Engineering Aboard Oceanographic Research Vessels

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Unless otherwise noted:

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- The presenter has no ownership interest in any commercial entity mentioned.

Special Ocean Rated
"No Chop Busting" Disclaimers

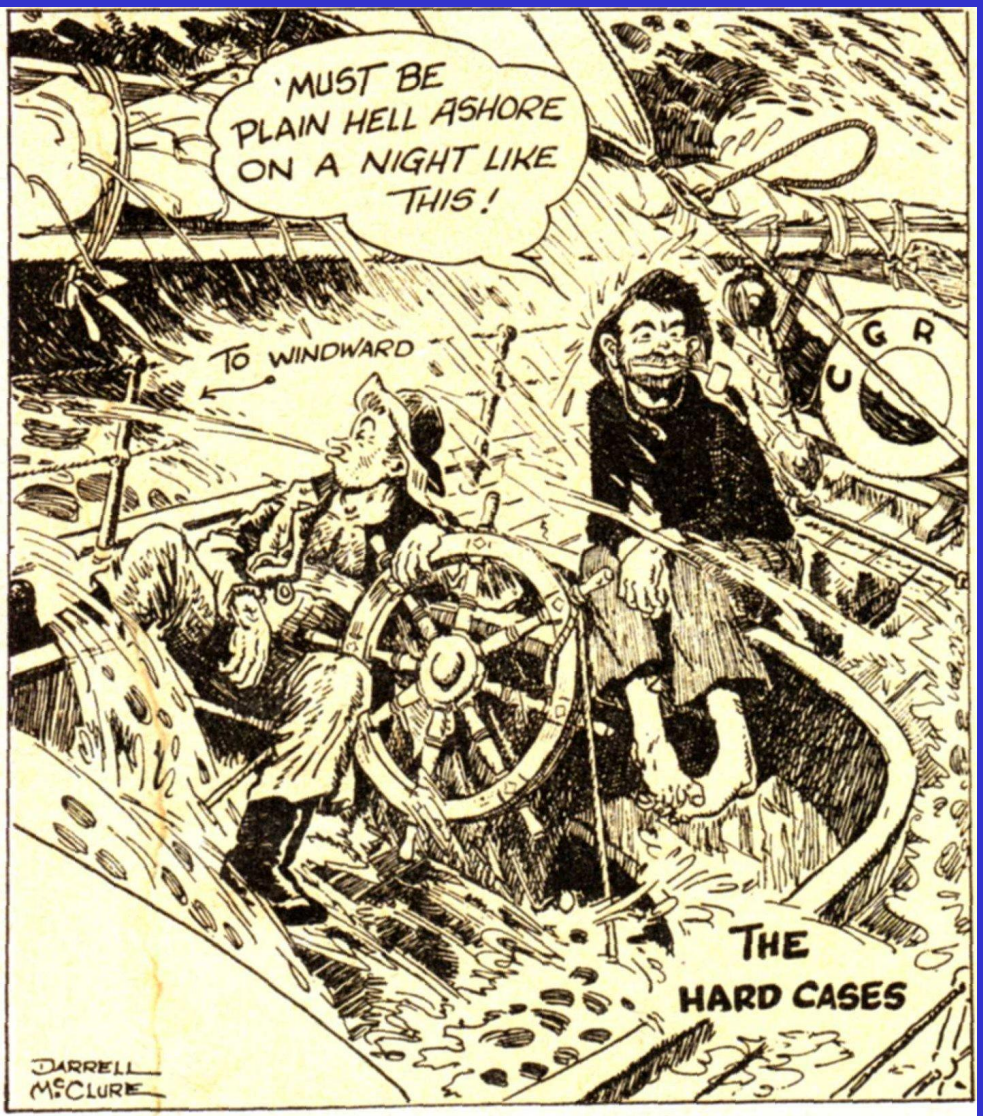
- The presenter has never dated anyone connected to any mentioned company, nor is this ever likely. Neither have those folks plied him with baubles, nor trinkets, nor fancy food and drink.

Anyone who implies otherwise is asking for trouble.

New recruits are so excitable…

"Jaws" - 1975 (He said a bad word. 25 cents in the swear jar)

…but eventually shipmates fit right in.



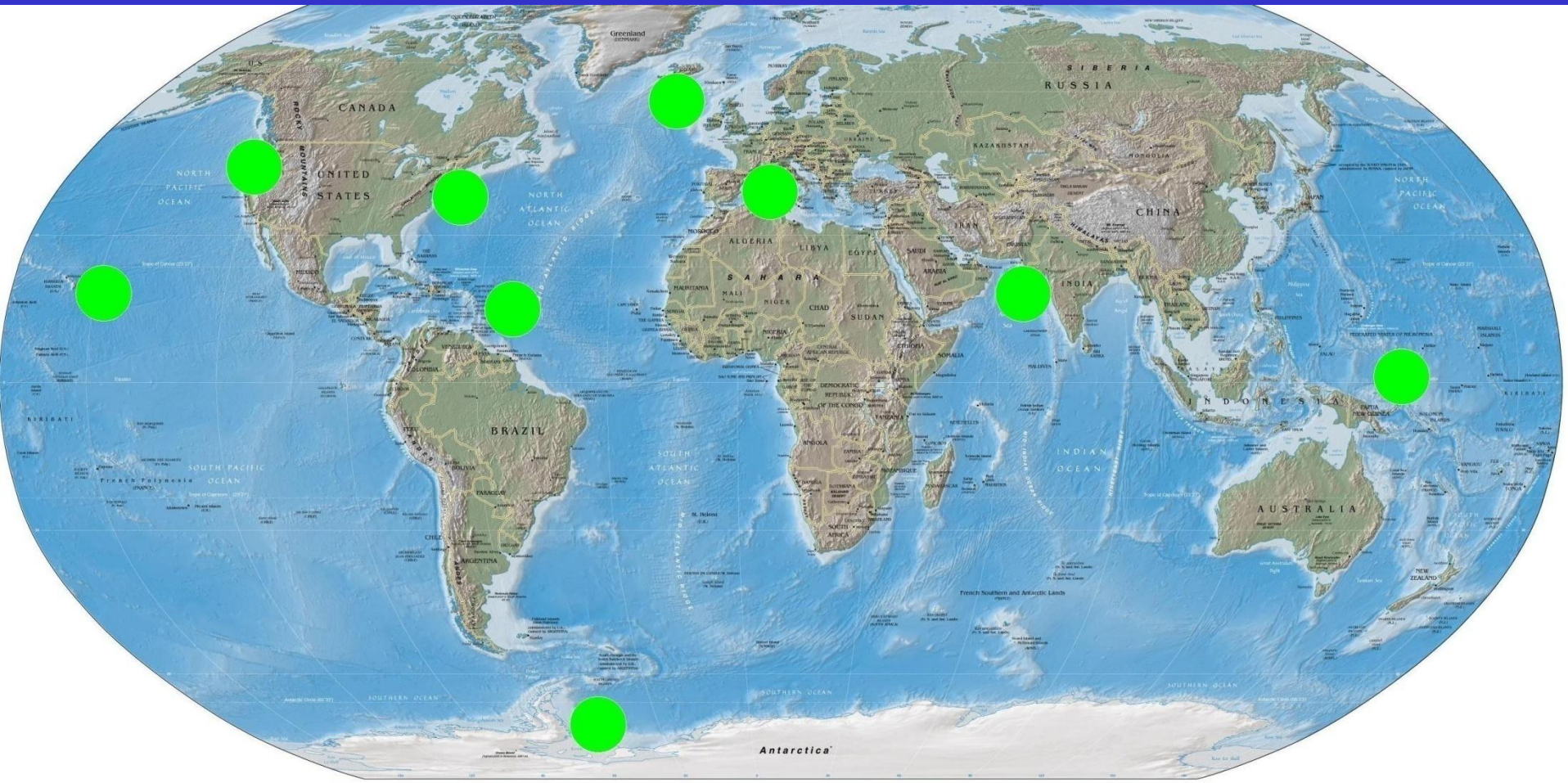
Courtesy Darrell McClure. From *The Gaff Rigged Yachtsman: Cartoons by Darrell McClure*, Yachting Publishing Corporation, New York, 1944

"Being in a ship is being in a jail, with the chance of being drowned… a man in a jail has more room, better food, and commonly better company."

- Samuel Johnson (1709-1784)

Research vessels are oceangoing laboratories

Research vessels work all over the world…



… and The Sea Will Find You Out

“You cut corners, leave something done halfway to right, say to yourselves, 'Ah, that's good enough,' and the sea will find you out, boys, and … she'll show no mercy, nor forgiveness either."

The Voyage - Philip Caputo.

Shipshape is more than an aspiration, it’s an operational necessity.

Research vessels come in many sizes…

USCGC *Healy* – 420 foot research icebreaker

R/V *Roger Revelle*

Operator: Scripps Institute of Oceanography. Built 1996.
Global class: 273 feet, 21 crew, 37 scientists, world wide operations

R/V *Neil Armstrong*

Operator: Woods Hole Oceanographic Institution. Delivered April 2016.
Ocean Class, 230 feet, 20 crew, 22 scientists, world wide operations

R/V *Endeavor*

Operator: University of Rhode Island
Intermediate class
185 feet, 11 crew,
29 scientists,
hemispheric operations

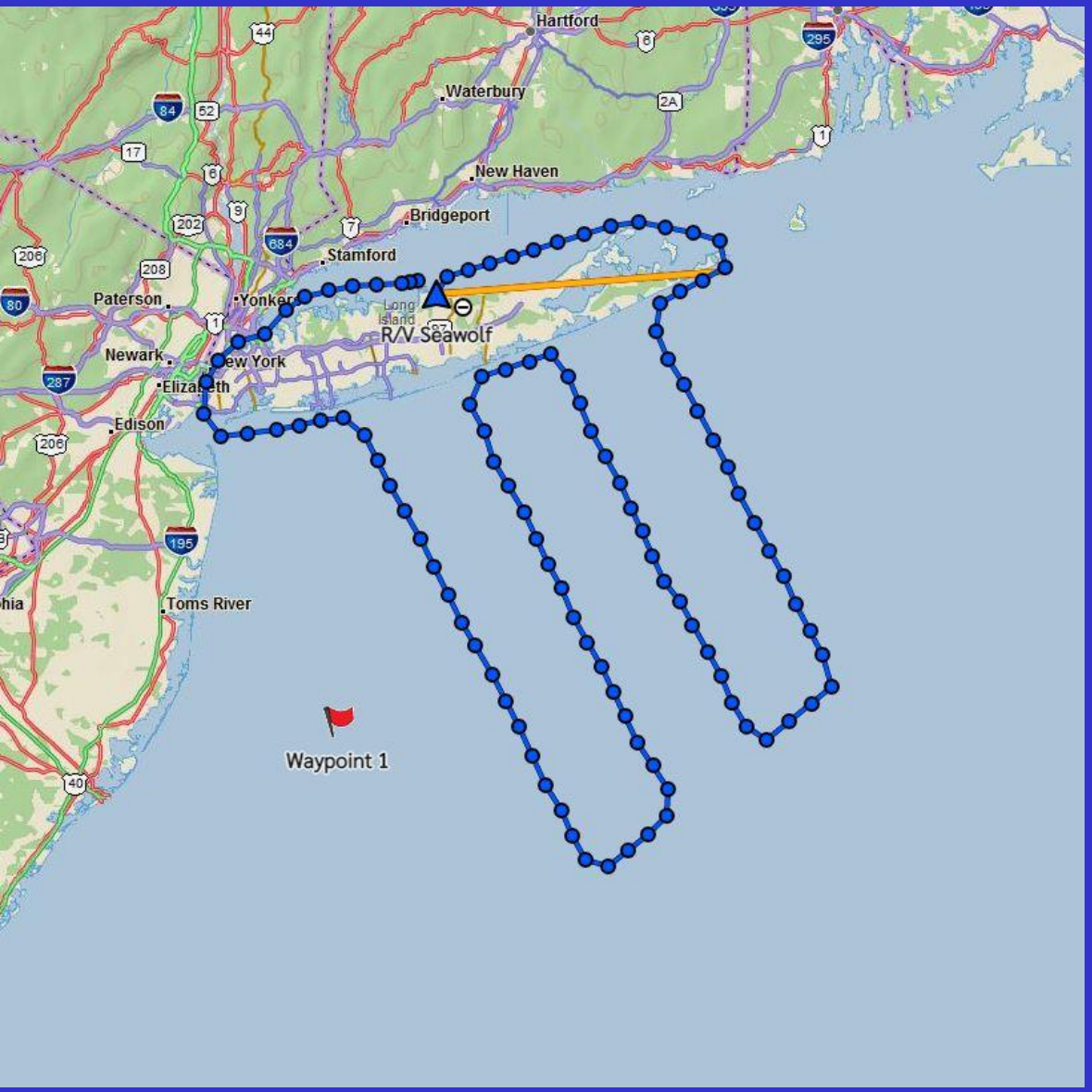
R/V *Pelican*

Operator: Louisiana Universities Marine Consortium (LUMCON)
Regional class: 115 feet, 6 crew, 14 scientists, regional operations.

R/V *Seawolf*

Operator: Stony Brook University. Built 1982, converted 2000.
Local class: 80 feet, 3 crew, 10 scientists, local operations

Do not disrespect the local class boat.



The Seawolf works out to the edge of the continental shelf (100+ miles offshore), north to Cape Cod MA, south to Cape May NJ, and up the Hudson River to Albany.

Endurance 12 days.

Offshore indicators cruise track: May 2023

Do not disrespect the local class boat.

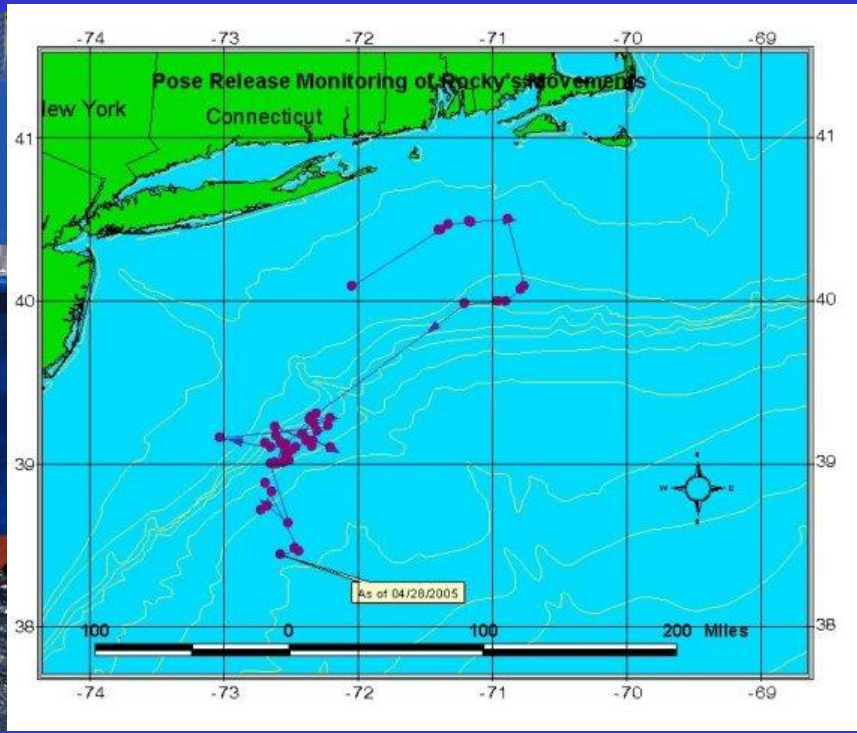
In 2002, Seawolf Captain Steve Cluett recovered a two ton ship's anchor dating from the 1890s while trawling Ambrose Shoal near the entrance to NY Harbor.

Captain Cluett's son Chris and Port Jefferson's Boy Scout Troop 45 restored the anchor as an Eagle Scout Project and donated it to Port Jefferson Village, where it now graces the entrance to Harborfront Park.

Do not disrespect the local class boat.

The Seawolf is more than equal to any vessel of her size anywhere in the world - and more capable than many larger vessels.

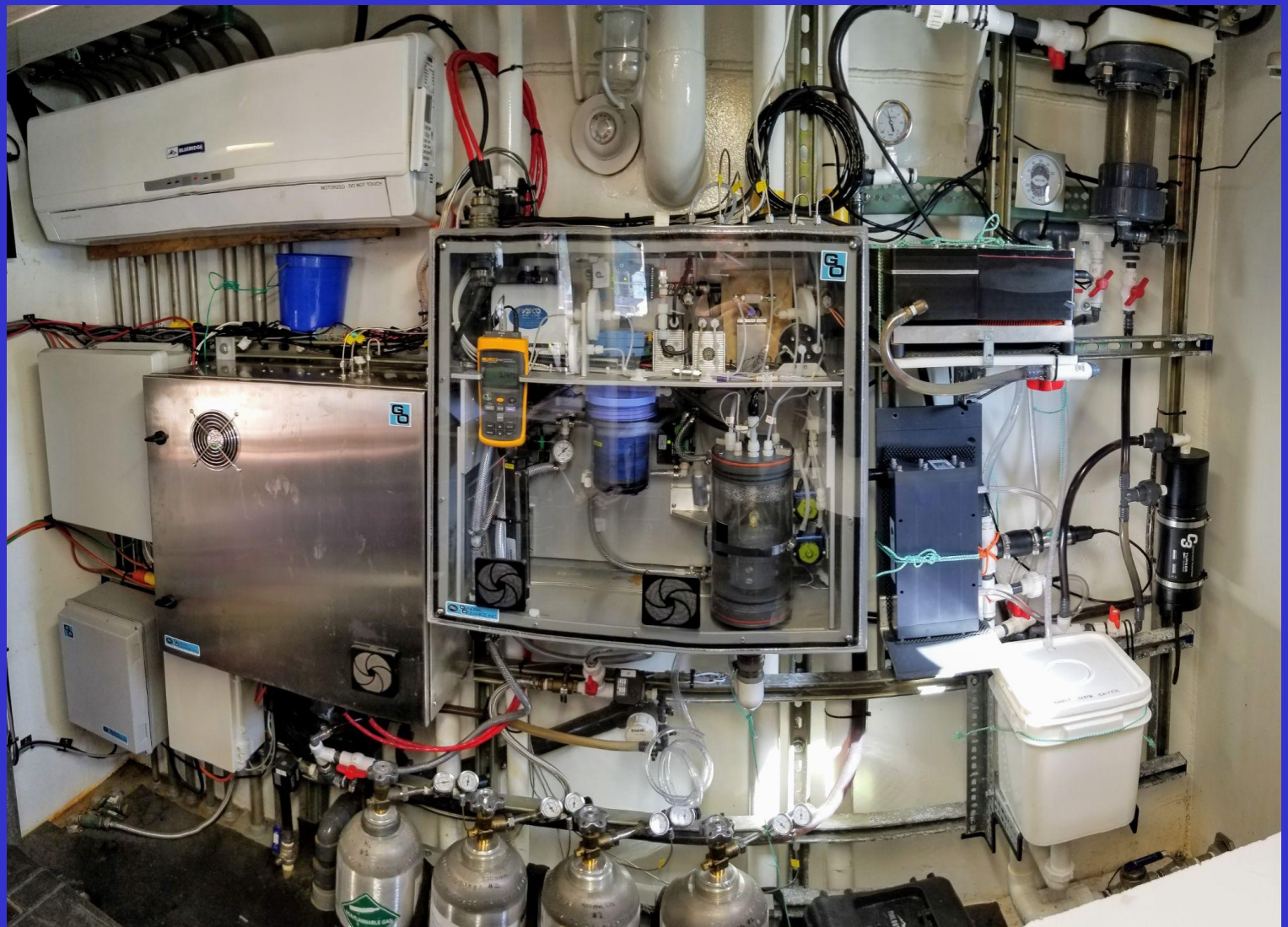
Research we do include physics, biology, geology, chemistry, atmospheric sciences, fisheries, and multibeam sonar.



Rehabilitated Pilot Whale Release

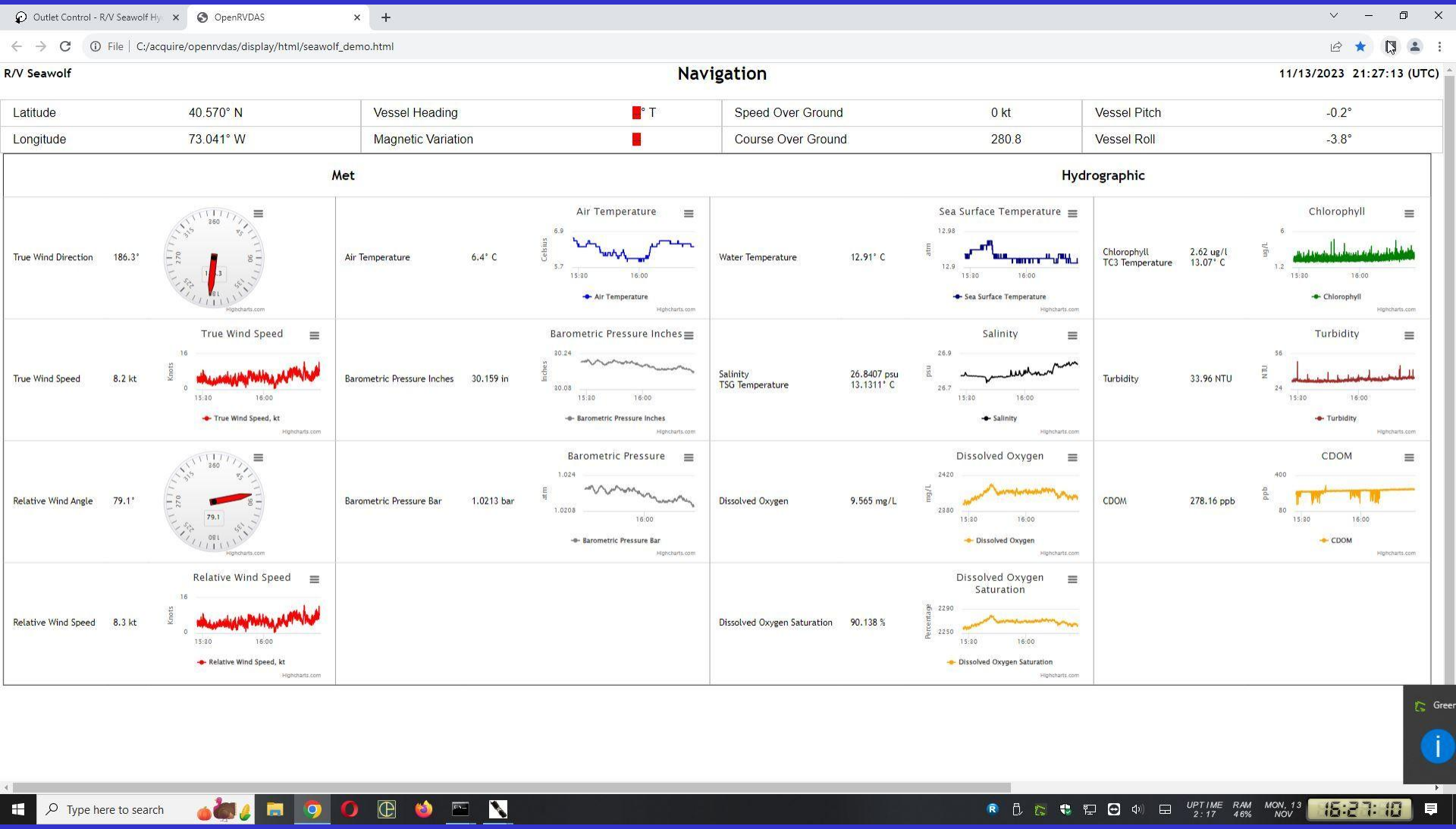
“Water Wall” on R/V Seawolf

Temperature, salinity, dissolved oxygen, chlorophyll, turbidity, CDOM, pH, pCO_2



OpenRVDAS on R/V Seawolf

Python-based open source data acquisition



CTD and 12 bottle Rosette Sampler

CTD and 24 bottle Rosette Sampler

Photo: Schmidt Ocean Institute, *R/V Falkor (too)*

Electromechanical Sea Cable

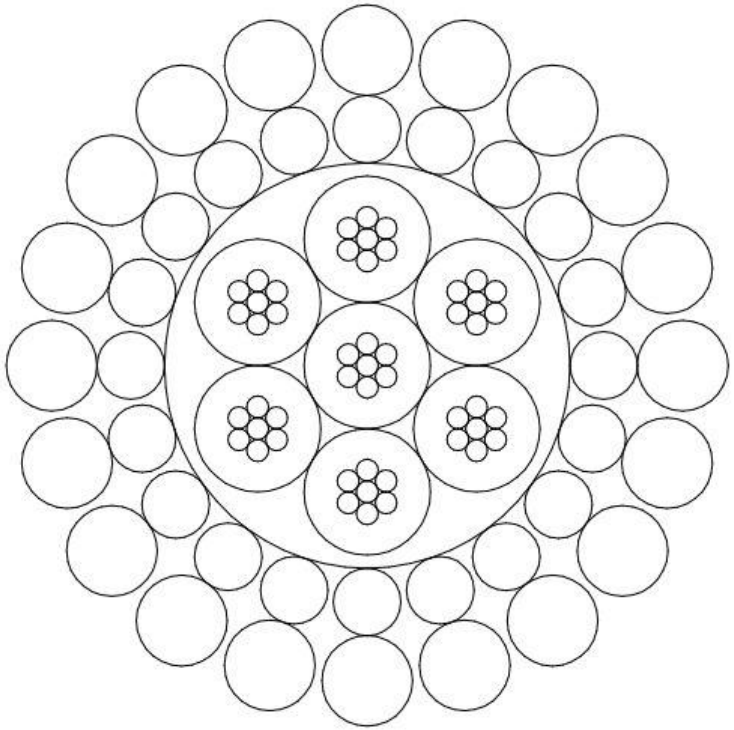
Double armored well logging cable

Galvanized steel strength members, 7 electrical conductors

11,000 lbs breaking strength, 17 inch minimum bend diameter

DATALINE®

Description	mm	Inch
CONDUCTORS (7) #22 AWG, 7/0.010" (0.25 mm) Bare Copper	0.76	0.030
INSULATION 0.014" (0.36 mm) Wall EPC	1.47	0.058
CORE 6 insulated cdrs around 1	4.47	0.176
BELT 0.005" (0.13 mm) Wall TPE	4.72	0.186
ARMOR: GEEIPS Inner: 20/0.031" (0.79 mm) Outer: 20/0.0415" (1.05 mm)	6.30 8.41	0.248 0.331

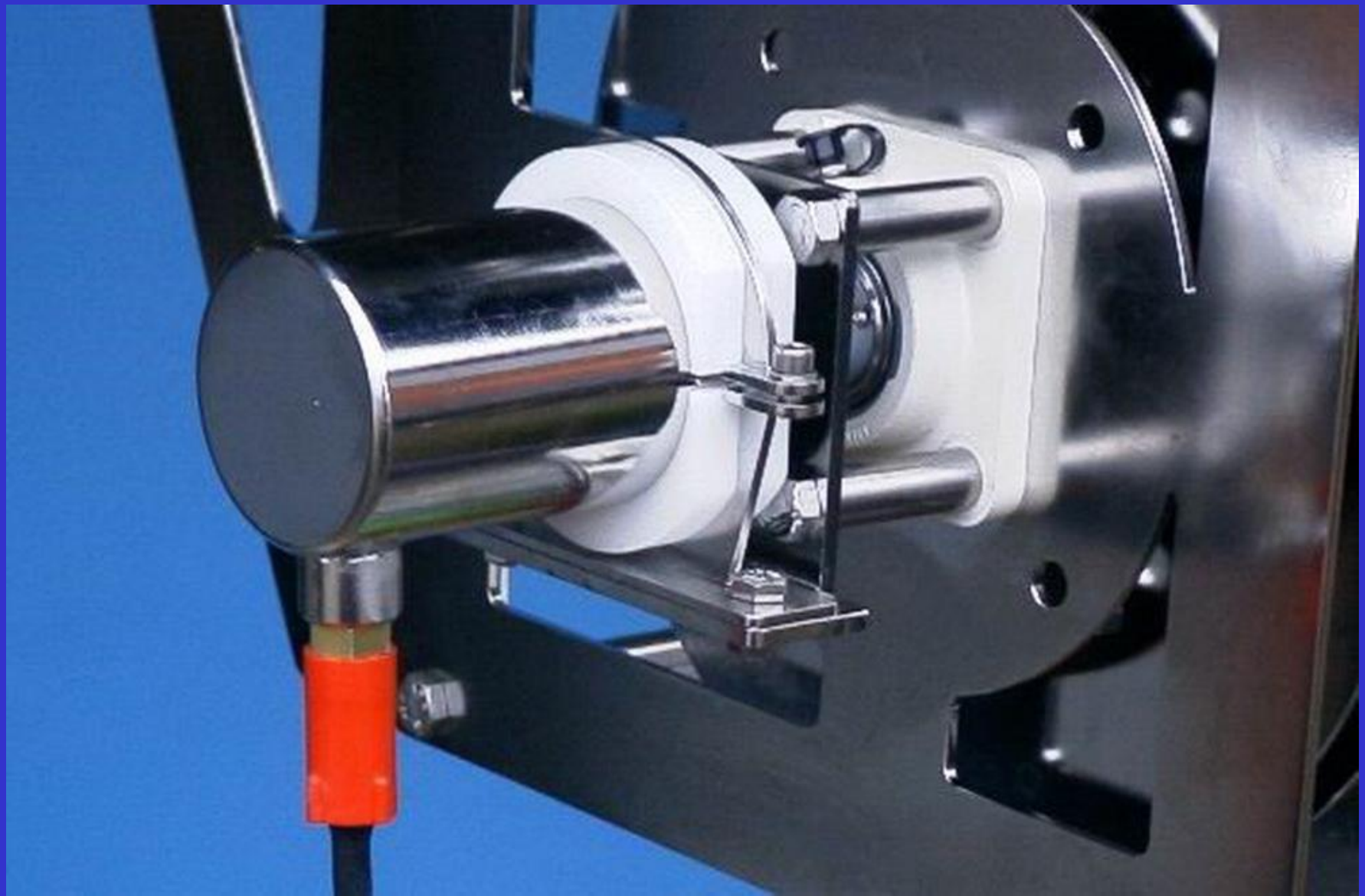


Electromechanical Sea Cable and Poured Metal Termination

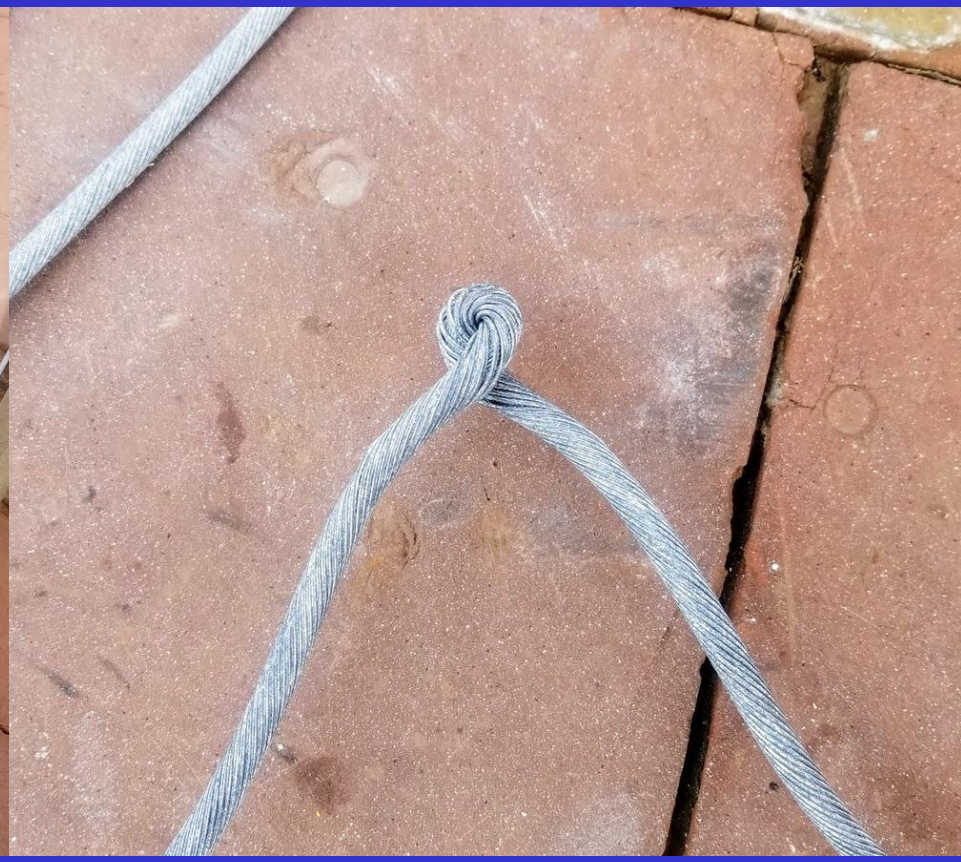
Electromechanical Winch

Slip Ring

Can be electrical or electrical/fiber



Ship roll + light payload = time to reterminate!



At depth the payed out cable often weighs far more than the payload at the end.

Traction Winch

Dynacon winch from UNOLS Winch Pool

Capacity 10,000 meters (32,810 feet) of 17.29mm (0.681 inch) fiber optic cable

Materials strength limitations for steel cable. Nonmetallic cables have different challenges: cost, durability, permanently lose strength if compressed.

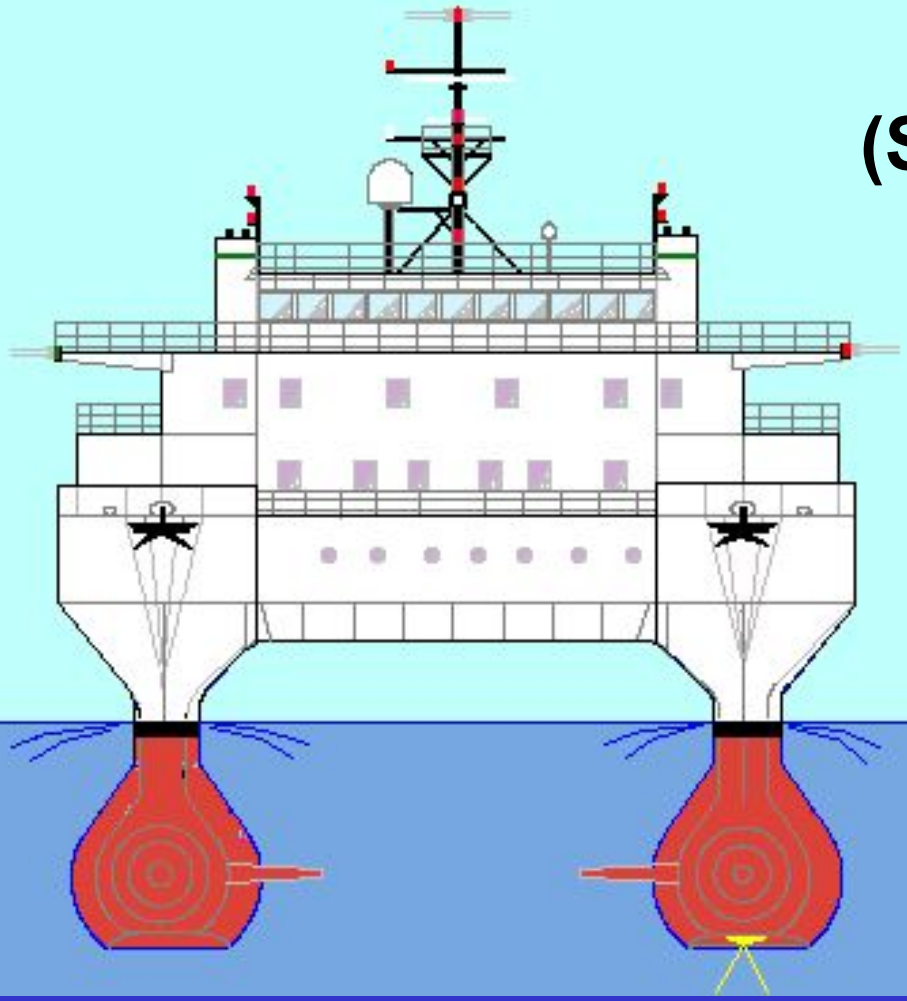
Research vessels come in many shapes…

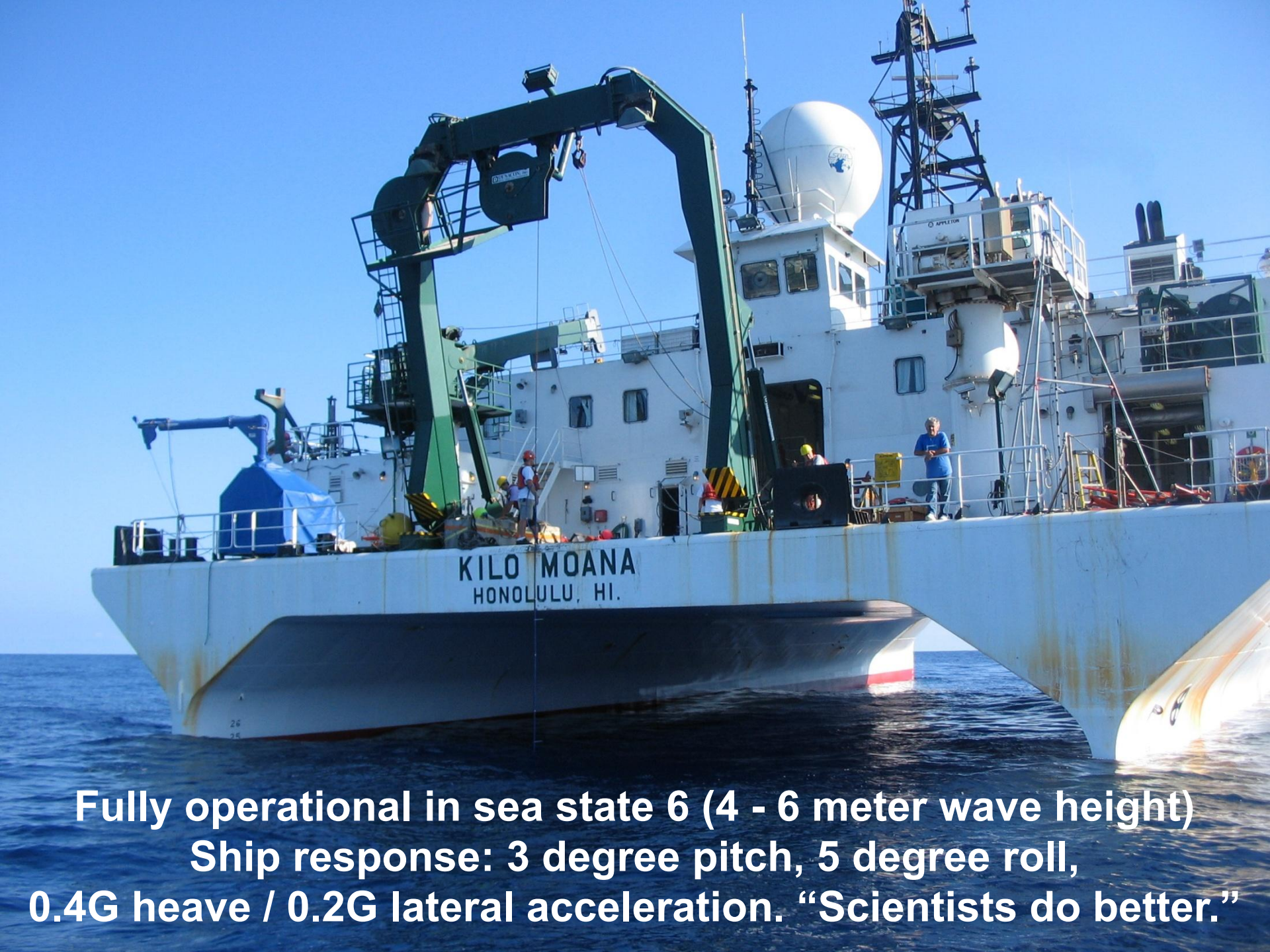
R/V *Kilo Moana*

Operator: University of Hawaii

186 feet long, 88 foot beam

SWATH Ship
(Small Waterplane Area Twin Hull)





Fully operational in sea state 6 (4 - 6 meter wave height)
Ship response: 3 degree pitch, 5 degree roll,
0.4G heave / 0.2G lateral acceleration. “Scientists do better.”

Launch day
November 17, 2001


11-16-01

Trevor Young

2010 Stony Brook University Environmental Studies Graduate

Instrument Technician, University of Hawaii Ocean Technology Group

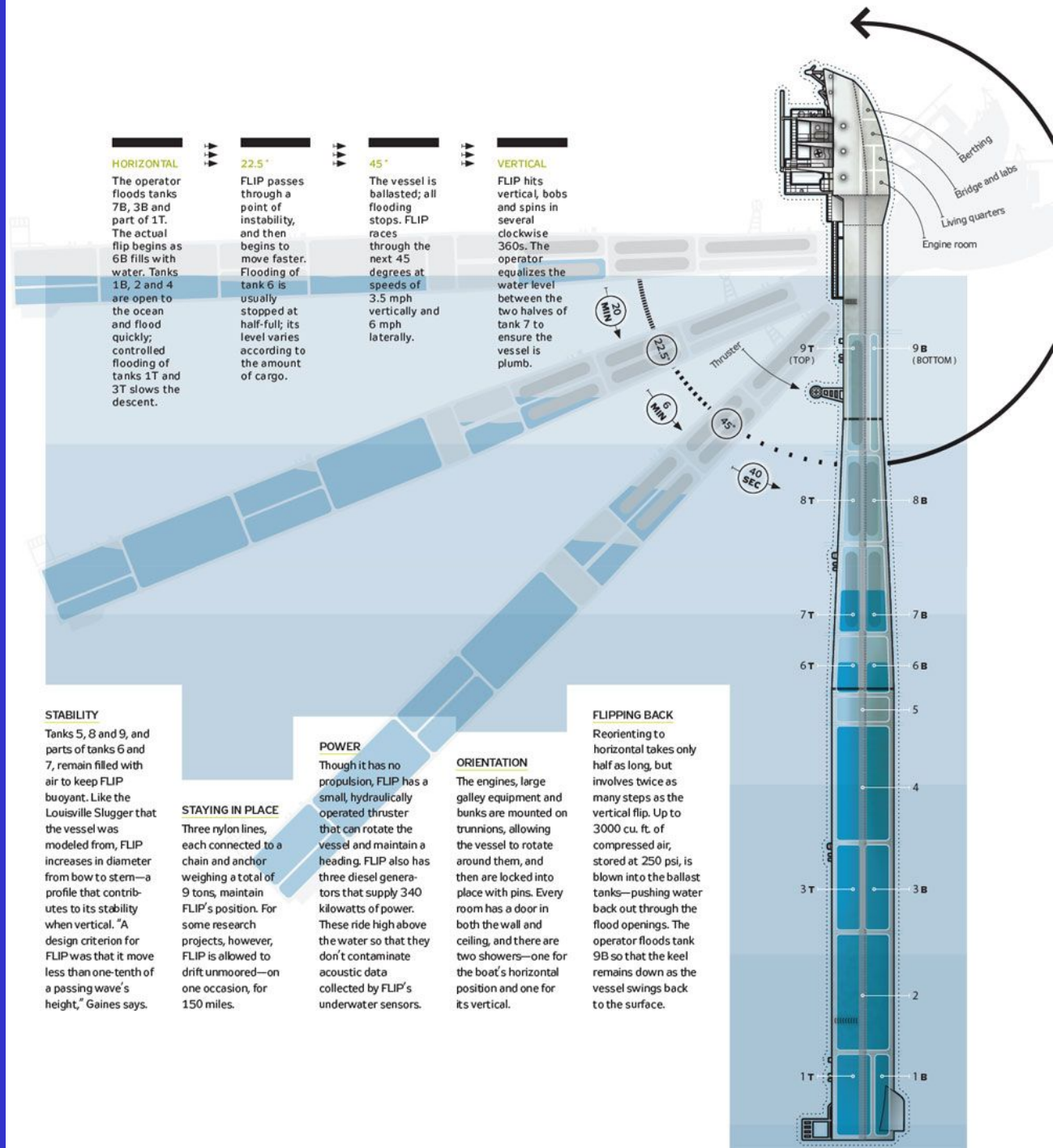

LIFEGUARD

30:00

R/P *FLIP*

Operator: Scripps Institute of Oceanography.
355 feet long.
Built 1962.

Design inspired by a Louisville Slugger baseball bat.

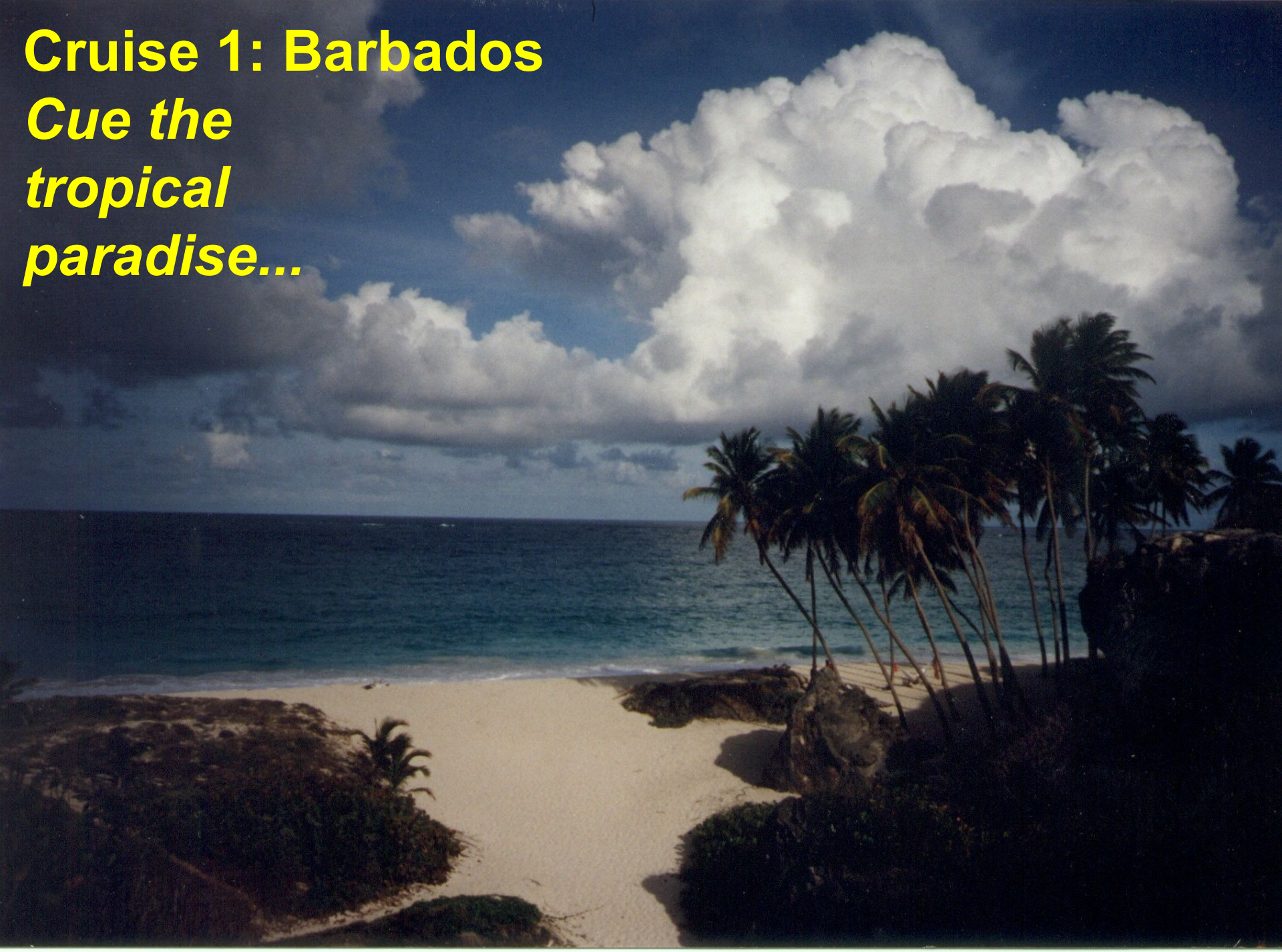


R/P *FLIP*

FLIP operates in both horizontal and vertical configurations, so things are a little unusual inside.

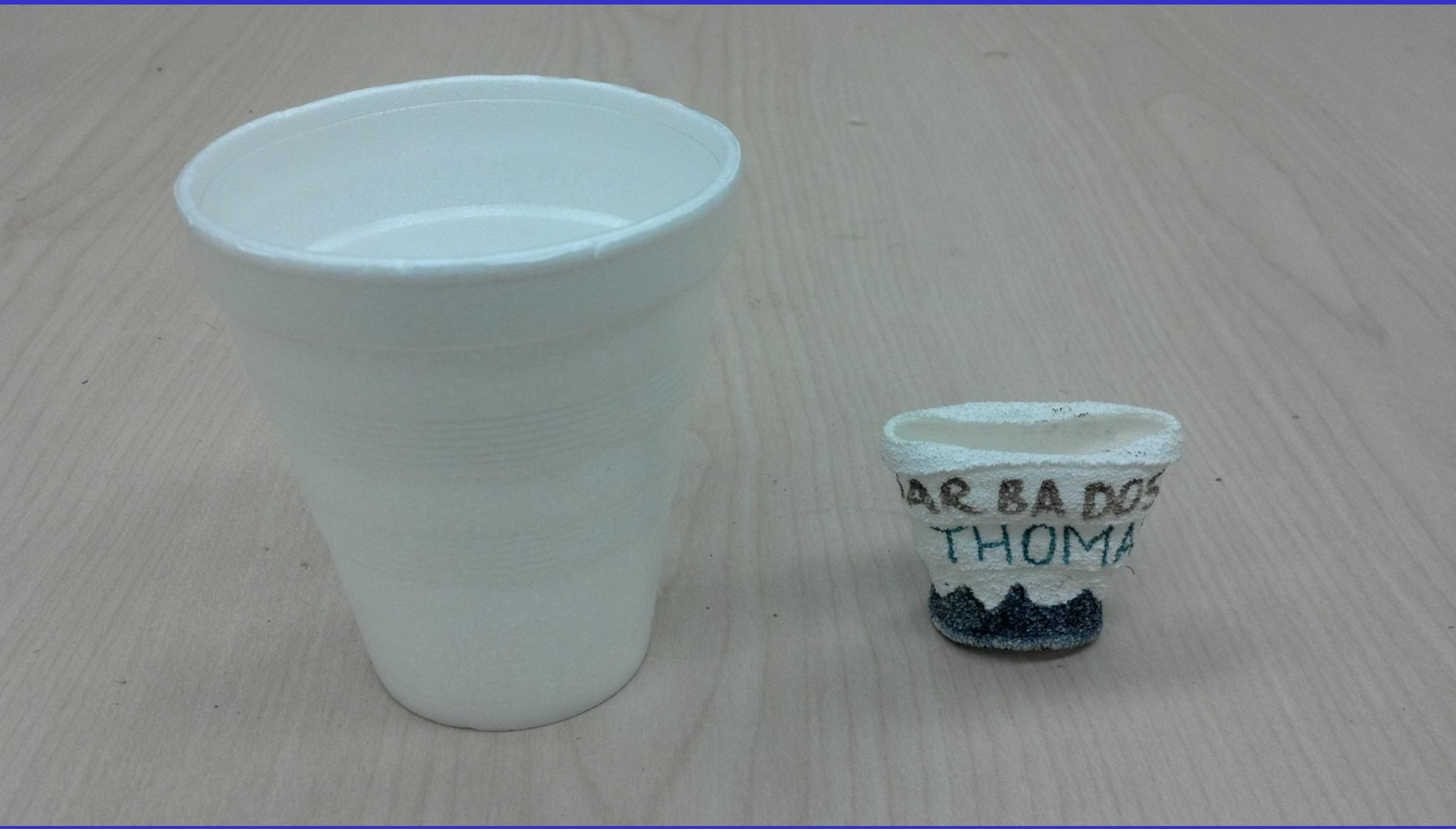
Stove on pivots, rotates with ship, coffeepot certified.

Decommissioned August 6th, 2023


Cruise 1: Barbados
Cue the tropical paradise...

Science Party

Deploying an instrument mooring


AR BA DOS
THOMA


Haley
CHEF
Judy

Under Pressure

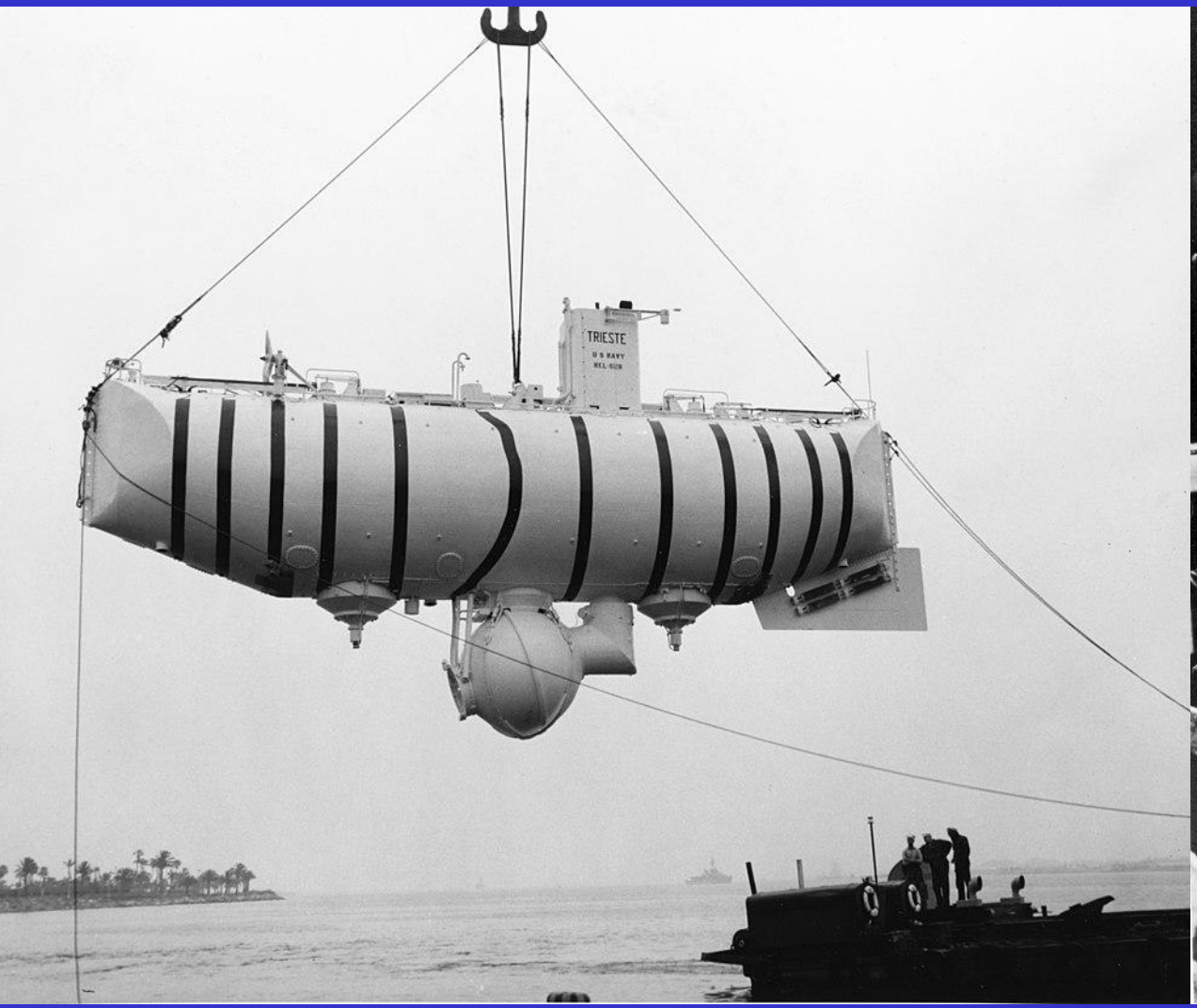
- Sea level atmospheric pressure = circa 14.7 psi absolute.
- 2 feet immersion in seawater = circa 1psi additional.
- 10 meters immersion = circa 1 bar additional pressure.

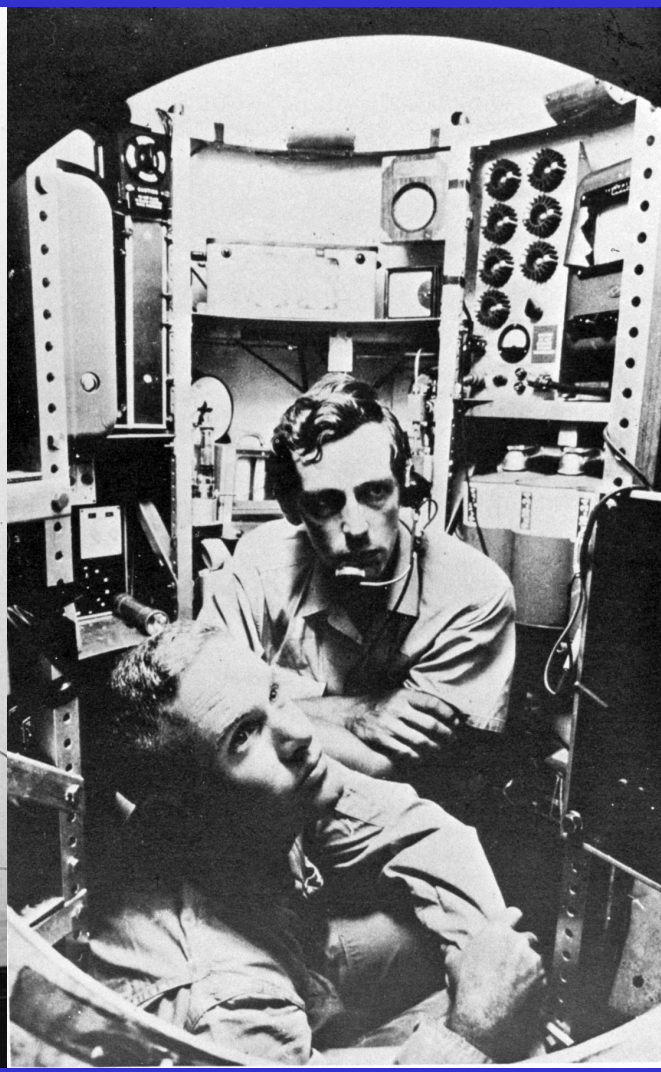
Average depth of the world ocean is 3,682 meters = 12,080 feet = about 6,000 psi.

Deepest spot in the world ocean is the Challenger Deep in the Mariana Trench. 10,935 meters = 35,876 feet = about 18,000 psi.

Until recently, more people had walked on the moon than had visited Challenger Deep!

Bathyscaphe Trieste

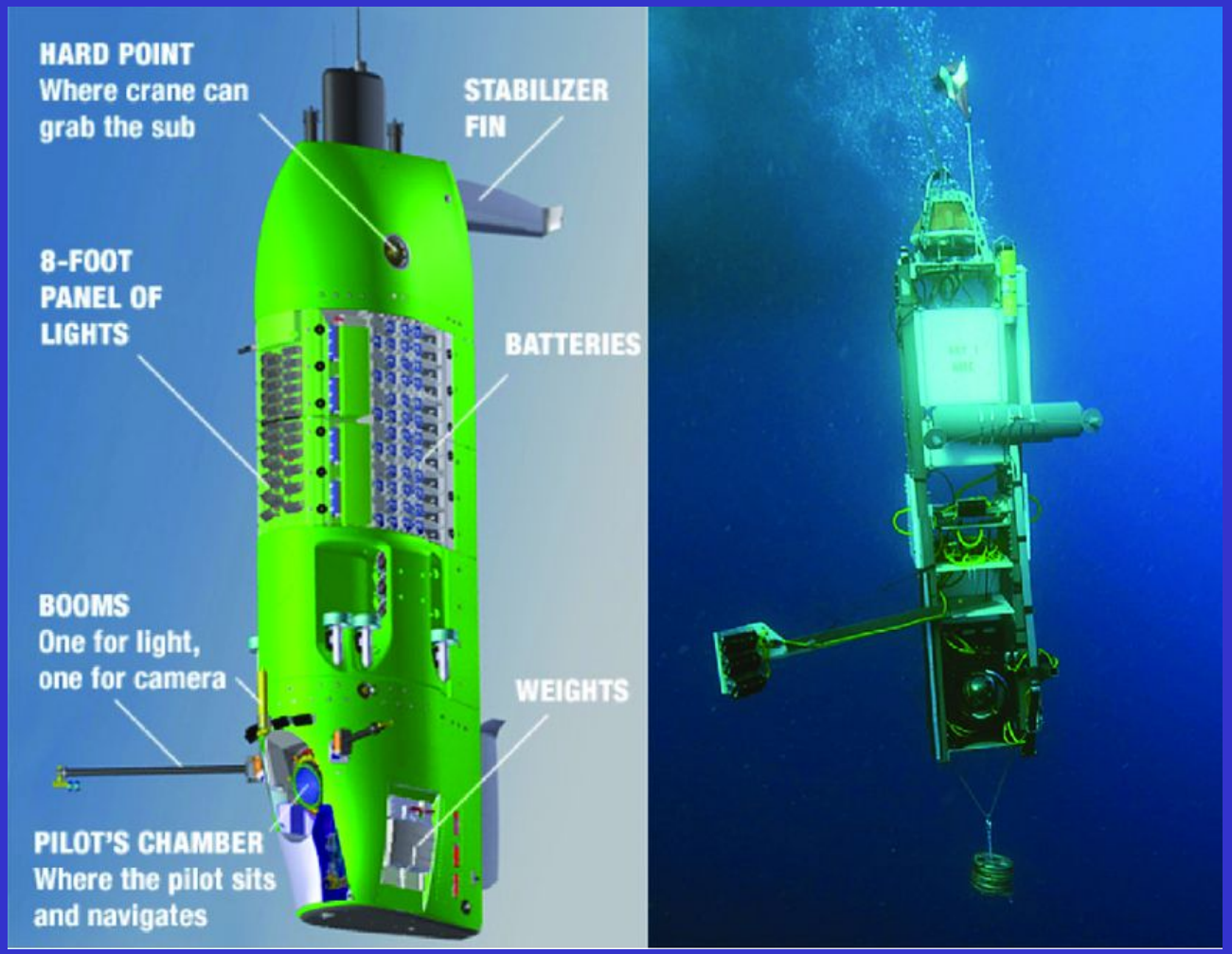




Trieste in 1958, Jacques Piccard and Don Walsh, USN

Deepsea Challenger

Second submersible to reach Challenger Deep, March 26, 2012



Funded and piloted by James Cameron.

Engineering Strategies for Deep Submersion

- Spherical pressure housings.
- Acrylic pressure spheres: better visibility but less depth rating. Stainless and titanium for greater depth.
- PBOF: Pressure balanced oil filled assemblies: cables, junction boxes, motors.
- Syntactic foam flotation - safer than glass spheres.
- Extensive and recurring testing and certification.
- Fail safe “return to surface” designs for vehicles.

Engineering Strategies for Underwater Housings

- Usually cylindrical.
- Depending on design depth: plastic, stainless, titanium.
- O-ring seals. Usually single but sometimes double.
- Underwater connectors.

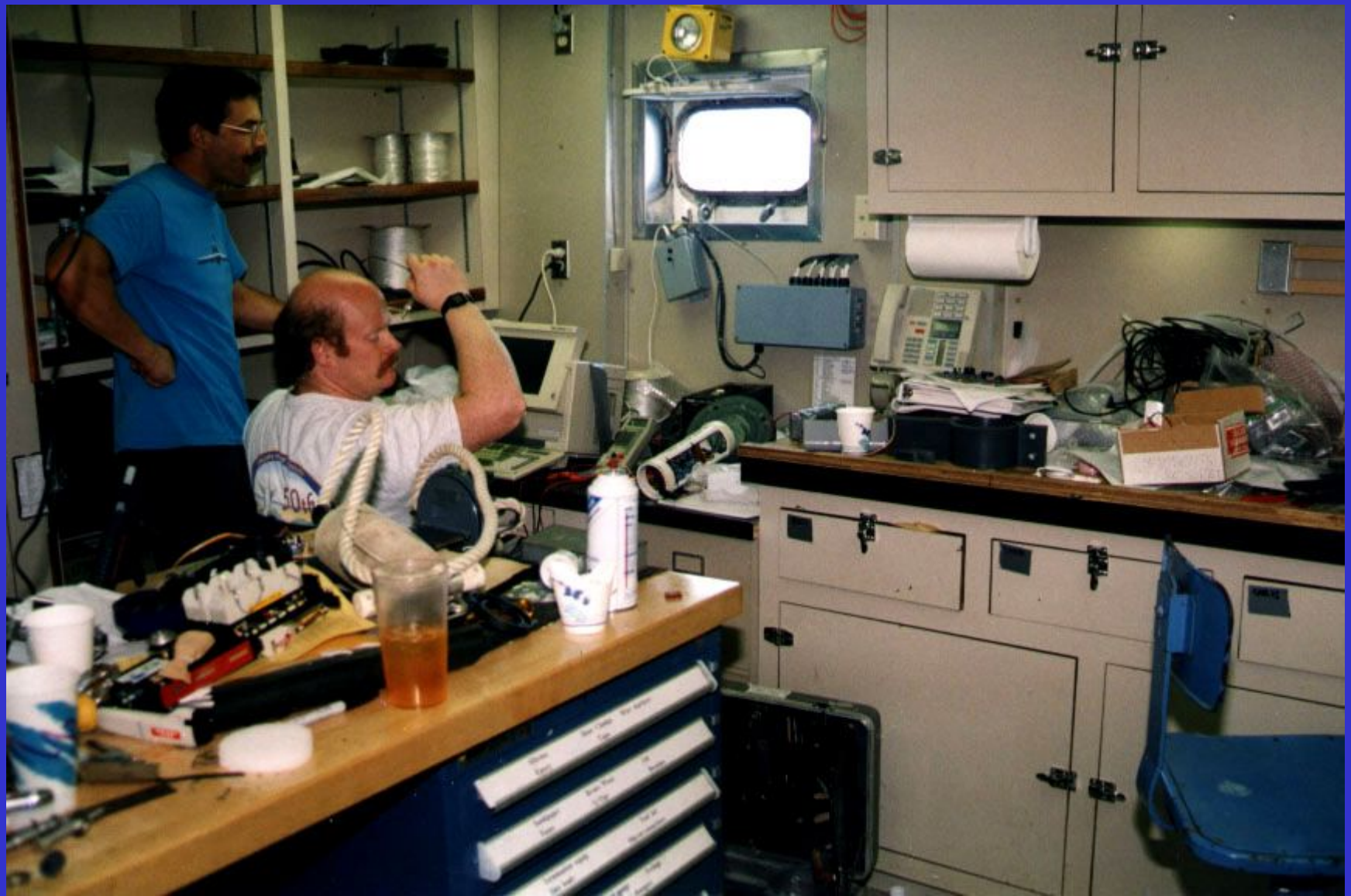
Preparing a MOCNESS multiple plankton net array

Scientist working with winch operator to “fly” the MOCNESS at desired depth

Preparing to deploy GPS drifter - note the mesh sock deep drogue.

“Hey Bob,
I said put it
over the side
***GENTLY!*”**

My workshop at sea - after 24 hours it's just as messy as my workshop on land



Engineering Strategies to Minimize Corrosion

- Seawater is 0.5% to 3.8% salt.
- Paint.
- Select noncorrosive and less corrosive materials - plastic, copper, bronze, stainless, titanium.
- Crevice and pitting corrosion.
- Beware of sintered parts.
- Galvanic corrosion: anodes and active cathodic protection.

Communication and Telemetry at Sea

Voice

- Inmarsat voice and data.
- Iridium.

Data - bytes to kilobytes.

- Argos 2
- Iridium SBD - Garmin InReach

Data - megabytes to gigabytes.

- 4G and 5G cellular - works to a few miles offshore.
- Various satellite data systems.
- StarLink

Sea Creatures Number One...

50:00

Sea Creatures Number Two...

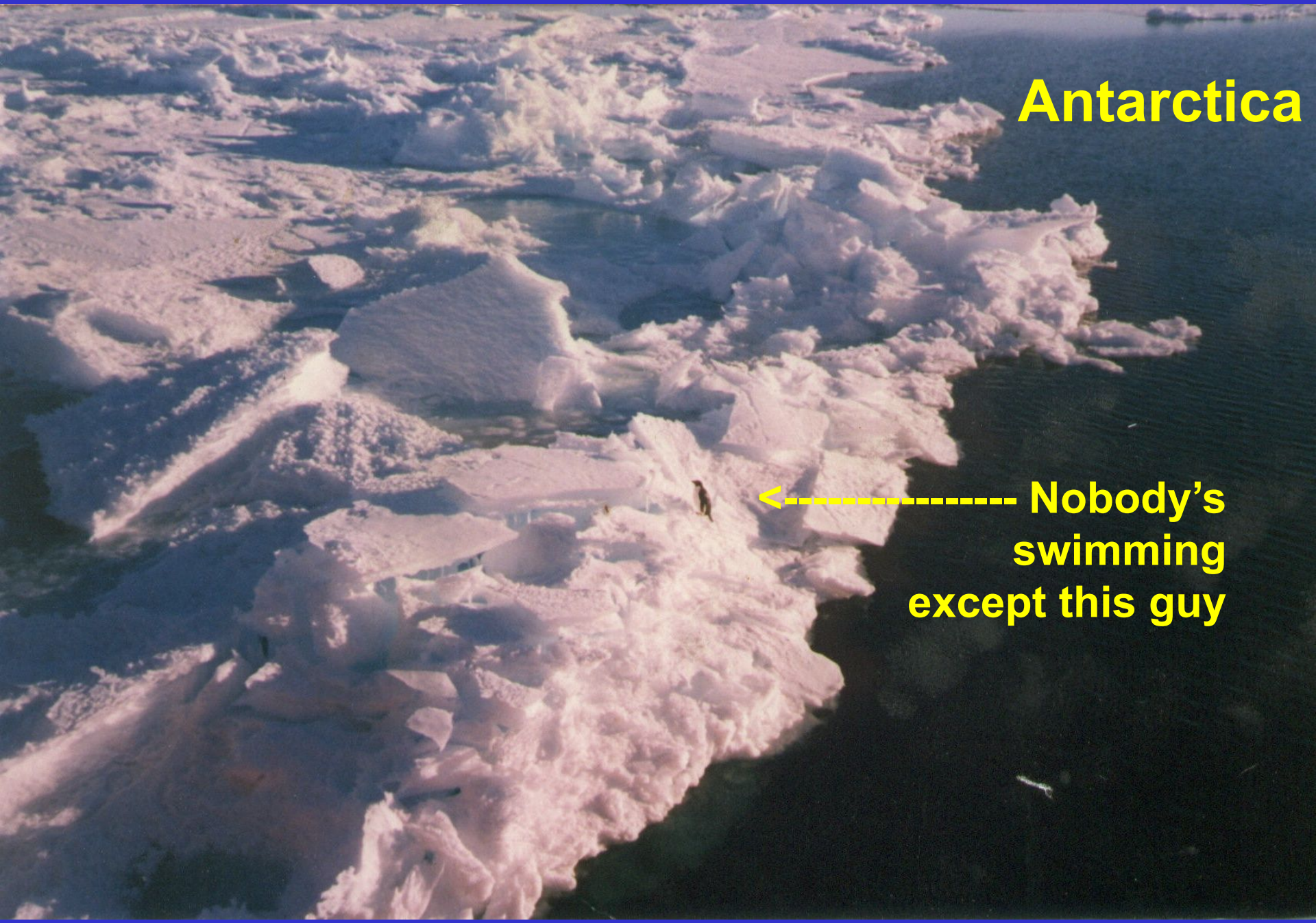
Sea Creatures Number Three

(or, Why you really, really want to be the Cook's friend)


ONE DOLLAR

If you visit Barbados, don't skip the flying fish…

… but exercise caution with the condiments.


Antarctica
<---------- Nobody's swimming except this guy

Another mooring deployment

- one year under the ice.


Anchor made of old railroad wheels. Note spray painted "1400" (pounds).


Sometimes the weather is
delightful (if a bit cold)...

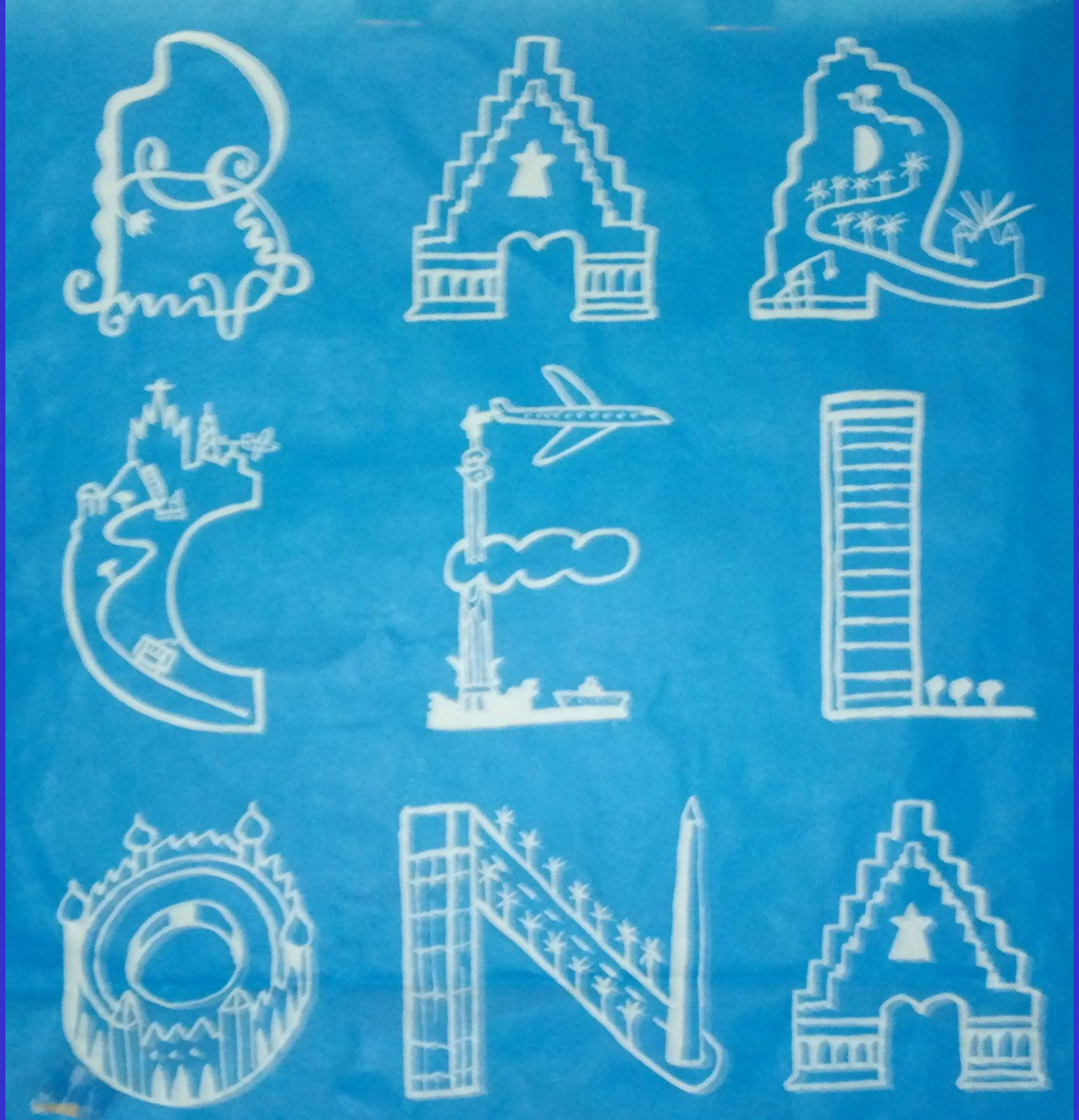

Sometimes it is not.


This is not the time you want to run out of Dramamine.

Some Engineering Challenges of Arctic Temperatures

- NB: polystyrene packing peanuts are banned from Antarctica by international treaty.
- PVC becomes brittle below 0C, substitute ABS.
- Alkaline batteries perform poorly below 0 C.
- Primary lithium batteries perform to -40C but be aware of supply chain and shipping issues.

Cruise 3:



60:00


B/O GARCIA DEL CID
EHUU
IMO 7523362
C.S.I.C
GARCIA DEL CID
© Alberto.H.A. 2010

Interesting neighbors…

El Said

337 feet long

New *Al Said*

508 feet long

Former vessel renamed *Loaloat Al Behar*, charters for 250K Euro per week.

International Travel Logistics

- Checked bags are usually much easier to get through Customs and shipped items. Don't forget stuff, you'll regret it.
- Fill our a temporary export declaration and have it signed/stamped by US Customs. Good to show when entering another country and when returning to USA.
- Wooden crates can be a problem.
- Shipping air restricted items in advance: the "Boom Box."
- Be prepared to explain yourself to Security and to turn stuff on.

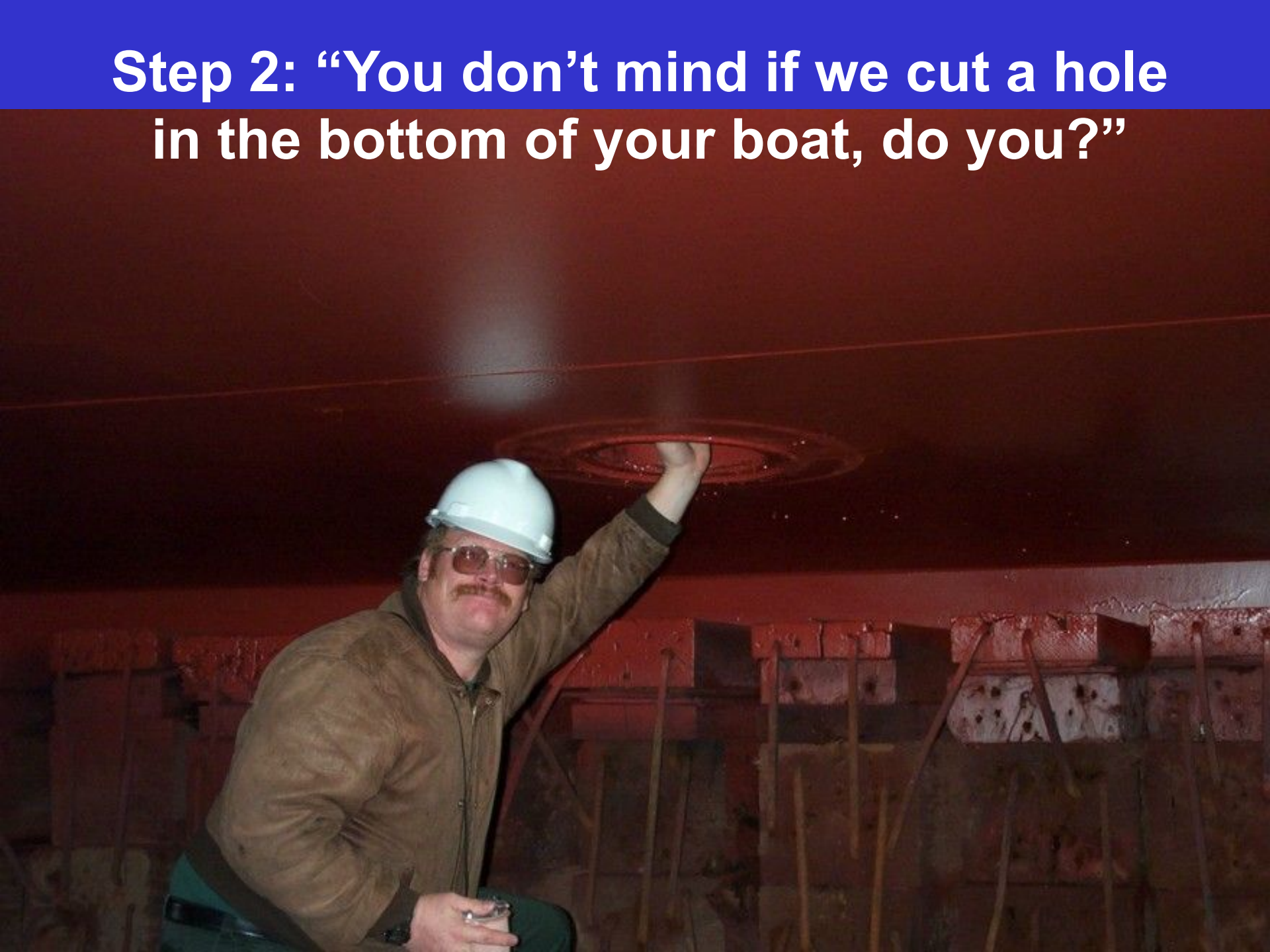
Cruise 4.1: Long Island Sound

Or “How to turn a perfectly good passenger ferry into a research vessel”

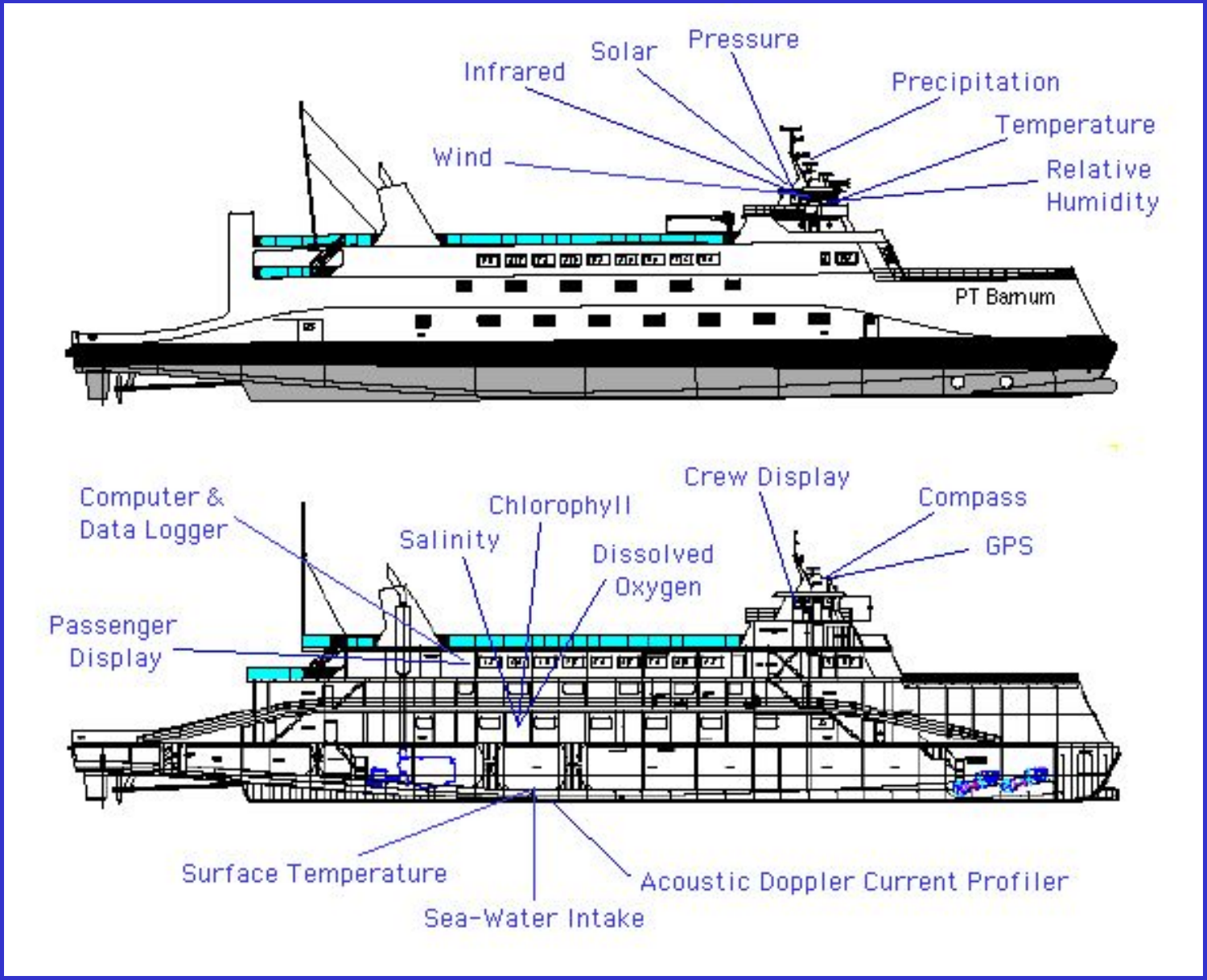
Step 1: Wait until the boat is in drydock

“I feel like an ant under a tennis shoe…”

Step 2: “You don’t mind if we cut a hole in the bottom of your boat, do you?”

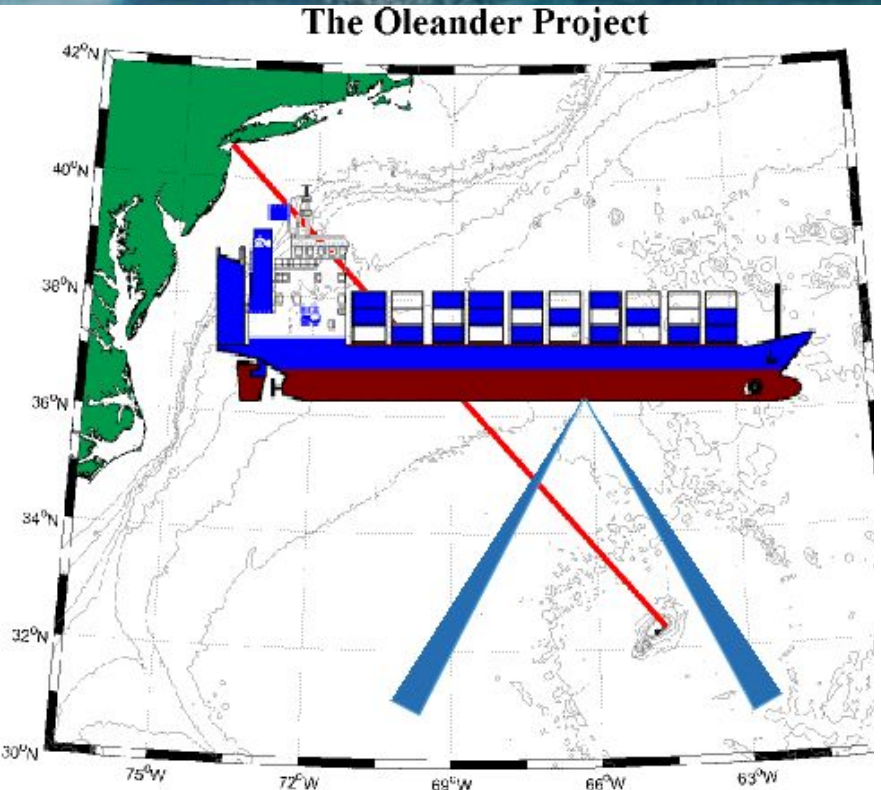


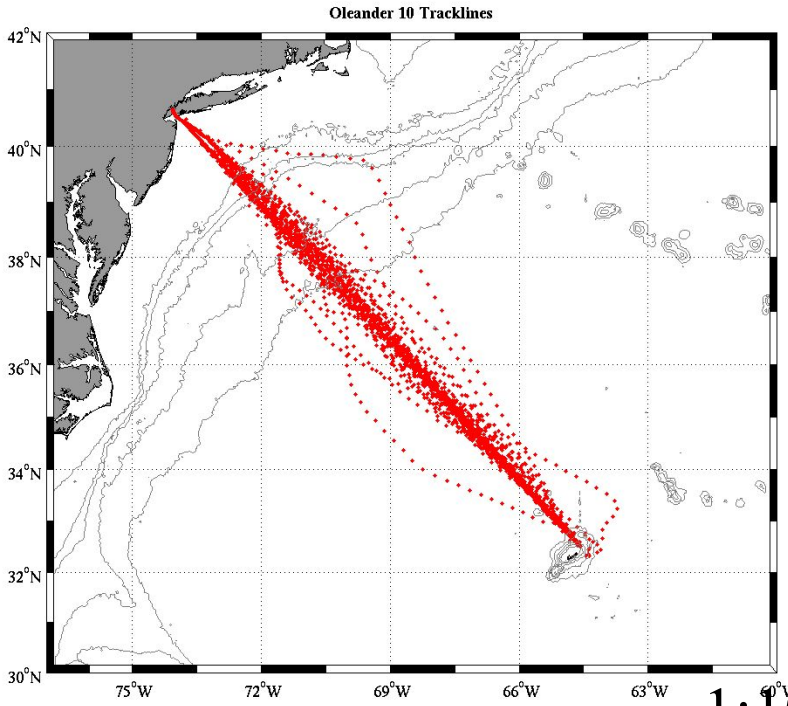
Fifteen instruments measure 30 parameters



Emerging from the low rent district

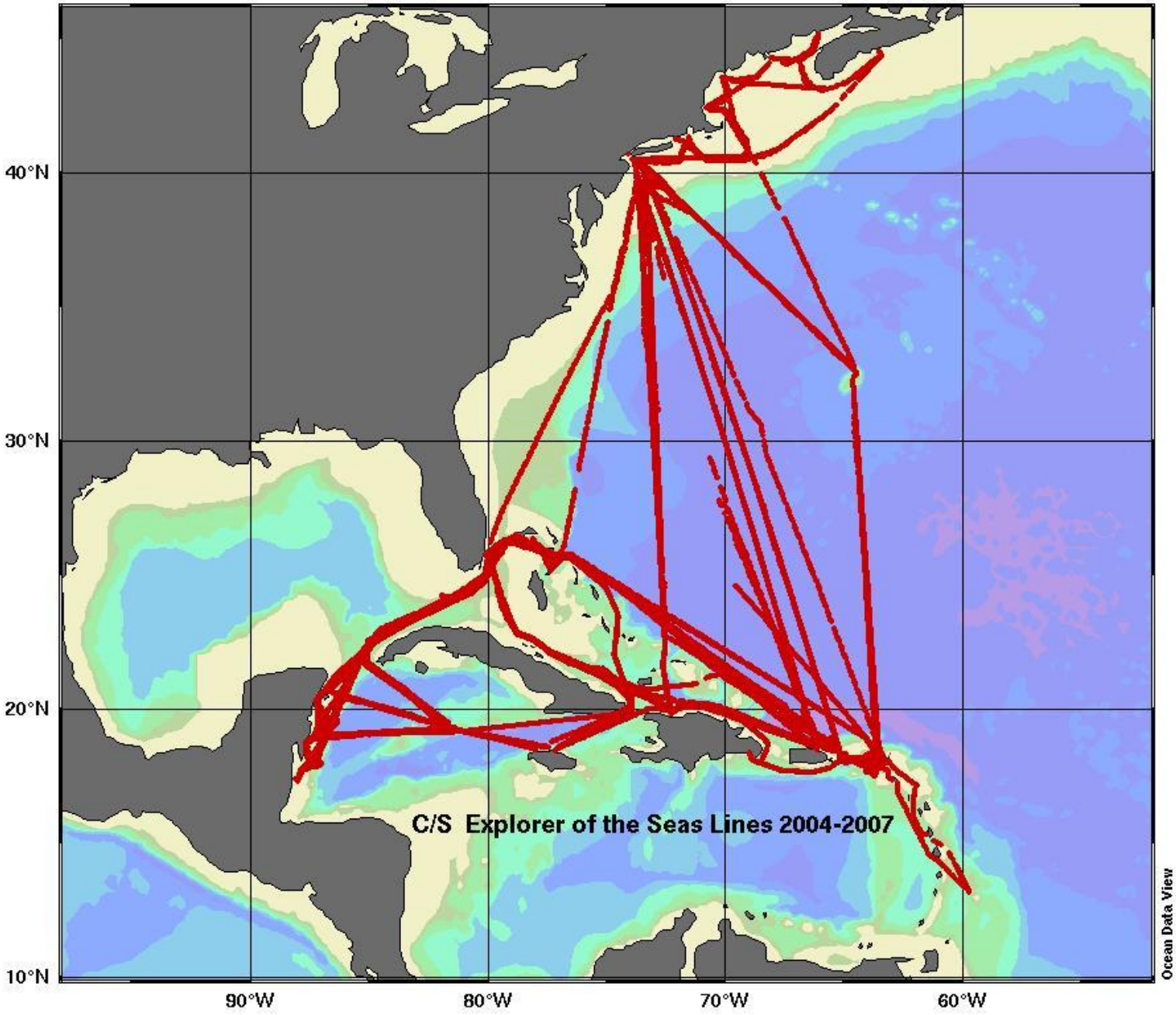
Cruise 4.1: Vessel of Opportunity – M/V *Oleander*





1:10:00

Cruise 4.2: MS *Explorer of the Seas*


40°N
30°N
20°N
10°N
90°W
80°W
70°W
60°W
C/S Explorer of the Seas Lines 2004-2007
Ocean Data View

Multi-Filter Rotating Shadowband Radiometer

All Sky Imager

Optical Precipitation Sensor

Ceilometer

Radian Wind Profiler

Weather Balloon and Radiosonde

On Roof of Atmospheric Lab (click for photo)

WeatherPak 2000 & Particle Samplers

Acoustic Doppler Current Profiler

Marine & Atmospheric Emitted Radiance Interferometer

Ocean Lab Instrumentation

Bow Thruster Space - Seawater Intake

Decorator's special effects were more impressive (and more costly) than the real scientific instruments.

Sailing in and out of Florida
- the lightning capital of the world

Working Aboard Ships of Opportunity

Safety and construction standards and inspections are much more rigorous for passenger and commercial ships than for research vessels.

- Watertight/fireproof transits between compartments.
- Cabling has to meet fire safety standards.
- No plastic below the waterline.
- Marine architects.
- Inspection by government authorities (USCG in USA).


JFK - Amsterdam
7.5 hours
Amsterdam - Entebbe
8 hours
Cruise 5: Africa!
A
B
C
Labrador Sea
North Sea
Ireland
United Kingdom
Danmark
Denmark
Беларусь
Belarus
Polska
Poland
Deutschland
Germany
Україна
Ukraine
Österreich
Austria
France
Bay of Biscay
România
Romania
España
Spain
Portugal
Ελλάς
Greece
Türkiye
Turkey
Mediterranean Sea
Syria
Tunisia
Morocco
Algeria
Libya
مصر
Egypt
Western Sahara
Mauritania
Mali
Niger
Chad
Sudan
Burkina Faso
Guinea
Ghana
Nigeria
Ethiopia
Gulf of Guinea
Gabon
DR Congo
Kenya
Tanzania
Angola
Zambia
Mozambique
North Atlantic Ocean
Cuba
PR
Caribbean Sea
Venezuela
Guyana
Suriname
Colombia
Ecuador
Perú
Brasil
Brazil
Bolivia
NL
QC
Gulf of St Lawrence
NB
ME
NS
NH
MA
CT
RI
PA
NJ
DE
MD
VA
NC
SC
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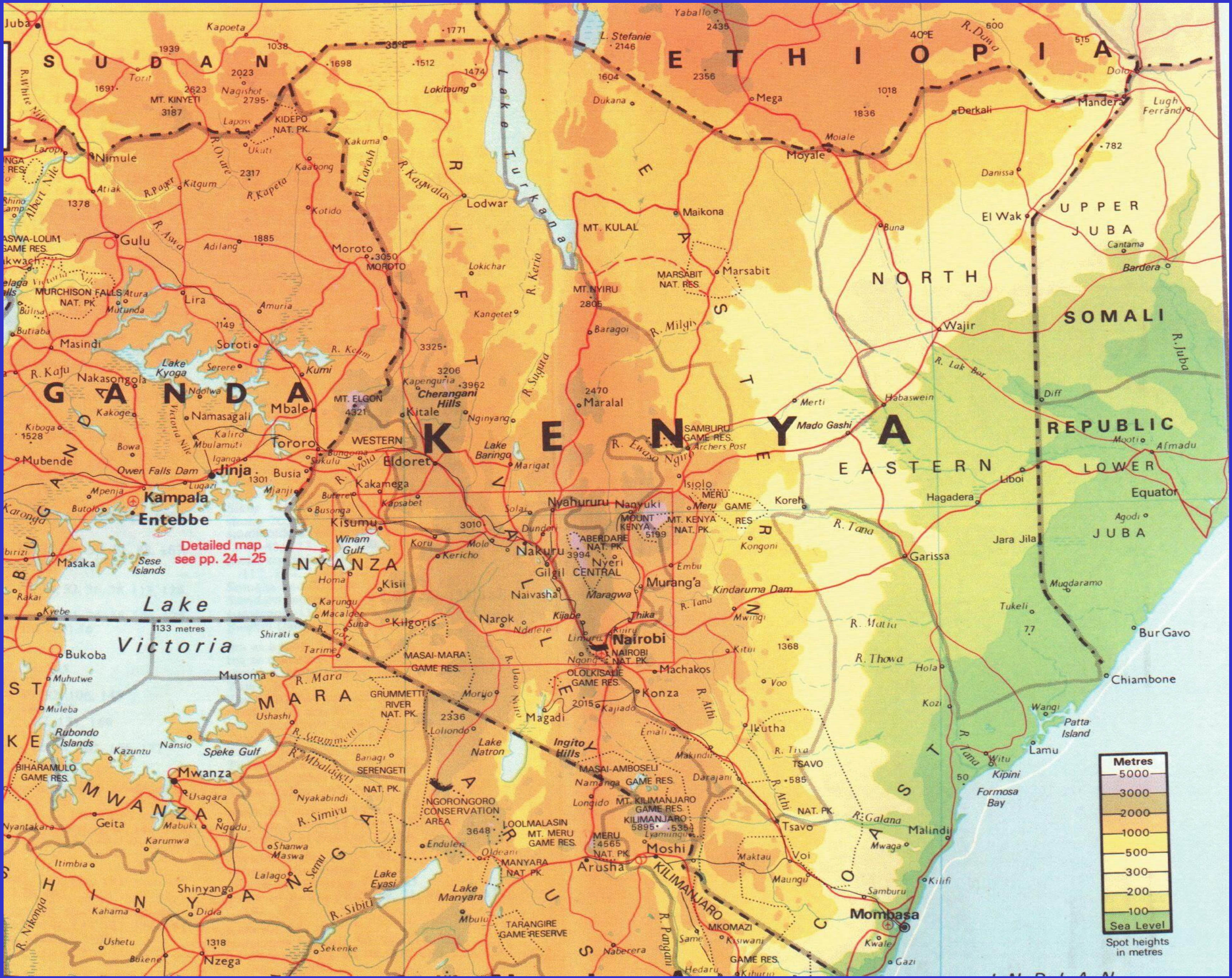


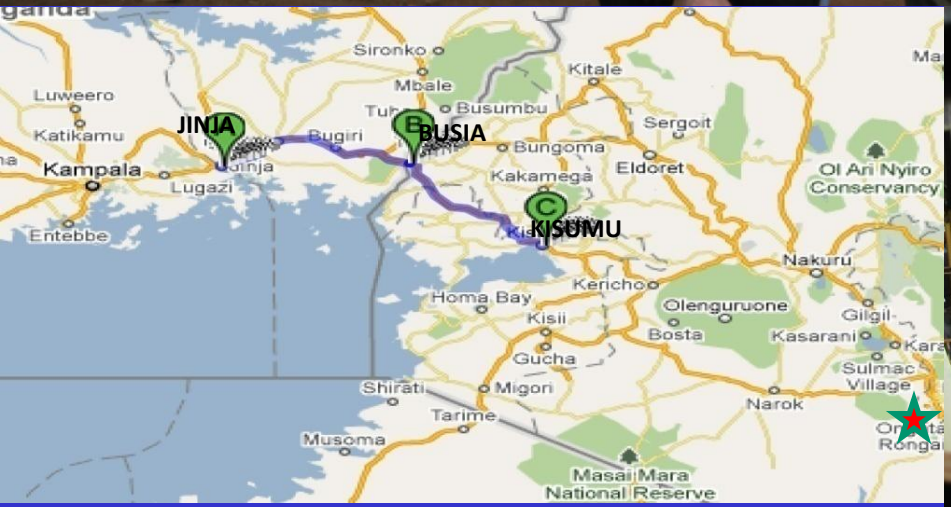
SUDAN
ETHIOPIA
KENYA
UGANDA
SOMALI REPUBLIC
Juba
Kapoeta
Torit
MT. KINYETI 3187
Nagishot
KIDEPO NAT. PK.
Nimule
Laropi
Kitgum
Gulu
Lira
Moroto
Soroti
Kumi
Mbale
Tororo
Jinja
Kampala
Entebbe
Masaka
Masindi
Lake Kyoga
Lake Victoria
Sese Islands
Bukoba
Musoma
Mwanza
Speke Gulf
Shinyanga
Nzega
Geita
L. Stefanie
Yaballo
Mega
Moyale
Dolo
Mandera
Lugh Ferrandi
Lokitaung
Lake Turkana
Lodwar
Kakuma
MT. KULAL
Maikona
Marsabit
MARSABIT NAT. RES.
MT. NYIRU
Baragoi
Maralal
Kitale
MT. ELGON 4321
Cherangani Hills
Eldoret
Kakamega
Kisumu
Winam Gulf
Kisii
Kericho
Nakuru
Lake Baringo
Nyahururu
Nanyuki
MOUNT KENYA 5199
ABERDARE NAT. PK.
Nyeri
CENTRAL
Murang'a
Naivasha
Narok
Nairobi
NAIROBI NAT. PK.
Machakos
Konza
Magadi
Kitui
Kilgoris
MASAI-MARA GAME RES.
Isiolo
Meru
Wajir
El Wak
Mado Gashi
Garissa
Hagadera
Habaswein
Merti
NORTH EASTERN
RIFT VALLEY
WESTERN
NYANZA
EASTERN
COAST
MARA
MWANZA
ARUSHA
SERENGETI NAT. PK.
NGORONGORO CONSERVATION AREA
Lake Natron
Lake Eyasi
Lake Manyara
Arusha
Moshi
KILIMANJARO 5895
Tsavo
Voi
Malindi
Kilifi
Mombasa
Lamu
Patta Island
Kipini
Formosa Bay
Kiunga
Chiambone
Bur Gavo
Kismayu
Jara Jila
Afmadu
UPPER JUBA
LOWER JUBA
R. Tana
R. Galana
R. Athi
R. Juba
R. Nile
Detailed map see pp. 24—25
Metres
5000
3000
2000
1000
500
300
200
100
Sea Level
Spot heights in metres


BANK OF UGANDA
200
SHILLINGS
2008

R/Vs *Ibis and Hammerkop*


YOU ARE NOW ENTERING
KENYA
ALL VISITORS REPORT AT THE
IMMIGRATION OFFICE
KARIBU KENYA
COOL PALACE
WE HAVE:
Accomodation.
01/16/2011


DAVITA


JINJA
BUSIA
KISUMU
Kampala
Entebbe
Lugazi
Jinja
Bugiri
Busumbu
Mbale
Sironko
Kitale
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Katikamu
Bungoma
Kakamega
Eldoret
Sergoit
Ol Ari Nyiro
Conservancy
Nakuru
Kericho
Homa Bay
Kisii
Olenguruone
Bosta
Gilgil
Kasarani
Gucha
Sulmac
Village
Shirati
Migori
Narok
Tarime
Musoma
Masai Mara
National Reserve


NO SMOKING
RIDING IN THE
CUSTOMS YARD
01/16/2011


LIONS CLUB OF
EQUATOR
EQUATOR

GPS reading places marker at 0.033 minutes = 200 feet south of geographic equator.

Altitude 5,086 feet above sea level

January 13, 2016. Arriving at Entebbe Airport with 12 bags, 11.5 of which are crammed with tools and instruments. Excess baggage charge was more than my airfare. We had to hire two minivan taxis to get to the hotel.

M/V *Serengeti*

Cargo and passenger Ferry Mwanza to Bukoba Tanzania

Weather, telemetry, and water quality sensor installation.

M/V *Serengeti*

loading cargo
Bukoba
Tanzania

Pop Quiz!

Question 1: What's the most dangerous animal in Africa?

Answer: *Anopheles* mosquito.

(394,000 malaria deaths in Africa in 2005)

OK, question 2: What's the most dangerous *non-human vertebrate* animal in Africa?

(Hint: kills more humans annually than big cats, poisonous snakes, and crocodiles combined)


Hippopotamus (Kiboko in Swahili)
Murchison National Park, Uganda
PAKWACH
PAKAA LODGE
starcasm.net


starcasm.net


starcasm.net

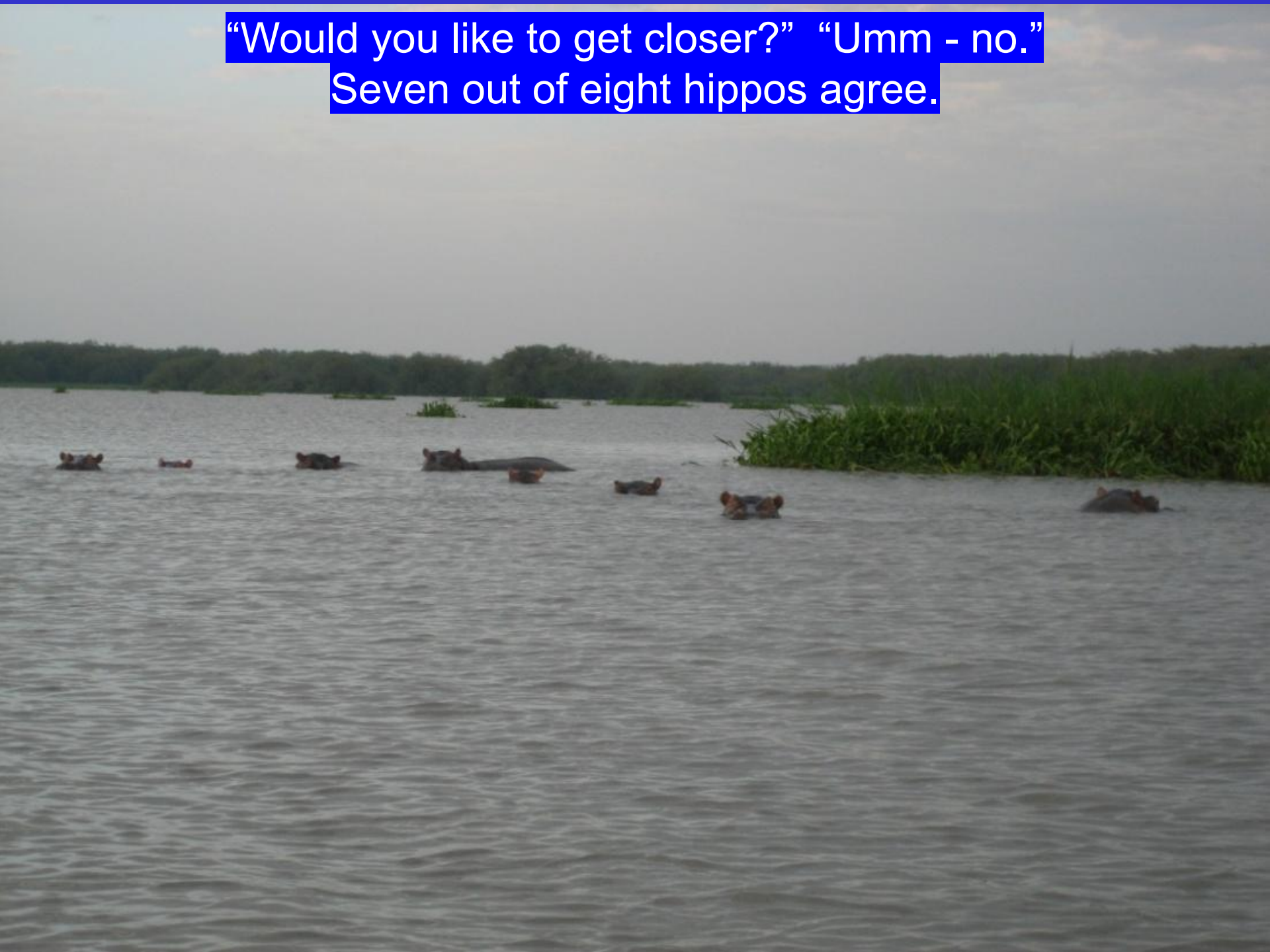

PARAA LODGE
AHEAD
starcasm.net

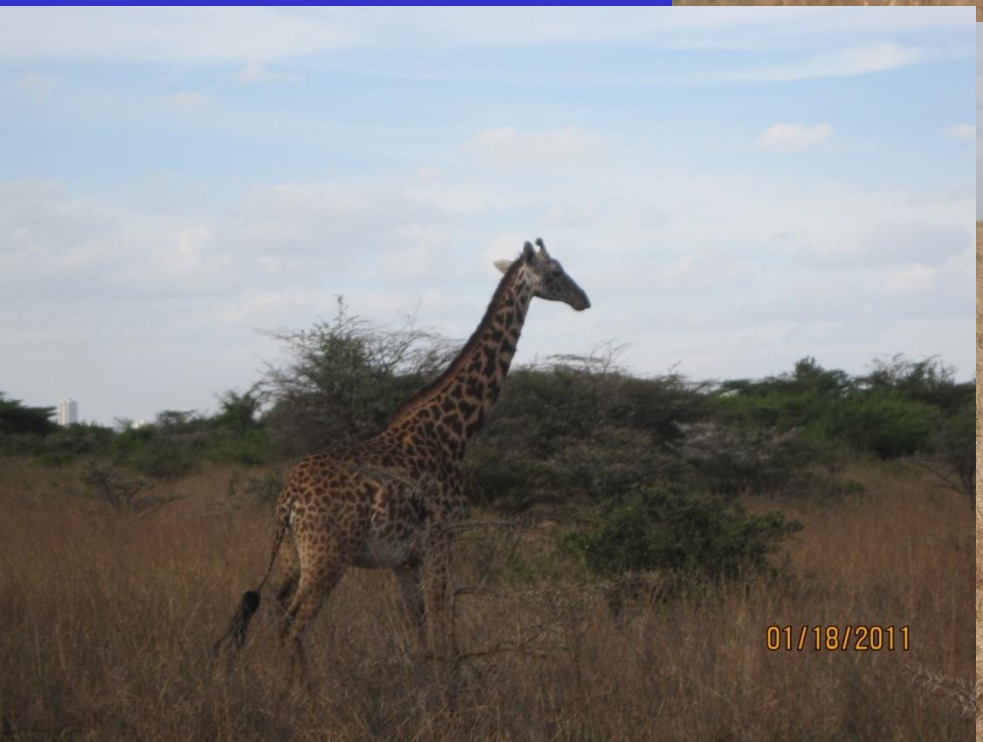
Kiboko Bay Lodge, Kisumu, Kenya

"Would you like to see a hippo?"


Mama Dorcas Ebenezer uses land breeze / lake breeze for the daily trip to the fishing grounds.
MAMA DORCUS
EBENEZER.
DUNGA BEACH
KSM3126


Showboating:
A universal
teenage trait.


“Would you like to get closer?” “Umm - no.”
Seven out of eight hippos agree.



Nairobi Game Park

Evely the heavily
armed wildlife protection officer

“Warthogs and children
have right of way”

Mount Kilimanjaro

Engineering in Remote Areas

- Battery Powered Tools
- International voltage, frequency, and connectors.
- Shipping takes forever
- Some things are better than USA - some are impossible. (Welding, isopropyl alcohol, electrical adapters)

A scoping trip is ALWAYS 1000% worth it.

Health and Safety

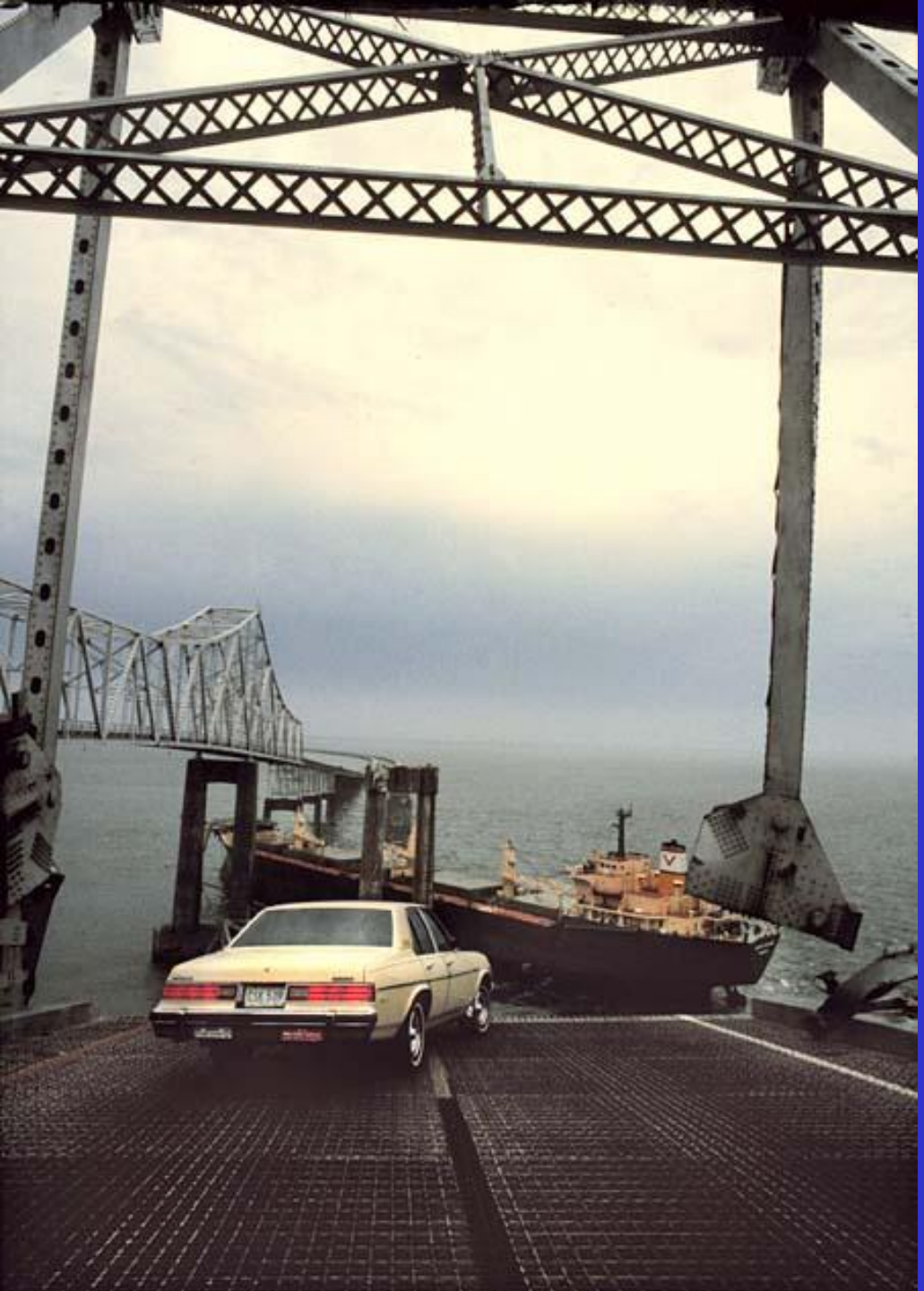
- Immunizations, extra glasses.
- Medications - keep in your carry on. Bring your prescription bottles, check for legality of your meds.
- International medical and evacuation insurance.

Cruise Number Six:
"Hey, it's not even a research vessel!"

Tampa Bay

9:00

Sunshine Skyway Bridge 1954



M/V Summit Venture
accident
7:30am May 9, 1980

Vessel lightly loaded
blown off course
in a storm

Pilot John Lerro
cleared by USCG
investigation
and Florida
Grand Jury

Main pier survived strike unprotected secondary pier collapsed

1300 feet of southbound span collapsed
35 fatalities

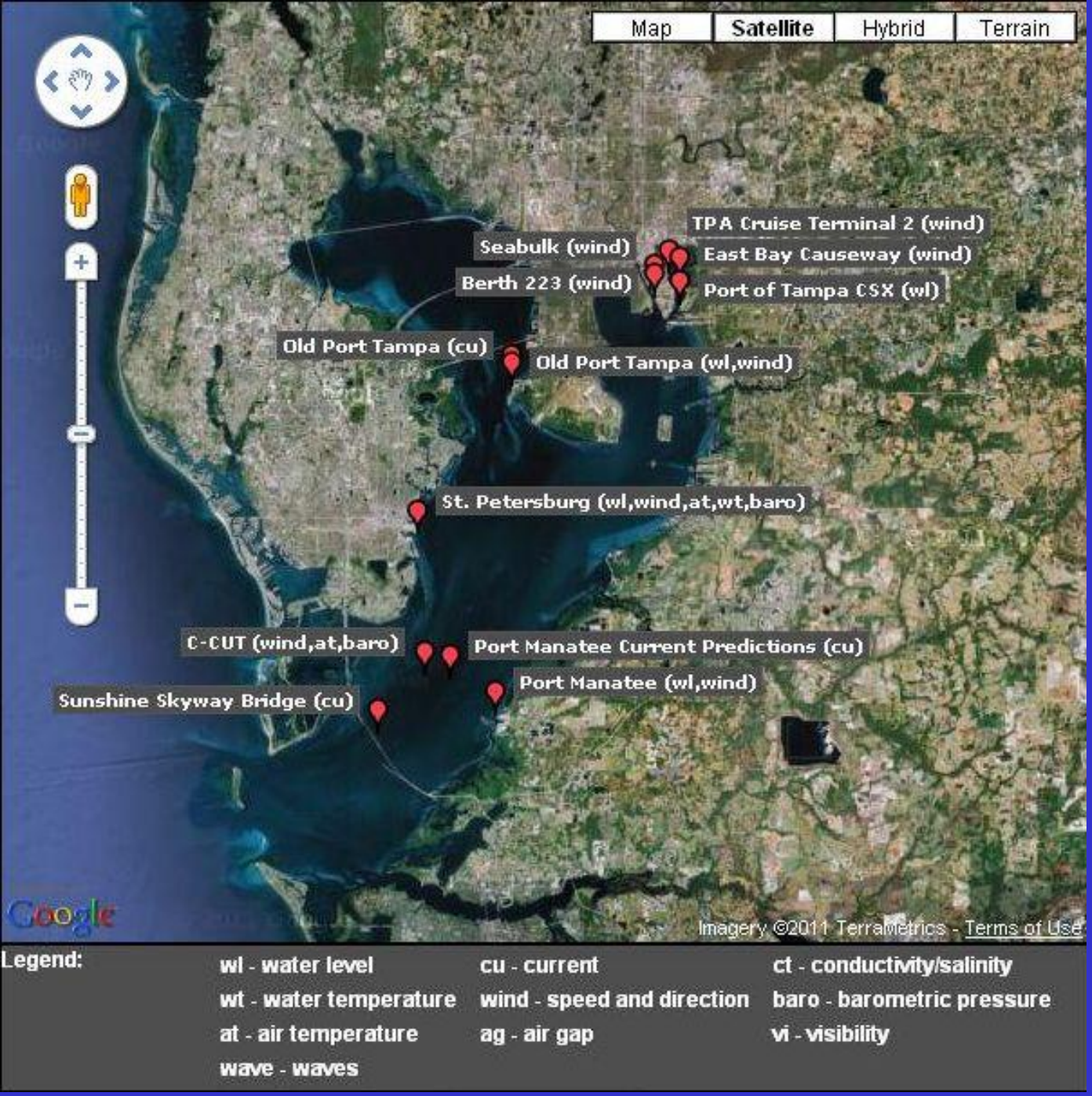
Wesley MacIntire was the sole survivor of those who fell from the bridge when his pickup landed on the deck of the Summit Venture.

1:40:00

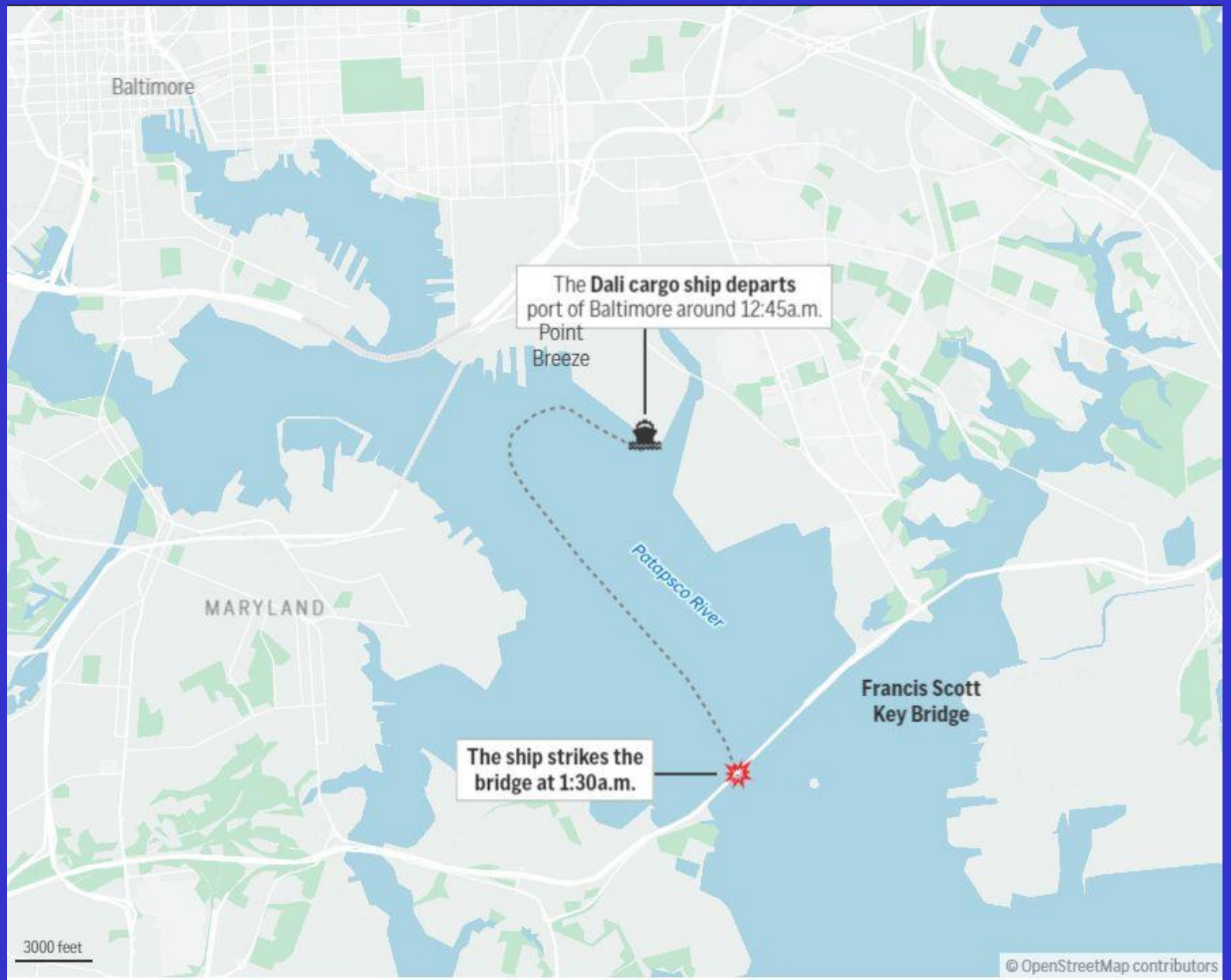
New Sunshine Skyway Bridge – 1987

Note protective dolphins

Tampa Bay Physical Oceanographic Real Time System (PORTS)



M/V Dali accident, March 26,2024



Safety Systems

A ship leaving or entering port
is much like an aircraft on takeoff or landing.

- Large ships:
  - Use harbor pilots.
  - May engage one or more tugs to provide redundancy.

- Redundant systems, R/V Seawolf:
  - Three GPS navigation units,
  - Three computers running electronic charting software,
  - Paper charts,
  - Two VHF radios plus handhelds
  - Two radars
  - Main and backup generator plus battery backup, any of which will run the bridge electronics.

Ship Engines

R/V Seawolf idles engine for at least 30 minutes before departing the dock. Large yachts can have dual fuel systems.

Long Island Real Time Systems

lishore.org/index.php

Welcome to LIShore

Sea, inlet, and bay conditions for Long Island, New York, USA.

QUICKLY ACCESS REAL TIME DATA by clicking on a map location above or choosing from the list or dropdown below.

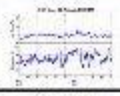
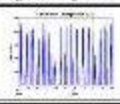
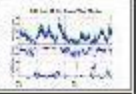
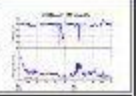
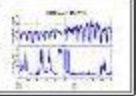
Bay Park	East Rockaway Inlet	SBU Health Sciences Center
Inwood	Jones Inlet/Point Lookout	Freeport
Mecox Bay	Merrick	Lindenhurst
Rockaway Inlet	Seaford	Oceanside
Smith Point	Southampton	Shinnecock Inlet
SBU Lot 40 (South P)	Kings Park *new*	Stony Brook Harbor

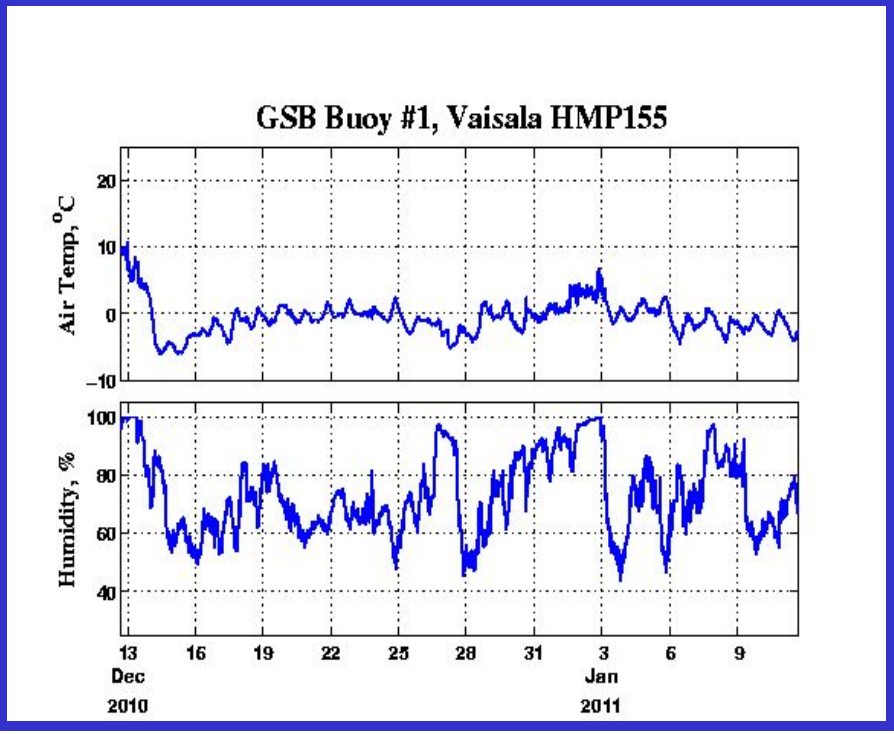
Choose an observatory location

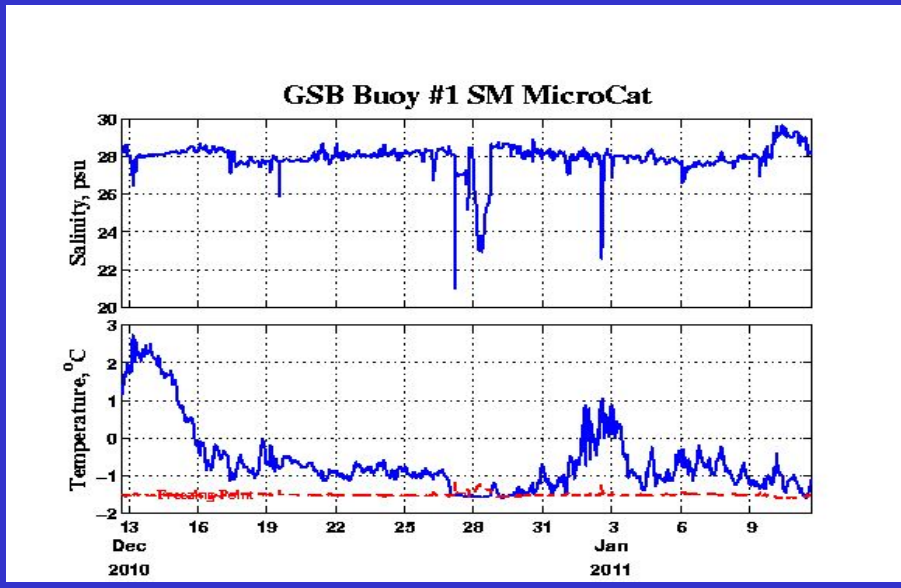
The Great South Bay Project

Buoy #1 - Real Time Data

40° 41.562' N Latitude, 73° 05.205' W Longitude

Date:	01-13-2011	
Time:	06:30:00 GMT	
Air Temperature:	-3.30 °C (26.06 °F)	
Humidity:	63 %	
PAR:	3.4 µEinsteins/m²sec	
Wind Speed:	14.52 knots	
Wind Direction:	from the NNW (342 °)	
Wind Gust:	19.13 knots	
Water Temperature:	-1.58 °C (29.16 °F)	
Salinity:	26.003 PSU	
Chlorophyll:	24.41 µgrams/liter	
Turbidity:	5.81 NTU	





Tide Gauge at Bay Park


GSB


GSB
631 632-3184


DISCOVERY HALL
GSB
SBU MARINE


GSB
SBU MARINE

1:50:00


GS GSB

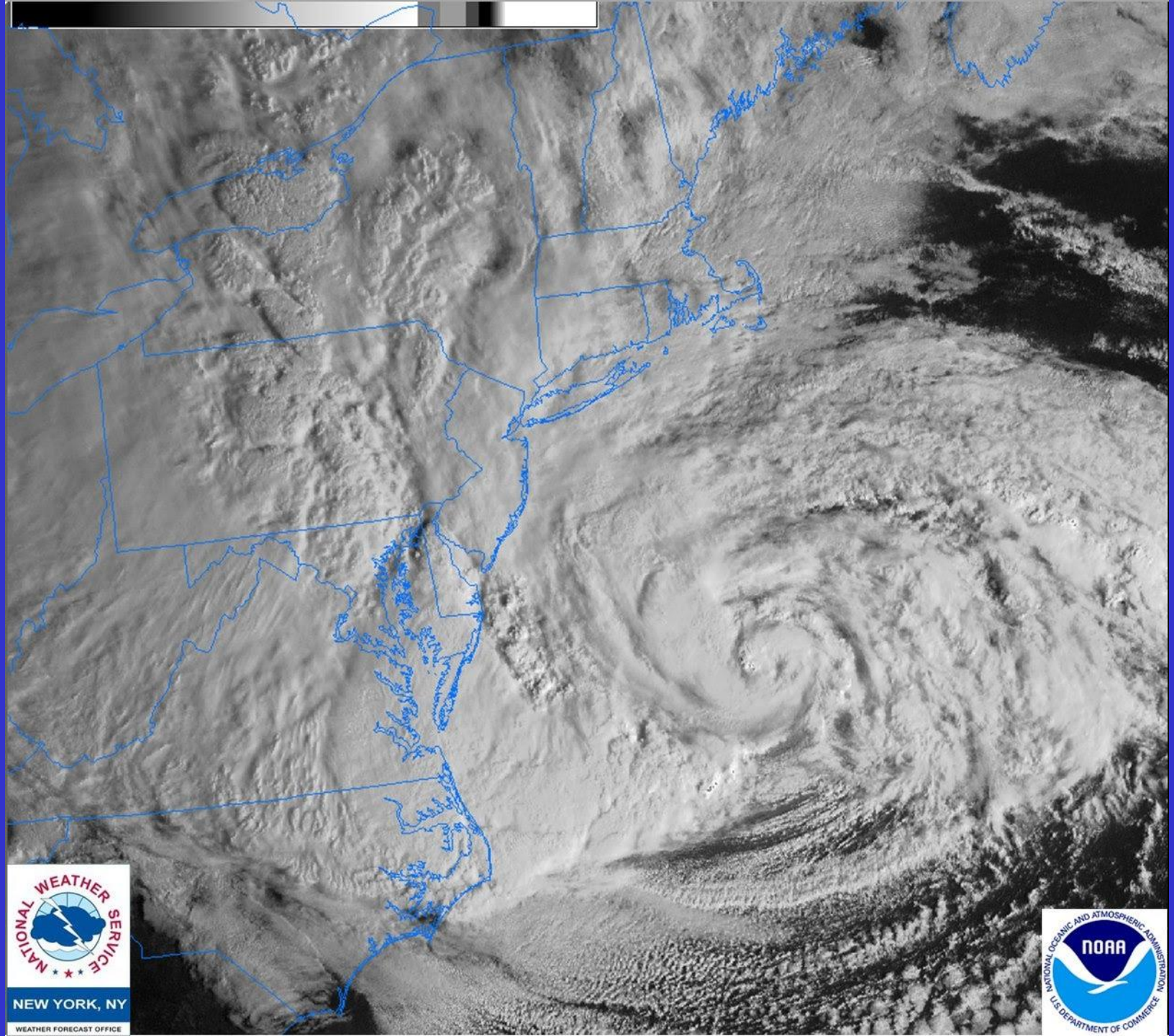

DATA BUOY
SoMAS
631-632-3184


GSB

Biofouling

and How to Combat It

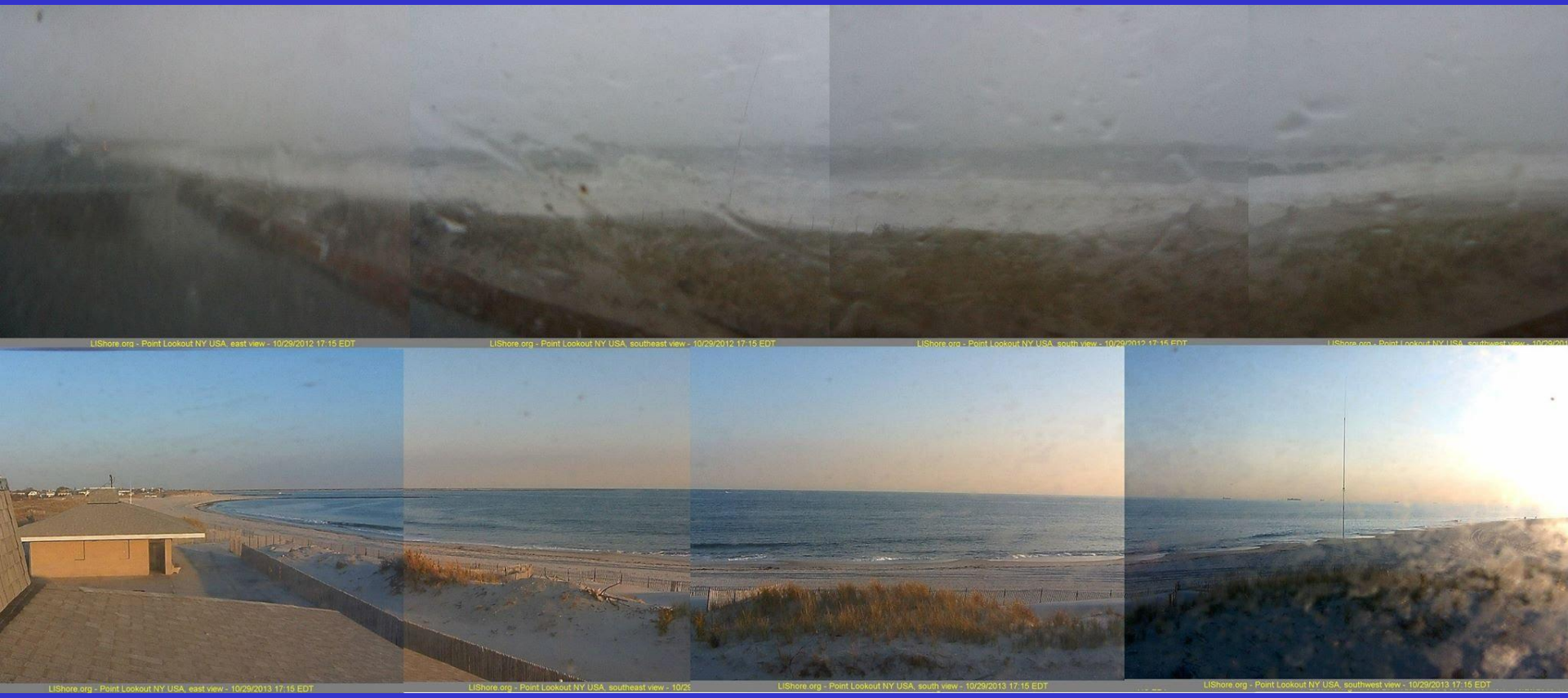
- Copper components
- Antifouling paints.
- Wrap in vinyl electrical bundling tape before painting.
- Active biocides - bleach.
- Power washing.
- When all else fails: “Scrape baby scrape!”


NATIONAL WEATHER SERVICE
NEW YORK, NY
WEATHER FORECAST OFFICE
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE


UE WATER YACHT CLUB


EZ Port

What a Difference a Year Makes



Point Lookout NY

Top: 5:15pm EDT, 10/29/2012

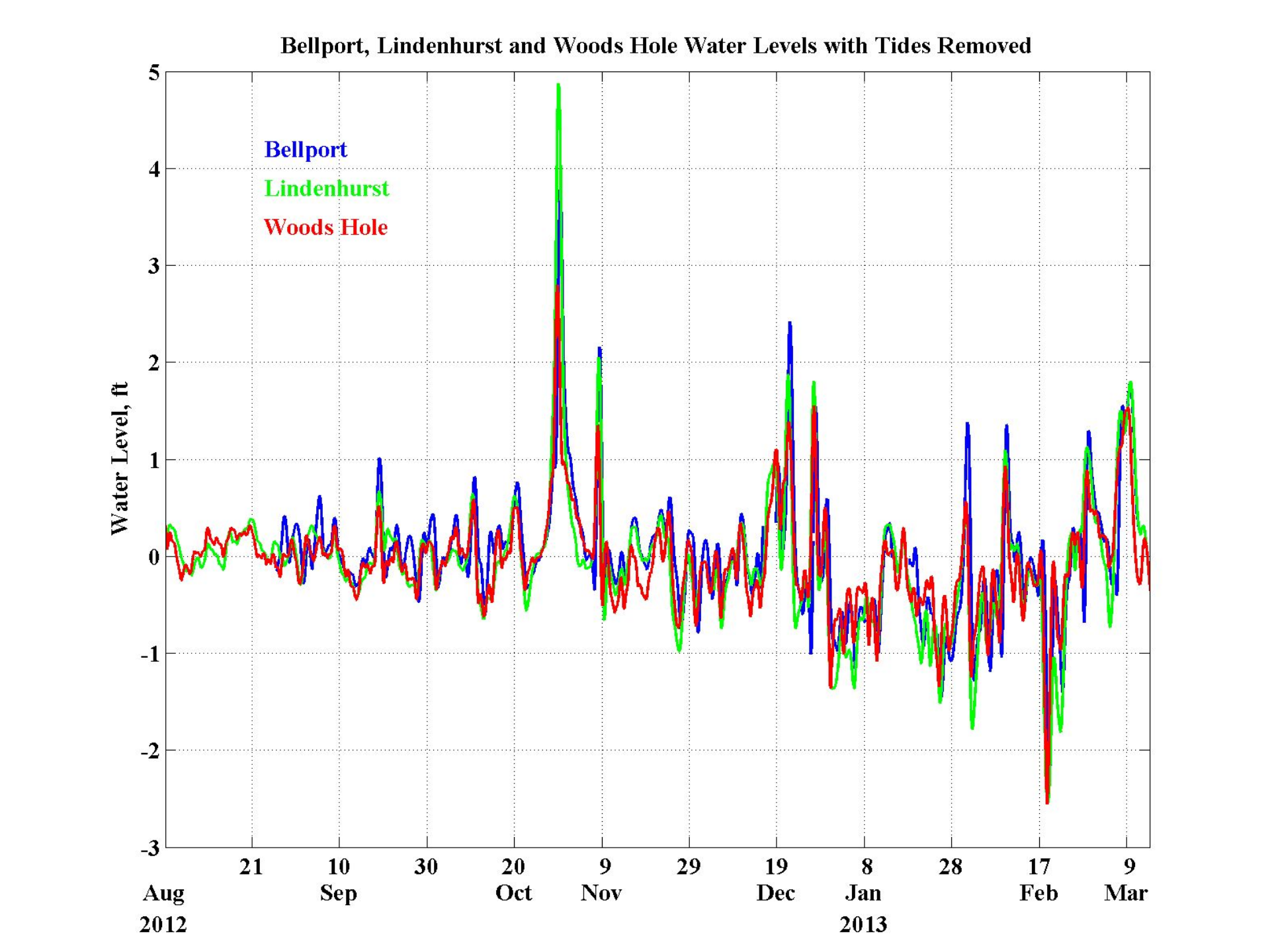
Bottom: 5:15pm EDT, 10/29/2013

Science based policy has made a difference

- 1960s: Silent Spring. The Cuyahoga River catches fire a dozen times.
- 1970s: The first Earth Day. Environmentalists were called tree huggers, Love Canal.
- 1980s: The garbage barge. Dumping of sewage sludge in the NY Bight Apex.


“The Breach / Old Inlet / New Inlet”
South of Bellport NY
Opened by Superstorm Sandy
October 29, 2012

2:00:00


Bellport, Lindenhurst and Woods Hole Water Levels with Tides Removed
Bellport
Lindenhurst
Woods Hole
Water Level, ft
5
4
3
2
1
0
-1
-2
-3
Aug
2012
21
Sep
10
30
Oct
20
Nov
9
29
Dec
19
Jan
8
2013
28
Feb
17
Mar
9

Saved >$15 million by not artificially closing New Inlet


CONN.
Long Island Sound
N.J.
SUFFOLK COUNTY
Sayville
Bellport
NASSAU COUNTY
NYC
Fire Island
Atlantic Ocean
Location of breach
20 miles

Water quality improvements in eastern GSB were Sandy's silver lining

Endangered Atlantic Sturgeon

in 1978, catching even small sturgeon
in survey trawls was unusual.

Now we run Sturgeon Cruises
that fit captured fish
with acoustic tracking tags.

This sturgeon netted
by R/V Seawolf
off Sandy Hook NJ
10/16/2016

Length
2.6 meters
(8 ft 6 in)

Weight
216 kg
(476 lb)

Humpback whales feeding on menhaden (bunker)
off Rockaway Penninsula, Queens NY.
Empire State Building in the background.

ACKNOWLEDGEMENTS

To teachers, mentors, students, and colleagues including

Henry Harrison, David Lucyk, Bob Slavonik,






Trevor Young Greg Smith Alex Sneddon Chris Crosby Miles Litzmann Lucas Merlo

All of whom ignored the sage advice…

"Mama, don't let your babies grow up to be oceanographers…"

Questions?

Thomas C. Wilson, Jr. ● twilson@brightwaters.com

Radar Meteorology Truck