University of Cape Town

School of Economics

THE SOCIO-ECONOMIC IMPACT OF THE SQUID STOCK VOLATILITY IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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LIST OF ABBREVIATIONS

Chokka – Squid

CPUE – Catch Per Unit Effort

DAFF - Department of Agriculture, Fisheries and Forestry

DEAT - Department of Environmental Affairs and Tourism

FAO – Food and Agricultural Organization

Focus Areas – Humansdorp, Jeffreys Bay and St. Francis

GDP – Gross Domestic Product

HACCP – Hazard analysis and critical control points

ISSA - Income and Expenditure Survey

MCM - Marine and Coastal Management

MLRM - Marine Living Resource Management

MLRA - Marine Living Resource Act

MSY – Maximum Sustainable Yield

LFS - Labour Force Survey

MRSU - Mobile Remote Sensing Unit

NDP – National Development Plan

SASMIA - South African Squid Management and Industrial Association

Stats SA – Statistics South Africa

SAWS - South African Weather Service

TAE - Total Allowable Effort

TAQ - Total Allowable Quota

ITQ - Individual Tradable Quota

ABSTRACT

This is an ongoing paper that discusses the socio-economics of three neighbouring small towns (Humansdorp, St. Francis and Jeffreys Bay) in the Eastern Cape of South Africa, each largely dependent on the squid fishery. The paper addresses four issues: (1) the operations of the squid industry in South Africa; (2) the local impacts of its operations; (3) the financial stability of the industry and (4) the manner in which the resource and the industry are managed by the ministry (and the implications of this). The linkages of the squid industry into both the local and provincial economies are estimated using mixed data from existing survey and census statistics, and from qualitative interviews and questionnaires. The paper also describes the roles played by industry participants in the squid value chain. A key element in the debates surrounding the management of marine resources is the benefits they provide for previously disadvantaged populations. The paper unravels some of the complexities underpinning this issue, in particular concerns regarding resource rights, management through closed seasons, and control over value chains. The stability and geographical origins of affected communities are focal issues. The paper also identifies major costs of industry operations and roughly quantifies them as a preliminary to establishing linkages to the local economy. It is noted that although the different vessels in operation vary in size and cost, the basic technology used is similar. The return on capital depends, therefore, on the skills of the fishers and the health of the resource.

1 INTRODUCTION

Being restricted to a small area of the Eastern Cape, it is unsurprising that, although locally dominant, the squid industry in South Africa is smaller than the country's other major sub-sector fisheries, such as hake, small pelagic, and rock lobster. However, for people in the area, squid harvesting is the dominant livelihood. These small areas provides few alternative sources of income other than tourism and agriculture. The areas are therefore heavily dependent on a resource known for its volatility. This creates uncertainty for both industry participants and local businesses in the entire local economy as well as in the squid sector itself, and has made finance very hard to obtain (SASMIA 2012), particularly as there is a high dependence on squid as a source of income. Although scientists and scholars have tried in the past to explain the possible reasons for the volatility of the squid resource (Cochrane et al. 2014), the impacts of fluctuations in the catch on the local and provincial economies have not been fully measured.

Most of the literature available focuses on the biomass, especially on the volatility of the biomass and water quality.

Measuring the economic value of the squid industry presents some conceptual challenges. A general industry is measured by its contribution to the countries' gross domestic product; it is also measured by its total contribution to employment. In the case of the squid industry, we ought to include its foreign exchange as the industry is highly export-focused and it is important to measure the effect of links to the local economy together with its local importance. This involves identifying what sort of substitute activities exist in the areas. Hoagland et al. (2013) state that to calculate such an impact, one would need to estimate the sum of the consumer and producer surpluses generated by the fishery, including the protection of the species. This, however, will not be covered in this paper.

From DAFF's perspective, the industry is challenging. Although an individual firm may be a simple profit maximizer, the state has a more complex objective function. It is striving to generate income, employment, foreign exchange, and stability, and all the while to ensure resource sustainability. The problem is finding a management policy that can provide such a bounded optimality.

1.1 Significance of the South African chokka squid fisheries

The Squid industry is small yet valuable; it is the fourth most valuable fishing industry in South Africa, after hake, small pelagics, and rock lobster (Cochrane et al., 2014; Roel et al.,1998). It is almost exclusively based on a single species, *Loligo Vulgaris Reynaudii*, locally referred to as 'Chokka' and commonly found on the continental coasts of Southern Namibia and along the Cape provinces (Augustyn, 1989). Prior to the late 1980s, the chokka squid fishery only existed as a "by-catch" of demersal trawlers. Subsequently, an offshore jig fishery was created which now accounts for more than 90% of the national squid catch (DAFF. 2010). Since it uses handlines, squid jigging is highly labour intensive, providing employment for over 3000 people in the Eastern Cape, (SAMIA, 2013). The industry in itself is also volatile because the resource is prone to extreme variations; not only between years, but within years. The seasonal fluctuations in recent years have been extreme, with large numbers of squid being found in coastal waters during the summer months.

South Africa's squid industry (and its employees) face many challenges. These include resource seasonality, labour intensity, resource and CPUE instability, geographic concentration of effort, and specialized non-flexible capital with limited alternative uses. All these challenges

render the local economy and its residents vulnerable, not only to the physical condition of the resource, but also to such exogenous economic factors as fuel prices, exchange rates, and conditions in the global market.

This paper addresses four issues: (1) the operations of the squid industry in South Africa; (2) the local impacts of its operations; (3) the financial stability of the industry; and (4) the manner in which the resource and the industry are managed by the ministry, and the implications of this.

1.2 Background and overview of the squid industry

South Africa's fisheries sector is a minor component of its economy, bringing in over R3,4 billion ($236m) of foreign exchange income every year, but contributing only 0.3% to the GDP. However, it is locally significant along the western and southern coasts of the country (Stats SA, 2016). In those areas, it contributes significantly to employment and often has extensive linkages to local small industry. Most sub-sectors in the industry have been operating for a long time and are now mature, implying that super-profits of the sort found when a new fish resource is mined down from its pristine level can no longer be expected. The stocks of most species, including squid, have been fished down, and annual harvests are now driven by levels of recruitment and mortality in earlier periods. The industry is managed by a central authority within DAFF that allocates long-term rights. Control is effected by restricting either effort or offtake in each individual fishery.

Although artisanal fisheries exist, most of the catches come from commercial operations which also provide the bulk of the value addition in the course of processing, marketing, and export. This is the case for the hake and small pelagic sectors, though perhaps to a lesser degree for rock lobster and squid where the value chains are shorter. All four minor fisheries sectors have significant export markets.

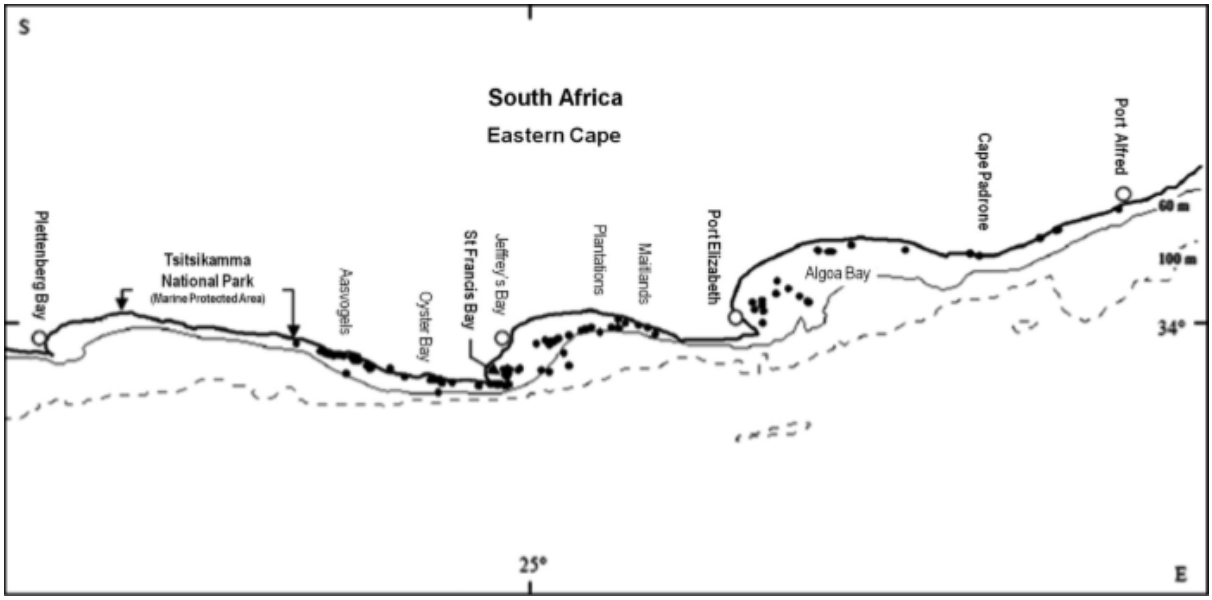
The productive waters of the south and west coasts support a variety of commercially exploited marine life, including hake, anchovy, sardine, horse mackerel, and tuna, while more accessible species, including rock lobster, squid, line-fish, abalone, and a range of intertidal resources, also provide livelihoods for coastal communities. Fishing rights in most sub-sectors are issued both on a short and long-term basis (Zantsi 2012:6). The 3000 jobs in the squid sector are about 10% of the employment generated by the fishing sector as a whole, but these are concentrated along a small segment of the coast. The fishery is believed to generate in excess of R480 million ($33m) in a good year (DAFF, 2016: 78)

Chokka squid are comparatively short lived (roughly eighteen months) and while annual recruitment has a clear link to the breeding population in the previous year, it is also directly affected by water condition and offshore currents (Sauer 1994 and Roberts 1998). Section 14 of the Marine Living Resources Act (2005) allows the management of a fishery via effort controls. This policy permits the minister to extend the allowable effort and accommodate more right holders (as happened in 2005).

The existing control system sets limits on both the number of fishermen and the number of vessels permitted to target squid. Control is also exercised through the use of annual closed seasons. At present, these entail a long closure of approximately three months and a shorter one of just over a month. For the past four years the closed seasons have been April, May, and June, plus 5 weeks over October and November (DAFF, 2016).

Other forms of control suited to inshore fisheries, such as territorial user rights, are inappropriate to the squid fishery. The resource is highly concentrated along a narrow section of the coastline. This is indicated in Figure 1 below, which shows the location of the main fishing grounds of the chokka squid fishery (indicated by black dots), the 60 m contour line (solid line) and the 100 m contour line (dashed line).

Figure 1: The primary fishing grounds for chokka squid (indicated by the dots) off the southern coast of South Africa



Source: K.L. Cochrane et al. / Marine Policy 43 (2014)

The Eastern Cape Province is one of South Africa's struggling regions (Stats SA, 2014). The triple threats of low growth, unemployment, and inequality are urgent priorities in this province, as set out in the National Development plan.

The Eastern Cape's commercial fisheries can be broken down into two sets: largely offshore industrialized or capital-intensive fisheries (such as hake trawls and pelagic purse seine fisheries), and close-shore smaller-scale and more labour-intensive fisheries (such as line fisheries). The squid fishery falls into the latter group.

Commercial fisheries usually exploit high-value species by targeting stocks. Where there has been excessive effort, stock rebuilding may be an important strategy for the commercial industry. Such strategies are in place for the squid industry, as well as for the line-fish, rock lobster and abalone sectors (FAO 2010). These are supported by the recently recommended TAE of 250 000 person-days and a three-month closed season, which has been implemented since 2013 to accommodate the allocated crew complement of 2 422. In addition, a 5-week closed season (October–November each year) has been implemented with the intention of protecting spawning squid and improving recruitment the following year (DAFF, 2016:79).

As practiced in the Eastern Cape, squid fishing uses simple labour-intensive technology. It should therefore be ideal for emergent artisanal fishers and there are indeed rights holders who are small-scale fishers. At the same time, squid harvests are primarily directed to the export market: the money is in the export value chain, and as such the marketing (including supply chain management and HACCP controls) is as important as the catching. As fishing rights come up for renewal, a key question for managers of this sector is, therefore, whether or not some of the effort should be reserved for small-scale businesses. It has to be established whether the small-vessel owners will benefit from this protection or if they just have to sell their catch to the bigger operators in any case.

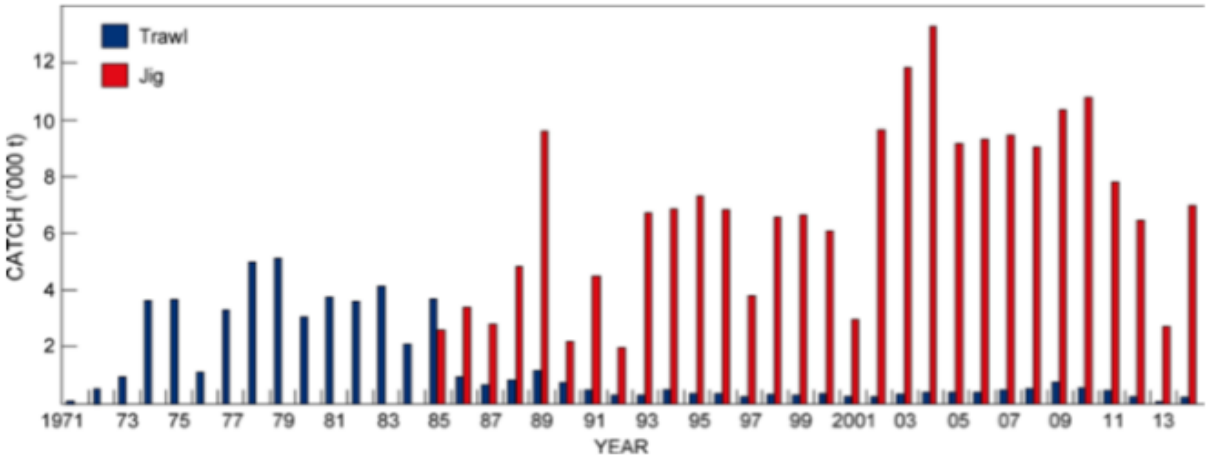
The squid sector, however, is prone to external challenges as it highly exportable relative to any of the other inshore or small-scale fisheries. The focus on export for the squid industry can provide incentive for higher catches. Those sub-sectors that focus on exports, particularly the squid sub-sector, are geographically localized and have high potential as a source of income and employment, if they are properly managed and conditions are good.

To understand the current state of the industry and the impact of the volatility of the squid resource, several factors must be taken into consideration, such as the earnings of fishermen, the number of years spent in the industry, contract types, benefits, and ownership in terms of BEE. Evidence suggests that the current system is not favourable to workers, as 15% of fishermen earn less than R4800 per season during a dry spell (Statistics South Africa, 2015).

Zantsi (2012), commenting on the 2005 rights allocation, stated that ownership rested in the hands of already-established businesses that were predominantly white, leaving only a handful of businesses under black ownership. The current structure of ownership and fishing rights has, however, improved, as this paper will show in later sections.

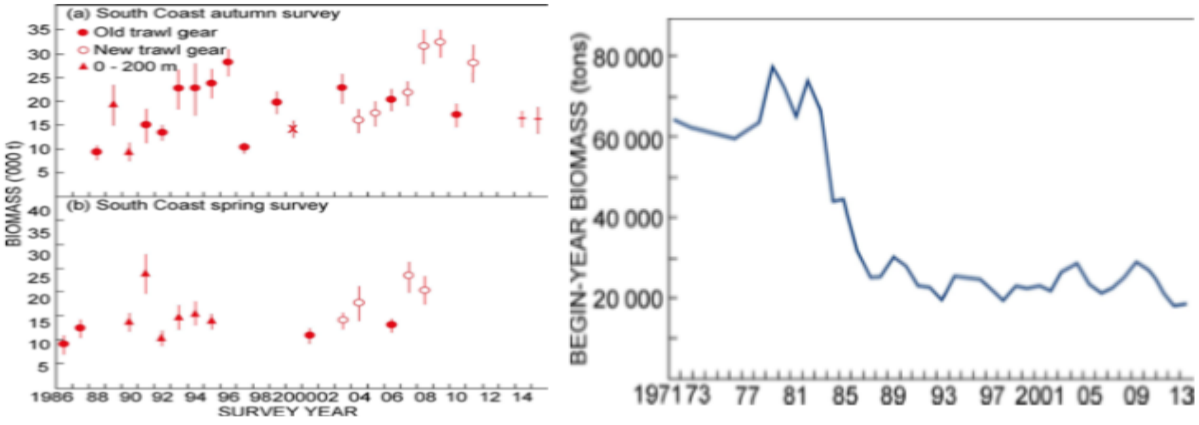
The exploitable biomass of squid on the South African coast appears to be volatile, as shown by the graph below.

Figure 2: Annual jig and trawl catches of Chokka squid (tons).



Source: DAFF, 2016

Figure 3: Survey abundance indices for chokka squid and estimated begin-year biomass, 1971–2013



Source: DAFF, 2016

The squid sub-sector uses hand-operated jigs, making it labor-intensive. Mandating sustainability requires a management strategy that provides sustained employment without ruining the industry for the next generation (DEAT 2005b). DAFF is not only managing a resource, it is also managing an industry. Its mandate is rooted in the Marine Living Resource Act (MLRA) of 1998 which requires, not only sustainability, but also transformation (i.e. a

management strategy that rectifies the historically racialized imbalances of access to natural resources). In order to understand the roles played by each player in the industry, it is important to characterize the three places that are significant to the squid industry.

1.3 Focus areas (Humansdorp, St Francis and Jeffreys Bay)

For a clear understanding of how the squid industry works, we need to first consider the three small centres (i.e. excluding Port Elizabeth) from which it operates: Humansdorp, St Francis, and Jeffreys Bay. The local economies of these centres are dominated by three economic activities: Fishing, Tourism and Agriculture. The three areas have recently started to develop and coordinate regional frameworks and planning institutions in an attempt to promote area-wide economic growth (Kouga Municipality, 2017: ID7). Institutions targeted have included formal and informal business associations, consortia, economic development agencies, and networks, the primary objective being to create jobs.

Table 1: Population Jeffreys Bay, Humansdorp and St Francis, (Sarah Baartman District).

Kouga Municipality				
(Population for the major towns)				
Humansdorp	Jeffreys Bay	St Francis bay	Other	Total
28990	27107	4933	37528	98558

Source: Stats SA, 2011; and Community Survey, 2016

Tourism and fishing are key economic drivers in the three places, providing impetus for linked sectors. Dominating the local fishing sector is the squid fishery. Being a single species whose stock fluctuates severely means that, while the squid industry benefits the local economy, it may also destabilize it.

Economic activities are not distributed evenly across the three focus areas. Jeffreys Bay is more strongly invested in tourism than is Humansdorp, and the port for squid fishing is located in St Francis. Both the squid and the tourism industries in all three focus areas have in the past been volatile. However, since the squid market is mostly international, its demand-side is less affected by changes in local disposable income than by the exchange rate and the condition of economies in traditional markets such as Southern Europe and the Far East. Moreover, the global market is not simply for a generic squid product. Some export markets prefer large squid,

and some small squid; changing demand in specific foreign markets can therefore have implications for product pricing and marketing strategies.

1.4 The Employment Profile

The squid value chain is far shorter and flatter than the value chains of most other export-based fisheries. Consequently, comparatively more of the sector's employment is made up of shipboard jobs, and less of dockside and product processing jobs. Unfortunately, a detailed sector-wide breakdown is not yet available. As an indicator, however, Table 2 below presents a detailed breakdown that shows the composition of the employment of the fishing sector as a whole between 2012 and 2016.

Table 2: Breakdown of the employment of the fishing sector

	2012	**2013**	**2014**	**2016***
Efective Employment Tonnage for HDST	134 722	145 272	144 601	159 321
Overall Employment in '1000 FTE qouta tons	65	65	65	65
Total Employment	8757	9443	9399	10623
Sea based	2189	2361	2350	2612
Shore based	6568	7082	7049	8011
Employment breakdown				
Admin and Management	350	378	376	489
Markerting	175	189	188	217
Sea going	1664	1764	1786	2005
Shore based	2189	2361	2350	2984
Processing	4378	4721	4700	7998
Female	3284	3541	3525	3603

Source: Lallemand et al 2016. The figures for 2016* are the author's compilation using the data from DAFF 2016 and personal consultations.

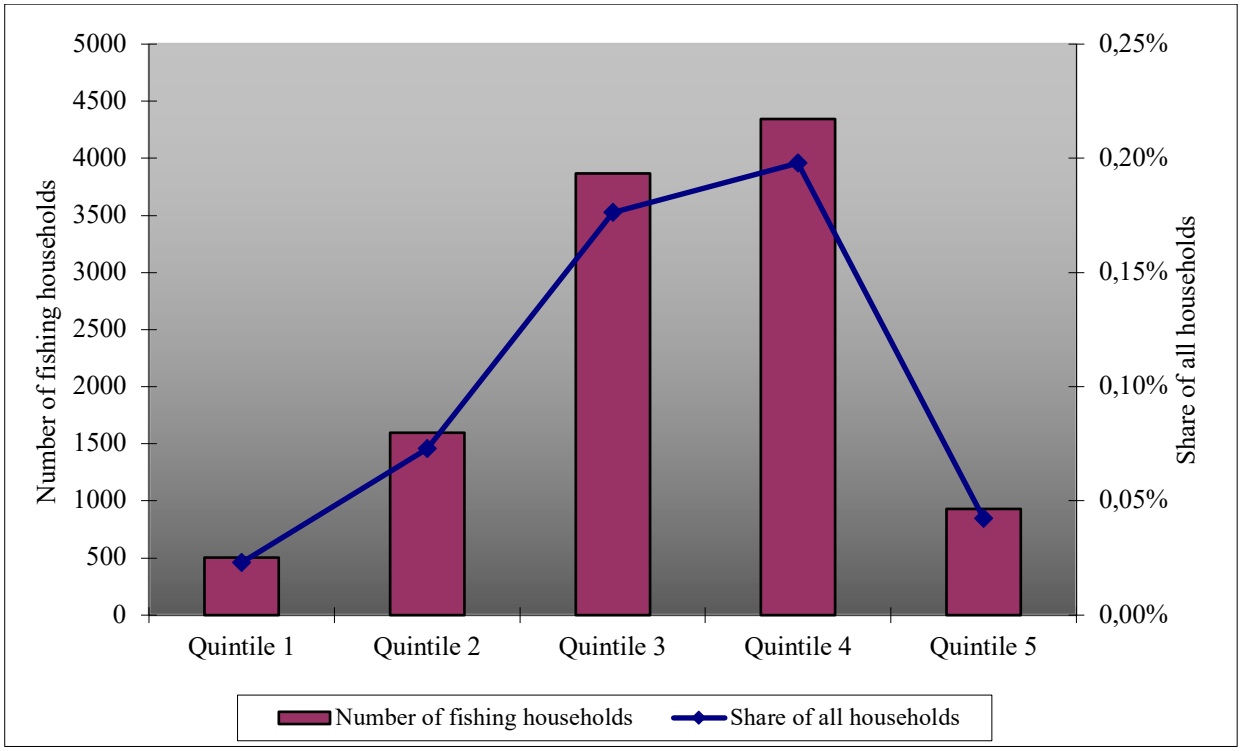
1.5 Household Profiles

A local social accounting matrix is a planned long-run output of this study and is still a long way from being complete. In the interim, data available from the national SAM is being used, with figures related to fishing being the focus of interest.

Interestingly, the household and the factor components given by the national SAM are derived from the merging of the Income and Expenditure Survey (ISSA, 2010/11) with the Labour Force Survey (LFS, 2010). The result shows that households that derive income from employment in the fishing industry unsurprisingly live mainly in coastal areas, providing a large enough sample of the fishing households in coastal areas to justify further analysis.

With respect to the income levels of fishing households, the majority of studies in South Africa indicate that most households fell into the middle-income group. This means that if South African households were to be split into five groups of the same size, in which the income of each household is ranked per capita, then most fishing households would find themselves in quintiles three and four, as shown in Figure 4 below. Figure 4 places Coloured fishing households in quintiles two, three and four, with only Whites reaching quintile five. Black African fishing households are spread across the first four quintiles. [1]

Figure 4: Income quintiles of the fishing households

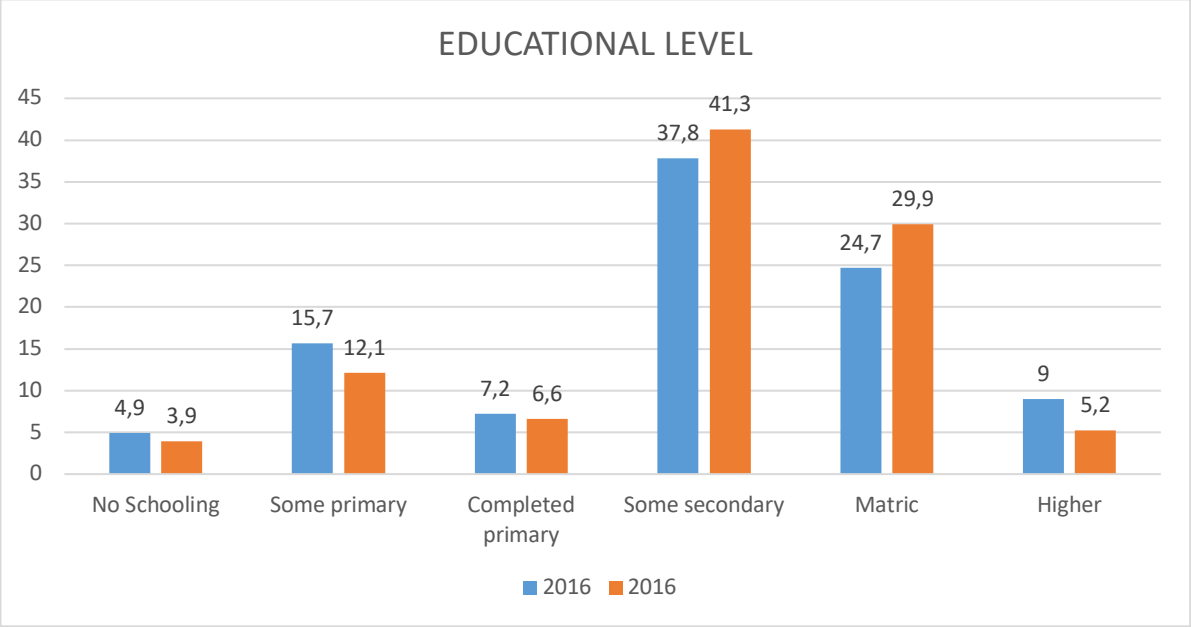


Source: ISSA 2010/11 and LFS 2010

[1] The annual mean per capita income levels in 2009/2010 Rands in these fishing households ranged from R892 ($132.54) in quintile one, to roughly R6 952 ($1032.98) in quintile three and about R132 413 ($19675.03) in quintile five.

1.6 Education

Figure 5: Educational status of residents: Humansdorp, Jeffreys Bay and St Francis



Source: Stats SA, 2011; and Community Survey, 2016

Figure 5 above shows the educational distribution for the three focus areas. These figures are for the general population; it is not yet clear what proportion of these subdivisions are engaged in the squid sector. Labour flexibility and mobility (and to a degree bargaining power) depend on the level and quality of worker education. Other key factors will be the degree of unionisation and the local level of unemployment. There is little evidence of strong unionisation in the focus areas, but the larger firms do have worker representatives. The roles of unions and worker representatives in the negotiation of worker contracts will be an aspect of the ongoing study.

A number of related issues remain. Are the fishermen happy with the *status quo*? What are the implications of employment as a full time or a part time worker (if any)? Do workers in Port Elizabeth (which are purposely excluded in this current study) have a different level of union power than workers in the three focus areas? These questions will discussed in section 4.

2 LITERATURE

2.1 Empirical literature

Most of the existing literature has focused on biophysical aspect of squid. This includes extent of the stock, the influence of the reproductive habitat, the impact of directional changes in coastal currents on squid abundance, and of water clarity and temperature on catch per unit effort (Cochrane et al. 2014). Literature on the economic aspect of the squid industry has, however, been limited, particularly on the relationship between the industry, the broader economy, and the local area.

In the few studies that mention the socio-economic issues facing the squid industry (Harris 2002, Roberts and Sauer 1994, Bergh 2013, etc), there is a general consensus that the squid fishery is an important contributor to human well-being in the Eastern Cape Province, but that, from a BEE perspective, there is scope for further of transformation and equity. The consensus view is that given the lack of experience and capital amongst potential new entrants, the risks associated with rapid transformation in this fishery are likely to be high. Such risks would also follow rapid allocation of rights to communities (in line with the new small-scale fisheries policy). However, they agree that such risks could be mitigated by meeting a number of pre-conditions. These include not allowing total effort in the fishery to increase, adequate capacity-building for new entrants, ensuring effective management by the responsible government authorities, both individuals and cooperatives, and ensuring new entrants have viable long-term business plans (Cochrane et al. 2014; Sauer et al., 2010; Roberts, 2005; Augustyn et al., 1998).

The literature currently has a gap on the socio-economic impact of the resource stock's volatility and the impact on those that are most vulnerable. In the Eastern Cape, the oncoming review of long term rights, together with the new small scale fisheries policy, has prompted debate on the possibility of fishermen, and fishing communities, owning their own boats and being self-employed, with the assistance of the government. Although the notion appears attractive to those seeking opportunities to further racial transformation of ownership, the current format of employment contracts appears to offer a valid alternative.

Under the present system, the captain and crew effectively lease and run the vessel and its permit, in exchange for a share of the catch at a preset price per kg. This form of contract parallels the sharecropping contract in which workers provide their labour and receive access to land in exchange for a present share of the farm's output. Stiglitz (1974) and Cheung (1969) modelled the case of a farm rental contract in which a tenant pays fixed rent for the land and

keeps all the net revenue but also bears all the risk, and a sharecropping contract in which the tenant pays no rent, but shares the net revenues with the landlord, and also shares the risks. For a risk-averse individual, it makes more sense to share the financial risk of a fishing venture with workers. Such a contract, as Stiglitz (1974) and Cheung (1969) suggest, means that the manager does not carry all the risk of renting or leasing the boat. In coming to this conclusion, however, an important proviso is that the terms of the contract should be set in a situation where power is not asymmetric: for any set of power relations, the same basic outcome should apply.

Can the existing contractual system in the squid fishery be further extended to permit captains and crews to form long-lasting cooperative structures, to apply for long-term quota or effort rights, and then to lease a boat on a sharecropping type contract? It would be interesting to evaluate whether splitting the catch with the vessel owner on a fixed ratio, and then being free to sell the remainder to any buyer, would yield significant changes. Under such a contract the owner of the vessel would be effectively renting it to the captain and the fishing crew, who would keep a predetermined proportion of the catch to pay themselves, and would pay rent for the vessel by handing the remainder to the vessel owner.

The political imperative to achieve visible transformation would be addressed by this arrangement. However, the question would remain, could the entire fishery be run in such a way, and, if it were, would the fishermen be any better off? Would transformation benefit the transformed?

An understanding of the operational structure of the squid industry is important because of the role played by domestic and international markets in determining the sector's profitability. Key variables that shape the viability of the industry include exchange rates, the labour contracts in operation, the type of product demanded, product prices, the system of resource management, the extent to which the wild resource has long-term property rights attached to it, the fleet structure, fuel prices, and other running costs such as electricity, maintenance, labour, and general vessel-related expenses. The literature covering these key variables is however, limited, and this is what the current study hopes to address as part of a larger ongoing study.

The viability of the industry hinges on two sets of issues: the first comprise economic variables, and the second resource issues. The economic factors include product prices, fuel prices, and exchange rate, as well as the industry's structure and the effort control process imposed on it from above. The resource issues include the condition and catchability of the resource, their

determinants, whether these have a stochastic dimension, and the role of exogenous environmental variables. This means the link between the health of the stock and the CPUE is driven by variables such as vessel captains' knowledge the resource's extent and location, and their understanding of the significance of other exogenous factors, such as water and weather conditions, that affect the catchability coefficient. Such information is crucial for both managers of the resource, and managers of the companies that harvest it.

Mismanagement of these economic and resource issues could cause the collapse of the fishery. Roughgarden and Smith (1996) make an interesting case on why fisheries collapse and what can be done about it. They suggest that a fishery should be managed for ecological stability rather than allowing harvesting in an ecologically unstable equilibrium. They further expand their case by pointing out that such an ecological stable target stock may be attained either by annual variation in quotas or through taxation of landings. With longer lived species, next year's population often depends critically on this year's escapement. Roughgarden and Smith's approach is, however, less reliable for short lived species whose populations are naturally prone to extreme natural fluctuations. This is the case with squid, a resource for which a season's harvest is less clearly determined by the previous season's escapes.

If the focus is on social rather than ecological conditions, over-regulation can still cause the collapse of a fishery. Zantsi (2012) warns that policy that emphasizes the welfare of workers above the sustainability of companies, is mutually destructive - a trade-off must be made to ensure that companies and workers can co-exist (Zantsi, 2012).

A feature dominating the literature on chokka squid is the catch's propensity to sudden crashes. It is not wholly clear to what extent these parallel the resource stock, the population may be crashing, but it may alternatively be relocating, or its catchability may have fallen. In such a fishery the optimal method of control is far from clear. The ideal method of controlling harvests in a fishery characterized by stock uncertainty has long been a topic of debate. Weitzman (2002) compares the merits of landing fees and harvest quotas using a stochastic model to demonstrate variations in the fish stock under uncertain conditions. Conventional wisdom among fisheries economists is that landing taxes are inferior to quantity controls as instruments. Weitzman, however, argues that a landing fee is always superior to a harvest quota, and stresses that this is especially true when the condition of the resource is unknown ex ante. It is important, in the context of Weitzman's argument, to evaluate what effect a landing fee system would have on the squid sub-sector, especially whether it would be more effective at restricting

effort than the current method. It would be necessary to evaluate whether it can be sustained, particularly if external factors, such as the exchange rate or fuel prices, were to change, and whether it would secure the resource better than a closed season.

Grafton et al. (2006) argue that direct controls are less important than the management of fisher motivation when managing fisheries. They use evidence from more than a dozen natural experiments in commercial fisheries to argue that incentive-based approaches, which better target community and individual harvests, promote sustainable fisheries. They further argue that territorial rights and price ecosystem services, coupled with public research, monitoring, and effective oversight, also promote sustainable fisheries.

In response to Weitzman, a paper by Danielsson (2001) explains the advantages of "catch and effort quotas" in the presence of risk by using a general bioeconomic model. The model addresses the biological dynamics of the fish stock and "catch per unit effort". It develops a method for comparing the efficiency of control variables in a stochastic dynamic programming model which is applied to the management of the fisheries with catch and effort quotas. The lessons on variations in fish stock drawn from this paper can be applied to the squid industry.

2.1.1 Job creation and livelihood

Many rural communities in the Eastern Cape, rely heavily on the fishing industry (DAFF, 2016:78). The structure of the fishing sector, particularly the squid sub-sector, is designed to give income to both employers and employees, creating a direct and indirect connection of the circular flow of income that is powered by a sustainable fishery. It has been argued that free access to fisheries would help the local poor to improve their standards of living, but the common demand that government should give people the right and the ability to fish for subsistence also poses major problems for DAFF. The issue in this case is that the government is supposed to be creating jobs and giving the people access to national assets. However, achieving that speedily will mean that there will be a significant decline in catches (DAFF, 2016:78).

2.1.2 Value chain

Catching squid is only the first step in an industrial value-chain process. Squid has to be frozen, packaged, transported, marketed, and delivered abroad. At each stage the value increases. The process, and the increases in value per kg that accompany it, constitute the squid value chain. A fundamental challenge for small enterprises is that the ability to catch squid does not bring with it the ability to access or control the value chain. In this ongoing study, an estimate of the

slope of the value chain would be useful to establish the selling price for a squid dockside, and evaluating its worth when landed in European markets.

2.2 Theoretical framework

The management of marine resources commonly involves two points of focus: the health of the resource, and the economic rents it can generate. The former requires an understanding of the resource, its life-cycle, its environment, and the natural risks to both. The latter requires an understanding of the industry, its structure, the costs of entry and exit, the points of mark-up along the value chain, the costs of monitoring effort and the harvest, and the determinants of the operational costs and revenue.

The squid sector can be analyzed using conventional stylized models such as the Schafer or Ricker Models, or age cohort approaches such as Beverton and Holt's. However, it will be shown that the means by which the local species of squid is harvested (hand-lining into breeding aggregations) means that a more nuanced analysis is needed.

2.2.1 Gordon-Schaefer Model

The simplest contributing model in applied fishery is the Schaefer model. This particular model focuses on points fundamental to all fisheries with its unique bioeconomic application to the fishing industry. The model can be used to compute the desired maximum sustainable yield by taking into consideration biological growth rates, total costs and revenues, carrying capacity, and marginal costs and revenues for the respective fishing industry.

The important feature of the model is that Gordon's version of it demonstrates how sensitive a renewable fish resource can be to the harvesting process selected (Shah and Sharma, 2003:43-49). Clark's (2010) shows that while open access in itself threatens the existence of rents, open access together with certain characteristics of the species harvested can threaten the resource's survival as well. In particular, the characteristics of these types of species involve aspects of behavior that keep catches as a function of the resource stock. If that is not the case (i.e. a species that can be fished at low cost in breeding aggregations or along narrow migration routes), then open access and low entry cost bring a substantial risk of commercial or even physical extinction, especially where the stock is volatile and difficult to predict, making a TAC-based system an impossibility. What the model shows is that a sustainable strategy will need a limit on effort – such as a closed season.

This is precisely the justification of the control system used for the South African squid industry, and seems to be understood by corporate managers interviewed. However the pattern

of closed seasons causes great difficulty for the crews of squid vessels. In interviews, it soon became clear that the actual fishermen do not understand the background to this system of control, and it causes significant disaffection.

In a nutshell, Gordon's model shows that overharvesting destroys rents. The question of how to reduce effort still remains. Gordon makes some interesting comments towards the end of his article, largely explaining how the models are structured to focus on the market rather than the resource (i.e. fish).

While the model is valuable for mapping economic efficiency, further analysis needs to be done to measure the deep socio-economic impact and welfare measurements.

Age-structured models consider factors affecting biomass through time, such as growth, recruitment and mortality, in a population homogeneously distributed in space and time. These models often follow the approach of Beverton and Holt (1957), and explicitly include the age structure of the population. Beverton and Holt modelling uses a different warning system to predict oncoming collapse, the warning being focused on catch at length data instead of falls in CPUE. This simply means that the greater the number of small catches in comparison to big catches, the greater the risk that the resource is being overfished. The more small individuals, and the smaller the proportion of large ones, in the catch, the closer one is to a collapse

The disadvantage of the management techniques mentioned is that fishermen end up carrying much of the resource risk. This is because they get paid only for what they catch, which means no income on days when they have no catch. The opportunity cost is also high for the fishermen because they would have otherwise spent their time searching for alternative income. Even though fishermen bear majority of the risks, the impact is however transmitted to the population and local business community, because of the decline in disposable income leading to a decrease in the purchasing power of the fishermen and their dependents.

2.2.2 The Input/ Output Model (I/O)

Any attempt to model the impacts of changes in the squid stock that only looks at the fishery itself clearly misses an important issue. In a small local economy, which is heavily dependent on the resource, the fishery has backward and forward linkages that may have far wider effects (Hirschman, 1958). An important question is therefore: are the impacts of variations in the squid stock primarily felt through linkages between the industry and local firms, or through expenditure by workers employed in the industry? To answer this, two tools need to be

developed, an I/O table and a Social Accounting Matrix. In a fully-defined model of this nature it is standard practice to evaluate also the impact of the employment change on household income. As industry income changes, industry participants are able to spend and/or save more, which has a further feedback effect on the production side of the economy. Since this model excludes the feedback effect of industry, the danger exists that the overall welfare effect is underestimated. However, in a fixed-price model there is also the danger that the overall welfare effect is overestimated, since prices adjust as household demand fluctuates, and variations in household demand are not balanced by prices. Our welfare estimates are therefore perhaps conservative, but certainly not underestimated. This is explained further in the SAM below.

2.2.3 Social Accounting Matrix (SAM)

The SAM is a useful tool for most impact studies as it represents the flows of all economic transactions that take place within a country and can also be used in provincial and local analyses. Essentially, it is simply a matrix representation of the National Accounts, which can also be extended to include non-national flows. A SAM is a square matrix in which each account is represented by a row and a matching column, such that each shows the payment from the account of its column to the account of its row. Calibrating a simple SAM model starts with deriving the coefficient matrix. The multiplier formula is therefore: $Z=(1-M)-1E$

This simply tells us that when a particular exogenous demand E increases (for example), then when one accounts for all rounds of direct and indirect linkage effects, the result will be a final increase in total demand equal to Z.

The SAM has advantages, as it can easily be extended to include other flows in the economy and is a relatively efficient way of presenting data, since it can disaggregate a large share of economic activities to smaller groups to show the effect of each group. However, SAMs also certainly have weaknesses. These general limitations result from restrictive assumptions made that all firms in a given industry employ a constant production average of inputs, output, labour, and technology, and produce identical products, so that the model assumes there are no economies or diseconomies of scale in production or factor substitution.

Previous literature shows that there are many distinct approaches that can be followed to examine the overall welfare effects of a change in employment associated with the various export shocks. The disaggregated I/O analysis can be useful if full data is available, and one

can also use different multivariate statistical techniques to arrive at a plausible distribution of employment gains in the economy. A combination of surveys by Stats SA, academics, and Kouga community survey data provides background information about conditions in the fishing sector of the study area. The I/O and SAM models are only mentioned for completeness because this paper is part of an ongoing study, but they will not be used in the current paper.

2.2.4 Welfare measurement

It is common for welfare to focus on household incomes and the prices households pay for a given consumption bundle. The welfare situation in the three focus areas has, however, further dimensions: the income insecurity related to the nature of the wage contract, the instability of the resource and the volatility of the global squid market. The study recognizes that the welfare effects of income are not linked to the mean level, but to the variation around it, and in particular to income insecurity. The I/O model that is briefly outlined above assumes that prices are constant and not open to variation at the whim of the producer (no monopoly power). Although squid prices demonstrably fluctuate, much of the national catch is internationally tradable. Since South Africa is a price taker in the global fish market, it can be argued that this is a fair assumption. The squid fishing and fish processing industries are small relative to the rest of the economy and to the world market for fish. Consequently the welfare impact that needs to be analysed is effectively an income effect, caused by changes in total value added.

An increase in value added can be interpreted in a number of ways. Value added consists of payments for factors of production, and is the product of the employment level and wages, and hence a rise in value added can be interpreted as an increase in wages or employment or both. The question that seems to arise for most researchers is "Which approach is best suited to the South African economy?" Typically, the approach followed allows for skilled workers to be fully employed at flexible wages, while unemployment among semi- and unskilled workers keeps their wages fixed. However, in a fixed price I/O model it makes some sense to allow wages to vary, and consequently we opt for the 'excess capacity' assumption. Given the small magnitude of the shock, it is also reasonable to assume that this excess capacity exists at the prevailing wages for many skill levels. Furthermore, since the fishing industry in particular is fairly low-skill intensive, the demand effect for scarcer high-skilled workers is likely to be small. Once again, this is part of the ongoing study and some of the results of the industry interviews will be discussed in the results section.

2.3 Regulation of the squid-fishing industry

The recent Long-term Rights Allocation Management Process (2015) has strongly allocated some of the squid rights to the collective workers. There is a new reallocation currently under way and acts as an additional source of uncertainty in the industry.

The following table puts the racial composition of the squid sector's fishing rights into an industry-wide perspective

Table 3: Shift of white permit holders to black in the fishing sector.

SECTOR	2001	2005	2009	2017*
Squid	33	48	45	49
Hake Deep Sea trawl	25	27	59	56
South Coast Rock Lobster	72	71	79	64
Horse Mackerel	41	43	38	41
Hake Inshore Trawl	42	48	99	82
Small Pelagics	75	61	51	60
Patagonian Toothfish	40	58	47	60
KZN Prawn Twal	17	63	40	59
Demersal Shark	50	73	86	69
Hake longline	90	91	92	80
Seaweed	43	55	6	14
Tuna Pole	43	55	50	42
West Coast Rock Lobster	60	62	73	70

Source: DAFF (personal communication) & the asterisk indicates the author's calculation for 2017

Table 3 shows the percentage of black ownership in 2001, 2005, 2009 and 2016, as a percentage of rights permit holders with over 50 % ownership allocation / total allocation. In almost all sectors, there has been an increase in the black ownership and the amendment of regulations has been effective. Gaps in the literature and methods still exist, however, and the limitation of the availability of recent data has led the current study to focus more on quantitative measures than on qualitative analysis. This study is therefore essentially a means of gathering and combining the existing information to create a foundation for detailing the entire socioeconomic effect of volatility in the squid industry in the ongoing study.

3 METHODS

This study was exploratory in nature and collected both qualitative and quantitative data. A descriptive design was used to collect information. Such a design is important for the collection of primary data that will be used to inform decisions and recommendations (Creswell, 2009:190).

3.1 Sampling procedure and data collection

The study relied heavily on probability sampling restricted to the squid industry. Probability sampling determined the likelihood of any fishermen in the squid group being selected to answer the questionnaire. Thereafter, a stratified sampling method allowed the researcher to divide the population into groups that differ in many ways (i.e. fishermen, vessel owners, and local businesses).

Interviews were conducted with the 5 major companies (vessel owners) in the three focus areas. The process was extended to include other local businesses (both formal and informal) in the communities.

In this study, the target was limited to three basic groupings: fishermen employed in the chokka squid industry by one of the identified major companies, the management of the vessel owning firms that employ fishermen in the three focus areas, and local (non-fishing) businesses within the communities where the squid industry operates.

The reason for probability and stratified sampling of all three key groups is to observe a representative sample of persons 'interested and affected' by the condition of the squid industry. The study also focused on the fishermen's experiences, as well as on their opinions regarding the issues facing the chokka squid industry. Dividing the targets into three groups allowed the researcher to find the total number of non-executive employees and thus calculate the percentage points in each group. The stratified sampling method required dividing the sample population into subgroups, followed by random selection of subjects from each subgroup (Sekaran & Bougie, 2010).

65 questionnaires were initially distributed to fishermen; 5 companies were interviewed, and 25 local businesses in the focus areas were randomly identified and interviewed. It is important to note that only 60 questionnaires were completed and returned by the fishermen, reducing the number of observations from 95 to 90.

3.1.1 Questionnaires

The first section of the questionnaire requested biographical data; the second part focused on the fishermen's role in the industry and their understanding of it. Lastly, the questionnaires tried to collect information that would indicate the linkages between fishing incomes and the local economy, i.e., their impact in a broader economic context. A copy of the questionnaire that was distributed to the fishermen is contained in appendix 2.

3.1.2 Interviews

Semi-structured interviews were conducted with the management of vessel-owning firms (employers) and with managers of local businesses. The interviews were intended to provide a picture of the industry, the relative magnitudes of costs and linkages to other local firms, the nature of employment contracts, the risks faced by the industry, and the relationship with government. Interviews were also conducted with firms, both formal and informal, that depend indirectly on the health of the squid stock. These attempted to elicit information on the impact of the squid catch volatility on their enterprises, and whether these were direct (as linkages to the industry), or indirect (via employees of the squid sector).

3.2 Data Analysis

The data in this study was analyzed by using descriptive statistic methods with Microsoft Excel. Trek (2016) explains descriptive statistics as methods which are typically used for eliminating data by set of measurement and quantitative data presenting information graphically or in a table. The quantitative method for evaluating the information obtained in this study was the modified Schaefer model. This type of model is tractable and simple, making it useful for heuristic purposes, even if it tends to ignore the underlying natural volatility of species like squid.

The Schaefer model calculations and results largely depended on the establishment of annual catches per unit effort and the data collected about squid catches and effort would allow estimation of the parameters. The 'efforts' in the Schaefer model was calculated using the TAE – the number of allowable fishermen (crew), see DAFF, 2016.

3.3 Ethical considerations

The author of this study obtained permission from the Ethics Research Committee of the Commerce Faculty of the University of Cape Town. The proposal and questionnaires were both submitted to the Ethics Committee for approval and received ethical clearance. The ethical clearance letter is copied in appendix 2.

4 RESULTS

Local information suggests that squid volatility affects the industry's participants in broadly the same way but with different magnitude. We first need to view and observe the trend of the squid catches to analyse the behavior of the players in the industry when the catches fluctuate. This will allow us to proceed with a critical assessment of the information to determine how each agent can best react and intervene. There is a need to study the major key players

responsible for the day-to-day activities of the squid sector as there might be a strong correlation between the role-players and the squid-stock volatility.

Successfully modelling a Schaefer model largely depends on getting the right statistics for the total squid catches, from jig and as by-catch from trawl, as well as squid TAE over the period 2003–2017. The table on appendix 1 shows the published catches, as given by DAFF, from 2003 to 2014. In this, the "catches" for 2015-2017 used the average mean from the data collected when the vessel owners (employers) had to answer a question relating to the catches of the previous 5 years. It should be noted that the bycatch figures do not closely parallel the hand-line catches. Since effort was relatively stable across the entire period, CPUE should have been a good proxy for resource (spawning stock) biomass if the catchability coefficient was stable. This would be determined by water clarity.

4.1 The Schaefer Model

Table 4 below expresses the squid harvest in a Schaeffer format, where CPUE proxies spawning biomass, since the technology targets this section of the squid population.

Table 4: Squid landings (catches), effort and catch per unit effort

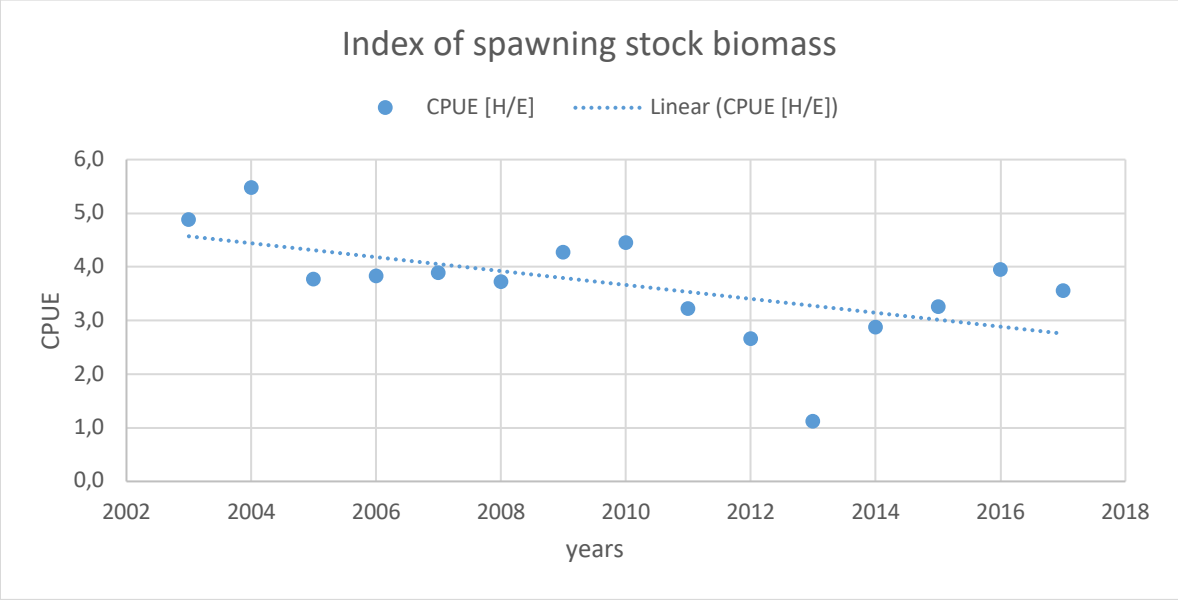
Year	Catch (tons) [H]	Max Allowable Effort (crew) [E]	CPUE [H/E] catch per crew member
2003	11820	2423	4,9
2004	13261	2423	5,5
2005	9147	2423	3,8
2006	9291	2423	3,8
2007	9 438	2423	3,9
2008	9 021	2423	3,7
2009	10 341	2423	4,3
2010	10 777	2423	4,4
2011	7 796	2423	3,2
2012	6 458	2423	2,7
2013	2 705	2423	1,1
2014	6 983	2423	2,9
2015	7 895	2423	3,3
2016	9 564	2423	3,9
2017	8 622	2423	3,6

Note: effort data includes the unrestricted number of crew at sea on a squid vessel
Source: Author's compilation using the data from DAFF 2016 and information (averages) from the companies.

If CPUE proxies spawning biomass, then Table 4 provides a typical general surplus yield model. An important feature of this model is that there is a stock externality: the more effort is applied, the fewer squid are left, and the higher the next fisherman's marginal cost of catching one. The model is inherently stable: in the event of heavy fishing the level of stock reduces,

but in the absence of an Allee effect (depensation), it will always rebound. Figure 6 below shows this in detail using the CPUE and the yield.

Figure 6: The relative magnitudes of the spawning biomass over the period 2003 to 2017.



Source: Author's compilation

The diagram shows major inter-annual fluctuations - the catch is volatile for exogenous reasons, and not because of increased or decreased fishing pressure in earlier years. While the graph appears to show a declining trend, removing the two outliers (2004 & 2013) would leave the trend line almost horizontal.

It would be interesting to work out the predicted yield, but information on the ground strongly suggested that there may be other factors one would need to consider which would be likely to change the function and slope of the model. This is likely to make the function non-linear and therefore one might need a different stochastic model which would capture other information about the squid industry.

4.2 Industry role-players

Given that the squid industry has over the past years generated an estimated amount of R480 million per year, its contribution to the local economy is significant (DAFF, 2016:78). Despite this monetary significance, the volatility in catches has profound implications for all role players in the sub-sector. It is therefore necessary to understand how these risks are shared and mitigated across industry players.

The nature of a firm's contract with its employees is structured so as to share risks. In most South African industries, companies carry the bulk of risk: in a cyclical downturn they cannot lay workers off easily, cannot lower wages, and typically pay wages determined through centralised bargaining. Market conditions, therefore, have limited effects on the conditions faced by employees, though the process encourages labour saving in the economy as a whole. The squid fishery, however, has a labour contract that shares the risk between the fishermen and the firm (Zantsi, 2012). Stiglitz (1974) and Cheung (1969) in the literature on sharecropping contracts, where tenants do not pay rent but share the net revenues and risks with the landlord, suggest that such contracts encourage employment and investment in the industry. Unfortunately, it also means that the workforce's disposable income is unstable; in a bad season it falls and in a good season it rises.

4.2.1 Fishermen

A typical workday at sea begins for the fishermen at sunset when the vessel lowers its lights into the water. They fish, jigging with hand lines, until the following morning. Each worker's individual catch for the evening is weighed before being flash-frozen.

Most of the workers in the fishing industry come from the poorer sectors of the community; in other respects, however, the industry is one of the most diverse in South Africa. Most crew members come from rural areas within the Eastern Cape, Kwa-Zulu Natal, and also a few from Lesotho. Squid fishermen eat and work on the ocean, spending approximately 132 days and nights at sea, making it their second home. Most fishermen agree that there is nothing more enticing and yet enslaving than life at sea, because although they risk their lives, they are still able to earn a source of income to provide for themselves and their families. Although they earn an income at the end of the trip, the costs involved in preparation for sea are sometimes high, especially if the fishermen (rather than the vessel owner) bear the costs themselves (i.e. pre-sea certificate, medical checkup, transport costs, etc.) or where companies deduct these expenses from post-trip payments.

Most squid fishermen do not get paid a set salary, however, there is a statutory minimum wage— it is low, but they still get it if catches are poor. Thus, as catches increase, the pay rises above the minimum, and in a good season they can do well. The norm is therefore a contract which offers a floor wage, but in which actual (catch related) earnings are expected to be greater. This means that there is never a guarantee of a fixed income because the catch is unpredictable. In a bad month, they can earn as little as R300 after deductions, but can bring

home up to R8000 for three weeks of fishing in a good one. In addition, they earn a commission on the crew catch for every kg caught, which can range from R11 to R15 per kg. In large firms, they are guaranteed R90- R110 per day in the unlikely event that they do not catch an average of 10kg per day for the trip.

The bargaining power of fishermen is limited because only half of fishermen interviewed have been unionized. One reason is that differences in the political affiliations of the union heads, and compromised leadership has weakened their bargaining power. During the closed season, most fishermen look for piece-work employment in other low-skilled jobs as they do not have the skills required to transition easily to alternative full-time employments. The data suggest that most settle for construction-type jobs or anything available at the time.

The table below summarizes the findings of the study to give an overall picture of the distribution and characteristics of the fishermen that work in the squid industry. The dependency ratios for the squid fishermen who were breadwinners were calculated by aggregating the number of dependent children (those under 15 years) and of the elderly (older than 65 years) in the families, then dividing that total by each area's working age population and expressing the result as a percentage. In a normal season, the study assumes full employment, therefore the 11.8% is split among the 5 groups, adding 2.36% to each group. The same is done for Jeffreys Bay, with 4.04% being added to each group, and St. Francis (3.16% to each group).

Table 5: Household income and characteristics of sampled squid fishermen and general populations in Greater Humansdorp

	Humansdorp		**Jeffreys Bay**		**St Francis Bay**	
	Sampled Squid fishermen 2017	Stats SA, Survey Consensus	Sampled Squid fishermen 2017	Stats SA, Survey Consensus	Sampled Squid fishermen 2017	Stats SA, Survey Consensus
Number of households	18	5061	23	10 327	19	1665
Average household size	6.3	3.8	8.1	2.5	3.9	2.5
Education						
No Schooling	50%	2.6%	60.9%	4.9%	47.36%	2.6%
Incomplete schooling	33.3%	45.8%	26.1%	61.4%	42.10%	54.7%
Matric	16.67%	34.8%	8.6%	26.4%	10.52%	28.4%
Post-school qualification	0%	16.8%	4.35%	7.2%	0%	14.2%
Dependency ratio	60	56.6	82	57	49.1	49
Working age		63.8%		63.7%		67.1%
Average trips per year	10		11		9	
Average catches (tons)	3		2		2	
Annual income (2017 prices) (for squid						

fishermen in bad seasons)						
< R4 800	54%	15.1%	61%	23%	58%	18.9%
R4 801–R9 600	42%	5.8%	30.4%	4.8%	25%	5.3%
R9 601–R19 600	4%	15.6%	8.65	12.2%	17%	14.2%
R19 601– R38 200	0%	22%	0%	14.2%	0%	20.8%
> R38 201	0%	41.5%	0%	45.8%	0%	40.8%
Annual income (2017 prices In a normal season)						
< R4 800	4%	5.66%	7%	6.84%	10%	6.26%
R4 801–R9 600	26%	8.16%	22%	8.84%	26.4%	8.46%
R9 601–R19 600	65%	17.96%	57%	16.24%	55%	17.36%
R19 601– R38 200	4%	24.36%	9.66%	18.24%	8.6%	23.96%
> R38 201	1%	43.86%	4.34%	49.84%	0%%	43.96%

Note: For the census data, education is for the household head. Source: Statistics South Africa 2011; data collected by Senzo P. Mthembu for 60 squid fishermen for 2017

Table 5 shows how income changes from a bad season to normal one. The information collected suggests that in a bad season, none of the crew members earn more than R19 600 per month. Those that come closest to earning that amount are doing more than just fishing: these include vessel skippers, and fishermen who cook at sea. There is, however, a discrepancy between the earnings reported by fishermen and the full costs of employment that the companies report paying. One possibility is that participants may not respond truthfully, either because they cannot remember, or because they omit less visible aspects of their pay package. They may also misrepresent their earnings strategically, or to enhance their social acceptability. These are well-known weaknesses of self-reporting.

Throughout the survey, an issue that arose repeatedly was the lack of trust between industry participants. Social fragmentation amongst fishermen along racial and tribal lines seemed common, and in some cases reportedly contributed to incidents of violent on board protest over poor catches. A ‘blame game’ seemed an inevitable consequence of poor catches; in some cases, the crew would blame the skipper or vice versa when the catch was insufficient to cover the amount spent on shipboard rations.

The lack of trust also manifests in the relationship between fishermen and companies. Recognizing the problem of zero-earnings in the closed season, some vessel owners offered to provide an income smoothing scheme, but this was rejected by fishermen, who indicated a lack of confidence in the companies. The intention had been to set aside a percentage of fishermen’s earnings, which would then be disbursed as a buffer during the closed season, but opposition by fishermen forced the firms to drop the saving plan.

4.2.2 Companies (vessel owners)

The collected information identified five leading companies, all of which are vessel owners. The five biggest companies in the three focus areas, ranked in order of quantity caught, are Balobi, DMA Fishing, Frontline Seafood Traders, Komicx Products (Pty) Ltd., and Vukani Fishing (Ocean Sun). There are other, smaller, stakeholders in the area, some of whom are new entrants and own small vessels. Discussions with the management of some of these firms indicated an unofficial market in squid permit. There is also a domestic market for squid (from local small operations to larger export-focused processors); this forms part of the value chain. Information also reveals that while some permit holders own the vessel they operate, others do not.

The vessels owners reported in the interviews that 99% of their non-labour expenditures take place in Port Elizabeth; this includes maintenance and other items necessary for the daily running of their business.

The firms interviewed attributed 65% of vessel operating costs to labour, paid in the form of wages to fishermen. The fishermen in turn spend much of this money in the three focus areas. This is critical to the issue of linkages, because it indicates that the impact of the squid industry on the local economy comes via workers.

Risk mitigation is clearly important where the target resource is unstable. This is often achieved by risk spreading, and the exploitation of economies of scale and scope. The big companies are involved in more than just the squid fishery, and typically have a range of permits. During the squid closed season they can continue to fish for hake, snoek, and other fish. Unfortunately, small and new firms suffer from having fewer opportunities for risk spreading. They are less likely to have spare vessels and alternative permit, and the smaller (and older) vessels are less able to cope with good catches when they occur. In this respect the capacity of the flash-freezing system is critical. Smaller flash-freezing systems may mean that good catches are wasted: either the crew stops fishing till there is freezer space, or the catch deteriorates and brings lower prices. All companies revealed that the maintenance of vessels is a considerable expense, and in discussion it was suggested that bigger vessels would only become viable if CPUE rose.

In early 2018, supplying a typical small squid vessel for 21 days at sea required approximately 3000 litres of diesel at a cost of R38 000 (this is before the sharp rises in diesel prices in 2018). Together with food and all the other supplies necessary for the crew and trip, the total cost was

over R60 000. All of the costs are carried by the companies in large firms, but food expenses are sometimes shared with the crew by small firms. To manage these costs, some vessel owners in small firms choose to hire a crew that is particularly vulnerable, which enables them to make significant cash outlays to cover their rations and cooking on board. Companies may also incur additional costs when they choose to send new fishermen for sea-safety training before they start working, but they do not always choose to do so, as the pre-season training is done by an external company. Internal training of new recruits takes the traditional form of "on the job-training", while formal training may be offered through mentorship programmes with established vessels, and seamanship courses for powered vessels.

The squid fishery, with its smaller vessel sizes and its reliance on hand-jigging methods, has a much higher labour/capital ratio than other fisheries. An average fisherman will catch about 2 tonnes of squid over a normal season, resulting in annual wages of R24 000 in 2017 Rands. When catches are low, the data suggests that vessel owners struggle to earn enough to cover the variable costs of each trip, and will still have to pay their fixed costs, which include the minimum wages of the fishermen. This is the case for all firms.

In bad seasons, the distribution of risk between firms and workers varies from firm to firm, and this is apparent in the way their cost structures change between good and bad seasons. For the reasons already mentioned, such as smaller freezers, older vessels, limited alternative permit, and a lower ability to hedge costs and revenues, the revenue volatility of small firms is likely to be greater than that of larger enterprises.

Results from those that were interviewed suggest that in large companies, workers get paid during a bad season regardless of the amount of squid caught. Another way which large and small firms differ is in the duration of the employment contracts they offer. Larger firms having established workforces with secure employment, while smaller firms tend to hire part-time workers on short term contracts. The pay contracts that currently exist have been the subject of much contestation. This is because many are short-term in nature, with little focus on permanent employment. A new standardized contract between the fishermen and the companies is currently being drafted and is expected to be finalized by the end of 2018. This new contract will ensure that both small and large firms offer secure long-term employment. It will also give clarity on issues such as Unemployment Insurance Fund, pension funds and medical aid. Currently benefits such as UIF, medical health insurance, and pension fund are recognized in

medium-term contracts, but these are commonly offered only by large firms, as small firms tend to offer short-term contracts.

During poor seasons companies necessarily adopt loss-mitigating strategies. These also impact workers and local firms. One common such strategy is to reduce the number of days at sea whenever weather or sea conditions appear poor. This strategy affects the incomes of workers directly.

As squid is 99% exported, the prices are strongly determined and sensitive to outside market forces, and companies must always keep in mind the world squid stock and catches, exchange rates, supply, and demand as Zantsi (2012) suggests. The squid fishery in particular is open to fluctuations in many different factors. The history of all squid fisheries shows tremendous fluctuations in abundance and catches. Most vessel owners believe that some of the ecological issues facing the fishery cannot be mitigated. Squid are a short-lived species which can be affected by environmental conditions in a much more drastic way than longer lived species. An entire cohort can be wiped out by an environmental event such as extremely cold water, extremely hot weather, a turbidity event, or similar natural occurrences.

4.2.3 Local businesses

The local squid companies have most of their direct linkages with suppliers and operations in Port Elizabeth. The fishermen, however, do most of their spending locally. Since 65% of costs are labour related, and are contractually linked to the catch, the health of the resource affects local worker expenditure directly. Many of the linkages to the local economy take the form of spending on basic goods and services. Most fishermen surveyed live with their families. To understand how local businesses are affected by squid volatility, consider the implications for the local economy if the resource crashes. As shown in figure 2, the resource is known for its volatility. The link between the resource and the local 'non-fishing' economy is direct. Though the bulk of corporate expenditure tends to occur in Port Elizabeth, workers' wages, which make up roughly 60% of operating costs, are spent locally. It is therefore no surprise that the local economy suffers when catches are poor into the local towns.

Information from the interviews reveals that the worst year ever for businesses was during the 2013 fall in the squid stock, during which a number of local businesses reported having had to let go of workers, whilst some closed down, multiplying the local loss of income. Discussants reported that fifteen local businesses were either bankrupted, or so indebted as to temporarily

close down.[2] When businesses were asked how to mitigate the impact of low catches, most replied that not much could be done on their side.

4.2.4 Recommendations

There is no doubt that management of the squid resource through closed seasons and restrictions on total allowable effort and imposes on short term hardship on squid fishermen and local firms. However, there are no realistic alternatives to these tools. Fishing into breeding aggregations has advantages, but sustainability unfortunately requires the existence of 'no-take' periods. While this is well understood by management, it is not widely grasped by the fishermen themselves, and seems a cause of deep resentment. A low-cost and important intervention would be a simple scheme to educate fishers as to the reality of the problem. It is difficult to compare the fishing industry, particularly the squid industry, to other industries (e.g., the mining industry). A complete policy framework for the squid industry would need to involve more education for all role-players, especially the fishermen. It would also need to include command and control regulation, by setting a quota for number of fish that could be caught, adding a fiscal policy (tax) in the form of a "Per unit tax" on the quantity of fish caught, and lastly, using an Individual Tradable Quota (ITQ) which would determine the optimal harvest and the number of licenses, auction or grandfathering that allows license owners to rent (one or multiple years) or to fish for multiple species.

The issues raised in the chokka squid industry, at least for now, include two imperatives: to ensure sustainability and to achieve transformation. Viewing it in surplus production terms, it is established that the resource has already been mined below B_{MSY}, any further allocation of fishing rights would therefore have to be at the expense of existing operations. There is a zero-sum dimension to this problem. The question arises: would there be any benefit to adding further control systems to the present use of TAE and closed seasons?

Economists tend to favour taxes over command and control techniques, arguing that they are both more effective and more cost-efficient. A lump sum tax, on the vessel or as a license fee, is supposed to be non-distortionary and therefore may appear particularly attractive. A tax can lead to a static-efficient sustainable yield allocation because the tax revenues represent transfer costs and not real-resource costs. These transfer costs might involve the transfer of resources from one part of society to another. On the other hand, a tax represents an increase in costs,

[2] These unrecorded numbers were given in conversation and are unverified, but are indicative of perceptions amongst local enterprises.

and taxes tend to be shifted. Since they cannot be shifted forward into the international market, they are likely to go backward - and would not be sustainable as the fishermen, who are the least able to pay, would be the ones most affected.

South Africa uses Individual Quotas in many of its fisheries, but these are not officially tradable. For squid, however, they are effort quotas rather than catch rights. As indicated earlier, trade in IQs does take place in reality. If this practice is legalized, it has the potential to increase efficiency and plausibly state revenues since, in the next round of rights allocations, permits could be grandfathered or auctioned, or possibly a mix of the two.

With regard to the fishermen, if we consider Marx's definition of pure socialism as from each fishermen according to his ability and to each according to his labour, this would require an analysis of whether the new labour contract that is to be enacted in 2018 is fundamentally socialist in nature. The weakness in this hypothesis is that effort is constrained, so that factors cannot be added to reach an equilibrium. The controller of the capital is still able to dominate the functional distribution of income. It would be interesting to see if it would be any different if workers themselves received the permit and vessel owners had to bid against each other for these workers (and the permit they owned). In theory, this would be beneficial, but the community of fishermen is unstable and the process seems unworkable.

The 'share contract' would appear to remain the best remuneration system for the industry. Currently, there are no feasible ways to address the three important factors that influence the share contract in South Africa: the risk appetite of the vessel owner (risk adverse or neutral or taker), the competitive labour market, and regulation in the sector. With the share contract, the vessel owner can spread some of the risks to the crew, reducing the risk cost.

Proposing key reform structures in the squid industry of the Eastern Cape would be less effective if the problems of adverse selection and moral hazard are not clearly recognized. If quota is given to new entrants who do not have vessels, they might go into partnership with foreign vessel owners. This is a risk in all of South Africa's fisheries. Should South Africa have foreign vessels in its waters, other serious problems are likely to follow. This might be even more problematic if such vessels hire foreign crew. Since the fish is caught on the sea, this is a situation where a coastal water state (the principal) contracts with the distant water state (agent or fishing companies) to do fishing in the water under the jurisdiction of the coastal water state. The principal might not always know the right type of the agent, which it is usually assumed are of two types: low-cost and high-cost agents. In short, this creates space for illegal landings

and catch distortions. This usually occurs when moral hazard is associated with the catches that are reported. Fishermen and owners have private information about their catches. Monitoring and observing catches is in many case too costly and is often not done efficiently in the Eastern Cape. Because accurate information about real catches is important, there is an incentive problem when the information is kept private. If the total real catch is higher than the level set by the regulator, there may ultimately be an unsustainable harvest level, leading to direct short- and long-term economic losses. Since the true "real" catch remains unknown, the assessment of the level of stock will be uncertain, leading to a situation where the assessment of a current stock is different from the real and existing stock. This has implications for policy formulation. Policies are formulated as a function of the state of stock biomass and other measures might need to be introduced to deal with the squid industry in the Eastern Cape properly.

For future in-depth research, a study is needed that would employ a correctly extended input-output model and correctly specify the SAM method. Although the present study was aimed at understanding the industry and the key role-players, it would be useful to get as many observations as possible for any future study. This will allow the future study to use statistical methods of analyzing the areas concerned. Also the present study ignores Port Elizabeth, which is where the majority of fishing expenditure by the companies takes place.

Getting the right policies to mitigate the problems of depleting stock faced by the chokka squid industry can be complicated. The industry has two closed seasons, and any proposal of additional longer periods of non-fishing is likely to make both companies and fishermen poor. A strategy is needed to catch the chokka squid when it is in abundance, and such a strategy must be in line with the Schaefer model that suggests that there is less effort when the resource is scarce. The economic viability of sending boats to sea strongly influences the decision of whether to fish (apply effort) or not. Local businesses see the closed seasons as painful but interesting, as they believe it might be the best plan currently since it appears to be working. This could, however, just be a coincidence and we would need a longer period of assessment to be able to respond with any degree of confidence.

5 CONCLUSION

The chokka squid industry is a small but valuable fishery. The study focused on three areas: Humansdorp, Jeffreys' Bay and St. Francis. The analysis of the chokka squid industry highlighted the key role-players and the additional momentum provided to local. Problems facing the squid industry cannot be easily mitigated, but the industry needs proper planning

and management. The results suggests a strong message to the resource decision-makers in a political setting: that it is possible for all agents to facilitate and support the industry, and to work together to ensure that thousands of jobs are rescued, by avoiding the depletion of the squid stock. To do this will contribute immensely to reducing poverty in these three areas. The threat is not from fishermen, nor from companies, as the resource is managed and the system of closed seasons secures it. However, before any attempt to extend rights to new entrants, a politically tempting prospect, it is necessary to recognize some fundamental realities of the impact caused by the high volatility of this resource. Collective action problems beset all area-wide initiatives. As this is the first phase of an on-going study, there is a need to conduct future research on area-wide initiatives, including a survey of fishermen from Port Elizabeth, which might need better statistical methods able to handle large data, giving a less unbiased and more robust results. These might include a quantitative approach to analyzing the data. Above all, it is also critical to the health of the stock being harvested, keeping in mind that while one can invest in vessels, one must also invest in the fish themselves, and letting a depleted stock recover may be much cheaper, and may offer a better return, than buying more boats.

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7 APPENDICES

Appendix 1: Squid catches in the period of 2003-2014

Year	Squid jig catches	Squid landings as bycatch from hake trawl	Squid TAE
2003	11 820	338	2 423 unrestricted crew* 41 restricted crew*
2004	13 261	391	2 423 unrestricted crew* 41 restricted crew*
2005	9 147	374	2 423 unrestricted crew* 22 restricted crew*
2006	9 291	358	2 423 crew or 138 vessels, whichever occurred first
2007	9 438	496	2 422 crew or 136 vessels, whichever occurred first
2008	9 021	523 ń	2 422 crew or 136 vessels, 2 422 crew or 136 vessels, whichever occurred first
2012	6 458	227	2 422 crew or 136 vessels, whichever occurred first
2013	2 705	61	2 422 crew or 136 vessels whichever occurred first
2014	6 983	213	2 422 crew; vessels commensurate with number of crew

Source: Status of the South African Marine Fishery Resources 2016

Appendix 2: Ethical clearance letter

Faculty of Commerce

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07 August 2018

Mr Senzo Mthembu
School of Economics
University of Cape Town

REF: REC 2018/008/069

Dear Senzo Mthembu,

The Socio-Economic of the squid stock volatility in the Eastern Cape Province Of South Africa

We are pleased to inform you that your ethics application has been approved. Unless otherwise specified this ethical clearance is valid for 1 year and may be renewed upon application.

Please be aware that you need to notify the Ethics Committee immediately should any aspect of your study regarding the engagement with participants as approved in this application, change. This may include aspects such as changes to the research design, questionnaires, or choice of participants. The ongoing ethical conduct throughout the duration of the study remains the responsibility of the principal investigator.

We wish you well for your research.

Modie Sempu
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Appendix 3: Questionnaire

RESEARCH TOPIC: *THE SOCIO-ECONOMIC IMPACT OF THE SQUID STOCK VOLATILITY IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA*

Semi-structured interview

I am conducting a research based on the above mentioned topic within the University of Cape Town, School of Economics. The purpose of this research project is investigating the extent and adaption measures to social and economic impacts through understanding the structure and economics of the industrial side of the fishery, assessing of the low catches on the industrial and fisher components and give recommendation of potential mitigation measures for periods of low catch. I would be grateful if you would assist me by allowing me to complete this questionnaire/semi-structured interview on you as it will not take more than 15 minutes to complete and I bind myself that the information you shall provide will only be used for this academic research and will be highly confidential. Your participation in this research is voluntary. You can choose to withdraw from the research at any time. This research has been approved by the Ethics in Research Committee of the Commerce Faculty of the University of Cape Town.

SECTION A: BIOGRAPHICAL INFORMATION

INSTRUCTIONS TO RESPONDENT
This semi-structured interview must be answered by people working (fulltime/part-time) in the squid sector only Unless instructed otherwise, please complete by marking an X in the appropriate shaded block.

1. RACE					
1	2	3	4	5	6
BLACK	COLOURED	INDIAN	WHITE	OTHER	PREFER NOT TO SAY

Tribal affiliation (if any) _____

GENDER		
1	2	3

MALE	FEMALE	PREFER NOT TO SAY

3. DATE OF BIRTH:

4. FIRST DATE OF EMPLOYMENT AS SQUID FISHER

5. NATURE OF POST?		
1	2	3
FULLTIME	PART-TIME	OTHER

If **OTHER** please specify _____

6. WHAT IS YOUR LEVEL OF EDUCATION?	
No schooling	1
Primary	2
Secondary	3
Tertiary	4
Other (Specify)	5

7. HOW MANY PEOPLE ARE RESIDING IN YOUR HOUSEHOLD?			
1	2	3	4
Less than 3	4 - 6	7 - 10	More than 10

8. ARE YOU THE ONLY BREADWINNER IN YOUR HOUSEHOLD?	
YES	1
NO	2
9. IF YOU ANSWERED NO TO Q8, HOW MANY OTHER INCOME EARNERS ARE THERE IN YOUR HOUSEHOLD?	

	1

10. HOW MANY DEPENDENTS ARE THERE IN YOUR HOUSEHOLD?	
	1

11. WHAT IS YOUR AREA OF RESIDENCE(S) AND ADDRESS(ES) FOR THE MOST OF THE YEAR?	
Rural area	1
Urban area	2
ADDRESS:	3

Municipalities: _____

SECTION B

1. What is your job responsibility in the squid industry?

_____

_____

_____

2. a) In the last 6 months prior to working here , did you work fulltime?

_____

b) If yes, please describe the job you held.

_____

_____

3. Do you enjoy this job you are doing or is it because there is no better alternative?

_____

_____

_____

4. Which of the following options provided below best describes the situation in the squid industry?

There is no crisis in the squid industry, there is job security and the media is overreacting.	
A crisis exists and is causing a threat to job security, the productivity of the region and the country. A crisis of this type needs to be addressed at the national level through effective policy planning and the development of strategies for awareness education and vocational training.	
A crisis may exist but it is not that serious and everyone's job is secured thus, there is no sense of job insecurity.	
NONE OF THE ABOVE	

5. In your view, is the government doing enough to uplift the lives of general fishermen in this region?

YES	
NO	
NOT SURE	

If Yes or No, give a reason for your response

6. How many trips do you make in a year and how long was your last trip?

7. In the boats you have worked in, is there a basic wage or salary before "catch bonus" (How salaries are organized)?

8. In the last year or season, what was the most, least and average catches of squid by any other fishermen?

Most	
Least	
Average	

9. From the time you started working, what has been the variation in your catches?

10. In your own understanding, how much does the best and average person earn?

11. During the closed-season, what do you do? (What do you spend your time doing and where?)

12. Do you have an alternative job or other means of getting money (between trips and in closed-seasons)?

13. What programmes and trainings do you think can be implemented to improve the lives of fishermen?

14. If you were not able to fish, what would be your next best job?

THANK YOU