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INTRODUCING VESSEL MONITORING SYSTEM IN THE COMMERCIAL TRADITIONAL LINEFISH SECTOR IN SOUTH AFRICA

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ABSTRACT

Fisheries management is a necessity to ensure that the society realises the potential of its fisheries to create rents. Lack of management will result in irreversible damage of fish stocks as they may be severely depleted due to overexploitation. In 2007, overexploited global fish stocks were estimated at 28% with 50% fully exploited and 20% moderately exploited. To prevent the over exploitation of fish stocks, governments apply restrictive measures (regulations) and monitor compliance with such regulations. Vessel Monitoring System (VMS) is one important tool to allow governments to monitor fishing vessel activities in near real time and detect infringements with regulations. South Africa has elected to introduce VMS in the commercial Traditional Fish Sector (TLFS) following reports of stock decline. The introductory process failed due to lack of planning. Costs and technical attributes of the VMS were some limiting factors in the introductory process. Cost benefit analysis conducted in reviewing the process suggests that the introduction of VMS in the commercial TLFS has negative benefits and should be suspended. Focused monitoring directed to vessels responsible to vast amount of catches proves to be a solution to redress the situation. The range 16% to 24% of the fishing fleet accounts for 60% to 75% of reported catches respectively. Monitoring should, therefore, focus on these vessels.

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1 INTRODUCTION

The tendency for overexploitation of renewable resource such as fish is well known and documented. Fisheries management is a necessity to ensure that the society realises the potential of its fisheries resource to create rents. It is also important to avoid irreversible damage to severely depleted stocks where no proper management is in place (Arnason *et al* 2003). Fisheries management requires a collective government and fisheries resource users' intervention. Food and Agricultural Organisation (FAO) in 2007 estimated that 28% of global fish stocks were over-exploited and 52% fully exploited with 20% moderately exploited (FAO 2008).

In order to prevent over exploitation of fisheries resources fisheries management authorities (usually governments) apply different policy tools such as catch quotas (Total Allowable Catch-TAC) and fishing effort limits (Total Allowable Effort-TAE). For selected tools to be effective they must be enforced (Arnason 2006). Enforcement requires extensive monitoring resources such as personnel, sea patrol vessels and air patrol crafts (Chang *et al.* 2009). Monitoring resources are often limited and costly, making it economically important to apply enforcement activities close to optimal level (Arnason 2006).

One important tool for fisheries management is satellite or remote Vessel Monitoring Systems (VMS) (Chang *et al.* 2009). VMS allows fisheries management authorities to monitor near real time movements of fishing vessels from land-based stations. As a result the legality of the catch with respect to fishing area can be verified and fishing effort can be more accurately estimated. VMS further provide for directed vessel inspections when infringements are detected thereby limiting the costs of routine patrols (FAO 1998).

The fisheries management authority in South Africa has selected the VMS as a fisheries management enforcement tool and introduced the system in the commercial Traditional Line Fish Sector (TLFS) in 2007. Although the VMS had been successfully introduced in other fisheries sectors in the country, challenges have been observed following its introduction to the commercial TLFS. Included in recognised challenges was the affordability (costs) of the VMS, the technical attributes of the VMS units and the availability of VMS supplies.

The current study intends to outline the fisheries management authority's objectives and process approach in introducing the VMS in the commercial TLFS. The challenges faced will be tabled and a review of the introductory process will be conducted. A standard cost-benefit analysis (CBA) will be applied in an effort to estimate monetary benefits of the introduction of the VMS. Recommendations will be provided based on the VMS introduction process review and the results of the CBA.

2 BACKGROUND

This section contains a brief description of South Africa, the country's population dynamics and economy profile, to set the background for the current study. Fisheries and fisheries management in general in the country will also be presented. Finally a separate description of the commercial TLFS will be offered.

2.1 South Africa (description, population dynamics and economy)

South Africa is the southernmost country on the African continent. The land area is approximately 1.2 million km^2 with an estimated 49 million inhabitants (CIA 2009). The country is bordered by Namibia, Botswana and Zimbabwe in the north with Mozambique and Swaziland situated on the northeast. The Republic of South Africa (RSA) completely encircles the Kingdom of Lesotho in the southeast (RSA INFO 2009) (Figure 1).

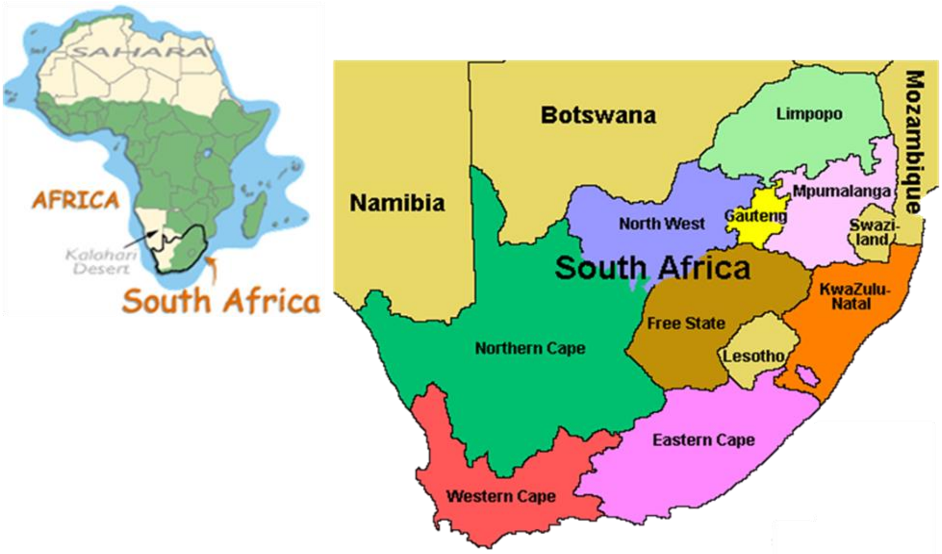


Figure 1: Map illustrating South Africa in the African continent and neighbouring countries.

South Africa is a democratically governed developing nation. The government is operating in terms of a constitution adopted in 1997. The country has three capital cities, Tshwane/Pretoria (administrative and executive capital), Bloemfontein (judicial) and Cape Town (legislative).

The economy of South Africa is referred to as an emerging market with vast supply of natural resources. The country has well developed financial, legal, communication, energy and transport sectors. Modern infrastructure further supports efficient distribution of goods to urban centers across the country. South Africa is the world's largest producer of platinum, gold and chromium and has a stock exchange that is the 17th largest in the world (CIA 2009). The currency is South African Rand (R) currently trading at an average R7 to the US Dollar (R7 = US$1). The unemployment rate is regarded as high, estimated at 23% in 2008. It is estimated that 40% of the South Africans live below the poverty line (earning less than R352 per month) (SSA 2009) with crime and HIV/AIDS also compounding social problems.

2.2 South African waters

South Africa lies at the junction of two major currents and two oceans; the warm Agulhas current on the east (Indian Ocean) and the cold Benguela current on the west (Atlantic Ocean) (Figure 2). The effects of the currents are apparent along the coastal areas with the coastal areas relatively warmer in the east as compared to their cooler western counter parts RSA INFO (2009).

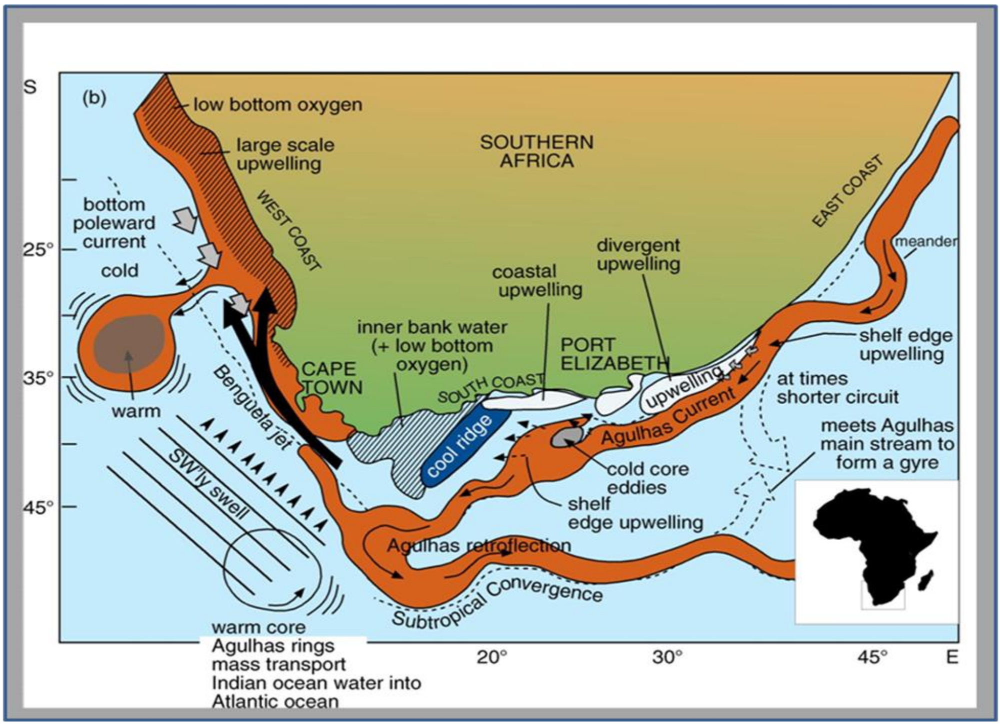


Figure 2: Ocean circulation around South Africa (Verheye 2006).

Contrasting oceanographic conditions are observed on the east and west along the country’s 3200 km coastline. The Benguela current region on the west of the country is one of the world’s major upwelling and systems. The Benguela is highly productive and in its nature supports diverse and abundant marine life from plankton to economically valuable fisheries resources. Fisheries resources in these waters include small pelagic fish (anchovy and sardines), cape hakes (*Merlucius spp.),* rock lobster and various Linefish species (tuna, snoek, yellowtail etc.) (Hutchings *et al.* 2009). It is as a result of the Benguela current that the west coastal region has developed fishing industry operations that include fishing vessels, fish processing factories and fishing harbours.

2.3 South African fisheries general

The South African 200 nautical miles Economic Exclusive Zone (EEZ) was declared in 1977 providing the country with effective control over her fisheries resources (JAPP 2001). The South African fishery is composed of three distinct fisheries sectors namely commercial, subsistence and recreational. The legislation provides for no sale of fish in the subsistence and recreational sectors. For the purpose of this study attention will only be given to commercial fisheries sector and its management. Fisheries sector refers to a category of fishery determined either by targeted species and/or employed harvest methods. Presently there are 22 commercial fisheries sectors with operators inclusive of companies and individuals.

The total fish production was 484 268 tons in 2008 a 17% decline from 2007 recorded landings. The value of the fishery was estimated at R5.6 billion in 2008. Most caught fish are the small pelagics (anchovy and sardines) accounting for 62% of recorded landings in 2008. The most valuable fishery in the country is the demersal fishery (mainly cape hakes) responsible for 48% of the total fishery revenues (Figure 3) Fishing in South Africa is very important and granting access is always a challenge due to a political bearing. However though contested and important, fishing contributes less than 1% of the country's GDP, a 0.2% in 2008 (DEAT unpublished data).

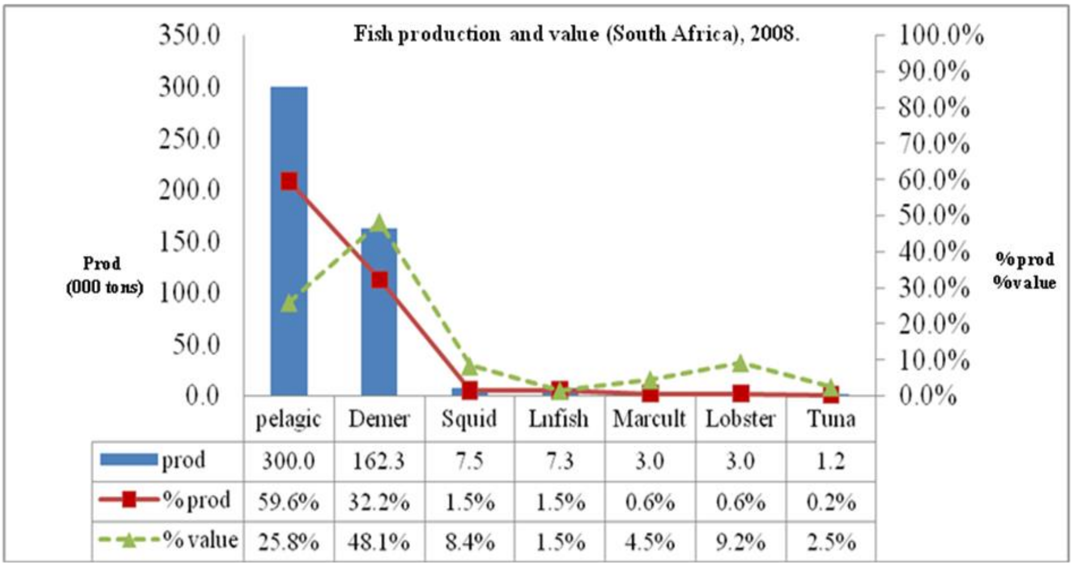


Figure 3: Fish production (South Africa) 2008 (excluding seaweed) (legends: Prod= production (000 tons), pelagic=small pelagics, Derm =Dermesal, Lnfish=Linefish, Tuna (includes swordfish)).

Fisheries are administered in terms of the Marine Living Recourses Act of 1998 (Act 18, 1998), the "MLRA". The MLRA sets out principles to promote orderly exploitation of marine living resources and to exercise control over the resources in a fair and equitable manner to benefit all South Africans. The management authority is the Department of Environmental Affairs (DEA), the "department".

The MLRA provides that commercial fishing operators must be granted fishing rights either medium term (less than five (5) years) or long term (in excess of five years currently up to fifteen (15) years). The fishing right grants stipulate the initial Total Allowable Catch (TAC) and/or Effort (TAE) that is reviewed annually for the duration of the fishing right. Subsequent to grant of fishing rights operators are issued with fishing permits for a given fishing season not exceeding a period of twelve (12) months. All permits are issued with permit conditions detailing how the permit must be utilised, spelling out legislation (e.g. fishing area and/or catch restrictions) and other processes (including administrative responsibilities) to be adhered to. Commercial fishing vessels are registered and issued with fishing vessel licenses.

All transactions are subject to an application process and payment of fees, which include a levy fee per mass of fish landed. Fishing rights are transferable on approval by the department. Monitoring Control and Surveillance (MCS) exists to enforce legislation and monitor compliance by operators. The MLRA further provides for the revoking, suspension of fishing rights or payment of penalty fees when act(s) of misconduct by operator has/have been identified. Figure 4 provides a summarised institutional framework for the management of commercial fisheries.

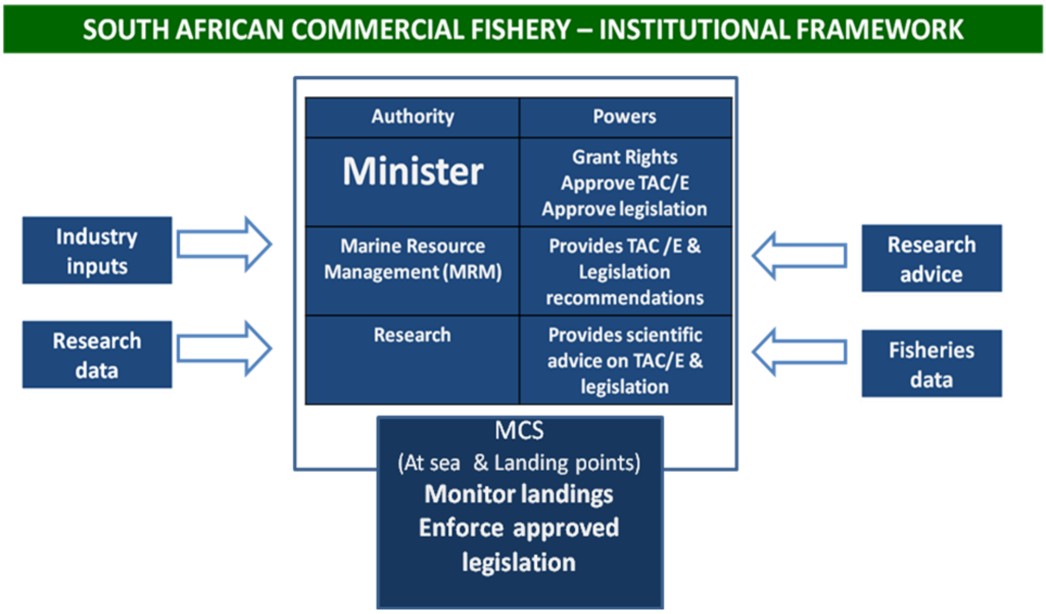


Figure 4: South African commercial fishing institutional management framework.

3 THE COMMERCIAL TRADITIONAL LINEFISH SECTOR (TLFS)

3.1 Description of the commercial TLFS

Line fishing in South Africa includes various line fishing methods applied worldwide. These methods utilised are long-lining and simpler methods such as hand held lines or rod and reel with baited hooks. Long-lining employs capital intensive operations which involve larger vessels and sophisticated technology (Sainsbury 1996). South African long lining operations target high value species mainly offshore and in the high seas. Targeted species include tuna, swordfish, patagonian toothfish and hake.

Fishing with simple lines (hand held or on rod) with baited hooks is one of the traditional methods applied in the fishery. These methods have changed little over centuries and are common type of harvesting in remote areas (Sainsbury 1996). In South Africa these methods are typical of commercial inshore linefishing and are referred to as traditional, making a distinct identification from other linefishing methods. This distinction has led to the origin of the commercial TLFS.

3.2 History of the commercial TLFS

The origin of boat based line fishery is traced back to fishing activities of the European seafarers in the 1500s. In 1652 restrictions were imposed in the fishery by the Dutch following their colonisation of the Cape. Despite the abundance of fish the imposed restriction resulted in slow development of the fishery. In 1795 the British captured the Cape colony from the Dutch and lifted all restrictions. Subsequently boat based linefishing became a thriving industry in the mid-1800s (Griffiths 2000) operating row and sailboats (DEAT 2003).

First attempts to manage the commercial TLFS were date back to 1940. Notable was the introduction of a management framework in 1985 following a decrease in catch trends during the latter half of the 20th century and an increase in fishing effort. Restrictions and controls included in the 1985 management framework were commercial fishing licenses (fulltime-A category and part-time-B category) and revised minimum size limits equalled to size at maturity. The management framework also provided for a division of the species into categories based on apparent exploitation vulnerability (i.e. more vulnerable reef species and more resilient shoaling species). Bag limits and closed seasons for some species were introduced and the effort was maintained at the 1985 levels (Griffiths 2000).

Despite the imposed restrictions catch rates of many species have continued to decline, stock assessments indicated that so-called more resilient species were severely over-exploited. Research surveys reveal that the regulations have failed to provide substantial measure of resource protection. It is argued that either the restrictions themselves were not limiting or they may have been poorly enforced (Griffiths 2000). As a result of declining stocks and the increasing claim for access in the fishery a substantial revision of the management procedure became necessary to prevent possible stock collapse. A new commercial TLFS management protocol was installed (DEAT 1999).

In response to the reported status of traditional Linefish stocks, and the proposed management protocol, the Minister declared an emergency in the fishery and effort was reduced by 70% to 455 vessels and 3450 crew (DEAT 2000). Effective enforcement and monitoring became a necessity in order to restore diminishing fish stocks.

3.3 Resource users today

In the commercial TLFS fish are caught from small open boats (single outboard engine or non-motorised), ski-boats (single or twin outboard engines) and a few larger deck-boats (diesel inboard engines).

In total 455 long term fishing right (10 year right) holders were allocated rights in 2006. Effort limitations are set at 455 vessels and 3450 crew. The vessel capacity profile (size categories) is illustrated in Figure 5. Right holders are limited to utilise one vessel and no more than one right holder is allowed to harvest from a single vessel (DEAT 2005). Approximately 82% of the right holders partake (Right Holders issued with fishing permits) in the fishery in any given year (fishing season) and 6% of the allocated rights were never activated (Right Holders not issued with fishing permits).

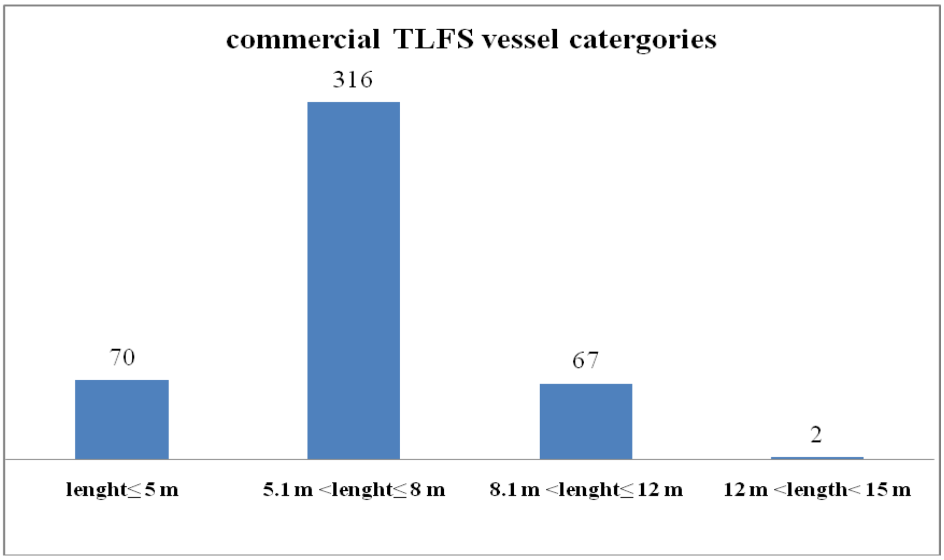


Figure 5: Commercial TLFS vessel category profile.

3.4 Fisheries resources and management measures

About 40 teleosts species are targeted and 20 may be regarded as economically important (Griffiths 2000). Right Holders are requested to compile, file and send records of catch and effort data to the department on a monthly basis. Nil records are also mandatory for periods when no fishing is conducted. These data returns include the particulars of the vessel, days fished, area fished, number of men fishing on a particular day or trip and the amount of fish caught (weight of individual fish species or species group). Most commonly caught species include Snoek (*Thyrsites atun*), yellowtail (*Seriola lalandi*), geelbek (*Atractoscion aequidens)* and kob (*Argyrosomus* spp). (Griffiths 2000). Size limits, bag limits and closed seasons are set for various species. Marine protected areas are declared, amongst other objectives for the protection of linefish species.

The right holders are further confined into regional management zones. There are three regional management zones described for the fishery namely Zone-A (Port Nolloth to Cape Infanta), Zone B (Cape Infanta to Port St. Johns) and Zone C **(**KwaZulu-Natal). Figure 6 illustrates the management zones and their current allocations and number of approved landing sites. The regional management zones restrict the mobility of the fleet, therefore providing some protection for migratory shoaling species outside the boundaries of a given management zone. However even with these management restrictions in place reported catch data as illustrated in Figure 7 suggested that catches are declining.

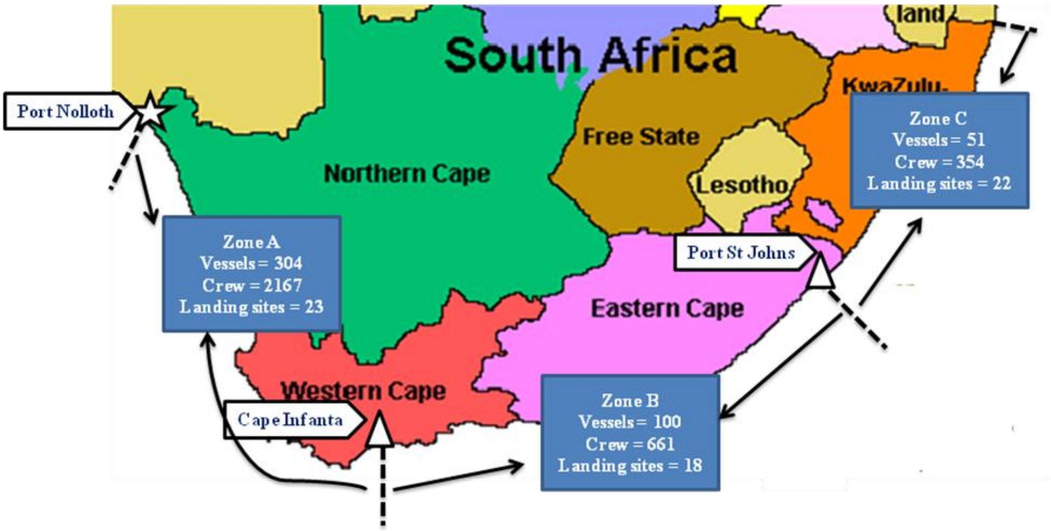


Figure 6: Commercial TLFS regional management Zones as described for the fishery (DEAT 2005).

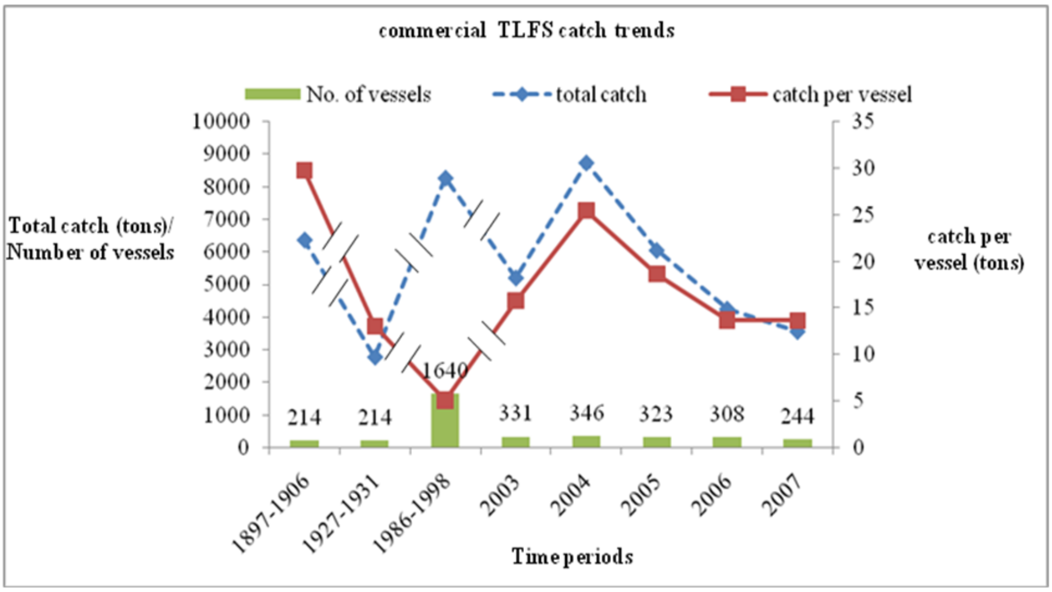


Figure 7: Commercial TLFS catch trends in Zone-A (total for nine selected species equivalent to 80% of the total catches) (averages presented for periods (1897-1906, 1927-1931 and 1986-1998 (Griffith 2000).

The Right Holders have organised themselves into various fisheries associations with specific mandate to engage with the department to promote aspects of co-management. The membership of these associations is however pending verification but it is envisaged that sound co-management with views of all participants is expected in this fishery.

Enforcement measures include the requirement to launch and land only at approved landing sites. Discharge of fish is to be conducted at the presence of fisheries control officer and/or catch monitor. Right Holders are to ensure that the fishing vessel is fitted with a functioning vessel monitoring system (“VMS”), which is approved by the department. The department has in place a fleet of four modern Environmental Protection Vessels (EPVs), which conduct sea patrols. These vessels include 83 meter offshore patrol vessel *Sarah Baartman* and three sister 47 meter inshore patrol vessels *Lillian Ngoyi*, *Ruth First* and *Victoria Mxenge*.

Management measures in the TLFS can be summarised as follows:

- Administrative processes (fishing rights, fishing permits and vessel fishing licenses);
- Area restrictions (regional management zones, landing points and MPAs);
- Catch limitations (applied effort, size and bag limits, prohibition of catch for over-exploited and collapsed species and zonal closed seasons);
- Effort and catch data returns; and
- Monitoring and enforcement (Land based Fisheries control officers/marine resource monitors, at sea patrol and Vessel Monitoring System-VMS).

4 THE VESSEL MONITORING SYSTEM

4.1 Description of the VMS

The Vessel Monitoring System (VMS) can be described as a vessel tracking system whereby equipment installed on a fishing vessel provides information on the vessel's movements. The information is relayed to a land based fisheries authority centre where the vessel's movements are monitored and recorded. The VMS is then based on remote monitoring differing from traditional monitoring methods, which include aerial patrols, sea-surface patrols, on-board observers and vessel logbooks (FAO 1998).

The VMS requires that and electronic unit (VMS unit) be installed permanently in a participating vessel and be assigned a unique identifier. Wide ranges of onboard VMS unit types make use of satellite communication systems that have an integrated Global Positioning System (GPS). Satellite communication systems are preferred as they have a greater geographic coverage allowing for tracking vessels further offshore. For that reason satellite communication has power over other less coverage communication system types that may be used. The less coverage communication systems types include high radio frequency and cellular phone technology. These latter systems possess similar reliability as the satellite systems and can effectively be employed in near shore fisheries for smaller vessels at expectedly lower costs (FAO 2009). A diagrammatic illustration of a VMS configuration is presented in Figure 4.

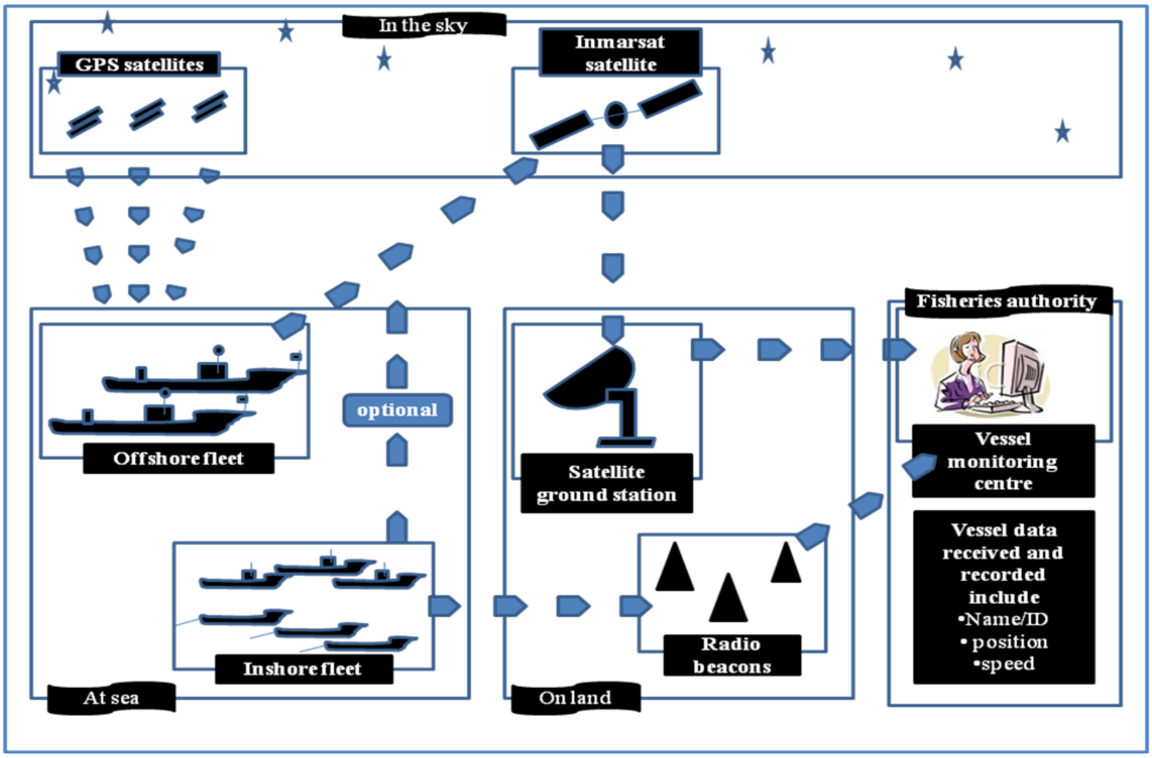


Figure 8: Diagrammatic illustration of a VMS configuration.

4.2 The general purpose of the VMS in fisheries

The primary benefits for the VMS in many fishing nations are for fisheries resource management and conservation (FAO 1998). These benefits include:

- Improvement of compliance with fisheries regulations by providing regular positional and vessel activity information.
- Improvement of scientific information with regard to status of fish stocks as it contributes increased accuracy in catch and effort data.

  other benefits include;
- Provision for targeted inspections whereby patrol vessels maybe be deployed when infringements are detected and thereby reducing costs if traditional methods where to be employed.
- Data communication capability where data can be transferred to a land based station while the vessel is still at sea either for the fisheries authority or for business related activities.
- VMS information may be used in an emergency for the purposes of search and rescue missions. The information may include the exact or last know position of the vessel in distress and also the positions of vessels that maybe available to respond to the emergency.

4.3 The purpose of the VMS in the commercial TLFS

With particular regard to the commercial TLFS the VMS can provide the following important information:

- Verification of fishing effort information reported by the commercial TLFS right holders in their catch and effort data returns. *Currently sea days are used as the lowest effort unit and with aid of the* VMS *data, accuracy of the reported information can be established.*

- Adherence to regional management zone and effort distribution. *Right Holders are allocated to specific regional management zones. The* VMS *will provide information whether the Right Holders have adhered to the specified management zones and where exactly they have been fishing for the given reporting period.*
- Determination of illegal fishing inside MPAs. MPAs *serve a key function in the management of many stocks in* TLFS. MPAs *are importance reference areas to determine parameters of stock assessment models that maybe include determination of natural mortality. Illegal fishing inside* MPAs *is detrimental to their role in protecting parts of spawning stocks and thus if it happens its extent must be determined as an aid for informed scientific conclusions.*

One can conclude that for the commercial TLFS the VMS will bring about information necessary to i) verify and refine catch and effort data submitted (applied effort and spatial distribution), ii) to predict levels of illegal fishing activities in MPAs and closed areas, iii) to determine effort reduction required for stock recovery and iv) to improve compliance with described fishing areas (regional management zones). It is therefore important to weigh and analyse the costs of introduction of the system against its potential benefits.

5 INTRODUCTION OF VMS IN THE COMMERCIAL TLFS

The department undertook a decided to utilise VMS as one of the Monitoring Control and Surveillance (MCS) tools in the commercial TLFS. Adams (1997) states that activities within an organisation can be regarded as projects with unique characteristics and varying standards of importance. Projects are meant to create change or solve specific problems (Adams 1997). Although not explicit the department has practically initiated a project named "introduction of the VMS in the commercial TLFS".

The department therefore was expected to follow a defined project process flow that includes the definition of the project itself, its objectives, project standard, design, financing (costs-benefits, funding) and schedule (time frame). Also essential in the project process is the provision for evaluation of the project prior its commencement (Pinto 1998) and whilst underway. Project evaluation provides for informed decision on whether to postpone, implement, withdraw or continue the project. Variable factors may influence the decision and may include achievability of project goals, state of funding, human capital, equipment and materials needed (Heldman 2005).

5.1 Design and implementation process

In an effort to implement the VMS, the department stated in 2005 policy for the allocation of long term commercial fishing rights in the TLFS. It expressed that all successful applicants (Right Holders) will have to invest in a VMS. Further, it stated that regard to costs would be given attention prior to implementation (DEAT 2005). This statement suggests an accepted approach with reference to a basic project process as potential benefits have already been identified and the proposal is to consider the costs.

The commercial TLFS Long Term Rights (LTR) allocation process was completed in the second quarter of 2006 with fishing rights valid until the end of 2015. At the end of 2006 the department approved permit conditions for the 2007 commercial TLFS fishing season/year that contained reference to the VMS. The permit conditions stated that the Right Holder must ensure that the fishing vessel is fitted with a functional VMS. In this statement the department officially introduced the VMS in the commercial TLFS (DEAT 2006).

The 2007 permit conditions' statement noticeably overlooked the aspect of basic project process flow. Required project design and interactive revision was not undertaken and the VMS was introduced (implemented). Following implementation challenges such as cost, supply, technical attributes of the VMS units and the enforcement of the VMS became apparent.

The reason for the oversight may be related to the fact that several other fisheries sectors administered by the department were already operating with the VMS and there was an established VMS operation centre in site. These other fisheries sectors are however not comparable to the commercial TLFS as participants are well-established companies operating larger offshore fleets with a higher degree of economic potential.

It is therefore necessary to revisit, evaluate and rectify the project implementation Highlighted challenges will be outlined and evaluated in detail in successive sub-chapters.

5.1.1 Cost of the VMS (purchase, monthly connection and repair costs)

The cost of purchase and monthly connection fee became an evident challenge facing the VMS introduction process. As the implementation process overlooked these aspects it was argued by most fishers that the costs imposed to them as a result of the introduction process were out of their reach (DEAT 2008). The process further impacted negatively to the fishers' livelihoods, as the fishers were not permitted to continue fishing without an operational VMS installed onboard the fishing vessel.

The VMS unit was priced at approximately R16 000.00 at 2006 and in early 2007 when it became compulsory. An additional fixed monthly connection fee of R247.00 was payable to the service provider. Some fishers were able to purchase and install the VMS units and continued to harvest the resource with the majority struggling to comply.

It is common and argued that the fishing industry is the main beneficiary of fisheries management therefore should pay the fishery management cost. This approach appears to be derived from ideas of justice and fairness (Arnason *et al* 2003). The department has clearly followed this approach by imposing all cost of purchase, installation and connection directly to the fishing Right Holders.

Most countries worldwide have also adopted the common theory of cost responsibility with regard to their VMS programmes and have been successful in meeting their needs. (FAO 2009). It is however inappropriate to entirely compare the commercial TLFS VMS process with VMS programmes undertaken by other nations as vessels involved are fairly small (averaging between five and eight meters in length) with less economic return potential. Nations which include Australia, New Zealand, Chile and others have the VMS compulsory to vessels that are 10 m or more in length (FAO 2009) The FAO Committee on Fisheries (COFI) has in its 25th session of 2003 noted requirement for VMS installation on smaller vessels. COFI submitted that the costs of VMS are limiting for smaller size vessels. Although onboard units are becoming relatively cheaper the cost of message transmission has increased (FAO 2003). In 2006 a FAO expect consultation on the VMS agreed that there be a case-by-case fishery consideration prior implementation as a universal solution was not applicable (FAO 2007). Considerations should therefore be limited to principles that had been followed in the VMS implementation programme process in these nations including success in RSA.

The high cost of VMS in the commercial TLFS can be attributed to the fact that there was only one supplier when it was introduced and therefore no sales competition existed to lower the prices. The latter could have been addressed by a focused implementation approach with cognisance to market and supply. However a negotiation process led by Right Holders' representative brought about two more suppliers driving the unit prices to almost half during 2008. Table 1 provides a summary VMS profile of the commercial TLFS by the end of 2008 as provided by the VMS operational centre.

Table 1: VMS profile of the commercial TLFS in December 2008.

Category (m)	Number of vessels	% composition	VMS not installed	% without VMS (fleet)
Up to 5m	71	16%	45	**10%**
5.1 to 8.0m	317	70%	81	**18%**
8.1 to 10.0m	58	13%	12	**3%**
10.0 to 15.0m	9	2%	2	**<1**
Total	**452**	100%	137	**31%**

By the end of 2008, 69% of the fleet had purchased and installed VMS units (Table 1). Having highlighted the issue of cost 69% can be regarded as a substantial response from the industry. However in verification of the presented figures it was discovered that several units were non functional and some had not be transmitting for periods exceeding 12 months, because of non payment of connection fees, damage to the unit and high costs of repairs. In some few cases VMS units had been transferred to other vessels without notification being sent to the department. The transfer of the VMS units may result in one unit being accounted for more than one vessel. All listed reasons relate to the limited ability to afford the VMS.

The VMS introduction process proves to have encountered significant challenges with regard to the affordability of its varying financial aspects. The cost responsibility to the industry is a common argument and warrants proper evaluation, which must include the state of financial resources of the cost bearer. The well accepted method to evaluate cost of a project is a cost benefit analysis (CBA) which analyses cost against potential benefits (Hanley and Spash 1998). A CBA was not conducted for the introduction of the VMS. An attempt to estimate cost and benefits of the process will be undertaken in this study.

5.1.2 Technical attributes of the system (functionality, water proofing etc.)

In engaging with the Right Holders the department had further been provided with technical reports regarding to the VMS.

The Right Holders have provided the department with reports that the VMS is not as reliable as expected.

- The VMS unit is not fully water proof or water resistant. It corrodes and malfunctions or ceases to function.

- The unit may not be shock resistant when and exposed to the pounding in the sea and fails to function.
- The Right Holders are not always aware if the system is reporting to VMS operation centre. The department has been notified that VMS units do not transmit while they are on and when they are at sea.
- Workmanship during installation and repairs has been reported to be poor (e.g. loose wire connections) and it results to the unit's failure to function and cost of claimed endless repairs.
- The six months guarantee period in event of malfunctioning is thought to be short

The provided information suggests that the VMS units supplied for the commercial TLFS are of low standard and not suitable for use at sea. The service provider and its technical personnel are not providing high quality service when installing the units. In this case trial runs of the equipment would have been a proper way if sufficient planning had been undertaken and by doing so creating a sales competition platform for the VMS providers.

5.1.3 Enforcement and monitoring

Having introduced an MCS tool (VMS) in the management of the commercial TLFS the department has to enforce its decision if it to be effective. Right Holder in the commercial TLFS may not conduct fishing without the fishing vessel being fitted with an operating VMS as first stipulated in the 2007 commercial TLFS permit conditions. However at the beginning of the fishing season 2007 the department's permitting unit (Marine Resource Management –MRM) issued fishing permits irrespective of the VMS status of the permitted vessels. Poor co-ordination of the process was observed as the Monitoring Control and Surveillance unit (MCS) was not adequately informed. The MCS ground personnel permitted Right Holders to conduct fishing operations as they were in possession of valid fishing permits for the given fishing season. In contrast the MCS personnel onboard the EPVs were enforcing the permit conditions. A chaotic environment was created and the department had to devise counter measures.

Some smaller open deck vessels were physically incapable of hosting a VMS unit as they have neither power supply nor a secure place to mount the VMS unit. It therefore became unreasonable to enforce the VMS in this category of vessels. Some Right Holders who had invested and installed the VMS units on their vessels decided to switch their VMS units off as they concluded that the process of introduction of the VMS was unjust. It is then that problems continued to escalate and that the Marine Resource Management unit had to engage with affected stakeholders in an attempt to resolve the matter.

Following discussions between the department and the fishing Right Holders a concession was given to Right Holders utilising vessels under five meters (<5m) in length to operate without a VMS being installed. The concession was formalised by way of a ministerial document approved in June 2008 (DEAT 2008). Manipulation was observed where some fishing Right Holders declared inaccurate survey of their vessels claiming that their vessels were actually under the five-meter limit. Counter-measures have recently been imposed with the department refusing to issue fishing permits to those Right Holders with vessels without functional VMS. These enforcement measures have resulted in some fishers not fishing at all and others taking the risk and fishing illegally. The latter has negative socio-economic implications as viewed by fishers, fishing communities and the political arena.

6 COST BENEFIT ANALYSIS

According to Hanley and Spash (1998) a Cost Benefit Analysis (CBA) is a stepwise process with several key stages essential to provide baseline information for decision to engage or not to engage in a specific project. These steps include i) the definition of the project, ii) identification of project impacts, iii) defining which impacts are economically valuable and iv) the physical quantification of relevant impacts. The CBA employs money as a common unit but does not suggest that money is the most important matter and therefore v) monetary valuation of relevant impacts is of importance. Having expressed the cost and benefits in monetary terms it becomes necessary to express monetary amounts into present value terms (PV) by (vi) discounting the cost and benefit flows. All costs and benefits are therefore discounted using a discount rate that is assumed to be the (real) rate of interest (r).

The present value of cost or benefits (X) received at time (t) is calculated as follows:

$$PV(X_t) = X_t\ [(1+r^{-t})]$$

As highlighted earlier the main purpose of the CBA is to help select projects that are efficient in terms of resources use. Determining efficient use of resources is achieved by vii) applying the Net Present Value (NPV) test. The NPV test is computed by way of summing up the discounted benefits and discounted losses. If the sum of NPV is positive then the project can be referred to be efficient (Hanley and Spash 1998). The function of net present values to be used is expressed below.

$$\sum NPV = \sum B_t\ (1+r^{-t}) - \sum C_t\ (1+r^{-t})$$

Where B =benefits (gains) and C = costs (losses)

Potential costs and benefits have been highlighted in preceding chapters. The CBA will be conducted in order to evaluate whether the introduction of the VMS in the commercial TLFS is an efficient project in terms of resource use.

6.1 Data collection

Economic data on the costs and benefit to the industry (private costs and benefits) were obtained from the department. The data were collected during commercial fishing right performance reviews conducted in mid November to mid December 2009 where individual right holders were interviewed with regard to their performance since the allocation of fishing rights in 2006. These data covered a period of three years from mid 2006 (2006/7, 2007/8 and 2008/9) Cost data included running costs (fuel, maintenance, crew wages), cost of fishing permits, vessel fishing licenses, fish levy fees and depreciation of assets (vessel and tow vehicle). Data on catch and revenues were also obtained over the mentioned time periods. The VMS costs were extracted from department and industry consultation meeting reports (commercial Traditional Linefish Management Working Group minutes).

The department has provided management costs with regard to enforcement. These data include the costs of running sea patrols and those of running the VMS operation centre. Enforcement costs provided were inclusive of all fishing sectors. Costs applicable to the commercial TLFS were computed by taking into account the number of vessels in the commercial TLFS and the total fishing fleet. Therefore, 27% of the total management costs were estimated to be incurred when enforcing the regulation in the commercial TLFS. Catch and effort data series have also been obtained for the period 2003 to 2007. The catch and effort data is data captured from monthly catch data return logsheets which right holders are mandated to submit. The regional management zone from Port Nolloth to Cape Infanta (Zone-A) was selected as study area and data were further streamed for this purpose. Nine most important species as described by Griffiths (2000) were chosen for the analysis. Summary of data relevant to the study is presented in Table 2.

Table 2: Data summary for the CBA: Data extracted for Zone-A.

Periods	catch (kg) - (nine selected species)	number of vessels	cost per unit catch	fish price	VMS cost per unit	VMS cost monthly connection fees	Permit, license and levy fees	social cost investment cost	social cost running cost
1897-1906 (avg)	6669600	224							
1927-1931 (avg)	2918272	224							
1986-1998 (avg)	8262386	1640							
2003	5210656	331							
2004	8727837	346							
2005	6052788	323							
2006	4256581	308			R16 000.00				
2007	3569374	244			R16 000.00	R247.00			
2005-2007 (avg)	5563447	310							
2008		304			R8 000.00	R247.00			
2009		304			R14 000.00	R247.00		R62 077.52	
2006-2009 (avg)					R12 666.67				
2007-2009 (avg)		304	R8.79	R11.78	R12 666.67	R257.00	R1,08m		R16,86m

6.2 Data analysis

For the purpose of the CBA model cost per unit of catch (**CPUC**), unit price of fish (**Price**), total catch of fish (**Catch**) for a given period were necessary. Monitoring costs and the actual costs of the VMS were included. The selection of Zone-A had an added advantage, which was the availability of published historical catch and effort data for three decades (1897-1906, 1927-1931 and 1986-1998) (Griffiths 2000). These historical data provided reference for estimating optimal catch levels of nine most important harvested species selected for the CBA constituted approximately 86% of annual reported catches.

The South African Rand (R) (R7 = US$1) was selected as the base currency and kilogram (kg) as a catch unit for the CBA model. A cost per unit of catch (R/kg) was computed as an average of [annual expenses divided by the corresponding annual catch]. Price unit was calculated as an annual turnover divided by the corresponding annual catch. The CPUC and price were estimated at R8.79/kg and R11.78/kg respectively. The Private Net Benefits (total benefits to operators in Zone-A were calculated as illustrated formulae below.

PRIVATE COSTS = CPUC x Catch

PRIVATE REVENUES = Price x Catch

NET PRIVATE BENEFITS = PRIVATE REVENUES – PRIVATE COSTS

The benefits of a fishery sector include the costs and revenues to fishing right holders and the cost of management (social costs) by the management authority (government). In this study the social costs were limited to the enforcement of the VMS (sea patrols and running of the VMS operation centre). To estimate the benefits of the fishery a difference of the government costs of enforcement and (referred to as social costs) and private net benefits was computed. The social costs in Zone-A amounted to an approximate R16.9 million, a 19% of the total for the South African fishing fleet. Cost recovery methods in the commercial TLFS in Zone-A were estimated to recover R1.08 million, a 6.4% of the applicable social costs.

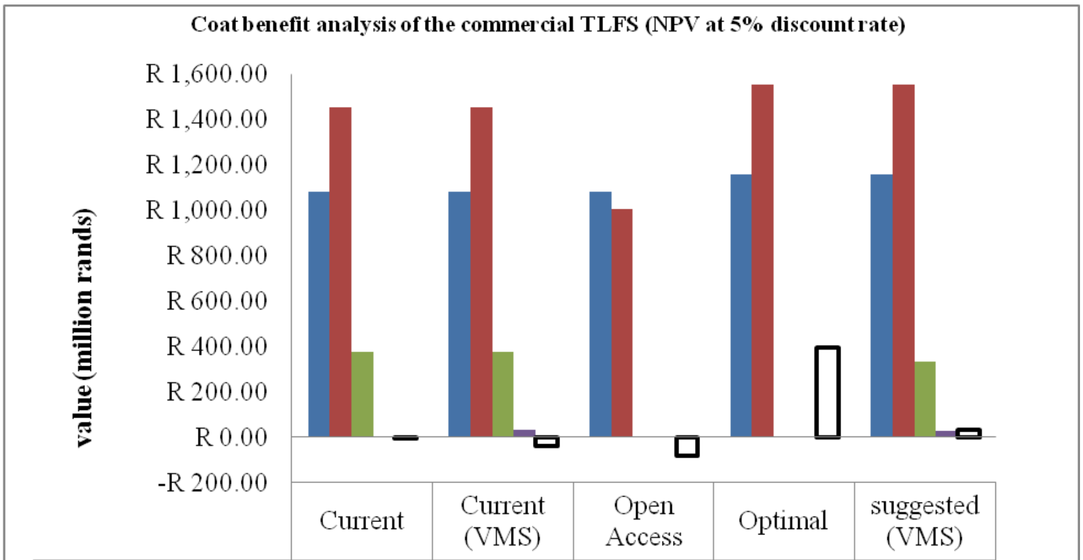
The fisheries benefits were calculated for five selected scenarios. These were i) current situation (cost and benefits at current catch levels), ii) current situation with VMS costs, iii) open access (cost and benefits without social costs or no enforcement applicable), iv) optimal (costs and benefits at optimal catch levels) and v) suggested (costs and benefits at suggested catch levels and introduction of VMS costs). The current situation was computed from the catch and effort data for the period 2003-2007. Theory suggests that open access situation lead towards a point where revenues and costs are at equilibrium due to increased competition hence no benefits are expected, fishing (Arnason 2009). The open access situation was modeled for a period of 10 years estimating that harvest will decline at a 5% rate while the cost of harvesting are maintained over the period. The optimal and suggested situations were set at catch levels equal to average catch total for the nine species recorded in the period 1897-1906. These situations were modeled over a period of 10 years with an initial effort reduction of 20% followed by a 5% increase in harvest in successive years as estimated from Grant *et al* (1978). The optimal outcome assumes voluntary compliance and it was therefore assumed that no social costs or any enforcement costs were necessary. The suggested situation in cooperated minimum VMS costs (R8000.00 per unit). The net present values (NPV) were computed for all scenarios at 5% discount rate, a discount rate in range applicable for social project evaluation (Kristófersson pers. comm.). NPV sensitivity analysis with regard to discount rate, social cost (excluding fixed costs), fish price and private cost (excluding VMS costs) was conducted for the range minus20% to 20% of the estimated values.

Differing levels of enforcement determined in terms of number of vessels monitored with the VMS were modeled. Vessels were ranked in terms of catches per year from highest to lowest. Cumulative catch was computed for the categories five (5), 10, 25, 50, 75, 100,150, 200, 250 and the maximum (310) and averaged for the period 2003-2007. A cost-benefit analysis at minimum VMS cost (R8000.00 per unit) was applied for each category. This analysis was done to provide base for the prediction of optimal enforcement level or level range.

6.3 Results

The results of the CBA reveal that the current situation has negative NPV (negative R4.99 million). With the inclusion of the VMS the NPV drops to approximately negative R38.07

million. The open access situation has negative NPV. The optimal situation has positive NPV. Suggested situation results in minimal positive NPV. Figure 9 illustrates the results of the analysis.



	Current	Current (VMS)	Open Access	Optimal	suggested (VMS)
Private cost	R 1,082.39	R 1,082.39	R 1,082.39	R 1,158.72	R 1,158.72
Private benefits	R 1,450.57	R 1,450.57	R 1,004.67	R 1,552.87	R 1,552.87
Social cost	R 373.11	R 373.11	R 0.10	R 0.00	R 334.83
VMS cost	R 0.00	R 33.09	R 3.76	R 0.00	R 26.94
Fishery net benefits	-R 4.99	-R 38.07	-R 81.63	R 394.09	R 32.32

Figure 9: Cost Benefit analysis results of the commercial TLFS.

The sensitivity analysis results illustrated in Figure 10 indicate that the NPV are less sensitive to the discount rate variation with fairly horizontal slope for all scenarios. Social cost, fish price and private cost sensitivity results presents steeper slopes. Even the suggested situation falls to the negative whenever the costs exceed 10% of the estimated value.

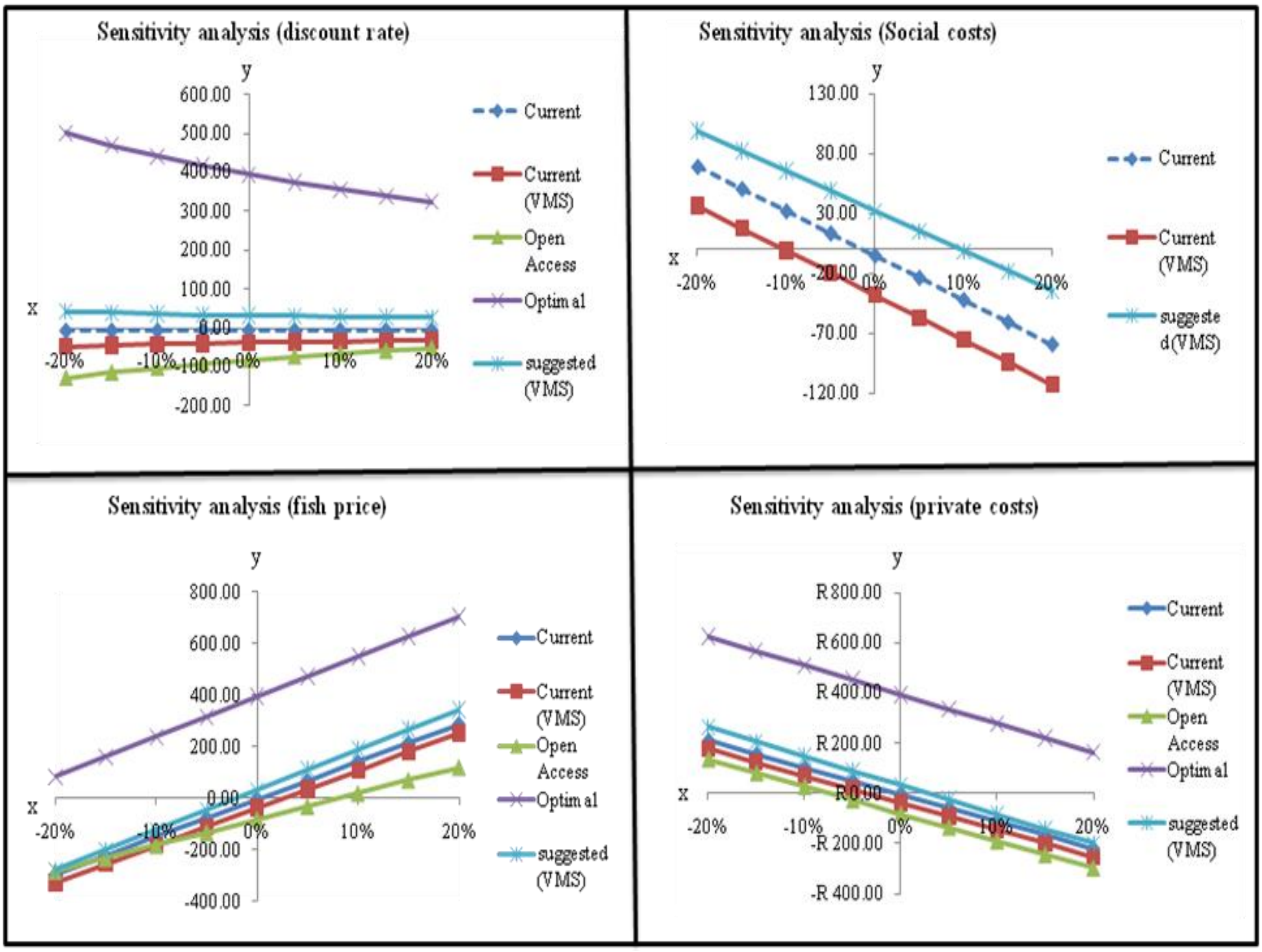


Figure 10: Sensitivity analysis (x-axis percentage variation, y-axis NPV (million rands)).

The results as illustrated in Figure 11 mean that the selected a small portion of the fishing fleet was responsible for a significant portion of the catch. More than half of the reported total catch was accountable to 16% of the fleet and 24% of the fleet accounted for a 75% of the catches. Figure 12 indicates that fishery net benefits are positive for when enforcement is directed to limited number of vessels. When 50% of the vessels are monitored the social costs and net fishery benefits are at equilibrium. Further, increase in number of vessel monitored the social costs exceeds net fishery benefit resulting is social losses.

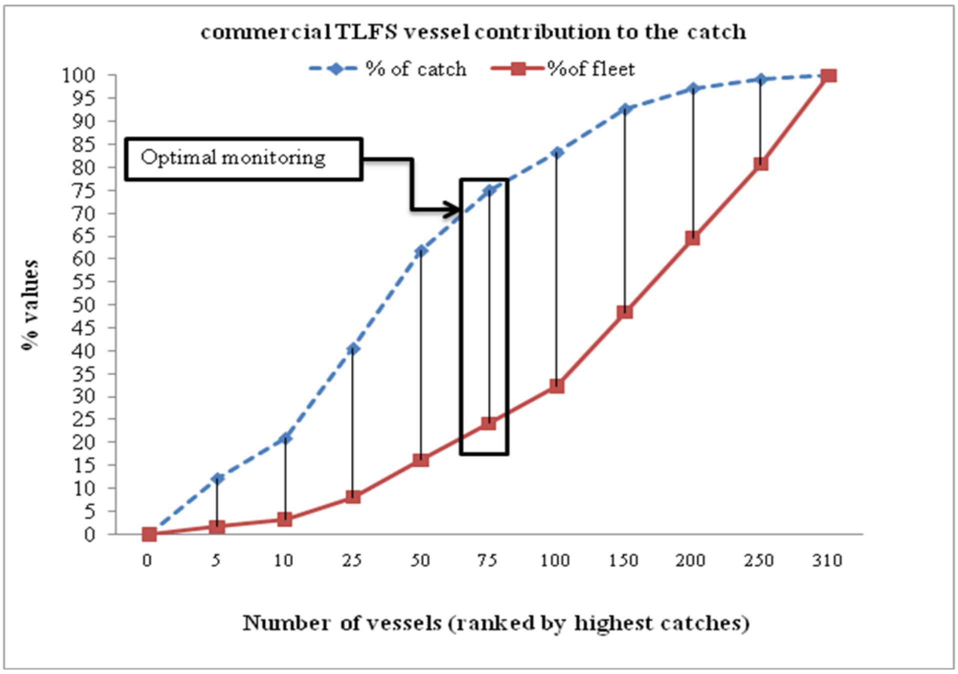


Figure 11: ranked vessel contribution to total catch (average 2003-2007).

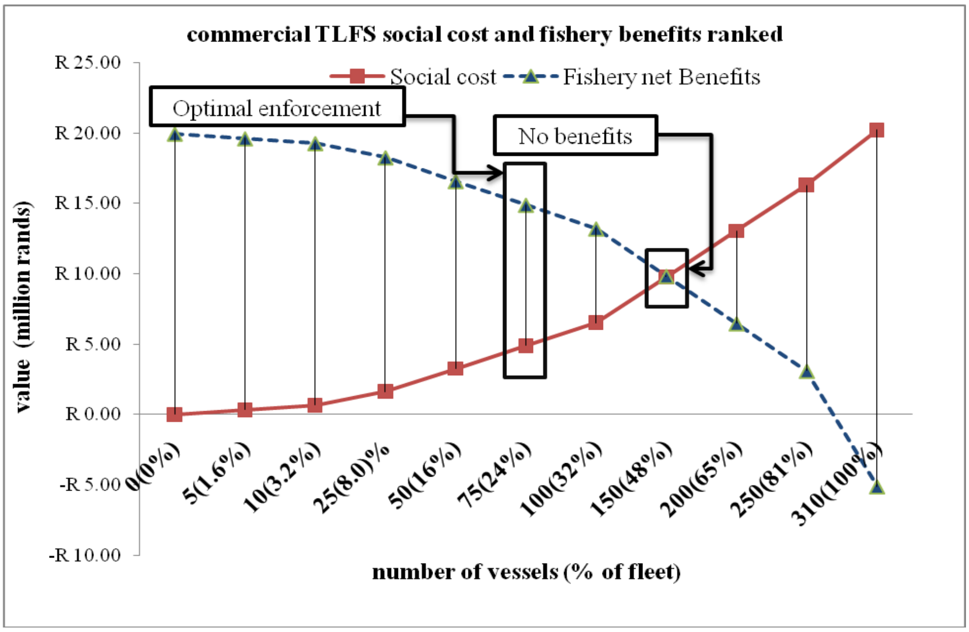


Figure 12: Ranked Cost Benefit analysis.

7 DISCUSSION

The introduction of the VMS in the commercial TLFS overlooked basic aspects of project management process. Background research of the cost and supply of the VMS units was not evident. Poor technical attributes of the VMS were manifested during the implementation process. Although benefits of the VMS were clearly outlined, in principle the highlighted process weaknesses have resulted to the non-achievement of the potential benefits. A feasibility study taking into account the costs, cost responsibility, supply and technical aspects of the system was required. It therefore became necessary to review basic aspects of the introduction of the VMS in the commercial TLFS and for this reason this study was conducted, applying an accepted project evaluation method, CBA.

Fisheries sectors contribute to the social cost indirectly through cost recovery methods applied by their governments. Governments tend to be more efficient when cost and benefits are concentrated in the same group (Anderson and Sutinen 2003). This study reveals that the potential social cost contribution from the fishery was R1.08 million, a 6% of the total applicable social costs. This suggests that the commercial TLFS is subsidised by other fisheries sectors regarding its management. In the current situation when no cost of VMS is included, the fishery has negative net benefits (negative NPV), indicating that the fishery is operating at marginal cost with limited or no benefits. Introducing the VMS in this fishery sector reduces the benefits further, given the current catch levels (Figure 9). It is therefore clear that current process on introduction of the VMS results in social losses. According to economic theory, projects with negative net benefits should not be continued.

An optimal situation where resource users comply with regulation without any measure of enforcement as illustrated in Figure 9 has enormous benefits as compared to other scenarios. However the optimal situation is unlikely in fisheries management. If the sector was operating at optimal levels, or at catch levels equalling those recorded in the period 1897-1906, the benefits would be positive. Catch records indicate that the average catch from 2003-2007 amounts to 87% of the optimal levels. The 87% average does not suggests for healthier stock levels as these catches continue to decline for individual years with a 54% recorded in 2007 (Figure 7). This may be that the fishery is operating at marginal stock levels at maximum fishing effort. With the emergency declared in 2000 and the observed continuing decline of catches the situation warrants effective effort monitoring. The VMS is an important tool to achieve the needed monitoring. Nevertheless the VMS introduction in the fishery has very limited benefits given the approach applied. In an attempt to remedy the approach options to be considered in the introduction process were modelled.

The VMS is meant to improve the situation bringing about better enforcement of regulation. In order to achieve the implementation of the VMS an extensive cost benefit analysis refining the findings of this study is necessary to determine optimal costs. Attention is to be regarded to fish price and all costs while refining t. NPV values proved to be sensitive to cost and price and that correct assumption of these parameters is key to a proper CBA. Attempt to measure the fleet contribution to catches revealed that 24% of the fleet was responsible for 75% of the reported catches (Figure 10). Directing monitoring at this level will reduce the costs by 76% resulting in high positive net benefits as compared to the current approach (Figure 11). This level is regarded as optimal as it provides for monitoring of the substantial catches rather than the number of vessels. It is therefore necessary to consider this level when deciding on optimal enforcement levels.

8 CONCLUSION

Introduction of the VMS in the TLFS to improve monitoring and enforcement was a sound idea. The process failed to achieve its objective due to limited planning. The CBA reveals that the current process has negative benefits and therefore the introduction process has to be suspended. Focused monitoring will yield better results. Monitoring must be directed to a portion of the fleet responsible for the vast catches rather than attempting to monitor all vessels. Recommendation for an alternative approach is presented in chapter 9 below.

9 RECOMMENDATIONS

It recommended that the introduction of the VMS in commercial TLFS be continued with a revised process approach. The department must consider introducing the VMS in a stepwise approach initially targeting the Right Holders responsible for the significant catches. The initial base line is proposed to be a range between 16% and 24% of the fleet accounting for 60% and 75% of the catches respectively. These vessels may have acquired the VMS units. In an event where the VMS has not been acquired the Right Holders must carry the cost of the VMS units so as to promote sense of ownership and care for the units. Cost to Right Holders must include VMS unit purchase and repairs.

The department must negotiate with the suppliers and enter into a contract with regard to the VMS costs. Further, the department must consider subsidising the monthly connection fees for the identified vessels to ensure constant reporting. Sourcing minimum funds from the non-selected Right Holders should be considered so to promote participation by all stakeholders.

It is envisaged that the situation may bring about disagreements and that extensive consultation with the right holders is required to reach agreement. The department needs to present the reason behind the selection of such Right Holders highlighting potential benefits of cooperation. Potential benefits include better catch and effort estimation, improvement management decision, stock recovery and improved fishery benefits. The selected Right Holders are to be convinced that they are the main beneficiaries of management processes and that their cooperation will better the fishery economic returns. It is likely that compliance will get better as those that are constantly monitored will develop a sense of responsibility and report intruders. The project process should be constantly reviewed and that findings should be shared between the right holders and the department. Stepwise process approach provided in Figure 13 can be considered, reviewed, and instituted by the department.

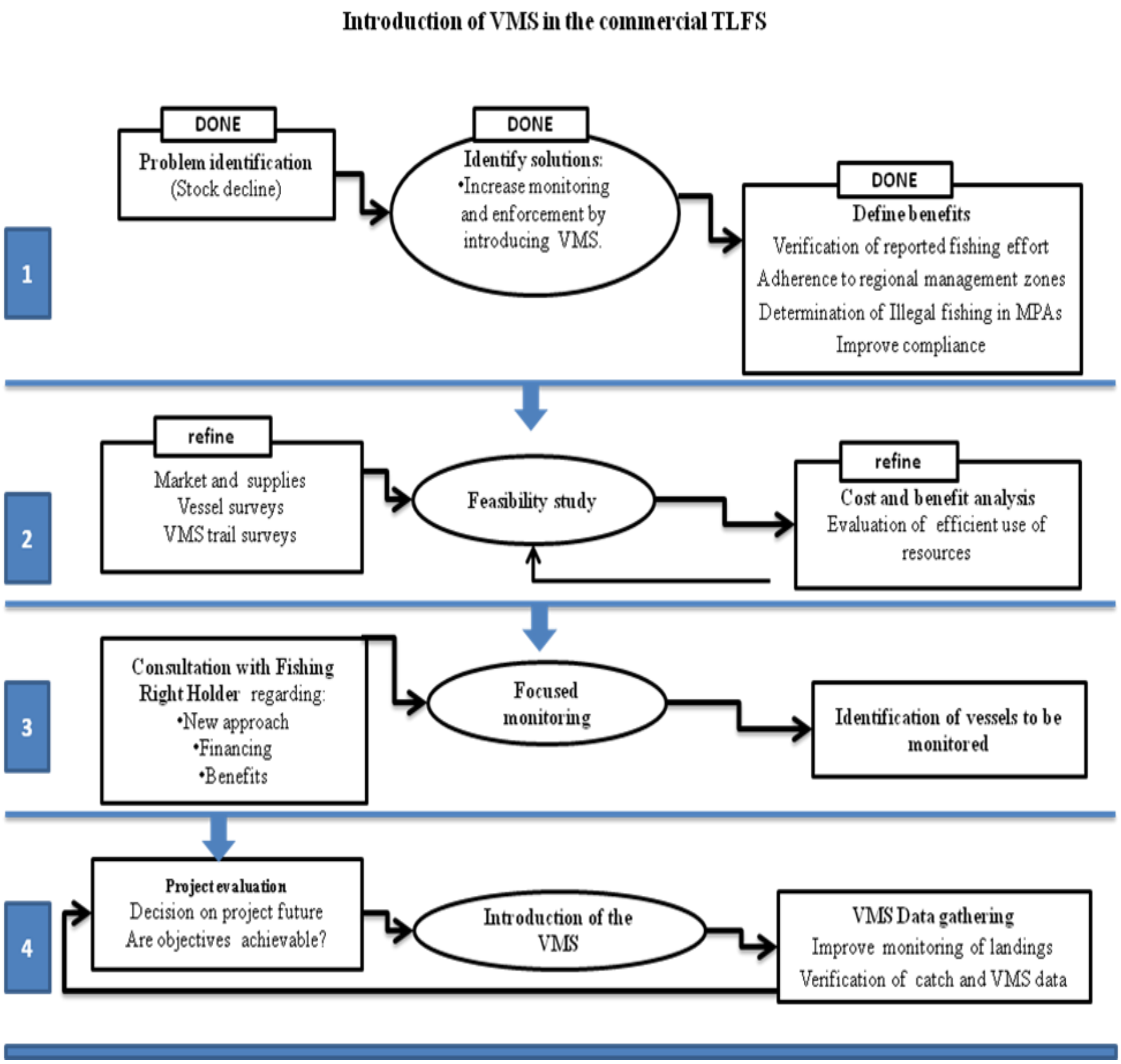


Figure 13: Introducing VMS in the commercial TLFS (summary plan).

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LIST OF REFERENCES

Adams, J.R. (1997). *Principles of Project Management.* USA: The Project Management Institute.

Andersen, P., Sutinen, J.G. (2003). Financing Fisheries Management: Principals and Economic Implications. In Schrank, W. E., Arnason, R. and Hannesson, R.eds. *The Cost of Fisheries Management*. pp. 45-63. Aldershot, England: Ashgate Publishing Company.

Arnason, R., Hannesson, H. and Schrank, W.E. (2003). *The Cost of Fisheries Management: Who should pay?* In Schrank, W. E., Arnason, R. and Hannesson, R.eds. *The Cost of Fisheries Management*. pp. 9-19. Aldershot, England: Ashgate Publishing Company.

Arnason, R. (2006). Fisheries Enforcement: Basic Theory. International Institute of Fisheries Economics and Trade (IIFET), 2006 Portsmouth Proceedings.

Arnason, R. (2009). Fisheries management and operation research. *European Journal of Operational research* 193:741-751.

CIA (Central Intelligence Agency) (2009): The World Factbook: South Africa [December 2009] <https://www.cia.gov/library/publications/the-world-factbook/geos/sf.html:>

Chang, S.K., Liu, K.Y., and Song, Y.H. (2009). Distant water fisheries development and vessel monitoring system implementation in Taiwan – History and driving forces [Electronic version]. *Marine Policy.* 34(3):541-548.

DEAT (Department of Environmental Affairs and Tourism). (1999). New Management Protocol for the South African Linefishery.

DEAT (Department of Environmental Affairs and Tourism). (2000). Government Gazette Notice (No. 4727 of 2000) South Africa.

DEAT (Department of Environmental Affairs and Tourism). (2003). An Economic and Sectoral Study of the South African Fishing Industry. *Fisheries Profiles* 2:115-121

DEAT (Department of Environmental Affairs and Tourism). (2005). Traditional Linefish Policy: Policy for the allocation and management of commercial fishing rights in the Traditional line Fishery: 2005. South Africa: pp 13

DEAT (Department of Environmental Affairs and Tourism). (2006). Traditional Linefish permit conditions (for the 2007 fishing season). South Africa.

DEAT (Department of Environmental Affairs and Tourism). (2008). Memorandum against the installation of the VMS in the Traditional Linefish sector (Ministerial response). South Africa.

Food and Agricultural Organization of the United Nations. (1998). Fishing Operations: 1. Vessel Monitoring Systems. *FAO Technical Guideline for responsible fisheries* <http://www.fao.org/docrep/003/w9633e/w9633e00.htm>

Food and Agricultural Organization of the United Nations. (2003). Corporate document repository. Committee on Fisheries February 2003, Making Monitoring control and Surveillance of Fishing vessels more effective. [December 2009] <http://www.fao.org/docrep/meetings/005/y8216e.htm>

Food and Agricultural Organization of the United Nations. (2007). Report of the Expert consultation on the use of vessel monitoring Systems and satellites for fisheries monitoring, Control and surveillance, Rome October 2006 [March 2010]. <http://www.fao.org/docrep/009/a0959e/a0959e00.htm>

Food and Agricultural Organization of the United Nations. (2008). The state of world fisheries and aquaculture. [February 2010]. <http://www.fao.org/docrep/011/i0250e/i0250e00.htm>

Food and Agricultural Organization of the United Nations. (2009) Fishing vessel monitoring systems [December 2009] <http://www.fao.org./fishery/vms/2/en>

Grant, C.J., Cowper, T.R., and Reid, D.D. (1978). Age and Growth of Snoek, *Leionura atun* (Euphrasen), in South-eastern Australian Waters. *Australian Journal of Marine and Freshwater Research* 29:345-444.

Griffiths, M. (2000). Long term trends in the catch and effort of the commercial Linefish off South Africa's Cape Province: Snapshots of the 20th century. *South African Journal of Marine Science* 22: 81-110.

Hanley, N. and Spash, CL. (1998). *Cost Benefit Analysis and the Environment*. Cheltenham, UK: Edward Elgar Publishing Limited.

Heldman, K. (2005). *Project management professional- study guide*. Hoboken New Jersey: Wiley Plublishing Inc.

Hutchings, L., van der Lingen, C.D., Shannon, L.j., Crawford, R.J.M., Verheye, H.M.S., Bartholomae, C.H., van der Plaas, A.K., Louw, D., Kreiner, A., Ostrowski, M., Fidel, Q., Barlow, R.G., Lamont, T., Coetzee, J. Shillington, F., Veitch, J., Currie, J.C. and Monterio, P.M.S. (2009). The Benguela current: An ecosystem of four components. *Progress in Oceanography*. 83: 15-32

Japp D, 2001. The allocation of harvesting rights in the South African Hake fishery. *FAO Fisheries. Technical. Paper.* 411: 118-135

Pinto, J.K. (1998). *Project Management Handbook.* San Francisco: Jossey-Bass Publishers.

RSA INFO (South African Government Information). (2009). [December 2009] http://www.info.gov.za/aboutsa/landpeople.htm

Sainsbury, J.C. (1996). *Commercial fishing methods: an introduction to vessels and gear*, 3rd ed. Onsney Mead, Oxford: Fishing News Book.

SSA (Statistics South Africa) (2009). Assets and capabilities poverty in South Africa. [January 2010] <http://www.statssa.gov.za/isi2009/ScientificProgramme/IPMS/0938.pdf>

Verheye H. M. (2006). CMarZ activities in South West Indian Ocean, Census of Marine Zoology (CmarZ) Proceedings, Tokyo. [January 2010]
<http://www.cmarz.org/ppt/TokyoSSG_Nov06_ppt/Verheye_Tokyo_Nov06_SW_IndianOcn.ppt>