Ecosystem based fisheries management:

A NE Atlantic view.

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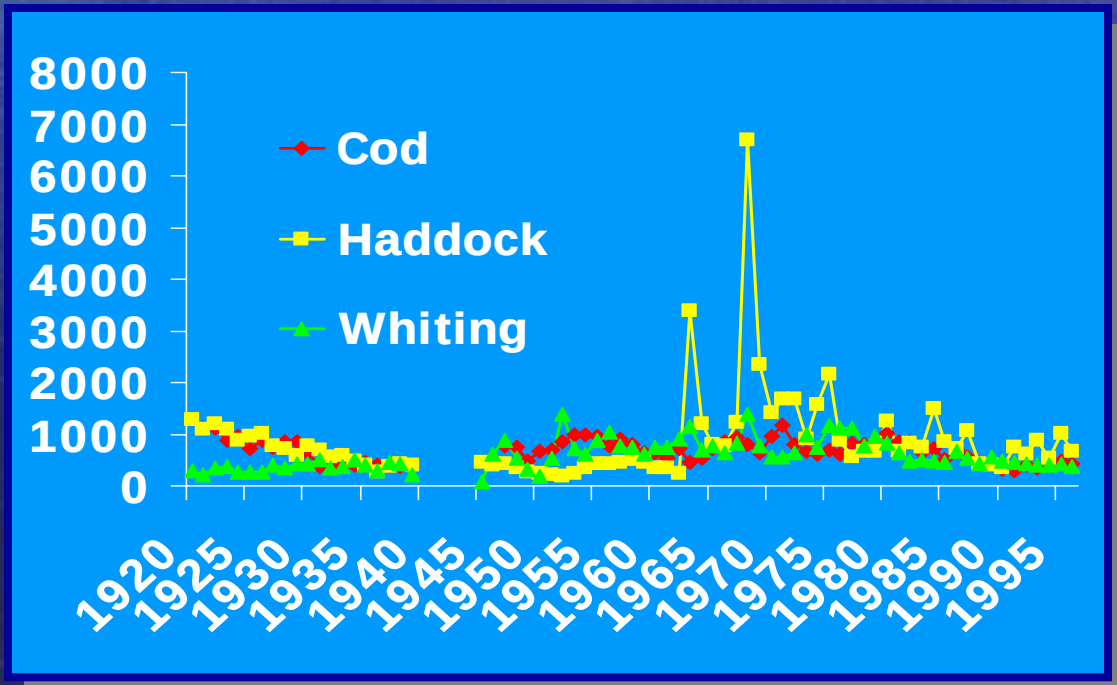
Traditional fisheries management

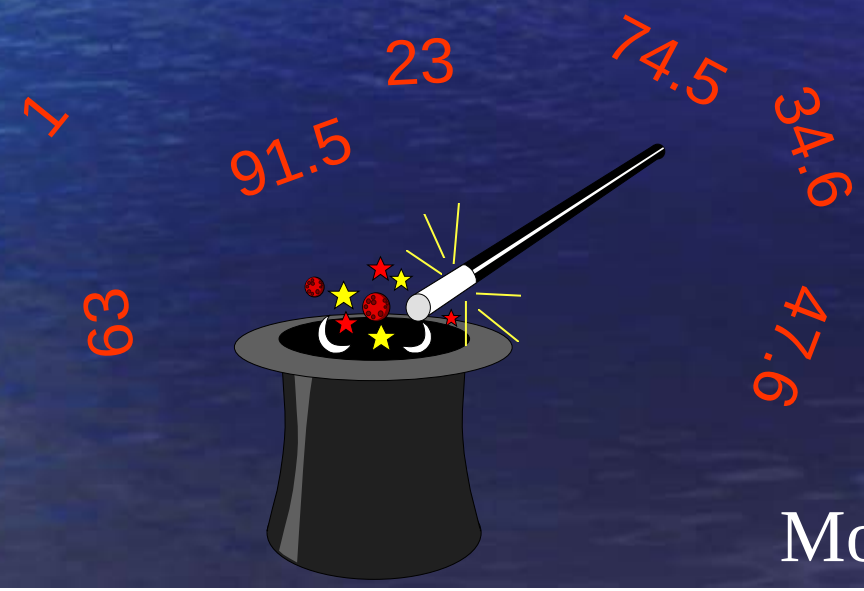
- How many fish are in the sea?
- How big is the sustainable harvest?
- What age should we harvest?
- Population models



Techniques and approaches

- Population models predict future population size based on a limited number of measures of the current situation and some knowledge of the biology of the organisms.

VPA
Virtual
Population
Analysis

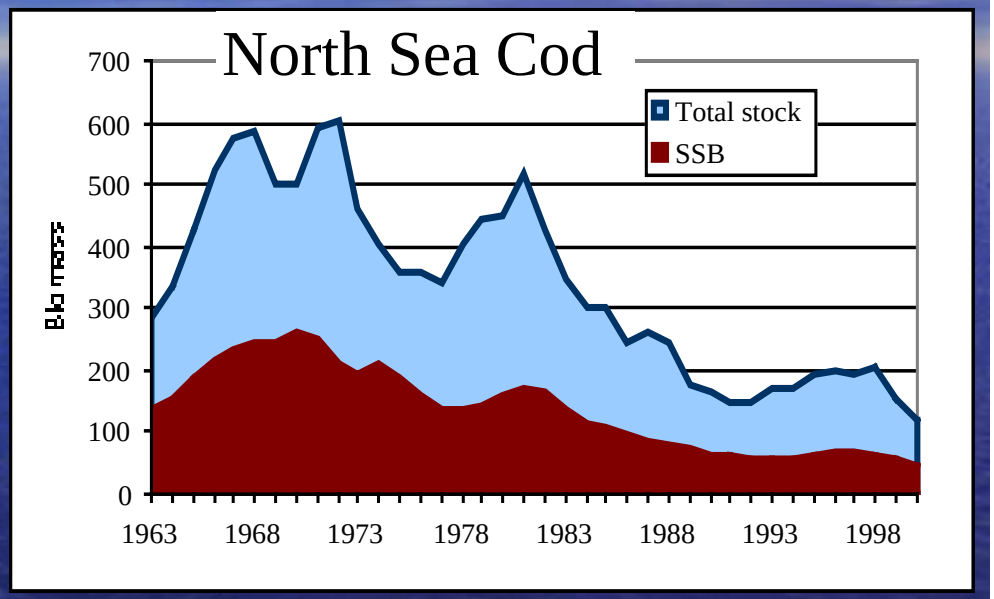


4M
Multi-species
Multi-fleet
Multi-area
Modelling package

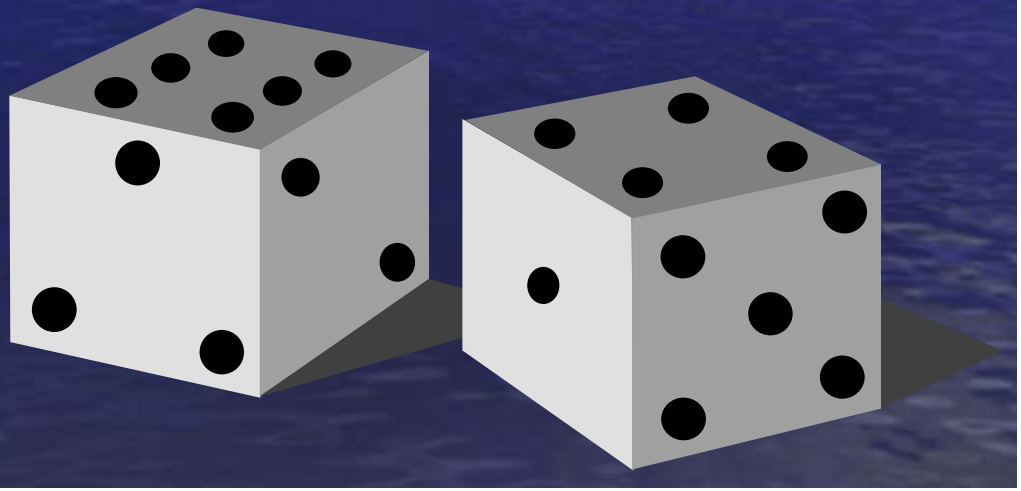
Fisheries Management - Failures

After 100 years of scientific fisheries management:

- Over 70% of global stocks over fished
- Including ~10% that are severely depleted



- Are we doing better than a lottery?



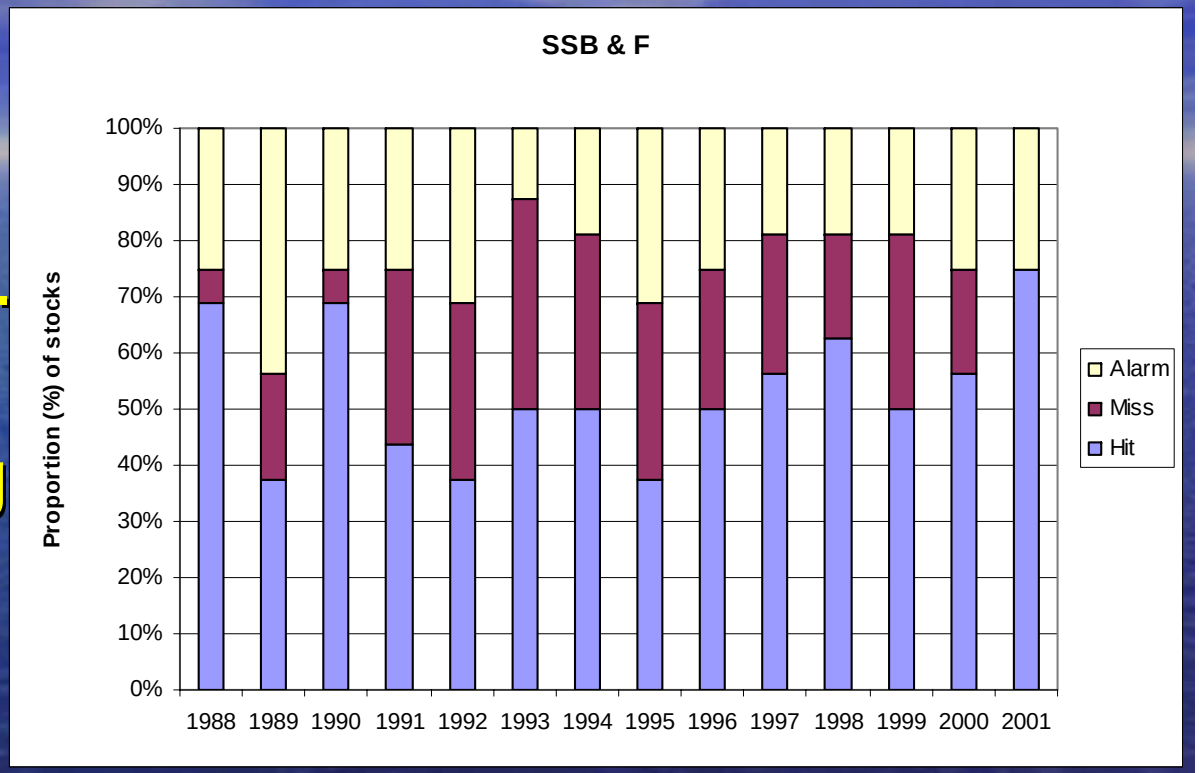
ICES Advice

- Objective to keep stocks within safe biological limits
- Management advice is given in a precautionary framework and with respect to the desired biomass of fish in the sea (B_{pa}) and the level of fishing mortality that matches this biomass (F_{pa})
- Three criteria can be used to determine whether a stock is within these limits and hence whether the objective was met:
  - SSB was above the desired level ($SSB>B_{pa}$)
  - F was below the desired level ($F<F_{pa}$)
  - Both of the above ($SSB>B_{pa}$ and $F<F_{pa}$)

Performance of ICES Advice

Using F only resulted in relatively low False Alarm rates but high Miss rates.

Using SSB only resulted in a strong decrease of Miss rates together with a markedly higher proportion of False Alarm rates.



The best results were achieved using both criteria with a 53% Hit rate, 23 % Miss rate and 24% False Alarm.

(Based on 18 stocks from the OSPAR region on which advice is given)

Fisheries and the ecosystem

- Direct effects
  - removal of biomass of landed species
  - size selective
  - mortality of non-target fish and benthos
  - habitat modification
- Indirect effects
  - removal of C to terrestrial food chains
  - altered predation pressure
  - altered nutrient cycling

Existing ecosystem considerations in fisheries management

In the NE Atlantic area we currently produce fisheries advice that includes consideration of:

- Multi-species interactions
- Effects on predators
- Bycatch and discards

Multi-species interactions

- Multi-species VPA (MSVPA) takes account of interactions between modelled species
- Very limited as an ‘ecosystem’ model
- Lacks spatial resolution and fishers behaviour
- 4M (Multispecies, Multi-fleet, Multi-area Model) seeks to overcome these but is hampered by a lack of data

Effects on predators

- Sandeels and kittiwakes
  - North Sea sandeel box
    - closed if kittiwakes in local colonies fledge less than 0.5 chicks per pair for 3 consecutive years
    - only reopens if fledging raises above 0.7 per pair for 3 consecutive years
    - Fishery closed in 1999, closure renewed in 2002

Bycatch and discards

- Real time closures for discards
  - Iceland and Norway
  - Requires on board observers
  - reopening only after research vessel survey show discard levels have dropped
  - Now available in the EC

Seabirds in Cornwall

- St Ives Bay is a key wintering site for auks, such as guillemots, and a variety of other birds.
- In the last 10 years estimated 10,000 seabirds killed, >100 observed in a single net.
- Under a Cornwall Sea Fisheries Committee byelaw, the gill net fishery in St Ives Bay is closed, temporarily, if significant numbers of seabirds are trapped.

Porpoise bycatch

- Aim to keep bycatch mortality below 1.7% of population for all small cetaceans
- Significant take of harbour porpoises in the North Sea and Baltic
- Mandatory use of pingers

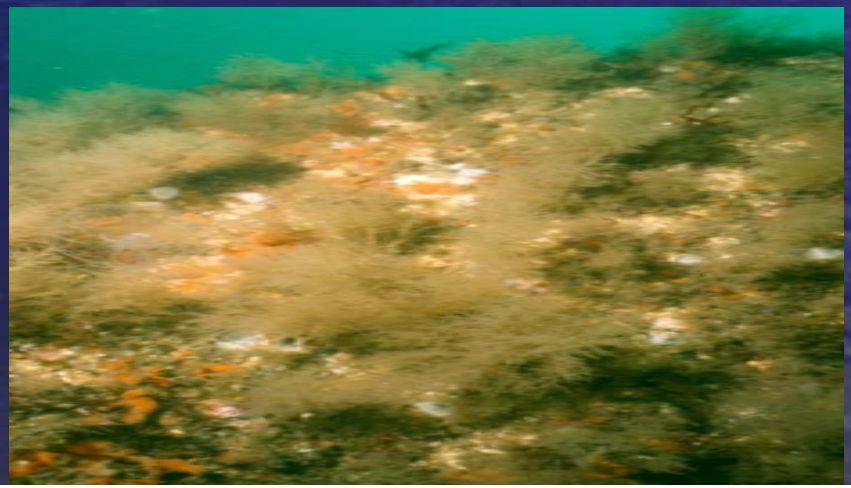
Ecosystem issues identified but not yet addressed

- Sensitive habitats
- Ecological dependent species
- Genetic biodiversity

Sensitive habitats

- First you need an agreed classification of the habitats!

In EUROPE the EC has produced the EUNIS scheme, a hierarchical classification.



Sensitive habitats

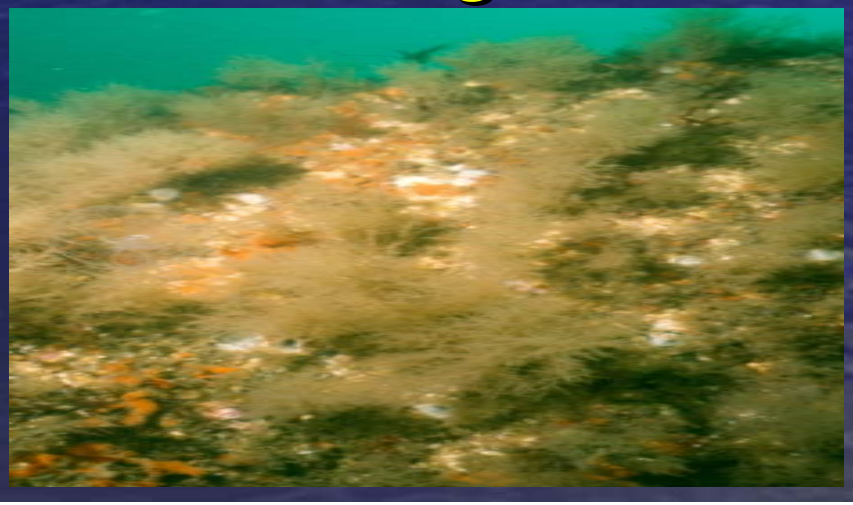
- First you need an agreed classification of the habitats!
- Sys
sen
e.g.

The OSPAR draft list of sensitive (to fishing) habitats

1. **Deep water biogenic habitats:** *Lophelia pertusa* reefs, carbonate mounds, oceanic ridges with hydrothermal vents, seamounts and deep water sponge communities.
2. **Structural benthic epifauna:** *Sabellaria spinulosa* reefs.
3. **Benthic infauna**: Seapens and burrowing megafauna communities.
4. **Shellfish beds:** *Ampharete falcata* sublittoral community, *Ostrea edulis* beds, *Modiolus modiolus* beds and intertidal mussel beds
5. **Nearshore communities:** *Zostera* beds and littoral chalk communities.

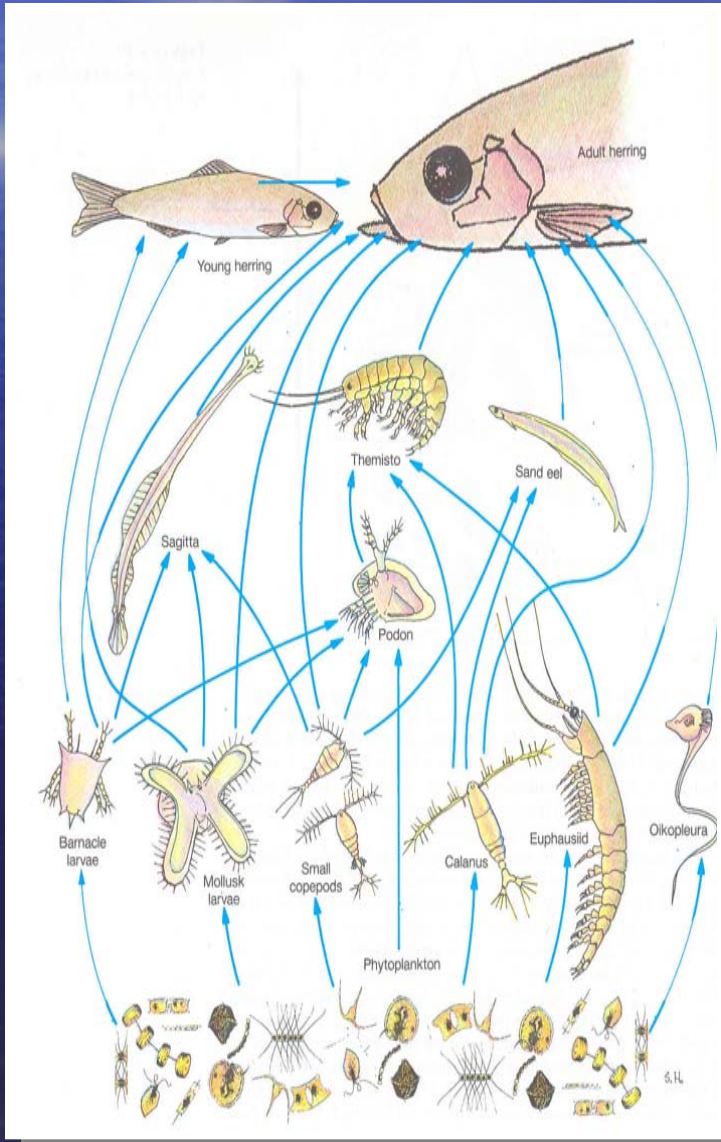
Sensitive habitats

- First you need an agreed classification of the habitats!
- Systematic reviews of habitats sensitivity to different activities e.g. fishing metiers
- Management responses are straight forward (!)
  - Closed areas
  - Gear modifications



Recognising ecological dependence

- Habitat issues (EFH)
- Forage fish
  - Sandeels and seabirds
  - Cod and capelin



Management of Barents Sea Cod - Capelin

- Capelin recruitment failed in 1984 and 1985, during a period when the biomass of an alternate forage fish, the herring, was also very low.
  - Starvation of many species that fed on pelagic fish, including cod, seals and seabirds.

- Capelin in the Norwegian-Barents Sea ecosystem are now managed with a target escapement strategy.
- The harvest control rule allows (with 95% probability) the SSB to be above B_{lim}, taking account of expected predation by cod.

Genetic diversity

In the absence of data to allow specific risk assessments ICES currently advises that

- Fishing mortality should be kept suffi to maintain large populations
- The harvest should be wi geographically a am populations to fragmentati
- Reductio ng e t rather than alternative mana t approaches that result in fisheries bec ing even more selective
- Case by case evaluation of risks associated with loss of genetic diversity vs. benefits of imposed action

There is NO WAY BACK

Learning from environmental management or *why reinvent the wheel?*

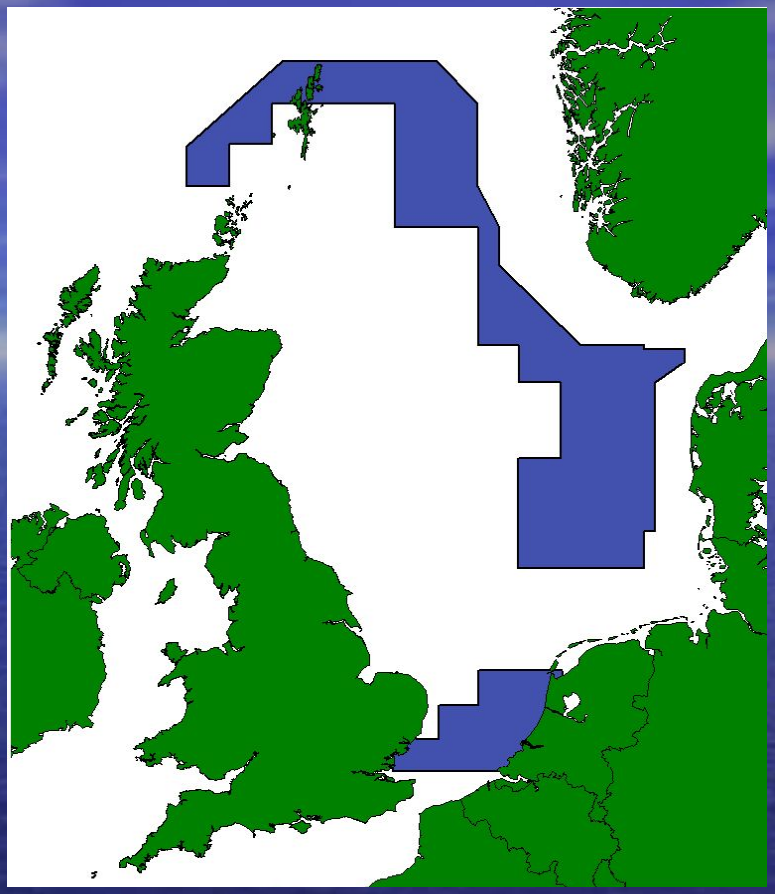
- US EPA (1969) and EC 1985 Directive set the requirement to predict the environmental consequences of development plans
- Assessment
- Consideration of alternatives
- Mitigation

EIA process and fisheries

- Assess current biological resources
- Describe consequences of fishing activity
  - Direct effects
  - Indirect effects
- Assess ‘significant effects’
- Select and evaluate mitigation measures
- Regulator decision on appropriate management action
- Monitor and review

The cod closure

- North Sea cod stock was considered by ICES to be outside of safe biological limits and at serious risk of collapse
- EC plan to protect the cod stock during the spawning season and to deter discarding and mis-reporting of cod in all fisheries



The area of the cod box closure from 14 Feb. - 31 April 2001.

- The Cod Recovery Plan included (1) closed areas (2) technical measures and (3) comprehensive proposals for longer term measures

North Sea CRP - Ecosystem effects

- The aim of the emergency closure wa o reduce fishing mortality on spawning co but the r consequences of this closur were not co outset
- The closure
  - grounds not usua
  - beam trawl
  - Sli the production of
  - Some o awling effort was displaced to areas that had ver been beam trawled, and recovery of benthic ommunities could take ten years or more.

An EIA type assessment would have predicted these and mitigation/alternatives management could have been put in place.

Where are we heading?

What changes in fisheries management can we expect in the medium term?

Management measures to reduce ecosystem effects

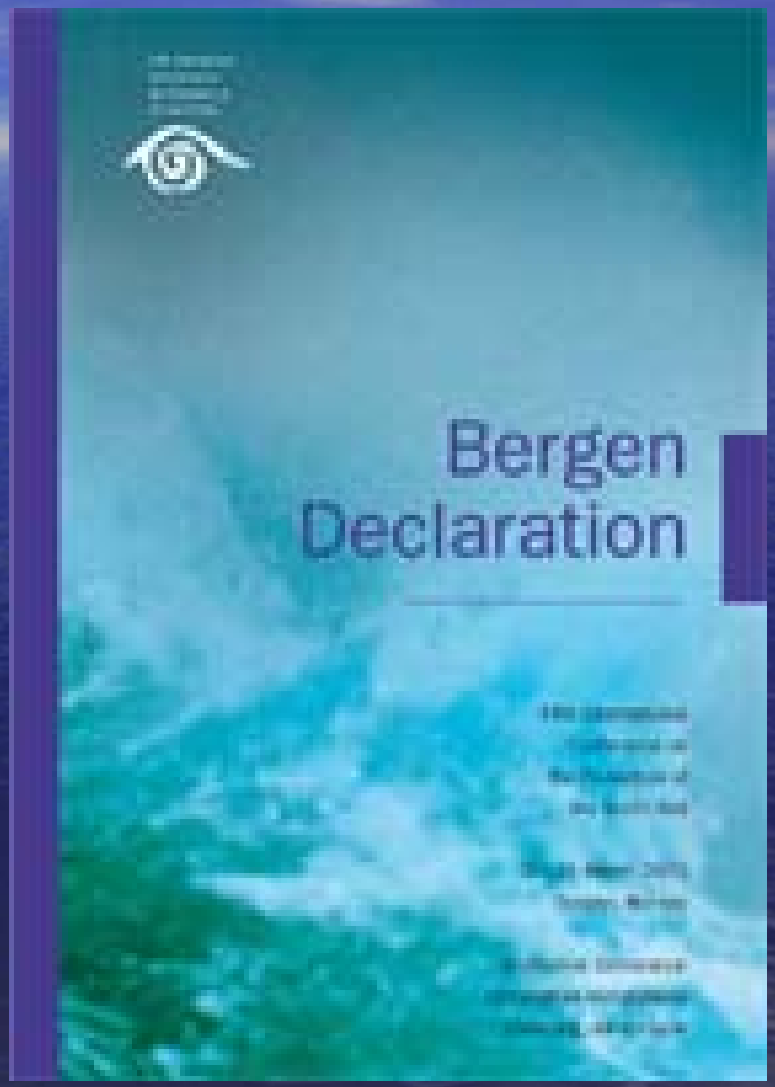
- Reduce EFFORT now and permanently
  - will prevent further impacts on habitats and gene pool
  - will eventually allow recovery of species impacted
- Other measures

  e.g. gear modifications

  may bring additional benefits

OSPAR and the Bergen Declaration 2002

- Ecosystem approach
- Closed areas
- Threatened and declining species
- Sensitive habitats
- Ecological Quality Objectives



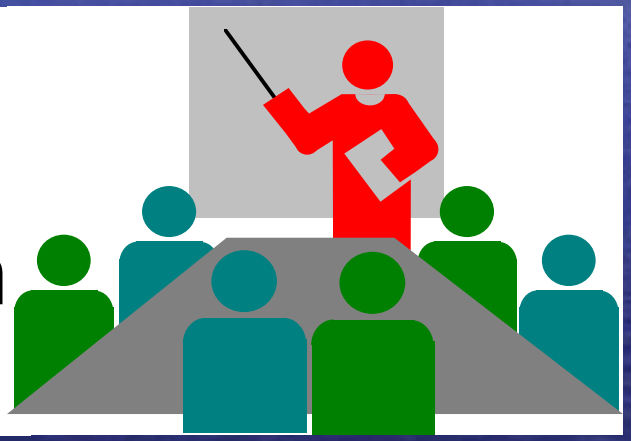
EC Common Fisheries Policy 2002 reform

- Effort reduction
- Regional management
- Stakeholder involvement
- Multi-annual management plans
- Ecosystem approach

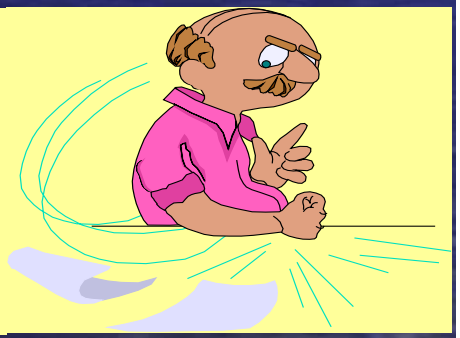
Science and the Ecosystem Approach

Science has to contribute to this process in two distinct areas:

- clearly communicating with all stakeholders about possible configurations of the ecosystem
  the educator role



- the provision of clear advice to managers
  – the advisory role.



The Educator Role

- Not mandatory marine biology degrees but informing stakeholders of 'What it is feasible to wish for?'
- This will involve explicitly predicting possible ecosystem scenarios, for example,
  - this many seals in the North Sea will mean a maximum catch of *x* salmon and *y* cod, and will also mean *z* birds.
  - if we can catch this much cod and this many sandeels, we would then expect *x* porpoise to be killed each year in our nets and only *y* birds to breed.

The Educator Role II

This will require:

- a major shift in the attitudes and behaviour of scientists. The fisheries science community is not used to communicating directly with society.
- a massive advance in our predictive capabilities.

The Advisory Role

- Society will express a preference for the state of the ecosystem. This will lead to the setting of clear objectives.
- Science has advised managers on the steps to be taken to meet the objectives and in monitoring the system to continue to provide advice in response to the observed status.
- This role is similar to that currently fulfilled in fisheries management, although the broader ecosystem basis of the management objectives presents greater challenges.

Ecosystem Approach = Participatory Governance?

If the Ecosystem Approach is not just lip service then,

- Marine scientists will need to undertake additional roles
  - informed advocacy - entering into the debate about possible objectives and management schemes. This may be an uncomfortable role for some.
- Participatory management involves
  - 'education/communication'
  - openness
    - science to stakeholders
    - stakeholders to scientists

    (i.e. on fishers' behaviour in response to management measures)

Conclusions

- Ecosystem based approach requires a much wider range of science than traditional fisheries management.
- It is no longer fisheries science but marine science that needs to inform fisheries management

Take Home Message

- Marine science should fulfil two important roles in this new, participatory approach:
  - an educational role
  - an advisory role
- This will require:
  - some radical thinking within fisheries governance institutions
  - a redirection of resources by government and other advisory customers