Study on the ecosystem construction of using ecopath model in inland waterway

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Abstract. In this paper, Ecopath with Ecosim 5.1 software is used to simulate the constructed water ecosystem of inland waterway. According to the characteristics of feeding relationship, the ecopath model of water ecosystem is divided into seven functional groups: phytoplankton, hydrophyte, zooplankton, herbivorous, omnivorous, polychaetes and detritus. By analyzing the important ecological parameters of the ecosystem, such as biomass, biomass / biomass, consumption / biomass, trophic level and ecological nutrient conversion efficiency, the software integrates the energy flow process of the ecosystem, the ratio of the total net primary production and the sum of all respiratory flows is 1.314, it’s indicating that the ecosystem is equilibrium. The research method of this paper can be widely used to evaluate the stability of the ecosystem of the domestic river.

1. Introduction
Excavation engineering of inland waterway will damage the fish, benthos and phytoplankton in the water, and then affecting the entire water ecosystem. It’s a hot topic of how to repair and rebuild the water ecosystem, the research of inland waterway is located in Punan Village, Dapu Town, Yixing City, Jiangsu Province (119°49’E, 31°22’N), the area faces Taihu lake on the east, which belongs to the network of rivers, flat, thick rivers, bidirectional flow. The construction of the ecosystem of inland waterway is based on the common software of Ecopath with Ecosim5.1 developed by ICLARM (International Center for Living Aquatic Resources Management). The software uses the nutrition dynamics principle to construct the water ecosystem structure directly, describe the energy flow and determine the energy balance model of the ecological parameters, and estimate the biomass and food consumption of the different groups in the aquatic ecosystem[1-3].

2. Software theory and method
The ecosystem defining by Ecopath model is maded up of a series of ecologically relevant functional components (group or box) that can include organic debris, plankton, a fish, a particular age group or a type of ecosystem characterization (such as feeding) in same species, all functional components can
basically cover the whole process of energy flow in the ecosystem [4]. According to the thermodynamics principle, the Ecopath pattern defines the energy input and output balance of each biological function group in the system, the energy balance is expressed as: production - predation death - other natural death - output = 0. The prerequisite for using the software is to assume that the biomass of each biological group is stable in a year, so the production rate for this year = predation + non-predation loss + output. The consumption rate is related to the consumption rate of the predator and the diet composition, and the natural death and output can be calculated respectively from the ecotrophic efficiency and the fish catch and sedimentation rates. According to the characteristics of the relationship with feeding habits, the Ecopath model of the aquatic ecosystem is divided into seven boxes, Phytoplankton, Hydrophyte, Zooplankton, Herbivorous Fishes, Omnivorous Fishes, Polychaetes and Detritus. The division of boxes can basically cover the main flowing process of biological energy in aquatic ecosystems in the region.

3. Determination of parameters
In the computer model, the biology of each unit is required, and at least three items should be entered in the following five data, Biomass (B), production of unit biomass (P/B), metabolic consumption per unit biomass (C/B), ecological efficiency (EE, the parameters of any of the various energy flow parameters between the trophic level and the trophic level), gross efficiency(GE). P/B and Q/B are based on the actual situation, the relevant domestic data estimates and checking through the Fishbase network (www.fishbase.org)[5,6].Ecological efficiency is a more difficult parameter to obtain, in the input parameters of the Ecopath model, the EE of most functional groups is usually unknown. One of the debugging processes of the Ecopath model is to adjust the value of all EE to less than 1, so that the flow of energy in the whole system to maintain balance, so as to obtain a reasonable ecological parameters of the ecological system (EE greater than 1 is wrong, indicating that the energy flow equilibrium condition in the system is destroyed, because the using of any organism in the system can not be greater than the energy output of the organism itself [7].

The basic input of the model is shown in figure 1.

3.1. Determination of biomass
The biomass of the three functional groups of the omnivorous fishes, herbivorous fishes and the hydrophyte are 40g/m², 50g/m² and 500g/m², the local data of the zooplankton, polychaetes, phytoplankton and detritus are 1.4g/m², 57.22g/m², 7g/m² and 10g/m².

3.2. Determination of production of unit biomass (P/B)
The P/B values for fishes are equal the total mortality Z.

\[ Z = \ln X \]  

(1)

X is the survival rate of fish, omnivorous fish is 0.75, herbivorous fish is 0.5, the P/B values for omnivorous fish and herbivorous fish are 0.3 and 0.7, the P/B values for zooplankton, polychaetes, phytoplankton and hydrophyte are 20, 1.1, 50 and 1.2 [8-10].

3.3. Determination of metabolic consumption per unit biomass (C/B)
C/B values for using \((P/B)/(C/B)\) = gross efficiency, the general gross efficiency is between 0.1-0.3, in which phytoplankton and hydrophyte belong to autotrophic organisms, the value of C/B is 0.

**Figure 1.** Basic input for Ecopath.

In addition, the program simulates a stable ecosystem also need to enter the feeding composition form, the information is estimated by the fish contents and the FishBase network, as shown in figure 2.

**Figure 2.** Prey /predato.

4. **Preliminary results analysis**

Preliminary analysis by software, the results shown in figure 3.

**Figure 3.** Basic parameter estimates.
Trophic level column shows the average trophic level of each functional group in the figure, the highest class is omnivorous fish, its value is 2.41, it’s very close to 2.38 which is checking from FishBase net, without calculating. The ecological efficiency (EE) calculated in the program is a reasonable value, because it means there is no natural death (starvation, aging and other factors of death), when EE is equal to 1.0. at the same time, the highest ecological efficiency of phytoplankton which value is 0.951 in line with Tongling [1] describing the general phytoplankton ecological efficiency is about 0.95.

5. Statistics of total parameters of the water ecosystem
The program statistics the parameters of the water ecosystem simulation of inland waterways, as shown in figure 4.

| Summary State | Food Intake | Higher: Prey |
|---------------|-------------|--------------|
| Parameter     | Value       |              |
| Sum of all consumption: | 1075.000 |              |
| Sum of all exports: | 227.238 |              |
| Sum of all respiratory flows: | 722.762 |              |
| Sum of all flows into detritus: | 806.326 |              |
| Total system throughput: | 2033.206 |              |
| Sum of all production: | 1057.042 |              |
| The fishery has a 'mean trophic level': | - |              |
| Gross efficiency (catch net p.p.): | - |              |
| Input total net primary production: | - |              |
| Calculated total net primary production: | 950.00 |              |
| Unaccounted primary production: | - |              |
| Total primary production: total respiration: | 1.314 |              |
| Net system production: | 227.238 |              |
| Total primary production: total biomass: | 1.449 |              |
| Total biomass: total throughput: | 0.231 |              |
| Total biomass (excluding detritus): | 655.620 |              |
| Total catches: | - |              |
| Conformity Index: | 0.472 |              |
| System Omnivory Index: | 0.016 |              |

Figure 4. Summary stats.

The total net primary production of the whole water ecosystem is 950 t/km²/year, and the sum of all respiratory flows is 722.762 t/km²/year, the ratio of the two is 1.314. When the ecosystem reaches a mature state, total net primary production will be very close to or equal to the sum of all respiratory flows, so we can see the inland waterway ecosystem has reached a mature state.

6. Conclusion
We choose the measured data, synthesizes the domestic and foreign literature, constructing and simulating the food network energy transfer model of the water ecosystem in the inland waterway with the Ecopath software. Further explores the food source of fishery creatures in inland waterways and the transmission path of its energy in the food web by calculating the amount of energy transferring between
the biological, biological and organic debris, and the estimating amount of biological respiration in the energy balance. The results shows that most of the material transport in the water ecosystem is transported to the upper layer by means of feeding, or the energy is consumed by respiration, and a small part of the material forms debris, the debris is returned to each biological group by feeding, and form the biogeochemical cycle. It’s indicating that the ecosystem is equilibrium when the total net primary production is very close to the sum of all respiratory flows. The research method of this paper can be widely used to evaluate the stability of the ecosystem of the domestic river.

Acknowledgement
This work was supported by the Central Public Welfare Fund（Tks160209）.

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