



NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: AGE 311

**COURSE TITLE: FISHING AND POND MANAGEMENT IN
SCHOOLS**



AGE311
FISHING AND POND MANAGEMENT IN SCHOOLS

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Introduction

Fishing and Pond Management in Schools is a third year, 2-credit unit course available to all students offering Bachelor of Science in Agricultural Education. It may be taken by students who wish to know more about agricultural science methods.

Agricultural education is a formal instruction in the science and art of agriculture and agricultural practice in organised institutions of learning. It is aimed at finding scientific solutions to practical farming problems. In global definition, education itself is the development of the whole man. Agricultural education is an essential aspect of our educational set up because it educates youths of the tremendous opportunities in agrobusiness and exposes them to a vast store of knowledge available for anyone contemplating big time agricultural farming.

Fisheries and aquaculture management essentially deals with the prudent management of fisheries resources and pond management to ensure sustainable production from the wild and profitable outputs from the ponds. To many people, fisheries and aquaculture is catching and culturing of fish respectively. However, these terms go beyond the ordinary definitions and encompass scientific processes which lead to formation of suitable production and management procedures.

What You Will Learn in This Course

This course comprises 4 modules which are subdivided into 16 units. This course guide tells you briefly what the course is all about and the course materials you will be using. It also suggests some general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully.

It gives you guidance in respect of your Tutor-Marked Assignment (TMA) which will be made available in the assignment file. There will be regular tutorial classes that are related to the course. It is advisable for you to attend these tutorial sessions. The course will prepare you for the challenges you will meet in the field of fisheries and pond management in schools.

Course Aims

This course aims to provide an understanding, appreciation and the status of fisheries and pond management as an integral part of agricultural science in schools.

Course Objectives

To achieve the aims set out, the course has a set of objectives. Each unit has specific objectives which are usually included at the beginning of the unit. You should read these objectives before you study the unit. You may wish to refer to them during your study of the unit to check on your progress. You should also look at the unit's objectives after completing a unit. By doing so, you would be able to locate your bearing and level of attainment of the objectives of the unit.

Below are the comprehensive objectives of the course as a whole. By meeting these objectives, you should have achieved the aims of the course as a whole. After going through this course, you should be able to:

- state the essence of fishing and aquaculture and their relevance in the Nigerian context
- decipher trends in fishing and aquaculture
- define fishing and aquaculture strategies for a school
- state the objectives of fisheries management
- identify the objectives of pond management
- describe the attributes of small scale fisheries
- state the attributes of small scale aquaculture
- state the need for sustainable management of fish stock
- determine appropriate management options for various pond problems and activities
- describe the problems of fisheries management and aquaculture management
- determine the appropriate management measures
- advocate management approaches for a fishery
- identify the intricacies in the process of reviewing and amending management plans
- state the fisheries policy in Nigeria
- design pond, channels and drainages
- state the process of fish breeding
- carry out stripping and fertilisation.

Working through the Course

To complete this course, you are required to read each study unit of this study material and other materials which may be provided by the National Open University of Nigeria. Each unit contains self-assessment exercises for this course and at a certain point in the course; you will be required to submit assignments for assessment purposes. At the end of the course, there is a final examination. The course should take you

about 17 weeks to complete. Below, you will find listed, all the components of the course, what you have to do and how you should allocate your time to each unit in order to complete the course on time and successfully.

You should avail yourself the opportunity of attending the tutorial sessions where you have the opportunity of comparing knowledge with peers.

The Course Materials

The main components of the course are:

1. The Course Guide
2. Study Units
3. References
4. Assignments
5. Presentation Schedule

Study Units

The course is divided into 4 modules that are made up of 16 units. The study units in this course are as follows:

Module 1

- | | |
|--------|--|
| Unit 1 | History, Definition and Purpose of Fishing and Aquaculture |
| Unit 2 | Systems, Production and Trends of Fishing and Aquaculture |
| Unit 3 | Fishing and Aquaculture in Schools |
| Unit 4 | Objectives of Fishing and Pond Management in Schools |

Module 2 Fishing, Pond Management and Administration

- | | |
|--------|---|
| Unit 1 | Attributes of Small Holder Fishing and Aquaculture Ventures |
| Unit 2 | Fisheries Management |
| Unit 3 | Pond Management and Administration |
| Unit 4 | Prospects and Problems of Fishing and Pond Management |

Module 3 Management Plans For Fishing Pond Areas in Nigerian Schools

- | | |
|--------|------------------------------------|
| Unit 1 | Designing a Management Plan |
| Unit 2 | Implementation of Management Plans |

- Unit 3 Reviewing and Amending Management Plans
Unit 4 Government Policy in Fishing and Pond Management

Module 4 Aquaculture Engineering/Breeding

- Unit 1 Construction of Ponds, Channels and Drainages
Unit 2 Pond Preparation
Unit 3 Maintenance of Ponds
Unit 4 Fish Breeding

The first unit focuses on the differences between fishing and aquaculture and gives a brief history of fishing and aquaculture development. The second unit deals with identification and differences between systems of aquaculture. It also gives a brief overview of world and Nigerian aquaculture production. The third unit deals with the types of fishing and aquaculture methods that schools and teachers can suggest for adoption.

In the 2nd module, unit one categorically handles the objectives of fisheries and pond management. Unit two discusses the attributes of small scale fisheries and aquaculture and unit six puts forward the problem of over-fishing so it can be appreciated as well as the purpose and objectives of fisheries management. Unit three explains the activities in aquaculture that need proper management and how to determine appropriate management options for various pond problems and activities. Unit four describes the problems of fisheries management and aquaculture or pond management. It further gives a vivid picture of the outlook of fisheries and aquaculture.

Unit one of module 3 teaches the need to appreciate consultation with recognised interest groups before determining the appropriate management measures. Units two and three teach how to advocate for management approaches in a fishery and the process of review and amendment of management plans. Unit four gives a firm grasp of the fisheries policy in Nigeria.

In the last module, unit one introduces aquaculture engineering. It explains the construction of ponds and their location. It also includes the design of channels and drainages. Unit two explains the preparation of ponds for stocking while unit three discusses the maintenance of the ponds. Unit 4 explains the process of breeding and rearing of fry to fingerlings.

Each unit consists of one to two weeks work and includes an introduction, objectives, reading materials, exercises, conclusion, summary, TMA, references and further reading. The unit directs you to

work on exercises related to the required reading. In general, the self-assessment exercise questions you on the material you have just covered. Together with TMAs these exercises will help you in achieving the stated learning objectives of the individual units and of the course.

Presentation Schedule

Your course materials give you important dates for the early and timely completion and submission of your TMA's and attending tutorials. You should remember that you are required to submit all your assignments by the stipulated time and date. You should guard against lagging behind in your work.

Assignment File

In your assignment file, you will find the details of the works you must submit to your tutor for marking. The marks you obtain from these assignments will count towards the final mark you obtain for this course. Further information on assignments will be found in the Assignment File itself, and later in this course guide in the section on assessment.

There are many assignments for this course, with each unit having at least one assignment. These assignments are basically meant to assist you to understand the course.

Assessment

There are three aspects to the assessment of this course. First is self-assessment exercise, second is the tutor-marked assignment and third is the written examination/end of course examination.

You are advised to be sincere in attending the exercises. In tackling the assignments, you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted to your tutor/facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file. The work you submit to your tutor for assessment will count for 30% of your total course work. At the end of the course, you will need to sit for a final or end of course examination of about three hours duration. This examination will count for 70% of your total course mark.

Tutor-Marked Assignment (TMA)

The TMA is a continuous assessment component of your course. It accounts for 30% of the total score. You are required to submit at least 4 TMAs before you are allowed to sit for the end of course examination.

The TMAs would be given to you by your facilitator and returned after you have completed them.

Assignment questions for the units in this course are contained in the assignment file. You will be able to complete your assignment from the information and materials contained in your reading your study units and references. However, it is desirable to demonstrate that you have read and researched more into other references which will give you a wider view point and may provide a deeper understanding of the subject.

Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you cannot complete your work on time, contact your facilitator before the assignment is due to discuss the possibility of an extension. Extension will not be granted after the due date.

Final Examination and Grading

The end of course examination for Fishing and Pond Management in Schools will be about 3 hours and has a value of 70% of the total course grade. The examination will consist of questions which will reflect the type of self-testing, practice exercise and tutor-marked assignment problems you have previously encountered. All areas of the course will be assessed.

Utilise the time that you have between finishing the last unit and sitting for the examination to revise the whole course. You might find it useful to review your self-assessment exercises, TMAs and comments on them before the examination. The end of course examination covers information from all parts of the course.

Course Marking Scheme

Assessment	Marks
Assignment 1 – 4	Four assignments, best three marks of the four account at 10% each = 30% of the course marks.
End of Course Examination	=70% of overall course marks
Total	100% of course materials.

How to Get the Most from This Course

1. In distance learning, the study units replace the university lecture. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your own pace, and at a time and place that suits you best. Think of it as reading the lecture instead of listening to the lecturer. In the same way a lecturer might give you some reading to do, the study units tell you when to read, and which are your text materials or recommended books. You are provided exercises, to do at appropriate points, just as a lecturer might give you an in-class exercise.
2. Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit, and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These objectives let you know what you should be able to do, by the time you have completed the unit. These learning objectives are meant to guide your study. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course.
3. The main body of the unit guides you through the required reading from other sources. This will usually be either from your references or from a reading section.
4. The following is a practical strategy for working through the course. If you encounter any trouble, telephone your tutor or visit the study centre nearest to you. Remember that your tutor's job is to help you. When you need assistance, do not hesitate to call and ask your tutor to provide it.
5. Read this course guide thoroughly, it is your first assignment.
6. Organise a study schedule. Design a 'course overview' to guide you through the course. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester is available at the study centre. You need to gather all the information into one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates and schedule of work for each unit.

7. Once you have created your own study schedule. Do everything to stay faithful to it. The major reason why students fail is that they get behind with their course work. If you get into difficulties with your schedule, please, let your tutor know before it is too late for help.
8. Turn to unit 1, and read the introduction and the objectives for the unit.
9. Assemble the study materials. You will need your references and the unit you are studying at any point in time.
10. As you work through the unit, you will know what sources to consult for further information.
11. Visit your study centre whenever you need up to date information.
12. Well before the relevant due dates (about 4 weeks before due date), visit your study centre for your next required assignment. Keep in mind that you will learn a lot by doing the assignment carefully. They have been designed to help you meet the objectives of the course and therefore, will help you pass the examination. Submit all assignments not later than the due date.
13. Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study materials or consult your tutor. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to space your study so that you can keep yourself on schedule.
15. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also the written comments on the ordinary assignment.
16. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit's objectives (listed at the beginning of each unit) and the course objectives (listed in the course guide).

Facilitators/Tutors and Tutorials

There are 14 hours of tutorial provided in support of this course. You will be notified of the dates, times and location of these tutorials as well as the names and phone number of your facilitator, as soon as you are allocated a tutorial group.

Your tutor or facilitator will mark and comment on your assignments. Keep a close watch on your progress on any difficulties you might encounter and provide assistance to you during the course. You mail your tutor-marked assignment to your tutor before the schedule date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your facilitator by telephone, e-mail and discuss problems if you need assistance. The following might be circumstances in which you would find help necessary. Contact your facilitator if:

- you do not understand any part of the study units or the assigned readings.
- you have difficulty with the self-test or exercises.
- you have a question or problem with an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your course facilitator and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain much benefit from course tutorials prepare a question list before attending them. You will learn a lot from participating in active discussion.

Summary

Agricultural education is a course that intends to provide you with the concept and instructional methods. Upon completing this course, you will be equipped with the basic knowledge of a fishery, aquaculture, management options/approaches in fisheries and ponds, pond construction and fish breeding technology for use in schools. Hence you will be able to prepare management plans for small scale fisheries as well as management strategies for aquaculture ventures in schools. In addition, you will be able to answer the following type of questions:

- What is a fishery and what is aquaculture?
- What are the various fishing gears?

- What is the present state of fishing and aquaculture in the world, Africa and Nigeria?
- What are the trends of fishing?
- What are the management approaches in fisheries?
- What are the management considerations in ponds?
- What are the problems, attributes and prospects of fishing and aquaculture management?
- What are the construction procedures for a pond?
- How can fish be bred?

Of course the list of questions that you can answer is not limited to the foregoing list.

We wish you success in the course and hope that you will find it interesting and useful.

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MODULE 1

- Unit 1 History, Definition and Purpose of Fishing and Aquaculture
- Unit 2 Systems, Production and Trends of Fishing and Aquaculture
- Unit 3 Fishing and Aquaculture in Schools
- Unit 4 Objectives of Fishing and Pond Management in Schools

UNIT 1 HISTORY, DEFINITION AND PURPOSE OF FISHING AND AQUACULTURE

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Brief History of Fishing and Aquaculture
 - 3.2 What is Fishing?
 - 3.3 What is Aquaculture?
 - 3.4 Purpose of Fishing and Aquaculture
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

Fish is a valuable source of micronutrients, minerals, essential fatty acids and proteins in diets of many Nigerians. With a population of 150 million, Nigeria consumes more than 1.3 million tonnes of fish annually. Per caput consumption in 2000 was estimated at 14.49kg. In 2003, per caput consumption of fish in Nigeria rose to 19.0kg. In the same year, world per caput fish food supply was estimated as 13.3kg (excluding China).

Fish consumption accounts for about 25 per cent source of animal protein in Nigeria. Average per capita fish supply in Nigeria is 5 to 10kg. Nigerians consume 2 to 4g of fish protein per capita per day. Fish provides 180 kilocalories of energy per day in Japan; though 20 to 30 kilocalories per day is common worldwide.

The challenge is to find suitable and sustainable technologies which can ensure physical and economic access to sufficient, safe and nutritious food at all times: a situation referred to as food security.

2.0 OBJECTIVES

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

- differentiate fishing from aquaculture
- give a brief history of fishing and aquaculture development
- define aquaculture and fishing
- determine the essence of fishing and aquaculture and their relevance in the Nigerian context.

3.0 MAIN CONTENT

3.1 Brief History of Fishing and Aquaculture

People have fished for food since ancient times, when pieces of bone were used as hooks and lengths of vine as line. The oldest known painting of an angler using a rod or staff comes from Egypt and is dated about 2000 BC. Greek philosophers Plato and Aristotle mentioned angling in their writings, and another Greek writer, Plutarch, gave tips about fishing lines. In the 2nd and 3rd centuries AD, Roman rhetorician Claudius Aelian wrote about Macedonian trout anglers using artificial flies as lures (Crise 2009). The methods and tackle used for fishing evolved slowly through the centuries, and not until the late 15th century did sport fishing as it is now known really begin.

The farming of fish in ponds is an ancient practice. It was presumably developed by early farmers as one of many primary production systems to stabilise food supplies. The earliest known references to pond fish culture are from China, some 4000 years ago, and from Mesopotamia, about 3,500 years ago. The integration of pond fish culture and rice farming is documented as early as the Mid-Eastern Han Dynasty (*AD 25-220*) in China (FAO 2000). Fish farming was practiced during the times of the Roman Empire in the Mediterranean region, and later became part of the food production system of Christian Monasteries in Central Europe.

3.2 What is Fishing?

Fishing is the act of catching fish. It may be large commercial fishing, recreational fishing, or small subsistence fishing (fishing to provide the basic needs of the fishing community). A fishery is an industry that deals with the harvesting of fish, shellfish, and other aquatic animals.

Fishing is an important source of food, income, jobs, and recreation for people around the world. This is particularly true in island nations, such as Japan and Iceland, where seafood is eaten as a major source of protein.

3.3 What is Aquaculture?

The FAO defines aquaculture as the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants under controlled or semi-controlled conditions. Farming implies some form of intervention in the rearing process to enhance production as well as ownership of the stock being cultivated.

Aquaculture is far more akin to farming and animal husbandry than to fishing, as it involves the rearing and management of living aquatic resources in a restricted environment. Rather than fishing or hunting, which entails the harvesting of fish or animals from an open or common access resource, aquaculture involves tenure and ownership. Tenure of production facilities, and property rights to the produce, are as important to the success of aquaculture as land tenure is to agriculture.

3.4 Purpose of Fishing and Aquaculture

Poverty, hunger and malnutrition affect millions of people across the globe; of these, 25 percent live in sub-Saharan Africa (Pinstrup-Anderson, Pandya-Lorch and Rosegrant, 1999). The challenge is to find suitable and sustainable technologies with access to sufficient, safe and nutritious food at all times: a situation referred to as food security.

Aquaculture has been developed to serve a variety of purposes. Today, its more frequent goals are:

- producing high nutritional value food for human consumption
- contributing to rural income and employment through farming and related activities
- enhancing capture and sport fisheries
- cultivating ornamental species for aesthetic purposes
- controlling aquatic weeds or pests hazardous to humans or crops
- desalination and other forms of soil recuperation
- serves as sources of foreign exchange to the country

Fishing and the activities surrounding it - processing, packaging, distribution and marketing are important from the village level to the level of national and international macroeconomics.

Fishing generates significant revenue. In 2000, the global fish catch was worth US\$81 billion while aquaculture production added another US\$57 billion (FAO 2002a); and the international fish trade totaled over US\$55 billion. Income from fishing is particularly important to developing economies, which often depend heavily on revenues from natural resources such as timber, mining, oil, and fish. Fisheries are a major

foreign exchange earner for developing countries, which produce more than half of all international traded seafood.

Fishing is also a crucial source of livelihoods in developing nations, particularly for low-income families in rural areas where job options are limited. FAO (2008) estimates that some 43.5 million people are directly engaged either full-or part-time, in fishing and aquaculture, and this may be an underestimation. Over 95 percent of them live in developing countries, and the majority is comprised of small scale fishers. In some countries, these subsistence fishers contribute more to the national economy than large-scale commercial operators because of their larger numbers.

The contribution of fisheries to the global food supply is also significant. In 2000, fish constituted 15.3 percent of the total animal protein (or 5.7 percent of all dietary protein, including grains) consumed by people worldwide. More importantly, about 1 billion people - largely in developing countries - rely on fish as their primary animal protein source.

4.0 CONCLUSION

From the forgoing, fishing dates back in time and it is one of the oldest professions known to man. There is a record of it in the Bible. Fishing is the act of catching fish. It may be large commercial fishing, recreational fishing, or small scale subsistence fishing. Aquaculture however is an attempt to make up for depleting wild stocks. Fish contains various micronutrients such as iron, iodine, zinc, calcium, vitamin A and vitamin B. It serves as a rich source of protein for people in Low-Income Food-Deficit Countries (LIFDCs).

5.0 SUMMARY

Fish is a valuable source of micronutrients, minerals, essential fatty acids and proteins in diets of many Nigerians.

Fishing is the act of catching fish. It may be large commercial fishing, recreational fishing, or small subsistence fishing (fishing to provide the basic needs of the fishing community). A fishery is an industry that deals with the harvesting of fish, shellfish, and other aquatic animals.

The FAO defines aquaculture as the farming of aquatic organisms, including fish, molluscs, crustaceans, and aquatic plants under controlled or semi-controlled conditions.

6.0 TUTOR-MARKED ASSIGNMENT

1. Give a brief history of fishing as a profession.
2. What is fishing?
3. What is aquaculture?
4. Why is fishing and aquaculture important?

7.0 REFERENCES/FURTHER READING

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UNIT 2 SYSTEMS, PRODUCTION AND TRENDS OF FISHING AND AQUACULTURE

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- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Systems of Aquaculture
 - 3.2 Fishing Gear
 - 3.3 World/Nigerian Aquaculture Production
 - 3.4 Trends in Fishing and Aquaculture
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

Aquaculture has prospects in alleviating under-nutrition and poverty. It can also serve as a source of foreign exchange while also serving as a viable alternative and remedy to the already depleted capture fisheries. Aquaculture can be operated on a small scale at low-cost utilising family labour or at medium and high cost under intensive operation. This provides opportunities for both the poor and the rich to improve their standards of living, and also serves as a source of employment. Generally, most of the fish farms in the country could be classified as small scale (70%), medium scale (20%) and large scale (10%). The last 10 years saw much awareness of the profitability of fish farming when compared with the situation 11 – 30 years ago. Almost 80% of the fish farms started within the last ten years.

2.0 OBJECTIVES

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

- identify and differentiate between systems of aquaculture
- describe various gear used for fishing
- give a brief overview of world and Nigerian aquaculture production
- explain the trends in fishing and aquaculture.

3.0 MAIN CONTENT

3.1 Systems of Aquaculture

Omitoyin (2007) classifies aquaculture systems as follows:

a. Based on Rearing Facilities

Earthen Ponds

This is the most popular type of production facility in Nigeria. Sizes vary from small usually less than half a hectare to large ponds that are greater than one hectare while intermediate sizes of 0.5 to 1 hectare can also be found. They could be fully excavated, semi-excavated or full embankment ponds. They are constructed using manual labour or heavy equipment like the bulldozer, pay-loader and excavator. The shape depends on design, size of land, type of soil and topography. They are easier to manage, and production is faster since natural fish food supplements the artificial diets. Fish are however prone to predation.

Concrete Tanks

Cement blocks with the hollows filled with concrete or reinforced concrete slabs can also be used to construct holding facilities for fish. These can be rectangular or circular. Depth is between 1 and 1.2m and size/capacity may vary. This type of rearing facility is common in urban areas and semi-urban areas where suitable lands for earthen ponds are not available. Water supply can be static renewal, re-circulatory or a complete flow through system. The stocking density is high and management level is high.

Plastic Tanks

These are large plastic vats that are used for rearing fish. They are manufactured by plastic companies that manufacture the popular plastic water holding tanks. These come in various shapes but the circular shape is most common.

Cages

This entails rearing of fish in cages especially in open waters such as flowing rivers, lakes and reservoirs. Cages are net enclosures where fish are held while immersed in a natural water body. Rearing of fish in cages is at the research/experimental stage in Nigeria. This system is threatened by water pollution, poaching and clash of interest in use of open water ways.

b. Based on Production Technology**Extensive System**

Stocking density under this system is low and little or no artificial diet is offered the fish. The level of investment is low hence fish depend on natural food. Production levels are low and is less than 1tonne/ha annually.

Semi-Intensive System

Stocking density ranges from 2 to 25 fish per cubic metre of water. Artificial diets are provided for the fish but not in sufficient quantity to meet their nutritional needs. Also, pond fertilisation is carried out to increase primary productivity. Production cost is moderate and yields can be between 5 tonnes to 10 tonnes per hectare annually.

Intensive System

This is characterised by a high stocking density; between 25 to 450 fish per cubic metre of water. Fish are fed exclusively on nutritionally balanced artificial diets. Cost of production is very high just as the yield is also very high. Water inflow could be a complete flow through system or even a re-circulatory system. Aeration of rearing tanks is a prerequisite.

c. Based on Species Combination**Monoculture**

This is the culture of just one species of fish in a pond or tank. This therefore means that if catfish is being cultured, only catfish of the same species are stocked in the pond. The farmer will therefore understand the fish very well and to make feed that fits the nutritional requirements of the fish. However, an outbreak of species specific infection will wipe out the entire stock.

Polyculture

This system involves culturing two or more species of fish in a pond or tank. Example is culture of catfish with tilapia or tilapia with heterotis and catfish or common carp. Natural food is better utilised since these species feed at different columns of water. Outbreak of species specific diseases will only affect a single species since different fish are susceptible to different diseases. This system can ensure the control of

excessive breeding of tilapia through predation by catfish. However, if stocking combination is faulty yield can be very poor i.e. if more catfish are stocked than tilapia can afford, predation will wipe out the tilapia leaving only the catfish.

Integrated Aquaculture

This is the culture of fish alongside other forms of agriculture. It is a semi-intensive farming system where resources are efficiently utilised and re-cycled in order to achieve higher production than in a single production system. It results in optimal utilisation of resources with higher return on investment. Cost of production is reduced since wastes from livestock or farm produce are re-cycled to feed fish and water and silt from the ponds can serve the crops. There are various types of integrated aquaculture systems and they range from very simple systems such as fish with one kind of domestic animal or crop to complex ones like fish with animals and crops. The most common ones are:

- Fish cum poultry
- Fish cum piggery
- Fish cum livestock
- Fish cum duck
- Fish, rabbit and grass cutter
- Fish and vegetables
- Fish and plantain or banana or pineapple
- Fish cum rice culture

d. Based on Location

Land-Based Systems comprise mainly ponds, rice fields, and other facilities built on dry land. Ponds are the most common of all aquaculture systems, and range from small, rudimentary, gravity-fed facilities to large geometric ones, constructed using machines and with sophisticated water management regimes. Carps and tilapias, both widely cultivated fish species, are commonly grown in freshwater ponds, whereas shrimp and finfish tolerant to more saline waters are cultivated in brackish water ponds.

Water-Based Systems include enclosures, pens, cages and rafts, and are usually situated in sheltered coastal or inland waters. Enclosures are formed by closing off a natural bay, where the shoreline forms all but one side, and access to open water is closed off by a solid, net or mesh barrier. Pens and cages are enclosed structures, made from poles, mesh and netting. Pens rest on the bottom of a water body, whereas cages are suspended from poles or rafts which float on the water surface. Similar, for example, to livestock production systems that range from extensive

ranching to intensive feedlot systems, aquaculture also is practiced at different intensities.

3.2 Fishing Gear

Commercial fishing gears are classified into two main categories—active gears and passive gears. **Active gears** are gears that are moved about during operation. They do not assume a fixed position. **Passive gears** are gears which are not moved about during operation. They assume fixed position and fish move into them voluntarily. Below are some of the most common fishing gears used on a commercial scale:

Active Gears

Trawls

A trawl is a bag-like net with a large mouth, tapering to a narrow end. The mouth is held open by a solid beam or steel doors. Bottom trawls are towed by a trawler along the sea bottom to catch demersal species such as flounder, sole, cod, rockfish, and shrimp. As they make contact with the sea floor, bottom trawls can seriously disturb the habitat, damaging or removing vegetation and organisms such as sea sponges, worms, and other bottom-dwelling species. Midwater trawls target species such as pollock, herring, hake, and mackerel that live higher in the water column. Surface trawling targets species like clupeids, sardinella, tuna, etc.

Dredges

Dredges are specifically designed to harvest bottom-dwelling species such as scallops, clams, oysters, and sea urchins using a metal frame lined with a metal net. Because the dredge occasionally digs into the sediments as it is dragged along, it can disturb and damage the sea bottom ecosystem, in the same way as the bottom trawls.

Surrounding/Encircling Nets (Clap Net or Purse Seine)

Surrounding or encircling nets are large netting walls used for surrounding fish both from the sides and from underneath. *Purse seines* are a widely used type of surrounding net requiring one or two boats to deploy; one of the boats or a buoy remains stationary while the other encircles a school of fish. Purse seines are used to target schooling pelagic fish such as anchovies, sardines, mackerel, herring, salmon, and tuna.

Cast Nets

Usually circular in design, they are thrown, with considerable skill, over a fish school in very shallow water. The fish are trapped on the bottom and can be retained in the net as it is taken from the water by the fisherman.

Beach Seine

This consists essentially of a bag (a sort of large cod-end) with a long rectangular and relatively narrow panel of netting (known as a wing) attached to the bag on either side of the "mouth", with corkline and leadline to keep it vertical in the water; for fishing, it is usually staked at one end (of a wing) to the beach, then, from a boat, set around a school of fish. The other wing is then hauled onto the beach, leadline first, and the captured fish school removed from the bag.

Pole and Line

A pole and line is the most simple and least expensive way of fishing. The pole can be made of cane, bamboo or a straight piece of tree branch. You do not use a reel with a pole. You tie line directly to the end of the pole, and the line is normally a little longer than the pole. Safety pins have been known to be substitutes for hooks. When fishing from the bank in an area that is near fishable cover, the angler uses the rod to swing the baited hook near the cover/structure. Some boating anglers utilize cane poles when they anchor over a fishing spot that usually contains cover/structure.

Passive Gears

Gillnets

Gillnets consist of large panels of nearly transparent monofilament netting that hang vertically from floats like a curtain in the water. Because they can't see the netting, fish swim into it, entangling themselves. Bottom gillnets target demersal fish like cod, flounder, and pollock, while midwater gillnets target pelagic fish like mackerel, herring, swordfish, salmon, and sharks. Gillnets frequently entangle many non-target animals such as marine mammals and seabirds.

Driftnets consist of many panels of gillnets strung together to make extensive walls of netting. Because of the high mortality rate of non-target animals in driftnets, the use of large-scale driftnets (in excess of 2.5 km) in the high seas was banned by a United Nations resolution in 1992.

Longlines

Longlines use a stationary mainline to which are attached as many as 12,000 hooks on shorter branching lines. Longlines, which may be several kilometers in length, may be left in place from hours to days, and can be deployed on the sea bottom to catch demersal fish or in midwater to catch large pelagic species such as swordfish and tuna.

Traps and Pots

Traps and pots that rest on the sea bottom are used to catch crustaceans such as lobsters, crabs, prawns, and whelks, as well as some fish species such as the Pacific cod and black sea bass, and even some tunas in the Mediterranean.

Hook and Line

Individual lines with baited hooks are still used in commercial fishing for a variety of pelagic and demersal fish, especially in small-scale and sport-fishing operations.

3.3 World/Nigerian Aquaculture Production

The FAO (2009) maintained that the contribution of aquaculture to global supplies of fish, crustaceans, mollusks and other aquatic animals continues to grow, increasing from 3.9 percent of total production by weight in 1970 to 32.4 percent in 2004 and 36 percent in 2006. Aquaculture continues to grow more rapidly than all other animal food-producing sectors. Worldwide, the sector has grown at an average rate of 8.8 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems over the same period. Production from aquaculture has greatly outpaced population growth, with per capita supply from aquaculture increasing from 0.7 kg in 1970 to 7.1 kg in 2004, representing an average annual growth rate of 7.1 percent.

Aquaculture Production in Nigeria

According to Ojo and Fagbenro, (2004), domestic fish demand in 1998 was 1.52 million tonnes while domestic production was 292,800 tonnes (sufficiency ratio of 19.26%). The gap between production and demand is being offset by both aquaculture and importation of frozen fish. This makes Nigeria the highest importer of fish and fishery products in Africa. Fish, which contributes 36.6gm per day of net protein utilisation in Nigerian homes, is still below the recommended 0.75g/kg body weight requirement by the World Health Organisation (WHO). The

short fall is not because of the non availability of the resource but due to none maximisation and sustainable utilisation of available aquatic resources. Nigeria has over 12.5 million-hectares of inland water capable of producing over 350,000 tonnes of fish annually.

As at 2007, local production was about 617,507 tonnes and production from aquaculture accounted for about 85,087 tonnes and total production was 1,357,173 tonnes (FDF 2007). Hence less than 50% of Nigeria's total annual fish consumption is produced locally. It is therefore necessary for us to exploit maximally and in a sustainable manner our fishery resources and concentrate more on aquaculture development which has potential to increase fish production both for domestic consumption and for export.

3.4 Trends in Fishing

Prior to the 1950s, only a handful of countries had industrial fishing fleets. They operated mostly in the North Atlantic and the North Pacific, and only a few harvested more than 1 million metric tons (MT) of fish per year. Today, more than 20 countries regularly produce 1 million MT or more per year, either through wild harvest of fish or aquaculture. While in 1960 only three developing nations — Peru, China and India — made the list of top ten fish producing countries, developing nations now account for half of the top producers. This is a measure of the profound shift in fish production that occurred through the 1970s and 1980s: developing nations now produce more than 70 percent of the fish consumed by humans (Delgado *et al.* 2003).

According to the FAO (2009), global capture production in 2006 was about 92 million tonnes. This represents a decrease of 2.2 million tonnes in comparison with 2005. The change in total world capture production was mostly caused by environmentally-driven fluctuations in anchoveta catches. While total inland water catches increased significantly in 2005 and 2006, total global marine capture production (excluding anchoveta catches) has remained fairly stable since 2002 at between 74.3 and 75.3 million tonnes. However, important groups of species, countries and fishing areas do show different trends.

Trends in Aquaculture

Over the past three decades, aquaculture has become the fastest growing food production sector in the world; it has increased at an average rate of 9.2 percent per year since 1970 — an outstanding rate compared to the 1.4 percent rate for capture fisheries or the 2.8 percent rate for land-based farmed meat products (FAO 2002). Aquaculture has achieved this rapid growth by expanding, diversifying, and intensifying production, as

well as by introducing technological improvements in its operations. In comparison, capture fisheries production has been stagnant with increasingly larger quantities of fish being caught to produce fishmeal and fish oil — about 31 million metric tons in 2001, or one third of capture fish production (Vannuccini 2003).

A total of 262 fish, crustacean, and mollusc species representing the most important animals used in aquaculture worldwide are listed in a recent survey. Although not all aquatic organisms are suitable for culture, the variety of cultured species is still increasing. To those most in need, access to fish and fishery products is decreasing as diminishing supplies elevate market prices above their purchasing power.

With the aim of improving rural and semi-urban livelihoods in developing countries, development organisations have focused on aquaculture with one, or a combination of the following objectives:

- to increase household food supply and improve nutrition
- to increase household resilience through diversification of income and food sources
- to strengthen marginal economies by increasing employment and reducing food prices
- to improve water resource and nutrient management at household or community levels
- to preserve aquatic biodiversity through re-stocking
- to reduce pressure on fishery resources.

4.0 CONCLUSION

Aquaculture can be classified using various schemes. Fishing can be carried out either on a small scale or large scale. In the same manner, Fish farming can either be extensive, semi-intensive or intensive in nature.

The contribution of aquaculture to global supplies of fish, crustaceans, mollusks and other aquatic animals continues to grow.

Nigeria is leading in aquaculture production in the sub-Saharan African region, with reported production of 44,000 tonnes/annum of catfish, tilapia and other freshwater fishes.

5.0 SUMMARY

Over the past three decades, aquaculture has become the fastest growing food production sector in the world; it has increased at an average rate of 9.2 percent per year since 1970. Aquaculture systems are classified

based on: rearing facilities, production technology, species combination and location.

Commercial fishing gears are classified into two main categories—active gears and passive gears. **Active gears** involve a vessel or a group of people towing a net or dredge in pursuit of one or more fish species.

Passive gears consist of nets or traps set in one location or drifting with the current, with the target species entangling themselves in the net or swimming into the trap.

The majority—about two thirds—of the world’s fish production comes from marine capture fisheries or wild harvest.

A total of 262 fish, crustacean, and mollusc species are the most important animals used in aquaculture.

6.0 TUTOR-MARKED ASSIGNMENT

1. Give a full classification of aquaculture.
2. Write a brief account of world/Nigerian aquaculture production.
3. What is the trend in world fishing and aquaculture?
4. Classify gears used in fishing.

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UNIT 3 FISHING AND AQUACULTURE IN SCHOOLS

CONTENTS

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- 2.0 Objectives
- 3.0 Main Content
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 - 3.2 Sport Fishing and Aquaculture in Schools
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1.0 INTRODUCTION

Fishing for sport, recreation, and relaxation is called sport-fishing, or angling. Angling is one of the most popular forms of recreation in the world. People fish from shore and from boats, for almost every type of *game fish* (a fish that is prized for the sport involved in catching it). The basic tools for sport fishing are rod, a reel, fishing line, and hooks and lures. Fishing tools are inexpensive and finding a place to fish is easy, therefore, almost anyone can fish. The sport provides a source of fresh food, and anglers also enjoy the time spent outdoors.

2.0 OBJECTIVES

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

- state the different methods of sport fishing most suitable for schools
- state the methods of aquaculture that can be practiced in schools.

3.0 MAIN CONTENT

3.1 Types of Fishing

Sportfishing may be done in fresh water or salt water. Freshwater fishing takes place in lakes, ponds, rivers, and streams. Game fish in these waters include synodontis (kurungu), clarias (catfish), tilapia, *Lates niloticus* (Giwana ruwa), *Gymnarchus niloticus* (Osan) and many other species. They range in size, from fish as small as 0.25kg to as large as 45kg. Saltwater fishing occurs in oceans, estuaries, and tidal rivers. Game fish found in these waters tend to be larger than average freshwater fish. An example is tuna.

All anglers use the same basic angling techniques, but there are many types of fishing. The most common are bait fishing, spin fishing, trolling, fly-fishing, and ice fishing.

a. Bait Fishing (Hook and Line)

When bait fishing, the angler hooks live or dead bait and then casts, letting the bait sink. Depending on the game fish the angler intends to catch, he or she then might let the bait sit on bottom, hoping that the bait's odor attracts fish; jig the bait up and down so that the action attracts fish; or reel the bait in, attempting to entice fish swimming between the bottom and the surface. Popular baits in fresh water include worms, crayfish, insect larvae, fish eggs and frogs.

b. Spin Fishing

This involves the use of artificial lures, which spin as the angler reels in the line. Spin-fishing anglers pay close attention to the retrieval speed and the depth of the lure, trying to imitate a game fish's prey. If a fish strikes the moving lure, it will usually hook itself. When the fish is hooked, bait-casters and spin-casters reel it in and land it with a net or *gaff* (a sharp, hook-like pole). Lighter fishing rods are used for smaller fish, and heavier rods for bigger fish. It is considered unsporting to use large rods for small fish because a heavier rod tires them quickly and denies them a chance to fight and escape.

c. Trolling

Anglers troll by motoring or paddling a boat and dragging the bait or lure about 30 m (about 100 ft) behind the stern. At the correct speed, trolling produces a motion in the bait that mimics a live, unhooked fish. The most common use of trolling is in saltwater big-game fishing. Once a fish hits a lure and is hooked, the boat is stopped and the fish is reeled in. Trollers often use electronic depth finders or sonar to locate schools of game fish.

d. Fly Fishing

Perhaps the most difficult angling method is fly-fishing. The fly angler uses a rod much longer and lighter than those used for bait and spin fishing. Fly-fishing rods can be 3 m (10 ft) long in freshwater fishing and 4 m (14 ft) long for saltwater fishing. To cast a fly, the angler whisks the fly rod forward and back using only the forearm. Generally, the rod is moved from the 10 o'clock position to the 2 o'clock position without letting the line touch the water or ground. During this movement the angler pays out line. The movement continues until a considerable

amount of line is airborne. The angler then casts the line to a specific spot with a sharp but smooth snap of the wrist.

Sport fishing as described above is suitable for adoption in Nigerian schools to enable students grasp the art of fishing as a means of recreation and at the same time giving them the opportunity to increase their animal protein intake.

3.2 Aquaculture in Schools

Aquaculture can be practiced on a small scale using some methods to rear fish that are common in Nigerian aquaculture.

At the school level, two kinds of aquaculture are recommended: **Small and medium scale, semi-intensive aquaculture systems**, which could be in earthen ponds, concrete tanks or plastic tanks.

Semi-intensive culture systems depend largely on natural food produced *in-situ*. However, the production of natural food is enhanced by application of organic or inorganic manure or combination of both. At this level, the practices are known as low-cost semi-intensive system. Further intensification in these systems are attained by increasing the stocking density and application of commercially available or farm made feed or locally available agricultural byproducts like bran of rice, wheat, maize etc., and various types of vegetable de-oiled cakes as supplementary feed.

Semi-intensive fish farming requires a moderate level of inputs and fish production is increased by the use of fertiliser and/or supplementary feeding. This means higher labour and feed costs, but higher fish yields usually more than compensate for this.

Before embarking upon any aquaculture project, it is essential to construct a comprehensive plan and to carefully consider all aspects of site location, farm layout and pond design. The precise set-up and management of any aquaculture operation will be specific to the site and to the resources, vision and needs of school.

Some considerations for an earthen pond facility for semi-intensive aquaculture in schools include:

Blocking

When building a pond complex there are definite advantages to building ponds in blocks.

- Construction costs will be significantly reduced by ponds sharing common walls.
- Land will be more efficiently utilised.
- The costs of associated infrastructure such as piping, aeration and netting will be reduced.
- Ponds that are close together can be managed more efficiently and effectively.

Sump

It is essential that the bottoms of all ponds slope towards a well-defined low point, or sump, so that when ponds are drained crayfish and fish will follow the receding water and gather in the sump. Periodic draining of ponds is essential for both stock management and pond hygiene purposes.

Pond Dimensions

There is no magic formula for determining the optimum dimensions of a pond. The pond must be of a size that is appropriate for specific site, management practices and labour requirements. Small rectangular grow-out ponds with approximate dimension of 20 × 50m are ideal though size of school land can limit the dimension of the pond. Depth is very much dependent upon water availability with ponds usually being from 0.75 to 1m deep.

Pond Profile

In addition to having a sump it is also advantageous for a pond to have definite shallow and deep ends and a distinct “V” shaped cross profile. Organic wastes and sludge will gravitate down the walls of the pond so as to accumulate in the central channel. This results in the majority of the pond bottom remaining

Drainage and Overflow Systems

For security and convenience school ponds should be capable of rapid (over-night) drainage and should incorporate an overflow system. In order to reduce construction costs it is wise to utilise a portable pump rather than placing drainage pipes through the pond walls. With an appropriate pump and correct fittings, pond draining and filling can be a trouble free and inexpensive process. In order to cater for extreme rainfall events, all ponds should incorporate a diversion channel. When ponds are drained there are usually large numbers of crayfish and fish that must be harvested. Manually scooping the harvest from the sump is very labour intensive and can stress the fish. It is recommended that

facility for a more efficient harvest process be incorporated into the pond design. Another drainage option is to lay pipes through the pond wall so that gravity can be utilised for passive pond draining.

4.0 CONCLUSION

Schools natural or artificial water bodies are encouraged to teach students the art of sport fishing. In addition adoption of either small or medium scale semi-intensive aquaculture will assist students in generating interest in aquaculture.

5.0 SUMMARY

Sport fishing may be done in fresh water or salt water. Freshwater fishing takes place in lakes, ponds, rivers, and streams. Fishers use the same basic angling techniques, but there are many types of fishing: hook and line fishing, spin fishing, trolling and fly fishing.

Semi-intensive fish farming requires a moderate level of inputs and fish production is increased by the use of fertiliser and/or supplementary feeding. This can be introduced in schools at the small or medium scale. The precise set-up and management of any aquaculture operation will be specific to the site and to the resources, vision and needs of school.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is sport fishing?
2. List three types of sport fishing that can be practiced in schools.
3. Describe the systems of aquaculture suitable for schools.

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UNIT 4 OBJECTIVES OF FISHING AND POND MANAGEMENT IN SCHOOLS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
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1.0 INTRODUCTION

Will society be capable of better managing its water resources to ensure a high quality of life for future generations? The answer to this question will depend in large part on the strength of the educational system for aquaculture and fisheries science. Knowledge is transferred to the practitioners of the future primarily at colleges and universities, and it is there that much of the new knowledge needed to solve problems of inland aquatic ecosystems are developed.

2.0 OBJECTIVES

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

- state the objectives of fisheries management
- identify the objectives of pond management.

3.0 MAIN CONTENT

3.1 Definition/Objectives of Fisheries Management

Fisheries management involves regulating when, where, how, and how much fishermen are allowed to harvest to ensure that there will be fish in the future (NOAA, Undated).

Technically, fisheries management is the integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives (FAO 1997).

Fisheries management draws on fisheries science in order to find ways to protect fishery resources so sustainable exploitation is possible. Modern fisheries management is often referred to as a governmental system of appropriate management rules based on defined objectives and a mix of management means to implement the rules, which are put in place by a system of monitoring control and surveillance.

Fisheries management options generally fall into three broad categories:

- those that manage fishing effort by limiting the number of fishers or the gear they can use (so-called “input controls”); those that manage the level or size of the permissible catch (so-called “output controls”); and technical measures, such as the designation of limited fishing seasons, restricted zones, or limits on fish size. All these measures restrict *when*, *where*, and *how* fishing takes place or how many fish can be harvested in order to protect fish stocks and maximise economic output. Some of these approaches also restrict who can participate in a fishery.

The aim is to manage the stocks at a level which maintains both the catches and a profitable catch rate, based on the biological potential of the resources concerned. Hence fisheries management aims at:

- ***Protection of Target Fish Stock*** Fishing operations must be conducted in a manner that does not lead to over-fishing, or in a manner that demonstrably leads to the recovery of depleted populations
- ***Protection of Surrounding Habitat and Ecosystems*** Fishing operations must maintain the productivity, functioning, diversity, and community structure of the ecosystem on which the fishery depends
- ***Presence of Institutional and Operational Framework to Implement the Principles*** The fishery must be subject to an effective management system that incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

Typical political objectives in fisheries management are to:

- maximise sustainable biomass yield
- maximise sustainable economic yield
- secure and increase employment in certain regions
- secure protein production and food supply
- increase income from export
- biological and economic yield

3.2 Objectives of Pond Management

Ponds are the oldest, most natural, and usually the most economical, production system for most aquaculture species. All production systems must be able to provide oxygen for the fish and remove toxic waste products produced by the fish. A pond's ability to accomplish these actions is based on naturally occurring processes and the fact that a pond is a small semi-closed ecosystem.

Management of ponds requires constant monitoring of Aquatic weeds which often cause serious problems in ponds including serving as sites for predators and parasites of fish. In addition, when vegetation is dense, tilapia can become overcrowded and stunted because the weeds prevent catfishes from adequately reducing their numbers. Extremely dense growths of filamentous algae and submerged weeds may also cause fish kills as a result of nighttime oxygen depletion. It is generally better to keep your pond clear of aquatic weeds. Weeds that root to the bottom or begin forming on the bottom are usually a problem only in ponds that are shallow or have shallow areas (water less than 24 inches deep). Once established, many weeds have the ability to spread to deeper water. Problems with planktonic algae and floating weeds, such as duckweed, usually develop in very fertile ponds. Ponds that receive runoff from livestock operations or other nutrient-rich areas are prime candidates for duckweed and algal problems. Deepening all areas of the pond to a minimum of 24 inches will reduce weed infestations. Most pond owners use this method as a last resort, but for shallow ponds it is often the only lasting solution.

Turbidity management in a pond is also essential as turbidity from mud can cause injury to the gills of fish. The first step in clearing a muddy pond is to eliminate the source of the turbidity. Common causes of muddy water are runoff from non-vegetated acreage in the watershed, livestock wading in the pond, or some undesirable fish species (such as *gymnarchus*) stirring up the bottom of the pond. After the source of the turbidity has been eliminated, the water will usually clear naturally, but this may take from several weeks to several months, depending on the soil type in the watershed.

Typical objectives of pond management include:

- maximising production using the available resources
- removal of waste and silt from the pond bottom to facilitate re-stocking
- prevention and treatment of parasite infections, diseases and removing predators
- removal of invasive aquatic macrophytes

- stocking to ensure that every niche in the pond is utilised
- using the least cost combination of feed to achieve high productivity
- controlling turbidity
- tracing the causes of fish kills

4.0 CONCLUSION

The overall objective of fisheries management is the rational use of available natural production to the advantage of the present generation while also ensuring sustainability for future generations. This is achieved through the balance between stock and the maximum sustainable yield of the water body while pond management ensures maximum productivity for the farmer and this is achieved through the combination of efforts to make the pond habitable for the fish as well as disease prevention and use of artificial feeds that will guarantee growth.

5.0 SUMMARY

Fisheries management options generally fall into three broad categories: those that manage fishing effort – input controls; those that manage the level or size of the permissible catch – output controls; and technical measures. The aim is to manage the stocks at a level which maintains both the catches and a profitable catch rate, based on the biological potential of the resources concerned.

Pond management aims to maximise production with available resources through removal of silt and waste from the pond for re-stocking, removal of aquatic weeds, control of turbidity and fish diseases as well as feeding at the lowest possible costs for fish stocked to maximise the niches in the pond.

6.0 TUTOR-MARKED ASSIGNMENT

1. State three broad categories of fisheries management.
2. Distinguish between the political aims and the technical aims of fisheries management.
3. What do you think can cause problems in a fish pond?
4. List the objectives of pond management.

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MODULE 2 FISHING, POND MANAGEMENT AND ADMINISTRATION

- Unit 1 Attributes of Small Holder Fishing and Aquaculture Ventures
- Unit 2 Fisheries Management
- Unit 3 Pond Management and Administration
- Unit 4 Prospects and Problems of Fisheries and Aquaculture Management

UNIT 1 ATTRIBUTES OF SMALL HOLDER FISHING AND AQUACULTURE VENTURES

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Attributes of Small Scale Fishing
 - 3.2 Attributes of Small Scale Aquaculture
- 4.0 Conclusion
- 5.0 Summary
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1.0 INTRODUCTION

Small-Scale Fishery

The term “small-scale” applies to a broad range of smaller fishing vessels with less sophisticated fishing technology. A small-scale fishery is characterised by small-capacity fishing craft with non-mechanised propulsion or low-horsepower engines and the absence of fish-finding and navigation devices. Small-scale fishers often use traditional fishing gear, operated by hand (rather than diesel winch), and tend to fish closer to the shore.

The International Labour Organisation defines small-scale fishers as “people of both genders who usually operate their own fishing craft and equipment, and go to sea themselves, either alone or with a few crew members (preferably their own relatives)” (Ben-Yami 2000). Nonetheless, in many places, small-scale fisheries are populated by small boat owners employing hired hands as crew. In other cases, small-scale fishers may rent boats and gear from local boat owners.

Related to this is subsistence fishery. A subsistence fishery is one where the fish caught are shared and consumed directly by the families of the fishers rather than being bought by middlemen and sold at market. Very few fisheries are truly “subsistence fisheries” because the products are often used for barter. Subsistence fishing is usually a very small-scale activity, undertaken with low-technology - and often traditional - boats and gear (FAO Fisheries Glossary 2003).

Rural Aquaculture usually targets species for local or domestic consumption, such as tilapias and cyprinids, which require low capital investment and often provide affordable fish for local markets. This aquaculture system is often integrated with crops and livestock production; typically use rice fields, ponds, and cages; and involve polyculture (i.e., the practice of raising more than one species in the same pond).

2.0 OBJECTIVES

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

- describe the attributes of small scale fisheries
- state the attributes of small scale aquaculture.

3.0 MAIN CONTENT

3.1 Attributes of Small Scale Fishing

In fishing, people compete for limited resources and it would be expected that they will naturally try to obtain the best from their operations, not only in terms of catch and landed value, but also in terms of their reputation and position in the community.

Small-scale fishing is much more significant - as a source of livelihoods, food security, and national income - than most people realise. Like small-scale agriculture, small-scale fishing is widespread and crucial to employment and food supply in innumerable communities in developing nations, where some 95 percent of all fishers ply their trade (FAO 2002).

Because of the sheer numbers of small-scale and artisanal fishers, their vulnerability to competition from industrial fleets, and their potential impacts on marine and freshwater ecosystems, it is essential to factor this sector into fisheries management policies. Unfortunately, just the opposite has happened. For decades, policy-makers and consumers have ignored the importance of small-scale fishing. Since large-scale industrial fishers generally produce the fish consumed in developed countries and marketed through the international trade, most of the

attention of fisheries managers has focused squarely on them. Only recently is the need for appropriate management and protection of small-scale fisheries slowly gaining recognition (Berkes *et al.* 2001; FAO 2000; FAO 2002).

Dearth of information is one of several factors that have contributed to the lack of attention to small-scale fishing. Data on this sector are very poor, with the number of small-scale fishers - and especially subsistence level freshwater fishers - grossly underestimated by national governments. An accurate picture of small-scale fishing at the global level is also hard to assemble, because the definitions of small-scale and artisanal fishing vary by country. Indeed, the fish caught by small-scale fishers frequently go unreported in official government statistics and the impact of these fishers on fish stocks and ecosystems is rarely monitored. This means that the economic importance of the sector remains hidden from official view, and the implications for national fisheries policy remain unclear.

In addition, small scale fishers tend to inhabit the political margins. Fishing communities are often remotely located, and therefore isolated from decision-making centers, increasing the likelihood that their interests will be marginalised (Berkes *et al.* 2001). As a consequence, the aquatic environments and resources upon which small-scale fishers depend frequently suffer from poor management, competition from industrial fishing, and degradation from land-based activities, such as deforestation, pollution, and coastal development.

Small-scale fishing is a labour intensive activity and it is estimated that each fisher's job creates at least two other jobs in processing and distribution.

In terms of employment, small scale fishing is a bigger factor in many national economies than large-scale industrial fishing, even though industrial fishers are usually responsible for a larger share of the catch. Although industrial fleets are more efficient at catching fish, and therefore more profitable, they generate much less employment than small-scale fishing.

3.2 Attributes of Small Scale Aquaculture

Fish farming can be combined with agriculture, animal husbandry and irrigation practices, which can lead to better utilisation of local resources and ultimately to higher production and net profits. This practice is called 'integrated fish farming' and it is a common feature of small holder farms.

Small-scale, extensive and semi-intensive aquaculture has become widely recognised as a significant contribution to local economies and diets, as well as being associated with a lower degree of environmental impacts, although the cumulative impact of a large number of small farms can be just as damaging as a large-scale operation.

The trend in most countries is to intensify aquaculture operations toward more input-dependent practices. Aquaculture products have certain advantages over wild-caught fish, such as a more regularity of supply, job security, and income generation.

- ***Regular supply and lower prices.*** Controlled production makes it possible to meet market demand regardless of natural fluctuation in wild stocks and seasonal changes. Technical advancements - including genetic improvements - allow for industrial operations where mass production can reduce costs and hence lower the price for the consumer.
- ***Income generation.*** Aquaculture is an income-generating activity and can provide considerable foreign exchange revenue for developing countries.
- ***Food Security.*** Aquaculture's contribution to food security and livelihoods is of enormous significance, especially in remote and resource-poor areas. Small-scale, low input aquaculture that is done in combination with rice cultivation can "increase household resilience through diversification of income and food sources" (FAO 2000). Extensive aquaculture of carp, for example, increases the amount of dietary protein that is available to the rural poor—needed protein that otherwise these communities cannot afford.
- ***Multiple Use of Ponds.*** The water in aquaculture ponds need not only serve to culture fish. In parts of South Asia, fishponds are used for bathing and irrigating homestead fruit and vegetables, others for disposing of domestic wastewater. As a source of irrigation water, pond water is usually richer in nutrients than well water and also contains nitrogen-fixing blue-green algae which can improve soil fertility. After the fish harvest, nutrient-rich pond mud can be used as fertilizer or the pond can be used to grow forage and other crops. In areas where seasonal water shortages occur, a pond can be vital for ensuring year-round crop production, livestock watering, domestic water supplies and fire protection.

4.0 CONCLUSION

The fisheries sector, including aquaculture, is an important source of employment and income. However, employment in fishing and fish farming cannot be taken as the sole indication of the importance of fisheries to a national economy. The fishing industry also generates considerable employment in shipbuilding, shipyard operations; and fishing gear industry. In aquaculture, feed production, processing, packaging and transport are major sources of employment.

5.0 SUMMARY

Like small-scale agriculture, small-scale fishing is widespread and crucial to employment and food supply in many communities in developing nations, where some 95 percent of all fishers ply their trade. Small-scale, extensive and semi-intensive aquaculture has become widely recognised as a significant contribution to local economies and diets, as well as being associated with a lower degree of environmental impacts.

6.0 TUTOR-MARKED ASSIGNMENT

1. Differentiate between small scale fisheries and small scale aquaculture.
2. What are the attributes of small holder aquaculture?
3. What are the attributes of small scale fishing?

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UNIT 2 FISHERIES MANAGEMENT

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Depletion of Fish Stocks
 - 3.2 Purpose of Fisheries Management
 - 3.3 Objectives of Fisheries Management
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

There are no clear and generally accepted definitions of fisheries management. A working definition, for the purpose of this course, may be taken as:

- The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives (FAO 1997).

Historically, oceans were considered an inexhaustible source of fish. While fishing rights in near shore waters were often locally controlled, waters beyond easy boating distance from the shore were open to everyone. Open access resources, as they are called, are those that are owned by no one, and as such are particularly difficult to govern, precisely because no one individual has an exclusive right to use them, yet each person's use can diminish the remaining resource. As new technology made fishing more productive and lucrative, the open accessibility of ocean and coastal waters was an invitation to over-fishing - the action of excessive harvesting that leads to the depletion of the fish stock. This was fueled by the growth in human population with its increased demand for fish as food, as well as the growing demand for economic opportunities. Even as over-fishing of traditional stocks became apparent, the economics of the fishing enterprise rewarded continuous expansion of activities into new fishing grounds and unexploited stocks - the birth of today's fisheries crisis. Over-fishing was formally recognised as a localised problem as far back as the early 1900s. Fisheries management is about making difficult decisions among

multiple choices. The decisions go beyond choosing between multiple stock assessment model/data results with different degrees of uncertainty and also include choosing or balancing between conflicting objectives.

2.0 OBJECTIVES

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

- state the problem of over-fishing
- define the need for sustainable management of fish stock
- state the purpose and objectives of fisheries management.

3.0 MAIN CONTENT

3.1 Depletion of Fish Stocks

The FAO (2003) gives the definitions of various terminology that describe the state of a fish stock. A fish stock is considered to be *fully fished* when increases in fishing effort do not significantly increase the amount of fish harvested, but substantially increase the risk of overfishing. *Fully fished* stocks are said to be exploited at their biological limit—a reference point below which the spawning stock is too low to ensure safe reproduction.

The term *overfishing* refers to the action of fishing beyond the level at which a fish stock can replenish itself through natural reproduction. In other words, if too many fish are harvested because of excessive fishing pressure, the stock reaches a point where there are not enough fish of spawning age to reproduce and sustain the stock.

Continued overfishing of a stock can result in removal of a high proportion of fish of all age classes - juvenile to mature adult. When few mature adults remain to spawn and few juveniles remain to grow to a harvestable size (a process called recruitment), such a stock is known as *depleted*.

Prolonged overfishing of a depleted stock can lead to its *collapse*, that is, the reduction in fish abundance to levels at which the harvest is negligible compared to historical levels. Depleted or collapsed stocks may require a long time to recover, even if fishing pressure has been reduced or eliminated entirely. Indeed, they may never recover their former productivity, due to changes in population dynamics, habitat conditions, and other biological factors that influence reproduction.

3.2 Purpose of Fisheries Management

The traditional concept of the dynamics of fishery resources is that there is an underlying model which as fishing effort increases, implies catch will increase up to a maximum and if effort continues to grow, then catches will decrease. This leads directly to the concept of maximum sustainable yield (MSY) which has been the anchor of fisheries management (Larkin, 1977). The specific shape of the yield curve (Fig. 1) does not matter. The important principle always holds: zero effort means zero catch; too much effort leads to small or almost zero catch (Bonfil, 2005). Also, in theory there should be a point at which catch has a maximum – at least on average – and theory implies that once the curve reached the top, the MSY level has been found (Larkin, 1977).

While early fisheries management had implicitly or explicitly MSY as its most important objective, at present MSY is considered only a biological concept and benchmark to guide management. Although MSY still plays an important role as a guiding light for fisheries management, often specific and multiple objectives of fisheries management may be more important than obtaining maximum yield in the long term.

According to Hilborn and Walters (1992), the most widely accepted fundamental purpose of fisheries management is “to ensure the sustainable production over time from fish stocks, preferably through regulatory and enhancement options that promote economic and social well-being of the fishermen and industries that use the production.”



Fig. 1: A Graphical Representation of the Maximum Sustainable Yield (MSY) Concept

In the modern world of fisheries, management tries to balance multiple objectives that span beyond biological concerns. Oftentimes these multiple objectives are in opposition to each other such that it is not possible to achieve all of them simultaneously. Managers have to make quantitative decisions about how many fish can be caught, what is the number of boats that will be allowed to enter a fishery, or what is the minimum size of a fish or a gillnet mesh that should be allowed. They also have to make decisions about how much should be spent on research, enforcement of regulations, administration, etc.

3.3 Objectives of Fisheries Management

1. Biological and Conservation Objectives

By default the biological objective of fisheries management is obtaining MSY, or in other words achieving biological yield maximisation. This concept has already been explained above. The standard indicator of biological yield is the annual weight or number of fish caught. The conservation of resources, as well as conservation of biological and genetic diversity are also important biological objectives with an increasingly important role in fisheries management. Explicit directives to avoid putting stocks of target and non-target species at risk of extinction, and to develop plans for their recovery in case they are already endangered, play an important role in fisheries legislation in many parts of the world. Several fishery management plans already incorporate ecosystem objectives and it is just a matter of time before ecosystem-based objectives replace some of the more traditional biological objectives such as obtaining single-species MSY levels.

2. Economic Objectives

In economic terms, to obtain the maximum amount of fish (MSY) is not the main objective. Fishery is an economic activity and thus should aim for economic rent and more specifically for profit maximisation; that is the maximisation of total revenue minus the total costs. Thus, the concept of Maximum Economic Rent (MER) is an economic analogue to MSY. The MER level is defined as the point on the revenue curve (i.e. the yield curve times the unit value of fish landed) where the difference between the total costs of fishing (typically a straight inclined line) and revenues is greatest. However, as shown in Fig. 2 the point on the curve of MER will always be at an effort level that is lower than MSY. It is clear from this that it is impossible to attain MSY and MER at the same time and this is an example of a likely conflict between multiple objectives in fisheries management.

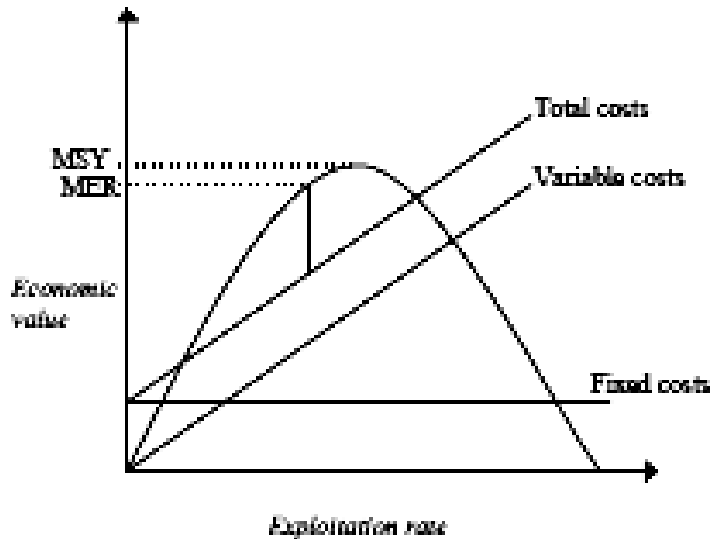


Fig. 2: A Graphical Representation of the Maximum Economic Rent Concept and a Comparison with MSY

3. Social Objectives

Social objectives are concerned with employment and equity. Fisheries are not only about landing fish and making money, but also about employment and making sure that those involved in the fishery make a living that is adequate and sustainable. Fishing is the most important source of employment in many coastal communities and in such situations, having a large number of not-so rich fishermen might be more desirable than having a few rich ones. Also, it is often important to preserve community structure and traditional lifestyles. Communities that have been fishing for a few hundred years and hold traditional fishing rights, such as the case with many indigenous groups, must be taken into consideration as part of management. From the social point of view, the total number of jobs related to the fishing activity is often a standard indicator, as well as the distribution of income among fishers and the maintenance of traditional lifestyles.

4. Recreational Objectives

In some parts of the world, fish stocks have to be shared between commercial and recreational fisheries. Although both sectors are pursuing fish, their objectives are often different. For recreational purposes, both catch and effort (number of successful fishing trips) might be important objectives. The total number of fish available to be fished is usually more important to a sport fishery than the total biomass of fish available and in the specific case of trophy fish (such as marlins, swordfish or tunas), the size of the fish will be of utmost importance. In such a case it might be an objective for the fishery to have few large fish

rather than many small ones. The standard indicators for recreational fisheries include the estimated total value of recreational effort (dollars per day times days fished), and the number and size of the recreational catch.

4.0 CONCLUSION

A holistic approach to fishery management will lead the manager toward a fishery assessment rather than a stock assessment. When all the fisheries of a country are considered together, the fisheries assessment will become an exercise that is commonly referred to as a fishery sector review or assessment. The manager will usually perceive a sector review as a huge and daunting task that cannot be undertaken without external assistance with funding and expertise. The same general arguments for undertaking a preliminary fishery assessment apply equally to a sector review. It can be approached using available information and expertise, then reviewed and revised as information becomes available. Review and revision need not encompass the entire sector assessment: it can be broken down into its component parts, which can be tackled as the need arises and information becomes available.

5.0 SUMMARY

Fisheries management is about making difficult decisions among multiple choices. A Fish stock can either be fully fished, overfished, depleted or collapsed. The traditional concept of the dynamics of fishery resources is that there is an underlying model which as fishing effort increases, implies catch will increase up to a maximum and if effort continues to grow, then catches will decrease. This leads directly to the concept of maximum sustainable yield (MSY) which has been the anchor of fisheries management. Management objectives can either be biological/conservative, economic, social or recreational.

6.0 TUTOR-MARKED ASSIGNMENT

1. Give a brief overview of the need for fisheries management.
2. What are the differences between fully fished, overfished, depleted and collapsed fisheries?
3. Explain the concept of Maximum Sustainable Yield (MSY).
4. Briefly explain the objectives of fisheries management.

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UNIT 3 POND MANAGEMENT AND ADMINISTRATION

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Management Activities in Ponds
- 4.0 Conclusion
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1.0 INTRODUCTION

A wide range of management systems is already employed in aquaculture operations with varying degrees of success. Given that aquaculture systems range from small, relatively self-contained farms for subsistence, to large-scale commercial units for trade purposes, variable success is hardly surprising. Thus, a “one-size fits all” approach is unlikely to be successful. A systematic approach to production management, however, allows the farmer to manipulate and control production inputs that will result in more efficient, cost-effective production and minimise excessive outputs with negative environmental impacts. There is a lot of information on site selection, farm construction and design features, aquatic animal health management, broodstock and seed production and care, production techniques, the use of appropriate feeds, feed additives and fertilizers, water and sediment management, including effluent control, and others.

2.0 OBJECTIVES

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

- explain activities in aquaculture that need proper management
- identify appropriate management options for various pond problems and activities.

3.0 MAIN CONTENT

3.1 Management Activities in Ponds

Liming

Some ponds benefit from the occasional addition of lime. Ponds with very soft, acidic water (less than 20 parts per million total alkalinity) will not be very productive, and also may not respond to fertilisation, unless they are limed. Fish growth will be poor if the pH is below 6.0. A pH value between 6.5 and 9.0 is considered optimum for fish ponds. The recommended use of lime is for disinfecting the bottoms of ponds or pond waters by applying 1000 – 2000 kg ha⁻¹ during pond preparation (Boyd and Tucker 1998). The lime should be distributed as evenly as possible over the entire pond. New ponds are easiest to lime while they are still empty. Lime, if required, can be spread over the bottom of the pond and disked in before the land is flooded. Builder's lime (calcium oxide) is generally not recommended, as it is caustic and has the potential to increase pH too quickly, killing the fish. If fish are not present or if agricultural lime is not readily available, hydrated lime can be applied carefully at the rate of 56kg/ha of pond surface.

Fertilisation

As with land and crops, the fertility of the water determines the productivity of a pond. A typical pond supports 110 to 170 kg of fish per hectare. Fertilisation can double or triple this production by stimulating the growth of microscopic plants (phytoplankton) and animals (zooplankton), which comprise the base of the food chain. These organisms are fed upon by insects and small fish, which provide forage for larger game fish. Pond fertilisation can, however, have negative side effects. Excessive fertilisation can create noxious algal blooms. In addition, the decomposition of dead algae can cause low oxygen levels, which may cause fish kills during extended periods of cloudy weather. Fertilisation is a pond management option that may not be necessary for every pond. Ponds that are naturally fertile, have high flow rates, or don't get heavy fishing pressure should not be fertilised. Fertilisation can increase productivity, but it takes time and money, and has to be done right to avoid problems.

As a general guide, you can determine whether fertilisation may be beneficial by the water clarity. If a light-colored or shiny object, such as your hand or a small (6- inch) pie tin or lid, can be seen clearly 18 inches under water, fertilizing is an option. Before beginning a fertilisation program, measure the pH and hardness of the water. Ponds with alkalinity below 20 parts per million usually don't respond to

fertilisation, and need to be limed first. Apply lime at least 2 weeks before fertilisation. For many ponds, liming may support adequate pond productivity without fertilisation. Once begun, fertilisation should be continued from year to year. Discontinuing fertilisation will affect fish populations by reducing the food supply in an extensive system and will encourage the growth of filamentous algae and other undesirable aquatic vegetation. Do not fertilize ponds that have extensive shallow areas. *Do not apply fertilizer to ponds with weeds already present, as the fertilizer will promote weed growth and compound the problem.*

Feeding

Feeding can be used to increase the growth of fish and harvesting rates of ponds. Stop feeding if the water temperature is greater than 30°C as fish will generally not feed at higher temperatures. It is best to place the feed in the pond daily at several locations. Feed only the amount that the fish consume in about 10 to 15 minutes and no more than 11kg/ha/day. Excessive feeding can cause fish kills because the decomposition of uneaten feed depletes the oxygen supply. Discontinue feeding if the fish stop accepting the feed. Automatic and demand feeders are commercially available. Several commercial feed preparations are available in either floating or sinking varieties. Although it is more expensive, floating feed makes it possible to observe the extent and duration of feeding. Moldy feed should not be used, as it can be toxic to fish.

Fish Kills

Fish die from a variety of natural causes. Observing a few dead fish in a pond is not uncommon and is no reason for concern unless it continues for several days. When fish die in large numbers, however, there is reason for concern. A common cause of fish kills is oxygen depletion. This condition usually occurs in very fertile ponds as a result of pond turnover or the die-off of an algal bloom. During hot weather most ponds have a layer of water near the bottom that contains little or no dissolved oxygen. Preventing oxygen depletion is difficult, but the following suggestions may help:

If fertilising, follow the prescribed guidelines and *do not overfertilise!*

- Do not allow livestock to wade in the pond or animal waste to enter the pond.
- Do not treat aquatic weeds with herbicides indiscriminately. If a herbicide application is necessary, treat no more than one-fourth to one-third of the pond at a time to prevent oxygen depletion

which can lead to fish kill. Aerating the pond can also help reduce the chances of an oxygen-depletion fish kill.

- During extremely hot weather, check your pond regularly at sunrise for signs of stressed fish. If fish are observed at the pond's surface gulping for air, stop feeding the fish and aerate the pond as soon as possible. Oxygen can be added to the pond by circulating the water with an irrigation pump or by running an outboard motor around in the pond. Commercial aerators do an excellent job of aeration. The paddlewheel type is especially effective, as it moves a large volume of water.

Fish Parasites and Diseases

Wild fish normally carry a variety of parasites, and usually show no negative effects unless the infection is extremely heavy. Signs of fish health problems are indicated by fish behavior or appearance. Sometimes a symptom as obvious as death indicates an infection or parasite problem. Infected fishes may appear sluggish, lethargic, turn quickly and repeatedly in circles (flashing), or even stop eating feed that they have been trained to eat. There are also a wide range of visual symptoms that might be observed on a fish's body. These include the excessive buildup of mucus on skin, emaciation, discolored areas, eroded areas or sores, swelling of the body or gills, bulging eyes, hemorrhages, cysts or tumors, or an obvious accumulation of fluid in the body cavity. Fish diseases can be broken down into six major categories:

- environmental
- nutritional
- viral
- fungal
- bacterial
- parasitic

Environmental factors have a tremendous influence on fish health. Maintaining a clean environment, or good water quality, is important for reducing the susceptibility of fish to disease.

Nutritional diseases are rare in fishes in the wild unless they are artificially fed. Commercially available feeds are formulated to meet the dietary requirements of a specific type of fish.

- **Viral:** Viruses are the worst types of fish disease. They cannot be treated and may suddenly kill an entire population. Viral diseases include Infectious Pancreatic Necrosis (IPN), Infectious Hematopoietic Necrosis (IHN), Erythrocytic Inclusion Body

Syndrome (EIBS), and Viral Hemorrhagic Septicemia (VHS). So far, virus related diseases have not been reported in African catfish (FAO 2010).

- **Fungal:** Fungi are unavoidable and always present in ponds. Saprolegnia is a common fungal disease that affects all freshwater fish and fish eggs. Saprolegnia attacks injured or dead tissue and produces a cotton-like growth.
- **Bacterial:** Bacteria are normally present in ponds and only become a problem when fishes become stressed. Bacteria can infect a single fish and multiply rapidly to cause a substantial fish kill in a few days or weeks. They are often identified by their damage to fish tissue since they are not visible to the naked eye.
- **Parasitic:** A parasite is an organism that lives in or on another organism. Fish often have parasites attached to gills, skin, inside the gut, or as tiny grub-like worms in their muscle tissue. Most are barely visible to the naked eye and often go undetected.

Disease Treatment

Potassium permanganate, KMnO_4 , is a chemical oxidizing agent that will react with any organic matter in a pond including algae, bacteria, fish, particulate and dissolved organic, and organic bottom sediments. It has been used in fish ponds to treat common fish pathogens such as gill parasites and external bacterial and fungal infections. Common treatment rates are 2 parts per million (ppm) or milligrams per liter (mg/L) for an indefinite pond application or 10 mg/L for a 10-minute tank treatment. Actual treatment rates in ponds will vary depending on the amount of organic matter, or organic load, in the water. As with any chemical treatment, it is crucial to accurately estimate the volume of water to be treated.

Copper has been used for many years as a chemical tool in freshwater farm ponds and aquaculture operations in the form of copper sulphate. It is both an effective algicide and a parasite treatment. The problem with the use of copper is that there is a thin line that separates effective treatment levels from overdoses, which can kill fish.

Before you use any form of copper treatment, you need to measure the total alkalinity of the water, since the toxicity of copper to fish increases as the total alkalinity decreases. A good rule of thumb is to divide the total alkalinity (in parts per million) by 100 to get the concentration of copper sulfate to use in parts per million (1 ppm = 1 milligram/liter). If the total alkalinity is less than 50 ppm, copper treatments are not

recommended because of the high risk of killing fish. If the total alkalinity is over 250 ppm, do not use more than 2.5 ppm of copper sulfate (Watson and Yanong, 2006).

Muddy Water

Muddy water can have negative effects other than detracting from the aesthetics of the pond. Muddy water can hinder the feeding ability of fish and even reduce their growth. Additionally, phytoplankton growth and abundance is reduced in muddy water. This may compound the problem of poor fish growth in muddy ponds by reducing the amount of food available through the entire food chain. The first step in correcting a persistent problem with muddy water is to determine the cause. To do this, collect a jar full of pond water, cover it with a lid and allow it to sit undisturbed for one week. If the water appears clear after one week and sediment is noticed at the bottom of the jar, chances are that something in the pond is stirring up the sediments. However, if the water is still cloudy, then there is a good chance that suspended particles of clay soil are the cause of the muddy water. The problem may also be a combination of disturbed sediments and the presence of clay soils in the watershed. If disturbed sediments are determined to be the problem, one or more of the following suggestions may help remedy the situation:

- 1 Fence livestock away from the pond and avoid pasturing them on the pond's watershed.
- 2 Keep domestic ducks and geese away from the pond. Their feeding activity may destroy shoreline vegetation and resuspend soil particles from the pond bottom.
- 3 Maintain good vegetative cover throughout the watershed. If you do not have ownership of the entire watershed, then establish buffer strips of vegetation around the pond.
- 4 Plant windbreaks to prevent wind from causing excessive wave action and disturbing sediment in shallow water.

Leaky Ponds

If a pond's water level drops much more than 6 to 12 inches in one month, it may have a serious leak. Drought conditions should be taken into consideration when determining whether or not a pond leaks. Fortunately, pond leaks can often be sealed by adding clay material to pond soil or using a plastic liner.

4.0 CONCLUSION

Pond management is similar to farming in many ways. The pond owner is attempting to grow a crop (fish) in a limited amount of space (the

pond) while battling weeds (undesirable fish species) under the influence of unpredictable weather. A farmer's crop production is limited by the acreage and quality of his land. In the same way, fish production is limited by the size, shape, fertility of a pond, feed provided for the fish by the farmer and level of management.

5.0 SUMMARY

Lime, if required, can be spread over the bottom of the pond and disked in before the land is flooded. Builder's lime (calcium oxide) is generally not recommended. Signs of fish health problems are indicated by fish behavior or appearance. Sometimes a symptom as obvious as death indicates an infection or parasite problem. Fish diseases can be broken down into six major categories: 1) environmental, 2) nutritional, 3) viral, 4) fungal, 5) bacterial, and 6) parasitic. Potassium permanganate, KMnO_4 and Copper sulphate can be used to treat infections. Pond leaks can often be sealed by adding clay material to pond soil or using a plastic liner.

6.0 TUTOR-MARKED ASSIGNMENT

1. What Management actions must a farmer carry out on a pond?
2. Write short notes on Liming and Treatment of parasitic infections and diseases.
3. How can a leaking pond be sealed?

7.0 REFERENCES/FURTHER READING

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UNIT 4 PROSPECTS AND PROBLEMS OF FISHERIES AND AQUACULTURE MANAGEMENT

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Problems of Fishing and Aquaculture Management
 - 3.2 Prospects of Fisheries and Aquaculture Management
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

Small scale fisheries in the developing world are diverse, numerous, geographically dispersed, vulnerable to forces external to the sector, and in crisis. Historically, development interventions have sought to reduce poverty through accelerated economic growth, improvements in technology and infrastructure, and market-led economic policy reform. The limited results of these interventions, however, has led to a re-examination of the causes of poverty, the recognition of the significance of vulnerability and the recognition of the need for new strategies for poverty reduction. There is increasing recognition that establishing appropriate pro-poor governance and institutions for fisheries management are central to maximizing the contribution of fisheries to poverty alleviation and food security. Such strategies may include rights-based approaches, co-management regimes and fishing capacity reduction.

2.0 OBJECTIVES

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

- describe the problems of fisheries management and aquaculture management
- explain the outlook of fisheries and aquaculture.

3.0 MAIN CONTENT

3.1 Problems of Fishing and Aquaculture Management

A. Problems of Fisheries Management

Fisheries have been the direct and indirect cause of international and sectoral conflicts for decades, but especially since the advent of the Exclusive Economic Zones (EEZs), which drastically reorganised access rights in marine fisheries. Fisheries-related conflicts range from basic competition among fishers over the same fish stock to international trade disputes over fishing rules and regulations. But in general, most fisheries-related conflicts arise from disputes over fishing rights within territorial seas and EEZs; disputes over the use of fishing environments between fisheries and other industrial sectors (i.e., tourism, coastal development); and disputes between different fishing sectors, such as industrial and small scale, or sport and commercial fishing.

1. EEZ and Other Territorial Disputes

Fisheries disputes related to territorial boundaries have been widespread for decades. However, they have intensified in many parts of the world, sometimes invoking violence, as countries have established sovereign rights within their EEZs—200 nautical miles of their coast—under United Nations Convention of the Law of the Sea (UNCLOS). Instead of freely accessing fish stocks in these formerly open-access waters, governments now have to negotiate access to fishing grounds in other countries' EEZs and abide by the laws and regulations of the coastal state. Encroachment by fishing vessels into another country's EEZ continues to cause numerous international fisheries disputes.

2. Conflicts between Fisheries and other Sectors

When multiple development goals and conflicting interests compete over the use of the same water body or coastal zone, fisheries can often be marginalised in favour of other development sectors such as agriculture or energy. Dam construction, for instance, alters the flow regime of the rivers; inundates riverine fish spawning grounds; and blocks the migratory paths of anadromous fish; all of which affect inland, floodplain, and fish resources downstream

3. Large-Scale versus Small-Scale Fisheries

Disputes between large and small-scale fisheries are common in many parts of the world, both in inland and marine waters and usually arise where these two very different sectors compete over the same fish stocks

and fishing grounds. In marine environments the most documented conflict between large and small-scale fishers occurs when industrial trawlers encroach into near-shore fishing grounds where small-scale fishers operate. Industrial bottom trawlers not only can destroy the nets set by small-scale and local artisanal fishers, but also may overexploit commercially valuable fish, and degrade the fishing grounds upon which local people depend. Artisanal fishers plying their trade in coastal waters can experience severe drops in their catch for several days after an industrial bottom trawler has swept the area. Where small-scale fishers are organised as a sector and have a political voice, negotiations with the national government requesting fair allocation of fishing rights and protection from the encroachment of industrial fleets is possible. However, enforcement of these measures usually falls short. For example, in West Africa, nearly all countries have passed laws giving artisanal fishers exclusive fishing rights to coastal waters within a fixed distance from the shore (1–12 nautical miles, depending on the country), and have prohibited industrial trawlers from operating in these waters. Unfortunately, foreign and national industrial vessels do not usually adhere to these laws, and enforcement by national governments is weak and limited by lack of adequate funding, staffing problems, and corruption.

Illegal, Unreported and Unregulated Fishing IUU fishing, now recognised as an environmental crime, is a major impediment to achieving long-term sustainability. It undermines management efforts and rewards fishers who fail to observe national and regional management arrangements. Countries have reported that their fisheries resources are subject to persistent IUU fishing by both national and foreign vessels.

B. Problems of Aquaculture Management

There are a number of problems which have been militating against the development of aquaculture. These include:

- high cost and difficult access to land and water
- lack of quality fish seed
- lack of suitable cost effective fish feed
- weak extension support
- lack of financial resources especially credit
- lack of organised markets
- incomplete understanding of what aquaculture can do
- shortage of well trained professional aqua culturist
- poorly operating government policy on aquaculture
- lack of organisation and co-ordination of existing research capacity.

3.2 Prospects of Fisheries and Aquaculture Management

A. Prospects of Fisheries Management

All countries, irrespective of their level of development, are grappling with the implementation of new approaches to the management of fisheries. Conceptually, these approaches are readily elaborated and understood but constraints are encountered when action is required to put them into practice.

1. The need for ongoing capacity building and institutional strengthening, taking into account the difficulties and needs identified by developing countries, is critical if further progress is to be achieved. Efforts to build on past outcomes by broadening and deepening implementation are required.
2. Many countries are focusing more sharply on the implementation of port state measures and product traceability and trade measures as a means of blocking landings and sales of IUU-caught product.
3. The logistical aspects of promoting “inclusive” approaches to fisheries, as envisaged in the Code of Conduct for Responsible Fisheries, are proving to be a challenge for many countries and greater efforts should be devoted to achieving higher levels of participation in decision-making. In many countries, participatory approaches to fisheries are new, requiring fundamental adjustments in both thinking and organisation.
4. Those who harvest, sell and buy fish are gradually becoming aware of the power and importance of rights-based approaches and they are exerting a growing influence on their future use.

B. Prospects of Aquaculture Management

1. A promising way to alleviate malnutrition among poor children in remote rural areas is the use of School Fishpond Programmes. While the programme provides immediate direct nutritional benefits among students of targeted schools, the benefits go beyond the school boundaries; the program serves as a catalyst in the communities to promote the use of water resources for integrated aquaculture. The schools act as a focal point, providing outreach to students, parents, and other members of the communities, and a hub for information exchange and dissemination.

2. Innovative approaches to enhance learning and community participation in the planning and use of water resources for integrated aquaculture can improve livelihood options and enhance benefits for targeted groups. The Department of Fisheries could support such approaches by targeting agents of learning and information dissemination, such as teachers, students, community-based organisations, village leaders, and extension officers. Understanding relevant features of water resources management and their competing and complementary uses can prevent conflicts and mitigate adverse environmental impacts.
3. Fish health is a major concern in aquaculture. When fish farmers change their farming practices from extensive and semi-intensive to intensive farming, they inevitably face increased risks of fish diseases. Extension Leaflets from Research Institutes now give guidelines for the proper use of drugs and chemicals for fish disease protection and treatment.
4. Domestic marketing of freshwater fish is complex, involving several channels and types of markets and parties. In general, the distribution and marketing of freshwater fish needs to be strengthened. Market information in pricing must also be provided to prevent small scale farmers from being ripped off by middlemen.

4.0 CONCLUSION

If aquaculture is to contribute to the enhancement of the world's food security, it should be apparent that the focus must be on small-scale and rural aquaculture. Aquaculture should not be viewed strictly from its technical perspective, since its future prosperity and sustainability depend on many other aspects, such as political and socio-economic influences. Technically, aquaculture must be broadened to embrace biological, natural and computer sciences, engineering and physics.

In small-scale fisheries, particularly in developing countries, the idea of shared power and responsibilities between the government and fishing communities has emerged as an alternative framework for managing fish stocks. This management approach is referred to as “co-management”—management where government and local resource users are each given specific decision-making and monitoring rights and responsibilities. The rationale behind co-management is that conventional management approaches have often failed to manage small-scale fisheries effectively or in a manner that is fair to local fishers. In pre-colonial times, local

fisheries were managed by traditional authorities such as chiefs or village councils.

5.0 SUMMARY

Fisheries management is bedeviled by several problems and the most significant is the problem of Illegal, Unreported and Unregulated fishing (IUU). Other problems include EEZ and territorial disputes as well as dispute between fisheries and other sectors. There is also the in-house dispute between small scale and large scale fisheries.

High cost and difficult access to land and water, lack of quality fish seed, lack of suitable cost effective feed, weak extension support and lack of financial resources especially credit have been the bane of the aquaculture industry.

Many countries are focusing more sharply on the implementation of port state measures and product traceability and trade measures as a means of blocking landings and sales of IUU-caught product.

A promising way to alleviate malnutrition among poor children in remote rural areas is the use of School Fishpond Programmes.

6.0 TUTOR-MARKED ASSIGNMENT

1. Outline the problems facing successful management of fisheries.
2. What are the prospects of aquaculture or pond management?

7.0 REFERENCES/FURTHER READING

Kura, Y.; Revenga, C.; Hoshino, E. & Mock, G. (2004). *Fishing for Answers Making Sense of the Global Fish Crisis*. Washington D.C.: World Resources Institute

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MODULE 3 MANAGEMENT PLANS FOR FISHING POND AREAS IN NIGERIAN SCHOOLS

Unit 1	Designing and Implementation of Management Plans
Unit 2	Fisheries Management Approaches
Unit 3	Reviewing and Amending Management Plans
Unit 4	Government Policy on Fishing and Pond Management

UNIT 1 DESIGNING AND IMPLEMENTATION OF MANAGEMENT PLANS

CONTENTS

1.0	Introduction
2.0	Objectives
3.0	Main Content
3.1	Identifying and Agreeing on Objectives for the Fishery
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	Reference/Further Reading

1.0 INTRODUCTION

A fisheries management plan is a formal or informal arrangement between a fishery management authority and interested parties which identifies the partners in the fishery and their respective roles. It details the agreed objectives for the fishery and specifies the management rules and regulations which apply to it and provides other details about the fishery which are relevant to the task of the management authority. It is suggested that management plans reflecting the management objectives should be drawn-up for all fisheries. These management plans will then serve as a reference and information source for the management authority and all interest groups, summarising the current state of knowledge on the resource, its environment and the fishery, and reflecting all the decisions and actions agreed upon during the course of consultations between the management authority and the interest groups. Ensuring plans are developed and implemented for all fisheries helps to avoid planned management measures on one fishery creating unforeseen problems and externalities in a neighbouring fishery for which no plan is available.

2.0 OBJECTIVES

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

- state the need for consultation with recognised interest groups
- define the appropriate management measures.

3.0 MAIN CONTENT

3.1 Identifying and Agreeing on Objectives for the Fishery

The need for consultation with recognised interest groups:

- In most fisheries, governments have the primary responsibility and accountability for making decisions in relation to fisheries management. However, such decisions should be preceded by a number of processes, the details of which will vary according to the nature of the fishery.
- It is essential that the decisions made on objectives and management measures for a fishery should reflect the best scientific information available.
- The utilisation of living aquatic resources and the management of this utilisation should be seen as partnerships between the management authority and the interest groups. The objectives should reflect the reasonable desires of the interest groups, within the constraints imposed by the biological and ecological limitations of the resources and the overriding objectives of national planning. Therefore, consultation and joint decision-making are essential in determining the objectives.
- Many reasonable objectives will be mutually incompatible. For example, maximising average yield from a fishery is incompatible with minimising biological risk to the resource or minimising impact on other stocks, such as those predators also dependent on the resource. Similarly, maximising the economic returns from a fishery may be incompatible with maximising employment opportunities. Therefore, interest groups will frequently have opposing objectives. In order to achieve maximum compliance and cooperation from all parties, it is important to arrive at a compromise which will at least be accepted, if not without reservation, by all or most of the interest groups. This will require open and transparent decision-making and close consultation with all recognised interest groups and the

application of effective decision-making procedures and approaches.

There are four possible scenarios to be considered within the time frame of the management plan:

- further changes in the external factors are likely which will further modify the fishery ecosystem
- further changes are likely but will not markedly affect the fishery
- external influences on the fishery will diminish
- the situation is likely to remain stable.

Different management responses will be required depending on which of these scenarios is believed to be correct.

Determining the appropriate management measures

- A variety of management measures are available to fisheries managers, and each of them will have different implications for the resource and for the objectives set for the fishery. The most appropriate set of management measures should therefore be selected to facilitate achieving these objectives.
- In evaluating management measures, it is necessary to consider their implications for the biological, ecological, economic and social objectives of the fishery under consideration.
- Any fishery exists within a broader ecological, economic and social context. Failure to recognise this and to adopt management measures which are consistent with the policies, objectives and management approaches of the broader geo-political zone could result in failure, or reduced efficiency of the fisheries management strategy, or conflict between different users.
- Similarly, management measures need to reflect the macro-economic policy, for example, the catchment area, river basin, coastal zone, local area or state.
- There is seldom a single correct set of management measures that should be applied to a fishery; rather, there are trade-offs between desirable, less desirable or undesirable effects. The most appropriate set of management measures is that which maximises the desirable effects and minimises the undesirable effects for a particular fishery and the objectives set for it.

- An important consideration in the implementation of a management plan is that any controls or constraints on the fishers or other interested parties should be implementable by the management authority.
- As with setting objectives, the management measures in operation form a part of the social contract or arrangement between the management authority and the interested parties. Consideration and selection of the set of measures for a given fishery should be undertaken openly and transparently and with full participation by all recognised interest groups.

4.0 CONCLUSION

Fisheries management draws on fisheries science in order to find ways to protect fishery resources, so sustainable exploitation is possible. Modern fisheries management is often referred to as a governmental system of appropriate management rules based on defined objectives and a mix of management means to implement the rules, which are put in place by a system of monitoring control and surveillance. Fisheries management is that branch of fisheries science, which deals with the study and surveillance of system of fishery resources, in terms of rules and objectives to prevent over-exploitation.

5.0 SUMMARY

In most fisheries, governments have the primary responsibility and accountability for making decisions in relation to fisheries management. However, such decisions should be preceded by a number of processes, the details of which will vary according to the nature of the fishery. In evaluating management measures, it is necessary to consider their implications for the biological, ecological, economic and social objectives of the fishery under consideration.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the importance of agreeing and identifying management objectives for a fishery.
2. What steps should be taken to determine management measures?

7.0 REFERENCE/FURTHER READING

FAO (1997). *Fisheries Management*. FAO Technical Guidelines for Responsible Fisheries. Rome: FAO.

UNIT 2 FISHERIES MANAGEMENT APPROACHES

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Technical Measures
 - 3.2 Input Control
 - 3.3 Output Control
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

The only mechanism available to maintain the biomass and productivity of a resource at a desirable level, at least in wild capture fisheries, is controlling fishing mortality by regulating the amount of fish caught, when they are caught and the size and age at which they are caught. In regulating fishing mortality there are a number of approaches which can be used, and each one will have different implications and different efficiencies for regulating fishing mortality, impact on fishers, feasibility of monitoring, control and surveillance and other facets of fisheries management.

2.0 OBJECTIVES

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

- advocate management approaches for a fishery.

3.0 MAIN CONTENT

The major management approach options are presented below:

- Technical measures, which are restrictions or constraints to regulate the output which can be obtained from a specified amount of effort, for example gear restrictions, closed seasons and closed areas. In terms of the above regulations, these measures generally attempt to influence the efficiency of the fishing gear.
- Input controls directly regulate the amount of effort which can be put into a fishery. In general, inputs are more easily monitored than outputs.

- Output controls directly regulate the catch which can be taken from a fishery and can be seen as an attempt to circumvent the problems associated with defining and enforcing appropriate technical measures and effort regulations by directly limiting the factor of primary concern: the total catch. However, catch controls also have problems, largely associated with monitoring and surveillance.

3.1 Technical Measures

Gear restrictions affect the type, characteristics, and operation of a fishing gear. Some gears have been prohibited outright to:

- avoid increases in fishing capacity through increased efficiency
- avoid some unwanted impact on noncommercial sizes, species or critical habitats, or, very often
- avoid an injection of new technology which could modify significantly the existing distribution of exploitation rights (particularly when these involve new participants).

Regulation of gear characteristics such as minimum mesh size or dimensions of mouth opening of nets or traps is generally introduced to control fishing mortality on some particular component of the resource, such as smaller individuals. Gear restrictions may also be designed to reduce the total catch by reducing the potential efficiency of the fisher.

Gear restrictions tend to be species-specific and, for example, a mesh-size designated to capture mature individuals of a smaller species will still catch immature individuals of a co-occurring larger species. The use of subsidiary devices such as by-catch reduction devices (BRDs), turtle excluder devices (TEDs) and grids can be an integral part of responsible fisheries management where, for example, by-catches of over-exploited or threatened species are occurring or fishing is having a negative impact on aquatic communities, and should be utilised by fisheries management authorities as necessary.

Area and time restrictions can be used to protect a component of a stock or community such as spawning adults or juvenile stages.

Marine protected areas can have a critical role to play in sustainable fishing. Particularly for territorial species or those with relatively stationary life styles, marine protected areas can be used to preserve spawner biomass above the thresholds (based on biological reference points) necessary to ensure sustained recruitment.

In addition to their role in conserving the resources, area and time restrictions can be used to reduce or eliminate conflict between different components of the fishery system (e.g. artisanal, industrial, and foreign fleets) or between them and other users.

Gear specifications, area and time restrictions can lead to economic inefficiency and distortions. These measures therefore need to be used as part of an overall strategy developed in consultation with the interest groups. Good scientific information arising from appropriate stock assessment and social and economic studies and projections should be used to guide the choice of technical measures as part of an overall study.

Minimum size and maturity restrictions can also be used to reduce fishing mortality on life stages of stocks which are considered to require special protection. Where implementation of these regulations (such as on minimum allowable size at landing) requires returning captured individuals to the water, the management authority should determine the survival of returned individuals to ascertain the efficacy of these measures.

3.2 Input (effort) Control

Input controls can include restrictions on the number of fishing units through limiting the number of licenses or permits issued; restrictions on the amount of time units for fishing, such as individual effort quotas, and restrictions on the size of vessels and/or gear.

Placing an appropriate limit on effort and therefore on fishing mortality is seen as being very important in responsible fisheries. Some degree of effort limitation by the management authority is a pre-requisite for responsible fisheries, whatever other control measures are in place.

The greatest problems in using input controls alone to regulate fisheries are associated with problems of determining how much effort is actually represented by each fishing unit.

Effort control may also be desirable to avoid the problems of excess capacity, even where output controls are in place.

Input control is easier and less costly to monitor and enforce than output control, particularly in mixed species fisheries where many output controls (i.e. species-specific quotas) may be required to control fishing effort.

Associated with the above, mis-reporting of catch is not a serious factor in input control, as there is little or no incentive for the fisher to provide incorrect catch statistics.

In multi-species fisheries there should be less serious problems of discarding and high-grading because fishers are not regulated on the amount of by-catch landed or reported.

3.3 Output (catch) Control

Output control is a popular management measure for fisheries, particularly for large-scale fisheries, and there is an even greater interest in extending its application, in association with limited entry, with the current widespread interest in individual transferable quotas (ITQs).

Output or catch control, in theory, allows estimation and implementation of the optimal catch to be taken from a stock by a given harvesting strategy. Given good information on the dynamics of the stock and its response to fishing mortality, the correct catch can, in theory, be estimated to achieve the desired objectives. Catch controls usually involve setting a total allowable catch (TAC) which is then sub-divided into individual quotas by fishing nation (in the case of international fisheries), fleet, fishing company, or fishermen (e.g. in the case of individual quotas).

In theory, catch control eliminates the need, for control purposes, of estimating the fishing efficiency of all units in the fishery, and of monitoring and responding to changes in fishing efficiency with time, which are features of effort control. However, such assessments will remain necessary, from time to time, to facilitate adjustment of the overall fleet capacity to take into account technological improvements. Without such adjustments, unregulated increases in capacity will increase the incentives for excess fishing and mis-reporting.

Catch control also has problems in its implementation

- While catch control may protect the resource, in the absence of limited entry and individual quotas, it does not reduce the social and economic distortions brought about by competing fishers racing to obtain the greatest possible share of the TAC before it is filled.
- Arguably, the greatest problem associated with output control is monitoring the outputs, the catches. The incentive on fishers to mis-report their catches is high when this is the factor used to regulate their own right to fish. Therefore, the management

authority has to monitor closely catch per user and in total, to ensure the TAC, and individual quotas where issued, are not exceeded. This leads to the need for a comprehensive, accurate and hence costly monitoring system that collects and analyses data in close to real-time for effective management.

- TACs and individual quotas are normally set and issued for single stocks. In multispecies fisheries this leads to the problem of discards and high-grading, as TACs and quotas for co-occurring species will be filled at differing rates. If fishers have completed their quota or TAC of a given species but continue fishing for other species, they will be left with little choice but to discard or land illegally catches of the species for which the quota is completed.

4.0 CONCLUSION

It is apparent that different methods of control of fishing have different effects, advantages and disadvantages that will make them more or less suitable under different conditions. There is no single correct approach to controlling fishing, and fisheries management authorities will have to select the option or, more usually, combination of options, which best suits the nature of the fishery and the objectives of the interest groups.

5.0 SUMMARY

The major options for fisheries management are Technical measures, Input controls and Output controls. Gear restrictions affect the type, characteristics, and operation of a fishing gear. Gear restrictions tend to be species-specific. Placing an appropriate limit on effort and therefore on fishing mortality is seen as being very important in responsible fisheries. Output control is a popular management measure for fisheries, particularly for large-scale fisheries. Input control is easier and less costly to monitor and enforce than output control.

6.0 TUTOR-MARKED ASSIGNMENT

Discuss technical measures used in fisheries management.

7.0 REFERENCES/FURTHER READING

FAO (1997). Fisheries Management. FAO Technical Guidelines for Responsible Fisheries. Rome: FAO.

Kura, Y.; Revenga, C.; Hoshino, E. & Mock, G. (2004). Fishing for Answers Making Sense of the Global Fish Crisis. Washington DC: World Resources Institute.

UNIT 3 REVIEWING AND AMENDING MANAGEMENT PLANS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Reviewing and Amendment of Management Plans
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

Countries are experiencing problems in managing fisheries, developing fisheries management plans and in implementing the international plans of action. They have also pointed out that some fisheries are not subject to management and that such open-access conditions are leading to over-fishing. Furthermore, even when fisheries are subject to management, many of the stocks under such regimes continue to be either fully exploited or overexploited and the recovery plans for these stocks, which should be a high priority, are being implemented only slowly.

2.0 OBJECTIVES

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

- explain the intricacies in the process of reviewing and amending management plans.

3.0 MAIN CONTENT

3.1 Reviewing and Amendment of Management Plans

Countries have reported difficulties in applying more advanced forms of fisheries management practices and have indicated the need for assistance in areas such as:

- drafting national codes and national plans of action
- implementing vessel buy-back and industry restructuring schemes to reduce fishing capacity

- improving fisheries research capabilities, including possible twinning arrangements between research institutes in developing and developed countries
- identifying and assessing new and underexploited fisheries resources
- implementing the ecosystem approach to fisheries.

Noting the strong social and economic pressures on fisheries, including vulnerability to poverty and a lack of alternative employment opportunities for fishing communities, countries have stressed that overcapacity in the fisheries sector should be addressed through employment creation in other economic sectors (FAO 2007).

The status of the resource, the circumstances and priorities of the interest groups, the national circumstances and priorities of any geopolitical zone changes with time. This means that management objectives and measures can also become obsolete or inappropriate with time. For this reason, a regular evaluation should be undertaken of the effectiveness and efficiency of the management plan, normally every three to five years with revisions made as necessary. Such revisions should be undertaken with all the normal pre-requisites for decision-making.

The management authority should continually monitor the suitability and cost effectiveness of fisheries regulations and evaluate them in detail when modifying management plans for specific fisheries. Those provisions which appear to be obsolete or not enforceable should be amended as required. Further, the laws and regulations implemented should be readily enforceable, and the jurisdictional and administrative procedures supporting enforcement should be fair and transparent. Failure to consider properly these issues is likely to undermine the credibility and acceptability of the overall fisheries legal regime and the level of compliance.

All relevant international legal instruments, and in particular the 1982 UN Convention on the Law of the Sea and the 1995 UN Convention on Straddling Fish Stocks and Highly Migratory Fish Stocks, should be taken into consideration when preparing or amending fisheries management legal regimes. When relevant, and particularly with regard to inland fisheries, full use should be made of the provisions which exist in international instruments or arrangements providing mechanisms for integrated management of fisheries resources at river basin level. The coastal and riverine zones are usually covered by several overlapping maritime, water, forestry or other legal regimes. The fisheries legislation should be in harmony with the general body of legal instruments covering these activities. Particular attention should be given to other

legal regimes in the context of integrated coastal area management, either at domestic or international levels.

Where the management policy includes some form of formal partnership arrangement with one or more interested party, potentially useful principles rooted in traditional practice could provide valuable guidance to national legislators and should not be overlooked.

Appropriately widespread consultation should be undertaken with the interested parties during the process of formulating or amending legal provisions relating to fisheries management. Such collaboration should ideally be accompanied by acceptance by interested parties of their obligations with respect to management measures. Failure by the interested parties or their representatives to abide by the regulations set by the authority must lead to penalties which should be set at a level to be effective deterrents. Such deterrents should include, where appropriate, the loss of the right to participate in the fishery.

Fishery administrators need to develop partnerships with a range of organisations to improve management. These include a host of non-governmental organisations with an interest in fisheries or those groups whose activities impinge on fisheries. Various NGOs may have interests that coincide or conflict with those of fishers. Many environmental organisations work for the protection of the health of coastal areas and help conserve aquatic resources. For example, the Community Environmental Resource Centre (CERC) of Jamaica was involved in a grassroots environmental sensitisation strategy by showing the relationship between improper sewage disposal and fouling of oyster beds and recreational beaches in the Kingston harbour.

Ecosystem-based management can be an important complement to existing fisheries management approaches. One of the distinguishing features of ecosystem-based management is its emphasis on protecting the productive potential of the system that produces resource flows, as opposed to protecting an individual species or stock as a resource. In many other respects, however, ecosystem-based management is not very different from what many fishery managers trained in marine ecology already do: paying attention to species interactions such as competition and predation, conservation of habitat, and protecting critical life history stages by closing nursery areas and spawning locations to fishing. Another point to note is that if the ecosystem is already degraded, sustainability no longer makes sense as a goal. There is no point in maintaining an ecosystem which is impaired. Instead, the goal should be “rebuilding” or restoring the ecosystem.

4.0 CONCLUSION

As fisheries management evolved, it became clear it was about managing people, and not fish. Fish can't effectively be instructed to avoid nets and hooks. Fish populations are managed by regulating the actions of people. Management regulations must also consider the implications for stakeholders. Commercial fishermen rely on catches to provide for their families just as farmers rely on crops. Essentially commercial fishermen are just harvesting fish for distribution to the public. Commercial fishing can be a traditional trade passed down from generation to generation. Most commercial fishing is based in towns built around the fishing industry; regulation changes can impact an entire town's economy. Cuts in harvest quotas can have adverse affects on the ability of fishermen to compete with the tourism industry. Increasing property values and taxes along waterfronts and properties can diminish water access.

5.0 SUMMARY

Countries have reported difficulties in applying more advanced forms of fisheries management practices and have indicated the need for assistance in several areas. The status of the resource, the circumstances and priorities of the interest groups, the national circumstances and priorities of any geo-political zone changes with time. Appropriately widespread consultation should be undertaken with the interested parties during the process of formulating or amending legal provisions relating to fisheries management.

6.0 TUTOR-MARKED ASSIGNMENT

1. What Management actions must a farmer carry out on a pond?
2. List areas of need of countries relating to fisheries management plans.
3. What are the salient points to be considered in reviewing fisheries management plans?

7.0 REFERENCES/FURTHER READING

- Berkes, F.; *et al.* (2001). *Managing Small-Sale Fisheries: Alternative Directions and Methods*. Ottawa, Canada: International Development Research Centre.
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- FAO (2007). *The State of World Fisheries and Aquaculture 2006*. Rome: FAO Fisheries and Aquaculture Department.

UNIT 4 GOVERNMENT POLICY ON FISHING AND POND MANAGEMENT

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Government Policy on Fishing and Pond Management
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

In Nigeria, the management of inland waters is regarded as the exclusive responsibility of the States to which such water bodies belong. Whereas there is a Sea Fisheries Decrees Act of 1971, as well as the relevant Fishery Regulations and the Exclusive Economic Zone (EEZ) Decree of 1978, which enable the Federal Government to control, regulate and protect the sea fisheries resources, there is at present no such uniform law for inland fisheries.

2.0 OBJECTIVES

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

- discuss fisheries policy in Nigeria
- justify the need for comprehensive inland fisheries legislation in Nigeria.

3.0 MAIN CONTENT

3.1 Government Policy on Fishing and Pond Management

Nigeria has no specific legislation on aquaculture at national level, nor is this activity mentioned in the Sea Fisheries Decree and Regulations (respectively 1992 and 1971). However, the Inland Fisheries Decree (1992) makes a single provision empowering the minister in charge of fisheries matters to determine whether the set up of enclosures, such as pens and cages, should be subject to a licence fee (FAO 2005).

From an institutional point of view, the authority competent for the management of fisheries and for the preparation of policies and programmes for the development of fisheries is the Federal Department

of Fisheries (FDF) of the Federal Ministry of Agriculture and Natural Resources, which provides technical support to State Departments of Fisheries (SDF). Likewise, the latter provide support to Local Government Authorities (LGA) on fisheries matters. Moreover, fisheries and aquaculture research is carried out by the Nigerian Institute for Oceanography and Marine Research (NIOMR) and by the National Institute for Freshwater Fisheries Research (NIFFR), while aquaculture training is ensured by the African Regional Aquaculture Centre (ARAC). There is no legal definition of aquaculture.

Nigeria is a member of WTO (World Trade Organisation) and has ratified both the Convention on Biological Diversity (CBD) and the Biosafety Protocol. Nigeria is also a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

From a regional perspective, Nigeria has signed the Revised Convention for the Establishment of the Niger Basin Authority (Convention révisée portant à la Création de l'Autorité du Bassin du Niger) (N'djamena, 1987), which replaces the Niger River Commission, and the Convention and Statutes concerning the development of the Chad Basin (Convention et Statuts relatifs à la mise en Valeur du Bassin du Tchad) (Yaoundé, 1964), which establishes the Chad Basin Commission. Other parties to the former convention are Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Guinea, Mali, Niger, and Chad, whereas only Cameroon, Niger, and Chad are party to the latter (Atlas of International Freshwater Agreements 2001).

The Sea Fisheries Decree only regulates a specific type of authorisation (operation and navigation of motorised fishing boats) to be issued by the Ministry of Agriculture and Natural Resources, which cannot be analogically applied to aquaculture. No other provisions were found.

According to the Land Use Act (1978, as amended), state governors have the power “to grant statutory rights of occupancy to any person for all purposes”, and Local Government shall “grant customary rights of occupancy to any person or organisation for the use of land in the Local Government Area for agricultural, residential and other purposes”. The law does not specifically mention aquaculture purposes.

In contrast, water management is vested in the federal government, as stated by the Water Resources Decree (1993). Accordingly, the Minister for Water Resources has the power to “prohibit or regulate the carrying out of any activities on land or water which is likely to interfere with the quantity or quality of any water in any water course or groundwater”. Free use of water is allowed for minor purposes: the licensing system

established by the decree only concerns the diversion, storage and use of water on a commercial scale for the construction, maintenance, operation, repair of hydraulic works. No reference is made to agricultural water use in general, or to aquaculture activities in particular.

The Environmental Impact Assessment Decree (1992) provides that, in general, any project or activity which might significantly affect the environment is subject to an environmental impact assessment. Applications are to be filed with the Federal Environmental Protection Agency (FEPA).

The Schedule to the Decree contains a list of activities subject to the full EIA process, which entails a mandatory study of the project and a preparation of a mandatory study report. As far as aquaculture is concerned, only "land based aquaculture projects accompanied by clearing of mangrove swamp forests covering an area of 50 hectares or more" are subject to the full process.

Furthermore, according to the Water Resources Decree, the Minister for Water Resources is in charge of regulating the safe disposal of sewage, effluent and water-borne waste and is responsible for the control and prevention of pollution.

The Inland Fisheries Decree provides that the import and export of live aquatic species is subject to an authorisation to be issued by the Minister in charge of fisheries. Procedural details are not available in the reviewed legislation. There are no specific provisions on animal health and disease control.

4.0 CONCLUSION

The justification for comprehensive inland fisheries legislation has been advanced by the Federal Department of Fisheries based on the need to harmonize the administration, management, protection and improvement of the fisheries resources in inland waters including rivers, reservoirs, lakes and their associated wetlands. Although it could be argued that these waters are within state boundaries and should therefore be subject to state legislation, the waters usually traverse more than one state. Apart from the fact that fish do not respect state boundaries, migratory fish often enter channels which pass through more than one state. Consequently, action or lack of action by one state can have a profound effect on the fishery resources and fishing in another state. In addition, migrant fishermen often cross state boundaries using unlawful methods to capture fish, and the dumping of poisonous products or industrial wastes in one state, which does not give priority to fisheries, can lead to

mass destruction of valuable fishery resources downstream in another State where fishing may be of high priority.

5.0 SUMMARY

Nigeria has no specific legislation on aquaculture at national level, nor is this activity mentioned in the Sea Fisheries Decree and Regulations (respectively 1992 and 1971). However, the Inland Fisheries Decree (1992) makes a single provision empowering the minister in charge of fisheries matters to determine whether the set up of enclosures, such as pens and cages, should be subject to a licence fee.

6.0 TUTOR-MARKED ASSIGNMENT

Critically assess the fisheries policy in Nigeria.

7.0 REFERENCES/FURTHER READING

“Environmental Impact Assessment Decree No. 86” (1992). Supplement to Official Gazette Extraordinary No. 73 Vol. 79, 31st December, 1992-Part A A979

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Ita, E.O. (1993) “Inland Fishery Resources of Nigeria.” *C.I.F.A Occasional Paper* No. 20. Rome: FAO.

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“Water Resources Decree No. 101” (1993). Online at: <http://www.ielrc.org/content/e9302.pdf>

MODULE 4 AQUACULTURE ENGINEERING/BREEDING

Unit 1	Construction of Ponds, Channels and Drainages
Unit 2	Pond Preparation
Unit 3	Maintenance of Ponds
Unit 4	Fish Breeding

UNIT 1 CONSTRUCTION OF PONDS, CHANNELS AND DRAINAGES

CONTENTS

1.0	Introduction
2.0	Objectives
3.0	Main Content
3.1	Site Selection
3.2	Construction of Ponds
3.3	Construction of Channels and Drains
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	References/Further Reading

1.0 INTRODUCTION

The majority of freshwater fish are raised in ponds. Water taken from a lake, river, well or other natural source is channeled into the pond. The water either passes through the pond once and then it is discharged, or it may be partially replaced so that a certain percentage of the total water in a system is retained. Pond systems that yield the highest fish production only replace water lost through evaporation and seepage. Water flow generally reduces the natural production of pond systems in the tropics.

2.0 OBJECTIVES

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

- state the requisite conditions for location of ponds
- list and explain construction parameters
- design channels and drainages.

3.0 MAIN CONTENT

3.1 Site Selection

Success or failure of any aquaculture venture largely depends on the right selection of the site for it. In choosing a site, several factors other than the physical aspect of the site are to be considered. The factors to be considered cut through various disciplines and range from socio-economic aspects of aquaculture to all the physico-chemical and biological conditions of the environment; this consideration should be with reference to the specific culture system and species chosen. In selecting a site for a specific system of culture both technical and non-technical aspects need to be considered.

Socio-Economic, Political and Legal Factors

They are socio-economic aspects such as social and religious customs; consumer preference; nature of manpower (labour) - quality and quantity available; transportation and communication facilities; i.e. infrastructure facilities; accessibility and nearness to market; and also costs and availability of construction materials.

The objectives of producing fish in a culture system should be clearly spelt out. While the acceptance or preference of the local community would be of prime interest in producing fish for local consumption, the acceptability of the target group to whom the fish are supplied, in some cases, even by export, is of major interest.

Topography and Ground Elevations

Pond design (width, depth, orientation) and farm layout (grow-out areas, building sites, settlement and holding dams) will be influenced by the topography of the land. Pond construction costs can be minimised by building on land with a gentle slope (1% - 3%). The steeper the land the more works that are required and the higher the water pumping cost. With very flat land it is more difficult to design and operate a farm because of the need to have slopes on the pond bottoms to allow complete drainage and to ensure discharge drains from the ponds can transfer water to settlement ponds and holding dams. This water can then be recirculated through the farm or used for irrigation purposes. Land should be above flood levels to prevent the loss of the crop or the translocation of species, which may be non-indigenous to the area, into the natural river system. Land that floods more than one year in 100 should not be considered for grow-out ponds.

Soil

The site must have soils that hold water and can be compacted. If pond levees are constructed with soil that has high water permeability (leakage), the cost of pumping water could become prohibitive. Soils should contain no less than 20% clay. Soils with high sand and silt compositions may erode easily and present a piping hazard soil-water flow along pipes which could wash out a levee. Anti-seep collars can help minimize that problem.

Water Supply Quality, Quantity and Dynamics

Aquaculture requires large volumes of good quality water. A supply of good quality water is also essential. Poor water quality reduces fish survival and growth. The water supply must be relatively free of pollutants, sewage and other dissolved wastes, heavy metals, oils, pesticides, herbicides, chlorine, methane, hydrogen sulphide and other poisonous substances. Do not use water of extremely high turbidity (caused by silt and clay colloids) as it may stress fish, reducing growth and resistance to disease.

Water quality variables need to be monitored regularly as they interact and can change from acceptable levels to lethal levels within several days, particularly during summer. Monitor temperature, dissolved oxygen, pH and ammonia.

Source water for fish farms can be drawn from many sources; for example runoff, rivers, creeks, impoundments, small dams, lakes, irrigation canals and underground (bore water). The type, size, location and topography of a farm will determine the best or most practical source of water. Normally, a well or surface water source (river, stream or spring) is required. Surface sources may be polluted, intermittently available (affected by weather, e.g. drought).

Borehole water has a number of features that make it very suitable, particularly in intensive facilities. They include:

- regular, dependable supply
- free of pathogens
- free of organic, agricultural or industrial pollution
- free of suspended particles and so allows close observation
- relatively constant temperature
- free of trash fish and other undesirable aquatic organisms.

Water must be of high quality and free of pollutants, sewage and toxic contaminants. Generally, water that is safe for livestock and domestic use or that supports wild fish populations is safe for aquaculture.

Chemical characteristics of water that are desirable for good animal growth include:

- pH - 6.5 to 8.5
- Total Alkalinity - 75 to 250 mg/L (less than 500mg/l as CaCO₃)
- Total Hardness - 75 to 250 mg/L (less than 500mg/l as CaCO₃)
- Total alkalinity and hardness should not be below 20 mg/L.

Avoid water from domestic supplies as it contains chemicals such as chlorine, which can be toxic to fish. The cost of supplying water to the site may be a major factor determining the economic feasibility of a fish farm. Pumping costs are high and must therefore be minimised. Utilise gravity flow, as it is efficient and cheap. Use a large reservoir to implement gravity flow.

Type and Density of Vegetation

The land must be free of stumps and shrubs that interfere with excavation. Thick vegetation is not ideal as it blocks sunrays hence phytoplankton from carrying out photosynthesis.

Other important factors that must be considered include:

- susceptibility of the site to flooding
- availability of electricity
- availability of suitable manpower to operate the farm
- accessibility
- proximity to markets
- ability to secure the site against poaching and sabotage
- potential impact on the environment.

3.2 Construction of Ponds

Building a pond can be the most difficult and most expensive part of fish farming. A well-built pond is a good investment that can be used for many years.

The steps in building a fish pond are:

1. Prepare the site
2. Build a clay core (in the case of contour ponds)

3. Dig the pond and build the dikes
4. Build the inlet and outlet
5. Protect the pond dikes

Prepare the Site

First remove trees, bush and rocks, then cut the grass in the area where the pond will be made. Measure and stake out the length and width of the pond. Remove the top layer of soil containing roots, leaves and so forth and deposit this outside the pond area. Save the topsoil for later use when grass is to be planted on the pond dikes.

Build a Clay Core (in the case of contour ponds)

A clay core is the foundation for the pond dike, which makes it strong and prevents water leaks. A clay core is needed in contour ponds and is built under those parts of the dike where the water will be above the original ground level. A clay core is not needed in excavated ponds because there the water level is below the original ground level. Remove all the topsoil in the area of the pond dikes and dig a 'core trench' in the same way as you would dig the foundation for a house. The trench needs to be dug out along the lower side of the pond and halfway along each short side of the pond. Fill the trench with good clay. Add several centimetres of clay at a time and then compact it well. This will provide a strong foundation upon which the pond dikes can be built.

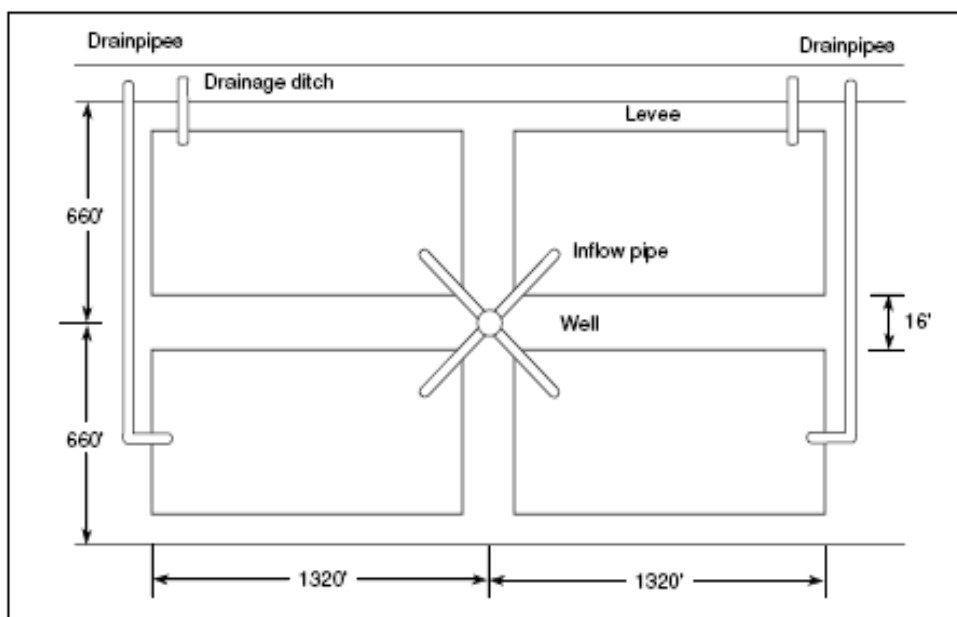


Fig. 1: Layout of a Typical Pond with Dike or Levee

Dig the Pond and Build the Dikes

Use the soil that you dug out when making the trench for the clay core to build up the dike on top of the core trench. Try not to use sandy/rocky soil or soil that contains any roots, grass, sticks or leaves. These will decay later and leave a weak spot in the dike through which the water can leak out. Keep compacting the soil at regular intervals while you are building the dike. After adding each 30 cm of loose soil trample it well while spraying water on the dike. Then, pound it with a heavy log, or a piece of wood attached to the end of a pole. This will make the dike strong. Pond dikes should be about 30 cm above the water level in the pond. If catfish are to be farmed in the pond, build the dike to 50 cm higher than the water level to prevent the catfish from jumping out. Once you have reached this height, add a little more soil to allow for settling and then refrain from adding any more soil on top of the dikes. The pond dikes should have a gentle slope. The best slope for the pond dike is one that rises 1 metre in height for every 2 metres in length. The pond bottom should also slope so the water varies in depth along its length.

Build the water inlet and outlet

The water **inlet** consists of a canal to bring in the water, a silt catchment basin, and a pipe to carry water into the pond. The water coming into the pond often contains a lot of soil and silt and will make the pond very muddy. A silt catchment basin will prevent this soil from entering the pond. By widening and deepening the inlet canal right outside of the pond dike, the soil will settle into this hole – called a silt catchment basin – instead of entering the pond. The water inlet pipe runs from the catchment basin through the pond dike into the pond. It should be about 15 cm above the water level so that the incoming water splashes down into the pond. This will prevent fish from escaping by swimming into the inlet pipe. It also helps to mix air (and thus oxygen) into the water. The water overflow pipe is used only in emergencies. Water should **not** flow out of the ponds on a daily basis. During heavy rains the overflow pipe takes excess rainwater and run-off water out of the pond. The inlet, outlet and overflow pipes can be made of plastic, bamboo, wood or other material. Install the pipes through the pond dike near the water surface. Pipes should have screens to stop fish from entering or leaving the pond. The INLET pipe is screened at the edge, which is outside the pond to stop wild fish and objects like branches and leaves from entering. The OUTLET (also called drainage pipe) is screened inside the pond to stop fish from escaping.

Protect the pond dikes

When the pond dikes are finished, cover them with the topsoil that was removed when digging the pond. On the dikes, plant grass such as Bahamas grass. Do not use plants with long roots or trees because these will weaken the dikes and may cause leaks. The fertile topsoil will help the new grass to grow, and the grass will help to protect the dikes from erosion. Flooding during heavy rains can destroy pond dikes, if too much rainwater and run-off water flows directly into the pond. It can be prevented by diverting the run-off water around the sides of the pond. This can be done by digging a ditch along the upper side of the pond. Use the soil from this ditch to build a small ridge below it. The ditch will carry run-off water away from the pond, which will prevent flooding and protect the pond dikes.

3.3 Construction of Channels and Drains

A perimeter drainage channel system should be constructed to receive effluents and to prevent water from standing outside dikes. The existing drainage system might be modified, or a new system constructed. Earth removed during construction of the drainage ditches can be used as fill for dikes. Drains and channels are most often installed after the dike is constructed by trenching through the levee with a backhoe. This ensures proper placement of the drain and minimizes the risk of settling, which can hinder the complete draining of the pond. A single 10-inch diameter drain PVC pipe is adequate to maintain water level and drain a commercial pond. Most soils used for pond construction have high clay content and most dikes are relatively low, anti-seep collars are not usually included on the drainpipe. The drain should extend into the pond and past the outside dike toe by at least 5 feet. A 1-inch drop in the pipe to the levee toe will ensure complete drainage of the pipe when the pond is dry. The inside (pond side) drain end is capped with an expanded metal screen (0.5-inch mesh) 3 to 4 feet long to keep fish from entering the drain. If the pipe does not extend properly outside the pond, severe levee erosion is likely to occur when overflow or drain water is released. The outside end is fitted with a "T" standpipe to set the desired pond level and capped at the end with an alfalfa valve. The length of the plastic terminal sleeve (or "jam pipe or riser") can be altered to adjust the water level in the pond. Other drain types such as "swivel pipes" and concrete "monks" can be installed in commercial ponds but are not recommended because they cost more and have limited usefulness. The area immediately surrounding the interior drain (25-foot-radius) should be slightly deeper (3 to 4 inches) than the rest of the pond so that the pond drains fully. Any fish remaining at drawdown will be concentrated in this area.

4.0 CONCLUSION

Proper design and construction of ponds is critical to the success of a commercial fish operation. Well-designed ponds, constructed on soil with proper clay content and adequate water supply, have a useful life of at least 10 years. Ponds constructed without proper planning may not hold water, may have persistent weed problems, be difficult to harvest and drain completely.

5.0 SUMMARY

Building a pond can be the most difficult and most expensive part of fish farming. A well constructed pond is a good investment that can be used for many years. The steps in building a fish pond are: Preparing the site, Building a clay core (in the case of contour ponds), Digging the pond and build the dikes, Building the inlet and outlet and Protection of the pond dikes. A perimeter drainage channel system should be constructed to receive effluents and to prevent water from standing outside dikes.

6.0 TUTOR-MARKED ASSIGNMENT

Outline the steps to be taken in building a fish pond and briefly explain three of these steps.

7.0 REFERENCES/FURTHER READING

- Carballo, E.; *et al.* (2008). *Small-Scale Freshwater Fish Farming*. Wageningen: Agromisa Foundation.
- Steeby, J. & Avery, J. (2002). *Construction of Levee Ponds for Commercial Catfish Production*. Southern Regional Aquaculture Center SRAC Publication No. 101.

UNIT 2 POND PREPARATION

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Pond Preparation and Stocking
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 Reference/Further Reading

1.0 INTRODUCTION

Pond preparation for stocking of fish is very important. Concrete ponds need to be cured to prevent toxicity of cement to the fish. Earthen ponds need to be well prepared to avoid seepage and silting which can affect the health of the fish. Some new pond owners pay a lot for pond construction and then neglect to finish the project. Unless the soil is protected, it may wash into the bottom of the pond. Gullies and rills can develop with the first rainfall, making maintenance difficult and even jeopardising the integrity of the pond. Establishing proper cover is cost-effective because it prevents excessive erosion, reduces mowing costs, and allows all weather access to ponds. Filling ponds by connecting pipes pond to pond is not recommended because it takes longer to fill connected ponds and disease and trash fish can be transferred easily from one pond to another.

2.0 OBJECTIVES

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

- prepare ponds for stocking
- state appropriate stocking densities for species.

3.0 MAIN CONTENT

3.1 Pond Preparation and Stocking

The following steps are necessary before a pond can be stocked: curing (for concrete ponds) fertilising the pond, fencing the pond, filling the pond with water and stocking the fish.

Curing the Pond

Concrete ponds should be left to stand inundated for between 7 to 14 days to allow for chemical reactions between cement and water to be reduced to the barest minimum. After this, flush out the water and wash the pond thoroughly before another impoundment to accommodate the fish.

Fence the Pond

Putting a fence around the pond will protect children from falling into the pond and it can help to keep out predatory animals. To make a low cost and sturdy fence, plant a thick hedge around the pond or build a fence using poles and thorn branches.

Fertilising the Pond

The natural fish food production in the pond can be increased by the use of fertilizers such as animal manure, compost or chemical fertilizers. Spread the fertilizer on the dry pond bottom before filling the pond with water. Add fertilizer to the pond water at regular time intervals, preferably each day in the late morning or early afternoon. This continuous adding of fertilizer will ensure a continuous production of natural fish food. If the soil is acid, add lime or wood ashes to the pond bottom in addition to fertilizer before filling the pond. Use 10-20 kg of lime or 20-40 kg of wood ashes for each 100 m² of pond bottom.

Fill the Pond with Water

Before filling the pond, put rocks on the pond bottom at the spot where the water falls when coming in from the inlet pipe. This will keep the incoming water from making a hole and eroding the pond bottom. Then open the inlet canal and fill the pond. Fill the pond slowly so that the dikes do not subside due to uneven wetting. While the pond is filling, the water depth can be measured with a stick. Stop filling the pond when the required depth is reached. To prevent overflowing, do not fill the pond too full. Water in the pond should not flow through (and should thus be stagnant), because water flowing through the pond will slow down fish growth by flushing away the naturally produced fish food. The only water added to the pond should be to compensate for water loss through evaporation and seepage. New ponds often seep when they are filled with water for the first time as the soil partly takes up the water. Keep adding new water for several weeks and gradually the pond should start to hold water.

Stocking the Fish

Wait 4-7 days before stocking the fish. This allows the natural food production in the pond to reach a sufficient level to sustain fish growth. In case you decide to introduce substrates in the pond, you will have to wait longer until the substrates are colonised by organisms that can be eaten by the fish. Stock the fingerlings gently, by immersing the bucket or container holding them into the pond water gently. Note, the temperature of water from which the fingerlings were brought from should be about the same as the water temperature in the pond. For Semi-intensive Systems, stocking density ranges from 2 to 25 fish per cubic metre of water while in Intensive systems it ranges between 25 to 450 fish per cubic metre of water. From this point onwards it is important to maintain the pond in a good state and monitor water quality.

4.0 CONCLUSION

Pond preparation is an important prerequisite for successful fish rearing and therefore ensures maximum productivity from the stock. Fish introduced to a well prepared environment will thrive well and this will translate to greater profit and maximal use of available resources.

5.0 SUMMARY

Concrete ponds should be left to stand inundated for between 7 to 14 days to allow for chemical reactions between cement and water to be reduced to the barest minimum. The natural fish food production in the pond can be increased by the use of fertilizers such as animal manure, compost or chemical fertilizers. Spread the fertilizer on the dry pond bottom before filling the pond with water. Putting a fence around the pond will protect children from falling into the pond and it can help to keep out thieves and predatory animals. Fill the pond slowly so that the dikes do not subside due to uneven wetting. Wait 4-7 days before stocking the fish.

6.0 TUTOR-MARKED ASSIGNMENT

Briefly describe steps to be taken in preparing a pond for stocking and the process of stocking.

7.0 REFERENCE/FURTHER READING

Carballo, E.; van Eer, A.; van Schie, T. & Hilbrands, A. (2008) *Small-Scale Freshwater Fish Farming*. Agromisa Foundation and CTA, Wageningen.

UNIT 3 MAINTENANCE OF PONDS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Pond Maintenance
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

To achieve a high production of fish in the pond, regular maintenance and monitoring is vital. Daily management includes:

- Checking the water quality (oxygen, pH, colour, transparency, temperature, etc.)
- Checking the pond for possible water leaks.
- Cleaning the screen of the water inlet and outlet.
- Observing the fish while they feed: Do they eat normally? Are they active? If not, and if they are gasping for air at the surface, the oxygen level in the water is too low. Stop feeding and fertilizing and let water flow through the pond until the fish behave normally again. Otherwise, look for symptoms that could indicate a disease.
- Watching out for predators, or signs of predators such as footprints, and taking precautions if necessary.
- Removing aquatic weeds growing in the pond water quality is a vital factor for good health and growth in fish.

2.0 OBJECTIVES

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

- explain the importance of various water quality parameters necessary for pond management
- manage ponds based on these parameters.

3.0 MAIN CONTENT

3.1 Pond Maintenance

Oxygen

Oxygen is a gas that is produced by all plants in the pond (including phytoplankton) with the help of sunlight. The more sunlight falls on the pond and the larger the quantity of phytoplankton, the higher the oxygen-production will be. The oxygen produced partly dissolves in the water and the rest escapes to the air. The oxygen level of the water varies during a 24-hour period because the production and absorption of oxygen by the plants change with light and darkness. The phytoplankton in the pond only produces oxygen when there is light. At night they need oxygen like any other plant or animal in the pond, but because of the lack of sunlight no oxygen can be produced. Consequently, the quantity of dissolved oxygen in the water decreases after sunset. Normally, the oxygen level is at the highest in the afternoon and at the lowest in the morning (oxygen has been used up throughout the night). Shortage of oxygen is the most important cause of fish death when the pond has been fertilised with manure or fed too much. A sufficiently high oxygen level is important for good fish production. If fish are gulping for oxygen at the water surface, you can solve this problem by flowing extra freshwater through the pond. Stirring up the water in the pond also helps to increase the amount of dissolved oxygen. Do not feed and fertilise the pond at this moment because this is often one of the reasons for the oxygen shortage. Over-stocking of fish in the pond could be another possible cause of oxygen shortage. This can cause stress for the fish, which can result in disease outbreaks and mortality.

Water Acidity, Alkalinity and Hardness

Water suitable for fish farming should have a certain degree of acidity, indicated by the water pH-value. This should preferably range between 6.5 and 8.5 (figure 4). Values above or below this range inhibit good fish growth and reproduction. Phytoplankton require a pH of about 7 and zooplankton (tiny animals in the pond water on which the fish feed) a slightly lower pH of 6.5.

<i>Fish growth</i>							
<i>death</i>	<i>slow growth</i>		<i>good growth</i>		<i>slow growth</i>		<i>death</i>
<i>pH 4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>

Fig. 4: Carballo, *et al.*, 2008. *The Effect of pH on Fish Growth.*

Sometimes the pH of the pond water can change quickly. For example, heavy rain may carry acid substances, dissolved from the soil into runoff water, into the pond. In this way, the pond water gets more acid and thus the pH-value decreases. The best way to increase the pH-value of the water again to neutral (about 7) is to add lime to the pond. Water alkalinity is a measure of the acid-binding capacity of the water (buffering ability), and is the opposite of water acidity. This means that when pond water alkalinity is high, more acid substances are needed to decrease the water pH-value. Water hardness is the measure of total water-soluble salts. Water that contains many salts is called 'hard' and water that contains few salts is called 'soft'. One method of measuring hardness is to carefully examine the pond dikes. If a white line appears on the dike at the same height of the water level, this means that salts present in the water have dried on the pond dikes. Therefore the pond contains hard water. Hard water is important for good fish growth. If the water is too soft (i.e. the amount of water soluble salts is low), the farmer can increase the hardness by adding lime to the water. In this manner, water fertility will increase, so natural food production and ultimately fish production in the pond will also increase. Water acidity, alkalinity and hardness can all be changed by adding lime to the pond as described above. These three water quality measurements are not the same but are usually related to each other in the following way:

- **Low alkalinity \approx low pH \approx low hardness**

So, the aim of adding lime is to increase water alkalinity, water hardness or pond water pH (to about 7). Ponds that have just been built need a different treatment than ponds that have already been limed before.

- **Newly built ponds:** These should be treated with 20 to 150 kg agricultural lime per 100 m². This is mixed with the upper (5 cm) layer of the pond bottom. The pond is subsequently filled with water to a depth of 30 cm. Within one week the pH of the pond water should have reached 7 and you can start fertilising.
- **Ponds limed before:** These should be treated with 10 to 15 kg quicklime per 100 m², added to the damp pond bottom to get rid of fish pathogens, fish parasites and fish predators. After a period of 7 to 14 days the ponds should be refilled with water. After filling the pond to a depth of 30 cm, the pH of the water can be adjusted by adding agricultural lime.

Turbidity

Turbidity is the term for the amount of dissolved, suspended dirt and other particles in the water, which give the water a brown colour. High

turbidity of water can decrease fish productivity, as it will reduce light penetration into the water and thus oxygen production by the water plants. Dissolved, suspended solids will also clog filters and injure fish gills. A method for measuring water transparency which is an indirect way to estimate turbidity is Secchi disc visibility. A suitable method for reducing turbidity is using a silt catchment basin. This is a small reservoir at the inlet of the pond. The water flows into this reservoir and is kept there until the mud settles on the bottom. Then the clear water is let into the fish pond. Another way of clearing muddy water is to place hay and/or manure in the pond and leave it there to decompose (resulting in sedimentation of mud particles). This method should not be used during very hot weather because the hay will begin to rot very quickly. This could lead to oxygen shortage in the pond. In the case of water turbidity caused mainly by factors other than phytoplankton abundance (water colour is not greenish), there are some widely used practices to decrease this turbidity. For instance, before stocking the fish, place animal manure in the pond at a rate of 240 g/m^2 . Do this three times with an interval of three to four days between the applications. Another method to decrease turbidity is to apply lime, gypsum, or preferably alum at 1 gram per 100 litres of water. However, the only real long-term solution to turbidity is to divert muddy water away from the pond and ultimately protect dikes from erosion, which cause the high water turbidity.

Toxic Substances

Toxic substances in the water supplied to the pond can decrease fish production seriously, so it is wise to investigate any existing or potential sources of water pollution in the vicinity of the pond. Many chemicals used in animal husbandry and crop cultivation are poisonous to fish. Therefore, chemicals should never be used in the area around the pond.

Ammonia

Ammonia reaches pond water as a product of fish metabolism and decomposition of organic matter by bacteria. In water, ammonia nitrogen occurs in two forms, un-ionized ammonia and ammonium ion. Un-ionized ammonia is toxic to fish, but the ammonium ion is harmless except at extremely high concentrations (Boyd and Lichtkoppler, 1979).

The toxic levels for un-ionized ammonia for short term exposure usually lie between 0.6 and 2.0 mg.L^{-1} for pond fish, and sub-lethal effects may occur at 0.1 to 0.3 mg.L^{-1} (EIFAC, 1973 and Robinette, 1976). In a properly managed aquaculture pond setting, ammonia seldom accumulates to lethal concentrations. However, ammonia can have negative effects that don't result in death but cause reduced growth

rates, poor feed conversion, and reduced disease resistance. So, even though the fish don't die directly from ammonia toxicity, it can affect the system in other ways and ultimately affect the overall crop.

There are a couple processes that also result in the loss or transformation of ammonia. The most important process is the loss of ammonia through the uptake by algae and other plants. Plants use the nitrogen as a nutrient for growth. Photosynthesis acts like a sponge for ammonia uptake so overall plant or algae growth in the ponds can help use up ammonia. The other ammonia removal process is the transformation of ammonia through nitrification. Two main types of bacteria, *Nitrosomonas* and *Nitrobacter*, effectively oxidize ammonia in a two-step process. First they convert ammonia to nitrite (NO_2^-) and then to nitrate (NO_3^-). Essentially, nitrification is a process of nitrogen compound oxidation (effectively, loss of electrons from the nitrogen atom to the oxygen atoms).

Even though practical ammonia management actions may be limited in a large pond aquaculture setting there are some ways to reduce ammonia levels:

- a. **Reduce feeding rates** - since excess feed and fish excretion are the main culprits of ammonia build up it seems reasonable to feed only what the fish need.
- b. **Increase aeration** - aeration increase DO levels causing fish to be less stressed. Avoid vigorous aeration to prevent stirring bottom sediment which can actually increase ammonia concentrations.

Nitrite and Nitrates

Nitrite is an intermediate product in nitrification, which is a common, bacteria-mediated transformation of ammonia to nitrate in soils and water. Nitrite accumulates to significant levels in ponds only when ammonia concentrations are relatively high and some factor causes the rate of ammonia oxidation to nitrite to exceed the rate of nitrite oxidation to nitrate. Accumulation of nitrite is undesirable because it can be toxic to fish at relatively low concentrations.

An inexpensive and convenient prophylactic treatment is the application of common salt. Monitoring is necessary using water quality test kits. As such, losses to nitrite toxicosis will result only when the farm manager is negligent in instituting the proper management plan.

Other Pond Management Activities

Apart from water quality management, other routine activities which are critical to the success of the aquaculture venture include:

Feeding

Obtaining best performance results from fish feed is not dependent on pellet quality alone. Better results are obtained when fish are fed correctly using the right techniques that ensure all fish have access to the feed, the fish's nutritional needs are being met and that no excess feed is fed. Feeding fish correctly means:

- giving feed of the correct nutritional quality for the specified age of fish
- feeding the right feed size for easy consumption
- feeding the correct amounts
- feeding at the right time(s) each day.

When fish are fed correctly, growth rates are good and uniform across the population, feed conversion ratios (FCR's) are low and pond water quality is better managed. In order to avoid over or under feeding the fish, the right amount of feed must be given each time. The amount of feed to be provided to the fish per day, the feeding rate (ration), is dependent on the fish's body weight. Farmed fish typically are fed 1-4% of their body weight per day (Craig, 2009).

Feed can be offered to fish in ponds by one of the several ways:

- by broadcasting (floating and sinking pellets). Slow broadcasting of pellets is the recommended way for administering pellets to catfish grow-out ponds
- via feeders (floating and sinking pellets)
- applied within feeding rings (floating feeds – especially for juveniles in ponds).

Weeding

Aquatic weeds are more likely to grow in shallow ponds. Excess weeds in the pond interfere with seining and reduce the levels of dissolved oxygen available for fish production. Weeding involves physical removal of aquatic plants from the pond. The most convenient method of removal involves pulling them out, or in the case of floating plants like water hyacinths, collecting them by hand or in a net. This becomes increasingly more difficult and time consuming as the extent of the problem increases.

Pond Maintenance

a. Leakages

Leaks in ponds can be difficult and expensive to repair. Where possible, prevention is always easier and less expensive than repairs after the leak has become a problem. Most leaks occur through the dyke, a porous pond bottom or through channels in rock shelves in the pond. Leaks in dykes can occur along trickle tubes or other pipes that go through the dams. Small water channels form along the pipe, especially when poor soils deficient in clay are used in the pond dam. The channels enlarge over time and may eventually cause failure of the dyke.

Leaking ponds can be a frustrating experience. Problems can be avoided by using proper construction techniques, including anti-seep collars on pipes when ponds are constructed. Many pond leaks also can be prevented by a program of pond maintenance that includes prevention of tree growth on dikes and removal of burrowing animals before they dig holes. When leaks do occur in ponds, there are a variety of materials and management techniques that can be used to stop the flow of water:

Clay

Ponds built in gravel beds or in rock shelves generally do not hold water very well. Clay lining of at least 30.5cm thick is needed to properly seal these ponds and at least 15cm of clay on interior slopes to prevent leaks. If less clay is used, the pond will usually develop leaks again within a few years. Ponds that are frequently drained are especially prone to leaks. As the pond bottom dries, large cracks appear that open channels for water drainage. In areas where clay is available, it is usually the least expensive method of repairing leaking ponds.

Dyke Repair

Leaks in pond dykes are best repaired from inside the pond. To do this, drain the pond down 30 – 60cm below the site of the leak. Dig out the area surrounding the leak for several centimetres back into the dyke. The resulting trench is filled with clay and compacted every 20 – 25cm as it is filled.

b. Cleaning of Screens

Screens are used for the removal of unwanted particles from water and to prevent fish from escaping from tanks and ponds. Mesh and net screens have a very large ratio of open area to screen material, but are difficult to clean effectively due to particles becoming wedged in the

angles of the hole. The stiffer the screen material or screen, the easier manual cleaning is. Screens are generally cleaned by hand.

Security Issues

It is essential to maintain more efficient security arrangements for ponds in the school. Poaching and wanton killing of stocks by students and other people can occur in varying degrees in almost all schools. Adequate security is needed around the ponds to protect the investment.

4.0 CONCLUSION

Regular maintenance and monitoring is vital to achieving high productivity in a fish pond. Successful pond management depends on the knowledge and skill of the farm manager in terms of water quality management, feeding, control of aquatic weeds, managing leaky ponds and adequate pond security.

5.0 SUMMARY

Adequate management of the pond is necessary for the growth and well being of fish. Shortage of oxygen is the most important cause of fish death when the pond has been fertilised with manure or fed too much. A sufficiently high oxygen level is important for good fish production. Stirring up the water in the pond also helps to increase the amount of dissolved oxygen. Do not feed and fertilize the pond at this moment because this is often one of the reasons for the oxygen shortage.

Water suitable for fish farming should have a certain degree of acidity, indicated by the water pH-value. This should preferably range between 6.5 and 8.5. High turbidity of water can decrease fish productivity, as it will reduce light penetration into the water and thus oxygen production by the water plants. Dissolved, suspended solids will also clog filters and injure fish gills. The real long-term solution to turbidity is to divert muddy water away from the pond and ultimately protect dikes from erosion, which cause the high water turbidity. Many chemicals used in animal husbandry and crop cultivation are poisonous to fish. Therefore, chemicals should never be used in the area around the pond, especially avoid spraying on windy days. Farmed fish should be fed at 1-4% of their body weight per day. Weeding involves physical removal of aquatic plants from the pond. The most convenient method of removal involves pulling them out. Leaky ponds can be repaired by using clay lining on the bottom. Clay lining at least 30.5cm thick is needed to properly seal these ponds and at least 15cm of clay on interior slopes to prevent leaks. If leakage is from the dyke, dig a trench into the dyke, fill with clay and compact every 20 – 25cm as it is filled. Screens are

generally cleaned by hand. Adequate security is needed around the ponds to protect the investment from poachers.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is the relevance of oxygen and turbidity to fish production?
2. List four other important things that should be monitored apart from water quality parameters for successful fish production.

7.0 REFERENCES/FURTHER READING

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UNIT 4 FISH BREEDING

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Breeding Catfish
 - 3.2 Breeding Tilapia
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Reading

1.0 INTRODUCTION

Semi natural or hormone induced reproduction in ponds or concrete tanks can be used by farmers on small farms to produce their own larvae and fingerlings. However, the method has not proved to be a reliable method for mass production needed for larger fish farms or distribution centres of catfish fingerlings. Therefore artificial propagation under more controlled conditions including; stripping of eggs, collection of the sperm, followed by fertilisation of eggs has been developed.

2.0 OBJECTIVES

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

- explain the process of fish breeding
- list the processes involved in carrying out stripping and fertilisation

3.0 MAIN CONTENT

3.1 Breeding Catfish

The artificial reproduction of the African catfish, as for all finfishes, consists of a chain of activities which is more or less similar to that which occurs during the course of natural reproduction. Artificial reproduction starts with the selection of males and females from broodstock ponds after which they are transferred to the holding tank within a hatchery. Ideally, broodfish weigh between 500-1000 grams, with larger fish being difficult to handle and may often result in substantial egg losses prior to or during stripping. In general mature females are selected according to the following criteria:

- A well distended, swollen abdomen from which ripe eggs can be obtained by slightly pressing the abdomen toward the genital papilla. Ripe eggs are generally uniform in size and an experienced hatchery operator can see the nucleus as a small dark point in the centre of the egg
- A swollen, sometimes reddish or rose coloured genital papilla.
- Egg colour is usually golden or dark greenish
- For male broodstock the only major criterion is that they should not be less than 9 months old.

Hormone Injection

The most common technique employed to induce final maturation and ovulation in African catfish is to inject the female with hormones or pituitary gland material. The most commonly used hormone is Ovaprim at a dose of 0.5ml/kg of fish weight. The most common method of administering the hormone solution is by intra-muscular injection into the dorsal muscle.

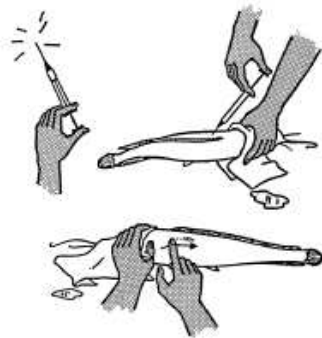


Fig. 5: Viveen ;*et al.* (1985). *Injection of the Female Breeders*

Stripping

Stripping of the female spawners is carried out by gently pressing their abdomen with a thumb from the pectoral fin towards the genital papilla. Ovulated eggs will flow out easily in a thick jet from the genital vent and are usually collected into a dry plastic container.

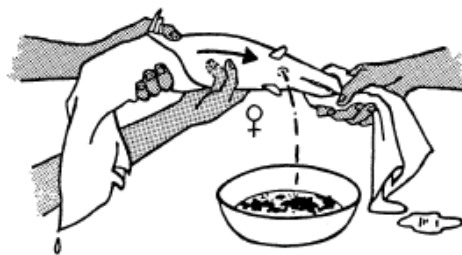


Fig. 6: Viveen; *et al.* (1985). *Stripping of the Female African Catfish.*

The males of the African catfish cannot be stripped and consequently the sperm can only be obtained by sacrificing a male. The male is killed and the body surface thoroughly dried after which the testis is dissected and placed in a mortar or a teacup. The edge of the testis is rapidly cut using a scissor and finally the milt is squeezed out with the hand either directly on the stripped eggs or into a small container or cup.

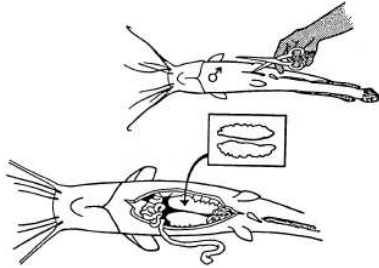


Fig. 7: Viveen; *et al.* (1985). *Collection of Milt from Male African Catfish.*

The sperm (diluted in 9% saline or non-diluted) is added to the stripped eggs, and then mixed together gently with a feather or plastic spoon. An equal volume of clean water is then added to the egg mass by gently shaking the bowl or use of feather or plastic spoon. Eggs must be stirred continuously once water is added until they are spread in a single layer in the karkaban in the incubation tank. (The karkaban can be made from 1mm mesh size of net or strands of plastic bags tied together where the eggs attach to).

Incubation of Fertilised Eggs

The development process from fertilised egg to hatching, like all other biological processes, is dependent upon water temperature. The higher the water temperature the faster the eggs hatch. Freshwater is allowed to flow in and out of the incubation tank to improve the oxygen level and remove waste produced during the process of incubation of eggs.

Hatching

Eggs start to hatch between 18 – 36 hours after incubation when water temperature is above 26°C. The hatchlings (1-1.5mg) will drop to the base of the incubation tanks from the karkaban and settle in the dark corners of the tank. The un-hatched eggs attached to the karkaban are removed from the incubation tank while the hatchlings are allowed to feed on their yolksac for 2 – 3 days. After their yolksac has been fully absorbed, they are fed with exogenous food to enhance their survival and development. The hatchlings can be transferred out of the incubation tank into a well prepared nursery facility which can be an

earthen pond or concrete, plastic or wooden tank. The nursery facility should be protected from predators to ensure high survival.

3.2 Breeding Tilapia

Egg production presents no problem as tilapia readily spawns in the ponds. The preferred water temperature during spawning is 25 to 30 °C. Usually, tilapia females of about 200 - 300g weight are stocked in one pond at an average density of one fish per 2 m² in a sex ratio of one male to four or five females. Tilapia males will begin digging holes in the pond bottom immediately, attracting the female to the hole who will simply release her eggs. If the pond bottom is not loose, pottery jars or wooden boxes can be used as nesting material. Tilapia can then breed every 3 to 6 weeks. The number of eggs produced per spawning depends on the size of the female: a 100 g female Nile tilapia spawns about 100 eggs while a 600-1,000 g fish will spawn 1,000-1,500 eggs. The fry are collected at monthly intervals and grown to fingerlings in nursery ponds. The average monthly production is about 1,500 fry/m².

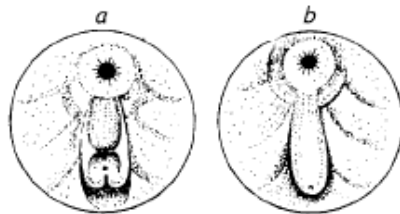


Fig. 8: Chakroff, (1976). Genital Papillae in (a) Female, and (b) Male Tilapia

During the early stages, the fry feed on natural food produced in the pond. The fry are removed from the spawning ponds and transferred to nursery ponds or directly to grow-out ponds. Once they are transferred to the nursery ponds, supplementary feeding is provided at a rate of about 6 to 8% of body weight, depending on food type.

4.0 CONCLUSION

Artificial reproduction by induced breeding through hormone treatment followed by artificial fertilisation and incubation of fertilised eggs and the subsequent rearing to fingerling size has several advantages including: better rates of fertilisation and hatching, protection against enemies and unfavourable environmental conditions and better conditions for growth and survival.

5.0 SUMMARY

The artificial reproduction of the African catfish, as for all finfishes, consists of a chain of activities which is more or less similar to that which occurs during the course of natural reproduction. Artificial reproduction starts with the selection of broodstock from broodstock ponds after which they are transferred to the holding tanks in the hatchery. Egg production for tilapia presents no problem as they readily spawns in the ponds. The preferred water temperature during spawning is 25 to 30 °C.

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the method of artificial reproduction in the African catfish.
2. Describe spawning in tilapia.

7.0 REFERENCES/FURTHER READING

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