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Research Article

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Broad Bioeconomic Model Application

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Abstract: This paper mainly tells of the generalized biological economic model in not damage the ecological environment, and on the basis of solving the problems related to economic development, discusses the generalized biological economic model of background and its application scope. Use of differential equation stability and economic benefits for generalized biological methods to study economic model, and to analyze it and draw the conclusion, when to amount to, biological economic model can get the optimal solution, economic benefit and not damage the ecological environment, and concluded that the generalized biological economic model prospects and its significance.

Keywords: general biological economics model; differential equation stability theory; economics benefit

1. Introduction

The background of the generalized bioeconomic model

Ecosystem is also known as the "giant complex system", which is one of the most complex among all the generalized systems. Since the 20th century, the research on ecological balance has become a wide research field in the world today. In 2001, the European national natural science fund members will plan the research plan of ecological environment complexity, ecological environment complexity and ecological balance function has been identified as the European national fund of environmental discipline priority subsidy direction. The research plan content using cross the latest technology research projects, study the broad biological economics, broad social economics and broad mathematical system, connected to various ecosystems and the ecological environment dynamic interaction phenomenon. To solve the generalized bioeconomic model problem, the application of the generalized bioeconomic model in mathematics arises.

The evolution of the ecosystem is highly uncertain and shows complex evolution characteristics, so it is necessary to use the quantitative research means to understand its unique laws. Since the 1950s, Scholars have applied differential, difference equation theory to describe ecosystems, Complete system modeling, complex dynamic behavior analysis and control problem research, Differential and difference equation theory has become an important means to study the dynamic activity mechanism of the ecosystem. With the rapid development of commercial capture behavior, Biological ecosystems are increasingly closely integrated with related issues in economics, In order to comprehensively and accurately describe the complex ecological phenomena within the ecosystem and the complex interaction between the system and the external environment, It often necessary to construct models with higher dimensions and complex levels, yet, It is difficult for the traditional research methods represented by the differential and difference equation theory to study the above complex phenomena comprehensively and accurately and the related control problems. The objective situation requires powerful theoretical tools to construct a mathematical model that can comprehensively and accurately reflect the actual situation. At the same time, it can also effectively analyze the complex dynamic behavior of the model and study related control problems. In recent years, great breakthroughs have been made in the innovation of natural life science and biotechnology, and the worldwide natural scientific and technological revolution has been taking shape. With the completion of the genetic map in 2001, it is considered to be another huge new starting point in the history of modern science and technology in the world after the use of the space industry and the network. In western countries, biotechnology-related industries should account for 25-35 percent of GDP, according to the vice president of the Chinese Academy of Sciences. This is also the evolutionary history of the generalized bioeconomic model.

Application scope of the generalized bioeconomic model

Many natural biological phenomena can be solved by the use of generalized bioeconomic methods. To solve some bioeconomic phenomena, the study of these generalized biological mathematical models often uses the content of differential equation theory. For example, in medical biology, the drugs that people absorb, irrigate the whole body, etc., are a continuous process that can be solved using bioeconomic models, but people take drugs orally IV, it is a behavior called pulse, to put this pulse。

2. Example of the Application of Generalized Bioeconomic Models

In the pursuit of the maximum output and the best economic benefits. We should maintain the ecological balance and get the greatest economic benefits. Explore the maximum harvest of a shrimp: assuming A shrimp has five age group, called A shrimp, B, C shrimp, D shrimp, E shrimp, A shrimp weight of 4.08 (grams), B shrimp 5.12 (grams), C shrimp weight of 14.38 (grams), D shrimp weight of 16.03 (grams), E shrimp weight of 13.98 (grams) this shrimp for seasonal concentrated spawning, the mortality rate of five shrimp (years) survival rate (1 shrimp to total spawning n) is 1.22 X1011 / 1. 22 X1011+n.

According to the national aquaculture regulations, shrimp fishing can only be caught within another seven months a year. Assuming that if the number of vessels and people fished for each year is constant, the proportion of annual catches and the yield of all ages is constant, the fishing intensity coefficient is the interest rate of the number and yield caught. Generally use fishing net fishing, and the fishing net can control C shrimp and E shrimp of fishing coefficient, aquaculture using this way of fishing (1) to establish generalized biological economy mathematical model analysis does not affect the reproductive ability of the next generation and under this condition to maximum economic benefit (2) a breeding company want to raise five years, but the contract requirements must guarantee the original number of shrimp guarantee the same. The initial value of the shrimp is 1,892,456,789 (bar), starting to explore how to ensure the maximum benefit of the company.

In the case of known mortality, reproductive rate, fishing period, breeding period and fishing methods of all age groups, (1) establish mathematical models to analyze how to achieve sustainable fishing of shrimp herds, and the catch is the largest. (2) How to catch the highest total harvest in the fixed contract period, and the production capacity of shrimp herds is not caused by too much damage.

Model assumptions

1) The number of shrimp herds in each age group is a continuous differentiable function of time t. Only the reproduction and fishing of each type of shrimp are considered, and the migration and migration of shrimp are not considered in the process of shrimp herd growth.
2) Death rate of shrimp within 12 months.
3) All 3-and 4-year-old shrimp complete the spawning and hatching process in the last four months of each year (the second 1 / 3 years) of each year. The hatched young shrimp at the beginning of the next year to become the first age of shrimp into the first age of shrimp group.
4) spawning occurs at the beginning of the last four months and is completed in an instant. The natural death of the spawning shrimp occurs after spawning.
5) A, B, C, D and E species change continuously from each other.
6) All shrimps over four years old die or are still 4 years old.
7) It can be assumed that it can be caught at the specified fishing time.

Model system symbols and data descriptions

$y_i(t)$—t Number of shrimp herds in the time age group.

b —Average natural mortality rate of the five species of shrimp, b =0.8.

$x_i - i$ A、B、C、D、Egenundity of shrimp in the age group,

$\left(x_1, x_2, x_3, x_4\right) = \left(0,0,0.5,a\right), a = 1.109\times10^5$

$w_i - i$ A、B、C、D、E Net weight of the shrimp in the age groups;

i —Fishing intensity coefficient for the age groups $\left(p_1, p_2, p_3, p_4\right) = \left(0,0,0.42E, E\right)$;

$T = \frac{2}{3}$

Model building

Growth of each group in the absence of fishing

$$\begin{cases} \frac{dy_i(t)}{dt} = -ry_t(t) - p_i(E)y_i(t) i = 3;4 k \le t \le k+T & (1) \\ \frac{dy_i(t)}{dt} = -ry_i(t) i = 1,2; k+T & (2) \\ y_i(0) = y_i(3) & \\ y_{i+1}(k+1) = y_{i^-}(k+1) = \lim_{t\to k} y_i(t), i = 1,\ldots 4; k = 0,1\ldots & (3) \\ y_i(k+1) = \frac{1.22\times10^{11} y_0(k)}{1.22\times10^{11} + y_0(k)} & (4) \\ & (5) \\ y_0(k) = 0.5ay_3(k+T) + ay_4(k+T) & \end{cases}$$

Explore the solutions of (1) and (2)

$$y_{i+1}\left(k+1\right) = sl_i\left(E\right) y_i\left(t\right), i = 1,2,3 \quad (6)$$

$$y_1\left(k+1\right) = \frac{cy_0\left(k\right)}{c + y_0\left(k\right)} \quad (7)$$

$$y_0\left(k\right) = 0.5ay_3\left(k+T\right) + ay_4(k+T)$$

$$y_1(k+T) = y_3\left(k\right)e^{-(r+p_3)T} = s^T y_3\left(k\right) l_3\left(E\right)$$

$y_0(k) = 0.5as^T l_3(E) y_3(k) + as^T l_4(E) y_4(k)$ $c = 1.22\times10^{11}$ $l_1(E) = l_2(2) = 1$,

$$l_3(E) = e^{-0.42TE} = P_3^E, \quad l_4(E) = e^{-TE} = P_4^E.,$$

$$P_3 = e^{-0.42T} = e^{-0.28} = 0.7558, P_4 = e^{-T} = e^{-2/3} = 0.5134$$

Let's take a look at the solution process of (6):

$$y_i\left(t\right) = y_i\left(k\right)e^{-b(t-k)} \left(i = 1,2,3\right)$$

$$y_i\left(k+1\right) = y_{i+1}\left(k+1\right) = y_i\left(k\right)e^{-b} = sy_i\left(k\right) l_i\left(E\right) \left(t = k+1\right) \quad (9)$$

$$y_i\left(T+k\right) = y_i\left(k\right)e^{-(b+P_1)^T}$$

$$y_i(k+1) = y_{i+1}(k+1) = y_i(T+k)e^{-b(1-T)}$$

Explore the above type $y_{i+1}(k+1) = y_i(k+1) = y_i(k)e^{-b}e^{-p_i T}$

$$y_{i+1}(k+1) = y_i(k+1) = sy_i(k) l_i(E)$$

Fishing volume model $x_0\left(k\right) = 0.5ax\left(k+T\right) + ax_4(K+T)$

$$x_3\left(k+T\right) = x_3\left(k\right)e = s^T y_3$$

$$y_4(k+T) = y_3(k)e = s^T y_3$$

Exploring the above two types to maximize the fishing capacity, that is, the fishing benefit is the largest, and the fishing model achieves the maximum economic benefit on the basis of not destroying the ecological environment.

$$D(E) = 2.56$$

$$b_i(t) = p_i(E) y_i(t), \quad k \le t < k+T$$

The total catch of species A, B, C, D and E in the whole year k (within 10 months) is:

$$\begin{aligned} Y_i(k) &= \int_k^{T+k} d_i(t)dt \\ &= \int_k^{T+k} p_i(E) y_i(t)dt \\ &= \frac{p_i(E) y_i(k)(1 - s^T P_i^E)}{b + p_i(E)} \end{aligned} \tag{11}$$

Total catch in year k is: $Y(k) = w_3 Y_3(k) + w_4 Y_4(k)$ (12)

A model of sustainable fishing

By (6), (7), (8) have $y_{i+1}^* = s l_i(E) y_i^*, i = 1,2,3$

Or

$$\begin{aligned} y_2^* &= s y_1^*, y_3^* = s y_2^* = s^2 y_1^* \\ y_4^* &= s l_3(E) y_3^* = s^3 P_3^E y_1^* \end{aligned} \tag{13}$$

$$y_0^* = 0.5 a s^T l_3(E) x_3^* + a s^T l_4(E) y_4^* \tag{14}$$

$$y_1^* = \frac{c y_0^*}{c + y_0^*} \tag{15}$$

take y_3^*, y_4^* substitution (14) type get: $y_0^* = (0.5 + s P_4^E) a s^{8/3} P_3^E y_1^*$ (16)

take y_0^* Substitute for the (14) formula of: $y_1^* = c(\frac{B(E)-1}{B(E)})$ (17)

inside; thereinto $B(E) = (0.5 + s P_4^E) a s^{8/3} P_3^E$

When $B(E) \le 1$, there is, $y_1^* \le 0$ This represents a strong coefficient of fishing, meet the Bernoulli condition $D(E) = 35.5$ The overexploitation of shrimp leads to effort. So $D(E_0) = 29.8, B(E) = 1$ the solution.

Conclusion: When reached $D(E) = 35.5$ time, We can achieve ecological balance and sustainable. The maximum capture question will be studied in No $E < E_0$ The value of.

Under the condition of ecologically balanced and sustainable fishing, the total number of catches in the first age group is:

$$Y_i = \frac{g_i(E) y_i^* (1 - s^T P_i^E)}{b + g_i(E)} \tag{18}$$

The total annual fishing weight of the whole shrimp flock is:

($Y(k) = w_3 Y_3(k) + w_4 Y_4(k)$ The k year)

Then:

$$Y(E)=[\frac{w_3g_3(E)y_3^*(1-s^TP_3^E)}{r+g_3(E)}+\frac{w_4g_4(E)y_4^*(1-s^TP_4^E)}{r+g_4(E)}]$$
$$=(\frac{0.42w_3(1-s^TP_3^E)}{b+0.42E}+\frac{w_4(1-s^TP_4^E)sP_3^E}{b+E})Es^2c(\frac{B(E)-1}{B(E)})$$

Solving the optimization problems: $\underset{E<31.4}{Max}Y(E)$ (19)

Conclusion: In the premise of sustainable fishing:

$Y^*(E^*)$ (=38.87Ten thousand tons) ;

The number of ecologically balanced sustainable fishing shrimp groups A, B, C, D and E is

$$y_1^*(=119601343172), y_2^*(=53740347635),$$
$$y_3^*(=24147094734), y_4^*(=84025418)$$

The fishing rate of age groups A, B, C, D and E:

$$h_i=\frac{b_i}{y^*_i}=\frac{p_i(E)(1-s^TP_i^E)}{b+g_i(E)}\ (i=3,4) \tag{20}$$

$h_1=h_2=0,\ h_3=89.70\%, h_4=95.59\%$

Sustainable maximum harvest model

It can be seen that it can be caught during the fishing period without destroying the growth of the next generation of shrimp, that is, when the effort is reached, it does not destroy the stable development of the ecological level. The shrimp raising economy can be maximized.

$$D(E)=\sqrt{(x_1-x_2)+(x_3-x_4)}$$
$$D(E)=\sqrt{(y_1(5)-y_1^*)^2+\cdots+(y_4(5)-y_4^*)^2} \tag{21}$$

If we assume that the amount of effort taken during the five years is fixed, the dynamics of the shrimp population over the five years can be determined by (6) (7) (8) and initial conditions:

$(y_1(0), y_2(0), y_3(0), y_4(0))=(122, 29.7, 10.1, 3.29)\times 10^9$ K shrimp yield (11) is given.

The total production for five years was

$$Y(E)=Y(1)+Y(2)+Y(3)+Y(4)+Y(5) \tag{22}$$

Harvest the most model problems over the next five years $X(E_1)=X(E_2)$

$$MaxY(E) \tag{23}$$
$$MinD(E) \tag{24}$$

There are many ways to deal with the above issues. As a single-target optimization problem:

The solved optimal effort catch is: $E^*=17.84$, the best index value is $J(E^*)=1477164613075$

Optimal five-year output: $Y(E^*)=160.5$ Ten thousand tons, Shrimp production in the fifth year:Y(5)=38.17Ten thousand tons

A 、 B 、 C 、 D 、 E Age composition of the annual shrimp herd:(119172969564, 53612417452, 23649689723, 71038025);The solved optimal effort catch is:

$E^*=17.84$ Optimal five-year output: Y(5)=38.17Y Ten thousand tons

Fish production in the fifth year:(5)=38.17 Ten thousand tons.

A、B、C、D、E Age composition of the growing shrimp population:(119172969564, 53612417452, 23649689723, 71038025).

$$\begin{aligned} & y_1^*(=119601343172), y_2^*(=53740347635), \\ & y_3^*(=24147094734), y_4^*(=84025418) \end{aligned} \tag{25}$$

The difference between the number of shrimp herds and sustainable catch after five years is: 428373608, 127930183, 497405011, 12987393;

The total number of shrimp decreased in all age groups was:0.0036, 0.0024, 0.0206, 0.1546;

The Euclidean distance is given for the:D(E)＝6.6892e+008.

3. Model conclusion

From the model mentioned above, it can be concluded that when the amount of effort is reached, the number of shrimp produced until k years $Y(k) = w_3Y(k) + w_4Y_4(k)$, and the optimal solution can be obtained, to pursue the maximum yield or the best benefit. We should maintain the ecological balance and ensure the maximization of economic benefits. Sustainable development is a basic national policy, for example, shrimp industry, aquaculture industry such renewable resources, must always pay attention to moderate use, short economic prosperity is not permanent economic prosperity, we must not affect the shrimp reproduction to pursue economic development. The fishing rate and continuous yield are reduced under the maximum principal benefit, while the shrimp factory remains at the beginning

The stable shrimp volume increased and the conditions for maintaining the stable field were determined using the equilibrium point stability analysis. Mathematical models solve the stability of biological systems and pursue the maximization of the economy.

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