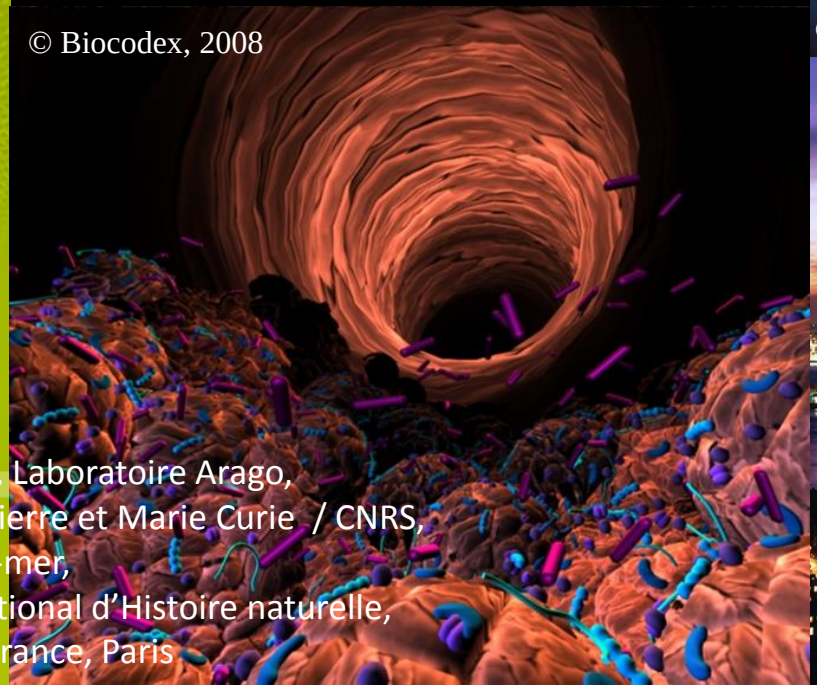
Biodiversité, de l'Océan et la Forêt, à la Cité

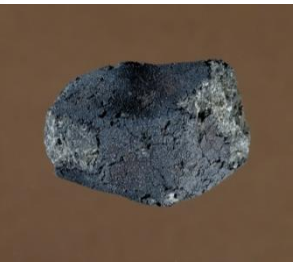
© Santo, 2006


© F Hédelin 2005


© Biocodex, 2008

Séminaire « biodiversité et services écosystémiques »
Bordeaux
24 janvier 2014

Gilles Boeuf, Laboratoire Arago,
Université Pierre et Marie Curie / CNRS,
Banyuls-sur-mer,
Muséum national d'Histoire naturelle,
Collège de France, Paris



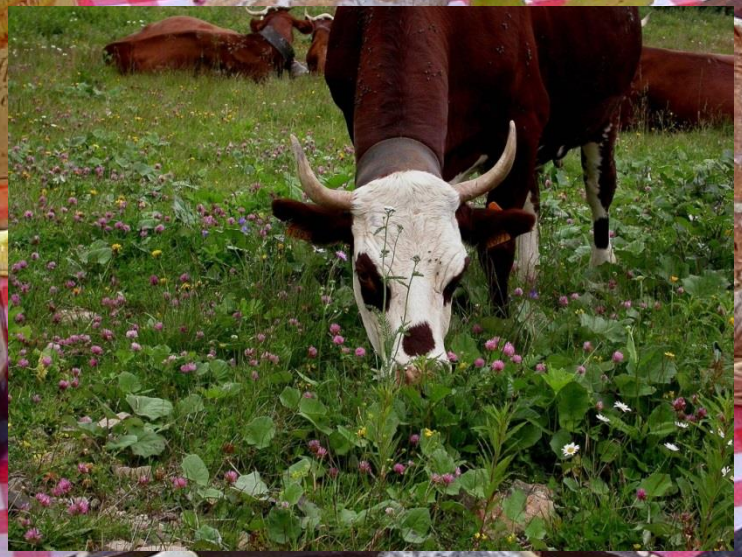
Biodiversité ?

> 1,7 million d'espèces continentales

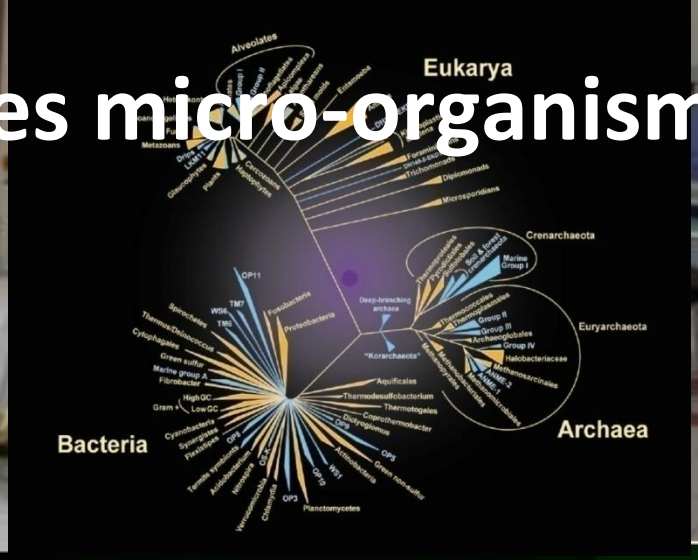
< 0,3 million d'espèces marines

C'est la fraction vivante de la Nature, c'est le vivant dans toute sa diversité et sa complexité

Domestication et utilisation d'organismes par l'Homme



Biodiversité des micro-organismes



Naegleria fowleri

Giardia spp.

Cryptosporidium parvum

P Lebaron, Lab Arago, Banyuls 2002

Legionella pneumophila

Escherichia coli

Virus et bactéries
Eau de mer naturelle

« *…Most organisms smaller than 1 mm occur worldwide wherever their required habitats are realised. This is a consequence of ubiquitous dispersal driven by huge population sizes . Metapopulations of microbial eukaryotes are cosmopolitan…*" Finlay & Fenchel 2004. "*…Current evidence confirms that, as proposed by the Baas-Becking hypothesis, 'the environment selects' and is, in part, responsible for spatial variation in microbial diversity. However, recent studies also dispute the idea that 'everything is everywhere'…* ». .Martiny *et al*., 2006.

La vie : tout a commencé dans l'océan !

Naissance du vivant dans l'eau il y a 3,5 milliards d'années

Pas de vie sans eau

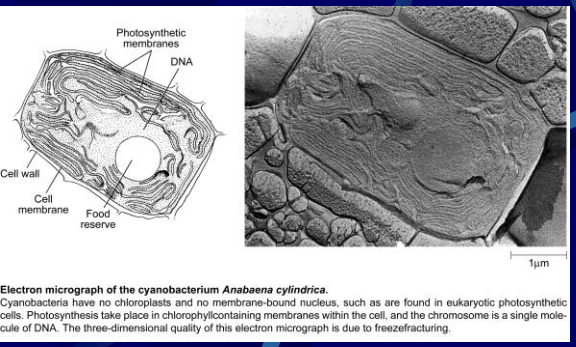
© A Stéphan, 1980

Anions	$g.kg^{-1}$ EM	Cations	
Cl^-	18.98	Na^+	10.56
SO_4^{2-}	2.65	Mg^{2+}	1.27
HCO_3^-	0.14	Ca^{2+}	0.40
Br^-	0.06	K^+	0.38
F^-	0.001	Sr^{2+}	0.01
H_3BO^{3-}	0.03		Tchernia,1969

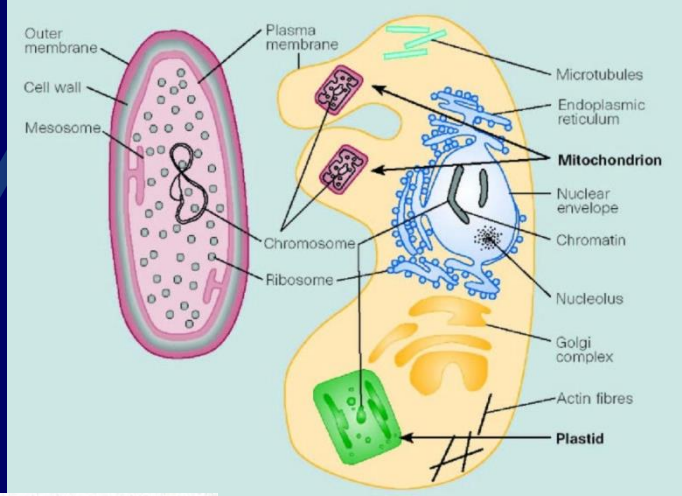
© G Boeuf, 2007

© G Boeuf, 2009

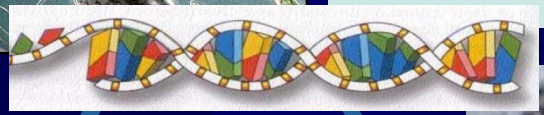
Les origines de la Vie



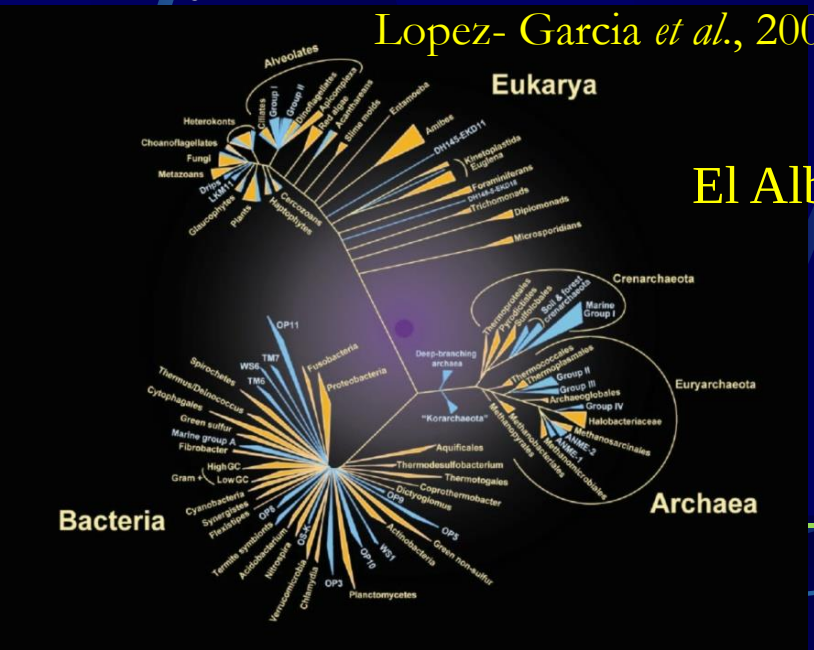
Electron micrograph of the cyanobacterium *Anabaena cylindrica*.
Cyanobacteria have no chloroplasts and no membrane-bound nucleus, such as are found in eukaryotic photosynthetic cells. Photosynthesis take place in chlorophyllcontaining membranes within the cell, and the chromosome is a single molecule of DNA. The three-dimensional quality of this electron micrograph is due to freezefracturing.



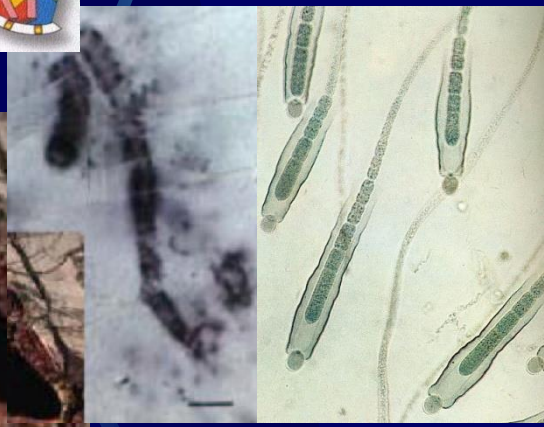
Prokaryotes-Eukaryotes : 2.2 milliards d'années,
Protozoans-metazoans : 2.1 milliards d'années
Organelles : 1.9 (Mi) and 1.4 (Pl)
Sexuality : 1.5 milliards d'années

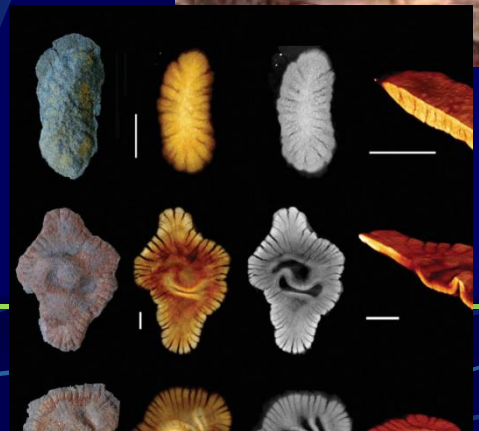


Lopez- Garcia *et al.*, 2002



El Albani *et al.*, 2010

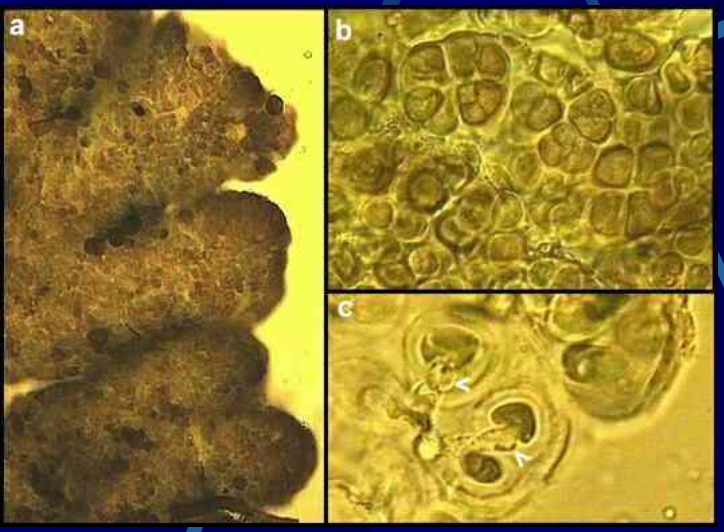


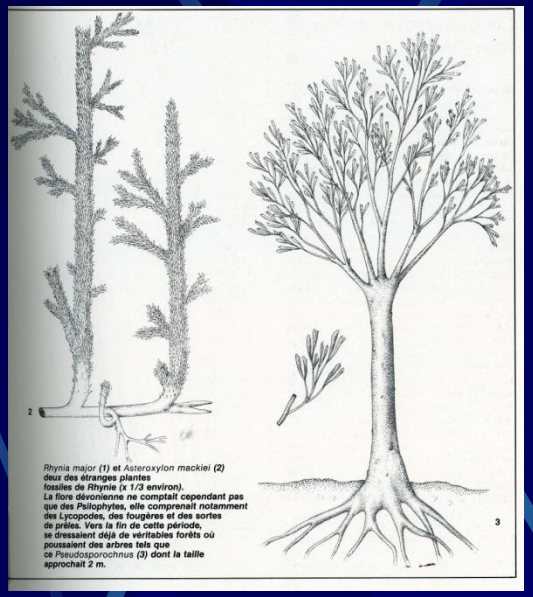


- Milieu intérieur humain
- osmolarité, 302 $mOsm.l^{-1}$
- 100-105 mM de Cl^-
- 138-142 mM de Na^+
- 3-5 mM de K^+
- cellule rénale et fluide 3000 $mOsm.l^{-1}$

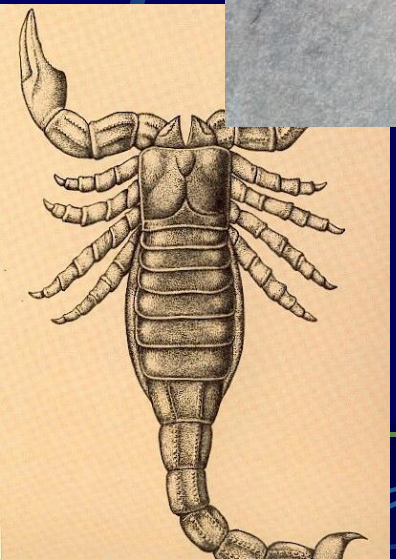
S’est poursuivi par le littoral…

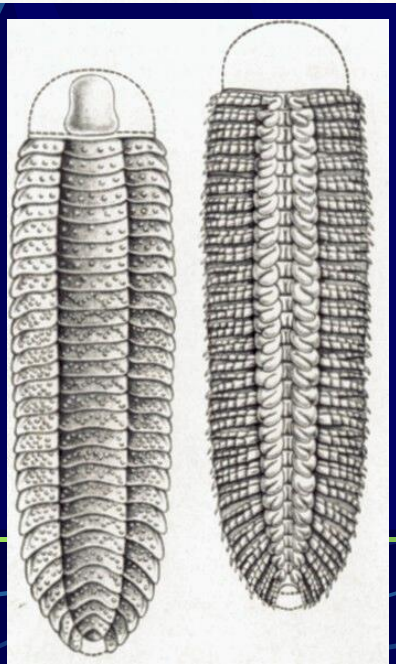
Les sorties de l'océan





440 Ma
1 Mda?



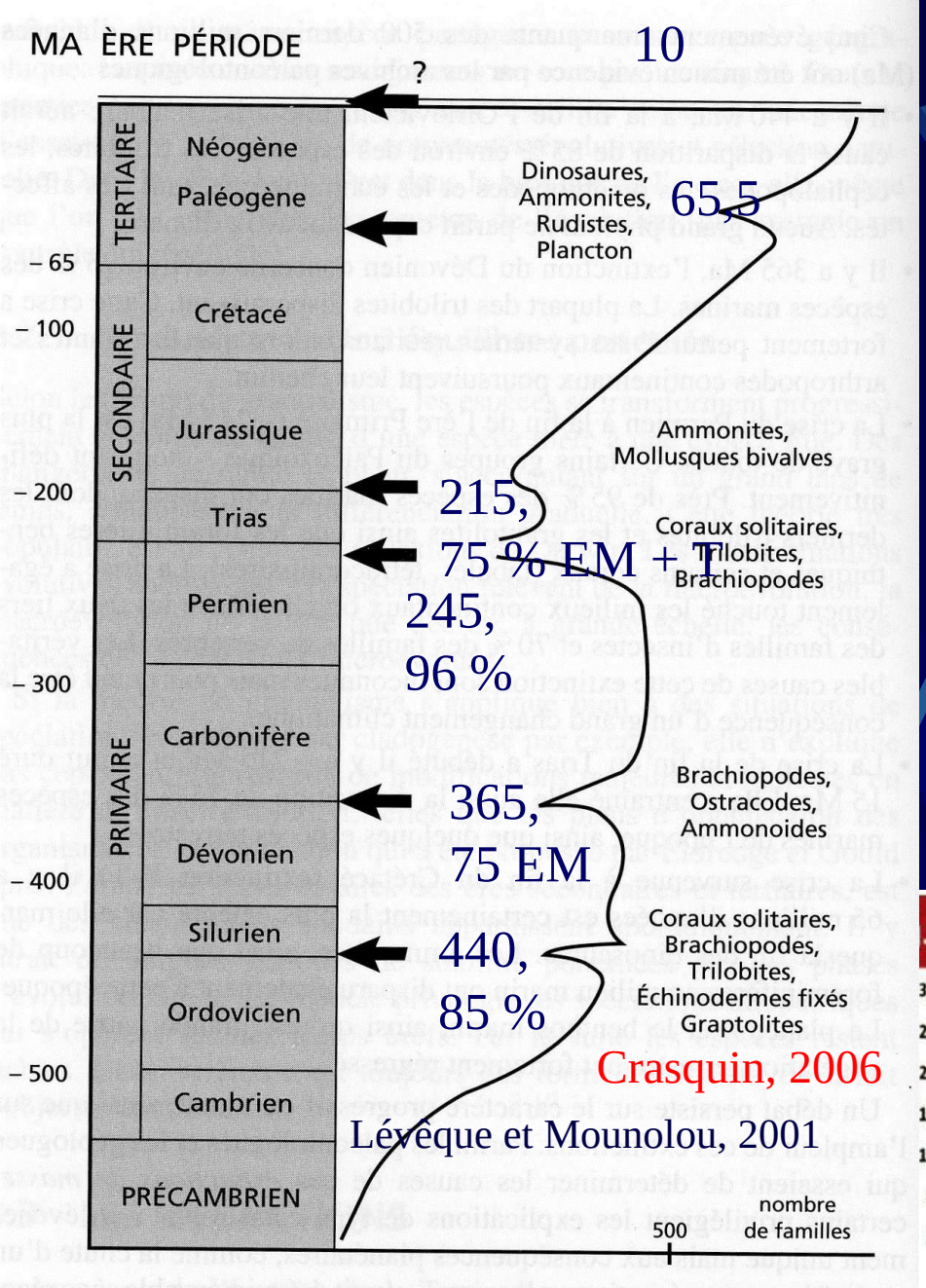


Une forêt du Carbonifère, il ya 345 Ma…

Puis est passé par la forêt…

Bwindi, Ouganda, © GBoeuf, 2012

Guyane, les Nouragues, © GBoeuf, 2011 ,



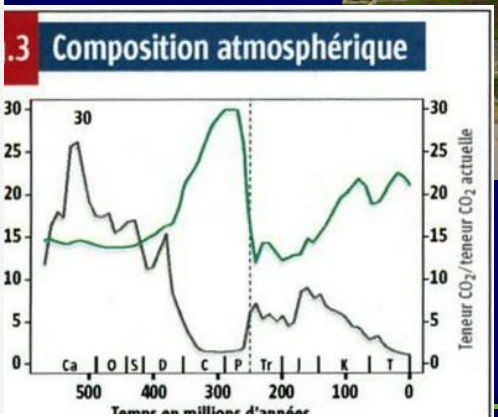
The largest mass extinction occurred at the end of Permian (ca. 250 million years ago)

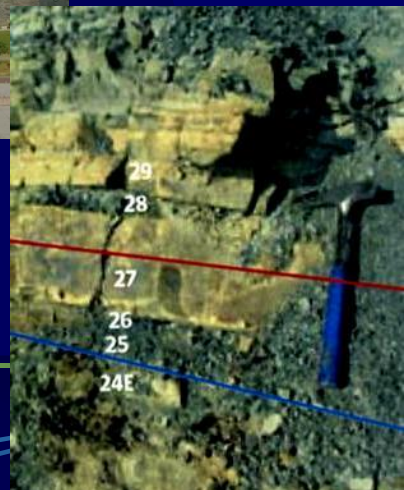
- It was caused by asteroid impact, intense volcanic activity, atmospheric warming (6°C) and methane emission from oceanic gases hydrate deposits.
- Ca. 95% of species died off in less than 4 million years.
- One hundred million years were needed to bring back biodiversity to its previous level.

Benton & Twitchett, 2003

Gaston & Spicer 1998.

Meishan in China bed 25 free of fossils!

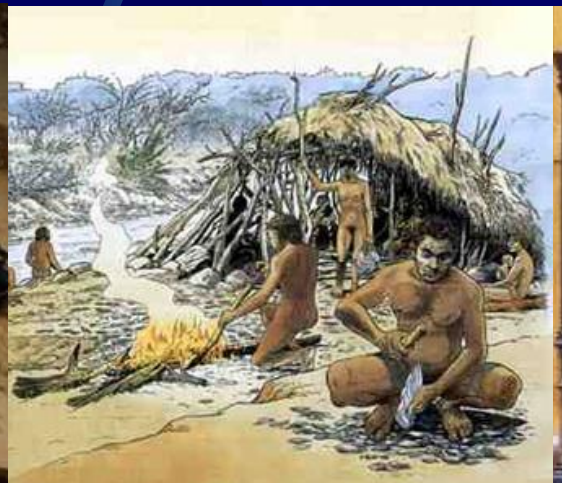


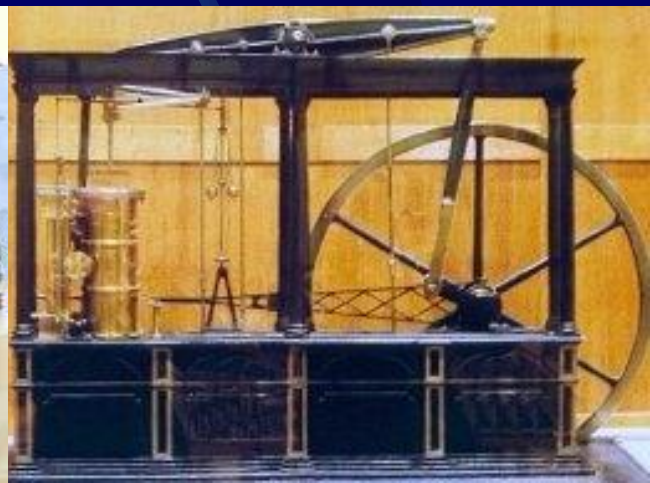


Les grandes crises d'extinction

Les « grands » moments de l'histoire de l'Homme ?

- La domestication du feu, 800 000 ans en Israël,
- Le néolithique, 8-12 000 ans, premières domestications et agricultures, premières cités,
- La machine à vapeur, D Papin, J Watt, 1784 (première locomotive).

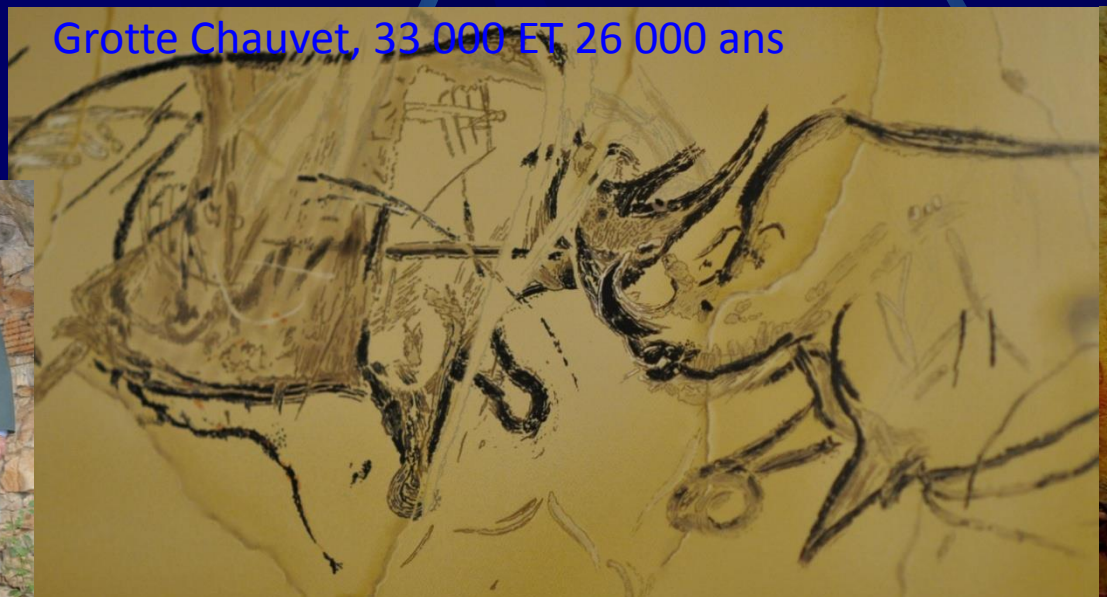


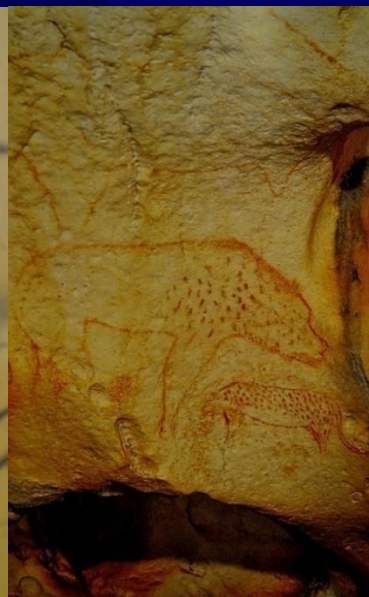


La biodiversité : quand ?

16 avril 2012

Grotte Chauvet, 33 000 ET 26 000 ans





Agriculture et élevage

5 M humains

La biodiversité arrive en ville !

Plan Biodiversité à Paris, adopté le 15 nov 2011

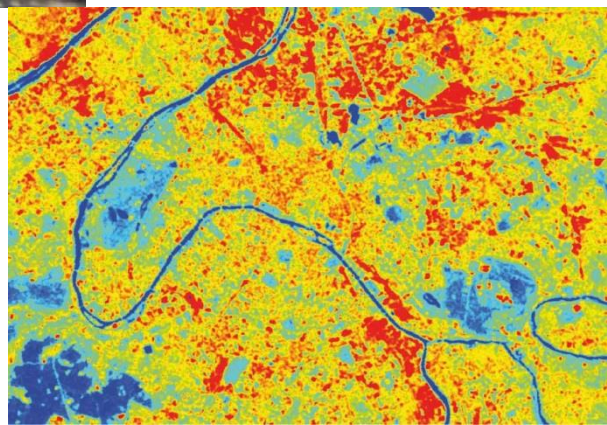
Renforcer les continuités écologiques,

Mieux intégrer la biodiversité dans le développe ment durable de Paris,

Développer et fédérer la connaissance, porter les messages : l'observatoire de la biodiversité,

Changer le regard sur la biodiversité, 95 propositions pour améliorer la biodiversité,

Oiseaux parisiens, des mares pour développer la biodiversité, opération « sciences participatives » au sein de « Vigie Nature », « Sauvages de ma rue »



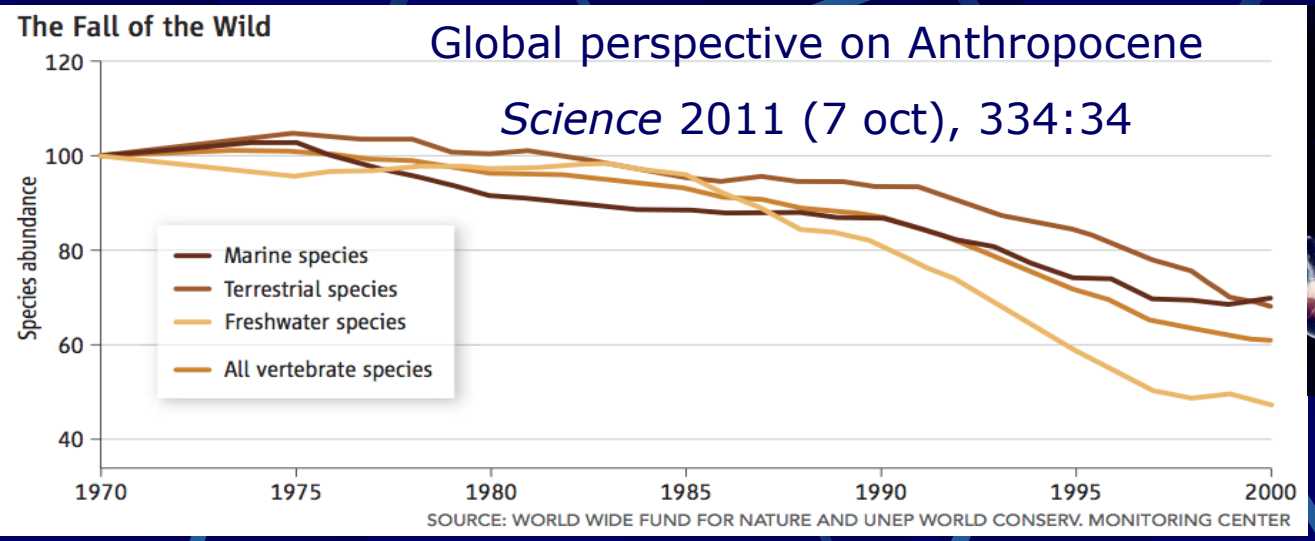
Les impacts de l'humanité : l'anthropocène ?

- En 3 siècles, population et urbanisation multipliées par 10, réserves de combustible fossile disparues,
- 160 t annuelles de dioxyde de S (X 2), plus de 2 fois plus de N fixé, > 30 % pour CO_2, > 150 % pour CH_4,
- 40 % des terres transformées, la moitié des ressources en eau utilisées, climat et biodiversité affectés,
- Cinq actions majeures sur : cycles biogéochimiques planétaires ; structure, stabilité et productivité des écosystèmes ; composition des faunes et des flores ; physiologie, démographie et génétique des espèces vivantes ; santé et qualité de vie,
- Deux exemples flagrants, ancien, l'Ile de Pâques ; récent, la Mer d'Aral, tragédies écologiques de la planète !

Un éléphant dans un jeu de quilles

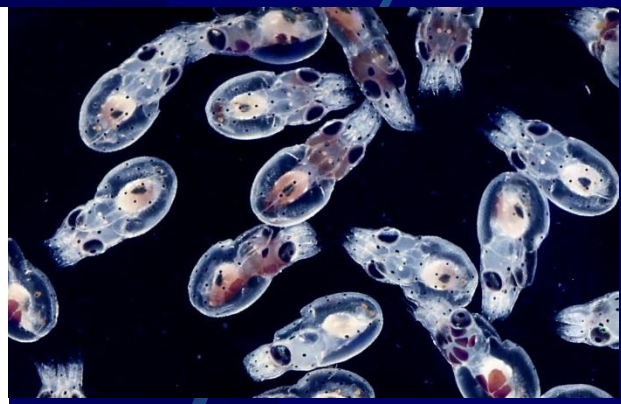
R. Barbault, 2006

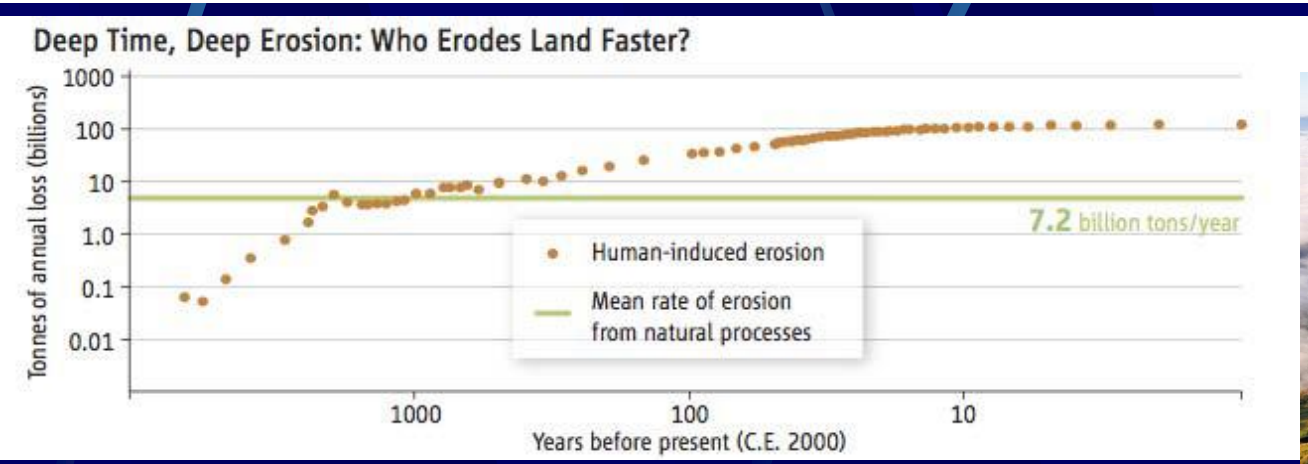
Fall of the Wild …



Global perspective on Anthropocene

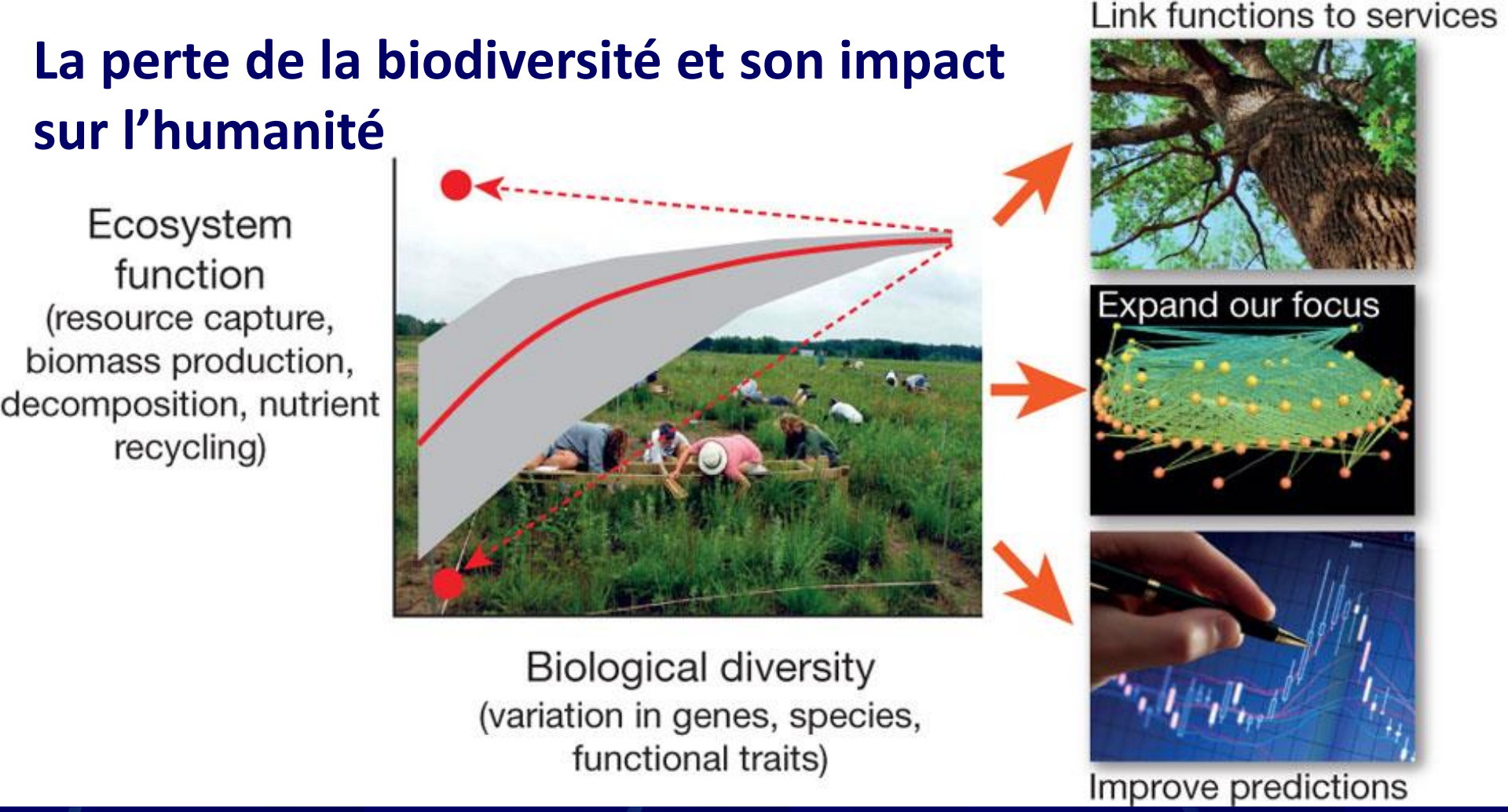
Science 2011 (7 oct), 334:34





Mammal mass: 90 % humans and domestic animals, 0,1 % there are 10 000 years!
2 millions species known, maybe 20? And the human and a few dozens of domesticated species, (one B cows!).To continue to treat and operate « wild species »?

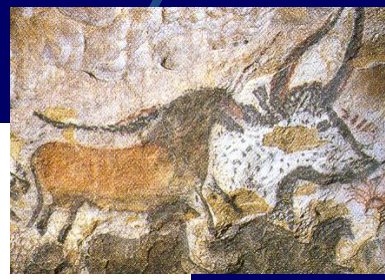
La perte de la biodiversité et son impact sur l'humanité

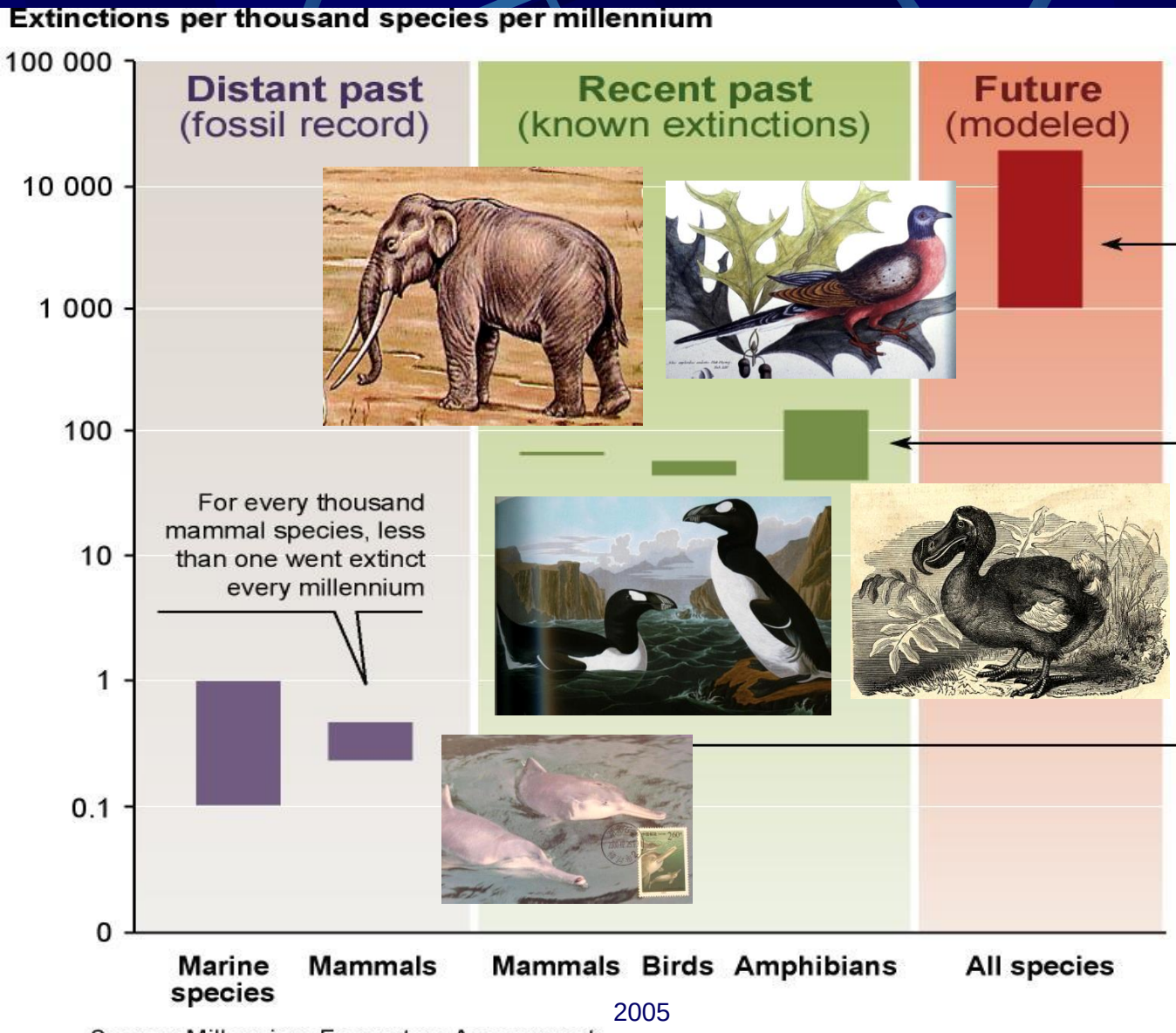


Biodiversity loss and its impact on humanity, Cardinale B J *et al*., June 2012, Nature, 486, 59-67.

The form of a typical diversity–function relationship. This conceptual diagram summarizes what we know about the shape of the biodiversity–ecosystem functioning (BEF) relationship based on summaries of several hundred experiments. The red line shows the average change across all combinations of genes, species, or traits. The grey polygon represents the 95% confidence interval, whereas red dots give maximum and minimum values of the most or least productive species grown alone in monoculture. To improve our predictions of how diversity loss influences the goods and services of ecosystems, we must now take this experimental relationship and (1) link the ecosystem functions measured in experiments to the provisioning and regulating services of ecosystems; (2) expand the focus of research to better mimic realistic extinction scenarios and trophic structures of natural ecosystems; and (3) develop mathematical models that can scale experimental results to whole landscapes.

Les extinctions à travers l'histoire





Projected future extinction rate is more than **ten times higher** than current rate

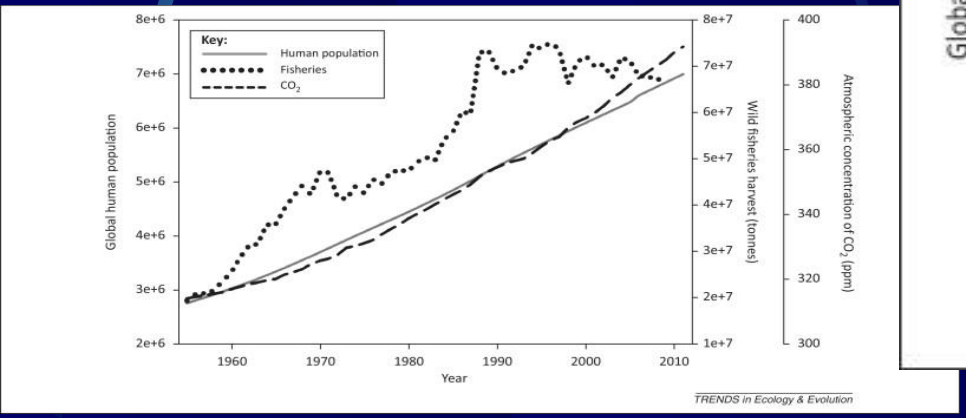
Current extinction rate is up to **one thousand times higher** than the fossil record

Long-term average extinction rate

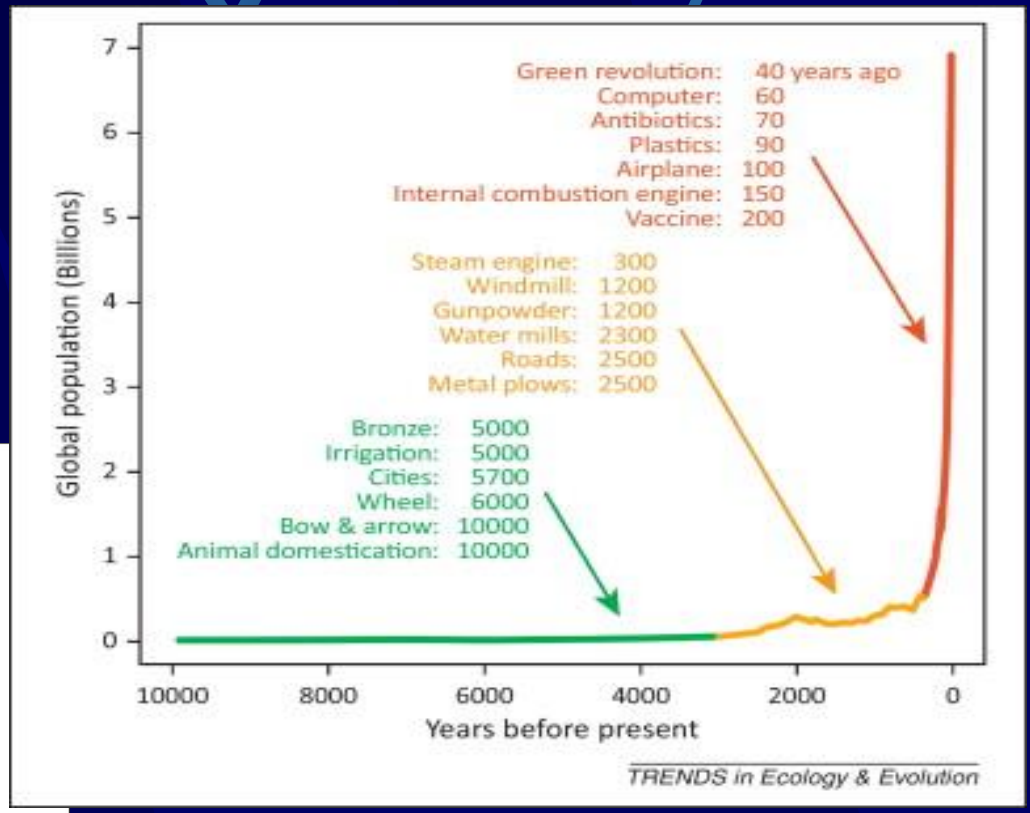
1 Negative population growth for a number of generations, followed by zero growth; 2 A steady-state economy based on sustainable use of renewable energy and material resources; and 3 New social norms that favour the welfare of the entire global population over that of specific individuals and groups. The authors largely rely on biological and/or cultural evolution to attain such goals.

The Malthusian–Darwinian dynamic and the trajectory of civilization

Nekola *et al*., TrEE, March 2013

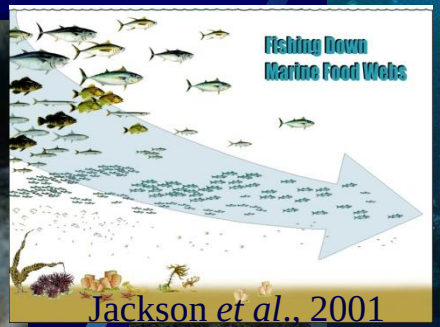


The trajectories of atmospheric CO_2 and wild fisheries harvest in relation to global population since 1955. Note that the increase in CO_2 concentration has accelerated, whereas fisheries harvest reached a peak in the 1990s and has since declined..

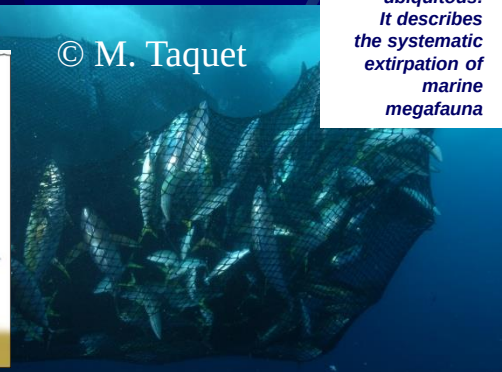


Global human population over the last 10 000 years. Examples of major innovations that have helped to expand human carrying capacity are listed for three time periods in years before present (ybp): 10 000–3000 ybp (green), 3000–300 ybp (orange), and 300 ybp–present (red).

La biodiversité en danger ?



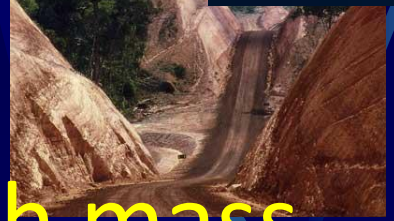
Jackson *et al*., 2001

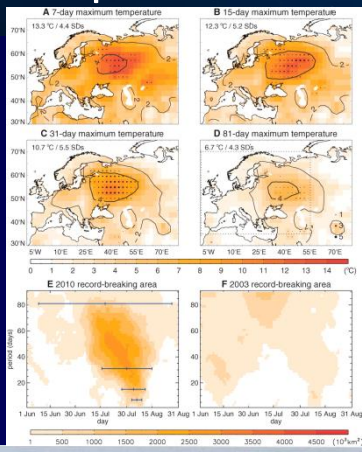


The 'fishing down' effect is ubiquitous. It describes the systematic extirpation of marine megafauna

2 Surexploitation

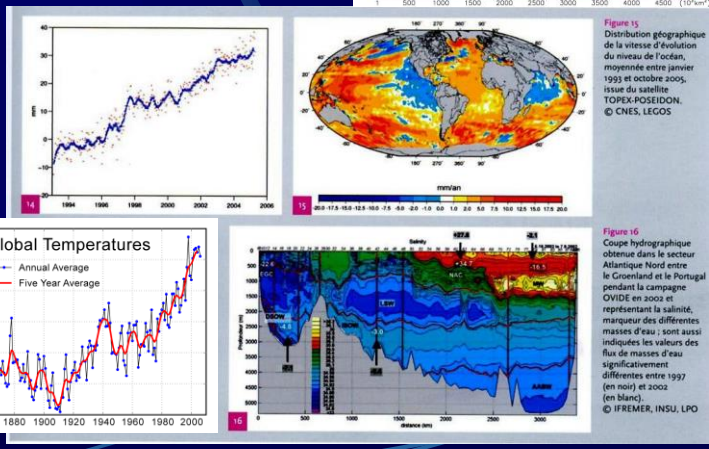
1 Destruction et pollution

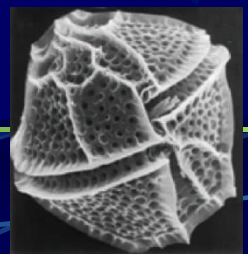




Has the Earth's sixth mass extinction already arrived?

Barnosky *et al*., Nature, 2011





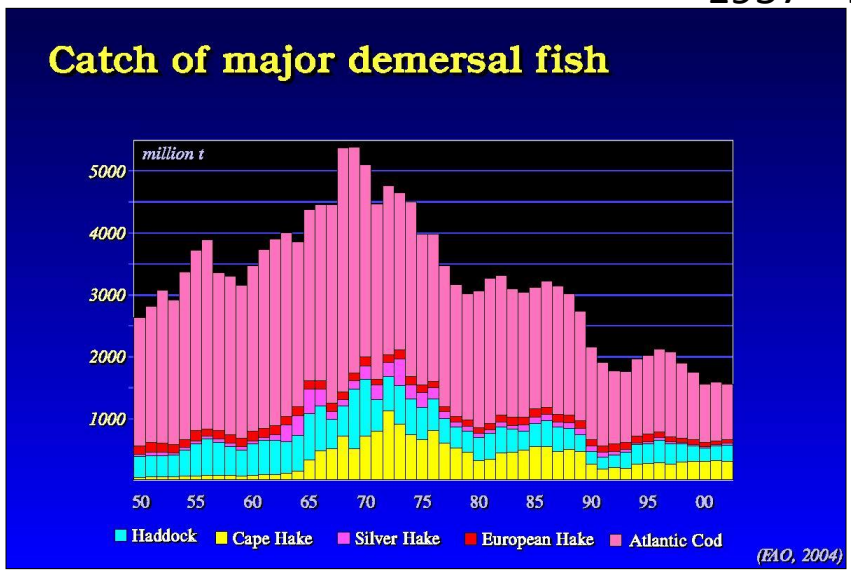
3 espèces invasives

4 Changement climatique

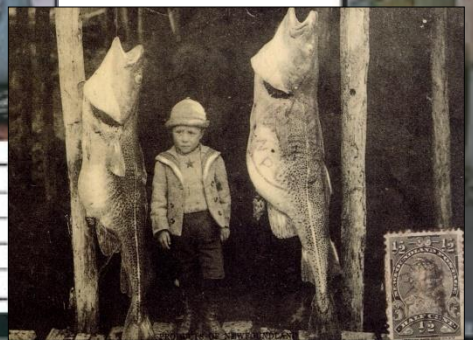
« Shifting baseline »

1926 – Thon rouge en mer du Nord

1957 - Trophées de Key West (USA)

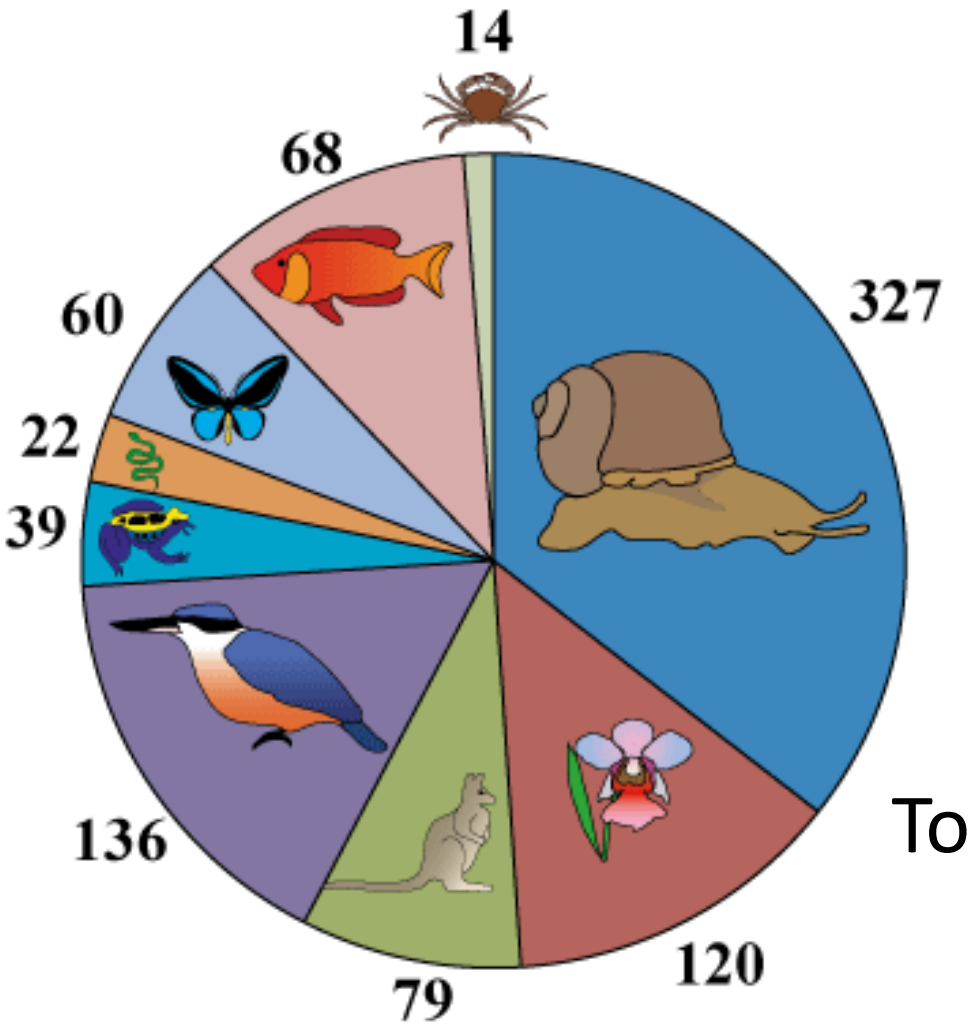


Début des années 80 – Key West



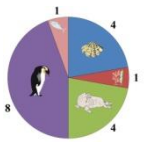
2007 – Key West

Liste Rouge UICN 2012
Espèces éteintes



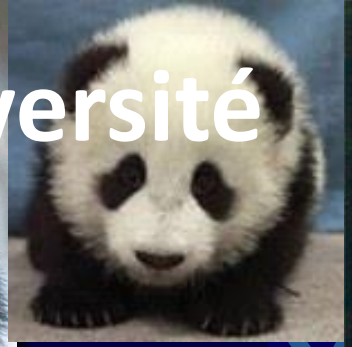
Total : 865

Dont espèces marines



Total 18

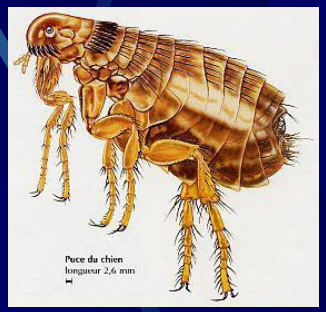
Sauver la biodiversité

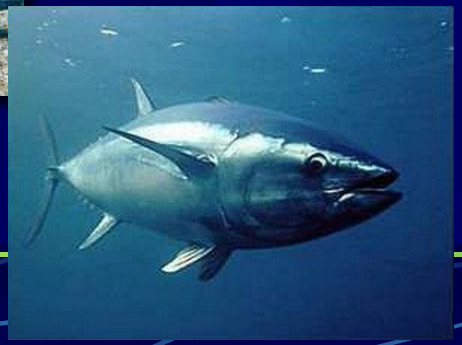


Des espèces emblématiques ?

N espèces « en vrac » ?

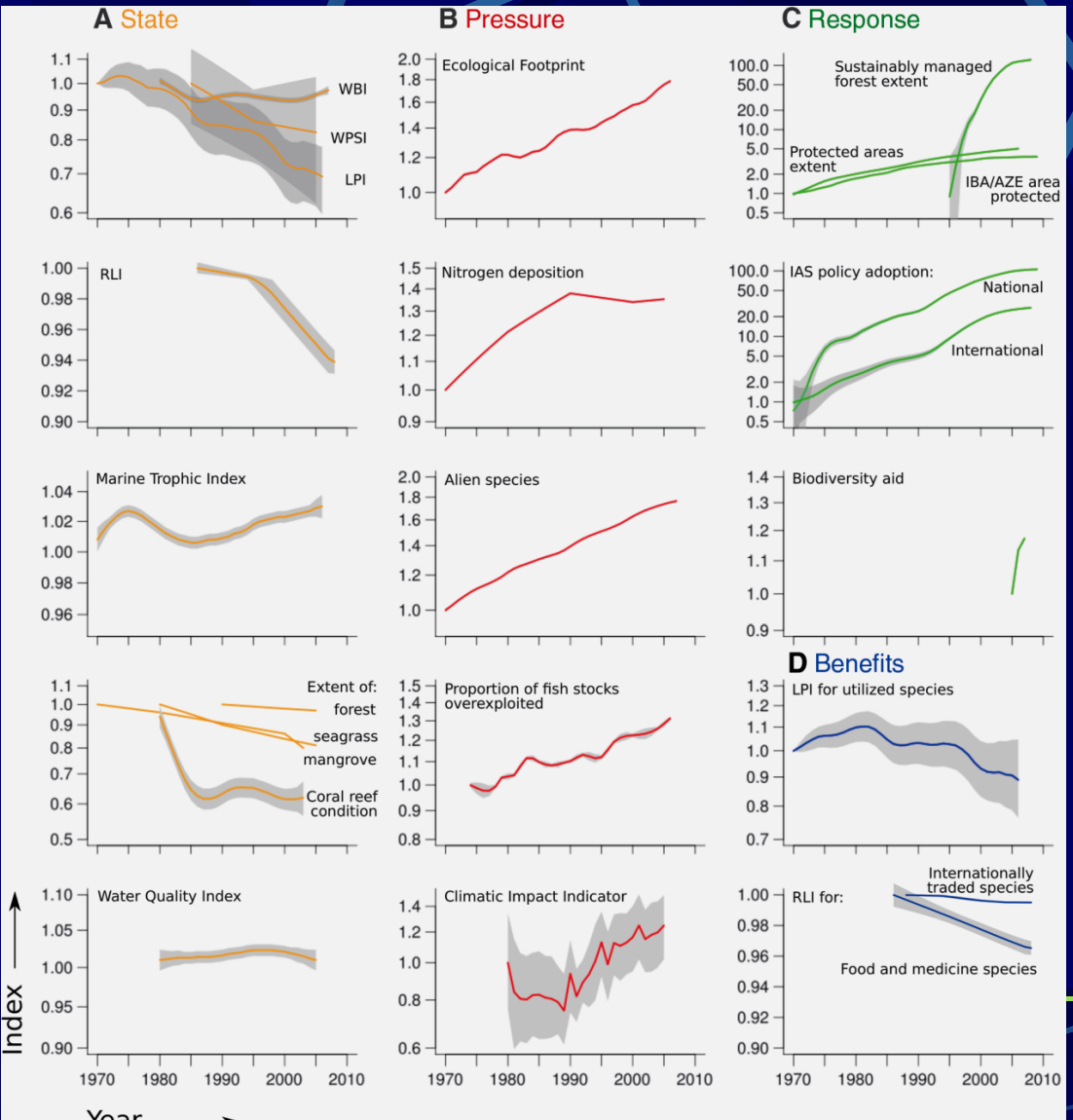
Une espèce qui pullule ?





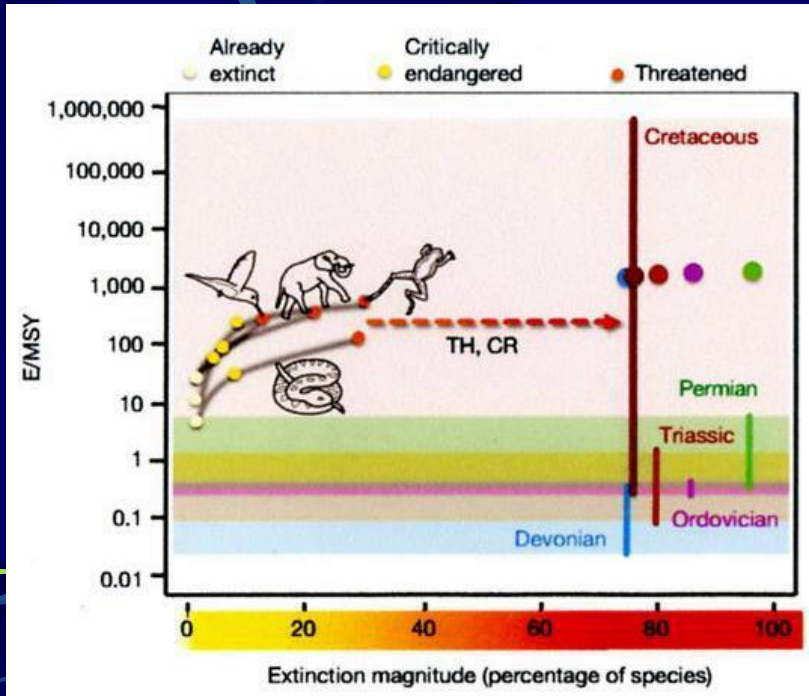
Après 12 années d'«efforts» ?

Tiré de Butchart *et al.*, *Science*, 2010



Indicators trends for: A the state of biodiversity, B pressures upon it, C responses to address its loss, D the benefits human derive from it.

Barnosky *et al.*, Nature, 2011



Securing natural capital and expanding equity to rescale civilization

Ehrlich P R *et al*., Nature, June 2012

Barnosky A D *et al*.. Nature June 2012

BOX 1

Quantifying the values of natural capital under future scenarios

The Natural Capital Project, an international partnership, is developing tools for the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST). These software-based models help decision makers visualize the impacts of potential policies by quantifying and mapping the generation, distribution and economic value of ecosystem services under alternative scenarios[35]. The models span a range of terrestrial and marine services (Box 1 Fig. 1a). They are designed for use in an iterative decision-making process, in which stakeholders identify critical management decisions and explore scenarios of change (for example, demographic, climate, technological). The outputs identify tradeoffs and compatibilities between environmental, economic and social benefits. The models are being applied in a wide range of decision contexts and scales (Box 1 Fig. 1b).

InVEST quantifies and maps

a

Managed timber production	Water purification	Carbon storage and sequestration	Aquaculture	Marine water quality
Crop pollination	Reservoir hydropower production	Aesthetic quality	Fisheries	Renewable energy production
Agricultural production	Groundwater recharge	Recreation	Coastal vulnerability	
Sediment retention	Flood risk and mitigation	Habitat risk and biodiversity	Coastal protection	

Model coming soon

b

Box 1 Figure | Mapping ecosystem services. **a**, The suite of InVEST models, created and being improved through an open-source process. **b**, Applications of InVEST models in major policy decisions so far. Many new applications are now being initiated.

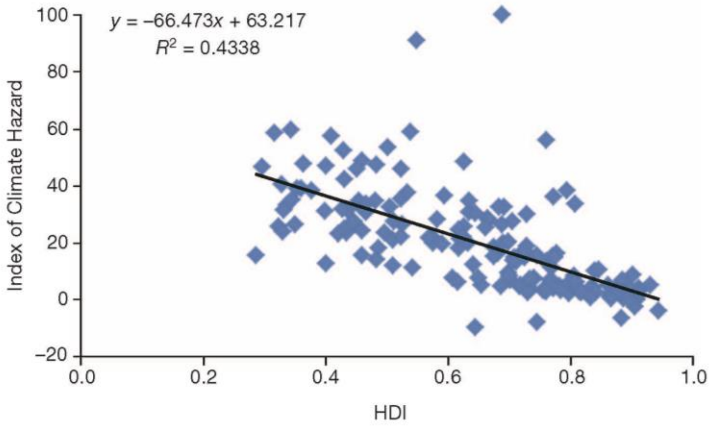


Figure 1 | The relationship between national-level poverty (as measured by HDI) and vulnerability (as measured by the Index of Climate Hazard). The HDI combines indicators of life expectancy, educational attainment and income into a composite index that ranges between 0 and 1 (data taken from the UN Development Programme Human Development Report; http://hdr.undp.org/en/statistics/hdi/). The Index of Climate Hazard combines three dimensions of climate risk: sea level rise and storm surge, extreme weather events, and reduced agricultural productivity, taken from D. Wheeler[99]; this climate hazard represents the expected near-term increase in risk (that is, from 2008 to 2015). The two outliers are China (0.687, 100) and India (0.547, 90.8), probably owing to their very large populations and large, climatically diverse land areas, serious water problems, and long coast lines.

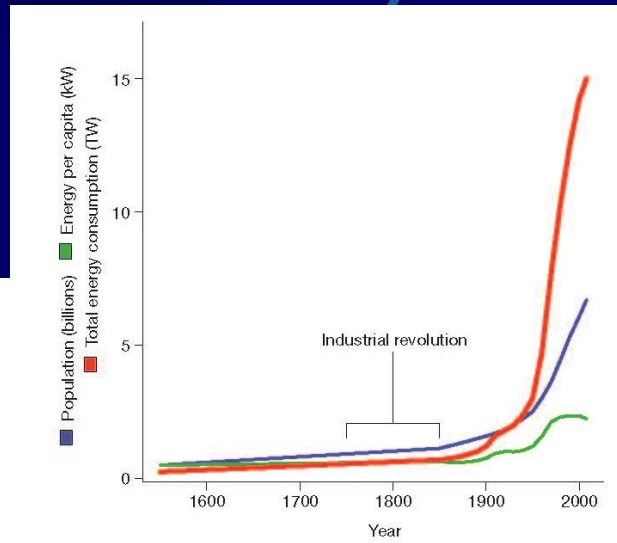


Figure 2 | History of growth in world population and environmental impact of *Homo sapiens*, indicated by its surrogates, per capita and total human energy use. Note the more than 20-fold increase in total energy use since the industrial revolution, with the growth caused slightly more by population increase than by expansion of per capita consumption[100] (Population Reference Bureau, UN, World Population Projections to 2100 (1998), and US Energy Information Administration).

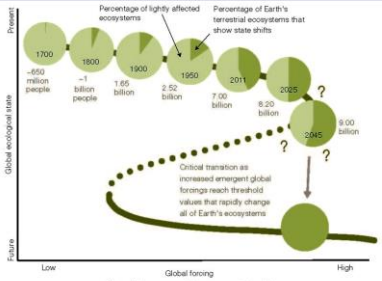
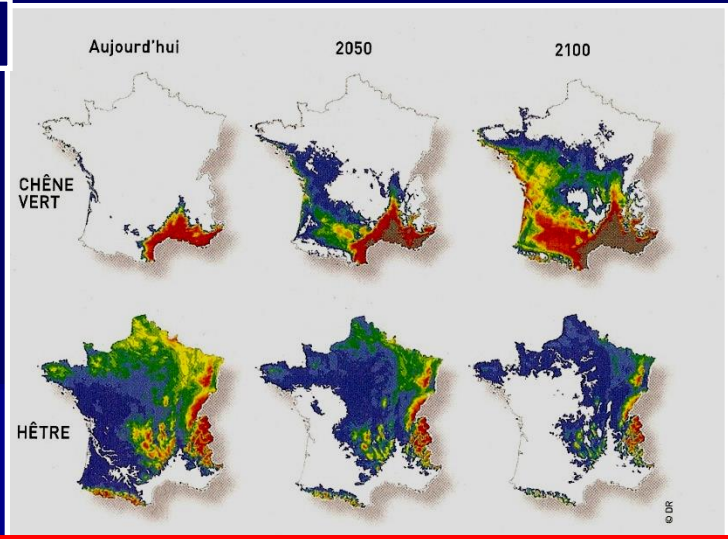


Figure 2 | Quantifying land use as one method of anticipating a planetary state shift. The trajectory of the green line represents a fold bifurcation with hysteresis[24]. At each time point, light green represents the fraction of Earth's land that probably has dynamics within the limits characteristic of the past 11,000 yr. Dark green indicates the fraction of terrestrial ecosystems that have unarguably undergone drastic state changes; these are minimum values because they count only agricultural and urban lands. The percentages of such transformed lands in 2011 come from refs 1, 34, 35, and when divided by 7,000,000,000 (the present global human population) yield a value of approximately 2.27 acres (0.92 ha) of transformed land for each person. That value was used to estimate the amount of transformed land that probably existed in the years 1800, 1900 and 1950, and which would exist in 2025 and 2045 assuming conservative population growth and that resource use does not become any more efficient. Population estimates are from refs 31–33. An estimate of 0.68 transformed acres (0.28 ha) per capita (approximately that for India today) was used for the year 1700, assuming a lesser effect on the global landscape before the industrial revolution. Question marks emphasize that at present we still do not know how much land would have to be directly transformed by humans before a planetary state shift was imminent, but landscape-scale studies and theory suggest that the critical threshold may lie between 50 and 90% (although it could be even lower owing to synergies between emergent global forcings). See the main text for further explanation. Billion, 10^9.

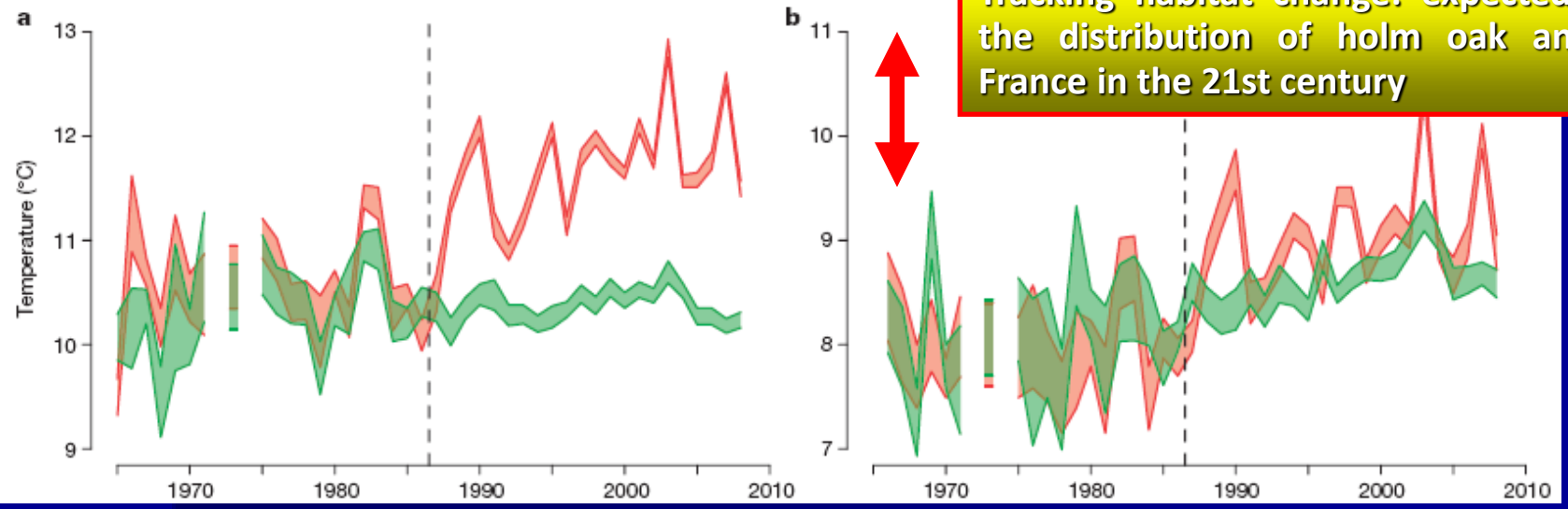
Dupouey *et al.* 2004

Lowland plant lag behind climate warming

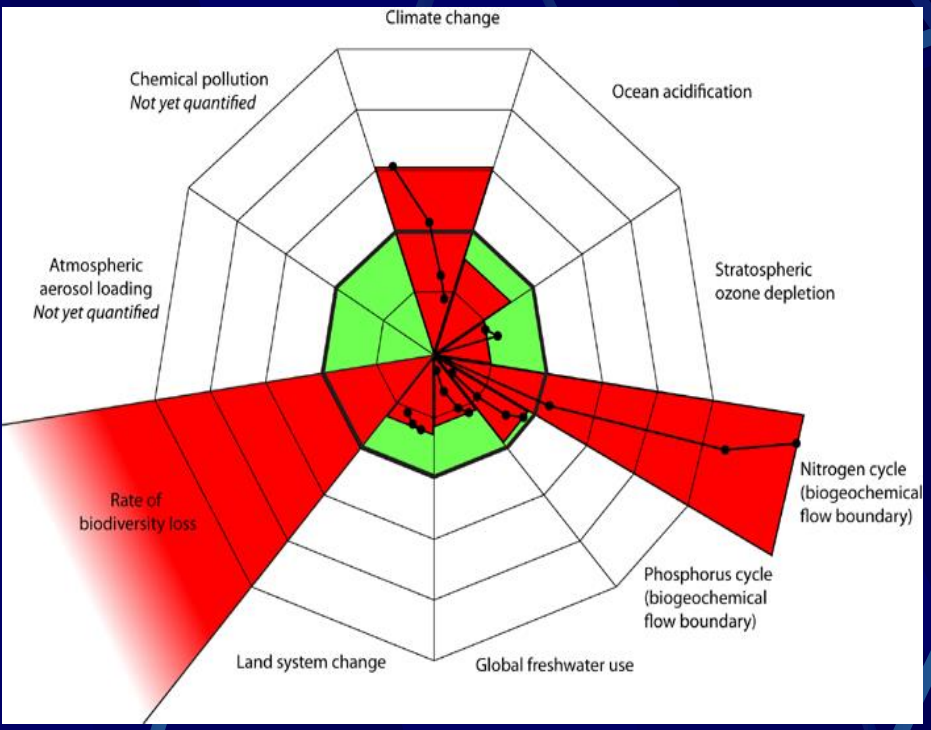
R. Bertrand *et al, Nature* 2011, 479, 517-520



Tracking habitat change: expected changes in the distribution of holm oak and beech in France in the 21st century



Comparison of floristically (green) and climatically (red) reconstructed temperature trends 1965 - 2008.
a, Trends in lowland forest plant communities (<500m a.s.l.).
b, Trends in highland forest plant communities (500–2,600m a.s.l.). The thickness of lines shows the range of reconstructed temperature trends (n=1,000 trends). Dashed lines indicate the start of the contemporary climate warming period (1987–2008). Breaks in trends are due to no sample convergence for the years 1965 (in highland areas), 1972 and 1974 (in both lowland and highland areas).



Estimate of quantitative evolution of control variables for seven planetary boundaries from preindustrial levels to the present . The inner (green) shaded nonagon represents the safe operating space with proposed boundary levels at its outer contour. The extent of the wedges for each boundary shows the estimate of current position of the control variable. Points show the estimated recent time trajectory (1950–present) of each control variable. For biodiversity loss, the estimated current boundary level of >100 extinctions per million species-years exceeds the space available in the figure. Although climate change, ocean acidification, stratospheric ozone depletion, land-use change, freshwater use, and interference with the phosphorus cycle are boundaries defined as the state of a variable (concentration of atmospheric CO2, aragonite saturation state, and stratospheric ozone concentration, percentage of land under crops, maximum amount of global annual freshwater use, cumulative P loading in oceans, respectively), the remaining boundary, biodiversity loss, and the component of the biogeochemical boundary related to the human interference with the N cycle are defined by rates of change for each respective control variable (extinctions per million species per year, rate of N2 removed from atmosphere for human use).

Rockström *et al*., Ecology and Society, 2009, Nature, 475, 2009,

Planetary Boundaries: Exploring the Safe Operating Space for Humanity

Conférence de Rio, juin 1992,
Conférence de Johannesburg, août 2002,
Conférence de Paris, janvier 2005,
Conférence de l'Unesco, Paris janvier 2010
Rio + 20, juin 2012,
Conférences Environnementales, Paris, sept 2012 et 2013

La conférence française pour la biodiversité

Du 10 au 12 mai 2010
Chamonix-Mont-Blanc

Quelle gouvernance pour réussir ensemble ?

Ressources, territoires, habitats et logement
Énergie et climat Développement durable
Prévention des risques infrastructures, transports et mer

Présent pour l'avenir

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

GRENELLE ENVIRONNEMENT ENTRONS DANS L'ACTE D'APRÈS
2010 Année Internationale de la Biodiversité

chamonix MONT-BLANC

Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer,
en charge des Technologies vertes et des Négociations sur le climat

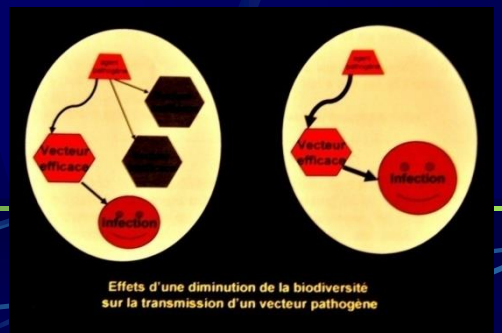
www.developpement-durable.gouv.fr

Biodiversité et pathologies infectieuses

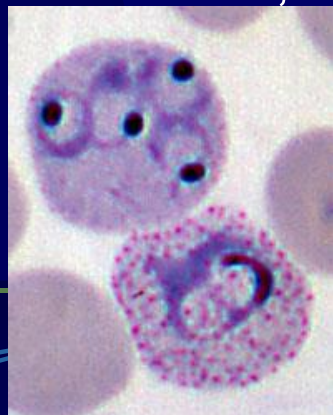
- *"…Mounting evidence indicates that biodiversity loss frequently increases disease transmission. In contrast, areas of naturally high biodiversity may serve as a source pool for new pathogens.*
- *Overall, despite many remaining questions, current evidence indicates that preserving intact ecosystems and their endemic biodiversity should generally reduce the prevalence of infectious diseases…"*

Keesing *et al*., Nature, Dec 2010

La diversité spécifique, support hôtes et pathogènes,
La biodiversité érodée : « champs libre » pour le développement d'espèces opportunistes,
Les disséminations inconsidérées, volontaires ou non, le changement d'hôtes,
Changement climatique et santé, les besoins de « nature ».

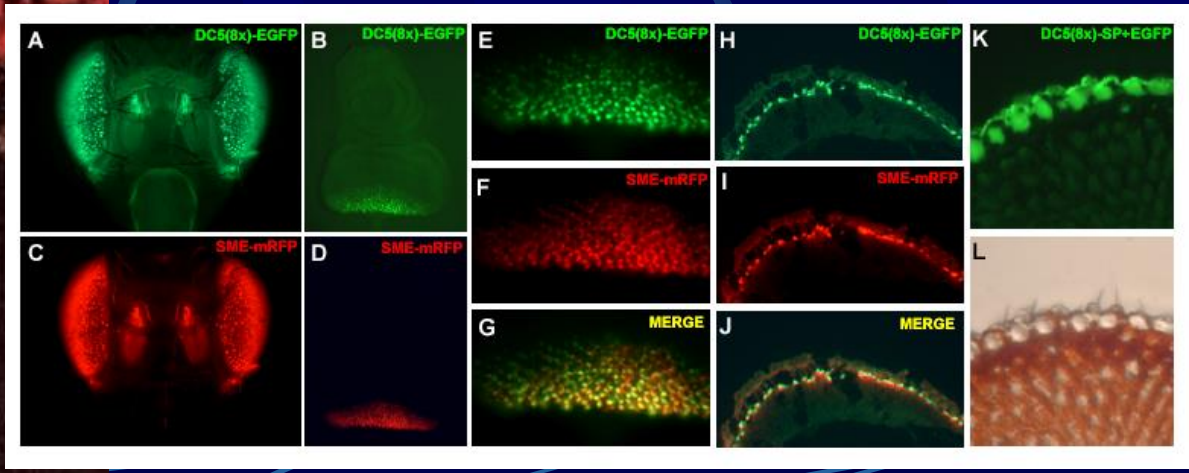


Effets d'une diminution de la biodiversité sur la transmission d'un vecteur pathogène

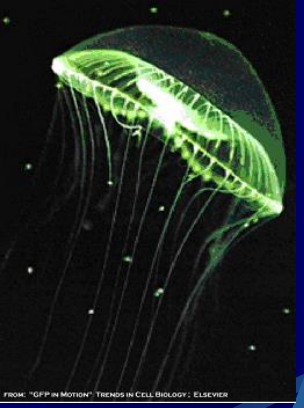


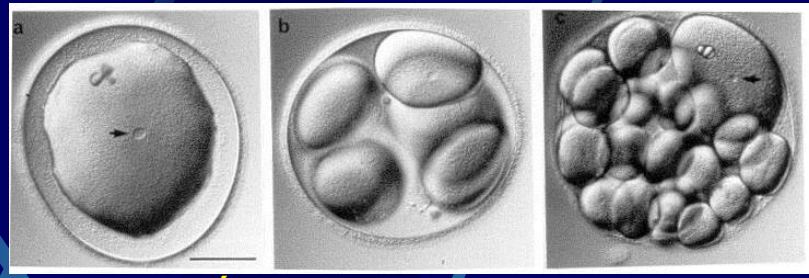
Molécules d’intérêt pharmacologique

- Environ 50 % des molécules actives aujourd’hui utilisées en pharmacie sont extraites ou synthétisées à partir de produits naturels
- Plus de 25 000 produits ont été isolés d ’organismes marins et certains sont passés en utilisation courante : anticancer Ara-C (leucémie myélocytique aigüe et lymphome non-Hodgkin), anti-viral Ara-A (herpès), nucléosides isolés d ’éponges, bryostatine (de bryozoaire), antiviraux bactériens (anti-HIV)... Sondes moléculaires, 30 % des substances ont été trouvées chez les spongiaires,
- Anti-cancereux ,antibiotiques, antiviraux, anti-fungi, immunostimulants, immunosuppresseurs, facteurs, de croissance, régénérateurs osseux,…. outils moléculaires (polymérases, protéines de fluorescence… *etc*…) .



Régulation du cycle cellulaire et cancer

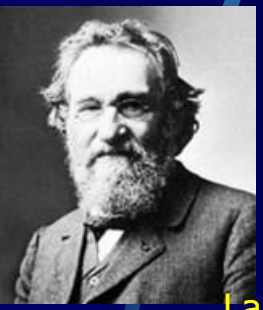




Vée *et al.*, *J. Cell Science*, 2001

Onze Prix Nobel obtenus à partir de modèles aquatiques

E Metchnikoff 1908



O von Warburg 1931

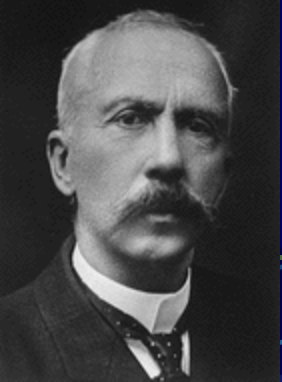
J W Szostak

EH Blackburn 2009

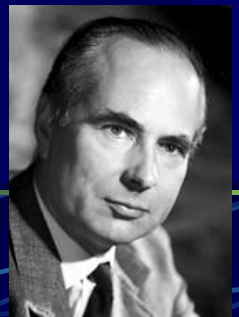
C W Greider

La phagocytose, les vagues calciques intra-cellulaires, le choc anaphylactique, les modalités de la transmission de l'influx nerveux, les bases moléculaires de la mémoire, les molécules-clé du cancer, le premier récepteur membranaire à un neurotransmetteur, la protéine de fluorescence verte de méduse, l'enzyme télomérase…

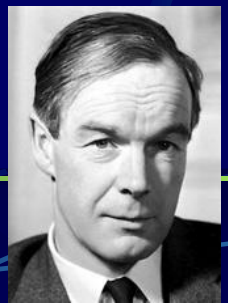
C Richet 1913



A Hodgkin 1963



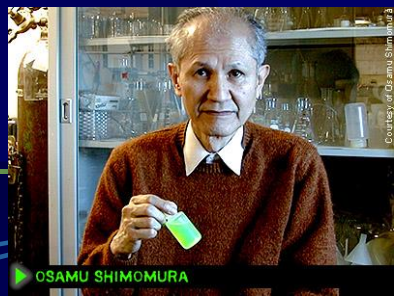
A Huxley



E Kandel 2000

T Hunt 2001

O Shimomura 2008



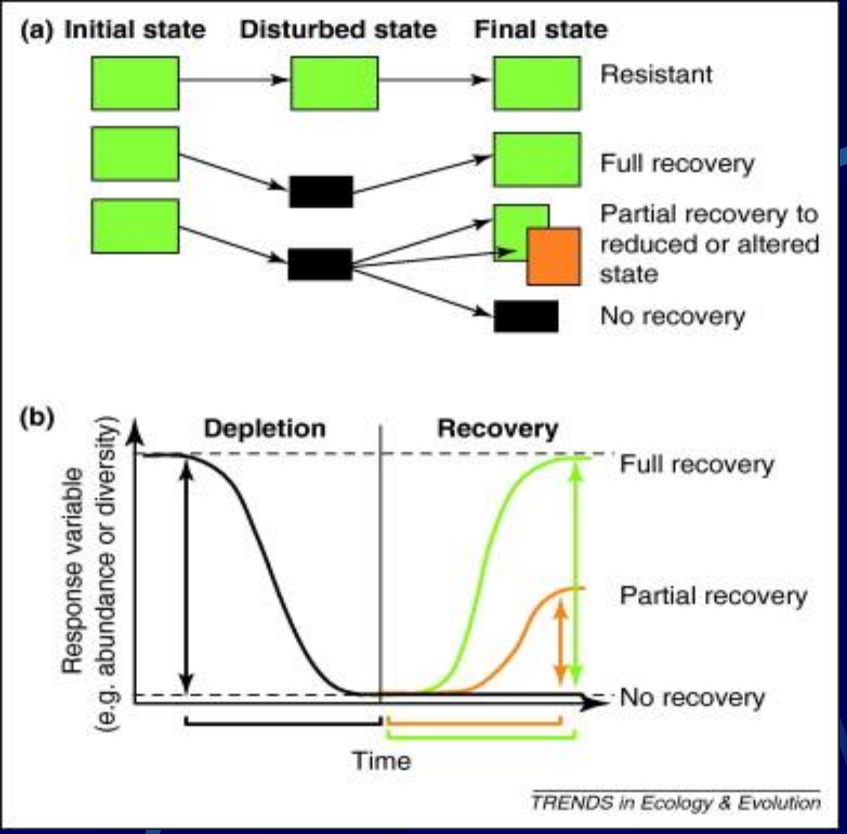
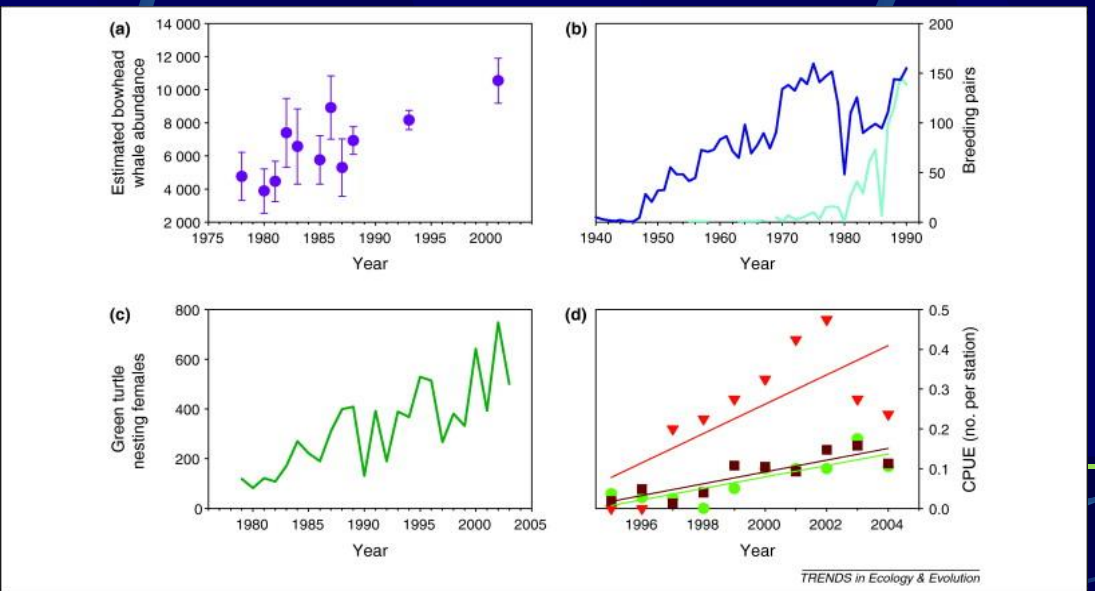


Illustration of theoretical and practical aspects of recovery. **(a)** In the face of external disturbances, populations or ecosystems can be resistant and remain fundamentally unchanged (green boxes) or they can be disturbed (depleted or degraded; dark-gray boxes) and, afterwards, either fully recover to their initial state, partially recover to a reduced or altered state (orange box), or irreversibly remain in the disturbed state. **(b)** Recovery can be measured as the magnitude (arrows), rate (slope) and time of increase (or sometimes decrease) in a response variable, and compared to the magnitude, rate or time of previous depletion or degradation. Note that 'no recovery' could also consist of further decline or degradation.

Recovery of marine animal populations and ecosystems

Lotze *et al.*, TrEE, Nov 2011



Selected examples of population recovery: **(a)** Estimated abundance and standard deviation for the western Arctic bowhead whale stock. **(b)** Breeding pairs of recovering shelducks *Tadorna tadorna* (dark-blue line) and recolonized common eiders *Somateria mollissima* (light-blue line) in Niedersachsen, German Wadden Sea. **(c)** Abundance of green turtle nesting females since 1979 at the Ogasawara rookery on Chichi-jima, Japan. **(d)** Catch per unit effort (CPUE; and linear regression lines) of giant sea bass *Stereolepis gigas* (green circles), soupfin shark *Galeorhinus galeus* (red triangles) and leopard shark *Triakis semifasciata* (×10; brown squares) from a monitoring program after the ban of gill nets in 1994 in the Southern California

- Abandonner la conception de la conservation de la nature à l'écart des humains…L'Homme n'est pas extérieur à la Nature, il en fait partie !
- Analyse de « *l'empreinte écologique* »,
- L'écologie visitée à travers les modèles de l'économie : 40% de l'économie mondiale reposent sur les produits biologiques et les processus écologiques

Economie et écologie : la réconciliation ?

Et surtout, mieux partager les ressources !

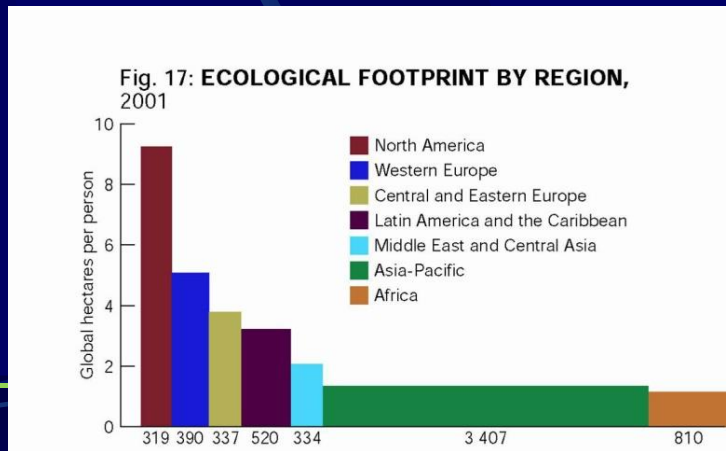
continuer dans un monde où 20 % des humains contrôlent 80 % des ressources ?

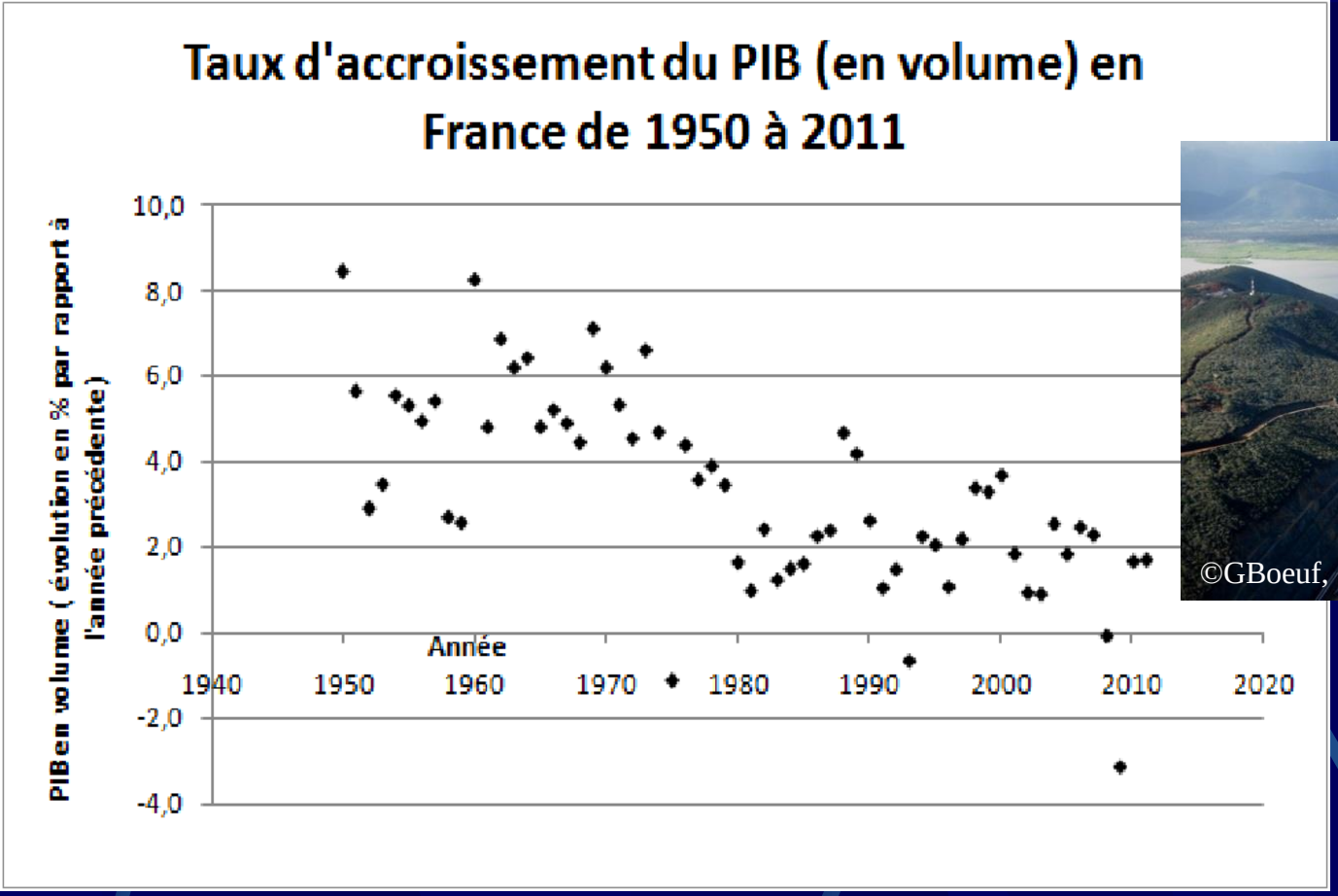
Appel du 20 juillet 2006 dans *Nature*

Appel de Paris le 3 février 2007, ONUE

Grenelle de l'environnement, octobre 2007, Grenelle de la mer, juin 2009

Création d'IPBES janvier 2013

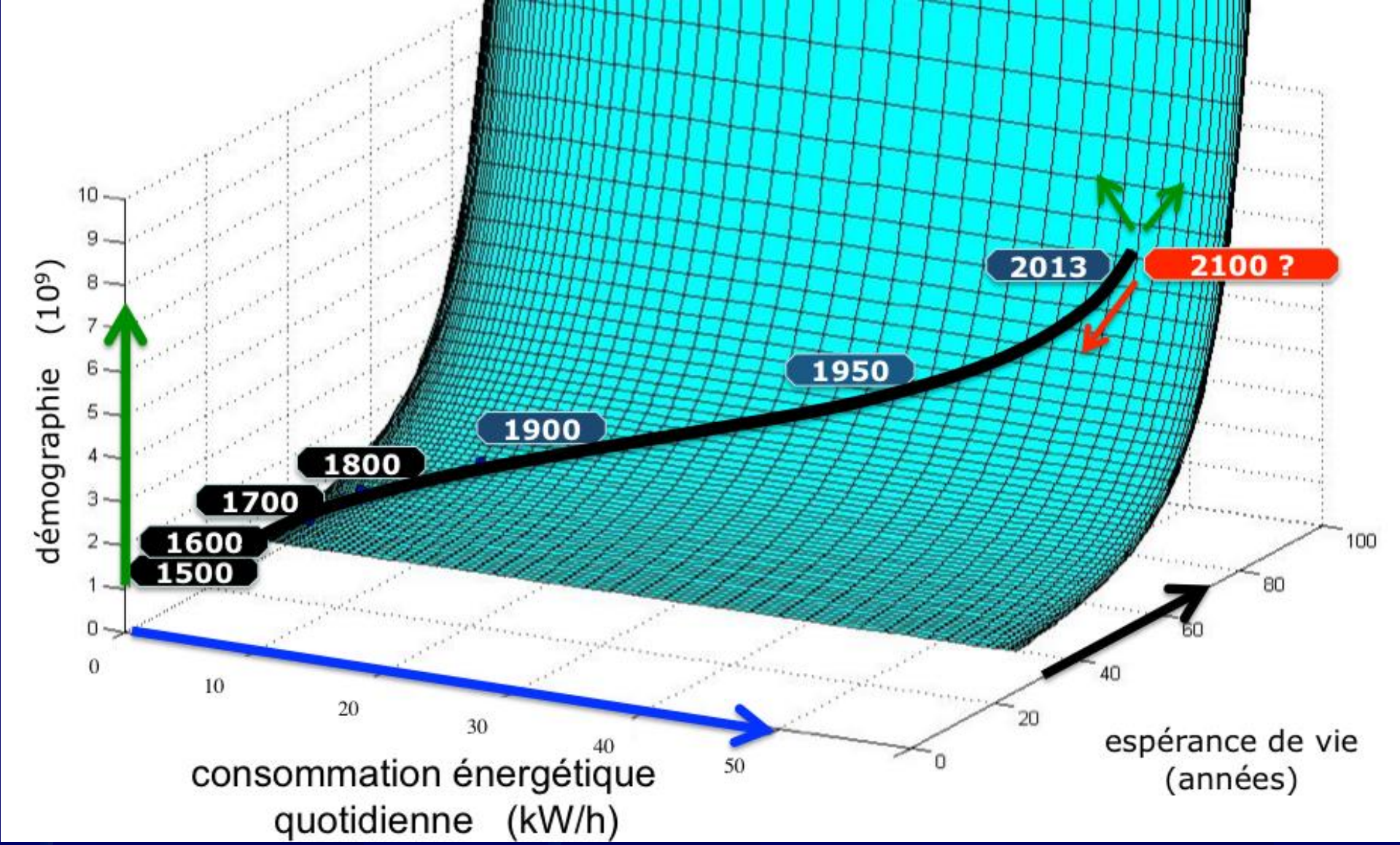




Le taux d'accroissement du PIB, après une augmentation importante au cours des années 1950-1970 (Les « Trente Glorieuses ») connait une stagnation depuis vingt ans et se négative de plus en plus souvent. Données INSEE 2013.

La principale question réside maintenant dans la possibilité de maintenir des valeurs nulles (c'est le cas du Japon depuis 20 ans) faute de quoi l'enchainement de chiffres de plus en plus négatifs, signera le recul économique et ses conséquences sociales historiquement classiques .

Robert Costanza, 2013, « la croissance du PIB ne contribue plus à l'amélioration du bien-être ! Celui qui croit qu'une croissante exponentielle peut continer infiniment dans un monde fini est soit un fou soit un économiste ! Ne pas focaliser sur la croissance matérielle, mais sur le vivre mieux ! ».



Evolution conjointe de la démographie et de l'espérance de vie humaines selon l'énergie consommée per capita (moyennes mondiales) au cours des derniers siècles. À mesure que la consommation énergétique s'accroît, la démographie et l'espérance de vie augmentent ; cependant, leurs relations ne sont pas linéaires mais logistiques ou logarithmiques. La dernière période montre un relèvement de la surface des possibles, aboutissant à un rendement moins important de l'énergie dissipée dans le « système *sapiens* ». Ses gains d'espérance de vie sont alors plus faibles (*source données : ONU, AIE 2012, méthodologie : Irmes,* Marck *et al.*, 2013), .

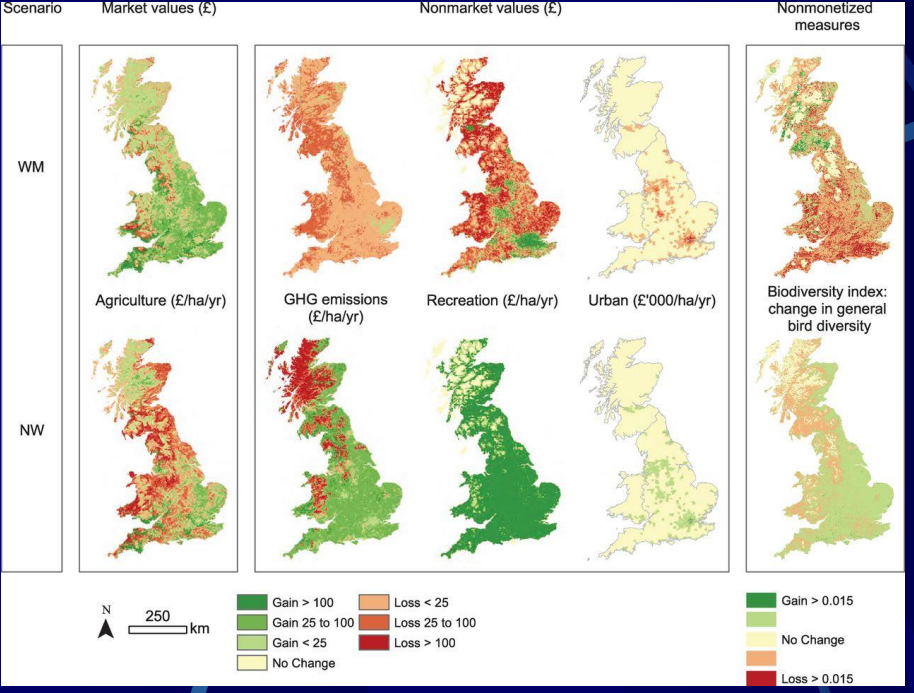
Economie et écologie

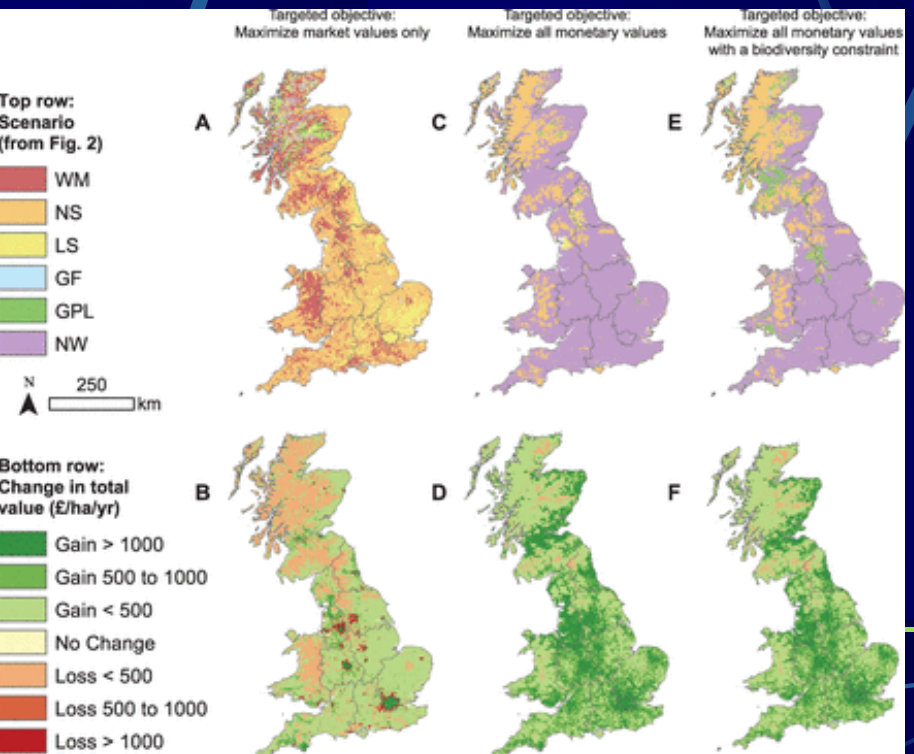
- Organisation économique actuelle anthropocentrée : création de richesses par destruction des écosystèmes et surexploitation, non durable dans un monde fini

- Organisation future écocentrée : création de richesses par optimisation des fonctions, développement des solidarités par un nouveau « vivre-ensemble », solidarité écologique, économique et sociale

J Weber, 2011

Les conditions d'un développement durable





Spatial distribution of the changes in market and nonmarket ecosystem service economic values and nonmonetary wild species–diversity assessments.

Bringing Ecosystem Services into Economic Decision-Making: Land Use in the United Kingdom

Bateman *et al.*, Science, 341, 6041, 45-50, July 2013

Optimal scenarios and changes in value. Optimal scenarios (**A**, **C**, and **E**) for each 2-km grid square and corresponding changes in value from 2010 to 2060 (**B**, **D**, and **F**) in Great Britain under three alternative targeted objectives: (i) conventional approach maximizing market values only (A and B); (ii) maximizing the value of all those ecosystem services that can be robustly monetized (C and D); (iii) maximizing all ecosystem service values but with a constraint so that no scenario that gives a net loss of wild bird diversity is permitted in the area affected (E and F).

S’inspirer ?
La vie, quelle entreprise* !

- S’inspirer des formes,
- S’inspirer des mécanismes,
- S’inspirer des relations durables établies,
- Très grande interdisciplinarité.

Humilité,
Harmonie,
Partage et Respect

*R Barbault et J Weber, 2011

D'un point de vue opérationnel, la biodiversité c'est :

- **Une priorité scientifique (comprendre sa genèse, ses fonctions et enrayer son érosion)**
- **Un enjeu économique (ressources biologiques et génétiques à valoriser et partager)**
- **Un enjeu éthique (droit à la vie des espèces)**
- **Un enjeu social (partage des valeurs et des avantages)**

(termes de la CDB)

Ce concept associe étroitement les sciences de la nature et celles de l'homme et de la société

J Blondel, 2007

L'Homme peut-il s'adapter à lui-même ?

Colloque au MNHN, 29-30 oct 2010, « *L'Homme peut-il s'adapter à lui-même ?* », premier volet,
Fondation des Treilles, 7-11 nov 2011, « *La biodiversité, état des lieux et perspectives* »,
Colloque au MNHN, 12 sept 2012, « *Adaptation, persistance, extinction* »,
Colloque au MNHN, 10 déc 2012, « Systèmes bio-inspirés : une opportunité pour la transition écologique ? »,
Colloque au Collège de France, 22-23 mai 2014, « *L'Homme peut-il s'adapter à lui-même ?* », second volet.