International Journal of Environmental and Ecology Research
www.environmentaljournal.in
Online ISSN: 2664-7117; Print ISSN: 2664-7109; Impact Factor: RJIF 5.42
Received: 28-08-2020; Accepted: 13-09-2020; Published: 29-09-2020
Volume 2; Issue 2; 2020; Page No. 19-22

Study of energy flow in a pond

Taruna Jyoti
Department of Botany, College of Commerce, arts & Science, Patna, Bihar, India

Abstract
A large pond surrounded by humans, in west Patna, has been studied for distribution of biomass distribution among the major trophic groups and with the help of Ecopath component of the Ecoptah with Ecosym (EwE 6), the eco-modelling software , its ecosystem was modelled. Analytical results and observation are presented here briefly.

Keywords: Pond ecosystem, ecosystem modelling, EwE6, Ecopath modelling

Introduction

A pond is a lentic body of water too small to wave action and too shallow to measure temperature changes from upper level to muddy or silty bottom with muddy or silty bottom with plants on edges in most cases. EwE software was used for analysis of a pond with some modifications. Ecopath with Ecosim and Ecospace (EwE) is a software, is designed for, parameterization, analysis of mass- balance, trophic models of aquatic and terrestrial ecosystems and straightforward construction to prepare a complex model of a mass balanced marine or aquatic ecosystem for present and future impacts of fishing and exploring optimal fishing policies. The model Pond is located at west of Patna district of Bihar (India), with an area of 261360 sq. ft. and a depth of 5 ft. approx having geographic location as 25.560262N and 85.039013E.

Materials and Methods

The study was carried out in the month of March'18, just before the raining season. The pond had practically no chance of immigration or migration of species. Ecological simulation software EwE 6 (Ecopath with Ecosim 6) (Pauly *et al*., 2000) [8] was used to derive flow of energy through food chain relationship in model. Estimation of biomass of organisms of different groups was done as per Saxena (1987) [9].

Input parameters are presented by table 1 as fed into the software for further calculations by the software. Estimated data of biomass, initially calculated as kg/m$^{2/}$year, were converted as tones/km$^{2/}$year to suit the application. Respiration/assimilation, presented by table 2, is the estimation that by the consumer organisms by the software on the basis of the input data. Output like Key indices, basic estimates, consumption estimates etc., and other estimates by the program are not shown here.

Table 1: Input parameters for Ewe6

	Group name	Habitat area (fraction)	Biomass in habitat area (t/km²)	Production / biomass (/year)	Consumption / biomass (/year)	Ecotrophic Efficiency	Other mortality	Production / consumption
1	Macrophytes	1.000	15.60	468.0				
2	Euglinophyceae	1.000	0.00151	2420000				
3	Cyanophyceae	1.000	0.000044	52800000				
4	Cholorophyceae	1.000	0.00252	2260000				
5	Zooplankton	1.000	0.0231	250000	325000			
6	Amphibian	1.000	5.900	7.190	26.00			
7	Snailes	1.000	11.60	6.440	10.000			
8	Tortoise	1.000	5.200	3.150	11.34			
9	Snake	1.000	2.100	2.520	10.58			
10	Rohu	1.000	124.5	3.530	10.25			
11	Catla	1.000	37.36	3.540	14.00			
12	Naini	1.000	31.13	3.530	12.75			
13	Common carp	1.000	24.90	3.670	4.980			
14	Grass carp	1.000	65.38	3.670	4.600			
15	Silver Carp	1.000	28.02	3.710	4.700			
16	Detritus	1.000	893.7					

Table 2: Respiration/ Assimilation Estimates of the Consumer Organisms

	Group name	Respiration (t/km²/year)	Assimilation (t/km²/year)	Respiration / assimilation	Production / respiration	Respiration / biomass (/year)
1	Macrophytes					
2	Euglinophyceae					
3	Cyanophyceae					
4	Cholorophyceae					
5	Zooplankton	231.0	6006	0.0385	25.00	10000
6	Amphibian	80.30	122.7	0.654	0.528	13.61
7	Snailes	18.10	92.80	0.195	4.128	1.560
8	Tortoise	30.79	47.17	0.653	0.532	5.922
9	Snake	12.48	17.77	0.702	0.424	5.944
10	Rohu	581.4	1021	0.570	0.756	4.670
11	Catla	286.2	418.4	0.684	0.462	7.660
12	Naini	207.6	317.5	0.654	0.529	6.670
13	Common carp	7.819	99.20	0.0788	11.69	0.314
14	Grass carp	0.654	240.6	0.00272	367.0	0.01000
15	Silver Carp	1.401	105.4	0.0133	74.20	0.0500
16	Detritus					

Results and Discussion

Figure 1 presents flow of energy between discrete trophic groups defined by Lindeman Spine as per the calculation by EwE. The energy flow diagram as drawn by the program is presented in figure 2.

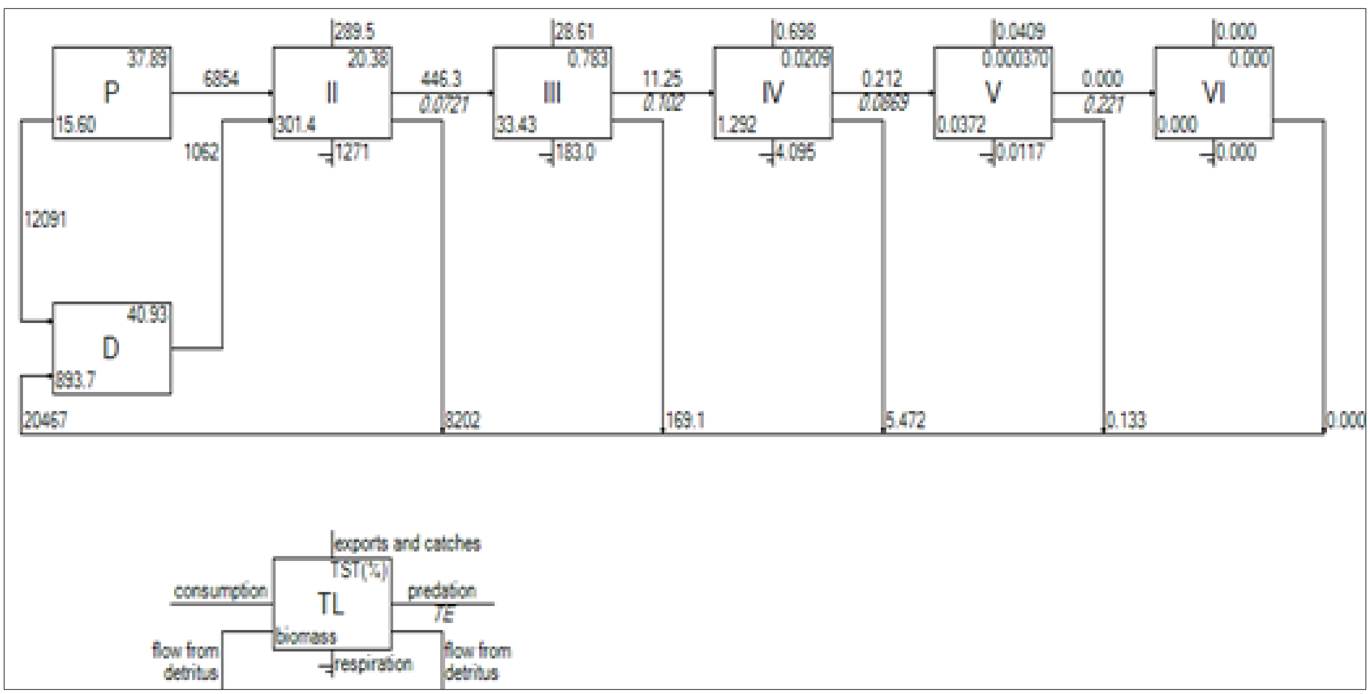

Fig 1: Lindeman Spine showing flow of biomass and energy between discrete trophic level (Lower small figure explain the values shown by the spine)

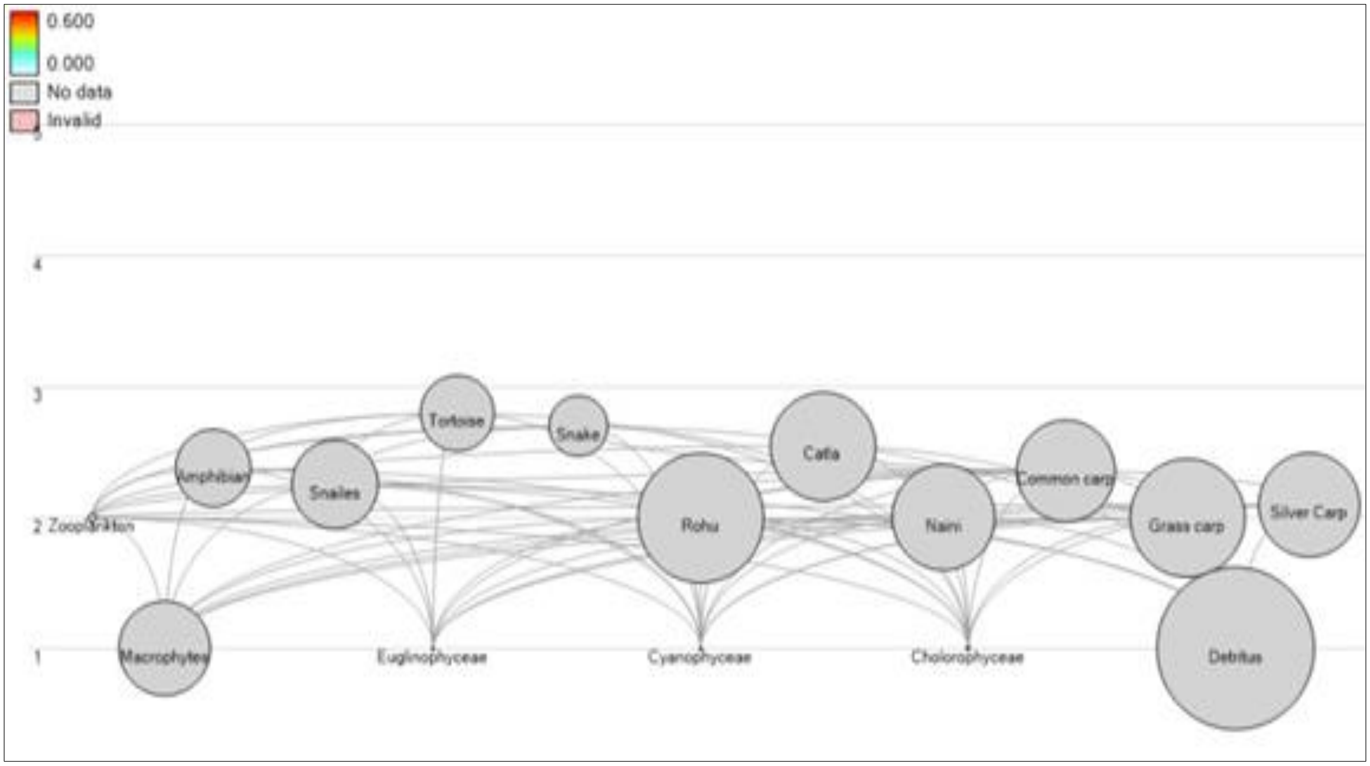

Fig 2: Flow diagram (The Size of the circle denotes the amount of biomass of the group.)

To create a static snapshot of the resource and energy flows within the ecosystem and to link functional biomass within dynamic system of the Ecopath component of the software, EwE makes use of mass-balance principles (Christensen and Pauly, 1992 [2]; Pauly *et al*. 2000 [8], Christensen and Walters, 2004) [3]. Two basic equations are required for parameterization of an Ecopath modeling.

The total sum of net migration, biomass accumulation, predation, catch and other mortality is the production i.e. Production = net migration + biomass accumulation + predation + catch + other mortality, mathematically –

$$Pi = Yi + M2i \times Bi + Ei + BAi + M0i \times Bi \quad \text{(Eq1)}$$

Where Pi refers to production, Yi is catch rate of total fisheries of i, M2i is the predation rate for group I, net migration is shown by Ei (emigration − immigration), biomass accumulation rate for I is presented by BAi, while M0i is the 'other mortality' rate for i. Pi is calculated as the product of Bi, the biomass of i and (P/B) I which is the production/biomass ratio for i. For each functional group, Ecopath requires input of average fraction and yield, and from the four parameters, three required are B, P/B (production to Biomass ratio), QB (food consumption per unit biomass for consumer and EE (Ecotrophic efficiency defined as the fraction of the production consumed within or harvested from the system). After the 'missing' parameters have been estimated to ensure mass balance between groups, energy balance is ensured within each group using the following equation –

$$\text{Consumption} = \text{production} + \text{respiration} + \text{unassimilated food} \quad \text{(Eq2)}$$

The EwE software calculates many ecological characteristics including the Production: consumption ratio (P/Q), detritus flow, net efficiency, omnivory index etc.

As Field *et al.* (2006) [4] and Chen *et al*. (2008) [1] observed regarding ecosystem modeling, it is a research method which can be used to project ecosystem responses to disturbances. It is used to identify processes and relationships within the ecosystem that cannot be easily measured, or have been overlooked, or unknown. Regarding ecosystem modeling, Ma *et al*. (2010) observed that it is driven by long-term data sets generated by the modeling software. It has unlimited potential to be used as an adaptive management tool by policy makers, scientists and managers. Kumar (1988) [5] and Kumar and Hafiz (2000) [6] have discussed about the cybermatic management of ecosystems, particularly aquatic ones. They found that water bodies usually tend to degenerate fast resulting into depletion of huge resources if ecosystem balance is perturbed. The assessment of the ecosystem of the present pond in terms of trophic relationship and flow of energy has shown that the system is more or less balanced and should be sustained by taking proper care (like disease management etc.) and feed.

References

1. Chen Z, QiuY, Jia X, Xu S. Using an Ecosystem Modeling Approach to Explore Possible Ecosystem Impacts of Fishing in the Beibu Gulf, Northern South China Sea: Ecosystems. 2008; 11:1318-1334. DOI: 10.1007/s10021-008-9200-x
2. Christensen V, Pauly D. Ecopath II - a software for balancing steady- state ecosystem models and calculating network characteristics. Ecological Modeling. 1992; 61:169-185. doi:10.1016/j.ecolmodel.2003.09.003.

3. Christensen V, Walters CJ. Ecopath With Ecosim: Methods, Capabilities and Limitations. Ecological Modeling. 2004; 172(2-4):109-13.
4. Field JC, Francis RC, Aydin K. Top-down modeling and bottom-up dynamics: Linking a fisheries-based ecosystem model with climate hypotheses in the Northern California Current. Progress in Oceanography. 2006; 68(2-4):238-270.
5. Kumar J. Cybernetic management of ecosystems for environmental management. Proceedings of National Workshop on Technology delivery system for rural development. NIWARD, New Delhi, India, 1988.
6. Kumar J, Hafiz A. Schematic conservation of wetlands of Bihar. Int. J Mendel. 2000; 17(1-2):17-18.
7. Ma H, Townsend H, ZhangX, Sigrist M, Christensen V. Using a fisheries ecosystem model with a water quality model to explore trophic and habitat impacts on a fisheries stock: A case study of the blue crab population in the Chesapeake Bay. Ecological Modelling. 2011; 221(7):997-1004.
8. Pauly D, Christensen V, Walters C. Ecopath, Ecosim, and Ecospace as tools for evaluating ecosystem impact of fisheries. – ICES Journal of Marine Science. 2000; 57:697-706.
9. Saxena MM. Environmental analysis. Agro-Botanical Publishers, Bikaner, India, 1987.