JOINT SESSION BREAKOUT 2A: INCLUDING HABITAT-SPECIFIC LIFE HISTORY RATES IN POPULATION MODELS, GROUNDFISH/REEF & UNTRAWLABLE/DIADROMOUS GROUPS

Facilitators: Richard S. McBride (NEFSC), Eric Bjorkstedt (SWFSC)

Rapporteur: David Dale (SERO)

Top Recommendations

- Develop reconstructions of historical habitat conditions (analogous to catch reconstructions) to provide context for future assessments.
- Hold regional workshops to develop specific, regionally relevant demonstration projects.
- Promote collection of ecosystem data to support comprehensive inclusion of dynamic habitat in future assessments.
- Construct prototype assessment models capable of assimilating data with heterogeneous spatial resolutions.

Three trigger questions were used during this session to engage participants on the subject of including habitat-specific life history rates in population models:

1) What life history rates are useful and feasible to measure on a habitat-specific basis?
2) How can habitat-specific life history rates be incorporated into population models? Does this require spatially-explicit models?
3) What new projects are feasible to implement in the next five years? What are longer term research needs?

Participants included NMFS scientists and managers identifying themselves as most strongly associated with the 'groundfish' or 'reef/untrawlable' categories, with only a few associated with diadromous fishes or habitats. The following summary synthesizes the group's lively and wide-ranging discussion in response to the above questions.

The discussion group began by identifying life history variables relevant to population models as well as by defining what constitutes 'habitat'. The following equation captured several life history rates of interest:

$$P = (G + R) - (F + M)$$

Where P = production, G = growth, R = reproduction (or recruitment), F = fishing mortality, and M = natural mortality of a population. Age, size, or ontogenetic stage also affect movement between or residency within habitats, thereby affecting abundance, distribution, and production of fish stocks.

In terms of the discussion, defining habitat was just as interesting as identifying the life history variables. Characterizing habitat by physical or structural types (e.g. reef, mangrove, estuary) was familiar to everyone but further discussion revealed the limitations of such static categories. In particular, replicate habitat types are embedded in larger-scale environments. Some of these environments may be easy to measure, understand, and predict (e.g. latitudinal clines in temperature, estuarine salinity gradients, or cross-shelf depth zones), whereas others may be less so (e.g. basin-scale climate indices such as the Pacific decadal oscillation, North Atlantic oscillation, or El Niño-southern oscillation). Time itself is a dimension of habitat, because habitats can change over time due to either natural (succession) or anthropogenic drivers. Even when systems are stationary over long periods, they can exhibit shorter-term dynamics of abiotic (seasonal temperatures) or biotic (predator-prey fields) components.

Detailed habitat maps are uncommon, and while this is frustrating to habitat ecologists, this is not necessarily an obstacle to including habitat-specific vital rates in stock assessments, if the vital rates themselves are not measured at a similarly fine spatial or temporal scale. For example, catch is often aggregated across large areas or cannot otherwise be disaggregated at the microhabitat scale. Thus, improved habitat data gained by advances in technology or partnerships may have limited scope to improve opportunities for fishery models to use habitat data. On the other hand, simple—but well established—data sets of temperature, salinity, depth, and ocean-climate indices are particularly promising sources of habitat information for incorporating into stock assessments in the near term.

The discussion group tried to generalize some conditions where existing population models could be improved with habitat- or spatially-specific data. Most assessment models assume a well-mixed stock of individuals that exhibit the same average life history. Habitat-specific variability exists, but is unspecified, in the data. When habitat can be specified as the source of life history rate variation, then it can be used as a basis for converting these overall mean parameters into weighted-means that reflect variability in habitats sampled in a manner analogous to stratified abundance estimators. Growth is often the easiest vital rate to determine and is therefore the strongest candidate for measuring at a habitat-specific scale. Reproduction and movement are quantified poorly for most stocks, but examples should be developed further where exceptions exist. Estimating natural mortality is likely to remain very difficult to measure. However, habitat-specific fishing mortality may be feasible, at least if there is strong contrast of fishing effort across spatial gradients or in relation to 'regulatory' habitats, such as closed or otherwise protected areas. In this regard, the fishing industry's view of the seascape is another important way to characterize habitat.

General concepts from the literature that support the idea of subgroups within a population that could be habitat-based are that of fish "platoons" (Phil Goodyear) or "contingents" (Dave Secor). Some more specific examples that were discussed during the session included:

- Sea scallops grow faster in shallower areas of the continental shelf, and slower in deeper waters, so that habitat-specific growth rates are used to predict yields and therefore the opening and closing of fishing areas.
- Bluefin tuna is managed by habitat areas, albeit on a very large scale.
- Fishing mortality rates of hogfish vary along a spatial gradient related to fishing effort and this affects demographic patterns of this species in south Florida.
- New Zealand hoki, a groundfish, was noted as a case where spatially structured assessments are being developed, although not based on specific habitat types.
- A multispecies, end-to-end model in the Bering Sea is an active project that will integrate primary production, habitat, fishing and markets.

Ideally, process-oriented studies are used to develop mechanistic models. The findings of such studies are not, however, always unequivocal and the data sets relevant for complex models may not extend beyond a few years or decades, whereas fishing rates may have had significant effects on populations for decades or even centuries. Mechanistic models may be the best way to advance confidence in the predictive power of NMFS stock and ecosystem assessments, particularly under climate change scenarios that depart from the observational record, so continued investment and development are needed. Nonetheless, the mission of NMFS can still be met by less sophisticated models, so scientists and managers need to fully use what is available today.

Habitat-specific information can be directly injected into the stock assessment process through presentations at data review meetings or by submitting documents to be included in the final assessments. Examples of potential data sources or studies include synthesis of ship- or trawl-track data and information on habitat recovery rates. It was proposed that reconstructions of historical habitat conditions would provide useful context for assessments. When essential habitat loss occurs, this will affect rebuilding targets without restoration or mitigation.

Discussion of potential near-term research efforts or demonstration projects yielded the following list of recommendations:

- Examine potential to integrate habitat-weighted average vital rates in current assessments.
- Include presence-absence (or categorical density indices) habitat information in assessments.
- Enhance efforts to estimate vital rates with sufficient frequency and spatial coverage to relate these to the habitat level within stock boundaries in future assessments.
- Promote collection of 'ecosystem' data, including information on predator-prey interactions to support comprehensive inclusion of dynamic habitat in assessments.
- Develop habitat reconstructions analogous to catch reconstructions, so that future assessments can move away from assumptions that habitat-related quantities (e.g. production or capacity) are stationary.
- Construct prototype assessment models capable of assimilating data with heterogeneous spatial resolutions. Such a model can be used to learn how best to 'scale down' assessment models or 'scale up' habitat data by exploring a continuum of model structures ('global' models to individual-based models).
- Scale up current, detailed surveys (e.g. remotely operated vehicle survey of Heceta Bank) to the stock level to better inform assessments.
- Integrate population models as a tool for understanding or predicting the effects of habitat restoration, particularly for diadromous fishes.

- Account for insights from the study of marine protected areas and associated fisheries. Careful design will be required for these studies to account for any trends in habitat quality between protected and open areas.
- Integrate outputs from ocean circulation models and remote sensing data, including estimates of production and transport, in habitat evaluations and assessments across diverse taxa. In doing so, pay close attention to conditions that enable or disable continuity along species' life cycles.
- Where practical, use otolith microchemistry or other natural tags as tools for evaluating habitat-specific vital rates at scales relevant to assessments.
- Plan future workshops to develop specific, regionally relevant demonstration projects.

Proceedings

11th National Stock Assessment Workshop

Characterization of Scientific Uncertainty in Assessments to Improve Determination of Acceptable Biological Catches (ABCs)

Joint Session of the National Stock and Habitat Assessment Workshops

Incorporating Habitat Information in Stock Assessments

1st National Habitat Assessment Workshop

Moving Towards a National Habitat Science Program

Hosted by the Southeast Fisheries Science Center, Southeast Regional Office, and
Office of Science and Technology
St. Petersburg, FL
May 17–20, 2010

Edited by Kristan Blackhart

November 2010
NOAA Technical Memorandum NMFS-F/SPO-112

U.S. Department of Commerce
Gary Locke
Secretary of Commerce

National Oceanic and Atmospheric Administration
Jane Lubchenco, Ph.D.
Administrator of NOAA

National Marine Fisheries Service
Eric C. Schwaab
Assistant Administrator for Fisheries

Copies of this document may be obtained by contacting:

Office of Science and Technology, F/ST
National Marine Fisheries Service, NOAA
1315 East West Highway
Silver Spring, MD 20910

An online version is available at http://www.st.nmfs.noaa.gov/

This publication may be cited as:

Blackhart, K. (ed.) 2010. Proceedings. 11th National Stock Assessment Workshop: Characterization of scientific uncertainty in assessments to improve determination of acceptable biological catches (ABCs); Joint Session of the National Stock and Habitat Assessment Workshops: Incorporating habitat information in stock assessments; and 1st National Habitat Assessment Workshop: Moving towards a national habitat science program. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-112, 153 p.