Module 13

Modern Navigation Systems

Terrestrial and Marine Navigation Systems

Module 13B

Terrestrial and Marine Navigation

Summary of Module 13

- The simplification of the GPS and celestial algorithms to the 2-dimensional case is presented. But first, a few catch-up slides are included to elaborate further on concepts explored in earlier modules. The sub-module concludes with a brief introduction to hyperbolic radio-navigation systems. (13A)
- **The basics of practical terrestrial and marine navigation will be introduced via a combination of slides, charts, and photographs that illustrate various important features. (13B)**
- The module includes a photo-documentary of the voyage of a commercial freighter from Bremerhaven, Germany to Newark, New Jersey in 1978, pre-GPS. (13C)
- Students will continue presenting their final projects.

House boating on the Erie Canal

The Mallard, the world's slowest boat… (4 knots)

VHS marine radio for contacting bridge and lock tenders and for distress calling; it is waterproof and floats

GPS receiver that is waterproof and floats

Side thrusters for maneuvering in locks

Roughing it…

VHF Marine Radio

- It is waterproof and floats
- It has single button access to emergency channel 16
- It receives NOAA weather channels.

A previous 525.445 student swamped his Boston Whaler in a matter of seconds several miles off Nantucket Island.

Everything was lost except the VHF transceiver, which floated to the surface and made a channel 16 distress call possible. The rescue was reported on national network television.

Portable GPS Receiver

- It's waterproof and floats

The Brunton Transit

This is a precision compass designed for geologists. It can be used *in extremis* as an inclinometer for estimating the elevation angle of the sun or moon for navigation purposes.

It is useful in mountaineering for estimating relative heights of pinnacles at a complex summit.

Combined Inclinometer and Compass

This instrument features sighting ports on each end that permit determining the elevation angle of stars within a degree or two, and determination of compass headings to similar accuracy.

It is electrically lit and can be used to obtain a lat/long fix from the sight to a single star using the mathematical techniques developed in the previous modules.

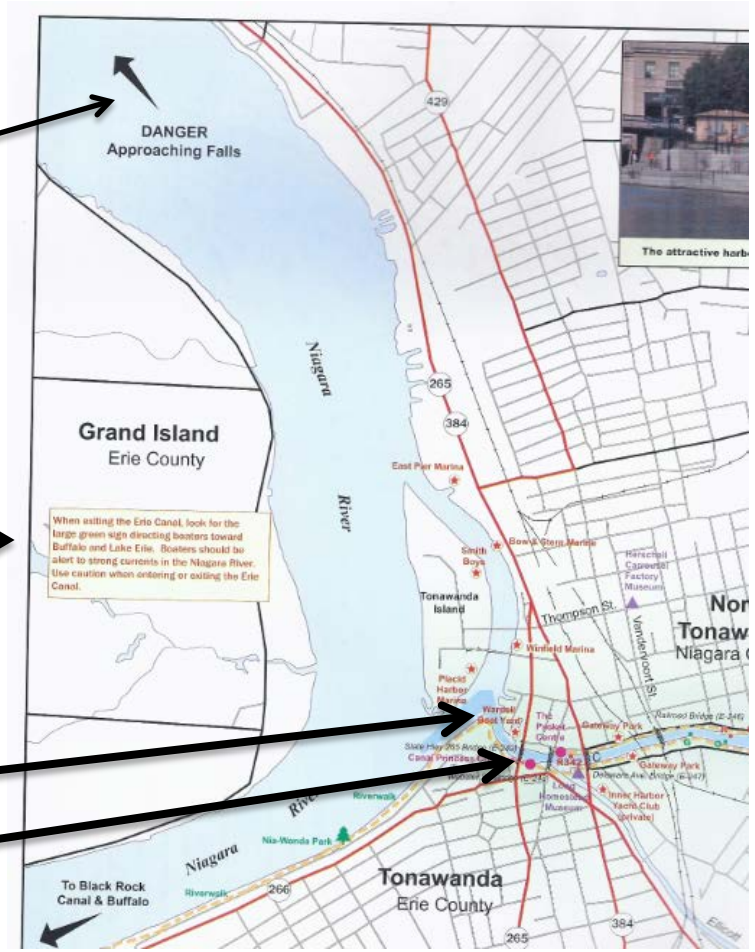
First rule of navigation: read the chart!

A very good reason to read the chart

"When exiting the Erie Canal, look for the **large green sign** directing boaters toward Buffalo and Lake Erie. Boaters should be alert to strong currents in the Niagara River. Use caution when entering or exiting the Erie Canal."

End of the Erie canal

House boat dock



Top of the American Falls

Read the signs…

Read the signs

The Erie Canal is managed by the New York State Thruway Commission, hence the signage is compliant with Interstate Highway Standards

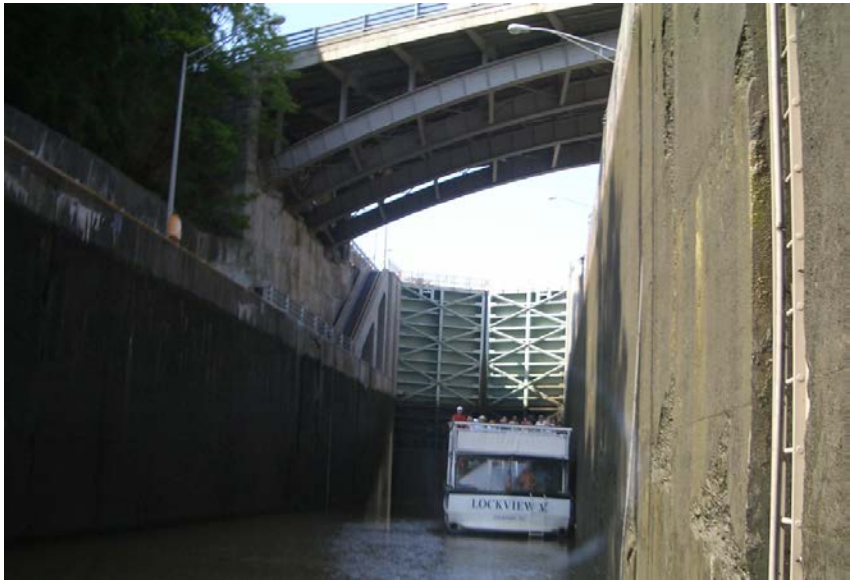
Obey the traffic signals

Green gives permission to enter the lock

Pay attention to local landmarks

This is Perce Rock, at the tip of the Gaspe Peninsula. Drive on US 1 North from JHU/APL until the Canadian border, then continue north until everyone speaks French and the road ends. Park your car, throw your kayak in the "Bay de Chaleur" (cf. Fourier Theory) and keep on going. This is what you will see.

“Locking through” the Erie Canal



Lift Bridges

When using VHF radio to contact bridge and lock tenders, boat operators are always addressed as “Captain…”

“Low bridge, everybody down…”

Chesapeake Bay Navigation: the Sawyer

Cockpit of the Sawyer at Hooper Island, MD

Radar

Depth gauge

The Chesapeake Bay and its tributaries are extremely shallow at low tide, and the use of both depth finders and strategically placed radar reflectors make finding deep water at low tide easier.

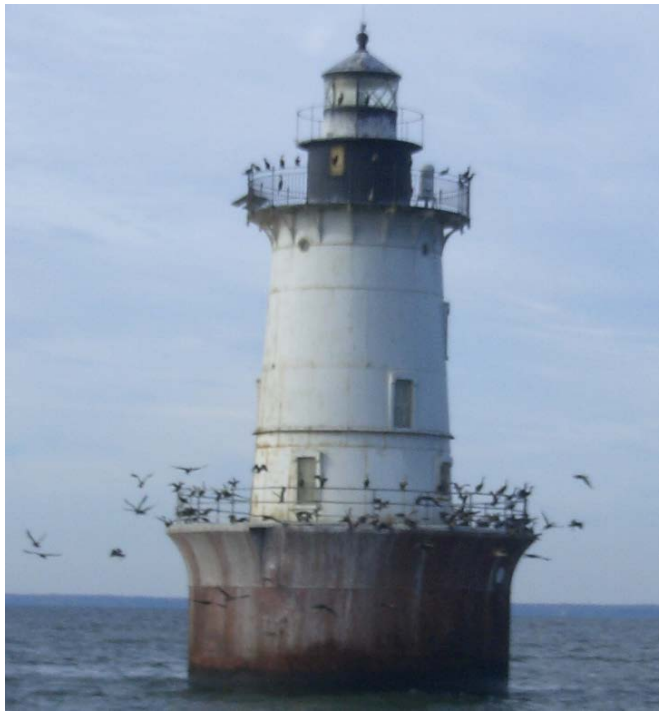
Radar reflectors are used to “illuminate” the “deep” channel into the Bay from the Honga “River”

Hooper Island lighthouse and rain squall

Hooper Island Light, Chesapeake Bay

A low-cost plastic substitute for a glass Fresnel lens

Hooper Island Light



The lighthouse sits on the floor of the bay, which is about 18 feet deep at the light at high tide.

Once inside, it is possible to take the stairs to the basement and stand on the bottom of the bay.

The birds ignore the foghorn.

View from the “Lantern Room”

Coast Guard work boat

Note the radar, flashing lights and loud speaker. This boat goes 40 knots. It has a crane in the bow well for lifting heavy equipment.

Coast Guard foghorn maintenance at the Hooper Island Light

The white on the balustrade is bird droppings, not paint.

Inside of an electronic foghorn

“Portland Head” Lighthouse, Portland, Maine

Passive Acoustic reflector for directing and enhancing sound from the foghorn at Portland Head Lighthouse, Maine

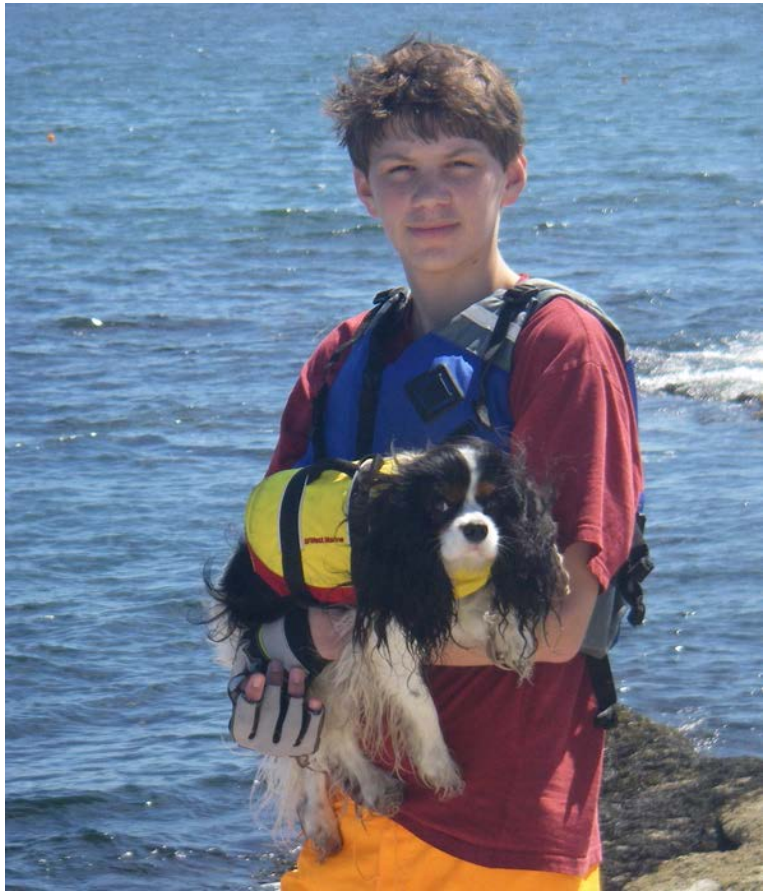
Note the use of the same model foghorn as seen on the Hooper Island light.

Note the sound hazard warning.
The Hooper foghorn operates continuously, regardless of the weather, but only in the winter months. The foghorn at Portland Head operates year-round, but only when there is fog.

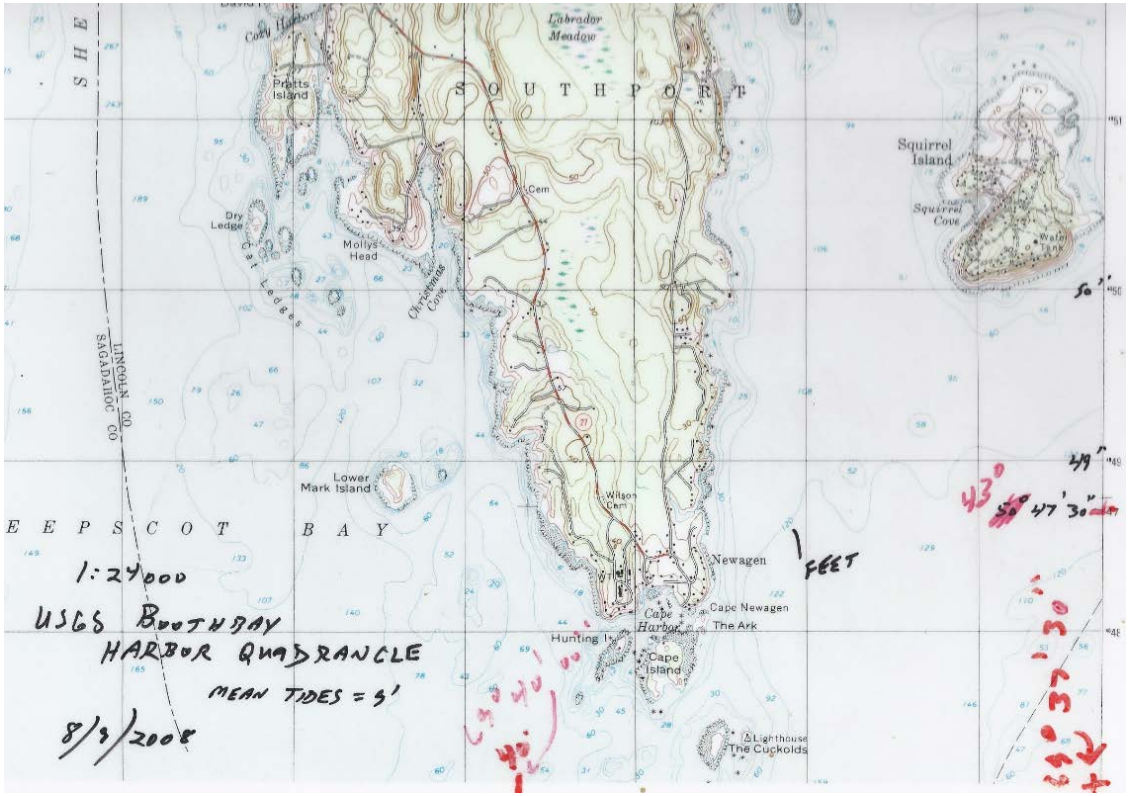
Optical-reflective fog sensor at Portland Head

Fog causes an optical sensor to detect the reflected light from the optical source; hence the two lenses. This seems to be the optical equivalent of a microwave door opener at a grocery store.

Kayaking in Maine. In small craft, everyone wears a personal flotation device: ALWAYS!



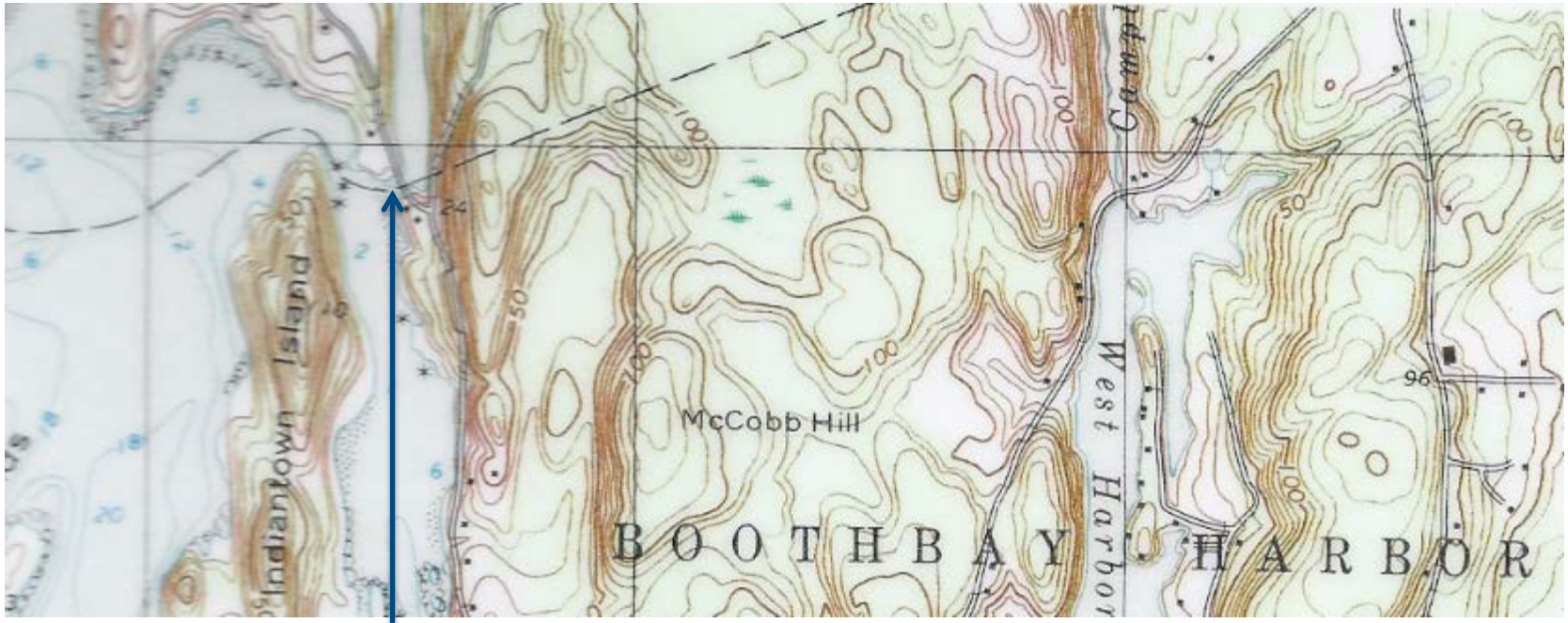
Annotated Nautical Chart, Boothbay Harbor, ME



For kayaking, it is useful to laminate the chart to make it waterproof.

This also makes it possible to write on using a waterproof “Sharpie”.

Kayaking through a culvert in a race against the tide, Boothbay Harbor, Maine



The culvert

The inland culvert, Boothbay Harbor, ME

GPS fix for culvert is
43° 51.919’ N
69° 39.901 W

The importance of knowing the tide schedule

Google Earth view of the same culvert

With broadband wireless near-shore, it is now possible to see what is around the next corner in 3-D with nothing but a GPS-equipped smart-phone.

Google Earth, overhead view

Google Earth, street view

A comment on tides

- Tides vary from 9 feet to 27 feet off the northeast coast of Maine.
- It is very, very easy to run out of water when boating at low tide, even on the Potomac River (especially south of Reagan National Airport).
- At low tide, one never runs out of mud
  - Don’t expect to see your shoes or flip-flops again if you exit your boat to walk to shore.
- At the same time, the use of low tide in order to sail under bridges (or go through culverts and aqueducts in a kayak) is an essential skill, as is tilting your sailboat to the side when going under a bridge (under power) in order to avoid lowering the mast.

Assignment 13-2

1. Surf the web, and read about the USS Enterprise and when it went aground while crossing under the Golden Gate Bridge.
2. Read about how the USS Intrepid became stuck in the mud in New York, and how the Navy dealt with this.

Post any thoughts you have in the module discussions.

End of Mod 13B