OCEANIC FISHERIES PROGRAMME

Advances in fisheries science for South Pacific albacore

South Pacific albacore fisheries

There is a discrete stock of albacore tuna in the South Pacific that is separate from the North Pacific stock. Distant-water longline fleets of Japan, Korea and Chinese Taipei, and domestic longline fleets of several Pacific Island countries, catch adult albacore over a large proportion of their geographic range (Fig. 1). The Chinese Taipei fleet in particular has targeted albacore consistently since the 1960s, although to a lesser extent since 2000. In recent years the longline catch has increased considerably, with the development (or expansion) of small-scale longline fisheries targeting albacore in several Pacific Island countries, notably American Samoa, Cook Islands, Fiji, French Polynesia, New Caledonia, Samoa and Tonga. A troll fishery for juvenile albacore has operated in New Zealand's coastal waters since the 1960s, and in the central Pacific (near the subtropical convergence zone) since the mid-1980s. Driftnet vessels from Japan and Chinese Taipei targeted albacore in the central Tasman Sea and in the central Pacific near the sub-tropical convergence zone during the 1980s and early 1990s. Surface fisheries are highly seasonal and occur mainly from December to April. Longline fisheries operate throughout the year, but the catch is very seasonal, with the fishery operating in the south (mostly south of 35° S) during late summer and autumn, moving north in winter.

South Pacific albacore fisheries science has advanced over the last two years. The Oceanic Fisheries Programme (OFP) at the Secretariat of the Pacific Community has completed two stock assessments for the species on behalf of the Western and Central Pacific Fisheries Commission in 2008 and 2009. This has included an evaluation of the biological assumptions that have underpinned past assessments. Significant research programmes have also begun through the 9th European Union Development Fund project, "SciFish", with activities designed to improve our knowledge on their reproductive biology, growth and movement dynamics implemented. Significant work has also begun to characterise the interaction between South Pacific albacore catches and the oceanography of the South Pacific. The results so far are outlined below.

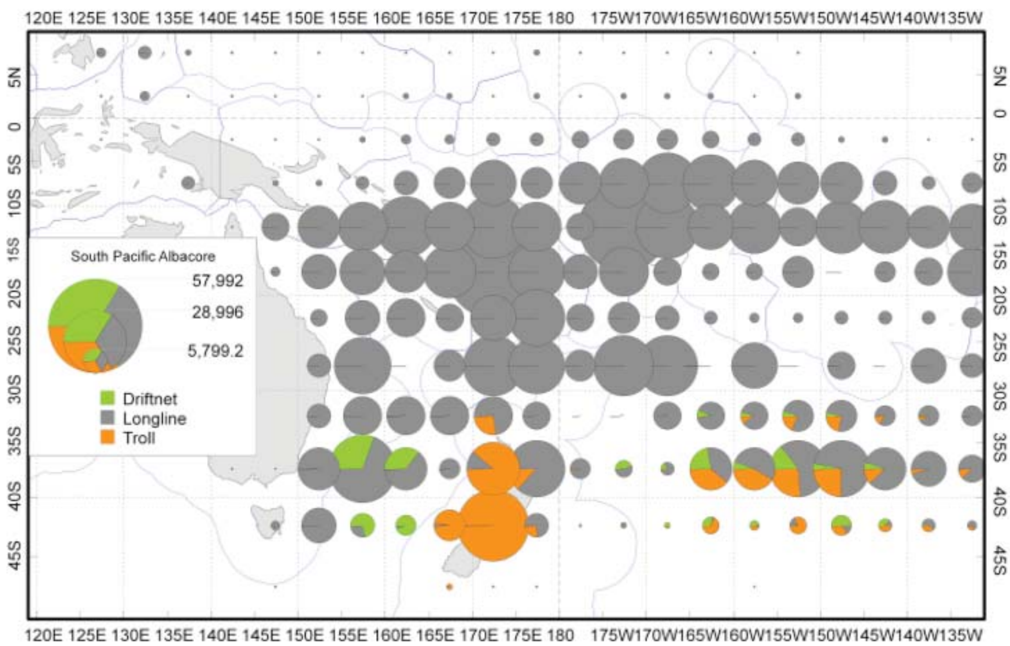

Figure 1. Total catch (in metric tonnes) of South Pacific Albacore from 1958-2008 in the western and central Pacific Ocean.

Recent developments in South Pacific albacore — Oceanographic relationships

The relationships between albacore tuna longline catch per unit of effort (CPUE) and environmental variables are being undertaken at high resolution. Analysis is being undertaken for American Samoa, Cook Islands, Fiji, French Polynesia, New Caledonia, Vanuatu and Samoa. Analysis for New Caledonia is complete and has demonstrated that a large part of albacore CPUE variability can be explained by seasonal, interannual and spatial variations of habitat. The latitudinal movement of sea surface temperature (SST) isotherms appeared to drive the migration of albacore and the seasonality of catches. At the exclusive economic zone scale, higher CPUEs are associated with warm waters in the intermediate layer. In Figure 2 (left panel), the effect on CPUE is highest around 20–21°C. Albacore CPUE also varied in response to the east–west currents in the surface layer, with increasing CPUE for moderate westward currents. In the austral winter, longline CPUE appeared to depend on prey densities (Fig. 2, middle panel). Albacore CPUE was highest at moderate prey densities in the epipelagic layer[1] at night, and for quite low prey densities in the mesopelagic layer[2] by day. Basin-wide oceanographic events also influenced albacore CPUE in New Caledonia, with above-average CPUEs during strong El Niño episodes (Fig. 2, right panel).

Recent developments in biological knowledge

Stock assessments for South Pacific albacore require estimates of biological parameters that describe population dynamics. However, some of the estimates used have been quite uncertain, either because of missing or scarce biological data, or because data had not yet been analysed. Sustainable fisheries need continued reproductive output, and so stock assessments use spawning biomass in stock status indicators and reference points. Past stock assessments for South Pacific albacore reported on spawning biomass as the product of numbers at age, weight at age, and maturity at age. The dynamics of tuna however are more complex. The sex ratio of tuna changes with size, with maturation being an interaction between the age and size of an individual with some faster growing individuals beginning reproduction younger than slower growing individuals, and egg production increasing more rapidly with increasing length. A more accurate method for measuring spawning biomass is spawning potential because it includes age-related and sex-related effects on reproductive output. This can be calculated as the product of numbers at age, maturity at age, proportion of females at age, fecundity at age, and the fraction spawning at age. Sensitivity analysis demonstrated that reference points based on spawning potential can differ significantly from those based on spawning biomass for South Pacific albacore.

For albacore, the proportion of males increases with size (Fig. 3). Sex ratio data were supported by an increase in natural mortality for mature females (Fig. 3), but differences between sexes in growth or vulnerability may also contribute to this observation. A preliminary study of the age, growth and reproductive biology of albacore was completed by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2008. This study used representative samples of albacore from the Australian

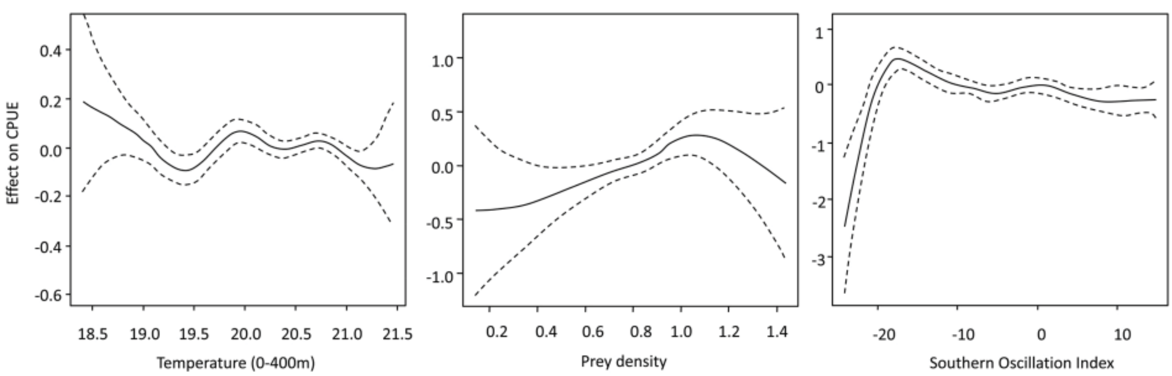

Figure 2. Effects on CPUE of water temperature in the depth range 0–400 m (left panel), prey density (middle panel) and Southern Oscillation Index (right panel). Above zero effects represent higher CPUE and negative values lower CPUE. Extreme values on the x-axis should be interpreted with caution as the Generalized Additive Models (GAM) poorly estimated at these margins.

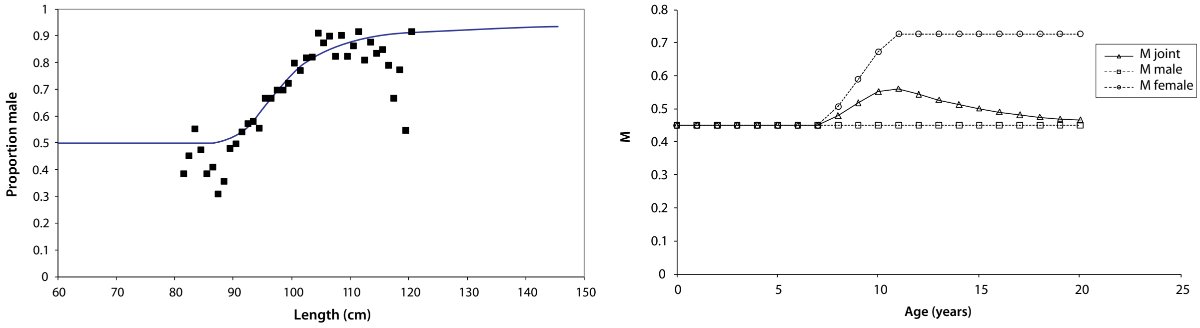

Figure 3. The relationship between sex ratio (proportion of males) of South Pacific albacore and length (left panel) and estimated natural mortality curve (right panel).

Eastern Tuna and Billfish Fishery to estimate the age structure, growth rates, sex ratios and maturity of albacore off the east coast of Australia. The oldest albacore sampled in this study was 14 years and the average maximum length was 103 cm fork length (FL), with males growing slightly larger than females. There were more males than females sampled, particularly in the larger size classes, and 50% of females were mature by 82 cm FL and four years of age. The maturity information differed from that used in the stock assessment, indicating that there may be regional variation in age at maturity. Information on fecundity at length and spawning fraction at length are extremely uncertain for South Pacific albacore.

OFP and CSIRO are now collaborating on a larger project that will expand the preliminary biological study from Australia. It will investigate spatial variation in reproductive and growth biology of albacore across the western and Central Pacific Ocean (WCPO). As part of this collaborative project, a large-scale sampling programme was implemented in 2008 to collect biological samples (gonads and otoliths, Fig. 4). The objective was to collect samples from approximately 100 albacore in each of 25 grids across the WCPO (Fig. 5). During SPC observer training workshops, fishery observers were trained to extract samples, and have already collected several hundred. Sampling will continue until the end of 2010.

The sophisticated stock assessment models used in the WCPO integrate catch, size and tagging data. Catch and size data are collected annually for South Pacific albacore, but only a small tagging dataset is available. Over 17,000 albacore were tagged with conventional tags in the convergence zone of the South Pacific during dedicated tagging programmes between 1985 and 1992.

These tagging programmes have provided the most useful information to date on the potential movement patterns, growth rates and exploitation rates of South Pacific albacore. However, there is a need to obtain more contemporary data to refine our knowledge of albacore movements and exploitation rates.

As part of the SciFish project, a tagging study was developed with the overall objective of obtaining better estimates of exploitation rates, movement patterns, and growth rates of albacore. The first phase of albacore tag-

Figure 4. South Pacific albacore gonad (left panel) and otoliths (right panel).

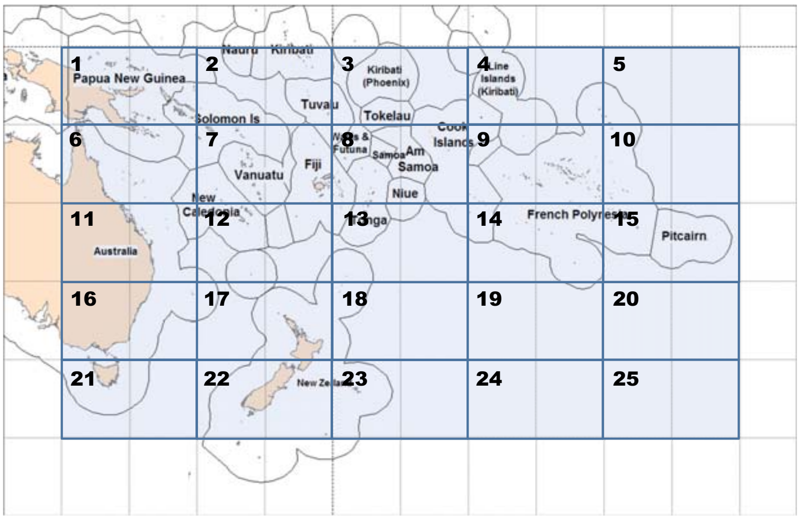

Figure 5. Locations where South Pacific albacore gonads and otoliths are sampled.

ging was completed in 2009 off the west coast of the south island of New Zealand where 2,766 albacore were tagged and released; 1,457 of these fish also received an injection of oxytetracycline (OTC) as part of an experiment to validate age estimates for albacore. To date, only one recapture has been reported from these tagged fish. This fish was recaptured 11 months after release, approximately 200 km from the release site.

The second phase of albacore tagging will be completed by the end of 2010 and will include tagging in New Caledonia, New Zealand and Tonga. A focus for the tagging in 2010 will be the deployment of 30 miniature pop-up satellite archival tags (miniPATs) on large (~ 20 kg) albacore. The miniPATs can provide detailed information on the vertical and horizontal movement of fish, and are particularly suited for albacore, which typically suffer from low recapture rates, such that standard archival tags are not a viable option.

Tagging in New Zealand has been completed for 2010 with 92 albacore tagged with conventional tags and injected with OTC. Five albacore were also released with miniPATs. Since their deployment, 3 miniPATs have released prematurely after 9, 11 and 30 days. The data from these tags have been received from the satellites revealing detailed information in the vertical movements of albacore (Fig. 6). An interesting observation from these individuals is the predominance of occupying habitats in the 17.5–19.5°C range. On the east coast of New Zealand this has typically been in the 50–100 m depth range with regular bounce dives to deeper and colder habitats. Further analysis will provide information on the horizontal movements of these individuals.

Fore more information, please contact:

Dr Simon Nicol
SPC Principal Fisheries Scientist
(Tuna Ecology and Biology)
(SimonN@spc.int)

or OFP scientists:

Karine Briand
(karineb@spc.int)

Ashley Williams
(ashleyw@spc.int)

Simon Hoyle
(simonh@spc.int)

Nick Davies
(nickd@spc.int)

1. Epipelagic layer: From the surface to around 200 m depth, in the illuminated surface zone where there is enough light for photosynthesis.
2. Mesopelagic layer: From 200 m down to around 400 m, in a zone where some light penetrates but is insufficient for photosynthesis.

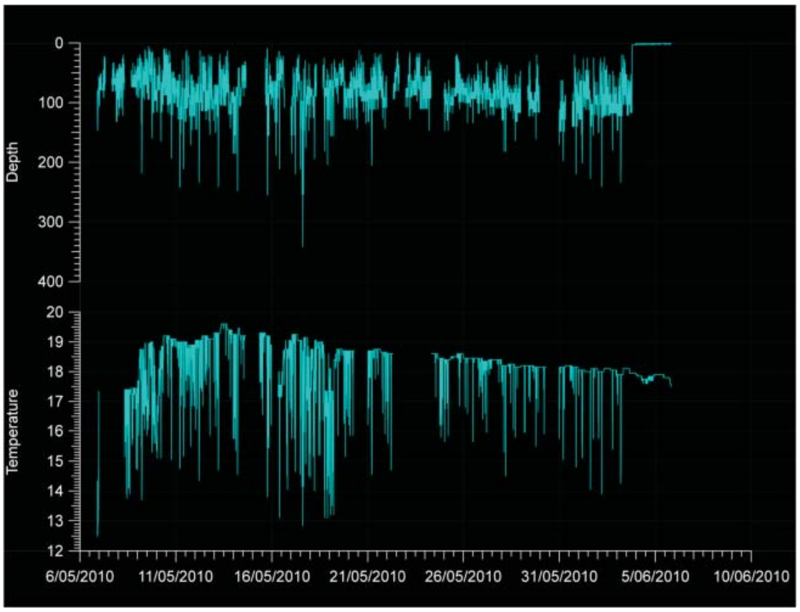

Figure 6. Vertical movement and temperature profile of one PSAT-tagged South Pacific albacore tagged of the east coast of New Zealand in May 2010.