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Ευρωπαϊκή Ένωση  
Ευρωπαϊκό Κοινωνικό Ταμείο



ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ  
ΕΚΠΑΙΔΕΥΣΗ ΚΑΙ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗ  
επένδυση στην κοινωνία της γνώσης

ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ ΚΑΙ ΘΡΗΣΚΕΥΜΑΤΩΝ  
ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ

Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

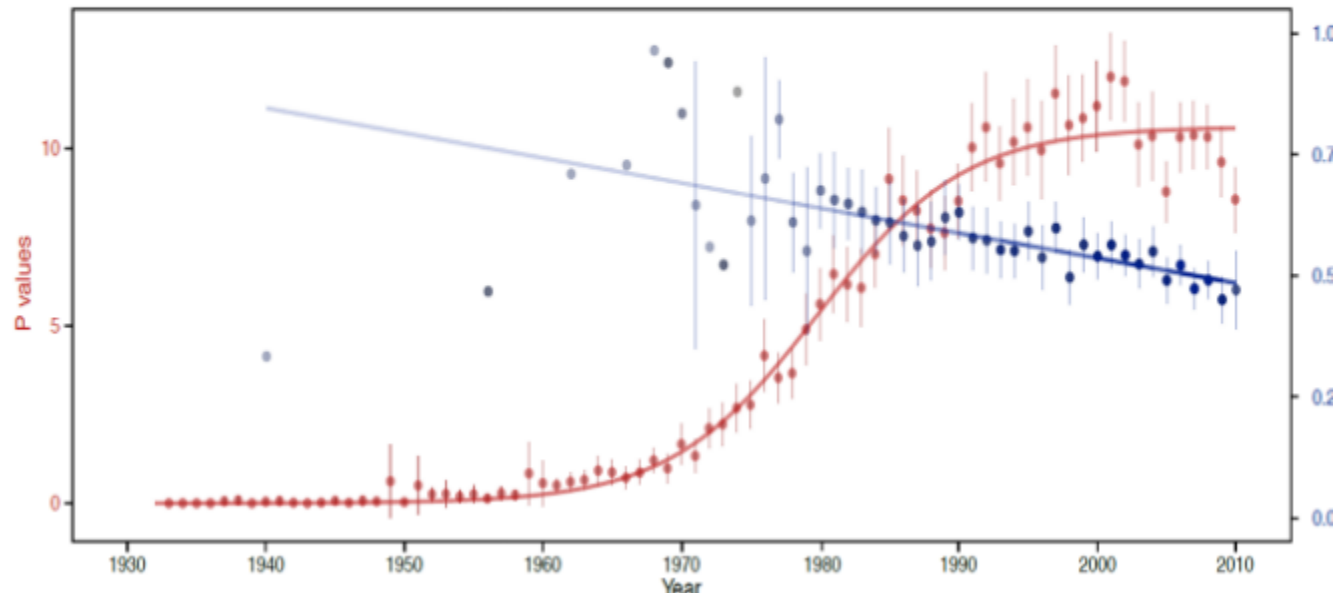


ΕΣΠΑ  
2007-2013  
πρόγραμμα για την ανάπτυξη  
ΕΥΡΩΠΑΪΚΟ ΚΟΙΝΩΝΙΚΟ ΤΑΜΕΙΟ

# ΠΕΓΑ: Βιοτικοί Πόροι- Τεχνικές Μελέτης και Αξιολόγησης Διάλεξη 3: Οι μεγάλες εξελίξεις

## Ecology's troubling statistical trends

The number of reported P values (red, average per paper) has risen, while R2 values have dropped (blue, average per year).



Ανδρέας Τρούμπης  
Καθηγητής Οικολογίας

2014-2015

Η πράξη «Περιβαλλοντική Διαχείριση-Σύγχρονα Εργαλεία», του Επιχειρησιακού Προγράμματος «Εκπαίδευση και Δια Βίου Μάθηση», συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ευρωπαϊκό Κοινωνικό Ταμείο-ΕΚΤ) και από Εθνικούς Πόρους.

## Τί το θεμελιώδες έχουμε μάθει τα τελευταία 20 χρόνια για την Οικολογία ως επιστήμη εφαρμογής;

- Καλύτερη κατανόηση της Στατιστικής μεθόδου
- Σημασία των Big Data
- Νέα θεώρηση της Μαλθουσιανής διαμάχης
- Σύνδεση πολιτικής, οικονομίας και ιδεολογίας: το παράδειγμα των καμπυλών Kuznets (ΕΚC)
- Λειτουργική σχέση Βιοποικιλότητας και Οικοσυστημικών Διεργασιών (BEF)
- Έννοια των «κοινωνικο-οικολογικών» συστημάτων (SES)
- Οικονομική αξία των βιοτικών πόρων

# Τί το θεμελιώδες έχουμε μάθει τα τελευταία 20 χρόνια για την Οικολογία ως επιστήμη εφαρμογής;

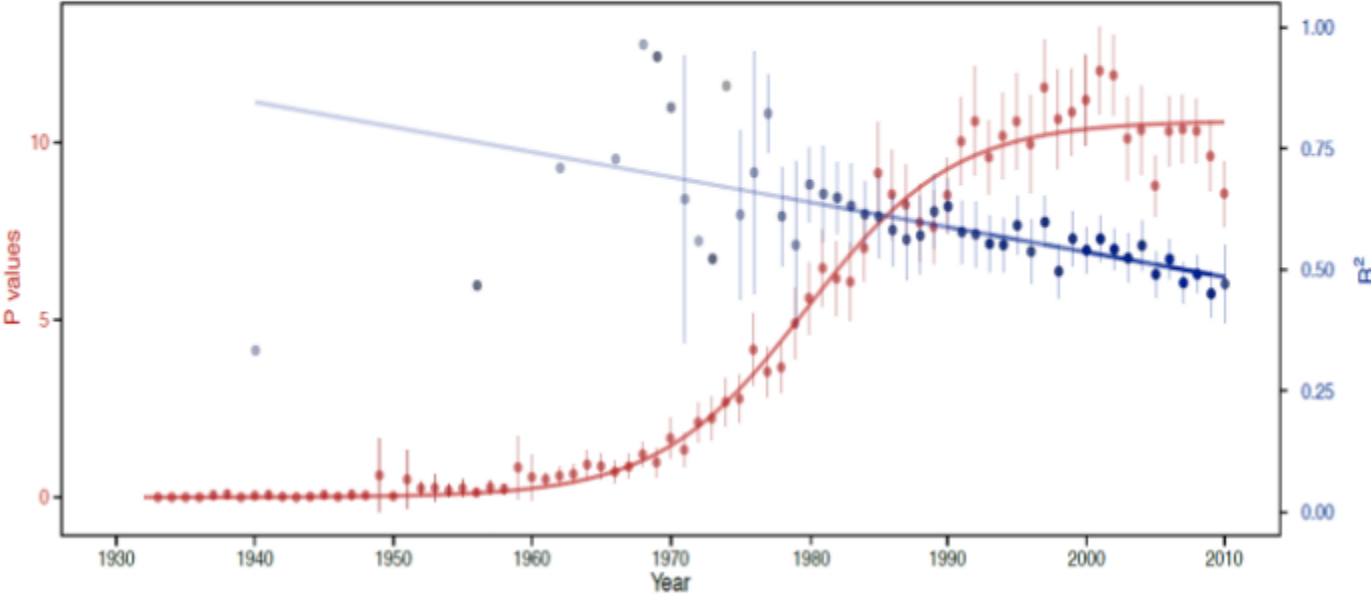
- As in many sciences, Ecology has become less descriptive and more quantitative as it matured (Science, 2014).
- The search for high significance in experiments: the proliferation of P values (which is happening in many fields) concerns statisticians, because the value by itself doesn't say anything about the size of the effect or its biological significance. Nearly half of all papers in Ecology did not appear to include other statistics that would clarify for readers whether the result had a major ecological impact. The more P values that are calculated, the higher the odds that any given result will appear to be significant even if it's just the result of chance.
- Η ατέρμων επιδίωξη της βεβαιότητας σε έναν πολύπλοκο Κόσμο είναι αλυσιτελής καθότι η στατιστική ποσοτικοποίηση εμπεριέχει την αβεβαιότητα!
- Το γεγονός αυτό ευρίσκεται στον πυρήνα της δυσχέρειας μετασχηματισμού της οικολογικής γνώσης σε περιβαλλοντική πολιτική!
- Οικονομία, ιδεολογία, αξίες, ...

# Rising complexity and falling explanatory power in ecology.

Etienne Low-Décarie, Corey Chivers, and Monica Granados 2014. Rising complexity and falling explanatory power in ecology. *Frontiers in Ecology and the Environment* **12**: 412–418.

## Ecology's troubling statistical trends

The number of reported P values (red, average per paper) has risen, while R2 values have dropped (blue, average per year).



## Rising complexity and falling explanatory power in ecology.

Etienne Low-Décarie, Corey Chivers, and Monica Granados 2014. Rising complexity and falling explanatory power in ecology. *Frontiers in Ecology and the Environment* **12**: 412–418.

- Low-Décarie et al. 2014 downloaded 18,076 articles, dating back to 1913, from three journals that cover a range of ecological research: the *Journal of Ecology*, the *Journal of Animal Ecology*, and *Ecology*. Rising complexity and falling explanatory power in ecology
- Ecologists are testing more and more hypotheses, but their studies are explaining less of the world.
- Ecologists have made major contributions to shaping modern views of how the natural world works, from documenting competition and cooperation in nature to clarifying the valuable services that ecosystems can provide to humans, such as purifying water or buffering storms and floods.
- The average number of P values per paper has been steadily rising, they found. A typical paper now reports 10 P values, double the number from the 1980s. This suggests that researchers are conducting more experiments than before or exploring more variables. In other words, ecological research is getting more complex. A scientist trying to predict algal blooms probably has an equation that considers not just phosphorus levels, but also temperature, water clarity, and many other factors.
- $R^2$ —a more informative statistical indicator—has been on the decline. In 1980, the average  $R^2$  reported in papers was about 0.7. By 2010, it had fallen to just under 0.5

Read More: <http://www.esajournals.org/doi/abs/10.1890/130230>

## Error Type I and II

- Η ποσοτικοποίηση της Οικολογικής έρευνας προς την κατεύθυνση της εφαρμογής απαιτεί την βαθεία κατανόηση της έννοιας του σφάλματος και της στρέβλωσης στον πειραματικό σχεδιασμό (**bias: the combination of various design, data, analysis, and presentation factors that tend to produce research findings when they should not be produced**).
- In statistical hypothesis testing, a **type I error** is the incorrect rejection of a true null hypothesis (a "false positive"), while a **type II error** is the failure to reject a false null hypothesis (a "false negative").
- A **type I error** is detecting an effect that is not present, while a type II error is failing to detect an effect that is present. The terms "type I error" and "type II error" are often used interchangeably with the general notion of false positives and false negatives in binary classification.

## Error Type I and II: το κλασσικό παράδειγμα της ποινικής δίκης!

Δικάζεται πολίτης με ποινική κατηγορία. Ο ένορκος ή ο δικαστής ελέγχει την Υπόθεση

**Hypothesis:** "The evidence produced before the court proves that this man is guilty."  
(Προϋπόθεση δίκαιης δίκης)

**Null hypothesis ( $H_0$ ):** "This man is innocent.« (Τεκμήριο αθωότητας)

|   | Null Hypothesis ( $H_0$ ) is valid           | Null Hypothesis ( $H_0$ ) is invalid           |
|---|--|--|
| Reject $H_0$<br>I think he is guilty!         | Type I error<br>False positive<br>Convicted! | Correct outcome<br>True positive<br>Convicted! |
| Don't reject $H_0$<br>I think he is innocent! | Correct outcome<br>True negative<br>Freed!   | Type II error<br>False negative<br>Freed!      |

Δεκάδες παραδείγματα από την Οικολογία, Οικοτοξικολογία, Περιβαλλοντική Χημεία, ΚΟΚ...

# Why Most Published Research Findings Are False

J.P.A. Ioannidis, PLoS Med. 2005 August, 2(8): e124

| Research Finding | True Relationship         |                                 | Total  |
|------------------|---------------------------|---------------------------------|--|
|                  | Yes                       | No                              |  |
| Yes              | $cR(1 - \beta^n)/(R + 1)$ | $c(1 - [1 - \alpha]^n)/(R + 1)$ | $c(R + 1 - [1 - \alpha]^n - R\beta^n)/(R + 1)$ |
| No               | $cR\beta^n/(R + 1)$       | $c(1 - \alpha)^n/(R + 1)$       | $c([1 - \alpha]^n + R\beta^n)/(R + 1)$         |
| Total            | $cR/(R + 1)$              | $c/(R + 1)$                     | $c$  |

DOI: 10.1371/journal.pmed.0020124.t003

**R**: the ratio of the number of “true relationships” to “no relationships” among those tested in the field. The pre-study probability of a relationship being true is  $R/(R + 1)$ .

The probability of a study finding a true relationship reflects the power  $1 - \beta$  (one minus the Type II error rate).

The probability of claiming a relationship when none truly exists reflects the Type I error rate,  $\alpha$ .

**c**, # or rate of, relationships being probed in the field.

**n**, # of replications



# Why Most Published Research Findings Are False

J.P.A. Ioannidis, PLoS Med. 2005 August, 2(8): e124

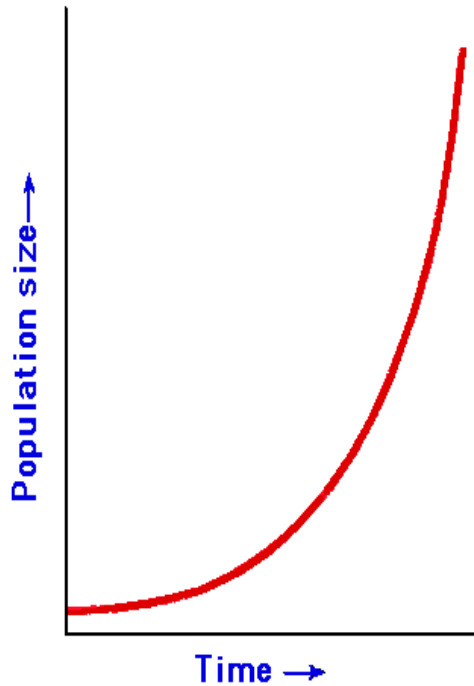
## **Ioannidis corollaries:**

- **Corollary 1:** The smaller the studies conducted in a scientific field, the less likely the research findings are to be true.
- **Corollary 2:** The smaller the effect sizes in a scientific field, the less likely the research findings are to be true.
- **Corollary 3:** The greater the number and the lesser the selection of tested relationships in a scientific field, the less likely the research findings are to be true.
- **Corollary 4:** The greater the flexibility in designs, definitions, outcomes, and analytical modes in a scientific field, the less likely the research findings are to be true.
- **Corollary 5:** The greater the financial and other interests and prejudices in a scientific field, the less likely the research findings are to be true.
- **Corollary 6:** The hotter a scientific field (with more scientific teams involved), the less likely the research findings are to be true.

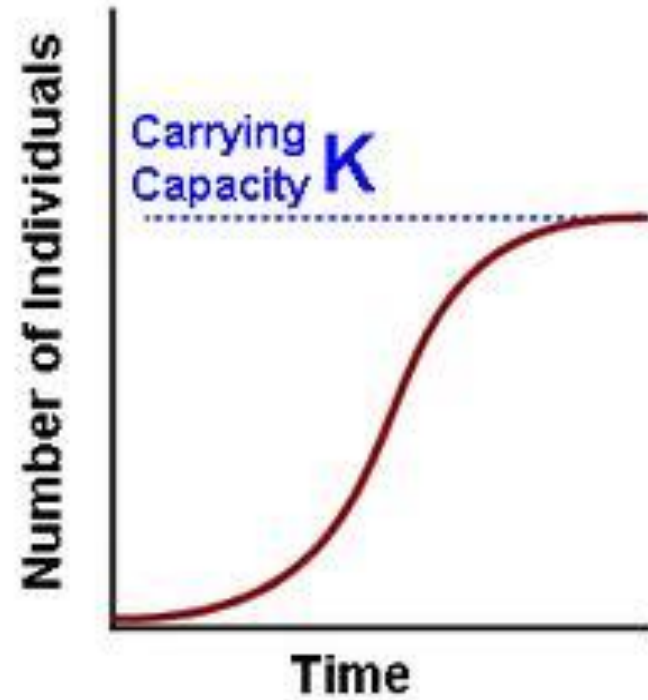
## Η Οικολογία στο σταυροδρόμι... της Επιστημονικής Μεθόδου

- Το ζήτημα της **a priori** στατιστικής: Ho και Error Types
- Το ζήτημα της **a posteriori** στατιστικής: Bayes
- Το ζήτημα των **big data**:
- **Η δυνατότητα συλλογής και επεξεργασίας μεγάλης ποσότητας δεδομένων αντικαθιστά την ίδια την επιστημονική Μέθοδο/Θεωρία!**

# Η Μαλθουσιανή διαμάχη, στην Ιστορία...

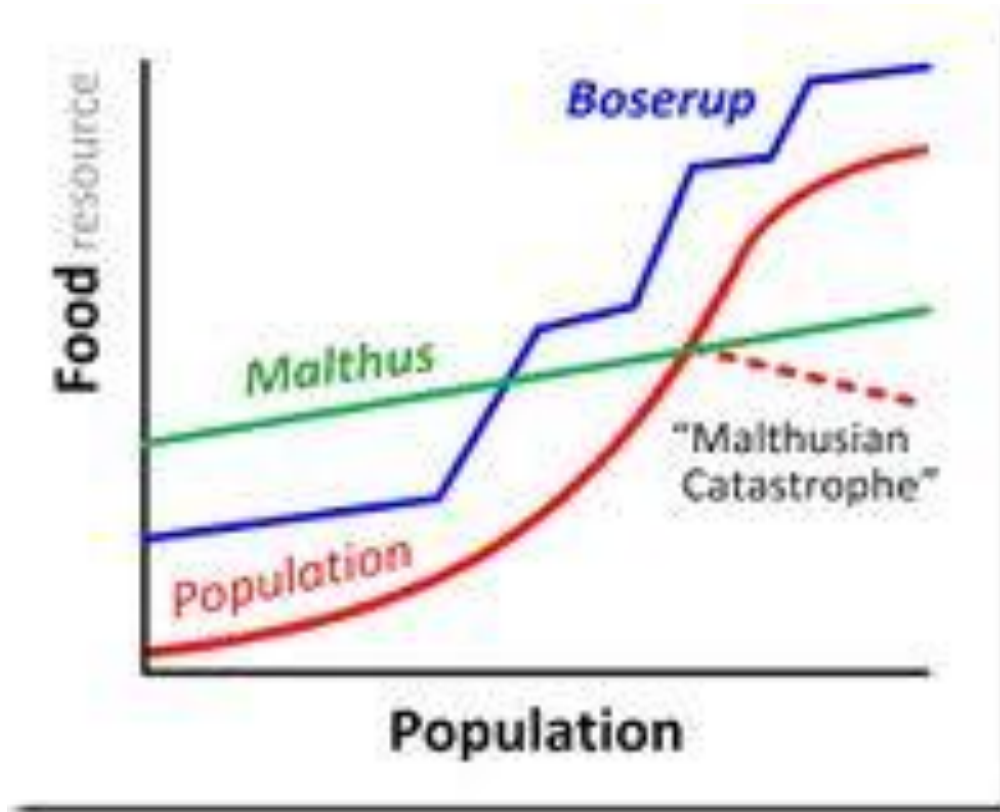


Εκθετική εξίσωση (Malthus)



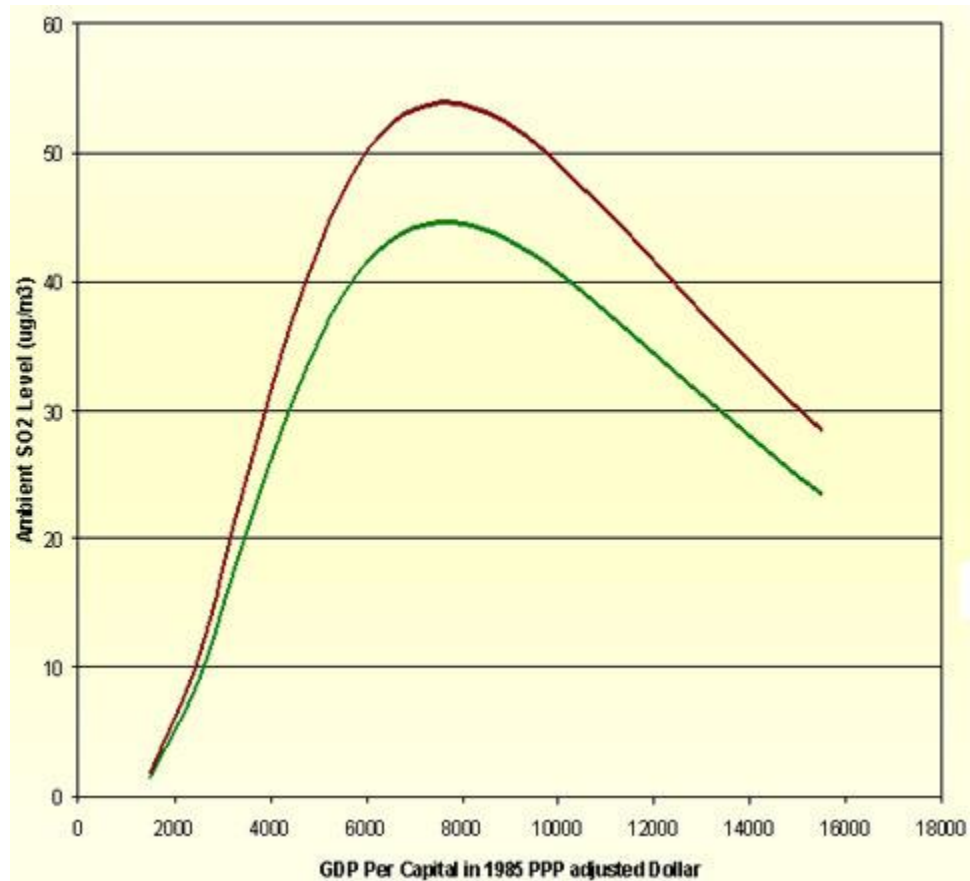
Λογιστική εξίσωση (Verhulst)

# Η Μαλθουσιανή διαμάχη, σήμερα... Η σύγκρουση των θεωριών: πληθυσμός, ανάπτυξη, περιβάλλον και οικονομία...

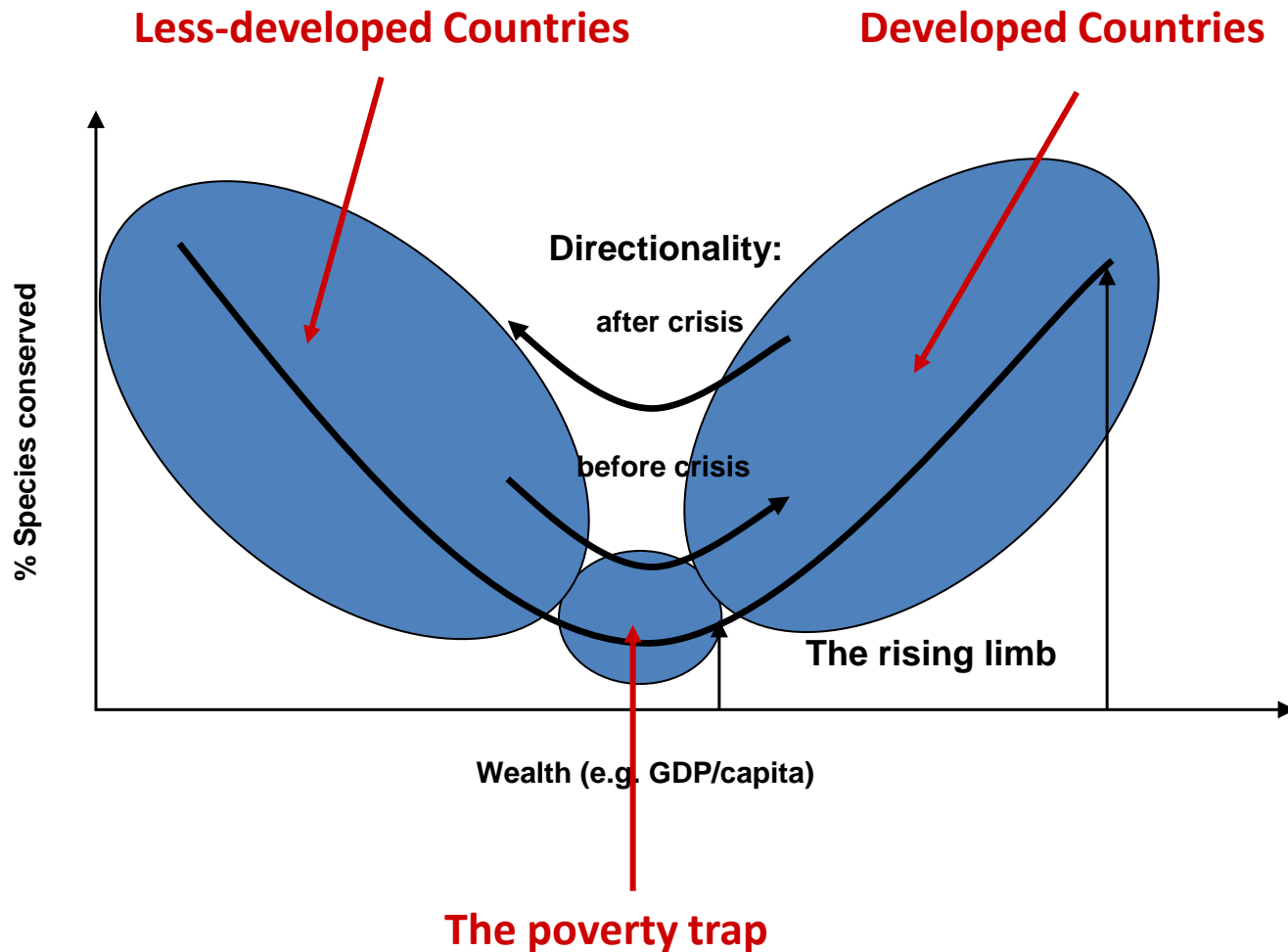


Σε ένα γράφημα, η σύγχρονη διαμάχη επί της πενίας των πόρων, της φτώχειας, της αιιφορίας και των διεθνών σχέσεων!

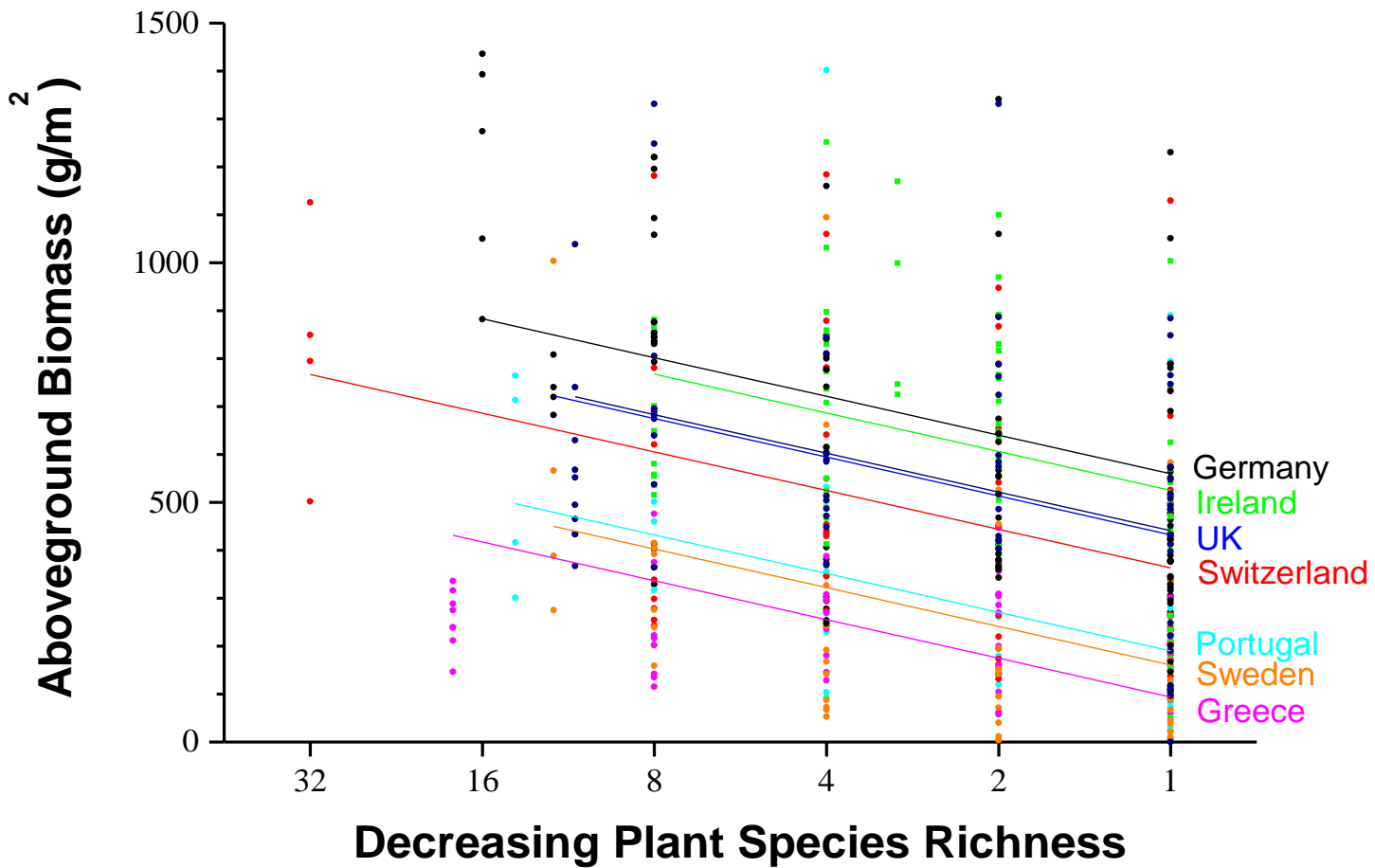
# ΕΚCs: μονοκόρυφες κατανομές περιβαλλοντικής επίπτωσης ως προς την οικονομία



# EKCs και κρατούσα θεωρία περί διατήρησης της βιοποικιλότητας

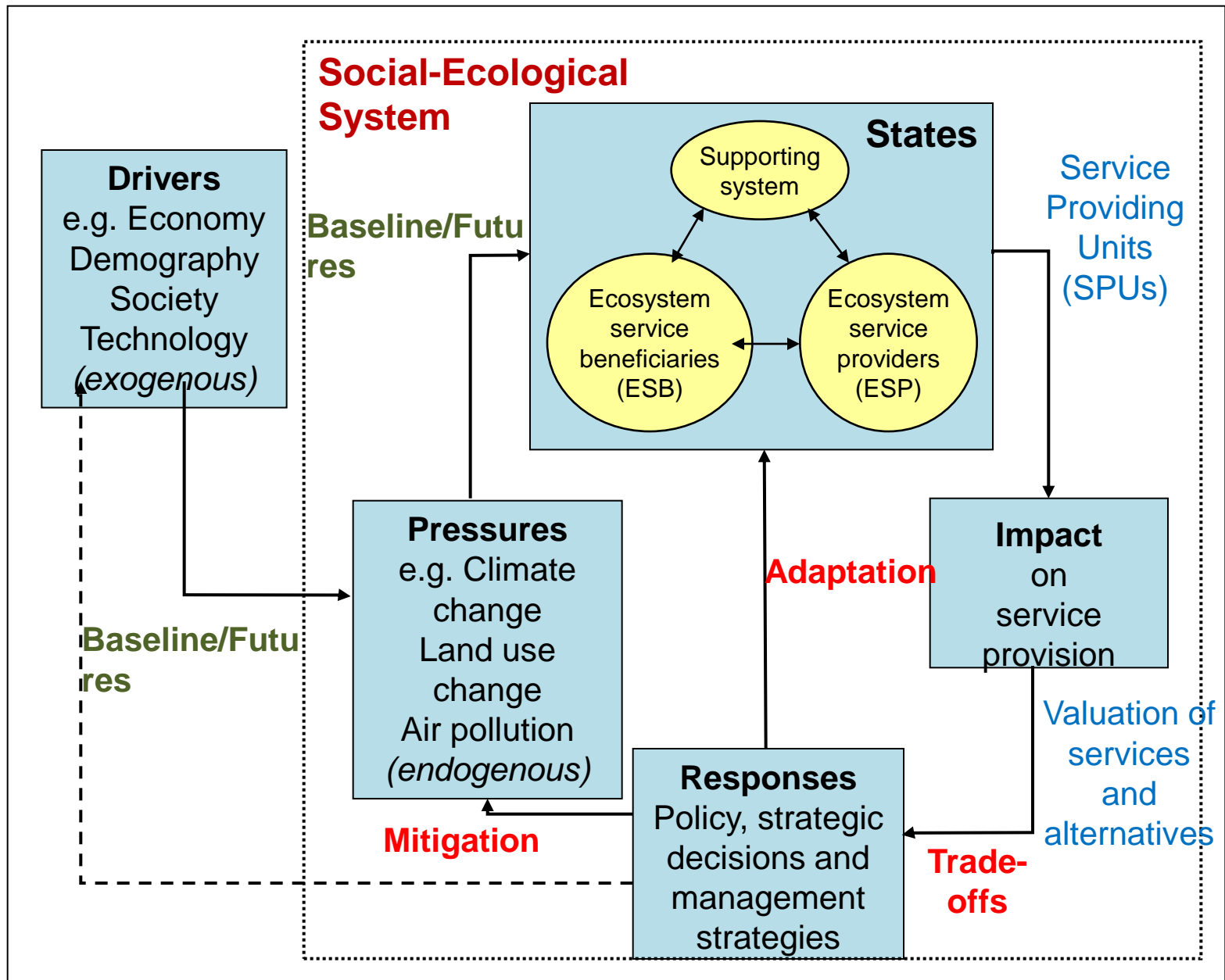


# Λειτουργική σχέση Βιοποικιλότητας και Οικοσυστημικών Διεργασιών (BEF): **BIODEPTH: ΒΠ-Παραγωγή**



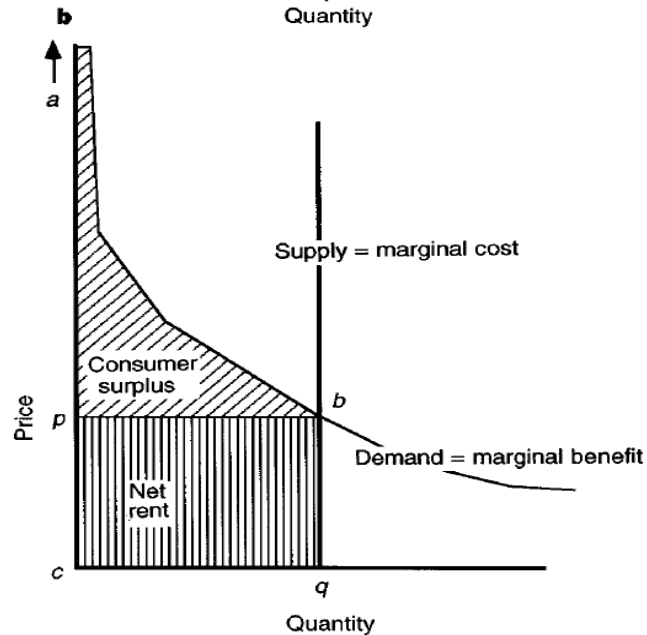
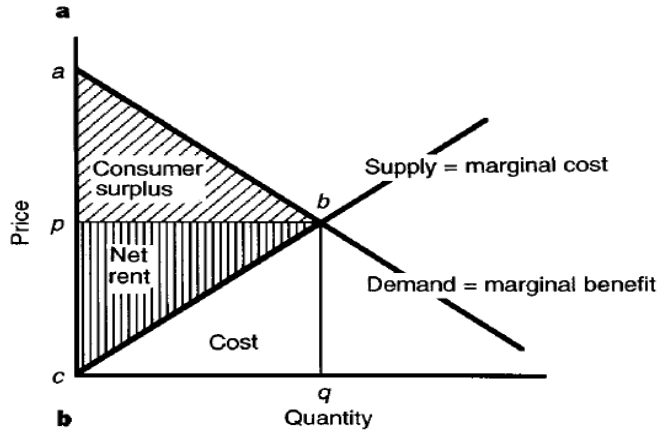
Hector et al., *Science* 286: 1123–1127 (1999)

# SES: Framework for the Ecosystem Service Provision (FESP)

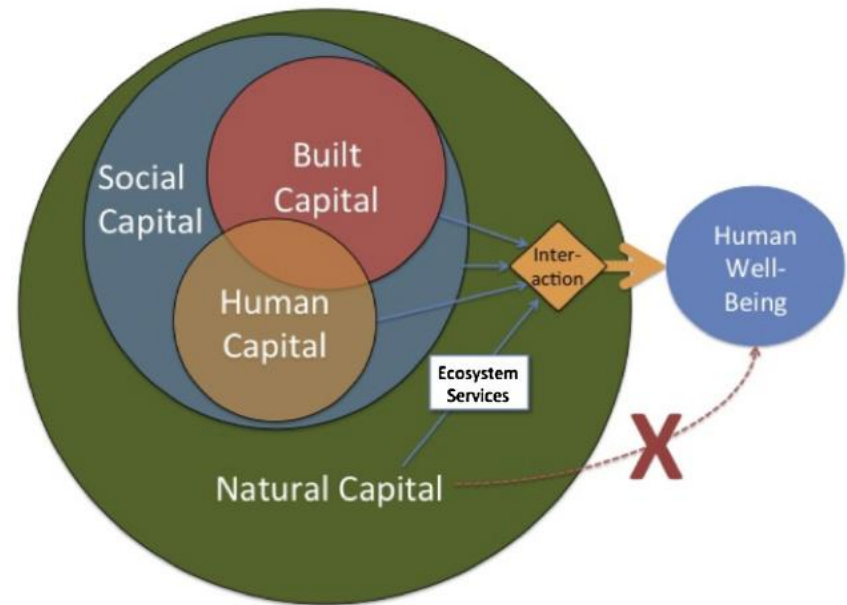




# Οικονομική αποτίμηση βιοτικών πόρων...



Costanza et al. 1997....



Costanza et al. 2014...

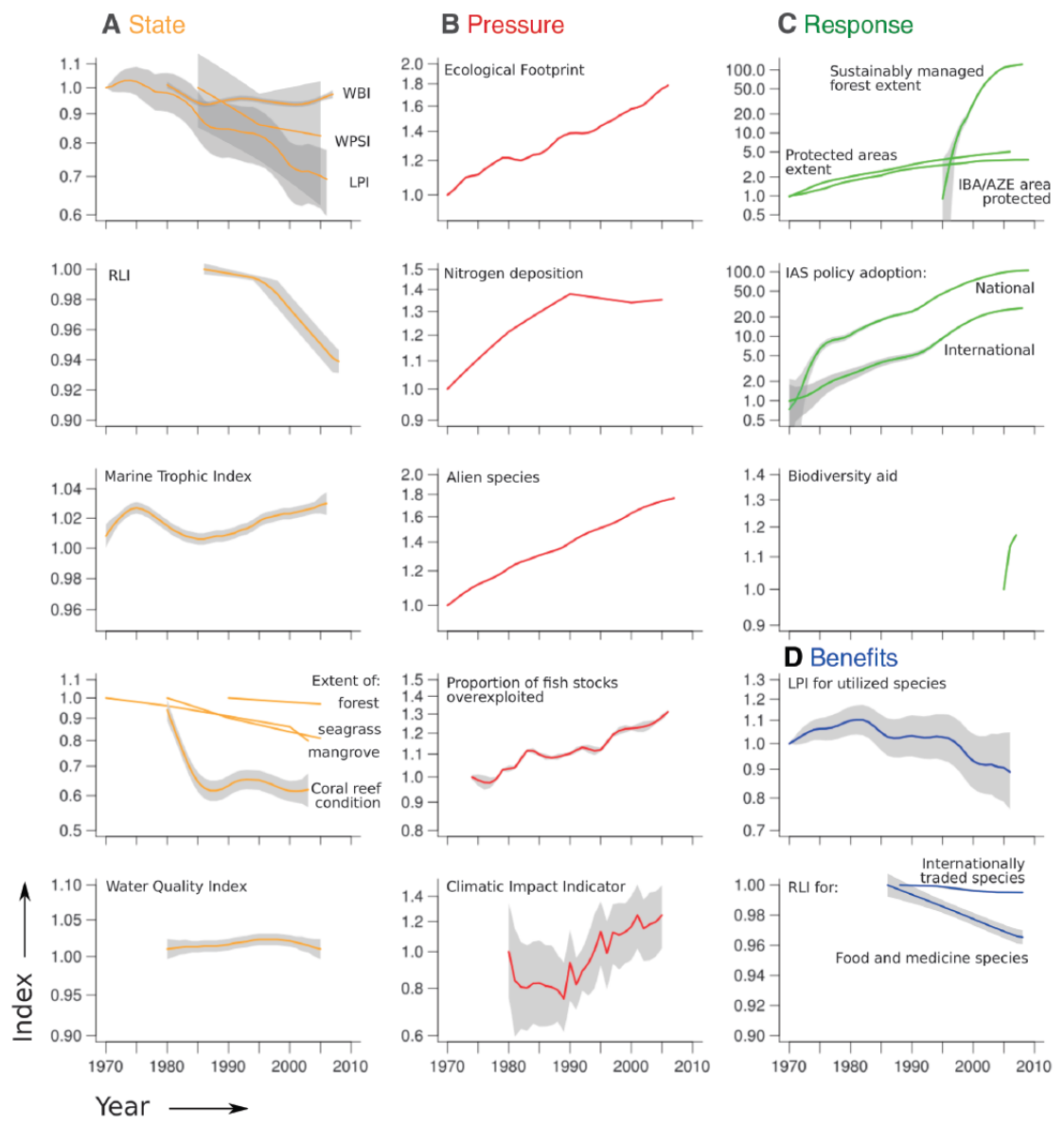
# Από τη Θεωρία στην πραγματικότητα: η οικονομική αξία...

**Table 3**

Changes in area, unit values and aggregate global flow values from 1997 to 2011 (green are values that have increased, red are values that have decreased).

| Biome                 | A. Original   |               |           | B. Change unit values only |         |           | C. Change area only                         |              |             | D. Change both unit values and area |                  | E. Column C - Column A |                  | F. Column D - Column B |  |
|-----------------------|---------------|---------------|-----------|----------------------------|---------|-----------|---|--------------|-------------|-------------------------------------|------------------|------------------------|------------------|------------------------|--|
|                       | Area (e6 ha)  |               | Change    | Unit values (2007\$/ha/yr) |         | Change    | Aggregate Global Flow Value (e12 2007\$/yr) |              | Change      | Change in Value (e12 2007\$/yr)     |                  | 1997 unit values       | 2011 unit values |                        |  |
|                       | 1997          | 2011          | 2011-1997 | 1997                       | 2011    | 2011-1997 | 1997  | 2011         | 2011        | 2011                                | 1997 unit values | 2011 unit values       |                  |                        |  |
| <b>Marine</b>         | <b>36,302</b> | <b>36,302</b> | 0         | 796                        | 1,368   | 572       | 28.9  | 60.5         | 29.5        | 49.7                                | 0.6              | (10.9)                 |                  |                        |  |
| Open Ocean            | 33,200        | 33,200        | 0         | 348                        | 660     | 312       | 11.6  | 21.9         | 11.6        | 21.9                                | -                | -                      |                  |                        |  |
| Coastal               | 3,102         | 3,102         | 0         | 5,592                      | 8,944   | 3,352     | 17.3  | 38.6         | 18.0        | 27.7                                | 0.6              | (10.9)                 |                  |                        |  |
| Estuaries             | 180           | 180           | 0         | 31,509                     | 28,916  | -2,593    | 5.7   | 5.2          | 5.7         | 5.2                                 | -                | -                      |                  |                        |  |
| Seagrass/Algae Beds   | 200           | 234           | 34        | 26,226                     | 28,916  | 2,690     | 5.2   | 5.8          | 6.1         | 6.8                                 | 0.9              | 1.0                    |                  |                        |  |
| Coral Reefs           | 62            | 28            | -34       | 8,384                      | 352,249 | 343,865   | 0.5   | 21.7         | 0.2         | 9.9                                 | (0.3)            | (11.9)                 |                  |                        |  |
| Shelf                 | 2,660         | 2,660         | 0         | 2,222                      | 2,222   | 0         | 5.9   | 5.9          | 5.9         | 5.9                                 | -                | -                      |                  |                        |  |
| <b>Terrestrial</b>    | <b>15,323</b> | <b>15,323</b> | 0         | 1,109                      | 4,901   | 3,792     | 17.0  | 84.5         | 12.1        | 75.1                                | (4.9)            | (9.4)                  |                  |                        |  |
| Forest                | 4,855         | 4,261         | -594      | 1,338                      | 3,800   | 2,462     | 6.5   | 19.5         | 4.7         | 16.2                                | (1.8)            | (3.3)                  |                  |                        |  |
| Tropical              | 1,900         | 1,258         | -642      | 2,769                      | 5,382   | 2,613     | 5.3   | 10.2         | 3.5         | 6.8                                 | (1.8)            | (3.5)                  |                  |                        |  |
| Temperate/Boreal      | 2,955         | 3,003         | 48        | 417                        | 3,137   | 2,720     | 1.2   | 9.3          | 1.3         | 9.4                                 | 0.0              | 0.2                    |                  |                        |  |
| Grass/Rangelands      | 3,898         | 4,418         | 520       | 321                        | 4,166   | 3,845     | 1.2   | 16.2         | 1.4         | 18.4                                | 0.2              | 2.2                    |                  |                        |  |
| Wetlands              | 330           | 188           | -142      | 20,404                     | 140,174 | 119,770   | 6.7   | 36.2         | 3.4         | 26.4                                | (3.3)            | (9.9)                  |                  |                        |  |
| Tidal Marsh/Mangroves | 165           | 128           | -37       | 13,786                     | 193,843 | 180,057   | 2.3   | 32.0         | 1.8         | 24.8                                | (0.5)            | (7.2)                  |                  |                        |  |
| Swamps/Floodplains    | 165           | 60            | -105      | 27,021                     | 25,681  | -1,340    | 4.5   | 4.2          | 1.6         | 1.5                                 | (2.8)            | (2.7)                  |                  |                        |  |
| Lakes/Rivers          | 200           | 200           | 0         | 11,727                     | 12,512  | 785       | 2.3   | 2.5          | 2.3         | 2.5                                 | -                | -                      |                  |                        |  |
| Desert                | 1,925         | 2,159         | 234       | -                          | -       | 0         | -   | -            | -           | -                                   | -                | -                      |                  |                        |  |
| Tundra                | 743           | 433           | -310      | -                          | -       | 0         | -   | -            | -           | -                                   | -                | -                      |                  |                        |  |
| Ice/Rock              | 1,640         | 1,640         | 0         | -                          | -       | 0         | -   | -            | -           | -                                   | -                | -                      |                  |                        |  |
| Cropland              | 1,400         | 1,672         | 272       | 126                        | 5,567   | 5,441     | 0.2   | 7.8          | 0.2         | 9.3                                 | 0.0              | 1.5                    |                  |                        |  |
| Urban                 | 332           | 352           | 20        | -                          | 6,661   | 6,661     | -   | 2.2          | -           | 2.3                                 | -                | 0.1                    |                  |                        |  |
| <b>Total</b>          | <b>51,625</b> | <b>51,625</b> | 0         |                            |         |           | <b>45.9</b>                                 | <b>145.0</b> | <b>41.6</b> | <b>124.8</b>                        | <b>(4.3)</b>     | <b>(20.2)</b>          |                  |                        |  |

# Η συντριπτική αποτυχία της πολιτικής διατήρησης της βιοποικιλότητας: 40 έτη μύθων...



# Η συντριπτική αποτυχία της πολιτικής διατήρησης της βιοποικιλότητας: 40 έτη μύθων...

**Fig. 2.** Aggregated indices of **(A)** the state of biodiversity based on nine indicators of species' population trends, habitat extent and condition, and community composition; **(B)** pressures on biodiversity based on five indicators of ecological footprint, nitrogen deposition, numbers of alien species, overexploitation, and climatic impacts; and **(C)** responses for biodiversity based on six indicators of protected area extent and biodiversity coverage, policy responses to invasive alien species, sustainable forest management, and biodiversity-related aid. Values in 1970 set to 1. Shading shows 95% confidence intervals derived from 1000 bootstraps. Significant positive/upward (open circles) and negative/downward (filled circles) inflections are indicated.

