

Exploitation patterns in fisheries, a global meta-analysis from Ecopath models.

Kolding, J.; Bundy, A.; Christensen, V.; Steenbeek; Law, R.; Plank, M., Zwieten, P.A.M et al.

Balanced harvesting: Can it reconcile fisheries and conservation objectives, and how can it be done?

Jeppe Kolding , Serge M. Garcia, Jake Rice, Marie-Joëlle Rochet, Shijie Zhou, Takafumi Arimoto, Jan E. Beyer, Lisa Borges, Alida Bundy, Daniel Dunn, Beth Fulton, Martin Hall, Mikko Heino, Richard Law, Mitsutaku Makino, Adriaan D. Rijnsdorp, François Simard, Anthony D.M Smith, and Paul A.M. van Zwieten.

6th *World Fisheries Congress*, 7-11 May 2012. Sustainable Fisheries in a Changing World. *Edinburgh*



Why Ecopath?

- Balanced harvest = catches proportional to production

$$Y = F \cdot \bar{B}$$

$$P = Z \cdot \bar{B} = {}^P/_B \cdot \bar{B}$$

$$E = \frac{F}{Z} = \frac{Y}{P}$$

Data

- 200+ Ecopath models

- Christensen *et al. in press* “Fish biomass in the world ocean: a century of decline” Global Ecology and Biogeography.

- Reduced to 151 models with fishery catches

Type	# N
Temperate	51
Tropical	47
Tropical upwelling	25
High Latitude	16
Temperate upwelling	10
Inland Sea	2
Total	151



The oceans contribute 50% of
the global biological production

But humans only collect 2% of
our food from the oceans.

Unutilized?



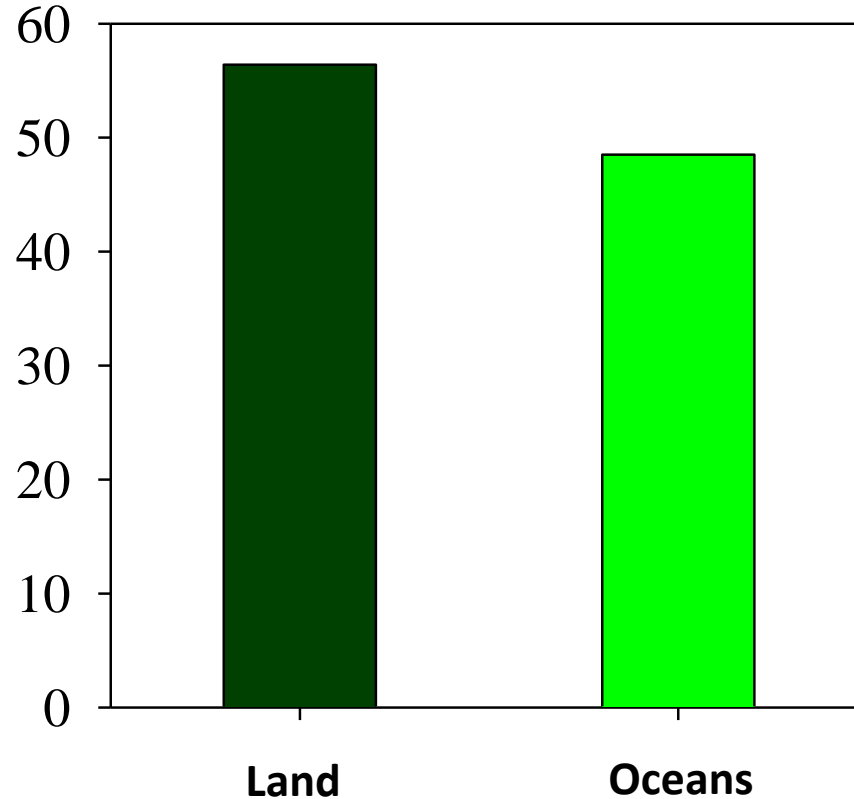
Still Waters: The Global Fish Crisis

➤ **1,000**
Google scholar
hits for
**fisheries
crisis**

> 1,000,000
Google hits for
**fisheries
crisis**

Can we harvest the waters as land?

Global plant production
Billion ton carbon (Giga t)



- ✓ 2% of human food from oceans
- ✓ 4-5% of the primary production on land is directly consumed by humans
- ✓ All domesticated animals for food are herbivores

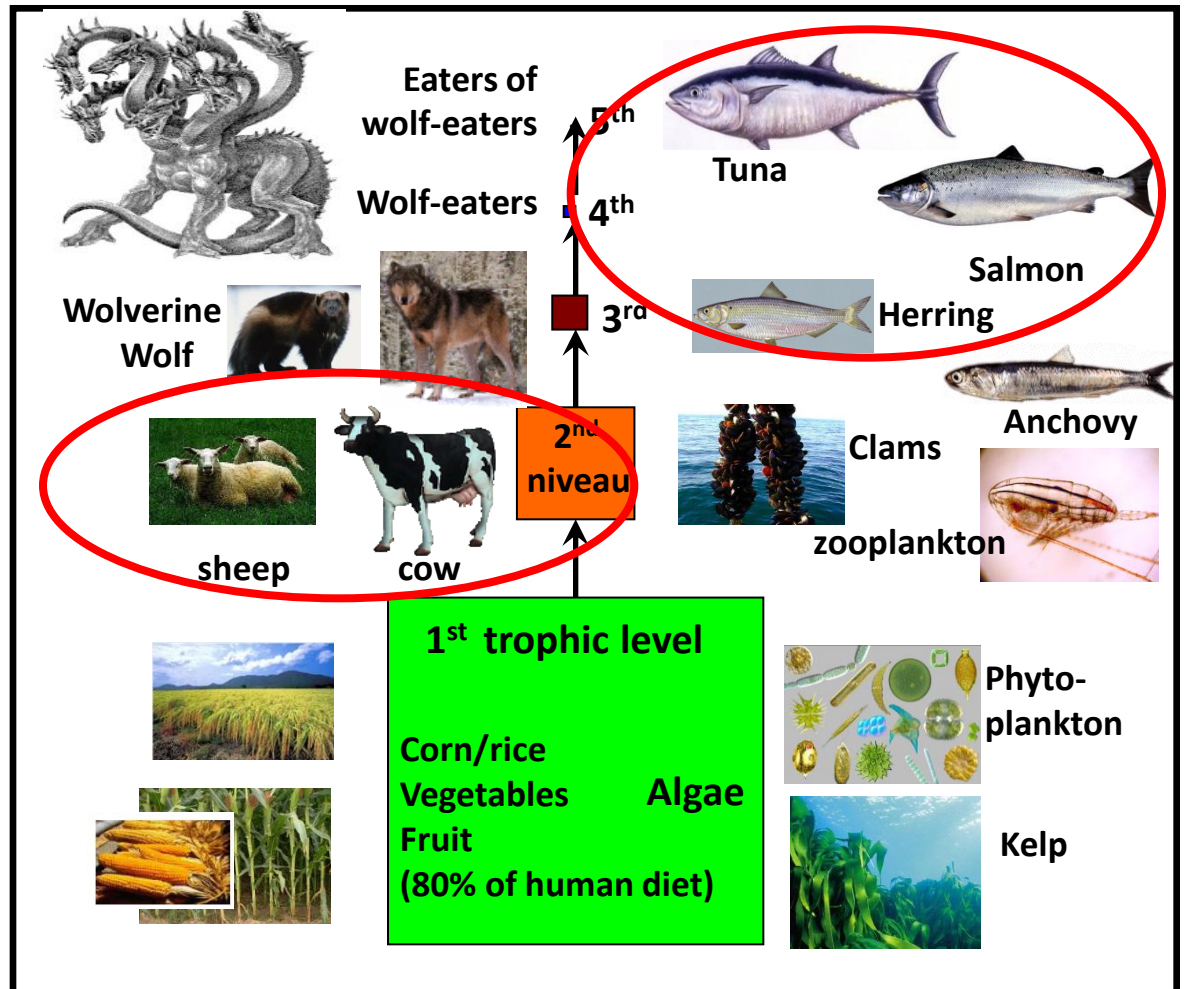


The food chain in fisheries and agriculture

- ◆ Humans (TL 2.21) feed 2 trophic levels higher in the oceans than on land
- ◆ Very inefficient utilization of the primary productivity

Food chain agriculture

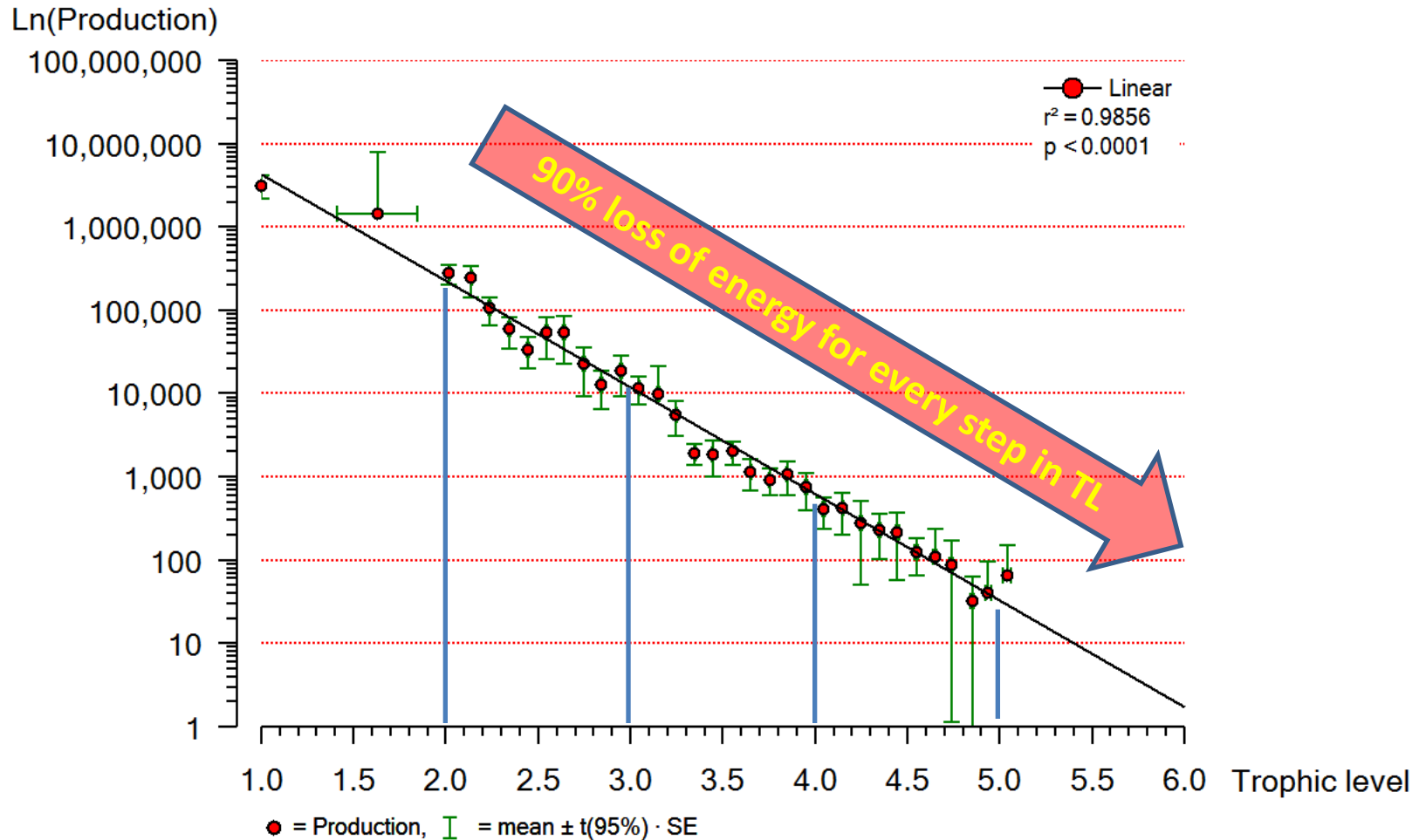
Food chain fisheries



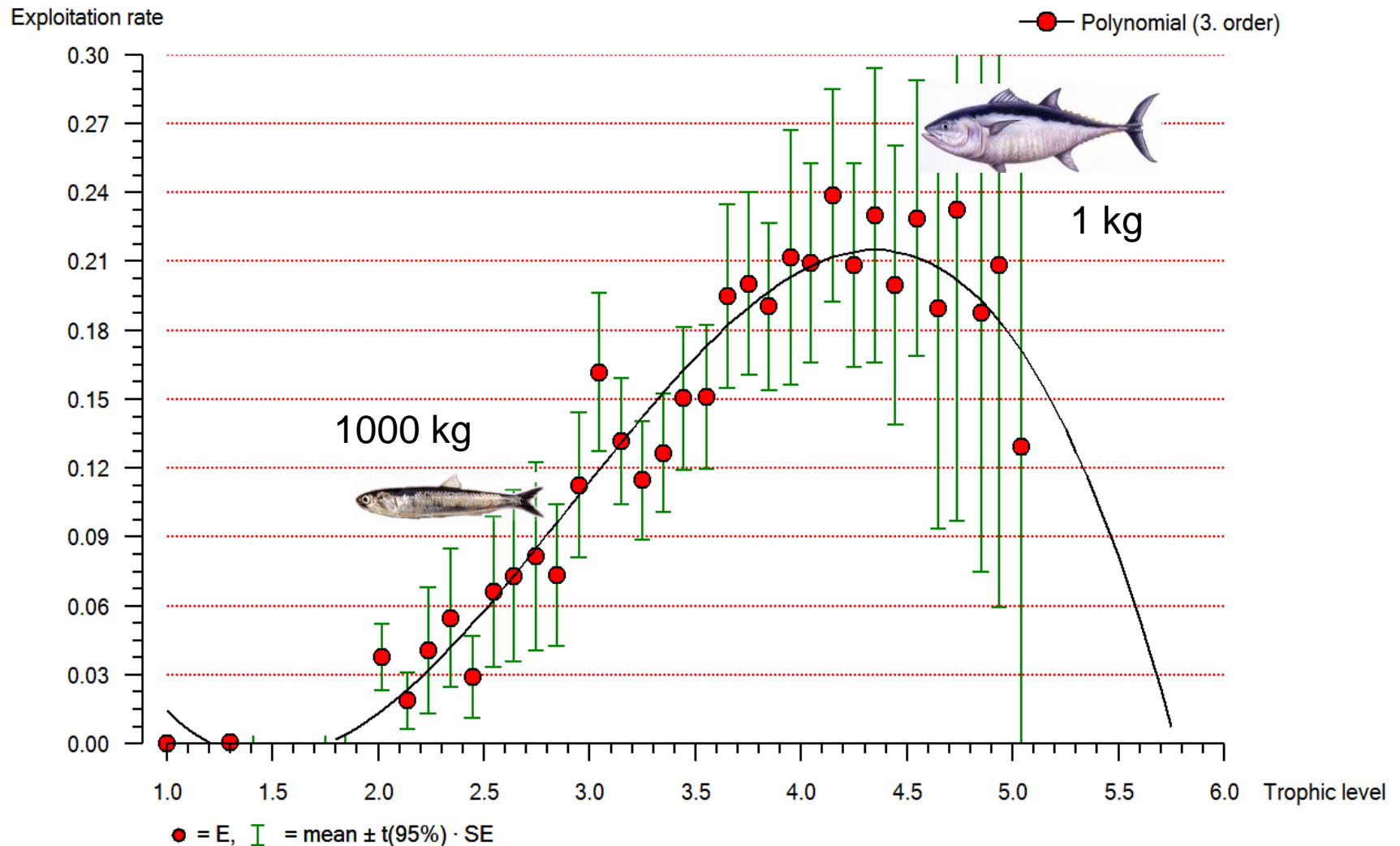
After Duarte et al 2009

Exponential relationship between production and trophic level

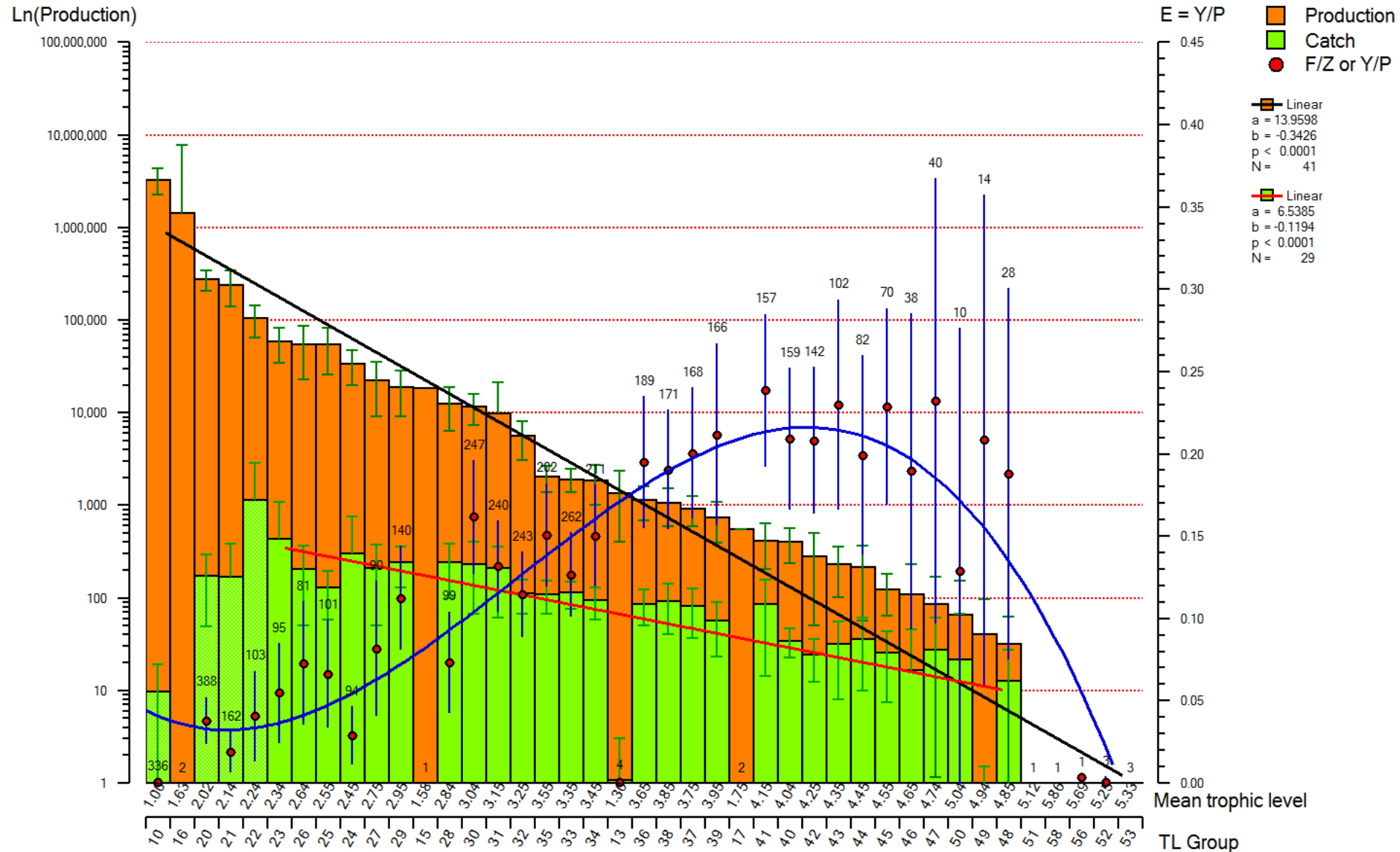
Data from 150 trophic ecosystem models across the world



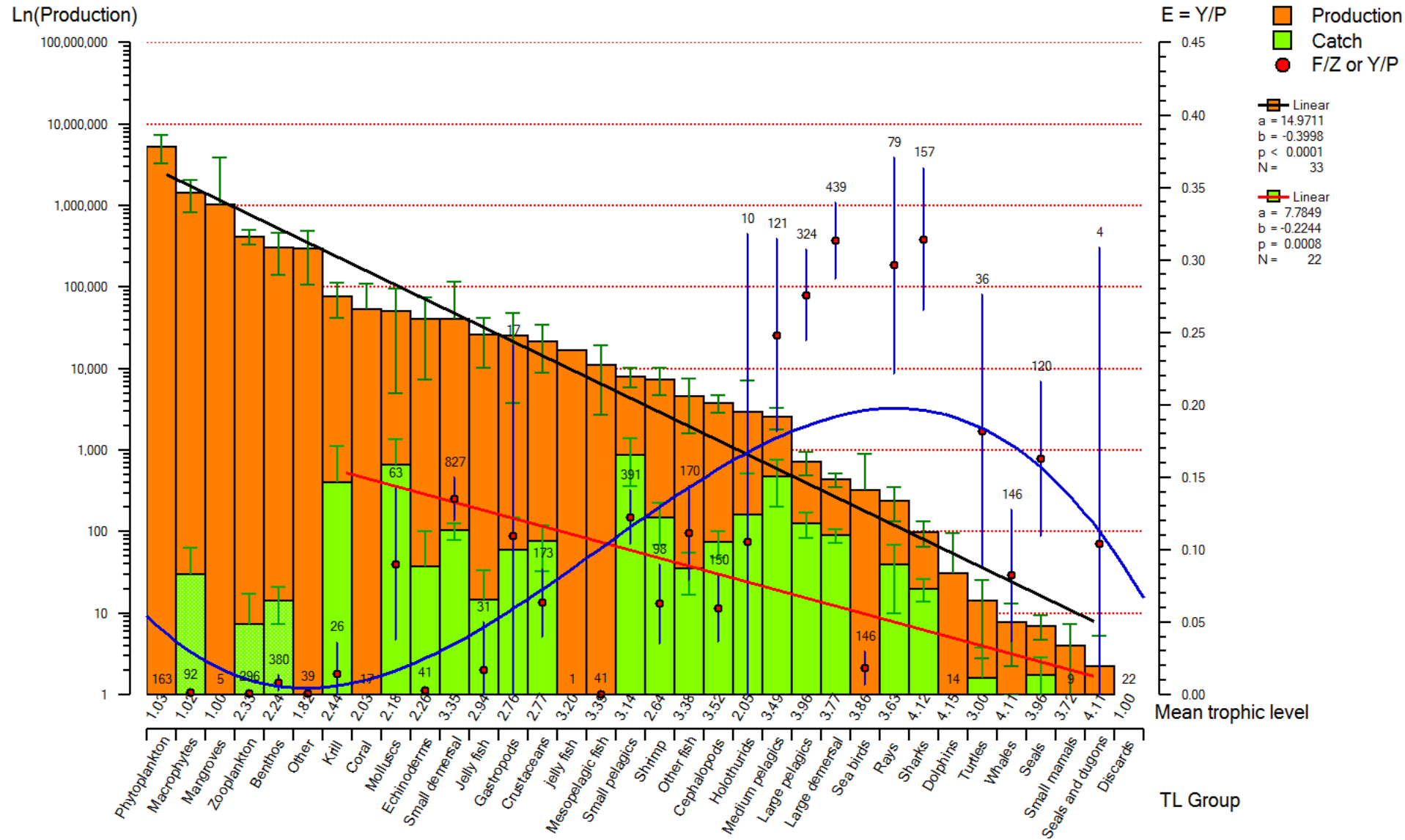
Global mean exploitation rate vs trophic level



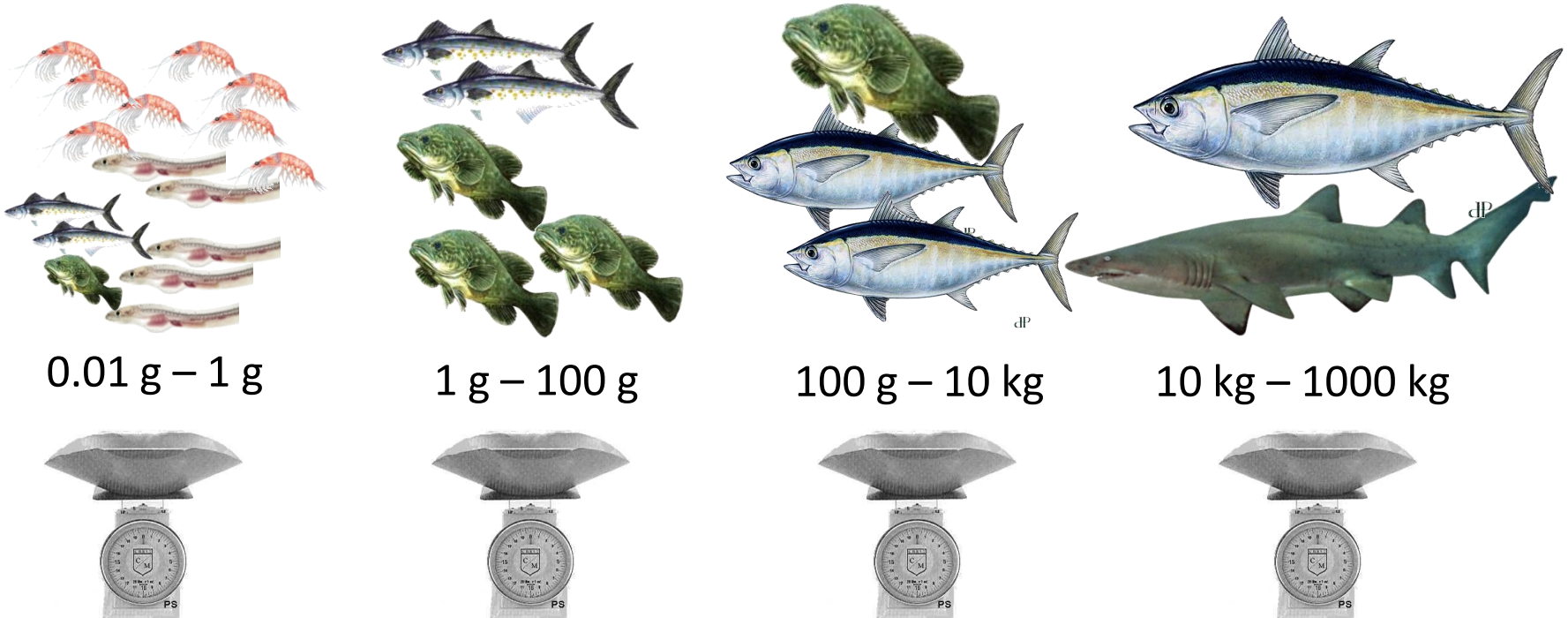
Global fishing pattern by TL



Global fishing pattern by 33 functional groups



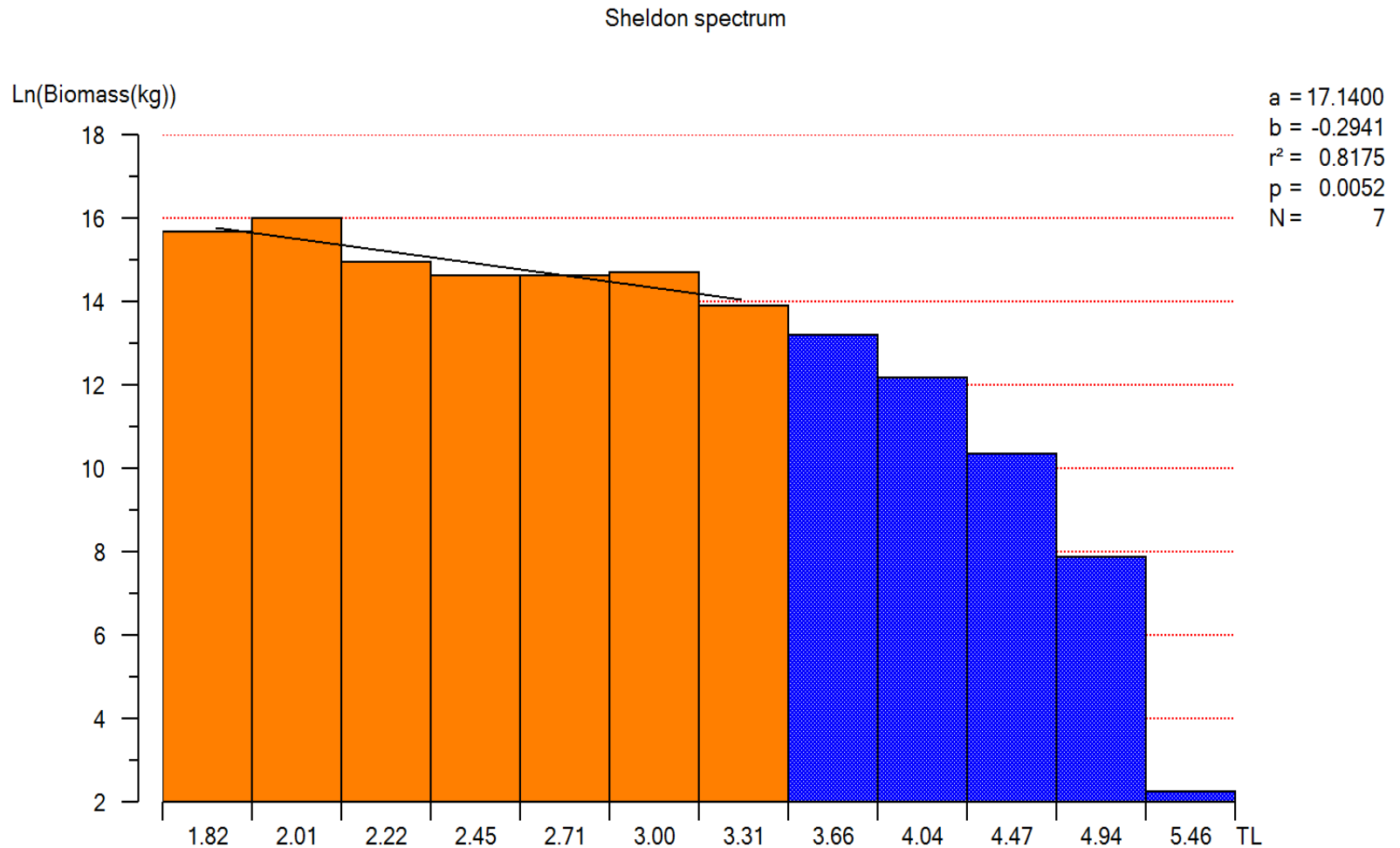
Body size vs abundance



Invariance of biomass:

Biomass is constant over logarithmically sized bins

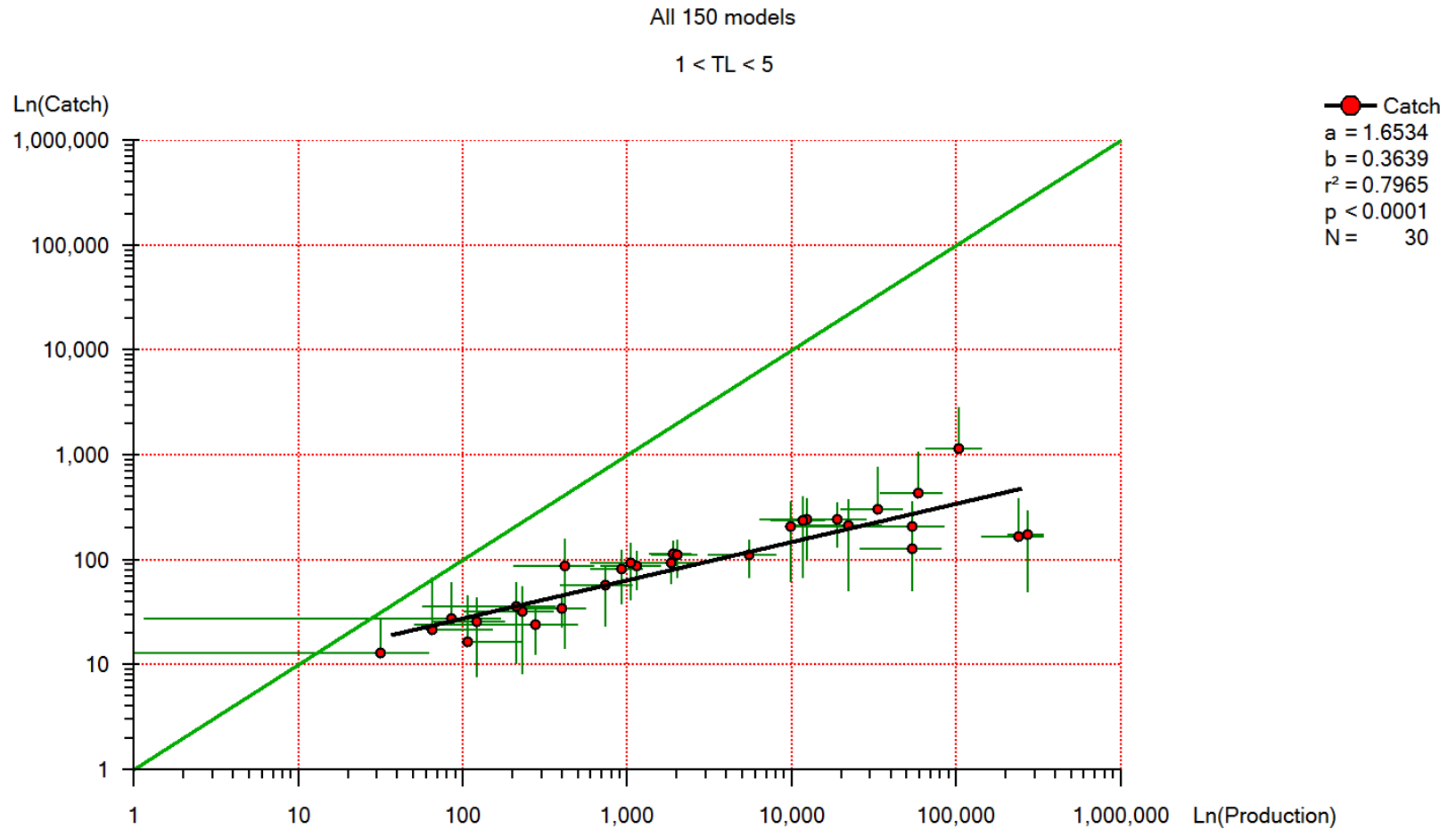
Sheldon spectrum on TLs?



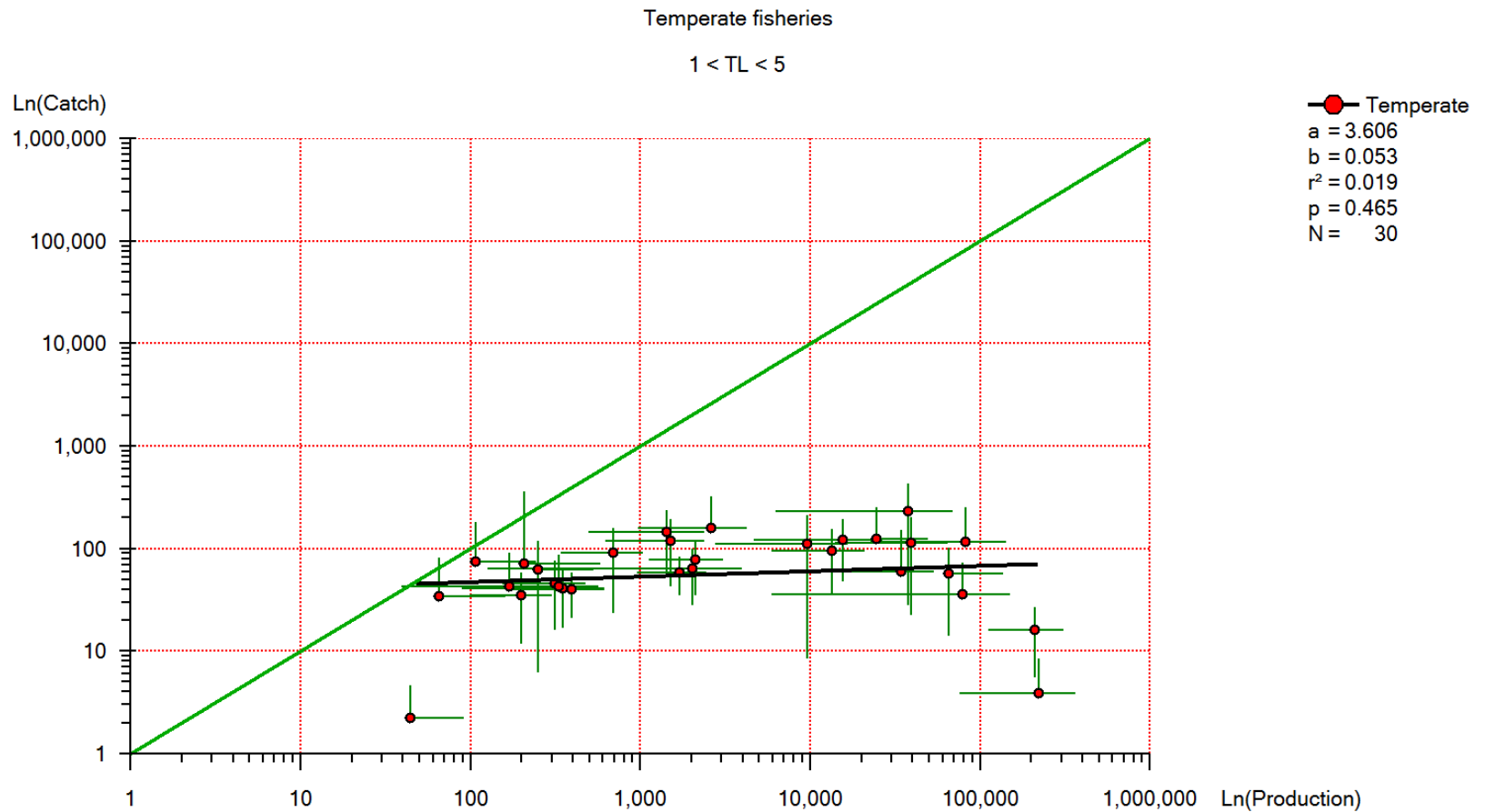
Hypothesis

- Fishing pattern is driven by market demand
- Higher prices for large fish in the North than in the South
- Fishing pattern is less balanced in the North than in the South?

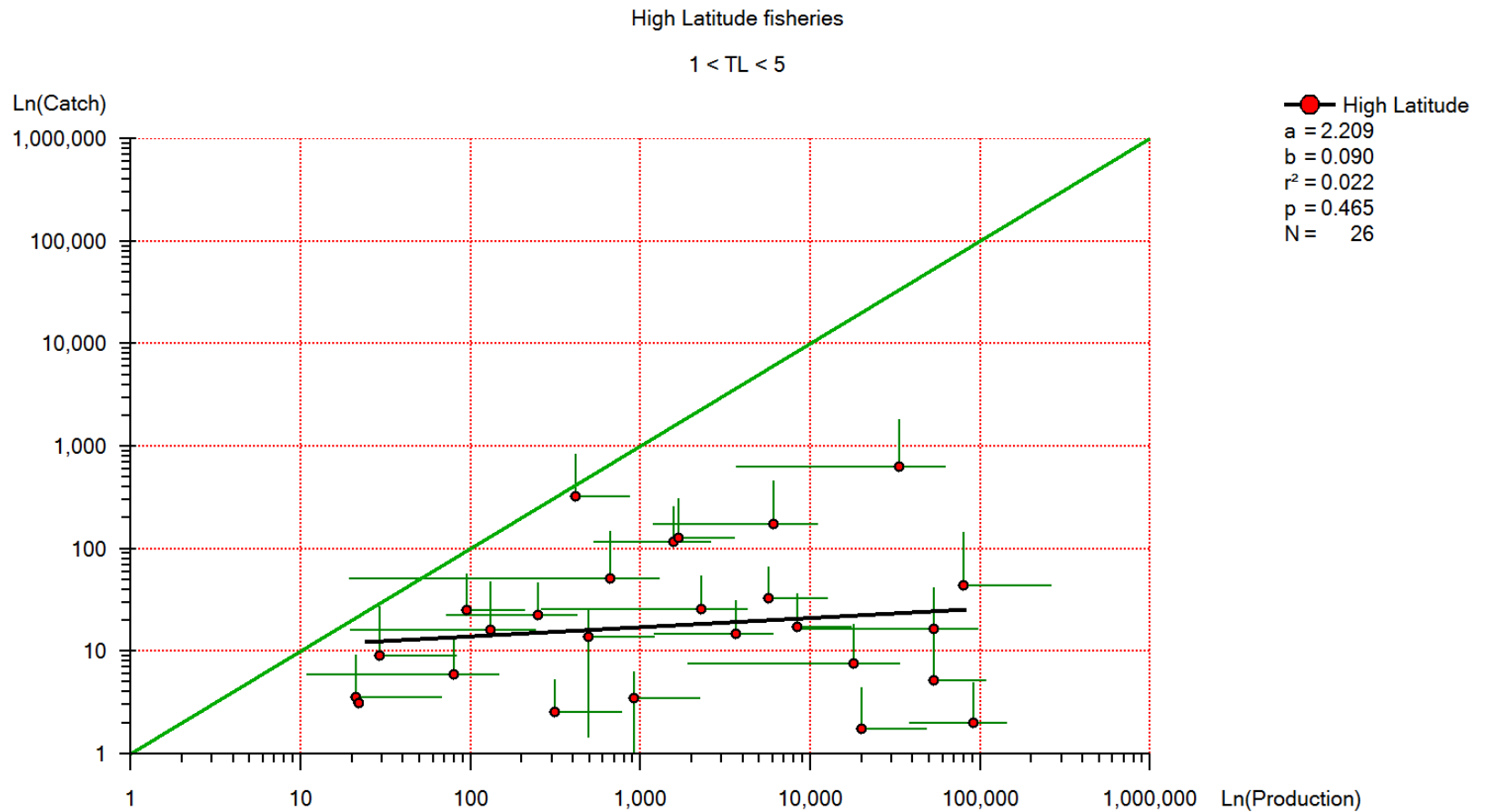
Global fishing pattern



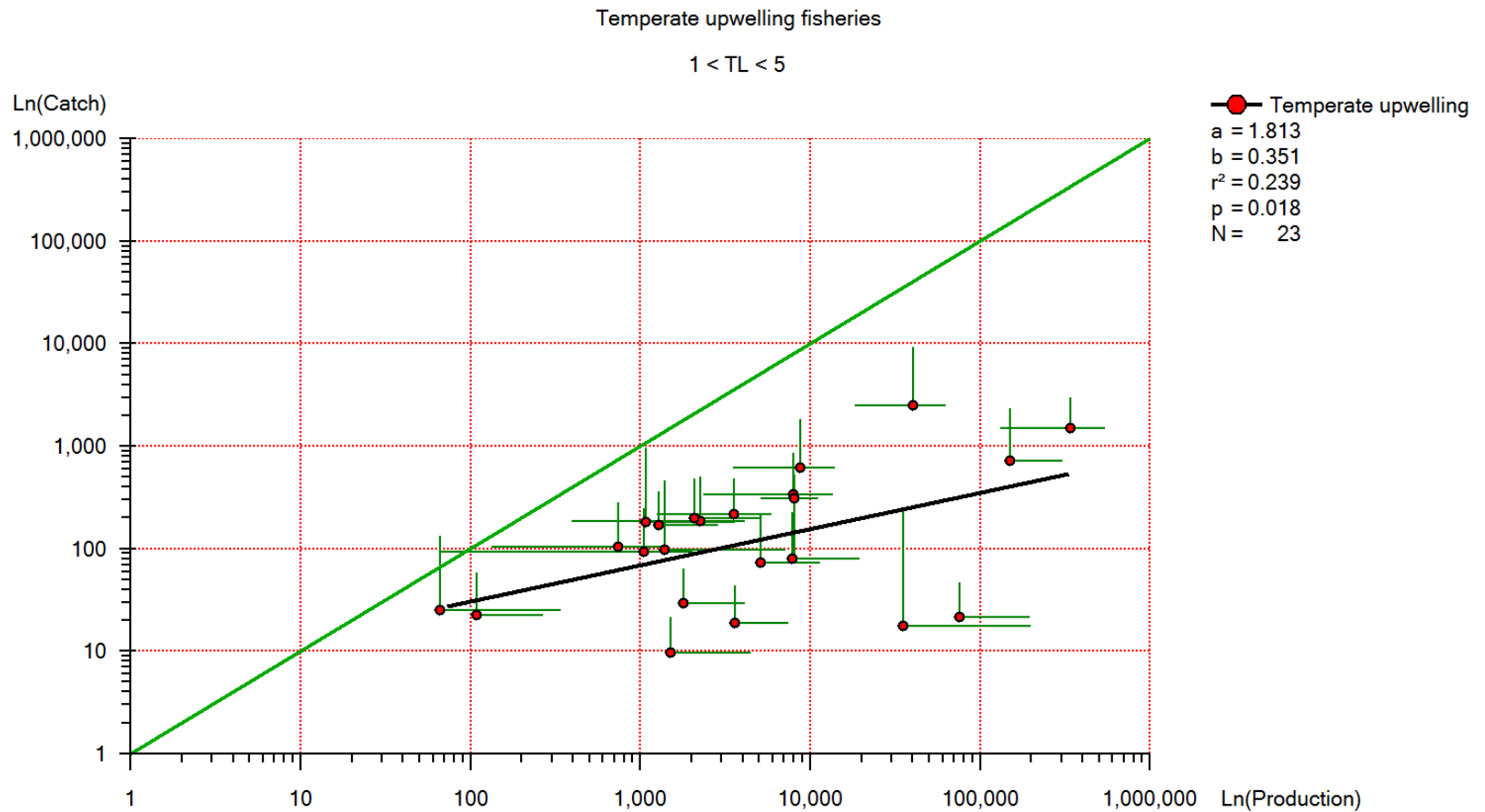
Temperate fisheries



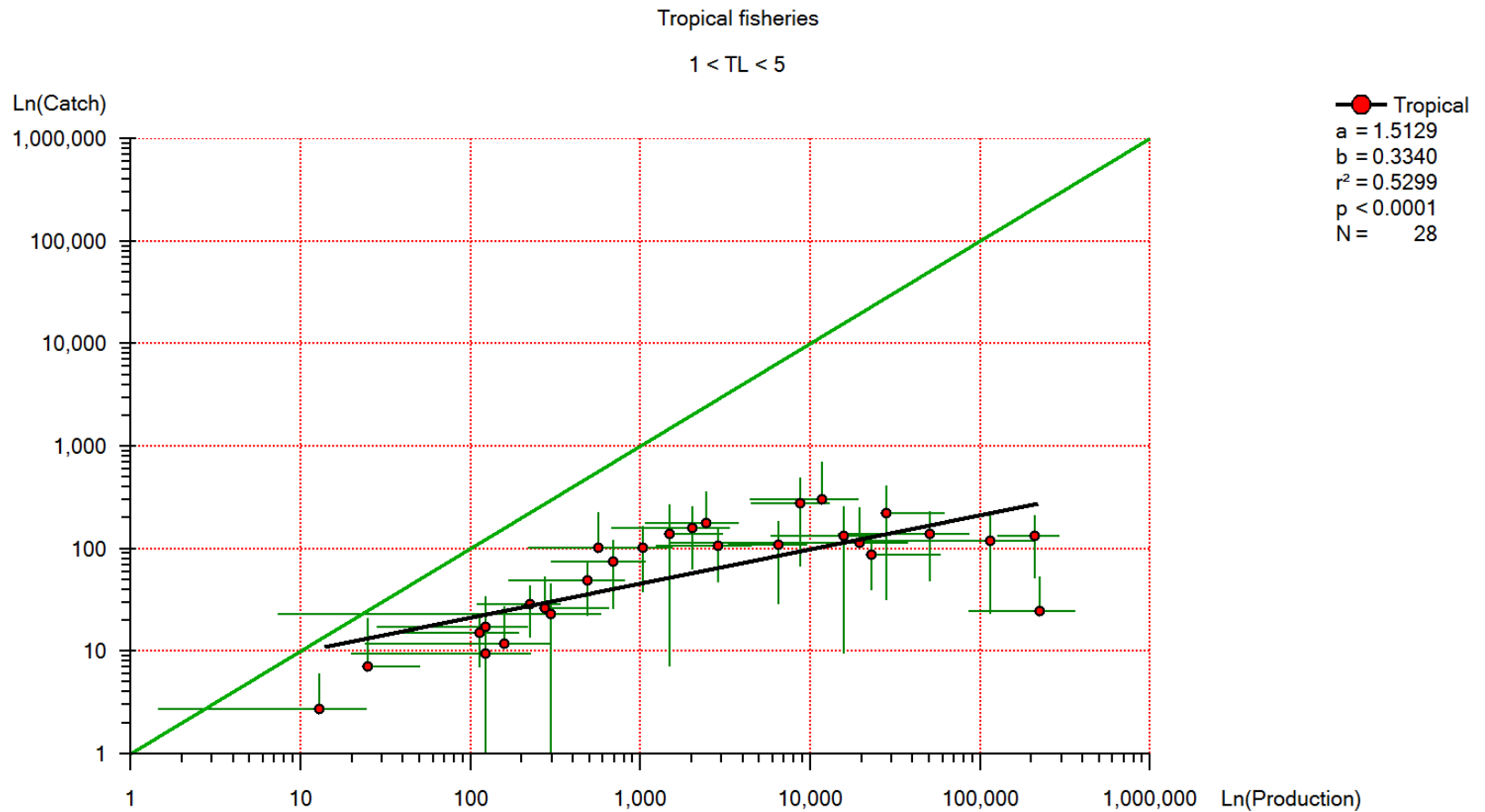
High latitude fisheries



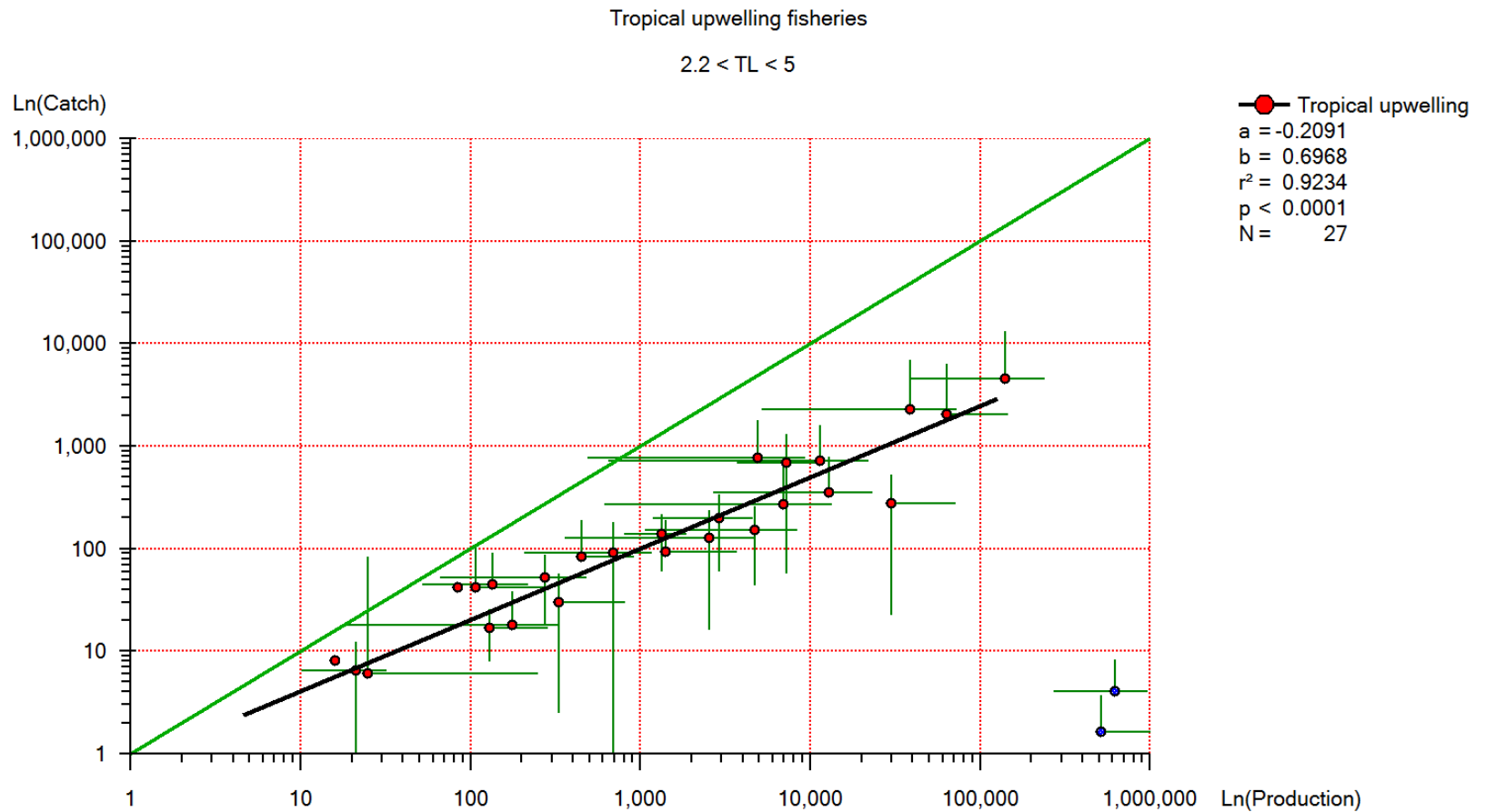
Temperate upwelling



Tropical fisheries

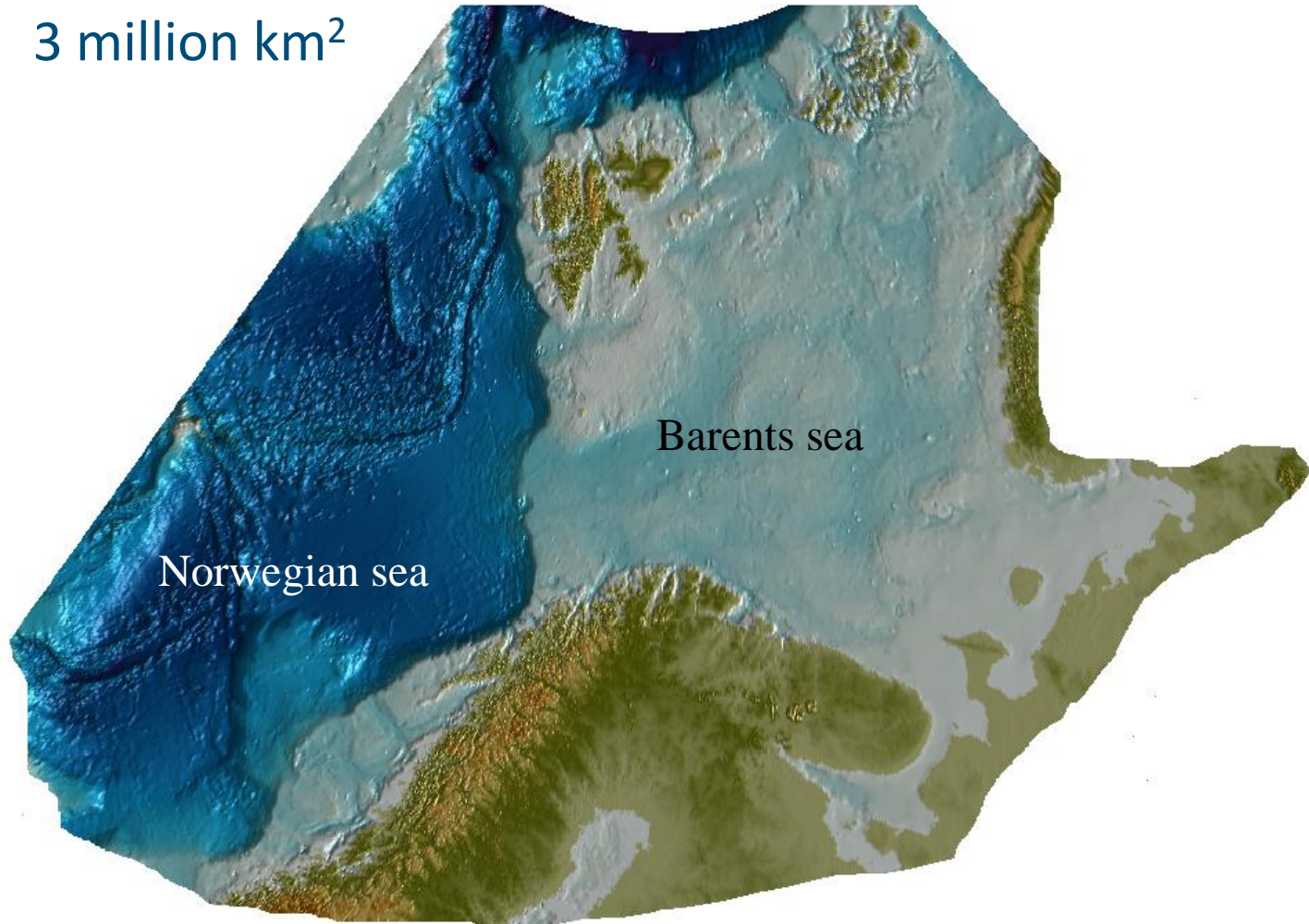


Tropical upwelling

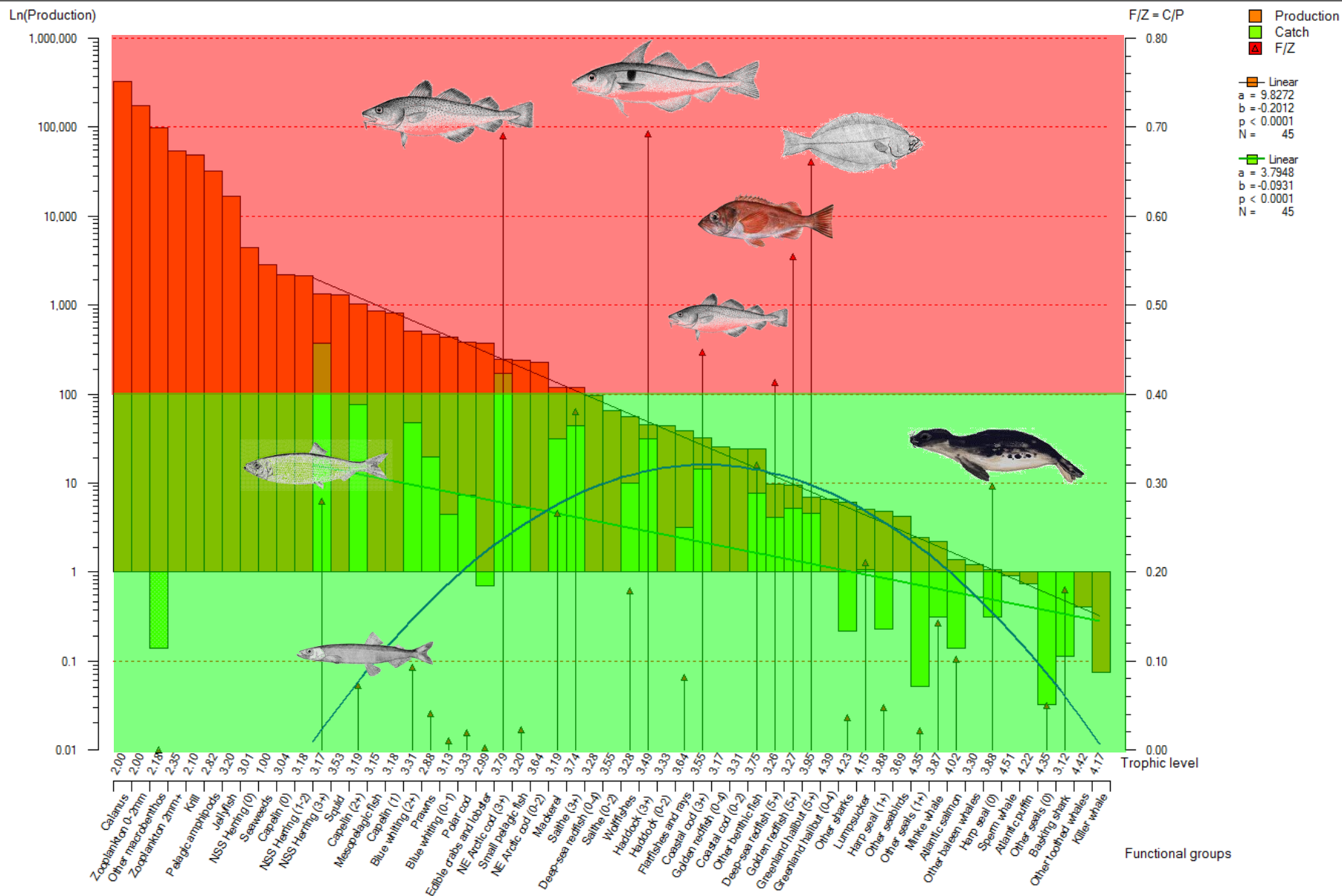


Norwegian Sea and the Barents Sea: ECOPATH model (1997-2001)

3 million km²

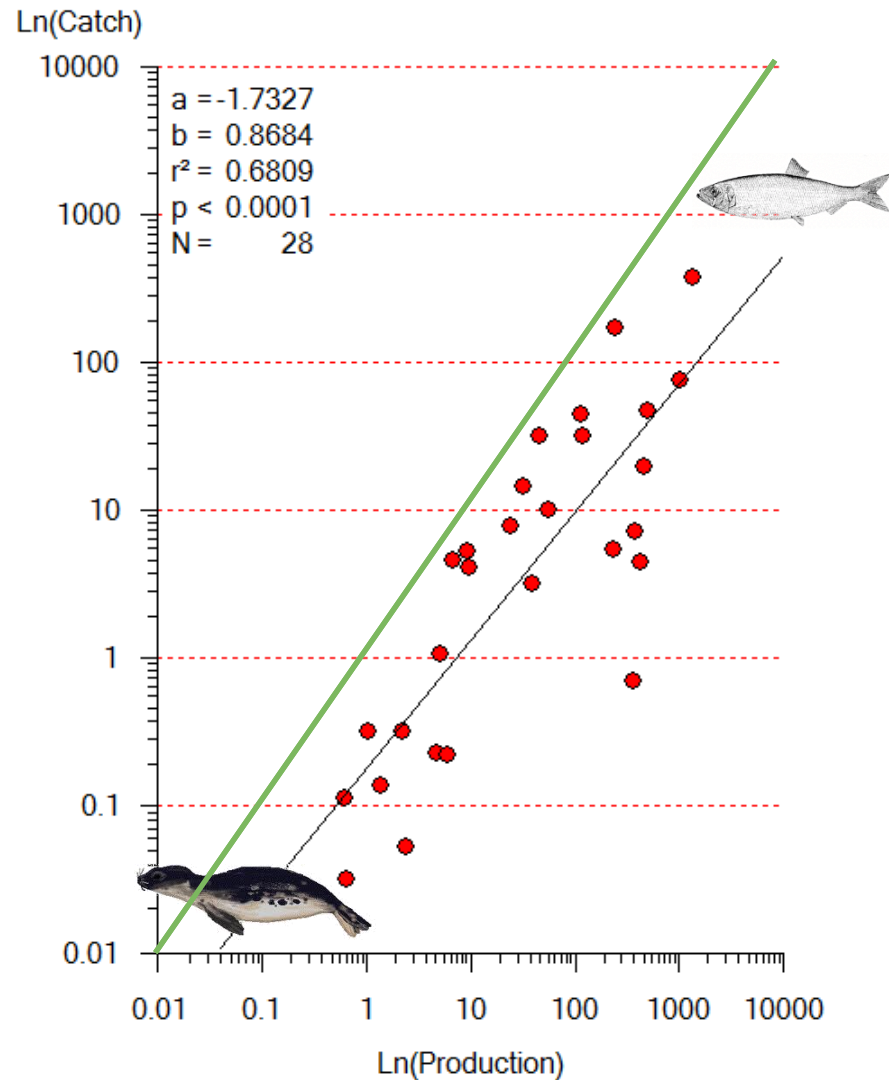


Is the Norwegian fishery in balance?

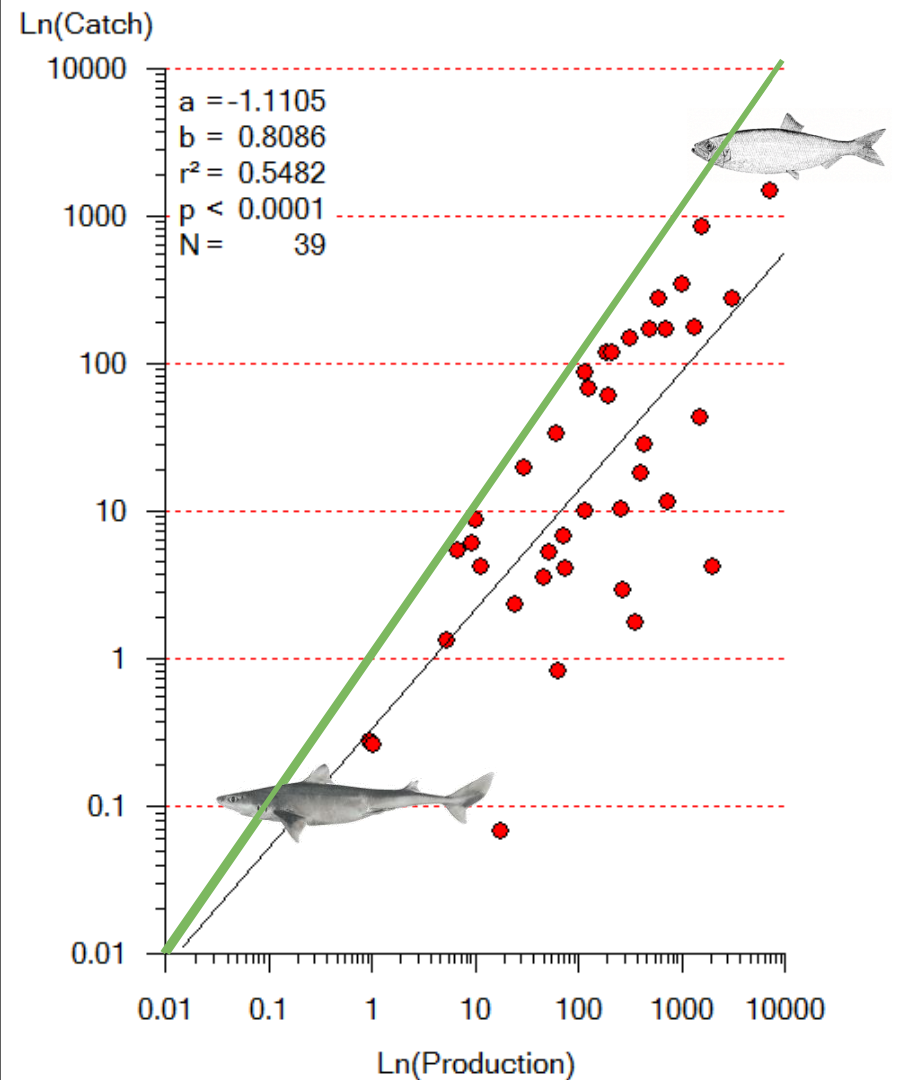


Balanced harvest = catches proportional to production

Norwegian and Barents Sea



North Sea



and now Alida..

