Synoptic Risk Assessment for Ship Passage and Hydrographic Uncertainty Representation

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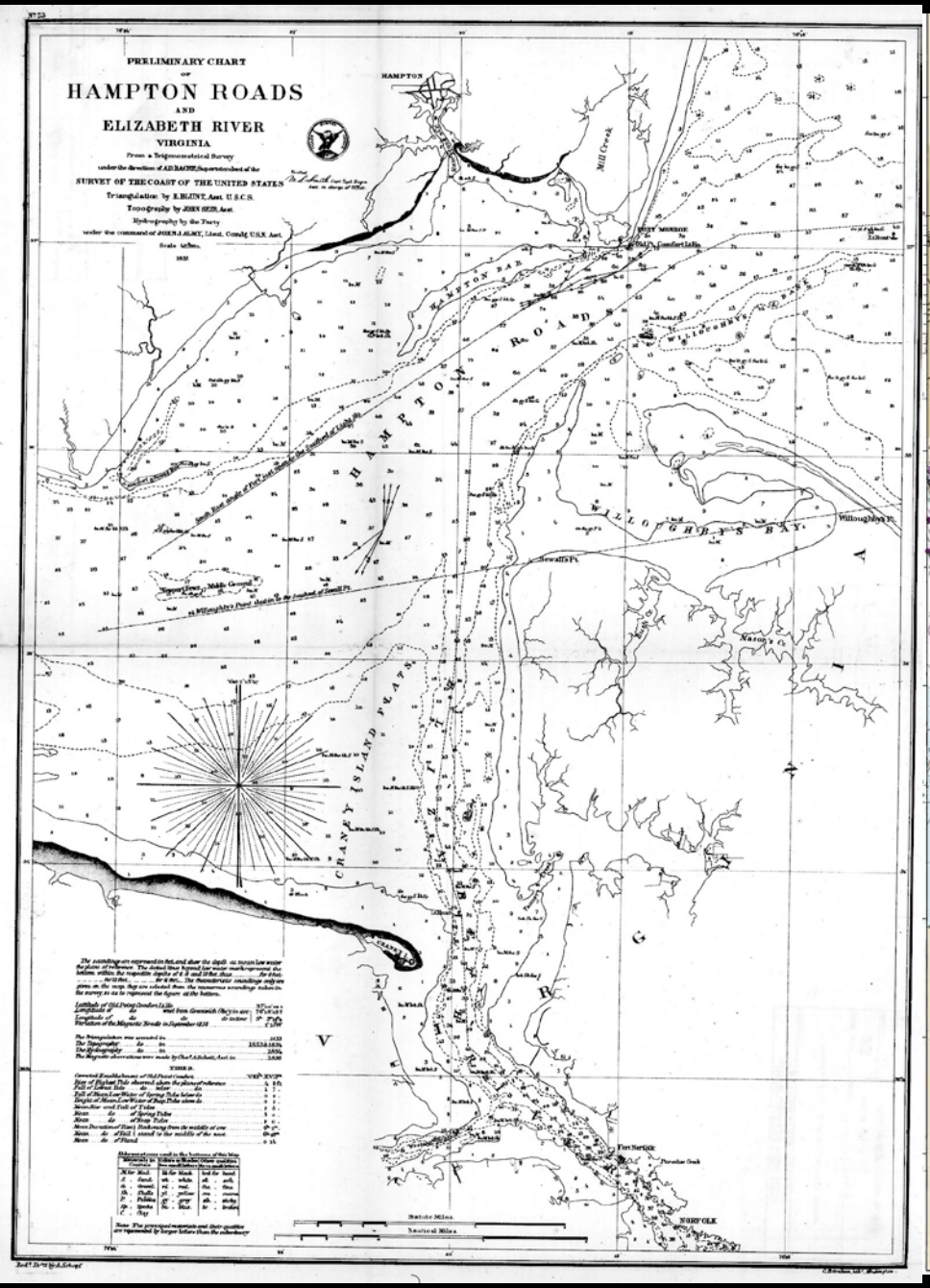
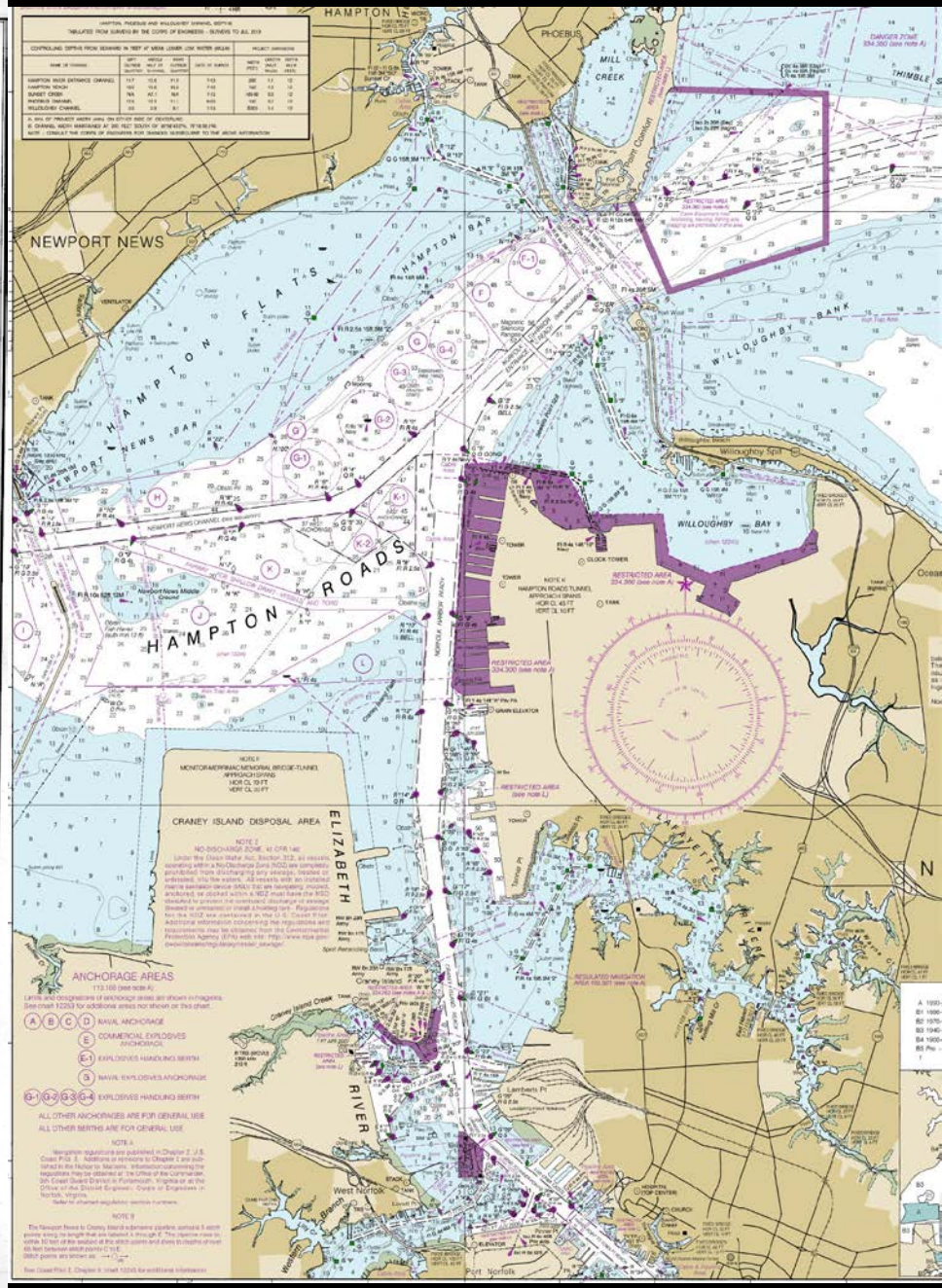
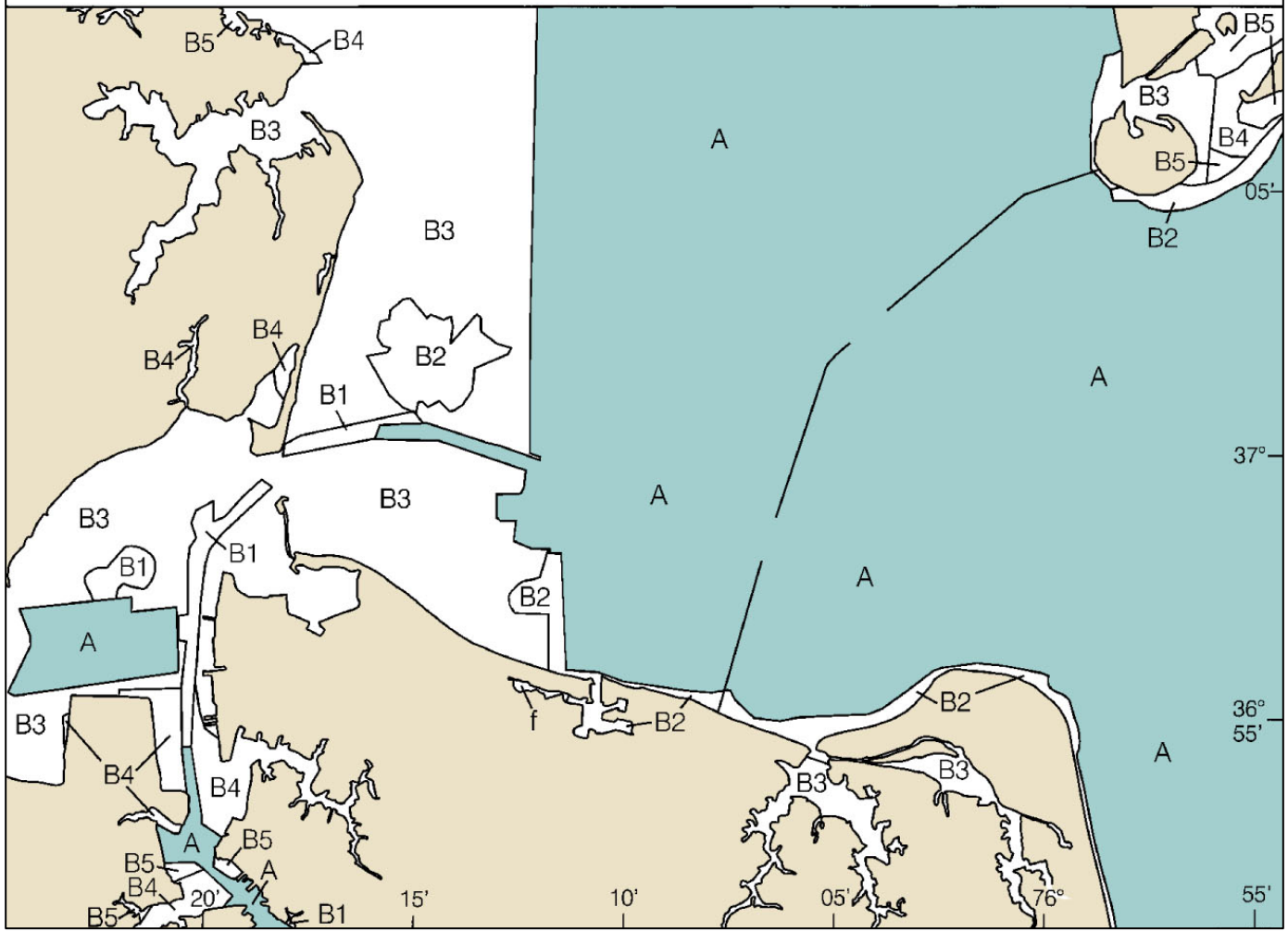

PRELIMINARY CHART
OF
HAMPTON ROADS
AND
ELIZABETH RIVER
VIRGINIA
From a Trigonometrical Survey
under the direction of A.D.BACHE, Superintendent of the
SURVEY OF THE COAST OF THE UNITED STATES
Triangulation by R.BLUNT, Asst. U.S.C.S.
Topography by JOHN GUIS, Asst.
Hydrography by the Party
under the command of JOHN J.ALMY, Lieut. Comdg USN Asst.
Scale 1:40,000.
1850
HAMPTON
Mill Creek
POST MONROE
Comfort Inlet
HAMPTON ROADS
NEWPORT NEWS BAR
WILLOUGHBY'S BAY
Willoughby Pt.
Newsells Pt.
Newport News Middle Ground
Craney Island Flats
CRANEY ISLAND FLATS
Craney Island
Fort Norfolk
Pinnacle Rock
NORFOLK
Statute Miles
Nautical Miles


HAMPTON
PHOEBUS
MILL CREEK
NEWPORT NEWS
HAMPTON BAR
HAMPTON FLATS
NEWPORT NEWS BAR
WILLOUGHBY BANK
WILLOUGHBY BAY
HAMPTON ROADS
ELIZABETH RIVER
CRANEY ISLAND DISPOSAL AREA
ANCHORAGE AREAS
Craney Island
West Norfolk
Port Norfolk

SOURCE

A	1990-2013	NOS Surveys	full bottom coverage
B1	1990-2001	NOS Surveys	partial bottom coverage
B2	1970-1989	NOS Surveys	partial bottom coverage
B3	1940-1969	NOS Surveys	partial bottom coverage
B4	1900-1939	NOS Surveys	partial bottom coverage
B5	Pre - 1900	NOS Surveys	partial bottom coverage
f		Miscellaneous Surveys	



We’re answering the question:

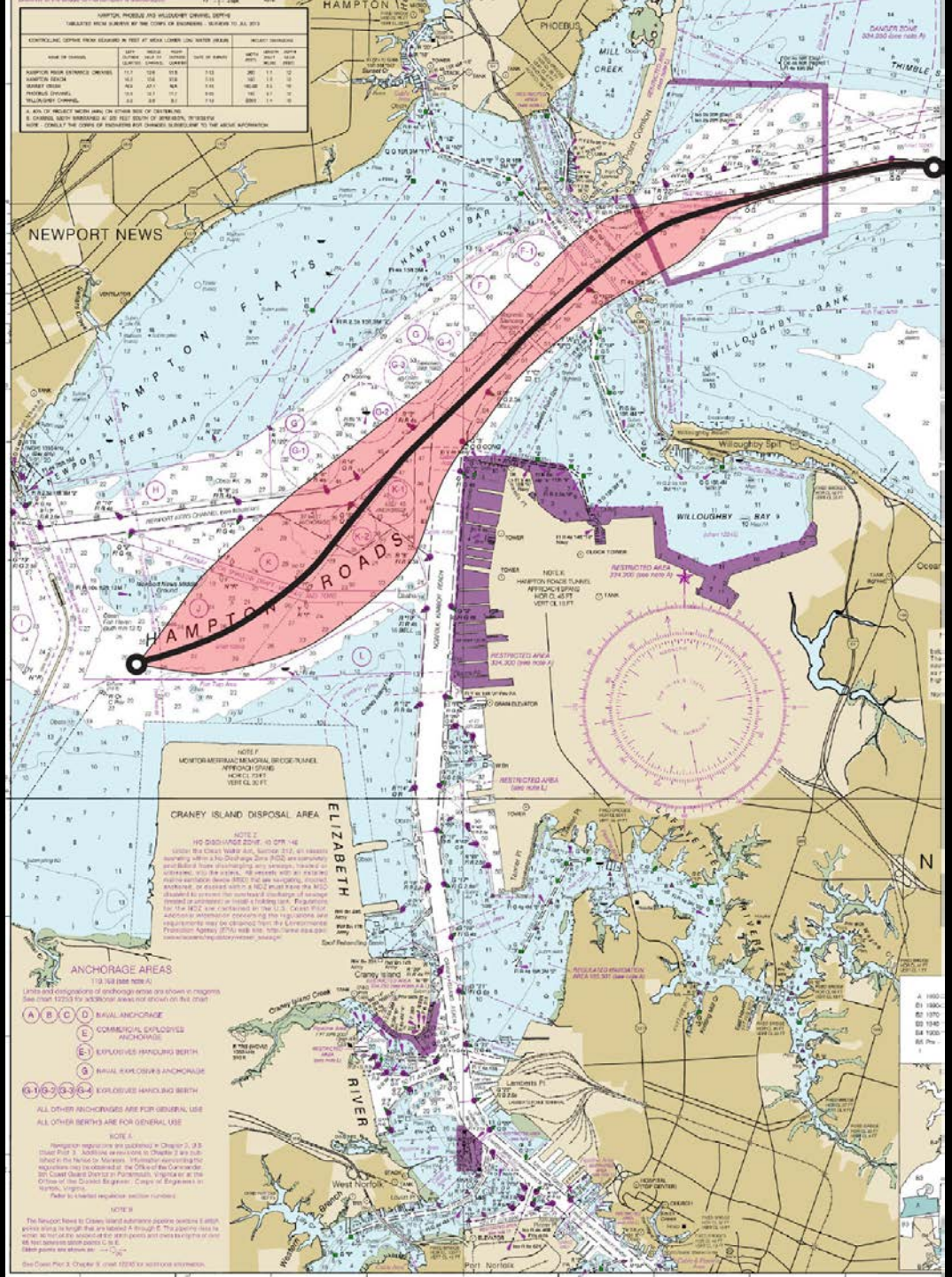
“What did we do?”

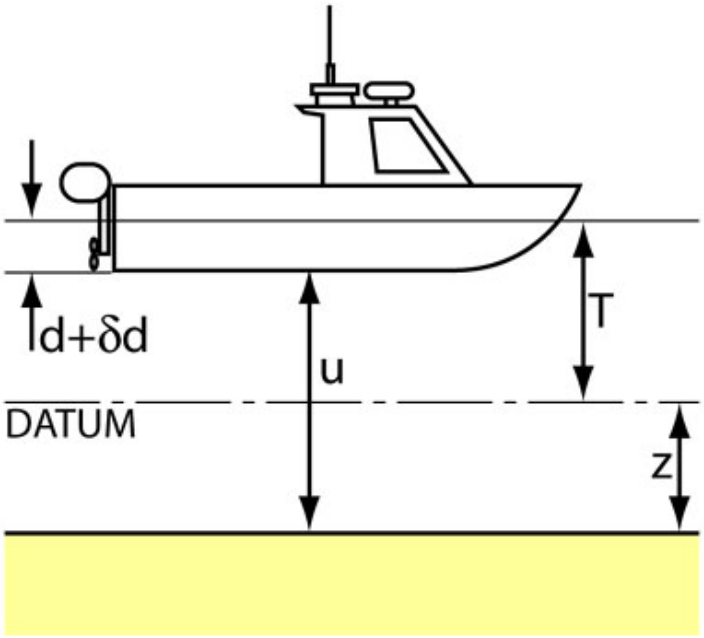
… and not:

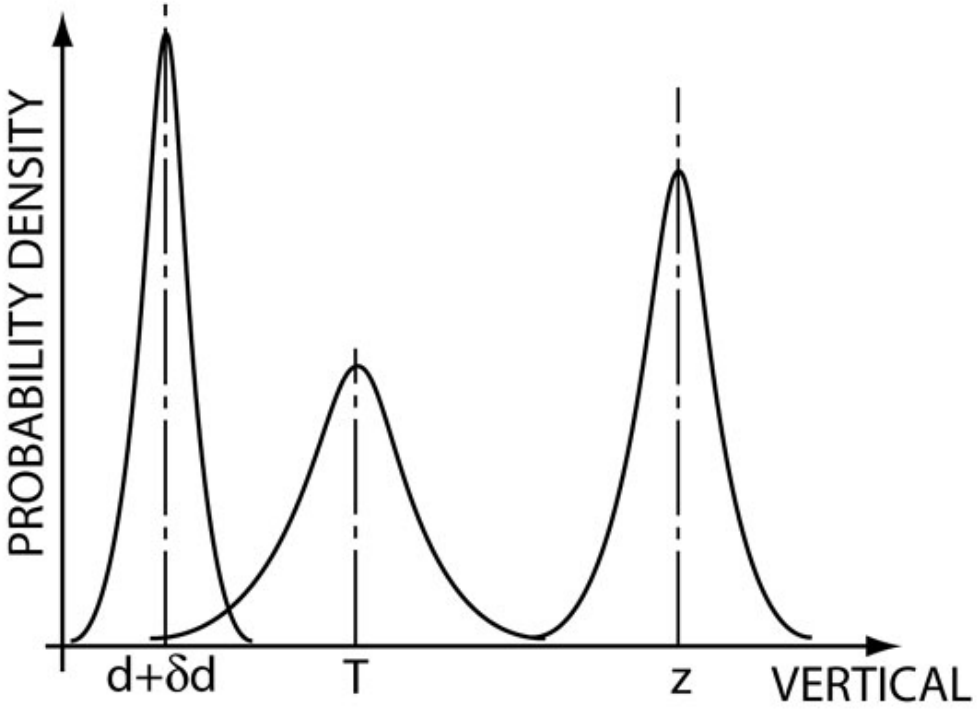
“How much do we know about the area?”

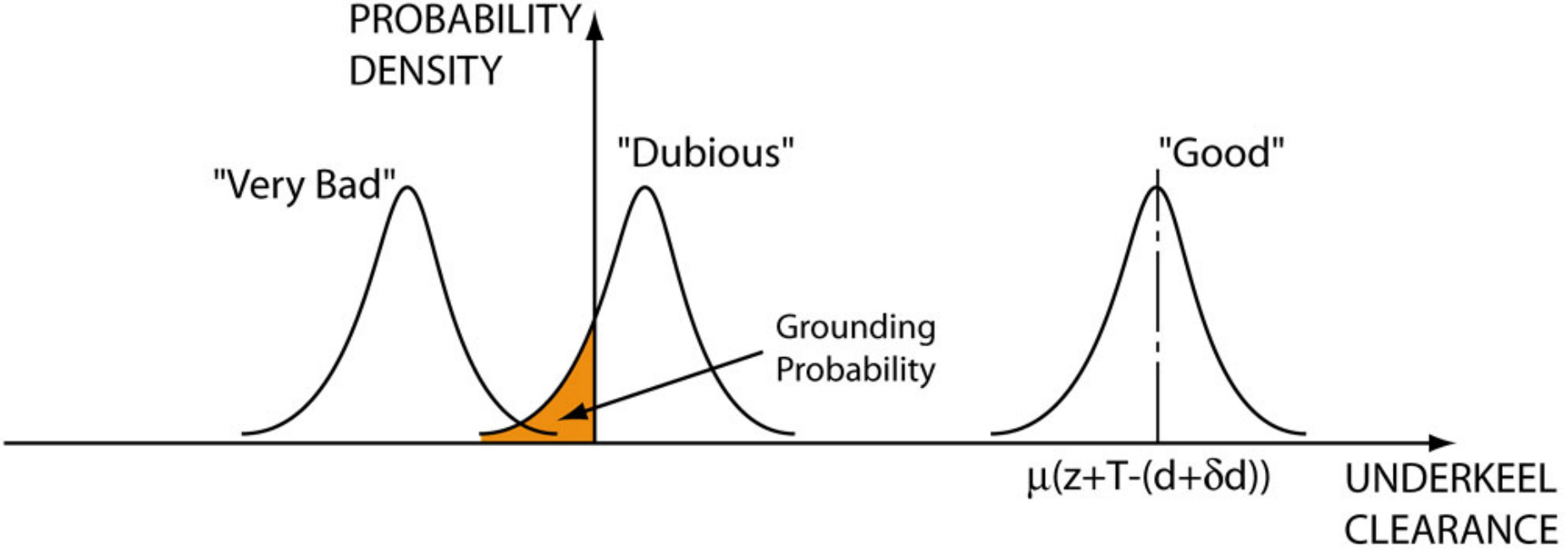
The user’s question is more like:

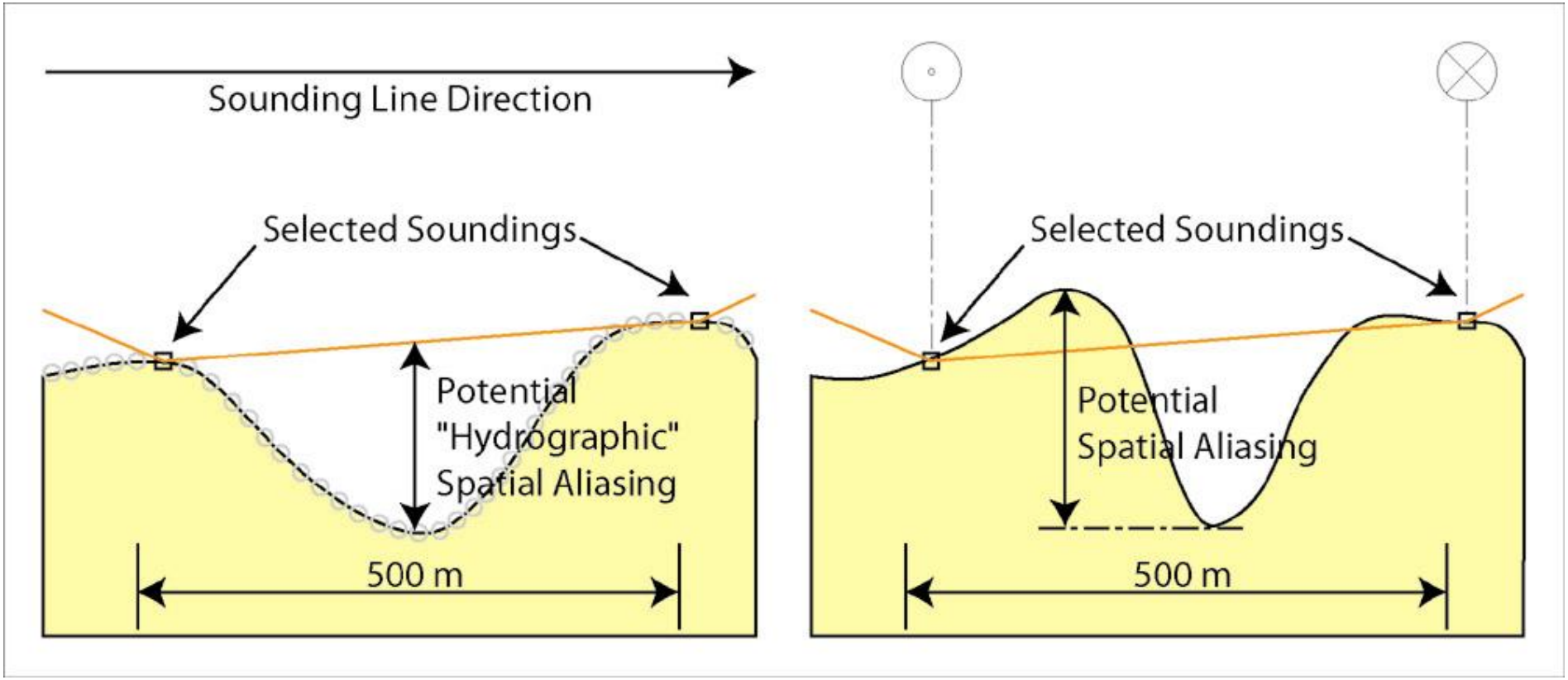
“What’s my chance of going there safely?”

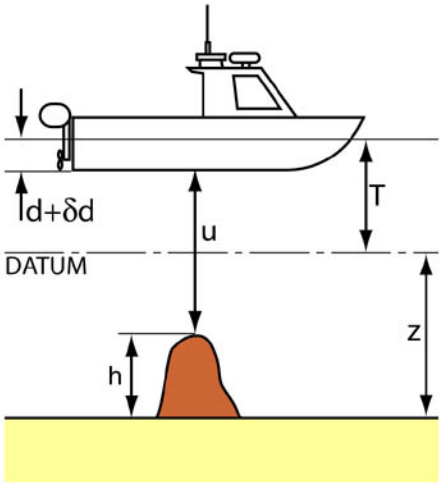

HAMPTON
PHOEBUS
MILL CREEK
THIMBLE
NEWPORT NEWS
HAMPTON FLATS
HAMPTON BAR
WILLOUGHBY BANK
NEWPORT NEWS BAR
HAMPTON ROADS
WILLOUGHBY BAY
Willoughby Spit
CRANEY ISLAND DISPOSAL AREA
ELIZABETH RIVER
Craney Island
West Norfolk
Port Norfolk
ANCHORAGE AREAS
NOTE A
NOTE B
NOTE C
NOTE D
NOTE E
NOTE F
NOTE G
NOTE H
NOTE I
NOTE J
NOTE K
NOTE L
RESTRICTED AREA
334,300 (see note A)
N


d+δd
u
T
DATUM
z


PROBABILITY DENSITY
d+δd
T
z
VERTICAL

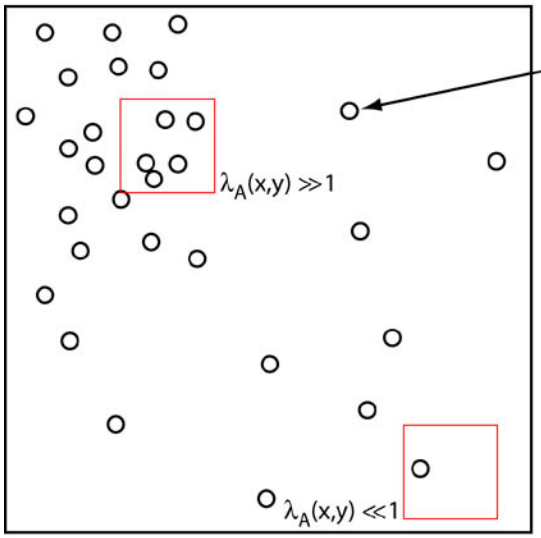

PROBABILITY
DENSITY
"Very Bad"
"Dubious"
"Good"
Grounding
Probability
μ(z+T-(d+δd))
UNDERKEEL
CLEARANCE

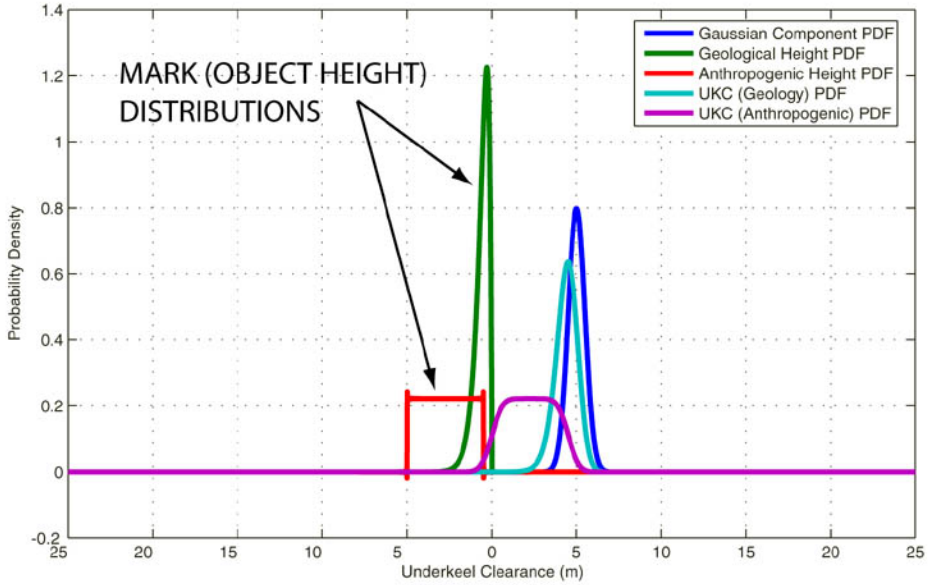

Sounding Line Direction
Selected Soundings
Potential
"Hydrographic"
Spatial Aliasing
500 m
Selected Soundings
Potential
Spatial Aliasing
500 m

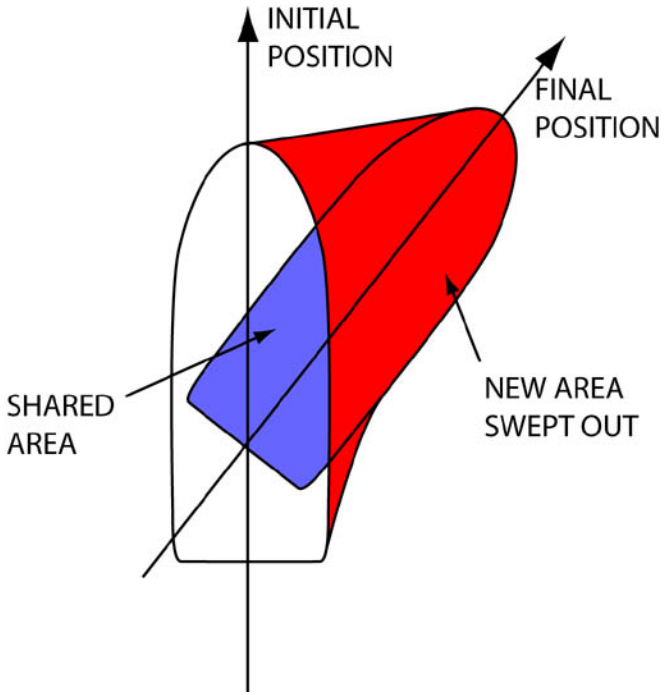


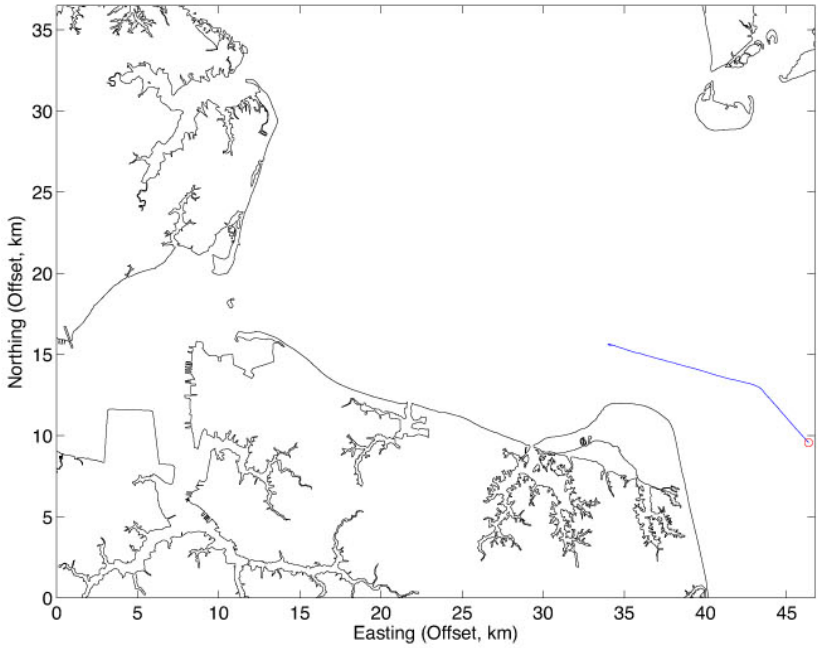
$$u = z + T - (d + \delta d) - h$$

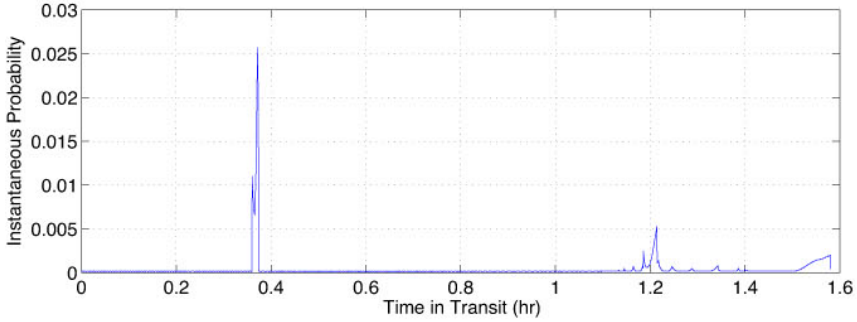
NON-HOMOGENEOUS MARKED SPATIAL POINT PROCESS MODEL

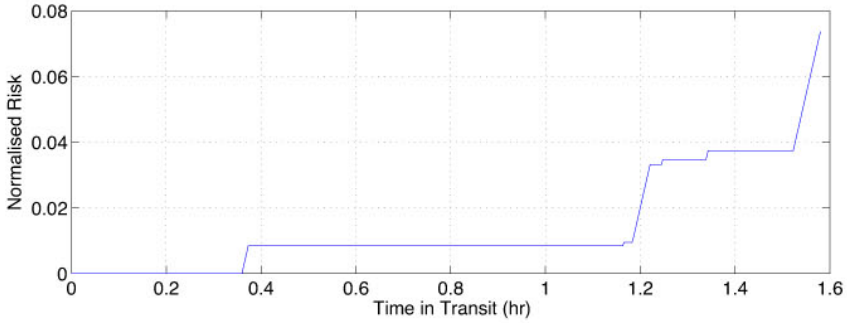


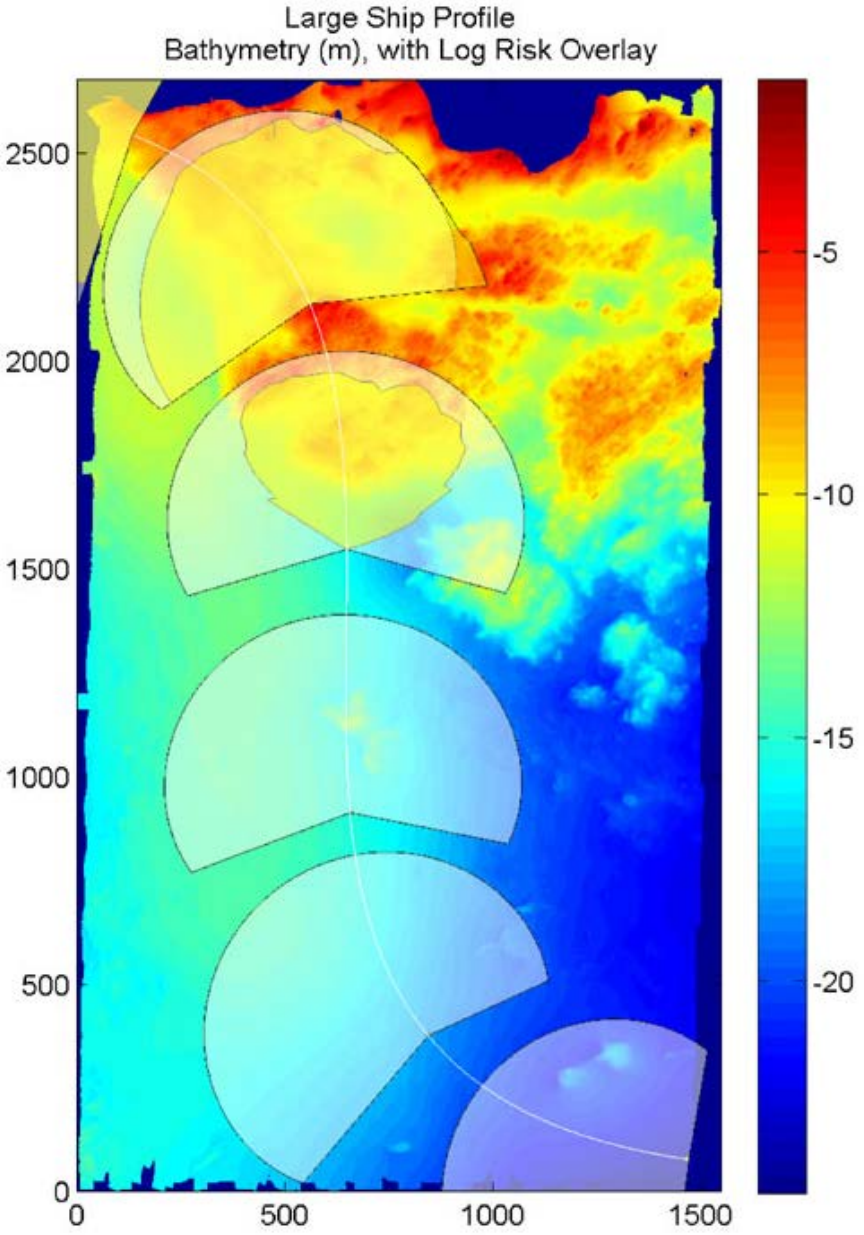


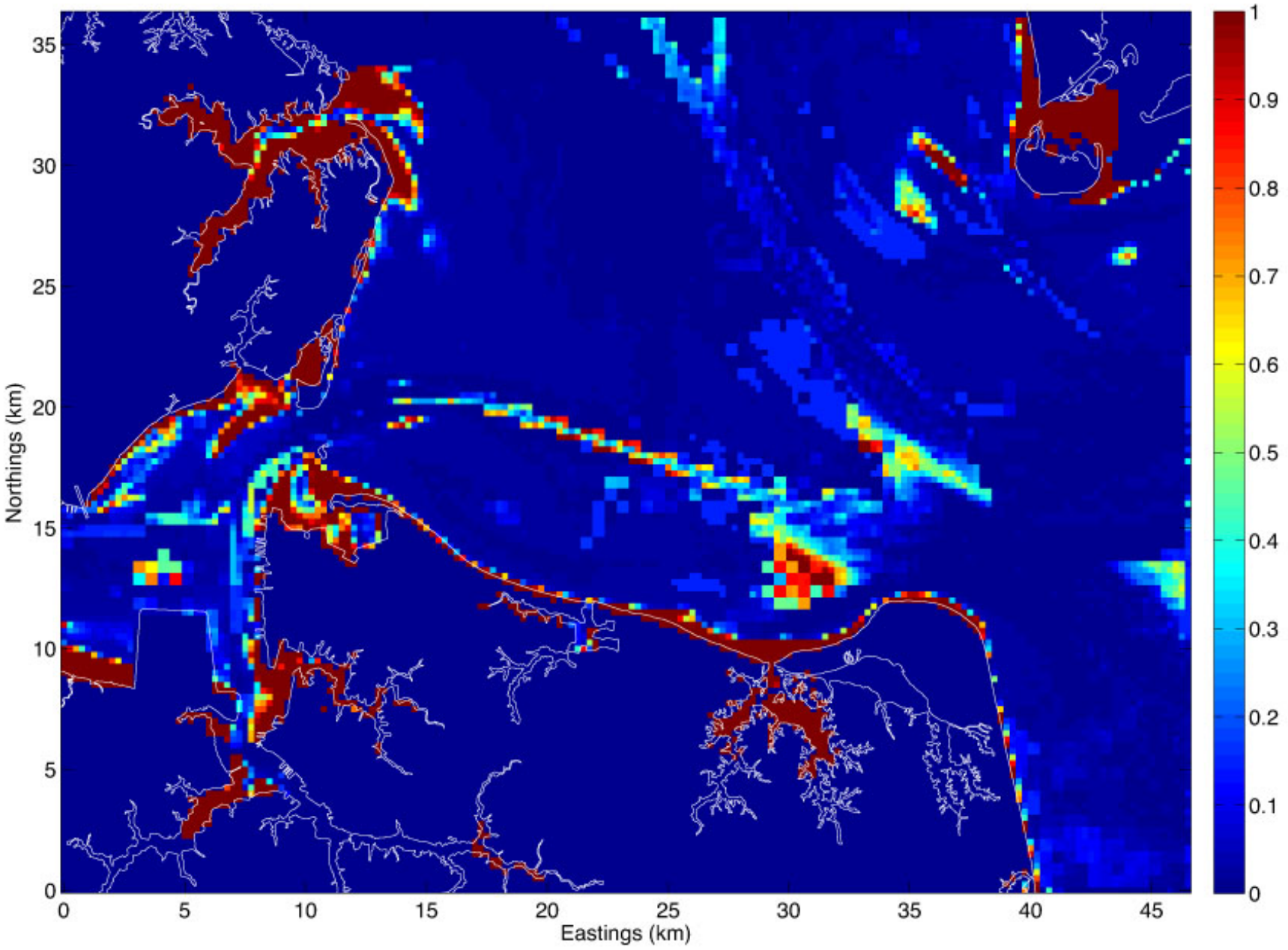


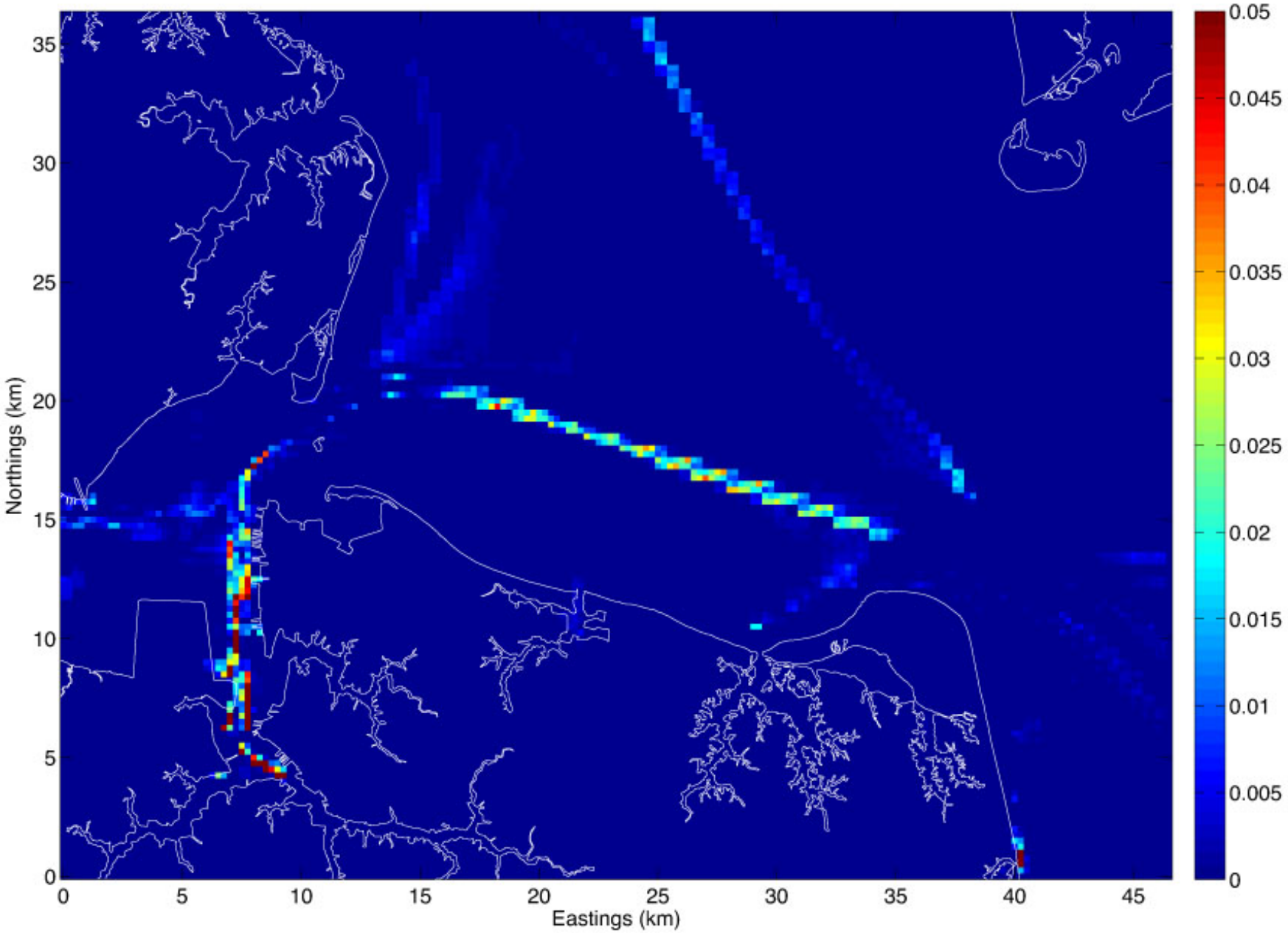

Northing (Offset, km)
Easting (Offset, km)
0
5
10
15
20
25
30
35
40
45

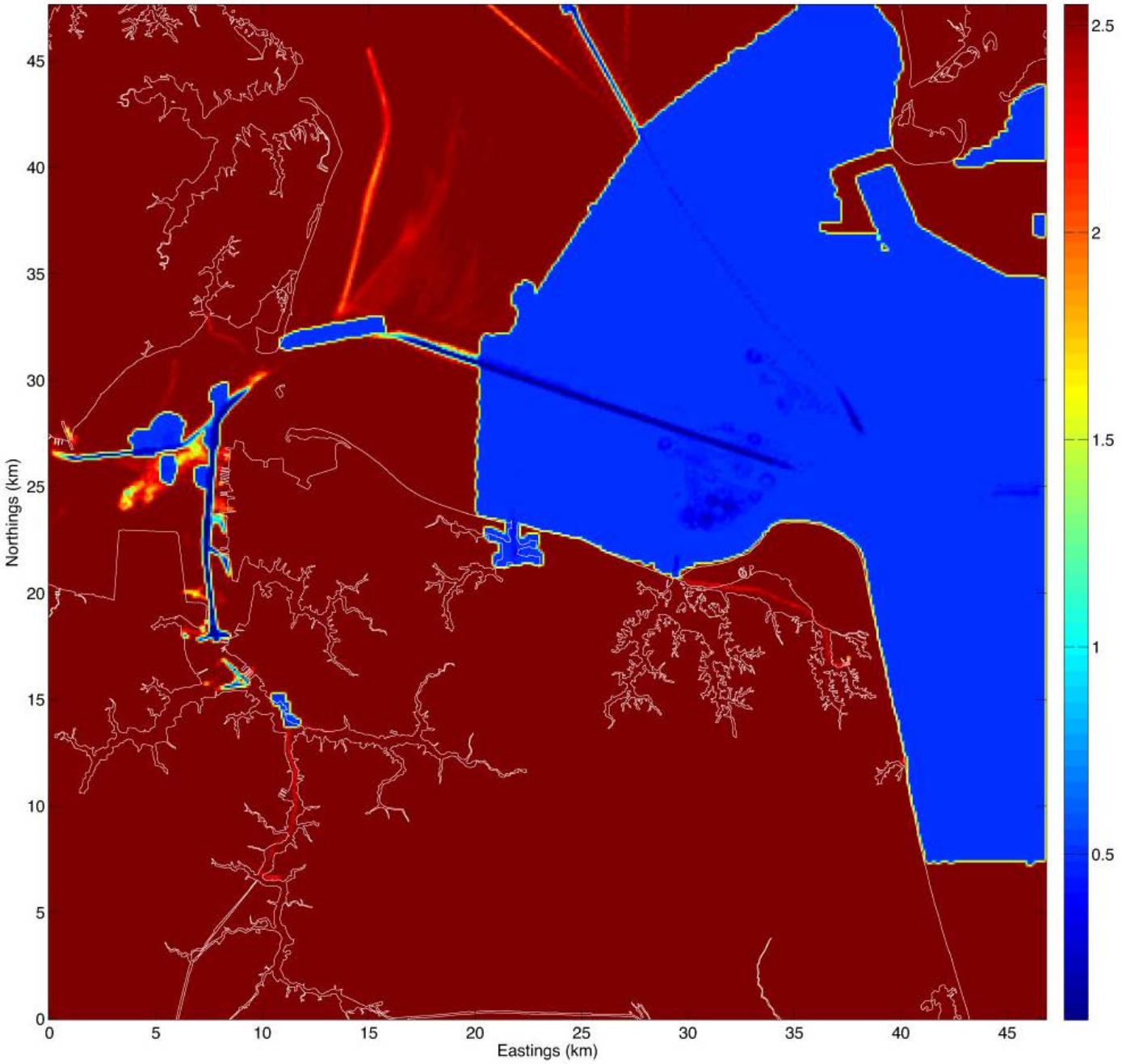

Instantaneous Probability
Time in Transit (hr)
0
0.005
0.01
0.015
0.02
0.025
0.03
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

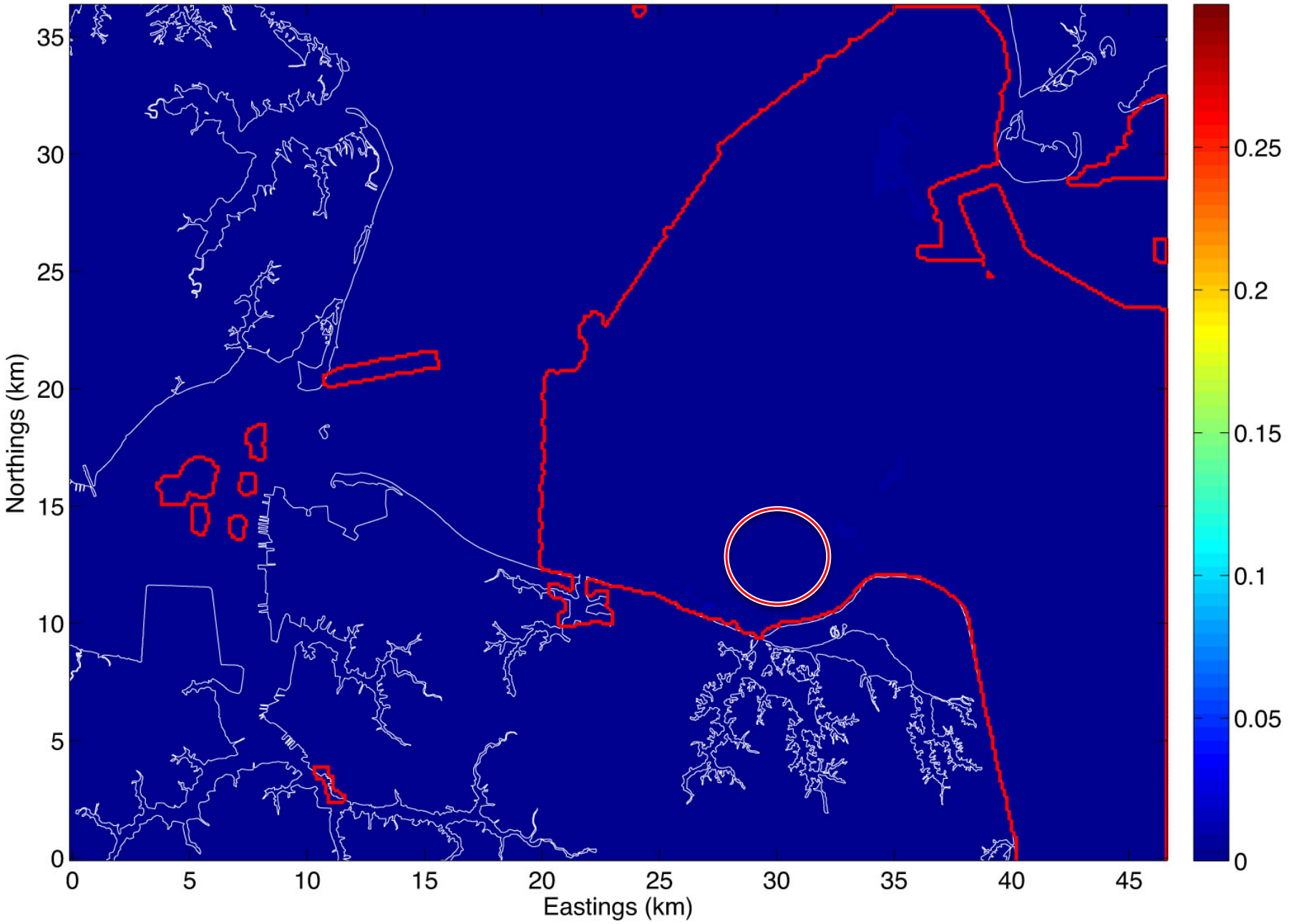

Normalised Risk
Time in Transit (hr)
0
0.02
0.04
0.06
0.08
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6


Large Ship Profile
Bathymetry (m), with Log Risk Overlay
2500
2000
1500
1000
500
0
0
500
1000
1500
-5
-10
-15
-20

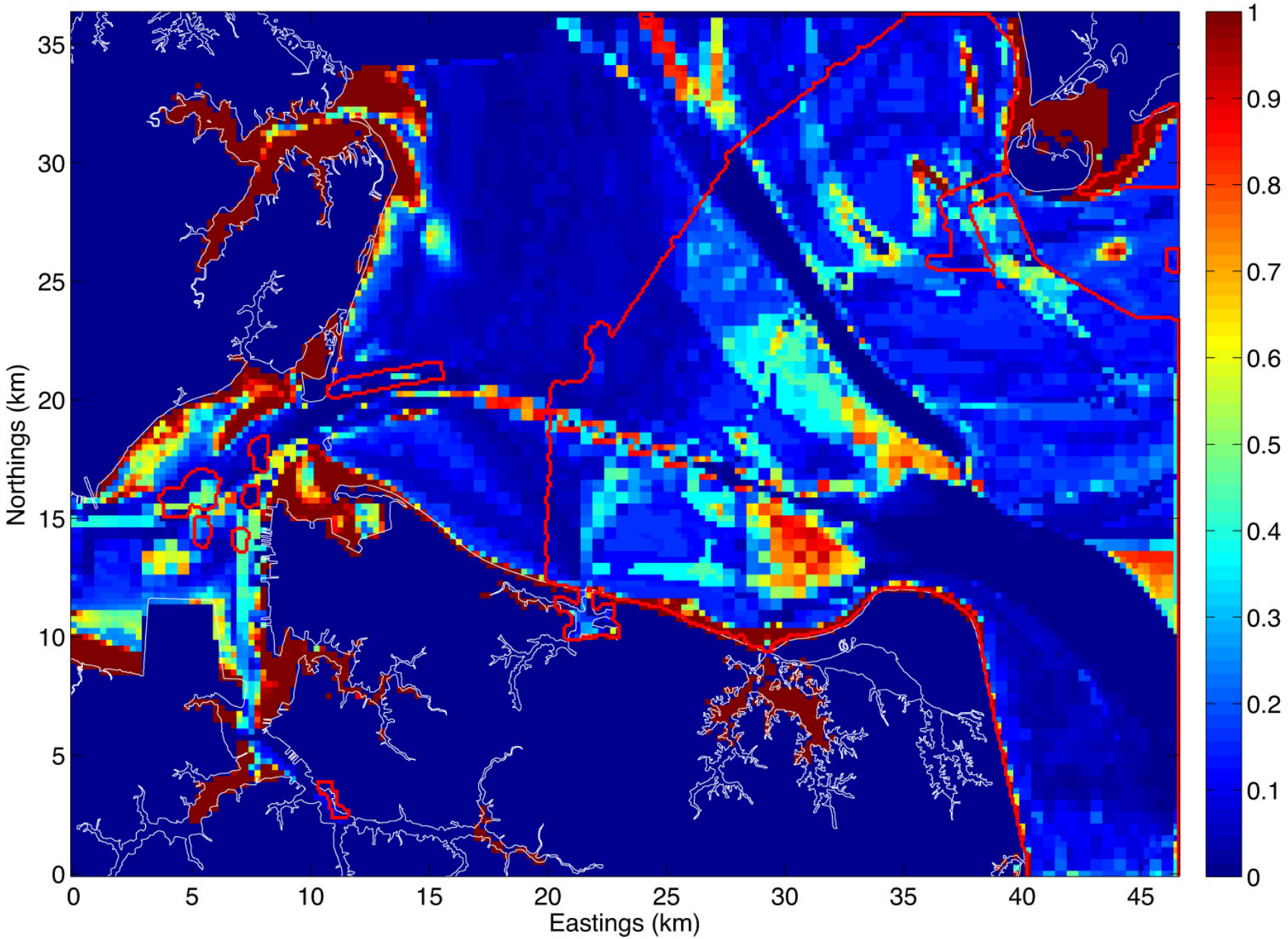

Northings (km)
0
5
10
15
20
25
30
35
Eastings (km)
0
5
10
15
20
25
30
35
40
45
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


Northings (km)
Eastings (km)
0
5
10
15
20
25
30
35
40
45
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0

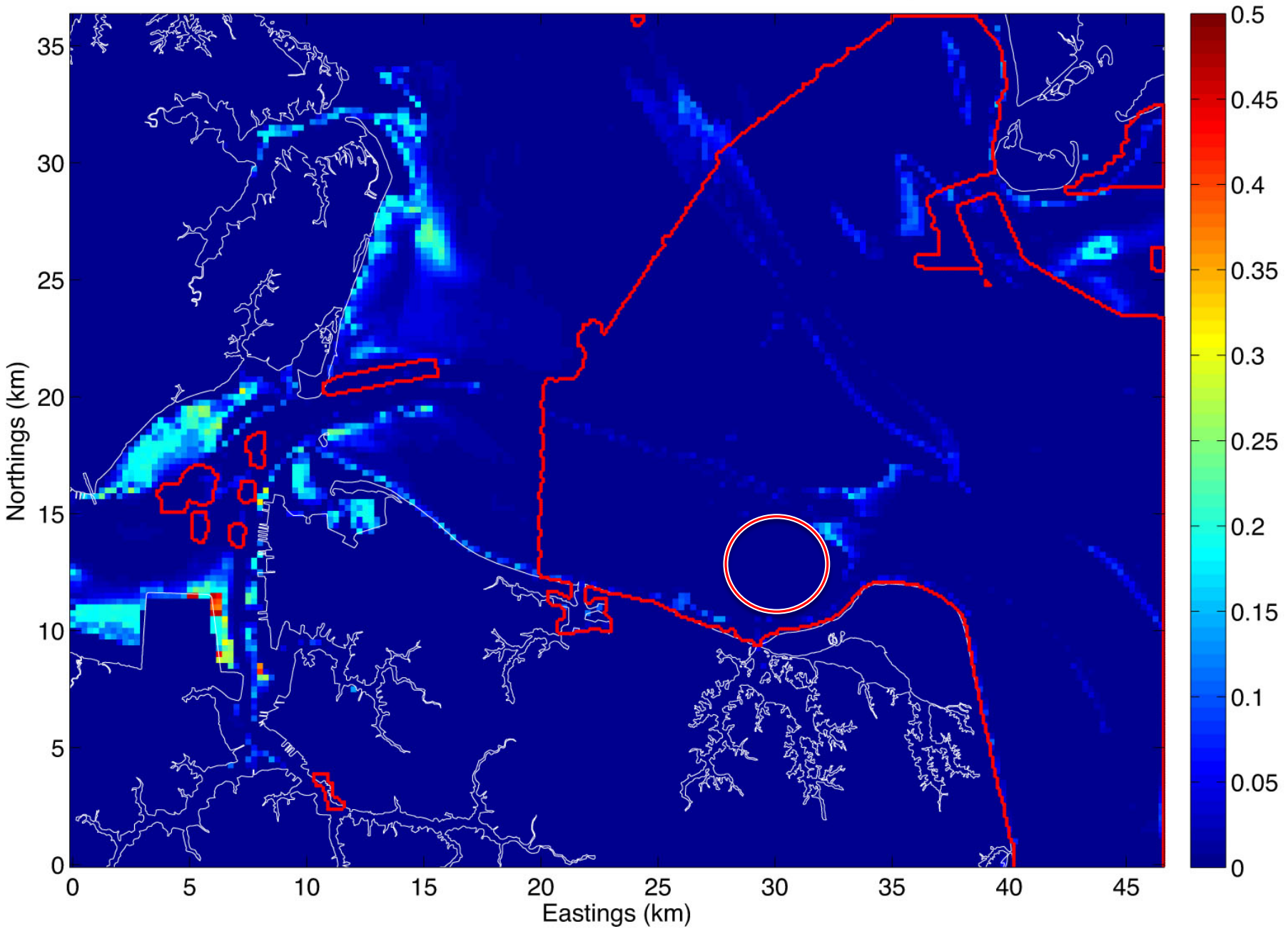

Northings (km)
Eastings (km)
0
5
10
15
20
25
30
35
40
45
2.5
2
1.5
1
0.5



Predicted *a posteriori* potential gain



a posteriori predicted surface shipping risk



a posteriori potential remaining risk improvement

Summary

- Risk models provide estimates of:
  - Risk along transit [minimum risk transit selection]
  - Alternative route risk [real-time decision aid]
  - Risk per spatial cell [user-level “uncertainty” measure]
  - Potential risk improvement after survey [resurvey priority]
  - Predicted risk reduction by tool [survey tool selection]
  - Residual risk improvement achievable [survey completeness]
- Model calibration can be difficult
- AIS data can be used for calibration
  - Traffic density
  - Non-observable area priors
  - Keel-drag unobservable object reduction
  - Noisy: ~50% unusable for these purposes

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