
# Spatial Stock Assessment Methods: International Approaches & Advancements

## WEBINAR

## An Introduction to the Project and Study Design

May 17, 2021

**Working group:** Caren Barceló (ECS Fed. in support of NOAA), Aaron Berger (NOAA), Jennifer Devine (NIWA), Alistair Dunn (Ocean Enviro.), Daniel Goethel (NOAA), Simon Hoyle (NIWA), Patrick Lynch (NOAA), Craig Marsh (UofA, NIWA), Jeremy McKenzie (NIWA), Sophie Mormede (SoFish)

**Steering Committee:** Paul DeBryun (IOTC), Rich Little (CSIRO) , Pamela Mace (NZ Fisheries), Mark Maunder (IATTC), Rick Methot (NOAA), Richard O'Driscoll (NIWA)

# Webinar House Keeping

- Please make sure you are muted (thanks!)
- Please add questions to chat box & please be succinct!
- There will be space for question/answer session in the middle & at the end of the presentation during which time you are welcome to unmute (when prompted).
- Webinar is being recorded and provided to participants (along with slide deck) afterwards.
- Github link: https://github.com/carenbarcelo-NOAA/Spatial-Assessment-Modeling-Workshop

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# Outline of Webinar

- Objectives
- General outline of experimental design
- Plans for results (what is in it for you?)
- Brief pause for big picture questions
- Description of OM and datasets
  - SPM simulator background
  - Description of yellowfin tuna operating model
  - Datasets being provided to analysts
- Github
- Communication during experiment
- Question & Answer

# Spatial Stock Assessment Methods

- A wide range of methods and assumptions can be applied to modeling spatial dynamics.
- The assemblage of methods for modeling spatial dynamics in assessment packages is often linked to the species/situations encountered by the agency sponsoring the package
- The spatial capabilities of software can affect analysts' decision-making, which may affect how analysts interpret population status.
- There is currently little guidance about how to identify misspecification of spatial structure.

# Objectives

- Objective #1: Discuss best practices in spatial model development by exploring the decision-points an analyst encounters for each platform.

- Objective #2: Evaluate within-platform performance and the impacts of different spatial configurations by comparing spatial and spatially aggregated models; and

- Objective #3: Explore general performance across different categories of spatial models (e.g., non-spatial, spatially-implicit, spatially-stratified, and fully spatiotemporal) by comparing bias and precision across the broad categories. *No ranking of platforms!

# Participating stock assessment platforms

| Stock Assessment Platform or Model | Acronym |
|---|---|
| Metapopulation Assessment System | MAS |
| Globally Applicable Area-Disaggregated Ecosystem ToolBox | GADGET |
| Stock Synthesis 3 | SS3 |
| Stock Synthesis with Areas-As-Fisheries | SS3 with FAA |
| C++ Algorithmic Stock Assessment Laboratory | CASAL |
| C++ Algorithmic Stock Assessment Laboratory (2nd generation) | CASAL2 |
| MULTIFAN-CL | MFCL |
| Assessment For All | a4a |
| Spatial Processes And Stock Assessment Methods | SPASAM |
| Spatiotemporal Models | Cao et al. |
| Recapture Conditioned Models | - |
| Several Other Bespoke Models | - |

**This is a working list that is subject to change.*

# Context

This **simulation experiment is strictly a research endeavor**, with the specific fish species chosen as an example to address broad study objectives.

*Research assessments from this workshop/experiment are **not meant to directly inform operational management.***

# Key Features

**Simulation Experiment**

*Spring 2021 – Winter 2022*
*(Austral autumn 2021 – summer 2022)*
[Q2 2021 – Q1 2022]

**Your Seminar**

*Fall 2021 – Winter 2022*
*(Austral spring 2021 – summer 2022)*
[Q4 2021 – Q1 2022]

**Workshop (in person)**

*Spring 2022*
*(Autumn 2022)*
[Q2 2022]

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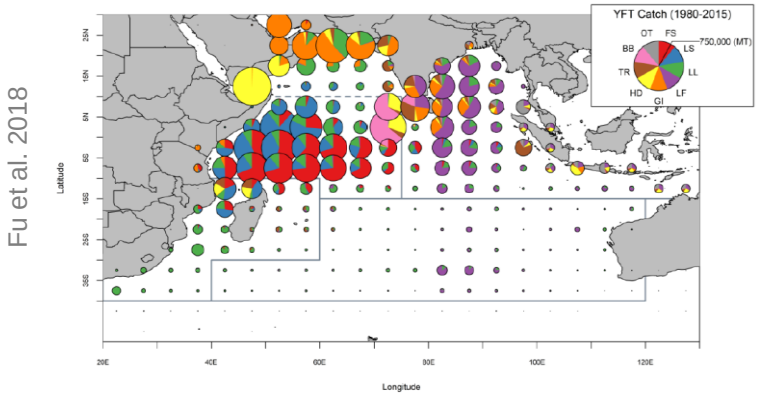
# SPM-built Operating Models

## Yellowfin Tuna

(YFT; *Thunnus albacares*)

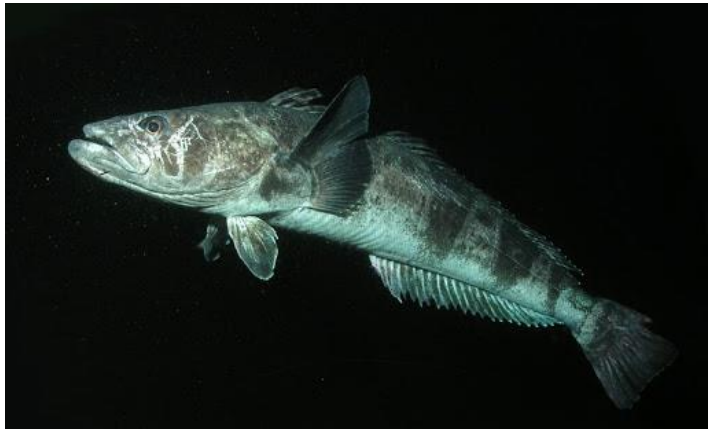

Annual spatial movement



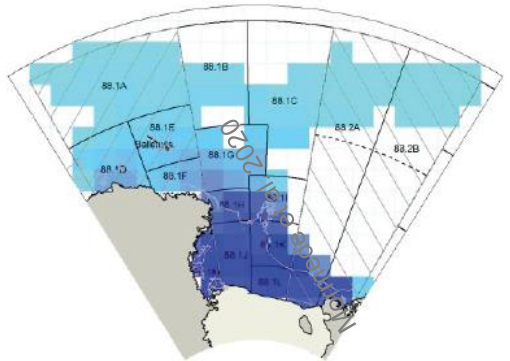

Fu et al. 2018

## Antarctic Toothfish

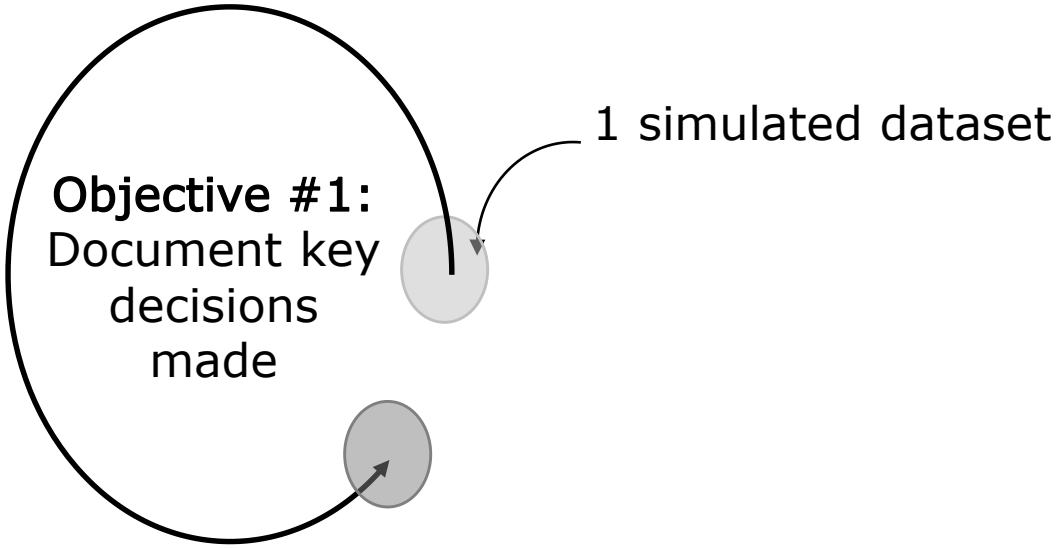
(AT; *Dissostichus mawsoni*)



Ontogenetic spatial movement



# Simulation Experiment: Study Design

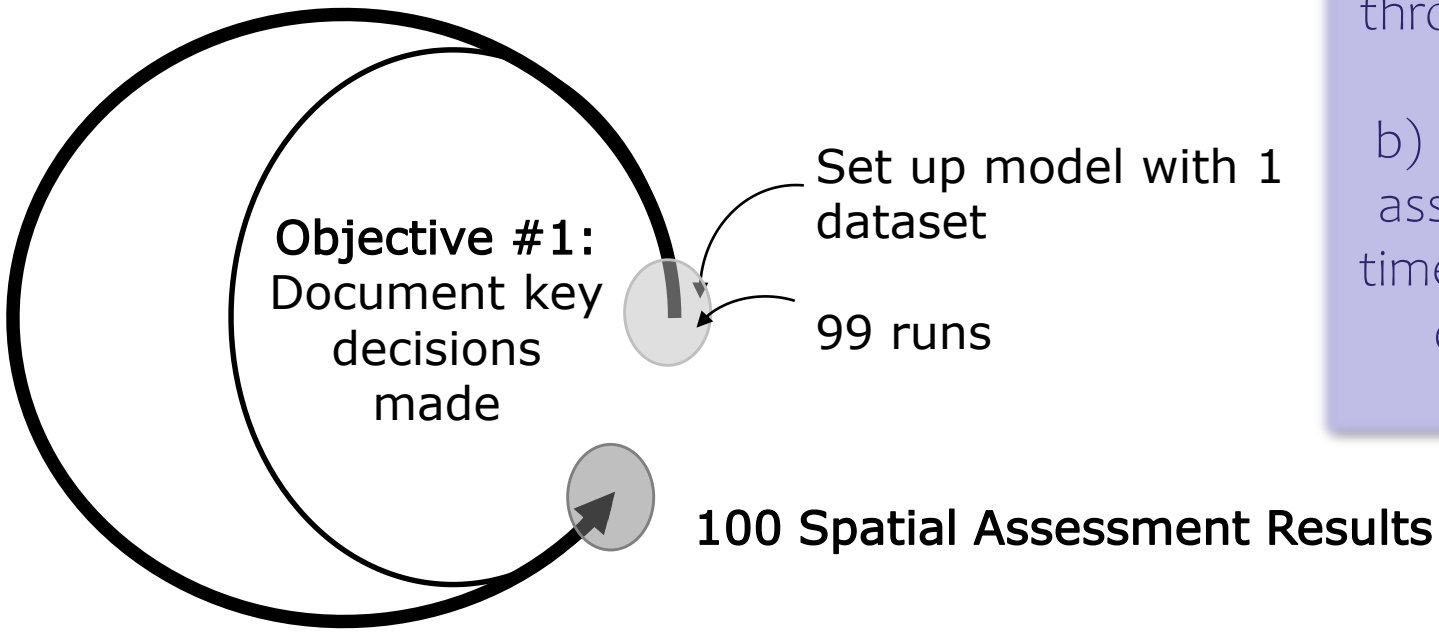



Step 1:

a) Set up assessment in platform of choice with single representative simulated dataset

b) Document decisions made

# Simulation Experiment: Study Design




Step 2:

a) Run 100 total assessments through platform of choice

b) Provide standard stock assessment outputs (SSB time series, F, etc) for each of the 100 simulated datasets

- Fully spatial disaggregated (5x5˚grid) simulated datasets available upon request
- Observation Error: CPUE, Tagging and Length Frequencies
- Recruitment stochasticity:  Year class strength and spatial apportionment of recruitment

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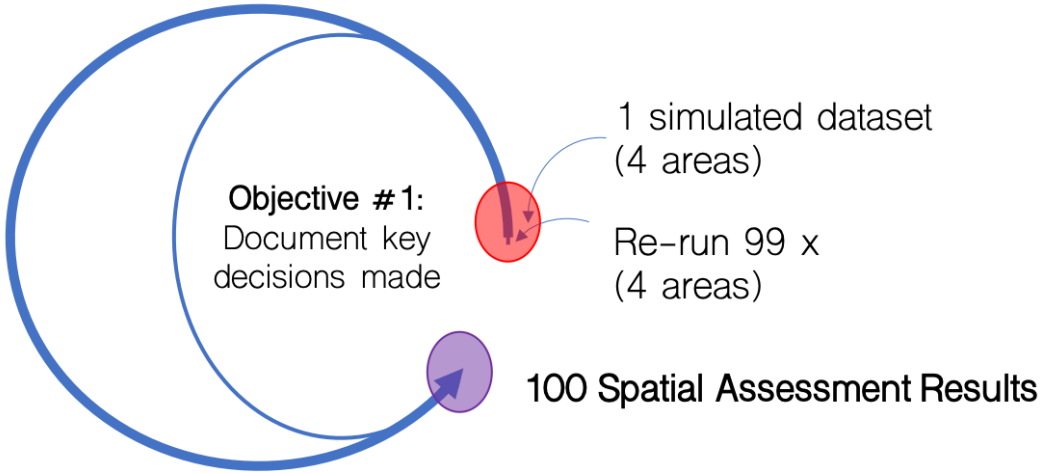
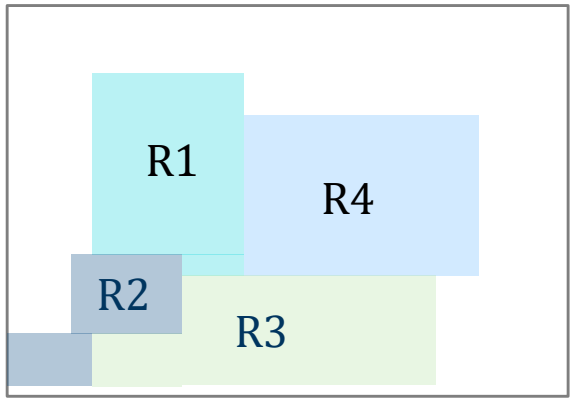
# Simulation Experiment: Spatial Design




YFT example)



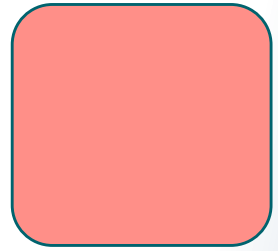

Spatial

*4 areas encouraged as based on areas defined in operational assessments

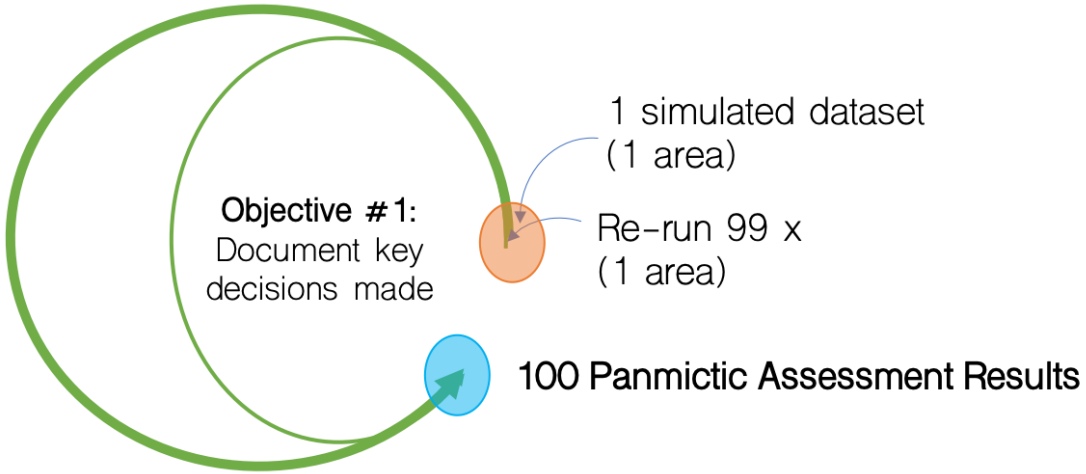
(alternate area aggregations also welcome)

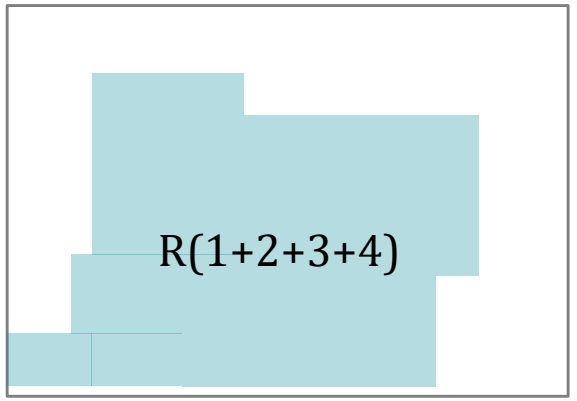
- Observation Error: CPUE, Tagging and Length Frequencies
- Recruitment stochasticity: Year class strength and spatial apportionment of recruitment

# Simulation Experiment: One Area Design



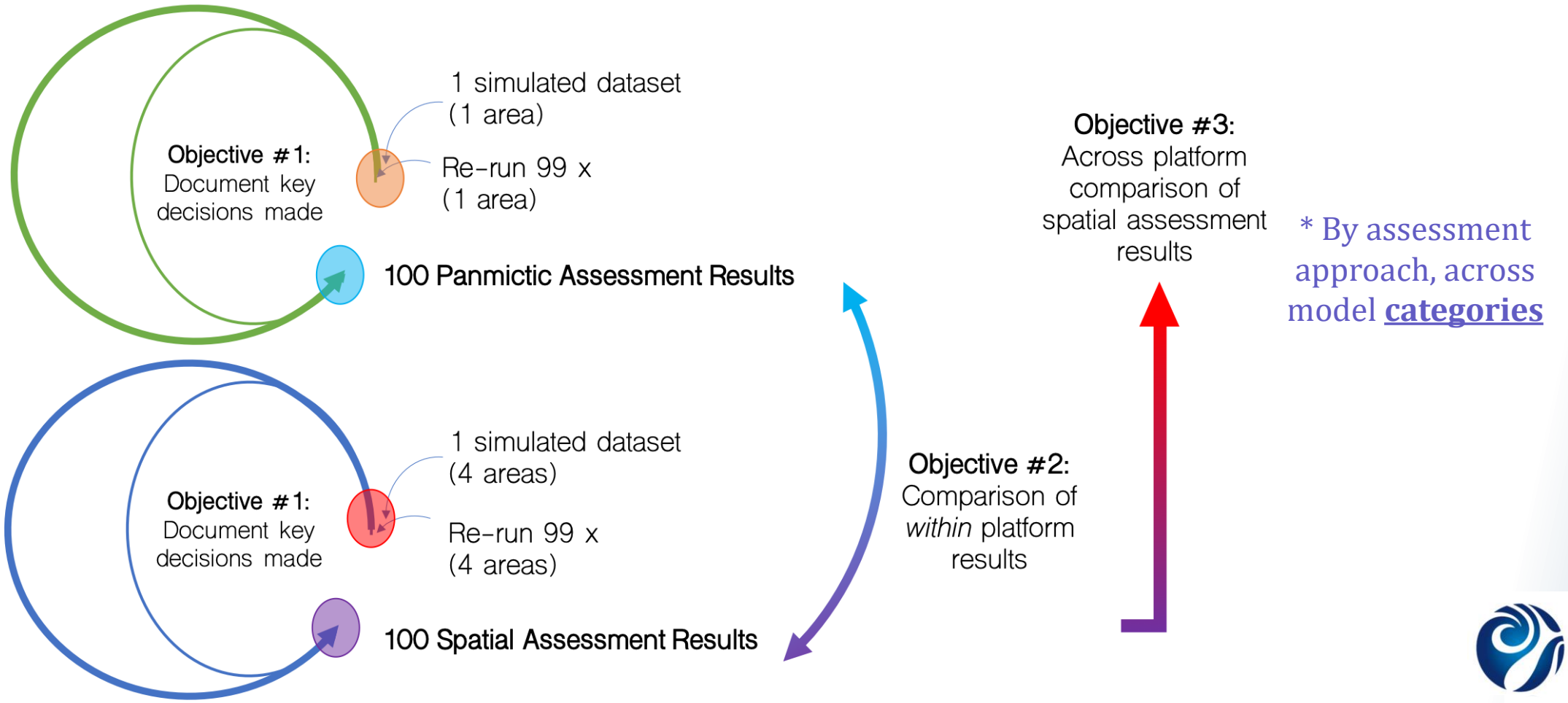
One area




- Observation Error: CPUE, Tagging and Length Frequencies
- Recruitment stochasticity: Year class strength and spatial apportionment of recruitment

# Simulation Experiment: (Base) Study Design




* By assessment approach, across model **categories**

# Compiling Results: Requests of Analysts

- Standard set of assessment outputs (1 & 4 Area results)
  - Analysts encouraged to explore alternate aggregations/model parameterizations, time permitting
- Decision point analysis
  - How did model spatial functionality influence decisions?
- Model diagnostics
  - How were diagnostic tools used to determine spatial parametrization?
- Summary statements given your results
- Seminar presentation of results

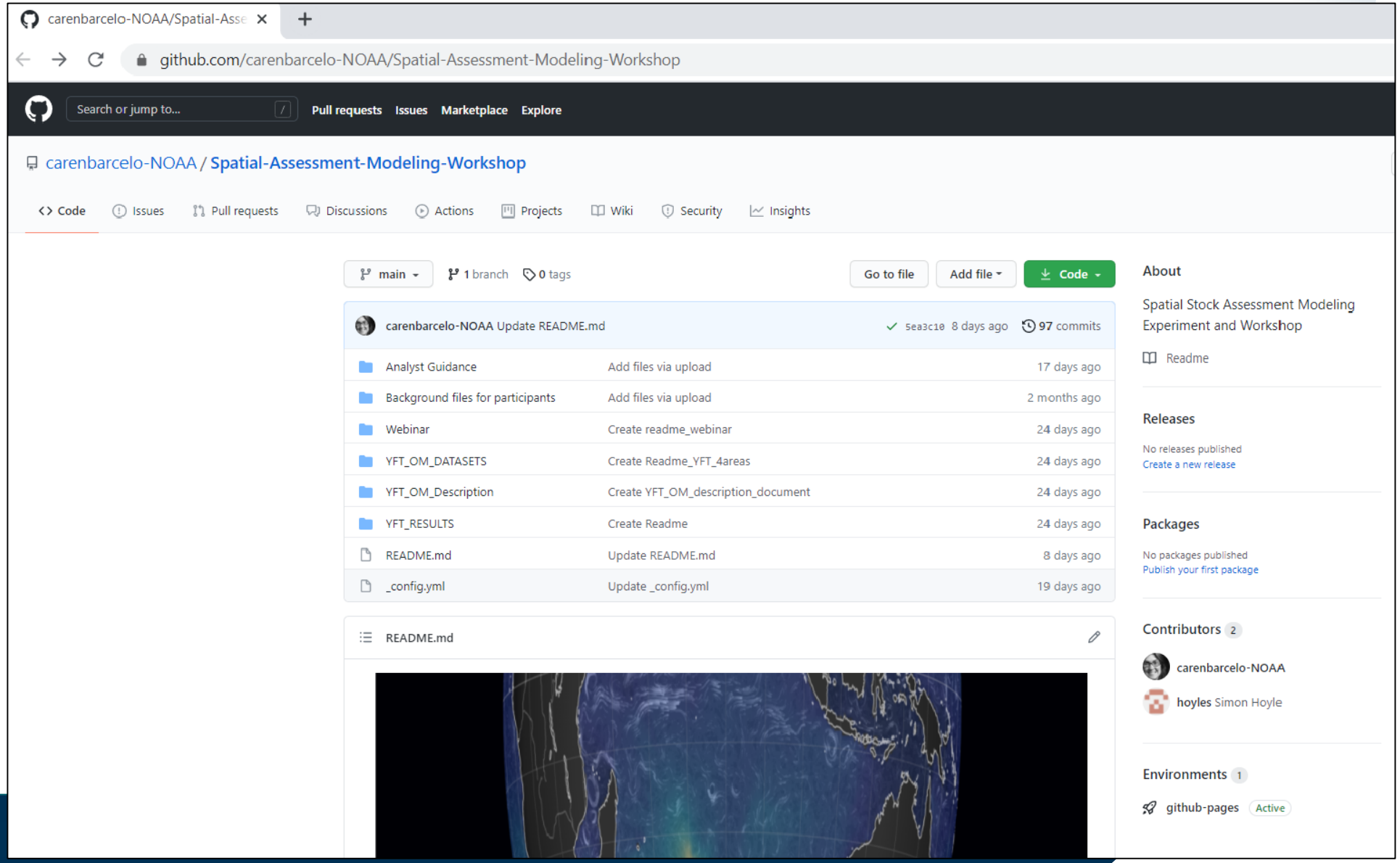
# Seminars: A Discussion Forum for Your Results

- 90 minute 'workshop style' seminar of simulation results for each analyst/analyst group
  - 45 to 60 minute virtual presentation by each analyst group (or platform group)
  - 30 to 45 minute question and answer and discussion amongst all simulation and guest participants
  - Best practices/future needs discussion
  - Seminars will be public and are intended to elicit feedback and discussions on decision point analysis, model diagnostics, and within model comparisons.

# Github site

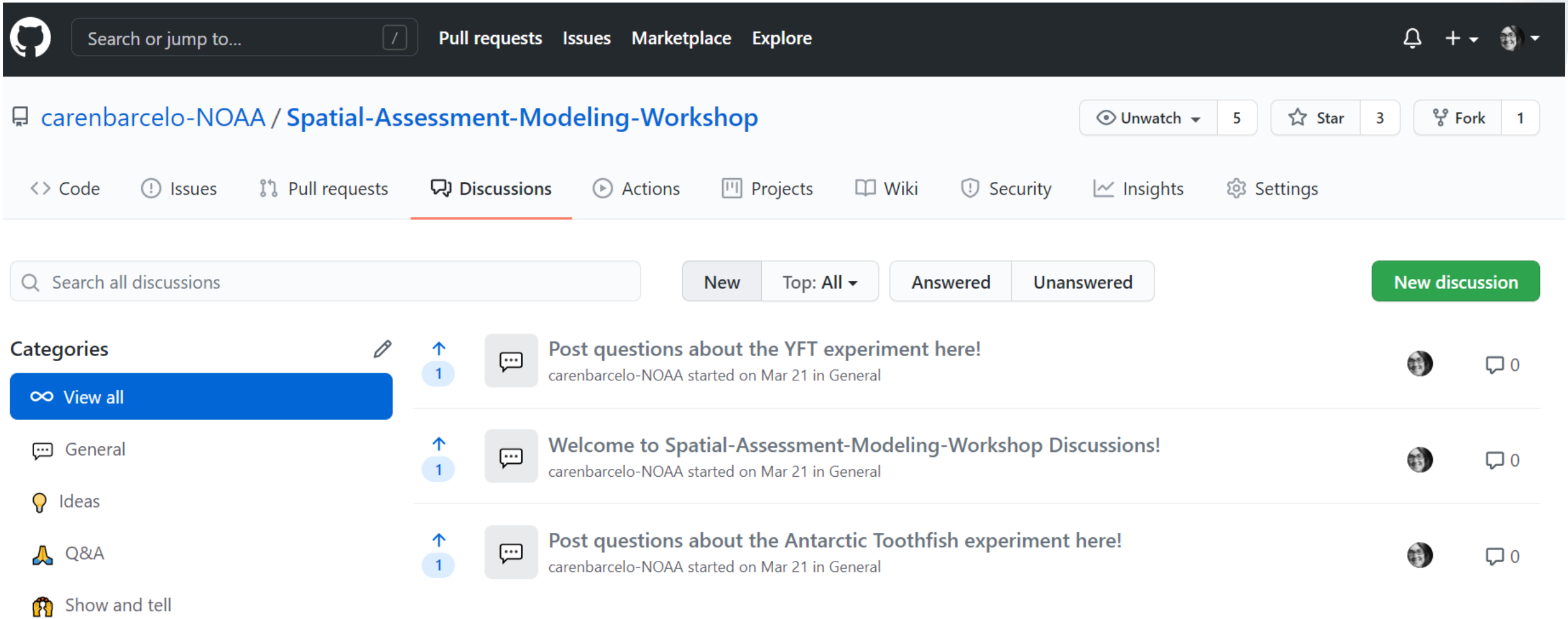
https://github.com/carenbarcelo-NOAA/Spatial-Assessment-Modeling-Workshop

- Project overview
- Retrieve important files and background material
- Retrieve simulation data (once available)
- Participants can email organizers &/or use Github issues/team discussions



# Communication (will be key!)

GITHUB handle:
carenbarcelo-NOAA



# Communication (will be key!)

- Email organizers at any time for individual needs (caren.barcelo@noaa.gov)
- Github Team Discussions (during experiment)
- Follow up webinars (data details, Q&A with analysts)
- Platform-specific teams – coordination/collaboration is encouraged

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# Plans for Experiment Synthesis

Organizers

- **Organizers:** Organize and compile information from each assessment platform

- **Organizers:** Synthesize differences and similarities among model types and across panmictic v. spatial assessment results & summary workshop report.

All (analysts & organizers)

- **All:** Collaboratively develop peer-reviewed workshop synthesis manuscript(s)

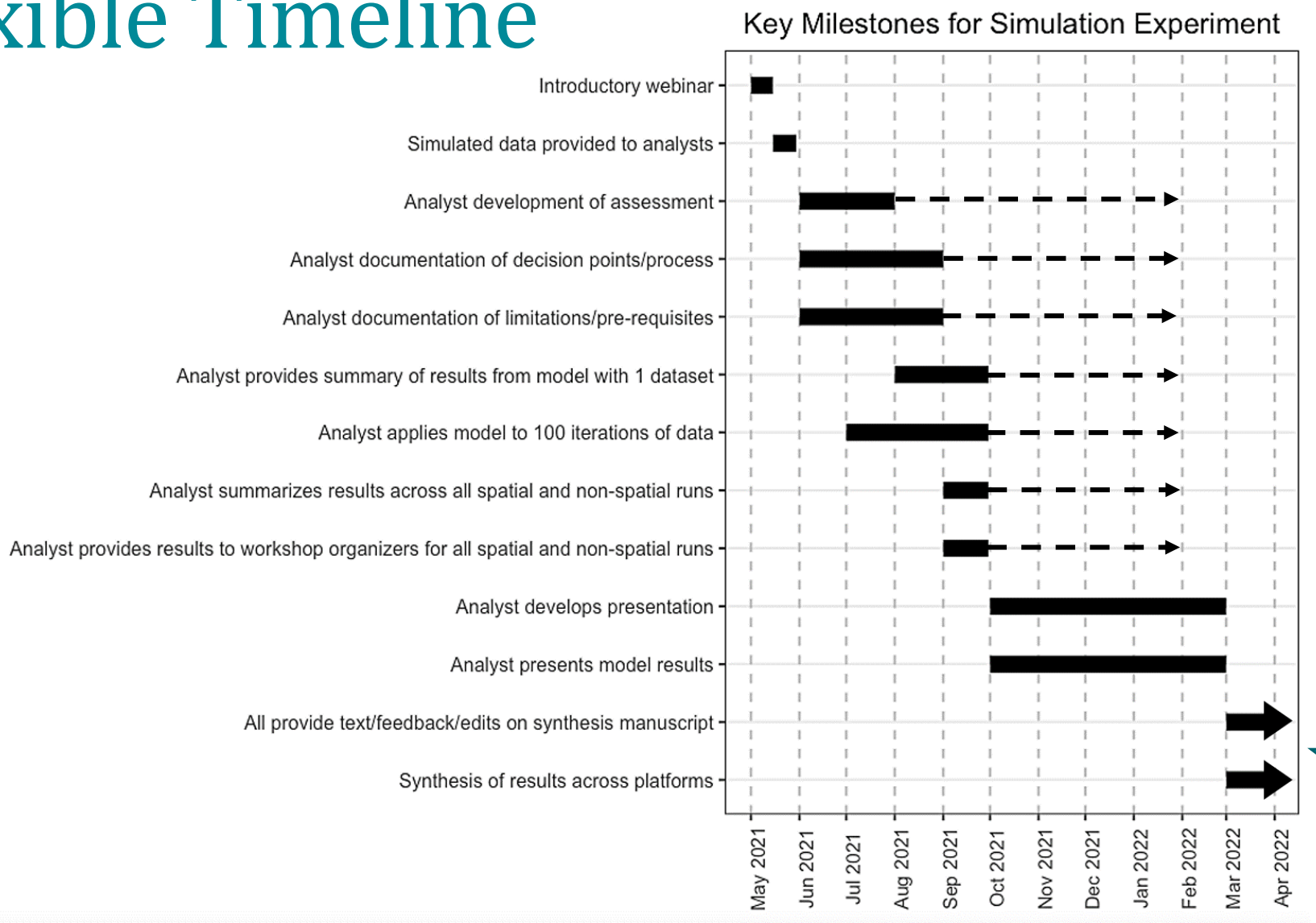
- All those who actively participated in the simulation experiment (and are interested/have time) will be invited to be **co-author on synthesis manuscript(s)**.

# Plans for In-Person Workshop 2022

- Discussion of best practices when developing spatial models
- When (TBD; ~ this time 2022)
- Where (Details TBD)
- Useful for best practices discussions

  @ CAPAM 2022

# Flexible Timeline



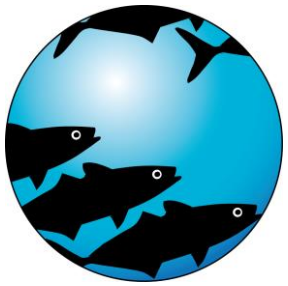

Timeline developed to be flexible to individual needs

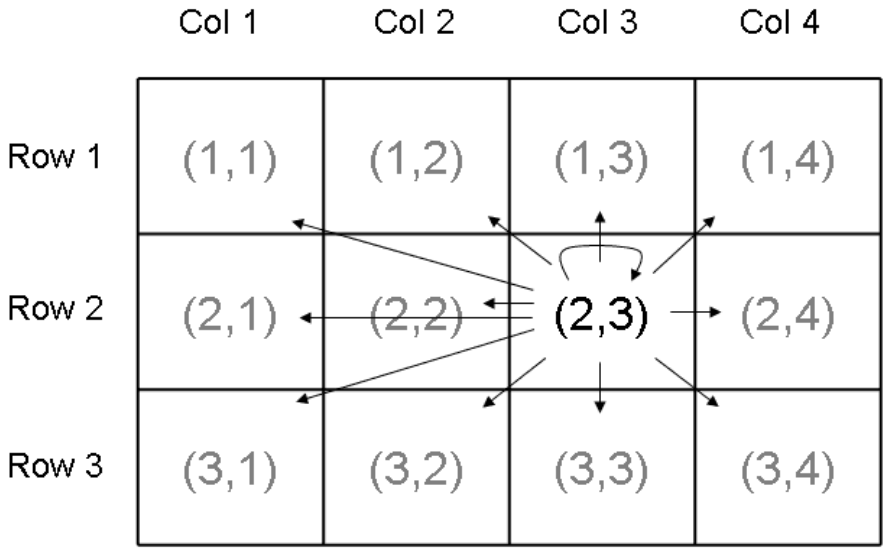
★ General plan for in-person workshop

# Brief (big picture) clarifying questions?

# Brief SPM Overview

https://github.com/alistairdunn1/SPM






- Developed at NIWA in mid-2000s to investigate biases with the use of tagging data for the assessment of Antarctic Toothfish in the Ross Sea
- Written in C++. Source code is on GitHub
- Allows generalized space-time structures, with a range of observation and process types and can:
  - **Estimate** a wide range of free parameters
    Profile, point estimates, and MCMC using Maximum Likelihood and Bayes
  - **Simulate** observations from a given set of parameters and model structure

Dunn, A.; Rasmussen, S.; Mormede, S. (2020). Spatial Population Model User Manual, SPM 2.0.3-2020-08-29. Ocean Environmental Technical Report. Ocean Environmental Ltd. Wellington, New Zealand. 235 p.

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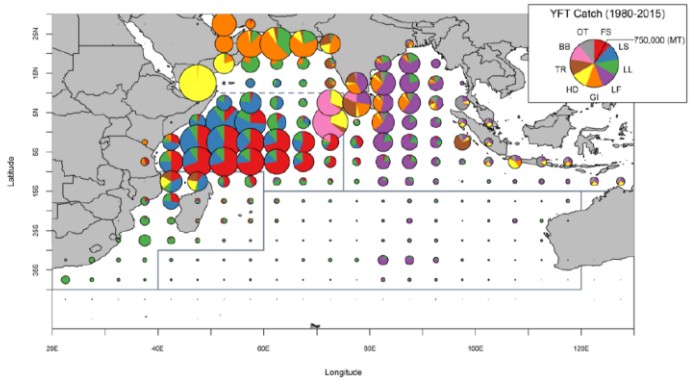
# SPM-built Operating Models

Yellowfin Tuna (YFT; *Thunnus albacares*)


Fu et al. 2018




*Details coming soon!*

Antarctic Toothfish (AT; *Dissostichus mawsoni*)

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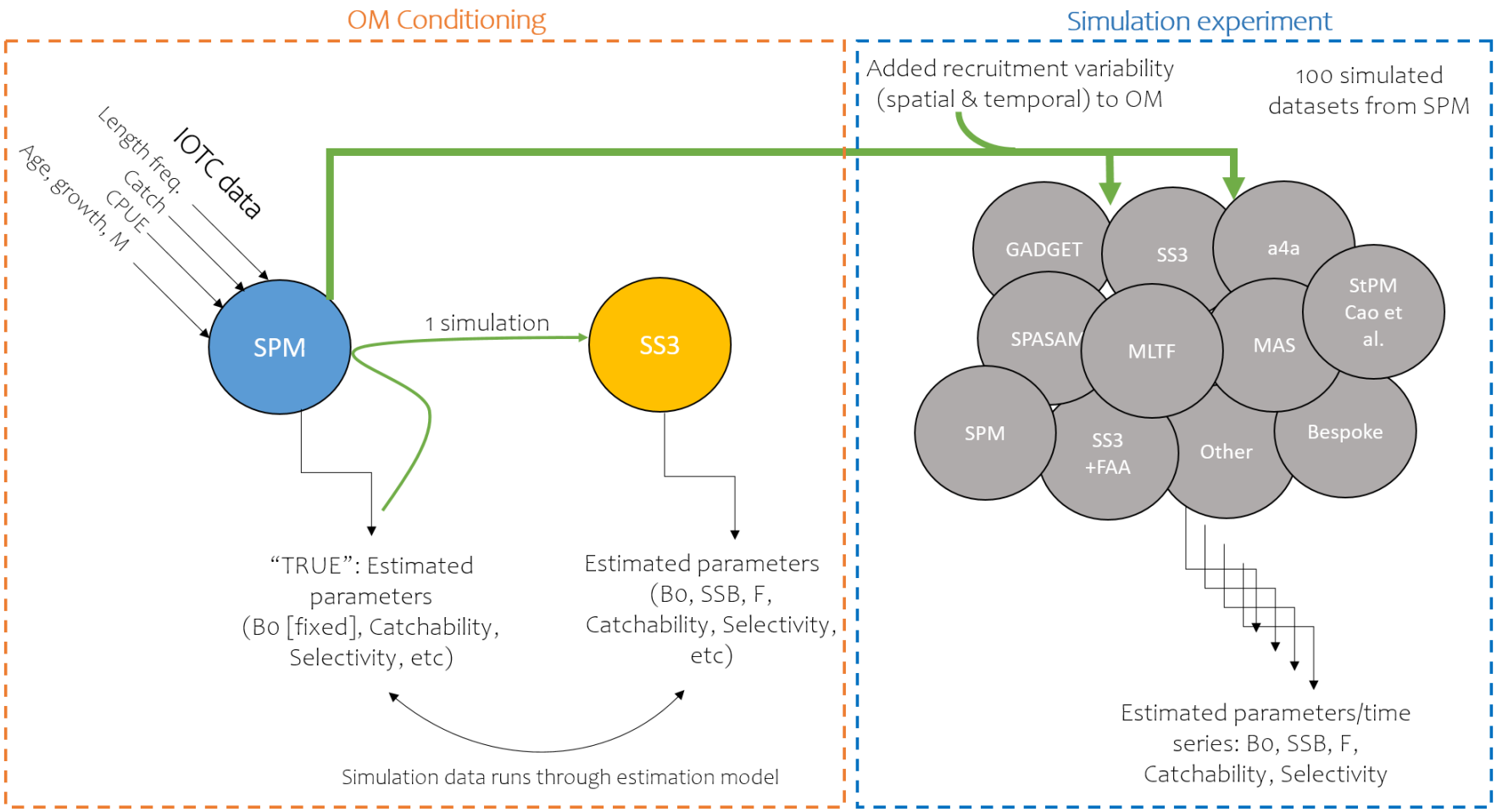
# YFT OM & Simulation Set-up

# YFT OM & Simulation Set-up


NIWA
Taihoro Nukurangi
IOTC-2020-WPTT22(AS)-19_Rev1

Development of spatially explicit operating models for yellowfin tuna populations in the Indian Ocean

*Prepared for the Indian Ocean Tuna Commission*

*October 2020*

Alistair Dunn,
Simon Hoyle,
Samik Datta

Climate, Freshwater & Ocean Science

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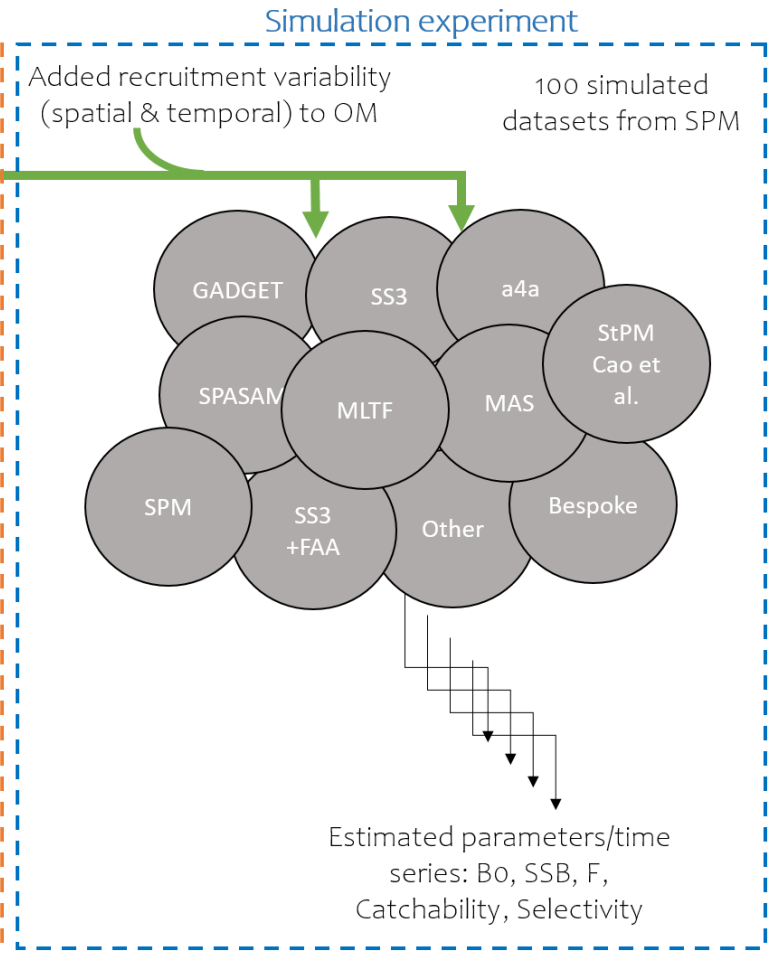
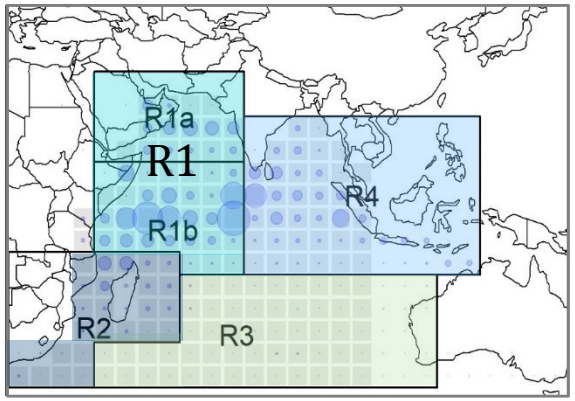
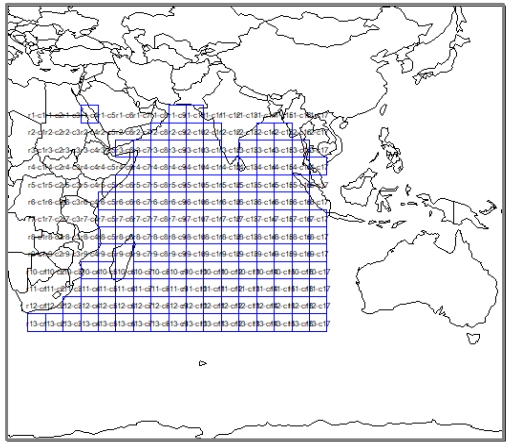
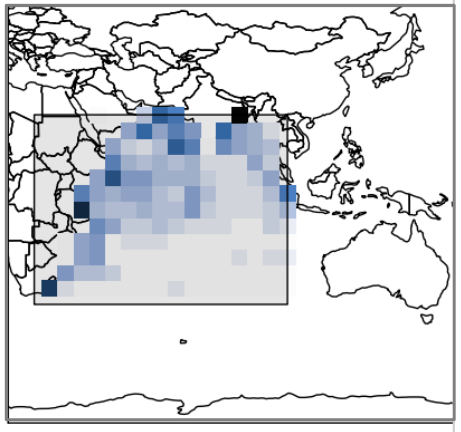


# YFT OM: Structural Overview

## Spatially Explicit Layers



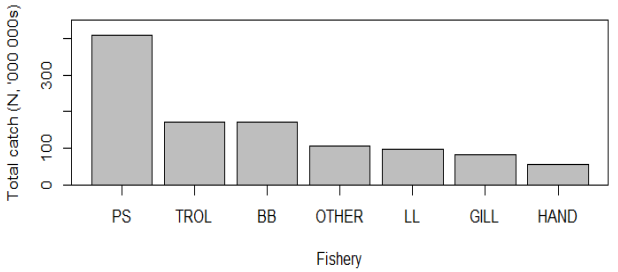





*Spatial structure provided and based upon dynamics and data at 5x5 grid cells*

## Fishing

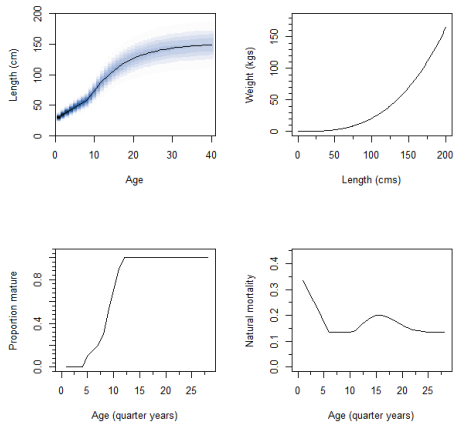
7 'fisheries' (by gear type)




*Parametric shape of selectivity for each fleet provided*

* Fisheries not by country, just by gear type (6 fisheries + 1 'Other' fishery category)

## Biology



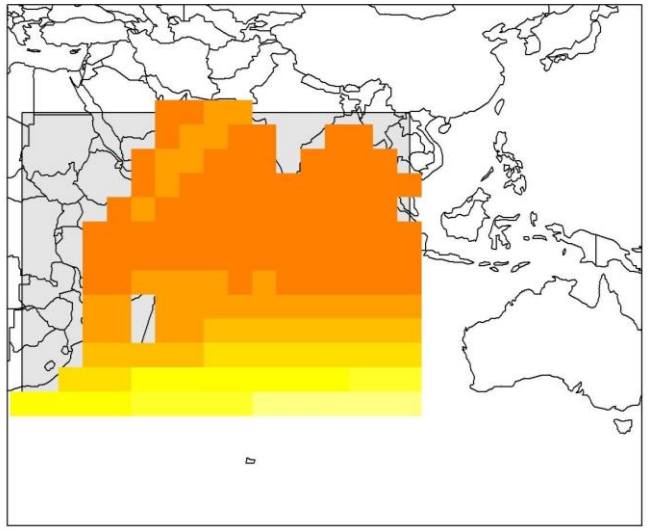

*Biological parameters provided*

# YFT OM: Structural Overview

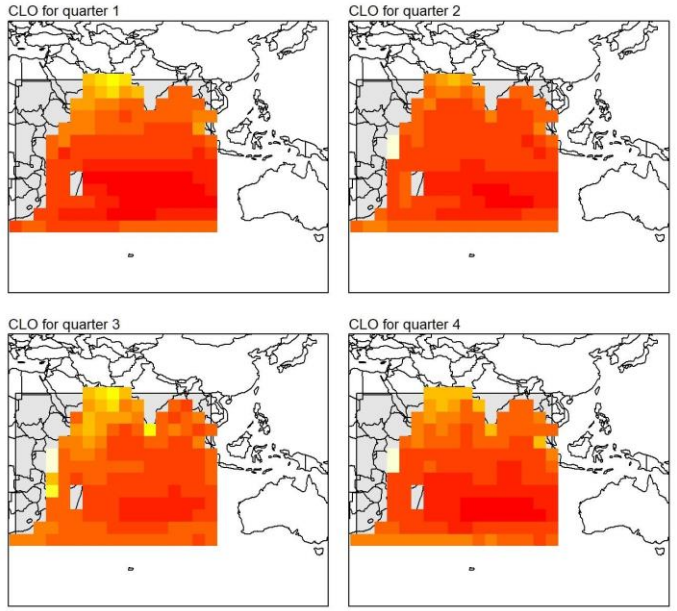
## Movement

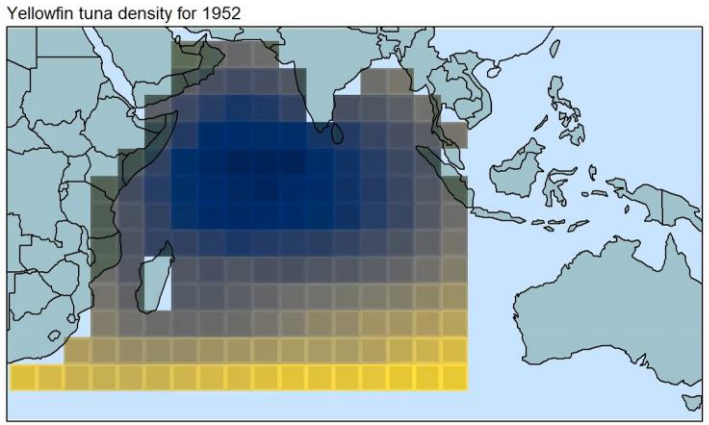
Habitat based preference functions by age group { mature or immature }

Sea surface temperature



Chlorophyll-a

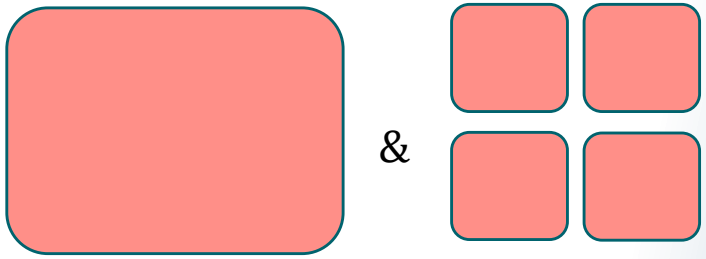



& Linear distance between locations

*Preference functions used to model movement*

# YFT OM: Observations




- Catch by fleet **and area**

  Observation Error: NONE (assumed precise known catch from simulation) Not by country, but different gear types (PS, LL, etc)

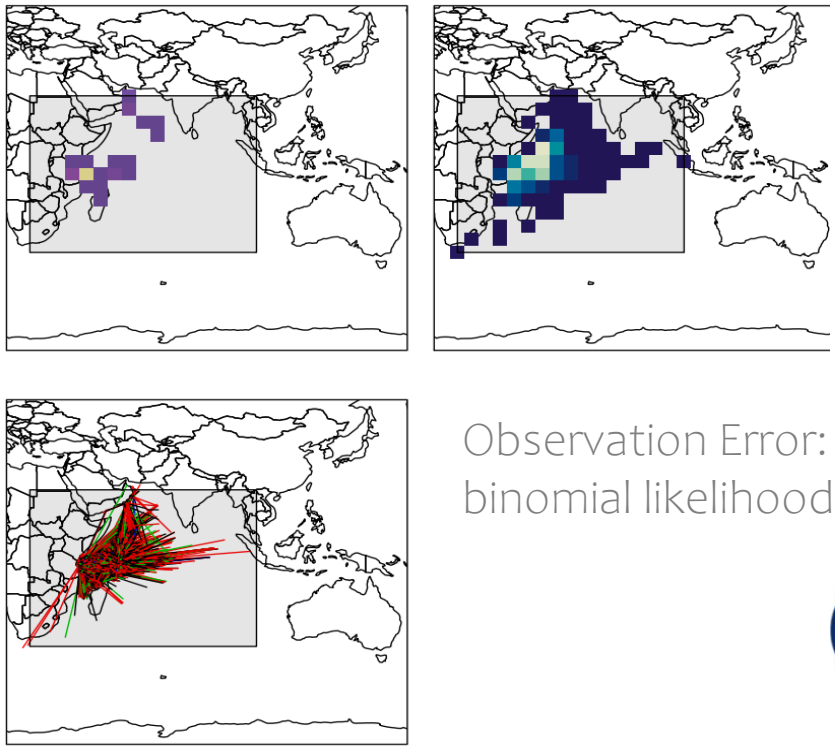
- Standardized CPUE indices for Pelagic Longline fleet **by area**

  Observation Error: Simulation lognormal likelihood CV =0.2. Standardized & regionally weighted by abundance following Hoyle & Langley (2020)

- Length compositions by fleet **and area**

  Observation Error: Simulation multinomial likelihood

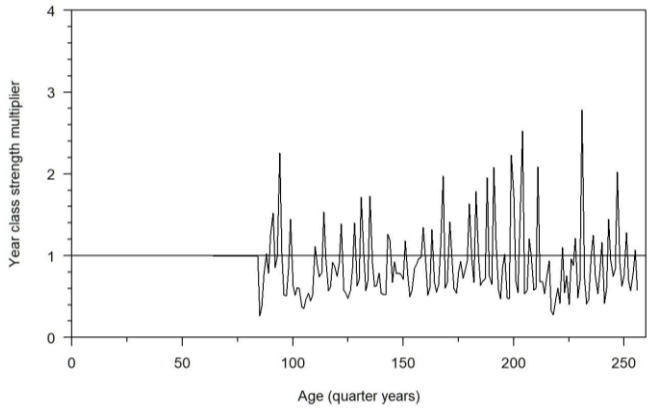
- Tagging data (mark-recovery)



Observation Error: Simulation binomial likelihood

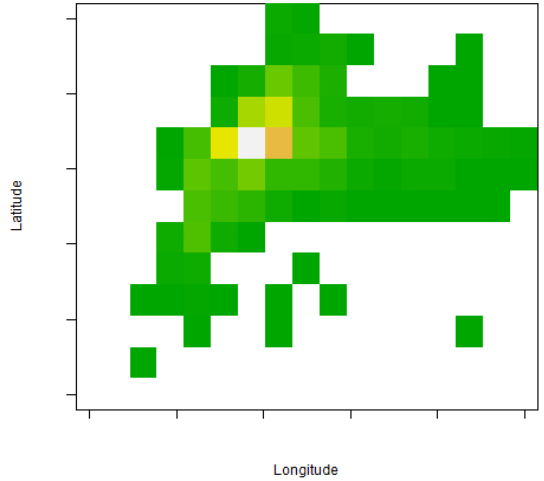
# YFT OM: Structural Overview

## Incorporated recruitment stochasticity (spatial & temporal)




Temporal stochasticity in recruitment:

Log normally distributed recruitment deviations Generated 100 time series of 256 time steps (quarters)

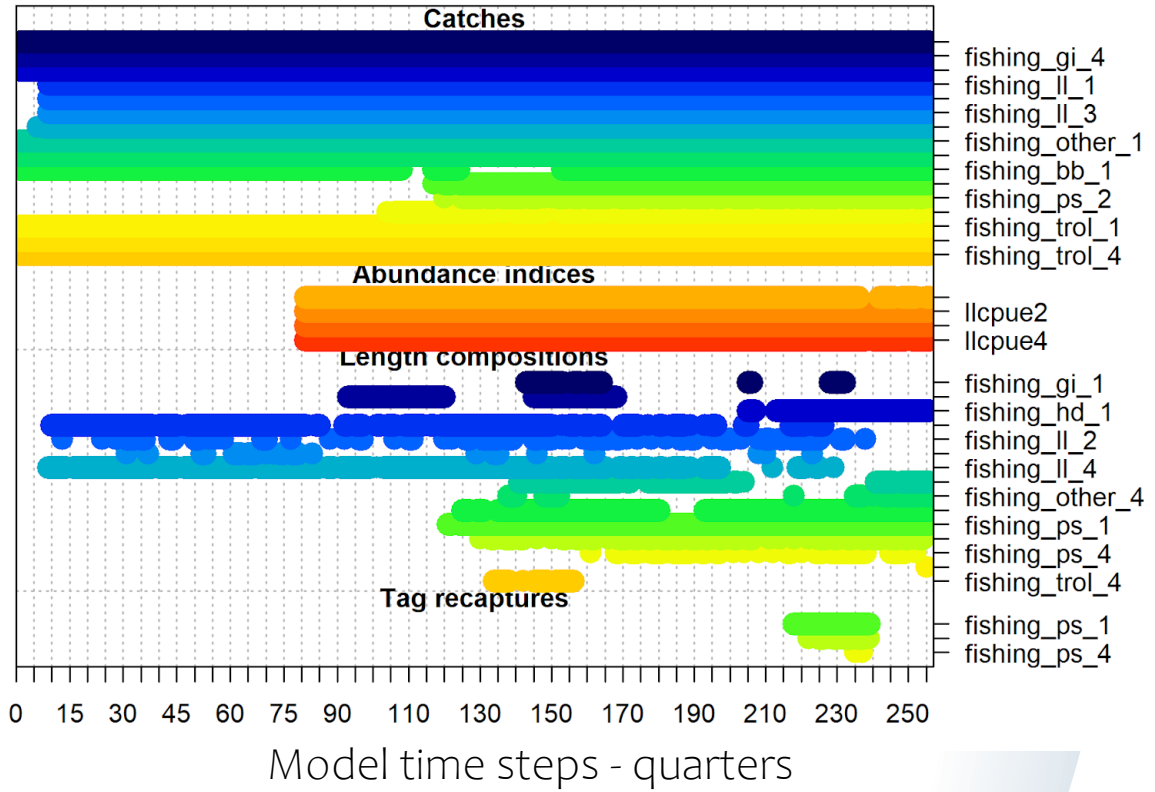



Spatial stochasticity in average recruitment apportionment:

Gaussian correlated random fields Generated 100 grids for each of the 256 model time steps (quarters)

# Data file formats

- Well commented text files
- Files will generally follow, or be similar to, stock synthesis input data.ss / .Rdata
- Reach out for clarifications or assistance!




Also, please reach out to the organizers if you would like the data in other aggregations/ways and we can work with you!

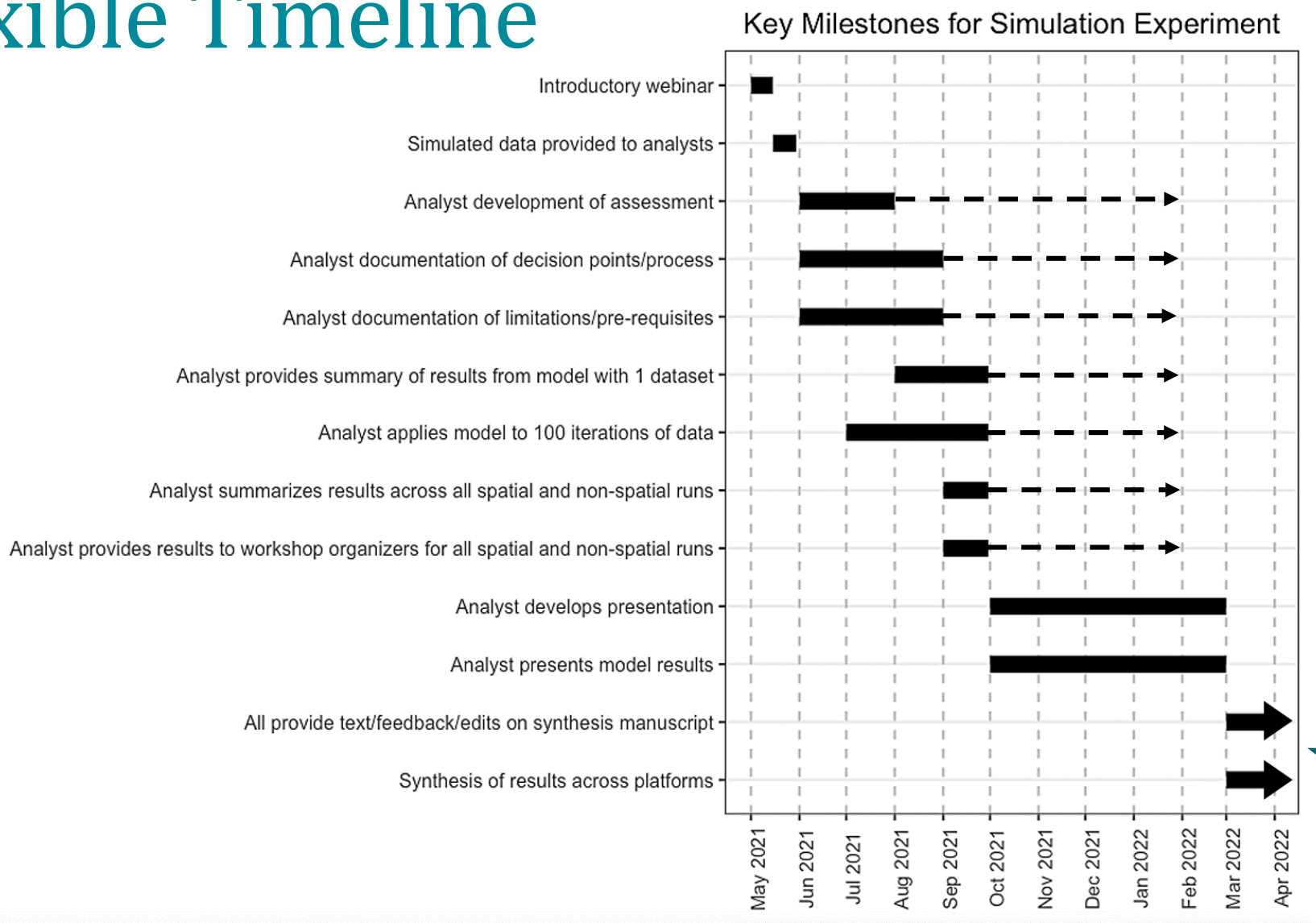
# Objectives

- Objective #1: Discuss best practices in spatial model development by exploring the decision-points an analyst encounters for each platform.

- Objective #2: Evaluate within-platform performance and the impacts of different spatial configurations by comparing spatial and spatially aggregated models; and

- Objective #3: Explore general performance across different categories of spatial models (e.g., non-spatial, spatially-implicit, spatially-stratified, and fully spatiotemporal) by comparing bias and precision across the broad categories. *No ranking of platforms!

# Flexible Timeline




Timeline developed to be flexible to individual needs

★ General plan for in-person workshop

# Thank you!

Please email us if you have any questions/comments/concerns.

Email: caren.barcelo@noaa.gov

We look forward to working with you!

**Working group**

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Aaron Berger (NOAA)
Daniel Goethel (NOAA)
Simon Hoyle (NIWA)
Alistair Dunn (Ocean Environmental, LLC)
Patrick Lynch (NOAA)
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**Steering Committee**

Pamela Mace (Fisheries NZ)
Mark Maunder (IATTC)
Rick Methot (NOAA)
Rich Little (CSIRO)
Paul DeBruyn (IOTC/FAO)
Richard O'Driscoll (NIWA)

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# General questions/comments