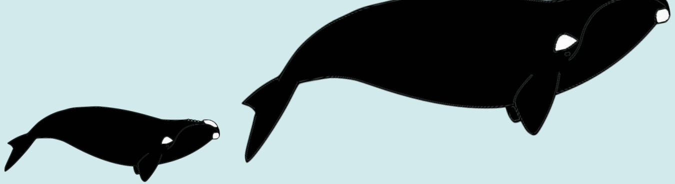
ALWTRT Informational Webinar:
Decision Support Tool Peer-Review Update



June 15, 2023

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TRT Members: Participating in Today's Webinar

Please Note: *Today's event is being recorded* (including anything typed into the questions box) and will be available through the event registration page after the meeting.

Reminders for Team Members:

- Please hold questions until the end
- Use the RAISE HAND function to ask a question
- Include the slide number or topic of your question
- When you are called on, we will un-mute you, and then you will need to un-mute yourself to ask your question
- A PDF of today's slides will be sent to the Team following today's presentation

Non-Team Members: You are welcome, but Q&A time is reserved for Team members.

Recordings of past webinars are available on Atlantic Large Whale Take Reduction Team web page under "Team Meetings." Follow the registration link of the under the recent team meeting and the recording will begin.

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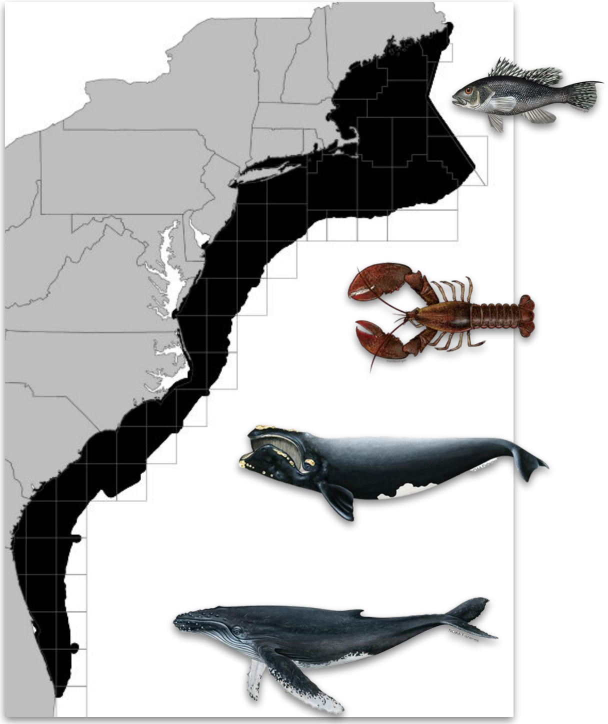

Decision Support Tool Model Peer-Review Update

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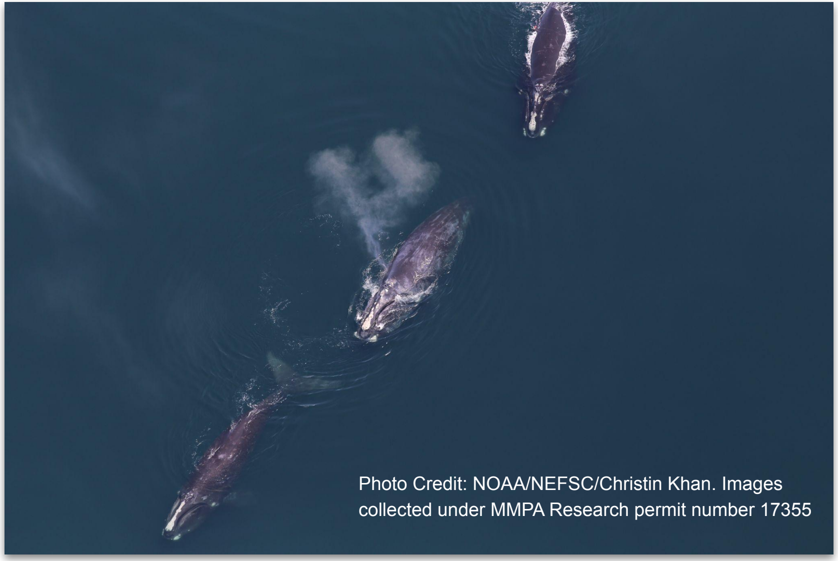
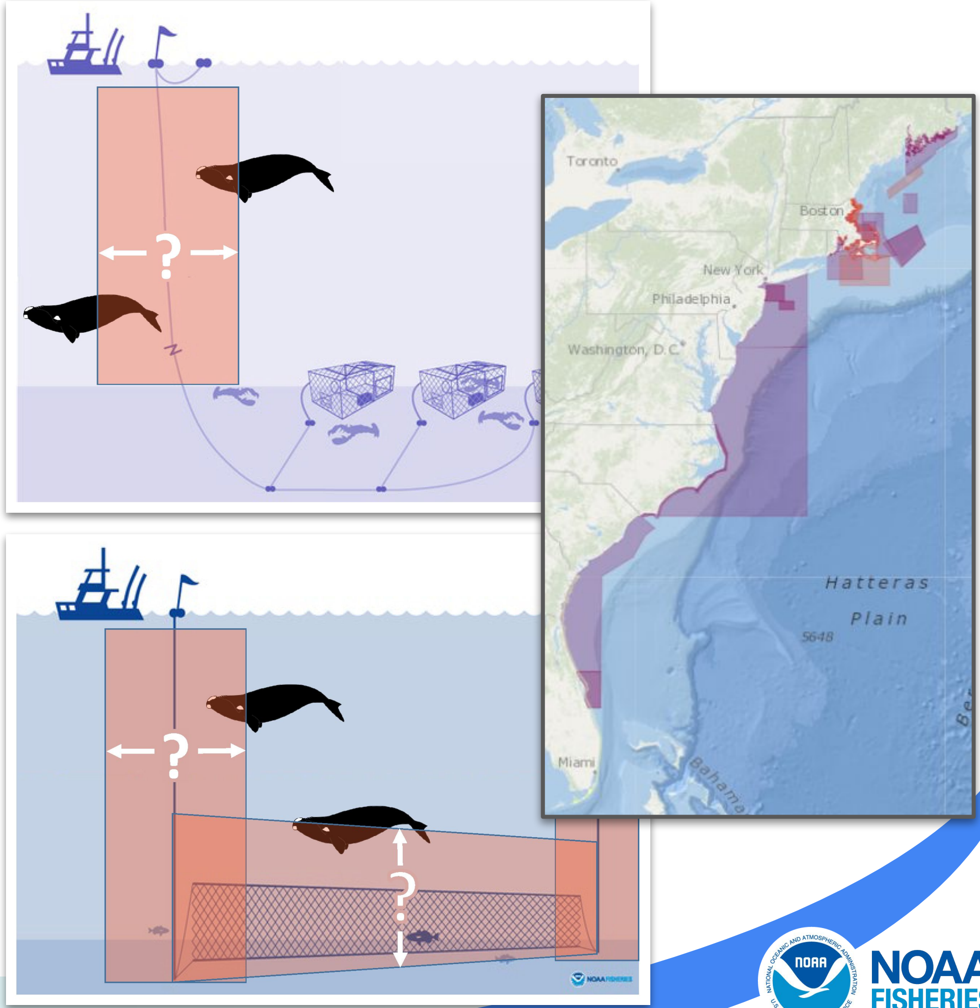
Outline

- Brief overview of the DST Model and the Terms of Reference for the Peer Review
- Overview and Peer Review Responses with Updates to the following sections of the DST
    - Fishery Input Layer
    - Whale Input Layers
    - Threat Model
    - Model Output and Uncertainty
- Current & Future Work



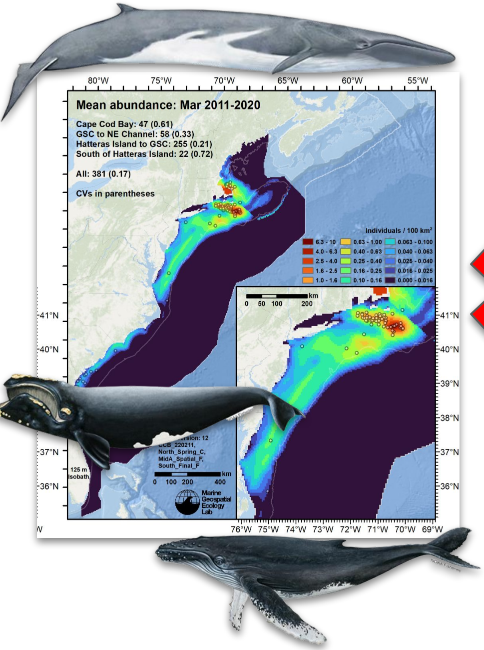
Decision Support Tool

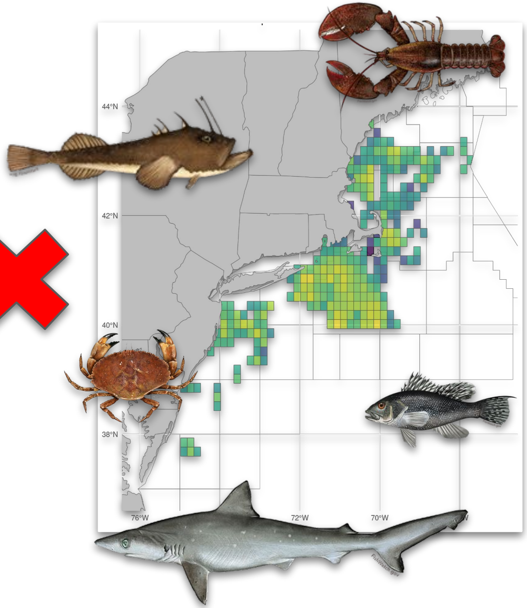
- Tool developed to assist decision-making processes assessing scenarios and allowing stakeholders to rapidly evaluate various candidate management actions.
- Uses an expanded co-occurrence model with estimates of vertical lines overlaid on modeled whale densities based on distance sampling methods and surface density models.
- Considers "Relative Risk Units" (Farmer *et al*. 2016) by incorporating three factors:
    - Distribution of right whales
    - Distribution of vertical lines
    - Relative differences in lethality of various gear configurations and characteristics

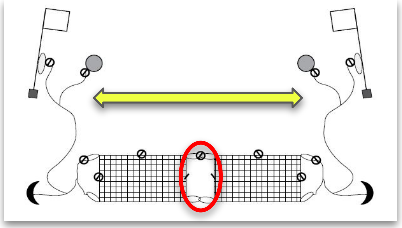


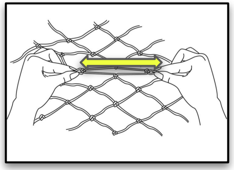
Model Structure

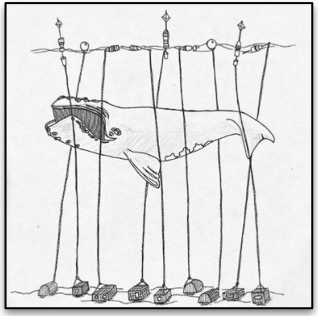
WHALES ✖ GEAR DENSITY ✖ SEVERITY = *RISK

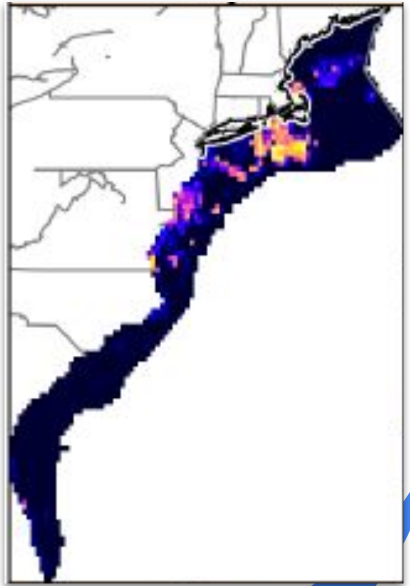












*Calculated for each month and area and summed across all months area locations

Terms of Reference (TOR)

1. Incorporates the U.S. lobster, gillnet, and other trap/pot commercial fishery dependent (i.e., catch) data sets necessary to determine fishing effort and distribution for the Phase 2 and 3 DST,
2. Incorporates spatially and temporally relevant estimates of right whale distribution and densities,
3. Uses appropriate entanglement risk coefficients by gear type,
4. Incorporates appropriate approaches to applying these coefficients to estimate relative risk (and risk uncertainty) of large whales encountering gear, and
5. Using the fishing effort and right whale density data reviewed under TORs 1-2, provides appropriate estimates of risk reduction of large whales encountering gear.

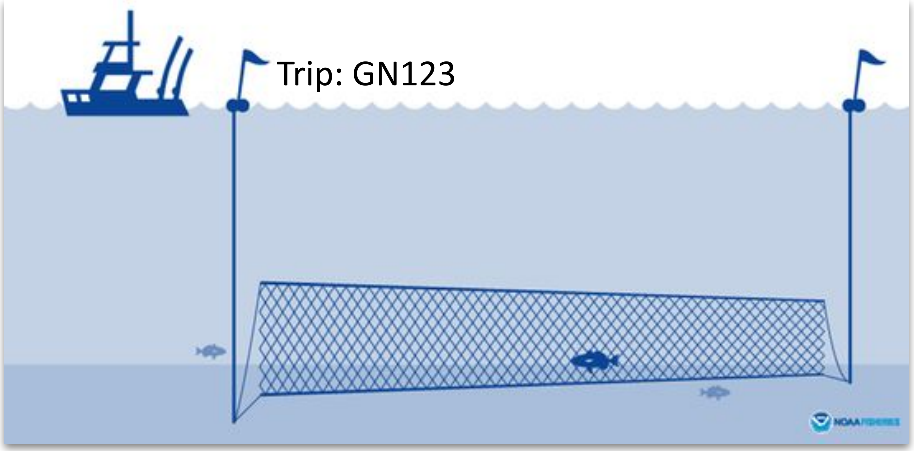
Fishery Input Layers

Fishery Inputs: Construction Overview

TOR 1

- Trip reports are available for gillnet and trap/pot fisheries from a variety of fishery-dependent and -independent sources
- Gear configuration described in trip reports are translated into monthly gear density that are described by the fishery layer

Trip ID	# of Strings	Nets per String	Endlines per String	Gillnet Type	Mesh Size	Net Height (ft)	Net Length (ft)	Soak Time (Days)	Endline Diameter	Head Rope Diameter
GN123	1	1	2	Anchor	Large	?	?	?	?	?



Example: A trip report describing the gear configuration of this gillnet illustration assumes the vessel fished the single illustrated trawl

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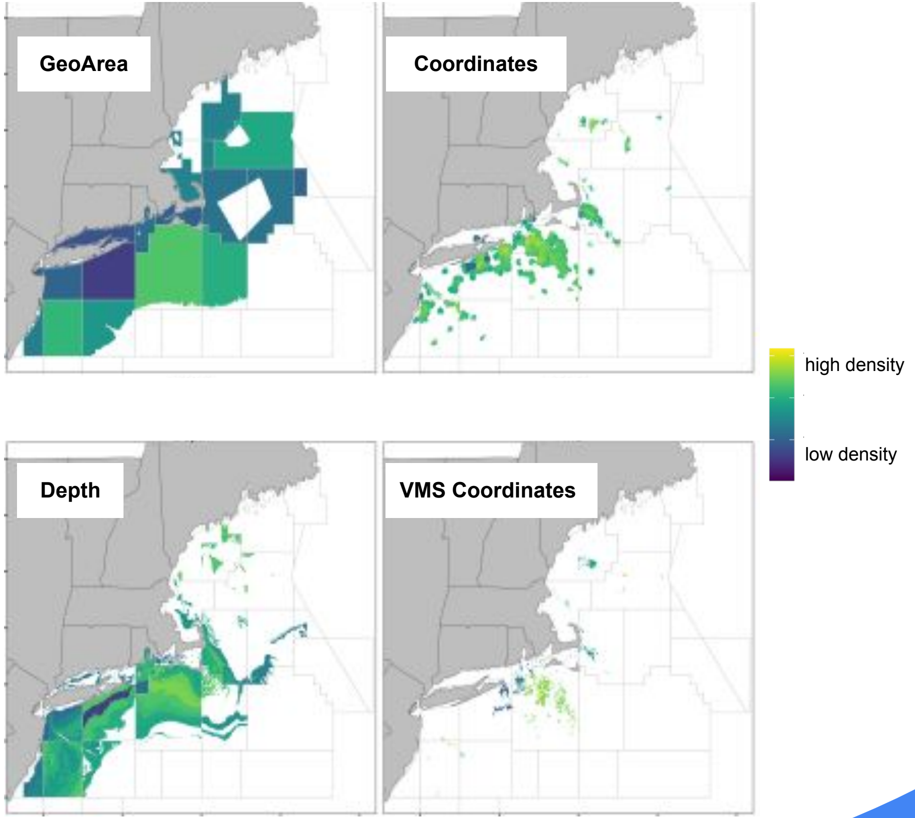
Fishery Inputs: Construction Overview

- Once the gear configuration is determined, the gear density is distributed over space
- Four gear distribution methods are used, depending on the spatial resolution of the trip report data
  - Statistical/SubArea (*GeoAreas*)
  - Statistical/SubArea & Depth (*Depth*)
  - Coordinates (*Coords*)
  - VMS Coordinates



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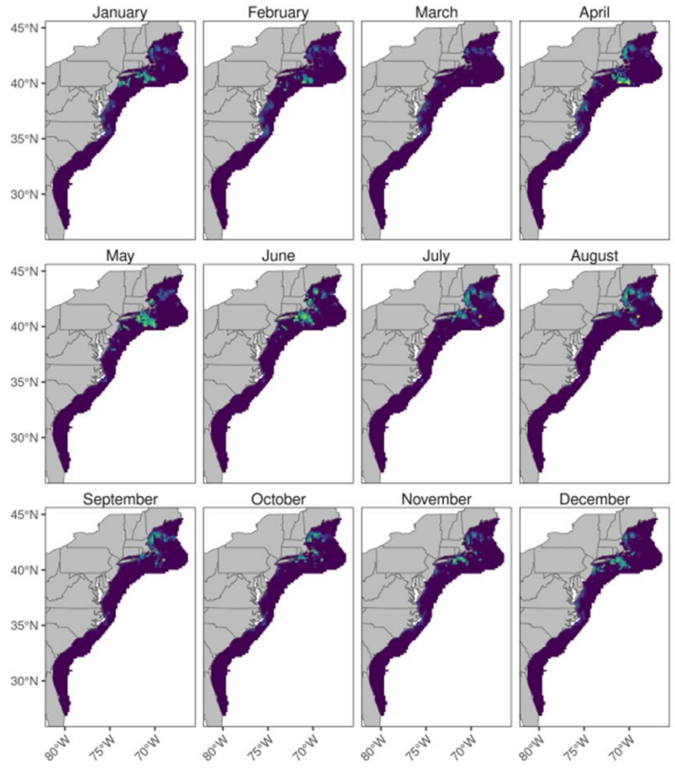
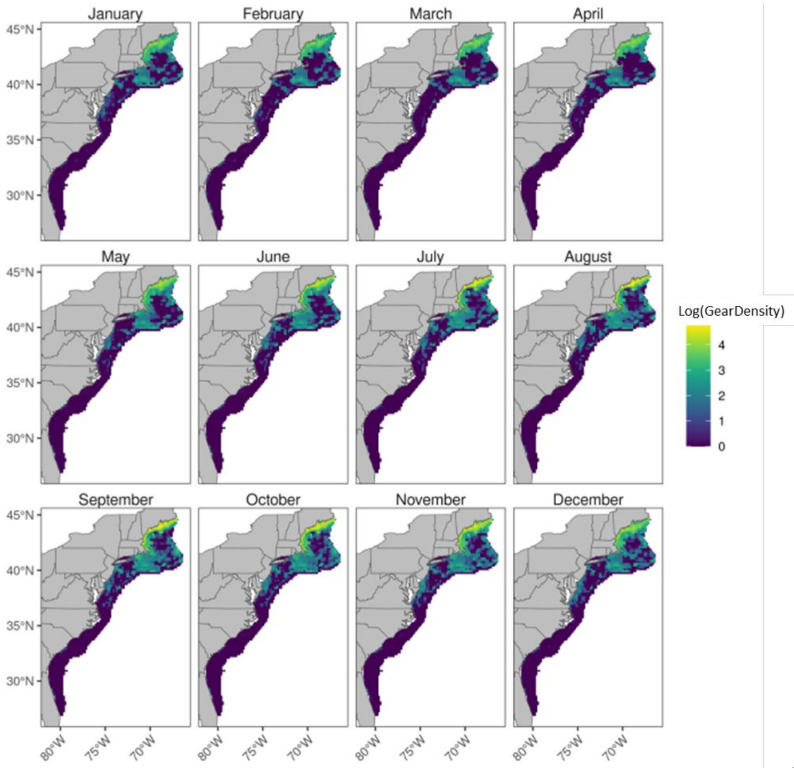
Fishery Inputs: Fishery Layers

Gillnet



Trap/Pot

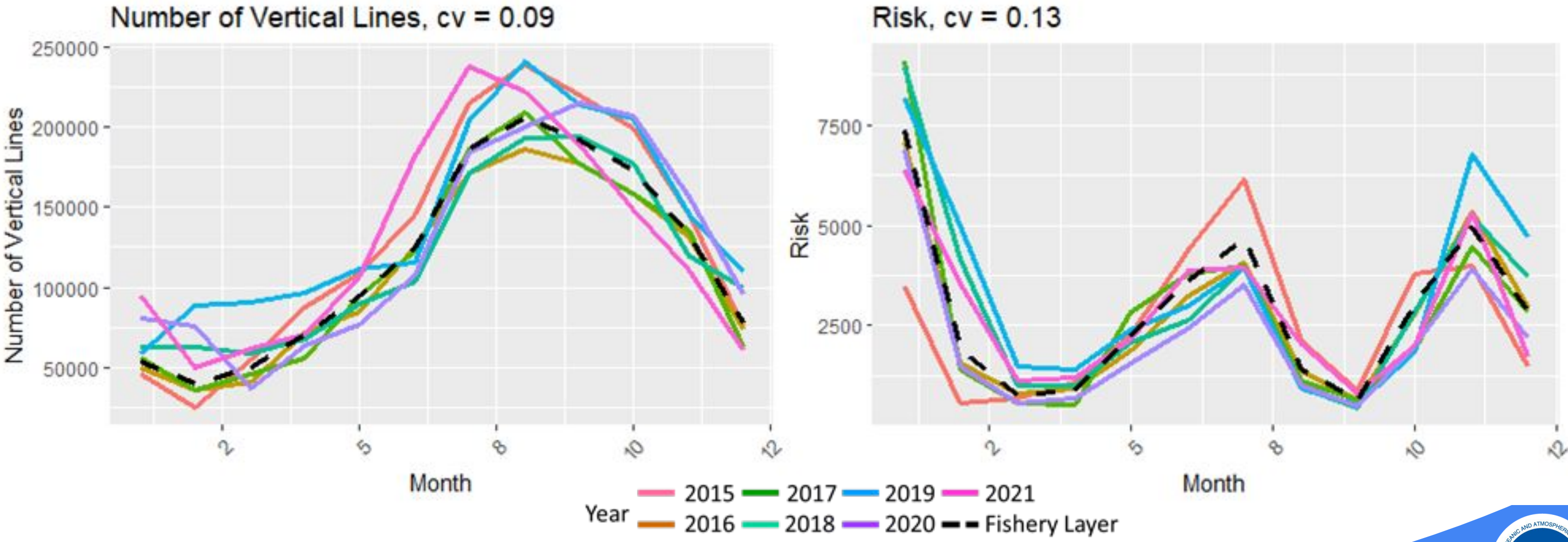


Fishery Inputs: Panel Response

- Panel recognized the extensive work that went into constructing the fishery inputs given the variability in spatial distribution, gear configuration and reporting requirements across fisheries
- In recognition of these uncertainties, panel requested a formal uncertainty analysis be performed to quantify the level of uncertainty in the fishery layer based primarily on…
  a. **Interannual variability in fishery characteristics (distribution, configuration, density)**
  b. **Gear allocation methods for fisheries with low reporting resolution**
  c. **Model resolution (1nm^2 vs. 10nm^2) in consideration of low spatial resolution in some fisheries**

Fishery Inputs: DST Response to Recommendations

a. **Interannual variability in fishery characteristics (distribution, configuration, density)**
   - Federal lobster fishery in LMA 1 used as an example to examine interannual variability in fishing effort and risk
   - The aggregated layer captured the range in effort and risk across years, and prevented the layer from describing single anomalous high or low years of effort
   - **Next Steps: Repeat for remaining fisheries**



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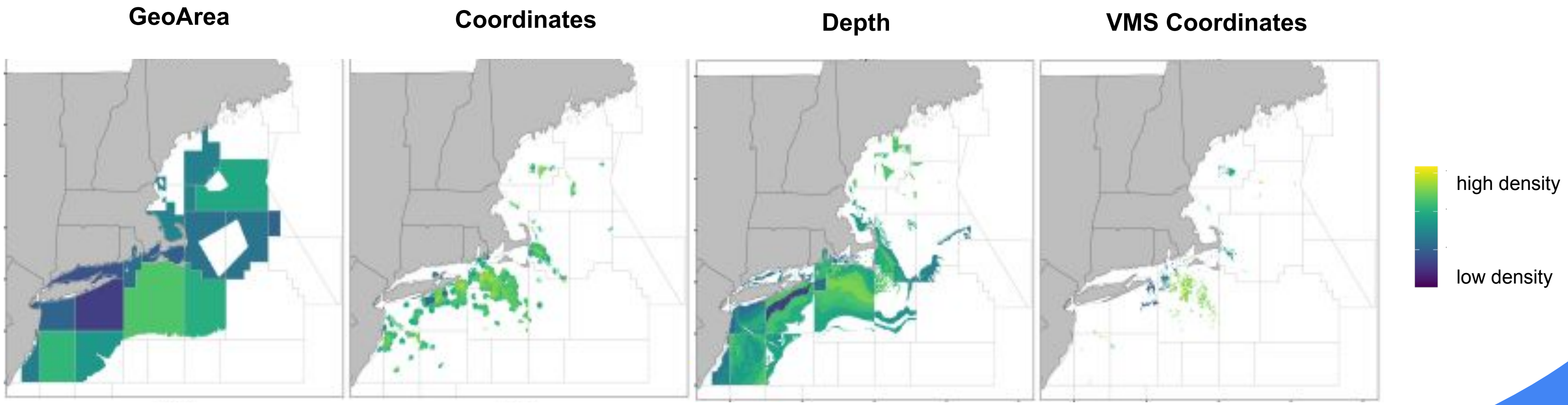
Fishery Inputs: DST Response to Recommendations

b. Gear allocation methods for fisheries with low reporting resolution

- Below are four gear maps generated using the same data, but allocated using each of the four allocation methods (GeoArea, Coordinates, Depth & VMS)
- The VMS map is the most spatially-explicit and should most accurately describe the true fishing effort
- Each gear map has the SAME number of vertical lines, though each map distributes them differently according to what spatial information is available to distribute the lines

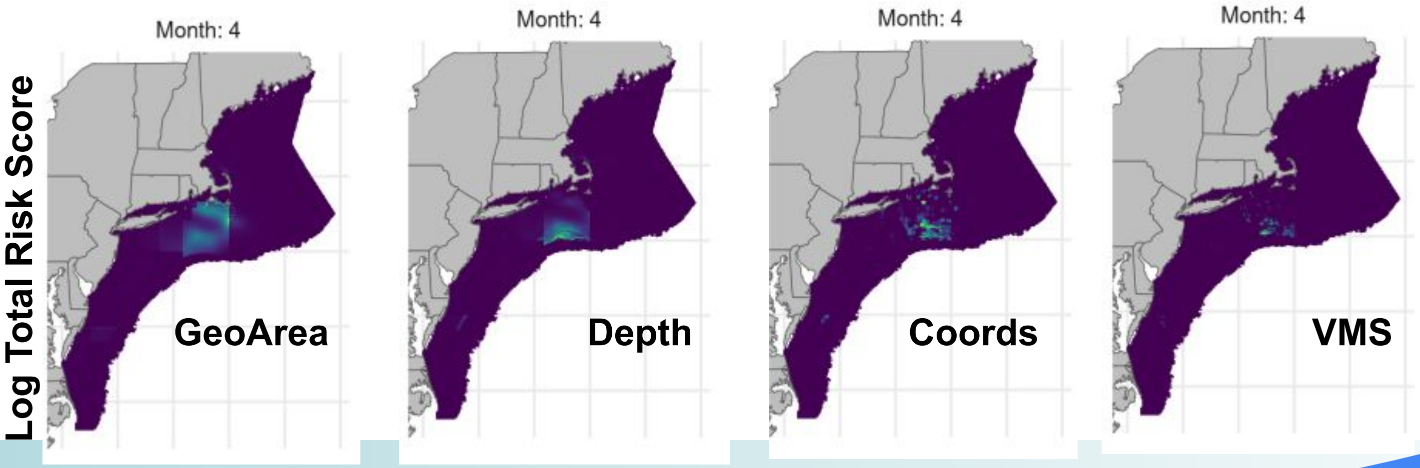


Fishery Inputs: DST Response to Recommendations

b. Gear allocation methods for fisheries with low reporting resolution

- Though the estimated number of vertical lines is nearly equal, distributing those lines across a broader space results in ~2x as much risk as distributing with coordinates
- This is an extreme example, as SNE is a whale hotspot in April, and most federal fisheries have at least some level of coordinate reporting
- The methods with less information on fishery effort distribution (GeoArea, Depth) produce biased-high risk estimates because fishing effort is negatively associated with whale densities in space. If fishing effort was positively associated, the bias would be reversed.

Gear Dist.	CoOc	Risk
GeoArea	29,799	4,908
Depth	21,820	3,836
Coords	13,666	2,433
VMS	11,892	2,129



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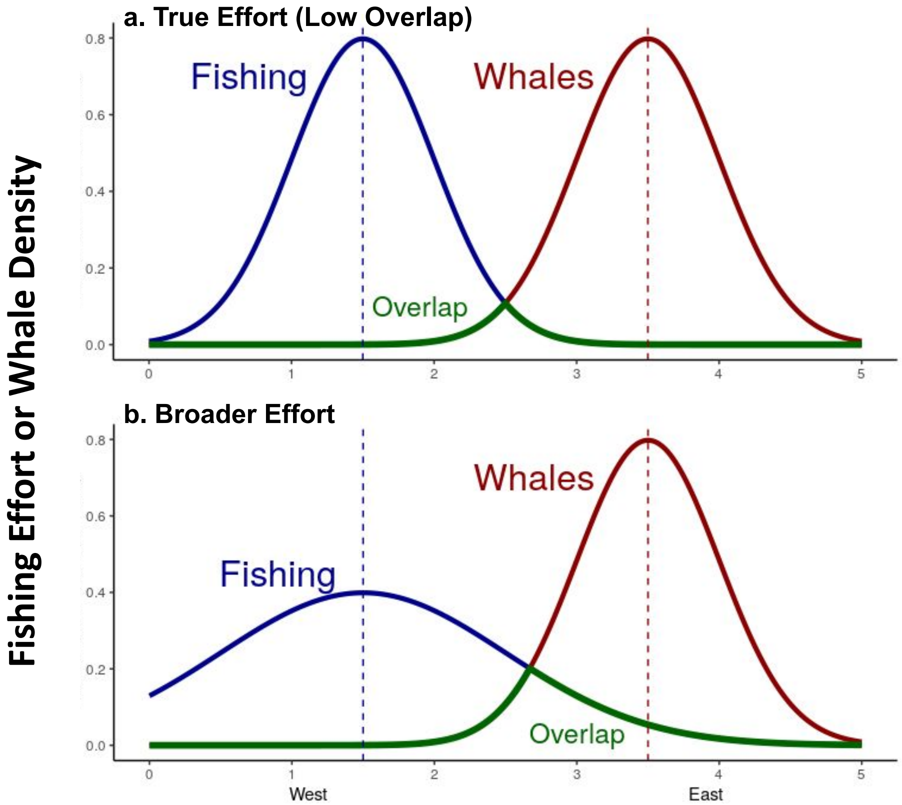
Effects of incorrect effort allocation on risk estimates

TOR 3, 4

- In the previous example, incorrectly spreading fishing effort too broadly resulted in biased high risk estimates.
- It is important to note that, in cases where we don't have good spatial data, the bias associated with allocating gear in space depends on both how actual fishing effort is spatially distributed, relative to whale presence, and if fishing effort is spread too broadly or too narrowly.

Effort Distribution	Spatial Relationship between Fishing and Whales: High Overlap	Spatial Relationship between Fishing and Whales: Low Overlap
Too Broad	Biased Low	Biased High
Too Narrow	Biased High	Biased Low

Effects of incorrect effort allocation on risk estimates: Example of Low Overlap / Broad Allocation

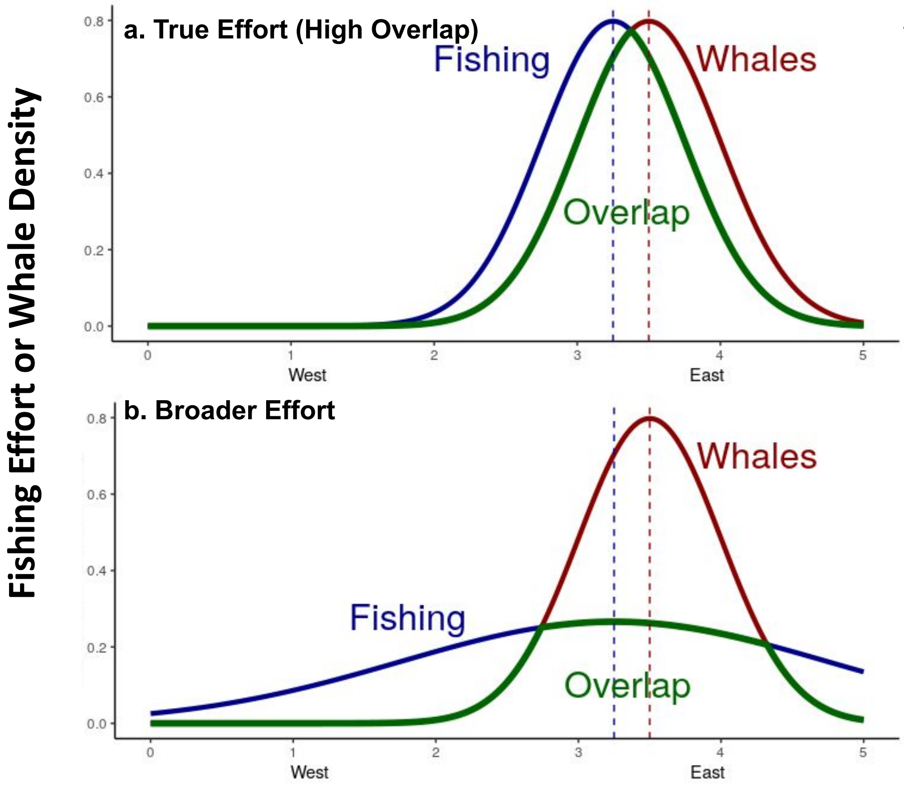


Assume top panel is the “true” relationship.

a. **True Effort (Low Overlap)**
   - Fishing minimally overlaps with whales
   - Small amount of risk

b. **Effort Broadly Distributed in Gear Map**
   - If fishing is spread too broadly, the overlap **increases** and a **higher** level of risk is estimated
   - If fishing effort was instead allocated too **narrowly**, the overlap would would **decrease** and a **lower** level of risk would be estimated

Effects of incorrect effort allocation on risk estimates: Example of High Overlap / Broad Allocation



Assume top panel is the “true” relationship.

a. **True Effort (High Overlap)**
   - Fishing overlaps extensively with whales
   - Large amount of risk

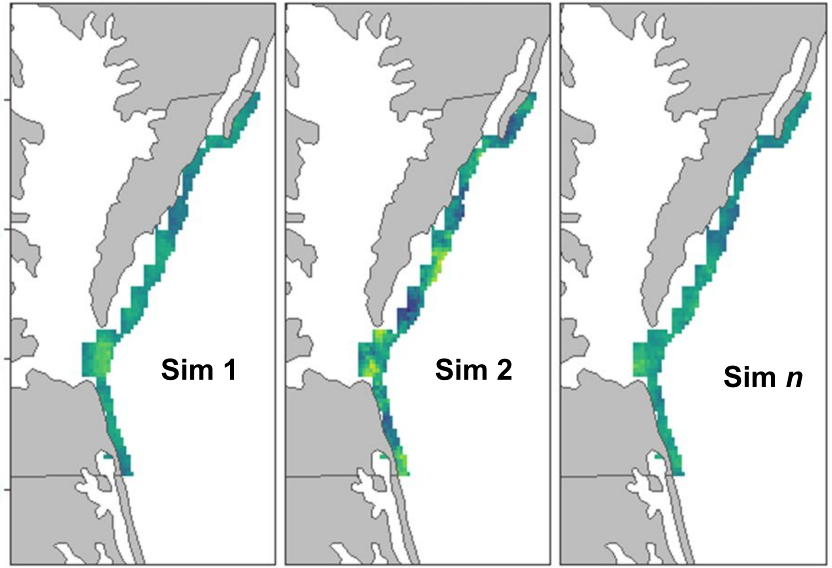
b. **Effort Broadly Distributed in Gear Map**
   - If fishing is spread too broadly, the overlap **decreases** and a **lower** level of risk is estimated.
   - If fishing effort was instead allocated too **narrowly**, the overlap would would **increase** and a **higher** level of risk would be estimated

Fishery Inputs: DST Response to Recommendations

b. Gear allocation methods for fisheries with low reporting resolution

- Second analysis simulated 1000 line density maps for a state OTP fishery with on SubArea reporting resolution
- Co-occurrence from the baseline fishery layer was within 5% of the simulated mean
- **Next Steps: Repeat for remaining fisheries with low reporting resolution**

Simulated Line Density Distribution



Distribution of Simulated Co-Occurrence

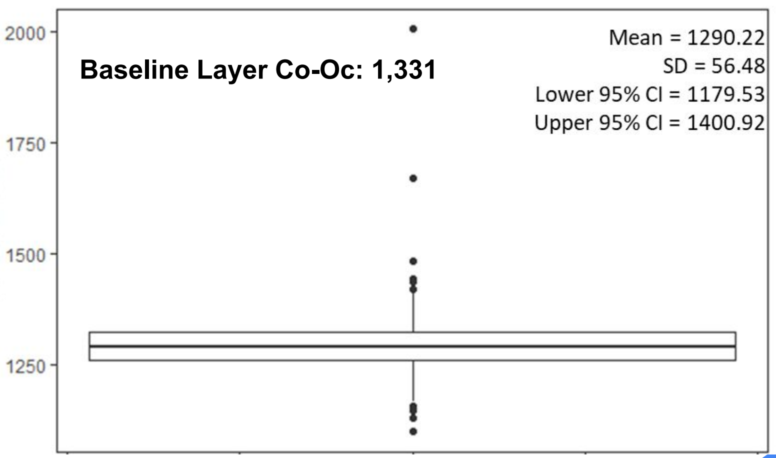



Photo Credit: NOAA/NEFSC/Christin Khan. Images collected under MMPA Research permit number 17355

Whale Input Layers

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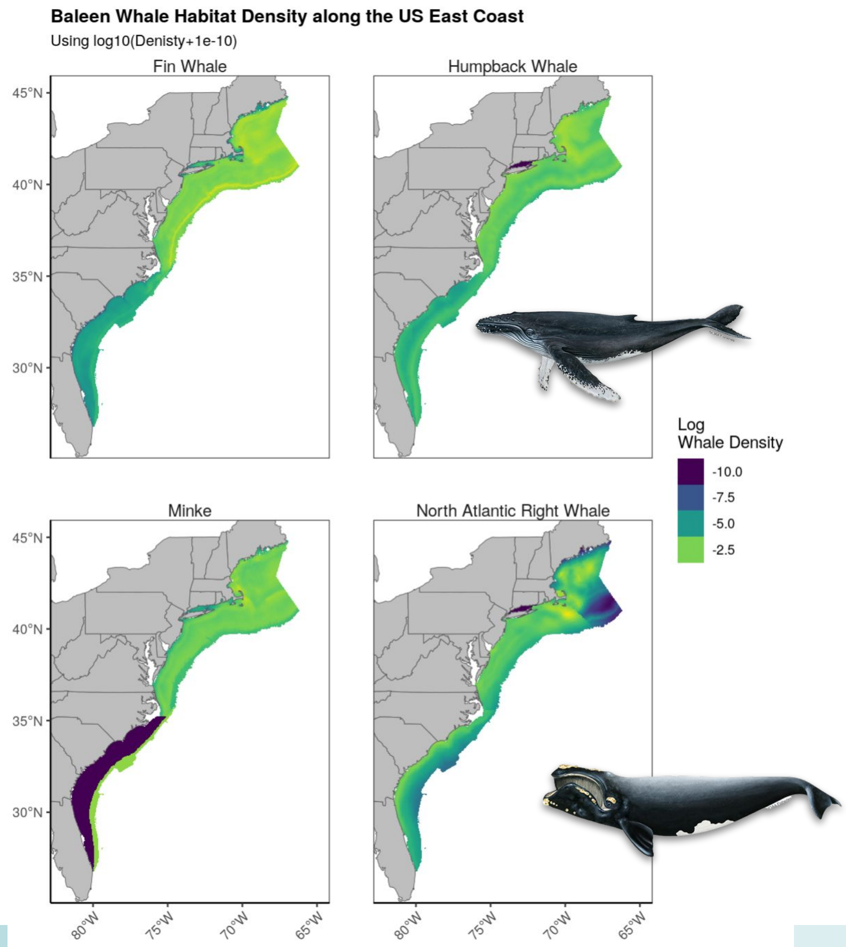
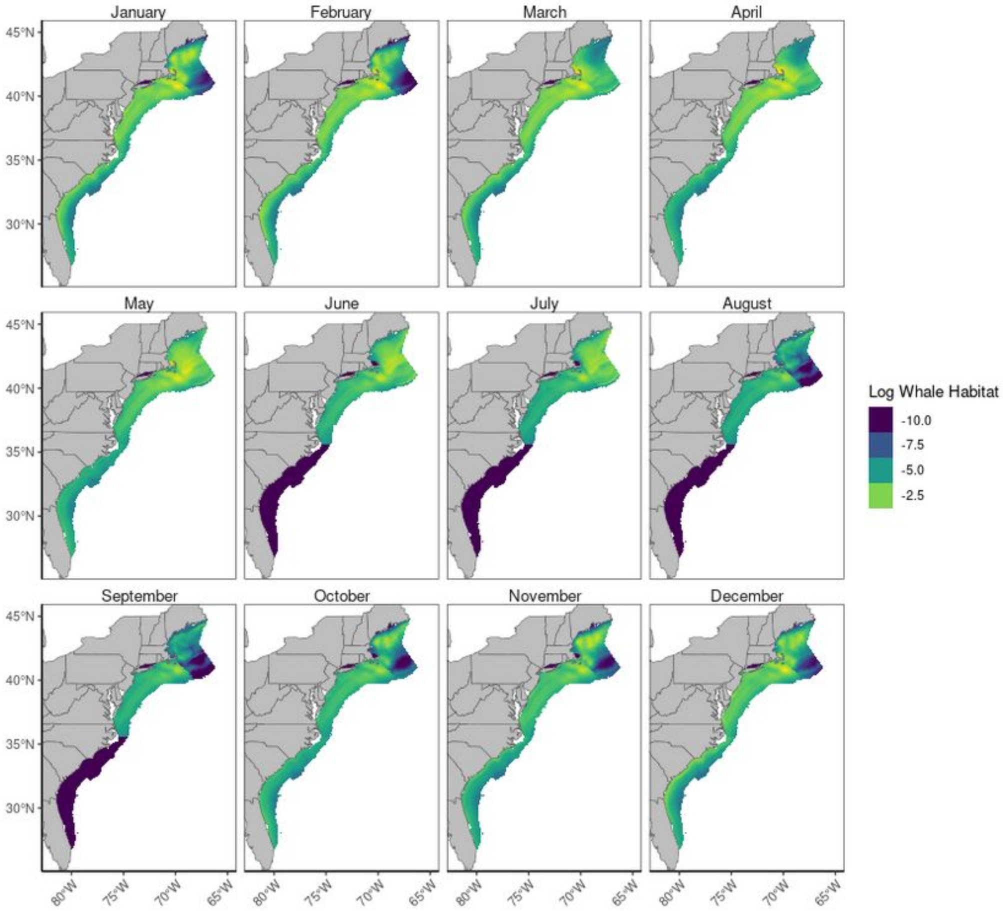
Whale Habitat Density Layer: Overview

TOR 2



- The DST model relies on the whale habitat density model built independently by Jason Roberts *et al.* team at Duke University.
- The model uses whale sightings data from various sources, that correspond with oceanographic and habitat variables for predicting whale habitat density at a given location.
- We have whale habitat data for:
    - North Atlantic Right Whale (2003- Sept 2020)
    - Humpback Whale (2009-2019)
    - Fin Whale
    - Minke Whale

Whale Inputs: Panel Response



1. The Panel is concerned with the complexity of the Duke whale habitat model and recommends that the DST explores or generates alternative whale models.
2. They also questioned how the Roberts et al. model compares to the fishery input layers in terms of spatial and temporal scale.
3. Quantify scientific uncertainty in the whale Surface Density Maps

Whale Inputs: DST Response to Panel Recommendations

1. The Duke whale habitat model:
   a. Produced externally, built and peer reviewed through a separate process from the DST. The updated versions have been tailored for the needs to the DST and to address concerns to the stakeholder.
   b. To our knowledge it is currently the best model of right whale density readily available for US waters
   c. We would welcome the development of other whale models and incorporate them into the DST model structure as alternatives.


Photo Credit: NOAA/NEFSC/Christin Khan. Images collected under MMPA Research permit number 17355

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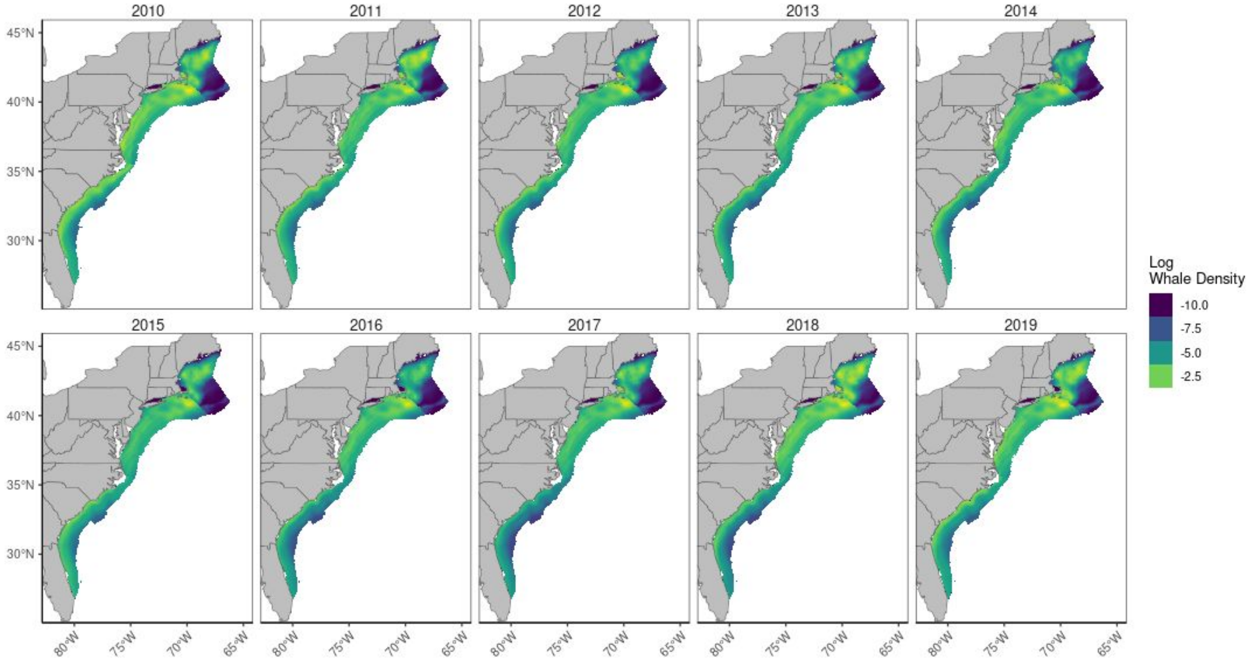
Whale Inputs: DST Response to Panel Recommendations

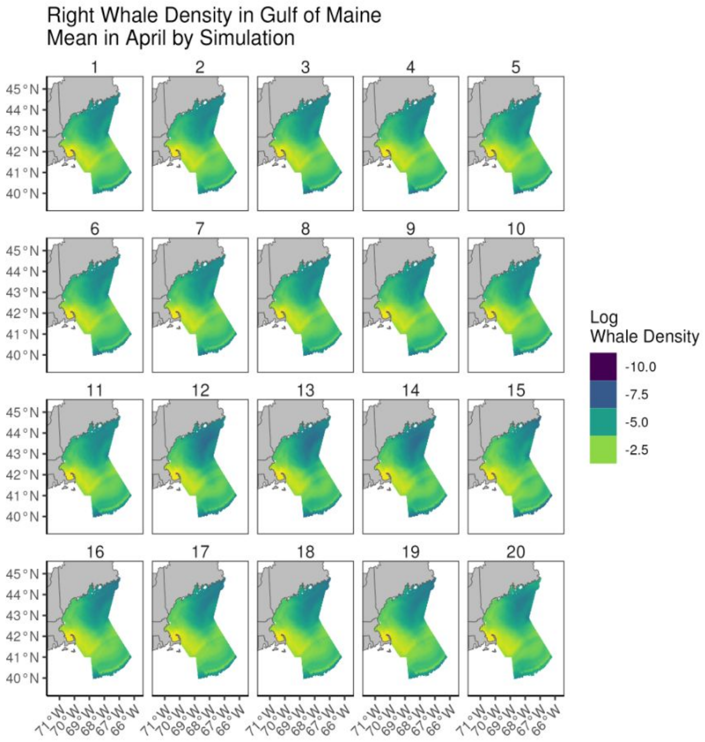
2. Dealing with Spatial Resolution
   a. Both the Duke and DST models are produced at monthly resolutions. We re-cast the Duke model (5 or 10km grid cells) to the higher resolution grid used in the DST (1 Nm) so spatial density structures produced by the Duke model are not lost in adapting to the DST.
   b. Predicted whale densities by year are available for some whale species. This allows us to assess the effectiveness of management actions across different years.

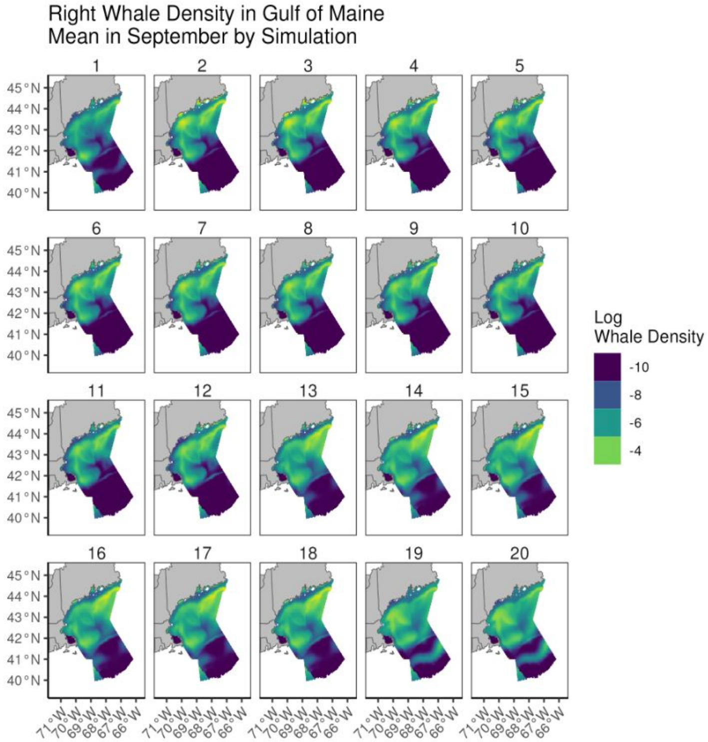


Whale Inputs: DST Response to Panel Recommendations

Dealing with Uncertainty of the Whale Habitat Density

3. For Right Whales, Roberts *et al*. have simulated 200 alternative whale density models produced, based on resampling whale model parameters, by month and year across the time series.
    - This does not include uncertainty from whale survey data or selection of parameters for the whale model.





Whale Inputs: DST Response to Panel Recommendations

Methods to Quantify Uncertainty:

We explore uncertainty in the whale layer by applying each of the simulated whale layers to the line density maps from a DST model run and examine how much risk reduction varies across the alternative whale maps.

For Example:

Management Scenario: Gear Cap of 200 gear units for all fisheries in Stat Area 537. Applied to 20 Whale Simulations

Results:

Distribution of Simulated Co-Occurrence Reduction

Mean: 67.32% (Original 65.3%)
Standard Deviation: 1.27
95% Lower CI: 64.7
95% Upper CI: 68.8

Individual simulations have different baseline risk due to different whale abundances, but the management action perform similarly

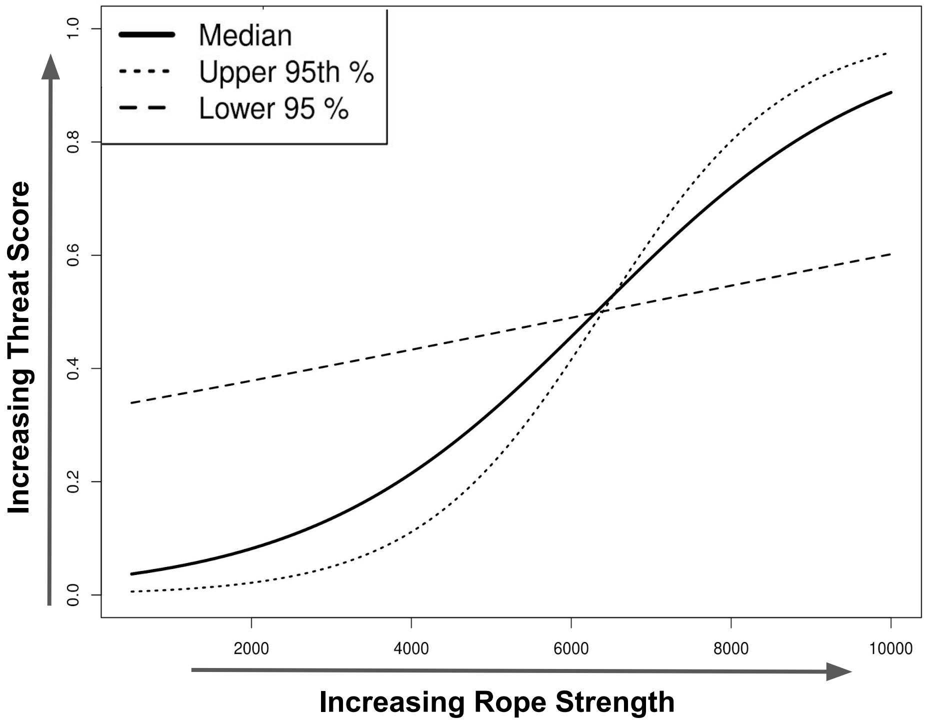
Sim	Baseline	Scenario	Reduction
1	53864.21	19385.98	64 %
2	56806.05	20197.45	64.4 %
3	74220.6	23509.35	68.3 %
4	74220.6	23509.35	68.3 %
5	74220.6	23509.35	68.3 %
6	74220.6	23509.35	68.3 %
7	66191.41	21713.66	67.2 %
8	63655.31	21245.09	66.6 %
9	65361.57	21536.85	67 %
10	65361.57	21536.85	67 %
11	64436.08	21181.95	67.1 %
12	66393.96	21364.49	67.8 %
13	67999.86	21593.29	68.2 %
14	67999.86	21593.29	68.2 %
15	70335.58	21957.47	68.8 %
16	68132.95	21225.11	68.8 %
17	61391.91	20150.49	67.2 %
18	61391.91	20150.49	67.2 %
19	61184	20349.74	66.7 %
20	60088.7	19803.46	67 %

Threat Model

Threat Model: Rope Strength and Risk

TOR 3, 4, 5

- Co-occurrence and relative risk threat are reported for management scenarios run through the DST, relative to the “baseline” co-occurrence and relative risk estimated pre-Phase 1
- While co-occurrence simply reports the estimated overlap between gear and whale density, risk is the product of a threat model (Knowlton et al. 2010), which estimates risk to serious injury or mortality as predicted by rope strength
- The DST also reports upper and lower bounds of risk from the 95% confidence intervals of the threat model.



Threat Model: Panel Response

- Considering the importance of "weak" rope (1,700lbs) in TRT management discussions, and the uncertainty around its utility to reduce entanglement risk, the panel asked "**What would be the outcome of the analysis if this assumption was incorrect, and breaking strengths need to be reduced to much lower levels?"**

Threat Model: Subsequent Analysis

- First analysis imposed 100% weak rope coastwide
- Co-occurrence effectively assumes that weak rope contributes no reduction in risk, while threat models estimate varying levels of reduction
- This scenario is unrealistic to represent as a management package, so next analysis examined the contribution of weak rope to risk reduction estimated by Phase 1 measures

Risk or Co-Occurrence Reduction

	100% Weak Rope (1,700 lbs)
Co-Occurrence	0.0%
Risk- Lower 95% Threat Model	7.0%
Risk- Median Threat Model	49.5%
Risk- Upper 95% Threat Model	75.8%

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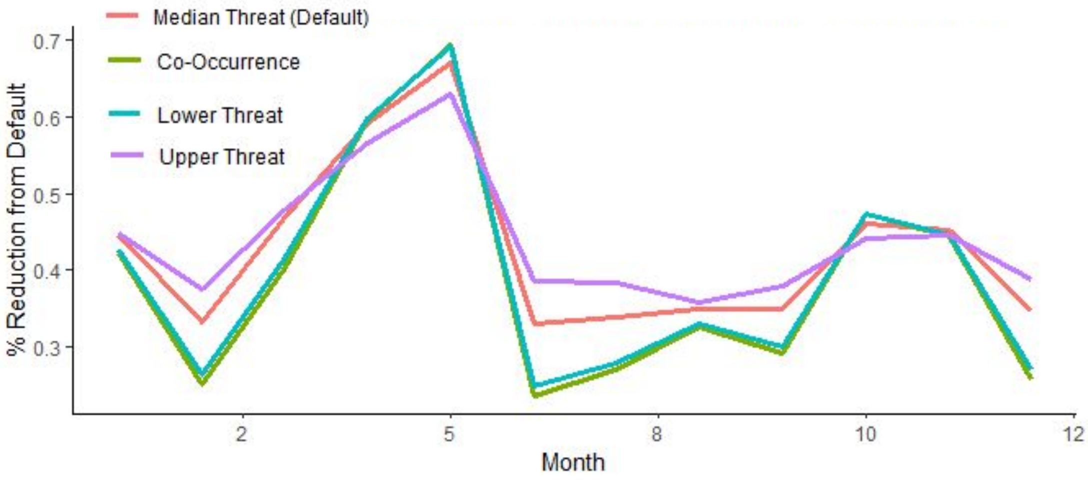
Threat Model: Subsequent Analysis

- Phase 1 management scenario applied in the DST
- Co-occurrence and the three threat models were used to estimate risk reduction

Risk or Co-Occurrence Reduction

	Phase 1 Measures
Co-Occurrence	43.7%
Risk- Lower 95% Threat Model	44.2%
Risk- Median Threat Model	46.5%
Risk- Upper 95% Threat Model	46.8%



- Assuming weak rope of 1,700 lbs does contribute to the estimate of risk reduction, co-occurrence will continue to act as a metric unaffected by the threat model and available as concerns for uncertainty of the threat model are considered

Model Output and Uncertainty

Model Output and Uncertainty: Panel Response

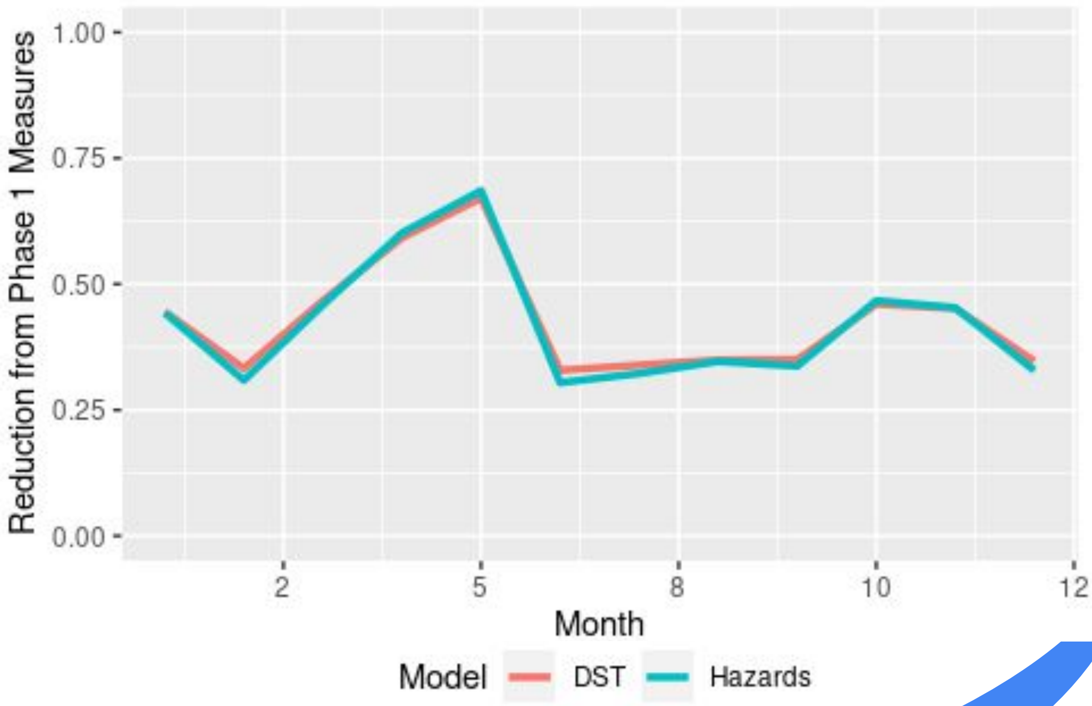
Understanding uncertainty in the DST was a consistent theme throughout the peer review

a. Reformulate risk units into instantaneous hazards to create more meaningful measure of risk
b. Investigate uncertainty arising from spatial precision and understand the impact of the DST run in low resolution (10 nm^2) versus high resolution (1 nm^2). Is 1 nm^2 resolution appropriate given the low spatial resolution of some fisheries?

Model Output and Uncertainty : DST Response

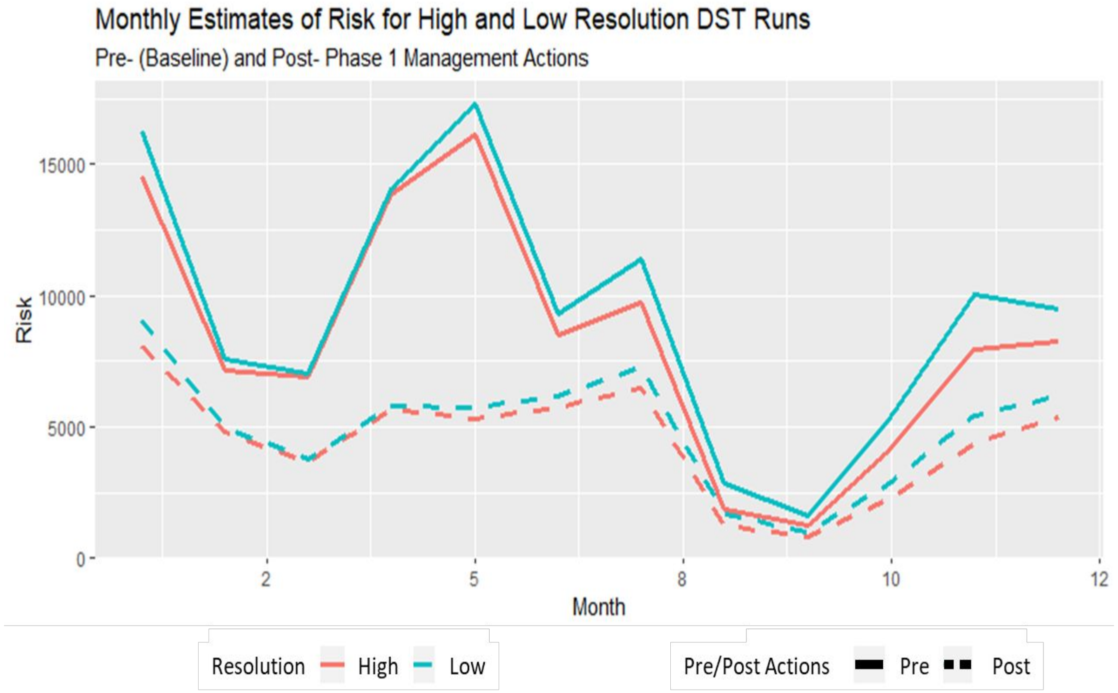
a. **Reformulate risk units into instantaneous hazards to create more meaningful measure of risk**

- A simple hazards approach was constructed using the baseline fishery input layer and a scenario of Phase 1 management measures.
- Overall the resulting risk reduction was nearly identical to that from the DST assessment.
- The benefits of this approach and initial results support including this metric in the DST framework moving forward.
  - Ability to estimate annual survival and mortality rate due to entanglement
  - Clearer parameterization and uncertainty within the model
  - Methodology familiar across other biological risk assessment work



Model Output and Uncertainty : DST Response

b. **Investigate uncertainty arising from spatial precision and understand the impact of the DST run in low resolution (10 nm^2) versus high resolution (1 nm^2). Is 1 nm^2 resolution appropriate?**



- DST currently has the functionality and flexibility to be run at low and high resolution
- When comparing low and high resolution runs of a fisheries baseline and Phase 1 measures, the low resolution model run consistently generates slightly higher estimates of risk than the high resolution model run. Aggregated across months, this amounts to ~10% difference in risk, or ~10,000 risk units.

Model Output and Uncertainty : DST Response

b. **Investigate uncertainty arising from spatial precision and understand the impact of the DST run in low resolution (10 nm^2) versus high resolution (1 nm^2). Is 1 nm^2 resolution appropriate?**

Month	Percent Risk Reduction Management Scenario		
	Low Resolution	High Resolution	Difference (Low - High)
January	44.4%	44.5%	-0.1%
February	34.0%	33.3%	0.7%
March	46.4%	46.7%	-0.3%
April	58.5%	59.2%	-0.7%
May	66.9%	67.1%	-0.2%
June	33.8%	32.9%	0.9%
July	36.2%	33.9%	2.3%
August	40.6%	34.9%	5.7%
September	39.0%	35.0%	4.0%
October	46.4%	46.0%	0.4%
November	46.0%	45.2%	0.8%
December	35.0%	34.7%	0.3%
All	46.6%	46.5%	0.1%

- In general, the difference between a high and low resolution DST run had negligible impact on risk estimates for fisheries reporting only effort at the coarse scale of a statistical area/subarea.
- In months where discrepancies were present, the low resolution model tended to overestimate risk reduction relative to the high resolution model
  - Largely occurred during months of low whale density

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Current and Future Work: Peer Reviewed Publications and Documentation

1. DST model documentation in review as NOAA Tech Memo. (In review)
2. Peer-reviewed publication on the fishing effort allocation methods and sensitivity of assumptions. (Expected to submit early Summer 2023)
3. Peer-reviewed publication on the core structure and methods employed within the DST. (Expected to submit mid Summer 2023)
4. Designing a simulation study to examine uncertainty in spatial allocation of fishing effort and resulting risk distributions. (Draft manuscript for peer-review expected early 2024)

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Current and Future Work: Incorporating New Data

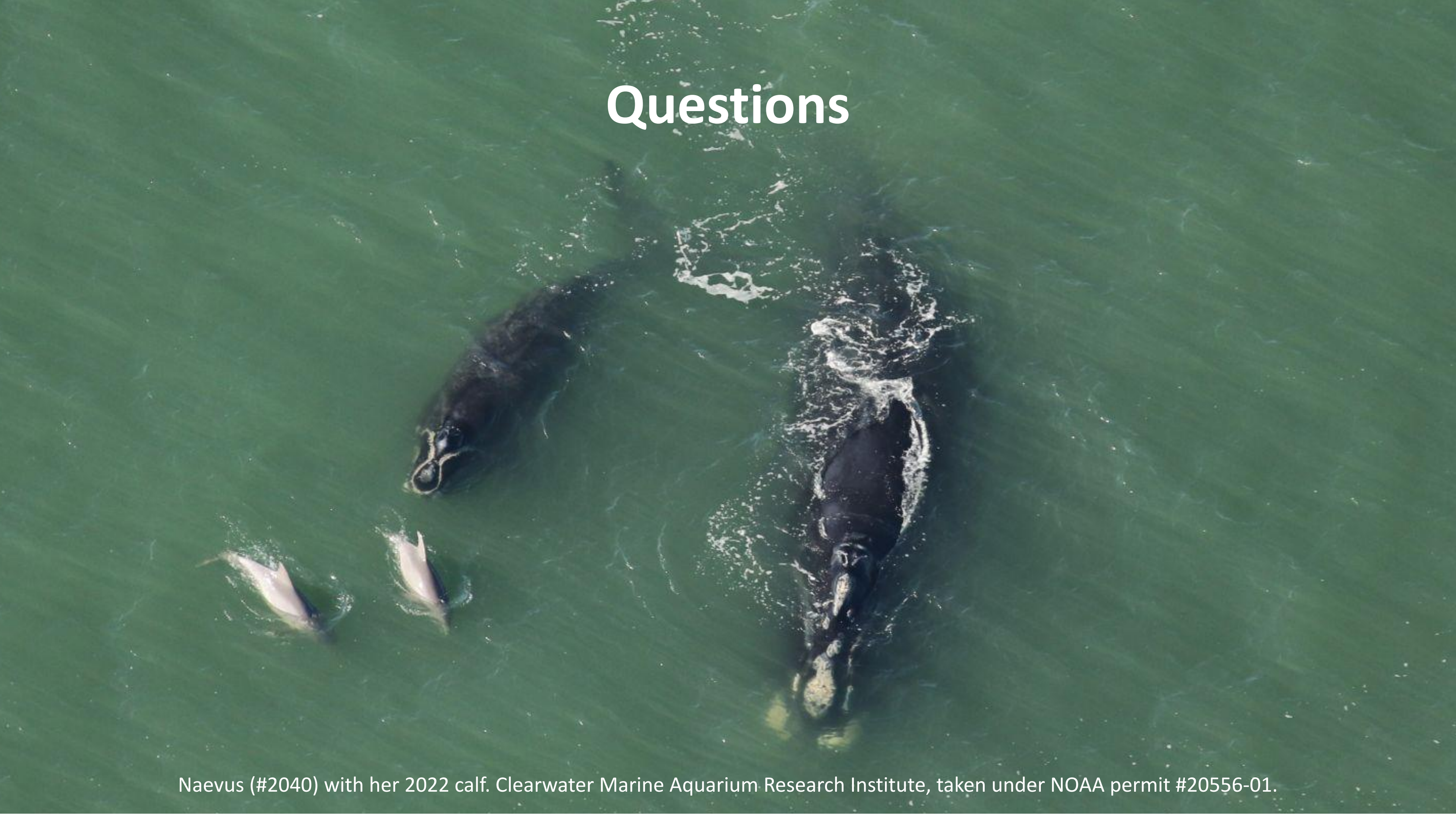
1. **Updated Fishery Inputs**
   a. Include data through 2022. (Expected late 2023)
   b. Future iterations will benefit from increased reporting and vessel tracking requirements
2. **Vertical Whale Distribution**
   a. Work closely with colleagues from the ship strike team as the develop models for the vertical distribution of whales and how we can best represent gillnet fisheries that are fishing off the bottom

Georgia Department of Natural Resources under NOAA permit #15488.

Current and Future Work: Addressing Additional Recommendations

1. **Graphical Representation of Uncertainty** - As uncertainty is better incorporated into the model, we will work on providing additional graphics as part of our model outputs that can help inform stakeholders in the decision making process.
2. **Consider Estimating Management Uncertainty**
   a. DST assumes 100% compliance.
   b. Lack of quantitative data available on compliance rates. We look forward to working with managers to determine if we can estimate management uncertainty.

Questions



Naevus (#2040) with her 2022 calf. Clearwater Marine Aquarium Research Institute, taken under NOAA permit #20556-01.

Policy Update: Weak Rope/Insert Analyses

- The 2021 rule analyses: inserts every 40 ft = full weak line
- We are now using an interval of 60 ft = full weak line
- Updated Phase 1 estimates for consistency:
  - ~1 to 2% increase in risk reduction
  - ~48% risk reduction relative to all ALWTRP fisheries
  - ~52% risk reduction for the NE lobster and Jonah crab fisheries alone

Note: this does not change the number of inserts required under the ALWTRP, only how they are analyzed. Currently, most areas require inserts every 60 feet or a specific number of inserts. See the current requirements from the 2021 rule for more information.

Policy Update: Added New Right and Humpback Whale Incident Sheet (2000-2021) to the ALWTRT Google Drive Folder

Name ↑
2021 Materials
2021- June/July Meeting Materials
2022 December Meeting Materials
2022 May - Meeting Materials
2022 November Meeting Materials
2022 September Meeting Materials
2022- March ALWTRT Getbacks
April 2019 Team Meeting Materials
Large Whale Info
Offshore Weak Rope Discussion Resources
Right Whale Spatial Distribution Model Maps

Old Tables
2000-2021_right and hback incidents for ALWTRT
2019 Entanglement Report.pdf
Gillnet locations - Mn & Eg

*Contact Jennifer Goebel if you are a new member and need access to the Google Drive folder

NOAA FISHERIES

Next Steps

Rulemaking: Gillnet & Non-Lobster Trap/Pot Timeline

- Proposed Rule, Public Comment ~ **April/May 2024**
- Final Rule Published by **May 2025**
- Implement by **December 2025**

Take Reduction Team

- Annual monitoring meeting next Spring
- Continue monthly updates via email