



Introduction à l'environnement et la biodiversité

UE CERES-AA-05-S1
David Claessen

www.environnement.ens.fr

Ecole Normale Supérieure

24 rue Lhomond, 75005 Paris, Rez-de-chaussée, bureaux E026



The tragedy of the commons in ecology, evolution and environmental science

UE CERES-AA-05-S1
David Claessen

The author is professor of biology, University of California, Santa Barbara. This article is based on a presidential address presented before the meeting of the Pacific Division of the American Association for the Advancement of Science at Utah State University, Logan, 25 June 1968.

13 DECEMBER 1968

The Tragedy of the Commons

The population problem has no technical solution;
it requires a fundamental extension in morality.

Garrett Hardin

At the end of a thoughtful article on the future of nuclear war, Wiesner and York (1) concluded that: "Both sides in the arms race are . . . confronted by the dilemma of steadily increasing military

sional judgment. . . ." Whether they were right or not is not the concern of the present article. Rather, the concern here is with the important concept of a class of human problems which can be

What Shall We Maximize?

Population, as Malthus said, naturally tends to grow "geometrically," or, as we would now say, exponentially. In a finite world this means that the per capita share of the world's goods must steadily decrease. Is ours a finite world?

A fair defense can be put forward for the view that the world is infinite; or that we do not know that it is not. But, in terms of the practical problems that we must face in the next few generations with the foreseeable technology, it is clear that we will greatly increase human misery if we do not, during the immediate future, assume that the world available to the terrestrial human population is finite. "Space" is no escape (2).

A finite world can support only a finite population; therefore, population growth must eventually equal zero. (The

It is fair to say that most people who anguish over the population problem are trying to find a way to avoid the evils of overpopulation without relinquishing any of the privileges they now enjoy. They think that farming the seas or developing new strains of wheat will solve the problem—technologically. I try to show here that the solution they seek cannot be found.

The « commons »

- « Common » = « village green »



TWO LECTURES
ON THE
CHECKS TO POPULATION,

DELIVERED BEFORE

THE UNIVERSITY OF OXFORD,

IN MICHAELMAS TERM 1832.

BY

THE REV. W. F. LLOYD, M.A.

STUDENT OF CHRIST CHURCH,

PROFESSOR OF POLITICAL ECONOMY.

OXFORD,

PRINTED BY S. COLLINGWOOD, PRINTER TO THE UNIVERSITY,
FOR THE AUTHOR.

SOLD BY J. H. PARKER, OXFORD;
AND BY J. G. AND F. RIVINGTON, LONDON.

MDCCCXXXIII.

484.



William Forster Lloyd (1833)

- Pasturelands left open to many herds of cattle with **a resource available to all**,
- the **greediest** herdsmen would gain—**for a while**
- **Mutual ruin** was just around the corner.
- As demand grew in step with population (while supply remained fixed), a time would come when the herdsmen, acting as Smithian individuals, would be trapped by their own competitive impulses.
- The **unmanaged commons** would be ruined by **overgrazing**



As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, “What is the utility *to me* of adding one more animal to my herd?”

This utility has one negative and one positive component.



This utility has one negative and one positive component.

1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly $+1$.



This utility has one negative and one positive component.

1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly $+1$.

2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of -1 .



Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another. . . . But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.



D'où vient le problème?

|

AN ESSAY
ON THE
PRINCIPLE OF POPULATION;
OR,
A VIEW OF ITS PAST AND PRESENT EFFECTS
ON
HUMAN HAPPINESS;
WITH
AN INQUIRY INTO OUR PROSPECTS RESPECTING THE FUTURE
REMOVAL OR MITIGATION OF THE EVILS WHICH
IT OCCASIONS.
BY
THE REV. T. R. MALTHUS, A.M. F.R.S.
LATE FELLOW OF JESUS COLLEGE, CAMBRIDGE, AND PROFESSOR OF HISTORY AND POLITICAL
ECONOMY IN THE EAST-INDIA COLLEGE, HERTFORDSHIRE.
—
SIXTH EDITION.
IN TWO VOLUMES.
VOL. I.
LONDON:
JOHN MURRAY, ALBEMARLE STREET.
MDCCCXXVI.

Thomas Robert Malthus



- **Geometrical population growth**
- The increase of population is necessarily **limited** by the means of subsistence;
- The superior power of population is repressed, and the actual population kept equal to the means of subsistence, by misery and vice.

$$\dot{S} = S \left(\frac{aS}{1+S} - b - cS \right) - \theta SX,$$

$$\dot{X} = X(\eta\theta S - \mu).$$

S = resource
 X = consumer population
abundance

Fitness $W = \eta\theta S - \mu$

Fitness is defined as the
per capita exponential growth rate

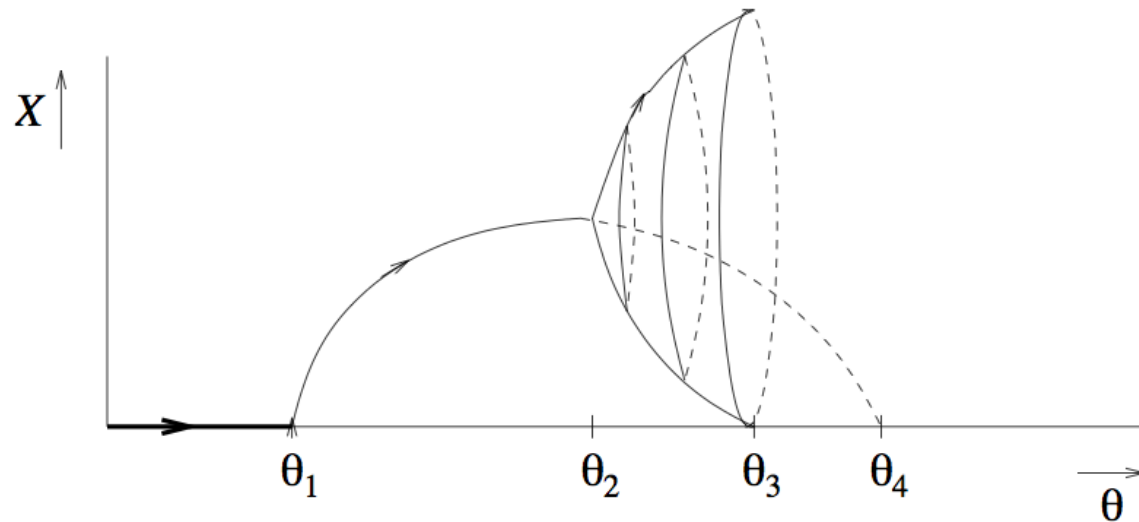


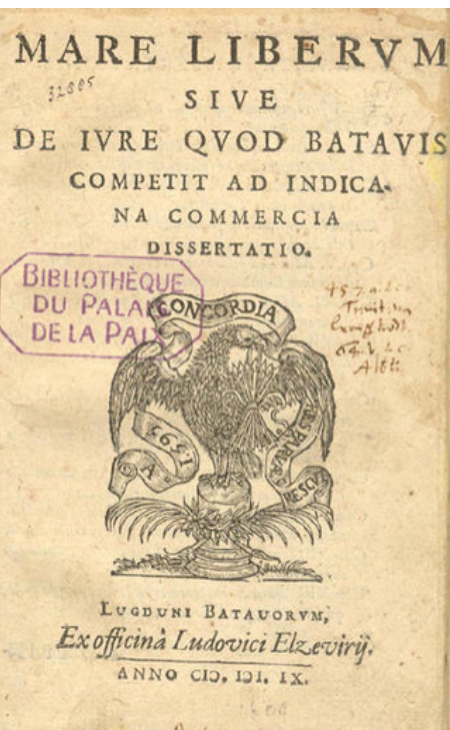
Fig. 8. Bifurcation diagram for (6.1). The adaptive dynamical increase of θ is indicated by the arrows (but, admittedly, the arrow between 0 and θ_1 is meaningless).

D'où vient le problème?

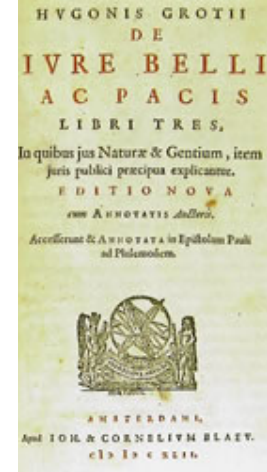
||



1609, Hugo de Groot
(*Hugo Grotius*) :
“The freedom of the seas”



« Peter Pett and the *Sovereign of the Seas* »
Peter Lely (1637)

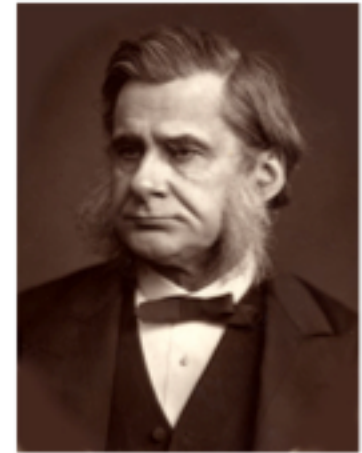


1625, **Hugo de Groot** (*Hugo Grotius*) :

“The extent of the ocean is in fact so great that it suffices for any possible use on the part of all peoples for drawing water, for fishing, for sailing.”

“Probably all great sea-fisheries are
inexhaustible”

– 1884-Sir Thomas Huxley



« I know the human being and fish
can coexist peacefully »

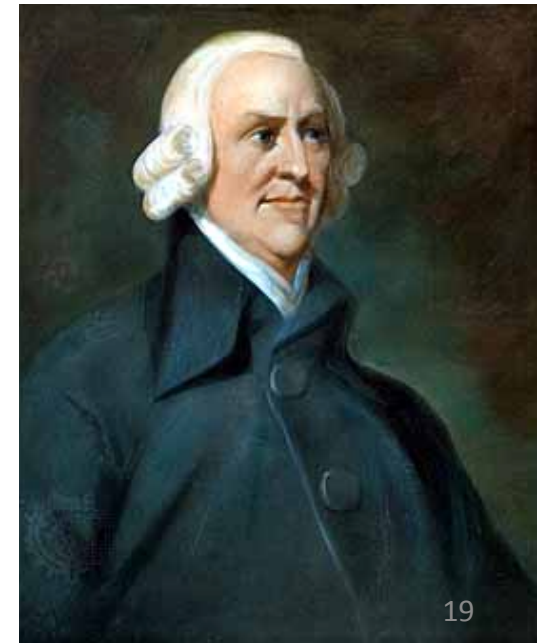
Saginaw, Michigan; September 29, 2000



« Freedom of the seas » in combination with « the invisible hand » (Adam Smith 1776)

→ Tragedy of the commons

In economic affairs, *The Wealth of Nations* (1776) popularized the “invisible hand,” the idea that an individual who “intends only his own gain,” is, as it were, “led by an invisible hand to promote . . . the public interest”



Rapid worldwide depletion of predatory fish communities

Ransom A. Myers & Boris Worm

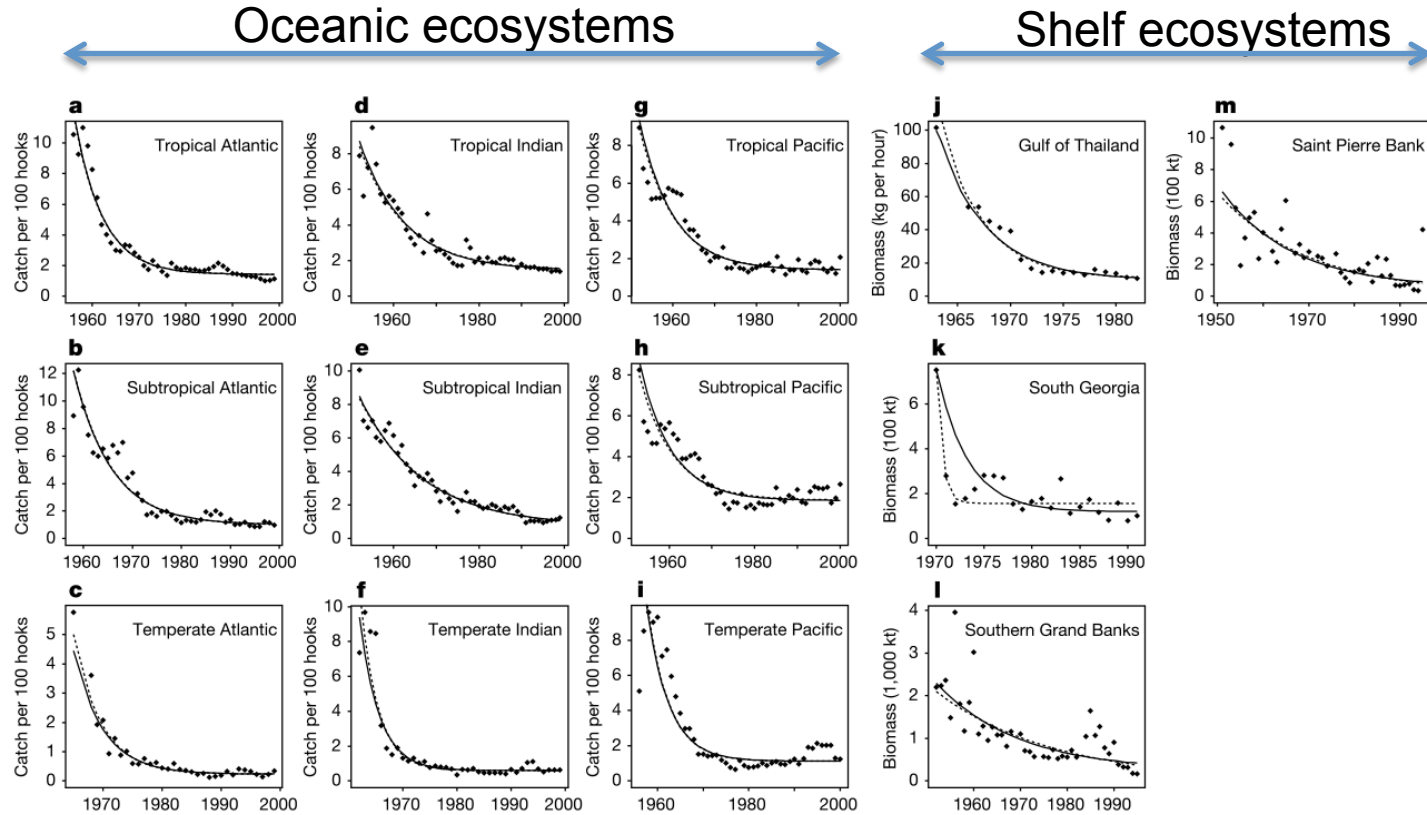


Figure 1 Time trends of community biomass in oceanic (a–i) and shelf (j–m) ecosystems. Relative biomass estimates from the beginning of industrialized fishing (solid points) are shown with superimposed fitted curves from individual maximum-likelihood fits (solid lines) and empirical Bayes predictions from a mixed-model fit (dashed lines).

Rapid worldwide depletion of predatory fish communities

Ransom A. Myers & Boris Worm

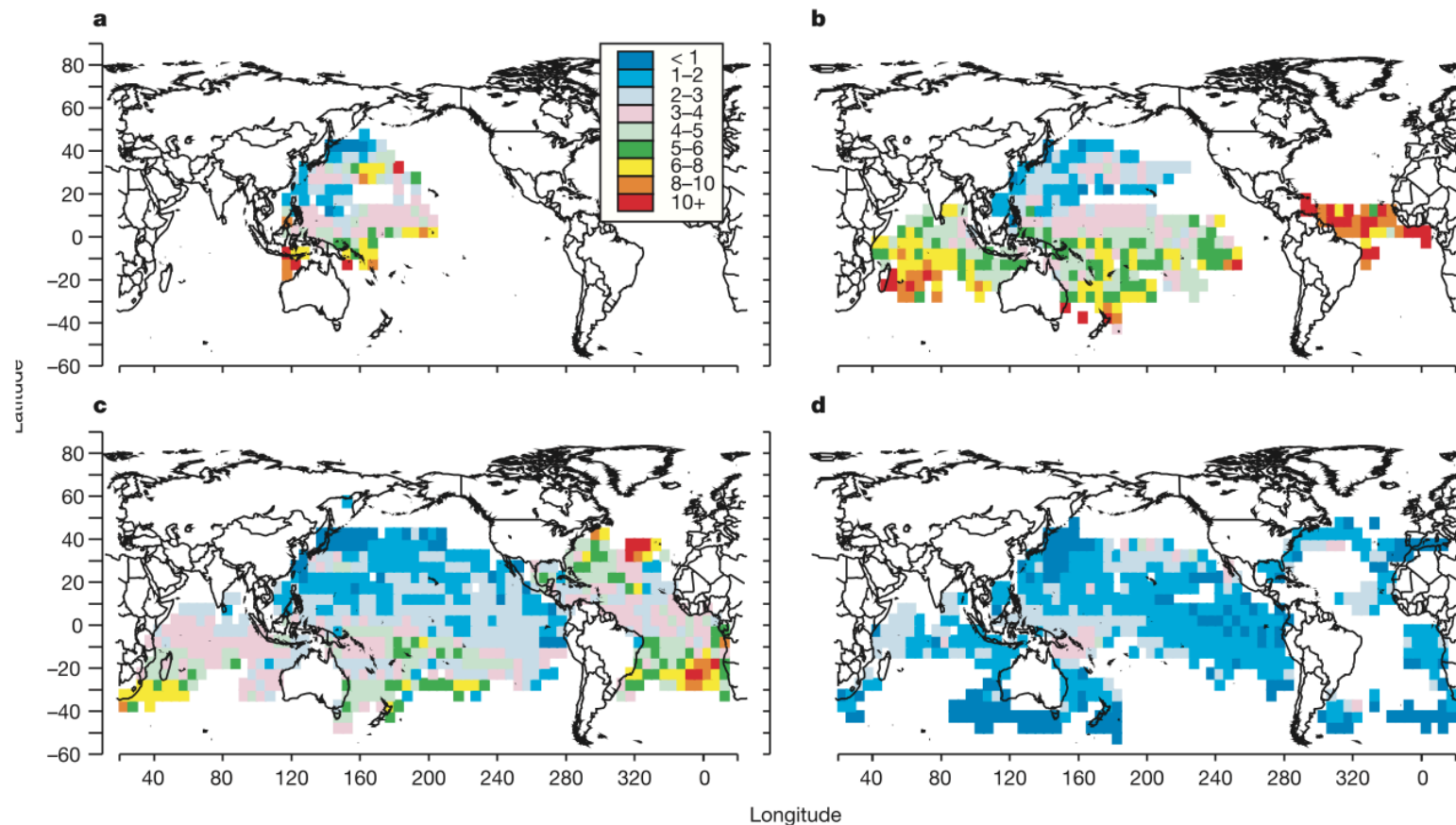


Figure 2 Spatial patterns of relative predator biomass in 1952 (a), 1958 (b), 1964 (c) and 1980 (d). Colour codes depict the number of fish caught per 100 hooks on pelagic

longlines set by the Japanese fleet. Data are binned in a global 5° × 5° grid. For complete year-by-year maps, refer to the Supplementary Information.