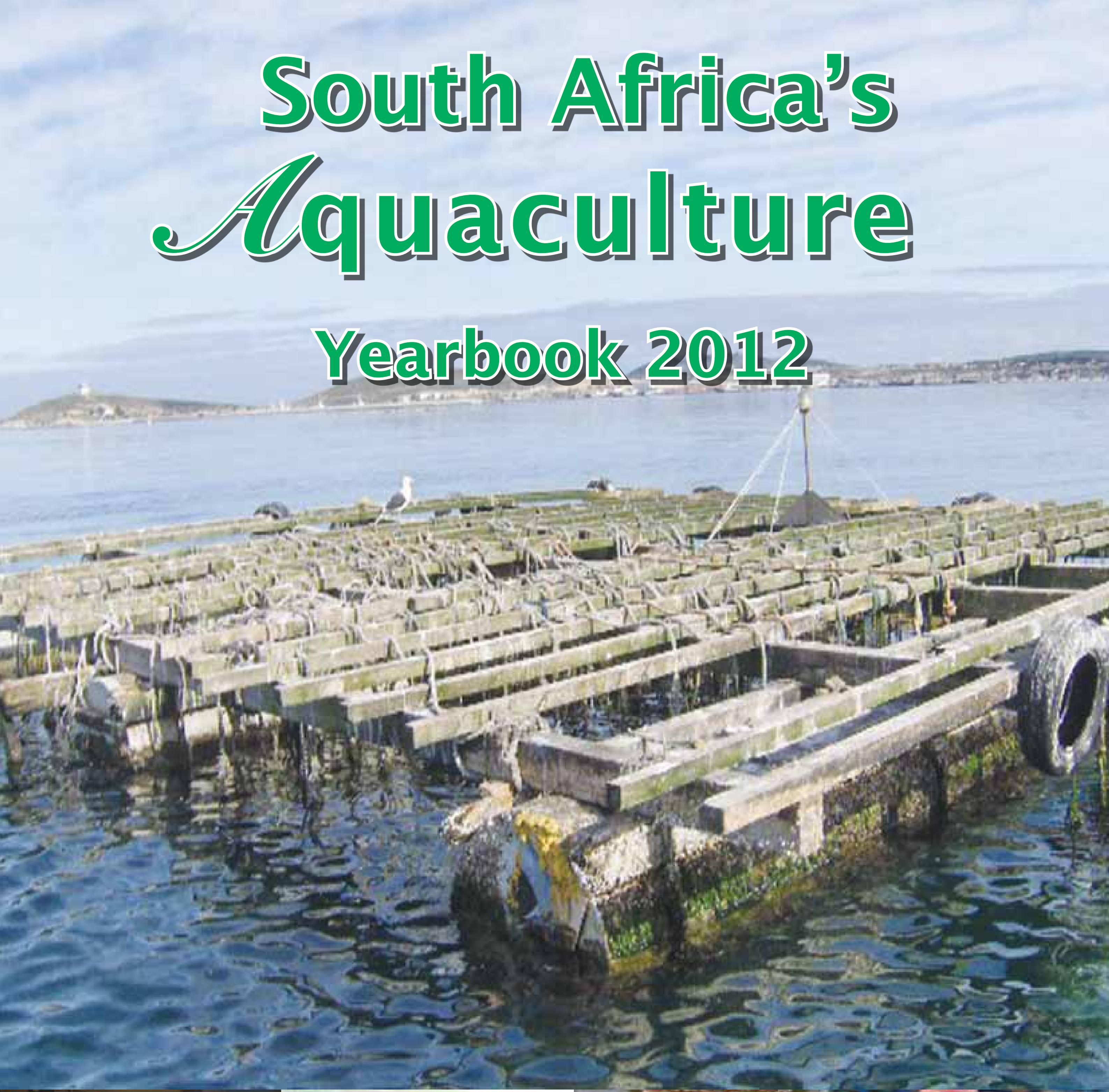
South Africa's Aquaculture

Yearbook 2012



agriculture,
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Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

AQUACULTURE YEARBOOK

2012

SOUTH AFRICA

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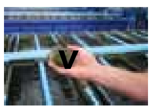
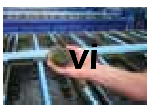
CONTENTS









EXECUTIVE SUMMARY

Marine species cultured in South Africa in 2011 included abalone (*Haliotis midae*), oysters (*Crassostrea gigas*), mussels (*Mytilus galloprovincialis* and *Choromytilus meridionalis*), finfish (*Argyrosoumus japonicus* and *Seriola lalandi*) and seaweed, both Ulva spp and Gracilaria spp. 52 permits to engage in marine aquaculture were issued and a total of 30 farms were operational. The Western Cape had the highest number of operating farms in 2011, with a total of 20 followed by Eastern Cape with 6, Northern Cape with 3 and KwaZulu Natal with only 1.

South Africa's total production (excluding seaweed) in 2011 was 1 883 tons. The Western Cape was the dominant province in terms of production and recorded a total of 1 624 tons. The abalone sub-sector was the highest contributor to total production making up 55% of total production output, followed by mussels 35.1%, oysters 14.3% and finfish at 0.4% (7.99 tons). Total production in 2011 decreased by 108.6 tons from 2010 (5.5%) and this decline was due to decreased production from 2 of the main contributing sub-sectors; namely, mussels and oysters. These sub-sectors recorded decreases of 129.98 tons (18.6%) and 7.23 tons (2.6%) respectively whilst the abalone sub-sector experienced increased production of 20.57 tons (2%).

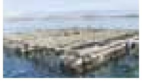
The freshwater species cultures in 2011 included trout (*Oncorhynchus mykiss* and *Salmo trutta*), tilapia (*Oreochromis mossambicus*), catfish (*Clarias gariepinus*), carp (*Cyprinus carpio* and *Ctenopharyngodon idella*), mullet (*Liza richardsonii*), largemouth bass (*Micropterus salmoides*), marron crayfish (*Cherax tenuimanus*), Atlantic salmon (*Salmo salar*) and a number of ornamental species. The Western Cape Province had the highest number of farms operating during 2011. Trout is the most cultured freshwater species in South Africa, followed by Ornamental species. Total freshwater aquaculture production for 2011 was 2 921 tons. The freshwater species with the largest aquaculture production in 2011 was trout at 1 428 tons. The second largest sub-sectors include ornamentals and koi carp which delivered production of ±660 and ±572 tons respectively. Total freshwater aquaculture production has shown an improvement of 12. 7 % from, 2006 to 2011, recording an increase of ±660 tons over the last six years.

The total value of the marine aquaculture sector was estimated at R379 million, the sector achieved a growth rate of 0.2% in sales value in 2011. Abalone sub-sector sales increased by 0.6% to R357 million, representing 94% of the entire sector. The Oyster sub-sector declined by 0.6% to R14 million and contributed 3.6% in terms of value, whilst mussel sales declined by 18%. Marine aquaculture contributed 0.020% towards South Africa's Gross Domestic Product (GDP) in 2011.

The marine aquaculture sector invested approximately R179 million in capital investment, an increase of 38% from 2010. The marine aquaculture sector employed approximately 1 607 fulltime individuals directly on the farms, increasing by 2% during 2011. The abalone sub-sector exported 1036.01 tons with a value of approximately R357 million in 2011. The export value increased by 0.5% compared to 2010. South Africa exported approximately 78.24 tons of farmed and wild caught oysters valued at R3.7 million and approximately 27 tons of mussels with an estimated value R702 708 in 2011. Approximately 4 tons of oysters were imported over the past year and these were in the form of spat, live animals and value added products. More than 200 tons of mussel products valued at approximately R5.3 million were imported during 2011. Salmon imports from Norway, Chile and the United Kingdom amounted to approximately 290, 42 and 4.6 tons respectively.

The Department conducted site surveillance of 17 marine aquaculture Right Holders, including 8 abalone farming operations, 6 oyster farming operations, 2 finfish farming operations and 2 mussel farming operations.

There were 26 farm closure notices sent to shellfish farms by the SAMSM & CP office in 2011. West of Cape Point 19 notices were issued with 7 notices issued east of Cape Point. Most of the closures were due to biotoxins and a few



were due to the presence of microbiological contamination. There were no closures due to any other hazardous substances viz. heavy metals, pesticides, PCBs or radionuclides.

During 2011 a number of aquaculture research projects were undertaken by the DAFF Researchers with some in collaboration with Universities. These projects included *Halioticida noduliformans* infections on South African abalone farms; Epizootic Ulcerative Syndrome from South Africa; The potential for sea urchin cultivation in South Africa; Assessment of scallop grow-out in Saldanha Bay; Predicting shellfish toxicity on the South African coast; Effect of suspended bivalve culture on the benthos in Saldanha Bay: over a decade later and the Abalone effluent water quality survey.



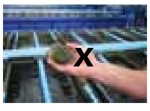
ABBREVIATIONS AND DEFINITIONS

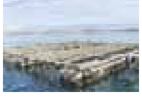
ADS	Abalone Aquaculture Dialogue Standards
ADZ's	Aquaculture Development Zones
AED	Chief Directorate Aquaculture and Economic Development
ADEP	Aquaculture Developmental and Enhancement Programme
AIF	Aquaculture Intergovernmental Forum
ARTDP	Aquaculture Research and Technology Development Programme
ASP	Amnesic Shellfish Poisoning
ATM	Abalone Tubercle Mycosis
ATS	Directorate: Aquaculture Technical Services
BEE	Black Economic Empowerment
BMP's	Aquaculture Better Management Practices
CITES	Convention on International Trade in Endangered Species
CSIR	Council for Scientific and Industrial Research
CTPAET	Critical Thinkers' Platform in Aquaculture and Emerging Technologies
DAFF	Department of Agriculture, Forestry and Fisheries
D:AR	Directorate Aquaculture Research
DDG	Deputy Director-General
DBSA	Development Bank of South Africa
DEA	Department of Environmental Affairs
DSP	Diarrhetic Shellfish Poisoning
DST	Department of Science and Technology
The dti	Department of Trade and Industry
DWA	Department of Water Affairs
ECDC	Eastern Cape Development Cooperation
EIA	Environmental Impact Assessment
EIF	Environmental Integrity Framework
EOP	Environmental Officer Production
EUS	Epizootic ulcerative syndrome
FAIL	Freshwater Aquaculture Industry Liaison
FAO	Food and Agriculture Organisation of the United Nations
FOB	Freight On Board
FPE	Fish Processing Establishment
FR&D	Chief Directorate; Fisheries Research and Development
GDP	Gross Domestic Product
HAB	Harmful Algal Blooms
HDI	Historical Disadvantaged Individuals
HDPE	High Density Polyethylene
IDC	Industrial Development Cooperation
IPAP	Industrial Policy Action Plan
LCFLD	Liquid Chromatography Fluorescence Detector
LCMS	Liquid Chromatography Mass Spectrometry
MAIL	Marine Aquaculture Industry Liaison
MAWG	Marine Aquaculture Working Group
MLRA	Marine Living Resources Act No. 18 of 1998
MRM	Chief Directorate Marine Resources Management



MSC	Chief Directorate: Monitoring, Control and Surveillance
NASF	National Aquaculture Strategy Framework
NEF	National Empowerment Fund
NEMBA	National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
NG	New Growth Path
Non – HDI	Non-Historically Disadvantaged Individual
NRCS	National Regulator for Compulsory Specifications
OIE	World Organisation for Animal health
PCB	Polychlorinated Biphenyls
PAIF	Provincial Aquaculture Intergovernmental Forum
PSP	Paralytic Shellfish Poisoning
qPCR	quantitative polymerase chain reaction
SAM	Directorate: Sustainable Aquaculture Management
SAMSM&CP	South African Molluscan Shellfish Monitoring and Control Programme
SETA	Sector of Education and Training Authority
SOE	State-Owned Entities
TCP	Technical Cooperation Program

Active surveillance	(also referred as stock inspection) shall include (as amended from EU regulation (Reg. 2006/88/EC) a) Routine inspection by the Department or by other qualified health services provider on behalf of the Department b) Examination of the aquaculture animals on the farm for clinical disease c) Diagnostic analysis of samples collected on a suspicion of a disease or observed increased mortality during inspection
Commercial Scale	Status at which project is producing a product for sale primarily for widespread distributions and consumption
Disease	Any condition whereby the normal functions of any organ or the body of an animal is impaired or disturbed by any bacterium, virus, parasite, fungus or other organisms or agent in a culturing environment (as amended from Animal Disease Act, 1998)
East Coast	East of Cape Point to border of Mozambique
Intra-trading	Trading of organisms between farms within the same sub-sector
Pilot Scale	Status at which a project is testing or conducting trials in order to demonstrate the effectiveness of a full program
Production	Amount of organisms produced from a farm specifically for human consumption (excluding seaweed)
Targeted surveillance	Prescribed samples of aquaculture animals to be taken and tested for specific pathogen(s) by specific methods.
West Coast	West of Cape Point to border of Namibia

1. OVERVIEW OF AQUACULTURE YEARBOOK 2012

1.1 INTRODUCTION

The Global community faces numerous challenges ranging from economic crisis to climate change and at the same time it needs to meet the growing food and nutritional needs of a growing population with finite natural resources. Fisheries and aquaculture make crucial contributions to the global food security (protein) of a large percentage of the world's population. Preliminary fish landing data from 2011 indicate that world capture fisheries and aquaculture produced 154 million tons of fish (FAO 2012). Aquaculture production contributed 63.6 million tons (41%) of the total world fish landings in 2011 (FAO 2012). Inland aquaculture contributed 44.3 million tons and marine aquaculture 19.3 million tons (FAO 2012). World capture fisheries remain stable, while aquaculture production is one of the fastest growing animal food-producing sectors.

In South Africa, most wild capture fisheries are peaking at their maximum sustainable yields and the only real growth avenue for fisheries is aquaculture. The National Aquaculture Strategic Framework has been developed to "provide guidance to DAFF and its partners as it identifies the much needed government interventions and support measures which will facilitate the removal of constraints and create an enabling environment for the development of an equitable, diverse, viable, competitive and sustainable aquaculture sector."

1.2 AQUACULTURE YEARBOOK 2012

The main purpose of AAR (Aquaculture Annual Report) is to promote access to information and transparency related to the status of the aquaculture sector whilst creating awareness and promoting the sector. Objectives of this report include recording and monitoring progress of the sector; ensuring provision of reliable statistics and information to all stakeholders; facilitating public awareness; identifying challenges hampering the sector growth; assisting in identifying areas for further research and development; identifying deficiencies in management systems; and to contribute to the business cases for future development.

The 2012 AAR has been compiled based on data collected from aquaculture farms operating in South Africa during 2011. Data was collected using different mechanisms for marine and freshwater aquaculture as the management and regulatory framework are different for these sectors.

According to the conditions of operational permits issued in terms of section 13 of the Marine Living Resources Act, 1998 (Act No. 18 of 1998), marine aquaculture permit holders are obligated to submit a monthly report to the DAFF. The monthly report is divided into three separate reports designed to correspond with the major production phases at any aquaculture facility, namely broodstock, hatchery/juvenile and grow-out. The broodstock report gives an indication of how many broodstock animals are currently at the facility, number of broodstock restocked, origin of broodstock, mortalities and cause thereof and the number of spawning events that occur each month The hatchery/juvenile report gives an indication of the total number of animals produced, mortalities and the total number of animals moved to the grow-out section. The grow-out report outlines monthly production for the farm which is recorded as the total wet weight of the stock.

Freshwater aquaculture data was collected with the aid of freshwater aquaculture associations via questionnaires. The associations were requested to outline species farmed and production data for 2011. It is noted that the data collected may not be an entirely accurate reflection of the sector performance due to the lack of a mandatory requirement to submit such data to the DAFF. In some instances lack of cooperation from farmers contributed to freshwater data gaps observed.




2 STATUS OF MARINE AQUACULTURE 2011

2.1 Marine aquaculture species culture and systems used in South Africa in 2011

Species cultured in 2011 included abalone (*Haliotis midae*), pacific oyster (*Crassostrea gigas*), mussels (*Mytilus galloprovincialis* and *Choromytilus meridionalis*), dusky kob (*Argyrosomus japonicus*) and yellowtail (*Seriola lalandi*) whilst pilot scale operations included dusky kob, silver kob and yellowtail. Other species included seaweed, both *Ulva* spp and *Gracilaria* spp. Table 1 illustrates species cultured in South Africa and their operational scale in the sector.

Technology used to culture the above species included flow-through systems, cages used to culture abalone; floating wooden HDPE (High Density Polyethylene) rafts and longlines used to culture mussels with longline, raft and rack culture systems used for oyster culture as well as recirculation systems used in culturing finfish.

Table 1: Marine Aquaculture species and their operational scale in South Africa during 2011.

Marine Aquaculture species in South Africa, 2011		
Common Name	Scientific Name	Operational Scale
Dusky kob	*Argyrosomus japonicus*	Commercial
Yellowtail	*Seriola lalandi*	Pilot
Abalone	*Haliotis midae*	Commercial
Pacific oyster	*Crassostrea gigas*	Commercial
Mediterranean mussel	*Mytilus galloprovincialis*	Commercial
Black mussel	*Choromytilus meridionalis*	Commercial
Seaweed	*Ulva* spp	Commercial
Seaweed	*Gracilaria* spp	Commercial
White stumpnose	*Rhabdosargus globicep*s	Research
Spotted grunter	*Pomadasys commersonnii*	Research
Yellowbelly rockcod	*Epinephelus marginatus*	Research
Atlantic Salmon	*Salmo salar*	Research
South Coast Sea Urchin	*Tripneustes gratilla*	Research
South African Scallop	*Pecten sulcicostatu*s	Research
Bloodworm	*Arenicola loveni*	Research
Sea cucumbers	*Holothuridea* spp	Research

2.2 Marine aquaculture farms operating in 2011

A total of thirty (30) farms were operating by the end of 2011. Table 2 presents the number of farms operating, species cultured and the province in which they are situated. The Western Cape Province had the highest number of operating farms in 2011, amounting to twenty (20) and comprising of four (4) sub-sectors namely abalone, finfish, oysters and mussels. In the Eastern Cape Province six (6) farms were in operation and comprised three sub-sectors namely abalone, finfish and oysters. The Northern Cape had three (3) farms active in two sub-sectors namely abalone and oysters, whilst KwaZulu Natal had the least number of farms with only one finfish farm in operation. The distribution of these farms is presented in Figure 1.



Table 2: Total number of marine aquaculture farms operating in South Africa by sub-sector and province in 2011.

	Number farms cultivating species in each province				
Species	Western Cape	Eastern Cape	Northern Cape	KwaZulu Natal	Total
Abalone	11	1	2	0	14
Finfish	0	2	0	1	4
Mussels	3	0	0	0	3
Oysters	6	3	1	0	10
Total	**20**	**6**	**3**	**1**	**30**

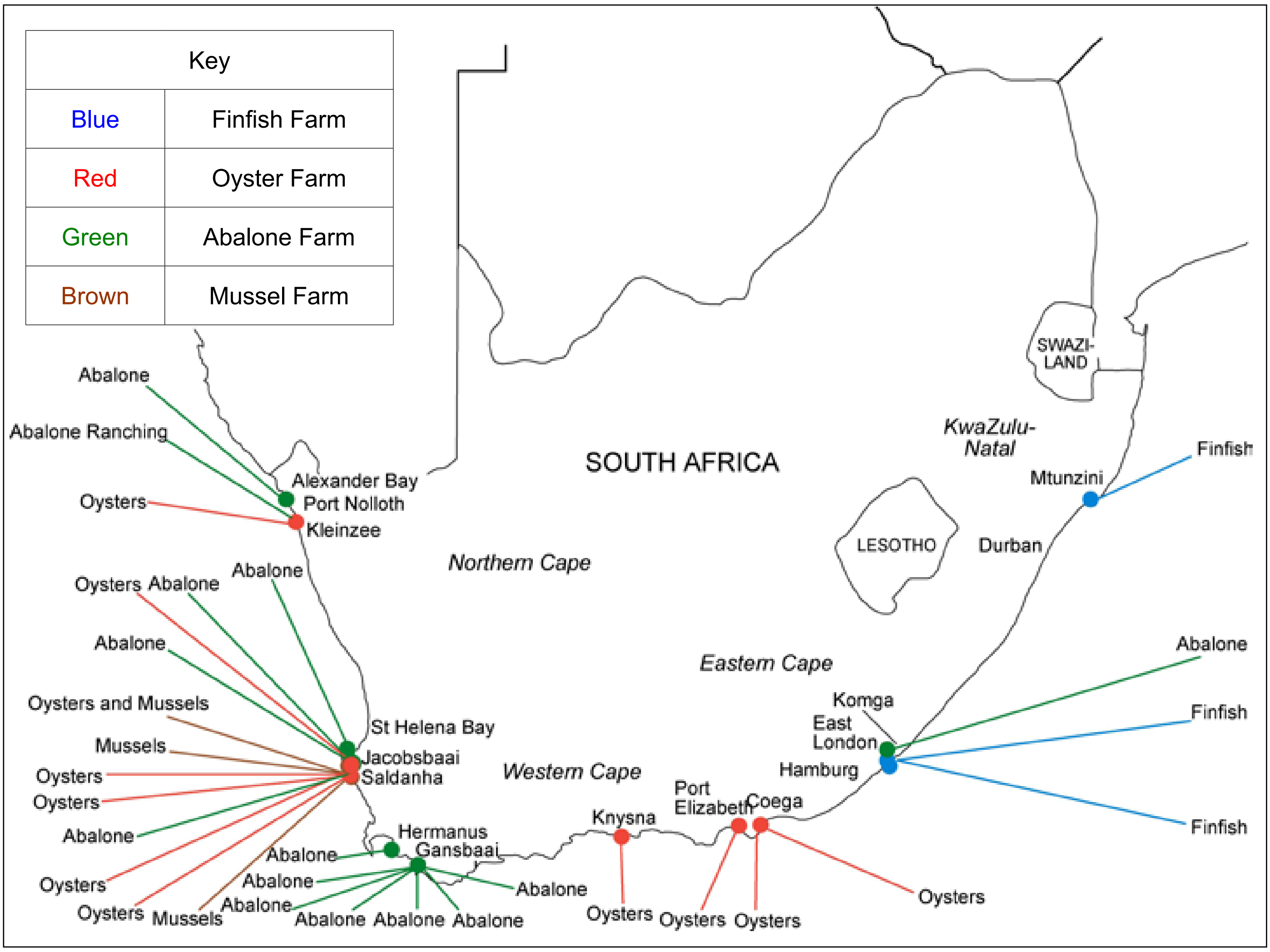


Figure 1: Farms in operation during 2011 and the distribution of cultured marine aquaculture species in each province.

2.3 Marine Aquaculture Authorization

The promulgation of the MLRA created a regulatory framework for the conservation of ecosystems, sustainable utilisation of marine living resources and orderly access to exploitation, utilisation and protection of certain marine living resources. Marine aquaculture also formed part of the activities that are regulated in terms of the MLRA, meaning that it was necessary that proper regulation was implemented in the form of issuing of Rights, Permits and Exemptions where necessary.

2.3.1 Marine aquaculture Rights

Marine Aquaculture Rights are granted in terms of Section 18 of the MLRA which states that:
"*18.* *(1) No person shall undertake commercial fishing or subsistence fishing, engage in mariculture or operate a fish processing establishment unless a right to undertake or engage in such an activity or to operate such an establishment has been granted to such a person by the Minister*".

The Marine Aquaculture Policy, gazetted in September 2007, provides for the Department to grant marine aquaculture long-term Rights which are valid for a period not exceeding fifteen (15) years. On the 27th March 2009, the Minister gazetted a General Notice No. 313 of 2009 inviting applications for long term Rights.

In 2011, two Marine Aquaculture Rights were granted. The Rights were for finfish, seaweed and marine ornamental species. Applications for a marine aquaculture Right can be submitted to the DAFF on a continuous basis. and the application process is open to any individual or registered business entity that has shown interest in exercising the activity. The applicant must meet the criteria set out in the application form and submit all relevant supporting documentation.

2.3.2 Permits

To activate a Right or Exemption outlined in paragraph 3.3.1, a Permit is issued in accordance with Section 13 of the MLRA which states that:

"13 (1) No person shall exercise any right granted in terms of section 18 or perform any other activity in terms of this Act unless a permit has been issued by the Minster to such a person to exercise that Right or perform that activity:

(2) Any permit contemplated in subsection (1) shall-

(a) be issued for specific period not exceeding one year;

(b) be issued subject to the conditions determined by the Minister in the permit; and

(c) be issued against payment of any fees determined by the Minister in terms of section 25(1).

(3) The holder of a permit shall at all times have that permit available for inspection at the location where the right or activity in respect of which the permit has been issued, is exercised.

(4) A permit to exercise an existing right in terms of the Act may be refused if the conditions of a previously issued permit had not been adhered to."

During 2011, 428 permits for Marine Aquaculture were issued in South Africa to Right holders, agencies, importers, exporters, Fish Processing Establishments (FPEs) and transportation companies (Table 3). Imports permits issued exceeded exports. This is a clear reflection of increased fish demand in the country and general economic trends of net importation into South Africa. There were 35 permits issued to "Possess and sell Undersized Cultured Abalone obtained from Right holder".

Table 3: Permit type and total number of permits issued in South Africa during 2011.

Permit type	Number issued
General Imports	82
Ornamental Imports	48
Exports	105
Transport	27
Engage in Marine Aquaculture Activities	52
Possess Broodstock and Operate a Hatchery	16
Possess and sell Undersized Cultured Abalone obtained from Right holder	35
Engage in Ranching Activities of Marine Species: Harvesting	1
Collect Broodstock for Marine Aquaculture purposes	10
Operate a Fish Processing Establishment	17
Scientific Investigations and Practical Establishments	20
Vessel license	10
Diving ban	5
Total Issued	**428**

2.4 Overview of South Africa's marine aquaculture production in 2011

In this document production is defined as the quantity of organisms produced from a farm specifically for human consumption and is expressed in tons. This definition excludes seaweed which in South Africa is only used as feed on abalone farms. South Africa's total production (excluding seaweed) in 2011 was 1 883 tons. Table 4 below illustrates the total production per sub-sector and province. In 2011 the Western Cape recorded a production of 1 624 and was the main contributor to South Africa's total marine aquaculture production followed by the Eastern Cape and Northern Cape recording production of 252 tons and 6 tons respectively. There was no production recorded in KwaZulu Natal in 2011.

The abalone sub-sector was highest contributing sub-sector in terms of production, producing 1 036 tons, followed by mussels and oysters producing 570 tons and 269 tons respectively. The finfish sub-sector contributed the least to total production, recording a production of 7.99 tons. Figures 2 and 3 below illustrates production levels for each sub-sector. The percentage contributed by each sub-sector was; abalone 55%, mussels 30.3%, oysters 14.3% and finfish 0.4%




Table 4: 2011 Marine aquaculture total production for human consumption per sub-sector and province.

	Production (tons) per Species and Province				
Species	Western Cape	Eastern Cape	Northern Cape	KwaZulu Natal	Total
Abalone	903.96	125.77	6.28	0	1 036.01
Finfish	0	7.99	0	0	7.99
Mussels	570.16	0	0	0	570.16
Oysters	150.37(21)	118.97	0 (26)	0	69.34
Total	**1 624.49**	**252.73**	**6.28**	**0**	**1 883.50**

() Oysters sold or moved to other provinces for grow out to market size

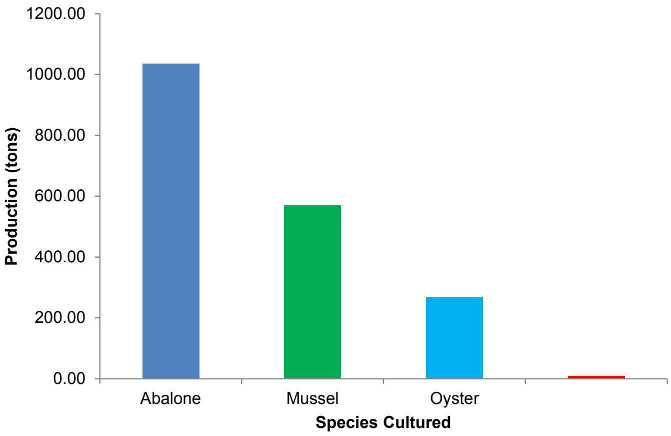


Figure 2: South African marine aquaculture production for human consumption per sub-sector for the year 2011.

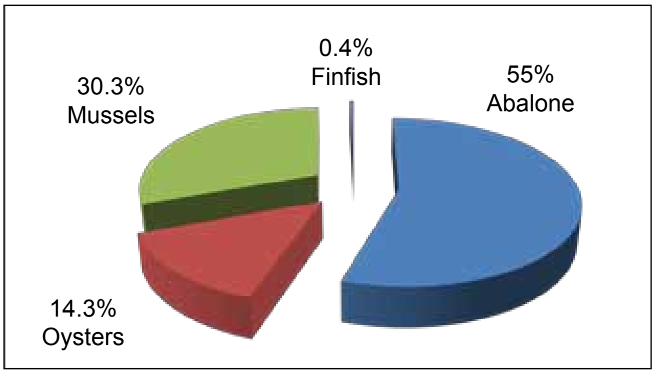


Figure 3: The percentage contribution of each sub-sector to total production in 2011.

2.5 South Africa's Marine Aquaculture production from 2000 – 2011

Total production in 2011 decreased by 108.6 tons from 2010 (a 5.5% decline). This decreased production is mainly due to lower production from two main contributing sub-sectors namely mussels and oysters. The mussel and oyster sub-sectors recorded decreases of 129.98 tons (18.6%) and 7.23 tons (2.6%) respectively. The abalone sub-sector experienced increased its production by 20.57 tons (2%) whilst the finfish sub-sector increased its production from zero in 2010 to 7.99 tons in 2011. Seaweed production increased by 869.6 tons from the year 2010 to 2011 (43.16%). Table 5 below illustrates production from 2000 to 2011 and the growth rate of the industry. Overall the marine aquaculture industry (excluding aquatic plants) displayed a growth rate of 6.46% from 2000 to 2011 (Figure 4).



Table 5: South Africa's marine aquaculture production 2000 – 2011.

	Year and Production (tons)												Total production (tons) 2000 – 2011
Sub-sector	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Abalone	181.03	372.88	429.42	462.02	509.2	670.8	833.36	783.25	1037.11	913.58	1015.44	1036.01	8244.10
Finfish	1.04	0.3	2.38	14	1.81	1.68	0	0	2.71	22.75	0	7.99	54.66
Mussels	500	600	429.11	623	640	472	542	466	736.74	682.4	700.14	570.16	6961.55
Oysters	247.01	187.53	272.1	255.24	147.66	174.91	279.87	157.86	226.62	223.53	276.57	269.34	2718.24
Prawns	126.84	120.19	157.7	124.88	0	0	0	0	11.44	17.92	0	0.00	558.97
Seaweed	0	0	0	0	0	0	664	0	1833.49	1900.18	2015.01	2884.61	-*
Totals**	**1055.92**	**1280.9**	**1290.71**	**1479.14**	**1298.67**	**1319.39**	**1655.23**	**1407.11**	**2014.62**	**1860.18**	**1992.15**	**1883.50**	**18537.52**

*Seaweed culture data not confirmed for previous years
**Totals exclude seaweed cultured

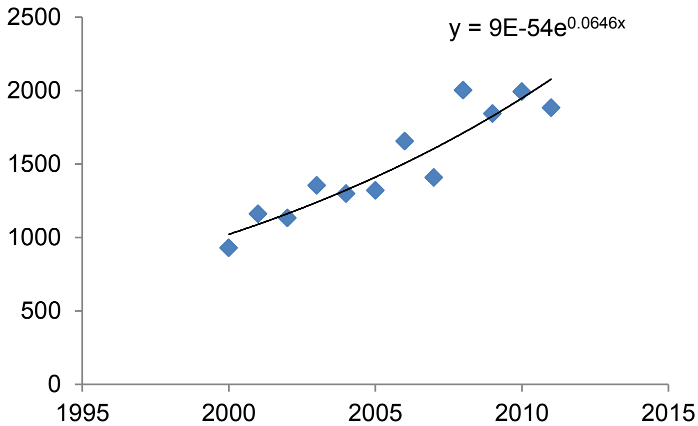


Figure 4: Graph illustrating growth rate of the marine aquaculture industry from 2000 to 2011.

2.6 Analysis of marine aquaculture sub-sectors

2.6.1 Abalone Industry

The abalone species cultivated in South Africa is *Haliotis midae* and it contributed 55% to South Africa's total production in 2011, recording a total production of 1 036 tons (Figure 5). The total spat moved from the hatchery/nursery (including weaning) to the grow-out section amounted to 15 million spat weighting between ±0.2g - ±2g. The total broodstock within the abalone sub-sector at the end of 2011 was at 2 732 tons.

Total feed used in the abalone sub-sector during 2011 was 7 830 tons which comprised of 1 009 tons artificial feed and 6 820 tons of seaweed/kelp. During 2011, 14 abalone farms where in operation in South Africa 12 of these were land-based facilities with independent hatcheries whilst the other 2 abalone farms included 1 sea cage farm and 1 ranching operation.

The abalone industry's distribution range stretches from the North and Western Cape to the Eastern Cape. 2 farms were




operational in the Northern Cape in 2011, 1 situated in Port Nolloth and the other a ranching operation situated in Kleinsee. 11 abalone farms are situated in the Western Cape of which 8 are located within the Overberg region and 3 along the West Coast at Saldanha Bay, Jacobsbaai and St Helena Bay. In the Eastern Cape there was only 1 abalone farm in operation in 2011. This abalone farm is situated in Komga, a few kilometres outside East London. The Western Cape dominated abalone production and contributed 87.3% to total abalone production in South Africa, followed by Eastern Cape with 12.1% and the Northern Cape with 0.6%

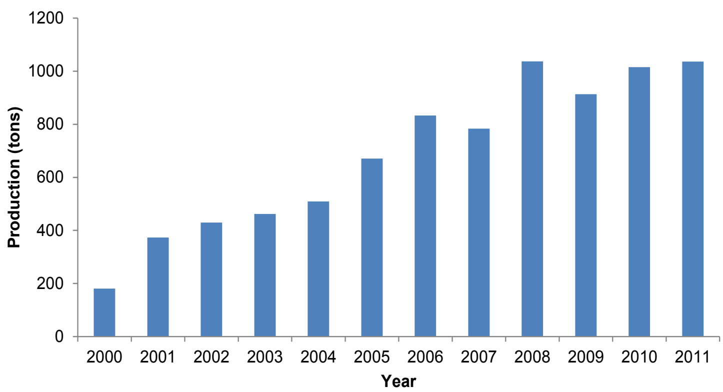


Figure 5: Abalone production for the years 2000 – 2011.

Figure 6: Abalone farmer displaying abalone in grow out facility.

2.6.2 Finfish Industry

The marine finfish species cultivated in South Africa in 2011 was dusky kob (*Argyrosomus japonicus*). Yellowtail (*Seriola lalandi*), mangrove Snapper (*Lutjanus argentimaculatus*), spotted grunter (*Pomadasys commersonnii*) and yellow belly rockcod (*Epinephelus marginatus*) were not cultured in 2011 although there were broodstock held on farms. The finfish sub-sector recorded nil production for 2010, however in 2011 the sub-sector recorded a production of 7.99 tons (Figure 7). The increase in production and the use of a variety of species is an indication of the sub-sectors development and ongoing growth.

Four farms were in operation during 2011 and they are situated in the West and Eastern Cape and in KwaZulu Natal. These operations include; a recirculation facility in the Western Cape, a pond culture facility in KwaZulu Natal and two recirculation facilities in the Eastern Cape.

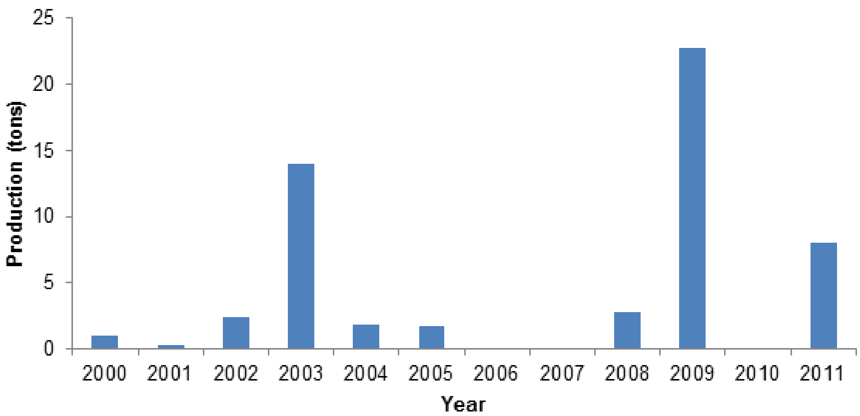


Figure 7: Finfish production for the years 2000 – 2011.

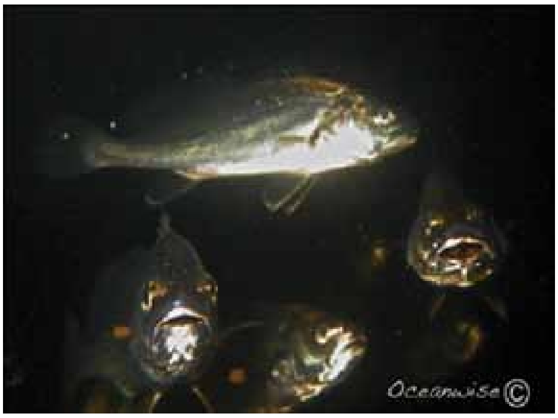


Figure 8: Juvenile dusky kob feeding (picture supplied by Oceanwise Pty, Ltd).

Figure 9: Mangrove Snapper (*Lutjanus argentimaculatus*) broodstock (picture supplied by Pure Ocean Pty, Ltd).

Figure 10: Yellow belly rockcod (*Epinephelus marginatus*) broodstock (picture supplied by Pure Oceans Marine Pty, Ltd).

2.6.3 Oyster Industry

The oyster species cultivated in South Africa is the exotic Pacific oyster (*Crassostrea gigas*). 12 farms were operational in 2011, which included 2 farms producing oysters as a secondary crop. The production of oysters in the sub-sector was 269 tons displaying a decrease in production from 2010 (Figure 11). The decrease in production is attributed to the large number of farm closures experienced in 2011. According to the South African Molluscan Shellfish Monitoring and Control Programme SAMSM & CP (Section 3.9) there were 26 farm closure notices sent to shellfish farms in 2011, some farms were closed for a period of six months and they were not allowed to market live products. The oyster sub-sector contributed 14.3% to total production in 2011. The recorded intra-industry of oyster was 47.26 tons. Oyster spat were imported from Chile, Guernsey and Namibia during 2011.

Oyster farms are currently situated in the North, West and Eastern Cape. 7 farms in the Western Cape were operational with 5 in Saldanha Bay, 1 in Knysna and 1 in Paternoster. The Western Cape oyster farms contributed the majority of production, contributing 55.8%. Oyster farming in the Eastern Cape is represented by 3 farms, 2 located in Port Elizabeth (although 1 closed down during the year) and 1 in Jeffery's Bay. The oyster farms in the Eastern Cape made up 44.2% of the total production of oysters in South Africa.



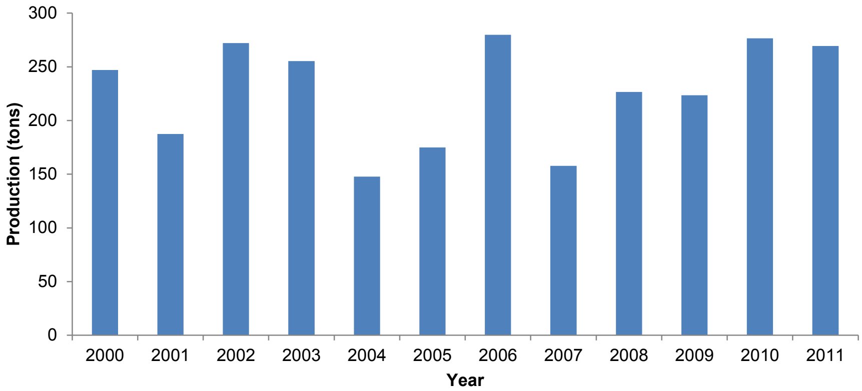


Figure 11: Oyster production for the years 2000 – 2011.

Figure 12: Workers on an oyster farm sorting the oysters into crates after harvest.

Figure 13: Oysters being purged, ready for the market.

2.6.4 Mussel Industry

Mussel farming in South Africa is situated in Saldanha Bay, Western Cape and is represented by 3 operations in the area. The species cultured in South Africa are the exotic Mediterranean mussel (*Mytilus galloprovincialis*) and the indigenous black mussel (*Choromytilus meridionalis*). In 2011 this sub-sector produced 570 tons of mussels decreasing by 129.98 tons (18.6%) (Figure 14). Similar to oyster this decrease in production is a result of the large number of farm closures experienced in 2011 which disallowed product from being marketed. The mussel sub-sector contributed 30.3% to total production in 2011 and is presently the second highest contributor.

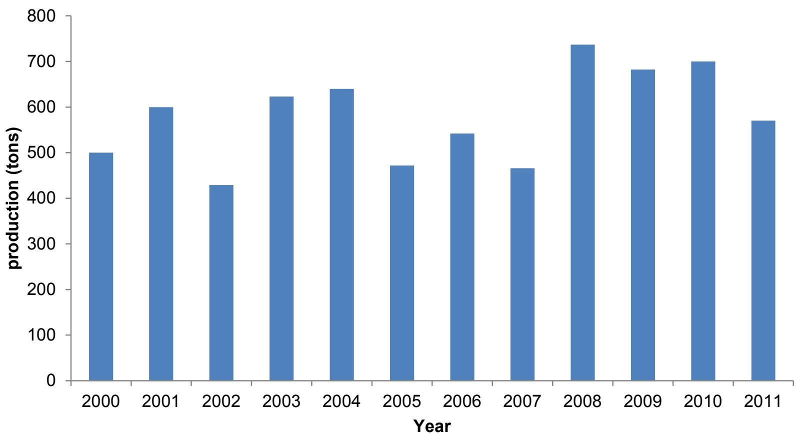


Figure 14: Mussel production for the years 2000 – 2011.




2.6.5 Seaweed Industry

The species cultivated in South Africa include the *Ulva* spp and *Gracilaria* spp. Three farms cultivated seaweed in 2011, one situated in the Eastern Cape and two in the Western Cape. The total seaweed produced and used as feed for abalone in 2011 was 2 884 tons, increasing production by 869 tons (43.16%) from the 2 015 tons produced in 2010.

2.6.6 Other Marine Aquaculture Industries

There were no legally registered marine ornamental farms operating in South Africa.

2.7 Marine Aquaculture Economics

This Marine Aquaculture economic section is an annual update version of the economic section provided in 2010. The Information contained in this report was collected from a questionnaire submitted to industry and also through various sources referenced in the summary. The purpose of the summary is to provide industry with statistics as well as to monitor economic trends of the sector. Over the past year there have been several major developments which have greatly stimulated and enhanced the development of the Marine aquaculture sector in South Africa.

2.7.1 The Value of the Marine Aquaculture sector

The estimated total value for the marine aquaculture sector was R379 million and the sector achieved a growth rate of 0.2% in sales value in 2011. Abalone sub-sector sales increased by 0.6% to R357 million, representing 94% of the entire sector. The Oyster sub-sector declined by 0.6% to R14 million and contributed 3.6% in terms of value, whilst mussel sales declined by 18% (Figure 15).

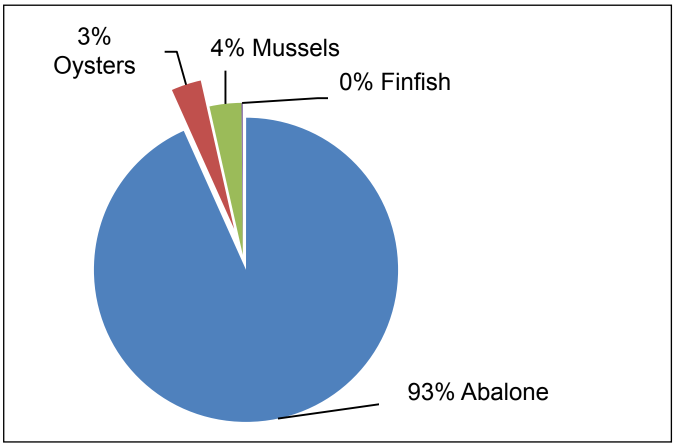


Figure 15: The estimated percentage contribution to total production value of South African's Marine Aquaculture Sector in 2011.

2.7.2 Contribution to the Gross Domestic Product

The South African marine aquaculture sector is still developing and accounts for less than 1% of Africa's total aquaculture production output. The sector achieved minimal growth during the past year even though it has demonstrated potential to grow and contribute to South African economic growth. During 2011 Marine aquaculture's contribution to the Gross Domestic Product (GDP) was minimal; the sectors contribution to GDP was estimated to be approximately 0.020%.

2.7.3 Investments

Capital investment in the marine aquaculture sector from private equity firms, owner's capital contribution and Development Finance Institutions was approximately R179 million in 2011, increasing 38% from 2010. The reason for investment was primarily expansion to increase production output and it is anticipated that the increased production output will increase empowerment shareholding and the number of employment opportunities in the sector. An example of investment included a R52.5 million capital investment for an Abalone farm by a private equity firm in collaboration with the Industrial Development Corporation (IDC). Recapitalisation and expansion of a Black Economic Empowerment (BEE) mussel farm initiative was also funded by the National Empowerment Fund (NEF) at R9.9 million. Figure 16 below illustrates the percentage of capital investment into the industry in 2011.

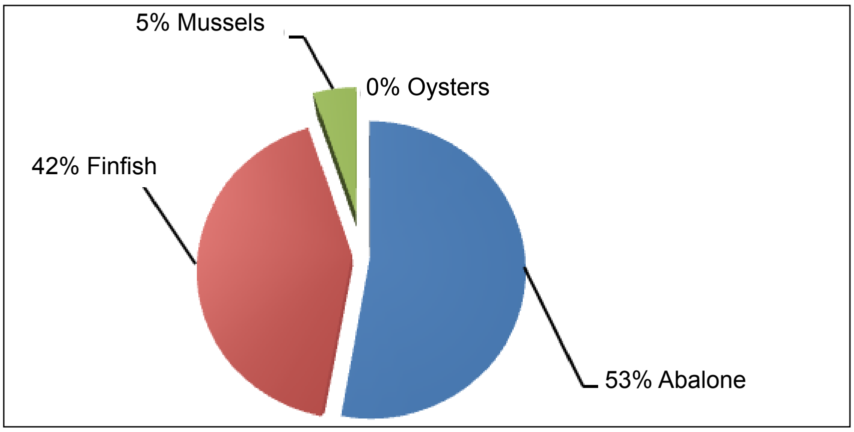


Figure 16: The South African Marine Aquaculture capital investment made by the sub-sectors in 2011.

2.7.4 Employment

The South African marine aquaculture sector is developing and contributing towards creating employment. In 2011 the sector employed approximately 1 607 fulltime individuals directly on the farms, an increase of 2%. It is anticipated that this figure could be doubled to approximately to 3 214 if the services sector such as; feeds, processing, security, transport, packaging, manufacturing of equipment, research and government services is taken into account. The marine aquaculture sector is creating jobs that contribute to food security through income generated.

The Abalone sub-sector created the majority of jobs totaling to 1 219, of which 74% were male and 23% female. This was followed by the Oyster sub-sector which created 157 employment opportunities, with 83% of workers male and 17% of them female. The marine finfish sub-sector employed 152 individuals on a full time basis and 71% were male and 29% female. The Mussel sub-sector employed 79 individuals' directly on farms, 85% male and 15% female (Figure 17).

The Western Cape Province employed a total of 1 255 individuals representing 78.1% of the total employment in the marine aquaculture sector. Eastern Cape was the second largest employer with 352 workers, 76% male and 24% female in 2011. No employment was recorded during 2011 for the KwaZulu Natal Province.

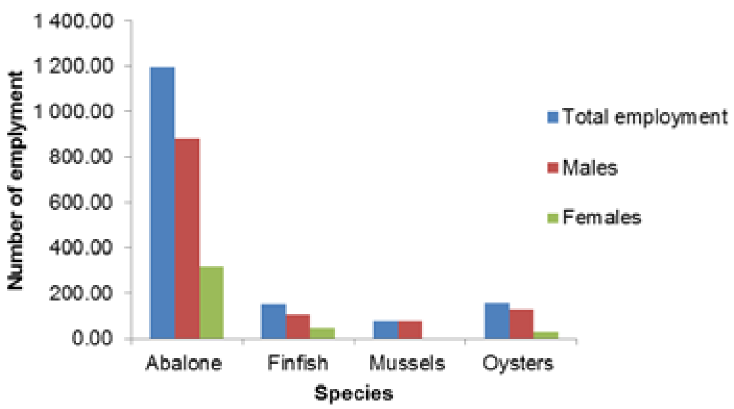


Figure 17: Full time employment in the Marine Aquaculture sector by species group during the year 2011.

2.7.5 Market structure

Marine aquaculture products are marketed locally and internationally depending on the species. The exports and imports in the summary include marine aquaculture combined with that of captured fisheries. The only exception was the Abalone sub-sector as their entire production is exported to the Asian market. Small quantities of farmed oysters and mussels were however also exported during 2011.

2.7.6 Marine aquaculture exports

2.7.6.1 Abalone exports

The South African abalone species is rated amongst the best species and product globally and has developed an excellent reputation in terms of brand quality over the past ten years. Abalone producers have also developed their own niche markets in countries such as China, Hong Kong, Japan, Thailand, Taiwan, Singapore and Malaysia. The abalone sub-sector is export orientated which resulted to the entire production being exported to the Asian market. The sub-sector exported 1036.01 tons with a value of approximately R357 million in 2011 (Table 6). Export value increased by 0.5% compared to 2010 and this increased value could be attributed to the increased production output and a relatively stable exchange rate. Despite the growth in value, it was indicated that the sub-sector is experiencing competition with international sales from lower cost countries with higher production yields and lower production costs[1]. Other challenges include high energy costs and the cost of health services.

Table 6: South Africa's farmed abalone exports during 2011.

Species	Region	Export quantity (mt)	Value (million)
Abalone	Asia	1036.01	357

Data compiled from monthly production reports submitted to DAFF- data may include official, semi-official or estimated data

2.7.6.2 Oyster exports

The Oyster sub-sector recently started to export small quantities of oysters to the Far East to test the market. Excellent quality of domestically produced Shellfish has opened new markets offshore and the South African Oysters is poised to grow significantly in the Far East.

The Oyster sub-sector experienced several challenges when exporting their products. Some of the challenges included not having requisite Export Health Certification and an affordable product Health Certification Programme for bivalve molluscs which prevent the sub-sector from exporting[2]. This may prevent the sub-sector from exporting to other countries because certification can be used as barrier of entry to certain markets when competing in the global market.

According to SARS 2011 statistics, South Africa exported approximately 78.24 tons of farmed and wild caught oysters valued at R3.7 million in 2011. Hong Kong was the biggest importer with over 41 tons, followed by Malaysia with 23 tons of oysters' products. China and Singapore imported the least, 2.2 and 0.045 tons respectively. Mozambique was the leading African importer for local oysters with 8.6 tons. Last year, the majority of oyster exports went to the Asian market and a small proportion was channeled to the African market. Table 7 below, demonstrates the exported volumes of South African oysters to the international market. From the table it is clear that the bulk of South African oysters go to Asian markets.

1 Stated as a challenge by the Abalone producer in the marine aquaculture economic survey used for data collection by DAFF.
2 Indicated as challenge by the Oyster producers in the economic survey questionaire submitted to DAFF.

Table 7: South African exports of oyster products during 2011.

Species	Country	Quantity (mt)	Value (FOB)
Oysters	Hong Kong	41.7	R 2 773 502
Oysters	Zambia	0.5	R 32 619
Oysters	Zimbabwe	1.6	R 64 931
Oysters	St. Helena	000.5	R 779
Oysters	Malaysia	23.4	R 202 270
Oysters	Mozambique	8.7	R 35 144
Oysters	Singapore	0.05	R 2 839
Oysters	China	2.3	R 169 475
Oysters	Mauritius	0.002	R 459
Oysters	Angola	0.04	R 2 000
Total tons		**76**	**R 3 794 534**

Source: South African Revenue Service statistics 2011

2.7.6.3 Mussels exports

South Africa exported approximately 27 tons of mussels with an estimated value R702 708 in 2011. The bulk volume of exports was for the African market representing 80% and only 20% was destined for Asian markets. Table 8, demonstrates South African exports of Mussels to the different countries in African and Asia in 2011.

Table 8: South Africa's exports for mussel products during 2011.

Species	Country	Quantity (mt)	Value (FOB)
Mussels	Zambia	3.83	R 66 354
Mussels	Zimbabwe	2.20	R 80 379
Mussels	Mozambique	1.9	R 84 765
Mussels	China	5	R 34 421
Mussels	St. Helena	0.005	R 681
Mussels	Angola	1.58	R 69 281
Mussels	Ghana	0.695	R 21 649
Mussels	Mauritius	8.58	R 286 885
Mussels	Hong Kong	0.426	R 41 775
Mussels	Uganda	0.109	R 3 346
Mussels	Congo (DRC)	0.151	R 2 719
Mussels	Malawi	0.036	R 2 404
Mussels	Nigeria	3.29	8049
Total tons		**27.8**	**R 702 708**

Source: South African Revenue Service statistics 2011



2.7.7 Marine aquaculture Imports

2.7.7.1 Oysters imports

Approximately 4 tons of oysters were imported over the past year and these were in the form of spat, live animals and value added products. Countries exporting to the domestic market were China, Chile, France, Taiwan, United States and Mozambique. Imported Oyster products have been identified as a possible threat to the growth and development of the local industry since they are not subject to the same certification requirements as local producers even though they are competing for the same market. In addition, there is high competition with lower quality and cheap oysters from foreign countries, an import tariff was recommended as a protection measure that can assist the local producers from dumping. Table 9, Indicates the quantity and country origin for oyster products imported into South Africa during 2011

Table 9: South Africa's imported oyster products during 2011.

Species	Country	Quantity (mt)	Value (FOB)
Oysters	France	0.1	R1 514
Oysters	Chile	0.1	R1 514
Oysters	Taiwan	0.049	R103
Oysters	United States	0.008	R 4 860
Oysters	China	1.8	R13 361
Oysters	Mozambique	1.85	R18 324
Total tons		**3.91**	**R39 676**

Source: South African Revenue Service statistics 2011

2.7.7.2 Mussels imports

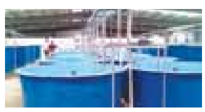
The South African mussel farming industry faced rigid competition from frozen mussel exporters in other countries that are not subject to the same certification requirements as local producers. More than 200 tons of mussel products valued at approximately R5.3 million (FOB) were imported during 2011. The major exporting country was New Zealand with 110 tons, followed by China with 68 tons, then Chile with 42 tons and Denmark and United Kingdom with less than a ton each (Table 10). This partially demonstrates a demand for mussels and may be a market for local farmed mussel products

Table 10: South Africa's imported mussel products during 2011.

Species	Country	Quantity (mt)	Value (FOB)
Mussels	China	68.2	R 773 762
Mussels	Denmark	0.12	R19 685
Mussels	Chile	42.59	R925 657
Mussels	New Zealand	110.84	R3 659 180
Mussels	United Kingdom	0.008	R1 901
Total tons		**221.68**	**R5 380 185**

Source: South African Revenue Service statistics 2011



2.7.7.3 Salmon imports

The Salmon industry is well-established internationally and has been dominated by Norwegian, Chilean and Scottish producers for many years (International Trade Probe, July 2012). Table 11 below, presents three countries that exported salmon to South Africa in 2011. The countries of origin for South African imports were Norway, Chile and the United Kingdom who exported approximately 290.1, 42.2 and 4.6 tons respectively. The demand for imported Salmon products has increased in South African over the past eleven years.

Table 11: South Africa's imported Salmon products during 2011.

Species	Country	Quantity (mt)	Value (FOB)
Atlantic Salmon	Chile	42.2	R 14 509 78
Atlantic Salmon	Norway	290.1	R 12 2093 89
Atlantic Salmon	United Kingdom	4.6	R 1 987 46
Total		**336.1**	**R 12 2093 89**

Source: South African Revenue Service statistics 2011

2.8 Marine Aquaculture site Surveillance in 2011

Site surveillance of the marine aquaculture sector has played a vital role since 2008 in ensuring compliance with the Department's marine aquaculture permitting frameworks and the regulations promulgated under the Marine Living Resources Act, 1998 (Act No. 18 of 1998). This has been essential in ensuring that non - compliant operations are communicated through proper channels such that the Directorate: Monitoring, Control and Surveillance (MCS) who performs its role responsibly in protecting the wellbeing of the industry. Between January and November 2011, the Department conducted site surveillance of 17 marine aquaculture Right Holders, including 8 abalone (*Haliotis midae*) farming operations, 6 oyster (*Crassostrea gigas* and *Striostrea margeritacea*) farming operations, 2 finfish (*Argyrosomus japonicus* and *Seriola lallandi*) farming operations and 2 mussel (*Mytilus galloprovincialis*) farming operations, between Port Nolloth on the west coast and Port Elizabeth on the east coast.

In 2010, the Department initiated an economic survey through the Directorate: Aquaculture Technical Services (ATS) and a shellfish sanitary survey through the Directorate: Sustainable Aquaculture Management (SAM). This has been an ongoing exercise implemented throughout 2011 in collaboration with site visits to marine aquaculture operations and has formed an integral part in evaluating the economic and food safety status of the sector. The Department aims to work closely with industry and ensuring open channels for communication from the marine aquaculture sector through the continued support provided in implementing continued site surveillance. More recently in 2012, the Department has initiated an oyster biosecurity survey of the marine aquaculture sector through the Directorate: Sustainable Aquaculture Management (SAM) in collaboration with site surveillance. This will prove vital in evaluating the biosecurity status of existing oyster farms operating between Kleinzee in the Northern Cape and Port Elizabeth in the Eastern Cape.

2.9 South African Molluscan Shellfish Monitoring and Control Programme

2.9.1 Overview of programme

The South African Molluscan Shellfish Monitoring and Control Programme (SAMSM & CP) is a programme within the Aquaculture and Economic Development Chief Directorate, which falls within the Fisheries Management Branch of the Department of Agriculture, Forestry and Fisheries (DAFF). The programme aims to provide the necessary guarantees to local and international markets that the risk of disease and poisoning through consuming molluscan shellfish is adequately managed and minimised in South Africa. To ensure that this aim is achieved, the SAMSM & CP is working




closely with the Fisheries Compliance Office (FCO) of DAFF, South African molluscan shellfish farmers, laboratories, the National Regulator for Compulsory Specification (NRCS), the Department of Health (DoH) and Municipalities.

The molluscan shellfish species farmed in South Africa include *Haliotis midae* (Abalone), *Crassostrea gigas* (Oyster), *Mytilus galloprovincialis* (Mediterranean mussel) and *Choromytilus meridionalis* (Black mussel).

The shellfish farms are monitored by the SAMSM & CP for human health hazards such as biotoxins, microbiological organisms, heavy metals, pesticides, polychlorinated biphenyls (PCBs) and radionuclides. Should the regulatory limit for any of the hazardous substances or organisms be exceeded the farms are temporarily closed for harvesting until the contaminant has dropped to below the regulatory limits.

2.9.2 Shellfish farm status

There were 19 shellfish farms monitored by the SAMSM & CP during 2011 of which 9 were West of Cape Point and 10 to the East. The farms to the west included 3 abalone farms, 2 mussel farms and 2 oyster farms. The farms east of Cape Point included 8 abalone and 3 oyster farms. 1 of the mussel farms west of cape point also cultures oysters and 1 of them mussels.

Most abalone farms are land based and one is sea based. Abalone on land based farms is grown in tanks and water is pumped from the sea into the tanks through free flow and/or recirculation systems.

Oyster and mussel farms are sea-based and grown on ropes suspended from floating rafts; on one farm however oysters are grown on racks planted in the substrate.

Shellfish farms are susceptible to poor water quality as a result of Harmful Algal Blooms (HABs), sewage and industrial and domestic contamination. The farms which are at most risk are those situated near developed areas. Most of the farms in South Africa however are situated in areas that are relatively free of pollution and have had relatively low incidences of biotoxin concentrations exceeding the regulatory limit.

2.9.3 Monitoring data and farm closures

Data has been captured and analysed for marine aquaculture farms along the South African Coast. The biotoxins were analysed separately for 2 regions viz. west of Cape Point and east of Cape Point. The other hazardous substances were analysed for the coast as a whole. There were 26 farm closure notices sent to shellfish farms by the SAMSM & CP office in 2011. West of Cape Point 19 notices were issued and 7n were issued for farms east of Cape Point. Most farm closures were due to biotoxins, and a few due to microbiological contamination. There were no closures due to other hazardous substances viz. heavy metals, pesticides, PCBs or radionuclides.

2.9.4 Biotoxins

During 2011, two farms were closed due to non-compliance to the biotoxin testing schedule; otherwise farms were only closed due to PSP and DSP causing toxins levels exceeding the regulatory limit.

2.9.5 Paralytic Shellfish Poison

The concentrations that exceeded the regulatory limit triggered farm closures. Only 3 abalone farms were closed as the PSP toxin levels exceeded the regulatory limit. These farms were not allowed to market live product, only processed products where the abalone was eviscerated and scrubbed. Some of these farms were closed for sale of live products for approximately six months during 2011 and were under an intensive sampling schedule to ensure close monitoring of PSP toxin. No PSP toxins detected in shellfish farms East of Cape Point and as a result there were no closures.




2.9.6 Diarrhetic Shellfish Poison

The mussel and oyster farms in Saldanha Bay tended to experience more DSP closures in 2011. Farm closures due to DSP occurred mostly between April and August. Some of the farms remained closed for about six months. Only 1 oyster farm experienced closures as a result of the DSP toxin tests.

2.9.7 Amnesic Shellfish Poison

Though low levels of Amnesic Shellfish Poison (ASP) toxins have been detected in mussels in Saldanha Bay, no shellfish farms were closed due to ASP exceeding the regulatory limit. There has been no ASP toxin detected in abalone to date.

2.9.8 Microbiological Contaminations

E. coli, which is used as an indicator species, is used for the classification of growing areas and is an important indicator of sewage pollution and associated diseases. The farms were all classified as “Approved” based on the data received. Other microbiological organism’s data analysed included *Salmonella* and *Vibrio*. Data for wet storage facilities for the oyster farms are also analysed.

2.9.9 Escherichia coli

In 2011 there were a few farms that were sent closure notices due to *E. coli* levels exceeding the regulatory limit. The closures were mostly between April and July and in some cases appeared to be associated with high rainfall events.

2.9.10 Heavy metals, Pesticides, PCBs and Radionuclides

The levels of heavy metal tended to be higher in mussels and oysters than in abalone; most of these farms are at Saldanha Bay. East and West of Cape Point there were no farm closures due to heavy metals exceeding the regulatory limits.

2.9.11 Compliance History

Most of the farms have complied with the requirements of SAMSM & CP. There were only 2 that did not. The main reason for non-compliance was failure to do the required tests according to the frequency stipulated in the SAMSM&CP. The farms are now both complying with the SAMSM & CP

2.9.12 Shellfish Monitoring Programme Progress

South African shellfish farmers have accepted the SAMSM & CP and are prepared to comply with its requirements. A few oyster farms have however contested the DSP Mouse Bioassay, but they have not provided any suitable alternative to date. DAFF has increased its capacity to improve on the effective management of the programme by appointing two new staff.

There are now 3 staff members managing the programme, which includes an Assistant Director, an Environmental Officer Special Production (EOSP) and an Environmental Officer Production (EOP).

In 2011 the SAMSM & CP office through an audit conducted with assistance from NRCS, identified a gap in phytoplankton monitoring for food safety purposes. Standard Operation Procedures (SOPs) for On-farm phytoplankton identification and SAMSM & CP lab phytoplankton monitoring have been compiled. These SOPs are compiled in relation to the SAMSM&CP manual. The SAMSM & CP staff also attended phytoplankton identification courses as a capacity building exercise. Currently phytoplankton monitoring is being implemented.



The Liquid Chromatography Mass Spectrometry (LCMS) for biotoxin analysis that was procured by the DAFF in 2010 to assist famers with effective analysis of shellfish samples has been fully implemented for testing DSP causing toxins. Currently the CSIR lab is in progress with validation of an AOAC method 2005.06 to test for PSP causing toxins on the Liquid Chromatography Fluorescence Detector (LCFLD). The use of the LCMS has reduced the overall cost of biotoxin analysis and increased accuracy of analysis.

The SAMSM & CP staff has improved the working relationship with other stakeholders involved in the programme. In 2011 several meetings were held to improve working relationships with labs and other stakeholders. In these meetings ideas were exchange and that assisted with the improvement of the office and the stakeholder's activities, for example improvement of turnaround time for the availability of results to the SAMSM & CP office and farmers. Some challenges with laboratories that were not compliant with the SAMSM & CP requirements were addressed in these meetings.
According to the SAMSM & CP internal audit and NRCS independent audit, the biotoxin and microbiological labs and the SAMSM & CP office met more than 60% of the EU requirements for export of shellfish to the EU countries. The SAMSM & CP office has also assisted the oyster and mussel farmers towards achieving the export requirements of China.

2.10 Animal Health

2.10.1 Aquaculture and animal health

While aquaculture is poised to contribute crucially to the world's wellbeing and prosperity (FAO, 2012), the development however depends on accessible regulatory and facilitative aquatic animal health and welfare management frameworks to promote the sustainable development of the industry. In order to address the issue of animal health in aquaculture, the Department had initiated animal health surveillance and disease control systems by outsourcing an aquatic animal health specialist to assist in conducting active surveillance in operational marine aquaculture farms during 2011/2012. This surveillance included annual routine inspections and examination of the aquaculture animals on the farm for clinical disease and histopathological analysis of samples collected.

2.10.2 Animal Health Surveillance and Disease Control system

In general, surveillance is aimed at demonstrating the absence of disease or infection, determining the occurrence or distribution of disease or infection, while also detecting as early as possible exotic or emerging disease. In 2011, the animal health surveillance through stock inspections was conducted on abalone, oysters and marine finfish to detect and facilitate the control of disease or infection. Inspections for this year were characterized by an unusually high number of re-inspections of farms exhibiting high numbers of mortalities. Through the annual animal health surveillance, collectively 5 farms were identified to be of concern to developing a disease; however, measures implemented by farms' management were put in place to minimize the risk of possible cross infections to other farms.

2.10.3 Disease events in 2011

2.10.3.1 Abalone Tubercle Mycosis (ATM)

A single suspect case of abalone tubercle mycosis was histologically detected during the annual animal health surveillance in a land-based aquaculture facility. Based on the active surveillance results, the findings of the suspect case were incidental.

2.10.3.2 Epizootic Ulcerative Syndrome (EUS)

EUS was confirmed in 2 sites of freshwater systems in the Western Cape Province during the year 2011. Pathology of the animals showed granulomatous and necrotizing dermatitis and furunculosis with suspected hyphae as well as



focally extensive ulcerative dermatitis. There had been evidence that if the two outbreaks have common source, movement of fomites between dams without appropriate cleaning, could be a potential source of the infection. Reports on these events were provided to the OIE and the Department is undertaking an ongoing targeted surveillance on the sites in question.

2.10.4 Animal Health Training

In 2011, the Department was involved in major training exercises and conferences with aquaculture stakeholders. These training sessions included the OIE-BSTF regional aquatic animal disease focal points training seminar in Grahamstown, the World Veterinary Council held at Cape Town and Histopathological training at the Stellenbosch Veterinary Community Clinic. These trainings sessions were held to address issues of service delivery by capacitating practicing veterinarians, state veterinarians and aquaculture officials in order to support the growing aquaculture industry.



3 STATUS OF FRESHWATER AQUACULTURE 2011

3.1 Fresh water aquaculture species culture in South Africa in 2011

The freshwater aquaculture industry is the oldest aquaculture sector in the country and is more developed in terms of number of producers and the diversity of species cultured in South Africa. Sub-sectors in the freshwater industry include trout (*Oncorhynchus mykiss* and *Salmo trutta*), tilapia (*Oreochromis mossambicus*, *Oreochromis niloticus* and *Tilapia rendalli*), catfish (*Clarias gariepinus*), carp (*Cyprinus carpio* and *Ctenopharyngodon idella*), mullet (*Liza richardsonii*), largemouth bass (*Micropterus salmoides*), marron crayfish (*Cherax tenuimanus*), Atlantic salmon (*Salmo salar*) and a number of aquarium species (i.e. koi carp, goldfish, guppies, etc.). However, the major farmed species are rainbow trout, koi carp and ornamental species, tilapia and catfish (Table 12).

Table 12: Freshwater aquaculture species cultured in South Africa during 2010 and their operational scale

Freshwater Aquaculture species in South Africa 2011		
Common Name	Scientific Name	Operational Scale
Rainbow trout	*Oncorhynchus mykiss*	Commercial scale
Brown trout	*Salmo trutta*	Commercial scale
Mozambique tilapia	*Oreochromis mossambicus*	Pilot scale
Nile Tilapia	*Oreochromis niloticus*	Commercial scale
Redbrest Tilapia	*Tilapia Rendall*i	Commercial scale
African Sharptooth catfish	*Clarias gariepinus*	Pilot scale
Common carp	*Cyprinus carpio*	Commercial scale
Koi carp	*Cyprinus carpio*	Commercial scale
Largemouth bass	*Micropterus salmoides*	Commercial scale
Freshwater mullet	*Myxus capensis*	Pilot scale
Southern mullet	*Liza richardsoni*	Pilot scale
Flathead mullet	*Mugil cephalus*	Pilot scale
Marron (Freshwater crayfish)	*Cherax tenuimanus*	Commercial scale
Cichlids	*Family Cichlidae*	Commercial scale
Goldfish	*Carassius* spp	Commercial scale
Guppies	*Poecilia* spp	Commercial scale
Atlantic Salmon	*Salmo salar*	Pilot Scale

The Western Cape Province had the highest number of farms operating in 2011 and the majority of these farmed rainbow trout (Figure 18). Other provinces dominated by freshwater aquaculture activity were Mpumalanga followed by KwaZulu-Natal and Gauteng. Free State, North West, Northern Cape and Limpopo are still developing aquaculture provinces. Trout is the most cultured freshwater species and its distribution expands across the West and Eastern Cape, Mpumalanga and KwaZulu-Natal. Ornamental fish are the second largest cultured species in the country and farms are located across South Africa (Figure 18).



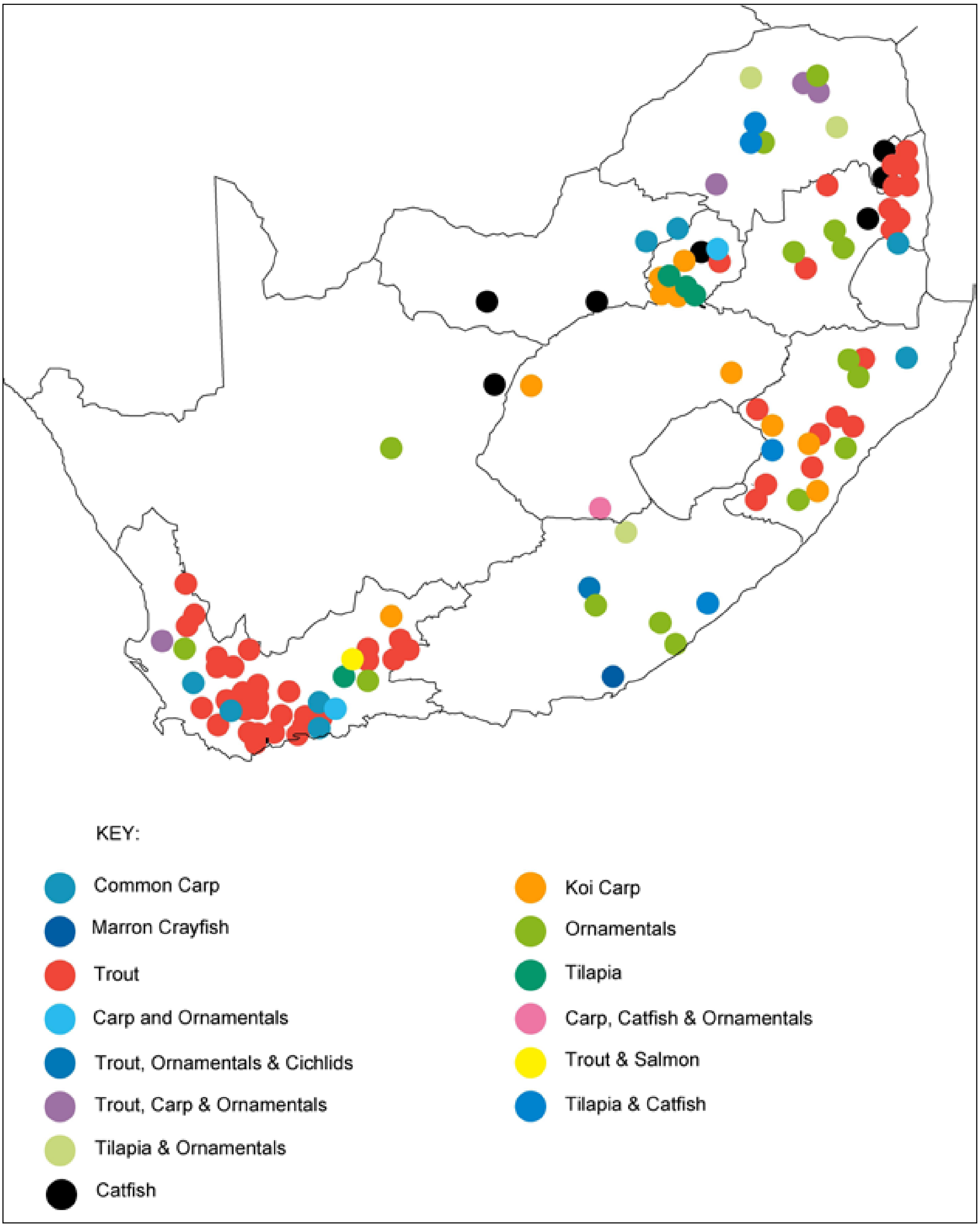



Figure 18: Distribution of cultured freshwater aquaculture species in each province in 2011.




3.2 Freshwater aquaculture production from 2006 - 2011

Total freshwater aquaculture production for 2011 was ±2 921 tons (Table 13). The freshwater species with the largest aquaculture production in 2011 was trout which recorded ±1 428 tons (Figure 19). The second largest sub-sectors include ornamentals and koi carp which had production levels of ±660 and ±572 tons respectively. The fourth and fifth sectors include Catfish and Tilapia with ±160 and ±100 tons respectively. Marron crayfish, common carp, Malawi cichlids and Atlantic salmon all recorded very low levels of production in 2011 (Figure 20). Total freshwater aquaculture production has shown an increase of 660 tons (12.7%) from 2010 to 2011.

Table 13: South Africa's freshwater aquaculture Production 2006 - 2011

	Year and Production (tons)						Total production (tons) 2006– 2011
Sub-sector	2006	2007	2008	2009	2010	2011	
Tilapia	0	0	0	10	10	100	120
Trout	807	658	943	948.62	950	1 428	5 734.62
Salmon	0.1	0	0	0	0	0	0.1
Catfish	180	180	180	180	180	160	1 060
Malawi cichlids	0.01	0.01	0.012	0.012	0.015	0.016*	0.075
Koi Carp	493	518.8	514.2	515.6	520	572*	3 133.6
Ornamentals	546	609	601	585.5	600	660*	3 601.5
Marron	0.2	0.4	0.4	0.4	0.8	0.8*	3
Carp	0.65	0.45	0.65	0.75	0.8	0.8*	4.1
Total	**2 026.96**	**1 966.66**	**2 239.26**	**2 240.88**	**2 261.62**	**2 921.62**	**1 3657**

* *Estimation based on industry information*

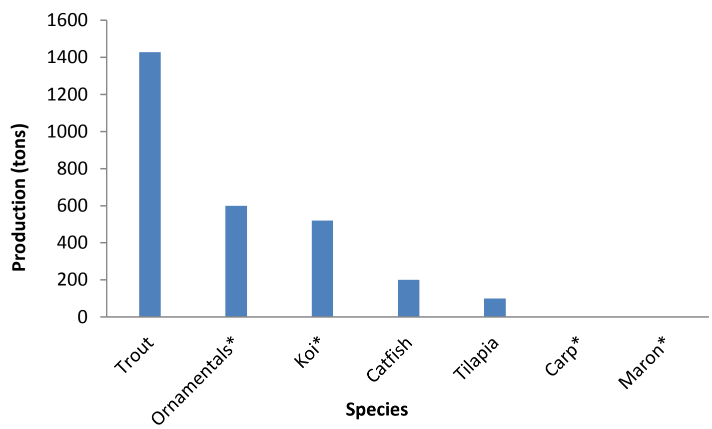


Figure 19: South African freshwater aquaculture production per sub-sector for the year 2011.

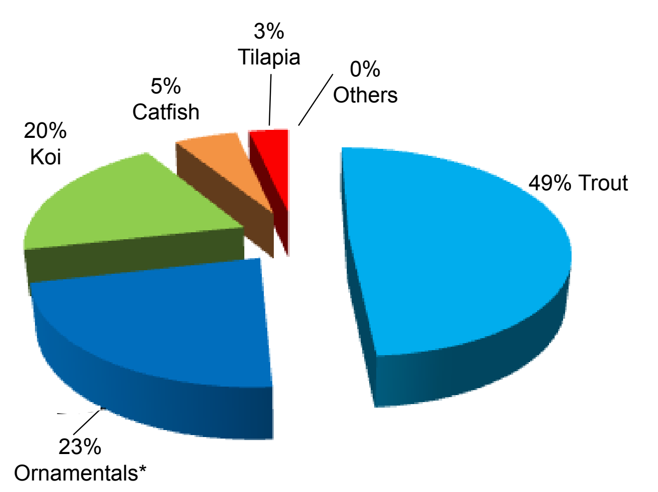


Figure 20: The percentage contribution of each sub-sector to total production in 2011.

4 AQUACULTURE RESEARCH AND DEVELOPMENT

4.1 Aquaculture Research and Technology Development Programme

The Department recently finalised the Aquaculture Research and Technology Development Programme (ARTDP). The ARTDP was developed to provide an overarching strategic framework for aquaculture research and technology development in South Africa. Research will be the primary activity and the programme will focus on creation and development of new knowledge and technology. This programme represents a consensus of priority sector research focus areas. It is comprised of two key industry focus areas (diversification and competitiveness; and sustainable production). Industry diversification and competitiveness is comprised of six dedicated programmes (new species; genetics; production systems; technology transfer and pilot/demonstration projects; nutrition and feed development; and markets and post-harvest technology). The sustainable production focus area is comprised of three dedicated research programmes (environmental interactions; food safety; and animal health and welfare). The dedicated research areas are essential to fast-track development of an economically and environmentally sustainable aquaculture industry in South Africa.

During 2011 a number of aquaculture research projects were undertaken by DAFF Researchers and some in collaboration with Universities. Some of the projects undertaken and/or underway during this period are:

i. *Halioticida noduliformans* infections on South African abalone farms
ii. Epizootic Ulcerative Syndrome from South Africa
iii. The potential for sea urchin cultivation in South Africa
iv. Assessment of scallop grow-out in Saldanha Bay
v. Predicting shellfish toxicity on the South African coast
vi. Effect of suspended bivalve culture on the benthos in Saldanha Bay: over a decade later
vii. Abalone effluent water quality survey

4.2 *Halioticida noduliformans* infections on South African abalone farms

Production of the local abalone *Haliotis midae* in South Africa has intensified noticeably since the inception of this industry in the mid-1990s. South Africa is now the largest producer of cultured abalone outside Asia and cultured abalone is also the largest contributor towards the total marine aquaculture commodity produced in South Africa (~94% in terms of monetary value). Until recently, the main disease problem encountered by the local abalone aquaculture industry has been the sabellid worm *Terebrasabella heterouncinata*. However, abalone exhibiting typical clinical signs of tubercle mycosis were discovered in South African abalone culture facilities for the first time in October 2006, posing a significant threat to the industry.

Abalone Tubercle Mycosis (ATM) is characterised by epithelial defects, approximately 2-3 mm in diameter, on the foot, epipodium and mantle of infected abalone. These lesions are sometimes covered in loosely adherent off-white material, surrounded by a thin black reaction zone (Figure 21 A and B). Affected farms typically have high mortality levels, with up to 90% mortality in spat and up to 30% mortality in older animals. Correct identification and classification of the disease agent responsible for ATM in farmed abalone was deemed essential by the Department for ongoing and future management of this disease.



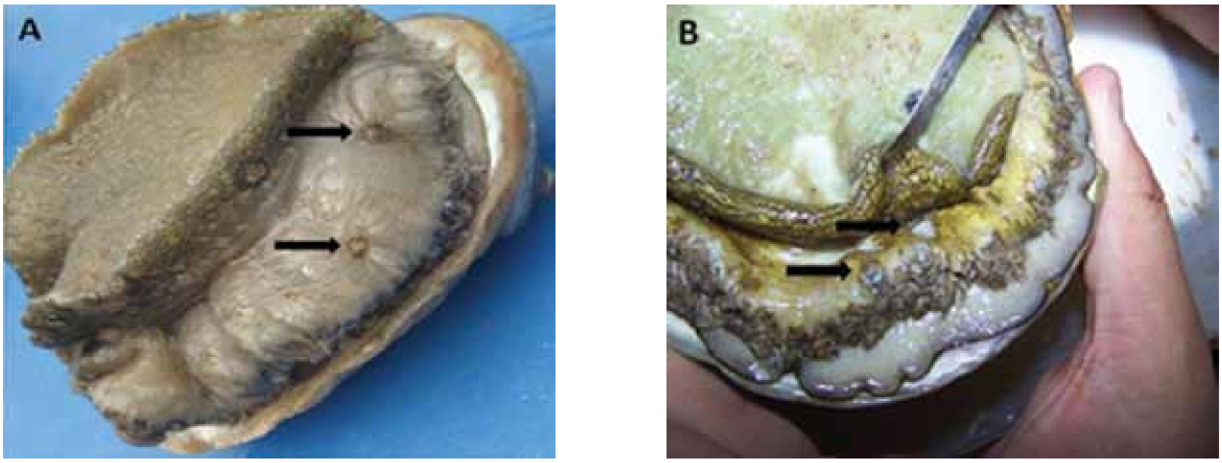


Figure 21: *Haliotis midae* exhibiting typical clinical lesions of tubercle mycosis caused by *Halioticida noduliformans.* (A) Epithelial defect, (B) Epithelial defect covered in loosely adherent off-white material and surrounded by a thin black reaction zone.

Using molecular techniques (gene sequencing) and by studying the mode of asexual reproduction, the fungus responsible for the outbreak has been identified as *Halioticida noduliformans*, a fungus-like eukaryotic microorganism belonging to a group of organisms known as the Peronosporomycetes (Macey *et al*. 2011). The Peronosporomycetes are closely related to chromophyte algae and heterokont protists and contain a number of species that are well known pathogens of commercially important plants, fish and crustaceans (Sekimoto *et al*. 2007). Key morphological characteristics of this fungus-like organism include highly branched hyphae, containing numerous oil droplets, and fragmentation of the hyphae by protoplasmic constrictions (Figure 22).

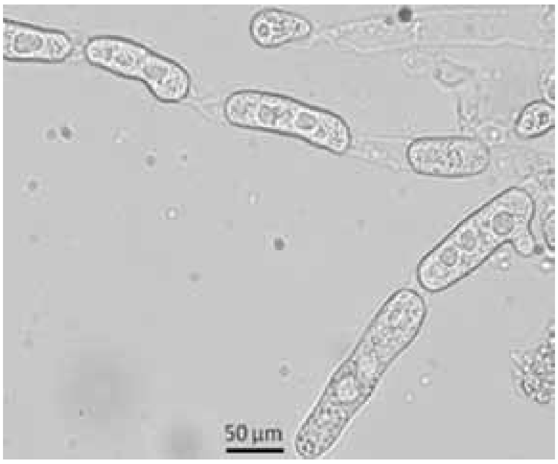


Figure 22: Light micrograph of *Halioticida noduliformans* showing the aseptate branched hyphae, characteristic oil droplets and cytoplasmic fragmentation.

Furthermore, by studying the physiological characteristics of this fungus, it was demonstrated that the pathogen is an obligate marine fungus that requires a minimum salinity of 8 ppt for growth and has an optimum temperature for growth between 20 and 25°C, but grew at a wide range of temperatures (10-25°C), suggesting that the fungus is suitably adapted to the temperate region within which most abalone aquaculture facilities in SA are located. Since growth did not occur at temperatures above 30°C nor in fresh water, elevated temperatures and fresh water treatment may provide suitable means for control of the pathogen.

Histopathology and gross observation were initially the two methods used to diagnose ATM. Since these diagnostic methods are accurate only when animals are exhibiting clinical signs, accuracy of diagnoses of animals not exhibiting clinical signs remained in question and may thus further elevate the risks posed by this pathogen. Molecular biology techniques have however revolutionized the detection, identification and enumeration of microbes in complex ecosystems and the polymerase chain reaction (PCR) technique currently resides at the forefront of molecular diagnostic technology. As a consequence, a real-time quantitative PCR (qPCR) assay for species-specific detection and quantification of H. noduliformans was developed to provide accurate and rapid identification of the pathogen for effective management of ATM (Greeff *et al*. 2012). Methodology for the extraction of fungal genetic material (DNA) from tissues of infected abalone were developed and optimized to yield high quality DNA with minimal PCR inhibitors. A qPCR assay was then designed to specifically amplify H. noduliformans DNA in the large sub-unit (LSU) rRNA gene and tested for cross-reactivity to DNA extracted from related and non-related fungi isolated from seaweeds, crustaceans and healthy abalone; no cross amplification was detected. The sensitivity of the qPCR assay was determined to be approximately 2.3 spore equivalents in a 25 µL reaction volume.

Subsequent identification and characterization of the fungus responsible for ATM and the development of a practical, specific, sensitive and rapid molecular diagnostic tool has greatly improved management and containment of this pathogen. The pathogen is currently managed as a production type disease and effective containment has been achieved by destocking of affected raceways/ facilities, sterilisation of equipment, removal and decontamination of biological filter material (when present) and adherence to suitable fallowing periods. Collectively, these measures appear to have successfully mitigated the risk for the release, exposure and establishment of this pathogen in South Africa.

4.3 First reports of Epizootic Ulcerative Syndrome from South Africa

Epizootic ulcerative syndrome (EUS) is an epizootic of both wild and farmed freshwater and estuarine fish. This disease is caused by water mould *Aphanomyces invadans* (Oomycetes: Saprolegniales) and is listed by the World Organisation for Animal Health (OIE) as an internationally significant and notifiable disease. More than 76 species of both farmed and wild freshwater fish have been documented as being susceptible to EUS and include members of the Cyprinidae, Clariidae, Cichlidae, Mormyridae and Centrarchidae. *Aphanomyces invadans* has a direct life cycle and is transmitted horizontally from one host to another through the release of motile flagellated secondary zoospores which infect the new host. A successful transmission usually requires skin damage, susceptible fish and favourable environmental conditions. Some EUS outbreaks have been associated with heavy rainfall, low alkalinity and low salinity. Ectoparasites have also been associated with particular outbreaks. Movement of fish between water bodies for conservation, aquaculture and recreational angling purposes are all proven pathways for pathogen transfer. In the early stages of the infection, infected fish develop small pinpoint red spots with localised swelling and raised areas of the body surface which progresses to the loss of scales and skin erosion. These areas eventually develop into large ulcerative lesions with a necrotic centre exposing the underlying muscle tissue (Figure 23). These lesions are most commonly observed on the lateral surfaces of the affected fish. Generally, when the disease progresses this far, most affected fish die.

Figure 23: Moribund catfish (*Clarias gariepinus*) with typical ulcerative lesions.



EUS was first reported from Sub-Saharan Africa in October 2006. This outbreak led to a Food and Agriculture Organisation of the United Nations (FAO) technical cooperation Program (TCP) toward the emergency assistance to combat EUS in Chobe –Zambezi. One of the outcomes of this program was the initial surveillance of the Lower Zambezi river or water system for this disease and further outbreaks were confirmed in Namibia, Botswana and Zambia. In December 2010, the first suspect case presented itself in South Africa. Juvenile Blue gill (*Lepomis mcrochirus)* and bass (*Micropterus salmoides*) with fungal infections were sampled from the Palmiet River system near Grabou, Western Cape. EUS was confirmed from these fish by wet skin scrapes showing typical Aphanomyces-like secondary zoosporangia (Figure 24) and histopathology showing typical deep penetrating fungal hyphae with a characteristic granulomatous tissue reaction (Figure 25). Definitive confirmation was also obtained through the amplification of the internal transcribed spacer (ITS) region of the ribosomal DNA by PCR according to the specifications of the OIE and comparison of sequence data to existing sequences on the Genbank data base, a collection of all publicly available nucleotide sequences.

Figure 24: Secondary zoosporangia of *Aphanomyces invadans.*

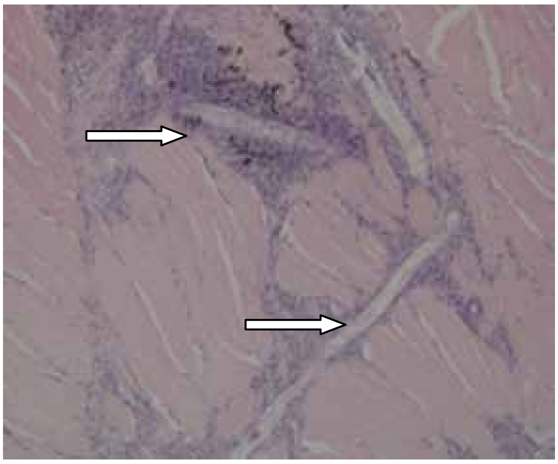


Figure 25: Histology section of muscle tissue of an infected Bluegill Sunfish (*Lepomis macrochirus*) showing deeply penetrating fungal hyphae with associated granulomatous tissue reaction.

In October 2011, a second positive case presented itself in the lower Eerste River drainage system near Stellenbosch, Western Cape. Large scale mortalities of sharptooth catfish (*Clarias gariepinus*) were reported and the EUS diagnosis was again confirmed as positive by histology and PCR.

The confirmation of EUS in the Western Cape in South Africa and the subsequent reporting thereof to the OIE has led to the development of a surveillance project to determine the current geographical and host range for EUS in South Africa, to improve awareness and capacity regarding aquatic animal health management at various levels in South Africa and to improve capacity to recognise and deal with aquatic disease outbreaks and emergencies. The surveillance is comprised of both the opportunistic reporting from the general public who observe abnormalities (Passive Surveillance) and the systematic collection, collation and analysis of information related to EUS (Targeted Surveillance).

4.4 The potential for sea urchin cultivation in South Africa

Sea urchin gonads, otherwise known as 'roe' or 'uni' in the sushi restaurant trade, are a sought after delicacy, particularly in countries such as Japan which consumes approximately 80% of the world's sea urchin roe production. Various urchin species are harvested worldwide, but the most commercially important species in Japan is *Tripneustes gratilla* (Figure 26 A). *T. gratilla* is a fast-growing shallow-water echinoid that occurs throughout the waters of the tropical Indo-Pacific, with small isolated populations found along the north-eastern coast of South Africa. Unregulated harvesting and a high market demand for this and other echinoid species has however led to severe overfishing and the near collapse of many natural populations. Consequently, countries are now examining the feasibility of sea urchin aquaculture (echinoculture).

T. gratilla has been proposed as a viable candidate for aquaculture due to its fast growth rate (~9 months from fertilization to reach market size), early maturation and a high gonadal production. Gonads that are large in size, contain few to no gametes, have a firm texture, and are bright yellow or orange in colour are regarded as the most commercially valuable (Figure 26 B). However, in order for echinoculture to be economically viable, high-quality feeds need to be formulated to promote fast growth rates and improve the market acceptability of urchin gonads. Previous research indicates that high protein artificial diets tend to produce large gonads that are pale and so unacceptable in terms of market colour and palatability. Natural algae diets on the other hand frequently produce brightly coloured gonads of marketable colour but these tend to be small and below ideal market size. In collaboration with scientists from the University of Cape Town (Prof. John Bolton, PhD student Mark Cyrus & MSc student Rheinhardt Sholtz) and the University of Stellenbosch (Mr Lourens de Wet), the Department engaged on projects to (1) determine the effects of incorporating varying levels of the algae *Ulva* into an artificially formulated feed on *T. gratilla* gonad mass, colour and quality; and (2) identify optimal micro algal feeds for *T. gratilla* larval rearing, settlement and metamorphosis.

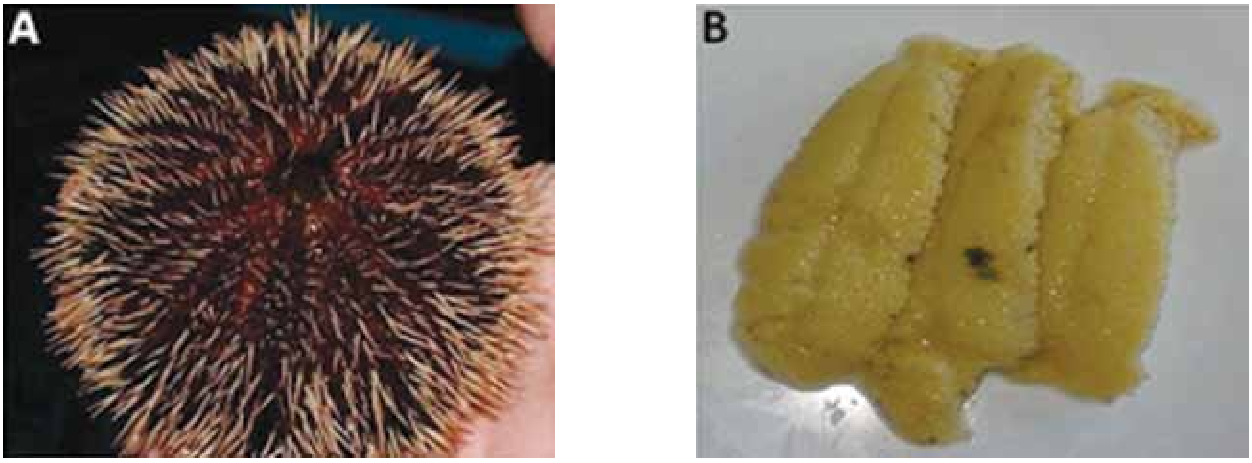


Figure 26: (A) Adult *Tripneustes gratilla* and (B) gonads obtained from *Tripneustes gratilla* fed the protein-rich artificial diet supplemented with 20% dried *Ulva*.

We demonstrated that *T. gratilla* consumed significantly higher amounts of *Ulva rigida* when offered four seaweed species (*Ulva rigida*, *Ecklonia maxima*, *Porphyra capensis* and *Gigartina polycarpa*) in paired consumption tests. Since South African *Tripneustes* prefer *Ulva* and because farm-grown *Ulva* is available in large quantities from local aquaculture facilities, *Ulva* was selected as an additive for an experimentally formulated urchin feed. A protein-rich artificial diet was thus supplemented with varying amounts (0, 5, 15 and 20% weight/ weight (w/w); designated 0U, 5U, 15U and 20U, respectively) of the macroalga *Ulva* and fed to adult *T. gratilla* (50-70 mm test diameter) over a 12 week period. Gonad size, texture, colour and a number of production performance parameters were quantified and compared to urchins fed fresh *Ulva* (FU) and a combination of FU and artificial feed (FB). We showed that a protein-rich artificial diet supplemented with 20% dried *Ulva* increased urchin gonad somatic index (GSI) by 205% within just nine weeks, compared to a 57% increase in the GSI of urchins fed fresh *Ulva* alone over the same time period (Figure 27 A). Gonad colour was calculated using three colour parameters, namely L* (lightness), a* (redness) and b* (yellowness). Gonads that are bright yellow in colour have a high market value and as expected, the fresh *Ulva* diets produced gonads with the highest marketable value. It was only the 20U and FB treatments that produced gonads that were similar in colour to the fresh *Ulva* treatment (Figure 27 B).

These findings indicate that there is real potential for artificial diets containing *Ulva* as an alternative feed additive to support commercial echinoculture in South Africa. A full life-cycle grow out study, where broodstock animals are induced to spawn and larvae are raised in a hatchery until their gonads reach export size, is in progress to determine the effects of the 0U, 20U and fresh *Ulva* diets on gonad mass, colour and quality. Additional research has also been conducted to determine daily feed consumption and apparent digestibility coefficients for protein and energy for each diet and to



determine whether the dried *Ulva* incorporated into the artificial feeds acts as a feed attractant. Optimizing growth and settlement conditions for *T. gratilla* larvae are essential to ensure efficient and cheap production. Diet type is one of the major factors governing early development, settlement and survival rates of echinoids. We investigated the effects of five microalgal diets, namely *Isochrysis* sp., *Pavlova lutheri*, *Chaetoceros muelleri*, *Tetraselmis suecica* and *Skeletonema pseudocostatum*, on the growth, development and survival of *T. gratilla* larvae. Although differences were observed in larval development over time between feeds, overall growth data suggests that *Chaetoceros*, *Isochrysis* and *Skeletonema* are optimal feeds for *T. gratilla* larval rearing. *Pavlova lutheri* and *Tetraselmis suecica* were not successful and these feeds are consequently not recommended for the echinoculture industry. Settlement assays using four species of benthic diatom, namely *Amphora* sp., *Cocconeis* sp., *Navicula jeffreyi*, and *Nitzschia closterium* were also tested using sterile Petri dishes coated with each species. Although good settlement rates were obtained for all tested species, we demonstrated significantly higher settlement rates under low light conditions (0.1 μmol.m^{-2}.s^{-1}), as opposed to the high light conditions (11 μmol.m^{-2}.s^{-1}) tested in the study. Collectively, this research clearly demonstrates the potential for *T. gratilla* cultivation in South Africa.

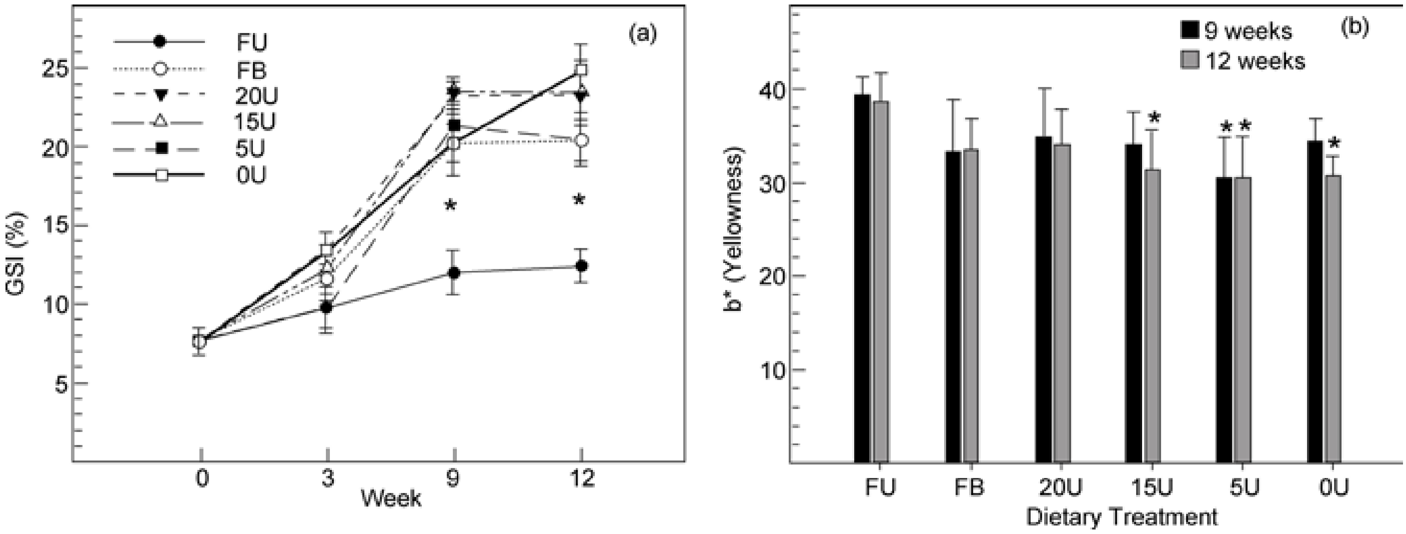


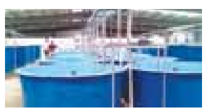
Figure 27: Mean (A) gonad somatic index (GSI) and (B) gonad yellowness of *Tripneustes gratilla* fed with four artificial diets, fresh *Ulva* or a mixed diet consisting of fresh *Ulva* and a basal feed over a 12-week grow-out period.

4.5 Assessment of scallop grow-out in Saldanha Bay

South Africa is aimed at promoting an economically sustainable and globally competitive marine aquaculture industry. One of the key objectives of the Directorate Aquaculture Research & Development within the Department of Agriculture Forestry and Fisheries is to expand the resource base from a few species currently being farmed to a more diverse array of species in the form of conducting culture experiments on different species. A candidate species currently being investigated for its culture potential is the local scallop *Pecten sulcicostatus*. The considerable success of scallop culture particularly in Japan and China has initiated an interest in the culture of *P. sulcicostatus* on the South African coast. A major determinant of the economic feasibility of scallop culture is the growth rate of the species of interest, as the cost of production is largely determined by the length of the grow-out period. A study was conducted of the growth and survival of hatchery-produced juveniles of *P. sulcicostatus* in suspended culture in Saldanha Bay. Saldanha Bay is considered suitable for the culture of shellfish as it offers the protected waters needed for long-line and raft cultivation and currently supports the bulk of shellfish production in South Africa. The influence of environmental conditions on the growth and survival of *P. sulcicostatus* was specifically examined in relation to high resolution measures of temperature and phytoplankton biomass.

Hatchery-reared juvenile scallops ranging in size from 4.5 – 11.0 mm shell height (mean of 6.9 mm),were placed in a



suspended culture system at 5 m depth in Saldanha Bay (Figure 28 A,B and C). Subsequent growth was assessed monthly through increments in shell height in relation to changing environmental conditions as determined through continuous measures of temperature and Chl *a*.

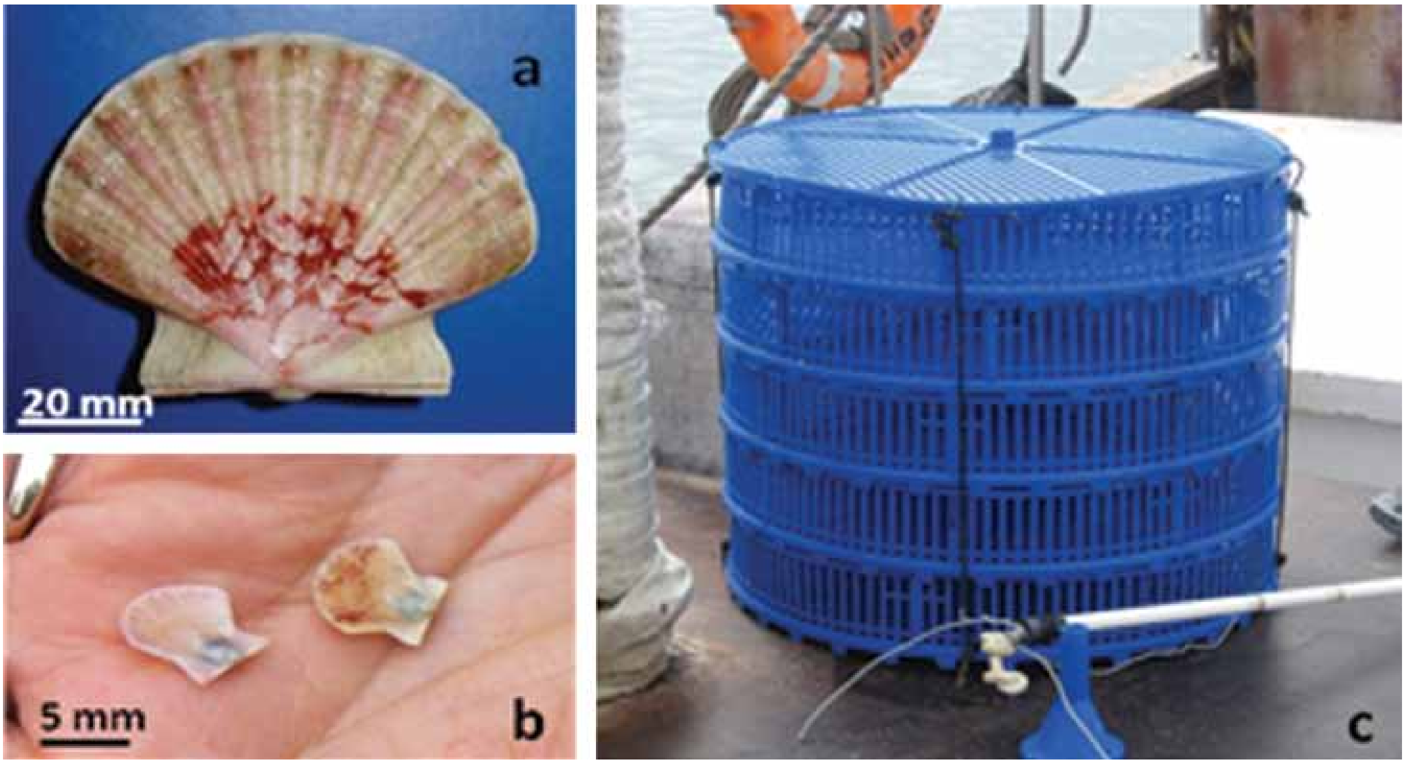


Figure 28: (a) *Pecten sulcicostatus* broodstock collected from False Bay at a depth of 30 m, (b) hatchery-reared juvenile scallops, and (c) plastic circular rigid cages used for the grow-out of scallops (Arendse and Pitcher, 2012).

Upon termination of the experiment after 12 months scallops ranged in size from 42.1 – 48.7 mm (mean of 45.1 mm), representing an increment in shell height of 38.2 mm over one year. The mean growth rate of 0.10 mm day^{-1} (mean specific growth rate of 0.0046 day^{-1}) compares favorably with other commercially cultured species and exceeds previous estimates of growth of naturally occurring populations of *P. sulcicostatus*. Scallop growth was poorly correlated with either temperature or Chl *a* concentration. However, scallop mortalities appear closely aligned to temperature regime as demonstrated by the application of an exponential function to the data showing low mortalities when temperatures were low and temperature fluctuations were small (< 2 °C), and high mortalities when temperatures increased and also fluctuated dramatically (> 10 °C), (Figure 29).

The observed high mortality of scallops in Saldanha Bay, particularly in association with mean temperatures >17°C, is therefore a likely outcome of a cold water species that is unable to tolerate the temperature regime of the surface waters of Saldanha Bay.

The study specifically examined the growth and survival of scallops as influenced by food availability and ambient temperature, thereby providing an assessment of the suitability of Saldanha Bay for the commercial culture of *Pecten sulcicostatus*. Although acceptable growth rates were achieved, the high cumulative mortality of scallops observed during grow-out in Saldanha Bay indicated suboptimal conditions.

Although the high and variable surface temperatures of Saldanha Bay during summer appear to provide an environment unsuitable for the grow-out of *Pecten sulcicostatus*, it is feasible that the bottom waters of the Bay may provide a more favorable environment. Saldanha Bay is highly stratified during summer with the result that bottom temperatures remain considerably lower than surface waters and temperature fluctuations are also less extreme. It is therefore recommended that further studies of scallop grow-out be conducted by deeper setting of the scallop cages to below the thermo cline.

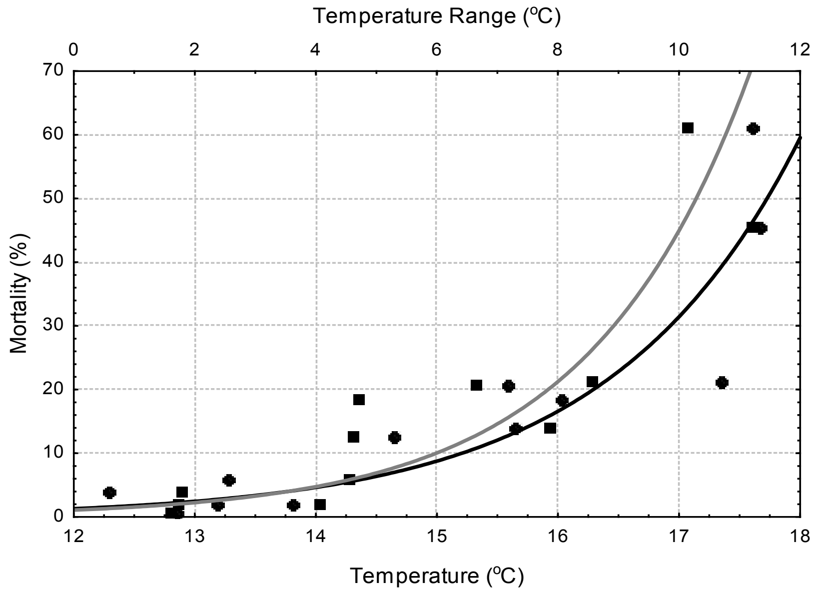


Figure 29: Relationship between scallop mortality and mean temperature (R = 0.91; 82,9% variance is explained) and the temperature range (R = 0.90; 81.0% of variance explained) for each of the monthly intervals (Arendse & Pitcher, 2012 in press).

4.6 Predicting shellfish toxicity on the South African coast

Harmful algal blooms (HABs) are common on the South African coast and negative impacts include the poisoning syndromes in humans known as paralytic shellfish poisoning (PSP) and diarrhetic shellfish poisoning (DSP). Accumulation by shellfish of the toxic dinoflagellate *Alexandrium catenella* is considered the primary cause of PSP which regularly threatens the safety of shellfish on the west coast. DSP has been shown to be commonplace on the west and south-west coasts and is usually attributable to the dinoflagellates *Dinophysis acuminata* and/or *Dinophysis fortii.* Diatom species of the genus *Pseudo-nitzschia*, some of which produce the toxin domoic acid responsible for amnesic shellfish poisoning (ASP), pose an unknown risk on our coast (Figure 30).

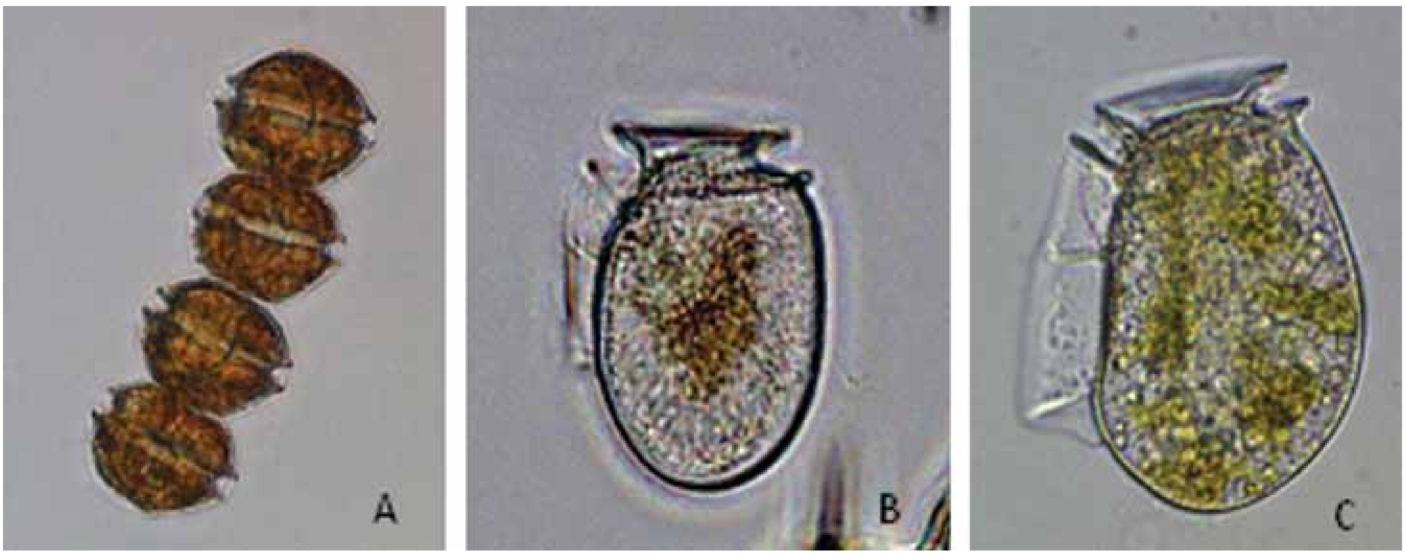


Figure 30: On the South African coast the dinoflagellate (a) *Alexandrium catenella* is considered the primary cause of Paralytic Shellfish Poisoning, whereas Diarrhetic Shellfish Poisoning is attributed to (b) *Dinophysis acuminata* and/or (c) *Dinophysis fortii*.

Managing the impacts of these HABs on the aquaculture industry will benefit from improved prediction of shellfish toxicity. For this purpose we have investigated the variability of toxigenic phytoplankton and the consequent uptake and loss of toxins by shellfish on the west coast. These studies were conducted off Lambert's Bay with concomitant observations and measurements of: [1] the presence of the causative species and of the environmental conditions influencing their concentrations; [2] the toxicity of the causative species through assessment of the cell toxin composition and quota; and [3] the uptake, biotransformation and loss of toxins from different shellfish species.

These studies have shown rapid shifts in phytoplankton community structure to be driven by upper mixed layer characteristics and flow patterns as determined by modulation of the upwelling process by winds. Consequent rapid changes in the presence and concentration of toxigenic phytoplankton, scaling several orders of magnitude over periods of 3-10 days, severely compromise monitoring programmes designed to provide an early warning of potential biotoxin contamination of shellfish. Although time series of toxic cells and particulate toxins, as determined from analysis of plankton concentrates, revealed good correspondence (Figure 31), large variations in cell toxin composition and/or quota were

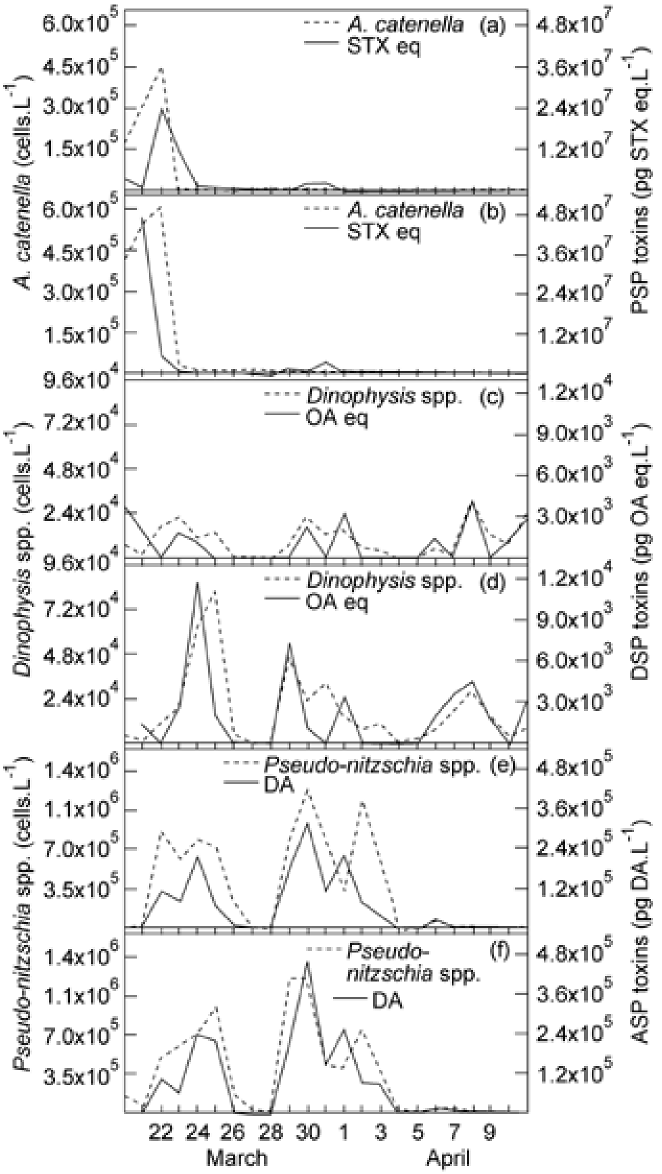


Figure 31: Daily time-series off Lambert's Bay of *Alexandrium catenella* and particulate concentrations of saxitoxin equivalents at (a) 0 m and (b) 5 m; of *Dinophysis* spp. and particulate concentrations of okadaic acid equivalents at (c) 0 m and (d) 5 m; and of *Pseudo-nitzschia* spp. and particulate concentrations of domoic acid at (e) 0 m and (f) 5 m from 20 March – 11 April 2007 (from Hubbart *et al.* submitted).




shown for all groups of toxigenic plankton. Variations in cell toxin content are regulated by intrinsic genetic factors, but are also subject to the responses of different strains to environmental factors. This variability further complicates assessment of the risk posed by these toxic species as the prediction of toxin transfer to shellfish based solely on cell concentration is unlikely.

Striking differences were also observed in the accumulation of toxins by different shellfish species (Figure 32). The accumulation of phycotoxins in bivalves is not only dependent on the concentration, time of exposure and toxicity of cells in suspension, but also on the balance between the mechanisms regulating toxin uptake and elimination in shellfish. The accumulation of toxins occurs primarily as a function of ingestion of toxic cells, and the high inter-specific differences in the capacity of bivalves to accumulate toxins is a function of clearance rates, their ability to capture toxic cells from suspension, their capacity to select particles prior to ingestion, and the efficiency of absorption and toxin elimination processes. The varying toxicity of mussels and oysters during our studies reflects all these processes and also the possibility of enzymatic or chemical transformation of toxins within shellfish tissues.

The findings of our studies are important in informing the *South African Molluscan Shellfish Monitoring and Control Programme* in that they show that the monitoring of toxic phytoplankton are unlikely to provide an adequate substitute for direct monitoring of bivalve toxicity. The results further indicated a need to establish shellfish-specific sampling frequencies for high and low risk species.

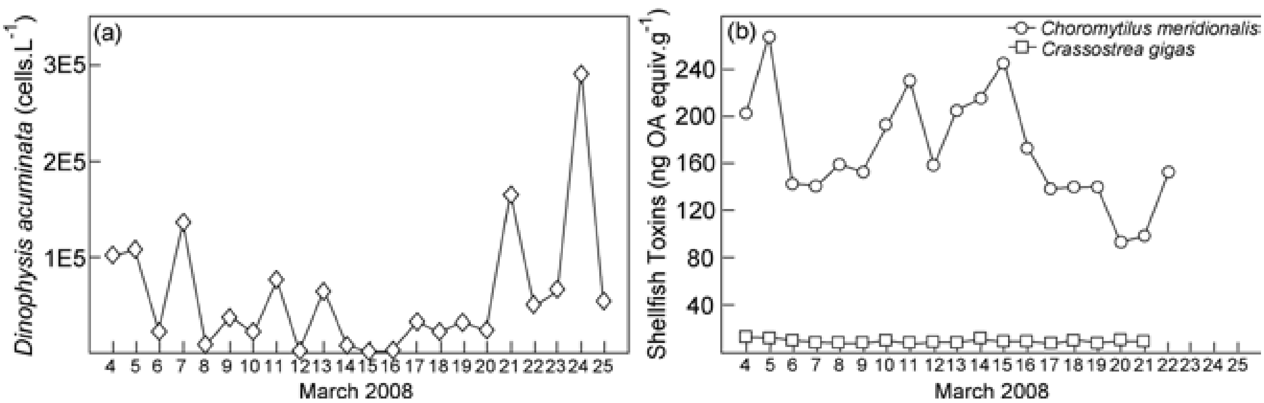
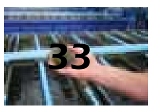


Figure 32: A time-series off Lambert's Bay of (a) the cell concentration of *Dinophysis acuminata*, and (b) DSP toxins in the mussel *Choromytilus meridionalis* and the oyster *Crassostrea gigas*, from 4–25 March 2008. The average concentration of DSP toxins in the mussels exceeded that in the oysters by approximately 20-fold. *C. meridionalis* was therefore shown to be a high-risk species for DSP contamination in that the regulatory limit for toxins was often exceeded, whereas the oyster *C. gigas* was a low-risk species, for which the regulatory limit was not exceeded (from Pitcher *et al*. 2011).

4.7 Effect of suspended bivalve culture on the benthos in Saldanha Bay: over a decade later

One of the major components of current appreciation of global change is coastal eutrophication; predominantly through anthropogenic release of nutrients to nearshore waters. These nutrient sources may stimulate excessive plant production leading ultimately to decay and oxygen depletion and consequent ecosystem disturbance. Certain marine aquaculture practices can make a significant contribution to this deleterious process, at least on a local scale, by release of wastes from high density populations of culture animals. Although not regarded as damaging to the ecosystem as say fish and prawn culture, which require feed subsidies, suspended culture of bivalves interacts with both the pelagic and benthic realms through a complex series of mainly, biotic pathways. The most obvious of these is the removal of organic and inorganic particles by bivalves from the water and transfer of undigested particulate material as biodeposits to the sediment surface (Newell 2004). This has the effect of concentrating organic matter and nutrients in the sediments which will stimulate oxygen consumption within the sediment and release of N and P to the water column. Since oxygen supply is limited by physical and biological factors that dictate exchange across the sediment water interface, oxygen





depleted conditions are created if consumption exceeds supply (Hargrave *et al*. 2008). Such changes in oxygen conditions in surface sediments will affect both the biomass and taxonomic composition of benthic in-fauna. Under extreme anoxic conditions oxidised sulphur compounds are reduced to highly toxic sulphides which impact on biodiversity. In addition, release of nutrients via faunal excretion or bacterial decomposition may lead to localized effects on pelagic foodwebs.

With this background in mind, a study was initiated in 1997 to measure the effects of increase biodeposition under the mussel rafts in Saldanha Bay on sediment biogeochemistry. The present study presents some results of a follow-up study aimed at ascertaining whether there has been further deterioration at the culture site and to establish the status of sites that have only recently been used for suspended bivalve culture. The same 4 sites in Small Bay were sampled as in the original study and 2 additional sites in Big Bay were included as a control and impacted site for oyster cultivation (Figure 33). Parameters that were measured include sediment composition, oxygen demand, nutrient release (as NH_4, NO_3, NO_2 and PO_4), and grain size composition.

Figure 33: Map of Saldanha Bay showing sampling sites for sediment biogeochemical studies.

Over 100 different macrofauna species were identified in the size range > 1mm. A brief summary of these findings is presented below:

- Generally, the suspension feeding prawn *Upogebia capensis* dominated biomass in relatively undisturbed sites such as B10, NS2 and BBC. The raft control site, RC, was also dominated by suspension feeders but in this case it was the clam *Veneruptis corrugata* and the holothurian *Thyone aurea*.

- At the heavily impacted site in the middle of the mussel farm, R28, besides mussels that had fallen off the rafts, the carnivorous gastropod *Nassarius speciosus* dominated biomass. In addition, a number of different detritivorous poychaete species were present in high numbers but low biomass.
- The oyster culture site in Big Bay BBT, was likewise colonized mainly by the scavenging carnivores *Nassarius* and *Bullia*.

This dominance of carnivores at impacted sites and suspension feeders at control sites is in agreement with what had been measured in the previous study and elsewhere. Interestingly, the NS site, which has only been under cultivation since the initial study, although still dominated by suspension feeders, had a significant biomass of carnivores as well, indicating perhaps the developing deterioration of the sediments here with the initiation of farming.

Looking at a comparison biogeochemical rates between the 2 studies it is evident that, as before, sediment oxygen demand was not markedly different for both impacted and control sites (data not presented). Somewhat unexpectedly oxygen demand did not prove to be a good indicator of the status of the benthos though we are intending to repeat these measurements with newly acquired instrumentation. In the previous study we found that the ratio of NH_4 to PO_4 release proved to be a sensitive indicator of sediment deterioration. As before the heavily impacted site R28, had the highest ratio (Figure 34). Interestingly, NS and BBT, the sites that have been farmed subsequent to the initial study, show an elevated NH_4/PO_4 ratio indicating deterioration of the benthos. The above findings compare well with the macrofauna results and support the conclusion of no further degradation within the long-standing mussel farm (R28) but indicate the onset of benthic impacts at the newly farmed sites (NS and BBT).

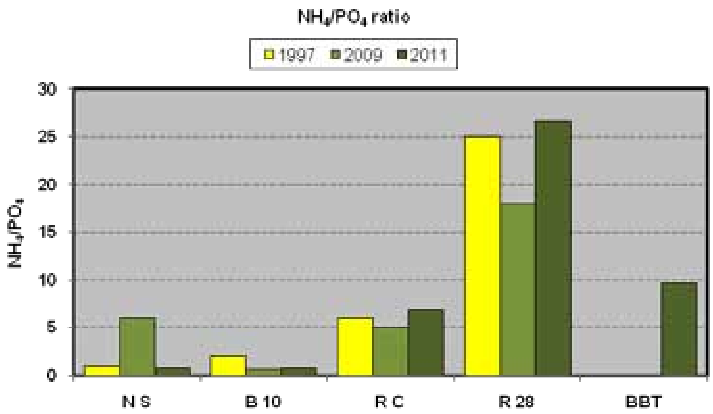


Figure 34: The sediment NH_4/PO_4 release ratio for 5 of the sampled sites measured during the initial study in 1997 and two subsequent years (2009 and 2011).

Figure 35: Filtering of effluent water.

It has taken us some time to develop a reliable suite of instruments, equipment and techniques to perform the necessary measurements for these benthic biogeochemical studies. However, we feel we are now in a position to apply this approach in a predictable manner. At least one further study is planned for Saldanha Bay. However, the system is flexible and can be employed in other situations which will hopefully provide an additional source of information for the management of future aquaculture sites and practices.

4.8 Abalone Effluent Water Quality Surveys

In an effort to quantify the potential impact of abalone farms on the receiving near shore environment, the Department has conducted a number of surveys beginning in 2009 on the South coast and extended to the West coast in 2011 & 2012. Water samples were collected from various abalone farms at different spatial and temporal scales to address various aspects of farming operations. Samples were collected of incoming and effluent waters during the course of a working day when tanks were being cleaned as well as after hours when work ceases (Figure 36 and 37). The following parameters were measured: suspended solids, biochemical oxygen demand and nutrients such as ammonium nitrite, nitrate and phosphate. Where multiple effluent channels were sampled, measured concentrations were weighted according to their respective flow rates. Only the suspended solids and ammonium concentrations are presented in this report.

Figure 36 and Figure 37: Effluent pipes from an abalone farm.

Suspended solids

The results from these surveys were compared the Abalone Dialogue Standards (2010), an initiative sponsored by the World Wildlife fund. The DWAF water quality standards aim to "ensure that the water quality of water resources remains fit for recognized uses and that the viability of the aquatic ecosystem is maintained and protected. According to these guidelines the concentrations of suspended sediments should not be increased by more than 10% of the ambient concentrations. The Abalone Dialogue Standards recommend that the annual median concentration of total suspended solids in effluent compared to influent or in the receiving water beyond the zone of initial dilution, is <5mg/l. South African guidelines do exist for suspended solids in receiving waters for the natural environment (Dept of Water Affairs and Forestry 1995), though these specify a limit in excess of ambient concentrations (<10%) beyond the initial mixing zone. Such guidelines are difficult to implement as they imply prior knowledge of the extent mixing zone. Furthermore, they would require sampling in generally very exposed, and hazardous, coastal waters.

Sampling conducted to date show that the raw effluent concentrations are over the recommended standard of <5mg/l for both coasts (Table 14). When corrected for inflow into the tanks the values are reduced but remain in excess of the recommended standard during working hours for the West Coast farms. By way of contrast, the afterhours effluent concentration corrected for inflow to the tanks are much reduced, even negative for the West coast indicating settlement in the tanks overnight. Weighting the median suspended solid concentration for an eight hour working day indicates that over a 24 hour period, effluent concentrations fall within the recommended standard of <5mg/l.

Table 14: The median concentration of total suspended solids (mg/l) measured in the effluent waters of abalone farms located on the South and West Coast of South Africa.

	Raw Effluent			Effluent Corrected for inflow (post settlement pond/ drum filter)			Effluent Corrected for ambient environmental concentrations (raw seawater)		
	WD	AH	Daily weighting	WD	AH	Daily weighting	WD	AH	Daily weighting
South Coast TSS	10.81	5.84	7.49	4.95	0.82	2.20	6.33	0.71	2.59
West Coast TSS	18.78	6.39	10.52	16.47	-2.12	4.08	14.72	-2.76	3.07

(Note WD stands for working day sample and AH stands for after hours sampling. Also the daily weighting is based on an 8 hour working day with the remaining 16 hours of the day attributed to afterhour's time.)

Performing similar calculations for effluent corrected for ambient seawater concentrations, i.e. prior to any settlement or filtration on the farm reduces the values even further. Although the working day limit exceeded the standard, major settlement seems to be occurring in the tanks afterhours leading to negative outputs in the case of the West Coast farms. It must be noted that these findings are based on a limited dataset (n=44) and the situation may change as more data are collected.

All farms with exception of Farm I (25-30% re-circulation) were operating in full flow through mode during sampling. There is obvious inherent variability between individual farms as shown in Figure 38. Farms G, H and I demonstrate the extremes of this variability. Farms B and C effluent values were corrected for incoming suspended sediments as opposed to raw seawater, and thus might be overestimates. High after hours suspended sediment for Farm D after hours reading is attributed to one particularly high effluent concentration, when omitted from calculation the median value drops to 1.06mg/l. When viewed as a collective of farms there appears to be little cause for concern. However, some individual farms may at times be well outside the given guidelines. If such situations persist for extended periods certain mitigatory actions may need to be taken.

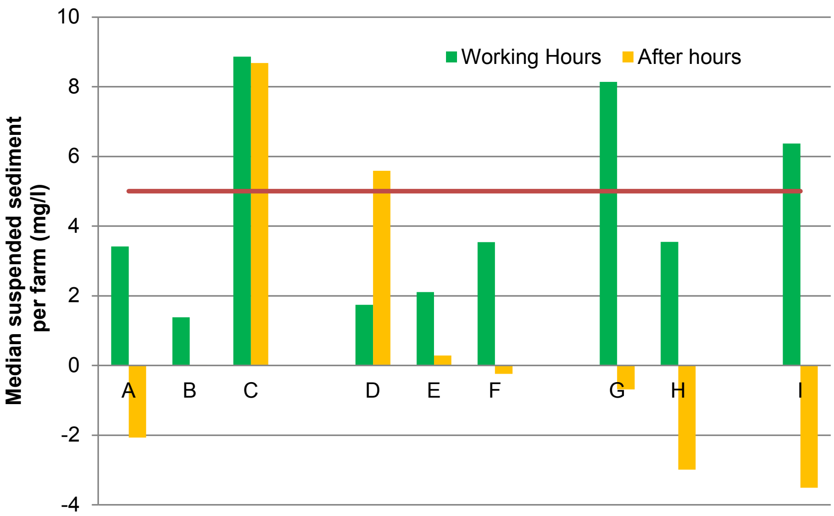


Figure 38: Median suspended solid concentration recorded during working hours and after hours for nine abalone farms around the South African coastline, in excess of the raw seawater suspended sediment load. The red line indicates the 5mg/l recommended standard. Farms A-F are found on South Coast and Farms G-I are found on the West Coast.

Ammonia concentrations

The recommended target value as stipulated in the South African Water Quality Guidelines and in the Abalone Aquaculture Dialogue Standards (ADS) for total ammonia, is 600µg/l (0.6mg/l. The ADS standards further qualify this limit as an annual median concentration of total ammonia nitrogen in effluent or receiving water beyond the mixing zone

The measured values of total ammonia in Table 15 are well below the recommended ADS standard even during periods of maximum release.

As with suspended solids there is appreciable variability between individual farms (Figure 39). However, all farms are well within recommended guidelines and mitigatory measures are unlikely to prove to be necessary.

Table 15 The median concentration of total ammonia (mg/l) measured in the effluent waters of abalone farms located on the South and West Coast of South Africa.

	Raw Effluent			Effluent Corrected for inflow (post settlement pond/ drum filter)			Effluent Corrected for ambient environmental concentrations (raw seawater)		
	WD	AH	Daily weighting	WD	AH	Daily weighting	WD	AH	Daily weighting
South Coast NH_4	0.08	0.1	0.1	0.05	0.05	0.05	0.07	0.0.8	0.07
West Coast NH_4	0.04	0.06	0.05	0.01	0.01	0.01	0.02	0.02	0.02

(Note WD stands for working day sample and AH stands for after hours sampling. Also the daily weighting is based on an 8 hour working day with the remaining 16 hours of the day attributed to afterhour's time.)

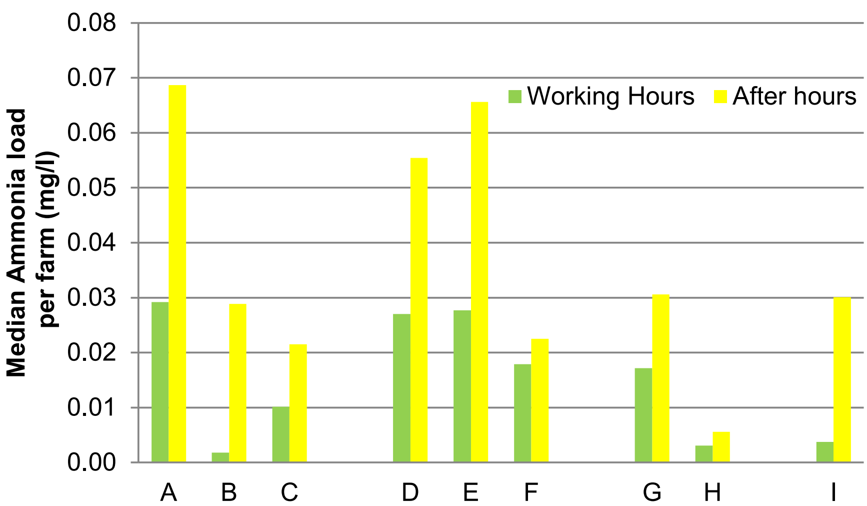


Figure 39: Shows the median ammonia concentration recorded during working hours and after hours for nine abalone farms around the South African coastline, less the incoming seawater ammonia load coming onto the tanks. Farms A-F are found on South Coast and Farms G-I are found on the West Coast.

In conclusion, this study indicates that regulatory monitoring of abalone farm effluents, particularly of suspended solids, should take into account the different signals during working hours and after hours as well as the different sampling points such as incoming seawater to the farm, inflow to the grow-out tanks, and obviously the effluent itself. As a sector, abalone farm results to date indicate little cause for concern with both key water quality variables. However, some farms may at times exceed the recommended suspended solids limits. Further sampling is necessary to fully address the inherent variability in these signals in providing a better estimation of annual median concentrations.




5 AQUACULTURE ENVIRONMENT INTEGRITY

5.1 What is Aquaculture Environment Integrity?

The Environmental Integrity Framework (EIF) for Marine Aquaculture is based on the principles of "*sustainable development*", requiring the optimisation of human beneficiation and equity from the use of natural resources, while maintaining ecological and biological diversity and protecting ecosystem function. The EIF seeks to promote the ecologically sustainable development of the marine aquaculture sector and is an easily accessible reference for information relating to the potential environmental impacts of marine aquaculture. It outlines possible ways in which associated impacts can be mitigated, managed and monitored. It was developed as a source of information for aquaculture investors to manage the potential environmental impacts of their operations and further serves as a tool for governmental decision-makers and other interested stakeholders.

5.2 Biodiversity Risk and Benefit Assessment for Alien Species of Aquaculture

Alien species provide a valuable food source and an economic opportunity in both the fisheries and aquaculture sectors globally. However, there is environmental risk associated with the uncontrolled introduction and use of alien species. Aquaculture in South Africa is composed of a blend of indigenous and non-indigenous species. While the culture of indigenous, non-invasive species is encouraged, developing the technology for breeding and domestication of indigenous species requires time, technological and financial resources. The Department has commissioned a Biodiversity Risk and Benefit Assessment for Alien Species of Aquaculture that will assist the Department and other relevant decision-makers to promote the consideration of the appropriateness, and (if appropriate), the effective management of specific alien species used in aquaculture, and ultimately contribute to the ecologically sustainable development of the sector. Species to be assessed are the Pacific Oyster, Mediterranean Mussel, Sharp tooth Catfish, Rainbow and Brown Trout, Nile Tilapia and Marron.

5.3 Aquaculture Environmental Impact Assessments

The construction of new and the expansion of existing aquaculture operations frequently trigger a basic assessment or Scoping and Environmental Impact Report, depending on the nature, production and type of activity. Specific information in this regard can be gleaned from the EIA and Environmental Management Guideline for Aquaculture in South Africa (DEA, 2011). The Directorate Sustainable Aquaculture Management (SAM), Sub-Directorate Aquaculture Animal Health and Environmental Interactions renders technical advisory services to the industry regarding Environmental Impact Assessments (EIAs) which includes reviewing and commenting on EIAs for aquaculture operations and any developments that may have an adverse impact on existing aquaculture farms. During 2011, SAM, received and reviewed EIA's for the construction of a new abalone farm, the construction of a new marine finfish farm and the expansion of an existing abalone farm.

5.4 Undertaking Environmental Impact Assessments for the establishment of Aquaculture Development Zones

The Department aims to create an enabling environment for the development and growth of the South African aquaculture sector through the establishment of Aquaculture Development Zones (ADZ's). The location of ADZ's is based on the availability of state-owned land, as well as suitable sea-space conducive to the cultivation of various aquaculture species, in and along coastal provinces. These suitable areas are subject to undergoing Environmental Impact Assessment (EIA) processes and receiving Environmental Authorisation as well as installation of basic infrastructure prior to being declared ADZs.

In 2011 the Qolora land-based ADZ in the Eastern Cape received a positive environmental authorisation from the Department of Economic Development, Environmental Affairs and Tourism and will be the first established ADZ once rel-




evant infrastructure has been installed. The Department is currently in the process of appointing qualified independent Environmental Assessment Practitioners (EAP's) to undertake the Environment Impact Assessment processes for two additional land-based ADZ's, namely, the Buffelsrivier ADZ in the Western Cape and the Amatikulu ADZ in KwaZulu-Natal.

The EIA process for the establishment of a Sea-based ADZ in the Eastern Cape is currently being conducted by an independent qualified EAP. The availability of suitable sea-space for the establishment of sea-based aquaculture operations was refined through conducting a Strategic Environmental Assessment (SEA). The SEA site selection methodology made use of quantitative criteria that were developed in conjunction with key industry, academic and government stakeholders. Areas not suitable in terms of the identified criteria were eliminated and depicted using Geographic Information System software. The SEA for identification of potential marine aquaculture development zones for fin fish cage culture (DAFF, 2012) is available for downloading on the Departmental website.



6 STAKEHOLDER ENGAGEMENT

6.1 Aquaculture Stakeholder Engagement Forums

As in many sectors, stakeholder involvement plays a crucial role in sector development. The DAFF has identified several forums to serve as vehicles that need to drive the activities related to the aquaculture industry. The forums are focused and specialized to allow specific deliberations regarding the industry. To allow industry to provide input and communicate specific challenges they are experiencing, two forums were identified, one of which is the Marine Aquaculture Industry Liaison (MAIL) and Freshwater Aquaculture Industry Liaison (FAIL). This is yet to be established. Both will be chaired by the DAFF.

Aquaculture sector development is led by the DAFF and several government Departments in all spheres of government, especially national and provincial government who plays a crucial supporting role. The roles of other government in the sector needed to be coordinated to avoid duplication of efforts and to align activities towards one government goal and position on aquaculture development. To address this, two important forums have been formed on national and provincial level, that is Aquaculture Intergovernmental Forum (AIF) and Provincial Aquaculture Intergovernmental Forum (PAIF) and both forums will be chaired by the DAFF.

6.2 Marine Aquaculture Industry Liaison (MAIL)

The MAIL consists of Marine Aquaculture Rights and Permit Holders representatives, the DAFF under the Branch: Fisheries includes all Chief Directorates within the Branch, i.e. Aquaculture and Economic Development (AED) as a lead Chief Directorate; Fisheries Research and Development (FR&D); Monitoring, Control and Surveillance (MCS) and Marine Resources Management (MRM); and the Department of Environmental Affairs (DEA), Branch: Oceans and Coasts. The forums had four meetings during 2011 and discussed strategic programmes that are aimed as sub-sector development. The programmes are harmonization of Marine Aquaculture and Wild Fisheries permit conditions; Aquaculture Information Management System (AIMS); Shellfish Monitoring Programme; National Aquaculture Strategy Framework (NASF); Export Health Certification; European Union regulations related to bio-toxins; Animal Health Services; DEA's Coastal Waters Discharge Permit Regulations; Health Certification for Algoa Bay oyster farms; Finfish monitoring working groups; Best Management Practices (BMP) for Marine Aquaculture; and Guidelines ASP testing in abalone Local Sales Permit Applications.

6.3 Freshwater Aquaculture Industry Liaison (FAIL)

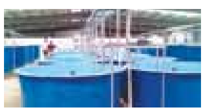
The FAIL is a forum which will be established in the next financial year. It will provide a platform for industry to engage and communicate with government on issues that affect the freshwater aquaculture industry. Its members will be DAFF officials from relevant Chief Directorates such as Fisheries Research and Development, Aquaculture and Economic Development, Monitoring Control and Surveillance, and Freshwater Aquaculture industry members.

6.4 Aquaculture Intergovernmental Forum (AIF)

AIF was established to ensure better communication amongst national Government Departments that have a mandate in aquaculture management and development. This forum is led by the DAFF and its main objective is to provide better management and development of the sector through joint facilitation, planning, coordination, resource mobilization, monitoring and evaluation. In addition, the AIF ensures oversight for aligned implementation and reporting of all key programs of Government in order to achieve sustainable aquaculture development in the country. The targeted participants for the AIF are key national government departments that have a role to play in aquaculture management. State-owned entities (SOE) and affected provincial departments are invited when the need arises.

During 2011, seven meetings of the AIF took place and the participants included DAFF as the lead agent for aquaculture



development; Department of Trade and Industry (DTI), Department of Science and Technology (DST); DEA and the Department of Water Affairs (DWA). The main deliverables that resulted from the forums are contribution to finalization of the National Strategic Framework (NASF) that is still awaiting approval and drafting of the supporting Implementation Plan which will be jointly implemented by the AIF members. There were several documents that were discussed in the AIF and inputs obtained from all affected Departments, i.e. draft Aquaculture Developmental and Enhancement Programme (ADEP); Aquaculture Environmental Impact Assessment Guidelines; and the concept of the Critical Thinkers' Platform in Aquaculture and Emerging Technologies (CTPAET).

6.4.1 Critical Thinkers' Platform in Aquaculture and Emerging Technologies (CTPAET)

The CTPAET is one of the activities identified in the NASF that should be organized annually to provide a platform to discuss aquaculture policy issues, share information, showcase local products, research and technology solutions. This event is arranged by DAFF in collaboration with AIF government departments. The CTPAET was inaugurated in Port Elizabeth on the 06th and 07th October 2011. The participants included government departments, investors, researchers, aquaculturists, finance institutions, research institutions, academia, and science councils.

During the inaugural event the CTPAET provided the Department's aquaculture scientists and researchers with an opportunity to share research results with the aquaculture stakeholders. The farmers were also given an opportunity to showcase their knowledge that has been acquired from their farms over the years. The event provided an opportunity for interested and affected stakeholders to have a dialogue with government departments (such as DAFF, DEA, DST, DTI and DWA) on aquaculture issues.

6.5 Provincial Aquaculture Intergovernmental Forum

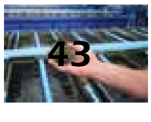
PAIF was established to ensure coordination between the aquaculture programmes within both National and Provincial Governments especially with Freshwater Aquaculture being a concurrent function and shared mandate. The PAIF is also key platform for information sharing and providing directions to the provincial department. The forum's inaugural meeting was hosted by the Eastern Cape Development Cooperation (ECDC) in East London on the 20th October 2011. During the inaugural meeting participants included provincial department dealing with aquaculture. To set the tone, information on the draft NASF; the Aquaculture Research Programme; the Framework for Aquatic Animal Health and Welfare; the Shellfish Monitoring Programme; and the Environmental Monitoring Programme was shared by the DAFF. The Provincial Departments provided an update on aquaculture activities and programmes within their provinces. In addition, the outcomes and recommendations of the "*Participatory development Provincial Programme for improved rural food security and livelihoods alternatives*" were presented to sensitize the Provincial Departments of the gaps identified.

7 AQUACULTURE PROJECTS

The Department is implementing a number of aquaculture projects in order to develop the aquaculture sector in South Africa. The projects are implemented in line with the NASF. These projects are aimed at empowering local communities through skills development, transfer of technology and job creation. The projects are expected to contribute towards improving the economic activities within the local communities and to a larger extent the country.

One of the projects that are being implemented is the Hamburg Aquaculture Project officially recognised as the Eastern Cape Development of Processing Facilities. The project entails the revitalization of the oyster farm and the establishment of a Dusky kob pilot project in Hamburg, Eastern Cape. The project will produce oysters for the local market and pilot the Dusky kob farming in the area. An EIA will be conducted on the site to determine the suitability of the site for the implementation of a 400 tons dusky kob farm. Currently fifty-eight (58) local people are employed in the project for a period of two (2) years.

A freshwater aquaculture project is being implemented in partnership with the Free State Provincial Department of Agriculture and Rural development. The projects will produce catfish (Clarias gariepinus) in a Recirculating Aquaculture System at a production capacity of 36 tons.



8 TRAINING AND CAPACITY BUILDING IN 2011

Participation at training programmes was undertaken by several officials within DAFF through cooperation agreement signed by South Africa with the People's Republic of China in 2006. South Africa was invited to participate in several capacity building activities that took place from July 2011 – August 2011. Additionally, the Ministry of Agriculture in the Republic of Indonesia had invited South Africa to participate in the international training programme for African countries on marine fish. The courses are outlined below:

8.1 Seminar on Aquaculture and Technical extension for South Africa offered by China

This course took place in the People's Republic of China from 21 July to 9 August 2011. Eleven Government officials at both Provincial and National level of the Department attended the seminar. The aim of the course was to provide participants with skills for providing extension services for the aquaculture sector. The training course consisted of lectures and study tours. The topics of the lectures covered all aspects of aquaculture such as:

- Impact of extension services on inland aquaculture development
- Management of Tilapia and Catfish hatchery
- Community based coastal Resource management
- Aquaculture health and fishery drug management
- Research and Development of early warning system for Tilapia industry
- Effective management and utilization of Fishery Resources in inland open water
- Management and practice on fine breed

Several study tours were also conducted to various state hatcheries, demonstration centers and research facilities as part of the course for officials to gain practical knowledge on aquaculture in China.

8.2 Integrated fish farming course offered by China

The course took place in the People's Republic of China from 01 -30th of August 2011. It was attended by 12 officials representing academic institutions and Government officials at both Provincial and National level. The objective of the course was to transfer the techniques and experiences of Chinese integrated fish farming through theoretical studies and practical training. The course focused on key areas such as:

- Successful integration of fish farming and other farming activities
- Establishment of sustainable aquaculture systems with low input and high output
- Training in fish health management
- Technological support to sustainable development of Chinese fisheries
- Biology and lab work on major cultured species
- Species selection for different culture species
- Lecture and lab work on fish induced breeding
- Practice on brooder selection and hormone injection
- Lecture and lab work on natural food organisms culture
- Development, diagnosis and prevention of fish diseases
- Lab work on diseased fish sample
- Fish bacteria diseases

Study tours for the course included visits to Health management facilities, seed production centers and state owned hatcheries.



8.3 Seminar on the management of Agricultural Technology Demonstration center offered by China

The seminar took place in the People's Republic of China from 6-26 July 2011.The seminar focused on the construction and management of agricultural technology demonstration centers in China. It also adopted typical case analysis of demonstration centers, field visits to Freshwater Fishery Research center under China Academy of Fishery Sciences and other activities in order to help participants to experience China's successful modes in the promotion of agricultural technologies. The main contents of the seminar included

- Management and operation of demonstration centers
- Status quo and prospect of agricultural cooperation between China and African countries
- Function positioning of demonstration centers and conception of sustainable development
- Establishment of the scientific research and technology demonstration systems in China.

8.4 International training programme for African countries on marine finfish in the brackish water aquaculture development center offered by Indonesia

The objective of this training programme was to provide participants with technical knowledge and skills on the rearing technology for marine and brackish water fish, particularly the grouper species. The programme comprised of lectures and practical courses. The lectures focused mainly on the following topics:

- Biology of marine and brackish water fish
- Site selection for coastal aquaculture
- Grouper and shrimp seed production, nursery and grow-out techniques
- Culture Environment and Water quality management
- Nutrition and feed for fish and shrimp larvae
- Diseases and Fish health management
- Grading, harvesting, packaging and transportation
- Fish farming in floating net cages

A number of small, medium and large scale hatcheries, nurseries and grow-out farms for grouper and shrimp were also visited during the training programme.



9 PUBLICATIONS

The following documents were published in 2011 from Directorate: ATS

9.1 Aquaculture Better Management Practices (BMP's)

Aquaculture BMP's document was developed in order to promote sustainable growth of the aquaculture sector as well as encourage investor confidence. This will ensure that responsible farming of aquatic animals is practised to improve the quantity, safety and quality of products which are placed in the market. The document focuses on issues such as environmental management, culture technology methods, disease management, water quality management and authorisation issues related to aquaculture. The BMP's have the following objectives:

- To improve farm management practices and sector governance;
- Raise aquaculture awareness and farmer capacity building;
- Encourage self-administration;
- Serve as a guide to clients and stakeholders;
- Build product quality assurance, enhance consumer confidence and;
- Encourage environmentally sustainable farming.

9.2 Guidelines for Marine Finfish Farming in South Africa

The Marine Finfish Farming guideline document has been developed to support the emerging finfish sub-sector by providing relevant information to existing and potential finfish farmers. Various guidelines on site selection, food safety, fish health and management are addressed in the document to ensure sustainability of marine finfish operations. The Marine Finfish farming sub-sector is a relatively new sector in South Africa with great potential to contribute to food security, job creation through skills based employment and community empowerment.

9.3 Aquaculture progress report on the cooperation between South Africa and China

The Republic of South Africa through the DAFF signed a cooperation agreement with the People's Republic of China through the Ministry of Agriculture in 2006. This cooperation strives to achieve, among others, the promotion of Aquaculture in South Africa to ensure food safety, poverty alleviation and financial profit by the production of a marketable commodity. The aim of the progress report was to summarise and assess the outcomes of the bilateral review activities regarding aquaculture which was carried out during the financial year 2010/2011 between the two governments.



10 OVERVIEW OF UNITS DIRECTORATES RESPONSIBLE FOR AQUACULTURE FUCTIONS WITHIN DAFF

Prior to 2009, management of marine and freshwater aquaculture on a national level resided within two government departments i.e. the former Department of Environmental Affairs and Tourism (DEAT) and Department of Agriculture (DoA) respectively. After restructuring of government departments, the DAFF was identified as a lead government department for the development and management of both marine and freshwater aquaculture. This decision prompted alignment of programmes to ensure that both marine and freshwater aquaculture is managed as a single sector i.e. aquaculture. Three units within DAFF were established to solely manage the sector i.e. Aquaculture Research and Development; Aquaculture Technical Services; and Sustainable Aquaculture Management.

10.1 Directorate Aquaculture Research and Development

Aquaculture is a technology driven industry which relies heavily on research to develop new species and the appropriate technology for commercial production. This is also supported by the NASF which identified the development of aquaculture technology, particularly for indigenous species, as a key strategy for growing the local aquaculture sector. Related to this is a need to make South African producers more internationally competitive by reducing costs through improved aquaculture technology innovations. The Directorate: Aquaculture Research and Development (D: ARD) has been established to oversee, facilitate and conduct aquaculture research in South Africa.

It's vision is *"Excellence in aquaculture research to support the growth of a sustainable and globally competitive aquaculture sector for South Africa - 20:20)"* with the intention for a 20% growth rate in the next 20 years or growth target to 20 000 tons in the next twenty 20 years. The responsibility of the aquaculture research division is to conduct research in support of a competitive and sustainable development of aquaculture in South Africa. The main focus areas are:

- Research and development of culture technology for aquaculture species
- Research on aquatic animal health and diseases for aquaculture
- Research on the interaction between the environment and aquaculture

10.2 Aquaculture Technical Services

Aquaculture technical and advisory services has been lacking due to the limited skills in the country. In order to address this aspects, the Aquaculture Technical Services (ATS) of the Fisheries branch was established to concentrate on the technical and socio-economic aspects in aquaculture development. The main pillars and functions of the ATS directorate are:

- **Aquaculture Support Services**: To ensure that farmers are obtaining the necessary support. A sub-unit was established which is responsible for developing and implementing farm support programmes; provide technical advisory services; and facilitate training and capacity building within the sector.
- **Aquaculture Information Management:** It is important to ensure that the sector information is available to assist in decision making. A sub-unit responsible to drive the collection and dissemination of information was established:sector promotion through awareness programmes; development and dissemination of sector promotion material; and most importantly development and publication of the *Aquaculture Yearbook.*
- **Aquaculture Economics:** The economic assessment of fish farms is crucial to ensure its success. A sub-unit dealing with this function is also located with ATS. This includes market issues; facilitating access to finance; and economic monitoring of the sector.
- **Aquaculture Infrastructure and Facility Management**: Currently, government does have an infrastructure for aquaculture under the management of both national and provincial departments. To ensure that this infrastructure




supports the current sector needs, ATS has been tasked with identifying and managing the infrastructure.

- **Aquaculture Development:** To ensure an enabling environment has been created for the sector. ATS has been tasked with addressing zoning and facilitation of seed supply.

10.3 Directorate Sustainable Aquaculture Management

The Directorate: Sustainable Aquaculture Management (D: SAM) is responsible for the development, management and regulation of a sustainable aquaculture industry that contributes towards job creation, food security, rural development and economic growth. D: SAM aims to achieve the above mentioned strategic objectives through the development and implementation of relevant enabling legislation, policies and programs that are aligned with the government's Industrial Policy Action Plan (IPAP) and New Growth Path (NGP) as well as responsive and compliant to international obligations and agreed standards.
D: SAM's functions comprise of five pillars which are supported by sub-units as follows:

- **Environmental Assessments**: This sub-unit is responsible for aquaculture environmental interactions. This entails the assessment of the impact to the environment associated with aquaculture and related activities.

- **Food Safety:** This sub-unit is responsible for the development and management of food safety programmes. Currently, the sub-unit is managing the South African Molluscan Shellfish Monitoring and Control Programme (SAMSM&CP). The objectives of the SAMSM&CP are, to ensure guarantees to domestic and international markets and consumers that South African farmed shellfish products are safe for human consumption. In order to ensure functional food safety programmes, the sub-unit collaborates with other agencies such as the National Regulator for Compulsory Specifications (NRCS) and Council for Scientific and Industrial Research (CSIR).

- **Aquatic Animal Health:** Aquatic animal health is a very important aspect in aquaculture development. To address this aspect, a sub-unit has been established which is responsible for the development, implementation and review of the Aquatic Animal Health Strategic Framework; the undertaking of farmed aquatic animal stock inspections; render advice to farmers of aquatic animals in terms of health and welfare issues; development of the biosecurity and better management guidelines; reporting of aquatic animal diseases in consultation with the D:ARD; and conduct training, education and awareness programs on aquatic animal health.

- **Intergovernmental and Policy Coordination: Even though DAFF is the lead department for aquaculture development and management, other departments from all spheres of government are contributing through their mandates.** A sub-unit to deal with coordination of stakeholder engagements has been established within DAFF. Amongst others, this unit is responsible for coordinating all intergovernmental engagements (e.g. National Aquaculture Intergovernmental Forum, Provincial Aquaculture Intergovernmental Forum, and Aquaculture Value-Chain Round Table); and coordination of the review of legislation and aquaculture policies.

- **Aquaculture Authorizations: As per legislative requirements, authorization of aquaculture activities is required. This gave impetus to establish a sub-unit responsible within DAFF. This sub-unit is r**esponsible for the receipt, processing and granting of aquaculture rights, ranching rights and exemptions, issuing of permits and licences; development and review of permit conditions, coordination of aquaculture stakeholder working groups (e.g. Marine Aquaculture Working Group and Marine Aquaculture Industry Liaison); farm visits for data collection and monitoring; and handling of appeals.



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