Fisheries Newsletter

Pacific Community
Communauté du Pacifique

174 | May–August 2024

ISSN: 0248-076X

SPC activities

Regional news

Feature articles

FAME
Fisheries, Aquaculture and Marine Ecosystems Division

In this issue

SPC activities

3 Dr Timothy David Pickering
Neville Smith, Chinthaka Hewavitharane, Andrew Smith and Ian Bertram

6 Pacific fisheries ministers chart a course for a sustainable future at the fifth regional meeting
Terry Opa

9 Pacific Islands leaders commend progress on scaling up community-based fisheries management (CBFM) and extend the Pacific CBFM Framework for Action for a further five years
Watisoni Lalavanua

12 Local communities on board: Citizen science is building the regional database on stranded drifting FADs in French Polynesia
Jennyfer Mourot

16 Establishing a sclerochronology lab at SPC – Bombs are never good, but their signature can be useful
Allen Andrews and Jed Macdonald

News from in and around the region

19 The 2024 Climate Awareness Workshop (CLAW) - Raising awareness of climate change by learning its language: perspectives from a participant and an organiser
Francisco Blaha and Steven Hare

23 The art of climate change: SPC regional Pacific photo competition
Johanna Johnson

Feature articles

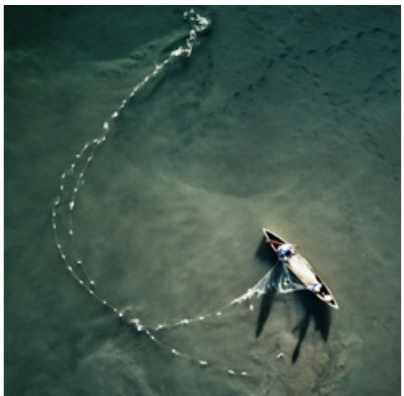
28 Towards inclusion of persons with disabilities in coastal fisheries in the Pacific:
A review of current practice and approaches
Jenny House, Aurélie Delisle, Vasemaca Malverus, Tarateiti Uriam, Lyn Vaike and Dirk Steenbergen

36 Starter pack for octopus monitoring: An overview of octopus biology, ecology and measurement protocols for fisheries management
Hannah Gilchrist, Indah Rufiati and Epeli Loganimoce

Cover picture: Lady walking home with a skipjack tuna in Tarawa, Kiribati. © Francisco Blaha

page 12

page 23



page 36

Establishing a sclerochronology lab at SPC – Bombs are never good, but their signature can be useful

Allen Andrews[1] and Jed Macdonald[2]

Proper fisheries management across the Pacific region requires that we understand how our fishes live and grow to plan for ecosystem and resource sustainability. Closely coupled with this information is how long a species can live because its potential reproductive output throughout its lifespan is an important factor in understanding population dynamics. In general, the age at which a fish matures and how many years it can reproduce are important factors in estimating how many fish can be taken sustainably over time. A lack of understanding and use of incorrect ages and growth traits may lead to harvest levels that exceed the capacity of the population to replenish itself, potentially leading to declines in fishery productivity and risks to food security. For teleost fishes (bony fishes), the most used method of age estimation is counting growth rings in the ear stones, also known as otoliths, but the structure of the rings can be complicated, and as a result the age estimate from counting the rings needs to be tested (Figure 1). A method that can be used to validate fish age, as well as the age estimation procedures, is the use of a chemical signature that is stored in otoliths known as bomb-produced radiocarbon.

The use of bomb radiocarbon (^{14}C) dating as a tool in the validation of fish age and lifespan has covered 30 years of progress in establishing a better understanding of fish ecology and stronger baselines for the sustainability of fisheries throughout the world. This approach uses a signal that was created in the 1950s and 1960s during cold-war efforts to increase the power of nuclear bombs. The sudden rise of bomb-produced ^{14}C from these nuclear tests can function as a time-specific marker in conserved structures, like the rings of trees and in the growth rings of otoliths. While the rings in trees are easy enough to prove as annual growth (one set of layers or rings per year), it is not as easy to know if the rings being counted in otoliths are in fact annual. Hence, if the bomb ^{14}C signal can be detected in the otoliths, then estimated age can be compared to the timing of this marker to determine if the age was correct.

The most common approach has been the use of the rise period as a reference to align ^{14}C measurements from otoliths to references in time, but for fish collected in recent years the hatch dates would need to be in the 1950s and 1960s (Figure 2), making them more than 50–60 years old. While this scenario is appropriate today for some long-lived species, it is necessary to use the declining ^{14}C signal that has occurred after peak levels were reached for recently collected fish that live no more than 20–30 years. A good example of success with this method is from recent findings for giant trevally (*Caranx ignobilis*) of Hawaii where ages up to 25 years were estimated from otoliths and then validated by a strong alignment of the otolith ^{14}C values with the coral ^{14}C chronology (Figure 3).

Figure 1.Otolith of yellowfin tuna that was sectioned to reveal growth structure that can be aged to 14 years by counting the growth zones visible in this view (marked with yellow dots). It is easy to see just how difficult counting an otolith can be in some parts of the otolith and that even though the age determination is based on reader experience and interpretation, the estimate must ultimately be validated. © Jessica Farley, CSIRO

[1] Senior Research Officer (Sclerochronology), SPC
[2] Senior Fisheries Scientist (Tuna Biology & Ecology), SPC

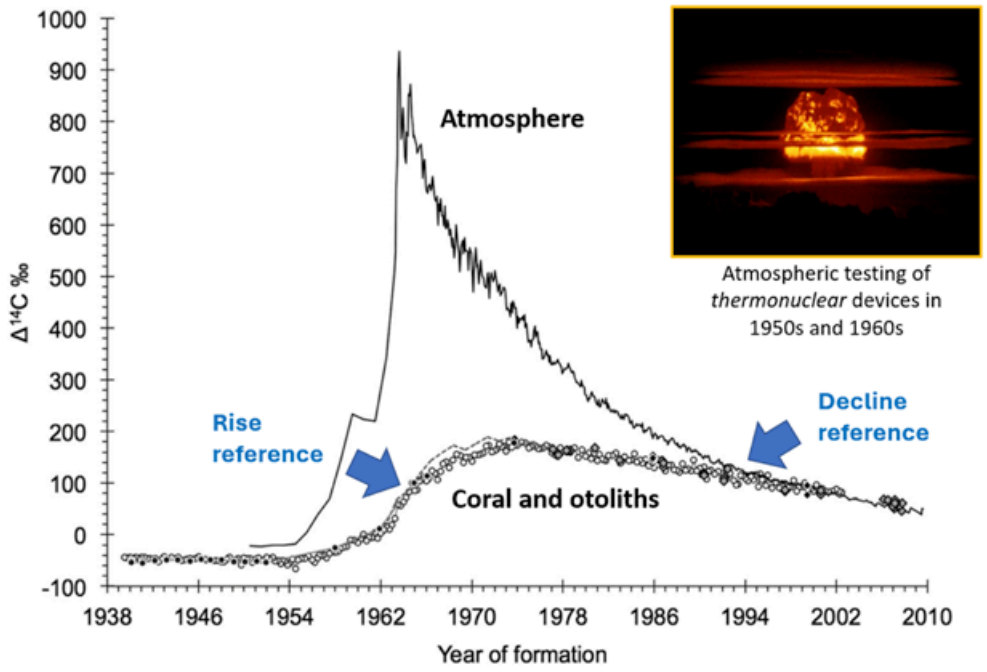


Figure 2. Bomb-produced radiocarbon (14C) in the atmosphere led to reference chronologies stored in known-age coral and otoliths of the marine environment that can be used to test estimates of age. The rise and the post-peak decline periods can be used to validate estimates of age for fishes of numerous aquatic environments of the world.

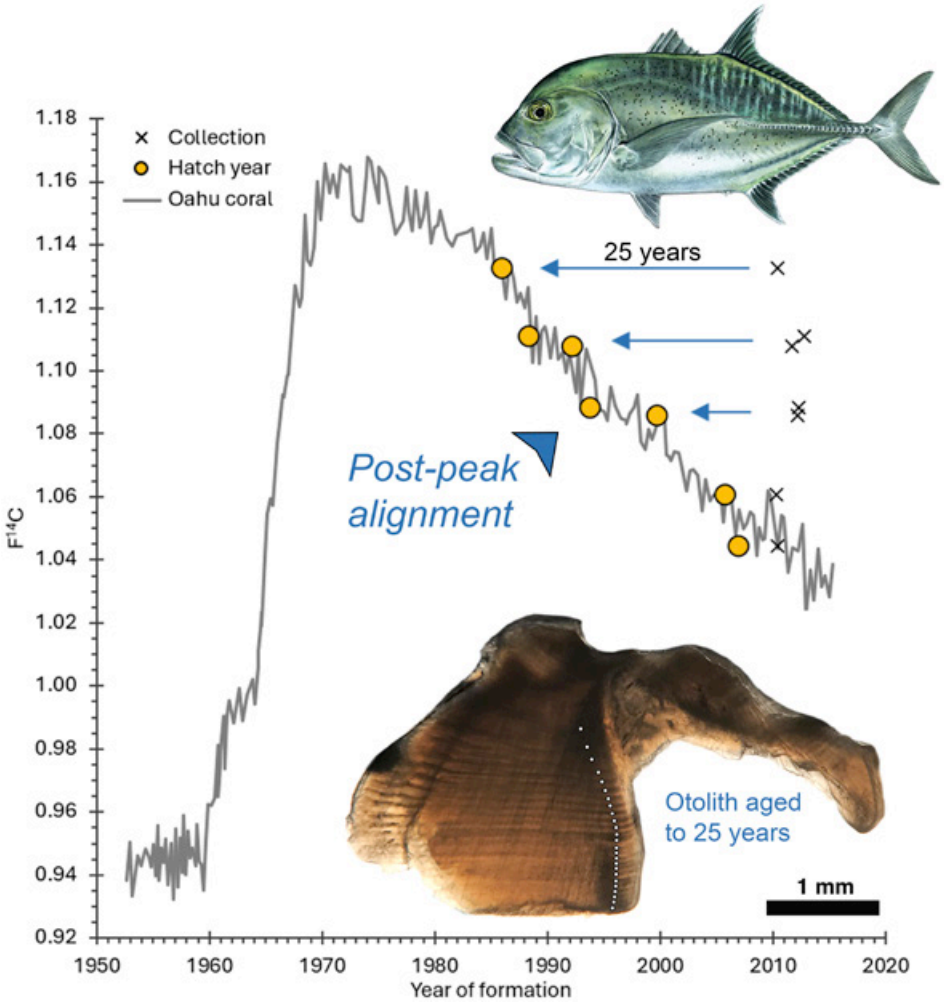


Figure 3. Giant trevally that were aged using otoliths — see inset image of an otolith cross-section that was aged to 25 years with each year marked by a white dot — had 14C measurements that aligned well with the post-peak decline of the Oahu coral 14C chronology. The X represents the capture or collection dates, from which the measured 14C value was projected back to its calculated hatch years (yellow dots). Alignment of the hatch years from seven fish (aged 3 to 25 years) with the chronology for Oahu is an indication the otolith ages were correct, and that this species can actually live 25 years.

One of the goals of the new SPC Sclerochronology Lab in Noumea is to continue to apply bomb ^{14}C dating to the fishes of the western and central Pacific Ocean (WCPO) by establishing new ^{14}C reference chronologies and then using them to test estimates of age for tunas, billfishes, and other pelagic fishes. In addition, this line of work will enhance SPC's Coastal Fisheries and Aquaculture Programme and project partners by addressing questions of age and growth for fishes of insular waters of the SPC member countries. To date, we have established a workspace that has state-of-the-art instruments, as well as the tried-and-true machines used in otolith processing (e.g. saw and grinding wheel) that will allow SPC to investigate the age and growth of regional fishes and provide a unique training hub for research in this field across the region. One of the first additions to the lab is the latest version of a micromilling machine by ESI, the MicroMill2 (MM2; https://www.icpmslasers.com/products/micromill2/), which was recently christened using a rare otolith sample (Figure 4) — a fortuitous capture of a giant grouper (*Epinephelus lanceolatus*) in Pohnpei (FSM) led to collection of the otoliths, of which one was the first sample analysed on the MM2. The measurement of ^{14}C from this otolith core (within the first year of growth) was at a level that could only be formed during the pre-bomb period, a hatch year earlier than 1958, indicating the fish was at least 61 years old.

This is the first validated age estimate for giant grouper throughout its Indo-Pacific range and while an age exceeding 60 years is not uncommonly encountered among large-bodied groupers, this fish was not even close to its maximum reported size of 2.7 m (~9 feet) with possible weight exceeding 400 kg (882 pounds). The fish from Pohnpei that we studied here was measured at 1.83 m (6 feet) with a weight of 126 kg (278.5 pounds) and was likely to have been an early adult considering maturity may be reached at lengths near 1.3 m. Further study on this species is currently being pursued across the Pacific, so please reach out to us if you happen to capture one of these leviathans of the fish world by accident as any assistance with gathering otoliths is most welcome.

Other notable progress from the lab includes a recently published paper[1] that has proven the age reading of thin-sectioned otoliths of Pacific yellowfin and bigeye tuna provide accurate estimates of age to 14–15 years. Following close on the heels of this work are age validation studies of skipjack tuna of the WCPO, broadbill swordfish in the southwest Pacific, and southern bluefin tuna of the Indian Ocean working in collaboration with member countries. Overall, an exciting new chapter in fish age and growth research has begun for SPC.

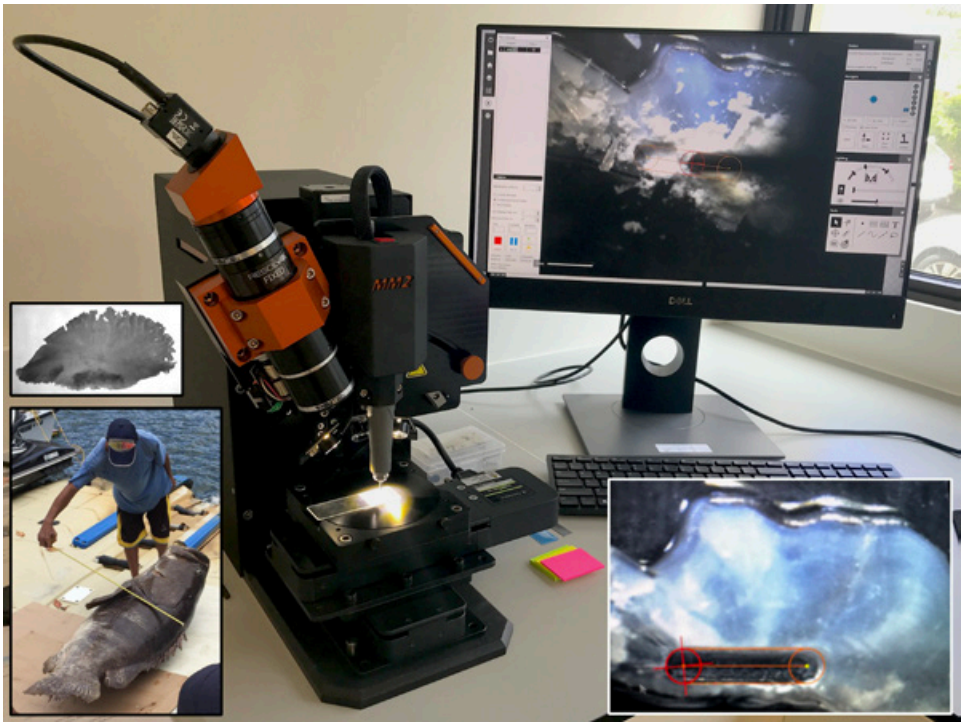


Figure 4. Photograph of the new ESI Micromill 2 in the SPC Sclerochronology Lab in Noumea with the monitor screen showing the live extraction of the earliest otolith growth using a computer-controlled dentist drill bit. The inset image on the bottom left is the captured giant grouper (*Epinephelus lanceolatus*) in Pohnpei (May 2019), with one of the collected otoliths from this individual shown above the fish picture. The inset image on the bottom right is the core extraction path as was cut from the otolith section (transverse) and measured for a 14C level. The otoliths were collected by James Wichman and made available for study by Ian Bertram.

[1] Andrews A.H., Eveson J.P., Welte C., Okamoto K., Satoh K., Krusic-Golub K., Lougheed B.C., Macdonald J.I., Roupsard F. and Farley J.H. 2024. Age validation of yellowfin and bigeye tuna using post-peak bomb radiocarbon dating confirms long lifespans in the western and central Pacific Ocean. ICES Journal of Marine Science 81(6): 1137–1149. https://doi.org/10.1093/icesjms/fsae074.