Scoping the next stock assessment platform

Project 123 progress update and outline of options

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SPC Pre-Assessment Workshop (PAW)
Nouméa, 10 April 2025

Overview

Overall Plan *migrating from MFCL, project outline, objectives, activities, timeline*

SC20 in 2024 *international expert meeting, overview of software*

Latest Developments *workshop in Aug 2024, multiple-criteria decision analysis, external analysis of tagging data, workshop in May 2025*

SC21 in 2025 *evaluation of model features, outline of options, required resources*

The need to to migrate to new software

MULTIFAN-CL (MFCL) has been used in SPC tuna assessments since 1990s

MFCL team (Dave Fournier, John Hampton, Nick Davies) retiring in the 2020s

Development of new features is slowing down

Resources are being allocated to succession plans

Migrating all MFCL assessments to other platforms

Shared process, **continuous** communications, **adaptive** strategy

WCPFC – guidance

SPC – conduct and coordinate the work

Also involved: other tuna RFMOs and various research labs

Swordfish and striped marlin assessments migrating to Stock Synthesis in 2025

Tuna assessments in MFCL, currently evaluating alternative platforms and development options

Project outline

This scoping project is scheduled from 1 Feb 2024 to 31 Dec 2026. It will:

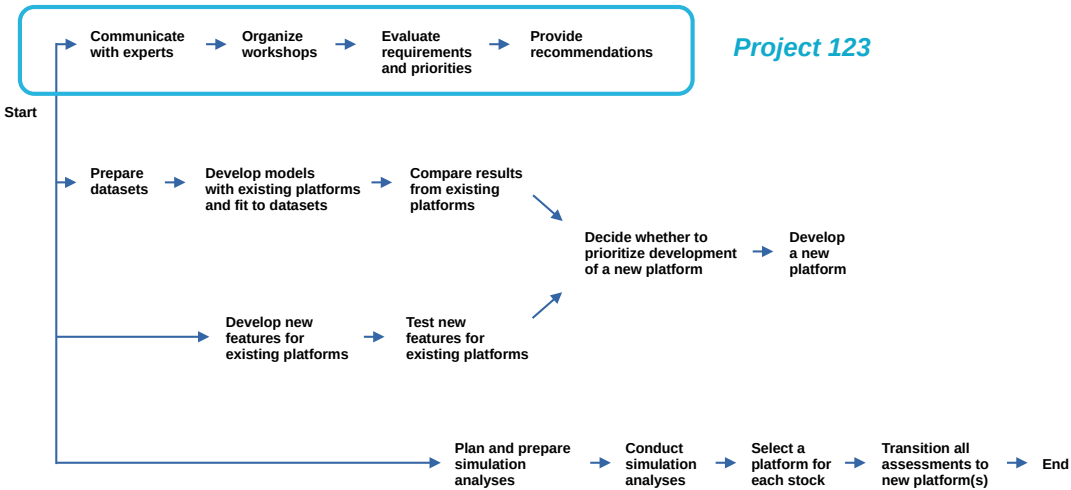
- Evaluate features and capabilities that will be important in future tuna assessments
- Explore fitting models to tuna data using existing software platforms
- Guide decisions on what kind of new software development will be required
- Establish collaboration with tuna RFMOs and research labs to achieve these goals

Objectives

The ideal outcome would be that in 10–15 years, the WCPFC tuna assessments are conducted in software that has the following three characteristics or criteria:

1. **Scientific quality**: has good estimation performance, makes good use of available data, allows spatial and temporal variability in processes, runs fast.
2. **Beginner friendly**: new staff scientists can conduct a stock assessment in their first year of contract, configuring and understanding the models.
3. **Widely used**: large development team and user community beyond SPC, new staff scientists can find expert help outside of SPC, tools to work with model input and output are feature complete and maintained outside of SPC, external reviewers have a good understanding of model configurations and options.

Scoping project and possible follow-up projects



2024 project activities

Scoping project launched (Feb)

PAW discussion (Mar)

International expert meeting (May–Jun)

SC20 discussion (Aug)

Developer workshop (Aug)

Follow up with tuna RFMOs and research labs (Dec)

2025 project activities

Evaluation of RTMB as a development platform (Jan–Feb)

PAW discussion (Apr)

Follow up with tuna RFMOs and research labs (Apr)

Spatio-temporal tagging model workshop (May)

SC21 discussion (Aug)

Model development workshop (Quarter 4)

2026 draft plan

Evaluation of external analysis of tagging data (Quarter 1)

PAW discussion (Apr)

Model development workshop (Quarter 2)

Follow up with tuna RFMOs and research labs (Quarter 2)

SC22 discussion, final report of P123 (Aug)

$\Rightarrow$ Launch a project similar to P123, coordinating activities related to the migration of assessments and related research & development

$\Rightarrow$ Launch collaborative projects conducting work related to the development of next-generation assessment models

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Recommendations from 2024 international expert meeting

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1. **Tuna** assessment software
   design and develop a model specific for tuna assessments
2. **RTMB** programming environment
   lean software development paradigm, maybe a specific model for each species
3. **State-space** formulation
   statistically and computationally efficient way to allow time-varying processes
4. **Age-length** structure
   explicitly track the population by age and length, if not too costly
5. **Simple** models
   short-term staff, young scientists, simple user interface, simpler models
6. **Collaboration** between tuna RFMOs
   MFCL and Stock Synthesis in a sunset phase, data analyses comparable between RFMOs

Stock assessment software

Existing software, ready for multi-region tuna assessments

- **Stock Synthesis** is used by IATTC, IOTC, and ICCAT
- **Gadget** has many features relevant for tuna assessments
- **Casal** has many features relevant for tuna assessments

These could be extended further as needs arise

Stock assessment software

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Software that could be developed further:

- **sbt** is built around CKMR, currently for single-region assessments
- **ALSCL** is a state-space model that fits length comps, currently no catches
- **WHAM + Length** is a state-space that fits length comps, currently single-region
- **SAM + Length** is an early exploration of extending SAM to fit length comps
- **Stock Synthesis + Enhanced Tags** is a proposed enhancement of the tag module

Stock assessment software

Also relevant:

- **Stock Synthesis + CKMR** is an experimental add-on, not included in core software
- **FIMS**, NOAA project coordinating the development of a next-generation framework

Stock Synthesis

Cons

- fewer features than MFCL
- old software, but will be used in tuna assessments until a next-generation software platform comes about

Pros

+ used by IATTC, IOTC, ICCAT, and ISC (and NOAA, ICES, GFCM, CSIRO, etc.)
+ facilitates collaboration between the tuna RFMOs, including future development
+ shortens training time for new SPC staff, makes skills and experience transferable
+ large user community, relevant for peer reviews and discussing technical decisions
+ exceptionally complete suite of tools, diagnostics, automated plots and tables
+ next-generation frameworks will support transitioning from Stock Synthesis

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Scoping project workshop (Aug 2024)

Matapouri, 26-30 August 2024

Arni Magnusson, Nick Davies

Objectives

Project discussion: objectives, options, possible outcomes, and other project-level topics

Simulation study: discuss objectives and study design, related to future software development

Technical explorations: TMB automatic sparseness detection, RTMB fisheries examples and modular design, and tagging model in MFCL

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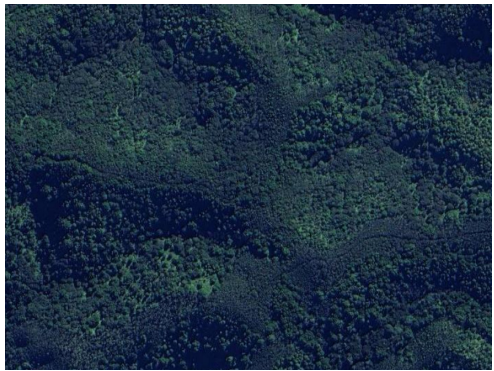

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Multiple-criteria decision analysis

The three criteria incur conflict in their achievement, and inevitable trade-offs are required when considering the various options for future platforms. Consider the following three existing platforms:

MFCL	The main problems in the near future are related to the criteria 2 and 3. The current usage of MFCL already meets criterion 1.
Gadget	Gadget could perhaps provide an incremental improvement in criterion 1 but would perhaps not solve the problems in meeting criteria 2 and 3.
Stock Synthesis	Migrating tuna assessments from MFCL to Stock Synthesis could be a partial sacrifice in criterion 1 to greatly improve criteria 2 and 3.

Noting that the comments in respect of the above three scenarios are subject to further explorations and a simulation study.

Long-term possible outcomes

In 10–15 years, the WCPFC tuna assessments could be conducted in:

- Stock Synthesis
- Gadget
- New software developed independently by SPC
- New software developed jointly by tuna RFMOs, independent of FIMS
- New software developed jointly by tuna RFMOs, linked with FIMS libraries
- Other new software that may come about

Other tuna stock assessments around the world (IATTC, IOTC, ICCAT, ISC) use Stock Synthesis and will probably continue to do so until a next-generation framework comes about, which could be FIMS

Evaluation of RTMB as a model development platform

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Scripts

RTMB is a recent R package, providing a streamlined interface for TMB

The skipjack growth project was using TMB scripts and used the opportunity to convert the analysis to RTMB scripts, in order to compare RTMB and TMB

This resulted in streamlined code that runs equally fast and gives the same result as the original TMB scripts

No compilation required, considerably easier to develop and modify models

$\Rightarrow$ RTMB can be recommended as a better alternative to TMB for most scripts

Package

The next step was to evaluate RTMB as the basis of a model package

fishgrowth: Fit Growth Curves to Fish Data

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Fit growth models to otoliths and/or tagging data, using the 'RTMB' package and maximum likelihood. The otoliths (or similar measurements of age) provide direct observed coordinates of age and length. The tagging data provide information about the observed length at release and length at recapture at a later time, where the age at release is unknown and estimated as a vector of parameters. The growth models provided by this package can be fitted to otoliths only, tagging data only, or a combination of the two. Growth variability can be modelled as constant or increasing with length.

Version:	1.0.2
Depends:	R ($\geq$ 2.10), RTMB
Suggests:	areaplot
Published:	2024-04-08
DOI:	10.32614/CRAN.package.fishgrowth
Author:	Arni Magnusson [aut, cre], Mark Maunder [aut]
Maintainer:	Arni Magnusson <thisisarni at gmail.com>
License:	GPL-3
URL:	https://github.com/arni-magnusson/fishgrowth
NeedsCompilation:	no
Materials:	NEWS
CRAN checks:	fishgrowth results

Documentation:

Reference manual:	fishgrowth.pdf

External analysis of tagging data

P123 reaching out in December 2024 to Mark Maunder (IATTC) who provided:

1. Useful comments on the initial ideas of a simulation study design
2. Recommendation that SPC consider the possibility that post-MFCL assessments might analyze tags outside the stock assessment model

IATTC has recently employed a new Mildenberger-Nielsen (2022, 2023, 2024) spatio-temporal model to analyze skipjack tags in the Eastern Pacific Ocean

Incorporated in the IATTC EPO skipjack 2024 assessment

$\Rightarrow$ Spatio-temporal model produces a biomass index, overall or by region, that can be incorporated into any stock assessment platform

External analysis of tagging data

INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

15TH MEETING

La Jolla, California (USA)
10-14 June 2024

DOCUMENT SAC-15 INF-G

A SPATIOTEMPORAL PETERSEN-TYPE MODEL FOR SKIPJACK IN THE EPO

Tobias K. Mildenberger, Anders Nielsen, and Mark Maunder

External analysis of tagging data

SPC-DTU Workshop 2025

Copenhagen, 12–16 May 2025

Anders Nielsen, Arni Magnusson, Inna Senina,
Joe Scutt Phillips, Tobias Mildenberger

Objective

Explore the possibility of applying the Mildenberger-Nielsen spatio-temporal tagging model to SPC tagging data. The end product of such an analysis could be a region-specific abundance index that can be incorporated in a tuna stock assessment. The workshop will focus on skipjack tuna in the western and central Pacific Ocean.

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SC21 in 2025

Two main options seem particularly relevant at this point

1. MFCL → Stock Synthesis → Next-generation
2. MFCL → Wait . . . → Next-generation

Between PAW (April) and SC21 (August)

- Elaborate on the benefits, drawbacks, uncertainties, and required resources related to the above options
- Explore the possibility of analyzing the tagging data outside of the stock assessment model
- Evaluate features and capabilities that will be important in future tuna assessments

Project website

https://github.com/PacificCommunity/ofp-sam-transition-plan

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