Historical background to the South African horse mackerel fishery and its management

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History of fishery

The commercial fishery for the South African horse mackerel *Trachurus capensis* began in 1950. Horse mackerel are exploited by four fleets: purse-seine, offshore demersal, inshore demersal, and midwater trawl. Characterisation of the catches by these sectors is complex. A brief summary will be given here, and will be described in more detail later.

Purse-seine fleet: This operates on the West Coast only. From the 1950s to 1960s this targeted adult horse mackerel. The large surface schools of adult fish have since disappeared. Subsequently this fleet takes juvenile horse mackerel as a bycatch in the anchovy and pilchard fishery on the West Coast.

Inshore demersal fleet: This operates on the South Coast and targets mainly hake and sole using bottom trawl nets with 75mm mesh. There is limited horse mackerel targeted fishing using bottom trawl gear with 75mm or 85mm mesh. Foreign vessels (mainly Japanese) operated prior to 1991. In 1991 the foreign fleets were phased out.

Offshore demersal fleet: This operates on both the West and South Coasts. Adult horse mackerel are taken as a bycatch in hake-directed fishing on both coasts. Horse mackerel targeted fishing occurs (mainly on the South Coast) when concentrations of horse mackerel are located during hake-directed fishing. This targeted fishing could be with bottom or midwater trawl gear. Mesh size is 110mm on the West Coast, whereas 75mm, 85mm and 110mm mesh is used on the South Coast.

Midwater trawl fleet: This operates on the South Coast only, and comprises mainly large fast specialist midwater trawl vessels.

Purse-seine fleet

The purse-seine catches of adult horse mackerel peaked in the early 1950s (at maximum 118 000 t in 1954), declined to 80 000 t in the late 1950s, 40 000 t in the mid-1960s and finally levelled off at approximately 3 000 t between the early 1970s and late 1980s. By the 1970s the large surface schools of adult horse mackerel that were targeted by the early purse-seine fleet had disappeared from

the West Coast. Subsequent purse-seine catches have comprised juvenile fish, largely taken as a bycatch in the pilchard and anchovy fishery.

From the mid 1960s to the mid 1990s the annual purse-seine take has generally been less than 3 000 t, but exceeded 25 000 t in 1969 and 1989. Purse-seine catches showed an increasing trend from 1995, reaching 26 000 t in 1998. (This is believed to be due to increased targeting of juvenile horse mackerel by anchovy quota-holders, when quotas have been reduced.) Although this catch level appears low compared to that of the 1950s and 1960s, recent purse-seine catches are of juvenile fish. Consequently, the number of fish per ton caught by purse-seine in 1998 is actually much greater than was the case during the 1950s. Concern about the effect that the large catches of juveniles would have on the fishery for adult hoarse mackerel on the South Coast led to the introduction of measure to limit the purse-seine catch in 1999. A bycatch limit of 5 000 t was introduced in 2001.

In 1968, smaller mesh “anchovy” nets were widely introduced in the purse-seine industry (11mm mesh compared to the older 32mm mesh nets). Given the size of juvenile horse mackerel, it is unlikely the pre-1968 pelagic horse mackerel industry caught many juveniles. Most scientific indications are that the West and South Coast horse mackerel populations are a single stock. Therefore catches of juveniles made by the purse-seine fleet on the West Coast could reduce potential future catches of adult horse mackerel on the South Coast.

Offshore and inshore Demersal fleets

The demersal trawl fishery (targeting hake and sole) started in the early 1900s (the hake catch record starts in 1917). Horse mackerel would undoubtedly have been taken as bycatch almost from the start of the demersal fishery. However, recorded horse mackerel catches are available from the mid 1960s only.

Adult horse mackerel are taken as an incidental bycatch in the demersal trawl fishery on both the West and South Coasts, but catches are higher on the South Coast. When concentrations of horse mackerel are encountered during hake-directed fishing operations, vessels often switch to horse mackerel-targeted fishing. Prior to 2002, demersal vessels were allowed to carry both bottom and midwater trawl gear, and they would often switch to midwater trawl gear when horse mackerel were encountered. Although the skippers were required to indicate the trawl gear used, there is some doubt as to the reliability of the data recorded. This is especially during the run up to the introduction of a local midwater trawl sector, when operators may have declared bottom trawl catches as midwater trawl catch in an attempt to establish historical performance.

In the late 1970s foreign vessels began targeting horse mackerel on the South Coast using midwater trawl gear. Following the declaration of the exclusive economic zone (EEZ) in 1977, the foreign fleets were excluded except for limited access under license. A Japanese midwater trawl fleet was allocated a catch of between 8 000 and 25 000 t per annum between 1977 and 1990. This fleet was phased out in 1991 to make way for the development of a local midwater trawl sector.

The annual catch of horse mackerel by this sector has generally been between 12 000 and 26 000 t.

Midwater Trawl Fleet

Catches by the local midwater trawl fleet were initially fairly low, mainly taken by demersal trawlers diverted to midwater trawl when horse mackerel were abundant. Catches in this sector have increased since 2002 with the allocation of 31 500 t of horse mackerel p.a. to midwater trawl right holders.

History of the assessment and management of the resource

Punt (1989, 1992) developed a surplus production model (based on the Japanese CPUE series of the 1980s - the Japanese CPUE series was the only reliable CPUE series available). This model was used to provide management advice between 1989 and 1991. An annual TAC of 35 000 t (applicable to the demersal fishery) was applied. However, when Japanese fleets were stopped from fishing South African waters in 1992 this meant the loss of the Japanese CPUE time-series and that the production model assessment method could no longer be applied. A PMCL (precautionary maximum catch limit) of 40 000 t was imposed for 1991. Furthermore, preliminary results from an acoustic survey completed in October 1991 indicated that the surplus production model may have severely under-estimated the horse mackerel resource. At this time, annual stock assessments were thus suspended pending further data from acoustic surveys. In 1992, no assessment was made, and a PMCL was set at 40 000 t.

In 1992, Butterworth and Raubenheimer (1992) developed a Beverton-Holt yield-per-recruit type modelling approach (appropriate for situations for which limited information is available). This approach determined the proportion of the pre-exploitation biomass that could be harvested in order to produce (roughly) a maximum sustainable yield, using tables developed by Beddington and Cooke (1983). The application of this approach yielded a recommended PMCL of 55 000 t for 1993. The PMCL was increased to 58 000 t in 1994 and remained at that level until 1997. Note however these catch limits were not reached – see Fig. 1.

This yield-per-recruit approach was refined by Butterworth and Clarke (1996), using parameters more appropriate for the horse mackerel. Both the original model and this refinement incorporated a "safety factor", designed to ensure that the chance of the spawner biomass falling to a level below 20% of the mean pre-exploitation spawning biomass (K^{sp}) over a 20-year period, was only 10%. This, more conservative, approach was adopted in the light of a trend towards increased catches of juvenile horse mackerel by the purse-seine fishery on the West Coast (Fig. 1), and the uncertain impact of these catches on the adult stock on the South Coast. The refinement of the yield-per-recruit model led to a decrease in the PMCL to 34 000 t in 1998. The main reasons for this lower value were that the refined model used a lower age-at-recruitment and took account of interannual recruitment variability.

During 1999, an age-structured production model was developed for horse mackerel, based on total annual landings of both trawl and pelagic fisheries (Horsten 1999a,b; Johnston and Butterworth 2001, 2002; OLRAC 2001). For model fitting, demersal swept area survey biomass estimates for the West and South Coasts were used. The model was used to produce biomass trajectories for different combinations of demersal and pelagic catches. The results suggested that there is a pronounced yield-per-recruit effect, i.e. the horse mackerel stock is very sensitive to purse-seine catches with even a small pelagic catch having a substantial negative effect on the level of demersal catch that can be sustained. The model also indicated that the *MSY* from a trawl fishery (targeting adult fish) is very much higher than that of a purse-seine fishery (targeting juvenile fish). Furthermore the model indicated that, to maintain a trawl harvest of over 30 000 t p.a., the pelagic catch should not exceed 5 000 t p.a. These estimates were shown to be reasonably robust to alternative assumptions for natural mortality and its age-dependence. Based on this model, in 2001 a PMCL of 34 000 t was set for the trawl fishery. In addition it was recommended that the by-catch of juvenile horse mackerel in the pelagic fishery should not exceed 5 000 t.

The models developed for the horse mackerel resource have, of necessity, been conservative because of the lack of information content in the available data. In response to increased demand for access to the resource, the age-structured model was updated in 2001 and used to project expected resource response to different management options. These showed that, under reasonable assumptions of steepness (h) and catchability (q) parameters, the PMCL could be increased from 34 000 to 44 000 t per annum for the next four years while maintaining risk at a reasonable level.

The PMCL was thus increased to 44 000 t in 2002 with the intention of maintaining it at that level until 2005 unless a negative impact from the higher catches were detected. For 2005 it has been recommended that the PMCL for horse mackerel for remain at 44 000 t. This limit is to include 31 500 t allocated to rights holders for targeted trawling, and 12 500 t set aside as a reserve to cover incidental by-catch in the demersal trawl fishery). It has also been recommended again that the annual catch of juvenile horse mackerel in the purse-seine fishery should not exceed 5 000 t (note that this is not a component of the PMCL). However, it is also recommended that, pending further analyses, reasonable flexibility should be exercised regarding this last limit during years when the high incidence of mixed-species shoals makes it very difficult for the pelagic fleet to avoid juvenile horse mackerel. It is recommended that the pelagic industry should implement management procedures to prevent targeting and to limit by-catch of juvenile horse mackerel.

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Fig. 1: Catches of the South African horse mackerel.