

Beverton and Holt's yield per Recruit Model

Introduction

- Future yields and stock biomass levels can be predicted by means of mathematical models.
- The prediction models can be used to forecast the fishery of a stock and by adopting suitable management measures pertaining to optimization of fishing effort and increase or reduction of fishing fleets, regulation changes in mesh sizes, closed season, closed areas etc., could be sustained without depletion.
- Therefore these models form a direct link between fish stock assessment and fishery resource management.

Introduction contd.....

- Further the prediction models also incorporate aspects of prices and value of the catch.
- Hence these models are also suitable for bio-economic analysis.
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Yield / recruit model of Beverton and Holt

- The Beverton–Holt model is a classic discrete-time population model which gives the expected number n_{t+1} (or density) of individuals in generation $t + 1$ as a function of the number of individuals in the previous generation.
- The yield / recruit model of Beverton and Holt is also called as analytical model.
- This model is in a principle a “Steady state model”.
- This means that the model describes the state of stock and the yield in a situation when the fishing pattern has been the same for such a long time that all fish alive have been exposed to it since they recruited. (Sparre and Venema, 1998).

Yield / recruit model of Beverton and Holt

contd.....

- Using a right mesh size, yield is optimized from a given number of recruits.
- According to Gulland (1983), calculation of yield from a given recruitment, known as yield per recruit, is a basic element in the assessment of fish stocks.

Assumption to be taken for using Analytic model

1. Recruitment, fishing and natural mortalities in a stock should be constant.
2. All fish of a cohort are hatched on the same date
3. Recruitment and selection are 'Knife-edge'.
4. There should be complete mixing within the stock

Assumption to be taken for using Analytic model conted.....

5. The length-weight relationship has an exponent 3, i.e. $W \propto L^3$.

Under these assumptions, the yield from a cohort during its life span is equal to the yield from all cohorts during a year.

Derivation of the model

- At birth the cohort of a fish has age zero.
- The cohort grows and attains T_r , which is called as age at recruitment. From '0' age to T_r , the stock is in the pre-recruitment phase.
- From age T_r to T_c (age at first capture), the cohort is not experiencing any fishing mortality.
- In these lengths, the fish escapes through the meshes if they

Derivation of the model

contd.....

- In these lengths, the fish escapes through the meshes if they enter the gear.
- From age 0 to T_c , the cohort experience only natural mortality and this is assumed to be constant through the entire life span of the cohort.
- At age T_c , the fish start to be caught with the mesh size actually in use and from age T_c onwards, the fish experiences fishing mortality.
- The fishing mortality is also assumed to be constant throughout the life span of the cohort.

Input data needed

1. Growth parameters of a stock
2. Mortality parameters of a stock
3. Selection parameters of a stock

Equation

$$Y / R = F \bullet \exp [-M^* (TC - Tr)] * W_{\infty}^* [1/Z - 3S/Z+K + 3/S^2/Z+2K - S^3 / Z+3K]$$

$$S = \text{EXP. } [-K^* (T_c - T_o)]$$

K = Growth coefficient or curvature parameter.

T₀ = Initial condition parameter

Input data needed conted.....

T_c = Age at first capture

T_r = Age at recruitment

W_∞ = Asymptotic body weight

F = Fishing mortality

M = Natural mortality

Z = $F + M$ = Total mortality

Calculation procedure

- Yield / recruit is calculated for a tropical species as a function of F .
- This is because 'F' is proportional to effort.
- Using different 'F' values, an optimal 'F' value could be ascertained to give maximum sustainable yield per recruit.
- The optimal 'F' value is denoted as F_{MSY} and the corresponding yield is called as Maximum Sustainable Yield. Thus by testing various F values, maximum value of Y/R , the maximum sustainable yield per recruit could be achieved.

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