The science of sardines

Refinements to the management of the small pelagic fishery highlight some of the excellent science that underpins this sector – a vital contributor to food security in South Africa.

CLAIRE ATTWOOD PROVIDES A WIDE ANGLE PERSPECTIVE

Did you know that three million Lucky Star meals are consumed every day? Not all the fish that goes into Lucky Star cans comes from the South African fishery for sardines, but a large chunk of it does and of course there are several other brands of canned sardines on supermarket shelves.

Sardines are renowned as a low-cost, high protein food, so it's encouraging to see that some clever science is taking place behind the scenes and that the management of the fishery is being refined and improved in partnership with the fishing industry.

Recently, with the encouragement of the most energetic proponent for small pelagic fish who ever lived, Carl van der Lingen (a researcher with the Department of Agriculture, Forestry and Fisheries, DAFF) I took some time to read a few scientific papers that together provide convincing evidence that the sardine stock that supplies all those cans of pilchards, may not be quite what we assumed it to be.

Understanding the stocks

The story goes something like this. For years the fishing industry and management authorities considered the sardine *Sardinops sagax* stock to be a single, homogenous one and accepted that some deft footwork was required to manage competing interests in the fishery: some vessels target sardines for human consumption, while others catch anchovy for reduction to fishmeal.

Because they shoal together as juveniles, and because mostly juvenile anchovy are targeted, there is the potential to have a high sardine by-catch in anchovy-directed fishing. Catches of the two species cannot be simultaneously maximised and there is a trade-off: high anchovy catches will mean lower sardine catches, and vice versa.

The two fisheries have been jointly managed since 1994 by some fairly complicated Operational Management Procedures developed in conjunction with UCT's Marine Resource Assessment and Management (MARAM) group.

Joint management went along swimmingly until the turn of the 21st century when there was a boom in abundance and an almost simultaneous eastward shift in the sardine population. Although this shift caused consternation in the fishing industry, which began to transport sardines from landing sites in Mossel Bay to the west coast for processing, it also provided scientists with some new ideas about stock structure.

Questioning joint management

For instance, Janet Coetzee (also a DAFF researcher) and her co-authors, writing in the *Ices Journal of Marine Science* observed that, during periods of low and medium abundance, sardine distribution was concentrated in widely separate areas, but during periods of high abundance, sardine distribution was more or less continuous between Cape Columbine and Port Alfred.

Sardine eggs collected during research surveys also showed two discrete spawning areas separated by the Central Agulhas Bank.

This observation raised the possibility that there are two separate adult spawning aggregations of sardine. What makes the subject even more complex is the fact that sardines also spawn off the east coast during the annual "sardine run", but more about that later.

Joint management went along swimmingly until the turn of the 21st century when there was a boom in abundance and an almost simultaneous eastward shift in the sardine population. Although this shift caused consternation in the fishing industry, which began to transport sardines from landing sites in Mossel Bay to the west coast for processing, it also provided scientists with some new ideas about stock structure.

Debunking the two stock hypothesis

It was the unusual abundance of sardines that prompted scientists to scratch a little deeper and a two stock hypothesis has gradually been developed over the past 10 years.

Initially, Carl van der Lingen and his co-workers relooked at the biology of

Sardinops sagax and discovered some interesting things. For instance, they found that sardines caught on the south coast were generally fatter than those caught on the west coast; and fish caught on the east coast had fewer vertebrae and a different body shape to those from the west or south coasts.

The size and shape of sardine gills have also been shown to differ according to region, but the differences have not always been consistent across size classes. Differences in the reproductive characteristics of sardines have been observed. For example, fish caught off the south coast seem to mature at a larger size than those off the west coast. But most recently, scientists have looked at the parasites that sardines carry and their findings provide quite startling evidence in favour of the multiple stock hypothesis.

The most common parasite to occur in *Sardinops sagax* is the larval stage of a parasitic flatworm (Subclass *Digenea*), known as tetracotyle type metacercariae. During the second stage of its lifecycle, when it infects sardines, the metacercarian parasite is about one millimetre long and looks like a blob with a tiny nose.

Approximately 46 percent of sampled sardines carried this parasite. It turns out that sardines on the west coast carry more of this parasite than those on the south or east coasts.

Moreover, the infection rate (the number of parasites per fish) was higher for fish from the west coast than for those on the south or east coasts, and fish on the south coast become infected at a larger size than those on the west coast.

Namibian sardines do not carry this particular parasite and sardines from the east coast are generally very lightly infected.

Importantly, scientists observed similar patterns with another common parasite *Eimeria sardinae* that is found in the reproductive organs of sardines. This parasite is transmitted by spawning fish and the study suggests that in southern Africa the parasite is restricted to the west and south coasts.

Eimeria sardinae was not detected in fish caught in Namibia or off the east coast, supporting the hypothesis that the sardine stocks off Namibia and South Africa's east coast are separate from the west and south coast stocks.

The picture is, of course, much more intricate than I have described, but the results of the parasite studies are important because they lend weight to the idea that the sardine resource targeted by the purse-seine fishery probably consists of a west coast and a south coast stock – and that there is some movement of individual fish between the two.

Currently the most plausible explanation put forward by van der Lingen and his co-researchers is that older, west coast fish may migrate to and remain in the south stock, or that south-stock individuals may move to the west stock – but not form part of the west stock – for a particular part of the year.

It is hoped that this movement might be described more fully in time, probably by examining the number and size of sardines that are infected by the metacercarian parasite.

As an aside, it is also probable that the sardine run, that causes such excitement when fish move up to the coast of KwaZulu-Natal in winter, is the spawning migration of a third stock.

Impact on the fishing industry

With a picture forming of a sardine stock that is infinitely more complex than was previously thought, the obvious question is whether this makes the slightest difference to the fishing industry and, in turn, the millions of South Africans who look to canned sardines for a wholesome meal. The short answer is yes.

As scientists acquire more knowledge about the resource, so they are better able to manage a fishery that is known to be susceptible to environmental change and which requires close management because of the sardine/anchovy dynamic.

In response to the convincing work that is being done by DAFF scientists and their co-researchers, the industry has agreed to try to balance sardine catches taken west and east of Cape Agulhas to within 10 percent of the average biomass split between the two catch areas from the past two November surveys.

This means that, if scientists observed 60 percent of the sardine biomass west of Cape Agulhas in November 2013 and 70 percent west of Cape Agulhas in November 2014, then the industry will aim to take 65 percent of its catch on the west coast in 2015.

This is to make sure that the industry exploits the putative west and south stocks in a more balanced way than previously, when exploitation rates were higher on the western stock than the southern stock.

In future, it is likely that the two stock assessment model that is gradually being developed will take into account the movement between the stocks, possibly using the parasite data as an index of sardine residence time on the west coast. And, it is possible that, in time, a stock-specific total allowable catch will be set.

In future, it is likely that the two stock assessment model that is gradually being developed will take into account the movement between the stocks, possibly using the parasite data as an index of sardine residence time on the west coast. And, it is possible that, in time, a stock-specific total allowable catch will be set.

In conclusion, one of the most difficult things about science is that it is seems, to the casual observer like me, to be so very, painfully slow. But in this case, it is fascinating to see how over many years some very clever people have slowly built a hypothesis about the sardine resources and systematically tested it.

In so doing, they have created new knowledge that, once it is fully developed, should help to improve the management of the small pelagic fishery and ensure its sustainable use. It seems to me that the science is cutting edge and I look forward to finding out more in the future. I am also very pleased to end the year with a good news fishing story! ■

* Claire Attwood is a writer and editor with a special interest in fisheries. She works with a number of fishing companies and consults to the South African Deep Sea Trawl Industry Association, SADSTIA. She writes in her personal capacity.