SPCMS – RESEARCH PROJECTS

1: DISCOVERING THE MOVEMENT AND BEHAVIOUR OF THE OCEANS' BIGGEST FISH

Many fish species are global citizens, ranging across oceans during the course of their lives, belonging to no single nation.

In 2007 the then New Zealand Minister of Fisheries, Jim Anderton, called for Pacific nations to work together to keep their tuna fish stocks from being catastrophically depleted. Tuna is vital to many Pacific Island economies and the Minister reminded New Zealand that it had a responsibility to "play our part in our corner of the globe".

Managing and conserving fish species that are so wide ranging is a tough task and one made tougher because we know so little about the movements and behaviour of these amazing animals. Now, exciting new technologies are making it possible to study them.

With the use of this technology, The University of Auckland's South Pacific Centre for Marine Science is currently collaborating with partners from New Zealand and other countries to discover more about the movement of some of the oceans biggest fish – marlin, bluefin tuna and stingrays.

PLAYING TAG WITH THE BIG FISH

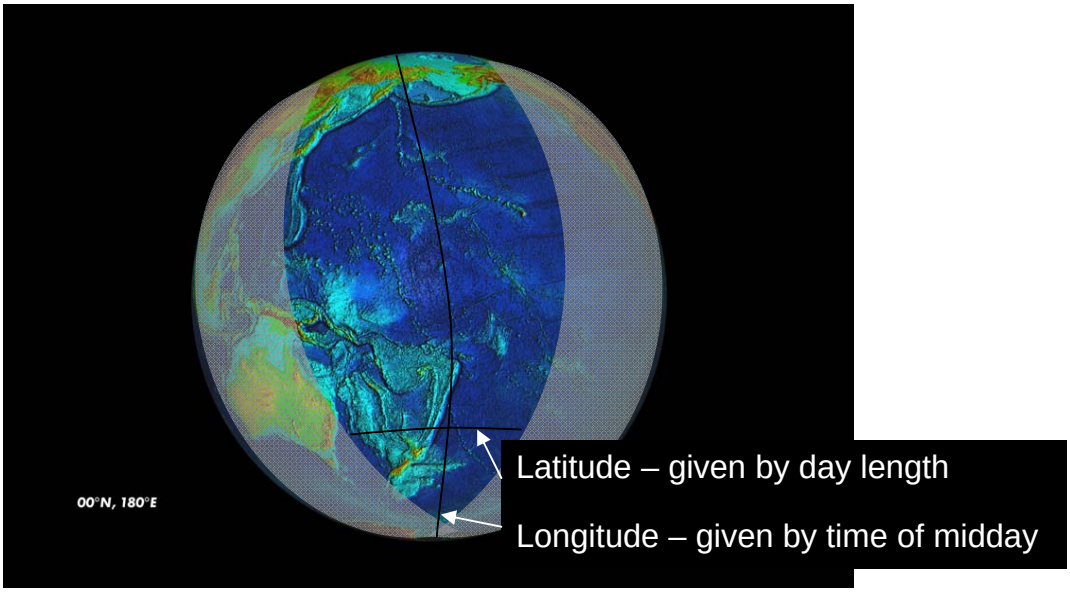
While the movement of some large animals which surface regularly – many sharks and New Zealand's striped marlin - can be tracked directly through satellite telemetry, most fish do not rise to the surface of the water often enough for this method to keep track of them. A more innovative approach is needed. One alternative is archival tags, particularly suited to large fish species like great white sharks or tuna.

The technology is based on a small computer chip in which a highly accurate clock is combined with external sensors which record temperature, depth and light level every 60 seconds. Thousands of pieces of this information, data, is stored (or archived) for up to several years.

Some archival tags are implanted inside a fish and the data recovered when the fish is recaptured. Another kind is attached to the outside of the fish and programmed to automatically 'pop-off' and float to the surface where it makes radio contact with a satellite and downloads its data via the satellite to the desktops of the programme's researchers. This method is particularly useful with fish like great white sharks or stingrays that are unlikely to be caught again.

PLOTTING POSITION

The tags capture a remarkable amount of information about where the fish has been while it was tagged. Once the clock on the tag is proved accurate, the latitude and longitude of the fish's position and movement can be established relatively accurately. Latitude is estimated by calculating the time of mid-day or mid-night, while variations in the length of the day are used to give the approximate latitude. This technique of fixing position using sunlight data is known as light-level based geolocation.



Principal of Light-Level Based Geolocation

WHERE'S THE FISH

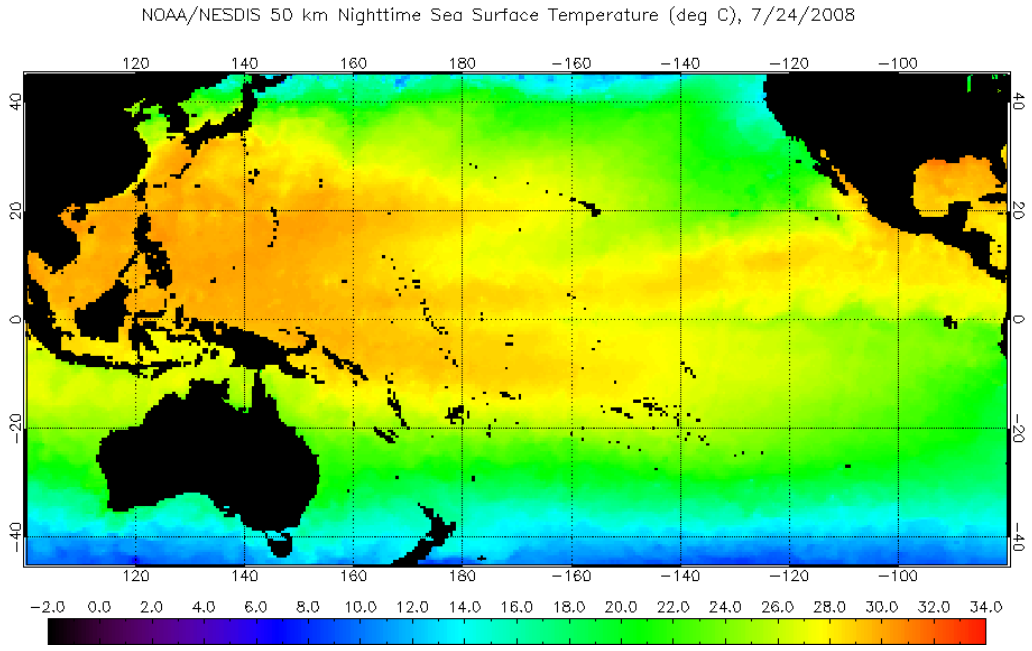
Where would you be if you were a marlin and your tag was telling you that today was July 30, and sunrise was at 19:22 GMT and sunset 5:33 GMT?

Midday at 00:31 GMT puts you on a longitude of 174.45E, the day's length of 10 hours and 11 minutes puts you at 36.51S. That is to say, you are under the Auckland harbour bridge heading up the Waitemata Harbour and should probably turn around and head back out to sea.

(Data for this exercise is taken from the time of sunrise and sunset on July 30th at Auckland - see www.rasnz.org.nz/SRSStimes.htm#July.)

FOLLOWING THE TRAIL

Other data can help in fixing a fish's position more exactly. Cross referencing sea surface temperatures measured by the tag against surface temperatures measured by satellites enables latitude estimates to be refined significantly. These methods together can estimate longitude to within ±0.5° and latitude to within ±1.0-2.0°.



Sea surface temperature map of the Pacific Ocean from NOAA (USA)

The tag's data also provides other important information to questions about the fish's behaviour:

- Is it migrating and travelling long distances each day, or is it milling about feeding?
- How often and how deep is it diving?
- Is it feeding at the surface or at depth?
- Is it migrating at the surface or at depth?
- What is its migration route?
- Is there a return seasonal migration?

Finding answers to all these questions is important in managing and conserving these fish. The following are some of the current projects using new tagging technology.

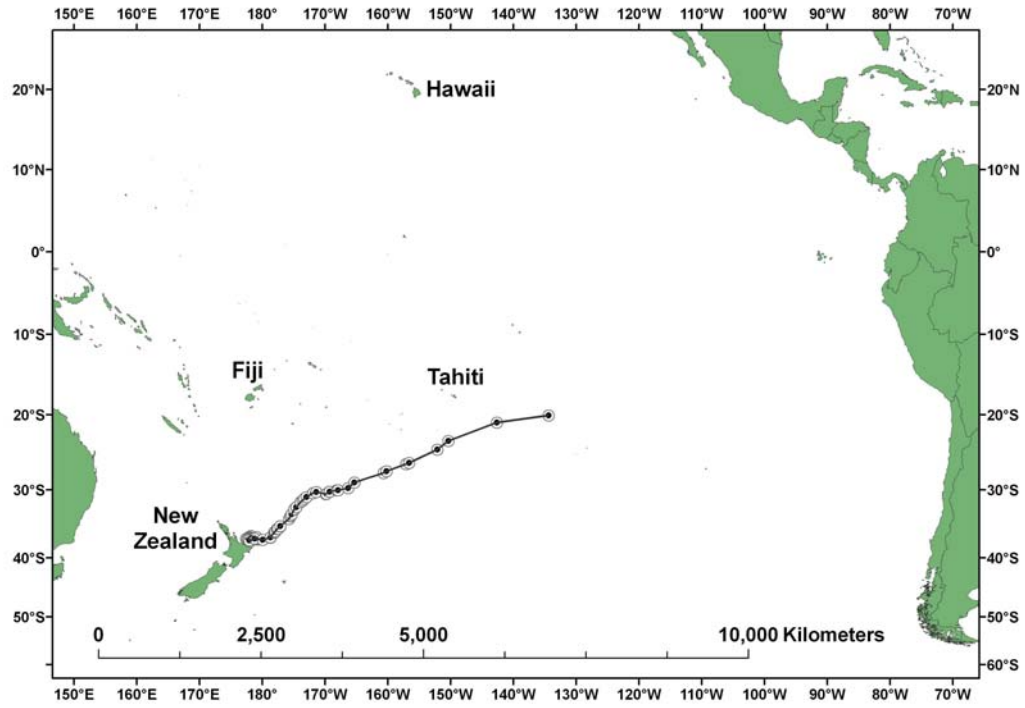
MARLIN

Tim Sippel is a PhD student at the SPCMS working on striped marlin and bluefin tuna. He's been involved with striped marlin satellite tagging since arriving at the laboratory at Leigh from the USA in 2002.

The initial success of satellite tagging striped marlin provided a building block for expansion of this research in New Zealand. The striped marlin and bluefin tuna research is being conducted in partnership with Blue Water Marine Research in Northland, NZ, and with an international programme called Tagging of Pacific Pelagics (TOPP). (Pelagic means swimming in the open ocean and pelagics include key Pacific predators such as tunas, billfishes, sharks, marine mammals.)

TOPP is one of the cornerstone projects of the Census of Marine Life, a global effort to map and catalogue past, present and future oceanic systems. One of the key aims of TOPP is to provide a framework for sustainable resource management and marine conservation. It is jointly run by Stanford University's Hopkins Marine Station, University of California Santa Cruz's Long Marine Laboratory, and the National Oceanic and Atmospheric Administration's (NOAA) Pacific Fisheries Ecosystems Laboratory.
http://www.toppcensus.org/web/Background/Overview.aspx.

Through links to TOPP, regular updates of marlin tagged by Tim Sippel can be viewed on the non-TOPP website hosted by the Tagging of Pacific Pelagics programme:
http://las.pfeg.noaa.gov/nonTOPPtags/



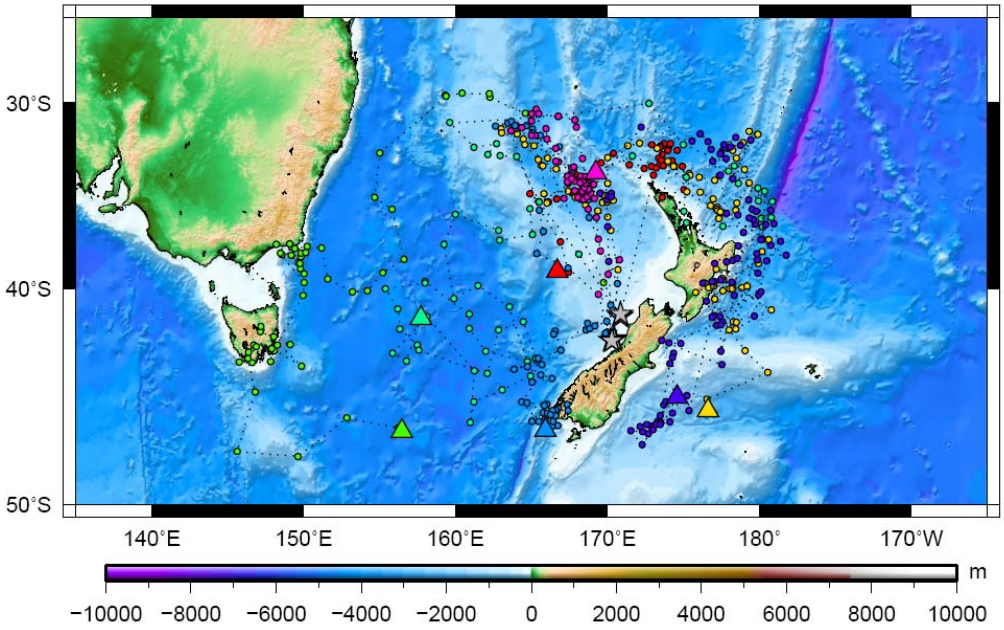
Movement track of a striped marlin carrying a satellite telemetry tag from Eastern Bay of Plenty to French Polynesia in 2007

BLUEFIN TUNA

In August 2006 Blue Water Marine Research (NZ) partnered with TOPP to satellite tag the first Pacific bluefin tuna (*Thunnus orientalis*) from a rapidly growing recreational fishery off the west coast of the South Island.

There are three species of bluefin tuna (2 Indo-Pacific and 1 Atlantic Ocean), with those from the Atlantic Ocean so heavily over-fished they have been considered for listing as threatened or endangered species. Pacific stocks are also heavily exploited, but their status is not well understood.

Genetic sampling has revealed New Zealand to be the first place in the world where all three species of tuna have been found simultaneously, which could have significant implications for conservation and management in both the Atlantic and Indo-Pacific species. In 2008 we initiated a plan to tag an additional 16-20 Pacific bluefin with PATs (pop-off archive tags) which will provide important information on movement and migration.



Tracks of Pacific bluefin tuna from PAT tagging

(*TOPP, Ministry of Fisheries, Blue Water Marine Research and the National Research Institute of Far Seas Fisheries (Japan) contributed to data represented in this map.*)

STINGRAYS

Agnes le Port is another PhD student at the Leigh Marine Laboratory using PAT tags to study the movements of stingrays at the Poor Knights Islands. Her work is aimed at understanding the behaviour behind the groups of rays that turn up at the Poor Knights each summer. This work has featured in a recent *NZ Geographic* article (issue 90).

GREAT WHITE SHARKS

Although not being conducted by The University of Auckland, we can't pass up the opportunity to mention ongoing work by Clinton Duffy of the Department of Conservation, Dr Malcolm Francis and Michael Manning of NIWA, and Dr Ramon Bonfil of Shark-Tracker. Clinton and his colleagues have been attaching PAT tags to great white sharks around Chatham and Stewart Islands since April 2005.

Their results show that white sharks tagged in these areas are generally resident around the islands for three to five months before undertaking relatively rapid long distance migrations:

- Three sharks tagged at the Chatham Islands all moved north towards the tropics in winter. One moved over 1000 km northeast towards the Louisville Ridge before its tag released, one travelled to New Caledonia and the other to southern Vanuatu.
- One large female tagged at Stewart Island appears to have made an excursion south to Auckland Islands before travelling over 3000 km to Swain Reefs off Rockhampton in Queensland.

CONCLUSION

New technologies for tracking are providing us with important new information on the movement and behaviour of these important large predators of the ocean.

Not only are species such as tuna hugely important as a fishery, but as top predators all of these species provide us with key insights into the health of the oceans.

New Zealand has the world's 5th largest Exclusive Economic Zone, and an important responsibility to the South Pacific. Discovering the movement and behaviour of the top predators in this area is a contribution to "playing our part in our corner of the globe".