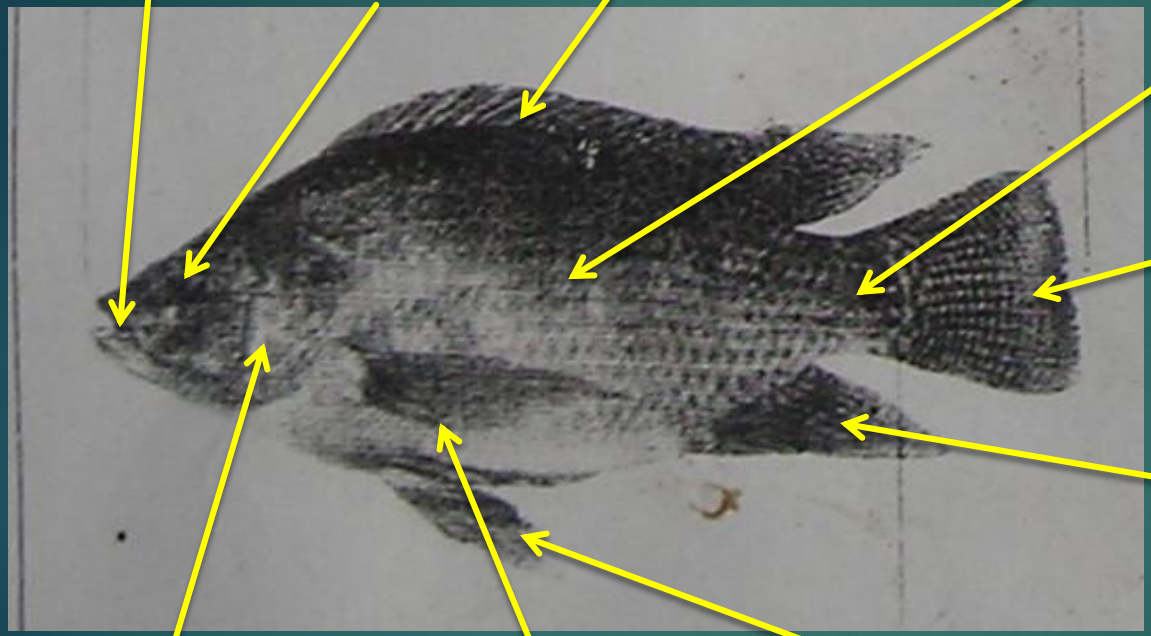
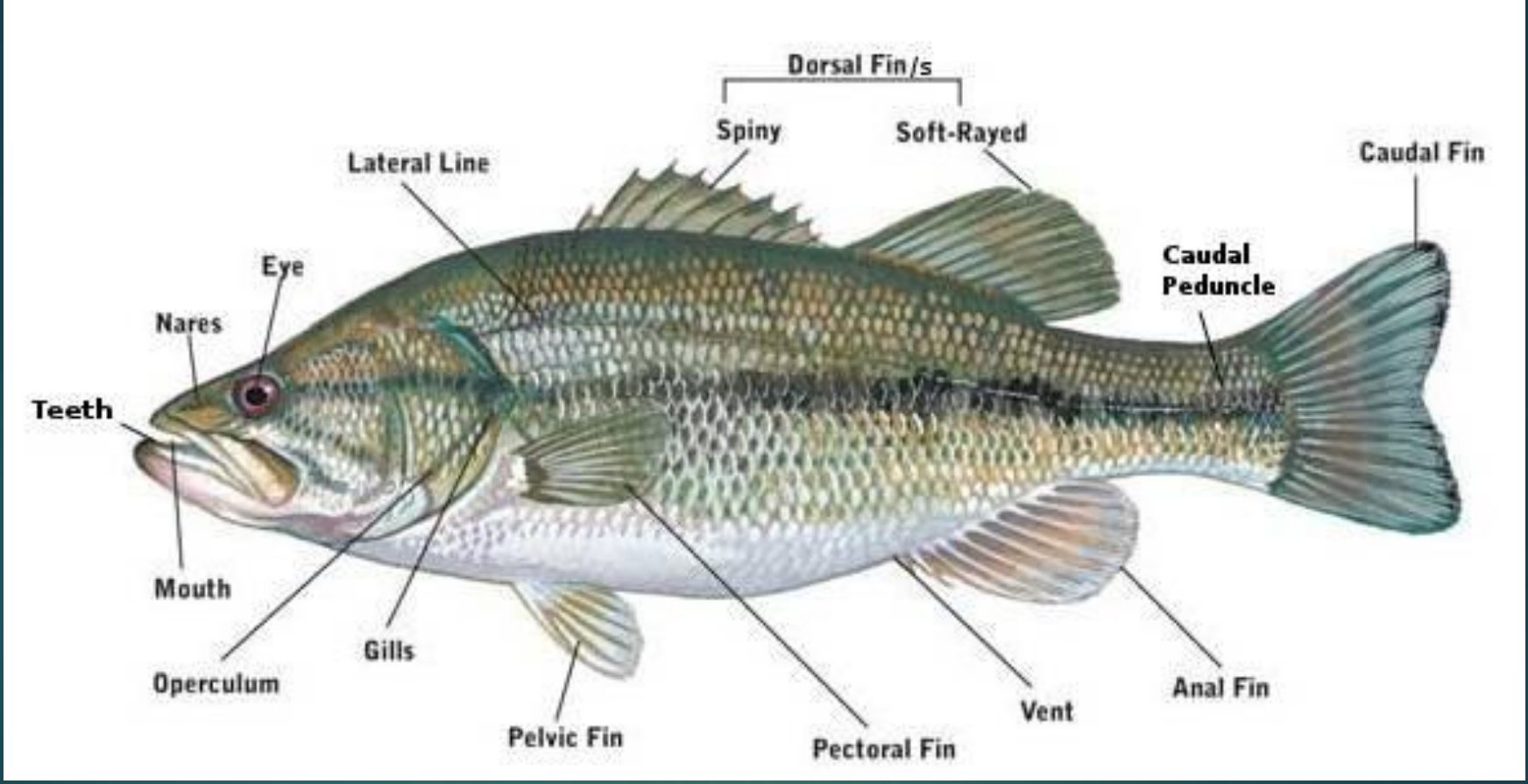
FISH CULTURE

FISH

- cold blooded animal
- gills
- fins
- backbone (vertebra)
- live in water

External parts of a bony fish





- Image Credit: Sandeep Raghuvanshi

- A fish is identified by its External Morphology.
- Morphology is a branch of science which deals with study of the form and features of any living organism.

The body of fish can be divided into two main parts:

- Head
- Body.

Head Region contains following parts:

- Snout.
- Lips.
- Mouth.
- Jaws.
- Teeth.
- Barbells.
- Nostrils.
- Eyes.
- Operculum/gills.
- Median groove.
- Pectoral girdle.
- Occipital process.

Body Region consists of following parts:

- Fins.
- Lateral Line.
- Skin.
- Scales.

Snout

- Snout is the anterior most part of the fish (forward end of head).
- It is rounded or obtuse in most cases.
  There can be many variations to the shape of snout
  - Pointed and Sharp
  - With a groove across the top.
  - Tubular with jaws at tip.
  - Smooth in most cases.
  - Overhanging the mouth.

Lips

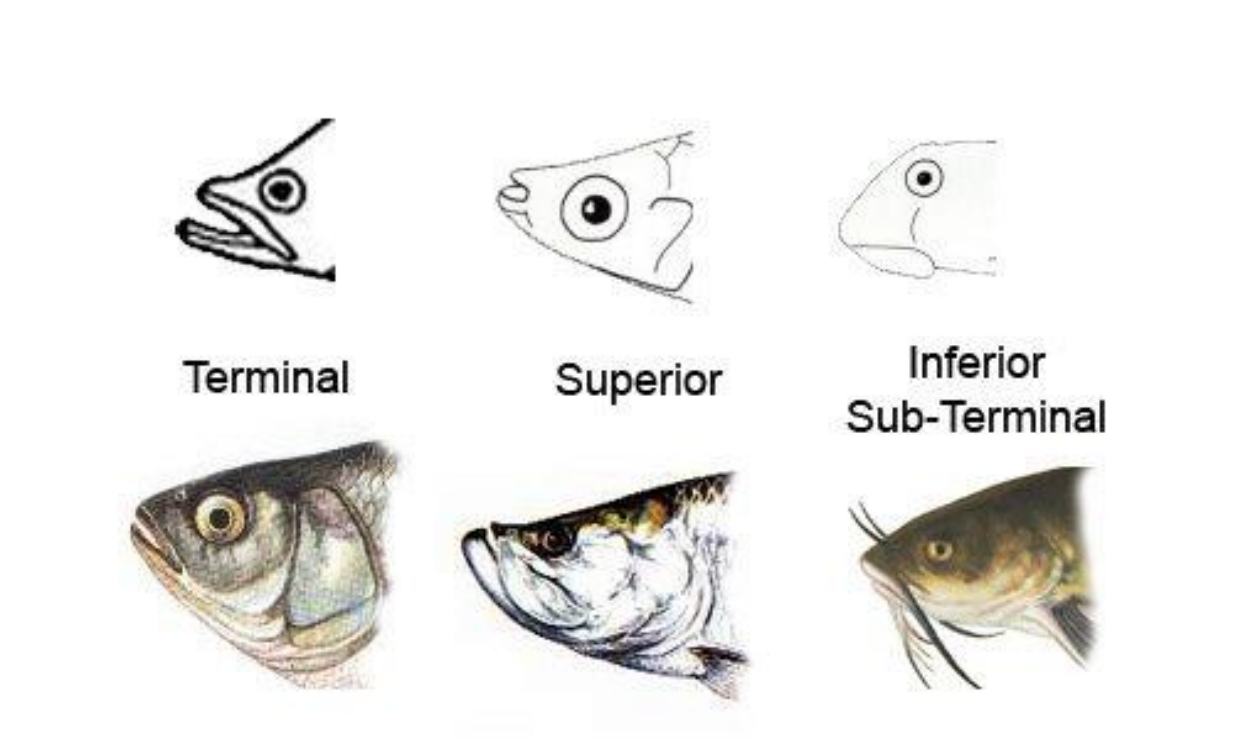
- bone of the upper and lower jaw are covered by lips.
- thin smooth membranes but in some cases they may have pores, stripes or modified to form a sucker like disc in Garra species.
- may be terminal (in front) or inferior (beneath the head).

- Lips of Garra

Image Credit: Wikipedia

Mouth

- main organ which fish use while feeding.
- position and shape of the mouth depends the type of food a fish eats and the level at which it swims.

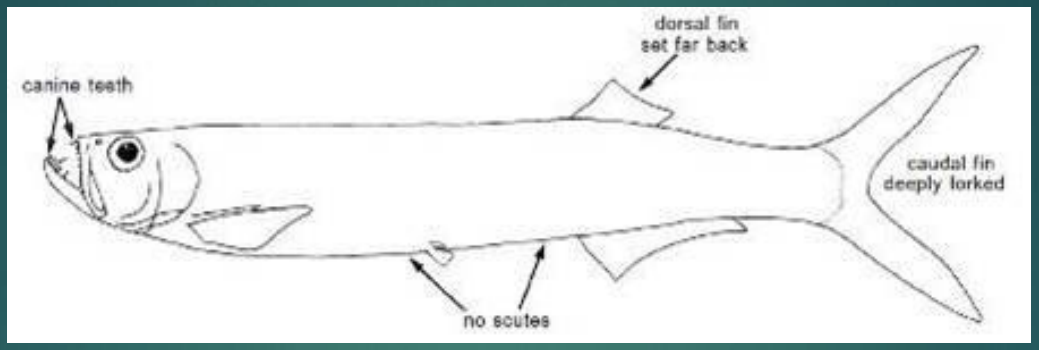


Jaws

- consists of the upper jaw and lower jaw.
- upper jaw consists of bones called pre-maxillaries and maxillaries, while the lower jaw consists of Mandible bones.
- connected by a joint which enables the fish to open and close the mouth.
- Jaws contain teeth and frame the shape of the mouth.

- Jaws of Megladon; An Extinct Shark
  Image Credit: Wikipedia

- The family Clupeidae has a longer lower jaw,



Longer Lower Jaw;Family Cupeidae
Image Credit: Wikipedia

- while the fish in family Engraulidae have a longer upper jaw.

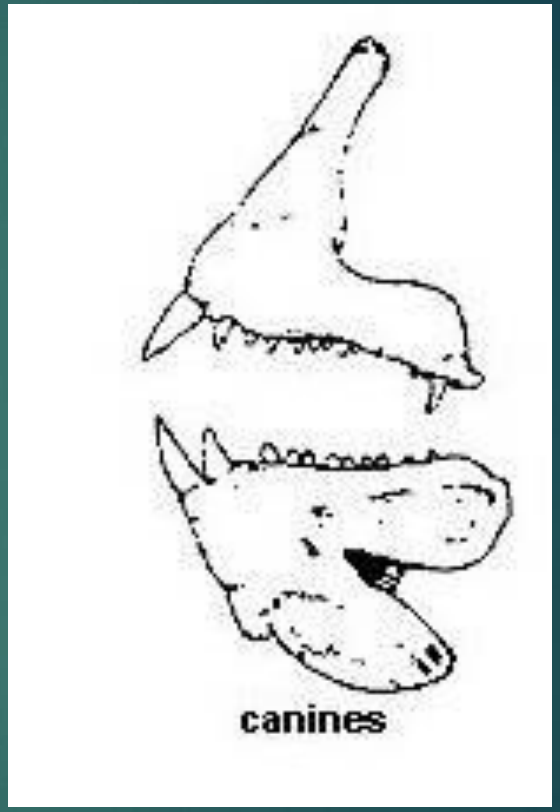
Longer Upper Jaw;Family Engraulidae
Image Credit: Wikipedia

Teeth

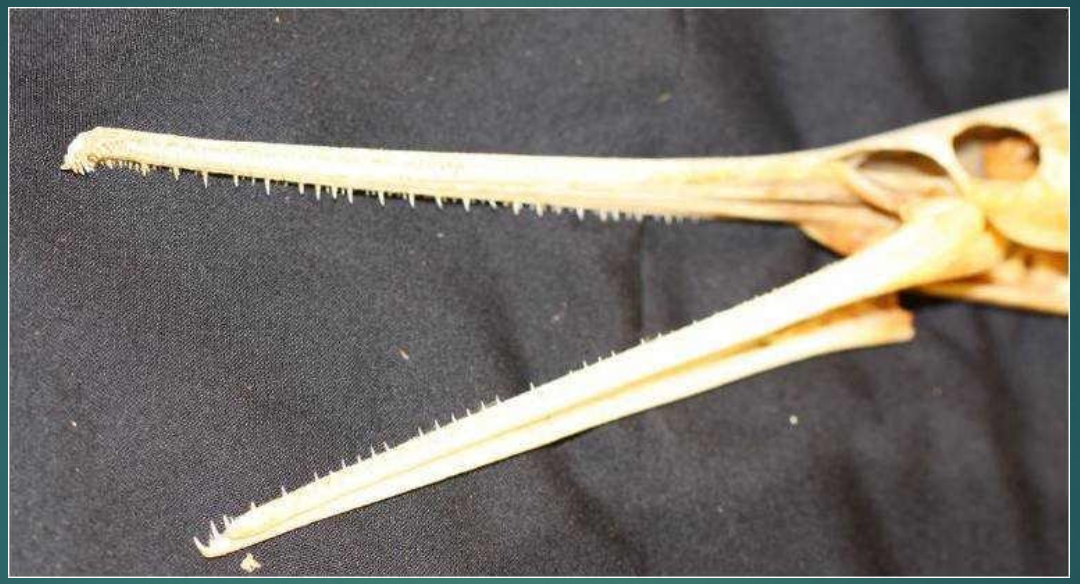
- Most fish have teeth on jaws and palate.
- In addition to these teeth some fish have pharyngeal teeth also.
- However not all fish have teeth like cyprinids.
  - Canine
  - Viliform
  - Molariform
  - Cardiform
  - Incisors
  - Pharyngeal teeth

Canineteeth

- Canine Teeth are large conical teeth frequently located at the corners of the mouth, for example, snappers.



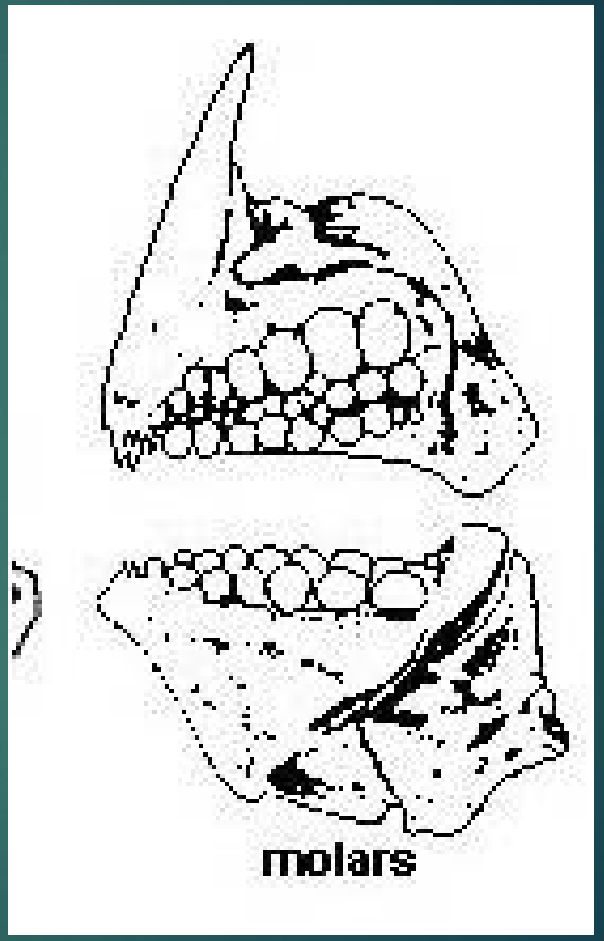
Viliform



- These are small, fine teeth, and are found in Needlefishes (Belonidae) and Lion fishes(Pterois).

Molariform

- Molars are pavement like crushing teeth
  These type of teeth are found in cow nose rays (Rhinopterinae) in which they form plates, or as individual molars in fishes such as the wolffishes (Anarhichadidae).

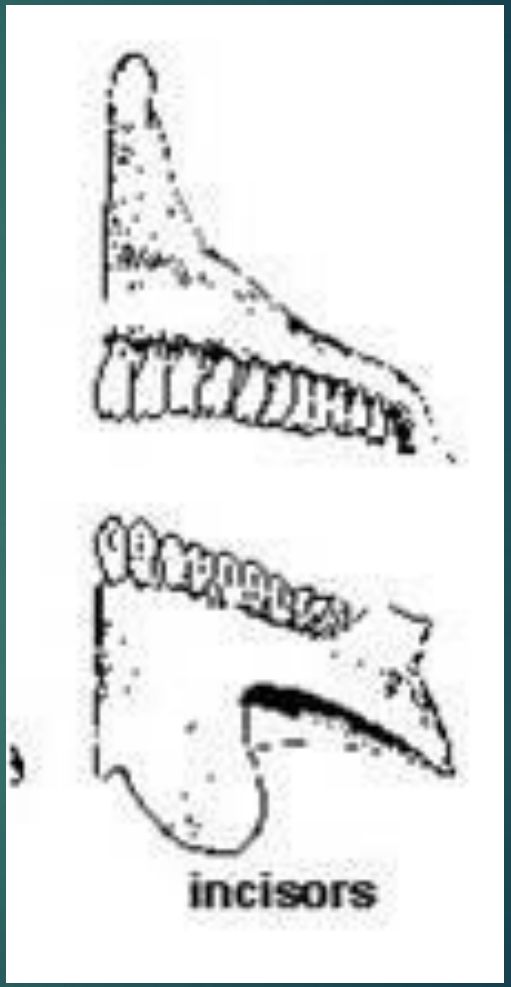


Cardiform

- Cardiform These are fine, pointed teeth arranged as in a wool card
- They are found in pickerels.

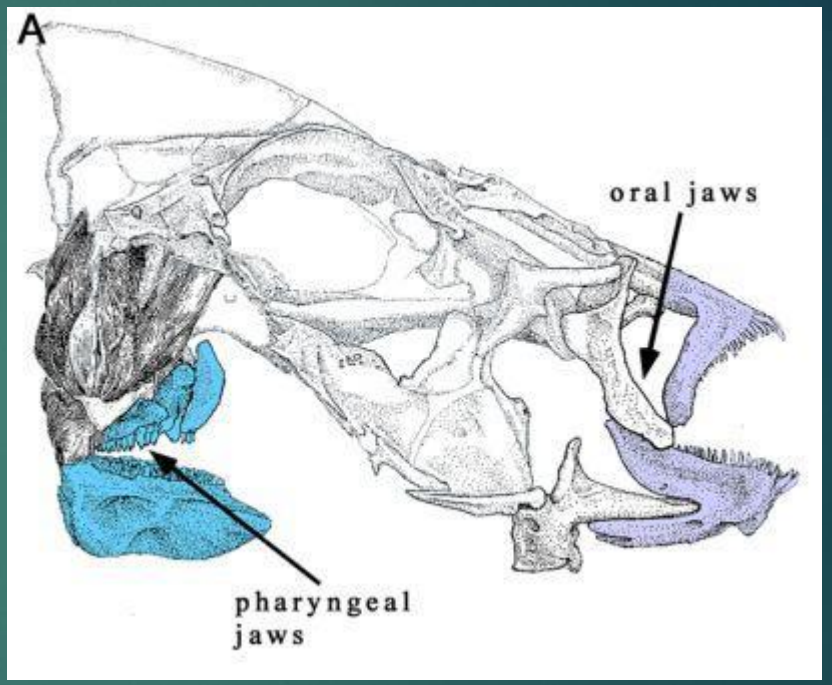
Incisors

- These are large teeth with flattened cutting surfaces adapted for feeding on mollusks and crustaceans; for example, chimaeras (Holocephali).



Pharyngeal teeth

- Pharyngeal or throat teeth are found in fish like cichlids and Cyprinids.



Barbells

- Barbells are slender, whisker like tactile organs near the mouth.
- They are found in fish like Arowana,catfish, carps etc.
- They house the taste buds are used by fish to find food.

Barbels on catfish

Nostrils

- Nostrils are pair of apertures or slits on the snout of the fish.
- They are openings for the smell organs leading to the nasal canal on the skull.
- They are small to medium and are sunk in snout, in some fish like catfish they are covered with mucus.

Eyes

- Eyes are mainly used by fish for seeing, food, enemies and predators.
- They are placed dorso - laterally (upper part- on the side) in most fish.
- placement depends upon the habitat of fish. They can be placed at the top or bottom of the skull.

Eyes Placement Normal

Eyes Placement on top of head

- Some fish like *Astyanax jordani* which live in underground caves do not have any eyes

Blind Fish: Astyanax jordani

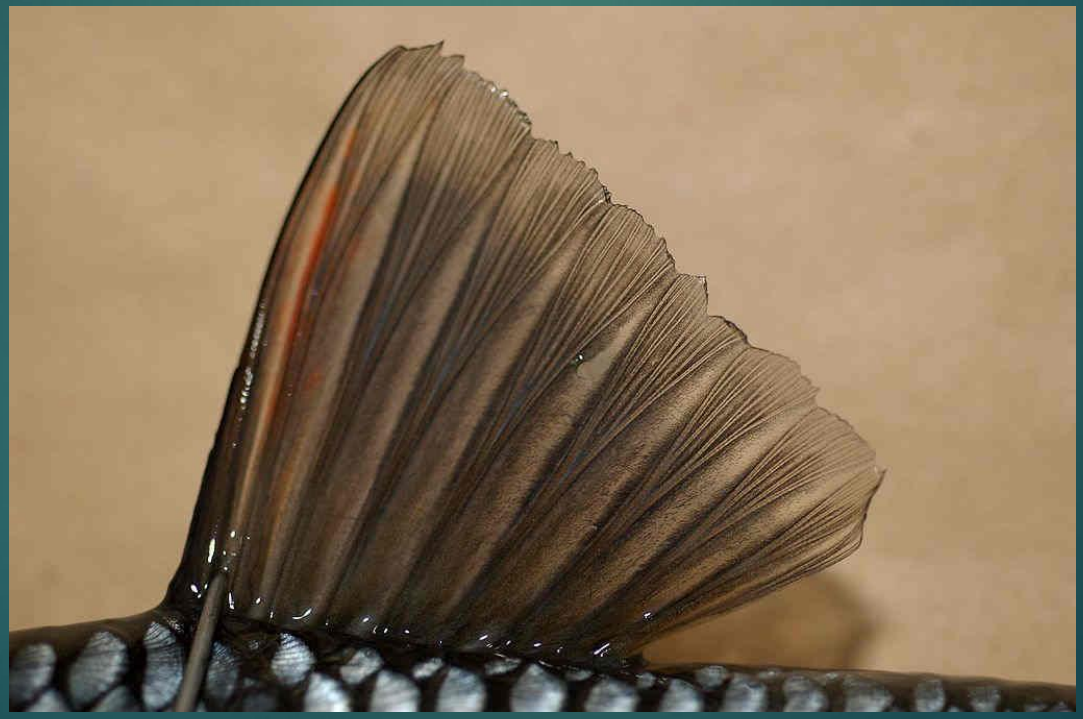
Operculum and gills

- Operculum along with gills form breathing apparatus for the fish.
- On each side of fish there are slits called gills. The gills are composed of comb-like filaments called "gill lamellae", which help increase their surface area for oxygen exchange.
- In bony fish, the gills lie in a branchial chamber covered by a bony operculum.

- A fish breathes by taking water in through its mouth and forcing it out from gills.
- There are tissue linings in the gills which absorb oxygen.
- Co2 is also expelled from the gills.
  The majority of fish have 5 pairs of gills.

Fins

- Fins are thin appendages on the body of fish.
- In case of bony fish or Osteichthyes they are made of bony spines protruding from the body of fish with skin covering the spines and joining them.



- In case of cartilaginous fish they are present as flippers.

Fins of a Cartilaginous Fish

- Fins are foil shaped and are primary means of locomotion for the fish.
- Some generate thrust when moved, others are used for stabilizing and treeing.
- In bony fish (Osteichthyes), most fins may have spines or rays.
- A fin may contain only spiny rays, only soft rays, or a combination of both.
- If both are present, the spiny rays are always anterior (in front).

Spiny rays alonght with Soft rays

Dorsal Fin

- a single fin present on the top of the body(viewed from top) also known as dorsal side.
- The dorsal fin serves to protect the fish against rolling, and assists in sudden turns and stops.
- When the top of rays is connected with membrane they are called soft, else they are called hard spines.

Types of Dorsal Fins

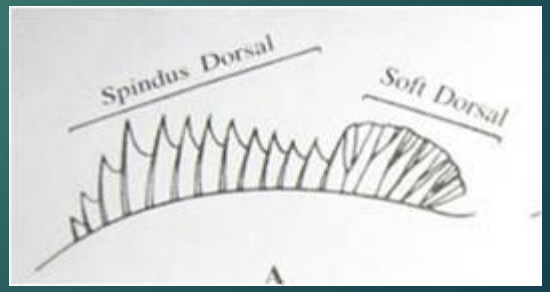
Single Dorsal Fin:

- In many fish it is single and concave in shape.
  First spine is longest and last spine shortest.

Double Dorsal Fin

- In perches there are two dorsal fins, one after another.
  The first fin is separated by either a short or long gap, or it may be combined.

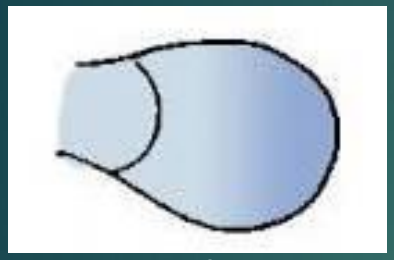
Double Dorsal Fin



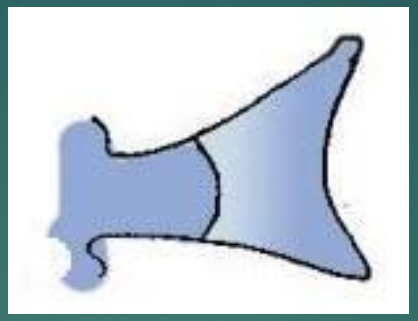
Double Dorsal Fin Combined

Caudal Fin

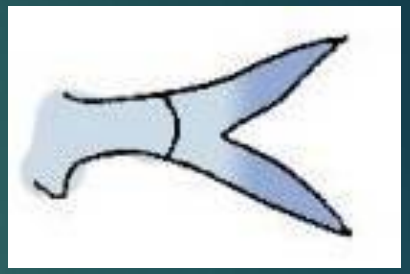
- Caudal or tail fin is located at the end Caudal peduncle of the fish.
- The caudal peduncle is the narrow part of the fish's body to which the caudal or tail fin is attached.
- It is always a single fin and acts as rudder for the fish.



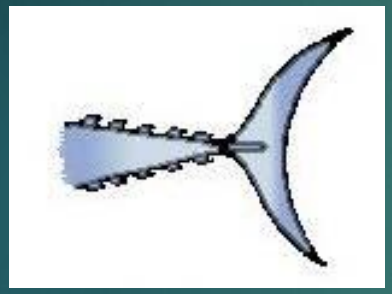
Round



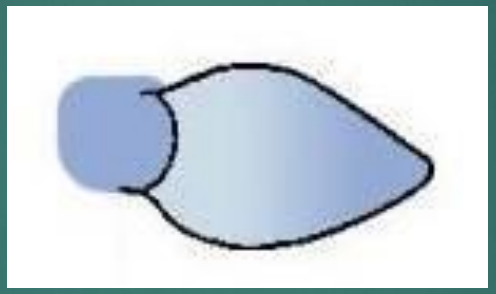
Indented



Forked Caudal Fin



Luncate Caudal Fin

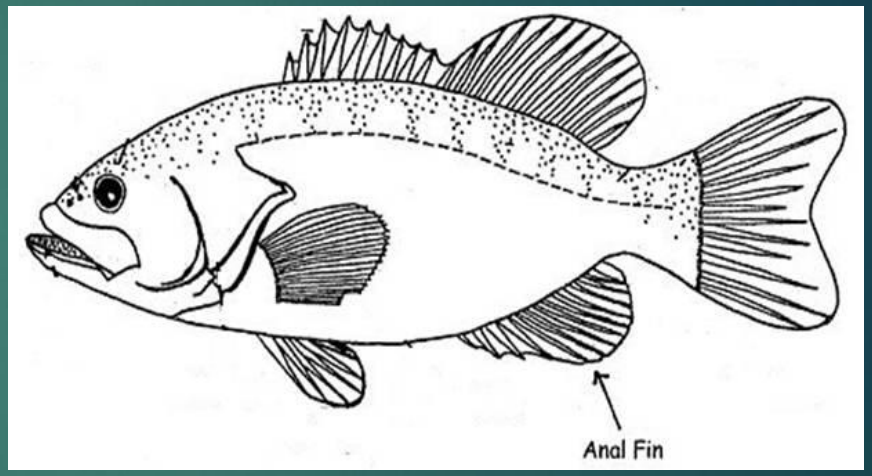


Pointed Caudal Fin

Truncate Caudal Fin

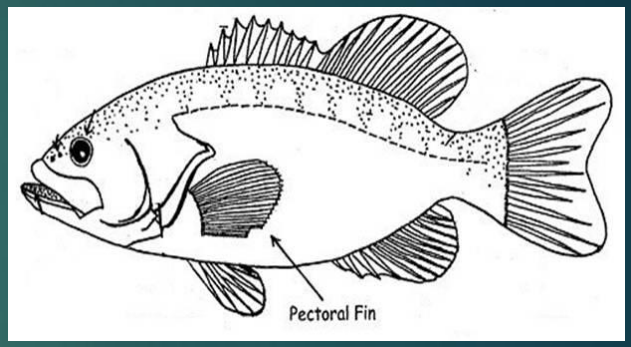
Anal Fin

- The anal fin is located on the ventral (lower) surface behind the anus.
- This fin is used to stabilize the fish while swimming.
- Anal fin is usually a single fin, but can be paired also.
- It is mostly free but can be joined with the tail fin in some cases.



Pectoral Fin

- The pectoral fins occur in pair and are located on each side.
- They usually just behind the operculum (gill cover), and are similar to the forelimbs of tetra pods.
- There are many adaptions to these fins in some cases they create a dynamic lifting force that assists some fish, such as sharks, in maintaining depth and also enables the "flight" for flying fish.

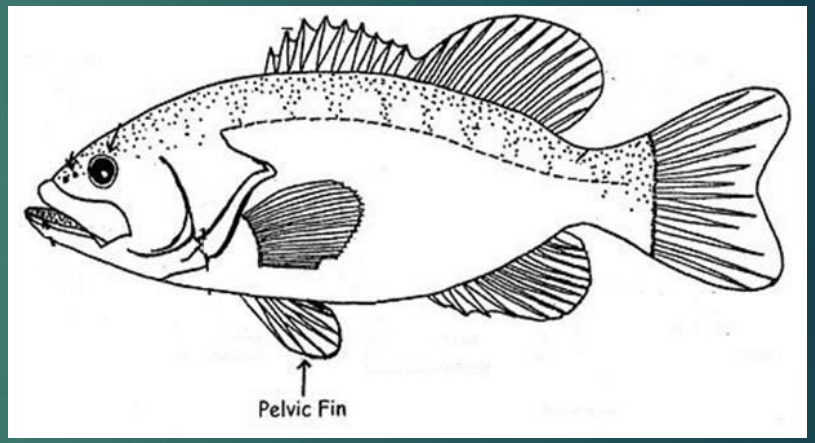


- In many fish, the pectoral fins aid in walking, especially in the lobe-like fins of some anglerfish and in the mudskipper.

Pectoral Fin of Mud skipper

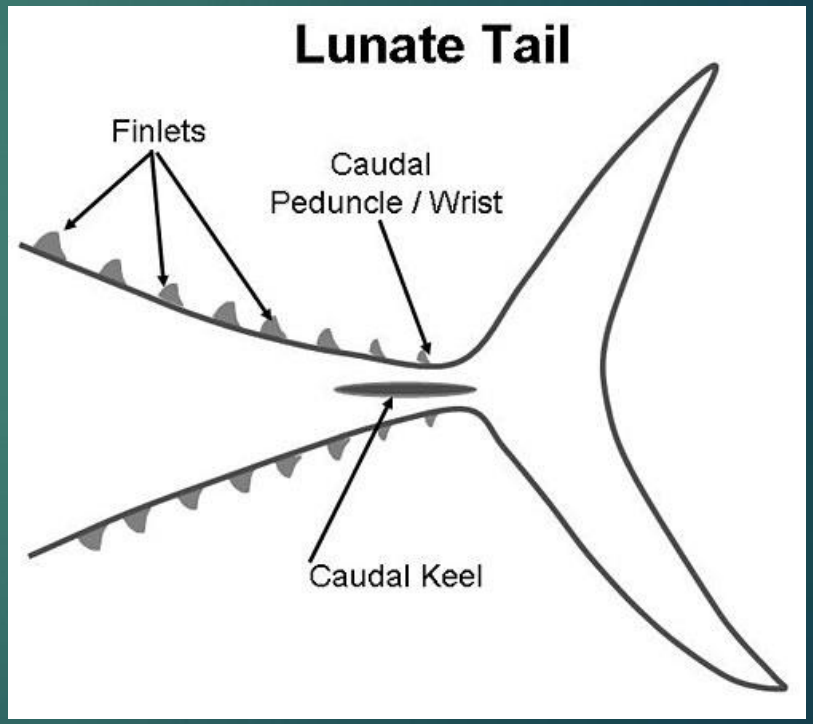
Pelvic Fins

- Pelvic fins occur in pairs and are found on the ventral (lower) side of the fish below the pectoral fins.
- They assist the fish in going up and down in water, turning and stopping.

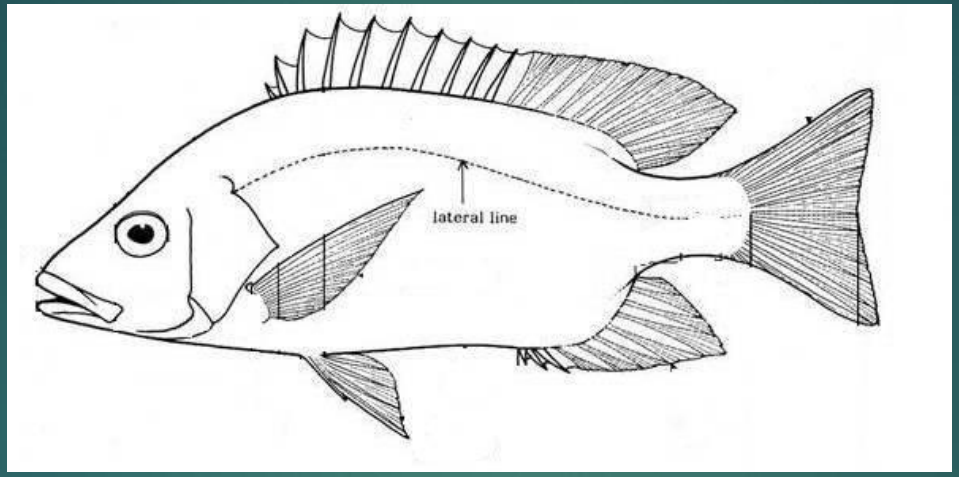


Caudal Fins

- Many fast swimming fish have a horizontal keel just in front of tail fin.
  it is present as ridge in Caudal penciled.
- Caudal Keel provides stability and support to the tail fin.
- They are always present as either a single pair or double pair, one of each side.



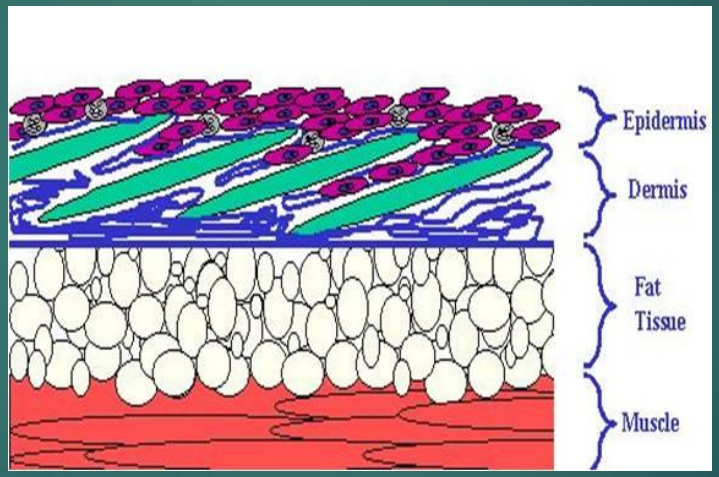
Lateral Line



- The lateral line is a sense organ used to detect movement and vibration in the surrounding water.
- In most species, it consists of a line of receptors running along each side of the fish.
- It can be continuous or broken. In some fish families like cichlids it is broken, the two parts of lateral line are separated and may not be in a single line.

Skin

- The skin of fish consists of live cells, there is very superficial amount of keratin in outermost layer.
- The skin is generally permeable,i.e. fluids can pass through very easily.



Structure of Fish Skin

Fish classification

BONY FISHES (Teleost)

(Class Osteichthyes)

- bony skeleton (milkfish, tilapia)

CARTILAGINOUS (Elasmobranch)

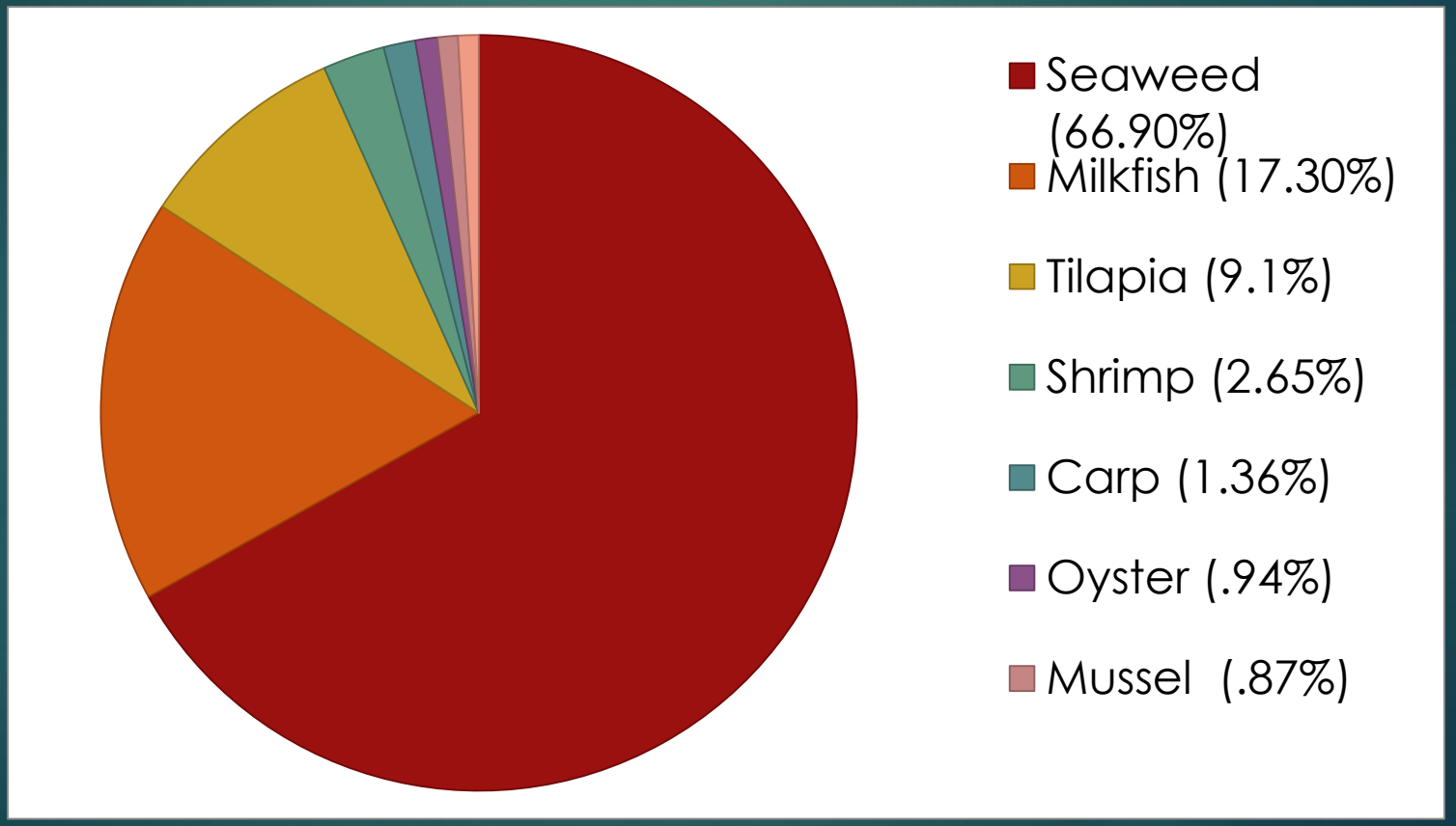
(Class Chondricthyes)

- presence of cartilage (sharks , rays)

Other fishery products

- **CRUSTACEANS** – crabs, shrimp, prawn
- **ECHINODERMS** – jellyfish, sea cucumber
- **MOLLUSC** – mussel, oyster, giant clam shellfish
  - **Univalve/Gastropods –** one shell (abalone, snail)
  - **Bivalve/Pelycephoda–** two shelled**– (**mussel, oyster)
  - **Cephalopod** – shell inside the body – (squid , octopus)

Seven major aquaculture species in the Philippines



Fish Culture, FISH FARMING Aquaculture

- fishery operations involving all forms of raising and culturing fish and other fishery species in fresh, brackish and marine waters.

Aspects of fish culture

FISH PROPAGATION – natural or artificial method of promoting or enhancing reproduction of fish.

FISH CULTIVATION - rearing of fish and other aquatic products.

FISH CONSERVATION – public control and maintenance of various fisheries where fish are derived

Culture System

EXTENSIVE

- Seaweed culture
- Coastal Bivalve culture (mussels, oysters, clams, etc.)
- Coastal fishponds (Milkfish, shrimps, tilapias)
- Pen and cage culture in eutrophic waters (carps, catfish, milkfish, tilapias)

SEMI-INTENSIVE

- **Fresh- and brackishwater pond** (shrimps and prawns, carps, catfish, milkfish, mullets, tilapias)
- **Integrated agriculture-aquaculture** (rice-fish; live stock/poultry-fish; vegetables - fish and all combinations of these)
- **Sewage-fish culture** (waste treatment ponds; latrine wastes and septage used as pond inputs; fish cages in wastewater channels)
- **Cage and pen culture**, especially in eutrophic waters or on rich benthos (carps, catfish, milkfish, tilapias)

INTENSIVE

- **Freshwater, brackishwater and marine ponds** (shrimps; fish, especially carnivores - catfish, snakeheads, groupers, sea bass, etc.)
- **Freshwater, brackishwater and marine cage and pen culture** (finfish, especially carnivores - groupers, sea bass, etc. - but also some omnivores such as common carp)
- **Other - raceways, silos, tanks, etc.**

CULTURE FACILITIES

Fishponds – earth enclosed body of water provided with gates.

Fish pens – sides enclosed with net, bottom is soil

Fish cages – all sides enclosed with net

Fish tanks – concrete/wooden/canvass

Aquarium – aesthetic/ breeding

Hatchery – breeding purposes in large quantity

FISHPOND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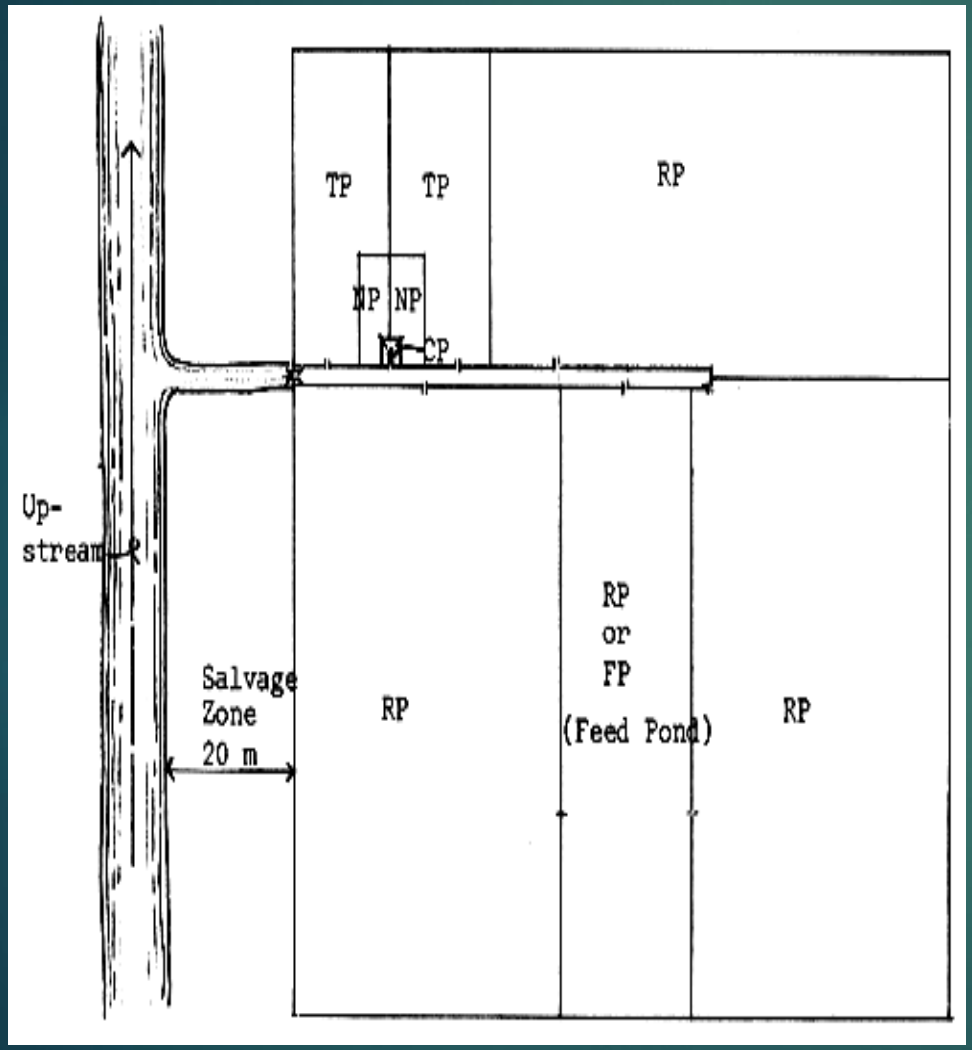
FISHPOND LAYOUT



A one hectare layout of a conventional pond system with the following specifications:

Area = 10,000 m^2
NP = 1%
TP = 9 %
RP =80%
CP = At least 2% of the NP

NP = 10,000 x 1%
= 10,000 x 0.01
= 100 m^2
RP = 10,000 x 80%
= 10,000 x 0.80
= 8,000 m^2
CP = 100 x 2%
= 100 x .20
= 2m^2

Common Compartment Units of a Fishpond

Fry acclimatization pond

- Also called fry box
- smallest unit in a pond system usually 4 to 8 m^2.
- Fry are first stocked in this pond for 1 to 4 days and then allowed passage to the nursery pond proper by just cutting open the small dike partition (Djajadiredja and Daulay, 1982).

Nursery pond

- about 1 to 4 percent of total production area and usually square or rectangular in shape.
- used for rearing the fry for at least 30 days (in the case of milkfish) before transferring into another larger pond.

Transition pond

- holding or stunting pond
- located adjacent to the nursery pond in order to have efficient and quick transfer of fingerlings.
- close to 10 percent of the total production area
- The fingerlings or post-fingerlings are reared here for varying periods before finally stocking them in the production or rearing ponds.

Production or rearing pond

- also called growout pond.
- for raising fingerlings up to marketable size.
- largest compartment in the pond system occupying about 80 percent of the total farm area.

Catching pond

- serves as a concentration area or basin for the fish during harvest
- may be provided also for nursery ponds, transition ponds, and rearing ponds.
- usually about 2 percent of the respective compartments' water surface area

Food growing pond

- Kitchen pond
- a compartment set aside for growing live food organisms at high density.
- for producing food such as lab-lab, lumut or plankton.

Breeding pond

- for confining breeders.

Hatching pond

- for depositing eggs until these are hatched.

Head pond

- for storing reserve water.

Water supply canal

- for supplying water to the different compartments.

Supply canal

Catching pond

Common Accessory Units of a Fishpond

1. **Main gate –** controls water in the pond system. It could be wooden or concrete.
2. **Secondary gate** – controls the incoming and outgoing water in the different pond units
3. **Tertiary gates or pipes** – controls the incoming and outgoing water in the smaller compartment of the pond system.

MAIN GATE

SECONDARY GATE

TERTIARY GATE

Main/perimeter dike

- surrounds the entire pond system to ensure protection and safety of the stocks. It is composed of the biggest and highest blocks of earth.

Secondary dike

- subdivides the pond system into several compartments.

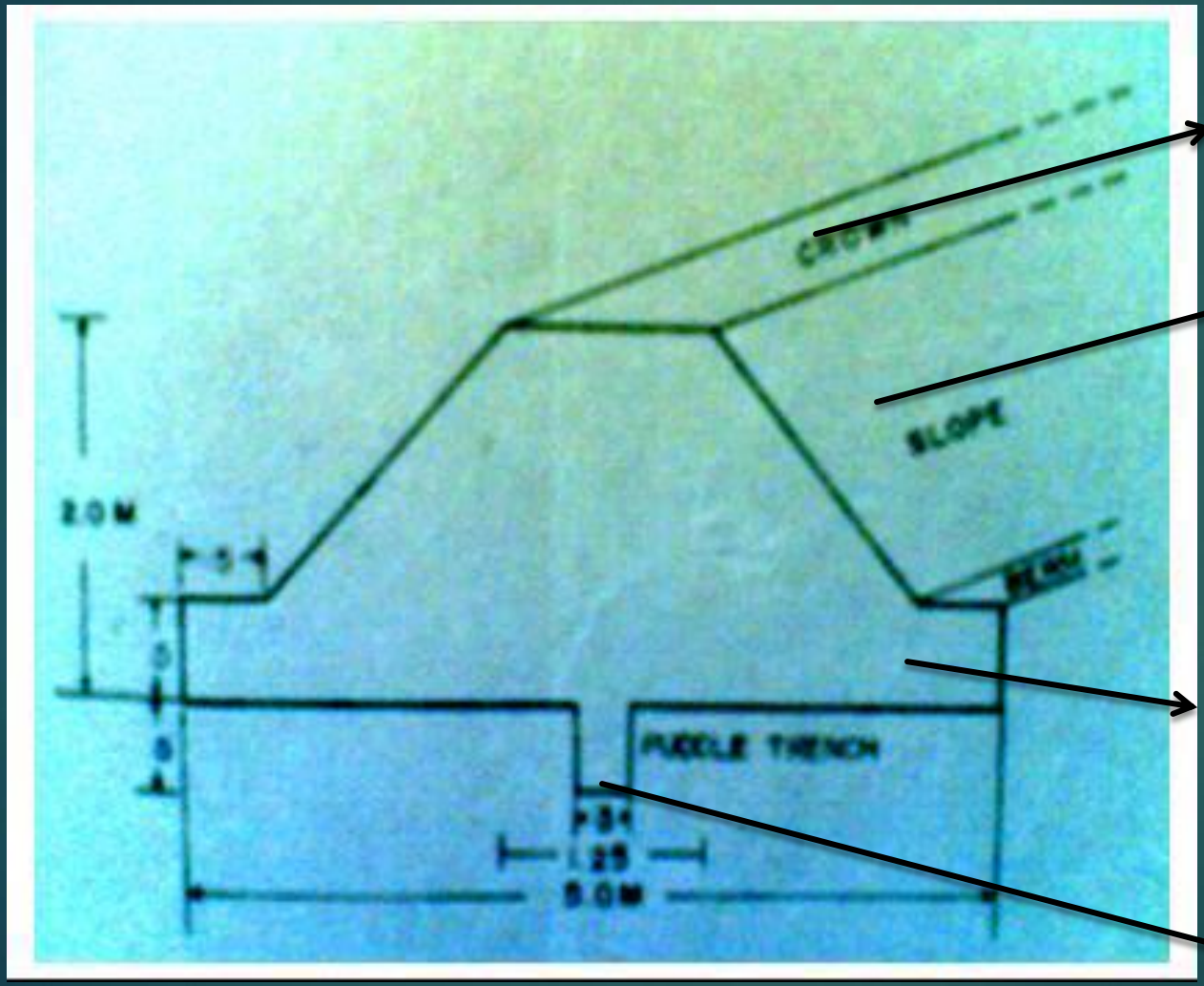
Tertiary dike

- subdivides the pond system into smaller compartments and serves as partition in the nursery pond.

MAIN DIKE

SECONDARY DIKE

PARTS OF A DIKE



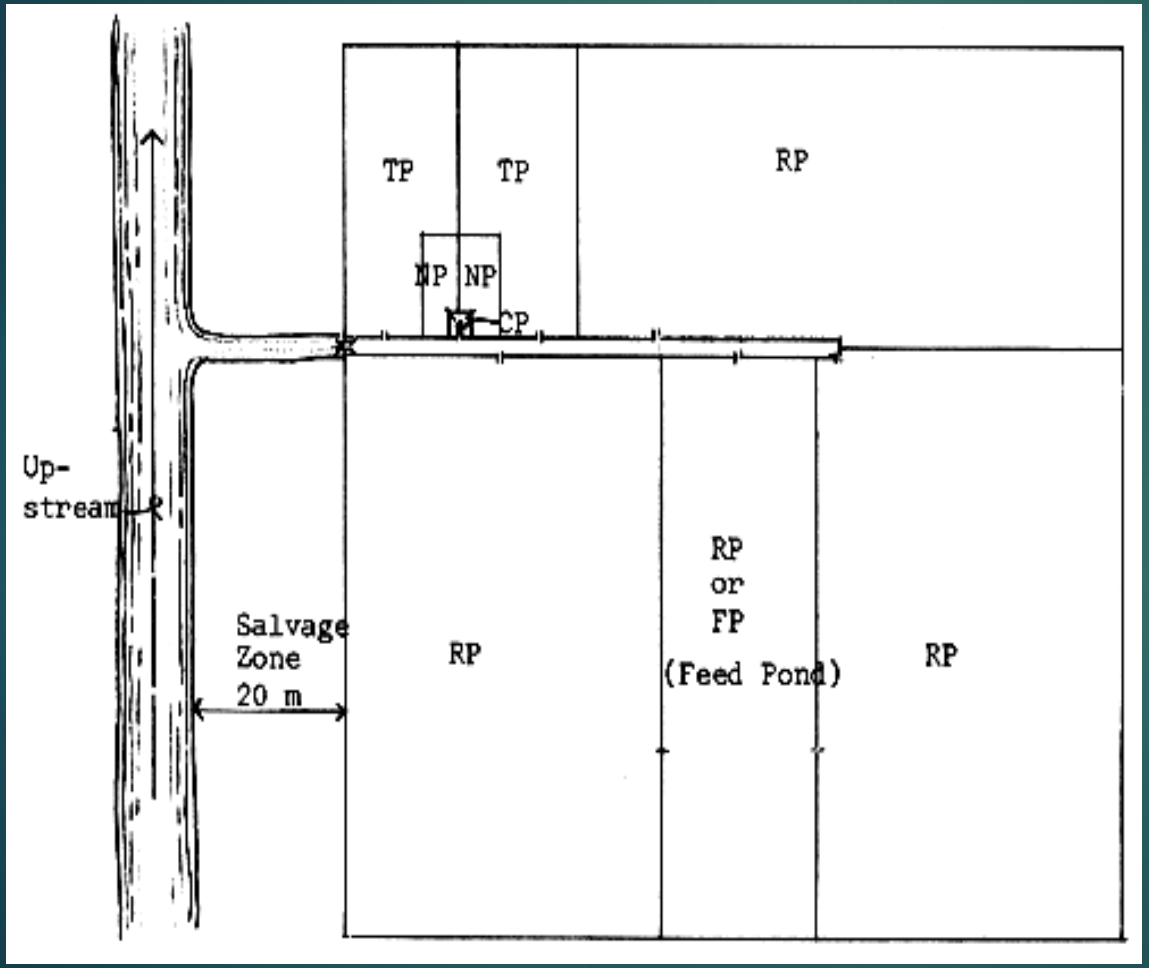
CROWN

SLOPE

BERM

PUDDLE TRENCH

Brackish water Fishpond Systems



Conventional Pond System

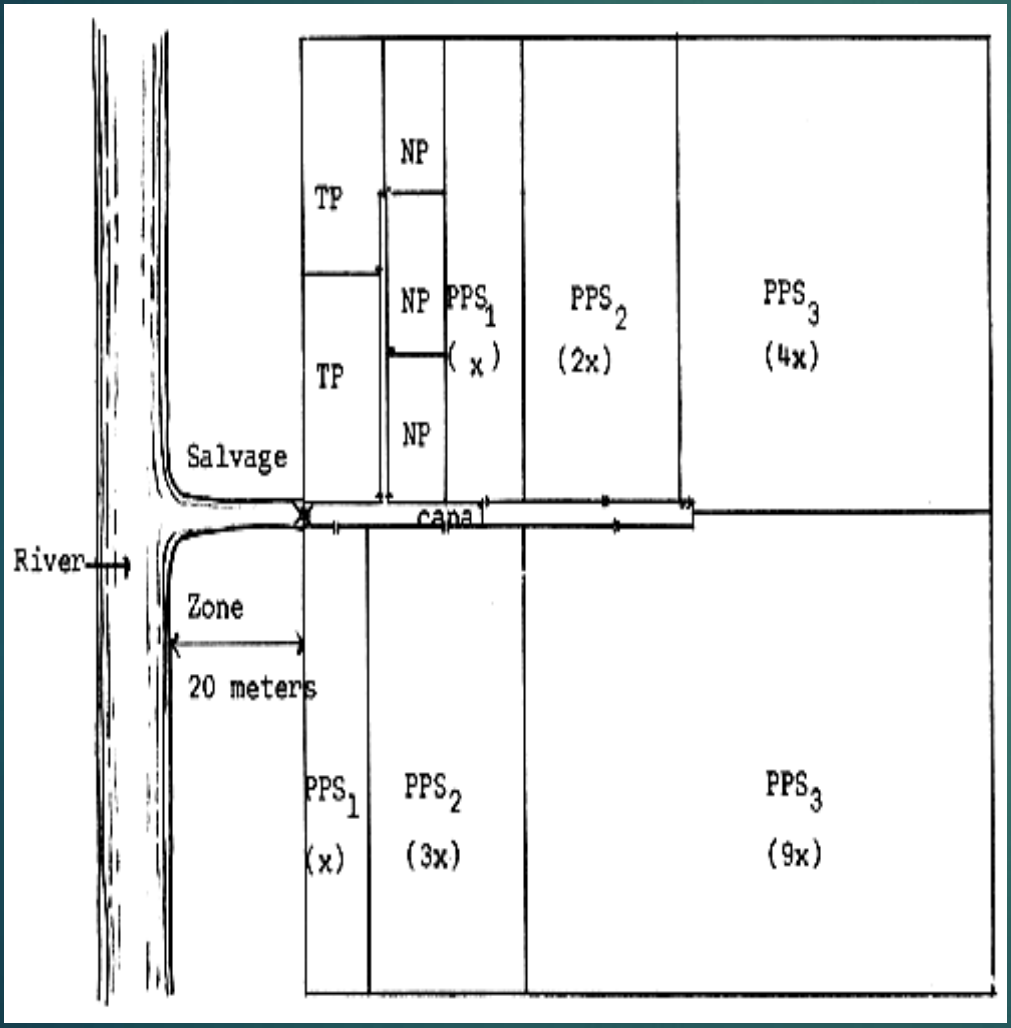
NP : 1%

TP: 9%.

RP: 80%

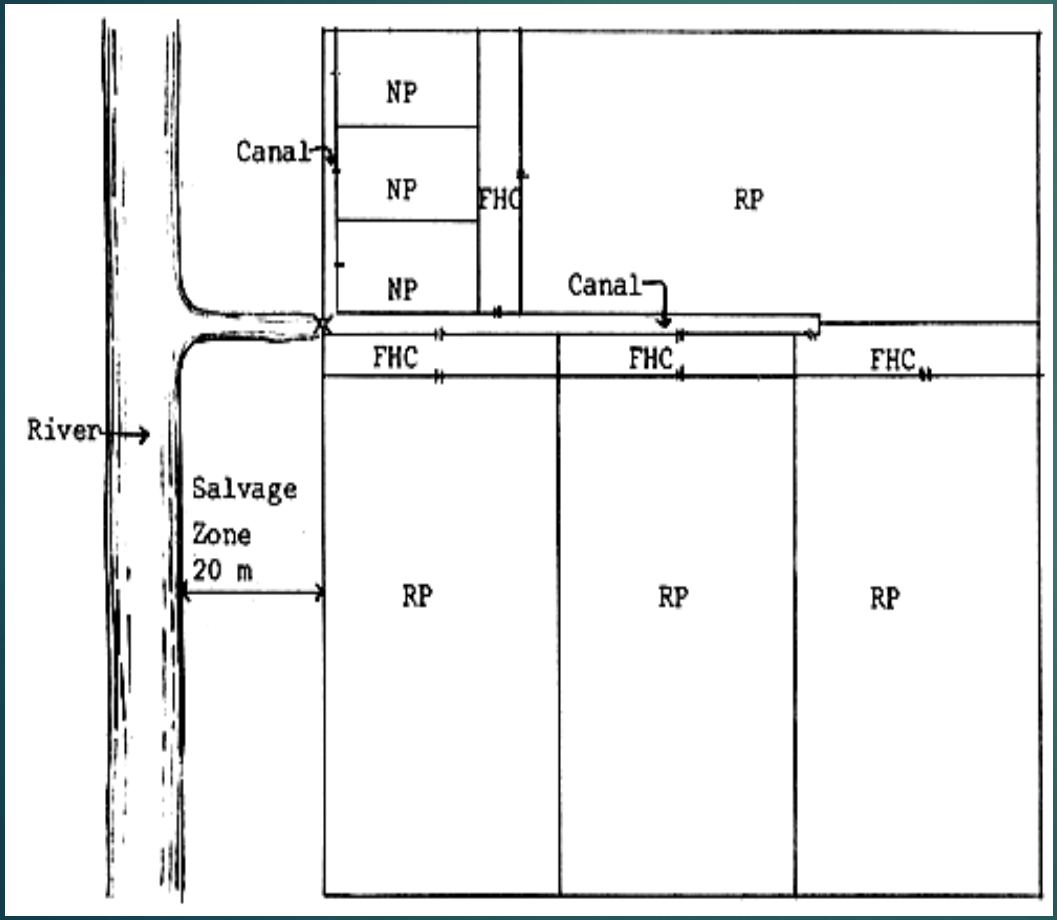
Dikes and Canals: 10 %

MODULAR POND SYSTEM



NP: 4%.
TP: 6%
RP: 80% is divided into three Production Process Stages (PPS).
PPS is 1:2:4 for upper PPS and 1:3:9 for lower PPS.
Dikes & Canals: 10%

Multiple Stock/Harvest system.



NP: 6%
FHC: 1% of each RP's
RP: 84%
Dikes and Canals:10%

FISH CAGE

Fish cages

circular Fish tank

Hexagonal fish tank

Blower and aerators

POND MANAGEMENT

- Pond preparation
- Stocking
- Feeding
- Water Management
- Pond Maintenance
- Harvesting

POND PREPARATION/ CONDITIONING

- Pond draining
- Pond drying
- eliminating predators and/or wild species that may compete with cultured organisms for food and space.

STOCKING

- fish fingerlings or shrimp post larvae are stocked at the appropriate density depending on the culture strategy, size of pond, and the size of fingerlings, among others.
- fingerlings are properly acclimated and conditioned prior to stocking and weak or diseased fish eliminated.

STOCKING DENSITY

Number of fish per unit area (pcs/sq.m)

SD = Total Stock/Total Area

Example: What is the SD if 1 hectare pond was stocked with 20, 000 pcs tilapia fry?

SD= 20,000 pcs/10,000 sq.m

SD = 2pcs/sq.m

FEEDING

- Fish/shrimp grown in semi-intensive and intensive culture ponds are given supplementary and full artificial feeds, respectively, the former to augment the natural food in the pond, the latter to totally replace the natural organisms in the water as a source of nutrition.

Methods of feeding

- Hand feeding
- Automatic feeding
- Demand Feeding

Supplemental feeds

- rice bran
- fish meal
- corn , coconut meat

Facts about feeding

- Small fish should be feed with high protein for growth
- As fish grow bigger, they consumed less.
- Feeds alone consumed the biggest farming expenses

Sampling

Determine the ABW

To adjust feeding

ABW: average body weight

ABW: Total weight/ Number of fish

Example: What is the ABW if 10 pcs of tilapia weighs 500 grams?

ABW = 500 grams/10 pcs

= 50 grams/pc

WATER MANAGEMENT

- a **pond water depth** of 1 meter is considered best for culture of tilapia, carps, and shrimps;
- traditional milkfish ponds can do with just 40-60 cm of water.
- Pond water is not just maintained at a certain depth; its **quality** must also be kept high to ensure optimal growth of the culture organism.

- Dissolved oxygen levels are kept, as much as possible, above 5 ppm by pumping and aeration.
- Problems of acidity are corrected by liming.
- Salinity is an important parameter for penaeid culture and has to be maintained within a range of 15-25 ppt for best results.
- During summer months, high-salinity water can be diluted by mixing with fresh water from springs or deep wells.

POND MAINTENANCE

- Fertilization
- Liming
- Elimination of Pests and Predators
- Stock Monitoring
- Regular Upkeep and Maintenance of Facilities

FERTILIZATION

- Extensive ponds are fertilized regularly using either organic fertilizers like chicken, cow, or pig manure, or inorganic fertilizers like urea, ammonium phosphate, or both, to maintain the plankton population in the pond.
- Semi-intensive and intensive culture systems do not require fertilization since they are not natural food-based, except for those which grow plankton-feeders like milkfish whose diet is largely algae dependent.

LIMING

- ponds also need to be given regular doses of lime to maintain water pH at alkaline or near-alkaline levels (preferably not lower than six).
- **Agricultural lime** is broadcast over the pond and applied on the sides of the dikes to correct soil and water acidity.

ELIMINATION OF PESTS, PREDATORS and DISEASES

- Unwanted and predatory species which may have survived the application of pesticides during pond preparation or which were able to enter the pond through the gate screens or through cracks in the dikes, are eliminated by the **application of pesticides, preferably organic**, into the pond.

DISEASES

1. Environmental
2. Nutritional
3. Viral
4. Bacterial
5. Fungal
6. Parasitic

Environmental

- caused by adverse environmental conditions and nutritional disorder.
- **Gas Bubble Disease** – supersaturation of oxygen or nitrogen. Bubbles in abdominal cavity, eyes skin.(Prevention: monitor DO, sufficient water exchange)
- **Hypoxia** – caused by low levels of oxygen, Fish swim in the surface. (Prevention : Monitor DO.)

Nutritional Diseases

– diseases due to deficiency, excess or imbalance of nutrients present in food/feeds.

- **Black Death** – due to vit C deficiency
- **Blue disease –** deficiency in carotenoids

VIRAL

- **Spinning Tilapia Syndrome (ST)**- swim in spiral pattern dies within 24 hours. Caused *by Iridovirus*
- **Sleepy Grouper Disease (SG)–** swim in circles and anemic, 100% mortality in 11 days. Caused by I*ridovirus*
- No treatments only prevention in viral diseases. Avoidance and use of virus free fry. Reduction of Stress. Use of vitamins. Used of commercial feeds. Surveillance of Disease.

White Spot Syndrome Virus(WSSV)

- (Penaied : shrimps and other crustaceans) White cuticular spots in exoskeleton. Caused by baculovirus. 100 % mortality in 3 – 10 days.

Monodon Baculovirus Disease (MBV)

- (Shrimps). Pale bluish gray to dark blue coloration and sluggish behavior and in active feeding . 20 – 100 % in postlarvae (PL). 70 % in juvenile.

Bacterial

Streptocccal Infection

- (Species Affected : Seabass, Tilapia, Siganids). Erratic swimming and darkening of the body, hemmorrhages in opercula and base of fins.

Luminous bacteria

- (shrimps) (caused by *Vibrio harveyii)* greenish glow when observed in total darkness. Hepatopancreas infection may result to 100% mortality. (prevention: disinfection of water and facilities.

Prevention: Maintain good water quality and nutritionally adequate diets, minimize overcrowding and stress. Apply **probiotics**, Perform vaccination, Water management,

Antibiotics as last resort.

Fungal

- **Saprolegniosis** (Freshwater fishes e.g. goldfish and carps) caused by *Saprolegnia spp.* Formation of white cottony growth on epidermis.(treatment of salt 22g/L. or formalin of .4-.5 ml 30 % formaldehyde for 1 hour)
- **Brachiomycosis (Gill Rot) –** carps , goldfish and eels caused by *Brachiomyces spp.* Gills become pale with brownish areas dues to hemorrhages .treatment of copper sulfate (100 ppm for 10-30 mins. or salt 0f 3 – 5%.

Parasitic Diseases

- **Ichthyophthriasis (Ich)** – (catfish, carp , tilapia, grouper and snapper. Presence of whitish or grayish spots on the skin. Treatment of salt of .05% or 100 ppm formalin for 1 h for 3 days.)
- **Argulus infestation** (Fish Louse) (tilapia, milkfish , catfish) parasite attached to skin and fins.(treatment of $KMnO_4$, 3-5 mins.)

STOCK MONITORING

- The culture organisms are monitored closely and regularly to determine their rate of growth and the general condition of the stock. They are regularly sampled for length-weight measurements as a basis for determining/estimating their biomass in the pond and therefore their daily feed rations, as well as for making projections on harvest schedules and procurement of pond inputs.

HARVESTING

- Marketable-size fish/shrimps are harvested at the end of the culture period by **draining** the pond and using **harvesting nets** to catch the fish or shrimps. The latter are harvested with a **bag-net** attached to the **sluice gate** as water is drained out of the pond at low tide. Tilapia are harvested using **seine nets** after the pond water is drained to half-level the night before.

CULTURE SPECIES

- The choice of species for stocking and rearing in pens and cages is governed by much the same criteria as in species selection for pond culture, including (Guerrero, 1982):

(i) fast growth in confinement;

(ii) good consumer acceptance;

(iii) high tolerance to a wide range of environmental conditions;

(iv) resistance to disease;

(v) ready supply of fish seed for stocking; and (vi) ease of culture and management.

CULTURE SPECIES

Species		Climate	Type of Feeding
Salmonids	Rainbow trout	Temperate	Intensive. High protein (40%)
	Salmon (various species) smolts	Temperate	Intensive. High protein (452)
Carps	Chinese carps (Silver carp, grass carp, bighead carp)	Temperate - tropical	Mainly semi-intensive, although also extensive (Asia)
	Indian major carps (Labeo rohita)	Sub-tropical – tropical	Semi-intensive
	Common carp	Temperate – tropical	Mainly semi-intensive, although also intensive
Tilapias	(O. Mossambicus, O. niloticus, etc.)	Sub-tropical – tropical	Mainly semi-intensive, although also intensive
Catfishes	Channel catfish	Temperate – sub-tropical	Intensive
	Clarias spp.	Tropical	Semi-intensive
Snakeheads	Channa spp. Ophicephalus s pp.	Tropical	Semi-intensive/intensive
Pangasius spp.		Tropical	Semi-intensive
Milkfish	Chanos chanos	Tropical	Semi-intensive

- Other species have been suggested as possible candidates for utilization in pen/cage culture in the following **three different environments** (SEAFDEC/IDRC, 1979):

(i) Freshwater

- Habitats with high natural productivity (e.g., lakes, oxbow lakes, swamps, mining pools, rivers, and reservoirs): mullets, eels, catfish, Puntius gonionotus.
- Habitats with low natural productivity: Leptobarbus, Clarias batrachus, Oxyeleotris, and Macrobrachium.

(ii) Brackishwater

- Sea bass, mullet, siganids, sea bream, grouper, snapper, threadfin, carangids. Hilsa spp., Sparus spp., and eels.

(iii) Marine

- Siganids, pampano, yellowtail, tuna, grouper, snapper, sea bass, sea bream, carangids, pomfret.

Important terminologies

- **Migratory species -** refers to any fishery species which in the course of their life could travel from freshwater to marine water or vice versa, as part of their behavioral adaptation for survival and speciation:
- **a. Anadromous species -** marine fishes which migrate to freshwater areas to spawn (Salmon)
- **b. Catadromous species -** freshwater fishes which migrate to marine areas to spawn. (Eels)