Univ. Iceland	**09.51.70 Fish Population Dynamics**	
Monday	**5. March 2004**	**08:00-11:00**
Accessories allowed: Handouts, books and calculators	**Note** that laptop computers and mobile phones are not allowed in the exam area	**The points** for each problem are indicated

1. (10) Figure 1 indicates the yield per recruit as a function of fishing mortality for various values of natural mortality (M=0.1, 0.2, 0.3, 0.4). Total mortality has been estimated for this stock at Z=1.1 on the oldest fish.

(a) What is F and what will the yield per recruit be if natural mortality if M=0.2?
(b) Can one justify that fishing at F=0.3 will give a sustainable fishery?

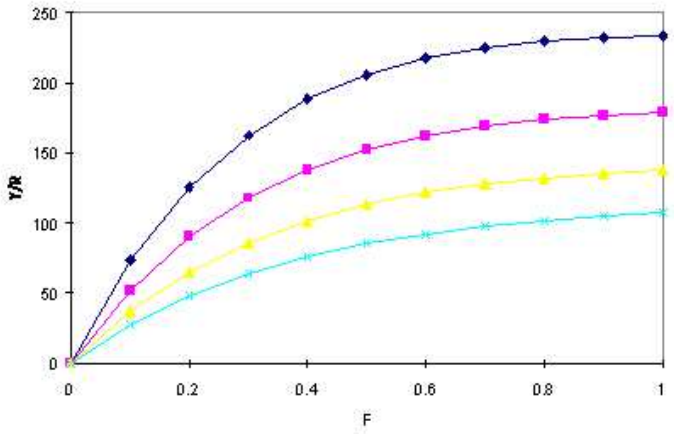

Figure 1: Yield per recruit for various values of M
Mynd 1: Afrakstur á nýliða miðað við mismunandi M

2. (15) The following table give mean weight at age, the fishing patter, natural mortality, proportion mature and an estimate of the size of each yearclass in the stock (millions) at the beginning of the year 2004. The fishing mortality is estimated at 0.5 on average for ages 5-6. A recruitment prediction indicates that recruitment in 2005 will be 200 million individuals.

(a) Predict the stock size in numbers at age in the beginning of 2005.

(b) Predict the yield (in tonnes) for 2006, for constant effort (fishing mortality).

Take care of the units used.

Age	w_a	s_a	M_a	p_a	N_a
1	0.07	0.04	0.2	0.00	500
2	0.49	0.16	0.2	0.00	800
3	1.43	0.40	0.2	0.01	300
4	2.94	0.80	0.2	0.05	500
5	4.99	1.00	0.2	0.27	200
6	7.52	1.00	0.2	0.73	50

3. (25) Figure 2 depicts (a) yield per recruit (b) spawning stock biomass per recruit, (c) a Beverton-Holt relationship between spawning stock biomass and ($R = \alpha S/(1 + S/K)$) along with replacement lines corresponding to F=0, 0.25, 0.35 and 1.1 and finally (d) equilibrium catch for each level of spawning stock biomass. Some of the figures include vertical lines for reference (corresponding to the same F-values.

(a) What is F_{max}?
(b) What is $F_{0.1}$ (approximately)?
(c) What is F_{crash}?
(d) What is MSY?
(e) What is F_{MSY}?
(f) What is the equilibrium spawning stock biomass at $F = 0.35$?
(g) What is the long-term catch at $F = 0.35$?
(h) Will a catch control law (harvest rule) with $F = 0.8$ as a target lead to a sustainable fishery?

For reference (in some cases the figures are enough):

F	Y/R	S/R
0.00	0.0	27.8
0.25	2.3	10.7
0.35	2.4	8.0
1.10	2.0	2.0

Given numbers: $\alpha = 0.5$, $K = 20000$.

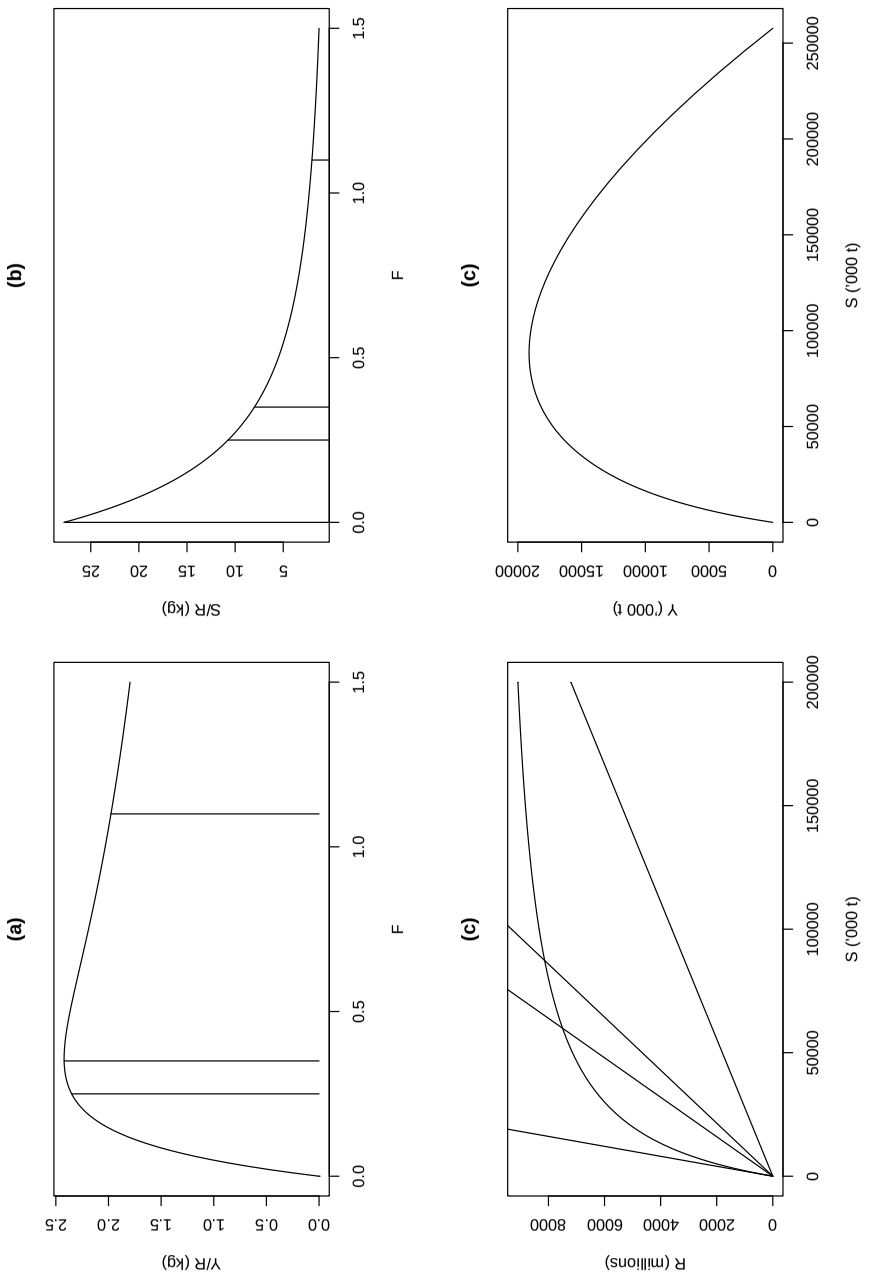

Figure 2: Various figures, see text.
Mynd 2: Ýmsar myndir, sjá texta.

4. (15) Suppose a fleet first caught 5 million fish from the 1995 yearclass of a given stock in 1996, followed by 10 millions in 1997 and 7, 4 and 2 million in the following years. It is believed that natural mortality is $M = 0.3$ for this stock. Assume $F = 1$ on the oldest fish and estimate the size of the yearclass at age one.

5. (15) Assume natural mortality is $M = 0.2$ for a certain stock.

If fishing mortality excerted on a certain yearclass is $F = 0.4$, then what is

(a) The fraction to survive the year?

(b) The fraction to die during the year?

(c) The fraction caught from the yearclass?

If F has not been computed, but it is known that the number of fish (alive in the stock) at the beginning of the year was 150 million fish but in the end of the year there were 100 million fish left, what was

(d) The fishing mortality?

(e) The catch in numbers from the cohort?

6. (20) Suppose the Cushing equation, $R = \gamma S^{\beta}$, describes the relationship between the spawning stock and recruitment, but otherwise the assumptions of problem 2 above. Draw this curve for $\gamma = 2.1$ and $\beta = 0.7$, with the Beverton-Holt curve of problem 2 in the same figure and the replacement curve corresponding to a moratorium on fishing.

Notice that the Cushing equation describes a curve which is constantly increasing. Give a justified answer to: Is it correct that the stock will increase without bound when no fishing takes place?