

Research Article

On Diagnostic Index and Method of Healthy Wetland Food Chain

Li-Juan Cui, Xin-sheng Zhao and Wei Li

Department of Wetland Research, Chinese Academy of Forestry, Beijing, 100091, China

Abstract: Wetland food chain is the channel of the matter and energy transfer or flow in the wetland ecosystem. From wetland food chain scission mechanism, the structure and functional characteristics of the wetland food chain scission were analyzed, while building a healthy wetland food chain diagnostic index system. Depending on wetland ecosystem health research results, this study brought forward the wetland food chain structure stability and functions of wetland energy measures and their quantitative calculation formula and finally we gave the healthy wetland food chain diagnosis process in order to provide scientific basis for wetland food chain restoration.

Keywords: Artificial wetland, ecological restoration, ecosystem, food chain, wetland

INTRODUCTION

Healthy ecosystem in time to maintain its organizational structure, self-regulation and the resilience of the stressand has strong stability and sustainability (Billen *et al.*, 2007; Per-Arne *et al.*, 2009; Pieter *et al.*, 2010; Cui *et al.*, 2011). Study showed that when ecosystem functions do not exceed the threshold limit, the ecosystem is healthy (Friedrich *et al.*, 2006; Ciesielskia *et al.*, 2010). Relative to the formulation of healthy ecosystems, healthy wetland food chain is reflected in the wetland food chain structure stability and functional activity of the wetland food chain material cycling and energy flow unimpeded and food chain structure and composition to achieve the optimal ratio between the relatively stable (Susanne *et al.*, 2007; Tariku *et al.*, 2011). The same food chain as an important part of the ecosystem health characteristics and health food chain is different from the level of ecosystem health and more reflects the multi-level relationship of the internal food chain species, population and community levels, although researchers have proposed health of the basic theoretical framework of the food chain (Hans, 2006; Hideyuki *et al.*, 2009; Jake and William, 2007), a more detailed exposition of the relevant aspects of the connotation of the food chain concept and the food chain scission mechanism (James *et al.*, 1997, 2010; John *et al.*, 2006; Junya *et al.*, 2011), but have not formed a more systematic and complete system, especially for wetlands food chain health diagnosis the index system, methods and processes system. According to the latest research progress at home and abroad, given the food chain diagnostic wetland health indicator system and diagnostic methods and technical processes for wetlands food chain theory

and practical application of scientific references (Kuo *et al.*, 2006; Kooi *et al.*, 2008). The main purpose of this study is to establish a set of scientific wetland biomass diagnostic indicator system and method, which will provide a support to wetland ecosystem health assessment and wetland ecosystem restoration.

DIAGNOSTIC INDICATORS

Wetland food chain structure and wetland food chain functional characteristics, as shown in Table 1 of the wetland food chain diagnostic indicators, including structured diagnostic indicators, including the structure of biological communities, species diversity, alien species, native species, intermediate interaction, composition of the food chain (Pieter *et al.*, 2010; Cui *et al.*, 2011) Wetland food chain stability is determined by the structure and function of the diagnostic standard wetland ecosystem structure and functional characteristics of indicators to represent.

Wetland food chain is weak or there is a chain scission phenomenon is often caused by one or several factors. Therefore, you can determine whether the wetland food chain stability can change according to certain indicators (Luis and Felipe, 2006; Linda *et al.*, 2009). Of course, caused the loss of wetland food chain stability due to a combination factors play a decisive role, but can be screened by technical means. We can seek a set of standards to the wetland food chain stability evaluation. These standards not only can determine the overall performance of the wetland food chain, but also to predict the sustainability of the wetland food chain. These indicators must meet three conditions (Marina and Donald, 2006; Magali *et al.*, 2008; Maarten *et al.*, 2009):

Corresponding Author: Li-juan Cui, Department of wetland Research, Chinese Academy of Forestry, Beijing, 100091,China, Tel.: +086-010-6282-4151, Fax: +086-010-6282-4182

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Table 1: Wetland food chain diagnostic indicators

Diagnostic content	Diagnostic indicators	Chain scission	Weak	Health
Structured diagnostic	Community structure	Simple	Medium	Complex
	Species diversity	Low	Medium	High
	Alien species	Throughout the	Occasionally	scarcity
	Native species	Lose	Occasionally	Many
	Interspecific interaction	Lose	Presence	Strong
Function diagnosis	Food chain composed of the mix	Lose	Single-chain	Multi-chain
	First of net primary productivity	Lose	Low	High
	Material recycling	Lose	Medium	High
	Population regulation and control capacity	Lose	Medium	Strength
	Biomass	Low	Medium	High

- Standard can be quantitative or semi-quantitative, the number of species food chain, such as wetlands, biomass, life expectancy and primary net primary productivity
- Standard requires the use of a weighting factor, the purpose of comparison and aggregation of the different ingredients in the food chain system
- The standards must be hierarchical level, on different temporal and spatial scales interdependence

DIAGNOSTIC METHODS

Draw on the findings of wetland ecosystem health, wetlands food chain structural stability and functional activity measures can be taken to the bio-physical, space-time metrics and indicators of stress and reaction for quantitative diagnosis (Melanie *et al.*, 2006; Martine *et al.*, 2008; Oliver *et al.*, 2010; Paul *et al.*, 2011).

Functional and structural metrics:

- **Biophysical measurement:** Biophysical wetland food chain structure and function of the main features, such as material recycling, energy flow, species diversity, dominant species of animals, plants and habitat diversity. These show the characteristics of a wetland food chain and humans depend on ecosystem services.
- **Space-time metric:** Wetland food chain interferes with the complex spatial and temporal response. The same interference may take place in a different time and space. Interference is first expressed in the wetland food chain ingredient separation (such as the sensitive behavior alternating), then the performance of the wetland food chain of a link to the disappearance of the composition of species in space (Mazej *et al.*, 2010; Wang *et al.*, 2011).
- **Stress and response:** Stress factors, including the single stress factors and stress factors. Single stress factors and wetland food chain through a single stress factor analysis stress response relationship between the safety analysis methods; more stress factor is that most of the wetland food chain deformation is caused by the role of multiple stress factors, such as natural remodeling, introduction of

alien species, harvest intensity. A variety of factors may produce a cumulative effect in changing the viability of the wetland food chain.

Functional and structural measure formula:

- **Function dynamic diagnosis:** Functional vitality of diagnostic quantitative indicators, include the wetland food chain of material circulation and energy flow of two. Ulanowicz (1986) raised the total system production (Total Systems Throughput) (TST) and net inputs (Net Input) (NI) to measure the vitality of wetlands food chain function. The total production capacity of the wetland food chain system exchange conversion material in the channel number of different individuals in the unit of time; net input can easily separate the total production capacity of the wetland food chain system. Total biomass of available community characterizes the dynamic status of the wetland food chain. The formula is: $V = P_x \text{ in } / P_m$, where P is the wetland food chain biomass (g/m^2), $V \in [0, 1]$, such as $V > 1$, then take $V = 1$.
- **Structural stability of diagnosis:** Quantify the wetland food chain structure can be used to determine the wetland food chain composed of a number of ingredients as well as all aspects of the food chain biological composition of the index to achieve or measure of the ecosystem structure combination of features, such as the frequency of species distribution, plant average height, the biological species of wetland species, the number of individuals Determination of available structural organization of force index and the index of biomass, the producer of primary productivity, species and age composition, etc.

DIAGNOSTIC PROCESS

Wetland identification and characteristics of the food chain type: A combination of methods through the literature search, field monitoring and laboratory analysis, clear and wetland food chain types and illustrates the food chain component composition characteristics and structural and functional

characteristics; the use of principal component regression method to determine the suitable environment of the wetland food chain key component conditions and the threshold range. With field tracking and monitoring experiments, according to the wetland food chain components of biological rhythms and seasonal variation of the wetland food chain components of fish, benthic classes and zooplankton animal population density and biomass monitoring; on wetland food chain group points of wetland plants in the ecological characteristics of productivity, biomass density, plant height variation monitored.

Wetland food chain energy flow and material cycling: Monitoring the wetland food chain components of productivity and biomass, based on the food chain composed of the structural characteristics, consider the wetland food chain system cascade relationship, with energy analysis method, quantitative analysis of the wetland food chain energy flow, to clarify the impact of wetland food chain the key factors of the energy flow. Consider the wetland food chain to the different seasons of growth and reproduction of the law, analysis of wetlands in different parts of the food chain components (e.g., plant flowers, stems, leaves and roots, etc.), content of nutrient elements, especially nitrogen and phosphorus content, the use of the material mass balance principle, to quantify analysis of wetland food chain material recycling transfer rule. Was constructed wetland food chain scission evaluation index system, the use of principal component analysis and analysis of a wetland food chain is weak or broken chain characterization.

Wetland food chain scission "section to identify and drive analysis: Quantify the wetland food chain key components of biological characteristics, particularly concerned about the density, abundance, species number and coverage indicators; to determine the elements of variation of key groups (wet food chain scission "section") and its surroundings. With canonical correspondence analysis, multiple co-inertia analysis and the number of ecological methods clearly wetlands food chain is weak or even exercise the degradation factor and determine the exercise of specific aspects.

CONCLUSION

At present, the health assessment for wetlands food chain has been lacking. This article draw on the theory of the wetland ecosystem health assessment, initially given the slash to the food chain health diagnostic methods and processes, the index system of the wetland food chain diagnosis. Future studies need to further strengthen the screening of the indicators, evaluation criteria and determining the weights to strengthen the monitoring of the wetland food chain long-term dynamic investigation, provide the basic data for the

wetland food chain diagnostic evaluation. Research significance of this study is that the created wetland food chain diagnostic index system and evaluation method contribute to the achievement of the quantitative evaluation of wetland food chain health assessment. To carry out the wetland food chain health diagnostic evaluation studies and contribute to the advancement of the wetland ecosystem-based management, wetlands protection and restoration project to provide a theoretical basis and scientific guidance.

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