JIMAR, PFRP ANNUAL PROGRESS REPORT
FY 2003

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Project Proposal Title: Causes of rapid declines in world billfish catch rates (revised to "Reconstructing ecosystem dynamics: The long-term effects of exploitation on apex predators in the open ocean")

Funding Agency: NOAA, JIMAR, PFRP

1. Purpose of the project and indicative results.

The research aims to identify key processes that influence the responses of pelagic fish populations to exploitation by longline fishing gear. PFRP funding was scheduled to commence in January 2003.

Quantitatively describe the pelagic fish communities of the open ocean when longline fishing commenced.

Preliminary analyses of survey data indicate that the pre-exploitation population size of pelagic fish in the open ocean was much larger than previously believed. The analyses are based on detailed scientific survey data, which predate the time-series of commercial fishing data that are routinely used in stock assessment.

Of significance are data from longline surveys during the 1950s and from observers deployed on commercial longliners since about 1980. Abundance indices derived from those data sets must be adjusted for the effects of variations in the timing of longline operations, the quantity of hooked fish removed by scavengers, gear saturation and bait loss.

Identify spatial and temporal patterns in the distribution, abundance and size composition of the populations comprising those communities.

The standardized longline data will be used to describe spatial and temporal patterns in the populations from the 1950s through to the present. General patterns, if they exist, will be highlighted by comparison of trajectories in different areas (e.g., central tropical Pacific compared to the Gulf of Mexico and north-western Atlantic). Population attributes will include size composition and species abundance. Abundance will be considered in terms of number of individuals and also as biomass derived from species-specific length–weight relationships applied to length data.

Test hypotheses that might explain the observed patterns.

The analysis of patterns in the populations will point to key processes that influence the responses of pelagic fish populations to longlining. Those processes will be linked to testable hypotheses. Because they are an output of the pattern analysis, we are not yet in a position to identify exactly what hypotheses will be investigated. Examples of hypotheses that might be investigated include density dependent habitat selection, competition between fishing gear and population sub-structuring.

2. Progress during FY 2002. Provide a thorough discussion of accomplishments and problems.

Quantitatively describe the pelagic fish communities of the open ocean when longline fishing commenced.

Compilation of observer, survey and historical catch and effort time-series are largely complete. We have five-degree square – month Japanese longline data for 1952–99 in the Pacific and Indian Oceans and for 1952–99 in the Atlantic Ocean. We do not have access to finer, set-by-set records. However, they exist only since the mid-1970s, which is later than the period of particular interest to the current project.

We have assembled databases for observers on longliners in the central and North Pacific (observers on Hawaii-based longliners), western Pacific (SPC observers on various longliners), the South Pacific (Australian observers on Japanese longliners) and western Atlantic and Gulf of Mexico (US observers on US and Japanese longliners).

We have survey data from the Pelagic Fisheries Oceanic Investigations (POFI) during 1950–53 and recently came across a similar, though smaller data set for the Eastern Pacific during the late 1950s. Monthly length frequency data have also been obtained in hard copy form for Japanese longliners in the Pacific during the 1950s.

We are currently assembling data on the status of each hook at retrieval (bait intact, bait missing or hook broken off) for the central tropical Pacific (1950s and 1990s) and the Indian Ocean (1990s). The data are limited to the 1950s POFI surveys, Townsend-Cromwell research surveys during the 1990s and an Indian Ocean observer program. Those data are in hard copy and are currently being entered into an electronic database.

We have completed analyses of the effects of timing and soak time on abundance indices. The analyses reveal that abundance estimates are strongly influenced by soak time and also by the timing of longline operations in relation to dawn and dusk. Longline catch data will underestimate the total mortality of several species because the animals are lost from the longline before retrieval. In contrast, soak time has a strong positive effect on the catch rates of most shark and billfish species. At the beginning of longline retrieval, for example, swordfish catch rates are four times those at the end of retrieval.

The original motivation for examining the effects of soak time was the expectation that soak time had increased as a result of increases in the number of hooks per operation since longlining commenced. However, the analyses indicated that soak time actually declined, resulting in an underestimation of the catch rates of many species in recent years. More significant may be changes in the timing of longlining operations. A shift from operations that spanned both dawn and dusk to operations concentrated more on dusk may have moderated the effects of reduced soak time for many species.

We have commenced analysis of the effects of depth and shark damage on abundance indices. Those analyses include a comparison of observed catches and those predicted by habitat models.

Identify spatial and temporal patterns in the distribution, abundance and size composition of the populations comprising those communities.

We are about to submit for publication a comparison of early 1950s and 1990s pelagic fish communities in the central tropical Pacific Ocean. That analysis, which takes into account the effects of variations in soak time and longline depth, shows substantial

declines in the species that were initially most abundant, e.g., yellowfin tuna, oceanic whitetip shark and silky shark. Several species show increases, e.g., skipjack and snake mackerel. The early surveys were conducted as controlled experiments with longline gear and techniques held constant throughout the study. Survey longlines were deployed in a grid at pre-determined stations spaced one-degree apart. Searching for target species is an important difference to be considered when comparing survey and commercial catch rates. Unless the effects of improvements in efficiency and searching can be accounted for, the catch rate estimates for the early surveys must be considered minimums.

Test hypotheses that might explain the observed patterns.

Hypotheses are yet to be identified. Examples of conceptual models have been developed.

3. Plans for the next fiscal year.

Enter and analyze 1950s size data.

Enter bait status data and investigate factors affecting the rate of bait loss and gear saturation.

Investigate relationship (if any) between shark damage rates and removals of fish hooked on longlines.

Identify spatial and temporal patterns in the distribution, abundance and size composition of the populations.

Identify and test hypotheses to explain the patterns.

4. List of papers published in refereed journals during FY 2003.

None (Effects of soak time accepted for publication by Fishery Bulletin in February 2003.

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5. Other papers, technical reports, meeting presentations, etc.

Presentation of project outline at PI's meeting (December 2002).
Project review though PhD Admission to Candidacy examination (February 2003).

6. Names of students graduating with MS or Ph.D. degrees during FY 2003. Include title of thesis or dissertation.

None.

7. For multi-year projects, provide budget for the next year on a separate page.

The summary budget from the original funding application shows the budget for Year 2 of the project.