South African Small Pelagic Fisheries

Small pelagic species play a vital role in marine food web functioning because they convert energy from lower trophic levels, by consuming phytoplankton and zooplankton, into food for species at higher trophic levels, such as larger fish, marine mammals, and seabirds. The abundance and distribution of small pelagic species is closely linked to the variability of the upwelling systems in which they exist - small pelagics worldwide are characterised by large fluctuations in population size due to their highly variable recruitment patterns (Cury et al, 2000). This is therefore one of the principle reasons why the management of these “forage” species is so complex and is underpinned by the Ecosystem Approach to Fisheries (EAF).

Management complexity - understanding the difference between “Targeting” and “Bycatch”

The small pelagic fishery is the largest South African fishery by volume, as well the largest in terms of direct and indirect employment, and the second most valuable after the demersal fishery. Although there are two target quota species, the sardine (Sardinops ocellatus sagax1) and anchovy (Engraulis encrasicolus) several other species contribute significantly to the fishery mostly as a bycatch. Bycatch is a frequently used term in fisheries management that is often misunderstood. “Bycatch” is defined as the retained catch when fishing for the primary (target) species and is most often differentiated by the type of gear used. For example the sardine and anchovy (target) fisheries use purse seine nets each with different mesh sizes. In each of these fisheries however there is a bycatch of sardine (in the sardine fishery) and sardine (in the anchovy fishery). Juvenile sardine and anchovy school together during the first few months of life, when the juveniles of both species begin their southward migration along the west coast (from as far north as the Orange River) and around Cape Point then to their main spawning grounds on the eastern and western Agulhas Bank. A Total Allowable Bycatch or “TAB” limit is therefore set for juvenile sardine in both the anchovy and adult sardine directed fisheries. This naturally presents managers and the skippers with a challenge to minimise the impact on one species when targeting the other.

Another species that shoals with anchovy and sardine is juvenile horse mackerel (Trachurus trachurus capensis). To protect this species from over-exploitaion by the purse seiners in this cycle of their life history, precautionary catch limits are imposed. Further, round herring or redeye pilchard Eutrephorus whiteheadi adds to the complexity of the management of the fishery and is also caught.

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1 We refer to sardine also as pilchard and also use their common names to avoid confusion. Most “sardine” species have the more concise taxonomic reference “sagax” as well added onto the scientific name.
as a bycatch in both the anchovy and sardine target fisheries as well as being a targetted non-quota specie and is also controlled by a precautionary upper catch limit (PUCL).

This complex management system is often not always clearly understood by the public in general. Bycatch is retained for processing and is different from “discarding” which is not permitted and refers to the dumping of unwanted catch.

The use of Operational Management Procedures (OMPs) is a relatively new approach in South African fisheries, having played a central role in the management of South Africa’s fisheries since the early 1990’s (Plagányi et al., 2007). The anchovy fishery has been regulated using an OMP since 1991, and the first joint sardine and anchovy OMP was implemented in 1994 (De Oliveira et al., 1998). OMPs are designed to make management of fisheries easier by integrating the science (complex models), EAF, commercial aspects (including minimising variability from year to year), the catch (often referred to as “total mortality” incorporating target species, bycatch and all other sources of mortality) with the risk. The risk which is determined mostly from the models applied, is associated with many factors related to uncertainty in the information that feeds into the models. For small pelagic fisheries in particular, where managers must deal with year on year variability, this is a big challenge and one which is currently well-managed within the Department of Agriculture, Forestry and Fisheries (DAFF) working closely with the fishing industry, NGO’s and numerous other specialists and consultants. The small pelagic fishery is also spatially and temporally spread around much of the West and South coast (Figure 1).

![Figure 1: Distribution of the average small pelagic effort in South African waters from 2000 to 2012 (CapFish observer data, 2014)](image-url)
**Management of Small Pelagic Stocks**

The OMP process underpins the scientific recommendations each year. The principle means of control for small pelagics in South Africa is the limiting of catches against fishing rights within a Total Allowable Catch (TAC) and a TAB. In fisheries jargon this is referred to as Output (catch) controls. Some fisheries such as for squid, have both output and input or effort controls that limit the number of boats as well as the number of men on each boat. The 2014 TACs and TABs for the small pelagic fishery are shown in Table 1. In this table the limitations on bycatch and size (juveniles and adults) is shown. Clearly the management of bycatch in fisheries where similar gear can have catches of not only other species, but also juveniles of one or the other species is very complicated and requires close monitoring and discipline by fishers.

**Table 1:** South African small pelagic fishery TACs and TABs set for 2014 (DAFF, 2013)

<table>
<thead>
<tr>
<th>Directed (Target) Fisheries</th>
<th>Allowable Catch</th>
</tr>
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<tbody>
<tr>
<td><strong>Sardine TAC</strong> : Adult Sardine (bigger than 14 cm)</td>
<td>90 000t</td>
</tr>
<tr>
<td><strong>Sardine TAB</strong> : Juvenile sardine (less than 14 cm) bycatch permitted in sardine-directed catches</td>
<td>6 300t</td>
</tr>
<tr>
<td><strong>Anchovy TAC</strong> : Anchovy (normal season 15 January to 31 December)</td>
<td>450 000t</td>
</tr>
<tr>
<td><strong>Anchovy TAB</strong> : Bycatch of juvenile sardine permitted when targeting Anchovy</td>
<td>44 477t</td>
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**Precautionary Upper Catch Limit Fisheries**

| **Anchovy TAB** : Sardine-only rights holders | 500t |
| **Round Herring PUCL** : Target round herring PUCL (not allocated to specific rights holders) | 100 000t |
| **Round Herring Target TAB** : Adult sardine TAB permitted in directed round herring and anchovy fishing | 7 000t |
| **Round Herring Target TAB** : Juvenile sardine TAB with directed round herring fishing | 1 000t |
| **Horse Mackerel PUCL** : Juvenile TAB for horse mackerel in small pelagic fisheries | 15194t |
| **Lantern and Lightfish PUCL** | 50 000t |

The use of a Precautionary Upper Catch Limit (PUCL) also called a “puckle” is another management tool used in fisheries. This is applied when the actual catch and impact on any one stock is uncertain. For example DAFF has encouraged the development of a red eye (round herring) fishery as their research suggests there is a large and valuable resource. The 100 000 t is therefore set as a precautionary limit for small pelagic rights holders to encourage them to test that fishery. Rights holders are not allocated a quota as such and the resource is open for exploitation by those willing to
try and exploit it. In the case of horse mackerel however, avoiding juveniles in the directed sardine and anchovy purse seine fisheries can be challenging and in recent years the high abundance of juvenile horse mackerel on the west coast has been problematic. In this example, the scientists managing the resource have devised different PUCL rules that allows a total precautionary catch of juvenile horse mackerel in the small pelagic fisheries for example, not to exceed 16 814t over a three year period (a moving average) with catches not to exceed 8 407 t in any one year.

**Sardine and Anchovy**

The model that underpins the OMP (currently under revision) and which ultimately guides the setting of the TACs, depends on numerous types of data. To set a suitable TAC each year, fishery independent estimates of fish abundance measured by scientific acoustic surveys are plugged into models under the Operational Management Procedures (OMPs) that consist of formulae that base TAC levels on observed stock sizes.

The November 2013 acoustic survey undertaken by DAFF shows the density of sardine and gives an estimate of the biomass of sardine in their second year of growth (adults) at 851 553 t, most of which (651 582 t) was concentrated between Cape Point and Cape Agulhas (Figure 2). The November 2013 biomass estimates are therefore lower than the long-term (1984–2012) biomass average of 999 000t for this stock, but considerably higher than the 2012 sardine biomass estimate of 345 000t (Figure 3).

![Figure 2: South African sardine S. ocellatus sagax distribution and relative density for the 2013 spawner biomass survey (Mhlongo et al., 2013)](image-url)
The survey estimates for anchovy were more positive. Spawner biomass was estimated at around 5.17 million tonnes (Figure 4), substantially higher than that estimated in recent years and the highest estimate since 2001 (Mhlongo et al., 2013). The bulk of the anchovy spawner biomass continues to be found to the east of Cape Agulhas, with a small proportion of the total biomass (30%) in the area to the west of Cape Agulhas (Figure 5). This suggests that the reported eastward shift of the anchovy biomass and the mechanisms for maintaining the shifts are still present (Mhlongo et al., 2013).

**Figure 3:** South African sardine *S. ocellatus sagax* recruitment and adult abundance over time from 1984 to 2013 (SWG-PEL meeting, 2013)

**Figure 4:** South African anchovy *E. encrasicolus* recruitment and adult abundance over time from 1984 to 2013 (SWG-PEL meeting, 2013)
The OMP used in such calculations of TACs and TABs is designed to specifically maximize average sardine and anchovy catches in the medium term, while ensuring that the risk to both populations is managed below agreed upon levels. The OMP also includes constraints on the extent to which TACS can vary from year-to-year in order to enhance industrial stability.

The availability of small pelagic species also has a global context – the South African fisheries for anchovy and sardine must also compete in this market. Globally, small pelagic stocks are characterized by high interannual variability in population size as a result of highly variable recruitment. Such large temporal and spatial variations in population makes management of such stocks complicated, because of the difficulty in quantifying the stock abundance. Therefore, the primary challenge for policymakers and fisheries managers is to determine a “safe” limit of catches each year, whilst bearing in mind the ecological importance of small pelagics (i.e. leaving enough fish for other predators such as penguins and seals), and to ensure that the allocated “safe” catch limit does not fluctuate too much year to year as to impede the success of the fishery involved. An indication of the main areas exploited for sardine in the world and the approximate catch levels is shown in Figure 6.
The largest reported catch of sardine in 2012 was the European sardine (*S. pilchardus sagax*) targeted in the north east Atlantic. This species is found in the Adriatic Sea, the eastern Mediterranean basin (North Aegean Sea), off the coast of Spain and Portugal (the European Sardine is one of the most consumed fish species in Portugal) and in Moroccan and Mauritanian waters. In recent years (up to 2012) the global catch of this species has approximated 1 million tons 2012 (FAO, 2014 – see [http://www.fao.org/fishery/species/2910/en](http://www.fao.org/fishery/species/2910/en)). The Californian sardine reported a catch of 364 386 t in 2012, the Japanese sardine 269 972 t in the same year and South African sardine (pilchard) 134 922 t. The comparative catch of South American pilchard is insignificant (399 t).

There are however numerous similar species that compete on the global markets some of which include the sardinella’s. Sardinella are for example caught in many tropical waters such as off Angola and east Africa. Many of these fisheries are not on the same industrial scale as those in South Africa or as shown in Figure 6. They are nevertheless an important species group for coastal and artisanal fishers in these areas.

Intensive fisheries for sardine and anchovy are conducted in the western (Japan system) and eastern (California Current) boundary areas of the North Pacific, the eastern boundary (Humboldt Current) of the South Pacific, and both the northern (Canary Current) and southern (Benguela system) boundaries of the eastern Atlantic.
**Red-eye (Round Herring)**

Spawner biomass survey estimates (November 2013) for redeye were 1 286 473 t (Figure 7). This represents a considerable increase from the 2011 estimate, and is slightly higher than the long-term (1984-2012) average of 952 000 t (Mhlongo et al., 2013). The red eye biomass was distributed widely over most parts of the 2013 survey area (Figure 8), but mostly concentrated over the central Agulhas Bank. The 2013 survey also revealed an unusual “gap” in red eye biomass distribution between Cape Point and Danger Point (Figure 8).

The species is considered underexploited and has a Precuationary Upper Catch Limit (PUCL) of 100 000 t which has never been caught. Oceana, and currently Lucky Star, have in the past tried innovative fishing methods to target this species which is found in deeper water than sardine and anchovy. Red-eye behaviour also differs from that of sardine and typically they are not easily caught with traditional sardine or anchovy-directed purse seine nets. The current Lucky Star initiative is in the form of a specialised experimental permit granted by DAFF using mid-water trawl vessels which have the power and gear to target the deeper, faster-swimming red-eye. Catching them is only the first step however, processing follows which again will require innovation to ensure best utilisation is made of this resources potential.

![Figure 7: South African red-eye *Etrumeus whiteheadi* recruitment and adult abundance over time from 1984 to 2013 (SWG-PEL meeting, 2013)](image-url)
Lanternfish

As most fish stocks around the globe are either fully, or over exploited, the potential for increasing yields from such fisheries is poor. Therefore, alternative fish stocks are being considered world-wide, and of these “unconventional” stocks, mesopelagic fish are one of the most promising (Branch, 1995). The lanternfishes (family Myctophidae) are the most widespread and ubiquitous of the mesopelagic stocks, comprising the highest abundance (600 million tons) of all organisms in the mesopelagic zone. In the mid-waters of the northwest Arabian Sea and adjacent Gulf of Oman for example, it was estimated (1975-1983) that lanternfish had a standing stock of some 100 million tons. In the eastern South Atlantic, lanternfish biomass has been estimated at 18 million tons.

This unexplored and unexploited biomass is therefore of interest to various groups globally. Limited operations targeting lanternfish exist in South Africa, in the sub-Antarctic, and in the Gulf of Oman.
These operations process lanternfish into fishmeal or fish oil, and while some species have been canned for human consumption, most have a high content of wax-ester in their flesh making them unsuitable for human consumption.

In 2014, a PUCL of 50,000 t has been issued for lantern and light fish. Lanternfish landings in South Africa have varied considerably since their discovery in 1966 - a maximum of 42,369 t was taken in 1973 (Crawford, 1980), but annual totals exceeding 10,000 t are rare. This may be due to the preference of the species for deep water, making it inaccessible to surface purse-seine gear, but also because purse-seiners avoid lanternfish if other target species are available as the high oil content of the fish can cause problems using the conventional processing methods.

References


Department of Agriculture, Forestry and Fisheries (2013) Total allowable catches (TACs) and total allowable efforts (TAEs) for 2013/2014 fishing season. TACs and TAEs/2013


SWG-PEL Meeting, 12 December 2013. November 2013 Biomass Survey Results: presentation

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