Green Gears
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AREA 2

FUNDAMENTALS OF AQUACULTURE ENGINEERING

ENGR. JOHN LUDOVICE

Comparable to hunting, this refers to the collection and gathering of fish from their natural habitats.

A. Fish Farming
B. Aquaculture
C. Fishing
D. Silviculture

Comparable to hunting, this refers to the collection and gathering of fish from their natural habitats.

A. Fish Farming
B. Aquaculture
C. Fishing
D. Silviculture

This refers to the deliberate cultivation and raising of fish.

A. Fish Growing
B. Fish Culture
C. Aquatic Farming
D. Aquaculture

This refers to the deliberate cultivation and raising of fish.

A. Fish Growing
B. Fish Culture
C. Aquatic Farming
D. Aquaculture

This refers to the rearing and breeding of aquatic organisms in an environment which is more or less controllable by man.

A. Fish Growing
B. Silviculture
C. Aquatic Farming
D. Aquaculture

This refers to the rearing and breeding of aquatic organisms in an environment which is more or less controllable by man.

A. Fish Growing
B. Silviculture
C. Aquatic Farming
D. Aquaculture

The following refers to the importance of aquaculture as an industry except:

A. To increase food production.
B. To increase fishball production.
C. To prevent overharvesting of natural stocks.
D. To foster economic development.

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D. To foster economic development.

INTRODUCTION TO AQUACULTURE

Aquaculture basically refers to the deliberate **breeding and rearing of aquatic organisms in an environment that is controllable by man**. Although fishing and aquaculture are both components of the fisheries industry, fishing is more comparable to hunting, referring to the collection of aquatic organisms from their natural habitat. The importance of aquaculture includes:

- **To increase food production and meet global demands.**
- **To reduce pressure and prevent overharvesting natural stocks.**
- **To foster economic development.**

This refers to aquaculture in which organisms are raised in a medium with a salinity of less than 0.5 ppt.

A. Mariculture
B. Unsalted Aquaculture
C. Freshwater Aquaculture
D. Brackishwater Aquaculture

This refers to aquaculture in which organisms are raised in a medium with a salinity of less than 0.5 ppt.

A. Mariculture
B. Unsalted Aquaculture
C. Freshwater Aquaculture
D. Brackishwater Aquaculture

This refers to aquaculture which is heavily dependent in tidal phases and freshwater discharge.

A. Mariculture
B. Aquasilviculture
C. Discharge Aquaculture
D. Brackishwater Aquaculture

This refers to aquaculture which is heavily dependent in tidal phases and freshwater discharge.

A. Mariculture
B. Aquasilviculture
C. Discharge Aquaculture
D. Brackishwater Aquaculture

This refers to aquaculture in which organisms are raised in water with a salinity of beyond 35 ppt.

A. Salty Culture
B. Aquasilviculture
C. Sea Aquaculture
D. Mariculture

This refers to aquaculture in which organisms are raised in water with a salinity of beyond 35 ppt.

A. Salty Culture
B. Aquasilviculture
C. Sea Aquaculture
D. Mariculture

This system integrates mangrove resource rehabilitation and aquaculture.

A. Mangrove Culture
B. Aquasilviculture
C. Sea Aquaculture
D. Intensive Mariculture

This system integrates mangrove resource rehabilitation and aquaculture.

A. Mangrove Culture
B. Aquasilviculture
C. Sea Aquaculture
D. Intensive Mariculture

CLASSIFICATIONS BASED ON GROWING MEDIUM

1. **Freshwater Aquaculture** - aquatic organisms are grown in freshwater (salinity is <0.5 ppt) sourced from springs, rivers, lakes, and also from developed underground water resources.

2. **Brackishwater Aquaculture** – brackish water refers to the combination of fresh and sea water, typically found in estuaries and mangrove areas where the river mixes with tidal water. The salinity of brackish water is often variable, ranging from 0.5-35 ppt depending on the tidal phase and the freshwater discharge.

3. **Mariculture** – this refers to the use of sea water as the growth medium, typically in coastal areas. The salinity of water is above 35 ppt.

CLASSIFICATIONS BASED ON PURPOSE OR FUNCTION

1. Broodstock
2. Hatchery
3. Nursery
4. Growout
5. Combination

This method of aquaculture is characterized by using solely natural feeds and minimal water exchange rate.

A. Natural Method
B. Intensive Method
C. Extensive Method
D. Traditional Method

This method of aquaculture is characterized by using solely natural feeds and minimal water exchange rate.

A. Natural Method
B. Intensive Method
C. Extensive Method
D. Traditional Method

This method of aquaculture is characterized by a moderate stocking density and partial water exchange.

A. Semi-Intensive Method
B. Semi-Extensive Method
C. Partially Intensive Method
D. Moderate Method

This method of aquaculture is characterized by a moderate stocking density and partial water exchange.

A. Semi-Intensive Method
B. Semi-Extensive Method
C. Partially Intensive Method
D. Moderate Method

This method of aquaculture is characterized by high stocking density, use of artificial feeds, and high water exchange rate.

A. Technological Method
B. Semi-Extensive Method
C. Artificial Method
D. Intensive Method

This method of aquaculture is characterized by high stocking density, use of artificial feeds, and high water exchange rate.

A. Technological Method
B. Semi-Extensive Method
C. Artificial Method
D. Intensive Method

CLASSIFICATIONS BASED ON METHODS OF PRODUCTION

1. **Extensive Method** - this is characterized by minimal stocking density (1-3 fish per sq. m) and dependence on natural feed in the culture facility.

2. **Semi-Intensive Method** – this is characterized by moderate stocking density (4-6 fish per sq. m), the use of natural and supplemental feed (with fertilizer), and with partial water exchange.

3. **Intensive Method** – this is characterized hy high stocking density, (6 and more fish per sq. m), the use of artificial feeds, and high water exchange rate (for maximum aeration).

Princess Daisy wants to culture milkfish in an extensive culture. What is the maximum number of fish that she may harvest if she owns a total of four 1-acre ponds?

A. 48,000
B. 16,000
C. 29,000
D. 35,000

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C. 29,000
D. 35,000

Princess Daisy wants to culture milkfish in an extensive culture. What is the maximum number of fish that she may harvest if she owns a total of four 1-acre ponds?

A. 48,000

$$No.\,of\ Fish = Stocking\ Density\ x\ Area$$

$$= \left(3\frac{fish}{m^2}\right)\left(4\ x\ 1\ acre\ x\ \frac{1\ ha}{2.47\ acre}\ x\ \frac{10000\ m^2}{1\ ha}\right)$$

$$= 48{,}583$$

Mr. Sorry wants to raise Nile Tilapia in a 1-ha pond with a stocking density of 6 fish/sq. m. If he is to account a 75% fry survival rate, what is the initial fry count?

A. 60,000
B. 45,000
C. 80,000
D. Cherry Pie Picache

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Mr. Sorry wants to raise Nile Tilapia in a 1-ha pond with a stocking density of 6 fish/sq. m. If he is to account a 75% fry survival rate, what is the initial fry count?

C. 80,000

$$Stock = \frac{(Stocking\ Density\ x\ Area)}{Survival\ Rate}$$

$$= \frac{\left(6\frac{fish}{m^2}\ x\ 1\ ha\ x\frac{10000\ m^2}{1\ ha}\right)}{75\%}$$

$$= 80{,}000$$

This refers to aquaculture products that are cultured for the purpose of its nutritional value, such as in food and medicine.

A. Food Products
B. Nutritional Products
C. Nutraceutical Products
D. Ornamental Products

This refers to aquaculture products that are cultured for the purpose of its nutritional value, such as in food and medicine.

A. Food Products
B. Nutritional Products
C. Nutraceutical Products
D. Ornamental Products

This type of products are raised primarily for leisure, such as bait fish used in sports fishing.

A. Recreational Products
B. Entertainment Products
C. Sporty Fish Products
D. Ornamental Products

This type of products are raised primarily for leisure, such as bait fish used in sports fishing.

A. Recreational Products
B. Entertainment Products
C. Sporty Fish Products
D. Ornamental Products

This type of products are raised primarily for their aesthetic appeal.

A. Pretty Products
B. Ornamental Products
C. Design Products
D. Ergonomic Products

This type of products are raised primarily for their aesthetic appeal.

A. Pretty Products
B. Ornamental Products
C. Design Products
D. Ergonomic Products

CLASSIFICATIONS BASED ON AQUACULTURE PRODUCTS

1. **Nutraceutical Products** - aquatic organisms are raised for the purpose of food and medicine.

2. **Recreation** - aquatic organisms are raised primarily for leisure (bait fish for sport fishing)

3. **Ornamental** - aquatic organisms are raised for their aesthetic appeal.

In this type of system, aquatic organisms are reared in natural or man-made bodies of water.

A. Open Aquaculture System
B. Natural Aquaculture System
C. Flow Through Aquaculture System
D. Recirculating Aquaculture System

In this type of system, aquatic organisms are reared in natural or man-made bodies of water.

A. Open Aquaculture System
B. Natural Aquaculture System
C. Flow Through Aquaculture System
D. Recirculating Aquaculture System

A type of aquaculture system in which water makes one pass through the system and is discharged.

A. **Single-Pass Aquaculture System**
B. **Natural Aquaculture System**
C. **Flow Through Aquaculture System**
D. **Recirculating Aquaculture System**

A type of aquaculture system in which water makes one pass through the system and is discharged.

A. Single-Pass Aquaculture System
B. Natural Aquaculture System
C. Flow Through Aquaculture System
D. Recirculating Aquaculture System

A type of aquaculture system characterized by reconditioning and reuse of water.

A. Open Aquaculture System
B. Unnatural Aquaculture System
C. Closed Aquaculture System
D. Circulating Aquaculture System

A type of aquaculture system characterized by reconditioning and reuse of water.

A. Open Aquaculture System
B. Unnatural Aquaculture System
C. Closed Aquaculture System
D. Circulating Aquaculture System

CLASSIFICATIONS BASED ON WATER USE

1. **Open Systems** - aquatic organisms are raised in natural or man-made bodies of water (such as in cages, pens, and enclosures).

2. **Flow-Through Systems** – also referred to as semi-closed systems, are systems in which the culture water makes a single pass through the aquaculture system and is then discharged

3. **Closed Systems** - the water is reconditioned and then recirculated throughout the system.

A type of aquaculture system in which only one type of organism is being cultured.

A. Low-Cost Aquaculture
B. Single Aquaculture
C. Monoculture
D. Monotype Aquaculture

A type of aquaculture system in which only one type of organism is being cultured.

A. Low-Cost Aquaculture
B. Single Aquaculture
C. Monoculture
D. Monotype Aquaculture

A type of aquaculture system in which two or more types of organisms are being cultured.

A. Expensive Aquaculture
B. Multiculture
C. Interculture
D. Polyculture

A type of aquaculture system in which two or more types of organisms are being cultured.

A. Expensive Aquaculture
B. Multiculture
C. Interculture
D. Polyculture

CLASSIFICATIONS BASED ON NUMBER OF SPECIES

1. **Monoculture** – only one organism is raised in the system.

2. **Polyculture** – two or more organisms are raised within the same system, such as milkfish and tilapia, milkfish and shrimp, etc.

This refers to species that are naturally indigenous to an area.

A. Native Species
B. Endemic Species
C. Exotic Species
D. Monogastric Species

This refers to species that are naturally indigenous to an area.

A. Native Species
B. Endemic Species
C. Exotic Species
D. Monogastric Species

This refers to species that are introduced to an area and is not indigenous to a given region.

A. Outsider Species
B. Endemic Species
C. Exotic Species
D. Introduced Species

This refers to species that are introduced to an area and is not indigenous to a given region.

A. Outsider Species
B. Endemic Species
C. Exotic Species
D. Introduced Species

This refers to species that are peculiar to an area.

A. **Endemic Species**
B. **Natural Species**
C. **Wonderful Species**
D. **Special Species**

This refers to species that are peculiar to an area.

A. Endemic Species
B. Natural Species
C. Wonderful Species
D. Special Species

This refers to sexually mature fish that is kept for use as parent stock for the production of fry and fingerling.

A. Broodstock
B. Mama and Papa Fish
C. Spawner
D. Brooder

This refers to sexually mature fish that is kept for use as parent stock for the production of fry and fingerling.

A. Broodstock
B. Mama and Papa Fish
C. Spawner
D. Brooder

This refers to a fish that is pregnant.

A. **Pregnant**
B. **Gravid**
C. **Fish-in-Fry**
D. **Mommy Oni**

This refers to a fish that is pregnant.

A. Pregnant
B. Gravid
C. Fish-in-Fry
D. Mommy Oni

This refers to a fish that is ready to lay eggs.

A. Spawner
B. Spawnacious
C. In Heat
D. Estrous

This refers to a fish that is ready to lay eggs.

A. Spawner
B. Spawnacious
C. In Heat
D. Estrous

This refers to organism that inhabit the bottom of the body of water, which sometimes serves as food for fish.

A. Plankton
B. Benthos
C. Lab-lab
D. Algae

This refers to organism that inhabit the bottom of the body of water, which sometimes serves as food for fish.

A. Plankton
B. Benthos
C. Lab-lab – algal mat used as feed for milkfish
D. Algae

This refers to tiny plant-like and animal –like organisms which drift with the water current and serves as food for fish.

A. Plankton
B. Benthos
C. Lab-lab
D. Algae

This refers to tiny plant-like and animal –like organisms which drift with the water current and serves as food for fish.

A. **Plankton**
B. **Benthos**
C. **Lab-lab**
D. **Algae**

This refers to organisms that can withstand small variations in the salinity of the growing medium such as carps and mackerels.

A. Stenohaline Organism
B. Euryhaline Organism
C. Analine Organism
D. Kataline Organism

This refers to organisms that can withstand small variations in the salinity of the growing medium such as carps and mackerels.

A. Stenohaline Organism
B. Euryhaline Organism
C. Analine Organism
D. Kataline Organism

This refers to organisms which spawns in freshwater and spends their lives in saltwater habitats.

A. Stenohaline Organism
B. Euryhaline Organism
C. Anadromous Organism
D. Katadromous Organism

This refers to organisms which spawns in freshwater and spends their lives in saltwater habitats.

A. Stenohaline Organism
B. Euryhaline Organism
C. Anadromous Organism
D. Katadromous Organism

This refers to organisms that can withstand wide variations in the salinity of the growing medium such as crabs.

A. Stenohaline Organism
B. Euryhaline Organism
C. Analine Organism
D. Kataline Organism

This refers to organisms that can withstand wide variations in the salinity of the growing medium such as crabs.

A. Stenohaline Organism
B. Euryhaline Organism
C. Analine Organism
D. Kataline Organism

This refers to organisms which spawns in salt water and spends their lives in freshwater habitats.

A. Stenohaline Organism
B. Euryhaline Organism
C. Anadromous Organism
D. Katadromous Organism

This refers to organisms which spawns in salt water and spends their lives in freshwater habitats.

A. Stenohaline Organism
B. Euryhaline Organism
C. Anadromous Organism
D. Katadromous Organism

This refers to the degree of hotness or coldness of the culture media.

A. Temperature
B. Climate
C. Hot Maria Clara
D. Oxidation-Reduction Potential

This refers to the degree of hotness or coldness of the culture media.

A. Temperature
B. Climate
C. Hot Maria Clara
D. Oxidation-Reduction Potential

This refers to the visible hue or tint of the water due to dissolved substances.

A. Turbidity
B. Haziness
C. Color
D. TDS

This refers to the visible hue or tint of the water due to dissolved substances.

A. Turbidity
B. Haziness
C. Color
D. TDS

This refers to the clarity of the water as an effect of the scattering of light due to suspended particles.

A. Turbidity
B. Haziness
C. Color
D. TDS

This refers to the clarity of the water as an effect of the scattering of light due to suspended particles.

A. Turbidity
B. Haziness
C. Color
D. TDS

This refers to a simple device used to determine the turbidity of water in units of depth.

A. Secchi Disk
B. Vinyl Disk
C. Diskney Princess
D. Princess Daisy

This refers to a simple device used to determine the turbidity of water in units of depth.

A. Secchi Disk
B. Vinyl Disk
C. Diskney Princess
D. Princess Daisy

This refers to small solid particles that are dispersed in water.

A. Dissolved Solids
B. Suspended Solids
C. Insoluble Solids
D. Volatile Solids

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A. Dissolved Solids
B. Suspended Solids
C. Insoluble Solids
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WATER SUPPLY AND QUALITY

The availability and quality of water supply is the most crucial factor to be considered in aquaculture. An **adequate supply of water free from any form of pollution** should be available throughout the year or at least the whole growing period.

- A minimum requirement of 5 L/sec/ha of pond for systems supplied with water from reservoirs such as rivers, wells, groundwater.

- A minimum requirement of 10-15 ha of catchment area to 1 ha of pond for systems supplied with rainwater.

WATER SUPPLY AND QUALITY

- **Temperature** – this refers to the hotness or coldness of the growing medium.
- **Color and Turbidity** – color refers to the visible hue or tint of the water due to dissolved substances, while turbidity pertains to the clarity of the water as an effect of the scattering of light due to suspended particles.
- **Suspended Solids –** small solid particles that are dispersed in water.
- **Dissolved Oxygen** – this refers to the amount of oxygen that is present in water. A DO level greater than **3 mg/L** is required for aquaculture.

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Parameter	Acceptable range
pH	7.0 - 8.5
Alkalinity (as $CaCO_3$)	100 - 400 ppm or mg/L
Dissolved oxygen	> 3 mg/L
Total hardness	100 - 400
Carbon dioxide	0 - 15
Iron – ferrous (Fe^{2+})	Less than 0.1 ppm
Unionized Ammonia (NH_3)	Less than 0.02 ppm
Nitrate-N (NO_3-N)	0 - 3.0 ppm
Nitrite-N (NO_2-N)	0.1 ppm

Which of the following is not suitable for aquaculture?

A. A soil that is not highly permeable.
B. Soils that have at least 20 percent clay content.
C. Soils that have excessive seepage loss.
D. Soils that have good compaction.

Which of the following is not suitable for aquaculture?

A. A soil that is not highly permeable.
B. Soils that have at least 20 percent clay content.
C. Soils that have excessive seepage loss.
D. Soils that have good compaction.

TYPE OF SOIL

1. The soil should not be highly permeable to prevent the excessive seepage of water from the pond. It should also be able to support vegetation growth at the pond bottom.

VEGETATION

Vegetation in an area can also provide insights regarding the quality of the soil. The type and density of vegetation is indicative of the productivity and physical property of the soil.

Which of the following is generally suitable for an inland aquaculture system?

A. Flat areas with at least 3 percent slope.
B. Very steep areas.
C. Areas that are susceptible to drought.
D. Areas that have a rolling type of terrain.

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A. Flat areas with at least 3 percent slope.
B. Very steep areas.
C. Areas that are susceptible to drought.
D. Areas that have a rolling type of terrain.

TOPOGRAPHY AND DRAINAGE

Topography refers to the lay of the land with respect to the variations in elevation. Site suitability should be assessed based on the economic cost of converting the area into a fishpond.

Which of the following is correct?

A. **Winds does not have erosive property.**
B. **Ponds should be designed based on the height of a flood with a recurrence interval of 10-15 years.**
C. **Ponds should be designed based on the height of a flood with a recurrence interval of 20-25 years.**
D. **There should be no wind in the aquaculture site.**

Which of the following is correct?

A. Winds does not have erosive property.
B. **Ponds should be designed based on the height of a flood with a recurrence interval of 10-15 years.**
C. Ponds should be designed based on the height of a flood with a recurrence interval of 20-25 years.
D. There should be no wind in the aquaculture site.

WATERSHED AND CLIMATIC CONSIDERATIONS

1. Prevailing winds are considered in designing due to its erosive properties and its ability to provide natural aeration to the pond.

2. Rainfall and watershed is also evaluated due to its influence in flooding and runoff. Generally, a larger watershed produces a larger quantity of runoff.

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Which of the is not a finfish?

A. *Perna viridis*
B. *Oreochromis niloticus*
C. *Chanos chanos*
D. *Clarias batrachus*

Which of the is not a finfish?

A. *Perna viridis*
B. *Oreochromis niloticus*
C. *Chanos chanos*
D. *Clarias batrachus*

Which of the following is crustacean?

A. *Perna viridis*
B. *Lates calcarifer*
C. *Scylla serrata*
D. *Crassostrea iredalei*

Which of the following is crustacean?

A. *Perna viridis*
B. *Lates calcarifer*
C. *Scylla serrata*
D. *Crassostrea iredalei*

Which of the following is grown on ropes?

A. *Kappaphycus*
B. *Hypophthalmichtys nobilis*
C. *Epinephelus spp.*
D. *Chanos chanos*

Which of the following is grown on ropes?

A. *Kappaphycus*
B. *Hypophthalmichtys nobilis*
C. *Epinephelus spp.*
D. *Chanos chanos*

Milkfish (*Chanos chanos*)

1. Bangus can grow in salt water and freshwater but is mainly cultured in brackish water ponds

2. Usually raised in extensive and semi-intensive systems.

3. Takes at least 3-4 months to reach marketable size.

https://www.fao.org/fishery/docs/CDrom/aquaculture/I1129m/fil e/en/en_milkfish.htm

PNS:BAFS 196:2025 Milkfish and Tilapia – Code of Good Aquaculture Practice

Table A.1. Recommended stocking density for milkfish in relation to the type of cage (PCAARRD-DOST, 2016)

Type of cage	Stocking density
Floating and stationary cages in shallow water	5-30 pcs/m^3
Floating cages in deep lakes and bays	30-40 pcs/m^3
Offshore cages	40-100 pcs/m^3

Table B.1. Water quality requirements of milkfish (PCAARRD-DOST, 2016)

Parameters	Range
Dissolved oxygen	5 ppm
pH	-
Temperature	25 ℃-32 ℃ or 10 ℃ – 40 ℃
Salinity	0.5-40 ppt

Nile Tilapia (*Oreochromis niloticus*)

1. Nile Tilapia is cultured in floating fish cages and fish pens, usually in semi-intensive or intensive methods
2. Also cultured in earthen ponds.
3. Takes at least 4 months to reach marketable size.

https://www.fao.org/fishery/docs/CDrom/aquaculture/I1129m/file/en/en_niletilapia.htm

PNS:BAFS 196:2025 Milkfish and Tilapia – Code of Good Aquaculture Practice

Table A.2. Recommended stocking density for tilapia in ponds based on the type of culture system (Eguia et al., 2020)

Culture system	Stocking density (fingerlings/m$^{3)}$
Extensive	1-2
Semi-intensive	3-4
Intensive	5-10

Table B.2. Water quality requirements of tilapia (Eguia et al., 2020)

Parameter	Range	Optimum for growth
Salinity (ppt)	0-36 ppt (depending on species)	Up to 19 ppt
Dissolved oxygen (mg/L)	Down to 0.1	>3
Temperature	8-42	22-29
pH	3.7-11	7-9
Ammonia (mg/L)	Up to 7.1	<0.05

Catfish (*Clarias spp.*)

1. Common catfish species raised in the Philippines are *C. gariepinus, C. macrocephalus, and C. batrachus.*

2. Cultured in freshwater ponds and tanks; known or being very hardy.

Grouper

1. Groupers, commonly known as lapu-lapu, may be raised in sea-based cages and pens and brackishwater ponds and tanks.

PNS:BAFS 334:2022 Grouper – Code of Good Aquaculture Practices

Big Head Carp (*Hypophthalmichthys nobilis*)

1. Bighead carp is usually grown together with tilapia or milkfish in Laguna Lake.

2. Has a very niche market.

Asian Sea Bass / Barramundi
(*Lates calcarifer*)

Pompano
(*Trachinotus blochii*)

Tiger Shrimp (*Penaeus monodon*)

1. Locally known as sugpo.

2. Raised in brackishwater ponds, commonly polycultured with milkfish.

3. It takes at least 4 months to grow prawns into marketable sizes.

Whiteleg Shrimp (*Penaeus vannamei*)

Giant Freshwater Prawn (*Macrobrachium rosenbergii)*

Mud Crab (*Scylla serrata*)

1. Thrives in brackishwater and is a popular species for aquasilviculture.

Oyster (*Crassostrea iredalei, Saccostrea spp.*) and Mussels (*Perna viridis*)

1. Farms are constructed in shallow coastal areas with clean water and free from heavy waves.
2. Oysters feed on planktons.

SEAWEEDS

1. Seaweed farms are constructed in shallow coastal areas with clean water and free from heavy waves. Starter stocks are tied in ropes.

2. The most common species grown are Kappaphycus and *Euchema*

https://www.fao.org/4/ab719e/AB719E09.htm

This refers to aquaculture systems in which there is only a few restriction in the interaction between the culture and the immediate environment.

A. Open Systems
B. Non-Restricted System
C. Closed Systems
D. Mama Mo

This refers to aquaculture systems in which there is only a few restriction in the interaction between the culture and the immediate environment.

A. Open Systems
B. Non-Restricted System
C. Closed Systems
D. Mama Mo

This refers to a type of culture in which organisms are reared in a volume of water enclosed in all sides while allowing free circulation of water.

A. Cage Culture
B. Free Culture
C. Open Culture
D. Pen Culture

This refers to a type of culture in which organisms are reared in a volume of water enclosed in all sides while allowing free circulation of water.

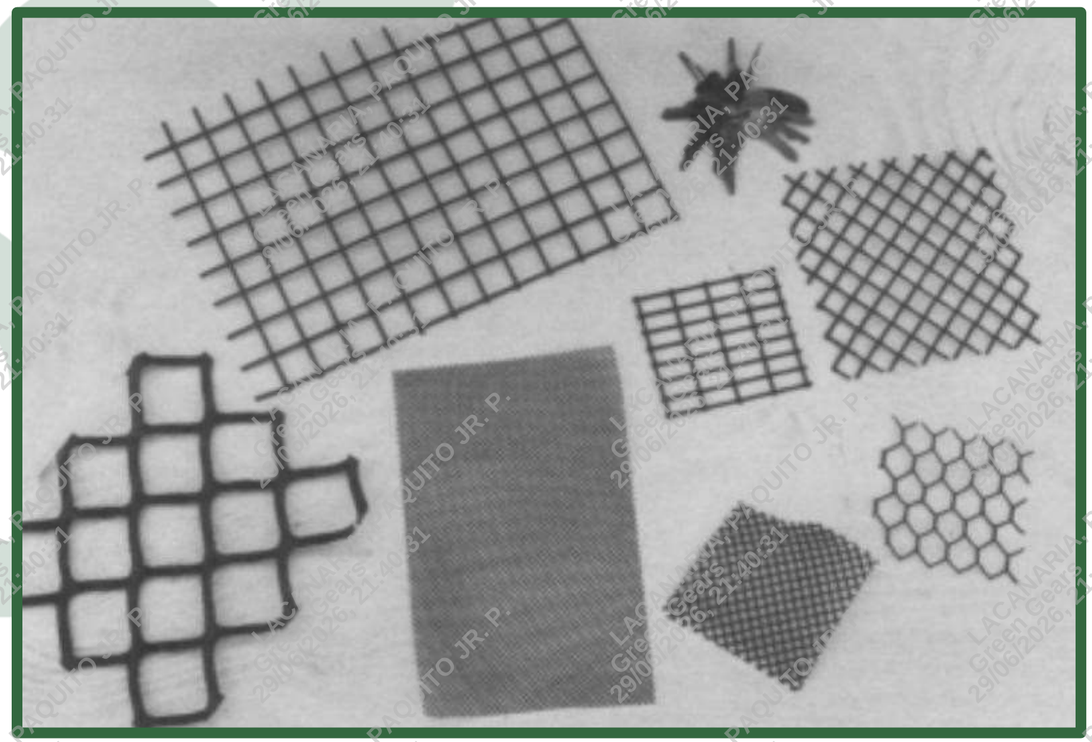
A. Cage Culture
B. Free Culture
C. Open Culture
D. Pen Culture

This refers to mesh or net structure which holds the fish in a cage system.

A. Cage Bag
B. Cage Nets
C. Cage Enclosure
D. Cage Enclosure

This refers to mesh or net structure which holds the fish in a cage system.

A. Cage Bag
B. Cage Nets
C. Cage Enclosure
D. Cage Enclosure



This refers to structure used to support the cage bag, generally following its shape.

A. Frame
B. Collars
C. Moors
D. Shape Retainer

This refers to structure used to support the cage bag, generally following its shape.

A. Frame
B. Collars
C. Moors
D. Shape Retainer

This refers to a structure used retain the shape of the cage bag in the horizontal plane. It also usually is integrated with the float device to provide buoyancy to the system.

A. Linings
B. Collars
C. Floats
D. Shape Retainer

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This refers to a structure used retain the shape of the cage bag in the horizontal plane. It also usually is integrated with the float device to provide buoyancy to the system.

A. Linings
B. Collars
C. Floats
D. Shape Retainer

This is composed primarily of lines and anchors which keeps the cage in place.

A. Anchoring System
B. Bedding System
C. Mooring System
D. Stay Put System

This is composed primarily of lines and anchors which keeps the cage in place.

A. Anchoring System
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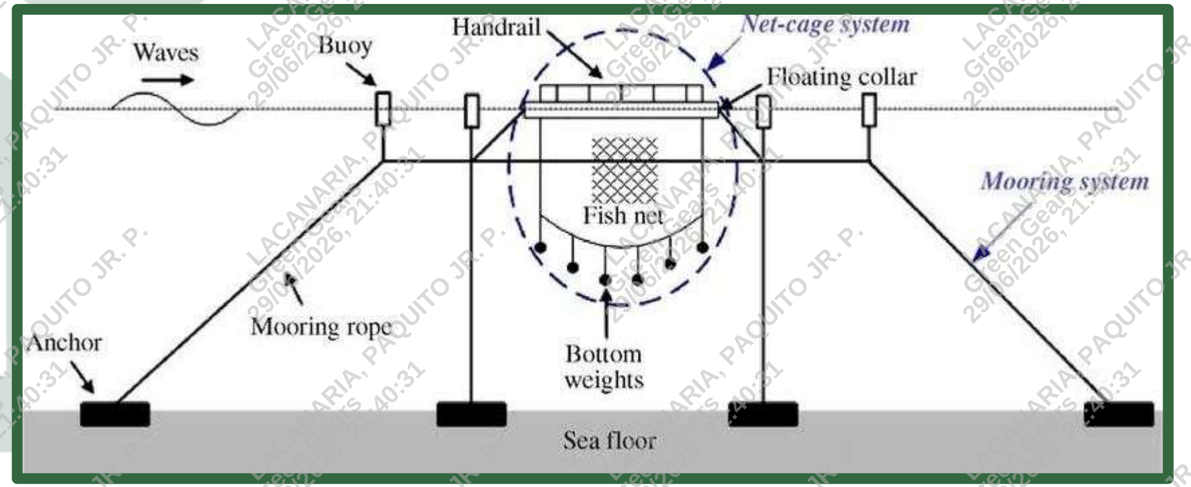

This refers to a type of fish cage which is fixed into position using poles or post.

A. Rigid Cage
B. Fixed Cage
C. Stationery Cage
D. Buoyant Cage

This refers to a type of fish cage which is fixed into position using poles or post.

A. Rigid Cage
B. Fixed Cage
C. Stationery Cage
D. Buoyant Cage

This refers to fish cages which are supported by a floating frame where net bags hang in water without touching the bottom.

A. Floating Cage
B. Fleeting Cage
C. Versatile Cage
D. Buoyant Cage

This refers to fish cages which are supported by a floating frame where net bags hang in water without touching the bottom.

A. Floating Cage
B. Fleeting Cage
C. Versatile Cage
D. Buoyant Cage

This refers to fish cages which are suspended from the surface of water and has adjustable buoyancy.

A. Adjustable Cage
B. Submersible Cage
C. Versatile Cage
D. Buoyant Cage

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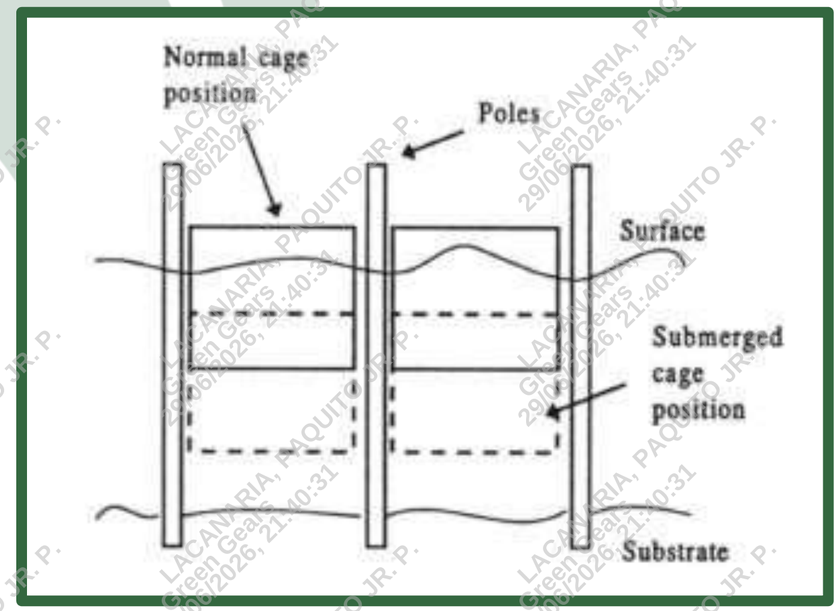
A. Adjustable Cage
B. Submersible Cage
C. Versatile Cage
D. Buoyant Cage



This refers to fish cages which are fitted in sold frames and is submerged under water.

A. **Submerged Cage**
B. **Underwater Cage**
C. **Rigid Cage**
D. **Ordinary Cage**

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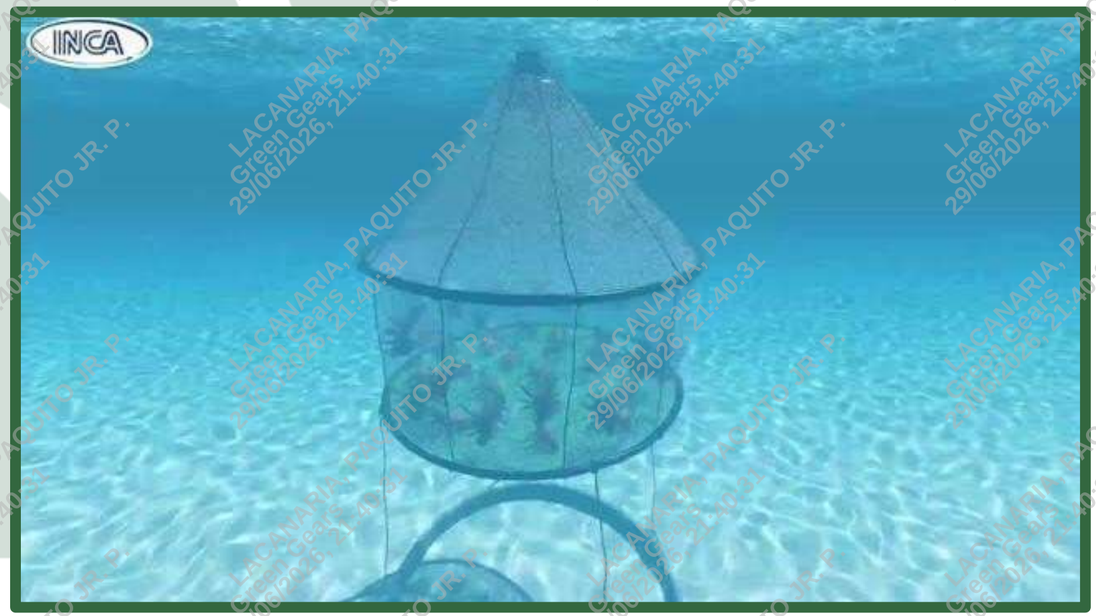

This refers to the fish in a volume of water enclosed in all sides except the bottom.

A. Pen Culture
B. Pond Culture
C. Bottomless Culture
D. Sides Culture

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A. **Pen Culture**
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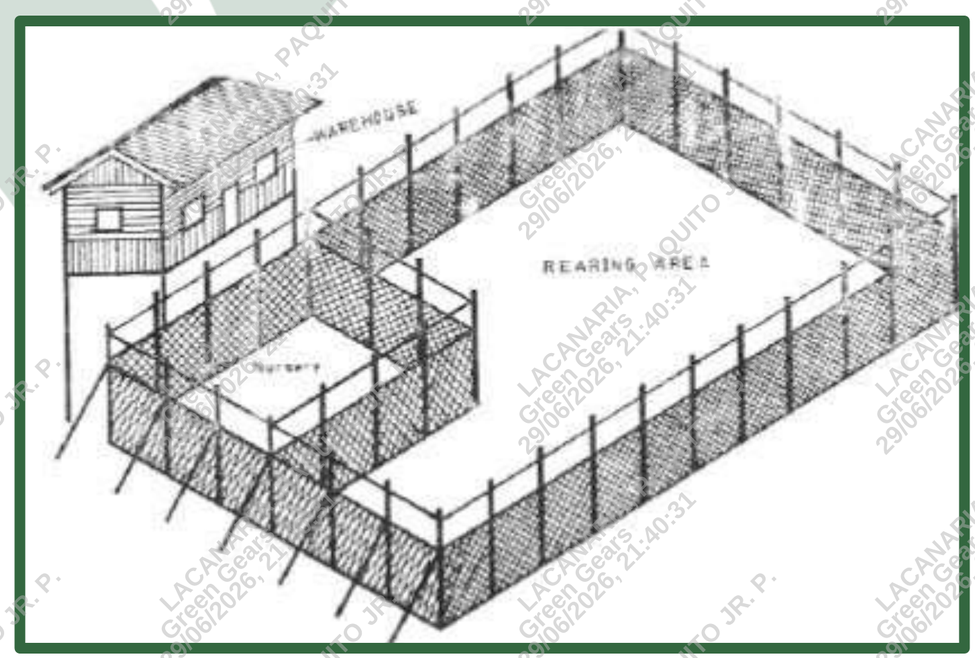

The following are suitable conditions for pen culture except:

A. **Water must shallow, not deeper than 10 meters.**
B. **Flow velocity must be 0.2-0.5 m/s.**
C. **Siltation is encouraged.**
D. **Bottom soil must have presence of detritus.**

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This type of pond involves the construction of dams in natural valleys in which aquatic organisms will be culture.

A. Valley Ponds
B. Watershed Ponds
C. Valley Balls
D. Pond Raceways

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This type of pond constructing dug out reservoirs where aquatic organisms will be culture.

A. **Excavated Ponds**
B. **Levee Ponds**
C. **Fish Ponds**
D. **Confidential Pond**

This type of pond constructing dug out reservoirs where aquatic organisms will be culture.

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This pond culture involves the construction of levees, dikes, and bunds to contain water for raising aquaculture organisms.

A. Dug Out Ponds
B. Enclosure Ponds
C. Sinking Ponds
D. Embankment Ponds

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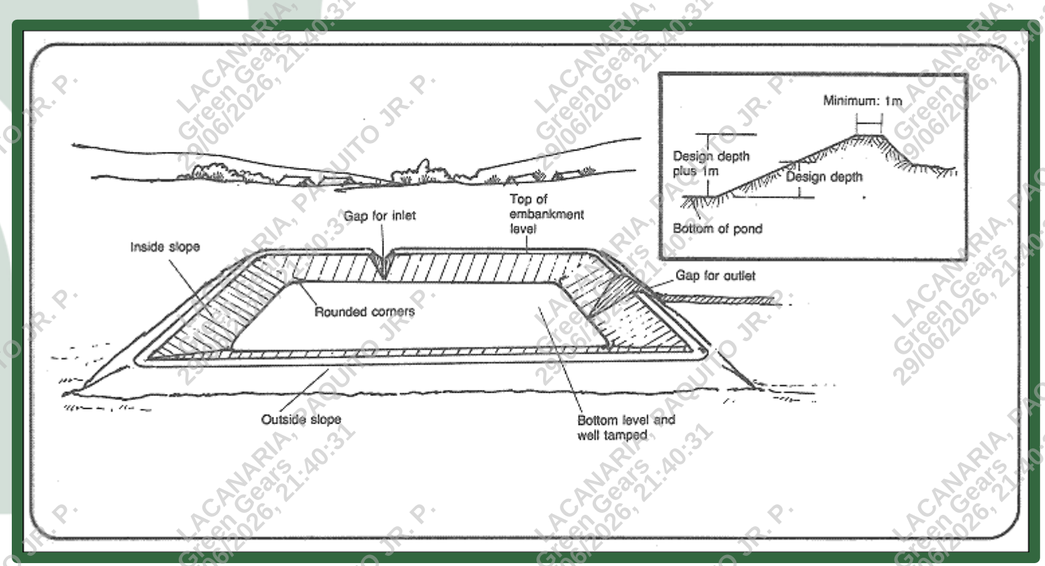

TYPES OF PONDS

1. **Watershed Ponds** - involves the construction of dams in natural valleys. The depth of water is dependent on the topography of the area. the watershed is the source of water.

2. **Excavated / Dugout Ponds** - reservoirs are dug out in the soil and is filled with water for the purpose of aquaculture production. Generally constructed in relatively flat areas and has to be pumped to drain.

3. **Embankment Ponds** - levees, dikes, and bunds are constructed to contained water for raising aquaculture organism. This is the primary method of pond culture and can be constructed over a wide range of topography. This process involves both digging (for depth) and construction (for embankments).

Considerations in Pond Construction

1. Pond design should be dependent on topography, water supply, drainage, and purpose. The bottom slope should be at least 0.05 to 0.2 percent.

2. Smaller ponds incur greater construction and maintenance cost but is easier to manage. Deeper ponds are expensive to construct.

3. Oxygen depletion is less likely on larger ponds, but contamination and infestation is harder to manage. It is also more prone to the erosion due to the effect of wind (produces waves).

$$\boldsymbol{Wave\ Height = 100 \times 1/3\ sqrt(B)}$$

Wave Height is in cm, fetch is in km.

where B = fetch (pond dimension in the wind direction)

A rectangular pond with dimensions 60 m x 80 m with 1.2 m water depth is oriented diagonally along the general wind direction. Estimate the wave height.

A. 10.5 cm
B. 9.5 cm
C. 8 cm
D. 12.7 cm

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A rectangular pond with dimensions 60 m x 80 m with 1.2 m water depth is oriented diagonally along the general wind direction. Estimate the wave height.

1. **Find the length of the fetch.**

$$B = \sqrt{Length^2 + Width^2}$$
$$= \sqrt{(80\ m)^2 + (60\ m)^2}$$
$$= 100\ m$$

A rectangular pond with dimensions 60 m x 80 m with 1.2 m water depth is oriented diagonally along the general wind direction. Estimate the wave height.

2. Estimate the wave height.

$$Wave\ Height = 100\ x\ \frac{1}{3}\sqrt{B}$$

$$= 100\ x\ \frac{1}{3}\sqrt{100\ m\ x\ \frac{1\ km}{1000\ m}}$$

= 10.54 cm

A rectangular pond with dimensions 90 m x 120 m with 1.5 m water depth is oriented in a way that the longer side is parallel to the general wind direction. Estimate the wave height.

A. 12 cm
B. 11 cm
C. 13 cm
D. 10cm

A rectangular pond with dimensions 90 m x 120 m with 1.5 m water depth is oriented in a way that the longer side is parallel to the general wind direction. Estimate the wave height.

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$$= 100\ x\ \frac{1}{3}\sqrt{90\ m\ x\ \frac{1\ km}{1000\ m}}$$

= 10 cm

Considerations in Levee Construction

1. If the longer side of the pond is perpendicular to the general wind direction, it reduces susceptibility to erosion; while being oriented parallel increases wind action and helps with aeration.

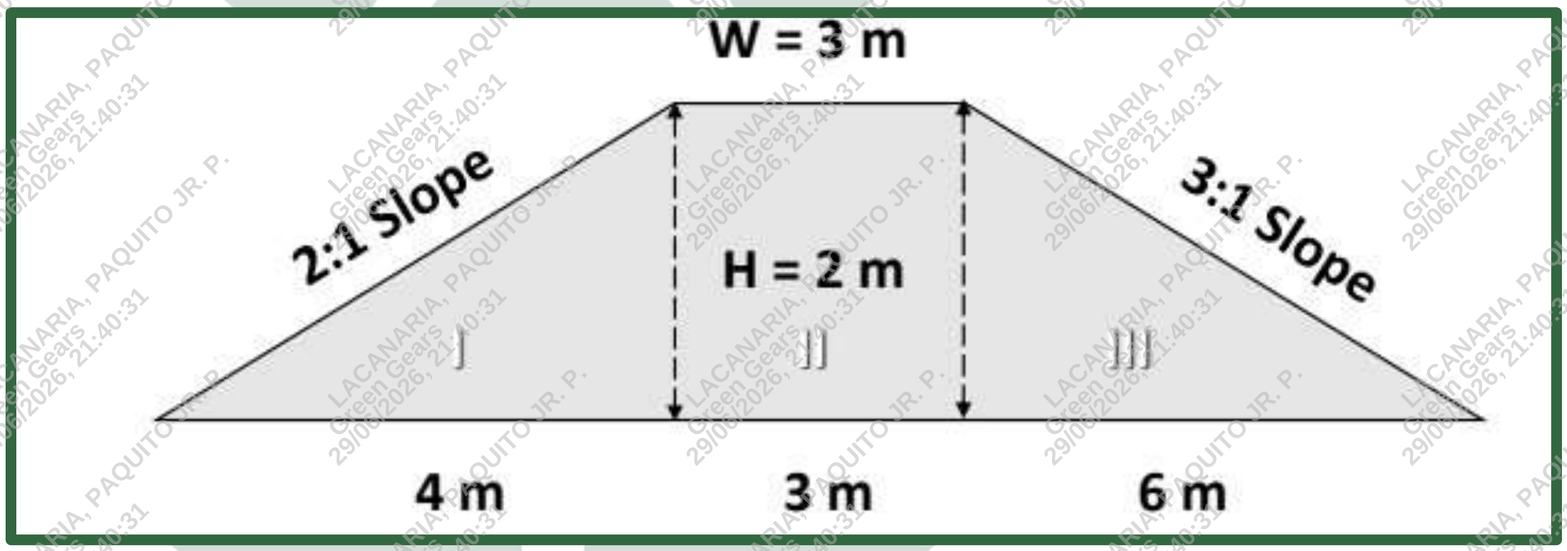
2. The main levee should be at least 6 meters wide to allow passage of harvesting equipment; while levees dividing the ponds should be at least 3 meters wide to for feed trucks.

3. The recommended side slope is 3:1. It should be provided with at least 30 cm of free board.

4. Add 20% for core trench and 15% for settlement.

What is the volume per linear meter of the levee?

A. 16 cu.m.
B. 19 cu. m.
C. 25 cu.m.
D. 22 cu. m.



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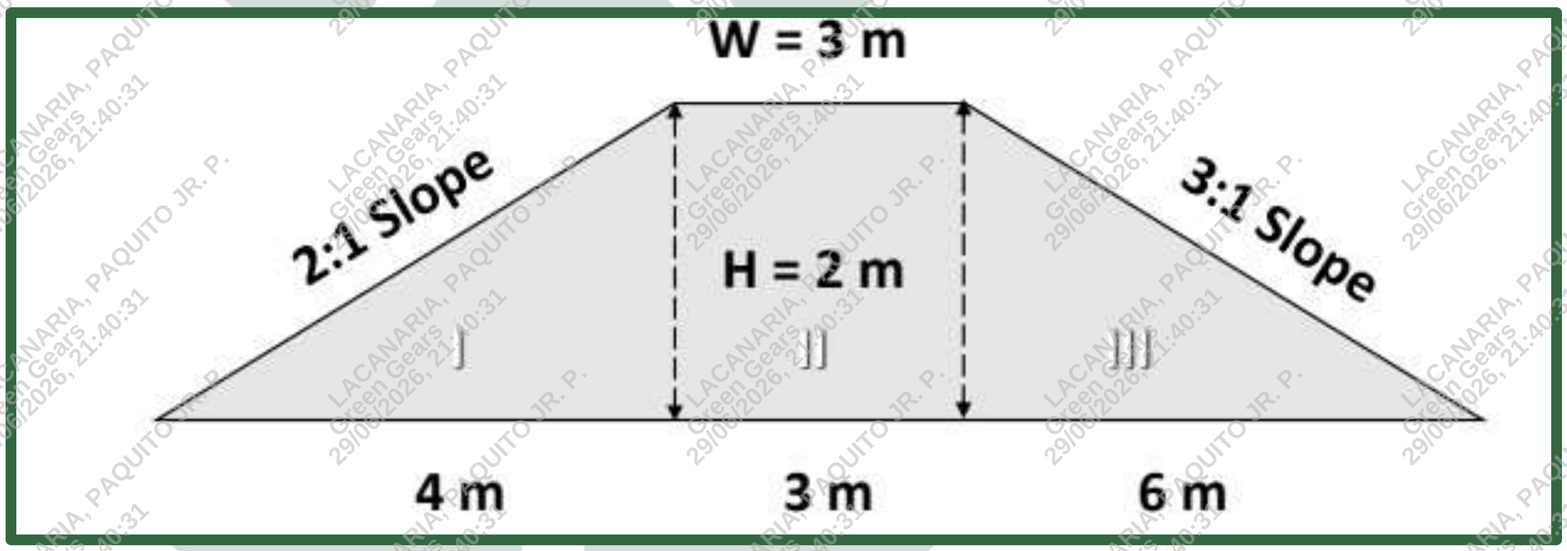


What is the volume per linear meter of the levee?

1. **Solve for the area using formula for trapezoid.**

What is the volume per linear meter of the levee?

1. Solve for the volume.

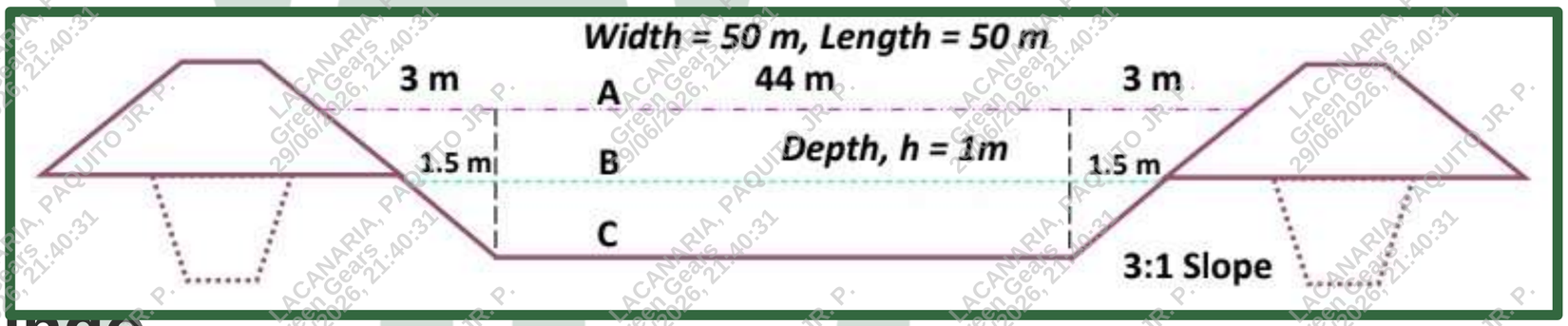
Other Considerations

1. The water supply must be able to fill the pond in seven days or less.

2. Ponds should be able to completely drain in less than two days.

What minimum discharge of the water supply is required for this pond?

A. 3.65 Lps
B. 6.53 Lps
C. 5.36 Lps
D. Eugene Domingo



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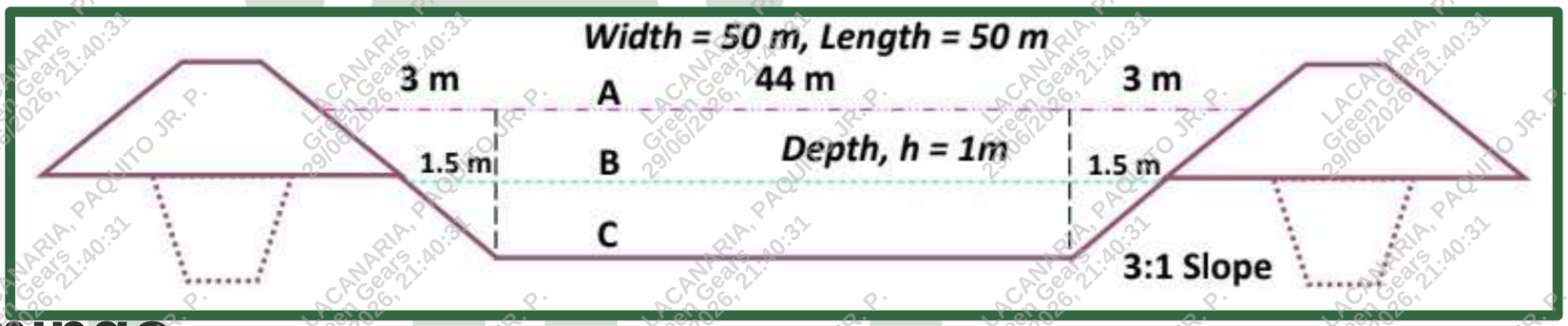
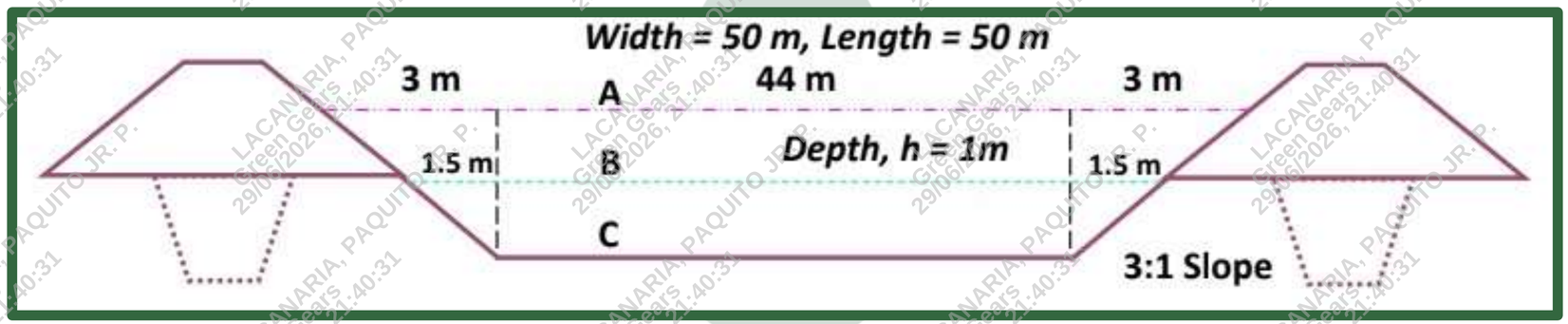
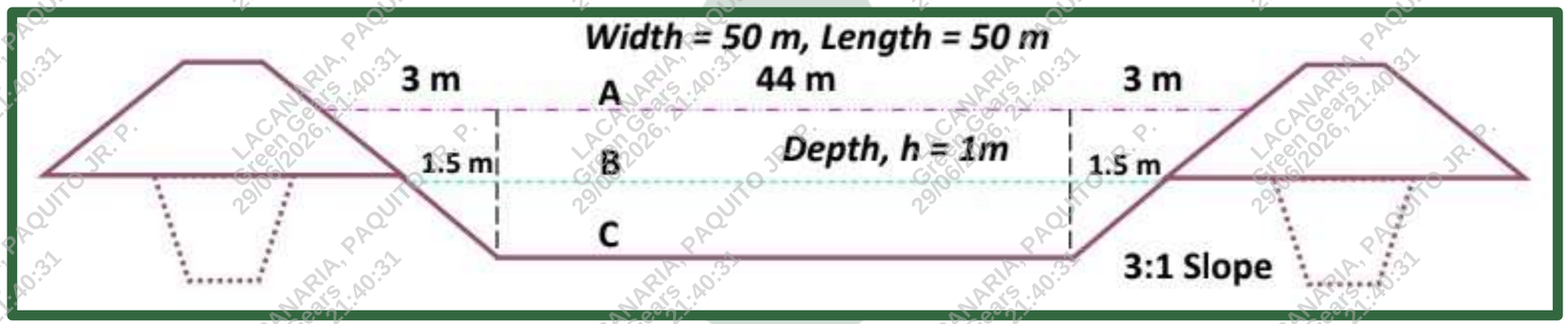




1. **Solve for the pond water volume.**

$$Volume = \frac{(A_a + 4A_b + A_c)}{6}(depth)$$

$$Volume = \frac{\left((50\ x\ 50\ m^2) + 4(47\ x\ 47\ m^2) + (44\ x\ 44\ m^2)\right)}{6}(1\ \mathrm{m}) = 2,212\ \mathrm{m}^3$$



1. **Solve for the minimum discharge using 7 days.**

$$Discharge = \frac{Volume}{Time}$$

$$Discharge = \frac{2{,}212\ m^3}{7\ days}\ x\ \frac{1000\ L}{1\ m^3}\ \text{x}\ \frac{1\ \text{day}}{24\ hr}\ x\ \frac{1\ hr}{3600\ s} = 3.65\ Lps$$

What is the required rate of flow for a fish farm with a total pond area of 2.5 ha and an average pond depth of 1.5 m if it must be filled within a week? Assume 90% conveyance efficiency and 85% application efficiency.

A. 0.076 Lps
B. 76 Lps
C. 0.062 Lps
D. 62 Lps

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Engr. John Henry Sy wants to raise bangus in an inland aquaculture system. A 150 m by 200 m pond with a depth of one meter is to be constructed. Use side slope = 4:1. Consider an application efficiency of 85 percent. What is the volume of the pond?

A. 28 600 cu.m
B. 26 800 cu.m
C. 30 000 cu.m
D. 33 700 cu.m

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A. 5 HP
B. 10 HP
C. 15 HP
D. 20 HP

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A. 2225 m^3
B. 5225 m^3
C. 2525 m^3
D. NOTA

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D. NOTA

Also referred to as flow-through systems, these are culture units in which water flows continuously, making a single pass through the culture unit before being discharged.

A. **Single-Pass Culture**
B. **Raceway Culture**
C. **Graduation Culture**
D. **Raiseway Culture**

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A. Single-Pass Culture
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These are basically channels where fish are reared.

A. **Fish Channel**
B. **Concrete Channel**
C. **Cipolletti Weir**
D. **Raceways**

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A. Fish Channel
B. Concrete Channel
C. Cipolletti Weir
D. Raceways

Which of the following is not true?

A. **Incoming water may require pre-treatment.**
B. **Discharge may not require pre-treatment.**
C. **Ease of harvest is one of the advantage of raceways**
D. **Raceways treat and reuse discharged culture water.**

Which of the following is not true?

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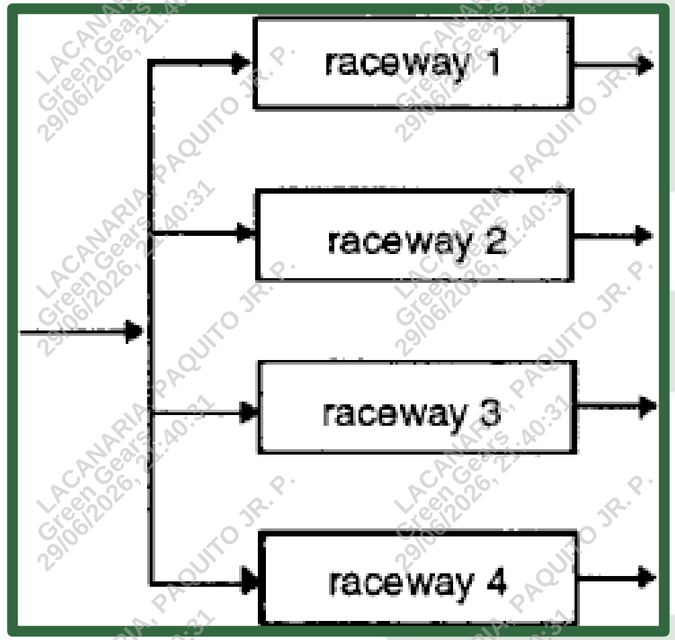
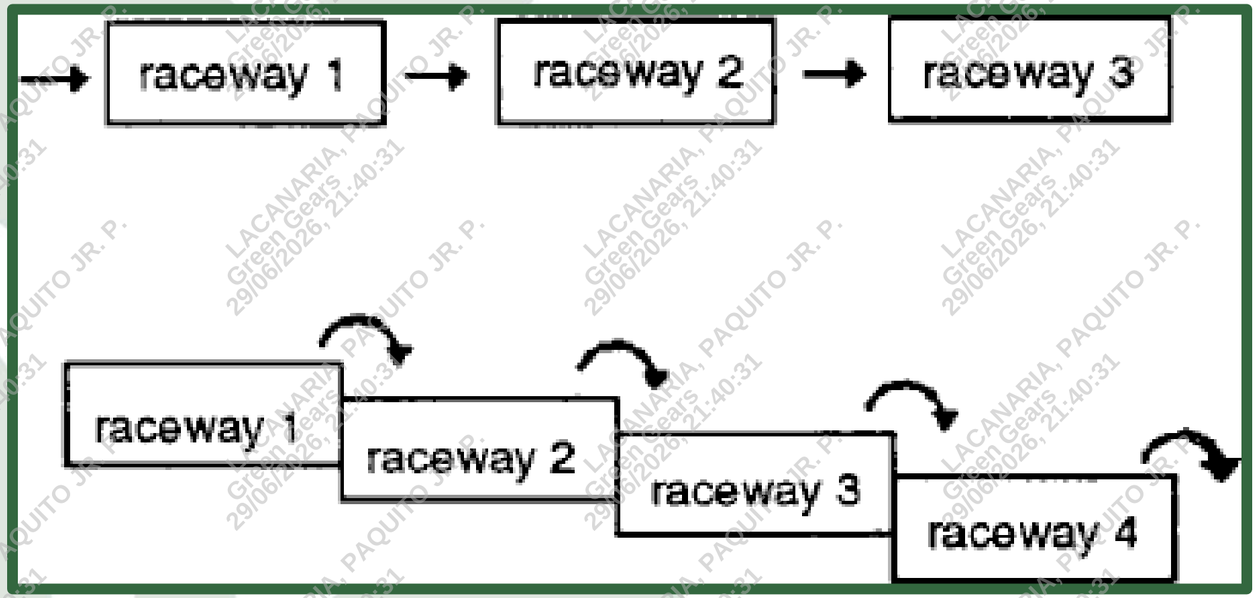
RACEWAY LAYOUT





Raceway Design Dimensions

1. Long, narrow, rectangular raceways with a length-to-Width ratio of 10:1.
2. Depth must be kept from 0.75 – 1.25 meters.

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Flow Requirement in Raceway Systems

Flow Requirement for Oxygen

$$Q_{DO} = \frac{K_{DO} \cdot F}{DO_{in} - DO_{out}}$$

Flow Requirement for Ammonia Flushing

$$Q_{TAN} = \frac{K_{TAN} \cdot F}{TAN_{out} - TAN_{in}}$$

Flow Requirement in Raceway Systems

Hydraulic Retention Time

$$HRT = Volume / Discharge$$

Time Required to Replace Water

$$t = -\ln(1-f)\ HRT$$

For every one (1) kg of feed:

250 g of DO consumption
30 g of TAN produced
8 g of Phosphorus produced
500 g of fecal solids produced
340 g of carbon dioxide produced

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What is the minumum flow requirement of a raceway system growing 350 kg of fish if the Total Ammonia Nitrogen must be kept below 1 mg/L? Assume a daily feed ration of 3% of fish biomass.

A. 218.75 Lpm
B. 154.32 Lpm
C. 574.23 Lpm
D. 365.78 Lpm

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A. 218.75 Lpm
B. 154.32 Lpm
C. 574.23 Lpm
D. 363.58 Lpm

In the same system, the DO influent and effluent levels are 10 mg/L and 3 mg/L. What is the minimum required flow rate?

A. 218.75 Lpm
B. 154.32 Lpm
C. 574.23 Lpm
D. 260.42 Lpm

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A. 218.75 Lpm
B. 154.32 Lpm
C. 574.23 Lpm
D. 260.42 Lpm

What is the minimum flow requirement of the tank?

A. 218.75 Lpm
B. 239.59 Lpm
C. 260.42 Lpm

What is the minimum flow requirement of the tank?

A. 218.75 Lpm

B. 239.59 Lpm

C. 260.42 Lpm

If the stocking density is 50 kg/m^3, what is the hydraulic retention time?

A. 30 mins
B. 20 mins
C. 40 mins
D. 50 mins

If the stocking density is 50 kg/m^3, what is the hydraulic retention time?

A. 30 mins
B. 20 mins
C. 40 mins
D. 50 mins

How long will it take to replace 50% of the water in the system?

A. 30 mins
B. 20 mins
C. 40 mins
D. 50 mins

How long will it take to replace 50% of the water in the system?

A. 30 mins
B. 20 mins
C. 40 mins
D. 50 mins

This shape of tank is commonly used for nursery and grow-out ponds and have better hydraulic characteristics.

A. Round Tank
B. Conical Tank
C. Tank ng Mama Mo
D. Rectangular Tank

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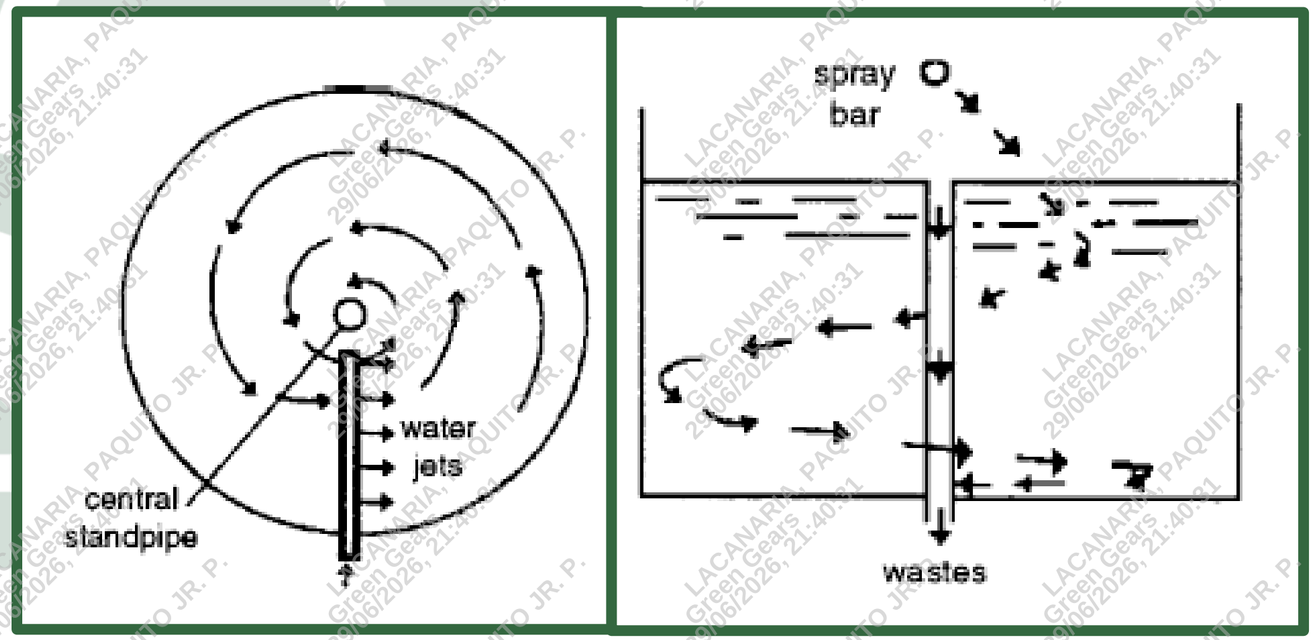

This shape of tank is commonly used in hatcheries and has better utilization of floor space.

A. Oval Tank
B. Rectangular Tank
C. Flat Tank
D. Tank Orange

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A. Oval Tank
B. Rectangular Tank
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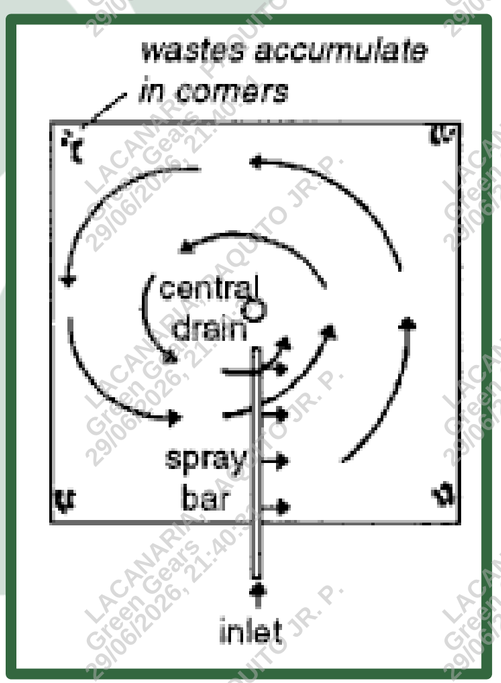

This shape of tank is combines the efficient space utilization of rectangular tanks and the self-cleaning hydraulics of circular tanks.

A. Oval Tank
B. Conical Tank
C. Flat Tank
D. Trapezoidal Tank

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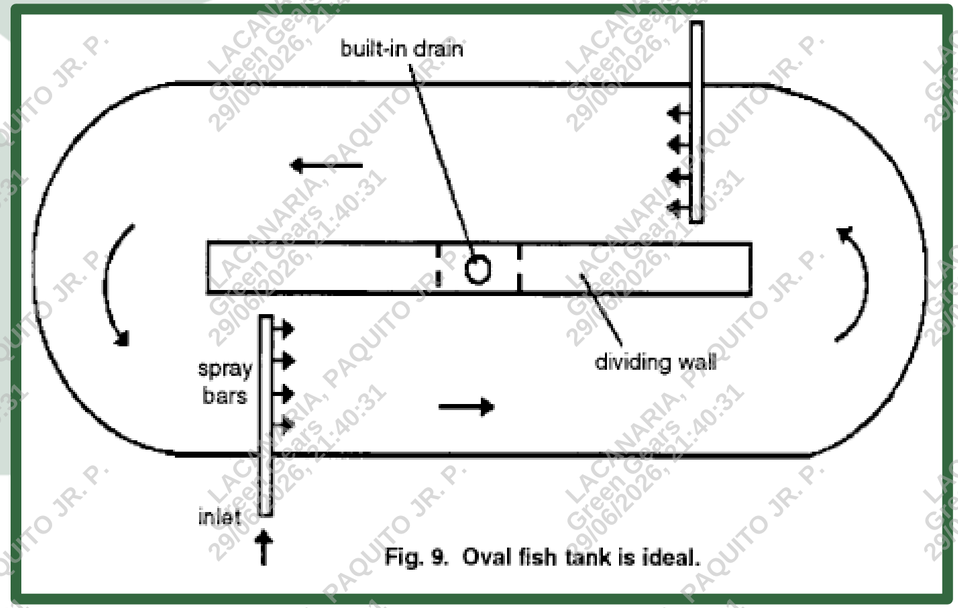

Fig. 9. Oval fish tank is ideal.

This is a self-contained aquaculture system that requires minimal water exchange due to the internal recycling of water and use of biological and mechanical filters.

A. Integumentary System
B. Recombination Agriculture System
C. Recirculating Aquaculture System
D. Water Filtration System

This is a self-contained aquaculture system that requires minimal water exchange due to the internal recycling of water and use of biological and mechanical filters.

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This is considered as the heart of a recirculating aquaculture system.

A. **Biofiltration**
B. **Physical Filtration**
C. **Immaculate Heart of Mary**
D. **Heart ni Henry**

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A. Biofiltration
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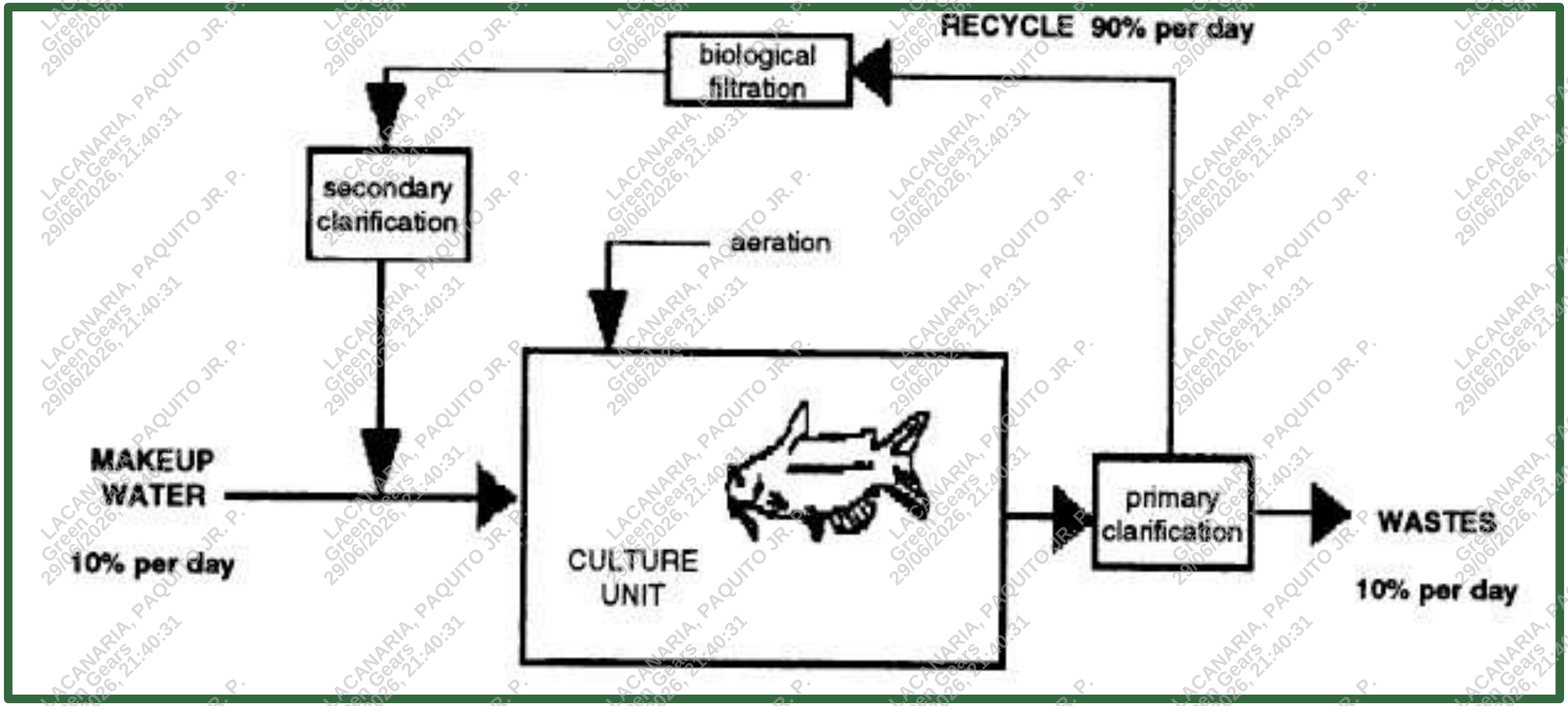

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BIOFILTER SIZING

Calculate the Ammonia Load.

$$E_{TAN} = 30 \text{ g TAN/kg} \times \frac{\% \text{ Crude Protein of your feed}}{35}$$

Choose the type of biofilter (Bead Filters, Fluidized Sand Beds, Trickling Filters, Rotating Biological Contactors)

Calculate the biofilter size (Bead Filters = 490 g TAN / m^3, RBCs = 0.1 – 3 g TAN / m^2)

BIOFILTER SIZING

Volumetric TAN Conversion Rate (Ammonia to Nitrite)

$$\mathrm{VTR} = \frac{K_c \cdot (TAN_I - TAN_E) \cdot Q}{V_m}$$

Volumetric Nitrite Conversion Rate (Nitrite to Nitrate)

$$\mathrm{VNR} = \mathrm{VTR} + \frac{K_c \cdot (NO_{2I} - NO_{2E}) \cdot Q}{V_m}$$

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A 20 ft^3 bead filter was used in a RAS in a 20 m^3 tank. At near harvest with a feed rate of 1% of biomass, a daily ration of 10 kg of 40% crude protein feed was used. Considering Q = 420 Lpm, influent and effluent TAN of 1.35 mg/L and 0.89 mg/L, what is the VTR?

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A 20 ft^3 bead filter was used in a RAS in a 20 m^3 tank. At near harvest with a feed rate of 1% of biomass, a daily ration of 10 kg of 40% crude protein feed was used. Considering Q = 420 Lpm, influent and effluent NO of 0.34 mg/L and 0.40 mg/L, what is the VNR?

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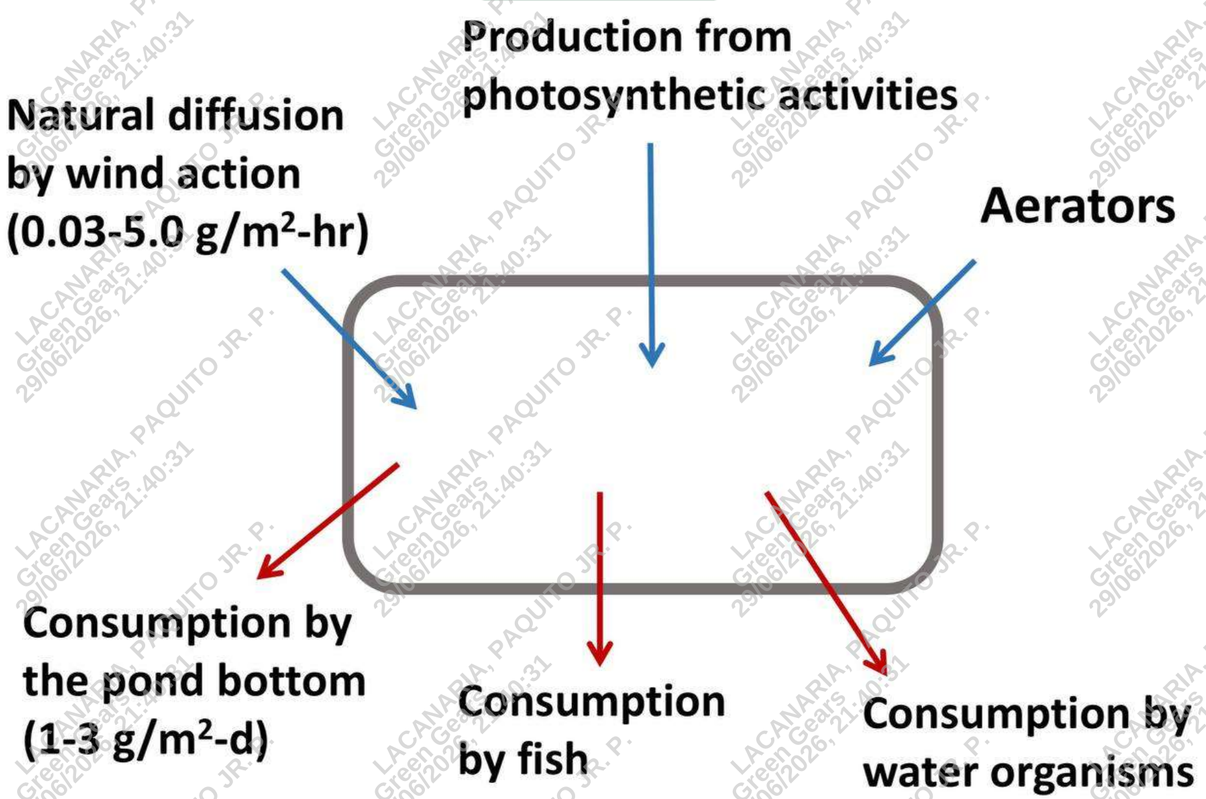
AERATION



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COMMON TYPES OF AERATORS

A measurement of the aerator’s oxygen transfer rate and the amount of energy used per hour, under standard conditions.

A. **Standard Oxygen Transfer Rate**
B. **Standard Oxygen Transfusion Rate**
C. **Standard Aeration Efficiency**
D. **Standard Aerator Efficiency**

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STANDARD AERATION EFFICIENCY

$$SAE = \frac{Standard\ Oxygen\ Transfer\ Rate}{Power\ Consumption}$$

Standard Aeration Efficiency (SAE) is an engineering metric used to evaluate the energy efficiency of mechanical aerators. It is a measure of how much Oxygen is physically dissolved into the water per unit of energy consumption.

Standard Oxygen Transfer Rate (SOTR) is the baseline performance of an aerator under standard conditions (Zero DO, 20 C, 1 atm)

Engr. Izz Nicki Meenaj is supposed to aerate a rectangular tank for the temporary holding of fingerlings. Consider the following:

Parameter	Paddlewheel	Diffused Aerator
Standard Oxygen Transfer Rate (SOTR)	20 kg O_2 / hr	6 kg O_2 / hr
Power Consumption	5 kW	4 kW

What is the SAE of the Paddle Wheel?

A. 4 kg O_2 / kW-hr
B. .25 kg O_2 / kW-hr
C. 1.5 kg O_2 / kW-hr
D. .67 kg O_2 / kW-hr

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Which is the more efficient aerator choice?

A. Paddlewheel because it has a higher SAE.
B. Paddlewheel because its more pretty.
C. Diffused Aerator because it has a higher SAE.
D. Diffused Aerator because it requires a lower power input.

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Which aerator should you use?

a. Paddlewheel because it has a higher SAE.
b. Paddlewheel because it will provide more water movement to increase the oxygen in the tank.
c. Diffused Aerator because it provides a less turbulent aeration compared to paddlewheel.
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Which document or certificate must be obtained prior to the establishment of aquaculture facilities as prescribed by national regulations?

A. Local Transport Permit (LTP)
B. Environmental Compliance Certificate (ECC) or Certificate of Non-Coverage (CNC)
C. Fishpond Lease Agreement (FLA)
D. Self-Monitoring Report (SMR)

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According to the layout and design standards, how must livestock and poultry production be managed relative to the farm's aquaculture production units?

A. They must be integrated using multitrophic design to recycle nutrients.
B. They must be done outside or separate from the aquaculture production units to avoid contamination.
C. They can be placed adjacent to reservoir ponds if a 10-meter buffer is maintained.
D. They must be managed by the same personnel using identical sanitizers.

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What is the mandatory storage protocol for medicated and non-medicated feeds on the farm?

A) They must be stored in the same pallets but labeled with different colors.
B) Medicated feeds must be kept in frozen containment (0-4 C)
C) They must be stored separately to minimize the risk of feeding to non-target animals.
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For products intended to be sold chilled, harvested aquatic organisms must be properly chilled and maintained within what temperature range to preserve freshness and safety?

A) -4 – 0 C
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C) 5 – 10 C
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What document must be secured from the issuing competent authority prior to the domestic transport of fishery products?

A) Self-Monitoring Report (SMR)
B) Environmental Compliance Certificate (ECC)
C) Local Transport Permit (LTP) accompanied by a health certificate and laboratory result
D) Occupational Health and Safety (OH&S) clearance

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When treating and controlling aquatic diseases with authorized veterinary drugs, what is required before any application can take place?

A) A public notification to the local host community
B) A proper diagnosis
C) An alignment assessment with ASEAN standards
D) The immediate draining of the production unit

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Under the Environmental Integrity guidelines, what is the policy regarding the use of lethal methods to eradicate predators?

A) They are allowed only during active disease outbreaks.
B) They are permitted if the predators enter land-based biosecurity sectors.
C) They are discouraged, particularly for those classified as vulnerable, threatened, or endangered.
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What administrative report must be accomplished by the operator to regularly monitor the aquaculture facility's environmental quality in accordance with existing regulations?

A) Occupational Health and Safety (OH&S) Log
B) Self-Monitoring Report (SMR)
C) Local Government Unit (LGU) Zoning Manifest
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Which of the following is an explicit requirement under the Socio-Economic clause of the standard regarding labor conditions?

A) Workers must be provided with continuous off-shore housing.
B) A proactive anti-child labor policy must exist in the farm and comply with regulations.
C) Workers must be selected exclusively from the host local community.
D) Managers must possess a degree in fisheries or aquaculture.

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For traceability purposes, for how long must the specified aquaculture records be kept and maintained by the facility?

A) At least 6 months
B) At least 12 months
C) At least 24 months
D) Permanently for the entire duration of the farm ownership

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FOOD AND SAFETY

Site and Layout: Facilities must be located in areas with minimal contamination risks. Livestock and poultry production must be kept completely separate from aquaculture units to prevent cross-contamination. Toilet and septic systems must be strictly designed to avoid leakage into production areas.

Chemical & Drug Restraints: The use of prohibited antimicrobials and biological substances (such as malachite green, gentian violet, beta-agonists, nitrofurans, olaquindox, carbadox, and chloramphenicol) is strictly banned.

FOOD AND SAFETY

Feed and Storage: Commercial feeds must be sourced from registered companies and are subject to monitoring for aflatoxins and chloramphenicol. Medicated and non-medicated feeds must be stored separately, utilizing a First-In, First-Out (FIFO) inventory control.

Harvesting & Postharvest Temp Control: Harvested organisms must be handled quickly and hygienically. For products sold chilled, they must be rapidly chilled and continuously maintained at a temperature range of **0°C to 4°C** throughout both postharvest handling and transport. Ice must come from approved facilities or be made with potable water.

ANIMAL HEALTH AND WELFARE

Stocking Health: Seed stock (wild-sourced or captive-propagated) must be clinically healthy and screened/tested by a competent authority before stocking.

Biosecurity & Health Plans: Operators are required to implement biosecurity measures and an aquatic animal health plan to prevent and control disease spread.

ANIMAL HEALTH AND WELFARE

Disease Management: Diseased or dead organisms must be collected immediately and disposed of hygienically using dedicated mortality pits or fish cemeteries. Treatment using authorized veterinary drugs requires a proper diagnosis, adherence to strict manufacturer guidelines, and mandatory compliance with withdrawal periods to meet Maximum Residue Limits (MRLs).

Humane Handling: Operators must minimize stress and physical damage during culture, sampling, harvesting, and quarantine, ensuring rapid and humane slaughter practices.

ENVIRONMENTAL INTEGRITY AND SUSTAINABILITY

Zoning & Carrying Capacity: All aquaculture activities must strictly remain within designated zoning areas to protect ecosystem carrying capacity. Proximity to ecologically sensitive hotspots (e.g., mangrove forests and coral reefs) must be tightly regulated.

Escapee Prevention: Farms must install screens, barriers, and trapping devices to minimize the risk of cultured species escaping into natural environments.

ENVIRONMENTAL INTEGRITY AND SUSTAINABILITY

Predator Control: The code strictly discourages the use of lethal methods to eradicate predators, particularly those classified as vulnerable, threatened, or endangered.

Exotic Species: Culturing exotic species is only allowed after a scientific risk assessment by a competent authority, and any disposal must strictly prevent their release into open waters.

Waste & Effluent Management: Farms must utilize reservoir ponds for incoming water and settling ponds for handling effluents. Regular environmental monitoring must be completed via a Self-Monitoring Report (SMR).

SOCIO-ECONOMIC FACTORS

Labor Rights: Workers must receive fair treatment, salaries, mandatory benefits, and incentives aligned with national laws and International Labour Organization (ILO) standards.

Health & Safety: Employees must be provided with Occupational Health and Safety (OH&S) training, appropriate protective gear, accessible first-aid kits, and mandatory annual medical examinations.

SOCIO-ECONOMIC FACTORS

Inclusivity & Community Care: The code mandates a proactive anti-child labor policy and strictly prohibits discrimination based on gender, race, religion, culture, or age. Furthermore, operations must respect the rights of host local communities, safeguarding public lands, infrastructures, and local fishing grounds.

TRACEABILITY AND DOCUMENTATION

To maintain compliance, farms must establish a traceability system and retain all operational, feed, and health records for a **minimum of 24 months**. Local Transport Permits (LTP) alongside health certificates are mandatory prior to moving aquatic organisms.