engine=R

Biomass Dynamic Models

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Init

■init, fig=false, echo=false■= dirMy="/home/lkell/flr/manual/ggplotFL" source(paste(dirMy,"R/ggplotFL.R",sep="/"))
@

1 Introduction

Introduction

2 Surplus Production

Surplus Production

The productivity (Pt) of a stock can be defined as the surplus production, i.e. following Hilborn (2001):

$$P_t + B_{t+1} - B_t - C_t$$

where B_t is total stock biomass, and B_t total catch weight (i.e yield) at time t.

Productivity is greatest at a biomass equivalent to B$_{MSY} with a yield equivalent to MSY.$

The same equation can be used to model stock dynamics

$$B_{t+1} = B_t - P_t - C_t$$

Where P$_t is then modelled by a production function; a review of such biomass models is given by Kingsland(1982).$

There are various functional forms for the production function that describes the relationship between surplus production and abundancee.g. Schaefer (1954), Gompertz (), Pella-Tomlinson (), Theta-logistic, Fletcher (), Pollacheck and Shepherd

2.1 Schaefer

Schaefer

$$B_t \quad = \quad B_{t-1} \ + \ rB_t\left(1 - \frac{B_t}{K}\right) \ - \ C_t$$

Where in biological terms, the second surplus production term combines recruitment, body growth, and natural mortalities.

Conceptually, the model describes the simplest case of linear recruitment, where all individuals have the same body weight, and the natural mortality rate is constant. Individiuals reproduce as 1-year-olds and then die. After a period of removals, the population rebuilds towards K until the number of individuals dying from natural causes equals the recruitment.

The relative growth rate, as a fraction of current abundance, is $(B) = g(B)/B$,

$$B \quad = \quad r \ - \ \frac{rB}{K}$$

so the relative growth rate approaches r when the abundance is close to zero, and declines linearly with B until zero growth occurs at abundance K with a maximum at $K/2$

2.2 Gompertz

Gompertz

The Gompertz (1825) growth equation as applied in stock assessment by Fox (1970)

■fig1,echo=FALSE,fig=TRUE,width=10,height=8,sanitize=TRUE■= plot(datx, daty) @

Figure 1: Plot using R base graphics

2.3 Pella and Tomlinson

Pella and Tomlinson (1969)

When $p = 1$ we get Schaefer and $p \to 0$ we get Gompertz,

The Pella-Tomlinson shape parameter p does not only shift B away from $0.5K$, but also changes the maximum height of the production curve. This is unfortunate, as the modeller might be interested in exploring different shapes without altering the maximum productivity.

2.4 Theta-logistic

Theta-logistic

Gilpin and Ayala (1973)

Different from Pella-Tomlinson, which has $\frac{r}{p}$ as the first term. The theta-logistic model has the nice property that r is the initial growth rate, independent of θ. The Pella-Tomlinson model has the nice property that it becomes the Gompertz model as $p \to 0$.

The theta-logistic model has a problem with low θ values. Maximum production tends towards zero with decreasing θ, so the model will need very large K when θ is small.

2.5 Fletcher

Fletcher

Prager (2002):

The Schaefer model corresponds to $n = 2$ where $\gamma = 4$,

Prager (2002) describes the shape of the production curve with the unitless ratio $\phi = \frac{B}{K}$, which has a more intuitive meaning than the n exponent. The relationship is:

Insert $n = 2$ and note how the Schaefer model corresponds to $\phi = 0.5$, as expected:

2.6 Polacheck

Polacheck

Polacheck et al. (1993)

where p controls the asymmetry of the sustainable yield versus stock biomass relationship.

The authors note that the $\frac{r}{p}$ term is often omitted when the formula is presented.

2.7 Shepherd

Shepherd

3 FLBioDym Class

```
qplot(x, ..., data, geom)
```

Listing 1: Simple plotting with qplot

Table 1: plot

Syntax	
x	`vector` values of one variable of interest
data	`data.frame` other variables
geom	`ggplot object` that sets the type of plot to construct, i.e. âpointâ, âlineâ, âhistogramâ.

3.1 Slots

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6.1 Validation

6.2 Testing

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7.2 Look up later

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