AQUACULTURE YEARBOOK 2017 SOUTH AFRICA

environment, forestry & fisheries

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PREFACE

The Department of the Environment, Forestry, and Fisheries (DEFF) is the lead agent responsible for the development and management of the aquaculture sector in South Africa. This is amongst core functions of the Branch: Fisheries Management. Through the Chief Directorate: Aquaculture and Economic Development, the DEFF has the responsibility to ensure availability of aquaculture information that includes but not limited to production; jobs created by the sector; contribution of the sector to the economy; and general status of the sector. To ensure this function is consistently implemented, the Directorate: Aquaculture Technical Services compiles and publishes the Aquaculture Yearbook on an annual basis.

The purpose of this publication, Aquaculture Yearbook, is to report on the status of the aquaculture sector in South Africa, with the aim of providing decision makers and stakeholders with consistent and sufficient information. It further aims to promote the sector in and outside South Africa.

ACKNOWLEDGEMENTS

The Department of the Environment, Forestry and Fisheries (DEFF) wishes to acknowledge the support provided by all stakeholders, especially industry members in contributing to the development and management of the aquaculture sector during 2016 and beyond. Special thanks are attributed to aquaculture associations, individual farmers, importers and exporters who had provided information to the DEFF in order to compile this publication.

Mr Semoli is acknowledged for his leadership as the Chief Director: Aquaculture and Economic Development. His contribution to the development of aquaculture has been noticed over the years. The Directorate: Aquaculture Technical Services under the leadership of Director, Ms Khumo Morake-Makhalemele is acknowledged for leading the compilation of the this publication, with contributions from the Directorate: Aquaculture Research and Development under the leadership of Acting Director, Ms Fatima Samodien; the Directorate: Sustainable Aquaculture Management led by Acting Director, Ms Zimasa Jika and the Sub-division: Operation Phakisa Delivery Unit led Operations Manager, Ms Andrea Bernatzeder. Contribution of all staff members within all aquaculture directorates is highly appreciated.

EXECUTIVE SUMMARY

The Department of the Environment, Forestry and Fisheries (DEFF) gathers aquaculture production data on an annual basis with the intention of providing stakeholders with the status of the aquaculture sector in the country. The gathered production data are analysed, interpreted and presented in an Aquaculture Yearbook. The Aquaculture Yearbook 2017 presents data collected in 2016 from aquaculture stakeholders. In 2016, species cultivated in the marine sector included abalone (Haliotis midae), pacific oyster (Crassostrea gigas), mussels (Mytilus galloprovincialis, Chromomytilus meridionalis), dusky kob (Argyrosomus japonicus), and seaweed (Ulva spp, Gracilaria spp). Species cultured during 2016 in the freshwater sector, were trout (Onchorynchus mykiss, Salmo trutta), tilapia (Oreochromis mossambicus, Oreochromis niloticus, Oreochromis rendalli), catfish (Clarias gariepinus), carp (Cyprinus carpio), and marron crayfish (Cherax tenuimanus).

A total of 216 aquaculture farms were reported to be operational in 2016, with 41 of the farms cultivating marine species and 175 farms cultivating freshwater species. There has been a notable increase of twenty seven (27) farms compared to the one hundred and eighty nine (189) farms that were reported to be operational in the previous year (2015).

The total annual production of the country's aquaculture industry in 2016 was 6012.44 tons. This figure does not include seaweed, carp, ornamentals or koi carp production due to the inconsistent reporting of the subsectors and again seaweed is grown as feed for abalone. The marine sector contributed 4140.18 tons while the freshwater sector 1872.26 tons. When compared to the previous year (2015), the aquaculture sector showed a 9.89% increase in production during 2016, representing a production increase of 594.39 tons (548.32 tons in the marine sector and 46.07 tons in the freshwater sector). In the marine sector, mussels represents the highest production output, followed by abalone then oysters. Finfish contributed the least to production in the marine sector. In the freshwater sector, trout contribute most to production, followed by tilapia, ornamentals, koi carp, carp, marron crayfish, and lastly, catfish.

In 2016, an investment of approximately R474 million was attained into the aquaculture sector, representing an increase of 44.30% from R264 million that was recorded in 2015. The total value of the aquaculture sector in 2016, was estimated at R 1 billion (R1 042 072 340.31). The marine sector contributed R903 million (R903 528 840.31), representing 86.71% to the overall aquaculture value. The freshwater sector contributed R136 million (R135 543 500), representing 13.29% to the overall aquaculture value. The sector also created additional 622 jobs during 2016 primarily due to the increased production. In terms of aquaculture research and development in South Africa, numerous research projects were undertaken in 2016. The species that were under investigations were the dusky kob (Arygyrosomus japonicus), Mozambique tilapia (Oreochromis mossambicus), spotted grunter (Pomadasys commersonni) and the white stumpnose (Rhabdosargus globiceps). The researches were focused on the reproduction, nutrition and growth performance of the aforementioned species.

The positive Environmental Authorisation (EA) that was awarded to the Qolora land-based Aquaculture Development Zone (ADZ) was extended to the 29th September 2020. The Department is in the process of initiating the second phase which includes securing of funds for the construction phase of basic infrastructure. Regarding the Algoa Bay Sea-based ADZ, following appeal processes, the DEFF conducted comparative studies to further assess the Algoa 5 and Algoa 1 sites. The Basic Assessment process was planned to be conducted in 2017 to get an EA to be reissued. Furthermore, the Department is planning to conduct an Environmental Impact Assessment (EIA) for establishment of a land-based ADZ at Amatikulu, Kwa-Zulu Natal. Specifications for undertaking this work were advertised in August 2016 and an Environmental Assessment Practitioner (EAP) will be appointed in 2017. Regarding the Saldanha Bay ADZ, an EAP was appointed in May 2016 to conduct an EIA. The EIA application and the Basic Assessment Report will be submitted to the Department of Environmental Affairs in 2017 for consideration.

During 2016, legislation applicable to the aquaculture industry was developed by Government institutions. This legislation included the Aquaculture Development Bill, Inland Fisheries Policy, Marine Spatial Planning Bill, 22 Proposed Marine Protected Areas Regulations, and Coastal Waters Discharge Authorisations.

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ABBREVIATIONS

AASA	Aquaculture Association of Southern Africa
ADZ's	Aquaculture Development Zones
ADEP	Aquaculture Developmental and Enhancement Programme
AIS	Alien Invasive Species
AIF	Aquaculture Intergovernmental Forum
AOAC	Association of Analytical Communities
ARC	Agricultural Research Council
ARTDP	Aquaculture Research and Technology Development Programme
ARU	Aquaculture Research Unit
ASP	Amnesic Shellfish Poisoning
ATDC	Agricultural Technology Demonstration Centre
BEE	Black Economic Empowerment
BMP's	Better Management Practices
CD: AED	Chief Directorate: Aquaculture and Economic Development
CD: FR&D	Chief Directorate: Fisheries Research and Development
CGA	Catfish Growers Association
CITES	Convention on International Trade in Endangered Species
CD	Crude Protein
CSIR	Council for Scientific and Industrial Research
DEA&DP	Department of Environmental Affair and Development and Planning
DAFF	Department of Agriculture, Forestry and Fisheries
D: ARD	Directorate: Aquaculture Research and Development
D: ATS	Directorate: Aquaculture Technical Services
DBSA	Development Bank of South Africa
DDG	Deputy Director-General
DEA	Department of Environmental Affairs
DFI	Development Funding Institutions
DMSO	Dimethyl sulfoxide
D: SAM	Directorate: Sustainable Aquaculture Management
DPH	Days Post Hatch

DSP	Diarrhetic Shellfish Poisoning
DST	Department of Science and Technology
The dti	Department of Trade and Industry
DWS	Department of Water and Sanitation
ECDC	Eastern Cape Development Cooperation
EIA	Environmental Impact Assessment
EIF	Environmental Integrity Framework
ELIDZ	East London Industrial Development Zone
EOP	Environmental Officer Production
EUS	Epizootic Ulcerative Syndrome
FAIL	Freshwater Aquaculture Industry Liaison
FAO	Food and Agriculture Organisation of the United Nations
FOCAC	Forum of China Africa Cooperation
FPE	Fish Processing Establishment
FS: DARD	Free State Department of Agriculture and Rural Development
GAP	Good Aquaculture Practice
GDP	Gross Domestic Product
GIFT	Genetically Improved Farmed Tilapia
HBSS	Hank's Balanced Salt Solution
HAB	Harmful Algal Bloom
HDI	Historical Disadvantaged Individuals
HDPE	High Density Polyethylene
IDC	Industrial Development Cooperation
IAC	Inter-Departmental Authorisations Committee
IPAP	Industrial Policy Action Plan
KHV	Koi Herpes virus
MAIL	Marine Aquaculture Industry Liaison
MAWG	Marine Aquaculture Working Group
MDARLA	Mpumalanga Department of Agriculture, Rural Development and Land Administration
MLRA	Marine Living Resources Act No. 18 of 1998
MOFCOM	People's Republic of China Ministry of Commerce
MTPA	Mpumalanga Tourism and Parks Agency

NDP	National Development Plan
CD: MRM	Chief Directorate: Marine Resources Management
CD: MSC	Chief Directorate: Monitoring, Control and Surveillance
MTPA	Mpumalanga Tourism and Parks Agency
NAPF	National Aquaculture Policy Framework
NASF	National Aquaculture Strategy Framework
NEF	National Empowerment Fund
NEM: BA	National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
NGP	New Growth Path
Non – HDI	Non-Historically Disadvantaged Individual
NRCS	National Regulator for Compulsory Specifications
OIE	World organization for animal health
OPDU	Operation Phakisa Delivery Unit
PCB	Polychlorinated Biphenyls
PAIF	Provincial Aquaculture Intergovernmental Forum
PCR	Polymerase Chain Reaction
PSP	Paralytic Shellfish Poisoning
RAS	Recirculating Aquaculture Systems
RoI	Return on Investment
D: SAM	Directorate: Sustainable Aquaculture Management
SAMSM&CP	South African Molluscan Shellfish Monitoring and Control Programme
Sd: AAH&EI	Sub-directorate: Aquaculture Animal Health and Environmental Interactions
SETA	Sector of Education and Training Authority
SEZ	Special Economic Zone
SOE	State-Owned Entities
SGR	Specific Growth Rate
TAN	Total Ammonia Nitrogen
TCP	Technical Cooperation Program
TCPF	Technical Cooperation Programme Facility
TL	Total Length
UIA	Un-Ionised Ammonia

DEFINITION OF TERMS

Active surveillance	Referred as stock inspection, 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; and c) Diagnostic analysis of samples collected on a suspicion of a disease or observed increased mortality during inspection.
Commercial	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.
Farm closure	A period where shellfish farms are temporally not allowed to market and or sell products due to microbiological contamination, detection of bio-toxins and as well as other hazardous substances such as heavy metals, pesticides, polychlorinated biphenyls (PCBs) or radionuclides.
Pilot scale	Status at which a project is testing or conducting trial in order to demonstrate the efficiency i.e technical and economics.
Production	Amount of organisms produced from a farm.
West Coast	West of Cape Point to boarder of Namibia.

OVERVIEW OF AQUACULTURE YEARBOOK 2017

01

1.1. History of the Aquaculture Yearbook

The Aquaculture Yearbook was initiated in 2009 under the then Department of Environmental Affairs and Tourism (DEAT). Its initial focus was marine aquaculture as the DEAT's mandated was limited to management of marine aquaculture and not freshwater aquaculture. The publication was called South Africa's Marine Aquaculture Industry Annual Report 2009. Due to the restructuring and reprioritisation of government mandates, the management of aquaculture was reassigned to the Department of Agriculture, Forestry and Fisheries (DAFF), which resulted in reviewing of the publication name in 2010 to the Marine Aquaculture Annual Report 2010. The 2010 publication covered broader aspects of marine aquaculture.
During 2010, the integration of marine and freshwater aquaculture took place, redefining of the government roles and responsibility towards the aquaculture sector as a whole. The inclusion of the freshwater aspects into the report took place, resulting in revision of the publication name in 2011 to South Africa's Aquaculture Annual Report. The last revision of the publication took place in 2012 to align with the overall fisheries sector. The name was revised to South Africa's Aquaculture Yearbook – 2012. The following publications took place prior to this edition:

- South Africa's Marine Aquaculture Industry Annual Report 2009
- Marine Aquaculture Annual Report 2010
- South Africa's Aquaculture Annual Report 2011
- South Africa's Aquaculture Yearbook 2012
- South Africa's Aquaculture Yearbook 2013
- South Africa's Aquaculture Yearbook 2014
- South Africa's Aquaculture Yearbook 2015
- South Africa's Aquaculture Yearbook 2016
- South Africa's Aquaculture Yearbook 2017 – current publication.

1.2. Purpose of the Aquaculture Yearbook 2017

The main purpose of the Aquaculture Yearbook 2017 is the provide access to information and ensure transparency related to the status of aquaculture sector in South Africa from 2016 activities. Its aim is to create awareness, promote the sector; make provision of information to decision makers, potential investors and general public. The objective of the South Africa's Aquaculture Yearbook includes recording and monitoring progress of the sector; to ensure availability of official aquaculture statistics and information to stakeholders; facilitate public awareness; identify deficiencies in development and management systems; and made a business case for future developmental initiatives of the sector.

1.3. Aquaculture Yearbook 2017 compilation process

Similar to other editions of the South Africa's Aquaculture Yearbooks, the South Africa's Aquaculture Yearbook 2017 was compiled based on the information collected from different aspects of the sector ranging from research, socio-economic and economic information, production statistics, to existing publications and other developmental aspects. Key component of this publication is the production data and socio-economic data. It was compiled based on data collected from farmers during 2016, both freshwater and marine aquaculture sectors.

Data collected from the marine aquaculture sector was from legislated and legally operating farmers, importers and exporters in terms of Marine Living Resources Act, 1998 (Act No.18 of 1998) (the MLRA). The submission of such data was guided by 2016 permits conditions of several sub-sectors and permits issued under several sections of the MLRA.
Collection of the freshwater aquaculture data continues to pose a challenge for the Department as it is currently voluntary for industry to submit. It was collected through questionnaires, telephonic interviews and through industry associations. The data in this report for freshwater aquaculture may not be a true reflection due to limitations resulting from gaps in legislation governing this process.

02

STATUS OF AQUACULTURE IN SOUTH AFRICA 2016

2.1 Overview of aquaculture in South Africa in 2016

South Africa has both freshwater and marine aquaculture sectors. The overall sector continues to grow fast, recording a total production of 6012.44 tons in 2016. Freshwater sector contributed 1872.36 tons while marine sector contributed 4140.18 tons. This production volume followed a total production of 5418.15tons recorded in 2015, indicating an increased output of 594.39 tons, an increased 9.89 % from 2015.

The sector operated from a range of various marine and freshwater species. The six (6) freshwater species cultured included trout (Onchorynchus mykiss and Salmo trutta), tilapia (Oreochromis mossambicus, Oreochromis niloticus and Tilapia rendalli), catfish (Clarias gariepinus), carp (Cyprinus carpio and Ctenopharygodon idella), marron crayfish (Cherax tenuimanus), and a number of ornamental species (e.g., Koi-carp). The most important areas of production for freshwater species include Eastern Cape, Kwa-Zulu Natal and Western Cape provinces.

Marine aquaculture was the main driver of the sector, and included abalone (Haliotis midae), pacific oyster (Crassostrea gigas), mussels (Mytilus galloprovincialis and Choromytilus meridionalis), dusky kob (Argyrosomus japonicas), Salmon (Salmo salar), dusky kob (Argyrosomus japonicus). The above mentioned species are farmed in the coastal provinces of the Eastern Cape, Kwa-Zulu Natal, Northern Cape and Western Cape provinces.

A total of 216 farms were recorded in 2016 for both freshwater and marine species (Table 1). Most freshwater farms utilise recirculating systems, race ways and earth ponds for cultivation of the species above, while marine molluscs are cultivated on rafts or long lines, and abalone is cultured in tanks with pump ashore technology. A total increase of thirty (30) farms, seven (7) of which were marine farms and twenty three (23) freshwater farms, was recorded during the year 2016.

Table 1: Total number of farms recorded for South Africa's aquaculture sector in 2016.

SPECIES	EC	FS	GP	KZN	LP	MP	NC	NW	WC	TOTAL
Abalone	2	0	0	0	0	0	4	0	13	19
Finfish	3	0	0	2	0	0	0	0	1	6
Mussels	0	0	0	0	0	0	0	0	8	8
Oysters	3	0	0	0	0	0	0	0	5	8
TOTAL (Marine)	**8**	**0**	**0**	**2**	**0**	**0**	**4**	**0**	**27**	**41**
Tilapia	3	0	22	5	18	11	1	15	2	77
Trout	2	0	0	5	0	12	0	0	32	51
Catfish	2	4	0	0	4	0	0	3	0	13
Marron Crayfish	1	0	0	0	0	0	0	0	0	1
Carp	0	0	1	0	1	0	1	0	1	4
Koi Carp	0	2	5	2	0	1	0	0	1	11
Ornamental species	2	2	4	5	1	2	0	0	2	18
TOTAL (Freshwater)	**10**	**8**	**32**	**17**	**24**	**26**	**2**	**18**	**38**	**175**
TOTAL (Marine and Freshwater	**18**	**8**	**32**	**19**	**24**	**26**	**6**	**20**	**65**	**216**

Species farmed: In 2016, a range of ten (10) species were farmed at various production levels. These included four (4) marine species namely abalone, oysters, mussels and finfish; and six (6) freshwater species namely tilapia, trout, catfish, carp, koi-carp and ornamentals.

Production: The total production of South Africa's aquaculture industry recorded during 2016 was 6012.44 tons. The sector has shown continuous growth since 2006 to date (Figure 1), with an increase of 594.39 tons from 2015 to 2016. This increase in volume represents an increase of 9.89%.

Marine aquaculture contributed 4140.18 tons towards the total production volume, making up 68.86% of the total production volume. This industry experienced an increase of 548.32 tons (13.24%) from 2015 (Figure 2, Table 2). The freshwater aquaculture, on the other hand, contributed 1872.36 tons (31.14%) towards the total production volume. This industry experienced an increase of 46.07 tons (2.46%) from 2015 (Figure 2, Table 2). The leading sub-sector in terms of production was mussels with a production volume of 1960.95 tons, followed by abalone with a production of 1703.32, and trout with a production of 1503 tons (Table 2).

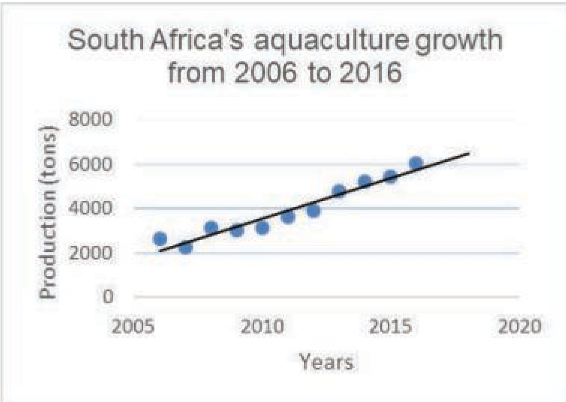


Figure 1: South Africa's aquaculture
Production growth from 2006 to 2016

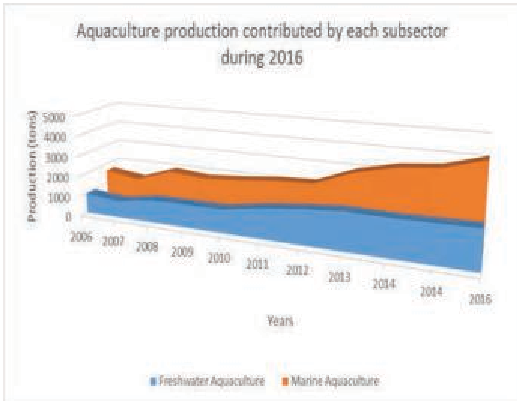


Figure 2: South Africa's production growth
per sector from 2006 to 2016

Table 2: Total production (tons) recorded for South Africa's aquaculture sector in 2016.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Abalone	146.43	0.00	0.00	0.00	0.00	0.00	1.83	0.00	1555.07	1703.32
Finfish	116.54	0.00	0.00	2.10	0.00	0.00	0.00	0.00	0.00	118.64
Mussels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1960.95	1960.95
Oysters	88.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	268.34	357.27
Total Marine	**351.90**	**0.00**	**0.00**	**2.10**	**0.00**	**0.00**	**1.83**	**0.00**	**3784.35**	**4140.18**
Tilapia	21.5	0.00	59.70	6.50	146.52	22.79.	3.00	75.80	5.00	340.81
Trout	236.20	0.00	0.00	378.70	0.00	138.00	0.00	0.00	750.10	1503.00
Catfish	3.30	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	3.30
Marron Crayfish	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Carp	0.00	0.00	1.60	0.00	2.50	0.00	0.60	0.00	0.55	5.25
Koi Carp	0.00	0.80	3.70	1.40	0.00	0.60	0.00	0.00	0.50	7.00
Ornamental species	1.70	1.20	0.00	3.10	0.80	1.30	0.00	0.00	0.90	9.00
Total Freshwater	**266.7**	**2.00**	**6.50**	**389.7**	**149.82**	**162.69**	**3.60**	**75.80**	**757.05**	**1872.36**
Total Marine and Freshwater	**618.60**	**2.00**	**6.50**	**391.80**	**149.82**	**162.69**	**5.43**	**75.80**	**4541.40**	**6012.54**

03 STATUS OF MARINE AQUACULTURE IN 2016

3.1 Marine aquaculture farms operating during 2016

In 2016, a total of 41 marine aquaculture farms were in operational in South Africa. There was an increase in the total number of marine aquaculture farms in the Western Cape Province. The Western Cape Province had the highest number of operating marine fish farms in 2016, amounting to twenty-seven (27) comprising of four (4) sub-sectors namely abalone (13), finfish (1), oysters (5) and mussels (8). In the Eastern Cape Province, eight (8) farms were in operation and comprised of three (3) sub-sectors namely abalone (2), finfish (3) and oysters (3). The Northern Cape Province had four (4) abalone farms whilst Kwa-Zulu Natal Province had the least number of farms with only two (2) finfish farms in operation. The total number of farms operating in Eastern Cape and Northern Cape included the abalone ranching operations, two (2) situated in Northern Cape (NC) and one (1) in Eastern Cape. There was no commercial marine aquaculture in the inland provinces. The distributions of the farms are presented in Table 3.

Table 3: Total number of marine aquaculture farms operating in South Africa by sub-sector and province in 2016.

Operational farms per species and province										
Species	**WC**	**EC**	**NC**	**KZN**	**NW**	**FS**	**MP**	**LP**	**GP**	**Total**
Abalone	13	2	4	0	0	0	0	0	0	19
Finfish	1	3	0	2	0	0	0	0	0	6
Mussels	8	0	0	0	0	0	0	0	0	8
Oysters*	5	3	0	0	0	0	0	0	0	8
Total	**27**	**8**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**41**

*(2) two oyster farms cultured mussels as well, however the farms haven't been captured under mussels as their primary species is oysters.

3.2. Marine aquaculture species farmed during 2016

A total of eighteen (18) species were cultured in South Africa during the year 2016. These species were clustered in five (5) sub sectors, namely abalone, oysters, mussels, finfish and seaweed. The four (4) sub-sectors farmed for human consumption whilst seaweed was utilised for abalone feed. The farm operational categories were commercial, pilot and research. Table 4 illustrates the species cultured in South Africa during 2016 and the operational scale in the sector.

A number of aquaculture species were kept on farm premises for conditioning and research purposes. These species included yellowtail (Seriola lalandi), mangrove snapper (Lutjanus argentimaculatus), spotted grunter (Pomadasys commersonnii), yellow belly rockcod (Epinephelus marginatus) and bloodworm (Arenicola loveni). The DAFF conducted research on potential species during 2016 at the DAFF Aquaculture Research Facility in Sea Point (Cape Town, Western Cape). Research was conducted on the following species: white stumpnose (Rhabdosargus globiceps), south coast sea urchin (Tripneustes gratilla), Octopus (Octopus vulgaris) and the South African scallop (Pecten sulcicostatus).

Marine aquaculture species cultured on a commercial scale included abalone (Haliotis midae), pacific oyster (Crassostrea gigas), mussels (Mytilus galloprovincialis and Choromytilus meridionalis), dusky kob (Argyrosomus japonicas), Salmon (Salmo salar), East Coast Rock Lobster (Panulirus Homarus) and seaweed, (Ulva spp and Gracilaria spp).

Table 4: Marine aquaculture species and their operational scale in South Africa during 2016.

Marine aquaculture species farmed in South Africa during 2016		
Common Name	Scientific Name	Operational Scale
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
Dusky kob	Argyrosomus japonicus	Commercial
Salmon	Salmo salar	Pilot
East Coast Rock Lobster	Panulirus Homarus	Pilot
Yellowtail	Seriola lalandi	Research
White stumpnose	Rhabdosargus globiceps	Research
Spotted grunter	Pomadasys commersonnii	Research
Yellowbelly rockcod	Epinephelus marginatus	Research
Mangrove snapper	Lutjanus argentimaculatus	Research
South Coast Sea Urchin	Tripneustes gratilla	Research
South African Scallop	Pecten sulcicostatus	Research
Bloodworm	Arenicola loveni	Research
Octopus	Octopus vulgaris	Research

3.3 Marine Aquaculture Authorisations in 2016

During 2016, the marine aquaculture industry continued to be managed under the Marine Living Resources Act, 1998 (Act 18 of 1998) (MLRA). The MLRA created regulatory framework for the conservation of ecosystems; the sustainable utilization of marine living resources and the orderly access to exploitation; utilization and the protection of certain marine living resources. Even though marine aquaculture is more development focus, it formed part of the activities that are regulated in terms of the MLRA due to its utilisation of the marine space and species. It continues to be regulated in the form of issuing of Rights, Permits and Exemptions where necessary, in terms of the MLRA. The DAFF embarked on a process of developing aquaculture legislation during 2014 and a concept note of the Aquaculture Bill was consulted with industry.

3.3.1 Marine aquaculture rights

Marine Aquaculture Rights are granted in terms of Section 18 (1) of the MLRA, which states that:
"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 2016, four (4) Marine Aquaculture Rights were granted in Saldanha Bay, Western Cape for two (2) marine shellfish species and five (5) marine finfish species (Table 5). Applications for a marine aquaculture Rights can be submitted to the DAFF on a continuous basis. The application process is open to any individual or registered business entity that has shown interest overtaking an aquaculture activity. The applicant must meet the criteria as set out in the application form and provide the relevant supporting documentation as required.

Table 5. Rights to Engage in Marine Aquaculture granted in 2016.

Company Name	Operational Area	Species	Duration of Right
Chapman's Aquaculture (Pty) Ltd	Port of Saldanha Bay, Western Cape (15 hectares in North Bay area)	Mussels (Mytilus galloprovincialis)	14/09/2016 - 15/09/2031
Molapong Aquaculture (Pty) Ltd	Port of Saldanha Bay, Western Cape (1 hectare near Jutten Island and 4 hectares near Langebaan)	Rainbow trout (Oncorhynchus mykiss), Atlantic Salmon (Salmo salar), Brown trout (Salmo trutta), King salmon (Oncorhynchus tshawytschia), and Coho salmon (Oncorhynchus kisutch)	01/06/2016 - 31/05/2032
Requa Enterprises (Pty) Ltd	Port of Saldanha Bay, Western Cape (15 hectares in Big Bay area)	Mussels (Mytilus galloprovincialis)	18/10/2016 - 18/10/2031
Salmar Trading (Pty) Ltd	Port of Saldanha Bay, Western Cape(5 hectares in the Inner Bay)	Pacific Oysters (Crassostrea gigas)	01/09/2016 - 31/08/2031

3.3.2. Exemption

Exemptions are granted in terms of Section 81 of the MLRA, which states that:
"If in the opinion of the Minister there are sound reasons for doing so, he or she may, subject to the conditions that he or she may determine, in writing exempt any person or group of persons or organ of state from a provision of this Act."

Most marine aquaculture Fish Processing Establishments (FPE's) operate under an exemption due to institutional delays in the granting of FPE Rights. Exemptions for "the possession and sale of undersized abalone and kob" (herein referred to as "local sales permits") are drafted to allow for the local sales of the products due to the implementation of wild caught fish size limitations on farmed products. The exemption process is a legislative process that is used as a mechanism to allow for the processing and local sales of undersized products. In the past year, the amount of permits approved for FPE's and local sales permits has increased as compared to the previous year, 2015.

3.3.3. Permits

To activate a Right or Exemption, a Permit is issued in accordance with Section 13 (1) of the MLRA which states that:

(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 2016, a total of 409 permits for marine aquaculture were issued in South Africa to Right holders, agencies, importers, exporters, FPE's and transportation companies etc. (Table 6). In terms of the total permits issued in 2015 (419), the Department through Directorate: Sustainable Aquaculture Management (D: SAM) has introduced streamlined permits which integrated a number of aquaculture activities into one Integrated Permit to Engage in Marine Aquaculture Activities. There was an increase in the Permits to Engage in Marine Aquaculture Activities from 44 in 2015 to 63 in 2016 due to new entrants in aquaculture sector and amendment permits for streamlined activities. Thus the total number of permits were reduced from 419 in 2015 to 409 in 2016 due to streamlining and permit integration process.

The permits issued for imports exceeded the number of permits issued for exports, due to increased number of traders that import non-consumption products such as aquarium species. There were 52 permits to "Possess and Sell Undersized Cultured Abalone obtained from Right holders" issued in 2016, depicting increased local demand for abalone.

Table 6: Types of permits issued in 2016.

No.	Permit type	No. of Permits issued
1.	Permit to Import Marine Species & Products (For consumption & non-consumption)	112
2.	Permit to Export Cultured Marine species & Products (For consumption & non-consumption)	68
3.	Permit to Transport Cultured Marine Species & Products	27
4.	Permit to Engage in Marine Aquaculture Activities	63
5.	Permit to Possess Broodstock and Operate a Hatchery	25
6.	Permit to Possess and sell Undersized Cultured Abalone obtained from Right holder	52
7.	Permit to Possess and sell undersized kob obtained from a Right Holder	0
8.	Permit to Engage in Abalone Ranching and Stock Enhancement Pilot Project: Seeding	8
9.	Permit to Engage in Ranching Activities of Marine Species: Harvesting	3
10.	Permit to Collect Broodstock for Marine Aquaculture purposes	2
11.	Permit to Operate a Fish Processing Establishment	24
12.	Permit to conduct Scientific Investigations and Practical Experiments	13
13.	Permit for the Purposes of Diving and possession of prohibited gear within the listed areas in terms of Regulation 3(3) of Government Gazette no. 30716 of 1 February 2008 (Regulations for the protection of wild abalone)	12
	TOTAL	**409**

3.4 Marine Aquaculture Production

3.4.1 Marine aquaculture production in 2016

In the South Africa's Aquaculture yearbook 2017, production is defined as the quantity of organisms produced from a farm specifically for human consumption and is expressed in tonnage. South Africa's total marine aquaculture production in 2016 was 4140.3 tons. Table 7 below illustrates the total production per sub-sector in each province. In 2016 the Western Cape Province recorded a production of 3826.09 tons and was the main contributor of South Africa's total marine aquaculture production followed by the Eastern Cape and KwaZulu Natal with a production of 351.90 and 2.10 tons respectively. The Northern Cape Province was the smallest contributor, recording a production of 1.83 tons. No marine aquaculture production was recorded for inland provinces.

Table 7: 2016 Marine Aquaculture total productions for human consumption per sub-sector and province

Production (tons) per species and province										
Species	WC	EC	NC	KZN	NW	FS	MP	LP	GP	**Total**
Abalone	1555.07	146.43	1.83	0.00	0.00	0.00	0.00	0.00	0.00	**1703.32**
Finfish	0.00	116.54	0.00	2.10	0.00	0.00	0.00	0.00	0.00	**118.64**
Mussels	1960.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1960.95**
Oysters	268.34	88.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**357.27**
Total	3784.35	351.90	1.83	2.10	0.00	0.00	0.00	0.00	0.00	**4140.18**

South Africa's total marine aquaculture production increased by 548.32 tons from 3591.86 recorded in 2015, representing an increase of 15.27%.The marine sector contributed 68.86% to the overall aquaculture production of 6012.54 tons. The mussel sub-sector contributed 47.36% to the total marine aquaculture production. It recorded an increase in production by 202.48 tons (11.51%) from 2015. The abalone sub-sector, even though it is the second in terms of production volumes, it contributed 41.14% towards the overall marine aquaculture production, and has increased by 224.10 tons (15.15%) from 2015. The finfish sub-sector contributed 2.87% towards the overall marine aquaculture production and demonstrated an increase 41.32 tons (53.44%) from 2015. The oyster sub-sector contributed 8.63% towards the overall marine aquaculture production and demonstrated an increase of 80.41 tons (29.0%) from 2015 (Figures 3 and 4). Seaweed, which has been excluded in the total production recorded 1114.4 tons in 2016, due to inconsistent recording of this subsector, the growth rate between 2015 and 2016 cannot be determined.

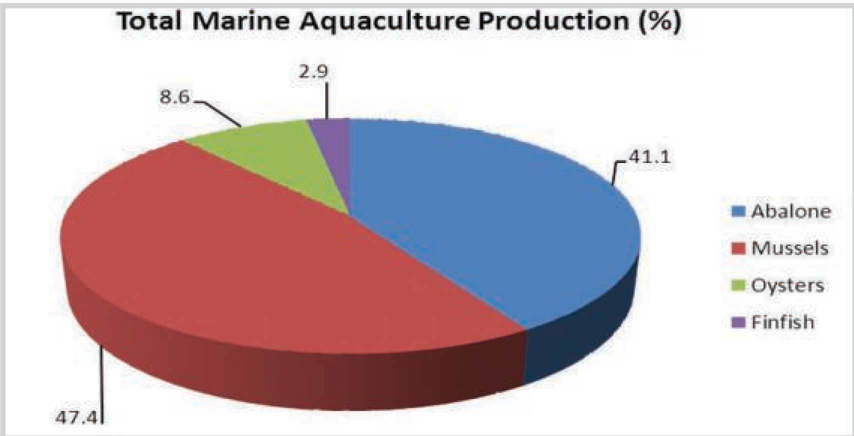


Figure 3: Contribution of each sub-sector to total marine aquaculture production in 2016.

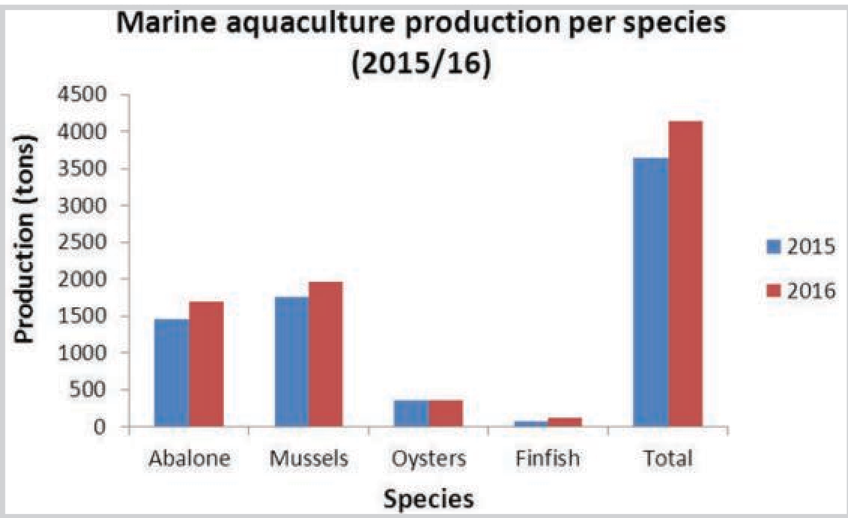


Figure 4: Marine aquaculture production per species for 2015 and 2016.

3.4.2. Marine aquaculture production trend from 2000 to 2016

Marine aquaculture production has been growing rapidly (exponential growth) since the year 2000 and the number of farms keep increasing yearly, which shows growth of the industry. Over this seventeen (17) year period, the lowest production volume was 1055.92 tons recorded in the year 2000 and the highest production volume was 4140.18 tons recorded in 2016. South Africa's total marine aquaculture production increased by 3084.3 tons between 2000 and 2016 (Table 8, Figure 5)

Table 8: South Africa's marine aquaculture production 2000-2016

SUB-SECTOR/ YEAOF PRODUCTION	2000	2001	2002	2003	2004	2005	2006	2007	2008
Abalone	181.0	372.9	429.4	462.0	509.2	670.8	833.4	783.3	1037.1
Finfish	1.0	0.3	2.4	14.0	1.8	1.7	0.0	0.0	2.7
Mussels	500.0	600.0	429.1	623.0	640.0	472.0	542.0	466.0	736.7
Oysters	247.0	187.5	272.1	255.2	147.7	174.9	279.9	157.9	226.6
Prawns	126.8	120.2	157.7	124.9	0.0	0.0	0.0	0.0	11.4
Seaweed	0.0	0.0	0.0	0.0	0.0	0.0	664.0	0.0	1833.5
Totals**	**1055.9**	**1280.9**	**1290.7**	**1479.1**	**1298.7**	**1319.4**	**1655.2**	**1407.1**	**2014.6**

SUB-SECTOR/ YEAOF PRODUCTION	2009	2010	2011	2012	2013	2014	2015	2016	Total (2000-2016)
Abalone	913.6	1015.4	1036.0	1111.4	1469.8	1306.8	1488.7	1703.32	**15324.1**
Finfish	22.8	0.0	8.0	48.5	122.5	161.9	77.3	118.6	**583.5**
Mussels	682.4	700.1	859.8	859.8	1116.1	1682.5	1758.5	1960.9	**14629.0**
Oysters	223.5	276.6	269.3	241.6	277.2	266.4	276.8	357.3	**4137.5**
Prawns	17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**559.0**
Seaweed	1900.2	2015.0	2884.6	2000.0	0.0	1643.6	0.0	1114.4	**14055.3**
Totals**	**1860.2**	**1992.1**	**2173.1**	**2261.2**	**2985.7**	**3417.6**	**3601.4**	**4140.18**	**35233.1**

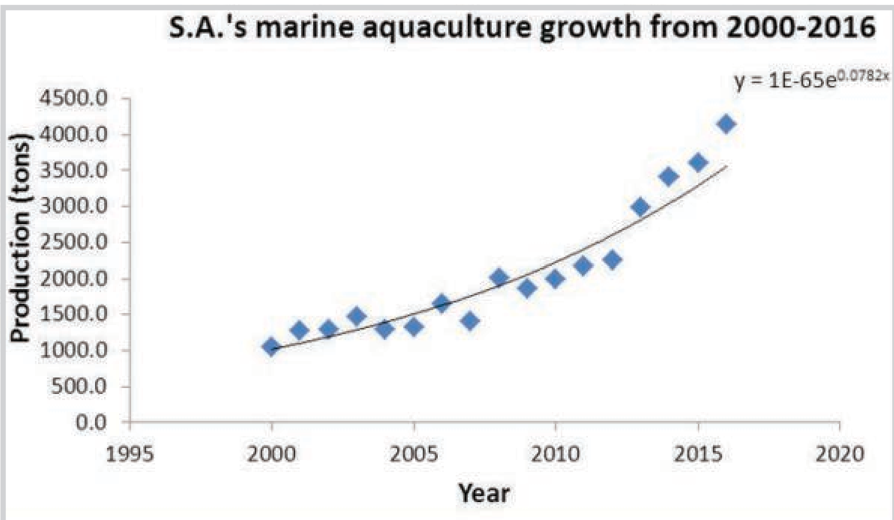


Figure 5: Growth rate of the marine aquaculture industry from 2000 to 2016.

3.5 Marine aquaculture analysis per sub-sector

3.5.1 Abalone sub-sector

Abalone species currently being cultivated in South Africa is Haliotis midae. In 2016, the abalone sub-sector contributed 41.14 % to South Africa's total marine aquaculture production recording a total of 1703.30 tons (Figure 6). The abalone sub sector increased by 224.10 tons (15.15%) from 2015.
The abalone sub-sector comprised of nineteen (19) farms in 2016 compared to 18 farms which operated in 2015. The abalone sub-sector distribution range stretches from the Northern Cape and Western Cape to the Eastern Cape. Four (4) farms were operating in the Northern Cape, two (2) in Eastern Cape and thirteen (13) in Western Cape. There were no abalone farms in Kwa-Zulu Natal.

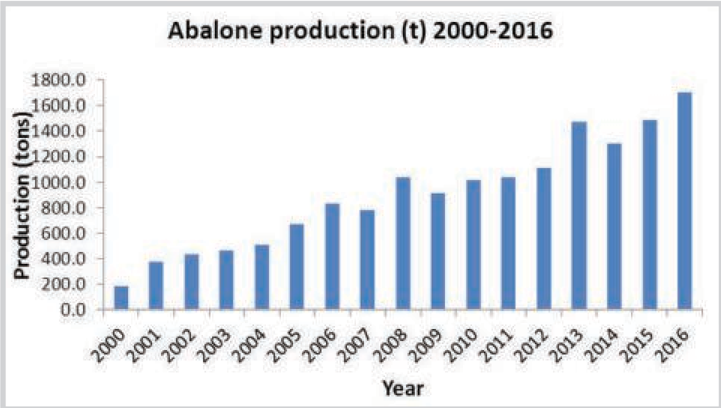


Figure 6: Abalone production in South Africa from 2000-2016.

3.5.2 Finfish sub-sector

The finfish sub-sector in South Africa is an emerging industry and it is showing great potential in terms of production. Over the years a number of species have been piloted to assess the feasibility and market access. Dusky kob (Argyrosomus japonicas) is the only commercial species being cultured in the industry. Finfish species such as spotted grunter (Pomadasys commersonnii), mangrove snapper (Lutjanus argentimaculatus), yellowtail (Seriola lalandi) and yellowbelly rock cod (Epinephelus marginatus) were kept on farm sites for research purposes. The finfish sub-sector's production growth has been unstable over the years. In 2016, the sub-sector recorded a production of 118.64 tons that is 2.87% of the total marine aquaculture production (Figure 7). The finfish sub-sector has increased by 41.32 tons (53.44%) from 2015.

A total of six (6) finfish aquaculture farms were operational in 2016, recording a decrease from the seven (7) farms operating in 2015. Finfish farming in the Western Cape was represented by one (1) recirculation facility situated in Saldanha Bay, two (2) pond culture facilities in Kwa-Zulu Natal and three (3) recirculation facilities in the Eastern Cape.

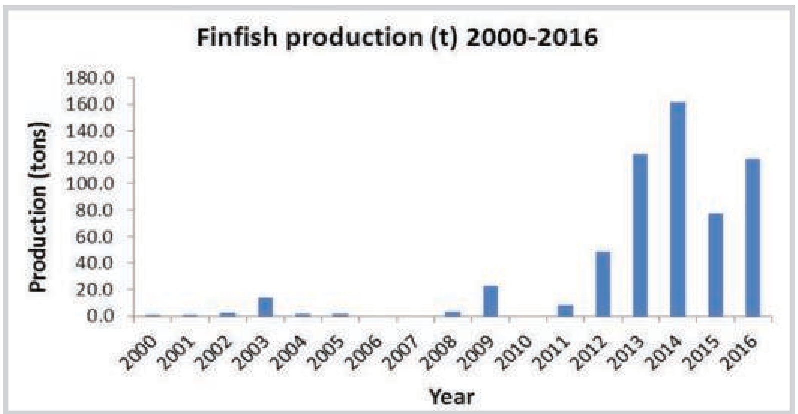


Figure 7: Dusky Kob production in South Africa from 2000-2016.

3.5.3 Oyster sub-sector

The species cultivated in South Africa is the exotic Pacific Oyster (Crassostrea gigas). In 2016 the sub-sector recorded a production of 357.27 tons and contributed 8.63% (Table 8 and Figure 8) towards the overall marine aquaculture production and demonstrated an increase 80.41 tons (29.04%) from 2015. Eight (8) oyster aquaculture farms were operational in 2016, indicating that the number of farms remained the same as those operational in 2015. Five (5) oyster farms are currently situated in the Western Cape and three (3) in the Eastern Cape.

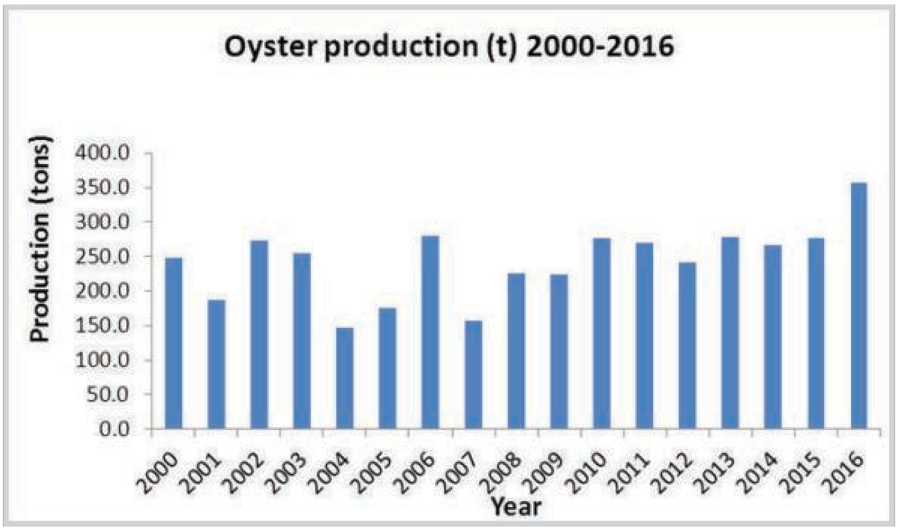


Figure 8: Oyster production in South Africa from 2000-2016.

3.5.4 Mussel sub-sector

Mussel farming in South Africa is situated in Saldanha Bay in the Western Cape, and in 2016 there were eight (8) farms in operation recording an increase from the four (4) farms operating in 2015. The species cultured in South Africa are the exotic Mediterranean mussel (Mytilus galloprovincialis) and the indigenous black mussel (Choromytilus meridionalis). In 2016 the mussels sub-sector recorded the highest production to date, of 1960.95 tons representing an increase of 202.48 tons from the 1758.47 tons of mussels produced in 2015 (Figure 9). The mussel sub-sector contributed 47.36% to the total marine aquaculture production in 2016 and is currently the highest contributor to aquaculture in South Africa.

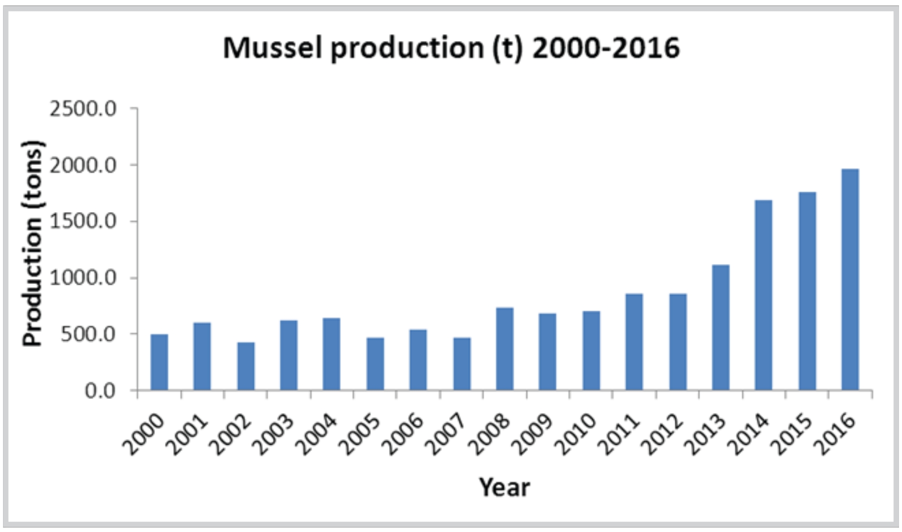


Figure 9: Mussel production in South Africa from 2000-2016.

3.6 Marine aquaculture site surveillance during 2016

Site surveillance of the marine aquaculture sector has played a vital role since 2008 in updating information on growth in the sector and ensuring compliance with the Department's marine aquaculture permitting frameworks and regulations promulgated under the MLRA. This has been essential in ensuring that non - compliant operations are communicated through proper channels such that the Chief Directorate: Monitoring, Control and Surveillance (CD: MCS) performs its role responsibly in protecting the wellbeing of the industry. This has also ensured open channels of communication between the Department and the marine aquaculture industry in the development of permit conditions for the sector. In 2016, the Department conducted site surveillance of 27 marine aquaculture right holders, one (1) experimental and four (4) abalone ranching pilot projects. These operations are outlined below:

- 1 abalone (Haliotis midae) ranching pilot operation in the Eastern Cape
- 3 abalone (Haliotis midae) ranching pilot operations in the Northern Cape
- 12 abalone (Haliotis midae) grow out operations in the Western Cape (i.e. St Helena Bay, Jacobsbaai, Hermanus, Buffelsjags, Doringbaai and Gansbaai),
- 2 abalone (Haliotis midae) grow out operations in the Northern Cape (i.e. Kleinsee and Port Nolloth)
- 1 oyster (Crassostrea gigas) grow out operation and 3 mussel (Mytilus galloprovincialis) grow out operations in Saldanha Bay, Western Cape
- 3 oyster (Crassostrea gigas) and mussel (Mytilus galloprovincialis) grow out operations in Saldanha Bay, Western Cape
- 1 oyster (Crassostrea gigas) nursery operation in Kleinsee, Northern Cape
- 1 dusky kob (Argyrosomus japonicus) and oyster (Crassostrea gigas) pilot grow out operation in Hamburg, Eastern Cape
- 2 dusky kob (Argyrosomus japonicus) grow out operations in the East London Industrial Development Zone (ELIDZ) in the Eastern Cape
- 1 dusky kob (Argyrosomus japonicus) experimental sea cage operation in the Richards Bay Harbour, Kwazulu Natal
- 1 dusky kob (Argyrosomus japonicus) grow out operation in Mtunzini, Kwazulu Natal
- 1 east coast rock lobster (Panulirus homarus) and abalone (Haliotis midae) grow out operation in Haga Haga, Eastern Cape

The Department aims to work closely with industry to ensure the continuous open channel for communication from the marine aquaculture sector through the continued support provided in implementing continued site surveillance.

STATUS OF THE FRESHWATER AQUACULTURE IN 2016

04

4.1 Freshwater aquaculture farms in 2016

In South Africa, freshwater aquaculture takes places in all nine (9) provinces. During 2016, a total of 175 freshwater farms were recorded, representing an increase of twenty-three (23) farms recorded in 2015. This increase might be attributed to factors such as growing number of entrant farmers venturing into aquaculture; increase in government support through the inclusion Comprehensive Agriculture Support Programme (CASP); Aquaculture Development and Enhancement Programme (ADEP); the implementation of the Operation Phakisa initiatives; and mentorship through skills developmental programmes etc.

Western Cape province had the highest number of farms operating in 2015 with a total of thirty-eight (38), followed by Gauteng (32), Mpumalanga (26), Limpopo (24), North West (18), Kwa-Zulu Natal (17), Eastern Cape (10), Free State (8) and Northern Cape (2).

Table 9: Total number of freshwater aquaculture farms operating in South Africa by sub-sector and province in 2016.

SPECIES	WC	GP	MP	LP	NW	KZN	EC	FS	NC	TOTAL
Tilapia	2	22	11	18	15	5	3	0	1	77
Trout	32	0	12	0	0	5	2	0	0	51
Catfish	0	0	0	4	3	0	2	4	0	13
Marron Cray-fish	0	0	0	0	0	0	1	0	0	1
Carp	1	1	0	1	0	0	0	0	1	4
Koi Carp	1	5	1	0	0	2	0	2	0	11
Ornamentals	2	4	2	1	0	5	2	2	0	18
TOTAL**	38	32	26	24	18	17	10	8	2	175

**The above data does not include information on crocodile farms.

4.2. Freshwater aquaculture species farmed in 2016

The 2016 freshwater aquaculture sub-sectors included rainbow trout (Onchorynchus mykiss and Salmo trutta), tilapia (Oreochromis mossambicus, Oreochromis niloticus and Tilapia rendalli), catfish (Clarias gariepinus), carp (Cyprinus carpio and Ctenopharygodon idella), marron crayfish (Cherax tenuimanus), and a number of ornamental species (e.g. Koi-carp). A total of seven (7) species were farmed at a commercial scale (Table 10).

Table 10: Freshwater aquaculture species cultured in South Africa in 2016 and their operational scale.

Common Name	Scientific Name	Operational Scale
Rainbow trout	Oncorhynchus mykiss	Commercial scale
Brown trout	Salmo trutta	Commercial scale
Mozambique tilapia	Oreochromis mossambicus	Commercial scale
Nile Tilapia	Oreochromis niloticus	Commercial scale
African Sharptooth catfish	Clarias gariepinus	Commercial scale
Common carp	Cyprinus carpio	Commercial scale
Koi carp	Cyprinus carpio	Commercial scale
Marron (Freshwater crayfish)	Cherax tenuimanus	Commercial scale

4.3 Freshwater aquaculture production

4.3.1 Freshwater aquaculture production in 2016

In 2016, South Africa's total freshwater aquaculture production was 1872.36 tons. The trout sub-sector was the highest contributor with 1503.00 tons, followed by tilapia with 340.81 tons; Ornamentals with 9.00 tons; Koi Carp 7.00 tons; and Carp with 5.25 tons. Marron Crayfish and African Catfish had the lowest production of 4 tons and 3.3 tons respectively (Table 11). The total production increased by 46.07 tons from 1826.29 tons recorded in 2015, representing an increase of 2.52%. The total freshwater aquaculture contribution to the overall aquaculture production is 31.14 % of 6012.54 tons.

Table 11: Production (tons) per species per province.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Tilapia	21.5	0	59.7	6.5	146.52	22.79	3	75.8	5	340.81
Trout	236.2	0	0	378.7	0	138	0	0	750.1	1503
Catfish	3.3	0	0	0	0	0	0	0	0	3.3
Marron crayfish	4	0	0	0	0	0	0	0	0	4
Carp	0	0	1.6	0	2.5	0	0.6	0	0.55	5.25
Koi-carp	0	0.8	3.7	1.4	0	0.6	0	0	0.5	7
Ornamental	1.7	1.2	0	3.1	0.8	1.3	0	0	0.9	9
Total	266.7	2	65	389.7	149.82	162.69	3.6	75.8	757.05	1872.36

4.3.2 Freshwater aquaculture production from 2006-2016

South Africa's freshwater aquaculture production has increased by 885.16 tons (89.66%) since 2006 (Figure 10). The total freshwater aquaculture production in 2016 was 1872.36 tons, demonstrating an increase of approximately 2.52% from 2015 production. From 2006 to 2016, total production has been recorded as 15636.96 tons. Over this ten (10) year period, the lowest production was 838.40 tons in 2006 and the highest was 1872.36 tons in 2016 (Table 12).

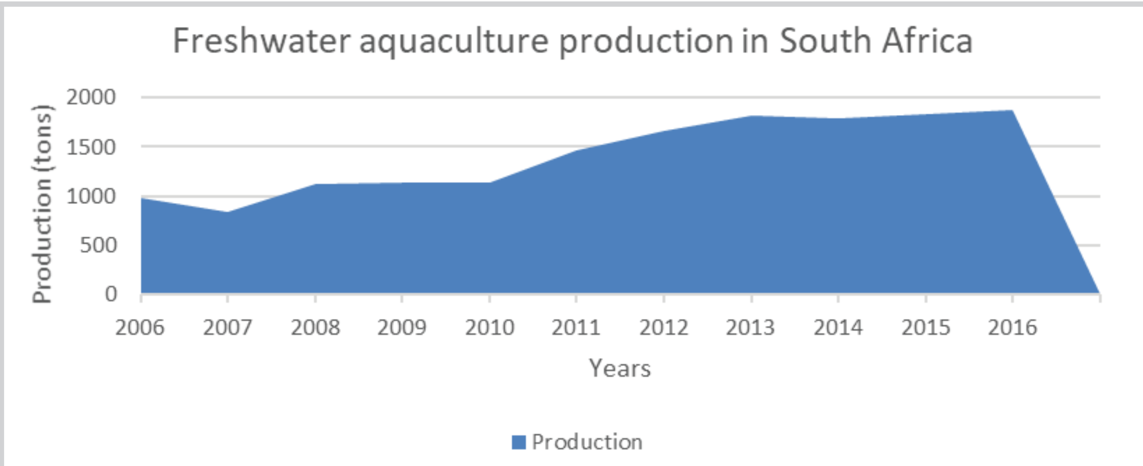


Figure 10: South Africa's freshwater aquaculture production from 2006-2016.

Table 12: Freshwater aquaculture production from 2006-2015 per sub-sector

Subsector	Year and production(tons)											Total production (tons)
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2006 – 2016
Tilapia	0	0	0	10	10	100	234.17	289.71	289.71	325.29	340.81	1 258.88
Trout	807	658	943	948.62	950	1199	1428	1497.3	1497.3	1497	1503	11425.22
Catfish	180	180	180	180	180	160	0	0	0	0	3.3	1060
Marron crayfish	0.2	0.4	0.4	0.4	0.8	0.8	3.5	5	5	4	4	20.5
Koi Carp	0	0	0	0	0	0	0	0	0	0	7	7
Ornamentals	0	0	0	0	0	0	0	0	0	0	9	9
Totals	**987.2**	**838.4**	**1123.4**	**1139.02**	**1140.8**	**1459.8**	**1665.67**	**1816.41**	**1792.01**	**1826.29**	**1872.36**	**15636.96**

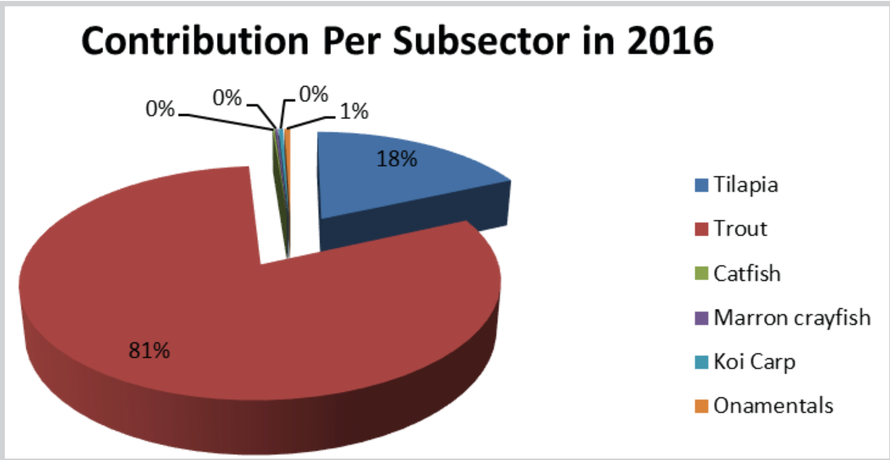


Figure 11: The contribution of each freshwater aquaculture sub-sector to the total production in 2016.

4.4 Analysis of freshwater aquaculture sub-sector

4.4.1 Trout sub-sector

The trout sub-sector has contributed 80.27% of South Africa's total freshwater production in 2016, recording a total production of 1503 tons (Table 12 and Figure 12). There was an increase of 6.00 tons. The trout farms are currently located in the Western Cape, Mpumalanga, Eastern Cape and Kwa-Zulu Natal provinces. Onchorynchus mykiss and Salmo trutta are the two (2) trout species currently cultured in South Africa. The technology used to cultivate these species includes raceway, pond, cage culture and recirculating systems.

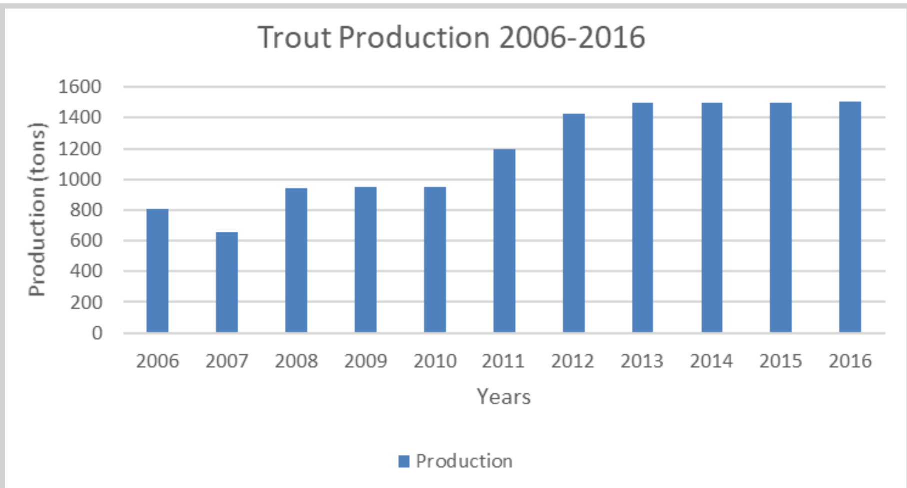


Figure 12: Trout production in South Africa from 2006-2016.

4.4.2 Tilapia sub-sector

The tilapia sub-sector in South Africa is based on the culture of the two (2) species, namely, the Mozambique tilapia (Oreochromis mossambicus) and the Nile tilapia (Oreochromis niloticus). This sub-sector contributed 18.20% to South Africa's freshwater production, recording 340.81 tons (Table 12). There was a 15.52 tons increase in production from 2015 to 2016 (Figure 13). Most tilapia farmers could be categorized as small-scale farmers and they employ recirculation and pond culture systems.

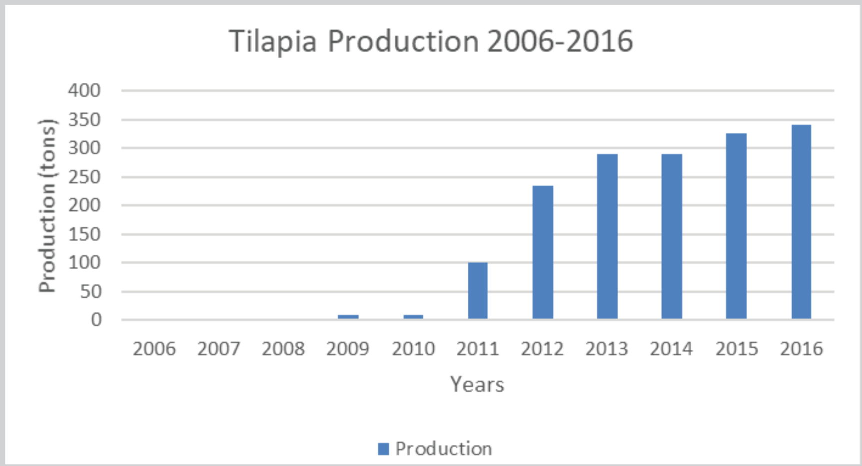


Figure 13: Tilapia production in South Africa from 2006-2016.

4.4.3 Catfish sub-sector

The catfish sub-sector in South Africa is based on the indigenous species, the African sharptooth catfish (Clarias gariepinus). The catfish industry recorded 3.3 tons production in 2016, depicting a 100% increase from a zero production recorded since 2011 (Figure 14). Farmers concentrated on producing fingerlings for the export market rather than growing the fish to market size.

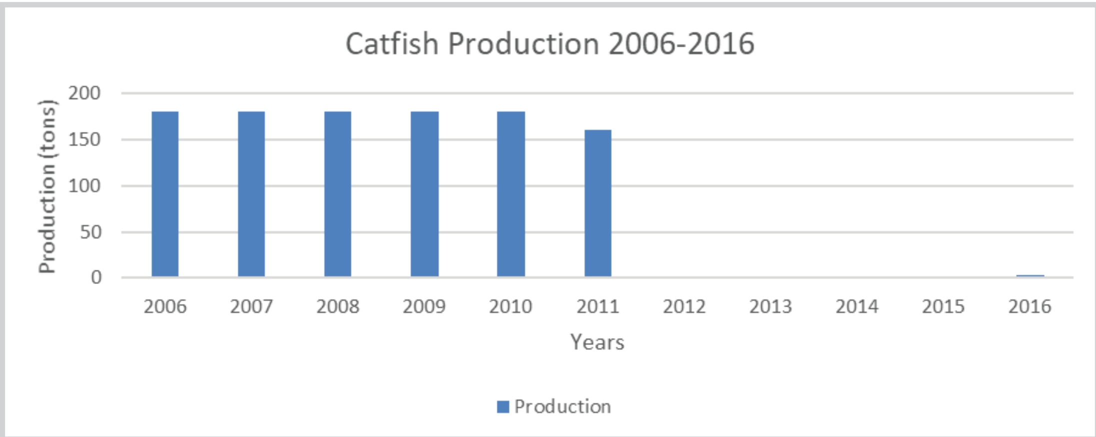


Figure 14: Catfish production in South Africa from 2006-2016

4.4.4 Marron crayfish sub-sector

Marron crayfish (Cherax tenuimanus) is exotic to South Africa with a single farmer culturing the species. The farm continued to produce a total of four (4) tons in 2016 as was in 2015 (figure 15). Marron crayfish produced in 2016 contributed 0.21 % to the total freshwater aquaculture sector. The current marron crayfish farm is located in the Eastern Cape where it is cultured in tanks during the juvenile phase, before being moved to semi-intensive pond culture for grow-out.

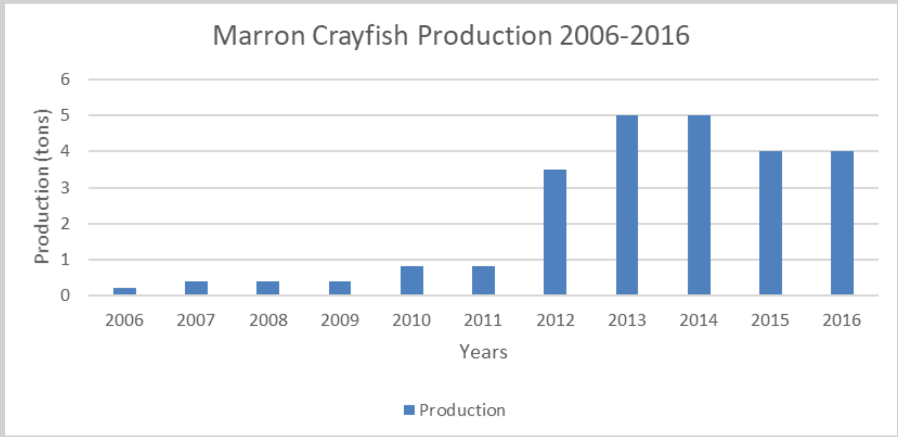


Figure 15: Marron crayfish production in South Africa from 2006-2016.

4.4.5 Ornamental sub-sector

The Ornamental sub-sector has contributed 0.48% to South Africa's total freshwater production in 2016, recording a total production of nine (9) tons following a zero production in 2015 (Table 12, figure 16). The Ornamental farms are currently located in the Western Cape, Mpumalanga, Eastern Cape, Free-State, Limpopo and Kwa-Zulu Natal provinces.

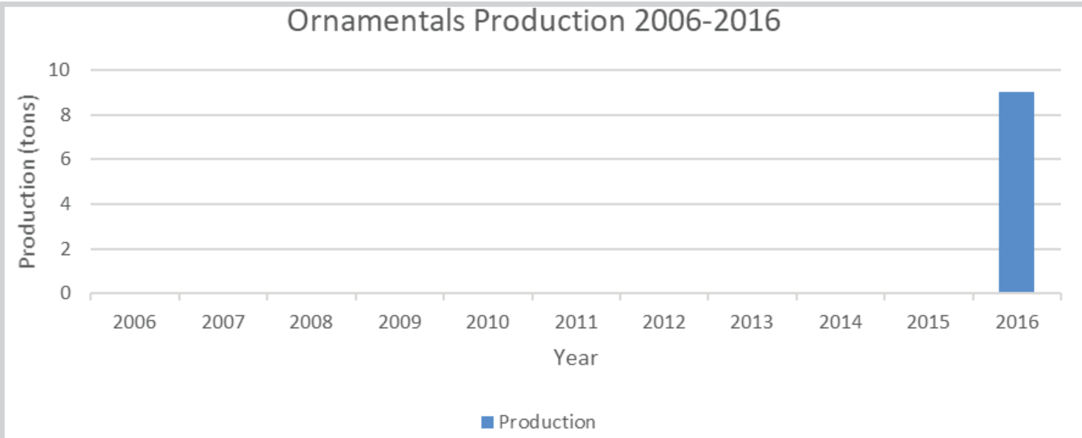


Figure 16: Ornamentals production in South Africa from 2006-2016.

4.4.6 Koi Carp sub-sector

The Koi Carp sub-sector has contributed 0.37% to South Africa's total freshwater production in 2016, recording a total production of 7 tons following a zero production in 2015 (Table 12 and figure 17). The Koi Carp farms are currently located in the Western Cape, Mpumalanga, Eastern Cape, Free-State, Gauteng and Kwa-Zulu Natal provinces.

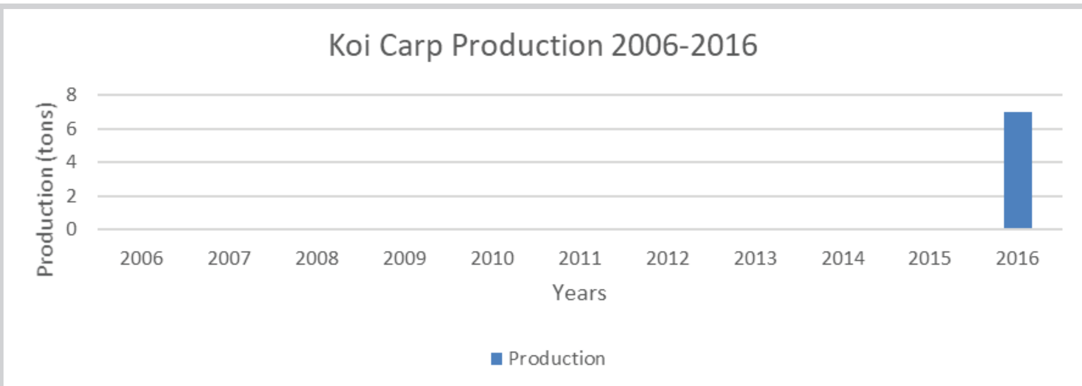


Figure 17: Koi Carp production in South Africa from 2006-2016.

4.4.7 Carp sub-sector

The Carp sub-sector has contributed 0.28% to South Africa's total freshwater production in 2016, recording a total production of 5.25 tons following a zero production in 2015 (Table 12 and figure 18). The carp farms are currently located in the Western Cape, Gauteng, Limpopo and Northern Cape provinces.

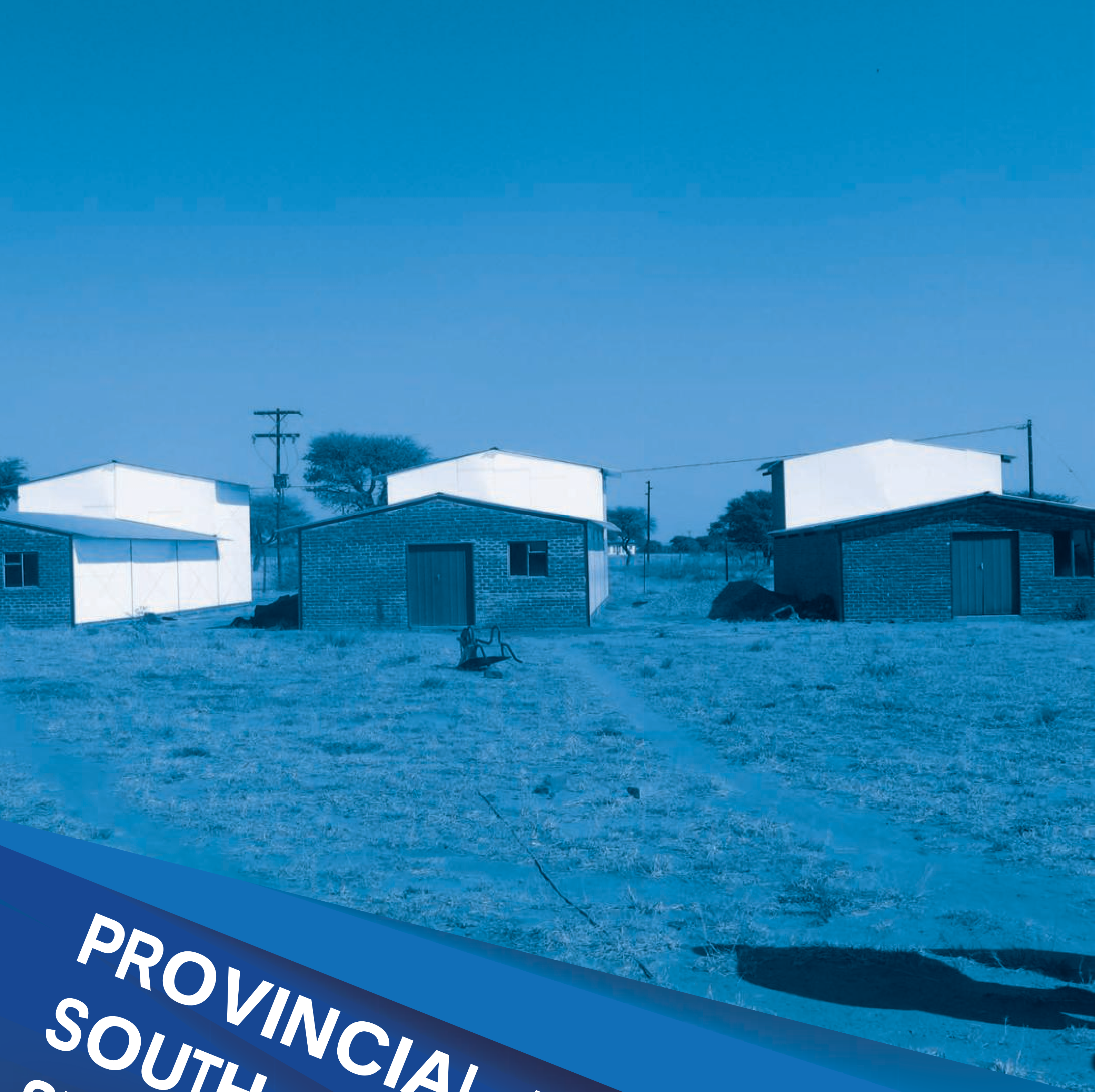
Figure 18: Carp production in per province in 2016.

4.5 Freshwater aquaculture authorisations in 2016

During 2016, freshwater aquaculture did not have an overarching legislation to manage and develop the sector. Several legislation implemented by numerous departments affect aquaculture. The slow growth of the freshwater aquaculture sub-sector can be attributed to this issue of fragmented legislative environment. In order to address this challenge, the DAFF has embarked on a process of developing dedicated aquaculture legislation, i.e. Aquaculture Bill.

4.6 Freshwater site surveillance in 2016

No site surveillances were undertaken for freshwater aquaculture in 2016. Non-existent legislative tools was a limiting factor for the DAFF. Some farms were visited as part of the Aquaculture Development and Enhancement Programme (ADEP) and are accounted for in the ADEP section of this report.



05

PROVINCIAL ANALYSIS OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2016

5.1 Eastern Cape

The Eastern Cape is one of the four coastal provinces able to undertake both marine and freshwater aquaculture activities.

Number of farms and species farmed: In 2016, the Eastern Cape province recorded a total of eighteen (18) farms, i.e. eight (8) marine farms and ten (10) freshwater farms. These comprised of two (2) abalone, three (3) finfish, three (3) oyster, three (3) tilapia, two (2) trout, two (2) catfish, two (2) ornamentals and one (1) marron crayfish farm. The numbers of farms recorded in 2016 increased by five (5) farms compared to 2015.

Production: The total production for the Eastern Cape was 618.60 tons, contributing 10.29% to the overall aquaculture production (Figure 19). In 2016, total aquaculture production in the Eastern Cape has increased by 120.14 tons (24.10.4%) from 498.46 tons in 2015. Marine aquaculture in the province produced 351.9 tons, accounting for 5.85% of the total national production and 8.50% of the national marine sector production. Freshwater aquaculture produced 266.7 tons in the Eastern Cape, accounting for 4.44% of the total national production and 14.24% of the national freshwater aquaculture sector production.

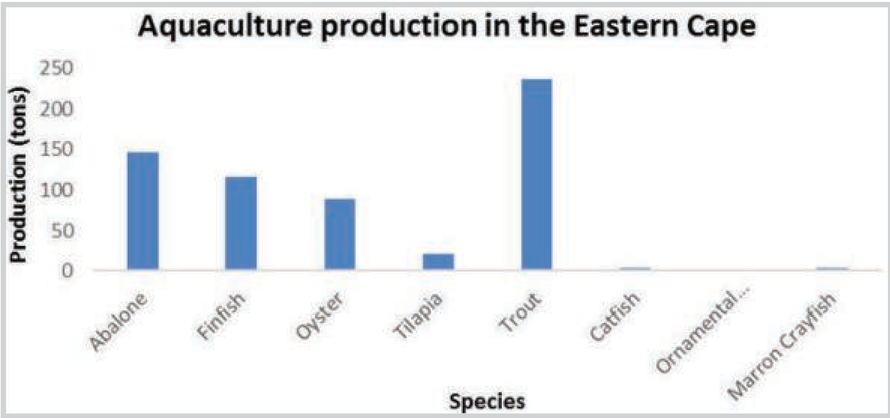


Figure 19: Aquaculture production in the Eastern Cape.

5.2 Free State

Free State province has a facility for training and capacity building, technology demonstration and aquaculture research that is located in Xhariep district.

Farms and species farmed: In 2016, the Free State province recorded a total of eight (8) freshwater farms. This represents a decrease of two (2) freshwater farms compared to the ten (10) farms recorded in 2015. The farms comprised of four (4) catfish farms, two (2) Koi carp farms and two (2) ornamental farms.

Production: The total production for the Free State was 2 tons, contributing 0.03% to total national aquaculture production and 0.11% of the national freshwater aquaculture production (Figure 20). Aquaculture production in the Free State increased by 2 tons (100%) from the 0 tons produced in 2016.

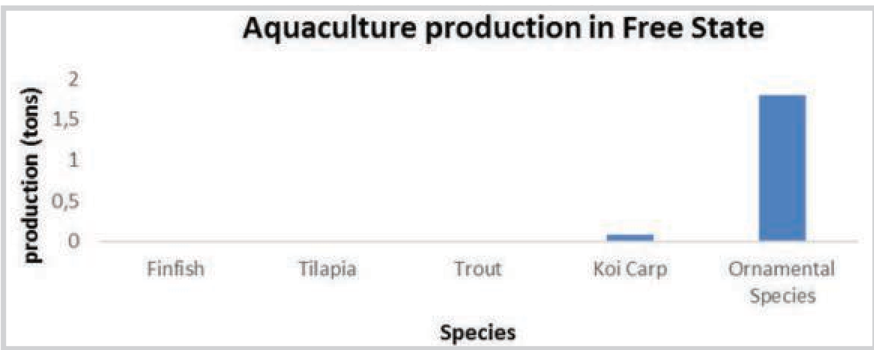


Figure 20: Aquaculture production in Free State.

5.3. Gauteng

Gauteng province has the potential to play a key role as an import and export hub for South Africa's aquaculture industry due to availability of relevant logistical resources and its proximity and accessibility to all provinces.

Number of farms and species farmed: In 2016, the Gauteng province recorded a total of thirty-two (32) freshwater farms representing an increase of one (1) farm compared to the thirty-one (31) recorded in 2015. The farms comprised of twenty-two (22) tilapia, five (5) Koi carp, one (1) carp and four (4) ornamental fish farms.

Production: The total production for Gauteng was 65 tons, contributing 1.08% to the national aquaculture production and 3.47% of the national freshwater aquaculture production (Figure 21). The total aquaculture production in the Gauteng in 2016 increased by 7 tons (12.07%) from the 58 tons produced in 2015.

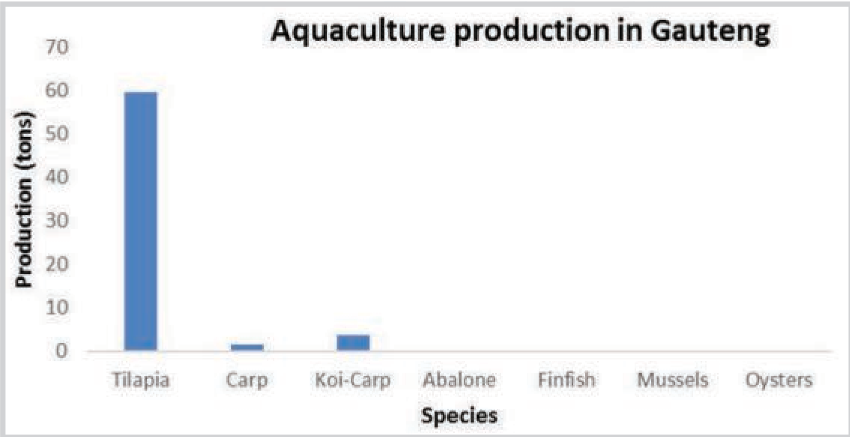


Figure 21: Aquaculture production in Gauteng.

5.4. Kwa-Zulu Natal

Kwa-Zulu Natal is one of the four coastal provinces able to undertake both marine and freshwater aquaculture activities.

Number of farms and species farmed: In 2016, the Kwa-Zulu Natal province recorded a total of nineteen (19) farms comprising two (2) marine farms and seventeen (17) freshwater farms. The number of farms recorded in 2016 increased by two (2) farms, from the seventeen (17) farms recorded in 2015, and comprised of two (2) marine finfish, five (5) trout, five (5) tilapia, two (2) Koi carp and five (5) ornamental farms.

Production: The total production for Kwa-Zulu Natal was 391.80 tons, contributing 6.52% to the overall aquaculture production (Figure 22). The total aquaculture production in Kwa-Zulu Natal increased in 2016 by 21.14 tons (5.12%) from 412.94 tons in 2015. The marine aquaculture production in the province recorded a production of 2.10 tons, accounting for 0.03% of the national aquaculture production and 0.05% of the national marine production. Freshwater aquaculture production in the province recorded a production of 389.7 tons, accounting for 6.48% of the national aquaculture production and 9.41% of the national freshwater production.

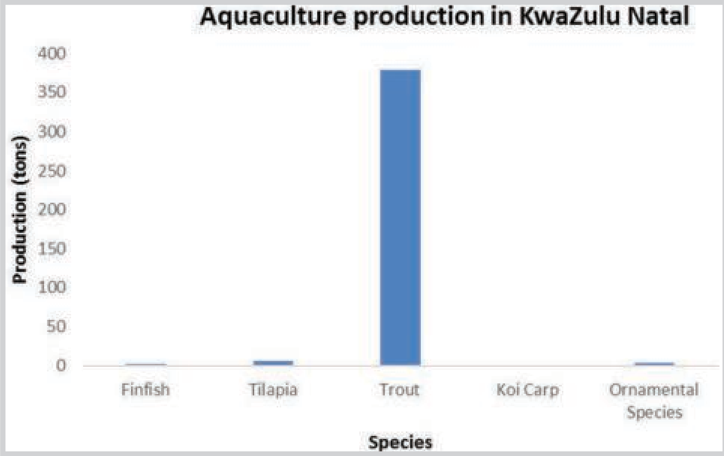


Figure 22: Aquaculture production in Kwa-Zulu Natal.

5.5. Limpopo

Limpopo province is supported by the Turfloop state-owned hatchery and research and development activities undertaken by the University of Limpopo.

Number of farms and species farmed: : In 2016, Limpopo province recorded a total of twenty-two (22) freshwater farms representing an increase of two (2) farms compared to the twenty (20) farms recorded in 2015. The farms comprised sixteen (18) tilapia, three (4) catfish, one (1) carp and one (1) ornamental fish farm.

Production: Limpopo province produced 149.82 tons in 2016, contributing 2.49% to the national aquaculture production and 8.00% to freshwater aquaculture production (Figure 23). Aquaculture production in Limpopo province decreased by 29.82 tons (24.85%) from the 120 tons produced in 2015.

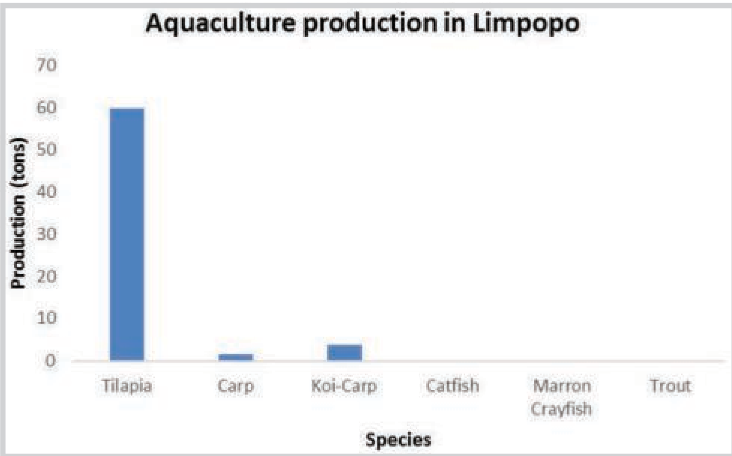


Figure 23: Aquaculture production in Limpopo.

5.6. Mpumalanga

Freshwater aquaculture has the potential of thriving in Mpumalanga province due to the ideal environment conditions. It is yet to be determined what are the factors hampering the sector growth in terms of production.

Number of farms and species farmed: In 2016, Mpumalanga province recorded a total of twenty-six (26) freshwater farms representing a decrease of seven (7) farms compared to the thirty three (33) farms recorded in 2016. The farms comprised eleven (11) tilapia, twelve (12) trout, two (2) ornamentals and one (1) koi-carp farm.

Production: The total production for Mpumalanga was 162.69 tons, contributing 2.71 to the national aquaculture production (Figure 24). Aquaculture production in Limpopo decreased by 5.57 tons (3.31%) from the 168.29 tons produced in 2015. Freshwater aquaculture produced 162.69 tons in Mpumalanga, accounting for 2.71% of the national aquaculture production and 8.69% of national freshwater aquaculture production.

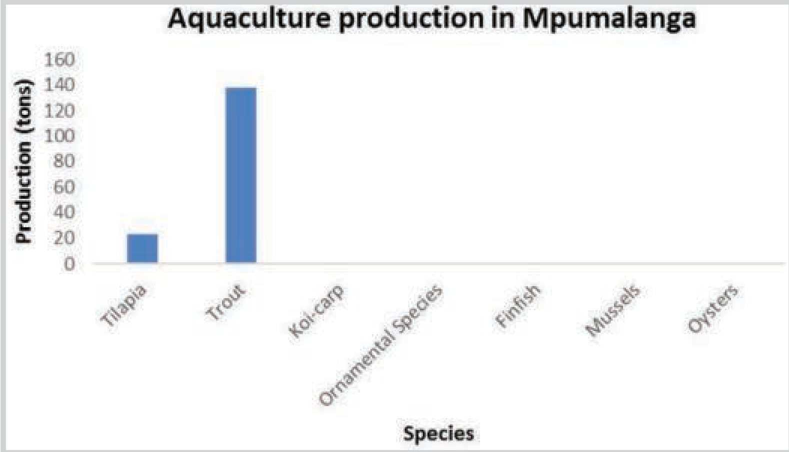


Figure 24: Aquaculture production in Mpumalanga.

5.7. Northern Cape

As in other coastal provinces, the Northern Cape is able to support both marine and freshwater aquaculture. In 2016, the province engaged in both marine and freshwater aquaculture.

Number of farms and species farmed: In 2016, the Northern Cape province recorded a total of six (6) farms comprising of four (4) marine and two (2) freshwater farms. There was a decrease of one (1) farm when compared to the seven (7) farms recorded in 2015. The farms comprised of four (4) abalone, one (1) tilapia and one (1) carp farm.

Production: The total production for the Northern Cape in 2016 was 5.43 tons, contributing 0.09% to the national aquaculture production (Figure 25) and representing a decrease of 17.19 tons (75.99%) from the 22.62 tons produced in 2016. Marine aquaculture produced 1.83 tons, accounting for 0.03% of the national aquaculture production and 0.04% of the national marine aquaculture production. Freshwater aquaculture produced 3.60 tons in the Northern Cape, accounting for 0.06% of the national aquaculture production and 0.19% of the national freshwater production.

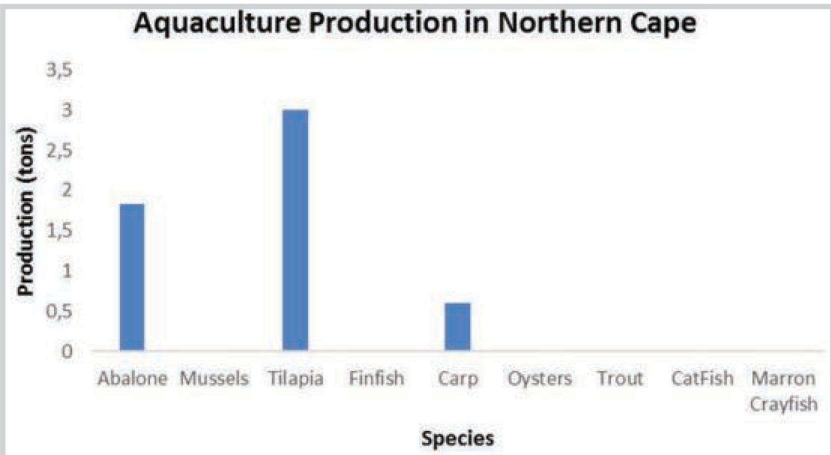


Figure 25: Aquaculture production in Northern Cape.

5.8. North West

North West province has proven to be at a disadvantage when looking at access to markets, but has a strong advantage in terms of access to suitable water bodies.

Number of farms and species farmed: In 2016, North West province recorded a total of eighteen (18) freshwater farms representing an increase of three (3) farms from the fifteen (15) farms recorded in 2015. The farms comprised fifteen (15) tilapia farms and three (3) catfish farm.

Production: The total production for North West was 75.80 tons, contributing 1.26% to the national aquaculture production and 4.05% of freshwater production (Figure 26). Aquaculture production in the North West decreased by 10.20 tons (0.12%) in 2016 from the 86.00 tons produced in 2015.

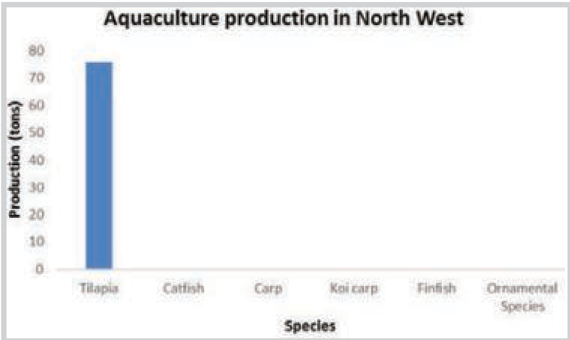


Figure 26: Aquaculture production in North West.

5.9. Western Cape

The Western Cape is also a coastal province able to support both marine and freshwater aquaculture activities. This province remains the backbone of the aquaculture sector in South Africa.

Number of farms and species farmed: In 2016, the Western Cape province recorded a total of sixty-five (65) farms comprising twenty-seven (27) marine farms and thirty eight (38) freshwater farms. There was an increase of twenty-two (22) farms compared to the forty-three (43) farms recorded in 2016. The farms comprised thirteen (13) abalone, one (1) finfish, eight (8) mussel, five (5) oyster, two (2) tilapia, thirty two (32) trout, one (1) carp, one (1) koi-carp and two (2) ornamental fish farms.

Production: The total production for the Western Cape was 4741.40 tons, contributing 78.86% to national aquaculture production (Figure 27). Aquaculture production in the Western Cape increased by 688.76 tons (16.90%) from the 4052.64 tons produced in 2015. Marine aquaculture produced 3784.35 tons, accounting for 62.94% of the national aquaculture production and 91.41% of the national marine aquaculture production. Freshwater aquaculture produced 957.05 tons in the Western Cape, accounting for 15.92% of the national aquaculture production and 51.11% of the national freshwater aquaculture production.

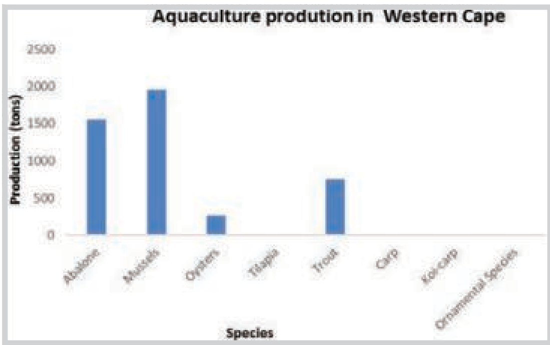


Figure 27: Aquaculture production in Western Cape.

06

AQUACULTURE FOOD SAFETY

6.1. South African molluscan shellfish monitoring and control programme

6.1.1. Shellfish farms status

Throughout the South African coastline, there were thirty two (32) shellfish farms monitored by the South African Molluscan Shellfish Monitoring and Control Programme (SAMSM&CP) during 2016. These farms include seventeen (17) abalone farms, seven (7) mussel farms and eight (8) oyster farms (Figure 28). There were six (6) abalone farms located to the west of Cape Point and eleven (11) farms to the east of Cape Point. The mussel farms were all located to the west of Cape Point in Saldanha Bay. There were six (6) oyster farms to the west of Cape Point in Saldanha Bay and only two (2) oyster farms on the east of Cape Point.

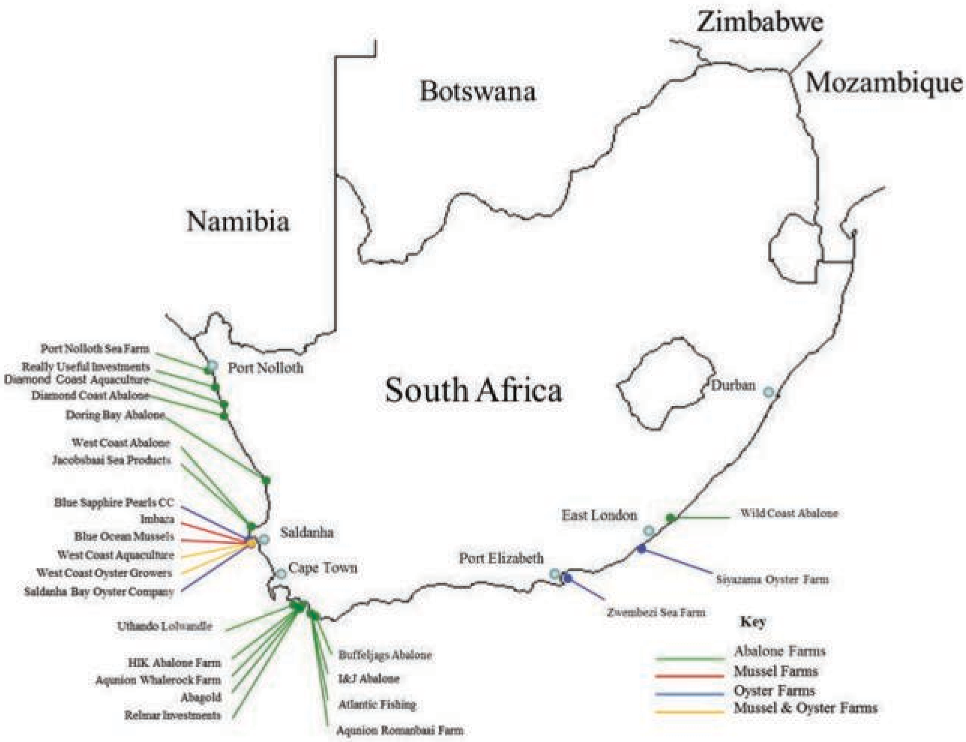


Figure 28: Distribution of shellfish farms along the South African coast 27.

All abalone farms that were monitored are land based. The animals are grown in tanks and the water is pumped into the tanks through free flow and/or recirculation systems. The oyster and mussel farms were sea-based and grown on ropes suspended from floating rafts or buoys.

Shellfish farms are susceptible to Harmful Algal Blooms (HAB's) as a result of contaminated water, sewage and industrial and domestic contamination. The farms which are at most risk of pollution are those situated near developed areas. Most of the farms in South Africa however are situated in areas that are relatively free of pollution. Generally the farms to the west of Cape Point are more at risk of biotoxin contamination than the farms to the east of Cape Point.

6.1.2. Monitoring of hazardous substances

Analysis for microbiological organisms were undertaken by the South African Bureau of Standards (SABS), situated in Rosebank, Cape Town and Mérieux NutriSciences laboratories situated in Claremont, Cape Town. The tests included E. coli, Salmonella species and Vibrio species. Mérieux NutriSciences is South African National Accreditation System (SANAS) accredited for Salmonella, Vibrio and E. coli. and SABS is SANAS accredited for Salmonella and Vibrio.

The Council for Scientific and Industrial Research (CSIR) in Rose bank, Cape Town, conducted tests for biotoxins. The biotoxins monitored included Paralytic Shellfish Poisoning (PSP) toxins, Diarrhetic Shellfish Poisoning (DSP) toxins and Amnesic Shellfish Poisoning (ASP) toxins. PSP, DSP and ASP toxins were tested using the Liquid Chromatography–Fluorescence Detector (LC-FLD), Liquid Chromatography–Mass Spectrometry (LC-MS/MS) and the High-performance liquid chromatography (HPLC) instruments respectively.

Mérieux NutriSciences analysed all other hazardous substances such as heavy metals (lead, mercury, inorganic arsenic and cadmium), pesticides, drug residues, dioxins, Polycyclic Aromatic Hydrocarbons (PAH), dyes and Polychlorinated Biphenyls (PCB's).

The test methods that the laboratories employ are stipulated in the SAMSM&CP and the methods used are SANAS accredited or the laboratories are working towards accreditation. The methods have however all been validated.

These hazardous substances and microbiological organisms were monitored at the frequency depicted in table 13 unless otherwise stipulated.

The routine monitoring frequency of farms and the location of sampling were based on the potential risk of contamination. There tend to be substantially more upwelling systems to the west of Cape Point resulting in higher incidences and concentrations of HAB's and concomitant biotoxin accumulation in the shellfish. The classification status of the farm was also considered when designing a monitoring programme.

Table 13: Schedule for testing of hazardous substances.

	West of Cape Point		East of Cape Point	
Hazardous Substances	Filter Feeder	Non – Filter feeder	Filter Feeder	Non – Filter Feeder
Biotoxins				
PSP coursing toxins	48h or twice a week for multiple harvesting	2 weekly	Monthly	Monthly
DSP Coursing toxins	Weekly	Monthly	2 weekly	Monthly
ASP	Monthly	Monthly	Monthly	Monthly
Microbiological Organisms				
E. coli	Monthly	-	Monthly	-
Salmonella	Monthly	-	Monthly	-
Vibrio	Monthly	-	Monthly	-
Other Hazardous substances				
Heavy Metals	Annually	Annually	Annually	Annually
Pesticides	Annually	Annually	Annually	Annually
PCB	Annually	Annually	Annually	Annually
Radionuclides	Every 3 years	Every 3 years	Every 3 years	Every 3 years

When any of the hazardous substances or microbiological organism concentrations exceeds the regulatory limit (table 14), the laboratories inform the SAMSM&CP office in the form of a red alert. The red alert requires that the lab to call the staff at the SAMSM&CP office responsible for farm closures and send an email to the official indicating the test result. The SAMSM&CP office then warns the farm not to harvest until the test result has been confirmed.

If the result is confirmed to exceed the regulatory limit the farm is temporarily closed and the relevant stakeholders are informed accordingly. A farm is also temporarily closed if shellfish are not tested in accordance with the SAMSM&CP. The farm is reopened only when the concentration of the hazardous substance is below the regulatory limit (table 14) and/or the programme is complied with.

Table 14: Regulatory limit for human health hazards monitored and test laboratories.

Hazardous Substances	Regulatory Limit	Laboratory
Biotoxins		
PSP toxins	< 0.8 mg PSP/kg edible flesh	Aspirata
Okadaic acid group toxins: OA, DTX 1, DTX 2 & DTX 3 and Pectenotoxins group toxins: PTX 1 & PTX 2	≤ 0.16 mg okadaic acid equivalents / kg edible flesh (Commission Regulation (EC) No 853/2004). (EU-RL* LC-MS/MS method) (Commission Regulation (EC) No 15/2011)	Aspirata
Yessotoxins group toxins: YTX, 45 OH YTX, homo YTX, and 45 OH homo YTX	≤ 8 mg yessotoxin equivalents / kg edible flesh (Codex). (^Liquid Chromatography Mass Spectrometry (EU-RL LC-MS/MS method) (Commission Regulation (EC) No 15/2011)	Aspirata
Azaspiracids group toxins: AZA1, AZA2 and AZA3.	≤ 0.16 mg azaspiracid equivalents / kg edible flesh (Commission Regulation (EC) No 853/2004). (^Liquid Chromatography Mass Spectrometry (EU-RL LC-MS/MS method) (Commission Regulation (EC) No 15/2011)	Aspirata
ASP	ASP < 20 mg DA/kg edible flesh	Aspirata
Microbiological Organisms		
E. coli	<230/100g edible flesh	SABS/ Mérieux
Salmonella	Absent	SABS/ Mérieux
Vibrio spp	Absent	SABS/ Mérieux
Other Hazardous substances		
Heavy Metals	Lead: < 1.5 mg/kg edible flesh Mercury: < 0.5 mg/kg edible flesh Cadmium: < 3.0 mg/kg edible flesh	Aspirata/ Mérieux
Pesticides	< 0.01 mg/kg	Mérieux
Non-dioxin-like -PCB	< 75 µg/kg	Mérieux
Dioxin-like PCB & Dioxin	< 6.5 µg/kg	Mérieux
Dioxins	< 3.5 µg/kg	Mérieux
PAH 4	< 35 µg/kg	Mérieux
Radionuclides	< 600 Bq/kg	NECSA/ Mérieux

The criterion for reopening a farm depends on the contaminant that is present on that particular farm. As an example, when a farm is temporarily closed due to biotoxins, the biotoxin concentration in three consecutive samples is required to be below the regulatory limit. The samples should be taken over a period not exceeding two weeks and samples may not be taken on the same day. When the farm is closed due to other contaminants, the farm is reopened when the contaminant is below the regulatory limit.

6.2. Monitoring data and farm closures

Data has been captured and analysed for marine aquaculture molluscan shellfish farms along the South African Coast. The biotoxins were analyzed separately for two regions viz. west of Cape Point and east of Cape Point. The other hazardous substances were analyzed for the South African coast as a whole.

There were thirty three (33) farm closure notices sent to shellfish farms by the SAMSM&CP office in 2016. Twenty five (25) farm closures were due to the presence of biotoxins, seven (7) farms were due to microbiological contamination and one (1) farm was due to non–compliance. There were no closures due to other hazardous substances viz. heavy metals, pesticides, PCBs or radionuclides.

The abalone, mussel and oyster farms located to the west of Cape Point experienced more closures than the farms on the east of Cape Point due to biotoxin (PSP and DSP toxin) concentrations exceeding the regulatory limits. The use of LC-MS/MS instrument has significantly decreased the number of farm closures attributed to DSP toxin accumulation in the shellfish products. The temporary closures due to E. coli concentrations exceeding the regulatory limit were fewer than the closures related to biotoxins. The E. coli that was present in shellfish samples appears to be associated with heavy rainfall periods and will thus be monitored more frequently during heavy rainfall periods.

6.3. Microbiological contamination

E. coli is used as an indicator species for the potential presence of sewerage borne diseases, as well as for the classification of production areas. The abalone farms were all classified as "Approved Class A" based on the data received. However the mussel and oyster farms were classified as "Conditionally Approved Class A". Other microbiological species tested for included Salmonella and Vibrio.

During 2016 the shellfish farms received 6 closure notices from the SAMSM&CP office informing them that the microbiological concentration in the shellfish had exceeded the regulatory level (Figure 29). The farms were prohibited from marketing live products; however, they were permitted to market processed products. Each time the closure notices were sent, the farms were temporarily closed for an average period of 9 days (Figure 30). There was one closure notice that was sent to a farm contaminated with Salmonella.

The abalone production facilities continued to be classified as Approved and exempted from testing the production area monthly for microbial contamination viz. E. coli. They were required to monitor for microbial contamination during official surveillance of end-of-line product. In 2016 there was no end-of-line products that were non-compliant and therefore there were no farm closures due to presence of microbiological contamination.

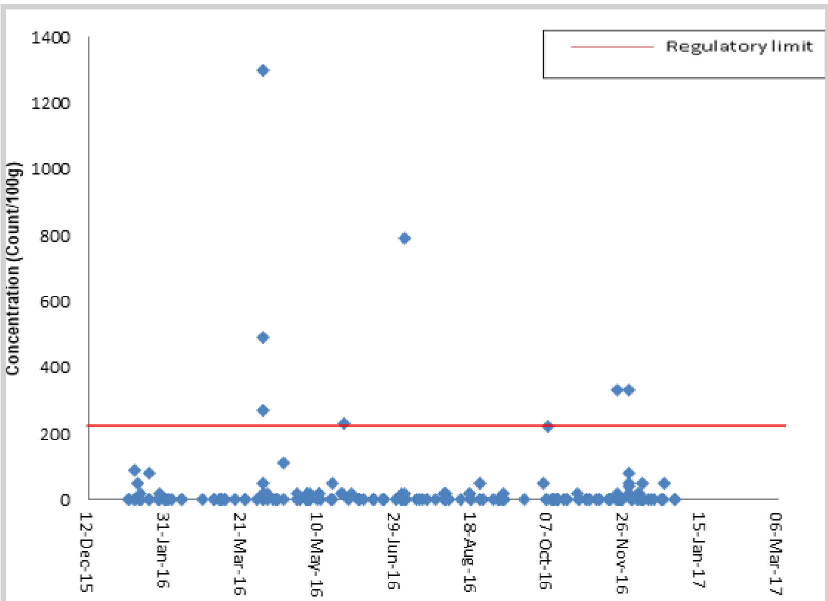


Figure 29: E. coli results for molluscan shellfish farms in 2016.

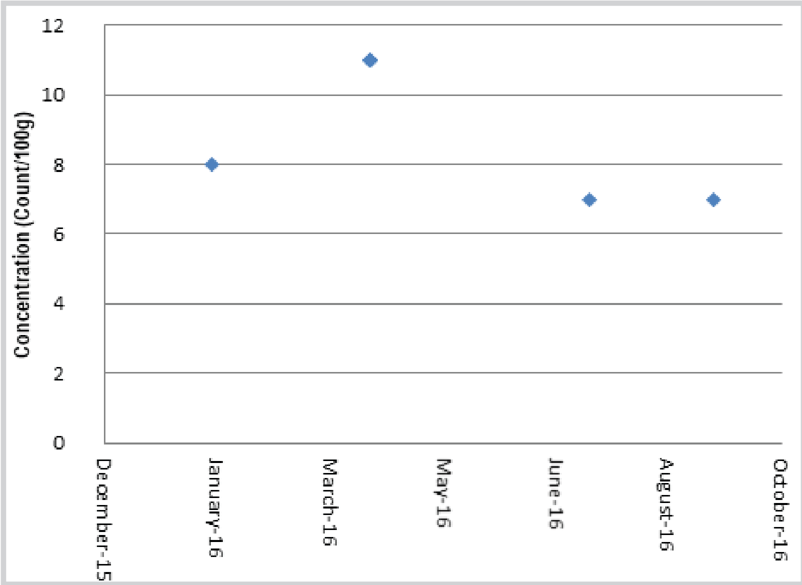


Figure 30: Number of days the farms were closed due to microbiological contamination in 2016.

6.4. Wet Storage Facilities

In 2016, one of the oyster farms in Saldanha Bay constructed a wet storage facility for its product. Wet storage refers to the temporary re-immersion of live shellfish in near shore waters or onshore tanks prior to placing on the market. The primary reasons for wet storage are holding shellfish harvested for a period of time to allow the shellfish to purge and be more accessible for marketing.

During that year, the wet storage facility was monitored weekly for E. coli and monthly for Vibrio cholera, Vibrio parahaemolyticus and Salmonella and classified accordingly. The microbiological contamination was below the regulatory limit throughout the year 2016.

6.5. Biotoxins

During 2016 a total 25 DSP closure notices were sent to shellfish farms informing them that the biotoxin concentration in the shellfish had exceeded the regulatory limit. ASP toxins were not detected on any of the shellfish farms. PSP toxins were only found in shellfish farms in low concentrations. Many of the abalone farms, however, canned their products thus further reducing the PSP toxin levels as the abalone were eviscerated and scrubbed to remove the PSP toxins (Figure 31). The farms that were affected by the presence of biotoxins were farms situated to the west of Cape Point.

Table 15: Count of toxins tested above regulatory limit in abalone.

Year	PSP	OA	AZA	YTX	DSP	ASP
2010	51 (228)	-	-	-	5 (133)	0 (122)
2011	16 (170)	0 (1)	0 ((1)	0 (1)	2 (99)	0 (129)
2012	21 (228)	0 (1)	-	-	0 (1)	0 (52)
2013	16 (273)	0 (43)	0 (34)	0 (38)	4 (112)	0 (17)
2014	9 (286)	0 (135)	0 (70)	0 (131)	0 (7)	0 (49)
2015	6 (269)	0 (148)	0 (145)	0 (145)	0 (0)	0 (35)
2016	3 (385)	141 (437)	0 (439)	0 (432)	0 (0)	0 (30)

() = Number of samples tested

PSP – Paralytic Shellfish Poisoning, OA – Okadaic Acid, AZA – Azaspiracid, YTX – Yessotoxin, DSP – Diarrhetic Shellfish Poisoning, ASP – Amnesic Shellfish Poisoning.

The mussel and oyster farms in Saldanha Bay were not allowed to market any product when the biotoxins exceeded the regulatory limit. Each time the closure notices were sent, the Saldanha Bay farms were temporarily closed for an average period of 22 days in 2016. Mussels and oysters were sampled from the sentinel sampling station at the mouth of the bay to indicate the presence of toxins in the bay. Therefore all the farms in the bay were closed simultaneously each time the toxin concentration in these samples exceeded the regulatory limit.

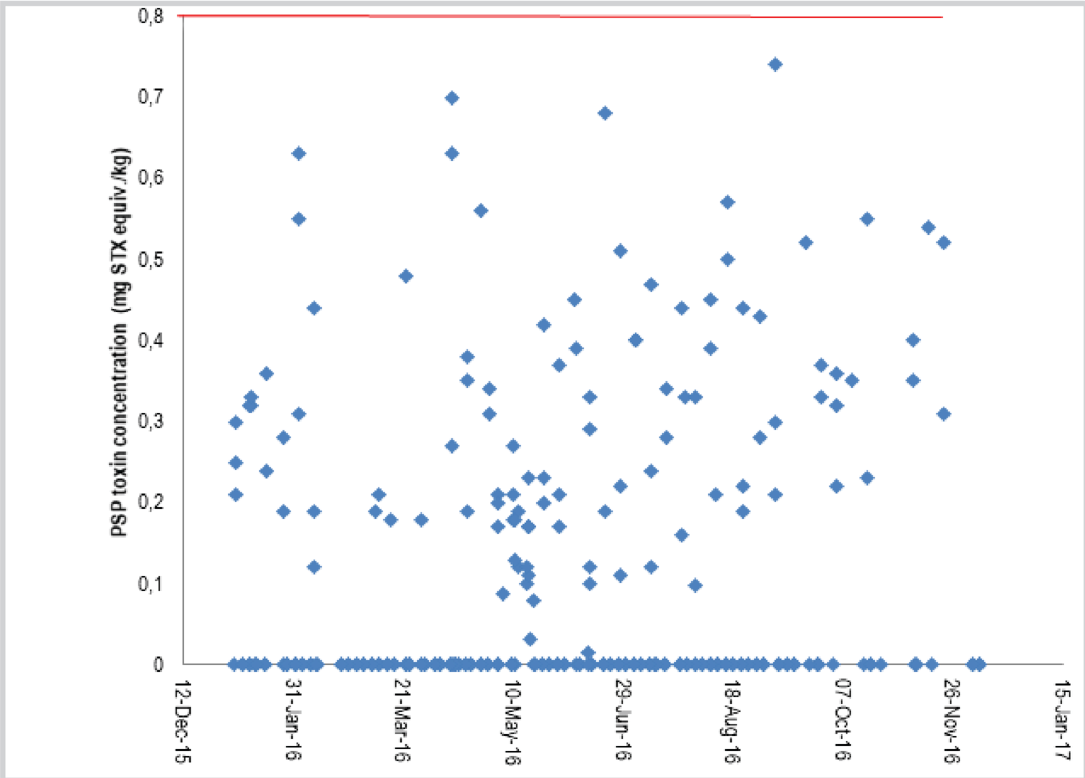


Figure 31: PSP toxin concentrations in shellfish cultured to the west of Cape Point in 2016.

6.6. Heavy metals, Pesticides, Dioxins, PAH, PCBs, Drug residues and Radionuclides

There were no farm closures due to heavy metal concentrations exceeding the regulatory limits. The heavy metals were, however, present in the cultured shellfish in low concentrations. Only those farms which had shellfish that contained heavy metals were recorded in the graphs below. Lead and cadmium was not detected in the majority of the abalone farms. For those farms that had concentration of heavy metals closer to regulatory limit such as the oyster and mussel farms in Saldanha Bay, contingency measures were applied namely increasing the monitoring frequency to test for heavy metals bi-annually.

There were no detectable levels of pesticides, dioxins, PAH, PCB or radionuclide present in any shellfish farms along the South African Coast.

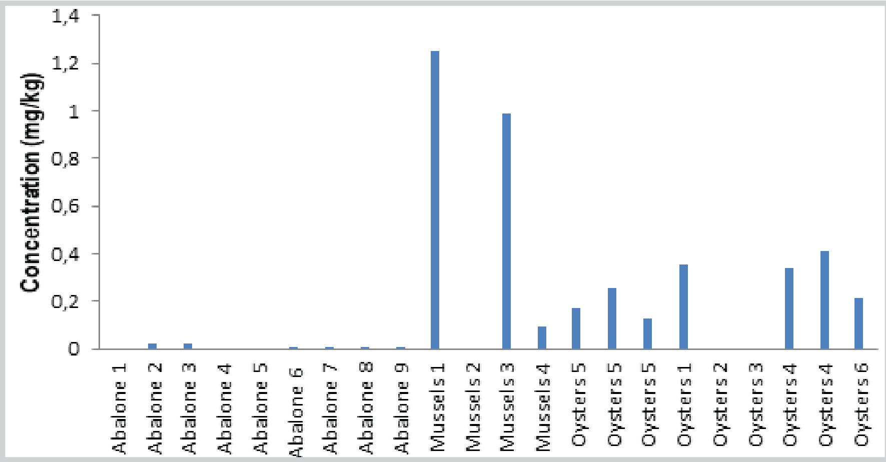


Figure 32: Lead concentrations in cultured molluscan shellfish in 2016.

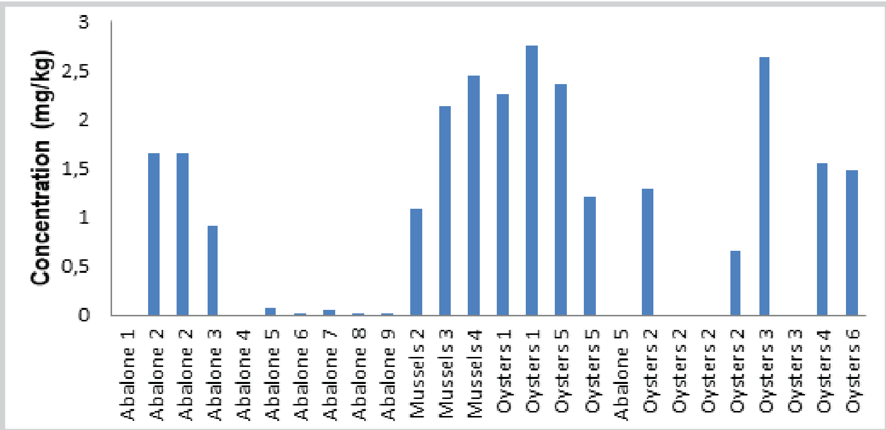


Figure 33: Cadmium concentrations in cultured molluscan shellfish in 2016.

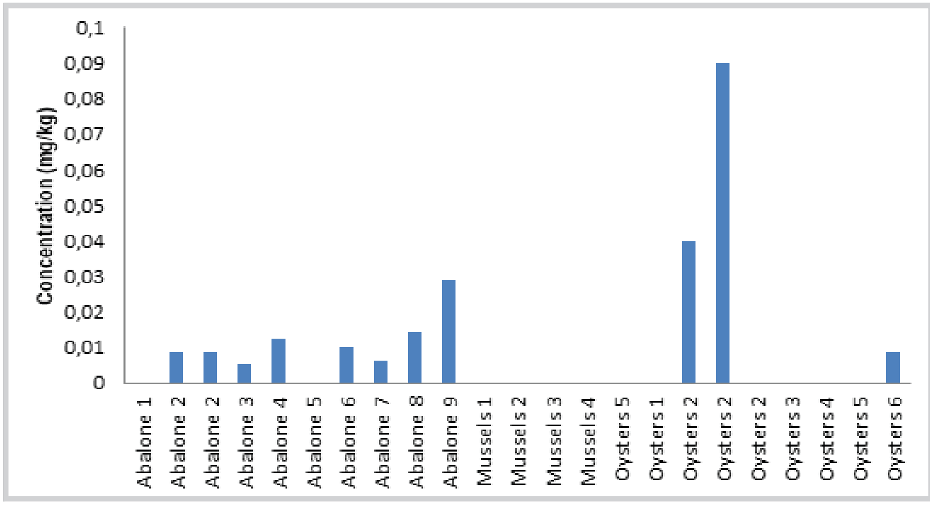


Figure 34: Mercury concentrations in cultured molluscan shellfish in 2016.

6.7. Compliance history

In 2016 all monitored farms continued to comply with the requirements of the SAMSM&CP. There was only one farm in the Northern Cape that was not compliant to the programme; the farm has been informed to comply with the SAMSM&CP requirements.

6.8. Shellfish Monitoring Programme progress

The SAMSM&CP had been reviewed and updated to ensure harmonisation with Codex Alimentarius standards as South Africa is a signatory to Codex Alimentarius. The South African shellfish farmers have accepted the revised SAMSM&CP and with the assistance of the SAMSM&CP office are prepared to comply with its requirements.

The official phytoplankton monitoring and the on-farm phytoplankton monitoring programmes were effectively implemented in 2016. The further developments of official satellite monitoring stations are, however, required for the official programme to be an effective early warning system. Only one station in Hermanus has been effectively established, the station worked and continues to do so with the SAMSM&CP in implementing the SAMSM&CP. The Department has procured two microscopes that are used for phytoplankton identification and enumeration. They microscopes have in-built cameras which can be linked up to a computer for downloading and sharing images. The microscopes have assist in improving the phytoplankton monitoring programme and sharing of data.

The Joint Biotoxin Monitoring Programme for the Saldanha Bay mussel and oyster farms had been updated. The biotoxin test results of the samples taken from the sentinel sites were shared by the programme members who jointly contributed to a joint fund managed by the farmers themselves. The SAMSM&CP office furthermore updated and continued to implement the Joint Microbiological Action Plan for Saldanha Bay and the Traceability Protocol for aquaculture products in order to bring the farms in line with Codex Alimentarius and national requirements.

The programme is conducting a risk assessment for the presence of norovirus in South African cultured shellfish in collaboration with an international laboratory. The Italian laboratory is sponsoring the costs associated with the norovirus testing. The farms have provided animals that will constitute the samples for the study. When the study is concluded, the SAMSM&CP and shellfish farms will establish if norovirus is a risk in South African aquaculture facilities.

The drug residue programme has been developed and implemented for the abalone farms and is being developed for the oyster farms wanting to export. The abalone farms and the oyster farms exporting, respectively, have joint accounts with the relevant laboratory, thus streamlining the payment of monitoring costs.

The SAMSM&CP staff continued to improve communications with relevant stakeholder involved in the programme. Various meetings were held to exchange ideas to assist with the improvement of service delivery e.g. improvement of turn-around times for the availability of results to the SAMSM&CP office and farmers.

The SAMSM&CP office have conducted an audit programme for phytoplankton monitoring, feed management, drug management; wet storage management and traceability of shellfish products. All shellfish and finfish farms have been audited and informed of findings where relevant.

In 2016 the SAMSM&CP office had been audited by several experts from the EU Commission. The delegation provided guidance to the SAMSM&CP office on where to improve the monitoring programme to meet EU import requirements. The suggestion have been considered and shared with relevant stakeholders.

Table 16: The number of tests conducted in 2016.

Substance	Count	Count exceeding regulatory limit
Total AZA Group Toxins	432	0
Total OA Group Toxins	437	141
Total YTX Group Toxins	439	0
PSP toxins	385	3
Cadmium (Cd)	92	0
Mercury (Hg)	34	0
Lead (Pb)	35	0
Inorganic arsenic	20	0
Total arsenic (As)	18	0
E. coli	194	6
Vibrio cholerae	22	0
Vibrio parahaemolyticus	17	0
Salmonella	168	0
Organochlorine pesticides	22	0
PCB	48	0
Radioactivity	0	0

ECONOMIC OVERVIEW OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2016

07

7.1 Introduction to Aquaculture Economics

In order for aquaculture to contribute significantly to food security and poverty alleviation, there is a need to pursue aquaculture as a business entity. It is essential to understand the commercial and marketing concepts. An understanding of how effective and efficient production and marketing systems are run will help the stakeholders establish economic problems in aquaculture for comprehensive decision making.

This section is aimed at providing overall annual economic performance of the aquaculture sector for the year 2016. This section analyses economic data and statistical trends of the sector in terms of capital investments, employment opportunities created, exports and imports.

7.2 Value of the Aquaculture Industry

The total value of the aquaculture sector in 2016, was estimated at R 1 042 072 340.31. The marine sector contributed R 903 528 840.31, representing 86.71% to the overall aquaculture value. Locally, aquaculture continues to be dominated by the abalone sub-sector which was estimated to be valued at R 779 560 217.73 in 2016, representing 86.28% to the marine value and 74.81% to the overall aquaculture value. In the marine sector, the oyster sub-sector was the second largest contributor at R 100 929 002.41, representing 11.17% of the marine value and 9.69% to the total aquaculture value, followed by mussels at R 13 548 420.9 and marine finfish at R 9 491 200, representing 1.50% and 1.05% respectively to the marine sector and 1.30% and 0.91% respectively to the overall aquaculture value.

The freshwater sector contributed R 138 543 500, representing 13.29% to the overall aquaculture value. The largest contributor was the trout sub-sector at R 120 240 000, representing 86.79% to the freshwater sector and 11.54% to the overall aquaculture value. The second largest contributor was tilapia with R17 040 500, representing 12.30% to the freshwater sector and 1.64% to the overall aquaculture value. Marron crayfish contributed R800 000, representing 0.58% to the freshwater sector and 0.08% to the aquaculture value. The second last contributor was carp at R315 000, demonstrating 0.23% to the freshwater sector value and 0.03% to the overall aquaculture production. The smallest contributing sub-sector was Catfish at R148 500, representing 0.11% to the freshwater value and 0.01% to the aquaculture value.

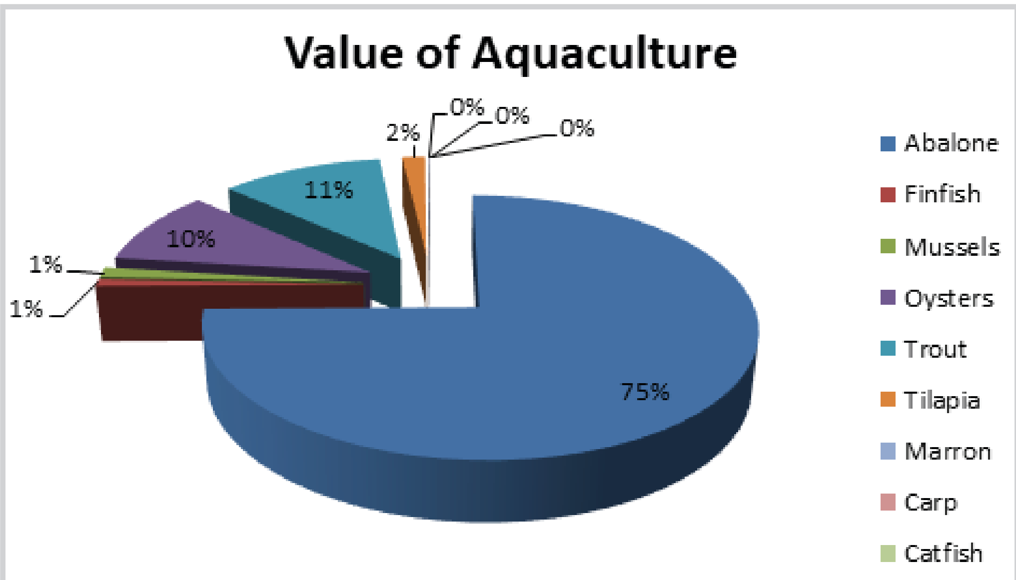


Figure 35: The estimated percentage contribution of the total value of South Africa's aquaculture sector in 2016.

7.3 Aquaculture Investment

Access to funding is one of the major challenges identified to hinder growth of the aquaculture sector. To address this challenge, the then Department of Agriculture, Forestry and Fisheries (DAFF) in partnership with the then Department of Trade and Industry **(the dti)** established an Aquaculture Development and Enhancement Programme (ADEP), an incentive scheme devoted to the aquaculture sector. ADEP has contributed significantly to the growth and development of the aquaculture sector. It has proven to be an important tool to positively contribute to increased aquaculture production, investments in the sector and job creation. Since the establishment of ADEP in 2013, R 207 512 494.00 has been paid out to beneficiaries with more than 1800 employment opportunities created over a period of 4 years.

There are various public-sector funding mechanisms that currently exist even though not dedicated to aquaculture; these are provided at national level by government departments such as DAFF, the dti and Department of Small Business Development (DSBD). Furthermore, at provincial level, institutions such as the Eastern Cape Development Corporation (ECDC), Gauteng Entrepreneur Propeller (GEP) and Mpumalanga Economic Growth Agency (MEGA) also provide funding. The aquaculture industry is also funded by private and Development Finance Institutions (DFIs) such as the Industrial Cooperation Development (IDC), Land Bank, the National Empowerment Fund (NEF) as well as commercial banks such as Amalgamated Banks of South Africa (ABSA), First National Bank (FNB) and Nedbank

The aquaculture sector remains an insignificant contributor to the national fish supply and the country's Gross Domestic Product (GDP).

In 2016, the total additional investment of approximately R474 million was attained from both the freshwater and the marine aquaculture sectors; representing an increase of 79.5% from R264 million that was recorded in 2015 (Table 17).

The Western Cape Province contributed 60% to the total capital investments while Northern Cape contributed 12% and Eastern Cape contributed 10%. KwaZulu-Natal contributed 8%, Limpopo and Gauteng both contributed 4%, Free State and North West contributed 2% and 1% respectively. No investments were recorded in Mpumalanga during 2016; this is illustrated in figure 36.

Table 17: Projected investments during 2016

PROVINCE	INVESTMENT
Eastern Cape	R47 675 000
Western Cape	R282 816 862
KwaZulu-Natal	R36 726 206
Northern Cape	R58 400 000
North West	R3 800 000
Gauteng	R20 016 436
Free State	R10 725 000
Limpopo	R13 847 897
Mpumalanga	R0
TOTAL	R474 007 401

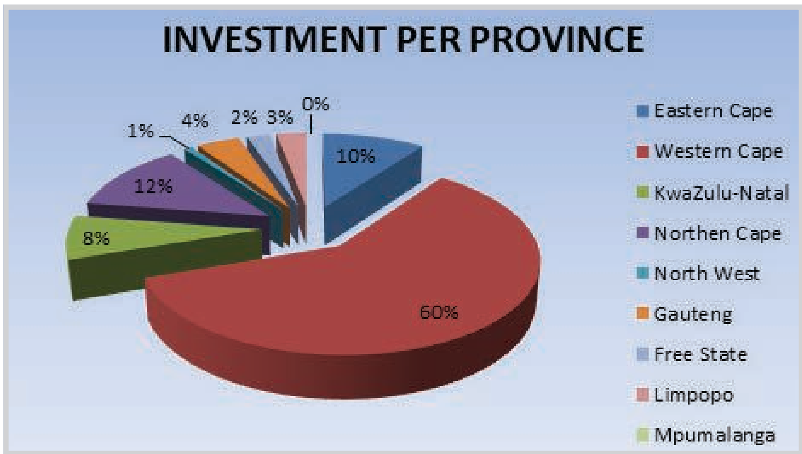


Figure 36: Capital Investments percentage contributed by each province during 2016.

The abalone subsector showed investments of approximately R 306 million, followed by mussels with R 51 million and tilapia with about R 45 million (Table 18). The highest investments were recognized from the abalone sector, contributing 64% to the overall total investments, followed by mussels and tilapia contributing 11% and 10% respectively (Figure 37).

Table 18: Projected investments per subsector during 2016

Name of Species	Projected Investment
Abalone	R306 650 422
Dusky kob	R30 726 206
Catfish	R9 230 000
Mussels	R51 136 440
Tilapia	R45 806 610
Trout	R17 825 723
Salmon	R6 632 000
Ornamental fish	R6 000 000
TOTAL	R474 007 401

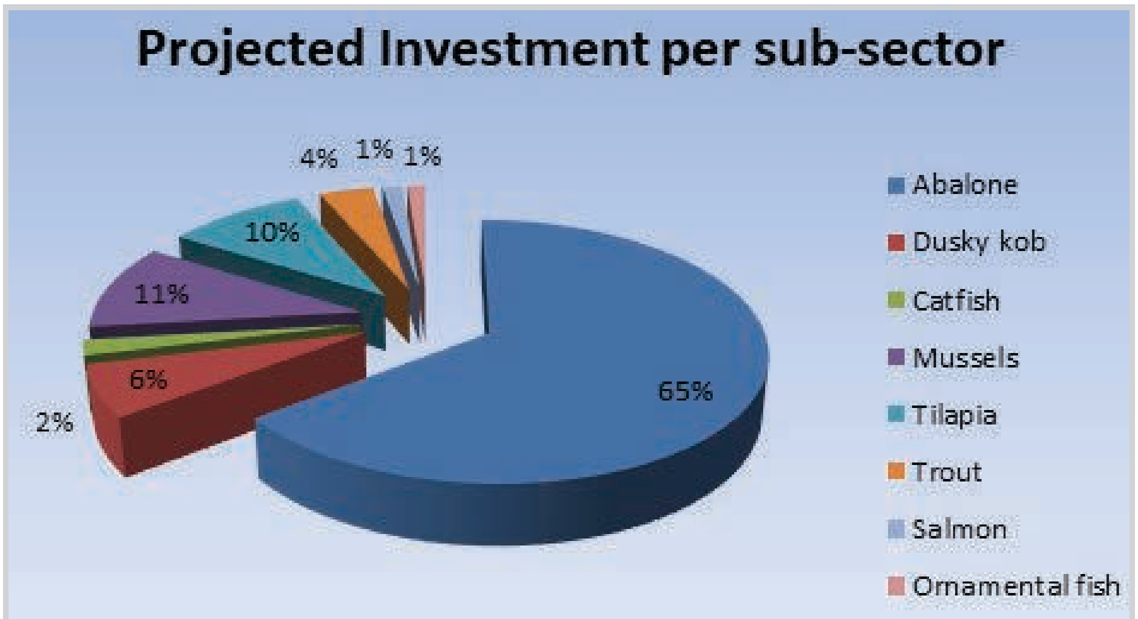


Figure 37: Capital Investments contributed by each sub-sector during 2016.

7.4 Employment Status

The aquaculture sector contributes to economic growth and the development by creating employment opportunities, being a food supplier and income generator.

The sector employed an estimated 3 826 people directly on farms during 2015 on a full time basis. The employment figure had increased to 4 448 in 2016 as a result of increase in aquaculture production, number of farms, investments and increased support from the government. A total of 622 additional jobs were created by the sector in 2016, representing an increase of 16, 3% from 2015 estimated employment figure.

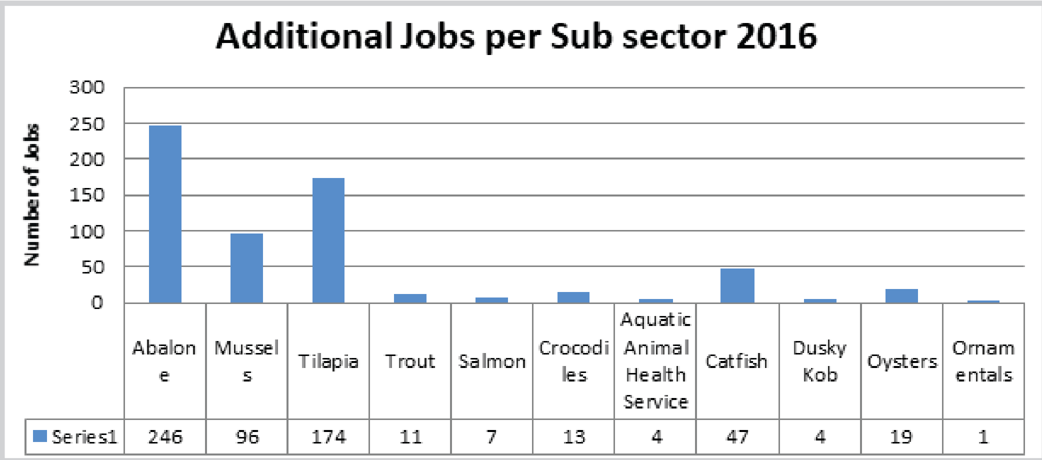


Figure 38: Additional jobs per sub-sector during 2016

There are government support programmes that intend to stimulate investments, increased production and job creation in the sector. The Aquaculture Development and Enhancement Programme (ADEP) and Operation Phakisa are among these programmes.

7.4.1 Aquaculture Development and Enhancement Programme (ADEP)

A total of 325 additional jobs were committed by the sector through ADEP projects beneficiaries in 2016. Figure 38 illustrates the additional jobs committed per province. The Western Cape created the highest number of jobs with 63% followed the Eastern Cape and Gauteng with 26% and 6% jobs respectively.

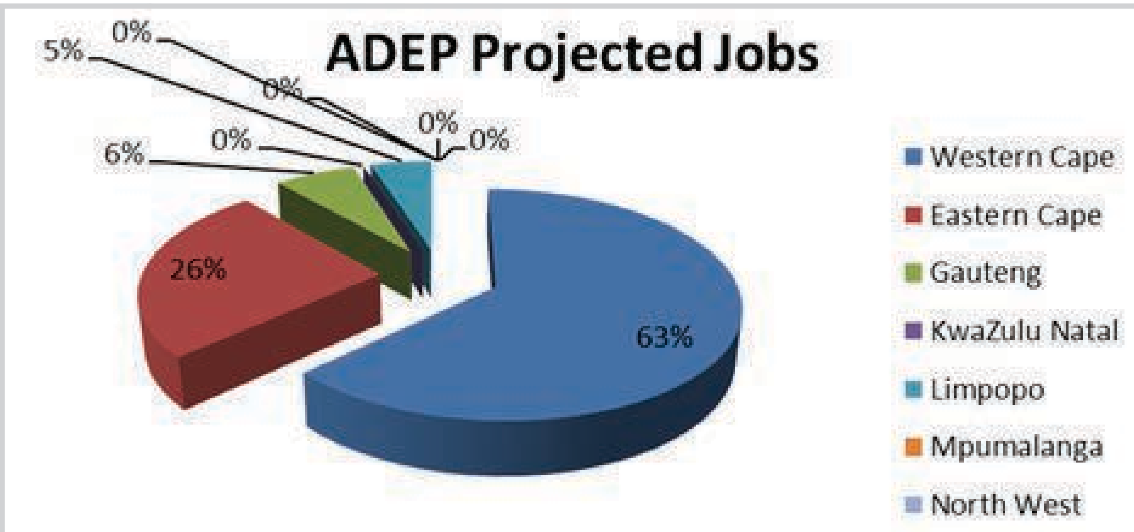


Figure 39: ADEP projected jobs during 2016.

The abalone sub-sector committed the highest employment opportunities with 125 jobs followed by tilapia and mussels with 93 and 75 jobs respectively (Figure 40 and figure 41).

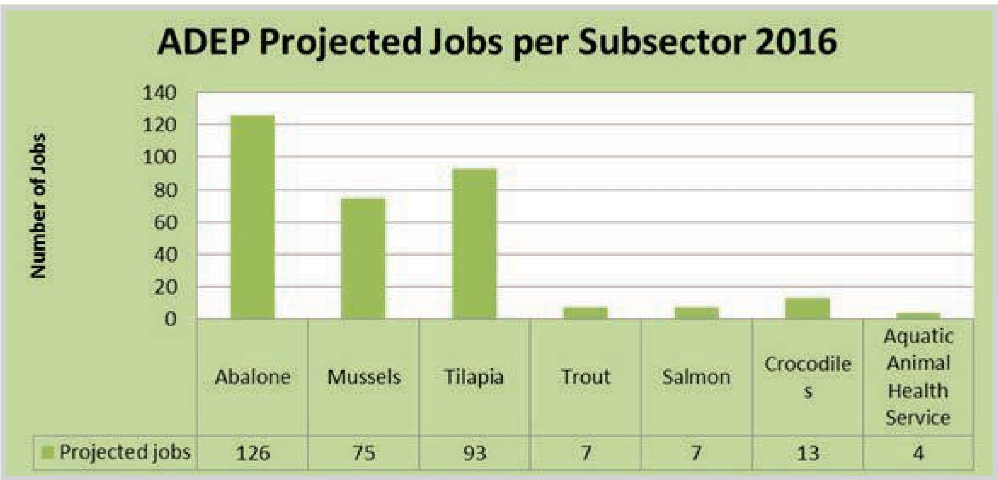


Figure 40: Projected employment per sub-sector during 2016

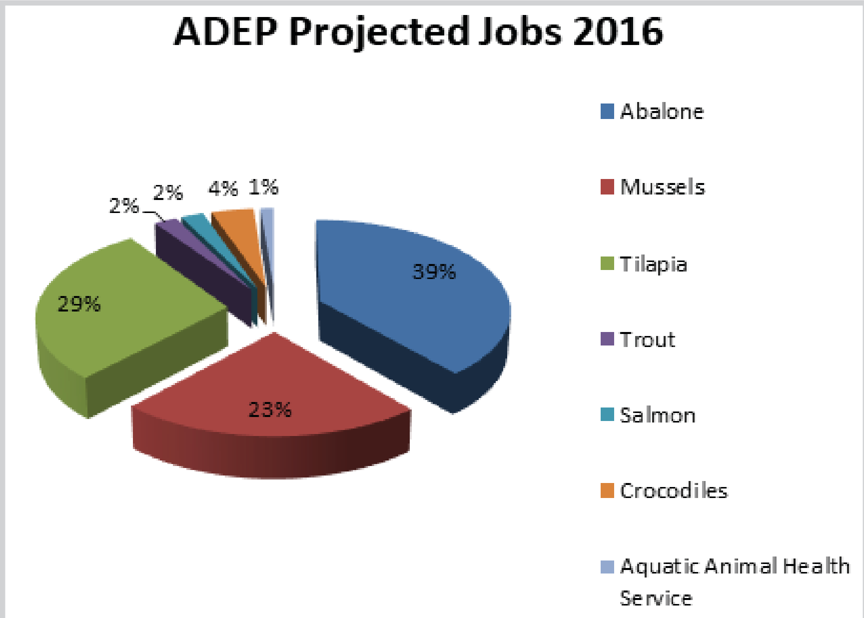


Figure 41: Projected employment percentage per sub-sector during 2016

The Western Cape continued to be the leading contributor to the increase in employment, contributing 63%. Eastern Cape and Free State Province contributed 24% and 5% respectively, with the lowest contributors being Northern Cape, KwaZulu-Natal, Limpopo and Gauteng contributing 3%, 2%, 2% and 1% respectively (Table 19 and Figure 42).

Table 19: Employment created per province during 2016

Province	Projected jobs
Eastern Cape	403
Western Cape	1068
KwaZulu-Natal	36
Northern Cape	43
North West	7
Gauteng	21
Free State	90
Limpopo	31
Mpumalanga	0
TOTAL	1699

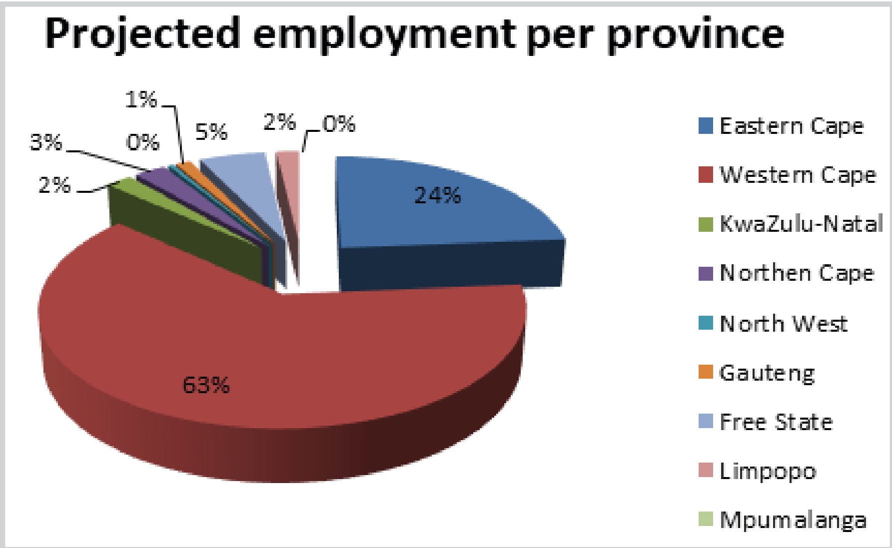


Figure 42: Projected employment per province during 2016

7.5 Overview of aquaculture market

Aquaculture is the fastest growing food production sector in the world. The contribution of aquaculture to the world fisheries production has been growing steadily over the last decade and accounts for almost half of total fish supplies for human consumption. With global demand increasing and natural stocks already largely at or exceeding their maximum capture potential, it is clear that aquaculture will play an important role in satisfying future global demand and in contributing to the security of the global food production system (FAO, The state of world's fisheries and aquaculture, 2010). Globally, marine aquaculture is fast becoming recognized as a priority sector. Considering the major contribution of this sector to the economy of other countries, South Africa needs to ensure that this sector grows to its significant potential. Currently, marine aquaculture contributes 0.029 percent to the South African GDP (freshwater aquaculture contribution not confirmed at present).

South Africa's aquaculture industry, though still in its infancy, has been identified by government as a key priority sector because of its potential to supplement dwindling wild-caught fish stocks with cultured fish products. The marine and freshwater aquaculture presents a good opportunity to diversify fish production to satisfy local demand; contribute to food security, job creation, economic and rural development, and improve export opportunities. Aquaculture operations can be found across South Africa in every province, producing a few important species under a variety of culture methods.

South Africa has suitable environmental conditions for aquaculture development and opportunities for commercial production of various cultured species. The local aquaculture sector has performed below its potential and remains a minor contributor to national fishery products and the country's GDP. However, more focus is being placed on the major constraints that have been limited to aquaculture growth. Constraints such as access to water and land, access to technology, high transaction costs, lack of supporting policies and legislation and barriers to marketing which are currently being addressed by DAFF.

7.6 Supply Structure

South African aquaculture products are marketed both locally and internationally, depending on the specific species. The abalone industry markets the bulk of their stock in Asia. The trout industry markets the bulk of their products locally. Products such as crocodile skins are exported, while many of the other experimental species such as dusky kob are marketed mainly on the local market (Aquaculture Market Value Chains: DAFF, 2015).

According to FAO, the growth of aquaculture has led to significant changes in how its products are perceived and marketed. In becoming an important contributor to the markets for seafood, aquaculture is increasingly subject to safety mechanisms and controls. The long-term viability of aquaculture development will be market driven, accounting for consumer demand and the capacity to adapt to the structure and legislative demands of the target markets.

Fish can be supplied to the market live or processed. Processing assures best possible market quality, provides a proper form of the semi-processed final product, assures health safety of products when produced in a HACCAP accredited environment, applies the most rational raw processing method and reduces waste to the extent possible.

7.7 Status of local aquaculture market

South Africa's coast has some production potential. In terms of freshwater aquaculture, however, South Africa's environment provides limited potential. The weather is too temperate to farm large amounts of warm-water fish like tilapia and catfish, which require tropical weather all year round. The rising electricity costs are a general concern for aquaculture stakeholders, including abalone farmers, who use a significant amount of power to pump water onshore and into tanks. Farmed products, therefore, tend to be quite expensive. South Africa continues to import low value species at cheaper tariffs to satisfy the local market. High value species which include abalone are exported due to higher returns from the international market. The challenge is to reduce production costs and align them with competing imports (SA moving to secure its share of world aquaculture growth, 2013).

7.8 Aquaculture export market

South Africa exported approximately 2263 tons of aquaculture products in 2016 with an estimated value of about R38 million. Tilapia sub-sector was the leading exporter with 1307.41 tons, followed by the abalone sub-sector with 379.385 tons and the mussel sub-sector with 261.759 tons. In terms of value, the abalone sub-sector contributed about R16 million while tilapia and pacific salmon contributed R12 million and R3 million respectively.

Abalone (82%) was mainly exported to China, Hong Kong. Conversely, Oysters (46%), Mussels (38%), Ornamental (73%) and Pacific salmon (70%) were mainly exported to Namibia. Other fish products such as Carp (100%), Trout (64%) and Atlantic salmon (31%) were mainly exported to Botswana, while Catfish (96%) and Tilapia (90%) were mainly exported to Democratic Republic of Congo.

7.8.1 Abalone

A total of 379.385 tons of abalone with an estimated value of R16 million were exported. Hong Kong imported 82% of South African farmed abalone, followed by Singapore 13% and Malaysia 4%. In 2016, abalone exports decreased by 49% in comparison with 2015 due to red tide events. Table below shows the quantity of abalone exported.

Table 20: South Africa's abalone exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rand)
Abalone	China, Hong Kong SAR	310.891	14.466	46.53077
Abalone	Singapore	47.612	1.677978	35.24275
Abalone	Malaysia	17.134	0.564213	32.92944
Abalone	Other Asia, nes	2.5	0.128593	51.4372
Abalone	China	1.244	0.076685	61.64389
Abalone	Zambia	0.004	0.000029	7.25
Total		**379.385**	**16.9135**	**235.0341**

Source: UN Comtrade, 2016

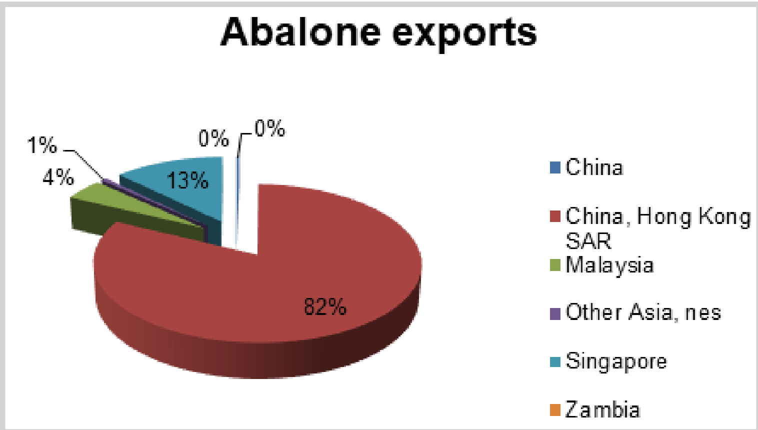


Figure 43: Abalone quantity exported during 2016

7.8.2 Oysters

South Africa exported 12 tons of oysters with an estimated value of R0.05 million (Table 21). Namibia imported 46%, China imported 16% while the rest of the country imported 38% of the South African produced oysters (Figure 44).

During the year 2015 oyster exports decreased significantly by 30% as compared to 2014. There was a significant decrease of 82% in the oyster exports in 2016 as compared to 2015.

Table 21: South Africa's oyster exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rand)
Oyster	Namibia	5.592	0.019909	3.560265
Oyster	China	1.913	0.015171	7.930476
Oyster	Nigeria	0.94	0.000771	0.820213
Oyster	Zambia	0.883	0.004264	4.828992
Oyster	France	0.8	0.001279	1.59875
Oyster	Angola	0.485	0.002324	4.791753
Oyster	Swaziland	0.469	0.000569	1.21322
Oyster	Botswana	0.444	0.002032	4.576577
Oyster	Zimbabwe	0.2	0.00236	11.8
Oyster	Mozambique	0.185	0.001402	7.578378
Oyster	Lesotho	0.061	0.000334	5.47541
Oyster	Maldives	0.061	0.000415	6.803279
Oyster	Malawi	0.058	0.000502	8.655172
Oyster	Ghana	0.035	0.000245	7
Oyster	Mauritius	0.033	0.000344	10.42424
Oyster	Saint Helena	0.022	0.000181	8.227273
Oyster	Uganda	0.016	0.000104	6.5
Oyster	Dem. Rep. of the Congo	0.004	0.000022	5.5
Oyster	Singapore	0.001	0.000003	3
Oyster	United Arab Emirates	0.001	0.000001	1
Total		**12.203**	**0.052232**	**111.284**

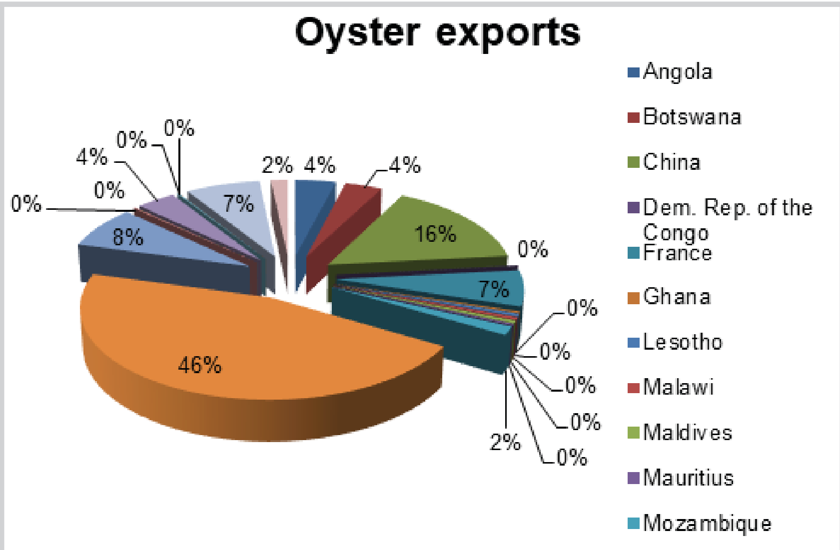


Figure 44: Oysters quantity exported during 2016

7.8.3 Mussels

South Africa exported 261.76 tons of mussels with an estimated value of R0.4 million. The leading countries that mussels were exported to are Namibia 38%, Angola 26% and Mauritius 10% (Figure 45). During 2015, the total tons exported were 102.53 tons compared to 261.76 tons exported in 2016 which constitutes 155% increase between the two years (Table 22).

Table 22: South Africa's mussels exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rand)
Mussels	Namibia	98.22	0.235764	2.40029321
Mussels	Angola	67.78	0.012924	0.190689782
Mussels	Mauritius	26.67	0.031666	1.187148534
Mussels	Mozambique	12.24	0.013378	1.092973856
Mussels	China	11.22	0.021146	1.884670232
Mussels	Zimbabwe	10.74	0.042337	3.942726765
Mussels	Zambia	9.03	0.033122	3.670027701
Mussels	Malawi	7.64	0.00997	1.305828422
Mussels	Botswana	6.06	0.01363	2.250288922
Mussels	Dem. Rep. of the Congo	3.922	0.008727	2.225140235
Mussels	Swaziland	2.036	0.005422	2.663064833
Mussels	Lesotho	1.464	0.001947	1.329918033
Mussels	Nigeria	1.414	0.002652	1.87553041
Mussels	Seychelles	1.061	0.00272	2.563619227
Mussels	Kenya	0.862	0.003794	4.401392111
Mussels	Ghana	0.412	0.002009	4.876213592
Mussels	China, Hong Kong SAR	0.381	0.001806	4.74015748
Mussels	United Rep. of Tanzania	0.27	0.001616	5.985185185
Mussels	Uganda	0.225	0.000479	2.128888889
Mussels	Saint Helena	0.114	0.000584	5.122807018
Mussels	Antarctica	0.007	0.000063	9
Mussels	Sudan	0.003	0.000071	23.66666667
Mussels	United Arab Emirates	0.001	0.000001	1
Total		**261.759**	**0.445828**	**89.5032311**

Source: UN Comtrade, 2016

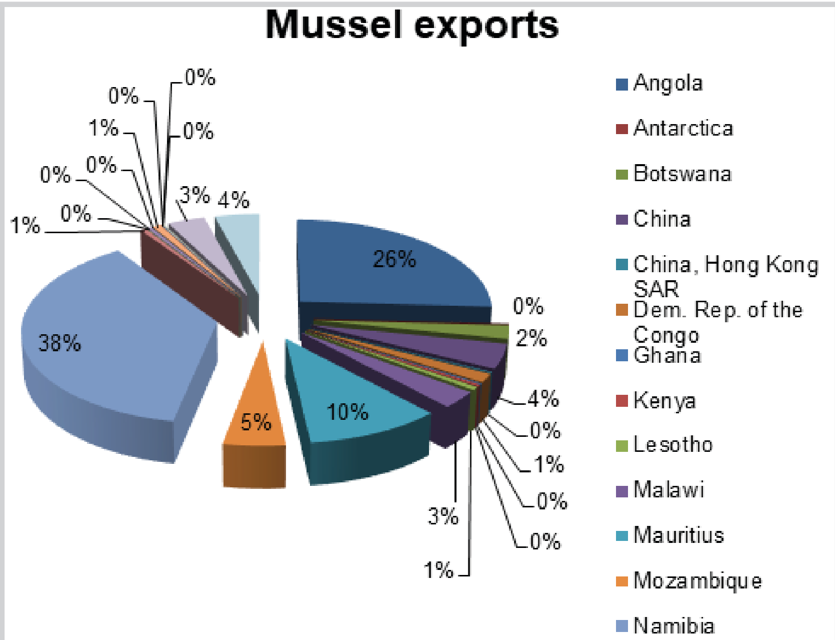


Figure 45: South Africa's mussel exports during 2016

7.8.4 Carp

In 2016, South Africa only exported carp to Botswana which was the third leading importer in the year 2015. A total of 1.9 tons were exported in 2015 when compared with 0.2 tons exported in 2016 (Table 23). This illustrates that Botswana imported 100% of South African carp valued at R0.007 million (Figure 46).

Table 23: South Africa's carp exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rand)
Carp	Botswana	0.2019	0.007377	36.53789
Total		0.2019	0.007377	36.53789

Source: South African Revenue service, 2016

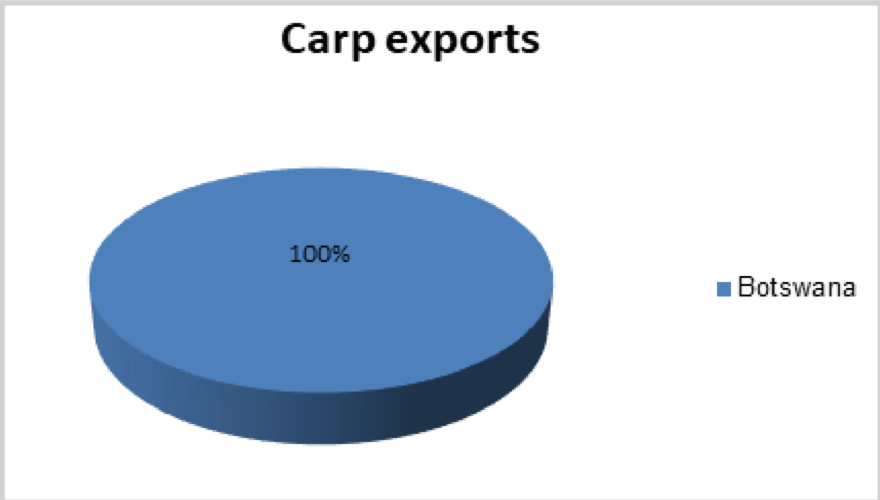


Figure 46: Carp quantity exported during 2016.

7.8.5 Catfish

The total volume of catfish that South Africa exported was 152.87 tons with an estimated value of R2 million (Table 24). The Democratic Republic of Congo imported more than 96% of South African catfish and the remaining 4% was exported to other African countries (Figure 47).

Table 24: South Africa's catfish exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rand)
Catfish	Democratic Republic Of Congo	146.95	1.998929	13.602783
Catfish	Togo	3.015	0.168482	55.88126
Catfish	Zambia	1.9432	0.06561	33.763895
Catfish	Nigeria	0.5	0.027441	54.882
Catfish	Zimbabwe	0.2	0.0096	48
Catfish	Mozambique	0.16	0.004641	29.00625
Catfish	Lesotho	0.102	0.021147	207.32353
Total		**152.8702**	**2.29585**	**442.45972**

Source: South African Revenue service, 2016

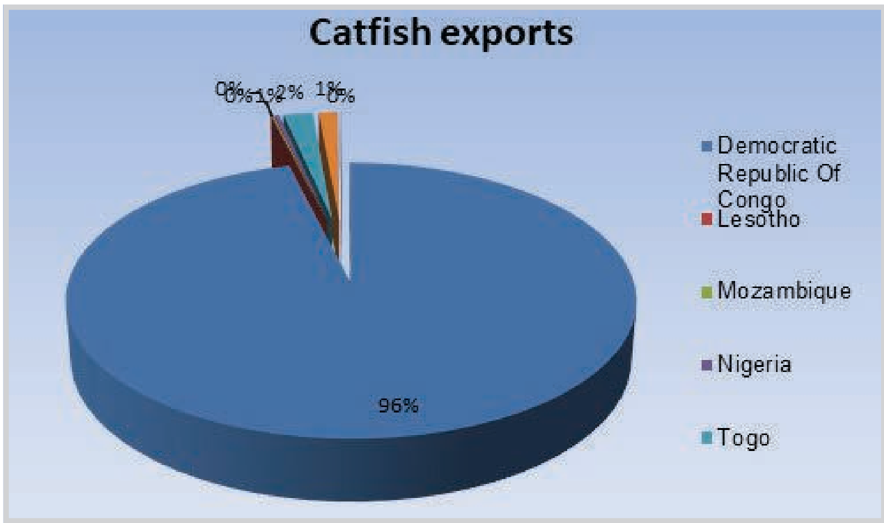


Figure 47: South Africa's catfish exports during 2016

7.8.6 Ornamentals

During 2016, South Africa exported 26.69 tons of ornamental fish estimated at R0.1 million (Table 25). The exports decreased by 22.95 tons when compared with 2015. Namibia was the leading importer with 73% followed by Botswana with 14% (Figure 48).

Table 25: South Africa's ornamentals exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Average Price/kg (Rand)
Ornamental fish	Namibia	19.392	0.016109	0.830703
Ornamental fish	Botswana	3.863	0.006879	1.78074
Ornamental fish	Mauritius	0.585	0.00657	11.23077
Ornamental fish	Gabon	0.551	0.012454	22.60254
Ornamental fish	Other Asia, nes	0.445	0.033917	76.21798
Ornamental fish	Swaziland	0.373	0.001919	5.144772
Ornamental fish	Zimbabwe	0.308	0.002582	8.383117
Ornamental fish	Japan	0.252	0.035357	140.3056
Ornamental fish	Mali	0.2	0.00001	0.05
Ornamental fish	Sri Lanka	0.186	0.019602	105.3871
Ornamental fish	Rep. of Korea	0.17	0.006365	37.44118
Ornamental fish	Singapore	0.107	0.007504	70.13084
Ornamental fish	China, Hong Kong SAR	0.084	0.008476	100.9048
Ornamental fish	Dem. Rep. of the Congo	0.076	0.00017	2.236842
Ornamental fish	Mozambique	0.051	0.000071	1.392157
Ornamental fish	Burkina Faso	0.04	0.000011	0.275
Ornamental fish	Lesotho	0.005	0.000029	5.8
Total		26.688	0.158025	590.1141

Source: UN Comtrade, 2016

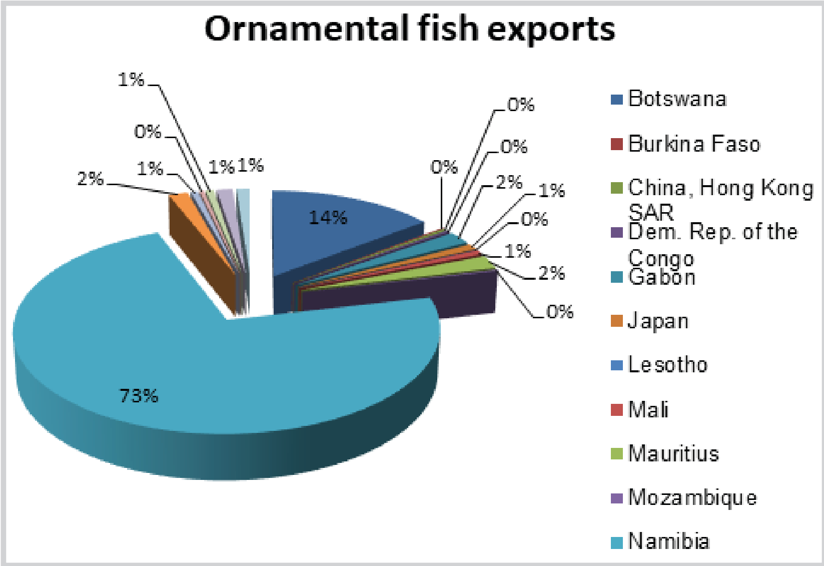


Figure 48: South Africa's ornamental fish exports during 2016

7.8.7 Pacific salmon

South Africa exported 62.99 tons of pacific salmon with an estimated value of R3.8 million (Table 26). In comparison with 2015, exports in 2016 decreased by 16 tons which illustrates a 20% decline. The three leading importers were Namibia 70%, Botswana 16% and Swaziland 8% (Figure 49).

Table 26: South Africa's Pacific salmon exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rand)
Pacific Salmon	Namibia	44.302	2.487972	56.15936
Pacific Salmon	Botswana	10.359	0.440726	42.54523
Pacific Salmon	Swaziland	5.25962	0.227182	43.19361
Pacific Salmon	Zimbabwe	1.86393	0.454707	243.9507
Pacific Salmon	Malawi	0.5193	0.1153	222.0297
Pacific Salmon	Ethiopia	0.20255	0.046586	229.9975
Pacific Salmon	Seychelles	0.131	0.029653	226.3588
Pacific Salmon	Gabon	0.1	0.025018	250.18
Pacific Salmon	Saint Helena, Ascension an Tristan da Cunha	0.09755	0.029883	306.3352
Pacific Salmon	Mozambique	0.07013	0.002788	39.75474
Pacific Salmon	Ghana	0.06	0.01779	296.5
Pacific Salmon	Zambia	0.0102	0.000942	92.35294
Pacific Salmon	Tanzania	0.00857	0.00112	130.6884
Pacific Salmon	Rwanda	0.00556	0.00167	300.3597
Pacific Salmon	Democratic Republic Of Congo	0.003	0.00143	476.6667
Pacific Salmon	Democratic Republic Of Congo	0.0024	0.000217	90.41667
Total		**62.99481**	**3.882984**	**3047.489**

Source: South African Revenue service, 2016

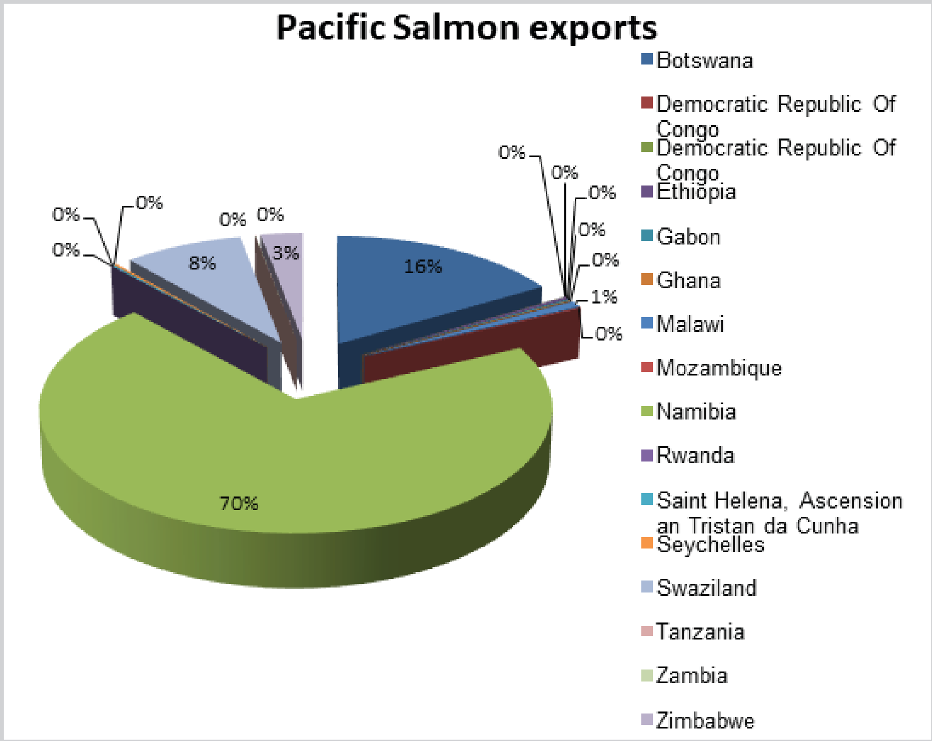


Figure 49: South Africa's Pacific salmon exports during 2016

7.8.8 Tilapia

South Africa exported approximately 1307.41 tons of tilapia valued R 12.65 million (Table 27). The top three destinations for tilapia were Democratic Republic of Congo with 90%, Botswana with 5% and China with 4% (Figure 50). The volumes of exports for tilapia increased significantly by approximately 300% compared with 2015.

Table 27: Tilapia exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million FOB)	Price (Rand)
Tilapia	Democratic Republic Of Congo	1141.726	9.728422	8.520802714
Tilapia	Botswana	64.24957	1.863343	29.00164157
Tilapia	China	52.444	0.680576	12.97719472
Tilapia	Unclassified	39.659	0.056943	1.435815326
Tilapia	Swaziland	7.6657	0.121843	15.89456932
Tilapia	Gabon	1.2	0.065699	54.74916667
Tilapia	Angola	0.2	0.053446	267.23
Tilapia	Tanzania	0.2	0.063	315
Tilapia	Zambia	0.041	0.01095	267.0731707
Tilapia	Lesotho	0.025	0.002363	94.52
Tilapia	Saint Helena, Ascension an Tristan da Cunha	0.00205	0.000126	61.46341463
Total		1307.412	12.646711	1127.865776

Source: South African Revenue service, 2016

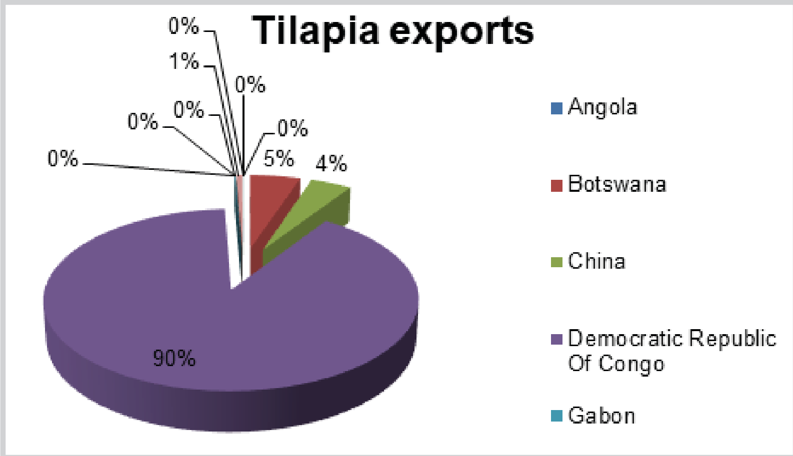


Figure 50: South Africa's tilapia exports during 2016

7.8.9 Trout

South Africa exported approximately 37.33 tons of trout valued at about R3 million (Table 28). The top leading importing countries include Botswana 64%, Lesotho 13% and Tanzania with 8% (Figure 51). Although there was a decrease in the value, the exports increased with 17.63 tons in 2016.

Table 28: South Africa's trout exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)
Trout	Botswana	23.70377	0.147401
Trout	Lesotho	4.97832	1.155578
Trout	Tanzania	3.02244	0.195142
Trout	Mozambique	1.21547	0.085876
Trout	Namibia	1.092	0.086403
Trout	Nigeria	0.86	0.120688
Trout	Peru	0.383	0.426412
Trout	United Arab Emirates	0.369	0.004799
Trout	Malawi	0.2451	0.054804
Trout	Russian Federation	0.236	0.274753
Trout	Zambia	0.22772	0.011399
Trout	Denmark	0.227	0.217494
Trout	Ship/Aircraft	0.2109	0.012227
Trout	Swaziland	0.17794	0.008788
Trout	Zimbabwe	0.16392	0.014663
Trout	Greece	0.13	0.160789
Trout	Bosnia And Herzegovina	0.083	0.076325
Trout	Antarctica	0.003	0.00081
Total		37.32858	3.054351

Source: South African Revenue service, 2016

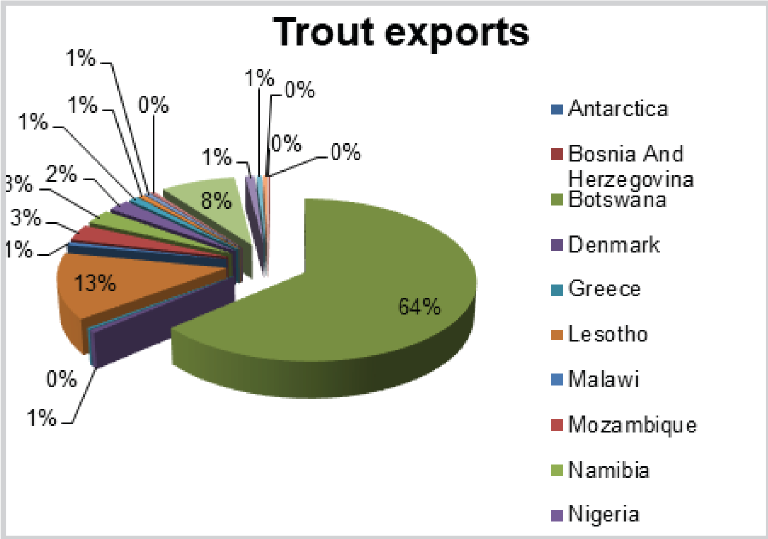


Figure 51: Trout quantity exported during 2016

7.8.10 Atlantic salmon

South Africa exported approximately 22 tons of Atlantic salmon valued at R 1.9 million (Table 29). The top three destinations for Atlantic salmon were Botswana with 31%, Zimbabwe with 30% and Swaziland with 16% (Figure 52).

Table 29: South Africa's Atlantic salmon exports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (million)
Atlantic Salmon	Antarctica	0,01	0,003037	303,7
Atlantic Salmon	Botswana	6,91641	0,314546	45,47821775
Atlantic Salmon	Mozambique	2,41718	0,281768	116,5688943
Atlantic Salmon	Namibia	1,5	0,077546	51,69733333
Atlantic Salmon	Nigeria	0,75	0,163918	218,5573333
Atlantic Salmon	Rwanda	0,55	0,087372	158,8581818
Atlantic Salmon	Saint Helena, Ascension an Tristan da Cunha	0,016	0,004088	255,5
Atlantic Salmon	Swaziland	3,46916	0,326653	94,1591048
Atlantic Salmon	Uganda	0,0517	0,0027	52,22437137
Atlantic Salmon	Zimbabwe	6,6066	0,73016	110,5197832
Total		22,28705	1,991788	1407,26322

Source: South African Revenue service, 2016

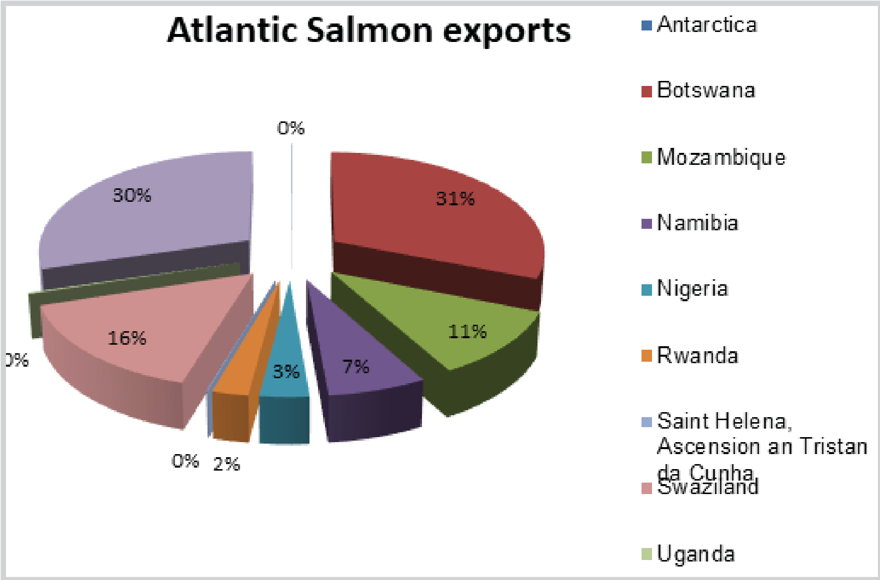


Figure 52: Atlantic salmon quantity exported during 2016

7.9 Aquaculture Import Profile

South Africa imported 8965.45 tons of aquaculture products during 2016. The leading importing sub-sector was tilapia with 4550.16 tons (95% of it being imported from China), followed by Pacific salmon with 1262.53 tons (70% from Norway) and Atlantic salmon with 1167.99 tons (89% imported from Norway). In terms of value, pacific salmon had the highest value of R121.29, Atlantic salmon with R101.58 and tilapia with R55.47.

China contributed 58.1% of South Africa's imports followed by Norway with 26.6%. The main countries of import and the quantity of species are outlined below.

Table 30: Specific countries of exports on various commodities

Species	Country	Quantity (%)
Atlantic salmon	Norway	89
Catfish	China	100
Carp	Namibia	97
Mussels	China	92
Pacific salmon	Norway	70
Tilapia	China	95
Trout	Norway	62
Oysters	China	73

7.9.1 Atlantic salmon

Atlantic salmon quantity imported amounts to 1167.997 tons (figure 53) with an estimated value of R 530.5828 (table 31). With Norway being the leader exporter with 89%, followed by Japan with 5% and Chile with 4%. When compared to 2015, the quantity imported decreased by 178.96 tons which represents 13.35% decline in 2016.

Table 31: South Africa's Atlantic salmon imports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Atlantic salmon	Norway	1037.166	93.8042	90.4428
Atlantic salmon	Japan	60.06	2.729768	45.45068
Atlantic salmon	Chile	44.516	2.398174	53.87218
Atlantic salmon	Germany	26.25436	2.646889	100.8171
Atlantic salmon	Portugal	0.0006	0.000144	240
Total		**1167.997**	**101.5792**	**530.5828**

Source: South African Revenue service, 2016

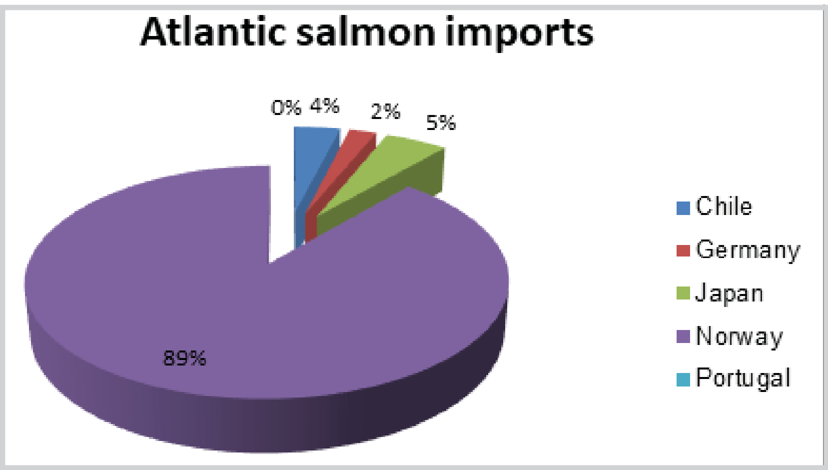


Figure 53: Atlantic salmon quantity imported during 2016

7.9.2 Catfish

South Africa imported 170.982 tons of catfish with an estimated value of R1.6 million (table 32). The quantity imported increased tremendously by 159.862 tons which signifies an increase of 1437.608 when compared with 2015. Catfish was imported from China and Vietnam, with China accounting for more than 99% while Vietnam contributed less than 1% (Figure 54).

Table 32: South Africa's catfish imports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Catfish	China	170.95	1.642691	9.60919
Catfish	Viet nam	0.032	0.000014	0.4375
Total		170.982	1.642705	10.04669

Source: South African Revenue service, 2016

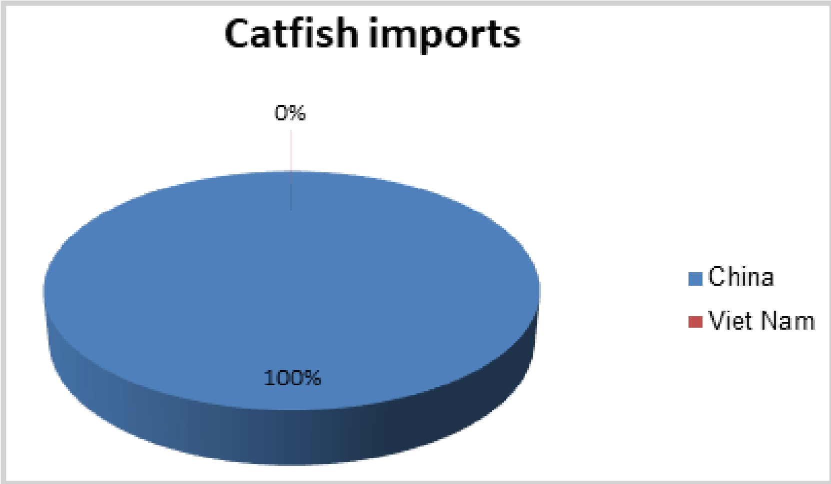


Figure 54: Catfish quantity imported during 2016

7.9.3 Carp

South Africa exported 24.09989 tons of carp from Japan and Namibia (Table 33) that is valued at R0.2 million. In comparison with 2015, the quantity imported increased significantly by 23.59289 tons showing 4653.43 increase in 2016. Namibia accounted for 97% and Japan with 3% (Figure 55).

Table 33: South Africa's carp imports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Carp	Namibia	23.41589	0.096	4.09978
Carp	Japan	0.684	0.202006	295.3304
Total		24.09989	0.298006	299.4302

Source: South African Revenue service, 2016

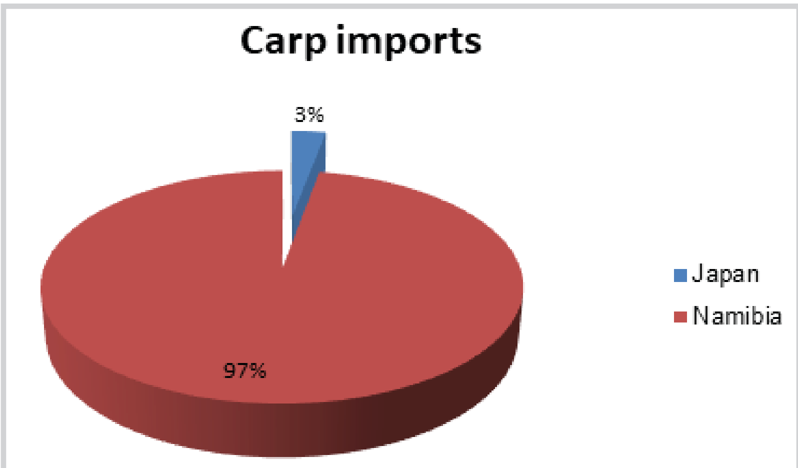


Figure 55: Carp quantity imported during 2016

7.9.4 Mussels

The total quantity of mussels imported in 2016 was 724.29 tons (estimated value R 2.89 million) (table 34) which was 491.79 tons more than the 232.5 tons imported in 2015, representing an increase of 211.54%. During 2016 China was the leading exporter with 92%, followed by Spain with 5% and Republic of Korea with 2% (Figure 56).

Table 34: South Africa's mussel imports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Mussel	China	665.583	2.685974	4.035521
Mussel	Spain	37.835	0.101233	2.675644
Mussel	Rep. of Korea	11.688	0.06426	5.497947
Mussel	New Zealand	8.725	0.037843	4.337307
Mussel	Namibia	0.318	0.001145	3.600629
Mussel	USA	0.1	0.003388	33.88
Mussel	Chile	0.039	0.000008	0.205128
Mussel	Denmark	0.008	0.000041	5.125
Total		**724.296**	**2.893892**	**59.35718**

Source: UN Comtrade, 2016

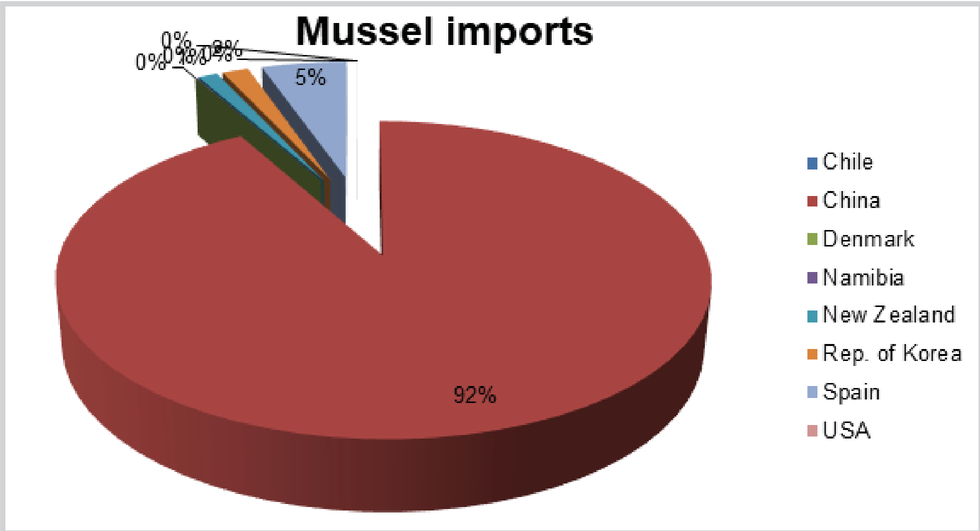


Figure 56: South Africa's mussel imports during 2016

7.9.5 Ornamental Fish

In 2016 South Africa imported approximately 217 tons (estimated value R 1.5 million) of ornamental fish which represents an increase of 178 tons from 2015. There has been 462.87% increase when compared to 2015. Indonesia contributed 19%, Israel 12% and Sri Lanka with 12% (Figure 57).

Table 35: South Africa's Ornamental fish imports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Ornamental fish	Indonesia	42.277	0.179226	4.239326
Ornamental fish	Israel	26.535	0.177559	6.691502
Ornamental fish	Sri Lanka	25.404	0.129527	5.098685
Ornamental fish	Thailand	22.609	0.121322	5.366093
Ornamental fish	Singapore	22.476	0.447517	19.91088
Ornamental fish	Viet Nam	20.587	0.163507	7.942245
Ornamental fish	Malaysia	11.454	0.085021	7.422822
Ornamental fish	Kenya	10.698	0.035217	3.291924
Ornamental fish	Japan	8.429	0.018451	2.18899
Ornamental fish	Other Asia, nes	8.182	0.073493	8.982278
Ornamental fish	Philippines	7.808	0.03484	4.46209
Ornamental fish	USA	2.626	0.040755	15.5198
Ornamental fish	United Kingdom	2.124	0.013093	6.164313
Ornamental fish	Nigeria	1.876	0.018163	9.68177
Ornamental fish	Colombia	1.816	0.014924	8.218062
Ornamental fish	China	0.75	0.008141	10.85467
Ornamental fish	India	0.385	0.003031	7.872727
Ornamental fish	Mauritius	0.368	0.001501	4.078804
Ornamental fish	China, Hong Kong SAR	0.358	0.000618	1.726257
Ornamental fish	Germany	0.272	0.001142	4.198529
Ornamental fish	Saudi Arabia	0.217	0.005519	25.43318
Ornamental fish	Zambia	0.161	0.000613	3.807453
Ornamental fish	United Arab Emirates	0.147	0.002517	17.12245
Ornamental fish	Burundi	0.11	0.003609	32.80909
Ornamental fish	United Rep. of Tanzania	0.106	0.003081	29.06604
Ornamental fish	Madagascar	0.1	0.000204	2.04
Ornamental fish	Malawi	0.08	0.000717	8.9625
Ornamental fish	Australia	0.012	0.000117	9.75
Total		**217.967**	**1.583425**	**272.9025**

Source: UN Comtrade, 2016

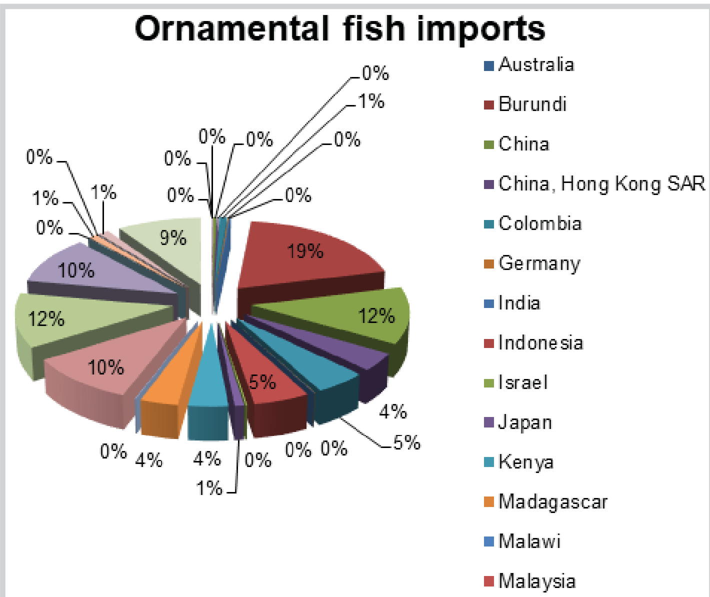


Figure 57: South Africa's ornamental imports during 2016

7.9.6 Pacific salmon

South Africa imported 1262.54 tons of Pacific salmon valued at approximately R121 million (Table 36). The imports decreased with 294.158 tons (19%) in 2016 when compared to 2015. The leading exporter was Norway with 70%, followed by Netherlands with 23% and Nigeria with 6% (Figure 58).

Table 36: South Africa's Pacific salmon imports during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Pacific salmon	Norway	876.3484	93.10265	106.2393
Pacific salmon	Netherlands	290.8844	25.98553	89.33284
Pacific salmon	Nigeria	78.434	0.147253	1.877413
Pacific salmon	Germany	11.96529	1.214702	101.5188
Pacific salmon	United Kingdom	2.14411	0.636863	297.0291
Pacific salmon	Denmark	1.7328	0.152864	88.21791
Pacific salmon	Namibia	0.45738	0.037577	82.15707
Pacific salmon	Thailand	0.42	0.001495	3.559524
Pacific salmon	Philippines	0.09	0.000165	1.833333
Pacific salmon	Sweden	0.0381	0.009875	259.1864
Pacific salmon	France	0.02147	0.005793	269.8184
Pacific salmon	Japan	0.00127	0.000185	145.6693
Total		**1262.537**	**121.2949**	**1446.439**

Source: South African Revenue service, 2016

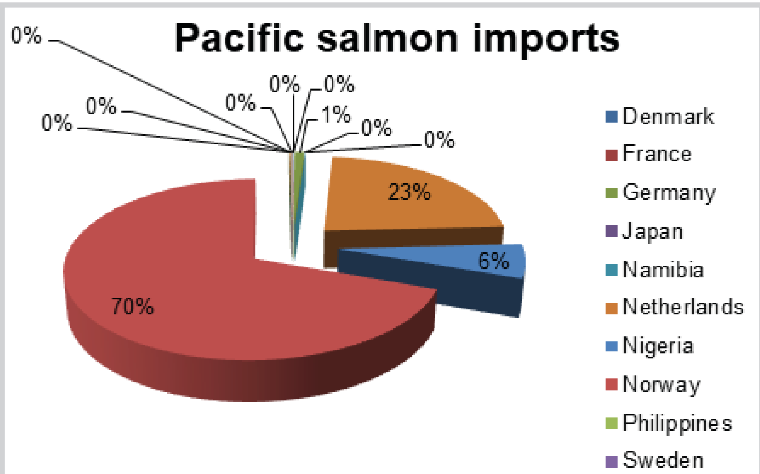


Figure 58: Pacific Salmon quantity imported during 2016

7.9.7 Tilapia

South Africa imported 4550.17 tons of tilapia valued at more than R55 million (Table 37). Tilapia imports increased by 49% compared to the quantity imported in 2015.

China exported about 4314 tons which exceeded the overall quantity exported in 2015. China's exports accounts for 95%, India with 3% while the rest of the countries account for only 2% (Figure 59).

Table 37: South Africa's tilapia imported during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Tilapia	China	4314.113	51.29739	11.8906
Tilapia	India	152.75	2.042684	13.37273
Tilapia	Zimbabwe	38.229	1.323566	34.62204
Tilapia	Singapore	25.13	0.30037	11.95265
Tilapia	Indonesia	12.3	0.451104	36.67512
Tilapia	Myanmar	4.1	0.025324	6.176585
Tilapia	Thailand	3.468	0.031656	9.128028
Tilapia	Italy	0.048	0.002138	44.54167
Tilapia	Namibia	0.028	0.000425	15.17857
Total		4550.166	55.47465	183.538

Source: South African Revenue service, 2016

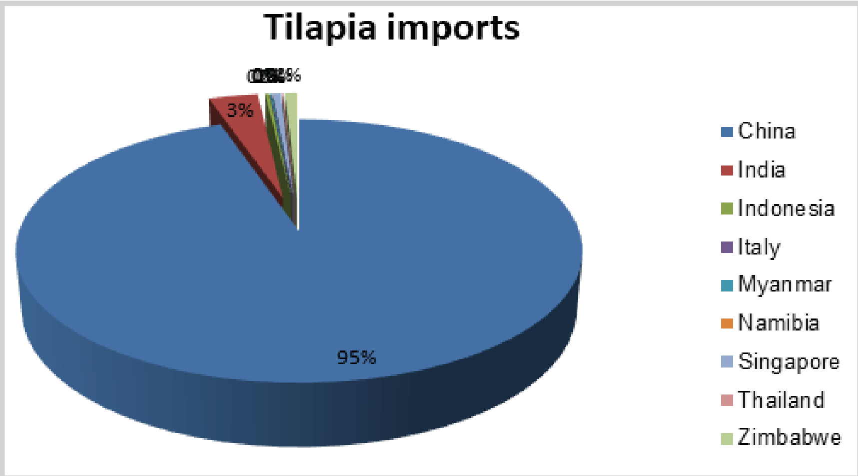


Figure 59: Tilapia quantity imported during 2016

7.9.8 Trout

During 2016, South Africa imported about 766 tons with an estimated value of R47 million (Table 38). The leading exporting countries were Norway with 62%, Lesotho with 38% and the rest of the countries contributed less than 1% (Figure 60). In comparison with 2015, the total quantity imported increased with approximately 10 tons which constituted a 1.3% increase.

Table 38: Trout imports in South Africa during 2016

Species	Country	Quantity (tons)	Value (ZAR-million FOB)
Trout	Norway	471.481	34.42084
Trout	Lesotho	292.3472	12.07671
Trout	Netherlands	1.5044	0.288431
Trout	United Kingdom	1.04438	0.138143
Trout	Australia	0.098	0.131831
Trout	Denmark	0.078	0.188269
Trout	Canada	0.023	0.067606
Total		766.576	47.31182

Source: South African Revenue service, 2016

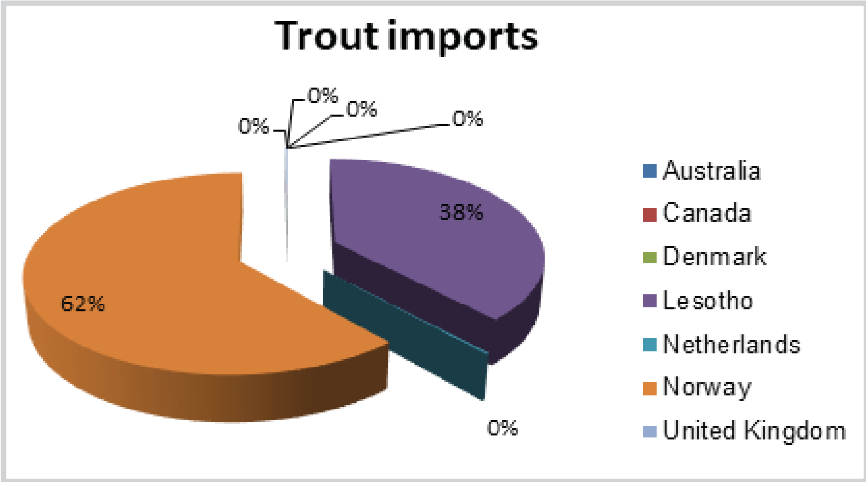


Figure 60: Trout quantity imported during 2016

7.9.9 Oysters

During 2016, 80.833 tons of oysters were imported, estimated at approximately R0.4 million (Table 39). Oyster imports came from three countries i.e. China, Namibia and Areas, with each contributing 73%, 24% and 3% respectively (Figure 61).

Table 39: Oyster imports in South Africa during 2016

Species	Country	Quantity (tons)	Value (ZAR million-FOB)	Price (Rands)
Oyster	China	58.92	0.389999	6.619128
Oyster	Namibia	19.715	0.053484	2.712858
Oyster	Areas,nes	2.198	0.006112	2.78071
Total		**80.833**	**0.449595**	**12.1127**

Source: UN Comtrade, 2016

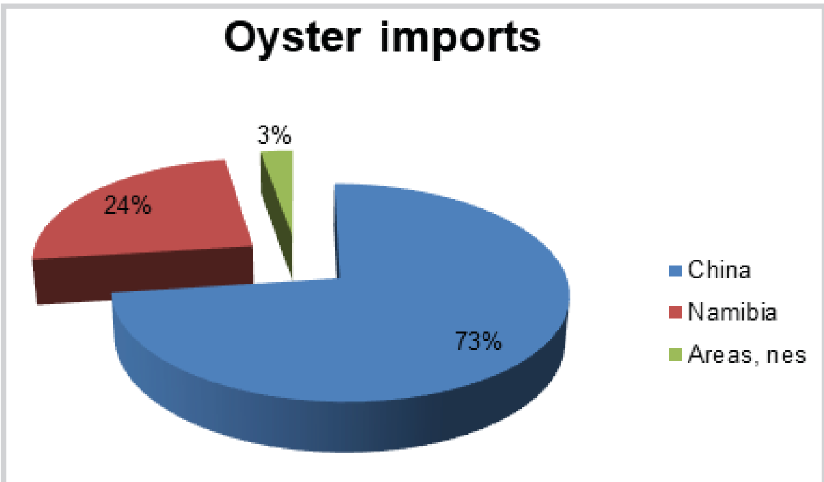


Figure 61: Oyster quantity imported during 2016

Table 40: List of supplying markets for products imported by South Africa (Share% values).

Exporters	2011	2012	2013	2014	2015	2016
Namibia	37.8%	43.9%	40.8%	36.3%	30.4%	0.5%
Norway	5.9%	7.1%	9.3%	11.3%	12.%	26.6%
India	15.4%	14%	18.5%	18.1%	12%	1.7%
Morocco	0%	0.25%	2.2%	2.4%	8.2%	0%
China	5.7%	5.35%	4.7%	4.4%	7.9%	58.1%
Spain	1.5%	2.5%	1.1%	2.9%	5%	0.4%
Argentina	3.4%	2.9%	2.6%	2.4%	3.75%	0%
New Zealand	5.2%	5.3%	2.6%	4.1%	3.45%	0.1%
Uruguay	0.8%	0.5%	0.1%	0.9%	2.4%	0%
Mozambique	2.2%	2.4%	3.6%	2.3%	2%	0%

7.10 Trade Balance

South Africa experienced a trade deficit of 6702.33 tons in terms of the quantity, but in terms of value the country maintained a trade surplus of R219.59 million. Table 41 and figure 62 below shows the total export volumes for aquaculture products, which were estimated at 2263.13 tons and valued at R38.63 million. Abalone was the main exported product contributing 54% to the total aquaculture export quantity followed by tilapia with a contribution of 23% and mussels with 7.2%.

The total quantity imported was 6963.13 tons valued at R251.93 million. The main imported product during 2016 included tilapia with 4550.17 tons, Pacific salmon with 1262.54 tons and Atlantic salmon with 1167.99 tons. Approximately 90% of tilapia imported in 2016 came from the Democratic Republic of Congo (DRC).

Table 41: South Africa's aquaculture exports vs imports in 2016

Trade quantity (tons)	Abalone	Trout	Mussels	Oysters	Tilapia	Ornamentals	Catfish	Carp	Atlantic salmon	Pacific salmon	Total
Exports	379.385	37.32858	261.759	12.203	1307.412	26.688	152.8702	0.2019	22.28705	62.99481	2263.12654
Imports	0	766.576	724.296	80.833	4550.166	217.967	170.982	24.09989	1167.997	1262.537	8965.45389
Trade balance	379.385	-729.24742	-462.537	-68.63	-3242.754	-191.276	-18.1118	-23.89799	-1145.70995	-1199.54219	-6702.32735

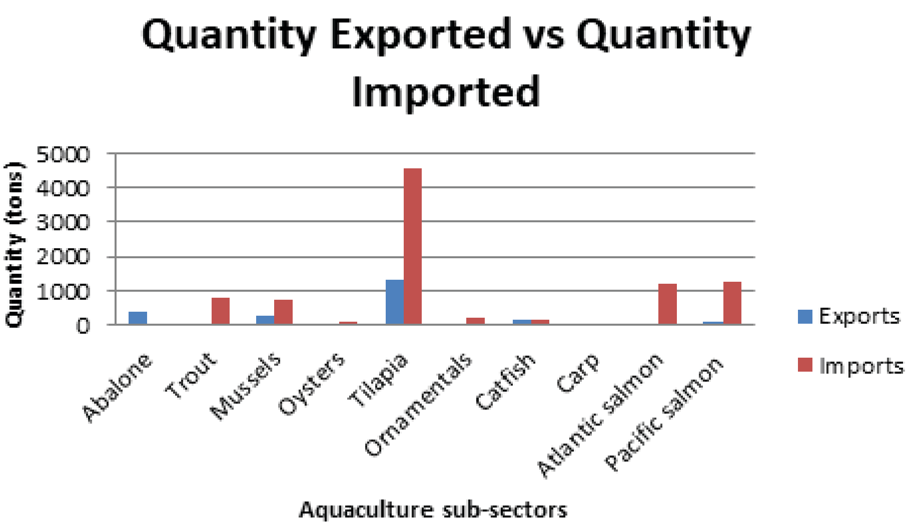


Figure 62: South Africa's quantity exported vs quantity imported in 2016

Due to lowest quantity exported, carp recorded the lowest export value contributing less than one million. Abalone and trout recorded the highest export value of R463.2million and R5.7 million respectively. In terms of import value, Atlantic salmon was the highest contributing approximately 35,5% to the aquaculture products import value, followed by Pacific salmon and trout with 30% and 16% respectively (table 42 and figure 63).

Table 42: South Africa's value of exports vs imports during the year 2016

Trade value (ZAR-million)	Abalone	Trout	Mussels	Oysters	Tilapia	Ornamentals	Catfish	Carp	Atlantic salmon	Pacific salmon	Total
Exports	16.9135	0.23857	0.445828	0.052232	12.6467	0.15803	2.29585	0.007377	1.991788	3.882984	38.632862
Imports	0	0.52089	2.893892	0.449595	55.4747	1.58343	1.642705	0.298006	101.5792	121.2949	285.73726
Trade balance	16.9135	-0.28232	-2.448064	-0.39736	-42.8279	-1.4254	0.653145	-0.29063	-99.58741	-117.4119	-247.1044

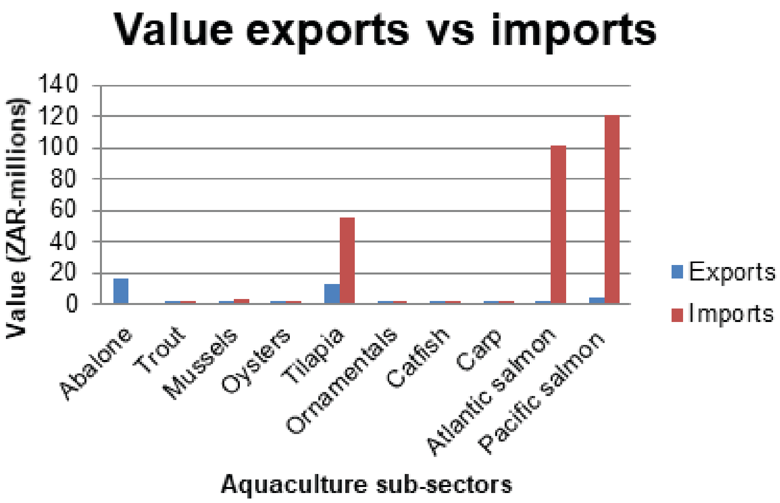


Figure 63: South Africa's exports value vs imports value in 2016

08

AQUACULTURE ENVIRONMENTAL INTEGRITY

8.1 Aquaculture Environmental Assessment's

Aquaculture operations trigger a number of listed activities under the National Environmental Management Act, 1998 (Act No. 107 of 1998): Environmental Impact assessment (EIA) Regulations of 2014. Depending on the listed activities triggered, this may require a Basic Assessment or a full Scoping and Environmental Impact Assessment. Other relevant legislation which should be considered by a new aquaculture venture are the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004), National Environmental: Integrated Coastal Management Act, 2014 (Act No. 36 of 2014), National Water Act, 1998 (Act No. 36 of 1998) and the Marine Living Resources Act, 1998 (Act No. 18 of 1998) to name but a few. On the 29th July 2016, the Alien and Invasive Species (AIS) Regulations and associated lists were gazetted under the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).

The AIS Regulations prescribe requirements for the farming of freshwater and marine alien species to be used for aquaculture purposes, however the listing of brown trout (Salmo trutta) and rainbow trout (Oncorhynchus mykiss) was omitted from the lists because of the process that was underway to map the existence of the species in South Africa.

Draft legislation developed in 2016, which may become applicable to the aquaculture industry in the future include the following:

- Aquaculture Bill – DAFF mandate
- Inland fisheries Policy – DAFF mandate
- Marine Spatial Planning Bill – DEA mandate
- 22 Proposed Marine Protected Areas regulations – DEA mandate
- Coastal Waters Discharge Permit – DEA mandate

The D: SAM, Sub-Directorate: Aquaculture Animal Health and Environmental Interactions (AAH&EI) renders technical advice regarding EIA's. It reviews and comments on EIA's for aquaculture operations and any developments that may have an adverse impact on existing aquaculture farms. Together with the provincial Department of Environmental Affairs and Development and Planning (DEA&DP) and the national Department of Environmental Affairs (DEA), the Sub-Directorate have been working alongside industry to set standards for the abalone and trout aquaculture sectors since 2011. The project is a national initiative to develop standards as a proactive environmental management tool to achieve efficiency and effectiveness in environmental impact management by reducing the time and cost of following an EIA process, whilst ensuring that the environmental management is adequately addressed.

Chapter 5 of the National Environmental Management Act, 1998 (Act No.107 of 1998) provides for the development or adoption of norms or standards for listed activities, or more specifically, that adherence to a norm or standard will negate the need to apply for an environmental authorisation (and by implication also negating the need for an EIA) as long as the proposed development falls within the scope of the standard. The draft abalone standards have undergone a number of edits and refinements to the scope and should be gazetted for public comment in 2017, however the trout standards require further refinement.

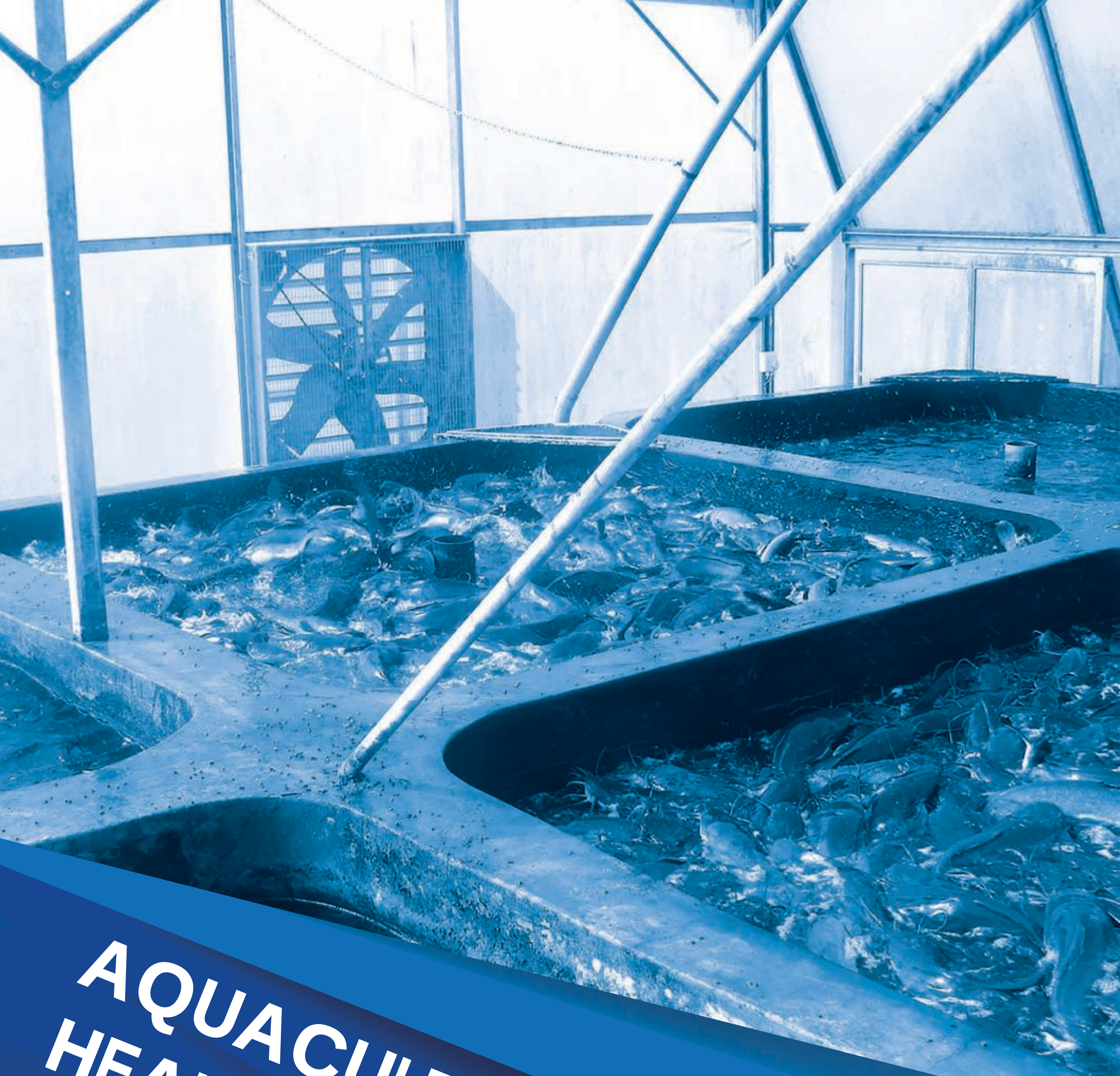
8.2. DAFF initiated Aquaculture Environmental Projects Update

The Department aims to create an enabling environment to facilitate the development and growth of the South African aquaculture sector through the establishment of Aquaculture Development Zones (ADZs). The locations of ADZs are 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 identified areas are subject to undergoing Environmental Impact Assessment (EIA) processes and receiving Environmental Authorisation prior to being declared as ADZs.

8.3. Strategic Environmental Assessment for Marine and Freshwater Aquaculture

One of the major challenges impacting negatively on the economic growth of the aquaculture sector is the lack of an enabling legislative environment. For this reason, the DAFF embarked on a process of undertaking Environmental Impact Assessments (EIA's) for various Aquaculture Development Zones around the country to create an enabling environment for new facilities. However, there are numerous challenges associated with this process which include the high cost of undertaking individual EIA's, the expiry of Environmental Authorisations (EA) after a specified period, the need to assess alternative locations within an EIA and the fact that most investors show serious interest to invest only once the EA is granted.

The then DEA and the then DAFF embarked on addressing the concerns of the aquaculture industry by undertaking Strategic Environmental Assessments (SEA) of the sector with the aim to streamline, fast track and reduce the number of EAs are required for these projects within the areas that are identified. The Council of Scientific & Industrial Research (CSIR) was appointed in 2015 to undertake the SEA with the aim to identify Aquaculture Development Zones (ADZ's) for offshore, inshore, land-based and inland water based aquaculture national, for the prioritising and incentivising of aquaculture. It is intended that through a pre-assessment of the environmental sensitivities within these ADZ's, certain aquaculture activities could be excluded from requiring EAs based on the implementation of aquaculture standards. In addition, within the ADZ's, the management and legislative framework will also be streamlined and integrated to reduce complexity and to incentivise environmentally sustainable aquaculture. The SEA is to be developed through an extensive consultative process which includes all relevant government departments, which will form part of the Project Steering Committee, as well as external stakeholders and people with expertise in aquaculture operation, and will be part of the Expert Reference Group. The SEA will be undertaken through the extensive use of spatial tools, positive and negative mapping of environmental attributes, sensitivity mapping and detailed assessment of potential impacts including cumulative impacts and risk assessments. Updating of the Biological Risk and Benefit Assessment for the seven species used for aquaculture has been included in CSIR scope of work, these species are rainbow trout, brown trout, African sharptooth catfish, Nile tilapia, Pacific oyster, Mediterranean mussel and marron.



09 AQUACULTURE ANIMAL HEALTH PROGRAMMES

9.1. Aquaculture and Animal Health

Globally aquaculture has contributed significantly towards food security, sustainable livelihoods and job creation. Aquaculture is currently the fastest growing food producing sector globally. However, with the fast growth of this sector there are associated challenges. Aquaculture as a global practice of farming aquatic organisms, including fish molluscs, crustaceans and amphibians, is prone to risk associated with the movement of live animals and products among traders and could result in the spread of diseases.

Health management is a critical issue in the aquaculture industry, as intensive culture of animals and plants (both on land and in the water) can increase the likelihood of disease. A disease outbreak can devastate farmed populations and severely impact the short-term profitability and even long term viability of aquaculture businesses. The department's Aquatic Animal Health programs aim to monitor disease occurrence, mitigate the economic and social effects of disease, facilitate the marketing of aquaculture and aquaculture products, and promote the welfare of farmed animals.

The **"Health management procedures for South African bivalves (oysters and mussels) produced for export"** and **"Health management procedures for South African abalone produced for export protocols** were developed in May 2016 as a collaborative effort between the marine aquaculture industry and the DAFF. These procedures were developed to maintain national biosecurity conditions with regards to the production and marketing of marine shellfish with the objective to facilitate access to international markets through meeting the international aquatic animal standards as stipulated by the OIE and countries of import.

9.2. Disease events and reporting in 2016

Two cases of Epizootic Ulcerative Syndrome (EUS) were reported to the Department in 2016 from the Northern Cape and the Western Cape respectively. Three cases of Koi Herpes virus (KHV) were reported to the Department in 2016 all from Gauteng Province. No further OIE listed diseases for aquatic animals or any other significant diseases of aquatic animals were reported.

9.3. Animal Health Training Courses / workshops presented

9.3.1. First Global Conference in Aquatic Animal Epidemiology (AquaEpi1) hosted by the International Society for Aquatic Animal Epidemiology (ISAAE) held from 20-22 September 2016 in Oslo, Norway

The global conference in aquatic animal epidemiology which was organised under the auspices of the International Society for Aquatic Animal Epidemiology (ISAAE) was the first of its kind, providing a platform for discussion about how to meet the research needs of the aquaculture industry, improve epidemiological surveillance and facilitate interaction with stakeholders, industry and regulatory agencies. The conference was supported by the Food and Agriculture Organisation of the United Nations (FAO) and the World Organisation for Animal Health (OIE) Collaborating Centre of Epidemiology and Risk Assessment for Aquatic Animal Disease. Two delegates from the department attended this conference and presented a paper entitled "A proposed surveillance approach for epizootic ulcerative syndrome (EUS) in South Africa.

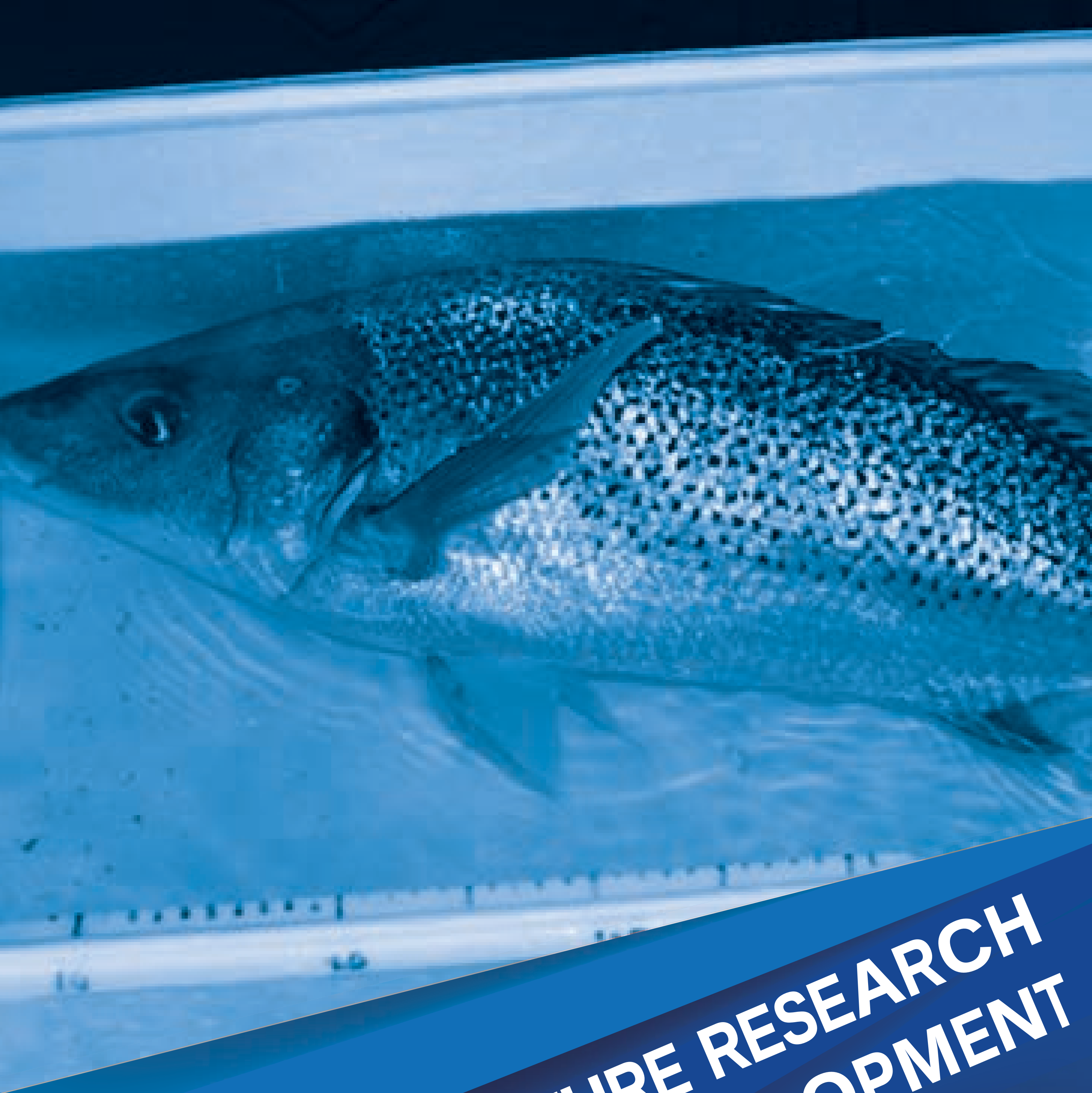
9.3.2. Aquatic animal health workshop on Strengthening Controls of Food Safety, Plant and Animal Pests and Diseases for Agricultural Productivity and Trade in Southern Africa held from 24 October- 3 November 2016 in Durban, South Africa

The workshop was divided into three general thematic sessions namely, (i.) Socio-economic assessment of aquatic diseases, (ii.) National Aquatic Animal Health Strategy (iii.) Introductory Training Course on Risk Analysis for Aquatic Animal Movement. Outcomes of the workshop included:

- Methodology for systematically assessing the socio-economic impacts of aquatic animal diseases. The methodology developed will then be pilot-tested in two countries under the auspices of the FAO project GCP /SFS/001/MUL
- Developing a national aquatic animal health strategy to support project participating countries in strengthening their capacities in the development of a national aquatic animal health strategy.
- Practical introductory training on risk analysis for aquatic animal movement and to develop and present a risk analysis framework for Southern Africa for reducing the risk of entry and establishment of these diseases in national territory and the SADC region

9.3.3. Aquaculture fish health engagements between South Africa and Polệ Aquimer from 26-28 September 2016 in Bourlogne Sur Mer, France

The purpose of the engagement was a follow up on the outcomes of the Deputy Minister's bilateral engagement with France (April 2016). This included a proposed collaboration between the DAFF (Operation Phakisa: Aquaculture) and the French Department of Agriculture, Agrifood and Forestry in the areas of training and capacity building in fish health, food safety and hatchery technology; fish health management and control and research collaboration in fish health, production systems and food safety.



10

AQUACULTURE RESEARCH AND DEVELOPMENT

The South African government is currently undertaking various aquaculture research projects which are intended to enhance the culture of the species and their economic viability. This species includes both freshwater and marine such as dusky kob, tilapia, spotted grunter and white stumpnose.

10.1. Determination of lethal concentration of an un-ionized ammonia on juvenile Dusky Kob (Arygyrosomus japonicas) and the effect of nonlethal concentrations on growth performance

Figure 64: Image illustrating the Dusky Kob species.

The DAFF through its National Aquaculture Strategic Framework and in response to the National Development Plan (NDP) objectives recognizes aquaculture as a part of the solutions to national food security, poverty alleviation and job creation challenges (Government gazette, 2013). Several aquaculture projects were then placed under Operation Phakisa, a government initiative to fast track implementation of NDP solutions through its ocean economy lab, which is aimed at doubling the aquaculture sector's revenue to almost R1.4 billion in 2019.

South African government's priority projects in the aquaculture sector include the farming of dusky kob, Arygyrosomus japonicus. Dusky kob is a sciaenid species which occurs in both southern and northern hemispheres. It has preference for estuaries therefore making it vulnerable to human actions and stocks are reported to be declining. Dusky kob has high-quality flesh and good market demand. Hence the local interest in culturing the dusky kob in South Africa that becomes a potential for more job creation into the sector.

Commercialization of this candidate species in high capital demanding recirculating aquaculture systems (RAS) has come with culture challenges. Factors that contribute to the success of a commercial aquaculture operation include providing the optimum environment to optimize fish growth and health for the cultured species. Well-designed RAS provide an optimized environment for intensive high production density capacities by effectively controlling critical water quality parameters such as ammonia, temperature, suspended solids, pH, dissolved oxygen, nitrite, carbon dioxide and alkalinity. Therefore, research into culture requirements for dusky kob in RAS is a key factor in identifying conditions under which commercial production could be optimized. This study will determine the LC 50 for juvenile dusky kob, as well as the effects of toxic levels of ammonia on the growth of juvenile dusky kob at a pH of 7.8.

Research outcomes

Results indicated that the unionized ammonia exposed LC50 concentration value for dusky kob juveniles is 0.56 mg L^{-1}, correspondent to 11 - 14 mg L^{-1} TAN at pH 7.8. It has also been determined that dusky kob fingerlings are tolerant to high total ammonia concentrations (TAN <10) at pH 7.8. The growth rate of juvenile dusky kob is not significantly influenced by unionised ammonia (UIA) levels below 0.17 mg L^{-1} or 4mg L^{-1} TAN. There is limited literature on similar marine congenerics to which the results could be compared to. However, El-Sherif et al., (2008) tested TAN concentrations ranging from 2.3, 5.17, 7.1, 8.5 and 11.0 mg L^{-1} in the aquaria of and the LC50 of unionized ammonia (48 h) of Nile tilapia (O. niloticus) fingerlings were found to be at 7.1 mg L^{-1} TAN. Their results were in full agreement with Aysel and Gulten (2005). The results of this study demonstrate that dusky kob can tolerate about twice the TAN concentration in water and is therefore a hardy species as compared to the fresh water species studied. The studies in literature were utilized as guidelines to determine unionized ammonia concentrations. Unionized ammonia tolerance concentrations are determined by the LC50 method which implies that 50% of animals will be killed at a specific concentration of UIA in the water. Verifying the LC50 for dusky kob is therefore imperative, as well as to determine the LC70 and LC90 as indicated for also in other academic studies.

There were few random mortalities (< 3 per treatment) related to fish escaping the experimental tanks throughout the experimental period. At the end of the experimental period (after 45 days from the stocking) the final average body weight observations of dusky kob showed no difference between the control and higher unionized ammonia concentrations. The study confirmed the importance of a frequent change in treatment solutions to maximise the exposure time to animals on test; the unionized ammonia concentrations were observed to drop in a relative short time window.

Further investigation is required to test sub lethal UIA levels on the growth performance of dusky kob under different pH conditions.

10.2. Development of sperm cryopreservation methods for Dusky Kob (Argyrosomus japonicas)

Figure 65: Image illustrating Dusky kob species.

Dusky kob is relative hardy and can be kept and grown at high production densities. It is also highly fecund - about 1million fertilized eggs yield per 10kg female. The DAFF also earmarked this finfish species as the first finfish candidate for commercial cultivation, and therefore the first choice in developing aquaculture technology by means of research. Cryopreservation is a valuable technique to assist in the genetic improvement of cultured stocks as well as providing a continuous supply of good quality sperm for artificial insemination. This method is of interest not only for fish farming but also for the conservation and genetic improvement of resources. This technique has been successfully established in some freshwater fish species mainly, salmonid, sturgeons and carps, however, only in the last decade research was focused in marine fish species.

The benefits of fish semen cryopreservation include at least six levels of improvements for existing industries. First, it can be used for stock protection from being totally eliminated due to sudden diseases outbreak, natural disaster, or accidents such as oil spills. Second, cryopreservation can be used to improve existing hatchery operations by proving sperm on demand and simplifying the timing of induced spawning. Third, frozen sperm can enhance efficient use of facilities and create new opportunities in the hatchery by eliminating the need to maintain live males, potentially freezing resources for use with females and larvae. Fourth, valuable genetic lineages such as endangered species, research models or improved farmed strains can be protected by storage of frozen sperm. Fifth, cryopreservation opens the door for rapid genetic improvement. Frozen sperm can be used in breeding programs to create improved lines (hybridization included) and shape the genetic resources available for aquaculture. Finally, cryopreserved sperm of aquatic species will at some point become an entirely new industry itself.

Application of cryoprotectants is done (in most cases) simply by incubating the cells in solutions into which these compounds have been dissolved. After this exposure, the cells are cooled to a low sub-zero temperature (specimens are typically held at the temperature of liquid nitrogen; −196°C). At the appropriate time, the specimen is warmed, washed free of the cryoprotectants, and used in whatever manner is deemed appropriate. While this seems like a relatively straightforward procedure, many types of injuries can result from any one of the steps; thus numerous lethal effects need to be avoided. Major cryoinjuries can occur in relation to freezing and thawing process during conventional cryopreservation within the temperature ranges of generalized cryopreservation procedures due to the cold shock during freezing and hot shock when the samples thawed. The cryoinjuries occur during prefreezing and post-thawing, at the temperature range between 0 and -40 C. Other causes of cryoinjuries include pH fluctuation, ice crystal formation, osmotic pressure, and cryoprotectant toxicity

Vitrification as an Alternate to Equilibrium Cryopreservation
The obvious benefit of vitrification is that the damage due to intracellular ice formation can be completely avoided. Unfortunately, other kinds of damage are more likely to occur when using this method.

Recalling the initial discussion of phase transitions in solutions during cooling, it was mentioned that with a sufficiently high solute concentration, ice formation could be avoided altogether. The easiest way to achieve vitrification would be to use a solution that has a high solute concentration. Unfortunately, the toxicity of such solutions is too high to render them practical. Similarly, solutions with concentrations around 60 wt% (Region III) are often too toxic to be useful, although they can also be cooled slowly without crystallization. Various strategies have been described to counter the potential toxicity of solutions, and include: (1) the use of a combination of solutes, each of which is below a concentration that is very toxic, yet in combination will facilitate vitrification; (2) the substitution of polymers in the extracellular medium for the smaller permeating agents; (3) the application of hydrostatic pressure; (4) the use of compounds which counteract the toxicity of other agents (e.g., acetamide with dimethylsulfoxide); and (5) reducing the time for which and/or the temperature at which the biomaterial is exposed to high concentrations of cryoprotectants.

As discussed above, when solution concentrations are reduced, the likelihood of devitrification during warming increases. Hence, the warming rate is an especially important consideration when designing vitrification strategies. Vitrification at moderate solute concentrations can be precarious. Reducing the solute concentrations in combination with higher cooling rates is currently the best strategy. However, modification of the cooling and warming rate is not the only strategy, since specific cryobiological properties of the cells must also be considered if available.

Research in other sciaenid species such as red and yellow drum, is showing promising results for the viability of post – cryopreserved sperm, and the efficiency thereof to fertilize eggs. In the former species the chosen diluent (HBSS – 200 mOsm kg^{-1}) and cryoprotectant (Dimethyl sulfoxide (DMSO): 10%) yielded an average of 50% sperm motility after thawing straws (0.5ml) at 40-50°C for 7 seconds. In the latter species the chosen diluent (C-F Hank's Balanced Salt Solution (HBSS) – 150 mOsm kg^{-1}) and cryoprotectant (EG : 5% or DMSO: 10%) yielded an average of 58.5% sperm motility after thawing straws (0.25ml) at 40°C for 7 seconds.

No sperm cryopreservation research has been done yet on dusky kob sperm c. The current investigation will focus on the following objectives:

1. The selection of diluents and cryoprotectants also based on those used for other sciaenids.
2. Vitrification of sperm using liquid nitrogen vapour.
3. Testing thawing of sperm at different temperatures and thawing times.
4. Determining sperm motility percentage as compared to fresh sperm activity.

Research outcomes

In terms of sperm cryopreservation, diluents and especially cryoprotectants have been very well studied because cryopreservation is difficult without them. In this study, two diluents (ASP, M-HBSS) and two cryoprotectants (DMSO and EG) were tested for the cryopreservation of dusky kob milt. Sperm activity (~70%) was highest when using ASP in combination with EG, which was distinctively higher than respectively tested for sciaenids such as the red and yellow drum (50-58.5%). It is hypothesized that the combined use of M-HBSS and EG may even performed better, since the combination of M-HBSS and DMSO yielded higher average sperm activity than for the ASP +DMSO trials. Furthermore, the use of calcium free HBSS and 5% EG were also best performing in post thaw sperm activity for the yellow drum. Using HBSS and DMSO (10%) in red rum also performed poorer at 50% motility level which was similar as determined for the current investigation. To our knowledge this is the first time that dusky kob sperm cryopreservation was investigated and the success of results is indicative that fertilization of eggs with cryopreserved post thawed dusky kob sperm should be successful.

10.3. Effect of dietary sea lettuce (Ulva sp) on growth performance, blood parameters and gut histology in juvenile dusky Kob (Argyrosomus japonicus)

The high cost of good quality dietary protein is a major constraint to profitable marine finfish aquaculture in the coastal regions of South Africa. The current study was designed to assess the effect of graded levels of green macroalgae seaweed, Ulva sp, on growth, blood parameters and gut histology when incorporated into diets of juvenile dusky kob, Argyrosomus japonicas. Five fishmeal-based, isonitrogenous (45% Crude Protein (CD)) experimental diets were formulated to contain 0, 50, 100, 150 and 200 g/kg seaweed on dry matter basis. Seventy-seven dusky kob fingerlings (per tank) (mean body mass 9.14 ± 0. 0.30 g) were distributed into twenty recirculating, 465 L black high density polyethylene tanks (67 cm deep (water) and 94 cm diameter), which were divided into four replicates per treatment. Fish were fed at a rate of 2.8% of average body mass and weighed weekly for nine weeks. Fish fed 5g/kg seaweed diet gained significant body mass as compared to the other three groups fed Ulva supplemented diets. The 200 g/kg Ulva diet fed group grew significantly slower compared to the rest of the groups, with some fish evidently losing weight. Few dead fish were collected from the group as a result. Increasing the levels of dietary seaweed reduced the specific growth rate of fish, with the control diet promoting the highest (2 g/day) Specific Growth Rate (SGR). Statistically, effect of the dietary treatments on growth performance was significantly different from the second week of feeding until the termination of the trial ($P< 0.05$).

The majority of hematological parameters were within normal range with the effect of seaweed inclusion evident on parameters such as cholesterol. Gut histology preparation revealed normal gut structure for all the diet treatments. Zero intestinal cellulase activity was recorded. In conclusion, Ulva supplementation beyond 50 g/kg is not recommended in dusky kob diets as this leads to reduced growth performance.

10.4. A preliminary investigation into the potential effect of Artemisia afra on growth and disease resistance in sub-adults of Oreochromis mossambicus

Figure 66: Image illustrating the Mozambique Tilapia, Oreochromis mossambicus.

In South Africa, the Mozambique tilapia, Oreochromis mossambicus (Peters 1852) (figure 66) is the most widely cultured tilapia species. The successful culture of O. mossambicus is attributed to several characteristics such as fast growth rates, tolerance of adverse environmental conditions and its ability to feed on a variety of food items. In spite of these qualities, fish mortalities caused by bacterial infections have been reported in tilapia farming, especially in intensive systems. The efficient eradication of infectious diseases in high density production systems remains a challenge. Poor growth performance and outbreaks of diseases result in the loss of substantial revenue in aquaculture enterprises, thus hindering the growth of the industry. Therefore, the improvement of growth performance and health has become critical aspects of fish farming.

Broad-spectrum antimicrobials remain the most effective method of controlling fish diseases. However, reports of several bacteria being resistant to treatment have emerged in aquaculture. The use of antibiotics in aquaculture is also being questioned as several studies have shown that they may negatively affect both fish consumers and the environment. Consequently, the European Union has regulated the use of chemical agents to treat or control disease in cultured fish. However, in South Africa, as in other developing countries, antimicrobials are still widely used in aquaculture. Thus, there is a need to look for alternatives in controlling the outbreak of diseases in aquaculture. Several studies have shown that medicinal plants can be used to enhance growth performance and act as prophylactics.

Artemisia afra Jacq. ex Willd. is among the many herbal plants that have been successfully used by many people to treat and control several ailments in South Africa and its neighboring states. Artemisia afra (Wormwood) belongs to the Asteraceae family. Despite its success in treating various diseases (e.g., colds, influenza, asthma, allergies, rheumatic pains) in humans, no investigation has been conducted to determine its potential to enhance growth and health in fish. Attempts to produce A. afra extract on an industrial scale are underway in South Africa. Some fish farmers in southern Africa are feeding A. afra to O. mossambicus in order to boost its growth and health. However, this is done without any information on appropriate dosages. It was thus deemed necessary to investigate the effect of different dosages of A. afra on growth and disease resistance in O. mossambicus.

Research outcomes

In the present study, no significant difference on growth parameters was detected between dietary treatments. The lack of a negative effect on feed utilization was evident in the feed intake which was not significantly affected between the treatments. The results from the current findings suggest that dosage plays a crucial role in growth performance. It would thus seem that the dosages used in the present study were not excessive to have a negative effect on growth. Many medicinal plants contain saponins and tannins and higher concentrations of these compounds could be harmful to fish and have been associated with poor growth performance and feed utilization. Higher levels of saponins and tannins have a bitter taste which reduces palatability, thus leading to poor feed utilization. Tannins are reported to affect fish growth by reacting with digestive enzymes, thus minimizing the availability of nutrients. On the other hand, saponins are said to damage cell membranes. Furthermore, the literature suggests that the effect of plants on growth and health may be species-specific.

The current study showed an increase in white blood cells (WBC's) in fish fed the extracts of A. afra than those offered low A. afra inclusion levels. An increase in WBC's is important because these cells are key components of the first line of defense against pathogens in fish. The current results are similar to other work which recorded higher amounts of WBC's in O. mossambicus after feeding with diets containing extracts of thyme, rosemary and fenugreek. The increase in WBC's recorded in this study was confirmed by the activities of phagocytes (quantified using the NBT technique), which were higher in fish fed the highest concentrations (D4 and D5) of A. afra than those fed lower (D1-D3) concentrations of A. afra. This may suggest that A. afra can improve the defence system in O. mossambicus to resist bacterial infections.

Increased non-specific immune response was also evident in the increased lysozyme activities in fish fed higher A. afra concentrations in their diets. Fish fed D4 and D5 had significantly higher lysozyme activity than those fed the control, D2 and D3. This is an indication of the ability of A. afra to increase the activities of lysozyme in O. mossambicus. The enhancement of the defence system was also shown in the challenge trial with A. hydrophila which showed an improvement in disease resistance in those fish fed diets with high A. afra inclusion levels. The findings indicated a reduction in disease resistance (lower survival rate) in fish fed the control, D2 and D3 than those fed D4 and D5. The increase in survival rate in fish fed D4 and D5, especially in those fish injected with the highest concentration of A. afra, is evidence of the increases observed in NBT and lysozyme in fish fed D4 and D5.

The present study showed that the inclusion of up to 4 % A. afra in the diets of O. mossambicus did not affect growth performance, but had a positive influence on disease resistance.

10.5. Advanced broodstock conditioning, followed by multiple spawning inductions over four weeks in the spotted grunter (Pomadasys commersonni) (family: Haemulidae)

Figure 67: Image illustrating the Spotted grunter species.

The Haemulidae are a family of demersal marine fish that is considered to be a candidate for commercial production in South Africa. Haemulids comprise 17 genera and as many as 150 species. Haemulids are distributed throughout the Atlantic, Indian, and Pacific Oceans and are mostly marine, although some brackish and freshwater species exist. Haemulids are called grunts because they can make a grunting or chattering noise by rubbing their pharyngeal teeth together.

Pomadasys commersonnii have been identified as a suitable candidate for marine aquaculture. Spotted grunter (figure 67) is not only valued as a good recreational fish species but also for human consumption due to its taste and texture. The species is euryhaline and has been found to inhabit ecosystems with a wide range of salinities ranging from 0 to 90‰ and can survive in low salinities for an extended period.

Spotted grunter has a life-span of 15 years with a maximum weight of approximately 10kg. They reach sexual maturity in their third year of life, with a total length (TL) of approximately 280mm for male and 350mm TL for females. In South Africa, spawning occurs during spring and early summer in August and December at the sea. Newly hatched larvae develop at sea and early juveniles of 20 to 30mm TL migrate to nutrient rich estuarine waters during spring and summer for nursery conditions for at least 3 years. Adults spent most of their lives at sea but post-spawning adults return to estuaries for feeding during spring and summer.

Spotted grunter are pelagic benthic feeders depending on their life stage and area in which they are found. Juveniles between 20 and 40 mm feed on zooplankton, particularly copepods, while larger fish between 50 and 100 mm become benthic feeders, feeding on crustaceans, polychaete worms and small bivalves. Larger fish occurring in estuaries feed mainly on mud and sand prawns, Upogebia africana and Callianassa kraussi, respectively

A rearing protocol for P. commersonnii was investigated and the optimal rearing temperature for spotted grunter was found to be between 24 to 25°C within a photoperiod of 12L: 12D.

To date no information exists on the conditioning and spawning of captive grunter broodstock. Spawning induction methods with GnRHa is comprehensively discussed elsewhere. This study will attempt to achieve the following aims:

1. To determine captive reared F1 spotted grunter broodstock maturation age and size.
2. To condition spotted grunter broodstock with photothermal cues that will ensure spawning induction repeatability and with minimalized time frame required.
3. To facilitate endocrine induced spawning of spotted grunter broodstock on a once weekly basis for 4 consecutive weeks.

Research outcomes

F1 spotted grunter raised in captivity reach sexual maturity already at an age of 1.5 years, with reproductively active males at a minimum respective body length and mass of 23cm 180g - and females at 30cm and 210g (smaller than natural counterparts). It should be mentioned that the current broodstock were tested in preliminary trials two months before with significant spawning success (collective egg mass over 200g). Captive broodstock may therefore be even smaller and younger and already sexually mature. However, wild fish only reach sexual maturity in their third year of life whilst the captive-raised fish already reached sexual maturity within less than18 months (1.5 years).

It is not sure how many fish spawned per spawning session or if they same fish were spawning active for each of the consecutive weeks of group spawning. However, since the collective egg output and egg fertilization success declined over the 4 weeks, it is possible that the same females have spawned. Also, previous unpublished research indicated that ovaries of spawners are only depleted of viable gametes as per collective RSI achieved for the 4 week period. Previous spawning induction research also indicated that active female grunter spawners do not shed all their eggs per spawning session. They are therefore multiple batch spawners which may display spawning activity in a periodic group synchronized mode. This may further explain why previous spawning-induction attempts (unpublished data) with slow release hormones did not let older fish (parental generation) spawn within a 7 day window post implant (slow release pellet). However, the parental generation did not spawn at any time afterwards and may have been too old (> 13 years). Therefore, slow release hormone technology should be applied in the F1 generation first to prove if uninterrupted serial spawning can occur.

It is also the first time that F1 grunter were raised exclusively on dry feed, which also nourished breeders to develop viable gametes in successful previous spawning attempts prior to the current investigation. However, the collective egg output of the same spawners in the current investigation was highest and is clearly indicative that the moist pellets were contributing to a higher spawning fecundity output. The average condition factor was also highest when compared with fish fed only the dry feed pellets (unpublished data).

10.6. Development of efficient larval rearing methods for the spotted grunter (Pomadasys commersonni) (Family: Haemulidae)

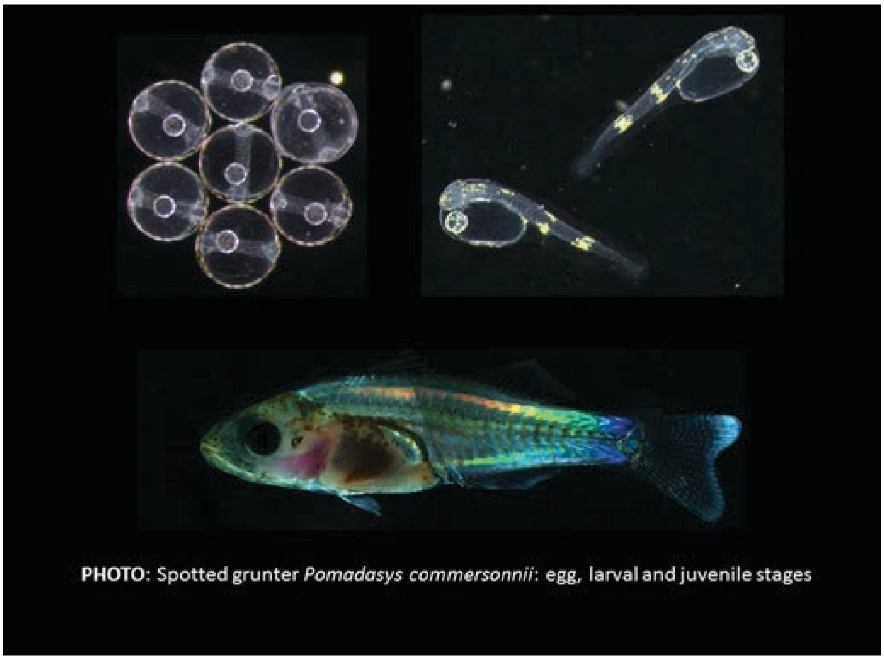


Figure 68: Spotted grunter larval and juvenile stages.

A number of indigenous fish species have been identified as suitable candidates for marine aquaculture which include dusky kob (Argyrosomus japonicus) and yellowtail (Seriola lalandi) and the spotted grunter, Pomadasys commersonnii, as one of the candidates for marine aquaculture due to its biological suitability to be cultured under captivity and high market demand.

Only a few species of Pomadasys have been studied in aquaculture, namely spotted grunter, P. commersonnii and javelin grunter, P. kaakan. Spotted grunter is not only valued as a good recreational fish (i.e. sport fishing species) but also for human consumption due to its taste and texture. In South Africa, spotted grunter spawning occurs during spring and early summer in August and December at sea. Newly hatched larvae develop at sea and early juveniles of 20 to 30mm TL migrate to nutrient rich estuarine waters during spring and summer for nursery conditions for at least 3 years. Adults spent most of their lives at sea but post-spawning adults return to estuaries for feeding during spring and summer.

Spotted grunter is pelagic benthic feeders depending on their life stage and area in which they are found. Juveniles between 20 and 40 mm feed on zooplankton, particularly copepods, while larger fish between 50 and 100 mm become benthic feeders, feeding on crustaceans, polychaete worms and small bivalves. Larger fish occurring in estuaries feed mainly on mud and sand prawns, Upogebia africana and Callianassa kraussi, respectively.

To date no information exists on spawning induction or hatchery rearing of hatchery produced larvae - to fingerling stage in the spotted grunter. This study will attempt to achieve the following aims:

1. To procure eggs from conditioned and spawning induced breeders.
2. To raise larvae for 21 days on live food in “pseudo-greenwater” culture conditions.
3. To successfully wean larvae - and raise them to fingerlings.

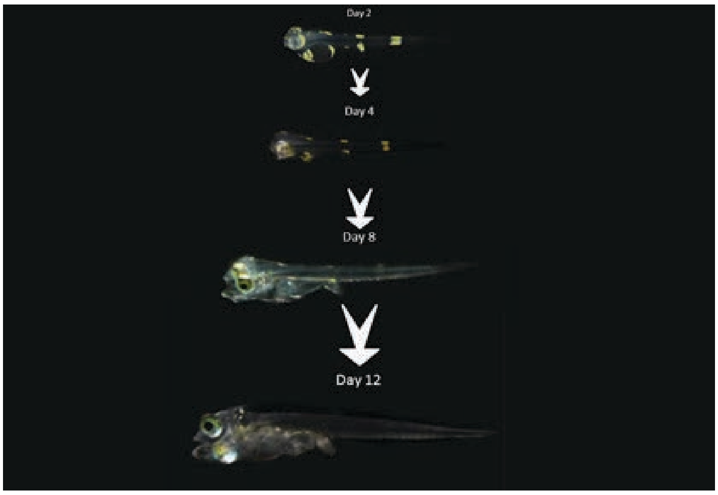


Figure 69: Post-hatching larval development of spotted grunter at 24°C.

Figure 70: Spotted grunter juvenile 45 DPH (Days post hatch).

Research outcomes

Larval spotted grunter commenced with exogenous feeding from 60 hours post hatch. Exogenous feeding was marked by dart like movements directed towards prey (Branchionus plicatilis). Larvae aggregated more in shaded areas of tanks. Most larvae dwelled close to the water surface during active feeding. Larvae were actively swimming most of the time.

Mortalities were acceptably low and consistent until 10 DPH (days post hatch). However, from this day mortalities were conspicuously increasing and fin/gill erosion was detected under the microscope. During this time – less water volume changes were done due to a depletion of the algae in bioreactor. About 15ppm oxytetracycline HCL was administered at 12 DPH. The larvae were recovering rapidly and no further mortalities occurred from day 15 post hatch. Similar tendencies occurred in all 4 fiberglass tanks. Larval survival was reduced to 5% (~1000) as a result of the bacterial invasion.

In tanks only fed with rotifers prior to weaning – the growth of larvae to juveniles was relatively uniform and an average juvenile (0.6g) density of 0.6 individuals L-1 was achieved at 40 DPH. However, feeding Artemia as rotifer supplement or eventual main live food yielded size variances and also observed cannibalism activities, concomitant with infected larvae that escaped from cannibalistic tank mates, but with tissue damage as a result. Infected damaged larvae mostly died eventually. An average juvenile (0.6g) density of only 0.01 individuals L-1 was achieved at 40 DPH. It is suggested that swimming Artemia were recognized as faster moving target than rotifers, and that co-inhabitant larvae were misinterpreted as Artemia by actively hunting larvae. Furthermore, cannibalism was only noted in tanks with added Artemia. Figure 70 indicates larvae with teeth already during the first stages of Artemia feeding.

It is therefore recommended that only rotifers must be used for larval rearing until weaning. Juvenile survival and densities should be significantly increased in further investigations, provided that retention water older than 24 hours in static keeping water tanks should be avoided. Retention longer than 24 hours created an environment for larval infections as experienced in the current investigation. Consistent availability of prolific algae and enriched rotifer is therefore an imperative prerequisite in raising spotted grunter larvae efficiently from yolk sac depletion to 40 DPH.

In conclusion, the larval rearing procedures for spotted grunter were successfully developed in the current investigation though larval survival rates should be improved in further investigations with the following proposed strategies:

1. Complete water replacement (daily) in larval tanks with 0.2micron filtered water for the whole experimental period to 40 DPH. The use of cylindroconical hatchery tanks will reduce sediment and bacterial build up.
2. Comparing larval growth and survival at different salinities (5, 10, 15, 20, 25,30ppt).

10.7. Development of an efficient chemotherapeutic surface disinfection method for White stumpnose (Rhabdosargus globiceps) fertilized eggs

Figure 71: White Stumpnose (Rhabdosargus globiceps).

Egg disinfection is the first step in combatting the transfer of diseases in fish hatcheries, and should be considered a mandatory requirement for all cohorts of eggs, whether produced in-house or sourced from external hatcheries. Disinfecting eggs of pelagic marine eggs significantly improve hatching success and larval survival through the presumed elimination of pathogenic bacteria, fungi and ectoparasites. Under hatchery conditions microbial contamination of fish eggs can become pathogenic because the egg surface is potentially an attractive substratum for microorganisms to settle and once pathogenic, these microorganisms could be transferred from parental stock to offspring. Through surface disinfection of eggs then, egg quality could be improved and the risk of parental contamination could be reduced.

The role that egg disinfection plays in egg quality and hatchery management has received greater attention with an increase in the number of dedicated studies. While several studies have been conducted on European sparids no work has been conducted on Rhabdosargus globiceps to determine an efficient protocol for the surface disinfection of hatchery-reared eggs.

As a first step, we need to determine if these chemicals are safe to use as disinfection agents on the eggs of Rhabdosargus globiceps and whether their oxidative properties are detrimental to egg development. Based on scientific literature and further testing of concentration levels and exposure intervals need to be undertaken. This study will attempt to achieve the following aims:

1. Developing an egg disinfectant procedure for selected chemotherapeutants (potential egg disinfectant agents) that will not affect egg survival and that should facilitate the reduction/ eradication of microbiota on Rhabdosargus globiceps eggs and reduces/prevents the probability of further disease transfer.
2. To determine the effect of selected chemotherapeutants on hatching success.

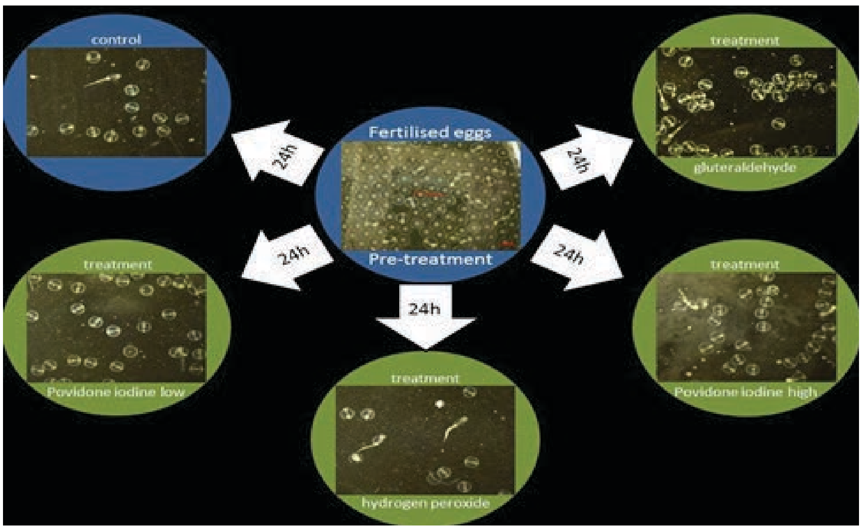
Research outcomes

Table 43 summarizes the egg treatment protocols and subjectively egg hatching rates as measured against control eggs hatching rate.

Table 43: Stumpnose eggs tolerance of disinfectants at 19°

Date	Time	Agent	Concen tration	ppm	ml/l	egg: water volume	Treatment time (min)	Comments
2016/03/17	10:00	Glutaraldehyde (and post treatment neu-tralizer = Gelatin* at 6.5g/L for 5min)	25%	200	0.2	1 to 1000	4	No egg mortalities (100%hatch-ing success)
2016/03/17	11:00	Povidone iodine solution (Dischem)	10%	300	0.3	1 to 1000	22.5	~ 2% mortality
2016/03/17	12:00	Povidone iodine solution (Dischem)	10%	600	0.6	1 to 1000	20	~30% mortality
2016/03/17	12:30	Hydrogen Peroxide	3%	300	0.3	1 to 1000	5	~10% mortality

The 25% gluteraldehyde at 200ppm treatment did not affect the egg survival and hatching rate as compared with the control. However, the other three treatments did affect the hatching rate of eggs with minimal impact (2%) for exposed to povidone iodine solution (300ppm) and 10% egg loss after the 300ppm hydrogen peroxide (3%) treatment. However, the 600ppm treatment with povidone iodine caused the highest egg mortality. These results clearly indicate that treatment concentrations and exposure times of chemotherapeutants should be tested at different levels to optimize treatment success as measured by egg survival and hatching rates. Further studies are also required to determine if egg disinfection was complete in terms of microbiotic eradication efficiency.



AQUACULTURE DEVELOPMENTAL PROJECTS BY THE DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES

11

11.1 Aquaculture Development Zones

The Department aims to create an enabling environment to facilitate the development and growth of the South African aquaculture sector through the establishment of Aquaculture Development Zones (ADZ's) which are areas or sites either on land or sea set aside exclusively for aquaculture use or development. The ADZ's are supported by the key government policies such as Industrial Policy Action Plan (IPAP), NASF, etc. The locations of ADZ's are 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 will have bulk infrastructure (reservoir, water pump, etc.) after the EIA has been conducted and authorisation granted. The ADZ's aims to attract investors

11.1.1 The Qolora Aquaculture Development Zone

In 2012, the Qolora land-based ADZ (figure 73) in the Eastern Cape received a positive Environmental Authorisation (EA) from the Department of Economic Development, Environmental Affairs and Tourism which was extended to the 29th September 2017. The area for the proposed activity covers 26.4 ha with authorisation to farm a variety of marine species such as yellowtail, kob, abalone, seaweed and other marine species. A hatchery, offices and on site centralised processing facility will also be constructed. The Department has completed the management plans which need to be established prior to construction phase. The Department is in a process of acquiring the Coastal Waters Discharge Permit, the Coastal Lease, the Water Use License for construction near or across the wetlands identified during the assessment phase of the EIA and negotiating with the Department of Rural Development and Land Reform around the granting a long term lease agreement between the Community Trust and the Minister of Land Affairs. The Department is in the process of initiating the second phase which includes the securing of funds for the construction phase of basic infrastructure.

Figure 73: Proposed Qolora Aquaculture Development Zone.

11.1.2 Algoa Sea-based Aquaculture Development Zone

The EIA process for the establishment of a Sea-based ADZ (figure 74) in the Eastern Cape was initiated in 2011 and conducted by an independent, qualified Environmental Assessment Practitioner (EAP). Indigenous finfish species, such as yellowtail, silver and dusky kob, white stumpnose, white steenbras and yellowfin tuna are amongst other species that will most likely be farmed in the Algoa Bay ADZ.

Following the appeals process the Minister of the then DEA instructed the then DAFF to undertake comparative studies to further assess the Algoa 5 and Algoa 1 sites. The Ecological Assessment, Feasibility and Socio-Economic Assessment were conducted as part of the comparative studies. The Amendment or Basic Assessment process was planned to be conducted in 2017 to get the authorisation reissued for the ADZ.

Figure 74: Algoa Bay ADZ Sites, (Algoa 1, the preferred site is the red area on the left and Algoa 5, red area on the right).

11.1.3 The Amatikulu Aquaculture Development Zone

The Department is looking to undertake the EIA process for establishment of a land-based ADZ at Amatikulu (Figure 75), Kwa-Zulu Natal. The area for the proposed ADZ is 108.37 ha and is situated next to the Amatikulu estuary. The site is suitable for indigenous and temperate water marine and fresh water species. The EIA will cover the existing ornamental fish facility currently operating as well as new marine and fresh water species such as finfish, prawns etc. Specifications for undertaking this work was advertised in August 2016 and an independent, qualified EAP will be appointed in 2017.

Figure 75: Image of the Amatikulu site.

11.1.4 Saldanha Bay Aquaculture Development Zone

The Department aims to develop and facilitate aquaculture by conducting the EIA process for the Saldanha Bay ADZ. The ADZ will assist the existing farms with expansion as well as enable new entrants to become established in Saldahna Bay. A qualified, independent EAP was appointed in May 2016. Indigenous species such as abalone, South African scallop, white stumpnose, silver kob and yellowtail, and alien species such as pacific oyster, Mediterranean mussel, black mussel, Atlantic salmon, Coho salmon, King/Chinook salmon, rainbow trout and brown trout and the seaweed Gracilaria gracilis, are potential species to be farmed, some of which are currently being farmed with.

The EIA application and the Basic Assessment Report will be submitted to DEA in 2017 for consideration.

11.2 Collaboration between DAFF & the Aquaculture Research Unit, University of Limpopo

The DAFF entered into a partnership with the Aquaculture Research Unit (ARU) of the University of Limpopo in 2012. The partnership opened new research opportunities for both DAFF and ARU scientists, currently conducting research on various projects focusing on freshwater fish species. At the core of the partnership, was the production of catfish (Clarias gariepinus) fingerlings (Figure 76) for demonstration and research centres around the country. Over the past two (2) and a half years, thousands of fingerlings have been produced for these centres. Non-governmental organisations involved in community outreach programmes and subsistence fish farmers have also benefited from this project. The production of fingerlings has also helped several students to successfully conduct research involving catfish.

Figure 76: Rearing of fingerlings in a recirculating aquaculture systems at University of Limpopo.

11.3 China-South Africa Agricultural Technology Demonstration Centre (ATDC): Gariep Dam, Free State

Project background

The China-South Africa Agricultural Technology Demonstration Centre (ATDC) is one amongst the other Agricultural Technology Demonstration Centres aided by the Chinese Government during the Beijing Summit on Forum of China Africa Cooperation (FOCAC) in 2006. It is the first project in which the Chinese Government aided South Africa in the area of agriculture.

The ATDC project is jointly undertaken by the Chinese Government, Ministry of Commerce (MOFCOM), the South African Governments (DAFF) and the Free State Department of Agriculture and Rural Development (FS: DARD).The major responsibilities of the ATDC includes:

- Breeding and technology demonstration
- Training and promotion, and
- Research and development.

Breeding and Technology Demonstration

The Centre is conducting breeding technics on the following species: African catfish (Clarias gariepinus), Common carp (Cyprinus carpio) and ornamental fish (Koi carp (Cyprinus carpio and Gold fish (Carassius auratus). Breeding of these species is done twice a year during summer season, around January to March and October to December. During winter periods, the average temperature is around 10 - 12^{o}C during the day and under the influence of the Atlantic sea breeze with the lowest temperature reaching -4^{o}C. Due to this condition, the gonadal development of these species decreases and hence the breeding is not done during winter seasons.

During the breeding season, the demonstration of artificial breeding (figure 77) on the species are facilitated in the hatchery. During artificial breeding process, both the male and female are injected with hormone to induce their spawning activities. The eggs are then stripped out from the female while the male is being sacrificed to collect the gonads. The malt from the gonads is sprayed and mixed with the eggs to induce fertilization. The fertilized eggs are kept in the tanks for hatching into fries. When the fries become fingerlings, they are transferred from the hatchery to the external ponds for further growth and improvement.

Figure77: Demonstration of artificial breeding of African catfish at the ATDC.

Table 44: The breeding cycles completed at ATDC from January 2016 to October 2016.

Breeding Year	Breeding Species	Quantity of Broodstocks	Quantity of Fries
Jan-16	African Catfish	33 females, 14 males	40000
Jan-16	African Catfish	12 males, 20 females	30000
Jan-16	Common Carp	1 male, 2 females	300
Jul-16	African Catfish	2 males, 1 female	2000
Sep-16	African Catfish	4 males, 3 females	8000
Sep-16	Koi Carp	4 males, 2 females	3000
Sep-16	Gold Fish	Natural Breeding	20 000
Oct-16	African Catfish	3 males, 2 females	2000
Oct-16	African Catfish	12 males, 4 females	5000
Oct-16	Gold Fish	Natural Breeding	15 000

Production Systems

a) Cage culture

Cage farming is demonstrated for easy handling and management of fish stock. The ATDC has demonstrated both the submerged and the floating cage culture system. The cage was constructed in December 2014 and in March 2015 Common carp (Cyprinus carpio), Goldfish (Carassius auratus), African catfish (Clarias gariepinus) were stocked. The purpose of the cage culture system was to study the growth rate, development of sex organs and the pathogenesis of these species. In March 2015 after the construction, Common carp was cultured in cages; African catfish in cages and Common carp fry in cages. These species were fed twice per day for 360 days except that Common carp fry was fed for 71 days. After the harvest, the same species were restocked in 15 March 2016 and fed twice per day, however, the days was reduced to 240. The growth rate of the fish fed for 360 days was greater than that of fish fed for 240 days. Thus, growth rate was due to flow of water, good water quality and high dissolved oxygen and the longer the fish stocked in cage culture. In natural environment, African catfish reaches sexual maturity within 2-3 years but in cage culture African catfish reached sexual maturity within a year of cultivation.

b) External ponds

The external ponds (figure 78) are stocked with Gold fish, Koi Carp, African Catfish and Common Carp for further growth after breeding. Routine feeding and cleaning are facilitated regularly. Some of the African Catfish are transferred from external pond to Hatchery during winter for over wintering as the temperature drops outside. Temperature drops in the ponds will slow down the metabolic rate of catfish which might result in mortalities.

Figure 78: The pond culture system demonstrated at ATDC.

c) Hatchery

Catfish were bred artificially as part of the programme to expose Glen College students and trainees to the various methods of fish breeding, thereafter catfish were also bred in a semi-natural method as part of an experiment to ascertain whether the breeding would be successful even though temperatures had already dropped over the winter months. The breeding was essentially effective as the fish were highly fertile, as a result of the ongoing conditioning of the brood stock.

Figure 79: The hatchery facility used for overwintering of fish and for keeping the broodstock.

Other activities that are done in hatchery and external ponds include:
Water quality monitoring
The water quality is tested on a daily basis for various water parameters including temperature, pH, ammonia, nitrite and nitrate levels. Tanks were also cleaned and maintained so that there can be fewer impurities.

Earthen ponds are natural systems exposed to the environment, and therefore accumulate algae, and other natural flora and fauna such as frogs and tadpoles. The ponds are drained regularly to control excessive algae, and frogs and tadpoles are controlled by using scoop nets.

Animal Health and diseases
Parasitological surveys were conducted on fish wherever there was unexplained mortalities, parasite were identified to genus level, however we were unable to identify them up to species level as we do not have the lab consumables to complete the process. Parasites so far found infesting and infecting fish at ATDC include, Trichodinids, Monogeneans and Ichthyophthyrius multifilis. The parasite burden was not unusual, therefore it was ascertained that the parasites were not the cause of death. However, it must be stressed that monogeneans and the protozoan Ichthyophthyrius multifilis have been known to cause high mortalities in aquaculture conditions, these should be closely monitored.

Furthermore the hatchery's daily activities included:

- Preparations of tanks and nets for collecting the eggs.
- Feeding of fish twice a day.
- Removal of any excess food, and mortalities.
- Water exchange in tanks
- Fish transfer.

d) Aquaponics farming.

The aquaponic system in the ATDC was established in May 2015. In normal aquaculture, excretions from the animals being raised can accumulate in the water, increasing water toxicity. In an aquaponic system (figure 80), water from an aquaculture system is fed to a hydroponic system where the by-products are broken down by nitrification bacteria into nitrates and nitrites, which are utilized by the plants as nutrients, and the water is then recirculated back to the aquaculture system. The symbiosis of the fish and plant makes use of the combination of aquaculture and hydroponics farming methods, to achieve stability in water quality during fish culturing, and growth of plants without fertilization. ATDC has successfully planted water spinach, celery, lettuce and strawberries with integration of Common carp in the absence of fertilization. The water spinach and strawberries achieved better effect with amount of 4000-5000 kg/mu and 100-200 kg/mu respectively within a year. This led to Common carp production yield 625kg/mu.

The aquaponics ponds are regularly cleaned and frogs are removed from the ponds for maintenance purposes. The growth of the Chinese spinach is also being measured on weekly basis to compare the rate of growth. All the vegetables were harvested in the month of June due to the lower temperature. The small green house was also created on the floating base where the vegetables grow so that the vegetables roots are remained during the winter period.

Figure 80: The Aquaponic system demonstrated at ATDC.

E) Feed processing plant

The service provider has been appointed and the Feed Processing Plant was completed in June 2016 (figure 81). The Chinese team applied the invitation letter for the engineer to come for the installation of the machinery. The invitation letter was signed off from FS-DARD HOD's office and the engineer arrived in South Africa during September 2016. The installation of the machine was completed during the November 2016. Officials from the DAFF were invited to experience the operation of the installed feed processing for the first time. On the 2nd of November 2016 the completed feed processing plant was launched at ATDC. The representatives from FS-DARD - Trompsburg, FS-DARD Glen engineering, FS-DARDS Glen HOD's Office, FS-DARD Glen communication media, ATDC staff - South African and Chinese counterpart as well as the consultants and contractor were present. Mr Song, Chinese engineer and the ATDC scientist demonstrated how the feed are produced from the machinery until the end product is achieved.

Figure 81: The newly established Feed Processing Plant at ATDC.

F) Training and Capacity Building

The ATDC has organized and hosted different promotional programmes which include: training, tours and site visits. The ATDC has organized different programmes for extension officers, farm workers, animal health practitioners, service trainees, interns and students. With the aid of FS-DARD, DAFF and other organizations, the Centre trained 117 candidates in 2016 (table 45)

The training courses provided was identified and selected by combining the needs of the farmers, high school students, higher education students and technical officials. In view of the fact that the farming of freshwater fish was not widely promoted, and there is little relevant experience in freshwater aquaculture in the provinces of South Africa. The courses offer a comprehensive educational and performance experience for most fish production techniques such as

- Fish Biology and Introduction of Fish Species
- Water Quality Requirements and Management
- Aquaculture Equipment
- Fish breeding and fry rearing
- Fish nutrition
- Fish transporting
- Environmental Legal Requirements of Freshwater Aquaculture
- Aquaculture Data collection
- Fish disease and Health Management
- Freshwater Aquaculture Stock Management
- Aquaculture economics
- Fish processing
- Aquaculture farming systems

Figure 82: The DAFF intern trainees during their training week at ATDC.

Table 45: The training status for trainees that were trained during 2016.

Training period	Type of participant	Origin of participant	Number of participants
29 June 2016 – 30 June 2016	Extension Officers	Mixed Provinces	10
29 June 2016 - 30 June 2016	Farmers	Mixed Provinces	15
29 June 2016 - 30 June 2016	University students	Mixed Provinces	15
29 June 2016 - 30 June 2016	High school students	Mixed Provinces	65
26-30 September 2016	Farmers	Gauteng	4
26-30 September 2016	Farmers	Lesotho	2
5 December 2016 - 9 December 2016	Extension Officers	Kwazulu-Natal Department of Agriculture	6
TOTAL			**117**

G) Education and Awareness

Youth Outreach Programmes

In an effort to expose the youth to opportunities available in the fisheries and aquaculture sector, the DAFF embarked on a three day career expo (Youth Outreach Programme) for youth from across South Africa in Gariep, in the Free State Province from 28th to 30th June 2016. The expo drew youth from eight provinces. The youth range from high school learners, fisheries and aquaculture students and those with a background in agriculture and forestry. In total, 400 young people engaged in the programme. The Minister of DAFF, Mr Senzeni Zokwana, together with the MEC of FS-DARD, HOD of FS-DARD and Mayors from Xhariep District and Kopanong Municipality visited the Centre on 28th June 2016. The Minister gave a speech for the 400 young people to encourage them to take part in the aquaculture as a career. The South African Police Services (SAPS) in Bloemfontein also dispatched a total of 74 school going youth and undergraduates who attended the aquaculture courses and engaged in the practical's (including fish dissection and farming skills promotion) in the Centre during the Youth Outreach Programme (figure 83).

Figure 83: A and B: Minister of Agriculture, Forestry and Fisheries, Mr Senzeni Zokwana, together with the MEC of FS-DARD, HOD of FS-DARD, Mayors from Xhariep District and Kopanong Municipality visited the Centre during Youth Outreach Programme.

11.4. The Hamburg Aquaculture Project

The Hamburg Aquaculture Project is a mariculture farm situated in in the Eastern Cape Province, Ngqushwa Local Municipality, in a small rural settlement called Hamburg. The farm is situated along the banks of the Keiskamma estuary, about 500 metres from the estuary mouth. The project has a dusky kob (Argyrosomonus japonicas) farm at a pilot scale and an oyster (Crassostrea gigas) farm under refurbishment (figure 84). The Hamburg Aquaculture Project aims to commercialize the dusky kob at a later stage to produce 1000 tons of fish. The project has twenty Siyazama Primary Aquaculture Co-operative members who are currently benefiting from it, about 50% of these beneficiaries are women.

Figure 84: The dusky kob farm at the Hamburg Aquaculture Project which is land based.

Figure 85. The oyster farm situated in the Keiskamma estuary.

Project progress

In 2016, the project obtained a permit to farming dusky kob (Argyrosomonus japonicas) and oysters (Crassostrea gigas). There were no fish sales in 2016, however, there was a procurement of fish stock. During this financial year, fish stock was rigorously groomed, while constantly monitoring their health and the culture system. Few adjustments were done on the dusky kob culture system. The oyster farm was continuously refurbished. The project implementer was appointed in October 2016.

11.5. Karoo Catch

Karoo Catch (Pty) Ltd is located in the Camdeboo Local Municipality, in the Eastern Cape Province. Camdeboo is a remote rural area which falls under the Cacadu District Municipality. Karoo Catch (Pty) Ltd is cultivating the African Sharptooth Catfish (Clarias gariepinus) in a Recirculating Aquaculture System (RAS) and is also breeding on site (Figure 86). The project aims to grow fish until a market size, thereafter, process, package and dispatch it to the market. The targeted monthly production of the farm is 20 tons.

Figure 86: Tunnels at Karoo Catch with a Recirculating Aquaculture system inside.

<u>Project Status:</u> The project is at its operational phase. The facility has a hatchery on site, grow out systems, and a feed storage tunnel. The facility is in the processing completing the installation of solar panels on site. Furthermore, Karoo Catch (Pty) Ltd is planning to rent a factory in Graaf Reinet for fish processing.

<u>Project's Human Resource:</u> Blue Karoo trust is a 100% owner of Karoo Catch (Pty) Ltd. The beneficiaries of Blue Karoo Trust are Camdeboo Aquaculture Trust, Ter Morshuizen Trust, Sondelani Trust and Joubert Trust.

<u>Skills Development:</u> Blue Karoo trust beneficiaries work through a holistic workforce development programme which offers them an opportunity to equip themselves with basic life skills, literacy and farm operations skills. The project intends to further train more people in the coming years.

<u>Research and development:</u> Proposals pertaining to a wastewater system are underway. The wastewater treatment system to be adopted will be the high rate algal ponds for the treatment of aquaculture effluent.

<u>Farm Operations and Products:</u> The project is using a RAS to cultivate fish for a period of six (6) months with a weight of 1 Kg. The facility purchases fish feed from Montego Animal Feeds factory which is stationed in Graaf Reinet. Once fish reach a market size, they will be transported to the processing facility in Graaf Reinet which will be rented. The fish will be processed to value added products, such as fish wors and fish burgers. Pet food will also be synthesized from fish viscera and other unwanted fish flesh. These products will be sold locally in the Eastern Cape, however, when the farm expands, products will also be sold nationally.

NATIONAL AQUACULTURE STAKEHOLDER ENGAGEMENTS

12

12.1. Aquaculture Intergovernmental Forum (AIF)

The main objective of the committee is to provide better management through joint planning, facilitation, coordination, resources mobilization and evaluation as well as oversight for the aligned implementation and reporting of all key programmes for government to achieve sustainable aquaculture development in the country. DAFF chairs the committee, and as an industry development and trade partner, the DTI deputizes. The committee consist of the DST as a technology partner; the DoH as the food safety partner; DEA, DWA and DRDLR as the custodians of the environment and natural resources and sustainability partners. Representatives of the key State-Owned Entities (SOEs) and Provincial Departments of Agriculture and Environmental Affairs are also invited.

12.2. Marine Aquaculture Working Group (MAWG)

This forum has an advisory role to the CD: AED and is convened and chaired by the D: ATS. It advises the CD: AED on any matter referred to it by the Chief Directorate or relevant matters within the industry, such as:

- The assessment of marine aquaculture scientific investigations and practical investigations permit applications;
- The assessment of Marine Aquaculture Right applications;
- The management and development of aquaculture, including issues relating to environmental protection ; guidance on the Aquaculture policy and legislation;
- And establishment and amendment of operational management procedures and sector development plans; and recommendation directives on areas of research.

The lead directorate is the D: SAM. The MAWG consists of representatives of the Branch: Fisheries from the CD: AED, Fisheries and Development and Monitoring, Control and Surveillance (MCS).The representative are nominated by the relevant Chief Director: The MAWG will sit every month, however the D: SAM may call an emergency MAWG meeting whenever appropriate. The D: SAM provide MAWG secretariat.

12.3. Aquaculture Industry Liaison (AIL)

This Forum provides a platform for industry to engage and communicate with government on issues that affect the marine aquaculture industry. Convened and chaired by Chief Directorate Aquaculture and Economic Development. Its members as DAFF officials from relevant Chief Directorates such as CD: FR&D, CD: AED, CD: MCS, Marine Aquaculture Right and Permit Holders.

12.4. Provincial Aquaculture Intergovernmental Forum (PAIF)

The main purpose of the PAIF is to ensure cooperation and coordination between national departments and provincial departments/agencies that have a mandate in aquaculture development. It is convened and chaired by CD: AED. Its members include aquaculture stakeholders nationally.

12.5. Aquaculture Value Chain Round Table (AVCRT)

The purpose of this forum is to foster collaborative industry-government action that helps to secure an enduring global advantage without limiting the round table to issues and developments that are external to South Africa. The round table considers domestic sectoral development activities as they directly impact on South Africa's global competitiveness and its reputation as food suppliers.

The objectives of the AVCRT are as follows:

- Create a formal platform to address key industry challenges and constraints and utilize opportunities for the benefit of the sector or subsector;
- Set goals and targets which, if achieved, will strengthen the sector's competitive position and enhance South Africa's overall capacity to meet the challenging demands of both domestic and international market;
- Building the maximum degree of agreement possible on the development and implementation of coordinated action plans to achieve set goals and targets;
- Track progress on implementation of agreed actions and thereby ensure results; and
- Develop and implement strategies and initiatives aimed at securing and utilising the country's competitive advantage.

13 AQUACULTURE AND OPERATION PHAKISA – OCEAN'S ECONOMY

13.1. Aquaculture Operation Phakisa Oceans Economy summary

The DEFF is the lead department for the Oceans Economy Aquaculture Lab and its deliverables. The lab concluded that South Africa's aquaculture sector has a high growth potential due to an increasing demand for fish in the face of declining fish stocks. The goal is to grow the aquaculture sector in South Africa to play a major role in supplying fish products and an enhanced role in job creation and contribution to national income. The targets over the next five years seek to grow sector revenue from R0.67 billion to R3 billion; production by 20000 tons; jobs from 2227 to 15000 and to ensure increased participation to support transformation in the sector.

Operation Phakisa is an initiative of the South African government which aims to implement priority economic and social programmes better, faster and more effectively and was launched by the South African President in October 2014.

The aquaculture lab comprised of stakeholders from industry, government and academia who identified eight key initiatives, which are expected to spur the growth of the sector. One initiative will address the selection and implementation of catalyst projects, improving both the number and productivity of new farms. Three initiatives relate to the creation of an enabling regulatory environment and others focus on funding support, increasing skills pool and awareness and improving access to markets.

To deliver these initiatives, the aquaculture lab created detailed implementation plans and accompanying budgets, a proposed governance system to take responsibility for initiatives and key performance indicators to help monitor delivery.

It has been two years since the launch of Operation Phakisa: Oceans Economy. The following provides an overview in terms of the targets reached and a summary of the progress to date.

- **Production:** 3500 tons by 26 projects
- **Jobs:** Total jobs sustained or created across the 26 projects was 1806 of which 171 were considered new jobs.
- **Investment:** Total committed investment to date is approximately R690 million (government and private), of which R227 million was from government.

1. Progress of Operation Phakisa initiatives

Initiative 1: <u>Selection and implementation of catalyst projects</u>

The first initiative (1) covers the ''Selection and Implementation of Catalyst Projects ''. The projects comprise of both new farms and the expansion of existing farms. Subsequent to the laboratory we have invited other projects to register with Operation Phakisa. There are currently 35 aquaculture Operation Phakisa projects.

- Five (5) of the original 24 projects conceptualised during the lab have been removed and placed on business opportunities.
- Sixteen6 (16) projects were accepted in the Lab in 2014.

Initiative 2: <u>Legislative reform</u>

Currently, the legislative framework governing aquaculture activities is fragmented and regulated by various departments as aquaculture occurs across sea, land and fresh water. Initiative 2 looks at 'Legislative Reform' which aims to amend legislation to streamline the assortment of existing regulations and creates an enabling environment to promote aquaculture sector growth.

- **Aquaculture Development Bill**

The socio economic impact systems on the bill were conducted and comments were received from the office of the chief states law advisor and the second draft of the bill in December 2016. The bill was presented at the National Economic Development & Labour Council (NEDLAC).

- **Strategic Environmental Assessment**

A strategic environmental assessment of the country was done to identify and map areas that are suitable for aquaculture throughout the country. The CSIR (Council for Scientific & Industrial Research) was appointed to undertake the assessment and begun public consultation.

- **Norms and Standards for Abalone**

Norms and Standards for Abalone were gazetted in Feb 2016 but were most likely be incorporated within the SEA process.

Initiative 3: Inter-departmental authorisations committee (IAC)

Currently authorisations can take up to three (3) years to be issued because of sequential administrative processes as the sector is regulated by various departments with several types of authorisations required. Initiative 3 covers the establishment of an 'Inter-Departmental Authorisations Committee' (IAC) which will streamline and coordinate applications and approvals in the aquaculture sector. The working group was established in September 2015. The IAC is made up of the following key member departments: Agriculture Forestry and Fisheries, Public Works, Environmental Affairs, Rural Development and Land Reform, Water and Sanitation, Public Enterprises (Transnet) and Mineral Resources.

Since its establishment in September 2015, the IAC achieved the following:

- **Mapping of business processes**
  The business processes pertaining to aquaculture authorisations from various national departments have been mapped and the inter-dependencies have been identified. The final report received on the mapping of business processes (GTAC) pertaining to aquaculture authorisations required by various departments was presented to the IAC in September 2016.
- **Access to land**
  Seven (7) of eight (8) initially approved leases with Department of Public Works were signed off in Saldanha
- **Access to sea space**
  One hundred and forty (140) hectares were made available to 10 projects in Saldanha Bay of which eight (8) are long-term leases (15-years) and two (2) are short-term leases (5 years) in 2016.
- **Environmental Authorisations issued for Phakisa Projects:**
  Since 2014, the following authorisations have been issued to Operation Phakisa registered projects:
  - Two Environmental Impact Assessments (EIA) were approved;
  - Two coastal discharge permits were issued;
  - One biodiversity risk assessment (Barramundi, Coho and King Salmon); and
  - Three marine aquaculture rights issued or amended

- **Saldanha Bay Aquaculture Development Zone EIA**
  In order to address the numerous expansion and new projects in Saldanha Bay, the DAFF commissioned an EIA for the whole bay and initial discussions and Background Information Document was released for comment.
- **Algoa Bay ADZ**
  In order to release the sea based aquaculture in Algoa Bay, the DAFF commissioned and completed a comparative assessment (socio-economic and environmental) of the two sites considered in line with the appeals directive from the Minister of Environmental Affairs.

Initiative 4: Globally recognised monitoring and certification system

Importing nations require health assurances that the products they receive are safe for consumption, therefore it is vital to ensure compliance with international standards to open up additional international markets for export and ensure safe products for the local market.

In 2016, the first aquatic animal health and wealth implementation plan in South Africa plan was developed. Furthermore the standard was published for live and raw mussels and oysters under the SANS code. The European Union (EU) conducted the fact finding mission for abalone and for access of markets, the findings were attended to by DAFF together with relevant departments. DAFF has the shellfish and finfish monitoring programme and these were boosted by the acquisition of microscopes for phytoplankton sampling baseline surveys.

Initiative 5: Aquaculture development fund

The 'Aquaculture Development Fund' aims to establish an integrated pool of existing funds in order to finance all phases of aquaculture projects (including pre-production) and encourage new entrants to participate in the aquaculture sector. A Working Group made up of the following key Development Funding Institutions (DFI's) and departments: Agriculture, Forestry & Fisheries: Comprehensive Agricultural Support Programme (CASP) and Micro Agricultural Financial Institutions of South Africa (MAFISA); Industrial Development Cooperation (IDC); LandBank; Eastern Cape Development Corporation (ECDC); Eastern Cape Rural Development Agency (ECRDA); Science & Technology; Jobs Fund; National Empowerment Fund; Trade & Industry; Small Business Development; National Treasury was established.

- **Funding directory**

To make funding more accessible, a funding guidelines brochure was drafted in 2016 and will be published during the financial year 2016/17. About forty (40) funding institution were consulted and found that 26 indicated interest in supporting aquaculture operations.

- **Investment promotion**

In order to attract further investment into the sector, investment promotions missions were undertaken to the Asia-Pacific Aquaculture Conference and Seminar in Xiamen, China and the International Seafood and Technology Expo in Tokyo, Japan. In addition, in collaboration with the dti and WESGRO and Investment Mission was undertaken in the Netherlands, France & Germany.

- **Aquaculture Species Feasibility studies**

Feasibility studies for marine finfish, oyster and mussels were completed and published.

Initiative 6: Capacity building and skills development for support services

There is currently a need for certified vocational training for basic aquaculture farming skills. In addition, aquaculture as an emerging sector has almost no dedicated and specialised extension officers, state veterinarians specialised in aquaculture and research officers at a provincial level. In order to address the above mentioned challenges, the following interventions were established:

- The Aquaculture Skills Working Group was established and meets on a quarterly basis
- Continuous training arrangements at the Agricultural Technology Demonstration Centre (ATDC) in Gariep. In 2016, training was provided to 281 farms/students, 534 visitor tours, and 9 interns.
- Training workshops arrangement.The DAFF also assisted with hosting and attending three aquatic training workshops in association with the FAO in November 2016 and participants were member state of the SADC region which covered socio economic impacts assessment of aquatic diseases, development of a national strategy of aquatic animal health and risk analysis for aquatic animal movement.

Initiative 7: Coordinated industry-wide marketing efforts

Initiative 7 seeks to launch "Coordinated Industry- Wide Marketing Efforts" to increase local consumption of aquaculture products and encourage the growth of small-scale farmers and new entrants.

Interest was received from Iran to supply 500 tons per month of tilapia. Taiwan has also expressed interest to source oysters from RSA.

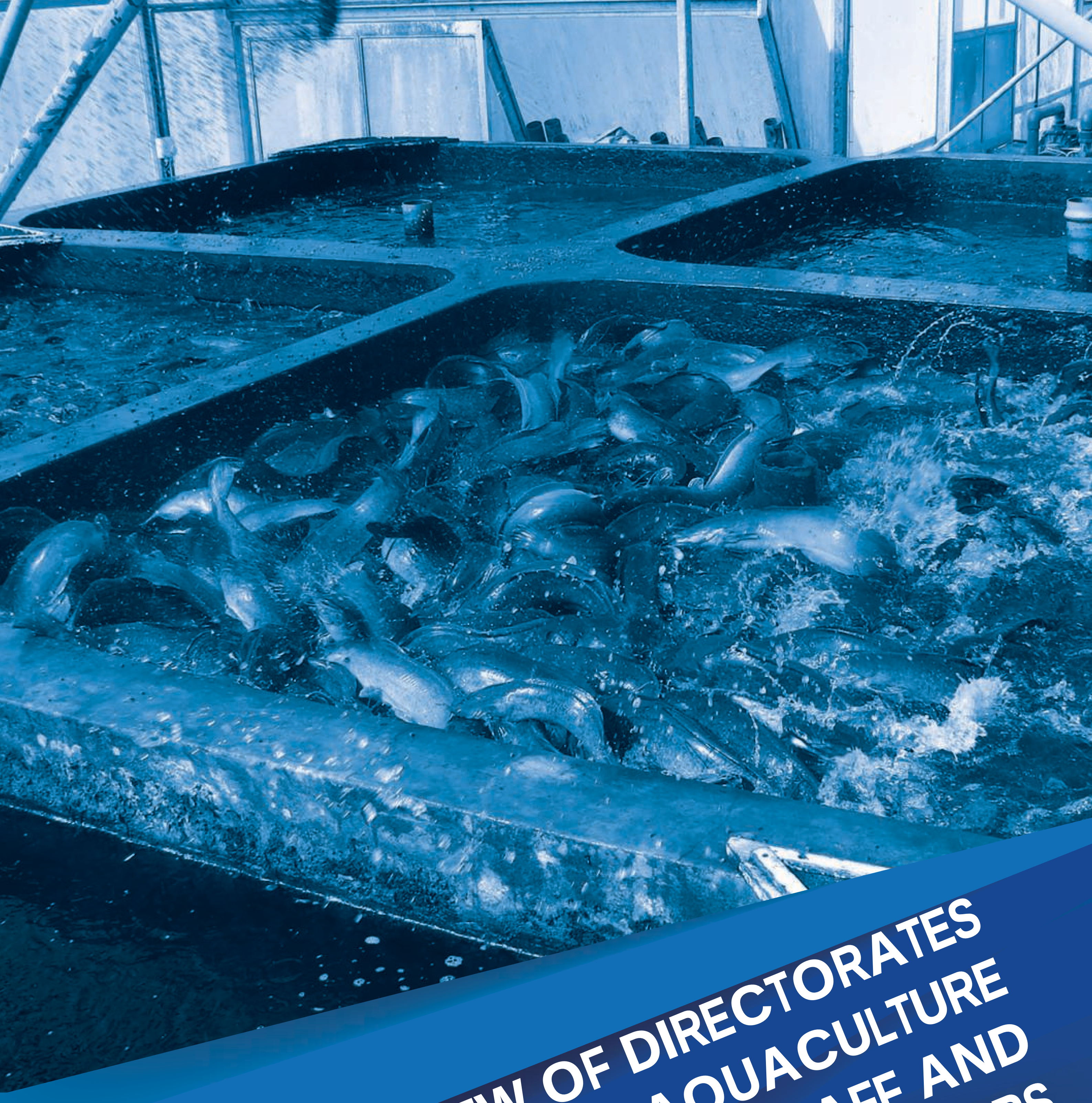
The Market Information System (MIS) template was developed to improve access to market information.

Various industry bodies were engaged regarding the establishment of AquaSA (statutory body under the Marketing of Agricultural Products Act).

Initiative 8: Preferential procurement

Fish protein provides the best value for money; however, per capita fish product consumption in South Africa is comparatively low. Preferential procurement can create local markets while contributing towards transformation and food security in South Africa. This initiative, 'Preferential Procurement', seeks to stimulate partnership with government institutions to procure aquaculture products, thereby increasing local consumption and improving nutritional levels in South Africa.

The DAFF and **the dti** are in discussion on procurement of fish products by schools, hospitals and correctional services. The Free State Economic Development Agency intends to source aquaculture products for school feeding schemes in the Free State province



14

OVERVIEW OF DIRECTORATES RESPONSIBLE FOR AQUACULTURE FUNCTIONS WITHIN DAFF AND RESPONSIBLE MANAGERS

14.1 Aquaculture Technical Services

The Directorate: Aquaculture Technical Services is responsible for the following functions:

a. Aquaculture Farmer Support

The Directorate ensures that farmers are obtaining the necessary support. It is again responsible for developing and implementing farm support programs; provide technical advisory services; and facilitate training and capacity building within the aquaculture sector.

b. Aquaculture Development

The Directorate ensures that enabling environment is being created for the aquaculture sector. It has been tasked with addressing zonation and facilitation of seed supply.

c. Economic and Information Management

The Directorate deals with economic assessment of fish farms in the country. Amongst other functions, this Directorate is also responsible for market issues; facilitating access to finance; and economic monitoring of the sector. It is important to ensure that the sector information is also available to assist in decision making. The Directorate is also established for driving information collection and dissemination; sector promotion through awareness programs; development and dissemination of sector promotion material; and most importantly development and publication of the South Africa's Aquaculture Yearbook. Furthermore, this Directorate deals with investment facilitation into the country.

14.2 Directorate Aquaculture Research and Development

The Directorate: Aquaculture Research and Development is responsible for the following functions:

a. Aquaculture Reproduction, Nutrition and Genetics

This Directorate deals with the research and development of culture technology for aquaculture species and their functions includes the development of programmable brood stock conditioning and hatchery methods for selected and prospective commercially viable aquaculture finfish and shellfish species. In terms of nutrition, functions includes optimising growth rates, production densities and FCR of selected commercially viable fish species, formulating and testing diets that will improve growth rates or FCR of commercially viable species.

The Directorate is also responsible for the developing techniques to optimize mass culture of phytoplankton and zooplankton required for commercial hatcheries, testing of integrated multitrophic aquaculture systems (IMTA) with respect to mechanized primary hatchery operations that will predictably produce fish juveniles with consistency, development of techniques for cryogenic stem cell preservation (genetic studies and aquaculture brood stock improvement application). They also contributing to the technology improvement of research based RAS for commercial application, functioning as a "Centre of Excellence" by providing advice and IP to ensure sustainable aquaculture industry development with minimal impact to the environment.

b. Environmental Interactions

The objective of the Environmental component of the Directorate: Aquaculture Research and Development is to promote an understanding of the interactions between the environment and aquaculture in support of a competitive and sustainable aquaculture industry in South Africa.

c. Aquatic Animal Health and Diseases

The Directorate focuses on research based on three main areas which includes:

- The development of novel methods for the diagnosis of new and emerging pathogens to provide accurate and reliable diseases diagnosis for aquatic animals.
- Collection of epidemiological data for significant aquatic animal health diseases in Southern Africa to inform management and contingency interventions.
- The development of effective preventive and treatment strategies for existing and emerging marine aquaculture diseases.

14.3 Directorate Sustainable Aquaculture Management

The Directorate: Sustainable Aquaculture Management is responsible for the following functions:

a. Aquaculture Authorisations

The Directorate is responsible for receiving, processing and granting of aquaculture rights, ranching rights and exemptions, issuing of permits and licenses; development and review of permit conditions, coordination of aquaculture stakeholder working groups (e.g. MAWG and AIL); farm visits for data collection and monitoring; and handling of appeals.

b. Aquatic Animal Health and Environmental Integrity

The AAHEI sub-unit is further divided into smaller units that include:

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; rendering 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 conducting of training, education and awareness programs on aquatic animal health.

Environmental Integrity

This 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 unit is responsible for the development and management of food safety programmes. Currently, the sub-unit is managing the South African Mollusca Shellfish Monitoring & Control Programme (SAMSM&CP). The objectives of the SAMSM&CP are, amongst other things, 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 programme, the sub-unit collaborates with other agencies such as the National Regulator for Compulsory Specifications (NRCS) and Council for Scientific and Industrial Research (CSIR).

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