

COMPETENCE BASED CURRICULUM
SENIOR SCHOOL GRADE 10

MARINE TECHNOLOGY NOTES



1.1 Fundamentals of Marine and Freshwater Fisheries

1.1.1 Importance of Studying Aquatic Environments

Understanding aquatic environments is crucial for various **career, business, research, and conservation opportunities**:

A. Career Opportunities:

- **Fisheries Officer** - Monitor fishing activities, enforce regulations, and advise on sustainable fishing.
- **Aquaculture Technician** - Manage fish farms, water quality, and feeding practices.
- **Marine Biologist** - Study marine species, ecosystems, and conservation strategies.
- **Fish Processor** - Handle fish cleaning, smoking, canning, and packaging.
- **Fishery Entrepreneur** - Start businesses in fish farming, feed production, and trade.
- **Environmental Consultant** - Advise on environmental impacts of fishing and aquaculture.

B. Business and Economic Opportunities:

- Fish farming (freshwater tilapia, catfish, shrimp farming in coastal areas).
- Fish processing and packaging for domestic and international markets.
- Fish export and import trade (e.g., Nile perch, tuna, prawns).
- Boat and fishing gear rentals.
- Fish feed production (pellets, natural feeds).
- Eco-tourism: snorkeling, diving, recreational fishing tours.

C. Research and Innovation:

- Discover and classify new fish species.
- Improve breeding techniques (hormonal induction, selective breeding).
- Develop sustainable fishing gear to reduce bycatch.
- Innovate fish storage, cooling, and processing technology.
- Study fish behavior and migration patterns.

D. Conservation and Sustainability:

- Protect endangered and threatened fish species (coelacanth, sharks, seahorses).

- Maintain water quality in rivers, lakes, and oceans.
- Preserve coral reefs, seagrass beds, mangroves, and estuaries.
- Promote responsible fishing methods and aquaculture practices.

Practical Activities:

- Visit landing sites, docks, and fish markets to observe species and market dynamics.
- Visit fish farms (ponds, cages, tanks) to observe aquaculture techniques.
- Use smartphones, tablets, and computers to research fish species, habitats, and economic uses.
- Conduct family and peer awareness campaigns on the importance of aquatic ecosystems.
- Collect water samples to test pH, salinity, and oxygen levels.

1.1.2 Types of Aquatic Environments

A. Marine Fisheries

- **Definition:** Fisheries that exploit fish and other aquatic resources in oceans and seas.
- **Physical Characteristics:**
 - ⊙ High salinity (30-35 ppt).
 - ⊙ Large water volume and depth.
 - ⊙ Strong tidal movements and currents.
- **Habitats:** Coral reefs, seagrass beds, mangroves, sandy shores, deep-sea areas, and open ocean.
- **Species Diversity:** Cod, tuna, mackerel, lobsters, shrimps, sardines, groupers.
- **Opportunities:**
 - ⊙ Commercial fishing.
 - ⊙ Marine aquaculture (cage culture for salmon, tilapia in seawater).
 - ⊙ Eco-tourism and marine conservation programs.
- **Examples of Marine Species:**
 - ⊙ **Fish:** Tuna, mackerel, sardines, cod, snapper, grouper.
 - ⊙ **Shellfish:** Lobsters, crabs, shrimps, clams, oysters.

B. Freshwater Fisheries

- **Definition:** Fisheries that exploit fish and aquatic life in rivers, lakes, dams, and ponds.
- **Physical Characteristics:**
 - ⊙ Low salinity (<1 ppt).
 - ⊙ Shallower than marine environments.
 - ⊙ Water flow can be stagnant (ponds) or flowing (rivers/streams).
- **Habitats:** Rivers, lakes, ponds, reservoirs, dams, swamps.
- **Species Diversity:** Nile tilapia, catfish, trout, perch, carp, eels.
- **Opportunities:**
 - ⊙ Pond fish farming.
 - ⊙ Cage culture in lakes and dams.
 - ⊙ Recreational fisheries (sport fishing, angling).
- **Examples of Freshwater Species:**
 - ⊙ Tilapia, catfish, trout, carp, perch, eels, mudfish.

1.1.3 Basic Characteristics of Aquatic Environments

Environment	Physical Characteristics	Chemical Characteristics	Biological Characteristics
Marine	High salinity (30-35 ppt), waves, tides, large depth	High dissolved oxygen near surface, nutrients in estuaries, variable pH	Coral reefs, fish shoals, plankton, shellfish, marine mammals (dolphins, whales)
Freshwater	Low salinity (<1 ppt), variable flow (rivers/streams), lakes may be stratified	Dissolved oxygen, pH varies, low salt content, nutrient availability	Aquatic plants (water lilies, reeds), freshwater fish (tilapia, catfish), amphibians, insects, mollusks

Observation Tips:

- Use field guides to identify species in rivers, lakes, or marine areas.
- Record water temperature, clarity, and pH during practical exercises.
- Use video clips and documentaries to observe coral reefs, mangroves, and estuaries.

- Compare species diversity between marine and freshwater systems.

1.1.4 Ecosystems in Aquatic Environments

A. Marine Ecosystems

1. Coral Reefs

- ⊙ Biodiversity hotspots with over 25% of marine species.
- ⊙ Provide shelter and breeding grounds for fish.
- ⊙ Threats: Pollution, coral bleaching, overfishing.

2. Seagrass Beds

- ⊙ Nurseries for juvenile fish and crustaceans.
- ⊙ Help in sediment stabilization and coastal protection.

3. Mangroves

- ⊙ Trees growing in brackish water.
- ⊙ Nursery grounds for prawns, crabs, and small fish.
- ⊙ Protect coastal areas from erosion.

4. Estuaries

- ⊙ Where rivers meet the sea; mix of salt and freshwater.
- ⊙ Nutrient-rich; supports high fish productivity.
- ⊙ Example: Lamu, Tana River estuary.

B. Freshwater Ecosystems

1. Rivers and Streams

- ⊙ Flowing water; oxygen-rich.
- ⊙ Supports species like catfish, trout, and tilapia.

2. Lakes and Ponds

- ⊙ Still or slow-moving water.
- ⊙ Stratification affects oxygen levels.

- ⊙ Tilapia, carp, perch, and eels thrive here.

3. Reservoirs/Dams

- ⊙ Artificial lakes for water storage.
- ⊙ Support aquaculture initiatives and hydroelectric power.
- ⊙ Can be used for cage culture of tilapia or catfish.

1.1.5 Appreciation of Aquatic Ecosystems

Importance of Aquatic Ecosystems:

- Maintain ecological balance and water cycles.
- Provide food and livelihoods for millions.
- Support biodiversity and endangered species.
- Regulate climate and purify water naturally.

Human Activities to Promote Sustainability:

- Avoid overfishing and illegal fishing methods.
- Reduce water pollution (industrial, agricultural, domestic).
- Plant mangroves and restore seagrass beds.
- Use sustainable aquaculture methods.
- Participate in community fish conservation projects.

1.1.6 Practical Learning Methods

- **Field Visits:**
 - ⊙ Fish landing sites, farms, processing factories, mangrove sites.
- **Digital Research:**
 - ⊙ Online databases (FishBase, FAO), YouTube educational videos, scientific articles.
- **Experiments:**
 - ⊙ Observe water quality (pH, turbidity, temperature).

- ⊙ Identify fish species using guides or keys.
- ⊙ Compare species diversity across habitats.
- **Community Engagement:**
 - ⊙ Career talks in schools.
 - ⊙ Awareness campaigns on fish conservation.
 - ⊙ Organize clean-up of rivers and lakes.

1.1.7 Examples of Career and Business Opportunities in Fisheries

A. Careers:

- Marine biologist, aquaculture officer, fisheries inspector.
- Fish processing plant manager, environmental consultant.
- Fisheries researcher, sustainable aquaculture technician.

B. Business:

- Fish farming: Tilapia, catfish, shrimp, prawns.
- Fish feed production (pellets, natural feeds).
- Fish packaging, smoking, and export.
- Eco-tourism: snorkeling, diving, reef tours.

C. Research and Innovation:

- Fish genetics and selective breeding.
- Sustainable aquaculture technology (cages, tanks, recirculating systems).
- Fish disease management and prevention.
- Development of efficient fish storage and transportation systems.

Summary

- Studying marine and freshwater fisheries helps learners identify career and business opportunities.
- Marine ecosystems include coral reefs, mangroves, seagrass beds, estuaries, and open oceans.

- Freshwater ecosystems include rivers, lakes, ponds, and reservoirs.
- Understanding physical, chemical, and biological characteristics of water bodies is key to sustainable fisheries management.
- Hands-on activities, field visits, and digital research enhance practical skills, ecological appreciation, and career awareness.

1.2 Practical Project: Study of Fish Species and Aquatic Ecosystems

Project “Investigation of Fish Diversity and Water Quality in Local Aquatic Ecosystems”

Materials Required:

- Field guides for fish identification
- Fishing nets, traps, or small fish collection kits
- Transparent containers for temporary fish observation
- Thermometer (water temperature)
- pH meter or pH test strips
- Turbidity tube or water clarity kit
- Salinity meter (for brackish or marine sites)
- Notebook and pen for recording observations
- Camera or smartphone for photographing fish and habitats
- Gloves and protective clothing

Methodology / Procedure:

1. Site Selection:

- ⊙ Choose a local water body: river, lake, pond, dam, or marine site (coast).
- ⊙ Note GPS location, size, and habitat type.

2. Observation of Physical Characteristics:

- ⊙ Measure water temperature at different points.
- ⊙ Record water clarity using a turbidity tube or Secchi disk.
- ⊙ Note water depth and flow patterns.

3. Chemical Analysis:

- ⊙ Test water pH and record values.
- ⊙ Measure dissolved oxygen if equipment is available.
- ⊙ For marine/brackish water, measure salinity levels.

4. Collection and Identification of Fish Species:

- ⊙ Use nets, traps, or local fishers' catches.
- ⊙ Observe fish using field guides or apps.
- ⊙ Record species name, number of individuals, size, and behavior.
- ⊙ Release fish back safely after observation if required.

5. Ecosystem Observation:

- ⊙ Record presence of aquatic plants, invertebrates, and other wildlife.
- ⊙ Note human activities impacting the ecosystem (pollution, fishing, agriculture).

6. Data Recording and Analysis:

- ⊙ Tabulate water quality parameters and fish species diversity.
- ⊙ Compare findings with known tolerances of species (e.g., trout need high oxygen).
- ⊙ Identify species richness and abundance.

7. Reporting:

- ⊙ Prepare a report including:
 - Introduction (purpose of study)
 - Methods and materials
 - Observations (tables, graphs, photos)
 - Analysis and discussion
 - Recommendations for conservation and sustainable use

Expected Outcomes:

- Identification of **at least 5-10 fish species** in freshwater, or 10-15 species in marine environments.

- Data tables for water quality parameters (pH, temperature, turbidity, salinity).
- Understanding of the link between water quality and fish diversity.
- Recommendations for improving fish habitats and conservation efforts.
- Development of practical skills in fish identification, water analysis, and ecosystem observation.

Assessment Criteria:

Criteria	Marks
Completeness of observations and data	15
Accuracy of fish identification	15
Correct measurement of water quality parameters	15
Analysis and interpretation of results	20
Recommendations and sustainability measures	15
Presentation (neatness, tables, diagrams, photos)	20

Total Marks: 100

1.1 Morphology and Anatomy of Fish

1.1.1 What is Fish Morphology and Anatomy?

- **Morphology:** Study of the form, shape, and external structures of fish.
 - Focuses on features such as fins, scales, mouth, and body shape.
- **Anatomy:** Study of the internal structures of fish such as organs, skeletal system, and internal systems.
- **Importance of Morphology and Anatomy:**
 1. Identifies different fish species for research and fisheries.
 2. Explains how fish adapt to feeding, movement, and habitat.
 3. Helps in aquaculture management (e.g., selecting suitable species for fish farms).
 4. Provides insight into evolutionary adaptations of fish.

1.1.2 External Morphology of Fish

Key Features, Descriptions, Functions, and Examples:

Feature	Description	Function/Adaptation	Examples
Eyes	Usually on the sides of the head	Detect movement, light, predators; adapted to low-light conditions	Nile perch, catfish, lanternfish (deep sea)
Scales	Hard covering; types include ctenoid, cycloid, placoid, ganoid	Reduce friction in water, protect against injury and parasites	Tilapia (ctenoid), shark (placoid), gar (ganoid)
Fins	Appendages for movement; types: dorsal, pectoral, pelvic, caudal, anal	Swimming, balance, steering, propulsion	Tuna (strong caudal fin for speed), catfish (pectoral fins for stability)
Mouth	Position: upturned, terminal, downturned; teeth type varies	Adapted to feeding habits: carnivorous, herbivorous, omnivorous	Shark (carnivorous), Tilapia (herbivorous), catfish (omnivorous)
Operculum	Bony flap covering gills	Protects gills; pumps water over gills	Tilapia, Nile perch

Lateral Line	Sensory organ along the side of the body	Detects vibrations, water currents, predators, and prey	Most fish: tilapia, catfish
Barbels	Whisker-like sensory organs	Detect food in murky water	Catfish, carp
Body Shape	Streamlined, flattened, elongated, or fusiform	Streamlined for speed; flattened for bottom-dwelling; elongated for hiding in crevices	Tuna (streamlined), flounder (flattened), eel (elongated)

Additional Notes:

- Some fish like mudskippers have modified fins to move on land temporarily.
- Coloration can also be part of external morphology, helping in camouflage or mating.

1.1.3 Internal Morphology of Fish

Organ/System	Description	Function/Adaptation	Examples
Gills	Feathery structures on sides of head	Gas exchange: absorb oxygen, release CO_2	All fish
Swim Bladder	Gas-filled sac	Maintains buoyancy; allows vertical movement; absent in sharks	Tilapia, Nile perch; absent in sharks
Heart	Two-chambered (atrium + ventricle)	Pumps blood through gills to body	All fish
Digestive System	Mouth → esophagus → stomach → intestines → anus	Digestion and absorption; length varies by diet	Carnivorous fish: shorter intestines; Herbivorous: longer intestines
Kidneys	Filter blood	Osmoregulation; maintain water/salt balance	Marine fish excrete salt; freshwater excrete excess water
Liver	Produces bile, stores fat/glycogen	Aids digestion, energy storage	All fish
Skeleton	Internal bony or cartilaginous structures	Support, protection, shape	Tilapia (bony), shark (cartilaginous)

Additional Features:

- Brain and sensory organs: detect food, mates, and threats.
- Gonads: reproductive organs; location varies in species.
- Some species have specialized organs, e.g., electric organs in electric fish.

1.1.4 Comparison of Bony and Cartilaginous Fish

Feature	Bony Fish (Osteichthyes)	Cartilaginous Fish (Chondrichthyes)	Examples
Skeleton	Made of bone	Made of cartilage	Tilapia vs Shark
Scales	Ctenoid or cycloid	Placoid	Tilapia vs Shark
Swim Bladder	Present	Absent	Tuna vs Shark
Gill Cover	Operculum present	No operculum; gill slits open	Tilapia vs Shark
Reproduction	Mostly oviparous	Ovoviviparous or oviparous	Tilapia vs Shark
Teeth	Fixed to jaw	Replaceable rows	Tilapia vs Shark

Note: Morphology reflects adaptations to habitat, feeding, and movement.

1.1.5 Adaptations of Morphology and Anatomy

1. Eyes:

- ⊙ Large in deep-sea fish for low light (e.g., lanternfish).
- ⊙ Lateral placement helps detect predators.

2. Mouth Type:

- ⊙ Uprturned: surface feeders (tilapia fry).
- ⊙ Terminal: midwater feeders (Nile perch).
- ⊙ Downturned: bottom feeders (catfish).

3. Fins:

- ⊙ Pectoral fins: steering and stability.
- ⊙ Caudal fins: propulsion and speed.
- ⊙ Dorsal and anal fins: prevent rolling.

4. Scales and Skin:

- ⊙ Protect against predators, parasites, friction.
- ⊙ Some fish have slime coating for protection and reduced friction.

5. Body Shape:

- ⊙ Streamlined for fast swimmers (tuna).
- ⊙ Flattened for bottom dwellers (flounder).
- ⊙ Elongated for hiding (eels).

1.1.6 Measuring and Counting External Features

- **Length Measurement:** Snout tip → tail fin tip.
- **Weight Measurement:** Using digital or spring balance.
- **Counting External Features:**
 - ⊙ Dorsal fins, caudal fin, anal fins, pelvic fins, pectoral fins.
 - ⊙ Opercula (usually 2).
 - ⊙ Barbels (if present: 2-6).

Practical Tips:

- Use common fish like tilapia, catfish, or Nile perch.
- Handle fish carefully; some may have spines or sharp fins.
- Record observations in tables for comparison.

1.1.7 Activities for Learners

1. Field Observation:

- ⊙ Visit landing sites, rivers, ponds, or fish farms.
- ⊙ Observe and sketch fish, noting body shape, fins, and scales.

2. Poster Creation:

- ⊙ Draw, color, and label external and internal structures.

3. Practical Measurements:

- ⊙ Measure length, weight, fin counts, and barbel numbers.

4. Digital Learning:

- ⊙ Research bony vs cartilaginous fish adaptations online.

5. Discussion & Presentation:

- ⊙ How morphology aids in feeding, protection, and habitat adaptation.

6. Group Project:

- ⊙ Compare three species of fish from different habitats.
- ⊙ Record data in a table: length, fins, scales, mouth type, swim bladder presence.
- ⊙ Present findings to class with diagrams.

1.1.8 Suggested Fish for Study

Bony Fish:

- Tilapia, Nile perch, Tuna, Carp, Catfish

Cartilaginous Fish:

- Shark (great white, hammerhead), Rays, Skates

Special Examples:

- Electric fish: electric organ adaptation
- Mudskippers: fin adaptation for land movement

1.1.9 Sample Project for Learners

Title: "Comparison of Morphology and Anatomy in Bony and Cartilaginous Fish"

Objectives:

- Identify differences in external and internal features.
- Understand how morphology aids adaptation.

Materials:

- Fish specimens (or models), measuring tape, balance, drawing sheets, rulers.

Procedure:

1. Observe and sketch external morphology.
2. Count fins, barbels, opercula.
3. Measure length and weight.

4. Research internal anatomy (heart, gills, swim bladder, digestive system).
5. Compare results between bony and cartilaginous fish.
6. Present findings with charts and diagrams.

Expected Outcome:

- Learners understand functional adaptations of fish.
- Improved observational, analytical, and presentation skills.

1.1.10 Summary

- **Morphology:** External features - eyes, mouth, fins, scales, operculum, lateral line, barbels.
- **Anatomy:** Internal organs - gills, swim bladder, heart, liver, digestive system, kidneys.
- **Bony vs Cartilaginous Fish:** Differences in skeleton, scales, swim bladder, gill cover, teeth, and reproduction.
- **Adaptations:** Morphology and anatomy reflect habitat, feeding, protection, and movement.
- **Practical Skills:** Observation, measurement, counting, sketching, and poster creation help learners appreciate diversity.

2.0 Aquaculture

2.1 Fundamentals of Aquaculture

2.1.1 What is Aquaculture?

Definition:

Aquaculture is the **controlled farming of aquatic organisms** such as fish, crustaceans, mollusks, and aquatic plants under managed conditions for human use.

Purpose of Aquaculture:

1. **Increase food production** - provides high-quality protein and essential nutrients.
2. **Provide employment opportunities** - creates jobs in farming, processing, marketing, and distribution.
3. **Generate income and boost the economy** - fish and aquatic products can be sold locally and exported.
4. **Promote sustainable use of aquatic resources** - reduces pressure on wild fish populations, prevents overfishing.
5. **Enhance research and technology** - encourages innovation in feed, breeding, and water management.

Types of Aquatic Organisms Farmed:

- **Fish:** Tilapia, catfish, Nile perch, carp, trout
- **Crustaceans:** Prawns, shrimps, crabs
- **Mollusks:** Oysters, clams, mussels
- **Aquatic Plants:** Seaweed (e.g., *Kappaphycus*, *Gracilaria*), water lettuce

Practical Tip:

- Visit **fish farms, hatcheries, and aquaculture centers** to observe operations firsthand.
- Record **species cultivated, feeding schedules, and pond management practices**.

Additional Examples:

- Carp in ponds for food production.
- Tilapia fingerlings sold to local farmers for stocking.
- Seaweed cultivation along the Kenyan coast (Lamu, Kilifi).

2.1.2 Types of Aquaculture Systems

Aquaculture systems differ by intensity, input, and stocking density.

System Type	Description	Advantages	Disadvantages	Examples in Kenya
Extensive	Fish grown in natural water bodies with minimal input.	Low cost, simple, low labor	Low yield, growth depends on natural conditions	Lake Victoria (tilapia), small earthen ponds
Semi-Intensive	Fish reared in ponds or cages with moderate input (feeding, fertilization).	Higher yields than extensive, manageable	Moderate cost, disease risk	Tilapia ponds, cage culture in Lake Victoria
Intensive	High stocking density with full feeding, water management, aeration.	Maximum yield, efficient production	High cost, requires technical skills, high disease risk	Recirculating tanks, commercial ponds with aerators

Other Systems:

- **Cage Culture:** Fish in cages in lakes, rivers, or sea (e.g., Nile tilapia in Lake Victoria).
- **Tank Culture:** Concrete or plastic tanks with controlled feeding and water quality (e.g., trout hatcheries in Kenyan highlands).
- **Integrated Aquaculture:** Combining fish farming with crops or livestock (fish-cum-duck, fish-cum-vegetables).
- **Recirculating Aquaculture Systems (RAS):** High-tech tanks with water filtration and recycling (used in urban fish farms).

Additional Notes:

- Pond fertilization improves natural food (plankton) production.
- Aeration in tanks ensures oxygen supply for intensive farming.
- Rotational harvesting can improve sustainability.

Activity:

- Draw diagrams of **extensive, semi-intensive, and intensive systems**. Label feeding methods, stocking density, and water management techniques.

2.1.3 Economic Importance of Aquaculture

1. Food Security:

- Provides **high-quality protein** for humans.
- Reduces **dependence on wild fish**, preventing overfishing.
- Examples: Tilapia, catfish, carp in local diets.

2. Employment and Income Generation:

- Jobs in **fish farms, feed production, hatcheries, and processing plants**.
- Supports side businesses: **boat building, net making, transportation of fish**.
- Examples: Kisumu and Mombasa fish processing plants.

3. Revenue for Government:

- Licensing fees and taxes from aquaculture businesses.
- Fish exports generate **foreign exchange**.

4. Industrial Development:

- Fish feed manufacturing, packaging, cold storage, fish oil, and fishmeal production.
- Promotes **small-scale and commercial aquaculture industries**.

5. Research and Innovation:

- Development of **new fish breeds**, better feeding systems, and disease control methods.
- Supports aquaculture programs in **schools, universities, and communities**.

6. Environmental Benefits:

- Reduces pressure on wild fish stocks.
- Integrated systems improve water and land use efficiency.

Activities:

- Start a **small fish pond or tank** at school for learning and demonstration.
- Sell **fingerlings** to local farmers.
- Grow **seaweed** and document growth stages.

2.1.4 Challenges Facing Aquaculture in Kenya

Challenge	Description	Possible Solutions	Examples
High Feed Costs	Commercial feeds make up 60–70% of production costs	Use local ingredients: maize, soybean, cottonseed, rice bran	Tilapia feed formulations in Bungoma ponds
Poor Water Quality	Pollution, low oxygen, poor management affect fish health	Regular monitoring, aeration, pond fertilization	Caged tilapia in Lake Victoria
Diseases and Parasites	Bacterial, fungal, and parasitic infections	Vaccination, quarantine, good hygiene	Aeromonas infection in tilapia ponds
Limited Technical Skills	Farmers lack modern aquaculture knowledge	Training workshops, extension services	Farmer groups in Western Kenya
High Cost of Fingerlings	Small-scale farmers struggle to buy quality seed	Community hatcheries, government support	Tilapia hatcheries in Kisumu and Bungoma
Environmental Constraints	Climate change, drought, floods affect ponds	Diversify production systems, water harvesting	Pond culture during dry season

Additional Notes:

- Proper pond management reduces risk of **disease outbreaks**.
- Use of **organic fertilizers** can improve plankton production naturally.

Activity:

- Conduct a **case study** on a local fish farm to identify problems and suggest solutions.

2.1.5 Role of Aquaculture in National Economy

- Provides **employment and livelihoods**.
- Increases domestic fish production, reducing **imports**.
- Promotes **fish exports** (shrimp, tilapia, ornamental fish).
- Supports industrial development (processing plants, feed production).
- Encourages research and innovation in sustainable practices.

Examples in Kenya:

- Cage culture in Lake Victoria contributes significantly to food security.
- Commercial shrimp farms in Lamu and Tana River generate export income.

Activity:

- Prepare a **report on economic contribution of aquaculture** in Kenya. Include employment, revenue, and export data.

2.1.6 Practical Activities for Learners

1. Field Visits:

- Observe ponds, cages, and tanks.
- Record **species, feeding schedules, pond management practices.**

2. Research Using Digital Media:

- Compare extensive, semi-intensive, and intensive systems.
- Explore the impact of aquaculture on **food security and the economy.**

3. Group Activities:

- Debate the **benefits and challenges of aquaculture in Kenya.**
- Create **posters or infographics** on types of aquaculture systems.

4. Brainstorming Exercises:

- Identify local challenges affecting aquaculture.
- Suggest **innovative solutions** for improving fish production.

5. Practical Projects:

- Set up a **small school pond** and document fish growth.
- Develop a **fish feed from local ingredients** and test its effectiveness.
- Grow **seaweed or small crustaceans** as a mini-project.

2.1.7 Examples of Fish and Aquatic Organisms in Aquaculture

Organism	System Used	Economic Use	Examples in Kenya
Tilapia	Ponds, cages, tanks	Food, fingerling sales	<i>Oreochromis niloticus</i>
Catfish	Ponds, tanks	Food	<i>Clarias gariepinus</i>
Nile Perch	Cage culture in Lake Victoria	Export, food	<i>Lates niloticus</i>
Shrimp	Ponds, tanks	Export	<i>Penaeus spp</i>
Oysters	Coastal farming	Food, pearls	Mombasa coast
Seaweed	Longline culture in sea	Export, food	<i>Kappaphycus spp</i>
Trout	Cold water tanks	Food, fingerling sales	Rainbow trout in highlands

Additional Examples:

- Mussels farmed along Kenyan coast for local consumption.
- Crabs in brackish water ponds for local and export markets.

2.1.8 Summary

- **Aquaculture** is the controlled farming of aquatic organisms for food production, income, and economic development.
- **Systems include:** extensive, semi-intensive, intensive, cage culture, tank culture, integrated systems, and RAS.
- **Economic importance:** food security, employment, revenue, industrial development, research, and innovation.
- **Challenges:** high feed costs, water quality, diseases, limited technical knowledge, and environmental constraints.
- **Practical learning:** field visits, research, posters, debates, and small-scale projects.

Project for Learners

Title: *"Setting up a School Aquaculture Pond"*

Objective: Learn how to manage a small-scale fish farm.

Materials Needed:

- Pond liner or dug pond
- Tilapia fingerlings
- Fish feed (commercial or local mix)
- Water quality testing kits
- Nets and aeration devices

Activities:

1. Prepare the pond: clean, fill with water, add fertilizer if needed.
2. Stock the pond with **fingerlings**.
3. Feed daily and record growth.
4. Monitor water quality and manage pond health.
5. Harvest after 4-6 months and evaluate yield.

Expected Learning Outcomes:

- Understanding aquaculture systems and practices.
- Knowledge of fish growth, feeding, and pond management.
- Practical skills in **fish farming as a business**.

2.2 Aquaculture Production Systems

2.2.1 Introduction to Fish Production Systems

Definition:

Fish production systems are **methods used to culture or rear fish under controlled conditions** to maximize production, maintain fish health, and ensure sustainability.

Purpose of Fish Production Systems:

1. **Maximize fish production** - provide consistent, high-quality fish for food and sale.
2. **Ensure sustainable use of resources** - prevent overfishing and environmental degradation.
3. **Adapt production to local conditions** - consider climate, water availability, and economic capacity.

Factors Affecting Choice of Production System:

- **Availability of water** - rivers, lakes, ponds, rainfall, or tanks.
- **Type of fish species** - different fish require different environments (e.g., trout needs cold, clean water).
- **Capital investment** - intensive systems require more money.
- **Management skills** - skilled personnel needed for high-density systems.
- **Space and land availability** - intensive systems can be small, extensive systems need larger areas.

Activity:

- List all **fish species in your locality** and suggest the **most suitable production system** for each.

2.2.2 Types of Fish Production Systems

System Type	Description	Advantages	Disadvantages	Examples in Kenya
Pond Culture	Fish reared in earthen ponds with feeding and water management	Low cost, simple, suitable for small-scale and community farmers	Low control over water quality, affected by drought, predation possible	Tilapia, catfish, carp in earthen ponds
Cage Culture	Fish in cages or nets in natural water	High stocking density, uses existing water,	Water pollution risk, disease spread, predators, strong cage	Nile tilapia in Lake Victoria,

	bodies	easy to harvest	structures required	catfish cages
Tank Culture	Fish in concrete, plastic, or fiberglass tanks with feeding and aeration	Full control of environment, ideal for high-value fish, year-round production	High cost, requires technical skills	Trout tanks in highlands, ornamental fish farms
Raceways	Long narrow channels with continuous water flow	Constant oxygen supply, suitable for trout, high growth	Expensive construction, constant water required	Rainbow trout raceways in Kenya highlands
Pen Culture	Semi-enclosed area in natural water bodies with nets or barriers	Partial protection, suitable for juvenile fish	Risk of escape, limited control over water quality	Nile perch fingerlings in rivers/lakes

Additional Notes:

- Pond culture is ideal for **low-tech, community-level aquaculture**.
- Cage culture maximizes **space utilization in lakes** but requires careful monitoring.
- Tank and raceway systems are **high-tech**, suitable for commercial operations.
- Pen culture is often used as a **temporary nursery system** before transferring fish to ponds or cages.

Activity:

- Create a **comparison table** showing pond, cage, and tank culture based on **cost, labor, water requirement, and production output**.

2.2.3 How Different Systems Affect Fish Culturing

1. Pond Culture:

- Fish have **more space to swim**, reducing stress.
- Water quality can fluctuate with **rainfall, temperature, and evaporation**.
- Growth depends on **natural food + supplementary feed**.
- Moderate disease risk; predation by birds is possible.

2. Cage Culture:

- **High fish density** → careful feeding management required.
- Waste accumulation may affect **water quality**, aeration is not possible.
- Predators (birds, larger fish) may attack.
- Easy harvesting using nets.

3. Tank Culture:

- **Full control of water quality, temperature, and oxygen** → higher growth rate.
- Year-round production independent of seasons.
- Disease spreads quickly if monitoring is poor; requires good hygiene.

4. Raceways:

- Continuous water flow ensures **high oxygen levels**.
- Ideal for species requiring **cold, clean water** (e.g., trout).
- Requires regular maintenance and monitoring of water flow.

5. Pen Culture:

- Juvenile fish grow in **natural water bodies** with partial protection.
- Minimal feeding may reduce production compared to ponds/tanks.
- Easy observation, partial protection from predators.

Key Point:

The choice of production system **affects fish growth rate, survival, water quality, disease management, and economic return.**

Activity:

- Prepare a **poster showing advantages and disadvantages of each system.**
- Conduct a **class discussion**: "Which system is best for small-scale vs commercial fish farming?"

2.2.4 Practical Activities for Learners

1. Observation Visits:

- Visit **ponds, cages, tanks, raceways, and pens** in fish farms.

- Record: pond/cage size, stocking density, water management, feeding regimes.

2. Drawing and Labelling:

- Draw **simple diagrams** of each production system showing:
 - ⊙ Water source
 - ⊙ Fish enclosure (pond, tank, cage, pen)
 - ⊙ Feeding and aeration system
- Example: Pond system with **inlet, outlet, aerator, feeding points, and shade.**

3. Digital Research:

- Find **case studies of farms in Kenya.**
- Compare **growth rates and survival of fish in different production systems.**

4. Group Activity:

- Debate: "**Which system is best suited for your community?**"
- Prepare a **poster showing production system, advantages, and limitations.**

5. Practical Project Idea:

- Set up a **small model pond, tank, or cage** in school and monitor fish growth for 2-3 months.
- Record **daily feeding, water quality, and fish health.**

2.2.5 Illustrative Diagrams (for Drawing)

A. Pond Production System:

- Rectangular/square pond
- Water inlet at one end, outlet at other
- Fish stocked evenly
- Feeding area indicated
- Optional aerator in center
- Surrounding vegetation for shade

B. Cage Culture in Lake:

- Floating cages with mesh sides
- Anchored to shore
- Feeding platform on top
- Fish visible in cage
- Water circulation around cage

C. Tank Culture:

- Rectangular tanks in rows
- Water inlet and outlet
- Aeration system shown
- Fish stocked evenly
- Feeding point marked

D. Raceways:

- Long narrow channel
- Water flowing from upstream to downstream
- Fish stocked along channel
- Inlet and outlet gates marked

E. Pen Culture:

- Semi-enclosed area in river/lake
- Net boundaries shown
- Juvenile fish inside
- Feeding station indicated

Activity:

- Draw **all five production systems** and **label components clearly**.
- Include **feeding points, water flow direction, and aerators**.

2.2.6 Examples of Fish for Different Production Systems

Production System	Fish Species	Notes
Pond Culture	Tilapia, catfish, carp	Community and small-scale farmers
Cage Culture	Nile tilapia, Nile perch, catfish	Commercial in lakes
Tank Culture	Trout, ornamental fish, catfish	High-value, year-round production
Raceways	Rainbow trout, salmon	Cold water species, high oxygen requirement
Pen Culture	Juvenile tilapia, Nile perch fingerlings	Temporary rearing before transferring to ponds/cages

Additional Examples:

- Mussels in pen culture along the coast for commercial sale.
- Shrimp tanks for high-value export markets.

2.2.7 Advantages of Knowing Production Systems

- Choose the **right system** for **available resources**.
- Optimize **fish growth, survival, and production efficiency**.
- Reduce **disease risk and environmental damage**.
- Improve **economic returns** from fish farming.
- Encourage **sustainable use of aquatic ecosystems**.
- Helps in **planning large-scale commercial fish farms**.

Activity:

- Prepare a **case study** of a local fish farm showing how the choice of production system affected output, profit, and challenges.

2.2.8 Practical Project for Learners

Title: *"Design and Setup of a Small-Scale Fish Production System"*

Objective:

Learn to select, design, and manage a fish production system suitable for local conditions.

Materials:

- Small pond liner, plastic tanks, or cage materials
- Fish fingerlings (tilapia or catfish)
- Water quality testing kits
- Fish feed (commercial or homemade)
- Nets, aeration system (if available)

Steps:

1. Choose a system suitable for your resources (pond, tank, or cage).
2. Design and draw the **layout showing water inlet/outlet, feeding points, aeration, and fish stocking areas.**
3. Stock fingerlings and **feed daily.**
4. Record **growth, water quality, mortality, and feeding patterns.**
5. Evaluate **production efficiency and challenges** after 2-3 months.

Expected Learning Outcomes:

- Understanding of **fish production systems** and their management.
- Knowledge of **feeding, water quality, and growth monitoring.**
- Practical skills in **planning, observation, and reporting.**

Summary

- Fish production systems include **ponds, cages, tanks, raceways, and pens.**
- Each system has **advantages, limitations, and suitability** for certain species.
- The chosen system affects **fish growth, survival, water quality, and economic returns.**
- **Field visits, drawings, research, and practical projects** reinforce theoretical knowledge.
- Understanding production systems is essential for **sustainable and profitable aquaculture.**

2.3 Fish Pond

2.3.1 Factors to Consider When Selecting a Suitable Site for a Fish Pond

Choosing the right site is critical for **pond success, fish health, and high yield**.

Factor	Description	Importance / Effect on Pond
Water Availability	Adequate supply from river, spring, borehole, or rainwater	Ensures survival, good growth, and supports natural food production
Soil Type	Clay soils are ideal; sandy or loose soils are unsuitable	Clay retains water, preventing leakage; sandy soils risk water loss
Topography	Slightly sloping land preferred	Aids drainage, prevents flooding, and allows easy water outlet management
Accessibility	Easy access to roads, markets, and inputs	Reduces transport costs, facilitates sale of fish and supply delivery
Climate / Temperature	Moderate temperatures suitable for chosen species	Fish growth rate and metabolism depend on water temperature
Security	Protect pond from theft, animals, or vandalism	Ensures survival of fish and protects pond infrastructure
Cost of Land	Affordable for construction and possible expansion	Minimizes initial investment
Proximity to Inputs	Nearby availability of fingerlings, feeds, fertilizers, lime	Reduces operational costs and delays in pond management

Additional Notes:

- Avoid areas prone to flooding or contamination.
- Ensure water source is reliable year-round.
- Conduct **site soil testing** to check clay content and water retention capacity.

Practical Tip:

- Use a **site survey checklist** to assess water availability, soil type, slope, and accessibility.

Activity:

- Identify **three potential sites in your locality** suitable for a fish pond. Compare them based on water source, soil type, accessibility, and safety.

2.3.2 Types of Fish Ponds

Pond Type	Description	Advantages	Disadvantages	Examples
Earthen Pond	Dug directly in soil without lining	Low cost, simple to construct, suitable for communities	Water may leak in sandy soils; depends on rainfall	Tilapia, catfish ponds in rural Kenya
Earthen-Lined Pond	Earthen pond lined with clay or plastic sheet	Reduces water loss; suitable for semi-intensive farming	Higher cost than unlined ponds	Intensive tilapia culture ponds
Concrete / Artificial Pond	Made using concrete, bricks, or reinforced materials	Highly controlled environment; easy to clean; durable	Very high initial cost	Trout tanks in highlands, ornamental fish ponds
Wooden-Lined Pond	Earthen pond lined with wooden planks	Portable and temporary; suitable for school projects	Prone to rotting; high maintenance	School demonstration ponds or experimental ponds

Practical Activity:

- Visit **earthen and concrete ponds** nearby. Note **size, depth, lining, water source, and safety features**.

Additional Notes:

- **Earthen ponds** are ideal for low-cost community or school projects.
- **Concrete ponds** allow for intensive farming of high-value species like trout and ornamental fish.

2.3.3 Steps in Constructing a Simple Fish Pond

Step 1: Site Preparation

- Clear vegetation, rocks, and debris.
- Level the land if uneven.
- Mark boundaries using **pegs and strings**.

Step 2: Excavation

- Dig pond according to **required size and depth** (usually 1-2 meters).
- Slope pond sides gradually to **prevent fish escape** and allow easy harvesting.

Step 3: Lining the Pond (if required)

- Earthen pond: no lining needed.
- Earthen-lined pond: compact clay or plastic sheets to prevent leakage.
- Concrete pond: build walls and floors with **cement and reinforcement**.

Step 4: Water Filling

- Fill pond slowly to avoid soil erosion.
- Check for **leaks** and repair immediately.

Step 5: Fertilization and Liming

- **Liming:** Apply agricultural lime to adjust pH to 6.5-8 for optimal fish growth.
 - Example: 200 kg lime per 1000 m² pond.
- **Fertilization:** Add organic (manure) or inorganic fertilizers to boost **plankton and natural food** production.
 - Example: 20 kg chicken manure per 1000 m² pond.

Additional Tips:

- Test water for **pH, turbidity, and oxygen levels** before stocking.
- Ensure proper **water inlet and outlet structures** for management.

Activity:

- Prepare a **diagram showing pond construction steps**: site prep, excavation, lining, water filling, liming, and fertilization.

2.3.4 Stocking a Fish Pond

Stocking involves introducing **juvenile fish (fingerlings)** into a pond for growth.

Steps in Stocking:

1. Sourcing Fingerlings:

- Buy from **certified hatcheries** to ensure healthy stock.
- Common species: Nile tilapia, catfish, common carp.

2. Acclimatization:

- Float fingerling bags in pond for **30-60 minutes** to match water temperature.

- Gradually mix **small amounts of pond water** into the bag before release.

3. Stocking Density:

Pond Type	Recommended Density
Extensive	2-3 fish/m ²
Semi-intensive	4-6 fish/m ²
Intensive	8-10 fish/m ²

4. Post-Stocking Management:

- Observe fish for stress, disease, or mortality.
- Begin feeding **supplementary feeds** if natural food is insufficient.

Practical Tip:

- Handle fingerlings **gently** to prevent injury or death.
- Avoid overcrowding to reduce stress and disease risk.

Activity:

- Conduct a **mock stocking simulation** using small containers to practice acclimatization and gentle handling.

2.3.5 Fish Pond Management and Maintenance

Proper management ensures **high productivity, fish growth, and survival**.

Practice	Description	Example
Water Quality Control	Maintain pH 6.5-8, dissolved oxygen, temperature	Aeration, water exchange, shading
Feeding	Supplementary feed when natural food insufficient	Tilapia feed pellets, catfish formulated feed
Disease Control	Observe behavior, lesions; treat promptly	Approved antibiotics, herbal remedies; quarantine new fish
Predator Control	Protect fish from birds, snakes, and other predators	Nets, fences, guard measures
Weed	Remove excess aquatic weeds reducing	Manual removal or mechanical harvest

Management	oxygen	
Record Keeping	Log stocking, feeding, water quality, growth, and harvest	Helps plan future pond management
Harvesting	Partial or full harvest depending on production plan	Nets to collect fish at optimal size

Effects of Management Practices:

- Proper management → **higher survival, faster growth, increased yield.**
- Poor management → disease outbreaks, low productivity, economic losses.

Activity:

- Maintain a **weekly pond management log**: water quality, feeding, fish growth, and weed control.

2.3.6 Appreciation of Fish Pond as a Production System

- Fish ponds provide **controlled and sustainable fish production.**
- Contribute to **food security, income, and employment.**
- Serve as **practical learning tools** for students in aquaculture.
- Promote **responsible and sustainable use of aquatic resources.**

Example:

- School pond projects allow learners to practice **construction, stocking, feeding, water quality monitoring, and harvesting**, creating real-life experience.

Activity:

- Research the **impact of school fish ponds on student learning and local community nutrition.**

2.3.7 Practical Activities for Learners

1. Field Visits:

- Observe fish ponds: **earthen, lined, concrete, or wooden.**
- Record **size, depth, water source, stocking, and feeding practices.**

2. Group Project:

- Construct a **simple school pond.**
- Stock with fingerlings and manage for **3–6 months.**

- Monitor fish growth, water quality, and weed/predator control.

3. Research and Digital Learning:

- Watch videos or read articles on pond construction, liming, fertilization, and stocking techniques.

4. Poster / Presentation:

- Draw a **labeled diagram of a pond** showing water inlet, outlet, aerator, feeding area, and depth levels.

5. Observation Exercise:

- Compare growth rates of fish under **different pond types** (earthen, lined, concrete) and **record findings**.

2.3.8 Examples of Fish Stocked in Ponds

Species	Stocking Density	Notes
Tilapia	2-10 fish/m ²	Fast-growing, hardy, feeds on natural and supplementary food
Catfish (<i>Clarias gariepinus</i>)	2-6 fish/m ²	Bottom feeder, carnivorous, requires high protein feed
Common Carp	3-6 fish/m ²	Omnivorous, suitable for integrated farming with ducks
Rainbow Trout	4-6 fish/m ²	Cold water species, high-value, intensive management needed

Additional Notes:

- Adjust stocking density according to **pond size, system type, and water quality**.
- Overstocking may cause **low oxygen, stress, and disease outbreaks**.

2.3.9 Suggested Mini-Project for Learners

Title: "Design and Management of a Simple School Fish Pond"

Objective:

To develop practical skills in **pond construction, stocking, feeding, and maintenance**.

Materials:

- Earthen pond, clay or wooden lining, or small concrete pond
- Fish fingerlings (tilapia or catfish)
- Water quality testing kits
- Fish feed, lime, and fertilizers
- Nets, aeration devices (if available)

Activities:

1. Select a **suitable site** based on water, soil, and accessibility.
2. Construct pond using **earthen, lined, or concrete methods**.
3. Fill pond with water, apply **liming and fertilization**.
4. Stock with fingerlings following **acclimatization and proper density**.
5. Monitor **feeding, water quality, weed growth, predator protection, and disease**.
6. Harvest partially or fully after **3-6 months**, record **fish yield and growth rates**.

Learning Outcomes:

- Practical knowledge of pond construction and management.
- Skills in **stocking, feeding, water quality management, and harvesting**.
- Understanding of **economic and food security importance of ponds**.

Summary

- **Site selection:** Water availability, soil type, accessibility, and safety are critical.
- **Pond construction:** Includes excavation, lining (if needed), filling, liming, and fertilization.
- **Stocking:** Requires healthy fingerlings, acclimatization, and proper density.
- **Management:** Water quality control, feeding, disease and predator control, weed removal, and record keeping.
- **Importance:** Fish ponds are sustainable production systems supporting **food security, income, employment, and learning**.

3.0 Capture Fisheries –

3.1 Fundamentals of Capture Fisheries

3.1.1 What are Capture Fisheries?

- **Definition:** Capture fisheries refer to the **harvesting of naturally occurring fish and other aquatic organisms** from oceans, lakes, rivers, wetlands, and lagoons.
- **Purpose:**
 1. Provide **food and nutrition** for local and national consumption.
 2. Generate **livelihoods and employment** for fishing communities.
 3. Contribute to **national economy** through trade, exports, and industrial supply.
 4. Support **both industrial and small-scale fisheries** for economic diversity.
 5. Encourage **research, sustainable management, and aquaculture integration**.

Practical Activity:

- **Brainstorming Exercise:** "How does fishing in rivers, lakes, or the ocean contribute to our daily lives and the economy?"
 - © Examples: Fish sold at local markets, Nile perch exported to Europe, or tuna exported to Asia.

Additional Notes:

- Capture fisheries rely on **wild populations**, unlike aquaculture, which is controlled.
- Sustainable capture fisheries prevent **overfishing and depletion of species**.

3.1.2 Types of Capture Fisheries

Type	Description	Characteristics	Examples in Kenya
Industrial Fisheries	Large-scale commercial fishing using mechanized vessels and equipment	High capital investment, long-distance trips, large catch volume, mechanized gear	Trawlers targeting tuna in the Indian Ocean; Purse seiners for sardines
Artisanal / Small-Scale	Small boats, traditional methods, mostly	Low capital, labor-intensive, mostly local consumption	Canoes with gill nets, traps, and handlines on

Fisheries	nearshore		Lake Victoria or coastal areas
Recreational / Sport Fisheries	Fishing for leisure, sport, or competition	Small-scale, catch often released, personal consumption	Sport fishing for marlin, tuna, or tilapia in rivers, lakes, or offshore

Key Note:

- Capture fisheries classification depends on **vessel size, fishing gear, scale, and purpose.**

3.1.3 Types of Artisanal / Small-Scale Fisheries

1. Subsistence Fisheries

- Fish caught primarily for **household consumption.**
- Small boats or canoes; minimal mechanization.
- Example: Tilapia caught with gill nets on Lake Victoria for family consumption.

2. Commercial Small-Scale Fisheries

- Fish caught for **sale in local markets.**
- Moderate use of nets, traps, or longlines.
- Generates income for fisher and family.
- Example: Sea bream or snapper caught along the Kenyan coast for sale in Mombasa markets.

Common Artisanal Fishing Gear:

- **Gill nets:** Vertical mesh nets that entangle fish.
- **Longlines:** Mainline with baited hooks for large fish.
- **Traps / Fish pots:** Capture and hold fish until harvest.
- **Handlines:** Simple line with hook, used from shore or boat.
- **Seine nets:** Large nets dragged across shallow water to encircle fish.

Common Artisanal Fishing Vessels:

- Dugout canoes.
- Small wooden boats (dhows, outrigger canoes).
- Inflatable boats with small outboard motors.

Activity:

- Identify **all fishing gear types** in your local area.
- Make a **diagram showing different artisanal fishing vessels and gear**.

3.1.4 Importance of Capture Fisheries in the Kenyan Economy

Capture fisheries contribute to **food security, employment, industrial development, foreign exchange, tourism, and culture**.

Contribution	Explanation	Examples
Food Security	Provides affordable, high-protein food	Nile perch from Lake Victoria, tilapia in rivers, sardines along the coast
Employment	Supports millions directly and indirectly	Fishers, processors, boat builders, net makers, transporters
Revenue Generation	Taxes, licensing, and export earnings	Tuna exports to Europe and Asia; Nile perch export
Industrial Development	Raw material for processing industries	Fish canning plants in Kisumu and Mombasa
Recreation & Tourism	Sport fishing and coastal tourism	Marlin and tuna sport fishing in Watamu and Malindi
Cultural Importance	Preserves fishing practices, traditional knowledge	Luo communities on Lake Victoria; Swahili coastal communities

Additional Notes:

- Capture fisheries are a key part of **Kenya's blue economy**, supporting **livelihoods and national development**.
- Sustainable fishing ensures continued **economic benefits and biodiversity conservation**.

Activity:

- Debate: "Which is more important to Kenya: industrial fisheries or artisanal fisheries?"
- Research how **capture fisheries contribute to local and national GDP**.

3.1.5 Practical Activities for Learners

1. Field Visits:

- Visit fish landing sites: Kisumu (Lake Victoria), Malindi and Mombasa (coastal fisheries).
- Observe gear types, vessels, and fish species.
- Record daily catch, fish size, and fishing techniques.

2. Group Discussions:

- Compare artisanal and industrial fisheries.
- Discuss economic, social, and environmental importance of capture fisheries.

3. Research & Digital Learning:

- Use online resources to explore industrial and artisanal fishing practices.
- Watch videos on fish processing, landing site operations, and export logistics.

4. Awareness Campaign / Mini-Project:

- Sensitize peers or community on **sustainable fishing practices** and the importance of capture fisheries.

Activity Idea:

- Prepare a **poster showing gear types, fishing vessels, and target fish species in Kenya.**

3.1.6 Examples of Fish from Kenyan Capture Fisheries

Water Body	Common Species	Capture Method	Purpose
Lake Victoria	Nile perch, tilapia, mudfish	Gill nets, longlines	Export, local consumption
Indian Ocean (coast)	Tuna, kingfish, mackerel, snapper	Purse seine, longline, traps	Export, local consumption
Rivers (Tana, Athi)	Tilapia, catfish	Handlines, traps, gill nets	Local consumption
Lake Naivasha	Tilapia	Seine nets, small gill nets	Local markets

Coastal lagoons (Kiunga, Mida)	Crabs, shrimps, small fish	Traps, hand nets	Local consumption
--------------------------------	----------------------------	------------------	-------------------

Additional Notes:

- Capture methods vary depending on **species behavior, habitat, and water depth**.
- Sustainable capture involves **catch limits, closed seasons, and size restrictions**.

3.1.7 Project / Mini-Project for Learners

Title: *"Study of Artisanal Fishing Practices in My Community"*

Objectives:

- Identify **types of artisanal fisheries and gear**.
- Understand **economic, social, and cultural importance** of capture fisheries.
- Promote **awareness on sustainable practices**.

Materials:

- Notebook, camera, measuring tools, internet access.

Activities:

1. Visit a **local landing site**.
2. Record types of **vessels, gear, and fish species** caught.
3. Interview fishers about **catch volumes, markets, and challenges**.
4. Prepare a **report or presentation** highlighting findings.
5. Suggest **improvements for sustainable fishing** (gear modification, closed seasons, pollution control).

Learning Outcomes:

- Practical understanding of **artisanal fisheries and capture methods**.
- Awareness of **fishery management and economic significance**.
- Improved **research, observation, and presentation skills**.

3.1.8 Summary

- **Capture fisheries:** Harvest fish from natural habitats using vessels and gear.
- Types: **Industrial, artisanal, and recreational** fisheries.
- Artisanal fisheries are further divided into **subsistence** and **commercial small-scale** fisheries.
- Fishing gear: *Gill nets, longlines, traps, handlines, and seine nets.*
- Fisheries are important for **food security, employment, industrial supply, revenue, tourism, and culture.**
- Understanding capture fisheries is key for **sustainable management** and contribution to **Kenya's blue economy.**

Extra Activities / Homework

1. Draw a **map of Kenya showing major capture fisheries locations**, including Lake Victoria, Lake Naivasha, Indian Ocean coast, and rivers.
2. Prepare a **table of top 10 fish species in Kenya by economic importance.**
3. Conduct a **role play** simulating an artisanal fishing community and challenges they face.
4. Calculate the **potential yield from a small-scale artisanal fishing operation** using sample data.

3.2 Safety and Survival Techniques in Capture Fisheries

3.2.1 Types of Accidents and Their Causes on Fishing Vessels

Fishing is one of the most hazardous occupations due to exposure to **water, weather, equipment, and human errors**. Awareness of risks is the first step to safety.

Type of Accident	Description	Causes	Examples
Drowning	Death by submersion in water	Falling overboard, rough waters, lack of life jackets	Fisherman falling into Lake Victoria during stormy weather
Hypothermia	Dangerously low body temperature from prolonged water exposure	Cold water, wet clothing, extended time in water	Capsized boat in Indian Ocean in cold season
Sea Sickness / Motion Sickness	Nausea and vomiting caused by vessel movement	Rough seas, lack of acclimatization	Fisher feeling sick during stormy weather
Fire on Vessel	Uncontrolled fire onboard	Engine failure, fuel spillage, electrical faults	Engine room fire on a trawler
Collision / Grounding	Vessel hits rocks, reefs, or another vessel	Poor visibility, navigation errors	Small boat hitting reef near Lamu
Capsizing / Overturning	Vessel overturns due to waves or overloading	Overcrowding, rough seas, poor vessel design	Wooden canoe capsizing in Lake Naivasha
Engine or Mechanical Failure	Loss of propulsion or steering	Poor maintenance, fuel issues	Outboard motor failure in coastal fishing
Cuts / Injuries	Cuts from hooks, knives, nets, machinery	Carelessness, slippery deck, sharp tools	Fisherman cutting hand while gutting fish
Slips, Trips, Falls	Falling on deck or wet surfaces	Wet or uneven deck, poor footwear	Fisher slipping while moving nets

Additional Notes:

- Human error is a **leading cause** of accidents: fatigue, poor decision-making, and lack of training.
- Environmental factors: sudden storms, tides, strong currents, and high waves are common hazards.

Practical Tips:

- Conduct a **risk assessment** before departure.
- Brief all crew members on **hazards and emergency procedures**.
- Keep a **logbook of incidents** for continuous learning.

Activity:

- List **10 potential hazards** in your local fishing area and suggest ways to minimize each.

3.2.2 Safety Equipment Required on Fishing Vessels

Safety equipment prevents accidents and increases chances of survival during emergencies.

Equipment	Purpose	Examples / Notes
Life jackets / PFDs	Prevent drowning	One per crew member, properly fitted
Life raft / Lifeboat	Escape during vessel sinking	Inflatable rafts with capacity for all crew
Fire extinguisher	Control onboard fire	ABC type for all fire classes
First aid kit	Treat minor injuries	Include bandages, antiseptics, scissors, tweezers
VHF Radio	Emergency communication	Contact coastguard or other vessels
Flares / Signal Rockets	Alert rescuers	Red flares for day/night use
Whistle / Horn	Attract attention	Sound signals during emergencies
Life buoys / Throwing lines	Rescue people overboard	Buoyant rings with ropes attached
Emergency lights / Torches	Visibility in poor conditions	Waterproof preferred
Navigation lights	Avoid collision at night	Green/red lights for port/starboard side

Additional Notes:

- Inspect all safety equipment **before departure**.
- Replace **expired or damaged items** immediately.
- Ensure **crew training on proper use** of all equipment.

Practical Activity:

- Conduct a **safety equipment inspection drill** on a mock fishing vessel in school or community center.

3.2.3 Basic Survival Techniques in Aquatic Environments

Survival skills are essential for minimizing fatalities in emergencies.

Technique	Description	Practical Tips
Swimming Skills	Ability to swim or tread water	Practice front crawl, breaststroke, survival float
Floating / Treading Water	Conserve energy while awaiting rescue	Back float or survival float position
Use of Flotation Devices	Life jackets or buoyant objects	Always wear PFDs near water
Signaling for Help	Attract attention	Wave arms, use whistle, flare, mirror, or torch
Buddy System	Stay with another person	Prevent separation, panic, and exhaustion
Calmness / Energy Conservation	Avoid panic, conserve body heat	Float on back, breathe slowly
Group Survival in Life Raft	Maintain morale and ration resources	Share water, rotate rest, collect rainwater if possible
Safe Boarding Techniques	Enter or exit raft safely	Enter feet first, stabilize raft before boarding
Hypothermia Prevention	Minimize heat loss in water	Huddle with others, wear thermal clothing if available

Additional Notes:

- Always **practice survival techniques** in pools or controlled water environments under supervision.
- Knowledge of **local currents, tides, and weather** improves survival chances.

Activity:

- Simulate a **capsized boat scenario in a pool**, demonstrating floating, buddy system, and signaling.

3.2.4 Basic First Aid for Fishing-Related Injuries

Fishing can cause cuts, burns, fractures, hypothermia, and drowning-related injuries. Prompt first aid **reduces severity and prevents infections**.

Injury	First Aid Steps	Notes / Examples
Cuts / Lacerations	Wash with clean water, disinfect, bandage	Deep cuts may require professional care
Burns	Cool with clean water, cover with sterile dressing	Avoid applying oil or grease
Fractures / Broken Bones	Immobilize with splint or sling	Use sticks, boards, ropes if splint unavailable
Drowning / Near Drowning	Rescue, check breathing, perform CPR if needed	Seek medical attention immediately
Hypothermia	Move to dry area, cover with blanket, provide warm fluids	Avoid rapid warming if severe
Eye Injuries	Rinse with clean water, cover affected eye	Seek professional care for chemicals
Sprains / Strains	Rest, ice, compression, elevation (RICE)	Reduce movement until healed
Shock	Lay patient flat, elevate legs, keep warm	Maintain calm, monitor breathing

Improvisation Tips:

- Use **plastic bottles or empty containers** for flotation.
- **Ropes and sticks** can serve as splints.
- **Sand or wet cloth** can extinguish small fires temporarily.

Activity:

- Role-play a **first aid scenario** on deck using manikins or peers.

3.2.5 Appreciation of Safety and Survival Practices

- Safety practices **save lives** and reduce accidents.
- Survival skills increase **confidence during water emergencies**.
- First aid **prevents infection and accelerates recovery**.
- Following safety regulations is **legally required for all fishing vessels**.
- Promotes a **culture of safety** in fishing communities.

Practical Tip:

- Conduct **regular safety drills** before departure.
- Keep **incident and first aid logbooks** for review and training purposes.

3.2.6 Practical Activities for Learners

1. Safety Equipment Demonstration:

- ⊙ Identify life jackets, life rafts, fire extinguishers, VHF radio, flares, life buoys.
- ⊙ Demonstrate **proper usage and inspection techniques**.

2. Aquatic Survival Practice:

- ⊙ Practice swimming, floating, treading water, using life jackets.
- ⊙ Simulate **group survival in life rafts**.

3. First Aid Simulation:

- ⊙ Treat cuts, burns, fractures.
- ⊙ Practice CPR on manikins.
- ⊙ Improvise bandages and splints using cloth, sticks, or ropes.

4. Classroom Discussions and Digital Research:

- ⊙ Discuss real-life fishing accidents and lessons learned.
- ⊙ Watch video clips of **vessel emergencies, rescues, and survival techniques**.

5. Awareness Campaign / Mini-Project:

- ⊙ Prepare **posters or presentations** on fishing safety.

- © Sensitize peers and community on **life jacket use, emergency preparedness, and safe fishing practices.**

3.2.7 Examples of Safety in Fishing Environments

Scenario	Safety Measures
Stormy weather on Lake Victoria	Wear life jackets, stay in sheltered area, maintain communication
Capsized canoe	Float with life jackets, signal for help with whistle or hands
Fire in engine room	Use fire extinguisher, isolate fuel, call for help
Minor cut while gutting fish	Wash, disinfect, and bandage immediately
Crew member falls overboard	Throw life buoy, keep victim afloat, pull to safety
Overcrowded boat in coastal waters	Reduce load, distribute weight evenly, wear life jackets

3.2.8 Mini-Project / Assignment for Learners

Title: *"Safety Audit and Survival Simulation on Fishing Vessels"*

Objectives:

- Identify hazards on a fishing vessel.
- Demonstrate safety equipment usage.
- Practice survival techniques and basic first aid.

Materials Needed:

- Life jackets, flotation devices, manikins, first aid kit, rope, whistle, fire extinguisher.

Activities:

1. Conduct a **safety inspection** of a mock vessel.
2. Simulate **accident scenarios**: overboard, cuts, fire, capsizing.
3. Practice **survival techniques and first aid**.
4. Record **lessons learned and improvement recommendations**.

Learning Outcomes:

- Awareness of common hazards.
- Practical experience in **equipment use, emergency response, and first aid.**
- Enhanced safety culture and readiness for real-life fishing scenarios.

3.2.9 Summary

- Fishing is **high-risk**: drowning, hypothermia, accidents, and injuries are common.
- **Safety equipment** is essential: life jackets, rafts, VHF radios, flares, fire extinguishers, and first aid kits.
- **Survival techniques**: swimming, floating, signaling, buddy system, group survival increase survival chances.
- **First aid**: prompt response reduces injury severity and prevents complications.
- Safety and survival practices are **critical for a productive, healthy, and sustainable fishing environment.**
- Practical drills, simulations, and awareness campaigns improve **knowledge, readiness, and community safety.**