

PFRP Annual Report for FY 2000

Pacific-wide analysis of bigeye tuna (*Thunnus obesus*) using a length-based, age structured modeling framework (MULTIFAN-CL)

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Purpose of the Project

Bigeye tuna (*Thunnus obesus*) are an important component of tuna fisheries throughout the Pacific Ocean. They are the principal target species of the large “distant-water” longliners from Japan and Korea, the longline fleet based in Hawaii, and the smaller “fresh sashimi” longliners based in several Pacific Island countries. The Pacific-wide longline catch of bigeye tuna has varied between 70,000 and 160,000 tonnes since the 1970s. During this time, catch-per-unit-effort (CPUE) by longliners has declined steadily, particularly in the area east of 160°W where the largest longline catches are taken. Surplus production model analysis based mainly on the longline data have suggested that the maximum sustainable yield (MSY) may be somewhat less than the maximum observed longline catch, leading to the conclusion that the stock of large bigeye exploited by longliners is at least fully exploited, and possibly over-exploited. It is probable, however, that the surplus production model is not an appropriate model for bigeye stock assessment, making the results of this analysis inconclusive. Since about 1994, a rapid increase in purse seine catches of juvenile bigeye, first in the eastern Pacific and more recently in the western and central Pacific, has created further uncertainty regarding the sustainability of the current levels of exploitation.

The purpose of this project is to develop a length-based, age-structured, spatially-explicit model of bigeye tuna population dynamics for the entire Pacific Ocean for use in stock assessment. Such a model would need to effectively deal with the diversity of fisheries catching bigeye tuna throughout the Pacific Ocean, the heterogeneous nature of the existing data and allow uncertainties in biological characteristics such as Pacific-wide mixing rates, to be assessed. The components of the project include data compilation, model development, data analysis and reporting.

Progress During FY 2000

The compilation of data and development of the model were largely completed during FY 2000 and work has begun on using the model to obtain a preliminary indication of the current status of the stock. Preliminary results were presented to the 13th meeting of the Standing Committee on Tuna and Billfish in July 2000. A summary of the results obtained is as follows:

The data cover the period 1962-1998 using a quarterly time stratification. The spatial coverage of the model is the entire Pacific Ocean (40°N-40°S, 120°E- the coast of the Americas), within which a four-region spatial stratification (boundaries along 20°N and 160°W) was adopted. Catch, effort and size data for 15 fisheries (4 longline, Philippines and Indonesia domestic, 5 eastern Pacific purse seine and 3 western Pacific purse seine fisheries) were used in the analysis. A limited amount of tagging data from SPC's Regional Tuna Tagging Project was incorporated into the analysis. The model structure adopted thus far includes: quarterly recruitment, 28 quarterly age classes, independent mean lengths for the first 8 age classes with von Bertalanffy growth constraining the mean lengths for the remaining age classes, structural time-series variation in catchability for all fisheries except three of the longline fisheries, age-specific natural mortality and age-specific movement among the model regions.

The model obtained growth estimates from the length-frequency data that are very consistent with independent estimates from otolith daily increments and tagging data. Overall, the model fitted the length data, which appear to be very informative regarding growth, very well. The catchability trends appeared to be mainly increasing for the purse seine fisheries, and particularly in recent years for FAD-associated sets. The natural mortality estimates were fairly consistent with expectation, with a basal level of around 0.55 per year for sub-adults with somewhat higher values for both smaller and adult bigeye. Estimated movement was predominantly west to east, reflecting the nature of the available tagging data. The lack of estimated movement from the eastern tropical region may simply reflect a lack of information on movement from this region (no tagging data available). Recruitment estimates showed strong intra- and inter-annual variation, with the most striking overall features being a decline in the western tropical region since the early 1990s and a strong increase in the eastern tropical region over the same period. The estimated trends in abundance were largely consistent with trends in CPUE standardized using a habitat model (fairly stable in the eastern Pacific, declining in the western Pacific, particularly since 1990). Overall fishing mortality is estimated to have increased but is not at a level that could be regarded as overfishing. These estimates are consistent with bigeye tag-recapture rates for the western Pacific.

Independent analyses of the same fisheries data (excluding tagging data) using the A-SCALA model of IATTC were consistent in many respects with the results of the MULTIFAN-CL analysis, although the A-SCALA estimates of fishing mortality tended to be higher and estimates of absolute population size lower. This may simply reflect the impact of the tagging data on the MULTIFAN-CL analysis, however further collaborative work with IATTC is required to better understand this divergence in results.

Plans for the Next Fiscal Year

During the next fiscal year, we will continue to examine different model structures and their impact on the model results. In particular we will:

1. Examine different hypotheses regarding stock structure (no east-west mixing versus a fully parameterized Pacific-wide movement hypothesis);
2. Examine the impact of different measures of longline fishing effort;
3. Undertake sensitivity analysis for the priors for longline fishery tag-reporting rates.
4. A final report of the project will also be prepared during FY 2001.

List of Papers Published in Refereed Journals During FY 2000

No papers were published in refereed journals during 2000.

Other Papers, Technical Reports

A presentation on this work, entitled “Preliminary results on the application of MULTIFAN-CL to Pacific-wide bigeye tuna” was given at the 13th Meeting of the Standing Committee on Tuna and Billfish, 5–12 July, Noumea, New Caledonia. A copy of the Powerpoint presentation is available from the author (JH) on request.