Fisheries and Aquaculture

Lecture Five

Fish diversity

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4.2 classification of fishes

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4.Diversity of fishes

Introduction

- Fish are cold-blooded animals with a backbone (vertebrates), gills for breathing underwater, and paired fins for swimming. They live underwater and are dependent on water for dissolved oxygen, support, food, and shelter. Marine mammals (whales, dolphins, seals, sea otters), reptiles (turtles), amphibians (frogs and salamanders), shellfish (oysters, clams, and mussels), and aquatic invertebrates (crayfish, starfish, lobster) are not fish. Although they may not look like fish, seahorses and eels actually are fish.
- Fish are very diverse and are categorized in many ways.
- Although most fish species have probably been discovered and described, about 250 new ones are still discovered every year.
- According to FishBase,there are more than 40,000 fish species.
- That is more than the combined total of all other vertebrates: mammals, amphibians, reptiles and birds.
- Traditional classification divide fish into three extant classes, and with extinct forms sometimes classified within the tree, sometimes as their own classes:

Introduction

- ❑ Class Agnatha (jawless fish)
  - ✓ Subclass Cyclostomata (hagfish and lampreys)
  - ✓ Subclass Ostracodermi (armoured jawless fish)
- ❑ Class Chondrichthyes (cartilaginous fish)
  - ✓ Subclass Elasmobranchii (sharks and rays)
  - ✓ Subclass Holocephali (chimaeras and extinct relatives)
  - ✓ Class Placodermi (armoured fish)
  - ✓ Class Acanthodii ("spiny sharks", sometimes classified under bony fishes)
- ❑ Class Osteichthyes (bony fish)
  - ✓ Subclass Actinopterygii (ray finned fishes)
  - ✓ Subclass Sarcopterygii (fleshy finned fishes, ancestors of tetrapods)

Class Chondrichthyes /Cartilaginous Fishes

- There are nearly 850 living species in the class Chondrichthyes, an ancient,compact, and highly developed group.
- Although a much smaller and less diverse assemblage than the bonefishes, their impressive combination of well-developed sense organs, powerful jaws and swimming musculature,and predaceous habits ensures them a secure and lasting place in the aquat community.

Class Chondrichthyes / Elasmobronchii/cartiligous

1) All are marine animals
2) Endoskeleton is made up of cartilage
3) Mouth is ventral
4) Air bladder is absent
5) 5 to 7 pairs of Gills.
6) A pair of claspers are present in males on either side of cloaca.
7) Fertilization is internal and many species are viviparous.

Class Osteichthyes

1) Endoskeleton is made up of bone

2) Inhabits both freshwater as well as marine.

3) Mouth is usually terminal or sub-terminal

4 pairs of gills .Their openings are covered by operculum or gill cover.

4) Air bladder is present in many species

6) Bony fishes are usually oviparous.

FISH DIVERSITY IN MARINE AND FRESH WATER BODIES

- Diversify of fishes varies by different categories, species size, habitat, breeding behavior, feeding behavior, vision, shape, locomotion, toxicity and human use but in this lecture we will focus on diversity of fishes by habitat .
- There is 10,000 times more saltwater in the oceans than there is freshwater in the lakes and rivers.
- However, only 58 percent of extant fish species are saltwater.
- A disproportionate 41 percent are freshwater fish (the remaining one percent are anadromous).
- This diversity in freshwater species is, perhaps, not surprising, since the thousands of separate lake habitats promote speciation.

African fishes

- 2000 species of freshwater fishes in Africa
- Third next to South East Asia (3000) and South America(2500)
- Zaire Basin in Africa has the highest diversity of fish
- 669 species and 554 are endemic
- South Africa has 54 species
- countries ,Tunisia, Morocco, Libya, have about 10 species each

Ethiopian Fishes

- Ethiopia has about 200 fish species
- Overall diversity is highest in Baro- Akobo
- 40 species are endemic
- Abay Basin has the highest endemicity
  - Lake Tana with 21 endemic species

Summary of Fish diversity in Main drainage basins of Ethiopia

Drainage basins	Number of family	Number of genera	Number of species
White Nile system	26	60	113
Blue Nile System	16	37	77
Atbara- Tekeze	10	22	34
Omo- Turkana	20	42	76-79
Rift valley	10	18	28-31
Wabishebele and Jube	12	21	33

Source:JERBE (Joint Ethio-Russian Biological Expedition),2008

Introduced (Exotic) Fishes

- Carps
  - Cyprinus carpio
  - Ctenopharyngodon idella
  - Hypopthalmichthys molitrix
  - Carassius auratus
- Tilapia zillii
- Tilapia rendalii
- Salmo trutta
- Oncorhynchus mykiss
- Esox lucius
- Gambusia holbrooki

Fresh water fish species of Ethiopia

Three major category : 1. Nilo-sudanic 2. East african 3. Endemic species

1. **Nilo- sudanic**

- Dominant in diversity, found in Baro-Akobo .Omo-ghibe ,Tekeze and abay drainage basin : E.g Labeo ,mormirus etc

2 **East African forms** – Found in Northern rift valley , highland lakes and associated river system and awash river basin

They are related to eastern and Southern Africa

– Includes ,Barbus, Claridae, Garra. O.niloticus

3. **Endemic species** :Labeobarbus ,Garra makienesis in Abay and Tekeze

COMMERCIALLY IMPORTANT FISHES

INTRODUCTION

- Fisheries, industry of harvesting fish, shellfish, and other aquatic animals.

❑ Fisheries may be

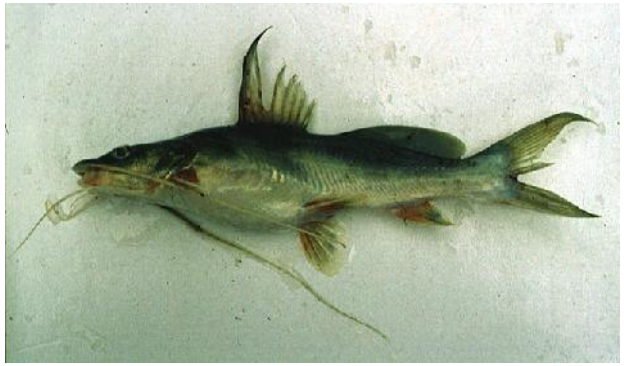
- large commercial fisheries
- recreational fisheries, or
- small subsistence fisheries (fishing to provide the basic needs of the fishing community).
- The term fishery is also used to describe the waters where fishing takes place or the species of fish being harvested.
- Fisheries include familiar finned fish species, like cod and flounder; mollusks, including oysters and squid; and crustaceans, such as shrimp and crabs.
- Lesser-known fisheries include echinoderms, like sea urchins; some amphibians, including frogs; and cnidarians, such as jellyfish.
- Even the harvest of whales is usually considered a fishery.

- Fisheries are 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.
- The average person in Iceland eats nearly 90 kg (200 lb) of fish per year, more than six times the worldwide average(14kg).
- In Ethiopia it is 240gm per year

Commercially important fish species of Ethiopia

- Ethiopia has about 200 fish species which have ecological and economical importance. However there are seven commercially important fish species in Ethiopia as indicated in table bellow

Common name	***Scientific*** *name*	***Local name***
Nile Perch	*Latus niloticus*	Nech Asa
Nile tilapia	*Oreochromis niloticus*	Kereso
Catfish	*Clarias gariepinus*	Ambaza
Barbus	*Barbus species*	Bilcha
Bagrus	*Bagrus docmak*	Kerkero
Labeo	*Labeo horii*	Barbo
Common carp	*Cyprinus carpio*	Duba



Bagrus docmak

Barbus platydorsus(Barbus species)

Oreochromis niloticus

Clarias gariepinus

Latus niloticus

Labeo horii

Cyprinus carpio

Fisheries and Aquaculture(Biol.3092)

Lecture 6

Fishery management

May,2019

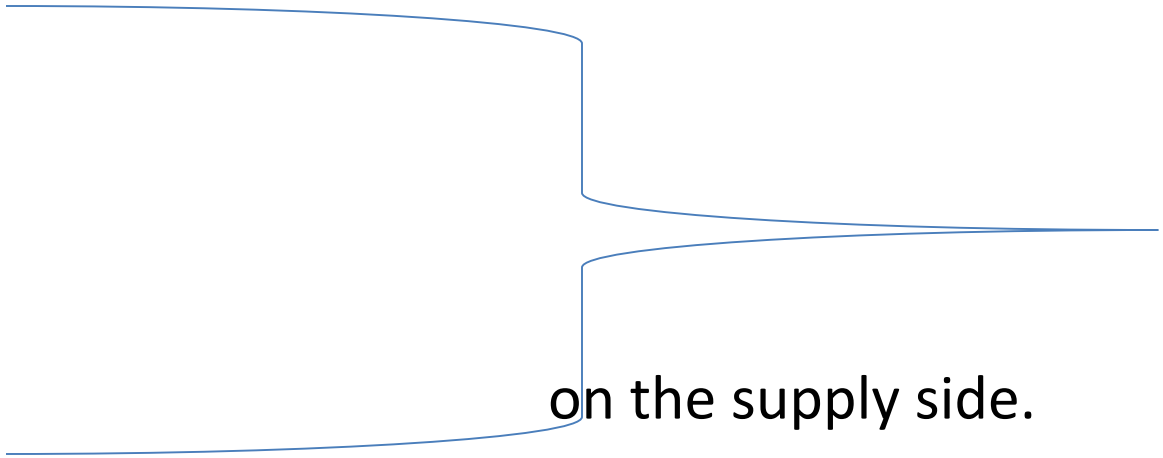
Lecture Content

1. Introduction
2. Definition of Fishery management
3. Fishery Development
4. Fishery management systems
5. Community based fishery management
6. Co-management
7. Fish stock and stock assessment
8. Basics in fishery management
9. Fishing Methods and gears

6. Fishery management

INTRODUCTION

- The rapid expansion of world fisheries since the Second World War
- spectacular increase in world total catches and in the volume and value of fish trade.
- High fish supply due to high demand
- The significant and continuous improvements in the methods and techniques used for
- spotting
- catching
- freezing
- preserving and
- marketing fish



on the supply side.

- rising standards of living
- high income
- Rising standards of food consumption

On the demand side

Fish may be sold in a fresh, canned or frozen state

- Fisheries have an important socio-economic role in many developing countries.
- Directly for 250 million people are directly involved in fisheries
- Including post harvest sector 300million

> 1 billion people relay on aquatic products for their main source of animal protein.

- Fishery has focus by the World Bank, the United Nations Development Program (UNDP)

- Fisheries management is a science of sustainable exploitation or utilization of fisheries resources.
- Fisheries management puts forward measures that that need to be implemented in order to sustainably utilize the fisheries resources.
- Sustainable utilization refers to the use of resources without compromising or affecting their future existence.

Definition of

- It is Decision making, budgeting, and the implementation of techniques and strategies used to ensure continued productivity of the fishery or to accomplish other fisheries objectives.
- fisheries management is a complex process incorporating
- ✓ fisheries biology
- ✓ and stock status information,
- ✓ food web and predator/prey relationships,
- ✓ habitat needs,
- ✓ socioeconomic needs of recreational and commercial fishermen,
- ✓ and law enforcement issues

- A Fisheries Management Plan (FMP) should be the basis for any fishery under management and should be designed based on **a water body's current status** and the **goals and budget of the owner.**

Fishery management and development

- The general objective of both management and development is the attainment of the optimum rate of exploitation of the fishery.
- For example, if the policy objective is to maximise the economic benefit from the fishery, the optimum rate of exploitation is MEY(maximum economic yield)
- If the actual catch is less than MEY because of insufficient fishing effort the fishery is said to be **economically underexploited** and further development is possible
- While if the catch is less than MEY because of excess effort the fishery is **economically overexploited** and management is called for

- If the policy objective is maximum fish production then the optimum rate of exploitation is defined by the **Maximum Sustainable Yield (MSY)**, that is, the maximum catch that can be obtained on a sustained basis.
- If the actual catch is less than MSY because of insufficient fishing effort the fishery is said to be biologically underexploited
- and further development is possible, while if the catch is less than MSY because of excess effort the fishery is **biologically overexploited** and management is called for.
- Thus it is not sufficient to know the MSY and to compare it with the actual catch; we need also to know the fishing effort required to obtain MSY and to compare it with actual effort

- Fishery development may be defined more broadly to include, in addition to the expansion of fishing effort (for under-utilised resource), improvement in post-harvest technology, marketing and transportation of fishery products as well as the provision of infrastructure and other related facilities (Panayotou 1982).
  - The resource is under-utilised, problem of marketing,
  - transport facilities
  - and access road are among the major bottle necks of most Ethiopian lakes fisheries .
  - Fishery development can be considered avoiding or reducing the above constraints of most Ethiopian lakes fisheries
- According to Bailey and Jentoft (1990), development is a process of change through which sustainable and equitable improvements are made to the quality of life for all or most members of a society.
- This definition may reflect the real needs.
- But, to satisfy such criteria, policy makers have to minimise mutually antagonistic goals in fisheries development (explained below).

Fishery management system types

Three types of fisheries management systems:

Traditional, **Mixed and Modern**.

- "Traditional: fisheries management by Traditional Government administration through Village Heads and District Heads.

Mixed : Traditional and Modern Government administrations participate together in management of fisheries, either intentionally or inadvertently.

Modern: fisheries management by Government administration through Federal State and Local Government Officers

- These days, the policy of the Government supports self management at the community levels in the following way by:

✓ providing special encouragement to communities participating in economic development free from state interference

✓ Voluntary participation of local communities and greater role for local administrative organs in development

Co-management: the modern with the traditional system

- The state is the owner of the resource with the modern top-down approach of management.
- Currently the government has an objective of increasing fish production up to MSY level with an assumption of welfare benefits for fishermen.
- The method of regulating fisheries through co-management is new in the country as well as the region.
- Managing fisheries through the cooperation of the fishermen may be a very important method.
- Because the fishermen may feel property right and this has a contribution to properly use the resource

- The stage in the process of co-management (planning, implementation or evaluation) which users became involved is another dimension to co-management.
- Under an ideal co-management regime, users groups should involved at all stages of the co-management process.
- But according to Sen and Nielsen (1996), a centralised approach at the planning stage will tend to have lower design cost than a cooperative approach, as it is likely to take less time to reach decisions

- Co-management is considered to be the solution to the growing problems of resource over-exploitation.

- Types of fisheries co-management arrangements in to five according to the role the government and user play.

1.Instructive: Government informing the users on the decision they plan to make.

2. Consultative: Decisions are made after consultation with the users.

3. Cooperative: Government and users come together as equal partners in decision making.

4. Advisory: Users advise government of decisions to be taken and government endorses these decisions.

5. Informative: Users are given responsibility to make decision and are also responsible for informing the government of this decision.

The community-based fisheries management

- Decentralized approaches to natural resources management of which community-based management is one type, have received an increasing amount of attention from governments around the world in recent years in response to the centralized management and the need to search for improved approaches.

Aims of the Community-based Approach

- The community-based approach (CBA) to renewable natural resources management implies that decisions as to the use of the such resources are made at community level, with a view to their sustainable use.
- The aim of CBA a planned approach can be set out under the planning objectives of efficiency and equity, as follows:

Efficiency

1. Resource efficiency- sustainable use of resources and protection from undesired uses.
2. Administrative efficiency- speedier and more effective decision-making and implementation with regard to resource use, at reduced financial cost.

Equity

1. Political equity- greater involvement and influenced by local people in decisions affecting their lives (empowerment).
2. Economic equity- the distribution of benefits from resource management so that the poor people get an equal, or more than equal share.

- Overall, it can be concluded that locating management authority at community level has the potential under certain circumstances to increase the efficiency both of administration and of resource use itself.
- Equity between communities is a factor to be considered, and one which will probably involve mediation at a higher level of government.

ECOSYSTEM-BASED FISHERIES MANAGEMENT

- Ecosystem-based fisheries management (EBFM) focuses on conserving the underlying health and resilience of the fishery ecosystem, thus maintaining the system's goods and services and leading to increased productivity.
- Developing an ecosystem-based approach to fisheries management need not be complicated. It is built around common sense principles that include

✓ Identifying critical fisheries nurseries,

✓ habitats, and linkages between habitats such as between mangrove forests, sea grass beds, and coral reefs

✓ Understanding freshwater inflows into coastal estuaries

✓ Maintaining the quantity, quality, and timing of such flows that make wetlands and estuaries some of the most productive ecosystems in the world

✓ Understanding how human activities impact ecosystem function

Fish stock and stock assessment

- A fish **population** is a biological unit referring to individuals of a species living in the same area.
- A fish **stock** is a management unit grouped by genetic relationship, geographic distribution, or movement patterns. For example, Lake Hayq Nile tilapia stock .
- This is because these fish stock don't mix with the Nile tilapia in other lakes. so the factors that affect the population of Lake Hayq Nile Tilapia, like fishing pressure, don't affect the other populations of Nile tilapia in other areas, and vice versa.
- In fisheries, determining stock status means determining whether the stock is large enough to sustain itself and whether we are fishing it too hard. If the **abundance** (numbers of fish) or **biomass** (weight) is below a sustainable reference value, the **population** is considered overfished.

- If the rate of fishing (i.e., **exploitation** or **fishing mortality**) is above a sustainable reference level, overfishing is occurring.
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- If the rate of fishing (i.e., **exploitation** or **fishing mortality**) is above a sustainable reference level, overfishing is occurring.
- Management actions are typically concerned with finding measures to stop overfishing when it occurs and rebuilding stocks considered overfished.
- Management also strives to avoid overfishing and prevent viable stocks from becoming overfished.
- Forecasts, or **projections**, are an important part of the management program used to set future catch allowances, evaluate alternative management strategies, and establish timeframes for rebuilding overfished stocks or protecting healthy stocks.

Data Sources for Stock Assessment

There are two types of data used in stock assessment:

- ✓ Fishery-dependent data
- ✓ Fishery-independent data.

What are fishery-dependent data?

- Fishery-dependent data are collected from commercial sources (vessel or dealer reports) and recreational sources (individual anglers, party or charter boats).
- Information is gathered on the total amount of fish removed from the ocean (catch and landings) and the level of fishing participation (effort).
- Additionally, information is collected about the fishing trip itself – who, what (target species), when (season), where (location) and how (gear type); related economic information (the cost of fishing trips); and biological information (species, age, length, weight, maturity of fish caught in a fishery).
- In some cases, information is also gathered on fishing gear interactions with **protected species** (marine mammals, sea turtles, and sea birds), bycatch of non-target species, and discards – fish returned to the sea dead or alive.
-

fishery-independent data

- Fishery-independent data are collected by scientists conducting long-term resource monitoring projects known as **fishery-independent surveys**.
- These surveys are specifically designed to follow consistent methods using the same gear for the duration of the survey in order to develop unbiased and independent indices of abundance.
- State, federal, and university scientists typically conduct fishery-independent surveys over many years to track long-term abundance trends of fishery resources.
- These data, when combined with fishery-dependent data from fishermen reports, provide a more accurate picture of stock status.
- Since the data are not influenced by specific management measures (size and bag limits, season closures, mesh sizes) or socioeconomic factors, they present an unbiased accounting of stock health.
- These surveys often collect biological data and other information used to describe juvenile and adult abundances, fish habitat characteristics, and environmental factors.

6.2 Recruitment of young

- Recruitment is central to the population ecology of fish because the abundance and survival rates of young in a cohort can have a strong influence on year-class strength in later life
- Factors that affect recruitment variation are of theoretical and practical interest and are often a focus of managers charged with resource conservation and recovery.
- Understanding the mechanisms that regulate recruitment is challenging because life history processes such as the timing and success of reproduction, growth, and rates of survival and dispersal of young are influenced by biological and physical factors
- For example, fluctuations in physical characteristics of rivers (e.g., discharge, water temperature, and sediment transport regimes) can influence timing of reproduction and habitat availability, which in turn affect growth and survival of early life stages of fish

The four basic points in fishery management

- For the management of any fishery, there are four basic points that should be considered seriously

1. **Objectives**
2. **Reference points**
3. **Management tools**
4. **Regulatory process**

1.OBJECTIVES

- Objectives are what the responsible authorities want to achieve.
- Fisheries management objectives can be divided in to at least four categories as prescribed below

A. Biological and conservation objectives

- The biological objectives of fisheries management is obtaining maximum sustainable yield (MSY).

B. Economic objectives

aim for economic rent and more specifically for profit maximization; that is the maximization of total revenue minus the total costs.

C. Social objective

-Social objectives are concerned with employment and equity in this sector.

D. Food supply

-Fish production; fulfilling the protein demand of the country

B. Economic objectives

aim for economic rent and more specifically for profit maximization;
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C. Social objective

-Social objectives are concerned with employment and equity in this sector.

D. Food supply

-Fish production; fulfilling the protein demand of the country

2. Reference points

- Once objectives are clearly defined they have to be translated in to reference points.
- A reference point is quantified expression of the chosen management objectives.
- two categories,
- target reference points (TRP) and
- Limit reference point (LRP) and in simple terms they are targets to be achieved and limits to be reached, respectively

3. Management tools

- These are tools used to monitors fishermen not to catch more than the recommended maximum sustainable yield (MSY).Major type of fishery management tools are mentioned below

✓ Closed season
✓ closed area,
✓ Catch quota
✓ Mesh size regulation
✓ Gear restriction
✓ Limit no of boat
✓ Limit no of gears
✓ Auction of property rights:
✓ Licensing
✓ Community right
✓ Taxes on effort or catch:
✓ Control of traders

4. Regulatory Process

- Includes the different laws, acts standards, enforcement ,controlled and requires the involvement of all parties concerned .
- Most importantly ,all members of the fishing community and the public should be encouraged to become an integrate part of the regularity, process rather than an object regulation.
- The regulation process should be open to the public and fishermen by law.
- Fishermen are encouraged to participate and ensure that their interests are considered when regulation is created.

- The following are regional, national and international acts used for regulating fishery, these are

1. The Amahara National Regional state Fisheries Development, prevention and utilization (Proclamation No.92/1996)
2. The Amahara National Regional state Fisheries Development ,prevention and Utilization Proclamation Enforcement (Proclamation NO.50/1999)
3. Fisheries Development and Utilization Proclamation of Ethiopia (Proclamation No.315/1995)
4. The 1982 United Nation Convention on the Law of the sea(UNCLOS)
5. The 1992 Convention on biological Diversity
6. The Magnuson-Steven Fisheries Conservation and Management Act or Magnuson Act, and latter named as the sustainable fisheries Act(SFA)

Fishing methods

- Fishing techniques are the methodologies that are employed in catching fish or the different systems used for improved fish catch.
- The techniques catching fish are classified as direct and indirect

❑ The direct techniques include

✓ Fishing gear

✓ Boats including mechanical or hydraulically equipments controlling the fishing gears

❑ The indirect techniques mainly includes

- Fish detection and attraction
- Know-how of the interaction of fish in response to fishing gears
- Identification of best fishing areas from hydrological and bathymetric data

- The fishing gear is the tool with which aquatic resources are captured, where as the fishing methods are how the gears are used.
- Generally fishery sampling gears are classified

1. as passive
2. and active

however, toxicants and electro-fishing don't feet these categories well.

- With passive gears, the capture of fish is based on the movement of the fish towards the gears(e.g,nets, traps,hooks),
- while with active gears capturing is based on aimed chased of the target fish (trawl, seines, spears).

General advantage of passive gears

- Simple design and construction
- Relatively low cost
- Requires little specialized training

General disadvantages of passive gears

- Rely on fish activity
- May damage bycatch (non target organisms)
- Can be selective for species, size or sex

General advantage of active gears

- Design assumptions easier to satisfy
- Fish can be caught in relatively short time
- Multispecies perspectives

General disadvantages of active gears

- Gear cost
- Labor intensive
- Not all the water areas are accessible

Fishing methods

- Fishermen use a wide range of gear to land their catch.
- Every type has its own effects on the water bodies.
- By selecting the right gear for the right job, the fishing industry can help minimize its impact on the environment.

1.Bottom Trawl

- A bottom trawl is a type of fishing net that's pulled along the seafloor.
- Fishermen commonly use bottom trawls to catch shrimp and bottom-dwelling fish like halibut and sole.
- Affect non- target organisms and habitat

2.Dredge

Dredges are large, metal-framed baskets that are dragged across the seafloor to collect shellfish like oysters, clams and scallops.

- can significantly impact seafloor habitat and bottom-dwelling species.

- Dredging also results in high levels of bycatch.

3.Gillnetting

- Gillnetting uses curtains of netting that are suspended by a system of floats and weights;
- they can be anchored to the seafloor or allowed to float at the surface.
- The netting is almost invisible to fish, so they swim right into it.
- Gill nets are often used to catch sardines, salmon and cod,
- but can accidentally entangle and kill other animals, including sharks and sea turtles

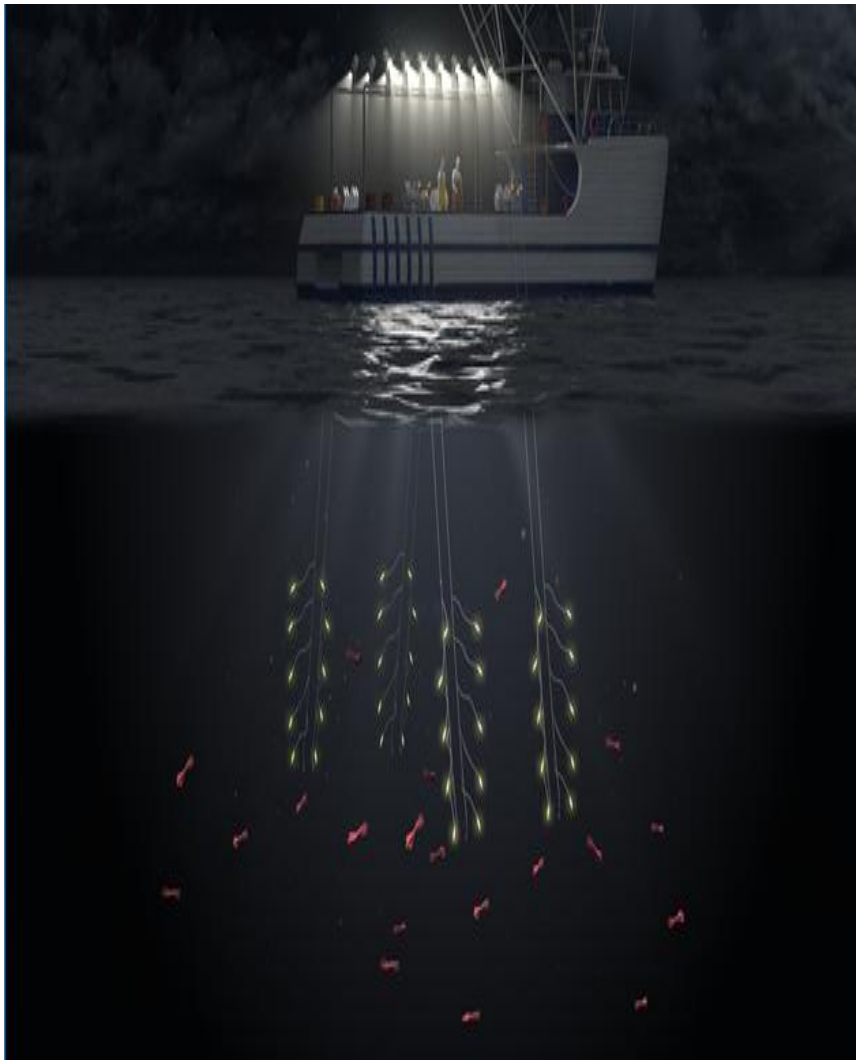
4.Harpooning

- Harpooning is a traditional method for catching large fish and it's still used today by skilled fishermen.
- When a harpooner spots a fish, he thrusts or shoots a long aluminum or wooden harpoon into the animal and hauls it aboard. Harpooners catch large, pelagic predators such as blue fin tuna and swordfish.
- Harpooning is an environmentally responsible fishing method By catch of unwanted marine life is not a concern because harpoon fishermen visually identify the species and size of the targeted fish before killing it.

Figure. Harpooning

5.Jigging

- Jigging is another way of hand-catching fish.
- A jig is a type of grapnel (or grappling hook) attached to a line, which is manually or mechanically jerked in the water to snag the fish.
- Jigging often occurs at night, aided by light to attract the fish.
- This targeted method of fishing has low levels of bycatch, making it an environmentally responsible fishing method.



6.Long lining

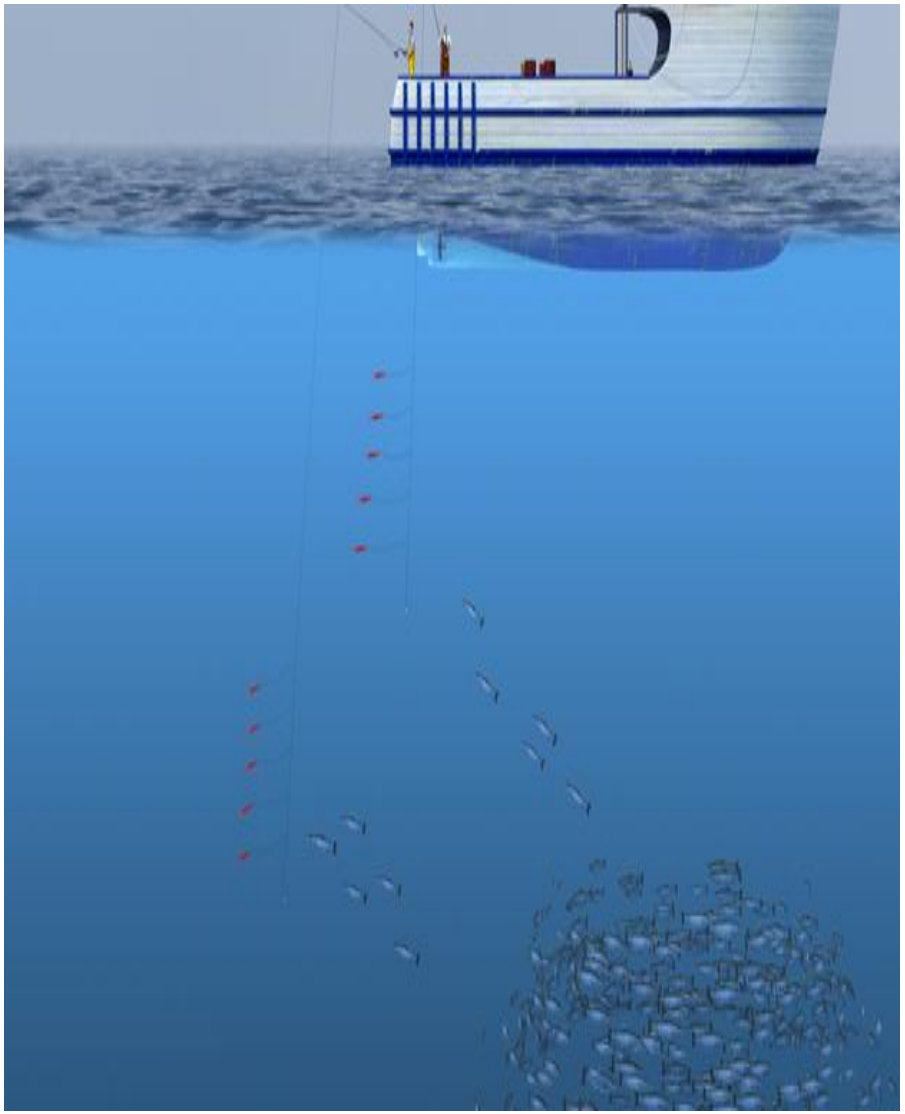
- Long lining employs a central fishing line that can range from one to 50 miles long; this line is strung with smaller lines of baited hooks, dangling at evenly spaced intervals.
- Loglines can be set near the surface to catch pelagic fish like tuna and swordfish, or laid on the seafloor to catch deep-dwelling fish like cod and halibut.
- Many lines, however, can hook sea turtles, sharks and seabirds that are also attracted to the bait.
- By sinking loglines deeper or using different hooks, fishermen can reduce the bycatch problem.

7.Midwater Trawl

- Midwater trawlers vary in size—from small ships to large factory vessels.
- Large industrial ships pull gigantic nets through the open ocean and can catch an entire school of fish—spanning the size of five football fields—at once.
- These trawls don't impact the seafloor when used in the midwater zone.
- Setting these trawls on schooling fish using streamer lines to scare away seabirds and avoiding areas with an abundance of marine mammals can help ensure low levels of bycatch in midwater trawl fisheries.

8.Pole/Troll

- fishermen use a fishing pole and bait to target a variety of fish ranging from open-ocean swimmers, like tuna and mahi mahi, to bottom-dwellers, like cod.
- Pole/troll fishing methods have very low bycatch rates because fishermen catch one fish at a time and can release unwanted species when they're caught.



9.Purse Seining

- Purse seining establishes a large wall of netting to encircle schools of fish.
- Fishermen pull the bottom of the netting closed—like a drawstring purse—to herd fish into the center.
- This method is used to catch schooling fish, such as sardines, or species that gather to spawn, such as squid.
- There are several types of purse seines and, depending on which is used, some can catch other animals (such as when tuna seines are intentionally set on schools of dolphins)

10.Seine Net

- A seine is a small-meshed net, suspended vertically in the water with floats and weights to enclose and concentrate fish. Beach (or haul). seines are dragged over the bottom into shallow water or onto the beach, either by hand or with power winches.
- Danish, Scottish and Japanese seines are typically larger gears pulled by vessels.
- They're deployed over soft sediment, like sand or mud, as the cloud of sediment helps herd the fish into the net.

11.Traps and Pots

- Traps and pots are submerged wire or wood cages that attract fish with bait and hold them alive until fishermen return to haul in the catch.
- Traps and pots are usually placed on the ocean bottom, often to catch lobsters, crabs, shrimp, sablefish and Pacific cod.
- They generally have lower unintended catch and less seafloor impact than mobile gear like trawls.

12.Trolling

- This hook-and-line method of fishing tows lines behind or alongside a boat, catching species, such as salmon, mahi mahi and albacore tuna, that follow a moving lure or bait.
- Fishermen can quickly release unwanted catch from their hooks since lines are reeled in soon after a fish takes the bait. This selective method of fishing results in very low bycatch levels.

Trolling

Other Fishing Methods

- Devices and techniques used with different fishing gears to improve the catch efficiency. These are mentioned below.

1. Light is used to attract fishes in many fisheries but mostly used with purse seining, beach seining during dark ether directly by attracting the fish or indirectly by eliminating the prey organisms
2. FADS (Fishing aggregating device) are also commonly used in some areas to aggregate fish. These can consists of anchored rafts of logs or other materials and act as artificial habitats that will attract fish and other organisms over time and hence create good fishing spot that can be exploited by different gears
3. Explosives(dynamite)will stupefy fish ,some of which will float to the surface and can be picked by hand but it is destructive method that can kill many fish than caught
4. Different chemicals can also be used in the same way. Rotenone (poison derived from plants) is one of best known chemicals that stupefy fish, mainly in fresh water system. similar to explosives this method kills many fish and other organisms than harvested

Fisheries and Aquaculture (Biol.3092)

Last Lecture

May,2019

Lecture Contents

1. Ecological /Environmental Requirements of some fish
2. Sustainable Exploitation of Fisheries Resources
3. Methods of Fish Preservation
4. Types of Fish marketing
5. Types of Fish Marketing
6. Benefits From Fisheries
7. Status And Potentials Of Ethiopia's Fishery Resources

1.Ecological /Environmental Requirements of some fish

a) Optimal Temperature:

- Various species and strains of tilapia differ in tolerance to low temperatures, but growth is poor at water temperatures below 16^{O}C and death occurs from temperatures below 12^{O}C.
- Most will not feed or grow at water temperatures below 15^{o}C and will not spawn below 20^{O}C.
- The normal water temperature should be between 20 to 30^{o}C. Higher temperatures will result to fish death.

b) Optimal Dissolved Oxygen (DO):

- Tilapias are able to tolerate low levels of dissolved oxygen.
- Usually, well fertilized ponds will have low levels of oxygen early in the morning.
- Night activities are dominated by respiration and decomposition which reduce DO. Larger fish are less tolerant than juveniles.
- This could be due to the difference in their metabolic demand.
- The optimal DO for tilapia culture is 4 mg/litre (50%) and should not go below 2.3 mg/litre.

c) Salinity

- All tilapia are tolerant to brackish water. The Nile tilapia is the least saline tolerant of the commercially important species, but grows well at salinities of up to *15 ppt.* The Blue tilapia grows well in brackish water up to *20 ppt salinity,* and the Mozambique tilapia grows well at salinities near or at full strength seawater.

d) pH

- pH refers to hydrogen ion concentration levels. Tilapia can survive in pH ranging from 5 to 10 but do best in a pH range of *6 to 9.*

e) Ammonia

- Massive tilapia mortality will occur within a few days when the fish are suddenly exposed to water with unionized ammonia concentrations greater than 2 mg/L. Prolonged exposure (several weeks) to un-ionized ammonia concentration greater than *1 mg/L causes deaths,* especially among fry and juveniles in water with low DO concentration.

f) Nitrite

- Nitrite is toxic to many fish and chloride ions reduce the toxicity. Tilapias are more tolerant to nitrite than many cultured freshwater fish. In general, for freshwater culture the nitrite concentration should be kept below 27 mg/L.

3. SUSTAINABLE EXPLOITATION OF FISHERIES RESOURCES

- Ensuring sustainable fisheries exploitation is a sole job of fisheries management.
- Overfishing, i.e. fishing beyond the maximum sustainable yield, is the major threat that has caused the natural or capture fisheries to peak off in most of the natural water bodies
- Maximum sustainable yield in fisheries may be defined as the level at which fisheries resources can be exploited without exhausting them.
- This is demonstrated in a simple fishery bio economic model given in next figure
- Any fishing effort exerted up to the point of the maximum sustainable yield (MSY) is biologically sustainable. In contrast, any fishing effort that goes beyond the MSY is unsustainable.
- As fishing effort is increased beyond the MSY, production starts to decline indicating that any fishing activity beyond the MSY causes the fishery resources to exhaust

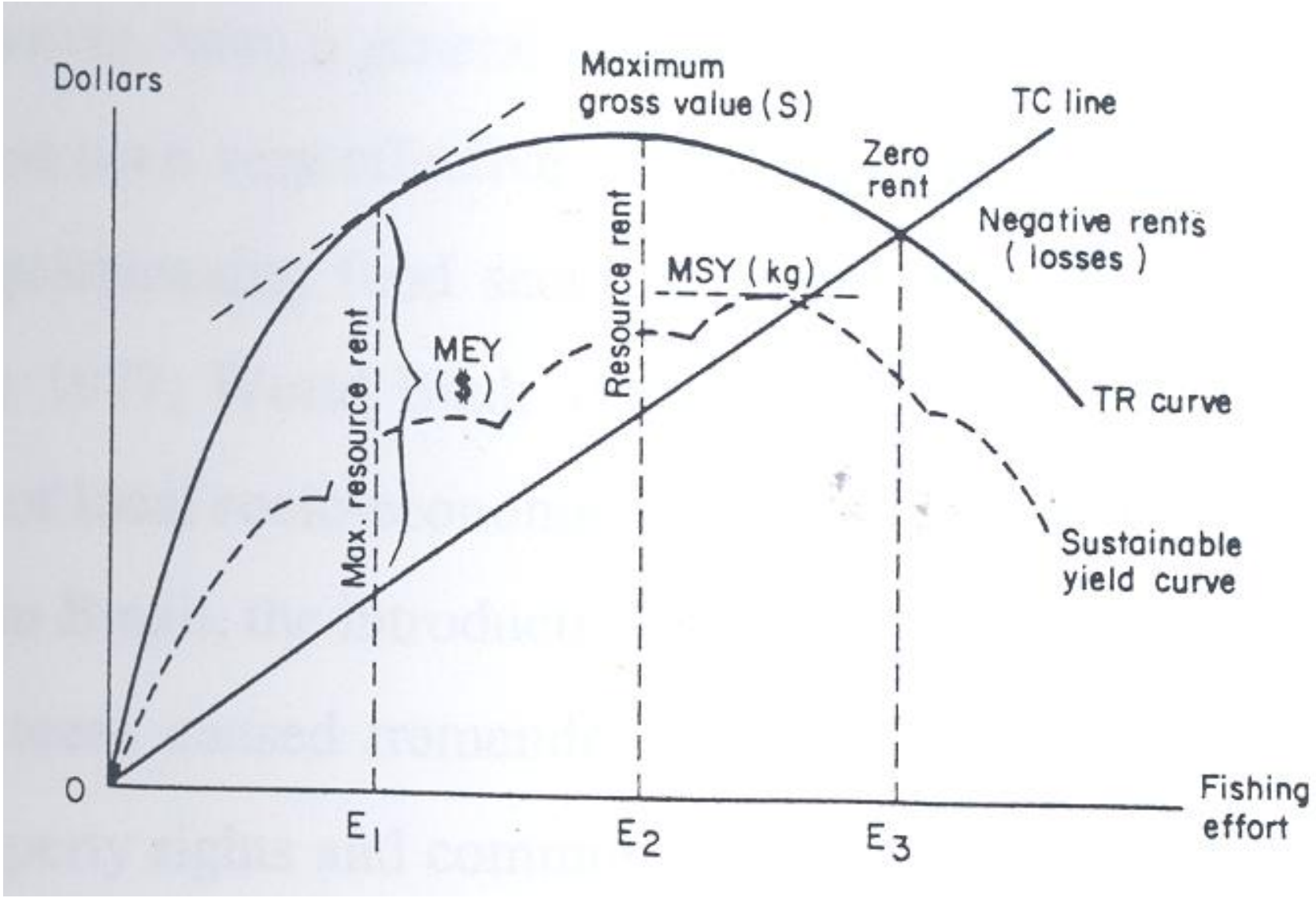


Figure : The bio economic model for fisheries management (Source, Panayotou, 1982)

Fish Preservation Methods

INTRODUCTION

- Fish is a major source of protein and its harvesting, handling, processing and distribution provide
- Livelihood for millions of people as well as providing foreign exchange earning too many countries.
- Appropriate processing of fish enables maximal use of raw material and production of value-added products which is obviously the basis of processing profitability.
- Fish processing, like the processing of the other food raw materials should: assure best possible market quality, provide a proper form of semi-processed final product, assure health safety of products, apply the most appropriate processing method and reduce wastes to the best possible extent.

- The development of appropriate fishing machinery and techniques that employed effective production, handling, harvesting, processing and storage cannot be over emphasized specially in the age when aquaculture development is fast gathering.

- Fish processing is the processing of fish and other seafood's delivered by fisheries, which are the supplier of the fish products industry.
- Although the term refers specifically to fish, in practice it is extended to cover all aquatic organisms harvested for commercial purposes, whether harvested from cultured or wild stocks.

- Fish processing may be subdivided into two major categories: fish handling (which is initial processing of raw fish) and fish products manufacturing.

- Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces chilled, frozen and canned products for the retail and catering trades.

- Fish processing can take place aboard fishing and fish processing vessels, and at fish processing plants

CHARACTERISTIC OF FISH IN THE FRESH STATE

- It is very important to know the quality of fresh fish so as to know when spoilage sets in
- **Color**: in the fresh state, fish color is bright, shiny and iridescent or lustrous (capable of reflecting different color).When spoilage sets in; the color is dull, dirty yellow or brown.
- **Skin texture**: the skin of a fresh fish is firm and elastic. Under spoilage, the skin becomes dry, slack, swollen and inelastic.
- **Eyes:** the eyes of a fish are bright, clear with bulging eye balls. The pupils are black brilliant and the cornea is white and bright. When spoilt, the eye is dull, shrinks and sinks in to the eye socket and the pupil becomes cloudy and milky; the cornea becomes opaque**.**

- **Gills:** the gills of a fresh fish are bright red or pink in colour; the colour changes to dark red or brownish when spoilt.
- **Flesh:** in the fresh state, the flesh of a fish is “firm”. As spoilage sets in, the flesh becomes gradually soften and when completely spoilt, it can strip of the backbone and exude juice when slightly pressed. It may even leave finger impressions.
- **Mucous**: the mucous coating on the sin of fresh fish is transparent, free floating and is like a lubricant. In a spoilt fish, the mucous is slimy, becomes thick. Sometimes the colour becomes whitish or creamy in colour and it is no longer transparent.
- **Smell/odour**: Fresh fish is said to have a fresh sea-weedy smell. The colour of spoilt fish is sour, bad and offensive. Spoilt fish is said to have “Off odour/flavour”.

Proper steps in handling fresh fish

1. Avoid exposing the fish to sunlight. Keep them in a shaded area.
2. Ice the fish immediately after they are caught to lower their temperature.
3. Remove the gills and internal organs.
4. Avoid soaking the fish too long in the water after death as this easily spoils the fish.
5. Use mechanical refrigeration if there are facilities.

Types of Preservation Methods

- If fish is not sold fresh, preservation methods should be applied to extend shelf-life.
- These include freezing, smoking, drying and heat treatment (Sterilization, pasteurization, etc).
- Efficient preparation of fish is important when top quality, maximum yield and highest possible profits are to be achieved. Whenever fish must be kept for several hours or longer before being consumed, they must be treated in some way to prevent spoiling. Below are basic means for preserving fish:

1. Cooling and icing
2. Pastes and sauces

1. Air drying and smoking

1. Kiln drying
2. Canning

1.Cooling and icing

- The first and simplest method to both preserve and process fish is to keep it cool. Cool fish keeps Longer than uncooled fish, although both will spoil in a matter of hours Salting

2.Pastes and sauces

- In areas where a rice diet predominates, a number of fermented fish products have been developed. If a fairly fixed procedure is followed, the product has a more or less consistent flavor and texture. In areas in which dried or salted fish is impractical because of the high humidity and temperature, fermented sauces or pastes may be an acceptable or preferable alternative.

Fish sauces

Small, ungutted fish are mixed with salt and sealed in vats or pots.

Pastes

- Fish paste are made from cleaned fish, which is mixed with salt and allowed to digest. Sometimes fermented rice, roasted grains, or bran are added

3.Air drying and smoking

- Even the most heavily salted fish will begin to spoil after a few weeks at warm temperatures. Some additional processing is required to preserve fish in any but the coldest climates.
- Moreover, although salt alone will protect against the growth of some bacteria, salt-loving bacteria continue to flourish.
- A combination of salt and reduced moisture, or salt and no air, will allow fish to be kept for several years. Bacterial activity ceases when the moisture content is reduced below about 25 percent
- Smoking dries the fish, and also adds bactericides that are present in the smoke.
- The process varies from a mild cure that will keep several weeks if chilled, to a hard smoke that will keep indefinitely if not moistened.
- Dry may be conventional(traditional) or improved solar drier like solar tent shown in next picture

Solar tent

Dried filleted fish

4.Kiln drying

- Kiln or oven or tunnel drying of fish is a more complex process, and the final product is much more palatable than natural air dried fish

5.Canning

- The bottling and canning of fish requires more precision and expense than the afore mentioned methods of preservation.
- Many nations during their lean fishing seasons import large amounts of canned fish to supply a source of protein

3.Types of Fish marketing

- Fisheries products are the world's most widely traded foods, with commerce dominated by developing countries.
- The total value of world capture fisheries production in 2009 was US$93.9 billion, a value greater than the global combined net exports of rice, coffee, sugar, and tea.
- Fisheries are globally important sources of much needed high quality animal protein — the primary protein source for 1.5 billion people worldwide and an important part of the diet of many more.
- Fisheries is also the largest extractive use of wildlife in the world, posing major threats to marine, coastal, and freshwater ecosystems around the world, and the sustainability of the sector itself.

- In spite of fisheries' important role in the national and local economies of many developing countries, the sector is often poorly planned and regulated, inadequately funded, and neglected by all levels of government.
- Globally, fisheries are frequently overfished and overexploited as a result of weak governance, poor management, perverse subsidies, corruption, and unrestricted access.
- In addition, destructive fishing practices can rapidly degrade marine ecosystems and contribute to the loss of critical habitats and species.
- The declining state of fisheries resources will have disproportionately heavy consequences for developing countries and their poorest members.
- A recent World Bank study indicates that the fisheries sector is losing an estimated US$50 billion annually in lost revenues due to poor management and from illegal, unreported, and unregulated (IUU) fishing. In small-scale fisheries, fishing is a household livelihood where men, women, and even children play roles in capturing, processing, and marketing the product

6.TYPES OF FISH MARKETING

- The fish marketing in Ethiopia is mainly for local consumption and most of the fishing marketing is practiced in unorganized form by individual traders involved different market actors mentioned below.
- **Retailers*:*** These are usually retailing whole fish at landing sites from fishermen or nearby destination sites accessible to road from local assemblers to larger urban areas.
- **Processor Retailers*:*** There are two types.
- The first are retailing gutted or filleted wet fish in all area and dried on far apart areas for households for further processing. The second groups are hotels and restaurants participating at the end level of processing both wet and dried fish for final consumers.

Processor and wholesalers

- These are processing and wholesaling whole fish or processed fish to exporters, retailers, domestic large farm investors, hotels and restaurants.
- They accessed the fish from fishermen, local assemblers or cooperatives.
- **Processor wholesaler and exporters*:*** These are similar to the above but they also export dried fish in traditional way or modern way using refrigerators to Sudan and other Arabian countries.

- **Large farm owner investors*:*** These are two types having large size farms either in areas like Humera , Wolkaite and Armacheho domestically or Sudanese in Gedarif.
- They purchase dried fish and give to employed laborers on their farm.

Consumers*:* These can be classified in to three with varying degree of dried fish and fresh fish consumption. `

A. Local communities*:* These are consumers of dried fish and fresh fish either from their catch or nearby market centers. Consumption of dried fishing except small sized *Labeobarbus , Garra spp* and other small barbus in rivers for different ceremonial purpose ,in some areas for Wedding

B.Employed laborers/Farmers*:* These are either Ethiopian or Sudanese employees/laborers working on large farms during peak seasons of harvesting in Sudan and weeding and harvesting in Ethiopia.

C. Hotel and restaurant customer consumers*:* These are in all urban centers of the surrounding for processed wet fish and some hotels and restaurants of some far areas like Wolkaite, Humera and Armacheho for dried fish.

- Fisheries marketing in organized way are practicing by Ethiopian Fisheries Production and Marketing Corporation (FPMC), collecting fishes from different lakes (Tana, rift valley) and River (Baro in Gambela Region).
- This organization has a license to export fish in frozen form to Sudan and other Arabian countries.
- The fishes sold by this corporation are mainly Tilapia, Catfish, *Labeobarbus*, Nile perch and Bagrus dockmac

7.BENEFITS FROM FISHERIES

- Fishery (plural: fisheries) is an organized effort by humans to catch fish or other aquatic species, an activity known as fishing.
- Generally, a fishery exists for the purpose of providing human food, although other aims are possible (such as sport or recreational fishing), or obtaining ornamental fish or fish products such as fish oil.
- Industrial fisheries are fisheries where the catch is not intended for direct human consumption
- The values of industrial or large scale commercial fishing extend beyond the food, income and employment benefits generated at the subsistence or artisanal fishing scale.
- The fishes caught through industrial fishing are processed into various products for export to international market in order to generate income that contributes to the national Gross Domestic Product (GDP).
- Moreover, the development of recreational fishing attracts tourists and thus generates a tourism industry which will also add to the national economy.

Fishery has employment opportunities for

- Field Investigator/Field demonstrator/ Village coordinator.
- Farm Manager.
- Laboratory Assistant in aqua farms, hatcheries and processing plants.
- Field marketing Assistant.
- Seed production Assistant.
- Farm storage Assistant.
- Jobs in fishery co-operatives.
- Opportunities in State Fishery Department.
- Fishery input Supplier.
- Seed producer.
- Fish producer.

- Fish can make a unique contribution to efforts to improve and diversify dietary intakes and promote nutritional well-being among most population groups.
- Fish have a highly desirable nutrient profile providing an excellent source of high quality animal protein that is easily digestible and of high biological value.
- Fatty fish, in particular, are an extremely rich source of essential fatty acids, including omega-3 polyunsaturated fatty acids (PUFAs), so important for normal growth and mental development, especially during pregnancy and early childhood.
- Fish are also rich in vitamins and minerals (especially calcium, phosphorus, iron, selenium and iodine in marine products).
- Fish therefore can provide an important source of nutrients particularly for those whose diets are monotonous and lacking in animal products.
- Increasing the availability of fish in the diet increases palatability and leads to increased consumption of a range of foods thereby improving overall food and nutrient intakes.

FOOD SECURITY AND NUTRITION

- Fisheries products are the world's most widely traded foods.
- Fish is a significant source of protein, essential amino acids, and vitamins in the diet of 2.6 billion people around the globe.
- In some countries, fish supply more than half of the animal protein in the average diet.
- In poor and marginalized groups living along coasts and inland waterways, fish is often the staple food.
- Even in small quantities, fish improve dietary quality by contributing essential amino acids often missing or underrepresented in vegetable-based diets.
- Fish is more than just an alternative source of animal protein.

- Fish oils are the richest source of omega 3 fatty acids that are vital to normal brain development in unborn babies and infants. Without adequate amounts of these fatty acids, normal brain development does not take place.
- For this reason, traditional infant formulas are often based upon wild fish.
- Fish are also an excellent source of vitamins like riboflavin (Vitamin B2), Vitamin A, Vitamin D, which prevents osteoporosis, and is a great source of necessary minerals such as calcium, iron, zinc, and potassium, and other important components of a healthy diet.

- As the world population grows, the demand for protein will increase, causing subsequent impacts on fisheries and aquaculture.
- For capture fisheries, increasing demand could drive prices higher and place additional pressures on this natural resource.
- Global and local food security will be achieved only through effective management of both capture fisheries and aquaculture. Such an approach is vital, especially in communities where fish is the main source of protein.

- Capture fishing is the largest extractive use of wildlife in the world, and one of the largest uses of an ecosystem “good.”

- It is a critical source of protein and livelihood, employing over 40 million fishers in Africa alone, and representing more than 20 percent of the animal protein in the diet of 2.6 billion people.
- In developing countries, where the vast majority of fishing communities and fishers are located ,fishing is uniquely important to livelihoods, food security, and poverty alleviation.

8. STATUS AND POTENTIALS OF ETHIOPIA'S FISHERY RESOURCES

INTRODUCTION

- Before 50 years ago, fisheries had insignificant role in the Ethiopian economy due to abundant land-based resources and a sparse population density.
- But, starting from the 1940s and 50s, the rapid population growth, which resulted in a shortage of cultivable land and depletion of land resources, forced the people to look for other occupations and sources of food from water resources at a subsistence level.
- Also, the rapidly growing demand for fish in the capital city by foreigners and modern town dwellers contributed to the start of commercial fishing as a new practice in Rift Valley lakes (from the 1950s) and, later, in Lake Tana (late 1980s).

Fisheries and aquaculture in Ethiopia

- Ethiopia has more than 200 fish species
- Average fishery potential is about 95,000 tones (EFASA, 2017)

S.No	Water body type	Area in KM2	Production in tonnes
1	Major lakes	7740	37346-41117
2	Major dams	1447	7698-8059
3	Small water bodies	4450	25678-26314
4	Rivers		18855-23954
5	sum		89577-99504

CAPTURE FISHERY POTENTIAL

- Ethiopia depends on the inland waters for the supply of fish as a cheap source of animal protein. It has a number of lakes and rivers with substantial quantity of fish stocks.
- Most of the lakes are located in the Ethiopian Rift Valley depression, which is part of the Great East African Rift Valley system.
- However, Lake Tana, the largest lake in the country and the source of the Blue Nile River is located in the northwest plateau outside the Rift Valley Lakes and rivers are stocked with various species of fish.
- One of the primary tangible benefits which water can offer is the living asset fish stocks.
- Fishing activities contribute directly to human welfare, for example, by providing source food (animal protein), which is urgently needed particularly by the poor rural population.
- Almost 120 thousand km^2 of the total land constitutes water and water courses, which may be exploited for fisheries directly or through enhancement.

- Under-exploitation of existing fisheries potential contained in the natural water bodies of the country is a great concern.
- Even if the available stocks of these fishery waters will be fully exploited in the near future, both current and future demand for fish by the population cannot be met.

- In the country, small to large size man-made water bodies have been and will continue to be built for drinking water supply, hydropower generation, irrigation and fisheries.
- Therefore the capture fishery in Ethiopia is more significant than aquaculture.

AQUACULTURE

- Even the country has suitable condition, soil and water, Aquaculture in Ethiopia is in its infant stage due to lack of trained manpower and facilities.
- Aquaculture prospects on an extensive scale seem considerable when viewed in the light of the high priority given to water harvesting, and from the physical suitability of the country for the best known cultured species.
- In addition, availability of agricultural residues and industrial by-products for feed seems to support small-scale commercial aquaculture.
- Commercial aquaculture for export seems promising.
- Looking at these possibilities, the government is planning to introduce in particular rural aquaculture as part and parcel of rural development strategies.
- However, systematic assessment of the technical and socio-economic potentials of aquaculture remains to be addressed, as does the acquisition of appropriate aquaculture production technologies, through either research or transfer.

- There are some efforts done by Sebeta National and Bahir Dar regional Fishery research centers in semi-intensive and extensive form of aquaculture in selected areas in North Shewas and East Gojjam on tilapia and common carp farming.
- The common carp growth rate in Gozamn fish pond was very interesting indicating that carp farming in fish pond is advisable for farmers involved integrated fish farming in rural areas.

Research

- The responsibility for research in fisheries and living aquatic resources lies with the Fish and Other Living Aquatic Resources Research Centre within the Ethiopian Agricultural Research Organization.

- Some regional states have their own agricultural research organization, but only three regions, Amhara, Oromia and Southern Nation Nationalities have organized fishery research centers.
- Universities mainly Addis Ababa University undertake basic research in fisheries.
- However, most of the research carried out in the past has been fragmented and academic, with limited relevance for practical fisheries development and management.

MAIN THREATS TO THE FISH DIVERSITY IN ETHIOPIA

- Problems related to water deficiency and water quality, over fishing and Introduction of exotic fish species are main threats in fish diversity of Ethiopia.

1 .Problems related to water deficiency and water quality

- Being located in arid zone of sub Sahara Africa and surrounding partly covered by several deserts.
- The country obviously faces water deficiency; from time to time this deficiency is enforced by dry periods in course of long term climate oscillation.
- Thus many water bodies and aquatic ecosystem within the limit of the country exists under unstable condition of precipitation and underground supply.
- This is exemplified by drying of Rivers like and lakes and continues shrinking of lakes Abijata ,Chamo,Tana ,Hayq(Logo)etc

2.OVER-FISHING

- It is not possible to speak out quantitatively without catch effort data, but it is possible to tell qualitatively.
- Commercial fisheries in two basins have been declined in 1980s and 1990s.
- It was possible to observe very effective fishing with beach seines at Baro and Gilo Rivers in the Gambela region.
- By mid 1990s this fishing was mostly terminated because of the depleting of fish stocks.
- In late 1980s and 1990s, the gillnet fisheries flourished first in lake Chamo then in Lake Abaya but they have deteriorated because of depleting fish stocks.

3 .INTRODUCTION OF EXOTIC FISH SPECIES

- The introduction of exotic fish species is often considered the cheapest and technically easiest to increase recourse to fisheries in natural or human made water bodies, however; introduction of exotic fish species has negative effect in the following way.
- Sometimes an introduction of one species may result in unpredictable disastrous change in the whole aquatic ecosystem, exemplified by introduction of Nile perch in Lake Victoria.
- Very frequently an introduced fish species may cause some negative effects on population of the indigenous fish species via predation and completion.
- With the purposeful particular introduction of some species, occasionally transfer of alien parasites and pest organisms occurs simultaneously.

4. Invasive Aquatic plants

- Those there are many macrophytes
- Water hyacinth is the worst
- **Water hyacinth-*Eichhornia crassipes* (Mart.)**

- **1st recorded-in 1824 by von Martius**
- **perennial monocot plant**
- **used for ornament**
- **fast sexual & asexual reproductive rate**
- **forms dense & interlocking mats due to complex root structure**
- **seeds survive up to 30 years, being a source of**

Water hyacinth in Lake Tana

- Research on water hyacinth's effects on water quality has focused mainly on the consequences of the dense mats formed by the interlocking of individual plants.

❑ Impact of the Water hyacinths on water bodies

- lower phytoplankton productivity
- Reduce DO concentrations beneath mats.
- Hinders transportation
- Damage feeding and breeding habitats of fishes and Birds
- Generally affects water quality and quantity
- Can change Aquatic ecosystem to upland