CONTENT **PAGE**

FISH BIOLOGY

1.0 INTRODUCTION

The biology of fishes is the biology of active living organisms in water. It introduces learners to the basics of fish biology, which entails: Anatomy, Physiology, Embryology and Endocrinology of bony and cartilaginous fish. Fishes are cold blooded or poikilothermic animals i.e. their body temperature varying passively in accordance with the ambient temperature (surrounding water temperature). Although, fishes as a group can tolerate wide range of temperature just below 0^0C to 45^0C, individual species generally have a preferred or optimum as well as a more restricted temperature range.

2.0 OBJECTIVES

At the end of this unit, you should be able to acquire practical knowledge of:

- The structure and physiology of fish
- Identify the basic diagnostic features of fish
- Explain the structural implication of fish to an aquatic existence
- Draw and label the internal organs and skeletal system of fish
- Differentiate between exocrine and endocrine glands.

3.0 PROCEDURE

Fish dissection to reveal the internal anatomical features of fish in the three living groups of fishes (cyclostomes, chondrichthyes and the osteichthyes. Demonstration of respiration, circulation or skeletal system in fish using plastic models

Procedure: External Anatomy

1. At your lab stations, you will have a dissection kit. Please be careful with the scalpel as they are very sharp.
2. Bring the pan to the front bench and get a fish.
3. Back at your station, and using the descriptions below, identify the external structures of your fish writing the answers to any questions that are posed.

   Eyes - Fish eyes serve a variety of purposes - to seek out food, to avoid predators and other dangers, and, perhaps even to navigate in the ocean. Fish do not have eyelids. They are constantly bathed in water and do not need tears.
4. Using your finger, gently move the eye in its socket. Is there an eyelid present?_____

Nostrils – Some fish have a well developed sense of smell and use this ability to seek out their home streams for spawning. In some cases, this scent is also helpful in avoiding predators. Fish breathe through their gills, not their nostrils.

Lateral Line - Fish do not have ears, as such. In part, low frequency sounds are detected in the water through a system of small holes along each side of a fish called the lateral line, which is connected to a delicate system of nerves. They also react to medium frequencies suggesting they detect these as well (this reaction is not well understood at this time).

Mouth - Fish use their mouth to catch and hold food of various types, but their food is not chewed before swallowing, it is swallowed whole. The mouth is the beginning of the fish's alimentary canal (digestive tract). In addition, it is a very important part of the breathing process. Water is constantly taken in through the mouth and forced out over the gills where oxygen is extracted.

5. Inside the mouth for teeth. Open and close the mouth. Describe how the upper and lower jaw articulates during this movement.

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6. Examine the upper and lower jaw. Does the lower jaw stick out further? This would mean the fish eats by attacking its prey from below. Or does the upper jaw stick out further? This would mean the fish eats by attacking its prey from above. Do both jaws meet at one common point? This fish eats by attacking from above or below. What direction do you think your fish attacks its prey from and why?

_____
_____
_____

Vent - The external opening of the alimentary canal. Urine, feces, eggs and milt exit here.

Gills - Fish gills are composed of two basic parts, the gill covers and the gill filaments. The gill cover, a bony structure called the **operculum**, protects delicate filaments and, together with the mouth, forces water containing oxygen over the gills. The gills are probably one of the most important organs in the body of a

fish. They are delicate but very effective breathing mechanisms. Gills are far more efficient than human lungs, because they extract 80% of the oxygen dissolved in water, while human lungs only extract 25% of the oxygen in the air.

7. Grasp the operculum to feel the bony structure. What is the benefit of having an operculum?

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Gills are thin walled structures, filled with blood vessels. Their structure is arranged so that they are constantly bathed in water. The fish takes in the water through its mouth. The oxygen dissolved in the water is absorbed through the thin membranes into the fish's blood. Carbon dioxide is simultaneously released from the blood into the water across the same membranes.

8. Open the operculum and look inside at the gills. Describe them, using three different adjectives.

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Fins – Fish have two sets of paired fins (pelvic and pectoral) and four single fins (dorsal, caudal and anal). Fish can contract their muscles and move the pelvic and pectoral fins for movement in all directions. The caudal fin is used for forward momentum. The dorsal and anal fins aid in stabilizing the fish in the water and preventing it from rolling. All fish fins are made of bony fin rays that are connected to each other with a thin membranous tissue.

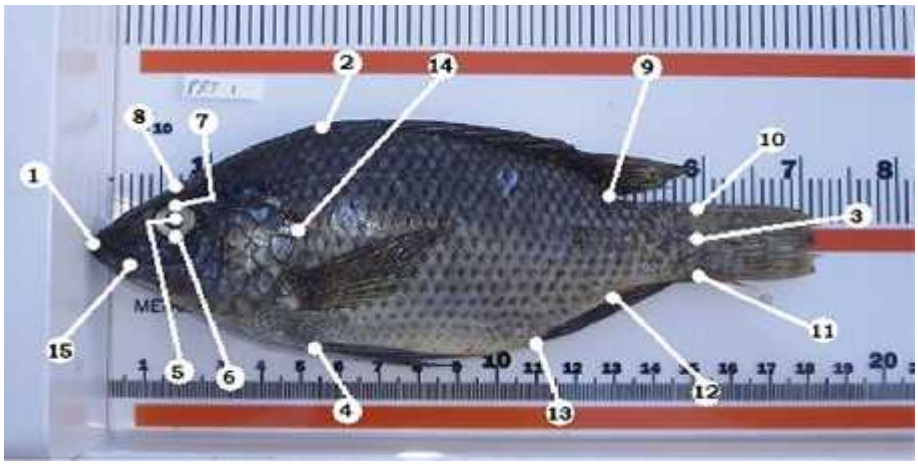
9. i) On the fish diagram below, label it with the name of the structures as well as determining the anterior, posterior, dorsal and ventral sides of the fish. List the parts of the fish numbered 1-15.

   ii) What is the function of the part numbered 14 in the above fish?

   _____

   iii) What is the difference between the parts numbered 12 and 13?

_____



Scales - The bodies of fish are protected by scales which grow in regular concentric patterns and can be used to determine the age and life history of the fish. Over the scales is a layer of mucous (slime) which further protects the fish from disease organisms and helps it slide through the water more easily.

10. Use the sharp edge of your scissors to take off one of the scales. Use a hand lens to look at the rings. By counting the larger rings, researchers can tell the approximate age of a fish. How old is your fish?

_____

_____

Procedure: Internal Anatomy

1. Place the fish on its side in the dissection pan, belly towards you, head pointing to your right. Insert a pair of sharp dissection scissors into the vent and make a shallow cut up to and between the pectoral fins all the way to where the opercula meet.
2. Locate the **heart**. It will be in the cavity anterior to the pectoral fins. Use the scissors to snip the aorta (large, white tube on top of the heart) and remove the heart.
3. The large, brownish organ in the body cavity posterior to the pectoral fins is the **liver**. It is used to synthesize and secrete the essential nutrients that were contained in the food. It plays a part in maintaining the proper levels of blood chemicals and sugars. The **gall bladder**, which is attached to the liver, contains green bile which in part is used to help digest fats.
4. Locate and remove the **alimentary canal**. It starts at the esophagus which is connected to the mouth and ends at the

intestines at the vent. Once removed, locate the following:
Esophagus: muscular tube that moves food from the mouth to the stomach_____

Stomach: a saclike organ that receives the food from the esophagus; mechanical digestion occurs here.
Intestines: tube running from the vent to the stomach; chemical digestion and nutrient absorption occurs here.

5. The **air bladder** is the only remaining organ in the body cavity. It is a whitish organ and the fish use it to control their buoyancy. They can inflate or deflate it with gas. Remove the air bladder.
6. The dark red line along the backbone is the **kidney**. The forward part of the kidney of a fish functions to replace red blood cells, the rearward part filters waste out of the blood. The kidney can be removed by slicing through the membrane along each side, and then scraping with a spoon.
7. What is left is the body cavity, or **coelom**, that houses major organs. If your fish is female, you should find the **ovaries** near the vent—they are an orange mass of eggs. Fish lay thousands of eggs and only a small percentage ever makes it to adulthood. If your fish is male, you should find a bladder of **milt**, or fish sperm, near the vent. Reproduction is carried out when the female deposits her eggs into the water and the male quickly fertilizes them with his sperm—this is called **external fertilization**. Any resulting fertilized eggs will develop in the water column without aid from the parents.
8. Is your fish male or female?

   _____
9. Clean up by disposing of the fish, cleaning the dissection materials and wiping down your lab area.

Post Lab Questions

1. Identify the structures in the diagram below.
2. What external features (3) separate bony fish from sharks?

   _____
3. What internal features (2) separate bony fish from sharks?

   _____

4. How is swimming accomplished in bony fish as compared to sharks?

   _____
   _____

5. What sensory organs do sharks and bony fish both have? What sensory structures are unique to sharks?

   _____
   _____
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Endocrine System

The endocrine system is made up of specialized cells, glands and hormones. Acting like a communication network, it responds to stimuli by releasing hormones, the chemical messengers that carry instructions to target cells throughout the body, from endocrine glands.

Practical Assignment

Highlight the functions of endocrine system labeled in the diagram above_____

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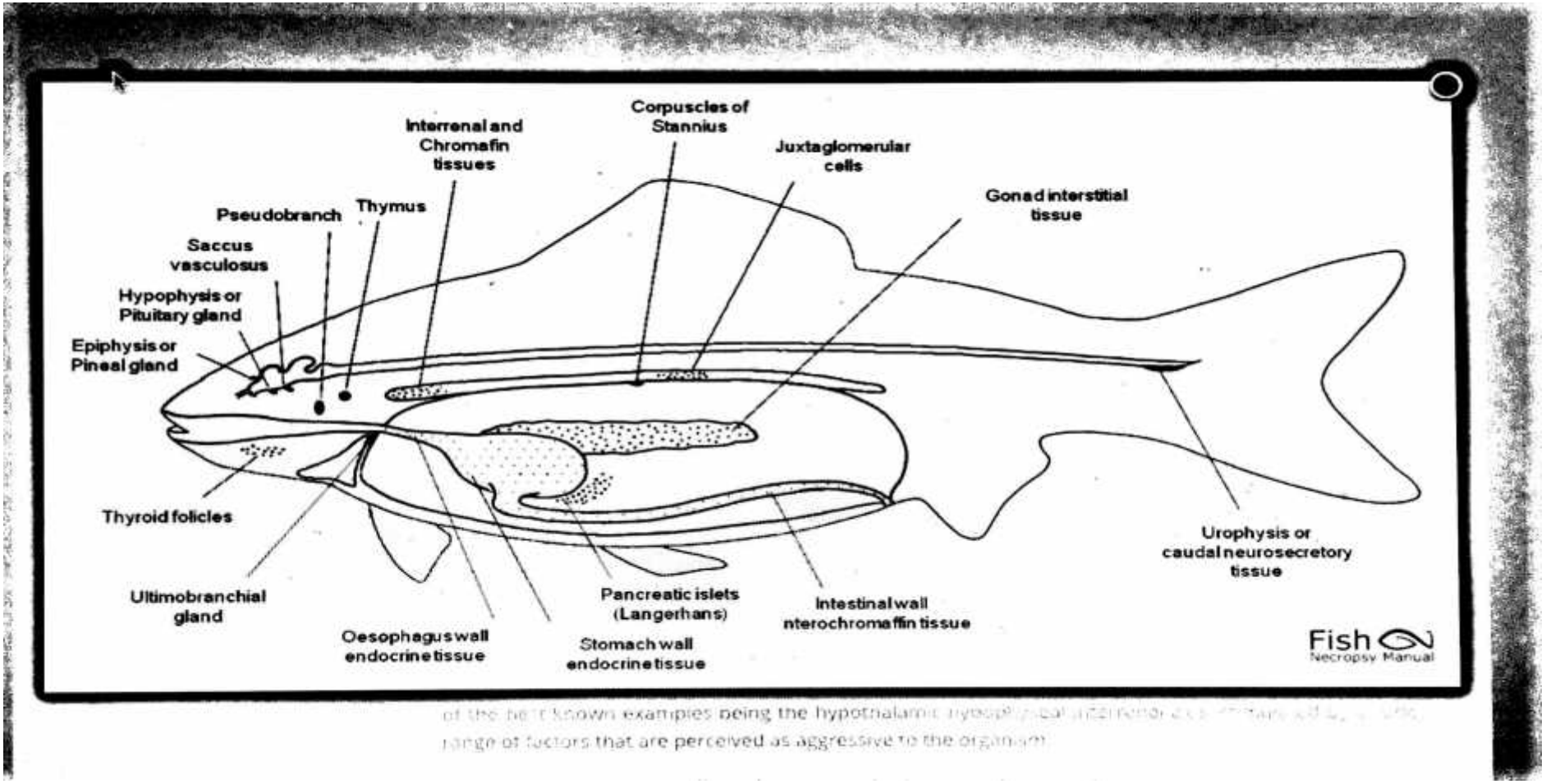

of the best known examples being the hypothalamic hypophyseal [illegible]
range of factors that are perceived as aggressive to the organism

4.0 CONCLUSION

The gross external anatomy allows an individual especially the fisheries scientist to identify most species with a fair degree of accuracy. All vertebrate animals (fish, amphibians, reptiles, birds and mammals, including humans) have the same general endocrine glands and release similar hormones to control development, growth, reproduction and other responses.

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ICHTHYOLOGY

1.0 INTRODUCTION

Ichthyology is the branch of zoology devoted to the study of fishes. This includes skeletal fish (Osteichthyes), cartilaginous fish (Chondrichthyes), and jawless fish (Agnatha). While a majority of species have probably been discovered and described, approximately 250 new species are officially described by science each year. According to Fish Base, 31,500 species of fish had been described by January 2010. There are more fish species than the combined total of all other vertebrates: mammals, amphibians, reptiles and birds.

The practice of ichthyology is associated with marine biology, limnology and fisheries science.

Ichthyology, a subset of zoology, is the study of fishes. Zoology is a branch of biology, and ichthyology incorporates many elements of biology in its studies. When people refer to the study of fishes, grammarians might note this as incorrect. It is correct because multiple species of fish are referred to as fishes.

Modern fish are divided into three classes.

i. AGNATHA- primitive jawless fish. Lampreys and Hagfish
ii. CHONDRICHTHYES- the jawed fish with cartilaginous skeletons. Sharks, Rays, Rat- Fishes
iii. OSTEICHTHYES- fish with bony skeletons; Lungfish, Trout, Bass, Salmon, Perch, Parrot Fish.

2.0 OBJECTIVES

At the end of this section you will be expected to:

- Define and understand what is ichthyology
- Understand the general characteristics of fishes
- Learn about Fish Classification
- Learn how to use dichotomous keys to identify different fish.

3.0 PROCEDURE

Visit a nearby river survey the fish composition. Use the existing fish identification keys in identifying freshwater and marine species. Observe the countable traits such as gill rakers or number of dorsal fin spine to analysis the meristic analysis of fish and examine the size and

shape using a measurable trait, such as standard length or wet weight, which can be gauged as a length, mass, angle or ratio of other measurements to determine the morphometric of different fish. Prepare of different stock solution of formaldehyde for the preservation of different specimens (whole, fish, tissues, organs).

When you follow a dichotomous key, your task becomes simpler if you use a few simple rules of thumb:

i. Read both choices in a couplet carefully. Although the first description may seem to fit your sample, the second may apply even better.
ii. Keep rough notes telling what sequence of identification steps you took. This will allow you to double-check your work later and indicate sources of mistakes, if they have been made.
iii. If you are unsure of which choice to make in a couplet, follow both forks (one at a time). After working through a couple of more couplets, it may become apparent that one fork does not fit your sample at all.
iv. Work with more than one sample if at all possible. This will allow you to tell whether the one you are looking at is typical or atypical. This is especially true when working with plants – examine more than one leaf, branch, cone, seed, flower, etc.
v. When you have keyed out an organism, do not take your effort as the final result. Double-check your identification scheme, using your notes.
vi. When reading a couplet, make sure you understand all of the terms used. The best keys will have a glossary of technical terms used in the key. If a glossary is unavailable, find a good reference work for the field (textbook, biological dictionary, etc.) to help you understand the term. A key has been provided with this activity.
vii. When a measurement is indicated, make sure that you take the measurement using a calibrated scale. Do not "eyeball" it or take a guess.

4.0 CONCLUSION

Ichthyology is the study of fishes. It's pronounced ick-thee-O-lo-gee. Scientists who study ichthyology are called ichthyologists. Can you guess how many kinds of fishes have ever been discovered? The answer is around 27,000 ... so far! But new species of fish are found all the time. For example, in 2016, ichthyologists found a whole new kind of fish in the Amazon River. That's one reason why ichthyologists study fishes: we're not even done counting them yet. You should be able at

least identify and count the fish species in your surrounding rivers, lakes, streams and marine environment.

5.0 Practical Assignment

i. Visit local streams in your area for the purpose of sampling and identifying the fish community as well as the abiotic characteristics of the habitats in which they occur. Record you findings:

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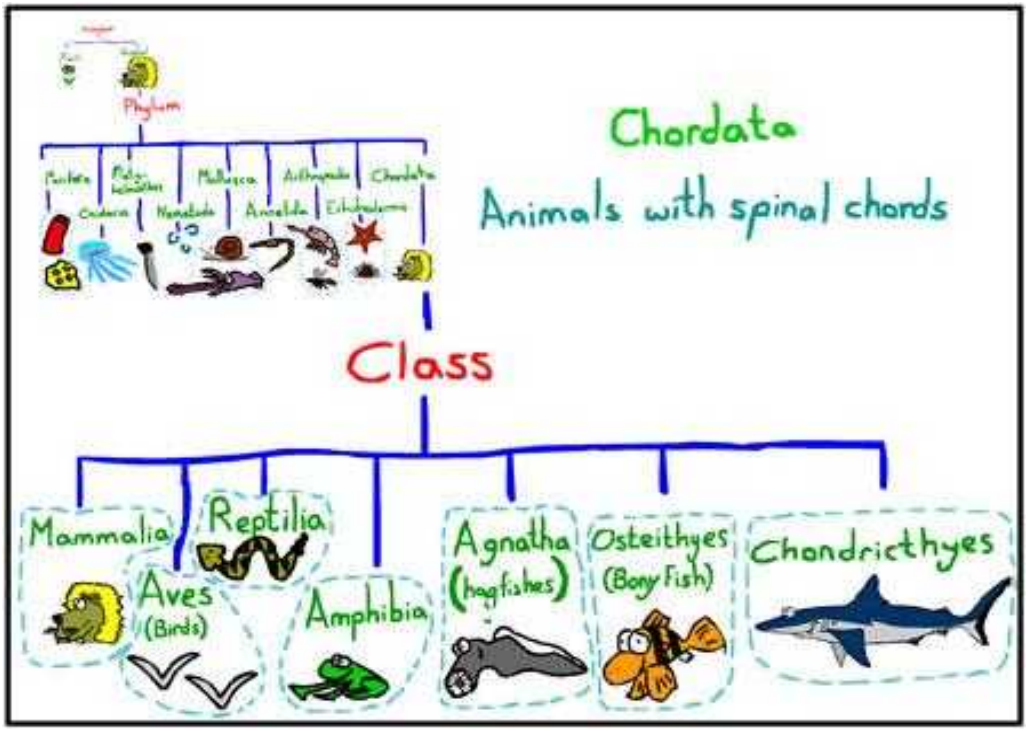

ii. List the characteristics and the fishes under the class **agnatha, Chondrichthyes and osteichthyes**
https://sharkresearch.rsmas.miami.edu/assets/pdfs/learning-tools/high-school/MODULE%202%20Ichthyology%20%20SECTION%20%201%20Introduction%20to%20Ichthyology%20and%20Classification.pdf

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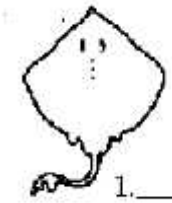
Use Key to Families to help you identify the family of each shark or batoid below:



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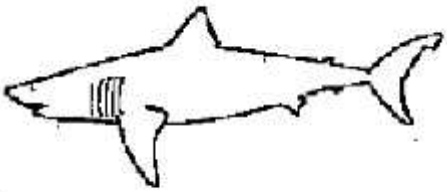
2. _____



3. _____

4. _____

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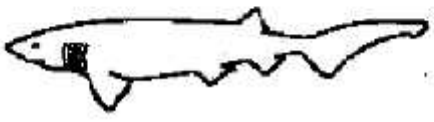

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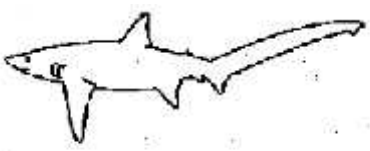

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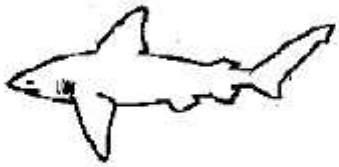

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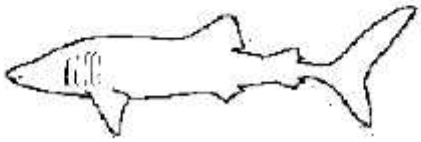
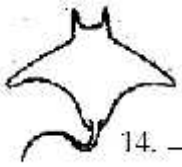


10. _____

11. _____

12. _____

13. _____



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LIMNOLOGY

1.0 INTRODUCTION

All organisms depend on water for their survival. Limnology evolved into a distinct science only in the past century, integrating physical, chemical and biological disciplines in order to describe and manage freshwaters ecosystems. Although inland water bodies are well below the oceans size, they are complex systems and they can't be fully understood if studied without taking into account the complex interrelations between physical, chemical and biological aspects. The study is vital because productivity and production are both dependent on the relative interaction of physical, biological, and chemical features operating within a given system.

2.0 OBJECTIVES

At the end of this section, you should be able to determine the physical, chemical properties of fresh water as well as biological factors. That is; Laboratory and field determination of:

- Physical (Temp, turbidity, current, light etc) of properties of fresh water
- Chemical (PH, DO, Co_2, Nitrite, Nitrate, ammonia BOD of properties of fresh water
- Biological factors of fresh water (primary productivity, energy flow, plankton sampling/analysis).

3.0 PROCEDURE

Keep all field equipment clean, dry, and fully charged. An important note to remember is that battery power is dependent on temperature because an instrument runs well a t20 C does not mean it will function properly at 0 C. Calibrations should be conducted at each sampling station to insure the accuracy of the measurements. Label all bottles and complete the inventory forms prior to sending them to the laboratory.

Field Measurements

Temperature: Before taking temperature measurements, calibrate the thermometer by placing the probe in a mixture of ice and water. The ice-water mixture is 0C. Record the temperature to the nearest 0.5 C at 1 meter intervals when the lake is stratified by lowering a 50-m

cabled probe through the water column, and at every other meter when the lake is isothermal.
Dissolved Oxygen: Calibrate the meter lower the probe while agitating if the probe is not equipped with an automatic stirrer, and record D.O. concentrations (mg-1L) and temperatures.

Salinity: 1) Prepare a salinity standard by dissolving 31.77 g of reagent grade NaCl in 1000 ml of DI water. This solution has a chlorinity of 19.4%% and a salinity of 35%%. 2) Measure the conductivity of the standard and the sample. Rinse the probe with DI water following the standard measurement before continuing to the sample. Solutions should be 15 C, and the meter's temperature compensator turned off.

Alkalinity: Calibrate the pH meter, Pour 100 ml of sample into a beaker and place on a magnetic stirrer. Immerse the pH probe in the sample. Using the buret slowly add titrant (0.02 N H2S04) to a pH of4.5. Record the volume (ml) of titrant. Rinse the probe with DI water before continuing to the next sample.

Turbidity: Calibrate the turbidimeter with a reference standard according to the manufacturer's instructions. Invert an unfiltered sample several times and pour into a cuvette. After all air bubbles have dissipated, record the NTU reading from the appropriate scale.

Dissolved Gases:

i. Collect the sample in a 300-ml BOD bottle without trapping air bubbles in the bottle
ii. Add in order 2 ml each of solutions I and 11. Invert several times to mix.
iii. Allow the floc or precipitate to settle, mix again, and allow to re-settle.
iv. Add 2 ml of sulfuric acid and mix until the floc is completely dissolved. The sample is now fixed and can be analyzed later (< 8 hr) if kept in the dark.
v. Pour 101 ml of the fixed sample into a 250-ml erlenmeyer flask,
vi. Using an automatic buret, titrate the sample with 0.025 N sodium thiosulfate to a pale straw color.
vii. Add 1-2 ml of the starch solution and complete the titration until the blue-black color turns clear. Record the volume (ml) of titrant used.

Nitrogen, Ammonium, Nitrate and Nitrite:

i. Pour 50 ml of sample or standard into a 50-ml stoppered cylinder

ii. Add 2 ml and invert to mix.
iii. Add 2 ml of phenol and invert to mix.
iv. Add 2 ml of potassium ferrocyanide and invert to mix
v. Add 5 ml of the hypochlorite solution, invert twice to after 15 minutes invert again.
vi. Allow 2 hours for full color development, and measure the absorbance at 640 nm against a DI water blank.

4.0 CONCLUSION

Limnology is a subject that should interest anybody who is concerned about the quality of life the freshwater environment either in Nigeria or any Third world Country of Africa and Asia. The practical application has therefore, been designed to help you understand the most complex problems of managing both the lotic and lentic water systems. You must apply concepts to understand limnology.

5.0 PRACTICAL ASSIGNMENT

Visit a fishery laboratory in your area and carry out the various experimental procedures to determine the physical, chemical properties of fresh water, lagoon and marine waters. Record your observations.

a. Temperature

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b. Dissolved Oxygen

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c. Salinity

d. Alkalinity

e. Turbidity

c. Dissolved Gasses

Nitrogen, Ammonium, Nitrate and Nitrite

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FISHERIES ECOLOGY

1.0 INTRODUCTION

Ecology is often referred to as the "study of distribution and abundance". One of the first things a field ecologist will want to know about an animal or plant species is: How **dense** is the population [units of density are number of individuals {or colonies etc.} per unit area {or volume}]. Another important question is: How are the organisms **dispersed** [The pattern of distribution in space] within the habitat? In most cases it is impossible to count every individual or plot their location on a map [This would be a **census**] because of the time, effort or money involved. So it would be useful if there were some way that we could get an accurate representation of some spatial characteristics of the population without having to map every organism.

By **sampling** the population we can do this, BUT the sampling must be done properly if we want our representation to be valid. To insure an adequate representation, some guidelines must be followed.

2.0 OBJECTIVES

At the end of this section, you should be able to:

- Basic knowledge of sampling methods
- Apply different sampling techniques in different ecosystem
- Assess fish biomass within an aquatic ecosystem.

3.0 Procedure

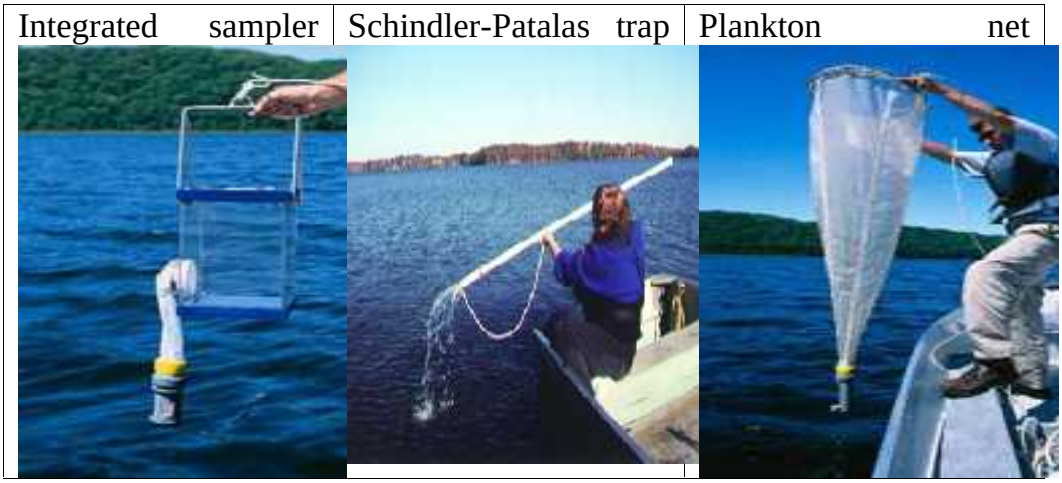
General Procedure: To obtain an unbiased estimate of the population, sampling should be done at **random** –or more specifically *the sampling should be conducted in such a way that the probability of each individual being selected in the sample is the same*. There are several ways of insuring this criterion is met – or at least approximated. **Random numbers** are series of numbers such that the chance of selecting, for example, any digit (0 – 9) is equal at any point in the sampling procedure. If the random numbers can be assigned to organisms or to locations in the habitat, they can be used to select the sample from the population. One way to generate a series of random numbers is to write the numerals 0 through 9 on slips of paper, mix them in a hat, draw the slips out, write the number down, then replace the slip in the hat, remix, and draw again, etc. etc. etc.

A faster and less cumbersome method is to use a **random number table**. You worked with ways of getting random numbers in the previous lab. You can use the numbers in the table to select sampling positions (e.g. paces along a trail, GIS coordinates, termite holes in a wall that you have numbered etc.). Most calculators and spreadsheet applications also have random number generating functions,

Procedure for Sampling Zooplankton

Three common methods for sampling zooplankton (shown in the photographs below) are net, trap, and tube. Nets are used most often, yet they have serious limitations in regard to obtaining good quantitative data, especially in nutrient and algae-rich waters. Nets are conical devices made of fine nylon mesh that are pulled through the water either vertically or horizontally for a known distance. Animals are captured in a vial or mesh-walled bucket at the bottom of the net and then can be rinsed into a storage bottle for counting.

The amount of water from which zooplankton are removed is estimated as length of tow times mouth diameter of the net. However, nets may not actually filter this volume of water. The main advantage to using a net is that samples of large volumes of lake water can be collected quickly. Nets can be obtained with various mesh sizes, depending on whether one wants to collect only the largest zooplankton or the entire size range that occurs in the water.



Photos of integrated sampler, Schindler-Patalas trap and plankton net

The most common trap sampler is the Schindler-Patalas trap, obviously named after the two scientists who invented the device. This is a clear plastic box that is lowered to a desired depth in the water column and then quickly closed (upper and lower doors) by pulling upward on the line by which the device is lowered and raised in the water. This traps zooplankton inside the box. When lifted into the boat, the water is

allowed to exit a small mesh net that is attached to the lower wall of the box, and zooplankton is collected inside a sampling bucket at the end of that net. This device provides a high degree of certainty regarding the actual volume of water sampled, but if the water column is deep, it may take many samples to collect animals from all depths from surface to bottom.

The third method is a tube, made of common PVC or Tygon. A tube is lowered into the water column, and when the bottom reaches the desired depth (near the sediments), a line is pulled to close the bottom with a rubber stopper or other device. The tube is raised into the boat and the collected water poured through a net to collect the zooplankton. This device also provides a high degree of certainty about volume of water sampled, but it may not be an effective way to sample large animals that occur at a low density, or animals that can detect and escape from a narrow sampling device.

Nets, traps, and tubes will be used to collect representative during the Zooplankton Ecology course, and students will participate in a critical analysis of these three common sampling techniques.

Counting and Biomass Estimation

Simple counts of zooplankton can be done with a light microscope. For large zooplankton such as Daphnia, which occur at relatively low densities (1 to 100 per liter), the entire sample may be scanned at a low magnification, counting all observed individuals. For small zooplankton, such as rotifers and copepod nauplii, which occur at high densities (>1000 per liter), it is standard practice to count a known percentage of the sample volume at high magnification, and then multiply by total volume / counted volume to obtain the total number of animals in the sample. Once you know the number of animals of each species in a sample, density in the lake is estimated as counts divided by volume of water filtered with the net or collected by the trap or tube.

Quantitative Analysis of Plankton: Generally, The counting procedure involves recording the taxa observed and the number of algal units (objects) for each taxon in a known area of the counting chamber. As the volume of sample added and area of the whole chamber observed is recorded, the concentration of each individual taxon can then be calculated.

Counting Procedure

The count should be carried out in the following manner: A low magnification (e.g. x 40 or x100), whole chamber count to pick up large taxa, followed by transect counts at an intermediate magnification (x250), which are helpful to enumerate "intermediate-sized" taxa that are too small for the low-magnification count but too large to be reasonably counted using fields of view at high magnification, followed by a high magnification count (x400 or greater) using fields of view. This picks up the small taxa. Aim to count 100 fields of view (i.e. about 400 units assuming the recommended sample concentration).

Qualitative and quantitative evaluation of plankton: Replicate plankton samples, each of 50 L, collected from various spots around a chosen river or lake by means of a bucket and filtered through bolting silk plankton net of 50 p,. The filtrate should be transferred to other bottle and preserved immediately in 1:100 Lugol's solution. Qualitative and quantitative analysis of both phyto-and zooplankton should be done following drop count method (APHA 1995). Identification of plankton is often made by following Ward and Whipple (1959) and Presecot (1962).

The inundation or saturation of wetland soils by water leads to the formation of anaerobic conditions as oxygen is depleted faster than it can be replaced by diffusion. The rate of oxygen loss in flooded soils can vary depending on other soil conditions, such as temperature and rates of microbial respiration. In most wetlands, small, oxidized layers of soils may persist on the surface or around the roots of vascular plants, but generally, anaerobic, or reduced, conditions prevail.

4.0 Conclusion

Freshwater Fisheries Ecology defines what we have globally, what we are going to lose and mitigate for, and what, given the right tools, we can save. To estimate potential production, the dynamics of freshwater ecosystems (rivers, lakes and estuaries) need to be understood. These dynamics are diverse, as are the earth? freshwater fisheries resources (from boreal to tropical regions), and these influence how fisheries are both utilized and abused.

5.0 Practical Assignment

Take a visit to a near dam or state fisheries departments' ecosystem within your area and carry out the following activities:

i. Identify and list different sampling techniques in ecosystem

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ii. Collect a named zooplankton from the ecosystem and counts the number of zooplankton with aid of a light microscope. Record your personal procedure and your findings:

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iii. Use plankton net to collect a sample of zooplankton in different sides of the rivers. Analysis the qualitative and quantitative analysis of plankton. Record your personal procedure and your findings:

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iv. Enumerate the techniques for assessment of fish biomass of a given ecosystem in your area.

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v. With aid of the figure below what is the relationship between D.O. and temperature using forested wetland and river through barren land. (https://www.nap.edu/read/4766/chapter/4#41)

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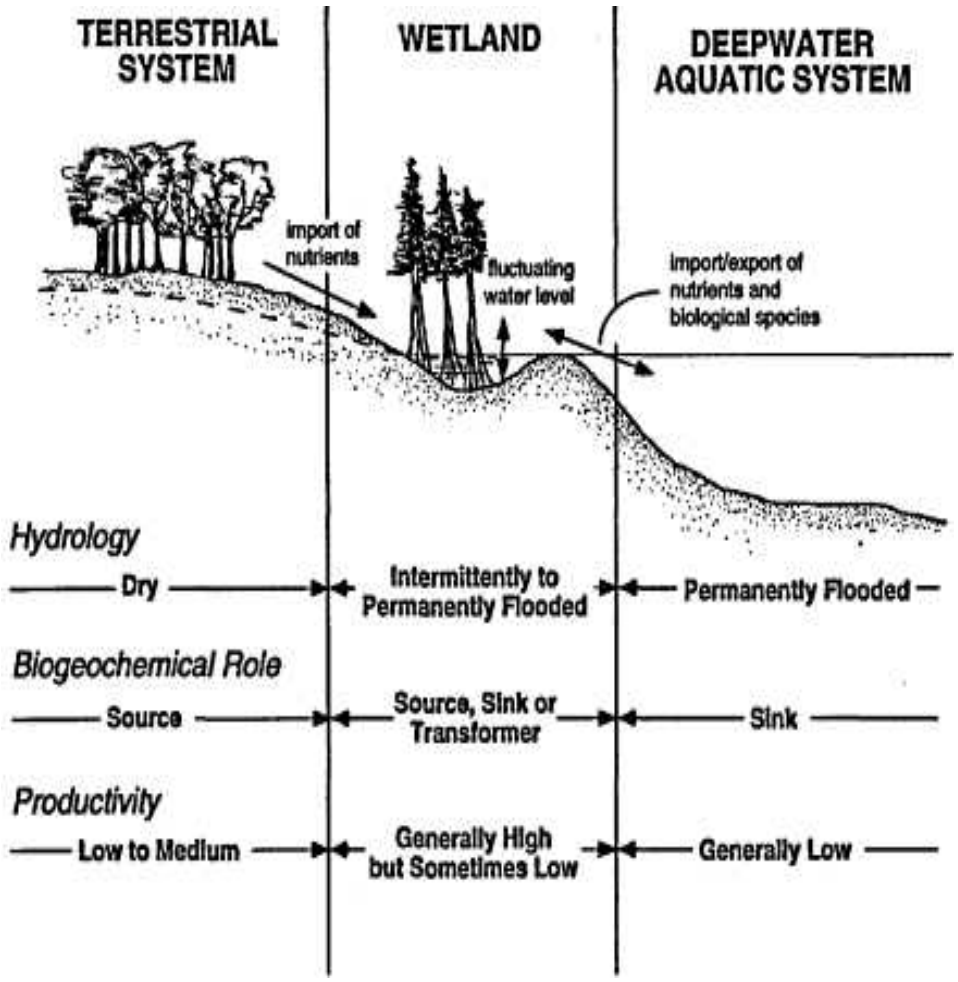


Figure 2.1: A Wetlands can be part of a continuum between terrestrial and deepwater aquatic systems. Source: Mitsch and Gosselink, 1993.

6.0 References

https://www.researchgate.net/publication/237633265_Guidance_on_theQuantitative_Analysis_of_Phytoplankton_in_Freshwater_Samples

Presecot, G.W. 1962. Algae of the Western Great Lakes Area. Revised. Ed W. M. C. Brown Company, 135 South locust street, Dubuque, Iowa, 977pp.

Ward, H.B. and Whipple, G.C. 1959. Freshwater Biology {?d ed), John Wiley and Sons, Incorporated, New York, 1248p.

AQUATIC FLORA AND FAUNA

1.0 Introduction

Aquatic plants grow in and around the rock pools and slow channels of the river. Some are rooted in mud or cracks in the rocks; others float on, or near, the water surface. They tend to be soft, fleshy, and easily torn. The first step toward correct identification of an aquatic plant is to observe how it is growing in the water. Understanding the growth habit will also help determine the best method and timing for control, if necessary. Some species may exhibit different growth forms in response to their environment. Furthermore, a plant's growth form may change during its life cycle. Invertebrates fauna are a vital part of the freshwater ecosystem. They include grazers, plant shredders, filterers, and predators. Many of them feed on plant matter (algae, leaf litter and aquatic "weeds") and in turn they provide the most important food source to almost all of the freshwater fish.

2.0 Objectives

At the end of this section, you should be able to:

- Identify different zooplankton present in water bodies and wetlands
- Collection of water samples from different sources for screening and identification
- Drawing and Classification of zooplankton
- Collection of aquatic animals
- Drawing and classification of collected animals

Collection of Various plant species

Different Flora in the fisheries ecosystem	**Distinguishing Characteristics**
OBJ  ***Canna spp.***	**•Ornamental growing tall with showy flower.** **•Large oval leaves pointing upward.** **•Usually growing in small clusters limited to the shoreline.**
 ***Cephalanthus occidentalis* (Buttonbush)**	**Distinguishing Characteristics** **•Woody, aquatic shrub with oval leaves coming to a point.** **•Loose clusters of round seed heads approximately 3⁄4-inch in diameter.** **•Grows in shallow water, often out from the shoreline.**
 ***Colocasia esculenta*** (Wild Taro)	**•Arrowhead-shaped terminal leaf up to 2 feet long.** **•3 primary leaf veins stretching to each lobe. Several secondary veins along the primary veins that are nearly opposite.** **•To separate amongst other plants with arrowhead-shaped leaves, *Colocasia esculenta* leaves are peltate.**
 ***Cuscuta spp.* (Dodder)**	**•Parasitic, aquatic vine found growing on other emergent plants.** **•Stems yellow to orange. •Occasional tiny white flower along stem.**
OBJ 	**•Leaves spade-shaped, with shallow cleft at petiole; petioles are grooved; leaves have 3 to 5 primary veins.** **•Flowers on short stalks whorled around leafless stalk;**

Echinodorus cordifolius (Creeping Burhead)	**whorls are intermittent along a long arching stalk. •Usually restricted to shoreline.**
 ***Eriocaulon spp.*** (Hatpins)	**•Thin rush with small terminal inflorescence resembling small cotton ball. •Rush loosely fanning in all directions. •Moist soil or very shallow water.**
 ***Hydrocotyle spp.*** **(Water Pennywort)**	**•Each stem has a single terminal leaf that is nearly round with shallow cleft; about the size of a half-dollar; similar to terrestrial dollarweed. •Stem attaches to center of leaf. •Usually found growing along shoreline in moist soil or very shallow water; can also form floating mat of tangled stems that are erect on terminal end similar to *Myriophyllum aquaticum*.**
 ***Hydrolea quadrivalvis*** (Waterpod)	**•Leaves alternate with rough margins. •Stiff thorns and blue flowers in leaf axis. •Stems have fine hairs. •Usually grows in isolated clumps along shoreline, but can eventually surround shoreline. Appearance and growth habit very similar to *Polygonum spp*.**
 ***Hygrophila costata***	**•Leaves arranged oppositely around stem; leaves have rough margins; primary and secondary leaf veins very distinct. •Small, white to pink flower in leaf axis; tiny leaves may also be present in leaf axis. •Stems**

(Lake Hygrophila)	**and sometimes primary leaf vein dark red. •Usually grows in isolated clumps along shoreline, but can eventually surround shoreline.**
 ***Hymenocallis spp.*** (Spider Lily)	**•Basal leaves appearing like grass blades; leaves up to 3 feet long and 1.5-inch wide. •Showy, white flowers in groups at end of thick, leafless stem. •Grows in moist soil to shallow water.**
 ***Justicia americana*** **(Waterwillow)**	**•Long, very narrow leaves arranged oppositely along stem. •Stems always erect and more narrow than alligator weed or water primrose. •Faint purple, irregular flower. •Spreads by rhizomes and can grow out from shoreline in deeper water.**
 ***Limnobium spongia*** (Frog's Bit)	**•Leaves spade-shaped and often curled upward on sides; leaves point upward; leaf stalks not bulbous at base but rather firm with ridges; leaf veins webbed. •Also has small floating leaves that are heart-shaped. •Plant has feathery white roots. •Forms thick mats growing out from shoreline.**
 ***Ludwigia peploides*** (Water Primrose)	**Leaves arranged alternately around thick, hollow stem that is green to red; leaves can have many different shapes, but often oval or club-shaped. •Flowers yellow. •Rooted along shoreline, but forms floating mat.**

 ***Luziola fluitans*** (Southern Water Grass)	**•Leaf blades 3 to 5 inches long; lying flat on surface or raised a few inches high. •Leaf blades feel rough on top. •Rooted at shoreline, but forms floating mat that creeps out from shore. Has the appearance of terrestrial crabgrass.**
 ***Marsilea spp.* (Water Clover)**	**•Delicate plant resembling 4-leaf clover. •2 growth forms: can grow erect on long, think stalk; or can grow in slightly deeper water with leaves floating on surface. Usually found in moist soil or very shallow water.**
 ***Various spp.* (Green algae)**	**•Green algae free-floating in the water column; the water itself appears green. •Directly related to water fertility and fish productivity.**
 ***Euglena spp.* (Euglena)**	**•Unicellular organism that has characteristics of both plant and animal. •Forms a rusty brown or green skim on surface depending on sunlight absorption. •Often associated with pond with high organic nutrient input.**
 **Blue-green algae**	**•Algae that forms a skim on the surface that can be light green, dark green, blue or even white. •Usually found in fertile ponds. •Often has a foul, sulfur odor.**

Fauna in the fisheries ecosystem

Freshwater invertebrates (insects, crustaceans, snails, worms and other small critters) are often used as indicators of the state of streams, rivers, lakes and ponds.

3.0 Procedure

Protozoans are unicellular organisms living independently or in colonies of similar cells. Most of them are microscopic organisms. They can be found in aquatic habitats such as streams, ponds, oceans and in moist soil. However, others live as parasites on animals and plants. Examples of protozoans include Amoeba, Paramecium etc.

Preparation of slides or fresh specimens of pond water:

- Place one drop of pond water in the center of the clean slide using the pipette.
- Cover the drop by lowering the cover slip gently down unto it in a slanting position. Ensure no air bubbles are trapped (those air bubbles are frequently mistaken for organisms).
- Use the coarse focusing knob and the lower power objective to ensure the sample is properly focused.
- Observe your preparation under the microscope using both low and high power objectives to identify any of the protozoans.
- Drawing under high power and label fully at least two protozoans you identify.

Where to Look and How to Sample Invertebrates

A single site can be used for a spot check, although most biological surveys involve a series of sites along a particular water body. Select sites with easy and safe access, and always seek permission to cross property. The widest range of stream invertebrates can be found in shallow (but permanently submerged), fast-flowing, stony-bedded reaches known as "riffles". Larger, more stable rocks usually support the most invertebrate types, although the rocks need to be small enough to be lifted or turned over.

Invertebrates can be picked or scraped off rocks and placed into a tray or transparent container. The more invertebrate types found, the more useful information you will gain relating to the "state of health" of the site. Be sure to look for the smaller species as well as the more obvious, larger species.

 Ameletopsis	Ameletopsis is a six-legged larvae generally a rare mayfly which is difficult to collect intact, but it is a good indicator of "clean" water.
 Zelandoperla	Zelandoperla is a six-legged larvae recognised by the very long antennae, tails and hairy legs. Like all of the large stoneflies they prefer high quality waters.
	Freshwater (Paratya) and estuarine shrimps are eight or more legged crustacean that prefer slow-flowing weedy streams, estuaries and lakes. They often tolerate nutrient enriched, or otherwise degraded waters.
	Helice mud crabs are eight or more legged Crustacea abundant in muddy river estuaries.
	*Potamopyrgus* is the widespread "pond snail" found in most freshwaters especially amongst weedbeds and streambed algae. This snail can tolerate various water quality conditions.

	Oligochaete worms are found everywhere, from pristine streams, to the most polluted waterways. Their ability to thrive in many heavily polluted habitats gives them the sensitivity score of 1(4).

Field identification of the different aquatic flora (emergence and sub-mergence weeds, by names/botanical classification. Identification of the different aquatic fauna in a typical fresh water ecosystem (invertebrates, vertebrates, benthos), a practical note on the economic importance of each.

4.0 Conclusion

Invertebrates can tell us a great deal about the "state of health" of our water bodies. The presence of many invertebrate species usually indicates clean water, cool temperatures and generally natural conditions. A stream which lacks any invertebrate life has a major habitat problem, possibly because of recent pollution, or low flow conditions.

5.0 Practical Assignment

1. Look out from the following fauna in your area, take a photograph of them, state their distinguishing characteristics and highlight the economic importance of each.
   i. *Spirogyra spp.* - Silk Algae
   ii. *Pithophora spp.* - Cotton Algae
   iii. *Lyngbya spp.* - Lyngbya
   iv. *Hydrodictyon spp.* - Water Net Algae
   v. *Wolffia spp* - .Watermeal
   vi. *Spirodela polyrhiza* - Giant Duckweed
   vii. *Pistia stratiotes* - Water Lettuce
   viii. *Eichhornia crassipes* - Water Hyacinth
   ix. *Azolla caroliniana* - Mosquito Fern
   x. *Nymphaea odorata* - Fragrant Water Lily
   xi. *Nelumbo spp.* - American Lotus
   xii. *Brasenia schreberi* - Watershield
   xiii. *Ruppia spp.* - Widgeon Grass
   xiv. *Potamogeton nodosus* - Long-leaf Pondweed
   xv. *Najas guadalupensis* - Southern Naiad

2. Use the following steps to identify, photograph and state their distinguishing characteristics and highlight the economic importance.
    i. Choose a "riffle" habitat in streams, or a shallow "weedy" habitat in stagnant or slow flowing waters.
    ii. If you are sampling a series of sites, ensure that the habitat types are as similar as possible.
    iii. Collect as many invertebrate groups as possible, from the under sides of stones, or grab samples of vegetation.
    iv. Use this guide (https://www.trc.govt.nz/assets/Documents/Research-reviews/Freshwater/Photographic-Guide-sm.pdf) to identify these groups as accurately as possible.

6.0 References

http://www.aces.edu/dept/fisheries/rec_fishing/documents/plantguide.pdf

https://www.trc.govt.nz/assets/Documents/Research-reviews/Freshwater /Photographic-Guide-sm.pdf

FISH FARMING TECHNIQUE AND HATCHERY MANAGEMENT

1.0 Introduction

Fish farming systems can be classified into different categories most especially based on the exposure to natural climates and influence of vagaries of weather. The three main classifications are: Open System, Semi-closed systems and Closed Systems. Culture techniques are either monoculture (culturing of a species of fish in a culture environment at a particular time) or Polyculture (rearing of more than one species of fish in a culture environment at a particular time). Hatchery is a place where process of producing young fish (Fingerlings) is taken place. Hatchery is important to the growth and development of fish farming in order to ensure availability of quality fish seeds that can meet up with the required quantity all the time of the year. Hatchery can be indoor or outdoor.

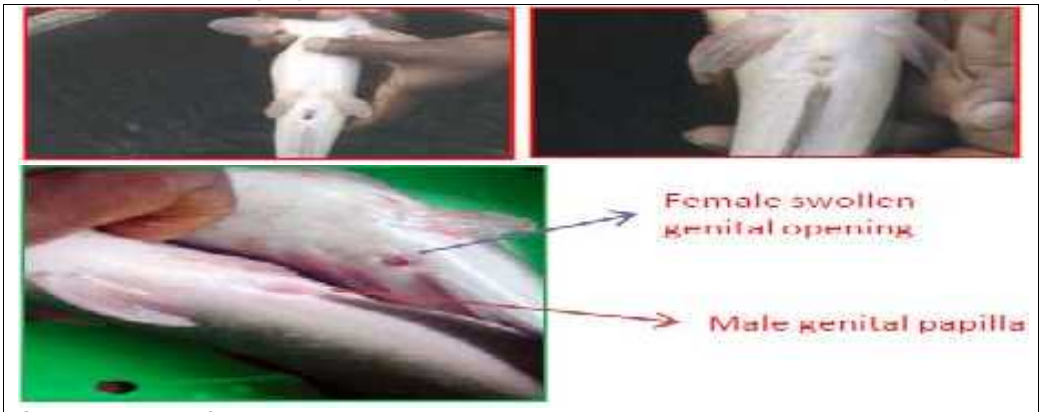
2.0 Objectives

At the end of this section, you should be able to:

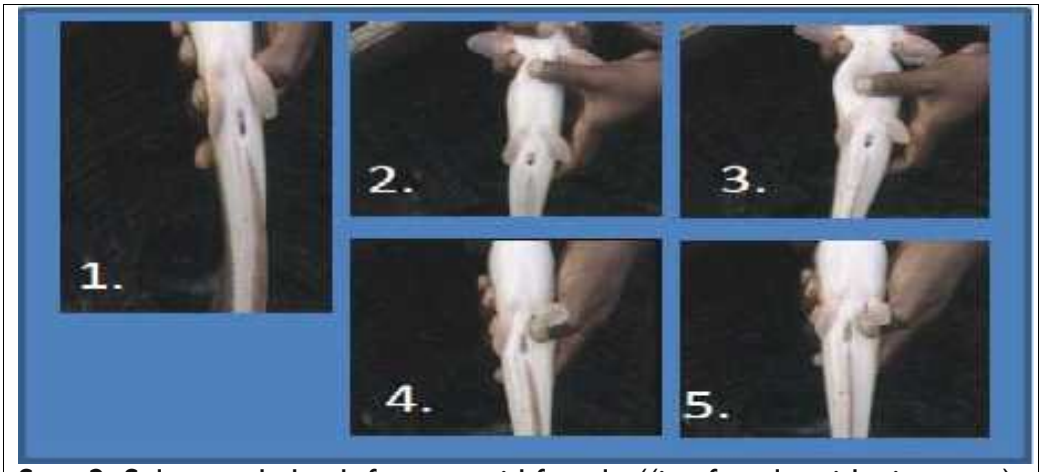
- Induced breeding of fish (Clarias or Heterobranchus) using crude pituitary extract (CPE) or synthetic hormone (Ovaprim).
- Dissect fish to extract hormone, preparation and injection of the fish
- Incubation fish at different temperatures and also with and without oxygenation. Students to determine the results under the different stages of gonadal maturity.

3.0 Procedure

Below are 18 steps procedure to efficient African Catfish Breeding:



Step 1: Identify and separate the sexes



Step 2: Select and check for a gravid female ((i.e. female with ripe eggs)

Step 3: Weigh the Female Fish Dried African Catfish Pituitary Gland, Grind the pituitary using a pestle until it becomes powder, Add 1ml saline solution. Collect the solution and Inject the female fish using an hypodermic Syringe.

Step 4: Prepare the female Catfish for injection. The fish should also be injected above the lateral line with the needle at 45 degrees to body of the fish.

Step 5: Isolate the Injected fish in a Comfortable, big bowl and wait for 10 to 12 hours.


Step 6: Prepare to strip the fish, Set up your incubator.

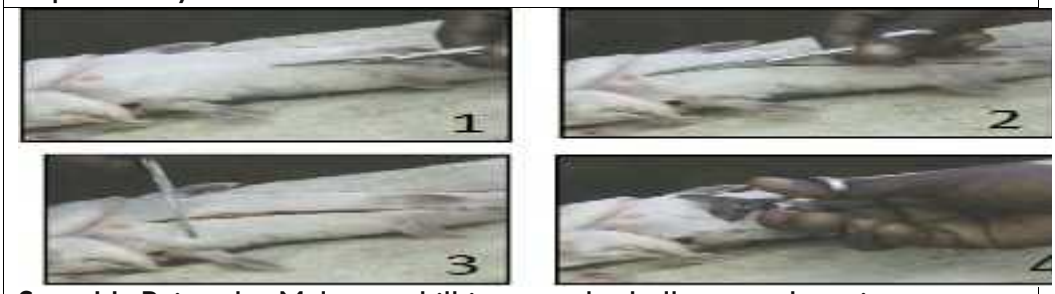
Step 7: Bring the Fish out after 10 to 12 hours gently and cover the head with a clean, moist towel.

Step 8: Wipe the body of the fish dry using a dry, soft towel.




Step 9: Strip the fish (i.e. press the eggs out of the fish).

Step 10: Weigh the stripped eggs. This helps to have an idea of the expected fry.



Step 11: Bring the Male out, kill it, turn the belly up and cut it open

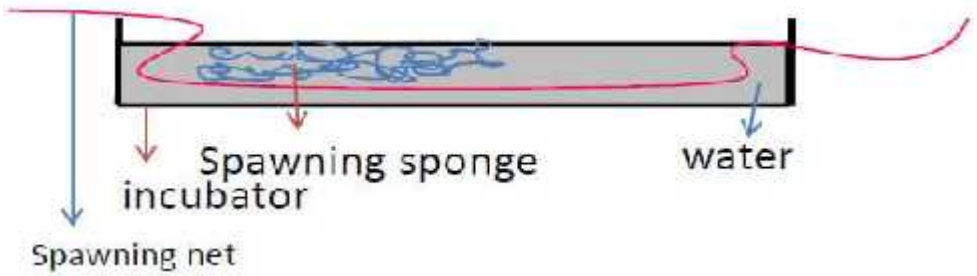
Step 12: Remove the milt sac

Step 13: Cut the testicles into bits to release the sperm

Step 14: Add saline solution to the milt

Step 15: Pour the mixture of saline solution and milt to the stripped eggs in the bowl and mix thoroughly and add fresh, clean, water. Continue mixing to prevent eggs from sticking together.

Step 16: Spread the eggs inside the incubator on the Spawning sponge. The spawning sponge is completely immersed in water. It however sits on the spawning net which keeps it suspended in the water. The net is held in place by pegs.



Step 17: Wait 20 to 36 hours. After 20 to 36 hours, remove the sponge and spawning net. By now the fry would have emerged from the hatched eggs and would have gone to the bottom of the net.

Step 18: Observe the newly hatched eggs, with yolk still visible and attached to the fry

4.0 Conclusion

The major practicable means of providing enough quality seed for rearing in confined fish enclosure waters such a fish ponds, reservoirs and lakes is through artificial propagation methods. This is because there is steady growing importance of fish farming which has compelled improvements in the technologies necessary for securing the initial and basic requirements for productive aquaculture.

5.0 Practical Assignment

1. Visit a fish-breeding laboratory, observe carry out the following:

    i. List various equipment used in the hatchery
    ii. Following the process stated above attempt to breed, incubating the fish at different temperatures and also with and without oxygenation.
    iii. Enumerate the different stages of gonadal maturity of African Catfish.

6.0 Reference

https://thefishsite.com/articles/19-steps-to-efficient-african-catfish-breeding

FISH NUTRITION

1.0 Introduction

Fish Nutrition is the science that interprets the interaction of protein, lipids, energy, vitamins and minerals and other substances in food in relation for growth, reproduction, health, disease of fish and other normal physiological functions.

Proximate Analysis is a partitioning of compounds in a feed into six categories based on the chemical properties of the compounds. It is important to remember that proximate analysis is not a nutrient analysis, rather it is a partitioning of both nutrients and non-nutrients into categories based on common chemical properties.

2.0 Objective

At the end of this section, you should be able to:

- Analyzeor measure the amount of each individual component in the feedstuff.

3.0 Procedure

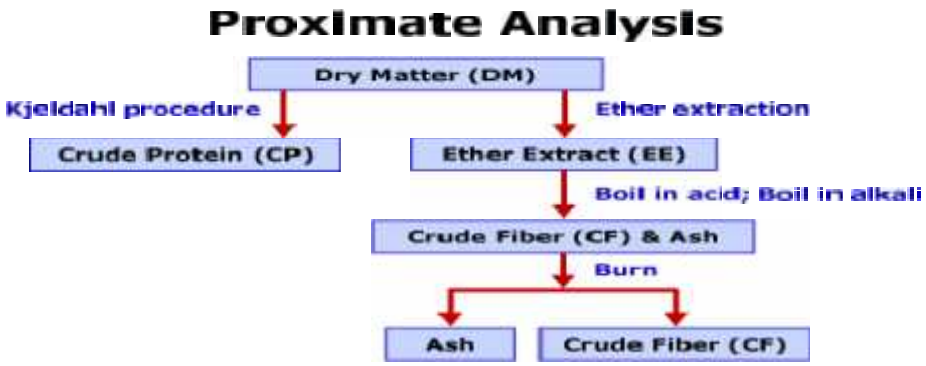


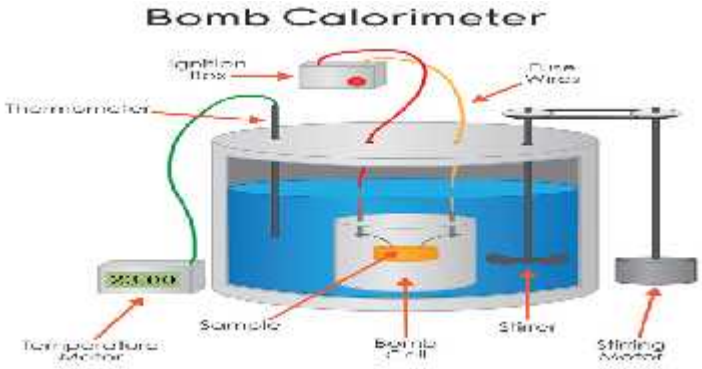
Diagram of the proximate analysis system

This system of analysis divides the food into six fractions: moisture, ash, crude protein, ether extract, crude fibre and nitrogen-free extractives.

1) The moisture content is determined as the loss in weight that results from drying a known weight of food to constant weight at 100^0C.
2) The ash content is determined by ignition of a known weight of the food at 550^{oC} until all carbon has been removed.

3) The crude protein (CP) content is calculated from the nitrogen content of the food, determined by a modification of a technique originally devised by Kjeldahl over 100 years ago.
4) The ether extract (EE) fraction is determined by subjecting the food to a continuous extraction with petroleum ether for a defined period.
5) The carbohydrate of the food is contained in two fractions, the crude fibre (CF) and the nitrogen-free extractives (NFE).

Determination of calorific value of fish feed (bomb calorimetry)



Bomb Calorimeter

A bomb calorimeter is used to measure the heat created by a sample burned under an oxygen atmosphere in a closed vessel (bomb), which is surrounded by water, under controlled conditions.

About 1g of solid or liquid matter (food) is weighed in a crucible and placed inside a stainless-steel container (the "decomposition vessel") filled with 30 bar (435psi) of oxygen. Next, the sample is ignited through a cotton thread connected to an ignition wire inside the decomposition vessel and burned (combusted).

After calibrating the decomposition vessel with a substance of a known heat, we know how much heat is necessary to heat up the water by 1°C. After that, the food will be burned and the unit displays the amount of energy inside the food sample in units of calories, J, or BTUper gram. Some food samples burn better inside the calorimeter than others.This is the physical calorific value.

Feed Formation Pearson's Method

You should follow the following guidelines when formulating feed using the Pearson Square method.

To use Pearson's Square:

1. Subtract the nutrient requirement (middle of square) from the nutrient concentration (on left of square) in the feed across the diagonal (top left – middle = bottom right; bottom left – middle = top right). Repeat this for both feeds. Make any negative numbers on the right side of the square positive. The answers on the right side of the square are the parts of each feed to include in the ration.
2. After subtracting across the diagonal, sum the parts of the two feeds to get the total.
3. Then, divide each part by the sum of the parts to calculate the percent of each feed in the ration.

4.0 Conclusion

Foods are defined as natural sources of nutrients produced in the environment, and feeds are natural and manufactured sources of nutrients produced elsewhere and added to the environment. Nutrients for cultured fish may come from various food sources, such as plankton, bacteria, insects and other fish from within the aquacultural ecosystem, and/or from organic matter and processed feeds added to the ecosystem. Feed formulation using the Pearson Square method is one of the simplest feed formulation techniques available. This method focuses on the Digestible Crude Protein (DCP) as the most basic feed nutritional requirement.

5.0 Practical Assignment

1. List all available feedstuff in your locality?

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2. Use the procedure of proximate analysis above to measure the amount of each individual component in the feedstuff

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3. Calculate the portion of a grain needed to make a 15% CP mix. The grain we have available is lupins at 30% protein and barley at 12% protein.

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6.0 Reference

http://www.tankonyvtar.hu/en/tartalom/tamop425/0059_fish_nutrition_and_feeding/ch01.html

FISHING GEAR TECHNOLOGY

1.0 Introduction

Fishing gear is the equipment used by fishermen when fishing. Almost any equipment or gear used for fishing can be called fishing tackle. Some examples are hooks, lines, sinkers, floats, rods, reels, baits, lures, spears, nets, gaffs, traps, waders and tackle boxes.

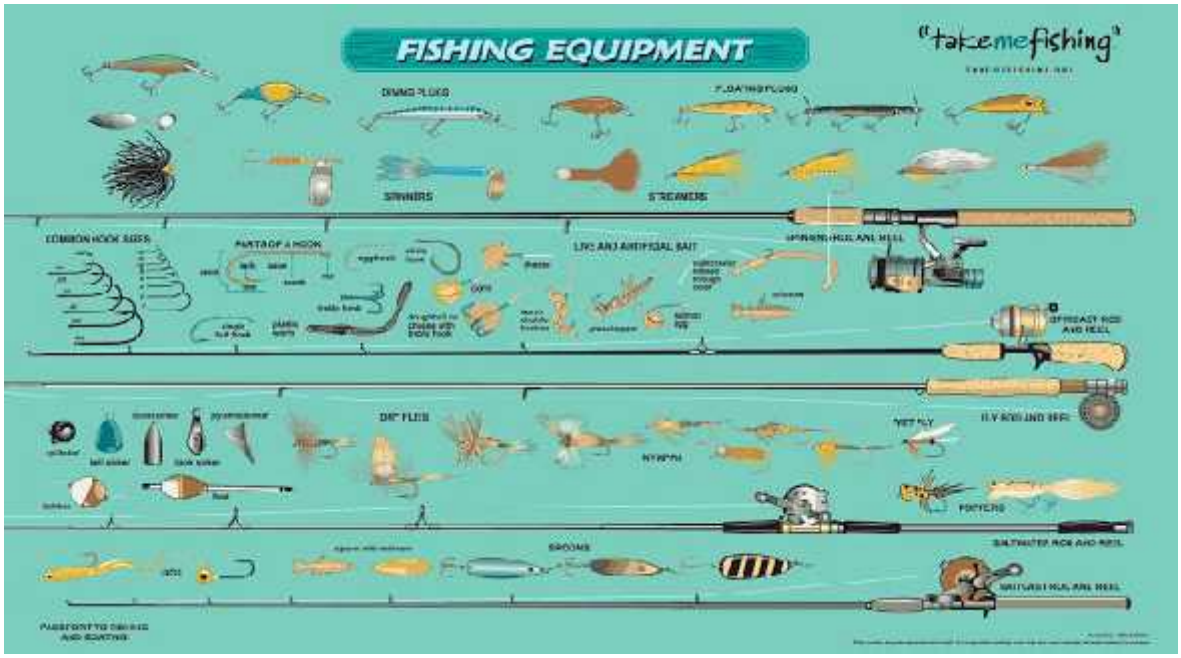
2.0 Objectives

At the end of this section, you should be able to:

- Identify equipment used by fishermen when fishing
- Examine fishing net market and identification of netting, twines etc.
- understand boat yard and identify the materials for boat building and
- Describe design and construction of different types of fishing gear and their maintenance

3.0 Procedure

Basic Fishing Equipment



Determination of hanging ratio of nets, buoyancy and sinking

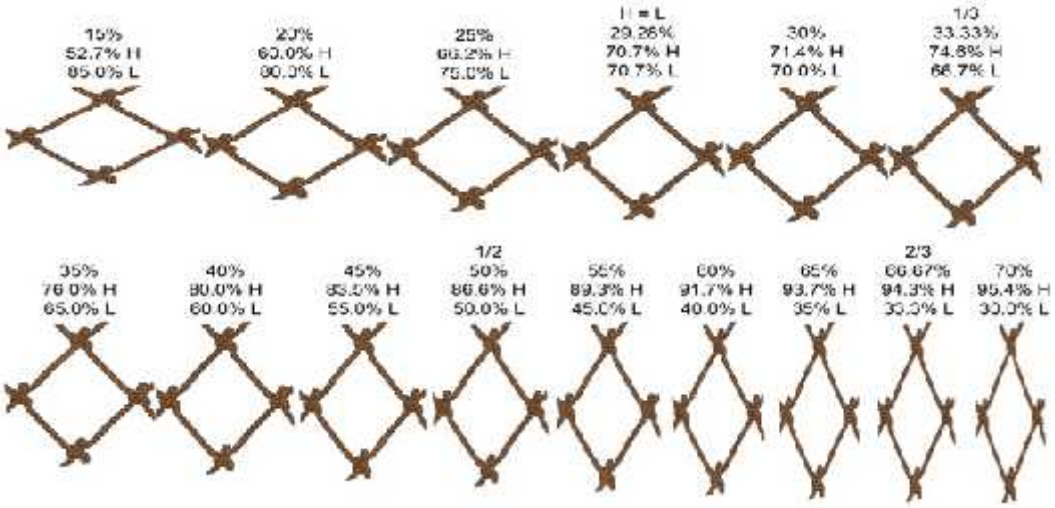
When netting is attached to lines, it should be longer than the lines so as to have a proper looseness. This excess length is expressed as a percentage of the stretched netting. This is the hanging ratio.

The formula for figuring the hanging ratio is stretched length of netting minus length of netting, divided by length of netting. Ratio % = (str length of netting less rope length)/str length of netting).

The shape of mesh is greatly influenced by the hanging ratio. Multiply the stretch mesh size times the number of mesh deep times the % height to get the total height of net.

Multiply the stretch mesh size times the number of mesh long times the % length to get the total length of net.

The following shows the heights and lengths of the mesh for different hanging ratios.



Transformation of net designs to fishing nets from a given netting bundle.

4.0 Conclusion

Fishing gear in fishing cannot be over-emphasized; as without it fish cannot be obtained. This is because fishery management requires a good knowledge of fishing gear. You must be able to identify the best fishing gear for the correct environment and target fish. The method and hanging ration used to catch fish affects the condition in which the product is landed.

5.0 Practical Assignment

1. Visit to fishing net market and identification of netting, twines, netting bundles, specifications and designations. Record the different netting and twines and state the characteristics of each.

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2. A visit to a boat yard and identify the materials for boat building, parts of the boat and engines employed. Record your findings:

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3. Take an excursion to riverine States/fishing companies and observe the application of marine fishing gear (gillnets, longlines, trawlnets, boat seines etc.). Record your observations.

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4. Describe floats, sinkers and their characteristics and properties.

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5. Describe design and construction of different types of fishing gear and their maintenance.

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6.0 References

Binyotubo, T. E. 2011. A Guide to Fishing Gear Technology. 60p

FAO. 1985. Definition and classification of fishery vessels types.FAO Fisheries Technical Paper No. 267. 63p.

FAO. 1990. Definition and classification of fishing gear categories. FAO Fisheries Technical Paper No. 222. 92p.

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http://www.fao.org/docrep/008/t0367t/t0367t00.htm

FISH PARASITES AND DISEASES

1.0 Introduction

Parasitic diseases of fishes are usually encountered more often than microbial diseases. From 30 to 50 percent of the cases received at several fish disease diagnostic laboratories involve parasites. Host reaction to parasitic invasion is highly variable. The severity of a parasite epizootic may be related to environmental factors; host condition, age, and size; and population density. Bacteria pathogens associated with fish into two: the non- indigenous bacteria pathogen and the indigenous bacteria pathogens. The non-indigenous pathogen contaminate fish or fish's habitat in one way or the other and the pathogens include Clostridium botulinum, Listeria monocytogenes, Staphylococcus aureus, Salmonella species, Shigalla species, Escherichia coli, etc. The indigenous bacteria pathogens are those naturally living in the fish's habitat.

2.0 Objectives

At the end of this section, you should be able to:

- Identify methods for application of antibacterial to fish
- Examine and identification of associated pathogenic organism
- Understand how parasitic diseases of fishes are usually encountered.

3.0 Procedure

Microscopic inspection of smeared slides (e.g. slime or wound)

Microscopic Examination Bacteriological examination is completed by a microscopic search for bacteria, in spoiled cans directly upon sampling or after incubation. Usually a wet preparation of smeared contents examined under phase contrast microscope is sufficient to detect microorganisms.

Identification of associated pathogenic organism (bacteria, fungus, protozoa)

i. Collect the infected parts of the fish aseptically by using sterile forceps and scissors.
ii. Homogenized collected sample in sterile mortar and pestle using phosphate buffer as solvent.
iii. Serially diluted homogenized samples up to 10-6.

iv. Poured One millilitre of diluted sample from each dilution into sterile petri dishes followed by sterilized molten agar medium
v. After solidification, were inverted all the plates and incubated in a thermostat incubator to allow the growth of bacteria.
vi. After incubation, the colonies appeared on the respective agar plates
vii. Finally, the cultures were stored in respective agar slants for further use and identification using microscope.

Methods for application of antibacterials to fish (Haya et al., 2005)

Method of application	**Comments**
Oral route (on food)	Needs palatable components; minimal risk of environmental pollution
Bioencapsulation	Needs palatable compounds; minimal risk of environmental pollution
Bath	Need for a fairly lengthy exposure to the compound, which must be soluble or capable of being adequately dispersed; problem of the disposal of spent drug
Dip	Brief immersion in a compound, which must be soluble or capable of being adequately dispersed; problem of disposal of the dilute compound
Flush	Compound added to a fish holding facility for brief exposure to fish; must be soluble or capable of being adequately dispersed; poses a problem of environmental pollution
Injection	Feasible for only large and/or valuable fish; usually requires prior anaesthesia; slow; negligible risk of environmental pollution
Topical application	Feasible for the treatment of ulcers on valuable/pet fish

4.0 Conclusion

Diseases and parasitic problems could constitute significant economic losses in fish production if not controlled, thus the need to continue monitoring its prevalence. Ability to identify associated pathogenic organism in the ecosystem and apply antibacterial of methods is critical to sustainable fisheries management.

5.0 Practical Assignment

i. How can you identify diseased fish in the pond?

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What are the methods of identifying and extracting the endo-parasites of fish?

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ii. How do fish farmer in your area prepare treatment " dips", "baths" for the treatment of fungal diseases?

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_____
_____
_____
_____

iii. How is oral drugs (food additives /antibiotics) against bacteria diseases calculated in the farm you visited?

_____
_____
_____

iv. What kind of protozoa infections are you likely to see on a fish?

_____
_____
_____

v. Mention only five that you know.

_____
_____
_____

vi. What are the signs of a fungal disease on a fish?

_____
_____

vii. How can you recognize them on fish?

_____
_____
_____

viii. What are the general preventive methods of keeping healthy fish?

_____

_____

_____

6.0 References

Haya, K., Burridge, L., Davies, I. & Ervik, A. (2005). A Review and Assessment of Environmental Risk of Chemicals Used for the Treatment of Sea Lice Infestations of Cultured Salmon. In Environmental Effects of Marine Finfish Aquaculture, edited by Barry Hargrave, 305-340. Springer Berlin / Heidelberg.

http://articles.extension.org/pages/58704/fish-disease

https://www.microscopemaster.com/microscope-slides.html

Kvenberg EJ (1991). Non-indigenous Bacterial Pathogens, In: Microbiology of Marine Food Products. (Eds). Donn, R. W. and Cameron, H. Van Nostrand Reinhold, New York, pp. 263-291.

OCEANOGRAPHY

1.0 Introduction

Oceanology is the study of the physical and the biological aspects of the ocean. Scientists study the ocean in many ways. Seagoing oceanographers have historically conducted observations from research vessels. However, examining the physical, chemical, and biological properties of the ocean in that manner can be very expensive. Today, thanks in part to new technologies, scientists employ multiple tools to monitorour oceans.

2.0 Objectives

At the end of this section, you should be able to:

i. Identify instrument for oceanic data collection
ii. Illustrate the uses of basic oceanic instrument in maritime environment.

3.0 Procedure

Visit to maritime environment, oceanography institutions, boat yards and fishing terminals in maritime states and exposure to the sea voyage, marine organisms, tidal rhythms, wave and oceanic vessels.

4.0 Conclusion

One of the main pieces of equipment that oceanographers use for the study of the ocean is a platform or research ship. A research ship is equipped with a variety of instruments to measure temperature, water current, turbidity, salinity, tides, waves, Oxygen, pH, and for collecting water samples and sea floor sediments. Other instruments, such as submersibles, remote controlled vehicles and autonomous robots equipped with photographic equipment help oceanographers study the oceans.

5.0 Practical Assignment

1. During your visit to maritime environment, oceanography institutions, boat yards and fishing terminals, what are instrument for oceanic data that you observed?

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2. What are the uses of current metre, echo sounder, sediment samplers, under – water cameras?

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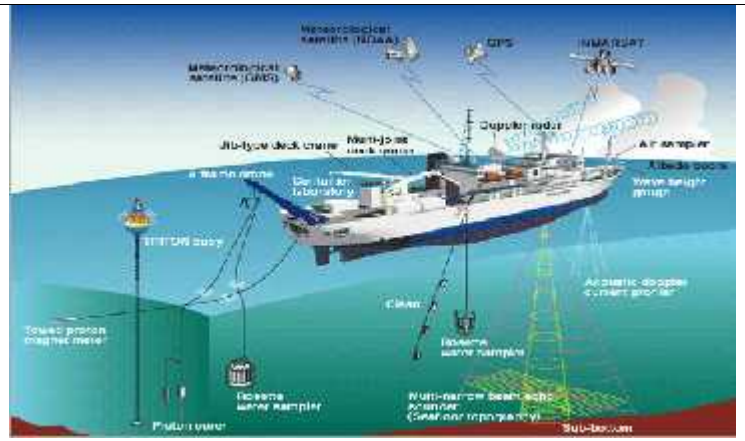
3. What are the uses of the following oceanic data collection?

Pressure Compressor



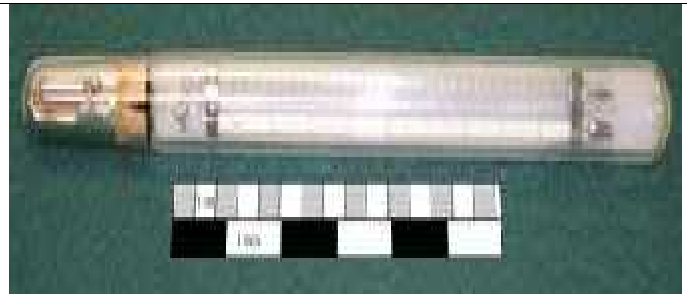
Linear Actuators

Rotary Actuators

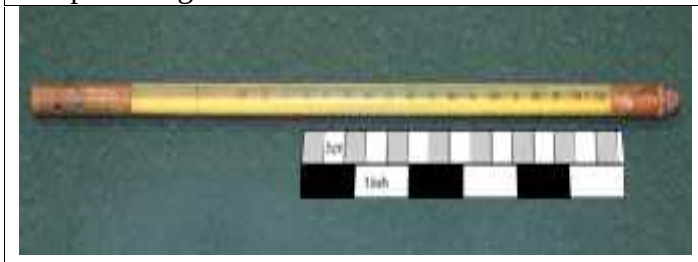
Laser Camera

Bucket Thermometer

Deep Sea Light

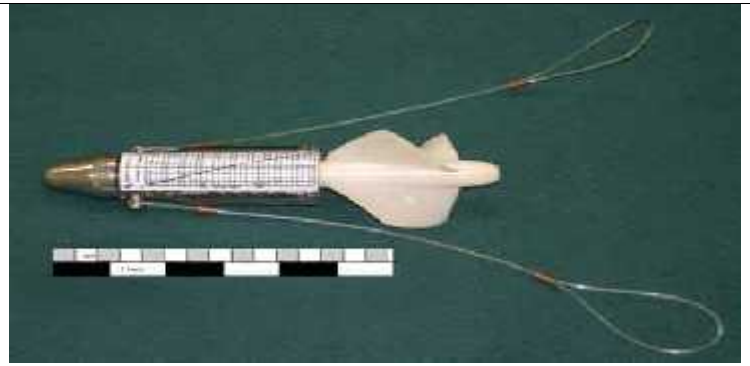


Reversing Thermometer (for Nansen Bottle)



Standard Thermometer

Bathythermograph (BT)

Salinity: Hydrometer (quick test type for aquariums)	**Hydrometer Set** (cylinder, hydrometer, thermometer, TSD graph)
 **Chemical Test Kit** (Knudsen Titration modification) for Salinity	 Salinometer
 Chemical Test Kit (Winkler Titration) for Oxygen	 Current Meters

 Fathometer	 Sounder (lead line)
 Secchi Disk	 pH meter

Chemical Test Kit for Saltwater pH

Dissolved Oxygen Probe

6.0 References

Davis R.A. 1987. Oceanography: An Introduction to the Marine Environment. Dubuque: Wm. C. Brown Publishers.

Pickard G.L., and W.J. Emery. 1990. Descriptive Physical Oceanography: An Introduction. 5th enlarged ed. Oxford: Pergamon Press.

SUN Working Group on Symbols, Units and Nomenclature in Physical Oceanography. 1985. The International System of units (SI) in oceanography. iapso Paris: Unesco Techni- cal Papers in Marine Science 45: 124.

http://www.marinebio.net/marinescience/01intro/tomeas.htm

http://www.actforlibraries.org/oceanographic-instruments/

ORNAMENTAL FISHERIES AND AQUARIA DESIGN

1.0 Introduction

Ornamental fishes can be defined as attractive colorful fishes of peaceful nature that are kept as pets in confined spaces of an aquarium or a garden pool with the purpose of enjoying their beauty for fun and fancy. An aquarium is a container, which displays the aquatic organisms in a simulated natural environment by introducing aquatic plants, rocks, gravels, artificial decorative and maintaining physic-chemical and biological parameters there in with the aid of equipment controlling aeration, water movement, temperature, suspended organic matter, and illumination besides feeding.

2.0 Objectives

At the end of this section, you should be able to:

- Identify freshwater and marine aquarium fishes suitable for home aquarium;
- Understand the various types of aquaria and their construction techniques;
- Construct a fish aquarium
- Manage and maintain the constructed aquarium

3.0 Procedure

Demonstration of the step – by – step construction of an aquarium;

i. Put the Growth Substrate.(2cm)
ii. Put the Gravel. (3-4cm)
iii. Place the decorating such as the Granite Cave and Moss Wall I will show you the next steps.
iv. Pour water up to the middle of the Aquarium.
v. Plant the Plants.
vi. Place the Heater in the corner on the back of the Aquarium (some Aquariums included along Heaters on the market) and a Thermometer.
vii. Place the Aquarium Filter (in the next step I will show how to build the Aquarium Filter).
viii. Bring the remaining water to fill the tank.

ix. Place the Aquarium Lamp and AC adapter (some Aquariums included along Aquarium Lamps on the market).
x. Put into operation the Lighting, Filter and Thermostat, and leave the Aquarium to work for at least 2-3 days

Implement utilized in the construction of an aquarium

i. Single edged razor blades.
ii. Acetone.
iii. A non-toxic 100% silicone sealant
iv. A roll of paper towels.
v. A washable felt tip marker.
vi. A roll of duct tape.
vii. Some emery cloth or silicone carbide sandpaper.

Identification of different kinds of aquarium

Freshwater Tropical Aquarium

i. This is the "standard" in the hobby.
ii. The water temperature usually ranges from 72- 84 Degrees Fahrenheit.
iii. Freshwater Tropical aquariums are far easier to maintain and keep.
iv. There are no fancy chemical additives (beyond basic water conditioners such as chlorine removers) that must be administered.
v. There is no need for expensive light fixtures or really complicated aquarium equipment.
vi. Tropical fish are generally less expensive when compared to marine fish.

Coldwater Aquariums

i. The temperature is usually below 70 degrees or at least room temperature in most homes.
ii. One of the most common coldwater species kept in a coldwater aquarium is the Goldfish.
iii. Setting up a goldfish aquarium is as simple as adding the proper equipment and in return, dramatically lengthening the lifespan of their little goldfish. Coldwater freshwater fish may be a little more expensive when you start shopping for species other than the standard goldfish. Koi and goldfish ponds are great examples of domesticated coldwater fish habitats.

Marine Aquariums

i. Marine tanks require saltwater for the fish to survive. Salt must be purchased and mixed before adding water to the tank.
ii. Marine tanks offer beautiful fish, colorful corals, and spectacular

invertebrates to admire. These specimens are usually significantly higher in price as compared to the tropical freshwater specimens.

iii. Marine aquarium equipment is significantly more expensive due mainly to keeping coral.

Brackish Aquariums

i. Brackish water is a mixture of saltwater and freshwater.

ii. It's like in the middle, not freshwater, but not as strong as marine saltwater.

iii. People generally do not have much success with brackish water fish due to the water conditions are hard to maintain and most of the fish that are brackish fish have not been housed properly before they end up in your home aquarium.

Different kinds of aquarium (ornamented) fishes

Aquarium maintenance

Aquariums can be maintained be reduce stress, Cycling the tank, performing periodic partial water changes, managing the filtration system, vacuuming the gravel and feeding the fish appropriately.

4.0 Conclusion

The keeping of fish in an aquarium became a popular hobby and spread quickly. It is the second largest hobby in the world next to photography due to its tremendous economic opportunities and prospects.

5.0 Practical Assignment

i. Visit aquarium home or farm. Identify and take photograph of different ornamental fish reared?

ii. Highlight the step by step techniques of fish aquarium construction?

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iii. Manage and maintain the constructed aquarium?

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iv. What are the characteristics of aquarium in your area?

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v. How would you know the type of ornamental fish to be reared in it?

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_____

6.0 Reference

George F. H and Jack H: A guide to freshwater aquarium fishes. Published by the Hamlyn group Ltd, London. 176p.