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# AQUATIC WEED BIODIVERSITY AND ITS IMPACT ON FISH PRODUCTIVITY OF PISCICULTURE PONDS IN SOME SPECIFIC SITES OF SOUTH BENGAL

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# AQUATIC WEED BIODIVERSITY AND ITS IMPACT ON FISH PRODUCTIVITY OF PISCICULTURE PONDS IN SOME SPECIFIC SITESOF SOUTH BENGAL

**A THESIS**


***Submitted by***

**Tanmay Sanyal**

***The Dissertation Paper submitted***
***For the partial fulfillment of the requirement of the degree of***

**Master of Philosophy**
**In**
**Environmental Science**

***Under Supervision of***
**Prof. Anilava Kaviraj**

**Department of Environmental Science**
**University of Kalyani**
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# Contents

Page No.

**1. Introduction** **10-11**

**2. Literature Review** **12- 20**

2.1 Seasonal variation, abundance and Presents of Different aquatic macrophytes

2.2 Impact of weed to other species population on same Ecosystem

2.3 Effecting or affecting factors for growth of macrophytes including role of herbicides

2.4 Importance of aquatic macrophytes

2.4.1 Role in nutrient assimilation

2.4.2 Role in nutrient removal

2.5 Classification of aquatic weed with various mode

2.6 Resource of wetland, aquatic flora and fish in India

2.7 Resource of aquatic weed in India and West Bengal

**3. Materials and Methods** **21- 23**

3.1 Collection and preservation of water samples

3.2 Analytical methods

3.2.1 Temperature

3.2.2 Water pH

3.2.3 Dissolved Oxygen

3.2.4 Water ammonia

3.2.5 Water nitrate

3.2.6 Water Phosphate

3.2.7 Alkalinity

3.2.8 Hardness

3.2.9 Turbidity

3.3 Photographs

3.4 Weed identification and determination of its density

3.5 Statistical Analysis

3.6 About the sites

DOI: 10.5281/zenodo.1013996 ISSN: 2277-9655

3.6.1 Zone 1
3.6.2 Zone 2

**4. Results and Discussion** **24- 43**

4.1 ANOVA of summer
4.2 Weed analysis of summer
4.3 ANOVA of monsoon
4.4 Weed analysis of monsoon
4.5 Accumulation of different weeds by different fish at different stocking density
4.6 Fish production at two sites
4.7 Turbidity and aquatic weed
4.8 Nutrient and aquatic weed

**5. Conclusion** **44-45**

**6. References** **46-48**

**Published by:**
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY
*Website: http://www.ijesrt.com/*
**DOI:** *10.5281/zenodo.1013996* *ISSN: 2277-9655*


| Table No. | Title | Page No. |
|---|---|---|
| 1. | Composition of some elements of aquatic weeds | **17** |
| 2. | No. of fish species in India | **20** |
| 3. | Production of fish at Mudialy | **24** |
| 4. | List of fish fauna at Nature park | **25** |
| 5. | Result of ANOVA at summer | **26-27** |
| 6. | Weed diversity during summer at zone 1 | **28-29** |
| 7. | Weed diversity during summer at zone 2 | **29-30** |
| 8. | Result of ANOVA during monsoon | **34** |
| 9. | Weed diversity during monsoon at zone 1 | **35-36** |
| 10. | Weed diversity during monsoon at zone 2 | **36-37** |
| 11. | Water parameters in relation to both zones at summer | **43** |
| 12. | Water parameters in relation to both zones at monsoon | **43** |

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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY
*Website: http://www.ijesrt.com/*
**DOI:** *10.5281/zenodo.1013996* *ISSN: 2277-9655*

## List of Graphs


| | *Graphs* | **Page No.** |
|---|---|---|
| 1. | Graph 1 : Removal of pollutants | **16** |
| 2. | Graph 2 : Removal of metal | **16** |
| 3. | Seasonal pH and Temperature | **38** |
| 4. | Seasonal DO and Ammonia | **39** |
| 5. | Seasonal Hardness and Alkalinity | **39** |
| 6. | Seasonal Phosphate and Nitrate | **40** |
| 7. | Turbidity and weed diversity at summer | **40** |
| 8. | Turbidity and weed diversity at monsoon | **41** |
| 9. | Production and maximum weed diversity | **41** |
| 10. | Variation of Nitrate concentration in different ponds | **41** |
| 11. | Turbidity and diversity at summer | **42** |
| 12. | Turbidity and diversity at monsoon | **42** |
| 13. | Production and maximum weed diversity | **42** |

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**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY**
*Website: http://www.ijesrt.com/*
**DOI:** *10.5281/zenodo.1013996* *ISSN: 2277-9655*

# Chapter 1:Introduction

Aquatic weeds are more scientifically termed as aquatic macrophytes. They have a great role on aquatic ecosystem as because they are the secondary producer on ponds, lake, river, ditches or any other aquatic ecosystem. Some of them have a great importance on mineral recycling by their several enzymatic metabolic action. Macrophytes are essentially a part of an ecosystem which can assimilate some essential nutrients such as – carbon, nitrogen, phosphate – they are not only the uptaker of nutrient, but also the source of nutrient bank to the higher organisms, i.e. consumer. Some macrophytes are good pollutant remover such as (heavy metals), so they are the major part for waste water purification system in aquaculture practice. Many species population density in directly or indirectly related with respect to the scale of pollution owing to their pollution indicating capability. The macrophytes when grow enormously and can chock the water body so that it has no such environment for good and hyginic pisciculture practice. Then they are transformed "macrophyte to "unwanted or undesirable weed". It has been proved that some macrophytes are essential for growing some species of fish directly by consuming macrophytes (*Ctenophrayngodon idella*) or can be indirectly beneficial for nutrition or food chain. Macrophytes are the flowers, bushes and trees of the under water wetland valued, they provide cover and spawning ground for fish, habitat for both invertebrate epiphytic community and food and habitat for the moose, muskrats and other animal. It can release $O_2$ to the fresh water animal. They are the vital component of all fresh water thats why must be preserved in moderate abundance for a healthy productive lake. The physical factor of sediment, texture, wave action, water depth and light have the key role for macrophytes growth. Water depth restricts immergent vegetation to a maximum depth of a about 1.5m and wave action abroads immergent, free flowting and flowting leaved vegetation. Disturb the bottom sediment can pull up the rooted vegetation which can increase the turbidity and reduce the light availability to the submerged plants. Aquatic macrophytes generally collonies to depth receiving 1% - 4% of surface light intensity. The mean summer Sacchidepth is about 1.3 m and macrophytes might be expected down to a depth of 3.3 m. A complex interaction between the physical and chemical parameters with respect to water is well established. In general oligotropic pond has low abundance of aquatic macrophytes in relation to mesotrophic pond. Macrophytes are restricted to a fringe on the shoreline because light levels under water are low as a result of planktonic algal concentration in hyper eutrophic lake. *Myriophyllum* sp., *Ceratophyllum* sp. and *Potamogeton* sp. are the indicator of nutrient rich condition of pond. Plant growth has additional effect on the formation and distribution of aquatic bed form. Because stem and leaf obstruct the flow (Hickin, 1984). The ecological and economic impact with invessive species are of critical concern to land manager.

Some past Botanical exploration on floral diversity in the Indian subcontinent by J. D. Hooker (1872 – 1897) included aquatic flora. Biswas and Caldar (1936) first gave a detailed account of aquatic plant published on "Aquatic plant resources of India", Subramanyam (1962) described the morphology and distribution of 117 taxa of aquatic angiosperm in India. Later on Deb (1975) raported the distribution and status of 144 aquatic and wetland taxa in different states of India. Lavania *et al.* (1990) compiled a list of aquatic and wetland plant of Indian subcontinent included 470 taxa.

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The major portion of the open water interface of unmanaged water body in Indian wet land are now occupied by exotic weeds mostly of South-American origin. Among these *Eichhornia crassipes* and *Alternanthera philoxeroides* are fairly common in most water body. In addition to these, the edge of water body occupies by *Sagittaria montovidensis* and free floating aquatic weeds like *Salvinia molesta* and *S. cucullata* are also common in nutrient rich water body. The submerged member of the family Hydrodaripaceae are mostly old world species and regard as serious weed in aquatic species. The aquatic submarged sp. introduced in India through acquarium plant. Beel fishery and aquaculture in bheries are the best examples of monoculture practice. Although oxbow lake and Meander creeks exhibit comparatively better diversity than traditional limited depth Bhery. Fish and macrophyte diversity in the later type of water body is better due to variation in water depth. Monoculture like pisciculture in the wetland is detrimental to the health of the ecosystem in long run and ultimately results in dwendling of species diversity. Ecosystem sustainability is more stable in case of mixed fish culture in wet land with *Collisa* sp., *Ambasio* sp., *Burbus ticto* also found to grow in this wet land accompanied with numerous mollusca and other invertebrate can also be harvested to supplement the poor man's protein from this wet land. When some aquatic plants die away in a particular season and again appear after several months. The dead and decaying plants remain settled into the bottom of the pond and decomposition process starts. Therefore, it is necessary to remove the dead plant and avoid toxicity and important matter is that the chemically treated aquatic vegetation should not be allowed to remain in the pond. Dead weed should be properly shifted from the edge of the pond or just dragged out on the margins of the pond and lake small broken pieces of seed of weed might be back into the water resulting in further occurrence of weeds all over the water surface.

So the main objectives of my work is to evaluate weed biodiversity measurement with special reference to physicochemical parameters of water & the annual fish production of these selected zones & also to evaluate the different types of weeds intensity & its correlation with fish production & water quality with emphasis on sustainable production & managed fishery practice.

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# Chapter 2:Literature Review

## 2.1 Seasonal variation, abundance and presence of different aquatic macrophytes

In a quantitative investigation of aquatic macrophyte growth on Beeshazar lake in summer and winter and spring found a distinct variation in distribution of macrophytes on the basis of important value index. *E. crassipes, C. demersum* and *Trapa, quadrispinosa* were dominant in summer. The summer is with highest species diversity. The luxuriant growth of aquatic vegetation is the evidence of highly productive nature of lake while the dominance of emergent vegetation indicate both the encroachment of littoral vegetation and successional trend towards marsh meadow (Burlauoti and Karmacharya, 2004).
Maximum growth of macrophytes is noticed in winter season at paddy wet lands, one of them being used to form fertilizers (Kamatsima-2003).

The most pollution tollerance genera and species of algae of 4 groups were found from 3 stations of "Panzara dam" by water quality and biological aspects measurement. These are Baccillariophyceae, Cyanophyceae, Chlorophyceae, Euglenophyceae (Nandan and Kumabhat, 1995).

Abundance of 3 different species of macrophytes, namely, *L. minor, P. stratiotes*, *E. crassipes* and 35 species of phytoplankton among which 16 are found in infested lake (Raut – 2003).

In Brazil, 2 aquatic invassives water weed and water hyancinth was conducted using hyper spectral imagery in 5 sites and result found that immergent weed can be detected both fine and coarse scale but submerged vegetation is only found as find spatial scale. Here water weed referred as *Egeria densa* (Underwood *et al.*, 2003).

Some observation of weed flora of rice field in Nile delta was made possible by Turki (2002).

Weed flora are associated with field crop of rice comprised with 23 dicot family, 5 monocot family found is Nile river (Sheded, 2002).

Phillipose *et al.* (1970) observed that in culturable water of Orissa, there was not much seasonal variation leafy aquatic plant. During monsoon, frequent rain accompanied by a rise in water level, high temperature and humidity and low sunshine, the floating plant such as *Eichhornia, Pistia, Spirodela, Lemna* and *Wolffia* dominent in many water body. Where floating weed are scarce of absent, *Nymphaea, Nelumbo, Nymphoides, Trapa* and *Myriophyllum* developed profusely by *Hydrilla, Najas* and their submerged vegetation, keeping pace with the rising water level. *Ipomoea, Jussica, Eleochoris, Neptunia, Panicum* and *Marsilea* usually developed along the margine by September-October, *Salvinia* is also developed during post monsoon period. *Azolla* gain a strong hold during winter.

During winter, *Pistia* usually die and decomposed. Leaves of water hyacinth usually turned brown and don't show any active vegetative growth still September, most of immergent weed

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continue to grow in winter. Beginning of summer, *Azolla* usually die and *Ceratophyllum* and *Utricularia* get placed by more aggressive floating submerged and immergent weeds.

Water samples from Rapti river was analysed in polluted and unpolluted site for detection of algal flora with respect to physico-chemical properties. At control sites, 29 genera and 36 species were recorded while 16 genera and 22 species were recorded at polluted sites. Temperature plays an important role for algal growth (Srivastava, 1995).

### 2.2 Impact of weed to other species population on same ecosystem

The epiphyte algal diversity associated with aquatic plants from 10-different site around Berhampur University campus revealed the strong potential epiphytic association inspite of unfavourable ecological condition. The greater no. of B.G.A. with a very marked degree of adaptation to the condition of an aquatic environment (Ratha *et al.*, 2003).

Submerged macrophyte modify food web interaction and stability of late littoral ecosystem (Kirsi, 2005).
Quantitative relationships between epiphyte and macroinvertebrate was analysed on the basis of units of collonisable plant surface of Typha, Phragmites on eutrophic lake and found no direct relationships between total macroinvertebrate abundance and epiphyte on mass on the plant surface (Dvoak, 1996).

Biodiversity in natural ecosystem can be considered at genetic diversity, species diversity and ecosystem diversity. Many environmental weeds are capable of causing an impact at one or more of these level, although the degree of impact is rarely quantitatively determined (Adair *et al.*, 1998).

Growth of water hyacinth has been prolific in many lake resulting in breeding vector and causing endemic disease (Reddy *et al.*, 2004).

Aquatic plants are more numerous in the warm and swampy which is a natural part of ecosystem used by many different animals either as food or hidding places, bat may interfare with peoples activity eitherby this over abundance or by their mere abundance (Dollas *et al.*, 2005).

Rooted aquatic plants are an important component of water bodies lifecycle. Idially aquatic plant should cover 15-20% of pond bottom and surface. Excessive vegetation may provide too much cover for bait fish which reduce availability of food for predator fish and could result in an over population of one or more sp. of fish (Brodford, 2004).

Weeds have much harmful effects like it reduce the water storage capacity in reservoir, tanks and ponds, impedes the flow and amount of water in water body's, reduce food production, interfere with navigation and aesthetic value and also promote habitat for mosquito. Snails are multiplied on macrophytes. Floating nature of weed can easily spread the snail and other arthropod to a new location (Lida Lancer and Kevin Karka, 2002). Fish production is greatly

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affected by floating and submerged aquatic weed, when their growth become thick, e.g. Harika lake in Punjab is decreasing population of fish due to dense weed growth.

The decomposition of huge amount of biomass creates condition where $CO_2$ and CO are produced and released to atmosphere. The decomposition period is much less than other vegetation on land. The decomposition can precipitate siliceous and other insoluble salts settle to the bottom which rise the waterbed level and affecting the life of water body.

Aquatic weed may be a hindrance to free flow of water, increase the seepage and cause rises in water table and lead to water logging which may create saline and alkaline nature in soil.

Stabilization midchannel bar due to collonization by herbs (Hooke-1986). Well known example are the formation of pools and associated downstream gravel bar ground tree root and large woody debris. (Gregory *et al.*, 1995).

Heavy metal accumulation like iron with higher concentration and chromium in lower concentration was studied at Rahara in respect to water, soil, aquatic weed and fish from industrial sewage (Pandey, 1995).

More recent studies identify the importance of plant architecture for spatial use of fish (Lewin *et al.*, 2004, Okun, 2005).

The submerged and free floating plants exerted different effect on the spatial distribution of fish, with important difference between the climate zone, temperate fish more pelagic and use free floating plants, in contrast subtropical fish prefer littoral behaviour and prefer submerged weed. (Meerhoff, 2006).

The effect of aquatic plants on lake functioning are crucial for resilience of shallow lakes to external changes, such as human induced climate changes (Folke *et al.*, 2004).

### 2.3 Affecting or effecting factors for growth of macrophytes including role of herbicides

The entire macrophytes are not killed by herbecides, retreatment is necessary (Langeland, 2001).
Weather condition, water movement, soil and water chemistry can great affect the success of aquatic herbicide application.
Nitrogen is an essential for making amino acid and enzyme for plants, many herbicides can affect the nitrogen metabolism (Flurodone and Glyphosphate). Some herbicides can also block photosynthesis, respiration, cell division and tissue growth (Herbicide technology, 1998).

Herbicide safety is necessary for applicant as well as sustainable management of aquatic macrophytes. So always should use licensed herbicides (Avery, 2003).

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Shallow water depth and lowspecific streampower make the suitability for submerged floating leaved plant especially when unshaded (West Lake – 1973).

For most situation visibility should between 12-18 inches, less than 12 inches indicates too much fertilization is to be taken place and visibility greater than 18 inches indicates that the fertilization is needed. If the pond has an abundance of aquatic plant, don't apply fertilizer, fertilization programme should be started early in the year before the plants begin to grow (Watson *et al.*, 2006).

Some of the parameters as e.g. DO, $NO_3$, $PO_4$, alkalinity, Ca, Cl, BOD showed marked difference between 2 ponds depending upon the quantity and quality of nature of organic pollution and anthropogenic activity (Sing, 1995).

The distribution of *Hydrozetes* sp. fight on obnoxious aquatic weed in different district of W. B. was found in association with *P. stratiotes* maintain the highest level (11-60 mites/plant) in the district of Nadia, followed by Burdwan, 24 Parganas and Hooghly. There was a significant reduction in the rate of increase in fresh weight of aquatic weed as a result of artificial innoculation with mites. (Sarkar *et al.*, 1990).

### 2.4 Importance of aquatic weed

Aquatic macrophytes are vital components of all fresh water and must be preserved in moderate abundance for a healthy productive lake (Chambers, 2004).

#### 2.4.1 *Role in nutrient assimilation*

Several sp. of floating plants as e.g. *Azolla pinnata* assimilates $O_2$ in association with algae, they contribute of about 22-30 kg nitrogen/hectare/season through nitrogen fixation and addition of phosphate fertilizer 250 kg/hectare/season in normal condition. $N_2$ level can reach upto 69 kg / hectare / season in temperate tropical and subtropical zone. It has been also reported that combined effect of $N_2$ and phosphate fertilizer stimulate plant growth and nutrient assimilation rate also increased (Sarkar, 1995).

#### 2.4.2 *Role in nutrient removal*

Removal of toxic compound by different species such as *Eichhornia, Azolla, Lemna* and *Pistia* depends upon the days of retention of plants and nutrients levels in pnds. Nutrient content of aquatic plants was found to be significantly positive correlation with nutrient concentration of water usually, intensity of nutrient removal aquatic plants depends upon the plant density, bacterial activity, amount of fertilizer and manures used in ponds and its intimation with various abiotic and biotic factors of ecosystem such as temperature, season, winds and rainfall.

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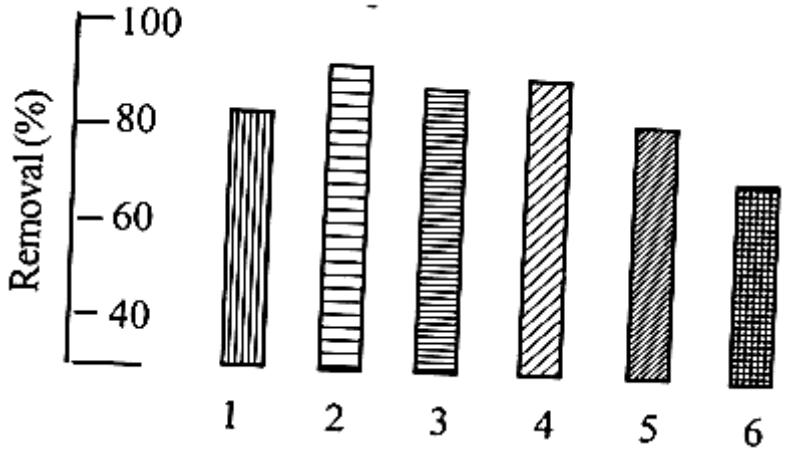
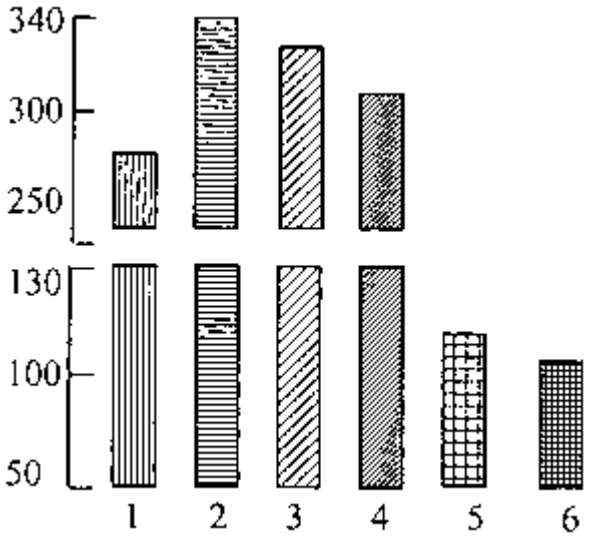



**Graph 1 :** Removal of pollutants from sewage, effluents by water hyacinths. In all case > 70% of pollutants were removed with in 14 days. (1) $NH_3$_$N_2$, (2) $NO_3$-$N_2$, (3) Total phosphorus, (4) BOD, (5) COD, (6) Suspended solids (Trivedy and Gudekar, 1985).




**Graph 2 :** Removal of metal from sewage sludge by water hyacinth. Note that an appreciable quantities of metals were removed with in one day. (1) Silver, (2) Copper, (3) Stronium, (4) Cadmium, (5) Lead, (6) Mercury (By-Wolverton and Mc Donald, 1975).

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***Table – 1 : Composition of some elements of aquatic weeds***

| Element | Plant | U.P. | Polluted | Moderate |
|---|---|---|---|---|
| Nitrate (mg/l) | Eichhornia | 18.6 | 29.6 | 24.4 |
| | Lemna | 8.5 | 16.8 | 12.3 |
| Phosphate (mg/l) | Eichhornia | 3.8 | 6.5 | 4.7 |
| Calcium (mg/l) | Lemna | 0.6 | 1.5 | 0.8 |
| | Eichhornia | 8.1 | 15.3 | 10.3 |
| Mg (mg/l) | Lemna | 10.0 | 18.7 | 15.2 |
| K (mg/l) | Eichhornia | 4.4 | 8.8 | 6.2 |
| | Lemna | 2.3 | 4.3 | 3.2 |
| Na (mg/l) | Eichhornia | 20.9 | 35.5 | 27.3 |
| | Lemna | 14.6 | 27.3 | 22.5 |

**Source : Tripathy (1990).**

Natural decay of aquatic macrophyte *Pistia stratiotes* significantly reduce the level of phosphate, nitrate, nitrite and ammonia of water composed of this macrophyte rendered very high amount of phosphate and ammonia-nitrogen into the water. The experiment revealed that composed could be a very good manure in pisciculture but the dose must be adjusted to avoid the eutrophication problem (Kaviraj *et al.*, 1996).

Commercial possibilities of dehydrated aquatic plants according to their protein and xanthophyll content was studied and showed that *Ceratophyllum* sp. have 18.3% protein and 922 ppm xanthophyll (Bailley, 1985) (Sci, SOC – 18 : 543-51).

Submerged, marginal and floating aquatic weeds were also studied according to their nutritional value e.g. protein, fat, pigments, tanin and also with macro and micro nutrients by Boyed (1968-1970).

### 2.5 Classification of Aquatic Weed with various mode

According to Biswas and Calder (1955) and from Bengal plants (1980) the aquatic weeds can be classified by 4 groups.

i) Floating weeds have their foliage above surface of water with rooted hanging free underneath.
ii) Emergent weeds, rooted in the bottom but having their foliage and flowers above the water surface.
iii) Submerged weeds may or may not be rooted.
iv) Marginal weeds are mostly rooted and infest the shallow fore sore areas of water bodies.

Lawrence 1955 add two more types as follows :

i) Hafs or Scums formed by filamentous algae and also by Chlamydomonas and Englinidae in the marginal areas or main body of water.
ii) Algae-disperse through the water bodies e.g. *Microcystis, Oscillatoria, Anabaena* etc.

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Mandy Tu and Barmy Mieyers, 2001 said another 4 types classification :

a) Species not yet of the site but which are present nearby. Pay special attention to species known to be pest else where in the region.
b) Species present as new population or outer of large infestation, especially if they are expanding rapidly.
c) Species present in large infestation that continue to expand.
d) Species present in large infestation that are not expanding.

Apart from these weeds are also …. Type A – Worst Weed, B – Bad weed & C – Minor pest.

Weeds are classified on the basis of anatomy depending upon their cycle :

i) Annual, ii) Biennials, iii) Perennials.

Annual weeds more commonly complete their life cycle in one season. This can be further classification as summer annuals, kharif annual e.g. Foxtail and Winter annual.
Biennual complete their life cycle in two years in first year they remain vegetative and in 2$^{nd}$ year they produce flowers and seeds.

Perennial weeds grow for 3 or more years. Classification according to cotyledenous – i.e. Monocot and dicot.

Apart from above, these can also be classified according to climate, according to nature of stem, according to altitude and according to their noxious effect.

A very essential scientific classification was made by Christopher D. K. Cook, 1996. On the basis of growth form (1990). Here briefly narrate about their status –
Plants not physiologically bound to water but tolerating longer period of submergence are Halophytes.

Plants physiologically bound to water with at least part of generative cycle taking place submerged in floating on water.

Plants attached to but not penetrating a solid substratum in the podostemaceae are termed as – Haptophytes, it can also penetrate a substrate or lying totally free, submerged or floating on water.

Plants with the juvenile phase submerged in or floating on water and the adult phase is terrestrial, plants developing flower while atleast partly submerged in or floating on water, are Tenagophyte.

Plants with all photosynthetic parts submerged. Plants occupying the zone between the bottom and the lower surface of water – plankton. Plants rooted in the substrate.

Leaves borne all plants assumed in a rossette i.e. Rosulate.

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Leaves arranged along elongated stems are vittlate.

Plants free floating on the surface not attached to or penetrating the substrate are pleustophytes.

Plants with root penetrating the substrate leaves &/or some free floating but not arising above water surface – Epiphydat leaves &/or stems emerging above water surface are Hyperhydates.

### 2.6 Resource of Wetland, aquatic flora and fish in India

Wet land including shallow water bodies cover 6% of the earth surface (Mitchel, 1986), but support nearly 20% of earth biodiversity (Gopal, 1997). India has about 4.1 million hector of wet land excluding paddy field out of which 1.5 million hectare is natural and 2.6 million hectares are man made (Anonymous, 1990). In West Bengal, there are about 54 natural and 9 man-made wet land that is more than 100 hectare (Biswas and Trisal, 1993).

The district wise distribution of wet land in West Bengal has been prepaired by I.W.M.A.B. department of environment. Govt. of West Bengal by Satelite imaginary. Among the natural wet land, seasonal water logged type of wetland in Midnapoor, cut off meander in Coochbehar. Marsh and Swamp in W. Dinajpur and Oxbowtype lake in Nadia are significant. Maximum no. of reservoir are observed in Bankura, tanks in Purulia, man-made water logged in Birbhum, abundoned quarries in Burdwan, Cooling pond in Mursidabad and Medinipoor.

According to Ghosh (1999), in Indian wet land, the aquatic flora are as follows –

### 2.7 Resources of aquatic weeds in India (URL 1)

i) Fern and fern allies – 26 species.
ii) Strictly aquatic monocot – 75 species.
iii) Strictly aquatic dicot – 47 species.
iv) Terrestrial family with some wet land representative – 594.
v) Mangrove and Mangrove associated – 68.

Among them, in West Bengal the total no of aquatic teridophytes are 8, aquatic dicot 12, monocot 36, representative of wet land habitat – 265 (Ghosh, S. K., 2002).

Some exotic weeds are *E. crasipes*, *Alternanthera* sp., *Sagittaria* sp., *Salvinia molesta and S. cucullata* are from latin America.

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- **Threatened sp. in West Bengal : (URL –1)**

| | |
|---|---|
| *Aldorvanda vesiculosa* | Water collected during 1957 from Tripura but now probably extinct from West Bengal. |
| *Caldesia oligococca* | Distribution is restricted due to anthropogenic activity. |
| *C. parnassifolia* | Extinct due to anthropogenic grazzing |
| *Drosera bunnannii* | Extinct due to anthropogenic grazzing |
| *D. indica* | Extinct due to anthropogenic grazzing |
| *Najas manina* | Extinct due to anthropogenic grazzing |
| *Isoetes coromandelina* | Over consumption by Pig. |
| *Euryale feros* | No nocturnal population found in Bengal except Maldah. |
| *Spiranthes australis* | Reproductive hue failure or unfeavourable habitat. |
| *Utricularia striatula* | Intra and inter specific competition and overgrazzing. |

Fish fauna in West Bengal represented by 172 sp. Distributed in 36 family and 12 orders (URL 1).

*Typha spp.* (Hogla), *Aeschynomene aspera* (Sola), *Cyperus* sp. (Modur Kathi), *Trapa bispinosa* (Panifal), *Eurypyla* sp. (Makhana) are also harvested commercially now specially at 24 Parganas (South), Hooghly, Howrah and Midnapore district of West Bengal and takes a major role for small scale industry at the village or rural area of our state.

***Table 2 : No. of Fish species in India (URL-1)***

| | | | |
|---|---|---|---|
| Fresh water | – | 620 | [Biodiversity Value index – 2837] [Anton Back – World Fisheries Trust, Victoria BC, CANADA] |
| Endemic | – | 196 | |
| Marine / Brakish | – | 985 | |
| Reef asociated | – | 283 | |
| Commercially important | – | 248 | |
| Game fish | – | 214 | |
| Threatened | – | 22 | |
| Introduced | – | 18 | |
| Potential aquarium | – | 221 | |
| Aquaculture | – | 30 | |

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# Chapter 3: Materials and Methods

## 3.1 Collection and preservation of water samples

For determination of physicochemical parameters like pH, DO, $PO_4$, $NH_3$, $NO_3$, hardness, total alkalinity, water samples were collected in air tight neutral polyethylene bottles every fortnight from every sample station. All samples were immediately brought to the laboratory and determine the parameters within 12-24 hrs of collection. On every zone, each bottle should be properly labelled according to their name or pond number.

## 3.2 Analytical methods

***3.2.1 Temperature*** **:** The temperatures of all ponds were measured by a Celsius thermometer (Scale ranging from $0^0C$ – $100^0C$).

***3.2.2 Water pH :*** The pH of water samples were measured directly in an electronic digital pH meter (Systronics-304).

***3.2.3 Dissolved Oxygen (APHA-1995) :*** At first take a 25 ml sample and add 0.25 ml each $MnSO_4$ and alkaline Iodide and allow 1 minute for precipitation. The ppt. is to dissolve by conc. $H_2SO_4$. This reacted 5 ml samples transfer to a conical flask and add 1% starch solution 5-6 drops. The sample turn blue, now this is ready for titration against sodium thiosulfate (0.25 N) solution. The end point of the solution should be noticed as colorless condition of the solution. The result was expressed as mg/l or ppm.

***3.2.4 Water Ammonia [By Spectrophotometric method] :*** Take a 25 ml sample and add 1 ml phenol solution and sodium nitroprusside solution each then add 2.5 ml oxidizing solution and shaking thoroughly after each chemical adding. Cover with aluminium fowel and let to color develop for minimum 1 hr in subdued light at room temperature. Prepare a blank and treat the blank as same as the sample. Measure the optical density at 640 nm and made a standard curve. [APHA, 1995]. The sample can be standardize at 10 ml also.

***3.2.5 Water nitrate [By Spectrophotometric method] :***At first a filtration is needed by Whatmann filter paper for 50 ml sample. The sample now ready to take 1 ml 1 (N) HCl solution treat standard same as sample and read the absorbancy against redistilled water set to zero. The OD is taken by 220 nm and 275 nm respectively. Results were obtained from the formula (x-2y) [Where x = conc. of 220 nm and y = conc. Of 275 nm absorbance] (APHA, 1995).

***3.2.6 Water Phosphate (By Spectrophotometric method]:*** 10ml filter sample of water are taken in a test tube and add 0.4ml of acid ammonium molybdate and then add 2-3 drops of stanous chloride reagent. After that take an optical density with respect to a blank at 690 nm just after 10minutes of adding $Sncl_2$ and prepare a standard curve.

***3.2.7 Alkalinity*** **:**Add 3-4 drops of phenolphthalein to 50 ml water samples if sample turns pink, it should be titrated against N/50 $H_2SO_4$ solution untill the pink color is disappear. If sample remain colourless after adding the reagent i.e. phenolphthalein, then it is concluded that phenolphthalein alkalinity is zero. To that sample initially or after titration colourless, add 2 drops of methyl orange, the sample turns orange, this sample should also be titrated against N/50 $H_2SO_4$ solution. Untill colour turns to red or pink. This is the end point. The total alkalinity calculated as = Phenolphthalein alk, + Methyl orange alk.

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***3.2.8 Hardness*** **:** Take 50 ml sample and mix well by adding 0.5 ml buffer, add 1-6 drops Eriochrome black T. before adding buffer and mix thoroughly. Titrate the sample against EDTA and stirring continuously and the end point is reached gradually from Red to Blue, true end point should be calculated when the Reddish tinge disappear completely.

$$\text{Total Hardness is mg/L or ppm} = \frac{\text{ml EDTA x 1000}}{\text{ml of sample}}$$

***3.2.9 Turbidity*** **:** The turbidity or transparency made by a similar apparatus like Sacchi disc, making this special apparatus manually to color one region of a compact disc (CD) and hanging by rope. The transparency or turbidity was measured by the disappearance of white region of the above mentioned disc within waterbody, calculation was made by cm scale just after withdrawn the disc from the turbid region of the water body. (Figure have shown on plates).

### 3.3 Photographs

The photographs were taken by Cannon digital camera and also by Sony Cybershot at 5 megapixel lens from different study sites on different observative months or seasons.

### 3.4 Weed identification and determination of its density

The identification of weed was done by the help of Prof. G. G. Maity, Dept. of Botany, University of Kalyani and placed then with specific family which were showed on latter table content.

In case of submerged weed the density was measured by $2ft^3$ quadrate study and all other aquatic weeds were studied by 2 $ft^2$ quadrate analysis and placed their category as follows : High density when weeds are present **≥ 10/2ft$^2$ or 2ft$^3$ (HD) < 10 > 5** is moderate density weed **(MD), < 5** thin density weed **(TD)** and **(AB)** or absent when they are absolutely not present on study sites.

### 3.5 Statistical analysis

Water quality parameters and weed diversity were subject to one way ANOVA taking pond type and season as independent factor (Gomez and Gomez, 1984). Significant difference between ponds and seasons was tested by least significant difference (LSD test) at 5% probability.

### 3.6 About the Sites

I have selected 2 specific zones at South Bengal for special emphasize on planned pisciculture practice and impact on weeds biodiversity om it with special reference on physicochemical parameters of 3 sampling ponds or Jhill on each zone. For identification, I also choose some paddy fields, source water creeks at different sites of Chakdaha, Kalyani University campus and Supreme paper mill area at Chakdaha, near the Gangetic plane. Very sort description about my selected site are given below :

#### *3.6.1 Zone 1, Kalyani Govt. Fish Farm*

The Govt. established fish farm has pays salary of all staff and bear all other expenditure by the Govt. This is situated at Kulia, Kalyani, Nadia, West Bengal. The aim of the farm is to

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collect the fish seed by spawning and marketed the seeds at different time of the year. The farm was established in 1966. The total land area of the farm 9.50 hectare. The normal range of Limnological parameters are – Temperature – $28^0$-$30^0$C, Transparency – 30-60 cm, pH – 7.8, DO – 5-10 ppm, Alkalinity – 100-180, according to their data provided to us. There are 3 Nursery pond, 10 rearing pond, 1 composite pond, 1 hospital pond and a large lake with 3 boats. The total production is near by 3.0-3.5 metrictone/year/h.

### *3.6.2 Zone 2. : Mudialy Nature's Park*

- **Mudialy Fishermen's Co-operative Society (MFCS) :**
  Located in a densely populated area about 20kms south-west of the heart of Calcutta is based on some wet lands of the Calcutta Port Trust which are taken or lease by this society (In 1961) with the help of Dept. of Fisheries. Using urban refuge and polluted waters of the city. This society has developed a completely indigenous bio-engineering to (i) Improving the waste, (ii) using waste water as input to grow fish, (iii) developing an ecologically balanced system, (iv) purification mostly done by macrophytes.

  **The ponds are denoted as**
  **Zone –1 : $S_2 \equiv P_1$, $S_6 \equiv P_2$, JHILL $\equiv P_3$**
  **Zone –2 : $M_9 \equiv P_4$, GHASBARI $\equiv P_5$, KHUDI $\equiv P_6$**

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## Chapter 4: Results and Discussion

Fish production is greatly affected by the thick presence of floating and submerged aquatic weeds, providing shelter and shade for fish when their density is moderate or thin, but when it cover the entire water body it can be lethal for fish growth. Fish may feel suffocating problem from lack of oxygen.

India has 1.9 million hac under water in reservoir and 1.2 million hac under irrigation and also nearly 2.2 million hac of village ponds and tanks have estimated.

Aquatic macrophytes cause tremendous loss of water from water bodies like lakes and other aquatic ecosystem through evapotranspiration.

The site selection was based on specially for pisciculture prone area i.e. Govt. Fishery Kulia fish farm at Kalyani, where a managed practice is made possible by some efficient scientists as well as skilled farmers. Another site could be a role model to reduce our pollution problem as well as good income source for fish farmers and their society, this is Mudialy Fishermens Co-operative Society Ltd. By whom it is now a location which is typically called "Mudialy Natures Park". Near about 25 million litres of Port Trust Sewage and Gardenreach industrial sewage are treated by naturally especially with aquatic macrophytes and with aquatic macrophytes and with bacteria. The same water is utilized for pisciculture practice at the beginning but now a days there is an integrated farming practice happening on the same site for multiple occupation. It helps to discharge flows of fresh water through "Monikhal" connected with Ganges. There is about 1.5 MT of fish (average) production in every year with polyculture practice and in this practice total purification of water is achieved by aquatic macrophytes at 2.5 lakes square meter.

Whereas in the managed richly diversified Kalyani Kulia fish farm is produced nearly 3.0-3.5 MT/yr/hac production.

***Table 3 : Production of fish at Mudially***

| **Year** | **Quantity** |
|---|---|
| 2003-04 | 126.86 MT |
| 2004-05 | 164.26 MT |
| 2005-06 | 138.82 MT |
| 2006-07 (upto Dec.) | 103.53 MT |

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*Table 4: the list of fish fauna at the nature park*

| Sl. No. | Local Name | Latin Name |
|---|---|---|
| 1 | Catla | *Catla catla* |
| 2 | Rahu | *Labeo rohita* |
| 3 | Mrigat | *Cirrhin mrigala* |
| 4 | Calbasu | *Labeo calbasu* |
| 5 | Bata | *Labeo bata* |
| 6 | Silver Carp | *Hypophthalmichthis molitrix* |
| 7 | Grass Crap | *Ctenopharyngodon idella* |
| 8 | Caurala | *Amblypharyngodon mola* |
| 9 | Puti | *Puntius sophore* |
| 10 | Puti | *P. conconius* |
| 11 | Puti | *P. chola* |
| 12 | Saral puti | *P. stigma* |
| 13 | Common carp | *Cyprinus carpio* |
| 14 | Big head carp | *Aristichthys nobilis* |
| 15 | Tilapia | *Tilapia mossambica* |
| 16 | Nyloctica | *Tilapia nylotia* |
| 17 | Chanda | *Chanda ranga* |
| 18 | Chanda | *Chanda nama* |
| 19 | Latha | *Channa punctatus* |
| 20 | Sole | *Channa striarus* |
| 21 | Sal | *Channa marulius* |
| 22 | Chang | *Channa barca* |
| 23 | Singi | *Heteropaeustes fossilis* |
| 24 | Magur | *Clarious batrachus* |
| 25 | Kai | *Anabu studincus* |
| 26 | Kholisa | *Colisa fasciata* |
| 27 | Mados | *Nadus nadus* |
| 28 | Sele | *Glossogobius giuris* |
| 29 | Falui | *Natopterus natopterus* |
| 30 | Chital | *Natopterus chitala* |
| 31 | Tangra | *Mystus tangra* |
| 32 | Tangra | *Nystus vittatas* |
| 33 | Tangra | *Mystus cavasius* |

### 4.1 Statistical analysis (ANOVA of Summer)

The experiment have passed through the one way ANOVA test LSD at 0.05 significant level and showed some important characteristics as follows.

**pH :** The season wise analysis showed that there is no such significant between group of pond-1 and pond 3 and also in $P_4$ and $P_6$ but rest were below significant level.

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**DO :** Dissolve oxygen significance was not found on $P_1$ and $P_6$ and also between $P_3$ and $P_5$. Except these two groups all were significant level.
**$NO_3$ :** $P_1$ and $P_2$ was also lack of significant on this parameters and also $P_5$ and $P_6$ were absent of significant level.
**$NH_3$ :** Ammonia had vast variation within a between ponds. The insignificants are as follows : P & $P_2$, $P_1$& $P_5$, $P_1$ and $P_6$, $P_2$ &$P_6$ is also $P_5$ and $P_6$.
**Hardness :** Hardness is with good significant level except $P_2$ and $P_5$, $P_6$ and $P_1$.
**Alkalinity :** Similarly alkalinity is very significant in all season in all ponds except $P_1$ and $P_2$.
**Turbidity** : Turbidity had very large scale of insignificant level. But there were 3 groups showed significant variation viz. $P_2$& $P_3$, $P_2$& $P_5$, $P_4$ and $P_5$.
**Temperature :** The temperature variation is also with high significant level. On different ponds because the same collection time and nearly same mouth period. Significant level on different ponds are as follows : $P_1$ and $P_2$, $P_2$& $P_3$, $P_2$& $P_4$, $P_3$& $P_4$, $P_3$& $P_5$, $P_5$& $P_4$, $P_6$& $P_5$.

***Table 5 : Results of ANOVA carried with data of physicochemical parameters of pond water during summer***

| | | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| PH | Between Groups | 5 | 0.136 | 4.927 | 0.039 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| DO | Between Groups | 5 | 2.712 | 245.634 | 0.000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| PHOS | Between Groups | 5 | 0.198 | 188.546 | 0.000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| NITR | Between Groups | 5 | 0.058532 | 351.200 | 0.000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| AMON | Between Groups | 5 | 0.171 | 214.267 | 0.000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| HARD | Between Groups | 5 | 831.081 | 44822.357 | 0.000 |

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| | | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| ALK | Between Groups | 5 | 1886.164 | 1399.534 | 0.000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| TURB | Between Groups | 5 | 76.505 | 81.258 | 0.000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| TEMP | Between Groups | 5 | 14.288 | 2.341 | 0.165 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |

### 4.2 Weed analysis

I have found large diversity in both zone at summer season with a large number of marginal weed. The highest diversity was observed at natural Jhill ($P_3$) at Kulia, in summer and lowest diversity mostly found at all managed pond which are specially used as productive pond. Several correlation specially for nutrient such as nitrate, ammonia and phosphate can be established specially for weed diversity and parameters and also with its density.

The most available or dominant species at zone 1 or Kulia at summer are *Eichhornia, Lemna, Spirodela, Trapa, Marsilea, Ipomoea, Colocasia, Scirpus, Monochoria, Saggitaria, Typha, Utricullaria, Hydrilla and some amount of Vallisnaria. Chara* is only found at $P_3$. *Aponogeton* is also found.

At zone 2 there is near about all species in lower abundant inrelation to zone I. *Eichhornia Monocharia, Saggitaria, Ipomoea, Colocasia, Pistia, Najas, Marsilea, Chara* and *Hydrialla* are frequently found. *Typha,* and *Cyperus* and small amount of *Phragmites* are also present occasionally (Table of summer aquatic weed biodiversity).

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*Table 6: Name of the Pond –Weed Diversity during summer season at zone 1*

| Category | Family | Example with Scientific Name | P1 | P2 | P3 |
|---|---|---|---|---|---|
| FLOATING | 1.Pontidariaceae | *Eichhornia crassipes* | MD | MD | MD |
| | 2.Araceae | *Pistia stratioites* | TD | AB | TD |
| | 3.Salviniaceae | *Salvinia cucullata* | TD | AB | TD |
| | 4.Azollaceae | *Azolla pinnata* | TD | AB | TD |
| | 5.Lemnaceae | *Spirodela polyrhiz* | AB | TD | MD |
| | 6.Lemnaceae | *Lemna minor* | AB | TD | MD |
| | 7.Lemnaceae | *Wolffia arrhiza* | TD | AB | AB |
| EMERGENT | 1.Nympheaceae | *Nymphoides hydrophylla* | TD | TD | MD |
| | 2.Nympheaceae | *Nelumbo nucifera* | AB | AB | AB |
| | 3.Onagraceae | *Trapa bisponosa* | AB | AB | HD |
| | 4.Haloragraceae /Myriophyllaceae | *Myriphyllum tuberculatum* | TD | AB | TD |
| | 5.Potamogetonacea e | *Potamogeton nodosus* | AB | AB | AB |
| | | *Aponogeton monostachyon* | AB | AB | AB |
| | | *Nymphaea spp* | AB | AB | TD |
| | | *Marsilea quadrifolia* | TD | TD | MD |
| MARGINAL | 1.Convolvulaceae | *Ipomoea aquatica* | TD | TD | MD |
| | 2.Onagraceae | *Jussiaea repens* | TD | MD | TD |
| | 3.Leguminosae | *Neptunia oleracea* | AB | TD | AB |
| | 4.Araceae | *Colocasia antiquorum* | MD | HD | HD |
| | 5.Graminae | *Typha elephantica* | AB | TD | MD |
| | 6.Cypiraceae | *Cyperus spp* | TD | AB | MD |
| | 7.Cypiraceae | *Scirpus articulatus* | TD | TD | MD |
| | 8.Graminae | *Panicum repens* | AB | AB | TD |
| | 9.Graminae | *Phragmites karka* | AB | AB | TD |
| | | *Monochoria spp* | TD | TD | HD |
| | | *Sagittaria spp* | AB | TD | TD |
| SUBMERGED | 1.Ceratophyllaceae | *Ceratophyllum demersum* | AB | AB | TD |
| | 2.Lentibulariaceae | *Utricullaria spp* | TD | AB | MD |
| | 3.Hydrocharitaceae | *Hydrilla verticillata* | TD | MD | TD |
| | 4.Hydrocharitaceae | *Nechamandra alternifolia* | AB | AB | AB |
| | 5.Hydrocharitaceae | *Vallisnaria spiralis* | TD | TD | TD |

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| Category | Family | Example with Scientific Name | P1 | P2 | P3 |
|---|---|---|---|---|---|
| | 6.Hydrocharitaceae | *Ottilia alismoides* | AB | AB | AB |
| | 7.Naiadaceae | *Najas indica* | TD | AB | TD |
| | 8.Chlorophyceae | *Chara zeylanica* | AB | AB | TD |

***Table 7: Name of the Pond –Weed Diversity during summer season at zone 2***

| Category | Family | Example with Scientific Name | P4 | P5 | P6 |
|---|---|---|---|---|---|
| FLOATING | 1.Pontidariaceae | *Eichhornia crassipes* | MD | MD | TD |
| | 2.Araceae | *Pistia stratioites* | TD | TD | TD |
| | 3.Salviniaceae | *Salvinia cucullata* | TD | TD | AB |
| | 4.Azollaceae | *Azolla pinnata* | AB | AB | TD |
| | 5.Lemnaceae | *Spirodela polyrhiz* | AB | TD | AB |
| | 6.Lemnaceae | *Lemna minor* | AB | TD | AB |
| | 7.Lemnaceae | *Wolffia arrhiza* | TD | AB | AB |
| EMERGENT | 1.Nympheaceae | *Nymphoides hydrophylla* | TD | TD | AB |
| | 2.Nympheaceae | *Nelumbo nucifera* | AB | AB | AB |
| | 3.Onagraceae | *Trapa bisponosa* | AB | AB | AB |
| | 4.Haloragraceae /Myriophyllaceae | *Myriphyllum tuberculatum* | TD | AB | AB |
| | 5.Potamogetonaceae | *Potamogeton nodosus* | AB | AB | AB |
| | | *Aponogeton monostachyon* | AB | AB | AB |
| | | *Nymphaea spp* | AB | AB | AB |
| | | *Marsilea quadrifolia* | MD | TD | MD |
| MARGINAL | 1.Convolvulaceae | *Ipomoea aquatica* | TD | TD | MD |
| | 2.Onagraceae | *Jussiaea repens* | TD | MD | TD |
| | 3.Leguminosae | *Neptunia oleracea* | AB | AB | AB |
| | 4.Araceae | *Colocasia antiquorum* | MD | MD | HD |
| | 5.Graminae | *Typha elephantica* | AB | MD | MD |
| | 6.Cypiraceae | *Cyperus spp* | AB | TD | TD |
| | 7.Cypiraceae | *Scirpus articulatus* | TD | TD | MD |
| | 8.Graminae | *Panicum repens* | AB | AB | AB |
| | 9.Graminae | *Phragmites karka* | AB | AB | TD |
| | | *Monochoria* | MD | TD | AB |
| | | *Sagittaria* | TD | AB | TD |
| SUBMERGED | 1.Ceratophyllaceae | *Ceratophyllum demersum* | AB | AB | TD |

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| Category | Family | Example with Scientific Name | P4 | P5 | P6 |
|---|---|---|---|---|---|
| | 2. Lentibulariaceae | *Utricullaria spp* | TD | TD | MD |
| | 3.Hydrocharitaceae | *Hydrilla verticillata* | TD | MD | TD |
| | 4.Hydrocharitaceae | *Nechamandra alternifolia* | AB | AB | AB |
| | 5.Hydrocharitaceae | *Vallisnaria spiralis* | AB | TD | MD |
| | 6.Hydrocharitaceae | *Ottilia alismoides* | AB | AB | AB |
| | 7.Naiadaceae | *Najas indica* | AB | TD | TD |
| | 8.Chlorophyceae | *Chara zeylanica* | AB | AB | AB |


***Trapa bisponosa***


***Mudialy treatment canal***


***Marginal weeds***


***Sagittaria and Eichhornia***


***Monochoria and Colocasia***


***Jussiaea repens***


***Scirpus and Eichhornoia***


***Cyperus***


***Ipomoea***

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*Najas*

*Trapa,Hydrilla,Aponogeton,Nymphoides*

*Nelumbo*

*Salvinia*

*Aponogeton*

*Nymphae*

*Lemna*

*Nymphoides*

*Ipomoea carnea*

*Phragmites*

*Monochoria*


*Mudialy*

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### 4.3 Statistical analysis (ANOVA on Monsoon)

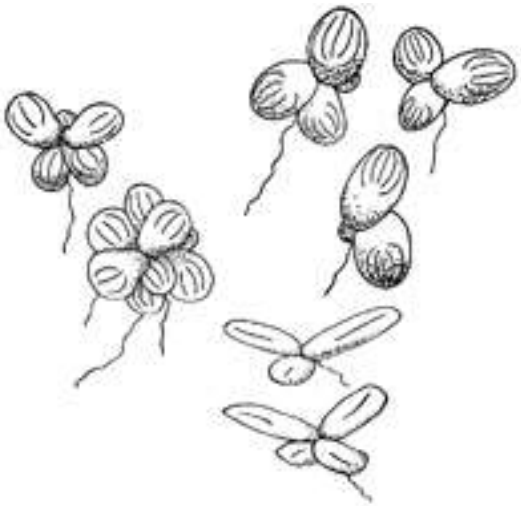
The all experiment showed marked significant upto LSD 0.05 level, i.e. the difference between the groups of all ponds have response very significantly.

**pH :** Apart from $P_1$& $P_3$, $P_4$& $P_6$ have not showed such significant difference but all other ponds of 2 zones have showed marked significant difference.
**DO :** $P_1$& $P_6$, $P_3$& $P_5$ have not showed significant difference at monsoon.
**$PO_4$ :** The all ponds except $P_1$& $P_2$ in widely accepted by significant level at 0.05%.
**$NO_3$ :** From 2 different zones at 2 different sites are without significant level at $P_1$& $P_2$ (Zone 1), $P_5$& $P_6$ (Zone 2) respectively.
**$NH_3$ :** The ANOVA analysis have proved many insignificant variation between the ponds, namely, $P_1$& $P_2$, $P_1$ and $P_5$, $P_1$ and $P_6$, $P_2$ and $P_5$, $P_2$ and $P_6$, $P_5$& $P_6$.
**Hardness :** Comparative study of hardness at different pond on different zone have proved marked significant difference except $P_1$ and $P_6$, $P_2$& $P_5$.
**Turbidity :** Among all parameters, turbidity ranges showed not such significant level, i.e. it proved all ponds are productive in nature. Though, seasonal variation with higher turbidity observed at monsoon.
**Temperature :** Temperature is also with good significant level.
**Alkalinity :** At monsoon season, there was very good variation is found among the ponds. $P_1$& $P_2$ is not response to the above mentioned significance level. (Graphs are showed as figure with respect to all physicochemical parameters with seasonal variation).

### 4.4 Weed analysis

Drastically, some immergent and floating weeds like *Nilumbo, Nymphoides, Trapa* are absent or scarcely present. At Mudially, there is a sudden reduction at the pollution treatment pond on *Eichhorhia, Monochoria, Saggitaria, Pistia,* etc. but with *Spirodela, Lemna, Wolffia* and with *Hydrilla*. Though the luxuriant growth of marginal weeds accompanied by *Colocasia, Scirpus, Ipomoea, Phragmites* &*Typha* are found at both zones. Though the observation showed a quite good biodiversity of aquatic weeds was also found at zone-1, i.e. Kulia, Kalyani (Table of aquatic weeds).

***Scirpus***



***Lemna***

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***Phragmites***

***Chara***

**White water lily**

***Typha***

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***Table 8 : Results of ANOVA carried with data of physico-chemical parameters of pond water during monsoon***

| | | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| PH | Between Groups | 5 | 0.878 | 174.158 | .000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| DO | Between Groups | 5 | 0.628 | 56.747 | .000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| PHOS | Between Groups | 5 | 2.112E-02 | 1157.488 | .000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| NITR | Between Groups | 5 | 2.793E-02 | 90.578 | .000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| AMON | Between Groups | 5 | 0.216 | 323380.400 | .000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| HARD | Between Groups | 5 | 1306.283 | 1045.027 | .000 |
| | Within Groups | 6 | 1.250 | | |
| | Total | 11 | | | |
| ALK | Between Groups | 5 | 798.683 | 416.704 | .000 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| TURB | Between Groups | 5 | 6.533 | 3.015 | .106 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |
| TEMP | Between Groups | 5 | 8.243 | 8.801 | .010 |
| | Within Groups | 6 | | | |
| | Total | 11 | | | |

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***Table 9 : Name of the Pond –Weed Diversity during monsoon season at zone 1.***

| Category | Family | Example with Scientific Name | P1 | P2 | P3 |
|---|---|---|---|---|---|
| FLOATING | 1.Pontidariaceae | *Eichhornia crassipes* | MD | MD | MD |
| | 2.Araceae | *Pistia stratioites* | AB | AB | TD |
| | 3.Salviniaceae | *Salvinia cucullata* | AB | AB | TD |
| | 4.Azollaceae | *Azolla pinnata* | TD | AB | TD |
| | 5.Lemnaceae | *Spirodela polyrhiz* | AB | TD | TD |
| | 6.Lemnaceae | *Lemna minor* | AB | TD | TD |
| | 7.Lemnaceae | *Wolffia arrhiza* | TD | AB | AB |
| EMERGENT | 1.Nympheaceae | *Nymphoides hydrophylla* | AB | AB | TD |
| | 2.Nympheaceae | *Nelumbo nucifera* | AB | AB | TD |
| | 3.Onagraceae | *Trapa bisponosa* | AB | AB | MD |
| | 4.Haloragraceae /Myriophyllaceae | *Myriphyllum tuberculatum* | TD | MD | TD |
| | 5.Potamogetonaceae | *Potamogeton nodosus* | AB | AB | TD |
| | | *Aponogeton monostachyon* | AB | AB | TD |
| | | *Nymphaea spp* | AB | AB | AB |
| | | *Marsilea quadrifolia* | TD | TD | MD |
| MARGINAL | 1.Convolvulaceae | *Ipomoea aquatica* | TD | TD | MD |
| | 2.Onagraceae | *Jussiaea repens* | TD | TD | TD |
| | 3.Leguminosae | *Neptunia oleracea* | AB | AB | AB |
| | 4.Araceae | *Colocasia antiquorum* | HD | MD | HD |
| | 5.Graminae | *Typha elephantica* | TD | TD | TD |
| | 6.Cypiraceae | *Cyperus spp* | TD | AB | MD |
| | 7.Cypiraceae | *Scirpus articulatus* | TD | TD | MD |
| | 8.Graminae | *Panicum repens* | AB | AB | TD |
| | 9.Graminae | *Phragmites karka* | AB | AB | TD |
| | | *Monochoria* | AB | TD | HD |
| | | *Sagittaria* | AB | TD | MD |
| SUBMERGEI | 1.Ceratophyllaceae | *Ceratophyllum demersum* | TD | AB | TD |
| | 2.Urticaceae | *Utricullaria spp* | TD | AB | MD |
| | 3.Hydrocharitaceae | *Hydrilla verticillata* | TD | MD | MD |
| | 4.Hydrocharitaceae | *Nechamandra alternifolia* | AB | AB | AB |
| | 5.Hydrocharitaceae | *Vallisnaria spiralis* | MD | TD | TD |

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| Category | Family | Example with Scientific Name | P1 | P2 | P3 |
|---|---|---|---|---|---|
| | 6.Hydrocharitaceae | *Ottilia alismoides* | AB | AB | TD |
| | 7.Naiadaceae | *Najas indica* | TD | AB | MD |
| | 8.Chlorophyceae | *Chara zeylanica* | AB | AB | TD |

***Table 10 : Name of the Pond –Weed Diversity during monsoon season at zone 2.***

| Category | Family | Example with Scientific Name | P1 | P2 | P3 |
|---|---|---|---|---|---|
| FLOATING | 1.Pontidariaceae | *Eichhornia crassipes* | TD | HD | MD |
| | 2.Araceae | *Pistia stratioites* | TD | TD | TD |
| | 3.Salviniaceae | *Salvinia cucullata* | AB | AB | AB |
| | 4.Azollaceae | *Azolla pinnata* | AB | AB | TD |
| | 5.Lemnaceae | *Spirodela polyrhiz* | MD | TD | AB |
| | 6.Lemnaceae | *Lemna minor* | AB | TD | AB |
| | 7.Lemnaceae | *Wolffia arrhiza* | TD | AB | AB |
| EMERGENT | 1.Nympheaceae | *Nymphoides hydrophylla* | TD | TD | AB |
| | 2.Nympheaceae | *Nelumbo nucifera* | AB | AB | AB |
| | 3.Onagraceae | *Trapa bisponosa* | AB | AB | AB |
| | 4.Haloragraceae /Myriophyllaceae | *Myriphyllum tuberculatum* | TD | TD | TD |
| | 5.Potamogetonaceae | *Potamogeton nodosus* | AB | TD | AB |
| | | *Aponogeton monostachyon* | AB | AB | AB |
| | | *Nymphaea spp* | AB | AB | TD |
| | | *Marsilea quadrifolia* | TD | TD | HD |
| MARGINAL | 1.Convolvulaceae | *Ipomoea aquatica* | TD | TD | TD |
| | 2.Onagraceae | *Jussiaea repens* | TD | MD | MD |
| | 3.Leguminosae | *Neptunia oleracea* | AB | TD | AB |
| | 4.Araceae | *Colocasia antiquorum* | HD | MD | TD |
| | 5.Graminae | *Typha elephantica* | TD | TD | MD |
| | 6.Cypiraceae | *Cyperus spp* | TD | AB | AB |
| | 7.Cypiraceae | *Scirpus articulatus* | TD | TD | MD |
| | 8.Graminae | *Panicum repens* | AB | AB | TD |
| | 9.Graminae | *Phragmites karka* | AB | AB | AB |
| | | *Monochoria* | AB | TD | AB |
| | | *Sagittaria* | AB | TD | TD |
| SUBMERGEI | 1.Ceratophyllaceae | *Ceratophyllum demersum* | AB | AB | TD |

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| Category | Family | Example with Scientific Name | P1 | P2 | P3 |
|---|---|---|---|---|---|
| | 2. Lentibulariaceae | *Utricullaria spp* | TD | AB | AB |
| | 3.Hydrocharitaceae | *Hydrilla verticillata* | MD | MD | TD |
| | 4.Hydrocharitaceae | *Nechamandra alternifolia* | AB | AB | AB |
| | 5.Hydrocharitaceae | *Vallisnaria spiralis* | AB | TD | AB |
| | 6.Hydrocharitaceae | *Ottilia alismoides* | AB | AB | AB |
| | 7.Naiadaceae | *Najas indica* | MD | AB | TD |
| | 8.Chlorophyceae | *Chara zeylanica* | AB | AB | AB |

**4.5 Accumulation of different weeds by different fish at different stocking density**

*Lemna* and *Hydrilla* is taking as food accompanied with *Potamogiton, Eleochoris, Myriophyllum* and *Seratophyllum* by *Cyprinus carpio* on grass carp, @ consume kg/month are 54 kg, 50 kg, 43 kg, 32 kg, 35 kg and 40 kg respectively with a stocking density of 175-225 kg/hectare, 79-173 kg/hectare, 40-80 kg hectare, 30-70 kg/hectare, 40-80 kg/hectare respectively where in case of Telapia, the filamentous algae and chara is consumed @ 55 kg and 50 kg respectively when stocking density is 2470-4940 ps/hectare (Chattopadhyay, 1951, Jhingram, 1988 & Avanti *et al.*, 1954), Vandiver proved that triploid sterile. *C. idella* consume more aquatic plants than normal fish. *C. idella* also accept *Azolla, Salvinia, Hydrilla, Wolffia, Ottelia, Lemna, Trapa* and *Ipomoea, Eichharnia, Pistia and Nymphoides* are also consumed by fish less voraciously (Campbell, 2002). Some culturing herbivore fishes such as *Puntius javanicus, Osphronemus gorami* does not interfare with other fishes, but can easily consume weed. Except *O. gorami,* altogether herbivore fish are found to be cultured at both zone. When *Pistia* is enormous, it can be destroyed *Hydrozetes* sp. (mites) inoculation (Sarkar *et al.*, 1990). Some lepidopteran insect can be threatened for *Hydrilla* (Allenbrey – 2003).

**4.6 Fish production at two sites**

The two managed pisciculture practice zone, namely Kulia and Mudiali has achieved a very good production rate during last 5 years except at 2000-2001 session. Kulia is under huge loss due to flood. Though this is a typical research station under Govt. of West Bengal. It has also benefitted by stocking, rearing and selling of spawn and fry to the farmers at very low cost with the help of fishery department. Normally, it gains 3-3.5 metric ton hectare/year. Normally Kulia sold the adult fish at different coast during last few years as follows :

Catla : 30 – 45 Rs./kg.
Rahu : 30 – 40 Rs./kg.
Mrigale : 25-30 Rs./kg.
Silver Carp : 25 Rs/kg.
Grass Carp : 25 Rs/kg.
Common carp : 20 Rs./kg.

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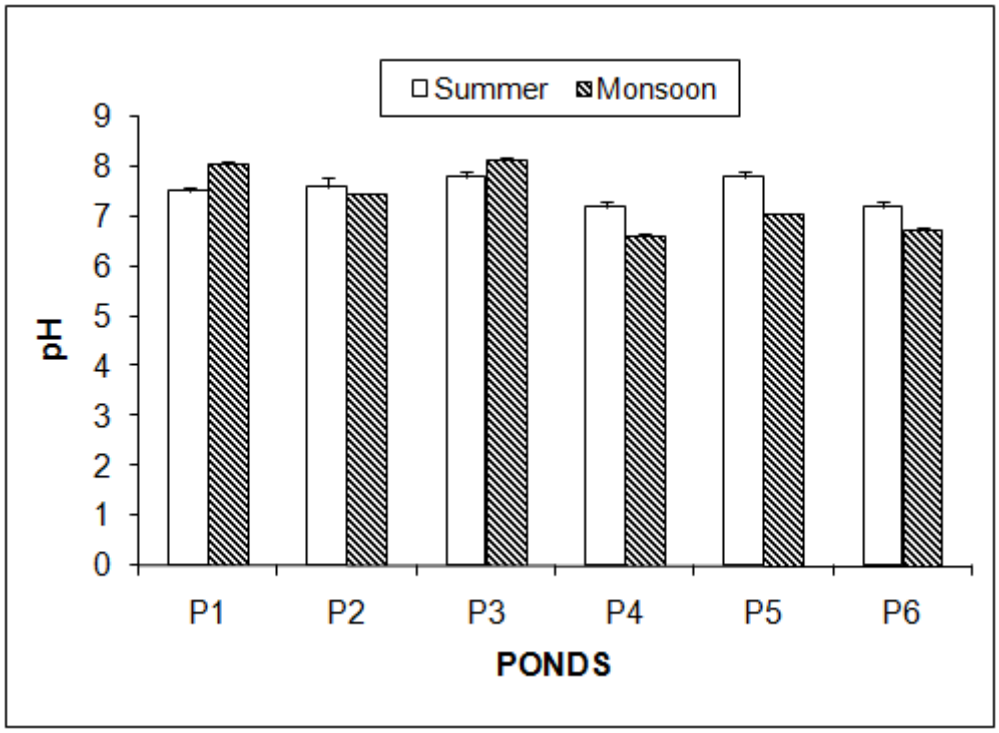
Mudialy is gaining its highest productivity during 2004-2005 @ 164.26 MT and exchange Rs. 6520059.00 and got best productivity award during last few years. Due to be a Cooperative Society, it has some social activities with financial support (Table showed early).

### 4.7 Turbidity and Aquatic weed

It has been noticed that, the summer season was with high transparency and also high aquatic weed biodiversity, but in monsoon, due to lack of water hyacinth and other aquatic weeds, the water become more turbid in contrast to summer (Graph show on figure).

### 4.8 Nutrient and Aquatic weed

Nitrate, ammonia, phosphate can be correlated with total species diversity of different zones are showed at ANOVA on different season.




***Graph 3: Seasonal (Summer and Monsoon) variation of pH of different ponds***

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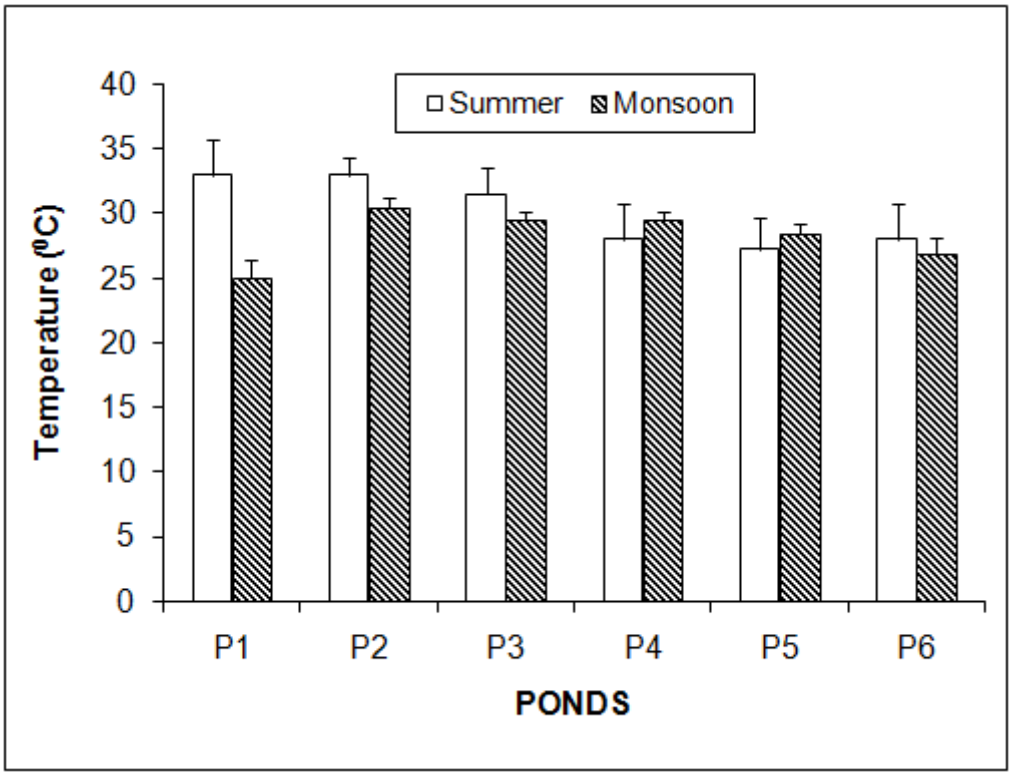
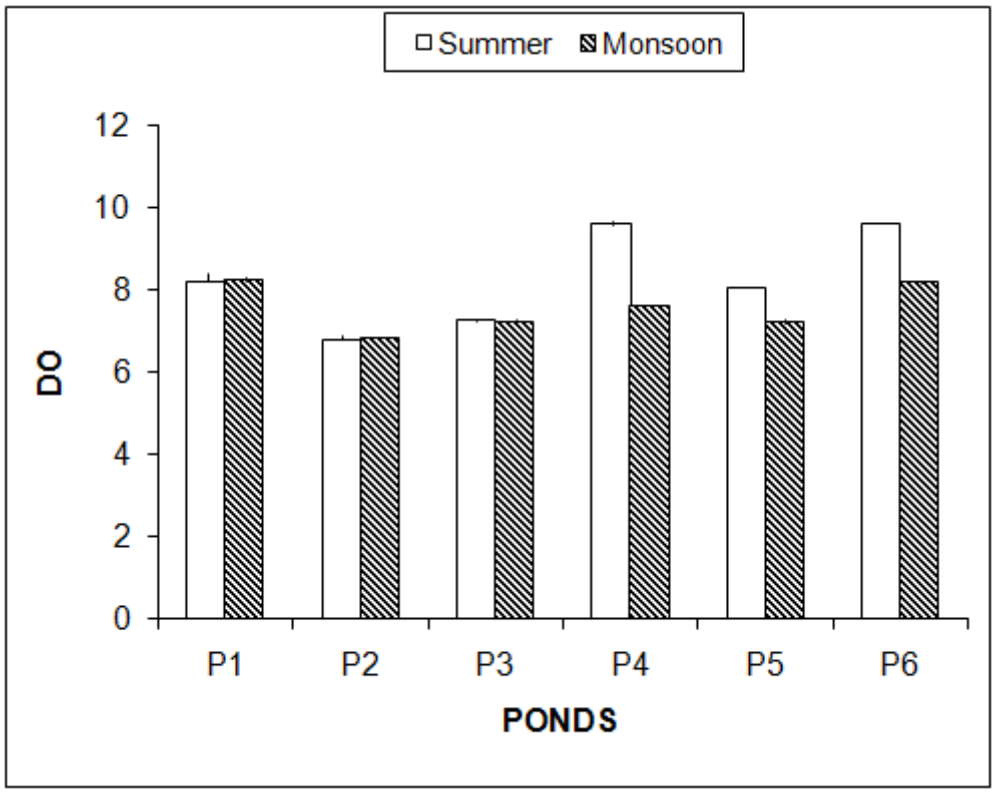



*Graph 4: Seasonal temperature variation*




*Graph 5: Seasonal DO (Dissolved oxygen) in different ponds*

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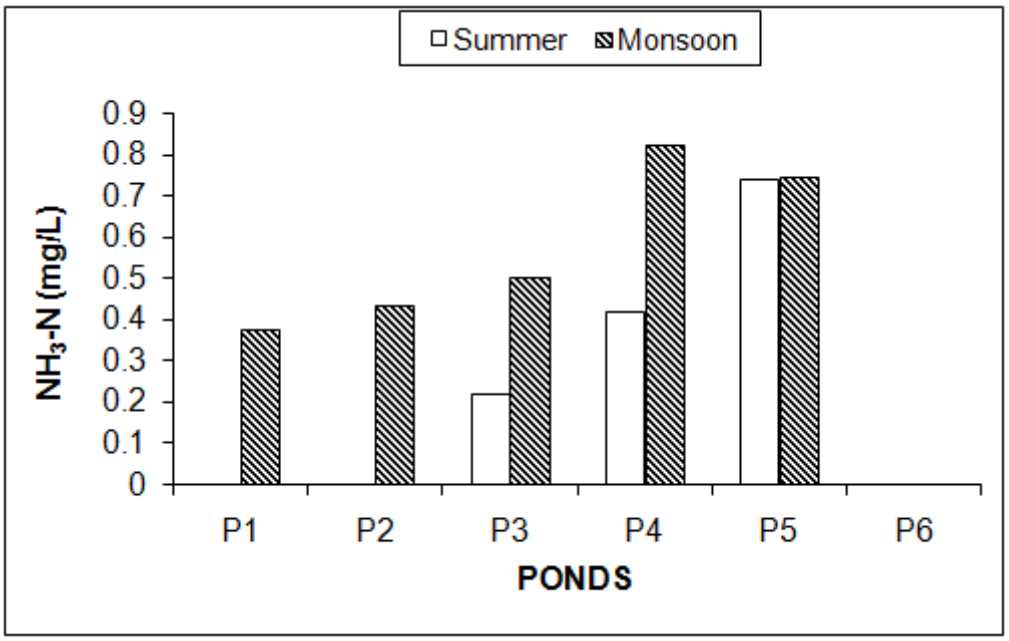
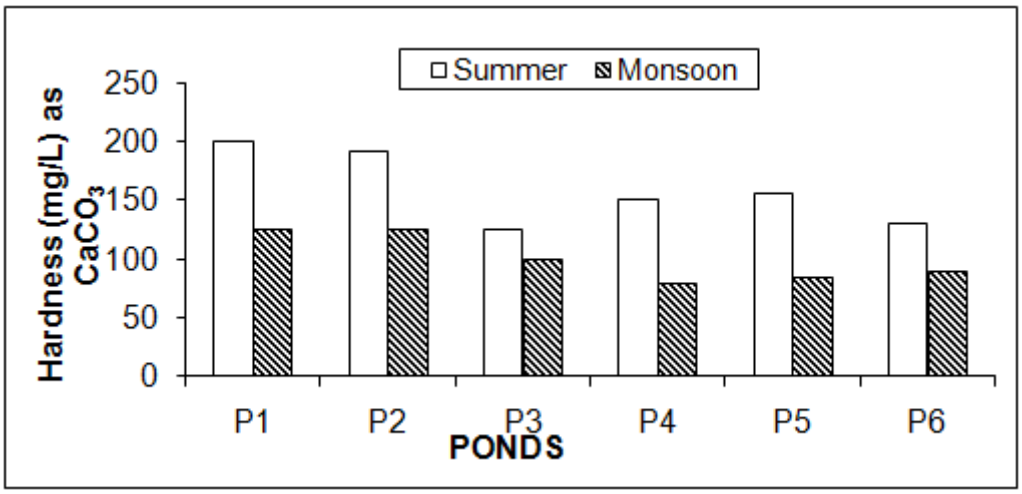



*Graph 6: Ammonia in different ponds with seasonal aspect*




*Graph 7: Hardness of different ponds in seasonal variation*

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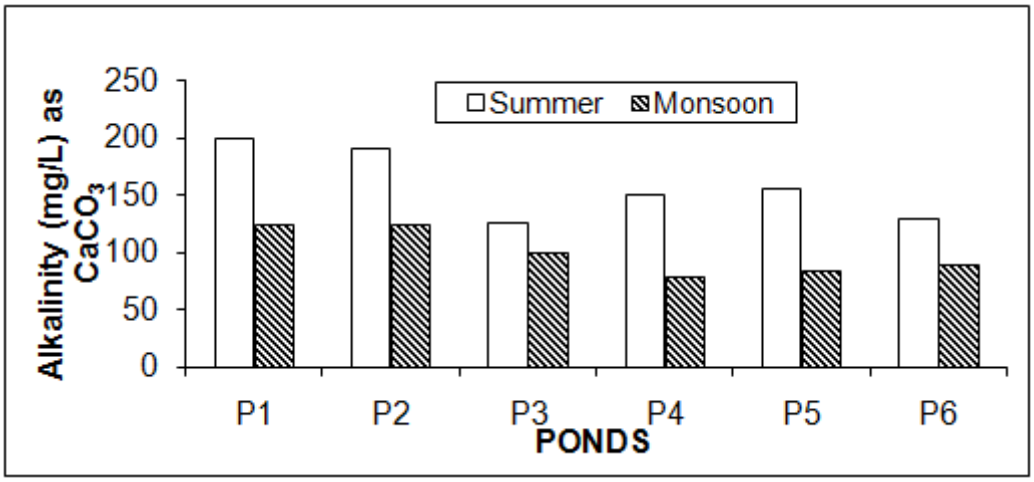
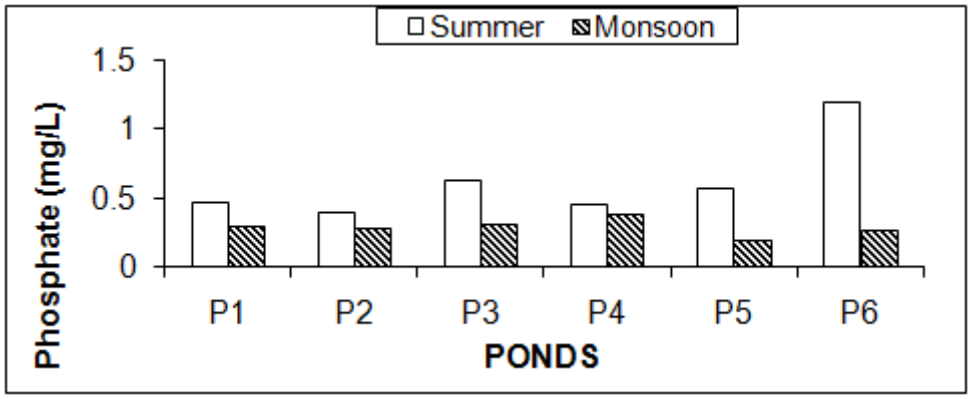
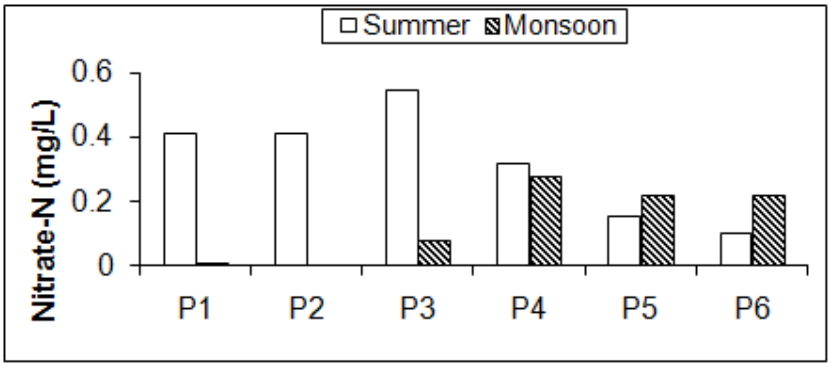



*Graph 8: Total alkalinity of different ponds*




*Graph 9 : Phospate in several ponds*




*Graph 10: Variation of Nitrate concentration in different ponds*

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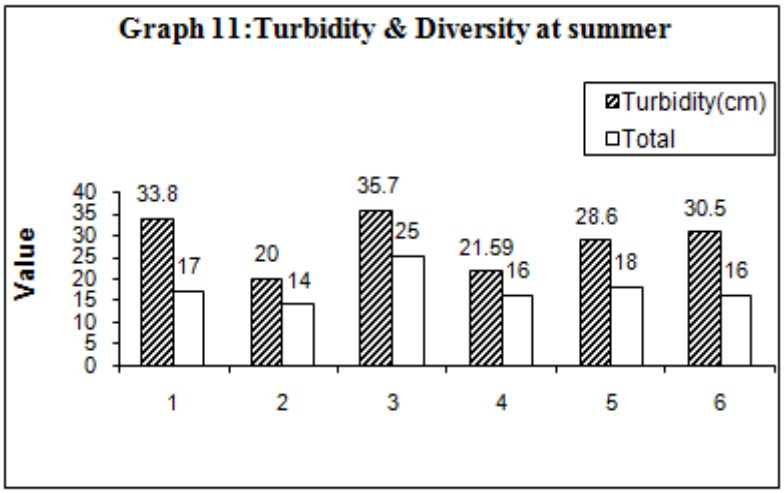


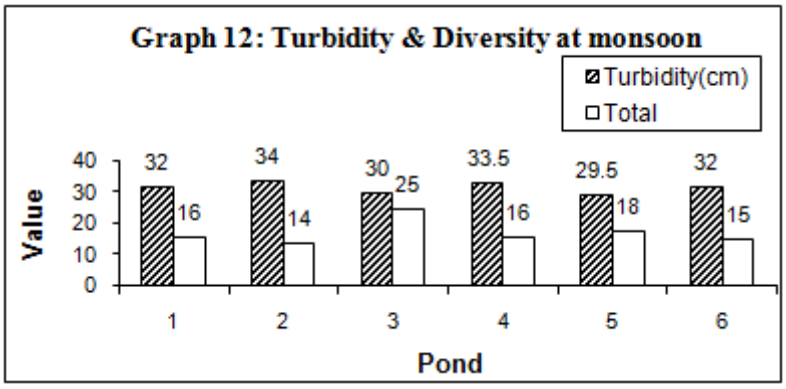


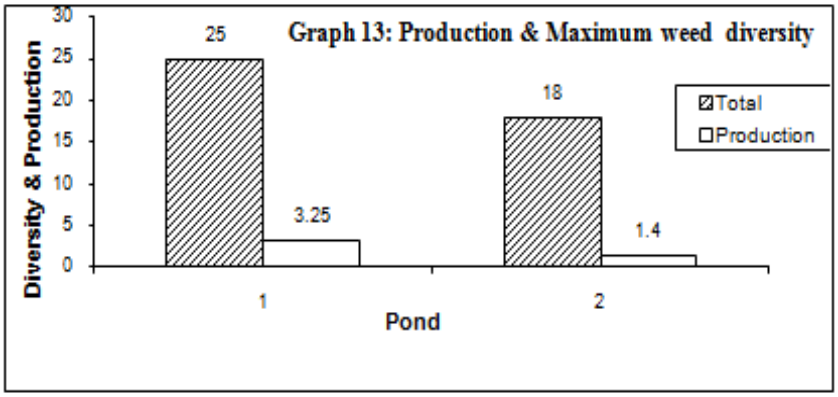

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*Table 11 : Water parameters in relation to both zones at summer.*

| PARA | PONDS | | | | | |
|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P4 | P5 | P6 |
| PH | 7.5±0.1 | 7.6±0.2 | 7.8±0.1 | 7.2±0.1 | 7.8±0.1 | 7.2±0.1 |
| DO | 8.2±0.2 | 6.8±0.1 | 7.25±0.05 | 9.6±0.1 | 8.07±0.02 | 9.6±0 |
| PO4 | 0.47±0.01 | 0.40±0.007 | 0.62±0.01 | 0.45±0.007 | 0.57±0.1 | 1.2±0.1 |
| NO3 | 0.41±0.01 | 0.41±0.01 | 0.55±0 | 0.32±0.01 | 0.15±0.01 | 0.1±0.01 |
| HARD | 190.4±0.10 | 191.5±0.07 | 170±0.07 | 170.2±0.1 | 220.1±0.1 | 210.15±0.15 |
| ALK | 200±0.14 | 191±0.008 | 125±0.10 | 150±0.1 | 156±0.02 | 130.15±0.15 |
| NH3 | BDL±0 | BDL±0 | 0.217±0.001 | 0.42±0.01 | 0.74±0.12 | BDL±0 |

*Table 12 : Water parameters in relation to both zones at monsoon.*

| PARA | PONDS | | | | | |
|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P4 | P5 | P6 |
| PH | 8.05±0.07 | 7.46±0.02 | 8.15±0.05 | 6.63±0.03 | 7.06±0.01 | 6.73±0.04 |
| DO | 8.2±0.1 | 6.81±0.01 | 7.2±0.1 | 7.57±0.025 | 7.2±0.1 | 8.15±0.05 |
| PO4 | 0.293±0.006 | 0.286±0.002 | 0.31±0.0003 | 0.39±0.001 | 0.195±.003 | 0.269±0.001 |
| NO3 | 0.002±00 | BDL | 0.075±0.005 | 0.275±0.005 | 0.217±0.003 | 0.215±0.005 |
| HARD | 132.5±0.5 | 153.5±0.5 | 88±1 | 150±1 | 156±0.5 | 130.±1 |
| ALK | 125±1 | 125.5±0.5 | 100±1 | 79.5±1.5 | 85±1 | 90±1 |
| NH3 | 0.37±0.01 | 0.43±0.03 | 0.5±0.01 | 0.82±0.02 | 0.74±0.03 | BDL±0 |

**The ponds are denoted as**
**Zone –1 : $S_2 \equiv P_1$, $S_6 \equiv P_2$, JHILL $\equiv P_3$**
**Zone –2 : $M_9 \equiv P_4$, GHASBARI $\equiv P_5$, KHUDI $\equiv P_6$**

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# Chapter 5: Conclusion

Different types of aquatic plants grow in ponds and takes in association with aquatic organisms and can form a complex biotic community. Fertilizers, manner and pollutants can trigger the development of aquatic macrophytes and as a result physiological activities and fish culture strategies are jeopardized. Though aquatic plants upset the equilibrium condition of physiochemical qualities of water, their beneficial effects in fish culture such as pollution control, production of animal feed and compost, should not be ignored. Efficiency of specially floating and submerged aquatic weed in nutrient assimilation, heavy metal removal and also for food purpose to the other herbivores fish must be emphasized. Inspite of various beneficial effect of aquatic plants, there have some harmful effects when their growth is enormous. So, management strategies are contemplated. Eutrophicated pond if treated with macrophytes, this could be a cheapest method through which pollutant can easily be removed within a very short time. Herbivores fish have a limited ability to convert plant material into animal tissue and to remove excess nutrients from the system. But being relatively efficient grazers and inefficient assimilator they may play a significant part in initiating the internal biologically mobilized (Prejs, 1984) grass carp partially digests its food to the faces are a large source of nutrients, which are utilized by phytoplankton resulting elevated algal biomass (Bettoli, *et al.*, 1993). The growth rate of *Ceratophyllum demersum* increased in the pressure of snail. A strong interaction between fish to snail to periphyton to macrophytes was established by Martin *et al*. (1992). Macrophytes are also an important source of food and habitat for certain macro invertebrates fish and birds and also be a good shelter for larval rearing and spawning of eggs. Cray fish is generally a stimulatory leading to and increase in the biomass of *Myriophyllum* and *Potamogeton*, though the plant growth is negatively imported by male crayfish. The effect of aquatic macrophytes on water body functioning is crucial for resilience of shallow pond like paddy field because it can absorb or assimilate some green house gas which are the major source for global warming. The free floating plants and their biogeographic distribution probably minimize the water temperature in the tropical and subtropical region. Free floating plants also increase the water transparency which is effective for pisciculture practice. Free floating plants hosted more fish than submerged plant but submerged plants have a great effect on alkaline phosphatase activity to reduce the alkalinity of water. I have found the more numerous biodiversity during summer season than monsoon, though some richness on uni species population were found at monsoon season. Climate warming may not directly affect submerged plants in a significant manner but other component such as fish community structure may affect the growth of submerged weed. Submerged and free floating plants exerted different effects on spatial distribution of fish, because temperate fish seems to display a more pelagic behaviour which indicate that they preferentially used free floating plants where as subtropical fish owing to their littoral habit prefer submerged weed. The number of fish and its length did not differ greatly according to different plant types present on water bodies. Smaller fish also prefer submerged plants for hiding with higher transparency. The abundance of submerged macrophytes and zooplankton played the decisive role in determining the stability of aquatic ecosystem and resistance to nutrient enrichment. When macrophytes are abundant and Cladocerans are low, phosphate enrichment favoured cyanobacteria, while P and N enrichment favoured chlorophytes as well as algae. It had been proved that submerged

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macrophytes *Elodea canadensis* hampared the growth and toxin production of cyanobactor and regulate phytoplanton zooplankton interaction which is beneficial for fish (Vakhilainen, 2005). Some macrophytes have inverse relationship to phytoplankton specially the floating weed can cover so that, the sunlight can not pass through the water hence the primary producer can not produce the food for absence of chlorophyll excitement. The macrophytes also excrete some toxic substances which are harmful for fish and other plankton. In organic fertilizers and Seechi Dish visibility up to 0.5m can inhibit macrophytes growth. According to K. K. Vaas. Macrophytes have profound effect on ecology and fisheries, the water of weed choacked beel have lower pH, turbidity and nutrient load as well as high diurnal variation of dissolve oxygen and carbondioxide. Low phytoplankton biomass is found at high choacked weed infeted area. Most macrophytes are not consumed by most of native fish, so solar energy is trapping by these plants making it less available to the next trophic level, this energy further cycled through detritus chain. In West Bengal the macrophytes biomass at natural beels are varied from 18.88 $g/m^2$ to 726.8 $gm/m^2$ (at dry wt.). There is also marked seasonal variation in the growth of macrophytes. Generally lower macrophytes infestation occur during south-west monsoon and gradually increased after mansoon i.e.$\Rightarrow$ during winter.

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