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Research Article

LENTIC WATER ECOSYSTEMS MMM MONITORING, MANAGEMENT AND MODIFICATION

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ABSTRACT
Restoration of ecosystem can be achieved by three M's Monitoring Management and Modification. Monitoring is performed in lentic water ecosystems such as Ponds and Pools and Physiochemical properties and Biota were studied. Physiochemical properties of other water bodies were also compared for Management purpose along with Successional pattern of Planktons and Macro invertebrates. At last Modification were devised for the purpose of any change in the water bodies due to different types of pollutants. It was also concluded that several years of study can only locate the permanent inhabitants of water bodies as the system is dynamic and changeable and to achieve balanced state an output to an ecosystem and input should be equal.

Key Words: *Restoration, Successional Pattern, Permanent Inhabitants, Balanced State*

INTRODUCTION

The occurrence of any species at a particular time and space is governed by its adaptation or modification which it tolerates. A successful species is that which has great tolerance, fighting for its survival and has established itself and had joined the evolutionary tree. It is a known fact that all the species follow the pristine niche and no changes have ever been observed. However society has changed and to draw the benefit they utilized the resources and to change their own niche they have changed the niche of other components of the ecosystem. The species have reacted to this change and adapted to the changed condition fed on the food provided by human being (Agriculture, Horticulture, Fish culture). But when the food became less they we obliterated from the environment. Although we put sensors for ecosystem restoration often monitoring the physical, chemical and biological requirement at the topmost level of technology but it is that ecosystem which develops as soon as it is deep enough to support the phytoplankton, other species start to colonize with the establishment of chemical cycles. It is this dynamic ecosystem which has its own survival parameters tend towards uniformity of energy flow on an annual basis. As the species completes its growth in a particular microhabitat it is replaced by other species performing essentially the same functions differing principally in the season of growth (Minshall, 1968; Sweeny and Vennote, 1978; Vennote, 1978 and Vennote and Sweeney, 1979). It is these continuous species replacements that functions to distribute the utilization of energy inputs over time (Wallace et.al 1979) and the other aspect it is the efficiency of an organism to utilize the resource which sometimes is lowered by overlapping niche but threshold has been reached. If sometimes leakage of energy occurs which may be a loss but that is the income for other species and predators. Study conducted in a seasonal wetlands suggest a rapid development of macro invertebrate assemblages beginning with early dominance of crustaceans, detrivore and filter feeders (eg phyllopods and ostracods) followed by later dominance of herbivore and predacious insects (hydrophillids and notonectids) Moorhead, Hall, Willig 1998.

MATERIALS AND METHODS

At least half a dozen system were studied both pools and ponds, temporary and permanent water bodies around the 5 Kms radius from Zero point of Ranchi city for four years in 2004, 2005, 2006, 2007 in four sector at North, South, East and and West zones. It is lucky to have ponds with natural condition but most of the ponds were polluted. Although hand net was lowered at more than two dozen water bodies but few ponds were selected. Specimens were caught and analyzed and released. Physiochemical properties were found and following parameters were further analyzed:

(1) Physical features: Ponds depth, Temperature Clarity, Types of soil.
(2) Sources of chemical influx into the pond.
(3) Floral and Faunal identification was performed.
(4) Comparison with natural pond like features.

RESULTS

First of all a general distinction between Pools / Ponds and Lakes is vague but Brown states that Ponds and Pools have their entire bottom surfaces exposed to light, while Lakes do not. Ponds and Pools have two regions-the pelagic open water Zone and a benthic Zone which comprises the bottom and shore region. The importance of bottom soil in influencing the pond water for productivity has been recognized by various workers (Gotterman, 1967 and Banerjee, 1967). In ponds not influenced by external factors the physiochemical properties of water which govern the biological production are more or less a reflection of bottom soil. Soil texture is one of the important physical factors while soil reaction (PH) and nutrient status are the chemical factors. Three types of soils especially Sandy, Silty and Clayey along with organic matter were seen in almost all the ponds with rocky bed in some cases.

Banerjee (1967) from the study of large number of fish ponds under different agro-climatic conditions in the country observed that ponds productivity depends on soil qualities such as its reaction, status of available nutrients (N2 and P2O5) into low, medium, high productive. On this basis of these nutrients status given below:

Available	Nmg/100 gms	Available P2O5 mg/100 gms	Oraganic Carbon %
Low	<25	<3	<0.5
Medium	25-50	3-6	0.5-1.5
High	>50	>6	>1.5

Suspended Soil Sediments washed into ponds after heavy rains and without any forest cover will change the clarity of water and make it turbid. The clarity range was 2-3 feet in most of the pond. Water temperature was in the range of 19 to 27.8. It is interesting to note that all the samplings were dominated by aquatic insect except one of the pond where fish catch were dominant. It was concluded by benthic survey that soil was rich in Organic manures and minimum insect catch was due to predation by fish. Another special feature which was encountered was sudden decision of pond owner to unload the pond. Although species abundance was same but species richness was affected. The cause of unloading the pond was due to the Eutrophication. All the Pools Surveyed have same condition, large amount of macrophytes due to the light penetration with clear or acidic waters and dominated by any one of the insect species due to the same condition all over the water body.

Pond Ecosystem Biota

Bacteria: A vast majority of bacteria in lakes and ponds obtain their energy by decomposing Vegetation and Animal matter. In the plegic Zone dead fish and occasional allochthonous input of litterfall are example of coarse particulate organic matter (CPOM>/mm). Bactaria degrade these into fine particulate organic matter (FPOM</mm) and then further consumed by protozoan which in turn consumed by Zooplankton and then further up the trophic level. Nutrients including those that contain Carbon and Phosphorus are reintroduced into the water column at any number of points along this food chain via excretion or organism death making them available again for bacteria. This regeneration cycle is known as microbial loop and is a key component of lentic food web.

Primary Producers

Lentic System gains most of their energy from photosynthesis performed by aquatic plants and algae. Their autochthonous process involves the combination of carbon dioxide, water and solar energy to produce carbohydrate and dissolved oxygen. Photosynthesis decrease with depth but are low at few millimeters. However photosynthesis rate is system specific. The energy created by this primary producer is important for transfer to higher trophic level via consumption. Nutrients stimulate Growth of tiny aquatic green plants called phytoplankton. Phytoplankton serves as a food sources for microscopic animal

life called Zooplankton. Zooplankton then multiplies and becomes food for small fish aquatic insects and larvae. Rooted aquatic plants are important component, they help keep the water oxygenated, provide food, cover and nesting sites. They reduce shoreline erosion and provide homes and food for variety of aquatic insects.

Invertebrates

Benthic invertebrates due to their high level of species richness have many methods of prey capture. Filter feeders, Grazers, Collectors, Deposit feeders and finally predators are those which include Crustaceans, Molluscs and numerous types of Insects. These organisms are mostly found in the areas of macrophyte growth where the rich resource, highly oxygenated water and warmest portion of ecosystem are found. The structurally diverse macrophyte bed is important sites for accumulation of Organic matter and provide an ideal area for colonization. The sediment and plant offers a great deal of protection from predatory fishes.

Fish and Other Vertebrates

Fish size, mobility and sensory capabilities allow them to exploit a broad prey base, covering multiple Zonation regions. Like invertebrates fish feeding habits can be categorized into guilds. In the pelagic zone herbivore graze on periphyton and macrophyte and pick phytoplankton of water coloumn, Carnivors, Insectivores, Detrivors, Piscivors are other trophic levels of fish. However any single fish occupies multiple feeding guilds within lifetime. Other vertebrates include amphibian (salamanders and frogs) reptiles (snakes, turtles) and large number of water fowl species. Most of the vertebrates spend part of their time in terrestrial habitats and thus are not directly affected by biotic factors. Many fish species prey species to large vertebrates.

Pollution Aspects

Around the world fresh water habitats are being subjected to increased level of human disturbance (Saundars *et al.,* 2002) though non conclusive, information provide strong indication that inland water ecosystem are suffering greatest negative impact from human activities at
present a (WWF 2002 WCM 2000) The use of living organism for monitoring water quality originated in Europe early in this century and in widely used (Claims and Pratt, 1993 and Metcaife Smith, 1994). A spectrum of biological communities include plankton, periphyton, microphy to benthos, macrozoobenthos, aquatic macrophytes and fish has been used in assessment of the water quality (De Paw *et al.,* 1992) However experiences from USA and European programmes have demonstrated that benthic macroinvertebrates are not most useful in monitoring fresh water ecosystem (De Pauw *et al.*, 1992; Hellawell, 1986 and Rosenberg and Rash, 1993). Biological assessment method using macroinvertebrates are based on the assumption with increasing pollution, change will occur in

(i) The species present (appearances of tolerant species)
(2) The number of species (species richness)
(3) Change in abundances of species

Restoring or managing damaged aquatic ecosystem will be exceeding difficult until the presence of toxic material and other societal waste is reduced. Toxic substances are present in contaminated sediments, the water column and in aquatic organism themselves. Beside chemical assessment are also involved as a independent monitoring where the biological assessment is poor. The important indicators for aquatic pollution are the Biological Oxygen demand (BOD), Chemical Oxygen demand (COD), Carbon dioxide, unionized ammonia, Hydrogen sulphide, Methane, Heavy metals and Mercury. Although heavy metals and mercury were not present because of no big industries. Increased concentration of metals like Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc etc. cause bio accumulation.

Acidification

Sulphurdioxide and Nitrogen oxides dissolve in atmosphere moisture and enter lentic system as acid rains. At Ph 5-6 algal species diversity and biomass decrease considerably leading to increase in water transparency a characteristic of acidified lakes and ponds. As PH continues lower all fauna became less diverse.

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Eutrophication

Eutrophic system contains high concentration of Phosphorus (-3+Hg/l), Nitrogen (-1500 Mg/l) or both. Phosphorus inters lentic water from waste water, treatment effluents, discharge from raw sewage, or from run off of farmland. Nitrogen mostly enters through agricultural fertilizers from run off leaching and subsequent groundwater flow. This increase in nutrients required for primary producers results in massive increase of phytoplankton growth, termed as plankton-bloom. This decreased in water transparency leading to loss of submerged plant. The resultant reduction inhabitat structure has negative impact on species that utilize for spawning, maturation and general survival. Additionally, the large number of short lived Phytoplankton results in massive amount of dead biomass setting sediment. Bacteria need large amount of oxygen reducing the oxygen concentration of water.

DISUSSION

Practically all aquatic ecosystem have been damaged (alters from pristine condition) by anthropogenic activities with the human population at its present size and distribution, restoring pristine condition may not be ecologically improbable but could result in strong social resistance both because of financial drain and disruption of present human activities. Determining the threshold concentration and condition of exposure below which no desirable biological effects are noted and above which adverse effects are noted is a problematic exercise requiring scientific evidence. A fish pond solves these problems.

Ideal Chemical Properties of Fish Pond

Chemical Properties	Normal level
Oxygen	4 mg/l
PH	7.5 - 8.5
Poultry manure	2100 Kg/ha
N : K : P	18 : 8 : 4
Hardness	30 – 80 Mg/l
Alkalinity	50-300 Mg/l
Metals	200 Mg/l
Mg	0.01-0.3Mg/l
Fe	4-16 Mg/l
Silica	75-150 Mg/l
Ca	

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A comparison between Natural and Modified pond are given below

Location	Nitrite	Nitrate	Phosphorus	Hardness Mg	Hardness Ca	Total Chlorine
Modified	0.4	0.08	0.154	3.06	0.7	0.012
Natural	0.2	0.2	0.142	1.366	1.118	0.02
Natural	1.6	0.02	0.0	1.376	0.916	0.028
Natural	1.27	0.06	0.2	1.806	1.724	0.024

A further study conducted in a Prairie pond in 2010, 2007, 2006 and 2005 and in Turtle pond in 2010, 2009, 2008 and 2007 are as follows respectively

	Chemical Para.	2010	2009	2008	2007	2006	2005
Prairie Pond	PH	6.5	-----	-----	6.4	6.27	7.7
	Phos.	1.8	-----	-----	2.1	0.42	1.14
	Nitra.	0.8	-----	-----	1.3	0.98	1.3
	DO	6.2	-----	-----	6.1	6.29	8.4
Turtle Pond	PH	7.3	6.6	6.98	6.43	-----	-----
	Phos.	0.3	0.4	0.18	0.3	-----	-----
	Nitra.	1.0	0.8	0.92	1.32	-----	-----
	DO	4.2	2.2	1.82	2.2	-----	-----

Physiological Aspects

Oxygen: - Oxygen present is due to dissolving processes at the air water interface. Formation of the waves due to wind, waterfalls and constant flow lot water are some of the means of Oxygenation of water. In

waste water containing large quantities of animal or vegetable decaying water, there is a great shortage of oxygen which is used in decomposition process. This Oxygen deficiency is no good for animal life however adapted individuals can survive.

Carbon dioxide: - Decomposition of the substances present in the water and the carbon dioxide released from the living organisms during respiration augment the bulk of carbon dioxide in water.

Nitrogen: - The supply of nitrogen for the aquatic organism is derived from nitrate and animal remains. The role played by bacteria in breaking down the complex proteins in dead animals and plants first to ammonia then to nitrites and to nitrates thus making assimilate form of nitrogen available forms a major source of nitrogen in aquatic environment.

Hardness: - Solid carbonates of Calcium and Magnesium are present in Soil is insoluble in pure water. In presence of CO2. They become changed to soluble carbonates and provide a reservoir of CO2 to plant life. If calcium carbonates or sulphates are present in excess water is called hard water which is only suitable for snails and most crustaceans and sycon type sponges.

Silica: - Silica present in water is good for diatoms and protozoan. Sulphates of Potassium. Sodium. Magnesium and Calcium. Phosphates of Calcium. Iron and Magnesium are also present at least in traces in most of the waters and furnish the requirements of plants and animals.

Phytoplankton and Zooplankton Communities in lake/pond undergoes Seasonal succession in relation to nutrient availability, predation ad competition. Summer et.al described there pattern as part of Plankton Ecology Group (PEG) Model. A single season cycle described by Bronmark and Hanssen is below.

Peg Model (Sucession)

Winter:

1. Increased nutrient and light availability result in rapid phytoplankton growth towards the end of winter. The dominant species such as diatoms are small and have quick growth capabilities.
2. These plankton are consumed by Zooplanktons which becomes the dominant plankton taxa.
3. A clear phase occurs, as phytoplankton population becomes depleted due to increased predation by growing number of Zooplankton.

Summer

4. Zooplankton abundance declines as a result of decreased phytoplankton prey and increased predation by Juvenile fishes and insects.
5. With increased nutrient availability and decreased predation from Zooplankton diverse plankton Community develops.
6. As the summer continues, nutrient become depleted in a predictable order, Phosphates, Silica and then Nitrogen
7. Small sized Zooplankton becomes the dominant type of Zooplankton because they are less vulnerable to fishes and insect production.

Fall

8. Predation by fishes is reduced due to lower temperature and Zooplankton of all sizes increase in number.

Winter

9. Cold temperature and decrease light availability results in lower rates of primary production and decreased phytoplankton population.
10. Reproduction in zooplankton decreases due to lower temperature and less prey.

Succession of Macro Invertebrate

Process regulating community structure are closely related to disturbances and course of events that follow them (Connel and Stalyer, 1977 and Pickett and White, 1985) studies suggest some general rules on the effect of habitat duration on community structure. In frequently disturbed habitats physical stress and adaptation of organism to the physical environment would be accepted to exert a dominating influence over community composition (Lubchenco, 1966) as the time period between a disturbance increases biotic interactions among the species would increase in importance. In intermediate duration

habitats physical constrains would be relaxed and organism would achieve higher densities As habitat duration increases further predators would increase in abundance (Heyer *et al.*, 1975) and could control species distribution.

In a 21 year study 19 species of aquatic insects were recorded *Sigara scotti, Hesperocorixa castanea* and *Notonecta obliqua* were the most abundant than the rest after the introduction of fish *Salmo trutta*. H. castarea and N. obliqua were confined to cover when the numbers of trout were reduced. These species extend to same as it was before. The composition of population varies little for fourteen years and then two species *Sigara distincta* and *Cymantia bonsdorffi* became numerous. Six species were not taken in more than three years and probably casuals that flown in. For fourteen years the Corixid fauna was identical with that in similar bodies of water but for seven years two species *S.dinsticta* and *C.bonsdroffi* has become abundant. Invasion has always become a hazard for any one attempting to categorize water body and that several years' collection would prove to be a conclusive permanent inhabitant.

Ecosystem are capable of self maintaining and self regulation .The system exhibits three states (blooms), balanced (biocycling) and replacements (predation /migrations) If increased output results in increased input the feedback is called positive and state of growth is achieved. If output and input is inverse negative feedback (ageiging system) certain steps can be considered while managing a lentic water aquatic ecosystem.

- The monitoring should be more frequent if the pond is newly build, since the pond water quality has not yet stabilized .
- Aeration of pond in stagnant thermally stratified, oxygen starved pond which leads to doubling of water clarity, reduction in ammonium etc.
- Addition of probiotics (Beneficial bacteria) balances the nutrient load.
- Limning raises the soil PH to a desirable level (near neutral), stimulates microbial decomposition of organic matter and toxicity and destroys parasites.
- Use of organic manure increases the abundance of zooplankton and benthic organism (Hickling 1971).
- Grass and Trees shout be planted around the pond which catches sediments before it enter the water and absorb excess nutrients.
- Grass Carp in used to reduce vegetation which large mouth bass is recommended as predator fish.

Even today limnologist engrossed with the specializes research probably do not have strong sense of urgency that is necessary to mobilize society as a whole to cope up with this problem. Planets population is growing at unprecedented rate and ecological resources are being destroyed at an unprecedented rate. A stable quota of ecosystem services per capita with a growing population on a finite planet means that restoring damages ecosystem is mandatory even if the population stabilizes and lost ecological capital is restored restoration of damages ecosystem should continue to create a resource of natural capital.

Adoption of modification depends upon new information. A ecological monitoring system consisting of biological chemical and physical component is essential to ensure the success of adaptive planning and management policy and programs with these small endeavor we can reach to Landscapes management programmers and can build ecological corridors that connect small fragment. Ecological corridor may restore some of the attributes of large ecosystem such as self maintenance that smaller isolate ecological fragments have. Self maintaining ecosystem are less costly to manage than fragment that have lost this attributes because fragment require more management

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