Oracles read climate impact in tuna entrails

Experts from the four corners of the globe gathered in Adelaide, Australia, from 14 to 18 October 2013 to assess the climate's impact on the ocean ecosystem. They had the hard task of predicting the future in animal entrails. Although very fashionable in ancient Rome, such predictions were quite unreliable when all was said and done. Our experts were true scientists, though, and were armed with new statistical tools developed to improve analyses and predictions based on the stomach contents of tuna and other large pelagic fish, such as swordfish and mahi mahi.

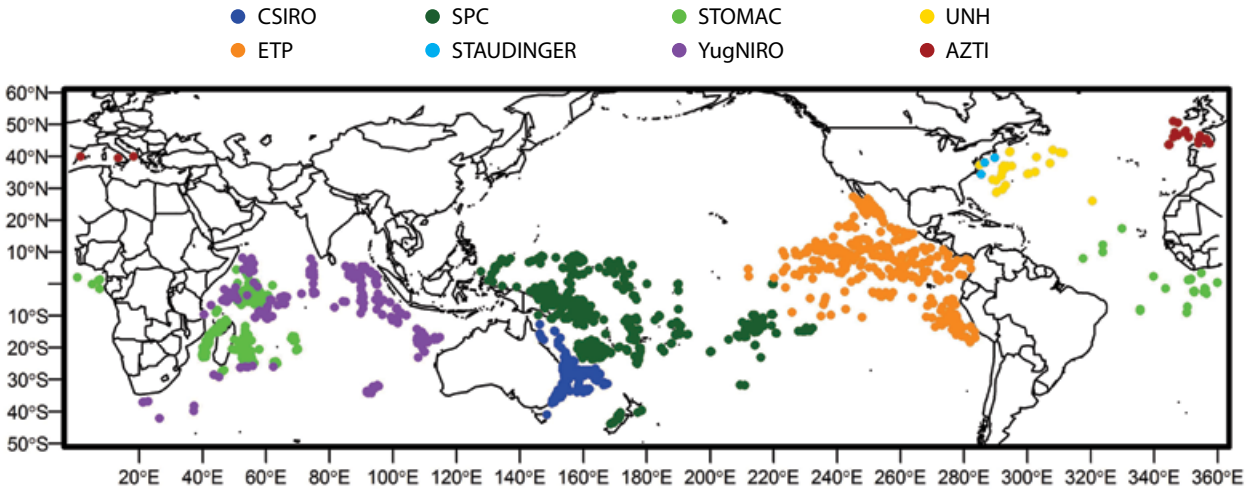
So what is the point of examining tuna stomach contents?

Tuna are what is known as generalist feeders. In other words, they eat whatever comes their way, making them excellent sentries of the marine environment in the open ocean.

The vast ocean expanse is difficult to explore; considerable amounts of staff, time, ships and money would be required to do so. But tuna roam the oceans tirelessly, eating whatever they find and so sample the small fry, crustaceans and squid for us. Fishers catch the tuna and all the teams of scientists need do is take the stomachs and see what is in them. It is no easy job, but it is a way of observing scarcely explored parts of the ocean.

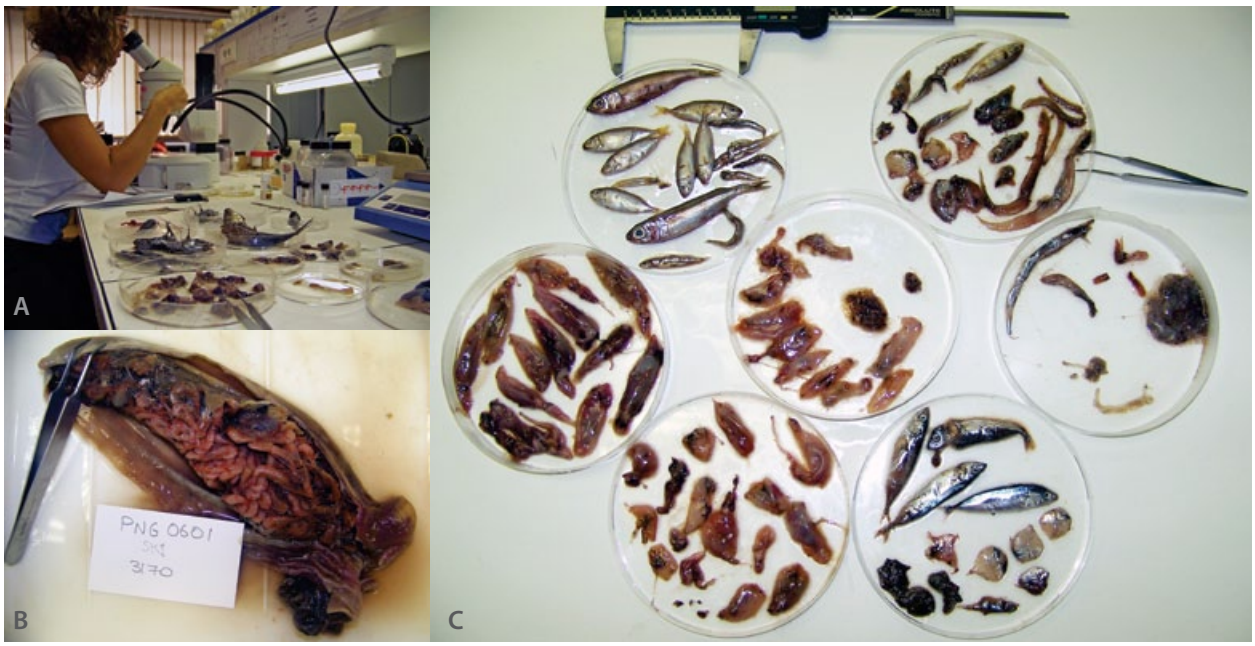
By examining the stomach contents of fish that live in different oceans and climates, we are better able to understand the impact the environment has on tuna and their prey. Very valuable information is collected on the effects that climate change has, not just on tuna, but on the whole ocean food network, which is still quite unknown even though the entire tuna industry depends on it.

It is a gargantuan task that cannot be accomplished by a single individual. So through the combined efforts of eight research organisations around the world, details about the stomach contents of nearly 22,000 fish have been pooled into a single database, paving the way for a whole host of studies. SPC is the largest contributor to the global database, with more than 7800 stomachs examined by our laboratory technicians. We would like to take this opportunity to acknowledge the tuna



Distribution of samples by Project

CSIRO:	*Commonwealth Scientific and Industrial Research Organisation, Australia*
SPC:	*Secretariat of the Pacific Community, New Caledonia*
STOMAC:	*IRD database, Institut de Recherche pour le Développement (Development Research Institute), France*
UNH:	*University of New Hampshire, USA*
ETP:	*IATTC database, Inter-American Tropical Tuna Commission, USA*
STAUDINGER:	*University of Massachusetts, Amherst, USA*
YugNIRO:	*Southern Scientific Research Institute of Marine Fisheries and Oceanography, Ukraine*
AZTI-Tecnalia:	*Centro tecnológico especializado en investigación marina y alimentaria, Spain*



A: Sorting and examining the prey found in a tuna stomach (image: SPC).

B: Opened stomach of a skipjack collected in Papua New Guinea showing the predator has been feeding on small shrimps (image: Caroline Sanchez, SPC).

C: Mix of small partially digested squids and fish found in a tuna stomach (image: Caroline Sanchez, SPC).

fisheries observers from all the countries in the region who collected such samples.

Pooling the data is a major achievement in itself, because such a level of cooperation covering the globe's three great oceans — the Atlantic, Indian and, largest of all, the Pacific — is very uncommon. The sample distribution map speaks for itself and clearly shows the scope of the work.

The other achievement of the expert meeting was the product of years of hard work, particularly by Commonwealth Scientific and Industrial Research Organisation (CSIRO) Adelaide statistician Petra Kuhnert from Australia and Inter-American Tropical Tuna Commission (IATTC) La Jolla fisheries biologist Leanne Duffy from the US who, together with the other experts attending, developed and tested a statistical tool that was particularly appropriate for this extraordinary database. It was a regression-tree classification method for multivariate data such as those on stomach content. The measure was not new, but what was original about the new approach was that it provided predictions about diet and uncertainty calculations. Developed in R, the new package is simply called Diet and will soon be freely available to and usable by all to analyse stomach content data and other data sets in the same, multivariate data format.

During the week of discussions in Adelaide, some interesting initial results were revealed. For example, a very clear pattern had emerged showing that albacore tuna juveniles prefer rich areas like the Bay of Biscay in Europe or New Zealand where they feed on one or two main prey, such as krill, that are plentiful in colder waters. Adults, on the other hand, were shown to hunt in warmer but poorer tropical waters, where they have to greatly vary their diet by eating smaller amounts of many different prey types. Bigeye tuna that live in deeper tropical waters appeared less affected by such climate differences than fish living closer to the surface. Climate change could, therefore, have very different effects depending on the tuna species considered, as the impact on their environment and the prey they feed on would be different.

Tuna stomachs still have a lot to teach us about tuna and their environment, and the marvellous data set plus the newly available statistical tools promise to reveal many more secrets yet.

For more information:

Valérie Allain
Fisheries Scientist, SPC
valeriea@spc.int