



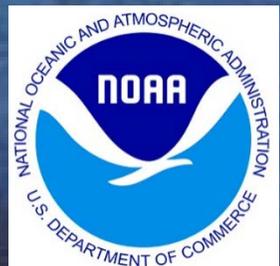
**NOAA  
FISHERIES**

## Topic 9 Emerging Technologies for Fisheries Stock Assessments

NOAA Science Advisory Board  
ESMWG  
Washington, DC  
December 17, 2019

# Topic 9 Report to the Science Advisory Board

Dr. Michael Castellini, University of Alaska  
Dr. Robert Johnston, Clark University  
Co-chairs





Science Advisory Board

## IMPROVING FISH STOCK ASSESSMENTS

A REPORT ON EMERGING STOCK ASSESSMENT TECHNOLOGIES

PRESENTED TO THE NOAA SCIENCE ADVISORY BOARD  
BY THE SAB ECOSYSTEM SCIENCES AND MANAGEMENT WORKING GROUP

DECEMBER 17, 2019

## CONTEXT

### SAB Work Plan Topic 9:

“Evaluate fisheries monitoring technologies to improve stock assessments. This evaluation should consider how to optimally balance electronic monitoring, eDNA, and other technologies...”

### 2018 Stock Assessment Improvement Plan (SAIP):

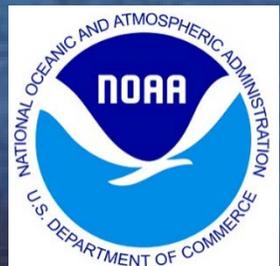
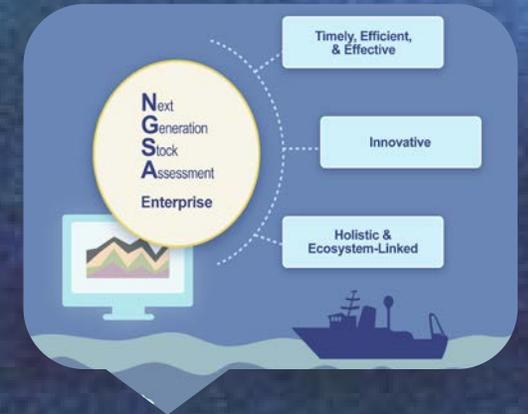
“To provide the best information possible and meet the demands for increased quality and quantity of stock assessments, we must continually improve stock assessments with new developments in science and technology.”

### 2016 ESMWG report on Emerging Technologies



## TIMELINE

- 2016: ESMWG report on broader New Technologies for NOAA
- May 2018: ESMWG discussions begin on Topic 9
- July 2018: SAB formally requests ESMWG Topic 9 report
- Fall 2018: ESMWG outlines concept
- May 2019: In-person meeting with NOAA experts
- May/July 2019: Literature review and writing
- July 2019: Draft outline to SAB
- October/November 2019: ESMWG meeting, writing & editing.
- December 2019: Submit report to SAB



# Topic 9 Report Structure

Three example technologies suggested by NOAA categorized by Technical Readiness Level:

TRL 1 = Research to TRL 9 = Fully Deployed

- Near term and currently being field verified TRL 7-8
  - Modern spectroscopy methods for fish aging
- Medium term at field testing stages TRL 5-6
  - Remote observing systems, e.g UxS surface vehicles
- Longer term development in laboratory and field TRL 2-3
  - 'Omics and molecular methods

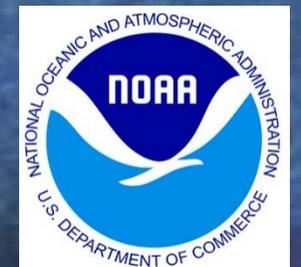


Near term: Dedicated field comparisons underway (TRL 7-8)

## Modern methods in fish aging through otolith analysis

Near IR FFT analysis of composition of otolith layers provides rapid age estimation with good precision, and greater than 800% efficiency compared to traditional methods.

- Consulting NOAA expert: Dr. Tom Helser; AFSC



Medium term: Calibration, testing, trials (TRL 5-6)

Remote observing systems (e.g. UxS) for assessment of population distributions and oceanic conditions



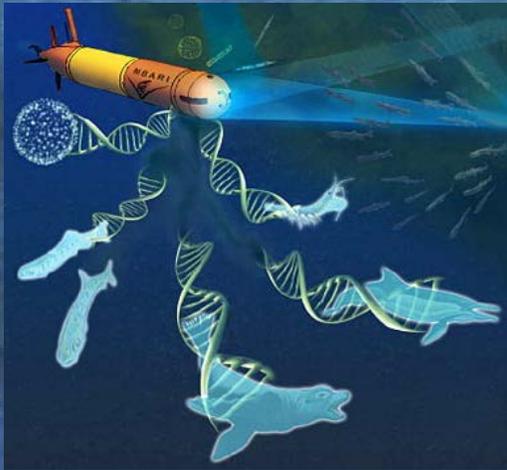
Multiple trials underway. Comparing to ship trawls and wide or rapid deployment.

Consulting NOAA expert: Christian Meinig;  
PMEL



# Longer term: Conceptual models, proof of concept studies, laboratory and university collaborations (TRL 2-3)

## 'Omics and molecular methods



**NOAA 'Omics Strategy**

The NOAA 'Omics Strategy will dramatically expand our application of 'omics—a suite of leading-edge methods used to analyze materials such as DNA, RNA, or proteins—by improving the efficiency, effectiveness, and coordination of 'omics development and usage across the agency. As 'omics are revolutionizing our ability to monitor and understand the biological communities of the oceans and Great Lakes, this Strategy will guide transformative advancements in the quality and timeliness of NOAA science, products, and services.

**Demonstrated Leadership in 'Omics**

In recent years, NOAA and its multisector partners have worked tirelessly to advance successful 'omics solutions that address our mission priorities. Specific fields include genomics, transcriptomics, proteomics, and metabolomics. Now we are leveraging that experience to integrate modern 'omics technologies across our agency. These advances will increase operational efficiency, improve ecosystem assessments and forecasts, and support stewardship. Example applications include:

- Sustaining fisheries;
- Developing aquaculture;
- Combating harmful and invasive organisms;
- Improving coastal resources and resilience;
- Discovering pharmaceuticals and other beneficial compounds; and
- Protecting vulnerable species and habitats, such as corals that provide essential fish habitat and support tourist economies.

This at-sea omics laboratory to promote biodiversity and deep-sea exploration represents a collaboration between NOAA's Northwest Fisheries Science Center and the Ocean Exploration Trust. Photo Credit: Ocean Exploration Trust.

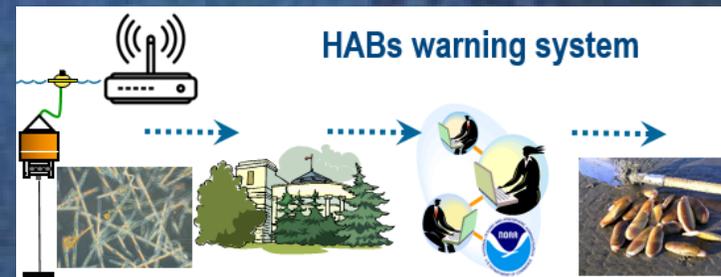
eDNA can provide comprehensive biological data with increased efficiency, resulting in more timely public access to information.

NOAA Science & Technology Focus Areas: Unmanned Systems • Artificial Intelligence • 'Omics • Cloud November 2019

The draft 'Omics Strategy is being made available for public comment at <https://arc.noaa.gov/NOAA-Science-Technology-Focus-Areas>.

Environmental eDNA for species identification, presence, distribution, life history.

Consulting NOAA expert: Dr. Kelly Goodwin, OAR, AOML, SWFSC



# Major Findings

All of the technologies have tremendous potential for enhancing current stock assessment methods. Some are more applicable to particular fisheries than others, but the potential for new directions and strategic utilization is high.

They should be considered *synergistic with ongoing stock assessment methods and processes*, and cannot serve as stand-alone replacements or provide immediate solutions to time, effort, funding and ship-use constraints.

Data created by some of these new techniques produce information that is substantially different from current data inputs to stock assessment and may have distinct biases that will need to be evaluated before they can be used.

These and other new methods will require dedicated studies comparing their results to NOAA's current best practices to ensure a high degree of integrity, reliability and credibility in stock assessments for fisheries management.

# Major Findings

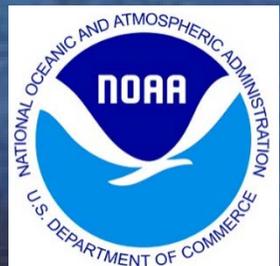
These techniques can expand the options, efficiency and accuracy of some existing NOAA research tools and may eventually enable new questions to be addressed.

The technologies require specialized personnel training to maximize their use.

These methods will likely provide information that goes beyond stock assessment and into areas of environmental assessment, ecosystem-based fisheries management, natural history and core biological information about the target species

# Recommendations

- A. Although new technologies may lead to efficiencies in the medium to long-term time frames, they should not be viewed primarily as cost-saving approaches, but rather as a means to improve stock assessments and ecological monitoring moving forward.
- B. NOAA will need to examine whether and how the new technologies can be linked to current stock assessment models and supporting analyses.
- C. New technologies can be advanced by holding workshops with diverse experts to develop ideas for how to apply these new technologies to stock assessment.
- D. Side-by-side dedicated comparisons between new technologies and ongoing stock assessment analyses will be needed to advance these new techniques.

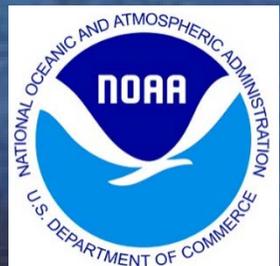


# Recommendations

E. NOAA will need to invest in laboratory and field testing of these methods...and should consider Public-Private-Partnerships (P3) to develop support for these methods in areas where the agency does not have primary responsibility.

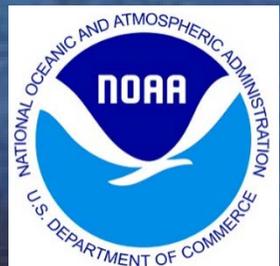
F. NOAA should explore the potential for workforce development, cooperative institutes, postdoctoral programs and training classes to provide current and prospective NOAA scientists training for these methods.

G. NOAA should consider how artificial intelligence, cloud computing and other approaches can be applied to process the large volumes of data that will be generated, and should consider implications for data access and ownership.



# Conclusion

To make use of emerging technologies, NOAA will need to investigate how these and other new methods could be useful to validate, expand and provide new possibilities for improving, and possibly reducing the costs and effort, of stock assessment analyses. However, given the levels of readiness of the techniques themselves and the ability of stock assessment models to accept new types of data, many technologies do not appear ready to replace current approaches on a wide scale. In the near-term, they could be useful for broad Ecosystem Based Fisheries Management (EFBM) efforts and might be especially useful in data-poor fisheries. All use will require trained personnel. The techniques clearly hold potential for new scientific developments beyond stock assessments and could open up new research directions for NOAA.



# Questions & Comments

