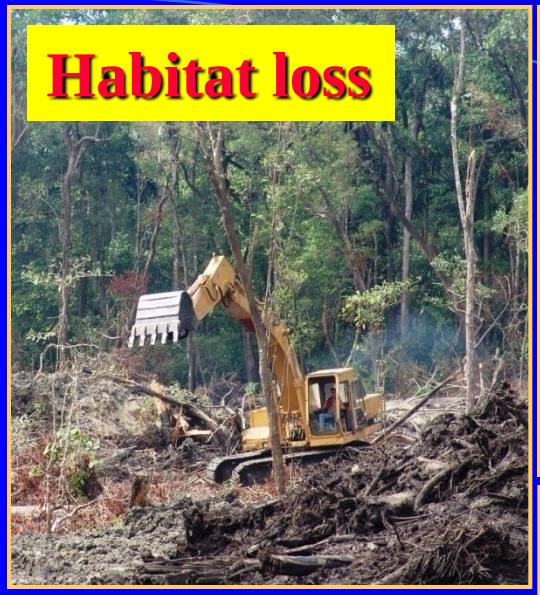
Averting Biodiversity Collapse in Tropical Protected Areas

William F. Laurance

Centre for Tropical Environmental and Sustainability Science

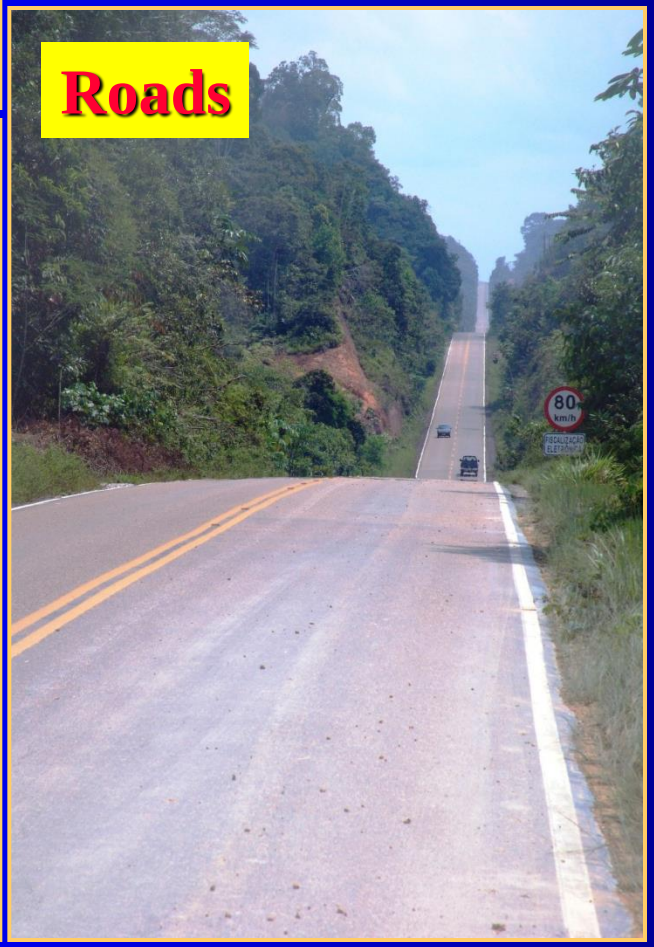
James Cook University
Cairns, Australia


Habitat loss


Climate change


Hunting

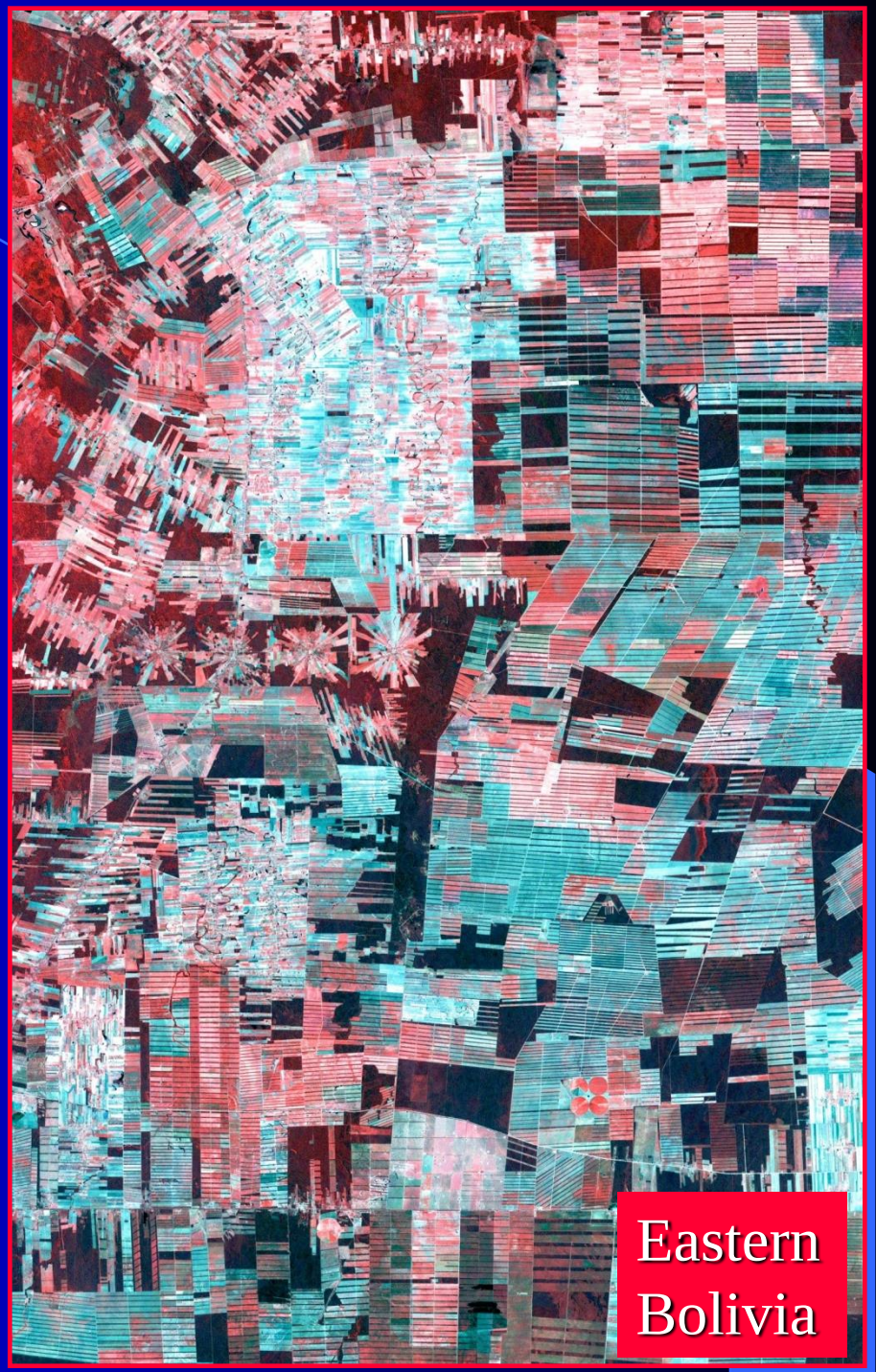

Fires


Roads
80
km/h


Exotic pathogens

Big Problem

- **Most data from remote sensing**
  - DeFries *et al.* (2005): Increasing isolation of reserves
  - Asner *et al.* (2005): Rampant logging in Amazonia
  - LaPorte *et al.* (2007): Logging explosion in Congo Basin
  - Wright *et al.* (2007): Corruption & poverty promote fires in reserves
- **Too little on-the-ground research, especially of broad-scale trends**



Key Questions

- **Will tropical nature reserves function as arks for biodiversity and ecological processes?**
- **What is driving changes?**

Best Available Data

Research Design

- **Global survey of 60 tropical reserves**
  - 20 each in Africa, Asia, and Neotropics
  - All tropical rainforest or woodland
  - At least 10 publications/site
  - Timeframe: ~20-30 years
- **Sampling expert knowledge**
  - 4-5 experts per site (262 total)
  - Detailed questionnaire (10 pages)
  - Interview (phone or face-to-face)
  - Only responses with ‘good’ or ‘high’ confidence considered

Change Variables

- **31 guilds**
  - 23 largely forest-dependent
  - 8 invading or disturbance-loving
- **21 environmental drivers**
  - Both inside & outside PA

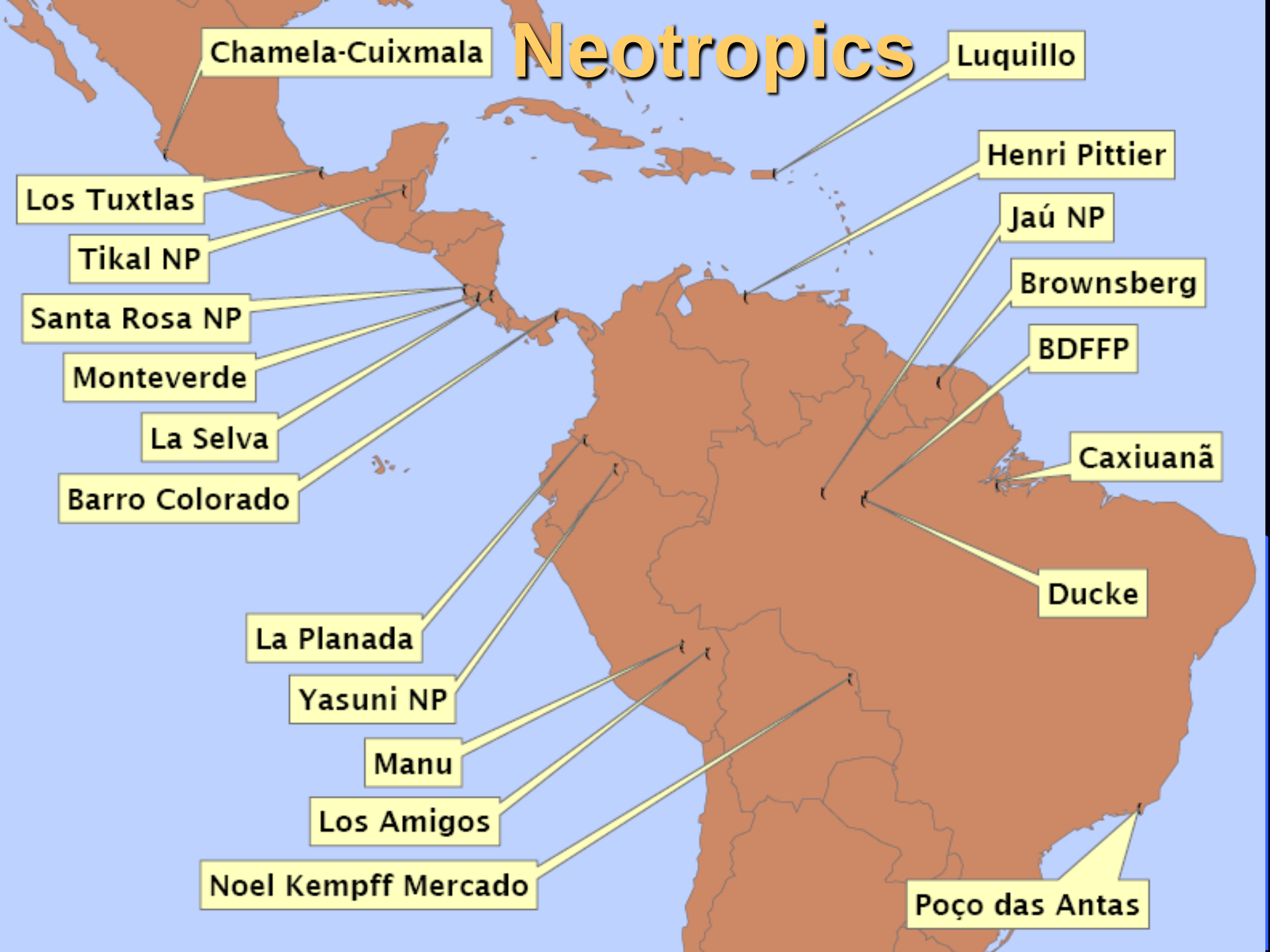




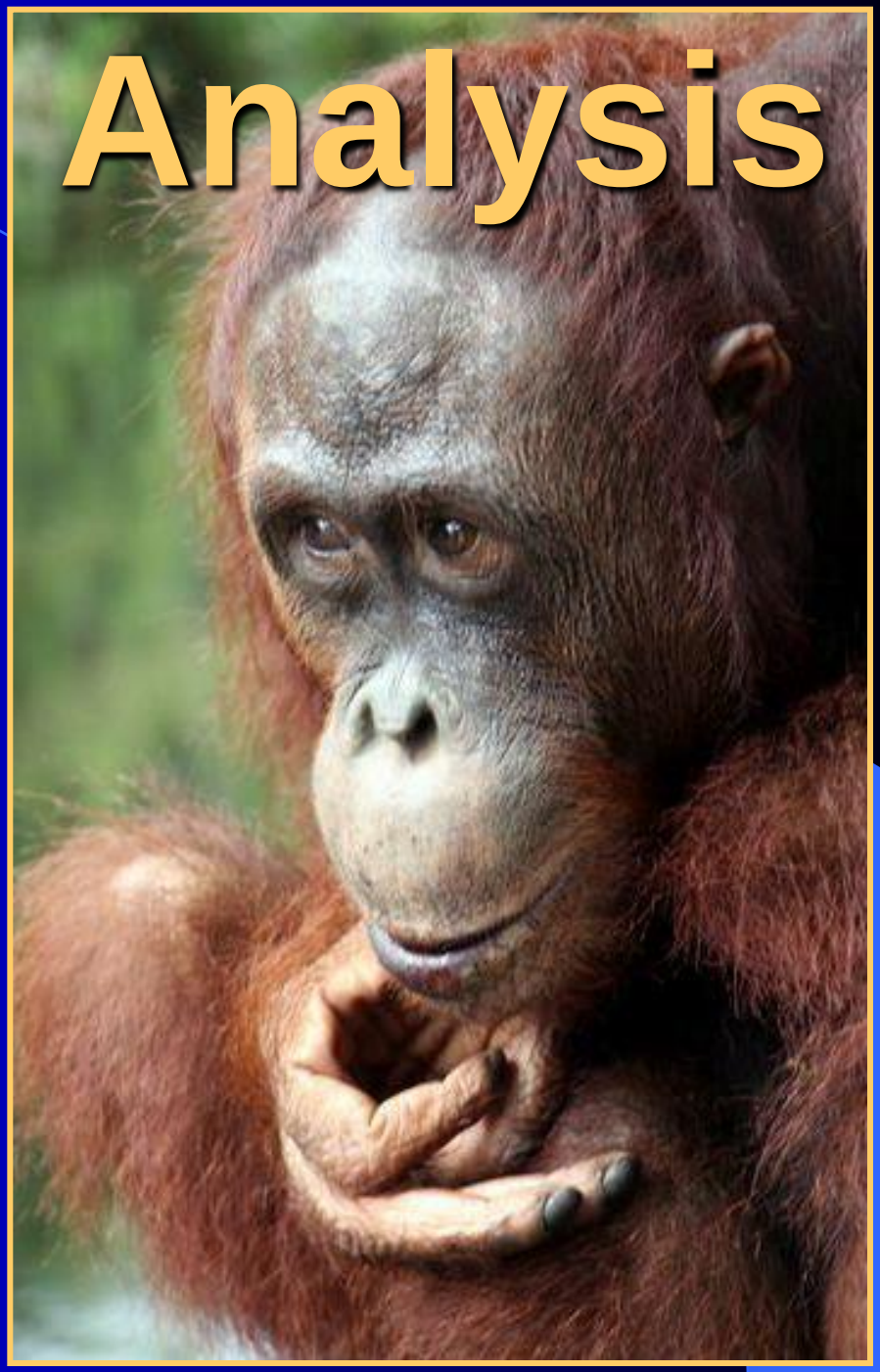


Africa
Kilim- Ijim
Kakum NP
Dzanga-Sangha
Tai NP
Ituri
Nouabale-Ndoki
Budongo
Lac Tele
Kibale NP
Korup NP
Kakamega
Lope NP
Virunga NP
Ivindo NP
Bwindi Impenetrable NP
Salonga NP
Udzungwa NP
Kahuzi-Biega NP
Nyungwe NP
Ranomafana NP


Asia
Chitwan NP
Xishuangbanna
Dinghushan
Fushan
Northern Sierra Madre
Gir NP
Subic
Kinabalu NP
Mudumalai
Danum Valley
Sinharaja
Lambir Hills NP
Huai Kha Khaeng
Lore Lindu NP
Khao Yai NP
Crater Mountain NP
Pasoh
Paluma Range
Bukit Timah
Gunung Palung NP

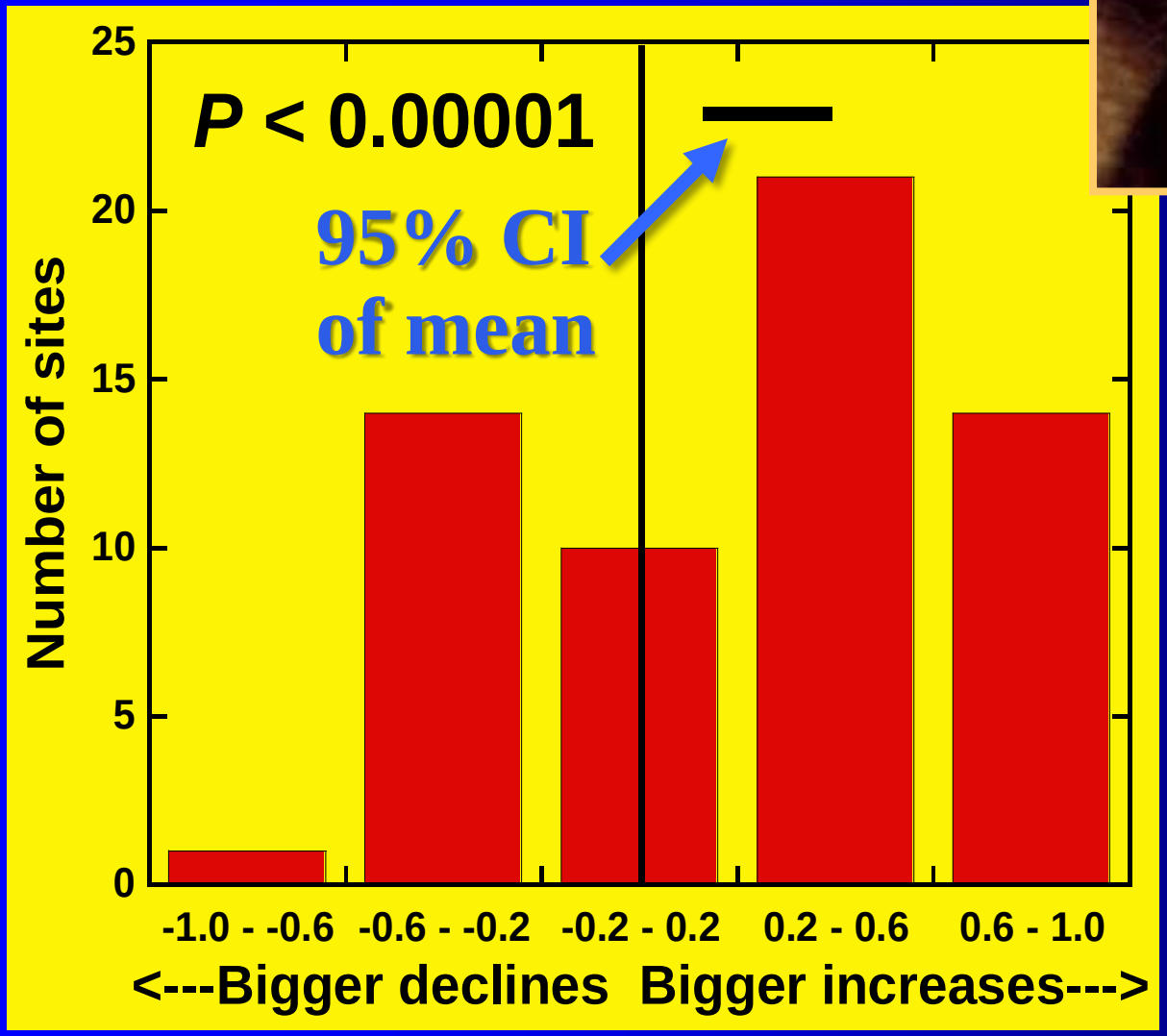

Neotropics
Chamela-Cuixmala
Luquillo
Los Tuxtlas
Henri Pittier
Tikal NP
Jaú NP
Santa Rosa NP
Brownsberg
Monteverde
BDFFP
La Selva
Caxiuanã
Barro Colorado
Ducke
La Planada
Yasuni NP
Manu
Los Amigos
Noel Kempff Mercado
Poço das Antas

Analysis



- Each response scored
  - -1 = decline
  - 0 = no change
  - +1 = increase
- Mean calculated for each site (if data available)
- Means pooled across all sites
- Bootstrapping used to generate 95% CI for overall mean
- If CI did not overlap with 0, then significant
- Bonferroni correction used (P=0.0056)

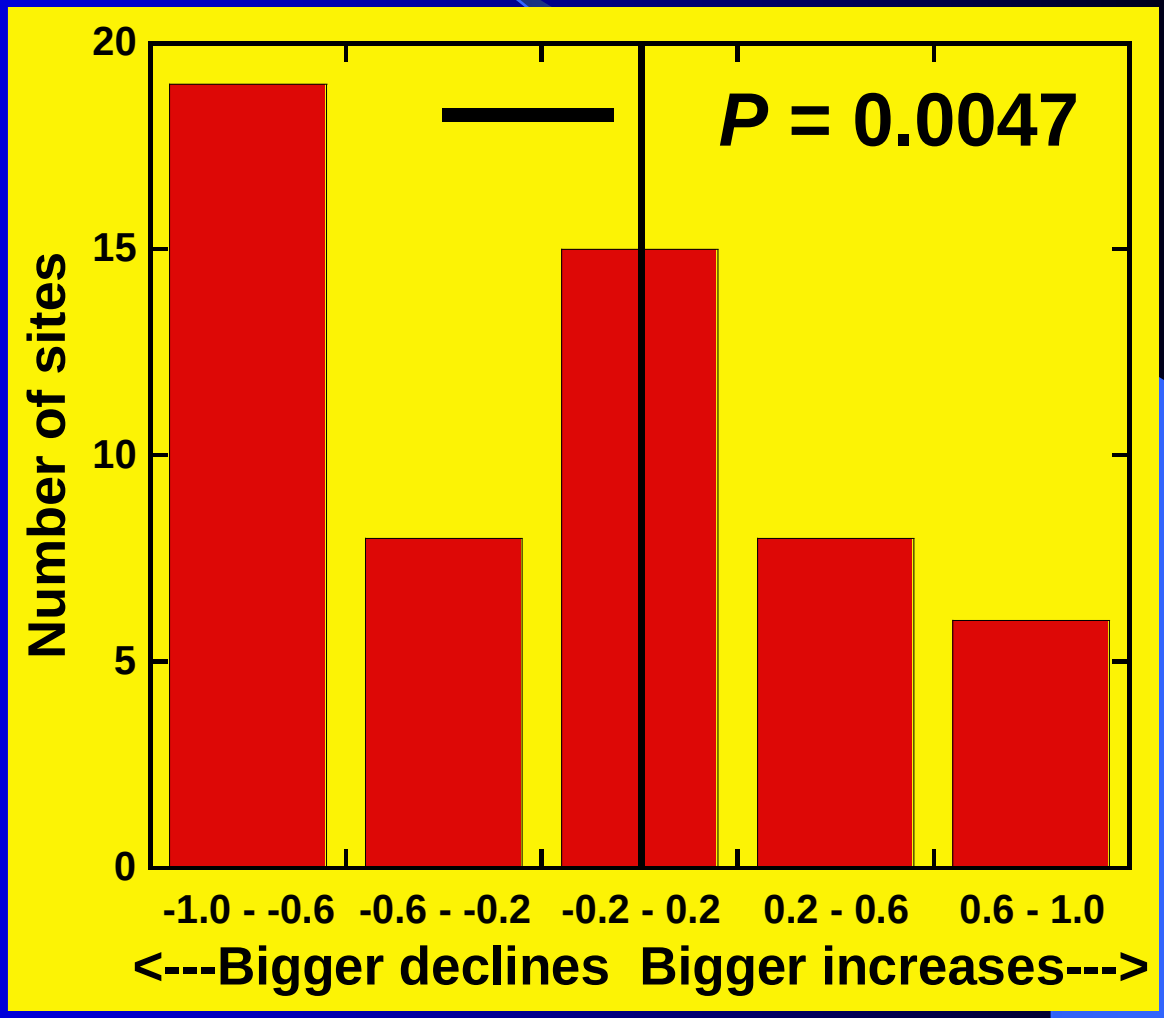
Good News



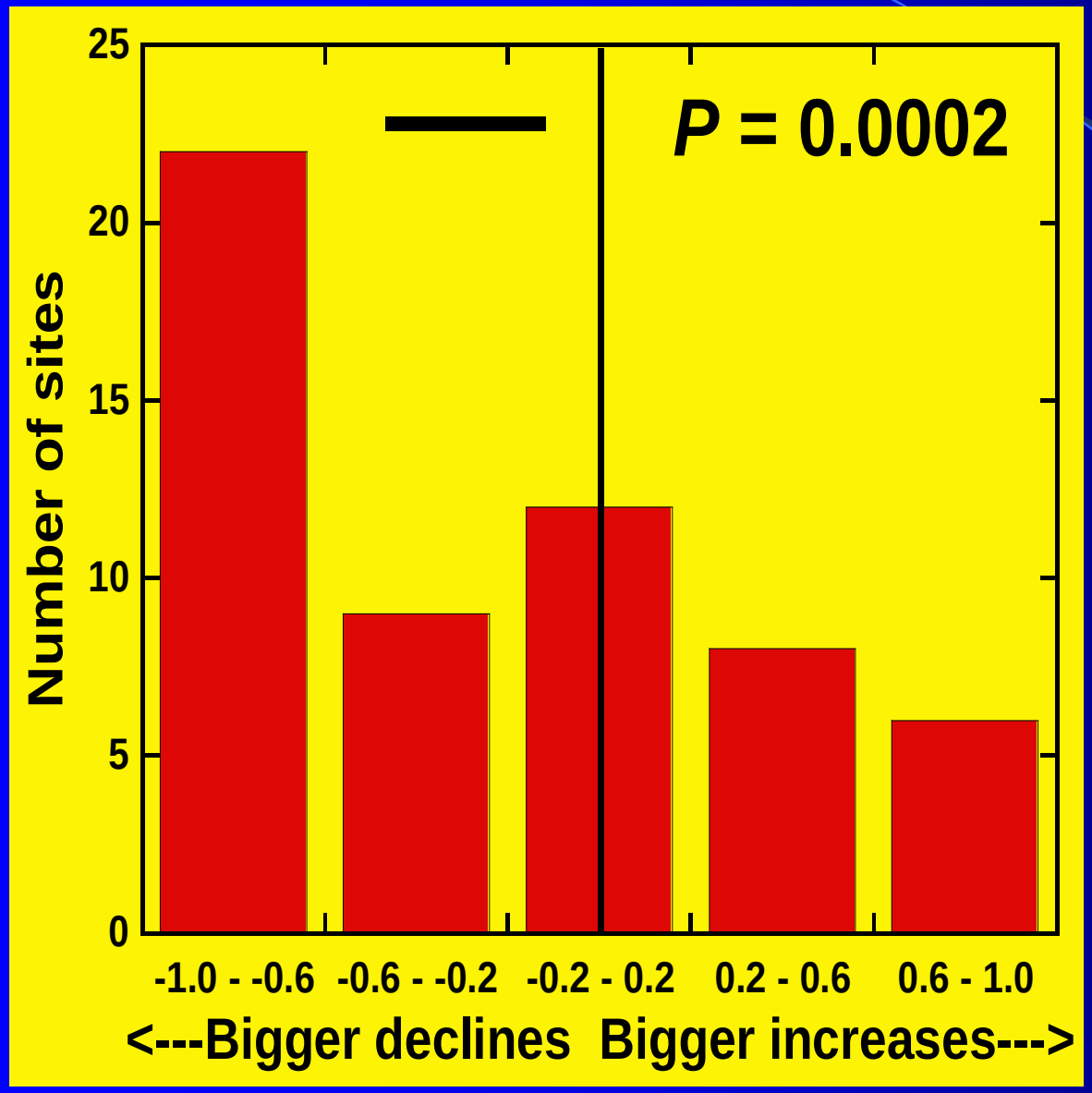
Though variable, legal and actual protection efforts have improved on average

Highly Vulnerable Groups

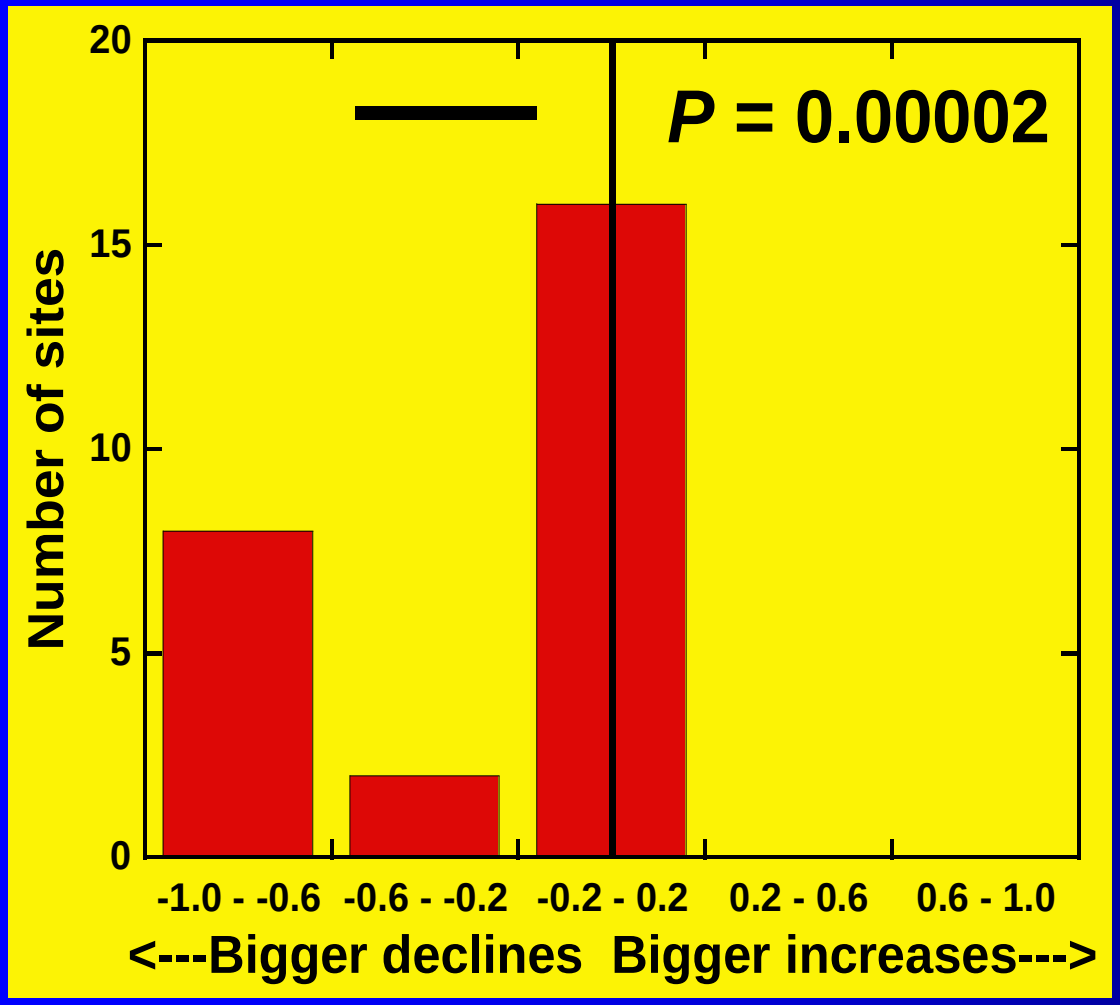
Apex Predators



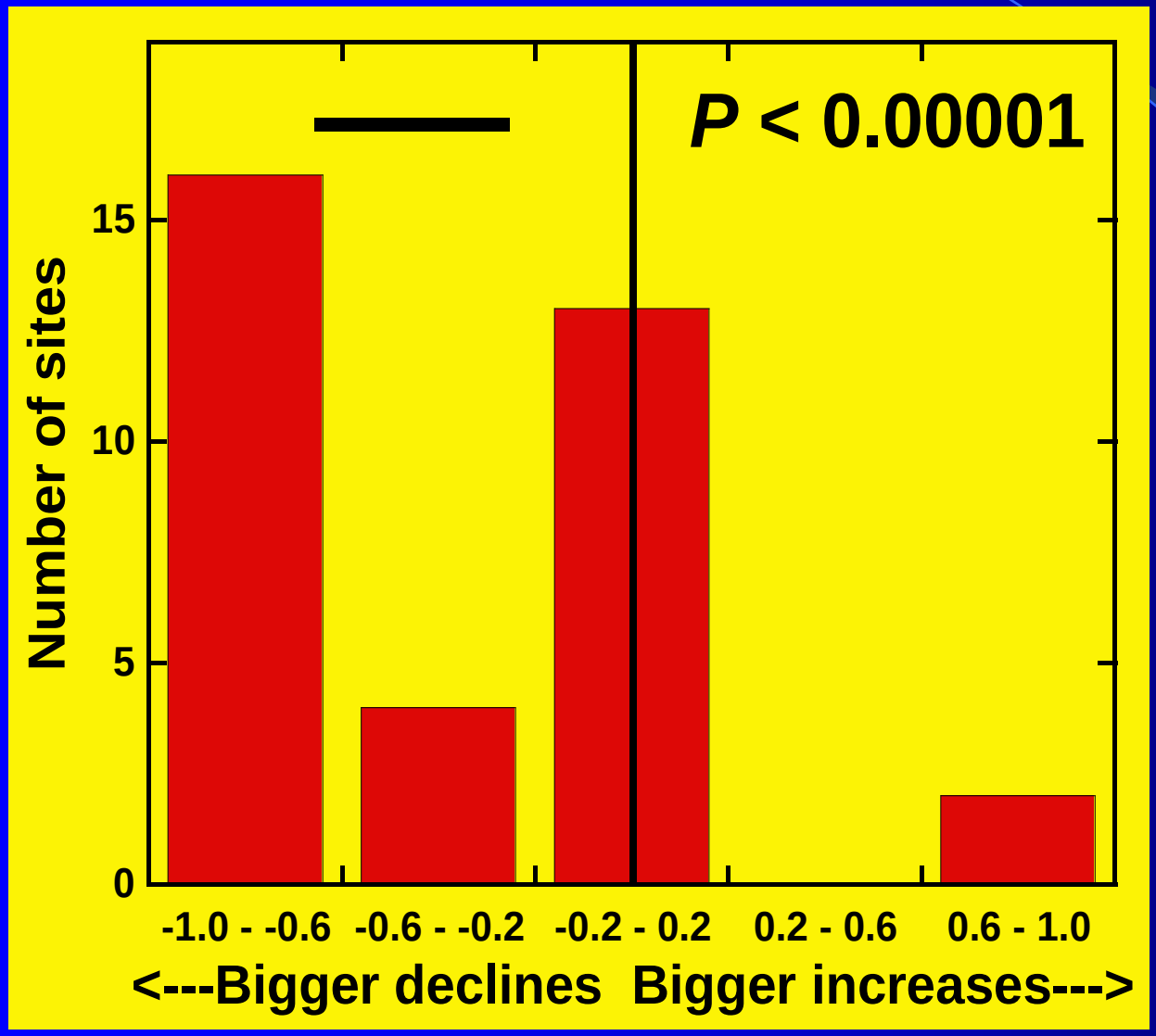
Large, Non-predatory Species



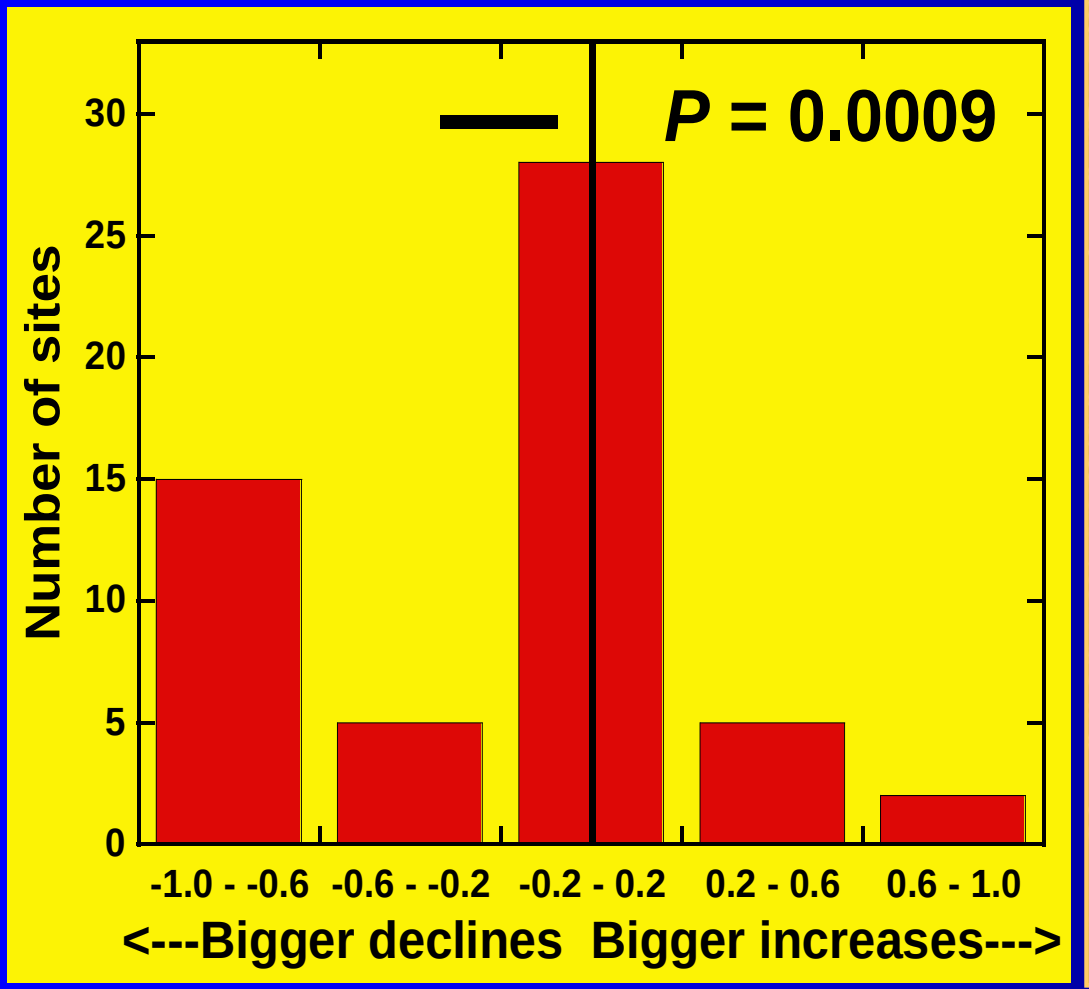
Stream-dwelling Amphibians

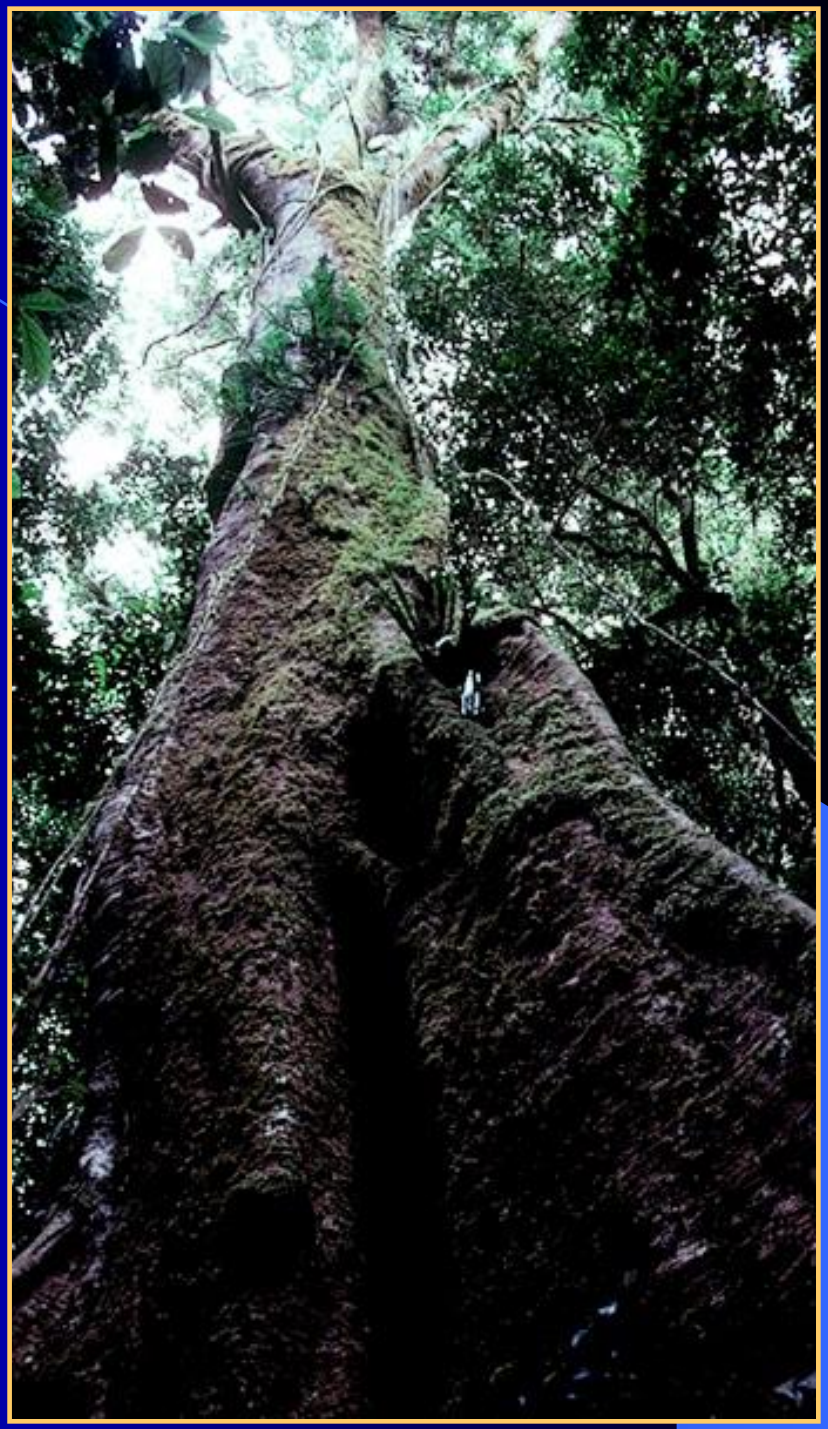


Stream Fish

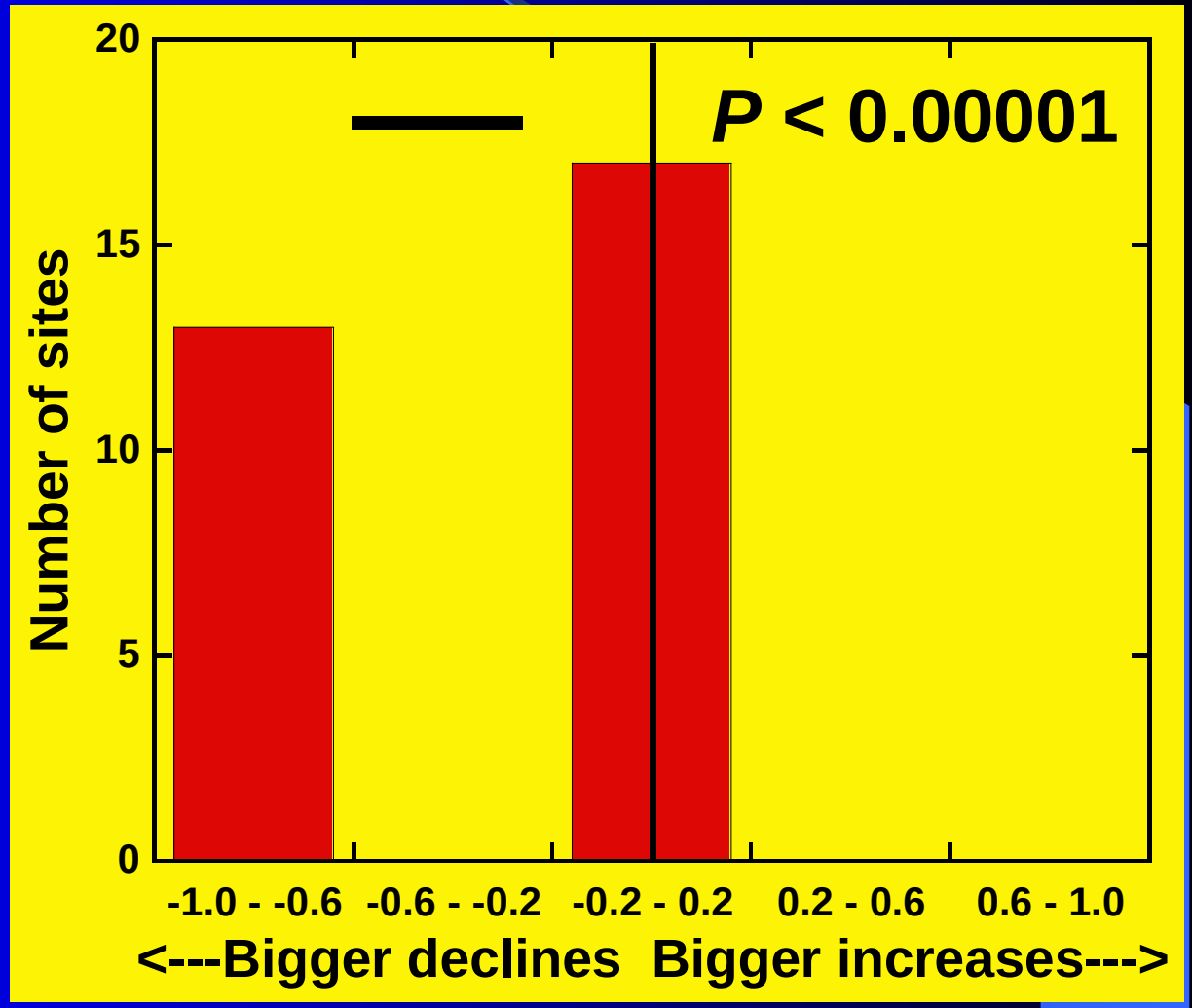

P < 0.00001
Number of sites
15
10
5
0
-1.0 - -0.6
-0.6 - -0.2
-0.2 - 0.2
0.2 - 0.6
0.6 - 1.0
<---Bigger declines
Bigger increases--->

Large-seeded Trees



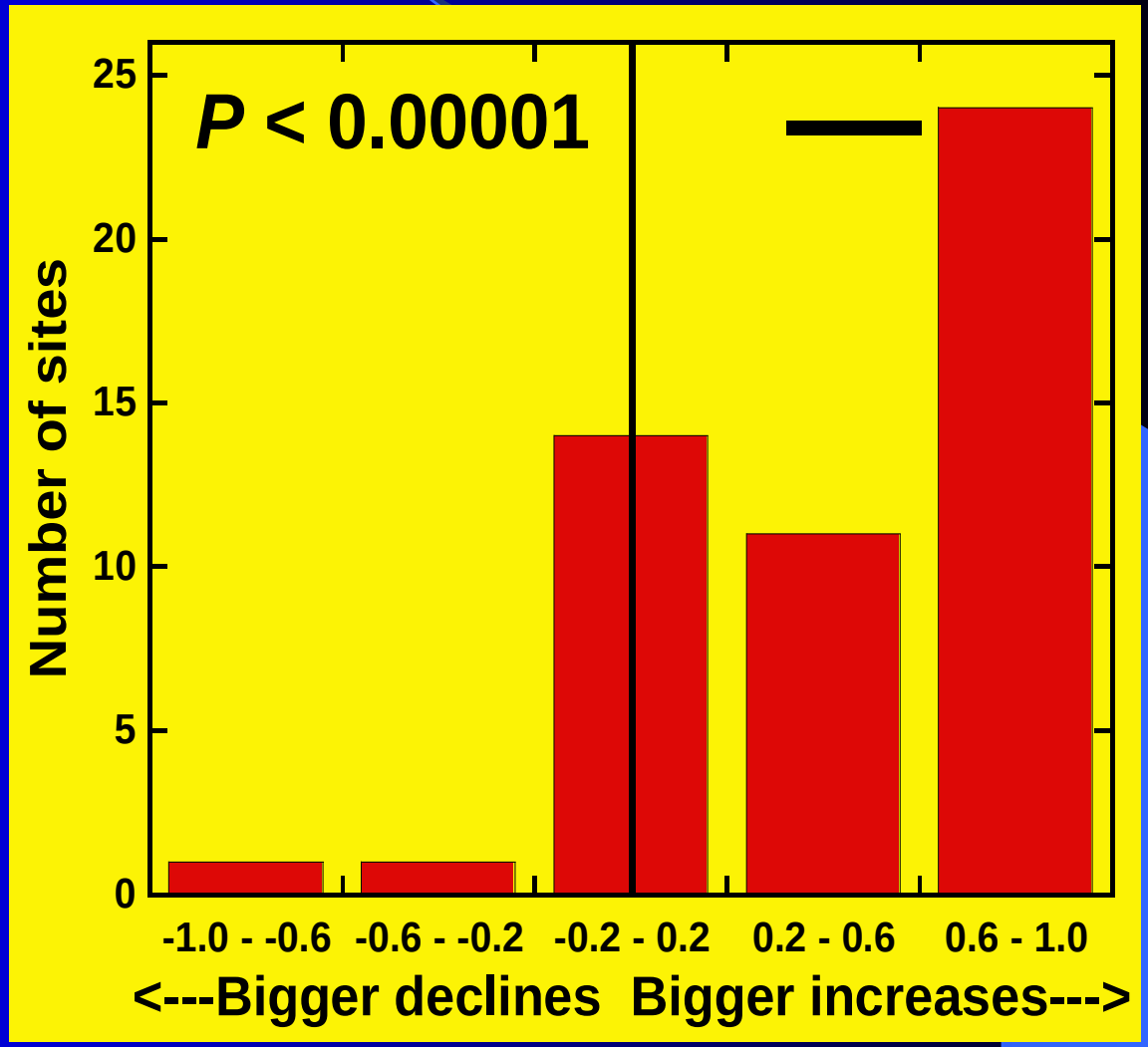


Ecological Specialists

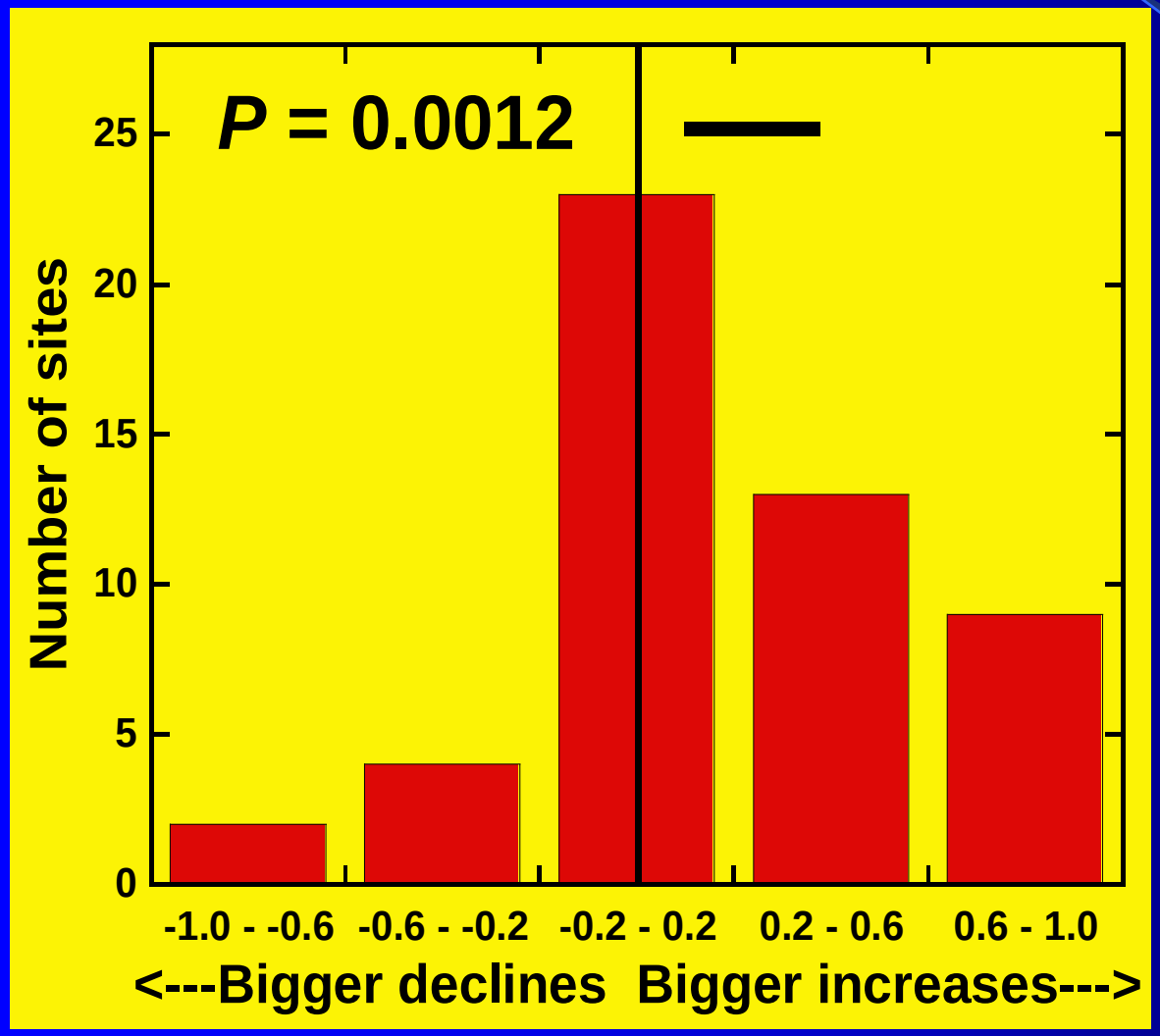


The Winners

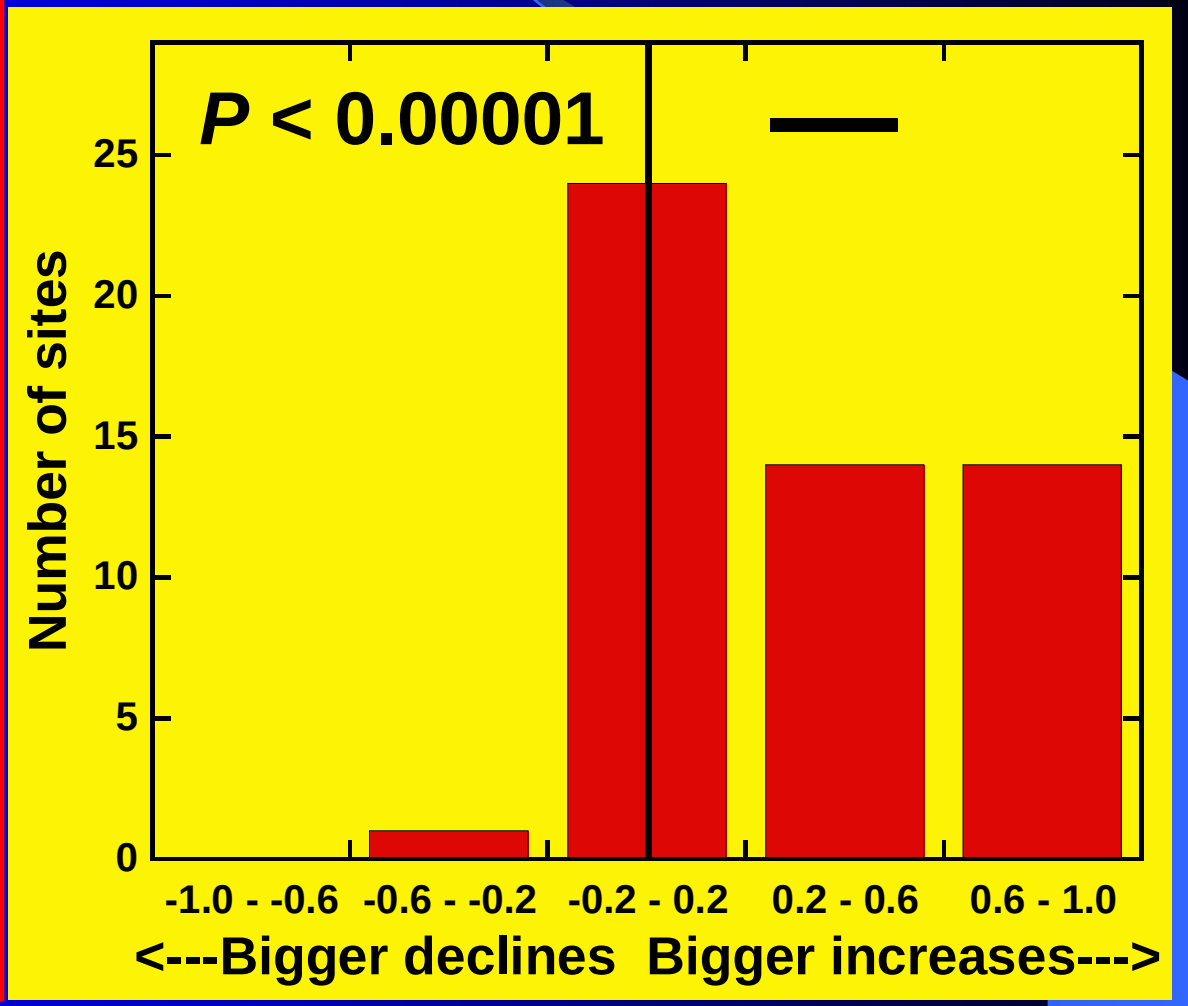
Disturbance- and Light-loving Trees



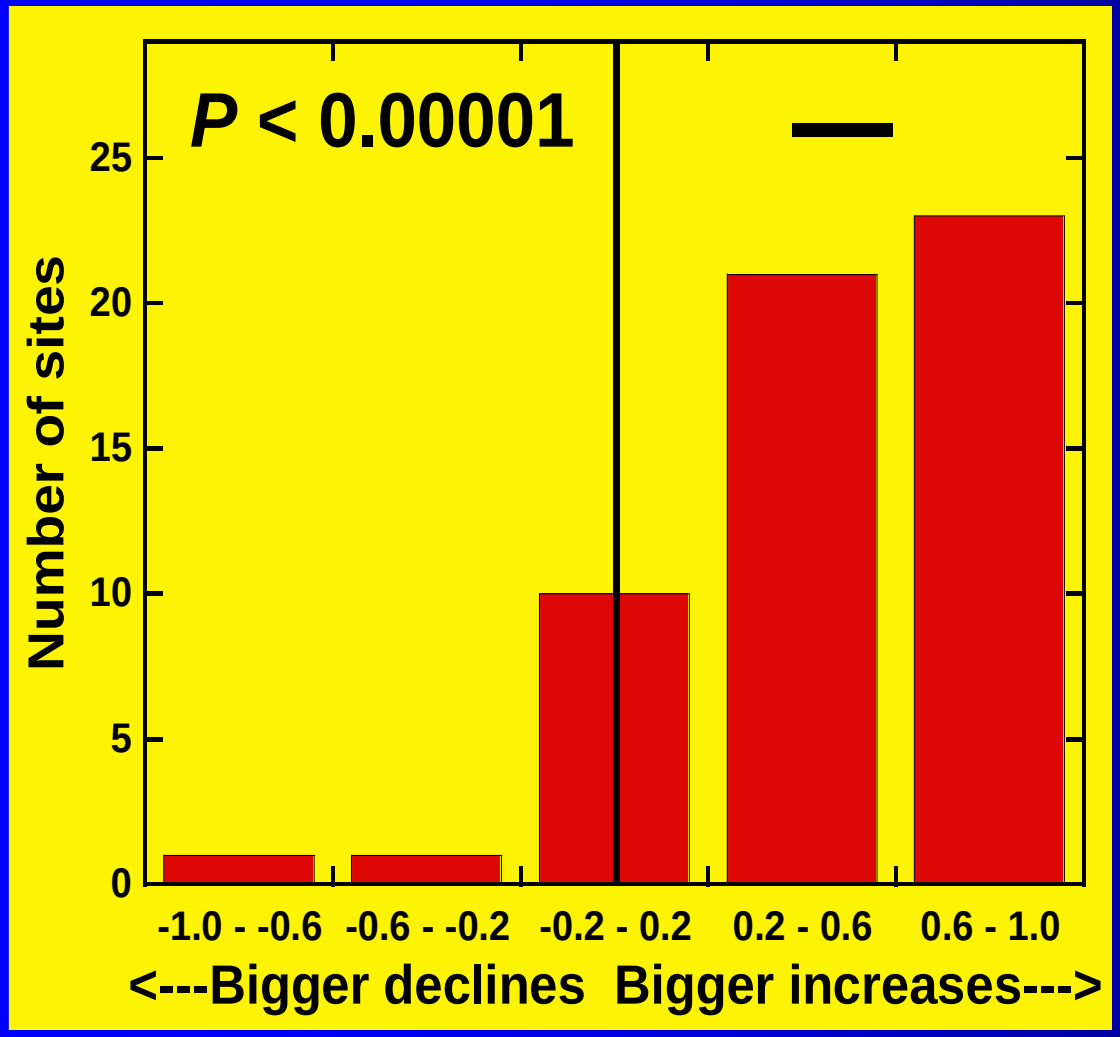
Lianas & Vines

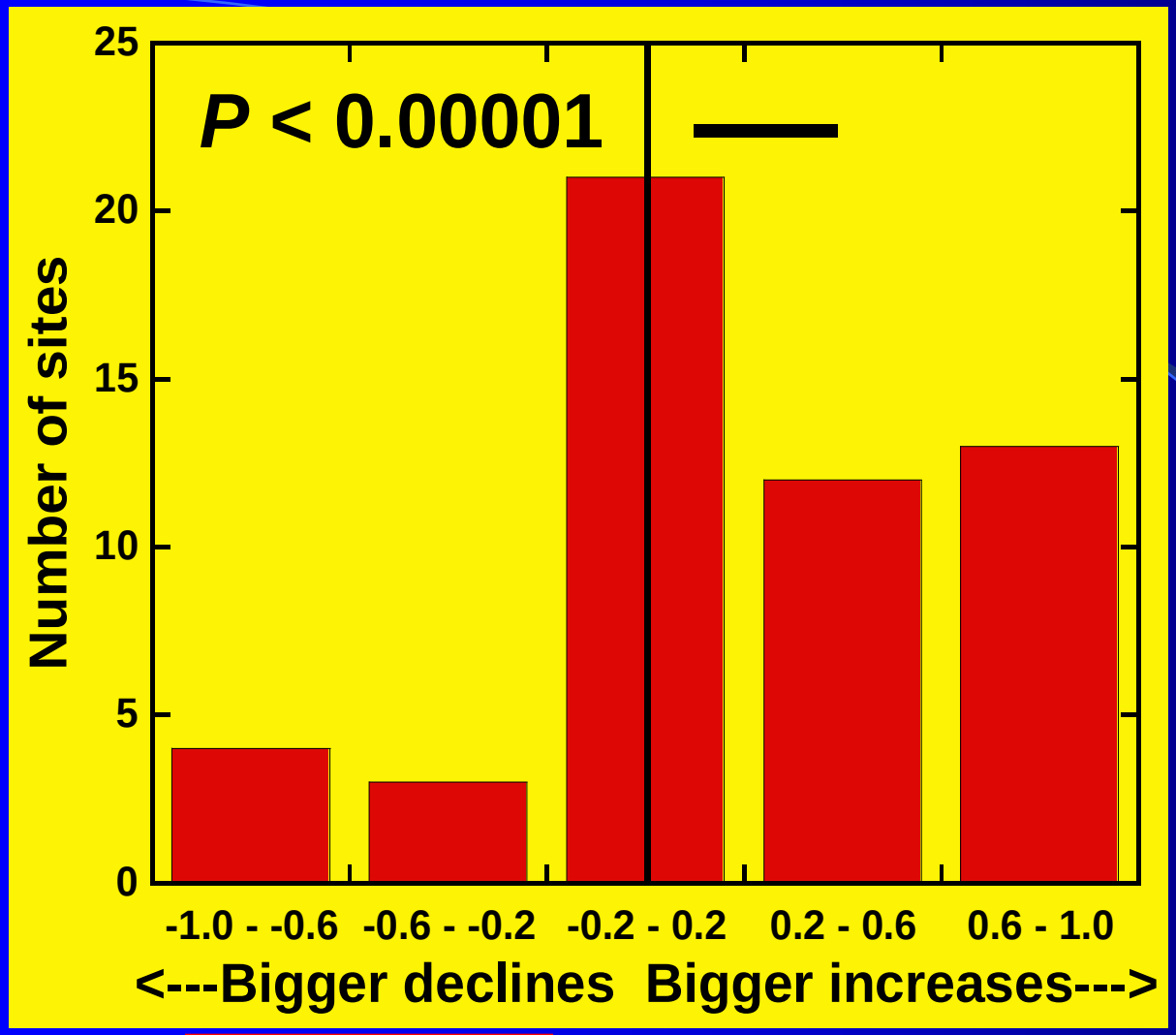


Invasive Animals



Invasive Plants



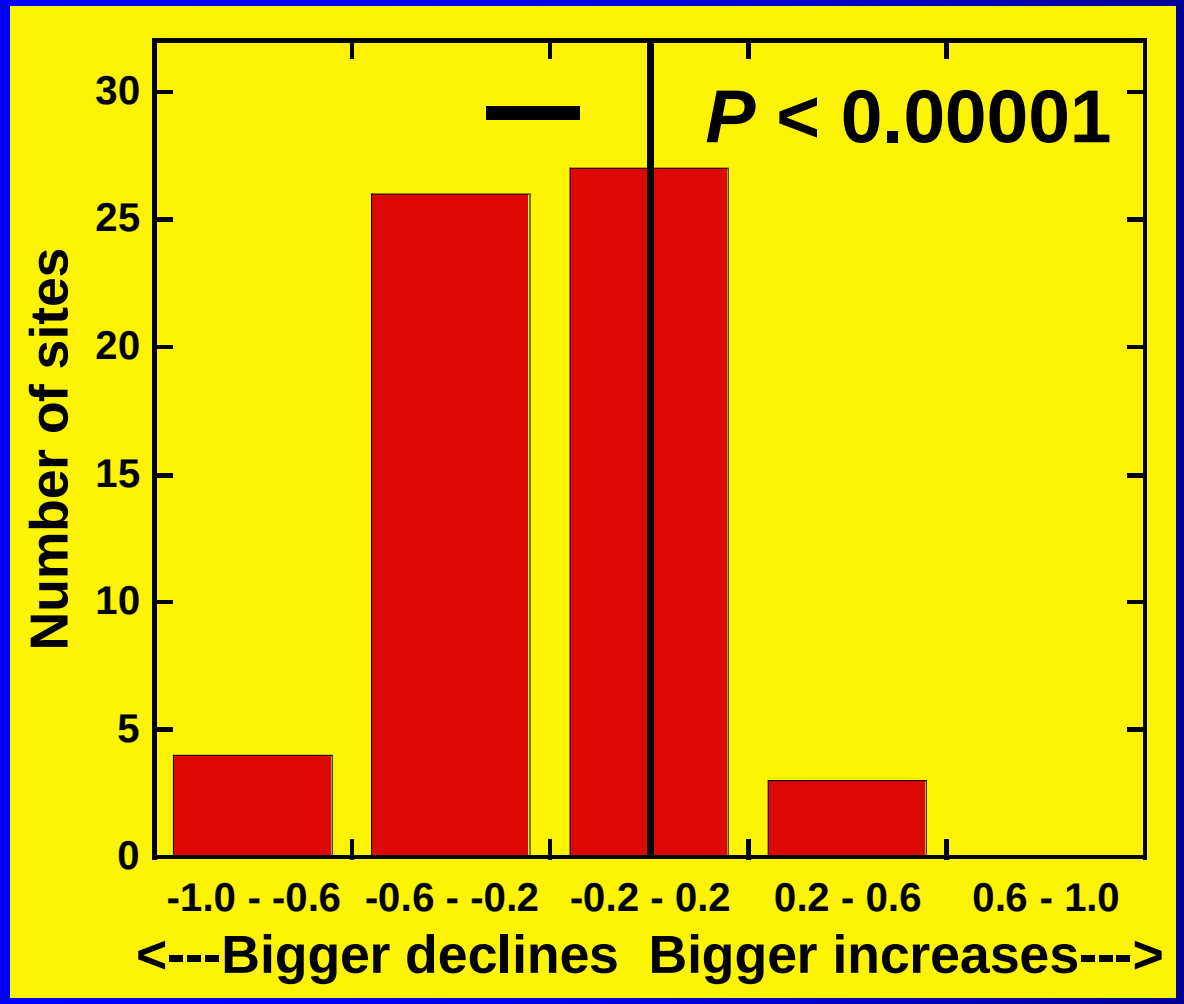


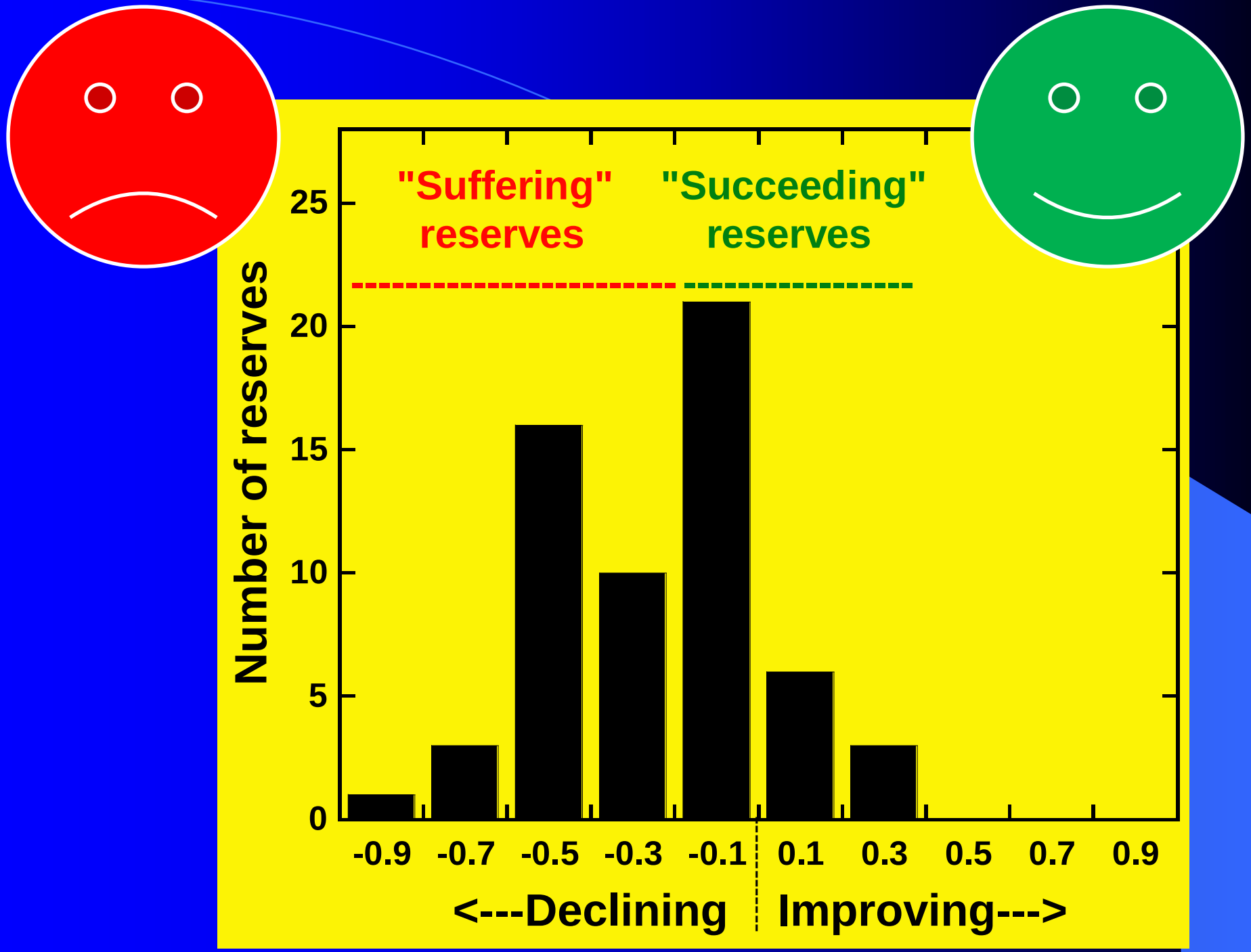
Human Diseases

Reserve Health Index

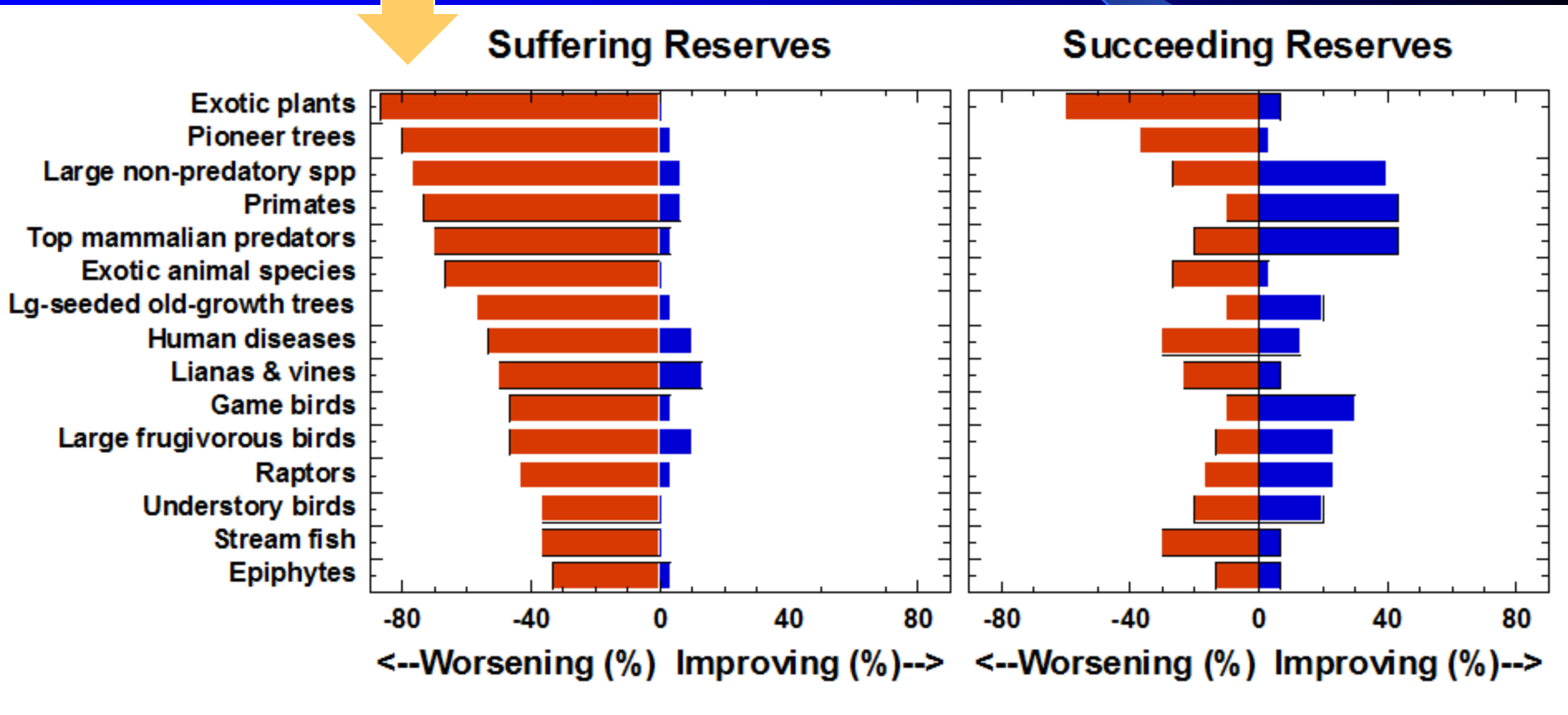
- 10 guilds both sensitive to degradation and whose fate is documented at most (≥85%) sites
- **6 disturbance-avoiders**
  - Apex predators
  - Large non-predatory species
  - Primates
  - Understory insectivorous birds
  - Large frugivorous birds
  - Large-seeded trees
- **4 disturbance-lovers**
  - Pioneer trees
  - Lianas & vines
  - Exotic animals
  - Exotic plants
- Mean score calculated, using negative values for disturbance-lovers

On Average, Reserve Health Is Declining




"Suffering" reserves
"Succeeding" reserves
Number of reserves
25
20
15
10
5
0
-0.9
-0.7
-0.5
-0.3
-0.1
0.1
0.3
0.5
0.7
0.9
<---Declining
Improving--->

Taxonomically and functionally widespread erosion of biodiversity



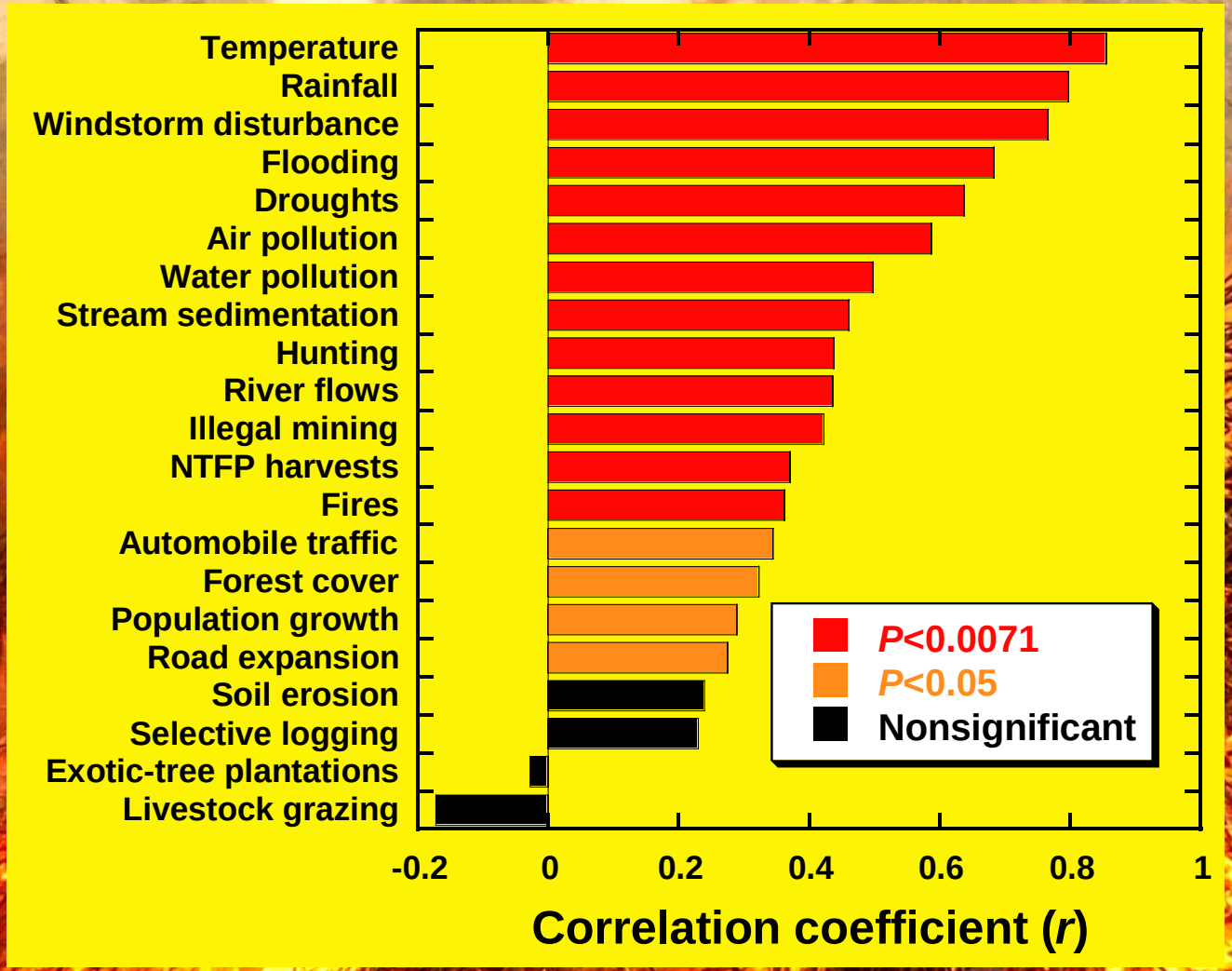

What is Driving These Changes?

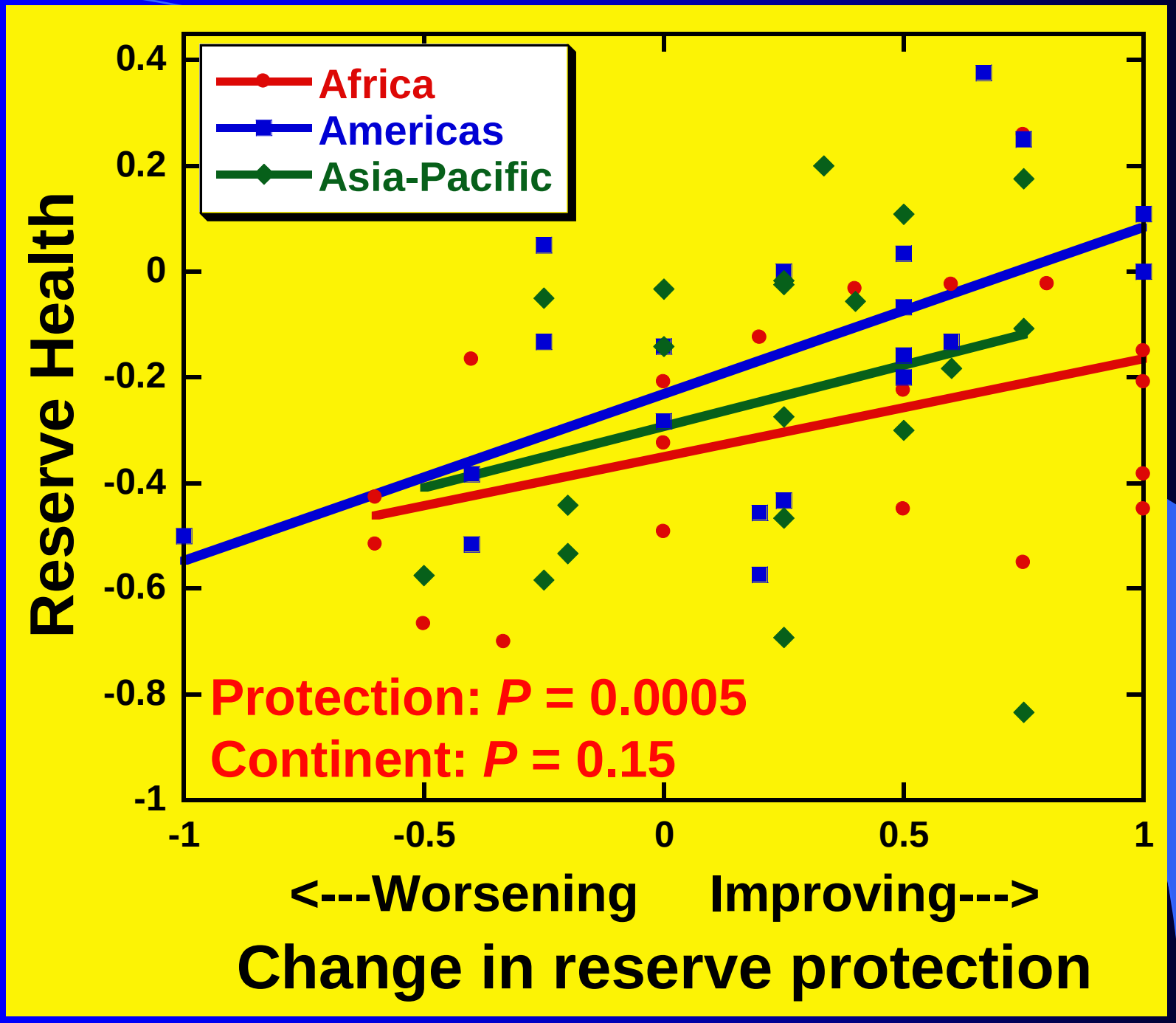
Top Correlates of Declining Reserve Health*

1) ↓ Forest cover inside reserve
2) ↑ NTFP harvests inside reserve
3) ↑ Logging inside reserve
4) ↓ Forest cover outside reserve
5) ↑ Hunting inside reserve
6) ↑ Fires outside reserve
7) ↑ Logging outside reserve

*All *P*<0.006, Spearman rank correlation

Mirror Effect




Africa
Americas
Asia-Pacific
Reserve Health
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1
Protection: P = 0.0005
Continent: P = 0.15
<---Worsening
Improving--->
Change in reserve protection

What makes a reserve happy?

- Protect it from internal habitat disruption (deforestation, fires, logging) and overexploitation (hunting, NTFP harvests)
- Manage the forest around the reserve (limit deforestation, fires, logging)
- Drivers such as pollution and climate change are of lesser importance

Conclusions

- Four-fifths of tropical reserves in our survey are deteriorating ecologically—and half seriously
- In the suffering reserves, erosion of biodiversity is taxonomically and functionally widespread
- Reserves that deteriorate least over time are those with the best on-the-ground protection
- Environmental changes inside and outside the reserve appear almost equally critical

Thanks