Fisheries Biology, Assessment & Management

Lecture 3

Is Sustainable Management Possible ?
(and if so, how ?)

Overview

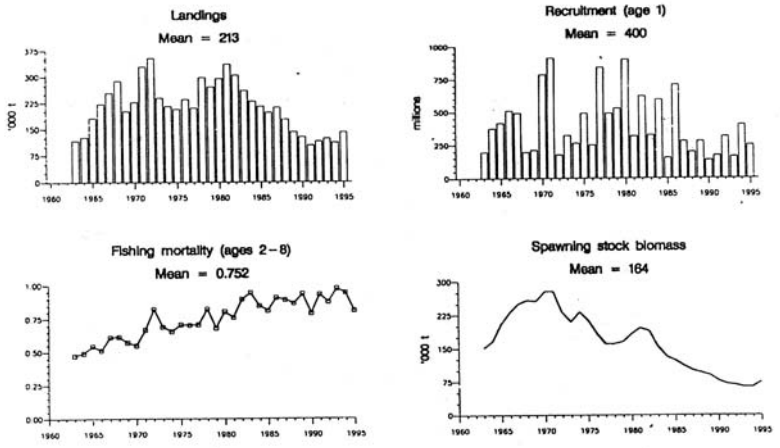
- What is the state of the stock ?
  - VPA/Cohort Analysis
- How could/should it be exploited ?
  - YPR/SBPR Analysis
- Might it collapse ??
  - Stock-Recruitment Analysis
- Overall synthesis
  - Combined Yield Analysis
- Compare actual with possible
- **Advise** on management measures needed

This Lecture

- What management is possible ?
- How can it be **implemented** ?
  - Catch Forecasts for TAC's
    - (Total Allowable Catches)
  - Effort Regulation
  - Other possibilities
- Is Sustainable Exploitation Possible ?

Example : The State of North Sea Cod

Figure 3.1.1 Cod in Fishing Areas IV, Skagerrak and VIId
9–10–1996



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Catch Forecasts

- Needed for management by TAC
- Require good recruitment estimates (in order to be sufficiently accurate)
- In practice require good (total) catch-at-age data, VPA **and** good survey data
- Based on Catch Equation (like YPR)
- Using **actual** population numbers-at-age
  - (not those calculated for an ideal cohort)

Catch Forecast (mathematics)

$$Y(y) = \sum_{a=r}^{max} P(y,a)F(y,a)\frac{[1 - \exp\{-Z(y,a)\}]}{Z(y,a)}w_c(a)$$

where

$P(y,r)$ = Recruits (estimated from surveys)

$P(y,a)$ = Survivors (estimated by "tuned" VPA)

$F(y,a)$ = Current value (from VPA)

(adjusted for any effect of management)

Catch Forecast (pseudocode)

- Use results for F & P (survivors) from VPA
  - (Use recruitment estimate for youngest age)
- Adjust F-at-age (level & pattern) if necessary
- For each age
  - Catch number : $C(a) = F(a)\, P_{bar}(a)$
  - Yield at age : $Y(a) = C(a)\, w_c(a)$
  - Survivors (for SSB and future years):
    $P(y+1,a+1) = \exp\{-Z(y,a)\}\, P(y,a)$
- Sum Y(a) over all ages

N Sea Cod : catch forecast

Catch Forecast Spreadsheet

M =	0.2						
Age	**Weight**	**Expected F-at-age**	**Maturity**	**Current Population** (from VPA)	**Current SSB**	**Forecast Catch** (numbers)	**Forecast Catch** (weight)
1	0.69	0.09	0.01	50000	345	3906	2695
2	1.08	0.64	0.05	16465	889	7129	7699
3	2.29	0.83	0.23	63654	33527	32982	75528
4	4.30	0.81	0.62	12932	34477	6594	28353
5	6.64	0.76	0.86	5296	30242	2587	17180
6	8.38	0.81	1.00	800	6704	408	3418
7	9.80	0.87	1.00	283	2773	151	1482
			Total	**SSB=**	108957	**Catch=**	136356

Example : ICES WG Option Table

Catch forecast for 2003:

Basis: F(sq) = F(99–01) = 1.11; Landings (2002) = 76.6; SSB(2003) = 35.4.

F(2003)	Basis	combined area	IIIa	IV (2003)	VIId	SSB(2004)
0	0*Fsq	0	0	0	0	87.1
0.11	0.1*Fsq	10.3	1.3	8.8	0.3	78.6
0.22	0.2*Fsq	19.7	2.4	16.8	0.5	71.0
0.33	0.3*Fsq	28.2	3.4	24.0	0.8	64.2
0.44	0.4*Fsq	36	4.4	30.6	1.0	58.1
0.55	0.5*Fsq	43.1	5.3	36.7	1.2	52.7
0.65	Fpa =0.59*Fsq	49	6.0	41.7	1.3	48.3
0.78	0.7*Fsq	55.7	6.8	47.4	1.5	43.5
0.89	0.8*Fsq	61.2	7.5	52.1	1.7	39.6
1	0.9*Fsq	66.2	8.1	56.3	1.8	36.1
1.11	1*Fsq	70.9	8.6	60.3	1.9	33.0

Weights in '000 t.

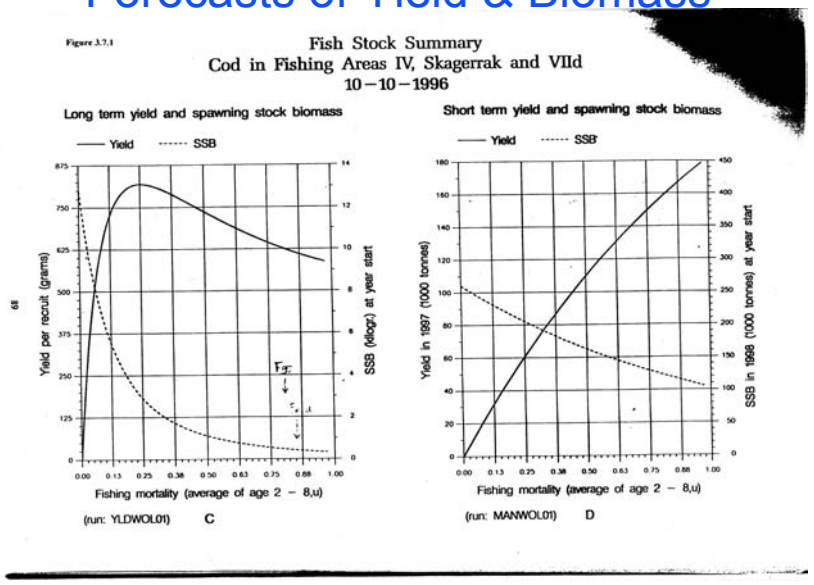
ICES WG Assessment in 1998

Catch forecast :

1997 assumptions : *staus quo* F=0.64,

F (98)	basis	Landings in combined area (98)	Lndgs in IIIa (98)	Lndgs in IV (98)	Lndgs in VIId (98)	SSB (99)	Medium term effect of fishing at given level
.26	0.4F(96)	84	10.2	71.4	2.3	252	SSB rebuilds with low probability of SSB falling below MBAL [1]
.38	0.6F(96)	119	14.6	101.6	3.2	223	"
.51	0.8F(96)	151	18.4	128.7	4.1	198	"
.64	1.0F(96)	180	21.9	152.9	4.9	176	"
.76	1.2F(96)	205	25.0	174.7	5.5	156	High probability of SSB falling below MBAL is

Example : Long-term & Short-term Forecasts of Yield & Biomass



The TAC Treadmill

- Precision Required : 10% (or better)
- Precision Attainable : 20% (at best)
  - requires **all three** forms of data
  - cost : £1 million per annum per stock ?
- Unattainable for many (most) stocks
- => Precautionary TAC's (=> Trouble !)

Management by TAC's and Quotas

- Facilitate (?) international negotiations
- Difficult (expensive) to enforce
  - "Black Fish" : Unreported Landings
  - Misreporting (by species or area)
  - Discards
  - Bycatches (in mixed fisheries)
- Do not directly affect fishing effort
- Do not improve economic position
- May encourage a "race to fish"

Management of Fishing Effort (e.g. Days-at-sea)

- Act directly on fishing effort (and mortality ?)
- Do not require catch forecasts
- OK in mixed fisheries (more-or-less)
- Rough & ready
- Difficult to protect individual stocks
- International negotiations more difficult
- May be the best blunt instrument available

Control of Fishing Effort

- Avoids the TAC treadmill
- Fewer problems with
  - black fish landings
  - discards (mixed fisheries, etc)
  - fluctuations (recruitment)
  - precautionary TAC's
- Easier to enforce effectively ?

Technical Measures

- limits on mesh size (protect young fish)
- closed areas (juvenile or spawning)
  - preferable to protect juveniles !
- Affect size/age **composition** of catch
  - do **not** limit total catch (or mortality)
- Not enough on their own (usually)
- Useful as part of a package

Decommissioning

- Reduce effort by reducing fleet size
- Effective only if draconian
- Need to buy out slack capacity
- Expensive ...
- Very difficult to target (at particular species)
  - needs support by restrictive licensing
  - or effort control
- Provides “exit” route for fishermen

Taxation

- Favoured by economic theory ...
- ... but not by fishermen !
- May be applied to
  - Earnings
  - Landings (levy)
  - Licences/Effort (charges)
  - Fuel Oil ?
- May be a few political problems !

Management : Summary

- TAC's & Quotas : not working very well
  - black fish, discards etc
  - but may be better than nothing
- Technical Measures on their own are not enough
- Effort control may be needed (desirable ?)
- **All conservation measures affect earnings**
  - need to look at bio-economic effects