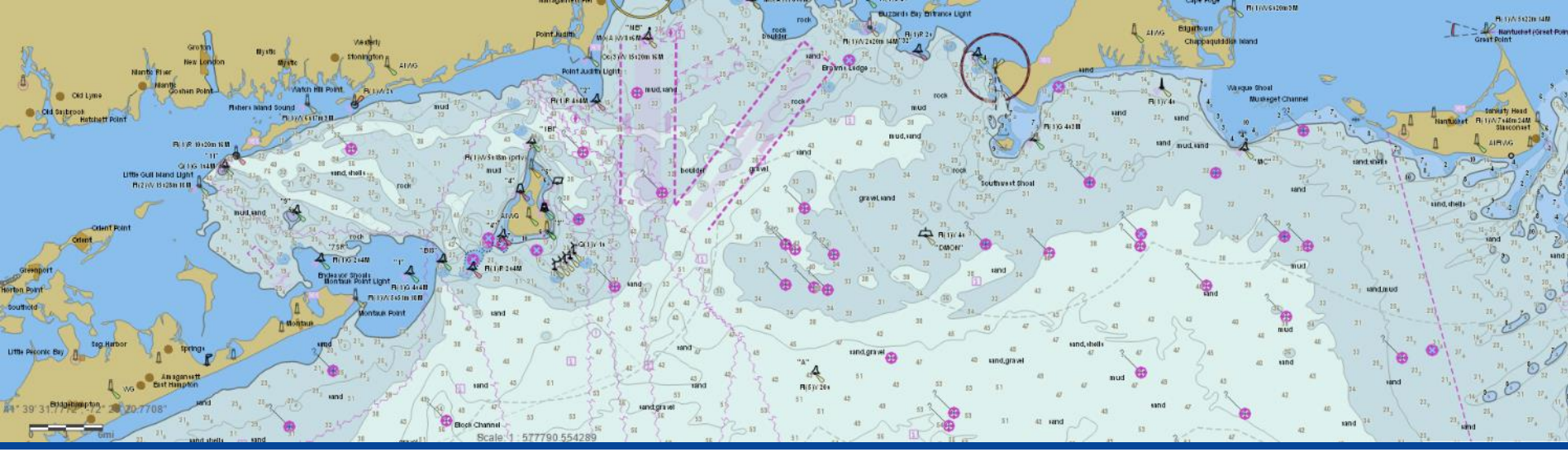


Leveraging Autonomy

NOAA Office of Coast Survey's Autonomous Systems Strategy

U.S. Hydrography

NOAA's Office of Coast Survey

National Geospatial-Intelligence Agency

U.S. Navy

U.S. Coast Guard

Who We Are

More than Two Centuries of Service

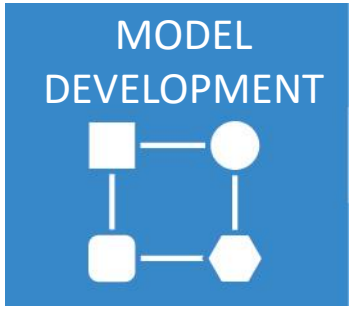
- First U.S. gov't science agency
- President Thomas Jefferson created the U.S. Coast Survey in 1807
- Over two centuries later, Coast Survey–now an office within NOAA in the DOC– continues to provide the navigation products and services that ensure safe and efficient maritime commerce.

U.S. Department of Commerce → National Oceanic and Atmospheric Administration → National Ocean Service → **Office of Coast Survey**

What we do

Products

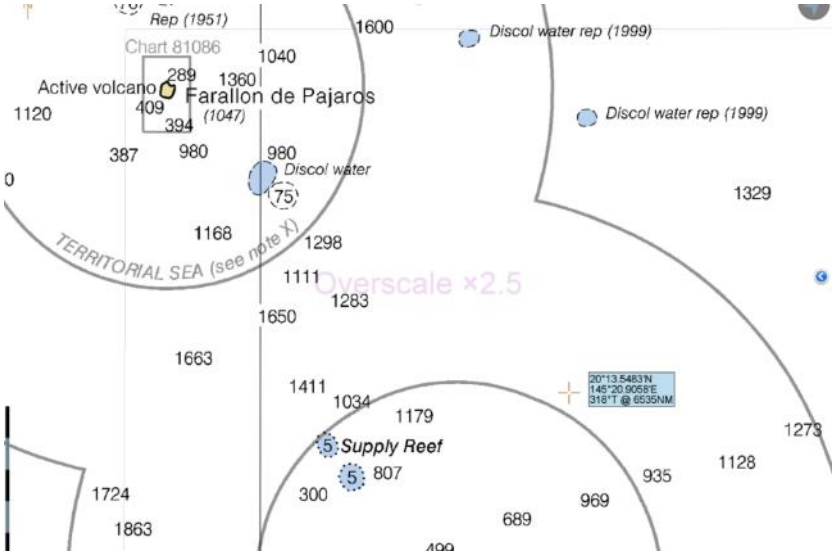
Services

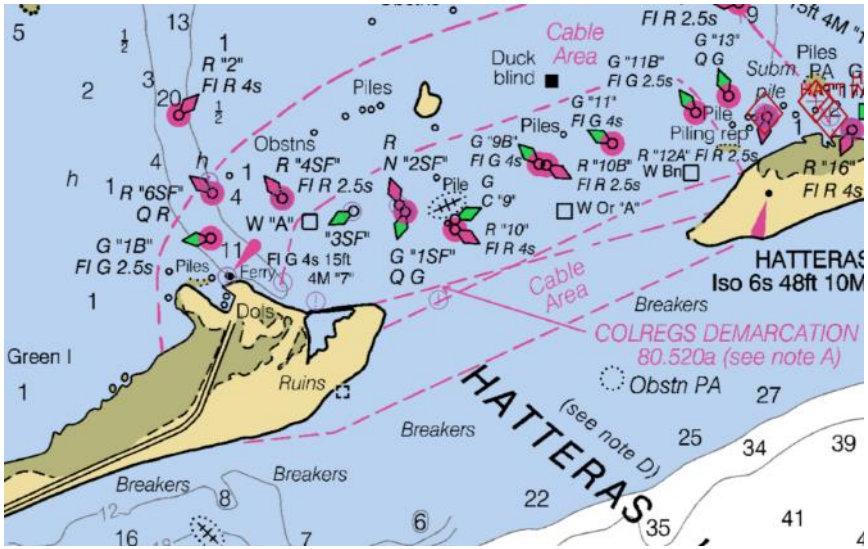


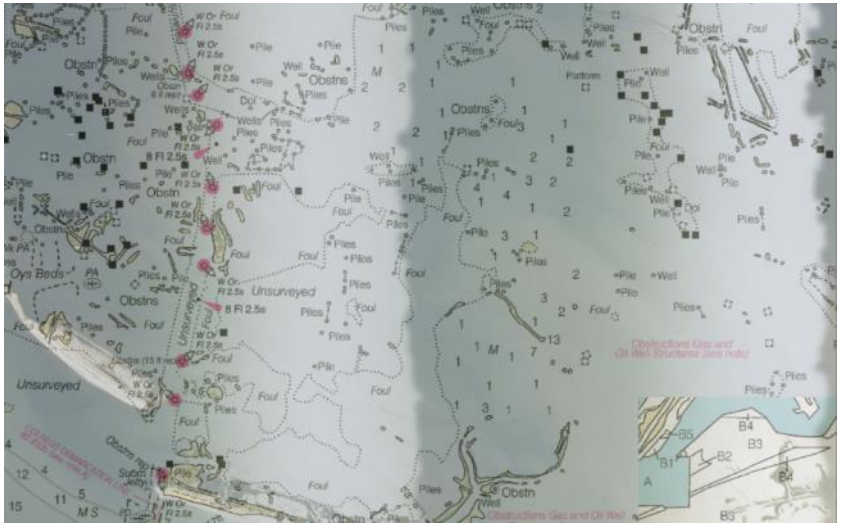
Coast Survey Focus Areas

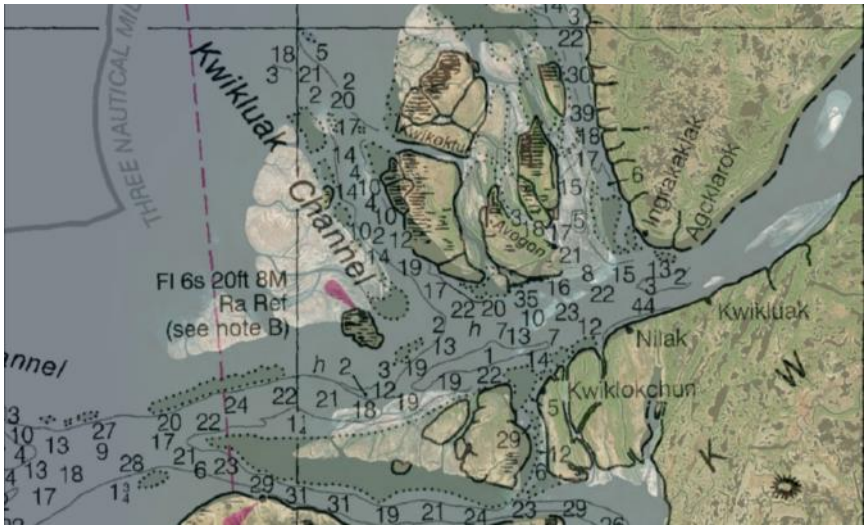
- Critical underkeel clearance areas in ports, approaches, corridors, and passes
- Reported or observed chart discrepancies
- Systematic, interdisciplinary seafloor mapping

Charted Discrepancies

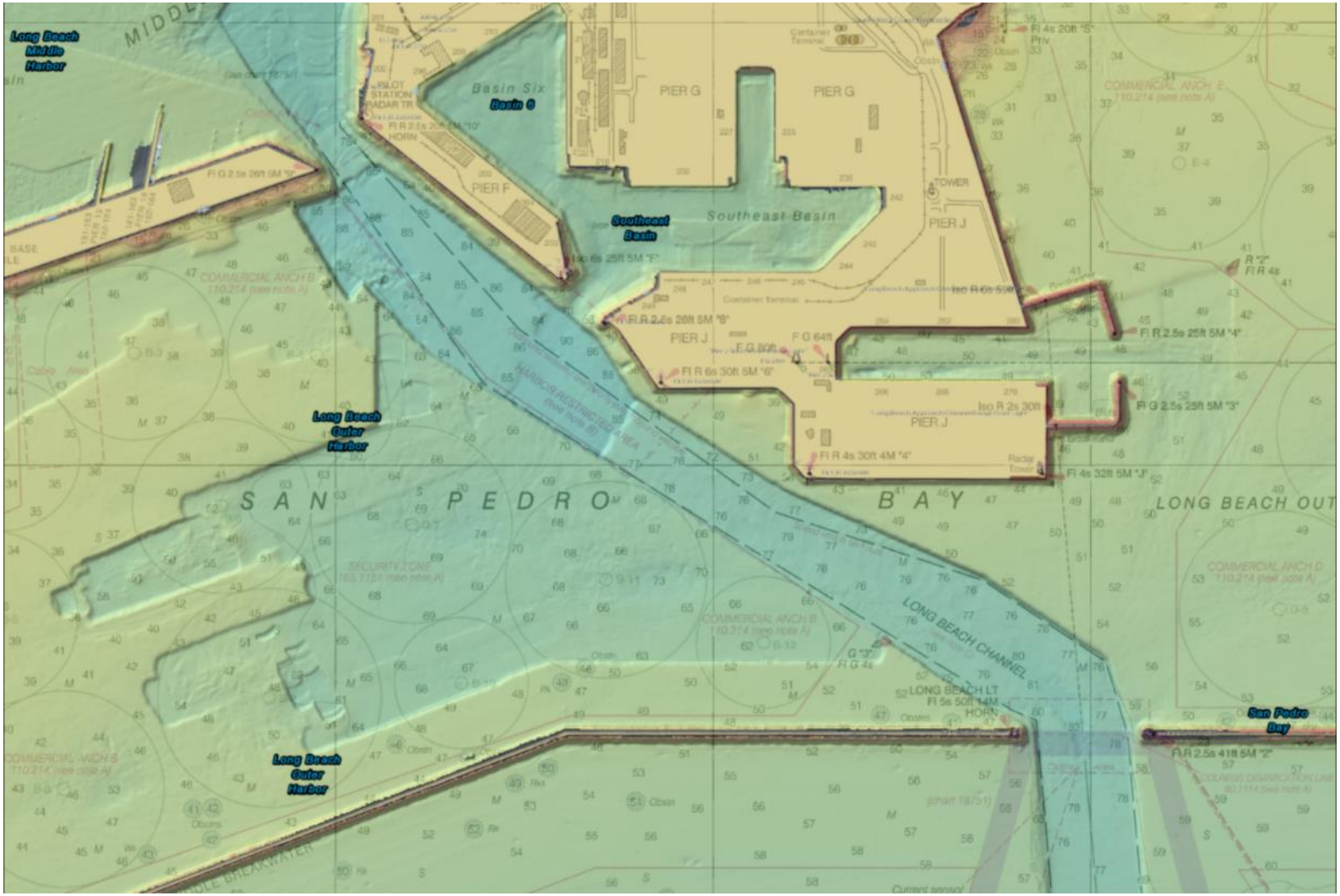




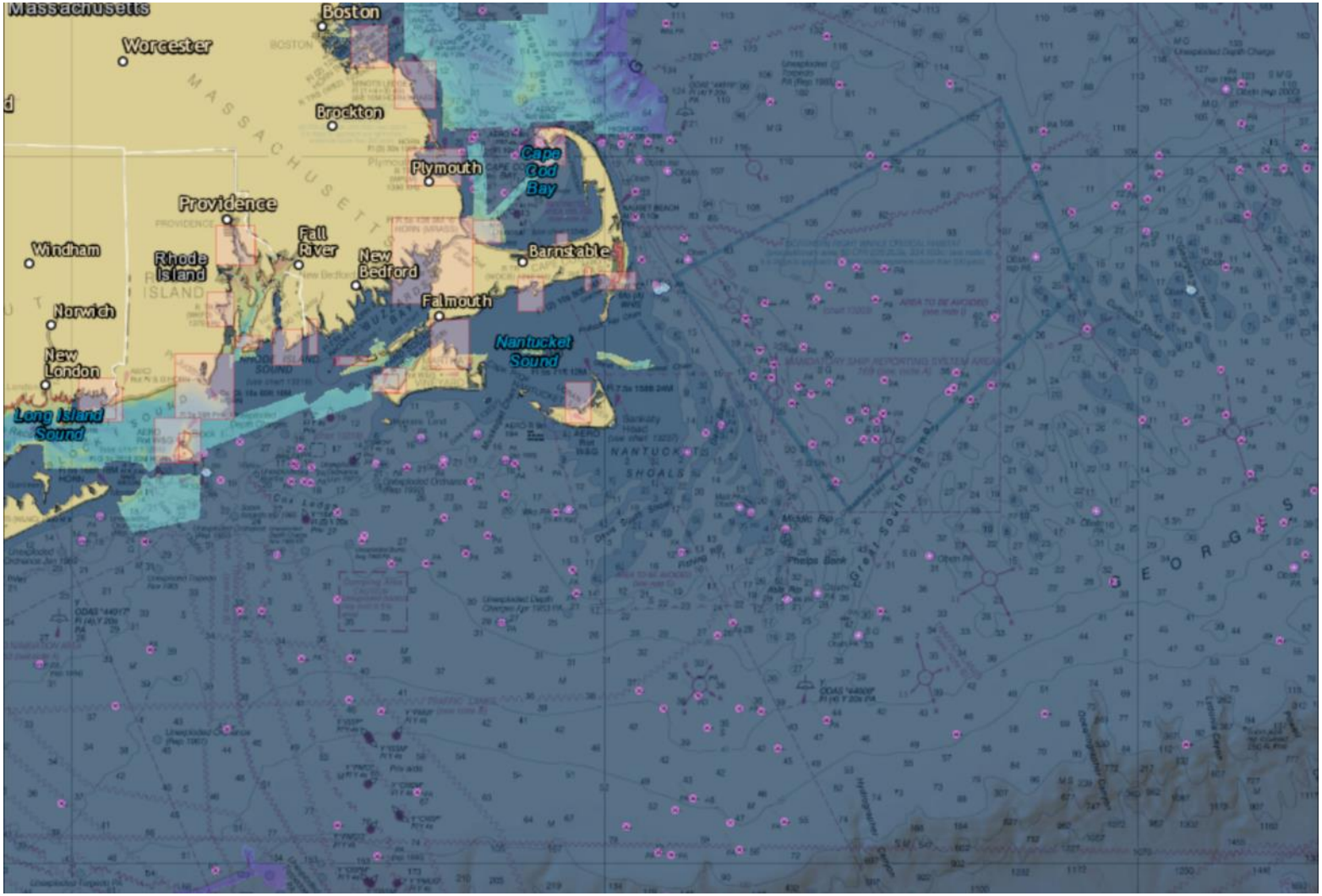




Critical Underkeel Clearance



Large Area Interdisciplinary Surveys



NOAA survey assets

Rainier
Newport, Oregon
1968

Fairweather
Ketchikan, Alaska
1968, 2010

Thomas Jefferson
Norfolk, Virginia
1992

Ferdinand R. Hassler
New Hampshire
2012

Bay Hydro II
Silver Spring, Maryland
2008

6 Navigation
Response Teams

King Air
2009

Unmanned Work to Date

Small AUVs (REMUS-100)

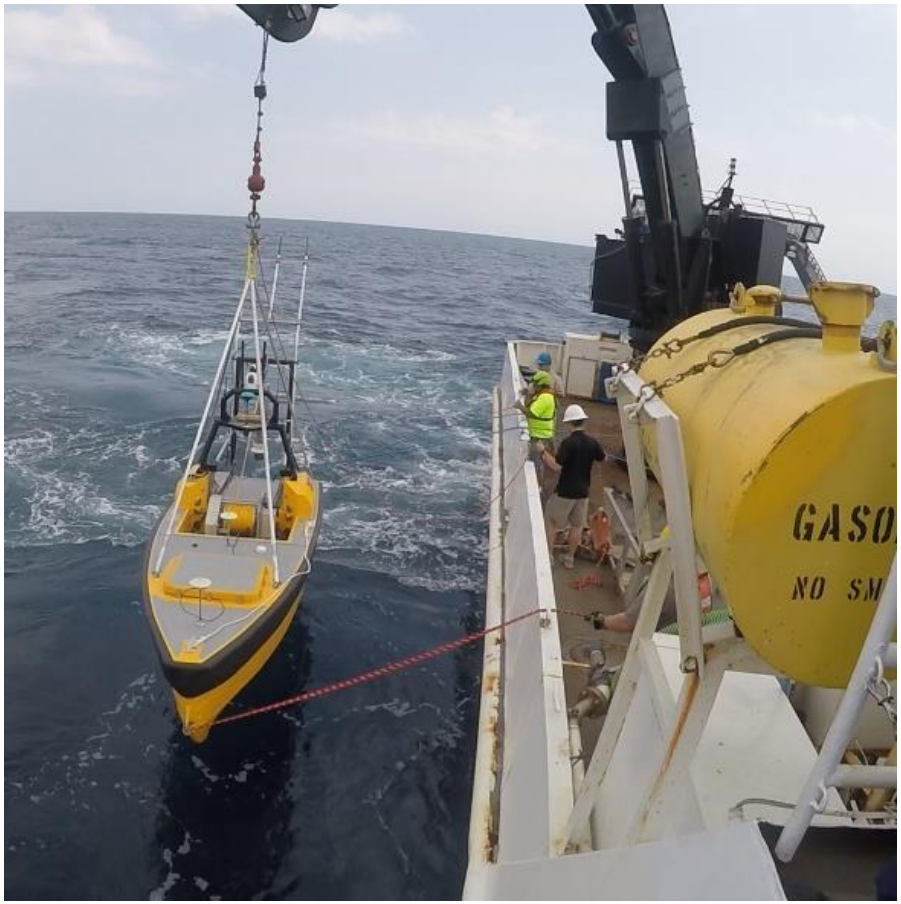
Small USVs (Z-Boats)

Large AUVs (REMUS-600)

Large USVs

USV Charter and Contract Partners

Purpose – Evaluate the shipboard infrastructure, staffing, and manpower requirements, technical capabilities, and operational concepts for deploying high-endurance USV.



USV Charter and Contract Partners

But can it work here?

AUTONOMY LEVELS

	Vessel	Mission	Sensor
Level 1: Remote Piloting (remote control)	X	X	X
Level 2: Basic Autonomy ("Do as your told")	X	X	
Level 3: Intermediate Autonomy ("React to what's known")			
Level 4: Advanced Autonomy ("React to what's sensed")			
Level 5: Planning ("Think")	Deliberative Autonomy Categories		

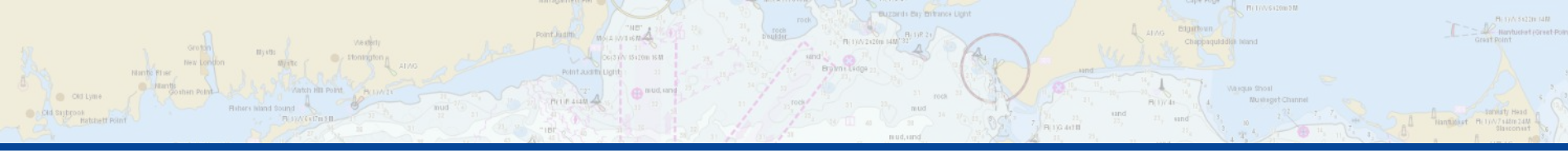
Key Findings

Unmanned Systems…

- require the development of new technologies
- must provide new capabilities or mission profiles
- require skilled personnel to operate and maintain
- do not diminish the need for ships
- require unique shipboard infrastructure
- require supervision as autonomous navigation is rudimentary

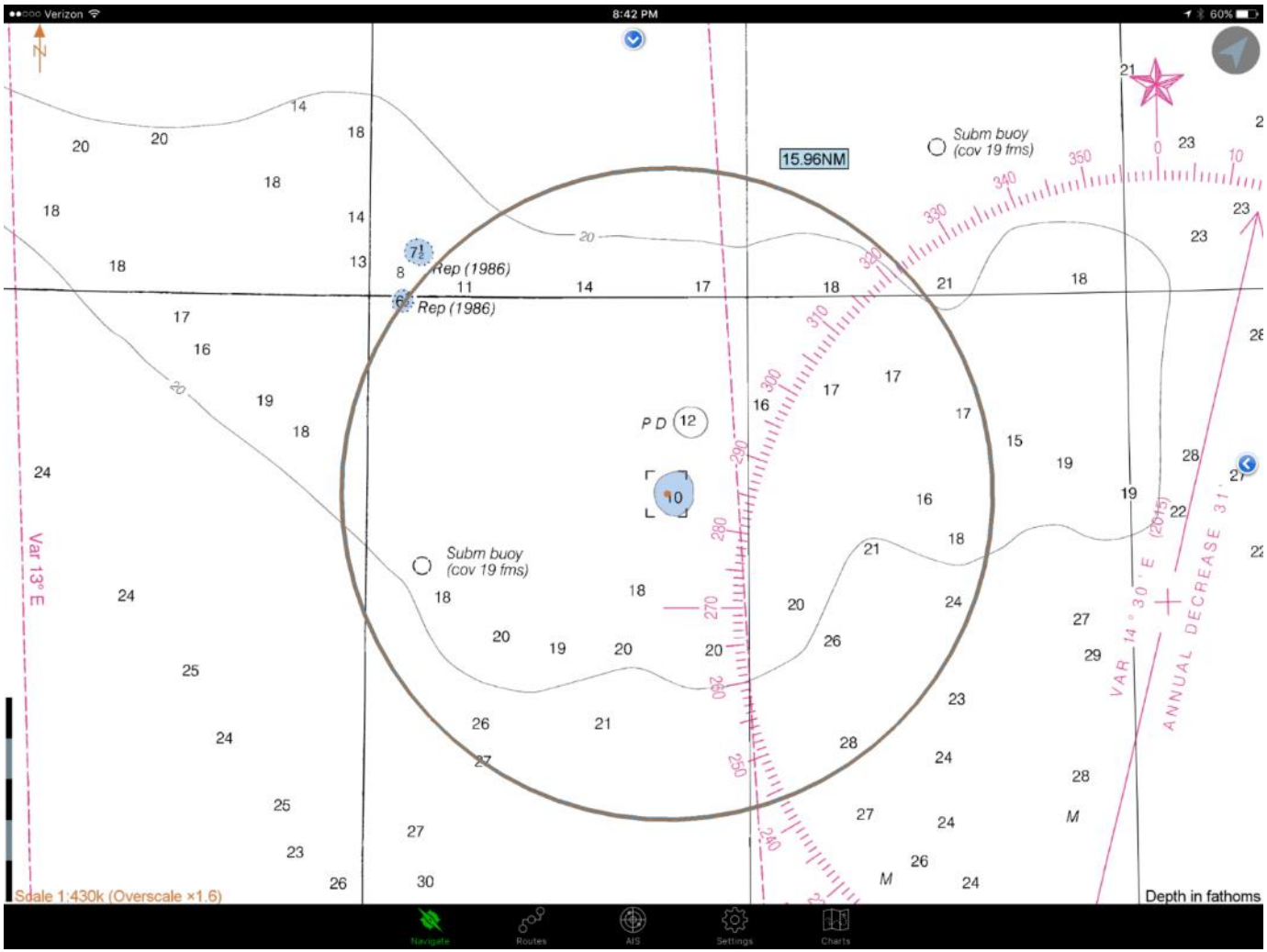
Coast Survey Unmanned Systems Roadmap

- Continue the development of technology and processes that support manned operations and enable unmanned systems
- Stand-up an operational unit with expertise in unmanned systems (Stennis Space Center, MS)
- Collaborate with academic and industry partners on developing the technology.
- Contract for the conversion of one or more NOAA survey launches to dual-mode (manned or unmanned) capability ("optionally manned").

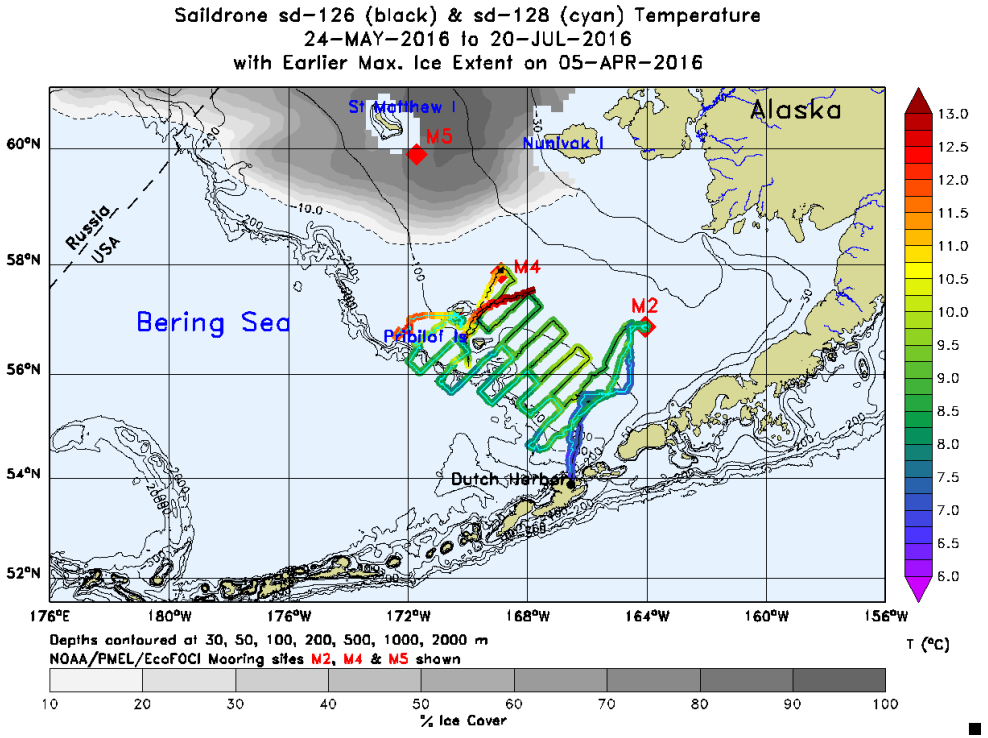


Mission Applications of Unmanned Systems

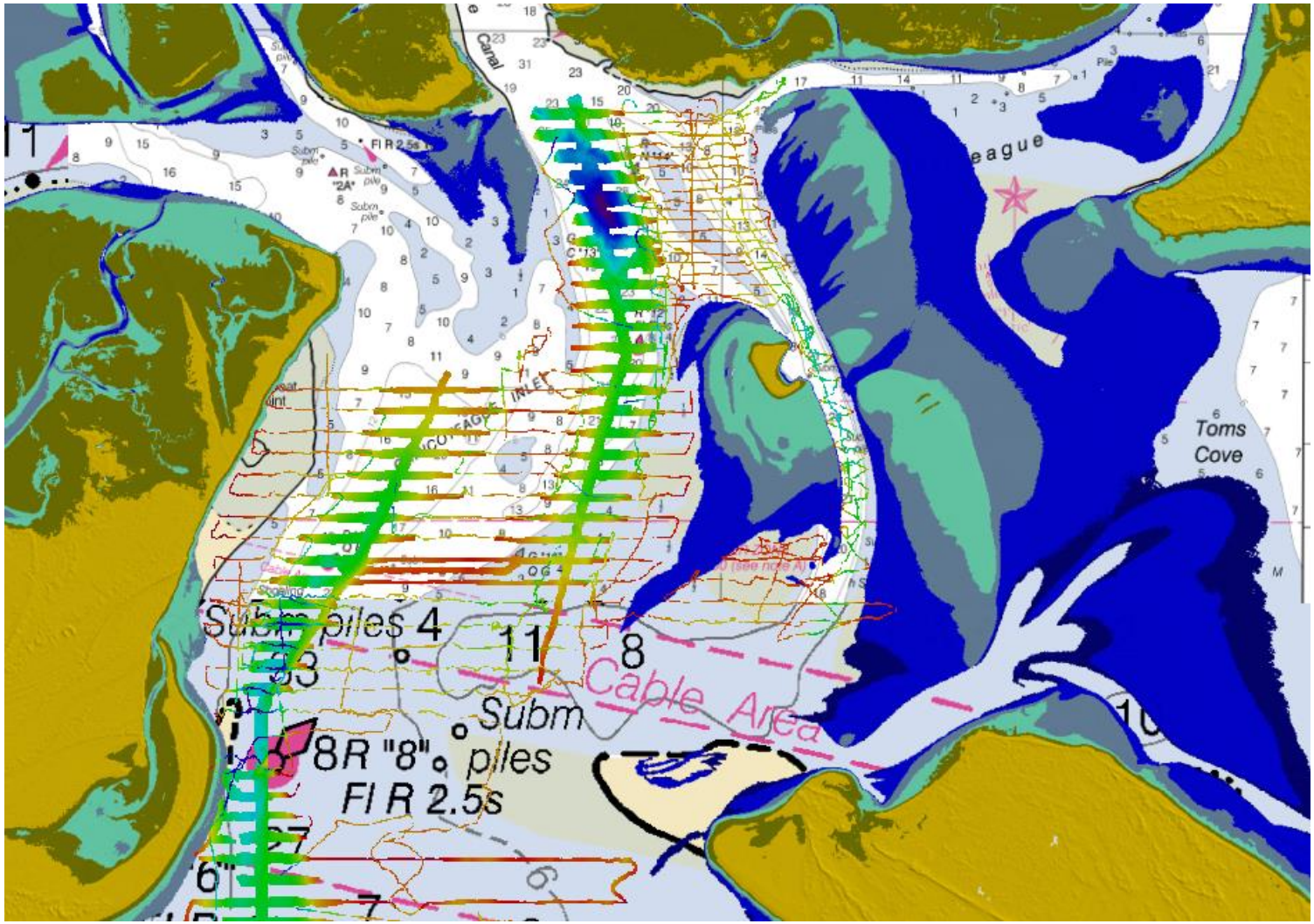
Arctic


Verizon
8:42 PM
60%
15.96NM
Subm buoy
(cov 19 fms)
Rep (1986)
Rep (1986)
P D
Subm buoy
(cov 19 fms)
Var 13° E
VAR 14° 30' E (2015)
ANNUAL DECREASE 3'
Scale 1:430k (Overscale ×1.6)
Depth in fathoms
Navigate
Routes
AIS
Settings
Charts

Arctic


Saildrone sd-126 (black) & sd-128 (cyan) Temperature
24-MAY-2016 to 20-JUL-2016
with Earlier Max. Ice Extent on 05-APR-2016
St Matthew I
M5
Nunivak I
Alaska
Russia
USA
M4
M2
Bering Sea
Pribilof Is
Dutch Harbor
60°N
58°N
56°N
54°N
52°N
176°E
180°W
176°W
172°W
168°W
164°W
160°W
156°W
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
T (°C)
Depths contoured at 30, 50, 100, 200, 500, 1000, 2000 m
NOAA/PMEL/EcoFOCI Mooring sites M2, M4 & M5 shown
10
20
30
40
50
60
70
80
90
100
% Ice Cover

Complement to Bathy Lidar



Validate Satellite Derived Bathymetry