AFRICAN UNION
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FOR ANIMAL RESOURCES



MAPPING STUDY OF AQUATIC ANIMAL DISEASES - SOUTHERN AFRICA

Prepared by: John Walakira, NAFFIRI – Aquaculture Research and Development Centre, Uganda.

Edited by: Nelly Isyagi, Mohamed Seisay and Simplice Nouala

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The Director
African Union – Interafrican Bureau for Animal Resources (AU-IBAR)
Kenindia Business Park
Museum Hill, Westlands Road
P.O. Box 30786
00100, Nairobi, KENYA
Or by e-mail to: ibar.office@au-ibar.org

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ACRONYMS

AAHS	Aquatic Animal Health Services
ANARC	African Network of Aquaculture Research Centres
AU	African Union
AU-IBAR	African Union – Interafrican Bureau for Animal Resources
CAADP	Comprehensive Africa Agriculture Development Programme
CAMFA I	First Conference of African Ministers for Fisheries and Aquaculture
CAMFA II	Second Conference of African Ministers for Fisheries and Aquaculture
CGIAR	Consultative Group for International Agricultural Research
CLAR	Central Laboratory for Aquaculture Research, Abbassa
CNRDPA	Algerian Research Centre for the Development of Fisheries and Aquaculture
CTA	Centre Technique d'Aquaculture
EU	European Union
EUS	Epizootic Ulcerative Syndrome (Aphanomyces invadans infection)
GAFRD	General Authority for Fish Resource Development
GDP	Gross Dpmestic Product
GIFT	Genetically Improved Farmed Tilapia
GIS	Geographic Information System
INSTM	National Institute of Marine Science
KOICA	Korea International Co-operation Agency
LCDV	Lymphocystis Disease Virus
LIMS	Laboratory Information Management System
LNCAPPASM	The National Control Laboratory and Analytical Products of Fishing and Aquaculture and Safety of Communities
PFRS	Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa
NACA	Network of Aquaculture Centres in Asia-Pacific
NEPAD	New Partnership for Africa's Development
NGOs	Non-Governmental Organisations
OIE	World Organisation for Animal Health
ONISPA/MPEM	Office National d'Inspection Sanitaire des Produits de la Pêche et de l'aquaculture
REAG	Regional Expert Advisory Group on Aquatic Animal Health
SDC	Swiss Agency for Development and Cooperation
SPF	Specific Pathogen Free
SVC	Spring Viraemia of Carp
TADs	Transboundary Diseases
TAADs	Trans-Boundary Aquatic Animal Diseases
TLEV	Tilapia larva encephalitis
TiLV	Tilapia Lake Virus
VS/AAHS	Veterinary Service/Aquatic Animal Health Service
VNN	Viral Nervous Necrosis
WAHIS	World Animal Health Information System
WSSV	White Spot Syndrome Virus

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FOREWARD

The potential of fisheries and particularly for aquaculture in Africa is large but remains not fully realized. However, the sector currently contributes to 6 % of the continents agricultural GDP. In recognition of this fact, the Fisheries have been identified as among the key agricultural value chains for transformation under NEPAD'S CAADP framework as well as the Malabo Declaration. Consequently The Policy Framework and Reform Strategy for fisheries and Aquaculture in Africa was endorsed by the Summit of AU Heads of States and Government as a blue print for Africa's fisheries and aquaculture development. The overall goal of this policy framework is to create a conducive and enabling environment for the fish sector to create equitable, social and economic development in Africa that shall result in sectoral growth and the accomplishment of the CAADP goals.

Among the key strategies for expanding the sector and attaining the envisaged socio-economic goals is the promotion of sustainable aquaculture development based upon private-sector led market-oriented aquaculture, the promotion of sustainable fisheries and the improvement of access to markets for Africa's fish and fish products. Establishing a vibrant commercial fisheries and aquaculture sector implies that the movement of fish stock and products within and between countries shall increase due to trade.

Aquatic production systems world over, not least in Africa, can be beset with issues of associated with sustainable environment management, biosecurity and fish diseases control. These issues pose significant threats to the productivity of natural and artificial aquatic systems with concomitant effects on food security, trade and income. Where such situations have occurred on the continent, their effect and impacts have been exacerbated due to inadequate strategies, both national and regional levels, for early response systems in the event of an emergence situation, including perturbations in the ecosystems due to environmental hazards, pollution, disease outbreaks, etc. The human and institutional capacity to effectively keep at bay as well as address any threat in aquatic production systems is grossly insufficient on the continent. There is severe dearth of personnel both in quantity and quality in these critical areas of environmental management, biosecurity governance and diseases control.

The continent has had in the recent past instances of environmental management and biosecurity governance issues arising from the outbreak of White Spot Syndrome Virus in Mozambique and Madagascar in prawn farms and Aphanomyces invadans infection (EUS) in the Zambezi River Basin that is believed to have spread into the Congo River Basin. It is probable that elsewhere on the continent there are diseases that are inhibiting productivity in inland waters and aquaculture systems. The poor status of knowledge on the occurrence of fish diseases and potential risk factors within the various waters bodies and aquaculture systems is a serious gap and inhibitory factor towards formulating appropriate disease control strategies. The first step in developing a strategic disease control program is to establish the occurrence of diseases, the risks of their occurrence and their potential impact on aquatic productivity systems.

Further to this, Consequently the risk of spread and introduction of new aquatic pathogens, pests and plants shall increase posing a high threat to aquatic production, aquatic environmental health and food safety. The predisposing factors that determine the onset of endemic diseases more often than not arise as a result of stressors in the environment. While drugs and disinfectants may be used to

control disease they too may have impacts on environment and the fish produced. The objectives of producers in such a commercial setting sector are to produce fish as food to earn an income. Consumer safety and economic prosperity therefore become primary targets. Incidences of disease reduce productivity, may cause mortality and lower the quality of products produced for sale. Under such circumstance, enterprise performance drops.

To safeguard against the above, one must control diseases in a manner that has minimal impact on the economic viability of establishments as well as products produced. The only way of doing this sustainably is by ensuring environmental integrity, animal welfare, food safety and economic gain; that is to establish biosecurity. The benefits of maintaining the upper-hand over disease conditions through effective Fish Health Management Plans and biosecurity governance include:

i. Prevention and control of aquatic biological hazards (notably pathogens, pests, toxins from algae, new species, etc.)
ii. Increased farm production and efficiency
iii. Access to markets (quality assurance and certification)
iv. Economic benefits (to the producer, community and nation)
v. Sustainable aquatic environmental management.

Biosecurity measures with respect to disease control and surveillance are the set management practices that prevent non-infected healthy stock from being exposed to infectious or parasitic agents. This involves the prevention of entry and control of such agents. Critical control points of concern are areas in the production and marketing process that may present or permit biological hazards, notably pathogens.

Establishing what the biological hazards are along the value chain, the factors that trigger these to result into disease and loss of fish quality and well as those that facilitate their spread are, among the first steps in establishing a biosecurity plan. Establishing a biosecurity program for a specific disease or region for that matter, is not possible if there is incomplete information on the disease status of countries. It is also not possible to set up a disease monitoring program if the precise sanitary condition of national aquatic stocks (wild and farmed) is unknown.

Information on the sanitary status of aquatic stock in Africa and infrastructure to control aquatic animal diseases is very poor. Fortunately, to-date there have been few reported serious outbreaks of fish disease, both in the wild and on farm, on the continent. However, in the last 10 years, outbreaks of trans-boundary notifiable diseases have been reported. At the OIE General Assembly 2015, key concerns for Africa in aquatic animal health were the emergence and spread of the Trans-Boundary Aquatic Animal Diseases (TAADs) like infection with Aphanomyces invadans (EUS), White Spot Syndrome Virus and Abalone herpes Virus from the Southern Africa northwards. Lack of knowledge of the status in neighboring countries and watersheds continues to pose a threat to their fisheries and aquaculture and hinders the establishment of appropriate biosecurity control measures.

It is only when one knows what the potential threats are, that one can develop mitigation measures to protect the stock, environement and markets. Knowing what aquatic animal diseases occur on the continent, where they occure and under what circumstance they have occurred will enable the project develop sanitary maps that shall provide the basis for establishing appropriate aquatic animal disease control, surveillance and biosecurity frameworks.

It is for this reason, that the Regional Fish Disease Mapping Studies were commissioned. The information generated from this study will provide baseline information to to strengthen the capacity of veterinarians in aquatic animal health and develop regionally appropriate aquatic animal disease control, surveillance and biosecurity control mechanisms.

Prof. Ahmed El-Sawalhy
Director, AU-IBAR

EXECUTIVE SUMMARY

The Fisheries Governance Project under AU-IBAR seeks to improve institutional and policy environment for sustainable management and utilization of fisheries resources in Africa; to increase food security, and economic growth in the region. However, due to recent outbreaks of Trans-Boundary Aquatic Animal Diseases (TAADs) in Africa like Epizootic Ulcerative Syndrome, and lack of efficient and effective biosecurity control measures, the fisheries and aquaculture resources are at greater risk of infection. Therefore, AU-IBAR proposes to carry out a situation analysis, create a geo-referenced inventory and determine risk factors for aquatic animal diseases in Africa for purposes of establishing an efficient aquatic biosecurity and disease control strategy.

A rapid assessment was undertaken using SurveyMonkey Tool® to determine: i) status of aquatic animal diseases within region; ii) production systems (fisheries and aquaculture); iii) disease risks determinants; iii) the geographical areas where aquatic diseases have occurred. The purpose is to contribute to continental efforts in establishing biosecurity measures against the spread of aquatic animal diseases.

This region has experienced outbreaks of notifiable diseases namely EUS in Zambezi river basin, Koi Herpes Virus in South Africa and White Spot Syndrome Virus disease in Madagascar and Mozambique causing economic loss to communities dependent on this resource. Environmental factors and uncontrolled movement of live aquatic animals contributed to the introduction and spread these diseases. However, SADC has made progress in establishing a regional strategy that will help to reduce the spread of TAADS, and can as well be adopted for the Africa region. Furthermore, considerable information on parasites affecting marine and water aquatic species has been generated though research. Nevertheless, Member States will still have to invest into human and infrastructure resources to prevent the introduction and spread of TAADS (and emerging diseases) as aquaculture is increasing and expanding in the region.

1.0 INTRODUCTION

1.1 Background

The African Union – InterAfrican Bureau for Animal Resources's (AU-IBAR) vision is to free Africa from hunger and poverty through development of animal resources that make significant contribution to the region.AU-IBAR is mandated to support and coordinate sustainable development and utilization of livestock, fisheries and wildlife resources to increase food security, nutrition and livelihoods, especially in rural areas. Fisheries and aquaculture sector is among the key agricultural value chains for transformation that will ensure equitable socio-economic development and enabling environment; underlined in NEPAD'S, CAADP frameworks and the Malabo Declaration. Subsequently, AU-IBAR in collaboration with the NEPAD established a Policy Framework and reform Strategy for Fisheries and Aquaculture in Africa (PFRS)

According to The State of World Fisheries and Aquaculture-FAO (2014), the total fish production in Africa is estimated at 9.4 million tonnes. About 4.9 million tonnes from marine capture fisheries (21%), 2.7 million tonnes from inland water fisheries (11 percent) and about 1.4 million tonnes from aquaculture (5%). However, the per capita fish consumption in Africa is 9.1kg is lower than the global level of 18.4kg. Nevertheless, the sector employs about 13 million people in the region of which 6.1 million (50 percent) are fishers, 5.3 million (42.4 percent) are processors and 0.9 million (7.5 percent) are fish farmers in Africa. Women contribute 27 percent of this labor; 3.6 percent among fishers, processors (58 percent), and aquaculture (4 percent)..

The Southern African Development Community (SADC) comprises 14 member states with coastline of about 20 000 km. Fisheries production is estimated 2.7 million tons worth USD 1.3 billion, and employing more than 250 000 people.The region is endowed with economically important freshwater and marine fauna that includes horse mackerel, herrings, toothfish, prawns and anchovy. Aquacuture production is mainly practiced in Zimbabwe, Malawi, Zambia, South Africa and Madagascar. Other countries are mainly involved in capture fisheries.

Disease outbreaks affect productivity of natural and artificial aquatic systems thus impacting negatively on livelihoods of communities dependent on this resource. Furthermore, natural fish stocks are at risk of contracting diseases if water-based aquaculture is not properly monitored. The spread of TAADS and emerging diseases can be augmented if human and infrastructure capacity in the region is inadequate. AU-IBAR and SADC now seek to improve institutional and policy environment for sustainable management and utilization of fisheries resources in Africa to increase food security, and economic growth in the region.

This study generated information on notifiable diseases and other pathogens basing secondary data. This information together SADC Animal Health Strategy will supplement and strengthen continental efforts to establish a continental biosecurity measures for aquatic resources.

2.0 SCOPE OF WORK

2.1 Purpose

To enhance the contribution of fisheries resources to food security and economic growth in Southern Africa.

2.1.2 Specific objectives

The objectives for mapping aquatic animal diseases are to:

1. Determine the current status of aquatic animal diseases within countries.
2. Establish the production systems (fisheries and aquaculture).
3. Establish disease risks determinants.
4. Establish the geographical areas where aquatic diseases have occurred.

3.0 METHODOLOGY

3.1 Study area



Figure 1: *Map showing South African states targeted in this study. Source: http://reliefweb.int/sites/reliefweb.int/files/resources*

This study covered Southern African countries namely Angola, (Burundi), Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Zambia and Zimbabwe (Figure 1). Focus was on aquatic animals resident in fresh and marine water ecosystems (Table 1).

Table 1. *Southern Africa countries and targeted aquatic environments for this study*

Country	Aquatic Environments
Angola,	Freshwater and Marine
Botswana,	Freshwater
Lesotho	Fresh water
Malawi	Fresh water
Mauritius	Marine
Mozambique	Freshwater and Marine
Namibia,	Freshwater and Marine
Seychelles	Marine
South Africa	Freshwater and Marine
Swaziland	Freshwater
Zambia	Freshwater
Zimbabwe	Freshwater

3.2 Desk/literature review

A Review of relevant literature, monographs, and other relevant information was done. Literature review provided secondary information regarding trends and current situation of aquatic diseases in southern African region. Important information included national and regional policies from Member State (MS) reports, thesis/dissertations and domestic and export markets. The documents reviewed include:

1. National Policies;
2. National Aquatic Animal Strategy-SADC;
3. The State of World Fisheries and Aquaculture (SOFIA) by FAO: 2000 – 2015;
4. The Aquatic Animal Health Codes;
5. Aquatic Animal Pathogen Quarantine Information-FAO

Secondary data was collected, collated and evaluated focusing on aquatic diseases and parasites affecting aquatic organisms (finfish, shellfish, mollusks and aquatic mammals) in the region. Factors influencing the spread of these diseases were also investigated. This information will be grouped into marine and freshwater ecosystems, types of diseases (including zoonotic), determinants and risk factors. Impact of aquatic animal diseases on the environment and communities dependent on this resource will be explored.

3.3 Online Survey

A cross-sectional survey tool (Survey Monkey®) was designed/customized to have a mixture of open-ended and closed-ended questions. Topics covered production systems, aquatic species, diseases, policies and Competent Authorities. Forty-two (42) key informants from thirteen southern countries were targeted, including Chief Veterinary Officers, Heads of Fisheries and Aquaculture department, Academicians, Oie Office-Southern Africa, FAO and REC representatives. Phone calls were also made to each informant explaining the purpose of the survey. This survey was conducted for 31 days and reminders sent every three-four days. Data was analyzed using the Survey Monkey® software. Annex…

4.0 OVERVIEW OF AQUACULTURE STATUS IN REGION

4.1. Production, systems and Species: Fish Production Systems in the Region

According to FAOSTAT (2016), aquaculture in this region is still developing producing low volumes of aquatic products from marine and freshwater environments. A diversity of commodities cultured includes finfish, crustaceans and mollusks, which contribute to national food security and economies. Inland Aquaculture production

Aquaculture production in this region was relatively low (less 5000t) for a period 1999-2009 but progressively increased thereafter since 2010 (Figure 1). Zambia and Zimbabwe are leading freshwater aquaculture producers of fish, producing over 20,000 and 10,000t, respectively while other member states continue to produce below 5000t annually.

Mauritius, South Africa, Swaziland and Zambia are engaged in farming freshwater crustaceans. Previously, Mauritius had a highest production of freshwater crustaceans (shrimp in the late 1990s but declined considerably from 40 to 5t since 2000. Production from other countries stagnated below 10t over the past decade (Figure 2).

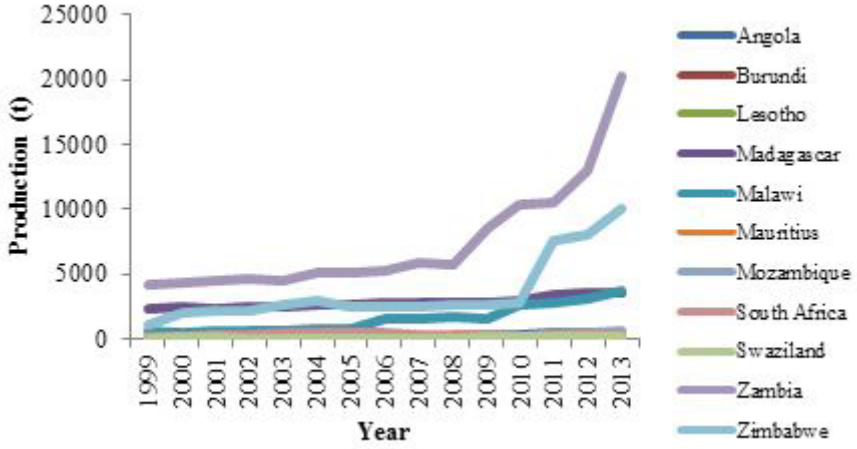


Figure 2. *Inland Aquaculture-Freshwater fish production trends*

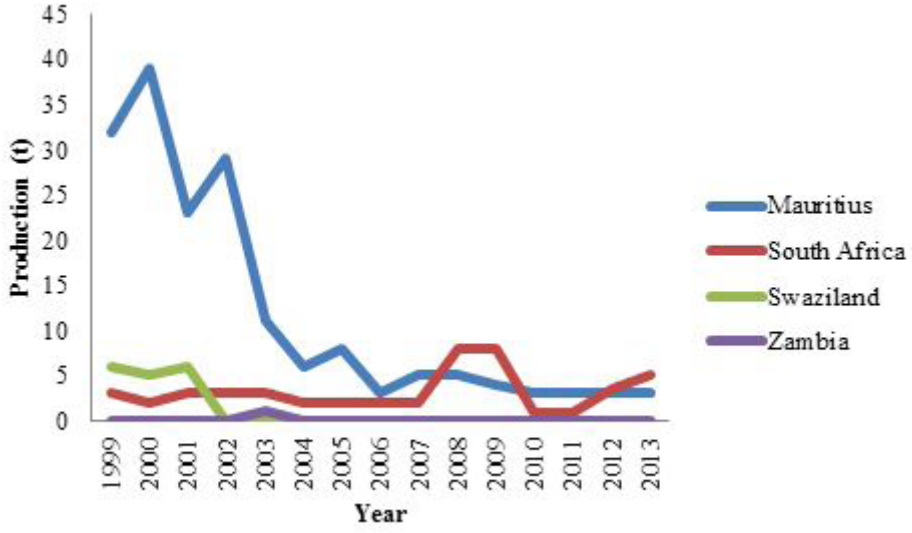


Figure 3: *Inland Aquaculture crustaceans production trends*

Marine Aquaculture production

Madagascar leads in producing farmed marine crustaceans where production increased from 3400 to 8500t in eight years (1999-2006) then dropped to 5400t in subsequent years (Figure 3).

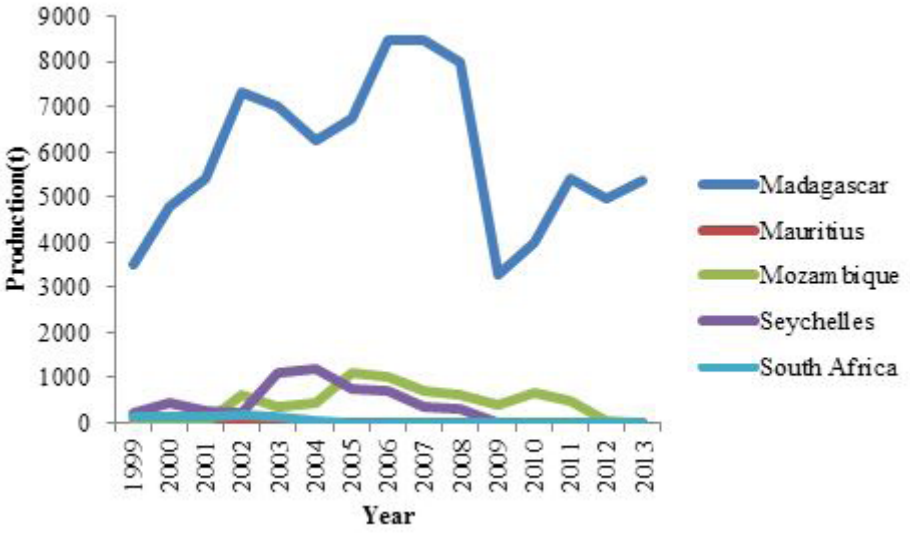


Figure 4: *Marine Aquaculture Crustaceans production trends*

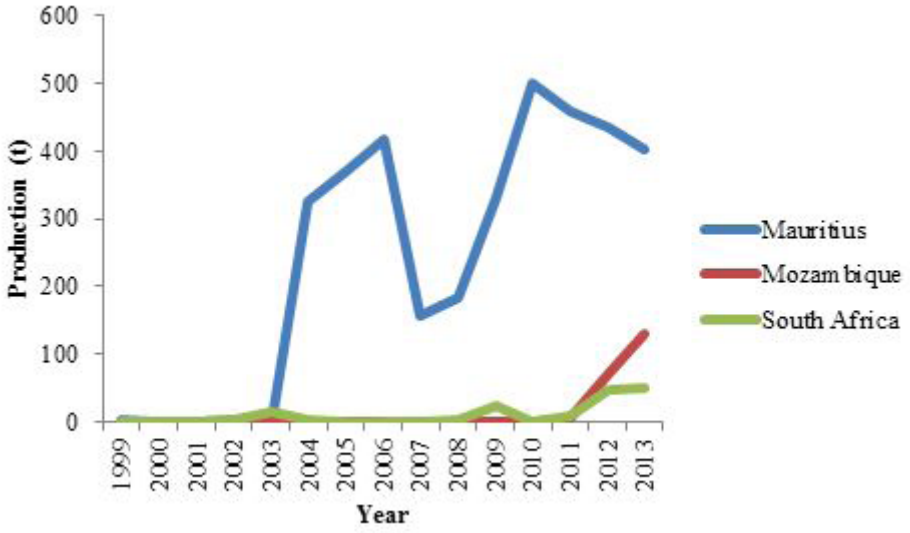


Figure 5: *Marine Aquaculture finfish production trends*

Generally, production dropped after 2009 probably due to outbreaks of WSSV in the region however production from other countries remained low at around 1000 t, annually.

Most marine farmed finfish is produced in Mauritius, producing about 500t in 2010 although it progressively declined thereafter (Figure 4). However, a gradual increase in production since 2010 from Mozambique and South Africa, largely due to advances in fisheries technologies especially aquaculture.

Southern Africa region is known to produce captured and farmed molluscs that are either consumed locally or exported (figure 5). Highest production was achieved in 2004 from South Africa (17,826t) but declined since. Other countries produce less than 3000t although Madagascar is gradually increasing.

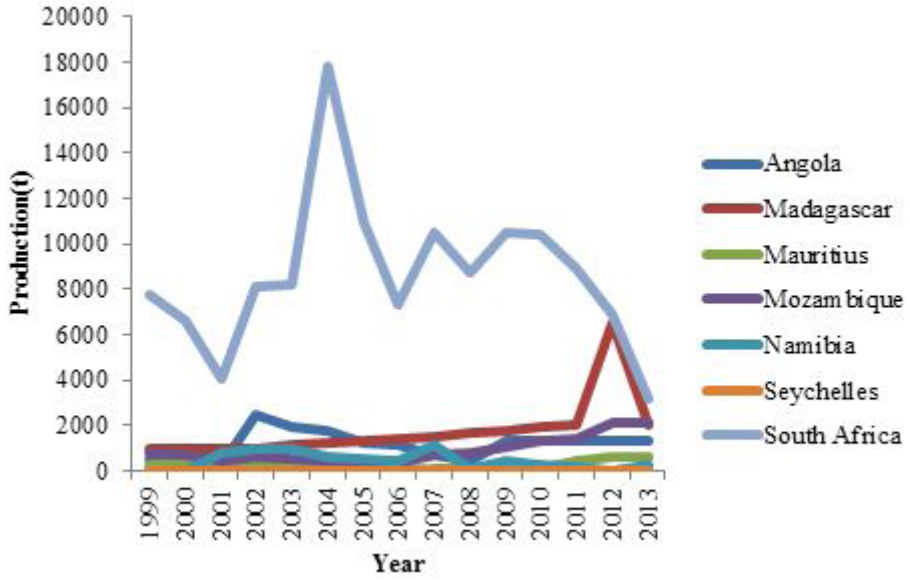


Figure 6: *Marine Mollusk production trends*

Production systems

Survey results indicate that , aquatic commodities are mainly produced in ponds, cages and tanks. Other countries use dams, tanks and long-lines (25%); only ponds and cages (13%); and, only ponds (13%). Ponds are the dominate aquaculture production system (..%?) followed by but tanks and cages are equally important. Long-lines are unique to Seychelles were Pearl culture is practiced. Over 72% of these production systems are located in freshwater ecosystems applied in small- to large-scale enterprises. Utilization corresponds to target aquatic species, and their distribution/availability is shown in table 2.

Table 2: *Categories of production systems in the Southern Africa reported in this survey*

Country	Production Systems	Availability (1-most and 3-least available)		
		1	2	3
Botswana	Dams/Ponds, Cages	Cages	Ponds/dams	-
Burundi	Ponds	Ponds	-	-
Lesotho	Ponds, Cages, Tanks	Cages	Tanks	Ponds
Madagascar	Ponds, Cages, Tanks	Ponds	Cages	Tanks
Malawi	Ponds, Cages, Tanks	Ponds	Cages	Tanks
Seychelles	Ponds, Cages, Long-lines	Ponds	Tanks	Long-lines
South Africa	Ponds Cages and tanks	Tanks	Ponds	Cages
Zimbabwe	Ponds and Cages	Tanks	Ponds	Cages

Cages are most productive systems in the region producing 200 kg/m3 while ponds and tanks yield about 914 kg/ha and 100 kg/m3 of aquatic products, annually.

A variety of aquatic species are reared in these systems, which include finfish (tilapia, carps, catfish and trout), shellfish, and mollusks (Oysters, Rock lobsters, Giant clams, Abalone, mussels and marron). Tilapia species (Oreochromis niloticus, O. shiranus, O. korangae and Tilapia rendali) are commonly reared in six countries while a few finfish (African catfish, Carps and Rainbow trout) are restricted to South Africa, Lesotho and Zimbabwe. Conventional aquaculture species (O. niloticus and C. gariepinus) are cultured in only three countries (Burundi, Zambia and Zimbabwe). This is mainly attributed to existing stringent laws on introducing exotic aquatic species for aquaculture in the region.

4.1.1 Levels of production systems

Three management levels are currently practiced to raise various aquatic commodities (Table 3); extensive, semi-intensive and intensive management systems. In extensively managed farms, monoculture is commonly practiced in ponds and cages. Apparently, monoculture and polyculture of aquatic commodities is also applied in semi-intensive and intensive systems. Tilapines are largely monocultured in ponds, cages and tank systems. Carps, catfish and Rainbow trout are either monocultured or polycultured in ponds, cages and tanks. Shellfish and mollusks are usually polycultured in ponds and tanks/liner. Southern African countries rarely share aquaculture commodities as shown in Table 3.

Table 3: *Aquaculture commodities and management systems in Southern Africa*

Country	Production System	Aquatic commodities	Management System		
			Extensive	Semi-intensive	Intensive
Botswana	Dams	Tilapia	Polyculture	-	-
Burundi	Ponds	Tilapia, Catfish	Monoculture	Polyculture	Monoculture
Lesotho	Ponds	Carps	Polyculture	Polyculture	Polyculture
	Cages	Trout	Monoculture	Monoculture	Monoculture
	Tanks	Carps	Monoculture	Monoculture	Monoculture
Malawi	Ponds	O.shiranus,	Monoculture	Monoculture	Monoculture
	Cages	O. korangae,	Monoculture	Monoculture	Monoculture
	Tanks	Tilapia rendali	Monoculture	Monoculture	Monoculture
Seychelles	Ponds	Giant Clams	-	-	
	Tanks				Polyculture
	Long-liners				Polyculture
South Africa	Ponds	Finfish, prawns, marron	Monoculture		Monoculture
		Finfish	Monoculture	Monoculture	
	Cages / Tanks	Abalone, Rock lobsters, finfish			Monoculture
	Barrels in open sea	Oysters, mussels, Abalone			Monoculture

Most producers obtain starting seed from public and private hatcheries, and wild environments. Similarly, most hatchery operators get brood-stocks from wild environments, as well as public-public hatcheries. Main reasons for these sources include low-cost inputs, accessibility and pathogen-free.

5.0 STATUS OF AQUATIC ANIMAL DISEASE IN THE REGION

Southern Africa is enriched with a diverse aquatic animal resource that contributes significantly to economies of member states. However, this resource is threatened by the existence or emergence of infectious pathogens that potentially deter development of fisheries and aquaculture sector. It is critical, therefore, to regularly profile health status of aquatic resources, and enforce sustainable mitigation strategies to control the spread of TAADS.

5.1. Prevalence and Incidences of aquatic animal diseases

This region has a history of globally reportable diseases namely, Epizootic Ulcerative Syndrome (EUS), Koi Herpes Virus diseases (KHV) and White Spot Syndrome Virus (WSSV) that affects wild and cultured aquatic animals. Specifically, EUS and KHV affect finfish while White spot disease affects crustaceans.

Epizootic Ulcerative Syndrome disease

This disease was first reported in 2006 in the Chobe-Zambezi River in Botswana and Namibia were mass mortalities of feral aquatic organisms occurred, caused by pathogenic water mold (Aphanomyces invadans) that has little host specificity (Huchzermeyer et al. 2012). However, subsequent outbreaks have been reported in the Kafue River system in Zambia (Mudenda 2010), and South Africa (2011) around trout cage farms (presented by Huchzermeyer). Surveillance studies conducted from 2007 to 2008 revealed that cichlid pink bream (S. giandi), Clarias gariepinus and C. ngamensis had the highest prevalence of EUS infections (Table 4).

Table 4: *Reported prevalence of fish with presumptive EUS infections caught from Zambezi river region during an angling competition*

Species	Prevalence (%)
Bream (Sargochromis giardi)	37.5
Thinface largemouth (Serranochromis angusticeps)	4.3
Three Spot Tilapia (Oreochromis andersonii)	3.0
Nembwe (Serranochromis. robustus)	1.1

Sourced from Huchzermeyer (2011)

Koi Herpes Virus disease

Officially identified in 1998 but was suspected to occur in 1996 among varieties farmed Koi carp (Cyprinus carpio) in Limpopo Province, South Africa. Thereafter, it was suspected to cause outbreaks in western cape of Kwaza Natal, South Africa. However, there hasn't been any comprehensive surveillance in this region to examine the prevalence and incidence of KHV. This disease has caused serious economic losses (not quantified) to koi aquaculture farms and impact on wild carp stocks is unknown (Oie 2008).

White Spot Syndrome Virus disease

A global epidemic recently reported in Madagascar and Mozambique coast (Flegel 2012). Mass mortalities occurred within shrimp (Penaeus monodon and Litopenaeus vannamei) farms causing loss of livelihoods among communities that are dependent on this enterprise (FAO 2013; Blythe 2015). However, data is documented to understand the prevalence and/or incidence of this disease in the region.

Other aquatic pathogens/diseases of importance:

i) Bacteria:

Insufficient information exists on prevalence and incidence of bacterial diseases affecting aquatic animals in Southern Africa (Table 5). Bacterial pathogens are ubiquitous within and around aquaculture production systems causing significant economic loss, worldwide. Literature available merely generalizes bacteria as infectious pathogens associated with farmed or wild fish. Bacterial infections can easily spread between and within farms if biosecurity measures are limited or absent. Additionally, some bacteria pathogens like Mycobacterium marinum, Streptococcus iniae and Vibrio vulnificus are zoonotic to humans but are also responsible for mass mortalities in farmed shellfish and finfish (Haenen, et al. 2013). Therefore, member states urgently need to undertake comprehensive epidemiological surveys that include aquatic bacterial pathogens. Furthermore, human and infrastructure capacity should be enhanced/strengthened to undertake bacteriological research.

Table 5: *Examples of bacteria cited/isolated from aquatic animals of Southern Africa*

Bacteria/disease	Aquatic animal	Country/ Region	Reference
Aeromonas hydrophilla,	Farmed Eel	South Africa	Jackson 1978
Myxobacterium/Columnaris	(Anguilla mossambica)		
Pseudomonads	Farmed Tilapia	Southern Africa	Paperna 1984
Staphylococcus sp. Citrobacter brackii, Citrobacter freundii, Enterobacter sakazakii, Enterobacter cloacae, Vibrio cholorae, Proteus mirabilis, Proteus vulgaris, Klebsiella pneumoniae and Aeromonas hydrophila	Tilapia and catfish in markets	Botswana	Mhango et al. 2010

ii) Parasites:

Southern Africa has generated substantial information on aquatic parasitology although from a few countries (Angola, Botswana, Namibia, Mozambique, Zimbabwe and South Africa). A summary of different parasites that affect or associated with farmed or wild aquatic animals is shown in Table 6.

Table 6: *Summary of aquatic parasites reported in Southern Africa*

Group	Species	Environment	Host	Country Reported	Prevalence	Reference
CILIOPHORA	*Chilodonella hexasticha*	Freshwater	*Oreochromis mossambicus.*	South Africa	Low	Oldewage & Van (1987); Van (2015)
	Cryptocaryon irritans *	Marine	*Aquarium fish*	South Africa		Smit & Hadfield (2015); Van (2015)
	Epistylis sp.	Freshwater	*Tilapia rendalli ; Oreochromis andersonii*	South Africa	Low	Mumba (2014).
	Hemitrichodina	Freshwater				Van (2015)
	*Ichthyopthirius multifillis***	Freshwater	*Finfish*	South Africa		Van (2015)
	Trichodina acuta	Freshwater	*Tilapia rendalli ; Oreochromis andersonii*	Namibia; South Africa	Low	Mumba (2014); Van (2015)
	T. pediculus	Freshwater	*Finfish*	Southern Africa		Van (2015)
	T. reticulata	Freshwater	*Finfish*	Southern Africa		Van (2015)
	T. luba	Marine	*Surgeonfish (Acanthurus xanthopterus)*	South Africa		Smit & Hadfield (2015); Van (2015)
	T. rhinobatae	Marine	*Lesser guitarfish, Rhinobatos annulatus*	South Africa		Smit & Hadfield (2015); Van (2015)
	Trichodinella	Freshwater		Southern Africa		Van (2015)
	Tripartiella	Freshwater	*Tilapia rendalli ; Oreochromis andersonii*	Southern Africa		Van (2015)
	Trypanosoma nudigobii	Marine	*Interdial fish*	South Africa		Smit & Hadfield (2015).
	T. haploblephari	Marine	*Sharks/elasmobranchs*	South Africa	High	Smit & Hadfield (2015).

Group	Species	Environment	Host	Country Reported	Prevalence	Reference
PLATYHEL-MINTHES						
Trematoda	*Clinostomum sp*	Freshwater	*Tilapia rendalli ; Oreochromis andersonii; Serranochromis robustus*	Namibia	Low	Mumba (2014).
	C. heterostomum	Freshwater	*Finfish*	Southern Africa		Van (2015)
	C. vanderhorsti	Freshwater	*Finfish*	Southern Africa		Van (2015)
	Cephaloporus bakeri	Marine	*Red-tail filefish*	South Africa		Smit & Hadfield (2015).
	Dactylostomum griffithsi	Marine	*Unknown*	South Africa		Smit & Hadfield (2015).
	Diplostomum	Freshwater	*C. gariepinus*	Zimbabwe	Moderate	Madanire-Moyo & Barson (2010).
	Enenterum elsti	Marine	*Stone-bream Neoscorpis lithophilus*	South Africa		Smit & Hadfield (2015).
	Euclinostomum	Freshwater				Van (2015)
	Echinoparyphium elegans	Freshwater				Van (2015)
	Phyllodistomum vanderwaali	Freshwater				Van (2015)
	Pseudaephnidiogenes rossi	Marine	*Bare head goby (Caffrogobius nudiceps)*	South Africa		Smit & Hadfield (2015).
	Thaparotrema botswanensis	Freshwater	*C. gariepinus*	Botswana		Rensburg et al. (2013); Van (2015)
Monogenea	*Acolpenteron*	Freshwater	*Finfish*	Southern Africa		Van (2015)
	Afrogyrodactylus	Freshwater	*Finfish*	Southern Africa		Van (2015)
	Branchotenthes robinoverstreeti	Marine	*Bow mouth guitarfish,* Rhina ancylostoma	*South Africa*		*Smit & Hadfield (2015).*
	Cichlidogyrus philander	Freshwater	*Pseudocrenilabrus philander philander*	South Africa	High	Le Roux et al.(2011).
	Dactylogyrus sp.	Freshwater	*Tilapia rendalli ; Oreochromis andersonii*		Low	Mumba. (2014).
	*Enterogyrus coronatus***	*Freshwater*	*Pseudocrenilabrus philander*	South Africa		*Madanire-Moyo & Avenant-Oldewage (2015).*
	Heterocotyle tokoloshei	*Marine*	*Short-tail stingray (Dasyatis brevicaudata)*	South Africa		*Smit & Hadfield (2015).*
Monogenea (Cont.)	*Gyrodactylus eyipayipi*	*Marine*	*Pipefish (Syngnathus acus)*	*South Africa*		*Smit & Hadfield (2015).*
	Gyrodactylus thlapi	*Freshwater*				*Van (2015)*
	Macrogyrodactylus spp	*Freshwater*	*C. gariepinus*	*Zimbabwe*		*Barson et al. (2010).*
	Mormyrogyrodactylus	*Freshwater*	*Finfish*			*Van (2015)*
	Myxinidocotyle eptatreti	*Marine*	*sixgill hagfish, Eptatretus hexatrema*	*South Africa*		*Smit & Hadfield (2015).*
	Neoheterocotyle robii	*Marine*	*lesser guitarfish (R annulatus)*	*South Africa*		*Smit & Hadfield (2015).*
	Paradiplozoon vaalense	*Freshwater*				*Van (2015)*

Group	Species	Environment	Host	Country Reported	Prevalence	Reference
	Pseudoleptobothrium christisoni	*Marine*	*lesser guitarfish*	*South Africa*		*Smit & Hadfield (2015).*
Digenea	*Clinostomum complanatum*	*Freshwater*	*O. mossambicus, C. gariepinus,*	*Zimbabwe*		*Barson et al. (2008).*
	Elytrophalloides humerus	*Marine*	*large-spot pompano (Trachinotus botla)*	*South Africa*		*Smit & Hadfield (2015).*
	Lecithochirium parafusiforme	*Marine*	*yellow- edged moray (G. flavimarginatus)*	*South Africa*		*Smit & Hadfield (2015).*
	Lecithostaphylus spondyliosomae	*Marine*	*Hottentot fish (S blochii)*	*South Africa*		*Smit & Hadfield (2015).*
	Pseudaephnidiogenes rhabdosargi	*Marine*	*yellow-fin bream (Rhabdosargus sarba)*	*South Africa*		*Smit & Hadfield (2015).*
Cestoda	*Botriocephalus achelognathi*	*Freshwater*				*Van (2015)*
	Caryophyllaeus	*Freshwater*	*C. gariepinus*	*Zimbabwe*	*Low*	*Madanire-Moyo & Barson (2010).*
	Echeneibothrium austrinum	*Marine*	*large skate; Cape hake, Merluccius capensis and Thyrsites atun*	*South Africa*		*Smit & Hadfield (2015).*
	Echinobothrium dorothyae	*Marine*	*spotted skate, Raja straeleni*	*South Africa*		*Smit & Hadfield (2015).*
	E. dougbermani	*Marine*	*lesser guitarfish (Rhinobatos annulatus)*	*South Africa*		*Smit & Hadfield (2015).*
	E. joshuai	*Marine*	*skate (Cruriraja hulleyi)*	*South Africa*		*Smit & Hadfield (2015).*
	Hepatoxylon trichiuri	*Marine*	*M. capensis and M. paradoxus*	*South Africa*	*high*	*Smit & Hadfield (2015).*
	Lytocestus spp	*Freshwater*	*C.gariepinus*	*Zimbabwe*	*Low*	*Madanire-Moyo & Barson (2010).*
	Polyonchobothrium clarias	*Freshwater*	*C.gariepinus*	*Zimbabwe*	*Low*	*Madanire-Moyo & Barson (2010).*
	Proteocephalus sp	*Freshwater*	*Oreochromis andersonii; Serranochromis robustus*	*Namibia*	*Low*	*Mumba (2014).*
	Proteocephalus	*Freshwater*	*C.gariepinus*	*Zimbabwe*	*Low*	*Madanire-Moyo & Barson (2010).*
MYXOZOA	*Ceratomyxa cottoidii*	*Marine*	*C. cottoides*	*South Africa*		*Smit & Hadfield (2015).*
	C. dehoopi	*Marine*	*Clinus superciliosus*	*South Africa*		*Smit & Hadfield (2015).*
	C. honckenii	*Marine*	*Amblyrhynchotes honckenii*	*South Africa*		*Smit & Hadfield (2015).*
	Henneguya sp.	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	Henneguya clini	*Marine*	*Clinus superciliosus*	*South Africa*		*Smit & Hadfield (2015).*
	Myxobolus	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	Kudoa thyrsites **	*Marine*	*large pike-like fish (snoek)*	*South Africa*		*Smit & Hadfield (2015).*
	Thelohanellus rhabdalestus n. sp.	*Freshwater*	*Fower (R maunensis)*	*Angola*		*Azevedo et al. (2011)*

Group	Species	Environment	Host	Country Reported	Prevalence	Reference
	Ortholinea basma	*Marine*	*Agile klipfish (Clinus agilis)*	*South Africa*		*Smit & Hadfield (2015).*
NEMATODA	*Anguillicola papernai* ***	*Freshwater*	*African longfin eel (Anguilla mossambica)*	*Mozambique*	*Moderate*	*Taraschewski et al.(2005); Van (2015)*
	Anisakis nascettii	*Marine*	*beaked whales*			*Smit & Hadfield (2015);Van (2015)*
	Contracaecum	*Freshwater*	*C. gariepinus*	*Zimbabwe*		*Madanire-Moyo & Barson (2010).*
	C. rudolphi	*Freshwater*	*Oreochromis mossambicus, Clarias gariepinus*	*Zimbabwe*		*Barson et al. (2008)*
	C. multipapillatum	*Freshwater*	*Oreochromis mossambicus, Clarias gariepinus*	*Zimbabwe*		*Barson et al. (2008)*
	C. rodhaini	*Freshwater*	*Oreochromis mossambicus, Clarias gariepinus*	*Zimbabwe*		*Barson et al. (2008)*
	Heliconema africanum	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	H. longissimum	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	Paracamallanus cyathopharynx	*Freshwater*	*O. mossambicus,C. gariepinus*	*Zimbabwe*	*High*	*Barson et al. (2008)*
	P. laeviconchus	*Freshwater*	*C. gariepinus*	*Zimbabwe*		*Madanire-Moyo & Barson (2010)*
	P. pseudolaeviconchus	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	P. (S) daleneae	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	Paraquimperia africana	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	Spinitectus	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	Spirocamallanus daleneae	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
ACANTHOCEPHALA	*Acanthocephala sp*	*Freshwater*	*Oreochromis andersonii*	*Namibia*	*Low*	*Mumba (2014).*
	Acanthocephaloides cyrusi	*Marine*	*blackhand sole; spotted grunter (Pomadasys commersoni)*	*South Africa*		*Smit & Hadfield (2015);Van (2015)*
	Longicollum chabanaudi	*Marine*	*lemon sole, Barnardichthys fulvomarginata*	*South Africa*		*Smit & Hadfield (2015);Van (2015)*
	Rhadinorhynchus capensis	*Marine*	*blackhand sole (Pegusa nasuta)*	*South Africa*		*Smit & Hadfield (2015);Van (2015)*

Group	Species	Environment	Host	Country Reported	Prevalence	Reference
	Neoechinorhynchus dorsovaginatus	*Marine*	*dusky kob (Argyrosomus japonicus)*	*South Africa*		*Smit & Hadfield (2015);Van (2015)*
CRUSTACEA						
Branchiura	*Argulus capensis*	*Freshwater & marine*	*Finfish*	*South Africa*		*Smit & Hadfield (2015);Van (2015)*
	A. japonicus	*Freshwater*	*Finfish*	*South Africa*		*Van (2015)*
	A. kosus/A. smalei	*Marine*	*Strepie (S. salpa) & unicorn leatherjacket (A. monoceros)*	*South Africa*		*Smit & Hadfield (2015).*
	Argulus izintwala	*Marine*	*kelee shad (Hilsa kelee)*	*South Africa*		*Smit & Hadfield (2015).*
	Chonopeltis	*Freshwater*	*C. gariepinus*	*Zimbabwe*	*Low*	*Madanire-Moyo & Barson (2010)*
	Chonopeltis australis	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	C. australissimus	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	C. fryeri	*Freshwater*	*Finfish*	*Southern Africa*		*Van (2015)*
	C. inermis	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	C. koki	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	C. lisikili	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	C. liversedgei	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	C. victori	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	Dipteropeltis hirundo	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	D. campanafomis	*Freshwater*	*finfish*	*Southern Africa*		*Van (2015)*
	Dolops ranarum	*Freshwater*	*Tilapia rendalli*	*Namibia; South Africa*	*Low*	*Mumba (2014); Van (2015)*
	Dolops ranarum	*Freshwater*	*C. gariepinus*	*Zimbabwe*	*High*	*Madanire-Moyo & Barson (2010).*
Copepoda	*Pupulina cliffi*	*Marine*	*mobulid rays (M. kuhlii and M. eregoodootenkee)*	*South Africa*		*Smit & Hadfield (2015).*
	P. merira	*Marine*	*mobulid rays)*	*South Africa*		*Smit & Hadfield (2015).*
	Schistobrachia jordaanae	*Marine*	*Diamond ray, G. natalensis*	*South Africa*		*Smit & Hadfield (2015).*
	Udonella caligorum	*Marine*	*Caligus sp. parasitising mullet*	*South Africa*		*Smit & Hadfield (2015).*
Isopoda	*Anilocra capensis*	*Marine*	*Pachymetopon blochii*	*South Africa*		*Smit & Hadfield (2015).*

Group	Species	Environment	Host	Country Reported	Prevalence	Reference
	Cinusa tetrodontis	*Marine*	*evil-eye pufferfish, Amblyrhynchotes honckenii*	*South Africa*		*Smit & Hadfield (2015).*
	*Cymothoa sodwana**	*Marine*	*Trachinotus botla*	*South Africa*		*Smit & Hadfield (2015).*
	Ceratothoa famosa	*marine*	*Diplodus sargus capensis*	*South Africa*		*Smit & Hadfield (2015).*
	Gnathia africana	*Marine*	*Intertidal fish; super klipfish*	*South Africa*		*Smit & Hadfield (2015).*
	G. cryptopais	*Marine*	*Unknown*	*South Africa*		*Smit & Hadfield (2015).*
	G. nkulu	*Marine*	*leopard catshark (P. pantherinum)*	*South Africa*		*Smit & Van (2000)*
	G. pantherina	*Marine*	*leopard catshark (Poroderma pantherinum); Haplobleparus edwardsii; blackspotted electric ray, (Torpedo fuscomaculata)*	*South Africa*		*Smit & Van (2000)*
	Mothocya spp.	*Marine*	*Hemiramphus far*	*Mozambique; South Africa*		*Smit & Van (2000)*
HIRUDINEA (Leeches)	*Austrobdella oosthuizeni*	*Marine*	*Cape rock lobster (Jasus lalandii)*	*South Africa*		*Smit & Van (2000)*
	Lizabdella africana	*Marine*	*mullets (Liza and Mugil)*	*South Africa*		*Smit & Van (2000)*
	Ottoniobdella stellata	*Marine*	*toby fish (Tetraodontidae)*	*South Africa*		*Smit & Van (2000)*

** Mass mortalities reported; ** Parasite has potential to cause disease outbreaks/mortalities; Prevalence: Low < 30%; High > 60%*

Considerable information has been generated but less describes the epidemiology, pathogenicity and control of identified parasites. Most describes parasites that are associated with wild aquatic animals, and less on aquaculture species. However, we are provided with list of parasites that may potentially contaminate aquaculture systems if, for example, brood stocks are sourced from wild environments or from other MS. Additionally, the importance of screening or quarantine against exotic pathogens with MS is important. Nevertheless, more research is still needed to explore more parasites that may threaten the development of fisheries and aquaculture sector. Aquatic parasitology is well advanced in this region, and the strength in this field is an advantage to this continent; for diagnostics and control. South Africa has wealth of experienced parasitologists who can be utilized to understand and map the diversity of parasites in the continent.

iii) Non-pathogenic diseases/agents: Teratogenic deformities in shark, cyanobacterial toxins and pollutants (e.g. Organo-chlorines and pesticides).

The above list indicates that both freshwater and marine organisms are vulnerable to aquatic diseases or pathogens.

5.2 *Distribution of reported aquatic animal diseases*

The three notifiable diseases (EUS, KHV and WSSV) are shown in Table 7 and figure 6;

Table 7: *Distribution of emerging notifiable aquatic diseases in Southern Africa*

Country	Diseases	Prevailing Water Quality parameters	Locations
Botswana	EUS	pH (4.53-6.5); Low Total Alkalinity (45 mg/L); Temperature (18-25° C)	Chobe-Zambezi River system
Namibia	EUS		Chobe-Zambezi River system
Zambia	EUS		Chobe-Zambezi River system
Madagascar	WSSV		South-West Coast
Mozambique	WSSV		Zambezia Province
South Africa	KHV		Koi farms (Limpopo & Kwazulu Natal)

Spatial distribution of these emerging diseases has serous implication to this region. There is continuous movement of live aquatic commodities within and cross-borders particularly in areas where outbreaks such as EUS occurred. This increases risk of spread especially when communities are not sensitized, and if general poverty prevails. Countries like South Africa have protected their aquatic biodiversity because of well-established Laws that are actually enforced. However, current economic developments (e.g. aquaculture development) in the region will probably impact on the environment. For example, the increasing demand and subsequent importation/exportation of improved fish seed (like ornamentals) in this region may enhance the spread of notifiable pathogens. EUS, KHV and WSSV have a potential to spread across the region if biosecurity measures are not well implemented; this definitely will impends initiatives to develop aquaculture, improve food security and livelihoods.

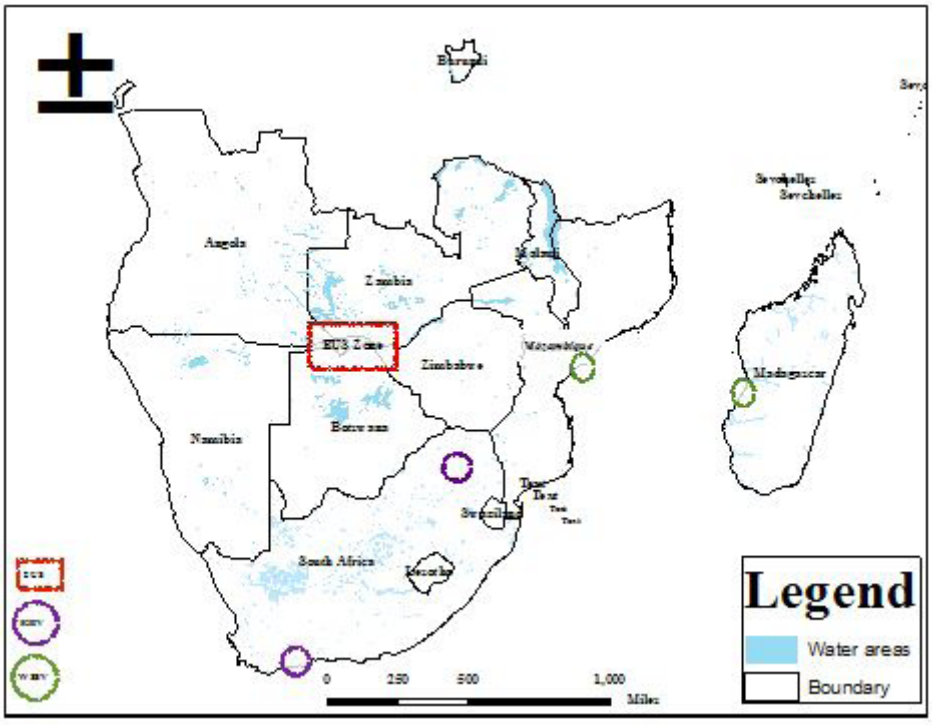


Figure 7: *Distribution of notifiable diseases in Southern Africa*

5.3 Overview of factors associated with occurrence and spread of aquatic animal diseases

5.3.1 Biological Factors (e.g. Species, production system)

EUS:

The etiology of Epizootic US is a fungal pathogen Aphanomyces invadens thought to be introduced in the region through aquaculture or spot fishing using infected baits in the late 2000s. Tropical and ornamental fish are susceptible to EUS infections. Feral finfish Barbus thamalakanensis, B. poechii and farmed Tilapia rendali in freshwater systems are reported to be vulnerable to EUS outbreaks. Main risk factors include floods, environmental factors (salinity≤ 2 g/L; Temperature ≥ 30°C), immune system of target fish and anthropogenic factors leading to outbreaks of EUS

WSSV:

The etiology of White Spot Syndrome Virus (WSSV) is a double stranded DNA virus (Whispovirus, Nimaviridae) that affects farmed shrimp (Penaids) in marine ecosystems. It was first reported on the 31st August 2011on a shrimp farm located in Quelimane, Zambezia in Mozambique but the disease was discovered to have been endemic for years affecting shrimp and crabs. Another outbreak was later experienced in the Southwest cost of Madagascar on the 9th May 2012. Subsequently, shrimp production was halted for at least one year: a decision that negatively affected community livelihoods. Biosecurity plans at farm and national were established to control this disease.

KHV:

A viral disease caused by a DNA-based virus with no specific clinical signs and incubates within seven days. Acute mortalities occur within 24-48 hours at optimum temperature, 22°C within 15 days. All ages of common carp (Cyrpinus carpio) are vulnerable but fingerlings are more susceptible. Outbreaks are most common in aquaria systems and breeding/nursing ponds/tanks.

Disease outbreaks (In this survey) are usually experienced in summer/dry and winter/wet seasons. In summer, disease outbreaks mostly occur in water-based aquaculture and natural environments systems mainly due to non-pathogenic agents (i.e. poor water quality) and pathogens. Water based (e.g. cages) and land-based systems are mainly affected in wet season when non-pathogenic agents cause mass mortalities. Hatcheries, grow-out and recreational systems are usually affected with outbreaks occurring more than twice every year.

5.3.3 Socio-Economic Factors

Live and processed aquatic commodities are usually transported for food, bait and recreational purposes. Some live aquatic products are traded for stock enhancement programs and ingredients for animal feed. All these routes potentially transmit or spread TAADS within and between member states. Anthropogenic factors like pollution and destruction of the environment can enable the spread of aquatic diseases and affect livelihoods of local communities. Importation of exotic aquatic animals will subsequently introduce exotic diseases, thereby threatening aquatic biodiversity, fisheries and aquaculture investments, regional and international trade and employment opportunities for local economies. Evidently, according to FAO (2009), the spread of EUS in Zambezi river system may have affected million of people in 7 countries; Angola, Botswana, Malawi, Mozambique, Namibia, Zambia and Zimbabwe. Poverty and illiteracy levels are still high in this region, therefore a holistic approach to manage these emerging aquatic diseases. Community-based research and collective decision-

making will ensure sustainable management of shared aquatic resources. Currently this region lacks information on economic losses caused by aquatic diseases, which will guide the sector to invest in disease management.

5.4 Overview of Aquatic Animal Disease Control

Member States (MS) should have adequate capacity (i.e. human and infrastructure) to enforce existing laws for controlling aquatic diseases especially TAADS. In this survey, South Africa, Zimbabwe and Mozambique have quarantine facilities but may not be functional. A regional diagnostic facility is also lacking but most MS have Competent Authorities (CA) who are Veterinary and Fisheries Officers. Their main functions include: i) enforcing sanitary and phyto-sanitary measures; and ii) inspect, treat or refuse entry consignments that do not comply with national laws.

The survey, chemotherapeutants and biotherapeutants are usually applied to control disease outbreaks following advise from public or private Veterinary and Fisheries Services.

5.4.1 National and Regional Aquatic Animal Disease Control Policies and Measures

Southern Africa is the only region in Africa that has formulated a Regional Aquatic Biosecurity Strategy for the Southern African Development Community (SADC) for 2015 to 2020; supported by FAO., South Africa has a National Aquatic Animal Health and Welfare Implementation Plan (NAAHWP) for the period 2015 – 2025. However, 50% of countries in this study lack national strategies although have established reporting system.

After the EUS outbreak in the Chobe-Zambezi River in 2007, an International Disease Investigation Task Force was established to combat the disease. All MS in the affected region were fully engaged, and consequently generated the following key recommendations;

i. Enhance surveillance and diagnostic capacity
ii. Formulate a regional emergency response strategy
iii. Increase education and awareness campaigns
iv. Promote responsible trade in aquatic animals in both affected and unaffected areas.

To date, most of these recommendations have been implemented, and the spread of EUS in the region is managed. Therefore, it is beneficial to have a Regional/national aquatic animal health strategy and a functional surveillance system that is enforceable and inclusive. Other strategies include the production of KHV-free seed that have shown to reduce this disease in South Africa (Huchzermeyer & Colly 2015). Therefore, investing in sustainable aquatic health research can be useful in this region.

5.4.2 Opportunities, Issues and Challenges

SADC has a regional strategy, which can facilitate the formulation and implementation of a continental African Aquatic Animal Health Strategy. This will accelerate the formation of an efficient and effective reporting system, which will rapidly respond to emerging aquatic diseases. Similarly, experiences learned when controlling EUS, KHV and WSSV outbreaks in this region will definitely assist other regions in developing rapid response strategies and early warning systems in other MS of the continent. Experienced CAs who have been involved in formulating national strategies or controlling TAADS can be out-sourced or engaged in building regional institutional capacities. Existing diagnostic laboratories can be improved to become continental diagnostic centers. However, success depends on the implementation or enforcement of individual MS whose capacity is not well strengthened.

Urgent need to explore impact due to climate change on aquatic disease outbreaks in this region. It is reported that changes in tropic-climate may accelerate the existence of virulent pathogens (Mennerat et al 2010). Food security and incomes will be affected as experienced during the WSSV outbreaks in Madagascar and Mozambique. Therefore, it important to understand the dynamics of climate change on fisheries and aquaculture production, its socio-economic implications, and strategies to build resilience among vulnerable communities.

Concluding Remarks and Observation

1. Response rate to questionnaires was low? Is it because there was no information. This reflects a weakness if reporting of aquatic animal diseases is to be improved.
2. The quality of information you received. Made it difficult for one to do quantitative analysis or epidemiological assessment. This may imply that there needs to be capacity building for this within the region, etc.

Recommendations

Based upon the observations and findings from the study, the following are recommended:

1. **Quality of data collected on aquatic animal diseases -** Responses show that most information is qualitative and cannot comprehensively be used for epidemiological assessments. Data criteria need to be set and harmonized between states.

Annexe 1: Survey instrument

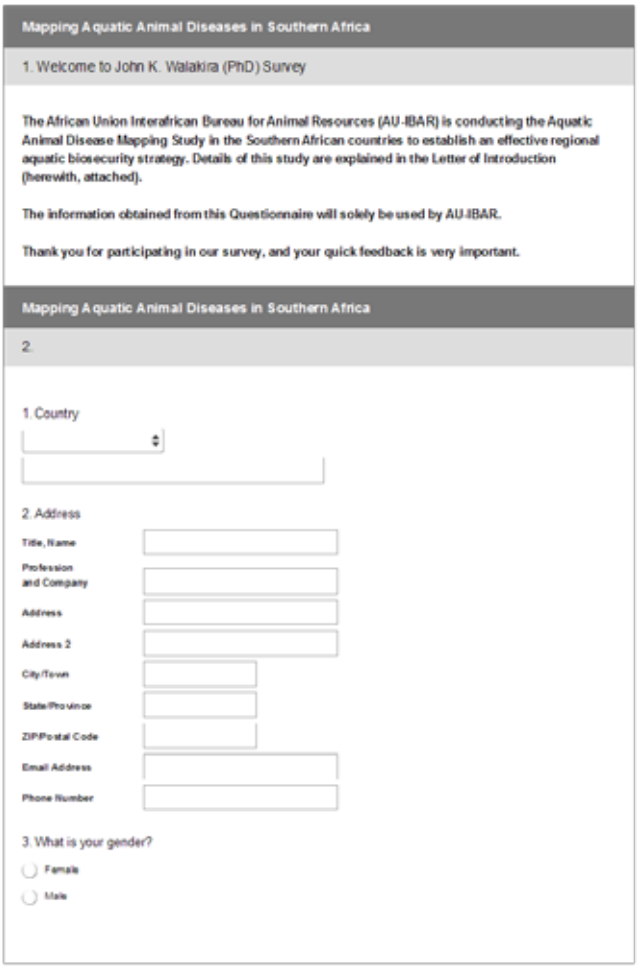
Guidelines for discussions;

- Number of fish farms within country/region, according to; size of production (tonnes fish/year), according to fish species.
- Number of fish farms/natural aquatic resources surveyed for diseases.
- National regulations that exist.
- Regional policy that may apply.
- Pathogens listed by regulation or policy, maps/locations.
- Sampling and laboratory analysis methods required by regulation or policy.
- Competence of human and institutions to handle aquatic animal diseases.
- Trade of aquatic commodities in the region;

Types, forms and destinations/movement of the following:

- Aquaculture (live product)
- Recreational fishing (live product)
- Stocking programs (live product)
- Human consumption (live and dead product)
- Animal (including aquatic animal) feed and bait (live and dead product)

Appendix 1: *Survey instrument to Map Aquatic Animal diseases in Southern Africa*



Mapping Aquatic Animal Diseases in Southern Africa

1. Welcome to John K. Walakira (PhD) Survey

The African Union Interafrican Bureau for Animal Resources (AU-IBAR) is conducting the Aquatic Animal Disease Mapping Study in the Southern African countries to establish an effective regional aquatic biosecurity strategy. Details of this study are explained in the Letter of Introduction (herewith, attached).

The information obtained from this Questionnaire will solely be used by AU-IBAR.

Thank you for participating in our survey, and your quick feedback is very important.

Mapping Aquatic Animal Diseases in Southern Africa

2.

1. Country

2. Address

Title, Name

Profession and Company

Address

Address 2

City/Town

State/Province

ZIP/Postal Code

Email Address

Phone Number

3. What is your gender?

Female

Male

1

4. Aquaculture Production systems present in your country

5. Water ecosytems in your country

- Freshwater
- Marine
- Both
- Other (please specify)

6. Rank the availability of production systems (1-most, and 3-least common)

- Ponds
- Cages
- Tanks

7. Average yields of production systems in your country

Ponds (Kg/ha)	
Cages (Kg/cubic meter)	
Tanks (Kg/cubic meter)	

8. List three main types of aquatic species commonly farmed

Ponds	
Cages	
Tanks	
Others	

9. Common management system practiced in your country?

	Extensive	Semi-intensive	Intensive
Ponds			
Cages			
Tanks			
Others			

10. Rank the main source of seed?

- Wild
- Private hatcheries
- Public hatcheries
- Wild and Public hatcheries
- Wild and Private hatcheries
- Public and private hatcheries

11. Rank the main source of brood stock or parent stock?

- Wild
- Private hatcheries
- Public hatcheries
- Wild and Public hatcheries
- Wild and Private hatcheries
- Public and private hatcheries

12. Main reasons for sources of seed/brood stock or parent stock

- Cheap
- Certified/pathogen free
- Easy access
- Donations/free
- Good performance

13. Other reasons for movement of aquatic commodities

- Recreational fishing/aquaculture
- Stock enhancement programs
- Human consumption (live and dead product)
- Animal (including aquatic animal) feed
- Bait (live and dead product)

14. Existing regulations for movement of live aquatic animals

- [ ] Quarantine
- [ ] Site Permit
- [ ] Supplier Permit
- [ ] Consignment Notes
- [ ] Notifications
- [ ] Other (please specify)

15. Availability of National Quarantine facilities for aquatic commodities

- ○ Present and functioning
- ○ Present and not functioning
- ○ Absent

16. Availability of Regional Quarantine facilities for aquatic commodities

- ○ Present and functioning
- ○ Present and not functioning
- ○ Absent
- ○ Not sure

17. Availability of Quarantine Officers/Aquatic Health Specialists

- ○ Present
- ○ Absent
- ○ Not sure

18. Rights and obligations of Quarantine Officers/Aquatic Health Specialist

- [ ] Can enforce sanitary and phyto-sanitary measures
- [ ] Make decisions based on scientific evidence
- [ ] Do not impose sanitary measures for diseases or pathogen conditions that occur in the importing country
- [ ] Importing country adopts measures (e.g. inspect, prohibit or treat), and can refuse entry, treat or detain consignments that do not comply

19. Quarantine periods

- ( ) < 3 months
- ( ) 6 months
- ( ) more than a year

20. Types of aquatic diseases and parasites affecting your country*

	Crustaceans	Fish	Mollusk
Taura syndrome			
White spot disease			
Yellowhead disease			
Infectious hypodermal and haematopoietic necrosis			
Crayfish plague *(Aphanomyces astaci)*			
White tail disease			
Infectious myonecrosis			
Necrotising hepatopancreatitis			
Epizootic haematopoietic necrosis			
Infectious haematopoietic necrosis			
Spring viraemia of carp			
Viral haemorrhagic septicaemia			
Infectious salmon anaemia			
Epizootic ulcerative syndrome			
Infection with *Gyrodactylus salaris*			
Red sea bream iridoviral disease			

	Crustaceans	Fish	Mollusk
^ Koi herpesvirus disease			
^ Infection with *Bonam ia ostreae*			
^ Infection with *Bonam ia exitiosa*			
^ Infection with *Marteilia refringens*			
^ Infection with *Perkinsus m arinus*			
^ Infection with *Perkinsus olseni*			
^ Infection with *Xenohaliotis californiensis*			
^ Infection with abalone herpes-like virus			

*see attachment for additional input

21. Reported disease outbreaks or fish kills

	Summer/Dry season	Winter/Wet season
Land-based Aquaculture systems		
Water-based Aquaculture systems		
Natural aquatic environments		

Other (please specify)

22. Frequency of disease outbreaks (per year)

	Land-based Aquaculture systems	Water-based Aquaculture systems	Natural aquatic systems
Hatcheries			
Grow-out			
Recreational			

Other (please specify)

6

23. Application of therapeutic drugs (Per cycle)

	Preventive	Treatment
Chemicals (e.g. salt, Potassium permanganate)		
Biocontrol agents (e.g. vaccines, plants)		
Both		
None		

Other (please specify)

24. Main source of technical advise for preventing/treatment of diseases

- Veterinary Services (Private)
- Veterinary Services (Public)
- Fisheries or Aquaculture Services (Private)
- Fisheries or Aquaculture Services (Public)
- Researchers
- Media
- Fellow Farmers/fishers
- Internet
- Publications (Journals, brochure, Fliers, posters etc)

25. Availability of aquatic diagnostic facility(ies)

- Present
- Absent
- Not sure

26. Availability of a harmonised reporting system

- Present
- Absent
- Not sure

7

27. What Ministry /Directorate/Department is responsible for harmonizing reports for aquatic diseases and parasites?

- ◯ Veterinary
- ◯ Fisheries and Aquaculture
- ◯ Other (please specify)

28. Availability of national policies and/or guidelines for aquatic animal diseases

- ◯ Available
- ◯ Not available
- ◯ Not sure

29. What is your role in aquatic disease management?

30. State three main challenges facing the implementation of disease and parasite management

31. Recommendations to improve disease and parasite management strategy

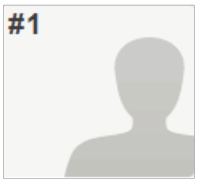
32. Please enter the date you completed this questionare

Date / Time DD / MM / YYYY hh : mm AM/PM

8

Appendix 2: Contacts

Mapping Aquatic Animal Diseases in Southern Africa — SurveyMonkey

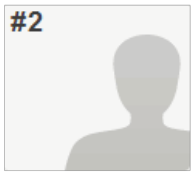


COMPLETE

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Last Modified: Wednesday, February 03, 2016 10:21:05 AM
Time Spent: 00:22:31
Email: barson001@yahoo.co.uk
IP Address: 154.120.229.39

PAGE 2

Q1: **Country**	Zimbabwe
Q2: **Address**	
Title, Name	Dr Maxwell Barson
Profession and Company	Parasitology lecturer & OIE Fish disease expert
Address	Biological Sciences Dept, University of Zimbabwe
Address 2	PO Box MP167, Mt Pleasant
City/Town	Harare
State/Province	Harare
ZIP/Postal Code	NA
Email Address	barson001@yahoo.co.uk
Phone Number	+263772734396
Q3: **What is your gender?**	Male
Q4: **Aquaculture Production systems present in your country**	Ponds and Cages
Q5: **Water ecosytems in your country**	Freshwater
Q6: **Rank the availability of production systems (1-most, and 3-least common)**	
Ponds	2
Cages	3
Tanks	1
Q7: **Average yields of production systems in your country**	
Ponds (Kg/ha)	2000
Cages (Kg/cubic meter)	10000
Q8: **List three main types of aquatic species commonly farmed**	
Ponds	Nile Tilapia
Cages	Nile Tilapia
Others	African catfish, rainbow trout

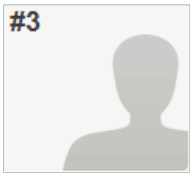


#2 **COMPLETE**

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Time Spent: 00:19:52
Email: maminiaina.fridolin@gmail.com
IP Address: 197.159.95.74

PAGE 2

Q1: **Country**	Other (please specify) MADAGASCAR
Q2: **Address**	
Title, Name	Dr Fridolin Olivier MAMINIAINA
Profession and Company	Chercheur Virologie- Bioinformatique - Vaccinologie Département de Recherches Zootechniques et Vétérinaires (FOFIFA-DRZV)
Address	Laboratoire de virologie/Biologie Moléculaire FOFIFA-DRZV
Address 2	Rue Farafaty Ampandrianomby BP 1690
City/Town	Antananarivo
State/Province	Antananarivo
ZIP/Postal Code	101
Email Address	maminiaina.fridolin@gmail.com
Phone Number	+261 34 14 950 72
Q3: **What is your gender?**	Male

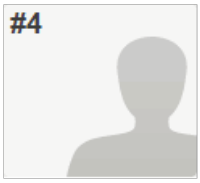


#3 **COMPLETE**

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Time Spent: 00:15:54
Email: lmodisa@gov.bw
IP Address: 129.205.193.250

PAGE 2

Q1: **Country**	Botswana
Q2: **Address**	
Title, Name	Dr Bernard Mbeha
Profession and Company	Epidemiologist, Veterinary Services
Address	Bag 0035 Gaborone
City/Town	Gaborone
Email Address	bmbeha@gov.bw
Phone Number	+2673928816
Q3: **What is your gender?**	Male



#4

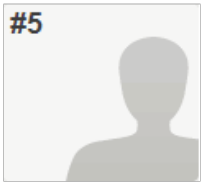
COMPLETE

Collector: Email Invitation 2 (Email)
Started: Friday, February 05, 2016 6:30:40 PM
Last Modified: Tuesday, February 09, 2016 6:39:10 AM
Time Spent: Over a day
Email: molomomarosi@gmail.com
IP Address: 64.57.124.193

PAGE 2

Q1: **Country**	Lesotho
Q2: **Address**	
Title, Name	Dr
Profession and Company	Veterinary Epidemiology
Address	Department of Livestock Serviecs
Address 2	Private Bag A82
City/Town	MASERU
State/Province	MASERU
ZIP/Postal Code	100
Email Address	molomomarosi@gmail.com
Phone Number	00266 58881922
Q3: **What is your gender?**	Female

Mapping Aquatic Animal Diseases in Southern Africa SurveyMonkey



#5

COMPLETE

Collector: Email Invitation 1 (Email)
Started: Tuesday, February 09, 2016 12:24:06 PM
Last Modified: Tuesday, February 09, 2016 3:08:48 PM
Time Spent: 02:44:42
Email: vlucas@sfa.sc
IP Address: 41.86.56.16

PAGE 2

Q1: **Country**	Seychelles
Q2: **Address**	
Title, Name	Mr. Aubrey Lesperance
Profession and Company	Principal Aquaculture Officer, Seychelles Fishing Authority
Address	P.O.Box 449
Address 2	Fishing Port
City/Town	Victoria
State/Province	-
ZIP/Postal Code	-
Email Address	aubreylesperance@gmail.com
Phone Number	+248 467 0300
Q3: **What is your gender?**	Male

#6

COMPLETE

Collector: Email Invitation 2 (Email)
Started: Wednesday, February 10, 2016 8:42:13 AM
Last Modified: Wednesday, February 10, 2016 8:53:22 AM
Time Spent: 00:11:09
Email: abudala.napuru@gmail.com
IP Address: 154.66.122.34

PAGE 2

Q1: **Country**	Malawi
Q2: **Address**	
Title, Name	Mr Abudala Napuru
Profession and Company	Aquaculture Enterprise
Address	P.O Box 2912
City/Town	Blantyre
ZIP/Postal Code	+265
Email Address	abudala.napuru@gmail.com
Phone Number	+265881112110
Q3: **What is your gender?**	Male

#7

COMPLETE

Collector: Email Invitation 2 (Email)
Started: Wednesday, February 03, 2016 4:26:59 PM
Last Modified: Wednesday, February 10, 2016 6:58:47 PM
Time Spent: Over a day
Email: sashas@daff.gov.za
IP Address: 41.193.102.66

PAGE 2

Q1: **Country**	South Africa
Q2: **Address**	
Title, Name	Dr Sasha Saugh
Profession and Company	State Veterinarian, Department of Agriculture, Forestry and Fisheries
Address	Marine Research Aquarium, Lower Beach Road,
Address 2	Sea point
City/Town	Cape Town
State/Province	Western Cape Province
ZIP/Postal Code	8005
Email Address	SashaS@daff.gov.za
Phone Number	+2721 430 7052
Q3: **What is your gender?**	Female

#8

COMPLETE

Collector: Email Invitation 2 (Email)
Started: Wednesday, February 10, 2016 11:41:36 AM
Last Modified: Thursday, February 11, 2016 11:55:27 AM
Time Spent: Over a day
Email: nzeyile@yahoo.fr
IP Address: 196.2.14.37

PAGE 2

Q1: **Country**	Other (please specify) BURUNDI
Q2: Address	*Respondent skipped this question*
Q3: What is your gender?	*Respondent skipped this question*

#9

COMPLETE

Collector: Email Invitation 2 (Email)
Started: Friday, February 12, 2016 2:15:07 PM
Last Modified: Friday, February 12, 2016 2:18:58 PM
Time Spent: 00:03:50
Email: seyvet@seychelles.net
IP Address: 41.203.241.43

PAGE 2

Q1: **Country**	Seychelles
Q2: **Address**	
Title, Name	Dr. Jimmy G. Melanie
Profession and Company	Veterinary Services
Address	Union Vale
Address 2	P.O. Box 166
City/Town	Victoria, Mahe
Email Address	seyvet@seychelles.net, pvo@email.sc
Phone Number	+248 4285950 (o) +248 2722869 (m)
Q3: **What is your gender?**	Male

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African Union – Interafrican Bureau for Animal Resources
(AU-IBAR)
Kenindia Business Park
Museum Hill, Westlands Road
PO Box 30786
00100 Nairobi
Kenya
Tel: +254 (20) 3674 000
Fax: +254 (20) 3674 341 / 3674 342
Email: ibar.office@au-ibar.org
Website: www.au-ibar.org