Maximum sustainable yield

Poul Degnbol

Head of ICES advisory programme

Sostenibilidad pesquera en los ecosistemas mrinos

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Maximum sustainable yield

- Concept developed in the 1930s
- The productivity of a population is maximum at intermediate population sizes

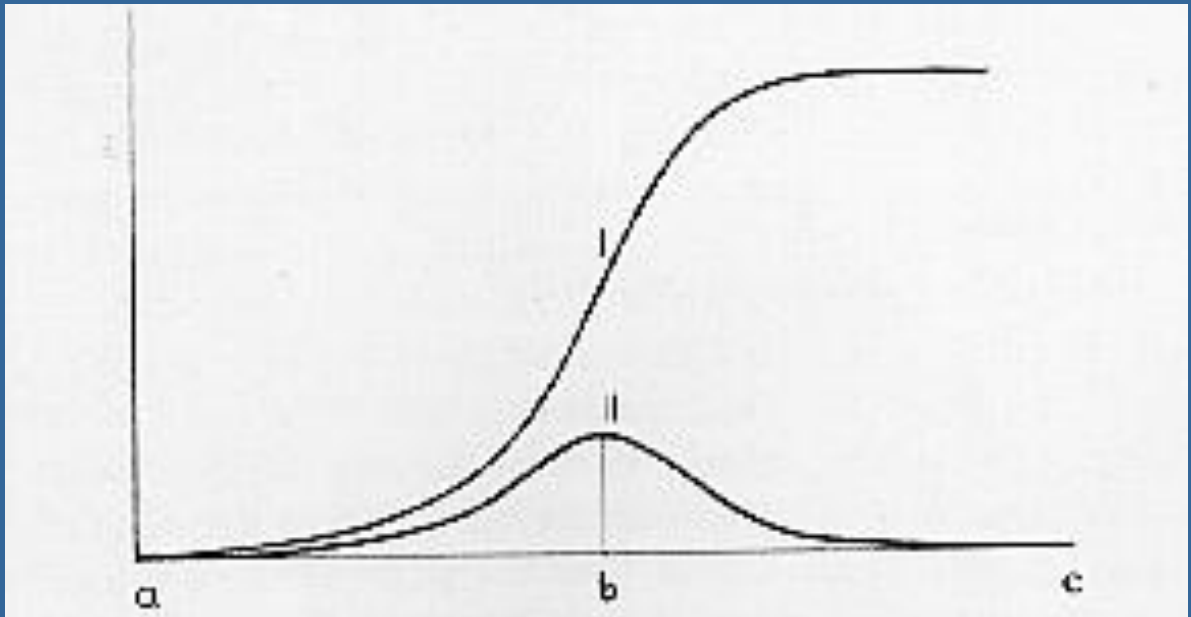


Fig. 67. Growth of a population of yeast cells. I. Growth curve. II. Curve representing the growth rate.

Hjort 1930

B&H 1956

- The productivity of a fish population is a balance between individual growth and mortality
- Fisheries yield will have a maximum

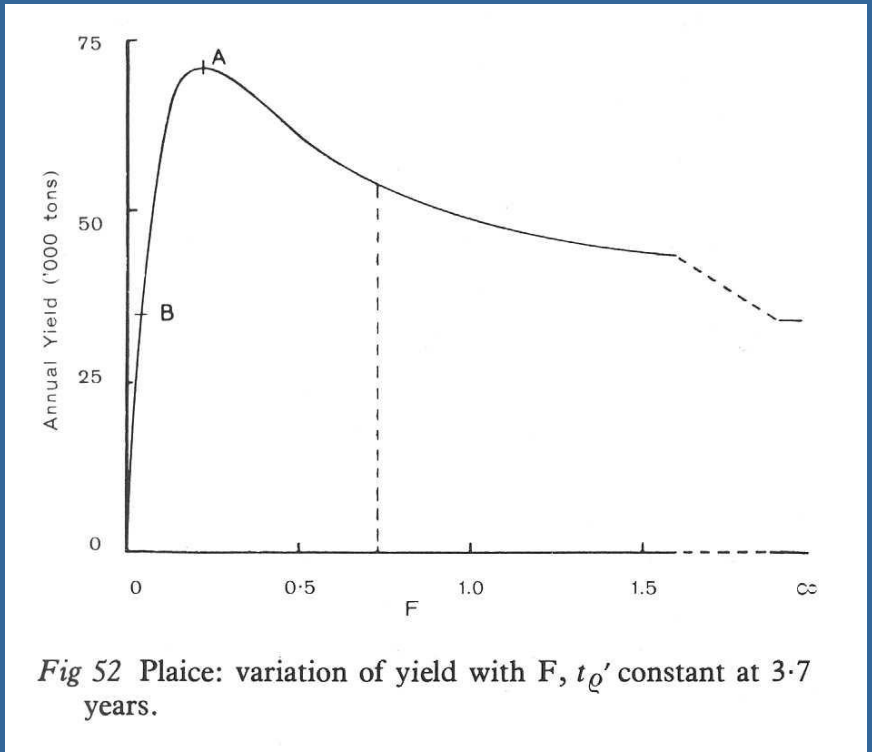
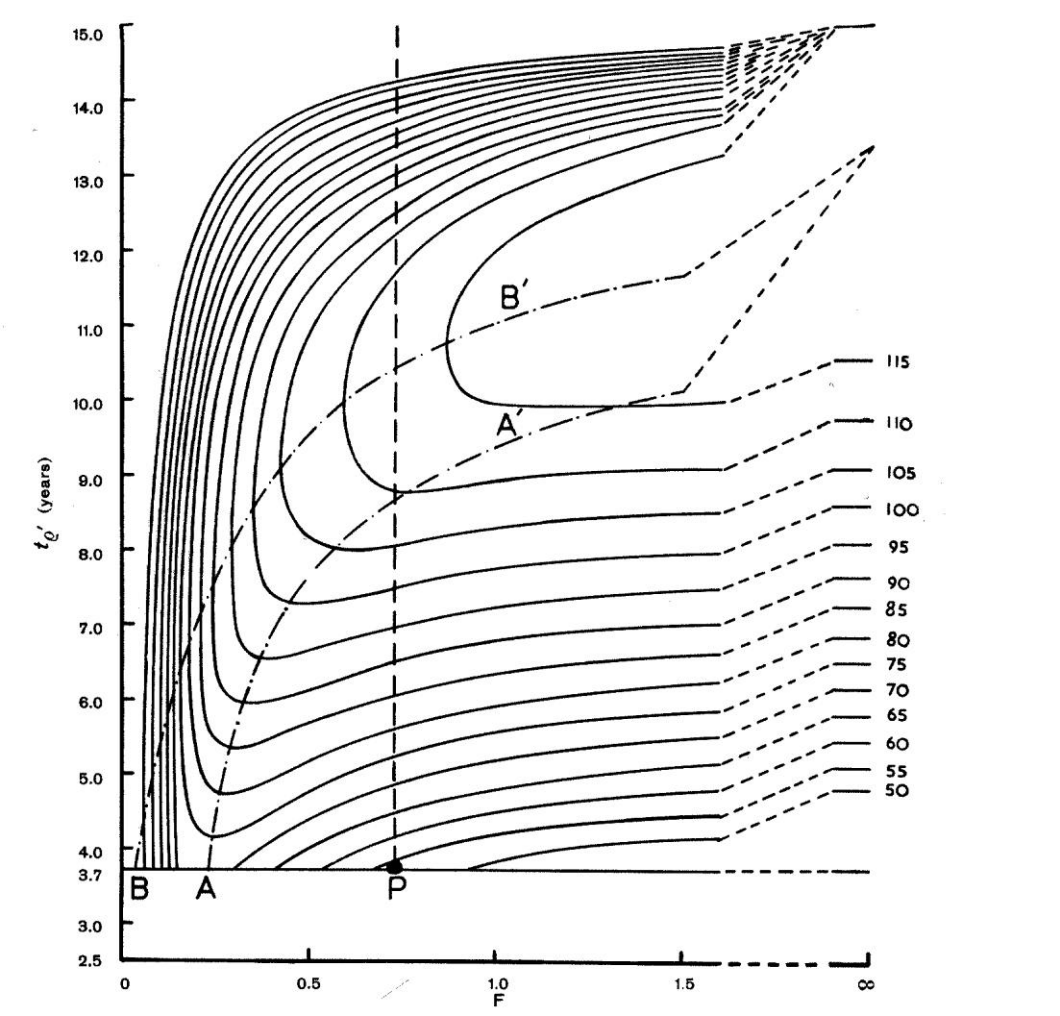


Fig 52 Plaice: variation of yield with F, t_{ϱ}' constant at 3·7 years.

Beverton and Holt 1956

MSY

- Fisheries yield depends on fishing mortality and selectivity



Beverton 1953

Uptake in management

- **MSY seems an easy basis for fisheries management**
  - **Relates to management instruments – TAC/effort and selectivity**
  - **Who would object to something which is ’maximum’ and ’sustainable’ ?**
- **Introduced formally in management from 1955**
- **Increasingly influential as the conceptual basis for fisheries management – formalised in UN stocks agreement 1995**

Critique

- **Larkin 1977:**
  - **Puts populations on too much risk**
  - **Does not consider spatial variation**
  - **Only considers target stock**
  - **Considers only benefits, not costs**
- **Later critique**
  - **Does not consider other elements of ecosystem**
    - **sensitive species**
    - **Habitat impacts**
    - **Ecosystem 'health' – food webs, biodiversity**
  - **Relates to equilibrium and a constant nature – this never applies in reality**
  - **Focus limited so biological sustainability**
    - **Social sustainability?**
    - **Economic optimality not equal to MSY**

Critique - Role of science?

- 1950s – 1980s : political concept of optimisation, science advising on optimal use of natural resources
- 1980s: science not to be normative about 'optimal use',
  - science should only advice on limit conditions
  - How to utilise natural resources within limit conditions is a societal choice
- 1990s – 2009: ICES advice based on precautionary limits only.
- MSY rejected as basis for advice on grounds of critque from science and scientific advice to point only to limits

MSY at the policy forefront

- UNCLOS
- UN fish stocks agreement 1995
- WSSD 2002
- EC MSY policy 2006

- Societal objectives firmly based on ’MSY’
- Which science has rejected in its classical shape

Dilemma

- Classical MSY concept flawed
- Political objectives refer to ’MSY’

- How to reinterpret ’MSY*?

Reinterpreting ’MSY’

- Interpretation: policy guidelines referring to ’MSY’ refer to the need to ensure optimal ecosystem services on the long term (not to the classical MSY concept)

- ’MSY’ must be within – not replacing other boundaries:
  - Precautionary approach
  - Ecosystem approach

MSY limits

- **’MSY’ must be within – not replacing other boundaries:**
  - **Precautionary approach**
  - **Ecosystem approach**
- **Precautionary approach: MSY limited by limit stock size**
- **Ecosystem approach: MSY limited by unacceptable ecosystem impacts (biodiversity, habitats, ecosystem health)**

Changes in ICES approach

1998 – ICES PA approach

Avoid recruitment impairment

2009 – ICES MSY framework

Getting most out of the stocks

MSY sufficient for PA

PA necessary but not suffient for MSY

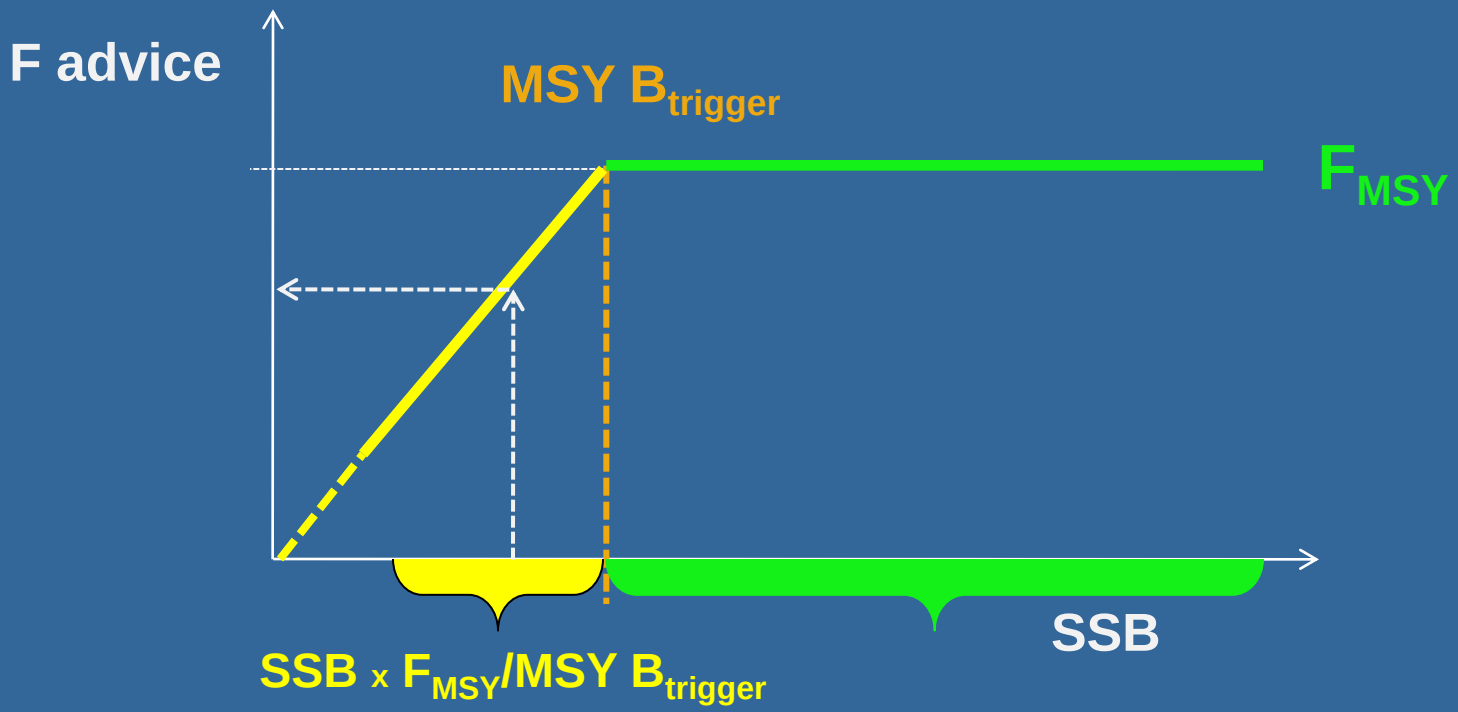
ICES MSY Framework

- Conceptual – not linked to a particular model
- Production function with an optimum
- We model this production function using several different approaches
- We advise based on stock specific knowledge and broad experience
- MSY estimates are never global but are conditional (on selectivity, growth, ...)

ICES MSY Harvest Control Rule (HCR)

Set F_{MSY} and MSY $B_{trigger}$ Ref. Points

Assess current SSB in relation to MSY $B_{trigger}$



MSY Framework Ref. Points

Based on an F_{MSY} and a biomass safeguard against low spawning stock biomass

F_{MSY} is the fishing mortality that in the long-term will maximize yield

MSY $B_{trigger}$ is a biomass reference point that triggers a cautious response: "A cautious biomass triggering action to maintain a stock within a desirable stock size range"

B_{MSY} is not explicitly a reference point

Reference points - F_{MSY}

F_{MSY} proxies

Y/R (F_{max}, $F_{35\%}$, $F_{0.1}$, M, ...)

Modified by

1) Intra-species interaction (Cannibalism, growth)
2) Environmental drivers (Recruitment)
3) Species interaction (Growth – Mortality)

Reference points: MSY $B_{trigger}$

Low percentile on expected observed SSB range when fishing at F_{MSY}

Accounting for

1) Natural variability: Recruitment – Growth – Mortality

2) Observation error

For 2011: use B_{pa} (if available)

Is the MSY approach a step backwards if we want to move to an ecosystem approach?

YES , if it is all we do
- Based on a single species approach
-Ignores species interactions and ecosystem impacts of fisheries

NO on the contrary, if we use it as one measure among others
- MSY as one component in an overall ecosystem approach

A cross-sectoral approach is required

An ecosystem approach cannot be implemented through one sector policy

Different sector policies must all contribute to a cross-sectoral ecosystem approach to marine management

The issue is therefore not an ecosystem approach to fisheries (EAF) but the contribution of the fisheries policy to an ecosystem approach to marine management (EAMM)

Benefits to fisheries as EAMM addresses the interaction both ways:

- **The impacts OF fisheries on marine ecosystems**
- **The impact ON fisheries from other sectors – pollution, mineral extraction etc**

The Marine Strategy Framework Directive is the cross-sectoral ecosystem approach in the EU – good environmental status by 2020

Good Environmental Status Descriptors in MSFD

(1) **Biological diversity** is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

(2) **Non-indigenous species** introduced by human activities are at levels that do not adversely alter the ecosystems.

(3) Populations of all **commercially exploited fish and shellfish** are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

(4) All elements of the marine **food webs**, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive Capacity.

(5) Human-induced **eutrophication** is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

(6) **Sea-floor integrity** is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

(7) Permanent alteration of **hydrographical conditions** does not adversely affect marine ecosystems.

(8) Concentrations of **contaminants** are at levels not giving rise to pollution effects.

(9) **Contaminants in fish and other seafood for human consumption** do not exceed levels established by Community legislation or other relevant standards.

(10) Properties and quantities of **marine litter** do not cause harm to the coastal and marine environment.

(11) Introduction of **energy, including underwater noise**, is at levels that do not adversely affect the marine environment.

Descriptors with important fisheries impacts

1. **Biological diversity** is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

3. Populations of all **commercially exploited fish and shellfish** are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

4. All elements of the marine **food webs**, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive Capacity.

6. **Sea-floor integrity** is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

1. Biodiversity

Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

ATTRIBUTE	**Criteria** to assess the descriptor	**Indicators** to be measured
Species state	Species distribution	Range
		Pattern
	Population size	Abundance and/or biomass
	Population condition	Demographic characteristics
		Genetic structure
Habitat state	Distribution	Range
		Pattern
	Extent	Area (volume)
	Condition	Condition of typical species
		Relative abundance/biomass
		Physical, hydrological, chemical composition
Ecosystem state	Ecosystem structure	Condition and relative proportion of habitats and species

3. Commercially exploited fish and shellfish populations

Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

ATTRIBUTE	**Criteria** to assess the descriptor	**Indicators** to be measured
Sustainability of exploitation	Exploitation systainable consistent with high long-term yield	Fishing mortality (F equal to or lower than FMSY) If F not available: ratio catch/biomass
Reproductive capacity	Reproductive capacity should not be compromised	Spawning stock biomass or biomass indices
Age and stock composition	Enough older/larger fish to ensure stock resilience	Proportion of fish larger than size of first maturity Mean maximum length across all species found in research vessel surveys 95% percentile of fish length distribution observed in research vessel surveys Secondary: size at first sexual maturity

4. Food webs

All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive Capacity.

ATTRIBUTE	**Criteria** to assess the descriptor	**Indicators** to be measured
Energy flow in food webs	Productivity of key species or groups	Performance of key predator species (production/biomass)
Structure of food webs	Proportion of selected species at the top of food webs Abundance of key groups/species	Proportion of large fish Abundance of functionally important groups/species -Early warning indicators/fast turnover -Affected by human activities -Habitat defining -Top of food web -Migratory -Spexies tighly linked to species at other trophic level

6. Sea floor integrity

Sea-floor integrity **is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.**

ATTRIBUTE	**Criteria** to assess the descriptor	**Indicators** to be measured
Physical damage having regard to substrate chracteristics	Biogenic substate impact Overall impact	Type, abundance and areal extent of biogenic substrate Extent of seabed affected by human activities for different substrate types
Condition of benthic community		Presence of particularly sensitive or tolerant species Indexes assessing bentic community function and functionality (diversity, richness, proportion of opportunistic or sensitive species)

Is a move to approach a step backwards for an ecosystem approach?

Present situation: Fishing mortality 2-3 times FMSY for many stocks

This means that there are excessively high pressures on marine ecosystems – habitat impacts, bycatches etc

Member States have subscribed to a MSY by 2015 target

Reducing Fishing mortality is IN THE PRESENT SITUATION the most significant step one can take to reduce ecosystem impacts (bycatches, habitat impact – descriptor 1,4,6)

In paralllel to that efforts must be made to reduce bycatches and habitat impacts (MSFD descriptor 1,4 and 6)

MSY by 2015 is a first step only which in itself does not address all aspects of an ecosystem approach – beyond 2015 further steps are required (MSFD descriptor 1,4 and 6)

MSY is a necessary but not sufficient element in an ecosystem approach

Is a move to MSY an economic threat to the industry?

YES, if a large step is made in one year undermining the short term viability of some fleets

No, on the contrary. Once at MSY there will be better fishing opportunities which may be taken with lower costs. Economically one would even go below F_{MSY}

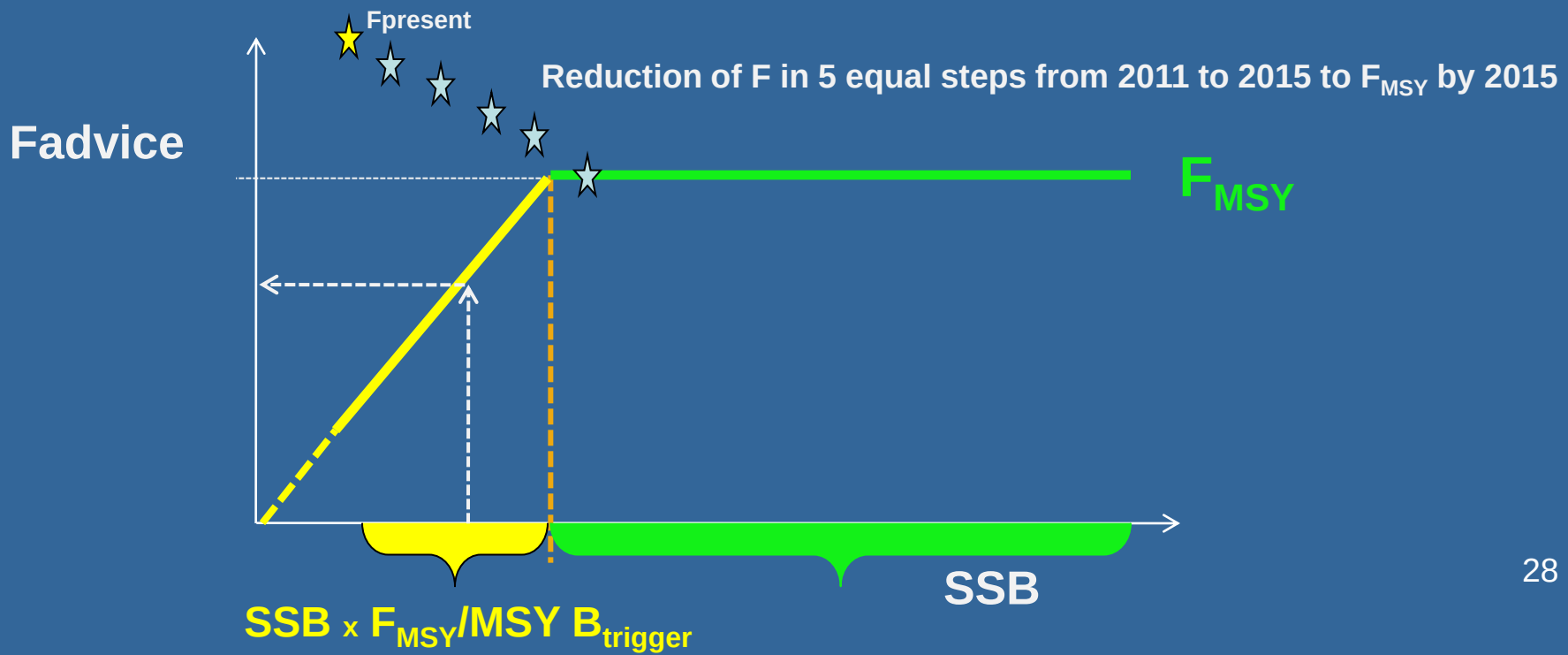
The challenge is to make a transition which ensures that we get there while maintaining economic opportunities

ICES MSY Harvest Control Rule (HCR) - Transition

WSSD 2002: Move to MSY at the latest by 2015

EU implementation: fish at F_{MSY} at the latest by 2015

B_{MSY} is not a target initially, will emerge when ecosystem adapts to reduced fishing pressure



Advice for 2o11?

ICES clients have given mixed messages – they want both the MSY advice and advice on basis of the pa framework and management plans

ICES approach – make these policy choices explicit

Management objective	Catch in 2011
Transition to an MSY-based approach with caution at low stock size (i.e. $F_{MSY\text{-}HCR\text{-}transition}$ (2011))	Less than 16.8 kt
Cautiously avoid impaired recruitment (i.e. PA)	n/a (greater than 50% increase in exploitation rate)
Cautiously avoid impaired recruitment and achieve other objective(s) of a management plan that is precautionary (e.g. catch stability)	Less than 13.2 kt **(Celtic Sea Herring example)**

Process and next steps

Consultations with clients – spring 2010

Expert workshop to develop concept

Advice for 2011 includes options according to the MSY framework – but also includes options according to former framework and management plans

Interactions with RACs on advice presentation meetings

Experiences will be basis for approach in 2011

ICES
CIEM

Thank you!