Programmatic Review of the PIFSC Commercial Fisheries Bio-Sampling Program

Hyatt Regency Garapan, Saipan
January 26–28, 2016

Review Panel Members

- Steven G. Smith, University of Miami
- Brad R. Moore, Pacific Community (SPC)
- Frank A. Camacho, University of Guam

Introduction: The stock assessment context of the Bio-Sampling Program

The coastal marine ecosystems of Hawaii, American Samoa, Guam, and the Northern Marianas Islands (CNMI) support economically- and culturally-important fishing industries as well as lucrative tourism industries. While hundreds of species of fish and shellfish are captured by commercial, sport, and subsistence fishers in the marine waters of these regions, very few have undergone formal stock assessments. A key management concern is thus whether these species/stocks are being fished in a sustainable manner. The main scientific roadblock stems from the lack of fundamental data for assessment for many species, a common problem for tropical marine fisheries around the globe.

There are two main types of data for developing indicator variables for assessment: (1) relative abundance, e.g., catch-per-unit effort (CPUE) from fishery-dependent dockside sampling or animal density from fishery-independent sampling of fishes in the water; and (2) length composition. These data types can be used in two different classes of assessment models to evaluate fishing mortality rates and stock sustainability. The first class is unstructured surplus production models which utilize relative abundance information. The second class is size/age structured models which utilize relative abundance-at-length information as well as life history data on growth and reproduction. Although developed from different branches of population dynamics theory, these two model classes should produce similar results for the same fish stock. For previously un-assessed species, it is prudent to collect both relative abundance (e.g., catch-per-unit effort) and length composition data for developing indicator variables for stock assessment, and then use both model classes to evaluate sustainability status, thus providing a cross-check to guard against things going awry during the modeling process. It is also advantageous to collect both relative abundance and length-composition data from different fishery sectors, e.g., the commercial fleet, recreational fleet, subsistence fleet, and fishery-independent surveys. Using data from multiple sources allows further cross-validation of the assessment results, and may provide a clearer understanding of stock sustainability status since it is often the case that no single data source—commercial, subsistence, or fishery-independent—covers the full spatial distribution of any given species. For example, the commercial fleet may fish deeper reef habitats than either the subsistence fleet or fishery-independent surveys, while fishery-independent surveys employing non-extractive gears may sample inside no-take marine reserves that are off limits to fishing by the extractive fleets.

Compounding the problems of data assessment and collection for tropical coastal fisheries are the vast number of species captured and the spatially-dispersed nature of artisanal fishers and landing sites. Designing fishery-dependent monitoring programs to obtain a representative sample of species catch and effort by gear and sector is a very complex endeavor.

I. General Observations

There appears to be two major components of the Bio-Sampling Program as presented to the review panel:

(1) Pilot program to improve data quality for the long-term creel sampling program. Creel data are intended to ultimately produce CPUE and CPUE-at-Length abundance indices, and estimates of total fishing effort and total catch. These abundance metrics are fundamental inputs for stock assessment models to ascertain sustainability status for fished species.

(2) Collection of life history data and tissues for developing population dynamics functions and parameters for stock assessments. The principal measurements and tissues collected by field samplers are length, weight, otoliths, and gonads for individual fish of a target suite of species. The key functions derived from this information include:

Length-Age growth function (e.g., von Bertalanffy). The function is used to convert numbers-at-length to numbers-at-age for estimating annual survivorship/mortality rates. The function also provides the important parameters of maximum age (lifespan) and average length at maximum age.

Weight-Length function. Used to convert numbers-at-length to biomass.

Proportion Mature-Length functions for females and males. Used to compute reproductive capacity of a population (e.g., spawning stock number, spawning stock biomass).

Notable accomplishments for component (1), the creel improvement pilot program, are:

- Identification of captured fish to species level rather than genus or family or species group. Development of impressive fish ID keys to facilitate training.
- More complete catch-at-length and effort data, e.g., sampling of whole catch from an individual fishing trip for species and lengths.
- Intercepting trips from components of the fishery that were previously not well sampled by the general creel program, e.g., night spearfishing.
- Impressive and innovative approaches for improved relationships between field scientists and fishers/vendors. These include sampling method refinements for minimal disruption to the normal business of selling/buying catch, and building relationships of mutual respect and trust among all involved parties. These advancements have undoubtedly led to better quality intercept sampling data from a greater number of fishers/vendors.
- Development of uniform data collection protocols among regions, including QA/QC procedures, a uniform data entry system tailored to each specific region, and a central database.
- Improved lines of communication between territorial and PIFSC bio-sampling staff.
- Impressive efforts at public outreach, and initial development of communication of bio-sampling data summaries and results to stakeholders and participating vendors and fishers.

Notable accomplishments for component (2), life history data, are:

- Initiating life history studies by obtaining specimens from the commercial catch, a logical and low-cost approach.
- Selecting target species for tissue sampling based primarily on important species in the catch with sparse or no previous life history information. Also, additional species of management concern were added to the target list in some cases.
- Development of standard and appropriate methods for tissue sample collection, labeling, preparation, storage, data recording and analysis that are fairly uniform among the 3 regions.

- Impressive numbers of tissue samples have been collected to date for many of the target species in all 3 regions.
- As for component (1), building relationships of mutual respect and trust among field scientists, fishers, and vendors were instrumental to the success of the life history component.

II. Key (Specific) Findings and Recommendations

(1) Pilot program to improve the creel survey
Finding: Great strides have been made in the pilot program for improving the quality of data in the intercept sampling of fishing trips and catches.

Recommended Next Steps:
1A) Use these improved practices/techniques to refine the general creel sampling program.

1B) Identify a statistician/analyst (or team of people) from the Stock Assessment group to work with Fishery-Dependent Data group. Begin the process of refining the sampling strategy for creel program to optimize sampling effort by fishery sector (commercial, recreational, subsistence), gear/method, time, and space for producing accurate and precise estimates of species-specific abundance metrics—CPUE, CPUE-at-length, Total Effort, Total Catch, Average Length, etc.—for use in stock assessments.

(2) Life history sampling
Finding #1: There is a large backlog of otoliths and gonads to prepare and analyze. Likely there has been some level of oversampling of these tissues for some species for developing population dynamics functions.

Recommended Next Steps:
1A) Identify a Stock Assessment statistician/analyst (person or team of people) as a key collaborator with life history group. Use the completed life history data for some of the principal species to evaluate the minimum required sample sizes by sex, length interval, location, etc., for developing accurate and precise length-age and maturity-length relationships. These initial sample size targets could then be used to randomly select specific otoliths and gonads by species, sex, length interval, location, etc., from the backlog of collected tissues for final preparation and analysis. These sample targets can also be used to guide future collection of tissues by Bio-Samplers for species, sexes, and size intervals that currently do not have a sufficient number of collected otoliths and gonads.

1B) Continue efforts to train and equip territorial scientists in tissue sample preparation and analysis to assist with the backlog and with future tissue collections for additional species and locations.

Finding #2: The general problem of deriving population dynamics functions and parameters from fished populations. In theory, population dynamics functions for growth, lifespan, and reproduction should be developed from data from a representative sample of a fish population that has never been subject to exploitation. Of course, the usual situation is that collection of life history information for a fish population begins after the stock has already been fished for many decades. With increased fishing, the chance of observing a fish at its maximum lifespan diminishes. In addition, the number of fish in the population above the minimum length of capture is lower than for an unfished population. These problems result in derived length-age relationships that have a lower maximum age than the true ecological maximum age, and expected length-at-age values lower than the true values over the exploited length range. In short, the species is perceived to grow to a smaller maximum length and age than the actual maximum length and age. This biased growth relationship results in biased estimates of mortality rates, all of which create biased results of sustainability status: the stock is perceived to be able to withstand higher rates of fishing and associated catch limits than the correct levels of exploitation and catch limits. Thus, the bias in the life history functions derived from fished stocks affects the assessment in a particularly negative way that could lead to a stock collapse. Consequently, the life history tissue sampling from the commercial catch needs to be augmented by other methods for collection which may hopefully overcome these biases.

Recommended Next Steps:
2A) The Stock Assessment statistician/analyst identified above should collaborate with the Fishery-Independent Sampling group and Life History group to develop a sampling plan for fishery-independent collection of life history data from lightly fished/pristine areas relative to the 3 regions. This would entail (i) comparison of existing FI and FD length composition data to identify potential habitats and regions with extended size ranges (both smaller and larger than found in the fishery-dependent sampling) for life history fishery-independent sampling. Some of these locations are fairly well-known, e.g., Rose Atoll in the general vicinity of American Samoa.

2B) Use target sample sizes in step 1A to guide collection of specimens.

3B) The trained territorial scientists (step 1B) can assist with tissue sample preparation and analysis.

Finding #3: Ageing of longer-lived species is sometimes problematic.

Recommended Next Step:
3A) Continue efforts for age corroboration between otolith and radiocarbon methods for species with lifespan > 30 years.

Finding #4: Variation in weight-at-length can be very high at larger lengths for some species. Some species reach their maximum length fairly early in their life history, and then remain at that length for many years to end of their lifespan. This is analogous to the growth strategy for mammals, for example. Weight, however, often increases with age (like humans, for example).

Recommended Next Step:
4A) The Stock Assessment statistician/analyst should collaborate with the Life History group to explore using girth as an additional metric for improving accuracy and precision of weight estimates from length.

III. Conclusions

Impressive strides have been made in improving the tactical aspects of Bio-Sampling. The program has sufficiently matured to the point where it is time to work on the strategic aspects in providing the essential information for conducting stock assessments. The specific recommendations above provide some examples for moving forward on this front.

Final Recommendation/Opportunity:

The struggles of PIFSC and state and territorial agencies with developing requisite information systems for conducting species-specific stock assessments and moving towards ecosystem-based fisheries analysis for coral reef ecosystems in the U.S. Pacific parallel those of the Southeast Fisheries Science Center (SEFSC) and state and territorial agencies in the southeastern U.S. and U.S. Caribbean. Parallel efforts spearheaded by SEFSC scientists are underway to improve: (i) fishery-dependent data collection and estimation of Catch, Effort, CPUE, and CPUE-at-Length for coral reef fishes; (ii) fishery-independent surveys for estimating size-structured abundance of target and non-target species; and (iii) life history data to support stock assessments. Likewise, similar problems and efforts to improve them are likely underway in neighboring countries/regions to American Samoa, Guam, and CNMI. It would greatly benefit all agencies and scientists involved to form trans-agency, trans-ocean, and trans-national working groups and meet on an occasional basis to inform, discuss, share methodologies and approaches, and perhaps develop innovative solutions to meet the scientific challenges of tropical fisheries ecosystem assessment.