

Using Vessels' Calculated Under-Keel Clearance to Estimate the Appropriate Level of Effort for Hydrographic Surveying **Desire**

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A Model of Hydrographic Health

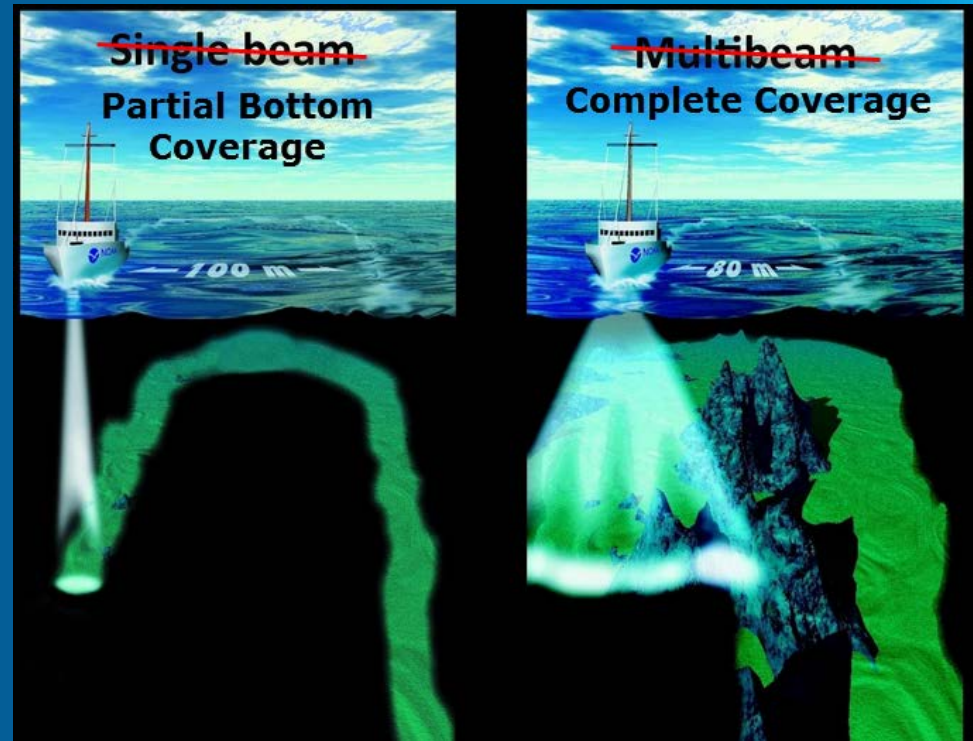
$$\text{Hydrographic Health} = \underbrace{\left(\text{Desired Survey Score} - \text{Present Survey Score} \right)^2}_{\text{Hydrographic Gap}} \times \underbrace{\sum \left(\text{Consequence} \times \prod (\text{Likelihood}) \right)}_{\text{Hydrographic Risk}}$$

- Hydrographic Gap
 - The difference between the desired and present survey score; the larger the gap, the worse the hydrographic health.
- Hydrographic Risk
 - Modeled as the risk to surface navigation due to inaccurate depths or unknown hazards; the greater the risk, the worse the hydrographic health.



What Problem Does Desire Address?

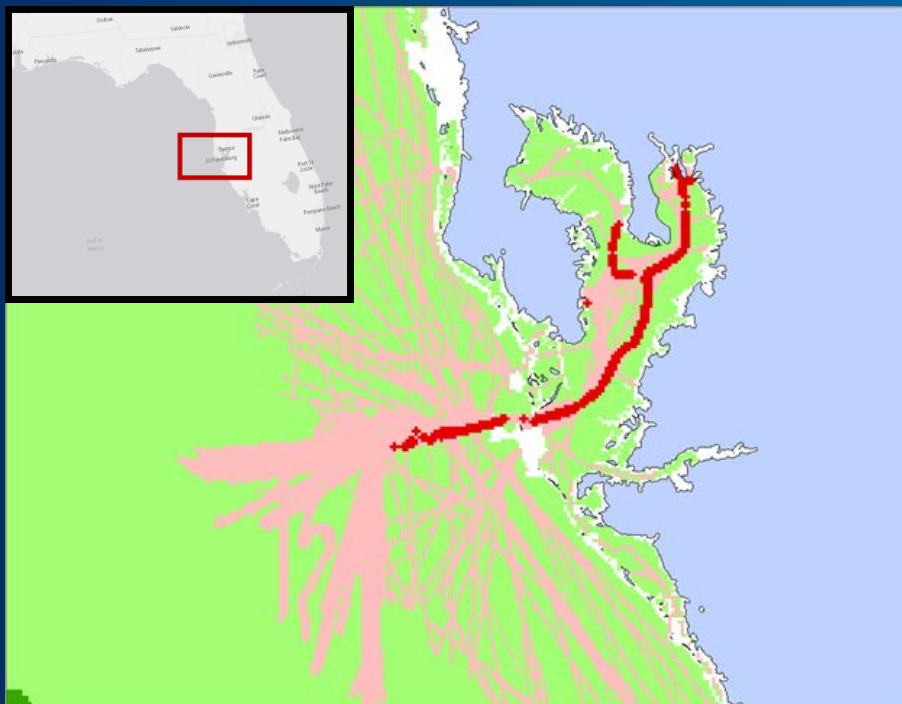
- How does one define adequacy of a hydrographic survey?
 - Risk: Left unanswered you may over/under survey (e.g. complete where set line spacing suffices)
- Empirically defined coverage requirements using
 - Under Keel Clearance
 - Existing Vessel Traffic
 - Seafloor Complexity



$$\text{Hydrographic Health} = \left(\text{Desired Survey Score} - \text{Present Survey Score} \right)^2 \times \sum \left(\text{Consequence} \times \prod (\text{Likelihood}) \right)$$

Under Keel Clearance:

- Join AIS records with AVIS database to query vessel draft.
- Compare with local depth to estimate Under Keel Clearance.
- Define coverage requirement based on proximity to seafloor.



DESIRED COVERAGE

If **SIMPLE** seafloor:

DSS = 100

Object Detection

DSS = 80

Complete Coverage

DSS = 30

Part. Bottom Coverage

DSS = 10

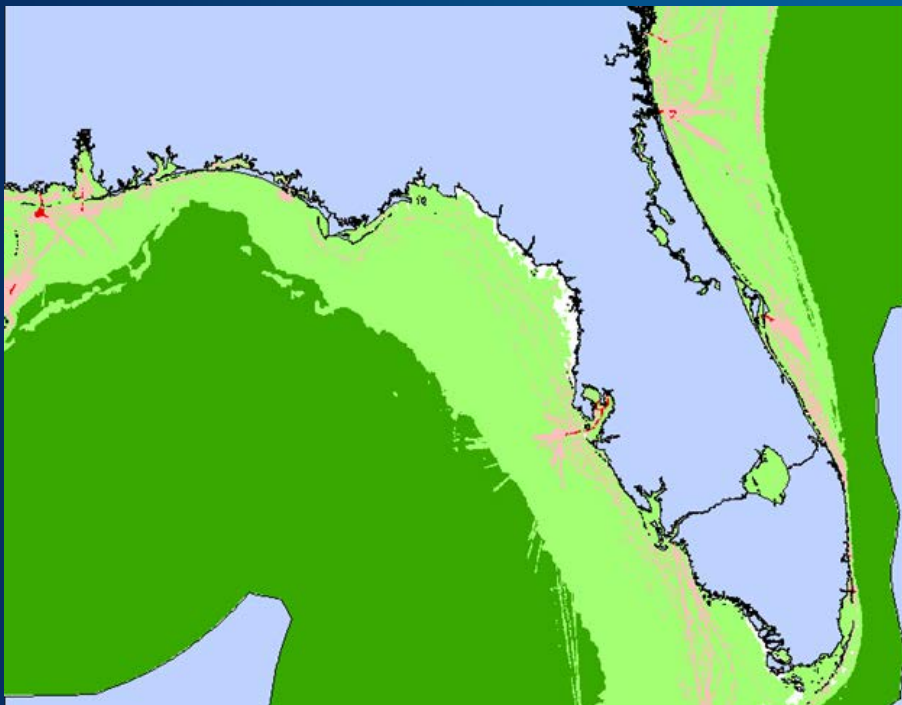
Lesser Coverage



$$\text{Hydrographic Health} = \left(\text{Desired Survey Score} - \text{Present Survey Score} \right)^2 \times \sum \left(\text{Consequence} \times \prod (\text{Likelihood}) \right)$$

Seafloor Complexity:

- In areas where the seafloor is dynamic, our desire for higher confidence bathymetry extends deeper (e.g. navigate with confidence in 30m when seafloor is flat, not when it's dynamic).



DESIRED COVERAGE

If **COMPLEX** seafloor:

DSS = 100

UKC = [-1,1]

DSS = 80

UKC = [1,40m]

DSS = 30

UKC = [20,100m]

DSS = 10

UKC > 100m



$$\text{Hydrographic Health} = \left(\text{Desired Survey Score} - \text{Present Survey Score} \right)^2 \times \sum \left(\text{Consequence} \times \prod (\text{Likelihood}) \right)$$

A combination of **Seafloor Complexity** and **Under Keel Clearance** will inform the desired **Coverage Requirement**

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SEAFLOOR COMPLEXITY

Data: Standard Deviation of Seafloor Slope (within 5nm)

Std. Dev < 0.15 → "SIMPLE"

Std. Dev ≥ 0.15 → "COMPLEX"

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DESIRED SURVEY SCORE

RANGE: 0 to 100

DSS = 100 Object Detection

DSS = 80 Complete Coverage

DSS = 30 Part. Bottom Coverage

DSS = 10 Lesser Coverage

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DESIRED COVERAGE - DEFINED BY VESSEL TRAFFIC

Data: For AIS records, compute UKC = Draft - Depth; if Draft is unknown, use Depth alone.

If **SIMPLE** seafloor:

DSS = 100 UKC = [-1,1]

DSS = 80 UKC = [1,20m]

or Depth w/ AIS = [2,20m]

DSS = 30 UKC = [20,50m]

or Depth w/o AIS = [2,50m]

DSS = 10 UKC > 50m

or Depth > 50m

If **COMPLEX** seafloor:

DSS = 100 UKC = [-1,1]

DSS = 80 UKC = [1,40m]

or Depth w/ AIS = [2,40m]

DSS = 30 UKC = [20,100m]

or Depth w/o AIS = [2,100m]

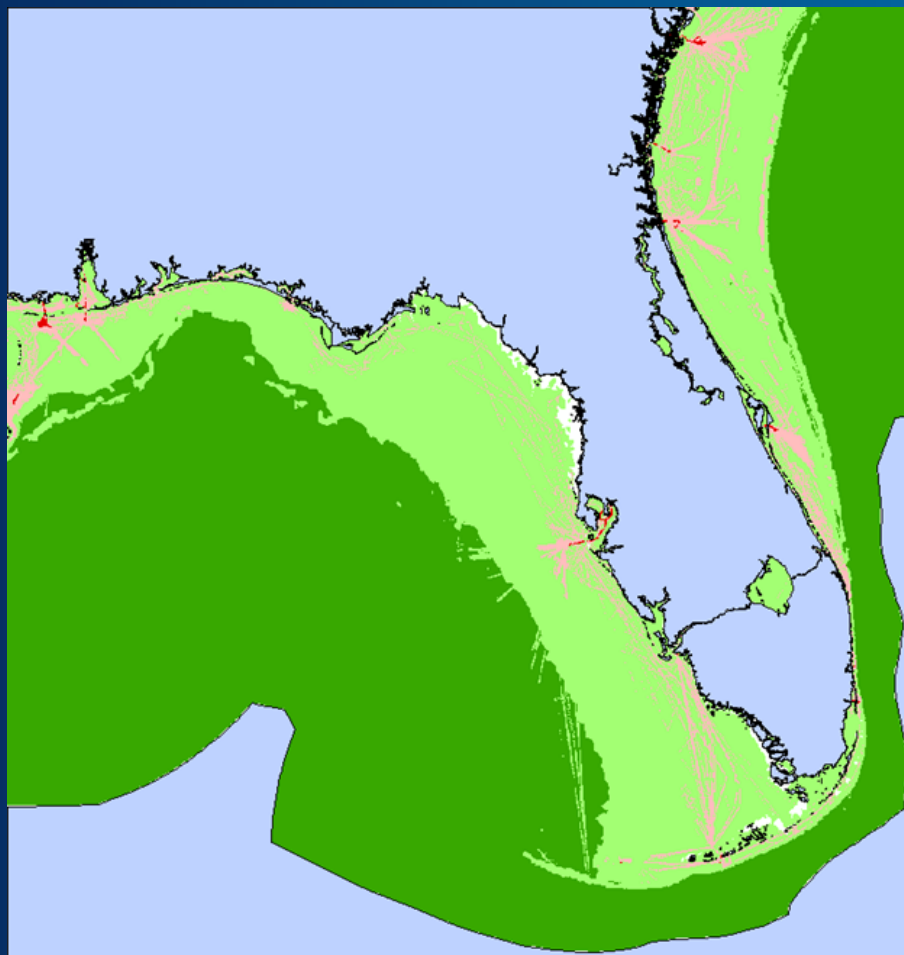
DSS = 10 UKC > 100m

or Depth > 100m



$$\text{Hydrographic Health} = \left(\text{Desired Survey Score} - \text{Present Survey Score} \right)^2 \times \sum \left(\text{Consequence} \times \prod (\text{Likelihood}) \right)$$

Desired Survey Score



DESIRED SURVEY SCORE

DSS = 100 Object Detection

DSS = 80 Complete Coverage

DSS = 30 Part. Bottom Coverage

DSS = 10 Lesser Coverage

Desired Survey Score

Coverage Requirement	Square Nautical Miles
Object Detection	200
Complete Coverage	7,000
Part. Bot. Coverage	48,000
Lesser Coverage	102,000

