Fisheries Integrated Modeling System (FIMS)

Terms of Reference
(18 November 2020)

(updated: 26 August 2021)

A. Purpose

The Fisheries Integrated Modeling System (FIMS) is a national project of the National Marine Fisheries Service (NMFS) to advance and maintain the capabilities of models used to assess the status of managed fish stocks while enhancing connection of such models to ecosystem, climate and socioeconomic factors. This document provides terms of reference for the organization and governance of groups involved in the FIMS project.

B. Background

The U.S. fisheries stock assessment community has relied on a suite of regionally-developed, individually-maintained software tools to assess 100+ fish stocks annually. These methods are accurate (Li et al., *accepted*[1]), but difficult to maintain and do not facilitate connection to ecosystem, climate and socioeconomic models. There has been a lag in adoption of new best practices (e.g., random effects, spatial models, ensemble modeling, multi-species, hierarchical Bayes estimation) due to the rigidity of current models and capacity for adding new features. Additionally, separate regional approaches create the unnecessary duplication of effort, and potential for "hidden" differences between similar models (Li et al., *accepted*). A number of parallel developments make now the ideal time to invest in a Fisheries Integrated Modeling System (FIMS). These developments include advancements in computing techniques, such as cloud computing, version control, parallel processing, and open-source development. Within NMFS, a centralized suite of tools (the Fisheries Integrated Toolbox; FIT[2]) and associated steering committees are increasing interdisciplinary collaboration in tool development. There is growing regional and international interest and effort in coordinating, advancing, and reducing duplication in modeling approaches, as evidenced by the 2019 Center for the Advancement of Population Assessment Methodology (CAPAM) Workshop on Next Generation Models (Punt et al, 2020[3]).

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[1] Bai Li, Kyle W. Shertzer, Patrick D. Lynch, James N. Ianelli, Christopher M. Legault, Erik H. Williams, Richard D. Methot Jr, Elizabeth N. Brooks, Jonathan J. Deroba, Aaron M. Berger, Skyler R. Sagarese, Jon K.T. Brodziak, Ian G. Taylor, Melissa A. Karp, Chantel R. Wetzel, and Matthew Supernaw. A comparison of four primary age-structured stock assessment models used in the United States. In review. Fishery Bulletin.

[2] https://noaa-fisheries-integrated-toolbox.github.io/

[3] André E. Punt, Alistair Dunn, Bjarki Þór Elvarsson, John Hampton, Simon D. Hoyle, Mark N. Maunder, Richard D. Methot, Anders Nielsen. 2020. Essential features of the next-generation integrated fisheries stock assessment package: A perspective. Fisheries Research 229. https://doi.org/10.1016/j.fishres.2020.105617.

Longer-term, FIMS is a stepping stone to facilitate increased interfacing between fish assessment community and ecosystem, climate-fisheries, and socioeconomic communities, and associated models.

Through FIMS, NMFS is leading the development of a modular software system that presents a unified approach to fisheries modeling, meets regional needs for conducting stock assessments and providing scientific advice across a range of data input, provides a focus for greater international collaboration, and builds a bridge between single-species, ecosystem, socioeconomic, and climate-fisheries models. FIMS will scale from data-limited to data-rich stock assessments, and provide population dynamics modules for use in other models and management strategy evaluations (MSEs). This FIMS effort will incorporate models currently in FIT with regionally specific models being developed, and then identify new modeling requirements that would benefit from national coordination. Use of a modular architecture and best practices for software development facilitates maintainability, extensibility, and continuity across a virtual, nationwide development team. These engineering approaches also allow FIMS to leverage cloud-computing infrastructure.

By managing FIMS centrally within the NMFS Office of Science & Technology (OST) and incorporating modular components developed regionally, we provide a well-designed system that meets the variety of needs across regional science centers, is extensible enough to assimilate new research quickly, and that can provide functionality to multiple regions without dependence on individual developers and scientists. A modular, flexible system allows us to incorporate emerging best practices in ensemble modeling, new model types, MSEs, and to adapt to future best practices. The FIMS initiative reduces duplication of effort, enhances stability, provides resources to develop sustainable architecture, supports regional stakeholders, and provides a scalable and accessible tool that meets a variety of needs and can familiarize staff with model capabilities and good practices. Overall, FIMS provides a deliberate national research to operations pathway.

C. Organization Overview

The FIMS project is created per the direction of, and operates under the oversight of, the NMFS Science Board[4]. A FIMS Implementation Team composed of participants from OST's National Stock Assessment Program (NSAP) and participants from all NMFS Science Centers conducts the project. NSAP participants lead software design processes while regional participants support data integration, applications and outreach. FIMS is coordinated with other NMFS and NOAA modeling projects (e.g. HI-EBFM, the Ecosystem Modeling Strategy, Climate Fisheries Initiative) through proactive communication with relevant groups, and a FIMS Council composed of members from the academic community and global partners with relevant expertise provides external input and comment.

[4] The NMFS Science Board is composed of the NMFS Chief Science Advisor and Director of Science Programs, the Director of the Office of Science and Technology (OST), the six Fisheries Science Center Directors, and the Senior Scientists for Ecosystems, Stock Assessments, and Socioeconomics.

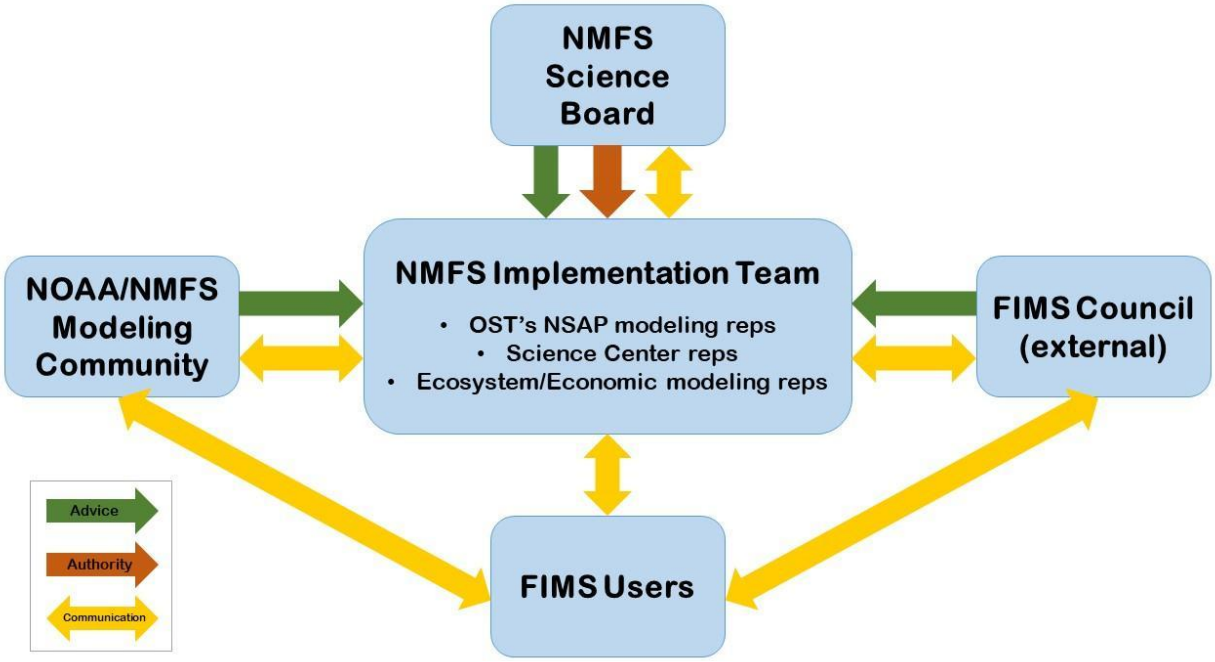

Figure 1. Major elements of FIMS organization and communication. The red arrow indicates that FIMS is a NMFS project established under the ongoing authority of the NMFS Science Board, as implemented by the NMFS Office of Science & Technology. The green arrows represent pathways by which formal, documented advice and individual comment are provided. The yellow arrows represent the fact that FIMS is established as a collaborative project that will proactively facilitate communication with the FIMS Council, various other NMFS/NOAA modeling entities, and the user community.

D. FIMS Council

The FIMS Council is a forum by which external partners and experts provide individual comments on FIMS plans and products. At no time does the Council provide consensus advice to NOAA. Its role is strictly limited to exchanging information and creating a forum for the provision of individual advice.

The FIMS Council is composed of distinguished scientists representing a diversity of perspectives external to NOAA. Council members are approved by the NMFS Science Board. Formal invitation is sent by the NMFS Chief Science Advisor and Director of Scientific Programs or designee. Members are recruited from the following groups:

i. Partner fishery management organizations [2-3]
ii. International assessment modeling projects [2-4]
iii. Ecosystem, climate, and socioeconomic modeling communities [1-2]
iv. Academic assessment modeling community [2]
v. U.S. Fishery Management Council Scientific and Statistical Committees (SSCs) (non-NOAA members) [2-3]

Terms of reference for the FIMS Council are as follows:

i. Meet at least twice per year (via video-conference) to enhance information exchange.
ii. Following meetings, members provide structured individual comments on FIMS:
    a. opportunities, strategies, and products;
    b. technical issues;
    c. outreach, communications, and management activities.
iii. Augment outreach on FIMS's science accomplishments and contributions, and facilitate interactions and input with national and international partners and the wider fisheries science community.
iv. Discuss current and future capabilities and needs of the fishery assessment modeling community and associated ecosystem, climate, and economics modeling communities.
v. Identify scientific trends, gaps, and opportunities for FIMS.
vi. Provide individual comments on effective ways to coordinate the FIMS project with other programs and the broader science community.

Operating procedures for the FIMS Council are as follows:

i. Members will be appointed for two-year, renewable terms.
    a. Half of the initial members will start under a three-year term to enable staggered rotation.
    b. Limits on renewable terms may be considered in future.
ii. The FIMS Council nominates a Chair to be reviewed and approved by the NMFS Science Board, or designee.
    a. The Chair is appointed or reappointed every two years.
    b. Prior to selection of the first chair from among Council members, the NMFS Senior Scientist for Stock Assessments will manage the meeting.
iii. The NMFS Senior Scientist for Stock Assessments will participate in Council meetings as a subject matter expert for NMFS programs.
iv. The FIMS Project Manager will set the agenda, provide presentations and subject matter expertise to the Council, along with other NMFS staff.
v. NMFS provides staff support to the Council and coordinates the Council meetings.
vi. NMFS prepares, in consultation with the Chair and Council members, reports summarizing Council activities; these reports capture discussions and do not serve as consensus advice.
vii. Any written reviews or recommendations from each Council member are provided to the FIMS Project Manager on behalf of the NMFS Science Board, and only represent their individual views and suggestions for FIMS development.
viii. Members of the FIMS Council shall not be compensated for their time spent on Council activities, but eligible members may be reimbursed for allowable travel and incidental costs associated with Council meetings and activities as permitted under 5 U.S.C. § 5703 *et seq.*

E. Conflicts of Interest

At no time will a Council member provide individual advice about an activity for which they receive NMFS funds. Should this situation arise, that member will recuse themself from commenting on that topic. SSC membership alone does not entail a conflict of interest.

F. NMFS Science Board

The NMFS Science Board serves as the standing leadership body overseeing and directing the NMFS science enterprise. The Science Board (composed entirely of senior level Federal employees) provides oversight and direction of the FIMS project. In particular, it:

i. Commissions the FIMS project as a priority NMFS activity.
ii. Receives semi-annual reports from the FIMS Project Manager, including FIMS Council reports and NMFS-prepared summaries of discussions with management partners and stakeholders.
iii. Annually reviews the FIMS project progress and provides direction.
iv. Evaluates the FIMS Project Management and Development Process.
v. Annually reviews these Terms of Reference and works with the Implementation Team via the Project Manager on any needed updates.
vi. Commissions a review of the developed product, and then approves the product before it enters operational status for conducting assessments.

G. FIMS Implementation Team

The FIMS Implementation Team develops and supports FIMS, and includes both Federal employees and affiliates. It is composed of participants from every NMFS Science Center and participants from the National Stock Assessment Program, which sits within the OST/Assessment and Monitoring Division organizational structure (https://www.fisheries.noaa.gov/about/office-science-and-technology). The Project Manager is a federal employee in the National Stock Assessment Program.

OST's National Stock Assessment Program participants:

i. Include the FIMS Project Manager, two Software Developers, a Toolbox Coordinator, and a Testing and Documentation Specialist.
ii. Are responsible for the primary coding, testing, and documentation for the project.
iii. Track progress, milestones, and success metrics, and ensure adherence to software development workflow and development plans.
iv. Are responsible for providing needed updates, reports, and presentations of project activities.

NMFS Science Center participants:

i. Include the equivalent of 0.5 full time federal employees from each Center, the composition of which can be split among individuals within a Center, and where personnel can change over time.
ii. May include NMFS assessment researchers engaging in the project on an *ad hoc* basis.
iii. Engage in researching, designing, developing, and testing needed features and code, and provide code reviews for software modules.
iv. Engage in testing and comparison to existing models.
v. Communicate regional priorities to the FIMS project.
vi. Act as project emissaries and serve as an outreach and communication pathway to the NMFS assessment communities and their regional and professional networks. This includes supporting training and integrating regional priorities into the FIMS operational system.

Liaisons:

i. The National Stock Assessment Program Lead provides input on national stock assessment science priorities.
ii. The National Ecosystem Modeling Coordinator provides links to ecosystem modeling and ecosystem-based fishery management issues.
iii. A socioeconomic representative provides links to social science, economic modeling, and related issues.

The Implementation Team operates under the following terms of reference:

i. Establish and maintain performance metrics and project management protocols, including tasking, project tracking relative to milestones and deadlines, rules of engagement, and identification of team member roles.
ii. Develop the FIMS Project Management and Development Process within one year of Team assembly.
iii. Use the direction from the Science Board, individual scientific and strategic input provided by the experts on the FIMS Council, national and regional NMFS priorities, and other input to prioritize development of desired features.
iv. Meet twice per month to review progress and ensure that priority work is meeting objectives and deadlines, making adjustments where needed.
v. After completion of FIMS version 1.0, the implementation team is responsible for continued testing and maintenance as new features are requested, prioritized, and added as appropriate.
vi. Provide semi-annual progress reports to the FIMS Council and, separately, to the NMFS Science Board; these reports are to include:
    a. Summary of progress on priorities and milestones
    b. Prioritization of module development and summary of necessary adjustments of development plans and priorities with reasons for those adjustments
    c. Information on new research findings relevant to FIMS development
    d. Summary of testing results, pilot applications, and other evaluations
    e. Status of communication materials and outreach (e.g., documentation, training, presentations, etc.)
    f. Status of user base and participation in community development

H. FIMS Outreach

i. The FIMS project and Project Manager take a proactive approach to communication with other modeling efforts in NMFS, non-NMFS components of NOAA, and external relevant modeling projects.
ii. Outreach includes regular communication and collaboration between FIMS and other NMFS working groups associated with population, ecosystem, climate, and socioeconomic science and modeling.
iii. Provide communication and awareness to other NOAA modeling efforts (e.g., Integrated Ecosystem Assessment, Climate and Fisheries Initiative, Unified Modeling Committee, and others).
iv. Collaborate with external model development efforts to the extent feasible (e.g., national and international stock assessment model development projects).

I. Timeline and Process

i. Establish the FIMS Implementation Team (completed early 2021).
ii. Hire FIMS Project Manager, two Software Developers, (complete early 2021) a Toolbox Coordinator (in progress, late 2021), and a Testing and Documentation Specialist (completed 2021)
iii. Establish the FIMS Council by late 2021 and hold the first meeting in 2021, or as schedules allow.
iv. In the first year, the Implementation Team will collate information on state-of-the-science, begin gathering input from the FIMS Council, and develop a draft project management protocol.
v. The Team will present an Implementation Plan with proposed timeline to the Council for comment, then to the Science Board for approval by the end of year 1.
vi. Development is expected to take two-three years after approval of the implementation plan.
vii. Supplemental funds from internal or external grants may be sought to conduct additional R&D for FIMS.
viii. The NMFS Science Board and the FIMS Council will receive semi-annual reports and annual presentations throughout the development period.
ix. An external technical review may be commissioned at an appropriate time (e.g., after 3 years) and results of that review will be presented to the Science Board for their consideration and determining the future project direction.
x. Subject to completion of the external review and subsequent Science Board direction, the Team will respond and adapt accordingly, and as appropriate, will continue to develop new features and modules, documentation, and a user interface for approximately one year.
xi. Subsequent to these final development steps, the Team will conduct performance testing across NMFS in coordination with management partners over the course of about a year.
xii. Following development, FIMS will transition to operational status; each Center's assessment scientists and regional advisors will determine a feasible pace for transition from existing frameworks to FIMS.
xiii. During the operational phase and beyond, FIMS will continue to operate under direction of the Science Board and will continue communication with the FIMS Council and other NOAA-NMFS modeling efforts. FIMS will improve and expand as appropriate, through a defined research-to-operations process and engagement with management partners and throughout the fisheries science community; maintenance, documentation, training, and other tools will continue to be developed.