test the usefulness and limitations of a model. Design, assess, and evaluate scientific models through group discussions.

Great Lakes Literacy Principles, High School Earth Science:
1.G
Lake level is the height of the Great Lakes relative to sea level. Lake-level changes are caused by variations in precipitation, evaporation, runoff, and snow melt, as well as wind and waves. While tides are typically not discernible in the Great Lakes, seiches are common in the lakes.

7.E
Models help us understand the complexity of the Great Lakes. Models process observations, describe interactions among systems, expose information gaps, and forecast change.

Background:
On November 10th, 1975, a massive storm struck Lake Superior causing the shipwreck of the *Edmund Fitzgerald*, a 729-foot freighter ship with 29 crewmembers, all of whom perished in the storm. It initially departed from Superior, Wisconsin at the western end of Lake Superior and was traveling near Whitefish Bay, Michigan when the wreck occurred.

While the exact cause of the accident is unknown, with theories ranging from damaging wave action, to structural failure, there is little doubt that gale force winds and massive waves contributed to the wreck. The official conclusion was that the combination of a large cargo load (26,000 tons of iron ore pellets) and water damage from the huge waves berating the ship caused the wreck. As arguably Lake Superior's most famous shipwreck, the story of the *Edmund Fitzgerald* has spawned controversy and a cultural aura that few wrecks can capture. It even spawned the famous narrative rock song, *The Wreck of the Edmund Fitzgerald*, by Gordon Lightfoot.

YouTube Link: The Wreck of the Edmund Fitzgerald
http://www.youtube.com/watch?v=Q0DqPSF2fyo

Principles:
Wave periodicity: Taller, more frequent waves pose the biggest hazard to large ships particularly when they exceed five meters in height.

Wave height: Is typically determined by **wind speed** and the **fetch** (distance over which the waves are generated)

Season: Autumn has produced some of the largest storms on record in the Great Lakes Region. "**November gale**" has become a common term to refer to autumn storms due to the history of storms in the region.

Route: The *Edmund Fitzgerald* was travelling from Superior, Wisconsin to Detroit, Michigan and loaded with over 26,000 tons of iron ore. The captain tracked a northern route across Lake Superior, a common practice during storms.

Ship speed: The ship was traveling at approximately 13 mph on its journey across Lake Superior.

Materials:
- Activity worksheet (GLWaves1_Edmund_Fitzgerald_Worksheet.pdf)
- Activity worksheet key (GLWaves1_Edmund_Fitzgerald_Worksheet_Key.pdf)
- Powerpoint slides (GLWaves1_Edmund_Fitzgerald_Slides.pptx)
- Background reading on exploring the November 1975 storm using today's technology (GLWaves1_Edmund_Fitzgerald_Hultquist_Article.pdf)

Procedure:
1. Introduce the background information about the Edmund Fitzgerald. Ask students if they know the story. Introduce the Gordon Lightfoot song to show the event's cultural significance.
2. Explain that the Great Lakes are large enough that storms can produce wave conditions that compare to ocean gales.
3. Talk about how waves are formed – that wave heights are a function of prevailing wind speeds and the water distance over which the wind travels.
4. Introduce the activity worksheet where students will have to plan a safe route based on historical "hindcast" data showing wave heights and wind direction for Lake Superior in relation to the Edmund Fitzgerald's location.

Works Cited:
Hultquist, Thomas R., Dutter, Michael R., and David J. Schwab. 2006. "Reexamination of the 9-10 November 1975 "Edmund Fitzgerald" Storm using Today's Technology." *Bulletin of the American Meteorological Society* (May 2006): 607-22.