JIMAR – PFRP ANNUAL REPORT FOR FY 2008

P.I./Sponsor Name:

PI: David S. Kirby; Co-PIs: Valerie Allain, Adam Langley, John Sibert

Oceanic Fisheries Programme, Secretariat of the Pacific Community, BPD5, 98848 Noumea, New Caledonia

Project Proposal Title:

Regime Shifts and Recruitment in Western and Central Pacific Ocean Tuna Fisheries

NOAA OFFICE (Of the primary technical contact): PIFSC
Funding Agency: NOAA

NOAA Goal (Check those that apply):

☒ To protect, restore, and manage the use of coastal and ocean resources through ecosystem-base management

☒ To understand climate variability and change to enhance society's ability to plan and respond

☐ To serve society's needs for weather and water information

☐ To support the nation's commerce with information for safe, efficient, and environmentally sound transportation

1. Purpose of the Project (one paragraph)

To detect and characterise long-term environmental variability in time series of physical, biological and fisheries data; to determine whether the 'regime shifts' documented for the North Pacific are evident in the tropical WCPO; and to incorporate indicators of long-term environmental variability in tuna recruitment estimation.

The project has three components, each of which has a PI and Research Assistant (RA):
i) Exploratory data analysis of ecosystem model input/ouput plus comparable datasets, using various methods for multivariate time-series analysis to derive ecosystem indicators (PI: David Kirby; RA: Karine Briand)
ii) Use ecosystem indicators to improve recruitment estimation for tunas in the stock assessment software MULTIFAN-CL (PI: Adam Langley; RA: Karine Briand)
iii) Stomach contents analysis for data pre- and post the regime shifts of the late 1970s and 1990s (PI: Valerie Allain; RA: Marie-Laure Coudron)

2. Progress during FY 2008:

Component (i)

Quantitative indicators of ecosystem state were derived multivariate analysis of physical and biological oceanographic variables for the WCPO, and then statistical tests applied to determine the existence of regime shifts in the mean and variance of the indicators. Shifts were found at times that are broadly consistent with other studies for the north Pacific (1976, 1989, 1998) although earlier shifts (ca. 1964) appear to be just as significant. There is no signal of a regime shift in 1976 in the western equatorial Pacific, although shifts are evident in 1989 and 1998. There is a strong shift in the physical variables of the central equatorial Pacific in 1976, and a strong shift in current direction and primary production in this area in 1998. The methods are sound for the purposes of ecosystem monitoring but are inadequate to build causal or predictive relationships between the ocean environment and tuna recruitment. Other statistical models – Component (ii) – have proved useful in that regard. The best single indicator for monitoring the effect of environmental variability on yellowfin tuna recruitment appears to be the area of the western Pacific warm pool, which accounts for 52% of the variance in recruitment predicted by the GLM (see below), and which expanded significantly in the early 1960s.

Component (ii)

A generalised linear model (GLM) was developed to predicts yellowfin recruitment from a range of oceanographic variables, from different areas and spatial/temporal scales. The final model accounted for 68% of observed variation in quarterly recruitment for the period 1980–2003, with the inclusion of 10 different oceanographic variables derived from two zones within the equatorial region of the WCPO. The robustness of the recruitment model was investigated by cross-validation. The model was then applied to hindcast recruitment for the period 1952–1979. Recruitment predictions from the GLM closely followed trends in recruitment estimates from the assessment model through most of this period. The long-term trend in predicted recruitment was largely driven by sea surface temperature in the northwestern area of the equatorial region. This work has direct application to stock assessment for yellowfin tuna in the WCPO. Principally, the GLM enables recent (last 1–2 yr) recruitment to be estimated more precisely, thereby increasing the precision of estimates of current biomass and exploitation rates. Increased precision of the current age structure of the population also improves the accuracy of short-term (next 1–2 yr) stock projections from the assessment model. In a broader context, the recruitment model provides a tool to investigate how yellowfin recruitment may change in response to short- and long-term variation in the oceanographic conditions of the WCPO. The modelling approach was also applied to bigeye tuna, with the fainl model accounting for 72% of the observed variation in quarterly recruitment. This allows confidence in stock assessment estimates for bigeye recruitment, with similar benefits for estimating recent recruitment and carrying out stock projections as noted for yellowfin.

Component (iiii)

Datasets from previous diet studies for tunas (New Caledonia: Grandperrin-IRD 1959-1974; French Polynesia: ECOTAP-IRD 1995-1997) were compared with recent work (Allain: GEF-PFRP 2001-2005) in order to identify any changes in diet that might indicate regime shifts in the pelagic ecosystem.

Table 1. Sample sizes (number of individuals) for comparative diet study

	New Caledonia		French Polynesia	
Species	OLD	NEW	OLD	NEW
Albacore	235	50	82	97
Yellowfin	435	96	90	80
Bigeye	28	59	140	97

For New Caledonia, the diets of all three species seems to have changed between the two studies, although the small sample sizes (Table 1) for albacore and bigeye in the ‘new’ data and for bigeye in the ‘old’ data must limit the extent of our inference. The diversity of fish prey families (Fig. 5) fell 17% (bigeye), 53% (albacore) and 61% (yellowfin) between ‘old’ and ‘new’ studies, with albacore consuming 12% more epipelagic crustacea and yellowfin consuming 18% more epipelagic forage fish and 10% less mesopleagic molluscs.

For French Polynesia, the diets of all three species seems to have changed between the two studies. The diversity of prey families fell 31% (bigeye), 42% (albacore) and 39% (yellowfin) between ‘old’ and ‘new’ studies, with albacore consuming 46% more epipelagic crustacea and 10% less mesopleagic molluscs, yellowfin consuming 22% more epipelagic forage fish and 12% less mesopleagic molluscs, and bigeye consuming 14% more epipelagic forage fish and 7% less mesopleagic molluscs.

Comparing diet studies is a difficult task, especially when working on ‘rescued’ data; this study highlighted the importance of metadata. Taxonomic identification level appears to be a major problem in the comparison process as it highly depends on the identification skills; analysis of the data at the family level is probably a good compromise between accuracy and precision. Environmental variability is highly likely to have played an important role in the changes apparent in the diet data. However, the lack of continuous monitoring means that it is difficult to discern interannual (ENSO type) variability from that at a decadal scale. Furthermore, the lack of precision in the ‘rescued’ data make it difficult to conclude that apparent changes are the result of an ecosystem regime shift.

3. Plans for the next fiscal year (one paragraph):

None - Project ended October 2007.

4. List of papers published in refereed journals during FY 2008.

Langley A, Briand K, Kirby DS, Murtugudde R (in press) Influence of oceanographic variability on recruitment of yellowfin tuna thunnus albacares in the western and central Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences

Kirby DS, Briand K, Langley A, Murtugudde R (submitted) Ecosystem indicators for regime shifts and tuna recruitment in the western and central Pacific Ocean. Marine Ecology Progress Series

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

Oral presentations to the second and third meetings of the Scientific Committee of the Western and Central Pacific Fisheries Commission, August 2005/6, Manila/Honolulu.
Oral presentations to PFRP-PI meeting, November 2006, Honolulu, HI, and to the 58th Annual Tuna Conference, Lake Arrowhead, CA.

6. Graduates (Names of students graduating with MS or PhD degrees during FY 2006. Provide titles of their thesis or dissertation):

Marie-Laure Coudron obtained her Master degree at the University of Caen in September 2006 presenting her work entitled "1998 regime shift detection by comparing tuna diets in French Polynesia".

7. Awards (List awards given to JIMAR employees or to the project itself during the period):

8. Publication Count (Total count of publications for the reporting period and previous periods categorized by NOAA lead author and Institute (or subgrantee) lead author and whether it was peer-reviewed or non peer-reviewed (not including presentations):

	JL Lead Author			NOAA Lead Author			Other Lead Author		
	FY06	FY07	FY08	FY06	FY07	FY08	FY06	FY07	FY08
Peer-reviewed									**2**
Non-peer reviewed							**2**	**2**	**2**

9. Students and Post-docs (Number of students and post-docs that were associated with NOAA funded research. Please indicate if they received any NOAA funding. For institutes that award subcontracts, please include information from your subgrantees):

Marie-Laure Coudron (Masters degree candidate, University of Caen) worked on diet data providing results for this and one other PFRP project: Trophic structure and tuna movement in the cold tongue-warm pool pelagic ecosystem of the equatorial Pacific.

10. Personnel:

(i) Number of employees by job title and terminal degree that received more than 50% support from NOAA, including visiting scientists (this information is not required from subgrantees): 2

Karine Briand MS – Research Assistant (12 months)

Marie-Laure Coudron MS – intern (3 months)

(ii) Number of employees/students that received 100% of their funding from an OAR laboratory and/or are located within that laboratory.

(iii) Number of employees/students that were hired by NOAA during the past year:

11. Images and Captions.

Figure 1. Statistically significant shifts (solid line, dates) in mean values of the two principal component (PC) scores (first two panels) from a multivariate analysis of oceanographic variables selected by the GLM for yellowfin recruitment (third panel)

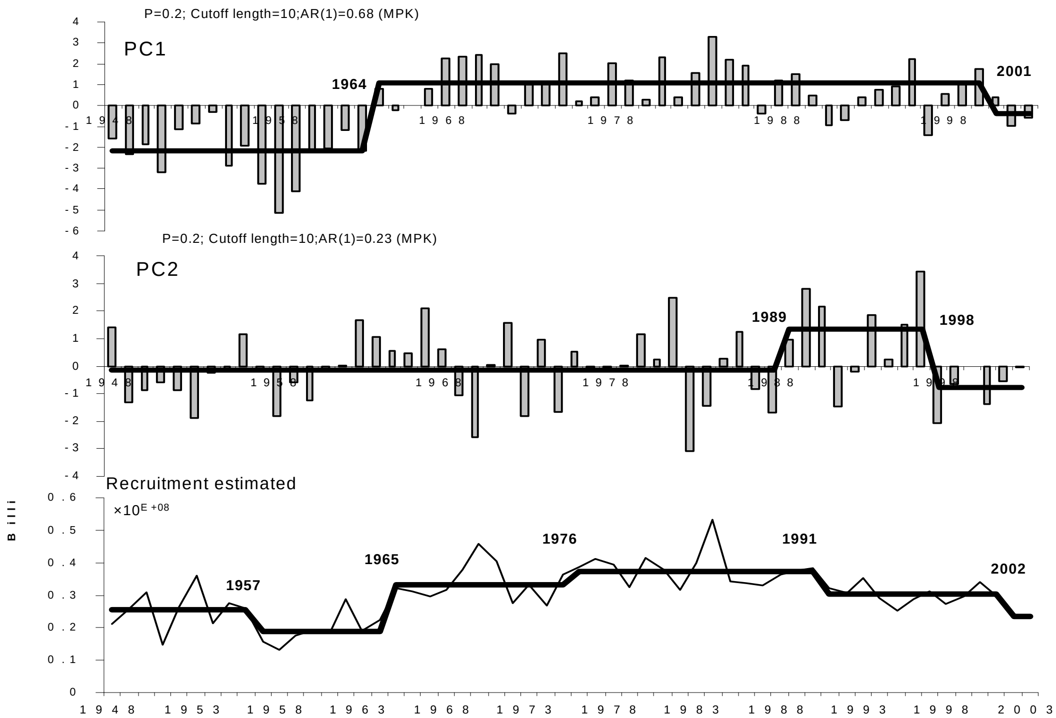


Figure 2. Statistically significant shifts (solid line, dates) in mean values of the two principal component (PC) scores (first two panels) from a multivariate analysis of oceanographic variables selected by the GLM for bigeye recruitment (third panel)

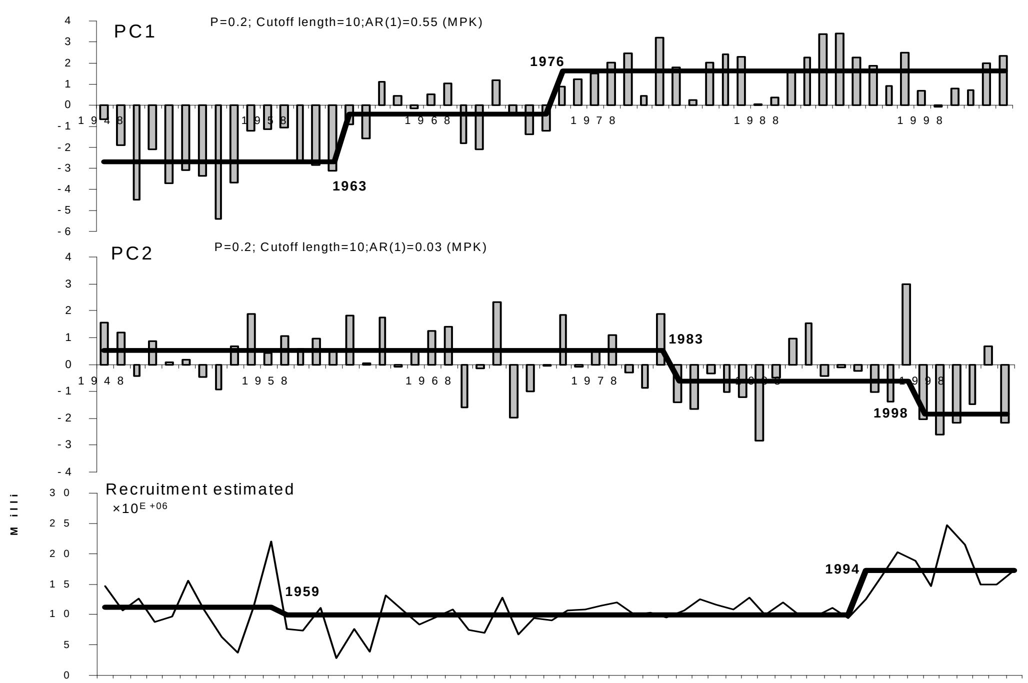


Figure 3. Recruitment GLM for yellowfin tuna. ‘Observed’: MULTIFAN-CL recruitment estimate; ‘predicted’: GLM recruitment estimate

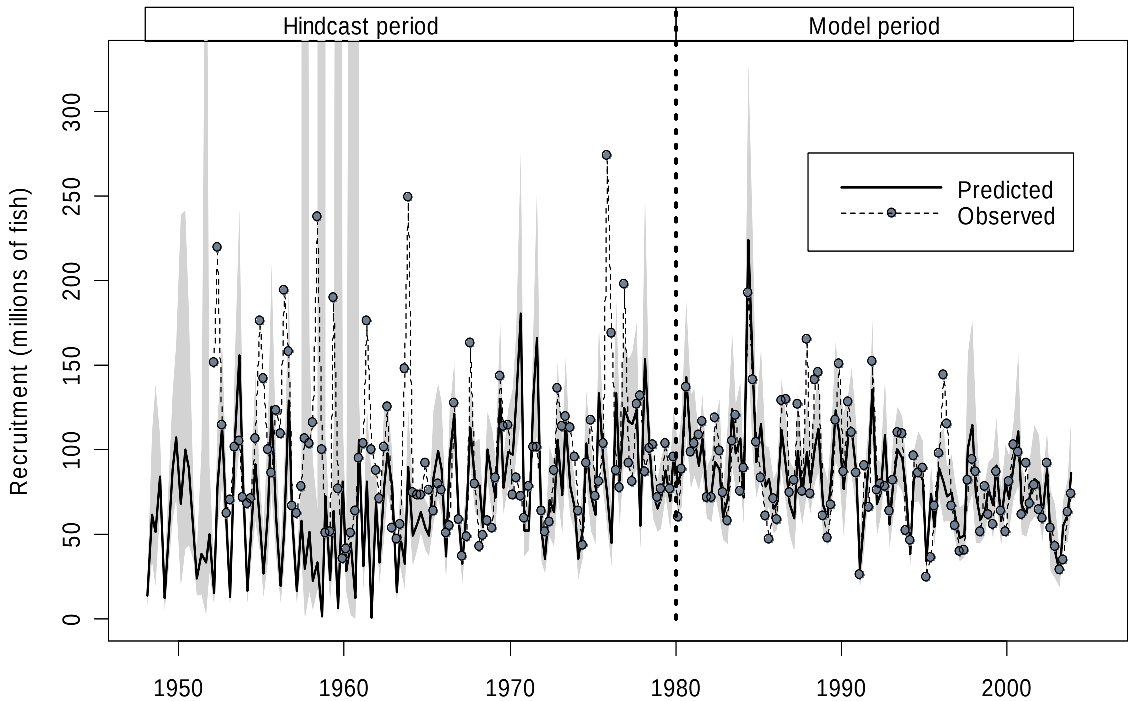


Figure 4. Recruitment GLM for bigeye tuna. ‘Observed’: MULTIFAN-CL recruitment estimate; ‘predicted’: GLM recruitment estimate

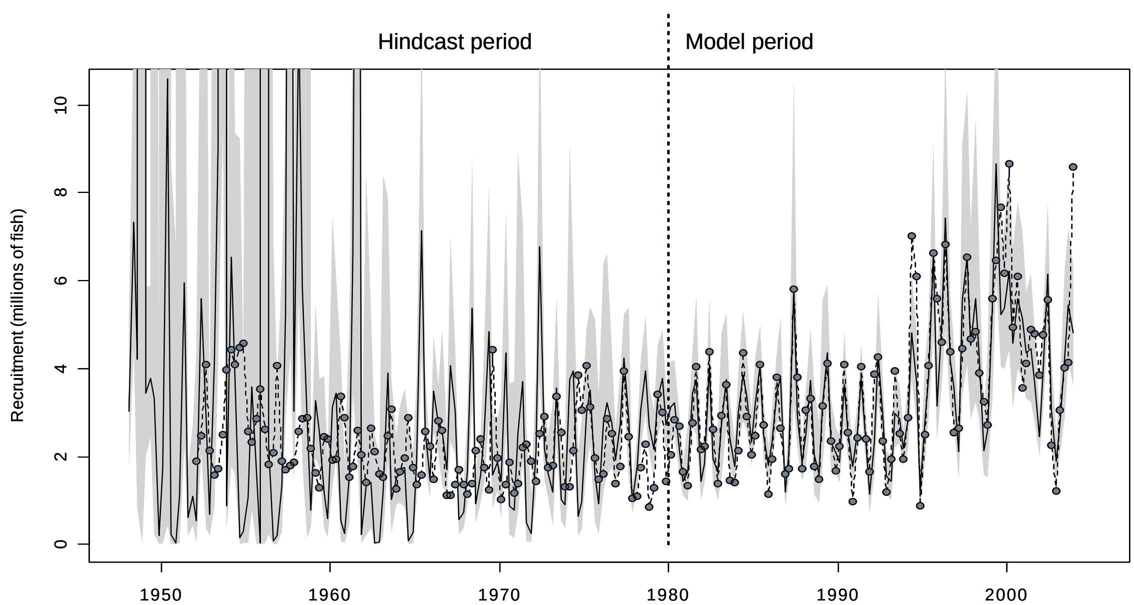


Figure 5. Diversity of fish prey families in tuna diet studies

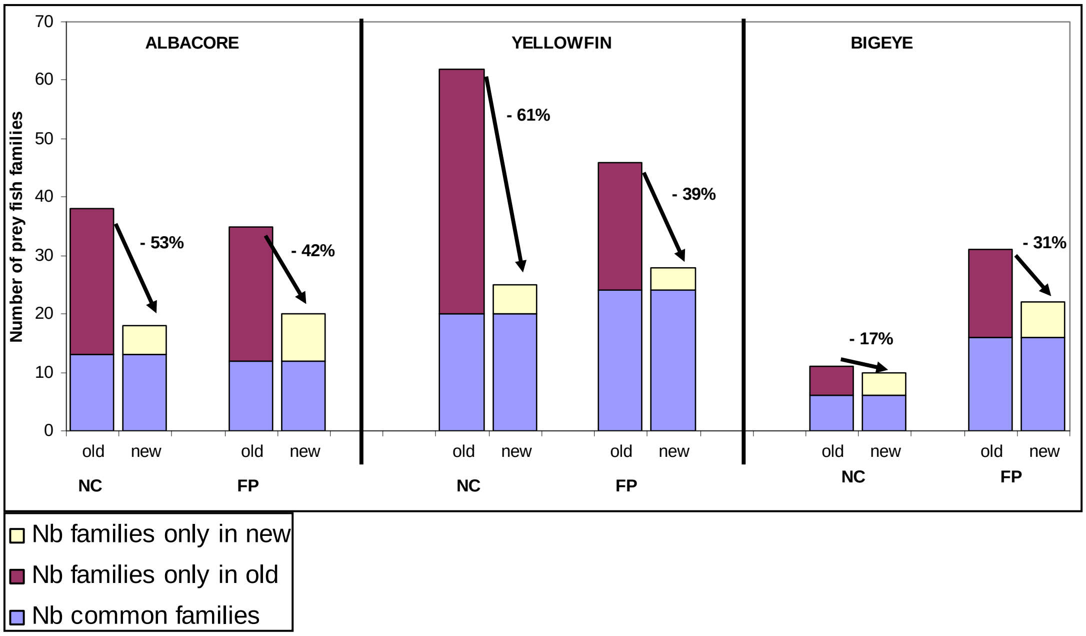
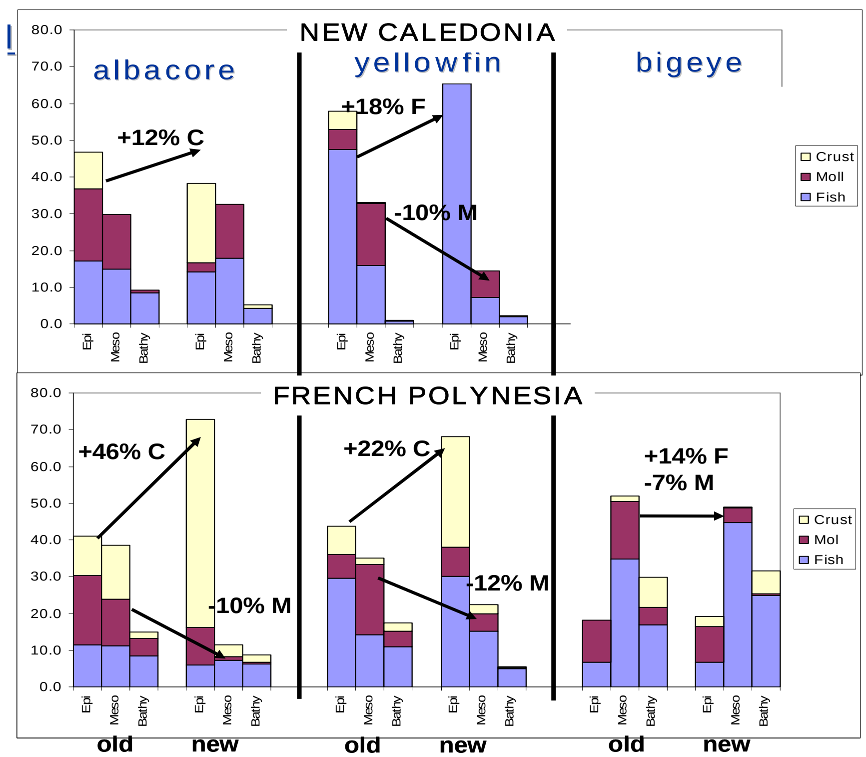


Figure 6. Changes in prey proportions by vertical class (% weight). Epi: epipelagic; Meso: mesopelagic; Bathy: bathypelagic; Crust: crustacea; Mol: molluscs; Fish: fish



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

All funds requested in the original proposal and approved budget revisions have been received or invoiced and hereby aquitted. No further funding is requested for next year.