AQUACULTURE YEARBOOK 2016 SOUTH AFRICA

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Key Directorates that contributed to the compilation of the 2016 Aquaculture Yearbook within the DAFF are the Directorate: Aquaculture Technical Services (D: ATS) under the leadership of Ms Khumo Morake, Directorate: Aquaculture Research and Development (D: ARD) under the leadership of Ms Fatima Daya, Directorate: Sustainable Aquaculture Management (D: SAM) under the leadership of Mr Asanda Njobeni and the Operation Phakisa Delivery unit under the leadership of the Chief Director of Aquaculture and Economic Development (CD: AED), Mr Belemane Semoli.

EXECUTIVE SUMMARY

Aquaculture production data is compiled annually to provide stakeholders with the status of the South African aquaculture sector. These production data are analysed, interpreted and presented in an Aquaculture Yearbook. The Aquaculture Yearbook 2016 presents data collected in 2015 from the aquaculture sector. During 2015, species cultivated in the marine sector included abalone *(Haliotis midae)*, pacific oyster *(Crassostrea gigas)*, mussels *(Mytilus galloprovincialis, Chromomytilus meridionalis)*, dusky kob *(Argyrosomus japonicus)*, and seaweed *(Ulva spp, Gracilaria spp)*. Species cultured during 2015 in the freshwater sector, included trout *(Onchorynchus mykiss, Salmo trutta*), tilapia *(Oreochromis mossambicus, Oreochromis niloticus, Oreochromis rendalli)*, catfish *(Clarias gariepinus)*, carp (*Cyprinus carpio),* and marron crayfish *(Cherax tenuimanus)*.

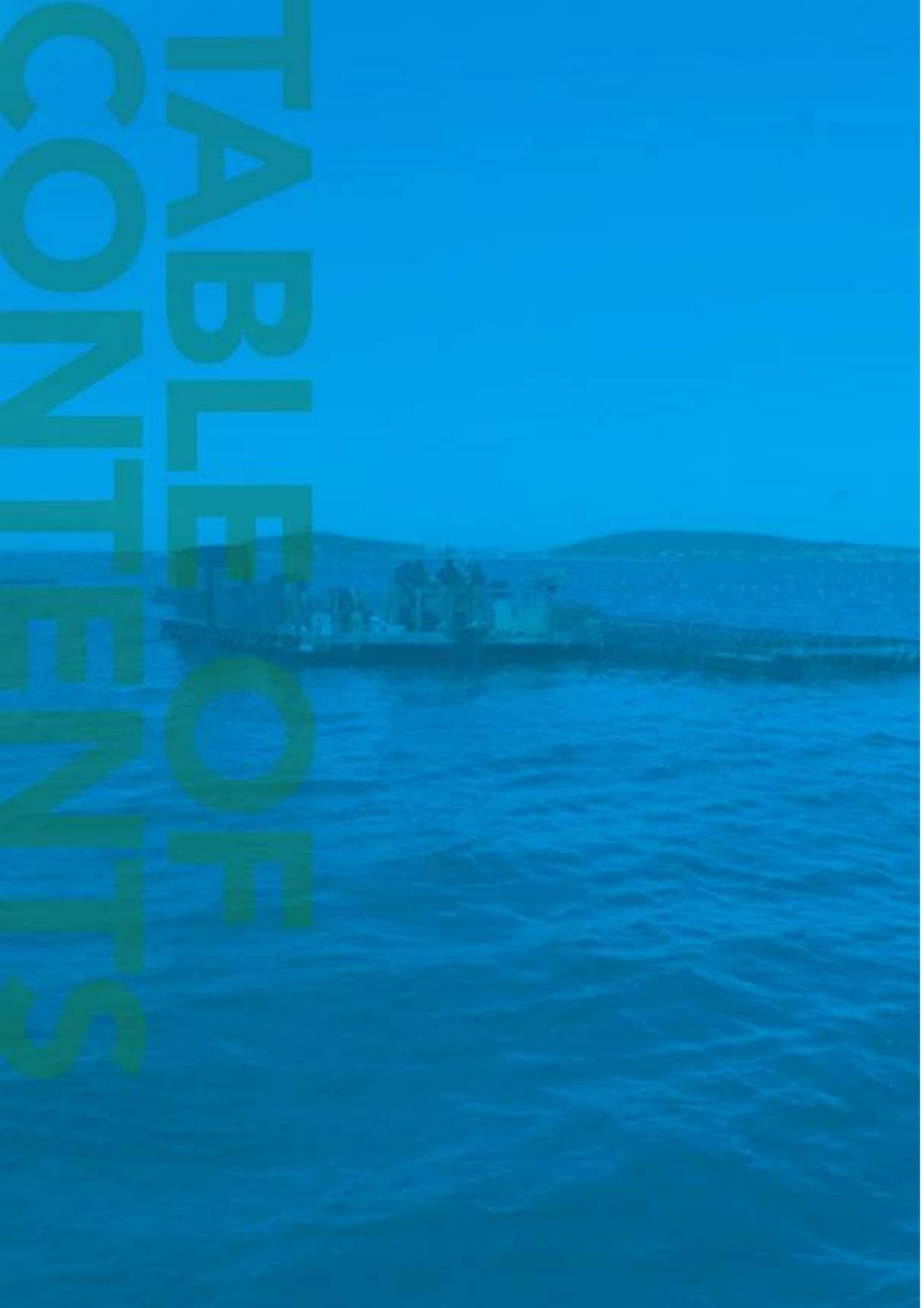
A total of 189 aquaculture farms were operational in 2015, with 37 of the farms cultivating marine species and 152 farms cultivating freshwater species. Compared to the total number of farms operational in 2014, this represents a substantial decrease.

The total production of South Africa's aquaculture industry in 2015 was 5418.15 tons. This figure does not include seaweed, carp, ornamentals or koi carp production. The marine sector contributed 3591.86 tons and the freshwater sector 1826.29 tons. Compared to 2014, the aquaculture sector showed a 4% increase in production during 2015, thus representing an increase of 208.55 tons (174.27 tons in the marine sector and 34.28 tons in the freshwater sector).

In the marine sector, mussels (1758.44 tons) contributed most to production, followed by abalone (1479.22 tons) and then oysters (276.85 tons). Finfish contributed the least to production in the marine sector. In the freshwater sector, trout (1497 tons) contribute most to production, followed by tilapia (325.29 tons) and then marron crayfish. No production figures were recorded for catfish during 2015. The aquaculture production of 2015 resulted to a total investment of approximately R264 million, representing an increase of 35% on the 2014 figure of R162 million. The sector created a further 282 jobs during 2015 primarily due to the increased production.

In terms of aquaculture research and development in South Africa, various research projects were undertaken in 2015. Highlights included projects on finfish reproduction and nutrition, project on the culture of the sea urchin *(Tripneustes gratilla)*, research on Ulva as a functional ingredient in aquafeeds and investigations on the suitability of Vanderkloof dam for the culture of the trout *(Oncorhynchus mykiss)*.

Activities pertaining to aquaculture environmental integrity were also implemented in 2015. The environmental authorisation of the Qolora Aquaculture Development Zone (ADZ) was still applicable during 2015, as it has been extended until 2017. In addition to this, an Environmental Impact Assessment (EIA) study for the Saldanha Bay ADZ was envisaged and specifications for conducting the EIA were advertised in December 2015. Processes of appointing an environmental assessment practitioner to conduct an EIA for an ADZ in Amatikulu were also initiated in 2015.



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ABBREVIATIONS

AASA	Aquaculture Association of Southern Africa
ADZ's	Aquaculture Development Zones
ADEP	Aquaculture Developmental and Enhancement Programme
CD: AED	Chief Directorate: Aquaculture and Economic Development
AIF	Aquaculture Intergovernmental Forum
AOAC	Association of Analytical Communities
ARC	Agricultural Research Council
D: ARD	Directorate: Aquaculture Research and Development
ARTDP	Aquaculture Research and Technology Development Programme
ASP	Amnesic Shellfish Poisoning
ATDC	Agricultural Technology Demonstration Centre
D: ATS	Directorate: Aquaculture Technical Services
BEE	Black Economic Empowerment
BMP's	Better Management Practices

ABBREVIATIONS

RoI	Return on Investment
D: SAM	Directorate: Sustainable Aquaculture Management
SAMSM&CP	South African Molluscan Shellfish Monitoring and Control Programme
SETA	Sector of Education and Training Authority
SEZ	Special Economic Zone
SOE	State-Owned Entities
TCP	Technical Cooperation Program
TCPF	Technical Cooperation Programme Facility

DEFINITION OF TERMS

Active surveillance	Referred as stock inspection, include (as amended from EU regulation (Reg. 2006/88/EC): a) Routine inspection by the Department or by other qualified health services provider on behalf of the Department; b) Examination of the aquaculture animals on the farm for clinical disease; and c) Diagnostic analysis of samples collected on a suspicion of a disease or observed increased mortality during inspection.
Commercial	Scale Status at which project is producing a product for sale primarily for widespread distributions and consumption.

DEFINITION OF TERMS

Disease	Any condition whereby the normal functions of any organ or the body of an animal is impaired or disturbed by any bacterium, virus, parasite, fungus or other organisms or agent in a culturing environment (as amended from Animal Disease Act, 1998).
East Coast	East of Cape Point to border of Mozambique.
Farm closure	A period where shellfish farms are temporally not allowed to market and or sell products due to microbiological contamination, detection of bio-toxins and as well as other hazardous substances such as heavy metals, pesticides, polychlorinated biphenyls (PCBs) or radionuclides.
Pilot scale	Status at which a project is testing or conducting trial in order to demonstrate the effectiveness.
Production	Amount of organisms produced from a farm.
West Coast	West of Cape Point to boarder of Namibia.

OVERVIEW OF AQUACULTURE YEAR BOOK 2016

01

OVERVIEW OF AQUACULTURE YEARBOOK 2016

1.1 South Africa's Aquaculture Yearbook 2016

The Department of Agriculture, Forestry and Fisheries (DAFF) has been entrusted to lead the development of aquaculture in South Africa. Amongst other instruments, information is key to informing decision making processes for the sector, therefore, the DAFF utilize the Aquaculture Yearbook as a key instrument for consolidation of sector information. The Yearbook is compiled on an annual basis having been first published in 2009. Over the years, the name of the document has been revolving due to sector development and revolution of Government structures.

In 2009, the former Department of Environmental Affairs and Tourism (DEAT) was responsible for marine aquaculture, whilst the former Department of Agriculture (DoA) was responsible for freshwater aquaculture. At the time, only marine aquaculture information was published and the name of the publication was "South Africa's Marine Aquaculture Industry Annual Report 2009".

The first review of the publication name was initiated in 2010 under the newly formed DAFF, but continued to focus on the marine aquaculture sector. The publication was named the "Marine Aquaculture Annual Report 2010". The DAFF had a mandate to lead the development and management of both marine and freshwater aquaculture, but had to allow for a transitional period before incorporating the freshwater aspects into the publication. In 2011, the freshwater and marine aquaculture mandates were fully merged through the National Aquaculture Strategic Framework (NASF) which made provision for the inclusion for a consolidated publication named "South Africa's Aquaculture Annual Report 2011". A further name change was implemented in 2012 to "South Africa's Aquaculture Yearbook 2012". Reports under the same name were published in July 2014, in June 2015 and in November 2016.

The current publication "South Africa's Aquaculture Yearbook 2016" was compiled based on data collected from South Africa's aquaculture sector during 2015. Due to limitations arising from fragmented legislative tools, data collection from the marine and freshwater aquaculture sectors was somewhat different. The marine aquaculture data was collected on the basis of provisions that exist in the Marine Living Resources Act (MLRA), Act no 18 of 1998 through compulsory submission of data by industry and site assessments conducted by officials from DAFF. The collection of freshwater aquaculture data continues to be a challenge as there is no overarching legislative tool that places an obligation on farmers to submit data. Data was collected on a voluntary basis through questionnaires submitted to individual farmers and aquaculture associations. Therefore, it should be noted that the data presented for the freshwater sector may not be a true reflection of the sector.

2.1 Overview of aquaculture in South Africa in 2015

South Africa's aquaculture, comprising freshwater and marine sectors, has experienced a rapid increase in recent years. A total production of 3926.89 tons was recorded in 2012, 4802.11 tons in 2013 and 5209.60 tons in 2014. Total production in 2015 was 5418.15 tons, which represents an increase of 4% from 2014.

Freshwater species currently being cultured in South Africa include Rainbow trout and brown trout *(Onchorynchus mykiss and Salmo trutta)*, crocodiles *(Crocodylus niloticus)*, Ornamental fish *(e.g., Koi carp)*, African sharptooth catfish *(Clarias gariepinus)*, Mozambique and Nile tilapia (Oreochromis mossambicus and Oreochromis niloticus), Marron Crayfish *(Cherax tenuimanus)* and Common carp *(Cyprinus Carpio and Ctenopharygodon idella)*. The most important production areas for freshwater species include Limpopo, North West, Mpumalanga, Free State, Kwa-Zulu Natal and Western Cape provinces. The freshwater sector contributed a total of 1826.29 tons to the total aquaculture production.

Marine aquaculture is a fast developing sector contributing 3591.86 tons, made up of abalone *(Haliotis midae)*, Pacific Oyster *(Crassostrea gigas)*, mussels *(Mytilus galloprovincialis and Chromomytilus meridionalis)*, Dusky Kob *(Argyrosomus japonicas)*, prawns *(Litopenaeus vannamei)* and seaweed *(Ulva spp. and Gracilaria spp.)*. The above mentioned species are farmed in the coastal provinces of the Western Cape, Eastern Cape, Kwa-Zulu Natal and the Northern Cape.

A total of 189 farms were recorded in 2015 for both marine and freshwater (Table 1). Most freshwater farms employ re-circulating systems, earth ponds or raceways for species cultivation whereas marine molluscs are farmed on rafts or long-lines, and abalone are cultivated in tanks with pump ashore technology. Forty-four (44) farm closures have resulted in a decrease in the number of operational farms during 2015.

Species farmed: In 2015, a total of eleven (11) species were cultured, of which four (4) were marine species, including abalone, finfish, mussels and oysters, and seven (7) freshwater species included tilapia, trout, catfish, marron crayfish, carp, koi-carp and ornamental species.

Production: The total production of South Africa's aquaculture industry (excluding catfish, carp, koi-carp and ornamental species) in 2015 was 5418.15 tons. The sector has shown continuous growth over the years (Figure 1), with an increase of 208.55 tons from 2014 to 2015, representing an increase of 4.00%. Marine aquaculture contributed 3591.86 tons towards the total production, accounting for 66.29% of the total production having increased by 174.27 tons (5.00%) from 2014 (Figure 2; Table 2). Freshwater aquaculture contributed 1826.29 tons of the total production, accounting for 33.71% of the total production having increased by 34.28 tons (1.02%) from 2014 (Figure 2; Table 2). The leading sub-sector was mussels with a production of 1758.47 tons followed by trout with a production of 1497 tons and abalone with a production of 1479.22 tons.

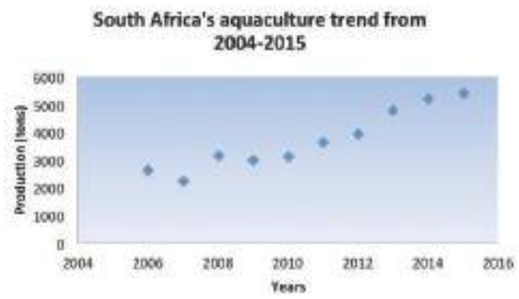

Figure 1: South Africa's aquaculture production trend from 2004-2015.

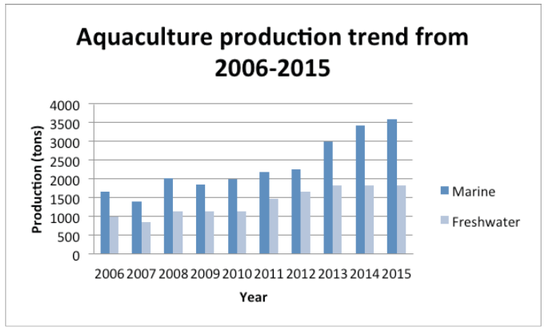

Figure 2: South Africa's aquaculture production per sector from 2006-2015.

Table 1: Number of farms recorded for South African aquaculture sector in 2015.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Abalone	2	0	0	0	0	0	4	0	12	18
Finfish	3	0	0	2	0	0	0	0	2	7
Mussels	0	0	0	0	0	0	0	0	4(2)	4(2)
Oysters	2(2)	0	0	0	0	0	1	0	5	8(7)
Total Marine	7	0	0	2	0	0	5	0	23	37
Tilapia	2	0	20	5	16	14	1	14	2	74
Trout	2	0	0	5	0	18	0	0	13	38
Catfish	1	7	1	0	3	0	0	1	0	13
Marron Crayfish	1	0	0	0	0	0	0	0	0	1
Carp	0	0	1	0	0	0	1	0	1	3
Koi-Carp	0	2	5	2	0	1	0	0	1	11
Ornamental species	0	1	4	3	1	0	0	0	3	12
Total Freshwater	6	10	31	15	20	33	2	15	20	152
Total	13	10	31	17	20	33	7	15	43	189

Table 2: Production (tons) recorded for South African aquaculture sector in 2015.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Abalone	156.93	0	0	0	0	0	19.62	0	1302.67	1479.22
Finfish	52.88	0	0	24.44	0	0	0	0	0	77.32
Mussels	0	0	0	0	0	0	0	0	1758.47	1758.47
Oysters	29.35	0	0	0	0	0	0	0	247.50	276.85
Total Marine	239.16	0	0	24.44	0	0	19.62	0	3308.64	3591.86
Tilapia	19.50	0	58	6.5	120	27.29	3	86	5	325.29
Trout	235	0	0	382	0	141	0	0	739	1497
Catfish	0	0	0	0	0	0	0	0	0	0
Marron Crayfish	4	0	0	0	0	0	0	0	0	4
Carp	0	0	0	0	0	0	0	0	0	0
Koi-Carp	0	0	0	0	0	0	0	0	0	0
Ornamental species	0	0	0	0	0	0	0	0	0	0
Total freshwater	258.50	0	58	388.5	120	168.29	3	86	744	1826.29
Total	497.66	0	58	412.94	120	168.29	22.62	86	4052.64	5418.15

03 STATUS OF MARINE AQUACULTURE

3.1. Marine aquaculture farms operating in 2015

A total of 34 marine aquaculture farms were operational in 2015. This represented a decrease on the reported 39 farms in operation during 2014, following the closure of five (5) farms primarily in the Western Cape Province. The Western Cape recorded the highest number of farms with a total of 23, followed by the Eastern Cape with eight (8) farms, the Northern Cape with five (5) farms and the Kwa-Zulu Natal province with two (2) farms. These farms comprise of eighteen (18) abalone farms, followed by eight (8) oyster farms, seven (7) finfish farms and four (4) mussel farms. The distribution of the farms is presented in Table 3.

Table 3: Number of marine aquaculture farms operating in South Africa by sub-sector and province in 2015

Number of marine aquaculture farms cultivating species in each province					
Species	**Western Cape**	**Eastern Cape**	**Northern Cape**	**KwaZulu Natal**	**Total**
Abalone	12	2	4	0	18
Finfish	2	3	0	2	7
Mussels	4(2)*	0	0	0	4(2) *
Oysters	5	2 (1)*	1	0	8 (7) *
Total	21	6	5	2	34

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

()* One finfish farm cultured oysters as well, however the farm haven't been captured under oysters as their primary species is finfish.

Note: Seaweed farms were excluded

3.2. Marine aquaculture species farmed in 2015

A total of seventeen (17) species were farmed in 2015 clustered into five (5) sub sectors namely: abalone, finfish, mussels, seaweed and oysters during 2015. Of the five (5) sub-sectors, only four (4) are utilized for human consumption, whilst seaweed is utilized for abalone feed. These species were cultured on commercial, pilot and research scales. Research was undertaken on nine (9) species whilst seven (7) species were farmed commercially and one (1) species was farmed on a pilot scale (Table 4).

Table 4: Marine aquaculture species and their operational scale in South Africa during 2015.

Common Name	Scientific Name	Operational Scale
Abalone	*Haliotis midae*	Commercial
Pacific Oyster	*Crassostrea gigas*	Commercial
Mediterranean Mussel	*Mytilus galloprovincialis*	Commercial
Black Mussel	*Choromytilus meridionalis*	Commercial
Seaweed	*Ulva spp*	Commercial
Seaweed	*Gracilaria spp*	Commercial
Dusky Kob	*Argyrosomus japonicus*	Commercial
Salmon	*Salmo salar*	Pilot
Yellowtail	*Seriola lalandi*	Research
White Stumpnose	*Rhabdosargus globiceps*	Research
Spotted Grunter	*Pomadasys commersonnii*	Research
Yellowbelly Rockcod	*Epinephelus marginatus*	Research
Mangrove Snapper	*Lutjanus argentimaculatus*	Research
South Coast Sea Urchin	*Tripneustes gratilla*	Research
South African Scallop	*Pecten sulcicostatus*	Research
Bloodworm	*Arenicola loveni*	Research
Octopus	*Octopus vulgaris*	Research

3.3 Marine aquaculture authorisations in 2015

Marine Aquaculture continues to be managed under the Marine Living Resources Act, 1998 (Act 18 of 1998) (MLRA). The MLRA created regulatory framework for the conservation of ecosystems, the sustainable utilization of marine living resources and the orderly access to exploitation, utilization and the protection of certain marine living resources. Even though marine aquaculture is more development focus, it formed part of the activities that are regulated in terms of the MLRA due to its utilisation of the marine space and marine species. It continues to be regulated in the form of issuing of rights, permits and exemptions where necessary. The DAFF embarked on a process of developing Aquaculture legislation during 2014 and a Concept note of the Aquaculture Bill was referred to industry and other relevant stakeholders throughout the country.

3.3.1 Marine aquaculture rights

Marine aquaculture rights are granted in terms of Section 18 (1) of the MLRA, which states that:

"No person shall undertake commercial fishing or subsistence fishing, engage in mariculture or operate a fish processing establishment (FPEs) 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 2015, two (2) marine aquaculture rights were granted for abalone *(Haliotis midae)* and oysters *(Crassostrea gigas)* (Table 5).

Table 5: Rights to engage in marine aquaculture granted in 2015.

Company Name	Operational Area	Species	Duration of right
Tuna Marine (Pty) Ltd	Still Street, New Harbour, Hermanus, Western Cape	Abalone (Haliotis midae)	01/01/2015-31/12/2030
Salmar Trading (Pty) Ltd	5 hectares of Inner Bay, Port of Saldanha	Oysters (Crassostrea gigas)	01/01/2015-31/12/2030

Fish Processing Establishment rights

The processing of marine aquaculture products is regulated under the MLRA. There were no rights issued for Fish Processing Establishment (FPE) during 2015 due to institutional delays in development of the implementing policy for FPE allocation. In order to ensure continuation of operations, the DAFF utilized Section 81 of the MLRA to exempt FPEs.

3.3.2 Exemption

Exemptions are granted in terms of Section 81 of the MLRA, which states that:

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

Exemptions for "the possession and sale of undersized abalone and kob" (herein referred to as "local sales permits") are drafted to allow for the local sales of the products due to the implementation of wild caught fish size limitations on farmed products. The exemption process is a legislative process that is used as a mechanism to allow for the processing and local sales of undersized products.

3.3.3 Permits

To activate a right or exemption, a permit is issued in accordance with Section 13 (1) of the MLRA which states that:

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

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

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

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

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

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

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

During 2015, a total of 419 permits for marine aquaculture were issued in South Africa to right holders, agencies, importers, exporters, FPEs and transportation companies (Table 6). The D: SAM began a process of streamlining all permit applications. This reduced the number of permits required by Right holders. The "permit to engage in marine aquaculture activities" was streamlined to include grow-out or hatchery, transport, FPE, broodstock collection and vessels. The permits issued for imports exceeded the number of permits issued for exports.

Table 6: Types of permits issued in 2015.

Permit type	No. issued
Imports	138
Exports	62
Transport	25
Engage in Marine Aquaculture Activities	44
Possess Broodstock and Operate a Hatchery	16
Possess and sell Undersized Cultured Abalone obtained from Right holder	35
Permit to possess and sell undersized Kob obtained from a Right Holder	0
Right to Engage in Abalone Ranching and Stock Enhancement Pilot Project: Seeding	7
Engage in Ranching Activities of Marine Species: Harvesting	5
Collect Broodstock for Marine Aquaculture purposes	1
Operate a Fish Processing Establishment	21
Scientific Investigations and Practical Establishments	17
Vessel license	0
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)	6
Total Issued	419

3.4 Marine aquaculture production

3.4.1 Marine aquaculture production in 2015

In the Aquaculture Yearbook 2016, production is defined as the quantity of organisms produced from a farm specifically for human consumption and is expressed in tonnage. This definition excludes seaweed which in South Africa is used as feed for abalone. South Africa's total marine aquaculture production in 2015 was 3591.86 tons (Table 7). In 2015 the Western Cape province recorded a production of 3308.64 tons and was the main contributor of South Africa's total marine aquaculture production followed by the Eastern Cape and Kwa-Zulu Natal with a production of 239.16 and 24.44 tons respectively. The Northern Cape province was the smallest contributor, recording a production of 19.62 tons. The total marine aquaculture production has increased by 174.27 tons from 2014 to 3591.86 tons in 2015. From the total production mussels contributed 49%, followed by abalone with 41% and the oysters and finfish contributed 8% and 2% respectively (Figures 3 and 4). The total marine production increased with 174.27 tons from 3417.59 tons that were recorded in 2014, representing an increase of 5.1%. The total marine aquaculture contribution to the overall aquaculture production is 66% of 5418.00 tons.

Table 7: Total marine aquaculture production (tons) for human consumption per sub-sector and province in 2015.

Production (tons) per species and province					
Species	WC	EC	NC	KZN	Total
Abalone	1302.67	156.93	19.62	0.00	1479.22
Finfish	0.00	52.88	0.00	24.44	77.32
Mussels	1758.47	0.00	0.00	0.00	1758.47
Oysters	247.50	29.35	0.00	0.00	276.85
Total	3308.64	239.16	19.62	24.44	3591.86

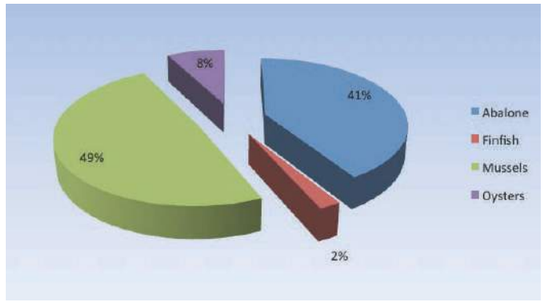

Figure 3: Contribution of each marine aquaculture sub-sector to total aquaculture production in 2015.

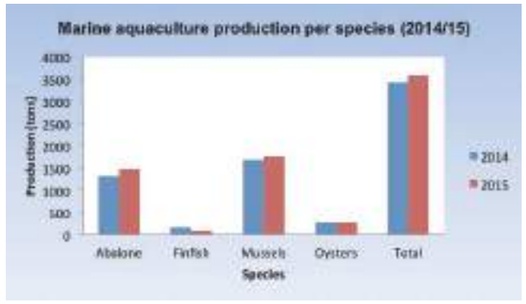

Figure 4: Production of marine aquaculture species for 2014 and 2015.

3.4.2. Marine aquaculture production trend from 2000 to 2015

Since the formal management and regulation of the marine aquaculture sector in South Africa production has continued to record a steady increase. Total production between 2000 and 2015 was 31083.50 tons. Over this sixteen (16) year period, the lowest production was 1055.92 tons in 2000 and the highest was 3591.86 tons in 2015 (Table 8).

Table 8: South Africa's marine aquaculture production 2000-2015 (*Totals exclude seaweed).

Sub-sector	Year and production (tons)																Total (2000- 2015)
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Abalone	181.03	372.88	429.42	462.02	509.2	670.8	833.36	783.25	1037.11	913.58	1015.44	1036.01	1111.41	1469.78	1306.50	1488.718	13620.81
Finfish	1.04	0.30	2.38	14.0	1.81	1.68	0.00	0.00	2.71	22.75	0.00	7.99	48.46	122.55	161.86	77.32	464.84
Mussels	500	600	429.11	623.0	640.0	472.0	542.0	466.0	736.74	682.40	700.14	859.77	859.77	1116.14	1682.48	1758.47	12668.02
Oysters	247.01	187.53	272.1	255.24	147.66	174.91	279.87	157.86	226.62	223.53	276.57	269.34	241.58	277.23	266.45	276.85	3811.38
Prawns	126.84	120.19	157.7	124.88	0.00	0.00	0.00	0.00	11.44	17.92	0.00	0.00	0.00	0.00	0.00	0.00	558.97
Seaweed	0.00	0.00	0.00	0.00	0.00	0.00	664.0	0.00	1833.49	1900.18	2015.01	2884.61	2000	0.00	1643.60	0.00	12940.89
Total*	1055.92	1280.9	1290.71	1479.14	1298.67	1319.39	1655.23	1407.11	2014.62	1860.18	1992.15	2173.11	2261.69	2985.69	3417.59	3591.86	31092.99

Total marine aquaculture production has increased by 2535.94 tons (240.16%) from 2000 to 2015 (Figure 5). This reflects an increase of over three (3) fold within a period of sixteen (16) years. This substantial increase was attributed to coordinated efforts between both Government and the private sector in developing the industry. In addition, a growing awareness amongst consumers played a role in increasing fish demand.

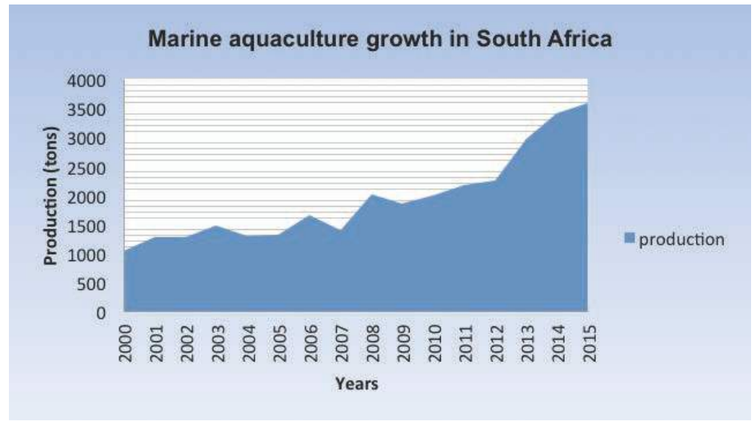

Figure 5: Marine aquaculture production from 2000 to 2015.

3.5. Marine aquaculture analysis per sub-sector

3.5.1. Abalone sub-sector

Currently one (1) abalone species, *Haliotis midae*, is farmed for commercial purposes. In 2015, a total of eighteen (18) abalone farms were recorded compared to nineteen (19) farms in 2014. The abalone sub-sector contributed a total production volume of 1479.22 tons, representing an increase of 181.92 tons on production in 2014 despite the closure of one (1) farm (Figure 6).

Out of the eighteen (18) abalone farms operated in 2015, twelve (12) were land-based facilities with independent hatcheries and four (4) operated grow-out facilities only. The other two (2) abalone farms included sea cage culture. Three (3) farms were registered as ranching operations where abalone is seeded into their natural environment. The abalone sub-sector distribution range stretches from the Northern Cape and Western Cape to the Eastern Cape. Four (4) farms operate in the Northern Cape, two (2) in the Eastern Cape and twelve (12) in the Western Cape.

Figure 6: Abalone production in South Africa from 2000-2015.

3.5.2 Finfish sub-sector

The finfish sub-sector in South Africa is still an emerging industry. Over the years a number of species have been piloted to assess their feasibility and market access. To date, the dusky kob (*Argyrosomus japonicas*) is the only commercial species being cultured in the industry. Other marine finfish species were kept on farm sites for research purposes. These species included yellowtail *(Seriola lalandi)*, mangrove snapper *(Lutjanus argentimaculatus)*, spotted grunter *(Pomadasys commersonnii)* and yellow belly rock cod (Epinephelus marginatus). The finfish sub-sector experienced a decrease in production of 84.54 tons (52.21%) from the 161.86 tons produced in 2014 (Figure 7).

In addition to the four (4) farms that were operational in 2014, three (3) new farms were established, resulting in a total of seven (7) farms in 2015. Western Cape operations included two (2) recirculation facilities, one situated in Paternoster and the other in Saldanha, two (2) pond culture facilities in Kwa-Zulu Natal, one located in Mtunzini and the other in Richards' Bay and three (3) recirculation facilities in the Eastern Cape, two (2) in East London and one (1) in Hamburg.

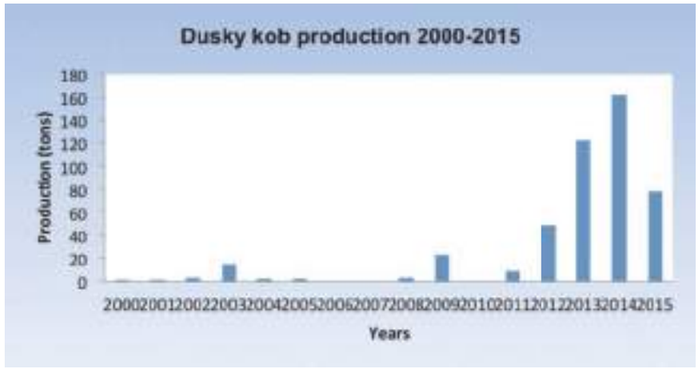

Figure 7: Dusky kob production in South Africa from 2000-2015.

3.5.3 Oyster sub-sector

The exotic Pacific oyster *(Crassostrea gigas)* is the only species cultivated in South Africa. There were eight (8) farms operating in 2015. This sub-sector reported a total production of 276.85 tons, indicating an increase of 10.4 tons from the 266.45 tons produced in 2014, demonstrating an increase of 3.90% which has contributed 7.69% to total marine aquaculture production (Figure 8). Oyster farms are currently situated in the Northern Cape, Western Cape and Eastern Cape. A total of five (5) farms in the Western Cape were operational and included four (4) in Saldanha Bay, one (1) in Knysna and one (1) in Paternoster. The majority of the production was contributed by the Western Cape with 89.39%. Oyster farming in the Eastern Cape is represented by two (2) farms, one located in Port Elizabeth and one (1) in Jeffery's Bay. The Northern Cape has one (1) oyster farm located in Kleinzee, Springbok.

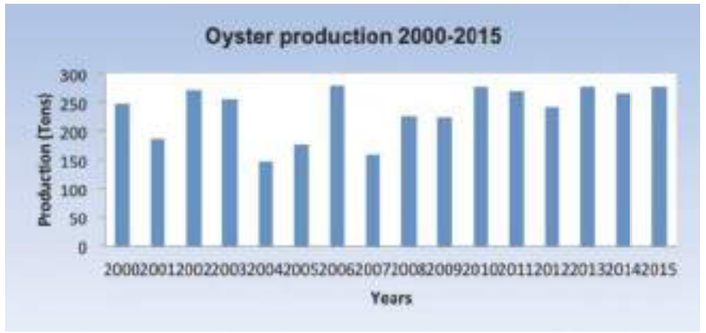

Figure 8: Oyster production in South Africa from 2000-2015.

3.5.4 Mussel sub-sector

Mussel farming in South Africa is situated in Saldanha Bay in the Western Cape, and in 2015 there were four (4) farms in operation. The species cultured in South Africa are the exotic Mediterranean mussel (Mytilus galloprovincialis) and the indigenous black mussel (Choromytilus meridionalis). In 2015 the mussels sub-sector recorded the highest production to date of 1758.47 tons, representing an increase of 75.99 tons on the mussels produced in 2014 (Figure 9). The mussel sub-sector contributed 48.83%, to the total production in 2015 and is the highest contributor to aquaculture production in South Africa.

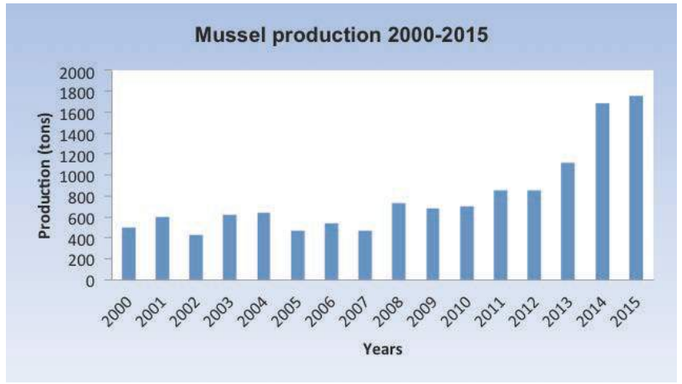

Figure 9: Mussel production in South Arica from 2000 - 2015.

3.6 Marine aquaculture site surveillance during 2015

Site surveillance of the marine aquaculture sector has played a vital role since 2008 in updating information on growth in the sector and ensuring compliance with the Department's marine aquaculture permitting frameworks and regulations promulgated under the MLRA. This has been essential in ensuring that non-compliant operations are communicated through proper channels such that the Chief Directorate: Monitoring, Control and Surveillance (CD: MCS) performs its role responsibly in protecting the wellbeing of the industry. This has also ensured open channels of communication between the Department and the marine aquaculture industry in the development of permit conditions for the sector. In 2015, the D: SAM conducted site surveillance of nine (9) marine aquaculture right holders and three (3) abalone ranching pilot operations, including:

- Abalone *(Haliotis midae)* ranching pilot operations in the Northern Cape *(i.e. Kleinzee and Hondeklipbaai)*;
- Abalone *(Haliotis midae)* operations in the Northern Cape *(i.e. Hondeklipbaai, Port Nolloth and Kleinzee);*
- One (1) oyster *(Crassostrea gigas and Striostrea margeritacea)* operation in Kleinzee, Northern Cape;
- oyster *(Crassostrea gigas and Striostrea margeritacea)* operations in the Eastern Cape (i.e. Hamburg and Port Elizabeth);
- One (1) finfish *(Argyrosomus japonicus)* pilot operation in Hamburg, Eastern Cape;
- One (1) mussel *(Mytilus galloprovincialis)* operation in Saldanha Bay, Western Cape; and
- One (1) prawn *(Litopenaeus vannamei)* operation in Krugersdorp, Gauteng.

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

STATUS OF THE FRESHWATER AQUACULTURE

04

4.1 Freshwater aquaculture farms in 2015

Freshwater aquaculture is advantaged in that it can take place in all nine (9) provinces. During 2015, a total of 152 freshwater farms were recorded, representing a decrease of forty two (42) farms recorded in 2015. This decrease might be attributed to lack of technical knowledge and skills. Mpumalanga province had the highest number of farms operating in 2015 with a total of thirty three (33), followed by Gauteng province with thirty one (31), Limpopo and the Western Cape each with twenty (20) farms, the North West and Kwa-Zulu Natal with fifteen (15) farms each, the Free State with ten (10) farms, the Eastern Cape with six (6) farms and the Northern Cape with two (2) farms (Table 9).

Table 9: Total number of freshwater aquaculture farms operating in South Africa by sub-sector and province in 2015.

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Tilapia	2	0	20	5	16	14	1	14	2	74
Trout	2	0	0	5	0	18	0	0	13	38
Catfish	1	7	1	0	3	0	0	1	0	13
Marron Crayfish	1	0	0	0	0	0	0	0	0	1
Carp	0	0	1	0	0	0	1	0	1	3
Koi carp	0	2	5	2	0	1	0	0	1	11
Ornamental species	0	1	4	3	1	0	0	0	3	12
Total	6	10	31	15	20	33	2	15	20	152

4.2 Freshwater aquaculture species farmed in 2015

The 2015 freshwater aquaculture sub-sectors include trout (Onchorynchus mykiss and Salmo trutta), tilapia (Oreochromis mossambicus, Oreochromis niloticus and Tilapia rendalli), catfish (Clarias gariepinus), carp (Cyprinus carpio and Ctenopharygodon idella), marron crayfish (Cherax tenuimanus), whiteleg shrimp (Litopenaeus vannamei) and a number of ornamental species (e.g., Koi-carp). A total of eight (8) species were farmed, seven (7) on a commercial scale and one (1) on a pilot scale (Table 10).

Table 10: Freshwater aquaculture species cultured in South Africa in 2015 and their operational scale.

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

4.3 Freshwater aquaculture production

4.3.1 Freshwater aquaculture production in 2015

South Africa's total freshwater aquaculture production in 2015 was 1826.29 tons. The trout sub-sector was the highest contributor with 1497.00 tons, followed by tilapia with 325.29 tons and marron crayfish with 4.00 tons (Table 11). The total production increased by 34.28 tons from 1792.01 tons recorded in 2014, representing an increase of 2.00%. The total freshwater aquaculture contribution to the overall aquaculture production is 34.00% of 5418.00 tons.

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

Species	EC	FS	GP	KZN	LP	MP	NC	NW	WC	Total
Tilapia	19.5	0	58	6.5	120	27.29	3	86	5	325.29
Trout	235	0	0	382	0	141	0	0	739	1497
Catfish	0	0	0	0	0	0	0	0	0	0
Marron crayfish	4	0	0	0	0	0	0	0	0	4
Koi-carp	0	0	0	0	0	0	0	0	0	0
Ornamental	0	0	0	0	0	0	0	0	0	0
Total	258.5	0	58	388.5	120	168.29	3	86	744	1826.29

4.3.2. Freshwater aquaculture production from 2006-2015

South Africa's freshwater aquaculture production has increased by 839.00 tons (85.00%) since 2006 (Figure 10). The total freshwater aquaculture production in 2015 was 1826.29 tons, demonstrating an increase of approximately 2.20% on the 2014 production. From 2006 to 2015, total production has been recorded as 13764.60 tons. Over this nine (9) year period, the lowest production was 838.40 tons in 2006 and the highest was 1826.29 tons in 2015 (Table 12). The trout sub-sector was the highest contributor producing 1497.30 tons, followed by 325.29 tons of tilapia and 4.00 tons of marron crayfish. The catfish sector did not produce in 2015. The trout sub-sector contributed 82.43% to the freshwater aquaculture sector, whereas tilapia contributed 17.90% followed by marron crayfish which contributed 0.22% (Figure 11).

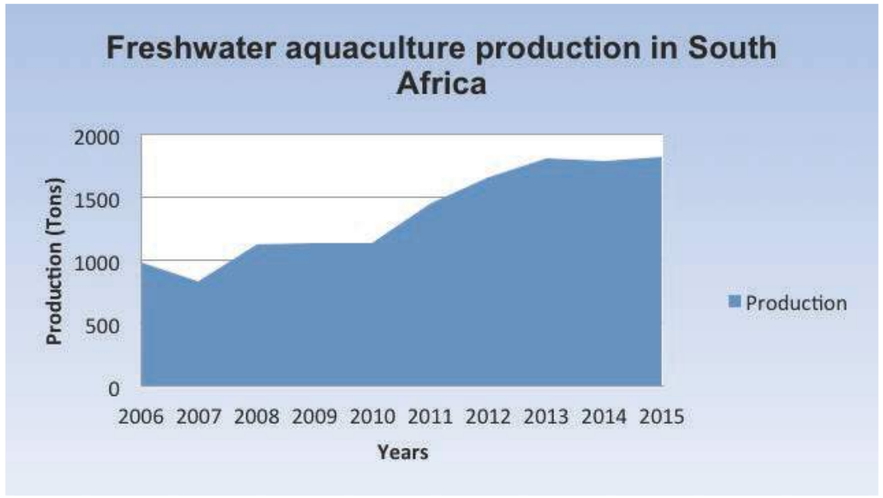

Figure 10: South Africa's freshwater aquaculture production from 2006-2015.

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

Sub-sector	Year and production(tons)										Total production (tons)
	2006	2007	2008	2009	2010	2011	2012	2013	2014	**2015	
Tilapia	0	0	0	10	10	100	234.17	289.71	289.71	325.29	1258.88
Trout	807	658	943	948.62	950	1199	1428	1497.3	1497.3	1497	11425.22
Catfish	180	180	180	180	180	160	0	0	0	0	1060
Marron crayfish	0.2	0.4	0.4	0.4	0.8	0.8	3.5	5	5	4	20.5
Totals	987.2	838.4	1123.4	1139.02	1140.8	1459.8	1665.67	1816.41	1792.01	1826.29	13764.6

**The 2015 data was analysed based on 2014 production data and 2015 export data, except for marron crayfish data.

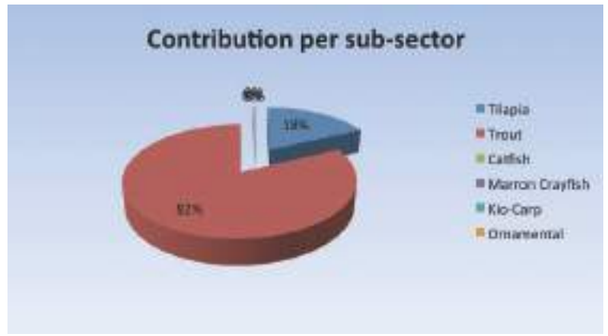

Figure 11: The contribution of each freshwater aquaculture sub-sector to the total production in 2015

4.4 Analysis of the freshwater aquaculture sub-sector

4.4.1 Trout sub-sector

The trout sub-sector has contributed 82.43% of South Africa's total freshwater production in 2015, recording a total production of 1497.00 tons (Table 13). There was no change in total production between 2014 and 2015, although there was a decrease of 3.54% in the contribution of the sub-sector to the total freshwater production (Figure 12). The trout farms are currently located in the Western Cape, Mpumalanga, Eastern Cape and Kwa-Zulu Natal provinces.

Onchorynchus mykiss and *Salmo trutta* are the two (2) trout species currently cultured in South Africa. The technology used to cultivate these species includes raceway, pond, cage culture and recirculating systems.

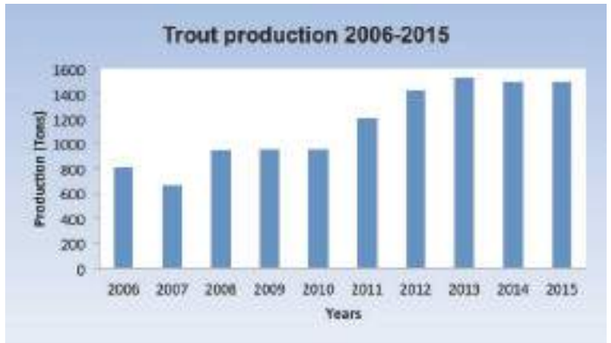

Figure 12: Trout production in South Africa from 2006-2015.

4.4.2 Tilapia sub-sector

The tilapia sub-sector in South Africa is based on the culture of the two (2) species, namely, the Mozambique tilapia *(Oreochromis mossambicus)* and the Nile tilapia *(Oreochromis niloticus)*. This sub-sector contributed 17.90% to South Africa's freshwater production, recording 325.29 tons (Table 14). There was a 35.58 tons increase in production from 2014 to 2015 (Figure 13). Most tilapia farmers are small scale farmers and they employ recirculation and pond culture systems.

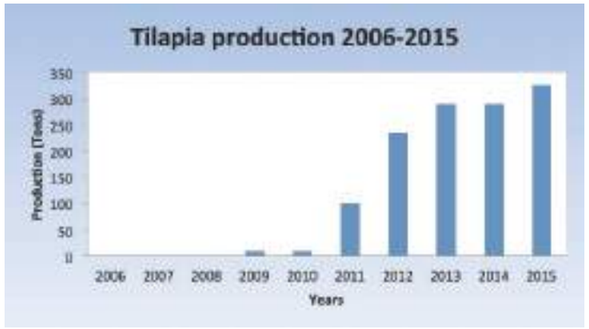

Figure 13: Tilapia production in South Africa from 2006-2015.

4.4.3 Catfish sub-sector

The catfish sub-sector in South Africa is based on the indigenous species, the African sharptooth catfish *(Clarias gariepinus)*. The catfish industry recorded zero production in 2015 having not produced since 2011 (Figure 14). Most of the farmers concentrated on producing fingerlings for the export market rather than growing the fish to market size.

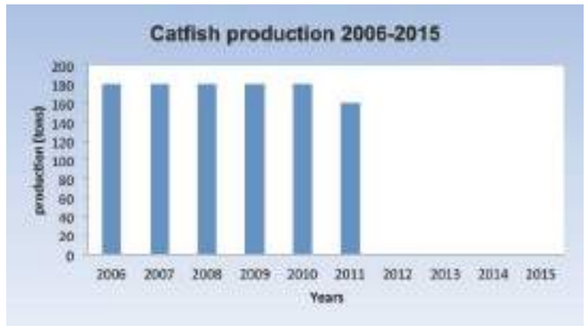

Figure 14: Catfish production in South Africa from 2006-2015.

4.4.4 Marron crayfish sub-sector

Marron crayfish (Cherax tenuimanus) is exotic to South Africa with a single farmer culturing the species. A total of 4.00 tons was produced in 2015, 1.00 ton less than that produced in 2014 (Figure 15). Marron crayfish produced in 2015 contributed 0.22% to the total freshwater aquaculture sector. The current marron crayfish farm is located in the Eastern Cape where it is cultured in tanks during the juvenile phase, before being moved to semi-intensive pond culture for grow-out.

4.5 Freshwater aquaculture authorisations in 2015

There are no authorizations for the freshwater aquaculture sector. This is due to lack of overarching legislative tool by the lead government department, i.e. DAFF. This needs to be rephrased. The DAFF is addressing this challenge through development of an Aquaculture Bill.

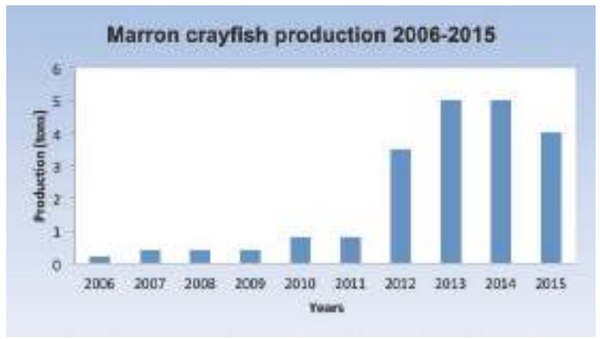

Figure 15: Marron crayfish production in South Africa from 2006-2015.

4.6 Freshwater site surveillance in 2015

No site surveillances were undertaken for freshwater aquaculture in 2015. The DAFF is 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.

PROVINCIAL ANALYSIS OF SOUTH AFRICA'S AQUACULTURE SECTOR IN 2015

The analysis below excludes the freshwater aquaculture sector and it should be noted that not all farms produced fish in 2015.

5.1 Eastern Cape

The Eastern Cape is one of the four coastal provinces able to undertake both marine and freshwater aquaculture activities. In addition, it also has the advantage of several ports for transportation.

Number of farms and species farmed: In 2015, the Eastern Cape province recorded a total of twelve (13) farms: six (7) marine farms and six (6?) freshwater farms. The numbers of farms recorded in 2015 was the same as that recorded in 2014 and comprised one (2) abalone, three (3) finfish, two (2) oyster, two (2) tilapia, two (2) trout, one (1) catfish and one (1) marron crayfish farm.

Production: During 2015 not all operational farms produced fish. The total production for the Eastern Cape was 498.46 tons, contributing 9.20% to the overall aquaculture production (Figure 16). The total aquaculture production in the Eastern Cape has decreased by 18.54 tons (20.98%) from 630.83 tons in 2014. Marine aquaculture in the province produced 239.16 tons, accounting for 4.40% of the national production and 6.40% of the national marine production. Freshwater aquaculture produced 258.50 tons in the Eastern Cape, accounting for 4.80% of the national production and 14.15% of the national freshwater aquaculture production. Freshwater production in the Eastern Cape in 2015 decreased by 5.50 tons (2.08%) from 2014.

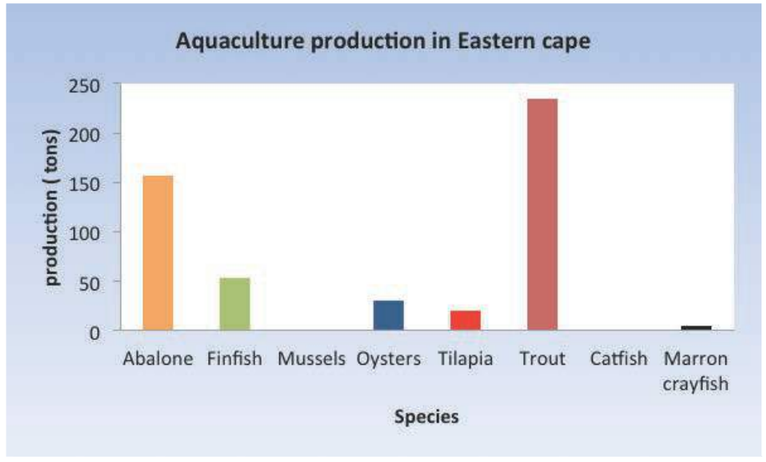

Figure 16: Aquaculture production in the Eastern Cape

5.2 Kwa-Zulu Natal

Kwa-Zulu Natal is also one of the four coastal provinces able to undertake both marine and freshwater aquaculture activities. In addition, its warm temperatures can reduce farming costs.

Number of farms and species farmed: In 2015, the Kwa-Zulu Natal province recorded a total of seventeen (17) farms comprising two (2) marine farms and fifteen (15) freshwater farms. The number of farms recorded in 2015 remained the same as that recorded in 2014 and comprised of two (2) finfish, five (5) trout, five (5) tilapia, two (2) Koi carp and three (3) ornamental farms.

Production: The total production for Kwa-Zulu Natal was 412.94 tons, contributing 7.60% to the overall aquaculture production (Figure 17). The total aquaculture production in Kwa-Zulu Natal increased in 2015 by 28.63 tons (7.45%) from 384.31 tons in 2014. The marine aquaculture production in the province recorded a production of 24.44 tons, accounting for 0.45% of the national aquaculture production and 0.68% of the national marine production. Freshwater aquaculture production in the province recorded a production of 388.50 tons, accounting for 7.17% of the national aquaculture production and 21.27% of the national freshwater production. Freshwater production in Kwa-Zulu Natal decreased in 2015 by 4.19 tons (1.09%) from 2014.

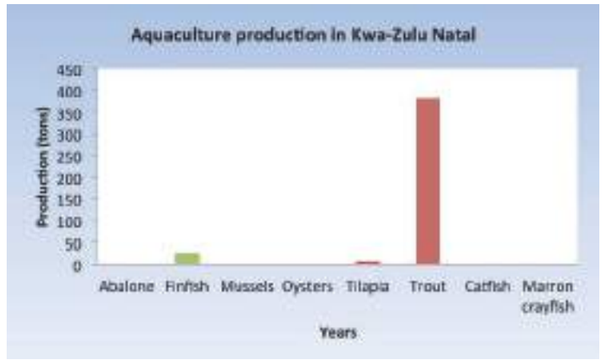

Figure 17: Aquaculture production in Kwa-Zulu Natal.

5.3 Northern Cape

As in other coastal provinces, the Northern Cape is able to support both marine and freshwater aquaculture. In 2015, the province engaged in both marine and freshwater aquaculture.

Number of farms and species farmed: In 2015, the Northern Cape province recorded a total of seven (7) farms comprising five (5) marine and two (2) freshwater farms. There was a decrease of four (4) farms when compared to the eleven (11) farms recorded in 2014. The farms comprised of four (4) abalone, one (1) oyster, one (1) tilapia and one (1) carp farm.

Production: The total production for the Northern Cape in 2015 was 22.62 tons, contributing 0.42% to the national aquaculture production (Figure 18) and representing an increase of 10.50 tons (86.63%) from the 12.12 tons produced in 2014. Marine aquaculture produced 19.62 tons, accounting for 0.36% of the national aquaculture production and 0.55% of the national marine aquaculture production. Freshwater aquaculture produced 3.00 tons in the Northern Cape, accounting for 0.06% of the national aquaculture production and 0.16% of the national freshwater production. Freshwater production in Northern Cape decreased by 1.50 tons (33.33%) from that produced in 2014.

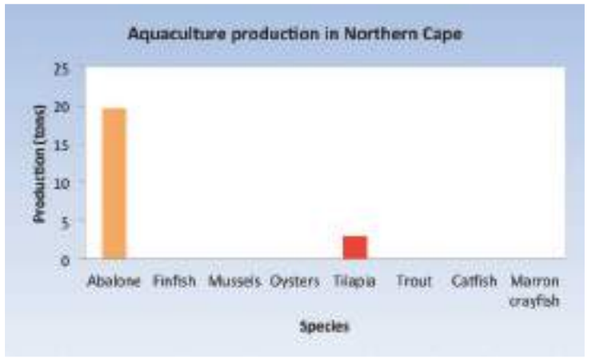

Figure 18: Aquaculture production in Northern Cape.

5.4 Western Cape

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

Number of farms and species farmed: In 2015, the Western Cape province recorded a total of forty three (43) farms comprising twenty three (23) marine farms and twenty (20) freshwater farms. There was an increase of sixteen (16) farms compared to the twenty seven (27) farms recorded in 2014. The farms comprised twelve (12) abalone, two (2) finfish, two (4) mussel, five (5) oyster, two (2) tilapia, thirteen (13) trout, one (1) carp, one (1) koi-carp and three (3) ornamental fish farms.

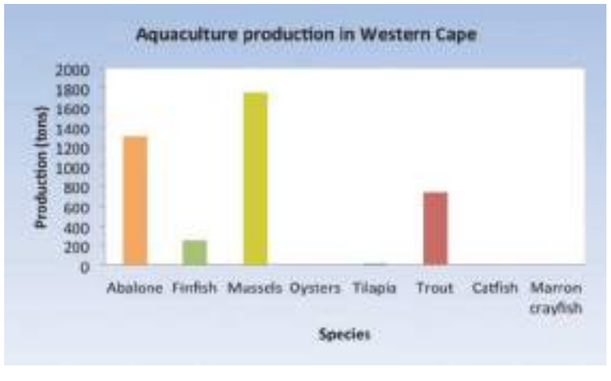

Figure 19: Aquaculture production in Western Cape

Production: The total production for the Western Cape was 4052.64 tons, contributing 74.80% to national aquaculture production (Figure 19). Aquaculture production in the Western Cape decreased by 259.42 tons (6.84%) from the 3793.22 tons produced in 2014. Marine aquaculture produced 3308.64 tons, accounting for 61.07% of the national aquaculture production and 0.68% of the national marine aquaculture production. Freshwater aquaculture produced 744.00 tons in the Western Cape, accounting for 13.73% of the national aquaculture production and 40.74% of the national freshwater aquaculture production. Freshwater production in the Western Cape decreased by 0.65 tons (0.09%) from that produced in 2014.

5.5 Free State

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

Farms and species farmed: In 2015, the Free State province recorded a total of ten (10) freshwater farms. This represents an increase of three (3) freshwater farms compared to the seven (7) farms recorded in 2014. The farms comprised of seven (7) catfish farms, two (2) Koi carp farms and one (1) ornamental farm.

5.6 Mpumalanga

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

Number of farms and species farmed: In 2015, Mpumalanga province recorded a total of thirty three (33) freshwater farms representing a decrease of nine (9) farms compared to the forty two (42) farms recorded in 2014. The farms comprised fourteen (14) tilapia, eighteen (18) trout and one (1) koi-carp farm.

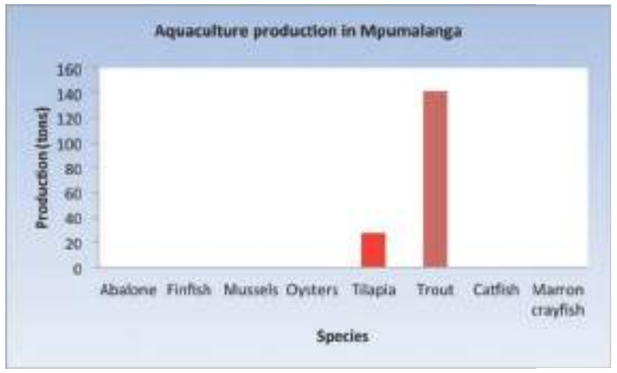

Figure 20: Aquaculture production in Mpumalanga.

Production: The total production for Mpumalanga was 168.29 tons, contributing 3.11% to the national aquaculture production (Figure 20). Aquaculture production in Mpumalanga decreased by 12.28 tons (7.87%) from the 156.01 tons produced in 2014. Freshwater aquaculture produced 168.29 tons in Mpumalanga, accounting for 3.11% of the national aquaculture production and 9.21% of national freshwater aquaculture production.

5.7 Gauteng

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

Number of farms and species farmed: In 2015, the Gauteng province recorded a total of thirty one (31) freshwater farms representing a decrease of six (6) farms compared to the thirty seven (37) recorded in 2014. The farms comprised twenty (20) tilapia, one (1) catfish, five (5) Koi carp, one (1) carp and four (4) ornamental fish farms.

Production: The total production for Gauteng was 58 tons, contributing 1.07% to the national aquaculture production and 3.18% of the national freshwater aquaculture production (Figure 21). The total aquaculture production in the Gauteng in 2015 increased by 4.45 tons (8.31%) from the 53.55 tons produced in 2014.

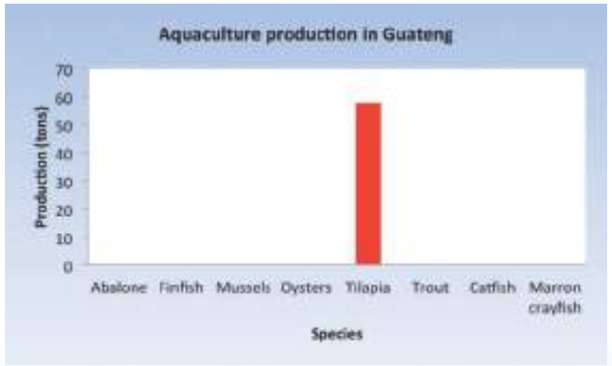

Figure 21: Aquaculture production in Gauteng.

5.8 Limpopo

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

Number of farms and species farmed: In 2015, Limpopo province recorded a total of twenty (20) freshwater farms representing a decrease of five (5) farms compared to the twenty five (25) farms recorded in 2014. The farms comprised sixteen (16),tilapia, three (3) catfish and one (1) ornamental fish farm.

Production: Limpopo province produced 120.00 tons in 2015, contributing 2.21% to the national aquaculture production and 6.57% to freshwater aquaculture production (Figure 22). Aquaculture production in Limpopo province decreased by 12.00 tons (11.11%) from the 108 tons produced in 2014. Freshwater aquaculture production in the province has recorded a production of 120.00 tons.

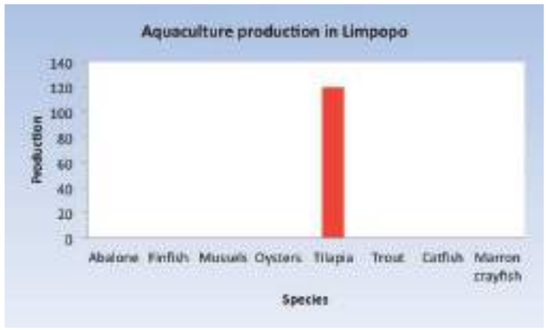

Figure 22: Aquaculture production in Limpopo.

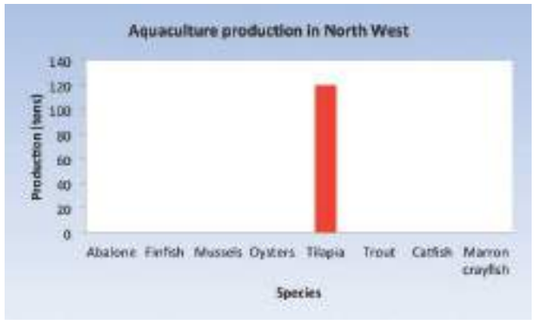

Figure 23: Aquaculture production in North West.

5.9 North West

North West province has proven to be at a disadvantage when looking at access to markets, but has a strong advantage in terms of access to suitable water bodies. Due to its location within the country, North West can only successfully engage in freshwater aquaculture and not in marine aquaculture

Number of farms and species farmed: In 2015, North West province recorded a total of fifteen (15) freshwater farms representing a decrease of eight (8) farms from the twenty three (23) farms recorded in 2014. The farms comprised fourteen (14) tilapia farms and one (1) catfish farm.

Production: The total production for North West was 86.00 tons, contributing 1.59% to the national aquaculture production and 4.71% of freshwater production (Figure 23). Aquaculture production in the North West decreased by 8.65 tons (11.18%) in 2015 from the 77.35 tons produced in 2014.

6.1 South African Molluscan Shellfish Monitoring and Control Programme

The South African Molluscan Shellfish Monitoring and Control Programme (SAMSM&CP) is a programme run by the D: SAM within the CD: AED and aims to provide the necessary guarantees to local and international markets that food safety risks associated with the production of molluscan shellfish are adequately managed and minimized.

To insure that this is achieved the SAMSM&CP works closely with the following stakeholders: Fisheries Compliance Office of DAFF, South African molluscan shellfish farmers, laboratories, the National Regulator for Compulsory Specification (NRCS), the Department of Health (DoH) and local Municipalities.

The molluscan shellfish species cultivated in South Africa include abalone *(Haliotis midae)*, oyster *(Crassostrea gigas*), Mediterranean mussel *(Mytilus galloprovincialis)* and black mussel *(Choromytilus meridionalis)*.

The shellfish farms are monitored by the SAMSM&CP for human health hazards such as bio-toxins, microbiological organisms, heavy metals, pesticides, polychlorinated biphenyls (PCBs), drug residues, dioxins, dyes and radionuclides during the production phase. Should the regulatory limit for any of the hazardous substances in the shellfish be exceeded, the farms are temporarily closed for harvesting until the contaminant reaches acceptable limits.

6.1.1 Shellfish Farm Status

In 2015, 30 shellfish farms were monitored by the SAMSM&CP of which eighteen (18) farms were to the west of Cape Point and twelve (12) farms to the East of Cape Point (Figure 24). The farms to the west of Cape Point included six (6) abalone farms, six (6) mussel farms and six (6) oyster farms. Farms to the east of Cape Point included eleven (11) abalone farms and one (1) oyster farm.

Figure 24: Distribution of shellfish farms along the South African coast

All abalone farms that were monitored are land-based while the oyster and mussel farms were sea-based. Shellfish farms are susceptible to contaminated water as result of harmful algal blooms (HABs), sewage, industrial and domestic contamination. The farms which are at most risk of pollution are those situated near developed areas. Generally the farms to the west of Cape Point are more at risk of bio-toxin contamination than the farms to the east of Cape Point.

6.1.2 Monitoring of Hazardous Substances in Shellfish

Analysis for microorganisms were undertaken by the South African Bureau of Standards (SABS), situated in Rosebank, Cape Town and Swift Silliker laboratories situated in Claremont, Cape Town. The tests included Escherichia coli *(E. coli)*, Salmonella species and Vibrio species. SABS and Swift Silliker were both accredited by the South African National Accreditation System (SANAS), SABS was accredited for Salmonella and Vibrio and Swift Silliker for E. coli.

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

Other hazardous substances monitored included heavy metals (lead, mercury, inorganic arsenic and cadmium), pesticides, drug residues, dioxins, PAH, dyes and PCBs. The CSIR in Rosebank, Cape Town tested the samples for heavy metals and the Swift Silliker in Claremont tested for pesticides and PCBs. Radionuclides are tested for by Nuclear Energy Corporation of South Africa (NECSA) in Pretoria.

The test methods that the labs employed are stipulated in the SAMSM&CP and the methods used are SANAS accredited or the labs are working towards accreditation. The methods have however all been validated. These hazardous substances and microbiological organisms were monitored at the frequency depicted in Table 13 unless otherwise stipulated.

The monitoring frequency on farms is based on the potential risk of contamination. For bio-toxins, farms west of Cape Point are considered to be at higher risk. Greater upwelling west of Cape Point is considered to lead to a high incidence of HABs and concomitant bio-toxin accumulation in the shellfish. The classification status of the farm was also considered when designing a monitoring programme.

Table 13: Schedule for testing of hazardous substances

	West of Cape Point		East of Cape Point	
Hazardous Substances	**Filter Feeder**	**Non – Filter feeder**	**Filter Feeder**	**Non – Filter Feeder**
Bio-toxins				
PSP causing toxins	48h or twice a week for multiple harvesting	2 weekly	Monthly	Monthly
DSP causing toxins	Weekly	Monthly	2 weekly	Monthly
ASP	Monthly	Monthly	Monthly	Monthly
Microorganisms				
E. coli	Monthly	-	Monthly	-
Salmonella	Monthly	-	Monthly	-
Vibrio	Monthly	-	Monthly	-
Other Hazardous substances				

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

If the positive result is confirmed the farm is temporarily closed and the relevant stakeholders are informed accordingly. A farm is also temporarily closed if shellfish are not tested in accordance with the SAMSM&CP. The farm is re-opened only when the concentration of the hazardous substance is below the regulatory limit as indicated in Table 14 and/or the programme is complied with.

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

Hazardous Substances	Regulatory Limit
Bio-toxins	
PSP toxins	< 0.8 mg PSP/kg edible flesh
Okadaic acid group toxins: OA, DTX 1, DTX 2 & DTX 3 and *Pectenotoxins* group toxins: PTX 1 & PTX 2	≤ 0.16 mg *okadaic* acid equivalents / kg edible flesh (Commission Regulation (EC) No 853/2004). (EU-RL* LC-MS/MS method) (Commission Regulation (EC) No 15/2011)
Yessotoxins group toxins: YTX, 45 OH YTX, homo YTX, and 45 OH homo YTX	≤ 8 mg *yessotoxin* equivalents / kg edible flesh (Codex). (Liquid Chromatography Mass Spectrometry (EU-RL LC-MS/MS method) (Commission Regulation (EC) No 15/2011)
Azaspiracids group toxins: AZA1, AZA2 and AZA3.	≤ 0.16 mg *azaspiracid* equivalents / kg edible flesh (Commission Regulation (EC) No 853/2004). (^Liquid Chromatography Mass Spectrometry (EU-RL LC-MS/MS method) (Commission Regulation (EC) No 15/2011)
ASP	ASP < 20 mg DA/kg edible flesh
Microorganisms	
E. coli	<230/100g edible flesh
Salmonella	Absent
Vibrio	Absent
Other Hazardous substances	
Heavy Metals	Lead: < 1.5 mg/kg edible flesh Mercury: < 0.5 mg/kg edible flesh Cadmium: < 3.0 mg/kg edible flesh
Pesticides	< 0.01 mg/kg
PCB	< 0.02 mg/kg
Dioxin-like PCB	< 2.5 mg/kg
Dioxins	< 3.5 mg/kg
PAH	< 5 mg/kg
Radionuclides	< 600 Bq/kg

The criteria for re-opening a farm, depends on the contaminant that is present on that particular farm. For example, when the farm is temporarily closed due to bio-toxins, the farm is required to submit three consecutive samples to CSIR lab for analysis of the contaminant. The samples should be taken over a period not exceeding two weeks and samples may not be taken on the same day. If all three samples are below the regulatory limit, the farm will be reopened.

6.2 Monitoring Data (analysis) And Farm Closures

Bio-toxins were analyzed separately for two regions namely, west of Cape Point and east of Cape Point. The other hazardous substances are analyzed for the South African coast as a whole.

There were 29 farm closure notices sent to shellfish farms by the SAMSM&CP office in 2015. Thirteen (13) of the farm closure notices were due to the presence of bio-toxins, fifteen (15) were due to the microbiological contamination, and a few due to non–compliance. There were no closures due to other hazardous substances namely heavy metals, pesticides, PCBs or radionuclides.

6.3 Microbiological Contamination

Escherichia coli are used as an indicator species for the potential presence of sewage 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, except for the mussel and oyster farms that were classified as "Conditionally Approved Class A". Other microbiological species tested for included *Salmonella* and *Vibrio.*

During 2015, shellfish farms received 15 closure notices from the SAMSM&CP office informing them that the microbiological concentration in the shellfish had exceeded the regulatory level. The farms were prohibited from marketing live products; however, they were permitted to market processed products. Each time the closure notices were sent, the farms were temporarily closed for an average period of thirteen (13) days.

The abalone production facilities classified as approved were exempted from testing the production area monthly for E. coli. They were required to monitor for microbial contamination during official surveillance of end-of-line product. However, in 2015 the test results of the end-of-line product from two abalone farms were non-compliant. The farms were monitored for a period of three (3) months and microbiological sampling was conducted weekly. The classification status of the implicated farms remained Approved Class A after the 3 month period.

6.4 Wet Storage Facilities

In 2015, one of the oyster farms in Saldanha Bay constructed a wet storage facility for its product. Wet storage refers to the temporary re-immersion of live shellfish in near shore waters or onshore tanks prior to placement on the market. The primary reason for wet storage is to allow shellfish to purge following harvesting.

The wet storage facility in Saldanha Bay was monitored weekly for *E. coli* and monthly for *Vibrio cholera, Vibrio parahaemolyticus* and *Salmonella* and classified accordingly. Microbiological contamination was shown to be below the regulatory limit throughout the year 2015.

6.5 Bio-toxins

During 2015, a total of twelve (12) DSP closure notices were sent to shellfish farms informing them that bio-toxin concentrations in shellfish had exceeded the regulatory limit. ASP toxins were not detected on any of the shellfish farms whereas PSP toxins were found in low concentrations. In terms of abalone, most farms eviscerate and scrub the abalone to remove the PSP toxins (Table 15) and canned the product to further reduce toxin concentrations.

Table 15: Positive toxin tests in abalone from 2010-2015

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

() = Number of samples tested

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

Mussel and oyster farms in Saldanha bay were not allowed to market any product when bio-toxins exceeded the regulatory limit. Each time closure notices were sent out, farms in the Bay were temporarily closed for an average period of 27 days. During the closure period, mussels and oysters were continually sampled from the sentinel sampling station at the mouth of the bay to test for the presence of toxins in the bay. Therefore all the farms in the bay were closed simultaneously each time the toxin concentration in these samples exceeded the regulatory limit.

6.6 Heavy metals, pesticides, dioxins, PAH, Pcbs, drug residues and radionuclides

Heavy metal concentrations did not exceed the regulatory limits in 2015 (Table 16), although they were present in low concentrations on certain farms. Lead and cadmium were not detected on the majority of the abalone farms. For those farms where heavy metal concentrations approached the regulatory limit, as in certain oyster and mussel farms, contingency measures were applied by increasing the monitoring frequency to bi-annual tests.

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

Table 16: The number of tests conducted and exceedance of regulatory limits in 2015

Substance	Count	Count exceeding regulatory limit
Total AZA Group Toxins	332	0
Total OA Group Toxins	334	25
Total YTX Group Toxins	335	0
Cadmium (Cd)	99	0
Mercury (Hg)	30	0
Lead (Pb)	31	0
Inorganic arsenic	11	0
Arsenic (As)	5	0
E. coli	278	9
Vibrio cholera	37	0
Vibrio parahaemolyticus	28	0
Salmonella	227	0
Organochlorine pesticides	19	0
PCB	20	0
Radioactivity	3	0

6.7 Compliance History

In 2015, all monitored farms complied with the requirements of the SAMSM&CP.

6.8 Shellfish Monitoring Programme Progress

In 2015, the SAMSM&CP in collaboration with farmers conducted a baseline study on drug residues. The aim of the study was to determine the risks associated with residues on cultured shellfish farms. The study will be concluded in 2016.

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

The official phytoplankton monitoring and the on-farm phytoplankton monitoring programmes were effectively implemented in 2015. The further developments of official satellite monitoring stations are, however, required for the programme to provide an effective early warning system.

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

The SAMSM&CP staff continued to improve communications with relevant stakeholders involved in the programme.

Based on the site visits and awareness programmes that the SAMSM&CP has been involved in, the office decided to conduct a workshop for all ports of exit, which included participation by DAFF Fisheries Compliance Officers (FCO). The aim of the workshop was to ensure that, D: SAM, border control officials and FCO share information on the implementation of food safety requirements, rights, permits and permit conditions.

ECONOMIC OVERVIEW OF SOUTH AFRICA'S AQUACULTURE SECTOR 2015

7.1 Introduction to Aquaculture Economics

The purpose of this section is to provide aquaculture stakeholders with trade information and statistical trends of the aquaculture sector annually. This section outlines the economic performance, growth and development of aquaculture in South Africa during the year 2015.

7.2 Aquaculture Investment

In terms of capital investment, there has been a significant growth of investment in the sector with contributions from both the government and the private sector. There are number of government funding programmes and Development Finance Institutions (DFI's) that provide financial support within the sector. The government has continued to support the development of the sector. The DAFF and the dti collaborated to develop a dedicated incentive scheme for aquaculture, the Aquaculture Development and Enhancement Programme (ADEP) which continues to stimulate investments in the sector.

Over the years lending institutions and government have realised that there is potential for aquaculture and as a result considerable progress has been made although it still faces several challenges. The sector has also benefited from traditional agricultural funding programmes such as Comprehensive Agricultural Support Programme (CASP) and DFI's such as the Industrial Cooperation Development (IDC) and the National Empowerment Fund (NEF).

In 2015, the total additional investment of approximately R264 million was achieved from both the marine (including crocodiles) and the freshwater aquaculture sectors r, representing an increase of 35% from R162 million in 2014.

The highest investments were from the abalone sector contributing 67% to the overall total investments. The tilapia subsector has also been growing rapidly over the past years and more than R37 million was invested in the sub-sector during 2015 (Table17). Tilapia sub-sector was the second contributor with 15%, followed by the trout sub-sector with 12%. The dusky kob sub-sector experienced the lowest investment with only R383 553 contributing less than 1% towards the total capital investments during 2015 (Figure 25).

Table 17: Capital investments made by different aquaculture sub-sectors during 2015

Table 17: Capital investments made by different aquaculture sub-sectors during 2015	
Subsector	**Investments**
Abalone	R 178 775 441,00
Crocodiles	R 5 000 000,00
Dusky Kob	R 383 553,00
Mussels	R 7 780 623,00
Oysters	R 1 980 000,00

Tilapia	**R 38 667 338,00**
Trout	**R 31 859 620,00**
Total	**R 264 446 575,00**

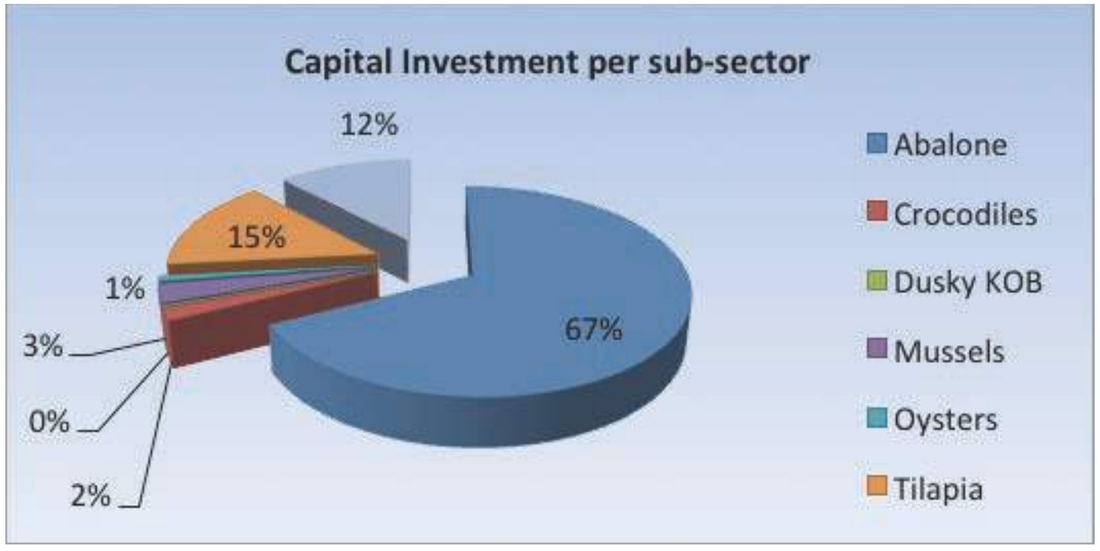

Figure 25: Capital investments made by different aquaculture sub-sectors during 2015

Western Cape Province contributed more than 70% to the total capital investments (Figure 26) this can be attributed mainly to the Abalone and mussel sub-sectors since most farms are based in the province. Mpumalanga and Limpopo contributed approximately 7% each followed by Gauteng Province with just 5%. No investments were recorded in North West and the Free State during the reporting period.

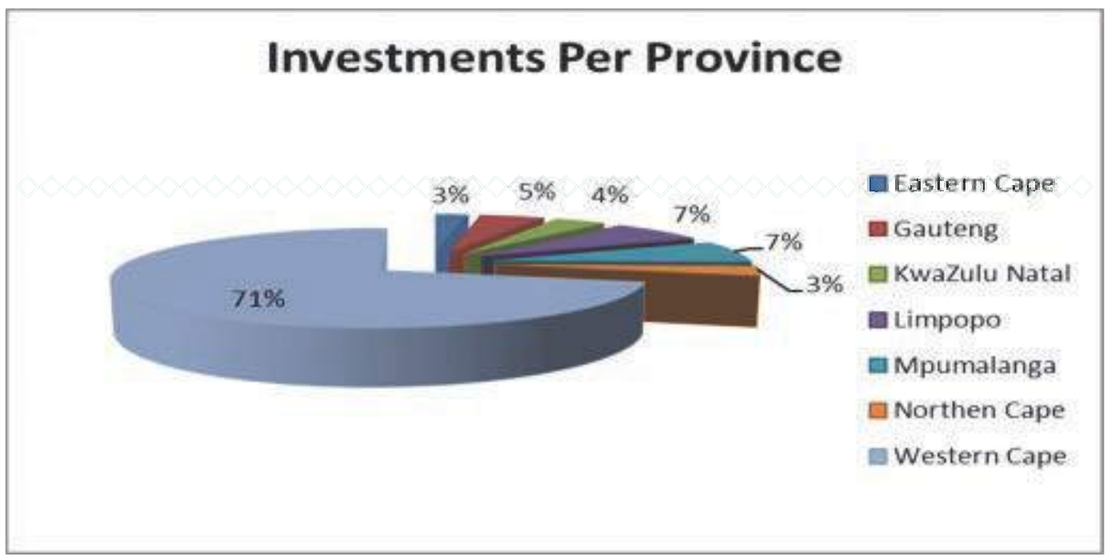

Figure 26: Capital Investments (%) contributed by each province during 2015.

7.3 Employment Status

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

The marine sector recorded 1556 jobs in 2010 and 1607 in 2011. In 2012, both marine and freshwater sectors collectively recorded 2227 jobs and 2831 in 2013. Due to lack of data no employment figure was recorded in the Aquaculture Yearbook 2014. Available statistics reveal the employment has increased by approximately 17, 5% between 2010 and 2013. Using average 425 (17, 5%) annual employment increase between 2010 and 2013, it can be estimated that in 2014 there were 3256 jobs in the sector. Based on the 2014 estimated employment baseline and the average 17, 5% annual employment increase, it can be estimated that there were 3826 jobs in the sector presenting 570 additional jobs created in 2015.

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

7.3.1 Aquaculture Development and Enhancement Programme (ADEP)

A total of 282 additional proposed jobs were created by the sector through ADEP projects beneficiaries in 2015. Figure 27 illustrates the jobs created per sub-sector. The Abalone sub-sector created the highest number of jobs with the total of 79, followed by the tilapia and the mussel sub-sector by 76 and 75 jobs respectively.

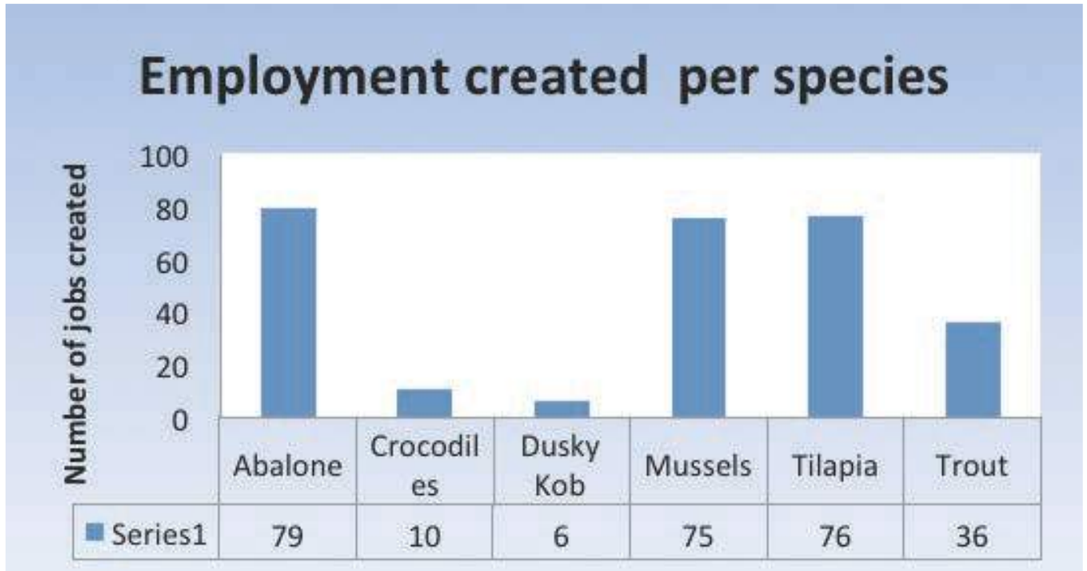

Figure 27: Total aquaculture employment created during 2015

The Western Cape continued to be the leading contributor to the increase in employment, contributing 60%. Gauteng Province and Limpopo contributed 13% and 10% respectively.

7.3.2 Operation Phakisa

Through Operation Phakisa Aquaculture priority projects the sector achieved 261 additional jobs in 2015. Achieving approximately 77,4% of the targeted 337 jobs to be created in 2015 set during the lab.

7.4 Overview of aquaculture market

The market for aquaculture products is expanding throughout the world; this represents the growing demand for aquaculture products and the growing source of foreign currency for many countries. According to Food and Agricultural Organization (2015), approximately 78% of aquaculture products were exposed in the international trade competition. The data from 2015 indicates the slow movement in the emerging markets with shrinkage in trade mainly in value terms. There are several factors that contributed to the slow movement in the international market which includes maturing global supply chain and strong exchange rate fluctuation.

South Africa is not a traditional fish eating nation but its consumers have become more aware of the growing range of aquaculture products. The growth of the South African aquaculture industry has the potential to contribute significantly to economic activity, poverty reduction, empowerment, employment and the sustainable use of coastal and inland resources to the benefit of local communities (FAO: National Aquaculture Sector Overview- South Africa, 2017).

7.5 Supply Structure

In South Africa a marketing system has developed among the primary processors of aquaculture products. The companies have developed their own cold storages and distribution network mainly to support their primary farm operations. There are also fully integrated marketing and merchandising operations that handle distribution to the retail sector, and is mostly used by new entrants.

7.6 Status for local aquaculture market

South Africa's local aquaculture market movement is mostly influenced by market price, consumer awareness, ease of accessibility and species availability. The increasing awareness of environmental sustainability and the increasing health concerns of consumers have resulted in increased demand for aquaculture products. Therefore, South Africa continues to import low value species at cheaper tariffs to satisfy the local market. However, high value species which include abalone are exported due to higher returns from the international market.

7.7 Aquaculture export market

During 2015, South Africa exported approximately 1 399 tons of aquaculture products with an estimated value of R487.80 million, with Hong Kong being the leading importer of aquaculture products, followed by Botswana and Taiwan.

7.7.1 Abalone

A total of 750.9 tons of abalone with an estimated value of R463.2 million was exported to the Asian market. Hong Kong imported 72% of South African farmed abalone, followed by Taiwan, Singapore and Japan. Abalone is exported in different forms, dried, canned and live. In comparison with 2014 the abalone exports decreased by nearly 5%, this might be caused by high mortalities on one of the abalone farms in 2015. Table 18 and Figure 28 show the quantity of abalone exported.

Table 18: South Africa's Abalone exports during 2015

Species	Importers	Quantity (Tons)	Value (ZAR Million FOB)	Average price/kg (Rands)
Abalone	Botswana	0.01	0.001199	119.9
Abalone	China	1.947	0.764206	394.9511
Abalone	Hong Kong	540.55	343.3245	635.1392
Abalone	Japan	19.05	30.20315	1585.4672
Abalone	Malaysia	3.787	4.423908	1168.1827
Abalone	Namibia	1.115	0.127308	114.1776
Abalone	New Zealand	0.012	0.017172	1431
Abalone	Singapore	23.806	20.02669	841.2455
Abalone	Swaziland	7.879	0.121091	15.36883
Abalone	Taiwan	144.969	62.83395	433.4303
Abalone	Tanzania	0.12	0.003594	29.95
Abalone	United Arab Emirates	5.881	0.480275	81.66553
Abalone	Viet Nam	1.789	0.95772	535.3382
	Total	750.915	463.2847	7385.81618

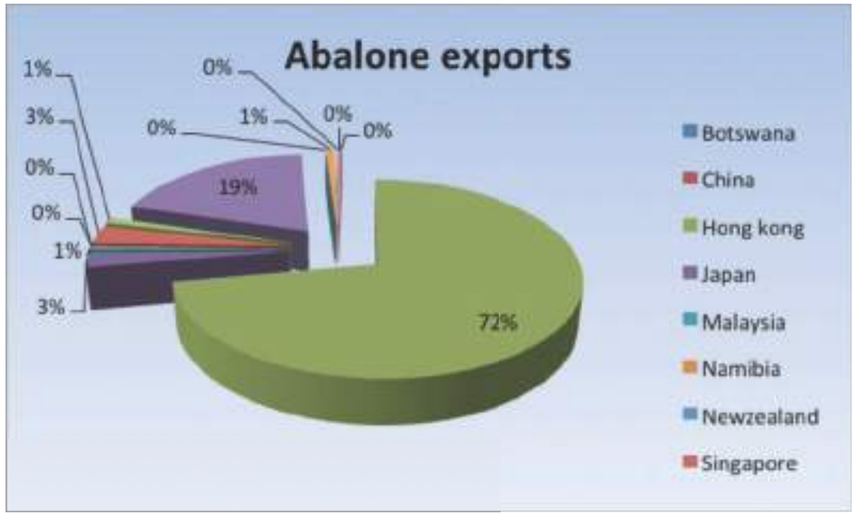

Figure 28: Abalone exported during 2015

7.7.2 Oysters

South Africa exported 67 tons of oysters with an estimated value of R4.3 million, 49% percent of oysters were exported to the Asian market while 51% was exported to African countries. In 2015, oyster exports decreased by 46.8% as compared to 2014 (Table 19; Figure 29).

Table 19: South Africa's Oyster exports during 2015

Species	Importers	Quantity (Tons)	Value (ZAR Million FOB)	Average price/kg
Oyster	Botswana	0.236	45450	197.8706
Oyster	Democratic Republic of Congo	0.197	5075	25.70531
Oyster	Hong Kong	33.5	4.142812	123.7178
Oyster	Lesotho	0.022	0.002652	126.1362
Oyster	Malawi	0.014	0.001925	156.4111
Oyster	Maldives	0.049	0.008632	176.1633
Oyster	Mozambique	0.084	0.004919	154.4623
Oyster	Namibia	0.61	0.96430	171.7583
Oyster	Nigeria	0.138	0.013067	94.10875
Oyster	Taiwan	0.308	0.047230	153.3442
Oyster	Swaziland	0.524	0.004962	120.4758
Oyster	Tanzania	0.01	0.002000	200
Oyster	Zambia	31.7	0.000999	199.9287
Oyster	Zimbabwe	0.5	0.003190	6.38
	Total	67.892	4.379344	1906.462

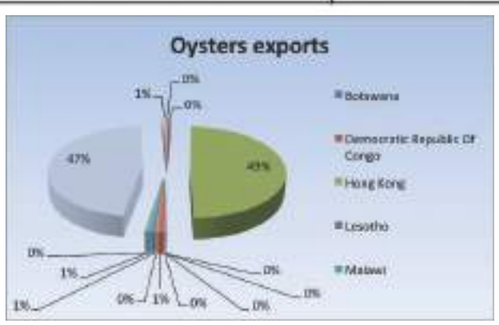

Figure 29: Oysters quantity exported during 2015

7.7.3 Mussels

During 2015 South Africa exported approximately 102.5 tons of mussels with an estimated value of R3.5 million. The bulk volume of mussels was destined to Namibia 50%, Mauritius 20%, Zambia 7%, Zimbabwe 3% and other African 20% countries. Compared to 2014 mussel exports experienced an 80% drop in volumes. (Table 20; Figure 30).

Table 20: South Africa's Mussel exports during 2015

Species	Importer	Quantity exported (Tons)	Value (ZAR million FOB)	Average price/kg (Rands)
Mussels	Angola	0.43	0.021847	51.07
Mussels	Botswana	0.43	0.021847	51.07
Mussels	Cameroon	0.47	0.021921	40.21225
Mussels	Democratic Republic Of Congo	0.68	0.033914	57.00086
Mussels	Equatorial Guinea	0.011	0.000472	55.625
Mussels	Ghana	0.61	0.018692	39.06735
Mussels	Kenya	2.383	0.209175	83.28537
Mussels	Lesotho	0.461	0.003135	21.86571
Mussels	Malawi	2.766	0.074558	50.89515
Mussels	Mauritius	19.526	0.722823	37.80155
Mussels	Mozambique	5.149	0.214437	51.36183
Mussels	Namibia	52.686	1.58906	65.17386
Mussels	Nigeria	1.735	0.048401	28.7921
Mussels	Saint Helena, Ascension an Tristan da Cunha	0.088	0.007193	179.8578
Mussels	Swaziland	0.228	0.013456	50.63094
Mussels	Tanzania	1.207	0.071078	62.20847
Mussels	Uganda	0.182	0.00525	33.889
Mussels	Zambia	8.829	0.266772	51.13414
Mussels	Zimbabwe	4.656	0.253479	77.54874
	Total	102.527	3.59751	1088.49

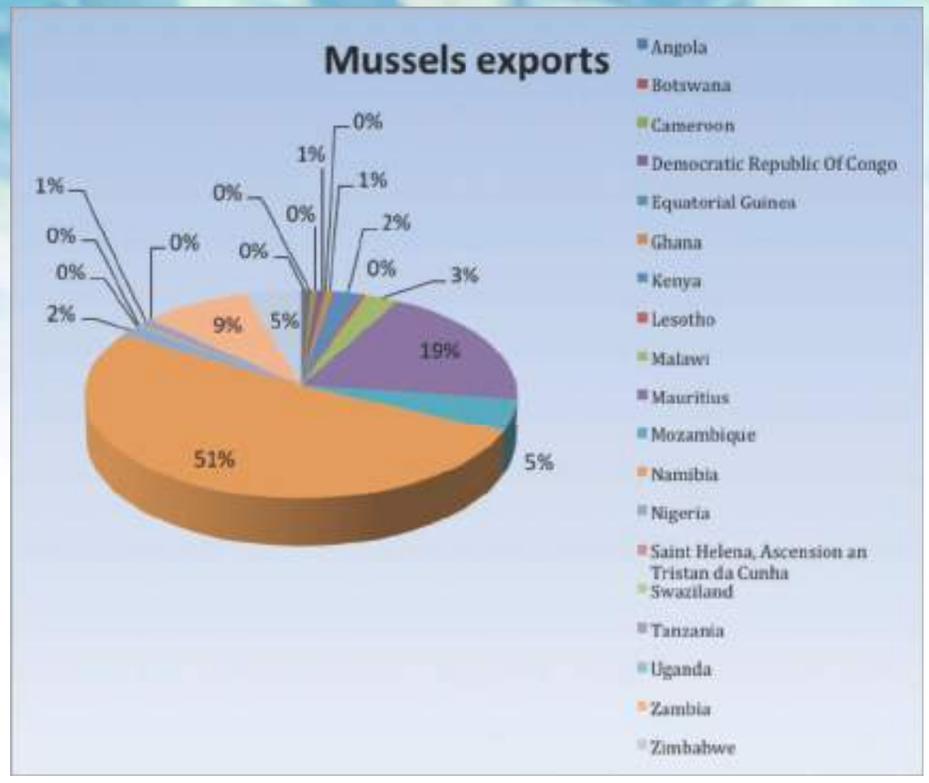

Figure 30: South Africa's Mussel exports during 2015

7.7.4 Carp

During 2015 South Africa exported 1.9 tons of carp with an estimated value of R0.12 million (Table 21). Between 2014 and 2015 carp export volumes decreased by 24%. Carp was destined mainly to four African countries. The difference in tonnage is 0.6. Mozambique imported approximately 40%; Swaziland 32 %, Botswana 27% and Lesotho 1% (Figure 31) represent the quantity exported in 2015.

Table 21: South Africa's Carp exports during 2015

Species	Importers	Quantity exported (Tons))	Value exported (ZAR Millions FOB)	Average exported in (Rands)
Carp	Botswana	0.492	0.02451	49.8171
Carp	Lesotho	0.13	0.0002	1.5385
Carp	Mozambique	0.750	0.03101	41.3467
Carp	Swaziland	0.600	0.040848	68.08
	Total	1.9	0.127578	160.7823

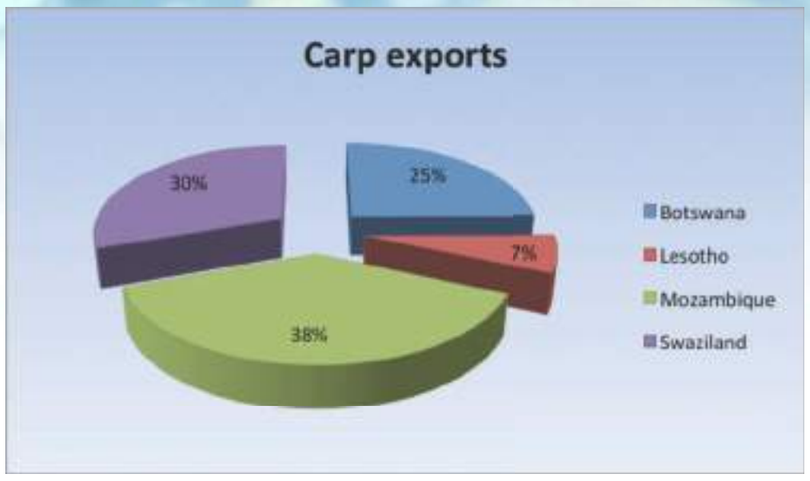

Figure 31: Carp quantity exported during 2015.

7.7.5 Catfish

South Africa exported 3.4 tons of catfish in 2015 with an estimated value of R202 564 (Table 22). The volumes of catfish exports decreased significantly by 96.93%% as compared to 2014. There were no commercial farms for catfish in 2015, however the assumption is that the quantity exported mainly came from the imported volumes. Figure 32 indicates catfish exports.

Table 22: South Africa's Catfish exports during 2015

Species	Importer	Quantity(Tons)	Value exported (ZAR Millions FOB)	Average price/kg (Rands)
Catfish	Botswana	0.150	0.001860	12.4
Catfish	Nigeria	1.265	0.072642	57.42451
Catfish	Others	0.100	0.002528	25.28
Catfish	Zambia	1.916	0.125534	52.50613
	Total	3.4	2.02564	147.6106

Source: South African Revenue service, 2015

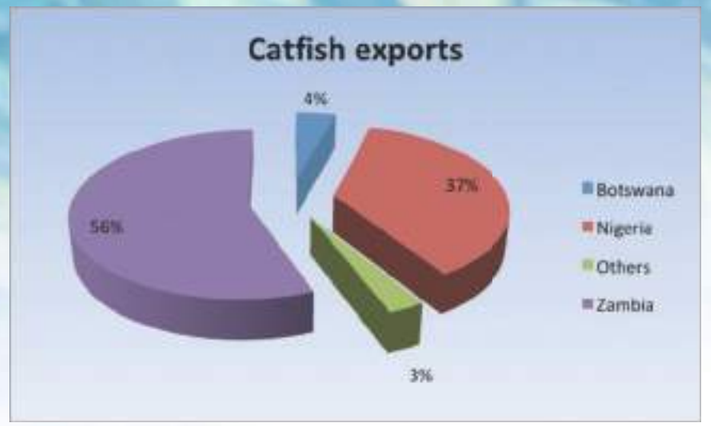

Figure 32: Catfish exports during 2015

7.7.6 Ornamentals

South Africa exported 49.64 tons with an estimated value of R1.3 million. The volumes of Ornamentals exports increased significantly by 353.75% as compared to 2014.Ornamentals were mostly destined for Hong Kong, Gabon, France and Japan. It should be noted that not all the ornamentals exported were farmed within South Africa; however some of them were imported from other countries (Table 23; Figure 33).

Table 23: South Africa's Ornamental exports during 2015

Species	Importers	Quantity (Tons)	Value (ZAR Million FOB)	Average price/kg
Ornamentals	Angola	0.065	0.013179	202.7538
Ornamentals	Botswana	2.803	0.037874	28.13361
Ornamentals	Burkina Faso	0.060	0.000200	3.333333
Ornamentals	Democratic Republic of Congo	0.050	0.000575	11.5
Ornamentals	France	7.8	0.020318	2.604872
Ornamentals	Gabon	8.95	0.002613	2.89697
Ornamentals	Hong Kong	24	0.058998	2.45825
Ornamentals	Japan	3.77	0.192069	50.9469
Ornamentals	Mali	0.360	0.000763	2.119444
Ornamentals	Mauritius	0.446	0.108398	243.0448
Ornamentals	Mozambique	0.210	0.019176	82.86317
Ornamentals	Namibia	0.579	0.095177	164.3817
Ornamentals	Senegal	0.120	0.000400	3.333333
Ornamentals	Spain	0.002	0.000500	250
Ornamentals	Swaziland	0.172	0.011170	63.5501
Ornamentals	Swaziland	0.172	0.011170	63.5501
Ornamentals	Taiwan	0.212	0.607953	2867.7028
Ornamentals	United Kingdom	0.001	0.000120	120
Ornamentals	United States	0.040	0.168619	3.3968
	Total	49.64	1.338102	4132.019882

Source: South African Revenue service, 2015

7.7.7 Pacific salmon

During 2015, there were no commercial salmon farms in the country. However, South Africa exported 5% of imported salmon mainly to African countries, with 95% sold on the local market. South Africa has a well-established market of salmon to African countries and the local demand for salmon continues to increase, in 2015 South Africa exported approximately 78 tons of salmon, valued at R3.2 million, the volumes of salmon exported increased by 48.06% as compared to 2015. The top three destinations for pacific salmon were Namibia with 38.989 tons (50%), Botswana with 23.089 tons (29%) and Zambia with 7.993 tons (10%). Table 24 and Figure 34 below indicate pacific salmon destination during 2015.

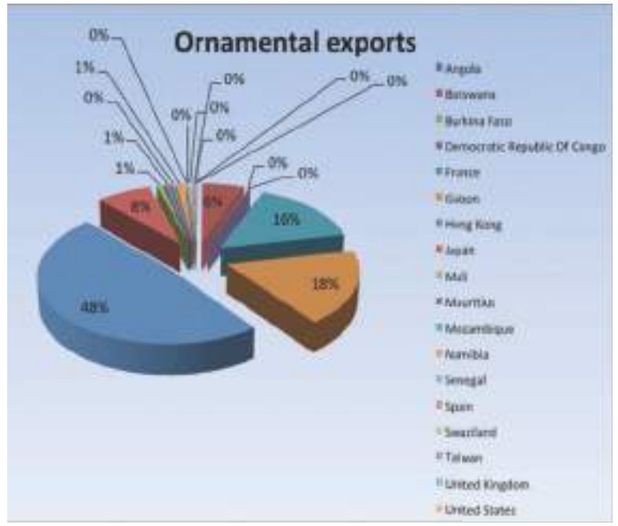

Figure 33: South Africa's Ornamental exports during 2015

Table 24: Pacific salmon exports during 2015

Species	Importers	Quantity (Tons)	Value (ZAR Million FOB)	Average price/kg
Pacific salmon	Angola	0.400	0.085112	222.83
Pacific salmon	Botswana	23.089	0.582156	54.01087
Pacific salmon	Cameroon	0.348	0.066731	191.3159
Pacific salmon	Equatorial Guinea	0.017	0.002800	161.8497
Pacific salmon	Ethiopia	0.820	0.166651	202.7888
Pacific salmon	Kenya	0.056	0.006125	109.375

Pacific salmon	Lesotho	0.068	0.008531	292.3161
Pacific salmon	Malawi	1.007	0.037033	35.75712
Pacific salmon	Mozambique	0.382	0.037370	254.2133
Pacific salmon	Namibia	38.989	1.624024	81.53153
Pacific salmon	Rwanda	0.029	0.000816	28.13793
Pacific salmon	Saint Helena, Ascension an Tristan da Cunha	0.066	0.013206	259.5435
Pacific salmon	Seychelles	0.089	0.017954	200.9965
Pacific salmon	Swaziland	0.622	0.027100	176.031
Pacific salmon	Tanzania	0.520	0.137240	162.9821
Pacific salmon	Uganda	0.469	0.027164	58.39666
Pacific salmon	Zambia	7.993	0.202770	49.57439
Pacific salmon	Zimbabwe	3.503	0.256004	85.43029
	Total	78.47156	3.298787	2627.081

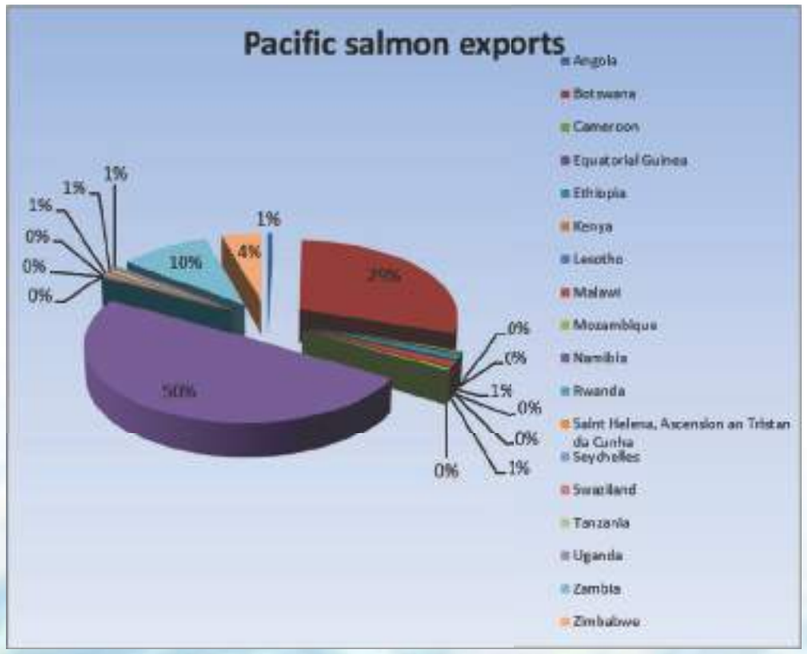

Figure 34: Pacific Salmon exports during 2015

7.7.8 Tilapia

In 2015 South Africa exported approximately 325 tons of tilapia valued R3.5 million. The top three destinations for tilapia were Botswana with 196 tons, Democratic Republic of Congo with 79 tons and China with 22 tons. Table 25 below represents export destination, exported quantity and the value of exports during 2015. The international market for tilapia is increasing, in 2014 there were 10 destinations for tilapia, in 2015 there were three more reported markets which include Saint Helena, Ascension a Tristan da Cunha, Hong Kong and Mauritius. The volumes of exports for tilapia increased significantly by approximately 322.63%, this massive increase is mainly caused by an increase in the volumes of imports and the increased number of tilapia farmers that were recorded in 2015. Figure 35 represents the export trends for tilapia in 2015.

Table 25: South Africa's Tilapia exports during 2015

Species	Importers	Quantity exported (Tons)	Value (ZAR Million FOB)	Unit price (ZAR)
Tilapia	Botswana	196.397	1.577344	2051.453
Tilapia	China	22.464	0.290225	12.91956
Tilapia	Democratic Republic Of Congo	79.780	0.797805	103.2665
Tilapia	Hong Kong	0.624	0.228956	366.7991
Tilapia	Lesotho	0.633	0.001815	84.41482
Tilapia	Malawi	0.762	0.052359	1087.177
Tilapia	Mauritius	0.030	0.000845	28.16667
Tilapia	Mozambique	7.413	0.415263	833.6749
Tilapia	Namibia	5.151	0.0098332	1047.443
Tilapia	Saint Helena, Ascension an Tristan da Cunha	0.001	0.000083	76.85185
Tilapia	Swaziland	12.163	0.133137	394.0947
Tilapia	Zambia	0.001	0.000543	480.531
Tilapia	Zimbabwe	0.009	0.000723	75.3125
	Total	325.428	3.5089312	6642.104143

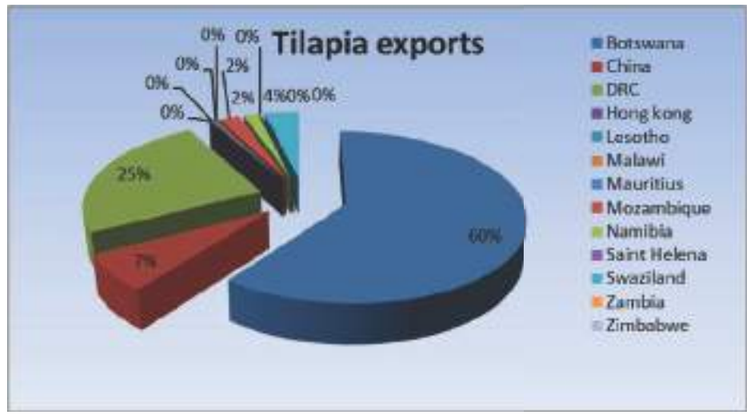

Figure 35: Tilapia exports during 2015

7.7.9 Trout

South Africa exported 19.7 tons of trout valued at approximately R5.7 million. Lesotho, Botswana and Peru were the leading importers of trout during 2015; Botswana imported nearly 4 tons, Lesotho 4 tons, Peru 3 tons, Table 26 below represents the importers of trout as well as the value of the quantity exported. Trout exports declined by 10% between 2014 and 2015, the trend is influenced by a wide range of factors which include limited fresh water resources, constrained supply of fingerlings and high feed cost which restrict the growth of the sector within the country, however the local market for trout continues to expand, this is shown by the decreased volumes of imports of nearly 10.4% between 2014 and 2015. Trout exports are shown in Figure 36.

Table 26: South Africa's trout exports during 2015

Species	Importers	Quantity imported	Value of quantity exported(ZAR FOB)	Average price
Trout	Botswana	3.853	0.086660	72.52416
Trout	Bulgaria	0.050	0.008488	169.76
Trout	Czech Republic	0.026	0.022321	858.5
Trout	Democratic Republic Of Congo	0.112	0.021410	191
Trout	Denmark	2.364	1.628892	536.7999
Trout	Egypt	0.002	0.000097	48.5
Trout	Georgia	0.042	0.041827	995.881
Trout	Greece	0.134	0.148426	1107.657
Trout	Kazakhstan	0.054	0.040868	763.4375
Trout	Kenya	0.047	0.039095	831.8085
Trout	Lesotho	4.068	0.872292	266.7259
Trout	Mozambique	1.537	0.094799	80.90654
Trout	Namibia	0.581	0.024259	57.713
Trout	Nigeria	2.060	0.216546	129.2462
Trout	Peru	3.116	2.067217	677.7681
Trout	Russian Federation	0.184	0.206872	1262.934
Trout	Slovenia	0.080	0.054741	626.2755
Trout	Swaziland	0.187	0.005464	31.61522
Trout	Tanzania	1.020	0.105063	102.9999
Trout	Uzbekistan	0.015	0.011425	761.6667
Trout	Viet Nam	0.045	0.032 193	715
Trout	Zambia	0.119	0.007148	62.61301
	Total	19.696	5.736103	10351.89

Source: South African Revenue service, 2015

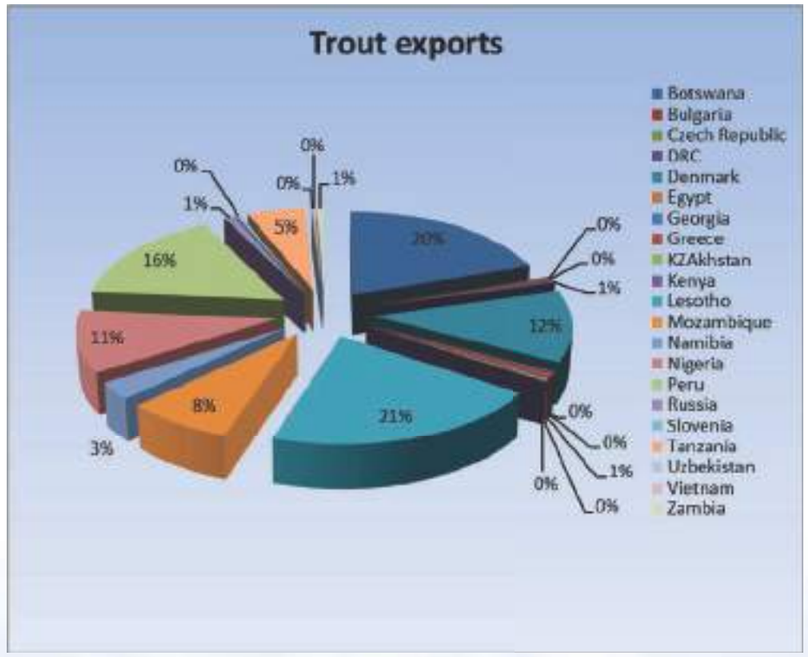

Figure 36: Trout quantity exported during 2015

7.8 Aquaculture Import Profile

In 2015, South Africa imported a total of 6 968 tons of aquaculture products with an estimated value of R268 million, with Norway being the leading supplier accounting for imports worth R205 million. China was the second leading supplier.

7.8.1 Atlantic salmon

According to the International Trade Centre (2015) the Atlantic salmon industry is a well-developed industry, for years it has been dominated by Norwegians. In 2015, South Africa imported a total of 1340 tons of Atlantic salmon with an estimated value of approximately R95 million. The volumes of Atlantic salmon exports increased significantly by 20.32% as compared to 2014..The main exporter of Atlantic salmon to South Africa during 2015 was Norway contributing more than 90% to the total quantity imported, followed by United Kingdom with nearly 2% and Japan with less than 1% Table 27. Figure 37 below shows the imports of Atlantic salmon.

Table 27: South Africa's Atlantic salmon imports during 2015

Species	Importers	Imported quantity in tons	Value (ZAR-millions FOB)	Average price/kg(Rands)
Atlantic salmon	Japan	12.000	0.584858	48.73817
Atlantic salmon	Norway	1302.373	92.892741	74.86342
Atlantic salmon	United Kingdom	26.58819	2.359389	85.29885
	Total	1340.961	95.836988	208.9004

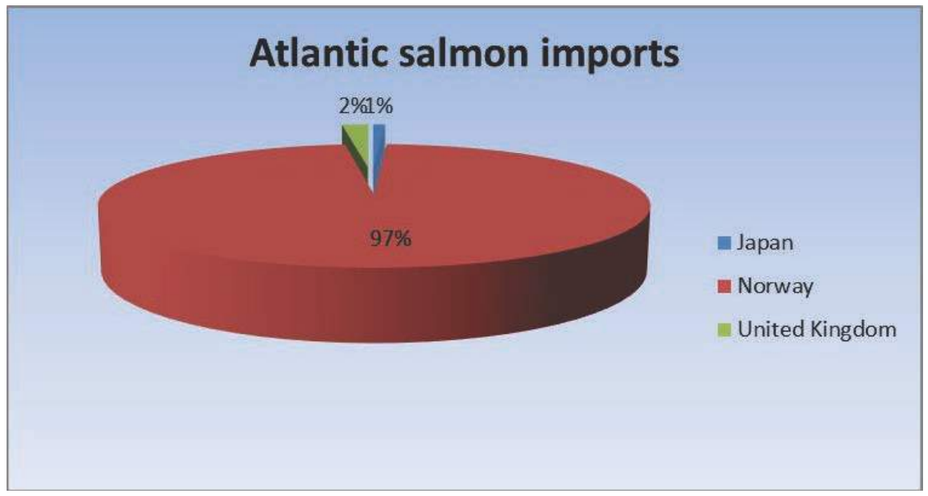

Figure 37: Atlantic salmon quantity imported monthly during 2015

7.8.2 Catfish

During 2015, South Africa imported 11 tons of catfish with an estimated value of R0.2 million (Table 28). Vietnam exported 90% of catfish imported into South Africa, while 10% came from Thailand. Compared to 2014, imports increased by nearly 554.12%, owing to an increase in the demand of catfish. Figure 38 below demonstrate the trends of catfish imports.

Table 28: South Africa's catfish imports during 2015

Species	Exporter	Imported quantity in tons	Value (ZAR-millions FOB)	Average price/kg(Rands)
Catfish	Thailand	1. 020	0.012 161	12
Catfish	Viet Nam	10.100	0.247 434	24
	Total	11. 120	0.259 595	36

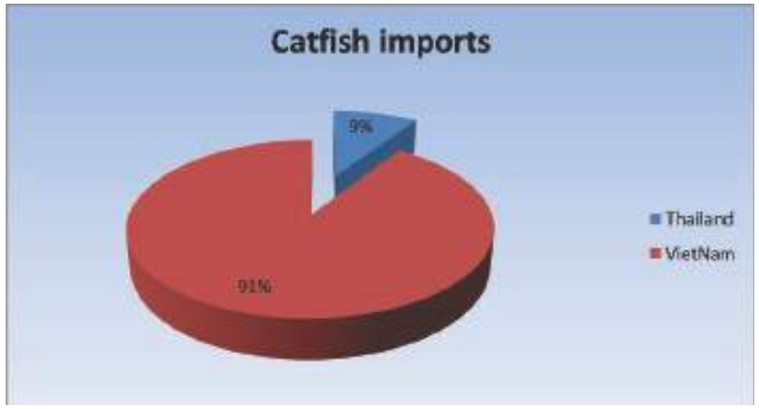

Figure 38: Catfish quantity imported during 2015

7.8.3 Carp

During 2015, South Africa imported 0.507 ton of carp valued at R0.5 million, in comparison with 2014 the quantity of imports decreased by almost 99% (Table 29; Figure 39). Japan and Thailand contributed 50% each to the carp imports.

Table 29 South Africa's carp imports during 2015

Species	Exporter	Quantity imported (tons)	Value (ZAR-millions FOB)	Average price/kg(Rands)
Carp	China	0.001	0.010 830	18
Carp	Japan	0.253	0.018 321	76
Carp	Thailand	0.254	0.029 151	47
	Total	0.507	0.058 302	141

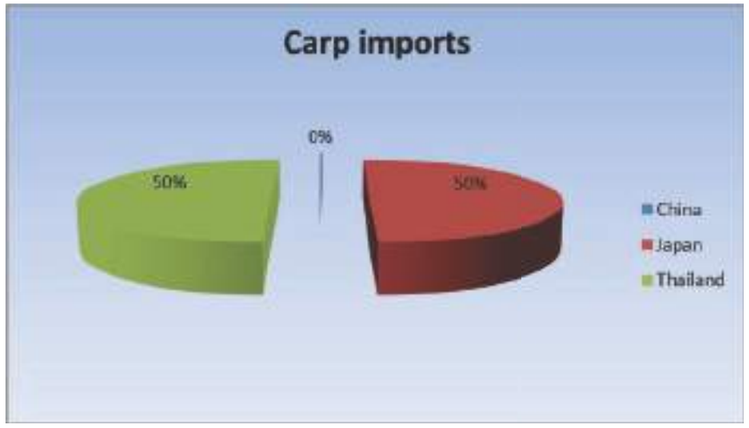

Figure 39: Carp quantity imported during 2015

7.8.4 Mussels

South Africa imported approximately 232.5 tons of mussels valued at R6 million during 2015. The volumes of Mussels exports increased by 54.91% as compared to 2014.Table 30; Figure 40 below shows the countries South Africa imported mussels from, the quantity imported and the value of imports. The main exporter for Mussels to South Africa during 2015 was China contributing 77% to the total quantity imported, followed by Namibia with nearly 10% and Chile with 9%.

Table 30: South Africa's mussel imports during 2015

Species	Exporter	Quantity imported (tons)	Value (ZAR-millions FOB)	Average price/kg(Rands)
Mussels	Chile	20	0.764824	38
Mussels	China	180	4.049239	22.50
Mussels	Mozambique	3	0	4
Mussels	Namibia	24.076	1.082876	294.57
Mussels	New Zealand	5	0.367 795	74
Mussels	Portugal	1	0.000934	81
Mussels	United States	0.04	0.070452	23
	Total	232.486	5.978322	537.1200244

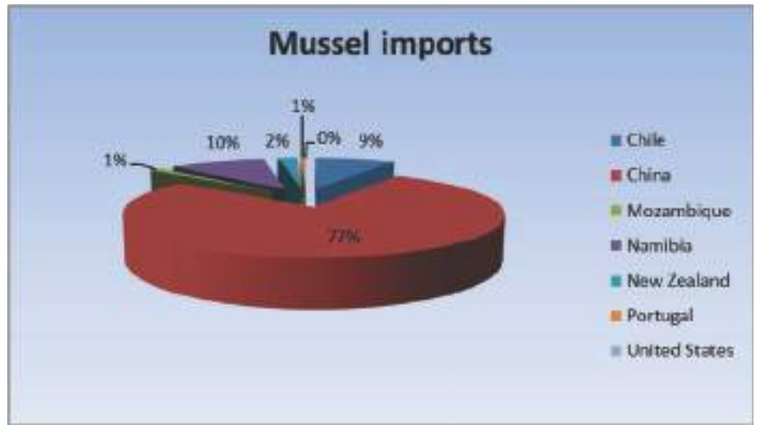

Figure 40: Mussel imports during 2015

Table 31: List of supplying markets for products imported by South Africa (Share% values).

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

7.8.5 Ornamental Fish

South Africa imported approximately 39 tons of freshwater ornamentals with an estimated value of R3.4 million. The ornamentals were sourced from different countries, such as Malaysia which contributed more than 40% to the total quantity of imports, Indonesia with 19%, Thailand with 17%, China with 2.5% and other countries contributed less than 1% (Table 32; Figure 41).

Table 32: South Africa's Ornamental fish imports during 2015

Species	Exporter	Quantity imported (tons)	Value(ZAR-millions FOB)	Average price/kg (Rands)
Ornamental fish	Malaysia	16.786	1.685949	97.52506
Ornamental fish	Netherlands	0.056	0.051381	917.5179
Ornamental fish	Nigeria	0.85	0.072237	85.41774
Ornamental fish	Singapore	1	0.133726	131.8272
Ornamental fish	Sri Lanka	1.107	0.060784	54.07202
Ornamental fish	Taiwan	1	0	80
Ornamental fish	Thailand	6.779	0.34307	52.63942
Ornamental fish	United Kingdom	0.03	0.083716	2790.533
	Total	38.724	3.450487	5414.427

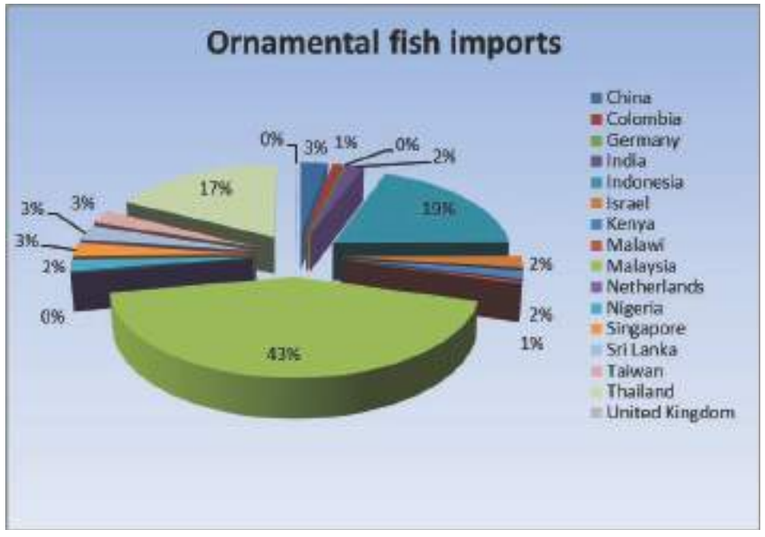

Figure 41: Ornamental imports during 2015

7.8.6 Pacific salmon

In 2015, South Africa imported approximately 1556 tons of Pacific salmon with an estimated value of R83.9 million (Table 33). The import of pacific salmon continues to increase, with an increase of 12.28% in comparison with 2014. The main exporters of pacific salmon to South Africa were Norway (97%) and Nigeria (3%). Figure 42 below shows the quantity imported during 2015.

Table 33: South Africa's pacific salmon imports during 2015

Species	Exporter	Quantity imported in tons	Value(ZAR-millions FOB)	Average price/kg (Rands)
Pacific Salmon	Denmark	0.0156	0.004403	281.7593
Pacific Salmon	France	0.0572	0.015665	520.9012
Pacific Salmon	Germany	2.07686	0.297121	392.0177
Pacific Salmon	Namibia	0.24205	0.013594	74.96845
Pacific Salmon	Nigeria	39.377	0.057640	123.1089
Pacific Salmon	Norway	1507.821	82.913409	54.86087
Pacific Salmon	Spain	2	0.001 068	574
Pacific Salmon	Sweden	3	0.007875	299.4297
Pacific Salmon	Uganda	0.018	0.000034	1.888889
Pacific Salmon	United Kingdom	2.08714	0.601246	300.3598
	Total	1556.695	83.912055	2623.488

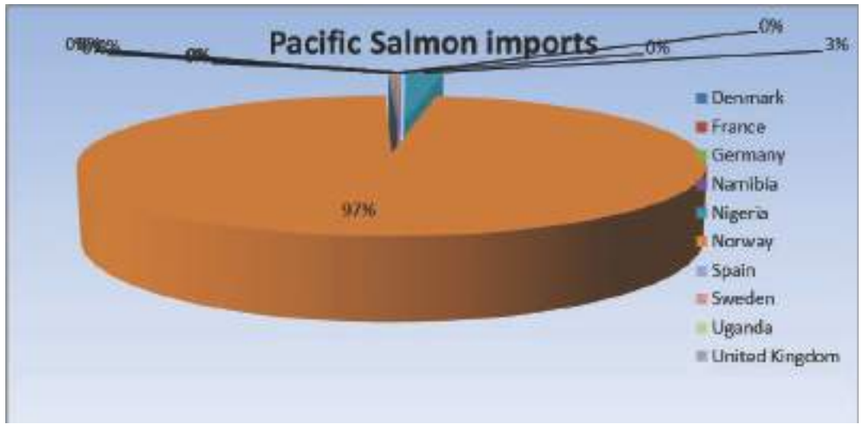

Figure 42: Pacific Salmon quantity imported during 2015

7.8.7 Tilapia

Foreign demand for tilapia has outstripped production and the capacities of fish farmers to satisfy expanding local and international markets. In 2015 South Africa imported approximately 3042 tons of tilapia with an estimated value of R33.3 million (Table 34). There is an expanding demand for all sizes of tilapia. South Africa imported tilapia of between 0 and 4kg, although it should be noted that this included the import of fingerlings. Figure 43 shows the quantity of tilapia imported in kilograms. Tilapia imports increased with an increase 72.08% in comparison with 2014. More than 80% of the imports came from China followed by India with 10% (Figure 43).

Table 34: South Africa's tilapia imported during 2015

Species	Exporter	Quantity imported (tons)	Value(ZAR-millions FOB)	Average price/kg (Rands)
Tilapia	China	2629.21	28.3169	11.39797
Tilapia	France	20	0.210736	10.5368
Tilapia	India	306.454	3.020295	10.44285
Tilapia	Indonesia	2	0.073784	R37
Tilapia	Myanmar	4.57	0.04184	10.13053
Tilapia	Swaziland	3.54	0.039747	11.22797
Tilapia	Thailand	3.87	0.038869	10.04367
Tilapia	United States	0.84	0.015171	179.9858
Tilapia	Zimbabwe	71.832	1.668549	20.84695
	Total	3042.316	33.35211	301.4865

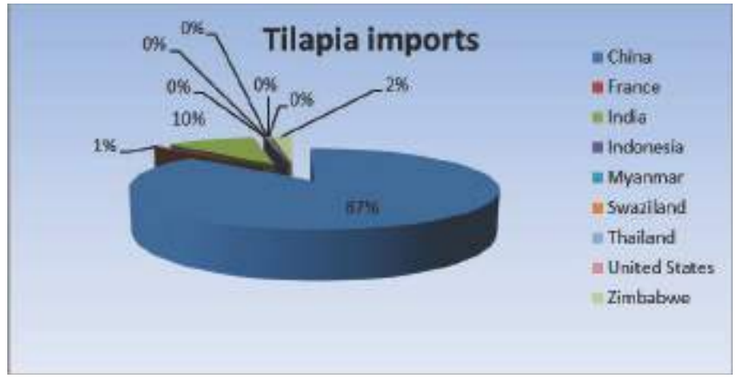

Figure 43: Tilapia quantity imported during 2015

7.8.8 Trout

A total of 756.65 tons of trout was imported in 2015 with an estimated value of R45.4 million. Norway was the leading exporter to South Africa with 65% followed by Lesotho with 19%, Chile with 14% and Denmark with less than 1%. As compared to 2014 the imports of trout increased significantly by 38.65% (Table 35). Figure 44 shows the monthly imports trends of trout.

Table 35: Trout imports in South Africa during 2015

Species	Trout	Quantity imported (tons)	Value(ZAR-millions FOB)	Average price/kg (Rands)
Trout	Chile	110.975	4.613681	40.86519
Trout	Denmark	0.47	0.150882	3232.844
Trout	Lesotho	147.927	8.879942	47.19067
Trout	Norway	497.278	31.83615	72.45575
	Total	756.65	45.48066	3393.355

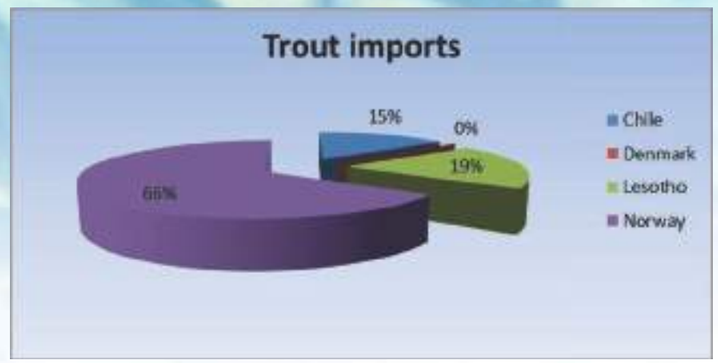

Figure 44: Trout quantity imported monthly during 2015

7.9 Trade Balance

South Africa experienced a trade deficit in terms of the quantity 5579.6 tons but in terms of value the country maintained a trade surplus of R219.59 million. Table 36 and Table 37 below show the total export volumes for aquaculture products, estimated at 1399.86 tons valued at R487.6 million. Abalone was the main exported product contributing 54% to the total aquaculture export quantity followed by tilapia with a contribution of 23% and mussels with 7.2%.

The total quantity imported was 6979.459 tons valued at 251.93 million. The main imported products during 2015 included tilapia with 3042 tons, pacific salmon with 1556.7 tons followed by both the Atlantic salmon and trout with 1340 tons and 756.65 tons respectively. Tilapia was mainly imported from China and salmon from Norway, making the two countries the highest exporters of fish products in South Africa.

Table 36: South Africa's aquaculture exports vs imports in 2015

Trade quantity (tons)	Abalone	Trout	Mussels	Oysters	Tilapia	Ornamentals	Catfish	Carp	Atlantic salmon	Pacific salmon	Total
Imports	0	756.7	232.5	0	3042.3	38.7	11. 1	0.5	1341	1556.7	6979.5
Exports	750.9	19.7	102.5	67.9	325.4	49.6	3.4	1.9	0	78.5	1399.9

Due to lowest quantity exported, Carp recorded the lowest export value contributing less than R1 million. Abalone and trout recorded the highest export value of R463.2 million and R5.7 million respectively. In terms of import value, Atlantic salmon was the highest contributing approximately 35,5% to the aquaculture products import value, followed by Pacific salmon and Trout with 30% and 16% respectively.

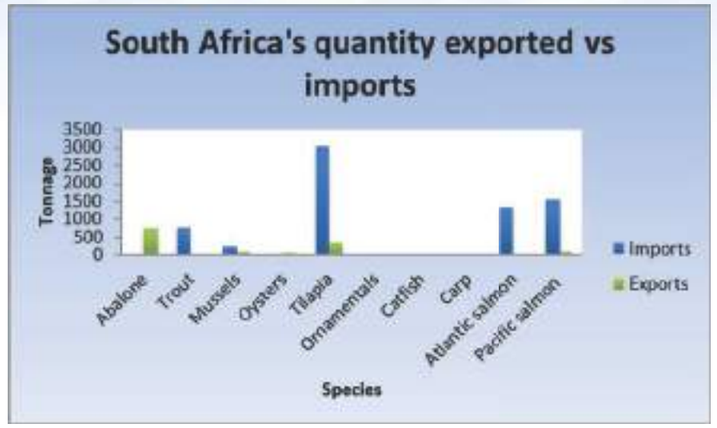

Figure 45: South Africa's quantity exported vs quantity imported during 2015

Table 37: South Africa's Value of exports vs imports during the year 2015

Trade Value (millions)	Abalone	Trout	Mussels	Oysters	Tilapia	Ornamentals	Catfish	Carp	Atlantic salmon	Pacific salmon	Total
Imports	0	45.48	5.98	0	33.35	3.45	0.26	0.06	95.84	83.91	268.01
Exports	463.28	5.74	3.6	4.73	3.51	1.34	2.02	0.09	0	3.29	487.61

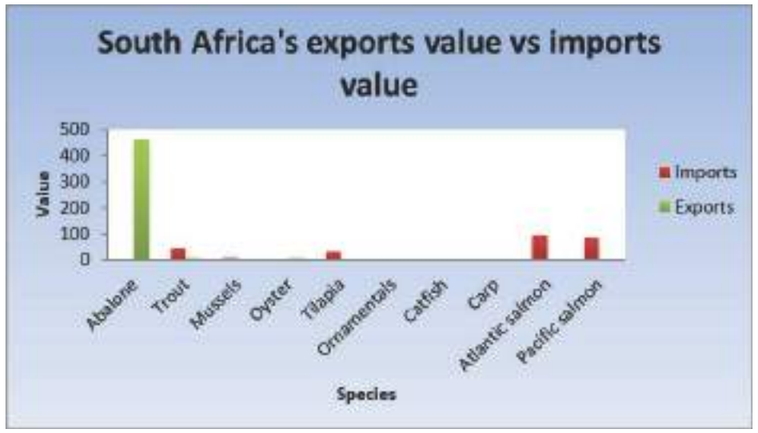

Figure 46: South Africa's exports value vs imports value

AQUACULTURE ENVIROMENTAL INTEGRITY

8.1 Aquaculture Environmental Assessments

Aquaculture operations trigger a number of listed activities under the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment (EIA) Regulations of 2014, as amended. Depending on the listed activities triggered, the level of environmental assessment and evaluation may either require a Basic Assessment or a full/comprehensive Scoping and Environmental Impact Assessment. Other relevant legislation that needs to be taken into consideration when planning a new aquaculture operation include, but not limited to, the National Environmental Management: Biodiversity Act (10 of 2004), the National Environmental: Integrated Coastal Management Act (36 of 2014), the Alien and Invasive Species Regulation of 2014, National Water Act (36 of 1998) and Marine Living Resources Act (18 of 1998).

Draft legislation developed in 2015, which may become applicable to the aquaculture industry in the future include the following:

- Draft Aquaculture Bill – DAFF mandate
- Draft Inland fisheries Policy – DAFF mandate
- Marine Spatial Planning Bill – DEA mandate
- 22 Proposed Marine Protected Areas regulations – DEA mandate
- Draft Oceans Bill – DEA mandate

The D: SAM, Sub-Directorate: Aquaculture Animal Health and Environmental Interactions, together with the Western Cape provincial Department of Environmental Affairs, Development and Planning (DEA&DP) and the national Department of Environmental Affairs (DEA) have been working alongside industry to set EIA standards for the Abalone and Trout aquaculture sectors since 2011. The project is a national initiative to develop standards as a proactive environmental management tool to achieve efficiency and effectiveness in environmental impact management by reducing the time and cost of following an EIA process, whilst ensuring that environmental management is adequately addressed. Chapter 5 of the National Environmental Management Act (Act No. 107 of 1998) provides for the development or adoption of norms or standards for listed activities, or more specifically, that adherence to a norm or standard will negate the need to apply for an environmental authorisation (and by implication also negating the need for an EIA) as long as the proposed development falls within the scope of the standard. The D: SAM, Sub-Directorate: Aquaculture Animal Health and Environmental Interactions also render technical advice regarding EIA's. The Sub-Directorate also provides review and comment on EIA's for aquaculture operations and any developments that may have an adverse impact on existing aquaculture farms. In this way, supporting the development and growth of the industry by providing proactive comments and guidance on aquaculture environmental impacts.

8.2 Update on DAFF initiated Aquaculture Environmental Projects

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

8.3 Strategic Environmental Assessment for Marine and Freshwater Aquaculture

One of the major challenges impacting negatively on the economic growth of the aquaculture sector is the lack of an enabling legislative environment. For this reason, the DAFF embarked on a process of undertaking 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 are, the high cost of conducting EIAs for individual ADZs, the expiry of environmental authorisations 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 authorisation is granted.

The DEA and the DAFF embarked on addressing the concerns of the aquaculture industry by commencing with Strategic Environmental Assessments (SEA) with the aim of streamlining, fast tracking and, reducing the number of environmental authorisations that are required for these projects within the areas that are identified. The Center for Science and Industrial Research (CSIR) was appointed in 2015 to undertake the SEA with the aim to identify ADZs for offshore, inshore, land and inland water based aquaculture within the country for the prioritising and incentivising of aquaculture. The SEA further aims to be developed through the extensive use of spatial tools, positive and negative mapping of environmental attributes, sensitivity mapping and detailed assessment of potential impacts including cumulative impacts and risk assessments. It is intended that through a pre-assessment of the environmental sensitivities within these ADZs, certain aquaculture activities could be excluded from requiring environmental authorisation based on the implementation of aquaculture standards. In addition, within the ADZs, the management and legislative framework must also be streamlined and integrated to reduce complexity and to incentivise environmentally sustainable aquaculture. The SEA is to be developed through an extensive consultative process which includes all relevant government departments as well as external stakeholders.

AQUACULTURE AND ANIMAL HEALTH

9.1 Aquaculture and animal health

Disease is a primary constraint to the culture of many aquatic species, impeding both economic and social development in many countries. Like other farming sectors, the likelihood of major disease problems increases as aquaculture activities intensify and expand. The continuous assessment and awareness regarding the health of aquatic animals is therefore regarded as fundamental to the sustainability of the aquaculture industry and commercial fishery whilst simultaneously protecting the greater public interest. The implementation and evaluation of basic biosecurity measures, including but not limited to import and export control, are further regarded as fundamental to mitigate the risks posed through trade in aquatic animal commodities and the assurance of safe aquatic animal products to local, regional and international markets. With the current expected growth targets for the aquaculture and fisheries sectors and increasing requirements for safe aquatic commodities globally, the DAFF has established a National Aquatic Animal Health working group comprised of Branch: Fisheries Management (including aquaculture and wild caught fisheries); Chief Directorate: Animal Production and Health; Chief Directorate: Inspection and Quarantine Services; National Regulator for Compulsory Specifications (NRCS); Onderstepoort Veterinary Institute (OVI) and Provincial Veterinary Services. The aim of the working group is to provide strategic guidance for the management, control and regulation of aquatic animal health, welfare and disease in South Africa through the development and implementation of a National Aquatic Animal Health and Welfare Implementation Plan (NAAHWP). Strategically, this plan was initially formed through the development of the National Aquatic Animal Health and Welfare strategic framework as an outcome of the National Aquaculture Strategic Framework (NASF). The NAAHWP is comprised of five (5) essential elements including institutional arrangements, policy and legislation, aquatic animal health, welfare services and facilities, human resources and capacity development and research and development.

9.2 Disease reporting

It is important for members of the industry to take note of the following disease reporting pathway to be followed for world organisation for animal health (OIE) listed diseases that are confirmed or suspected to be present in an aquatic animal population: the farmer should report the disease occurrence to the private veterinarian or provincial state veterinarian; the provincial state veterinarian reports this information to the central provincial point which reports it to the provincial director; the provincial director reports this information to the Sub-Directorate Epidemiology within DAFF which reports this to Directorate Animal Health which reports to this to Chief Directorate Animal Production and Health (office of the Chief Veterinary Officer) who is ultimately responsible for communicating the disease event to the OIE. It is important to note that all OIE listed diseases are notifiable to veterinary services within DAFF, i.e. obligatory reporting is required by all aquaculture stakeholders, veterinarians, para-veterinarians, etc. Furthermore all exotic diseases (i.e. diseases which have never been reported in South Africa) are also notifiable.

Non OIE listed diseases that are of national significance and listed as notifiable under relevant legislation or required to be reported as part of aquaculture permit conditions also need to be reported through the above mentioned pathway, except that reporting to the OIE will not occur.

For queries concerning disease reporting for any aquatic animal disease, please contact a provincial state veterinarian closest to you, or Aquatic State Veterinarian within DAFF at 021 430 7052.

9.3 Disease events in 2015

9.3.1 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 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.

Abalone farmers are required to notify the Department of the occurrence of this disease and this was effected through the permit conditions. Only one case of the disease was reported to the Department in 2015.

9.3.2 Epizootic Ulcerative Syndrome (EUS)

Epizootic ulcerative syndrome is a disease caused by the oomycete Aphanomyces invadans to which both wild and farmed freshwater and estuarine finfish are susceptible. The disease was first detected in South Africa in 2011 and is an OIE listed disease. Diseased fish exhibit the following clinical signs: ulcers with central necrotic (i.e. dead cells and tissues) areas; small pinpoint red spots; localized swelling and raised areas on the body surface; scale loss and scale erosion; reddened skin under scales. Lesions can occur on any part of the body but often occur on the lateral body surface. Four samples were submitted to Drs. Kevin Christison and Brett Macey for molecular confirmation in 2015. *Aphanomyces invadans* was detected using Polymerase Chain Reaction (PCR) test in two of these cases, namely from Barehead goby (*Caffrogobius nudiceps*) at Palmiet River Estuary in the Western Cape Province, and from Rainbow trout *(Oncorhynchus mykiss)* from Mpumalanga province. Both of these confirmed cases were duly reported to the OIE. Table 38 (below) provides a summary of EUS cases in South Africa to date.

Table 38: Reported cases of EUS from South Africa from 2010 - 2015

Year	Province	Affected fish hosts
2010	Western-Cape Province	*Lepomis macrochirus (Bluegill sunfish), Micropterus salmoides (Largemouth bass), Oncorhynchus mykiss (Rainbow trout)*
2011	Western Cape Province	*Clarias gariepinus (Sharptooth catfish)*
2012	Western Cape Province	*Clarias gariepinus (Sharptooth catfish)*
2013	No reported cases	
2014	North West Province	*Clarias gariepinus (Sharptooth catfish)*
2015	Mpumalanga Province	*Oncorhynchus mykiss (Rainbow trout)*
2016	Western Cape Province	*Caffrogobius nudiceps (Barehead goby)*

9.3.3 Koi Herpes Virus (KHV)

Koi Herpes virus (KHV) is thought to have been introduced into South Africa around 1998 following its global spread by infected ornamental fish. Initially the effects of this disease in South Africa were felt in the ornamental fish industry where the importation and local movement of ornamental koi has proceeded relatively unrestricted. Favourable environmental conditions for the virus persist in natural freshwater bodies in South Africa for a significant part of the year, thereby facilitating the spread of the virus to wild or feral common carp populations where contact is made with natural water bodies.

In 2015 KHV was reported from a feral population of common carp *(Cyprinus carpio)*, from the Western Cape province and was subsequently reported to the OIE.

Third Global International Organisation for Animal Health (OIE) Conference in Vietnam

Three DAFF delegates attended the conference held in Ho Chi Minh City in Vietnam, in January 2015. The aim of the conference was to highlight the importance of aquatic animal health management globally, and to build a framework to support this as well as the prevention and control of aquatic animal diseases. Some of the main issues highlighted included the OIE standards relating to the governance of aquatic animal health; disease notification; disease surveillance including concepts of compartmentalization and zonation; OIE capacity building; the importance of engaging farmers during surveillance planning; the economics of disease surveillance planning including the cost limiting factor when designing a surveillance programme; the importance of sampling to facilitate trade; using welfare indicators for both the veterinarian and farmer to aid and strengthen clinical evaluation of animals and the risks associated with different types of systems.

Aquatic animal health workshop in conjunction with the AASA Aquaculture 2015 Conference

The Department, in partnership with the Aquaculture Association of South Africa (AASA) and the Food and Agriculture Organisation of the United Nations (FAO), presented a one-day training workshop on aquatic animal health in conjunction with the AASA Aquaculture 2015 Conference on the 1st of October 2015.

The workshop was facilitated by Dr. Melba Reantaso (FAO, Rome, Italy) with contributions by Dr. Roar Gudding (NVI, Norway), Prof. Wilmien Luus-Powell (University of Limpopo), Dr. Brett Macey (DAFF:ARD) and Dr. Kevin Christison (DAFF:ARD). Thirty-nine participants, from all the relevant stakeholder groups in the aquaculture value chain comprising both public and private sectors (including veterinarians, farmers and researchers), participated in this workshop.

The workshop was divided into three general thematic sessions namely, (i) Aquatic animal health management: an important challenge to aquaculture sustainability, (ii) Biosecurity and disease control at farm level: diagnostics, surveillance, health inspection, sample collection and emergency response and (iii) Biosecurity governance. In general the workshop was well received by the participants who provided valuable, positive and constructive feedback.

AQUACULTURE RESEARCH AND DEVELOPMENT

14

10.1 Finfish reproduction, nutrition and research projects in the pipeline at the Marine Research facility at Sea point (DAFF).

Developments in the reproduction research of the dusky kob *(Argyrosomus japonicus)*, cape white stumpnose *(Rhabdosargus globiceps)*, spotted grunter *(Pomadysis commersonni)* and kingklip *(Genypterus capensis)* are presented.

10.1.1 Dusky kob

Preliminary results indicate that dusky kob can be induced to spawn on a weekly basis for as long as 6-8 weeks. The prerequisite is that they must eat within two days of the previous spawn and a follow-up induction for spawning can be done after 7 days from previous spawn provided that the fish will be feeding again. It is also imperative to induce the females with injected hormone, whilst males can receive a peritoneally implanted slow release hormone pellet every second week (Figure 46). However, the once-weekly handling of breeders still poses a problem since their appetite is influenced by handling stress. Research is now under way to develop a dietary route for induction hormones in order to avoid stress induced handling of broodstock. However, the same challenges are encountered as for the oral intake of insulin in humans. The bioactive peptides are easily digested by gastro-intestinal tract enzymes. Newest promising medical technologies are opening the door for the oral delivery of bio-active peptide hormones which will be enzyme protected when locked in a non-ionic excipient. The excipient will ionize in the intestines and will be a muco-adhesive agent that will enable transfer of the endocrine peptide to the intestinal tissue for systemic uptake.

Figure 47: Dusky kob receiving intraperitoneal slow release hormone pellet implant

10.1.2 Cape white stumpnose

The conditioning of cape white stumpnose broodstock is a function of exposure to seasonal photoperiodicity which was in ratio compressed to 2 months with success. A consistent temperature of 19°C was maintained. At the end of the conditioning period the breeders were monitored for secondary sexual characteristics such as dichromatic males with black ventral markings along the integument of the pectoral girdle, iridescent blue shine on head, and milt delivery upon slight pressure on the lateral pelvic area of the buccal cavity. Females were identified by the slightly red gonophore in the female cloaca, as well as a turquoise to green metallic shine on the forehead and dorsal-lateral body area.

Spawning induction of cape white stumpnose is now completely programmable. Males and females are intramuscularly implanted with slow release hormone pellets (Ovaplant® or lab made pellets) and spawning commenced 3 days after implant. Daily spawning was observed since viable floating eggs were collected every morning for 3-4 weeks. Fish were fed daily to keep breeders nourished for spawning. Spawning is predominantly a night time activity though a couple of supplemental spawning episodes occurred in the morning (8:00-11:00) during the spawning period. An average fertilized egg output of about 10g day^{-1} per single female was maintained with the mentioned slow release hormone therapies used over the spawning period (3-4 weeks). This equates to approximately 18 000 fertilized eggs day^{-1} $female^{-1}$.

The rearing of stumpnose larvae is still a challenge. Stumpnose larvae are smaller than kob or grunter larvae and are therefore more fragile. The first food offered to stumpnose larvae was rotifers though copepods such as *Parvocalanus spp* should increase the survival rate of stumpnose larvae. Rotifers were mainly fed with cultured *Nannochloropsis oculata (*one cell algae species generally used in marine fish hatcheries) prior to feeding them to the stumpnose larvae. The pseudo-green water technique works best for stumpnose larval growth and survival-as was also determined elsewhere for a closely related species in the Mediterranean. However, survival rates of less than 5% were experienced during the first two weeks post hatching.

Follow up trials will include the addition of a second algae species, *Isochrysis galbana* to enrich rotifers. These algae are richer in Omega-3 fatty acids (DHA) when compared to *Nannochloropsis.* A major challenge is the continuous availability of algae that proliferate in the exponential growth stage. A *photobioreactor (6KL*) was constructed for the mass production of *Nannochloropsis oculata.* A second *photobioreactor* will be constructed to culture *Isochrysis galbana.* It is anticipated that the combined use of these two algal species, when cultured on a mass scale, will contribute to a substantial increase in stumpnose larval survival. Follow up trials will confirm this. The constructed *photobioreactor* for the mass production of *Nannochloropsis oculata* is shown in Figure 48.

Figure 48: Mass algae production photobioreactor (3.8 m deep) at the Sea point Marine Research facility; (a) Unit before algae inoculation; (b) Unit closed with "breathing canopy" to prevent atmospheric transfer of contaminants.

10.1.3 Spotted grunter (culture and embryogenesis) and Kingklip (embryogenesis)

Spotted grunter hatchery practices are now standardized and F1 breeders below 1 kg (less than 2 years old) are used since they are highly fecund and respond consistently to spawning induction hormones. The F1 generation has been developed from old wild broodstock (over 10 years old) which do not condition consistently due to aging. The F1 breeders condition rapidly if exposed to a daily photoperiod of 14 hours and a temperature of 25°C with intermittent "cold front" declines to 22°C at a frequency of one episode (2 days) per 1-2 weeks. They respond to a once off injection with spawning induction hormones and spawning commences from the 27th hour post induction (night time) at 25°C. As mentioned for the dusky kob it is also believed that this species should spawn over a period of a month or two if induced on a weekly basis. This possibility will be investigated since the fish are partially shedding their eggs per initial spawning session.

Fertilized kingklip eggs were donated by the Two Oceans Aquarium and larval development stages captured with a Zeiss Discovery transmission microscope and camera. For interest sake the comparison between spotted grunter and kingklip larval development 12 DPH (days post hatch) is demonstrated in Figure 49 below.

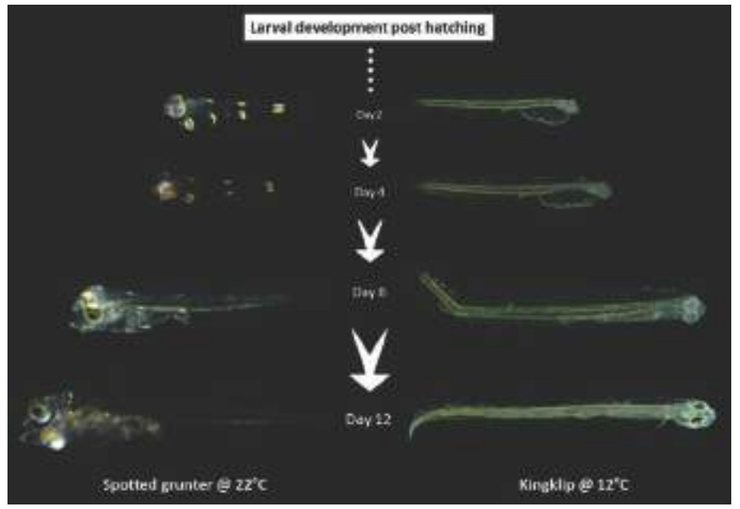

Figure 49: Comparison between spotted grunter and kingklip development to 12 DPH

10.2 Fish nutrition research

The carnivorous spotted grunter *(Pomadysis commersonni)* is currently investigated as a potential candidate species for commercial culture in South Africa. However, growth rate data prior to this investigation does not justify economic viability of this species. Therefore the investigation was focused on the selection of resource-able growth promoting nutritional ingredients incorporated in respective diets with white fish meal as the main constituent (80% of dry mass). The growth rate of juvenile fish with initial body mass of about 13 g was measured during a 12 week period using a selected inclusion (10.8 %) level of five presumptive growth promoting ingredients within five respective diets with approximate *isonitrogenous (4*9.2-50.2% CP) and *isolipidic* (14.4-15.5% crude fat) values. The inclusions were *Spirulina platensis*, Ulva sp, inactivated torula yeast *(Candida utilis),* and brewer's yeast (*Saccharomyces cerevisiae and Liv-Up® liquid (herbal).* Triplicate fish populations (n=15) allocated per diet ingredient inclusion were fed once per day with a fixed feed ration of 3.6% BW and maintained in a recirculation aquaculture system (RAS) at 25°C. The highest average weight gain (66.3 g) was eventually measured in fish fed the dietary torula yeast inclusion, though with no significant difference (P>0.05) when compared to the respective weight gains for the Spirulina sp (58.6 g), and brewer's yeast (58.9 g) additives. The differential feed conversion ratio (FCR) in these groups was also non-significant and ranged on average between 1.0 and 1.09. However, the eventual weight gains of the other test groups and control were significantly lower. Also, the dietary Liv-Up® inclusion induced an abnormal thickness and configuration of intestinal microvilli. The efficient minimum required inclusion levels of the best performing diet additives (*Spirulina platensis*, brewer and torula yeast) should be determined in further researched to test the economic viability thereof in the grow out production of the spotted grunter Figure 50 below.

Figure 50: Grunter juvenile that grew from 5 g to 105 g in 12 weeks

10.3 Research projects in the pipeline:

- Testing of weekly spawning induction efficiency (1-2 month period) for both dusky kob and spotted grunter as per simulated natural spawning season *(photothermal cues).*
- Cryopreservation technique development for stem cells (sperm) of dusky kob.
- Development of tetraploid sharptooth catfish (*Clarias gariepinus)* in order to produce triploid offspring for safe production of this species outside its feral geographical range.
- Refined formulation of food additives in diets of dusky kob, spotted grunter *(Pomadysis commersonni),* sharptooth catfish *(Clarias gariepinus)* and Mozambique tilapia *(Oreochromis mossambicus)* in order to improve growth rate and eventual commercial production viability.
- Determining the LC 50 value of ammonia poisoning on dusky kob as well as the production water level(s) of ammonia that will influence growth rate in this species.
- Development of improved larval survival and settlement techniques in the South African scallop *(Pecten sulcicostatus)*
- Development of advanced hatchery methods to increase larval survival and fingerling production of the Cape white stumpnose *(Rhabdosargus globiceps)*, spotted grunter *(Pomadysis commersonni)* and dusky kob *(Argyrosomus japonicus).*
- Acquisition of kingklip and seventy four broodstock in order to develop broodstock conditioning, spawning and hatchery procedures.

10.4 The suitability of vanderkloof dam for the culture of rainbow trout (*Oncorhynchus mykiss*)

In response to the identified need to expand aquaculture in South Africa, the DAFF, D: ARD, has embarked on a sampling programme to ascertain the suitability of various watercourses for the culture of Rainbow trout *(Oncorhynchus mykiss)*. Rainbow trout are a highly valued species for aquaculture being fast growing, easy to spawn, tolerant of a wide range of environmental variables, and easily weaned onto an artificial diet. They can tolerate water temperatures of between 0 and 26°C (even as high as 30°C with adequate aeration), however, the preferred water temperature for rainbow trout culture may be regarded as between 13 and 19°C. Dissolved oxygen levels appear to be a major limiting factor for O. mykiss, with an acceptable range of 4–5 mg l-1 for older fish. The minimum oxygen concentration for this species is 2.5 mg l-1 below which the risk of mortalities is high. The effect of suspended solids on salmonids is highly variable, depending on species and life stage. Concentrations < 25 mg l-1 may be regarded as providing a "high" level of protection.

A number of field trips were undertaken to Vanderkloof Dam (Figure 51) in 2015 during which various water quality variables were measured using profiling and moored instrumentation in combination with discrete water samples for extracted chlorophyll a (Chl a), total suspended solids (TSS), nutrients such

as ammonium (NH4), nitrite (NO2), nitrate (NO3) and phosphate (PO4) and silicate) and phytoplankton counts. Detailed water quality and process measurements were focused at a single station near the dam wall in about 72 m water depth. These measurements were supplemented with broader-scale transverse and longitudinal CTD transects.

Figure 51: Vanderkloof Dam

10.4.1 Temperature and oxygen

The seasonal progression in temperature is characterized by an intensification of stratification over the summer followed by a deepening of the thermocline and mixing from autumn to winter. The "preferred" range (13-19ºC) is restricted to the region of the thermocline during the summer. Maximum temperatures occur in summer in the upper epilimnion with a pronounced diurnal variability (Figure 52). Records to date show levels exceeding 25 ºC occur sporadically in January to February.

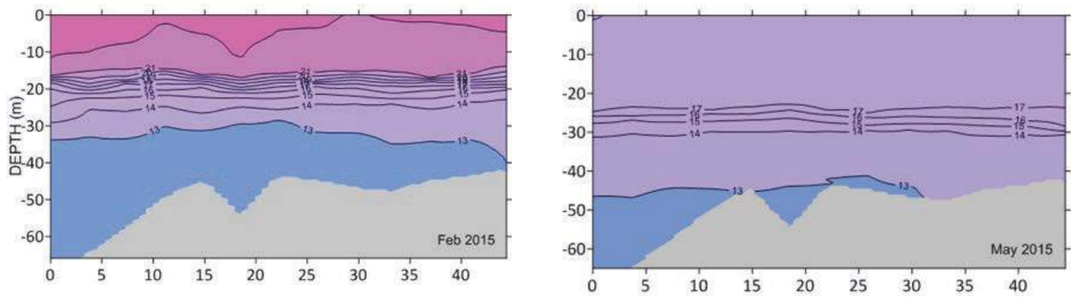

Figure 52: Summer (February 2015) and autumn (May 2015) temperature (ºC) variation along the transect line from near the dam wall to 40 km upstream.

Oxygen concentrations were well within the preferred range in early summer and the winter period of deep mixing. As summer progresses, oxygen concentrations in the thermocline decrease to below 2.5 mg l-1, potentially deleterious conditions for rainbow trout. This decrease in oxygen continues within the hypolimnion into the autumn (Figure 53). The winter is characterized by a well-mixed and oxygenated water column.

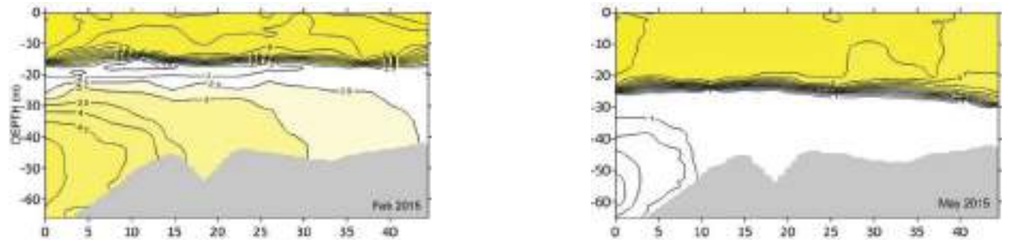

Figure 53: Summer (February 2015) and autumn (May 2015) dissolved oxygen (mg l-1) variation along the transect line from near the dam wall to 40 km upstream.

10.4.2 Total suspended solids

Relatively high concentrations of TSS were associated with the depletion of oxygen within the thermocline as summer progressed (Figure 54). Very high bacterial numbers were evident in this depth range. The mid-water column maximum in TSS increased upstream from the dam wall. TSS concentrations <10 mg l-1 were restricted to the upper water column closer to the dam wall.

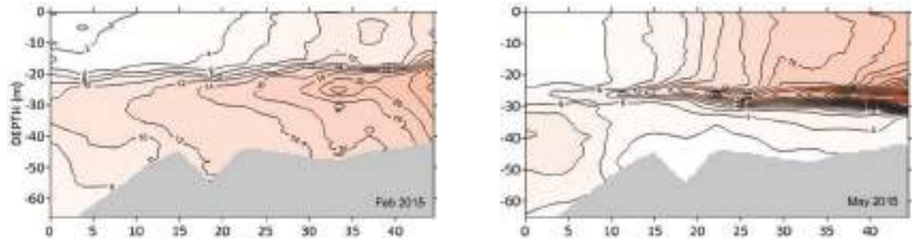

Figure 54: Summer (February 2015) and autumn (May 2015) total suspended solids (mg l-1) variation along the transect line from near the dam wall to 40 km upstream.

10.4.3 Nutrient concentrations and microalgae species

Vanderkloof Dam is a relatively unproductive water body characterised by severe phosphorus limitation with mean dissolved inorganic levels of 4.27 µg phosphorus l-1 as PO4, 0.21 mg nitrogen l-1 as nitrate (NO3-); nitrite (NO2-); ammonium (NH4+) and 6.80 mg Si l-1. Mean chlorophyll a (Chl a) concentrations in the upper 20 m range between 2.82 and 3.93 µg l-1 outside of the mid-summer period. Maximum concentrations occurred in February with a mean of 8.18 µg l-1 in the upper 20 m and peak values in excess of 40 µg l-1 well upstream of the dam wall. Examples of the more common phytoplankton species found in Vanderkloof Dam are shown in Figure 55.

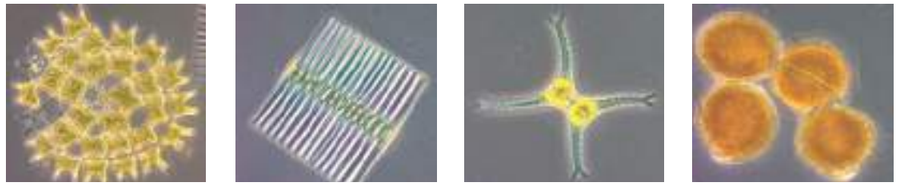

Figure 55: Mircroalgae species: left to right – Pediastrum spp., Fragilaria crotonesis, Staurastrum spp.and Gyrodinium spp.

10.5 Ulva as a functional ingredient in aquafeeds

Seaweed aquaculture has grown faster than any other marine production sector over the last 20 years, and there is a growing body of literature that suggests that Ulva will become a major component of global marine aquaculture; contributing towards the production of aquafeeds, functional foods, nutraceuticals and possibly human food (Bolton et al., 2016). South Africa is no exception, with local production of Ulva exceeding 2 000 tons per annum; making it the largest marine aquaculture product by weight. The vast majority of this Ulva is grown in effluent water from aquacultured abalone, as a means to bio-remediate effluent water before it is returned to the ocean, and is not sold, but fed on-farm as an abalone feed; either fresh or dried and incorporated into formulated feeds.

Since the use of fishmeal and fish oil in aquafeeds is deemed unsustainable in the long-term, there is presently extensive research focused at reducing their inclusion and/or identifying suitable replacements, particularly protein sources derived from plant proteins (Bolton et al., 2016). Since Ulva is consistently produced in large amounts Bolton et al. (2009) calculated that a conservative estimate of production over a full year from South African raceway systems was 20-26 g.dw.m-2.day-1, it has enormous potential for significantly reducing the use of fishmeal and fish oil in aquafeeds. Moreover, effluent grown Ulva is often produced with over 20% crude protein and Ulva protein has a similar amino acid profile to animal and other plant proteins. Extensive research on the effects of the dietary supplementation of aquafeeds with Ulva, as well as other seaweeds (e.g. kelp), on the growth of cultured abalone has been conducted by several local researchers (Rhodes, Stellenbosch and Cape Town Universities), but the exact mechanisms for improved growth have yet to be elucidated. To gain further insight on the role of Ulva as a functional ingredient in aquafeeds, researchers from DAFF (Dr Brett Macey, Mark Cyrus), the University of Cape Town (Prof. John Bolton, Morgan Brand) and the University of the Western Cape (Dr Denzel Beukes), have been studying the effects of dietary Ulva supplementation on feed attractiveness, growth performance, immune and physiological responsiveness and product quality of both abalone *(Haliotis midae)* and sea urchin *(Tripneustes gratilla)*.

Through this collaborative research effort the dietary inclusion of Ulva (200 g.kg-1) has been shown to significantly improve the palatability of artificial feeds, improving feed consumption rates and daily digestible protein intake of urchins (Cyrus et al., 2015a). Ulva supplementation significantly increased somatic growth of abalone and urchins and enhanced urchin gonad quality (color, texture, firmness) (Cyrus et al., 2014b). A beneficial impact on the innate immune response was also observed, with dietary Ulva supplementation improving the ability of abalone to render an injected dose of bacteria *(Vibrio anguillarum)* non-culturable (Brand et al., unpublished data). To determine the functional components of Ulva that are contributing to these observations, isonitrogenous diets consisting of effluent grown dried Ulva (10% w/w), the predominant carbohydrate extracted of Ulva (Ulvan, 1% w/w), and a monomeric sugar (glucuronic acid, 0.1% w/w), were formulated and their effects on FCR, specific growth rate (SGR), tissue glycogen, blood glucose and gut microbiome of abalone were determined and compared with abalone fed fresh Ulva (Figure 55; Figure 56).

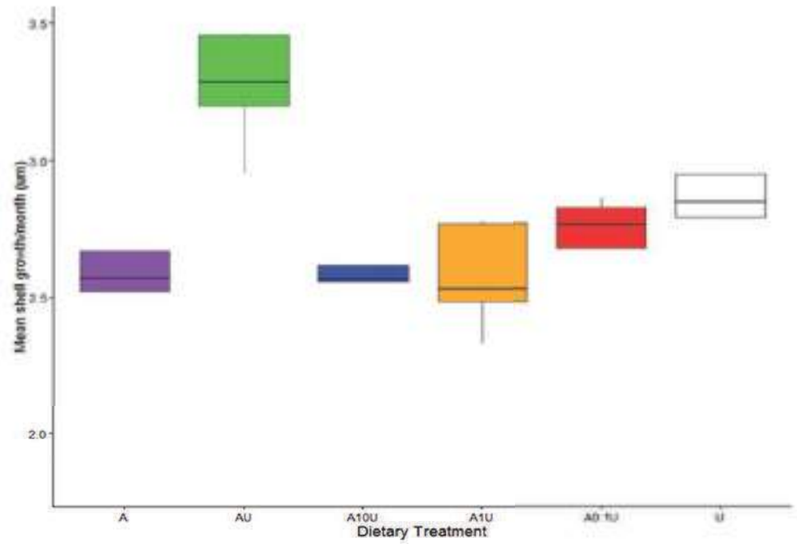

Figure 56: Mean (±SEM) shell growth of abalone (Haliotis midae) per month (µm) fed a commercial formulated feed 'Abfeed' (A); a mixed diet of Abfeed and fresh effluent grown Ulva (AU); fresh effluent Ulva (U); or Abfeed supplemented with 10% (w/w) dried effluent grown Ulva (A10U), 1% (w/w) Ulvan (A1U), 0.1% (w/w) glucuronic acid (A0.1U). Animals fed the mixed diet of 'Abfeed' and fresh effluent grown Ulva grew significantly better than all other treatment groups.

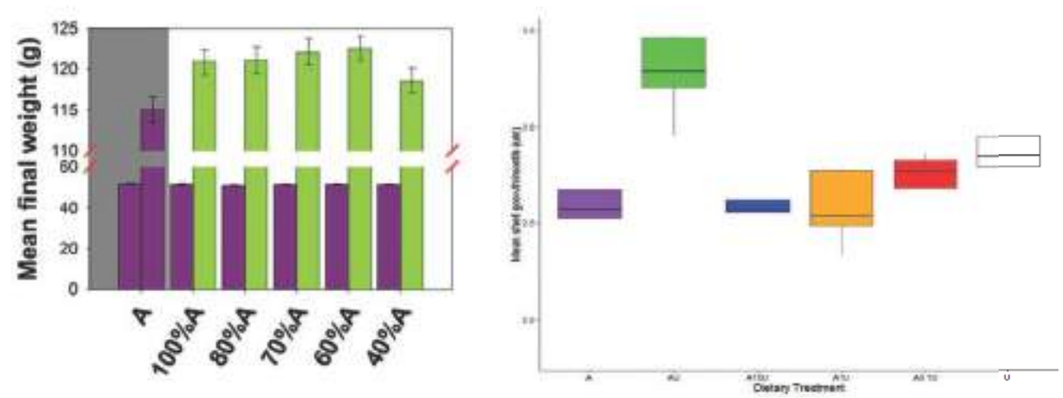

Figure 57: Mean (±SEM) body weight of abalone fed one of six experimental diets over a one year period. The control group was fed 100% Abfeed S34 (A) without Ulva. Abalone in the remaining treatment groups were fed 100%, 80%, 70%, 60% and 40% Abfeed, with Ulva fed ad libitum.

Addition of fresh effluent grown Ulva significantly improved abalone growth and we demonstrated that as much as 60% Abfeed can be removed from the abalone diet without compromising growth; when compared with the Abfeed control group.

It has been shown that dietary Ulva supplementation can significantly improve somatic growth of cultured abalone when fed in a mixed diet (Figure 56), or can reduce the amount of formulated feed required by the animals without compromising growth (Figure 57), thus reducing the amount of protein-rich feed required to produce a high quality aquaculture product.

Postprandial glucose levels were also reduced in animals fed Ulva supplemented feeds and significant dietary effects were recorded in tissue glycogen and moisture content, FCR and gut microbiome (using denaturing gradient gel electrophoresis and 16S rDNA amplicon sequencing) (Brand et al., unpublished data). More recent evidence also suggests that fresh Ulva as well as the diatom assemblages associated with fresh Ulva have a significant positive impact on urchin larval settlement rates (>90% settlement success). The benefits of fresh Ulva as a functional ingredient in aquafeeds are strong motivators for its continued inclusion as a part of the growing aquaculture industry.

10.6 South African Echinoculture of the sea urchin *Tripneustes gratilla*

Sea urchin roe is regarded as a premium seafood product, particularly in Asia, especially Japan, and European countries such as France (Liu et al. 2007a, 2007b; Kelly et al. 2000). High demand for these commercially valuable seafood products has, however, led to extensive exploitation and overfishing of many echinoid species *(Onitsuka et al. In press),* and the consequent decline of natural stocks has stimulated research and commercial interest in the development of methods for the successful intensive cultivation of edible species (Kelly et al., 2000). Although sea urchin aquaculture *(echinoculture*) has been practiced in countries such as Japan for many decades, *echinoculture* remains a relatively recent practice that is still in its infancy in most other countries, including South Africa.

In South Africa, *Tripneustes gratilla* is currently being investigated for its aquaculture potential. This species is a tropical fast-growing shallow water echinoid and can produce high quality gonads with excellent market acceptance. It is also one of the most commercially important sea urchin species in countries such as Japan, which consumes more than 80% of the world's total production of sea urchin roe. Gonads obtained from this species can have a wholesale value in excess of 9 000 Rand per kg (Tokyo-Tsukiji Market. 2012). Data on specific lifecycle stages of certain sea urchin species, including T. *gratilla,* however remains sparse and these knowledge gaps need to be filled in order to optimise and streamline the production of these species. Within the past 6 years, researchers at the DAFF Aquaculture Research Facility (Dr. MD Cyrus & BM Macey) in collaboration with researchers from the University of Cape Town (Prof. JJ Bolton, Department of Biological Sciences) have managed to successfully address the three key areas of research identified as presently hampering commercial sea urchin aquaculture globally: (1) Establishing conditioning protocols to ensure uniform development of adults prior to harvesting; (2) the development of a cost-effective gonad conditioning diet that can produce marketable quality gonads of a large size and bright, marketable, colour and (3) Improving the survival of plateaus larval stage, settlement success and post-settlement survival of larvae. Although a number of recent investigations have examined the effects of diet on growth and gonad quality of adult T. gratilla (Dworjanyn et al. 2007; Cyrus et al. 2014; 2015), very little attention has been devoted to the effects of diet on the growth and development of the pluteus larvae; and the effects of both diet and culture technology on settlement and post-settlement survival of larvae.

If the local industry is to be successful with T. *gratilla e*chinoculture, methods to increase the production of juvenile urchins and the survival of post-settled urchins are required. In the hatchery production of most species, the larval stage generally represents the most critical and delicate part of the lifecycle. Methods for large-scale hatchery production of urchins have been developed for a number of commercially important species, particularly *Strongylocentrotus* (Kawamura 1970, McBride et al. 1997, Pearce et al. 2002c). However, large-scale hatchery production of other species, including T. *gratilla*, is still under development and data remains sparse, particularly with regards to the effects of different microalgal feeds and physical conditions on the growth and development of the larvae. Development of sea urchin larvae is determined by a range of abiotic and biotic factors, including: feed type, pH, temperature, stocking density, dissolved oxygen and hydrodynamic factors such as flow, light and gravity. Chemical cues from a range of different sources (diatoms, adult conspecifics, macroalgae, and bacteria), physical cues or a combination of these (Pawlik 1992, Huggett et al. 2006, Dworjanyn and Pirozzi 2008) also have a direct impact on larval settlement and post-settlement survival. T. *gratilla* has a pelagic larval stage that lasts between 15 and 52 days, with the duration of this stage dependent on the biotic and abiotic factors mentioned above. In general, under favourable environmental and nutritive conditions the duration of the planktonic stage can be substantially reduced (Byrne et al. 2008b) and the presence of favourable chemical cues or physical substrates will enhance settlement and post-settlement survival of larvae. Increasing hatchery production by reducing the long larval period and increasing survival of T. *gratilla* larvae will certainly help improve production, profitability and the potential success for the cultivation of this species.

Current research at the DAFF Research Aquarium, Sea Point is investigating the effects of different microalgal feeds *(Chaetoceros muelleri, Isochrysis sp., Rhodomonas sp., Dunaliella salina)* individually and in combinations, on the growth, survival and morphology (Figure 57) of T. *gratilla* larvae in order to determine the optimum feed(s) for hatchery production. Investigations into the effects of larval diet/ substrates and settlement inducers on metamorphosis, survival and growth of the sea *urchin Tripneustes gratilla* are also being conducted. Marine invertebrate larval settlement and metamorphosis has, in many instances, been linked to associations with the recognition of specific substrates or substratum-specific biochemical signals.

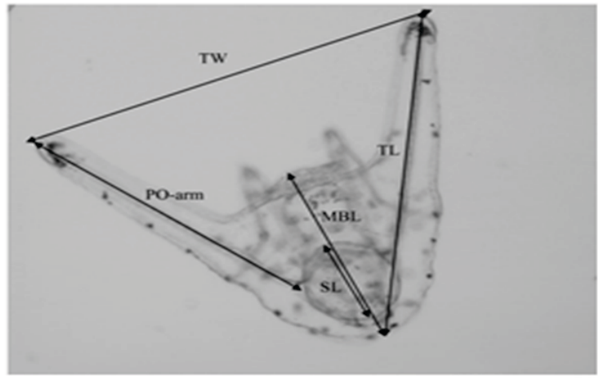

Figure 58: Digital image of the two-armed Tripneustes gratilla plauteus (40 x magnifications) depicting the five characteristics used to compare larval growth and morphology between feed treatments. TL: total length, TW: total width, PO: arm post-oval arm length' SL: stomach length, MBL: mid-body line length.

In most intensive aquaculture systems used at present, the required morphogenetic inducing substances may often be lacking due to the removal of such operations from natural systems. Many aquaculture operations, such as those working with sea urchins or abalone, can therefore suffer from costly and extensive early post-larval mortality, which can be linked to a delay in uniform and normal development during metamorphosis. The success of settlement substrates and inducers was tested by evaluating the rate of larval metamorphosis over a 48 hour period and tested a range of benthic microalgal species *(Amphora sp.; Cocconeis sp.; Navicula sp.; Nitzschia sp.; Natural Tank Diatom communities(TD)),* macroalgae species *(Ulva sp., Ulvella sp.)* and chemical cues (Histamine, Dibromoethane, γ-aminobutyric acid ("GABA"), Ulva Extracts) suggested to have an effect on metamorphosis, settlement and post-settlement survival of larvae. Preliminary results from these trials (Figure 58) indicated that benthic diatoms commonly used by industry for larval settlement *(Amphora sp.; Cocconeis sp.; Navicula sp.; Nitzschia sp)* had very low rates of settlement success (≈20%) for T. *gratilla*, compared with a naturally occurring diatom community

(≈90%). *Macroalgal* substrates (*Ulva & Ulvella)* also showed improved settlement success (50-60%); however the highest rate of settlement was achieved using a combination of *Ulva* and the natural diatom community (≤100% settlement success). Further investigation into identifying the composition of the diatom community and cues responsible for improved settlement in the above treatments are currently underway, including identification of the bacterial component involved (Figure 59).

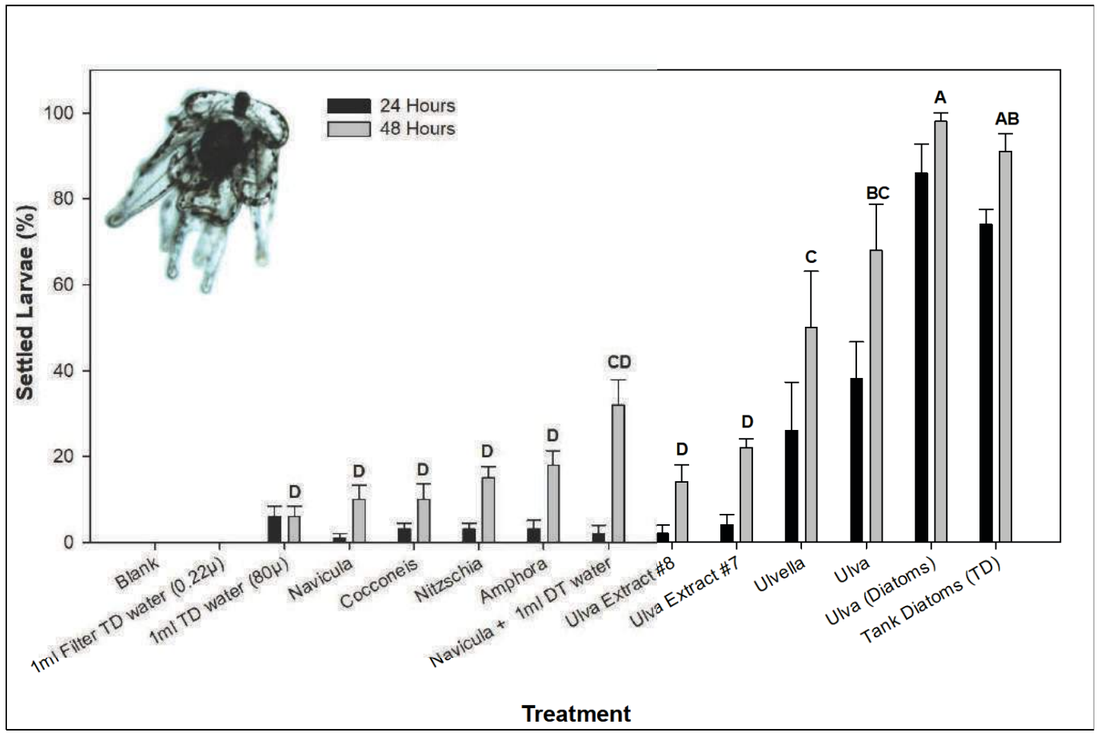

Figure 59: Mean (±SE) number of larvae that settled 24 & 48h in presence of different settlement cues. Urchins where considered settled only if full metamorphosis had occurred and not just larval attachment.

(Blank = filtered seawater; TD = Tank Diatom Community; Gaba = γ-Aminobutyric acid)

Letters (A, B, C, D) indicated significant differences between treatment groups.

The information generated from this study will contribute towards determining a range of ideal culture conditions that can increase larval survival, settlement and ultimately the production of juvenile urchins for commercially producing T. *gratilla.*

Juvenile urchins generated from these studies will be utilized to run pilot scale commercial trials on an existing aquaculture facility in the Eastern Cape (Wild Coast abalone) to test out previously developed feeds and feeding regimes to determine growth rates, optimal stocking densities and gonad quality of this species under farm conditions. At present we have been granted an "Experimental Permit" and are currently building an experimental set up at Wild Coast Abalone and hope to start the farm trials before the end of 2016. This part of the study is particularly exciting as it will be the first time that farmers will be exposed to this new species and see the growth potential for South African Aquaculture.

AQUACULTURE DEVELOPMENT ZONES

11.1 Aquaculture Development Zones

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

11.1.1 The Qolora Aquaculture Development Zone

The development of the land-based Qolora Aquaculture ADZ, covering approximately 26.5 ha was issued EA in 2011 (Figure 60). The conditions of the EA and Waste License included the requirement to develop a number of Management Plans prior to construction. In 2015 the Department of Agriculture, Forestry and Fisheries (DAFF), undertook the process of meeting the conditions stipulated in the EA and Waste License for the ADZ. The engagement represents Phase 2 of the Qolora ADZ implementation programme and included the following main tasks:

- Botanical Management Plan
- Storm Water Management Plan
- Health and Waste Management Plan (HWMP)
- Engineering Site Plans
- Environmental Management Systems and Emergency Preparedness Plan
- Relevant Permit Applications

- Coastal Water Discharge Permit application

- Coastal Lease application

- Water use license applications

- Endangered species destruction and removal permit application

A business case for an abalone farm has also been planned and is to be undertaken in 2016.

Figure 60: Proposed Qolora Aquaculture Development Zone.

- **The Qolora Aquaculture Development Zone**

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

11.1.2 Algoa Sea-based Aquaculture Development Zone

The Department of Environmental Affairs (DEA) completed a Strategic Environmental Assessment (SEA) aimed at identifying suitable land and sea space surrounding South Africa's coastal provinces for the establishment of Marine Aquaculture Development Zones (MADZs) in 2009. The purpose of the MADZs (Figure 61) is to encourage investor and consumer confidence in the marine aquaculture industry in South Africa, and also to create incentives for industry development, provide marine aquaculture services, manage risk associated with aquaculture, and provides skills development and employment for coastal communities. Out of the two shortlisted sites within Algoa Bay, Algoa 1 site was chosen as the most preferred site due to its proximity to the Port Elizabeth harbour, amongst other things. This site is about 285 ha and is located approximately 2 km offshore from the Summerstrand and Humewood beach area.

Figure 61: Algoa Bay ADZ Sites, (Algoa 1, the preferred site is the red area on the left and Algoa 5, red area on the right)

The DAFF appointed Environmental Assessment Practitioners in November 2010, after following a competitive bid process, to conduct the EIA process. To date, there have been a number of challenges for this project as the EIA process is largely affected by comments made by Interested and Affected Parties (I&APs). Further challenges were experienced in May 2012 when I&APs and authorities brought to the Department's attention further problems relating to the sites selected within Algoa Bay in the Eastern Cape. The sites were rendered unsuitable and internal discussions as well as meetings and communications with the Department of Environmental Affairs led to a change in the location of the sites. This resulted in the need for additional funds to conduct further oceanic surveys on the new sites selected for assessment in the EIA process moving forward. It further required a contract extension of five (5) months and both additional funds and the extension were granted through approval obtained from the Bid Adjudication Committee of DAFF.

The EIA process was concluded and an Environmental Impact Assessment Report was submitted to DEA in September 2013 for their perusal and decision making. DEA requested that an inter-governmental meeting be convened in order to discuss the project findings and concerns raised. This meeting was held in November 2013 in Port Elizabeth whereby DEA expressed satisfaction with the manner in which the service provider conducted the EIA process and considered it flawless.

Department of Environmental Affairs granted an Environmental Authorisation to DAFF on 9 July 2014. As provided for in the legislation, interested and affected parties were informed about this decision. Unfortunately, due to strong objections from interested and affected parties, some of them not registered, DEA received numerous appeals (about 127) and thus DAFF could do nothing to market the site until such time that the appeal process has been concluded and hopefully DEA has decided to uphold its decision. DAFF has since provided written responses to all appeals received. DEA then requested a meeting with the appellants and this meeting between DEA, DAFF and Appellants was held successfully in Port Elizabeth on 26 January 2015. DEA undertook to forward DAFF's Responses to all appellants by Wednesday, 28 January 2015 and this was done. The appellants were given 30 days within which to raise further concerns before DEA could take the next step.

The Nelson Mandela Bay Metropolitan Municipality advised DAFF that, in principle, they do not have an objection to fish farming in Algoa Bay, but they have an objection to fish farming at the preferred site, Algoa 1 and requested DAFF to consider alternative sites. DAFF, after consultation with DEA has decided to reconsider Algoa 5 site, which is closer to the Coega Harbour. The DAFF is currently in the process of appointing a competent service provider to undertake comparative assessment of the Algoa 5 site.

- **Algoa Sea-based Aquaculture Development Zone**

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

A total of 28 applicants lodged substantive appeals against the proposed ADZ and a detailed responding statement was submitted to the DEA by DAFF in December 2014. Following the appeal processes, the DEA Minister instructed the DAFF to undertake comparative studies to further assess Algoa 5 and Algoa 1. The comparative studies will be advertised and an appointment will be made.

11.1.3 The Amatikulu Aquaculture Development Zone

The Department is in the process of appointing an independent, qualified EAP to conduct an EIA for an ADZ in Amatikulu located in KwaZulu Natal approximately 120 km north of Durban. The service provider will be approved in 2016. The site has an area of approximately 108.37 ha and is situated next to the Amatikulu estuary. The site was a thriving prawn farm in the 1990's, however the only remnants of the prawn farm are the unused earthen dams, water inlet channel (which are extensively covered by vegetation) and demolished pump house situated at the mouth of the Amatikulu estuary. The farming of indigenous and temperate water species with a production output of 20 000-30 000 tons is envisaged. The Department will establish infrastructure for the ADZ such as access roads, electricity, sea water pipelines, pump station, reservoir, and fencing (Figure 62).

Figure 62: Image of the Amatikulu site

11.1.4 Saldanha Bay Aquaculture Development Zone

The Department aims to develop and facilitate aquaculture by conducting the EIA process for the Saldanha Bay ADZ. The ADZ will assist the existing farms with expansion as well as enable new entrants to become established in Saldahna Bay.

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

The DAFF entered into a partnership with the Aquaculture Research Unit (ARU) of the University of Limpopo in 2012. The partnership opened new research opportunities for both DAFF and ARU scientists currently conducting research on various projects focusing on freshwater fish species. At the core of the partnership, was the production of catfish *(Clarias gariepinus)* fingerlings (Figure 63) for demonstration and research centres around the country. Over the past 2 and a half years, thousands of fingerlings have been produced for these centres. Non-governmental organisations involved in community outreach programmes and subsistence fish farmers have also benefited from this project. The production of fingerlings has also helped several students to successfully conduct research involving catfish.

Figure 63: Rearing of fingerlings in a recirculating aquaculture systems at University of Limpopo.

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

Project summary

The China-South Africa Agricultural Technology Demonstration Centre (ATDC) is one of the twenty six Agricultural Technology Demonstration Centres aided by the Chinese Government during the Beijing Summit on Forum of China Africa Cooperation (FOCAC) in 2006.

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

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

Breeding and technology demonstration

Breeding of species is done during summer periods (January-March and October –December). Currently the centre has successfully bred African catfish *(Clarias gariepinus*), Common carp *(Cyprinus carpio)* and aquarium fish (gold fish (*Carassius auratus)* and koi carp *(Cyprinus carpio)*. There was an attempt to breed small mouth yellow fish but with no success. The breeding technique that has been demonstrated includes: the artificial, semi artificial and natural breeding as shown in Figure 64. The species that were bred in 2015 and their production are shown in Table 39.

Figure 64: A Illustrates the preparation of Hormone (HCG) injection in the lab, B Illustrates broodstock selection by checking the development of the eggs on female common Carp, C Illustrates the injection of the hormone in the carp, D Illustrates the fry produced after breeding of common carp.

Table 39: The 2015 production data of each species bred at the ATDC

Number of breeding sessions	Breeding date	Fish species	Production system	Type of breeding	Brood stock Number	Estimate Fingerlings Number
1	January 2015	African catfish (Clarias gariepinus)	Hatchery tanks	Semi artificial	2 Males and 2 Females	Approximate 6000
2	January 2015	African catfish (Clarias gariepinus)	Hatchery tanks	Semi artificial	2 Males and 2 Females	Approximate 15000
3	February 2015	African catfish (Clarias gariepinus)	Hatchery tanks	Semi artificial	15 Males and 45 Females	Approximate 30000
4	September 2015	Gold Fish (Carassius auratus)	Hatchery tanks	Natural breeding	60 Males and 30 Females	Approximate 30,000
5	October 2015	Common Carp (Cyprinus carpio)	Pond No.3 and Pond No.5	Natural breeding	22 Males and 11 Females	Approximate 80,000

Training and capacity building

The ATDC has organized and hosted different promotional programmes which include: training, tours and site visits. These programmes have been organised for local farmers, high school students, higher education students and technical officials who have all benefited from the aquaculture courses. During 2015, training has been organised for high school students and technical officials as shown in Table 40.

Table 40: Training programmes that were organised during 2015

Date	Training group	Town/Province/Country	Number of trainees
16/03/2015	G8-G9 Students	Gariep Dam, Free State	24
27/05/2015	G8-G12 Students	Edenburg	61
03/06/2015	Technical officials	Lesotho	5
30/06/2015	G5-G12 Students	Springfontein	60
30/06/2015-02/07/2015	G5-G12 Students	Wepener, Dewetsdorp, Vanstadenrus and Jacobsdal	30

Production systems

Net cage farming

Cages are usually floated in rafts, and either anchored to the lake/reservoir/river bottom, or alternatively connected to shore by a wooden walkway as show in Figure 65. In some parts of the world such as China and the Philippines, fixed cages are used in shallow waters (<8m) with muddy bottoms and synthetic fibre net bags are attached to posts driven into the substrate. They are simpler and cheaper to construct as they don't involve the construction of a buoyant collar, which can account for more than 50% of the capital outlay. The net cage culture system has also been tested at the ATDC.

The ATDC net cages were constructed in the January 2015 and became functional in March 2015. The cage culture is operating very well on the reservoir pond. The cages are stocked with common carp and catfish and fed twice a day (morning and afternoon). The cage has also being used to culture gold fish which have been successfully grown.

Figure 65: A illustrate the submerged cages demonstrated for Common Carp culture, B Illustrates the floating cages demonstrating the gold fish culture at ATDC.

Rice-fish (peddle field) farming

A rice-fish farming system is an integrated rice field or rice field/pond complex, where fish are grown concurrently or alternately with rice. China is the main producer of rice–fish culture with an area of about 1.3 million hectares of rice fields with different forms of fish culture, which produced 1.2 million tonnes of fish and other aquatic animals in 2010. The Free State is a leader in the agriculture sector. The demonstration of Rice-Fish integration in the ATDC brings this sector to a new level by combining the aquaculture with agriculture.

About 250 square meters of rice was planted in November 2015 and integrated with 200 Common Carp and African Catfish in the same pond (Figure 66). The rice was grown successfully and harvested in April 2016. The success of the rice planting and fish farming shows that this model can provide additional food and income by diversifying farm activities and increasing yields of both the rice and fish crops.

Figure 66: A Illustrates the rice-fish integrated pond,

B Illustrates the harvesting of rice after six months of growth.

Aquaponics farming

The aquaponics system in the ATDC was established in May 2015 (Figure 67). In normal aquaculture, excretions from the animals being raised can accumulate in the water, increasing water toxicity. In an aquaponics system, water from an aquaculture system is fed to a hydroponic system where the by-products are broken down by nitrification bacteria into nitrates and nitrites, which are utilized by the plants as nutrients, and the water is then recirculated back to the aquaculture system.

About 500 common carp fries were stored in the aquaponics ponds to compare the growing speed for those which were stocked in the normal farming ponds.

Figure 67: Maintenance of the aquaponics system

Hatchery and tank farming

Water temperature controlling, easy handling and fast monitoring make the hatchery best choice for natural breeding either for goldfish or African catfish. In the year of 2015, the breeding of African catfish and goldfish were carried out at the hatchery.

The fertilized eggs were kept in the tanks for hatching and the fries were also kept as illustrated in Figure 68. When the fries grow to be fingerlings, they are transferred from the hatchery to the external ponds for further improvement. Multiply techniques were demonstrated during the Technical Cooperation Phase, including data collection, breeding technology, hatchery feed production technology (rotifer production), sterilization technology, grow-out technology and overwintering technology.

Figure 68: A: Tanks used for holding fish fry after breeding,

B: Tanks used for brood stock conditioning prior to breeding.

External ponds

External pond farming systems are the most common method for freshwater fish farming (Figure 69). The advantages of utilizing micro-biological nutrition such as zooplankton, phytoplankton etc. made this model much more efficient than any other internal farming system. All the common carp fries were reserved for grow-out and all the gold fish fingerlings were moved to the outside ponds for further improvement after the fry stage.

Figure 69: Cleaning and maintenance of external ponds

11.4 The Hamburg Aquaculture Project

The Hamburg Aquaculture Project lies within the Eastern Cape Province, in the Ngqushwa Local Municipality. The project aims to revitalize an existing oyster farm and establish a 20 ton dusky kob pilot farm (Figure 70) and to carry out an Environmental Impact Assessment (EIA) study for a 1 000 ton dusky kob farm. The existing state of affairs of the farm is that the oyster farm that has been revitalized and is operational at present. Infrastructure development for a kob pilot project has been completed and the Environmental Authorisation has been granted by Eastern Cape Province, Environmental Authority for the 1000 ton expansion.

Figure 70: Recirculation Aquaculture System for dusky kob pilot farm in Hamburg, Eastern Cape.

The ownership and the marine aquaculture right of the project were transferred to Siyazama Aquaculture Primary Co-Operative Limited, members which are from the local community. The farm employs 21 people of which 10 are females and 11 are males (Figure 71 and Figure 72).

Figure 71: Project workers maintaining the oyster racks in Hamburg, Eastern Cape.

Figure 72: Project beneficiaries harvesting and packaging of dusky kob at the Hamburg Aquaculture Project, Eastern Cape.

The farm cultures the oyster species *(Crassostrea gigas)* and dusky kob *(Argyrosomus japonicas)*. In 2015, the farm stocked 577530 (586.569 kg) dusky kob fingerlings. The farm has not sold oysters thus far but have sold 989 kg (R 54 405.08) of dusky kob during 2015. Sales are expected to continue later during 2016, once the fish reach a marketable size. Marketing has been through Oceanwise (Pty) Ltd, a farm located in East London, which distributes to various areas. They handled the farm's full production with the exception of an 81 kg donation to DAFF and a small portion of 9.39 kg which were cash sales.

Job creation is expected to continue as soon as the expansion plans are put into execution. The beneficiaries are a total of 47 members of the project, of which 20 are already benefiting through employment. Although the farm has done well so far several challenges have been encountered. Skills development has been a major challenge. It is important to appoint suitable, dedicated technical and management personnel to the project in the future.

11.5 Camdeboo Satellite Aquaculture Project

The Camdeboo Satellite Aquaculture Project (CSAP) is located at Graaf Reinet in the Eastern Cape Province. This project is implemented by the Camdeboo Local Municipality which entered into an agreement with the Department of Agriculture, Forestry and Fisheries (DAFF) on the 26th of March 2012. The DAFF funded the project for an amount of R10 million for the construction of an aquaculture production system with an intended production capacity of 20 tons per month.

The CSAP is a project of the Blue Karoo Trust (BKT) which aims to establish a preserved freshwater fish industry in the Eastern Cape. The BKT aims to grow, process, package, market and distribute preserved catfish to bulk markets. The overall CSAP business concept thus consists of two main components – the primary production component (growing the fish), and the post-harvest factory component

(processing the fish into a market-ready product).

The project uses a Recirculating Aquaculture System (RAS) for the production of catfish (Clarias Gariepinus) and also breeds on site (Figure 73).

Figure 73: (A) The tunnels used to house the culture systems and (B) the recirculating aquaculture systems.

The primary aim of the project is to create sustainable self-employment opportunities for rural women and facilitate economic growth. This is achieved through the establishment of aquaculture clusters, each consisting of a central management farm and a network of satellite farming systems. The CSAP initiative has established a commercial catfish production venture through the establishment of aquaculture clusters, which consists of a central management farm (hatchery) and a network of satellite farming systems. Fish are reared at high densities in recirculating aquaculture systems, located in greenhouse tunnels.

11.6 Current status of Camdeboo Satellite Aquaculture Project (CSAP)

Human resource development: The CSAP currently has fifty four (54) beneficiaries which are receiving some mentorship provided by the Sondelani Trust. Thus far, the Sondelani Trust has recruited two people to join the other beneficiaries. The mentors provide guidance on anything pertaining to aquaculture matters, and work related in general.

Farming: At the moment, the facility produces 26 tons of fresh fish; however, they will expand this in year two and three of their production.

Research & development: There is a proposal of an algal ponding system for effluent treatment and biogas generation. The USA will deploy experts for the algal ponding system. There are also fertilizer trials which have been proposed. On the other hand, there is also a proposal to erect a new processing factory, thus far, rezoning has been completed, there has been an environmental authorisation appeal and a contractor has been appointed. About R57 million is required for this new facility and equipment. A solar power system is also being explored and expected to be installed by 2016. Also a taste testing survey will be conducted which aims to identify which products the market wants.

Fish processing, packaging & marketing: Currently, the CSAP has partnered with Bizbox, a fish processing company in Gauteng. However, fish processing equipment will be moved from Cape Town by engineers to Graaf Reinett later on. To date, eleven companies have been approached as a marketing strategy and the companies have indicated their interest in the products and monthly requirements.

Products: The envisaged products will be whole fish, fillets, fish cakes, polony, spreads and pouched fish for human consumption. Pet food will also be synthesized from fish viscera and other unwanted fish flesh.

Current challenges: The main challenges are the price of fish feed and training funds. The CSAP wants to change their feed company from Montego to OVI, which will allow them to save about 30%. About 54 trainees can drop out due to lack of sufficient funds.

11.7 Training and capacity building in 2015

This section outlines various training and capacity building programmes that were undertaken in 2015. These training programmes were achieved through the cooperation agreement that South Africa signed with the People's Republic of China in 2006. The Republic of South Africa through the Department of Agriculture, Forestry and Fisheries (DAFF) signed a cooperation agreement with the People's Republic of China through the Ministry of Agriculture in June 2006. This bilateral cooperation agreement has a complementary action plan signed in October 2010 including aquaculture activities. Subsequent to the above outlined Action Plan, various training courses in the fields of Agriculture, Forestry and Fisheries were attended by Government officials as well as farmers from May to October 2015 as part of the Capacity Building programme as discussed in detail below.

11.7.1 Training Course on Mariculture Technology for South Africa at the Fujian Institute of Oceanography in China, 15 May-12 August 2015.

The training course was specially designed with emphasis on three major culture categories, namely:

1. Fish,
2. Shrimp, and
3. Shellfish.

The training course which was held at Fujian Institute of Oceanography, Fujian Province, in China was attended by 27 participants from the National and Provincial Departments and the aquaculture industry. The course, which took place over 90 days, consisted of lectures and field trips to different operations across China. The primary objective of this training course was to improve participants' perceptions of Mariculture technology and practical operation skills. Lecture content covered the basic principles of mariculture, practical farming techniques and culture patterns within China, as well as disease prevention and control, aquatic feed production technology and fisheries management.

Theory lectures were delivered by different experts who came from universities and scientific research institutions such as: Xiamen University, Jimei University, Fujian Institute of Oceanography, Fisheries

Research Institute of Fujian. Various study tour sessions were organized for observation on artificial breeding and culture technology of the cultured categories of "Fish, Shrimp, Shellfish, Algae" and the study on various culture methods, such as: maritime cage culture, shellfish hanging culture, land-based industrialized culture, intensive pond aquaculture, pond polyculture, large-scale integrated culture in reclamation areas. In addition, field trips closely related to mariculture which include processing of aquatic products, aquatic products trade and logistics management, production of aquatic feed, as well as fishing port construction were arranged for the participants to gain in-depth knowledge across the entire value chain.

11.7.2 Seminar on Operation Management of China-Aided Agricultural Technology Demonstration Centre in China, from the 28 August 2015 – 17 September 2015.

The seminar focused on equipping managers and officials involved in the development of Agriculture Technology Demonstration Centres throughout Africa with relevant skills to operate the centres. The seminar was arranged by The Foreign Economic Cooperation Centre (China-EU Centre for Agricultural Technology, FECC) which is a government-affiliated institution of director-general level in agricultural economic cooperation under the Ministry of Agriculture of the People's Republic of China. This institution has been certified as a South-South Cooperation Research, Training and Reference Centre and is responsible for the management and implementation of foreign funded agricultural projects, bilateral and multilateral agriculture economic and technological cooperation projects.

This seminar focuses on the operation and management of the Centres to trigger their sustainability. It was divided into five (5) modules and the main contents included:

- China's agricultural development;
- Operation and management of demonstration centres;
- Discussions and
- Field visits.

Two participants from DAFF and three participants from FSDARD participated in the above mentioned seminar.

11.7.3 Seminar on Freshwater Aquaculture and Extension for Developing Countries was Held in Jiangxi College of Foreign Studies, 29 September- 19 October 2015

The seminar offered at Jiangxi College of Foreign Studies, Jiangxi Province, in China included twenty five (25) participants from ten (10) developing African countries. The purpose of the seminar was to share and exchange information on freshwater aquaculture between countries as well as offer training on different aspects of the industry.

A total of twelve (12) lectures were offered during the seminar as well as study tours to different aquaculture and agricultural sites. Lectures were presented on the topics given below.

- Aquatic Animal Diseases and Prevention Measures
- Laws, regulations and policies of China's Fishery industry
- Aquaculture of Tilapia
- Technologies for Standardized Aquaculture
- Open-water Aquaculture and Aquaculture Technology in Large water
- Certification and management of Chinese aquatic product quality and safety
- Development Status of China's Fishery organizations and specialized Cooperative
- The Advance of Nutrition and Feed in Conventional Freshwater Fish
- Management and strategies of Aquatic Germplasm Resource in China

Various study tours were conducted to Jiangxi agricultural university and Nanchang County where participants were given tours at aquaculture laboratories, outside ponds, hatchery, aquaponics production systems and mesh net cages.

NATIONAL AQUACULTURE STAKEHOLDERS ENGAGEMENT

12

12.1 Intergovernmental Forum (National and Provincial Aquaculture Intergovernmental Forum):

This Forum had a Joint Session for the First time when the Department convened a two-day Session from 23-24 February 2015 at the Gariep Agriculture and Technology Demonstration Centre in Gariep, Free State. The first day was dedicated to the development of the Aquaculture Development Bill by the Department and the second day was dedicated to the development of an Inland Fisheries Policy by the Department.

Mr Belemane Semoli and Mr Asanda Njobeni were the co-chairs at this Joint Session, with representation from DAFF, the dti, DWS, DEA, Provincial Departments of Agriculture (all represented with the exception of KwaZulu-Natal), Enact International (Service Provider for the Aquaculture Development Bill), Rhodes University (Service Provider for the Inland Fisheries Policy). The Co-chairs outlined the purpose of the Joint Session that it was to afford relevant government stakeholders an opportunity to meet the service providers appointed to work with the Department and its stakeholders for the development of enabling legislation for aquaculture and fisheries and to deliberate and provide input on the Draft Aquaculture Development Concept Document and get an insight on the road map for the development of the Inland Fisheries Policy. The attendees were also advised that this was a precursor to the informal Public Consultative Workshops that the Department would undertake throughout the country in March 2015.

On day one, presentations were delivered and the opening presentation was given by Enact International on the Aquaculture Development Bill Concept Document. This presentation touched on the proposed framework and scope of the bill, with about fourteen (14) chapters. The presenter gave the objects of the bill and how these were to be achieved through the provisions of the various chapters. Members of the Join Aquaculture Intergovernmental Session were tasked to pay particular attention to chapters and sections of the Draft Aquaculture Development Concept Document that are most relevant to their respective departments and provide input. This was followed by presentations by all member departments from both the national and provincial spheres of government, these included presentations from DAFF (on Aquaculture Programmes including Operation Phakisa outcomes); DWS (on feedback on aquaculture and related activities underway in the Department, particularly work on the development of Resource Management Plans for State Owned dams); the dti (on Jobs Fund and it being available to aquaculture stakeholders as well, with a grant of up to R14m, 20% of which goes towards infrastructure development); DEA (on progress on the New EIA Regulations, 2014, announcing that they have been published in the gazette for implementation); and Provincial departments in attendance also gave presentation on aquaculture programmes, projects and challenges.

On day two, DAFF gave a brief background overview on the need for government to develop an Inland Fisheries Policy. The Service Provider, Rhodes University, through a presentation, gave an in depth overview of the problem statement, the objects and pillars of the Inland Fisheries Policy. All government stakeholders were requested to support the Inland Fisheries Policy development

.In conclusion, it was proposed that an Intergovernmental Work Plan for 2015/2016 be developed and this was supported and a template had to be developed and a Draft 2015/2016 Work Plan circulated for input. Announcements were made for the AASA Conference to be hosted by DAFF and AASA in Polokwane, Limpopo from 28 September 2015 – 2 October 2015. It was also announced that South Africa would host the World Aquaculture Society Conference in June 2017 in Cape Town.

12.2 Marine Aquaculture Working Group

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

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

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

12.3 Marine Aquaculture Industry Liaison

This Forum provides a platform for industry to engage and communicate with government on issues that affect the Marine Aquaculture Industry. Convened and chaired by Chief Directorate Aquaculture and Economic Development. Its members include DAFF officials from relevant Chief Directorates such as Fisheries Research, Aquaculture and Economic Development, Monitoring Control and Surveillance, and Marine Aquaculture Right and Permit Holders.

12.4 Aquaculture Value Chain Roundtable

The Aquaculture Value Chain Roundtable (AVCRT) is a forum that brings aquaculture sector stakeholders together from all points along the entire value chain. These include the regulator, investors, feed producers, growers, processors, marketers, retailers, labour and academia.

The DAFF developed the concept document on AVCRTs during 2011 and the concept document was subsequently approved by the Minister in 2012. The aim of a AVCRT is to foster collaborative industry-government actions that help 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 a food supplier. The DAFF and the AASA co-chair AVCRT meetings, with DAFF also overseeing the secretariat functions.

In 2015, AVCRT Committee met twice, the first meeting was held on 3 March 2015 at the DAFF Cape Town Offices. Highlights of this meeting included the presentation on Aquaculture Stewardship Council (ASC) and ASC Certification that was given by the Chairperson of the ASC, Professor Peter Cook. He touched on what makes a certification programme more credible (e.g. there are national standard setting bodies, regulatory bodies and licensing bodies), benchmarking schemes set up by individual retailers also exist; emphasized that ASC is an independent not for profit organisation with a global footprint; and informed the committee that ASC works with all stakeholders in the sea food value chain. According to Prof Cook, ASC does not issue the certificate to the farms, independent auditors are the ones who visit and assess the farms. If the farm passes the certification audit process, the farm does not pay anything to the ASC, but the farm will be able to use the ASC logo in their farm products. Certification lasts for three (3) years.

A representative from the Trout South Africa Association gave a presentation on progress with regard to the Alien Invasive Species Regulations (AIS Regs). The Association expressed concern at not being consulted in the development of Trout Norms and Standards that were being developed by DEA. However, it was clarified that consultation was done with all sector association before the start of the development process. Progress was given on the implementation of Oceans Economy Operation Phakisa, Aquaculture Lab. Whilst progress is being made, it was reported that there are still challenges i.e. EIA delays, access to land problems and finalisation on lease for sea space, etc. These have since been escalated by the Department Senior Management for urgent intervention. On the Aquaculture Bill, DAFF briefed AVCRT members about progress that has been made, i.e. the Service Provider, Enact International was appointed on 1 December 2014; a Task Team, which is comprised of DAFF, DEA, DWS and the Aquaculture Sector representatives was established and met for the first time on 3 December 2014; a Joint AIF and PAIF meeting was convened on 23 February 2015 in Gariep, Free State where a briefing session was held on the development of the Aquaculture Development Bill and inputs were obtained from member departments; it was agreed that DAFF would circulate the Concept Document and the Programme for informal Consultative Workshops that DAFF was going to undertake on the Aquaculture Bill in March 2015.

An announcement was made by AASA Chairperson on the dates for the AASA Conference, i.e. 27th September 2015 to 2nd October 2015 as well as the World Aquaculture Society Conference that South Africa would host from 26-30 June 2017 in Cape Town.

The second AVCRT meeting was held on 16 July 2015 at the DAFF offices in Cape Town. This meeting, amongst other things, looked at the revised Terms of Reference for AVCRT. The issue of the constitution of the AVCRT membership was discussed after concerns were raised. Whilst a need to open the forum to more role players, a word of caution was made not to make the forum too open as this would prove difficult to manage. It was proposed that AASA assists with identifying core members of the AVCRT who must register formally. Progress on Operation Phakisa and a Revised Operation Phakisa Work Plan were presented by DAFF. In terms of Operation Phakisa implementation, there was 37% achievement of set targets. Breakthroughs have been made in establishing the Inter-Departmental Authorisations Committee, negotiations with DPW and Transnet also yielded good results with agreement to long-term leases (9 years and 11 months); DAFF was making good progress on the Aquaculture Development Bill and the completion of the mandatory Socio-Economic Impact Assessment Systems Report.

The dti gave a presentation on the Implementation of the Broad Based BEE Codes in ADEP, highlighting that the new codes, which were implemented from 1 May 2015 were being work shopped. An industry survey was going to be conducted in order to establish BBEEE Compliance level. A questionnaire was going to be sent to the industry for completion.

In conclusion, DEA representatives were formally requested to make a presentation at the AASA Aquaculture Conference in September 2015 on the EIA Regulations, 2014, and DEA agreed.

AQUACULTURE AND OPERATION PHAKISA OCEAN ECONOMY

13

13.1 Aquaculture year one review

The Department of Agriculture, Forestry and Fisheries is the lead department for the Ocean's Economy Aquaculture Lab and its deliverables. The lab concluded that South Africa's aquaculture sector has a high growth potential due to an increasing demand for fish in the face of declining fish stocks. The goal is to grow the aquaculture sector in South Africa to play a major role in supplying fish products and an enhanced role in job creation and contribution to national income. The targets over the next five years seek to grow sector revenue from R0.67 billion to R3 billion; production by 20 000 tons; jobs from 2 227 to 15 000 and to ensure increased participation to support transformation in the sector.

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

The aquaculture lab comprised of stakeholders from industry, government and academia who identified eight key initiatives, which are expected to spur the growth of the sector. One initiative will address the selection and implementation of 24 projects, improving both the number and productivity of new farms. Three initiatives relate to the creation of an enabling regulatory environment and others focus on funding support, increasing skills pool and awareness and improving access to markets.

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

It has been one year since the launch of Operation Phakisa: Ocean's Economy. Substantial developments have been made to grow the aquaculture sector. Below is a short overview of the targets reached up to now as well as the progress on each initiative:

- **Production:** 2300 tons by 24 projects (Increase of 175 additional tons from 2014)
- **Jobs**: The total new jobs either realized or committed are 521, implying a 23% increase from the 2012 baseline
- **Total jobs on the 24 projects:** 1550
- **Additional jobs:** 301
- **GDP:** R29 million increase in GDP contribution since 2014
- **Investment:** Total committed investment was R444 million, of which private sector investment is R338 million and government commitment R106 million

Table 41: Aquaculture investments

AQUACULTURE ASPIRATION	ACTUAL OUTPUT FOR 2015	TARGET SET DURING LAB	PERCENTAGE INCREASE
PRODUCTION	2300 tons by 24 projects (increase of 175 additional tons from 2014) ~8.4 tons of abalone seeded for ranching, ~25,000 fingerlings stocked in dusky kob cage farm, and ~200 abalone broodstock in abalone hatchery	2421 tons	Equates to 94% of projected target (8.2% increase)
JOBS	261 additional	337 additional	77% of target *The closure of one project has affected production and jobs

AQUACULTURE ASPIRATION ACTUAL OUTPUT FOR 2015 TARGET SET DURING LAB PERCENTAGE INCREASE

PRODUCTION 2300 tons by 24 projects (increase of 175 additional tons from 2014) ~8.4 tons of abalone seeded for ranching, ~25,000 fingerlings stocked in dusky kob cage farm, and ~200 abalone broodstock in abalone hatchery 2421 tons Equates to 94% of projected target

(8.2% increase)

JOBS 261

additional 337

additional 77% of target *The closure of one project has affected production and jobs

Initiative 1: Selection and implementation of 24 projects

Ten (10) out of the 24 prioritized fish farms were supported and are on schedule or ahead of schedule in terms of production, job creation and the impact on transformation.

Initiative 2: Legislative reform

First draft of the aquaculture bill and the socio-economic impact assessment were completed. The Environmental Impact Assessment regulations were changed to a basic assessment. Draft revised Alien Invasive Species (AIS) regulations were published for oysters and mussels.

Initiative 3: Inter-departmental authorisations committee

Eight new leases were approved by the Department of Public Works and 85 hectares of total water lease space was approved from the Transnet National Ports Authority

Initiative 4: Globally recognised monitoring and certification system

Draft standards for bivalves were developed.

Initiative 5: Aquaculture development fund

Nine (9) out of the 24 prioritised fish farms received support through ADEP (Aquaculture Development and Enhancement Programme), CASP (Comprehensive Agricultural Support Programme), and the WFFP (Working for Fisheries Programme), resulting in their scale-up plans being fully in progress.

Initiative 6: Capacity building and skills development for support services

The Skills Working Group was established and is currently assessing the skills requirements of the sector.

Initiative 7: Coordinated industry-wide marketing efforts

The AquaSA model was drafted and workshopped on 16 July 2015. Marketing Working Group established. South Africa received various requests from Iran and Taiwan for aquaculture production exports during the year.

Initiative 8: Preferential procurement

This initiative seeks to partner with government institutions to procure aquaculture products, thereby increasing local consumption and improving nutritional levels in South Africa. Desktop research on preferential procurement was conducted in respect of aquaculture projects and products, but due to capacity constraints, progress on this initiative has been limited.

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

The DAFF is the lead Department for aquaculture development and management in South Africa. It is managed under the Branch Fisheries Management. There are three Directorates responsible for the sector. i.e. Directorate: ATS and D: SAM within the CD: AED. The third unit is the D: ARD under the CD: AED and Development. In 2014, a special unit was established to deal with the Operation Phakisa-Aquaculture Lab called the Delivery Unit reporting directly to the CD: AED.

14.1 Directorate: Aquaculture Technical Services

The Directorate: Aquaculture Technical Services is responsible for:

a. Aquaculture Farmer Support

This section ensures that farmers are obtaining the necessary support. They are responsible for developing and implementing farm support programmes; provide technical advisory services; and facilitate training and capacity building within the aquaculture sector.

b. Aquaculture Development

The section ensures an enabling environment is created for the aquaculture sector. The D: ATS has been tasked with addressing zonation and facilitation of seed supply.

c. Economic and Information Management

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

14.2 Directorate: Aquaculture Research and Development

a. Aquaculture Reproduction, Nutrition and Genetics

This section deals with the research and development of culture technology for aquaculture species. The functions of the Directorate include the development of programmable brood stock conditioning and hatchery methods for selected and prospective commercially viable aquaculture finfish and shellfish species, testing growth rates, production densities and FCR of selected commercially viable fish species, formulating and testing diets that will improve growth rates or FCR of commercially viable species. The section is also responsible for developing techniques to optimize mass culture of phytoplankton and zooplankton required for commercial hatcheries, testing of IMTA (integrated multitrophic aquaculture systems) with respect to mechanized primary hatchery operations that will predictably produce fish juveniles with consistency, development of techniques for cryogenic stem cell preservation (genetic studies and aquaculture brood stock improvement application). They also contribute to the technology improvement of research based RAS for commercial application, functioning as a "Centre of Excellence" by providing advice and IP to ensure sustainable aquaculture industry development with minimal impact to the environment.

b. Environmental Interactions

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

c. Aquatic Animal Health and Diseases

The aquatic animal health and diseases sub directorate focuses on research based on three main areas which includes:

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

14.3 Directorate: Sustainable Aquaculture Management

a. Aquaculture Authorisations

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

b. Aquatic Animal Health and Environmental Integrity

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

- **Aquatic Animal Health**

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

- **Environmental Integrity**

This section is responsible for aquaculture environmental interactions, this entails the assessment of the environmental impact of aquaculture and related activities.

- **Food Safety**

This section is responsible for the development and management of food safety programmes. Currently, the sub-unit is managing the SAMSM&CP. The objectives of the SAMSM&CP are, amongst other things, to ensure guarantees to domestic and international markets and consumers that South African farmed shellfish products are safe for human consumption. In order to ensure functional food safety programmes, the sub-unit collaborates with other agencies such as the NRCS and CSI.

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