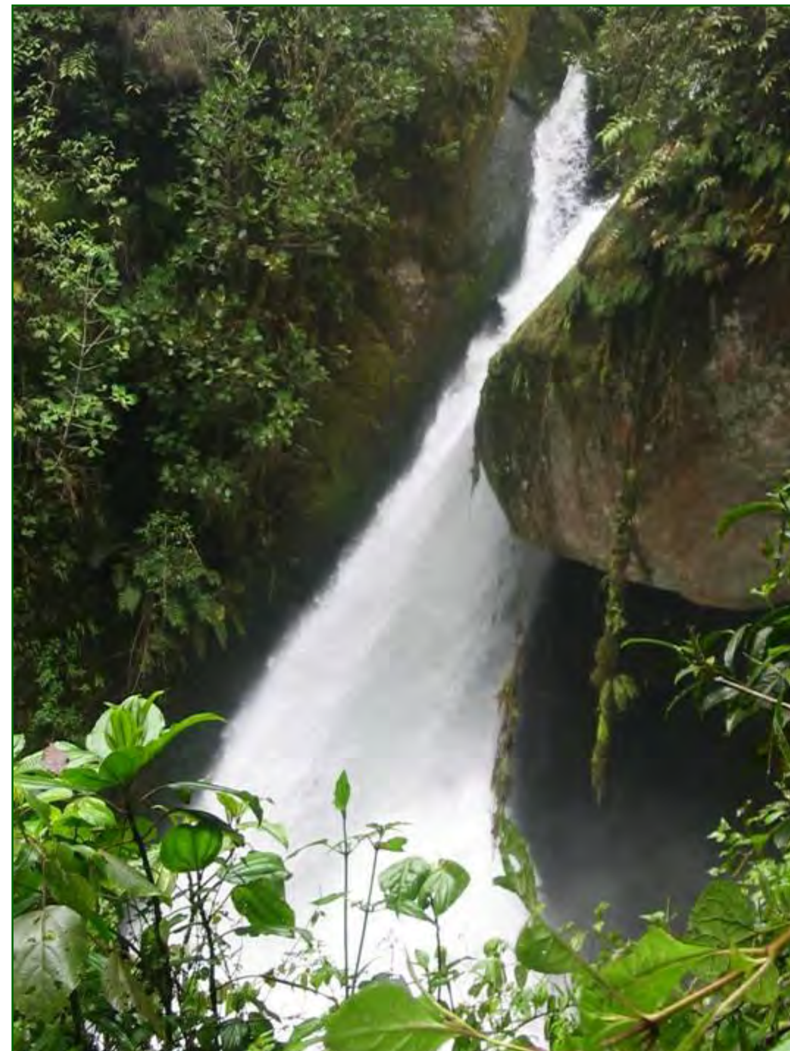
Gestion des ressources naturelles (la pêche) (Thomas Sterner)

Sém: Effets de seuil et changements de régime : Anne-Sophie Crépin, *Beijer Institute* (Stockholm)

MANAGEMENT of Natural Resources

- INTERTEMPORAL setting
- Spatial setting
- Ecological Setting



Historical Thinking on Growth

Malthus (1798) *The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race.*

Mankind doomed to poverty. What do you think?

Hotelling (Journal of Political Economy,1931): *“Contemplation of the world’s disappearing supplies of minerals, forests, and other exhaustible assets has led to demands for regulation of their exploitation. The feeling that these products are now too cheap for the good of future generations, that they are being selfishly exploited at too rapid a rate, and that in consequence of their excessive cheapness they are being produced and consumed wastefully has given rise to the conservation movement.”*

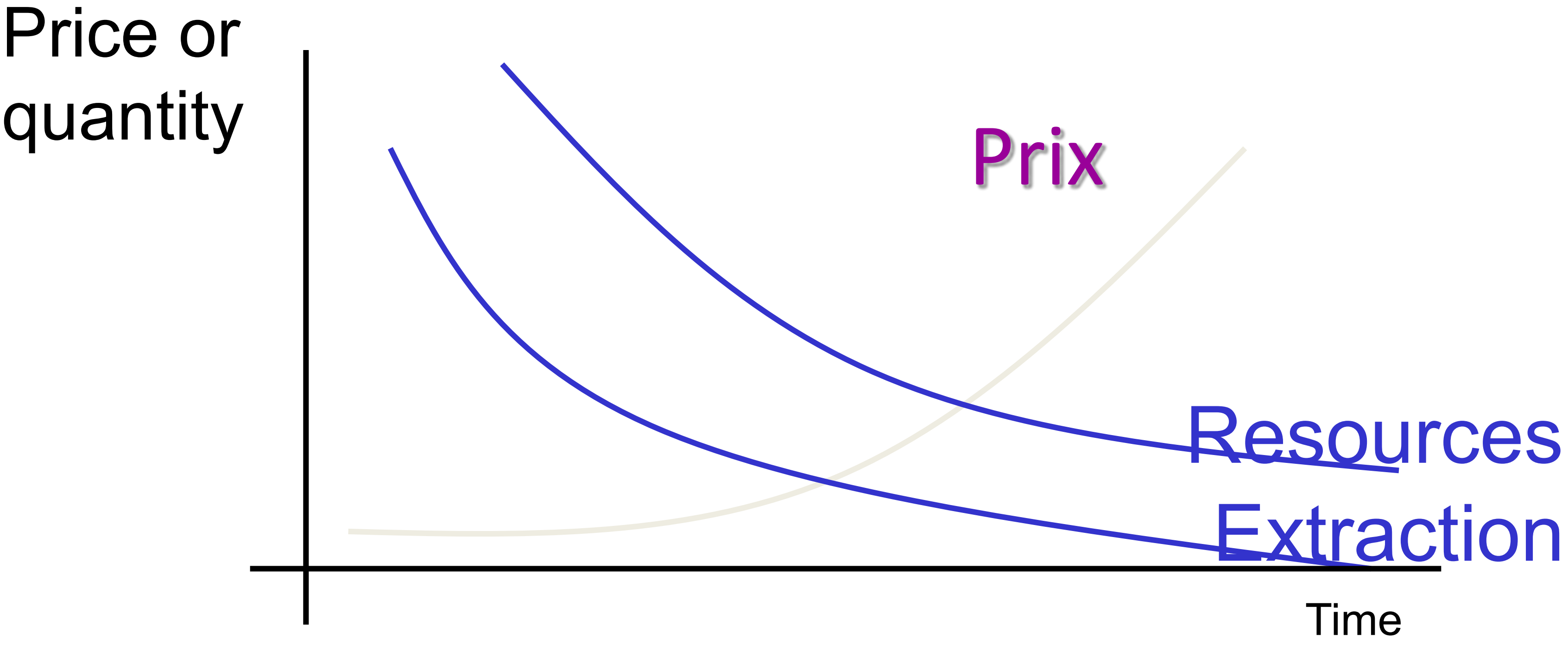
Is scarcity real? Malthus, RomeClub

- Physical indices: Reserve-to-use ratios (either static or exponential).
- Economic Indicators

La rareté : est elle réelle?

Resource availability according to the Rome Club (1970)

Mineral	Cu	Au	Fe	Pb	Hg	Al	Gas	Oil
Static	36	11	240	26	13	100	38	31
Expon	21	9	93	21	13	31	22	20



Rente de rareté augmente

Un Arbitrage

- Consider a 0 inflation economy with r=3%
- You have a bank account: it gives r= 3%
- You buy a painting by Monet for a Million.
- What is it expected to be worth next year?

The Arbitrage condition

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- 1,030 thousand. ?????

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- Assume some other value. Eg 1020 K
- .

The Arbitrage condition

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- You buy a painting by Monet for a Million.
- What is it expected to be worth next year?
- 1,030 thousand.
- Assume some other value. Eg 1020 K
- Then a normal capitalist would only be prepared to pay 1020/1,03 $\approx$ 990 K now.

- Grace au principe de Hotelling, Maltus aura tort?

HOTELLING pricing and optimal use of finite resources. How to use an oil well with Q ton.

Constant demand: $P_t = a – bq_t$

Assume pumping cost = c (fixed)

$$B_t = \int_0^{q_t} (a - bq)dq = aq_t - 1/2bq_t^2$$

Assume cost = c (zero)

$$\text{Max } L = \sum \frac{\left(aq_t - \frac{bq_t^2}{2} - cq_t \right)}{(1+r)^{t-1}} - \lambda(Q - \sum q_t)$$

$$\frac{\delta L}{\delta \lambda} = \overline{Q} - \sum q_t = 0$$

$$\frac{\delta L}{\delta q} = \frac{a - bq_t - c}{(1+r)^{t-1}} - \lambda = 0$$

$$\frac{P_t - c}{(1+r)^{t-1}} = \lambda$$

$$(p_t - c) = \lambda(1+r)^{t-1}$$

- Grace au principe de Hotelling, Maltus aura tort?

- Les ressources non-renouvelables sont inépuisables…

- Et les ressources renouvelables??

”The cod fishery, the herring fishery, the pilchard fishery, the mackerel fishery, probably all the great sea fisheries, are inexhaustible .. nothing we do seriously affects the number of fish”

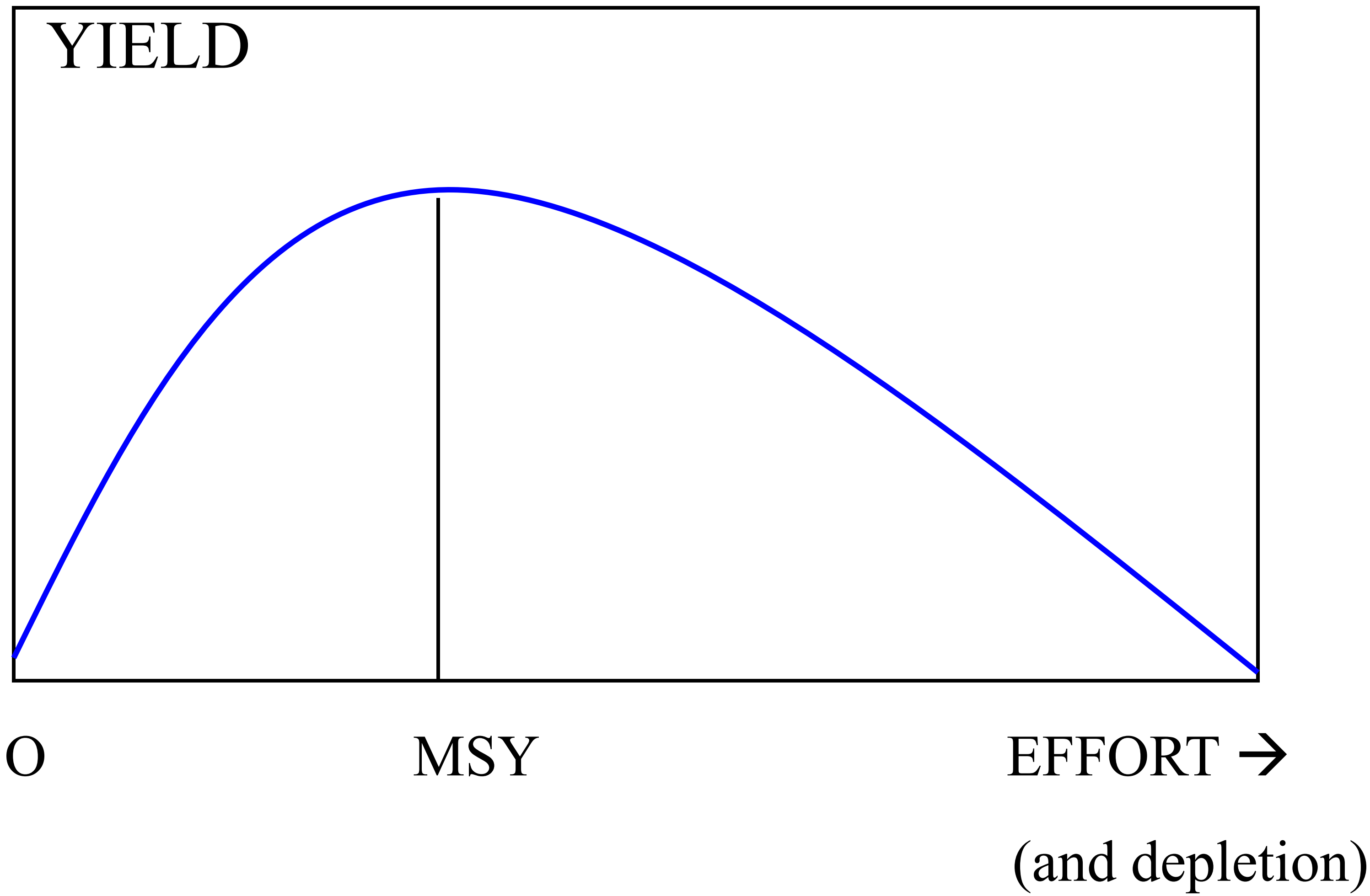
1883, Thomas H. Huxley

T. H. H. Opening Fisheries Exhibition (1882)
B.B.C. Hulton PIcture Library

Fisheries

- Rather like congestion
- Fishermen would all be better off if effort brought down.
- However a tax that collects all the rent will actually make the fishermen worse off
- Fishery policy badly needed but typical policies are exact opposite of required!

A Bio-<?! model of fishing



Bioeconomic model 3

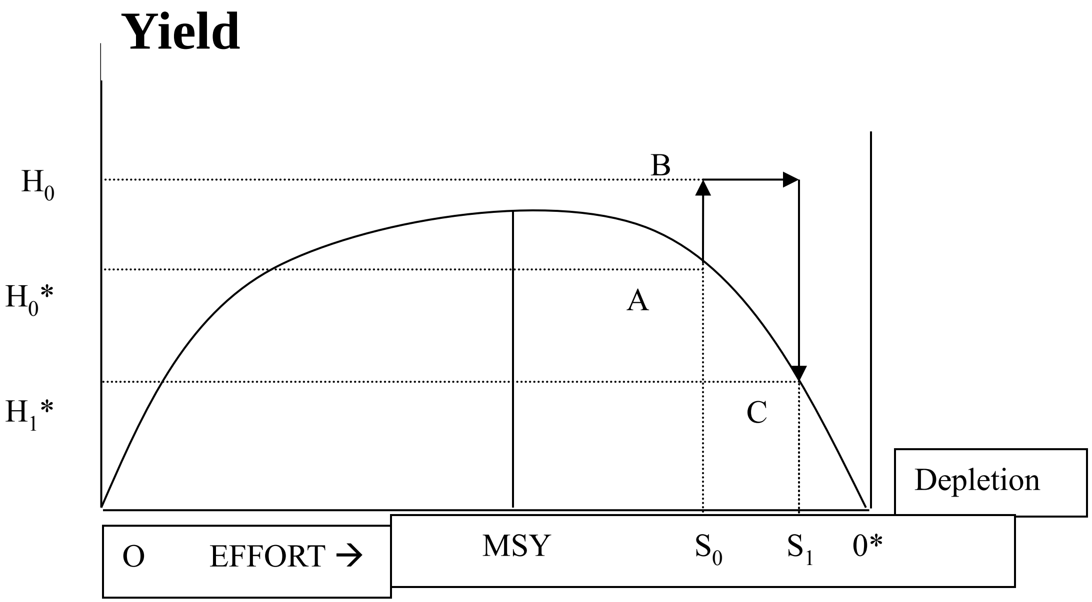
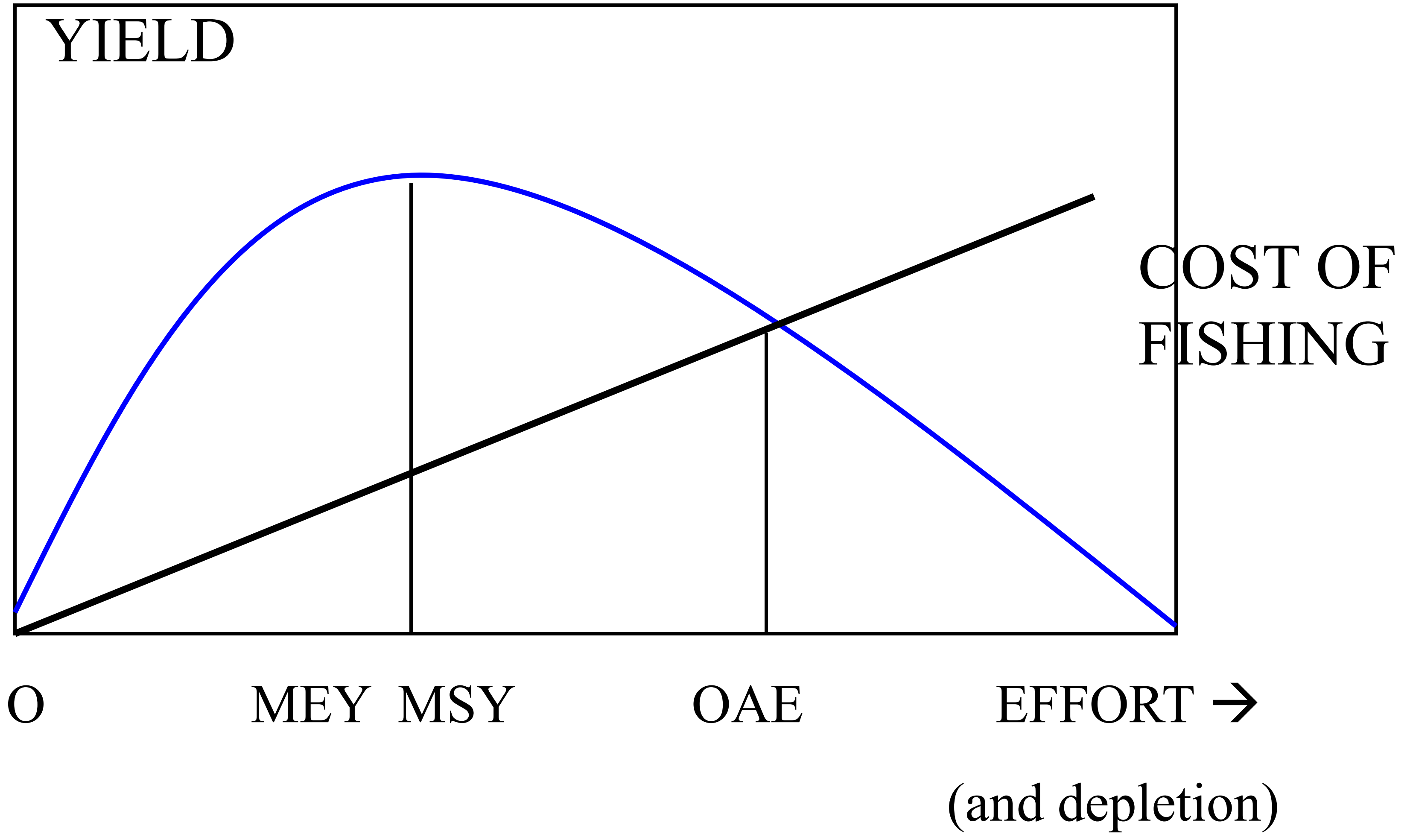
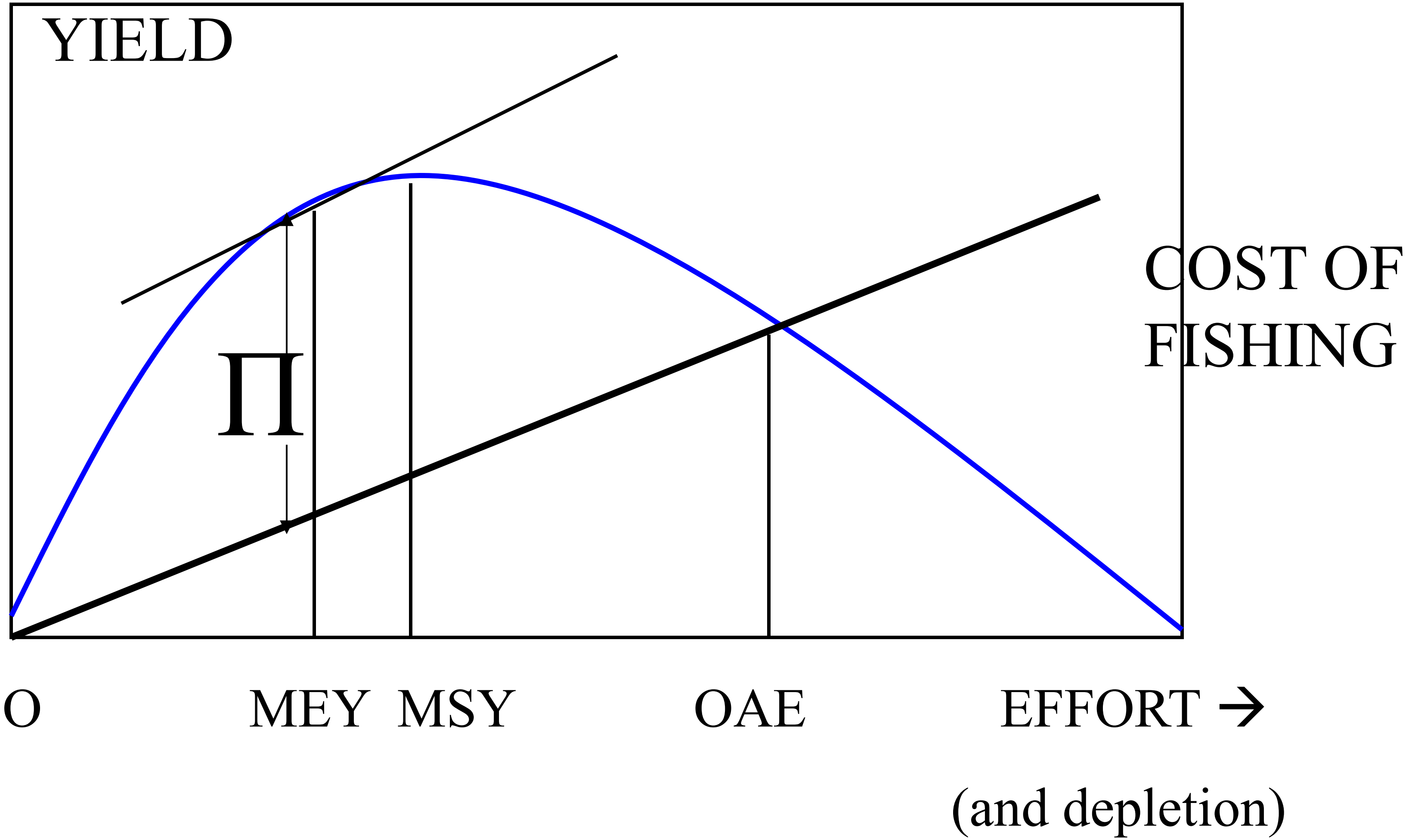


Figure 2. Depletion of fisheries.

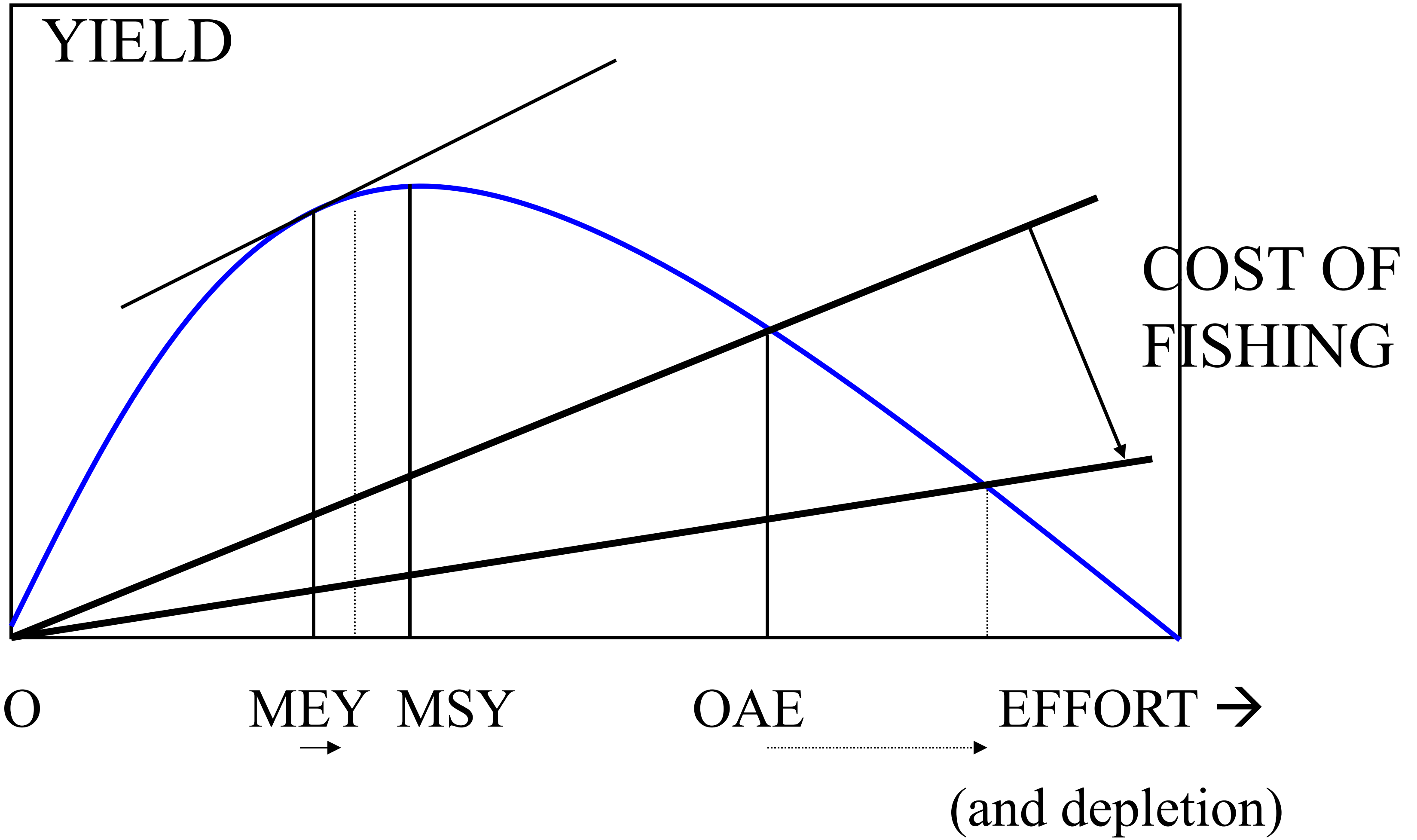
A Bio-economic model of fishing



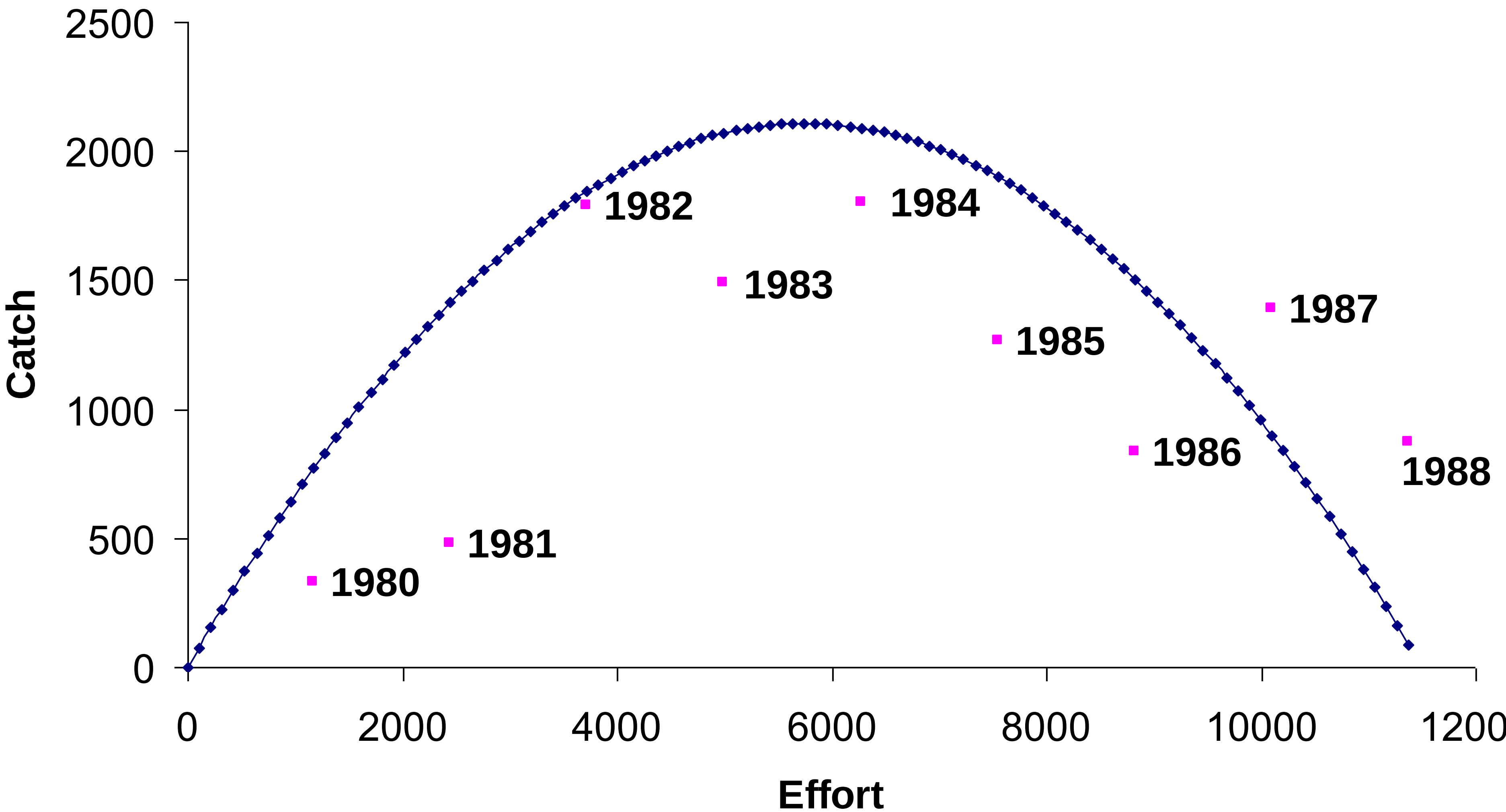
A Bio-economic model of fishing



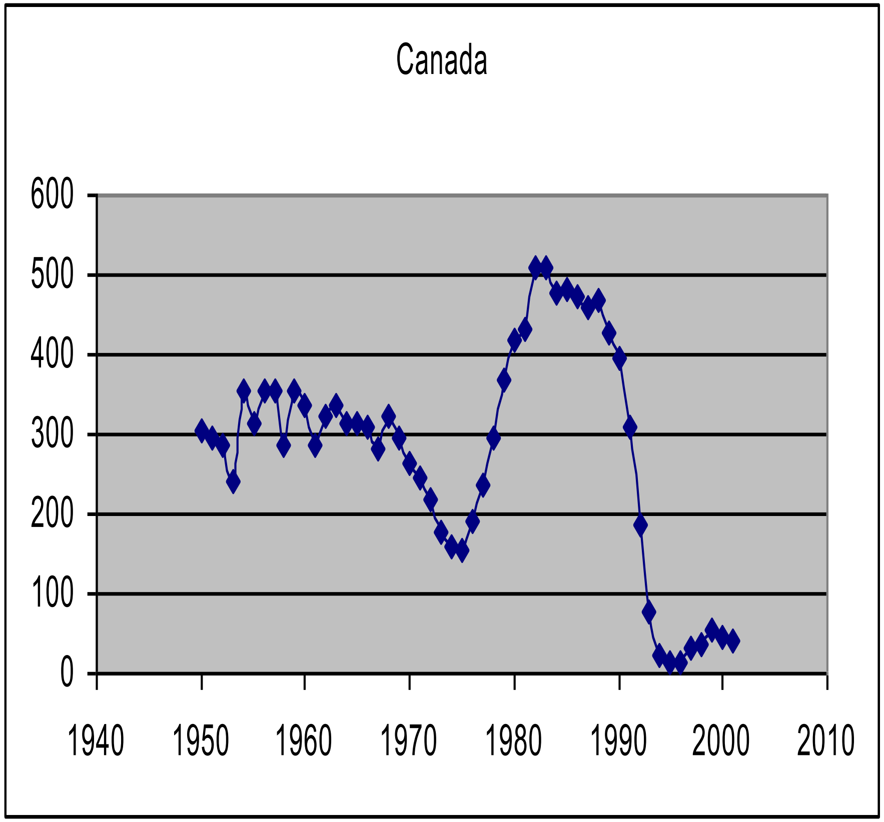
Bio-economic model of fishing 2
The effect of technical progress



Over-fishing on Zanzibar

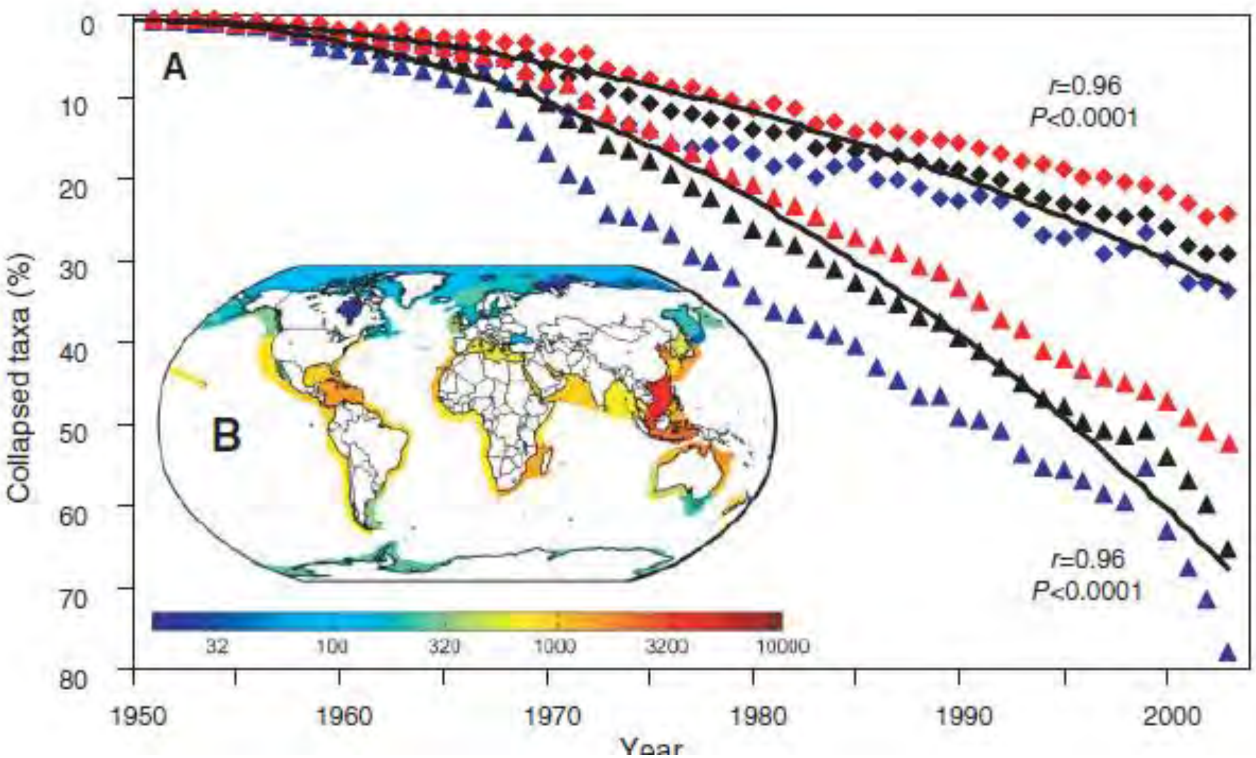


COD



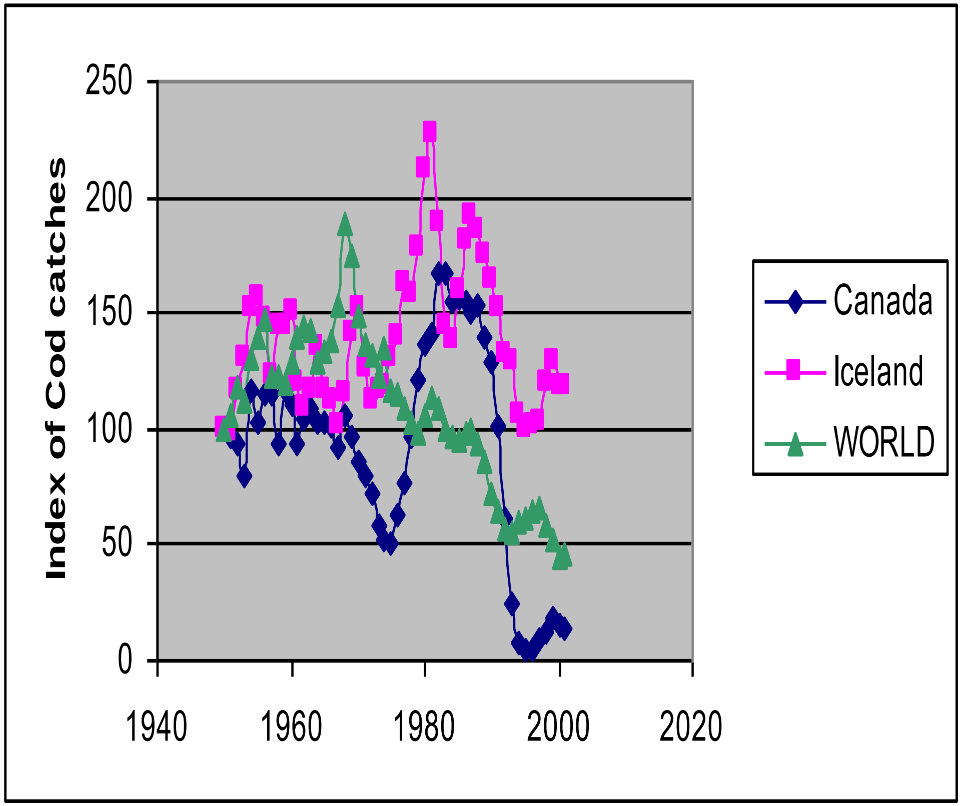
- Cod in Atlantic Banks outside Canada richest in the World
- Crashed 1992
- 30 000 fishermen unemployed
- No sign of recovery after 10 years!

Overfishing a threat to fish stocks globally



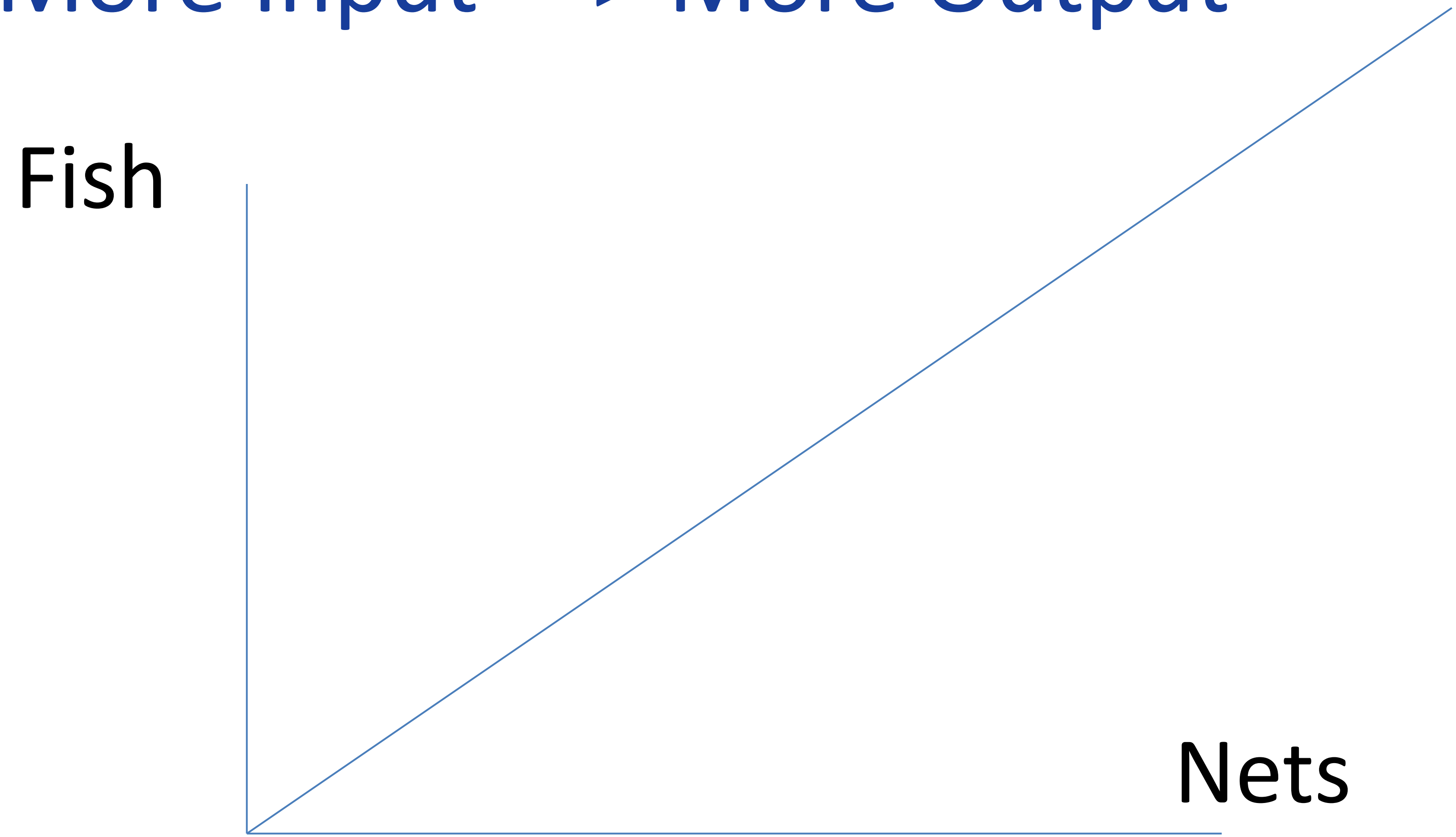
Worm et al 2006 Science

Iceland shows the way

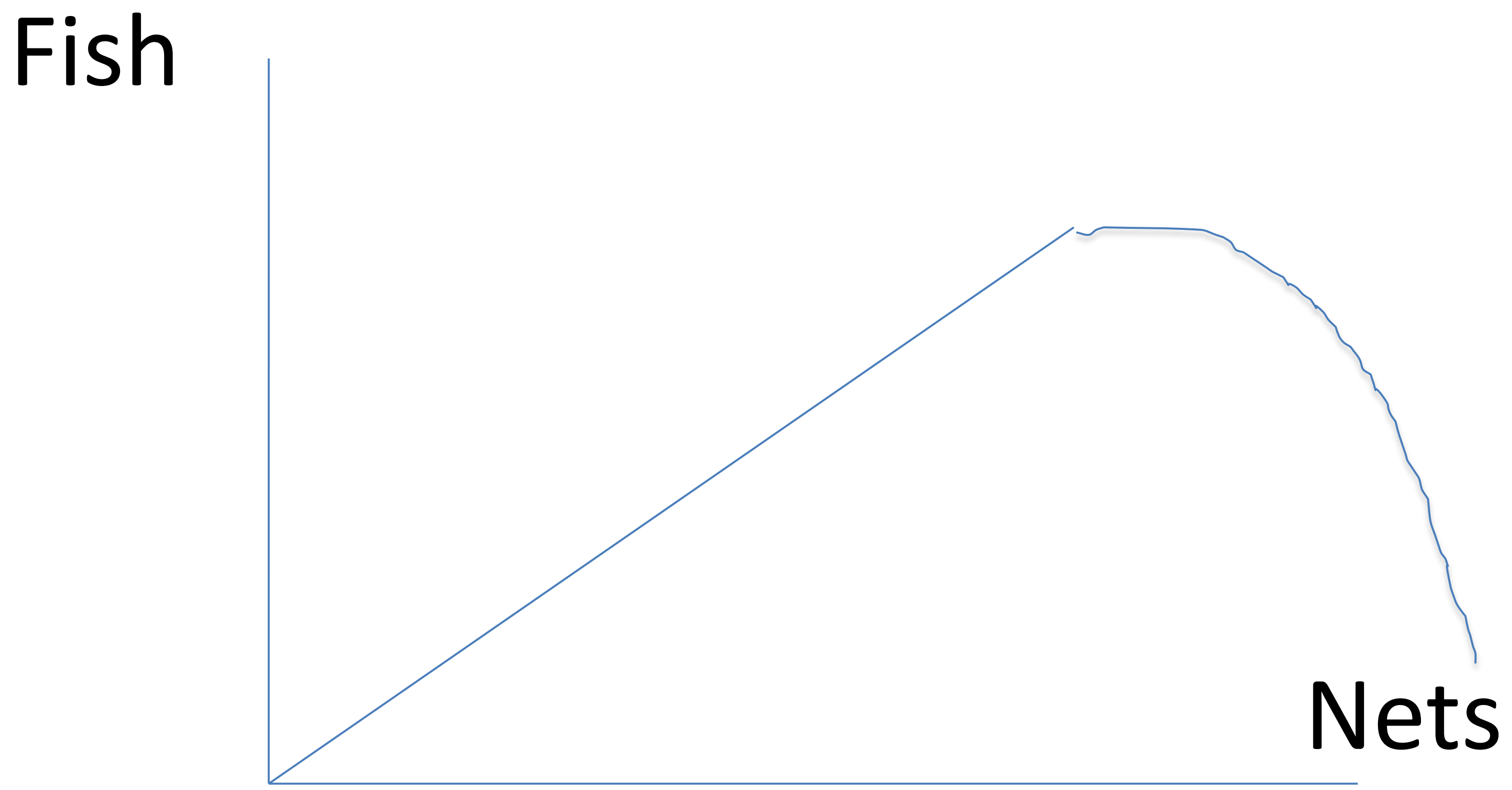


- World Cod catch down 75% since 1968
- 200 mile EFZ hopeful
- Private transferable quotas as SHAREs in TAC
- TAC decided by biologists

More Input --> More Output



More Input → More Output?



Market/Policy Failure

- Each fisherman fishes at will – covering his own costs but not value of fish stock.
- Fishing down stock increases costs for all.
- TRAGEDY OF … Open Access
- POLICY is needed

Policy Instrument selection

Price-type	Rights	Regulation	Info/Legal
Taxes	Property rights	Gear/Boat restriction	Public participation
Subsidy (Reduct.)			Information disclosure
Charge, Fee/Tariff	Tradable Quotas	Closed season or area	Voluntary agreement
Refunded Charge	Law of the Sea	Permits	Liability, Labelling
	CPR, TURFs	Zoning, Reserves	

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Fundamentals of Policy are **Rights**

TFCs are a solution: Combine a degree of asset stability with sufficient biological flexibility

Make negotiations on TAC less adversarial

Transferable Fishing Concession

- **Revocable** user entitlements to a specific part of fishing opportunities

- 'Fishing opportunity' means a quantified legal entitlement to fish, expressed in terms of **catches and/or fishing effort …**

Different types of “TFC”:

- Individual Transferable Quota (ITQ)
- Cooperatives
- Area-based rights system (TURF)

Many Countries Use TFCs

Many of the major fishing nations still use traditional management

A catch share program sets a catch limit and allocates a secure privilege to harvest a specified amount of a fishery's total catch to an individual or group (groups can be community-based), and holds participants accountable. They include IQs, ITQs, IVQs, Cooperatives, and TURFS with catch limits.

Status Quo vs. TFCs

Status Quo

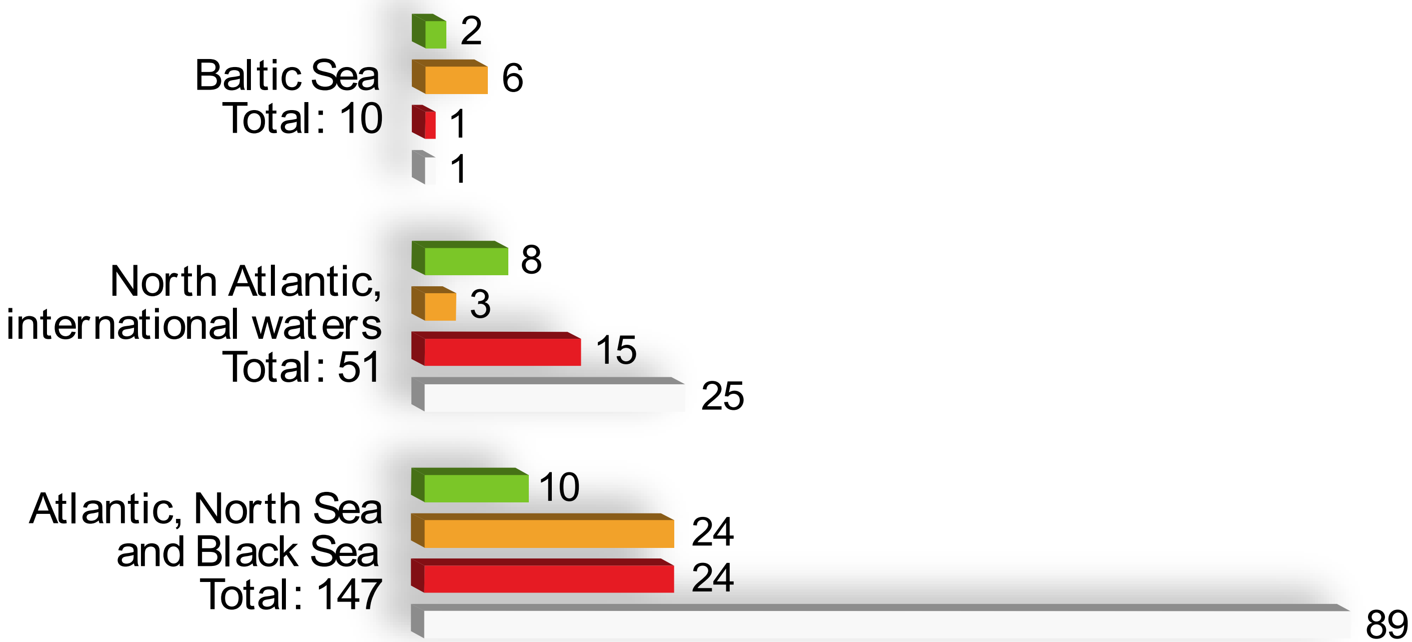
- Race for Fish
- Reduced season lengths
- Hard to maintain TACs
- Poor profitability
- Perverse incentives lead to decreasing stocks

TFCs

- Long term stake in fishery
- Flexibility to fish based on market needs
- Best way to meet TACs
- Increased CPUE
- Best way to rebuild stocks

sustainable exploitation and, if necessary, at facilitating the recovery of st

State of stocks by TAC area (2009)
(in number of stocks)



Source: EC Commission 2010

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Source:
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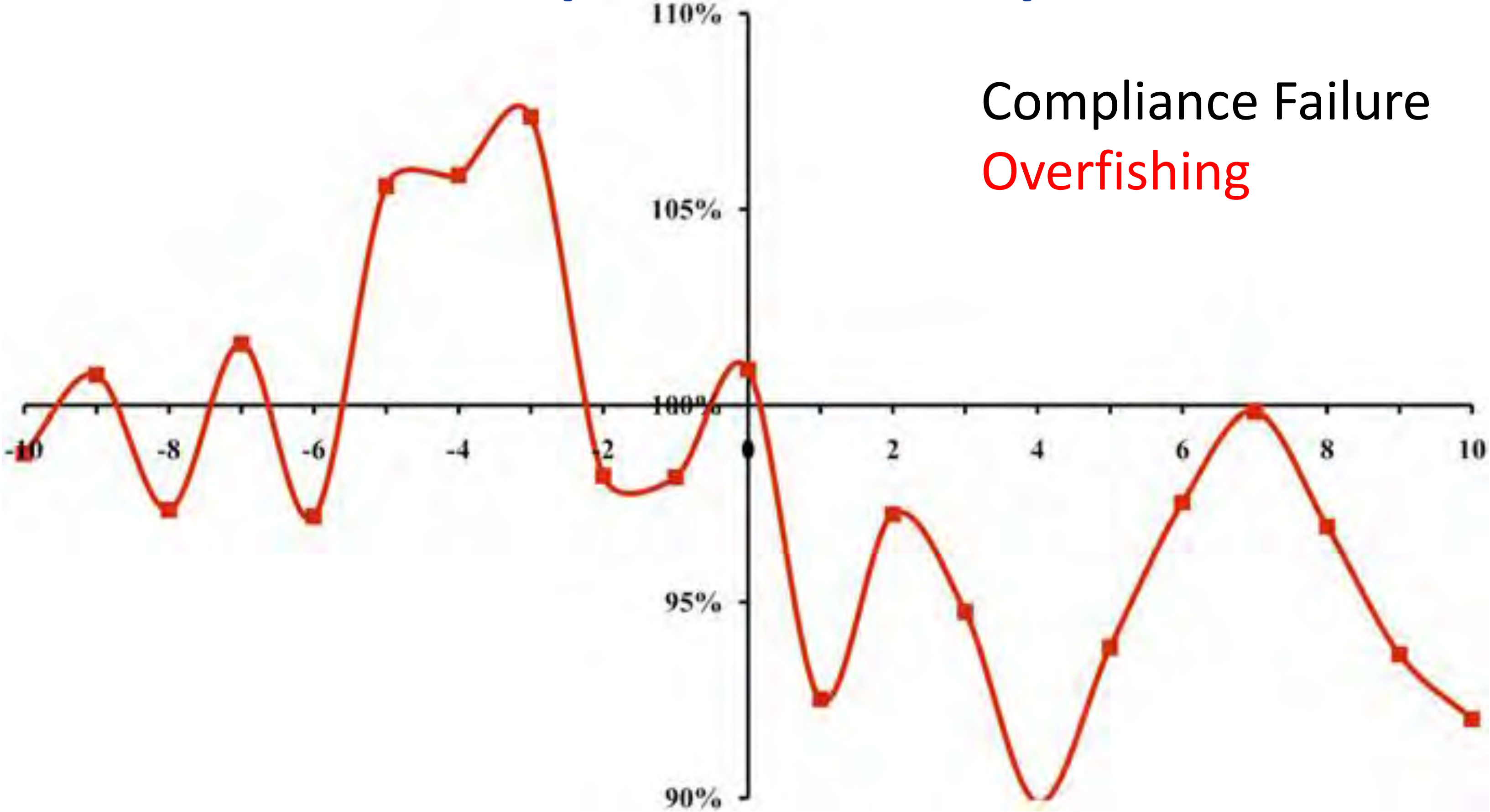
Today, 3 out of 4 stocks overfished:

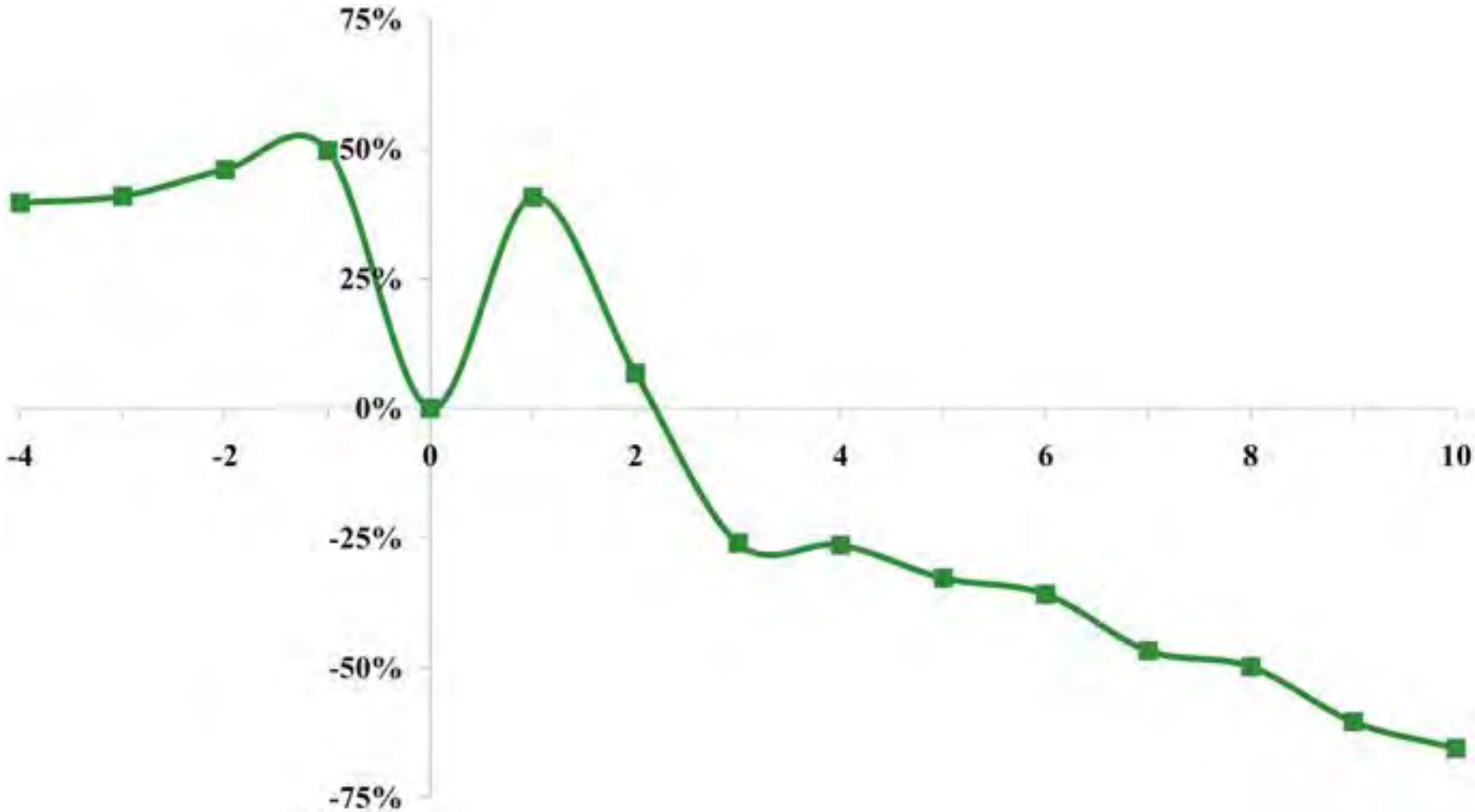
82% of Mediterranean & 63% of Atlantic stocks.

TFCs improve compliance



TAC overages reduced. Landings/TAC (average across fisheries).

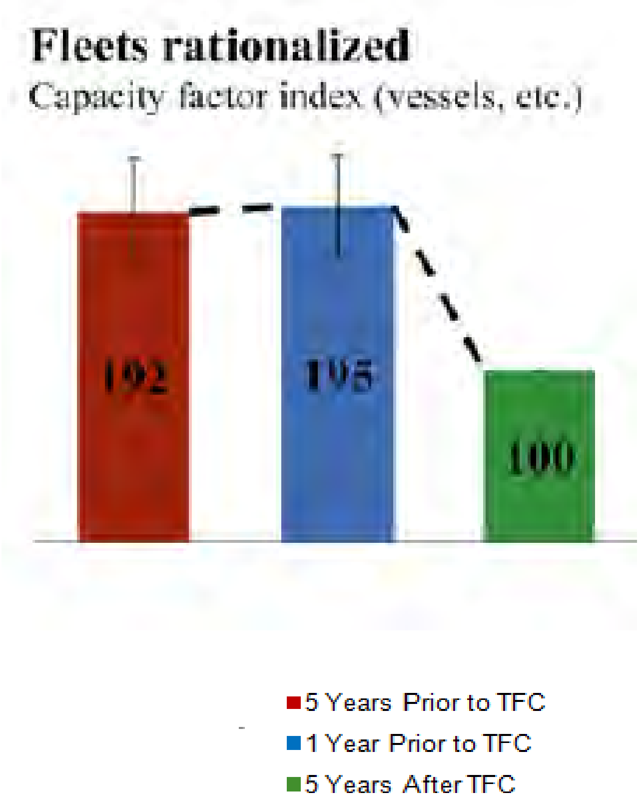
TFCs reduce discards



Commercial discards reduced. % reduction versus baseline year (year before catch shares).

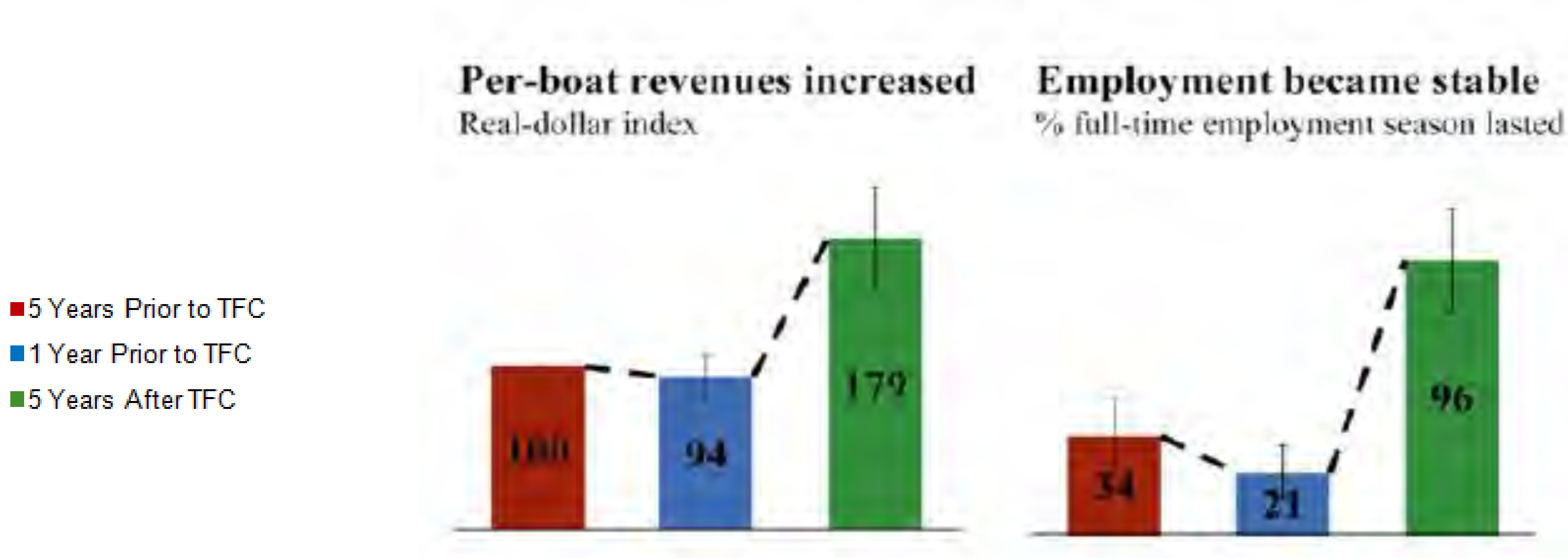
TFCs can address overcapacity

- TFCs can help match fishing resources to TAC.
- In a study of US fisheries capacity fell dramatically first 5 years



TFCs can increase revenue

Employment can stabilise & Revenue can increase



Unobserved Genetic Diversity and Stock Management

- Recent DNA studies have shown earlier unknown genetic diversity among such species as cod.
- Like salmon they may have their reproductive loci (?) to which they return but the phenomenon is unobserved by man since it takes place out of sight and the cod are morphologically very similar.

A FISHING MODEL

A simple model: single stock, logistic growth. Density dependent harvest and 0-profit condition. & Regulatory agency with full info and power to set quotas.

$$\frac{dX}{dt} = rX_t(1 - X_t) - H_t \qquad (1)$$

(2)

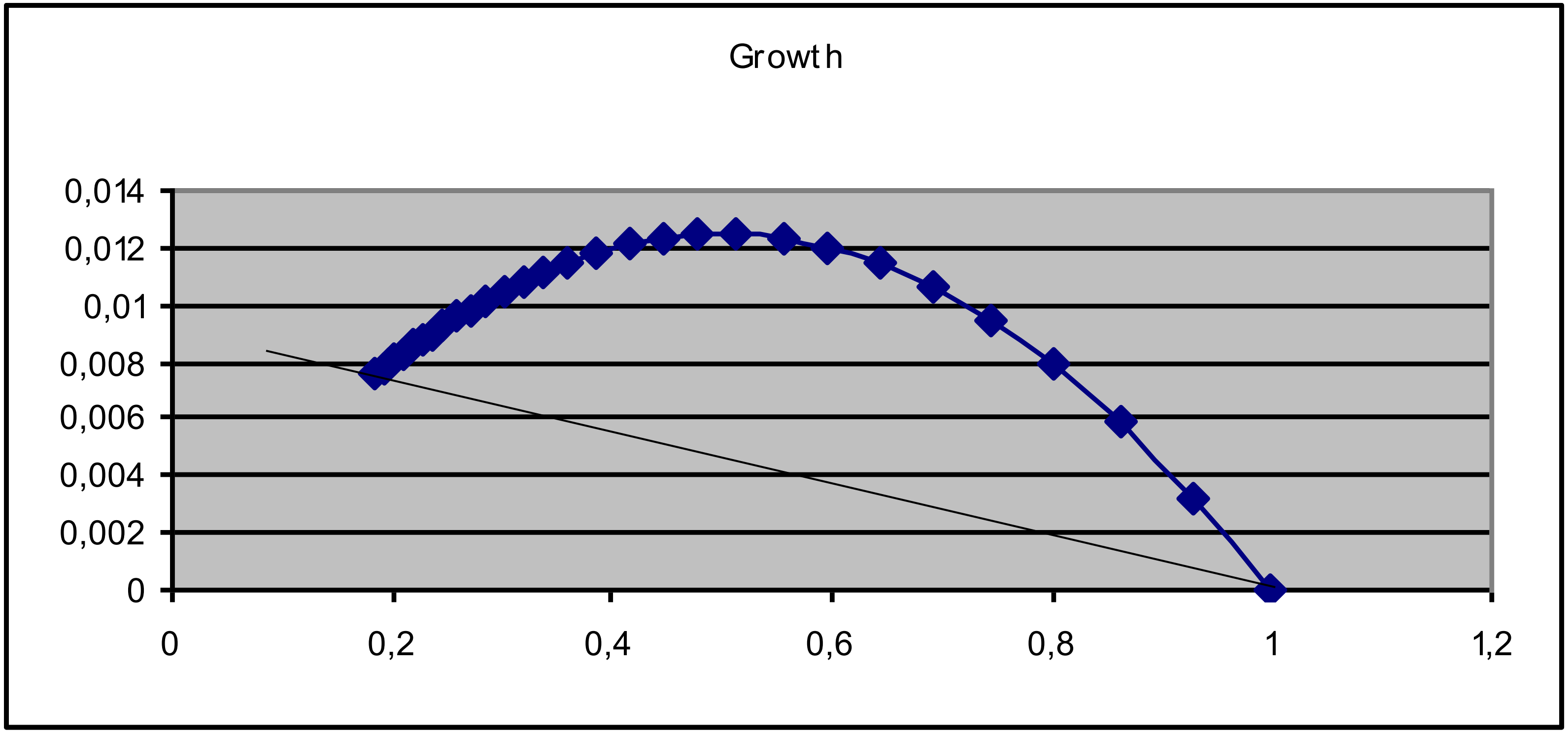
$$H_t = qE_tX_t$$

where w is the price per unit of effort E and F is the fixed cost of fishing.

$$PH_t = wE_t + F$$

(3)

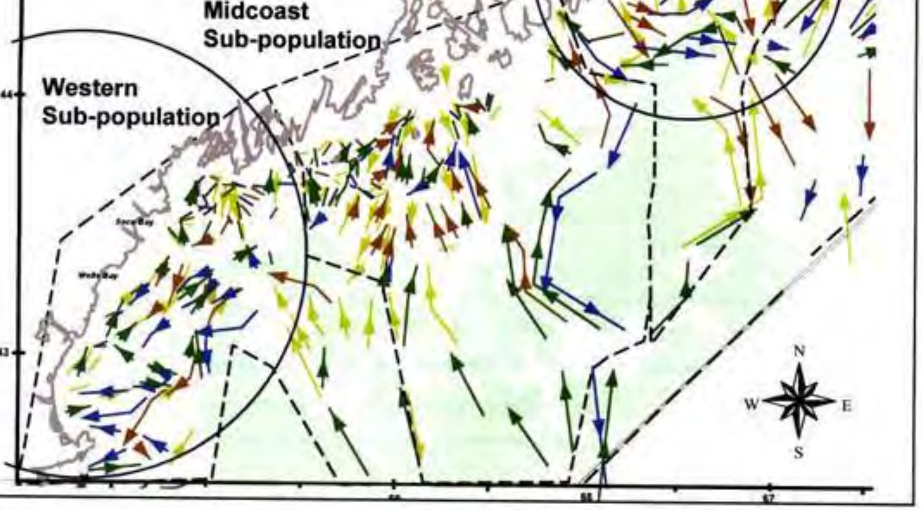
Simulation 1



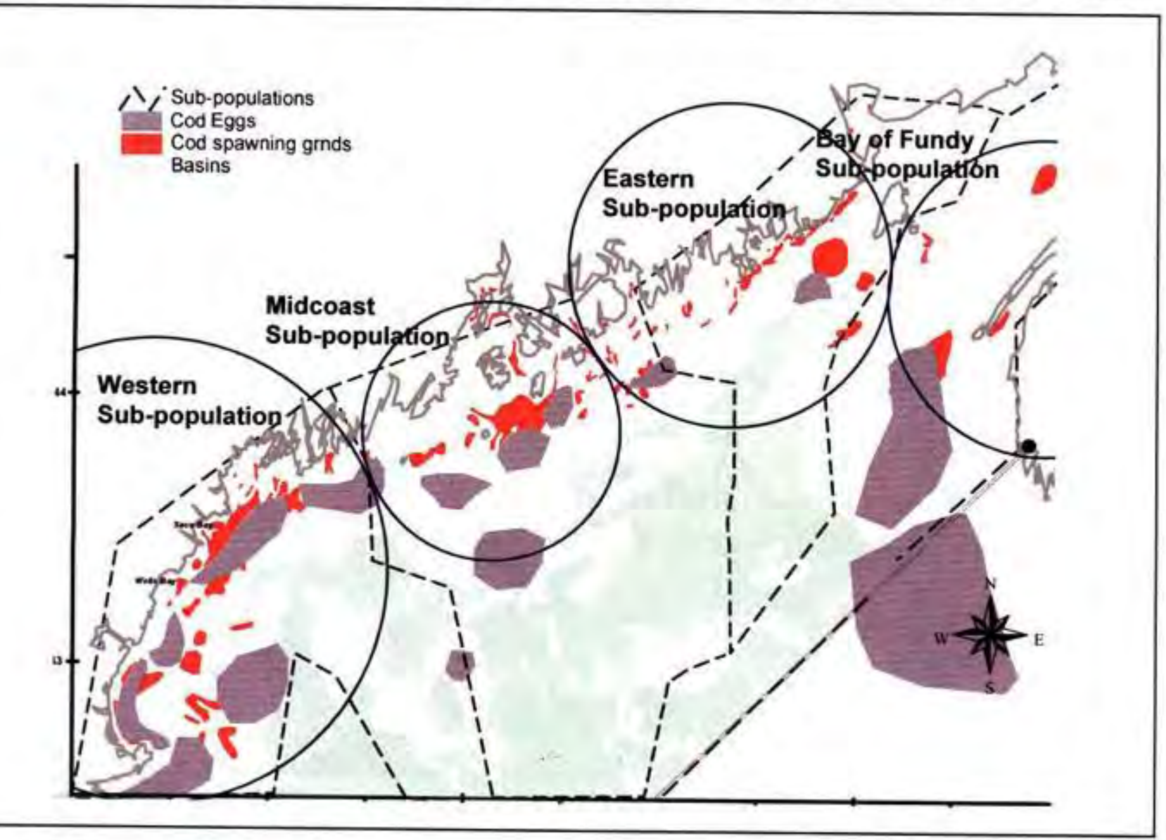
Salmon returning home to spawn

What about cod?

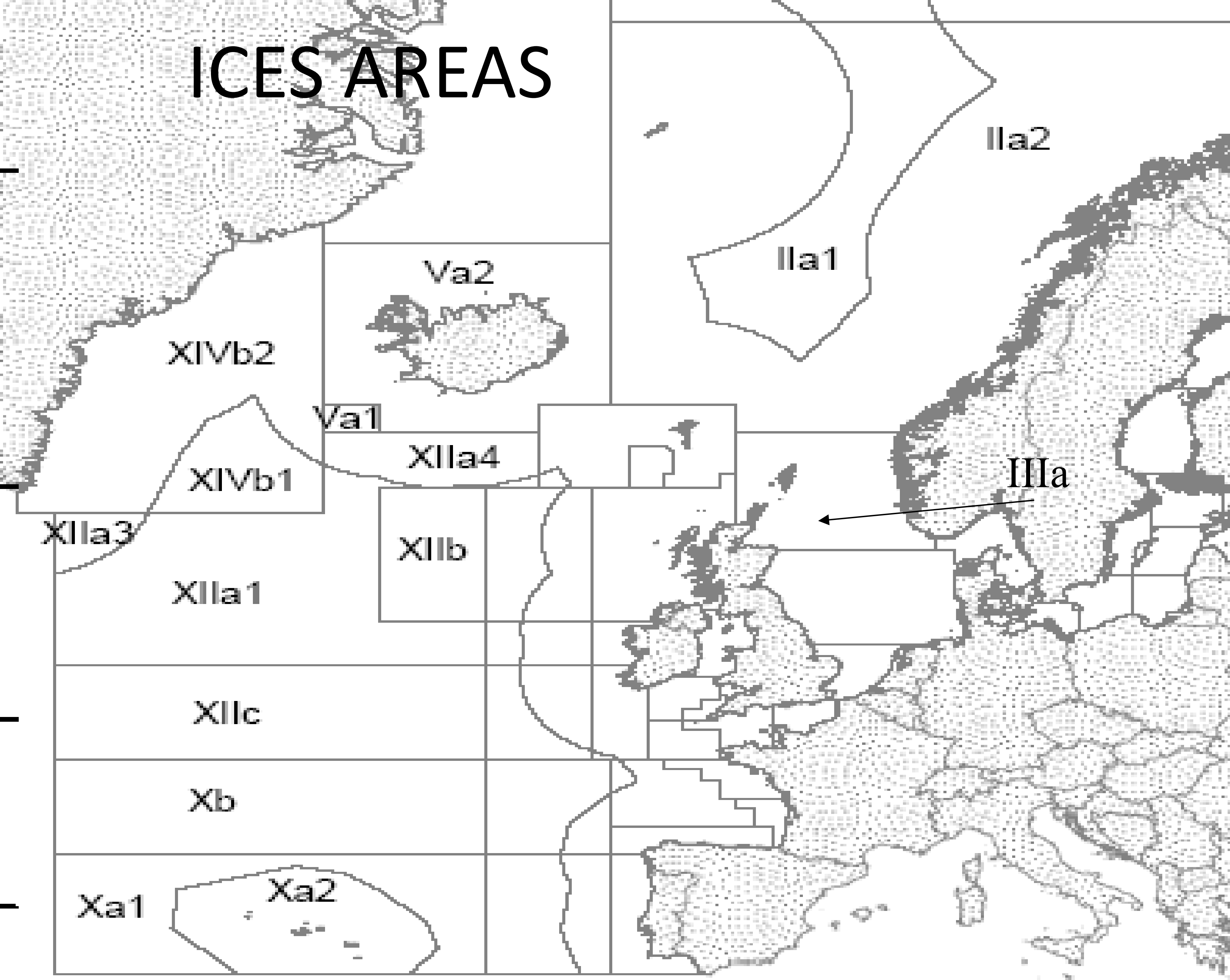
Subpopulations



re **6a.** Historical migration patterns of Atlantic cod in the Gulf of Maine followed contours of the coastal shelf and deeper offshore ridges and s. Recent tagging studies (circled areas) agreed with historical movements.
re **6b.** Historical spawning grounds (circled areas) were at the terminus of migration corridors used by specific sub-populations of Atlantic cod.



ICES AREAS



IIa2
IIa1
Va2
XIVb2
Va1
XIIa4
IIIa
XIVb1
XIIa3
XIIb
XIIa1
XIIc
Xb
Xa2
Xa1

ICES analyser & rekommendationer

Skagerrak (Division IIIa)

ICES Advice	Single-Stock Exploitation Boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to advice	Agreed TAC
F = F_{max}		<21		22.5
Reduce F				21.5
F at F_{med}		<23		20.5
F at F_{med}; TAC^{TAC}		21.0		21.0
TAC		15.0		15.0
70% of F(90)				15.0
Precautionary TAC				15.0
No long-term gain in increased F + precautionary TAC				15.5
If required precautionary TAC; link to North Sea				20.0
If required precautionary TAC; link to North Sea				23.0
If required precautionary TAC; link to North Sea				16.1
If required precautionary TAC; link to North Sea		21.9		20.0
F = 0.60 to rebuild SSB		17.9		19.0
F less than 0.55		<11.3		11.6
lowest possible catch		0		7.0
lowest possible catch		0		7.1
Closure		0		3.9
Zero catch	Zero catch	0	0	3.9
Zero catch	Zero catch	0	0	

wegian fjords not included. Weight in '000 t.

Simulation with 5 genetically diverse stocks

- See eqns in word file page 7
- ($q_1 > q_2 > \ldots q_n$). Note that effort E is not targeted at any particular species but for some reason (location of spawning grounds for instance) q is higher for some species. under these conditions a perfectly wise and well enforced quota that only has one fault (neglect of subspeciation) could lead to successive extinction of sub-species Without fishing effort, *surviving* stocks will eventually recover to their original size X_o but if the "stock" actually consisted of sub-stocks then only the surviving stocks will revert to their original unaffected size

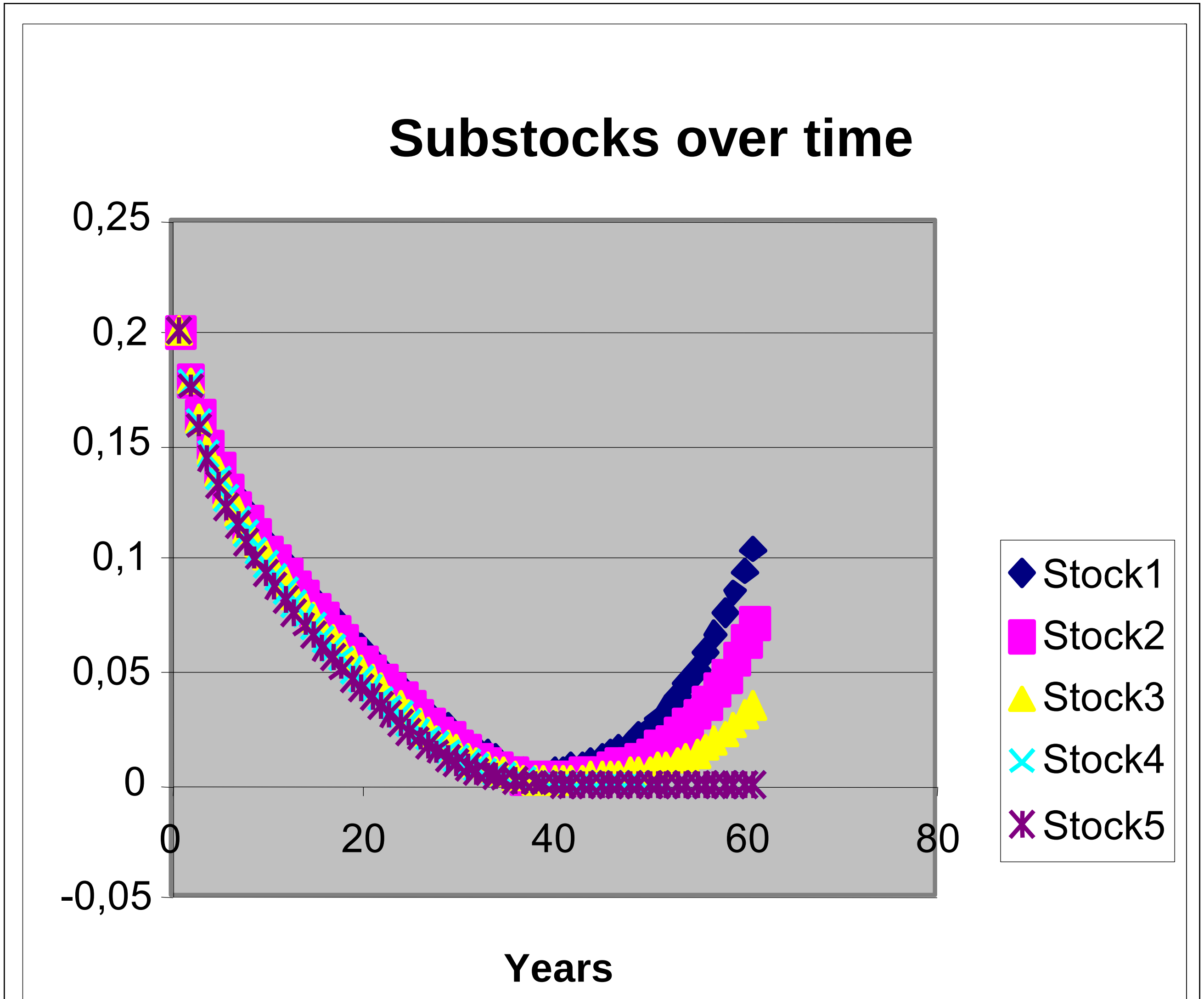
$$\frac{dX_i}{dt} = rX_{it}(1 - X_{it}) - H_{it} \qquad i = 1 \ldots n \quad (1')$$

$$H_{it} = q_i E_t X_{it} \qquad H = \sum H_i \qquad (2')$$

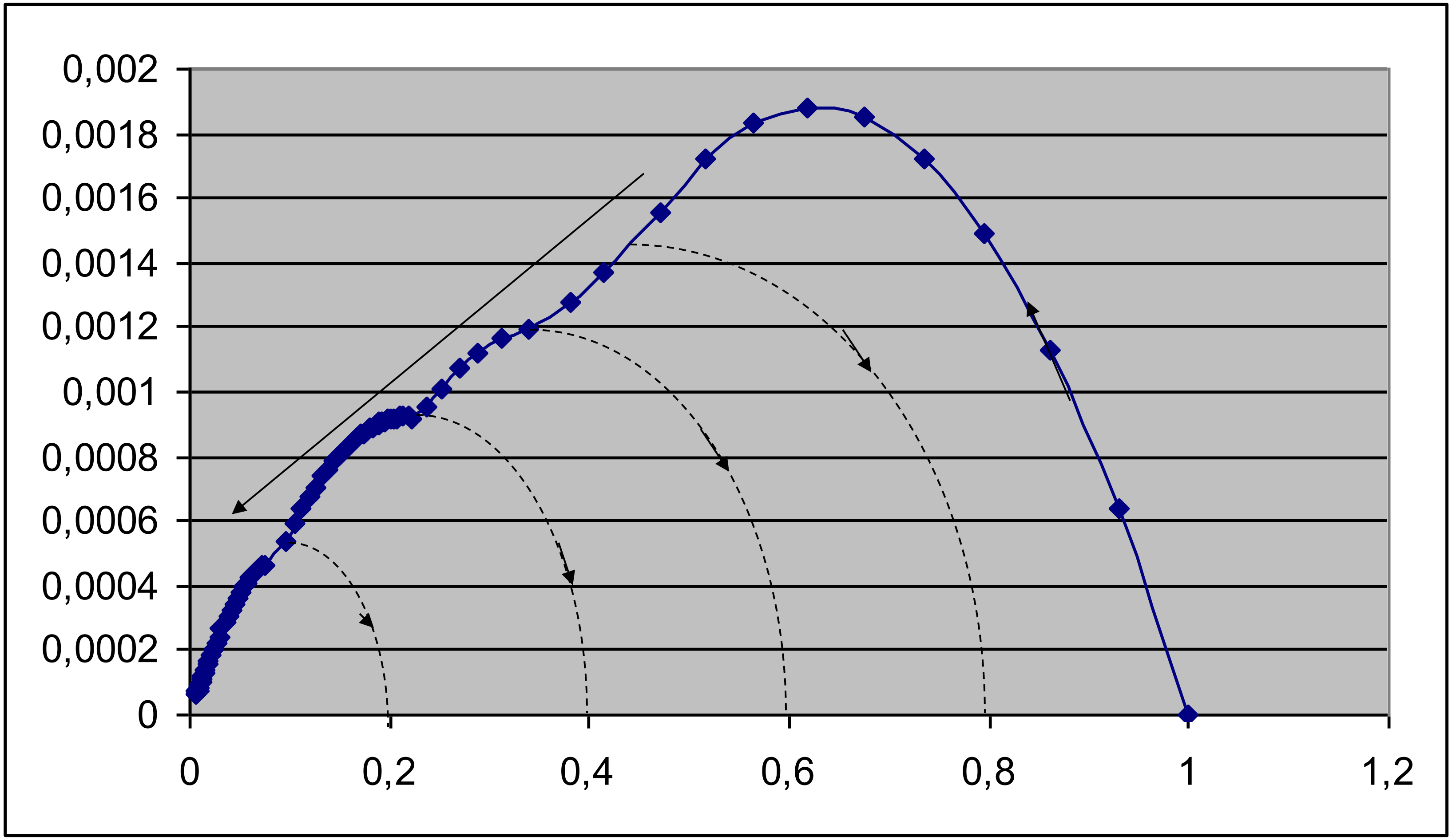
$$PH_t = wE_t + F \qquad (3')$$

Extensions: Reduce role of X in (2)
Vary also r between substocks
Employment goal instead of (3).

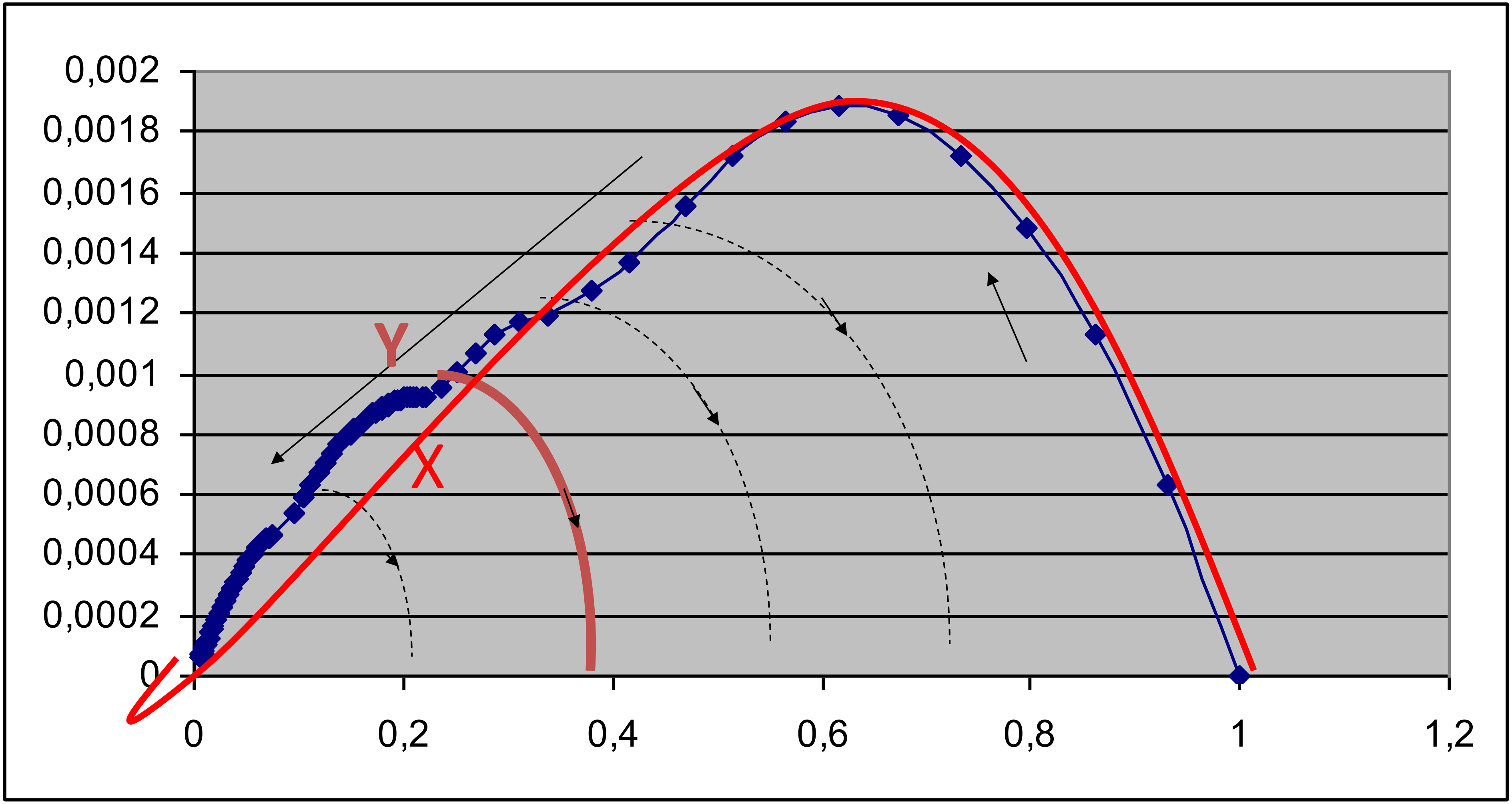
Depletion and partial recovery after a moratorium in year 37

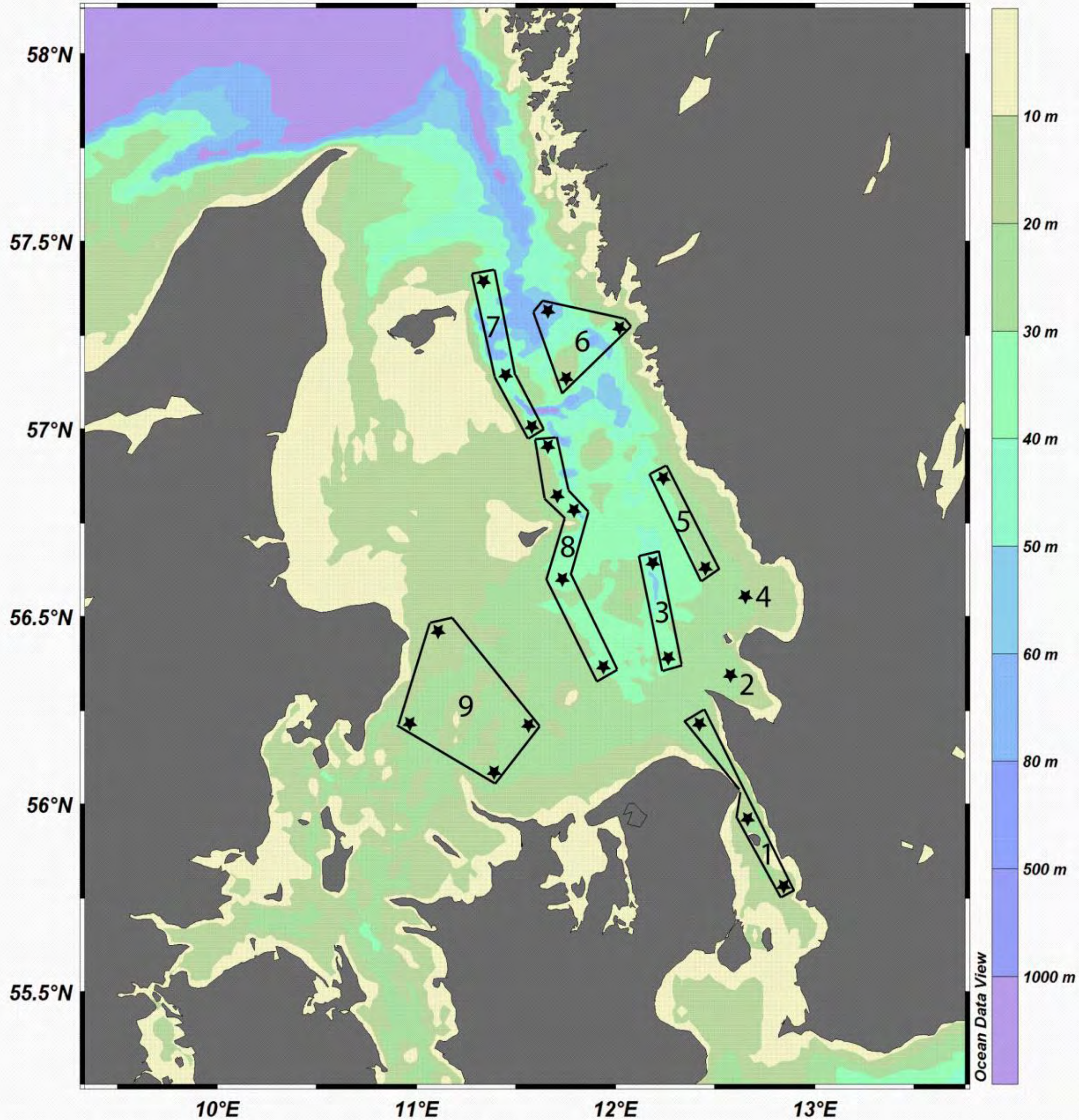


Gradual extinction through misspecification of stock diversity



Now Diversity invisible: Think you are at X but you are at Y





1. Öresund
2. Skälderviken
3. Kullen
4. Laholmsbukten
5. Stengrundet
6. Fladen
7. Läsö
8. Lilla Middelgrund
9. Western Kattegat

CONCLUSIONS

- Stock management must take biological realities into account including stock structure
- Caution with ITQs. Separate for each stock?
- Marine protected areas, or local management of coastal stocks →Consider Subsistence& Recr. fish
- Trawl limits for inshore fisheries/spawning aggregations
- Involve/ compensate fishermen/communities
- Also monitoring, discarding + highgrading, multispecies problems.