http://risk.kan.ynu.ac.jp/matsuda/2009/090720AHORC.ppt

Adaptive Risk Management of Marine Bioresources

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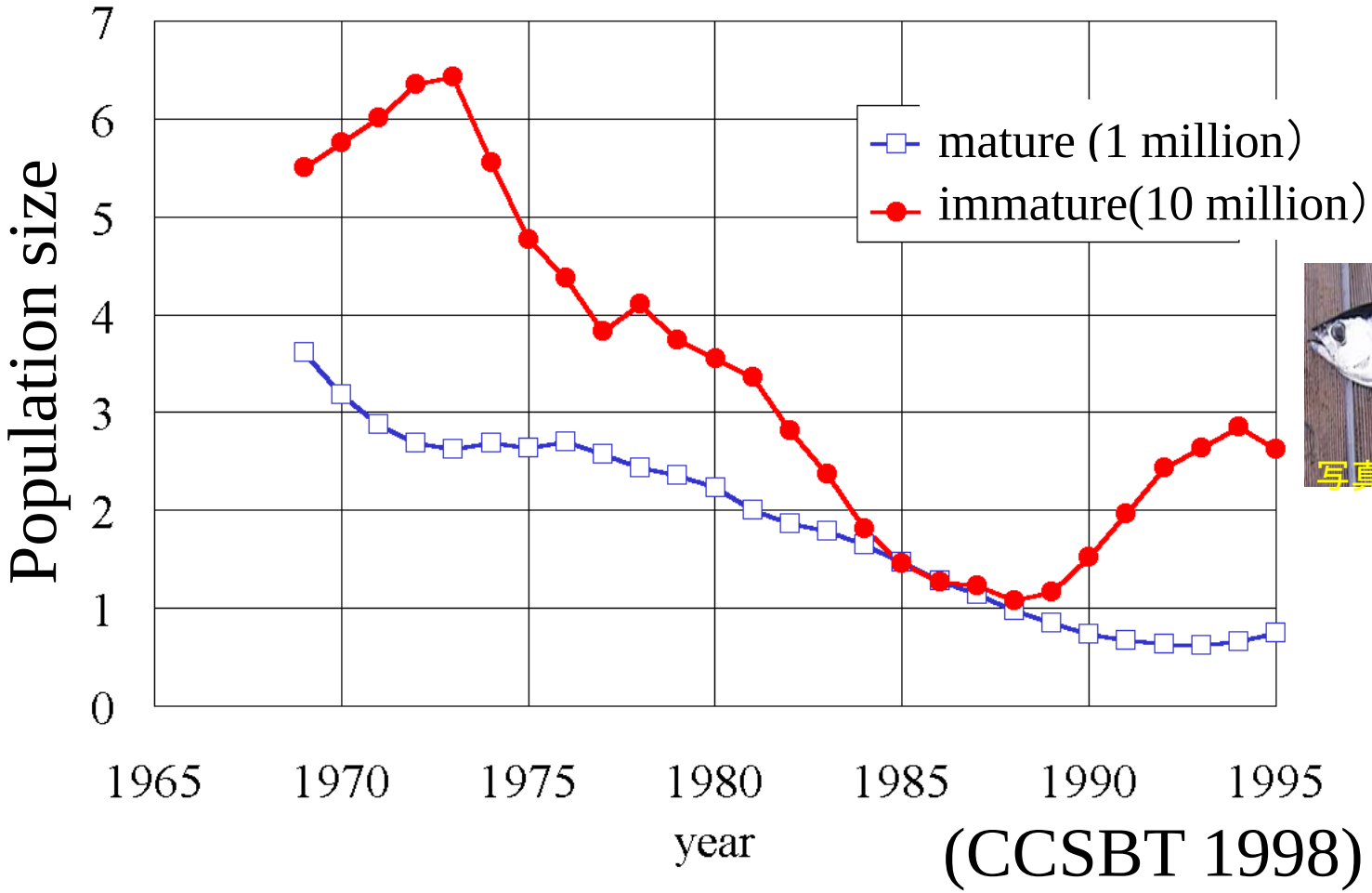
IUCN Redlist Criteria (2001)

Criterion	CR	EN	VU
A: Population decline rate is	>80%/10yrs or 3 generations	>50%/10yrs or 3 generations	>30%/10yrs or 3 generations
A1 (under managed)	>90%/10yrs or 3 gen.	>70%/10yrs or 3 gen.	>50%/10yrs or 3 gen.
B1: Area of occupied	<10km^2	<500km^2	<2000km^2
B2: Extent of occurrence is	<100km^2	<5000km^2	<20000km^2
C1: Population is declining and is	<250 (25%/ 3yrs or 1 gen.)	<2500 (20%/ 5yrs or 2 gen.)	<10000 (10%/ 10yrs or 3 gen.)
D1: Population size is	<50	<250	<1000
D2: AOO is	--	--	<10% of related sp.
E: Extinction risk is	>50% in 10yrs or 3 gen.(cap 100yrs)	>20% in 20yrs or 5 gen. (cap 100 yrs)	>10% in 100 yrs

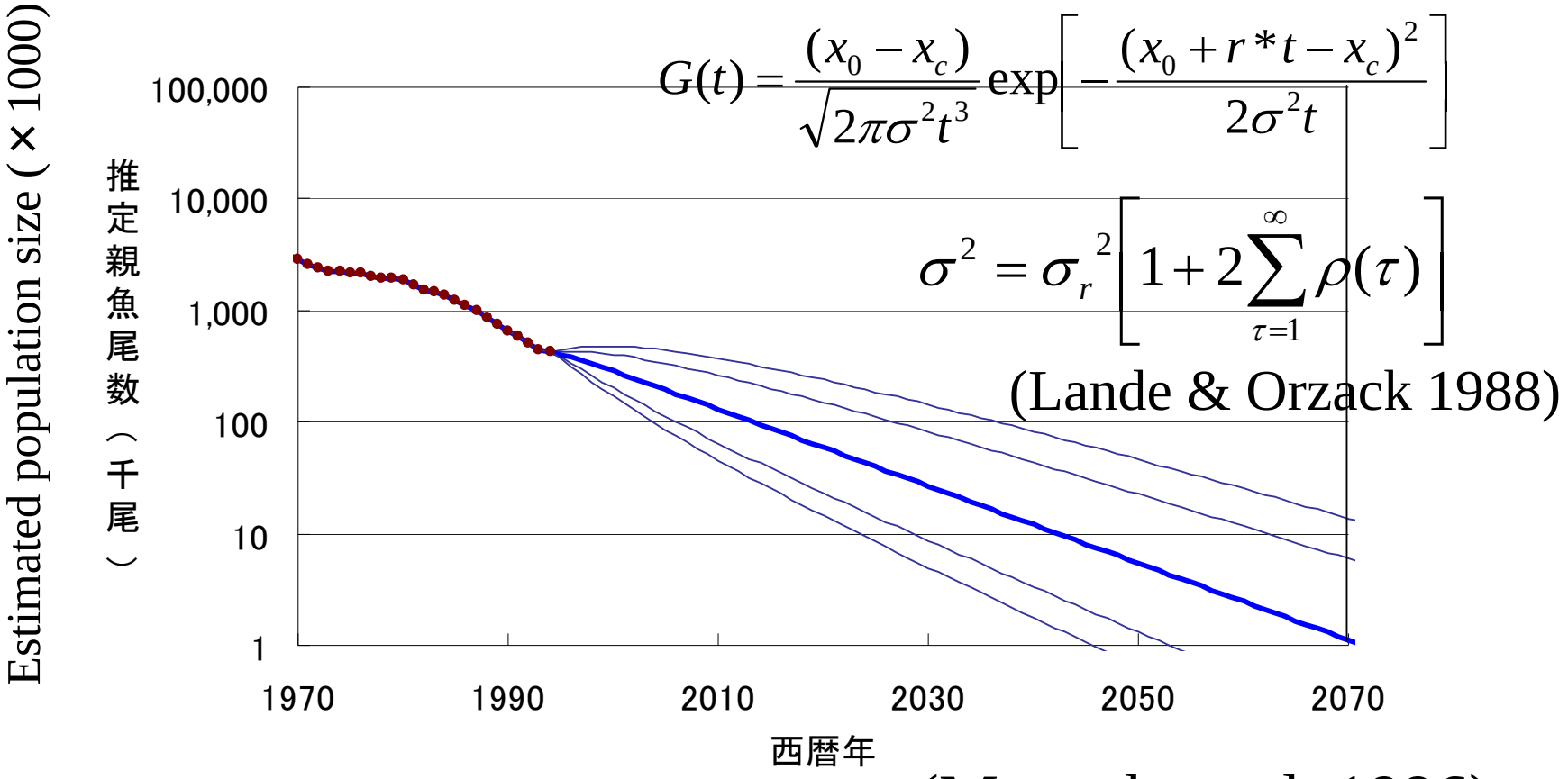
[1] http://iucn.org/themes/ssc/siteindx.htm

SBT satisfies Criterion A (80%↓/3 generations)



(CCSBT 1998)

Even under mismanagement, SBT will not go extinct within 50 years.

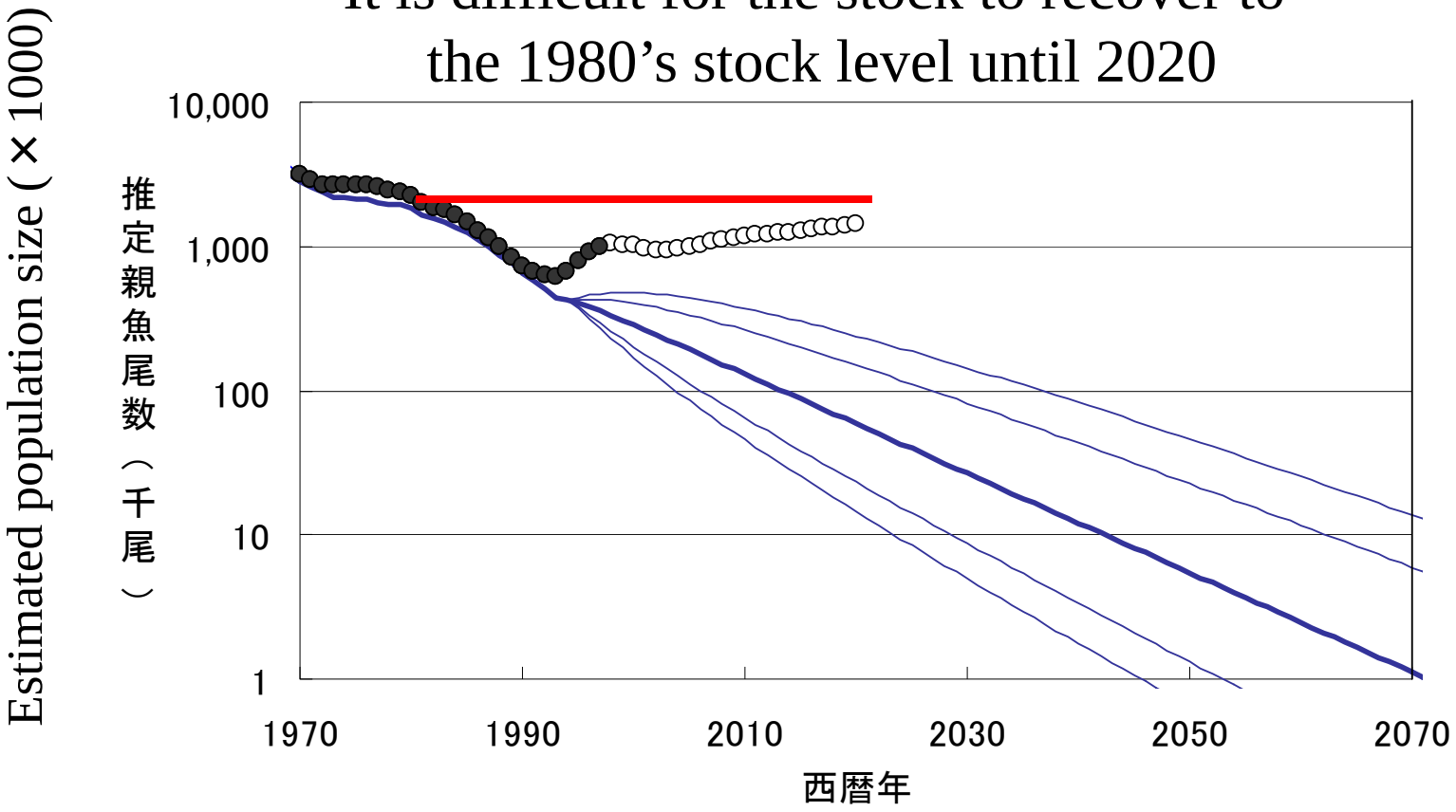


(Matsuda et al. 1996)

Will SBT recover?

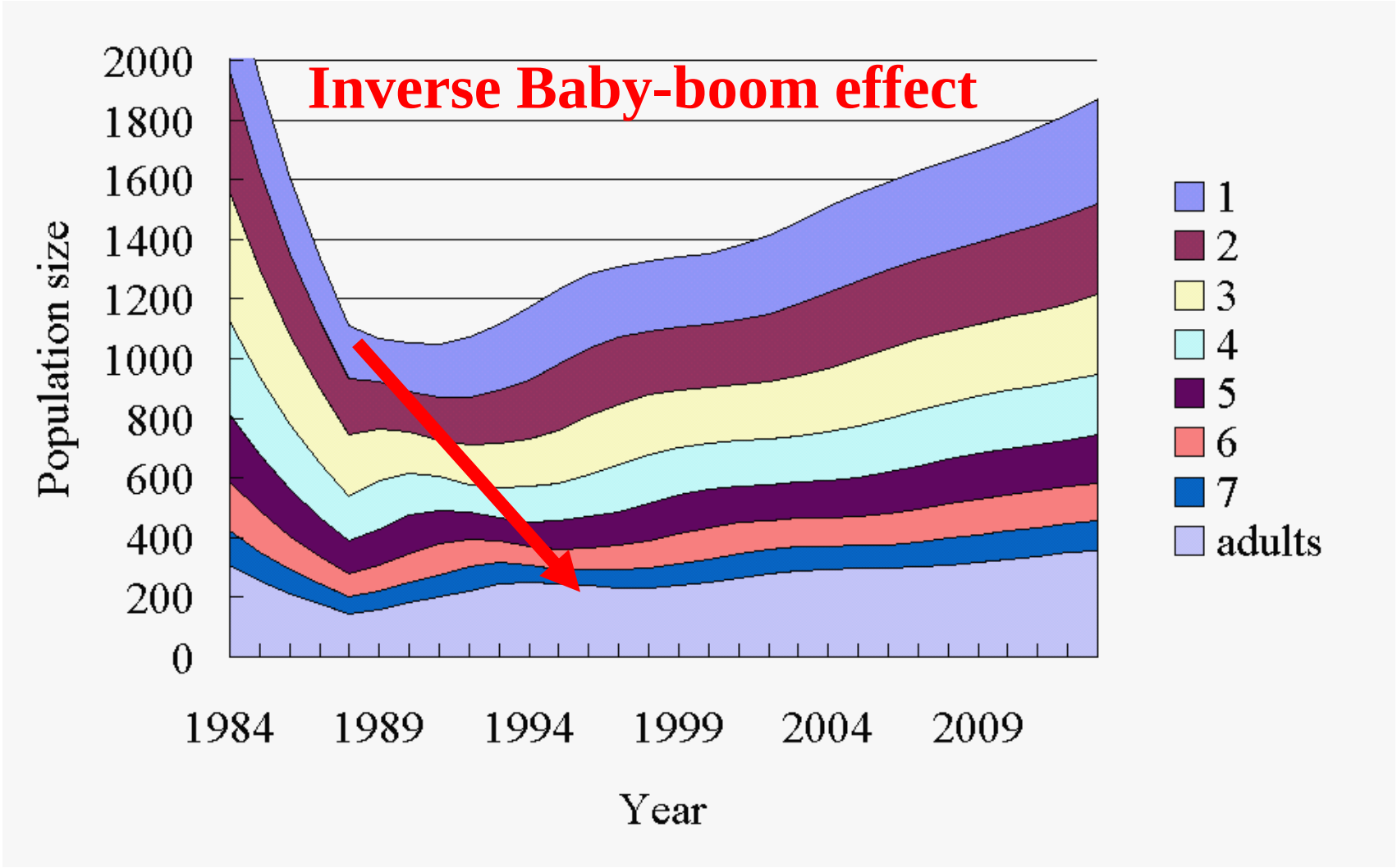
(Mori et al. 2001, Pop. Ecol. 43:125-132)

It is difficult for the stock to recover to the 1980's stock level until 2020

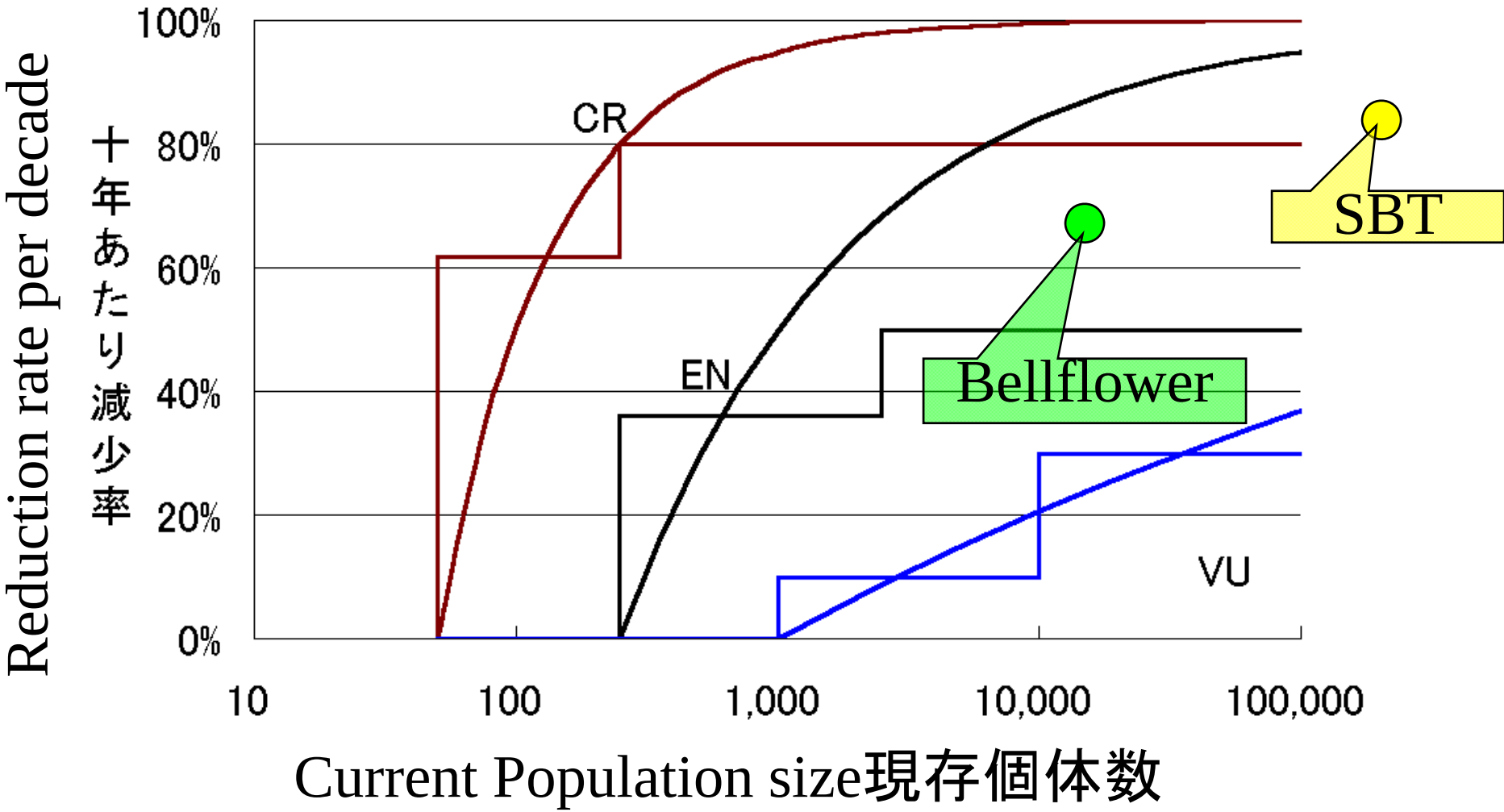


Inverse Baby-boom Effect

Inertia of over-fished age-structure



IUCN criteria and Japanese plant RDB



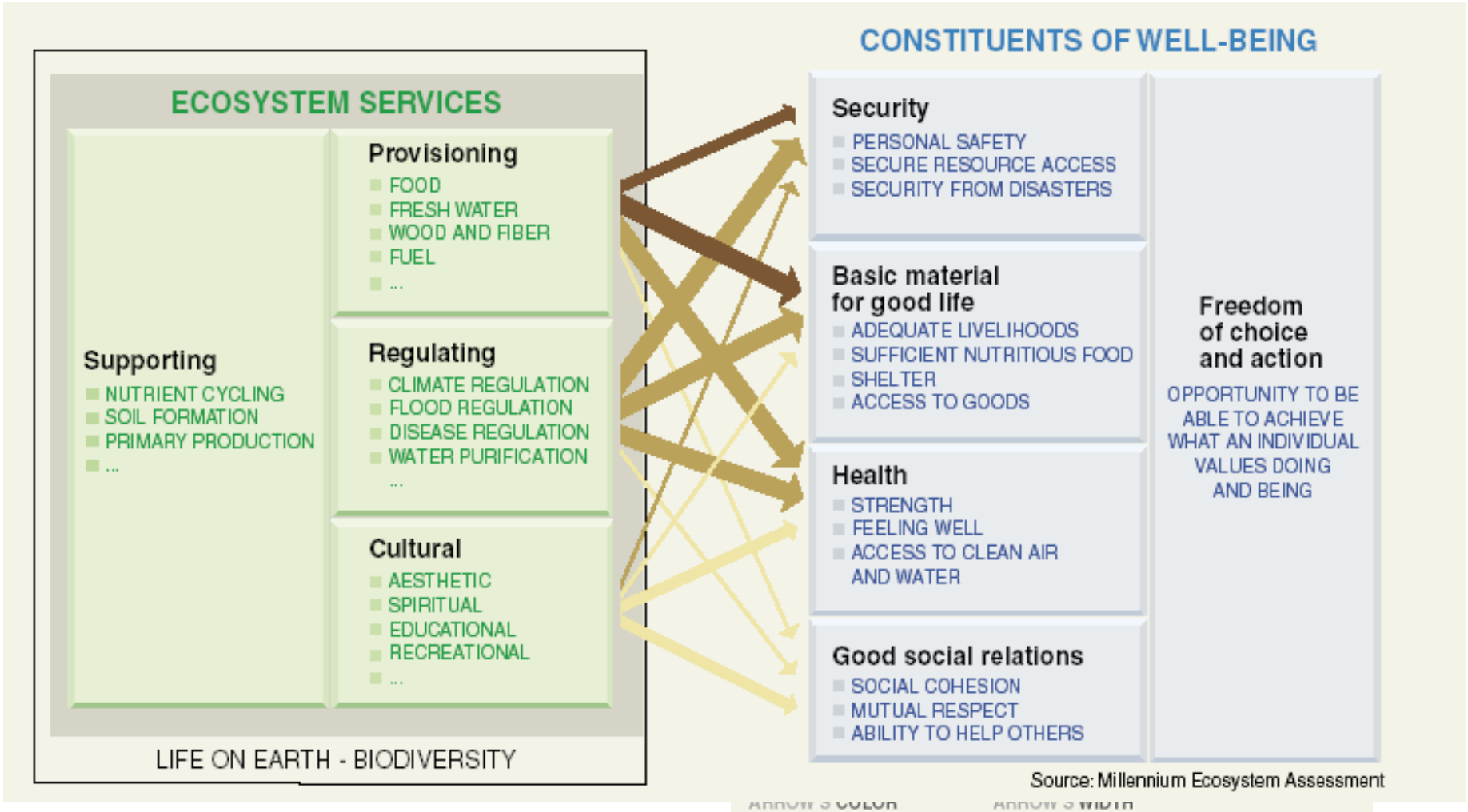
Two measures in risks

- Risk (type II errors)
  - Probability × hazard
- The weight of evidence (type I errors)
  - How certain is it?

  Do you use mobile phone in airplane? Why not?

(MA2005)

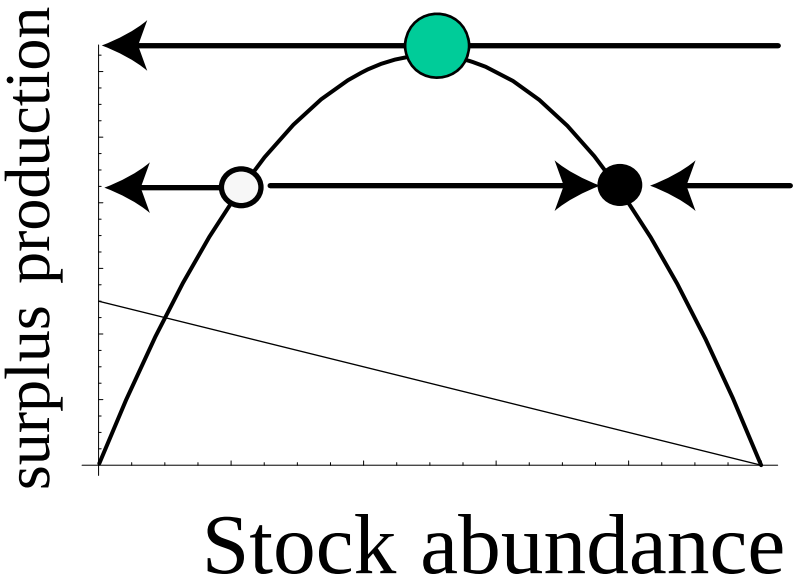
Ecosystem services and well-being



2006/5/22

Requiem to Maximum Sustainable Yield Theory

- Ecosystems are uncertain, non-equilibrium and complex.
- MSY theory ignores all the three.
- Does MSY theory guarantee species persistence?
  - No!!



Learning by Doing; Adaptive Management

- AM adapts management policy by recent monitored data (feedback control)
- AM tests assumptions by monitoring in the limited future
- The RMP Developed by IWC is an early example of AM.
- AM is recommended by CBD

Does feedback control work in complex ecosystems?

Stock size

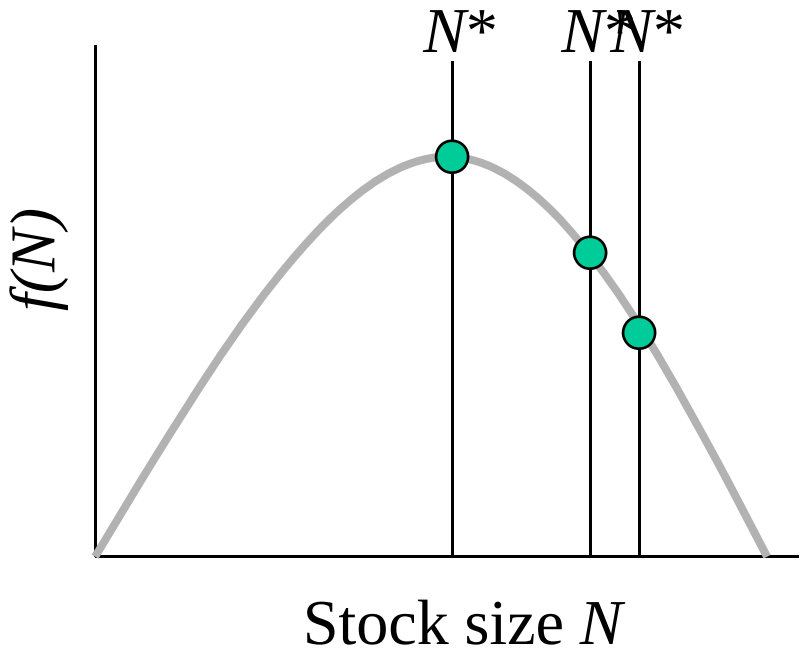
$$\frac{dN}{dt} = f(N) - qEN$$

Fishing effort

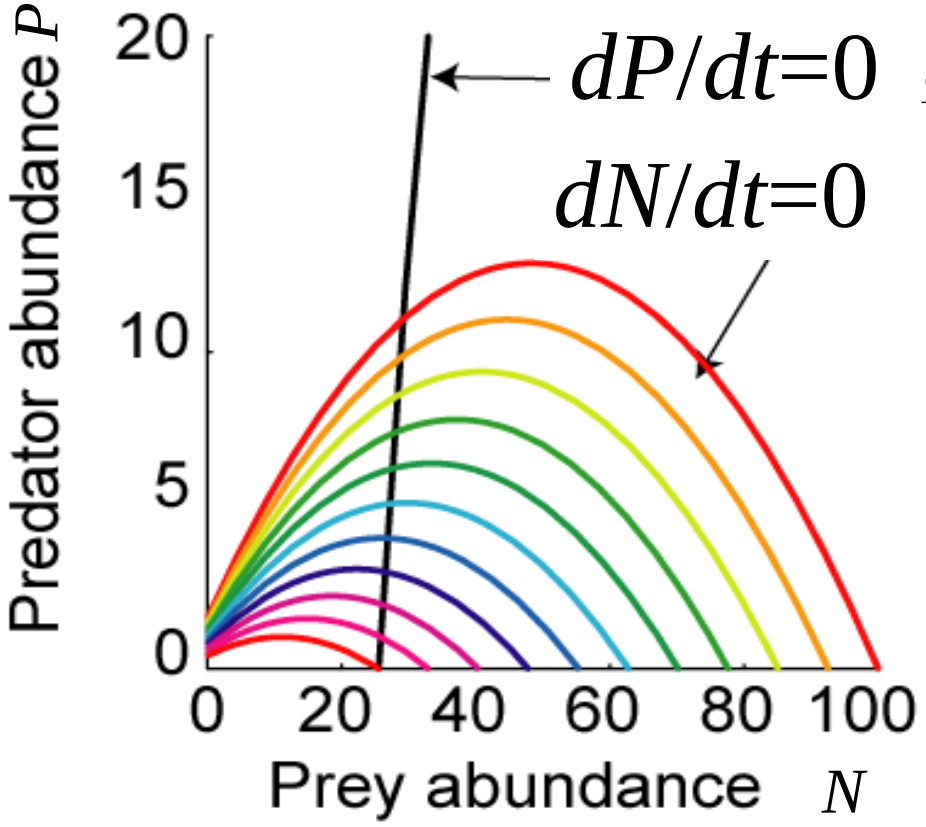
$$\frac{dE}{dt} = U\left(N - N^*\right)$$

Myth #4

- Even though the MSY level is unknown, the feedback control stabilizes a broad range of target stock level .



If prey is exploited and fishing effort is feedback control, ...(Matsuda & Abrams in prep.)



$$\frac{dN}{dt}=r\left(1-\frac{N}{K}\right)N-\frac{fCN}{1+hCN}P-qCEN$$

$$\frac{dP}{dt}=\left\{-d-gP+\frac{bfCN}{1+hCN}\right\}P$$

no adaptation (C is constant)

$dE/dt = U(N-N^*)$

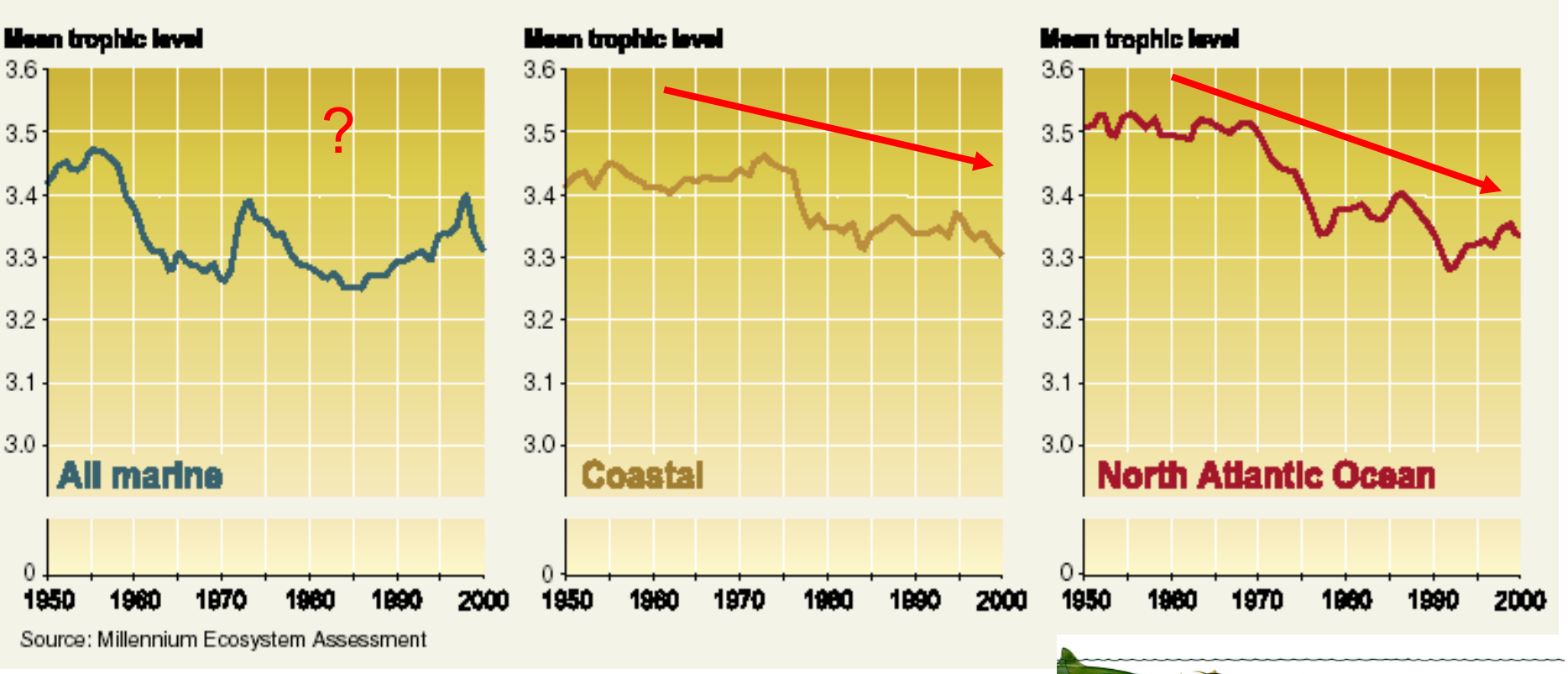
predator P **fishery E**

sardine N

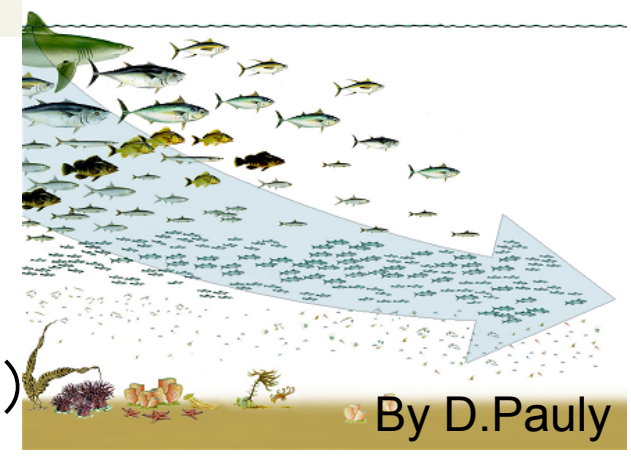
Conclusion

- Single stock monitoring is dangerous
- Target stock level is much more sensitive than we have considered in single stock models.
- We must monitor not only stock level of target species, but also the “entire” ecosystem.

Fishing down (MA 2005)

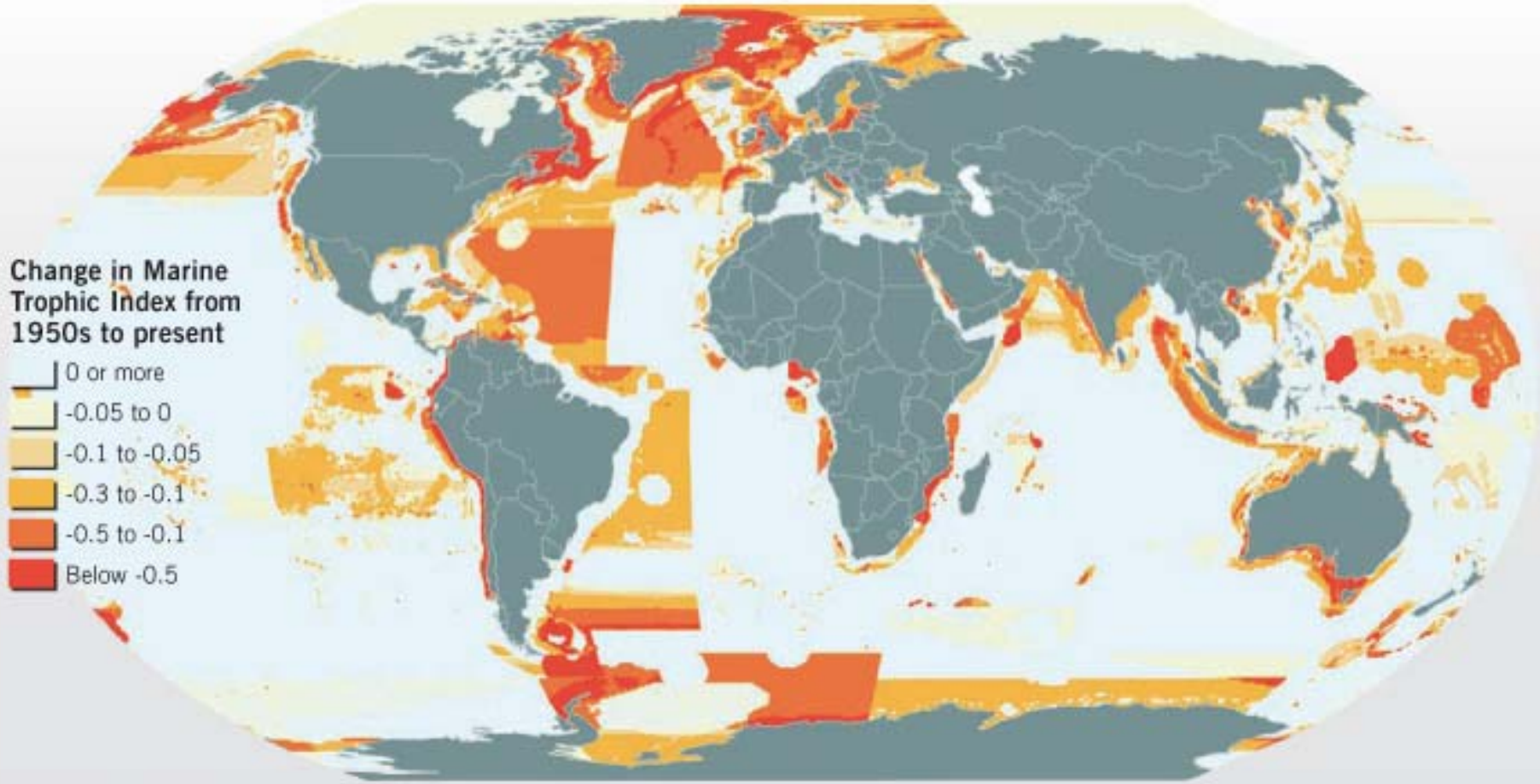


- Mean trophic level is obtained by FAO FISHSTAT and FISHBASE
- It does not mean the degree of overfishing
- Japan has a high MTL (Ecological Footprint?)



Changes in the Marine Trophic Index

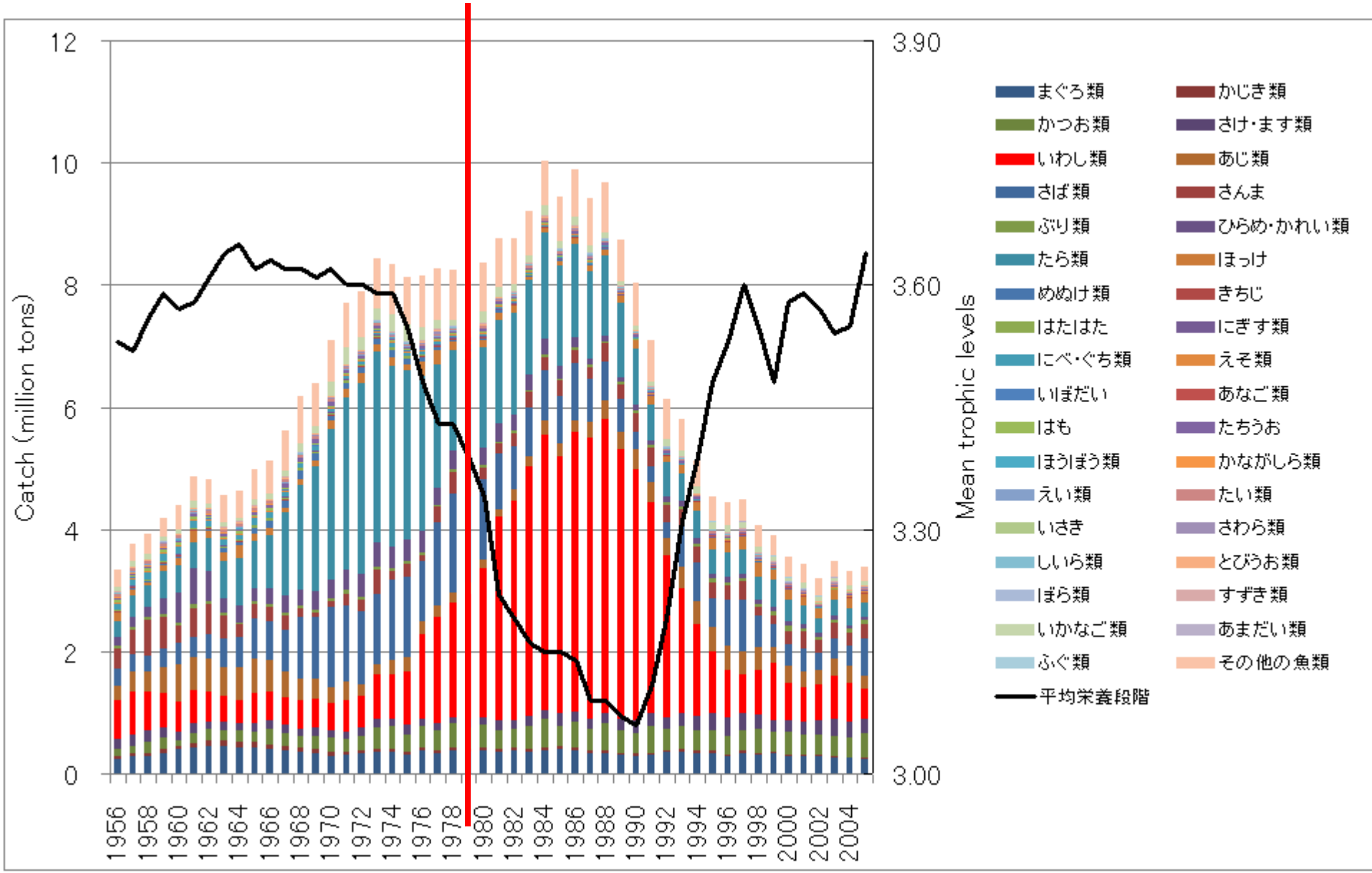
FIGURE 2.11 | Changes in the Marine Trophic Index (early 1950s to the present)



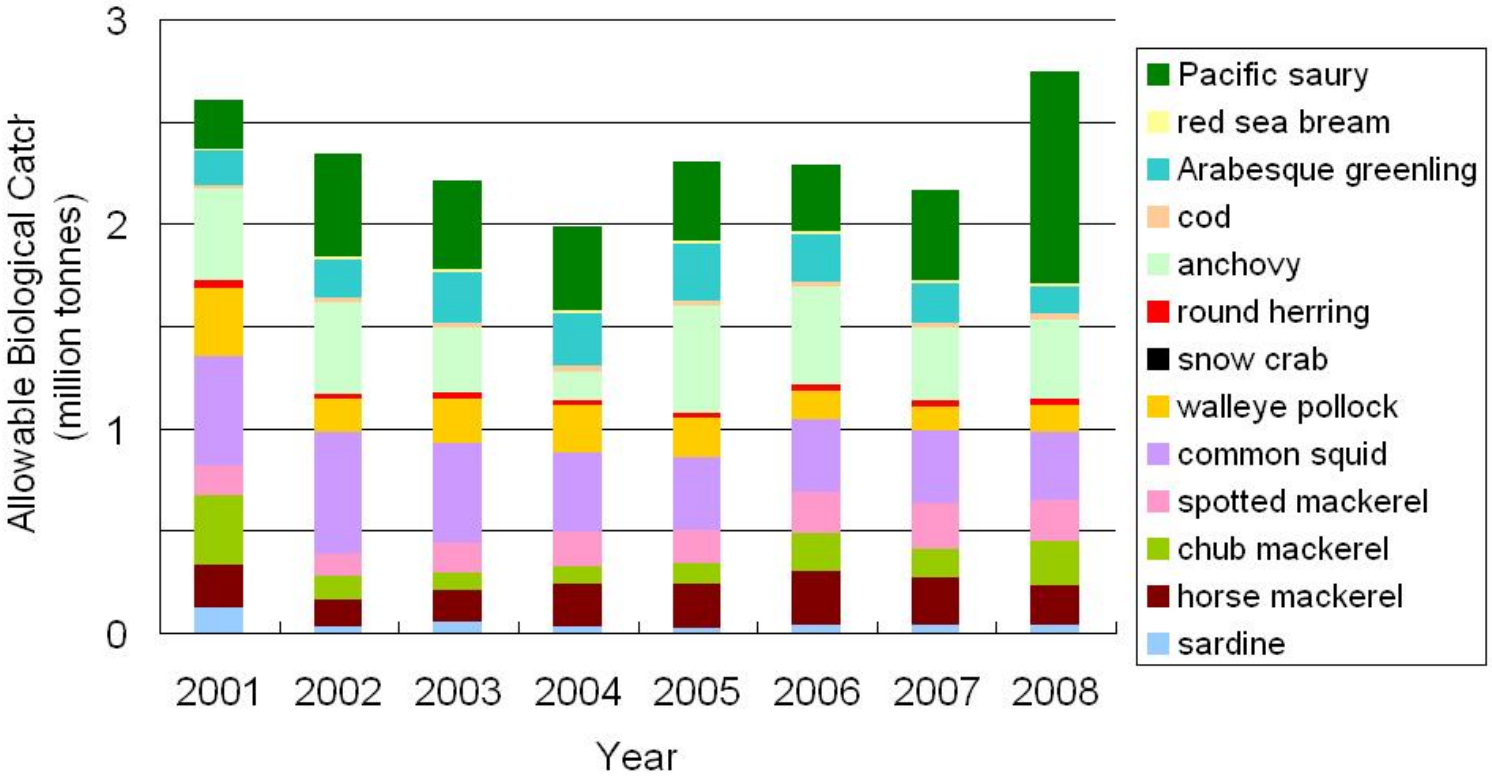
The dark red colouring represents areas of greatest change in the marine trophic index.
Note: The straight borders between colours represent artefacts of the underlying statistics.

Source: Watson et al. 2004[11]

Catch and mean trophic level in Japan



We can use >2 million tons of pelagic fishes sustainably in Japanese EEZ.

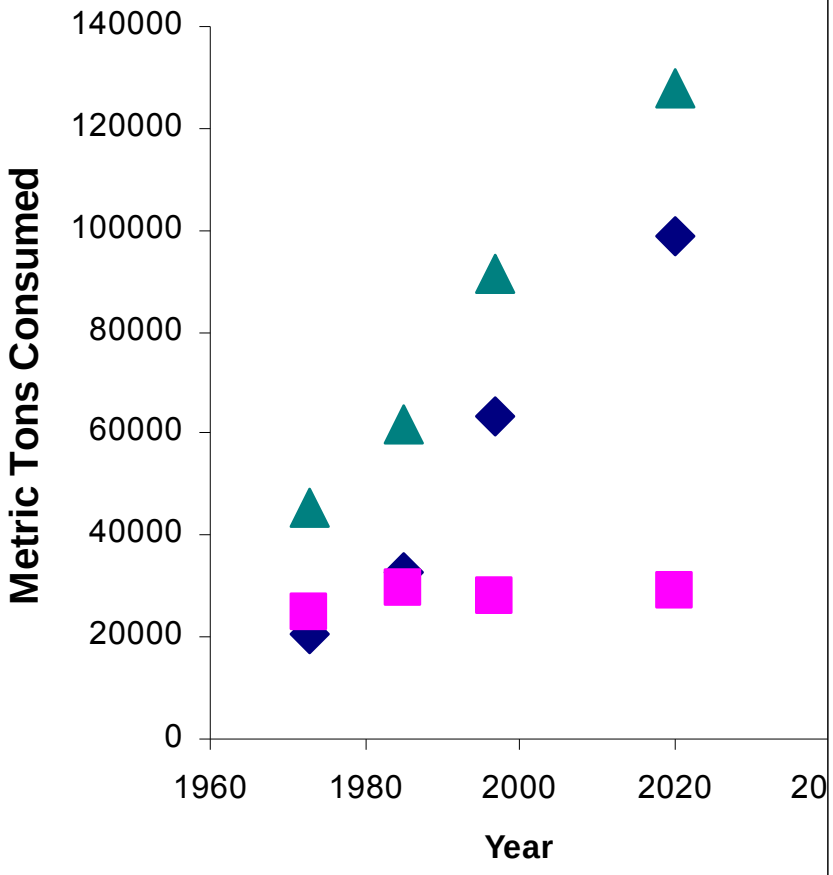


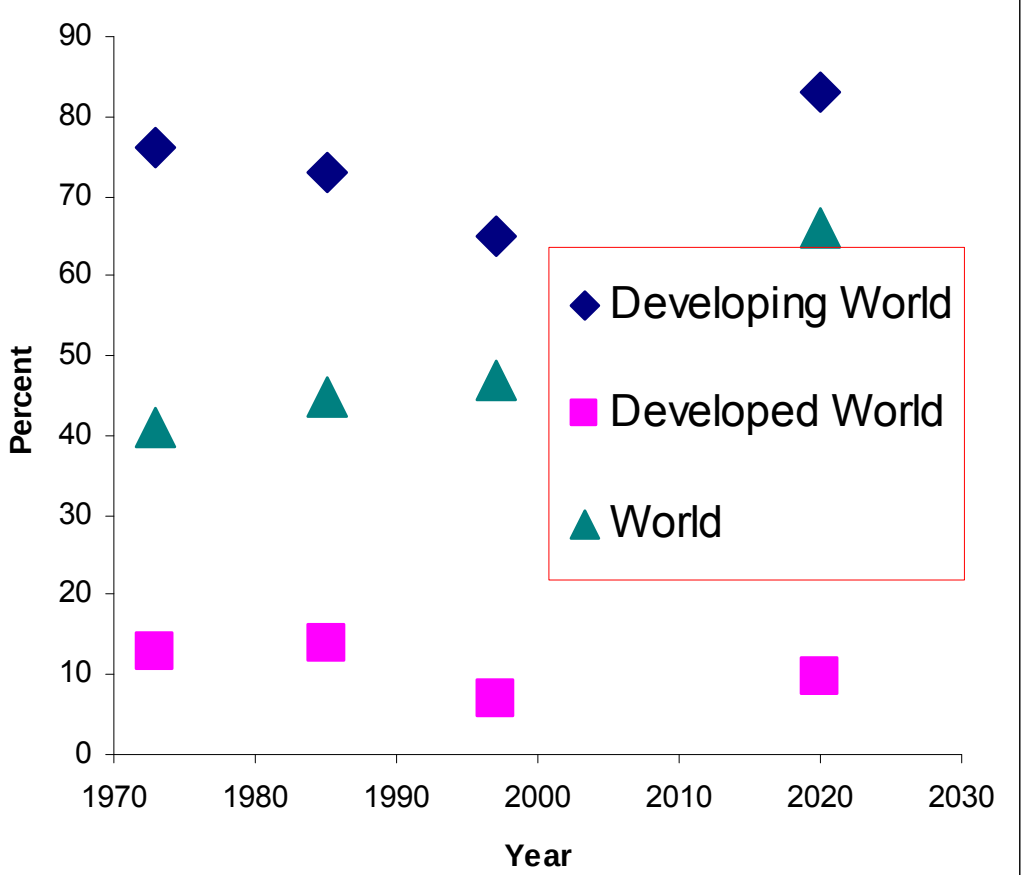
Source: Fisheries Research Agency, Japan

Developed countries people eat high value fishes, Developing countries people eat low value fishes

USGS

After Doug Beard



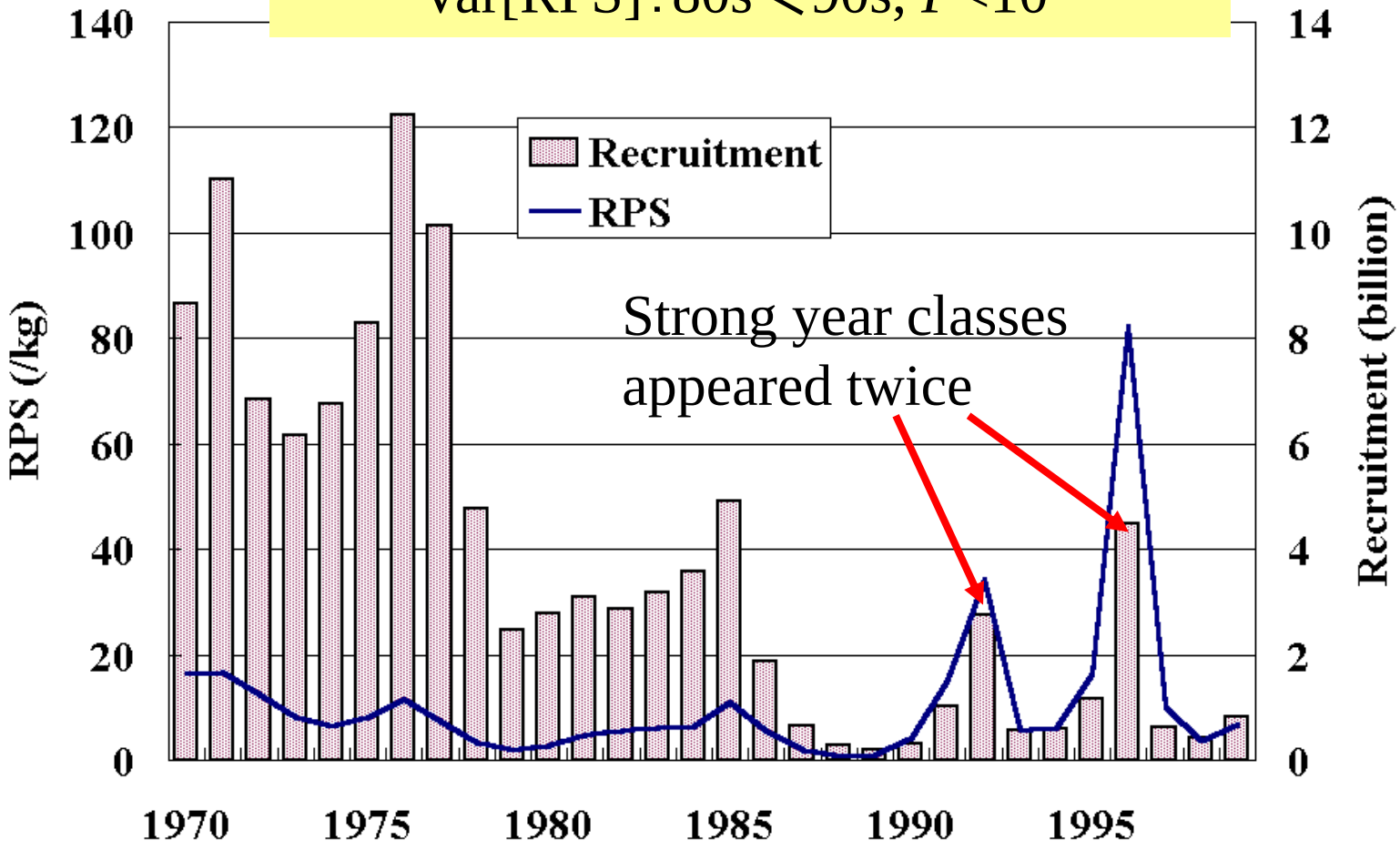


From Delgado et. al. 2002, Fish to 2020, Table E.14

From Delgado et. al. 2002, Fish to 2020, Table 3.3

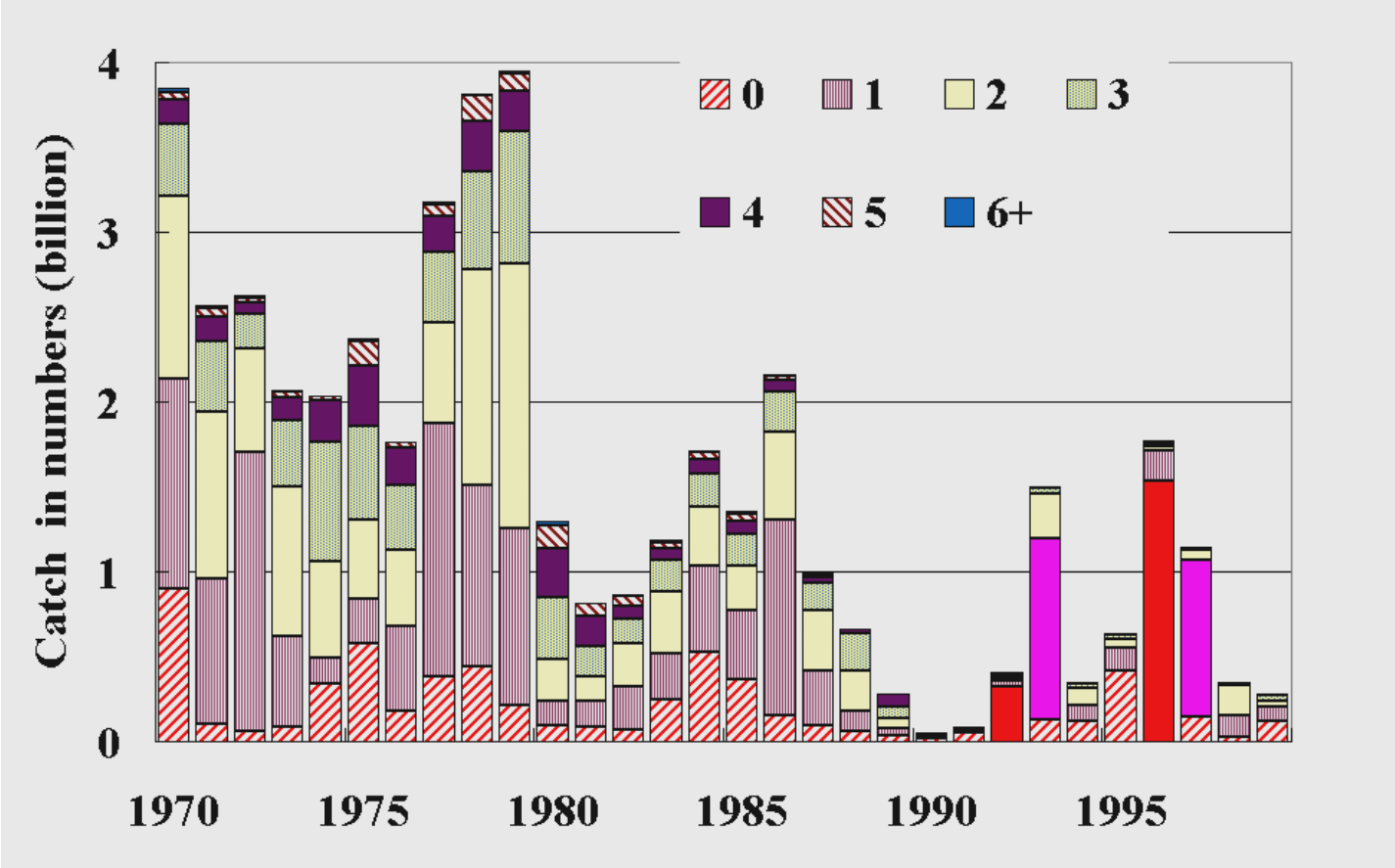
Large fluctuation of recruitment

Var[recruitment] : 80s > 90s, $P<0.3\%$
Var[RPS] : 80s < 90s, $P<10^{-7}$



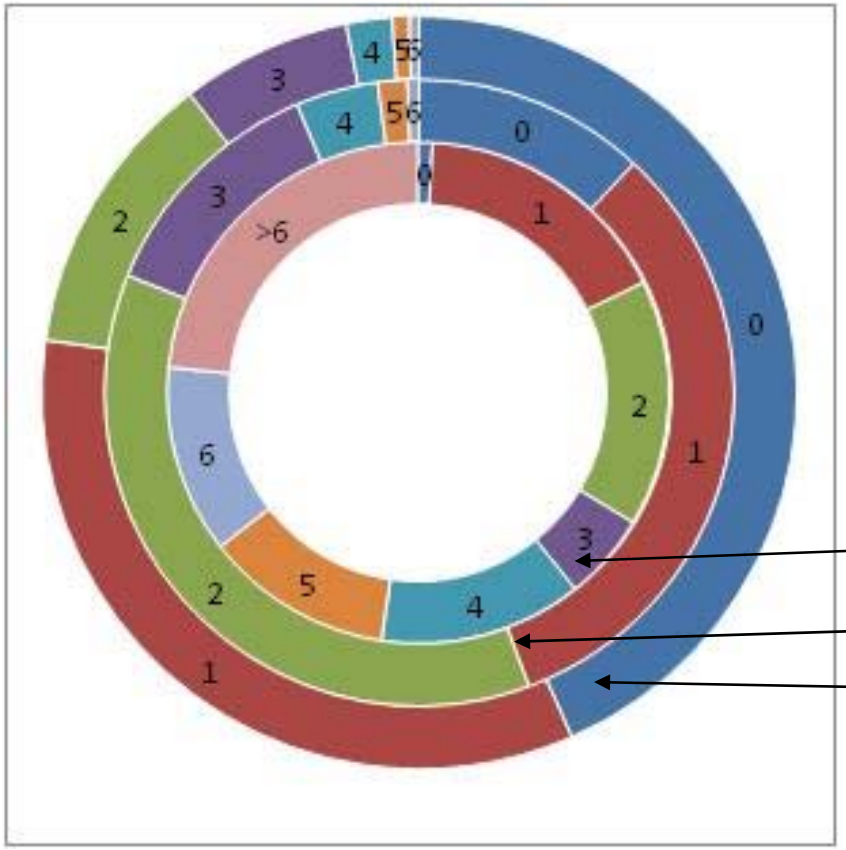
Strong year classes were caught before the age at maturity

	1970s	1980s	1990s	1993–
%immatures	**65.0%**	**60.0%**	**87.0%**	**90.6%**



http://www.ices.dk/marineworld/fishmap/ices/pdf/mackerel.pdf

Overfishing in chub mackerel immature fish!



Chub mackerel fisheries
Norway = Individual Quota
Japan = Dirby competition

Age composition of chub mackerel landings

North Atlantic 2000-2004

Japan 1970

Japan 1995

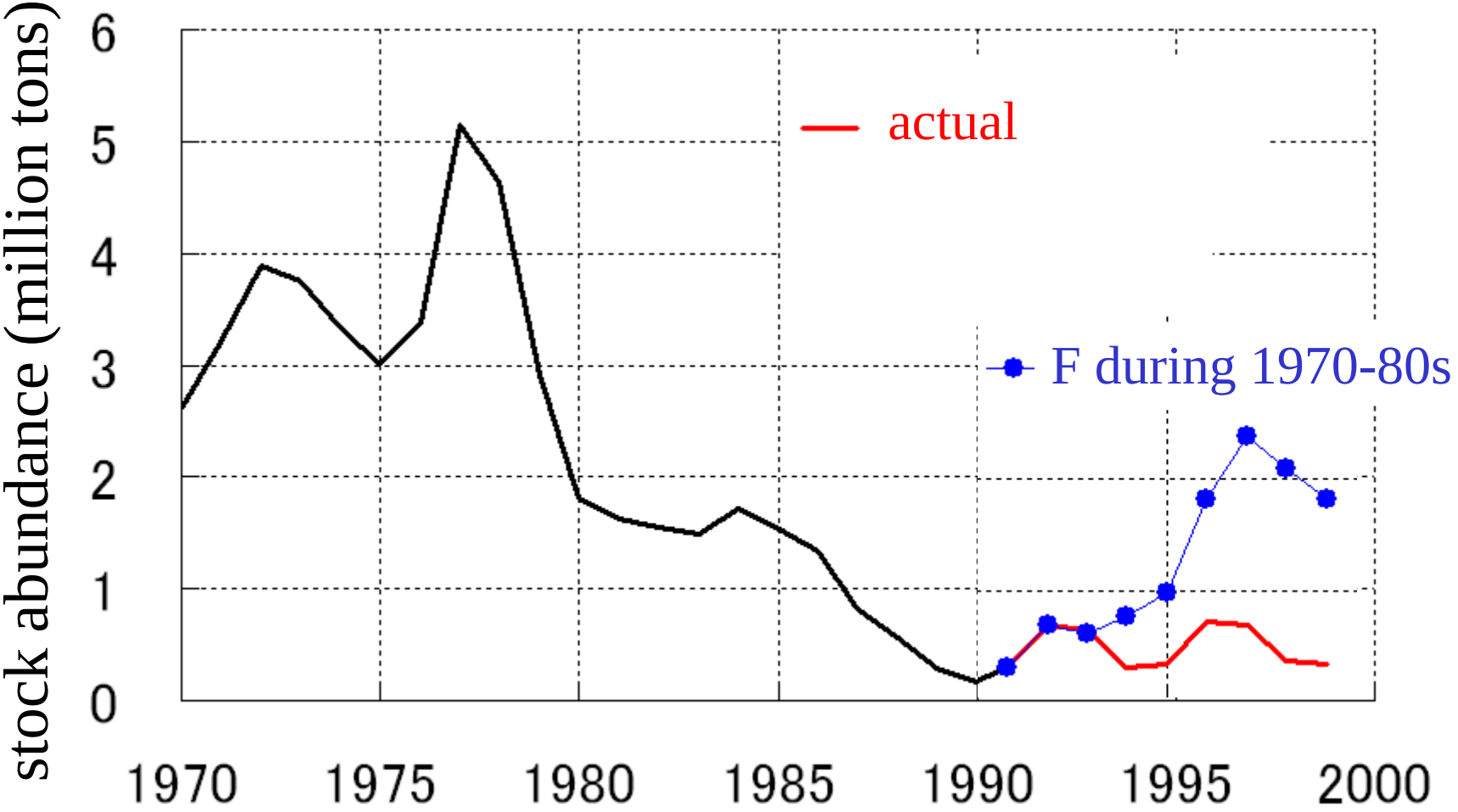
Risk assessment of stock recovery plan (“Simple Operating Model”)

- Start age structure of the current stock;
- Future RPS (α_t) is randomly chosen from the past 10 years estimates of RPS. (include process errors)
- $N_{0,t} = \mathrm{SSB}_t\, \alpha_t/(1+\beta\, \mathrm{SSB}_t)$
- $N_{a+1,t+1} = N_{a,t} \exp[-M-F_a]$ (a=0,1,...5, “6+”)
- $C_{a,t} = N_{a,t}\, \mathrm{e}^{-M/2}\, F_a\, w_a$

Kawai,…,Matsuda, Fish. Sci. 2002

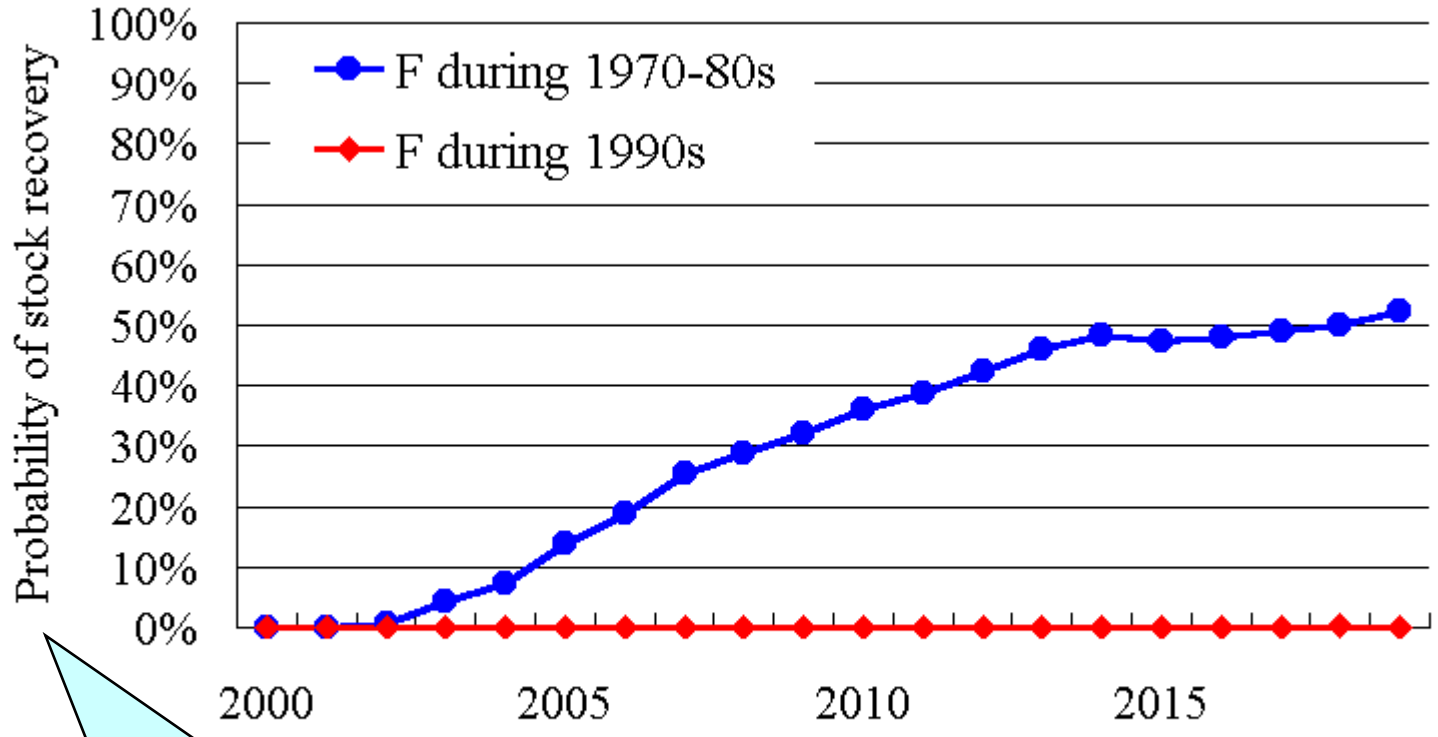
Fishers missed chance of recovery

Kawai,･･･,Matsuda, Fish. Sci. 2002



Probability of stock recovery

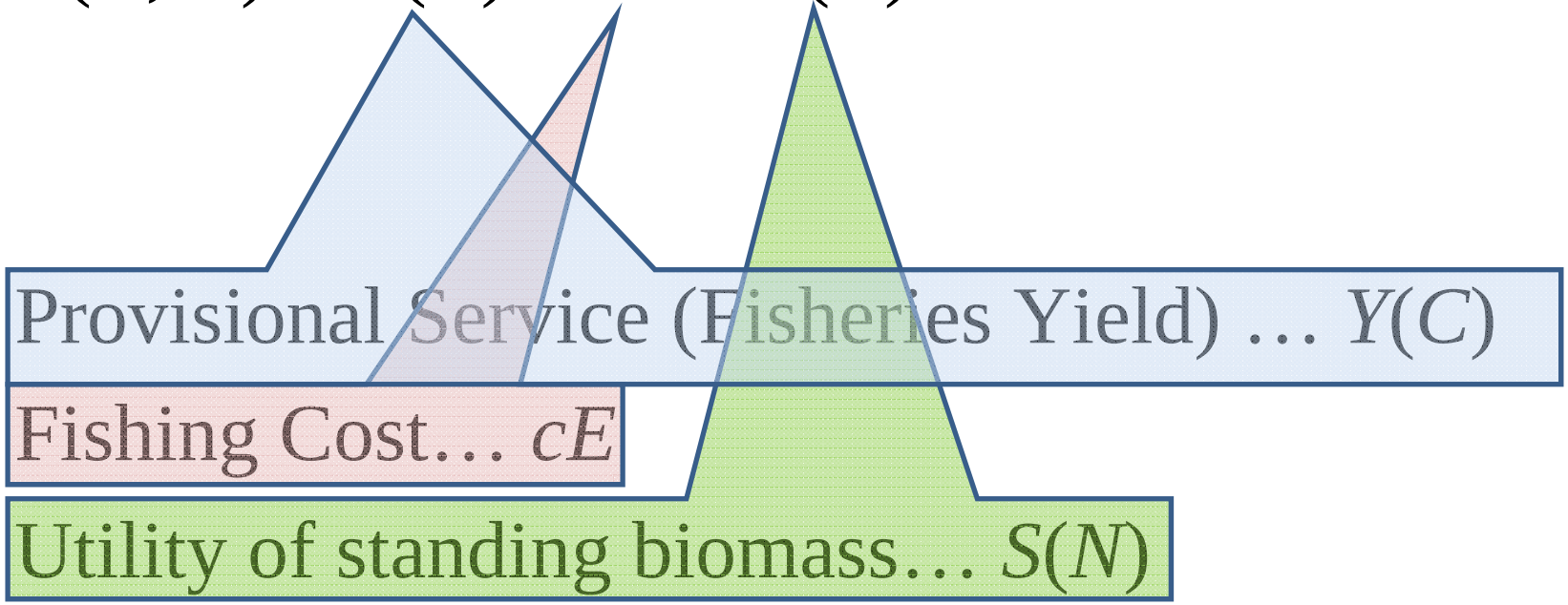
Kawai et al. (2002: *Fish. Sci.***68**:961-969)



Do not predict a single future

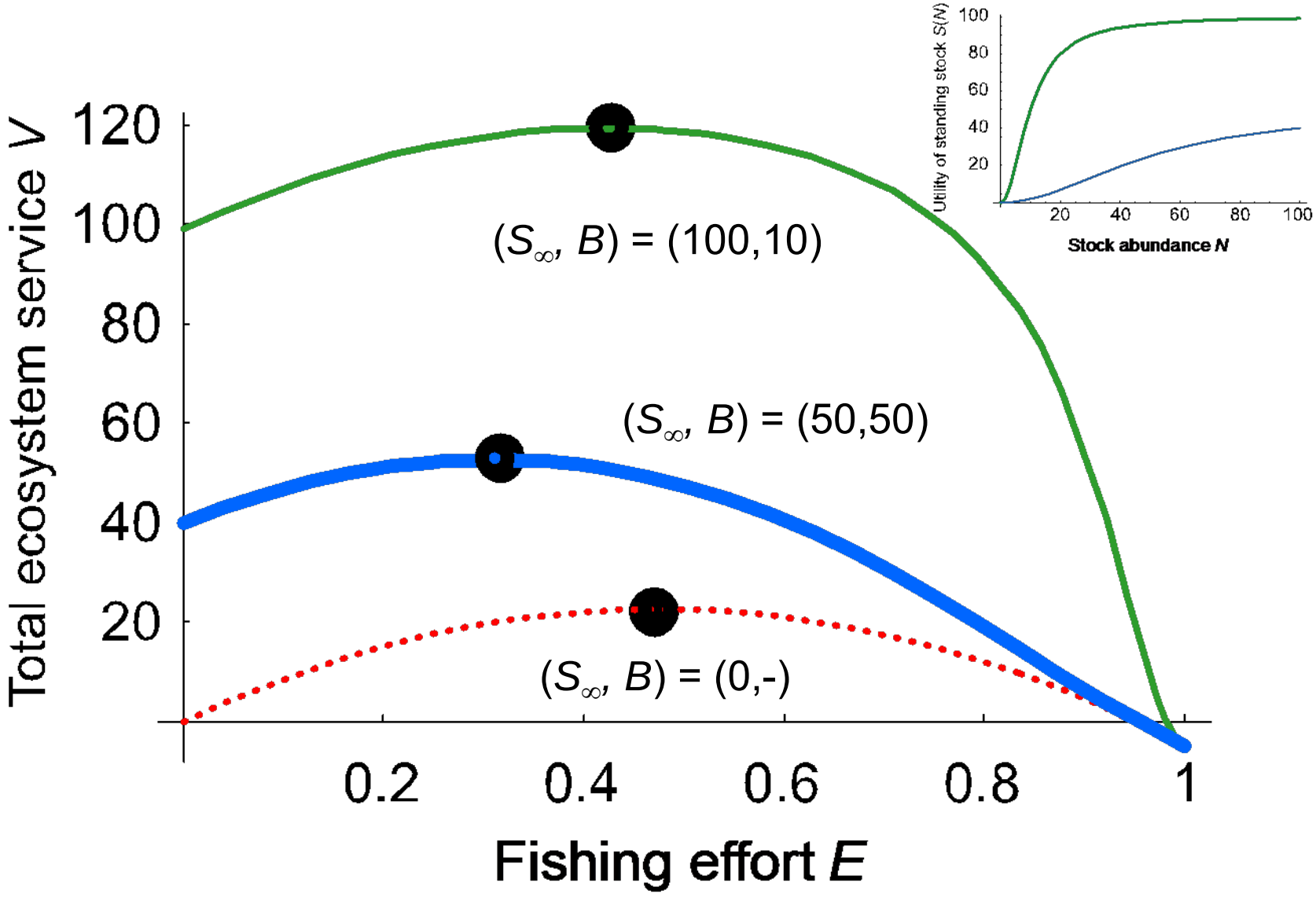
Ecosystem services $V(N, C)$

- $V(N, C) = Y(C) - cE + S(N)$



- Provisional Service (Fisheries Yield) … $Y(C)$
- Fishing Cost… cE
- Utility of standing biomass… $S(N)$
- C… catch; E… fishing effort; N… stock biomass

Maximum Sustainable Ecosystem Service



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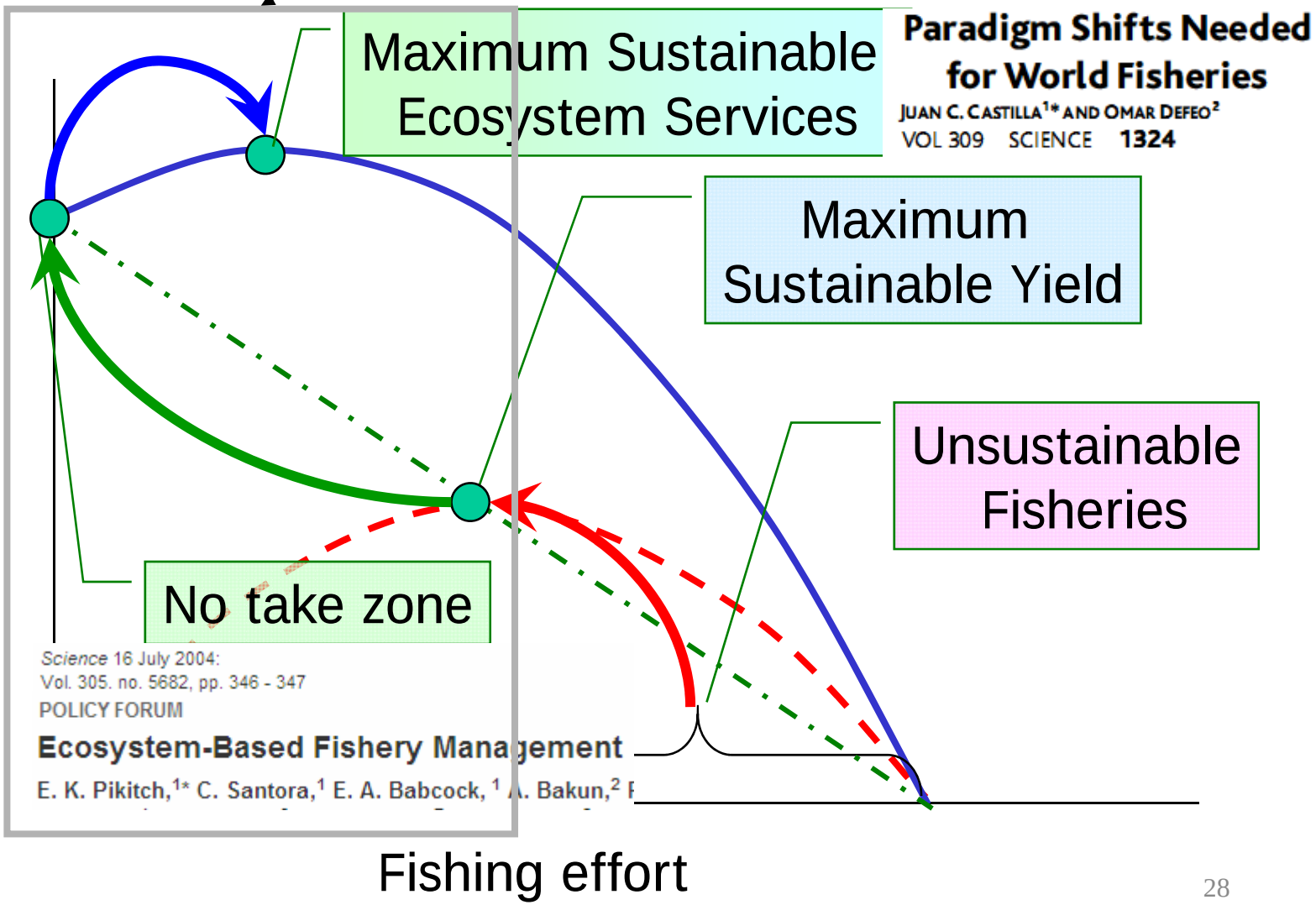
Paradigm Shift…



Risk Management: Minimum Tasks

- Focus on targets that should be solved
- Design management by multiple persons.
- Guess “all” events that may happen
- Estimate the frequency of these events
- Prepare action for each event
- Publish these plans
- Never forget existence of unforeseen events
- Remind ourselves that our present decision will become wrong in the future.

Simon A. Levin
"Fragile Dominion"

Conclusion 2

1. Use stochastic models (Don't predict a unique future)
2. Prepare how to change policy
3. Describe unverified hypothesis
4. Check consistence between aims and goals in management
5. Check feasibility in a management plan