CHAPTER 1

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1.1 PONDS

Fresh water has a great role in sustenance of life of human beings, other organisms of the environment and maintaining the balance of nature. Water resources are being used by human being for various purposes like agriculture, industries, hydropower, fisheries and recreational uses.

Fresh water ecosystems are of two general types: Lotic (running water) and lentic (still or stagnant water). Lentic ecosystem (such as ponds, lakes, wetlands, bogs, marshes, swamps) is one of the most productive ecosystems with respect to aquatic plants and animals in the biosphere and plays a significant role for sustainment.

A pond can be defined as an earthen depression filled with water, either natural or artificial that is smaller than a lake. Ponds can majorly classify on the basis of formation and availability of water.

On the basis of formation ponds have two types: Natural pond and artificial pond.

Natural pond: A natural pond is created by nature and helps to balance ecosystem. The real benefit of this kind of pond is that it requires virtually no maintenance. Such natural ponds are:

a) Ephemeral ponds (vernal ponds): Ephemeral ponds are formed in the spring by melting snow and increased rainfall.
b) Kettle ponds: Kittle ponds are often quite old, formed by retreated glaciers that carve depressions in to the ground.
c) Spring fed ponds: Spring fed ponds are, obviously ponds that are formed by underground spring as they flow up to the surface into some form of depression, very clean mineral rich pond system due to pass through soil and rock.
d) Meadow-Stream ponds: Formed by streams and rivers as they carve out sediment, found in lowland meadows and grasslands.
e) Mountain ponds: Formed by melting snow, water runoff, and shifting rock and exist only in mountain regions.

Artificial pond: Artificial pond is also known as manmade pond. It generally refers to bodies of water that are built and or are maintained by humans rather than Nature. It has great importance in aquaculture and fishery. Example of this kind of ponds is:

a) Fish ponds: Are the most popular type of artificial pond, and can house various species, including Koi, Goldfish, and Sturgeon etc.

b) Wildlife ponds: Wildlife ponds may not contain fish, but they are great for attracting native insects, birds, newts, frogs and even plants.
c) Mini ponds/ Bowl ponds: Mini ponds are quite small and can be made out of something as simple as a bowl, preformed plastic pot or a barrel that's been cut in half.
d) Swimming ponds: Swimming ponds can be converted pools of fish ponds and need to be maintained to keep away algae, sludge and pests.

On the basis of availability of water ponds are of two types: Temporary pond and Permanent pond.

Temporary pond or Seasonal pond: It is usually rain fed water bodies found in different geographical locations. It may dry out periodically or drought in year and example of inland wetland ecosystem.

Permanent pond or Perennial pond: This kind of ponds holds water all year round, providing permanent habitat for a range of wild life as well as a many occasional or periodic visitors.

Significance of ponds: Ponds can make impact a large on the big environmental issue such as all climate change, flooding and pollution and also fantastic for wildlife. In agriculture, treatment ponds may reduce nutrients released downstream from the pond. They may also provide irrigation reservoirs at terms of drought.

1.2 HYDROBIOLOGY OF PONDS

Hydrobiology of pond exists by its physicio-chemical and biological parameters. The physical properties such as solubility of gases and solids, transparency, temperature, density, the chemical factor such as salinity, pH, hardness, phosphates, nitrates, BOD, COD etc and biological parameters such as plankton, benthos, productivity directly or indirectly affects the pond water quality, productivity, survival and distribution of flora and fauna (Jhingran, 1985; Odum, 1984).

Temperature is most important and essential parameter which governs physical, chemical, and biological properties of water. It is inversely related to dissolve oxygen. Aquatic animals (Fishes and Zooplankton) are stressed when temperature changes rapidly (Boyd, 1998). A temperature of about 35ºc is generally considered as threshold for survival of aquatic life (ICAR, 2011).Turbidity or transparency means the clarity of water which is affected by the amount of the suspended solids in it. High turbidity reduces the light penetration and often accompanies organic pollution (Landau, 1992).

pH express by the hydrogen ion (H^+) and the hydroxyl ion (OH^-) in water. Water of around pH 7 is called neutral. The pH values ranging from 6.5 to 9.0 at day break are most suitable for fish production (ICAR, 2011).Alkalinity is the ability of water to neutralize acids. The total alkalinity is expressed by the concentration of carbonates and bicarbonates present in the pond water. Alkalinity probably influenced by the other more important factor, such as dissolved nitrogen and phosphorous (Rath, 1993).Hardness is presence of the concentration of Ca^{+2} and Mg^{+2} ions expressed in terms of equivalent $CaCo_3$. For optimal fish production total hardness of water body should be nearly equal to its total alkalinity value. Total Dissolve Solids indicate organic and inorganic matter in the sample. A high concentration of T.D.S increase density of water affects osmoregulation of fish water organisms reduces solubility of gases and utility of water for drinking.

Dissolve Oxygen acts as limiting factor in natural water bodies, because most of aquatic organisms die rapidly when oxygen in water becomes low or falls to zero. DO is inversely related to temperature and salinity helps breakdown of organic detritus.

Nutrients play a versatile role in defining trophic status of the pond ecosystem (Das & Chand 2003) Nitrogen and phosphorous are often identified a limiting nutrients in pond water for plankton production (Hecky & Kilham, 1988).

Such physical, chemical and biological parameters state the hydrobiology of a pond and influenced by surrounding environmental condition.

1.3 FISH POPULATION OF PONDS

A fish population is defined as a group of individuals of the same species or subspecies that are spatially, genetically, or demographically separated from other groups (Wells and Richmond 1995). A population will have a unique set of dynamics (e.g., recruitment, growth, and mortality) that influence its current and future status. Size, structure and distribution of the fish population fluctuate by environmental variation therefore, frequent assessments may be necessary to assess the fish population (Lett and Doubleday 1976; McRae and Diana 2005).

Fish population majorly estimated through the morphology, morphometry and condition factor of fishes of specific region or study area. The morphology and morphometry of fishes exists

size, structure and growth of fish population. The condition factor indicates the condition (good or poor) or well being of fishes in population.

Morphometric studies of fishes are essential:

- To understand taxonomy and health of a species (including reproduction) in environment.
- To understand shape, size and structure of species in the population (Mauro Jose Cavalcanti 1999).
- Helps to understand the relation between body parts in fishes.
- Such measurement revealed the inner relation between the lengths, weight, and fecundity of an animal species.
- Such study is a suitable technique for recognizing the degree of reproductive maturation without sacrificing the animals (Manimegalai et al, 2010).

Morphological characters are phenol-typically plastic and are influenced each year by the physical environment during spawning and early juvenile stages.

Condition factor also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley, 1972).

1.4 DETAIL OF TILAPIA (*Oreochromis mossambicus)* (Fig 1.2)

A. Taxonomy

Kingdom: Animalia

Phylum: Chordata

Class: Actinopterygii

Order: Perciformes

Family: Cichlidae

Genus: *Oreochromis*

Species: *mossambicus* (Peters,1852)

Common name: Mosambique Tilapia

Oreochromis mossambicus, is native to Africa but has been introduced to Florida and elsewhere as well. The species was introduced to the U.S. by the aquarium and aquacultures trades and were released either accidentally or intentionally into waterways of Texas, Florida

and Alabama (Brown 1961, Lee et al. 1980). It has been introduced to South India with a mis-belief that the fish is larvicidal. It has proliferated and now distributed across entire country. Tilapia was acclimatised in Asia, America and Europe during the second half of the 20th century. It has short body covered in small scales and a long dorsal fin.

B. Habit and habitat:

Tilapia is a freshwater fish found commonly in warm waters, but some species adapt very well to living in the sea.*O. mossambicus* are generalist/opportunistic omnivores that consume detritus, vegetation ranging from diatoms to macroalgae to rooted plants, invertebrates, and small fish. Diets differ depending on location-specific resource availability. *O. mossambicus* populations in different lakes ate different diets and trophic strategies ranged from detritivory, to herbivory, to near-exclusive carnivory with individuals preying on small fish and invertebrates (Boven 1979, De Silva et al; 1984).

C. Age, Size, Lifespan:

The maximum size of the *O. mossambicus* tends to vary based on its geographical location. Collections from within the native range indicate a maximum size of around 430 mm, while animals in the Gulf of Mexico measured a maximum of 360mm (Bruton and Allanson, 1974). *O. mossambicus* are long-lived surviving to approximately 11 years (Boschung and Mayden, 2004).

D. Reproduction:

Tilapia only breeds at a minimum temperature of 22ºC. Female *O. mossambicus* mature at approximately at the total length for female 150-160 mm, and males mature at approximately 170-180 mm (Hodgkiss and Man, 1978). Males construct nests in sparse to moderately vegetated bottoms where fertilization of the eggs takes place. To boost reproduction one male fertilises three females. Fertilised eggs carry by females in their mouth until they hatch. Several different females will lay eggs in the nest. Females can lay between 50-1,780 eggs, based on individuals' size and environmental conditions (Trewevas, 1983). Males are generally aggressive and ritualistic during reproductive season.

E. Environmental relation of *Oreochromis mossambicus*

1) **Temperature:** *O. mossambicus* was found to have a lower lethal limit of 9.5°C under laboratory conditions (Shafland and Pestrak, 1982). It does not tolerate temperatures below 10°C. This temperature limits its distributional range, although some studies suggest the species may exploit thermal refuges similar to other cichlids such as the blue tilapia, *O. aureus*, to move somewhat further north (Hubbs et al., 1978). Adult *O. mossambicus* will migrate to deeper waters as cold temperatures set in (Arthington and Milton, 1986).
2) **Salinity:** *Oreochromis mossambicus* have a broad salinity tolerance. They can survive from fresh water up to 40ppt, and are capable of spawning in estuarine waters at salinities as high as 34.5 ppt (Dial and Wainright, 1983). Typically found in fresh to estuarine waters, they appear to only inhabit freshwater lakes and ponds.

F. Economic importance:

Tilapia has high adaptability to the environment such as tolerance to high salinity, lower dissolved oxygen and high density, fast growth even fed on natural food or cheap formulated feeds, short reproduction cycle and natural spawning in the culture condition. It breeds easily and is resistance to disease. It can also be termed plastic animals in the sense that whereas most animals exhibit certain size, life span and a general pattern of growth, their growth rate and maximum obtainable size may be seriously affected by the physical and biological composition of their environment. It is easy to grow, which makes them an ideal aquaculture species.

Tilapia has a mild, white flesh that appeals to consumers, making them economically important food fish. This species contributes about 4% of the total tilapia aquaculture production worldwide, and is valued more when used for hybridization (Gupta and Acosta, 2004).

1.5 MORPHOLOGY, MORPHOMETRY ANDCONDITION FACTOR

Morphological and morphometric analysis of fishes exhibits, size, shape, structure and growth pattern of fish population. Such analysis is based on the length-weight relationships of fishes. The length-weight relationship is an important tool in fish biology; physiology and ecology and fisheries assessment (Vivekananda, E., 2005). This relationship serves many purposes such as:

- Determine the type of the mathematical relationship between two variables so that if one variable is known the other could be computed.
- To assess general well being of the fish and type of growth i.e. whether isometric or allometric.
- Exploitation and management of the population of fish species (Anene, 2005).
- Essential for stabilizing the taxonomic characters of the species (Pervin and Mortuza, 2008).
- Such relationship is a useful and standard result of fish sampling programs.
- It estimates biomass from length frequency distributions.
- It compares life history and morphological aspects of populations inhabiting different regions (Stergiou and Moutopoulos, 2001).

The relationship between the length (L) and weight (W) of fishes was expressed by equation $\mathbf{W=a\ L^b}$ where, the value of "**b**" provides the information on the growth pattern and shape of fishes.

Condition factor: In fisheries, condition factor is used in order to compare the "condition", "fatness" or well being of fish and based on the hypothesis that heavier fish of a particular length are in a better physiological condition. It is also a useful index for monitoring of feeding intensity, age, and growth rates in fish (Oni *et al*., 1983).Condition factor is strongly influenced by both biotic and abiotic environmental conditions. It can be used as an index to assessment of the status of the aquatic ecosystem in which fish survive (Anene, 2005).

Condition factor decreases with increase in length (Bakare, 1970; Fagade, 1979).It is also influences the reproductive cycle in fish (Welcome, 1979).

Thus the study of the condition factor (K) is important for understanding the life cycle of fish species and contributes to adequate management of these species and, therefore, to the maintenance of equilibrium in the ecosystem.

2. REVIEW OF LITERATURE

Fresh water is good resources for culture of aquatic animals. Lentic ecosystem such as ponds and lakes are most popular or well known for aquaculture. The hydro-biological status and water quality of fresh water affects by its physico-chemical and biological parameters. Runoff domestic sewage, industrial effluents, agricultural wastes, and anthropogenic activity by human being create pollution in fresh water. Such pollution enriched the nutrients and produced

eutrophication in freshwater ecosystem. Eutrophication badly affects the survival of flora and fauna in aquatic life. A number of researchers have studied physico-chemical and biological parameters, anthropogenic activity effect on water quality, water pollution and eutrophication of fresh water ecosystem.

According to Bagenal (1978) physical and chemical characteristics of water bodies affect the species composition, abundance, productivity and physiological conditions of aquatic organisms.

Due to human exploitation of the water resources, the normal dynamic balance in the aquatic ecosystem is continuously disturbed, and often results in each dramatic response such as depletion of fauna and flora, fish kill, change in physico-chemical character etc. (Bhatt *et al.,* 2009). Unni (1985) has suggested that total hardness can be used as an indicator for classifying domestic pollution. Mustapha (2008) studied that dissolved oxygen is an important indicator of water quality, ecological status, productivity and health of the pond ecosystem.

Kumar and Sharma (2002) noticed that high contents of nitrate in fresh water body indicate pollution by organic waste and domestic sewage. Kodarkar (1995) mentioned that high concentration of nitrate in summer may be due to higher decaying of macro-phytes.

According to Das (2000) and Mc Laughlin and Brindle (2001) phosphorus play as single element in maintaining aquatic productivity and one of the most limiting factor of production in Indian fresh water reservoirs. It is a primary nutrient for aquatic plants and major cause of eutrophication in fresh water ecosystem (rivers, ponds and streams). Jain *et al., (*1996) observed that the phosphate concentration above 0.5 mg/L indicates pollution.

Odum (1971) reported that BOD and COD are the significant parameters of pollution. Yazdandoost and Katdare (2000) noticed that the domestic and sewage effluents were run-off through drainage and may change or disturb the water quality. Radha and Seenyya (2004) pointed out that the heterotrophic bacterial activity reflects the nutrients levels in fresh water sources. Mishra *et al.,* (1988) studied that domestic toxic effluent also caused the contribution of microbial reproductions in river water.

Physico-chemical parameters also affect the diversity of fishes and plankton.Abdullah and Abdullah (2006) has worked on two fish pond in Khulna and revealed that physico-chemical condition affects the abundance and diversity of zooplankton and phytoplankton and also

emphasis that BOD has a great role in diversity of plankton. Basavaraja & Narayana, *et al.,* (2014) studied that water quality affects the abundance and diversity of fishes.

A number of researches have been done on fishponds. Fakruzzaman *et al*., (2001) studied the zooplankton of some fishponds in relation to its physico-chemical variables. Naz (1992) studied the eutrophic and hypertrophic nature of fishponds. Ameen *et al.,* (1986) made some observations on the physico-chemical and biological conditions of some fishponds. Chowdhury *et al*. (1989) worked on the seasonal variation of zooplankton in a fishpond in relation to some physico-chemical factors. Bhuiyan *et al.* (1997) observed the physico-chemical conditions in relation to meteorological conditions of a fish pond.

Some other investigations have been done on population indices, growth pattern, length-weight relationship and condition factor of fishes. Murta (2002) and Bowering (1998) studied that morphometric measurements are able to identify differences between fish populations. Pathak *et al.,* (2013) studied morphometric relationship, condition factor and growth pattern of fish population of Tilapia for two urban ponds of Vadodara. Moranta et al., (2003) observed that length-weight relationship has a number of important applications in fish stock assessment. Oni and Pauly (1983) pointed out that relationship between total length and body weight are also very much essential for stabilizing the taxonomic characters of the species.

3. Aims and Objectives

Reviewing the literature on status, conditions, and utility for fisheries potential of fresh water (lentic) ecosystem this project or investigation was initiated. To exploit fresh water lentic ecosystem with their best capacities, it is essential to have knowledge of their structural status and fishery potential etc. Present study emphasizes on the condition, hydrobiology and environmental status of lentic ecosystem and their effects on fishes. The investigation was carried out to study about physicochemical and environmental components with fishery potential of ponds through monthly variation. The main aim of this research work is to establish the relation between the environmental conditions and its impact on fish population. The work was planned to address the main objectives.

1) Assessment of physico-chemical status of the lentic ecosystem.

Fresh water resources were utilized for several domestic purposes by surrounding inhabitants. To understand possible impacts of urbanization and anthropogenic activities

on such ponds, water and soil samples from the study-sites were collected for detailed analysis of their physico-chemical properties.

2) Understand the biology of fish population.

   Biology of fish population estimated through length-weight relationship and condition factor of fishes. For such estimation fishes were collected from the study sites and analyzed through practical observations.

3) Establish interrelation between environmental conditions and fish population.

   Fishes always require a friendly environment for their sustainability and survival in an aquatic ecosystem with its surroundings. The growth, size, population density and condition of fishes affects through its environment and their conditions. The physico-chemical status, hydrobiology, biotic component, water quality, seasonal changes, human interference and surrounding of the fresh water ecosystem, creates the environmental conditions for fishes. This project was designed to assume that there is interrelation between environmental conditions and fish population of lentic ecosystem. For establishment of interrelation between environmental conditions and fish population, the fishes length-weight, and condition were analyzed with water and soil quality parameters and other surroundings of lentic ecosystem.