Ecology 8310
Population (and Community) Ecology

Predator-prey

- Empirical patterns:
  - Luckinbill's experiments
  - Huffaker's mites
  - Lake patterns in phyto-zoop as f(nutrients)
  - Causes of positive increases in consumer-resource

Tests that inform predator-prey models

COEXISTENCE IN LABORATORY POPULATIONS OF *PARAMECIUM AURELIA* AND ITS PREDATOR *DIDINIUM NASUTUM*[1]

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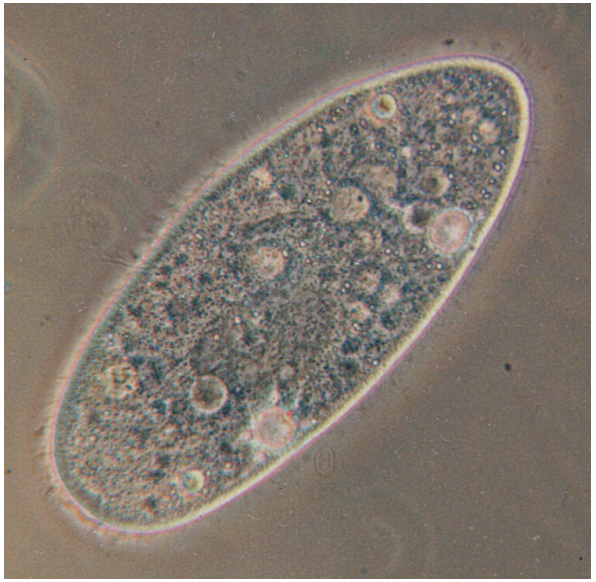
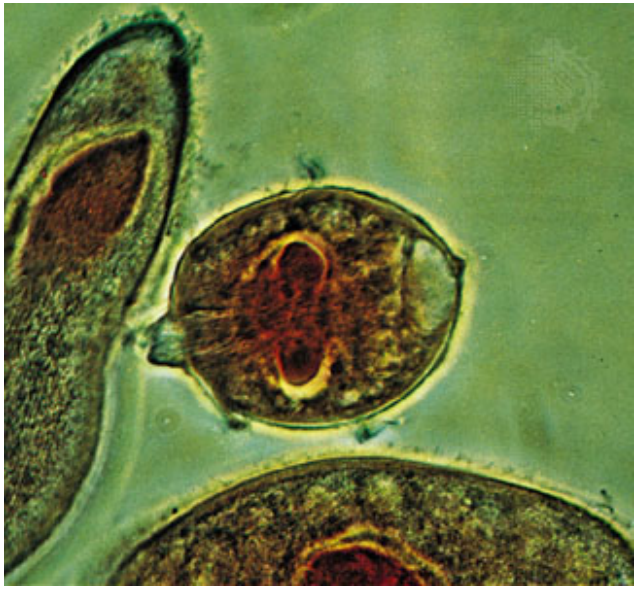
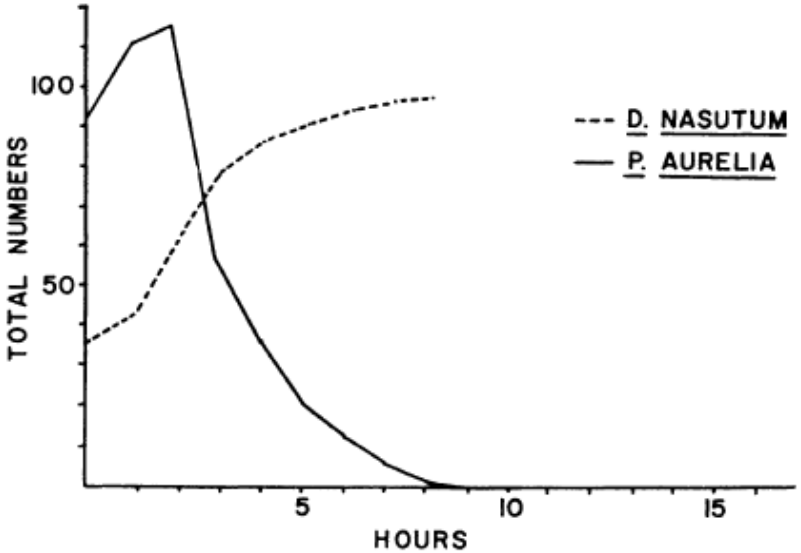
Ecology 54:1320-1327

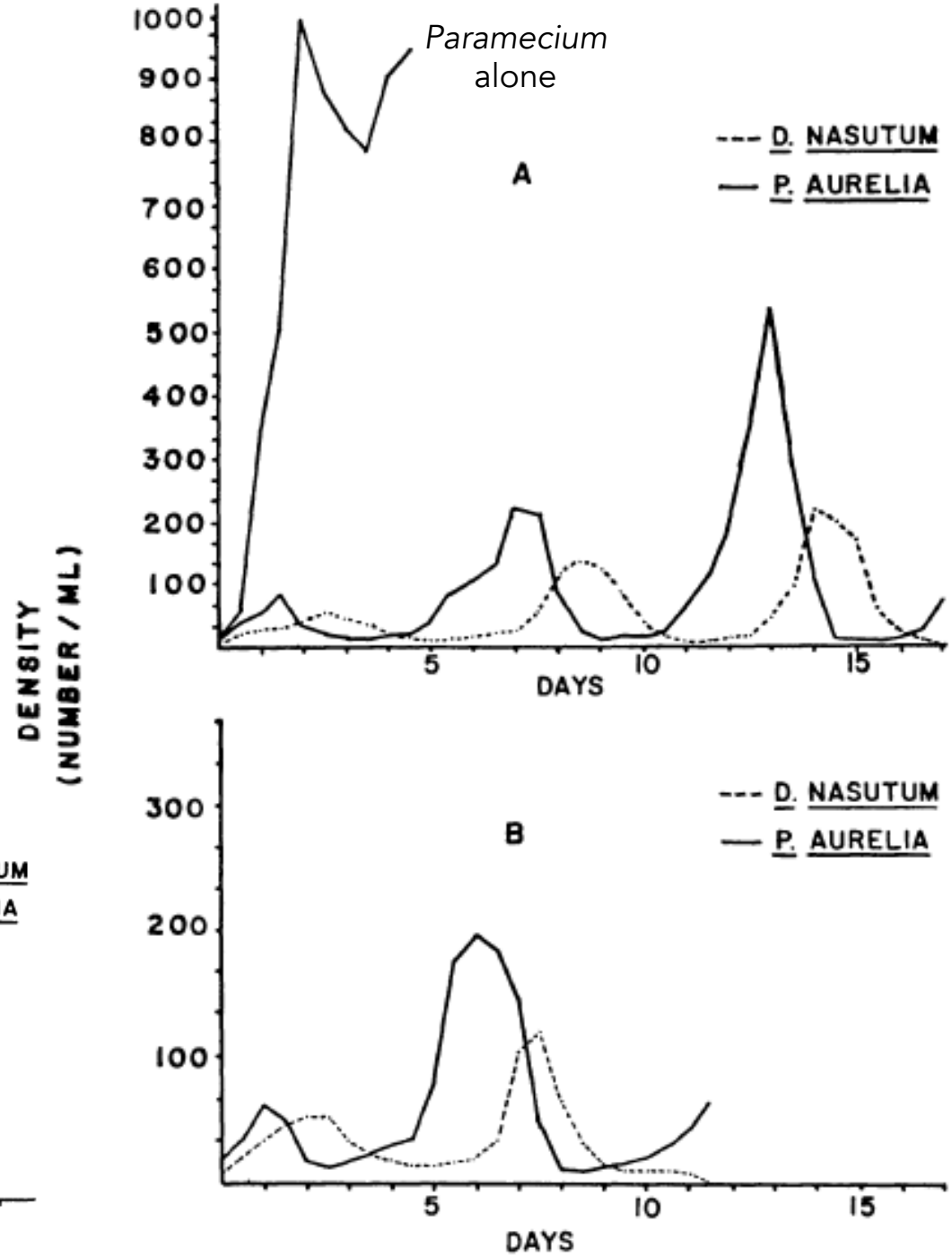




Baseline dynamics:

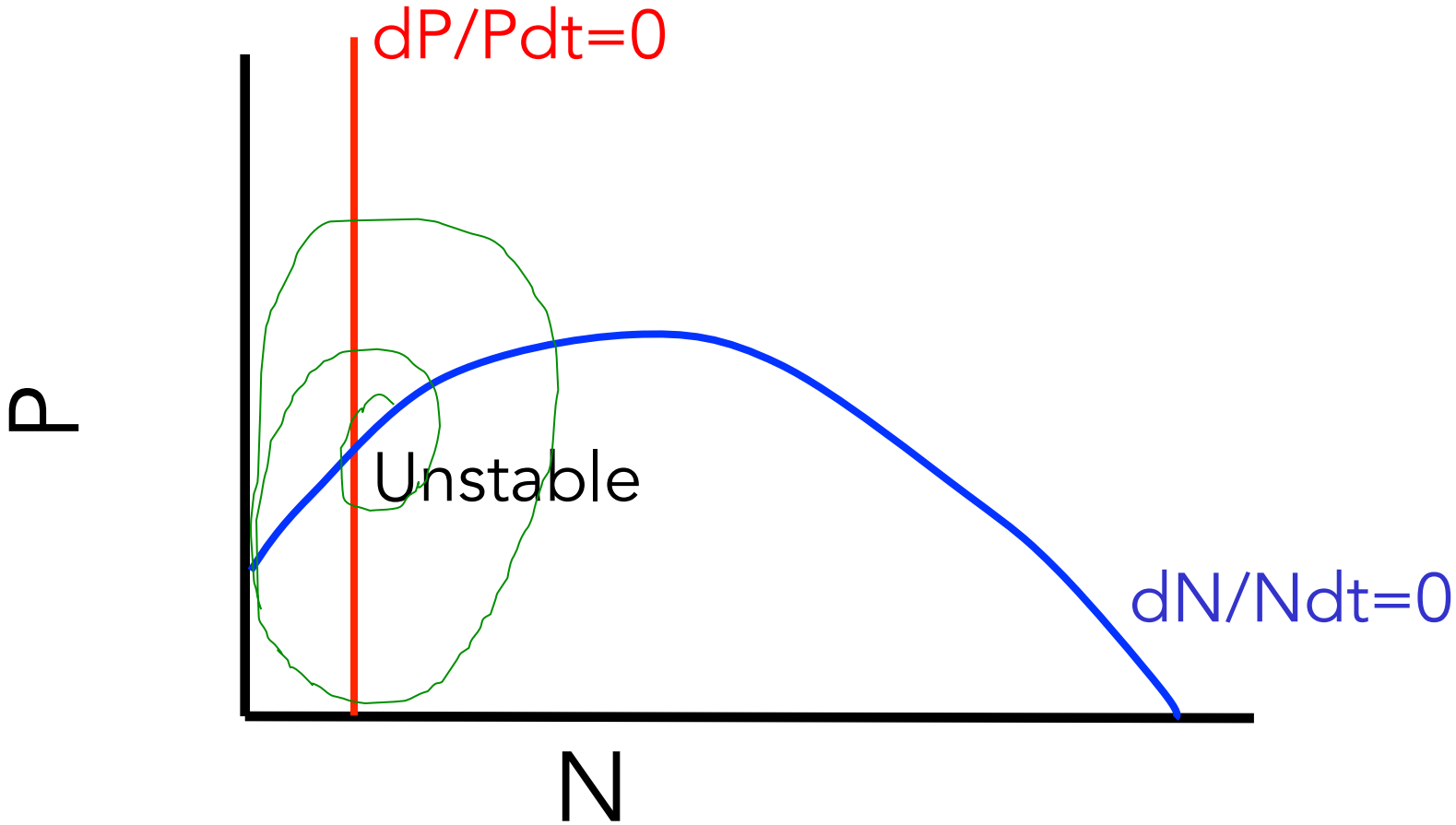
Note extinction after 1-3 predator-prey cycles.





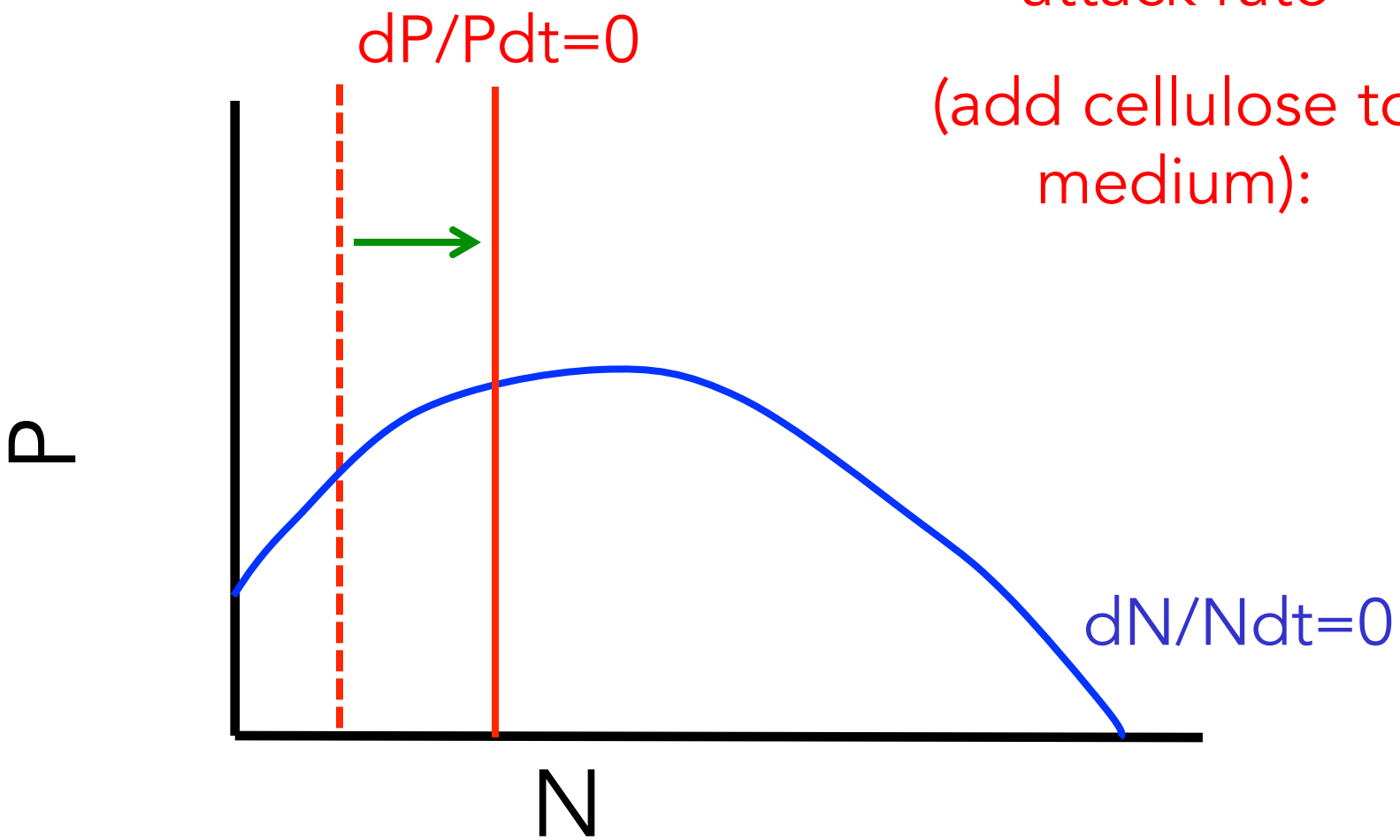
Recall unstable equilibrium in "paradox"

How can we stabilize this system?



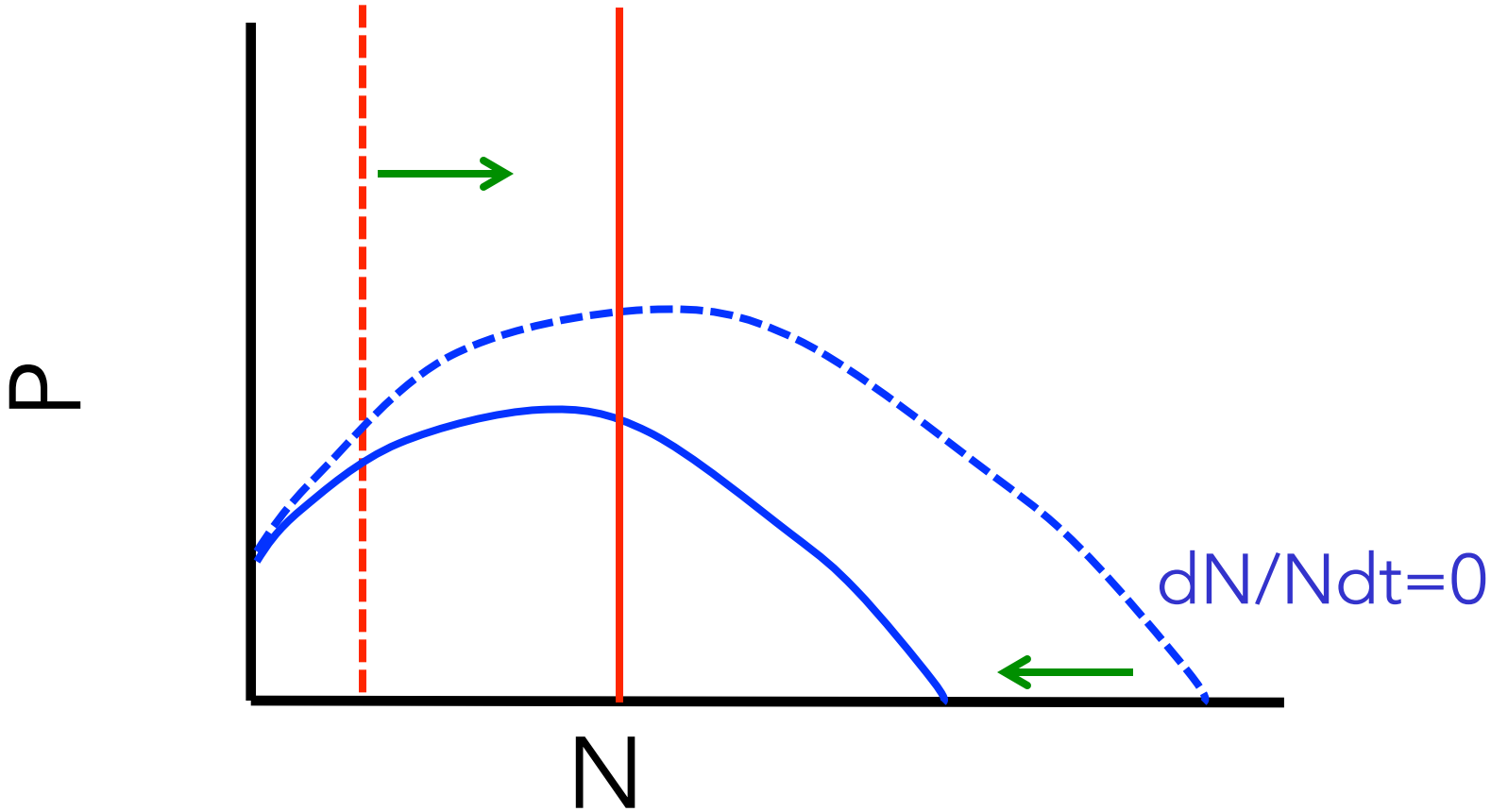
Reduce predators attack rate

(add cellulose to medium):



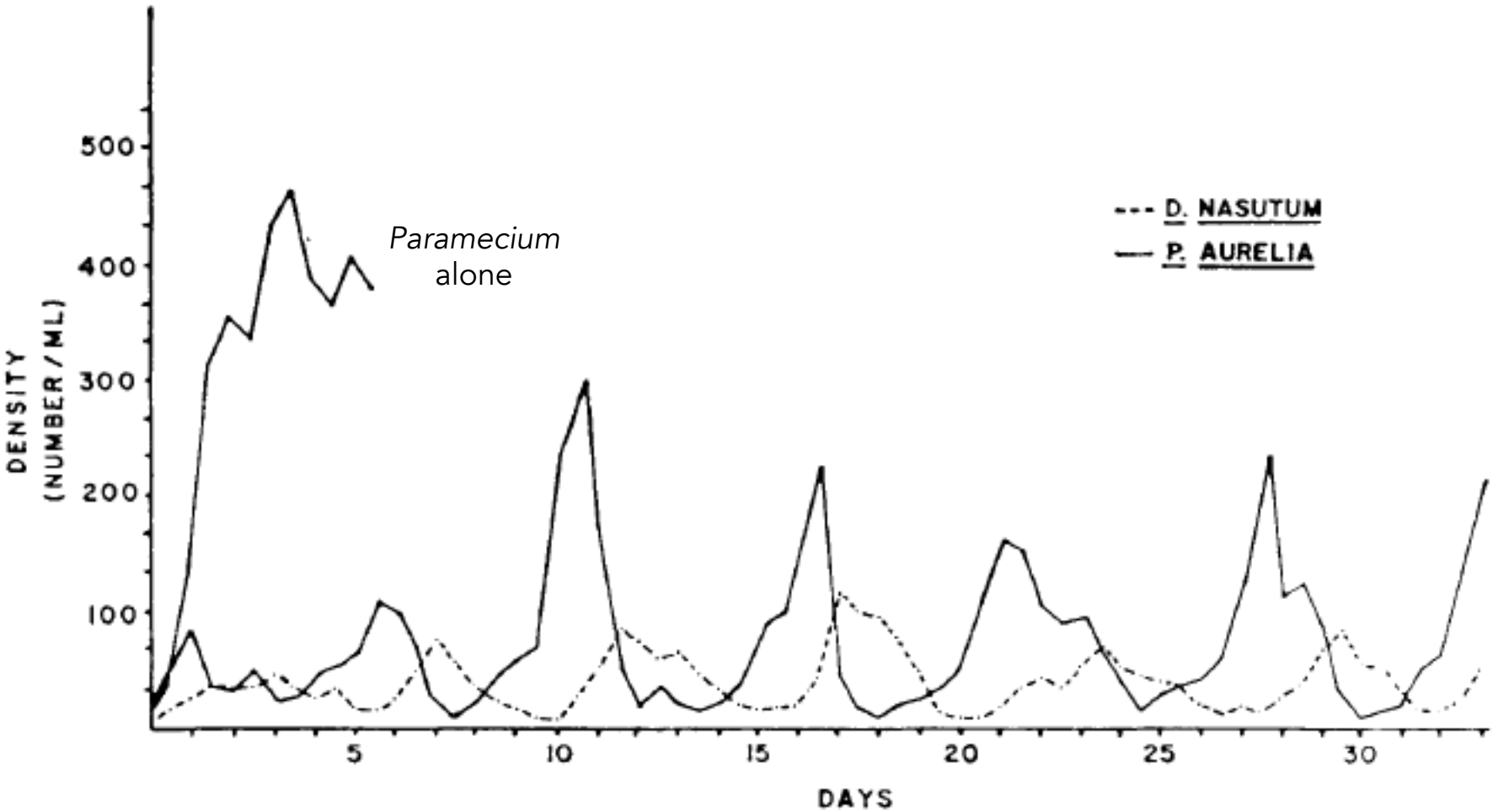
Reduce prey's K

(reduce food in medium):



Results:

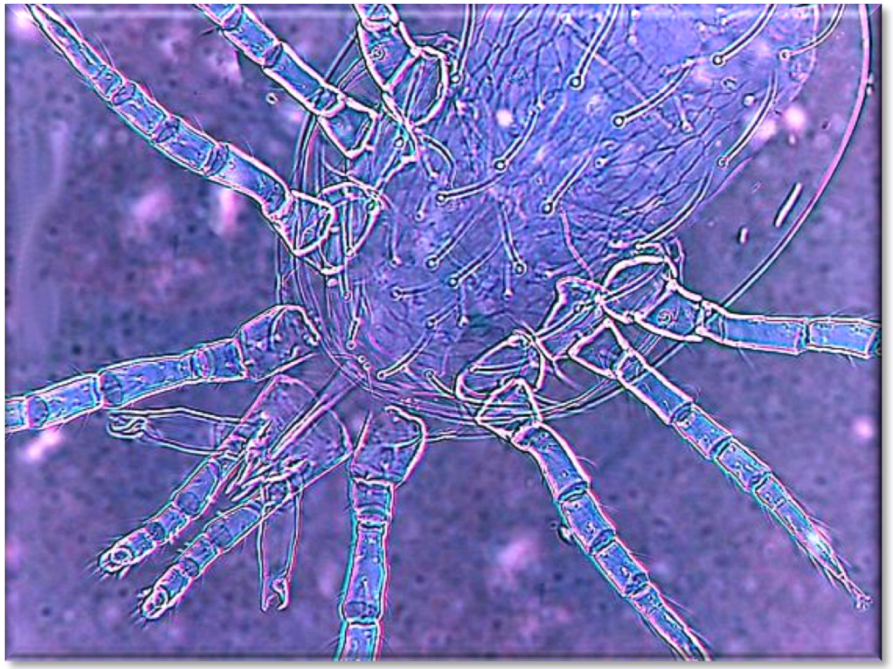
Increased persistence (stability)!



See Harrison (1995, Ecology) for data-model comparison

Huffaker's mites:

- one predator; one prey
- live on oranges



H I L G A R D I A

A Journal of Agricultural Science Published by the California Agricultural Experiment Station

Vol. 27 AUGUST, 1958 No. 14

EXPERIMENTAL STUDIES ON PREDATION: DISPERSION FACTORS AND PREDATOR-PREY OSCILLATIONS[1,2]

C. B. HUFFAKER[3]

Results:

Without predator: prey persist…

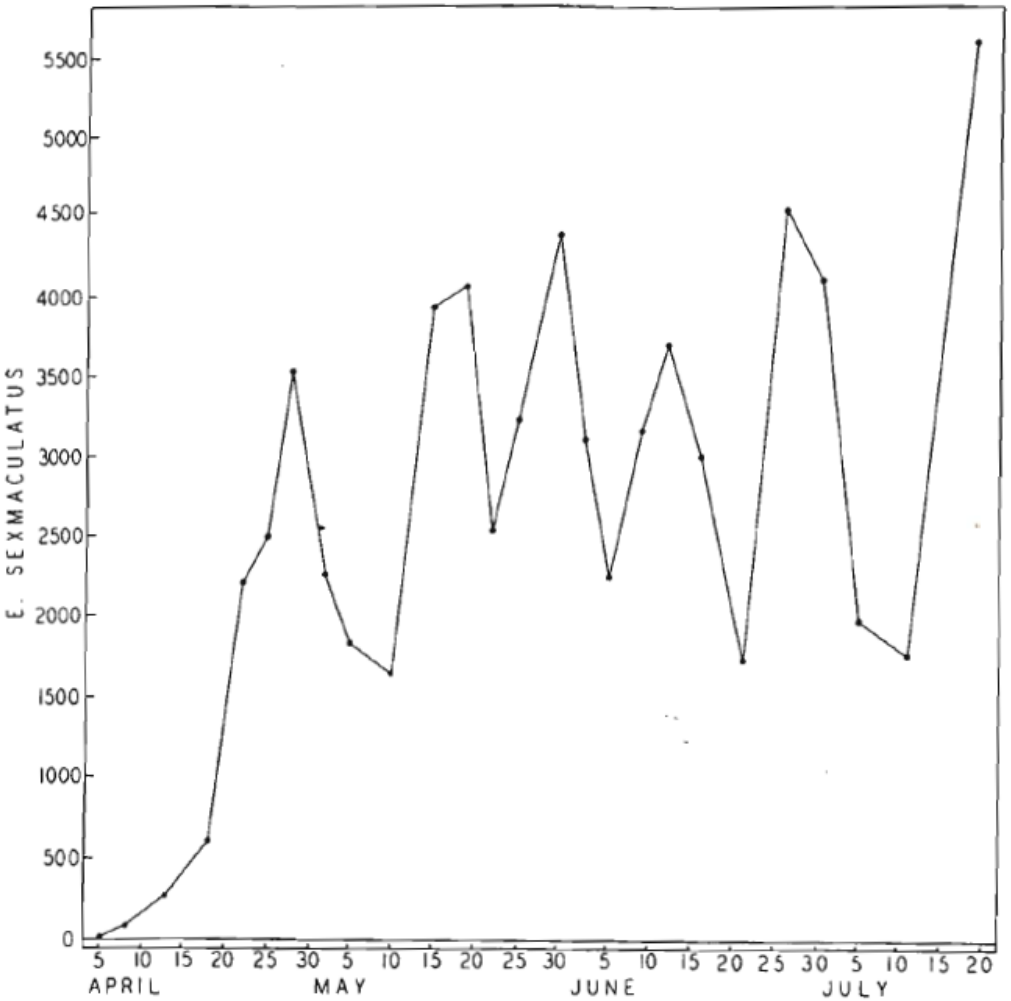
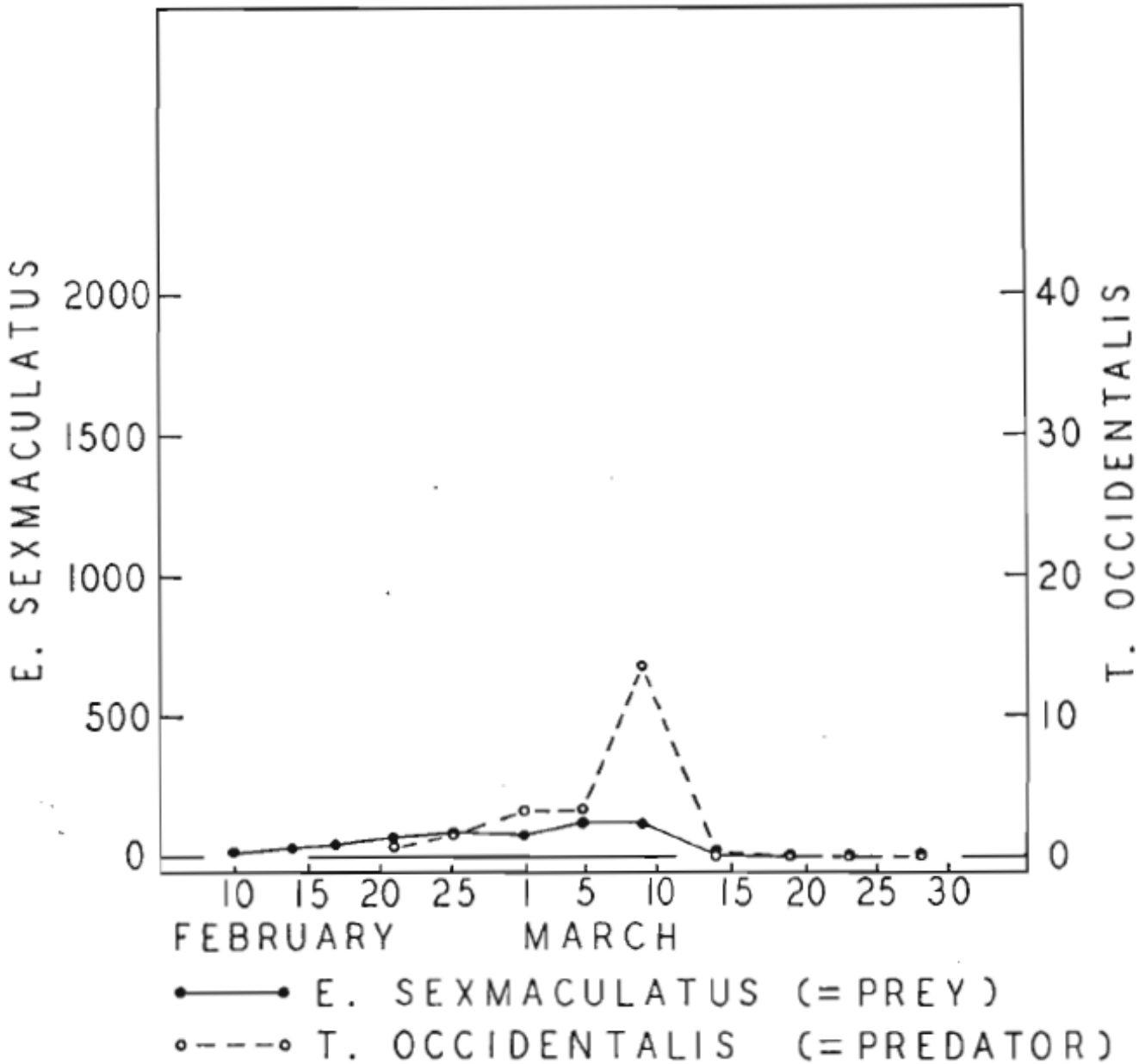


Figure 15.11b
***The Economy of Nature,* Sixth Edition**

Results:

With predator: extinction



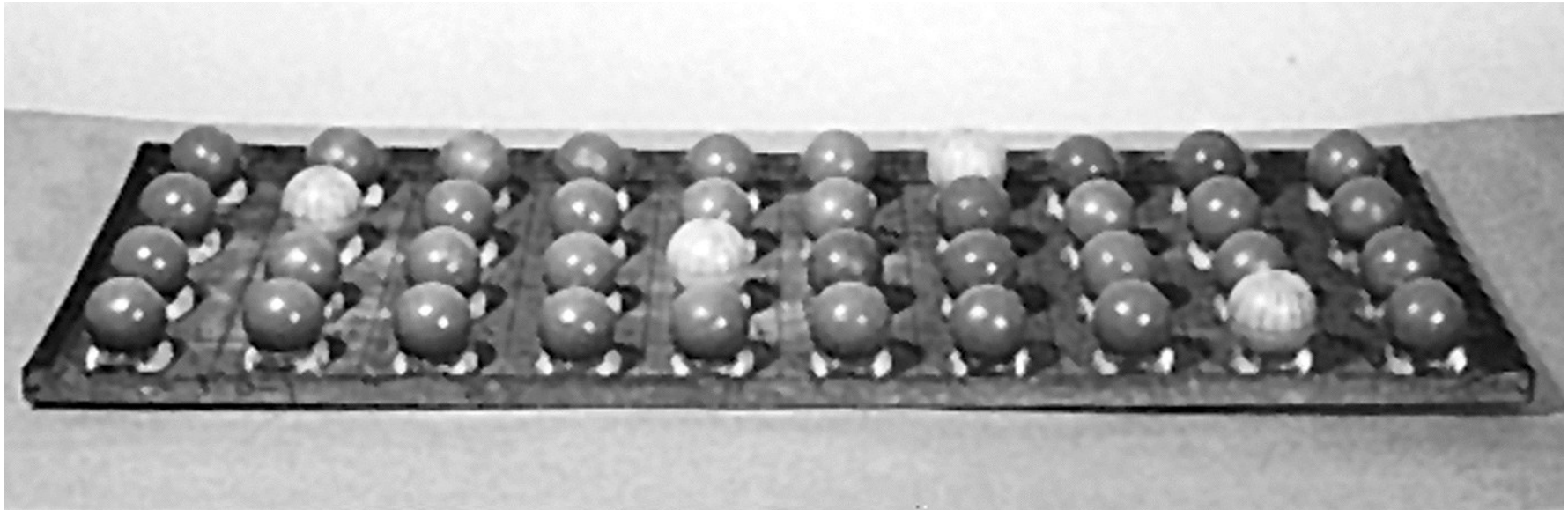
How might the system be modified to facilitate persistence?

1) Network:

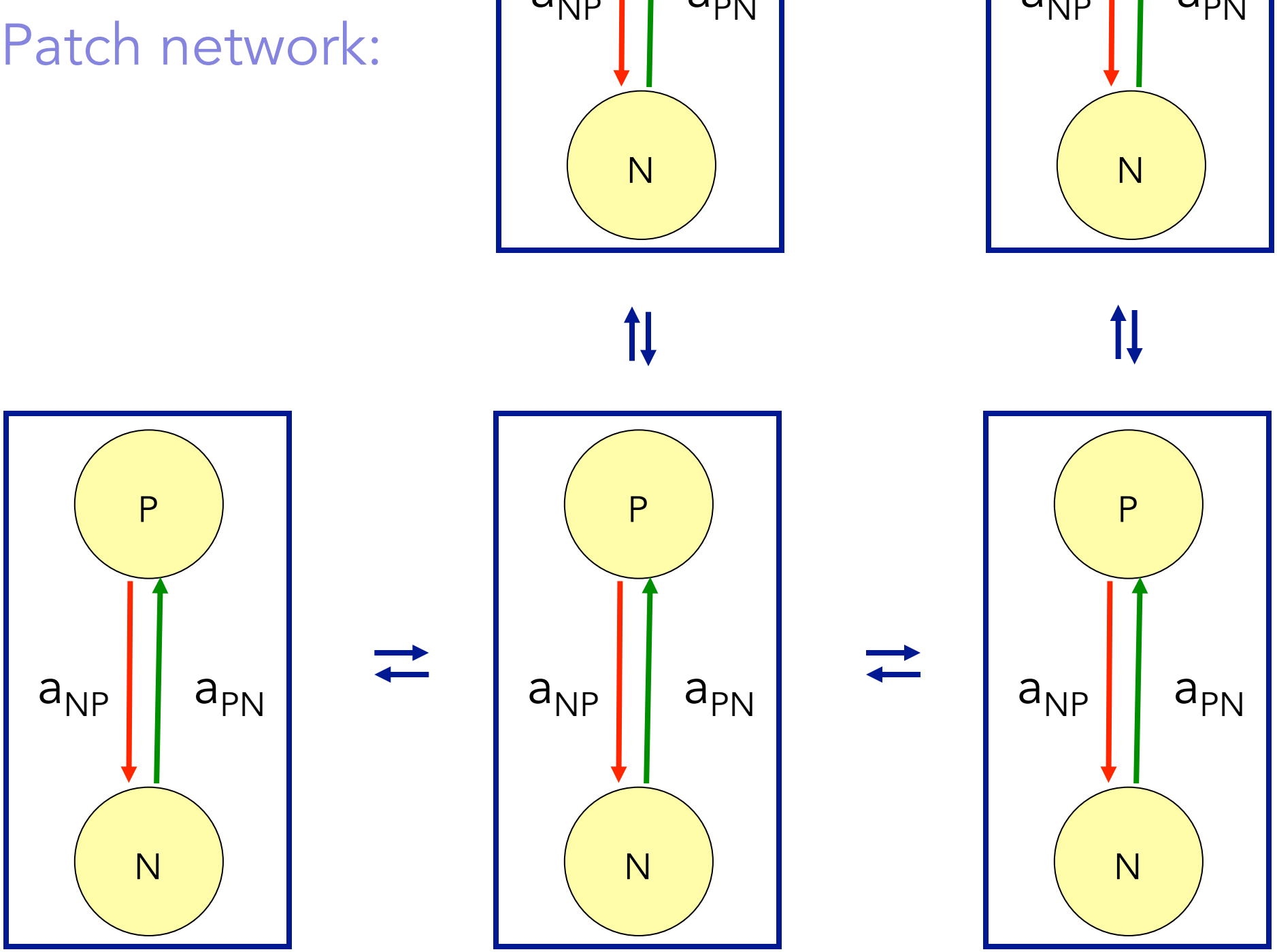
- Groups of oranges, coupled by migration…
- Many did not work…

2) Reduce predator dispersal ability among patches:

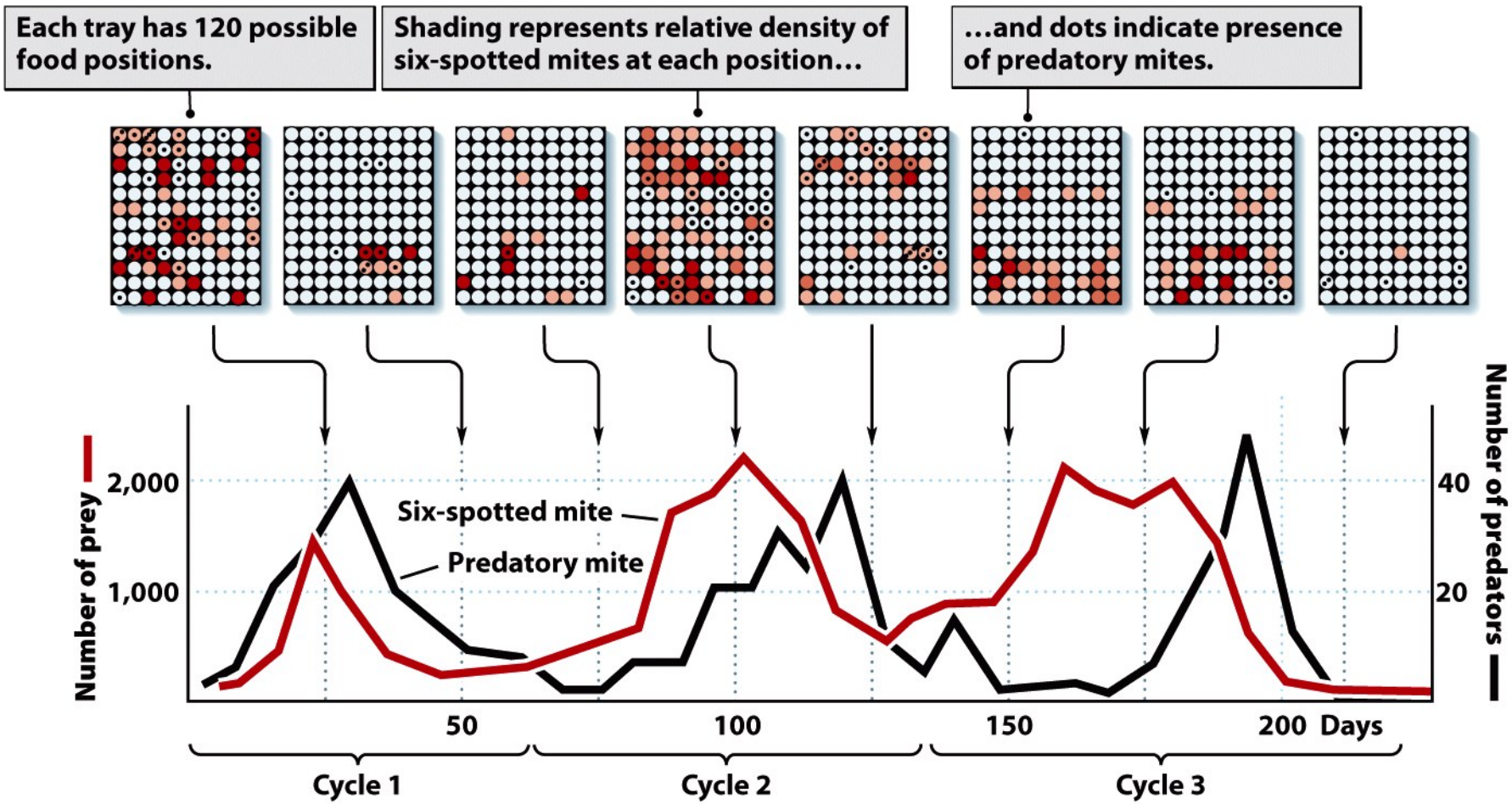
- dispersed oranges amid rubber balls, non resource; added barriers to slow down predator movement…



Patch network:



Results:



Patches transition:

none → prey → predator and prey → predator → none

Other data…enrichment in lakes

Ecology, 73(2), 1992, pp. 551–560

NUTRIENT ENRICHMENT AND GRAZER EFFECTS ON PHYTOPLANKTON IN LAKES[1]

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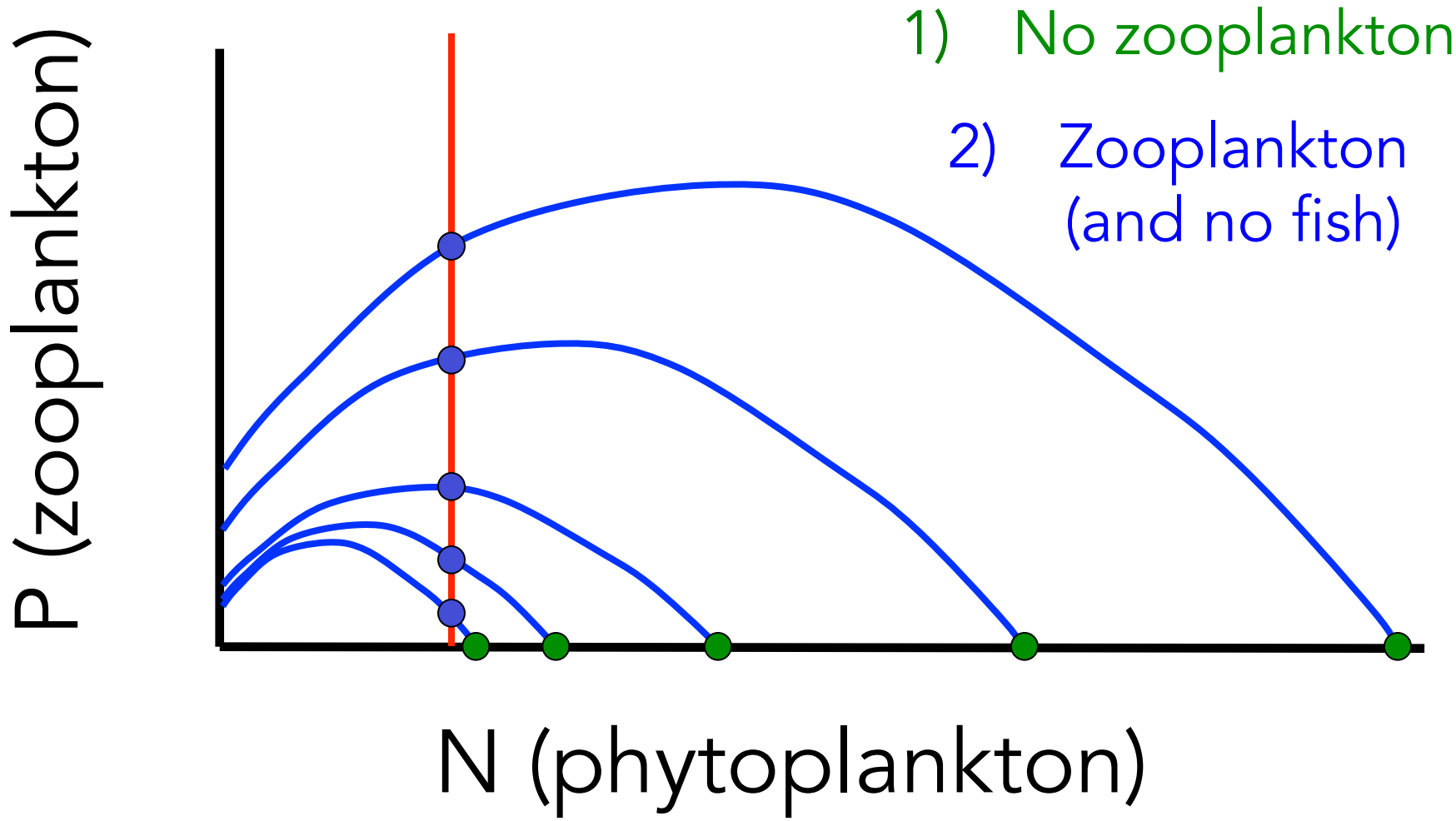
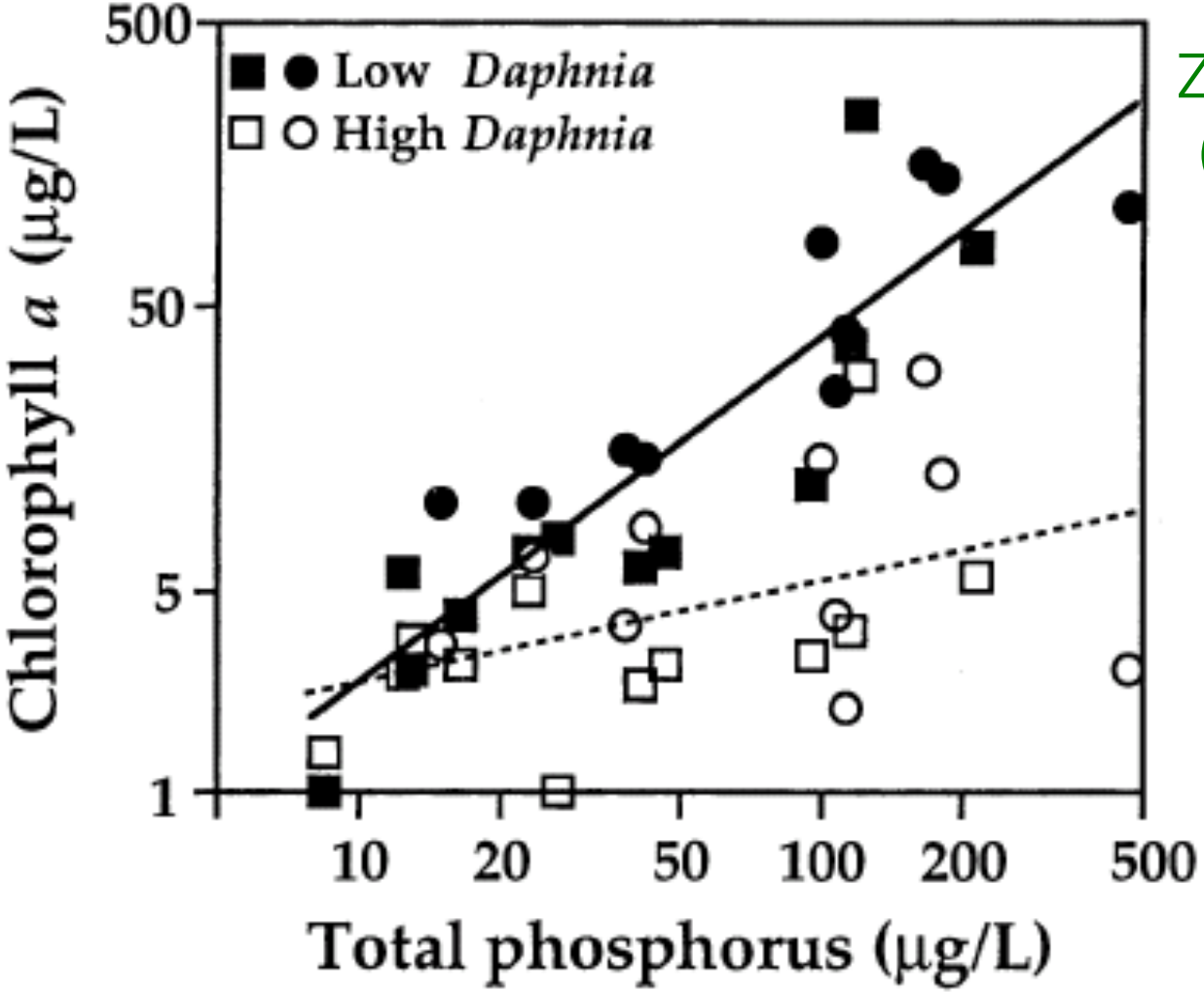
Compared phytoplankton in enclosures with vs. without fish (i.e., phyto only vs. phyto & zoop) in lakes that varied in nutrients (TP)

What do you expect based on LV pred-prey model?

Expectation:

Enrich system: e.g., increase prey's r and K



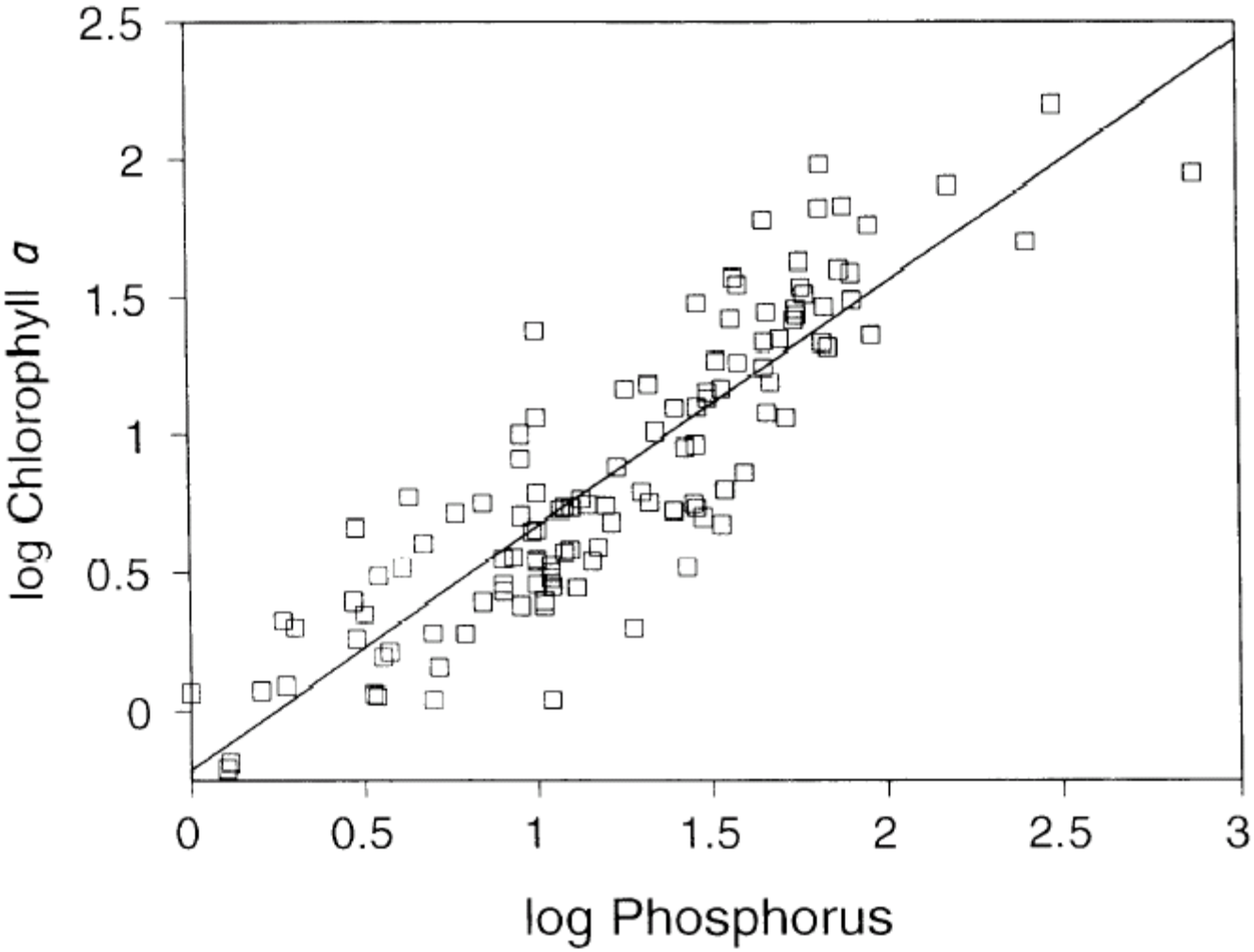


"No" Zoops (with fish)

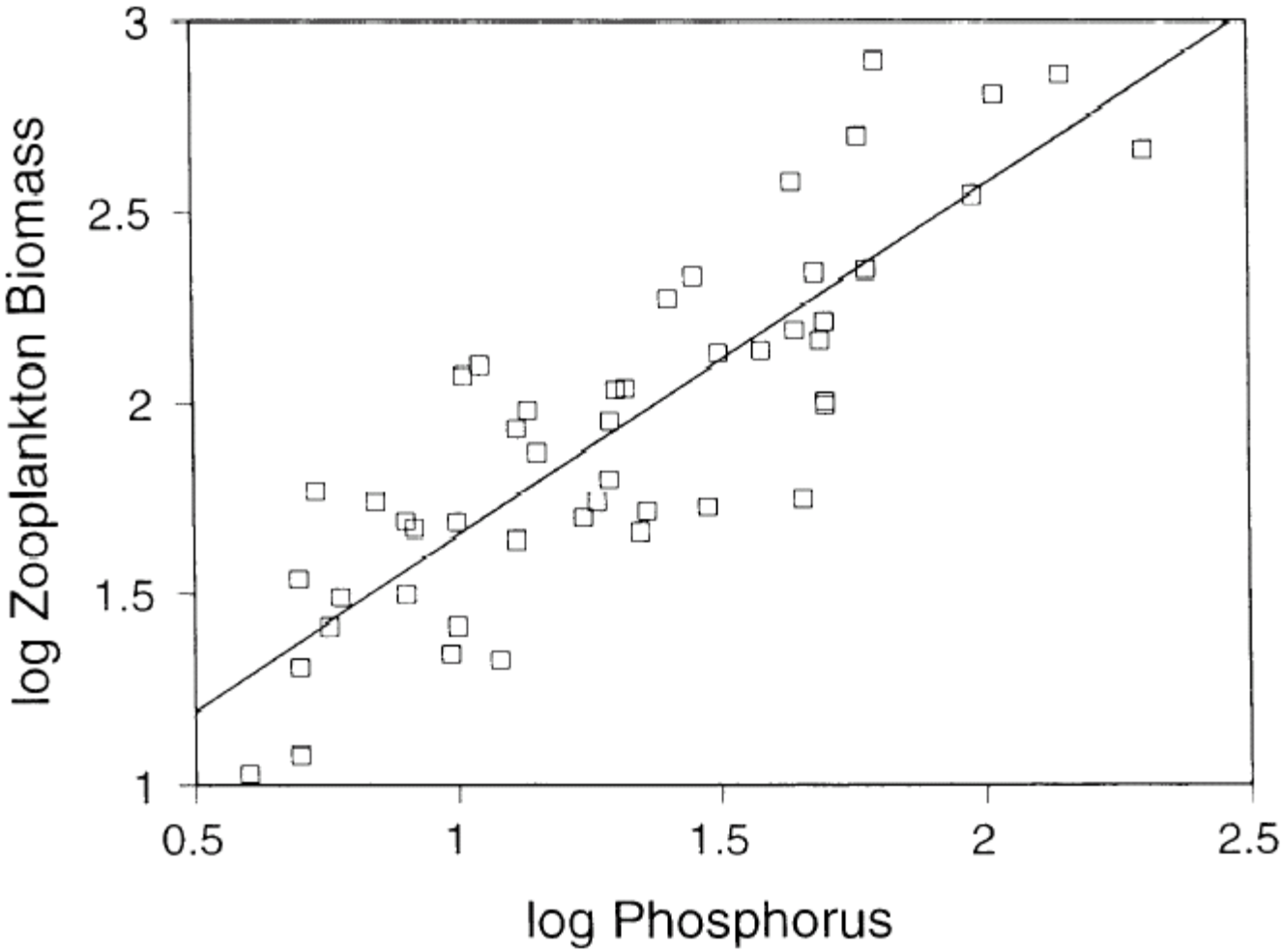
without fish

Is this the pattern we see in real lakes?

Phytoplankton (algae)



Zooplankton (e.g., *Daphnia*)

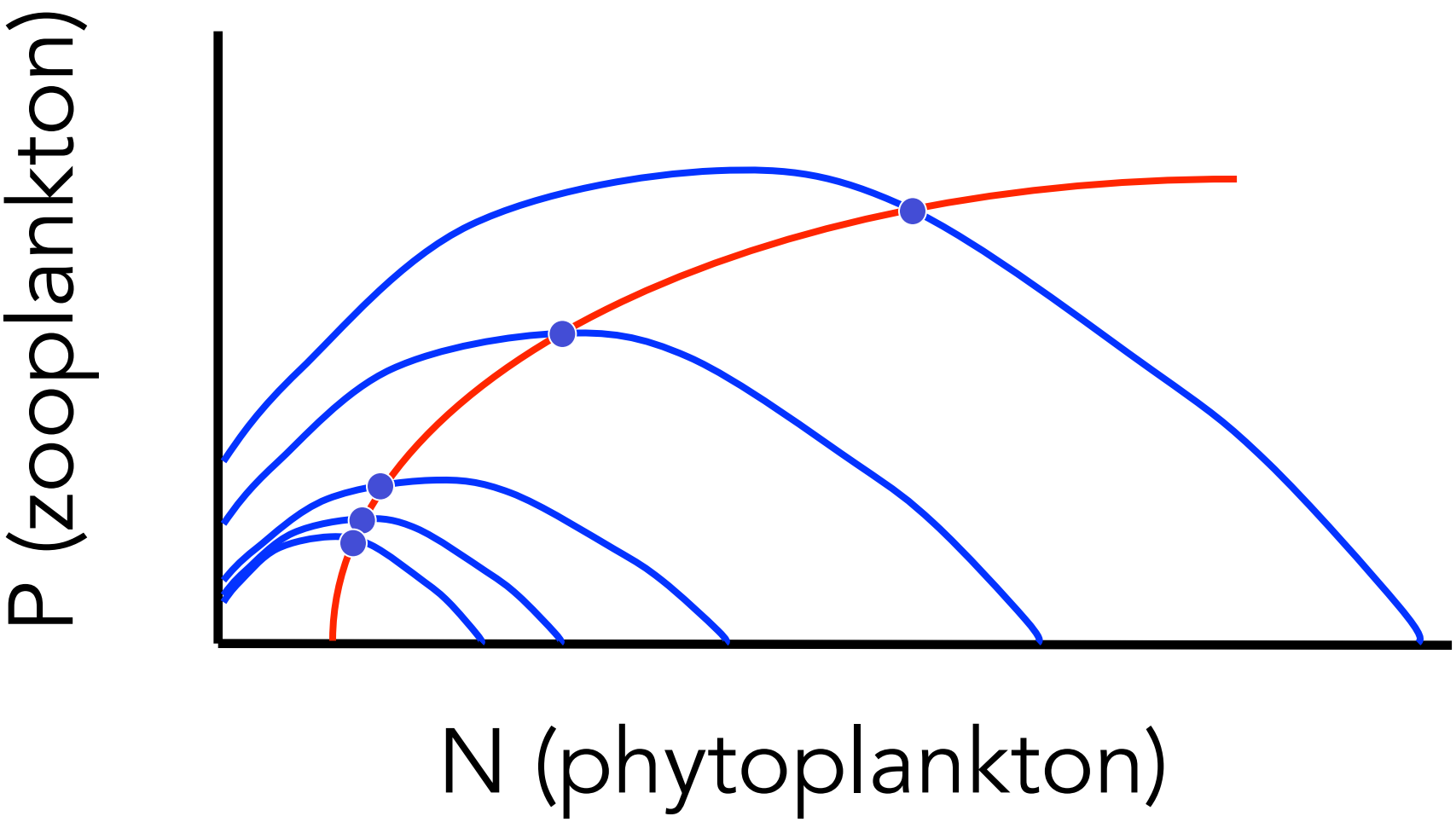


Why the discrepancy?

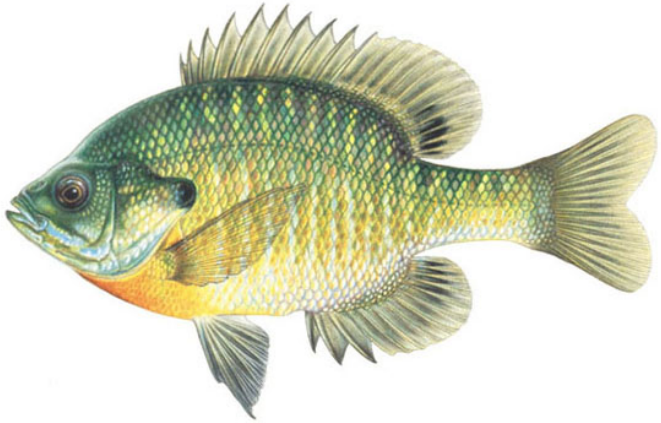
1. Interference among consumers
2. Pseudo-interference (consumer stage-structure)
3. Heterogeneity within trophic levels

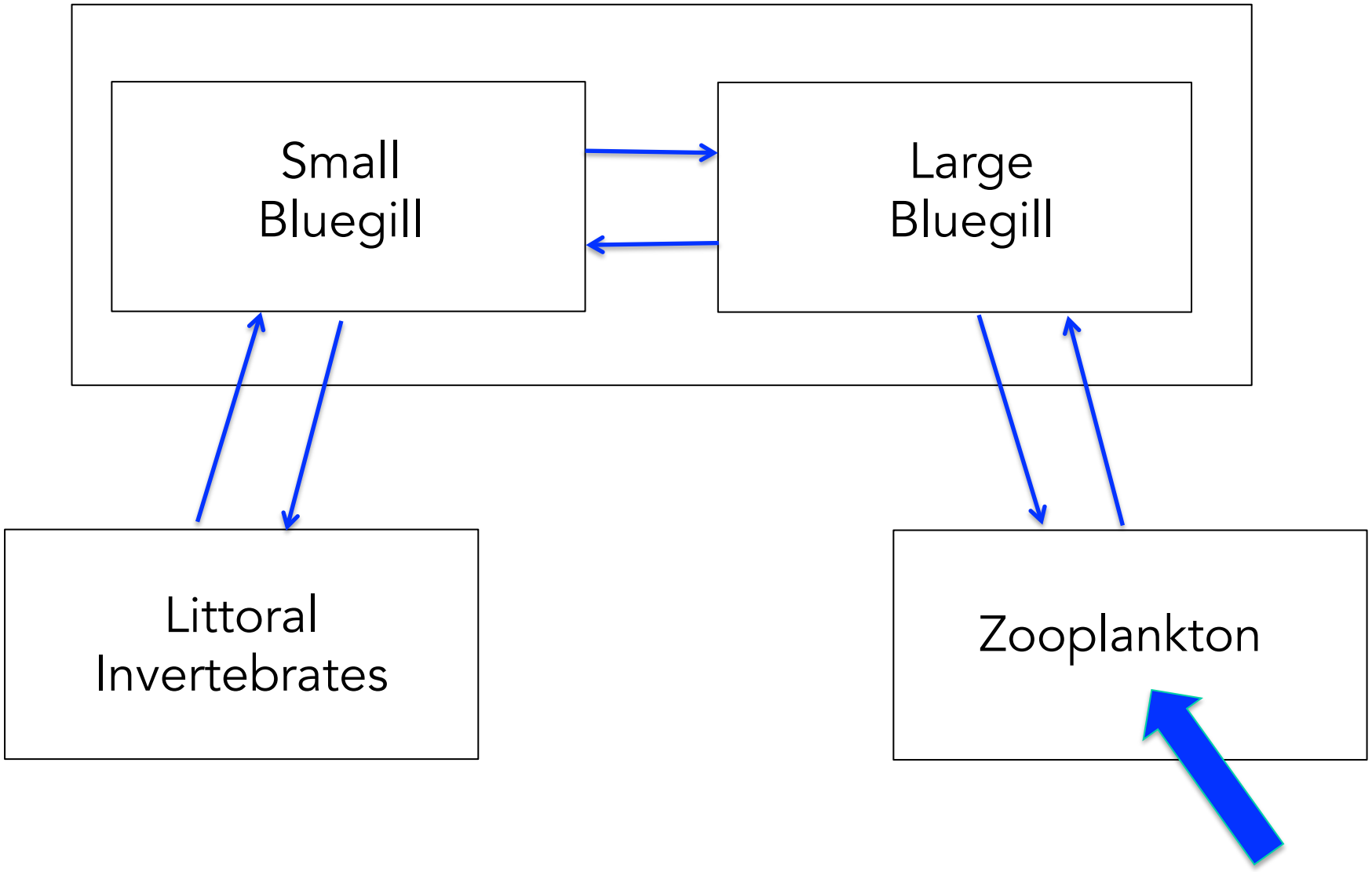
Expectation:

Effect of interference…

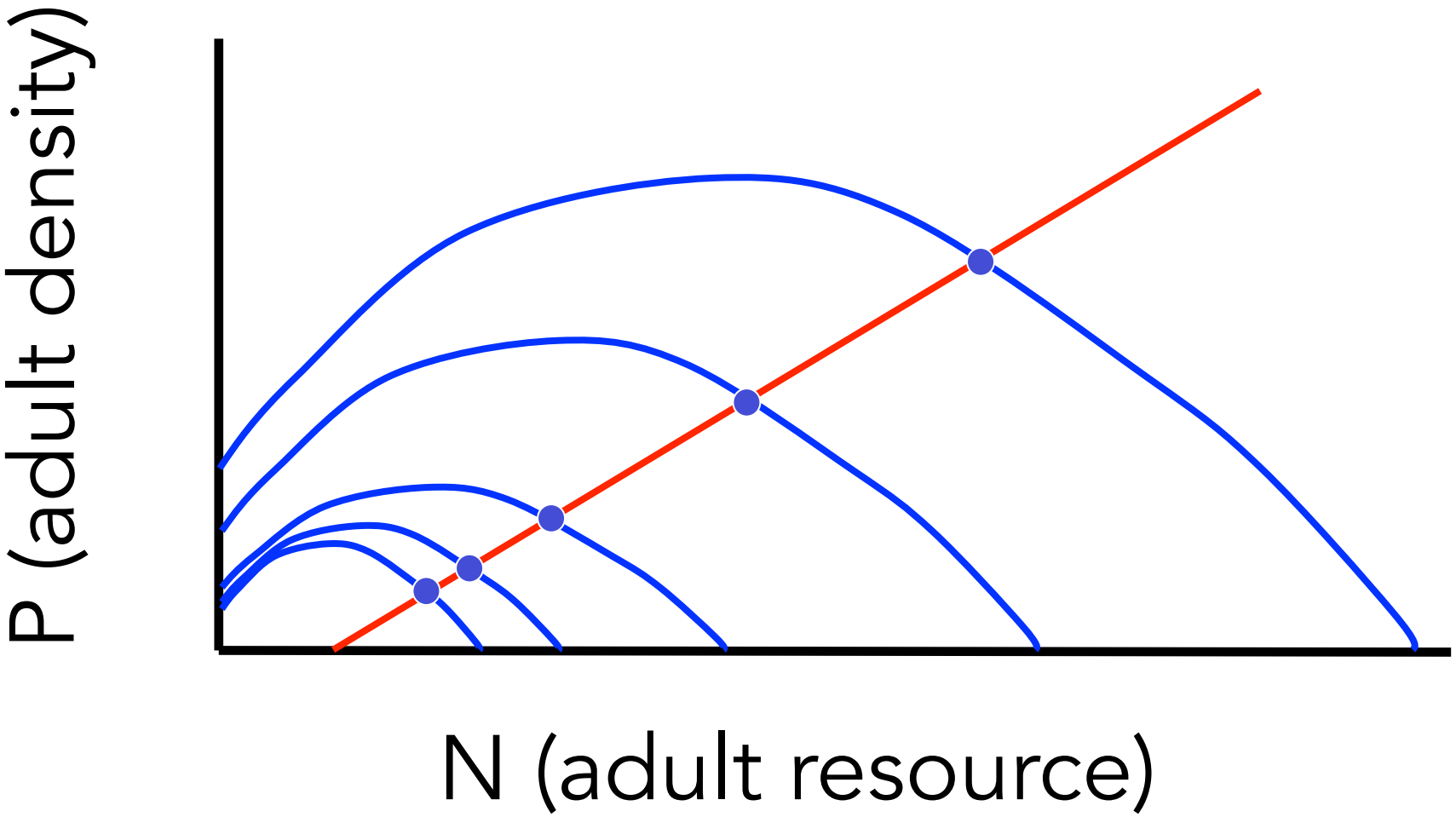


Are they other ways to create this slanted isocline?




Small
Bluegill
Large
Bluegill
Littoral
Invertebrates
Zooplankton

Juvenile bottleneck:



What about resource heterogeneity?

Vol. 134, No. 6 The American Naturalist December 1989

RESOURCE EDIBILITY AND THE EFFECTS OF PREDATORS AND PRODUCTIVITY ON THE OUTCOME OF TROPHIC INTERACTIONS

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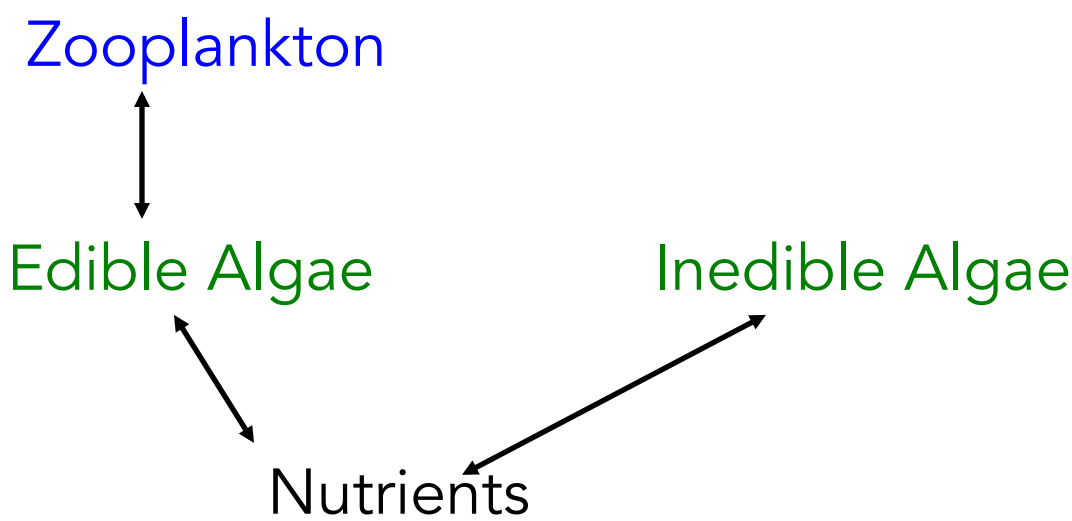
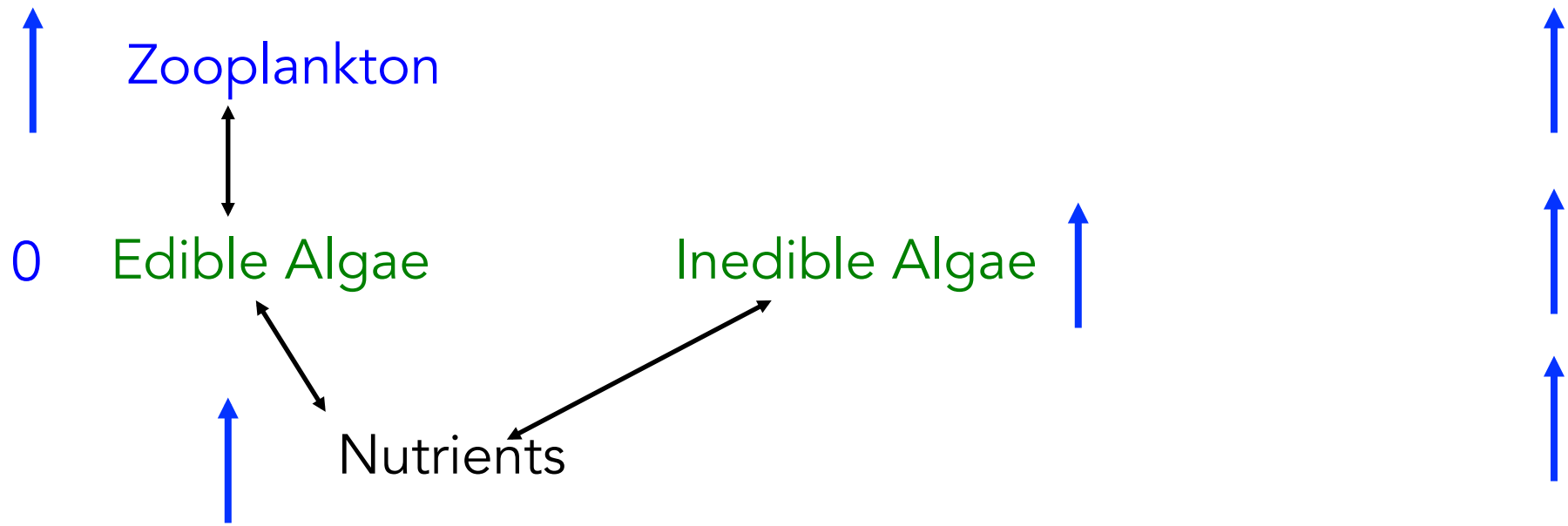
Submitted February 1, 1988; Revised July 1, 1988; Accepted December 16, 1988



$$dC/dt = C(b_e R_e + b_i R_i - P),$$

$$dR_e/dt = R_e[r_e(1 - R_e/K_e - a_{ei} R_i/K_e) - f_e C],$$

$$dR_i/dt = R_i[r_i(1 - R_i/K_i - a_{ie} R_e/K_i) - f_i C],$$



$$C^* = (r_i r_e / W)[b_e - a_{ie} b_i + b_i - a_{ie} b_e - P(1 - a_{ie} a_{ei}/K],$$

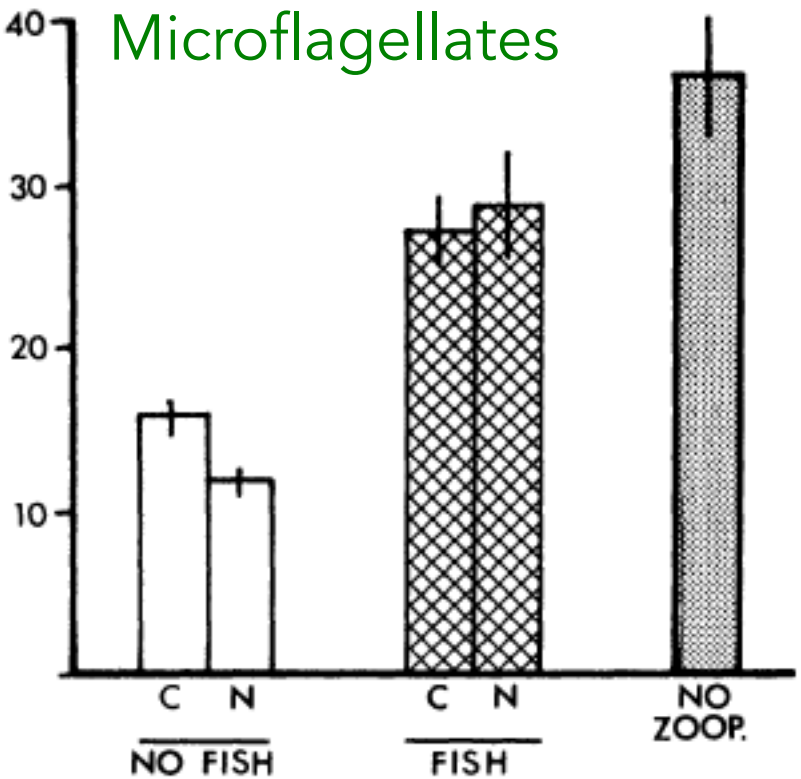
$$R_e^* = [Kq b_i (r_e f_i - r_i f_e) + P(r_i f_e - r_e f_i q a_{ei})]/W,$$

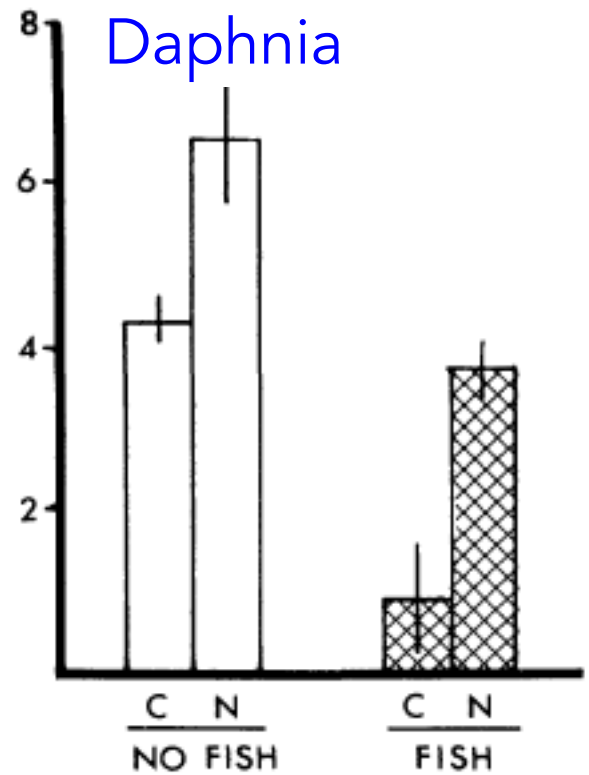
$$R_i^* = [Kq b_e (r_i f_e - r_e f_i) + P(r_e f_i q - r_i f_e a_{ie})]/W,$$

$$W = r_e f_i q (b_i - a_{ei} b_e) + r_i f_e (b_e - a_{ie} b_i).$$

Field experiment (vary nutrients and fish)

Results:


Microflagellates
40
30
20
10
C
N
NO FISH
C
N
FISH
NO
ZOOP.


Daphnia
8
6
4
2
C
N
NO FISH
C
N
FISH

Data fit simple (not complex) model.

Why?

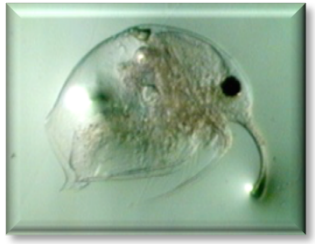
Synthesize results of other nutrient experiments…

Change in Density	Zoop	Inedible	Edible
Increase	20	7	8
No change	1	7	5
Decrease	1	0	0

These systems contain different grazers.

Compare systems with *Daphnia* vs. smaller grazers (due to their size, they perceive "edibility" differently):

vs.



Change in Density	Zoop	Inedible	Edible
Increase	10	1	2
No change	1	6	4
Decrease	0	0	0

Daphnia systems

(all algae are "edible")

→ heterogeneity key, but poorly resolved

Systems with smaller cladocera (some algae are "inedible")

Change in Density	Zoop	Inedible	Edible
Increase	10	6	6
No change	0	1	1
Decrease	1	0	0

Simple models have helped guide our understanding and have pointed to the role of additional biological features