Setting the TAC for sardine and anchovy

The simple but inescapable biological fact that sardine and anchovy are short-lived and can fluctuate substantially in abundance from year to year, makes South Africa's small pelagic fishery a very complex fishery to manage. In this, the first of a series of articles on various aspects of fisheries science, Carryn de Moor and Doug Butterworth of the University of Cape Town explain some of the basic principles behind the management of the small pelagic fishery.

In August this year, questions were asked in Parliament about the delay in the announcement of the mid-season revision of the anchovy total allowable catch (TAC). This sparked many questions around the way in which the TAC is determined and why it can't be set at the start of the fishing season, as is the case for other fisheries. In answering some of these questions, it is important to understand the basic life history of the sardine and anchovy and how the management approach that is used to regulate catches of small pelagic fish has to be matched to what we know about their life cycles.

The life cycle

Adult sardine and anchovy mainly spawn on the Agulhas bank in spring and summer (Figure 1). Eggs and larvae are transported by strong ocean currents from these southern spawning grounds to food-rich nursery areas along the west coast.

Young fish, called recruits, start to appear in the northern areas from March/April each year and then migrate southwards over the remainder of the season. As these fish mature into adults, they migrate even further eastward onto the Agulhas Bank and generally move further offshore where they in turn will spawn in subsequent years.

Sardine and anchovy are relatively short lived. Their recruitment can vary widely from year to year. For example, there could be more than five times the number of recruits in one year than there are in the next, resulting in large fluctuations in the total abundance of these fish over relatively short time periods.

Regular monitoring required

As a result, it is necessary to monitor these resources regularly. In South Africa, sardine and anchovy have been monitored by hydroacoustic surveys since 1984. Two surveys are conducted every year. The survey in November is used to estimate the abundance of adult fish (Figure 2), while the May recruitment survey targets fish in their first year of life which will "recruit" to the pelagic fishery. Because recruitment only begins in March or April, the earliest opportunity that scientists have to estimate whether recruitment is good or poor is in May.

The directed sardine fishery targets primarily adult fish because these are large enough to be canned. In contrast, the anchovy fishery targets juveniles during their southward return migration along the west coast.

This is the only time during which they are readily available for capture as they tend to move offshore as they mature. Because juvenile sardine and anchovy shoal together, fishermen who target anchovy cannot avoid catching some juvenile sardines as bycatch.

But the catch of juvenile sardines has a negative knock-on effect on catches of adult sardine in future years. In short, the more juvenile sardines that are caught in anchovy nets, the fewer adult sardines there will be for the canneries in the years to come.

Thus there is a trade-off: directed sardine and anchovy catches cannot both be optimised simultaneously. For this reason the sardine and anchovy fisheries have been jointly managed, by Operational Management Procedures (OMPs), since 1994 (Figure 3).

Formulating the OMP

In South Africa, OMPs have been used to recommend TACs and total allowable

Carryn de Moor and Doug Butterworth are applied mathematicians working with the Marine Resource Assessment and Management (MARAM) group at the University of Cape Town. MARAM is contracted by the Department of Environmental Affairs to offer expertise in mathematical modelling.

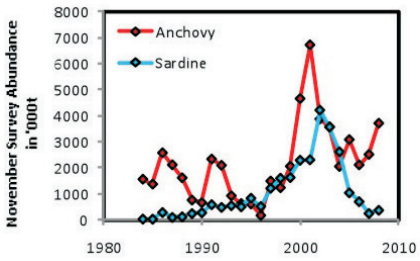

Figure 2. The estimated anchovy and sardine abundances from the annual November hydroacoustic surveys over the last 25 years.

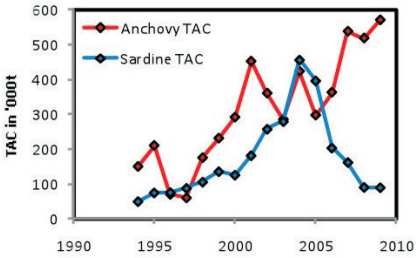

Figure 3. The annual anchovy TAC and directed sardine TAC recommended by OMPs from 1994 to 2009.

Some FAQs:

Q: Why can't a single anchovy TAC be announced in December so that industry can better plan their fishing for the following year?

A: Because most of the catch the following year will be recruits, many of which are not even "born" by December. A single TAC approach would require consistently low anchovy TACs to guard against the possibility that recruitment turns out to be low. Instead, we wait until recruitment can be measured (by an acoustic survey) and then increase the TAC if we can. This method gives higher catches over time.

Q: Weren't scientists irresponsible to recommend such high sardine TACs in the early 2000s – isn't this why the sardine resource is now so low?

A: Annual catches during the sardine boom over the turn of the century never exceeded 10% of abundance. The drop of 91% in surveyed abundance from 2002 to 2008 had nothing to do with those catches, but was the result of a succession of years of poor recruitment from 2004 onwards. Poor recruitment occurred even though the adult abundance was at record levels early in that period.

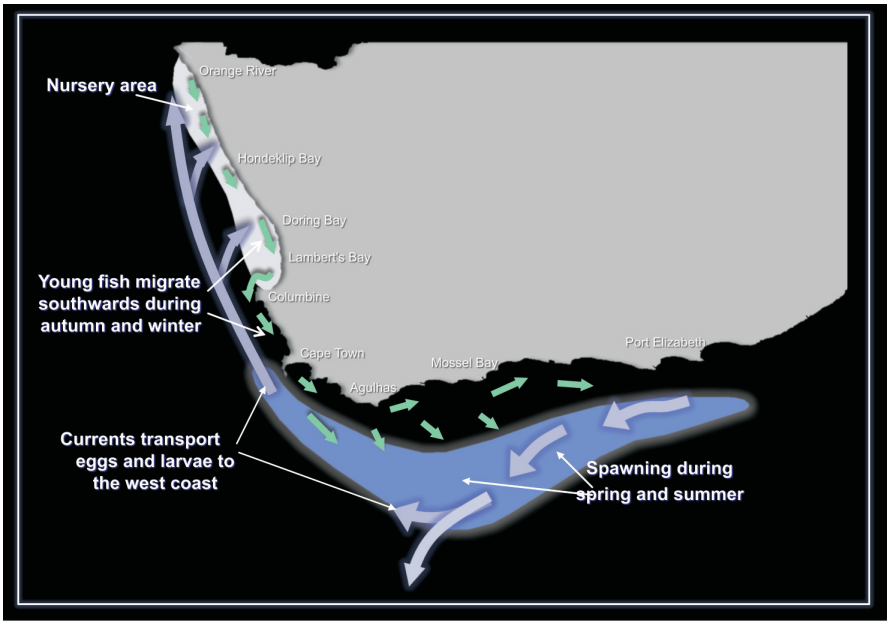

Figure 1. A map depicting the spawning areas of sardine and anchovy, the northwards transportation of eggs and larvae and the return southwards migration of the recruits.

Young scientist proves her worth

A young biologist at the South African Institute for Aquatic Biology (SAIAB), Dr Nicola James, has been awarded a NRF Y1 rating.

This rating is awarded through a rigorous selection process to scientists under the age of 35 years who show the potential to become leaders in their field. James achieved her rating on her first application.

Professor Alan Whitfield congratulates Nikki James on her NRF Y1 rating.

After receiving her MSc with distinction from the University of Natal, James registered at Rhodes University in Grahamstown for her PhD under the supervision of Professor Alan Whitfield and Dr Paul Cowley. Her field of study is global change in the coastal zone, specifically climate change and its effects on estuaries.

Climate change is a major challenge for the future and currently there is little, if any, other research in South Africa that focuses specifically on estuaries as indicators of climate change. With growing interaction with researchers around the world who are investigating climate change, James is already something of a leader in this field.

Her achievement was acknowledged by Professor Alan Whitfield, himself an NRF A-rated scientist, who said that the award carries certain expectations, one of which is that the rated scientist develops to become a leader in his or her field.

There are approximately 150 Y-rated scientists in the natural sciences in South Africa.

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bycatches (TABs) for more than 15 years. An OMP is an agreed set of rules or mathematical formulae that provide a management recommendation (eg. TAC/B for the pelagic fishery).

The OMP uses pre-determined sets of information, such as estimates of the abundance of adult fish and the recruitment of juveniles, to establish a TAC/B. An OMP is subject to prior testing by computer to ensure that it can cope with uncertainties.

One of the advantages of the OMP-approach is that it allows all stakeholders, including the fishing industry, to contribute to the way fisheries are managed.

Our understanding of the dynamics of fisheries resources is continually advancing as new data are acquired. For this reason, OMPs are commonly revised every three to five years. The OMP currently used for the South African sardine and anchovy fisheries is known as "OMP-08".

It was adopted by the Pelagic Scientific Working Group of Marine and Coastal Management in November 2007 and has been used to set the sardine and anchovy TAC/Bs since 2008. The pelagic OMP will next be revised in 2011 so that it is implemented in time to recommend the TAC/Bs for the 2012 fishing season.

The survey estimates of adult fish in November, and juvenile recruitment in May, provide the key information input into OMP-08. Once the results of the November survey are available, the directed sardine TAC for the following year, an initial anchovy TAC and an initial sardine TAB can be calculated.

As recruitment is variable, it is not possible to accurately predict how many juveniles are going to recruit to the anchovy population in the following year. For this reason, only a certain percentage of the anchovy TAC is made available at the start of the year.

The anchovy TAC and associated sardine TAB are updated mid-year once the results of the May survey become available. Typically, anchovy recruits are readily available to be caught by the fishery until sometime in September.

Scientific advice regarding possible increases in the anchovy TAC is therefore provided as soon as possible after the May survey ends, so that the industry has sufficient time in which to catch the fish. Unfortunately, bureaucratic processes may delay the final announcement of the anchovy TAC and sardine TAB, as resulted earlier this year.

Calculating the TAC

So what are the nuts and bolts of OMP-08 and how does it translate the survey data into TAC/Bs?

In essence, the TAC recommendation is the amount of fish that can be caught while still maintaining the resource for the future. The rules governing the sardine and anchovy TACs fall into three main categories, depending on the resource abundance (Figure 4):

- **Normal:** In general, the TAC is calculated as a proportion of the resource abundance estimated from the most recent survey. Therefore, if the resource becomes more abundant the TAC will increase, and vice versa. An upper limit to the TAC applies, based on the industry's processing capacity. In order to ensure stability for the industry, the TAC may not decrease from one year to the next by more than 15% for the directed sardine TAC, and 25% for the anchovy TAC.
- **Industry preservation:** TAC decreases are also constrained by a minimum TAC. Therefore, even if the resource abundance continues to decrease below a certain level, the TAC will not decrease further. This minimum is in the interests of maintaining an economically viable industry during periods of medium to low resource abundance.
- **Resource preservation:** This minimum TAC can, however, be maintained only up to a point. If the resource abundance drops below an even lower level, the minimum TAC is overridden and TACs are decreased rapidly to prevent severe resource depletion.

Some of the benefits of the OMP-approach are that all stakeholders have a clearer idea of what to expect in terms of future TACs, TAC variation and protection of the resource during periods of low abundance.

Having an agreed set of rules to calculate TAC/Bs provides increased transparency and removes the tendency for the annual TAC recommendation process to become a "lottery". One of the key benefits to industry from the OMP-approach has been the ability to safely incorporate constraints on variations in the TAC from year to year.

This facilitates planning by the industry and allows a more economically stable environment, providing better job security and protection for those employed in the fishing industry.

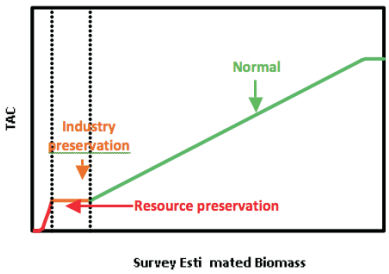

Figure 4. The general rule used to set directed sardine and anchovy TACs. In the "normal" range, the TAC is set at a proportion of the resource abundance. If the abundance decreases to a medium to low level, the TAC is kept constant at a minimum level ("Industry preservation"). However, if the resource abundance drops to a low point, the TAC is rapidly decreased ("Resource preservation").

Is an 80-year-old mistake leading to first species to be fished into extinction?

A species of common skate is to become the first marine fish species to be driven to extinction by commercial fishing, due to an error of species classification 80 years ago, reveals research published in the journal Aquatic Conservation.

The European common skate, Dipturus batis, has been on the World Conservation Union's Red List of Threatened Species since 2006, with France currently being responsible for 60.2 percent of reported landings. These catches are predominantly registered under the name 'D.batis,' however researchers, led by Dr Samuel Iglésias, show that 'D. batis' is in fact two clearly distinct species which have been incorrectly categorised as one since the 1920s.

From the mid-19th century the common skate was described as two distinct species, the flapper skate, D. intermedia, and the blue skate, D. flossada. However, in an influential work in 1926 R.S Clark recognised only 'D. batis' as a valid species and this classification has largely gone unchallenged since.

This classification confusion has resulted in the depletion of the flapper skate, the more endangered species of the two, being masked in the catch record. This means the risk of extinction is far higher than previously assessed and without immediate and incisive action the species may be in an irreversible decline towards extinction.

When conducting sampling in fish markets during the start of this study Dr Iglésias observed noticeable morphological differences in the 'Dipturus batis' specimens he sampled. In order to understand these differences the researchers not only analysed the systematic molecular data but also reviewed the species' life history and analysed fishery statistics.

"As the species was listed as 'Critically endangered' I wanted to understand who's who? I estimated at the beginning that it would take some weeks to resolve this question, but in the end it took me about two years," said Iglésias. "Our research clearly shows that D. cf. flossada and D. cf. intermedia are distinct and should be resurrected as two valid species."

Delving into the world of dolphins

Dr Stephanie Plön, a researcher with the South African Institute of Aquatic Biodiversity (SAIAB) has embarked on a three-year project to investigate the distribution of dolphins and whales in Algoa Bay. The project will determine feeding and breeding grounds of marine mammals in the region. Although Bayworld in Port Elizabeth has been home to captive dolphins for years, comparatively little is known about the ecology and biology of these animals. Plön's work is the first survey of its kind to be conducted in Algoa Bay.

"Due to the rapid development in Nelson Mandela Bay, this kind of information is vital," says Plön. "There has never been such a survey and we don't know how all these developments will affect the animals or where potential areas of conflict between humans and animals are. We are essentially establishing a baseline upon which to measure changes in the bay in the future."

Bayworld will collaborate with SAIAB and the South African Environmental Ob- servation Network (SAEON) to fund Plön's research.

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Dr Stephanie Plön conducts a practical session with post graduate students from Rhodes and NMMU at Bayworld in Port Elizabeth.