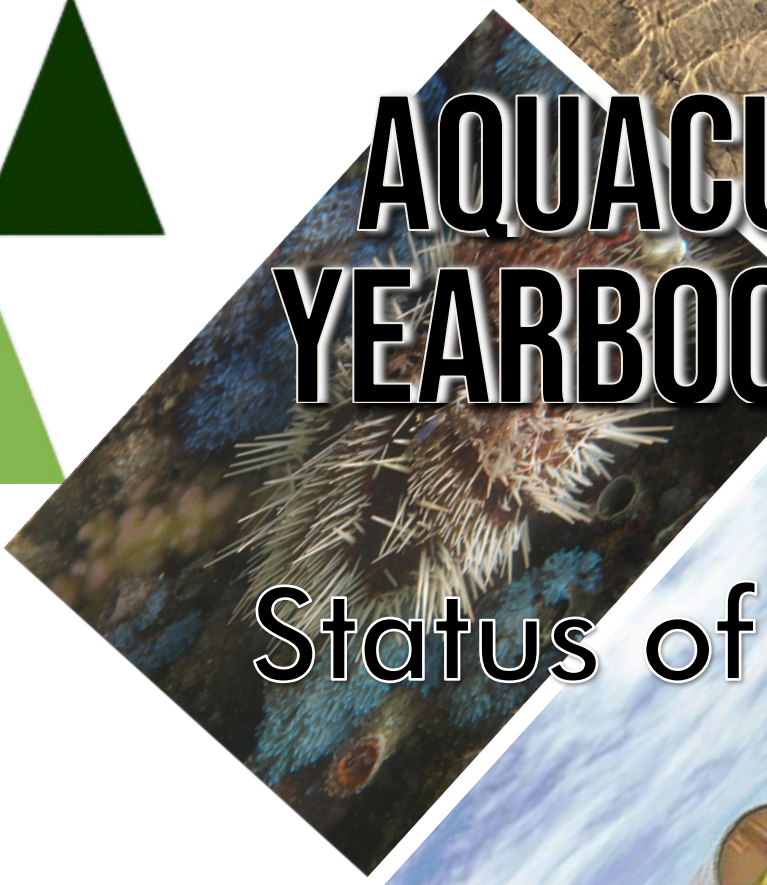
AQUACULTURE YEARBOOK 2020



Status of the sector

forestry, fisheries & the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

AQUACULTURE YEARBOOK 2020

STATUS OF THE SECTOR

ISBN: 978-0-621-49398-6

Department of Forestry, Fisheries and the Environment
Cape Town, 2020

PREPARED BY

The Department of Forestry, Fisheries and the Environment
Branch: Fisheries Management
Chief Directorate: Aquaculture and Economic Development
Directorate: Aquaculture Technical Services
Private Bag X2
Vlaeberg
Cape Town
8018
Email: www.dffe.gov.za
Tel: 021 402 3911

FOR ENQUIRIES CONTACT

The Department of Forestry, Fisheries and the Environment
Branch: Fisheries Management
Chief Directorate: Aquaculture and Economic Development
Directorate: Aquaculture Technical Services
Private Bag X2
Vlaeberg
8018
Email: callcentre@environment.gov.za

OR

Ms Khumo Morake - Makhalemele
Director: Aquaculture Technical Services
Email: Kmorake@ddfe.gov.za
Tel: 012 309 5727

Publication: March 2022

ACKNOWLEDGEMENTS

The Department of Forestry, Fisheries and the Environment (DFFE) as the lead Department acknowledges a collective effort made by government, its entities and private sector, as well as all stakeholders for their contribution towards aquaculture sector development.

Through the close working relationship between the government and the industry, the Department has been able to track the status of aquaculture in South Africa. This is done through collection of data and publication of the information of sector performance on the South Africa's Aquaculture Yearbook 2020. Special acknowledgement is dedicated to the Aquaculture line functions who compiled and packaged information from their various areas of expertise to ensure its publication through the South Africa's Aquaculture Yearbook 2020.

The positive and valuable contribution received from, among the many individuals who made efforts to contribute towards the compilation of this edition of South Africa's Aquaculture Yearbook, Mr Belemane Semoli (Chief Director: Aquaculture and Economic Development), Ms Khumo Morake-Makhalemele (Director: Aquaculture Technical Services); Mr Asanda Njobeni (Director: Sustainable Aquaculture Management), and Ms Fatima Daya (the Acting Director: Aquaculture Research and Development) in ensuring that all the sub-units within the Chief Directorate: Aquaculture and Economic Development played a key role is hereby acknowledged with appreciation.

EXECUTIVE SUMMARY

The Department collects aquaculture production data on an annual basis with the intentions of recording and monitoring South Africa's aquaculture industry performance. During the year 2019, the Department continued to collect, analyse and interpret data which will be published in the twelfth version of the South Africa's Aquaculture Yearbook, the "*South Africa's Aquaculture Yearbook 2020"*. Aquaculture functions within the department are the responsibility of Chief Directorate: Aquaculture and Economic Development. The Chief Directorate is therefore responsible to ensure the sustainable growth and development of the aquaculture sector. In ensuring the implementation of this crucial role, the Chief Directorate is provided support from various expertise by three (3) Directorates; Directorate: Aquaculture Technical Services, Directorate: Sustainable Aquaculture Management and Directorate: Aquaculture Research and Development. Additionally the Operation Phakisa Delivery Unit also plays a support role through overseeing the implementation of development and management initiatives of the Oceans Economy aquaculture workstream. The Chief Directorate continues to implement its role through engagements with both public and private aquaculture stakeholders through various platforms and time frames. These platforms include, but not limited to, National Aquaculture Inter-governmental Forum (NAIF), Marine Aquaculture Working Group (MAWG), Aquaculture Industry Liaison (AIL), Aquaculture Value Chain Round Table (AVCRT) and Inter-Departmental Authorisations Committee (IAC).

Information reflected in this publication is for both freshwater and marine aquaculture sector and it collected through the industry, individually and through the various industry associations. A total of 225 aquaculture farms were reported to be operational during the year 2019, with 35 of the farms cultivating marine species and 190 farms cultivating freshwater species. There has been a decrease of four (4) farms (1.75%), when compared to the 229 farms that were reported to be operational in 2018. The total annual production of the country's aquaculture industry, excluding seaweed production, in 2019 was 7085.65 tons. The marine sector contributed 5112.79 tons while the freshwater sector contributed 1972.86 tons. This production volume marks a total production increase of 719.85 tons, an increase of about 11.31% during 2019 from the 6365.8 tons recorded in 2018. This growth is more than the global average of 8%. Despite the sector's increased total production with marine sector presenting an increase of 868.39 tons, the freshwater sector experienced a decrease in production by 148.54 tons. These production volumes were achieved from cultivation of various fish species at commercial, pilot and small-scale levels.

The total annual production of 7085.65 tons as contributed by 5112.79 from marine sector and 1972.86 from freshwater sector is achieved from various sub-sectors. In the marine sector, mussels were the leading sub-sector with 3053.46 tons, followed by abalone with 1656.53 and then oysters with 382.70 tons. The finfish sub-sector contributed the least of 20.10 tons towards the total marine sector production. In the freshwater sector, trout contributed most of the production with 1583.00 tons, followed by tilapia (303.86 tons), catfish (59.90 tons), ornamentals (16.00 tons), common carp (6.10 tons), and lastly marron crayfish (4 tons).

Additional to the above species, there are species that were cultured for the purposes of undertaking

research studies in 2019. These species included the South Coast Sea Urchin (*Tripneustes gratilla*), tilapia mossambicus (*Oreochromis mossambicus*), South African scallop (*Pecten sulcicostatus*); spotted grunter (*Pomadasys commersonni*) and the white stumpnose (*Rhabdosargus globiceps*). The studies focused on the reproduction, nutrition and growth performance of the aforementioned species.

The performance of the sector during 2019 was analysed from all nine (9) provinces for freshwater production and from four (4) coastal provinces for the marine production. Out of the total provincial contributions (7085.65 tons) to the South Africa's aquaculture production, the Western Cape province is the major contributor with 5668.28 tons (80.00%) to the total aquaculture production from 61 farms. KwaZulu-Natal province was the second major contributor with 430.36 tons (6.07%) contribution from 20 farms. The third major contributor to the aquaculture production was the Eastern Cape province with 337.61 tons (4.76%) from 14 farms, followed by Mpumalanga province with 298.10 tons (4.21%) from 28 farms and then Gauteng province contributing 156.76 tons (2.21%) from 37 farms. The last four provinces' contributions were North West province contributing 92.00 tons (1.30%) from 24 farms, Limpopo province contributing 81.60 tons (1.15%) from 27 farms, Northern Cape province contributing 18.94 tons (0.27%) from 24 farms and last Free State Province contributing two (2) tons (0.03%) from 8 farms.

The DFFE lead the Oceans Economy Aquaculture focus area and its nine (9) deliverables for the past five (5) years, since the launch of Operation Phakisa government initiative in July 2014. For these five (5) years the department had targets, including but not limited to, growing sector revenue to R3 billion, with production volume reaching 20 000 tons and 15 000 jobs.

The South African aquaculture production has increased significantly over the years. During 2019, the sector recorded a total production of 7085.68 valued at R1 217 340 207 compared to the 2018 value of R1 115 499 300 that was recorded from a production volume of 6365.8. This shows an increase of 11.31% from the total production of 6365.79 tons recorded during 2018. The need for investment and finance to support the development of aquaculture in South Africa is highly significant. The sector contributed a total estimated value of R1 217 340 207 with freshwater contributing R155 528 951.60 and marine contributed a large value of R1 061 811 255.60 with the overall sector creating an estimation of 3873 candidates placed on farms, increasing employment at a 9.9% rate compared to 2018.

During 2019, a total of 43 marine shellfish and finfish farms were monitored for food safety to ensure that product safety risks associated with fish production are adequately managed and minimized for both local and international markets. All monitored farms were compliant with food safety requirements as prescribed in the food safety programmes (National Residue Programme, South African Molluscan Shellfish Monitoring & Control Programme and South African Aquacultured Marine Fish Monitoring & Control Programme). The South African Molluscan Shellfish and Finfish Monitoring & Control Programme Annual Report for 2019 outlined the status of 43 marine fish farms and the implementation of official food safety programmes. The abalone, mussel and oyster farms located to the west of Cape Point experienced more closures than the farms to the east of Cape Point due to biotoxin (PST and LST) and cadmium concentrations exceeding the regulatory limits. There were no closure notices that were sent to finfish or lobster farms.

The department continued to provide support to the Hamburg Aquaculture Project (HAP). The HAP continued to pilot its dusky kob and oyster culture activities with an intention to commercialise to 1000 tons of dusky kob per annum in future. Furthermore, the department focused on ensuring the functioning of the Aquaculture Technology Demonstration Centre (ATDC). The ATDC continued to benefit South Africa's aquaculture sector through its training programme, research, demonstration of breeding/hatchery and culture techniques as well as provision of extension services. These activities are executed from various production systems and various species such as African sharptooth catfish, carp, goldfish and koi.

The South African aquaculture sector is anticipated for expansion and there observation is that the emergence of new or existing aquatic animal diseases that appear in new geographic localities are considered important constraints to any potential aquaculture expansion. This requires a need to prevent the situation as it could ultimately suppress industry growth and present significant opportunity costs. The sector therefore gained a boost of substantial investment made by both the private and public sectors to provide evidence of freedom from aquatic animal diseases listed by the World Organisation for Animal Health (OIE) to support an aquaculture industry that is largely reliant on access to foreign markets for high-value aquaculture products. During the year 2019, disease occurrence was only noted for Abalone Tubercle Mycosis (ATM) in two farms and Epizootic Ulcerative Syndrome (EUS) in three farms. The department was able to conclude three research studies that highlighted culture technology projects. The projects focused on determining variables that guides the choice of fish products by the South African consumers; and the demonstration of rotifer populations' maintenance, stabilisation and proliferation only by using sustainably cultured marine yeast as a feed source. The last project focused on the development of packing strategies for successful aviation transportation of juvenile dusky kob with the objective of assessing the addition of chemical cocktails in the packing water.

Although the department continues to be the lead department on the development and management of the aquaculture sector, the current legislative framework governing aquaculture activities is fragmented and is regulated by various departments for both marine and freshwater sectors. During 2019, the then Department of Environmental Affairs (DEA) promulgated 20 Marine Protected Areas (MPA) gazetted under the National Environmental Management: Protected Areas Act (NEMPAA) (Act 57 of 2003). Under these regulations no aquaculture facility may extract or discharge water into a MPA. The South African Water Quality Guideline for Coast Marine Waters was gazetted in March 2019 and is still being finalised. However, the draft legislation which may become conducive to the aquaculture industry in the future included, but not limited to, the following:

- Aquaculture Bill – Department's mandate
- National Freshwater (Inland) Wild Capture Fisheries Policy of South Africa – Department's mandate
- General Discharge Authorisation – Department's mandate

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AbHV	Abalone Herpes Virus
ADEP	Aquaculture Developmental and Enhancement Programme
ADZs	Aquaculture Development Zones
AgriSETA	Agriculture Sector Education Training Authority
AIL	Aquaculture Industry Liaison
APP	Annual Performance Plan
AquaSEA	Aquaculture Strategic Environmental Assessment
ATM	Abalone Tubercle Mycosis
ATDC	Aquaculture Technology Demonstration Centre
AVCRT	Aquaculture Value Chain Round Table
CAPEX	Capital Expenditure
CDC	Coega Development Corporation
CPD	Continuing Professional Development
CSIR	Council for Scientific and Industrial Research
DACE	Department of Agriculture, Conservation and Environment
DAFF	Department of Agriculture, Forestry and Fisheries
DBE	Department of Basic Education
DCS	Department of Correctional Services
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DFFE	Department of Forestry, Fisheries and the Environment
DFI	Development Funding Institutions
DHA	Docosahexaenoic acid
DoA	Department of Agriculture
DoH	Department of Health
The dtic	The Department of Trade, Industry and Competition
DTX	Dinophysistoxins
EA	Environmental Authorisations
EC	Eastern Cape
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ELIDZ	East London Industrial Development Zone
EMPr	Enviornmnetal Management Programme
EU	European Union
EUS	Epizootic Ulcerative Syndrome

FAO	Food and Agriculture Organisation
FOREX	Foreign Exchange
FPE	Fish Processing Establishment
FS	Free State Province
FSDARD	Free State Department of Agriculture and Rural Development
FSDESTEA	Free State Small Business Development, Tourism and Environmental Affairs
FSO	Food Safety Officer
GDA	General Discharge Authorisation
GTAC	Government Technical Advisory Centre
GDP	Gross Domestic Product
GIT	Gastro intestinal tract
GP	Gauteng Province
HAB	Harmful Algal Blooms
HAP	Hamburg Aquaculture Project
HPLC	High-Performance Liquid Chromatography
HRMA	High-resolution melt-curve analysis
IAC	Inter-Departmental Authorisations Committee
IMTA	Integrated Multitrophic Aquaculture
IPAP	Industrial Policy Action Plan
KHV	Koi Herpes Virus
KZN	KwaZulu-Natal Province
LC-MS/MS	Liquid Chromatography–Mass Spectrometry
LHRHA	Lutinising Hormone Releasing Hormone Analogy
LP	Limpopo Province
LST	Lipophilic Shellfish Toxins
MAWG	Marine Aquaculture Working Group
MLRA	Marine Living Resources Act (Act 18 of 1998)
MP	Mpumalanga Province
MPA	Marine Protected Areas
NAIF	National Aquaculture Intergovernmental Forum
NASF	National Aquaculture Strategic Framework
NC	Northern Cape Province
NEMPAA	National Environmental Management: Protected Areas Act (Act 57 of 2003)
NOSA	National Occupational Safety Association
NRCP	National Residue Control Plan
NRP	National Residue Plan
NRCS	National Regulator for Compulsory Specifications
NW	North West Province

NWDARD	North West Department of Agriculture and Rural Development
NWU	North West University
OIE	World Organization for Animal Health
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated Biphenyls
PCR	Polymerase Chain Reaction
PST	Paralytic Shellfish Toxins
PTX	Pectenotoxins
QCTO	Quality Control for Trades and Occupations
RAS	Recirculating Aquaculture System
RU	Rhodes University
SABS	South African Bureau of Standards
SAAMFM&CP	South African Aquacultured Marine Fish Monitoring and Control Programme
SADC	Southern African Development Community
SALMSM&CP	South African Live Molluscan Shellfish Monitoring and Control Programmes
SAMSM&CP	South African Molluscan Shellfish Monitoring and Control Programme
SANAS	South African National Accreditation System
SAQA	South African Qualifications Authority
SEA	Strategic Environmental Assessment
SEDA	Small Enterprise Development Agency
SMME	Small, Medium and Micro-sized Enterprises
ToR	Terms of References
UCT	University of Cape Town
UFS	University of Free State
UKZN	University of KwaZulu-Natal
US	University of Stellenbosch
UWC	University of Western Cape
WAS	World Aquaculture Society
WC	Western Cape Province
YTX	Yessotoxins

OVERVIEW OF AQUACULTURE YEARBOOK 2020

01

1. OVERVIEW OF AQUACULTURE YEARBOOK 2020

1.1. History of the Aquaculture Yearbook

South Africa's Aquaculture yearbook dates back to 2009. This current publication is the twelve edition. The South Africa's Aquaculture yearbook evolved over time. This evolution was as a result of several developments over a period of time. It has been published under different names and different government Departments.

The first publication was in 2009, with the scope only focusing on marine aquaculture under the then Department of Environmental Affairs and Tourism (DEAT) and the publication was called *South Africa's Marine Aquaculture Industry Annual Report 2009*.

In 2010, the second publication was the *Marine Aquaculture Annual Report 2010* under the then Department of Agriculture, Forestry and Fisheries (DAFF). Due to the restructuring of government and formation of the then DAFF, the scope of the publication was broadened to cover developmental aspects of aquaculture. The impact of government restructuring also manifested in 2011 publication which required the inclusion of freshwater aquaculture. This resulted in further name change to *South Africa's Aquaculture Annual Report 2011*, still under the auspices of the then DAFF. The last revision of the publication name occurred in 2012 under the then DAFF. The name was changed to *South Africa's Aquaculture Yearbook* and has since been kept the same until this publication.

In 2019, there was further restructuring of government. The aquaculture functions amongst others were moved to form part of the Department of Environment, Forestry and Fisheries (DEFF). Publications for the years 2017 and 2018 were published under the Department. In April 2021, the name of the Department was revised to Department of Forestry, Fisheries and the Environment (DFFE), therefore the current publication is done under the auspices of DEFF.

Previous publications are stipulated below:

- South Africa's Marine Aquaculture Industry Annual Report 2009, published in 2009 under then the DEAT
- Marine Aquaculture Annual Report 2010, published in 2010 under the then DAFF
- South Africa's Aquaculture Annual Report 2011, published in 2011 under the then DAFF
- South Africa's Aquaculture Yearbook 2012, published in 2012 under the then DAFF
- South Africa's Aquaculture Yearbook 2013, published in 2014 under the then DAFF
- South Africa's Aquaculture Yearbook 2014, published in 2015 under the then DAFF
- South Africa's Aquaculture Yearbook 2015, published in 2016 under the then DAFF
- South Africa's Aquaculture Yearbook 2016, published in 2017 under the then DAFF
- South Africa's Aquaculture Yearbook 2017, published in 2020 under the DEFF
- South Africa's Aquaculture Yearbook 2018, published in 2020 under the DEFF
- South Africa's Aquaculture Yearbook 2019, published in 2021 under the DEFF
- South Africa's Aquaculture Yearbook 2020, will be published in 2021 under the DFFE

1.2. Purpose of the Aquaculture Yearbook 2020

Similarly, to previous publications, the main purpose of the *South Africa's Aquaculture Yearbook 2020* is to provide access to information and ensure transparency related to the status of aquaculture sector in South Africa. Its aim is to:

- create awareness,
- promote the sector; and
- make provision of information to decision makers, potential investors and general public.

The objective of the *South Africa's Aquaculture Yearbook 2020* includes, but not limited to,

- 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
- makes a business case for future developmental initiatives of the sector.

1.3. Aquaculture Yearbook 2020 compilation process

A consistent approach was taken towards the compilation of previous editions of the South Africa's Aquaculture Yearbooks and was used to compile the *South Africa's Aquaculture Yearbook 2020.* The compilation of this publication was based on the information collected from different aspects of the sector ranging from research, production statistics, to existing publications, socio-economic and economic information. Key component of this publication is the production data and socio-economic data. It was compiled based on data collected during 2019, from both freshwater and marine aquaculture farmers.

Data collected from the marine aquaculture sector were from legislated and legally operating farmers, importers and exporters as per the Marine Living Resources Act, 1998 (Act No.18 of 1998) (the MLRA). The submission of such data was guided by 2018 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 DFFE as it is currently voluntary for industry to submit information. 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. This aspect demonstrates an importance of having an overarching legislative tool that will encompass both freshwater and marine aquaculture sectors.

STATUS OF AQUACULTURE IN SOUTH AFRICA

02

2. STATUS OF AQUACULTURE IN SOUTH AFRICA

2.1. Overview of aquaculture in South Africa in 2019

Aquaculture in South Africa continues to demonstrate growth over the years. A total of 225 farms recorded in 2019 for both marine and freshwater aquaculture (Table 2.1). This included 190 freshwater farms and 35 marine farms. Freshwater farms utilise Recirculating Aquaculture Systems (RAS), raceways and earth ponds for cultivation of the species above while marine molluscs are cultivated on rafts or long lines, abalone is cultured in tanks with tank pump ashore technology and marine finfish farms utilize cage culture and pond culture. In 2018, the sector recorded 229 farms. In 2019, the number of recorded farms reduced by five (5).

Table 2.1: Total number of farms recorded for South Africa's aquaculture sector in 2019.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Abalone	2	0	0	0	0	0	2	0	12	16
Finfish	1	0	0	1	0	0	0	0	1*(2)	3*(4)
Mussels	0	0	0	0	0	0	0	0	11	11
Oysters	1	0	0	0	0	0	1	0	3*(5)	5*(7)
Total Marine	**4**	**0**	**0**	**1**	**0**	**0**	**3**	**0**	**27(30)**	**35**
Catfish	2	4	1	2	4	1	0	3	0	17
Common carp	0	0	1	0	1	0	2	0	1	5
Marron crayfish	2	0	0	0	0	0	0	0	0	2
Ornamental species	2	4	9	7	1	3	0	0	2	28
Tilapia	3	0	23	5	21	12	1	21	1	87
Trout	1	0	3	5	0	12	0	0	30	51
Total Freshwater	**10**	**8**	**37**	**19**	**27**	**28**	**3**	**24**	**34**	**190**
Total aquaculture farms	**14**	**8**	**37**	**20**	**27**	**28**	**6**	**24**	**61**	**225**

*(2) two farms cultured mussels and oysters; however the farms have been captured under the primary species which is mussels.

*(1) one farm cultured abalone and finfish; however the farm has been captured under the primary species which is abalone.

During 2019, the sector operated from a range of ten (10) species farmed for different purposes. These included six (6) freshwater and four (4) marine species. The freshwater species cultured in 2019 included trout (*Onchorynchus mykiss* and *Salmo trutta*), tilapia (*Oreochromis mossambicus*, *Oreochromis niloticus* and *Tilapia rendalli*), catfish (*Clarias gariepinus*), common carp (*Cyprinus carpio* and *Ctenopharygodon idella)*, marron crayfish (*Cherax tenuimanus)* and a number of ornamental species (e.g. Koi). Although freshwater aquaculture is operated in all the nine (9) provinces, the highly concentrated areas of production for freshwater species include

Western Cape with the highest producer, followed by KwaZulu-Natal, then Mpumalanga and Gauteng provinces.

Marine species farmed in 2019 included abalone (*Haliotis midae*), pacific oyster (*Crassostrea gigas*), mussels (*Mytilus galloprovincialis* and *Choromytilus meridionalis),* dusky kob (*Argyrosomus japonicus*) and Salmon (*Salmo salar*). As the main sector driver, marine aquaculture production is recorded at high production in Western Cape and Eastern Cape with the lowest production recorded from Northern Cape and KwaZulu-Natal.

The total production of South Africa's aquaculture industry recorded during 2019 was 7085.65 tons (Table 2.2) with freshwater recording 1972.86 tons (27.84%) and marine noted to be the main driver of the sector with 5112.79 tons (72.16%). In the year 2019, the recorded production has demonstrated the sustainability of the sector with an increase of 719.95 tons from a production of 6365.70 tons recorded during 2018. This volume represents 11.31% increase on the total annual production. Table 2.2 continues to illustrate the leading sub-sector in terms of production to be mussels with a production volume of 3053.46 tons, followed by abalone with a production of 1656.56 tons and then trout with a production of 1583.00 tons.

z

Table 2.2: Total production (tons) recorded for South Africa's aquaculture sector in 2019.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Abalone	157.88	0.00	0.00	0.00	0.00	0.00	14.94	0.00	1483.71	1656.53
Marine finfish	0.00	0.00	0.00	7.06	0.00	0.00	0.00	0.00	13.04	20.10
Mussels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3053.46	3053.46
Oysters	95.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	287.67	382.70
Total Marine	**252.91**	**0.00**	**0.00**	**7.06**	**0.00**	**0.00**	**14.94**	**0.00**	**4837.88**	**5112.79**
Catfish	51.90	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	59.90
Common carp	0.00	0.00	1.60	0.00	2.50	0.00	1.00	0.00	1.00	6.10
Marron Crayfish	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Ornamentals	1.70	2.00	3.70	4.50	0.80	1.90	0.00	0.00	1.40	16.00
Tilapia	27.10	0.00	53.46	7.00	78.30	43.00	3.00	92.00	0.00	303.86
Trout	0.0	0.0	98.00	403.80	0.00	253.20	0.00	0.00	828.00	1583.00
Total Freshwater	**84.70**	**2.0**	**156.76**	**423.30**	**81.60**	**298.10**	**4.00**	**92.00**	**830.40**	**1972.86**
Total aquaculture production volume	**337.61**	**2.0**	**156.76**	**430.36**	**81.60**	**298.10**	**18.94**	**92.00**	**5668.28**	**7085.65**

z

2.2. Overview of aquaculture sector activities and interventions since the year 2006.

During the past fourteen (14) years, the aquaculture sector had shown the potential to grow despite the fragmented legislative arrangements that the sector was facing. There have been multiple factors and interventions that have contributed to this growth. Yearly interventions made from various units of the former Departments of Environmental Affairs and Tourism, Department of Environmental Affairs, Department of Agriculture, Forestry and Fisheries were observed since the year 2006. The following, but not limited to, major government interventions were made:

During the years 2006 and 2009, the sector received interventions to leverage its potential growth rate and these included:

- Merging of the freshwater and marine aquaculture as one sector under the then Department of Agriculture, Forestry and Fisheries

During the five (5) year period between the years 2010 and 2015, the sector continued to gradually grow further interventions received were:

- Formulation of the Aquaculture and Economic Development Chief Directorate to oversee aquaculture sector (Marine and Freshwater aquaculture),
- Inclusion of aquaculture in the Customised Sector Strategies Programme and the Industrial Policy Action Plan (IPAP),
- National Aquaculture Strategic Framework for South Africa during 2012,
- National Aquaculture Policy Framework for South Africa during 2013,
- Review of legislation and institutional arrangements governing aquaculture in South Africa (detailed in Chapter 4),
- Aquaculture Development and Enhancement Programme approved and launched by the then Department of Trade and Industry, and
- Operation Phakisa – Oceans Economy (Aquaculture Lab).

For the last five (5) years, since 2015 to 2019, the sector performed very well and the interventions received were:

- Extension of the Aquaculture Development Enhancement Programme (ADEP); and ADEP guidelines reviewed to ensure that Black farmers benefit from the scheme
- Aquaculture Development Bill concept document (Gazetted)
- Aquaculture Development and Enhancement Programme reviewed
- Draft Aquaculture Development Bill
- Sector investment promotion initiatives outlined below:
    - The first international conference and exposition of the World Aquaculture Society (WAS) was held on the African continent at the Cape Town International Convention Centre 26-30 June 2017.

z

- Projects profiled at investment conferences nationally and internationally this includes the China Outward Investment Mission in Fujian and Hangzhou and the Sweden Blue Economy Business Seminar in Gothenburg, Sweden.
- New markets have been explored and interest was received from:
  - Iran for tilapia
  - China (Taiwan) for farmed oysters
  - Europe for finfish and abalone
- Investment readiness consultations were held with with Wesgro (Western Cape Trade & Investment Agency); and also business plan support was provided to African Olive Trading and Aquafoods through Small Enterprise Development Agency (SEDA).
- Projects that required investment were presented and profiled at investment conferences nationally and internationally as outlined below:
  - The dti and DAFF United Arab Emirates & Saudi Arabia Investment Mission (UAE and Saudi, March 2018).
  - Chile Scoping Mission with DAFF Deputy Minister: AquaSur International Conference (Puerto Montt, October 2018).
  - Operation Phakisa: Oceans Economy Italy Webinar (Pretoria, September 2018).
  - The Presidential Investment Conference (Sandton, October 2018).
  - United Arab Emirates Agriscape Conference and Investment Mission (Abu Dhabi, October 2018).
- The first Aquaculture Finance and Investment Seminar was held in Durban.
- The Public Awareness and Marketing Strategy for Aquaculture Products and the Sector in SA was completed (this also informs investment promotions internationally)
- The Value Proposition for the Aquaculture Sector was completed with the Department of Trade, Industry and Competition (**the dtic**). The value proposition provides an overview of why and how to invest into the sector which is a valuable tool for targeting new investors.

2.3. Overview of aquaculture production from 2006 to 2019 (14 years)

The aquaculture sector has shown significant growth over past fourteen years. A total of 62 141.25 tons have been recorded in the aquaculture sector since the year 2006 to the end of 2019 (Table 2.3). This total production proves the potential growth the South African aquaculture sector has as the growth pattern shows steady increase from 2006 to 2009 at a volume of 10 995.80 tons, the following five (5) years of 2010 to 2014 recording a volume of 20 680.00 tons and the last five (5) years recording a total volume of 30 465. 45 tons (Figures 2.1 and 2.2)

z

Table 2.3: Production recordings over 14 years per species.

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Abalone	833.36	783.25	1037.11	913.58	1015.40	1036.00	1111.40	1469.80	1306.80	1479.20	1703.30	1276.10	1522.20	1656.53	**17144.03**
Catfish	180.00	180.00	180.00	180.00	180.00	160.00	0.00	0.00	0.00	0.00	3.30	3.30	20.00	59.90	**18.50**
Common carp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30	7.10	6.10	**1146.50**
Marine finfish	0.00	0.00	2.71	22.75	0.00	8.0	48.50	122.50	161.90	77.30	118.60	115.60	73.80	20.10	**771.76**
Marron crayfish	0.20	0.40	0.40	0.40	0.80	0.80	3.50	5.00	5.00	4.00	4.00	4.00	4.00	4.00	**36.50**
Mussels	542.00	466.00	736.74	682.40	700.10	859.80	859.80	1116.10	1682.50	1758.50	1961.00	2083.50	2182.10	3053.46	**18684.00**
Ornamentals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	16.00	16.00	16.00	**64.00**
Oysters	279.87	157.86	226.62	223.53	276.60	269.30	241.60	277.20	266.40	276.90	357.30	432.70	466.20	382.70	**4134.78**
Tilapia	0.00	0.00	0.00	10.00	10.00	100.00	234.20	289.70	289.70	325.30	340.80	402.30	571.30	303.86	**2877.16**
Trout	807.00	658.00	943.00	948.62	950.00	1199.00	1428.00	1497.30	1497.30	1497.00	1503.00	1249.80	1503.00	1583.00	**17264.02**
	2642.43	**2245.51**	**3126.58**	**2981.28**	**3132.90**	**3632.90**	**3927.00**	**4777.60**	**5209.60**	**5418.20**	**6007.30**	**5588.60**	**6365.70**	**7085.65**	62141.25

Figures 2.1 and 2.2 demonstrate continuous sector growth since 2006 to 2019 with a significantly decreased production experienced during 2017 due to Harmful Algal Bloom (HAB) and drought. Figure 2.1, however, continues to reflect a recovery by both freshwater and marine sectors from the dip in 2017 and each picking up during 2018.

Figure 2.1: South Africa's aquaculture production growth from 2006 to 2019.

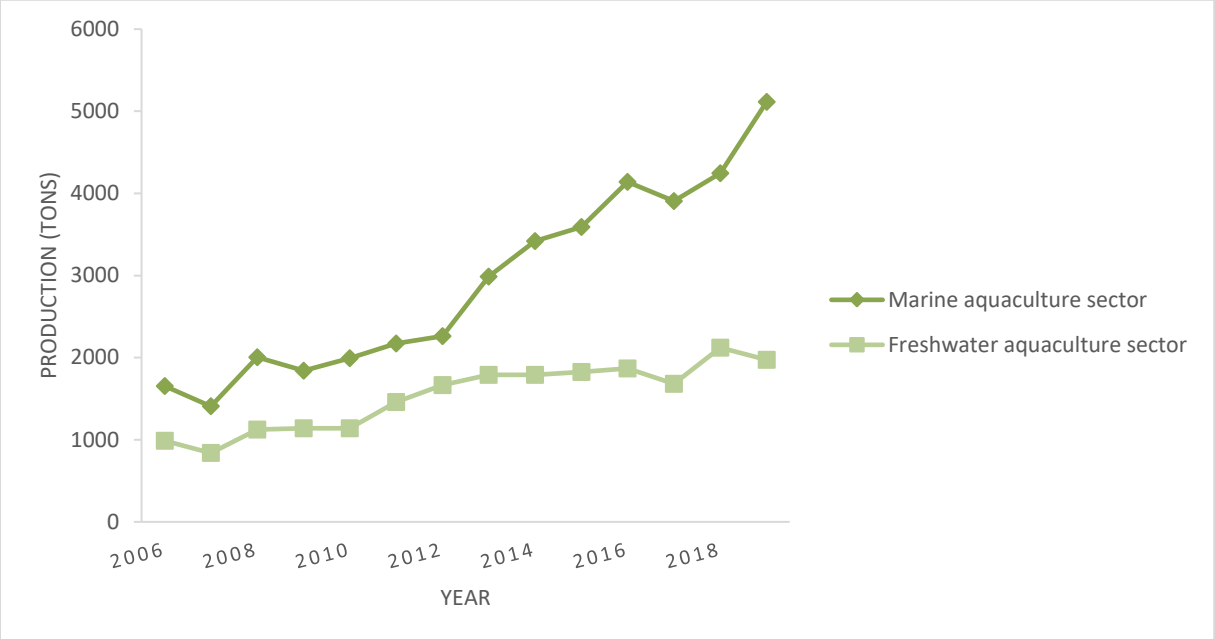


Figure 2.2: South Africa's aquaculture production growth per sector from 2006 to 2019.

STATUS OF MARINE AQUACULTURE IN 2019

03

3. STATUS OF MARINE AQUACULTURE IN 2019

3.1. Marine aquaculture farms operational during 2019

Aquaculture in the marine environment ("mariculture" or "marine aquaculture") means "the farming of marine plants and animals which is conducted in the open ocean, in enclosed sections of the ocean, or in tanks, ponds or raceways which are filled with seawater". This means that marine aquaculture sites are either directly located in the marine environment (sea-based marine aquaculture) or located on land, which abstract/utilise seawater to cultivate the produce in suitable facilities (land-based marine aquaculture).

In 2019, there were 35 marine aquaculture farms operational in South Africa, as represented in Table 3.1. The number of marine aquaculture farms operational in the Western Cape Province were 27 in 2019. The WC had the highest number of operating marine farms in 2019, comprising of four (4) sub-sectors: abalone (12), finfish (2), oyster (5) and mussel (12). The number of marine aquaculture farms operating in the Eastern Cape Province were four (4) in 2019. The Eastern Cape had the second highest number of operating marine farms, comprising of three (3) sub-sectors, abalone (2), finfish (1) and oyster (2). The Northern Cape province comprised of two (2) sub- sectors; abalone (2) and oyster (1). The KwaZulu-Natal province had the least number of farms with only one (1) finfish farm in operation. The total number of farms operating in the Eastern Cape and Northern Cape provinces include abalone ranching operations, two (2) farms in the Northern Cape province and one (1) farm in the Eastern Cape province. The Western Cape province has most of the marine aquaculture farms accounting for 77.00% of South African marine farms, followed by the Eastern Cape province accounting for 12.00%, Northern Cape accounting for 8.00% and KwaZulu-Natal accounting for 3.00% (Figure 3.1).

Table 3.1: Total number of marine aquaculture farms operating in South Africa by sub-sector and province in 2019.

Operational farms per species and province (2019)					
Species	**EC**	**KZN**	**NC**	**WC**	**Total**
Abalone	2	0	2	12	16
Finfish	1	1	0	1*(2)	3*(4)
Mussels	0	0	0	11	11
Oysters	1	0	1	3*(5)	5*(7)
Total	**4**	**1**	**3**	**27(30)**	**35**

*(2) two farms cultured mussels and oysters; however, the farms have been captured under the primary species which is mussels.

*(1) one farm cultured finfish; however the farm has been captured under the primary species which is abalone

Note: Number of farms based data reported to the Department of Forestry, Fisheries and the Environment. Seaweed farms were excluded.

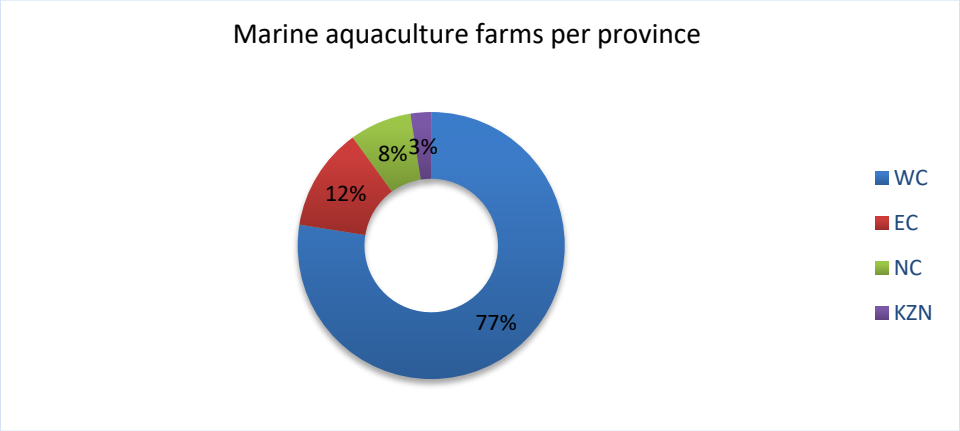


Figure 3.1: Marine aquaculture farms per province.

3.2. Marine aquaculture species farmed during 2019

In 2019 there were various marine species cultured at different operation scales as outlined in Table 3.2. Marine aquaculture species cultured at commercial scale included abalone (*Haliotis midae*), pacific oyster (*Crassostrea gigas*), mussels (*Mytilus galloprovincialis* and *Choromytilus meridionalis),* dusky kob (*Argyrosomus japonicas*), East coast rock lobster (*Panulirus Homarus*) and seaweed, (*Ulva* spp and *Gracilaria* spp). The DFFE conducted research on potential species during 2019; these species were held at the Aquaculture Research Facility in Sea Point (Cape Town) and included the following species, white stumpnose (*Rhabdosargus globiceps*), south coast sea urchin (*Tripneustes gratilla*), the South African scallop (*Pecten sulcicostatus*), spotted grunter (*Pomadasys commersonni*) and clams (*Venerupis corrugatus*). A number of aquaculture species were kept on farm premises for pilot and

research purposes. These species included ocean reared rainbow trout (*Oncorhynchus mykiss*).

Table 3.2: Marine aquaculture species and their operational scale in South Africa during 2019

Marine aquaculture species in South Africa during 2019		
Common name	**Scientific name**	**Production 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
East coast rock lobster	*Panulirus homarus*	Commercial
Ocean trout / Stealhead trout	*Oncorhynchus mykiss*	Pilot
White stumpnose	*Rhabdosargus globiceps*	Research
Spotted grunter	*Pomadasys commersonni*	Research
South coast sea urchin	*Tripneustes gratilla*	Research
South African scallop	*Pecten sulcicostatus*	Research
Clams	*Venerupis corrugatus*	Research

3.3 Marine aquaculture production

3.3.1. Marine aquaculture production in 2019

The analysis of marine aquaculture production excludes seaweed, which in South Africa is used as abalone feed. South Africa's total marine aquaculture production in 2019 was 5112.79 tons. Table 3.3 below illustrates the total production per sub-sector in each province. In 2019, the Western Cape Province recorded a production of 4837.88 tons and was the main contributor of South Africa's total marine aquaculture production followed by the Eastern Cape and Northern Cape provinces with a production of 252.91 and 14.94 tons respectively. KwaZulu-Natal province was the lowest contributor, recording a production of 7.06 tons.

Table 3.3: 2019 total marine aquaculture production per sub-sector and province

Sub-sector	EC	KZN	NC	WC	Total
Abalone	157.88	0.00	14.94	1483.71	**1656.53**
Finfish	0.00	7.06	0.00	13.04	**20.10**
Mussel	0.00	0.00	0.00	3053.46	**3053.46**
Oyster	95.03	0.00	0.00	287.67	**382.70**
Total	**252.91**	**7.06**	**14.94**	**4837.88**	**5112.79**

South Africa's total marine aquaculture production increased by 868.43 tons from 4244.39 tons recorded in 2018. The marine sector contributed 72.16% to the overall aquaculture production of 7085.68 tons. Figures 3.2 and 3.3 below illustrate contribution by each species to the total marine aquaculture and the current year's comparison to the 2018 contribution. The abalone sub-sector contributed 23.38% towards the overall aquaculture sector and contributed 32.40 % towards the marine aquaculture sector in 2019 demonstrating an increase of 134.34 tons (8.83%) from 2018. The finfish sub-sector contributed 0.28% towards the overall aquaculture sector and contributed 0.39% towards the marine aquaculture sector in 2019 demonstrating a decrease of 53.70 tons (72.76 %) from 2018. The mussel sub-sector contributed 43.09% towards the overall aquaculture sector and contributed 59.72% towards the marine aquaculture sector in 2019 demonstrating an increase of 871.33 tons (39.93%) from 2018. The oyster sub-sector contributed 5.40% towards the overall aquaculture sector and contributed 7.49% towards the marine aquaculture sector demonstrating a decrease of 83.53 tons (17.92) from 2018. Seaweed total production recorded in 2019 is 2154.54 tons. However, the seaweed production data was excluded in the 2019 total production data due to inconsistent reporting of this subsector.

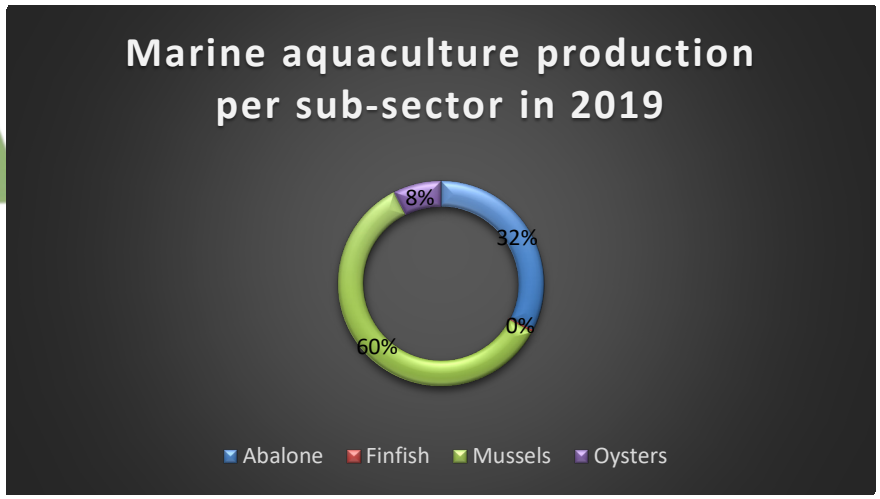


Figure 3.2: Contribution of each marine aquaculture sub-sector to total marine aquaculture production in 2019

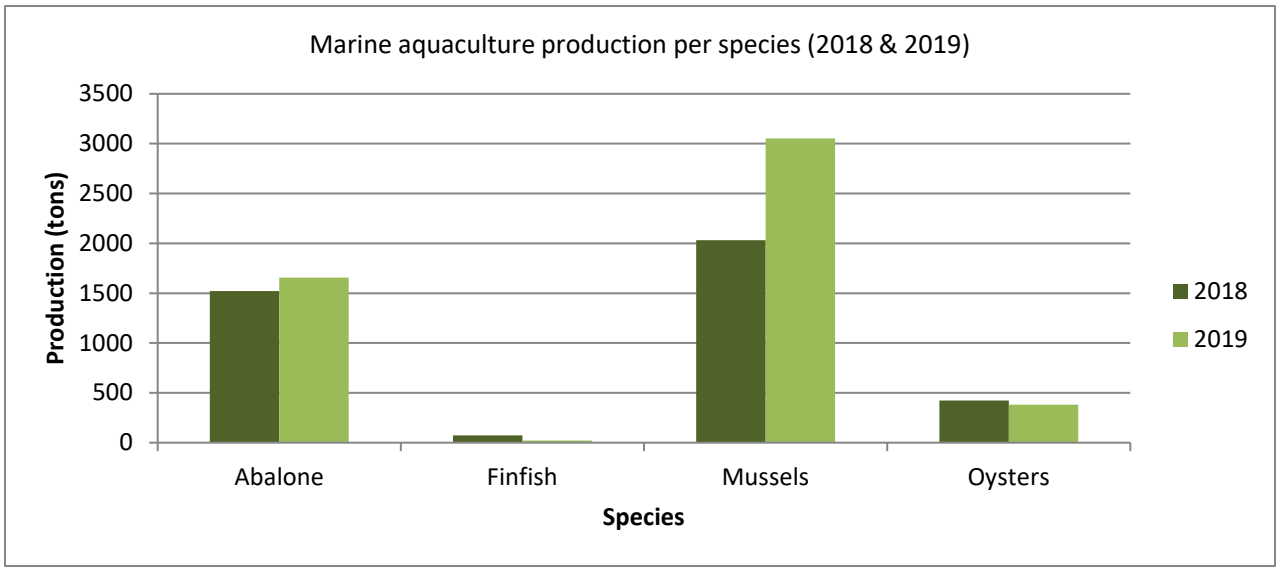


Figure 3.3: Production of marine aquaculture species for 2018 and 2019

3.3.2. Marine aquaculture production trend from 2000-2019

Marine aquaculture production has shown a rapid growth since the year 2000 (Figure 3.4). The industry has recorded a total production of 48003.19 tons as per Table 3.4 below. The industry's production has increased by 3315.31 tons since 2000 (Table 3.4 below). Over the last 20 years, the lowest production volume recorded was 929.08 tons recorded in the year 2000 with the highest production volume being 5112.82 tons recorded in 2019 (Table 3.4). Over the last 15 years, the lowest production volume was 1319.39 tons recorded in 2005. Over the last 10 years the lowest production recorded was 1992.10 tons was recorded in 2010. Over the past five (5) years the lowest production recorded was 3591.86 tons recorded in the year 2000. The marine aquaculture industry is represented by the abalone, mussel, oyster and finfish sub-sectors; with abalone and mussel sub-sectors contributing the largest share over the past 20 years (Figure. 3.4. and Figure 3.5. (A – D)). Over the past five (5) years the mussel sub-sector has shown significant growth contributing 3053.46 tons in 2019. Abalone is the second largest contributor contributing 1656.46 tons in 2019.

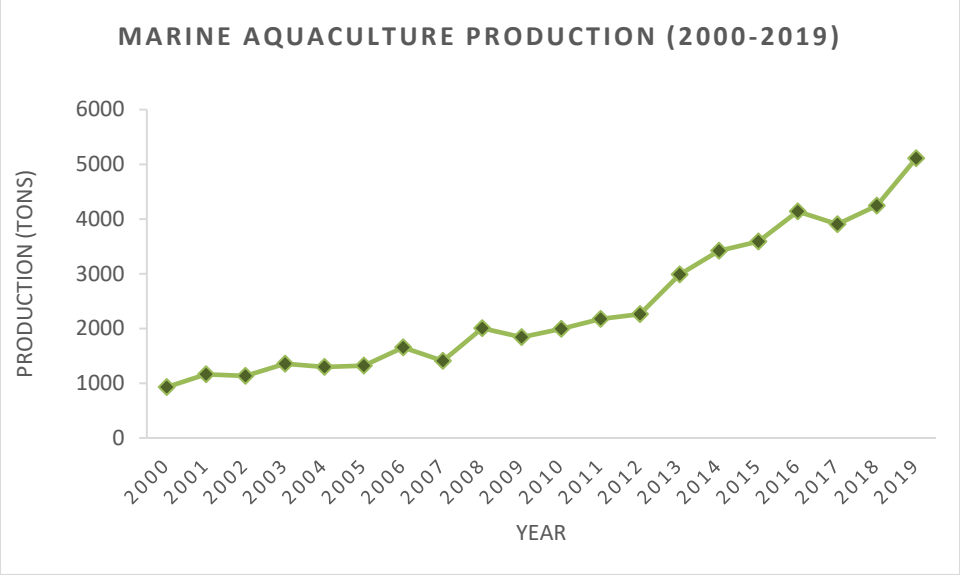
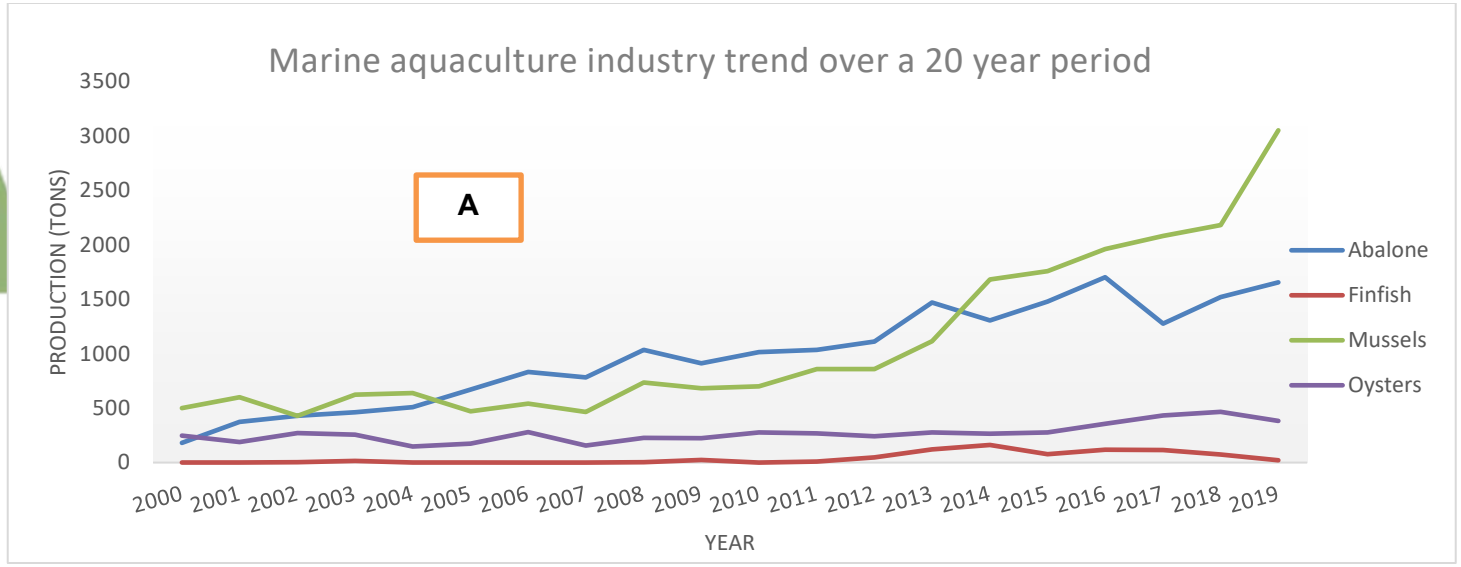
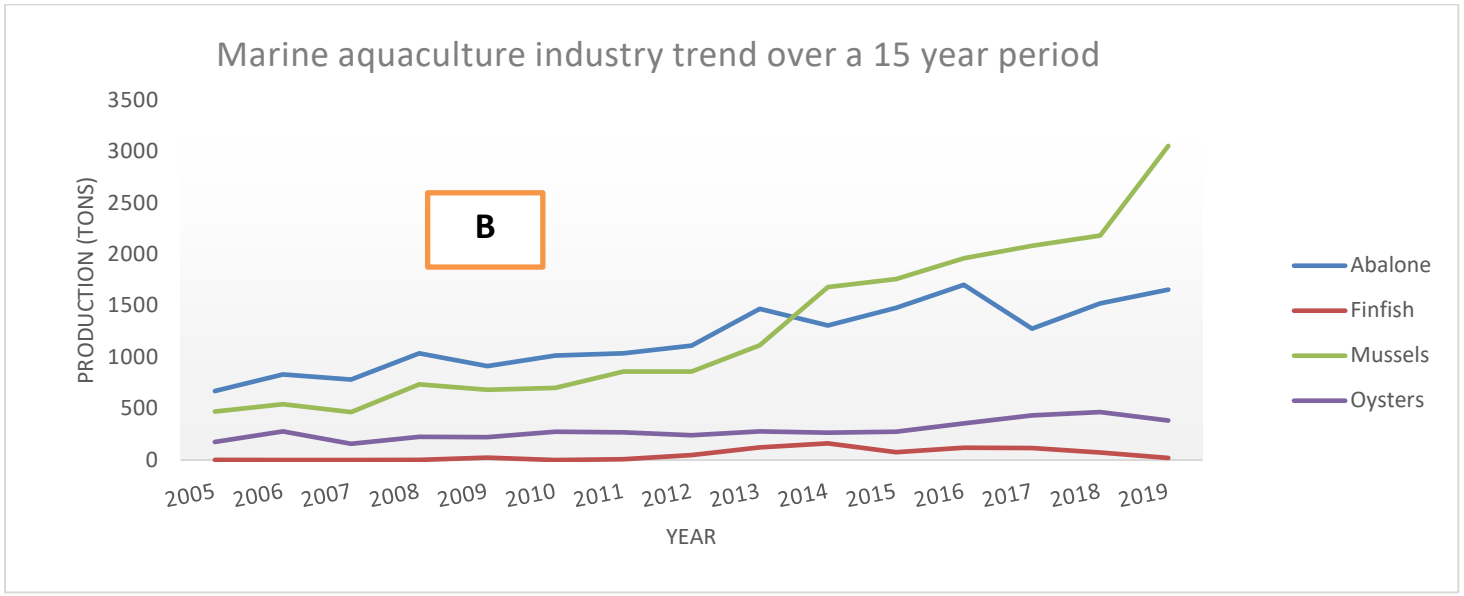
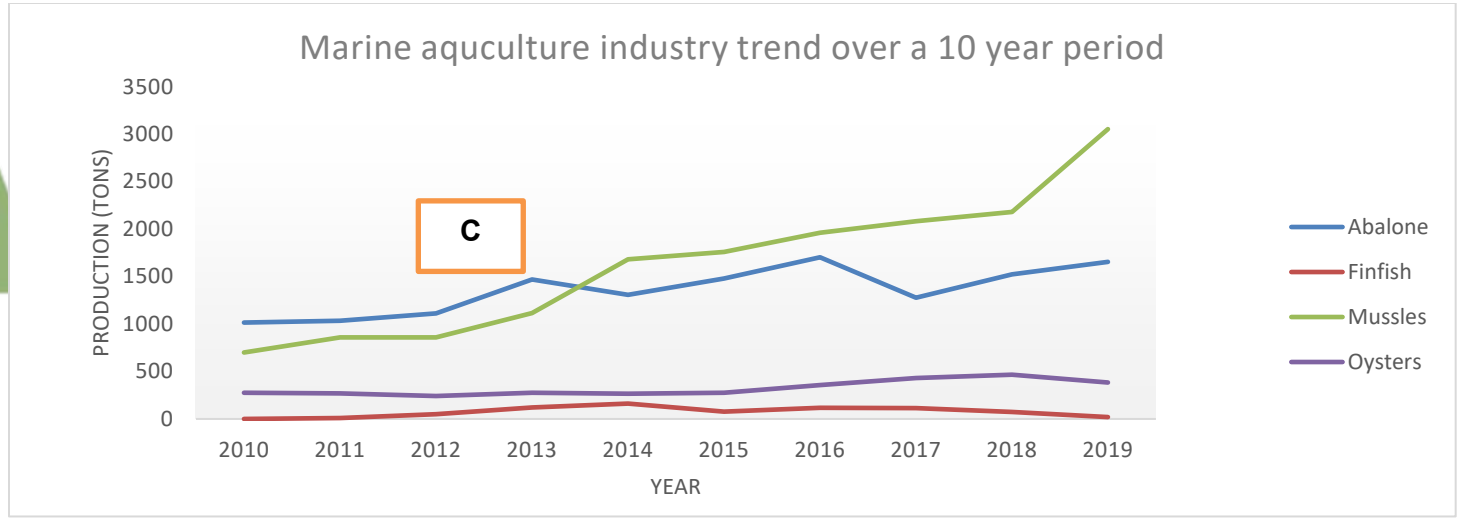


Figure 3.4.: Marine aquaculture production from 2000-2019


Marine aquaculture industry trend over a 20 year period
PRODUCTION (TONS)
3500
3000
2500
2000
1500
1000
500
0
A
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
YEAR
Abalone
Finfish
Mussels
Oysters


Marine aquaculture industry trend over a 15 year period
PRODUCTION (TONS)
3500
3000
2500
2000
1500
1000
500
0
B
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
YEAR
Abalone
Finfish
Mussels
Oysters



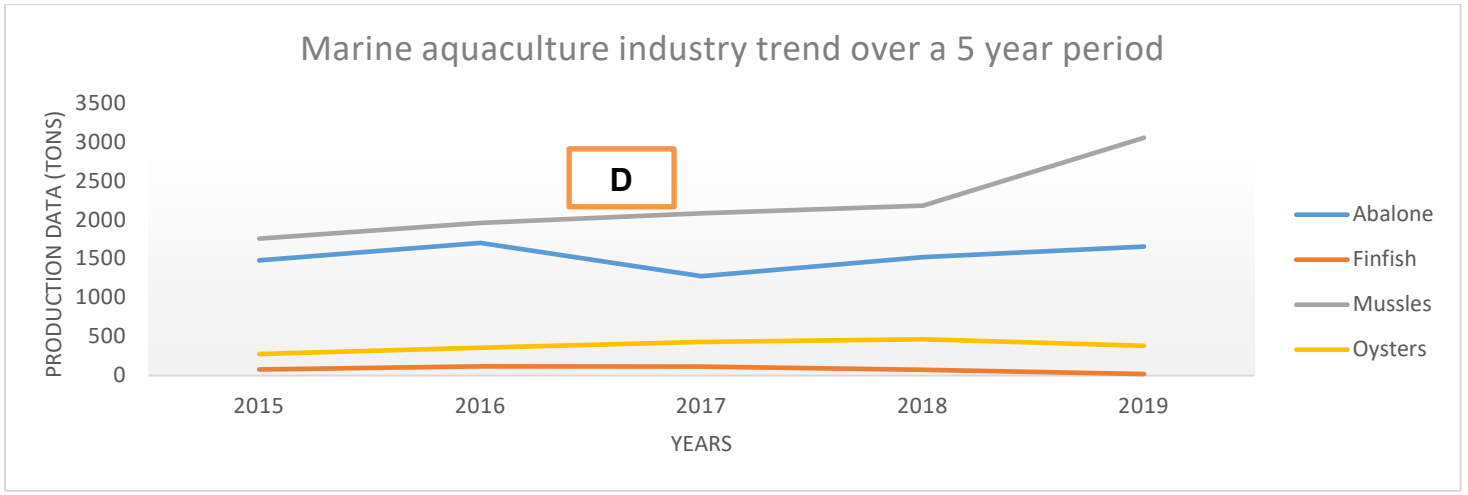


Figure 3.5 (A – D) Marine aquaculture industry trend over the past 20, 15, 10 and 5 years

Table 3.4: Marine aquaculture production 2000 – 2019 per sub-sector (*Total excludes seaweed)

	Year and Production data																			Total Production (tons)	
Sub-sector	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2000 -2019
Abalone	181.03	372.88	429.42	462.02	509.20	670.80	833.36	783.25	1037.11	913.58	1015.40	1036.00	1111.40	1469.80	1306.80	1479.22	1703.32	1276.06	1522.22	1656.56	19778.93
Finfish	1.04	0.3	2.38	14.00	1.81	1.68	0.00	0.00	2.71	22.75	0.00	8.00	48.50	122.50	161.90	77.32	118.64	115.56	73.81	20.10	794.09
Mussels	500.00	600.00	429.11	623.00	640.00	472.00	542.00	466.00	736.74	682.40	700.10	859.80	859.80	1116.10	1682.50	1758.47	1960.95	2083.52	2182.13	3053.46	21796.98
Oysters	247.01	187.53	272.10	255.24	147.66	174.91	279.87	157.86	226.62	223.53	276.60	269.30	241.60	277.0	266.40	276.85	357.27	432.66	466.66	382.70	5633.17
Seaweed	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*664.00*	*0.00*	*1833.49*	*1900.18*	*2015.00*	*2884.60*	*2000.00*	*0.00*	*1643.60*	*0.00*	*1114.40*	*862.07*	*1687.07*	*2154.54*	*18758.97*
Total	**929.08**	**1160.71**	**1133.01**	**1354.26**	**1298.67**	**1319.39**	**1655.23**	**1407.11**	**2003.18**	**1842.26**	**1992.10**	**2173.10**	**2261.30**	**2985.60**	**3417.60**	**3591.86**	**4140.18**	**3907.80**	**4244.39**	**5112.79**	**48003.19**

Disclaimer: Data reported is based on data reported to the Department by the industry.

z

3.4. Marine aquaculture analysis per sub-sector

3.4.1. Abalone sub-sector

The abalone species currently being cultivated in South Africa is *Haliotis midae*. In 2019, the abalone sub-sector has increased by 134.34 tons (8.83%) from 2018 recording a total of 1656.56 tons (32.3%) to South Africa's total marine aquaculture production (Figure 3.6). Favourable environmental conditions as well as the well-established infrastructure has contributed to the continuous growth of this sector. The abalone sub-sector comprised of 16 farms in 2019 compared to 12 farms which were operational in 2018. The abalone sub-sector distribution range stretches from the Northern Cape province and Western Cape province to the Eastern Cape province. Two (2) farms were operating in the Northern Cape province, two (2) in Eastern Cape province and 12 in Western Cape province with one (1) farm operating as an abalone hatchery. The production systems utilized within this sector include a flow-through, semi-recirculating aquaculture system, cage culture and ranching. In the Western Cape province abalone farming is represented by 12 farms operating as flow-through operations and one (1) farm operating as a cage culture operation. In the Northern Cape province one (1) farm is operating using as a flow-through system, one (1) farm operating as a semi-Recirculating Aquaculture System (RAS) and one (1) farm operating as ranching operations. In the Eastern Cape province abalone farming is represented by one (1) farm operating as a flow-through operation and one (1) ranching operation.

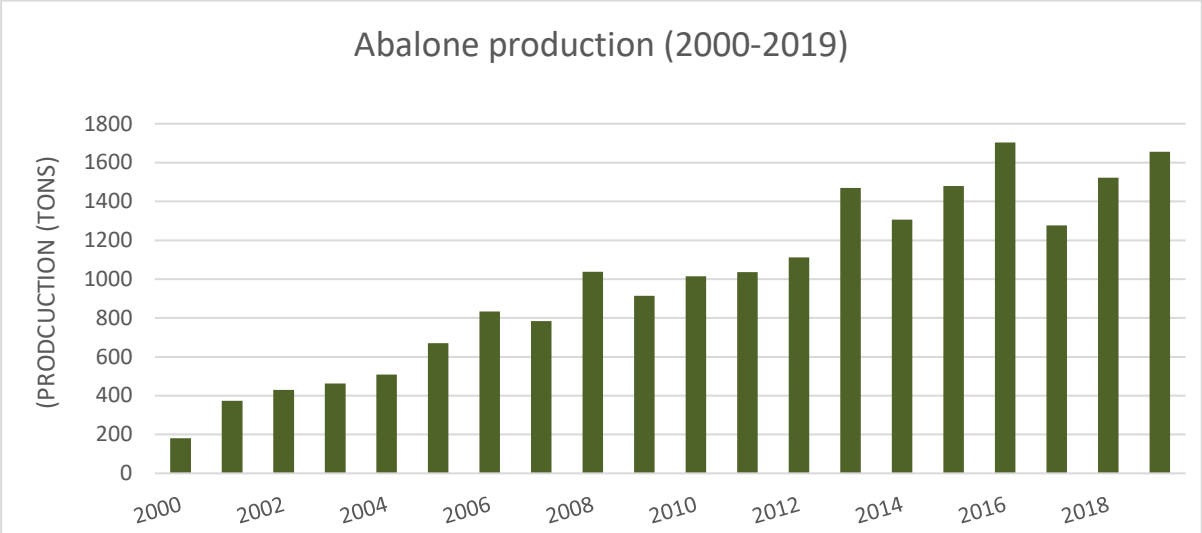


Figure 3.6: Abalone production in South Africa from 2000-2019

z

3.4.2. Finfish sub-sector

The finfish sub-sector in South Africa is an emerging industry and it shows great potential in terms of production, however a number of operations have not been feasible due to the lack of market, technology and their location. During 2019 the sub-sector contributed a production total of 20.10 tons (0.39%) to the total marine aquaculture production (Figure 3.7). Compared to 2018, the finfish sub-sector has decreased by 53.70 tons (72.76 %).

A total of four (4) finfish aquaculture farms were operational in 2019. Finfish farming in the WC is represented by two (2) farms; cage culture system situated in Saldanha Bay and a semi - RAS, one (1) pond culture facility in KwaZulu-Natal province and one (1) RAS facility in the Eastern Cape province.

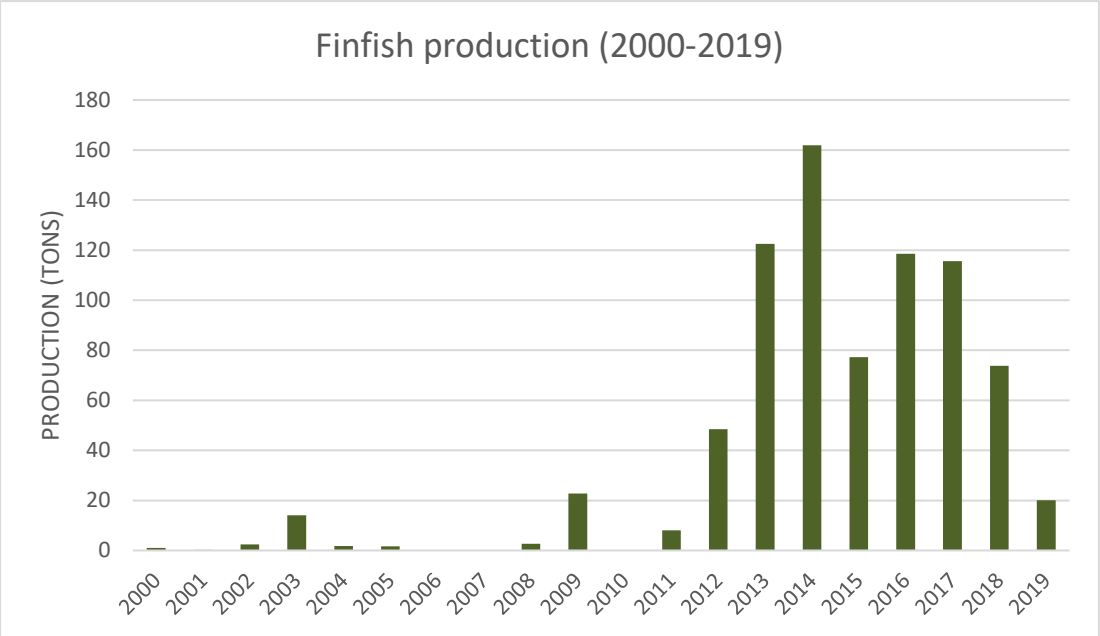


Figure 3.7: Finfish production in South Africa from 2000-2019

3.4.3. Mussel sub-sector

In 2019, there were 12 mussel farms operational compared to the 11 farms that were operational in 2018. The species cultured in South Africa are the exotic Mediterranean mussel (*Mytilus galloprovincialis*) and the indigenous black mussel (*Choromytilus meridionalis*). The mussels sub-sector recorded an increase of 871.33 tons (39.39%) tons thereby contributing a total production of 3053.46 tons (59.72%) to the total marine aquaculture as compared to the 2182.13 tons of mussels produced in 2018 (Figure 3.8). The mussel sub-sector is the highest contributor in term of biomass to aquaculture in South Africa. The sub-sector is entirely represented by the Western Cape province with nine (9) longline culture operations and three (3) raft culture operations.

z

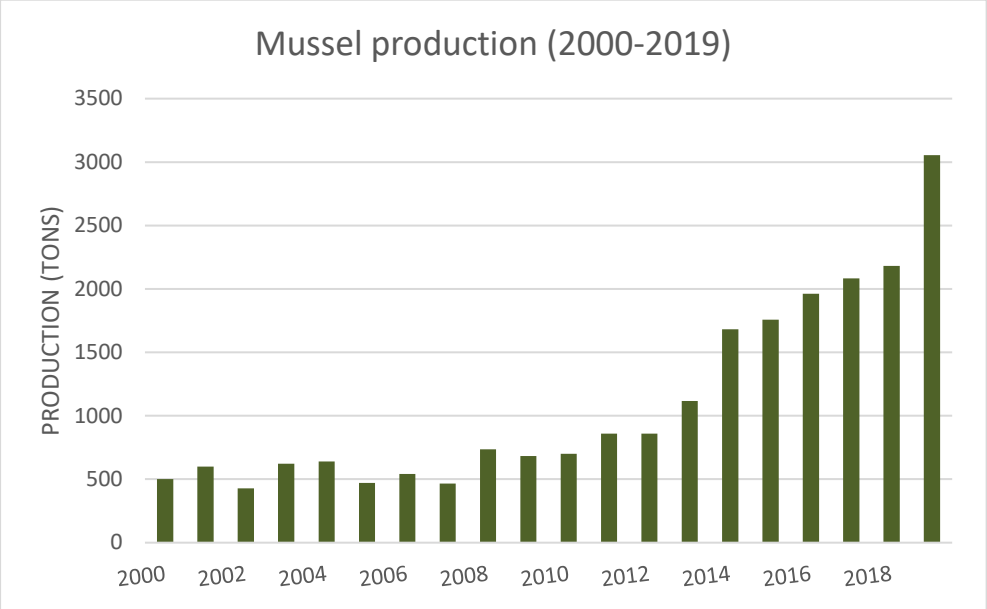


Figure 3.8: Mussel production in South Africa from 2000-2019

3.4.4 Oyster sub-sector

The species cultivated in South Africa is the exotic Pacific oyster (*Crassostrea gigas*). In 2019 the sub-sector recorded a production of 82.70 tons (17.92 %) (Figure 3.9) towards the overall marine aquaculture production therefore demonstrating a decrease of 83.92 tons (7.48 %) from 2018. A total of seven (7) oyster aquaculture farms were operational in 2019. The production systems utilized in this sector include longlines and rafts. Oyster production in the Western Cape province is represented by three (3) longline systems and one (1) raft system. In the Northern Cape province oysters were cultivated using longline systems whereas the Eastern Cape province is represented by one (1) long line systems and (1) one raft system.

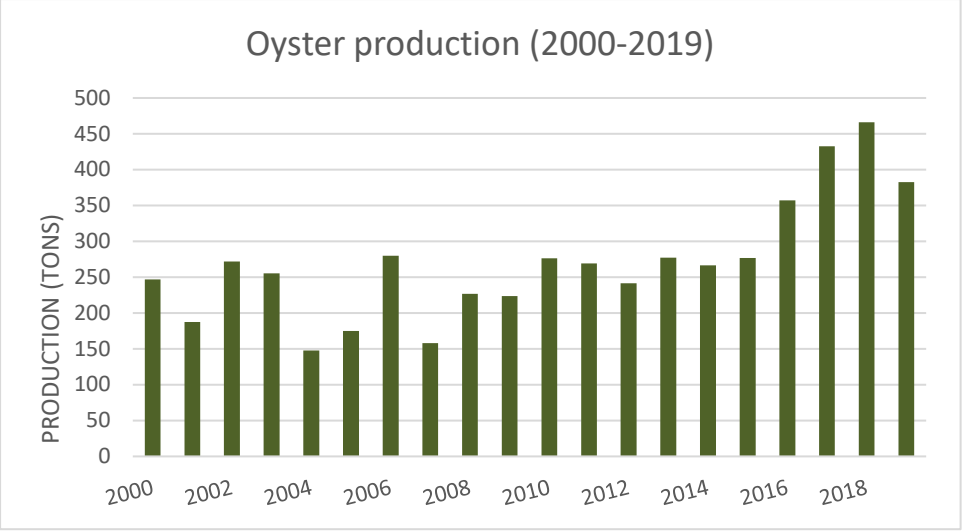


Figure 3.9: Oyster production in South Africa from 2000-2019

3.5. Marine aquaculture authorisations in 2019

The marine aquaculture sector is regulated under the Marine Living Resources Act, 1998 (Act 18 of 1998) (MLRA). The MLRA provides a regulatory framework for the conservation of ecosystems, the sustainable utilization, and protection of marine living resources. Even though marine aquaculture is

z

more developmental focused, it forms part of activities that are regulated in terms of the MLRA due to its utilisation of the marine living resources. It continues to be regulated in the form of issuing of Rights, Permits and Exemptions where necessary in terms of the MLRA. The then Department of Agriculture, Forestry and Fisheries (DAFF) have embarked on a process of drafting new legislation for the aquaculture sector. The development of the Aquaculture Development Bill will create an enabling environment and regulatory framework for both marine and freshwater aquaculture sectors in South Africa.

3.5.1. 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 2019, two (2) new marine aquaculture rights were granted in the Western Cape province and Eastern Cape province, respectively (Table 3.5). Applications for a marine aquaculture right can be submitted to the Department on a continuous basis. The application process is open to any individual with a registered business entity that has shown an interest in undertaking an aquaculture activity. The applicant must meet the criteria as set out in the application process and provide the relevant supporting documentation as required. The completed application with all supporting documentation is assessed by the Marine Aquaculture Working Group (MAWG), which will recommend approval to the delegated authority or request any outstanding requirements. Once approval is granted, the applicant will then be issued with a marine aquaculture right and will proceed to apply for a permit to engage in marine aquaculture.

Table 3.5 Rights to engage in marine aquaculture granted in 2019

Company Name	Operational Area	Species	Duration of Right
Kingfish Enterprises (Pty) Ltd	Erf 60891 Ikhala Road, East London Industrial Development Zone (ELIDZ) Sunnyridge East London	**Dusky kob:** *Argyrosomus japonicas* **Yellowtail:** *Seriola lalandi*	21/11/2019 – 21/11/2034
Southern Cross Salmon Farming (Pty)	30 hectares of sea space, portion of 20	**Mussels:** *Mytilus galloprovincialis;Choromytilus*	01/01/2019 –

z

Ltd	hectares in the North Bay, 10 hectares of Saldanha Bay, Saldanha, Western Cape	*meridionalis*	01/01/2034

3.5.2. Exemptions

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 (FPEs) operate under an exemption due to institutional delays in the granting of FPE rights for the marine aquaculture sector. Exemptions for "the possession and sale of undersized abalone and kob" (herein referred to as "local sales permits") are granted to allow for the local sale of undersized cultured products due to legal size limits implemented under the MLRA for wild caught products. The granting of an exemption is a legislative process that is used as a mechanism to allow for the local sale of undersized cultured products.

3.5.3. Permits

To legally use 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 2019, a total of 282 marine aquaculture permits were issued in South Africa to marine aquaculture right holders, agencies, importers, exporters, FPEs, and transportation companies (Table 3.6). The number of permits issued for exports exceeded the number of permits issued for imports in 2019 of marine aquaculture products. There were 38 permits issued to "possess and sell undersized cultured abalone" in 2019. The local market for cultured abalone is still small due to a number of challenges, including the need for adequate traceability and compliance monitoring to reduce the risk of illegal abalone flooding the market. The suppressed export market could also result in excess stock being sold locally, however the demand of cultured abalone on the local market still exists.

z

Table 3.6: Permits issued for 2019 in the marine aquaculture sector as per Section 13 of MLRA, 1998 (Act no. 18 of 1998)

No.	Permit type	No. of Permits issued
1.	Permit to Import Marine Species & Products (For consumption)	59
2.	Permit to Imports Ornamental species (For non-consumption)	24
3.	Permit to Export Cultured Marine species & Products (For consumption and non-consumption Public Aquariums only)	76
4.	Permit to Transport Cultured Marine Species & Products	10
5.	Permit to Engage in Marine Aquaculture Activities	35
6.	Permit to Possess Broodstock and Operate a Hatchery	9
7.	Permit to Possess and sell Undersized Cultured Abalone obtained from Right holder	38
8.	Permit to possess and sell undersized kob obtained from a Right Holder	0
9.	Permit to Engage in Abalone Ranching and Stock Enhancement Pilot Project: Seeding	5
10.	Permit to Engage in Ranching Activities of Marine Species: Harvesting	4
11.	Permit to Collect Broodstock for Marine Aquaculture purposes	0
12.	Permit to Operate a Fish Processing Establishment	17
13.	Permit to conduct Scientific Investigations and Practical Experiments	4
14.	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)	1
Total		**282**

3.6. Site surveillance of the marine aquaculture sector in 2019

Site visits are conducted annually by the Directorate: Sustainable Aquaculture Management to marine aquaculture farms when required on an *ad hoc* basis. It has played a vital role since 2008 in updating information on growth and development in the sector by ensuring compliance with the Department's marine aquaculture permitting frameworks and regulations promulgated under MLRA. The purpose of the site visits are to ensure compliance with permit conditions on animal health (e.g. biosecurity audit), food safety (e.g. annual European Union (EU) food safety audit), and reporting requirements. The site visits are also important to obtain information on any changes in shareholding, culture techniques, and expansion activities in the marine aquaculture sector. This has been essential in ensuring that non - compliant operations are communicated through proper channels such that the Chief Directorate: Monitoring, Control and Surveillance 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. The majority of fully established marine aquaculture operations have FPEs on site, which are

z

also required to comply with the necessary permit conditions.

In 2019, the Department conducted site surveillance of the marine aquaculture finfish, abalone, and bivalve sectors to existing operations situated in the Western Cape, Northern Cape, KwaZulu-Natal, and the Eastern Cape provinces as shown in Table 3.7 below.

Table 3.7: Number of marine aquaculture operations visited in the EC, NC, and the WC in 2019

Province	Sector			
	Abalone	Mussels	Oysters	Finfish
EC	0	0	1	1
NC	1	0	1	0
WC	0	9	4	1

In addition, abalone (2) abalone ranching pilot projects were visited in the Northern Cape province operating in concession areas NC2 and NC3. The Department would like to ensure the continuous open channel for communication from the marine aquaculture sector through the continued support provided in implementing site surveillance. The Directorate: Sustainable Aquaculture Management is working closely with other units in the Chief Directorate: Aquaculture and Economic Development (e.g. Operation Phakisa Delivery Unit and Directorate: Aquaculture Technical Services) when updating information on the status of the marine aquaculture sector.

STATUS OF FRESHWATER AQUACULTURE IN 2019

04

z

4. STATUS OF FRESHWATER AQUACULTURE IN 2019

4.1. Freshwater aquaculture farms in 2019

South Africa's freshwater aquaculture takes place in all nine (9) provinces. However, the department does not have an overarching legislation which enables government to collect data from the industry. Therefore it is important to note that the information reflected on this chapter is based on the reported data only and may not be a true reflection of the entire freshwater aquaculture sector.

The country continued to operate its freshwater fish production from 190 farms during the year 2019 as was during 2018. Although there were no increase or decrease in number of farms within the sector, there were seven (7) closures and seven (7) new entries experienced with other species. Of the 190 farms, thirty seven (37) of the farms were recorded from Gauteng province comprising of one (1) catfish, one (1) common carp, nine (9) ornamentals, twenty three (23) tilapia and three (3) trout. Further to that, thirty four (34) of the farms were recorded from Western Cape province, comprising of one (1) common carp, two (2) ornamentals, one (1) tilapia and thirty (30) trout. In Mpumalanga province, twenty eight (28) the farms were operating and comprised of one (1) catfish, three (3) ornamentals, twelve (12) tilapia and trout; and Limpopo province with twenty seven (27) farms which were comprised of four (4) catfish, one (1) common carp, one (1) ornamental and twenty one (21) tilapia. In the fifth place, was North West province with twenty four (24) of the farms which comprised of three (3) catfish and twenty one (21) tilapia; followed by KwaZulu-Natal province in the sixth place with nineteen (19) farms which comprised of two (2) catfish, seven (7) ornamentals, five (5) tilapia and five (5) trout, while the Eastern Cape province operated with ten (10) farms which comprised of two (2) catfish, two marron crayfish, two (2) ornamentals, three (3) tilapia and one (1) trout. Free State province operated with eight (8) farms which comprised of four (4) catfish and four (4) ornamentals while Northern Cape province operated with three (3) farms which two (2) common carp and one (1) tilapia. The total number of the operated farms are outlined in Table 4.1 and Figure 4.1 below.

z

Table 4.1: Total number of freshwater aquaculture farms operating in South Africa by sub-sector and province in 2019.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Catfish	2	4	1	2	4	1	0	3	0	17
Common carp	0	0	1	0	1	0	2	0	1	5
Marron Crayfish	2	0	0	0	0	0	0	0	0	2
Ornamentals	2	4	9	7	1	3	0	0	2	28
Tilapia	3	0	23	5	21	12	1	21	1	87
Trout	1	0	3	5	0	12	0	0	30	51
Total	**10**	**8**	**37**	**19**	**27**	**28**	**3**	**24**	**34**	**190**

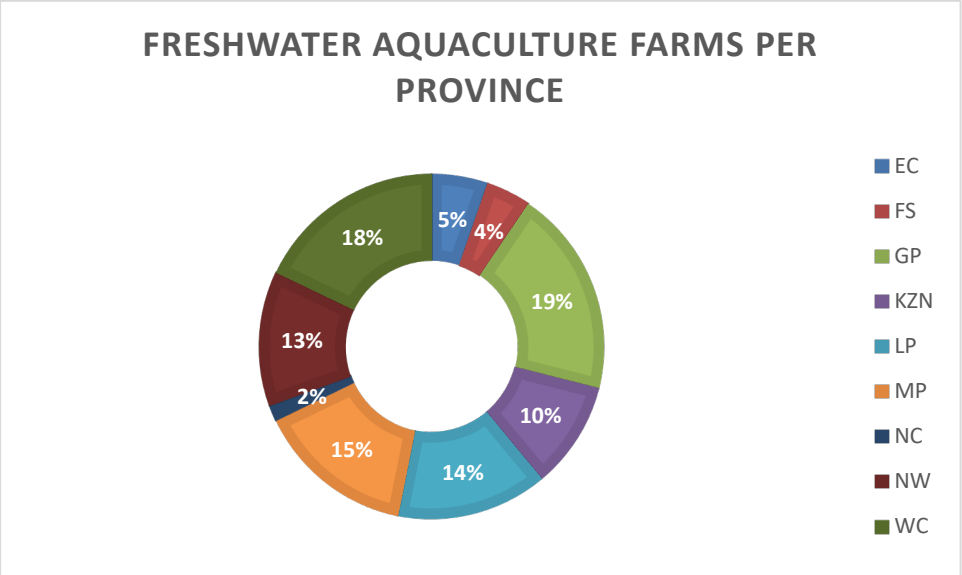


Figure 4.1: Freshwater aquaculture farms per province.

4.2. Freshwater aquaculture species farmed in 2019

The 2019 freshwater aquaculture sub-sectors included trout (*Onchorynchus mykiss* and *Salmo trutta*), tilapia (*Oreochromis mossambicus* and *Oreochromis niloticus*), catfish (*Clarias gariepinus*), carp (*Cyprinus carpio* and *Ctenopharyngodon idella)*, marron crayfish (*Cherax tenuimanus),* and a number of ornamental species, including koi carp. Table 4.2 below outlines various freshwater fish species farmed at different operation scales in 2019.

z

Table 4.2: Freshwater aquaculture species cultured in South Africa in 2019 and their operational scale.

Freshwater aquaculture species in South Africa (2019)		
Common name	**Scientific name**	**Production scale**
Rainbow trout	*Onchorynchus mykiss*	Commercial
Brown trout	*Salmo trutta*	Commercial
Mozambique tilapia	*Oreochromis mossambicus*	Small scale & research
Nile tilapia	*Oreochromis niloticus*	Commercial
African sharptooth catfish	*Clarias gariepinus*	Commercial & small scale
Common carp	*Cyprinus carpio*	Small scale
Koi carp	*Cyprinus carpio*	Small scale
Marron (freshwater crayfish)	*Cherax tenuimanus*	Small scale

4.3. Freshwater aquaculture production

4.3.1. Freshwater aquaculture production in 2019

South Africa's total freshwater aquaculture production recorded during 2019 was 1972.86 tons, with the sector experiencing a significant decrease of 148.54 tons (7.00%) from the 2121.40 tons recorded in 2018. The freshwater sector contributed 27.84% to the overall aquaculture production of 7085.68 tons. Table 4.3 below illustrates the total production per sub-sector in each province. In 2019, the Western Cape province recorded the highest production of 830.40 tons, KwaZulu-Natal recorded 423.30 tons, Mpumalanga province recorded 298.10 tons, while Gauteng province recorded 156.76 tons. The last five provinces which recorded less than 100 tons were North West province with 92.00 tons, Eastern Cape province with 84.70 tons, Limpopo province with 81.60 tons, Northern Cape province with 4.00 tons and lastly Free State with 2.00 tons.

z

Table 4.3: Production (tons) per species per province.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Catfish	51.90	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	**59.90**
Common carp	0.00	0.00	1.60	0.00	2.50	0.00	1.00	0.00	1.00	**6.10**
Marron crayfish	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.00**
Ornamentals	1.70	2.00	3.70	4.50	0.80	1.90	0.00	0.00	1.40	**16.00**
Tilapia	27.10	0.00	53.46	7.00	78.30	43.00	3.00	92.00	0.00	**303.86**
Trout	0.00	0.00	98.00	403.80	0.00	253.20	0.00	0.00	828.00	**1583.00**
Total	**84.70**	**2.00**	**156.76**	**423.30**	**81.60**	**298.10**	**4.00**	**92.00**	**830.40**	1972.86

Figures 4.2 and 4.3 below illustrate contribution by each species to the total freshwater aquaculture and the comparison of species production for the years 2018 and 2019. Although the trout sub-sector continued to be the highest freshwater species contributor with 1583.00 tons, it contributed 22.34% to the total aquaculture sector and 80.24% to the total freshwater sector. The trout sub-sector contribution demonstrated an increase of 80.00 tons (5.32%) from 2018. The tilapia sub-sector followed with a contribution of 4.29% to the total aquaculture sector and 15.40% to the freshwater aquaculture sector, demonstrating a decrease of 146.14 tons (32.48%) from 2018. The African sharptooth catfish sub-sector contributed 0.85% to the total aquaculture sector while contributing 3.04% to the freshwater aquaculture sector demonstrating an increase of 39.90 tons (two folds) from 2018.

The production of common carp has shown a decrease of 0.9 tons from the recorded 7.00 tons of 2018 and this represented a 12.86% decrease in production during 2019. The sub-sector contributed 0.09% to the total aquaculture sector and 0.31% to the freshwater aquaculture sector. The ornamentals and the marron crayfish sub-sectors did not record any increase in production from 2018 to 2019. The two sub-sectors, however, contributed 0.23% and 0.06% to the total aquaculture sector; and 0.81% and 0.20% to the freshwater aquaculture sector respectively.

z

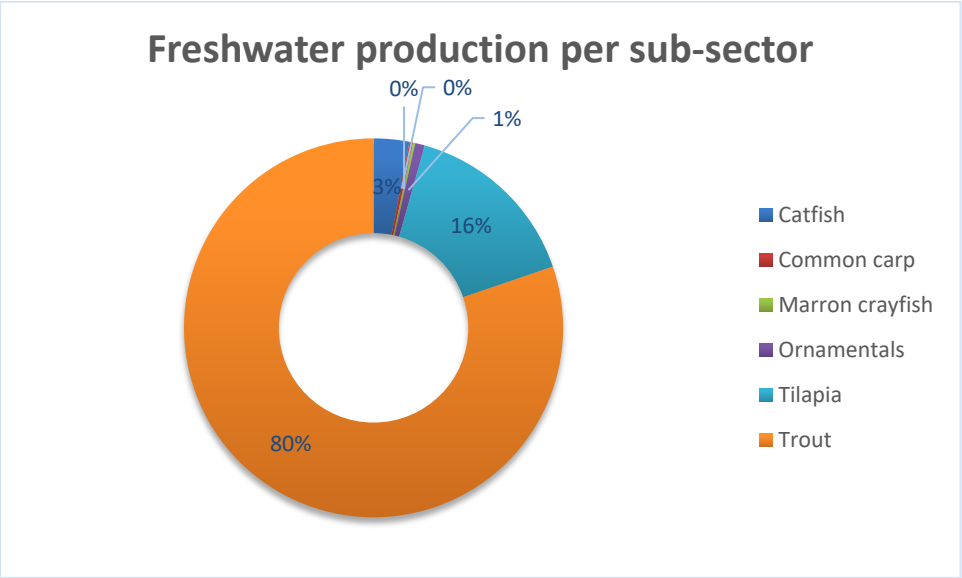


Figure 4.2: The contribution of each freshwater aquaculture sub-sector to the total production in 2019

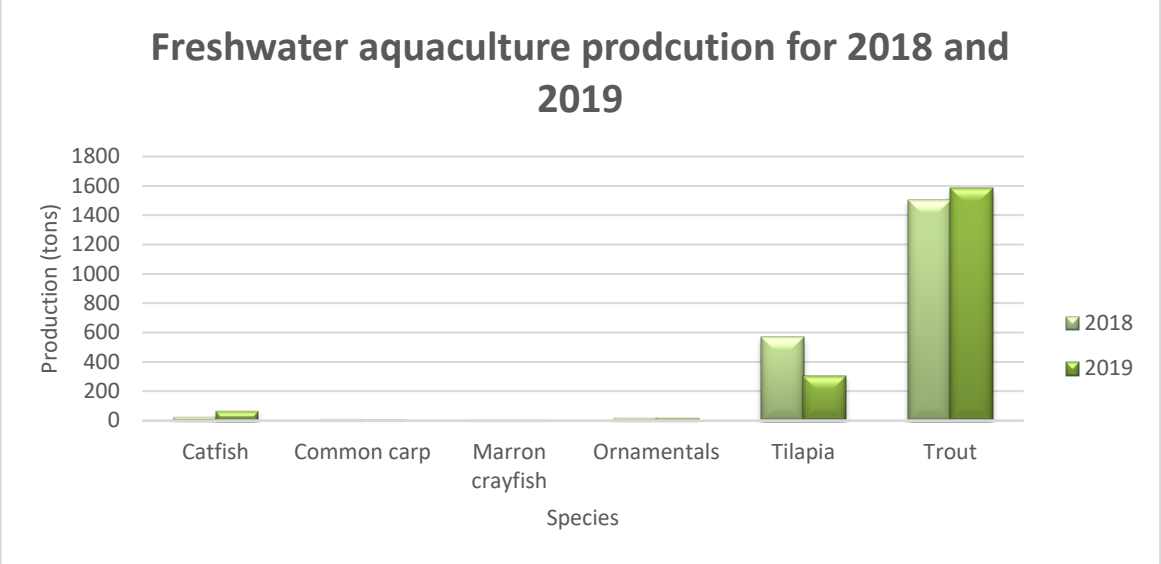


Figure 4.3: Production of freshwater aquaculture species for 2018 and 2019

4.3.2. Freshwater aquaculture production from 2006-2019

South Africa's freshwater aquaculture industry has shown a rapid growth since the year 2006. From 2006 to 2019, total production volume recorded is 21 406.68 tons. The industry's production has increased by 985.66 tons since 2006, demonstrating 99.84 % increase (Figure 4.4 below). Over the last 14 years, the lowest production volume of 838.40 tons was recorded in 2007 while the highest production volume was recorded in 2018 at 2121.4 tons (Figure 4.4, Figure 4.5A and Table 4.4).

From 2010 to 2019, total production volume recorded is 17 318.66 tons. The industry's production has increased by 832.06 tons since 2010, demonstrating 72.94 % increase (Figure 4.4 below). Over the last 10 years, the lowest production volume of 1140.80 tons was recorded in 2010

z

while the highest production volume was recorded in 2018 at 2121.4 tons (Figure 4.4, Figure 4.5B and Table 4.4).

From 2015 to 2019, total production volume recorded is 9 468.36 tons. The industry's production has increased by 146.56 tons since 2015, demonstrating 8.02% increase (Figure 4.4 below). Over the last five (5) years, the lowest production volume of 1680.70 tons was recorded in 2017 while the highest production volume was recorded in 2018 at 2121.4 tons (Figure 4.4, Figure 4.5C and Table 4.4).

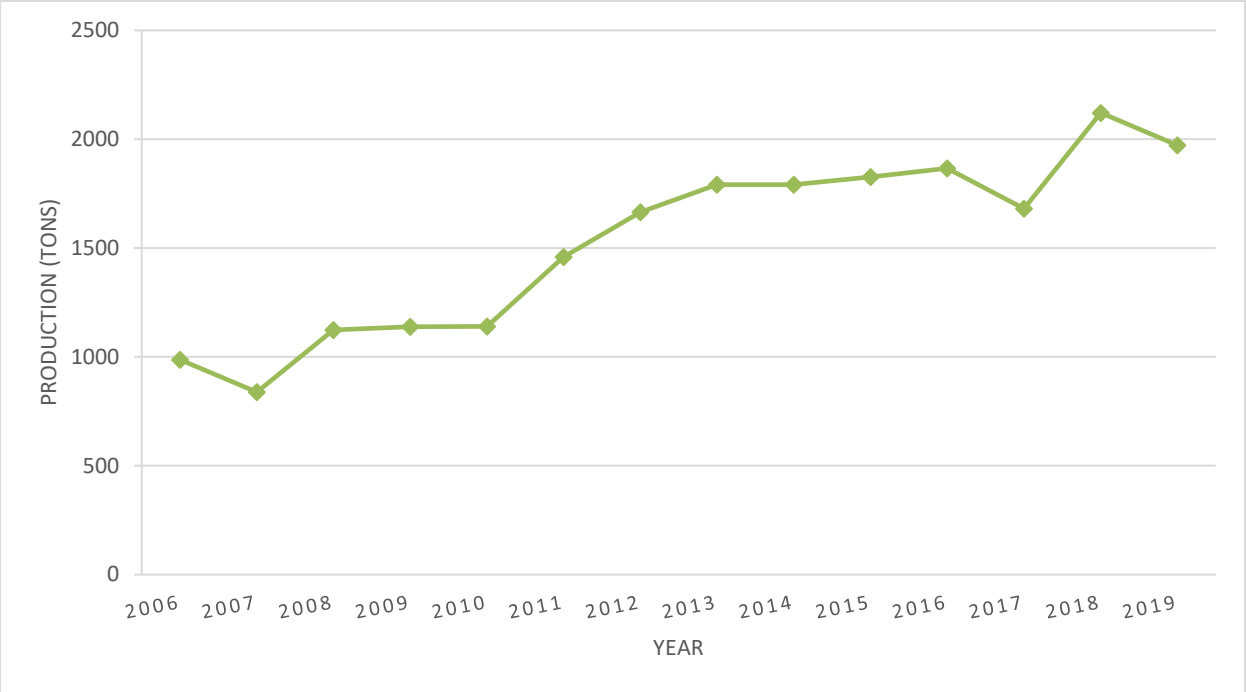
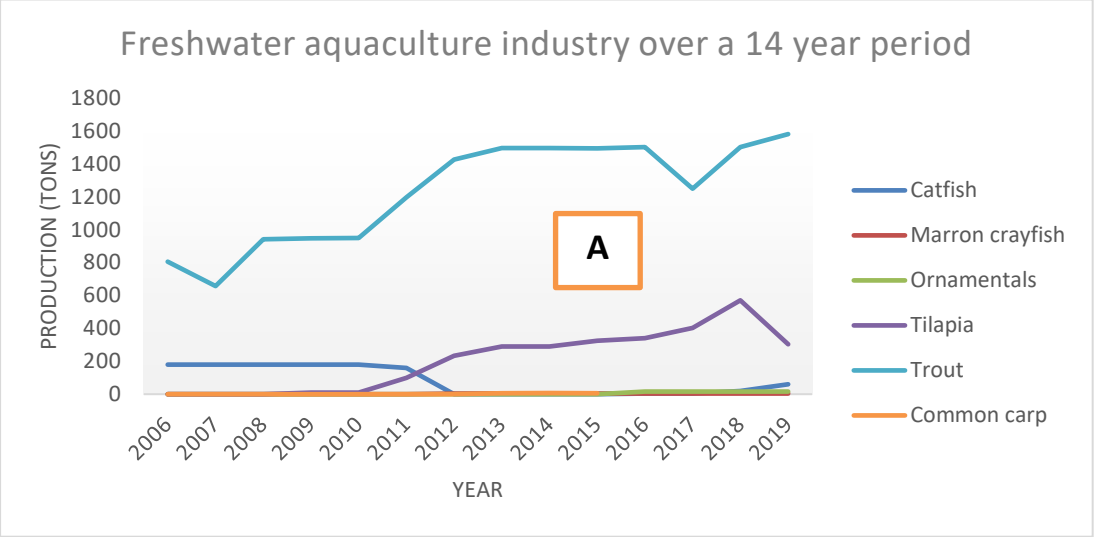
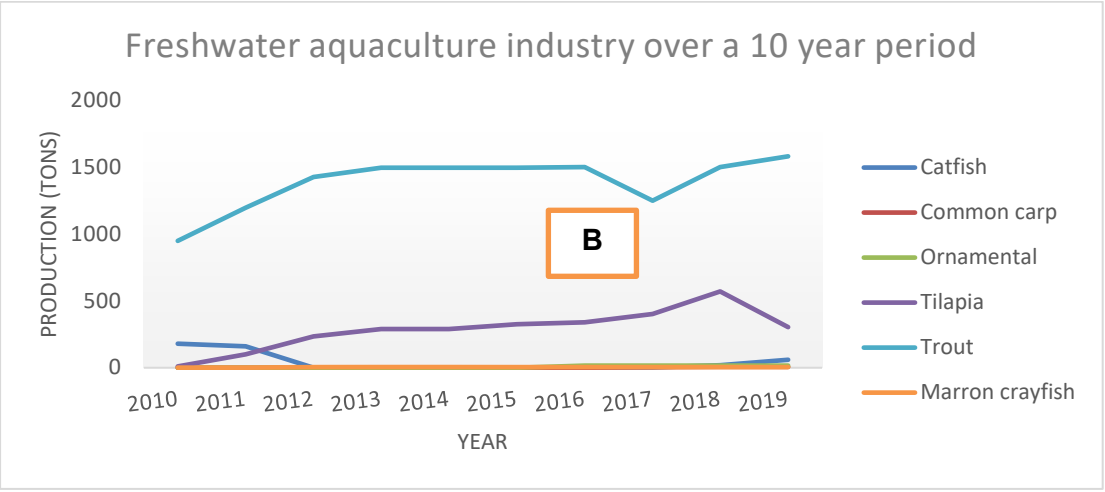


Figure 4.4: South Africa's freshwater aquaculture production from 2006-2019.



z



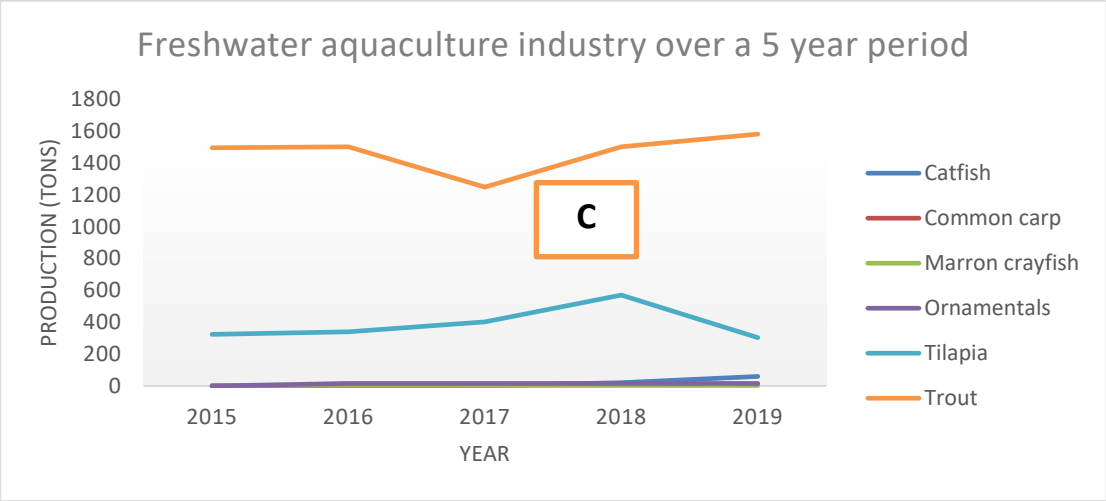


Figure 4.5. (A-C): South Africa's freshwater aquaculture production trend stages for 14, 10 and 5 years.

z

Table 4.4: Freshwater aquaculture production from 2006-2019 per sub-sector

Sub-sector	Year and Production (tons)														Total production (tons) 2006 - 2019
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Catfish	180.00	180.00	180.00	180.00	180.00	160.00	0.00	0.00	0.00	0.00	3.30	3.30	20.0	59.90	**1146.50**
Common carp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30	7.10	6.10	**18.50**
Marron crayfish	0.20	0.40	0.40	0.40	0.80	0.80	3.50	5.00	5.00	4.00	4.00	4.00	4.00	4.00	**36.50**
Ornamentals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	16.00	16.00	16.00	**64.00**
Tilapia	0.00	0.00	0.00	10.00	10.00	100.00	234.20	289.70	289.70	325.30	340.80	402.30	571.30	303.86	**2877.16**
Trout	807.00	658.00	943.00	948.62	950.00	1199.00	1428.00	1497.30	1497.30	1497.00	1503.00	1249.80	1503.00	1583.00	**17264.02**
Total	**987.20**	**838.40**	**1123.40**	**1139.02**	**1140.80**	**1459.80**	**1665.70**	**1792.00**	**1792.00**	**1826.30**	**1867.10**	**1680.70**	**2121.40**	**1972.86**	**21406.68**

4.4. Analysis of freshwater aquaculture sub-sector

4.4.1 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 59.90 tons production volume in 2019 as compared to the 20 tons production volume recorded in 2018 (Figure 4.6). The sub-sector therefore contributed only about 3.04 % to the total freshwater production. Most of the farmers concentrated on producing fingerlings for the export market rather than growing the fish to market size. The only one farm producing catfish to market size is in the Eastern Cape province.

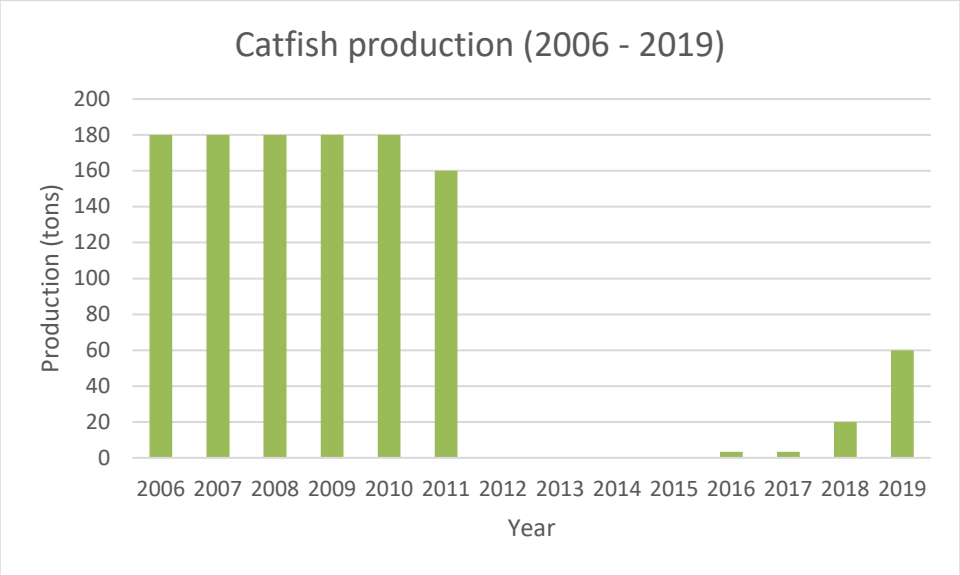


Figure 4.6: Catfish production in South Africa from 2006-2019

4.4.2. Common carp sub-sector

The Common carp sub-sector has contributed 0.30% to South Africa's total freshwater production in 2019, recording a total production of 6.10 as compared to the production of 7.10 tons recorded in 2018 (Figure 4.7). The decreased production of 1.00 represented a 14.08% decrease. The Common carp farms are currently located in the Western Cape, Gauteng, Limpopo and Northern Cape provinces.

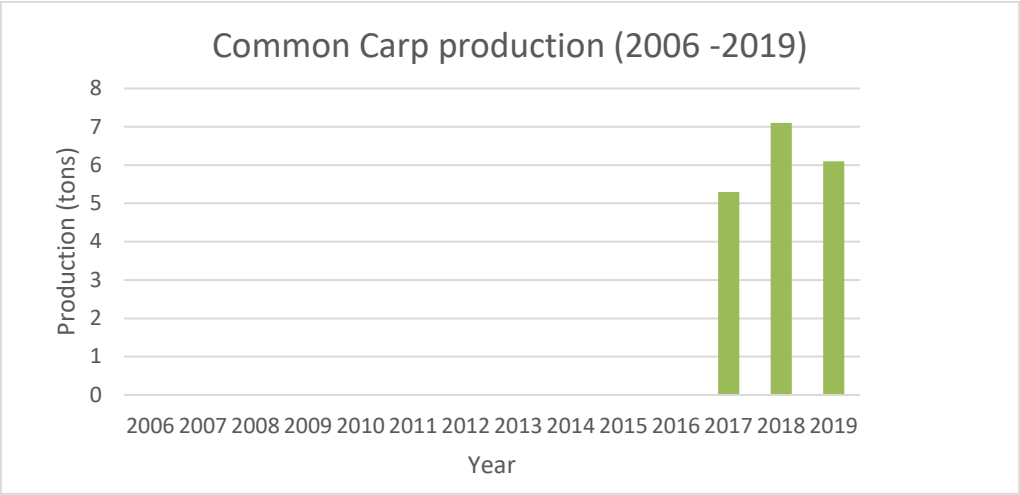


Figure 4.7: Common carp production in South Africa from 2006-2019

4.4.3. Marron crayfish sub-sector

Marron crayfish (*Cherax tenuimanus*) is exotic to South Africa with only two (2) farmers culturing the species. The farms continued to produce a total of 4.00 tons in 2019 as was in the previous four (4) years (Figure 4.8). Marron crayfish produced in 2019 contributed 0.20% to the total freshwater aquaculture sector. The current marron crayfish farms are both located in the Eastern Cape Province where the production is done in tanks during the juvenile phase, before being moved to semi-intensive pond culture for grow-out.

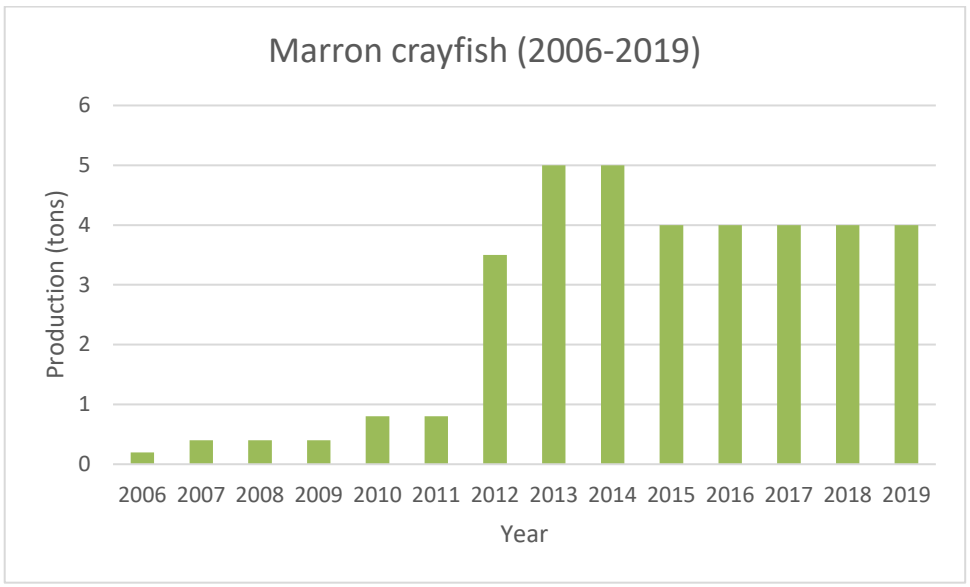


Figure 4.8: Marron crayfish production in South Africa from 2006-2019

4.4.4. Ornamental sub-sector

The Ornamental sub-sector has contributed 0.82% to South Africa's total freshwater production in 2019, recording the same production of 16.00 tons as was recorded in 2018 (Figure 4.9). The Ornamental farms are currently located in the Western Cape, Mpumalanga, Eastern Cape, Free-State, Limpopo and Kwa-Zulu Natal provinces.

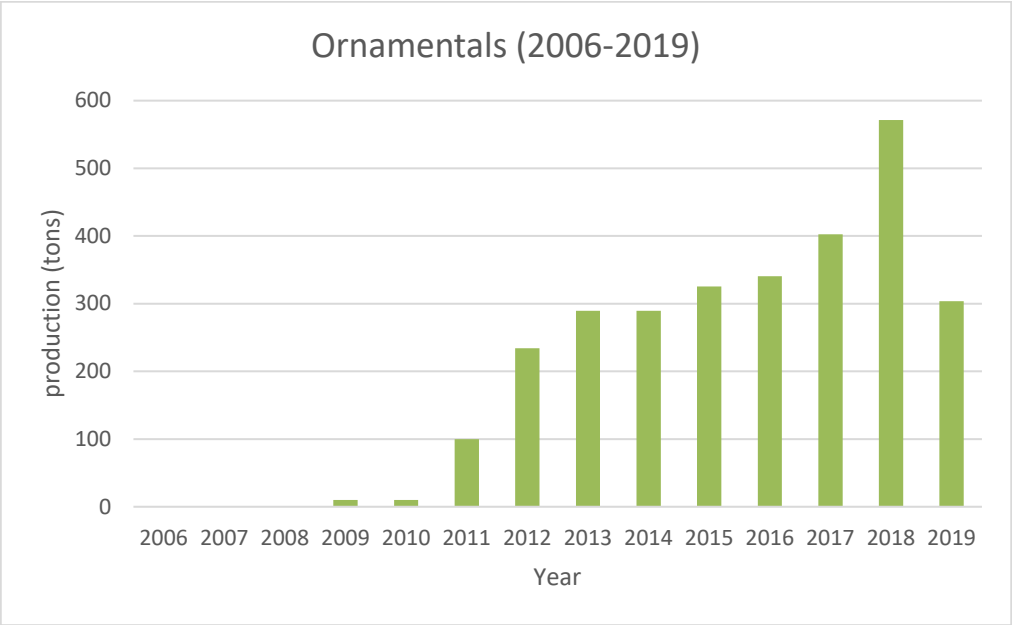


Figure 4.9: Ornamentals production in South Africa from 2006-2019

4.4.5. 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 15.40% to South Africa's freshwater production, recording 303.86 tons (Table 4.3). There was a 267.44 ton (46.81%) decrease in production (Figure 4.10). Most tilapia farmers are small scale farmers and they employ recirculation and pond culture systems and are located in all the provinces except in the Free State province.

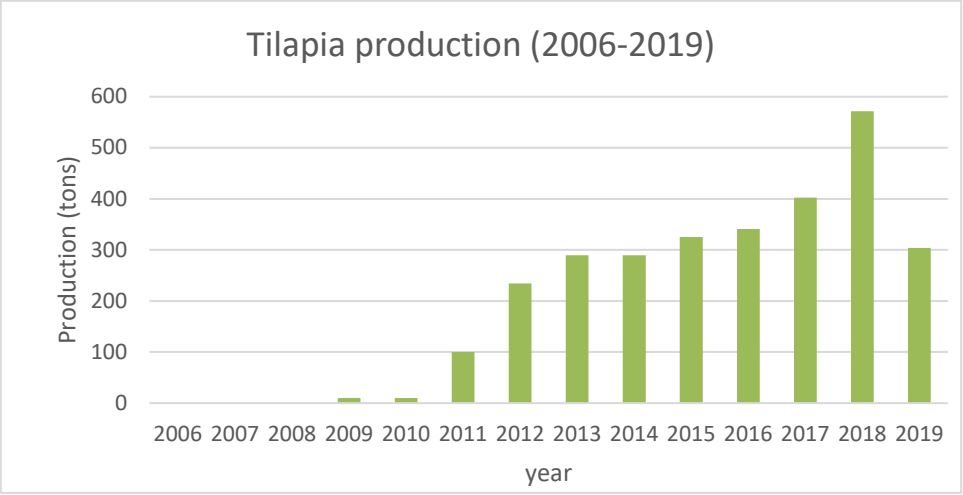


Figure 4.10: Tilapia production in South Africa from 2006-2019

4.4.6. Trout sub-sector

Rainbow trout and Brown trout are the two (2) trout species currently cultured in South Africa. The trout sub-sector has contributed 80.24% of South Africa's total freshwater production in 2019, recording a total production of 1583.00 tons (Figure 4.11). There was an increase of 80 tons, representing 5.32 % of the sub-sector. The trout farms are mostly currently located in the Western Cape, Mpumalanga, KwaZulu-Natal, Gauteng and Eastern Cape provinces. The technology used to

cultivate these species includes raceway, pond, cage culture and recirculating aquaculture systems.

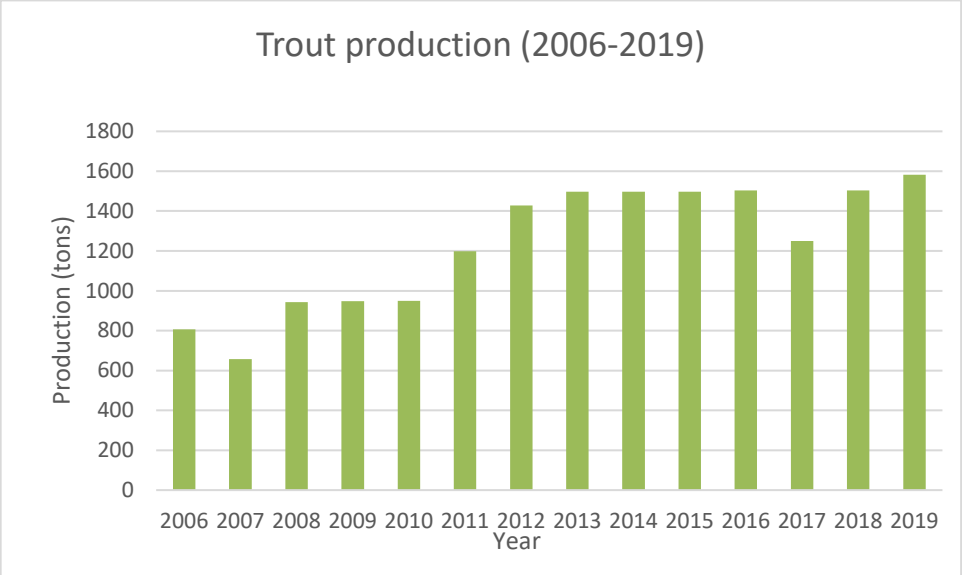


Figure 4.11: Trout production in South Africa from 2006-2019

4.5. Freshwater aquaculture authorisations in 2019

Freshwater aquaculture authorization is administered on the provincial level. Each province differ based on its governmental structures. In most cases, Departments responsible for agriculture or environment would be the entities issuing permits. Table 4.5 below shows provincial departments responsible for freshwater aquaculture authorization. Currently the national Department is not involved in freshwater authorization due to lack of overarching legislative tool by the then lead government department, i.e. Department of Agriculture (DoA), DAFF and now DFFE. The DFFE is addressing this challenge through development of an Aquaculture Development Bill.

Table 4.5. Provincial departmental authorities responsible for issuing fish farming permits

Province	Department
Eastern Cape	Economic Development, Environmental Affairs and Tourism
Free State	Economic, Small Business Development, Tourism and Environmental Affairs
Gauteng	Agriculture and Rural Development (Conservation Section)
Kwa-Zulu Natal	Ezemvelo Wildlife
Limpopo	Economic Development, Environment and Tourism
Mpumalanga	Tourism and Parks Agency
Northern Cape	Nature Resources
North West	Economic Development, Environment, Conservation and Tourism
Western Cape	Cape Nature

4.6. Freshwater site surveillance undertaken in 2019

No site surveillances were undertaken for freshwater aquaculture in 2019. The then DAFF was limited by the non-existent legislative tools. 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. Additional farm visits were conducted as part of the Comprehensive Agricultural Support Programme (CASP).

PROVINCIAL ANALYSIS OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2019

05

5. PROVINCIAL ANALYSIS OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2019.

5.1. Eastern Cape province

The Eastern Cape province is one of the four coastal provinces where both marine and freshwater aquaculture activities are practiced. The province has the advantage of several ports for transportation and access to international and local markets.

Number of farms and species farmed: In 2019, the Eastern Cape province recorded a total of fourteen (14) farms: four (4) marine farms and ten (10) freshwater farms. These comprised of two (2) abalone, one (1) finfish, one (1) oyster, three (3) tilapia, one (1) trout, two (2) catfish, two (2) ornamentals and two (2) marron crayfish farms.

Production: The total production for the Eastern Cape province was 37.61 tons from both freshwater and marine sectors, contributing about 4.76% to the national aquaculture production (Figure 5.1). Marine aquaculture in the province produced 252.91 tons, accounting for 4.95% of the national marine aquaculture production and 3.57% of the national aquaculture production. Freshwater aquaculture produced 84.70 tons in the Eastern Cape province, accounting for 4.29% of the total freshwater aquaculture production and 1.20% of the national production.

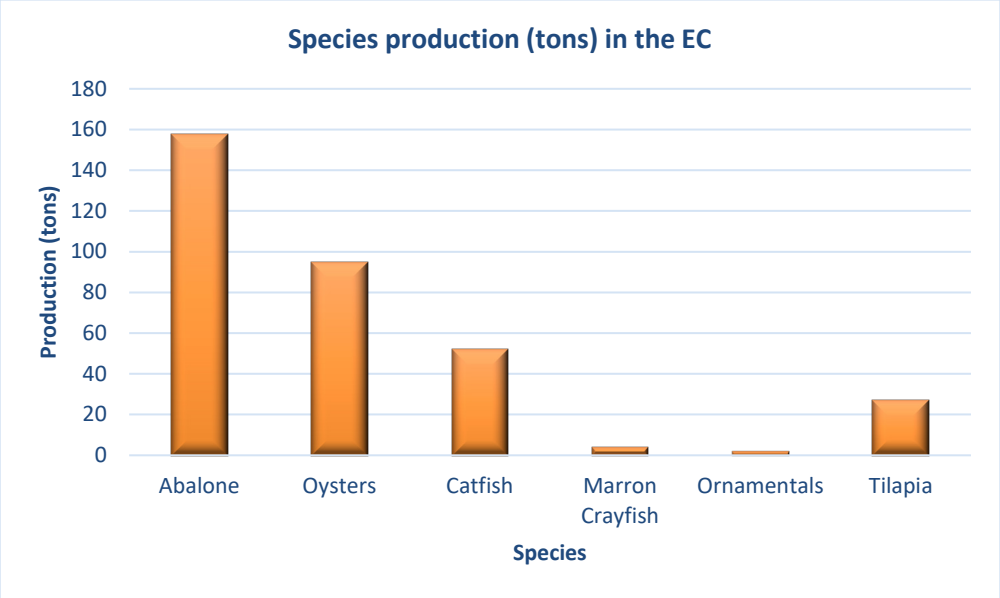


Figure 5.1: Aquaculture production in the Eastern Cape province.

5.2. Free State province

Free State province has a facility for training and capacity building, technology demonstration and aquaculture research studies that is located in Xhariep district of the province. Only activities for freshwater aquaculture were recorded as the province is land-locked and cannot practice any marine aquaculture activity.

Farms and species farmed: In 2019, the Free State province continued to record a total of eight (8) freshwater farms, as was recorded during 2018, with no newly established or closed farms. The farms comprised of four (4) catfish farms, and four (4) ornamental fish farms.

Production: The Free State province did not record any difference in the total production of 2.00 tons in 2019 as was recorded in 2018. The production volume was recorded only from the freshwater sector. The province's production contributed 0.10% to the national freshwater aquaculture production and 0.03% to the national aquaculture production (Figure 5.2).

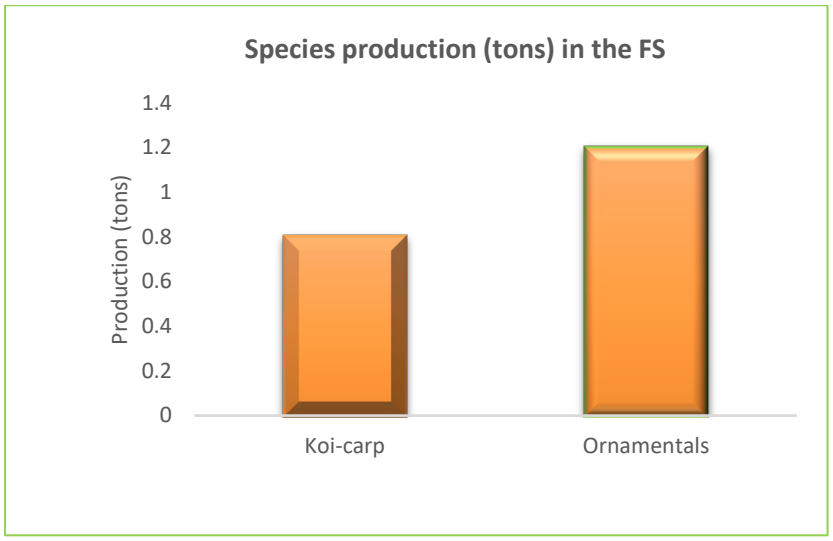


Figure 5.2: Aquaculture production in the Free State

5.3. Gauteng province

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 2019, the Gauteng province recorded a total of thirty seven (37) freshwater farms. The farms comprised twenty three (23) tilapia, three (3) trout, one (1) catfish, one (1) common carp and nine (9) ornamental fish farms.

Production: The total production for Gauteng was 156.76 tons from only freshwater sector, contributing 7.95% of the national freshwater aquaculture production and 2.21% to the national aquaculture production (Figure 5.3).

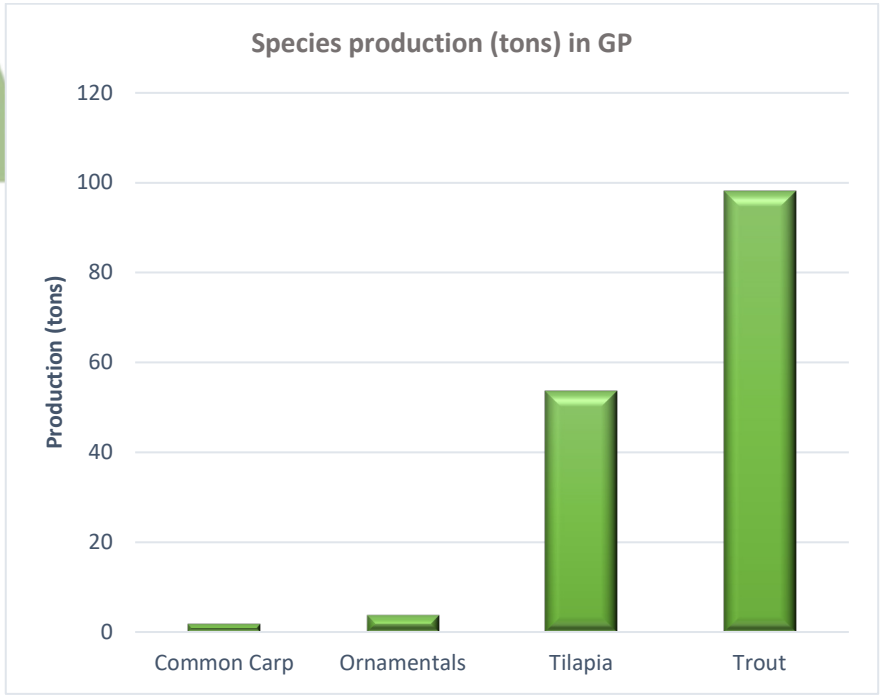


Figure 5.3: Aquaculture production in the Gauteng Province.

5.4. KwaZulu-Natal province

Kwa-Zulu Natal province is also one of the four coastal provinces able to undertake both marine and freshwater aquaculture activities. KwaZulu-Natal province warm temperature is an advantage as it can reduce operational costs. Furthermore, KwaZulu-Natal province has ports that can be an advantage with regards to access to markets.

Number of farms and species farmed: In 2019, the KwaZulu-Natal province recorded a total of twenty (20) farms comprising one (1) marine farm and nineteen (19) freshwater farms. The farms comprised of one (1) marine finfish, five (5) trout, five (5) tilapia, two (2) catfish and seven (7) ornamental farms.

Production: The total production recorded for KwaZulu-Natal was 430.36 tons from both freshwater and marine sectors, contributing 6.07% to the national aquaculture production (Figure 5.4). The marine aquaculture production in the province recorded a production of 7.06 tons, accounting 0.13% of the national marine aquaculture production and accounted 0.10% of the national aquaculture production. Freshwater aquaculture in the province continued to record a production of 423.30 tons, accounting 21.46% of the national freshwater production and 6.00% of the national aquaculture production.

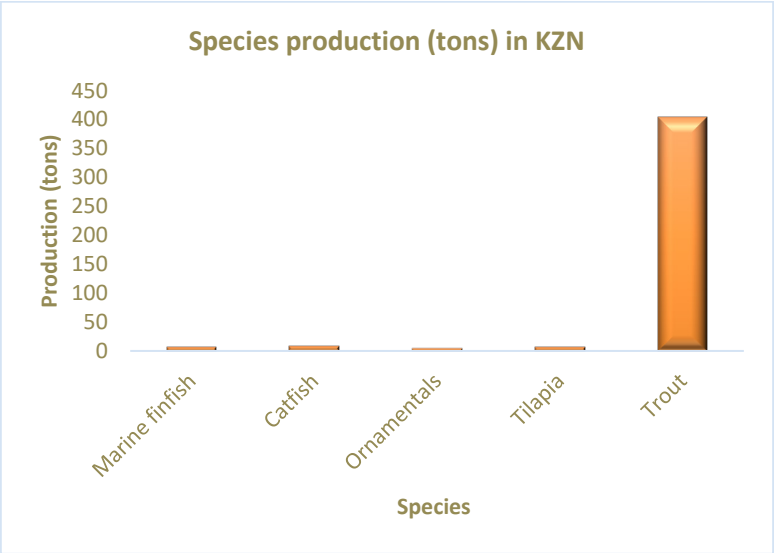


Figure 5.4: Aquaculture production in KwaZulu-Natal province.

5.5. Limpopo province

Limpopo province is supported by the Turfloop state-owned hatchery and research and development activities undertaken by the University of Limpopo. The province is not operating marine aquaculture activities as it is land-locked.

Number of farms and species farmed: In 2019, Limpopo province recorded a total of twenty seven (27) freshwater farms compared to the twenty four (24) farms recorded in 2018. The farms comprised twenty one (21) tilapia, four (4) catfish, one (1) common carp and one (1) ornamental fish farm.

Production: Limpopo province continued to produce 81.60 tons in 2019 only from freshwater sector, contributing about 4.14% to freshwater aquaculture production and 1.15% to the national aquaculture production (Figure 5.5).

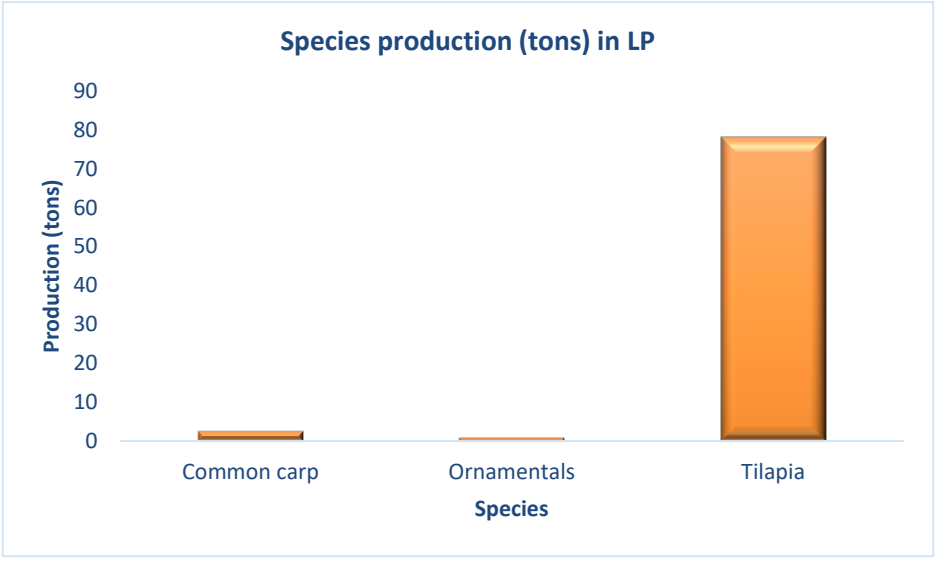


Figure 5.5: Aquaculture production in the Limpopo province.

5.6. Mpumalanga province

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 2019, Mpumalanga province recorded a total of twenty eight (28) freshwater farms as recorded in 2018. The farms comprised twelve (12) tilapia, twelve (12) trout, one (1) catfish and three (3) ornamentals farms.

Production: The total production for Mpumalanga province was 298.10 tons which accounted for 15.11% of the national freshwater aquaculture production and contributing 4.21% to the national aquaculture production (Figure 5.6).

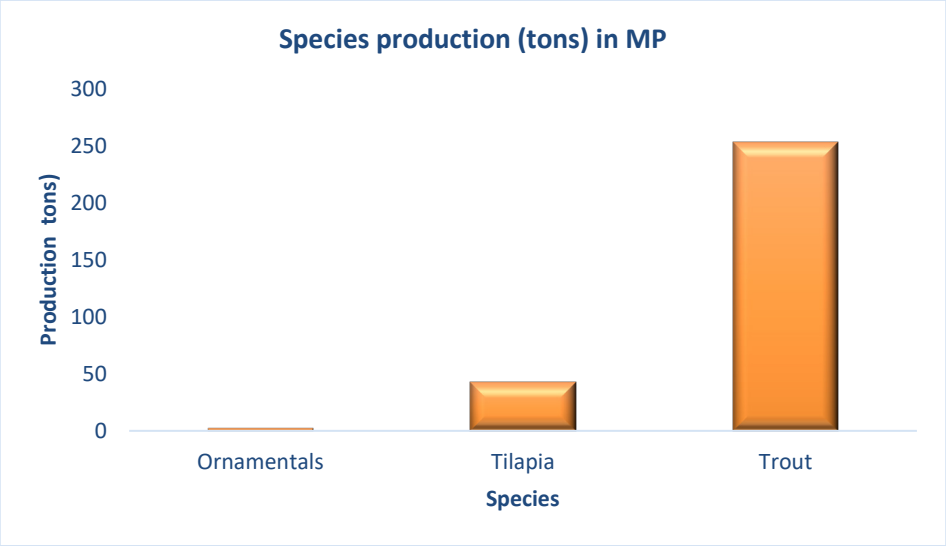


Figure 5.6: Aquaculture production in the Mpumalanga province.

5.7. North West province

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. Due to its location within the country, North West province can only successfully engage in freshwater aquaculture.

Number of farms and species farmed: In 2019, North West province recorded a total of twenty four (24). The farms comprised of twenty (21) tilapia and three (3) catfish farms. The three catfish farms in the province are not contributing to the total freshwater aquaculture production.

Production: The total production for North West province recorded from the freshwater aquaculture was 92.00 tons, contributing 4.66% of total freshwater aquaculture production and 1.30% to the national aquaculture production (Figure 5.8).

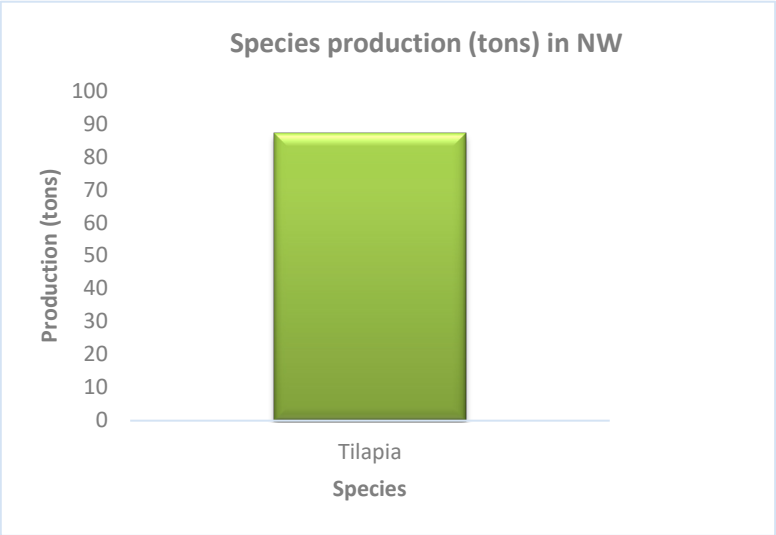


Figure 5.7: Aquaculture production in the North West province.

5.8. Northern Cape province

As in other coastal provinces, the Northern Cape is able to support both marine and freshwater aquaculture. In 2019, the province engaged in both marine and freshwater aquaculture.

Number of farms and species farmed: during 2019, the Northern Cape province recorded a total of six (6) farms comprising of three (3) marine and three (3) freshwater farms. The farms comprised of two (2), abalone, one (1) oyster, one (1) tilapia and two (2) common carp farms.

Production: The total production for the Northern Cape province in 2019 was 18.94 tons from both marine and freshwater sectors, contributing 0.27% to the national aquaculture production (figure 5.7). Marine aquaculture produced 14.94 tons, accounting for 0.29% of the national marine aquaculture production and 0.21% of the national aquaculture production. Freshwater aquaculture recorded 4.0 tons in the Northern Cape province, accounting for 0.20% of the national freshwater production and 0.06% of the national aquaculture production.

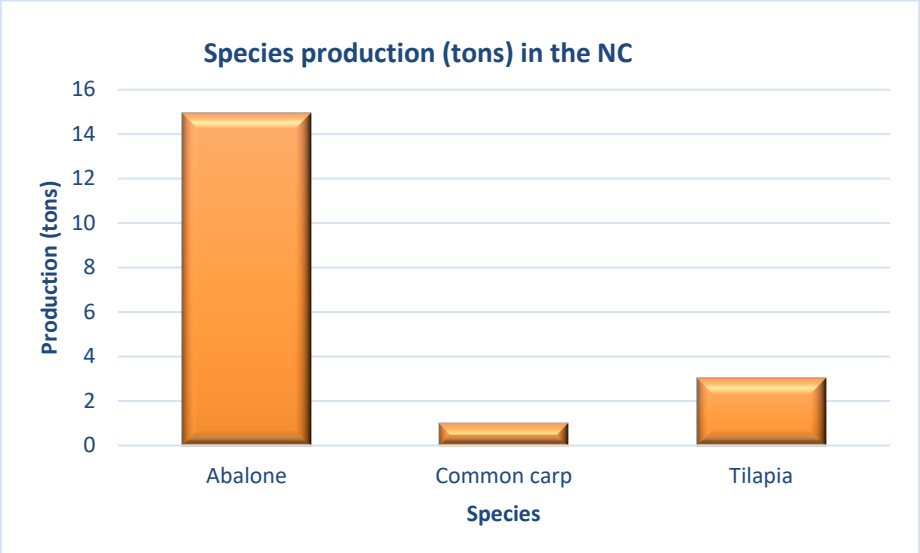


Figure 5.8: Aquaculture production in the Northern Cape province.

5.9. Western Cape province

The Western Cape province is 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 2019, the Western Cape Province recorded a total of sixty one (61) farms comprising of twenty seven (27) marine farms and thirty four (34) freshwater farms. The farms comprised twelve (12) abalone, one (1) finfish, eleven (11) mussel, three (3) oyster, one (1) tilapia, thirty (30) trout, one (1) common carp and two (2) ornamentals fish farms.

Production: The total aquaculture production recorded for the Western Cape province was 5668.28 tons from both freshwater and marine sectors, contributing 80% to national aquaculture production (figure 5.9). In the Western Cape province, marine aquaculture produced 4837.88 tons, accounting for 94.62% of the national marine aquaculture production and 68.28% of the national aquaculture production. Freshwater aquaculture produced 830.40 tons in the Western Cape province, accounting for 42.09% of the national freshwater aquaculture production and 11.72% of the national aquaculture production.

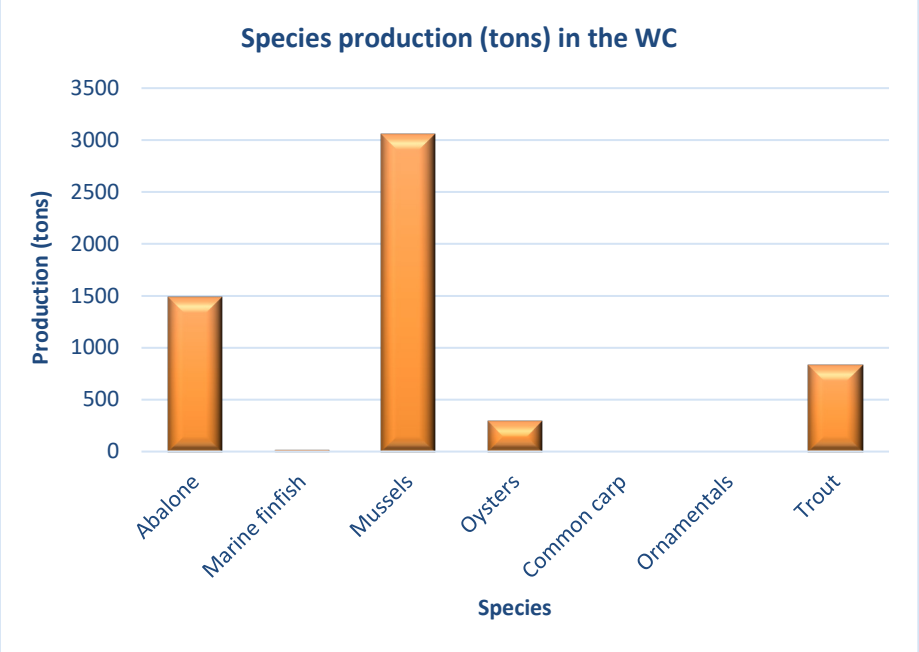
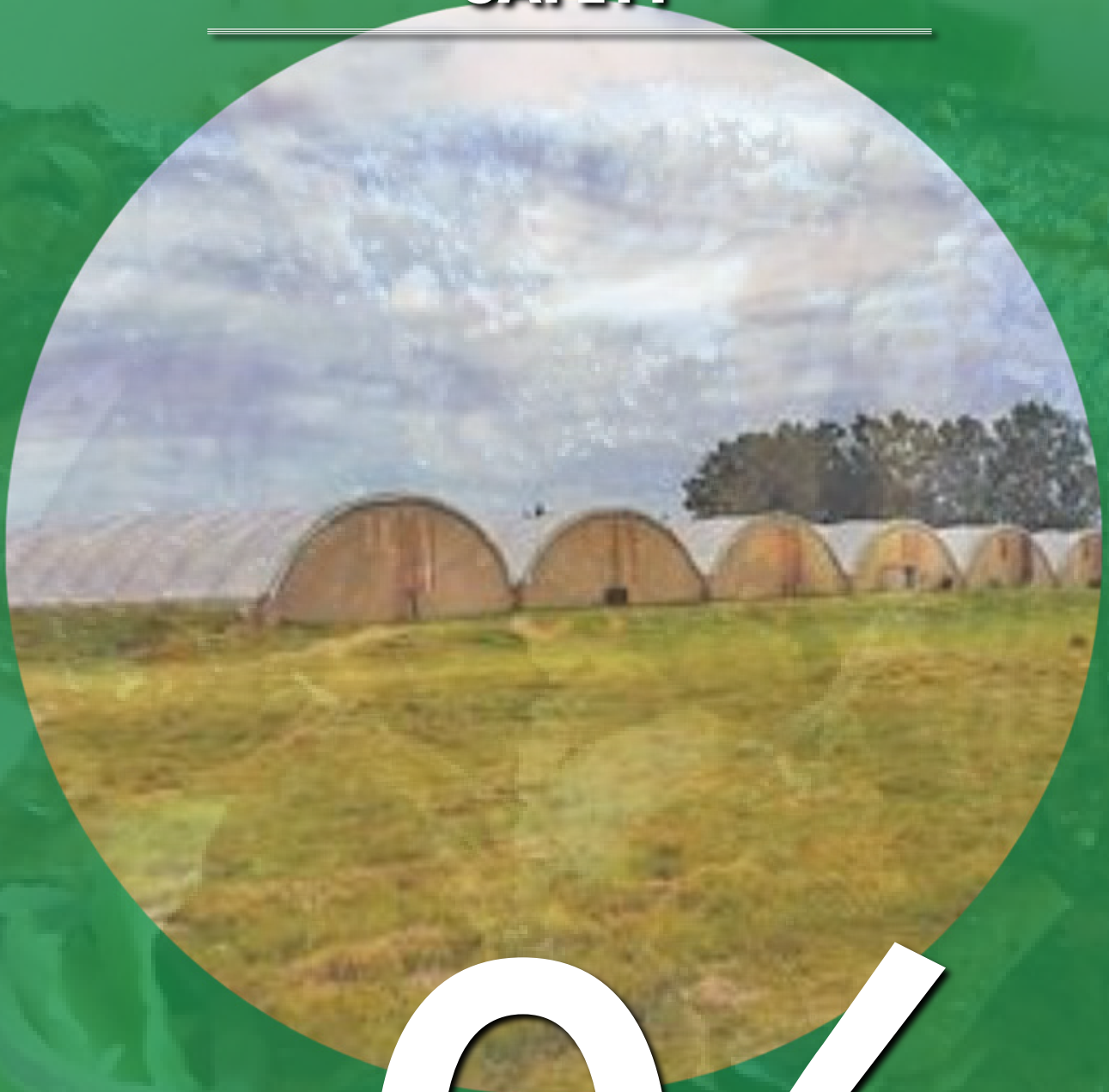


Figure 5.9: Aquaculture production in the Western Cape province.

AQUACULTURE FOOD SAFETY



06

6. AQUACULTURE FOOD SAFETY

6.1. Introduction to aquaculture food safety

Food safety monitoring is one of the most important activities in aquaculture. During the year 2019, the department continued to be responsible for the food safety monitoring of marine aquaculture farms, including the shellfish and finfish farms. The department implements food safety programmes which include the South African Live Molluscan Shellfish Monitoring and Control Programme (SALMSM&CP), the South African Aquacultured Marine Fish Monitoring and Control Programmes (SAAMFM&CP), the National Residue Control Plan (NRCP) and the National Residue Programme (NRP). The aims of these programmes are to ensure that the food safety risks associated with the production of fish are adequately managed and minimized for local and international market.

The DFFE is working closely with the National Regulator for Compulsory Specification (NRCS), the Department of Health (DoH), laboratories and marine fish farmers to ensure that the objectives of the food safety programmes are achieved.

The majority of the monitored farms include abalone farms, which are predominantly found in the Walker Bay and Buffeljags region on the south-west coast and to a lesser extent along the West Coast and Northern Cape and one farm is situated near East London (Figure 6.1). Oyster and mussel farming is predominantly undertaken Saldanha Bay and one oyster farm is situated in Algoa Bay. The finfish farms are located in Saldanha Bay, Western Cape province and Mtunzini in KwaZulu-Natal province. Molluscan shellfish species farmed in South Africa include *Haliotis midae* (abalone), *Crassostrea gigas* (oyster), *Mytilus galloprovincialis* (Mediterranean Mussel) and *Choromytilus meridionalis* (Black Mussel). The finfish that is currently farmed is *Argyrosomus japonicus* (Kob) and the crustacean farmed is *Panulirus homarus* (East Coast Rock Lobster).

6.2. Fish farms status

A total of 43 shellfish and finfish farms were monitored for Food Safety. The farms included 14 abalone farms, 14 mussel farms, 10 oyster farms, 4 finfish farms and 1 Rock Lobster Farm (Figure 6.1). All the abalone farms and the lobster farm that were monitored are land based. The abalone and lobsters are grown in land-based tanks and the water is pumped ashore and free flows through the tanks with varying levels of recirculation. The oyster and mussel farms were sea-based. The oyster and mussels are grown in cages and on ropes respectively suspended from floating rafts or buoys. The finfish farming was conducted in sea cages, pond systems and land base fish tank systems.

Abalone and oysters that are harvested are often placed into wet storage facilities for purging, conditioning and holding of stock prior to marketing.

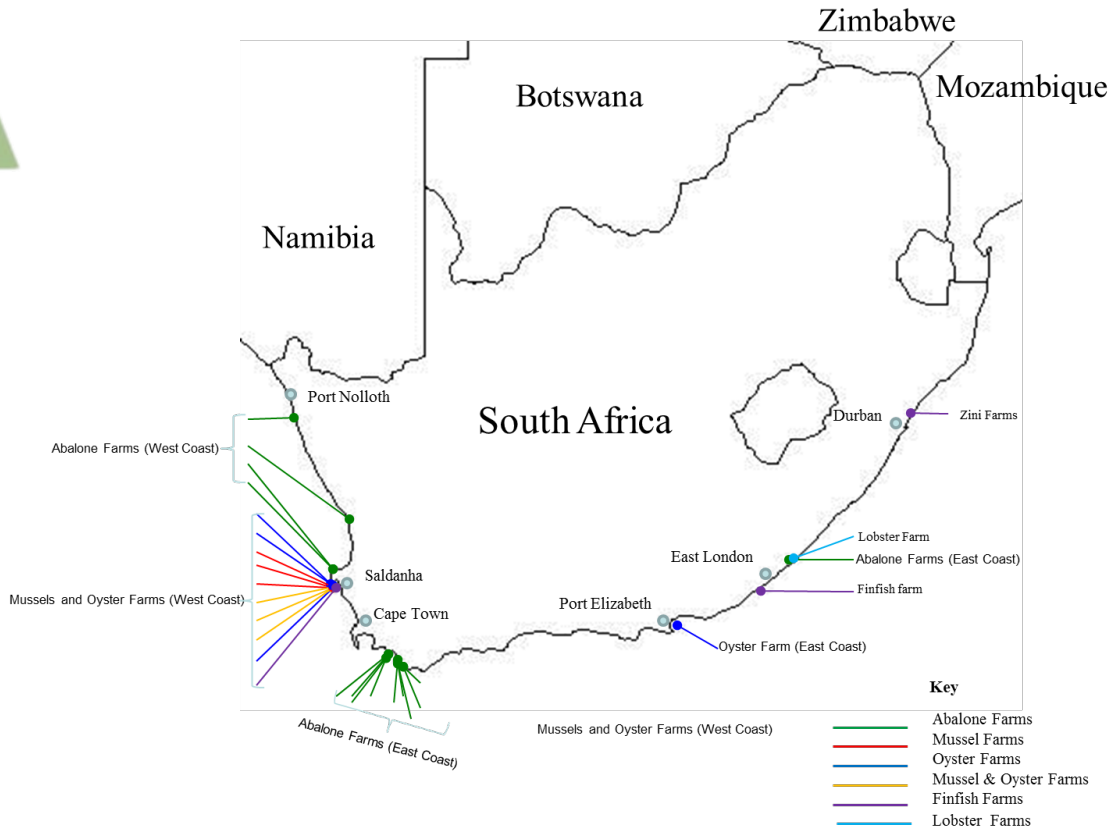


Figure 6.1: Distribution of monitored fish farms along the South African coast

6.3. Monitoring of hazardous substances

The farms which are at most risk of pollution are those situated near the industrialized or urban 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, particularly shellfish farms are more at risk of biotoxin contamination than the farms to the east of Cape Point.

The fish farms were monitored for human health hazards such as heavy metals, pesticides, polychlorinated biphenyls (PCBs), dioxins, dyes, veterinary drug residues and radionuclides during the production phase. In addition shellfish farms were furthermore monitored for biotoxins and microbiological contamination. Should the regulatory limit for any of the hazardous substances in the fish be exceeded, the farms were temporarily closed for harvesting until the contaminant reaches acceptable limits.

The methods used are stipulated in the food safety programmes and are South African National Accreditation System (SANAS) accredited or the laboratories are working towards accreditation. The laboratories are required to inform the Food Safety Office (FSO) in the form of a red alert, should a test result exceed the regulatory limit. The red alert requires that the laboratory phones the staff at the FSO responsible for farm closures and sends an email to the official indicating the test result. The FSO 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 fish are not tested in accordance with the food safety programmes.

When any of the hazardous substances or microbiological organism concentrations exceeds the regulatory limit, 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 (Table 6.1).

Table 6.1: Regulatory limit for human health hazards monitored and test laboratories

Hazardous Substances	Regulatory Limit	Laboratory
Biotoxins		
Paralytic shellfish toxins	< 0.8 mg STX equiv./kg edible flesh	NOSA
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	NOSA
Yessotoxins group toxins: YTX, 45 OH YTX, homo YTX, and 45 OH homo YTX	≤ 8 mg yessotoxin equivalents / kg edible flesh	NOSA
Azaspiracids group toxins: AZA1, AZA2 and AZA3.	≤ 0.16 mg azaspiracid equivalents / kg edible flesh	NOSA
Amnesic shellfish toxins	< 20 mg DA/kg edible flesh	NOSA
Microbiological Organisms		
E. coli	≤230/100g edible flesh	Mérieux
Salmonella	absent	SABS/ Mérieux
Vibrio cholera *Vibrio parahaemolyticus*	absent	SABS/ Mérieux
Residues		
Heavy Metals	Lead: < 1.5 mg/kg edible flesh Mercury: < 0.5 mg/kg edible flesh Cadmium: < 2.0 mg/kg edible flesh	Nosa/ 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/
Stilbenes & Hormones	Not detected	Mérieux
Sulphonamides	Not detected	Mérieux
Benzimidazoles (Anthelmintics)	Not detected	Mérieux
Chloramphenicol	Not detected	Mérieux
Florfenicol & Thiamphenicol	Not detected	Mérieux
ß-Lactams	Not detected	Mérieux
Malachite Green & Crystal	Not detected	Mérieux
Nitrofuran metabolites	Not detected	Mérieux

Hazardous Substances	Regulatory Limit	Laboratory
Quinolones	Not detected	Mérieux
Aflatoxins	Not detected	Mérieux
Nitroimidazoles	Not detected	Mérieux
Tetracyclines	Not detected	Mérieux
Avermectins, including ivermectin	Not detected	Mérieux

6.3.1. Microbiological Monitoring

The *E. coli* was tested for weekly in mussels and oysters and *Salmonella* and *Vibrio* was tested for monthly. These microbiological organisms were tested by the South African Bureau of Standards (SABS), situated in Rosebank, Cape Town and Mérieux NutriSciences laboratories situated in Claremont, Cape Town. Mérieux NutriSciences is SANAS accredited for *Salmonella*, *Vibrio* and *E. coli* and SABS is SANAS accredited for *Salmonella* and *Vibrio*. *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 farms were all classified as "Approved Class A" based on the data received. As from 15 March 2019 pathogenic Vibrio and Salmonella are tested by the NRCS in the end-of–line product in terms of the Compulsory Specification for Aquacultured Live and Chilled Raw Bivalve Molluscs (VC 9107). The abalone production facilities continued to be classified as Approved Class A and exempted from the monthly testing of the production area for microbial contamination, *E. coli*. They were required to monitor for microbial contamination during official surveillance of end-of-line product. In 2019 there were no end-of-line products that were non-compliant and therefore there were no farm closures due to presence of microbiological contamination. During 2019 the FSO did not issue any closure notifications to bivalve farm production areas for *E. coli* exceeding the regulatory limit.

6.3.2. Wet storage facilities

Wet storage refers to the temporary re-immersion of live shellfish in 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 to be more accessible for marketing. During the year 2019, the wet storage facilities were monitored weekly for *E. coli* and monthly for *Vibrio cholera, Vibrio parahaemolyticus* and *Salmonella*. During this period the FSO issued one closure notification to a wet storage facility on the east coast due to *E. coli*. exceeding the regulatory limit in oysters.

6.3.3. Biotoxin Monitoring

The routine monitoring frequency of farms (Table 6.2) and the location of sampling were based on the potential risk of contamination (accumulation in shellfish). There tends to be substantially more upwelling systems to the west of Cape Point resulting in higher incidences and concentrations of HABs and concomitant biotoxin accumulation in the shellfish.

Table 6.2: Schedule for testing of biotoxins

	West of Cape Point		East of Cape Point	
Hazardous Substances	Filter Feeder	Non – Filter feeder	Filter Feeder	Non – Filter Feeder
Biotoxins				
PST	48h or twice a week for multiple harvesting	2 weekly	Monthly	Monthly
LST	Weekly	Monthly	2 weekly	Monthly
AST	Monthly	Monthly	Monthly	Monthly

The biotoxins were monitored by conducting testing of samples at National Occupational Safety Association (NOSA) in Paarden Eiland, Western Cape. The biotoxins monitored include Paralytic Shellfish Toxins (PST), Lipophilic Shellfish Toxins (LST) and Amnesic Shellfish Toxins (AST) and 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. During 2019, three PST closure notices were issued to two abalone farms. Each time the PST closure notices were issued, the abalone farms were temporarily closed for selling live abalone until the PST results were below the regulatory limit. There was only one LST closure notice that was sent to one mussel farm. AST toxins were not detected in any of the shellfish farms. The farms that were affected by the presence of biotoxins were farms situated to the west of Cape Point. Figure 6.2 shows that the PST remained above intensive sampling threshold limit of 0.4 mg STX equiv/kg on a number of abalone farms. The regulatory limit was only exceeded on three occasions. Many of the abalone farms, however, canned their products thus reducing the PST levels as the abalone were eviscerated and scrubbed (Figure 6.2). Table 6.3 shows count of toxins tested above the regulatory limit in abalone and bivalves.

Table 6.3: Count of toxins tested above regulatory limit in abalone and bivalves

Year	PST	OA	AZA	YTX	AST
2014	9 (286)	0 (135)	0 (70)	0 (131)	0 (49)
2015	6 (269)	0 (148)	0 (145)	0 (145)	0 (35)
2016	3 (385)	141 (437)	0 (439)	0 (432)	0 (36)
2017	32 (491)	10 (380)	0 (381)	0 (367)	0 (153)
2018	28 (708)	1 (383)	0 (388)	0 (377)	0 (103)
2019	7 (471)	11 (327)	0 (329)	0 (326)	0 (134)

() = Number of samples tested

PST – Paralytic Shellfish Toxin, OA – Okadaic Acid, AZA – Azaspiracid, YTX – Yessotoxin, LST – Lipophilic Shellfish Toxins, AST – Amnesic Shellfish Toxins.

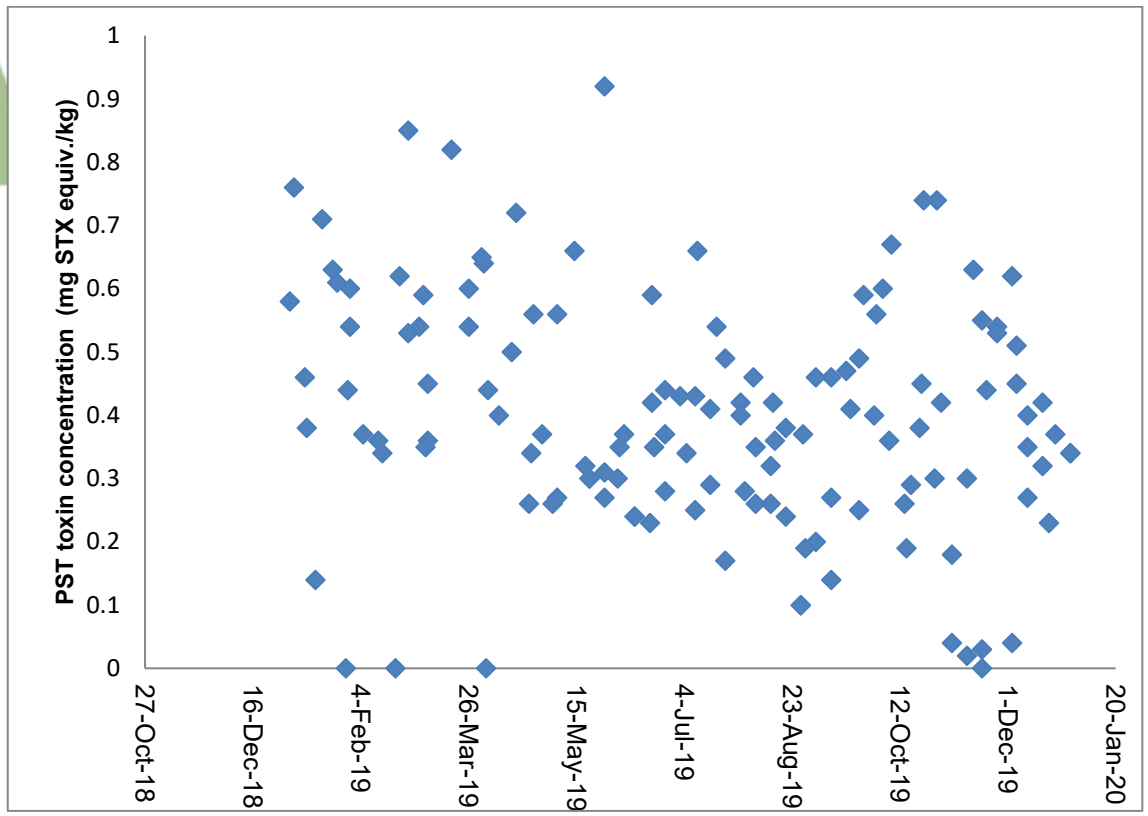


Figure 6.2: PST concentrations in abalone cultured to the west of Cape Point in 2019

6.3.4. Residue monitoring

The hazardous substances (Table 6.1) including heavy metals (lead, mercury, cadmium and arsenic), pesticides, drug residues, dioxins, polycyclic aromatic hydrocarbons (PAH), dyes and polychlorinated biphenyl (PCB) were tested randomly in the fish in accordance with the National Residue Programme. A minimum of one sample was collected from each of the fish farms. The compounds sought for analysis were selected according to their likely use and/or historical presence in the production system. The samples taken were submitted to Mérieux NutriSciences for testing.

There was only one closure notice that was sent to shellfish farms. The closures were due to cadmium in oysters exceeding the regulatory limits(Table 6.1). The farm was closed for 190 days. Other heavy metals such as lead and mercury were present in the cultured shellfish in very low concentrations.

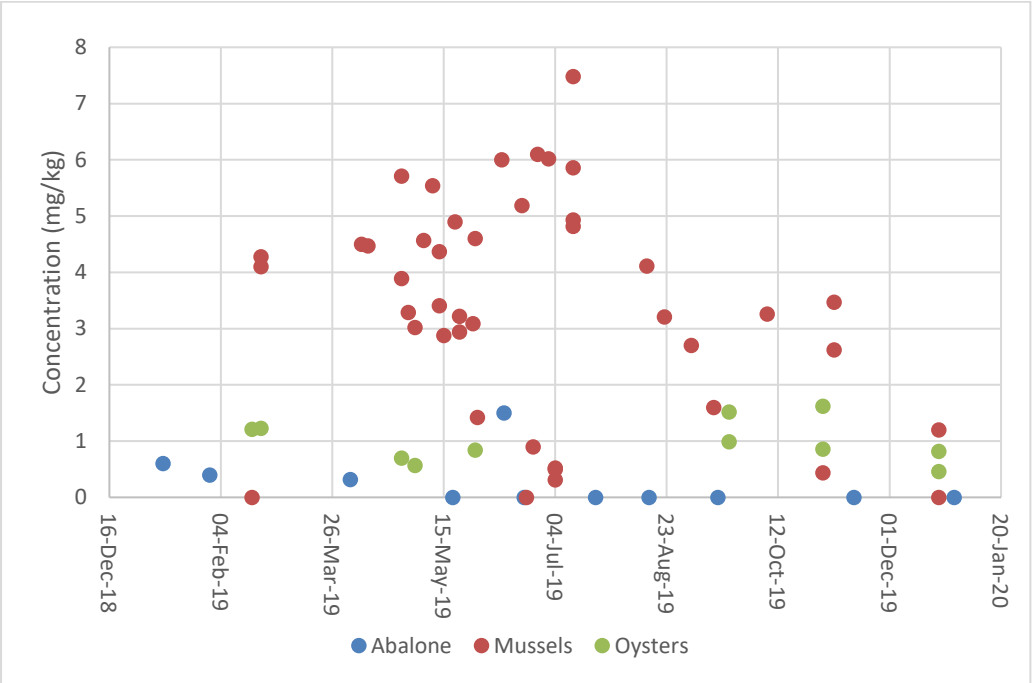


Figure 6.3: Cadmium concentrations in cultured molluscan shellfish in 2019

Pesticides, veterinary drug residues and dyes were not detected in the in the fish samples and dioxins, PAH, and PCBs were well below the regulatory limit. Table 6.4 shows counts of residues tested above regulatory limit.

Table 6.4: Count of residues tested above regulatory limit

Residue	2019
Heavy Metals	32 (136)
Anthelmintics	0 (22)
Antibiotics	0 (105)
Chloramphenicol	0 (17)
Nitrofurans	0 (3)
Nitroimidazoles	0 (4)
Steroids	0 (12)
Stilbenes	0 (14)
PAH	0 (17)
PCBs	0 (2)
Dioxins	0 (11)
Dyes	0 (11)
Radionuclides	0 (2)

(x) = Number of samples tested

6.3.5. Phytoplankton Monitoring

The FSO conducted official and on-farm phytoplankton monitoring for shellfish farms along the South African coastline. There are two official phytoplankton satellite monitoring stations that have been established by the FSO, namely the Saldana Bay and Hermanus phytoplankton monitoring station.

These two stations and the FSO combined monitor the phytoplankton for all shellfish farms along the South African coast.

HABs on the West Coast are usually associated with upwelling systems which are driven by persistent offshore south-easterly winds, typically in the region of 3 to 10 day events (Hill *et al.* 1998), resulting in upwelling of nutrient rich water into the euphotic zone (Pitcher *et al.* 2010). The timing of HABs are associated with seasonal wind patterns, particularly during late summer and early autumn (Pitcher *et al.* 2010). During this period the surface currents tend to be offshore and equator-ward (Pitcher *et al.* 2010). The HABs develop once there is relaxation of the offshore wind and increased solar irradiance, which leads to stratification (Pitcher *et al.* 2010).
The relaxation of the south-easterly wind also results in the pole-ward movement of the longshore current and an on-shore wind drives the bloom towards the shore (Pitcher *et al.* 2010) and together with the longshore current into close proximity of the aquaculture farms. Consequently the highest incidence of HABs south of Cape Columbine is during April and May 2019 (Pitcher & Calder 2000).

The official phytoplankton monitoring for 2019 shows that *Pseudo-nitzschia* dominated at all the phytoplankton monitoring stations throughout the year; other toxic phytoplankton species had a very low count, Figure 6.4.

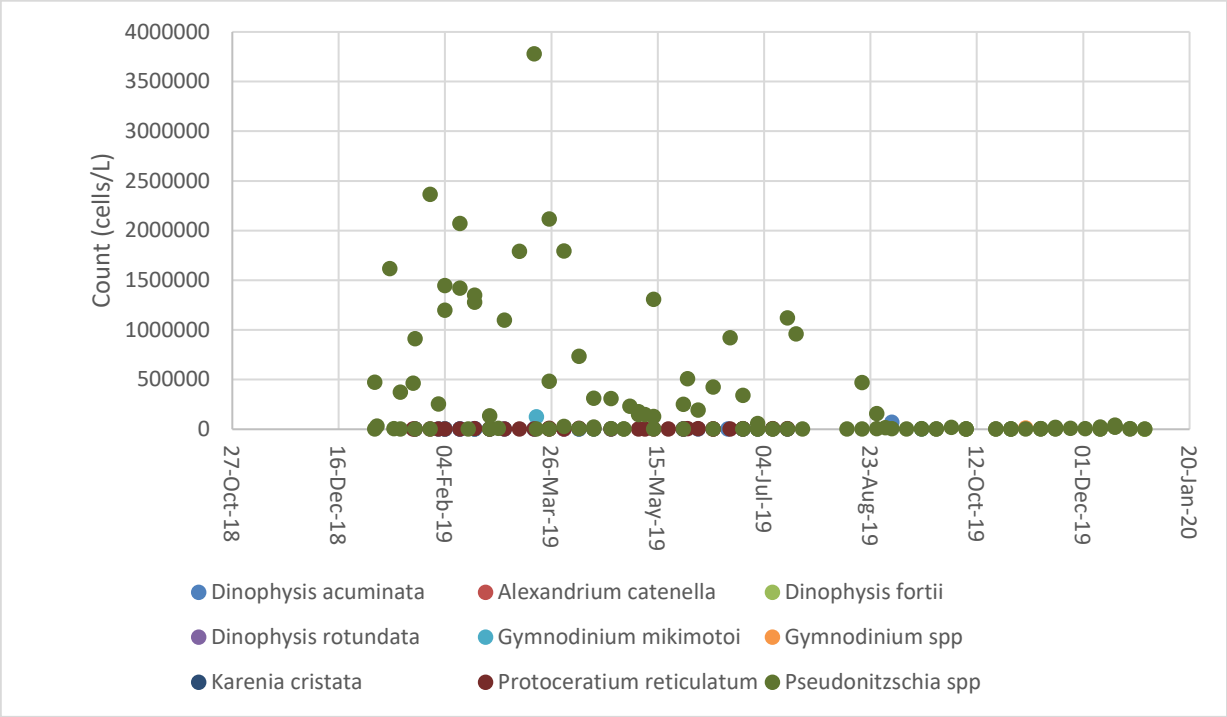


Figure 6.4: Official toxic phytoplankton maximum counts for 2019

6.4. Compliance history of farms

In 2019 all monitored farms continued to comply with the implementation of the food safety requirements as prescribed in the official food safety programmes.

6.5. Food safety monitoring programme progress

The FSO continue to ensure that the food safety programmes (SALMSM&CP, SAAMFM&CP and National Residue Programme) are reviewed and updated to ensure harmonisation with the relevant

South African legislation as well as Codex Alimentarius guidelines, as South Africa is a signatory to Codex Alimentarius.

The phytoplankton satellite monitoring stations continued to work well with the FSO in implementing the phytoplankton monitoring for shellfish farms. The FSO has also conducted phytoplankton audits that verified effective implementation of the programmes.

The Biotoxin and Microbiological Action Plans for the Saldanha Bay mussel and oyster farms continued to be implemented for the Saldanha Bay. The FSO is also in a process of developing Biotoxin and Microbiological Action Plans for Algoa Bay. When the action plan is completed, it will be implemented for the farm in Algoa Bay. The aim of these action plans is to ensure that biotoxin and microbiology monitoring is conducted adequately and efficiently for bivalves farms, which have a high risk of concentrating pathogens and biotoxins.

ECONOMIC OVERVIEW OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2019

07

7. ECONOMIC OVERVIEW OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2019.

7.1. Value of the Aquaculture Industry

The total value of the aquaculture sector in 2019, was estimated at R1 217 340 207 showing an increase 9,13% from R1 115 499 300 recorded in 2018. An increase in the value of aquaculture is attributed to a significant 719,88 tons increase in production recorded in 2019.

South Africa's aquaculture value has shown a significant increase over the years. Figure 7.1 illustrates the trends for aquaculture value over the five-year period (2015-2019), demonstrating an average percentage increase of 4.13% since the year 2016. The increase in value over the years is attributable to the increase in production volumes. The increase and fluctuation in prices also play a significant role in the increase of aquaculture value. Over the last five (5) years, the lowest value was R1 010 592 680 recorded in 2017 while the highest value was R1 217 340 207,00 recorded in 2019.

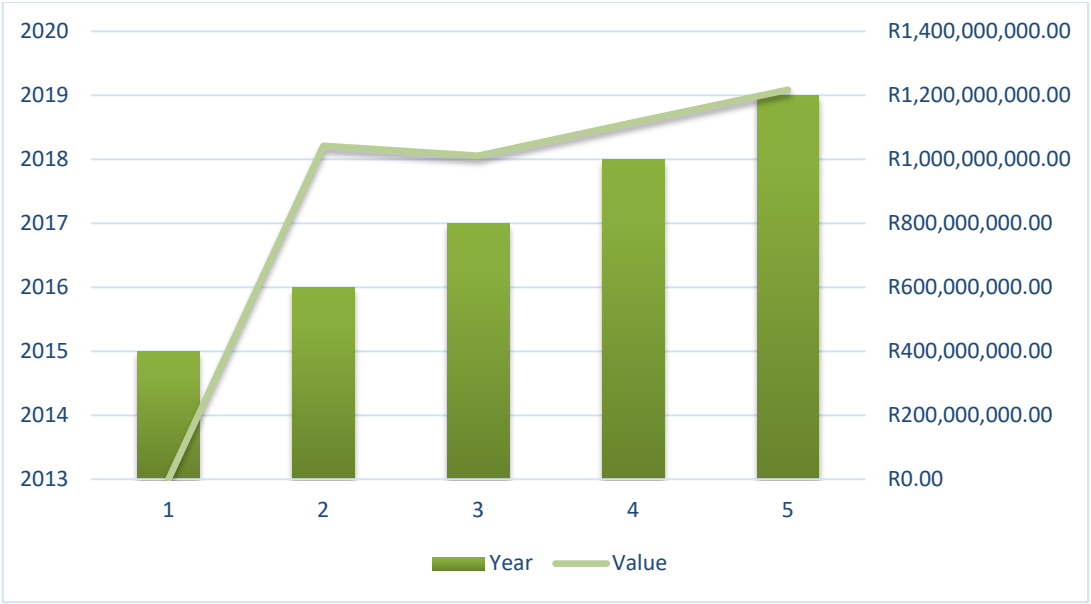


Figure 7.1: South Africa's aquaculture value trends from 2015-2019

In terms of the aquaculture subsector, the abalone led the sector by 78%, followed by the trout and oyster subsector with 11% and 6% respectively. The catfish, common carp and finfish subsectors were the lowest contributors towards the aquaculture value in 2019, contributing less than 1% respectively. (Figure 7.2).

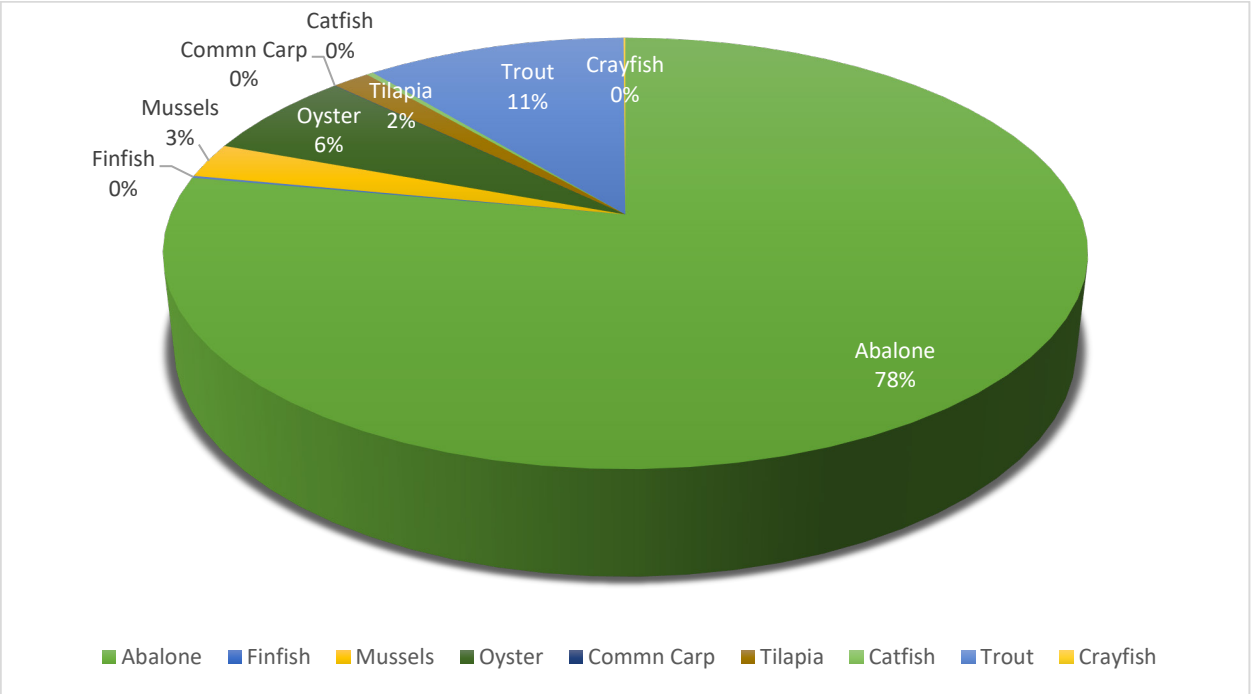


Figure 7.2: Percentage contributed per sub-sector towards the aquaculture value in 2019

South Africa's total marine aquaculture production increased by 868,43 tons from 4244.39 tons recorded in 2018 totaling to 5112.79 in 2019. Freshwater recorded only 1972.86 tons demonstrating a decrease of 148.54 tons when compared to 2121.40 recorded in 2018. The marine aquaculture contributed approximately 87% to the total aquaculture value with R1 061 811 255,60 showing growth in both in production and value. The freshwater contributed only 13% (R155 528 951,60) to the total aquaculture value due to 7% decline in production (Figure 7.3).

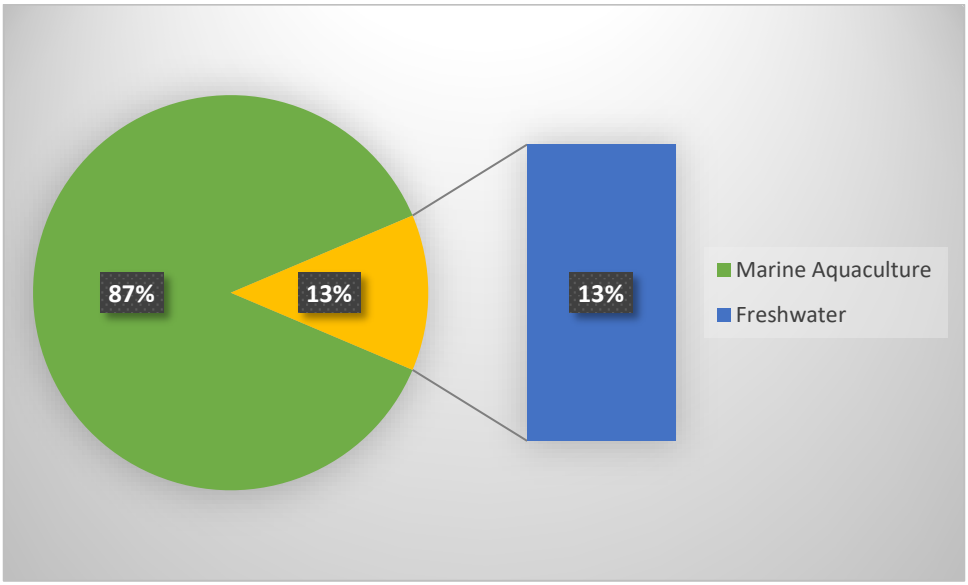


Figure 7.3: South Africa's total contribution per sector (marine and freshwater aquaculture) during 2019.

During 2019, the abalone sub-sector continued to be the highest contributor towards both the South Africa aquaculture sector total value and the marine aquaculture value. The sub-sector recorded the value of R948 463 428 in 2019 contributing 78% and 89% to the overall total value of aquaculture and the marine aquaculture value respectively. The value for abalone sub-sector showed an increase of 13.29%

from R837 221 000 recorded in 2018. The increase in value is attributed to the sub-sector experiencing a significant increase in production, whereby the sector production increased by 8.83%, from 1522.22 tons recorded in 2018 to 1656.56 tons in 2019. The oyster sub-sector was the second largest contributor with 8% declining from 10% contributed in 2018. The mussels' subsector continues to be the leading producer in terms of volumes recording 3053.46 tons in 2019 but only contributed 3% towards the marine aquaculture value despite its highest volumes. The finfish subsector only contributed less than 1% to the total marine sector value due to its decreasing production volumes. Figure 7.4 shows how each marine subsectors contributed towards the marine sector total value.

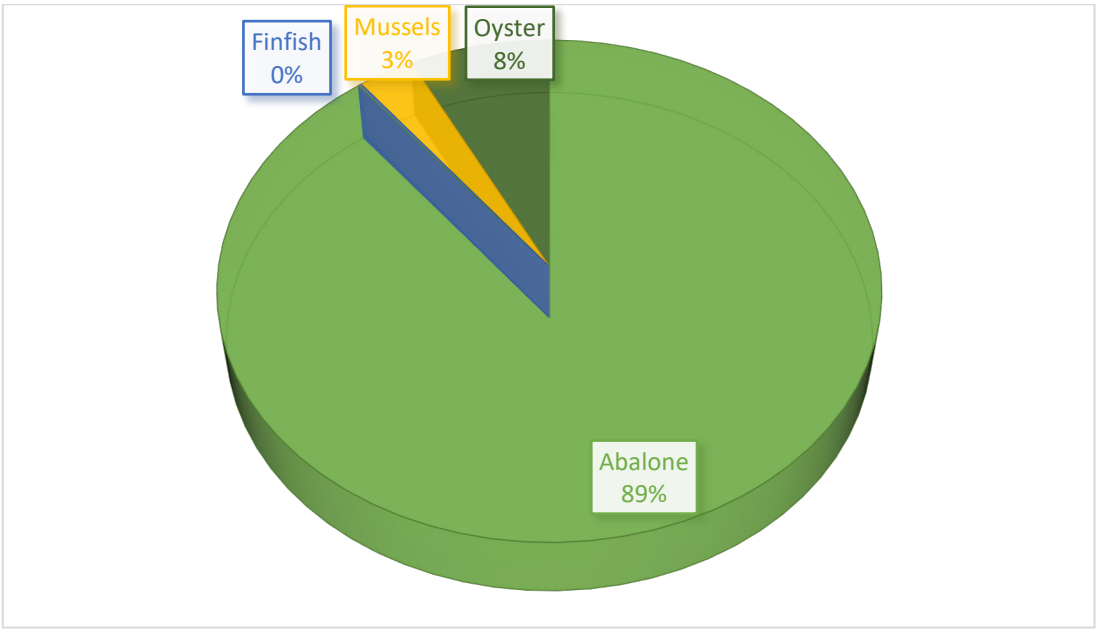


Figure 7.4: The estimated percentage contributed by each sub-sector towards the marine aquaculture total value in 2019.

The freshwater sector total value decreased from R156 914 000 recorded in 2018 to R155 528 951,60 in 2019. The decrease in freshwater value is due to a significant decline in tilapia production by 267.44 tons (46,81%) from 571.3 tons produced in 2018 to 303.86 tons in 2019. The freshwater sector contributed approximately 13% to the overall aquaculture value in 2019. The largest contributor was the trout sub-sector with an estimated value of 85% to the freshwater sector and 11% to the overall aquaculture value. The trout subsector, continues to lead the freshwater sector in terms of value due to its higher production volumes and premium prices when compared to other freshwater species. The second largest contributor was tilapia with 12% to the freshwater sector and 2% to the overall aquaculture value. The catfish subsector contributed 2% to the freshwater value. The smallest contributors were Common Carp and Crayfish contributing 1 and less than 1% to the freshwater aquaculture value. Figure 7.5 illustrate each subsector contribution towards the freshwater value in 2019.

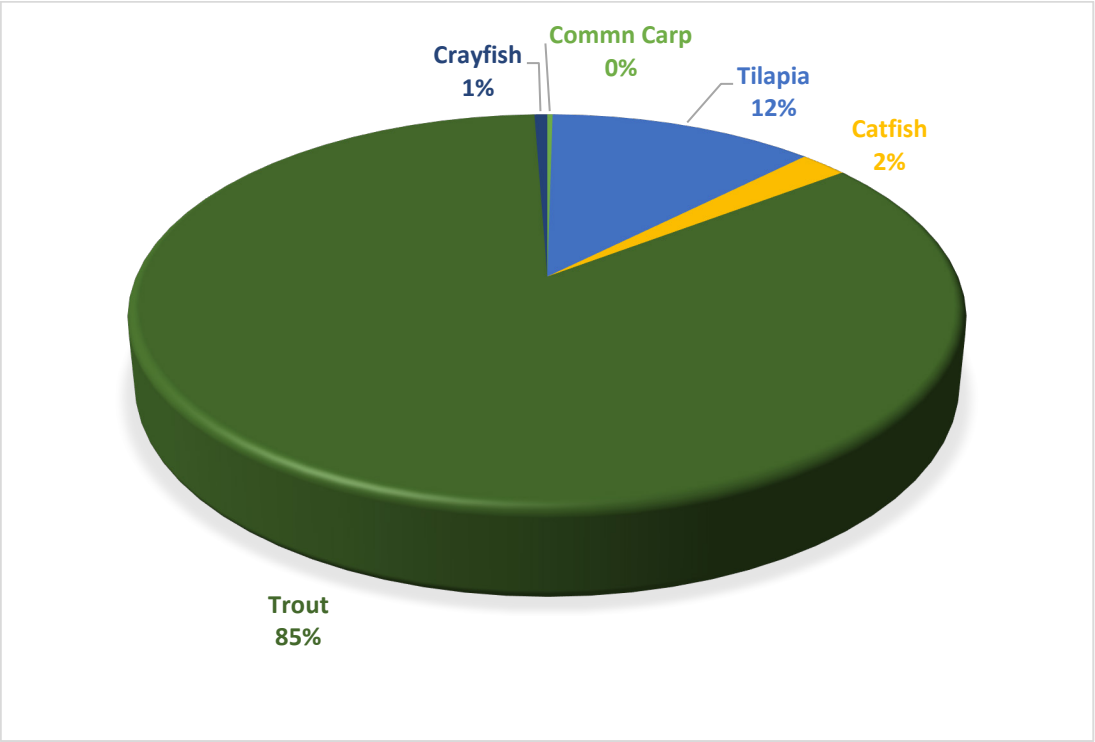


Figure 7.5: The estimated percentage contributed by each sub-sector towards the freshwater aquaculture total value in 2019.

7.2. Aquaculture Investment

Aquaculture is a capital-intensive sector because of its technology driven nature. To achieve rapid and sustainable aquaculture development, the sector requires more intensive, co-ordinated institutional support. Access to finance is still a hindering factor to the growth and development of aquaculture in the country. In countries that has the rapid growth in aquaculture, Government have provided financial support to boost the competitiveness of the sector both locally and internationally. In the development of commercial and competitive aquaculture sector in South Africa, financial assistance is crucial.

The need for investment and finance to support the development of aquaculture in South Africa is significant. There are various public-sector funding mechanisms that currently exist that can potentially provide financial support to aquaculture operations. These are provided at national level by government departments and provincial level. The Development Funding Institutions (DFIs) have varying financial solutions to meet the needs of farmers at various stages within the aquaculture value chain. Private finance is also available through commercial banks and other forms of private financing. The government is committed to grow the sector and stimulate the investments. The aquaculture sector remains an insignificant contributor to the national fish supply and the country's Gross Domestic Product (GDP).

During 2019, the sector achieved a total additional investment of approximately R512 688 274 from both the freshwater and the marine aquaculture sectors. This illustrates a decrease of 28% from R714 616 079,9 recorded in 2018.

South Africa's aquaculture investments has shown a rapid increase since the year 2015. Figure 7.6 shows the aquaculture investments trends for the period of five years (2015-2019). During this period, the sector's investments increased with an average percentage of 17,9% year on year. The peak was reached in 2018 where investments of R714.6 million were made and the lowest investments were reached in 2015 with R264.4 million. The fluctuation in investments in the sector can be attributed to the number of new farms, expansions and also competitive improvements which has increased over the years.

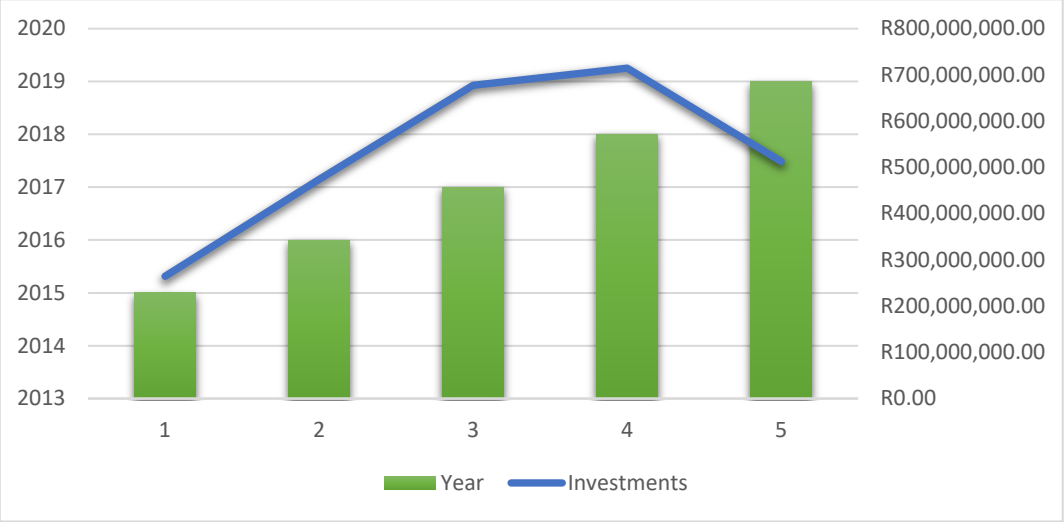


Figure 7.6: The South Africa's aquaculture investments from 2015- 2019.

In terms of provincial investments, the Western Cape continues to be the highest contributor to the overall aquaculture investments in the country with 57%. This can be attributed to a large number of capital intensive aquaculture activities in the province such as the abalone, oyster and mussels farming. The Eastern Cape and Northern Cape followed with 9% respectively which can be due to the presence of marine aquaculture activities increasing in the provinces. Free State, Limpopo and Gauteng followed with 8%, 7% and 5% respectively. Whereas, North West, Mpumalanga and KwaZulu Natal contributed the lowest with 4%, 1% and less than 1% respectively. This can be attributable to low number of existing and new farms in the provinces (Figure 7.7).

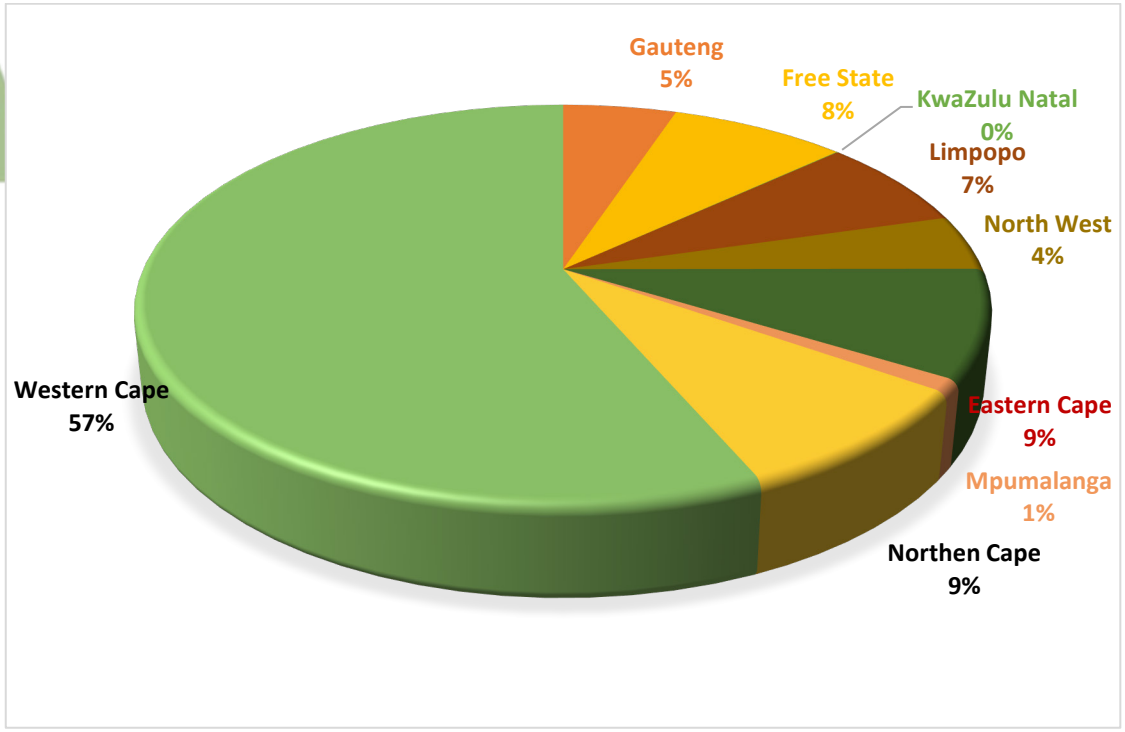


Figure 7.7: Aquaculture percentage investments per province in 2019

The abalone sub-sector contributed the highest towards the total overall investments in the sector with 83%. The investments in the abalone were primarily for further expansions and competitive improvements. The mussels sub-sector was the second highest contributor with 9%, followed by tilapia sub-sector 5%. The high investments in the mussels and tilapia sub-sectors can be associated with the increasing number of farms and expansions which has been witnessed over the years. The catfish, oyster and trout sub-sectors contributed 1% towards the overall aquaculture investments (Figure 7.8). There were no investments recorded for the Marron and finfish sub sector during the reporting period.

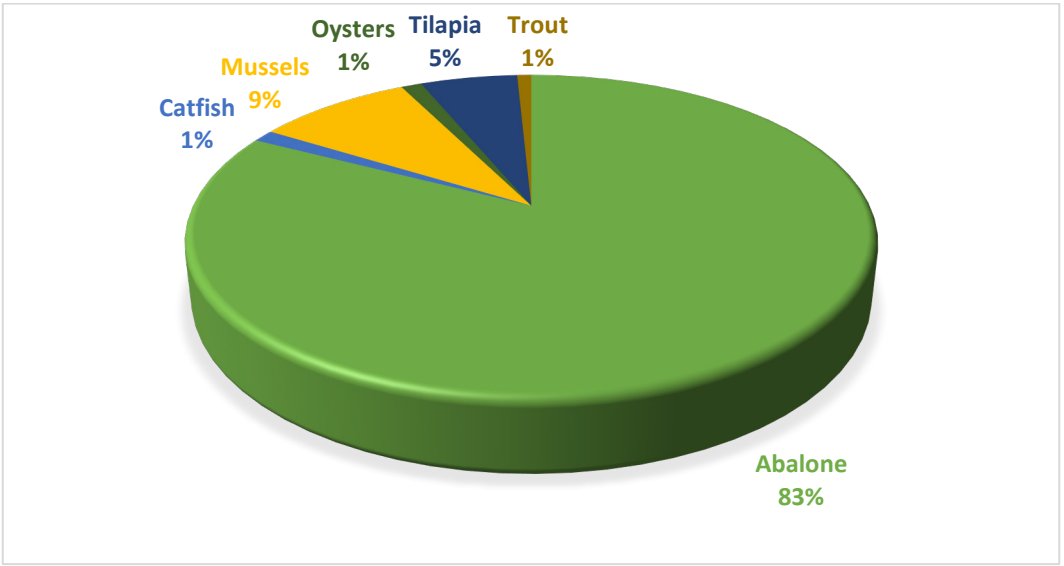


Figure 7.8: Percentage contributed by each sub-sector towards aquaculture investments in 2019

7.3. Employment Status

During 2019, aquaculture farms employed an estimated 3873 workers. This is an increase of 9,9% from

estimated 3486 people employed on farms in 2018. Figure 7.9 illustrates the trends of number of aquaculture jobs during the five-year period (2015-2019). The number of jobs has over the years increased by an average percentage of 1.4%. The increase in number of jobs was mostly driven by an increase in number of farms as well as expansions which took place in the sector over the reporting period. Similarly, during 2019, the increase in the number of jobs is also attributed to an increase of 719.89 tons in production volumes from 6365.79 tons in 2018 to 7085.68 tons in 2019.

Figure 7.9: Aquaculture jobs from 2015-2019

In terms of the number of jobs achieved per sub-sector during 2019, the abalone created more employment opportunities than other sub-sector with 43%, followed by the mussel's sub sector with 40% and trout with 10%. Oysters and tilapia followed with 5% and 2% respectively. The catfish, common carp, marron and ornamentals contributed less than 1% employment due to lowest number of farms and the lowest production produced in 2019, (Figure 7.10).

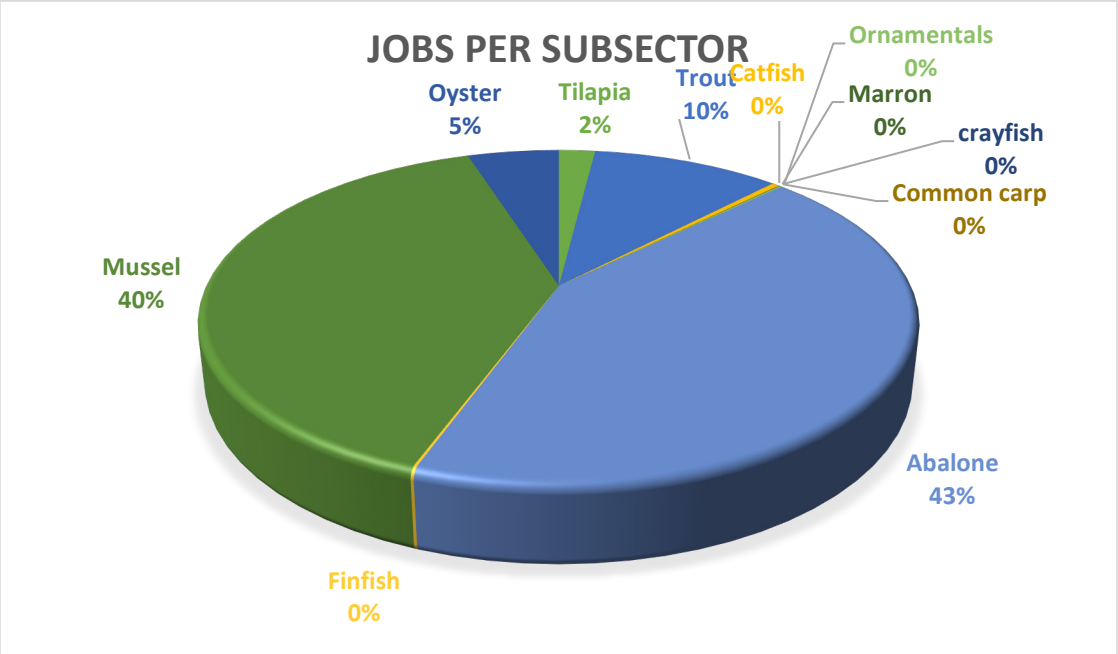


Figure 7.10: Percentage contributed by each subsector in 2019.

In respects to jobs created in each province in 2019, the Western Cape was the highest employer with 87%, which can be attributed to high number of labor intensive operations such as abalone farms. Eastern Cape was the second largest contributor with 6% followed by KwaZulu-Natal with 3%. The Western Cape maintained its position as the highest employer due to high aquaculture activities in the province. Low aquaculture activities in other provinces resulted in low production and low job opportunities, which collectively reported 13%. The Free State and Northern Cape had the lowest number of jobs, contributing less than 1% respectively (Figure 7.11).

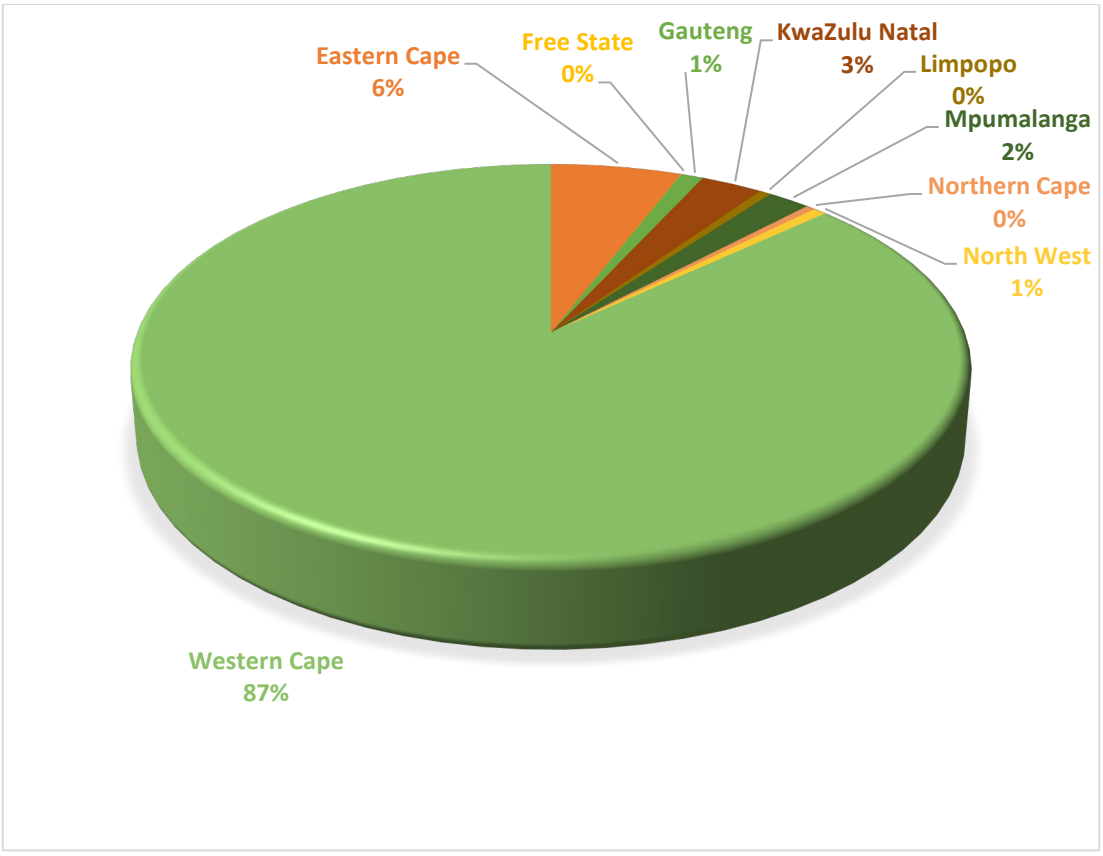


Figure 7.11: Jobs created per province during 2019

7.4. South Africa's Aquaculture Trade Analysis in 2019

During 2018, about 38% of total fisheries and aquaculture production were traded internationally at a value of 67 million tonnes. Trade recovered in the years 2016, 2017 and 2018 with annual growth rates of 7%, 9% and 5% in value terms respectively. Overall, from 1976 to 2018, the value of global fish exports increased from USD 7.8 billion to USD 164 billion, at an annual growth rate of 8% in nominal terms and 4% in real terms.

Countries such as China have been the major exporter of fishery products in terms of quantity. Norway has been the second major exporter followed by Vietnam, India, Chile and Thailand. The share of international trade by developing countries increased from 38% to 54 % of global export value and from 34% to 60% of total volumes between 1976 and 2018.

The largest importing market in 2018 was the European Union with 34%, followed by the United States of America with 14% and Japan with 9%. Africa is a net importer in volume terms but a net exporter in terms of value, reflecting the higher unit value of exports, which are destined primarily for developed country markets (FAO, 2020).
However, the escalation of trade tensions between two of the world's largest trading partners, China and the United States of America, introduced a note of uncertainty into the global fish market. While a number of heavily traded fish product items have been included on the list of tariffs of both countries, it is the wider economic impact and general uncertainty that have ultimately been the primary drivers of a growth slowdown, not only in China and the United States of America, but globally. FAO estimates for 2019 the total trade value contracted by about 2% in both quantity and value compared with 2018 (FAO, 2020).

In the regional context, the African continent contribution towards the global total aquaculture production is still low (Halwart, 2020). According to the FAO, aquaculture only contributed 18% percent to the regional total fish production in 2018 in Africa (FAO, 2020). Which means the captured fisheries accounted for about 82% towards the total fish production in the region. In terms of the world aquaculture production, Africa contribution remained insignificant with only 2196 million tons accounting for 2.67 percent in 2018 (Halwart, 2020). The leading producers in Africa are Egypt, Nigeria and Uganda and collectively account for about 90% of total aquaculture production in the region (Babatunde A. et al, 2020)

South Africa's total aquaculture exports for 2019 were 2366,85 tons with a value of R575 million. The quantity exported by South Africa decreased by 26% from 3190.56 tons in 2018. However, in value terms South African exports increased by 188% from R199 million in 2018 to R575 million in 2019. The major exported species in 2019 were abalone with 748.7 tons, followed by tilapia with 701.4 then Pacific salmon with 237.4, Atlantic salmon with 177.6 tons, followed by trout with 176.1 then oysters with 131.9 and mussels with 124. 8 tons. The least exported species were catfish, ornamentals, scallops carp and sea urchin with 36.3, 29, 3.2, 0.03 and 0.02 respectively (Figure 7.12 and Table 7.1).

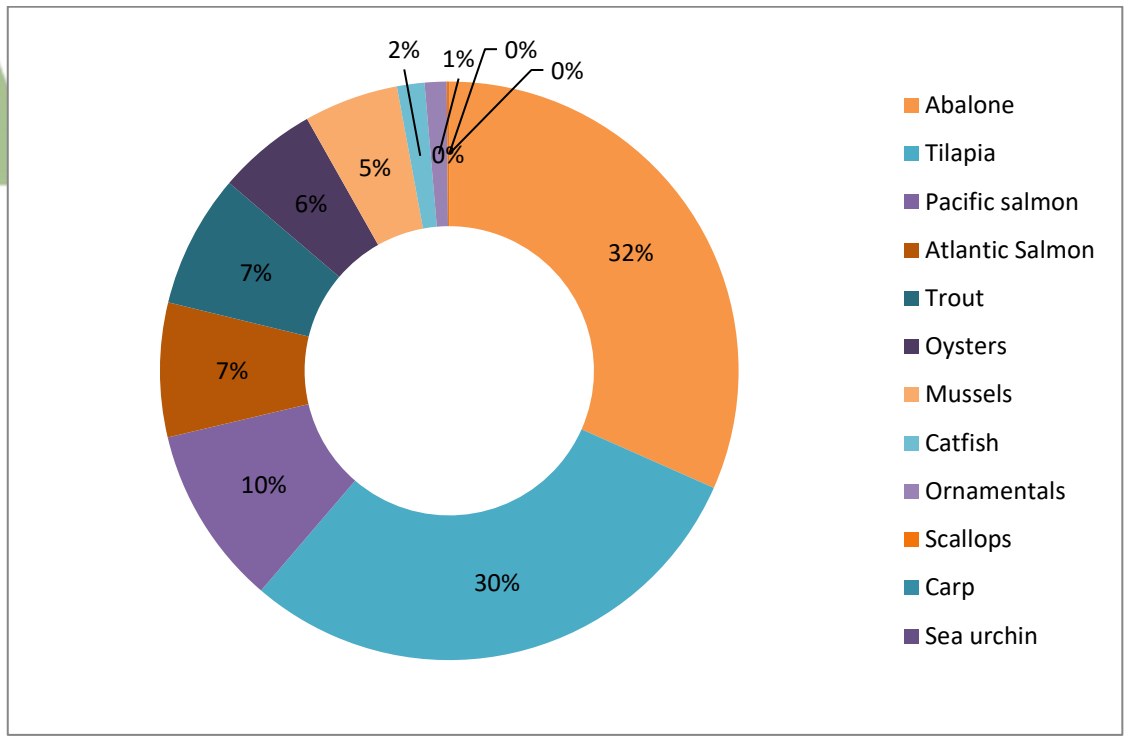


Figure 7.12: South Africa's aquaculture exports volume per sub-sector in 2019

Table 7.1: South Africa's aquaculture exports value per sub-sector in 2019

Specie	Tons:	Value (ZAR)
Abalone	748.75	R491 478 114,00
Tilapia	701.40	R12 077 024,00
Pacific salmon	237.38	R17 853 238,00
Atlantic Salmon	177.67	R11 765 119,00
Trout	176.16	R15 028 015,00
Oysters	131.95	R15 853 421,00
Mussels	124.88	R8 261 485,00
Catfish	36.37	R841 404,00
Ornamentals	29.04	R1 491 175,00
Scallops	3.23	R364 145,00
Carp	0.03	R560,00
Sea urchin	0.02	R632,00
TOTAL	**2366.9**	**R575 014 332,00**

During 2019 the top 5 importing markets for South African aquaculture products in terms of quantity were Malawi, followed by Hong Kong, Lesotho, Namibia and Taiwan and other countries combined (see Figure 7.13 and Table 7.2). Although, in terms of value out of the top 5 importing countries for South African total aquaculture products four of them were Asian countries, which were Hong Kong with R363 million, followed by Taiwan with R74 million then China with R29 million and Singapore with R18 million. Namibia was the only African country that is in the top 5 importing markets in value terms with R24 million and all other countries with R64 million (Figure 7.14).

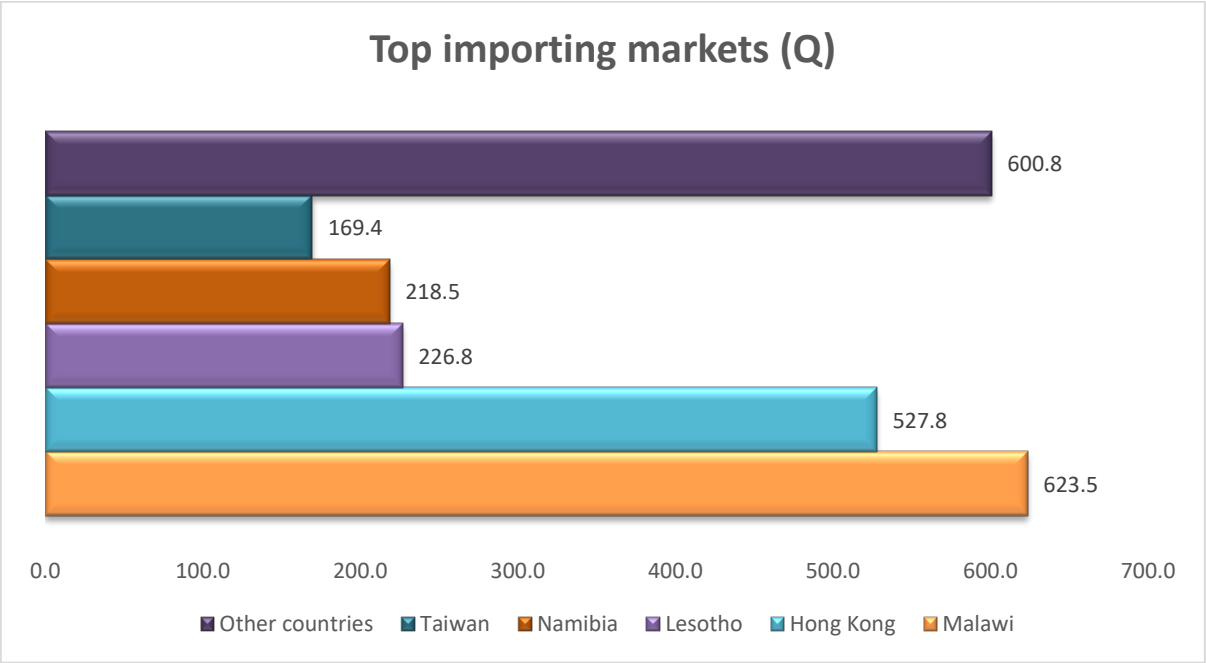


Figure 7.13: The top five importing markets for South African aquaculture products.

Table 7.2: Importing markets for South African aquaculture products.

Country	Quantity
Malawi	623.54
Hong Kong	527.80
Lesotho	226.77
Namibia	218.54
Taiwan	169.41
Botswana	97.65
China	83.55
Mozambique	80.79
Unclassified*	53.36
Zambia	46.57
Singapore	38.87
Portugal	31.91
Ghana	27.28
Swaziland	26.84
United States	24.84
Mauritius	24.63
United Arab Emirates	18.18
Democratic Republic Of Congo	14.90
Japan	7.26
Zimbabwe	5.15
Canada	4.63
Malaysia	2.67
Iran	2.42
Nigeria	2.19
Peru	1.66
Kenya	1.49

New Zealand	1.14
Saint Helena, Ascension an Tristan da Cunha	0.62
Thailand	0.33
United Kingdom	0.26
Denmark	0.25
Turkey	0.24
Rwanda	0.22
Uganda	0.18
Spain	0.14
Tanzania	0.12
Romania	0.12
Estonia	0.07
Congo	0.07
Germany	0.06
Seychelles	0.04
Russian Federation	0.02
Israel	0.018
France	0.01
Mali	0.011
Ethiopia	0.002
Central African Republic	0.0004
TOTAL	2366.85

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

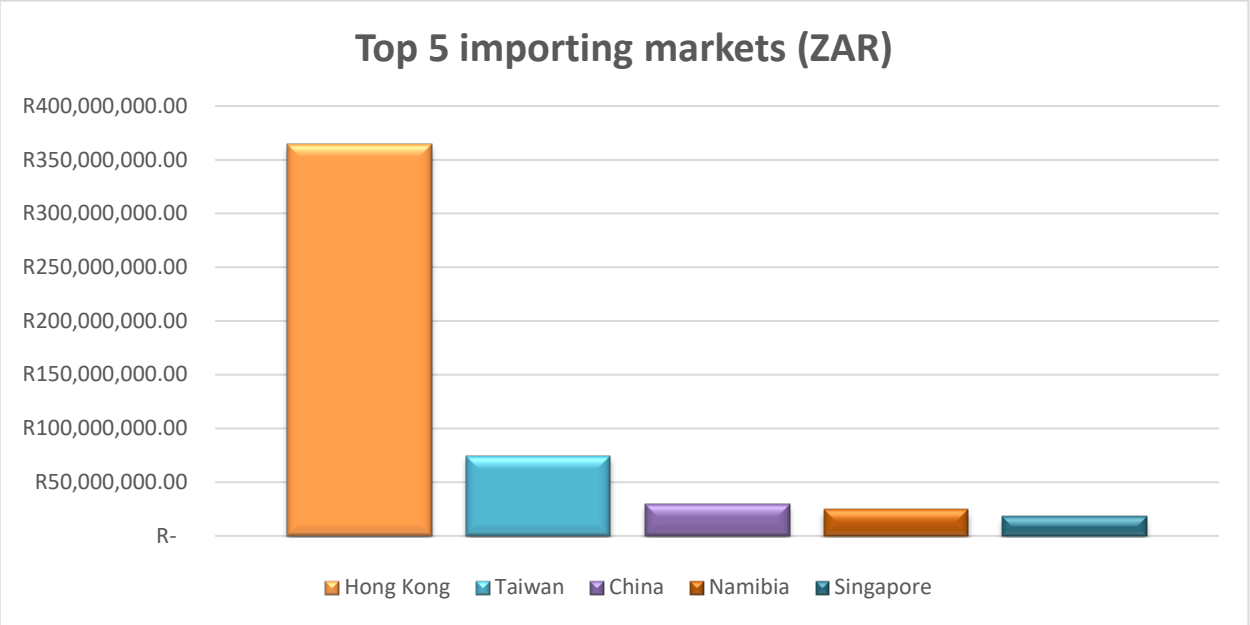


Figure 7.14: Value of top five importing markets of South Africa Products in 2019

7.4.1 Abalone

In 2019 South Africa exported 748,75 tons of abalone to a value of R491 million. This represents an increase of 167% from 279.70 tons in 2018. The top 5 importing markets for South African abalone were Hong Kong, Taiwan, China, Singapore, Namibia and other countries (see Figure 7.15 and Table 7.3) in 2019. The sector has been experiencing challenges as more than 50% of their abalone is sold to

the Asian market, this is due to the Hong Kong unrest and the continuing poaching. In 2020 it is expected that the challenges will continue and will be exacerbated by the outbreak of the coronavirus disease.

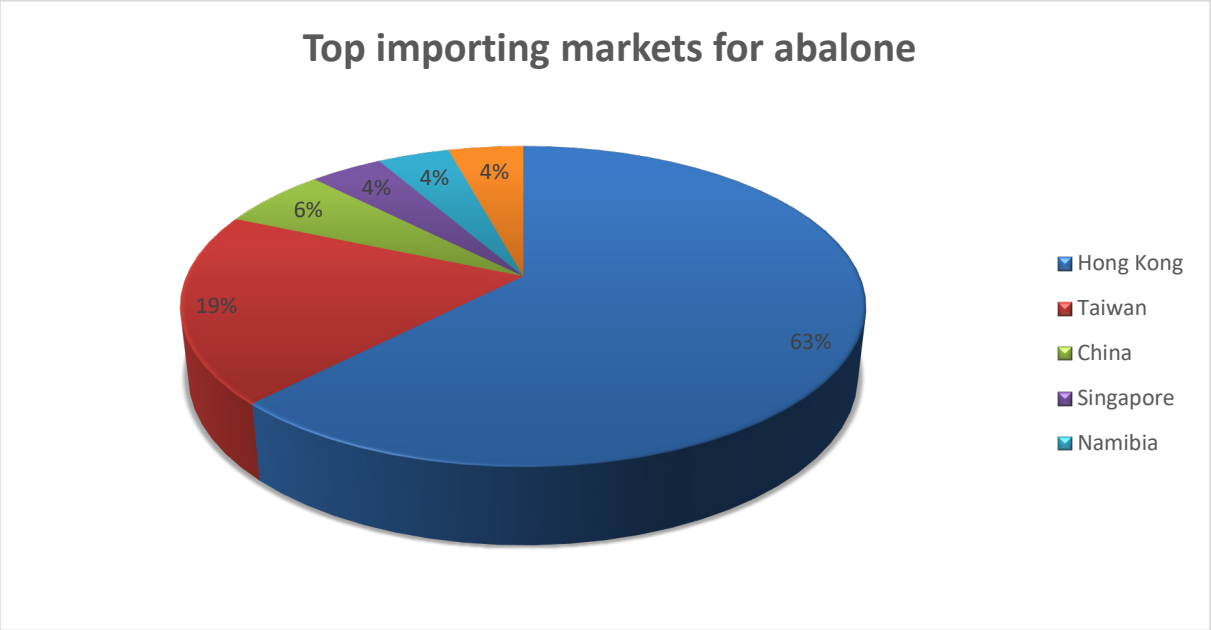


Figure 7.15: South Africa's export markets for abalone in 2019

Table 7.3: South Africa's export markets for abalone in 2019

Country	Tons	Value (ZAR)
Hong Kong	466.58	R355 182 220,00
Taiwan	143.77	R71 359 037,00
China	45.55	R26 282 102,00
Singapore	30.72	R17 511 201,00
Namibia	30.41	R10 012 472,00
Portugal	12.71	R669 839,00
Japan	7.26	R2 851 074,00
Canada	4.63	R4 800 090,00
Malaysia	2.67	R1 385 577,00
Unclassified*	1.5	R755 600,00
Mozambique	0.8	R29 332,00
Botswana	0.66	R78 635,00
United States of America	0.47	R349 373,00
Democratic Republic Of Congo	0.45	R50 536,00
Thailand	0.33	R152 430,00
Lesotho	0.1	R1 157,00
Zimbabwe	0.061	R6 750,00
Malawi	0.048	R91,00
Swaziland	0.01	R588,00
United Kingdom	0.0003	R10,00
Total	748.75	R491 478 114,00

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

Abalone was exported throughout the year in 2019 with the peak reached in the month of December with more than 100 tons. The second highest quantity was exported in January followed by October with 83.25 tons and 74.46 tons respectively. The lowest quantity was exported in March with 40.1 tons. On average, 62.4 tons of abalone was exported to other countries on a monthly basis (Figure 7.16).

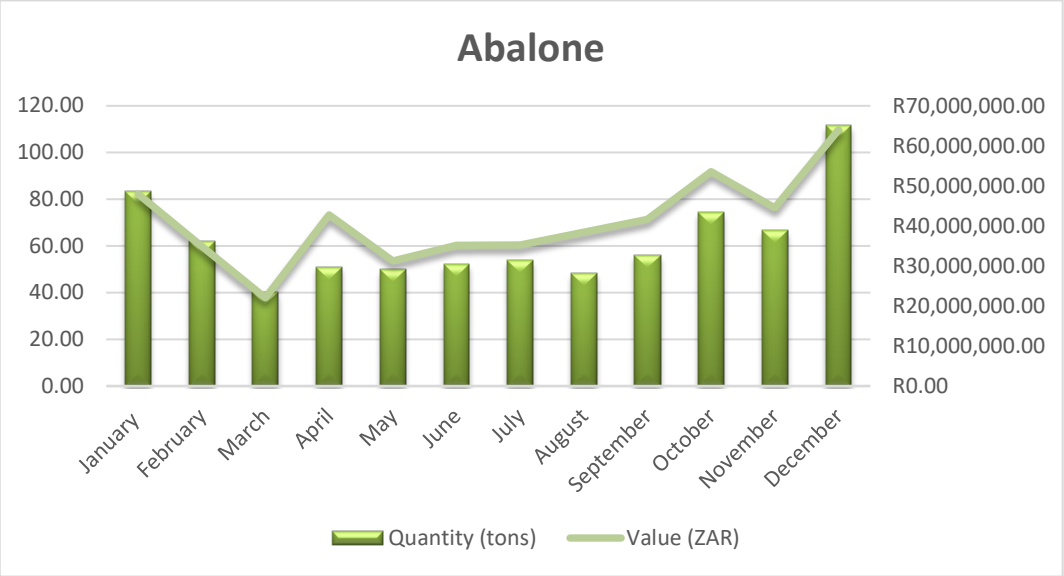


Figure 7.16: South Africa's abalone monthly exports trends during 2019

7.4.2 Tilapia

The global market for whitefish is competitive, with a relatively high degree of substitutability, but aquaculture producers of tilapia have successfully increased their share of the global fish market (FAO,2020). In the South African case, tilapia exports decreased by 62% from 1 846.12 tons in 2018 to 701.401 tons in 2019 to a value of R12 million (Figure 7.17 and Table 7.4). The top five (5) importing markets for tilapia in 2019 were Malawi, Zambia, China, Swaziland, Botswana and other countries with 88%, 4% and remaining countries 2% respectively.

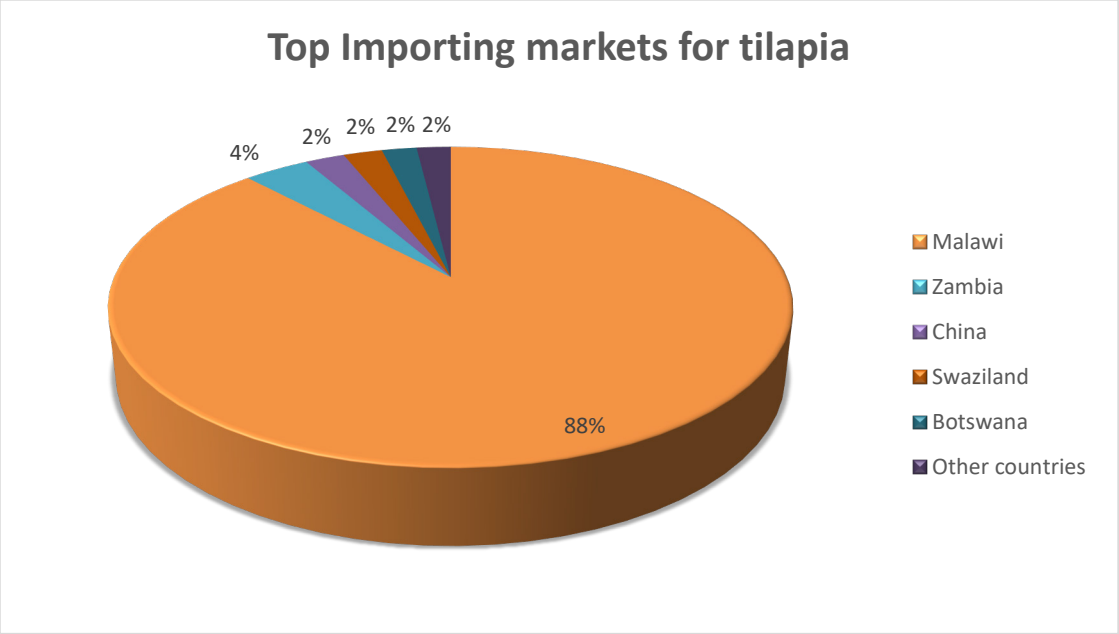


Figure 7.17: South Africa's export markets for tilapia in 2019

Table 7.4: South Africa's export markets for tilapia in 2019

Country	Tons	Value (ZAR)
Malawi	617.1836	R10 361 887,00
Zambia	25.9	R424 296,00
China	15.58	R262 887,00
Swaziland	15.43	R235 390,00
Botswana	13.79	R317 938,00
Namibia	10.334	R303 065,00
Mauritius	1.92	R64 920,00
Democratic Republic Of Congo	0.52	R59 950,00
Lesotho	0.518	R13 339,00
Mozambique	0.099	R10 307,00
Unclassified	0.078	R2 171,00
Nigeria	0.05	R20 874,00
Total	701.40	R12 077 024,00

In 2019, an average quantity of 58.4 tons of tilapia was exported to other countries on a monthly basis. The highest quantity was exported in November with 122 tons followed by August and December with 96.3 and 87.84 tons respectively. The lowest quantity of tilapia was exported in the first quarter of 2019 where 29.9, 8.65 and 1.28 tons of fish was exported in March, January and February respectively. The quantity increased during the second quarter reaching the peak in the last quarter of 2019 (Figure 7.18).

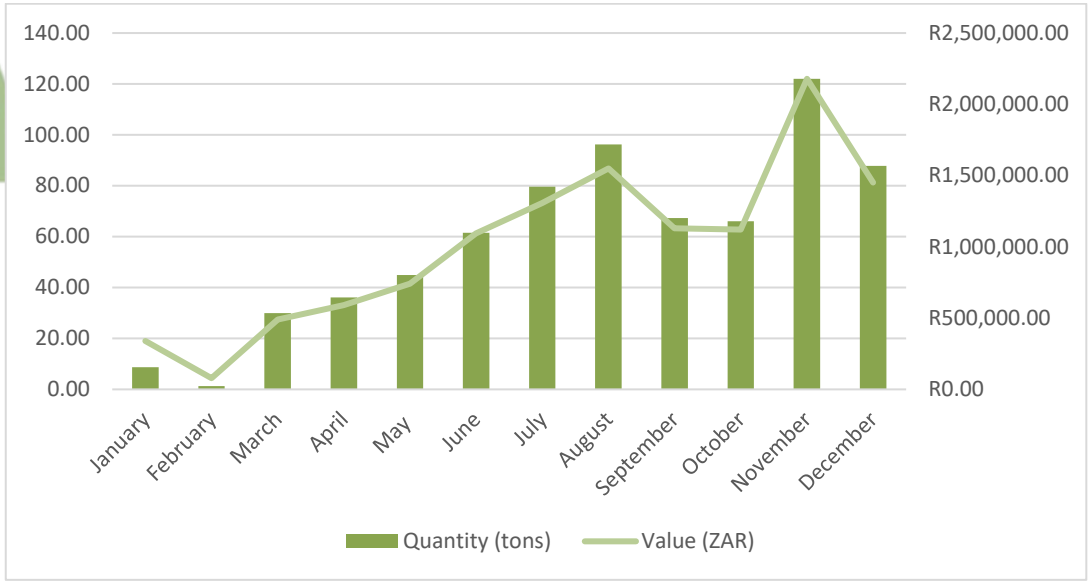


Figure 7.18: South Africa's tilapia monthly export trends in 2019

7.4.3 Pacific salmon

Salmonids have been the most important commodity traded in value terms since 2013 and accounted for about 19% of the total value of internationally traded fish products in 2018" (FAO, 2020). South Africa exported 237.38 tons of Pacific salmon valued at R 17 million. During 2019 the highest importing countries for Pacific salmon were Namibia with 27%, followed by Lesotho with 22%, Botswana with 14% then Mozambique with 13% followed by the unclassified nations with 11% and other countries with 13% respectively. Exports for Pacific salmon increased significantly in 2019 with 230% increase from 71.85 tons in 2018 (Figure 7.19).

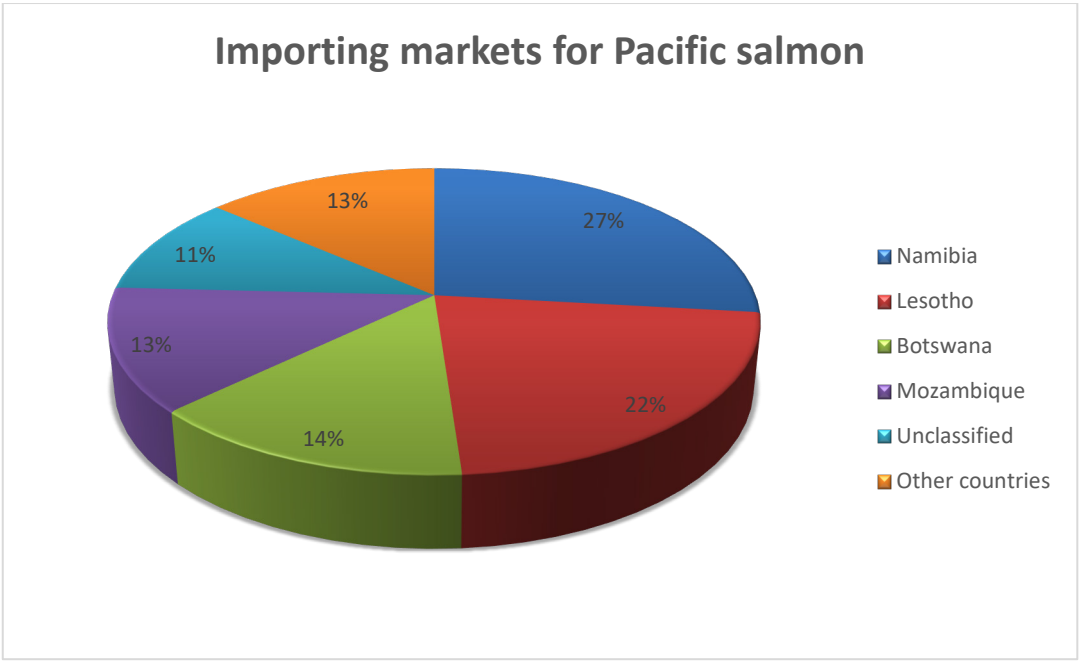


Figure 7.19: South Africa's export markets for Pacific salmon in 2019

Table 7.5: South Africa's export markets for Pacific salmon in 2019

Country	Tons	Value (ZAR)
Namibia	63.59	R6 543 831,00
Lesotho	52.39	R1 133 215,00
Botswana	33.20	R1 091 181,00
Mozambique	30.83	R3 030 641,00
Unclassified*	25.15	R3 254 743,00
Portugal	9.60	R654 581,00
Zambia	8.86	R487 449,00
Democratic Republic Of Congo	4.69	R386 072,00
Swaziland	2.28	R88 760,00
United States	2.16	R190 878,00
Zimbabwe	2.005	R552 530,00
Malawi	0.92	R210 162,00
New Zealand	0.57	R16 800,00
Ghana	0.44	R37 222,00
Nigeria	0.26	R68 640,00
Rwanda	0.14	R44 685,00
Uganda	0.13	R13 777,00
Tanzania	0.11	R40 625,00
Germany	0.03	R329,00
Saint Helena, Ascension an Tristan da Cunha	0.015	R5 359,00
Israel	0.009	R183,00
Ethiopia	0.002	R1 050,00
Mali	0.001	R525,00
TOTAL	237.38	R17 853 238,00

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

The exports for pacific salmon was at an average of 19.8 tons per month in 2019 in terms of quantity. Highest quantity was exported in October with 35.32 tons valued at R1 926 004. The lowest quantity was exported in December, where only 12.9 tons of pacific salmon was exported valued at R1 212 832 (Figure 7.20)

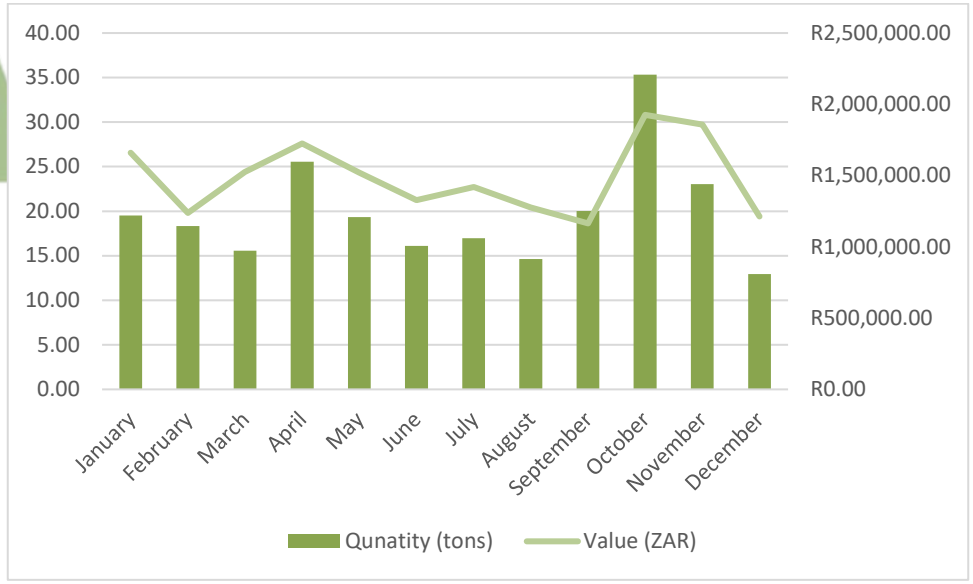


Figure 7.20: South Africa's pacific salmon monthly exports trends in 2019

7.4.4 Atlantic Salmon

Atlantic salmon, has proved a versatile and popular seafood item that aligns with trends in modern consumer preferences. The demand for the specie has been driven by a huge demand in both the developed and the developing markets (FAO, 2020). With regards to South Africa in 2019 exports of Atlantic salmon increased in quantity and value from 46.34 tons to a value of R3 million in 2018 to 177.66 tons to a value of R11 million. The top 5 importing markets for Atlantic salmon in 2019 were Lesotho, Namibia, Botswana, Unclassified nations, Portugal and Other countries respectively (Figure 7.21 and Table 7.6).

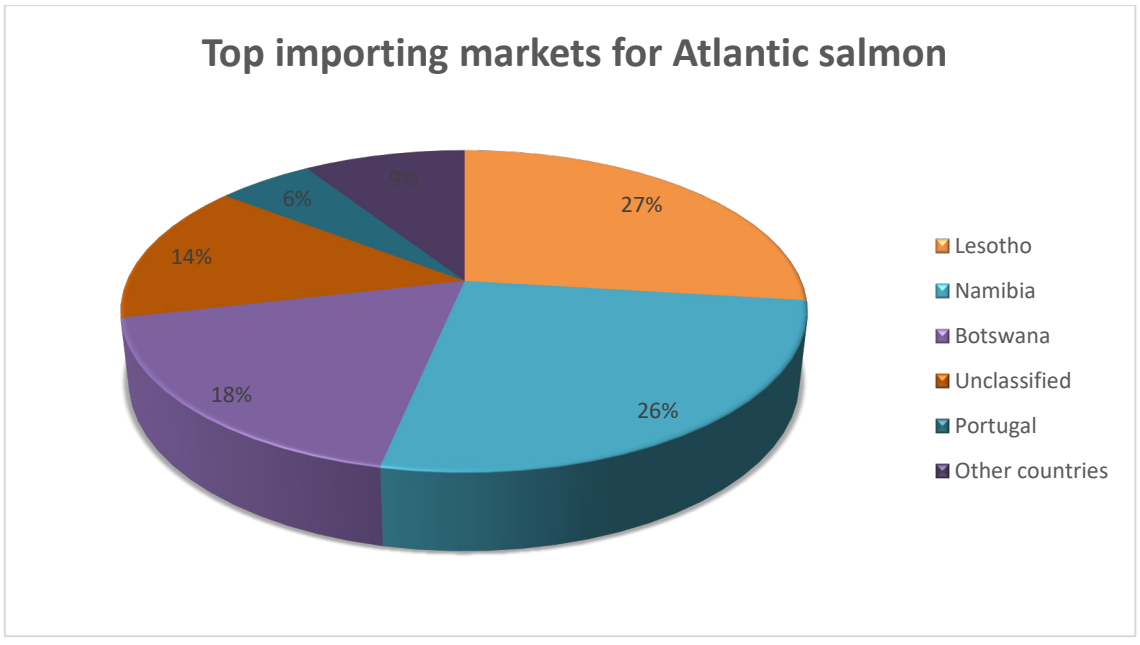


Figure 7.21: South Africa's export markets for Atlantic salmon in 2019

Table 7.6: South Africa's export markets for Atlantic salmon in 2019

Country	Tons	Value (ZAR)
Lesotho	47.88	R1 104 670,00
Namibia	46.79	R3 812 514,00
Botswana	32.09	R605 450,00
Unclassified	25.12	R3 273 938,00
Portugal	9.60	R654 581,00
Mozambique	6.45	R1 008 306,00
Malawi	3.34	R604 808,00
Zambia	1.64	R184 463,00
United States of America	1.33	R117 028,00
Swaziland	1.32	R127 266,00
Mauritius	0.73	R88 388,00
New Zealand	0.57	R16 800,00
Nigeria	0.42	R108 891,00
Democratic Republic Of Congo	0.23	R41 344,00
Rwanda	0.04	R6 524,00
Saint Helena, Ascension an Tristan da Cunha	0.04	R7 662,00
Germany	0.03	R329,00
Tanzania	0.01	R450,00
Israel	0.009	R183,00
Mali	0.007	R1 524,00
TOTAL	177.66	R11 765 119,00

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

A monthly average of 19.8 tons of Atlantic salmon was exported to other countries in 2019. The highest quantity was exported in October with 35.32 tons, followed by April and November with 25.6 and 23.04 tons respectively (Figure 7.22).

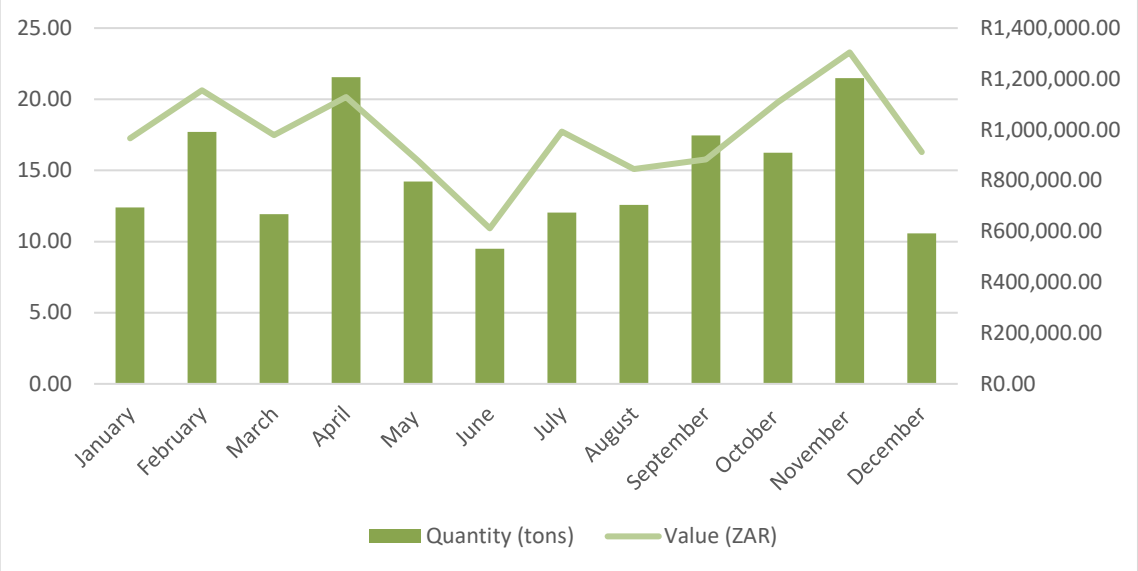


Figure 7.22: South Africa's Atlantic Salmon exports per month in 2019

7.4.5 Trout

South African trout exports were 176.16 tons to the value of R15 million in 2019. The top five (5)

highest importing markets for trout were Lesotho with 60%, followed by Mozambique with 16%, then Namibia and Botswana with 9% and 5% respectively then Zambia and other countries with 3% and 7% respectively. Compared to 2019 the importing markets have not changed with the exception of the quantity imported that has increased significantly at 178% when compared with 2018, (Figure 7.23 and table 7.7).

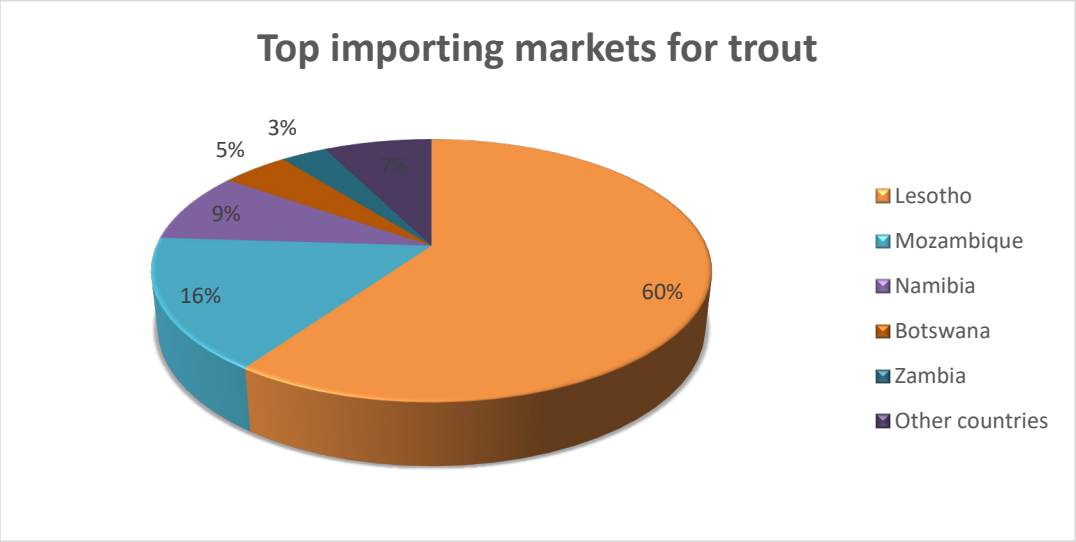


Figure 7.23: South Africa's export markets for trout in 2019

Table 7.7: South Africa's export markets for trout in 2019

Country	Tons	Value (ZAR)
Lesotho	105.27	R5 433 787,00
Mozambique	28.65	R835 100,00
Namibia	15.29	R1 175 868,00
Botswana	8.19	R734 149,00
Zambia	5.59	R284 453,00
Swaziland	4.10	R326 114,00
Iran	2.42	R2 917 883,00
Peru	1.66	R1 382 853,00
Unclassified*	1.27	R118 150,00
Kenya	1.15	R130 559,00
Zimbabwe	0.55	R54 281,00
Malawi	0.42	R141 466,00
DRC	0.34	R45 702,00
United Kingdom	0.255	R463 169,00
Denmark	0.25	R275 716,00
Turkey	0.24	R245 399,00
Spain	0.14	R184 086,00
Romania	0.12	R136 931,00
Estonia	0.07	R73 793,00
Nigeria	0.06	R24 252,00
Seychelles	0.04	R1 845,00
Rwanda	0.029	R5 137,00
Russian Federation	0.02	R37 322,00
TOTAL	176.16	R15 028 015,00

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

Trout was exported on a monthly basis in 2019 with an average of 14.7 tons per month. A peak was reached in February where 40.2 tons of trout was exported to other countries. May and September followed with the highest quantity exported with 36 and 33.8 tons respectively. Lowest quantity was exported in January, July and December with 3.1, 2.9 and 2.5 tons respectively (Figure 7.24).

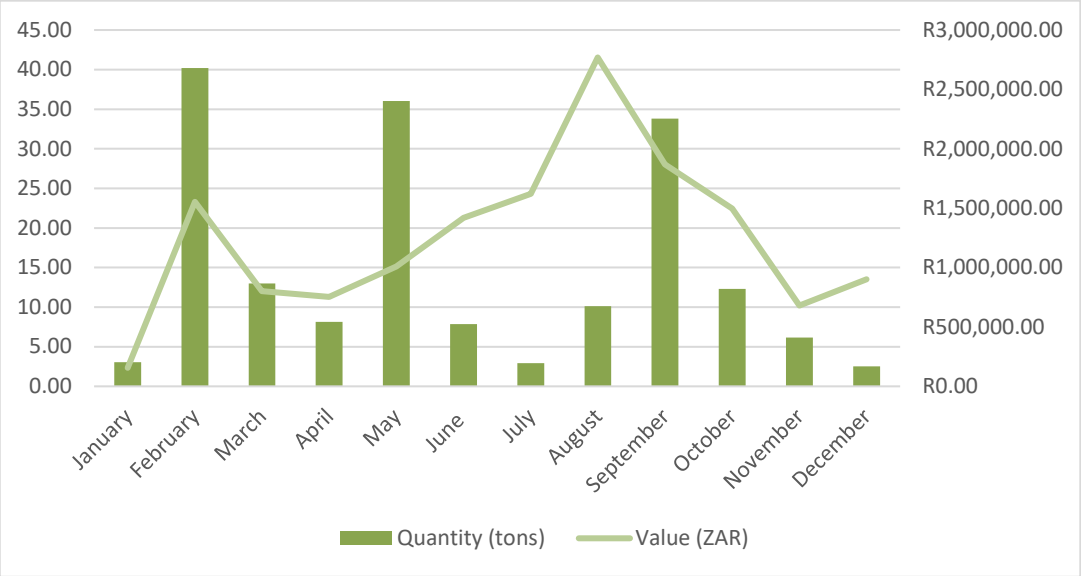


Figure 7.24: South Africa's trout exports per month in 2019

7.4.6 Oysters

The demand for oysters has increased significantly over time due to rising of incomes in the world. Furthermore, the demand has been caused by the favourable characteristics of bivalve species from a consumer perspective (FAO, 2020). South Africa exported 131.94 tons to a value of 15 million in 2019. This shows a decrease of 53% from 279.70 tons in 2018. The top 5 importing markets in 2019 for oysters were Hong Kong, Taiwan, China, Namibia, Mauritius and other countries with 46%, 19%, 17%, 7%, 5% and 6% in that order (Figure 7.25 and table 7.8).

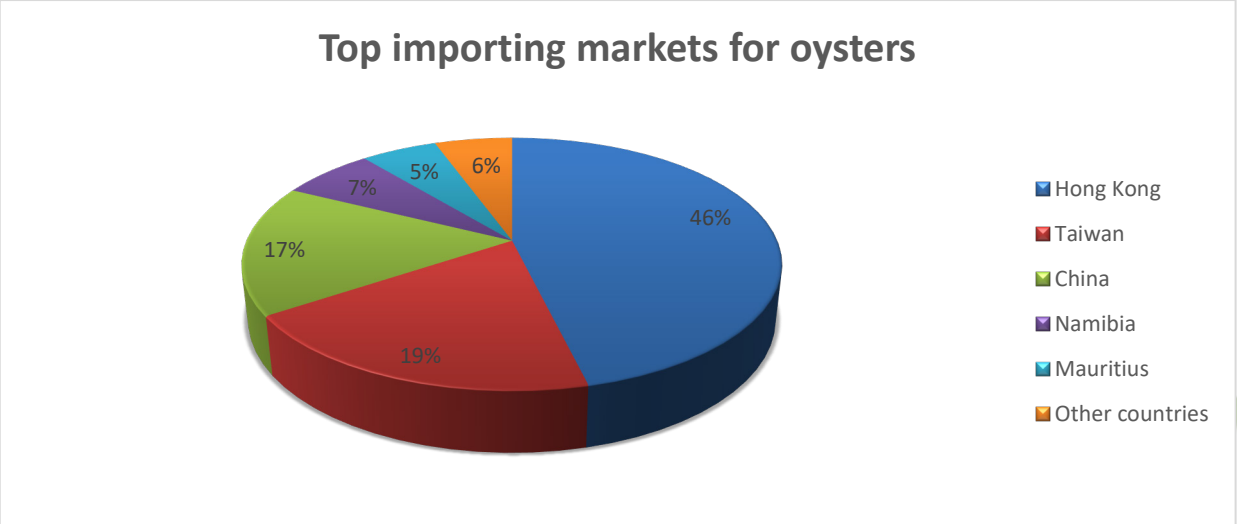


Figure 7.25: South Africa's export markets for oysters in 2019

Table 7.8: South Africa's export markets for oysters in 2019

Country	Tons	Value (ZAR)
Hong Kong	60.97	R8 613 151,00
Taiwan	25.64	R3 152 615,00
China	22.07	R2 780 062,00
Namibia	8.77	R439 320,00
Mauritius	7.17	R573 322,00
Botswana	2.06	R91 141,00
Mozambique	1.47	R67 130,00
Swaziland	1.09	R42 774,00
Zimbabwe	0.83	R5 077,00
Lesotho	0.7	R3 115,00
Zambia	0.47	R15 622,00
Malawi	0.25	R22 256,00
Unclassified	0.23	R8 099,00
DRC	0.12	R25 866,00
Ghana	0.07	R12 734,00
Kenya	0.03	R1 137,00
TOTAL	131.95	R15 853 421,00

During 2019, the highest quantity was exported in the month of August with 24.19 tons. The second highest quantity was exported in October followed by July with 20.9 and 11.8 tons respectively. The lowest quantity was exported in February where only 3.8 tons of oysters was exported. On average, 11 tons of oysters was exported on a month to month basis during the reporting period (Figure 7.26)

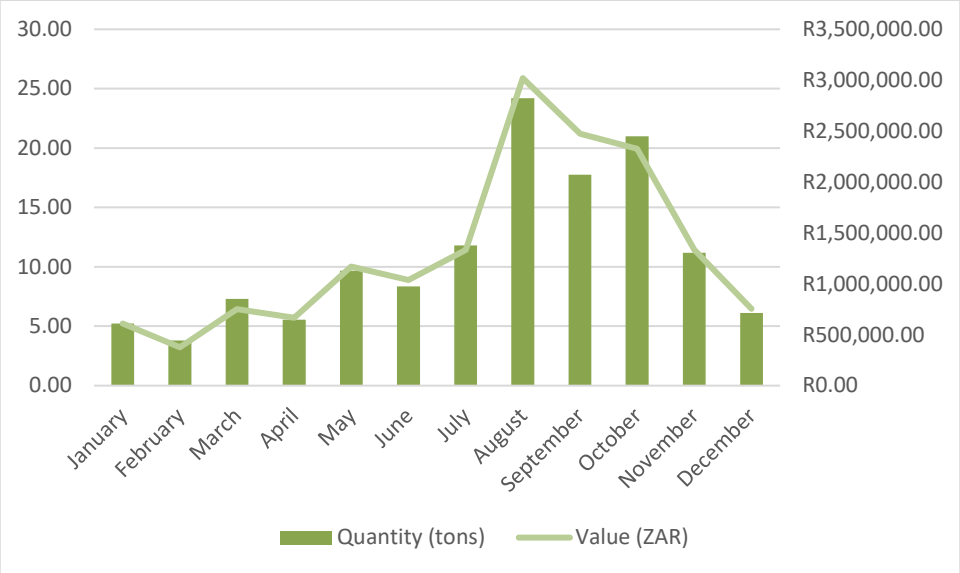


Figure 7.26: South Africa's oysters exports per month in 2019

7.4.7. Mussels

When considering the market potential for mussels, it is evident that there is a demand as shown by the South African exported quantity of mussels in Figure 7.20. With high per capita consumption of mussels in Europe, exports to the EU market would be highly favourable for South African producers. However,

there are various challenges for the export of bivalve products to European markets (DAFF, 2017).

During 2019 South Africa exported 124.88 tons of mussels at a value of R 8 million. This represents a significant increase of about 88% when compared to 66.17 tons in 2018. The top 5 importing markets for mussels in 2019 were Namibia with 34%, United States of America with 17%, United Arab Emirates with 13%, Mauritius with 12%, Singapore with 7% and other countries with 17% (see Figure 7.27 and Table 7.9).

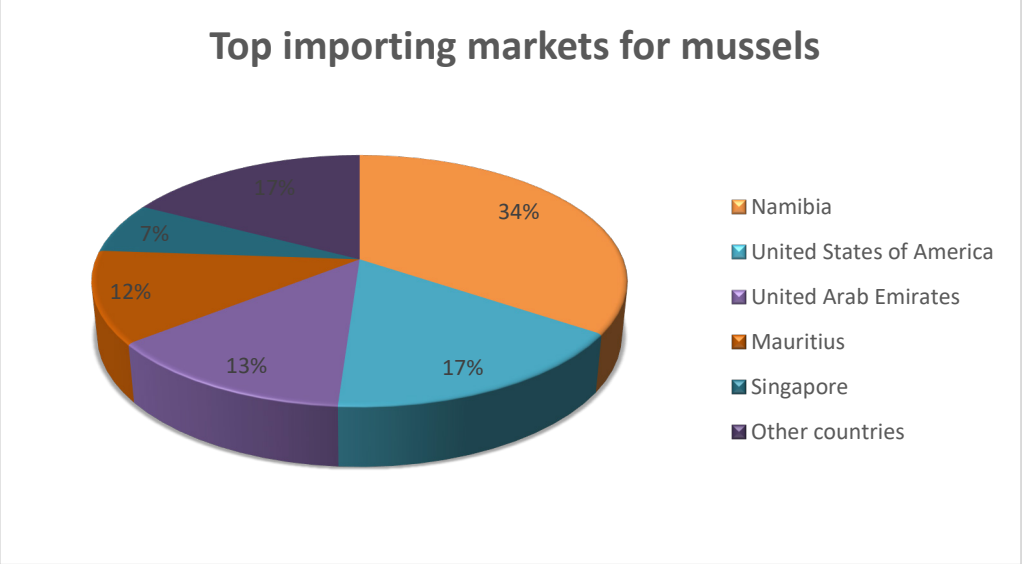


Figure 7.27: South Africa's export markets for mussels in 2019

Table 7.9: South Africa's export markets for mussels in 2019

Country	Tons	Value (ZAR)
Namibia	42.93	R2 149 003,00
United States of America	20.88	R1 431 553,00
United Arab Emirates	16.56	R1 419 097,00
Mauritius	14.72	R877 384,00
Singapore	8.15	R746 609,00
Mozambique	4.58	R315 010,00
Zambia	3.74	R226 685,00
Botswana	3.43	R114 855,00
Swaziland	2.60	R228 122,00
Lesotho	1.68	R10 645,00
Zimbabwe	1.61	R106 981,00
Nigeria	1.38	R84 992,00
Malawi	0.75	R51 401,00
DRC	0.72	R43 218,00
China	0.35	R267 394,00
Kenya	0.31	R16 776,00
Hong Kong	0.25	R154 715,00
Ghana	0.12	R6 150,00
Congo	0.07	R7 727,00

Uganda	0.05	R2 862,00
Rwanda	0.005	R210,00
Unclassified	0.001	R20,00
Central African Republic	0.0004	R76,00
TOTAL	124.88	R8 261 485,00

An average of 10.4 tons of mussels valued at R688 457 was exported on month to month basis in 2019. The highest quantity was exported in October with 32.4 tons followed by November and July with 18.9 and 12.4 tons respectively (Figure 7.28).

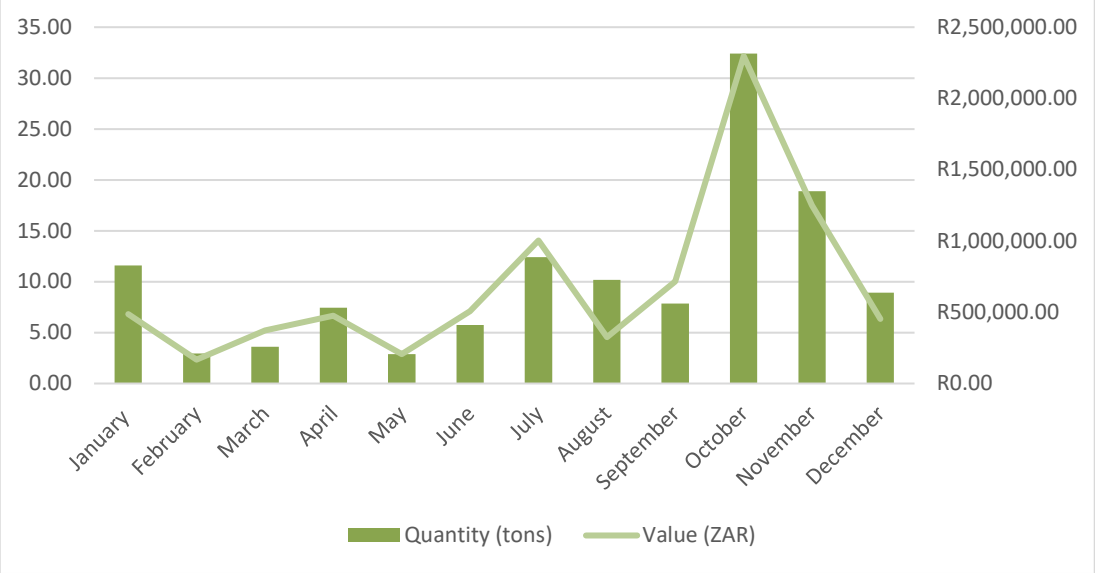


Figure 7.28: South Africa's mussels exports per month in 2019

7.4.8. Catfish

There is a resurgence of interest in the farming of catfish to satisfy local demand, although export demand also exists. Several small-sized operations have started up cautiously, having learned from past failures. Each is developing slowly and ensuring they have a market for the product as they proceed (Ter Morshuizen, 2020). South Africa exported 36.36 tons of catfish at a value of R841 thousand in 2019. For 2019 alone, the interest in the fish category has gone down, changing by 92% compared to the year 2018. This is a major decrease as the Democratic Republic of Congo which has been the major importer of South African catfish did not import. South Africa is facing major competition to countries such as Nigeria. The top 5 importing markets for 2019 were Ghana, Mozambique, United Arab Emirates, Namibia, Botswana and other countries (Figure 7.29 and Table 7.10).

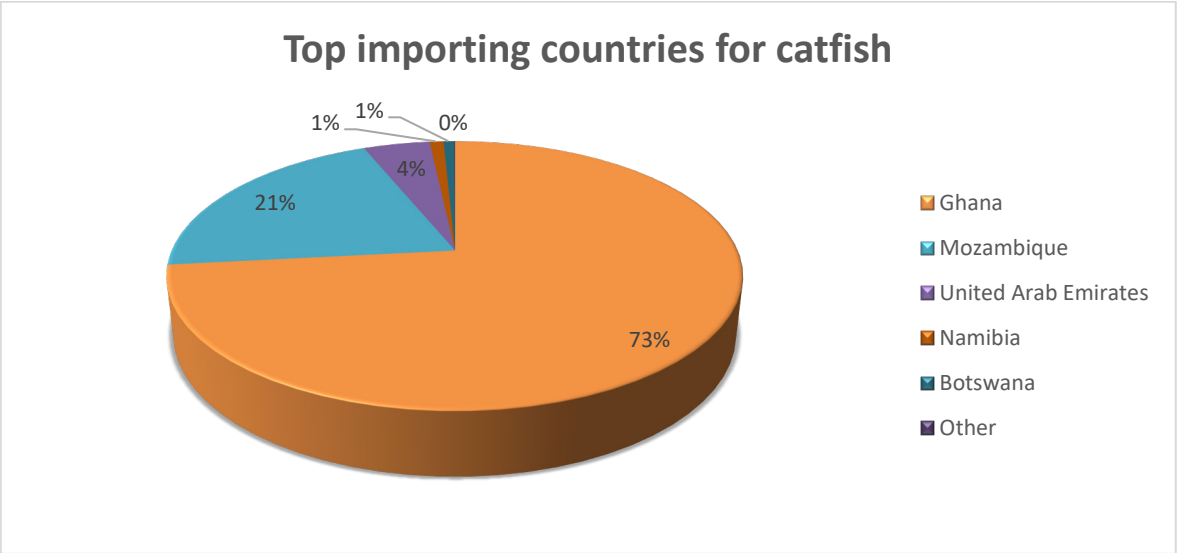


Figure 7.29: South Africa's export markets for catfish in 2019

Table 7.10: South Africa's export markets for catfish in 2019

Country	Tons	Value (ZAR)
Ghana	26.66	R534 234,00
Mozambique	7.47	R147 206,00
United Arab Emirates	1.62	R135 961,00
Namibia	0.34	R12 664,00
Botswana	0.26	R9 010,00
Nigeria	0.02	R2 329,00
TOTAL	36.36	R841 404,00

Catfish was exported in February to November and no exports took place in January and December. On average South Africa exported 23.9 tons per month in 2019. Highest quantity was exported in March followed by July and June with 5, 51.8 and 47.6 respectively. The lowest quantity was exported in February and October with 1.62 and o.26 respectively (Figure 7.30).

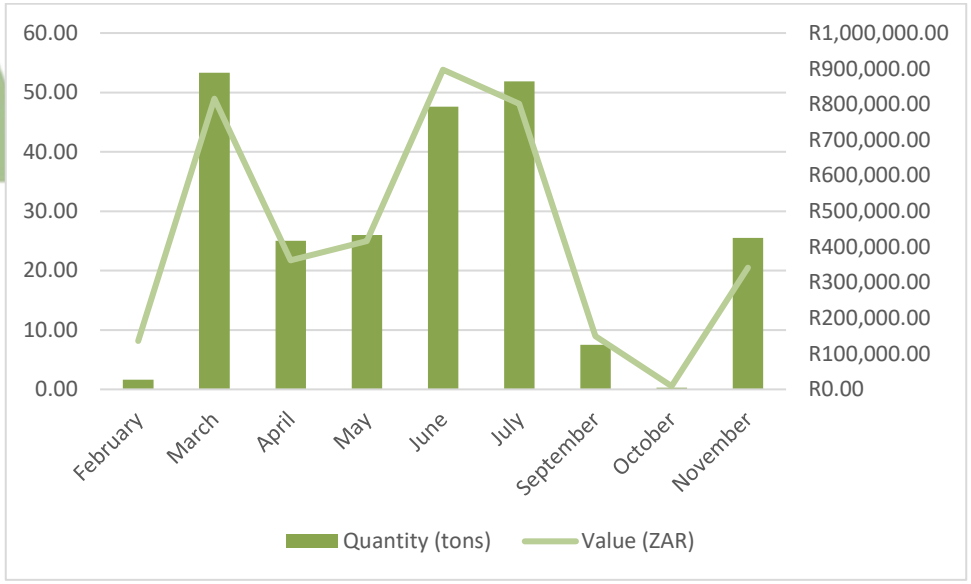


Figure 7.30: South Africa's catfish monthly exports in 2019

7.4.9. Ornamentals

During 2019 South Africa exported 29.04 tons of ornamentals to a value of R1 million. The top 5 importing markets for ornamentals from South Africa were Lesotho with 63%, followed by DRC with 21%, and then followed by Botswana, Saint Helena, Ascension and Tristan da Cunha, Malawi and other countries, with 13% 2%,0.1% and 1% respectively (Figure 7.31 and Table 7.11). The ornamentals exports decreased by 19% when compared to 36.36 tons exported in 2018.

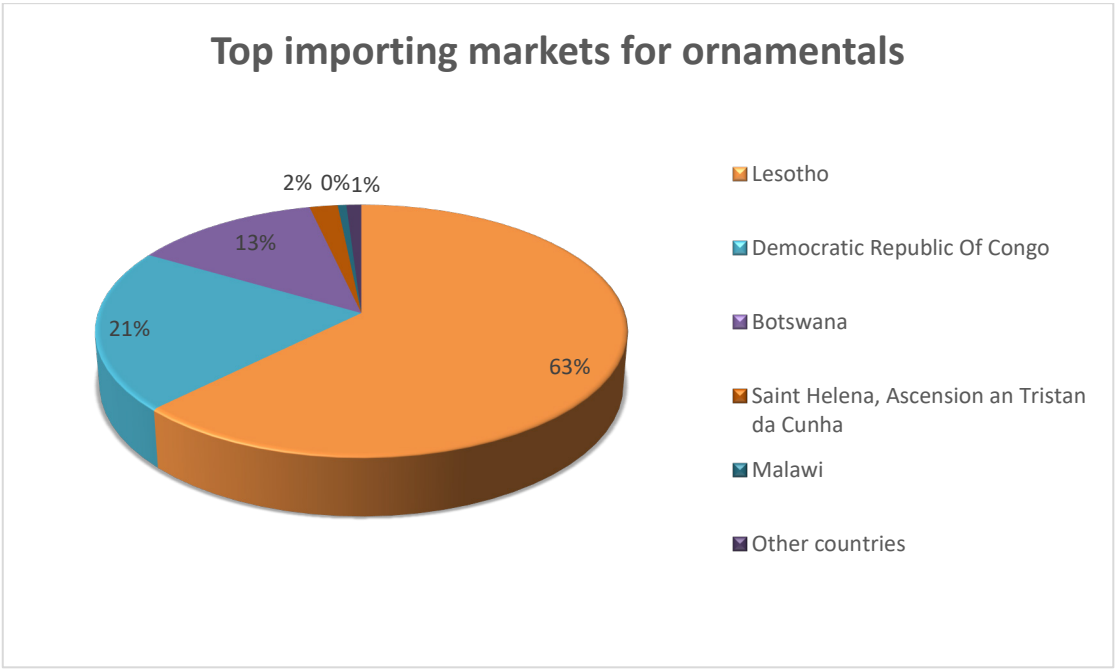


Figure 7.31: South Africa's export markets for ornamentals in 2019

Table 7.11: South Africa's export markets for ornamentals in 2019

Country	Tons	Value (ZAR)
Lesotho	18.18	R936 000,00
Democratic Republic Of Congo	6.029	R165 982,00

Botswana	3.78	R110 026,00
Saint Helena, Ascension an Tristan da Cunha	0.57	R170 070,00
Malawi	0.17	R29 931,00
Mozambique	0.15	R600,00
Mauritius	0.096	R59 237,00
Zimbabwe	0.03	R10 796,00
France	0.014	R5 054,00
Unclassified	0.01	R345,00
Namibia	0.003	R182,00
Taiwan	0.0015	R2 952,00
TOTAL	29.04	R1 491 175,00

An average of 2.4 tons of ornamentals valued at R124 264,58 was exported by South Africa each month in 2019. The highest quantity was exported in July and January where 18.35 and 6.43 was exported respectively. The lowest quantity was exported in March and February with 0.02 and 0.17 tons respectively (Figure 7.32).

Figure 7.32: South Africa's Ornamentals monthly exports in 2019

7.4.10. Scallops

South Africa exported 3.23 tons of scallops to a value of R 364 thousand. The highest importing countries of scallops were DRC with 56%, followed by Malawi with 24%, then Zambia and Mozambique with 11% and 8% respectively, then followed by both Botswana and other countries with 6%. This represents a decrease of 69% from 10.37 tons in 2018 (Figure 7.33 and Table 7.12).

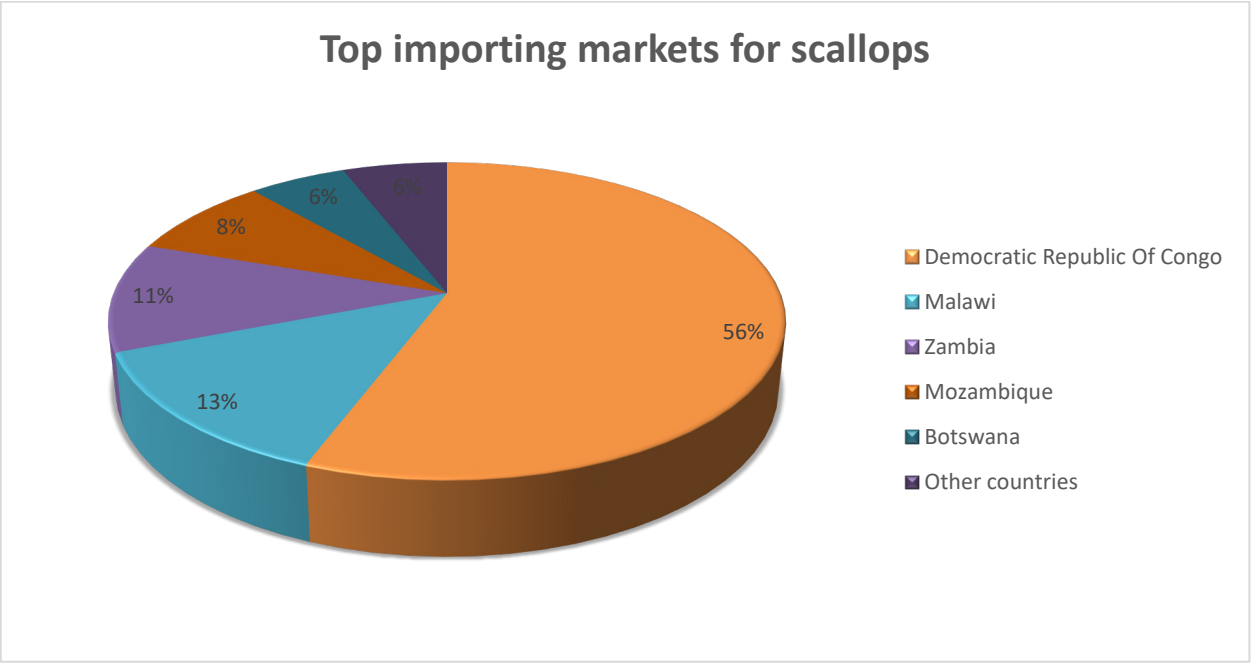


Figure 7.33: South Africa's export markets for scallops in 2019

Table 7.12: South Africa's export markets for scallops in 2019

Country	Tons	Value (ZAR)
Democratic Republic Of Congo	1.80	R207 980,00
Malawi	0.43	R29 968,00
Zambia	0.36	R30 210,00
Mozambique	0.27	R28 935,00
Botswana	0.18	R7 781,00
Namibia	0.08	R16 015,00
Zimbabwe	0.06	R39 000,00
Lesotho	0.04	R2 868,00
Rwanda	0.004	R815,00
Mali	0.0022	R573,00
TOTAL	3.23	R364 145,00

South Africa exported an average of 0.29 tons of scallops on a month to month basis excluding June in 2019. The highest quantity was exported in May with 1.32 tons to a value of R137 322 (Figure 7.34).

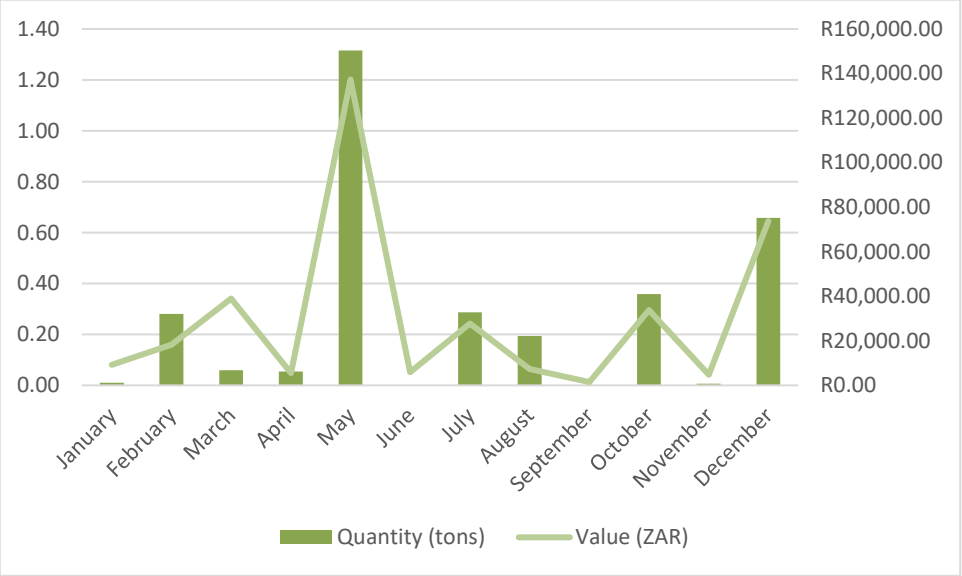


Figure 7.34: South Africa's scallops monthly exports in 2019

7.4.11. Common carp

South Africa exported 0.029 tons of carp to a value of R 560 in 2019. There were two importing markets of carp from South Africa in 2019 namely, Lesotho and Mozambique with 0.005 tons and 0.024 tons respectively. South African carp exports have been insignificant for the past years as there is not much production of the specie and there is major competition with top carp producers in the world. The exports decreased by 52% when compared to 2018 exports of 0.06 tons (Figure 7.35 and Table 7.13).

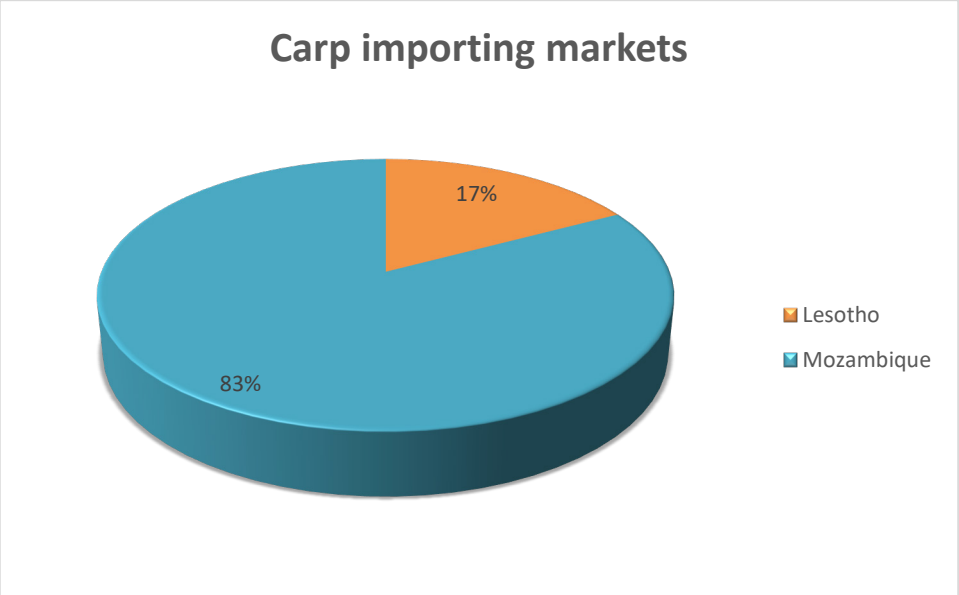


Figure 7.35: South Africa's export markets for common carp in 2019

Table 7.13: South Africa's export markets for common carp in 2019

Country	Tons	Value (ZAR)
Lesotho	0.005	R110,00
Mozambique	0.024	R450,00
TOTAL	0.029	R560,00

Common carp was only exported in April and May during 2019, 0.005 and 0.024 tons were exported by South Africa during this months (Figure 7.36).

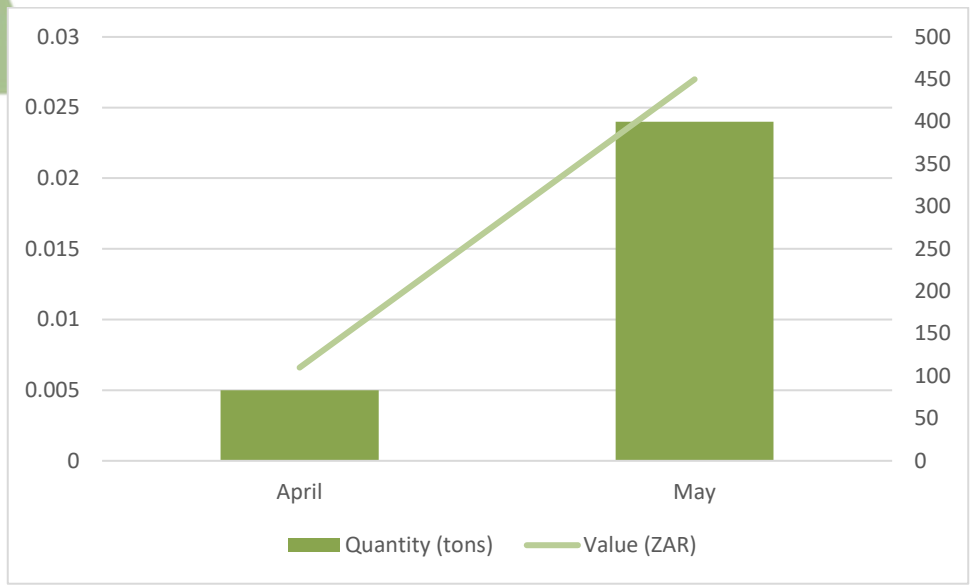


Figure 7.36: South Africa's common carp monthly exports trends in 2019

7.4.12. Sea urchin

South African sea urchin exports for 2019 were 0.01 tons to a value of R632. Importing markets for sea urchins were Botswana and Namibia with 65% and 35% respectively. Sea urchin exports have been insignificant over the years because the specie is currently under research in South Africa (Figure 7.37 and Table 7.14).

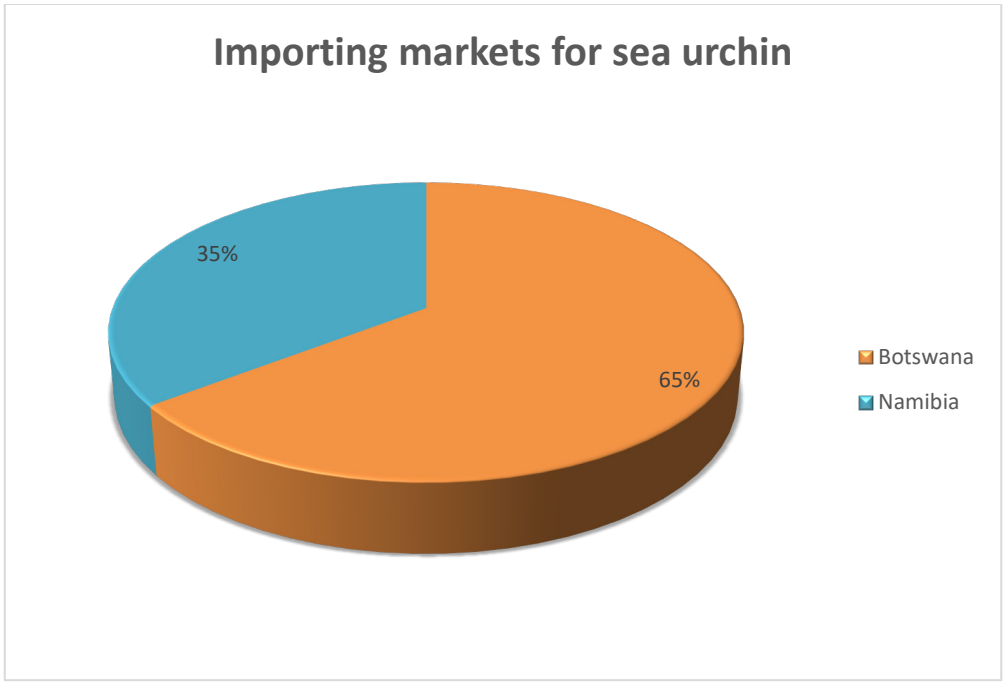


Figure 7.37: South Africa's export markets for sea urchins in 2019

Table 7.14: South Africa's export markets for sea urchins in 2019

Country	Tons	Value (R)
Botswana	0.01	R290,00
Namibia	0.005	R342,00
TOTAL	0.015	R632,00

South Africa exported sea urchins in February and July in 2019. Of 0.015 tons exported in 2019, 0.005 was exported in February whereas the remaining 0.01 tons was exported in July (Figure 7.38).

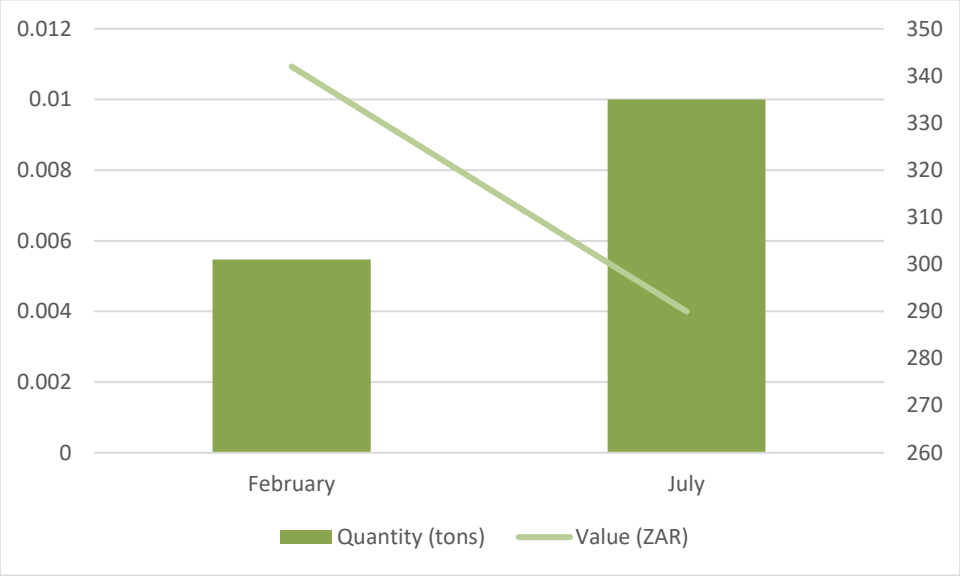


Figure 7.38: South Africa's sea urchins monthly exports in 2019

7.5. Imports trade analysis

South Africa total aquaculture imports for 2019 were 17670.9 tons with a value of R 63, 7 million (Figure 7.39 and Table 7.15). The quantity imported in South Africa increased by 30% from 13636.66 tons imported in 2018. Tilapia was the leading imported species in terms of quantity with 9575.43 tons increasing from 8942.81 tons imported in 2018. Atlantic salmon was the second imported product in terms of quantity with 3439.47 followed by trout with 2098.95. In terms of value, Atlantic salmon contributed the highest with R16, 9 million, followed by tilapia and trout with R113,6 million and R89,5 million respectively. In 2019 the top 5 exporting markets in terms of quantity were China, followed by Norway, Namibia, Lesotho and Vietnam and other countries combined (see Figure 7.40 and Table 7.16).

Table 7.15: Total imports of aquaculture species in 2019

Species	Quantity (Tons)	Value (ZAR)
Tilapia	9575.43	R11 359 146 600
Atlantic Salmon	3439.47	R31 678 624 800
Trout	2098.95	R8 951 962 100

Catfish	951.67	R3 262 181 900
Oysters	751.63	R882 838 300
Pacific Salmon	547.7	R4 957 066 400
Ornamental	253.48	R2 464 052 100
Mussels	48.79	R189 504 300
Scallops	3.33	R368 070.00
Carp	0.44	R 220 400
Sea urchins	0.004	R298.00
Total	17670.9	R63 745 965 268

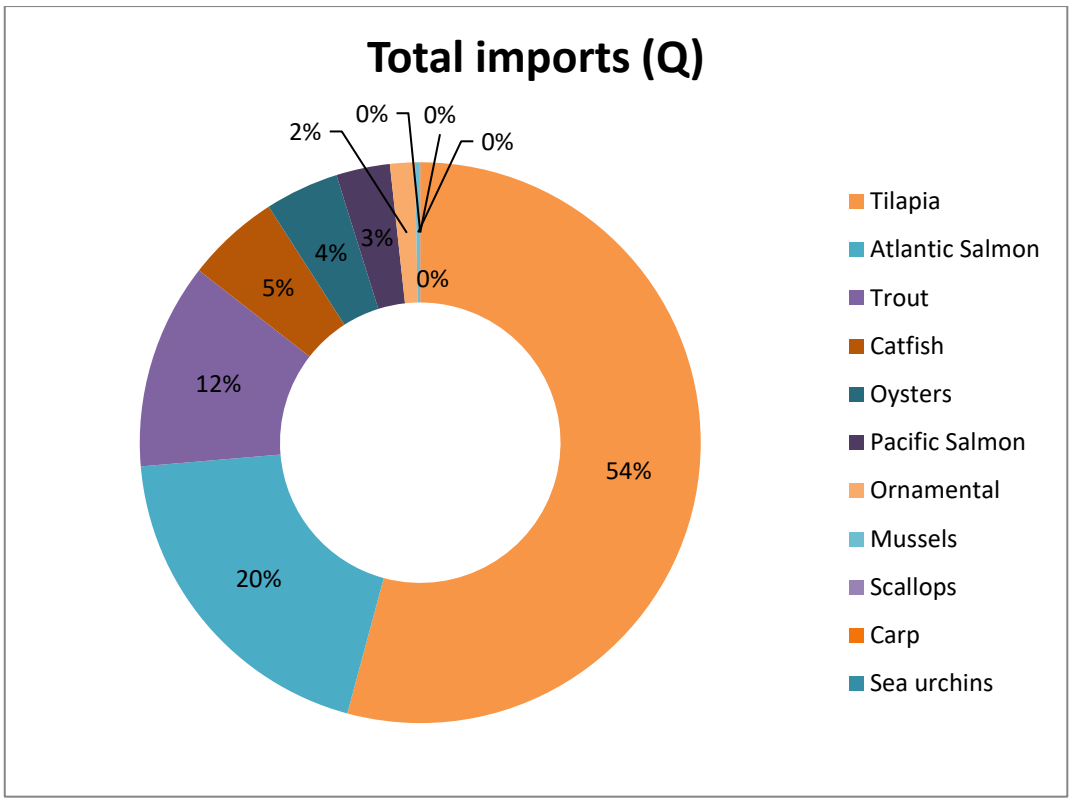


Figure 7.39: Total quantity aquaculture species imported per species

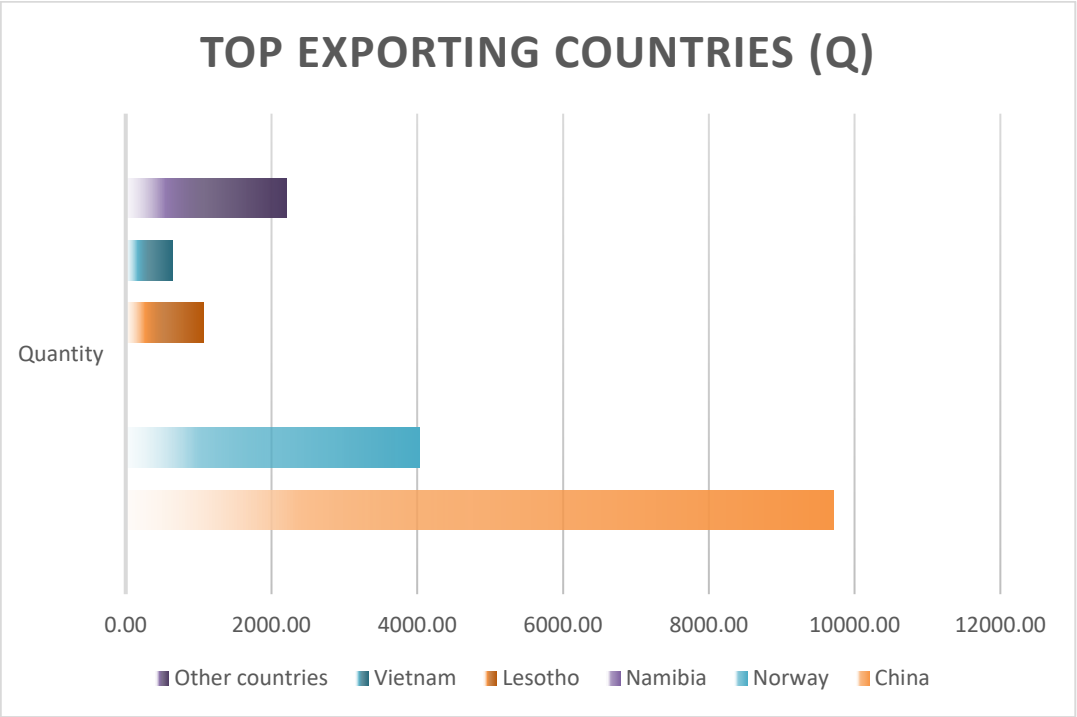


Figure 7.40: Total quantity aquaculture species imported per country

Table 7.16: Total quantity aquaculture products imported per country

Country	Quantity (tons)
Norway	4033.71
Namibia	1580.59
United Kingdom	1.83
France	0.101
Canada	0.02
Myanmar	1.08
China	9707.3
Singapore	32.56
Vietnam	644.63
Guernsey	0.001
Mozambique	11.97
New Zealand	0.704
Australia	2.75
Brazil	26.99
Chile	1.52
Colombia	0.83
Fiji	0.24
Germany	0.762
Hong Kong	2.71
India	0.46
Indonesia	52.39
Israel	27.91
Japan	14.77
Kenya	14.83

Lao People's Democratic Republic	0.079
Malaysia	13.55
Martinique	0.73
Mauritius	0.2
Netherlands	0.028
Nigeria	17.89
Philippines	5.28
Puerto Rico	0.14
Sri Lanka	38.84
Taiwan	4.08
Thailand	32.64
United States	54.15
Venezuela, Bolivarian Republic Of	0.81
Chile	1.79
Unclassified*	137.15
Guadeloupe	0.1
Malawi	15.43
Hong Kong	20.8
Beit Bridge	99.16
Congo	0.58
Lesotho	1064.27
DRC	1.80
Zambia	0.36
Botswana	0.18
Zimbabwe	0.16
Rwanda	0.0044
Mali	0.0022
TOTAL	17670.86

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

7.5.1. Atlantic salmon

The total quantity of Atlantic salmon imported in 2019 in South Africa was 3439.47 tons valued at R316,8 million (Table 7.17 and Figure 7.41). This is an increase of 144.5% from 1406.61 tons imported in 2018. Norway was the major exporter of Atlantic salmon in South Africa, contributing almost 100% to the total Atlantic salmon imported.

Table 7.17: South Africa's Atlantic salmon imports

Country of Origin	Quantity (tons)	Value (ZAR)
Norway	3435.07	R316 636 349,00
Namibia	4.28	R100 269,00
United Kingdom	0.10	R47 156,00
France	0.00	R1 605,00
Canada	0.02	R869,00
Total	3439.47	R316 786 248.00

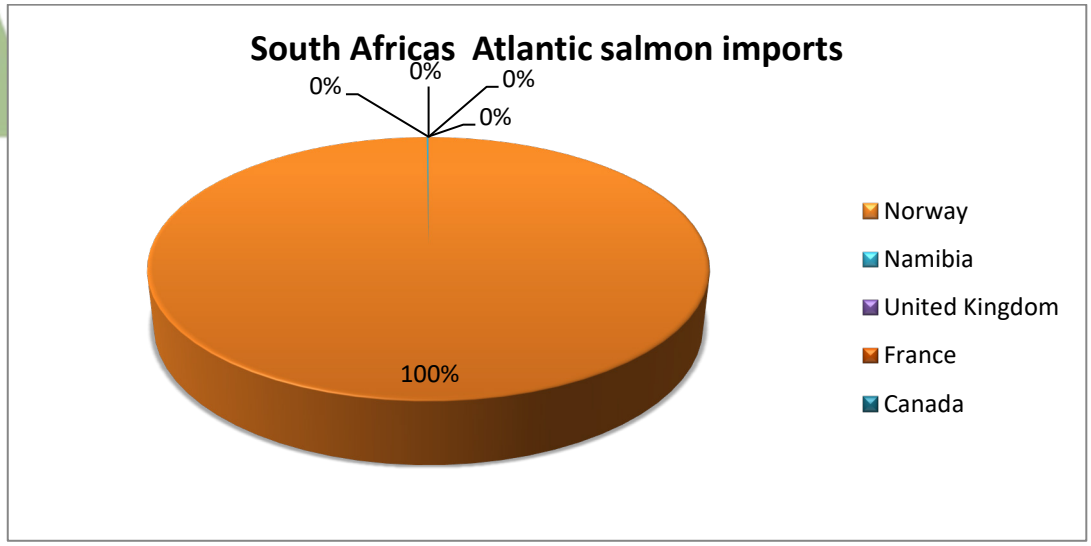


Figure 7.41: South Africa's Atlantic salmon imports

South Africa imported an average of 286.26 tons of Atlantic Salmon valued at R26.3 million on a month to month basis in 2019. The highest quantity was imported in October with 465.33 tons followed by September and November with 416.12 and 320.6 tons respectively. Lowest quantity was recorded during the second quarter of the year where in 196.9 and 195.8 tons were exported in July and June respectively (Figure 7.42).

Figure 7.42: South Africa's Atlantic salmon monthly imports trends in 2019

7.5.2. Common carp

South Africa imported approximately 0.44 tons of carp worth R2 204 in 2019. The quantity imported in 2019 decreased by 64.8% from 1.25 tons imported in 2018. During the reporting period carp was only imported in August and Myanmar was the only exporting country (Table 7.18).

Table 7.18: South Africa's common carp imports

Country	Quantity (tons)	Value (ZAR)
Myanmar	0.44	R2 204,00
Total	0.44	R2 204,00

7.5.3. Catfish

The total quantity of catfish imported in South Africa in 2019 was 951.67 at a value of R32, 6 million. The catfish imports increased with 57.6% from 603.69 tons imported in 2018. The leading country exporter was Vietnam with 77% and China with 22% (Table 7.19 and Figure 7.43). Chinas catfish exports to South Africa decreased by a significant 40% compared to 2018 exports of 549.66.

Table 7.19: South Africa's catfish imports

Country	Quantity (tons)	Value (ZAR)
China	327.46	R7 133 233,00
Myanmar	0.64	R3 685,00
Singapore	7.72	R319 658,00
Vietnam	615.85	R25 165 243,00
Total	951.67	R32 621 819,00

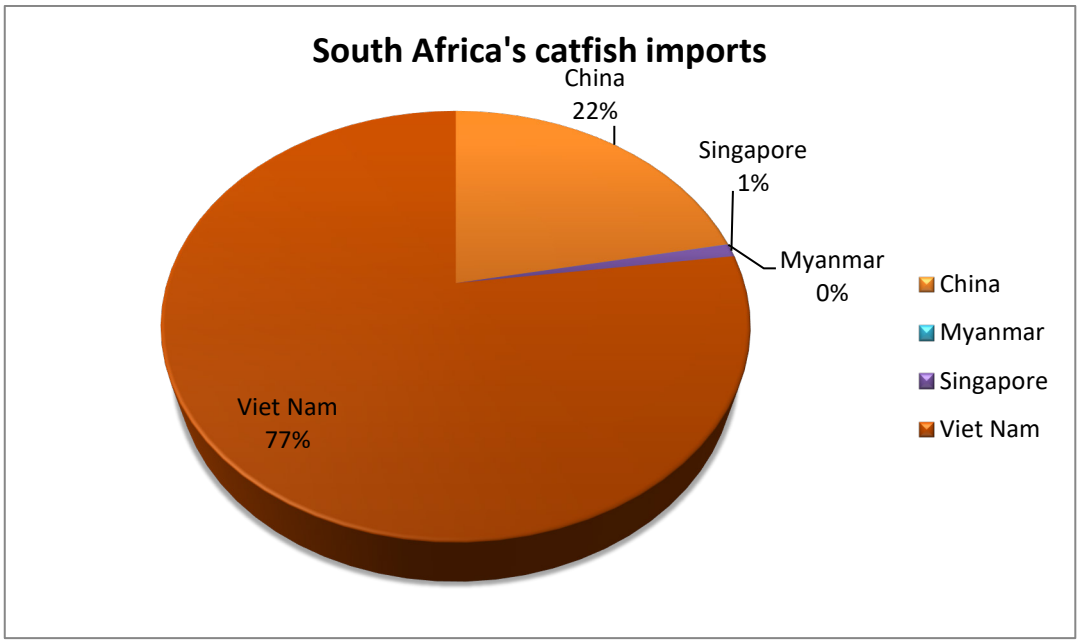


Figure 7.43: South Africa's catfish imports

An average of 51.3 tons of catfish values at R2 million were imported in the country per month during the reporting period. The highest quantity was imported during the month of June and September with 100.9 and 100.8 tons respectively. The lowest quantity was imported in April, October and November with 36, 34.2 and 32.75 tons respectively (Figure 7.44).

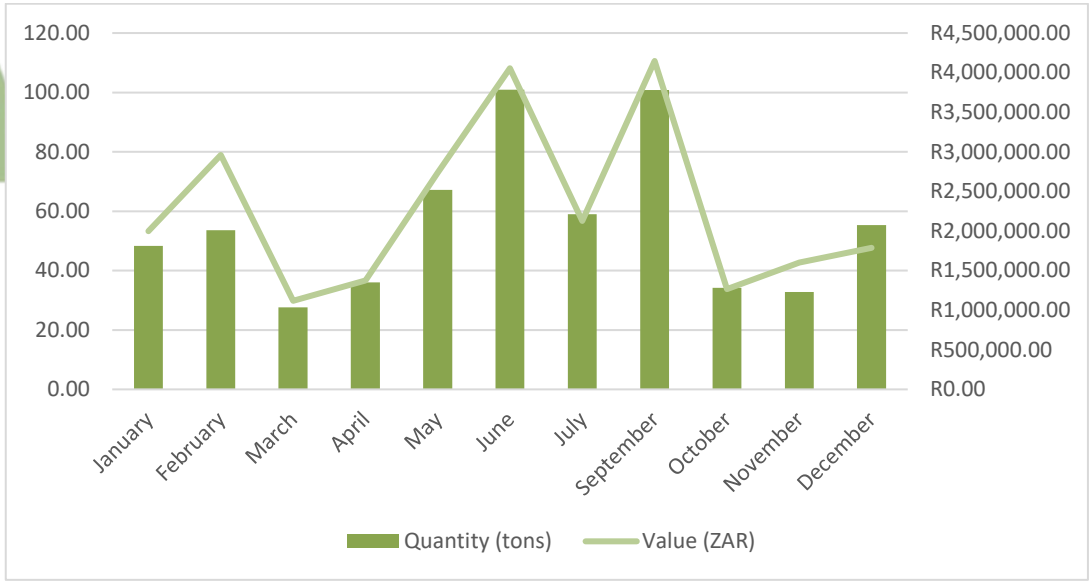


Figure 7.44: South Africa's catfish monthly imports in 2019

7.5.4. Mussels

The total quantity of mussels imported in 2019 was 48.79 increasing by 27.5% from 38.28 tons imported in 2018. The value for the mussels was R1, 9 million. The highest exporter of mussels in terms of quantity was China with 95%, Mozambique with 4% (Table 7.20 and Figure 7.45).

Table 7.20: South Africa's mussels imports

Country	Quantity (tons)	Value (ZAR)
China	46,08	R1 540 517,00
Guernsey	0,001	R13 773,00
Mozambique	2	R20 000,00
New Zealand	0,704	R320 753,00
Total	48,785	R1 895 043,00

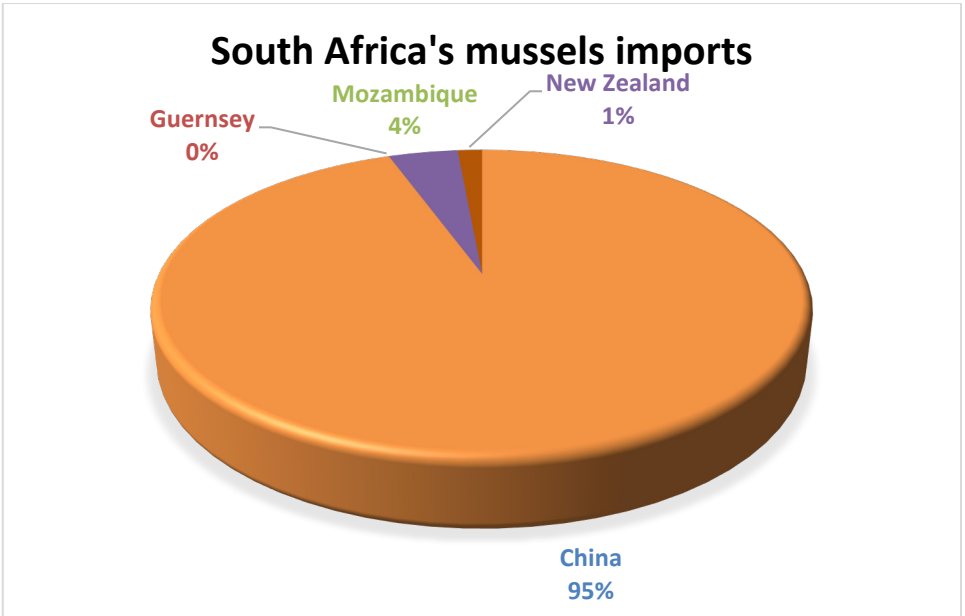


Figure 7.45: South Africa's mussels imports

In 2019, South Africa imported an average of 5.4 tons valued at an average R210 560 on a monthly basis. A peak in terms of quantity was reached in December with 22 tons followed by July and October with 11 and 7 tons respectively. No mussel imports recorded during the month of May, August and September during the reporting period (Figure 7.46).

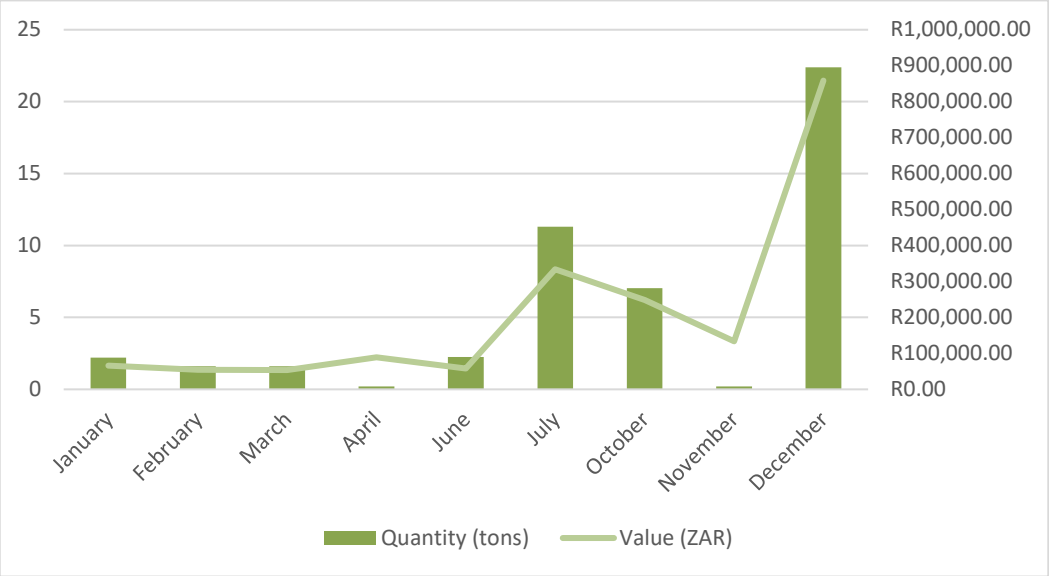


Figure 7.46: South Africa's mussels monthly imports in 2019

7.5.5. Ornamentals

South Africa imported 253, 48 tons of ornamental valued at R24, 6 million in 2019. The imported quantity increased by 12.4% when compared to 225.6 tons imported in 2018 (Table 7.21). The ornamentals were imported from 28 countries which is a decrease from 31 countries that exported ornamental fish to South Africa in 2018. Figure 7.45 shows top 10 exporters of ornamental fish to South Africa, Indonesia was the leading exporter contributing 19% followed by Sri Lanka, Thailand and Israel with 17%, 14% and 12% respectively (Figure 7.47).

Table 7.21: South Africa's ornamentals imports

Country	Quantity (tons)	Value (ZAR)
Australia	2.754	R1 027 185,00
Brazil	0.20	R56 286,00
Chile	1.52	R122 617,00
Colombia	0.83	R100 221,00
Fiji	0.24	R2 961,00
Germany	0.76248	R66 206,00
Hong Kong	2.71	R276 092,00
India	0.46	R54 920,00
Indonesia	43.06	R3 569 837,00
Israel	27.91	R3 267 332,00
Japan	14.77	R461 618,00
Kenya	14.83	R703 137,00
Lao People's Democratic Republic	0.079	R34 608,00
Malaysia	13.54	R1 069 923,00
Martinique	0.73	R34 260,00
Mauritius	0.2	R4 587,00
Netherlands	0.028	R47 084,00
Nigeria	2.055	R217 063,00
Philippines	5.28	R376 260,00
Puerto Rico	0.14	R15 337,00
Singapore	24.84	R4 482 719,00
Sri Lanka	38.67	R2 313 983,00
Taiwan	4.08	R598 577,00
Thailand	32.64	R3 503 114,00
United Kingdom	2.35	R127 033,00
United States	1.21	R314 633,00
Venezuela, Bolivarian Republic of	0.81	R100 333,00
Vietnam	16.78	R1 692 595,00
Total	253.48	R24 640 521,00

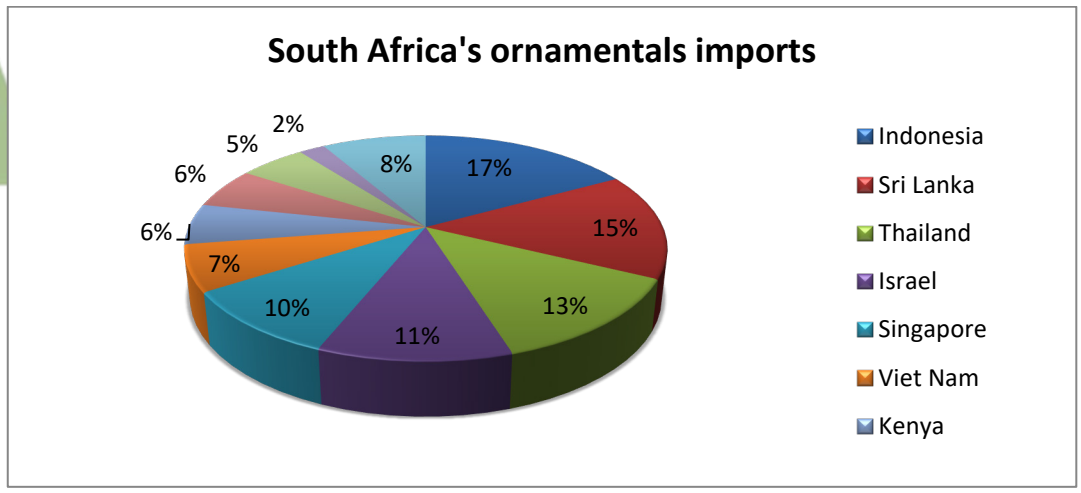


Figure 7.47: South Africa's ornamentals imports

South Africa imported ornamentals on an average of 23 tons on month to month basis. The average monthly value for ornamental imports was R2.2 million. The highest quantity was imported in December followed by November and May with 38, 25 and 23.8 tons respectively. A declined in ornamentals imports was experienced during the month of June, September and October with 18.7, 18.9 and 19.7 tons respectively (7.48)

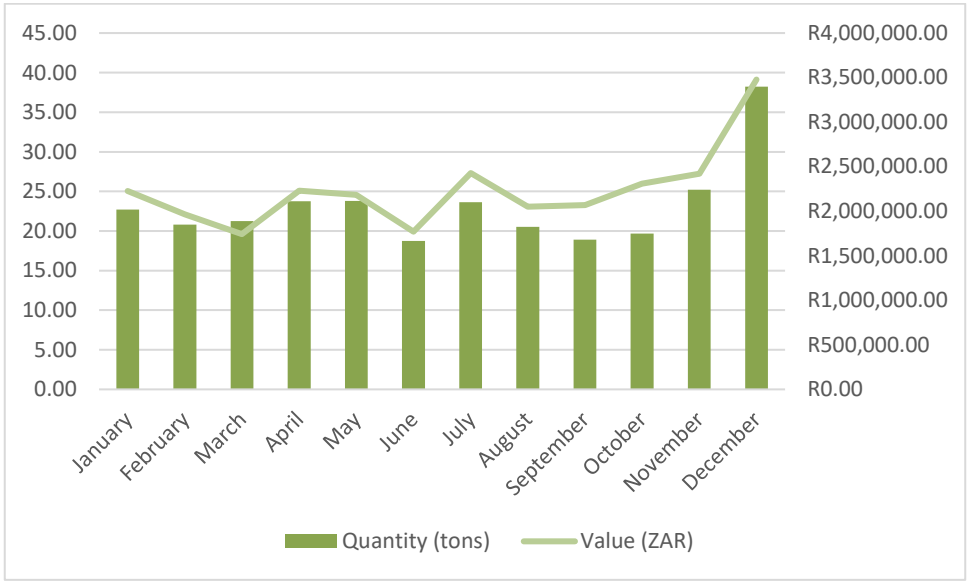


Figure 7.48: South Africa's ornamentals monthly imports trends in 2019

7.5.6. Oysters

During 2018, South Africa imported 751.63 tons of oysters valued at R8 828 383. The quantity imported in 2019 showed an increase of 109.8% from 358.34 tons of oysters imported in 2018 (Table 7.22). The leading exporting country was Namibia with 87% followed by unclassified countries with 12% and China with 1% (Figure 7.49).

Table 7.22: South Africa's oysters imports

Country	Quantity (tons)	Value (ZAR)
Chile	1.79	R1 166 490,00
China	7.53	R84 065,00
France	0.008	R926,00
Namibia	650.93	R6 650 947,00
Unclassified*	91.25	R784 500,00
United Kingdom	0.12	R141 455,00
Total	751.63	R8 828 383,00

*Unclassified- name of the country provided as unclassified by South Africa Revenue Services (SARS).

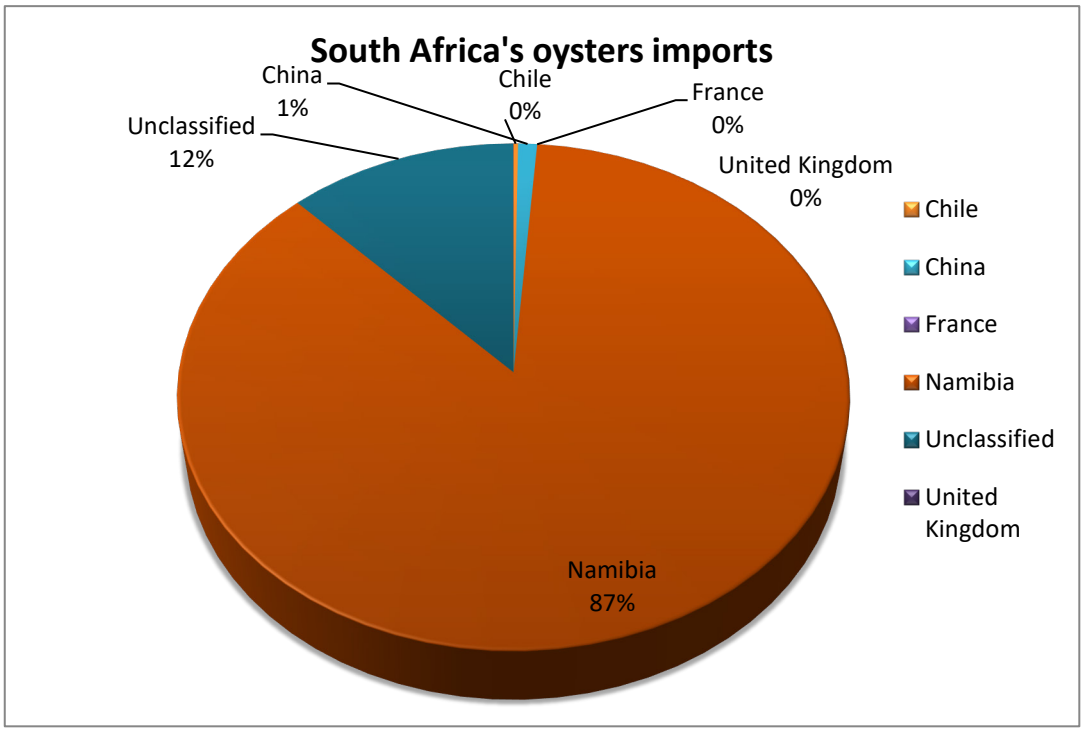


Figure 7.49: South Africa's oysters imports

During 2019, the highest quantity was imported during the month of June with 506.68 tons. The second highest quantity was exported in March followed by April with 52.7 and 43.6 tons respectively. The lowest quantity was imported in December where only 4.5 tons of oysters was imported. On average, 62.6 tons of oysters valued at an average of R735 698 was imported on a month to month basis in 2019 (Figure 7.50)

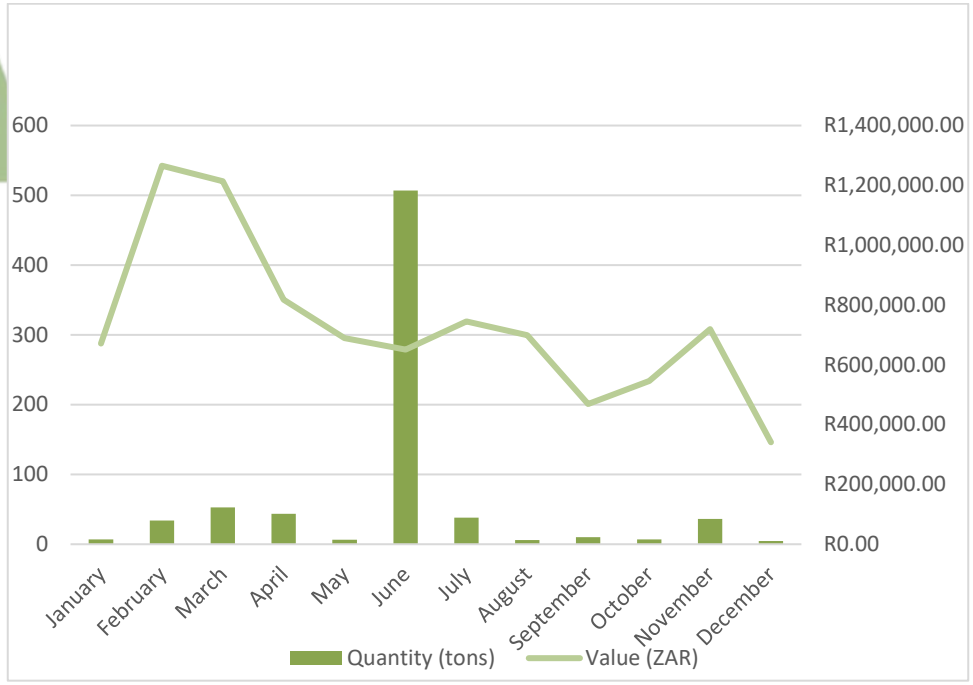


Figure 7.50: South Africa's oysters monthly imports in 2019

7.5.7. Pacific Salmon

During 2019 South Africa imported about 547.70 tons of Pacific salmon decreasing by 35% from 847 tons imported in 2018. The quantity imported in 2019 was valued at approximately R49 5million (Table 7.23). The top three exporting countries were Norway with 94% followed by Nigeria with 3% and Malawi with 3% (Figure 7.51). Other countries contributed less than 1% respectively.

Table 7.23: South Africa's Pacific salmon imports

Country	Quantity (Tons)	Value (ZAR)
France	0.09	R6 408,00
Guadeloupe	0.10	R37 134,00
Malawi	15	R59 307,00
Malaysia	0.01	R563,00
Namibia	0.28	R39 962,00
Nigeria	15.83	R39 780,00
Norway	514.71	R48 779 792,00
United Kingdom	1.61	R590 548,00
United States	0.06	R17 170,00
Total	**547.70**	**R49 570 664,00**

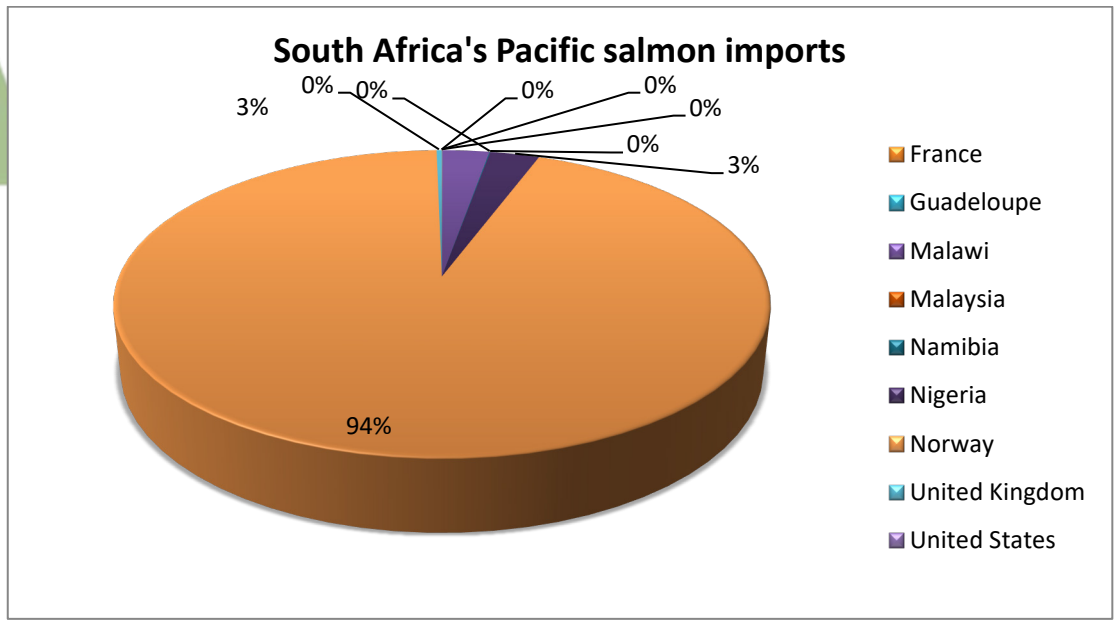


Figure 7.51: South Africa's Pacific salmon imports

Pacific salmon was imported at an average of 45.7 tons at an average value of R4.1 million each month in 2019. The highest quantity was imported during the first quarter where in January 80.6 tons was imported, followed by March and February with 70.8 and 68.4 tons respectively. The quantity decreased significantly during the fourth quarter of 2019 and the lowest quantity was imported in November with 1.2 tons (Figure 7.52).

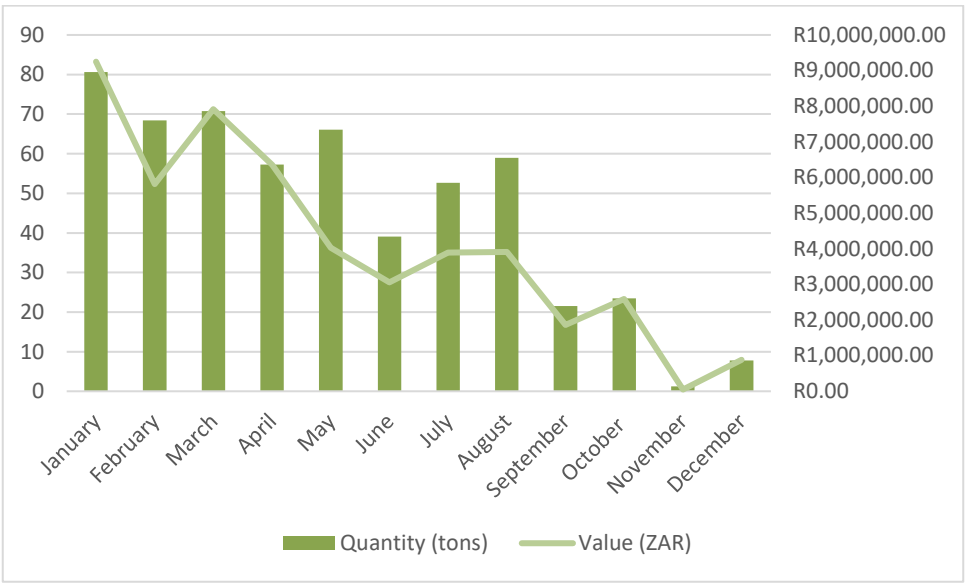


Figure 7.52: South Africa's Pacific salmon monthly imports in 2019

7.5.8. Tilapia

During 2019, South Africa imported approximately 9575, 43 valued at R 113, 6 million. This is an increase of 7.1% when compared to 8943 tons imported in 2018. The top three (3) exporting countries were China followed by United States, Beit Bridge with 97%, 1% respectively. All other countries contributed less than 1% to the total imported quantity (Table 7.24 and Figure 7.53).

Table 7.24: South Africa's tilapia imports

Country	Quantity (Tons)	Value (ZAR)
Brazil	26.79	R154 620,00
China	9326.23	R107 983 278,00
Hong Kong	20.8	R281 901,00
Indonesia	9	R356 908,00
Mozambique	5	R219 863,00
Namibia	2.02	R50 061,00
Unclassified	21.55	R273 470,00
United States	52.88	R496 422,00
Viet Nam	12	R177 910,00
Beit Bridge	99.16	R3 597 033,00
Total	9575.43	R113 591 466,00

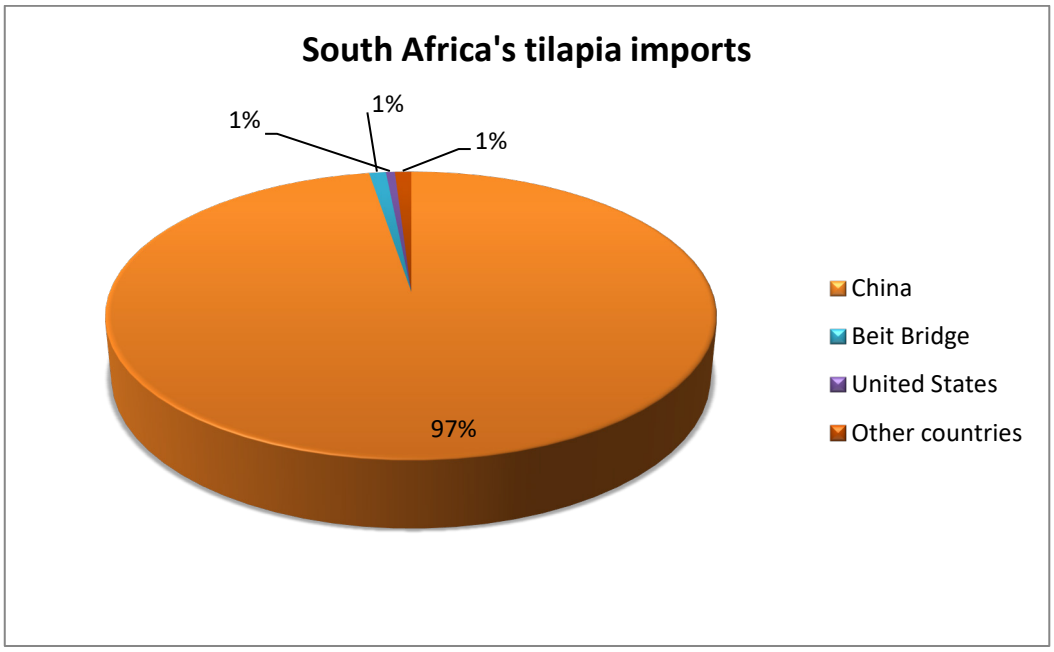


Figure 7.53: South Africa's tilapia imports

Due to high demand, tilapia was imported in the country at an average of 797.9 tons month on month in 2019. The average value was R9.5 million per month. The peak in terms of quantity imported was reached in August where 1130.2 tons was imported, followed by May and December with 1087.8 and 982.8 tons respectively. Lowest quantity was imported during the first quarter of 2019, where 463.4 and 378.9 was imported in January and March respectively (Figure 7.54).

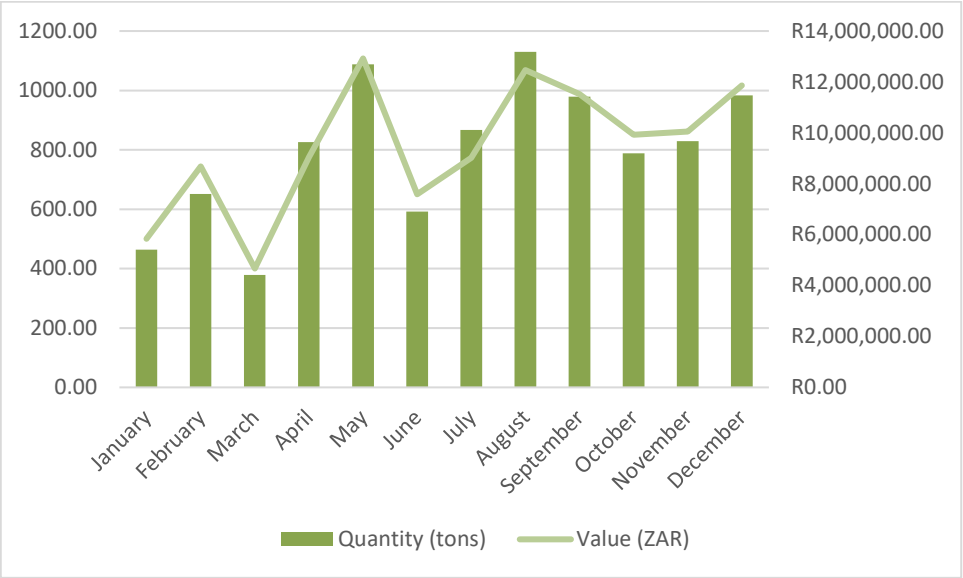


Figure 7.54: South Africa's tilapia monthly imports in 2019

7.5.9. Trout

South Africa imported 2098.95 tons with an estimated value of R89 519 621 in 2019 (Table 7.25). This is an increase of 97% from 1068 tons imported in 2018. Lesotho was the leading exporter with 51% followed by Namibia with 44% and Norway with 4% (Figure 7.55). South African imports increased by 1030.95 tons when compared with 2018 imports. The reason might be that South Africa has an established and increasing market for trout, therefore to meet the demand the suppliers have to import.

Table 7.25: South Africa's trout imports

Country	Quantity (Tons)	Value (ZAR)
Congo	0.58	R1 038,00
Indonesia	0.33	R22 662,00
Lesotho	1064.23	R68 757 699,00
Mozambique	4.7	R246 000,00
Namibia	923.00	R12 985 045,00
Norway	81.58	R5 685 434,00
Sri Lanka	0.17	R35 752,00
Unclassified	24.35	R1 785 991,00
Total	2098.95	R89 519 621,00

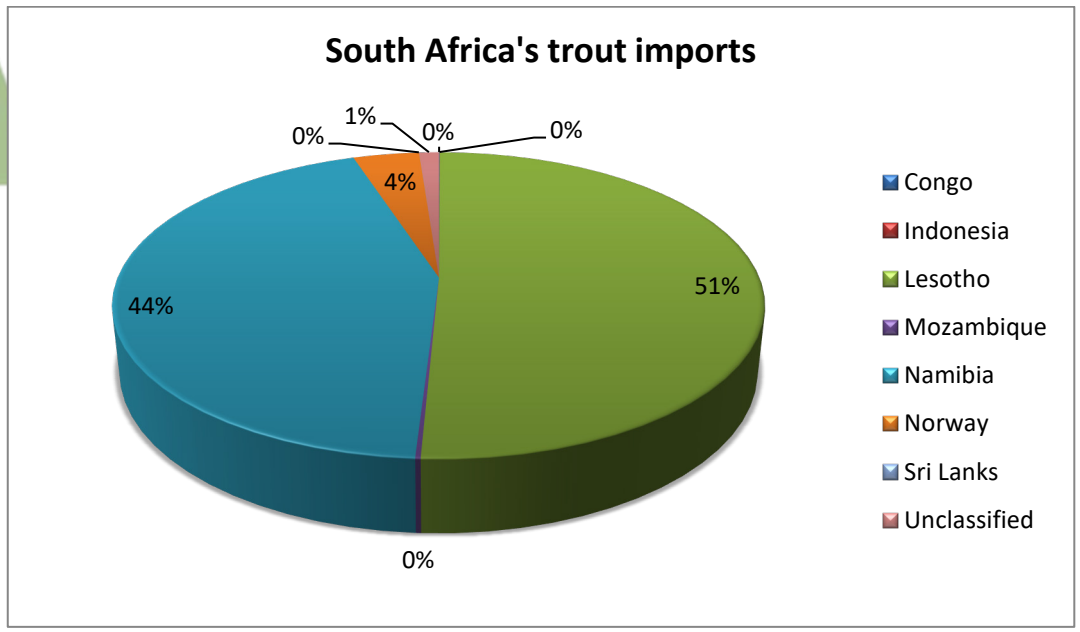


Figure 7.55: South Africa's trout imports

South Africa imported an average of 174.9 tons per month of trout in 2019. The highest quantity was imported in May followed by March and February with 280.5, 275.6 and 195.6 tons respectively. The lowest quantity was imported in July with 83 tons (Figure 7.56).

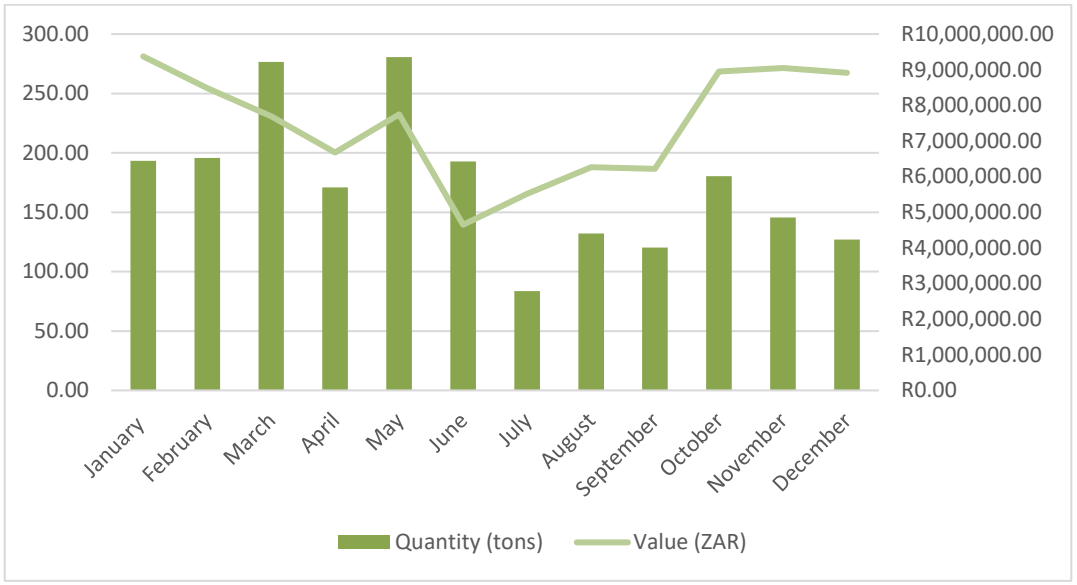


Figure 7.56: South Africa's trout imports

7.5.10. Scallops

South Africa imported 3.33 tons with an estimated value of R 368 070 in 2019 (Table 7.26). This is an increase of 32.7% from 2.51 tons imported in 2018. DRC was the leading exporter with 54% followed by Malawi with 13% Zambia with 11% and Mozambique with 8%. Other countries such as Botswana, Zimbabwe, Namibia, Lesotho and Rwanda were the least exporting countries (Figure 7.57).

Table 7.26: South Africa's scallops imports

Country	Quantity (Tons)	Value (ZAR)
DRC	1.80	R207 980.00
Malawi	0.43	R29 968.00
Zambia	0.36	R30 210.00
Mozambique	0.27	R28 935.00
Botswana	0.18	R7 781.00
Zimbabwe	0.16	R42 925.00
Namibia	0.08	R16 015.00
Lesotho	0.04	R2 868.00
Rwanda	0.004	R815.00
Mali	0.002	R573.00
TOTAL	3.33	R368 070.00

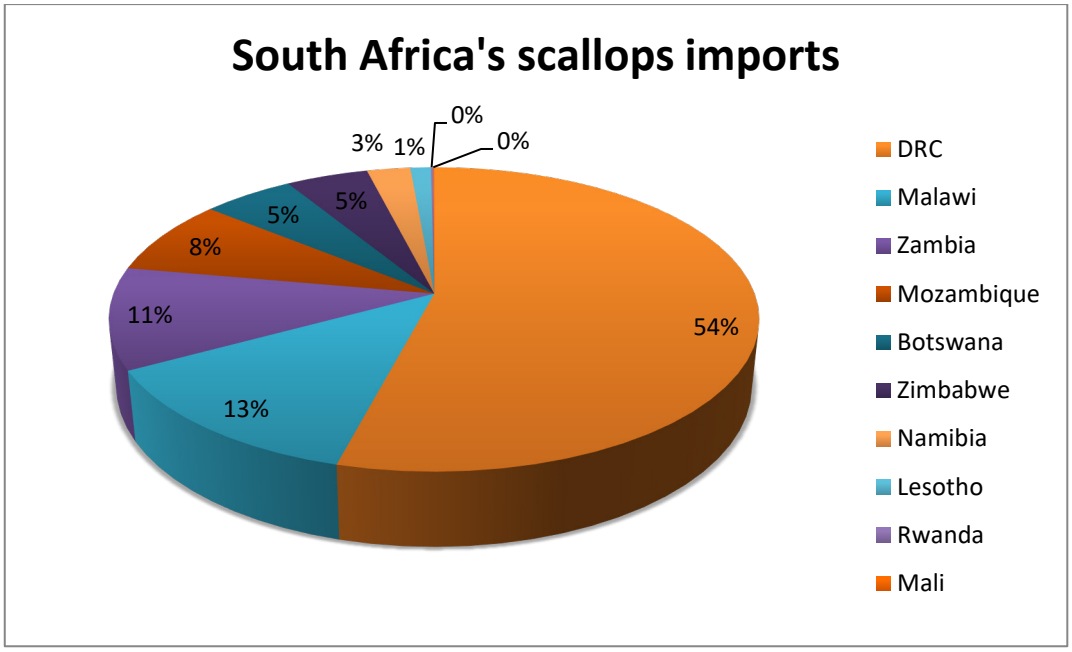


Figure 7.57: South Africa's scallops imports

Scallops were imported at an average of 2.7 tons per month in 2019. The highest quantity was imported in November with 8.2 tons followed by January and September with 6.8 and 5.2 tons respectively. The lowest quantity was imported in October and August with less than a ton respectively (Figure 7.58).

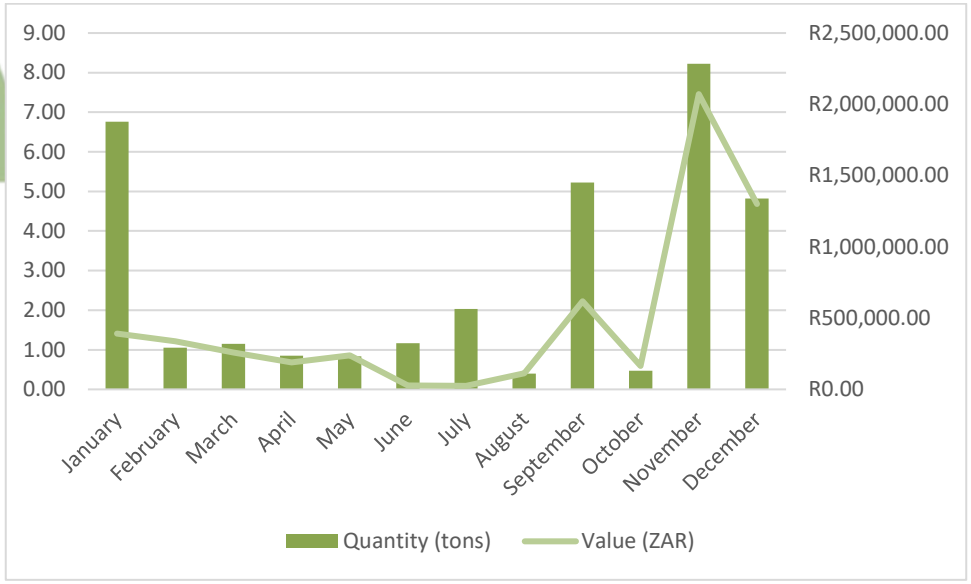


Figure 7.58: South Africa's scallops monthly imports

7.5.11. Sea Urchins

South Africa imported less than a ton of sea urchins in 2019 at a value of R 298 from France (Table 7.27). This represented a decrease of 99% compared to 2.2 tons experienced during 2018. Sea urchins were imported only in November and December with 0.0014 and 0.0022 respectively during the reporting period (Figure 7.59).

Table 7.27: South Africa's sea urchins imports

Country	Quantity (Tons)	Value (ZAR)
France	0.004	R 298

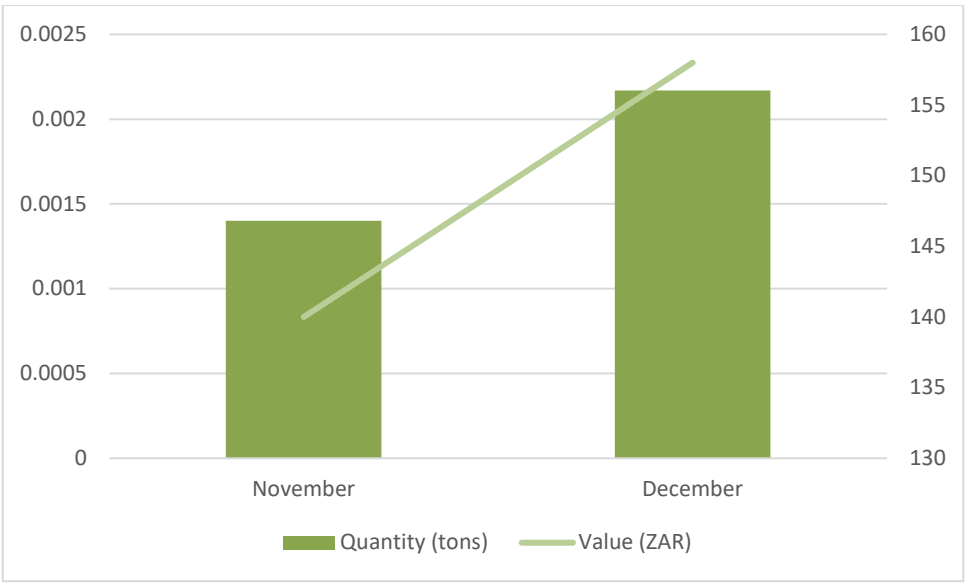
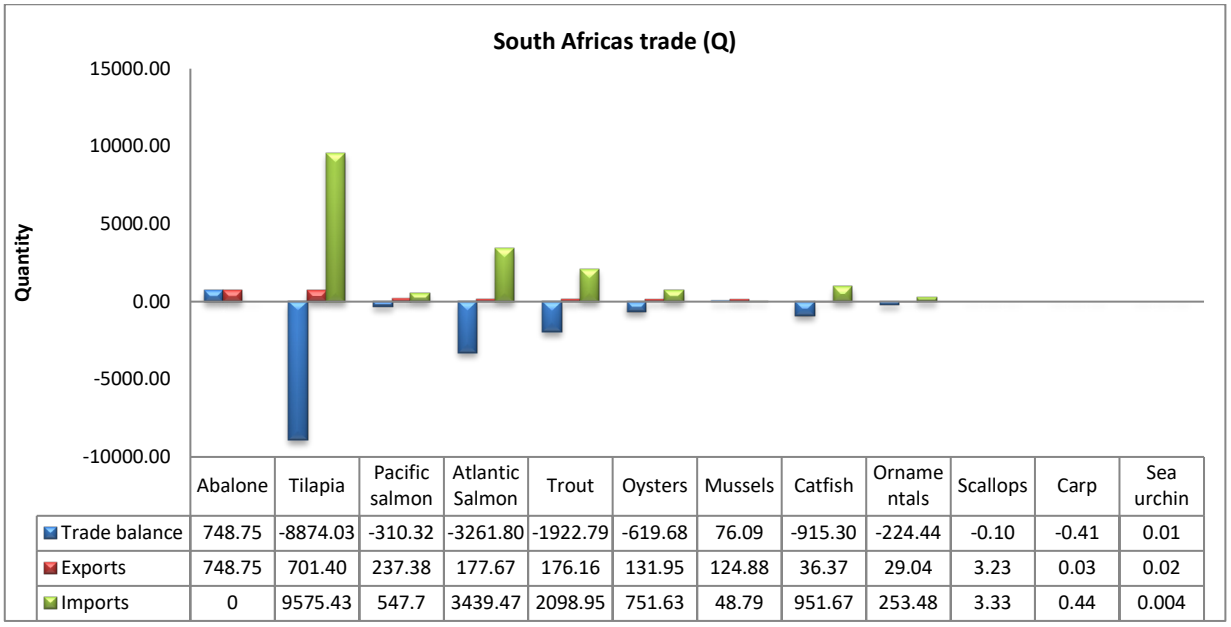


Figure 7.59: South Africa's sea urchins monthly imports in 2019

7.6. Trade balance

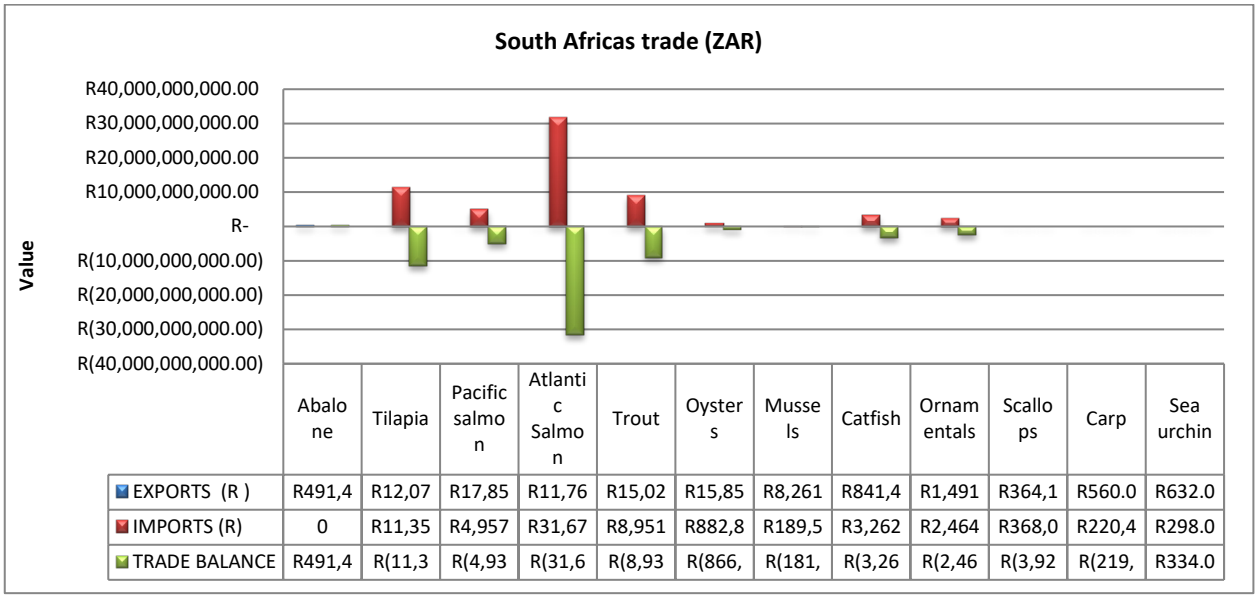
During 2019, South Africa's aquaculture trade depicted a trade deficit of 15304.04 in terms of quantity

as shown in Figure 7.60. Exports fell by 26% compared to 2018 in quantity terms mainly worsened by the significant decreases of exports of tilapia and catfish. Other species such as Pacific salmon, Atlantic salmon, trout, mussels, ornamentals, sea urchin, abalone, scallops and carp exports increased as compared to 2018. Imports surged by 30%, this is attributable to 13. 636. 66 total imports in 2018 and 17670.894 total imports in 2019. This is attributable to an increase in the imports of trout, oysters, catfish and mussels. Furthermore, in value terms, South Africa recorded a trade deficit of R 63 170 950 936 in 2019 (Figure 7.61). This is owing to R 575 014 332 of exports and R 63 745 965 268 imports.



	Abalone	Tilapia	Pacific salmon	Atlantic Salmon	Trout	Oysters	Mussels	Catfish	Ornamentals	Scallops	Carp	Sea urchin
Trade balance	748.75	-8874.03	-310.32	-3261.80	-1922.79	-619.68	76.09	-915.30	-224.44	-0.10	-0.41	0.01
Exports	748.75	701.40	237.38	177.67	176.16	131.95	124.88	36.37	29.04	3.23	0.03	0.02
Imports	0	9575.43	547.7	3439.47	2098.95	751.63	48.79	951.67	253.48	3.33	0.44	0.004

Figure 7.60: Trade balance in terms of quantity during 2019



	Abalone	Tilapia	Pacific salmon	Atlantic Salmon	Trout	Oysters	Mussels	Catfish	Ornamentals	Scallops	Carp	Sea urchin
EXPORTS (R)	R491,4	R12,07	R17,85	R11,76	R15,02	R15,85	R8,261	R841,4	R1,491	R364,1	R560.0	R632.0
IMPORTS (R)	0	R11,35	R4,957	R31,67	R8,951	R882,8	R189,5	R3,262	R2,464	R368,0	R220,4	R298.0
TRADE BALANCE	R491,4	R(11,3	R(4,93	R(31,6	R(8,93	R(866,	R(181,	R(3,26	R(2,46	R(3,92	R(219,	R334.0

Figure 7.61: Trade balance in terms of value during 2019.

7.6.1. Imports vs exports

Abalone

The abalone subsector exports its substantial stock. In 2019, the country exported 748.75 tons of abalone valued at R491 478 114. The abalone sub-sector was the main contributor to the total fisheries exports

value with 86% and there were no abalone imports. Furthermore, the sub-sector achieved a trade surplus of R491 478 114.

Atlantic salmon

In 2019 the Atlantic salmon subsector imported 3439.47 tons of Atlantic salmon valued at R 31 678 624 800 and exported only 177.67 tons valued at R11 765 119 to other countries. Atlantic salmon was the second highest imported specie with 49.70% and only 2% to the exports. The sub-sector achieved a trade deficit of R31 666 859 681 due to the sub-sector cost of its imports exceeding its exports.

Carp

Carp sub-sector imported 0.44 tons valued at R 220 400 and exported only 0.03 tons at a value of R560 due to its low volumes imported and exported, the carp sub-sector contributed 0% to both the imports and exports total values. The sub-sector achieved a trade deficit of R 219 840.

Catfish

In 2019, South Africa imported 951.67 tons and exported 36.37 tons of catfish valued at R 3 262 181 900 and R841 404 respectively. The sub-sector contributed 5.12% to the total import value and 0.1% to the total exports value. The catfish subsector has a trade deficit of R 3 261 340 496 as the cost of importing for the sub-sector exceeded the costs of exporting.

Mussels

The mussels sub-sector imported 48.79 tons valued at R 189 504 300 and exported 124.88 tons valued at R8 261 485. The increase in local production and demand for mussels has attributed to a decrease in quantity imported and exported. The sub-sector contributed approximately 0.30% to the total value of imports and 1.4% of exports respectively. Even though the quantity exported of mussels was quite significant the mussel subsector had a trade deficit of R 181 242 815.

Ornamentals

South Africa imported 253.48 tons of ornamentals at the value of R 2 464 052 100 and exported 29.04 tons at the value of R1 491 175.00. Ornamentals contributed 3.87% to the total imports and only contributed 0.3% to the total exports value. In terms of trade balance, ornamentals sub-sector achieved a trade deficit of R 2 462 560 925.

Oysters

The oyster sub-sector imported 751.63 tons of oyster valued at R 882 838 300 and exported 131.95 tons at the value of R15 853 421. The sub-sector contributed 4.25% to the total import and 1.4% to the total exports value. Oyster sub-sector attained a trade deficit of R 866 984 879 due to value of imports surpassing exports value.

Pacific Salmon

During 2019, South Africa imported 547.7 tons and exported 237.38 tons of Pacific salmon valued at R 4 957 066 400 and R17 853 238 respectively. The subsector contributed 7.78 % to the total imports value and 3.1 % to the total exports value. In terms of trade balance, the sub-sector achieved a trade deficit of R 4 939 213 162.

Tilapia

The sub-sector imported 9575.43 tons with a value of R 11 359 146 600 and exported only 701.40 tons valued at R12 077 024. Tilapia was the highest imported species and the second exported in terms of volumes in 2019. In terms of value, tilapia was the fifth contributor towards the total exports value with 2.1% and contributed 18% to the total imports value. Due the value of Imports higher than the value of exports, the tilapia sub-sector achieved a trade deficit of R 11 347 069 576.00.

Trout

The trout sub-sector imported approximately 2098.95 tons of trout valued at R 8 951 962 100 and exported only 176.16 tons valued at R15 028 015. The sub-sector contributed 2.6% towards the total exports value and 14.04 % towards the total imports value achieving a trade deficit of R 8 936 934 085.

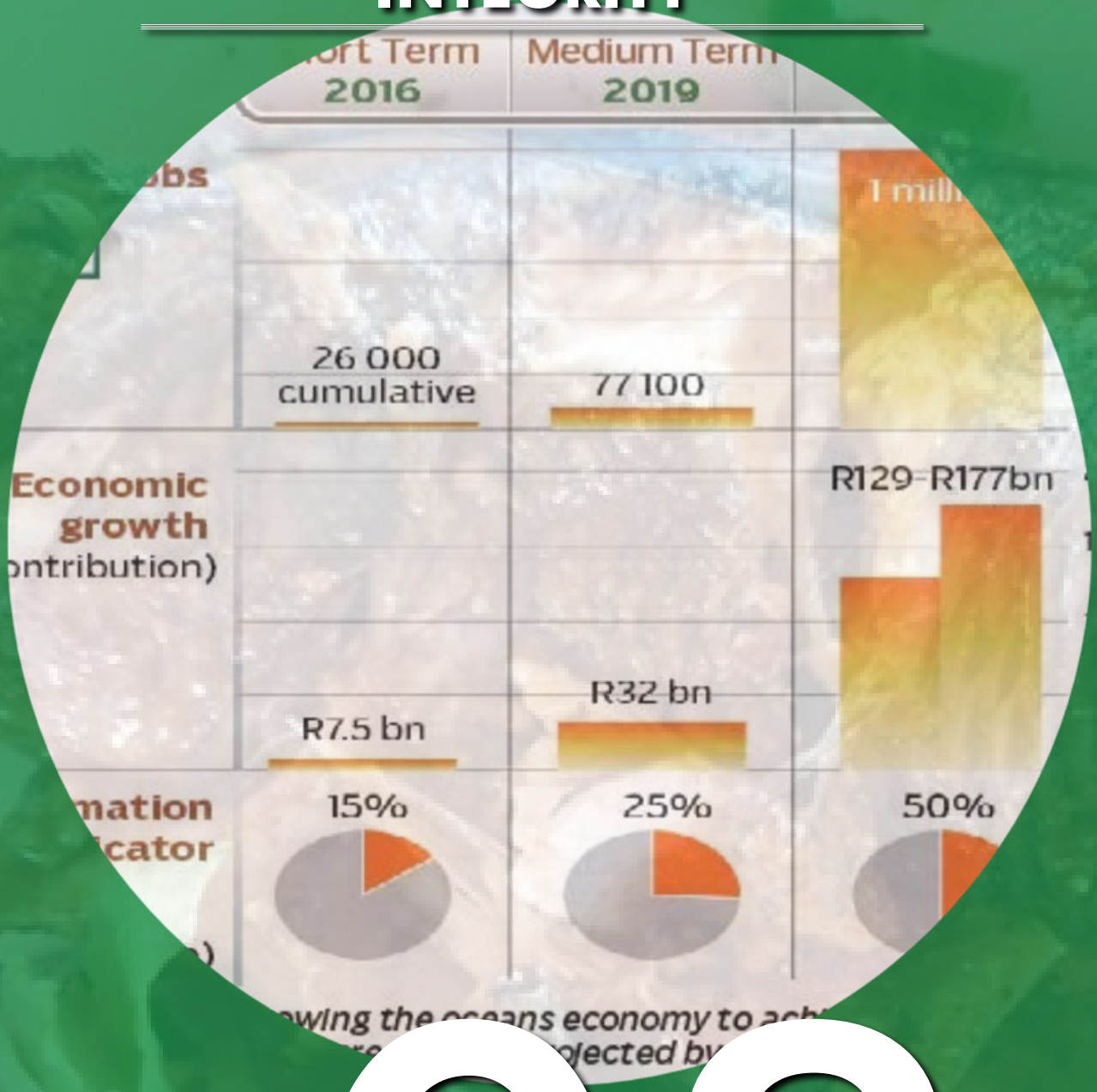
Sea Urchins

In 2019, South Africa imported 0.004 tons and exported 0.02 tons valued at R 298.00 and R632.00 respectively. Sea urchins contributed less than 0% to both the total value of imports and exports respectively achieving a trade surplus of R 334.

Scallops

South Africa imported 3.33 tons of scallops valued at R 368 070 and only exported 3.23 tons valued at R364 145. Scallops contributed 0% towards the total imports value and 0.1% towards the total exports. In terms of trade balance, scallops achieved a trade deficit of R 3 925, attributed to the value of imports higher than that of exports.

AQUACULTURE ENVIRONMENTAL INTEGRITY



08

8. AQUACULTURE ENVIRONMENTAL INTEGRITY

8.1. Introduction

Sustainable aquaculture development seeks to optimize the social and economic benefits arising from the use of natural resources, while protecting the biological diversity and maintaining the ecosystem function. The aquaculture industry in South Africa has learnt some important lessons over time as well as through aggressive research, and thus have developed commonly accepted "best management practices" to minimize impacts. Due to the high capital investment in aquaculture, operators ensure that they maintain a healthy environment for their fish and shellfish that they are cultivating. Precautionary approaches are advocated for many aquaculture practices, particularly with regards to alien invasive species and special considerations are given to sensitive habitats. The development and application of the Environmental Impact Assessment process combined with regular environmental monitoring can help provide for effective management measures targeting individual farms as well as farm clusters.

8.2. How is government ensuring the development of a sustainable aquaculture sector?

The Aquaculture Environmental Assessments unit under the Directorate Sustainable Aquaculture Management renders technical advisory services regarding Environmental Impact Assessments (EIA's) reviewing and commenting on EIA's for aquaculture operations and developments that may have an adverse impact on existing aquaculture farms. The Department aims to create and enabling environment for the development and growth of South African Aquaculture the through the establishment of Aquaculture Development Zones (ADZ's). EIA's for the zone are conducted and the basic infrastructure such as roads, electricity, security fences, reservoir, water pump, water extraction and discharge pipelines are installed. The purpose of which is to encourage investor and consumer confidence, create incentives for industry development, provide marine aquaculture services, manage the risks associated with aquaculture as well as provide skills development and employment for coastal communities. The then Department of Environmental Affairs (DEA) on the 23rd May 2019 promulgated 20 new Marine Protected Areas (MPA) gazetted under the National Environmental Management: Protected Areas Act (NEMPAA) (Act 57 of 2003). Under these regulations no aquaculture facility may extract or discharge water into a MPA. The South African Water Quality Guideline for Coast Marine Waters were gazetted in March 2019 for comment and is still being finalised based on the comments that were received.

8.3. Strategic Environmental Assessment for Marine and Freshwater Aquaculture

One of the major challenges that negatively impacts on the economic growth of the aquaculture sector is the lack of an enabling legislative environment. For this reason, the department embarked on a process of undertaking Environmental Impact Assessments (EIAs) for various ADZs around the country to create an enabling environment for new facilities. However, there are numerous challenges associated with this process which includes the high cost of undertaking individual EIAs, 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 Aquaculture Strategic Environmental Assessment (AquaSEA) was undertaken 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 to identify ADZs for offshore, inshore, land-based and inland water (freshwater) based aquaculture national, for the prioritising and incentivising of aquaculture, these zones were finalised and published in 2019. The process of identifying the zones was undertaken using 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.

A legal review on permits and authorisations for aquaculture was undertaken for streamlining under one Department. Biological Risk and Benefit Assessments for the seven species used for aquaculture species were updated for rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), African sharptooth catfish (*Clarias gariepinus*), Nile tilapia (*Oreochromis niloticus*), Pacific oyster (*Crassostrea gigas*), Mediterranean mussel (*Mytilus galloprovincialis*) and marron (*Cherax tenuimanus*) and these were published in end of 2019 and can be found online. The project concluded in October 2019 and the final AquaSEA Report was uploaded in the CSIR website https://aquasea.csir.co.za/.

8.4. Aquaculture Development Zones (ADZ's) initiated by the Department

The department has identified land and sea-based sites suitable for aquaculture activities along the South African coastline. An ADZ is an area that has been earmarked specifically for aquaculture activities. The purpose of which is to create an enabling environment for the aquaculture sector to develop and expand in a sustainable manner. The benefits of ADZs (Table 8.1) are to encourage investor confidence; create incentives for industry development; provide aquaculture services; manage the risks associated with aquaculture; job creation; skills development; empowerment of rural communities and most importantly benefit from Special Economic Zones incentives. The goals of the Department is to negotiate and obtain consent from the landowners; undertake EIA processes where necessary; declare an ADZ; develop the site by developing required basic infrastructure (roads, electricity, security fence, reservoir, water pump, water extraction and discharge pipeline) and the established support facilities e.g. processing establishment and laboratories.

Table 8.1. Summary of the DFFE ADZs

Name of Aquaculture Development Zone	Description
1. Amatikulu ADZ (KwaZulu-Natal) DFFE project	**Area:** Approximately 37 hectares to be used for aquaculture (12.6 ha for freshwater production and 24.6 hectares for marine production) **Targeted species**: Ornamentals, prawns, marine and freshwater finfish, sea cucumbers and crocodiles. **Current status:** Only two hectares is currently being used by two ornamental farms. The application is currently under appeal and a decision is pending. **Potential production:** Approximately 300 tons of table fish per annum
2. Richards Bay IDZ (KwaZulu-Natal) – DFFE project	**Area:** undefined **Targeted species:** Marine finfish **Current status:** No farming is currently taking place as the Basic Assessment process is to be undertaken. **Potential production:** Approximately 600 tons per annum
3. Coega Industrial ADZ (Eastern Cape) – Provincial project	**Area:** 440 hectares (land-based zone) **Targeted species:** Marine and freshwater finfish, abalone **Current status:** No farming is taking place **Potential production:** Approximately 20,000 tons per annum Coastal and Environment have been appointed to do the

Name of Aquaculture Development Zone	Description
	EIA for the Marine Pipeline which will supply the ADZ with sea water and help with discharge. Detailed design for bulk services for the ADZ being finalised and the Geotechnical investigations completed for bulk service installation planned for 2020.
4. East London Industrial development Zone (Eastern Cape) – Provincial project	**Area:** 32 hectares (land-based zone) **Targeted species:** Marine and freshwater finfish, abalone and seaweed **Current status:** One facility is currently operating as a hatchery and recently started production of dusky kob. The facility will expand to produce yellowtail and oysters in the future. The facility is expected to produce 100 tons by the end of year two and 300 tons per annum at full production. **Potential production:** Approximately 10 000 tons per annum *NB: Concerns about agriculture activity in an industrial-zoned area which may inflate levies for farmers.*
5. Qolora ADZ (Eastern Cape) – DFFE project	**Area:** 26.4 hectares (land-based zone) **Targeted species:** Marine finfish, abalone and seaweed **Current status:** No farming is taking place. The Department is currently seeking funding to support the development of basic infrastructure. **Potential production:** • Possibility of developing two 300 ton abalone/seaweed farms and a combination of fish farms. Total production capacity expected is as follows: o 600 tons of abalone production capacity (integrated abalone/seaweed farming) at 11 to 12 m above sea level. o 5 500 tons of finish at 15 to 25 m above sea level
6. Algoa Bay ADZ (Eastern Cape) – DFFE project	**Area:** 1 146 hectares (sea-based zone) **Targeted species:** Marine finfish, oysters and mussels **Current status:** One farm is operational in the Port Elizabeth Harbour (Algoa 6). The Final Basic Assessment report and application was submitted to the Competent Authority for consideration in October 2019. **Potential production:**

Name of Aquaculture Development Zone	Description
	• **Algoa 1:** 218 ha of mussel production (approximately 6 mussel farms) and 94 ha of oyster production. A viable mussel operation requires an annual production volume of +/- 500 tons and approximately 38 ha of space • **Algoa 6:** 479 hectares = approximately 16 oyster farms • **Algoa 7:** 355 ha – Three finfish operators produced 1 000 tons in the first year of the pilot study and up to 9 000 tons by year three.
7. **Vanderkloof Trout ADZ (Northern Cape) – DFFE project**	**Area:** 2nd largest dam in SA **Targeted species:** Freshwater finfish (trout) **Current status:** No farming is taking place. **Potential production:** Approximately 11 518 tons per annum ***NB: Feasibility study is complete, environmental authorisation has been granted. Trout pilot project has commenced but has been delayed.***
8. **Saldanha Bay ADZ (Western Cape) – DFFE project**	**Area:** 464 hectares of currently allocated area exist in the ADZ, of which 151 hectares were operational in 2018. With a further 420 hectare area for new production. **Targeted species:** The following species are considered for farming in the ADZ: • Currently cultivated bivalve species: ➢ Pacific oyster ➢ Mediterranean and Black mussel • New indigenous shellfish species: ➢ Abalone ➢ South African scallop • New indigenous finfish species: ➢ White Stumpnose ➢ Kabeljou ➢ Yellowtail • Alien finfish species: ➢ Atlantic salmon ➢ Coho salmon

Name of Aquaculture Development Zone	Description
	➢ King/Chinook salmon ➢ Rainbow and Brown trout ➢ Seaweed **Current status:** • 13 aquaculture farmers produce approximately 2300 tons of mussels and oysters in the bay. • One farm is producing under 50 tons of trout under a pilot phase. • 500 jobs have been created in the bay. • The Environmental Authorisation was granted in January 2018 however appeals process was entered and concluded in 2019. The Year 1 of implementation was undertaken from February 2019 –January 2020. • **Future growth:** • Environmental authorisation to increase production to 15 000 tons • Increase in the number of direct jobs to +/- 2500 (5-fold increase) • 255 ha of new water space has been issued to 4 existing projects and 14 new entrants (primarily PDI's and SMME's) **Production limits** • Limited to 10 000 tons per annum of shellfish (can increase after two years of monitoring) • Finfish production limited to 1000 tons per annum • Finfish production can achieve up to 5000 tons per annum over five years
9. Mossel Bay ADZ (Western Cape) – DFFE project	**Area**: undefined **Target species**: Marine finfish and bivalves **Current status**: The Basic Assessment application is to be undertaken. **Potential production**: undefined

Name of Aquaculture Development Zone	Description
10. Amatikulu ADZ (KwaZulu-Natal)	**Area:** Approximately 37 hectares to be used for aquaculture (12.6 ha for freshwater production and 24.6 hectares for marine production) **Targeted species**: Ornamentals, prawns, marine and freshwater finfish, sea cucumbers and crocodiles. **Current status:** Only two hectares is currently being used by two ornamental farms **Potential production:** Approximately 300 tons of table fish per annum *Based on the EIR (2019), the following recommendations were made for the Amatikulu ADZ:* • Conduct a feasibility study to determine the feasibility of constructing a marine water intake pipeline • Dispersion modelling to determine the dispersion and impact of discharged effluent into a Marine Protected Area is required. • A wetland offset within the same catchment must be identified and rehabilitated to make up for the loss of the wetland on the proposed site owing to the development of the ADZ. • Before construction, the presence of the critically endangered Pickergills Reedfrog must be confirmed (Nuleaf Planning and Environmental, 2019).

Name of Aquaculture Development Zone	Description
11. Coega Industrial ADZ (Eastern Cape)	**Area:** 440 hectares (land-based zone) **Targeted species:** Marine and freshwater finfish, abalone **Current status:** No farming is taking place **Potential production:** Approximately 20,000 tons per annum According to reports, it is anticipated that the ADZ will be ready for business by August 2021 (Fishing Industry and Aquaculture News, 2020)
12. East London IDZ (Eastern Cape)	**Area:** 32 hectares (land-based zone) **Targeted species:** Marine and freshwater finfish, abalone

Name of Aquaculture Development Zone	Description
	and seaweed **Current status:** One facility is currently operating as a hatchery and recently started production of dusky kob. The facility will expand to produce yellowtail and oysters in the future. The facility is expected to produce 100 tons by the end of year two and 300 tons per annum at full production. **Potential production:** Approximately 10 000 tons per annum *NB: Concerns about agriculture activity in an industrial-zoned area which may inflate levies for farmers.*
13. Qolora ADZ (Eastern Cape)	**Area:** 26.4 hectares (land-based zone) **Targeted species:** Marine finfish, abalone and seaweed **Current status:** No farming is taking place. Funding is required to support the development of basic infrastructure. **Potential production:** • Possibility of developing two 300 ton abalone/seaweed farms and a combination of fish farms. Total production capacity expected is as follows: o 600 tons of abalone production capacity (integrated abalone/seaweed farming) at 11 to 12 m above sea level. o 5 500 tons of finish at 15 to 25 m above sea level
14. Algoa Bay ADZ (Eastern Cape)	**Area:** 1 146 hectares (sea-based zone) **Targeted species:** Marine finfish, oysters and mussels **Current status:** One farm is operational in the Port Elizabeth Harbour (Algoa 6), however, an EIA is required for expansion. **Potential production:** • **Algoa 1:** 218 ha of mussel production (approximately 6 mussel farms) and 94 ha of oyster production. A viable mussel operation requires an annual production volume of +/- 500 tons and approximately 38 ha of space • **Algoa 6:** 479 hectares = approximately 16 oyster farms • **Algoa 7:** 355 ha – Three finfish operators produced 1 000 tons in the first year of the pilot study and up to 9 000

Name of Aquaculture Development Zone	Description
	tons by year three. *NB: Environmental authorization has been granted. However, the project is currently in the appeals phase.*
15. Vanderkloof Trout ADZ (Northern Cape)	**Area:** 2nd largest dam in SA **Targeted species:** Freshwater finfish (trout) **Current status:** No farming is taking place. **Potential production:** Approximately 11 518 tons per annum *NB: Feasibility study is complete, environmental authorisation has been granted. Trout pilot project has commenced but has been delayed.*
16. Saldanha Bay ADZ (Western Cape)	**Area:** 464 hectares of currently allocated area exist in the ADZ, of which 151 hectares were operational in 2018. With a further 420 hectare area for new production. **Targeted species:** The following species are considered for farming in the ADZ: • Currently cultivated bivalve species: ➢ Pacific oyster ➢ Mediterranean and Black mussel • New indigenous shellfish species: ➢ Abalone ➢ South African scallop • New indigenous finfish species: ➢ White Stumpnose ➢ Kabeljou ➢ Yellowtail • Alien finfish species: ➢ Atlantic salmon ➢ Coho salmon ➢ King/Chinook salmon ➢ Rainbow and Brown trout ➢ Seaweed **Current status:** • 13 aquaculture farmers produce approximately 2300 tons of mussels and oysters in the bay • One farm is producing 50 tons of salmon/trout

Name of Aquaculture Development Zone	Description
	• 500 jobs have been created in the bay **Future growth:** • Environmental authorisation to increase production to 15 000 tons • Increase in the number of direct jobs to +/- 2500 (5-fold increase) • 255 ha of new water space has been issued to 4 existing projects and 14 new entrants (primarily PDI's and SMME's) **Production limits** • Limited to 10 000 tons per annum of shellfish (can increase after two years of monitoring) • Finfish production limited to 1000 tons per annum • Finfish production can achieve up to 5000 tons per annum over five years *The branch Fisheries conducted an EIA process (BA) for the establishment of a sea-based ADZ in Saldanha Bay in 2016/2017. The Environmental Authorisation (EA) for the ADZ was granted on the 8th January 2018 by the then DEA, and appeals process followed where four (4) appeals were received. The Appeals decision was received on 7th June 2018 that the EA was upheld. The project is currently being implemented according to the EA and Environmental Management Programme.*
17. Richards Bay IDZ (KwaZulu-Natal)	**Area:** **Targeted species:** Marine finfish **Current status:** No farming is currently taking place. **Potential production:** Approximately 600 tons per annum

8.5. Saldanha Bay Aquaculture Development Zone Progress

Saldanha Bay has an established aquaculture industry with a number of aquaculture operations, mostly mussel and oyster farms. Research determined that the Bay can support additional aquaculture production. To facilitate investment and development of additional aquaculture in the Bay, the former Department of Agriculture, Forestry and Fisheries (DAFF) proposed the establishment of an ADZ in Saldanha Bay for sea-based aquaculture. Branch Fisheries Management obtained Environmental Authorisation (EA) for the ADZ in Saldanha Bay on 8 January 2018, which (after appeals) was upheld on 7 June 2018. In terms of Condition 29 of the EA, the department must appoint an independent Environmental Control Officer (ECO) for the construction and operation phases of the ADZ to ensure that mitigation / rehabilitation measures and recommendations (hereafter management measures) referred to in the EA are implemented and to ensure compliance with the provisions of the Environmental Management Programme (EMPr).

The following milestones were achieved in 2019 year 1 of the implementation of the ADZ:

- Notification of commencement was the 11th February 2019.
- An Environmental Control Officer was appointed by the DFFE on a six -month contract to act as the independent ECO from September 2019 to February 2020.
- The Part 1 amendment application was submitted on the 10th July 2019 to amend administrative errors in the EA.
- The ADZ Sampling Plan was finalised in January 2019 and after peer review.
- Rapid synaptic surveys were initiated by the Department to measure the oxygen and nutrient levels in the Bay and to map the oxygen variations as per the requirements of the Sampling Plan.
- The Consultative Forum and Aquaculture Management Committees established in 2018 continued to meet as per the EA requirements deliberating on the environmental management of the ADZ.
- Eighteen farm specific Environmental Management Programmes were endorsed by the AMC in 2019.
- Numerous guidelines and templates were developed in compliance with the EA.

AQUATIC ANIMAL HEALTH PROGRAMMES

09

9. AQUATIC ANIMAL HEALTH PROGRAMMES

9.1. Introduction

The importance of managing the aquatic organism health and aquaculture biosecurity is becoming increasingly apparent particularly in its role in preventing or reducing disease-related production and market losses. Pathogen surveillance programs are integral to national-level biosecurity. To maintain disease freedom, a system for rapid detection of disease underpins an effective response and is required to meet the country's obligation to the international community and the OIE to report any change in disease status, incursion, or emergence. Both passive and active surveillance contribute to the early detection of both listed and emerging diseases.

9.2. Surveillance and monitoring

The purpose of aquatic animal disease surveillance is to provide scientifically accurate and cost-effective information for assessing and managing risks of disease transfer associated with the trade of aquatic animals, animal production efficiency, and public health (Subasinghe et al. 2004). The primary objective of the surveillance activities reported here is the provision of evidence of freedom from diseases at the country, zone, or aquaculture establishment level relevant to the domestic and international movement of aquatic animals and products.

9.2.1. Targeted Surveillance

Targeted surveillance comprises the collection of information on a specific disease or condition to:

i. measure the prevalence of the disease within a defined population of susceptible hosts, or
ii. provide evidence to substantiate the absence of a disease or disease freedom within a defined population of susceptible hosts (Subasinghe et al. 2004).

The targeted surveillance for specified diseases of farmed abalone (*Haliotis midae*) and farmed oysters (*Crassostrea gigas*) are defined in the "*Health Management Procedures for South African Abalone Produced for Export"* and the "*Health Management Procedures for South African Bivalves (Oysters and mussels) Produced for Export"* documents respectively. These documents were developed to comply with the basic biosecurity conditions as required by the OIE (OIE 2018). These procedures describe the conditions required to continually demonstrate disease freedom from and ensure adequate disease security for the diseases currently listed by the OIE for *Haliotis* species and *Crassostrea gigas*.

Although the South African abalone and oyster industries have historically had access to private health management services, which include regular disease screening and testing of the farmed populations, the "Health Management Procedures" documents for each respective industry were first adopted and implemented in 2016.

Abalone

Although parasites and potential pathogens have been reported from farmed *H. midae* in South Africa (Mouton & Gummow 2011, Macey et al. 2011, Boonzaaier et al. 2014, Horwitz et al. 2016), there is a

high level of confidence that South Africa's farmed population of *H. midae* is currently free of all the diseases listed by the OIE for *Haliotis* species (infections with abalone herpesvirus, *Perkinsus olseni* and *Xenohaliotis californiensis*) (OIE 2018). Although these diseases have been reported from a range of *Haliotis* species from other parts of the world, *H. midae* has not been specifically listed as a susceptible host species for any of these diseases (OIE 2016).

Table 9.1: Number of abalone sampled per zone for the period 1 January 2016 to 31 December 2019 as reported to the Department in line with the "*Health Management Procedures for South African Abalone produced for Export"*

Zone	Infection with:	Diagnostic Test	2016	2017	2018	2019
East Coast Zone (1 Farm)	Abalone Herpesvirus (AbHV)	Histopathology	0	265	0	0
		PCR	60	0	70	69
	Perkinsus olseni	Histopathology	91	265	0	0
		PCR	0	0	70	69
	Xenohaliotis californiensis (Whithering Syndrome)	Histopathology	91	265	0	0
		PCR	0	0	0	69
South Coast Zone (12 Farms)	Abalone Herpesvirus (AbHV)	Histopathology	2804	3497	176	241
		PCR	0	0	1265	572
	Perkinsus olseni	Histopathology	2804	3497	0	241
		PCR	0	0	1244	572
	Xenohaliotis californiensis (Whithering Syndrome)	Histopathology	2804	3497	0	241
		PCR	0	0	892	572
West Coast Zone (5 Farms)	Abalone Herpesvirus (AbHV)	Histopathology	1001	416	0	85
		PCR	0	0	131	285
	Perkinsus olseni	Histopathology	1001	416	0	85
		PCR	0	0	131	285
	Xenohaliotis californiensis (Whithering Syndrome)	Histopathology	1001	416	0	85
		PCR	0	0	131	285

Table 9.1 presents the number of samples that were tested either by histopathology or PCR to demonstrate freedom from the three diseases listed by the OIE for *Haliotis* species. These data are presented according to each respective zone as described in Abalone Movement Protocol for South Africa as detailed in the "*Health Management Procedures for South African Abalone produced for Export"*. No evidence of infection with abalone herpes virus, *Perkinsus olseni,* and *Xenohaliotis californiensis* was found in any of these samples.

Oysters

Table 9.2 presents the number of samples that were tested either by histopathology or PCR to demonstrate freedom from the two diseases listed by the OIE for *Crassostrea gigas*. These data are presented according to each respective zone as described in Oyster Movement Protocol for South Africa as detailed in the "*Health Management Procedures for South African Bivalves (Oysters and Mussels) Produced for Export"*. No evidence of infection with Ostreid herpesvirus or *Perkinsus sp.* was found in any of these samples.

Table 9.2: Number of oysters sampled per zone for the period 1 January 2016 to 31 December 2019 as reported to the Department in line with the "Health Management Procedures for South African Bivalves (Oysters and Mussels) produced for Export"

Zone	Infection with:	Diagnostic Test	2016	2017	2018	2019
East Coast Zone (1 Farm)	Ostreid Herpesvirus 1 microvariants	Histopathology	165	165	0	0
		PCR	0	0	34*	34*
	Perkinsus sp.	Histopathology	165	165	0	0
		PCR	0	0	34*	34*
West Coast Zone (5 Farms)	Ostreid Herpesvirus 1 microvariants	Histopathology	0	165	0	0
		PCR	0	0	165	165
	Perkinsus sp.	Histopathology	0	165	0	0
		PCR	0	0	165	165
Northern Cape Zone (1 Farm)	Ostreid Herpesvirus 1 microvariants	Histopathology	165	0	0	
		PCR	0	165	165	165
	Perkinsus sp.	Histopathology	165	0	0	
		PCR	0	165	165	165

*Pooled samples (34 pools of 5 animals each)

9.2.2. Non-targeted surveillance

The abalone farm stock inspections form part of the active, non-targeted disease surveillance as described in the Approved Official Surveillance Program: Active Component of the "*Health Management Procedures for South African Abalone Produced for Export*". The stock inspections act as an early disease detection system and entail the assessment of mortality and morbidity in a representative sample of baskets housing abalone. During 2019 all 15 registered South African abalone grow-out farms were inspected by the Department and individual technical reports were generated and circulated to the respective farms.

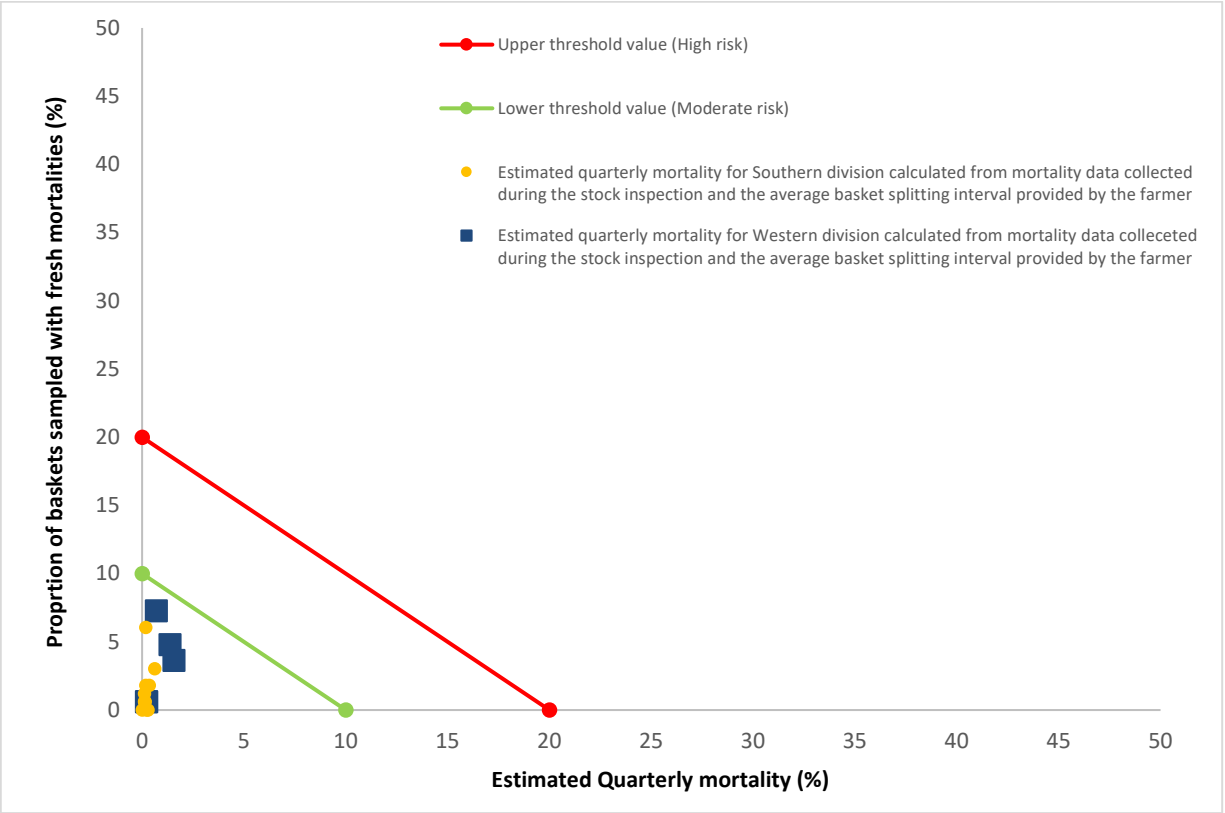


Figure 9.1: Proportion of baskets sampled with fresh mortalities (%) vs estimated quarterly mortality (%). Animal health and welfare risk distribution of South African abalone farms based on assessments from 2019 stock inspections.

9.3. Disease events in 2019

9.3.1. Infection with *Halioticida noduliformans* (Abalone Tubercle Mycosis)

Abalone tubercle mycosis (ATM) is a disease caused by the oomycete *Halioticida noduliformans* which was first detected in South Africa in 2006 (Macey et al. 2011, Greeff et al. 2012) and is considered a production disease. In South Africa, this disease has only been isolated from captive populations of abalone, *Haliotis midae*, and is still regarded by the department as having the potential to pose a significant threat to the abalone aquaculture industry.

During the 2019 cycle two cases of ATM, from separate farms, were reported to the department. The response by farmers and the department per the *"Abalone Tubercle Mycosis Management Protocol"* was sufficient to contain and reduce the risk of progression of the disease on farms. The occurrence of the disease is sporadic as ATM is ubiquitous in the farm environment; thus presenting more as a production disease and to some degree as an indicator of the health status of animals on the farm.

9.3.2. Infection with *Aphanomyces invadans* (Epizootic Ulcerative Syndrome)

Epizootic Ulcerative Syndrome (EUS) is a disease caused by the oomycete *Aphanomyces invadans* to which both farmed, wild, freshwater, and brackish water fish are susceptible. Five suspect cases were presented to the department in 2019 of which infection with *Aphanomyces invadans* was only confirmed in three of these cases (Table 9.3).

Table 9.3 Reported cases of EUS from South Africa in 2019

Province	Affected Fish Species	Diagnostic Test
Western Cape	*Micropterus dolomieu*	PCR
Free State	*Clarias gariepinus*	PCR
Northern Cape	*Clarias gariepinus*	Histology and PCR

9.3.3. Infection with Koi Herpesvirus

Koi herpesvirus (KHV) is a disease caused by cyprinid herpesvirus-3 following the nomenclature for other cyprinid herpesviruses. Initial outbreaks of infection with Koi herpesvirus in South Africa were in 2001-2003 (Haenen et al. 2004) where the disease caused serious losses in valuable koi collections (Huchzermeyer & Colly 2015). Although this disease is most commonly associated with the ornamental fish industry, in 2014 KHV was confirmed and reported from a feral population of *Cyprinus carpio* – Common Carp in Cape Town. No new cases of infection with KHV were reported in 2019.

9.4. Training (Capacity Development)

9.4.1. University of Stirling MSc program: Aquatic Veterinary Studies

As means of building veterinary capacity in the aquaculture sector, the department has, since 2016, embarked on a partnership with the University of Stirling for the training of South African veterinary professionals in aquaculture. In September 2018 three State veterinarians enrolled for the MSc in Aquatic Veterinary Studies offered by the University's Institute of Aquaculture; and completed their studies in September 2019. As part of the degree, the candidates had to cover an aquaculture-related research topic (see Table 9.4). In addition, two other State veterinarians (Dr. M. De Beer of the Free State Province and Dr. T. Anthony of the Western Cape) enrolled for the Aquaculture Continuing Professional Development (CPD) - Aquaculture Health Management course from January 2019 until March 2019. The core modules covered in the CPD course formed part of the academic program of the MSc Aquatic Veterinary Studies. The modules covered were Aquaculture Diagnostic Skills, Aquaculture Health Control, and Aquaculture Diseases.

Table 9.4 Research topics of candidates enrolled for the 2018/2019 MSc Aquatic Veterinary Studies offered by the University of Stirling, Scotland.

Candidates	MSc Research Topic
Dr. N. Matekwe	Health screening of tilapia (*Oreochromis* species) populations held at the Institute of Aquaculture Tropical Aquarium with particular focus on two specific pathogens: *Mycobacteria spp*. and Tilapia Lake Virus.
Dr. T. S. Phukubye	Identification of bacterial risks at a *Liptopenaeus vannamei* shrimp farm in Scotland, UK (Biosecurity).
Dr. M. P. Selotole	Survey of deformities in cultured juvenile ballan wrasse (*Labrus bergylta*)

9.4.2. World Organisation for Animal Health (OIE) Sub-Regional Workshop on Antimicrobial Resistance (AMR) in Aquaculture

The OIE held a sub-regional workshop of Southern African Developing Communities (SADC) countries looking at AMR in aquaculture. The workshop took place in Durban from 26th-28th November 2019. In attendance from the Department was Mr. B. Semoli (Chief Director: Aquaculture and Economic Development), Dr. K. W. Christison (Specialist Scientist), Dr. N. D. Chelopo (State veterinarian), and Mr. J. Foord (Environmental Officer Specialised Production). The workshop involved scenario-based group discussions regarding the use of antibiotics in aquaculture; as well as a farm visit to an aquaculture facility in the city.

The workshop was concluded with recommendations on the improvement of antimicrobial use at a regional level and the presentation of the Certificate of Attendance to the delegates.

AQUACULTURE RESEARCH AND DEVELOPMENT

10

10. AQUACULTURE RESEARCH AND DEVELOPMENT

10.1. Introduction

Aquaculture is a knowledge and technology driven industry which relies heavily on research to development of new techniques, species and the efficient technology for sustainable commercial production. This is also supported by the National Aquaculture Strategic Framework (NASF) which identified the development of aquaculture technology, particularly for indigenous species, as a key strategy for growing the local aquaculture sector. Related to this is a need to make South African producers more internationally competitive by reducing costs through improved aquaculture technology innovations. The Directorate: Aquaculture Research and Development has been established to oversee, facilitate and conduct aquaculture research in South Africa. The vision for the Directorate: Aquaculture Research and Development is "Excellence in aquaculture research to support the growth of a sustainable and globally competitive aquaculture sector for South Africa - 20:20". The responsibility of the aquaculture research division is to conduct research in support of a competitive and sustainable sector in South Africa. The main focus areas are:

- **Diversification and competitiveness**. Development of the aquaculture sector in South Africa requires diversification, with particular emphasis on indigenous species and the development of appropriate technology. Research that will enhance diversification throughout the value chain is undertaken and continuous improvement of existing aquaculture systems to enhance efficiency is also conducted. Research therefore includes the establishment of new species for culture, breeding and genetics, production systems, technology transfer and pilot/demonstration projects, nutrition and feed development and market and post-harvest technology.
- **Sustainable production**. Sustainability is of key importance for the South African aquaculture sector. This will require information gathering and development of knowledge on animal health and the effect on aquaculture activities on the environment and conversely the environment on aquaculture activities. Environmental sustainability is underpinned by the use of appropriate technology and development of sustainable management techniques. The focus area is comprised of the following dedicated research programmes: aquatic animal health and welfare, environmental interaction and food safety.

The Directorate: Aquaculture Research and Development has three sub-units that are responsible for addressing the above focus areas, namely i) Reproduction, Production and Nutrition, ii) Environment, and iii) Aquatic Animal Health. For the current year of reporting, more than 40 research projects were undertaken by the Directorate: Aquaculture Research and Development in collaboration with Universities and Industry. Research highlights for each Sub-unit, together with a list of the main projects undertaken, are summarised below.

10.2. Reproduction, production and nutrition sub-unit

The Culture Technology Research group of the Directorate: Aquaculture Research and Development has several main focus areas, namely (i) development of controlled reproduction methods for selected finfish and shellfish, (ii) development of production methods for various plankton, finfish and shellfish species, incorporating implementation of IMTA technologies, (iii) formulating cheaper fish diets derived

from terrestrial resources with similar or better growth characteristics than obtained with commercial feeds with fishmeal as main protein contributor and (iv) the development of tetraploid broodstock in alien fish species with aquaculture potential to improve performance and reduce environmental risk.

10.2.1. Research Highlights - Reproduction, Production and Nutrition

Development of oral hormone delivery technology for spawning induction in fish

The purpose of this research is to develop a procedure for the effective oral delivery of a spawning induction peptide. The outcome of this study will contribute significantly to programmable mass-spawning of breeders without having to use invasive methods that involve physical handling and intramuscular injection (which are potential stressors), especially for fish that are used chronically for breeding or that require frequent dosing with induction hormones. Stressors can manifest in delayed after-effects such as long periods of appetite loss (up to 14 days in spotted grunter *Pomadasys commersonni*, pers. obs.), even in the presence of feed.

Spawning induction of finfish using bioactive peptides such as luteinizing hormone releasing hormone analog (LHRHa) is strongly advocated due to its excellent specificity, selectivity, safety, and efficacy. Peptides are short amino acids occurring naturally in all living organisms and play a key role in diverse biological activity. The oral delivery of bioactive peptides presents challenging limitations, which include: low bioavailability due to peptide degradation in the gastrointestinal tract (GIT) by proteolytic enzymes and severe pH physiological conditions as well as poor permeability through the intestinal epithelium.

To date, we have produced two different peptide hormone carriers viz. alginate-chitosan encapsulation and chitosan phthalate microspore production. Preliminary testing of the activity of these peptide vehicles was undertaken and some responses were observed (kob males drumming but no reaction from females).

A third delivery vehicle was prepared as a complexed enteric-coated tablet to be tested on sharptooth catfish. The formulation includes:

1. Bioactive peptide hormone (100µg LHRHa) incorporated within chitosan hydrogel.
2. Hydrogel coated organic acid granules (preferably citric acid which will act as a low pH intestinal enzyme inactivator).
3. Carnitine and sodium salcaprozate (which will act as trans epithelial permeation enhancing shuttles)
4. Vitamin E (an anti-oxidant to prevent LHRHa methionine and tryptophan oxidation)
5. Microcrystalline cellulose (act as a disintegrant, a dry binder, and a lubricant)
6. Dried duck albumin powder (protease inhibitor).

Development of a relatively cheap fertilizer for the mass culture of *Isochrysis galbana* and *Nannochloropsis oculata*, the preferred algae species for rotifer enrichment and pseudo-green water practices in marine finfish hatcheries

Local marine finfish hatcheries use live algae cultures (predominantly *Nannochloropsis oculata*) and expensive imported algae paste and powders to maintain and nutritionally enrich rotifers, the first live

planktonic feed for post hatch finfish larvae. The availability of live algae cultures is always limited since it must be used to enrich rotifers, but also used to daily create pseudo-green water conditions in the hatchery. Large scale live algae culturing is costly (Walne's or Guillard's F/2 media).

An alternative low-cost fertilizer was developed consisting of: nitric acid (55%) at 160ppm, phosphoric acid (85%) at 4ppm, Nutrifeed (Starke Ayers)® at 50ppm, Fe-EDDHA (Ferric ethylenediamine-N,N′-bis(2-hydroxyphenylacetic acid)) at 0.5ppm (60g Fe kg^{1}), Thiamine (0.02ppm) and Vitamin B12 (0.001 ppm). Sodium bicarbonate (70ppm) was added to rectify pH (7-7.2) before algae inoculation. High density *Isochrysis galbana* cultures (>5x10^5 cells ml^{-1}) are known to "crash" within a relatively short period (<3 days). The developed fertilizer maintained *Isochrysis galbana* at 2x10^6 cells ml^{-1} for 7 days in a 2 kL culture vessel at a daily harvest rate of 30% volume removal and replacement. Culture conditions for *Isochrysis galbana*; cool white light exposure intensity of 170w m^{-2}, optical depth of 150 mm and consistent temperature (27 -28°C).
The cost of the alternative fertilizer equates to R19.90 per kL of culture water. We therefore developed an equipotent but attractively lower-cost fertilizer that is suitable for the mass culture of *Isochrysis galbana* and *Nannochloropsis oculata*.

Effect of dietary *Artemisia afra* on growth, some innate immunological parameters in *Clarias gariepinus* challenged with *Aeromonas hydrophila*

This study investigated the effect of *Artemisia afra* based on growth, haemato-biochemical parameters and disease resistance in *Clarias gariepinus* (African sharptooth catfish). Five diets were formulated to contain 0%, 3%, 6%, 9% and 12% of *A. afra,* designated as the control, D2, D3, D4 and D5, respectively. Each diet was fed to triplicate groups of 45 fish (32.49 ± 0.27 g). All groups were fed ad libitum twice a day at 09:00 h and 15:00 h for 45 days. There were no significant differences (P > 0.05) in feed conversion ratio and specific growth rate of fish between dietary treatments. Feed conversion ratio values increased from 1.64 in the control to 1.78 in D5. Specific growth rate values were lower in D5 (1.94) than in the control (2.02). White blood cells increased with increasing dietary *A. afra* inclusion levels from 3.61 (× 10^3/µℓ) in the control to 5.05 (× 10^3/µℓ) in D5. Similarly, red blood cells increased from 2.07 (× 10^6/µℓ) in the control to 3.26 (× 10^6/µℓ) in D4. Haemoglobin, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration also increased with higher *A. afra* inclusion levels. No significant changes (P >0.05) were observed in alanine transaminase, aspartate transaminase, alkaline phosphatase and lactate dehydrogenase levels between dietary treatments. Fish fed with D3, D4 and D5 had significantly higher (P <0.05) nitro blue tetrazolium and lysozyme activity compared to fish fed with the control and D2. After a challenge trial using the most virulent dosage (4 × 10^6 cfu ml^{-1}) of *Aeromonas hydrophila*, survival rate was lower in fish fed with the control (20%), D2 (30%) and D3 (40%) compared to fish fed with D4 (70%) and D5 (70%). This shows that *A. afra* can improve the health status of captive *C. gariepinus*.

Effects of dietary levels of essential oil extracts from *Moringa oleifera* and *Artemisia afra* on kidney histology, haemato- immunological parameters and disease resistance in *Clarias gariepinus*.

This experiment investigated the effect of dietary supplementation with essential oils from *Artemisia afra* and *Moringa oleifera* on haemato-immunological parameters and resistance in *Clarias gariepinus* (African Sharptooth catfish) (Burchell, 1822) challenged with *Aeromonas hydrophila*. The experiment lasted for 45 days. Prior to and post-challenge, white blood cells significantly increased (p <0.05) from the 3% to 12% *M. oleifera* and *A. afra* supplementation. Pre-challenge, no significant differences (p >0.05) in red blood cells, haemoglobin and haematocrit were observed between the control and *M. oleifera* supplementation, while in the *A. afra* supplementation, RBC and HCT significantly increased from 6% to 12%. Post-challenge, RBC, HGB and HCT were significantly lower (p <0.05) in the control and the 3% and 6% *M. oleifera* and *A. afra* supplementation. Both pre- and post-challenge, nitro-blue tetrazolium levels significantly increased (p <0.05) from the 3% to 12% *M. oleifera* supplementation while no significant differences (p >0.05) were observed in lysozyme activity between the control and treatment groups. In *A. afra*, NBT and lysozyme activities increased significantly (p <0.05) from the 6% to 12% supplementation pre- and post-challenge. Survival rate increased from the 3% to 12% in *M. oleifera* and *A. afra* supplementation groups. Significant kidney histological alterations were noted in the control and the 3% and 6% supplementation of both plants post-challenge, while no major histological changes were observed between treatment groups and the control pre-challenge. The results demonstrate that essential oil from *M. oleifera* and *A. afra* can improve immunity and enhance survival in *C. gariepinus*.

Development of a method for the mass culture and management of marine yeast to promote and sustain the mass culture of the marine rotifer *Branchionus plicatilis* in marine finfish hatcheries.

The availability and cost of algae are important limiting factors in sustaining or enhancing rotifer production in marine finfish hatcheries. Yeast is known to be a good alternative in sustaining rotifer cultures prior to enriching them with selected algae strains in preparation for larval fish feeding. It was determined that the highly viscous and dense yeast culture (3.8×10^7 cells ml^{-1}) required a dilution of at least 10:1 prior to being inoculated with rotifers. The diluted cultures facilitated propagation of egg-bearing rotifers with rotifer density increasing from an average of 1/ml to 14/ml after 4 days at 24°C. Rotifers were transferred from the laboratory to mass culture units (0.5 kL) and ultimately fed yeast exclusively from the yeast mass culture units, while monitoring rotifer fecundity, GIT fullness, swimming behaviour, temperature, ammonia and pH.

Rapid yeast and rotifer proliferation were observed at a relatively low temperature range of 20-22 °C. Culturing marine yeast is a function of low pH (3-4). Therefore, a valuable tool could be developed to prevent the presence of toxic unionized ammonia by adjusting the pH of rotifer + yeasts cultures to 6.8 using sodium hydroxide. This tool will prevent rotifer population "crashes" as previously experienced with algae fed cultures. We therefore developed a reliable method to culture marine yeast on a large scale and in a sustainable way using batch and semi-continuous culture methods. This investigation demonstrated that rotifer populations can be maintained, stabilized and proliferated by only using sustainably cultured marine yeast as a feed source.

Research Projects Undertaken by Reproduction, Production and Nutrition [Principle investigator(s) & student indicated in brackets]

1) Optimization of the settlement and post-settlement survival of *Tripneustes gratilla* [PI(s): Mark Cyrus (DFFE), Brett Macey (DFFE), Bolton (UCT), Vernon Coyne (UCT); M.Sc. Student: Michael Bennet (UCT)].
2) Identification and characterization of compounds within *Ulva* which act as feed attractants and settlement cues for *Tripneustes gratilla* [PI(s): Mark Cyrus (DFFE), Brett Macey (DFFE), John Bolton (UCT), Denzel Beukes (UWC); PhD Student: Lekraj Etwarysing (UWC)].
3) Pilot-scale commercial grow-out (Wild Coast Abalone farm trials) of *Tripneustes gratilla* to optimize feed/ feeding regimes [PI(s): Mark Cyrus (DFFE), Brett Macey (DFFE), Niall Vine (UFH), John Bolton (UCT), Richard Clark (Wild Coast Abalone), Daphne Taylor (Wild Coast Abalone); M.Sc. Student: Abigail John Onomu (FHU)].
4) Investigating the salinity tolerance of *Tripneustes gratilla* (LINNAEUS) under controlled laboratory conditions [PI(s): Mark Cyrus (DFFE), Brett Macey (DFFE), Rashieda Toefy (CPUT); M.Sc. Student: Rifaat Aziz (CPUT)].
5) Optimization of production technology and systems [basket design, stocking density, recirculation rates] for echinoculture of *Tripneustes gratilla* [PI(s): Mark Cyrus (DFFE), Brett Macey (DFFE), John Bolton (UCT), Vernon Coyne (UCT); M.Sc. Student: Bas de Vos (UCT)].
6) Culturing local marine copepods as live foods for marine fish larvae [PI(s): Chris Fouche (DFFE), Mark Goodman (DFFE) and Riaan Cedras (UWC); MSc student: Ngoepe Maphuti Eva (UWC)].
7) Development of advanced larval rearing techniques for spotted grunter *Pomadasys commersonnii* (family: Haemulidae) until the weaning stage [PI(s): Chris Fouche (DFFE) and Heather Marco (UCT); MSc Student: Amos Rakgoale (UCT)].
8) The effect of dietary acid-fermented chicken silage on growth performance, digestive enzymes and histology in *Oreochromis mossambicus* in South Africa [PI(s): Esau Mbokane (DFFE) and Chris Fouche (DFFE)].
9) Growth Performance and Haemo-biochemical Parameters in South African Dusky Kob (*Argyrosomus japonicus*, Sciaenidae) offered Brewer's Yeast (*Saccharomyces cerevisiae*) as a Feed Additive [PI(s) Molatelo Madibana (DFFE), Chris Fouche(DFFE) and Victor Mhlambo (UMP)].
10) Graded levels of commercial herbal stimulant, Aquapro® in diets for juvenile dusky kob (*Argyrosomus japonicus*, Sciaenidae) [PI(s): Brett Lewis (DFFE), Molatelo Madibana (DFFE)].
11) Feed utilization, growth performance and blood parameters in juvenile dusky kob (*Argyrosomus japonicus*, Scieaenidae) reared on insect meal-containing diets [PI(s): Molatelo Madibana (DFFE), Brett Lewis (DFFE), Chris Fouche (DFFE) and Victor Mhlambo (UMP)].
12) Tetraploid induction of a freshwater fish species (*Clarias gariepinus*) [PI: Chris Fouché; MSc Student: Thapelo Senyolo (SU)].
13) Effect of graded levels of dietary Ulva on growth, haematological and serum biochemical parameters in dusky kob, *Argyrosomus japonicus* [PI(s): Molatelo Madibana (DFFE), Victor Mhlambo (UMP), Brett Lewis (DFFE) and Chris Fouche (DFFE)].
14) Development of juvenile dusky kob aviation transportation techniques [PI(s): William Selapa

(DFFE), Mark Goodman (DFFE) and Chris Fouche (DFFE)].

15) Development of novel sperm cryopreservation methods for dusky kob *Argyrosomus japonicus* [PI(s): Chris Fouche (DFFE), Mark Goodman (DFFE) and William Selapa (DFFE)].
16) Microbial composition of the Sand River with three deliverables to be achieved [PI: Esau Mbokane (DFFE)].
17) Production scale larval rearing and settlement of spat of the scallop *Pecten sulcicostatus* (Pilot) [PI: Dale Arendse (DFFE)].
18) To describe the reproductive cycle of the clam *Venerupis corrugatus* from Langebaan Lagoon [PI: Dr Dale Arendse (DFFE)].
19) Testing the effect of unionized ammonia and carbon dioxide under rearing conditions, as measured by LC50 and haematological or histological stress indicators in juvenile dusky kob [PI(s): William Selapa (DFFE) and Chris Fouche (DFFE)].
20) Development of a novel and efficient method for the oral delivery of spawning induction peptides in the spotted grunter *Pomadasys commersonnii* [PI(s): Chris Fouche (DFFE) & Mark Goodman (DFFE)].
21) Growth performance and health parameter evaluation of graded Black soldier fly meal (BSFM) inclusions as partial fish meal replacement substitute in the diet of juvenile dusky kob [(PI): Molatelo Madibana (DFFE)].
22) Growth performance evaluation of juvenile dusky kob fed with respective experimental ration sizes [PI(S): Dr Molatelo Madibana (DFFE) and Bret Lewis (DFFE)].
23) Development of IMTA controlled larval rearing techniques for spotted grunter *Pomadasys commersonni* [PI(S): Chris Fouche (DFFE), Mark Goodman (DFFE) and Alick Hendrickse (DFFE)].

10.3. Environment sub-unit

Aquaculture has often been associated with environmental degradation relating to biological pollution (e.g., escapes, aliens, diseases), use of trash fish for fish feeds, organic pollution and associated eutrophication, fauna interactions (e.g., whale/shark entanglements, predators, etc.), chemical pollution and habitat modification. Without proper evaluation and mitigation of impacts in terms of an environmental assessment, and implementation of responsible environmental management plans, aquaculture stands to degrade the ecosystems upon which it is dependent. It is therefore important to locate and manage aquaculture activities so that degradation of the environment and biological impacts are minimized. An increased understanding and monitoring of the interactions between aquaculture and the environment is therefore required for effective management. The environment research unit of the Directorate: Aquaculture Research has two main focus areas, namely: (i) to address the suitability and assimilative capacity of different environments to various aquaculture practices, and (ii) to address the impacts of aquaculture practices on the environment.

10.3.1. Research highlights – Environment

Ocean deoxygenation links to harmful algal blooms

Events of anoxia in the coastal waters of South Africa have often been associated with the development of high biomass harmful algal blooms (HABs) and pose a threat to both wild fisheries and aquaculture. Investigation of the causes and consequences of these events by DFFE scientists provided the opportunity to contribute the chapter 3.3 *Ocean deoxygenation links to harmful algal blooms* by GC Pitcher and GS Jacinto to the publication *Ocean deoxygenation: everyone's problem – causes, impacts, consequences and solutions* edited by D Laffoley and JM Baxter as an initiative of the *International Union for the Conservation of Nature*. Globally, coastal environments subject to high biomass HABs and associated events of low oxygen are typified by elevated inorganic nutrients as a consequence of either natural or cultural eutrophication. In eastern boundary upwelling systems such as the Benguela these blooms, often referred to as red tides, are common owing to natural eutrophication (Figure 10.1). However, in other parts of the world the expansion of HABs is often attributed to anthropogenic eutrophication and in Asia relationships between the increasing prevalence of HABs and aquaculture operations are increasingly reported. Several regional model predictions further show the likelihood for increased nutrient pollution and, correspondingly, for continued regional and global expansion of coastal hypoxia and anoxia linked to HABs. The full article is freely available at https://portals.iucn.org/library/node/48892.

Figure 10.1. Example red tides in the southern Benguela of (a) the dinoflagellate *Alexandrium catenella* off Elands Bay on 11 April 2012 (© John Foord), (b) a green flagellate of the genus *Tetraselmis* in Saldanha Bay on 15 January 2003 (© Grant Pitcher), (c) *Noctiluca*

scintillans on the shoreline of Dassen Island off the west coast of South Africa on 6 October 2006 (© Tony van Dalsen), (d) *Gonyaulax polygramma* in False Bay off the Steenbras River mouth on 25 February 2007 (© Brent Johnson), (e) *Alexandrium minutum* in Cape Town harbour on 26 November 2003 (© Andre du Randt), and (f) the photosynthetic ciliate *Mesodinium rubrum* off Yzerfontein on 10 October 2016 (© Meredith Thornton).

Farmed Abalone Mortalities in Walker Bay

In 2017 abalone farms in Walker Bay were subject to an unprecedented mortality of several million abalone linked to the presence of a HAB in the bay. DFFE scientists teamed up with industry and other scientists to investigate and document this event through publication in 2019 of the paper *Devastating farmed abalone mortalities attributed to yessotoxin-producing dinoflagellates* by GC Pitcher, CJ Foord, BM Macey, L Mansfield, A Mouton, ME Smith, SJ Osmond and L van der Molen in the journal *Harmful Algae*. The mortality was attributed to two dinoflagellate species identified as *Gonyaulax spinifera* and *Lingulodinium polyedrum* (Figure 10.2) both known to produce yessotoxins (YTXs). The appearance of YTXs in abalone and their subsequent mortality were clearly shown to coincide with increases in dinoflagellate concentrations. Toxin concentrations were found to be highest in the gills which showed the most significant pathology, including severe disruption of the gill epithelium characterized by degeneration and necrosis of epithelial cells accompanied by an inflammatory response. The value of remote observations of ocean colour from satellites in observing the development of the bloom in Walker Bay was clearly demonstrated (Figure 10.3). These satellite observations will provide a useful tool in the development of an early warning system for farmers of future HABs.

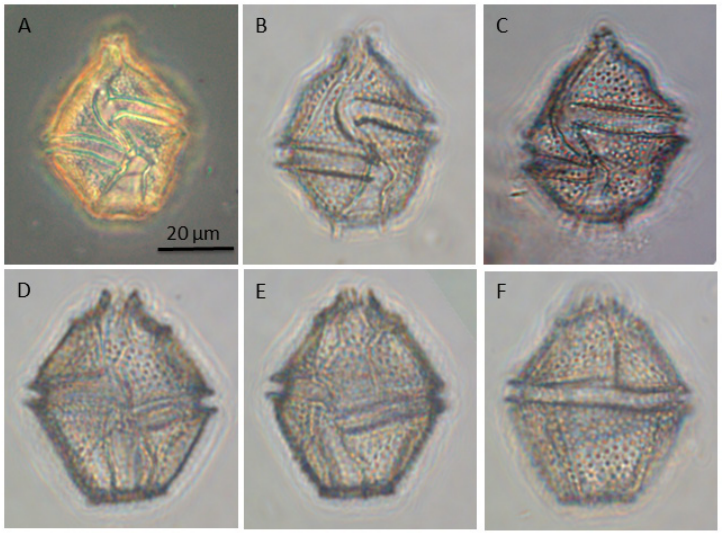


Figure 10.2. Light micrographs of (A–C) *Gonyaulax spinifera* distinguished by a moderate apical horn, typically two antapical spines, and an excavated cingulum that is markedly displaced with a prominent overhang, and of (D–E) *Lingulodinium polyedrum* without an apical horn or antapical spines, but distinguished by a descending cingulum without an overhang.

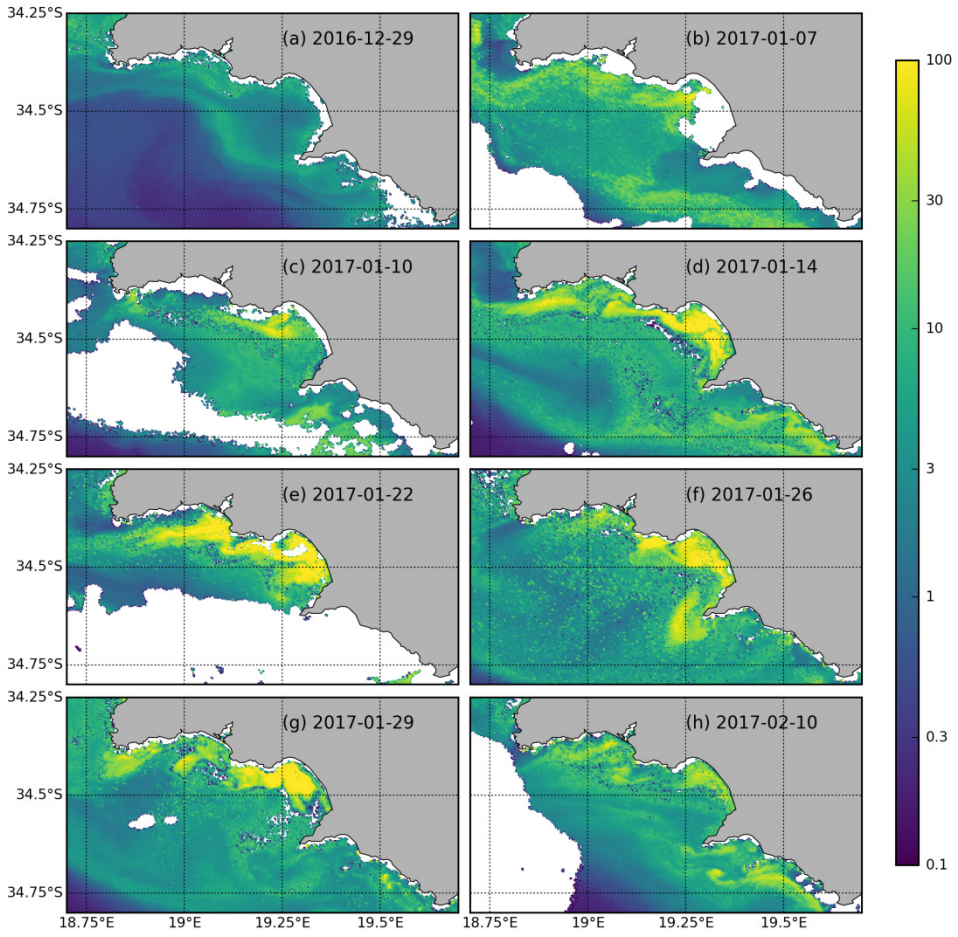


Figure 10.3: Selected satellite-derived images of Chl-a concentration (mg m^{-3}) from the Ocean and Land Colour Imager (OLCI) on board the European Space Agency Sentinel-3A satellite for the Walker Bay area between the 29 December 2016 and 10 February 2017. White areas represent either cloud or Chl-a algorithm failure.

10.4. Research Projects Undertaken by Environment [Principle investigator(s), collaborators & students indicated in brackets]

1. Investigate the threat posed by the toxic diatom *Pseudo-nitzschia* to shellfish farmers in Saldanha Bay [PI: Grant Pitcher (DFFE); Collaborators: Lisa Mansfield (DFFE); Allan Cembella, Bernd Krock (Alfred-Wegener Institut for Polar- und Meeresforschung, Bremerhaven, Germany)].
2. Investigation of Paralytic Shellfish Poisoning [PSP] toxins in farmed abalone [PIs: Grant Pitcher, Brett Macey (DFFE); Vernon Coyne (UCT); PhD student: John Foord (UCT).
3. Assessment of the threat to abalone farms of yessotoxin-producing dinoflagellate blooms through initiation of observation and monitoring activities in Walker Bay [PI: Grant Pitcher (DFFE); Collaborators: Andre du Randt, Lisa Mansfield (DFFE), Stewart Bernard (CSIR)].
4. Investigation of the threat posed by harmful algae to aquaculture operations in Algoa Bay [PI: Grant Pitcher (DFFE); Collaborators: Andre du Randt, Lisa Mansfield, Koena Seanego (DFFE), Derek du Preez (NMU); PhD student: Sifiso Mbambo (NMU)].
5. A global assessment of the role of satellite derived ocean colour data in the monitoring of harmful

algal blooms [PIs: Stewart Bernard (CSIR), Grant Pitcher (DFFE), Raphael Kudela (University of Southern California, USA), Lisl Robertson Lain (UCT).

6. Development of guidelines on climate change and harmful algal bloom research as part of the international IOC-SCOR programme GlobalHAB [PIs: Mark Wells (School of Marine Sciences, University of Maine, USA), Michelle Burford (Australian Rivers Institute, Griffith University, Australia, Anke Kremp (Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany), Marina Montresor (Stazione Zoologica Anton Dohrn, Italy), Grant Pitcher (DFFE].
7. Contribute to Global IOC databases [OBIS and HAEDAT] on Harmful Algal Blooms [PIs: Grant Pitcher (DFFE) and many international counterparts; Collaborator: Lisa Mansfield (DFFE).
8. Investigation of the oxygen environment of St Helena: specifically the role of harmful algal blooms in development of anoxia on the West Coast [PI: Grant Pitcher (DFFE), Collaborators: Andre du Randt, Lisa Mansfield, Koena Seanego (DFFE)].
9. Contribute to the International Union for Conservation of Nature and Natural Resources [IUCN] publication: Ocean deoxygenation: everyone's problem - causes, impacts, consequences and solutions [PIs: Grant Pitcher (DFFE), and numerous international counterparts].
10. Participate in IOC initiative of establishing a Global Ocean Oxygen Network [GO_2NE] to address the threat of de-oxygenation driven by global change [PIs: Grant Pitcher (DFFE), and numerous international counterparts].

10.5. Aquatic Animal Health Research sub-unit

The AAH research unit of the Directorate: Aquaculture Research has three main focus areas, namely (i) the development of novel methods for the diagnosis of new and emerging pathogens to provide accurate and reliable disease diagnosis for aquatic animals; (ii) collection of epidemiological data for significant aquatic animal diseases in Southern Africa to inform management and contingency interventions; and (iii) the development of effective preventative and treatment strategies for existing and emerging marine aquaculture diseases. The scope of research conducted by the unit spans all aquatic environments, including the freshwater environment in support of inland fisheries and aquaculture development.

10.5.1. Research Highlights - Aquatic Animal Health

Dietary effects on the reproductive performance of the sea urchin *Tripneustes gratilla*

Tripneustes gratilla has been identified as a commercially viable species for aquaculture production in South Africa, with the potential for inclusion in integrated multi-trophic aquaculture (IMTA) systems. However, these broadcast spawning animals often display differential parental contributions within aquaculture environments. This reproductive strategy can reduce genetic variation through a bottleneck effect, subsequently resulting in a poor response to artificial selection and poor production output in cultured populations (Grant *et al.*, 2017). Additionally, feed-type and -quality, as well as the feeding regimes used for broodstock conditioning, will impact feed intake, digestion and eventual nutrient availability, affecting gametogenesis and reproductive performance of these animals (Azad *et al.*, 2011). This study assess various biological and genetic factors for *T. gratilla* as well as different feeding regimes

that could affect reproductive competition, larval growth and juvenile performance after implementing a factorial breeding design.

First-generation (F1) broodstock animals (n = 32) were conditioned on four (4) diets [formulated feed (20% *Ulva* inclusion), kelp (*Ecklonia maxima)*, green seaweed (*Ulva rigida*) and mixture of the three diets] for approximately four months. Spawning was induced by injecting 0.5M KCl. Sperm or eggs were collected for quantification and subsequent morphological assessments, as well as for the quantification of egg lipids, proteins, carbohydrates and fatty acid profile assessments using gas chromatography flame ionisation detection (GC-FID). Remaining gametes were used in a factorial breeding design, where sperm and eggs of each individual were combined with that of other individuals fed the same broodstock conditioning diet. After spawning, broodstock animals were dissected, gonad weight and colour assessed and gonads processed for routine paraffin histology to evaluate gonad maturity. Larvae were reared in 130L conical tanks. Larval morphology and survival were assessed for 20 days. Larvae from the kelp and mixed diet fed broodstock survived for the full duration of larval rearing and were transferred to 87L settlement containers, pre-coated with *Ulvella lens*. Approximately 3 months post-metamorphosis, DNA was extracted and 10 species-specific microsatellite markers (Carlton and Lippé 2007; Wainwright *et al.*, 2012) were amplified across 16 F1 broodstock (eight fed kelp and eight fed mixed diet) and a total of 364 second-generation (F2) offspring. Genetic diversity of F1 broodstock relative to the F2 offspring, parental contribution through parentage assignment and heritability (h^2) estimates for growth were evaluated.

Across broodstock, significant differences ($P < 0.05$; ANOVA) in gonad and egg colour suggest a formulated feed (20U) should not be fed in isolation for reproductive purposes. Dietary carotenoids (red, orange and yellow pigments usually of plant origin) incorporated in sea urchin gonads and eggs could have downstream effects on urchin health and reproduction; via anti-inflammatory, pro-vitamin A, photoprotective, and immunity-related roles, resulting in improved hatching and larval survival. Excess linoleic acid (C18:2n6) was observed in samples from animals fed a formulated feed. Although these fatty acids may elicit inflammatory response in urchins, there are potential benefits to including a formulated feed in conjunction with natural feeds in a mixed feeding regime. The egg fatty acid profile associated with the mixed diet clustered separately (principal component analysis) from the singular feeds, possibly as a result of the interactions between the compounds obtained from the single feeds. Larvae from broodstock fed kelp and the mixed diet displayed similar growth rates, with larvae from broodstock fed a mixed diet displaying a greater extent of phenotypic plasticity. Genetic diversity analyses showed no statistically significant ($P > 0.05$) differences between F1 broodstock animals and their F2 offspring, with an average allelic richness (A_R) of 5.31 ± 0.52 and 5.18 ± 0.42, respectively. A total of 26 out of 32 possible parent pairs contributed to the F2 generation (Figure 10. 4) and juveniles assigning to broodstock fed a mixed diet were significantly ($P < 0.05$) larger (average offspring size of 0.94 ± 0.10 cm) than broodstock fed kelp (average offspring size of 0.66 ± 0.07 cm). However, a larger number of offspring (79.65%) were assigned to kelp fed broodstock (Figure 10. 1). An assessment of offspring phenotypic performance showed low heritability estimates ($h^2 = 0.050 \pm 0.058$) for body diameter, suggesting that additive genetic effects play limited roles in this trait.

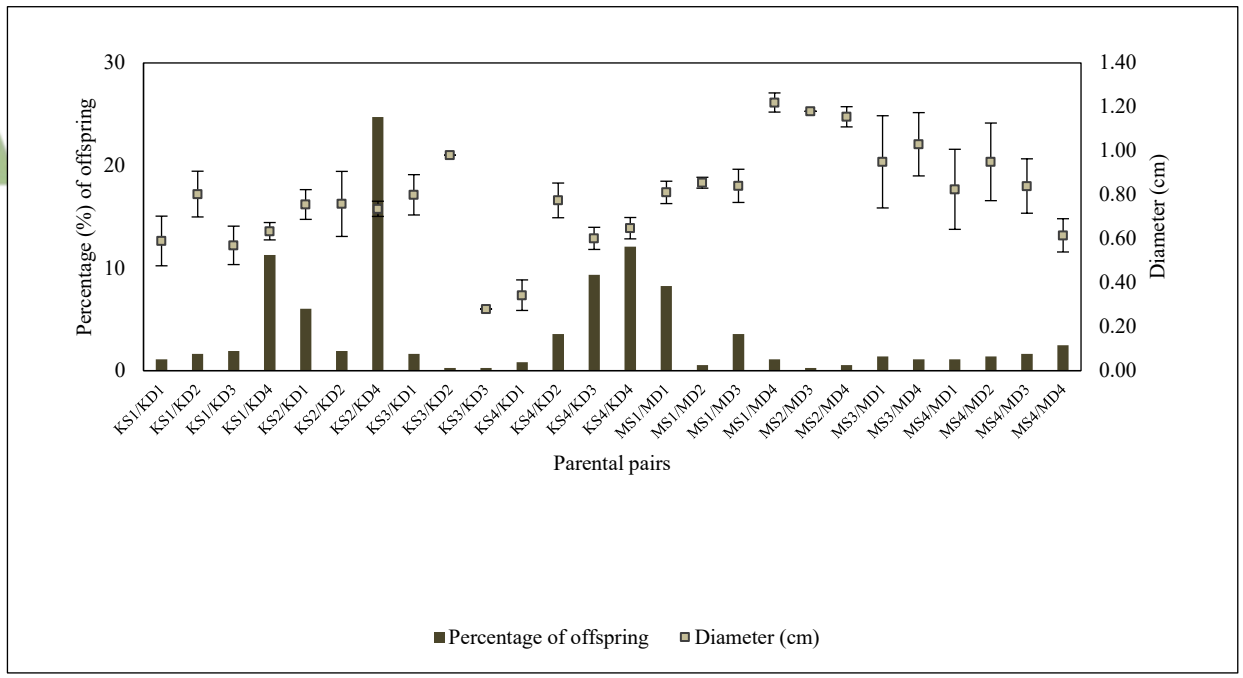


Figure 10.4: Percentage of *Tripneustes gratilla* offspring assigned to parental pairs in F2 cultured cohort, where 26 full-sib families were identified and mean family body diameters (cm) are indicated (K: Kelp, M: Mixed, S: Sire, D:

Aquaculture establishments could take advantage of the maternal provisioning strategy of sea urchins to benefit future commercial production. Animals fed the mixed feeding regime outperformed the other feeds across various measurements, with relatively equal parental contributions to offspring. The varied nutrient content of the included feeds, carotenoid content, diverse array of essential amino acids and fatty acids supplied by the respective singular feeds, as well as improved digestibility through the enzymatic activity of the bacterial communities of the natural feeds, could have contributed to the reproductive success of the mixed diet fed broodstock. This study also showed that the implementation of a factorial breeding design maximises genetic diversity in subsequent generations by negating unequal parental contributions to some extent.

Molecular characterization of Flavobacterium spp. isolated from Rainbow trout (*Oncorhynchus mykiss*) farmed in Southern Africa and development of a PCR-based tool for differentiating between isolates

Bacterial fish diseases caused by yellow-pigmented, filamentous bacteria of the genus *Flavobacterium* are among those that lead to significant losses in the international aquaculture industry. The genus accounts for ~13% of total fish bacterial pathogens and consists of more than 106 species that occupy diverse ecological niches. In salmonids, well know flavobacterial diseases include bacterial cold-water disease (*F. psychrophilum*), rainbow trout fry syndrome (*F. psychrophilum*), bacterial gill disease (*F. branchiophilum*, *F. aquatile*), and columnaris disease (*F. columnare*). Conventional diagnosis of *Flavobacterium* species is based on physico-chemical tests, but these tests are time-consuming and labor-intensive, and they frequently are unable to distinguish between closely related species due to morphological similarities.

Furthermore, little information exists on the diversity of fish associated *Flavobacterium* species from southern Africa. Recently, numerous, yellow-pigmented, filamentous bacteria were isolated from diseased rainbow trout farmed in South Africa and neighboring Lesotho. The aim of the present study was to elucidate the genotypic and phylogenetic diversity of the *Flavobacterium* species associated with these fish and to develop a new molecular system for rapid and accurate identification and differentiation of *Flavobacterium* species.

Ninety, mostly yellow pigmented, bacteria were isolated from diseased rainbow trout (*Oncorhynchus mykiss*) displaying gill necrosis, skin ulcers and systemic disease, from various freshwater fish farms in South Africa and Lesotho in 2018 (during February, March, April, July, and August). The bacteria were isolated from the head kidney, skin ulcers and other lesions, gills, and eyes of diseased rainbow trout. Genomic DNA was extracted from each of the ninety isolates using a modified heat-lysis method (Dashti *et al*., 2009), where after the small subunit (SSU) rRNA gene of each of the isolates was PCR amplified and the resulting products purified and sequenced. The phylogenetic diversity of ninety bacterial isolates was assessed by maximum-likelihood (ML) analysis. The SSU rRNA gene region of the genus *Flavobacterium* was selected to design genus-specific real-time quantitative PCR primers. The reaction and cycling conditions for producing a 146 bp amplicon were subsequently optimized to generate melting curves capable of discriminating between species within the genus Flavobacterium following high-resolution melt-curve analysis (HRMA) (Figure 10.5).

A BLAST search of the GenBank database revealed that 47 of the SSU rRNA gene sequences showed high similarity to several *Flavobacterium* spp.; 6 showed high similarity to *Chryseobacterium* spp., and 19 non-*Flavobacterium* isolates were identified, which included, amongst others, *Hafnia* spp. and *Aeromonas* spp. Fifteen isolates were excluded from further analysis due to poor DNA sequence data, whilst four isolates showed high similarity to uncultured bacterium and they were also excluded from further analysis. Phylogenetic analysis based on the maximum likelihood method confirmed the allocation of 46 isolates as *Flavobacterium* spp., and 6 isolates as *Chryseobacterium* spp. Differential identification of the *Flavobacterium* spp. was achieved following PCR amplification of a hypervariable region of the SSU rRNA gene followed by HRMA.

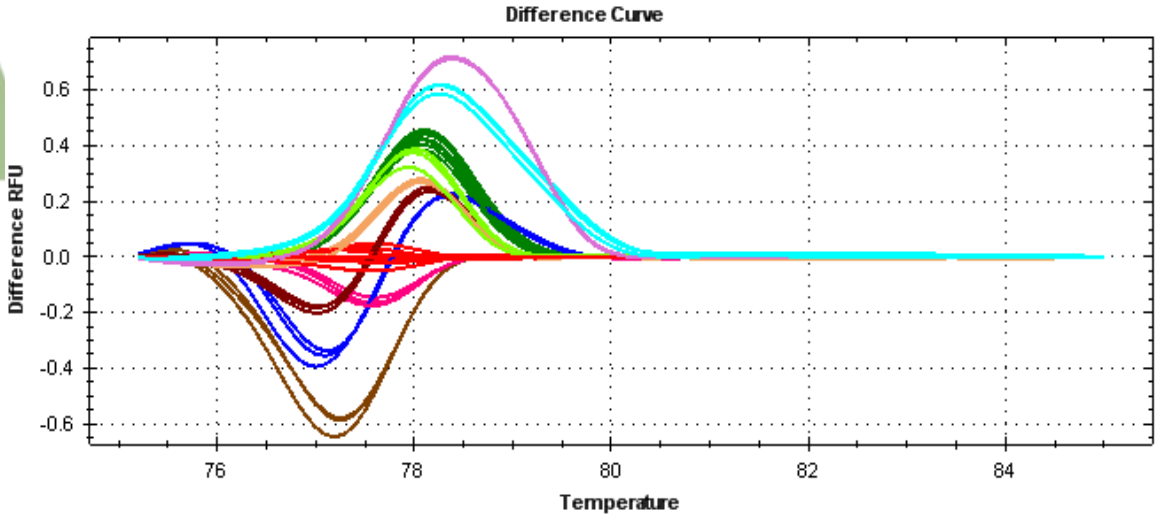


Figure 10.5: Melt curve analysis of 11 *Flavobacterium* spp. based on a 146 bp fragment of the SSU rRNA gene. OM-17(■), OM-24 (■), OM-44 (■), OM-45(■), OM-47 (■), OM-57 (■), OM-60(■), OM-73(■), OM-77(■), OM-84(■), and OM-86 (■). Only two of the isolates (OM-17 and OM-47) could not be differentiated. All reactions were performed in quadruplicates, and 10 replicates for the reference (Red curve).

The majority of *Flavobacterium* species are morphologically similar and hard to differentiate on routinely used isolation media and different strains can also vary in their pathogenicity. Hence rapid and specific methods are required to discriminate against different species of fish associated Flavobacteria and to inform effective treatment strategies and the appropriate selection of isolates/species for vaccine development. In this study, nine *Flavobacterium* species were successfully identified and differentiated using high-resolution melt analysis. The study also identified new *Flavobacterium* species from rainbow trout farmed in southern Africa. Collectively, the information generated in this project will contribute towards improved management of flavobacterial diseases.

10.6. Research projects undertaken by Aquatic Animal Health [Principle investigator(s) & student indicated in brackets]

1. Genetic studies for sustainable aquaculture of the sea urchin, *Tripneustes gratilla* [PI(s): Brett Macey (DFFE), Mark Cyrus (DFFE), Kevin Christison (DFFE), Rouvay Roodt-Wilding (US), Clint Rhode (US); PhD Student: Marissa Brink-Hull (US)].
2. Characterization of the microbiome of a partially recirculated abalone-Ulva IMTA system [PI(s): Brett Macey (DFFE), John Bolton (UCT), Marissa Brink-Hull (UCT), Mariska Vernon Coyne (UCT); PhD Student: Nokofa Bridget Makhahlela (UCT)]
3. Molecular characterization of Flavobacteriaceae isolated from rainbow trout (*Onchorhynchus mykiss*) and the development of a molecular diagnostic tool for differentiating between species in this genus [PI(s): Brett Macey, Leonard Flemming (Wemmershoek Diagnostic Laboratory), Vernon Coyne (UCT); M.Sc. Student: Godfrey Komane (UCT)].
4. The identification of antimicrobial compounds from *Ulva* grown in an integrated aquaculture system [PI(s): Brett Macey (DFFE), Denzel Beukes (UWC), Gavin Maneveldt (UWC), John Bolton (UCT); Honors Student: Niccole Okkers (UWC)].
5. Assessing the risk associated with the use of seaweeds as aquafeed and methods for sterilization [PI(s): Brett Macey (DFFE), Cliff Jones (RU), Dirk Weich (Marifeed); PhD Student: Petronilla Masika Mwangudza (RU)].
6. Development of an egg disinfection protocol for dusky kob (*Argyrosomus japonicus*) [PI(s): Brett Macey (DFFE), Niall Vine (UFH); M.Sc. Student: Angel Maapea (UFH)].
7. Targeted surveillance of local freshwater fish populations for Epizootic Ulcerative Syndrome (EUS) [Kevin Christison, Brett Macey, Dr. Mariska Greeff-Laubscher (NWU)]
8. Development and validation of a health assessment index for farmed dusky kob in RSA [Kevin Christison & Brett Macey, Prof. A. Vosloo (UKZN)]
9. Characterization and diagnosis of *Ichthyophonus hoferi* from Two Oceans Aquarium [Kevin Christison, Dr. G. Cole (Two Oceans Aquarium), MSc Student: Nicholas Nicolle (UWC), MSc. Student: Bret Wurdeman (UWC), MSc. Student: Siyanda Ndlovu (UKZN)]
10. Classification and characterization of aquatic animal pathogens [Kevin Christison, Dr. David Vaughan (CQU), Dr. Mariska Greeff-Laubscher (NWU)]

10.7. Publications by DFFE Directorate: Aquaculture Research and Development in 2019.

1. Bolton JJ, **Cyrus MD**, **Macey BM**. 2019. Integrating seaweeds into animal aquaculture in South Africa: a globally significant success. Maritime Review Africa. May/June 2019: 44 – 45.
2. Brink M, Kuys RD, Rhode C, **Macey BM**, **Christison KW**, Roodt-Wilding R. 2019. Metagenomic assessment of body surface bacterial communities of the sea urchin, *Tripneustes gratilla*. Marine Genomics 47: 1-11.
3. **Christison KW**. 2019 Building a sustainable aquaculture industry – The role of biosecurity. OIE Scientific and Technical Review 38(2): 589-600.
4. **Cyrus MD**, Bolton JJ, **Macey BM**. 2019. The use of stable δ13C and δ15N isotopes to track

the incorporation of *Ulva* and other important dietary ingredients into the gonads of the sea urchin *Tripneustes gratilla*. Aquaculture Nutrition 26(1): 174-185.

5. **Foord J** and **Pitcher GC**. In Press. An Appraisal of Paralytic Shellfish Toxins in Abalone. *Toxins*.
6. Garçon V, Karstensen J, Palacz A, Telszewski M, Aparco Lara T, Breitburg D, Chavez F, Coelho P, Cornejo-D'Ottone M, Santos C, Fiedler B, Gallo ND, Grégoire M, Gutierrez D, Hernandez-Ayon M, Isensee K, Koslow T, Levin L, Marsac F, Maske H, Mbaye BC, Montes I, Naqvi W, Pearlman J, Pinto E, **Pitcher G**, Pizarro O, Rose K, Shenoy D, van der Plas A, Vito MR, Weng, K. 2019. Multidisciplinary Observing in the World Ocean's Oxygen Minimum Zone Regions: From Climate to Fish — The VOICE Initiative. *Frontiers in Marine Science* 6: 722. doi: 10.3389/fmars.2019.00722
7. Greeff-Laubscher MR, **Christison KW**, Smit NJ. 2019. First record of the water mould, *Achlya bisexualis* (Saprolegniaceae) isolated from ornamental fish in South Africa. Journal of Aquatic Animal Health 31:354-363.
8. Knapp JL, Hoffman LC, Auerswald L, **Macey BM**. 2019. Effects of chronic hypercapnia and elevated temperature on the immune response of the spiny lobster, *Jasus lalandii*. Journal of Fish and Shellfish Immunology. 93**:** 752-762.
9. **Lewis BR**, **Madibana MJ**, Toefy R. 2019. Effect of Graded Levels of Aquapro® Herbal Stimulant on Growth and Intestinal Morphology in Dusky Kob, Argyrosomus japonicus (Temminck & Schlegel, 1843). *Asian Fisheries Science.* 32: 162-171. https://doi.org/10.33997/j.afs.2019.32.4.004
10. **Madibana MJ**, Mlambo V, **Lewis BR**, Uys, L. 2019. Dietary seaweed (Ulva sp.) does not alter fatty acid profiles and concentration in South African juvenile dusky kob (*Argyrosomus japonicus*, Sciaenidae) fillet. *Journal of Applied Animal Research.* 48 (1): 7–13
11. **Madibana MJ**, Mlambo V. 2019. Growth Performance and Haemo-biochemical Parameters in South African Dusky Kob (*Argyrosomus japonicus*, Sciaenidae) offered Brewer's Yeast (*Saccharomyces cerevisiae*) as a Feed Additive. *Journal of the world aquaculture society*. 50: 815-826. DOI: 10.1111/jwas.12632.
12. Malherbe W, **Christison KW**, Wepener V, Smit NJ. 2019. Epizootic ulcerative syndrome – first report in the Kruger National Park, South Africa. International Journal of Parasitology: Parasites and Wildlife 10: 207-210.
13. **Mbokane EM**, Moyo NAG. 2019. Effect of dietary Artemisia afra on growth, some innate immunological parameters in *Clarias gariepinus* challenged with *Aeromonas hydrophila*. *Aquaculture International*. https://doi.org/10.1007/s10499-019-00479-y.
14. **Mbokane EM**, Moyo NAG. 2019. Effects of dietary levels of essential oil extracts from *Moringa oleifera* and *Artemisia afra* on kidney histology, haemato-immunological parameters and disease resistance in *Clarias gariepinus*. *Aquaculture Research*. 51:410–425.
15. **Mbokane EM**, Theron J, Luus-powell WJ. 2019. Seasonal occurrence and ecological aspects of *Afrodiplozoon polycotyleus* (Monogenea: Diplozoidae) from the gills of three cyprinids from the Nwanedi-Luphephe dams, South Africa. *African Journal of Aquatic Science* 44: 53–60.
16. Pfaff MC, Logston RC, Raemaekers SJPN, Hermes JC, Blamey LK, Cawthra HC, Colenbrander DR, Crawford RJM, Day E, du Plessis N, Elwen SH, Fawcett SE, Jury MR, Karenyi N, Kerwath

SE, Kock AA, Krug M, Lamberth SJ, Omardien A, **Pitcher GC**, Rautenbach C, Robinson TB, Rouault M, Ryan PG, Shillington FA, Sowman M, Sparks CC, Turpie JK, van Niekerk L, Waldron HN, Yeld EM, Kirkman SP. 2019. A synthesis of three decades of socio-ecological change in False Bay, South Africa: setting the scene for multidisciplinary research and management. *Elementa Science of the Anthropocene* 7: 32. DOI: https://doi.org/10.1525/elementa.367.

17. **Pitcher GC**, **Foord CJ**, **Macey BM**, **Mansfield L**, Mouton A, Smith ME, Osmond SJ, van der Molen L. 2019. Devastating farmed abalone mortalities attributed to yessotoxin-producing dinoflagellates. *Harmful Algae* 81: 30–41.
18. **Pitcher GC**, Jacinto G. 2019. Ocean deoxygenation links to harmful algal blooms. D Laffoley and JM. Baxter (Eds), *Ocean deoxygenation: everyone's problem – causes, impacts, consequences and solutions*. Gland, Switzerland: IUCN. 580pp.
19. Santa Marta A, Ferreira JG, **Pitcher GC**, Lencart e Silva J. 2020. Sustainable Aquaculture in Saldanha Bay. *African Journal of Marine Science*.

Additional to the Directorate's research activities, the ARD team is providing support to the research studies conducted at the Aquaculture Technology Demonstration Centre (ATDC). The ARD officials form part of the Research and Development sub-committee that is established as part of the obligations of the partnership between DFFE, through MLFR, and the FSDARD. The support is provided towards the development of research topics and ensure implementation of these research and development projects. These projects focuses on the aquaculture economics, fish nutrition, inland fisheries and health aspects as outlined in Chapter 11 below.

AQUACULTURE TECHNOLOGY DEMONSTRATION CENTRE ACTIVITIES DURING 2019

11

11. AQUACULTURE TECHNOLOGY DEMONSTRATION CENTRE (ATDC) ACTIVITIES DURING 2019

11.1. Aquaculture Technology Demonstration Centre (ATDC) background

The Aquaculture Technology Demonstration Centre (ATDC), in Gariep Dam, is located along the Orange River system from which it receives water supply. The ATDC continues to benefit South Africa's freshwater aquaculture sector through training and promotion, demonstration of breeding and culture techniques as well as research activities. The intention of the DFFE is to broaden the services of ATDC to benefit individuals including Southern African Developing Communities (SADC) countries.The ATDC's operation and management is jointly taken care of by the DFFE and the Free State Department of Agriculture and Rural Development (FSDARD) where the department continued to provide the ATDC with both technical and advisory services as well as the financial support to ensure that all the planned activities are implemented. However, FSDARD was the implementing agent and also contributed financially as well as providing the necessary human resources.

11.2. Technology Demonstration

11.2.1 Cage culture system

The ATDC has demonstrated both the submerged and the floating cage culture system and have been successfully tested. The cage system has been stocked with Common Carp (in submerged cages) and Gold fish (in suspended/floating cages) for all seasons as they can withstand the temperature changes during winter and summer periods.

11.2.2. Pond culture system

About sixteen (16) external ponds are stocked with gold fish, Koi Carp, African Catfish and Common Carp for further growth after breeding, shown in Table 11.1. Some of the African Catfish are transferred from external ponds back into Hatchery for over wintering as the water temperature drops in the outside ponds.

Table 11.1: The number of fish stocked in the external ponds.

Pond no.	Species	Age	Quantity
2	Common carp & catfish	Fingerlings	854
4	Koi fish	Juveniles	967
5	Common Carp	Fingerlings	34
6	Common Carp	Fry	500
7	Common Carp	Fry	500
8	Common Carp	Fry	315
10	Goldfish	Fry	2372
11	Catfish	Juvenile	79
12	Common Carp	Fry	500
13	Common Carp	Fry	500
14	Catfish	Broodstock	228
16	Common carp & catfish	Fry & juveniles	1000 fry & 1500 juveniles
20	Catfish	Fingerlings	6300
32	Common Carp	Broodstock & Fingerlings	607
Total			**16 756**

11.2.3. Aquaponics system

About six (6) ponds have been utilised to demonstrate fish production, Table 11.2, from an aquaponics culture system. In 2019, Common Carp has been tested on the aquaponics system while the vegetables are planted on the growing bed which is floating on the surface of the water. The plant vegetables on this system included the water spinach, lattice and strawberries. The growth of the water spinach and the common carp was measured on weekly basis to compare the rate of growth.

Table 11.2: Number of fish stocked in aquaponics culture system

Pond no.	Species	Fish Age	Crop	Fish Quantity
9	Catfish	Fingerlings	Strawberry	315
10	Goldfish	Fry	Spinach	2372
11	Catfish	Juvenile		79
12	Carp	Fry		500
13	Carp	Fry	Garlic	500
14	Catfish	Broodstock		228
Total 3994				

11.2.4. Nursery

Table 11.3 below highlights the number of goldfish stocked in the nursery during the year 2018.

Table 11.3: Number of fish stocked in nursery

Species	Age	Mortality since stocking	Over estimation of number	Number of live fish
Goldfish	Broodstock	5	0	78
Goldfish	Fry	100	1500	2050
Total				**2128**

11.2.5. Hatchery

The following fish quantities have been recorded in the hatchery on the 26th September 2018 with 4015 both fry and fingerlings as well as 3745 broodstock, outlined in table 11.4 below.

Table 11.4: Number of fish stocked in the hatchery

Category	Tank	Quantity
Broodstock	A	67
	B loose	156
	B caged	3427
	C	70
Fry & fingerlings	1	1500
	2	1500
	3	200
	4	815
Total		**7760**

11.3. Breeding Techniques

The types of breeding techniques demonstrated at the ATDC in 2019 included: the natural breeding of tilapia (*Oreochromis mossambicus*), the semi-artificial breeding of Common carp (*Cyprinus carpio*), and also the fully artificial breeding of African sharptooth catfish (*Clarias gariepinus*). No ornamental

fish were bred during 2019. Fish breeding was conducted following the planned schedule as outlined on the table below (Table 11.5).

Table 11.5: The quantity of fries that were bred from African sharptooth catfish and common carp during 2019.

Date	Species	Number of broodstock used	Number of hatched fry
January	African sharptooth catfish	2 females & 1 male	0
	African sharptooth catfish	2 females & 1 male	0
February	African sharptooth catfish	2 females & 1 male	0
April	African sharptooth catfish	2 females & 2 males	0
May	African sharptooth catfish	3 females & 4 males	7000
June	African sharptooth catfish	3 females & 2 male	10877
August	African sharptooth catfish	1 female & 1 male	3000
September	African sharptooth catfish	2 females & 2 males	20
October	Common carp	10 females & 10 males	±1000
November	African sharptooth catfish	2 females & 2 males	3372

11.4. Training and Capacity Building

The ATDC offers different aquaculture training and capacity building programmes to farm workers/ farmers, potential farmers, higher education students, in-service training students and government officials. The aquaculture training programme focuses on providing lectures on Fish Biology and Introduction of Species; Fish Agro-processing; Fish Diseases and Health Management; Fish breeding and fry rearing; Water Quality management; Fish Nutrition and Basic Fish feeding Practice; Aquaculture Farming Systems; Fish Stock management; Aquaculture Economics; Fish Industry Legislative Environment; Biosecurity management and Aquatic Food security. The practical demonstration provided during training sessions includes the demonstrations on the use of aerators and auto-feeders; Fish packaging techniques/Water quality; Fish Breeding; Fish Biology and Fish Parasites.

Following the ATDC officially handed over to South Africa in 2017, 417 potential farmers and government officials were trained with109 candidates trained in 2017, 149 candidates trained in 2018 and 159 candidates trained in 2019. The details of the training activities conducted during 2019 are outlined below:

11.4.1. Training for trainers

On the 28th to 31st of May 2019, the ATDC officials attended and completed a training on inland fisheries. The training participation included six (6) ATDC, one (1) Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA) and two (2) Fezile Dabi District officials, (Figure 11.1). The training was offered by Prof. Olaf Weyl from NRF/SAIAB and Dr Leon Barkhuizen from FSDESTEA.

Figure 11.1: FSDARD officials who attended the Inland Fisheries training.

11.4.2. Training completed at ATDC

The ATDC Training is being organized by both FSDARD and DEFF. The ATDC has organized 7 training sessions where a total of 157 candidates were trained during 2019 Table 11.6. There were no interns trained during 2019, however only two (2) in-service training students were trained in the same year.

Table 11.6: Candidates trained at the ATDC over the seven (7) sessions during 2019.

Session	Period	Category of candidates	Origin of candidates	Number of candidates
1	21 to 25 January	Farmers and officials	Mpumalanga Province	4
2	18 to 22 February	Potential farmers, officials and college students	Eastern Cape and Kwa-Zulu Natal provinces	37
3	20 to 27 May	DEFF interns	Gauteng, Western Cape and Eastern Cape provinces	19
4	24 to 28 June	Extension officers, farmers and potential farmers	Mpumalanga, Eastern Cape and Western Cape provinces	49
5	19 to 23 August	Potential farmers	Kwa-Zulu Natal and Gauteng provinces	20
6	16 to 20 September	Extension officers, farmers and potential farmers	Kwa-Zulu Natal and Eastern Cape provinces	19

7	11 to 15 November	Potential farmers	Western Cape and Eastern Cape provinces	9
Total				**157**

The content of the course offered included the following:
Fish Biology and Introduction of Fish Species, Water Quality Requirements and Management, Aquaculture Equipment, Catfish and common carp breeding and fry rearing, Basic fish feeding and nutrition, Fish transporting, Environmental Legal Requirements of Freshwater Aquaculture, Aquaculture Data collection, Fish disease and Health Management, Freshwater Aquaculture Stock Management, Aquaculture Economics, Fish agro processing, Aquaculture farming systems, Bio-Security Management and Aquatic Food Safety.

Figure 11.2: Training activities held at the ATDC during 2019.

11.4.3. Education and Awareness (Promotion)

The ATDC has hosted 397 candidates who toured the ATDC during 2019. The visitors were coming from different entities which included the private sector, students and also government officials. The database of the day visits is listed on Table 11.7. The ATDC did not attend any exhibitions and events in order to promote its activities.

Table 11.7: The database of day visits that were hosted at ATDC during 2019.

Month & category	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
School children	0	0	41	0	0	51	0	101	0	0	0	**193**
Private visitors	2	0	4	3	0	3	1	27	5	137	5	**189**
Government officials	0	0	2	0	0	0	0	0	6	7	0	**15**
Total												**397**

11.5. Research and Development studies

Four (4) research projects were implemented by the ATDC officials in 2019. The research projects focuses on the list of topics below.

- ***Research project title:*** *Application of Phytomedicine on Fungal (Saprolegnia), Bacteria (Aeromonas hydrophila, Pseudomonas aerugnosa, Cytobacter columnaris) detected from ATDC, fish spp.*
- ***Research project title:*** *Economic Assessment of aquaculture projects: A case study aquaculture projects, Free State.*
- ***Research project title:*** *Development of a cost effective replacement of fish meal with selected cheaper locally available protein sources in sharptooth catfish (Clarias gariepinus).*
- ***Research project title:*** *Assessing small scale fisheries potential of lake Gariep, South Africa.*

11.6. Technology extension (Extension services)

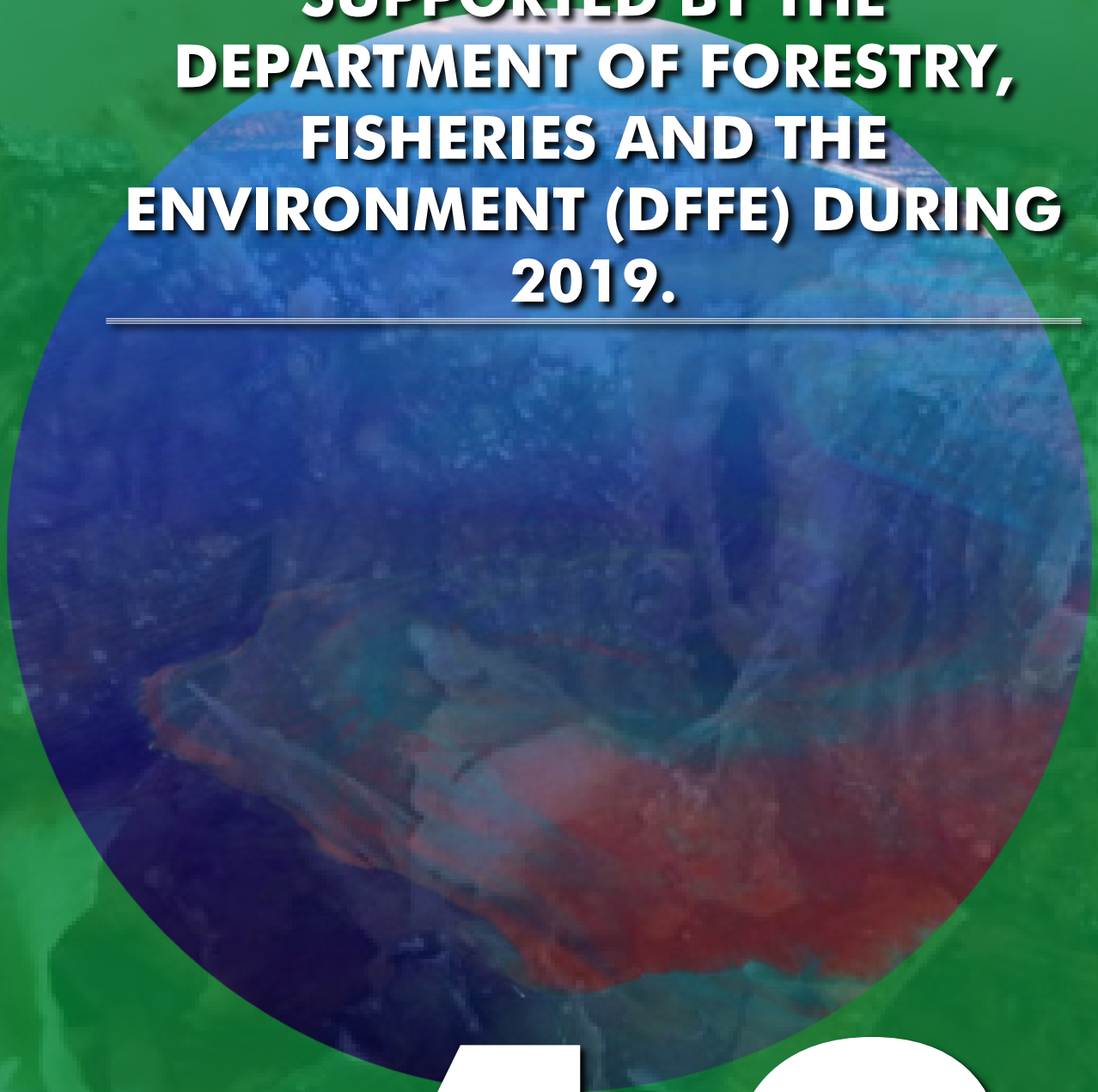
There were several projects that were supported with fingerlings during 2019. The supported farms included the following:

- Inmed South Africa, an aquaponic project based in Free State Province was supported with 2200 African catfish fingerlings on the 4th April 2019 (Figure 11.3 a). The project was also provided with additional 1000 African catfish fingerlings which were collected on the 20th May 2019.
- A private farmer (Erfdeel farm) from, Jacobsdal in Free State Province also bought and collected 3000 African catfish fingerlings on the 24th April 2019 (Figure 11.3 b). All the farms that are provided with fingerlings will form part of the supported farms under the Annual Performance Plan (APP).

Figure 11.3: Packing and collection of purchased fingerlings from ATDC.

- About 15 000 catfish fingerlings were sold to the Aquamor fish project in North West province on the 7th May 2019 (Figure 11.3 c).
- About 2 000 catfish fingerlings were provided to Bethulie project located in the Free State province, the fish were packed and collected from ATDC on the 4th of September 2019.
- About 1600 African Catfish fingerlings were purchased at R4000.00 and collected by Karoo Catch Company on the 9th of October 2019.
- A total of 10 000 of 5g sharptooth catfish fingerlings was collected and transported to Disaneng fish farm in North West Province on 4th November 2019 (Figure 11.1.d). This fish were sold at R25 000 and all the fish were weighed and transferred to transporting tanks with aerators. All the fish arrived at the farm with no mortalities.

AQUACULTURE DEVELOPMENTAL PROJECTS SUPPORTED BY THE DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT (DFFE) DURING 2019.



12

12. AQUACULTURE DEVELOPMENTAL PROJECTS SUPPORTED BY THE DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT (DFFE) DURING 2019.

12.1. The Hamburg Aquaculture Project (HAP)

Hamburg Aquaculture Project (HAP) is a mariculture farm situated 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 few metres away from the estuary. The project has a dusky kob (*Argyrosomus japonicus*) farm at a pilot scale and an oyster (*Crassostrea gigas)* farm under refurbishment. In addition to this, the project had trials on the farming of sea urchins (*Tripneustes gratilla*) which was successful. The project aims to commercialize the dusky kob at a later stage to produce 1000 tons of fish per annum. The HAP has twenty Siyazama Aquaculture Primary Co-operative Limited members who are currently benefiting from it, 50% of these beneficiaries are women and 10% are youth (Figure 12.1).

Figure 12.1. Siyazama Aquaculture Primary Cooperative Limited beneficiaries at the project site.

A Recirculating Aquaculture System (RAS) was stocked with dusky kob (Figure 12.2). However, the system was not stocked to full capacity due limited farms of dusky kob to supply the project with dusky kob fingerlings. Approximately 80 kg of dusky kob was sold in March 2019 to a local restaurant. The project received dusky kob fingerlings from the then DAFF research facility, Sea Point Aquarium in trenches, however, the system was still not fully stocked. The project had to wait for the Sea Point Aquarium to spawn more fish for the project.

Figure 12.2. The dusky kob farm at the Hamburg Aquaculture Project which is land based.

Maintenance of the oyster racks continues in the Keiskamma estuary (Figure 12.3). The National Regulator for Compulsory Specifications (NRCS) continued to take oyster samples for testing. The South African Live Molluscan Shellfish Monitoring and Control Programme of the then DAFF classified Siyazama Aquaculture Primary Cooperative Limited as Conditionally Approved Class A. The Eastern Cape Department of Rural Development and Agrarian Reform (DRDAR) was also involved in providing support to the oyster farm. The project made sales of wild caught oysters.

Figure 12.3. The oyster farm situated in the Keiskamma estuary.

With regards, to the sea urchins trial, at the beginning of the year the trial was still in progress (Figure 12.4). The growth of the sea urchins was monitored continuously, however, the trial ceased in March

2019. The trial proved to be a success, therefore, the Department had plans to grow sea urchins at a bigger scale on site. The proposed trial has the potential to boost the farm's income and job creation.

Figure 12.4. Sea urchins reared in oyster holding tanks.

The project is empowering local communities through skills development, transfer and exposure to technology, and job creation. The workers have been empowered through training programmes such as computer literacy, aquaculture training, driving lessons and skipper license in 2019.

12.2. Disaneng Fishery and Aquaculture

12.2.1. Project Background

The Disaneng Aquaculture and Fisheries Project was established in 2001 by the then Department of Agriculture, Conservation and Environment (DACE), now known as the North West Provincial Department of Agriculture and Rural Development (NWDARD). It is situated in Disaneng (25° 49′ 25″ S, 25° 18′ 20″ E), which is approximately 42 kilometres from Mafikeng in the North West Province. The aim of this initiative was to encourage communities living in areas close to rivers and dams to take up fish farming since there was over reliance on natural fish stock as a source of food security and livelihoods. Due to the concern on declining fisheries resources the project was initiated to build an aquaculture facility for the beneficiaries to be able to culture Catfish and sell for their own profit. Identified project beneficiaries focused mainly on catching fish from the dam and selling to the nearest market for profit.

The project has three (3) beneficiaries which include one (1) male and two (2) females. The project has expanded to include the breeding and grow-out of Nile tilapia (*Oreochromis niloticus*), in addition to Catfish (*Clarius gariepinus*). Aquaculture infrastructure at the project include three (3) grow-out systems, a hatchery building, a processing area and a tuck shop where fish products are sold. Market size fish cultured in fiber tanks within the facility are sold to the local community as deep fried or live products. Other products currently under investigation at the facility include fish wors, fillets, burgers and biltong.

The project had challenges of a flawed production system (i.e. faulty filtration system) that needed to be re-designed in order to operate optimally. Other challenges that were identified at the project includes limited market access, lack of aquaculture skills by beneficiaries and lack of quality production inputs. The then Department of Agriculture Forestry and Fisheries (DAFF) partnered with the then North West Department of Rural, Environment, and Agricultural Development (READ) to ensure the following:

- Technical design of the existing facility to optimize production output
- Design of a commercially viable plant that includes a hatchery and grow out for Catfish (*Clarius gariepinus*) and tilapia (*Oreochromis niloticus*).
- Explore possibility of cage culture in Disaneng Dam
- Development of a bankable business plan which will guide operations and facilitate funding.

Figure 12.5: Unit house used to house grow-out production system at the Disaneng Aquaculture and Fisheries project

12.2.2. Progress

From this partnership, the project managed to achieve the following:

(a). Technical design of the existing facility to optimize production output

A refurbishment of the existing production system was recommended in order for the project to be commercially viable to include the following elements:

- Additional voltex filters to be added for removal of larger solids that accumulate in the system.
- Deep filtration pit to be added to the system to ensure downward flow of water from component to component.
- Additional tanks to increase production of catfish to 34 tons p/a and the splitting of existing production units to operate independently in order to minimise loss of animals

during an outbreak or system failure.

(b). Design of a commercially viable plant that includes a hatchery and grow out for Catfish (*Clarius gariepinus*) and tilapia (*Oreochromis niloticus*).

The Disaneng Aquaculture and Fishery project has an existing hatchery building on site and a catfish facility. Furthermore, a design for the Nile tilapia grow-out was investigated and recommendations were made as follows:

Hatchery

The existing hatchery building on site will be used for hatchery production at a recommended minimum viable scale of 290 000 fingerlings per year. The fingerlings will be used to supply the Catfish facility on site with surplus being sold to other farms at an estimated price of R2.70 at a size of 10g. The maximum scale of fingerling production of the hatchery is estimated at 1.75 million fingerlings per year. The total cost for the hatchery, which includes the Capital Expenditure (CAPEX) and working capital is R1.1 million. This will generate approximately R191 142.00 cashflow in year with an IRR of 10%.

Catfish grow-out

The existing Catfish facility was recommended for use with refurbishment of the design as discussed in 3.1. The production capacity will be increase to 34 tons/pa, which is the minimum viable scale for the system. Fingerlings will be stocked at 10g and cultured for eight (8) months to 1kg which will be sold at R45/kg. This facility will employ a total number of four (4) permanent personnel which includes the production manager and three (3) production assistants. The total cost of the refurbishments, which includes new equipment as recommended is R1.2 million. The grow-out system will yield a total of R108 936.00 cash flow in year 1 with an IRR of 13%.

Nile tilapia grow-out

The establishment of a Nile tilapia grow-out requires new infrastructure which includes a greenhouse tunnel with twelve (12) grow-out tunnels. The minimum viable scale of 74 tons p/a was recommended with a grow-out period of five (5) moths. Fish will be sold at 310g at R55/kg. This facility will employ a total number of seven (7) permanent personnel which includes the production manager and six (6) production assistants. The total cost of the facility is R5.2 million. The grow-out system will yield a total of R285 359.00 cash flow in year 1 with an IRR of 9%.

Exploring the possibility of cage culture in Disaneng Dam

The Disaneng Dam was assessed for the possibility of cage culture activities and the findings indicated that the Dam was not suitable due to low water levels and heavy metals pollution.

Development of a bankable business plan which will guide operations and facilitate funding

A bankable business plan was developed for the Disaneng Aquaculture and Fisheries project in order to highlight the business concept for the establishment of a Nile tilapia grow –out, refurbishment of a

Catfish grow-out as well as Catfish hatchery. The business plan will be used by the project beneficiaries to source funds for the project and it gives an overview of the following:

- Current activities at the project site,
- Analysis of operational requirements,
- Financial analysis for the project,
- Potential risks and mitigation measures for the project.

NATIONAL AQUACULTURE STAKEHOLDER ENGAGEMENT

13

13. NATIONAL AQUACULTURE STAKEHOLDER ENGAGEMENTS

13.1. National Aquaculture Intergovernmental Forum (NAIF)

The main objective of the forum is to provide better management through joint planning, facilitation, coordination, resources mobilization and evaluation and oversight for the aligned implementation and reporting of all key government programmes to achieve sustainable aquaculture development in the country. The meetings are chaired by the Chief Director: Aquaculture and Economic Development from the DFFE.

The forum includes officials from the relevant National Departments and the relevant state-owned entities. The provincial departments responsible for management of aquaculture form part of the forum.

The meetings are convened biannually, however the chairperson may convene *ad hoc* meeting when necessary. Two (2) NAIF meetings were convened during the 2019/20 financial year. The first meeting was held on 29 May 2020 in Graaff-Reinet, Eastern Cape, in collaboration with the Eastern Cape Department of Rural Development and Agrarian Reform. The second meeting was convened in collaboration with the KwaZulu-Natal Department of Agriculture and Rural Development at Ulundi on 05 February 2020.

13.2. Marine Aquaculture Working Group (MAWG)

This forum has an advisory role to the Chief Directorate: Aquaculture and Economic Development and is convened by Deputy Director: Aquaculture Authorisations and chaired by the Director: Sustainable Aquaculture Management. It provides recommendations to the Delegated Authority where required on some of the following matters discussed within the marine aquaculture sector:

- the assessment of Marine Aquaculture Scientific Investigations and Practical Experiment permit applications;
- the assessment of Marine Aquaculture Right applications;
- the management and development of marine aquaculture, including issues relating to environmental protection, food safety, aquatic animal health, marine aquaculture permit conditions, as well as guidance on policy and legislation in the marine aquaculture sector; and
- the establishment and amendment of operational management procedures and sector development plans; and recommended directives in areas of research.

The lead directorate for co-ordinating the forum is the Directorate: Sustainable Aquaculture Management. The MAWG consists of representatives of the DEFF (Branch: Fisheries Management) Chief Directorate: Aquaculture and Economic Development, Chief Directorate: Fisheries Research & Development, and Chief Directorate: Monitoring, Control and Surveillance. Representatives from other relevant departments are also invited. The representatives are nominated by the respective Chief Directors. The MAWG meetings are held according to the Terms of Reference (TORs), however the Chairperson for MAWG may call Ad hoc MAWG meetings whenever appropriate. During the financial year 2019/20, four (4) MAWG meetings were held, three (3) MAWG meetings on 5 August 2019, 11 November 2019 and 10 March 2020 and one (1) *Ad hoc* MAWG meeting on 13 March 2020.

13.3. Aquaculture Industry Liaison (AIL)

This forum provides a platform for aquaculture stakeholders to engage and communicate with government on issues that affect the marine and freshwater aquaculture industry. The forum is convened and chaired by the Chief Director: Aquaculture and Economic Development. Its members are stakeholders from the industry sector, as well as provincial and national government departments. There were three (3) AIL stakeholder engagements held in 2019/20.

13.4. 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. There was no AVCRT meeting held during 2019/20 financial year. The objectives of the AVCRT are as follows:

- To create a formal platform to address key industry challenges and constraints and utilize opportunities for the benefit of the sector or subsector;
- To 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;
- To track progress on implementation of agreed actions and thereby ensure results;
- To develop and implement strategies and initiatives aimed at securing and utilizing the country's competitive advantage.

13.5. Inter-Departmental Authorisations Committee (IAC)

The purpose of the IAC is to streamline, as far as legally possible, permitting processes, creating institutional arrangements for aligned decision making, and ultimately working towards the realization of the "One Stop Shop" for aquaculture authorisations, which is now provided for in the Aquaculture Development Bill. The objectives of the IAC are to:

- Facilitate ongoing high-level discussion and cooperation between national, provincial and municipal organs of state in relation to the promotion and regulation of aquaculture;
- Develop a comprehensive plan, drive its implementation and report progress;
- Develop interventions and remedial actions for identified blockages and barriers;
- Provide guidance and advisory services on regulatory frameworks that govern authorisations;
- Develop and facilitate approvals and issuing of integrated permits and licences;
- Work with identified specialists/ service providers on operations management initiatives that include value stream mapping, improving lead times aimed towards an integrated permitting system;
- Manage change process and communication strategies within respective departments and existing concurrent arrangements with Provinces and Municipalities; and

- Provide feedback to principals in respective departments.

Only one (1) IAC meeting was held in 2019/2020, at the Fisheries Management Branch offices of the Department in Cape Town on 4 February 2020. A decision was taken to revise the Terms of Reference for the IAC and to ensure further formalisation of the IAC through nomination of representatives from member Departments, particularly now given the new configuration of National Departments post the National General Elections of May 2019. The IAC ToRs have since been revised and nomination of representatives from member Departments is currently under way. Furthermore, a decision was taken to ensure that, in order to improve attendance and participation, the IAC Secretariat and the NAIF Secretariat share diaries and try to synchronise meetings for the respective committees so that in future these meetings are held in one venue and city, back to back. This was raised by a representative from DEA who noticed that the Department was also hosting a NAIF meeting at Ulundi in KZN on 5 February 2020 and it was impractical for those IAC members who are also NAIF members to attend both.

OPERATION PHAKISA: UNBLOCKING THE ECONOMIC POTENTIAL OF SOUTH AFRICA'S OCEANS: YEAR FIVE REVIEW

14

14. OPERATION PHAKISA: UNBLOCKING THE ECONOMIC POTENTIAL OF SOUTH AFRICA'S OCEANS: AQUACULTURE YEAR FIVE REVIEW

14.1. Operation Phakisa Aquaculture Lab overview

Operation Phakisa is a fast results delivery programme launched in July 2014 to help implement the National Development Plan, with the ultimate goal of boosting economic growth and to create jobs. The National Development Plan (NDP) is South Africa's socio-economic development blueprint which enjoins us to create a better life for all citizens in an inclusive society. The NDP guides every sector's plans and policies; programmes; projects and operations – including how budgets, skills and other resources are allocated to move South Africa forward.

Operation Phakisa is a results-driven approach to development, setting clear plans and targets with on-going monitoring of progress; and making these results public in order to address the triple challenges of poverty, unemployment and inequality. It focusses on bringing key stakeholders from the public and private sectors, academia as well as civil society organisations together to collaborate in detailed problem analysis; priority setting; intervention planning and delivery. The Department of Planning, Monitoring and Evaluation leads Operation Phakisa. Department of Forestry, Fisheries and the Environment (DFFE) established the Oceans Economy Secretariat to lead the 'Oceans Economy'.

The Operation Phakisa: Ocean Economy programme focuses on:

- Marine Transport and Manufacturing, led by the Department of Transport;
- Offshore Oil and Gas, led by the Department of Mineral Resources and Energy;
- Aquaculture, led by the DFFE;
- Marine Protection Services and Ocean Governance, led by the DFFE;
- Small Harbours Development, led by Department of Public Works and Infrastructure; and
- Coastal and Marine Tourism, led by the Department of Tourism.

Each of the focus areas noted above are enabled by skills development and capacity building; as well as research, technology and innovation initiatives, led by the Department of Higher Education and Training and the Department of Science, Technology and Innovation.
DFFE is the lead department for the Oceans Economy Aquaculture focus area and its deliverables. The Lab concluded that South Africa's aquaculture sector has a high growth potential due to an increasing demand of fish products due to the increasing global population; increasing income by the middle class in developing countries and more awareness on the dietary benefits offered by fish products. Moreover the capture fisheries yield has been plateauing over the past decade while aquaculture continues to grow over 7% per annum. This growth is expected to continue at a higher rate in the future.

The goal is to grow the aquaculture sector in South Africa to play a major role in supplying fish products; an enhanced role in job creation; increased contribution to national income and rural livelihoods. The targets over five years (2014-2019), seeks to grow sector revenue from R0, 67 billion to R3 billion; production by 20 000 tons; jobs from 2 227 to 15 000 and to ensure increased participation to support

transformation in the sector.

The Aquaculture Lab comprised of stakeholders from industry, government and academia who identified nine (9) key initiatives. One initiative addresses the selection and implementation of catalyst projects, improving both the number and productivity of the new farms. Three initiatives relate to the creation of an enabling regulatory environment and others focus on funding support, increasing the skills pool and awareness; and improving access to markets. The initiative nine "Develop and Implement Aquaculture Development Zones (ADZ's)" seeks to promote investment into the sector and create an enabling environment.

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. The highlights outlined are consequences of the progress achieved on the 3 feet plans across the three horizons defined by the Lab participants in 2014.

Progress on aquaculture key performance indicators

It has been five years since the introduction of Operation Phakisa: Oceans Economy and considerable milestones were achieved to grow the aquaculture sector.

2019 Lab projections

During 2019 in the 3 feet plans targets, a total investment of R2.8 billion (Government and Private) since 2014 was required to unlock an additional 2 618 direct jobs, 20 970 tons production capacity and increase turnover across the 36 projects to over R1.6 billion per annum.

Table 14.1: Aquaculture investments, production, jobs, transformation and GDP driven by Operation Phakisa: Oceans Economy during 2019.

YEAR	2018 ACTUAL	2018 PROJECTED
INVESTMENT	By end of 2018, total actual investment committed to Operation Phakisa aquaculture projects was over R R1.78 billion, of which over R280 million was from government. This is 93.7% of the projected additional investment of 1.9 billion target for 2018/2019. The additional actual investment (private and government) in 2018 was R557 million. Committed government investment in 2018 was over R155 million, which will be utilised from 2019 onwards.	During 2018 as per the 3 feet plans an additional investment of R1.9 billion (government and private) was projected
PRODUCTION	Operation Phakisa projects contributed a total of 3 547.79 tons production in 2018, which is 337.71 tons less than 2017. This	13 347 tons additional production

	equates to an 8.69% decrease from 2017. The total production for marine and freshwater for the sector is 6 365.8 tons. The production target set in the Operation Phakisa Lab report for 2018 was 16 853 tons, therefore in terms of the sector as a whole the production is 37.7% on target.	
JOBS	The total number of jobs contributed by Operation Phakisa projects was **2 367**, these included: • 2030, previous total jobs on 35 farms in 2017; • 337, new direct jobs created in 2018; **Disaggregated jobs (of total jobs on farm)**: • **Gender:** Females (984) 42% Males (1 383) 58% • **Ages**: Youth (1 175) 50% • **Race:** African black (1 411) 60%; Coloured (760) 32%; White (194) 8%; Asian (2) 0,1% • **Disabilities:** (14) 1% • **Veterans:** (2) 0,1 % The total jobs for the sector were 6 500 (including the crocodile subsector and value chain jobs i.e. processing).	An additional 568 direct jobs
TRANSFORMATION	Operation Phakisa projects transformation statistics in 2018: SMMEs = 16 Cooperatives = 1 Average BBBE Level = < Level 4	
GDP	Total estimated turnover (based on tonnage) across 36 projects amounted to over R584 million per annum in 2018.	The projected increased turnover from the baseline of R770 million is R1.1 billion per annum across the 36

	The total value of the aquaculture sector in 2018, was estimated at over R 1.01 billion. This represents an increase of 3% in the value of the sector.	projects.

14.2. Initiative 1: Selection and implementation of catalyst projects.

Since the Lab in 2014, twenty eight (28) new projects have been assessed and incorporated as part of Operation Phakisa Oceans Economy. In total there are forty-five (45) projects. Six (6) of the original 24 projects conceptualised during the Lab have been removed and placed on business opportunities and one (1) project, Amatikulu Kob, was incorporated in the new Aquaculture Development Zone initiative nine. Twenty-four (24) of these projects are considered Small, Medium and Micro-sized Enterprises (SMMEs). Twenty eight (28) of the 45 projects are producing farmed aquaculture animals. In summary, the delays and challenges experienced by some projects include funding, road repair, poaching, coastal water quality, water leases, land leases and authorisations.

Hatcheries

In order to supply demand and promote new entrants into the sector, the DFFE completed feasibility studies for hatcheries (research and demonstration) in the Northern Cape and Eastern Cape. The feasibility study completed for the Northern Cape Abalone Hatchery shows significant potential to foster the growth of aquaculture in the province. The DFFE is now engaging the Public Private Partnership unit for National Treasury at the Government Technical Advisory Centre (GTAC) on suitable procurement models to explore.

Transformation Strategy and Small-scale framework for aquaculture

The department commissioned the development of a transformation strategy and small scale policy in order to support small scale aquaculture and ensure efficient transformation of the sector. Workshops were held on the draft 'Transformation Strategy for the Aquaculture Sector' and a Comprehensive Aquaculture Small Scale Framework was completed as a first step towards development of the small scale policy. The small scale feasibility studies were published for the following species: catfish; marron, crayfish, Nile and Mozambique tilapia, oysters, mussels and rainbow trout. This will assist new entrants with assessing the minimum viability for establishing a small-scale aquaculture operation in South Africa. The next phase is to draft the small scale aquaculture implementation plan which will be used as a technical guide for the small scale aquaculture framework. The plan aims to guide how the participation of small scale fish farmers can be improved and integrate as part of mainstream aquaculture activities.

Table 14.2: Potential production and job creation by 2023/2024 of nine new projects registered during 2019.

PROJECT NAME	LOCATION	SPECIES	POTENTIAL PRODUCTION BY 2023/2024	POTENTIAL JOBS BY 2023/2024
Blue-Green Aquaculture (Pty) Ltd	Bosplaas, NW	Tilapia 	200 tons	50 jobs on farm
Pluto Mussel and Trading (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
MMM Agriconsult (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
Simunye Mussels (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
Ulwazi Kukutya (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
Madima General Agricultural Trading (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
Lagoon Aquafarm (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
Blue Lagoon (Pty) Ltd	Saldanha Bay, WC	Oysters 	100 tons	22 jobs on farm
Mika Growers (Pty) Ltd	Saldanha Bay, WC	Mussels 	1000 tons	13 jobs on farm
TOTAL			**7 300 tons**	**163 jobs**

14.3. Initiative 2: Legislative reform to promote aquaculture development

The Aquaculture Development Bill was approved by Cabinet on 9 May 2018 and introduced to Parliament on 15 June 2018. During the 2019 reporting period, it is expected to be taken up by the newly appointed 6th administration.

Aquaculture Strategic Environmental Assessment (SEA)

The purpose of the SEA is to identify suitable areas where environmentally sustainable aquaculture development can be prioritised and incentivised. Secondly, it will provide a streamlined and integrated management and regulatory framework to reduce compliance complexities and improve decision-making processes. The study was completed and the next step is implementation.

Coastal Discharge Permits:

The General Discharge Authorisation (GDA) for coastal discharges, which includes aquaculture, is aimed at reducing the need for aquaculture operations to apply for a full Coastal Water Discharge Permit which required various specialist studies. The project is delayed due to significant amendments completed to the draft GDA. The internal approval process had to be redone entirely, prior to gazetting

for comment. The revised General Discharge Authorisation conditions were published for comment in 2019.

14.4. Initiative 3: Establishment of Interdepartmental Authorisation Committee

Environmental Authorisations issued for Operation Phakisa projects since October 2014:

- Nine (9) Environmental Impact Assessments (EIA) were completed and authorised, two appeals completed.
- Four (4) coastal discharge permits were issued.
- Nine (9) biodiversity risk assessments (Barramundi, Coho, King Salmon, Siberian Sturgeon, Rainbow Trout, Catfish, Nile Tilapia, Mozambique Tilapia and Common Carp).
- Saldanha Bay Aquaculture Development Zone Environmental Impact Authorisation:
    - ✓ The Minister of DFFE approved the ADZ authorisation on 8 January 2018 and the appeal decision took place on 7 June 2018.
    - ✓ Saldanha Bay ADZ could potentially create between 780-2500 jobs, bring in additional investment of R400 million, unlock R800 million revenue per annum and contribute towards rural livelihoods and food security (import substitution).
    - ✓ Requirements to commence were met such as appointment of Environmental Control Officer, establishment of the Aquaculture Management Committee (AMC) and Consultative Forum (CF).
    - ✓ DFFE and TNPA have engaged regularly around the allocation of new water space in Saldanha Bay in line with the revised area authorised in the EIA.
    - ✓ The year one external audit was conducted for February 2020.
- Algoa Bay Aquaculture Development Zone:
    - ✓ Alternative sites are being assessed and considered. There are three precincts with a different combination of species and area combinations. There is only one precinct being considered for finfish i.e. the Algoa 7 Coega site, other precincts propose the farming of bivalves.
    - ✓ The new Basic Assessment process has been completed and the appeals process is underway. The appeal decision is expected in December 2020.

- COEGA Aquaculture Development Zone 6:
    - ✓ On 7 February 2018 DFFE granted an integrated environmental authorisation for the development and operation of the Coega Land-Based ADZ in the Coega Industrial Development Zone.
- Seven (7) land leases have been issued.
- Nineteen (19) new water leases were allocated and approved in total. One for an Operation Phakisa aquaculture project in Port Elizabeth and eighteen (18) projects received lease options in Saldanha Bay (ADZ) new water leases were approved for projects in Saldanha Bay.
- The water use license notice for the Vanderkloof dam was received.
- Coastal lease and water use license was issued for Qolora ADZ.
- Fourteen (14) marine aquaculture permits/Rights were issued.

14.5. Initiative 4: Establishment of a globally recognised monitoring and certification system.

Certification framework

Stakeholder workshops were held in Cape Town and Pretoria with various bodies, government entities and industry. The final certification framework for aquaculture products in South African was completed in October 2019 and will assist the country with meeting local and international standards around certification for aquaculture.

European Union (EU) export approval

In order to access European Union (EU) export approval, a National Residue Programme was developed and implemented for abalone, finfish and bivalves. The programme, however, may not be approved due to the veterinary drug residue methods not being validated for the relevant matrices. To address this, DFFE is in the process of finalising a Service Level Agreement (SLA) with the Agricultural Research Council – Onderstepoort Veterinary Institute (ARC-OVI) to validate the required methods and have them accredited.

Standards:

DFFE and National Regulator for Compulsory Standards (NRCS) are working on the Dried Abalone Standard.

Sea Urchin Production:

A South African National Standard has been drafted for the exportation of live, raw chilled and processed aquaculture urchins (SANS 2091) and technologies for commercial grow-out of sea urchin have been further refined.

14.6. Initiative 5: Establishment of an Aquaculture Development Fund

Aquaculture Species Feasibility Studies:

The financial feasibility studies were conducted on key aquaculture species and are guidelines to inform new entrants, government authorities and funders to assist with policy and investment decisions. Feasibility studies were completed for marine finfish, oyster and mussels, tilapia, trout, abalone, catfish, freshwater ornamentals, marron crayfish and aquaponic systems to inform new entrants, funding agencies, policy and investors. The feasibility studies include general economic models based on various production systems per species. The studies indicate market assessments, minimum scale and financial analysis based on inputs from technical experts, industry stakeholders and peer-review workshops.

The feasibility studies and funding directory can be obtained from the links below:

Feasibility Studies: https://www.environment.gov.za/documents/research#feasibilitystudies

Funding Directory:
https://www.nda.agric.za/doaDev/sideMenu/fisheries/03_areasofwork/Aquaculture/economics/Funding%20Guide%202019%20Final.pdf

Aquaculture Development and Enhancement Programme

New ADEP guidelines were published by the DTIC and were effective from the 1 April 2019 and extended the programme until further notice.

Aquaculture Finance and Investment Seminar

On the 27 March 2019, the DFFE held the first Aquaculture Finance and Investment Seminar in Durban. Various private projects and government agencies presented to the full house of over 200 delegates. The seminar included live panel discussions and exhibition stands.

14.7. Initiative 6: Capacity and Skills Development

The skills and needs analysis assessment of the sector has been completed to inform further interventions and skills requirements. This was funded by AGRISETA and the National Skills Fund (DHET). In order to help inform interventions by various role players responsible for aquaculture, the skills needs were modelled and projected over the next five years in terms of quantifiable numbers.

Aquaculture qualifications (through AGRISETA):

The aquaculture qualifications for 'Aquaculture Farmer' and 'Aquaculture Farm Assistant' have been completed and approved by Quality Council for Trades and Occupations (QCTO) in March 2018. It is currently with South African Qualifications Authority (SAQA) for approval. The development and approval of the aquaculture farmer qualifications framework was completed in partnership with A.

Aquaculture Skills Programme (short skills) Booklet

The Aquaculture Skills Programme (Short Skills) available in SA booklet was developed and published in October 2019. One of the key challenges is information sharing and knowledge around the aquaculture sector in general, including the availability of local training opportunities. The Department of Agriculture, Rural Development and Land Reform publishes career booklets annually which includes various diploma and degrees available related to aquaculture. However, this does not include short skills and programmes. Therefore, the booklet provides a guideline in terms of short skills programmes currently provided for aquaculture.

Training opportunities through Departmental interventions

Local training database

The China-South Africa Agricultural Technology Demonstration Centre (ATDC) located near Gariep Dam in the Free State offers different aquaculture training and capacity building programmes. The aim of ATDC is to broaden the training programme to include SADC countries. Training record is outlined in Table 13.3 below:

Table 14.3: Training offered at the Aquaculture Technology Demonstration Centre in Gariep dam during 2019.

CATEGORY	DURATION	NUMBER TRAINED	GENDER		YOUTH	DISABLED
			Female	Male		

Introduction to aquaculture	5 days	157	93	64	101	1
Experiential training	4 months	2 (FSDARD)	2	0	2	0
Total		**159**	**95**	**64**	**101**	**1**

International training database

In order to address the scarce aquatic veterinarian skills and services available in South Africa, DFFE and Stirling University have signed an agreement for training of aquatic veterinarians and aquaculture specialists. Five (5) provincial veterinarians have completed one year Masters training programme, the (MSc in Aquatic Veterinary Studies); and completed their studies in September 2019. Two DFFE staff members completed three months of training on fish health management. Three new veterinarians have been sent for another year of training in September 2018. Two veterinarians attended short courses (3 months) during 2019. The total number of South African candidates received international training in aquaculture during the year 2019 is five (5).

14.8. Initiative 7: Coordination for industry wide marketing efforts

Marketing and Awareness

During 2019 the Public Awareness and Marketing Strategy for Aquaculture Products and the Sector in RSA was completed. The public awareness strategy report consists of two parts: the first provides a general global overview of studies on perceptions of aquaculture and the second provides specific recommendations for addressing public concerns, and the roles that key stakeholders can play in promoting the public understanding of aquaculture (PUA). In addition, strategies for promoting aquaculture as a career and business opportunity were identified. Key target groups for improving the PUA who were interviewed included a few South African consumers, restauranteurs and chefs, supermarket retailers, small seafood retailers/ fish shops/ fishmongers and seafood wholesalers.

Advertising Campaign

Videography content of local aquaculture species was developed to promote how farming is done and how to prepare recipes on each of the five species - mussels, oysters, catfish, trout and tilapia. These short videos were aired on local Mango airlines during various flights. The link to the videos can be found on the YouTube link here: https://www.environment.gov.za/media/audioandvisual#2019videos

Investment Promotions

The Value Proposition for the Aquaculture Sector was completed with **the dtic**. The value proposition provides an overview of why and how to invest into the sector which is a valuable tool for targeting new investors.

Establishment of African Chapter of the World Aquaculture Society (WAS)

South Africa (through DFFE) has facilitated and supported the establishment of an African Chapter of the WAS. The DFFE/WAS AC project began in June 2018 and ended 31 May 2019, after which the

Secretariat was handed over to the WAS and the hosting party, NEPAD.

14.9. Initiative 8: Preferential procurement of aquaculture products

Research on the current fish consumption of state owned entities and departments are currently underway. Information has been received from Department of Correctional Services and South African Airways (Airchefs).

Engagement:

DFFE and Department of Correctional Services (DCS) met in March 2018 and a follow up meeting was planned in May 2018 with their supply chain management. Possible collaboration will be discussed as DCS's nutritional guidelines require procurement of fish which is not always available in all the provinces. Follow up meeting held with Deputy Commissioner on the 16 May 2018. Discussions are ongoing. The Department of Basic Education (DBE) was engaged on the matter however there is less potential collaboration in the near future due to their requirements.

14.10. Initiative 9 (new): Develop and Implement Aquaculture Development Zones (ADZs)

There are currently eight ADZs registered and monitored under initiative nine:

1. **Amatikulu Aquaculture Development Zone:**

Progress: The Amatikulu ADZ application for Environmental Authorisation has been declined. The department has submitted an appeal.

2. **Richards Bay Aquaculture Development Zone:**

Progress: Richards Bay feasibility study is completed and engagements are underway with TNPA to discuss the way forward.

3. **Qolora Aquaculture Development Zone:**

An abalone farm is proposed for community participation and beneficiation. Other targeted species include marine finfish and seaweed The ADZ requires funding for basic infrastructure as all authorisations were received.

4. **Van der Kloof Aquaculture Development Zone: (trout)**

Vanderkloof dam has been identified as an ideal site for the declaration of an ADZ. The majority of permits have been received and the pilot has yet to commence.

5. **Saldanha Bay Aquaculture Development Zone:**

Refer to initiative three Inter-departmental Authorisations Committee for details. The ADZ has the potential to meet the Operation Phakisa production target, increase local employment in the area by unlocking up to 2 500 permanent direct jobs which can contribute up to 25% towards current local unemployment figures. It has the potential to increase investment into the area by over R400 million and the estimated direct revenue at full production could result to over R800 million per annum.

6. **COEGA Aquaculture Development Zone:**

Targeted species include marine and freshwater finfish and abalone. Based on the feedback received and technological development to reduce water exchange and consumptive water use, the CDC is also including intensive freshwater and brackish water aquaculture in the ADZ.

7. Mosselbay Aquaculture Development Zone:

Located in the Western Cape, this is a sea based ADZ. The target species are bivalves (mussels and oysters) and finfish however an EIA is planned for the zone and will determine the size, location and species best. An Environmental Assessment Practitioner needs to be appointed in order to undertake the EIA.

8. Algoa Bay Aquaculture Development Zone:

Progress: Refer to Initiative three. Public participation meetings were held in Port Elizabeth on the 31 July and 1 August 2019. The Final Basic Assessment report was submitted to the Branch: Environment on the 21 October 2019 as per the legislative timeframes and the decision is expected in February 2020.

For detailed information about progress and developments, please refer to the **Operation Phakisa Aquaculture Year Five Review** linked below:
https://www.environment.gov.za/sites/default/files/docs/publications/operation_phakisa_yearfive.pdf

OVERVIEW OF DIRECTORATES RESPONSIBLE FOR AQUACULTURE FUNCTIONS WITHIN DFFE

15

15. OVERVIEW OF DIRECTORATES RESPONSIBLE FOR AQUACULTURE FUNCTIONS WITHIN DFFE

The aim for the Chief Directorate Aquaculture Development is to ensure sustainable growth and development for the aquaculture sector.

Its functions are to:

- Provide technical support and essential services to aquaculture stakeholders;
- Provide integrated platform for management of aquaculture through effective administration of policies, legislation, certification and institutional arrangements;
- Provide scientific research and advice towards the development and sustainable management of the aquaculture sector;
- Oversee the implementation of Oceans Economy Operation Phakisa Aquaculture Initiatives; and
- Management of inland fisheries.

15.1 Directorate Aquaculture Technical Services

Aim: To provide technical support and advisory services to Aquaculture stakeholders.

Functions:

- Develop, manage and implement technical training programmes for Aquaculture stakeholders;
- Provide technical advisory services for Aquaculture stakeholders;
- Provide advisory services for Aquaculture stakeholders;
- Develop, manage and implement the information and data management systems;
- Provide economics support to support to the sector;
- Develop and manage aquaculture development facilities/infrastructure;
- Oversee the development and implementation of awareness activities for Chief Directorate in relation to aquaculture directorates;
- Develop, manage and implement programmes aimed at the development and growth of the sector;
- Provide support to overall aquaculture projects, both private sector and state driven projects; and
- Facilitate access to funding and investment for overall aquaculture projects.

15.2 Directorate Aquaculture Research and Development

Aim: To provide scientific research and advice towards the development and sustainable management of the aquaculture sector

Functions:

- Undertake aquaculture research that supports development of ecologically sustainable aquaculture i.e. environmental monitoring, HABs research, targeted surveillance, development of diagnostic methods and epidemiological research
- Provide support for diversification competitiveness for the aquaculture sector i.e. genetics research, new species, productions systems, culture technology development and transfer, design

and implement pilot/demonstration projects, nutrition and feed development, markets and post-harvest technology

- Provide scientific advice to support the developing aquaculture sector
- Develop and manage stakeholder networks, committees, forums and institutional support pertaining to research
- Establish and convene an Aquaculture Scientific Working Group
- Dissemination of research information including awareness materials
- Collaboration with local and international research institutions for advancing aquaculture research and development
- Development of publications, technical reports, manuals and guidelines
- Coordinate and implement a Research and Development programme for the sector

15.3 Directorate Sustainable Aquaculture Management

Aim: To provide integrated platform for management of aquaculture through effective administration of policies, legislation, certification programmes, stakeholder engagements and institutional arrangements.

Functions:

- Develop, manage and implement integrated licensing and permitting system
- Development implementation & review of legislation and regulations
- Develop norms & standards, guidelines & (include advisory and awareness
- Develop, manage and implement the compliance monitoring programmes with regards to legislation and permit conditions(include advisory, awareness
- Develop, manage and implement environmental, bio-security and food safety management programmes
- Develop and manage stakeholder networks, committees, forums and institutional support
- Develop and implement policy and strategies development and implementation for the aquaculture sector
- Facilitate authorizations to enable aquaculture development

15.4 Operation Phakisa Aquaculture Delivery Unit

Aim: To oversee the implementation of Operation Phakisa Aquaculture Initiatives. Operation Phakisa supports the work done by all Directorates responsible for aquaculture.

Functions:

- Profiling and investment promotion for Operation Phakisa projects;
- Facilitate Phakisa projects enablers e.g. Access to markets, land/water, finance and other enablers;
- Render advisory on technical and funding opportunities for Phakisa projects;
- Trouble shooting and Implementation of initiatives/projects;
- Provide technical advisory to Phakisa projects and initiatives;

- Provide and co-ordinate technical evaluation of concepts, 3feet plans, feasibility for Operation Phakisa;
- Promotion of Operation Phakisa projects;
- Undertake economics impact studies for Operation Phakisa projects;
- Monitor and reporting on Operation Phakisa initiatives (specifically for aquaculture); and
- Facilitate government procurement for aquaculture products.

OVERALL CONCLUSIONS AND RECOMMENDATIONS

16

16. OVERALL CONCLUSIONS AND RECOMMENDATIONS

16.1. Overall conclusions and recommendations

The South African 2019 aquaculture production cycle continues to demonstrate the country's aquaculture sector recovery from the dip that was experienced during 2017 due to drought and the HAB. This is evident with a 11.31% production increase recorded during 2019 from 2018. The overall aquaculture production in South Africa in the past decade has surpassed the global average production increase of 7%. During 2019, cultivation and development of a new candidate species was partially achieved through growth trials of sea urchins in Hamburg, Eastern Cape province. However, the production system and the economic viability of this species are still to be concluded following the outcomes of the development.

The government is committed to grow the sector and stimulate the investments with the intention to increase the sector's contribution to the national economy and socio-economic developments. However, there was a decrease in investment by both the public and private sector into the industry. The need for investment and finance to support the development of aquaculture in South Africa is therefore significant. The aquaculture sector remains a insignificant contributor to the national fish supply and the country's Gross Domestic Product (GDP).

To date, the industry demonstrated its potential by the increased number of direct and indirect jobs. The industry's potential has been demonstrated by the increased jobs from year to year, achieving a 9.9% increased jobs between 2018 and 2019. This increase is attributed to the increased production volume of 719.89 tons.

An observation has been made that as a country, we are still importing larger quantity of fish than we are actually producing. This therefore demonstrates that the demand exceeds the country's production volume. South Africa's aquaculture trade depicted a trade deficit during 2019, where exports decreased with 26% in quantity. Despite the decreased volume experienced, the export value increased due to some of the valuable products such as abalone which are mainly destined for export markets and bring in Foreign Exchange (FOREX).

There is still a disjuncture between marine and freshwater aquaculture management. Marine aquaculture development and management is solely a national government mandate and is implemented through MLRA whilst freshwater aquaculture is a shared mandate between the national and provincial government. Management and development of freshwater aquaculture lacks an overarching legislative tool on a national level, whilst on a provincial level it is managed through multiple provincial ordinances. There is an urgent need to develop an overarching legislation that is developmental focus and will harmonise the management of aquaculture.

Through support from government and its partners this sector has demonstrated great potential to provide vital source of food, employment, economic well-being of the nation as well as rural development, both for present and future generations.

REFERENCE LIST

17

17. REFERENCE LIST

17.1 Reference list

1. Azad, A.K., Pearce, C.M., McKinley, R.S., 2011. Effects of diet and temperature on ingestion, absorption, assimilation, gonad yield, and gonad quality of the purple sea urchin (*Strongylocentrotus purpuratus*). *Aquaculture* 317: 187–196.
2. Babatunde, A., Robertson-Andersson, D., Gan, M., Taylor, S., (2020). Aquaculture in Africa: A Comparative Review of Egypt, Nigeria, and Uganda Vis-À-Vis South Africa. *Reviews in Fisheries Science & Aquaculture*, *29(2),* 167-197.
3. Boonzaaier, M., Neethling, S., Mouton, A., & Simon, C. A. 2014. Polychaeta: Spionidae) on farmed and wild abalone (*Haliotis midae*) in South Africa – an epidemiological survey. *African Journal of Marine Science*. Submitted: 21.
4. Carlton, D.B., Lippé, C., 2007. Eleven new microsatellite markers for the tropical sea urchin *Tripneustes gratilla* and cross-amplification in *Tripneustes ventricosa*. *Molecular Ecology Resources* 7: 1002–1004.
5. Dashti, A.A., Jadaon, M.M., Abdulsamad, A.M., & Dashti, H.M. (2009). Heat treatment of bacteria: A simple method of DNA extraction for molecular techniques. *Kuwait Medical Journal*, *41*(2), 117–122.
6. Department of Agriculture, Forestry and Fisheries, 2017. *Feasibility Study of Oyster and Mussels Aquaculture in south Africa,* Cape Town.
7. Department of Agriculture, Forestry and Fisheries, 2017. South African Aquacultured Marine Fish Monitoring and Control Programmes
8. Department of Agriculture, Forestry and Fisheries, 2017. South African Molluscan Shellfish Monitoring and Control Programme.
9. Food and Agriculture Organisation, 2020. *The State of World Fisheries and Aquaculture,* Rome, Italy.
10. Greeff M., R., Christison K. W., & Macey B. M. 2012. Development and preliminary evaluation of a real-time PCR assay for Halioticida noduliformans in abalone tissues. *Disease of Aquatic Organisms* 99: 103 – 17.
11. Haenen O.,L.,M., Way K., Bergmann S., M., & Ariel E. 2004. The emergence of koi herpesvirus and its significance to European aquaculture. *Bull Eur Assoc Fish* 24:293–307.
12. Halwart M. (2020). Fish farming high on the global food system agenda in 2020. *FAO Aquaculture No.62.*
13. Horwitz R., Mouton A., & Coyne V. E. 2016. Characterization of an intracellular bacterium infecting the digestive gland of the South African abalone *Haliotis midae*. *Aquaculture* 451:24–32. Elsevier B.V.
14. Huchzermeyer K. D. A., & Colly P. A. 2015. Production of Koi Herpesvirus-Free Fish: Implementing Biosecurity Practices on a Working Koi Farm in South Africa. *Journal of Applied Aquaculture* 27:318–329. Taylor & Francis.
15. Macey B. M., Christison K. W. & Mouton A. 2011. Halioticida noduliformans isolated from cultured abalone (*Haliotis midae*) in South Africa. *Aquaculture* 315:187–195. Elsevier B.V.

16. Mouton A. & Gummow B. 2011. The occurrence of gut associated parasites in the South African abalone, *Haliotis midae*, in Western Cape aquaculture facilities. *Aquaculture* 313:1–6. Elsevier B.V.
17. OIE. 2016. *OIE Diagnostic Manual for Aquiatic Animal Diseases* (7th Editio). World Organisation for Animal Health, Paris, France. 1–237 pp.
18. OIE. 2018. *Aquatic Animal Health Code* (21st edition). World Organisation for Animal Health, Paris, France. 299 pp.
19. Pitcher G. C., & Calder D., 2000. Harmful algal blooms of the southern Benguela Current: a review and appraisal of monitoring from 1989 to 1997. South African Journal of Marine Science, 22(1), 255–271.
20. Pitcher G. C., Figueiras F. G., Hickey B. M. & Moita M. T. 2010. The physical oceanography of upwelling systems and the development of harmful algal blooms. *Progress in Oceanography*, 85(1), 5–32. doi:10.1016/j.pocean.2010.02.002.
21. Subasinghe R.P.,McGladdert S.E & Hill B.J. 2004. Surveillance and zoning for aquatic animal diseases. P. FAO Fisheries Technical Paper 451.FAO, Rome, Italy.88 pp
22. Ter Morshuizen, L., 2020. *South Africa online.* Online source, http://southafrica.co.za/catfish-production-south-africa.html.

.

BENEFITS FOR AQUACULTURE

Potential for the Aquaculture Sector in South Africa

SATISFY LOCAL DEMANDS,

CONTRIBUTE TO FOOD AND NUTRITIONAL SECURITY,

CREATE SUSTAINABLE JOB OPPORTUNITIES,

FOSTER ECONOMIC DEVELOPMENT,

CAPITALISE ON EXPORT OPPORTUNITIES,

STIMULATE RURAL DEVELOPMENT AND LIVELIHOODS,

ATTRACT FOREIGN DIRECT INVESTMENT,

SAFEGUARD SUSTAINABLE ENVIRONMENTAL INGETRITY,

CREATE SMMEs AND WEALTH GENERATING OPPORTUNITIES THROUGH AQUACULTURE.