WILDLIFE AND FISHERIES MANAGEMENT MEDICINE

(VCM 602)

2nd semester 600 level

AQUACULTURE PRODUCTION SYSTEMS

Aquaculture production usually involves three major systems namely: Broodstock systems, Fish seed production systems and Grow-out or table fish production systems.

BROODSTOCK PRODUCTION: Fish broodstock are the sexually matured male and female adult fish which are reserved and used for breeding. They are the parent stock which can be selected from the harvested table fish and reared for one year or more depending on the age at maturity of the species. They can also be sourced from the wild but care must be taken to collect healthy mature ones. The source of the broodfish must be known with no previous disease record. Broodstock are stocked at very low stocking densities and fed twice daily with high quality fish feed (= 40% Crude protein) at a feeding rate of 1- 2% body weight. The holding facilities are cleaned regularly and good water quality maintained so as to ensure good health condition and gamete viability.

FISH SEED PRODUCTION: Fish seed production is the method of production of off-springs or young ones from the parents. It ensures the continuation of the species from one generation to the other. It is very important in aquaculture for the stocking of ponds and tanks.

Types of Fish Seeds include: Fertilized eggs - (fusion of male and female gametes), Larvae - larvae are hatchlings with yolk sac, Fry -fry are free swimming small fish.

Fingerling - small, finger-sized fish

Post fingerling / Juvenile - these are the advanced stages of fingerlings

Methods of Fish Seed Production:

There are two major methods of fish seed production in Aquaculture

Natural Breeding: Fish spawns naturally in ponds of tanks after attaining sexual maturity. Injection is not used. E.g. *Tilapia*, Heterotis, Megalops

Artificial Breeding: The stocked fish is sexually mature but cannot breed naturally in the tank or pond. Hormone is injected into fish to induce the fish to release eggs or milt E.g. *Clarias spp*.

Pituitary: The pituitary gland produces, accumulates, and stores the gonadotropic hormone(s) which plays a decisive role in ovulation. Insofar as reproduction is concerned, the role of the pituitary gland is that of an intermediary between the central nervous system and the gonads. The gonadotropic hormone(s) is produced by sexually mature fish and the cyclical changes in its concentration in the pituitary gland are correlated with the reproductive cycle of the fish. Its concentration is maximum during the prespawning period, while it is very low or almost nil during and after spawning. The release of gonadotropin(s) by the pituitary gland is "ordered" by the hypothalamus through the secretion of gonadotropin-releasing hormone (GRH). The gonadotropin(s) is also responsible for inducing spawning migration, during which its concentration in the pituitary gland gradually decreases. The gonadal development during spawning migration is most probably directed by the continuously released gonadotropin(s). The pituitary gland is situated on the ventral side of the brain below the hypothalamus, which is connected to the pituitary gland by a funnel-like structure, the infundibulum. The part of the cranium where the pituitary gland is located is known as the sella turcica. The gland is usually embedded in fatty tissue. When the brain is taken out of the skull, the pituitary gland remains connected to the brain in some fishes, while in most fishes the infundibulum ruptures and the gland is left behind on the base of the skull.

ARTIFICIAL (SYNTHETIC) HORMONES Different types of synthetic hormones used in Nigeria

include Human chorionic gonadotropin (HCG), Luternizing hormone-Releasing hormone analog (LHRHa), Ovaprim, Ovatide etc. The most commonly used hormone is Ovaprim. The dosage is 0.5ml/kg of female spawner.

HORMONE INJECTION Carefully catch the female spawner, Cover the head of the female with a wet towel, and Insert the needle 2-2.5 cm deep towards the tail end. The most common method is intramuscular injection instead of interperitoneal. The fish is injected within the muscle at an angle of 45^0 below the base of the dorsal fin and just above the lateral line. For scaly fish, do not inject through the scale but under it. After injection, finger-rob the injected area. Return injected fish to the holding tank or container, Record the water temperature. Gravid females are injected preferably late in the evening.

STRIPPING

(a) COLLECTION OF MILT: Kill a mature male (1kg), Open the belly with a pair of scissors, Locate the two testes and carefully remove them. Puncture the testes and squeeze the milt into 0.9% salt solution in a container. It is preferable to collect the milt about 20 minutes before stripping of eggs

(b) COLLECTION OF EGGS: Stripping of females is carried out at the end of latency period. Latency period is the time interval between injection and stripping of eggs and is dependent on water temperature.

Water temperature C	25	26	27	28	29	30
Latency period (hours)	11	10	9	8	7.5	7

Drastic changes in water temperature will affect latency period and may result in very low

hatching rates (5 – 10%). At the end of the latency period --

- Carefully catch the injected female with a net.
- Dry the body and hold it tightly with a towel.
- Strip the eggs onto a dry container. Do not allow water to get in contact with the eggs.
- Stop stripping when blood appears. Do not allow the blood to mix with the eggs.
- Return the spent female to the holding tank.

Hand stripping of catfish to procure eggs for artificial fertilization

FERTILIZATION/INCUBATION OF EGGS: Artificial fertilization of the eggs occurs when water is added to the mixture of eggs and milt.

- Prepare the incubation trays
- Plastic sieves and mosquito netting can be used as incubation trays. They are placed in tanks containing clean oxygenated water.
- Pour the extracted milt over the eggs.
- Gently shake the bowl to ensure even mixing of the eggs and milt.
- Add clean water and mix gently by shaking the bowl. Decant some of the water.
- Pour the fertilized eggs in a single layer onto the incubation trays.
- Aerate the water to enhance hatching.

HATCHING

Incubation can be carried out in either running water or in aerated static water in concrete tanks, fibre–glass troughs, jars, trays or boxes. The fertilized eggs usually hatch out between 18 – 30 hrs after fertilization at a water temperature of about 27 - 30^{o}C. Water temperature

below 24^{o}C may result in low hatching rates The larvae remain in the incubation unit for 3 – 4 days (depending on water temp.) until their yolk – sac becomes reabsorbed. The yolk fry is not fed. Dead eggs during incubation will become whitish in colour and should be siphoned out of the incubation system to avoid fungal and bacterial infection.

Artificial incubation of the eggs of catfish; *Clarias gariepinus*

FRY MANAGEMENT

Fry rearing is an important aspect of hatchery management because the end products which are the fingerlings are derived from fry. As a result of their small size and delicate body, they can easily be affected by infections, parasites and poor water quality.

The hatchlings possess yolk sac, which serves as food for the first 3 – 4 days. After yolk sac absorption, the fry will start moving about searching for food. The use of live food as first feed ensures higher fry survival where live food is not available, highly nutritious artificial starter feeds must be used like Cyprico, Catco etc. Use the right particle sizes ranging from 0.2 – 0.3, 0.3 – 0.5, 0.5 – 0.8, 0.8 – 1.2 to 1.2 – 1.5mm as the fry grow. Feeding is carried out four to six times daily and fry is fed to satiation. For satisfactory growth and fry survival, the quantity and quality of the artificial feeds are of great importance. Most fish feed manufacturers have feeding tables which serve as guide for the farmer. After 8 weeks, fry should weigh 5-8g. Frequent grading and sorting of fry to remove shooters will enhance survival rates.

Good water quality is paramount for successful fry rearing. The desirable levels of some of the parameters are: water temperature 28^{o}C – 30^{o}C, dissolved oxygen = 3mg/l, pH of 6.5 – 8.5, ammonia < 0.1mg/l and nitrite < 0.5mg/l.

Cleaning and maintenance of hygienic environment will reduce the risk of infection. Uneaten food, fish excrement, etc must be siphoned out to prevent fouling of water.

The newly hatched larvae, 5-7 mm in size and 1.2 – 3 mg in weight can be kept in the incubator, and do not have to be fed as they rely on the food resource within their yolk sac for the first few days.

The healthy larvae tend to stay in the dark therefore should never be exposed to direct sunlight. In the hatching tank the water inlet should be covered so that the healthy larvae could gather in the dark. The egg remnants crippled and dead larvae are easily removed by siphoning without causing stress to the larvae. After hatching the larvae can stay in the aquarium for 1-2 weeks.

The optimum temperature for larval rearing is 28 - 30^{o}C. Within the next 2-3 days after hatching (48 hours at 28^{o}C) the yolk sac is absorbed and the hatchling is visibly developed into small cat fish and this fry starts to search for food at this stage this fry must be fed on external feed for its further development and survival.

The first feeding is with Artemia nauplii, the success of the intensive production of fingerlings of the African cat fish is greatly dependent on the use of this Artemia as first feed. Shortly before the yolk sac is fully absorbed the larvae are first fed with live Artemia nauplii. The feeding response of these larvae is stimulated by the movement of the nauplii in the water.

The Artemia is administered 6 times per day at regular intervals, this intervals can be adjusted by checking the larval stomach content after every feeding. The introduction of dry feed does not commence until after 3 days of first feeding with artemia. Replacement of these dry feed is usually gradual and commonly accomplished by co feeding with Artemia which is gradually withdrawn and replaced with commercially available dry feed.

TABLE FISH PRODUCTION

Table fish production involves the rearing or growing of fingerlings or juveniles to adult fish for human consumption. It lasts for a period of 4 – 6 months depending on the culture system and adoption of good management and adequate feeding protocols

PROCEDURE

- Check how much money you have and want to invest
- Decide on the species you want to culture and the culture system to be adopted
- Calculate the daily water requirement for the quantity of fish to be produced.
- Ensure that provision for supply of adequate good quality water is put in place.
- Prepare culture unit e.g. earthen ponds, concrete tank, fibre glass tanks etc. for stocking
- Impound the unit with good quality water
- Stock with right number of fish fingerlings/juveniles of same sizes and density.

PREPARATION OF PONDS OR TANKS

For earthen ponds, dry the pond bottom till it cracks. De-silt the bottom if silted. Lime the pond at the rate of 1000kg Agric lime/ ha. Weed the dykes and repair all damaged pond structures. Fill the pond with water and fertilize using a combination of organic manure (poultry) and in-organic manure (NPK). Leave for 3-5 days before stocking

For concrete tanks, wash several times to remove excess cement which will increase pH. Fill tank with water and leave to stand for 3 days. A pH range of 6.5 to 8.5 is ideal for stocking. Check if tank wall or water pipes are leaking and affect all repairs. For plastic of fibre glass tanks, wash thoroughly and fill with water. Check for water leakages

STOCKING RATE FOR DIFFERENT CULTURE SYSTEM

CULTURE SYSTEM	STOCKING RATE
Pond system	5-20 fish/m^2
Flow through (partial)	50 – 120 fish/m^3
Flow through (continuous)	200 – 300 fish/m^3
Recirculation system	200 - 400 fish/m^3

The above rates are to guide the farmer. There may be increase or decrease in the rates.

Fish Ecology

This is described as the interaction of fish species with their biotic (living) and abiotic (non living) in a defined natural or artificial environment for mutual and balanced co existence.

PLANKTONS

These are mass of tiny floating organisms usually made up of tiny animals and plants floating in the sea, lakes or ponds usually near the surface, and eaten by fish and other water animals.

PHYTOPLANKTON

These are very small free floating plants a typical example is one celled algae found in the planktons. In open waters photosynthesis is performed by phytoplankton with sunlight and nutrient in order to grow. Usually the sunlight for photosynthesis is not a problem however

shortage of nutrients especially in epipelagic zone is low in nutrient because organic debris (such as dead animals) sinks to much greater depth. Occasionally some nutrients are brought up from the ocean depth by upwelling, storms and ocean current. In this areas, phytoplankton grow rapidly and can become so numerous that the water turns green from their chlorophyll the pigment that gives land plant their color. These areas are the most productive in water supporting billions of aquatic life

ZOOPLANKTON

Microscopic animal present in planktons such as protozoas, phytoplankton are eaten by these zooplankton. The most abundant zooplanktons species are copepods and krills others are tiny crustaceans, jelly fish, larvae of fish marine worms, star fish and other marine organism. These zooplankton are however consumed by a huge variety of other animal in water. They range from small fish like sardines, giant marta rays, whale sharks and some sea birds also feed exclusively on zooplanktons.

NEKTONS

These are organisms living in water and these organisms can actively swim against the current typical examples are fish, marine mammals, penquins. Shell fish (lobsters, cray fish, crawal fish, shrimps, oyster, mussels, cockle, whelk etc)

BENTHOS

These are organisms both animal and plant that live on or in the sediment at the bottom of a sea or lake or deep water examples are clams, mussels.

MACROPHYTE

These are large water plants on water surfaces these are seen without the aid of a microscope examples water hyacinth etc.

CHEMICAL PARAMETERS

(A) **Dissolved Oxygen** (D.O): This is by far the most important chemical parameter in aquaculture. Low levels of D.O. have been responsible for mass fish deaths either

directly or indirectly. Levels of D.O. in fish pond water is a function of several factors including temperature, salinity, stocking density, duration of the day with level of phytoplankton in water etc. The higher water temperature and salinity the lower dissolved oxygen.

For fish, D.O. levels between 5ppm and 10ppm or mg/liter is considered safe while between 3ppm and 4ppm is the caution level. D.O. levels below 2ppm are lethal. At 3ppm, catfish with a full grown arborescent organ can survive. When low D.O. occurs, fish begin to come to the surface to "pipe" or go close to a source of fresh in- coming water. D.O. could be increased by using mechanical aeration method like paddle wheels or strippers. D.O. could be measured on site, using D.O. meters that have been calibrated

(B) **pH**: This is a measure of the acidity or alkalinity of water. The pH scale is from 1 to 14. A value of 7 is considered neutral while below 7 is acidic and above it is alkaline. Acceptable range is between 6.5 and 8.5. Different pH levels have their implications on fish growth as shown below

pH	**Effect on Fish**
4	Acid death point
4.5	No reproduction
5.0 -6.5	Slow growth
6.5- 8.5	Desirable range for fish production
9 -10	Slow growth
11 and above	Alkaline death point

Most cases of hatching failures have been associated with low pH and softness of water from the source. Calibrated pH meters could be used in measuring pH of fish pond water.

Low pH could be adjusted, using calcium carbonate or sodium bicarbonate. Very high pH could be adjusted to the normal range, using aluminium sulphate at 1ppm, to remove 1ppm of alkalinity which is also a reflection of the pH.

(C) Alkalinity: This is the capacity of water to neutralize acids without an increase in pH. This parameter is majorly a measure of the bicarbonates and carbonates. Alkalinity has a strong influence on productivity of fish ponds. It has been demonstrated that alkalinity of 100-250 mg/litre was the best for optimum productivity in fish earthen ponds.

(D) Hardness: This is chiefly a measure of the calcium and magnesium ions in water. A sample of water is considered to be soft when the measure of hardness is below 50 ppm. Most soft water samples are acidic. While those that are hard are alkaline, i.e. with pH above 7. Fish in soft water (very low Ca^{2+}), tend to lose Na^{+} and K^{+} and would have to spend some energy to re-absorb these ions back into the body, hence poor weight gain. Calcium carbonate or ground agricultural lime (limestone) could be used in increasing water hardness.

Experience has shown that excessive hardness of water at about 300-400 ppm or more will not support hatching operations, though juveniles of catfish bought from other sources would still thrive on such farms. At the hatchery level, zeolite (hydrated aluminium silicate mineral or volcanic ash) could be used as a means of reducing the level of calcium and magnesium ions.

(E) **Ammonia:** Fish excrete ammonia and less amount of urea into water as waste. Two forms that occur in water are the unionized ammonia (UIA) and the ionized ammonia (IA). Both are referred to as total ammonia nitrogen (TAN). Temperature and pH do affect the proportion of ammonia that is toxic (IA), and here the lower the pH, the better. The UIA concentration of 0.4 to 3.1 ppm within 96 hours has been shown to be toxic to catfish, while lower concentrations depress growth rates. High ammonia destroys fish gill tissues before leading to death.

Up to 25 times the water concentration of UIA can be found in fish tissue because of high

rate of absorption. Build-up of ammonia is more of a problem in intensive or super-intensive culture system. To prevent ammonia build-up, there is need to avoid over-stocking, over-feeding and ensure there is proper oxygenation of the system. This will help convert ammonia to nitrite (which is toxic) and ultimately to nitrate which rarely causes problems in catfish at concentration below 300ppm.

Where level of ammonia is high from source, such water sample should be passed through filters containing activated charcoal for proper adsorption before use in fish hatchery

(F) **Nitrite:** By the process of biofilteration, some bacteria convert ammonia to nitrite (which is toxic) and further convert nitrite to nitrate. Nitrite poisoning in fish is very lethal as the nitrite combines with haemoglobin to form methaemoglobin which cannot take up oxygen .This leads to anoxia and death. This condition is called “Brown blood disease”. Where the sign begins to show in stressed fish, it starts “piping”. The first step to correct this condition is an immediate water change before the use of salt (NaCl) based on the principle of competitive inhibition of nitrite at the gill epithelium by chloride ions.

(E) Temperature: Right from the developmental stage of fish embryo to the adult stage, temperature plays a major role in regulating metabolic processes in fish which is poikliothermic animal. The higher the water temperature, the lower the level of dissolved oxygen. At a lower water temperature, the feed consumption and metabolism equally becomes lower.

(F) Turbidity: This is a measure of the absorption of light passing through water. Light penetrates only a short distance in highly turbid waters. A secchi disk is used in measuring turbidity and the measure of transparency is an indicator of the degree of fertilization in earthen ponds.

Phytoplankton (which is vital for oxygen production by photosynthesis) and zooplankton in earthen ponds have their own roles in this system and are measured by different means. However in intensive/super-intensive re-circulatory system these have no place as formulated fish feed pellets are consumed by fish and aeration units are available. The

biological aspect that is important in the super-intensive re-circulatory system is the microbes like fungi and bacteria. The levels of these organisms could build-up dangerously in a closed system if not checked. This is the reason why U.V.radiation and ozone are used as a means of controlling these.

FEEDING METHOD

- In fish culture, provision of well balanced diet for the fish is very important.
- Good quality fish feed must be nutritiously balanced having a crude protein content ranging from 40 – 45% for catfish and 28 -30% for tilapia.
- For pond culture, feeding spots must be identified and adhered to when feeding.
- Always observe the response of the fish when feeding. If the fish is not accepting the feed, stop feeding and determine the cause of low appetite.
- Fish can be fed either manually or using automatic or demand feeders

Hints on how to construct a feeding table:

- Know the average weight of your fish in grams
- Know the total number of fish in the tank
- Use the two above to get your total biomass in kilogram or gram
- Know the recommended percentage body weight you want to feed for the next two weeks. Feeding rates for catfish production ranges from 2 – 6% total body weight
- Adjust the feeding ration every fortnight. Feed 2-3 times daily for pond and flow though system and 4 – 6 times daily for water recirculation system.
- Keep record of quantity of feed given daily for each tank or pond
- Record total feed purchase and total feed given monthly

FEEDING TABLES

Temp	Fish size (g)											
	1-10g	10-25g		25-50g		50-100g		100-300g		300-800g		
16	1.0	0.6	0.4	0.3	0.2	0.2						
18	3.0		1.6		1.0		0.8	0.6	0.5			
20	5.0		3.0		2.0		1.5		1.2	1.0		
22	6.8		4.5		3.0		2.4	2.0	1.7			
24	8.1		6.0		4.0		3.0	2.5	2.2			
26	9.5		6.6		5.0	3.6	3.2		2.8			
28	10.0		7.0		5.5		4.0	3.5		3.1		
30	9.8		6.8		5.3		3.7		3.2		2.9	
32	9.5		6.5		5.0		3.5		3.0		2.8	

FISH SAMPLING AND GROWTH MONITORING

- This is an integral part of fish production management, the farmer must know when to sample, why he is sampling and what he hopes to achieve by sampling.
- Fish sampling is important in different culture systems and it is dependent on the species of fish involved.
- In the catfish production, sampling is carried out to reduce cannibalism which is occasion by increase or size differential which can lead to the depletion of the standing stock.
- In Tilapia production, sampling is done to separate male and female fry for stocking for increased production.

Methods of Fish Sampling

- Weight the fish sample
- Count number of fish in the sample
- Calculate the average weight and total weight
- Calculate daily growth rate (g/day)
- Calculate weight gain
- Calculate food conversion ratio
- Cross – check with a standard table (Coppers or Durante feeding table).

BASIC HUSBANDRY ON FISH FARM

- This covers in general terms:
- Handling of stock with minimum stress
- Management of accommodation and environment
- Feeding and prevention of diseases
- Harvesting
- Record keeping
- Appropriate use of equipments
- All the above are essential aid to good management

SITE OF STOCK

Must be done in such a way that the risk of disease transmission between generation is minimised e.g fallowing of sites regularly especially at the end of production cycles. This may be difficult to achieve this when resources are limited and considering when the grow-out periods is long. However the benefit of fallowing is enormous considering where infectious diseases are enzootic.

SOURCE OF WATER

There are 2 sources of water for fish farming:

Surface water (river lakes etc)

Ground water (well, bore hole)

Surface water from rivers are most common sources of Furunculosis (bacteria infection caused by *Aeromonas salmonicida.* However Ground water supplies are free of this risk but may be a more expensive source because it has to be pumped and breakdown may require a back up and other expenses associated with pumping e.g electricity

- The problem of ground water is the frequency of super-saturation with dissolved gasess (O_2, Co_2, N_2) which can lead to gas bubbles disease in hatched fish.
- Water –flow for fishes should be sufficient to meet O_2 requirement as well as remove metabolic waste (Faeces and surplus feed)
- The long-term health problems due to poor water quality are rare in areas of rapid flushing but sedimentary conditions on heavily used sea sites in areas of poor water exchange can deteriorate to the point where gas production poses a threat to fish e.g in sea cages, net fouling not be allowed to impede the passage of water. Therefore simple monitoring methods can provide useful warming to potential problems and thus prevention of stock losses

TANK HYGIENE

Tanks should be cleaned daily to prevent accumulation of organic materials, dead or dying fish must be removed. Regular examination of fish for ecto-parasites should also be part of the daily routines.

Cleaning is usually done manually but can be supported by flushing. Circular designed tanks usually aid self-cleaning flows with centrally located drains. It should be noted that high water-flow rates stress fish.

STOCKING DENSITY

In the real sense there is no "correct" stocking density for commercial fish farmer. The goal of any fish farm is to extract acceptable returns from investment which can be easily calculated, while the biological need is to provide optimal condition for the stock. It may be difficult to reconcile the two needs. Physical condition at the site will also be a factor. From the point of view of husbandry and fish health, the following should be considered in relation to stocking density.

CONSIDERATION IN RELATION STOCKING DENSITY

- Water quality and exchange rate
- Current strength
- Spread of infectious diseases
- Total biomass on the farm
- Peer competition for feeding
- Available surface area in relation to number of fish
- Procedures which involve crowding, e.g Rx for lice, grading.
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Reducing of stocking density will improve individual fish performance (preferable all things being equal) but beyond a certain point, total yield will fall below commercially acceptable

levels.

GRADING

This is the most common procedures on a fish farm and is also one of the major causes of stresses on fish. The reasons for grading are:

- To put peer groups into narrow weight ranges.
- To reject deformity or undersized fish.
- To remove fish which are unlikely to grow well
- To thin stock while biomass increases.
- To set up population for transfer to on-going facilities
- To count fish into new tank or cage
- To control numbers.

Grading usually carried out several times, either by hand or machine. Grading involves crowding the fish often at high temperature which may result in large numbers of deaths.

Overcrowding fish during grading should not be done over a length of time. In sea cages fish can be bruised against the net or cages and may experience a period of low oxygen especially if the high temperature. The damages can also be inflicted by equipment not properly constructed therefore the surfaces of equipment should be properly smoothened

In-order to avoid abrasion. Outbreaks of diseases often follow grading, and should be anticipated. To minimise the need for repeated handling and fish farmer should incorporate other husbandry procedures e.g Vaccination, inspection for ecto parasites etc.

REMOVAL OF MORTALITY

Frequent removal of mortality is one of the most important measures in disease control in any intensive husbandry system, for the following reasons:

- Early detection of rising mortality

- Removal of source of continuing challenge in an enzootic
- Regular supply of fresh pathological materials for disease diagnosis.
- Indication of the efficacy of disease control measures e.g anti-bacteria, vaccination
- Reduction of self-pollution and the discharges of organic matter into the environment.
- More reliable assessment of stock number.

A special problem may arise especially when fry are 1st introduced to floating pen, they remain on the floor thus making the removal dead fish very difficult. However at the growth stage they spend less time on the bottom and mortality removal becomes easier.

WAYS OF REMOVING MORTALITY

Use of divers can guarantee that all mortalities are removed, but there are doubts about the safety of frequent of diving.

Raising net floors: The net floor may be raised so that dead fish can be lifted out in a hand net. This method is labour intensive and it crowd the fish. It usually possible to reach all the fish.

Dead sock: The net floor incorporated as a central trap or "dead sock" into which most of the dead fish eventually roll. The floor is raised and the dead fish are removed from the

Sock with hand net: Sometime in sea net cage tidal movement may distort the net, so that mortalities may accumulate in the corners.

RECORD KEEPING

Accurate and complete stock records are essential to good management and should include the following:

- Stock origin
- Stock number

- Mortalities and their causes
- Disease investigation reports
- Growth data and feeding details
- Treatment records and medicine withdrawal periods
- Medicine stock records
- Environmental data, including water quality.

The records constitute a valuable history for the veterinarian who may not have frequent contact with the farm. By careful examination of record, it is

Possible to detect trends before problems become intractable and to target actions most effectively. Close familiarity with husbandry practices on a particular farm is essential if an effective veterinary service is to be provided. The efficacy of therapy should be monitor closely , to avoid unnecessary and wasteful use of medicines.

The major disease condition encountered in aquaculture are caused specifically by changes, or deterioration, in the aquatic environment and many other conditions are precipitated or exacerbated by environmental effects. The majority of disease condition in aquaculture will be significantly reduced if proper attention is paid to good husbandry and to the maintenance of optimum environmental conditions especially water quality.

Diseases condition can be broadly split into 2 categories: Non infectious and infectious.

The non infectious disease includes the direct effect of all environmental factors on the health of the fish.

DISEASES OF FISH

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It must be noted that outbreaks of infectious disease may be precipitated by adverse environmental effects, which include any “stress” acting upon as result of change of physical environment or management of fish themselves, including handling, grading, crowding and administration of drugs.

Non infectious causes of fish diseases:

Direct environmental effects:

Temperature

High temperature above the optimum temperature range of fish result in a fall in dissolved O_2 causing respiratory distress, particularly if the respiratory capabilities are already compromised by the presence of established gill disease. This could result to acute mortalities this situation highlight the complex relationship between the environment and manifestation of diseases.

A sudden change in temperature can precipitate outbreak of infectious disease, perhaps because the pathogens adapts more rapidly than the immune system of the fish to the changes in temperature. Similarly sudden temperature changes during egg incubation can result in the developmental abnormalities.

Direct environmental effects:

Oxygen

Sources of o_2 in fish cultures are plant photosynthesis and diffusion from the atmosphere

(limited). Minimum level of 5mg/litre is considered ideal however higher amount may be required for hatcheries. In the night photosynthesis in plant does not takes place therefore overnight de-oxygenation and to certain extent clogging of the gills which eventually result in gasping of fish especially at night.

Carbon dioxide

This gas is essential for phytoplankton growth and is usually present as a free gas or in bicarbonates, carbonates and organic forms. Sources includes diffusion from atmosphere, inflowing underground water, decomposition of organic matter and respiratory waste of fish and other aquatic organisms. It is eliminated by chemical combination, diffusion

Carbon dioxide (contd)

Into the atmosphere, and use in photosynthesis. High level of free Co_2 can cause problems which to produce acidic pH due to dissociation reaction of gas in water:

$H_2 0 + Co_2 \text{---------} H^+ + HCo_3^- \text{---------} 2H^+ + Co_4^{2-}$

high level of Co_2 in water usually interfere with oxygen uptake and can also cause nephrocalcinosis a condition where calcium carbonate is deposited within the kidney tubules and for which there is no treatment.

Ammonia

This is the primary nitrogenous metabolic waste products of fish, but is also formed by the decay organic matter. High level is indicative of overstocking or overfeeding. The un-ionized ammonia (the toxic form) will cause primarily cause direct gill epithelial damage with consequent hyperplasia and reduced ability to take up oxygen. Depending on the spp of fish it can

Also cause liver, kidney and brain damage with reduced activity and growth. Low level of ammonia also causes chronic stress. The level of ammonia varies with pH and temperature

being minimise by low values of both parameters. Ammonia is usually a problem to fish in culture where plants are present, as it is used as a nitrogen source by plants. Therefore ammonia thus becomes problem where there are too few plants, and where there is insufficient flow to carry away excess. In such situation ammonia removal is very necessary.

Biological filters incorporated bacteria necessary for the conversion of ammonia to nitrates. The recirculatory system contains these filters with large surface areas achieved by use of specially designed mouldings which allow bacteria growth. These bacteria require some to grow in the filters so as to meet up with ammonia load.

Food Protein

Food and faecal fish

metabolic waste

NH_3 ----------→ loss to the atmosphere

NH_4_nitrosomonas$_{>>>}$ $NO_{2>}$ nitrobacter $NO_{3>}$ denitificatn N_2

plant_<_____Assimilation_____$NO_{3>}$

pH

This the measurement of the level of hydrogen ion (H^+) present in water. It is related directly with to the hardness and alkalinity or buffering capacity of the water and should be maintained within limits tolerable to spp of fish. If the pH is allowed to vary significantly, stress-related problems may become apparent. The optimum pH for most spp is between 6.5-8.5 out of this values toxic effects can occur and stress level will be high. The most damaging situation is a sudden change in pH and this can occur especially in areas affected by acid rain where a flush of low pH water enters the aquaculture facility. Heavy metal are more soluble in acid water , and consequently heavy metal toxicity can be associated with acidity problem.

Infectious Diseases of Fish

Viral diseases

The source of infection is usually from farmed or wild asymptomatic carriers in the watercourse: usually viral shedding and clinical disease may not be seen until the fish become stressed by movement, crowding, temperature rise etc. Virus can be carried by non susceptible spp of fish and other aquatic mammals and birds; movement of these spp, along with movement of susceptible spp between different water-course, play an important role in the epizootiology of viral infection.

Transmission is usually horizontal between fish where the principal routes of infection are skin abrasion, the gill and the gut; vertical through the egg from infected broodstock to their to their offspring.

Most economically important viral disease of fish include:

- Infectious pancreatic necrosis (IPN)

Infectious pancreatic necrosis (IPN): A serous disease of first feeding trout fry and it occurs when asymptomatic carrier become stressed from crowding, transportation. (stress mediated IPN). It is cosmopolitan in distribution especially among freshwater and marine fish and also in invertebrates.

Cx signs ; inappetence, darkening ascites and exophthalmia, loss of equilibrium and trailing faecal cast. Mortality usually up to 90% in very young first feeders but the disease is less severe with the increasing age of fish.

Pm: Ascitic fluid present, the gut is usually filled with white exudates; there may be occasional haemorrhages over the viscera.

Infectious haematopoietic necrosis (IHN). This virus is the same group as the viruses causing Viral Haemorrhagic septicaemia (VHS) and spring viraemia of carps (SVC)