

Fishery and Aquaculture

level III

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Standard (OS)**



**ModuleTitle: Applying aquaculture bio-security
measures**

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Introduction to the module

This learning guide describes the skills, knowledge and attitude required to identify fish diseases, pests and predators and apply bio-security control and treatment measures.

LG #10	LO 1: Identify biosecurity control measures
Instruction sheet-1	
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> ▪ Planning aquaculture biosecurity ▪ Identifying fish diseases, pests and predators ▪ Identifying materials, tools and equipment ▪ Identifying personal protective equipment ▪ Identifying hazard and risk control measures and procedures <p>This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> ▪ Plan quaculture biosecurity ▪ Identify Fish diseases, pests and predators ▪ Identify materials, tools and equipment ▪ Identify personal protective equipment ▪ Identify hazard and risk control measures and procedures 	
Learning Instructions:	
<ul style="list-style-type: none"> • Read the specific objectives of this Learning Guide. • Follow the instructions described below. • Read the information written in the information Sheets • Accomplish the Self-checks • Perform Operation Sheets • Do the “LAP test” 	

Information Sheet- 1

Introduction

The application of biosecurity in aquaculture is a shared responsibility where each individual involved plays a different but critical role in the implementation of the overall programme. In order to be effective, biosecurity is necessary at all levels within the aquaculture industry, from the control of the spread of infectious disease at an international level to the development of national controls and to the operation of suitable practices at a local level. In these terms, the World Organisation for Animal Health (WOAH) monitors the international status of diseases, our Government (through Cefas) is responsible for controlling biosecurity within national limits, and at a local level Aquaculture Production Businesses (APBs) are responsible for biosecurity within their enterprises.

The key elements of biosecurity include: practical and appropriate legislative controls, adequate diagnostic and detection methods for infectious diseases, disinfection and pathogen eradication methods, reliable high quality sources of stock, and best management practices. At the local level, implementation of an effective biosecurity measures plan is essential in reducing the risk of disease introduction to an APB. This follows the fundamental principle that prevention is better than the cure. In addition, it is widely accepted that prevention of aquatic animal disease is cheaper than the cure.

The Aquatic Animal Health (England and Wales) Regulations 2009 recognises the importance of effective biosecurity measures in restricting the spread of disease. It requires APB operators to implement a biosecurity measures plan as a condition of their authorisation.

1.1. Aquaculture biosecurity plan

Biosecurity planning in aquaculture involves considering your property and biosecurity practises you could put in place to minimise the introduction, establishment and spread of infectious diseases in your facility. A biosecurity plan should cover the steps you will take when bringing animals onto

your property, managing the biosecurity risks already present on your property and the steps you would take when moving animals off your property.

Poor biosecurity can allow diseases to enter your property and spread, infecting animals and causing loss of stock, money and potentially reputation for your business. Disease pathogens could spread from your property to neighbouring properties, that of your customers, or further afield across the state. A plan will help you minimise your biosecurity risks. When carefully followed, a biosecurity plan will help you maintain a high standard of fishery and aquaculture health.

1.1.1. Appointing a biosecurity manager

Identify an individual with the responsibility to ensure biosecurity measures are implemented at an APB, or over several APBs if the business is made up of more than one site. The biosecurity manager is responsible for producing and maintaining a biosecurity measures plan, as well as demonstrating its effectiveness through use of good record keeping. Additional responsibilities include ensuring staff are trained in biosecurity issues and visitors are aware of measures that apply to them. It is good practice to appoint a deputy in the event that the manager is unavailable.

1.1.2. Veterinary health contacts

The biosecurity manager should identify a veterinarian, and if appropriate an aquatic animal health consultant with specialised knowledge of aquatic animal health issues. The manager should endeavour to establish a good working relationship with their nominated veterinary professionals.

1.1.3. Identify the risks of contracting and spreading disease

One of the greatest risks of introducing an infectious agent into an APB comes with movements of aquatic animals. Where aquatic animals or eggs have to be introduced from outside sources you should consider the following:

- Assess the potential quality of the aquatic animals by ensuring your supplier is working to good bio-security practices.
- Do not hesitate to ask for details of aquatic animal health surveillance programmes and disease records
- Be aware of the provenance of the aquatic animals when buying from any supplier

- The stock must not be exhibiting any clinical signs of disease at the time of transport
- Attention should be paid to both transport water sources and disinfection procedures applied to the equipment used in transport
- Disinfect eggs before incubation and dispose of packaging in a safe and bio-secure manner
- If possible, isolate introductions of aquatic animals from other stocks until their health status can be established
- Consider the risks associated with the movements of dead aquatic animals or aquatic animal products and waste for processing
- Consider the risk posed by wild aquatic animals

1.1.4. Risk limitation measures

Once risks have been identified the APB biosecurity manager should decide on appropriate systems and procedures to control or reduce these risks. Such measures may include:

- Early identification of disease through regular stock inspections
- Training staff to recognise clinical signs of disease and enable them to identify procedures that carry a risk of introducing or spreading disease
- Ensure that aquatic animal husbandry is suitable for the species being held or cultivated
- Limit APB access to authorised staff or approved visitors
- Provide advice on biosecurity to visitors at farm sites and anglers at fishing lakes
- Identify and set up zones within your APB, e.g. hatchery, fishery lake, packing and processing, parking, storage
- Restrict access to these zones
- Provide zone-specific protective clothing. Consider using colour-coded boots/overalls for particular zones
- The use of suitable disinfectants and disinfection procedures for personal protective equipment and other equipment
- Introduce disinfection protocols for site visitors (including delivery vehicles)

It is the biosecurity managers responsibility to ensure these measures are implemented and regularly monitored for compliance.

1.1.5. Stock health inspections

- Routine inspection of stock should be an essential activity on a fish farm or fish holding unit
- Keeping an inspection log is highly recommended. This should record numbers of sick and dead fish in the holding units, as well as other significant details relating to the health of the fish, such as feeding behaviour and water quality parameters
- Establish a formal chain of reporting so that the biosecurity manager is quickly informed of any potential problems

1.1.6. Visitor details

- Keep a record of all visitors to the APB
- Ensure visitors are aware of the biosecurity measures that apply to them

1.1.7. Disinfection procedures

- Record dates of disinfectant solution replacements
- Disinfectant solutions need to be replaced before they lose efficacy

1.1.8. Monitoring the plan

Once procedures and measures have been implemented it is essential to maintain a clear recording system for results of checks made and actions taken. Accurate recording will aid the biosecurity manager to make informed decisions and take appropriate actions when a disease or breach of biosecurity occurs. A comprehensive log or diary can be used to demonstrate to interested parties (customers, senior management, auditors, quality management and inspection agencies) that a biosecurity measures plan is in operation. Examples of information to be recorded in the log are listed below and a template is included in this document.

Table 1.1: Fish biosecurity measures plan (format)

Site/Business Name	
Authorisation Number	

Table 1.2: Biosecurity Manager recording sheet

Name	
Contact Details	
Alternative Contact Name	
Alternative Contact Details	

Responsible Person name _____ signature _____ Date _____

Inspector Name _____ signature _____ Date _____

Table 1.3: Site Details recording sheet

Answer the following providing as much detail as possible:

Site Information	Yes/ No/NA	Details
Does the site have approved compartment status?		
Is there an isolation site		
Is the site currently under statutory disease controls? Is this detailed in the BMP?		
Are special permissions consented under statutory disease controls?		
Are contactors regularly used for activities such as fish transport or stock management?		

Table 1.4: Site Details recording sheet

Ensure all information is representative of the site plan and provide detail as appropriate:

Pond/ Tank/ System Number	Volume (m3)	Static/ Flow Through/ Recirculation

a) Risks of contracting disease

Use this section to identify how your business could possibly contract disease through both farming practices and business activities. Detail the risk limitation methods you have in place and how you will monitor and record these measures:

Table 1.5: Risk contracting disease recording sheet

Risks of contracting disease	Risk limitation measures	Monitoring the plan/ recording

b) Risks of spreading disease

Use this section to identify how your business could possibly spread disease through both farming practices and business activities. After identifying how disease can spread, detail the risk limitation methods you have in place and how you will monitor and record these measures.

Table 1.6: Risk spreading disease recording sheet

Risks of spreading disease from the site	Risk reduction measures	Monitoring the plan

1.2.Fish diseases, pests and predators

1.2.1. Fish diseases

Disease poses a major threat to these aquaculture environments with fish living in suboptimal conditions; overcrowding and low oxygen levels, poor nutrition, and living among zoonotic pathogens. Other factors that increase the risk of disease are, for example, the introduction of new species into existing aquaculture settings, poor monitoring of diseases, and climate change. Bacteria, viruses and parasites occur in natural aquatic environments but are more concentrated in fish farms.

In fish that are under stress, naturally occurring bacteria in their digestive tract can become dangerous and lead to infections, and fish are often given food with high levels of lipids to augment their growth and lower costs of feed, which can lead to excessive fat in the liver. *Lepeophtheirus salmonis*, a parasitic sea lice in salmon, feeds on the skin, mucus and blood of salmon, causing weakening of the cardiac muscle, increased stress, and an imbalance in osmoregulation, which balances salt and water levels in a fish.

Classification of fish diseases

Fish diseases are described based on the characteristics of the infection and the pathogen type.

Characteristics of the infection

- A. Infectious diseases
- B. Non-infectious diseases

Type of pathogen

- 1. Viruses
- 2. Bacteria
- 3. Fungi
- 4. Parasites

A. Infectious diseases

Infectious diseases are caused by pathogenic agents in the environment and spread between fishes and fish populations.

1. Viral disease

Viruses are small infectious bodies that replicate themselves inside the cells of living things. Different viruses infect literally all types of organisms: animals, plants, and bacteria. They possess some of the characteristics of other living organisms and are affected by natural selection, but they cannot replicate themselves without first invading a host cell. Virus particles consist of particular genetic material (DNA or RNA), covered by a protective layer of protein and, in some cases, an envelope of fat molecules that surrounds the protein layer. A typical virus is a hundred times smaller than the average bacterial cell and is too small to be seen through a regular microscope.

Viruses spread in a variety of ways: through direct contact, through air or water, by their host animals being eaten by another, or even by being shed in feces. Each type of virus has a range of host cells that it is able to infect. Some viruses can infect many different species, while others can infect only a few closely related types of fishes.

Over 125 different viruses have been documented in fishes (Noga 2010), but most of them have been in aquacultured food fishes, as that is where the most resources are focused. Symptoms of piscine viral infections overlap those resulting from some other diseases, so positive identification is difficult with aquarium fishes. Although vaccines are available to protect some species of food fishes from some viruses, it needs to be understood that no medications are available to treat active viral diseases in any fish. The most common viral fish diseases are:

i) Lymphocystis:

1. Woodcock (1904) identified this disease in fishes.
2. Marine, freshwater and aquarium fishes are susceptible to this disease.
3. Tumor formation is the important character of this viral disease.
4. The external lesions are raised and made up of the growing of granular, nodular tissue which is composed of many greatly enlarged host cells.
5. Matured lesions may become slightly hemorrhagic. Within 6-15 days of infection the tumors grow to 50 thousand times.
6. The only control measure is prevention.

ii) Viral Hemorrhagic Septicaemia (VHS)

- This disease is caused by an unequal shaped fish virus with RNA.
- This disease occurs in salmon fishes. Transmission of the disease occurs through the water by a flagellates.
- The symptoms are kidney swelling, reduced appetite, obvious distress, erratic spiral swimming, multiple haemorrhages in skeletal muscles, change in body colour, reddish fins.
- The only control measure is prevention.

iii) Infectious Pancreatic Necrosis (IPN)

- This disease is found in trouts.

- This disease causing high mortality of fry, fingerlings and occasionally larger fishes.
- The symptoms are darkening distension, haemorrhages in ventral areas including bases of fins. There is pronounced pancreatic necrosis.
- 200 ppm of chlorine is effective for treatment.

iv) Infective Haemopoietic Necrosis (IHN)

- IHN was observed for the first time in trouts in British Columbia (Canada) in 1967.
- Necrosis is observed in the haemopoietic tissue of kidney in infected fish.
- This disease occurs more in fry and fingerlings and occasionally in adults.
- The symptoms are pale gills, reddish fins, black colouration of the body, abdomen swelling and huge mortality.
- The symptoms are clear in 12-45 days after the entry of virus into the host body.

v) Chinook disease:

- A small size virus is responsible for this disease in Chinook salmon (*Oncorhynchus tshawytscha*) fingerlings.
- The symptoms are exophthalmus, distended abdomen, a dull red area on the dorsal surface anterior to dorsal fin.
- The liver, spleen, kidney, gills and heart are pale.
- The disease is transmitted by the egg from the carrier female.
- No treatment.

vi) Channel Cat Fish Virus Disease:

- This disease occurs in fingerling of cat fish (*Ictalurus punctatus*).
- The symptoms are that the fish show abnormal swimming and rotating, haemorrhagic areas on fins and abdomen, fluid accumulation in abdomen and pale gills.
- There is no treatment for this disease. Destruction of infected fish may prevent spread of the disease

<https://www.youtube.com/watch?v=TRp7YXi-p-0>

2. Bacteria disease

Epidemics of bacterial diseases are common in dense populations of cultured food or aquarium fish. Predisposition to such outbreaks frequently is associated with poor water quality, organic loading of the aquatic environment, handling and transport of fish, marked temperature changes, hypoxia, or other stressful conditions. Most bacterial pathogens of fish are aerobic, gram-negative rods. Diagnosis is by isolation of the organism in pure culture from infected tissues and identification of the bacterial agent. Sensitivity testing before antimicrobial use is recommended. A number of bacteria produce a similar syndrome, generically referred to as hemorrhagic septicemia and characterized by external reddening and hemorrhage in the peritoneum, body wall, and viscera. Morbidity and mortality are highly variable, depending on predisposing conditions such as low dissolved oxygen, other water quality problems, handling stress, or trauma. Ulcerative lesions are common as disease progresses, and mortality can be significant if stress is not controlled. Antimicrobial therapy is recommended if fish are dying. Common bacterial isolates from affected fish include *Aeromonas* and *Pseudomonas* spp, which are more common in freshwater animals, and *Vibrio* spp, more commonly isolated from marine fish. Control is based on removal of predisposing factors. If antimicrobial therapy is warranted, drug selection should be based on sensitivity testing when possible.

https://www.google.com/search?q=How+to+identify+bacterial+fish+disease&biw=1366&bih=657&tbm=vid&sxsrf=APwXEddxPU6tAI9PYfxhCr6nr_slua1cFg%3A1683546202243&ei=WuBYZNusDoXzkGh6rFI#fpstate=ive&vld=cid:5011509c,vid:E-up7f8fQMw

a) *Edwardsiella ictaluri*

This is commonly associated with disease in channel catfish; however, it is also responsible for high mortality in zebrafish, both in research laboratories and aquarium fish. It is an obligate pathogen and can be transmitted by direct contact with infected fish, water, and feces. Clinical signs of disease in infected zebrafish include hemorrhaging in the skin, pale gills, lethargy, and splenomegaly.

On histologic evaluation, bacteria frequently can be found in high numbers in spleen, anterior and posterior kidneys, nares, and forebrain. It can be isolated on standard culture media, but it is slow-growing. Coinfections with *Aeromonas* spp are common; *Aeromonas* spp are fast growers and can easily overgrow *E. ictaluri*.

b) *Edwardsiella piscicida*

This is an emerging disease and has been reported in many fish species, both freshwater and marine, and in ornamental, game, and food fish. When phenotypic identification of isolates are performed, it cannot be distinguished from *E tarda*; consequently it is recommended to submit bacterial isolates identified as *E tarda* for complete genome sequencing. Some fish infected with *E piscicida* often have a granulomatous response. Gram-negative bacteria may be seen in the granulomas.

c) *Vibriosis*

This is a potentially serious, common systemic disease of many cultured, aquarium, and wild marine and estuarine fish; it is less common in freshwater fish. Three genera of the family Vibrionaceae are frequently associated with infection in fish: *Vibrio*, *Listonella*, and *Photobacterium*. These genera can result in hemorrhages and ulcerations of the skin, fin, and tail; hemorrhagic and degenerative changes of internal organs; and other systemic changes. Diagnosis requires identification of pure isolates from infected tissues. Isolation of *V cholerae* from fish is not uncommon and should not cause alarm as long as the isolate is the non-O type. Preventive measures include minimizing stress and crowding. Coldwater vibriosis (Hitra disease), a serious problem in sea farming of salmonids, is characterized by high mortality, resistance to drug therapy, and stress mediation. The etiologic agent is *Aliivibrio salmonicida*. Because members of this family are ubiquitous in marine environments, avoidance is difficult. Preventive vaccination with formalin-killed *Vibrio* is used in the salmonid industry. Antimicrobial therapy should be based on results of antimicrobial susceptibility testing.

d) *Mycobacteriosis*:

This is a chronic or acute, systemic, granulomatous disease of aquarium fish and cultured food fish, particularly those reared under intensive conditions.

Predisposing environmental factors include low dissolved oxygen, low pH, and high organic load, all found in recirculating aquaculture systems.

Correct use of ultraviolet light as a way to disinfect system water reduces bacterial counts and can be a useful tool to control infection in exhibit animals.

3. Fungal disease

Aquatic fungi often are considered secondary tissue invaders that follow traumatic injuries, infectious agents, or environmental insults such as poor water quality or low water temperatures. Because many fungi grow on decaying organic matter, they are especially common in the aquatic environment.

Fusarium solani is emerging as an important cause of disease in captive marine fish, particularly elasmobranchs. This organism is found in aquatic plants and soils in tropical and subtropical regions.

Clinical disease has been reported in bonnethead and scalloped hammerhead sharks, as well as several species of marine fish, including angelfish and parrotfish. Disease is associated with low water temperatures ($< 27^{\circ}\text{C}$ [80°F]). Bonnethead sharks are particularly susceptible and develop erosions and granulomatous lesions along the head. Resolution of lesions requires warming the affected animals to a more appropriate temperature for the species.

Closely related to true fungi, microsporidia are tiny, obligate intracellular, spore-forming parasites with single polar filaments. They are common parasites of finfish and are host- and tissue-specific; they can also infect helminth parasites of fish. The spores are extremely resistant, and microsporidia are considered nontreatable. Microsporidia have a direct life cycle; therefore, horizontal transmission in an aquarium is likely. Some species of microsporidia cause the formation of xenomas; a xenoma results in the hypertrophy of an infected cell and its nucleus and is often surrounded by fibrous connective tissue by the host.

The tiny spores can often be seen on wet mounts of affected tissues. The spores are acid-fast variable but stain more reliably with the Luna stain. The spores are very hardy and can remain infective in water for many months. Ingestion of the spores is the primary route of infection, but entry through other portals (eg, damaged skin or gills) and transovarial transmission

are possible. Recommendations for management of microsporidian disease include removal of older and moribund animals from a population, ultraviolet sterilization, and strict biosecurity. Depopulation and disinfection are recommended for elimination of microsporidian infections.

4. Parasite disease

All of the major groups of animal parasites are found in fish, and apparently healthy wild fish often carry heavy parasite burdens. Parasites with direct life cycles can be important pathogens of cultured fish; parasites with indirect life cycles frequently use fish as intermediate hosts. Knowledge of specific fish hosts greatly facilitates identification of parasites with marked host and tissue specificity, whereas others are recognized because of their common occurrence and lack of host specificity. Examination of fresh smears or biopsies that contain living parasites is often diagnostic. The parasites of fish can affect gills, skin and internal organs of the fish.

i) Ciliate Parasites

Ciliated protists are among the most common external parasites of fish. Most ciliates have a simple life cycle and divide by binary fission. Ciliates can be motile, attached, or found within the epithelium. The most well-known organism in the latter group is *Ichthyophthirius multifiliis*, which has a more complex life cycle than the other ciliates.

The infection caused by *I. multifiliis* is referred to as ich or white spot disease. *Ichthyophthirius multifiliis* is an obligate pathogen that cannot survive without the presence of living fish. All freshwater fish are susceptible, and a similar appearing parasite, *Cryptocaryon irritans*, is seen in marine species. *Ichthyophthirius multifiliis* is readily transmitted horizontally via direct exposure to infected fish or via fomites (nets, etc). Fish that survive an outbreak may be refractory to infection in future outbreaks but may also serve as a source of infection to previously unexposed individuals. The parasite invades epithelial tissue of gills, skin, eyes, or fins, leaving a small wound and visible white spot or nodule where each parasite encysts. The organism causes substantial damage because of its unique life cycle, which allows a rapid intensification of infection. Mortality can be rapid and catastrophic.

Clinical signs of ich include lethargy, clamped fins, and dark coloration; white dots are often visible on the skin. Ich is diagnosed by examining small biopsies of skin mucus, fin, and gill where *I multifiliis* can be easily seen at 40× and 100× magnification. It is large (0.5–1 mm), round, covered with cilia, and has a characteristic horseshoe-shaped macronucleus. Its characteristic movement varies from constantly rotating to ameboid-like. In some infestations, the gills or fins may harbor more organisms than skin, so it is important to examine biopsies from all three locations.

Ich infections require immediate and thorough medical treatment. Formalin or copper are often drugs of choice. Over-the-counter medications for pet fish often contain formalin and malachite green and are effective but, because of regulatory concerns regarding the use of malachite green, should not be dispensed by the veterinarian. Multiple chemical treatments (with intervals determined by water temperature) are required for successful treatment of *I multifiliis*. At warm temperatures typical of home aquaria (eg, >26°C), infected fish should be treated daily. Three to seven treatments may be required

Constant chemical exposure for at least 3 weeks is generally recommended to control *Cryptocaryon* in marine systems; lowering salinity to 16–18 g/L is often helpful.

ii) Flagellate Parasites

Ichthyobodo spp are some of the most common and smallest (~15 × 5 mcm) flagellated protistan parasites of the skin and gills. A kinetoplastid protist, they are flattened, pear-shaped organisms with two flagella of unequal lengths. These parasites can be found on freshwater or marine fish from a broad geographic range. *Ichthyobodo* moves in a jerky, spiral pattern, and free-swimming organisms are fairly easy to identify in direct smear preparations. Once attached, the organism can be difficult to see, but movement typical of a flickering flame may be seen under 400× magnification and is characteristic. Affected skin often has a steel-gray discoloration due to copious mucus production (blue slime disease), and gills may appear swollen. Behavioral signs of infestation include lethargy, anorexia, piping, and flashing. *Ichthyobodo* is readily controlled with formalin, copper sulfate, or potassium permanganate baths. Because the parasite has a direct life cycle, a single treatment should be adequate. If reinfestation occurs, sanitation and quarantine practices should be evaluated.

One of the most serious health problems of captive marine fish is the parasitic dinoflagellate *Amyloodinium* spp. Its freshwater counterpart, *Piscinoodinium* spp, is frequently seen on zebrafish and some barbs, but can occur on any freshwater fish. Like *Amyloodinium* it can also result in high mortality. These parasites produce a disease that has been called velvet, rust, gold-dust, and coral disease because of the brownish gold color they impart to infected fish. The pathogenic stages of the organism are pigmented, photosynthetic, nonflagellated, nonmotile algae that attach to and invade the skin and gills during their parasitic existence.

When mature, these parasites give rise to cysts that contain numerous flagellated, small, free-swimming stages that can initiate new infections. Control of *Amyloodinium* is challenging, and the prognosis is guarded. Copper sulfate is the only therapeutic option for food animals in the US, and repeated treatments are necessary to break the life cycle. The disease is particularly problematic in clownfish. The treatments that are most effective are chloroquine, delivered at 10 mg/L as an indefinite bath, and copper sulfate.

1.2.2. Methods of identifying healthy and diseased fishes

Fish farmers should carry out a simple health inspection routine every day. To begin with, observe fish behaviour. See if the fish are reducing feed intake or showing abnormal swimming patterns. If you are certain that the abnormal behaviour is not connected with environmental factors, carry out a detailed health inspection (stage two). For example, check the body surface, fins and gills, and see if there are any surface parasites. If disease symptoms are detected, seek assistance from the veterinarians. The sign or symptoms of fish diseases are associated with abnormal changes in fish feeding, behavior, and physical appearances.

a) Observation of fish behavior

Feed intake: Reduced feed intake is the first sign of many fish diseases. Fish farmers should therefore keep daily feeding records to ensure they have sufficient information to compare general intake trends.

Abnormal swimming patterns: Examples are fish lying flat, rubbing against the bottom or swimming net cage edges, jumping out of the water, circling in water or losing balance. All these may be signs of disease. (<https://www.ratemyfishtank.com/blog/behavioral-changes-and-problems-in-aquarium-fish>: access date:8/5/2023)

Table 1.7: Differentiating between sick and healthy fish

	Sick fish	Healthy fish
Activity	Swimming slowly; sluggish response	Swimming actively; sharp and responsive
Body Colour	Dull, dark or discoloured	Bright and glossy
Body Surface	White layered patches	Intact
Body Shape	Thin	Normal size
Feed Intake	Poor appetite	Good appetite
Organs	Different fish diseases cause damage to different organs	Internal organs are healthy and normal

b) Detailed health inspection

- **Check the body surface and fins** - Body surface and fin wounds are obvious signs of infections. Common body symptoms of fish diseases are:



Figure 1.1: Body surface of the fish to be inspected

- **Check the gills:** If the gills are whitened or show ulcers or with deep red spots, or there are gill flukes, excessive mucus or obstructive substances, the fish may be infected and gill functions may be impaired.



Figure 1.2: Checking fish gill

c) Fish disease monitoring flow chart

This monitoring of fish disease flow chart refers the sum of both observation of fish behavior (stage one (a)) and their detailed health inspection (stage two (b)). Thus, way of inspect the health of fish in farmed stock is presented shortly in flow chart below.

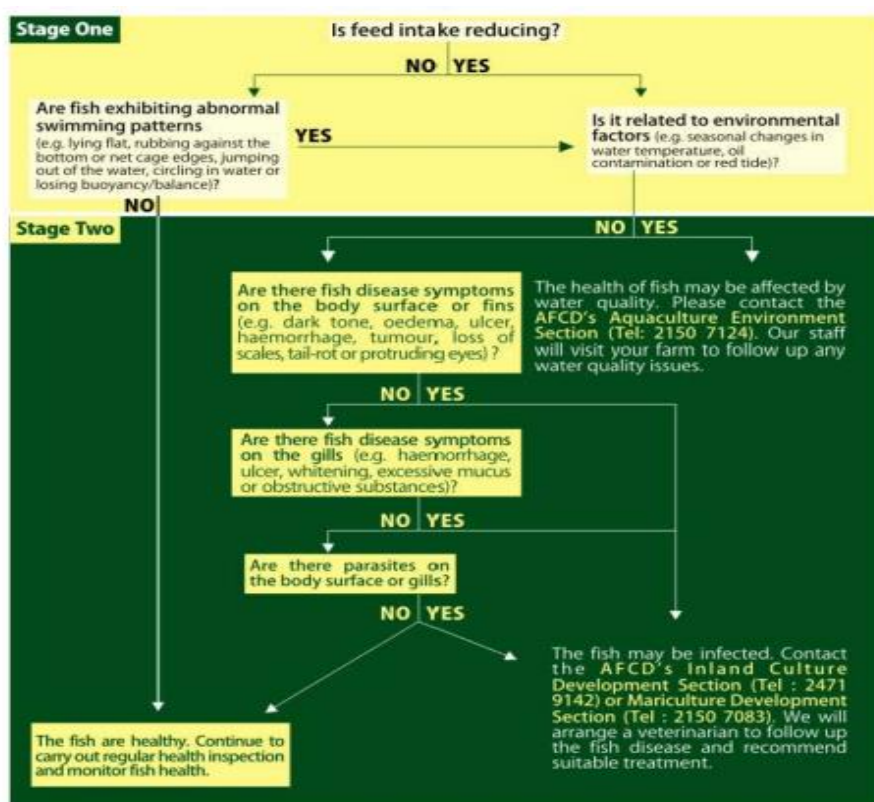


Diagram 1.1: Fish disease monitoring flow chart

Table 1.8: General approaches to fish disease Control

	What to control/Observe	Control Measures in Event in event of diseases
Fish	<ul style="list-style-type: none"> Water quality tolerances of the fish being reared Need and requirements during the different stages of life Change on fish and its behavior that occur when it exposed to physical, chemical or biological stressors Fish as cold blooded animals will immediately adapted to the changes in their environmental Factors that influence natural resistance to disease 	<ul style="list-style-type: none"> Early diagnosis from observation of changes in behavior, gross lesions, % population affected. Limit severity by improving water quality Enhance immunity and or treatment Select brood stock and eggs Rear disease resistant stock if available
Culture system	<ul style="list-style-type: none"> Site selection (eg. Prior land use & water source) Water quality parameters lie within optimum ranges Production capabilities Water temperatures Protection from predators and other animals Management practices Anticipate and /or be observant of changes (water quality parameters and temperatures) Record keeping Species and human activities within the water shed (i.e up stream and down stream of the farm) Potential disease carriers in the environment 	<ul style="list-style-type: none"> Disinfection of equipments and production units Remove dead fish Quarantine Dry ponds Control other animals Eliminate wild fish Screen or filter water
Disease	<ul style="list-style-type: none"> Cause of the disease (infectious or non infectious) Non-infectious (is it nutritional, water quality related, genetic, pollutant, tumor, physical injury?) Infectious (is it caused by bacterium, virus, parasite, fungi; is the pathogen an opportunistic or an obligate pathogen; virulence of the organism) Possible sources of pathogen entry in to the farm (eg. Other infected fish, equipment on farm, snails, birds, etc) Methods of spread of the disease (eg. From one fish to another through contact, from parent to offspring via gametes) Source of entry of the pathogen in to the fish 	<ul style="list-style-type: none"> Lab diagnosis Eliminate predisposing factors Prevention, treatment and control measures for the disease Institute biosecurity measures

	(water, gills, nares, wounds, via feed) <ul style="list-style-type: none"> ▪ Severity and patterns of mortality (chronic, acute, sub-acute, per-acute, latent, etc) ▪ Clinic signs of the disease ▪ Factors that affect resistance of the fish to the disease (eg. Species, age, prior exposure) ▪ Environmental changes that enhance virulence of the pathogen and infection rates 	
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B. Non-infectious diseases

Non infectious diseases are a disease that caused by environmental problems, nutritional deficiencies, genetic anomalies or physical injuries. Such diseases do not spread from one fish to another and usually cannot be cured by medications.

i) Low dissolved oxygen syndrome

In production systems, dissolved oxygen (DO) levels can also suddenly drop to lethal levels or slowly over several days. When DO levels suddenly fall, fish immediately show signs of stress and /or mortality.

Gradual declines in DO over several days results in to diseases. These may includes:

- Overcrowding
- Low water flow or exchange rates
- Algae population crash: may be due to natural causes or because of deliberate treatment to reduce levels of algae in ponds and/tanks.
- Cloudy days: on cloudy days days algae respire; there is no photosynthesis so dissolved oxygen is used up rather than produced during the day.

a) Clinical signs

- Acute mortality
- Piping for air
- Gathering at inflow
- Fish non-responsive to external stimuli
- Death with operculum flared

b) Management of low dissolved oxygen levels

- Increase aeration

- Reduced feed rates
- Reduce fish density
- Manage algal blooms

ii) Excessive levels of dissolved carbondioxide

Hypercarbia is commonly associated with in recirculatory systems and hatcheries sourcing underground water. It is also observed where there is over-crowding, algal bloom crushes and poorly buffered water is use for production.

It occurs when water has low pH and levels of dissolved CO₂ exceeding 15mg/l.

High levels of dissolved CO₂ in water:

- Inhibit diffusion of CO₂ out of the blood
- High blood CO₂ reduces blood pH
- Reduces the ability of fish to get oxygen into blood

Fish consequently become weak, loose appetite, reduced growth and icreased susceptibility to disease.

iii) Temperature

- Sudden changes in temperature are extremely stressful for juvenile fish
- Fish need to be acclimated when temperature differences are greater than 3⁰C at rate of about 1⁰C per to avoid stress
- Deaths as a result of sudden temperature changes are not immediate. Mortalities begin to occur several days after sudden temperature changes.

iv) Low pH

- The optimum ranges of pH is 6.5 to 9
- Acute low pH causes acute mortality, acute stress and hypoxia
- Chronic low pH results in increased mucus production and chronic stress response
- Indirect effects of low pH include:
 - ✓ Increased toxicity to other water quality parameters
 - ✓ Some metals become more toxic at low pH(eg. Aluminium)

a) Clinical signs

- Hypotrophy and mucus production in gills

- Sloughing of cells from skin and gills
- Causes hypoxia
- Increased unionised ammonia at high pH

b) Treatment

- Change and add buffer to water
- In aquaria if pH is too high, add an acid such as muriatic acids (HCl) or acetic acids

v) Nitrite Poisoning: commonly associated with re-circulating systems

a) Clinical signs

- Brown blood in the gills and internal organs
- Signs of hypoxia even when DO levels are suitable
- Fish non-responsive to external stimuli

b) Diagnosis

- Measure nitrite levels with water quality kit

c) Treatment

- 25 to 50% water exchange
- Increase aeration
- Add nitrifying bacteria to bio filter
- Decrease fish density
- Reduce feedings
- Add common salt to water at the rate of 10 times chlorine per ppm nitrite

vi) Ammonia poisoning

The level of ammonium (non-toxic) and ammonia (toxic) in water are temperature and pH dependent.

a) Clinical Signs

- Hyper-exitability
- Fish stop feeding
- Is among the chronic causes of hypertrophy and hyperplasia of the gills

C. Nutritional fish diseases

This nutritional disease is a disease caused due to nutrient deficiency. Most nutritional diseases develop slowly over an extended period and are difficult to distinctly diagnose. The common nutritional diseases are:

i) Malnutrition/stunting

When fish do not get enough food (energy and protein) their growth becomes impaired, they are lethargic, poor body condition (thin) and are more susceptible to diseases. For their age, they will be much smaller-commonly referred to as stunting.

ii) Vitamin C deficiencies

The deficiency of Vitamin C are common on farm feeding on farm made feeds and when feeds are used after two-three months of the manufacturing date. The growth rate are poor, increased susceptibility of secondary infection and skeletal deformities are observed. Fish in ponds with good productivity rarely shows sign of vitamin C deficiency.

Control and treatments

- Add premixes to the feed
- Spray onto the feed stability forms of vitamin C or
- Chop finely or crush or mix greens in to the fish feed.

iii) Mycotoxins in feeds

They caused liver and kidney necrosis which progressively results into decreased growth and increased susceptibility to disease.

Preventive measures

- Keep feeds in dry, cool place and out of direct sunlight
- Ensure short turnover between batches of feed
- Avoid using or storing feed in metal or other containers that on which water can condense

1.2.3. Fish pests and predators

Fish pests and predators are the major sources of stress to fish. They cause stress and eventually losses. This can be through:

- Consume the fish in the pond
- Consume the fish's feed
- May transmit parasites and other infections to fish
- Scare the fish when they are chasing them up
- Cause physical injury to several fish in the process of hunting and
- Reduce fish carrying capacity

The most common predators are:

a) **Human beings:** Provide security to your premises by fencing off and keeping the place active

b) **Frogs and snakes**

The population of frogs and snakes can be controlled by keeping premises around clean and clear. Do not allow bushes to grow around the ponds. Water channels should also kept clean and clear. Screen the ponds as recommended. Screen within the water channels also help to reduce frogs' access to the ponds. Frogs tend to come in to pond areas via the water channels.

c) **Birds**

Wading birds such as the heron, marabou stock and hamakop walk into the pond to catch the fish. To control wading birds ensure the pond average water depths of 1 meters so that the birds are unable to stand in the pond. Diving birds such as the king fishery and ducks fly over or swim on the water surfaces then dive down to pick the fish. Tying string at close intervals over the pond prevents them from being able to fly away once they come down dive through the string. Avoid setting your ponds near places where birds can perch such as under telephone, or electric wires/poles, trees and etc. this provides a spot for birds of prey to sit, watch the fish and time when best to hunt them.

Do not leave dead animals or feeds, etc lying around ponds because birds may come to feed up on them. Dispose of all rubbish and carcasses by burying them away from the pond area. one may also train dogs on the farm to scare away birds.



Figure 1.1: Common predator wading birds

d) Alligators and corocodiles

All crocodilians are predators, and they have large, strong jaws with numerous sharp teeth for gripping their prey. Crocodiles do not have cutting teeth. If they capture prey that is larger than they can eat in a single gulp, it is dismembered by gripping strongly with the teeth and rolling their body to tear the carcass. Some crocodiles will opportunistically cooperate to subdue a large mammal, and then to tear it into bits small enough to be swallowed. Corocodiles are semi-aquatic animals and hunt both animals in water and on land. They mostly eat fish, insects, and crabs. The corocodiles eat larger fish, and hunt vertebrate prey such as deer, capybaras, monkeys, birds, caimans, and even other smaller crocodiles. They are an opportunistic species and will typically eat anything that they find in their habitat.

e) Lizards and others

Clear the bushes around so that they have no nesting close by. Set traps to catch monitor lizards and other amphibians.

1.2.3.1. Control methods of pests and predators



As to minimise the risk of wildlife, scavengers, vermin, and pets transferring pests and disease onto, within or from the farm, the following practies recommended. These are:



- Control or exclude predators, wildlife, vermin and other organisms (e.g. aquatic life) from land-based systems
- Control, exclude or prevent aggregations of predators, wildlife, vermin and other organisms (e.g. aquatic life) from open water systems
- Regularly inspect farms for biosecurity breaches or signs of potential breaches and remedy as required
- Keep records of any presence of wildlife and vermin, or biosecurity breaches and any preventive or corrective actions taken.
 - Firearms and power heads
 - Air guns and other auditory measures
 - Scare lines and kites
 - Traps
 - Netting, fences and exclusion devices, barriers (mechanical, electrical)
 - Biological (such as hawks, dogs)
 - Human activity
 - Cleaning and disinfection of fish farm

1.3. Materials, tools and equipment

The necessary materials required for handling, transporting and maintaining water quality for fish are listed with their function in table below (table 1.8). However, for the biosecurity of the fish the materials tools and equipments must be cleaned and disinfected before and after using it properly. So, use warm water and detergent to clean materials, tools and equipment and then dry them. It is important to know that some disinfectants will not work effectively in the presence of dirt and organic matter such as fish mucus. Equipment must be thoroughly washed before applying disinfectant and sun dry to eliminate remaining bacteria or viruses. Most detergent-resistant bacteria and viruses can be killed with a broad-spectrum disinfectant such as sodium hydroxide, formalin, chlorine, iodine, or a peroxide product. Consult with your veterinarian to determine the best choice of cleaning and disinfecting agents to use on your farm.

Table 1.9: Materials, tools and equipment

No.	Items	Function	Picture
	Fish net	Used for harvesting fish	
	pH meter	Used to measure the pH of water	
	pH meter	Used to measure the pH of water	
	Dissolved oxygen meter	Used to measure the level of dissolved oxygen in water	
	Salinity meter	Used to measure the salinity of water	
	Ammonia test kit	Used to measure the level of ammonia in a water sample	
	Nitrate test kit	Used to measure the amount of nitrite in a water sample	

	Secchi disk	It is used to measure the turbidity of water	
	Thermometer	Used to measure the the temperature of water	

Procedures for cleaning tools and equipments:

To clean the fish farm tools and equipment follow the following procedures:

- Remove all visible debris or organic material
- Apply detergent / degreasing agent and leave for 15 minutes (or longer according to label instructions)
- Rinse off with clean water
- Apply appropriate disinfectant at recommended concentration and leave to penetrate for the period recommended by the manufacturer
- Rinse with clean water
- Recording









1.4. Personal Protective Cloths


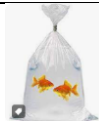
Personal protective equipments are the most important thing in maintaining workers and fish biosecurity by protecting disease transmission from fish to worker and vice versa. Thus, every worker working with fish must wear suitable PPE while working with fish. However, it can be a rout of disease transmission if not cleaned and disinfected before and after use and stored properly. Therefore, cleaning and disinfection all PPE will help to limit spread of disease for personnel who work in both ponds with diseased fish and ponds with healthy fish. The PPE equipments can be disinfected either by using warm water or chemichals or both. The common PPE for working with fish farm are listed in table below.

Procedures for cleaning PPE

- Clean with soapy water
- Rinse and soak in bleach or Virkon® (as per instructions).
- Rinse
- Dry

Table 1.10: Personnal Protective equipments

No.	Items	Function	Picture
A	PPE		
1	Gloves	Used to protect hands against damages	
2	Boots	Used to protect foots against damages	
3	Footbath	Used to control diseases from the farm	
4	Sunhats	Used to protects sun from heads	
5	Sunglass	Used to protect eyes against sun	
7	Overalls	Used to protect the bodys against damages	
8	Raincoat	Used to protect the body against rain	
9	Wader	Is a water proof boots used to protect foots against damage and water	

11	Life saver jacket	Is used to worn during fish harvesting as to minimize waater risks	
12	Oxygen plastic bags	Used to transport live fish	

1.5. Hazard and risk control measures and procedures

1.5.1. Hazards and types of hazards

Hazards and risks related to aquaculture can be categorized into occupational, environmental and food safety and public health. Each of the different types of hazards has other components such as biological and chemical. The culture fisheries industry has diverse workplaces with individual peculiarities. The hazards in aquaculture can be classified into:

- 1.** Physical
- 2.** chemical and
- 3.** biological hazards

B. Physical hazards

There are several physical risk factors in the culture fisheries industry. Farm hands and other workers in aqua farms are susceptible to many injuries in the course of their work. The fish farmers in the informal sector are more vulnerable, governments in developing countries have an apathy to occupational health and safety issues. All the stakeholders-farm management, workers and governments do not appreciate the problems that can be solved or mitigated through occupational safety and health. The list of physical hazards is as follows:

i. Noise

Feed mill workers (especially those that operate with locally fabricated machines in the developing countries) are exposed to excessive noise. The harmful defects to noise: hearing defects, hearing loss and mental fatigue.

ii. Injuries

Farmers are exposed to diverse injuries such as:

- ✓ **Sting from fish spines:** This arises during fish handling without appropriate safety devices. It may cause severe pains and can result to tetanus infection or wit low.

Cuts, sprain, fracture, etc: sharp implements/object such as knives, oyster shells, falls and other predisposing factors can cause these injuries. Hatchery workers are also exposed to the risk of needle stick injury which can open a gateway to many viruses and other diseases.

iii. Occupational asthma and rhinitis

Feed mill workers are at risk of contracting these diseases. Karkkainen (2002) observed that the greatest risks occur in the foodstuffs and agricultural sectors. He attribute dust released from flour and animal feed mill as the second most common cause of asthma.

iv. Snake bites, crab clawing and bites from fish

Snake bites and bites from fish such as tiger fish, snapper, etc are hazards workers in earthen pond fish farms are exposed to, especially when they are not using appropriate protective gear. This is prevalent in rural fish farming.

C. Chemical hazards

Use of chemicals in ponds and laboratories constitutes considerable risk to the environment. These chemicals can become disruptive and when they find their way into natural aquatic systems they can cause irreparable damage to the ecosystem. Chemicals such as fertilizers, pesticides, antifoulants (forcages), chemotherapeutants are all considered risk factors in the environment. Culture fisheries practitioners are exposed to chemical hazards through the following routes:

i. Constant use of chemicals

This includes inorganic fertilizers which are used extensively in enriching fish ponds. Others are lime, pesticides, formaldehyde, etc. Some of these are caustic and can cause severe burns or skin irritation resulting in severe cases of occupational dermatitis. Some laboratory chemicals are hazardous and Inhalation may lead to development of respiratory ailments such as bronchitis, rhinitis and asthma (Uronu and Lekei, 2004). Direct contact with these chemicals could result in burns, skin irritation and allergies.

It has been observed that laboratory workers that have prolonged exposure to organic solvents such as chlorinated hydrocarbons, alcohols, ester, ketone, etc. are at risk of brain and nervous system damage.

The symptoms include premature ageing, memory impairment, mild depression and anxiety. Karkkainen (2002) has also attributed the following symptoms to formaldehyde poisoning: allergic dermatitis asthma and rhinitis.

ii. Flocculants

These are applied to ponds to precipitate suspended clay particles. Examples are aluminium sulfate (alum), calcium suilhate (gypsum).

iii.Acute and chronic pollution of water ways

Pesticides, oil spills, and other xenobiotics can pollute ponds and water sources which can also pose risks for workers that work in such farms.

iv. Disinfectants

These are used to disinfect equipment and holding units e.g. formalin hypochlorite, etc.

v. Fumes, smoke and soot

Fumes from water pumping machines feed mill and other machines; and smoke inhaled by workers smoking fish or drying feed are considered serious health risks. These are associated with asthma, cancer and other serious ailments.

D. Biological hazards

These biological hazards include parasitic infestation and pathogenic infections.

i. Parasites

A wide variety of parasitic organisms have been reported as causing significant problems in grouper aquaculture. In the hatchery and nursery stages, parasitic diseases of groupers are caused predominantly by protozoans, particularly the ciliates. When grouper fry are transferred to grow-out facilities, they are subjected to handling and transport stress. These fish often carry a large variety and high intensity of ciliated protozoans, skin and gill monogeneans and caligid copepods. Protozoans are one-celled microscopic organisms with specialized structures for movement, food gathering and attachment. They can be external or internal parasites. They can multiply on or within their hosts.

ii. Pathogens

Pathogens are microorganisms that have the potential to cause infectious diseases. Viruses, bacteria, protozoans and fungi are all potential pathogens.

The different types of pathogens and the severity of the diseases that they cause are very diverse. Viruses, bacteria, protozoans and fungi are all . Most pathogens are able to avoid the immune responses of the host, triggering associated illnesses.

The pathogen then utilizes the host body's resources to replicate before exiting and spreading to a new host (like a virus). Pathogens are of different types and can spread through various means usually skin contact, body fluids, or contact with contaminated surfaces. Some pathogens exist as airborne particles. The most common types of pathogens are viruses, bacteria, and fungi.

1.5.2. Risks in fishery production

a) Drought

The intensification of climate variability and change has an impact natural resources like fisheries that are sensitive to climate. Fisheries are affected by decrease in average river runoff, shifts in precipitation and consequent change in the timing of peak river flows and changes in flood and drought frequency and intensity. Aquatic productivity processes are affected through effect on nutrient and dissolved oxygen circulation, primary and secondary production, alteration in food-webs, and shifts in fish communities and fisheries. Evidence of impacts of climate variability and change on fisheries resources has been observed with changes in fish species diversity, size and composition, species distribution, possible species extinction and reduced productivity. Therefore, the fishery pond site must be against runoff.

b) Flood

Flooding is usually considered a significant natural hazard causing disease, damage and loss to life, property, and infrastructure as well as disruption of public services. For example, floods can cause dangerous landslides, loss of crops and livestock, disruption of normal drainage systems, spillage of raw sewage and animal waste, and accelerated discharge of industrial and urban toxic materials, and nutrients into waterways. Because of their dramatic effects on people and infrastructure, the effects of flooding on aquatic ecosystems are often viewed as negative; however, this is not always the case.

Flooding can also provide many benefits, including recharging groundwater, increasing fish production, creating wildlife habitat, recharging wetlands, constructing floodplains, and rejuvenating soil fertility. Since the effects of flooding on aquatic ecosystems can be both negative and positive, ecosystem services should also exhibit a mix of negative and positive outcomes resulting from flooding.

c) Earthquake

An earthquake is the sudden, rapid shaking of the earth, caused by the breaking and shifting of subterranean rock. Initial mild shaking may strengthen and become extremely strong within seconds. Additional earthquakes, called aftershocks, may occur for hours, days, or even months.

Most are smaller than the initial earthquake, but larger magnitude aftershocks can also occur. Earthquakes can cause power outages or tsunamis. Earthquakes can happen at any time of the year and occur without warning. Once, it happened it damage and loss to life, property, and infrastructure as well as disruption of public services.

1.5.3. Control measures of hazards and risks in culture fisheries

The principles for controlling hazards in culture fisheries will include the identification of hazard, control of the hazard and monitoring of the effectiveness of the controls. This paper has identified the risk factors and hazards in the section above. In this section, control measures to reduce or minimize culture fisheries risks would be proffered. As stated earlier, ignorance on the part of workers and the apathy of employers and government agencies to their plight have caused preventable fatalities. Production of safe foods from aquaculture is, therefore, the shared responsibility of governments, industry and consumers, each having an important role to play in the protection of human health. Action at all levels is required for the development of regulations and the provision of resources for enforcement of, education and training in, and research on, responsible practices of culture fisheries. The recommend control measures of hazards and risks are discussed as follows:

i) Apply good fish husbandry practice

Excellent fish husbandry practices are very important for sustaining fish. The common fish husbandry practices are discussed as below.

a) Routine observations

All fish should be observed for signs of disease including changes in feeding response, other behavioral changes, changes in physical appearance including eroded fins, changes in color, bloody areas, exophthalmia (pop-eye), bloating, scale loss, increased mucus in the system, masses, and grossly visible parasites.

b) Feeds and feeding of fish

- All feeds entering the farm should be assessed for biosecurity risk and appropriate action(s) taken to address identified risk(s)
- Source feeds from reputable suppliers to ensure they provide assurances of quality and content
- Ensure any feed containing aquatic organisms is adequately treated to ensure safe product
- Store feeds in designated areas (e.g. clean and dry) to avoid contamination and reduced feed quality
- Regularly inspect feed to check for the presence of mould, vermin, and other undesirable organisms.

c) Water quality management

- Allow fresh water into fish tank daily
- Change water when you observe foaming or frothing, deep green or gray/black coloration, accompanied by foul odour/rotten eggs smell (Hydrogen sulphide)
- When fishes are swimming sluggishly, they are stressed, stop feeding and change water.
- Boil animal products before introduction into tanks
- It must not be too acidic or too alkaline (pH 6.5-9.0)
- It must contain enough dissolved oxygen. The dissolved oxygen level should be between 4-8 mg/litre and measures through use of secchi disc/hand
- It must be free of pollutants such as industrial waste (effluent, detergents and herbicides)
- The desirable water temperature level varies between 21°C – 32°C.

d) Stock health management

The fish stock health should be maintained to optimum levels using the following recommendations

- Keep stock stress to a minimum
- Maintain optimum water quality levels
- Maintain appropriate stocking densities
- Provide appropriate diets and nutrition
- Avoid unnecessary or rough handling of stock
- Keep transfers within or between farms to a minimum
- Monitor stock frequently
- Remove dead or dying stock from remaining stock as soon as practicable:
 - ✓ A veterinarian or aquatic health professional should be contacted as soon as possible to conduct testing
 - ✓ Store dead animals for testing in a biosecure manner
 - ✓ Dispose of sick (moribund) or dead animals in a biosecure manner (i.e. that is not accessible to other stocks, wildlife, vermin, or pose a hazard to the environment or human health)
 - ✓ Increase inspection frequency during periods of higher risk, such as elevated water temperatures or known problems elsewhere
 - ✓ Keep accurate records of all instances of pest occurrence, suspicion of disease and deaths and any treatments administered
- Monitor and keep records of all aspects of stock health management (e.g. water quality parameters, stocking densities, handling events, growth and feed conversion ratios).
- Use footbath to at the to minimize the risk of diseases
- Clean and disinfect all equipment, vehicles and vessels entering the farm for biosecurity risks

e) Staff and visitors management

Employees and visitors can easily spread disease-causing organisms on their shoes, hands and arms by immersing themselves in pond water, or handling animals or equipment in one pond and failing to disinfect themselves before handling fish, water or equipment in another pond. Disinfection stations for footwear and hands and access to showers and changing areas will help

limit spread of disease for personnel who work in both ponds with diseased fish and ponds with healthy fish. Assess all staff and visitor access to farms for biosecurity risk and ensure that risk is managed by taking appropriate action(s). Refusal of entry should be considered for high risk visitors

f) Record keeping

Recording all information necessary to trace and determine the origin of pest or disease in the event of an outbreak. So:

- Maintain records to trace stock, and their associated health status, onto, within or from the farm
- Maintain records for all aspects of the biosecurity plan (e.g. staff training, inspection and maintenance of farm infrastructure and equipment, visitor logs)
- Other records that should be maintained include, but are not limited to:
 - ✓ All stock transfer on to, within, and off your farm
 - ✓ stock health
 - ✓ purchases and sales
 - ✓ monitoring and surveillance activities
 - ✓ testing and declarations
 - ✓ stocking densities
 - ✓ stock performance
 - ✓ feed schedules
 - ✓ environmental parameters e.g. water and air temperature, water quality, pH, rainfall, dissolved oxygen levels
 - ✓ stock disease and mortalities
 - ✓ treatments and vaccinations administered
 - ✓ cleaning and disinfection procedures
 - ✓ breaches in containment
 - ✓ security breaches (intruders and thefts).

Self-Check-1	Written test
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Name: ID: Date:

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choose the best answer (12Points)

2. One of the following is infectious disease
 - b) Viral b) bacteria c) fungal d) parasites e) all f) none
3. The hazards in fishery and aquaculture is:
 - a. Physical b. Chemical c. Biological d. All
4. One is the common risks in fishery and aquaculture is:
 - a. Drought b. Floods c. Earthquake d.all
5. One is hazard and risk control procedures:
 - a. Apply good fish husbandry practice
 - b. Cleaning and disinfection of fish farm
 - c. Elimination (shooting or chemical poisoning)
 - d. All
6. One is fish predator control methods
 2. Firearms and power heads
 3. Air guns and other auditory measures
 4. Traps
 5. Netting
 6. All
7. The predators can affect the fish through one of the following
 - a. Consume the fish in the pond
 - b. Consume the fish's feed
 - c. transmittind parasites
 - d. Reduce fish carrying capacity
 - e. All
 - f. None

Part II. Give Short answers for the following questions

- a) What is the difference between infectious and non infectious fish disease?(5pts)
- b) Discuss the control methods of infectious and non infectious fish disease(5pts)
- c) Discuss the control methods of fish paracites and predators (5pts)
- d) Discuss the importance of PPE and its role in ensuring fish biosecurity (5pts)

Operation sheet 1

1.1. Cleaning and disinfecting PPE

6.2.2.1.1. Required materials tools and equipments

7. PPE
8. Water
9. Soap
10. Disinfectants (200 ppm iodine, sodium hypochlorite solution)
11. Bathtub

B) Procedures of disinfecting

- Wear Personal Protective equipment properly
- Identify PPE to be cleaned and disinfected
- Prepare the required materials tools and equipments
- Clean with soapy water
- Rinse and soak in bleach or Virkon® (as per instructions).
- Rinse with clean water
- Dry
- Store in place

1.2. Inspecting, identifying and reporting fish diseases from farmed fish

A) Required materials, tools and equipments

- Fish farm
- Disease identification checklist
- Paper
- Pen
- PPE

B) Observation checklist

Elements of observation	Observation results (you are expected to write all what you observed in respect to elements of observation)
Feeding intake	
Activity of the fish	

Body color	
Body surface	
Body shape	
Fish organs	
Your general recommendation	

1.3. Inspecting, identifying and reporting fish predators

A) Required materials, tools and equipments

- PPE
- Fish farm
- Pest and predator identification checklist
- Paper
- Pen

B) Observation checklist

Sn		Existing frequency			Its impact on fish
		Daily	Somethimes	Seasonal	
A	Fish predator				
1					
2					
3					
4					
5					
6					
7					
8					
9					

LAP Test-1	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hour. The project is expected from each student to do it.

Task 1: Clean and disinfect PPE

Task 2: Inspect, identify and report fish diseases from farmed fish

Task 3: Inspect, identify and report fish predators

LG#11

LO2: Apply biosecurity control measures

Instruction sheet-2

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Controlling measures of transmission routes
- Controlling measures of vectors
- Controlling measures to farm production practices
- Performing routine work and taking responsibility
- Identifying treatment measures

Treatment measures This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to understand:

- Control measures of transmission routes
- Control measures of vectors
- Control measures to farm production practices
- Perform routine work and taking responsibility
- Identify treatment measures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-2

Introduction

The essence of biosecurity control measure is to prevent the entry, exposure and spread of fish pathogens, particularly those that are infectious and have public health or negative environmental consequences. The development agents should be aware of requirements to implement biosecurity control and support producers at farm level.

2.1. Control measures of transmission routes

The movement of fish onto, within or off the farm is the greatest risk factor for disease introduction and spread in aquaculture. New fish brought to the farm for breeding, grow out or restocking may introduce pathogens to resident fish. This may include purchased fish (if not inspected) or eggs (if not disinfected), as well as wild stocks. Fish that have been taken off-farm and then returned may also pose a disease risk, especially if they have been co-mingled with other fish. Keep in mind that for some diseases, fish may be infected without showing signs of illness. These carrier fish can then serve as potential sources of infection to other fish.

2.2. Control measures of vectors

Understanding how fish diseases are spread, helps to identify necessary biosecurity measures. Fish diseases can be spread between fish by direct contact, ingestion (oral), water sources, fomites, and vectors. Not all pathogens are transmitted by all routes; some may be spread by multiple routes. Thinking about diseases (and subsequent prevention) in this manner can help to prevent and protect for a number of diseases versus addressing each disease individually.

Less commonly, fish diseases may be spread by vectors. Vectors are living creatures, such as fish-preying birds, that can spread disease pathogens. These animals may transfer fish diseases between locations by carrying the pathogen on their body or feet, or by dropping fish or fish parts at other locations. Rodents may also carry fish pathogens on their body or in their feces or urine, contaminating the environment or fish feeds. Domestic animals (such as pets running around the farm) may also serve as crosscontamination mechanisms for some pathogens. People can serve as vectors by transferring pathogens to fish during handling (e.g., hands). While not a

route of transmission to fish, zoonotic diseases are those diseases of fish that can be spread to humans, to cause illness. Examples include a number of bacterial organisms – Mycobacterium, Erysipelothrix, Klebsiella, Edwardsiella. Biosecurity measures should also address any zoonotic risks to you or your employees as well as the risk to your fish stocks.

i. Direct contact of fish

The direct contact of fish is one of the most common routes of disease transmission in aquaculture. This involves the transfer of disease causing agents through contact with infected fish. Entry may occur through the skin, open wounds, mucous membranes, or gills. Infectious microorganisms can be found on the mucus layer of fish as well as occur from seeping lesions. Some pathogens are spread from female fish to her eggs (vertical transmission). Entry into the susceptible fish can occur through the skin, open wounds or gills.

Disease pathogens can also be transmitted orally by consumption of contaminated feed, infected live or frozen fish, or cannibalism of dead or dying fish from the same unit. The ingestion of intermediate hosts for some pathogens (e.g., snails infected with parasitic organisms) can lead to the oral transmission of fish pathogens. Ingestion of water contaminated with waste products from infected fish may also serve as a transmission route. so, the health conditions of the fish must be inspected three times a day against sign of disease.

ii. Water sources

Many disease causing organisms can be transferred through water sources (e.g., surface water sources). Use pathogen-free water sources, such as well, springs, or other groundwater sources when possible. Surface water sources should be avoided as they have a greater potential for carrying fish pathogens. Infected fish can contaminate the water sources they are living in. Contamination occurs from the urine, feces, reproductive fluids and mucus of infected fish. Movement of this contaminated water during the transport of fish can spread pathogens to new locations. A few fish pathogens (e.g., Ichthyophthirius multifiliis (ICH)) have been found to spread via aerosols, sprays or splashes between tanks. This is less common and typically requires close proximity of sources

The safest water for fish production is water pumped straight from a well to the pond. Water that is recirculated or reused on the farm for different batches of fish is not likely to be the source of new diseases, but it may enable existing pathogens to accumulate in either the fish or in intermediate hosts held in the reused pond water. River water is the least desirable source of water for fish farming because it is likely to contain pathogens not already present on the fish farm. If river water must be used, pump it through a fine filter and hold it in fish-free ponds for at least 21 days before using it. This will interrupt the life cycles of parasites that cannot survive without a suitable fish host. Holding fish-free water in a reservoir before use will also give any bacterial or viral pathogens time to deteriorate in the absence of a suitable host. Specialized water treatment facilities that incorporate ozone treatment and ultraviolet light sterilization processes can be used to disinfect river water. However this technology is expensive and is economically feasible only if the farmer is producing a high-value fish product. However, the water supply for fish farm should be assessed for biosecurity risk and appropriate action(s) taken

iii. Controlling animals

A number of animals that live in or move around fish ponds can carry fish diseases. Of these, birds are the greatest concern. There is evidence that birds can transmit bacteria and viruses through their droppings. Birds can also drop fish from one body of water into another. Several species of fish-eating birds can carry the life stages of parasites (trematodes or “grubs”) that infest snails in culture ponds and then develop into parasites of fish. To reduce this problem, use the most effective legal means of discouraging birds from visiting farm ponds.

iv. Cleaning and disinfecting equipment

Fish diseases are easily transferred on wet, slime-laden or muddy equipment. In fact, exposing fish to fresh slime is almost as risky as exposing them to new fish. Drying equipment such as seines before each use kills many fish pathogens. Better yet, use warm water and detergents to clean equipment such as buckets, boots, waders and vehicles and then dry them. Transport trucks and other vehicles can be cleaned easily with a high-pressure hose at the local carwash. For the best results in killing pathogens, you must clean, disinfect and dry equipment before it is used else where on or off the farm. This is especially critical for equipment that has been used to handle, harvest or transport sick fish.

It is important to know that some disinfectants will not work effectively in the presence of dirt and organic matter such as fish mucous. Equipment must be thoroughly scrubbed clean with a brush and detergent and then rinsed to remove any dirt and detergent residue. Then an appropriate disinfectant should be applied and left on the equipment long enough to kill disease organisms. Rinsing after disinfection ensures that no residues are left behind. Drying equipment in the sun will destroy bacteria or viruses that may have survived. The choice of chemical cleaner or disinfectant is critical. Consider the type of disease organism you are trying to control and the type of equipment you are disinfecting, as well as the cost and safety of the chemical.

v. Manageing staff and visitors

Especially those coming from areas where they may have been exposed to fish diseases (e.g. other farms or areas with known disease outbreaks), may serve as vectors for the introduction of disease. These individuals should take measures to minimize the potential risk of disease transfer. This includes wearing clean coveralls and disposable or disinfected rubber boots while on the farm. Maintain a log of visitors to your farm. All visitors on your farm should be accompanied by farm personnel during their visit. When possible, these individuals should avoid animal areas and be restricted from contacting and handling your fish (unless absolutely necessary).

2.3. Control measures to farm production practices

The impact of fish diseases may result in the direct losses due to illness or mortalities; however, effects may be more indirect such as a decrease in production (e.g., reduced growth rates, feed conversion efficiency, or product quality). Optimum health of fish is essential and greatly improves their ability to fight off infection. This is achieved by minimizing stress, maintaining appropriate water quality parameters and proper nutrition, removing potential infectious disease sources, and monitoring and maintaining fish production and health records.

a) Minimizing stress

The susceptibility of fish to disease is greatly influenced by stress. A number of parameters in aquaculture can increase stress in fish, including high stocking densities, improper water quality parameters and poor nutrition. Minimize stress in your fish by keeping stocking densities within

acceptable parameters. Limit transfers of fish between units or locations when possible. When moving fish, use gentle crowding and fish handling methods.

b) Maintain optimum water quality

Fluctuations or improper maintenance of water quality parameters can predispose fish to disease. This includes temperature, as many fish pathogens have an optimum temperature range for infectivity and fish immune systems are influenced by water temperature (less effective at lower temperatures).

c) Provide proper nutrition

Store feed in a cool, dry place and use within 3 to 6 months. This serves to maintain vitamin and mineral stability in the feed as well as reduce the potential for moldy feed. Keep feed in areas secured from vectors (e.g., rodents, birds). Clean up any spilled feed to avoid attraction of birds or rodents. If live fish are used as feed, be sure to obtain healthy fish from reliable sources.

d) Remove dead or dying fish

Monitor fish frequently for disease. Employees should know the major signs of illness in fish and who to contact when these are noted. Early identification of fish diseases can help minimize its spread and impact on your farm. Ill or dead fish should be removed immediately as they can serve as potential diseases sources to the remaining stock. Dying fish should be promptly and humanely euthanized. Disposal should be in accordance with local and state laws and in a manner that predators or wild birds cannot access carcasses and further spread the disease. Sick fish should be removed and placed in an isolated area away from current fish stocks. This area, similar to quarantine, should have dedicated equipment and water sources. Care or treatment of these fish should occur after healthy resident fish or by an employee solely dedicated to this area. When signs of illness are noticed, contact your aquatic veterinarian or fish health specialist immediately. Necropsy and testing of ill fish can help identify a potentially infectious disease before it becomes widespread on your farm.

e) Keep accurate records

Maintenance and monitoring of fish production and health records can help to detect disease problems and highlight their severity (e.g. sudden versus gradual increases in death rate) and

often provides clues for disease diagnoses. Maintain accurate records of fish illnesses or deaths. Keep records on fish production parameters, such as growth and feed conversion ratios to aid in detecting subclinical disease problems. Record all new introductions or returning fish, their sources, and movements on or off the farm. This can help identify potential disease entry points in the event of a disease outbreak. Maintain records of any treatments or vaccinations or prior disease situations.

f) Use foot dips

Foots dips should be placed near the entrance to animal areas. Boots/waders should be cleaned and submersed for an appropriate period of time (see disinfectant product label) prior to and after leaving the area. Foot dip solutions should be changed daily or when visibly soiled with debris.

g) Use of PPE

Employees should wear clean clothing/coveralls and footwear when working with fish and wash or sanitize their hands when moving between areas. Foot dips for disinfecting footwear should also be used between these areas. Employees should perform tasks in areas from lowest risk to highest risk (e.g, inside tanks to outside tanks), from most susceptible to least susceptible populations (e.g., fry or fingerlings to adult). Personnel should save quarantine/isolation work for last. Access to egg incubation and fry facilities should be restricted to a minimum number of well-trained individuals

h) Clean and disinfect of equipments

Vehicles and equipment should not be shared between sites; if possible dedicated equipment or vehicles should be used. If this is not possible, these items should be cleaned and disinfected between fish lots or farms. Any residual water or debris should be removed; bilge water from boats should be removed and disinfected. Vehicle cleaning should include the wheel wells, tires and undercarriage. Wash stations should be provided onsite away from animal production areas.

Any equipment used at aquaculture facilities should be cleaned and thoroughly dried (preferably in direct sunlight) or chemically disinfected before being used in another location. Fish production tanks, raceways and ponds should be disinfected between each lot of fish. Many disinfectants can be lethal to fish, so thorough rinsing (away from production areas) and/or

neutralization (e.g., sodium thiosulfate for chlorine products) are necessary to remove any toxic residues. If possible, allow the item to thoroughly dry before re-using them with fish or at different locations. Drying, especially in direct sunlight, can also be effective at destroying a number of fish pathogens. There are a number of chemical disinfectants available that are effective against fish pathogens. Some can be toxic to fish, so should be used with caution or in areas away from live fish.

Cleaning and disinfecting procedures

The cleaning and disinfection process outlined below is recommended for all aquaculture sites:

1. Remove all visible debris or organic material
2. Apply detergent / degreasing agent and leave for 15 minutes (or longer according to label instructions)
3. Rinse off with clean water
4. Apply appropriate disinfectant at recommended concentration and leave to penetrate for the period recommended by the manufacturer
5. Rinse with clean water

i) Vaccination

Modern vaccines can be classified as killed, attenuated, DNA, synthetic peptide, recombinant vector, genetically modified, and subunit vaccines. Whole organism vaccines showed a better advantage than other types of vaccines. However, most of the vaccines do not completely prevent disease. The antigens are weak in most conventional vaccines that they cannot induce immunity in the recipient. In addition, they may not be easy for development to prevent emerging pathogens, the presence of antigenic shift and antigenic drift, during immune evasion of the host by pathogenic organisms, and microbes which cannot be grown by in vitro propagation, and development of these vaccines is a slow and time-consuming process, which sometimes poses difficulty in timely countering of emerging and reemerging pathogens. That is why advanced technologies of vaccine designing strategies are developed for the discovery of newer types of effective vaccines.

2.4. Perform routine work and taking responsibility

The roles of biosecurity response personnel may vary depending on the incident and even during the same incident. The number of personnel and the command structure are dependent on the size, duration, and complexity of the incident. Large scale incidents may involve multiple premises and cover large areas. As the response progresses personnel requirements may change. All roles and responsibilities may be designated to available and qualified personnel as needed.

2.4.1. Biosecurity group supervisor

The Biosecurity Group Supervisor is assigned to the Incident Command Post (ICP) and supervises all Biosecurity Teams (Strike Team or Task Force) and Biosecurity Team Members. Individuals selected as Biosecurity Group Supervisors are trained before an animal health emergency occurs.

The Biosecurity Group Supervisor does the following:

- Coordinates and creates a site-specific biosecurity plan and submits it to the Incident Commander for approval.
- Consults with biosecurity team leaders to assess the need for biosecurity personnel, vehicles, and equipment during a response.
- Determines the number and type of personnel and resources needed to conduct biosecurity operations.
- Communicates with the operations section chief to ensure availability of resources and advises the Operations Section Chief of personnel requirements that cannot be satisfied locally so that arrangements for additional personnel can be made.
- Verifies the credentials, training, and security clearances of all personnel assigned to the biosecurity group.
- Works with appropriate officials to issue contracts and leases regarding equipment or personnel for the biosecurity operation.
- Appoints biosecurity team leaders and assigns personnel to biosecurity teams
- Identifies personnel training requirements and ensures that responders receive the appropriate orientation training upon arrival at the Incident Site
- Ensures all biosecurity personnel receive training on the routes of pathogen transmission and measures to reduce the risk of pathogen transmission

- Ensures that biosecurity team leaders perform their tasks in accordance with established biosecurity policies and procedures
- Establishes and maintains effective working relationships with industry groups and producers, including producer groups, processing plant leaders, renderers, feed-mill operators, transportation company representatives, and other stakeholders
- Prepares regular briefings and reports.

2.4.2. Biosecurity team leader

The Biosecurity Team Leader does the following:

- Assists the Biosecurity Group Supervisor in creating a site-specific biosecurity plan
- Helps determine the number and types of resources needed to effectively and efficiently perform biosecurity and disease prevention activities.
- Assigns and supervises Biosecurity Team Members.
- Establishes a communication system between Team Members and the Team Leader.
- Assists the Biosecurity Group Supervisor with training personnel.
- Assists Biosecurity Team Members with their specific duties and biosecurity policies and procedures.
- Ensures that all personnel follow biosecurity measures and biosecurity measures are implemented for all people, animals, vehicles, equipment, and other materials entering or leaving the Control Area (CA).

2.4.3. Biosecurity team members

The biosecurity team members do the following:

- Brief the owner, the owner's family and premises' employees about hazards associated with the emergency
- Increase biosecurity awareness and ensure compliance with established movement restrictions.
- Coordinate activities with teams from other groups
- Monitor the disposal, laundering, and cleaning of contaminated materials (for example, disposable or reusable uniforms, coveralls, shovels, and boots)

- Monitor the inventory of biosecurity-related supplies on hand (for example, disinfectants, uniforms, footwear, and sprayers) and notify the Biosecurity Team Leader of any supply needs.

2.4.4. Worker responsibility

The worker must do the following:

- Maintain footbaths
- Monitor disposal, laundering, and cleaning of contaminated materials (for example, disposable uniforms, cloth overalls, shovels, and boots)
- Mix and provide disinfectants for handheld sprayers
- Monitor supply inventory related to biosecurity (for example, disinfectants, uniforms, footwear, and sprayers); and
- Coordinate with operations staff to ensure that supplies are adequate for field personnel.

2.5. Treatment measures

Treatments are only given to help to reduce the severity and other negative impacts of disease by interrupting an infectious process. Treatments supplement the fish's natural immunity. They are not a substitute for good husbandry. The treatment could be anti bacterial, anti parasitic agents, vaccination and anesthetics.

2.5.1. Treatment measures

a. Liming

Liming to sterilizing ponds and other facilities. Hydrated lime (Calcium hydroxide) is used to disinfect production ponds and other units. It does this by causing rapid rise in pH to 12 or higher, a level which kill most disease agents and/ or pests. Drain and clean ponds or premises prior to application. Enough hydrated lime should be added to cover the entire pond bottom with thin layer and then water added. This elevated pH will last for about a week. Do not stock fish during this period.

Also note:

- Always check the pH before stocking

- The use of hydrated lime is recommended when there is concern of carrying disease or pests to the next crop
- Do not add hydrated lime when fish are presented in a pond or tank. The rapid increase in pH is almost always lethal for fish.
- Hydrated lime is strong base. Care should be taken when applying it to breathing the dust or allowing contact with skin or eyes.

Recommended liming rates

During production, acidity level of water can be deduced by the pond's response to fertilization and fish behavior. Use litmus paper, pH meter or water quality test kit to assess the level of acidity and estimate lime requirement. About 150-200kg/ha agricultural lime may be adequate.

Application of lime to ponds

In empty ponds, spread the lime uniformly over the pond bottom. Ponds might require liming during production. This is more likely to happen where ponds are made from permeable acid soils with high seepage rates. In such case mix the lime with water and then sprinkle over the pond.



Figure 2.1: Application of lime before filling the pond water

b. Water treatment

Good water quality is critical to the health of the fish and to the control of pathogens. System water quality and water chemistry parameters should be compatible with the species in culture and should be monitored closely for any deviations from the ideal. In water maintaining water quality, the treatments may be added to water, to improve water quality in extreme cases, particularly during live transportation during which the possibilities of water exchanges are minimal. The treatments may include alum, zeolite, rock salt and salts.



Figure 2.2: Water treatment

c. Antibiotic treatment of fish

Antimicrobial agents can be defined as substances that have the capacity to kill or inhibit the growth of microorganisms. Antibiotics have become essential drugs for human and animal health and welfare. Antibiotics can be derived from natural sources or have synthetic origins. Antibiotics should be safe (non-toxic) to the host, allowing their use as chemotherapeutic agents for the treatment of bacterial infectious diseases. In addition to their use in human medicine, antimicrobials are also used in food animals and aquaculture, and their use can be categorized as therapeutic, prophylactic or metaphylactic. Therapeutic use corresponds to the treatment of established infections.

The use of antimicrobial drugs in aquaculture has well-known positive effects on the control of bacterial infections; however, several side effects that affect both the fish and the environment are associated with excessive use. If one takes into account that 70 to 80% of the antibiotics administered to fish as medicated pelleted feed are released into the aquatic environment via urinary and fecal excretion and/or as unused medicated food, it is not hard to imagine the extent to which antibiotics can affect the aquatic habitat. The effects of antibiotics on the environment are mainly due to the overuse of these drugs by the aquaculture industry and the presence of drug residues in fish products. Unfortunately, there are only a few studies that analyze the side effects of antibiotic use on fish themselves. There is evidence that some antibiotics can induce nephrotoxicity, but the most well documented side effect is immunomodulation.

2.5.2. Methods of administering treatments to fish

Type of treatment	Description	Advantages	Disadvantages
Topical	Drug or chemical applied directly to lesion	Direct contact with lesion	<ul style="list-style-type: none"> Each fish must be physically handled Labor intensive
Injection	<ul style="list-style-type: none"> Antibiotic injected directly into fish abdomen or muscles Methods also used for vaccination 	Each fish receives exact amount of drugs	<ul style="list-style-type: none"> Each fish must be physically handled Labor intensive
Food additives	<ul style="list-style-type: none"> Antibiotic incorporated into the feed or mixed with oil and sprayed on after extrusion 	Easy to apply to ponds and cages	<ul style="list-style-type: none"> Not all fish receive same dose Not applicable if fish are not feeding
Dip	<ul style="list-style-type: none"> Fish are placed in a strong concentration of chemical for up to two minutes Usually for small number of fish 	All fish are treated	<ul style="list-style-type: none"> Fish have to be handled Fish are exposed to high chemical concentration which adds to stress Labor requirements
Bath	<ul style="list-style-type: none"> Fish are placed in moderately strong chemical for up to 1 hour Aerate and observe fish during process Re-circulating systems: set up the system to prevent damage to biofilter 	<ul style="list-style-type: none"> All fish receive same dose Fish are not handled in this methods 	<ul style="list-style-type: none"> Fish must be handled if not done in rearing tank
Flushing	<ul style="list-style-type: none"> Concentrated chemical dosed in to the inlet of a 	<ul style="list-style-type: none"> All fish receive same dose 	<ul style="list-style-type: none"> Fish may react adversely to chemical

	<p>flow-through system and ‘flushed’ though</p> <ul style="list-style-type: none"> ▪ Usually done in raceways 	<ul style="list-style-type: none"> ▪ Not labour intensive ▪ Fish are not handled 	
Indefinite	<ul style="list-style-type: none"> ▪ Chemical applied in a relative low concentration to pond and is allowed to dissipate naturally 	<ul style="list-style-type: none"> ▪ Easy application ▪ Fish are not handled ▪ Not labor intensive 	<ul style="list-style-type: none"> ▪ Not all fish receive same dose if chemical is not distributed evenly

Self-Check-2	Written test
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Name: ID: Date:

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (12pts)

- Control measures related to transmission routes onto, within and from the aquaculture farm
 - Limit the movement of fish from off farm
 - Daily inspecting health condition of fish
 - Restricting the introduction of new fish to the stock
 - All
- One is the control measures of vectors
 - Cleaning and disinfecting equipments
 - Monitoring waters sources against diseases
 - Controlling parasites and predators
 - All
- Among the following, one is methods of administering treatment to the fish
 - Topical
 - Injection
 - Food additives
 - all
 - none
- What is the importance of sharing responsibility related to biosecurity
 - To increase the risk of disease
 - To control the risk of diseases
 - To reduce the sustainability of the fish
 - All
- one is the control measures to farm production practices
 - Increasing fish stress
 - Maintaining water quality
 - Providing improper feed
 - Keeping inaccurate records
 - All

Operation sheet-2

2.1. Cleaning and disinfecting equipments

a) Materials, Tools and equipment's

- Clean water
- Detergents (Peroxy Compounds, Chloramine)
- Bath or container
- Towel
- PPE
 - ✓ Overall
 - ✓ Wader
 - ✓ Boots
 - ✓ Gloves

b) Procedures/Steps

- Remove all visible debris or organic material
- Apply detergent / degreasing agent and leave for 15 minutes (or longer according to label instructions)
- Rinse off with clean water
- Apply appropriate disinfectant at recommended concentration and leave to penetrate for the period recommended by the manufacturer
- Rinse with clean water
- Recording

2.2. Apply lime to fish pond

c) Materials, Tools and equipment's

- Hydrated lime (Calcium hydroxide)
- Use litmus paper
- pH meter or
- water quality test kit

- PPE
 - ✓ Overall
 - ✓ Wader
 - ✓ Boots
 - ✓ Gloves

d) Procedures/Steps

- ✓ Wear PPE
- ✓ Remove all fish and vegetation
- ✓ Drain and clean ponds or premises prior to application
- ✓ spread the lime uniformly over the pond bottom
- ✓ Always check the pH before stocking, the rapid increase in pH is almost always lethal for fish.
- ✓ Stock fish after one week of liming the pond
- ✓ Recording

LAP Test-2	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hour. The project is expected from each student to do it.

Task 1: Clean and disinfect equipments

Task 2: Apply lime to fish ponds

LG #12	LO3:Maintain records and monitor biosecurity procedures
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Instruction sheet-3

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Ensuring records of stock
- Keeping traceability of farm inputs and outputs
- Monitoring and surveillance data
- Monitoring effectiveness of control measures of risks
- Monitoring work duties and ensuring biosecurity
- Reporting issues and concerns with biosecurity

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Ensure records of stock
- Keep traceability of farm inputs and outputs
- Monitor and surveillance data
- Monitor effectiveness of control measures of risks
- Monitor work duties and ensuring biosecurity
- Report issues and concerns with biosecurity

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 3

3.1. Ensuring records of stock

Keeping and analyzing records to make production and business decisions make it possible to execute production objectives within the cost-structure of the enterprise. Through records the evidence of what is at stake (your stock), changes that have occurred during production and marketing, impending challenges and opportunities becomes available.

The basic aquaculture records to keep are:

- A. Production records (feeding, management, stock, growth and survival)
- B. Marketing (marketing requirements and prices)
- C. Financial records (costs of expenses, sales, revenue and expenses)

B. Production records

As opposed to terrestrial animals, fish are always under water during the production cycle. The only time a fish producer sees them is at feeding, if they feed by response, or at sampling. Keeping records of stocking, species, inputs, water quality, management actions, average weights at sampling and mortalities up to date provides a lot of insight on the status of operations.

j) Stocking record sheet

No.	Species stocked	Quantity stocked	Average Size at stocking Cm and/or weight (gr)	Date stocked
1.				
2.				
3				
4				
5				

ii) Daily feeding record sheet

Farm ID: **Pond No:**

Date (DD/MM/YY)	Quantity to be fed and size of pellet (based on sampling data, for whole pond)	Quantity of feed that was fed KG	Quantity of feed returned to store (not fed) in Kg	Remarks/note

iii) Sampling record sheet

Date (DD/MM/YY)	Weeks (from stocking)	Average weight fish (grams)	Number of fish left (get it from observations)	Daily ratio to be fed in KG (calculate)

C. Marketing Records

Records of purchases and sales from the various markets, turnover, promotion and communication costs and results and market profiles are important.

Selling record sheet

Date (DD/MM/YY)	Species	Quantity harvested (pieces)	Weight of total harvest kg)	Quantity eaten (pieces)	Quantity sold (pieces)	Average price (ksh per piece sold)	Total sales (ksh)

D. Financial Management

The information on costs of inputs, expenses, revenue enables one control the use of inputs and production management decision to ensure optimum productivity and positive returns. The attach a financial value to the inputs, production process, goods produced and sold.

Profitability record sheets

Item	Quantity	Price per unit	Total Amount	Remarks
Total Income (Sales of fish)	_____ pcs _____ kg			
Expenses:Feed (kg)				
Other expenses				
Total labour costs				
Casual labour				
Other costs not captured				
Gross profits				

3.2. Keeping traceability of farm inputs and output data

Traceability can be said as the follow up on the movement of activities taking place. In case of any product, the ability to follow up on the movement of food through the stages of production, processing and distribution. Tracing plays an important role in helping businesses in the competitive era of domestic as well as globally. Today's agribusiness and food have utmost importance of accurate and timely traceability of products and activities. Customers do expect to know about the product at every step to make sure if they meet the requirements and expectations. Traceability is the only tool by which expectations of buyers could be meet. In a modern fisheries and aquaculture business this is complicated by the spatial dimensions of the supply chain, where inputs (feed, fish etc.) and outputs (final products) may all be traded internationally.

The need for traceability is for Complexity of supply chains. Meeting these requirements in the context of modern supply chains for food represents a considerable challenge. The supply chain

can consist of numerous separate business operators. An example of a supply chain for aquaculture products is shown in Figure 1. In a modern fisheries and aquaculture business this is complicated by the spatial dimensions of the supply chain, where inputs (feed, fish etc.) and outputs (final products) may all be traded internationally. Such complexity may occur even within vertically integrated businesses (for example in multi-site operations). Compliance with SPS measures is required to ensure a sustainable business, and this also requires traceability systems to be in place and operating, often across international borders.

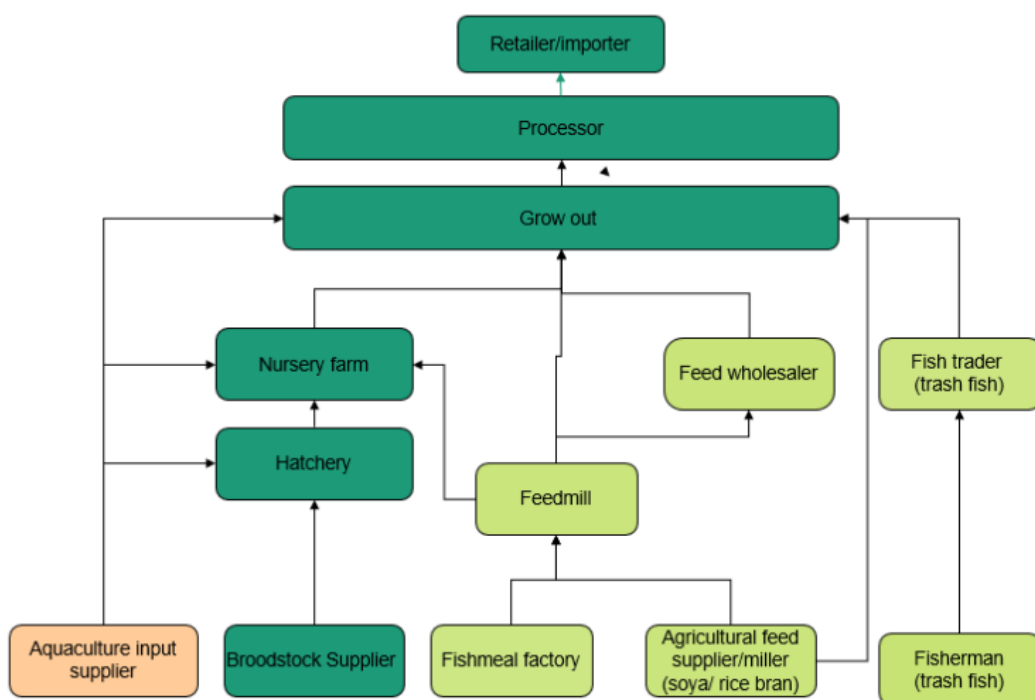


Figure 3.1: Typical supply chain for farmed fish

Objective of a traceability system

The objective of a traceability system (at any step in the supply chain) is to:

- Trace the flow of materials (feed, food, their ingredients and packaging)
- Identify necessary documentation and tracking for each stage of production
- Ensure adequate coordination between the different parties involved
- Improve communication among the involved parties and, most importantly
- Improve the appropriate use and reliability of information, effectiveness, and productivity of the organization.

Basic characteristics of a traceability system

The basic characteristics of a traceability system within a business operation are:

- 1) Identification of incoming products (or raw material and ingredients) and their sources
- 2) Identification and recording of information on activities linked to these products or batches during processing and storage
- 3) Identification of outgoing products, and their destinations

• Data inputs

Data on inputs will firstly identify an exclusive list of suppliers of materials and ingredients which could form part of the final product. A batch records should be prepared on receipt of the physical inputs. They should record the supplier, the date, the description of the product and any batch codes contained within the received consignments. The operator should apply his own codes or identifiers to be used for internal purposes. Thus, irrespective of the nature of the operation, an identifying code is applied to a batch of raw material on reception. Supply information such as name of supplier, date, quantity, species and other characteristics, and any supplier batch codes, is recorded against this code.

In capture fisheries, being a hunting process, the only material inputs to the product that could be considered to require traceability are water and ice. The vessel operator should record information relating to the supply of these substances. In aquaculture however, there are several inputs that need to be considered, notably eggs or juveniles, feed materials (including additives and supplements), and veterinary medicines. In processing operations, inputs will include fish, along with other ingredients (if the product is a composite one, such as canned fish in oil) and additives. Packaging materials are also usually included as an input in food traceability systems due to the potential contamination of the product.

• Data on production

In capture fisheries, a record of the vessel (including registration number), date, fishing location, gear used, and time of capture is often made. Other useful information could be ambient temperature and seawater temperature (which could impact on food safety conditions in tropical regions such as the Caribbean). Batch separation should be practised (avoiding mixing of old and

new catches) as a matter of good handling practice, and such separation should be maintained during discharge.

Aquaculture operators should record all activities involved in the production of the fish concerned. These include location (e.g. pond or cage number), dates, and quantities of application of feed (indicating the batch numbers of the feed used), along with other treatments applied (supplements, grading activities, veterinary treatments).

In fish processing steps, all treatments and associated data (for example HACCP records) applied to that batch are registered to that code. Associated data could also include storage location and conditions, date and shift of work, along with production yields.

- **Data on outputs**

The operator should maintain a record of outputs, which should contain sufficient information to link the final product to all of the data collected thus far (on inputs and processing) regarding the material it contains.

In simple operations (such as a processor, with one supplier, supplying one batch of a single species per day), the date of production will be sufficient. However, in more complex operations it will be necessary to devise and apply a batch coding system, to allow the process batch and its associated variables to be identified. The code is affixed to the product, or to the packing, or contained in the associated documentation, so that the receiver can make reference to this in case of need. It is this data which provides the essential data link to the next operator in the supply chain.

The receiver should of course be identified as part of the data collected on the outputs. Batch codes do not need to be understandable by the receiver (i.e. it can be an internal code unique to the business operator applying them).

3.3. Monitoring and surveillance data

Any aquatic health plan or any policy development for aquatic animal health is not possible without quality health data. This data can be used for disease control, quarantine, and health certification which can be achieved by conducting aquatic animal surveillance . Surveillance to

avoid introduction of disease is an important element of any biosecurity strategy to identify the possible route of disease introduction to aquatic firm and to detect the emergence of a new disease which will ensure that control strategies can be implemented before the pathogen becomes widespread. It is important to conduct surveillance regularly in order to reduce the risk of the spread of pathogens . Disease surveillance should be an integral and key part of all government aquatic animal health services.

3.3.1. Passive Surveillance

Data collected for other propose can be utilized to know aquatic animal health status and to plan appropriate measures to reduce the incidence of disease. Data can be obtained from laboratories, field visits, research projects, from farmers, and aquaculturists. Passive surveillance is useful for early detection of emerging diseases. Its limitation is that it does not allow estimation of disease incidence and prevalence and it cannot be used to demonstrate freedom from disease.

3.3.2. Active Surveillance

Active surveillance involves surveys to know the status of a particular disease in question. Evidence of disease in a specified population, and, in some instances, provides the data to prove that the specified population is free of a specific disease. Results of active surveillance may be biased unless properly designed and analyzed. Appropriate analyses can provide valid measures of incidence and prevalence of disease in particular area. Its advantages include information better in quality, it is faster and cheaper to collect information than passive surveillance

3.4. Monitoring effectiveness of control measures of risks

a) Risk management

Risk is characterized by both the probability and severity of a potential loss that may result from hazards due to the presence of an enemy, adversary, or some other hazardous condition. Risk management is the process of identifying, assessing, and controlling risks arising from operational factors and making decisions that balance risk costs with mission benefits.. This involves a three-step process to:

- Identify hazards
- Assess risks of injury or harm arising from each identified hazard and
- Control risks through implementation of control measures to eliminate or reduce them.

Step 1: Hazard identification

The first step in the risk management process is identifying hazards. This involves identifying anything that may cause injury or harm to the health of a person.

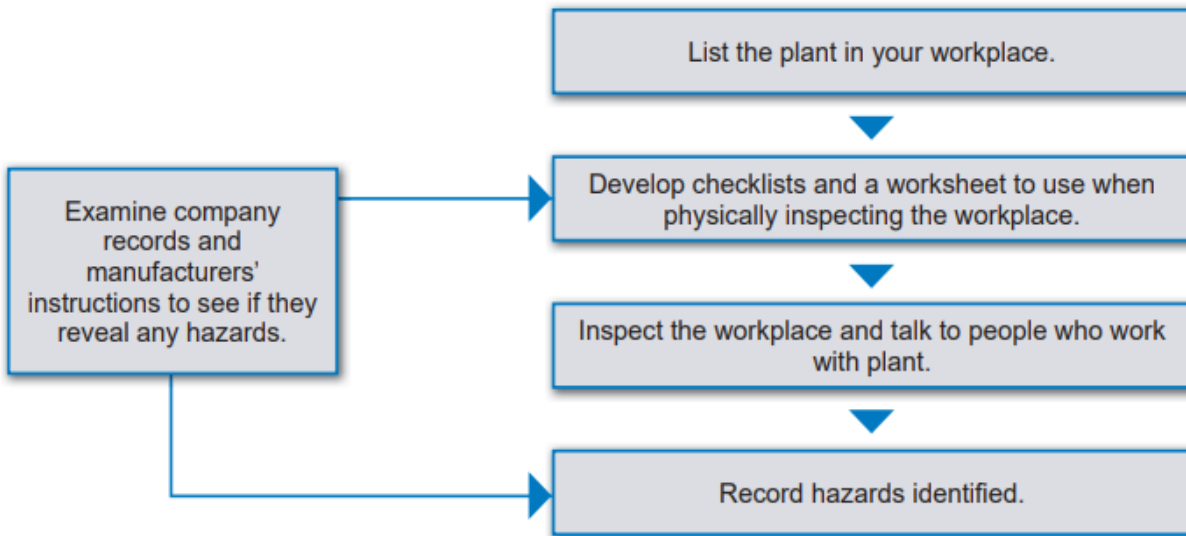


Figure 3.1: A process to identify hazards

Step 2: Risk assessment

The second step in the risk management process is assessing the risks of injury or harm arising from the hazards identified in the workplace. In general, this involves looking at the chance or likelihood of a hazard occurring and, if it does, the extent of any injury or harm, that is the consequences. It is a way of deciding which hazards need to be addressed first, that is where there is the highest risk of injury or harm.

This step should provide information on:

- where, which and how many workers are likely to be at risk of incurring injury or harm;
- how often this is likely to occur; and
- the potential severity of any injuries.

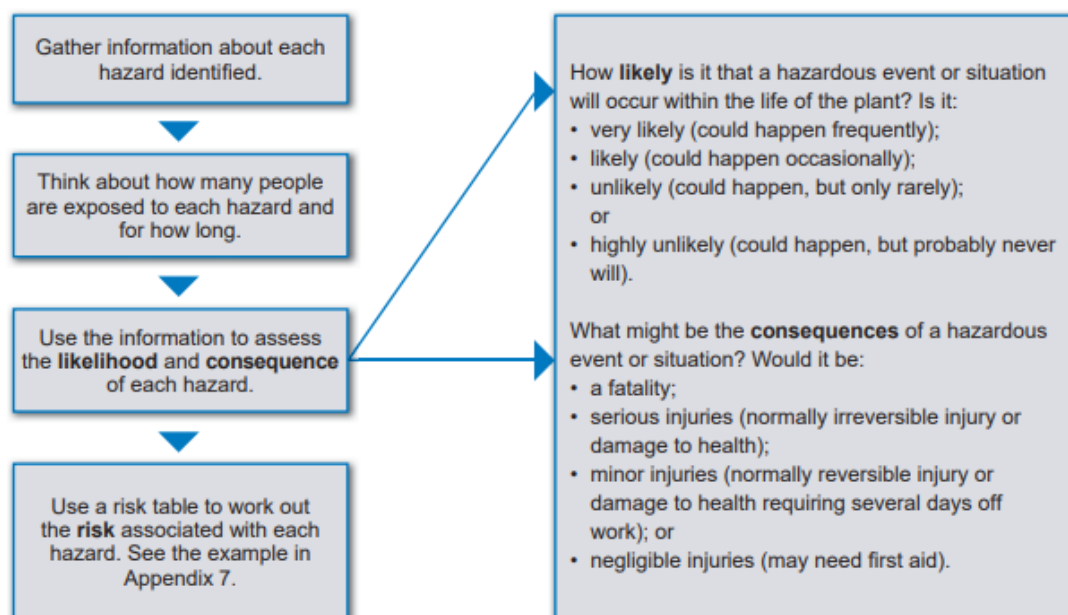


Figure 3.2: Risk assessment

Step 3: Risk control

The third step is to implement control measures to eliminate or reduce the risks of a person being injured or harmed and ensure the measures are monitored and reviewed on an ongoing basis. When considering risk control, there is a recommended order of control measures to implement, ranging from the most effective to the least effective, to eliminate or reduce the risks of injury or harm.

Activities necessary to allow the selected control measures to function or operate effectively include:

- **Developing work procedures:** these should be developed in relation to chosen control measures to ensure their effectiveness. Management, supervision and worker responsibilities should be clearly defined. In relation to use of machine safeguarding, the procedures should, at a minimum, cover:
 - ✓ arrangements for ensuring the appropriate guarding is purchased and correctly installed;
 - ✓ Arrangements for provision of instruction, supervision and training of workers to ensure the machinery is only operated with the guarding in place

- ✓ The requirement for workers to follow instructions
- ✓ Arrangements for workers to report malfunctions or problems with machinery
- **Consultation and communication:** workers and, where they exist, safety and health representatives must be consulted and informed about the control measures to be implemented and of any changes to these arrangements. Information may also need to be provided to others who may enter the workplace, including cleaners, visitors and contract staff;
- **provision of training and instruction:** training and instruction must be provided as necessary for workers, supervisors and others to enable them to use the control measure so they are not exposed to hazards. This information should be provided to workers in a manner that is readily understood, with special consideration given to language and literacy issues
- **Supervision:** adequate supervision must be provided as necessary to ensure that the control measures are being used correctly

b) Monitoring and reviewing effectiveness of control measures

Having implemented control measures, it is important that they be regularly monitored and reviewed.

Questions to ask

In monitoring and reviewing the effectiveness of control measures, it is useful to ask:

- Have control measures been implemented as planned?
- Af control measures have not been implemented, why not?
- Are the control measures being used and, if so, are they being used correctly?
- Are control measures working?
- Have changes made to control exposure to the assessed risks resulted in what was intended?
- Have implemented control measures resulted in the introduction of any new hazards?
- Have implemented control measures resulted in the worsening of any existing hazards?

In order to answer these questions, there may be a need to:

- Consult with workers, supervisors and, where they exist, safety and health representatives
- Measure levels of exposure, for instance take noise measurements in the case of isolation of a noise source
- Refer to manufacturers' instructions
- Monitor incident reports; and
- Contact industry associations, unions, government bodies or safety and health consultants

In determining the frequency of the monitoring and review processes, consider:

- The level of risk: high risk hazards need more frequent assessments; • the type of work practices or plant involved;
- A regular review of the process for hazard identification, risk assessment and risk control to ensure the risks are effectively managed; and
- Further review of control measures when new methods, tasks, equipment, hazards, operations, procedures, schedules are introduced, the environment changes or there is any indication risks are not being controlled

c) Keeping documents and records

It is advisable to record the chosen control measures. If a preferred control measure cannot be implemented immediately, the controls intended as short-term and longer term solutions, along with the proposed implementation timeframe, should be recorded.

3.5.Reporting issues and concerns with biosecurity

Report significant aquatic animal diseases and deaths as soon as possible. This allows serious pathogens to be confirmed, managed and contained early to minimise widespread and detrimental effects on the industry and the natural environment.

- animals coming to the edge or water surface of the pond, tank or cage
- animals demonstrating unusual swimming patterns
- reduced feeding and failure to thrive
- unusual changes in the physical appearance of the animal such as:

- ✓ red or black colouration of prawn
- ✓ ulcers or mouldy growth on skin
- ✓ blackening of skin
- ✓ pop eye
- ✓ erosion of fins and tails
- ✓ fouling of gills.

In reporting the following information must be incorporated.

- Location
- Date and time.
- Size.
- Colour.
- Water depth
- Environment (such as beach, sand, rock pools, in weed, on water, river, attached to structure).
- Hazards occurred
- Impact of hazards

Self-check- 3	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1: Give short answers

1. What is the difference between traceability of farm inputs and farm output?
2. What the importance conducting surveillance data?
3. What is the importance of determining the effectiveness of control measures?

Operation sheet-3

Managing risks

A. Materials, Tools and equipment's

- Paper
- Pen
- Observation checklist
- PPE

B. Procedures/Steps

- Identify hazards
- Assess risks
- Control risks
- Monitoring the effectiveness of the risks
- Recording

LAP Test-2	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hour. The project is expected from each student to do it.

Task 1: Manage risks

Reference Materials

Books:

Chapter 1.1.3. Methods for disinfection of aquaculture establishments. OIE (World Organization for Animal Health) Manual of Diagnostic Tests for Aquatic Animals 2013. http://www.oie.int/fileadmin/Home/eng/Health_standards/aahm/2010/1.1.03_DISINFECTION.pdf

Russo, J.R. and R.P.E. Yanong. 2002. Molds in fish feeds and aflatoxicosis. FA95. University of Florida IFAS Cooperative Extension Service. <http://edis.ifas.ufl.edu/FA095>

Yanong, R.P.E. 2002. Pentastomid infections in fish. FA90. University of Florida, IFAS Cooperative Extension Service. <http://edis.ifas.ufl.edu/FA090>

Yanong, R.P.E. 2002. Nematode (roundworm) infections in fish. FA91. University of Florida/IFAS Cooperative Extension Service. <http://edis.ifas.ufl.edu/FA091>

Anon. 2017. WorldFish Biosecurity Check List. CGIAR Research Program on Fish. 16 p.

Fish Health Directorate. Shellfish biosecurity measures plan – Guidance and templates for shellfish farmers. Weymouth, United kingdom: CEFA. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/278580/Shellfish_biosecurity_measures_plan.pdf]

Lee C.S. 2005. Application of biosecurity in aquaculture production systems. p. 66–75. In: Y. Sakai, J.P. McVey, D. Jang, E. McVey, and M. Caesar (Eds). Aquaculture and Pathobiology of Crustacean and Other Species. Proceedings of the Thirty-Second U.S. Japan Symposium on Aquaculture. Davis and Santa Barbara, CA, 17, 18, and 20 November 2003. UJNR Technical Report 32. NOAA Research, Silver Spring, MD.

Mohamed Din M.S. and Subasinghe R. 2017. Basic biosecurity manual for tilapia hatchery technicians in Bangladesh. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Manual: FISH-2017-10. [<https://digitalarchive.worldfishcenter.org/bitstream/handle/20.500.12348/664/FISH-2017-10.pdf>]

fub-Committee on Aquatic Animal Health (SCAAH). 2016. Aquaculture Farm Biosecurity Plan: generic guidelines and template. Canberra, Australia: Department of Agriculture and Water Resources. 40p. [<https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/fisheries/aquaculture/aquaculture-farm-biosecurity-plan.pdf>]

Web address

<https://www.ajsfisheries.com/fish-health-biosecurity>

<https://anglingtrust.net/wp-content/uploads/2021/09/Fisheries-Biosecurity-guidance-and-plan-Final.doc>

<https://www.fish.wa.gov.au/sustainability-and-environment/aquatic-biosecurity/Pages/default.aspx>

<https://www.swelluk.com/help-guides/common-fish-diseases-treatments/>

https://www.pondlife.me.uk/fishhealth/diseases_and_parasites.php

<https://panuliruscygnus.org/adults/predators-pests-disease/>

<https://agriflifeextension.tamu.edu/asset-external/field-guide-to-predators-parasites-and-pathogens-attacking-insect-and-mite-pests-of-cotton-recognizing-the-good-bugs-in-cotton/>

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