HISTORICAL OVERVIEW OF LONGLINING IN SOUTH AFRICA PREPARED BY THE SEA FISHERIES RESEARCH INSTITUTE FOR THE SUBCOMMITTEE REPORT OF THE SFAC ON LONGLINING FOR HAKE

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Longline experiment from 1983 to 1990

Longline fishing, one of the oldest fishing techniques known, is practised in many parts of the world. Wherever it has occurred in the past, it has always been considered a "traditional" fishing method and was given little attention by either fisheries scientists or managers. Technological advances, increased demand for fish and competition for limited resources has resulted in the emergence of longlining as a viable commercial fishing technique that can compete with the established commercial fisheries (such as bottom trawling).

Before 1983 there was only ***pelagic*** longlining for tuna and a small-scale longline fishery for sharks in South Africa. Established longline fisheries for hake and other species exist in Portugal and Spain and, based on the activities of these fisheries, the motivation for the first demersal longline (deep-water) permits were made in South Africa in 1982. The stated intention of the first applicant was to longline for hake. The initiatives of early entrepreneurs were followed by others and many more applications for longline permits were received by the Department. Nine 'experimental' permits for longlining were granted in 1983 (ten actually, but one was not activated). These permits were issued to the established trawling companies, all of which held hake quotas. The same permits were renewed in 1984, as well as one other. Not all permit holders fished actively in the beginning and in 1984 only eight vessels reported longline catches. During this period the fishery was still developing, and Spanish and Portuguese crews were imported for their expertise. Longline effort was directed mostly at the West Coast. Only towards the end of 1984 and in spring 1985 was great effort directed at the South Coast.

Although initially intended for hake, longlining in South Africa quickly developed with kingklip as the target species. Kingklip were abundant and the returns lucrative. Longliners avoided the traditional trawl grounds, but found kingklip plentiful on rough substrata. It was in the critical 1984/1985 period that the ***Demersal Bottom Double Longline*** became an established longline technique. This method was developed to cope with the rough grounds, harsh weather, strong currents and other hydrographic features encountered on the South African coast. The technique was also selective because it could be directed at either kingklip or, with changes to the bottom line, at hake as well.

In 1983 and 1984 only seven vessels were actively longlining. Scientists gave the first warnings at this early stage that effort in the fishery should be strictly controlled and that longlining could have a serious impact on the kingklip resource. The hake by-catch in the longline fleet was of little concern at that stage because it was small and was taken within the quota limitations of the individual companies. There were no restrictions on the catching of kingklip. In 1985 the longline fleet, now using well established techniques, targeted on the abundant kingklip resource on the South-East Coast. Large catches of kingklip were made by the seven active permit holders and the total kingklip landings increased sharply. Longline effort was further increased with the issue of six additional permits to independent operators (without hake quotas) towards the end of 1985. By the end of that year the longline kingklip catch had increased to nearly 7 000 t and the longline hake catch to 1 500 t.

In 1986 the (longline) kingklip catch increased further, most fish being caught on the South Coast where, owing to known spawning aggregations and a slackening of the current, kingklip were more available. At that time the independent operators also began targeting on hake. These longline operators had smaller vessels and found it more profitable and easier to target on hake (especially in the Cape Point area). Catch rates of kingklip, particularly in the peak spring period, began to drop sharply. Kingklip became a less viable option and, although asked to avoid targeting on hake, some of the larger operators also began targeting on hake. By the end of 1987, trawl by-catches of kingklip were showing signs of decline and longline catches were nearly treble that of the trawl fleet. Further, the sizes of both the hake and kingklip caught by the longliners differed from those caught by the trawlers. The longline method selectively caught large adult hake and kingklip and concern was expressed that the removal of the spawning stock was likely to have a detrimental impact on recruitment to both the trawl and longline fisheries. Although trawlers landed some large kingklip, their catch consisted mainly of small fish (< 60 cm) compared with the longliners which caught predominantly large fish (on average > 60 cm). The same selectivity pattern also applied to hake. Longliners caught exclusively large hake, whereas trawl-caught hake were mostly fish < 50 cm, with only a small proportion of the catch in the size-class landed by the longline fleet. By the end of 1989 kingklip catches (trawl and longline) had declined from the peak of 11 370 t in 1986 to 5 446 t. Longline catches of hake peaked at 5 514 t in 1988, but reported catches dropped sharply to 322 t and 386 t in the following two years.

The first assessment of the kingklip resource based on the longline data showed that the longliners were exploiting the kingklip resource well in excess of a rate required to maintain the stock at a sustainable yield. At this time the first assessments only used the available longline data and, based on this information, it was recommended that the longline experiment be discontinued and that permits be issued for the longlining of kingklip. Hake caught by the longline fleet was to be considered a by-catch (limited to 10% of the kingklip catch) and was deducted from the quota of the permit holder. A 5 000 t kingklip ***TAC*** was implemented and a closed season and area was introduced on the South Coast to reduce the impact of exploitation on the kingklip spawning aggregations.

By 1989 there were signs that the trawl by-catch of kingklip was decreasing significantly and that the steep decline in longline catch rates on the South Coast was continuing. The kingklip assessment was extended to include the historical trawl catches of kingklip. It was concluded from this assessment that the longline fleet had severely impacted on the kingklip spawner stock on the South Coast. There were also visible signs that recruitment to both the trawl and longline fisheries for kingklip was being affected. The kingklip ***TAC*** for 1990 was reduced to 2 500 t. Revision of the assessment in March 1990, using the full trawl data series for the first time (catches from 1932), showed that the kingklip resource had probably already been overexploited by the trawl fleet prior to longlining and that longlining had accelerated the decline by targeting the kingklip spawner biomass on the South Coast. As a result, all longlining was stopped by the end of 1990 and trawlers were requested to avoid directing effort at known kingklip grounds.

Longlining Subsequent to Closure of the Longline Fishery

Longlining remains a highly contentious issue and the present debate involves many parties with conflicting interests. The closure of the longline fishery caused much concern among the established longline fishermen. Those operators that did not have hake quotas were compensated with a hake allowance. Interest in longlining remained, however, and several groups continued to lobby for longline permits, while others opposed the idea. Much debate revolved around the definition of a longline and the effect closure of the longline fishery had had on the industry. In early 1991, fisheries control officers stopped shark longlining (a traditional fishery) as, by definition, longlining had been banned. The subsequent issue of special 'shark longline' permits to those operators that could prove 'traditional' shark-directed effort resulted in a resurgence of interest in longlining. Many fishermen, including former longliners and tuna permit holders, applied for, and were given shark longline permits. The floodgates opened and permit and non-permit holders started landing hake and kingklip ('line-caught'). The situation threatened to get out of control as hake catches were not within the scientifically recommended ***TAC***.

A further development was the growth of the handline fishery for hake and, to a lesser degree, for kingklip on the South and East coasts. Fishermen in these areas had traditionally caught hake in unrestricted (but small) quantities to supplement their line and squid catches. With the increase in demand for line-caught hake and the decline in catches of other linefish species, linefishermen developed techniques to improve their hake catches. This included the use of special line haulers that could lift lines with many hooks, i.e. longlines. The situation therefore arose where a species was on the open list for the 'line' fisheries but was strictly controlled by quotas and other means for trawling. The prospect of an open access fishery became a real threat to the hake resource. The Minister subsequently introduced legislation limiting the number of hooks on a line, defined a longline, took hake off the open species list and limited the number of hake and kingklip that could be landed per day per fisherman. At present, the only legal longlining allowed is the shark-directed longline fishery (21 permits). There are strong motivations by several groups for, or against, longlining. These groups include ***SADSTIA, SECIFA, SAMLMA, SALMIA***, the ***S.A. Trawling and Linefisherman's Union***, as well as other individuals and interested groups.

DESCRIPTION OF FISHING METHODS

Trawling

The South African trawl fisheries consist of several component groups. Relevant to the longline-for-hake debate are the ***Deep-Sea Fishery*** (operating offshore deeper than 110 m) and the smaller ***Inshore Fishery*** (operating on the South Coast only, generally in water shallower than 110 m). The deep-sea fishery nowadays consists entirely of stern trawlers, of which about 89 are active wetfish (ice) vessels and 18 freezer vessels, with lengths up to 100m. The inshore fishery consists of smaller side trawlers of 23 m average length. Effort of the deep-sea fleet is predominantly hake-directed and has a minimum mesh size of 110 mm. The inshore fleet directs effort at hake, sole and horse mackerel and has a minimum mesh size of 75 mm. Trawling is done by bottom gear (otter trawls mostly) and, because of the nature of the gear, trawlers are restricted to 'soft' substrata. Large areas of the South African coast are inaccessible to the trawl fleet, especially on the shelf margins and in areas were coral is prevalent on the South and East coasts. Although bobbins are not outlawed, they are seldom used, as good skippers can target on hard grounds by flying gear over very rough patches or by fishing 'lightly'. Trawling is done mostly in daylight hours, with three to four trawls per day of between 2-4 hours each. Fishing is weather-dependent and is also determined by species-abundance and size-category market requirements. The hake and sole trawling grounds are well established, and few pristine trawl areas exist.

The South African trawl fishery is dominated by two large companies (Sea Harvest Corp. and Irvin & Johnson Ltd). Together these two fleets control roughly 80% of the deep-sea hake quota. Irvin & Johnson also controls 42% of the inshore hake quota. These two companies, as well as some of the other bigger operators, such as Atlantic Fishing, Marine Products, Viking Fishing and Fernpar Fishing, have well-established infrastructures. Large factories and independent port facilities are owned by those concerns. Marketing is competitive, with the different companies developing a wide range of products. Established overseas markets also exist. Different markets exist for the frozen product (on board factory production) and the 'wet' product (fresh fish supply and shore-based processing). Factory (freezer vessels) spend as long as two months at sea whereas wetfish vessels have a turn around of about 10 days. Products of the trawl fleet are size-dependent. On-board processing of the smaller size categories for fillets is done, otherwise fish are headed and gutted and packaged by size category.

Bottom trawling is not selective, although skippers can target to a certain extent on a particular species and size category of hake. Although it has never been precisely quantified, trawl catches have a large by-catch of 'trash' fish that is dumped. Indications are that the trawl industry are making better use of the by-catch species, although wastage is still high. Dumping of unwanted catch is also likely, although this is also believed to be decreasing. Trawlers rarely seem to catch large spawning hake, but the reasons for this are not clear; it is probably associated with net-avoidance and distribution of hake. As the dynamics of hake behaviour in South African waters are not fully understood, several possibilities exist. For example, hake probably spawn at a depth not fished by the trawl fleet, or adults may simply prefer a different substratum (rough ground). Further, stronger swimming adults may be able to avoid the net or perhaps adults feed more actively and spend less time on or close to the bottom than do juvenile hake.

Removal of fish by seals is not a serious problem in the deep-sea trawl fishery, but it is of some concern in the inshore fishery, where the side-trawl caught fish are exposed to seal predation for longer periods while hauling the net on board. Trawl grounds are well established and nets are often dragged over the same area repeatedly. Damage to the sea bed by trawl gear has not been precisely determined, but because of the type of bottom trawl employed, actual damage to the sea bed is not likely to be extensive. However, destruction of the benthic fauna is highly probable. Occasional fouling of the sea bed by lost nets, trawl doors and warps also occurs.

Longline Fishing Techniques

The demersal longline techniques developed in South Africa in the 1980s are unique and are suited to local conditions. Variability in current strength and direction as well as weather changes were initially the major constraints to the development of the longline fishery. The longline methods that were developed are intensive and the lines, when set, occupy a large area of the sea bed. For example, a single longliner can use up to 15 000 hooks on a line and, with a hook spacing of about 1,7 - 2,0 m, the line can be 30 km long. Lines are normally set over a preferred ground and often looped or buoyed off in sections. It is possible, for example, for a group of 10 longliners to set 12 000 hooks each in an area of approximately 10 x 10 miles in a period of 20 h (120 000 hooks). The longline consists of an anchor line and floats (with markers) at either end and two continuous lines set on the bottom. The top line, the lighter, but thicker of these two lines, is buoyant and attached at 50-60 m intervals; it floats above the more dense bottom line that sinks and has the hooks, weights and floats attached. The two lines are set and hauled simultaneously and, if the bottom line (fish line) breaks, the rest of the line can still be recovered using the stronger top line (that is unlikely to foul). A longline of this type directed at bottom fish (such as kingklip), has none or only a few floats attached and lies flush on the sea bed. It is weighted at regular intervals and is prone to fouling. Changes in current strength and direction also increase the probability of losing the line. The snood or gangion refers to the length of monofilament line and hook that is attached to the bottom 'fish' line. Longlines are prepared in units called baskets or tubs that contain between 75 and 130 hooks.

In order to deploy the line off the bottom so that effort can be directed at hake, less weights are put on the bottom line, floats are attached instead and the gear is set later at night and left in the water for longer periods during the day. The depth at which the gear lies in the water depends on the frequency and spacing of the floats and weights attached to the bottom line. It is this adjustability of the longline that makes it selective. Longlines can be set at variable depths, over most substrata, at different times, with variable hook spacing, a range of bait types and hooks and numerous other characteristics.

Longline-caught fish are preferred for the fresh fish market because they are normally larger and are undamaged by net compression. However, longline-caught fish are affected by several unknown factors. Longlines are left to soak for up to 12 h before retrieval. This 'soak time' is important because the longer a fish remains hooked, the greater the chances are of losing it. The loss rate of fish once hooked is probably high and the exact percentage of fish lost needs to be determined. For example, hake are known to die soon after being hooked, but kingklip are more robust and survive for longer on the hook. Most demersal species swallow the bait whole and as a result are hooked in the stomach. This, combined with the barotrauma effect, results in a high rate of stomach eversion when the fish are hauled to the surface. Hooked fish are preyed upon by sharks, hagfish, sea lice and other fish predators. Many fish are also lost when hauling the line (fish break off the hook and float away), and perhaps the highest losses on longlines are attributed to seal predation. It is probable that only the high density of hake or kingklip hooked makes longlining viable. **Heavy losses on longlines (and therefore unaccounted mortality) is perhaps the biggest disadvantage of the technique and would need to be looked at carefully before reintroducing a hake-directed longline fishery.**

The more established and larger longline vessels (up to 35 m) had freezers fitted and were able to stay out at sea for up to a month at a time. Some of the smaller longline vessels were also fitted with freezers while the remainder kept their catch on ice. The longline fishing operation is extremely labour-intensive, requiring long hours and hard work. Should another longline fishery develop it is likely that automated baiting vessels would be considered. Vessels participating in the longline experiment in the 1980s that were owned by the established trawl companies had access to the same infrastructure as described for trawling. The smaller independent longline operators did not have the infrastructure of the bigger operators. They did not hold hake quotas and were to some extent dependent on the bigger companies for the processing and marketing of their catch. Longlining has the advantage that it is more amenable to the smaller operator and requires less capital outlay. Also, longline catches can be very specific and fishermen can, if they fish correctly, target on a range of species. The by-catch is small and few fish are discarded. Because the size of vessel used is smaller, more ports are accessible to them (assuming they have the necessary processing facilities there). Longlines are unlikely to cause much direct damage to the sea bed, although loss of lines in the past occurred frequently. In the years that the longline fishery operated, fouling of the sea bed by longlines was common, and both trawlers and longliners regularly picked up broken longline gear. Lines were also reported washed up on beaches. There was also hook damage to fish and retention of lines and hooks in the mouths and bodies of fish.

The exact methods employed for longlining in the linefish fishery have not been clearly defined, but it is understood that handlines with many hooks are used. Heavy lines and catches are hauled with small winches either attached to the gunwale of the vessel or small warping drums are used. Variations of the method also occur. For example, lines are often set on a single dropper, using a heavy weight as an anchor and a buoy as a surface marker. These lines may carry between 20 and 2 000 hooks and several lines may be set at a time, the vessel moving from one to the other recovering the lines.

RESOURCE CONSIDERATION

Before exploitation of a resource begins, the likely effect of the fishing method on the resource needs to be estimated, although only actual exploitation is likely to provide real answers. A good indication of the status of a resource as well as the likely effect of the fishing method to be employed on the stock(s) can be achieved through modelling. Because of the high degree of uncertainty in fisheries, management approaches are normally cautious and err on the conservative side. In a prospective longline fishery for hake, several other species are likely to be affected. This refers not only to a fishery in which hake is the target and other species such as kingklip, jacopever and shark are by-catch, but also to the effect of different ***types*** of longline fisheries and the areas in which they occur. For example, a longline fishery operating from Cape Town is likely to target on the ***deepwater hake*** species. Should their operating range vary and they move shallower they are likely to target on the ***shallow-water hake*** species. Any longline fishery on the South Coast is likely to be on a different scale and will probably be ***'artisinal'*** in nature eg. it is likely to include smaller boats (ski boats) operating inshore. In this case the target species will be the ***shallow-water hake***. The effect on **both** hake species is therefore an important consideration when investigating the impact of the introduction of a hake-directed longline fishery. Assessment of the Cape hake in the past has always considered the resource as single species. The assessments referred to in this document therefore consider hake as a single species.

The impact of the directed longline fishery for kingklip has been described and this serves to illustrate how a poor understanding of the dynamics of a resource and underestimation of the effectiveness of the fishing method (as well as excessive effort) had a serious impact on the resource. So what would be the effect of a directed longline fishery for hake, on top of an established trawl fishery? Kingklip have always been a small by-catch in the hake-directed trawl fishery and therefore no trawl-directed effort data were available when the longline assessments were done. By comparison, a much longer time series of catch and effort information is available for hake as well as considerably more biological information. Because of this we are in a better position to assess the possible effects of the introduction of a hake-directed longline fishery than we were with the kingklip resource at the start of the longline fishery in 1983.

Status of the Hake Resource

The hake time-series of catches and catch rates shows clearly the overexploitation of the resource in the 1970s. This was followed by the introduction of a conservative management policy and subsequently by a gradual improvement in the resource. Current estimates of stock size suggest that the hake resource on the South Coast is at about 52% and the West Coast at about 45% of pristine. The hake resource on both coasts is recovering slowly, and if the present management strategy ($f_{0.2}$) is retained, the hake biomass should continue to increase slowly.

By running the production model for hake with catches greater than the present strategy dictates, a simple but clear indication of the likely impact on the hake resource is predicted i.e. simulating line catches outside of the recommended ***TAC***. Any catches outside of the recommended ***TAC*** will have a negative impact on the resource. The degree of this impact obviously will depend upon the amount removed and the effect will vary from one in which the present recovery of the hake stocks is reduced to an extreme scenario where collapse of the hake stocks can occur within a relatively short space in time. It should be noted as well that the present resource biomass levels on the South and West Coasts differ. The hake resource on the South Coast, although estimated to be at a slightly higher level than the West Coast (as a proportion of the pristine biomass estimate), has a lower stock size and has less capacity to sustain an additional fishery.

Biological Effects

Several important questions need to be answered on the biological effect longlining is likely to have on the resource. One way of modelling these effects is to use a Beverton and Holt ***yield-per-recruit*** type model in which biological characteristics such as age and growth, age-at-maturity, natural mortality, fishing mortality and selectivity are essential components. Most of the biological characteristics of Cape hake are known and were used in models to compare the ***yield-per-recruit*** and ***spawner biomass-per-recruit*** of longline and trawl fisheries. The essential questions that were asked were: **1)** if the two fisheries had the same level of catch, which would result in a lesser reduction in the hake spawner stock?, or **2)** for the same reduction of spawner stock would longlining allow a greater catch?

An essential part of the calculations are the assumed levels of natural mortality, the expected fishing mortality and also the selectivity curves of the two fisheries. Both the fishing and natural mortalities can be tested for a range of values. Selectivity of the two gears is fundamental to the calculations. The selectivity curves used in the most recent models applied data from the now-closed longline fishery, research survey estimates of hake abundance and biomass, **VPA** estimates and commercial catch and length data. **The results of these models were clear. For the same level of catch in a fishery made up of just one of these activities (i.e. trawling or longlining), longlining would result in a lesser reduction of the spawning stock than trawling and, for the same extent of reduction of the spawning stock, longlining would allow a greater catch**. The results therefore suggest that longlining is biologically preferable to trawling. Further tests showed that the selectivity patterns used are robust to a wide range of assumptions. In an extreme case of no mixing of adult hake between longline and trawl grounds, longlining gives a marginally better ***yield-per-recruit*** but a poorer ***spawner biomass-per-recruit***. However if a reasonable degree of mixing does take place then a longline fishery is preferable in terms of both ***yield-per-recruit*** and ***spawner biomass-per-recruit.***

Resource considerations therefore favour the longline fishery (biologically). However, several important questions still need to be answered. Whereas mortality in the established trawl fishery (eg due to damage in the net) is accounted for in the models, no information is yet available on the mortality of longlines. Landed catches do not take into account the losses due to fishing (as discussed). Mortality due to seal predation as well as other losses on the longline may for example double the effective longline catch. Fish mortality on longlines therefore needs to be quantified before a longline fishery is introduced. Further, the selectivity curves used in the models were based on old longline data and were extracted from a fishery that was mostly kingklip-directed. Would the selectivity patterns of a strictly hake-directed longline operation be the same now? What are the selectivity patterns for a longline fishery on trawl grounds and do they differ from those on rocky grounds? Does the longline fishery selectively catch adult spawning females, i.e. what is the sex ratio of the longline catches? A further problem that needs to be addressed is the possibility of spatial and seasonal shifts in hake abundance that may affect the selectivity of the longline and trawl gear (this may include hake spawning aggregations).

It should be clear from these questions that although the models suggest that longlining as a single method of fishing is preferable to trawling, there is still much uncertainty. Only a well-structured research programme will answer these questions.

Such a project would have to run for one to two full years with one, or preferably more fully operational longline vessels. Simultaneous and comparative trawling experiments would also need to be done. Such a project will not come cheap. If management decisions on the viability of a hake-directed longline fishery have to be made in the future, then it is essential that they have a sound scientific basis. This can only be achieved if further research is conducted.