State of the Science–Stock Assessments: Science for Sustainable Fisheries

Context for Stock Assessments

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) governs marine fisheries management of over 500 fish and shellfish stocks in U.S. federal waters. In 2022, stocks managed under the MSA supported over 2.3 million jobs and generated over $321 billion in sales revenue (Figure 1). The MSA requires NOAA Fisheries to set annual catch limits that optimize long-term fishery yield, prevent overfishing, rebuild overfished (depleted) fish stocks, and are based on the best scientific information available. Stock assessments are the scientific process used to answer three key questions in fisheries management:

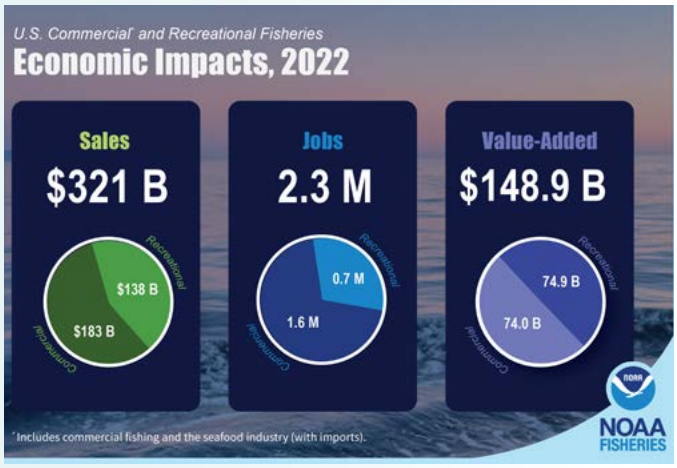

Figure 1. Summary of the economic impact of US marine fisheries. Value-added impacts include contributions to the gross domestic product in a region (e.g., fuel and ice purchases). Source: 2022 FEUS

1. What catch rate best balances resource conservation and use?
2. Has the stock been depleted below a level that jeopardizes the stock's ability to produce its maximum sustainable yield (is the stock overfished)?
3. Does a stock's recent catch rate exceed optimal levels (is overfishing occurring)?

Further, results from monitoring and assessing stocks has provided insight into dynamics of the ecosystem, thus supporting system-level decision-making under an ecosystem-based fisheries management (EBFM) framework.

NOAA Fisheries cannot assess every stock annually. Instead, scientists conduct about 200 stock assessments each year out of the 500+ managed stocks[1]. The stocks assessed each year change and are prioritized based upon factors such as the time since their last assessment, the amount of available data, and their economic, ecological, and societal value.

Researchers at the NEFSC and Woods Hole Oceanographic Institution retrieve an autonomous underwater vehicle equipped with cameras surveying sea scallops during a 2024 research cruise. Credit: Dvora Hart

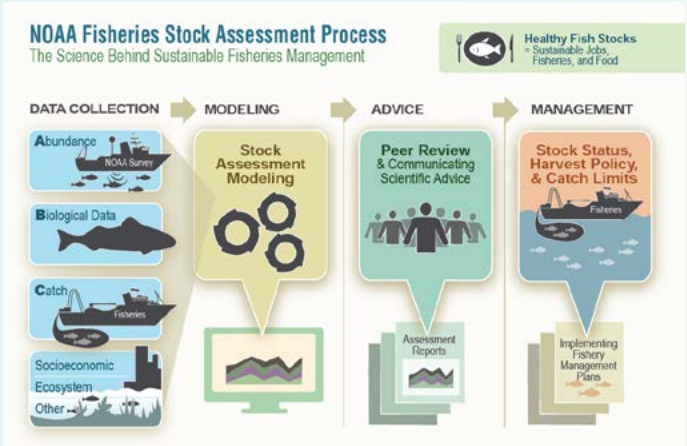

Figure 2. The main stages of the stock assessment process, data collection, modeling, and the provision of peer-reviewed scientific advice, are used by managers to implement sustainable fishery harvest management.

Stock Assessment Process

Stock assessments have multiple stages: data collection and processing, modeling, and providing management advice (Figure 2). Each requires coordination and collaboration with partners and stakeholders.

1. Data Collection and Processing

The data collection phase of stock assessments includes the collection and processing of three core data types:

- **Abundance** – the amount of animals in a stock
- **Biology** – information on animal reproduction, growth, movement, and natural mortality
- **Catch** –the total removal of animals by fishing

Abundance estimates typically come from data collected by scientific surveys conducted on NOAA ships, chartered commercial fishing vessels, or by collaborative partners. Those surveys follow statistical sampling designs that enable them to provide reliable estimates of annual abundance trends. To the extent feasible, these surveys also collect extensive data on ocean conditions and the ecosystem. Fishery catch rates also provide information on abundance that can augment survey-based estimates or stand in when survey data are not available, though their potential biases must be accounted for.

Biological data collection occurs during scientific surveys, and by fishery observers, dockside monitoring programs, and collaborative research projects with the fishing industry. Increasing the understanding of a stock's life history and productivity helps to better estimate optimum harvest levels. Data on the number of animals at each life stage is especially important for understanding the impact of fishing.

Catch data from commercial and recreational fisheries are tracked through programs that include dockside monitoring, at-sea observers, telephone and mail interview surveys, and commercial logbooks. These programs collect data on fishing location, gear used, catch size and species, discards, and effort. NOAA Fisheries is also expanding its systematic use of electronic monitoring and reporting initiatives to improve catch data monitoring and timeliness.

2. Stock Assessment Modeling

Stock assessment models are mathematical representations of fish stocks. They incorporate the types of data described in section 1 to calculate historical levels of fish stock abundance and fishing intensity and project future population trends. The available data influence the type of model that can be used. Stocks with more complete abundance, biology, and catch data support models that analyze abundance and fishing effects by age or size. They inform stock status determinations and provide short-term projections that inform managers' annual catch limits. For many stocks, however, data collection is limited by available resources. For these species, simpler approaches can provide some catch advice or status determination based on general biological concepts and available data. These are often applied as multispecies aggregate catch limits.

3. Developing and Communicating Advice

Even though assessments of stocks are based on the best available scientific information, data are limited and models are only approximations of the complexity of nature. Management procedures account for this uncertainty by scaling the risk of depleting or overfishing a stock based on the amount and quality of information available. Stock assessments produce scientific advice that is thoroughly scrutinized by scientists, the fishing industry, anglers, conservationists, and fishery managers. Independent reviewers evaluate the appropriateness and quality of the methods and data used to ensure that management advice is consistent with the best scientific information available and consider social and economic information. Successful stock assessments facilitate consensus among stakeholders with respect to the condition of a stock. NOAA Fisheries' assessment process is transparent, well-documented, and open to review and discussion.

Future of Stock Assessments

NOAA Fisheries' strategy for transitioning to a Next Generation Stock Assessment Enterprise includes recommendations focused on conducting more holistic and ecosystem-linked assessments, using innovative technologies, and establishing a more timely, efficient, and effective stock assessment process. Recent innovations include increased transparency and accessibility of stock assessment results shared with the public via the StockSMART tool.[2]

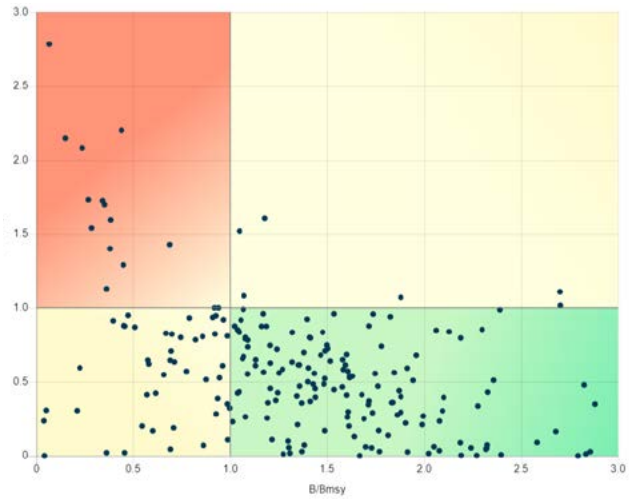

Figure 3. StockSMART data where each point is the status of a stock. Stocks above the horizontal line were recently fished above their overfishing level, and stocks to the left of the vertical line are considered below their target level of abundance. Many points are in the region (green) where the fishing level is somewhat below the limit and abundance is somewhat above the target. Source: 2024 StockSMART

Innovative and advanced technologies are key to augmenting traditional data collection. NOAA Fisheries is increasingly using technologies such as hydroacoustics, optical imaging, electronic catch monitoring, and uncrewed systems. Across regional science centers, scientists are developing autonomous underwater vehicles3 to collect data in areas that may be inaccessible for large vessels, such as offshore wind farms, or when vessels are unavailable.

Stock assessments increasingly use analytical approaches that can integrate new data streams and more accurately represent the breadth of ocean change and variability. These approaches include new modeling techniques and management procedures that account for climate dynamics in assessments, spatial models that account for variation in data collection, and open science projects that increase the transparency and reproducibility of the assessment process.

Stock assessments are a constantly evolving field of science. For the most up to date information, please visit:

https://www.fisheries.noaa.gov/topic/population-assessments

[1] https://www.fisheries.noaa.gov/feature-story/updated-stock-assessment-improvement-plan-builds-past-success
[2] https://www.fisheries.noaa.gov/resource/tool-app/stock-smart
[3] https://www.fisheries.noaa.gov/feature-story/long-running-sea-scallop-survey-diversifies-future