Live Fish Handling

During: stocking– sampling– harvesting- grading- marking- anesthesia- hatchery operations & transportation

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Why this lecture?

Questions are being asked all time:

Why fishes are not subject to the types of stresses in nature compared to that in aquaculture?

In nature fishes manage their life the way they feel good for their survival and well being;

and sometimes for their offspring too

In aquaculture, survival and well being of farmed fish is our responsibility in a way we believe it is good for them.

We are the ones who design the farming facility and carry out all farming practices.

We stock, sample, harvest, transport, grade, mark and any other practices

The challenge is doing all that with no or minimum stress?

Note: Stress could be severe and obvious or sometimes overlooked

Must be suffering

Even shadows could be scary

No flash allowed

Often seen in public aquariums

Stocking

- Usually carried out after any of stressful practice (harvest, transport, etc)
- Stocking success or failure indicate the efficiency of previous practices
- Good stocking eliminates doubts or unpleasant surprises afterwards

Remember

- Carried out only once for each production cycle
- Mortality estimates should not be the first option in case of doubtful shipments

Doubtful Shipments

Stressed fry most likely would not survive

The whole shipment could be rejected (best action)

If not, temporary stocking for enough time for treatment or recovery would be required

Stock only healthy fish in production facilities

Dead & stressed fry

If signs of stress or noticeable mortality is seen – stop estimating for potential loss

Stocking & unknowns

Mortality should be always expected even in good-looking shipments

Easy to count dead chicklings – **But** fish are not chicklings

Estimating dead fish after stocking is questionable especially in the case of small fish or earthen ponds

How to estimate dead fish eaten by animals, picked up by birds, got lost in aquatic weeds or never surfaced?

Stocking & minimizing unknowns

Handling upon stocking should be done as best as possible (acclimation, transportation, etc)

Natural acclimation – (e.g. mullet)

Mullet (*Mugil* sp.) is a migratory fish:

Capable to tolerate a wide range of salinity

Fry swim from sea water (the place of its creation) to waters of various salinities

An example of natural acclimation

Thermal acclimation

More than 2 ^{o}C difference → Fish **<u>Should Be</u>** tempered

Higher temperature difference indicates:

possible handling problems (time of stocking, transport, etc)

Higher temperature difference could lead:

thermal shock or death

Acclimation rate > 5 ^{o}C per hour → **<u>Not Recommended</u>**

Salinity acclimation - Osmosis

Salt concentration in vertebrates' blood: 10-12 g/l

Time and efficiency of salinity acclimation depends mainly on:

- Species tolerance (wide range to narrow range)
- Salinity difference between the two environments
- Duration of acclimation (quick to slow)

Fish would try to cope with salinity differences through **Osmosis** to maintain blood salinity at the natural level

Performing osmosis would require energy

Energy expenditure is on the cost of production traits such as growth

If energy requirement is beyond fish's ability, fish will be stressed or die

Optimum versus tolerance levels

pH Acclimation

The pH of vertebrates' blood –including fish- is about 7.4

Some marine species are sensitive to significant pH changes

Macrobrachium rosenbergii will need Acclimation for pH changes especially for significant differences (its favorite level is below 9)

Fish require longer periods for pH acclimation (the 20-min-acclimation) will not help

Remote acclimation may be required

Remote acclimation

If acclimation period gets long, it turns stressful

If differences in water quality are found beyond the ability to carry out on-farm acclimation, pre-acclimation would be required where more time could be made available

The acclimation of fry or fingerlings in hatcheries to match farm conditions (especially salinity and pH) is a good practice

The ability of a hatchery to carry out remote acclimation depends on hatchery facilities

Survival/mortality assessment

Each of the test cells is stocked with equal number of fish

Three compartments will be sufficient; two is the minimum

Even if handling practices are thought to be ideal, a simple field testing –if done- would:

- Indicate efficiency of all actions taken prior to stocking
- Provide realistic estimates about mortality rates of stocked fish

The followings should be noted in the field test:

- The test should not become a source of stress (location, stocking density)
- 2-3 days is sufficient for this test
- Mortality estimates of this test is used to correct for the stocked numbers

Enumeration methods

Fry & fingerlings are sold/bought in numbers

Standing biomass is measured in weight, but based on numbers

No matter what enumeration methods in use, it should lead to numbers

Enumeration methods include:

Weighing	
Volumetric	Direct; water displacement
Visual comparison	training is essential

Advanced technologies

(e.g. electronic counters). Used mainly for eggs/fry with high accuracy

Counting (practical – reasonably accurate)

Visual comparison

Volume/displacement

Few at a time

Too many to be followed

Samplers: soft & shallow

Enumeration of small fry (average weight)

Unless you have large number of fry

A drop of water can make a difference

Length-weight Tables are commonly used

Length-weight Tables

- It is easier to measure fish length than their weight especially for small fry
- Under field conditions, it is not recommended to use very sensitive balances to weight individual fry of milligrams as an average size. Instead, measure total length and consult tables to get average weights
- Because fish vary in shape (flat, slender, etc.), the same length would produce different weight

Various length-weight Tables for various species are available on the internet

Even though, **no** formula can ever replace actual weighing, these Tables provide **reasonable** estimates with **minimum** handling stress

If the species of interest is not on the published Tables, develop your own Table

Length-weight Models

Source: http://www.myoan.net/fishing/weight_calc.html

Pike calculator	
$Length^3/3500$	
1- Enter the length in inches	
2- Press to calculate the weight	
3- The fish weight in pounds	

Walleye calculator	
$Length^3/2700$	
1- Enter the length in inches	
2- Press to calculate the weight	
3- The fish weight in pounds	

Applications

Total length (inch)	**Weight (pound)**
12	0.494
15	0.964
18	1.666

Total length (inch)	**Weight (pound)**
12	0.64
15	1.25
18	2.16

Sampling

Why sampling?

- just to get an idea about the condition of fish
- adjust feeding rates & quantities
- determine harvesting time
- others (e.g. shrimp molting)

Related facts

- sampling could be a stressful practice
- what we should try is to minimize the stress through better management of sampling

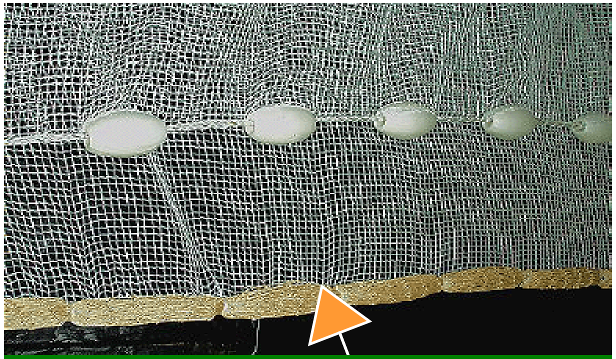
Sampling (sampling gears)

OK

Length

Short

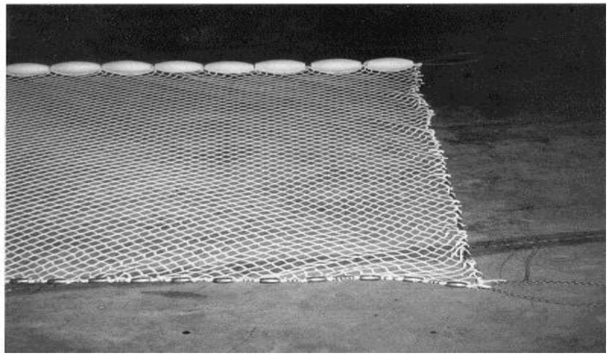
Mesh size



Strands of ropes bound together

Mud line (tilapia) seine:
slides smoothly over pond bottom; no digging of lead line in the mud; allows no niche for escapees

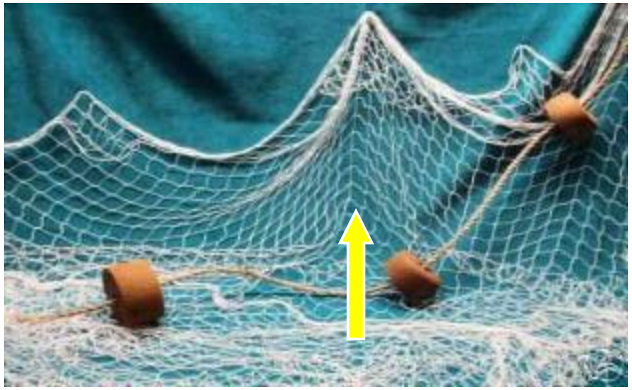
Use of wrong gears



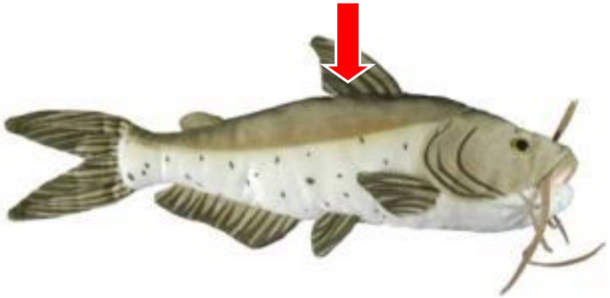
Traditional lead line seine

Nylon Seine Treatment

If seines are used for harvesting fish with spines similar to channel catfish, they should be coated with plastic, tar or petroleum based materials to prevent catfish spines from becoming entangled in the net.



What to sacrifice with- spine/seine?



Unfortunately, spines are often the first option to sacrifice

Sampling (sampling gears – cast net)

Limited sampling area

Freshwater prawn sampling (Thailand)

Casting is effective in assessing the overall condition of sampled fish

Management of sampling

Sampling frequency?

excessive sampling should be avoided

monthly sampling in grow-out is sufficient especially in earthen ponds

Remember –depending on means of sampling- feed may be withhold before sampling – not for small fry

Management of sampling

Sampling Size **05%?** **10%?**

Absolute number of sampled fish is more important than (%)

Unless there are good reasons, sampling of about 100 fish will be sufficient especially when done in earthen ponds and/or applied to hard to catch fish (e.g. tilapia – African catfish)

Notes:

Information obtained from sampling should be compared to possible sampling stress

Only sample what you can handle before stressing sampled fish

Sampling efforts target to come close to reality, sampling is still an estimate

Shrimp sampling

Regular shrimp observation is done upon checking the feeding trays

Commercial shrimp farms may set its sampling strategy.

For example, 15 castings/hectar

Most of the castings are done in the feeding zones; the remaining castings are in the far end of the grow-out pond.

The last sampling is done about 3 days before the suggested harvest day to ensure that the targeted weight has been reached

Harvesting – Rules

Only harvest what you can handle

Fish react differently to harvesting (hardy, sensitive)

Sensitive species are sorted first (even as food fish)

Molting shrimp usually of less commercial value. Harvest is done if **less than 5% of the shrimp are molting**, less than 10% have soft shells, and most animals are at the end of a molting period (sampling is needed to determine that)

Stressed fish spoil faster (especially when held in warm water)

Stress & Rigor Mortis

Rigor mortis: the stiffness of the muscles of an animal after death as caused by chemical change in the muscles

Chemical changes lead to the accumulation of lactic acid and a fall of pH which leads to stiffening

Stress: fish stressed especially during harvesting will go into rigor mortis more quickly compared to non-stressed fish

Tail flipping does not tell fish are not stressed

Harvesting methods

Vary according to:

- Farming facilities (ponds, tanks, cages)
- Species (finfish, shrimp, bivalve,…etc)
- Types of harvesting (selective – total)

Agree upon:

- Higher efficiency
- Lower post-harvest losses and better quality of the harvest

Harvesting methods – Current method

For a 4-ha Pond, a catch pond of:

2.5 m High and
10 m Long and
2 m Wide

Bottom of catch pond is 80 cm below pond bottom

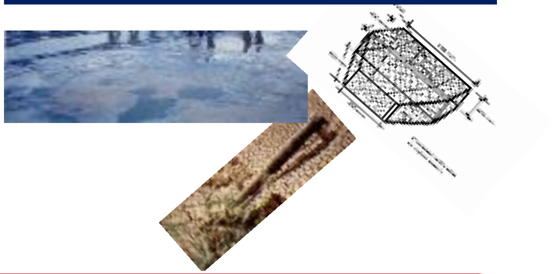
Water introduced @ 20 – 40 m^3/hr

This method is based on the swimming behavior of fish harvested (against water current)

Fish produced is cleaner with minimum left over fish in water pockets here and there

Water management is critical in this

Case study - trapping



Harvesting of small fry in weedy ponds or left-over water bodies

Harvesting methods - Drainage
(the sure means)

Earthen ponds are completely harvested only after drainage

Draining is of particular importance when fish can survive in small water pockets or burrow into the mud (African catfish, tilapia)

Selective harvesting

More efficient in mono-culture systems- harvest particular size leaving the rest to grow

Small tilapia

Using one seine in a polyculture system might catch the required size of slender species (e.g. mullet) but will catch smaller size of flat species (e.g. tilapia)

Electrofishing

Primarily used in freshwater

Electricity is used to stun fish **not to kill them**

For aquaculture, it could be used to get broodstock from deep water bodies

Faulty operations can result in serious injury or death

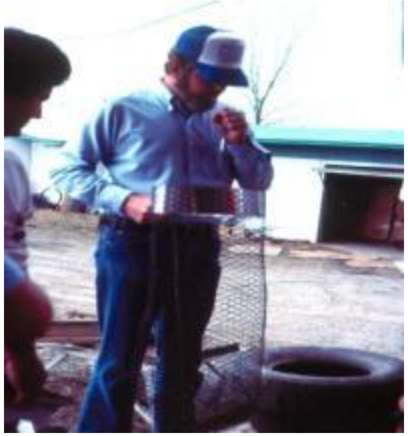
For safe operations, accredited training & licensing is essential

There are operation and safety guidelines for electrofishing

Harvesting and Biology & swimming behavior

When known harvesting methods cannot be used, fish could be collected while swimming against water current (e.g. in Alexandria)

Trapping is an ideal method for harvesting fish (especially fry in weedy ponds



The burrowing behavior of crayfish favors trapping as a practical means of their harvest

Shrimp harvesting

The steadily water flow upon draining of shrimp pond should be maintained; if the flow is repeatedly interrupted, the shrimp may settle in the mud and may be missed in the harvest

Similarly, the fluctuating water levels during the draining of shrimp pond can induce molting

If > 5% of the shrimp have recently molted (with soft shells), the harvest should be delayed for a few days to allow the shells to harden.

Non-burrowing shrimp are harvested during day time while burrowing shrimp are harvested during night and attracted by light

Grading

Carried out to:

Have uniform sizes which enhances management (e.g. nutrition: pellet size, protein contents, or feeding ratios)

Enhance the crop's market value when fish are sold by size or grade and/or meet consumer preference and market demand. Reduce predation & cannibalism especially in predator fish

Meet species-specific matters such as the sex reversal of tilapia fry

In mass tilapia spawning, grading is done to obtain the right size for sex reversal (about 11-12 mm as TL)

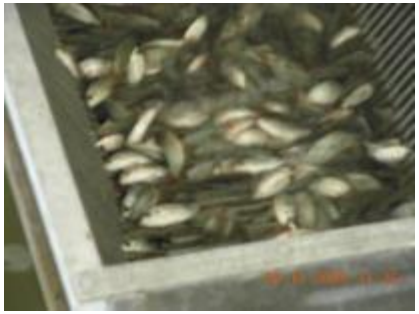
Grading - Rules

There is a biomass capacity for the grader (about 80 kg/m^3)

If the capacity of grader is exceeded, fish may die before having a chance to grade themselves

In layered graders, fish pass through layers until they are (retained). Enough space between layers should be sufficient to accumulate fish quantity in a given layer

Fish should be allowed at least 2 hours to recover after seining or transport before they are graded. Similarly, their stomachs should be empty



Biomass capacity

Grading - Rules

Fish usually require crowding for efficient grading.

However, excessive crowding and/or extended grading period could lead to drastic oxygen depletion in a localized area.

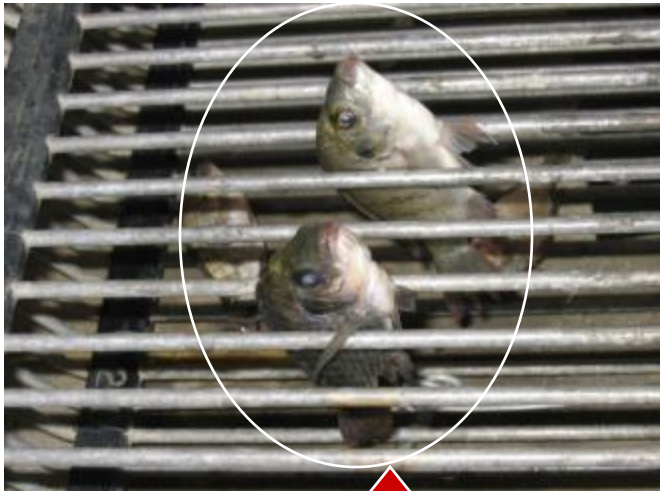
Thus, it is essential to maintain high dissolved oxygen levels in the grading or holding area at all times

Grading is carried out more frequent in predatory fish and fish with high growth rate especially in fry and fingerling phases; every 3 days – a week

Grading predator fish should target less than 30% difference in total length (TL) between graded fish

Grading should be done as quickly as possible with the smallest practical numbers of fish, because of the stress created by concentrating the fish at high densities

Grading

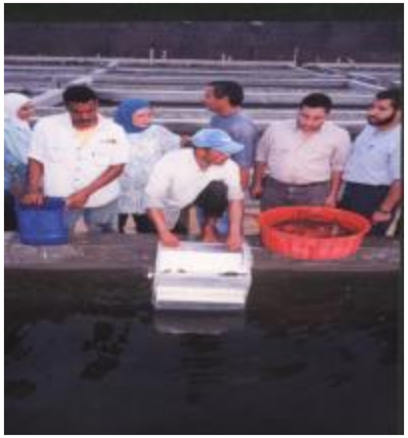


Problem

Smooth

Fish should be
Allowed to grade
themselves

Manual & Automated Graders



Grading is more practiced in intensive systems (management tool)

Hatcheries perform grading to:
• reduce cannibalism
• pricing tool

Automated grader - Italy

Marking

Marking is simply the identification of individuals or groups for various reasons including population dynamics, breeding, hatchery management

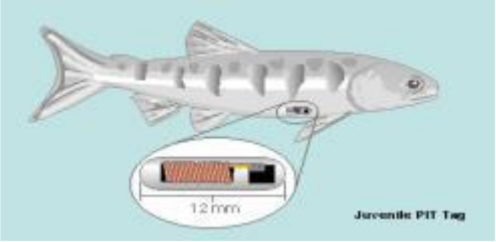
Marking should be:

- Fast and practical
- Minimum stressful to fish
- Adequate to marked fish (scaled, non-scaled, shrimp, changing color, etc.)
- Readable throughout the program (short, long)
- Some marking methods require anesthetizing (hot branding)

Individual marking = giving a name

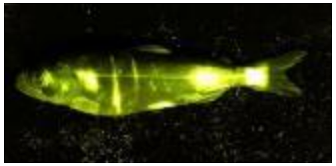
In breeding programs
Losing a tag = losing a fish

Pit tag - scanning



Group marking

Require UV



fin clipping

Right pectoral fin clipped

Concerns:
Unfair practice
Fin regeneration
Wound infection

Concerns:
How long the mark remains?

Ink & dye

Marking: Biology of fish/crustaceans

8?

Straight lines

Branding:
Hot branding
Cold branding: based on liquid nitrogen

Size of the wire

Post branding treatment

External tags

Marking and shrimp molting

Anesthesia

Classification A **Levels of Anesthesia**	Classification B **Levels/responses to Anesthesia**
1. Light sedation 2. Deep sedation	1. Sedation Reduced motion and breathing
3. Partial loss of equilibrium	2. Anesthesia Partial loss of equilibrium – reactive to touch stimuli
4. Total loss of equilibrium 5. Loss of reflex reactivity	3. Surgical anesthesia Total loss of equilibrium - No reaction to touch stimuli
6. Medullar collapse	4. Death Breathing ceases-heart beat stops - death

No major difference in the classification systems except combining or detailing

Anesthesia

Done only if needed to save the fish & protect operators during:

- stripping or sampling of eggs
- Branding
- surgery
- Transportation

Doses vary according to:

- species & size
- level of anesthesia required
- could be used with other protocols

Only 1 approved anesthetic for food fish

Main anesthetics in aquaculture

MS-222 (tricaine methanesulfonate)

Rapid induction and recovery

Good safety margin

Requires 21-day withdrawal period

The only anesthetics approved by FDA

Clove oil

Has a very high margin of safety

Inexpensive

Requires relatively long recovery time

Carbon dioxide

Extremely soluble in water

Rated as “Low Regulatory Priority”

No withdrawal period is required

Difficult to adjust and control its level

Requires long induction time

Quinaldine

Effective anesthetic at low cost

An irritant to fish

Has an unpleasant odor

A carcinogen

Anesthetizing protocols

Done through immersion in anesthetic solution, spraying on gills, …

Fish should be fasted for enough time before being anesthetized

Anesthetic bath should be aerated

Fish should be carefully monitored and proper actions should be taken whenever required

Anesthetizing considerations

- Not only consult product label but also consider other related factors (species, size, water quality, etc)
- To avoid the accumulation of anesthetics in body, use the lowest effective dose
- It is a good practice to test few fish first
- Closely monitor fish till their recovery and act when necessary

Use of ice in anesthetizing the broodstock of Asian seabass

Source video: http://youtu.be/fZwmVtEUCmU

Calming

Grapping from caudal peduncle

Covering eyes

Cachama white (Colombia)

Hatchery Operations

Acquisition of Broodstock

- Seining (knotted & knotless seine)
- Trapping
- Angling
- Electrofishing

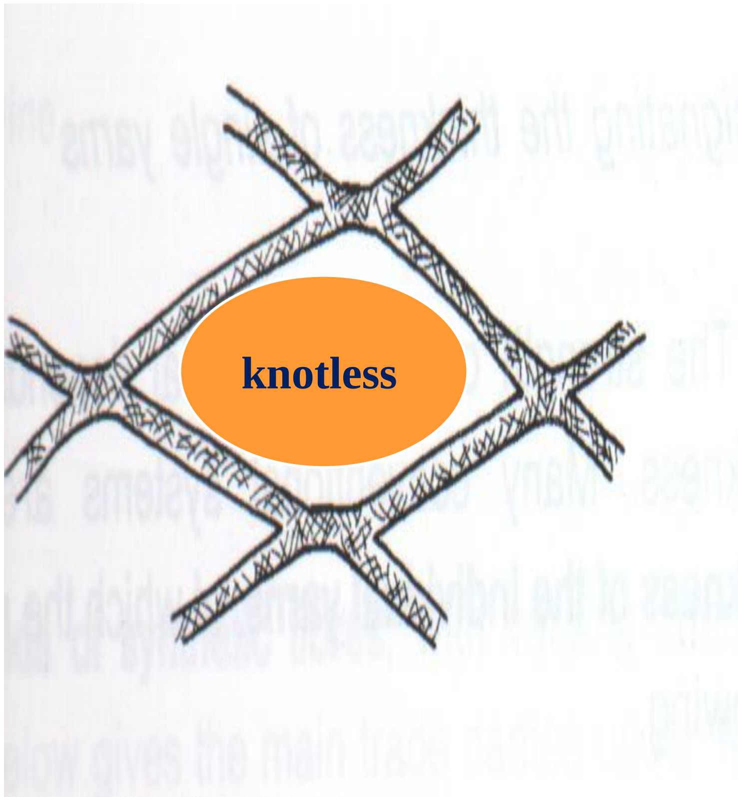
Spawning Operations

Acquisition of Broodstock

Fishing gears efficient in food fish fishery are not necessarily appropriate for broodstock acquisition

Broodstock deserve better treatment or different fishing gears

Safer fishing gears – Knotless seine



knotless

knotted

Spawning Operations
Catheterization (egg sampling)

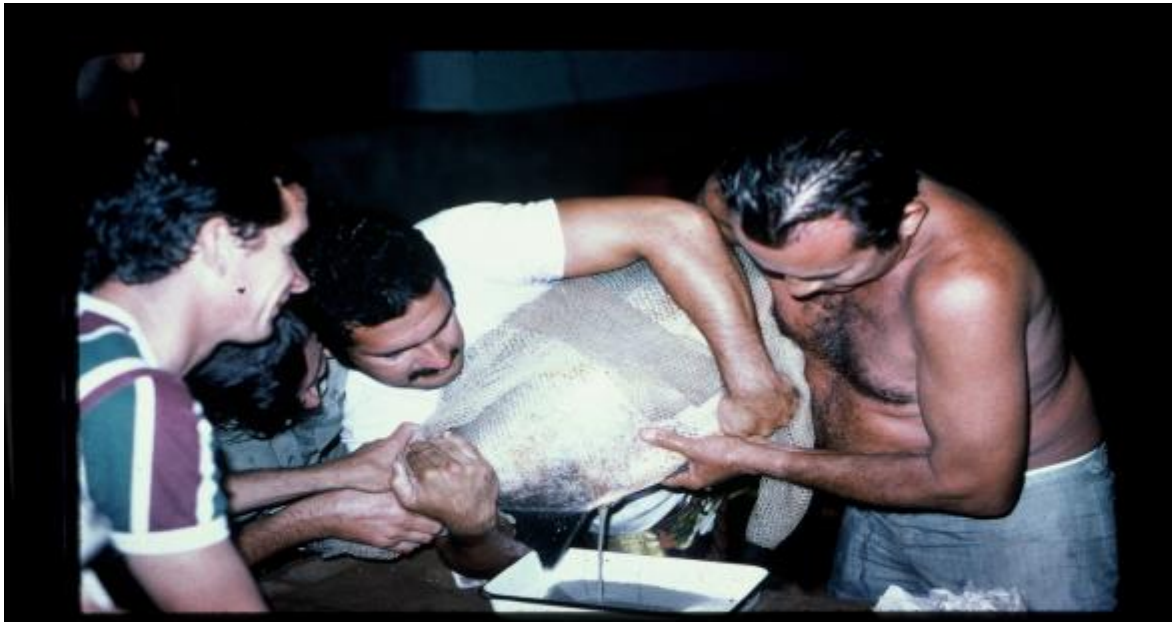
Catheter should be of adequate size to match fish size and the urogenital pore

Careful manipulation and minimum force is needed to avoid the damage of **sphincter muscles**

If sphincter muscles got torn, eggs at the posterior end of the ovary will water-hardened, and the plug is formed

Improper catheterization may result in hemorrhage and clotting & blocking of egg flow during ovulation

Stripping (female size, handling)



A female with a size as such should be anesthetized

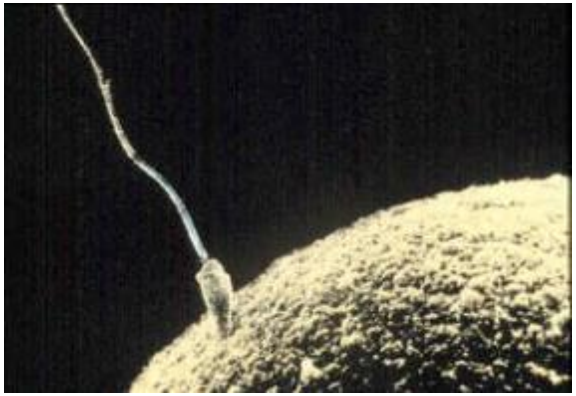
Watch for the effect of anesthesia on the sperm

Stripping (Cont.)

Blood or broken eggs resulting from improper handling will reduce the rate of fertilization

Protein from blood or broken eggs will coagulate and plug the micropyle reducing the rate of fertilization

Placing eggs in 0.6% salt solution (fertilization solution) makes the protein to go back into solution



Extending Solution (Ringer)

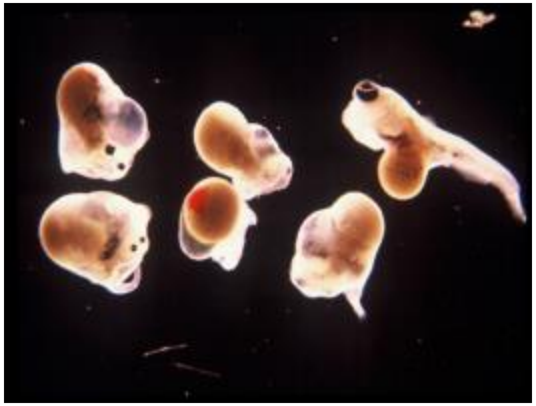
In 100 ml of water:

Sodium chloride	592 mg
Potassium chloride	172 mg
Calcium chloride	079 mg
Magnesium sulfate	031 mg

+

100,000 units of penicillin
100 mg of streptomycin

Deformity/Gas bubble disease



Due to temperature fluctuation

Check for Water Quality

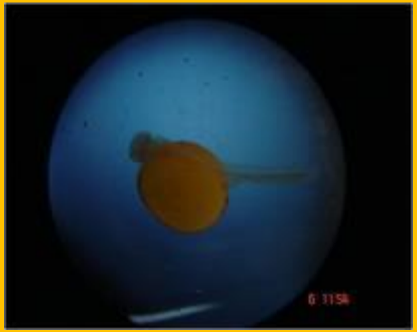
Use de-aerating devices (can be simple)

Pop Eyes

Spawning operations

Synchronize Hatching

Artificial (forced) hatching: this is done by drastically reducing water flow for few minutes), a normal flow of water must be restored immediately.



The delay can lead to suffocation and loss of the hatched embryos.

Transportation

Transportation is one of the challenging handling procedures as the concept of transport usually is:

Transport as many fish as possible in

a little water as possible with

a little loss as possible

Transportation
Factors affecting transportation efficiency

Physiological condition of fish

fish should be healthy – transportation should be postponed in case of stress or disease

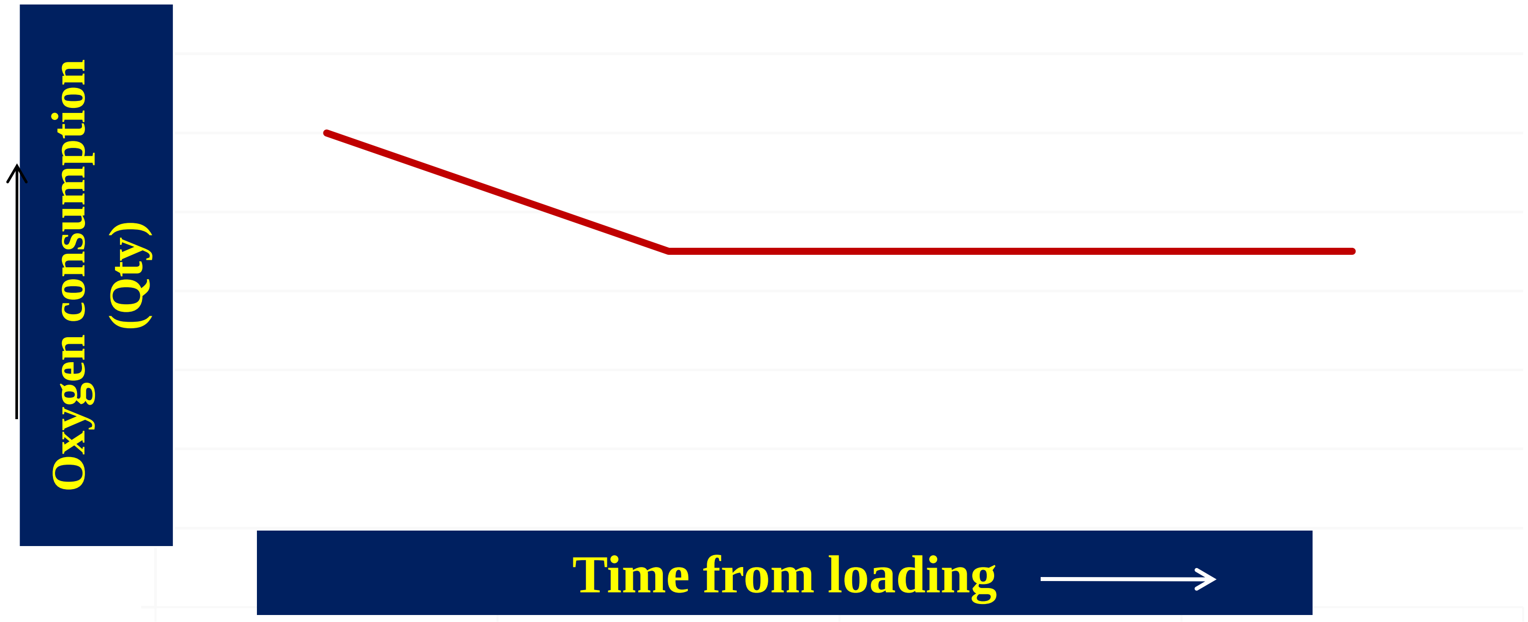
with the exception of small fry, fish should be given enough time to empty their stomachs before transportation (fish with full stomachs require larger amounts of oxygen for digestion)

Oxygen

the most critical factor in fish transport; serious problems are related to low or depleted of oxygen – mortality could be in mass and **observed**

more oxygen is consumed as fish gets excited upon loading

Transportation
Mode of oxygen use



The immediate period after loading is the most critical moment regarding oxygen use

Aerate water before loading

Transportation
Factors affecting transportation efficiency

Carbon Dioxide

free CO_2 is a poisonous product

as free CO_2 increases, more oxygen is required.

as CO_2 reduces the affinity of blood to oxygen, 25 mg/l of CO_2 seems risky

Ammonia

a major waste product especially at high temperature

if unionized ammonia (NH_3) reaches (about 1 mg/l), oxygen content of blood is reduced to 1/7 normal and CO_2 of blood is increased by 15% resulting in death by suffocation. (Bohr effect)

Transportation & temperature

The influence of temperature occurs through its impact on water quality parameters and fish physiology.

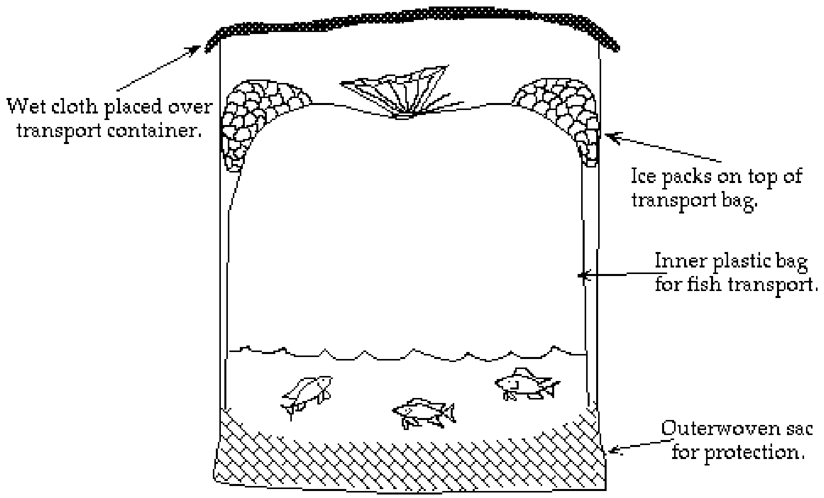
Lowering water temperature will lead to:

- reduce metabolic wastes (feces, ammonia, Co_2)
- reduce DO requirements
- increase the saturation level of water to DO

Fish species vary in regard to levels of temperature reduction

Various means to lower water temperature

Lowering water temperature – direct methods



Use of ice

Refrigerated trucks

Lowering water temperature
Indirect means (insulation)

Insulated tanks

Arrangement to poor insulated tanks

If a wet cloth is wrapped around the above container, water temperature will be reduced by evaporation

Insulation capacity is determined based on K Factor

K Factor: The amount of heat in BTU transmitted in one hour through one square foot of material one inch thick for each Fahrenheit degree difference between 2 surfaces of material.

Cork	k=0.29	Fiberglass	k=0.25
Styrofoam	k=0.28	Urethane	k=0.18 Best

Managing water temperature
Indirect means (management)

Timing of transportation is important in regard to temperature management

Late night/early morning is preferred

If transportation is done during optimum time, thermal acclimation on pond dike will be sufficient

Gentle release of fry

Why take the risk?

Flat tire or a traffic jam would destroy this shipment (mullet fry)

Transportation
Special arrangements (Shrimp)

Anti-punching arrangements to transport bags

In air transport, double bagging is recommended to help prevent bags from bursting due to pressure differentials. Each bag is sealed separately

Transportation
Plastic bags (Specifications)

Placing bags in boxes

Right thickness
0.04 mm (fry) – 0.06 mm (fingerlings)
0.1 – 0.15 mm (larger)

No trap ends for fry

Shipping rates

Shipping rates vary according to:

Duration of the trip

Temperature

Transportation method: (air, oxygen, insulation)

Species and size

If intended shipment will be done for the first time in regard to distance, species, sizes: It is a good practice to test before shipping

Examples of materials which could be used in transportation

Adding salt

- Adding salt up to 2 g/l will minimize energy spent in reducing salt loss from fish
- Some have used up to 5 g/l successfully.
- Tolerance limits of species should be considered
- If common table salt is used, it should be **iodine free**

Use of anesthesia

- Only if needed
- Reduce excitement and so stress
- Recommended level of anesthesia during transport should permit fish to be caught easily by hand **but not cause** total loss of activity or equilibrium.
- MS-222 is used at 15 to 60 mg/l for 6 to 48 hours to sedate fish during transport.

Antibiotics	Acriflavin @ 2-3 ppm
Buffers	Tris hydroxymethyl amino methane 1-2 ppt

Finally

In order to handle fish better we should understand its: (biology, requirements, tolerance, sensitivity, etc.)

Unlike other animals, aquatic environment is unique in a way that effects of improper handling may pass unnoticed before being discovered later

If protection is usually considered before treatment, in aquatic systems, protection should be **highly considered**