

ANIMAL PRODUCTION

LEVEL-III

Based on March 2022, Version-4 Occupational Standard



Module Title: - Carryout Aquaculture and Fishery
Production

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Ministry of Labor and Skills

Introduction to the Module

This module covers the knowledge, skills and attitude required to perform aquaculture and fishery production that required Identify body parts of fish, prepare facilities and undertake fish stock selection and handling, under take management and monitoring water quality, practices feed and feeding of fish, undertake harvesting and handling of fish stocks and control and prevent common disease and parasite of fish.

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LG#22	LO#1- Identify Body Parts of Fish
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Instruction sheet	
<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"> • Recognizing fish body location, structure and function • Practicing fish dissection • Identifying fish sex <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"> • Recognize fish body location, structure and function • Practice fish dissection • Identify fish sex 	
Learning Instructions:	
<ol style="list-style-type: none"> 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-1

1.1 Recognizing fish body location, structure and function.

Definition of terms

- **Fish:** are diverse group of animals that live and breathe in water (any aquatic animal) (or cold-blooded), typically ectothermic covered with scales. All fish are vertebrates (animals with backbones) with gills for breathing. Most fish have fins for swimming, scales for protection, and a streamlined body for moving easily through the water.
- **Fishery:** The science of producing fish and other aquatic resources for the purpose of providing human food, although other aims are possible (such as sport or recreational fishing), or obtaining ornamental fish or fish products such as fish oil.
- **Aquaculture:** is the farming of freshwater and saltwater organisms including molluscs, crustaceans and aquatic plants. Unlike fishing, aquaculture, also known as aqua arming, implies the cultivation of aquatic populations under controlled conditions.

Fish is aquatic vertebrates. They make up more than half of all vertebrate species. They are especially important in the study of vertebrate evolution because several important vertebrate traits evolved in fish. Fish show great diversity in body size. They range in length from about 8 millimeters (0.3 inches) to 16 meters (about 53 feet). Most are exothermic and covered with scales. Scales protect fish from predators and parasites and reduce friction with the water. Multiple, overlapping scales provide a flexible covering that allows fish to move easily while swimming.

1.1.1 External body structure and function of fish

Nostrils- The nostrils of fish do not open into the back of the mouth as do those of mammals, and are not, therefore, for breathing. They lead into organs of smell which are as a rule, very sensitive, so that a fish can detect the presence of food in the water at considerable distances.

Eyes- The eyes of a fish have large round pupils which do not vary in size.

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Hearing- Although fish have no ears visible externally they can hear by transmission of vibrations through the body to sensitive regions of the inner ear.

Mouth- The mouth serves for taking in food; also for the breathing current of water. Some fish have a wide gap, and filter microscopic plants and animals out of the surface waters as they swim along, trapping them in gill rakers before the water is expelled from the operculum.

The operculum- is a bony structure covering and protecting the gills in teleosts; it plays an important part in the breathing mechanism. Elasmobranchs do not have an operculum but there are separate gill slits for each gill.

The lateral line- is a jelly-filled tube or canal just below the skin. It opens to the water outside by a series of tiny pores. Its function is to detect movements in the water. A disturbance set up, for example, by a person's hand moving in the water, will cause the jelly in the tube to vibrate. The canal is lined with nerve endings which are stimulated by vibrations and send impulses to the brain. In this way the fish is made aware of the direction and intensity of water movements. The sensitivity of this system makes even a blind fish very difficult to catch by hand.

Fins- give stability, and control the direction of movement during swimming, as explained later.

Fish scale- is a small rigid plate that grows out of the skin of a fish. The skin of most jawed fishes is covered with these protective scales, which can also provide effective camouflage through the use of reflection and coloration, as well as possible hydrodynamic advantages.

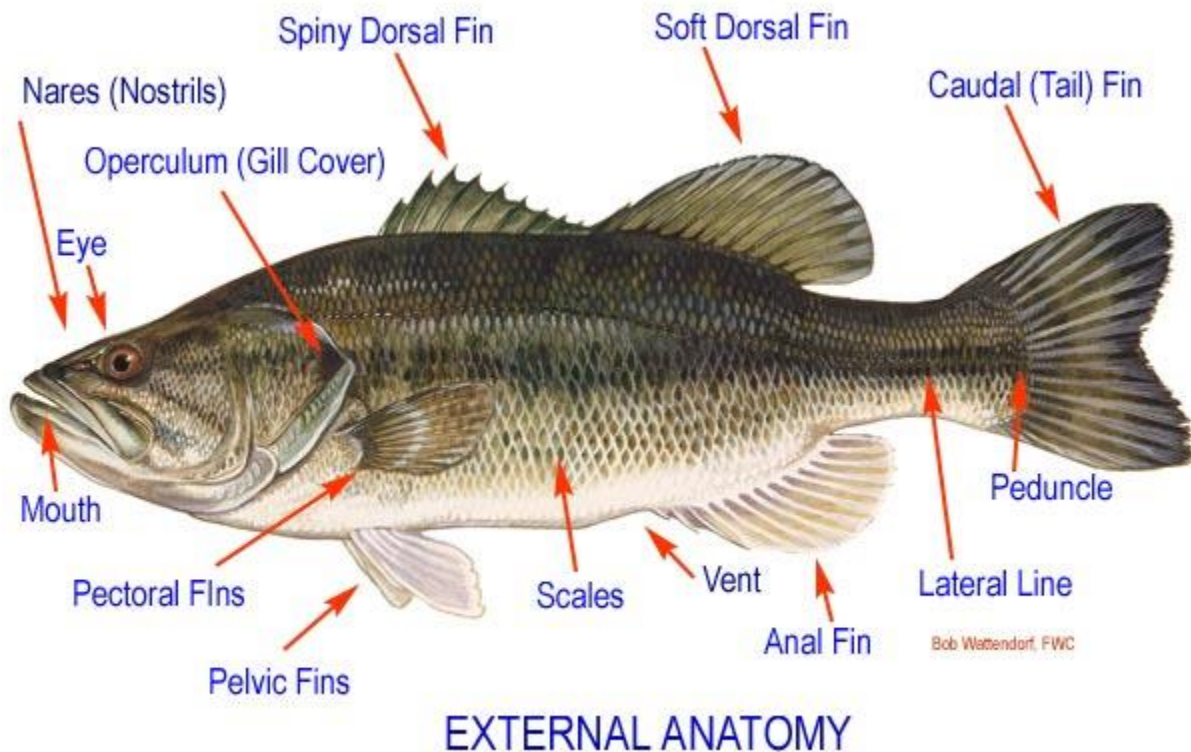


Figure 1.1. external anatomy of fish

1.1.2 Internal body Structure and Function in Fish

Spine: The primary structural framework upon which the fish's body is built; connects to the skull at the front of the fish and to the tail at the rear. The spine is made up of numerous vertebrae, which are hollow and house and protect the delicate spinal cord.

Spinal Cord: Connects the brain to the rest of the body and relays sensory information from the body to the brain, as well as instructions from the brain to the rest of the body.

Brain: The control centre of the fish, where both automatic functions (such as respiration) and higher behaviors occur. All sensory information is processed here.

Lateral Line: One of the fish's primary sense organs; detects underwater vibrations and is

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capable of determining the direction of their source.

Swim (Air) Bladder: A hollow, gas-filled balance organ that allows a fish to conserve energy by maintaining neutral buoyancy (suspending) in water. Fish caught from very deep water sometimes need to have air released from their swim bladder before they can be released and return to deep water, due to the difference in atmospheric pressure at the water's surface. Species of fish that do not possess a swim bladder sink to the bottom if they stop swimming.

Gills: Allow a fish to breathe underwater. These are very delicate structures and should not be touched by hand.

Kidney: Filters liquid waste materials from the blood; these wastes are then passed out of the body. The kidney is also extremely important in regulating water and salt concentrations within the fish's body, allowing certain fish species to exist in freshwater or saltwater, and in some cases (such as snook, tarpon, salmon, etc.)

Stomach And Intestines: Break down (digest) food and absorb nutrients. Fish such as bass that are piscivorous (eat other fish) have fairly short intestines because such food is easy to chemically break down and digest. Fish such as tilapia that are herbivorous (eat plants) require longer intestines because plant matter is usually tough and fibrous and more difficult to break down into usable components. A great deal about fish feeding habits can be determined by examining stomach contents.

Pyloric Caeca: This organ with finger like projections is located near the junction of the stomach and the intestines. Its function is not entirely understood, but it is known to secrete enzymes that aid in digestion, may function to absorb digested food, or do both.

Vent: The site of waste elimination from the fish's body.

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Liver: This important organ has a number of functions. It assists in digestion by secreting enzymes that break down fats, and also serves as a storage area for fats and carbohydrates. The liver also is important in the destruction of old blood cells and in maintaining proper blood chemistry, as well as playing a role in nitrogen (waste) excretion.

Heart: Circulates blood throughout the body. Oxygen and digested nutrients are delivered to the cells of various organs through the blood, and the blood transports waste products from the cells to the kidneys and liver for elimination.

Gonads (Reproductive Organs): In adult female bass, the bright orange mass of eggs is unmistakable during the spawning season, but is still usually identifiable at other times of the year. The male organs, which produce milt for fertilizing the eggs, are much smaller and white but found in the same general location. The eggs (or roe) of certain fish are considered a delicacy, as in the case of caviar from sturgeon.

Muscles: Provide movement and locomotion. This is the part of the fish that is usually eaten, and composes the fillet of the fish.

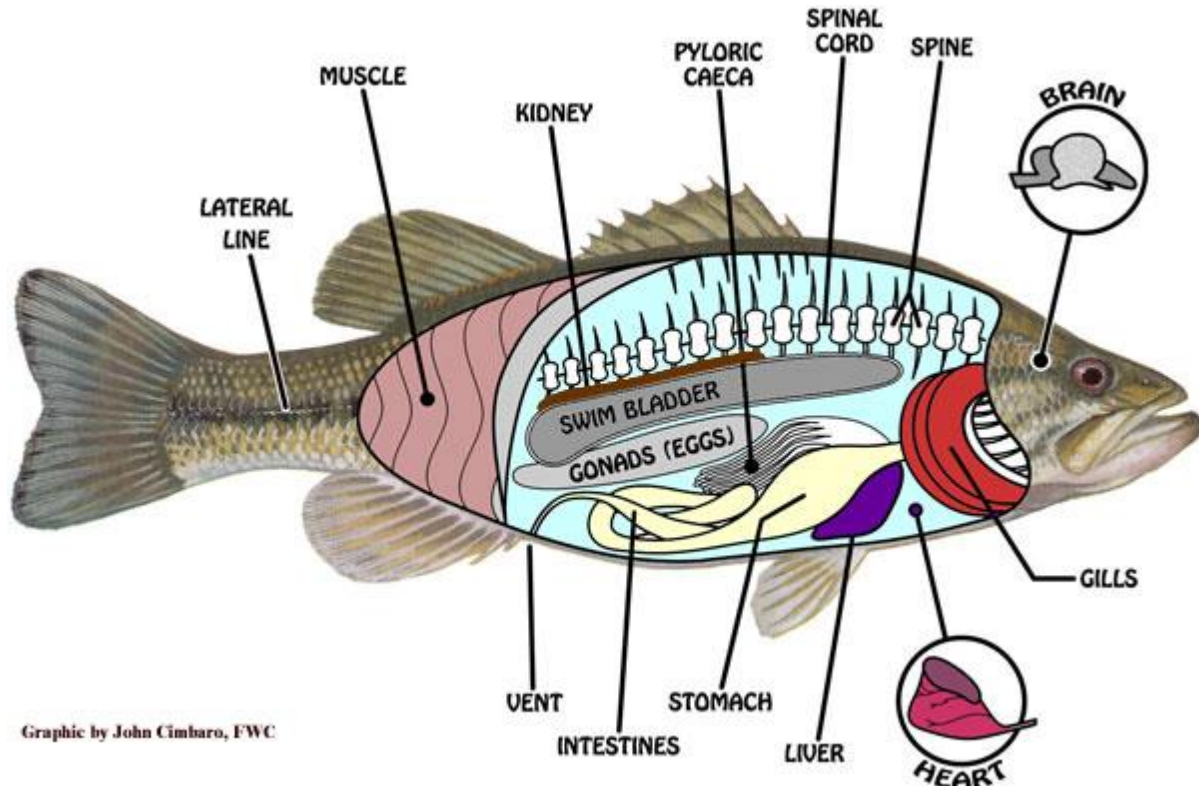


Figure 1.2. Internal anatomy of fish

1.2. Practicing Fish Dissection

Step1 select fish for dissection

For dissections a medium sized fish that isn't too expensive. I often choose to dissect perch because they have easy to see organs, don't have too much meat, and are cheap.

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Figure 1.3 selection fish for dissection

Step 2: Finding Fins

Fish is likely to have a pronounced and spiny dorsal fin (on top), pectoral fins (imagining chest level), a caudal fin (the tail), and an anal fin or two (in the back). Each one folds slightly differently.



Figure.1.4 Find fin of fish

Step 3: Color, Scales, and the Lateral Line

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Fish vary greatly on the colors of their sides, with many fish having iridescent scales like the milk fish shown here. Iridescence is an amazing phenomenon, and is caused by tiny guanine crystals in the scales of the fish that give them that metallic sheen.



Figure 1.5 Color, Scales, and the Lateral Line.

Step 4: The Head part

The natural start is to look at the eye, which as students can see they don't have eyelids like us (no why would this be?) In the case of the milkfish, they have an adipose eyelid which is a transparent membrane over the eye. If you look directly into the center of the pupil, you can even see the lens, which is much more spherical than ours



Figure.1.6 finding head parts of fish

Step 5: Making the cuts

Start by finding the anus (the only opening on the underside), and cutting a line not too deep all the way up to the gills. Open it up a bit, and then cut a lateral line up the side of the fish so you can open it up to see the way the guts are inside while they're in place.

Already you'll notice the ribs of the fish, and the thickness of the meat. In milkfish, they have a bulky muscular wall, and so there is a large amount of meat. If at the end of your dissection, you're still in the mood for fish, you can clean and fry it up.



Figure 1.7 making cuts of fish

Step 6: Identifying digestive system of fish

Track the digestive system either starting from the mouth or from the anus. You'll see a tiny fist-like organ which is mushy but tough, and that's the stomach! Start by removing it, and cutting it open to see what's inside. This is how biologists do gut exams and diet analysis. Our food material looks pretty well digested, but if they ate smaller fish shortly before they were caught, you can often see them in here.

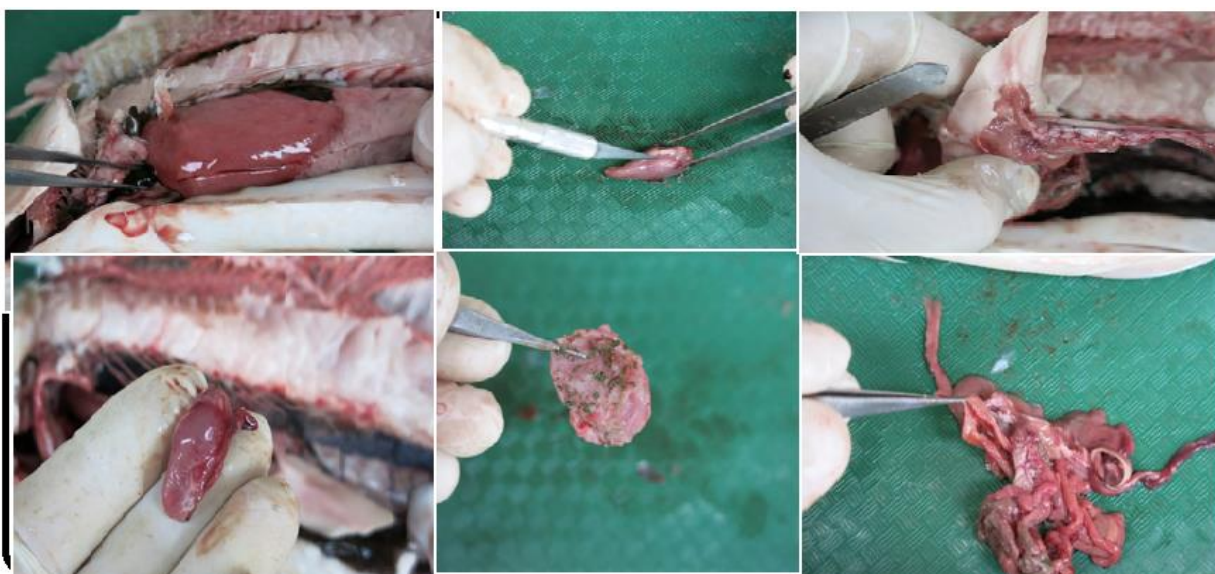


Figure 1.8 digestive systems of fish

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Step 7: Heart and Liver

Two pronounced organs in the fish near the pectoral fins are the heart and liver. The **heart** is often very dark and often has coagulated black blood surrounding it, and can be found just below the gills. You can remove it, and in larger fish even dissect it to see the two chambers inside. Human hearts, by contrast, have four chambers. The fish circulatory system is a single circuit, with blood flowing from the heart to the gills and then the rest of the body.

The liver is the largest item by volume in our milkfish. It is red, and often large in other fish, too, but varies by sex, species, and stage of life. Besides working to clean blood, the liver also often acts as food storage of fats, blood sugar, and vitamins for the fish and so is essential in times of low food availability.

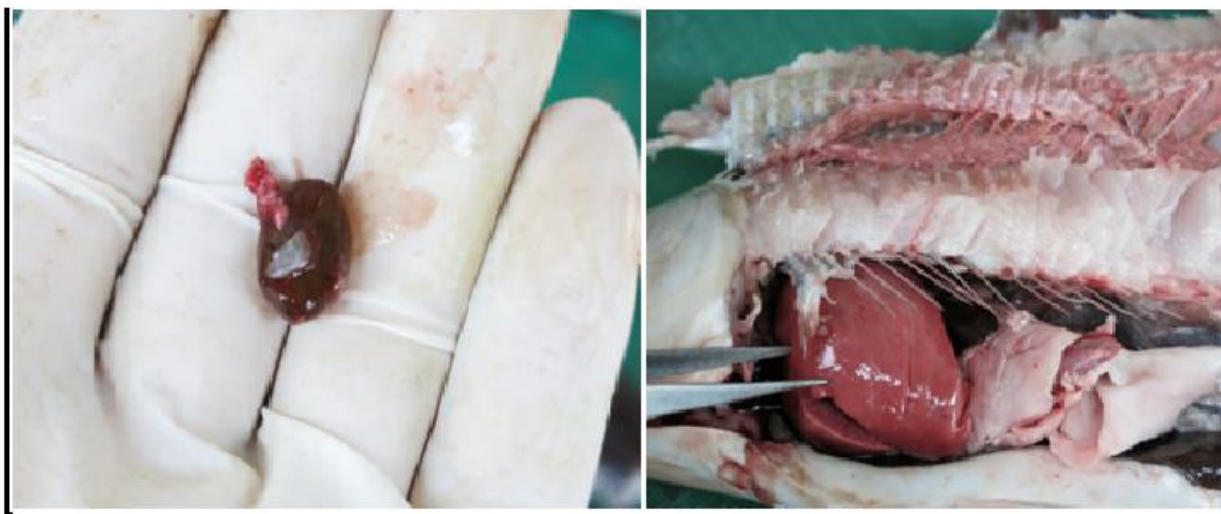


Figure 1.9 identification of heart and liver

Step 8: Swim Bladder

All aquatic animals have different strategies for changing buoyancy, and how they float or sink in the water. They are also called "gas bladders" or "air bladders" because they are air-filled organs that allow fish to maintain a level of buoyancy in the water without wasting energy swimming.



Figure 1.10 Swim Bladder

Step 9: Grills of Gills

Fish need all the help they can get to get oxygen, as they need it like we do. While air is approximately 21% oxygen or 210,000 parts per million, water often only has about 4-8 parts per million dissolved within. That means those gills have to do a lot of work



Figure 1.11 Grills of Gills

Step 10 Clean and keep exploring

Different fish will have different pronounced characteristics, and there are a few that weren't pronounced here that you can find in others. Fish gametes are one, where often if they have two large sacs toward their rear, they are male and one are female. Our milkfish was a juvenile and had not developed them yet. Fish brains are another, which are quite small and difficult to find, but are often somewhere between the eyes. There is always more, too, including spleens, olfactory bulbs, kidneys, and more.



Figure 1.12 Clean and keep exploring

1.3. Identifying fish sex

Males and females can differ strikingly in morphology and reproductive development behavior. While these phenomena, known as sexual dimorphism, are widespread in many species, the genetic mechanisms regulating such a ubiquitous pattern are diverse. Among animals, fish becomes a paradigmatic model, because their sex-determination mechanisms vary from environmental factors to distinct modes of genetic controls. Therefore, understanding of the genes and mechanisms involved in fish sex determination and reversals have long been one of the central topics in evolution and developmental biology.

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1.3.1. Molecular sex identification

Molecular identification of fish genders is not only a necessary step in genetic studies related to sex determination and/or differentiation, but also has broad applications in fishery industry.

The action of a major sex determining master gene, several sex-associated loci, an environmental factor (e.g., temperature) in an ecologically relevant context (i.e., occurring normally in the habitat of the species) or a combination of them, typically when the gonads are still sexually undifferentiated or even before they are formed at the most rudimentary stage (pre-gonadal stage). Successive events are connected by horizontal arrows and include differences in the proliferative rate of germ cells (females > males), which can be one of the first effects of the sex determining factor, whether genetic or environmental. During this period, the germ cell-somatic cell crosstalk is very important, but still largely uncharacterized. Also, during these early events, biotic and abiotic factors (e.g., stress, abnormally high temperature, etc.) can change the course of subsequent sex differentiation, usually in the female → male direction (diagonal dashed arrow).

Finally, also at the beginning of gonad differentiation – the transformation of an undifferentiated gonad into a testis or ovary – the accidental (i.e., contamination) or deliberate (e.g., sex control treatment) incorporation of sex steroids, androgens or estrogens can result in female → male (vertical blue dotted arrow) or male → female (vertical red dotted arrow) sex-reversal, i.e., in that genotypic females and males develop into phenotypic males and females, respectively.

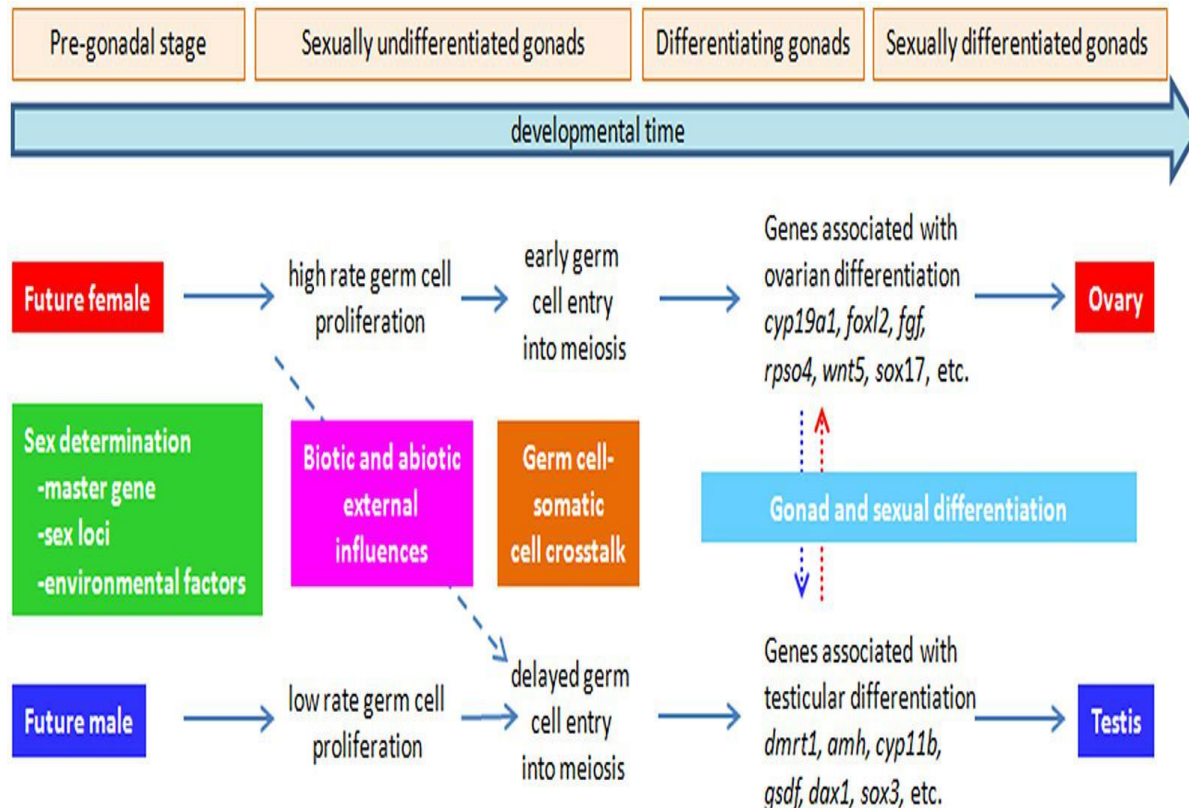


Diagram1.1. molecular sex identification

1.3.1. Sex identification through morphological Observations

Male of fish is displayed an elongated genital papillae (Figure 3a); while female was observed with rounded genital papillae with the presence of a small egg hole. On the other hand, the hump of male was easily distinguishable by the presence of relatively higher and bigger hump (Figure 4a). Unlike the hump on male, female is observed with lower and smaller bump (Figure 4b). Alleviation of the hump was seen more obvious on female

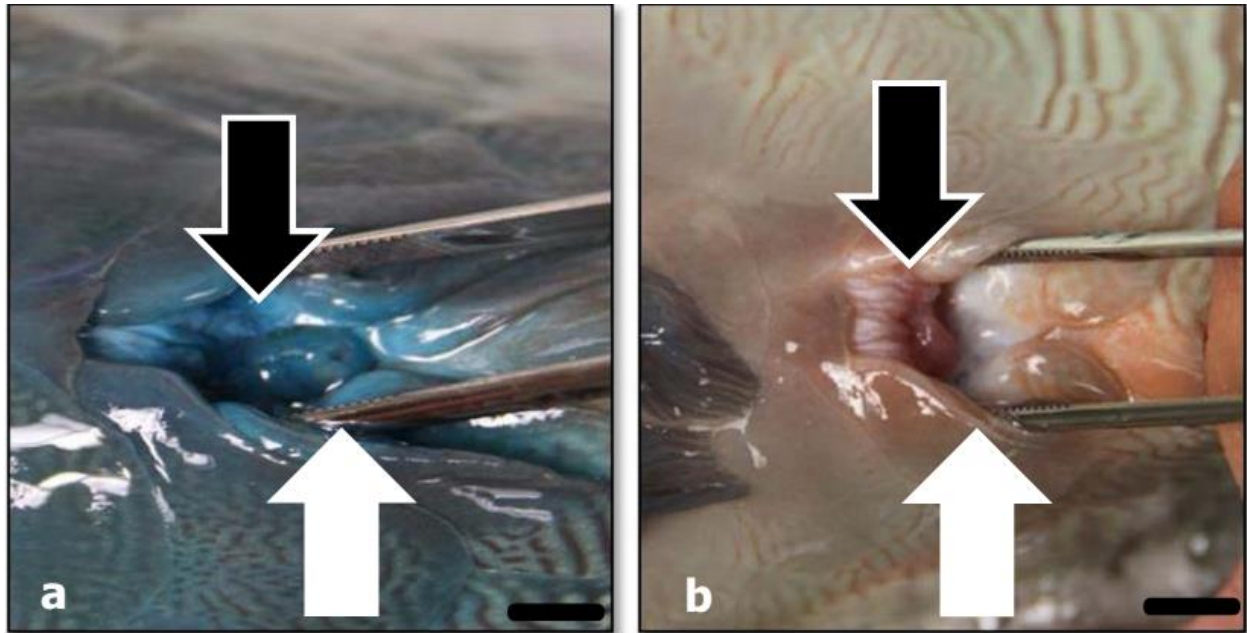


Figure 3 (a) Male *C. undulatus* genital papillae, (b) Female *C. undulatus* genital papillae

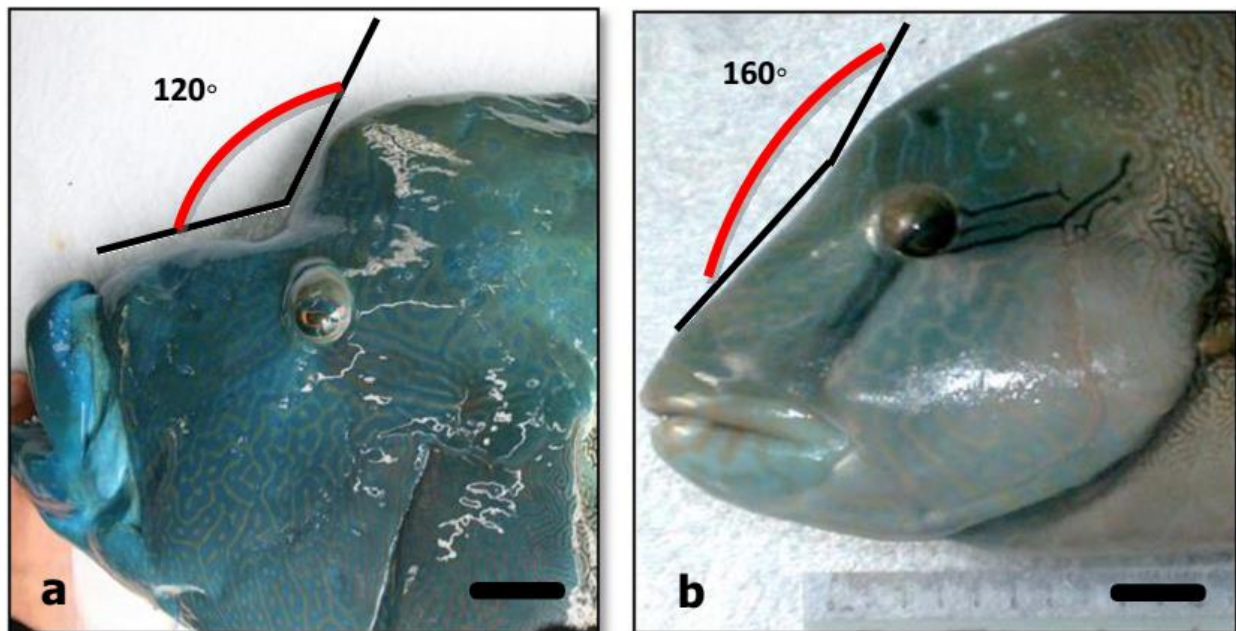


Figure 4 (a) Hump of male *C. undulatus*, (b) Hump of female *C. undulatus*

Figure1.13. morphological sex identification

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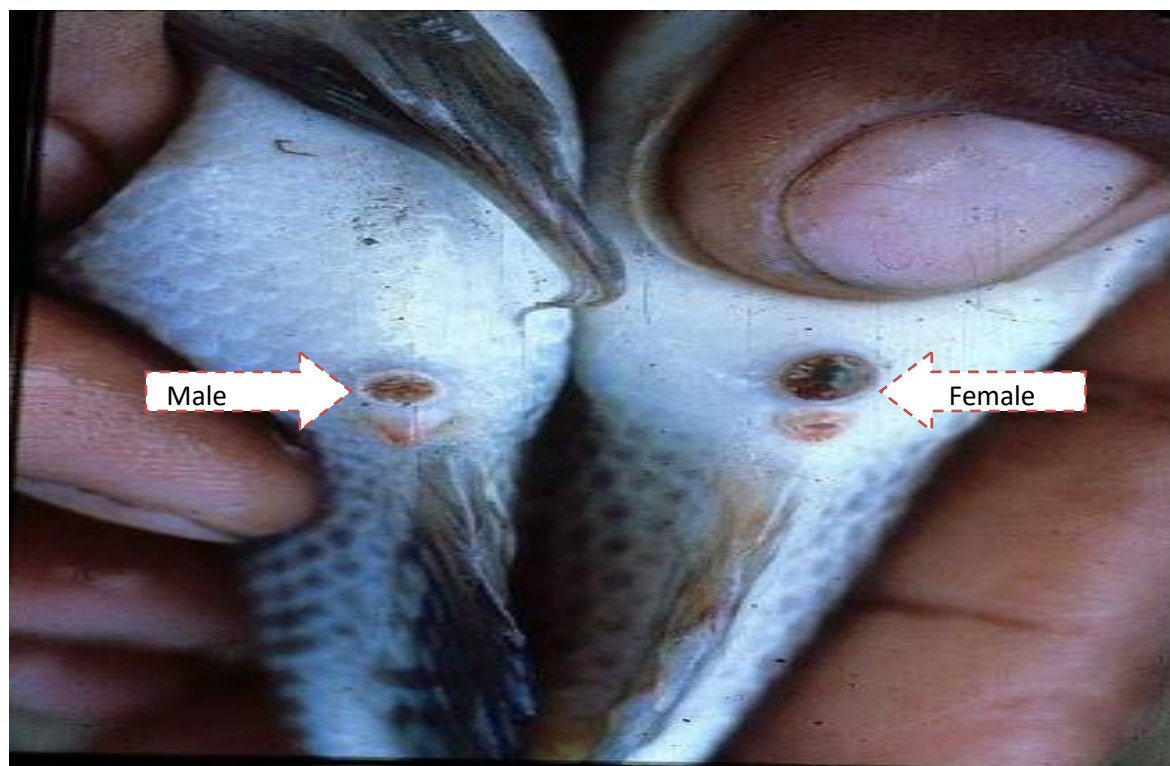


Figure 1.14. Identification of fish sex by observing sex organ

Self-check -1

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

I. Choose the best answer for the given questions(1 point each)

1. What the main function of operculum?
 - a. Detect movements in the water
 - b. control the direction of movement
 - c. covering and protecting the gills
 - d. serves as taking of food
2. Which one of the following is internal organ of fish?
 - a. Fish scale
 - b. Fins
 - c. operculum
 - d. Spinal Cord
 - e. b&c
3. Which organ fish is control centre of the fish, where both automatic functions (such as respiration) and higher behaviors occur
 - a. Mouth
 - b. Brain
 - c. Lateral line
 - d. Fins
 - e. operculum
 - f. liver
4. Among the following organs one is allow a fish to breathe underwater
 - a. Gills
 - b. Swim (Air) Bladder
 - c. Nostrils.
 - d. Eyes.
5. Among the following organ one is used filters liquid waste materials from the blood
 - a. Stomach And Intestines
 - b. Pyloric Caeca
 - c. Vent
 - d. Heart
 - e. Kidney
 - f. Muscles

II. Give short answers

1. Briefly discuss the difference between aquaculture and fishery (5)
2. What the function of swim (air) bladder? (3)
3. List the two method of sex identification of fish(2)

Note: Satisfactory rating 9 points Unsatisfactory – below 9 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -1

1. Conducting fish dissection for determination of internal organs

A. Tools and equipment's

- Suitable PPE
- Knives
- Forceps
- Table

B. Procedures/Steps/Techniques

- Wear appropriate PPE
- select fish for dissection
- Finding Fins of fish.
- Color, Scales, and the Lateral Line
- Remove head parts like eyes, operculum and mouth contents
- Making the cuts(dissect)
- Determining digestive organ of fish
- Determining leaver and heart, swim bladder and gills
- Clean and Keep exploring
- Check each and every equipments ,clean, disinfect, restore and properly dispose waste

LAP Test-1

Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task: identify external organ of fish

LG#23	LO#2- Prepare Facilities and Undertake Fish Stock Selection and Handling
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Instruction sheet

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

- Arranging labor resource requirements
- Selecting and checking suitable material, tools and equipment
- Preparing ponds, pens, cages and tanks
- Identifying fish species
- Identify fish stock selection criteria
- Performing fish stock handling activity
- Determining kinds of fish culture systems
- Identifying factors affecting health of fish stock
- Making plans to minimize risk and disease problem

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:

- Arrange labor resource requirements
- Select and checking suitable material, tools and equipment
- Prepare ponds, pens, cages and tanks
- Identify fish species
- Identify fish stock selection criteria
- Perform fish stock handling activity
- Determine kinds of fish culture systems
- Identify factors affecting health of fish stock
- Make plans to minimize risk and disease problem

Learning Instructions:

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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

2.1 Arranging Labor Resource Requirements

Fish farm workers help to breed and rear fish in ponds, tanks, cages or nets in the water and operate equipment, vehicle or vessel, specialized equipment and Transportation. Most fish such as salmon, trout or shellfish are farmed for food, but some are bred for perspective or for ornamental ponds. They are also called fish husbandry workers or fish farm technicians.

- Role of farm Works (labors)
 - ✓ feeding fish by hand or operating automatic feeding systems
 - ✓ grading fish by size, moving them to bigger tanks or cages
 - ✓ checking and maintaining water quality
 - ✓ checking fish for disease, preventing and treating infection
 - ✓ draining and cleaning tanks, filters and nets
 - ✓ repairing tanks or cages
 - ✓ getting fish ready for sale, gutting them and packing them in ice for transport
 - ✓ Maintaining buildings and equipment, involving basic joinery, plumbing and electrical work

- **Facilities for fish farming activities**

- 1) There should be good transportation system.
- 2) The farm should have electricity facility
- 3) The farm well facilitated for supplying necessary water throughout the year.
- 4) Establish the farm near river, canal or big streams.
- 5) There should be a market nearby.
- 6) The soil would be Silt; loamy and fertile soil is suitable for farm pond.
- 7) Concrete ponds & high stocking densities
- 8) Set vertically in the fish pond. Set horizontally along the outer perimeter of the fish pond. Turbine: Pumps are used for Pumping water into the ponds from surface water source or ground water. Also, they are used for draining ponds for final harvesting.
- 9) Provide right amount of food (availability of feed resources)

2.2. Selecting and Checking Suitable Material, Tools and Equipment

➤ Safety materials and equipments

- Boots
- Helmets
- Sunglass
- Sunhats
- Sunscreen Creams
- Gown
- Overalls
- Raincoat
- Gloves
- Waders
- Life Saver Jacket
- Polyethylene Bag

➤ Fish management, harvesting and processing materials and equipments

- Stocking materials (fry, fingerlings, egg, larvae)
- Fishing nets
- Ice box
- Refrigerator
- Measuring board
- Various needles
- Knives

➤ Water quality test materials and equipment

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- Thermometer
- pH meter
- Dissolved oxygen meter
- Conductivity meter
- Secchi disk
- Ammonia and Nitrate Test Kits
- Plankton nets
- Benthic sampler

The most commonly used equipment and recourse in construction of fish farms is described below

- Vessels
- Vehicles
- Trucks
- Trailers
- Cranes
- load shifting equipment
- Handling equipment
- Holding and transport equipment

2.3. Preparing Ponds, Pens, Cages and Tanks

2.3.1 Pond preparation

The vast majority of freshwater fish are raised in ponds. Water is taken from a lake, rivers, stream ground water or other natural source and is directed into the pond. The water either passes through the pond once or is discharged or it may be partially replaced so that a certain percentage of the total water in a system is retained and re-circulated. However, the pond systems yielding the highest fish production, only replace water evaporation and seepage losses and do not flow through. In general, water flowing reduces the production of pond systems in the tropics. Fish farming ponds range in size from a few hundred square meters to several hectares.

• Site selection

For pond construction you need to consider the following factors: soil type, quality and quantity of the water available and the requirements for filling and drainage of the pond.

✓ Soil

The quality of soil influences both productivity and water quality in a pond. However, it must also be suitable for dike construction. To determine soil suitability the two most important properties to examine are soil texture (particle size composition) and porosity or permeability

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(ability to let water pass through). The pond bottom must be able to hold water (have a low porosity like clay) and the soil should also contribute to the fertility of the water by providing

- **Water**

The availability of good water quality is important for all fish farming systems but water quantity is of even greater importance for land based fish farming systems. A constant water supply is needed, not only to fill the pond, but also to make up for the losses caused by seepage and evaporation

Investigation of the water sources is very important:

- What is the amount of water available?
- Is water available in all seasons, or is the availability different in the sequence of the seasons?
- Where are the water sources, are they likely to be polluted?

Ideally, water should be available all year round.

- **Landscape /slope:**

The land contour, and especially the land slope, determines the way to build the pond. The slope of the land can be used for the pond's drainage at harvest.

Totally flat land and a hilly terrain with a slope of more than 2%-4% are unsuitable for pond construction. All slopes between 2% and 4% can be used for pond construction. A 2% land slope means 2 cm drop in elevation for every meter of horizontal distance. If the slope is sufficient you can fill and drain by using gravity. However, you should take care to prevent erosion of the pond dikes.

Market: if the purpose of raising fish is for commercial purpose just like in large scale farms, market location and consumer preference and demand situations should be considered

Road and transportation: the farm must have access to road for transporting produce to market and bring different inputs to the farm

Other utilities: telephone, potable pipe water

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- Once the site is chosen, construction can begin on ponds and associated structures
- Pond construction should be completed during the dry season.
- For the highest-quality ponds, construction work should follow specific steps in a strict order.

Pond construction procedures

1. Planning pond layout or site selection
2. Cleaning of the site
3. Construct Water supply channel (water intake, the main supply canal & small canals)
4. Building Draining channel (So the bottom of the drainage canal must be much lower than the bottom of the pond.
This canal is usually built when the pond is finished
5. . Staking out the pond or mark the boundaries of the ponds or picketing
6. Building the dikes (The upstream dikes, Lateral dikes & the main dike, which is downstream
7. Pond bottom drain laying out
8. Building inlet, outlet and filtration
9. Making Decantation Pond
10. building other structures: Erosion fight, biological plastic, fence
11. Filling and conditioning the pond with water (1/2 it)
12. disinfecting the pond (30kg limestone for 20*10m pond) after filled with water
13. Fertilizing the pond (5-10kg of poultry waste & 20-30kg cattle manure /week for 20*10m pond).
Put in one side or two side corners of the pond.
14. putting or stocking fish in to the pond

2.3.2 Cage and Pen Culture

The terms enclosure, pen and cage are sometimes used interchangeably. Enclosure as used in this text refers to a natural or semi sheltered bay where the shoreline forms all but one side of the enclosure. In most cases, enclosures are separated from open water by a solid barrier or by a net or plastic mesh. The mesh size is typically small enough to retain the cultured fish but large enough to allow entry and exit of small fish and food organisms. Enclosures commonly range in

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size from about 0.1 ha to over 1,000 ha in surface area. Pens are man-made, constructed from bamboo, wooden poles or stakes driven into the substrate. Pens range in size from about 1 m² to several hectares in surface area. Cages are man-made and float off the bottom. They are much smaller than either enclosures or pens, ranging from about 1 m² to over 1,000 m² in surface area. Cage culture makes use of existing water

2.3.3. Tank Culture

Tanks are used for fry production or as temporary holding facilities for fingerlings or broodstock. Tanks may also hold aquarium fish for culture or for public display. Except for small operations, tanks are not normally used to produce food fish. Tanks must be durable, portable, easy to clean and sterilize, non-corrosive and affordable. Its interior should be smooth and non-toxic. Non-toxic seals such as epoxy, fiberglass resin paint or waterproof liners can be used.

2.4. Identifying Fish Species

Fish are found in almost every marine environment, from the deepest ocean trenches to mountain streams high above the sea level. They have been used as a major source of food since the beginning of recorded history.

Traditionally, extant fish species are divided into three classes. These are

- ✓ Agnatha (jawless fish),
- ✓ Osteichthyes (boneless fish), and
- ✓ Chondrichthyes (cartilaginous).

About 33,600 different species of fish are known. No other vertebrate groups show such species diversity. However, a far more detailed scheme also exists.

A. Salmon

Salmon is a member of the family Salmonidae. There are about nine species of salmon, all of which come from two different genera. Few other fish species are called salmon in different parts of the world but are not salmon (for example, Australian salmon and Hawaiian salmon). Today,

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salmon species are farmed extensively in different regions of the world but they are native to the Atlantic and Pacific oceans. Most of the salmon species are anadromous; a migration pattern in which fish migrates from ocean up onto freshwater to hatch or spawn.



Figure 2.1: salmon fish

B. Trout

Family: *Salmonidae*

Trout is a common name used to acknowledge a wide number of freshwater fish species that belong to three different genera; namely *Salmo* and *Salvelinus*, and *Oncorhynchus*. Patterns and coloration on trouts can vary based on their immediate environment, and many of its species exhibits intense coloration when they are about to breed. Apart from a few, all trout species are morphologically different from each other but show no signs of major genetic differences. Lake trout, which is widely popular in North America, can weigh more than 30 kg.

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Figure 2.2: Trout fish

C. Nile Tilapia

Scientific Name: *Oreochromis niloticus*

Nile tilapia is among the most important food fishes in the world. The species is native to northern Africa, though populations of Nile tilapia have been introduced in various other parts of the world. A Nile tilapia averages about 60 cm in length and rarely exceeds 5 kg in weight.

It appears, from various paintings, that the species was well known to the Ancient Egyptians. Nile tilapias are highly social. They even exhibit social hierarchies, where males are more dominant and usually have control over mating and food.



Figure 2.3: Nile Tilapia

D. Basa

Scientific Name: *Pangasius bocourti*

Basa is a widely consumed (by humans) fish species found mostly in mainland Southeast Asia. Regionally, the species is known by different names. In the UK, they are popularly known as “river cobbler”, while in Australia, they are called basa fish or swai.

In North America, the basa (from its native region) is mostly avoided. Environmental Research organizations like Ocean Wise, a part of the Vancouver Aquarium, have raised concerns about the potentially negative impact of basa on its immediate environment.



Figure 2.4: Basa fish

E. Common carp

Scientific Name: *Cyprinus carpio*

The common carp is a popular type of fish, used both as a food and in sport. Though common carp is native to Asia and Europe, it has been successfully introduced in other regions of the world.

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There is a striking difference in shape and size between domesticated and wild common carp. The domesticated ones tend to be bulky and larger sometimes as much as 4 times the wild common carps. The largest known specimen of the species weighed around 45 kg.

In a year, a single female common carp can lay close to one million eggs but only a few survive as they fall victim to a wide range of fungal and bacterial infections. Common carp are known to interbreed with goldfish.

Despite its popularity as fish food, the common carp is recognized as a pest in some parts of the world due to its highly destructive and invasive nature. In Australia, authorities are working on a few methods that would restrict their explosively growing population.



Figure 2.5: Common carp

F. Neon Tetra

ScientificName: *Paracheirodoninnesi*

Lifespan: 5-10 Years

The neon tetra is a popular aquarium fish, known for its vibrant color pattern. They are native to both clear water and black water streams in the Amazon basin but are also available in various

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Southeast Asian countries where they are farm-grown. The maximum length of a neon tetra is about 3.5 cm.

The species can be easily distinguished by two iridescent horizontal stripes on each side. The first is a shiny blue stripe that extends from its eye to adipose fin. The second one is a thick red stripe that originates from the middle of the body and ends near the back of its tail. These iridescent stripes become dull or grey at night.



Figure 2.6: Neon tetra fish

G. Atlantic Mackerel

Scientific Name: *Scomber scombrus*

The Atlantic mackerel is known by many names such as Scottish mackerel, Boston mackerel or just mackerel. They are commonly found in temperate waters of the North Atlantic Ocean. A mature Atlantic mackerel can grow up to 30 cm in length; however, the largest spotted specimen was about 60 cm long.

During a spawning season, a female Atlantic mackerel can produce as much as 450,000 eggs. Every year, about one million tonnes of Atlantic mackerel are caught by fisheries. One of the reasons why the species is in such high demand is because it is extremely rich in vital nutrients such as vitamin b, selenium, and Omega 3 fatty acid.

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Figure 2.7 Atlantic Mackerel

H. Atlantic Cod

ScientificName: *Gadusmorhua*

Lifespan: 25 Years

The Atlantic cod, or simply cod, is among the most consumed fish (by humans) in the world. They are found on both sides North Atlantic Ocean as well as parts of the Arctic Ocean including the North Sea and Baltic Sea.

The species can be recognized by a notable white stripe that runs along its lateral line and dark spots on the upper body. An average Atlantic cod measures about 1.2 meters in length and 40 kg in weight. The largest known cod on record, however, weighed about 96 kg. The Atlantic cod population registered a steep decline in the 1990s, due to its overfishing in the latter half of the 20th century, and it is still unable to fully recover.

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Figure 2.8 Atlantic Cod

J. Sword fish

Scientific Name: *Xiphias gladius*

Lifespan: 9 Years

Swordfish are recognized by their long, pointed beak or bill (rostrum). As a migrant species, swordfish are widely found in tropical as well as temperate regions of the world. They are known for their speed and agility, which allows them to catch prey more efficiently.

The largest swordfish, on record, measures about 4.5 meters in length and 650 kg in weight. Like few shark species, swordfish depends on the environment to regulate their body temperature. A specialized heating organ helps them raise the temperature to 15 degrees in tissues located around their eyes. Out of 25,000 species of bony fishes, Swordfish is one of the only 22 species that possess such heating mechanism.

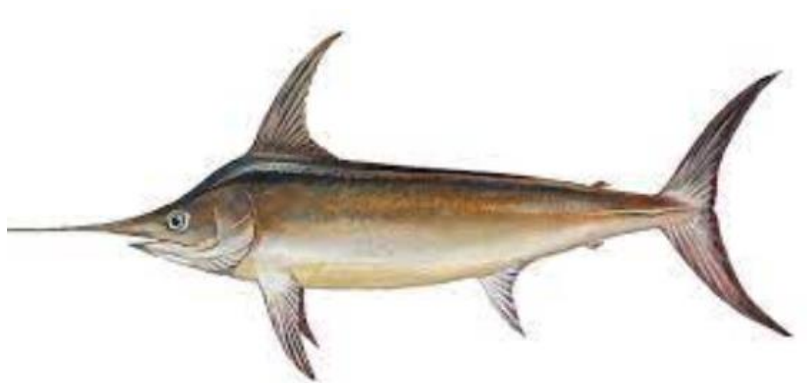


Figure 2.9: Sword fish

K. Wels cat fish

Scientific Name: *Silurus glanis*

Lifespan: 50 Years

Wels catfish, sometimes called sheat fish, is one of the extant species of catfish found in slow-flowing rivers and lakes around the Eurasian region. A small number of Wels catfish live in Chernobyl's long-abandoned cooling ponds. Surprisingly, they appear to be somehow unaffected by radiation.

At its full extent, a Wels catfish can measure up to 5 m in length and 300 kg in weight. It is the largest freshwater fish found in Eurasia. Large Wels catfish (above 15 kg) are a popular target for sport fishing due to their aggressive nature.



Figure 2.10: Wels cat fish

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L. Gold fish

Scientific Name: *Carassius auratus*

The goldfish is perhaps the most common aquarium fish in the world. If you have or ever had an aquarium, there is a big chance that you kept a goldfish as a pet.

Based on bodily characteristics and coloring, goldfish can be classified into 300 varieties. Most of the well-known goldfish varieties originated from China, where they were selectively bred for the first time about 1,000 years ago.

Carassius auratus is also one of the most well studied freshwater fish species. Multiple researches have shown that goldfish have powerful cognitive and learning abilities. In one such study, researchers found that goldfish can differentiate between different colors and shapes. They also have a memory span of three months.



Figure 2.11: Gold fish

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M. Siamese fish

ScientificName:*Bettasplendens*

Conservation Status: Vulnerable

The Siamese fighting fish, commonly known as the betta, is a common sight in aquariums around the world. Though betta specimens in aquariums often exhibit vibrant colors, they are usually dull brown and grey in appearance. On average, a Betta measures about 6.5 cm in length.

Bettas are territorially aggressive species. Both male and female bettas show a high level of aggression against each other, especially when confined to a small area. The species is native to Mainland Southeast Asian countries including, Thailand, Laos, Cambodia, and Vietnam.



Figure 2.12: Siamese fish

Table: 1.1 Common fish species in Ethiopia

No.	Scientific Name	Common Name	Local Name
1	Lates niloticus	Nile perch	Nech asa
2	Oreochromis niloticus	Nile tilapia	Qoroso
3	Barbus species	Barbus	Bilicha
4	Labeo species	Labeo	Barbo/Lebi
5	Clarias garipienus	Cat fish	Ambaza
6	Bagrus docmac	Bagrus	Kerkero
7	Polypterus bichir	Nile bichir	Eguwella
8	Gmnarchus niloticus	Gymnarchus	Wit
9	Malapterurus	Malapterurus	-
10	Crussian carp	Carp	Daba
11	Distichodus niloticus	Distichodus	Piro
12	Hydrocynus forskali	Hydrocynus	Weri
13	Heteroticus niloticus	Heteroticus	Ediwela
14	Citharinus	Citharinus	Ajaka
15	Synodontis species	Synodontis	Akoko

Source: EIRA

2.5. Identifying Fish Stock Selection Criteria

Criteria for species selection:

- a) Fast growing
- b) Market demand and high price
- c) Ability to counter diseases
- d) No competition for food
- e) Not predatory in nature
- f) Fish seed easily available

Determination of stocking density stocking density of fish depends on type of water body, earth type, depth, culture method and management. Other criteria to take into consideration include: Stocking density also depends on what size of fish you wish to harvest. If of same size then if stocking density is low then the fish will grow faster than when stocked at high density. If it is a new pond, then fish inhabiting top layer should be more and in case of older ponds, fish that feed in the bottom layer of the water body should be more

In shallow ponds where water is present for only 5-6 months, it should be stocked with fast growing fish such as tilapia, *P. goniontus*, silver carp, and *Cyprinus carpio* fish. Tilapia breed frequently releasing eggs 3-4 times a year and the fish seed can easily be harvested in seasonal ponds. In sandy soil pond, Thai shorputi (*P. goniontus*) and silver carp grow well. Within the same stocking density if different sizes of fish seed are released then at time of harvest different sizes of fish will be harvested

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2.6. Performing Fish Stock Handling Activity

The following task needs to be carried out after stock fish seed

- Application of supplementary feed
- Post-stocking fertilizer application
- Netting to remove excess plankton/aquatic vegetation
- Treating fish's growth and health
- Partial harvesting and marketing
- Management of on common problems in fish culture

Application of supplementary

In addition to the natural feed of the pond, it is necessary to give supplementary feed to ensure good production of fish. These are of two types:

- Pellet/granular feed – prepared by various companies and available in packets
- Granular/ball: such as oilcake, bran, dried fish powder, fishmeal etc.

Post-stocking fertilizer application

To get good production fertilizer should be given according to fish management process. Every 15 days or depending on the status of the pond's existing natural feed, fertilizer needs to be applied to the pond.

Table 2.1 Weekly/or as required rate of fertilizer application

Name of fertilizer		Amount for application(per decimal)
Organic fertilizer	Manure/compost	Manure:5-7kg/compost:8-10kg
Inorganic fertilizer	Urea	100-150gm
	TSP	50-75gm
	MP	25gm

✓ **Method of fertilizer application**

Cow manure (after gaseous decomposition) and TSP should be taken in a bucket with three times the amount of water and soaked for 12-14 hours. The TSP should be dissolved properly in the water. To this mixture urea should be added before applying to water body. Time of application is 10-11 in the morning on a sunny day sampling of fish for different management activities

Sampling is the method used to assess the growth, weight and health of fish being cultured by netting fish from the pond time to time.

Necessity of sampling:

- To know about the fish's growth
- To determine population of stocked fish
- To review and determine the amount of supplementary feed to be given
- Whether harvested fish are appropriate for sale
- Checking fish health, determination of any disease and to thus take necessary steps to solve this

Sampling method

To get proper results from sampling, 5-10% of the fish have to be caught or at least 10-20 pieces of every species of fish and prawn. The sampled fish that are netted are checked for overall growth, the fins, gills, scales, body slime. The fish body is also checked for any unusual marks or whether there are any parasites. According to species, every fish is then weighed and based on the average weight and stocked population of each of the fish species, following which these are added up to determine the total weight of fish in the pond is calculate

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2.7. Determine Kinds of Fish Culture Systems

On the basis of intensity of inputs and stocking density:

Extensive fish farming system: Extensive fish farming system is the least managed form of fish farming, in which little care is taken. This system involves large ponds measuring 1 to 5 ha in area with stocking density limited to only less than 5000 fishes/ha. No supplemental feeding or fertilization is provided. Fish depends only on natural foods. Yield is poor (500 to 2 ton/ha) and survival is low. The labour and investment costs are low and this system results in minimum income.

Semi-intensive fish farming system: Semi-intensive fish culture system is more prevalent and involves rather small ponds (0.5 to 1 hectare in area) with higher stocking density (10000 to 15000 fish/ha). In this system care is taken to develop natural foods by fertilization with/without supplemental feeding. However, major food source is natural food. Yield is moderate (3 to 10 ton/ha) and survival is high.

Intensive fish farming system: Intensive fish farming system is the well-managed form of fish farming, in which all attempts are made to achieve maximum production of fish from a minimum quantity of water. This system involves small ponds/tanks/raceways with very high stocking density (10-50 fish/m³ of water). Fish are fed completely formulated feed. Good management is undertaken to control water quality by use of aerators and nutrition by use of highly nutritious feed. The yield obtained ranges from 15 to 100 ton/ha or more. Although the cost of investment is high, the return from the yield of fish exceeds to ensure profit.

On the basis of fish species

Monoculture: Monoculture is a fish production system in which only one fish species is reared in a culture system. The major fish varieties reared in monoculture system are trout, tilapia, catfishes, carps, shrimp etc. Monoculture of high-value, market-oriented fish species in intensive

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system is a common practice throughout the world. Supplementary feeding is compulsory to ensure production.

Polyculture: Polyculture is a fish production system in which two or more different fish species are farmed or culture of fish along with some other aquatic animals like shrimp or prawn. In this system of culture species with different habitats and different food preferences are stocked together in such densities that there will be almost no competition for food or space. Polyculture practices give higher yield than monoculture under the same conditions for freshwater carp farming.

On the basis of enclosure

Pond culture: It is the most common method of fish culture. In this case water is maintained in an enclosed area by artificial construction of dike/bund, where aquatic animals are stocked and grown. Ponds are usually filled by rain, canal water and by manmade bores. They differ widely in shape, size, topography, water and soil qualities.

Cage culture: Cage culture is rearing of fish from juvenile stage to commercial size in a volume of water enclosed on all sides including bottom, while permitting the free circulation of water. Cage culture is more expensive and stands the risk of polluting the open water resource in which it is put. Algal bloom and escape of exotic species to open water are added hazards.

Pen culture: Pen culture is defined as raising of fish in a volume of water enclosed on all sides except bottom, permitting the free circulation of water at least from one side. This system can be considered a hybrid between pond culture and cage culture. Mostly shallow regions along shores and banks of the lakes and reservoirs are used in making pen/enclosure using net/wooden materials where fish can be raised. In a fish pen, the bottom of the lake forms the bottom of the pen. Pen has the advantage of containing a benthic fauna which serves as food for the fish and Polyculture can be practiced in pens as it is in ponds. The environment in fish pen is characterized by a free exchange of water with the enclosing water body and high dissolved oxygen concentrations. Pen culture is also expensive and stands the risk of polluting the open

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water resource in which it is put. Algal bloom and escape of exotic species to open water are added hazards.

Race-way culture: Raceway culture is defined as rising of fish in running water. It is a high production system in which fishes are grown in higher stocking density. Raceways are designed to provide a flow-through system to enable rearing of much denser population of fishes. Raceways are also expensive and the water in circulation has to be purified / renewed to avoid higher level of pollution and low level of oxygen.

On the basis of integration

Agriculture cum fish farming: In the fish integrated agriculture system, fish culture is integrated with agricultural crops such as rice, banana and coconut, thereby producing fish and agricultural crops. Agriculture based integrated systems include rice-fish integration, horticulture-fish system, mushroom-fish system, seri-fish system.

Animal husbandry cum fish farming: Livestock integrated fish farming system includes cattle-fish system, pig-fish system, poultry-fish system, duck-fish system, goat-fish system, rabbit-fish system. In this integrated farming the excreta of ducks, chicks, pigs and cattle are used directly in ponds to increase plankton production which is consumed by fish or serve as direct food for fish. Hence, the expenditure towards chemical fertilisers and supplementary feeds for fish ponds are totally avoided reducing the production cost.

2.8. Identifying Factors Affecting Health of Fish Stock

In aquaculture farms, risk can be introduced by many factors. For instance; failure in the aeration systems may lead to lethal fish. Dissolved oxygen (DO) concentrations during the evening hours, resulting in a massive fish kill.

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- **Environmental factor**

Mainly include adverse chemical conditions of the water. Although pollutants are common environmental stressors, extreme conditions or changes in 6 water quality parameters such as dissolved oxygen, ammonia, hardness, pH, gas content and partial pressures, temperature etc .

- **Physical factor**

Physical factor include those that involve handling, crowding, confinement, transportation and other forms of physical disturbance. Many such manipulations are common to the intensive husbandry of fish. Wild fish may also be under stress from physical disturbances when they encounter man made obstacles such as fences, weirs, and ladders.

- **Biological factor**

Biological factor can be manifest in dominance hierarchies which develop between individuals within boundaries such as experimental tanks or possibly in natural environments. Disease pathogens can also be considered as biological factor.

2.9. Making Plans to Minimize Risk and Disease Problem

The ways of prevention and contingently of medical treatment of fish are very specific and often different from those in warm-blooded animals. They require a thorough knowledge of the environment of fish. Preventive arrangements are consisting of complicated set of treatments elaborated on the base of a good knowledge of the aetiology of disease and host (fish) biology. It concerns the elimination or restriction of infection (invasion) sources and the possibilities of its further expansion likewise the enhancement of condition of fish organism in the way to be able to withstand the infection (invasion).

The prevention is of basic importance in diseases elimination. No specific therapeutics were developed for a number of diseases up to now and the result of the application of effective, experimentally verified medicaments, is often reversely affected by the operational conditions and/or the technology of rearing. The medical treatment becomes economically unrenumerative in this way.

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Generally accepted and effective principles are as follows:

a) Providing water sources free of pathogens

Underground waters are the most suitable water sources free of pathogens. These sources are limited both for trout farms and hatcheries and for other special fish culture units at present. The surface water from rivers and channels is used as the source of inflow water in most cases. In these situations, suitable filters can partially reduce the numbers of invasion stages of parasites in inflow water, above all when supplying smaller reservoirs with intensive culture. Bars are usually placed before these filters to separate rough particles. Sand filters are consisted of a set of sedimentation divisions terminated by filter with fibre and sand. These types of filters catch above all the heavier parasite stages unable to move actively (e.g. spores). Lower efficiency is registered in elimination of moving parasites like e.g. infusorians.

It is very profitable to supply the individual ponds and/or reservoirs independently, not through flowly. The water from each pond or reservoir should be drained separately and should not flow into any other. Especially quarantine ponds and other reservoirs can be separated by this way.

b) Protection from the transfer of pathogens

This principle means above all the transfer of pathogens by uncontrolled transport of fish and spawns. The transport of fish with unknown health condition is to be avoided in principle. All transported fish are to be accompanied by veterinary certificate confirming that fish were examined before transporting them, they are healthy and originate from the environment in which no important transfer diseases appear.

c) Disinfection of ponds, fish culture units and equipment

Disinfection is of a big importance in prevention and elimination of fish diseases. Preventive disinfection protects the fish stocks against pathogens. Hygiene of environmental conditions for

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fish is improved by this way. Focal disinfection is performed for control of the focus of dangerous fish disease.

d) Optimization of environmental conditions

The Optimization of natural environmental conditions is the main pre-condition how to ensure the good health condition of stock during the rearing period. The following principles must be ensured optimal water quality without stressing physico-chemical effects. Keeping the oxygen concentration on optimal level and protection against water pollution are of special importance,

Maximum development of natural food resources by the adequate interventions, feeding fish by supplementary feed mixtures in sufficient amount and quality (the attention should be paid on the quality of individual feed components and biofactors), basic preventive arrangements protecting the early developmental stages and young fish from bacteria and protozoan's, including sufficient amount of natural food of appropriate size and species composition.

Inadequately high stocking density results in stress behavior, worsened condition and resistance, and makes the expansion of diseases easier. The stocking density is of special importance in trout farming and fish culture in special intensive units (but also in ponds). Prevention from stress situations is evoked by other factors, above all manipulation during fishing out, transport and long-term storage.

e) Regular control of health condition and preventive treatment of fish

Preventive control of health condition is to be carried out in hatcheries and early fry rearing units twice a week, and in highly productive intensificated ponds, trout farms and fish culture units with recycling warmed water weekly. Other stocks (esp. in usual pond culture) are investigated monthly.

Health condition of fish is always to be controlled before fishing out, transporting fish and stocking. Preventive treatment can be suggested on the base of investigational results. This

treatment is performed above all by the application of medicaments into the water environment and feeding by medicated feeds.

Self-check -2

Name..... ID..... Date.....

I. Choose the best answer for the given questions (2 point each)

1. Among the following option which one is not fish species class?
 - a. Agnatha (jawless fish)
 - b. Osteichthyes (boneless fish)
 - c. Nile tilapia
 - d. Chondrichthyes (cartilaginous)
2. Which one of the following is fish stock selection criteria?
 - a. Fast growing
 - b. No competition for food
 - c. Ability to counter diseases
 - d. Fish seed easily available
 - e. b&d
 - f. all
3. _____fish farming system is the least managed form of fish farming, in which little care is taken.
 - a. Semi-intensive
 - b. Intensive
 - c. polyculture
 - d. extensive
4. Among the following on is not physical factor of water quality
 - a. Handling
 - b. Confinement
 - c. Transportation
 - d. pathogenic organisms
5. Which one of the following fish farming system is on the basis of fish species
 - a. Monoculture
 - b. Pond culture
 - c. Intensive
 - d. Agriculture cum fish farming

II. Give short answers

1. List at least four Fish stock handling activity (3)
2. What is Polyculture?(2)
3. Write six water quality parameters (3)
4. Write and discuss fish farming system on the basis of integration (5)

Note: Satisfactory rating 15 points Unsatisfactory – below 15 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -2

1. Applying organic fertilizer on fish pond after stocking

A. Tools and equipment's

- Suitable PPE
- Rope
- Dung or compost
- Wood
- Medaberia/bag

B. Procedures/Steps/Techniques

- Wear appropriate PPE
- Prepare materials and equipments needed
- Select types of dung/compost
- Determining amount of application
- Slit one of the two flat sides of the bag in the form of a letter “H.”
- Peel the resulting flap back.
- Lay the bag in shallow water with the open side toward the surface.

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- Disperse bags as much as possible.
- Follow label directions for the application of slow release pond fertilizer.
- Accomplish work and record

LAP Test-1

Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task: apply limestone on prepared pond

LG#24	LO#3- Under Take Management and Monitoring Water Quality
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Instruction sheet

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

- Identifying advanced water quality management
- Identifying routine water quality and environmental parameters
- Making repairs and calibrations
- Planning operational guidelines
- Communicating effectively to staff

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:

- Identify advanced water quality management
- Identify routine water quality and environmental parameters
- Make repairs and calibrations
- Plan operational guidelines
- Communicate effectively to staff

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. Identifying Advanced Water Quality Management

Water quality is the most important factor affecting fish health and performance in aquaculture production systems. Good water quality refers to what the fish wants and not what we think the fish wants. Different fish species have different and specific range of water quality aspects (temperature, pH, oxygen concentration, salinity, hardness, etc.) within which they can survive, grow and reproduce.

3.2. Identifying Routine Water Quality and Environmental Parameters

1. Physical aspects of water quality

A. Temperature & light

Fish are "cold-blooded" and therefore assume the temperature of the water they live in. Water temperature is therefore the most important physical factor for fish survival and growth. Body temperature, and thus the water temperature, has an effect on level of activity, behavior, feeding, growth, and reproduction of the fish. When water temperatures are outside the optimum range, fish body temperature will either be too high or too low and fish growth will be affected or the fish will even die.

B. Turbidity

Turbidity is result from suspended solids (clay) or plankton (phytoplankton & zooplankton).

Clay turbidity in pond can be controlled by: Treating affected ponds with animal manures at rates of 2.4 T/ha every three weeks or agricultural limestone, using recommended rates to improve soil pH and water alkalinity. Avoiding stocking species that stir up pond bottom mud e.g., the common carp. Designing water supply system such that muddy water can be diverted away from ponds.

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2. Chemical aspects of water quality

- pH
- Alkalinity
- Hardness
- Dissolved gases: oxygen, carbon dioxide, nitrogen, ammonia
- Salinity
- Essential nutrients: N, P, K

1. **Soil pH and acidity:** The measure of the alkalinity or acidity of water is expressed by its pH value. The pH value ranges from 0 to 14, with pH 7 indicating that the water is neutral. Values smaller than 7 indicate acidity and greater than 7, alkalinity

- Waters ranging in pH from 6.5 to 8.5 (at sunrise) are generally the most suitable for pond fish production.
- Most cultured fish will die in waters with pH below 4.5 and 10 or above.
- Measured by PH meter

2. Dissolved oxygen in fish ponds: is the amount of oxygen in pond water that is available to be used by fish. The acceptable range for freshwater fish is 5 – 7mg/L. Dissolved oxygen (DO) is essential for respiration and decomposition. Dissolved oxygen in water comes from atmospheric oxygen and photosynthesis. The atmospheric oxygen diffuses and dissolves into the water.

3. Ammonia: Comes from the decomposition of wastes. It is very poisonous to fish and will cause death. Levels should be below 0.05mg/L.

4. **Nitrite:** Very poisonous to fish and causes Brown blood disease, which kills fish. Must be below 0.01mg/L

5. **Hydrogen Sulphide:** Colorless toxic gas with an odor similar to rotten eggs. It kills fish by interfering with respiration

3.3. Making Repairs and Calibrations

Calibration and repair services differ in terms of expertise. Some companies specialize in the preventative maintenance or calibration of acoustic, avionic, environmental, fiber optic, marine, medical, and geophysical instruments. Others troubleshoot and adjust displays and panel meters, electrical and electronic test equipment, industrial computers, and process instruments. Calibration and repair services that rebuild, replace, and repair analytical instruments and laboratory equipment are commonly available.

Analytical instruments include shakers, environmental test chambers, laboratory ovens, mechanical test equipment, chillers, baths, and sample preparation equipment. Laboratory equipment includes spectrometers, microscopes, chromatographs, pH meters, TOC analyzers, colorimeters, titrators, diffractometers and other specialized instruments.

A. Dissolved oxygen meter

Description-A dissolved oxygen meter is used to measure the level of dissolved oxygen in water. It consists of a probe and a meter. The probe is lowered into water and gently moved from side to side, and then a reading is taken from the meter

Calibration and use

Follow these steps to calibrate and use a dissolved oxygen meter:

1. Turn the meter on and inspect the probe for damage.
2. Place the probe in a holder that contains a sponge which has been moistened with distilled water.
3. Allow time for the probe to "warm up" and for the air in the probe holder to become saturated with water vapor.
4. Set the altitude on the meter.
5. The probe will now be calibrated to 100% saturation.
6. Set the salinity of the water sample that you want to measure on the meter.
7. Put the probe into the water sample and gently move it from side to side.



8. Wait until the reading on the meter becomes stable, and then record the result.
- 9.

B. P^H meter

Description-A pH meter is used to measure the *pH* in water. It consists of a probe and a meter. The probe is lowered into the water sample and the pH of the sample will be displayed on the meter.



Calibration-Follow these steps to calibrate a pH meter:

1. Turn the meter on.
2. Connect the probe to the meter.
3. Place the probe in buffer 7 solution and wait for the reading to stabilize.
4. Press the "Cal" button to enter the calibrate mode.
5. Press the "Con" button to set the meter to pH 7.
6. This method can be repeated for a buffer 4 and/or a buffer 10 solution.
7. Press the "Meas" button and Measure will appear on the display screen.
8. Rinse the probe with distilled water.
9. The pH meter is now calibrated and ready for use.

A. Salinity meter

Description-A salinity meter is used to measure the *salinity* of water. A salinity meter has a probe that detects the salinity of a water sample, and a meter that displays the salinity of the water in parts per thousand.

Calibration-Most salinity meters don't require calibration. However, some salinity meters require the temperature of the water sample to be set on the meter before it can measure the salinity of the water sample.

Calibration: To use a salinity meter

1. insert the probe into the water sample so that the probe is completely submerged
2. allow time for the reading on the meter to become stable

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- Record the value of the reading on the meter once it stops changing.

B. Ammonia test kit

Description and use-An ammonia test kit is used to measure the level of Choose another item ammonia in a water sample. It comes with two separate reagents that are added to the water sample.

Calibration: To use the ammonia test kit

- fill the container with the water sample
- add the first reagent to the water sample
- add the second reagent, then wait for the water to change colour
- compare the color of the water sample to the color chart that comes with the test kit
- Find the color on the chart that matches the colour of the water sample, and take a reading of the value on the chart. This is the amount of ammonia in the water sample.

C. Nitrite test kit

Description and use-A nitrite test kit is used to measure the amount of *nitrite* in a water sample. The test kit often comes with two reagents and a sampling container.



Calibration: To use the nitrite test kit

- fill the container with the water sample
- add the first reagent to the water sample
- add the second reagent and wait for the sample to change color
- compare the color of the water sample to the color chart that comes with the test kit
- Find the color on the chart that matches the color of the water sample, and take a reading of the value on the chart. This is the level of nitrite in the water sample.

D. Sensitive electric Balance

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Description-A balance (or scales) is used to weigh fish or feed. They are Choose another item usually electronic and have a keypad, a digital display and a flat metal surface to hold the fish being weighed.

Calibration and use- To use a balance:

1. Turn the balance on
2. Press the button marked TARE or ZERO; this will set the balance to zero.
3. Place the item you wish to weigh on top of the plate and wait for a result.
4. Record results

3.4. Planning Operational Guidelines

During all life and production stages, sufficient water supply and good water quality is essential for the welfare of fish. Water quality refers to the physical and chemical environment that the fish are exposed to and comprises a complex set of interacting factors. Knowledge and practical experience of fish farming like;

- b. Methods for inspection of fish
- c. Welfare indicators including fish behaviour and physiology, the environment, and general signs of disease and poor welfare
- d. Operation and maintenance of equipment relevant to fish welfare
- e. Systems for management of water supply and quality control
- f. Methods for the management of situations frequently encountered during the containment of fish

3.5. Communicating Effectively to Staff

Before entering a production area, all staff should put on their protective clothing (e.g. overall, coat, gloves, boots, apron); then both boots and hands should be disinfected. It should be strictly forbidden to enter the area without the authorised protective clothing. No person should exit the facility wearing a working outfit, even if they have transited through the sanitary barrier and disinfected their shoes and hands.

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Self-check- 3

Name..... ID..... Date.....

I. Give short answers

1. What are physical aspects of water quality?(3)
2. What are chemical aspects of water quality?(3)
3. What is calibration?(3)
4. What is repairing (2)
5. Discuss the function of determining water PH in fish rearing (3)
6. List and discuss water quality parameters (10)
7. What the function of sensitive balance?(1)

Note: Satisfactory rating 17 points Unsatisfactory – below 17 points

- You can ask you teacher for the copy of the correct answers.

Operation Sheet -3

1. Applying organic fertilizer on fish pond after stocking

A. Tools and equipment's

- Suitable PPE
- 2 flasks with stoppers
- a calibrated pipette
- a graduated pipette
- manganese sulfate
- water
- alkali-iodide-azide
- sulfuric acid,
- sodium thiosulfate
- a starch solution

B. Procedures/Steps/Techniques

- Wear appropriate PPE
- Gather your materials.
- Collect a sample.
- Mix manganese sulfate with the water.
- Add alkali-iodide-azide to the sample
- Fix with sulfuric acid
- Titrate 201 ml of sample
- Introduce starch solution
- Continue to titrate.
- Understanding and recording the results
- Accomplish work, clean, disinfect and restore materials and equipments

LAP Test-3

Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **3** hour. The project is expected from each student to do it.

Task: 1 Calibrate PH test of water

Task: 2 perform PH test of water

LG#25

LO#4- Practices Feed and Feeding of Fish

Instruction sheet

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

- Identifying fish species feeding habits
- Assessing fish feed sources
- Determining Fish species nutritional requirements
- Performing Feeds selection, sampling, analyzing, computing and recording based on daily feed ration
- Determining Feeding rate of fish
- Assessing Feeding methods and feeding principles of fish

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:

- Identify fish species feeding habits
- Assess fish feed sources
- Determine Fish species nutritional requirements
- Perform feeds selection, sampling, analyzing, computing and recording based on daily feed ration
- Determine Feeding rate of fish
- Assess Feeding methods feeding principles of fish

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 -4

4.1. Identifying Fish Species Feeding Habits

They can be classified in to three based on their feeding habits Carnivorous (e.g., Nile perch eats meats & other fishes. There are four basic eating groups among fish: carnivores, herbivores, omnivores and Limnivores. Each group of fish needs to be fed in a particular way.

A. Carnivores (meat-eating) fish.

Whilst they will never damage your plant life, you will be lucky if you do not find any of the smaller fish disappearing mysteriously. If there are smaller fish in the aquarium with a carnivore, sooner or later the smaller fish will end up in the carnivore's stomach. Carnivores need at least 45% of protein in their food, without which they become severely malnourished. Although many of the prepared foods are spiked with extra protein to help such fish, carnivores are happiest when they are fed live food like worms.

➤ Recommended food for the carnivores would be:

- ✓ Earthworms, Red worms, Tubifex worms and Daphnia.
- ✓ Larvae of mosquitoes or fruit flies.
- ✓ Oysters, shrimps, clams and other fish.
- ✓ Lean chicken, turkey and salmon.

B. Herbivorous (plants eating fish)

These fish need to graze very often, and whether they are fed regularly or not, they will nip at your plant life. Many aquarists who like herbivores keep plastic plants in their aquarium. If real plants are used, the aquarium runs a risk of having a badly mauled garden. It is a good idea to feed these fish with fresh veggies. Planting leafy vegetables like spinach into the substrate is a

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good trick. The fish will keep nipping at these. Care should be taken to remove the frayed plants before they start decaying and rotting in the water.

➤ Recommended foods for this variety are:

- Cucumber, peas and potatoes.
- Vegetable flakes come in a variety of flavors.
- Algal flakes will also be a favorite among this kind of fish.

C. Omnivore fish will eat pretty much anything,

Dangerous to plants as well as to other smaller creatures in your aquarium. They are also voracious eaters and aquarists can sometimes mistake their eating frenzy for hunger. It is a common tendency to overfeed these species, and they do tend to pile on the fat very quickly if overfed.

D. Limnivores are also known as mud-eaters.

Limnivores fish feed mainly on algae and on the microorganisms in your aquarium. These kinds of fish are constantly eating, and can be given pellets and algae based foods.

4.2. Assessing Fish Feed Sources

Fish feed resources are expected to include low-trophic species produced or cultivated in the ocean, such as mesopelagic fish and zooplankton (krill, calanus and amphipods), polychaetes, macroalgae and crustaceans. Ingredients can also be produced from land-based production, such as microbial ingredients (bacteria, yeast and microalgae), insects and animal by-products [ABPs; poultry meal, meat and bone meal, blood meal and hydrolyzed feather meal (HFM). Resources derived from other commercial production, such as biodiesel, brewing and distillation industries, and by-products from the agriculture industry, can also be refined and used as feed ingredients. Generally fish feed recourse is classified natural and artificial

A. Natural feed

Natural food: The natural productivity of a pond or water as a result of fertilizer application give rise to feed such as small insects, plants and zooplankton. These are so small, they cannot be

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seen with the naked eyes, they can be perceived however by the color of the water. The color can be light green, brownish green or light brown. The natural food is two types:

- ✓ Flora : Very small algae type plants (phytoplankton)
- ✓ Fauna: Very small insects and bugs (zooplankton)

B. Artificial feed

In addition to the natural feed of the pond, it is necessary to give artificial (supplementary) feed to ensure good production of fish. These are of two types:

- Pellet/granular feed – prepared by various companies and available in packets
- Granular/ball: such as oilcake, bran, dried fish powder, fishmeal etc

4.3. Identifying Fish Species Nutritional Requirements

Fish to grow well and be able to prevent being afflicted by disease; it requires a complete nutrition in the feed they get. Fish nutritional requirement is simply understood as protein requirement. Nutritional requirement of fish depends on their age and species. Fish get 5-15% of their protein requirements from natural feed and therefore it is sufficient if the supplemental feed contains 25-30% protein nutritional details of various feed:

Table.4.1 Nutritional details of various feeds based on research

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Name of feed material	Nutritional value (%)		
	Protein	Carbohydrate	Fat
Rice bran	11.88	44.42	10.45
Wheat bran	14.57	66.36	4.43
Mustard oilcake	30.33	34.38	13.44
Sesame oilcake	27.20	34.97	13.18
Fish meal (A- grade)	56.61	3.74	11.22
Blood meal	63.15	15.59	0.56
Meat and bone meal	50-55	-	12.36
Wheat flour	17.78	75.60	3.90
Molasses	4.45	83.62	-
Corn	7.7	82.7	2.80
Soya bean oilcake	52.5	32.1	3.2

Table. 4.2 Formula to prepare supplemental feed at least cost

Feed material	Amount of feed (%)	Protein (%)		Necessary amount of feed material per kg of complete feed (gm)	Price per kg (tk)	Price of necessary feed material per kg of (tk)
		In the feed material	In the feed (%)			
Fish meal A grade	10	56.61	5.66	100	40	4.00
Mustard oilcake	25	30.33	7.58	250	25	6.25
Soya bean oilcake	10	52.5	5.25	100	26	2.60
Rice bran	50	11.88	5.94	500	18	9.00
Wheat	5	17.78	0.88	50	20	1.00
total	100		25.31	1000		22.85

*the price may vary according market price

For carp Polyculture in seasonal ponds, supplementary feed may be given as balls made from equal amounts of rice bran, wheat bran and oilcake. 24-48 hours before making the final feed, the oilcake should be soaked and with this the rice bran and wheat bran should be made mixed and made into balls.

Table 4.3 Amount of feed material for carp fish supplementary feed

Feed material	Example 1		Example 2	
	Utilization rate (%)	Gm/kg food	Utilization rate (%)	Gm/kg food
Wheat bran	-	-	25	250
Rice bran	45	450	30	300
Mustard oilcake	45	450	25	250
Fish meal	-	-	10	100
Wheat/molasses	10	100	10	100
total	100	1000	100	1000

Apart from feeding on supplemental feed, fish such as grass carp and shorputi (*P. goniontus*) feed regularly on duckweed, algae, soft grass, banana leaves, potato leaves, drumstick leaves, papaya leaves, Napier grass and various winter vegetables. On a daily basis, grass carp can eat up to 40-45% of its body weight. As fish grow larger, the rate of feeding slows down but overall total feeding increases. Below is given daily feed application in fish culture management

Table 4.4. Daily feed requirement

Total weight (gm)	Daily feed amount (%)
1-5	10
5-10	5
10-50	4
50-500	3

4.3 Performing Feeds selection, sampling, analyzing, computing and recording based on daily feed ration

4.3.1 Selecting feeds

➤ Criteria for selection of feed:

- ✓ Easily available feed
- ✓ Cost and nutritional benefits
- ✓ High feed conversion ratio

- ✓ Financial ability of the farmer

4.3.2 Sampling feeds

In cases of dry feeds, no specific pretreatment is usually necessary. Of course, any microbiological or chemical contamination should be avoided during the sampling

➤ Plankton sampling

Several devices exist for the study and analysis of phyto- and zooplankton, such as:

- ✓ Phytoplankton sampler (large sized water sampler to collect algae and for primary production analyses)
- ✓ Zooplankton sampler (large sized water sampler to collect zooplankton) to study
- ✓ zooplankton composition and biomass Zooplankton towing net (cone shaped net with 100-250 ug mesh size) to study zooplankton composition
- ✓ Zoobenthos sampler (grabs, box-corers, e.g. Ekman, Van Veen, dredges and hand• nets) to study benthic infauna and epifauna

4.4. Identifying Feeding rate of fish

Optimal feeding rate and frequency are essential in maximizing conversion rate of feed to shrimp. The accuracy of determine the feeding rate is based mainly on the estimate of the density and size of the stock. The more common methods used to determine the feeding rate is:

a. Adjustment of feeding rate through visual observation of left-over feed

This is employed by the use of feeding tray. Five to ten percent of the feeding ration is placed at the feeding tray while the rest are broadcasted into the pond surface. Prior to feeding, the tray is lifted to observe whether the previously given feed is totally consumed. If so, the previously given amount of feed is considered insufficient. Hence, an additional 2–5% of the feeding ration is added. However, if the feed is not totally consumed, the previous feeding rate is reduced depending on the left-over feed. This method is very subjective depending on the experience and skill of the operator.

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b. Periodic determination of the stock density for appropriate feed ration -

This is done by the use of cast net. The stock density estimation is described in earlier section. The stocks are sampled at 15–30 days interval. The feed is given at 5–10% of the estimated shrimp biomass per day.

c. Feed ration based on assumed density

This method of computing feed ration is based on the estimated survival rate. Most culturists assume 100% survival for the first month of stocking, 90% for the second month and 80% for the third month. Feeds are given at fixed rate of 5–10% of the estimated shrimp biomass per day. Although the food requirement for maintenance and growth increases with increasing biomass, the relative food requirements per unit weight of animal decreases with increasing shrimp size. Hence, a sliding feed ration of 10% of the estimated shrimp biomass and 4% for the fourth month has been adopted.

The common feeding frequency adopted is 2–5 times a day. Most culturists feed their stock every morning and afternoon only. However, experiments have shown that apportioning daily feed ration several times a day improve feed conversion efficiency as it reduces feed wastage, ensures feed quality and more even distribution to the stock. If the stocks are to be fed 5 times a day, two should be given in daytime and 3 at night as the shrimps are more active when dark.

4.5 Determining Feeding Methods and Principles of Feeding of Fish

A. Distribution of supplemental feed

Fish feed during the day and therefore on a daily basis the necessary daily feed should divided into two equal portions.

- ✓ The first portion should be given around 10-11 in the morning and
- ✓ Second portion 3-4 in the evening.

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To prevent wastage of feed, it is best to give the feed in a feed tray. Using a feed tray is effective to measure how much feed has been given or eaten as well as prevent wastage.



Figure 4.1 Distribution of supplemental feed

B. Making a feed tray:

The feed tray is 9 square feet (3ft x 3ft) bamboo frame to which a mosquito net is attached and hung like a dharma/lift net four inches high. In a 30 decimal pond, two trays should be made, in 60 decimal pond 4 trays and 100 decimal 6 trays. If feed tray is used it should be cleaned regularly. If a feed tray cannot be used, then a place along the pond bank should be selected where the feed can be given.

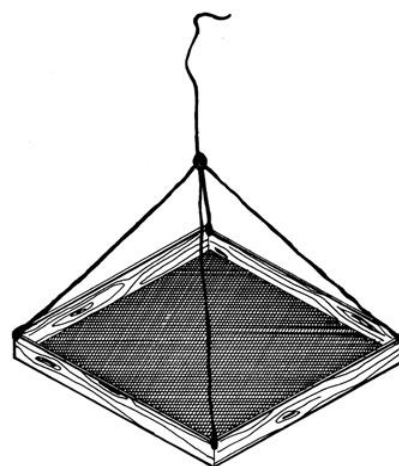


Figure 4.2 making a feed tray

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C. Providing green food:

Feed for grass carp or shorputi should be given in bamboo frame which might be round or square (feeding ring) and the green vegetation that they feed on should be given in this ring. The frame should be placed 1-2 feet from the ponds edge. The frame is usually 1m² or 10 square feet in a 30 decimal pond. If banana leaves are given, these should cut into small pieces. When the green feed finishes, it should be given again

Self-check- 4

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

I: Chose the best answer (2point each)

1. What is the Select criterion of supplementary feeds?
 - A. Of good nutritional values
 - B. Easy to handle and store
 - C. Cheap in price
 - D. Well accepted by the fish plan to feed
 - E. All
2. What is the objective of feeding fish?
 - A. To provide the nutritional requirements for good health
 - B. To optimize growth
 - C. To optimize yield
 - D. To optimize profits
 - E. All

II. Give short answers

1. List and discuss feeding habits of fish(3)
2. List recommended food for the carnivore's fish(5)
3. What is feed resources of fish?(3)
4. Write selection criteria of fish (2)
5. Discuss feeding rate and feeding method of fish (8)

Note: Satisfactory rating 15 points Unsatisfactory – below 15 points

You can ask you teacher for the copy of the correct answers.

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Operation Sheet -4

• Procedures Techniques of Artificial Fish Feed Preparation:

A. Material tools and equipment's

- ✓ Necessary PPEs
- ✓ Feed ingredient's
- ✓ Weighing balance
- ✓ Bucket
- ✓ Pelletizer
- ✓ Sieve

B. Procedures of steps of feed preparation

- ✓ Take correct amount kg of fish meal
- ✓ Take correct amount kg of Wheat flour
- ✓ 1% of Cod liver oil
- ✓ 1% multivitamins
- ✓ Mixed properly
- ✓ Fish meal () + Wheat flour ()
- ✓ Add water (200-400 for 1 kg)
- ✓ Boil or sterilized the mixed dough
- ✓ Cold down add oil and vitamins
- ✓ By using pelletizer make pellet of (1-3mm) depending on the mouth size of the fish
- ✓ Dry at 45degree in cold dark room
- ✓ Break the pellets into small pieces
- ✓ Sieve the food to separate out between layers and small food size.

LAP Test-4

Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **3** hour. The project is expected from each student to do it.

Task: 1 perform feeding of artificial of fish

LG#26

LO#5-Undertake Harvesting and Handling of Fish Stocks

Instruction sheet

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

- Marking infected pond
- Determining fish harvesting and handling methods
- Seining Pond and cages
- Determining fish processing methods
- Processing fish waste management

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:

- Mark infected pond
- Determine fish harvesting and handling methods
- Seine Pond and cages
- Determine fish processing methods
- Fish process waste management

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”

Instruction sheet-5

5.1 Marking infected pond

Most pond owners are under the impression that fish diseases are primarily introduced and passed on by fish. However, this is rarely the case, and it's usually up to whether your fish are healthy. In fact, more than 90% of the diseases are caused by inappropriate living conditions such as inadequate nutrition and poor water values.

Another sad reality is that illness in fish, unlike animals, are harder to detect, and often subtle changes in their behavior can signal that something is wrong. Fish diseases are difficult to spot without close inspection, but many conditions and diseases bring about a change in behavior for sure. So let's take a closer look at some of the signs and symptoms to look out for and how to treat fish diseases

The first warning sign that something is wrong in your pond is observing the behavior of your fish. Some things to be on the lookout for include lack of appetite, flashing, open sores, diving, or gasping at the surface. These are all warning signs that your fish are unwell. So get closer to the fish and inspect them for red sores on fins or mouth as these are signs of bacterial infection. White spots or a cottony appearance are signs of a parasite or fungal infection. Also, be on the lookout for fish gasping at the pond's surface as it is an indication or signs of stress from a lack of oxygen.

5.2 Determining fish harvesting and handling methods

Harvesting is catching fish either for marketing or for eating. In order to be profitable in fish culture, fish should be harvested at correct time and using appropriate method. Harvesting can be done in two ways: 1) partial harvest and 2) complete harvest. Each water body has its own

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holding capacity and when this fulfilled, the fish production slows down or stops even though fertilizer and feed continue to be supplied. This is not profitable for the farmer.

If some large fish can be harvested before the pond's holding capacity is fulfilled then other fish can continue to grow. This is partial harvesting and is recommended. Also partial harvest reduces the risk of loss from theft and disasters and if these are sold timely, good market price can be availed. Whether fish are partially or completely harvested, following points are taken into consideration:

- a. Fish size and weight
- b. Total fish population
- c. Market price
- d. Risks
- e. Availability of larger-sized fish fingerling for re-stocking

➤ **Method of fish harvest**

This depends on the size of the pond and number of fish to be harvested. There are various methods of harvesting fish

- A. Seine net method:** When the pond is large and number of fish to be caught is high then berjal is used. The net spacing should be according to smaller than size of fish to be caught. The net should be long as twice as deep as the pond and 1.5 times wider than the pond. In one pond, the netting should not be done more than twice so as to minimize the stress on the smaller fish. After drawing the net, large fish should be collected and smaller fish quickly released back into the water.
- B. Cast net method:** This method is used to catch smaller numbers of fish
- C. De-watering:** This best to collect catfish e.g. singh
- D. Time of harvest:** Fish should be caught in cool and clear weather especially in the early morning as well as taking into consideration of local market time

The need for proper handling and processing of fish is important both for the fishing industry and for the consumers. Improvement of the processing and handling of fish in terms of quality,

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product range and volume results in increased economic activity and employment. It is also one way of stabilizing fish marketing by providing an outlet for surplus and peak catch even during emergency harvest, thereby ensuring high fishing activities and stable prices.

➤ **Method of fish Handling**

The quality of fish depends on how it is handled from the time it is taken out from the water until it reaches the kitchen. Fish landed is usually subjected to rough handling treatments.

Three Cardinal Rules in Handling Fresh Fish

1. Cleanliness:

Observe cleanliness throughout the fish handling chain.

2. Care:

- Work on fish as quickly as and as promptly as possible.
- Sort fish properly before packing.
- When fish have to wait on deck or on the fish landing for some time before working on these, cover these to protect them from heat and other elements.
- Drain fish before icing
- Avoid brushing the fish
- Don't throw, trample or kick the fish

3. Cooling:

Temperature is the most important single factor affecting the quality of fish.

- ✓ Use plenty of ice. Put additional layer of ice on top, bottom and side of fish in boxes or shelves
- ✓ Don't over-fill a box or shelf. The next box or shelf on top will smash the fish below.
- ✓ Lay the fish belly downward – this prevents entry of dirt water into the fish.
- ✓ Don't pack fish so tightly that melted ice cannot flow.
- ✓ Fish is cooled more quickly when ice cold water is poured on them. Fish spoils easily when allowed to stay in stagnant water, blood or slime.
- ✓ Store fish in ice as quickly as possible. Make sure the fish room is always kept clean.

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5.3 Seining Pond and cages

The so-called undrainable fresh-water or brackish-water ponds require pumping to drain. For economic reasons they are drained only very occasionally, if at all. In such cases, and when multiple harvesting and stocking are practiced, it is necessary to resort to fishing with commercial fishing gear. The most common fishing equipment for pond farms is a seine net. It is well suited for harvesting most species of fish, although some species like tilapia (e.g. *Tilapia aurea*) and certain strains of common carp can escape the nets by burrowing into the bottom mud. Species like mullets, milkfish and silver carp can escape by jumping the net.



5.4 Figure 5.1 Seining pond and cages

5.5 Determining fish processing methods

Processing:

- Fish spoils very quickly within 12 hours after being harvested.
- This due to the high ambient temperature that is ideal for bacterial growth.
- To prevent contamination of the fish, proper hygiene must be ensured.

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- Contamination can come from people, soil, dust, sewage, surface water, manure, or spoiled foods.
- Poorly cleaned equipment, domestic animals, pets, vermin or unhygienic ally slaughtered animals can also be the cause.
- To prevent spoilage of the harvested fish, either the bacteria present in them must be killed or their growth must be suppressed.

Different methods exist to suppress bacterial growth:

Salting:

- This is an inexpensive method when salt is cheap, as no electricity is necessary and storage can be at room temperature.
- Fish quality and nutritional value are reasonable after salting.
- Storage life is long.

Drying:

- Inexpensive method as no electricity is required and little equipment is needed.
- Dry and / or airtight storage is required.
- Quality and nutritional value are reasonable if storage is good.

Smoking

- Inexpensive, little equipment and energy needed, but fuel must be available.
- Quality and nutritional value are reasonable.

Fermentation:

- This method is often inexpensive, but the fish taste and odour are radically changed.
- Storage life varies depending on the product.
- Nutritional value is often high.

Canning:

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- This is a fairly expensive method. Because, it is labour intensive and requires plenty of energy, water and equipment, such as tins or jars with lids, sterilizers and canning machines.
- Packaging is expensive. Storage is easy and possible for long periods (below 25 °C / 77 °F).
- Quality and nutritional value are good.

Cooling and Freezing:

- This is a very expensive method. Because, it involves high use of energy and large investments in equipment.
- Quality and nutritional value of the product are good and storage life is long.

Smoking of Fish

1. Remove the gills and entrails
2. Wash and soak in brine solution (1:3 salts to water) for 30 minutes to one hour depending on the size of fish.
3. Boil in 10% brine solution (1 part salt to 9 parts water) for 10 to 20 minutes.
4. Smoke for 30 minutes at 43-66°C.
5. Pack in plastic bags and refrigerate.

5.6 . Fish processing waste management

Waste management Fish Waste Management focuses on the generation, treatment, specification, controlling, prevention, handling, reuse and ultimate residual disposition of fish waste. Over the past 30, years many directives were initiated under the auspices of the European Union. These directives refer to the management of aquaculture waste and the environmental impacts of fishery brands. The growing utilization of by-products requires the implementation of guidelines for fishery policies. However, an optimal waste management system depends on both the costs and predicted benefits.

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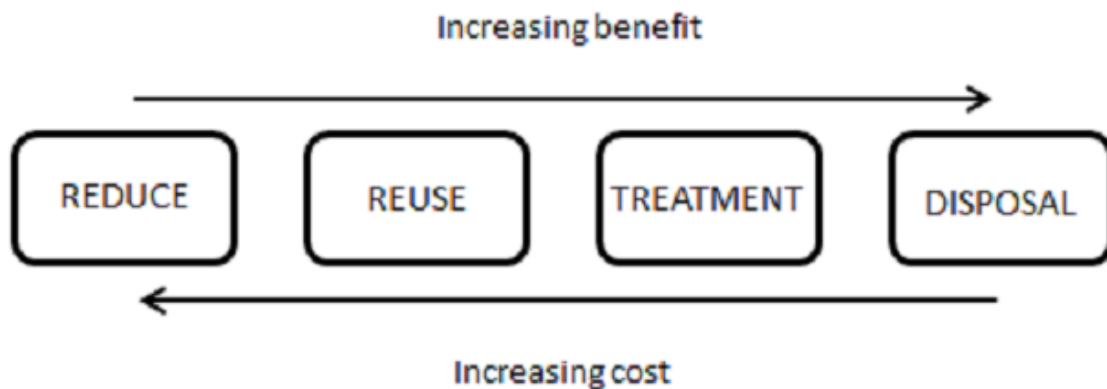


Diagram 5.1 fish waste management

Aquaculture and related industries process waste, which is suspected to pose a significant risk to the ecosystem. To mitigate pollution, appropriate technologies should be used. The conversion of these wastes and the simultaneous recovery of significant materials before disposal become the main aim for fishery management.

Self-check -5

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

I: Chose the best answer (5point each)

1. Which type of fish harvesting net is used to done in water less than 12 feet in depth.
 - A. cast net
 - B. scoop net
 - C. Seine
 - D. gill net
2. Which one of the following is used to store Harvested fish in a low-temperature environment.
 - A. chilling
 - B. freezing
 - C. heating
 - D. waste disposal

Note: Satisfactory rating 5 points Unsatisfactory – below 5 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -5

1. Performing seine of the pond

A. Tools and equipment' needed to seine the pond

- All necessary PPE
- Net
- Heavy wood
- Rope
- pole
- knife

B. Procedures of seine the pond

- Wear all necessary personal equipments
- Pull the seine from both sides of the pond
- Keep the fry in the net and move it towards the bank
- Take the net & enclose the fry in pocket
- Transfer the fry to container using dip net
- Accomplish work and record

LAP Test-5

Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task: 1 conduct fish processing

LG#27

LO#- 06 Control and Prevent Common Disease and Parasite of Fish

Instruction sheet

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

- Determining Common fish diseases and parasite
- Identifying Common fish diseases symptoms
- Identifying Disease prevention and control measures
- Isolating and disinfecting infected tools and equipment
- Collecting data or record sheets/books

Reporting the outbreak 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:

- Determine Common fish diseases and parasite
- Identify Common fish diseases symptoms
- Identify Disease prevention and control measures
- Isolate and disinfecting infected tools and equipment
- Collect data or record sheets/books

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”

6.1. Determining Common Fish Diseases and Parasite

Fish diseases may cause severe losses on fish farms through:

- ❖ Reduced fish growth and production;
- ❖ Increased vulnerability to predation;
- ❖ Increased sensitivity to poor water quality
- ❖ Increased fish mortality

➤ Infectious Diseases

Infectious diseases are mainly caused by viruses, bacteria, fungi, or unicellular algae (“ichthyomicrobial diseases”); e.g. bacterial enteritis, bacterial gill rot, and bacterial erythema. Infectious diseases account for 60 per cent of the production lost as result of disease. For this reason, the study of infectious disease is of primary significance to the development of aquaculture.

➤ parasitic Disease

Parasites diseases are caused by animal parasites such as trichodinosis, ichthyophthiriasis, lernaesis, argulusis, etc. Fish carrying parasites or the carcasses of diseased fish are a primary source of invasive diseases. Contaminated feeds, gears, pond water, silt, etc., are secondary sources. For example, mature oocytes of *Eimeria* or mature myxosporidia may enter the water with the fish and precipitate to the bottom of the pond. The pond silt is contaminated as a secondary source of parasites disease.

Like infectious diseases, parasitic diseases often appear in different seasons. This is because the pathogens and the fish are influenced by external factors (location, climate, physico-chemical properties of the water, farming skills, etc.) and internal factors (growth and physiological status). Parasites pathogens may also be species specific or organotropic.

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➤ Other Diseases

Physical and chemical factors or the influence of other organisms within the pond may retard growth or even kill the fish. For example, gasping and suffocation may upset the physiological balance of the fish and if serious, cause mass mortality.

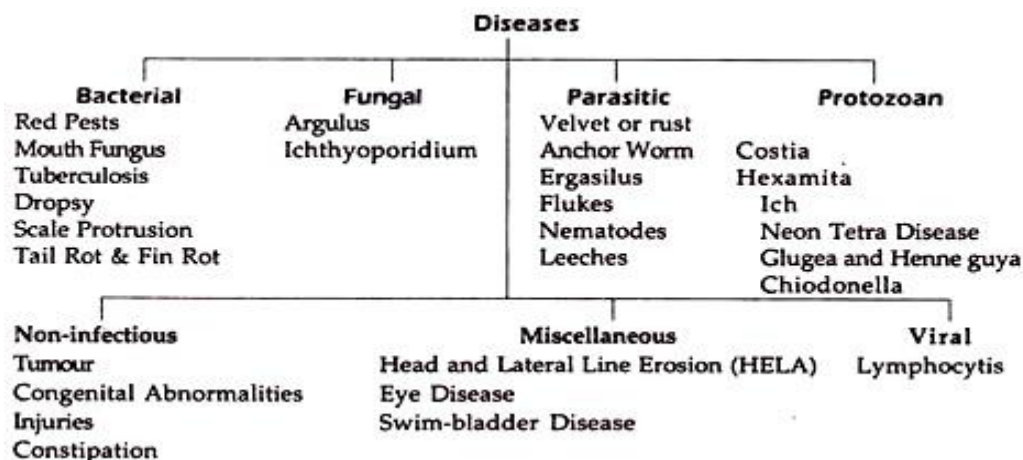


Diagram- 6.1 common diseases of fish

➤ The three main causes of disease are:

1. Inadequate feeding.

Nutritional diseases become more frequent as the cultivation system becomes more intensive and the fish are obtaining smaller proportions of their nutrients from natural food organisms.

2. Exposure to an extreme or toxic condition.

- Rough and/or excessive handling, such as during harvest or sorting/grading;
- Overcrowding and/or behavioral stresses, such as in storage or during transport;
- Unsuitable water temperature;
- Lack of dissolved oxygen;
- Changes in pH toward extreme values;
- Presence of toxic gases such as ammonia or hydrogen Sulphide;
- Water pollution by agricultural or industrial chemicals, sewage effluents and heavy silt loads.

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3. Pathogenic organisms

Which will either attack externally on the skin, gills or fins, or internally in the blood, digestive tract, nervous system, etc.

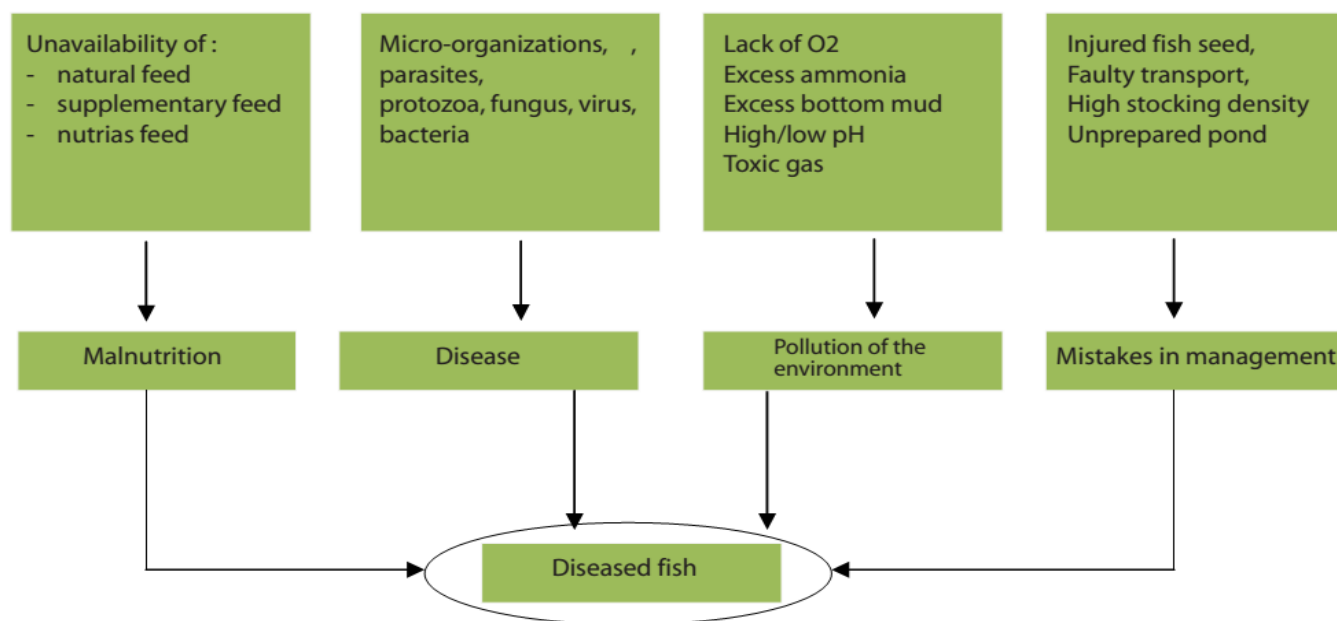


Diagram- 6.2 fish diseases

6.2 Identifying Common Fish Diseases Symptoms

- ✓ The behavior of your fish becomes unusual:
 - Swimming is weak, lazy, erratic,
 - Fish are floating in the water with their heads up,
 - Fish rub against hard objects,
 - Fish are flashing and twisting,
 - Fish are darting repeatedly,
 - Fish are crowding and gathering in shallow water or where the water flows into the pond,

- Individual fish are isolated from the main group
- ✓ Physical symptoms are present on the fish:
 - Gaping mouth,
 - Open sores, lesions, bloody areas, loss of scales, bloated belly, or abnormal coloration on the body
 - Gills are pale, eroded, swollen, bloody or brownish
 - Eyes are cloudy or distended
 - Fins are folded or eroded
 - Disease organisms are visible on the skull, gills, or fins.

6.3 Identifying Disease Prevention and Control Measures

Disease can be prevented through good management practices;

- ✓ Ensure that water quality is good.
- ✓ There should be a sufficient supply of water, adequate concentrations of dissolved oxygen, and no pollution.
- ✓ Keep the pond environment healthy. Control silt, control plants, maintain a healthy balance of phytoplankton and zooplankton, and change the water if necessary.
- ✓ Keep the fish in good condition by controlling stocking density. If necessary, keep deferent sizes or sexes separate to control fighting. Care for your fish during storage and transport.
- ✓ Prevent the introduction of disease organisms from outside your farm.
- ✓ Prevent the spread of disease organisms within your farm. If a disease breaks out, remove dead or dying fish from the ponds as quickly as possible (at least once a day), and do not disturb or stress the remaining fish more than necessary)

6.4 Isolating and Disinfecting Infected Tools and Equipment

Disinfection is employed as a disease management tool in aquaculture establishments as part of a biosecurity plan. Disinfection is used to prevent entry or exit of target pathogenic agents to or from an aquaculture establishment or compartment, as well as the spread of pathogenic agents within aquaculture establishments. Disinfection may be used during emergency disease response to support the maintenance of disease control zones and for disease eradication (stamping-out procedures) from affected aquaculture establishments.

The specific objective of disinfection will determine the strategy used and how it is applied. When possible, the spread of pathogenic agents should be prevented by avoiding transmission pathways rather than attempting to manage them through disinfection. For example, difficult to disinfect items (e.g. gloves, dive and harvest equipment, ropes and nets) should be dedicated to a specific site rather than moved between production units or aquaculture establishments after disinfection.

The disinfection process should include the following phases:

- a) Cleaning and washing
- b) Application of disinfectants
- c) Removal or inactivation of the disinfectant

6.5 Collecting data or record sheets/books

There is no particular form for data collection. It is more important to be careful in correctly recording the data whatever the format may be. The farmer can record data according to her own convenient format.

For any productive activity, it is important to maintain record in order to assess the success or failure of the activity. By maintaining records of the fish cultivation process, cost and income, helps to determine future decision-making in culture management and planning.

Therefore from start to finish of productive activity, the following should be recorded:

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- Physical characteristics of the pond
- Depth of water
- Description and cost of pond preparation
- Fish seed collection/ transport/ stocking cost
- Stocking density
- Fertilizer application data – type/weight/cost
- Feed application data - type/weight/cost
- Sampling data
- Amount of fish/prawns harvested/ income etc

6.6 Reporting the Outbreak

The basis of all good surveillance is the ability of Competent Authorities and aquatic animal disease diagnostic services to investigate outbreaks of unusual disease events efficiently.

An outbreak investigation should be aimed at systematic identification of the cause(s) and source(s) of the infection, in order to:

- control spread of the existing epidemic, and
- Prevent exposure to new infections in the future.

For isolated farms experiencing disease outbreaks, recommendations may take the form of a brief discussion with the farm manager, outlining the actions required for surveillance in order to prevent future outbreaks. A written report of the information, data and recommendations developed from the outbreak, provides a useful reference. For broader outbreaks, findings should be published in peer-reviewed scientific literature and, depending on the disease, reported to ensure transparent reporting to trade partners. Reports of investigations of serious outbreaks should include: case-history background; methods applied to diagnostic and epidemiological investigations; results; hypotheses; financial and ecological impacts (as appropriate) and recommendations for control.

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Self-check- 6

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

I: Chose the best answer (2 points each)

1. 1. What the effect of diseases on fish farms?
 - A. Reduced fish growth and production
 - B. Increased sensitivity to poor water quality
 - C. Increased fish mortality
 - D. All
2. Among the following one is not common disease of fish?
 - A. Reduce growth rate
 - B. Parasites
 - C. Infectious disease
 - D. fungal disease
3. Disinfection process should include the following phases except
 - A. Cleaning and washing
 - B. Application of disinfectants
 - C. Inactivation of the disinfectant
 - D. disease prevention
4. What is the three main cause of fish disease
 - A. Inadequate feeding
 - B. Exposure to an extreme or toxic condition
 - C. Pathogenic organisms
 - D. All

II. Give short answers

1. List common sign or behavior observed on diseased fish(3)
2. What is the importance of recording (5)
3. List at least five preventive method of fish disease (2)

Note: Satisfactory rating 12points Unsatisfactory – below 12 points

You can ask you teacher for the copy of the correct answers.

Reference

- Charo-Karisa, H., Munguti, J., Ouma, H., Masai, M.D., Opiyo, M.A., Okechi, J.K. and Orina, S.P., 2011. A fish farmer's Manual: For beginners. *Students and hatchery managers, KMFRI, River brooks Communication Network, Nairobi, Kenya*.
- Heise, K., Kontturi, E., Allahverdiyeva, Y., Tammelin, T., Linder, M.B. and Ikkala, O., 2021. Nanocellulose: Recent fundamental advances and emerging biological and biomimicking applications. *Advanced Materials*, 33(3), p.2004349.
- Hilaire, S.S., Kent, M.L. and Iwama, G.K., 1998. *Factors affecting the health of farmed and wild fish populations: a perspective from British Columbia*. Fisheries and Oceans.
- Hoggarth, D.D., 2006. *Stock assessment for fishery management: A framework guide to the stock assessment tools of the fisheries management and science programme* (No. 487). Food & Agriculture Org..
- Islam, M.M., Rahman, M.H., Rahman, M. and Basak, K.K., 2011. Training manual on household based pond aquaculture, homestead gardening and nutrition awareness.
- Israngkura, A. and Sae-Hae, S., 2002. A review of the economic impacts of aquatic animal disease. *FAO fisheries technical paper*, pp.253-286.
- Jithendran, K.P., 2014. Parasites and Parasitic Diseases in Fish Culture System. Not Available.
- Miller, D. and Semmens, K., 2002. Waste management in aquaculture. *West Virginia University Extension Service Publication No. AQ02-1. USA*, 8.
- Miller, D. and Semmens, K., 2002. Waste management in aquaculture. *West Virginia University Extension Service Publication No. AQ02-1. USA*, 8.
- Shakeri, A., Fard, M.S., Mehrabi, B. and Mehr, M.R., 2020. Occurrence, origin and health risk of arsenic and potentially toxic elements (PTEs) in sediments and fish tissues from the geothermal area of the Khiav River, Ardebil Province (NW Iran). *Journal of Geochemical Exploration*, 208, p.106347.
- Tan, B.L., Ching, F.F. and Senoo, S., 2019, November. Body Size and Morphological Characteristics in sex determination of Humphead Wrasse *Cheilinus undulatus* in captivity. In *Journal of Physics: Conference Series* (Vol. 1358, No. 1, p. 012010). IOP Publishing.
- Wada, T., Fujita, T., Nemoto, Y., Shimamura, S., Mizuno, T., Sohtome, T., Kamiyama, K., Narita, K., Watanabe, M., Hatta, N. and Ogata, Y., 2016. Effects of the nuclear disaster on marine products in Fukushima: an update after five years. *Journal of environmental radioactivity*, 164, pp.312-324.

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