

**JIMAR, PFRP ANNUAL PROGRESS REPORT  
FY 2004**

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**Project Title:** Causes of rapid declines in world billfish catch rates

**Funding Agency:** PFRP

1. Purpose of the project and indicative results.

Large predators, such as sharks, billfishes and tunas, may exert a strong influence over the open ocean ecosystem. However, their initial removal when longlining first commenced in areas like the tropical Pacific Ocean has not been quantified. This project aims to describe the pre-exploitation pelagic fish community and thereby identify key processes that influence responses to exploitation by longline fishing gear. To address those aims, the project consists of two components: (1) verification of longline catch and effort data as an index of abundance; and (2) quantification of community changes.

For component (1) we have investigated the effects of soak time and timing on catch rates and tested the predictions of “habitat models”. Habitat models are increasingly being used to adjust longline fishing effort for variations in the vertical distribution of pelagic fish species. They predict the vertical distribution from information derived from tracking and physiological studies combined with data from oceanographic models of conditions in the fishing area. However, habitat models have not been tested against the observed depth distribution of longline catches. Our analyses show significant discrepancies between the observed distribution of bigeye tuna and that predicted by a habitat model. We concluded that habitat models might accurately predict the distribution of pelagic fish species, but this might not reflect their vulnerability to longline fishing gear. For example, bigeye tuna frequently move to shallow depths at night, but they might not take longline baits in that situation. There is also uncertainty in estimating habitat model inputs (temperature and oxygen at depth) on the scale at which they may influence longline catchability.

Catch rates, expressed as the number of fish caught per 1000 hooks, are often used as an abundance index for longline fisheries. However, the time that baits are available in the water should also affect what is eventually brought on board. We obtained data on catches, deployment and retrieval times, and soak time from six fisheries. We found that the effects of soak time varied between species, with catch rates of large predators increasing with soak time. Conversely, catch rates of small species were lower on hooks with long soak times, probably because they

are lost or removed by scavengers. Our analyses showed that variations in longline deployment and retrieval times also affect catch rates. Consequently, historical variations in soak time and the timing of operations have introduced a systematic bias in estimates of mortality levels and abundance based on catch rates.

To quantify changes in the pelagic fish community (component 2), we derived estimates of body-size and “abundance” (standardized catch rates) from a scientific survey when longlining began in the early 1950s and compared them to those reported by observers on commercial longliners in the same area of the tropical Pacific Ocean in the 1990s. The survey data extend the time-series of commercial fishing data that are routinely used in stock assessment and they also include non-target species, such as silky shark. We found major shifts in standardized catch rates and the size composition of species available to longline fishing gear. Large predators showed declines of a factor of ten, whereas small species increased or showed no change. The results suggest that either the initial changes in the pelagic fish community are greater than previously believed or that assessments have overlooked important features of the population dynamics or operation of longline gear.

## 2. Progress during FY 2004.

### **The vertical habitat of pelagic fish in the open ocean**

- A comparison of the vertical distribution of bigeye tuna observed on longlines and the distribution prediction by habitat models. The analyses show that habitat models are poor predictors of the depth distribution of longline catches of pelagic fish species.

Status: Drafted. To be submitted to *Fisheries Oceanography* in June 2004.

### **The effects of soak time and timing on pelagic longline catch rates**

- Analyses showing that estimates of longline catch levels and catch rates may be influenced by the timing of longline fishing operations. Variations in soak time and the time of day when longlines are deployed and retrieved have introduced a systematic bias in estimates of mortality levels and abundance since longline fishing commenced.

Status: Completed (published in *Fisheries Bulletin* Jan. 2004)

### **Historical changes and variations in pelagic longline fishing operations**

- An examination of how soak time and the timing of longline operations has varied historically and between fleets. Combined with the estimates of the effects of soak time and timing, it provides insights into how variations in operations have biased estimates of catch rates and catch levels.

Status: Completed (available as a web document on <http://fish.dal.ca/~myers/pdfPapers.html>)

### **Comparison of 1950s and 1990s pelagic fish communities in the equatorial Pacific Ocean**

- Quantitative description of changes in the pelagic fish community available to longline fishing gear. Indicates major shifts in the standardized catch rates and size composition of the community since the start of longline fishing.

Status: Completed (submitted to *Ecology* in Nov. 2003, reviewed in Feb. 2004, revised version submitted in April 2004)

### **Changes in the pelagic fish community of the North Pacific Ocean**

- Quantitative description of changes in standardized catch rates and size composition of pelagic fish species in the North Pacific. Preliminary results confirm patterns of change identified in equatorial waters, e.g., reductions in the body-size and catch rates of large predators.

Status: Analyses underway (to be submitted to *Ecology Letters* in July 2004).

### **Estimation of relative abundance and body-size from longline data collected by surveys and observers**

- Details of the data used in estimating body-size and models used to standardize catch rates, including an examination of model performance. Reviews possible causes of the observed changes in the pelagic fish communities, e.g., longline fishing, oceanographic conditions.

Status: Completed (submitted to *Ecology* in Nov. 2003, reviewed in Feb. 2004, revised version submitted in April 2004)

3. Plans for the next fiscal year.

### **The effects of longline gear saturation and bait loss on estimates of abundance**

- Our analysis of the effects of soak time demonstrated how losses or removals from hooks during longline operations have introduced a systematic bias to estimates of mortality and abundance. Gear saturation and bait loss might also affect estimates of abundance. Our intention is to model bait loss as a function of factors that may have varied historically, e.g., soak time and the time of day when longline hooks are available. We will combine estimates of bait loss and catch loss to determine whether gear saturation has resulted in significant bias in the estimation of catch rates and abundance.

Status: 1950s survey data entered and in a format ready for analysis. Hardcopy of one Townsend Cromwell cruise available, but NMFS unable to provide copies of other cruises within the framework required by this project.

4. List of papers published in refereed journals during FY 2002.

Ward, P., R. A. Myers, and W. Blanchard. 2004. Fish lost at sea: The effect of soak time and timing on pelagic longline catches. *Fishery Bulletin* 102:179-195. <http://fishbull.noaa.gov/1021/ward.pdf>

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

- Presentation of Science Seminar at the Bureau of Rural Sciences, Canberra (August 2003), *Shifts in pelagic fish communities of the tropical Pacific Ocean coinciding with the commencement of fishing*.
- Presentation of project progress report at PI's meeting (December 2003).
- Project review through PhD Committee (February 2004).

6. Names of students graduating with MS or Ph.D. degrees during FY 2004. Include title of thesis or dissertation.

None.

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

PFRP funding commenced in 2003. The summary budget in the original funding application provides the budget for Year 2 of the project, which will support project activities until August 2004. The total amount requested (\$57,665) for Year 2 remains unchanged. However, the allocation of funds between sub-components has been modified to meet reductions in actual funding caused by a 10–15% depreciation of the US dollar against the Canadian dollar. This includes a reduction in time spent on the project from 10 months in 2004 to 8.5 months. The PFRP staff is currently checking details of those proposed variations.

<b>Budget Summary</b>	Year 1	Year 2	Total
I Personnel	34,599	<b>46,732</b>	81,331
II Equipment	259	<b>2,363</b>	2,622
III Travel	1,698	<b>5,450</b>	7,148
IV Other costs	1,550	<b>227</b>	1,777
Sub-total USD	<u>\$38,106</u>	<u><b>\$54,771</b></u>	<u>\$92,877</u>
Overheads (@35%)*	2,567	2,894	5,461
<b>Total USD</b>	<u>\$40,673</u>	<u>\$57,665</u>	<u>\$98,338</u>