Predation II

BIOL/BOT 160 – Ecology

Drs. Lawrence Uricchio & Scott Shaffer

Learning objectives

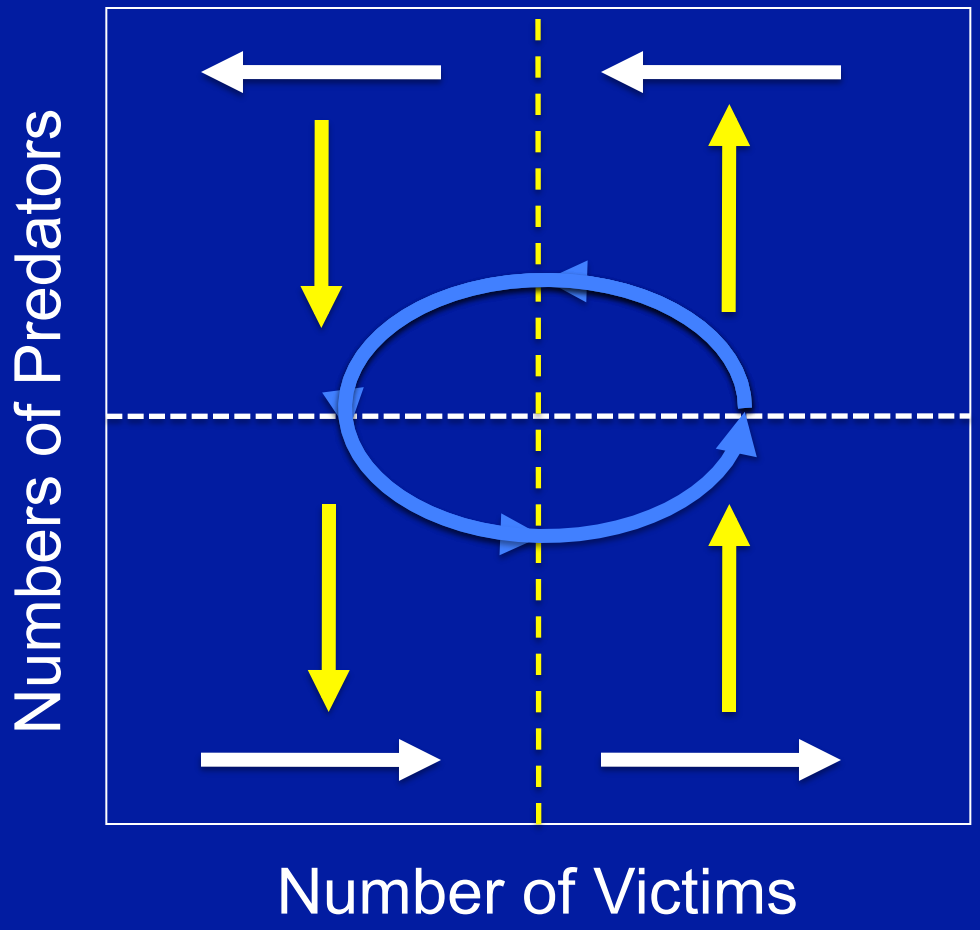
- Students should be able to:
  - Explain the concept of the Rosenzweig and MacArthur (1963) predator prey model
  - Analyze vector plots with the Rosenzweig and MacArthur (1963) model
  - Predict how predation may affect competitive relationships between prey species

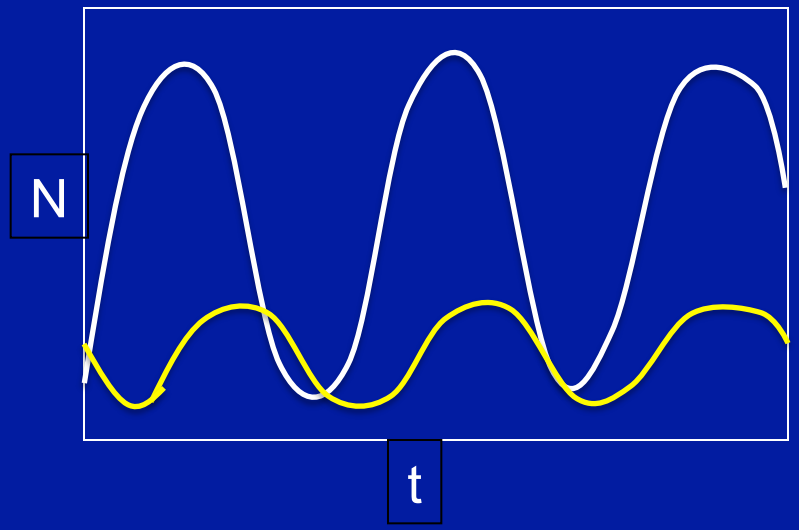
Lotka Volterra predator-prey model

- Last time we introduced a model for interactions between predators and prey
  - Prey equation: $dV/dt = rV - \alpha VP$
  - Predator equation: $dP/dt = - qP + \beta VP$

Lotka-Volterra predator-prey model

Putting prey and predator isoclines together:





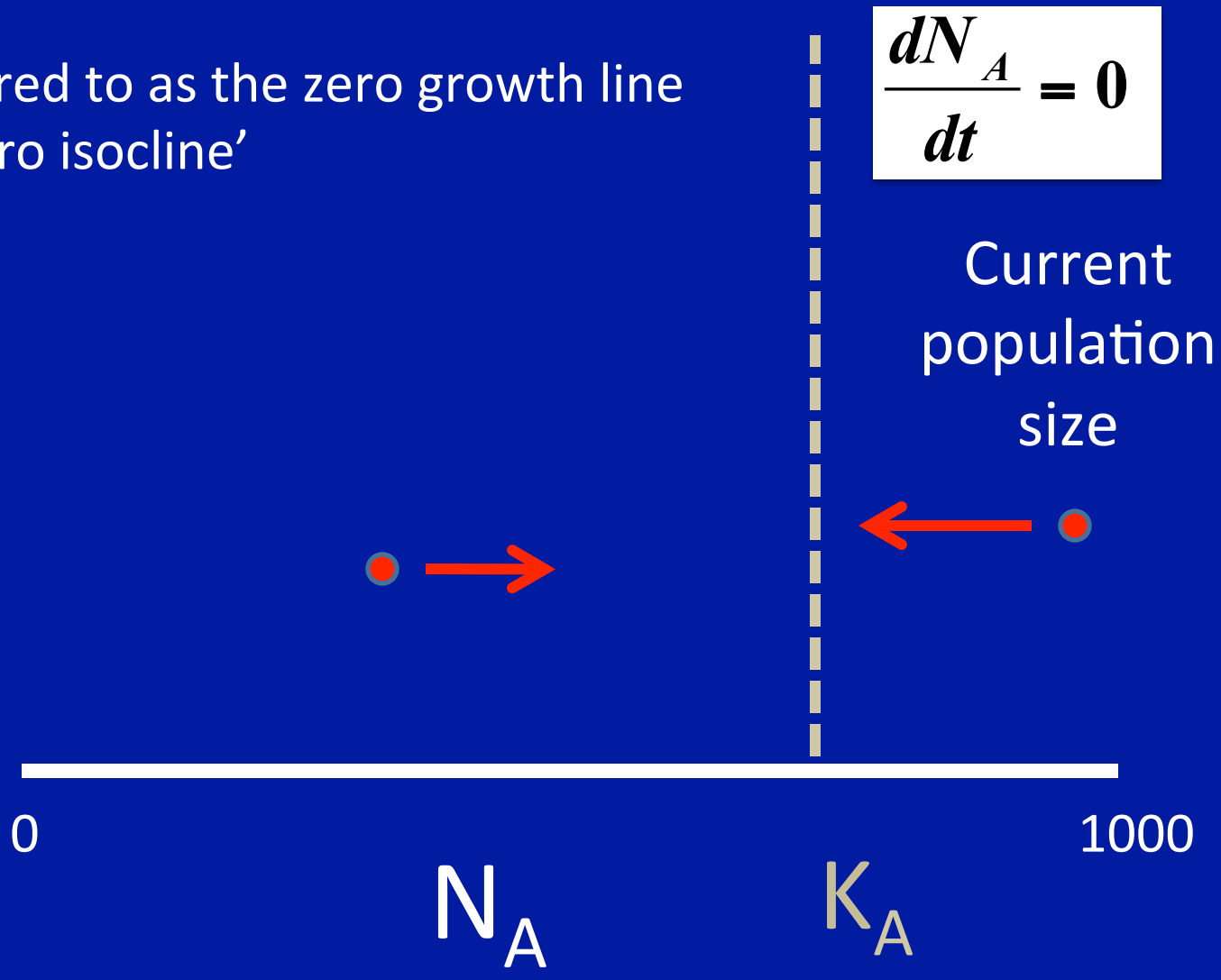
Lotka Volterra predator-prey model

- Last time we introduced a model for interactions between predators and prey
  - Prey equation: $dV/dt = rV - \alpha VP$
  - Predator equation: $dP/dt = - qP + \beta VP$
- Why might this not be realistic?
  - Does not include intraspecies competition
  - Very small populations likely not sustainable in the long run

Vector Plot – Species A

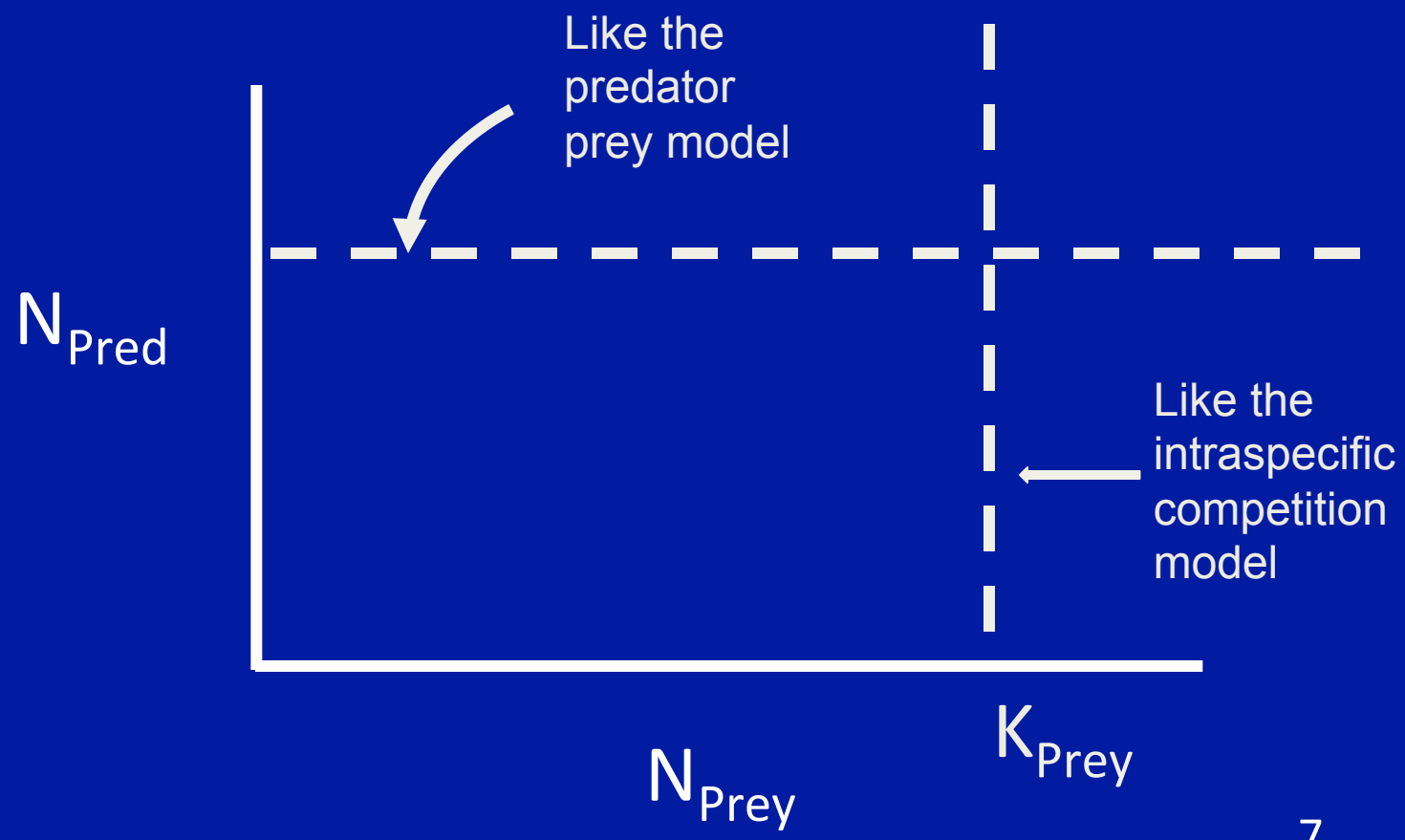
Referred to as the zero growth line or 'zero isocline'

$$\frac{dN_A}{dt} = 0$$



Lotka Volterra predator-prey model

- Rosenzweig and MacArthur (1963) modifications



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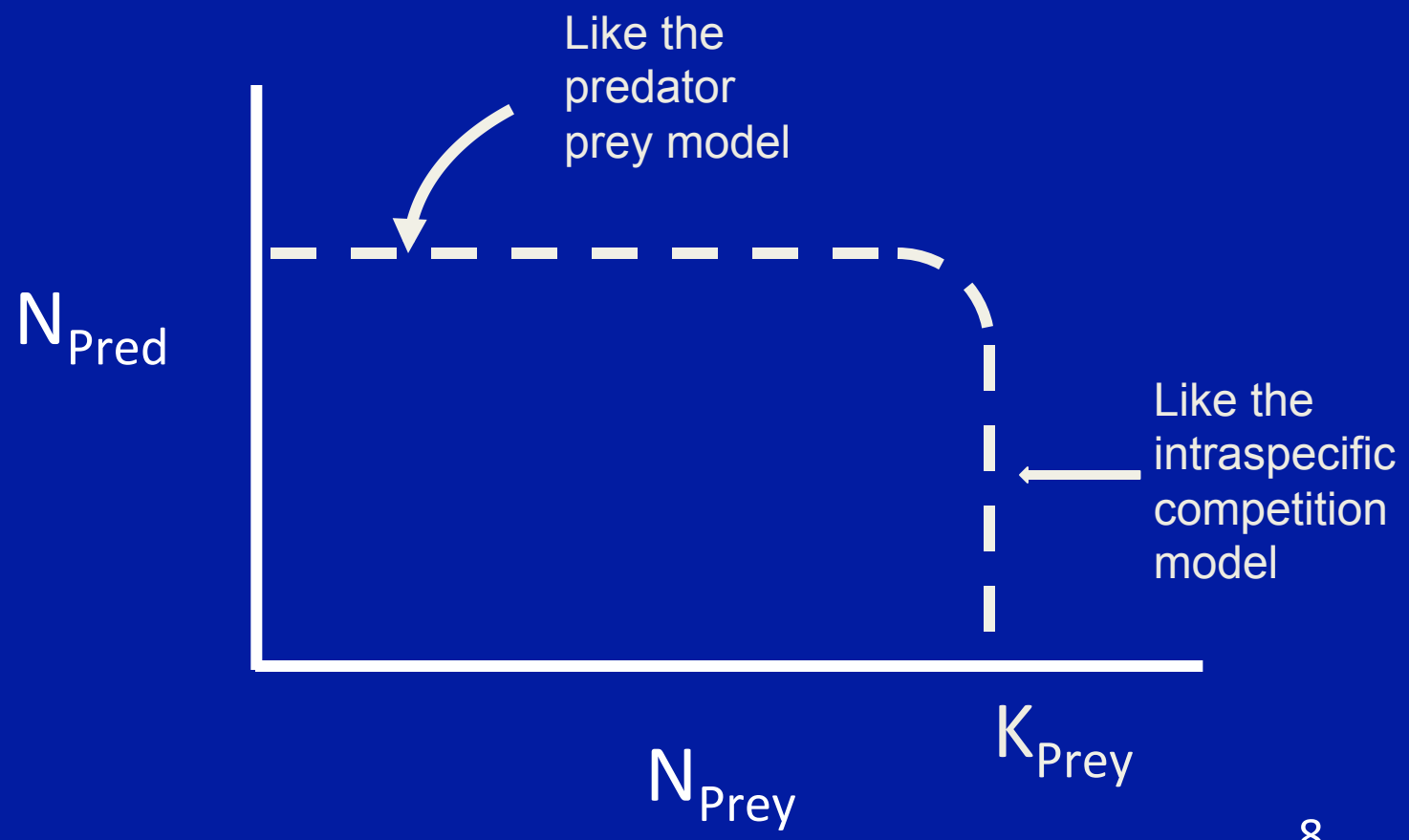

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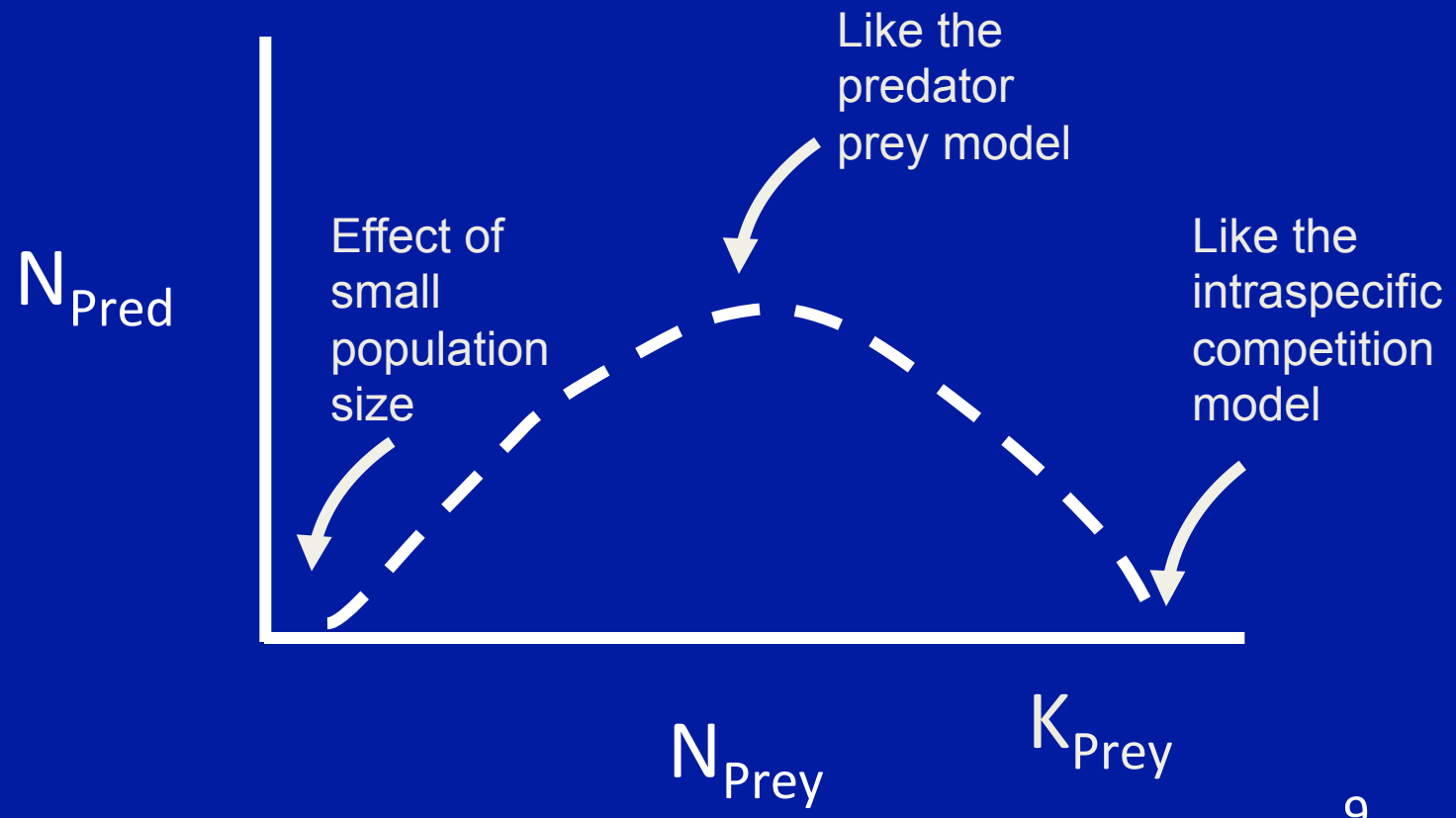
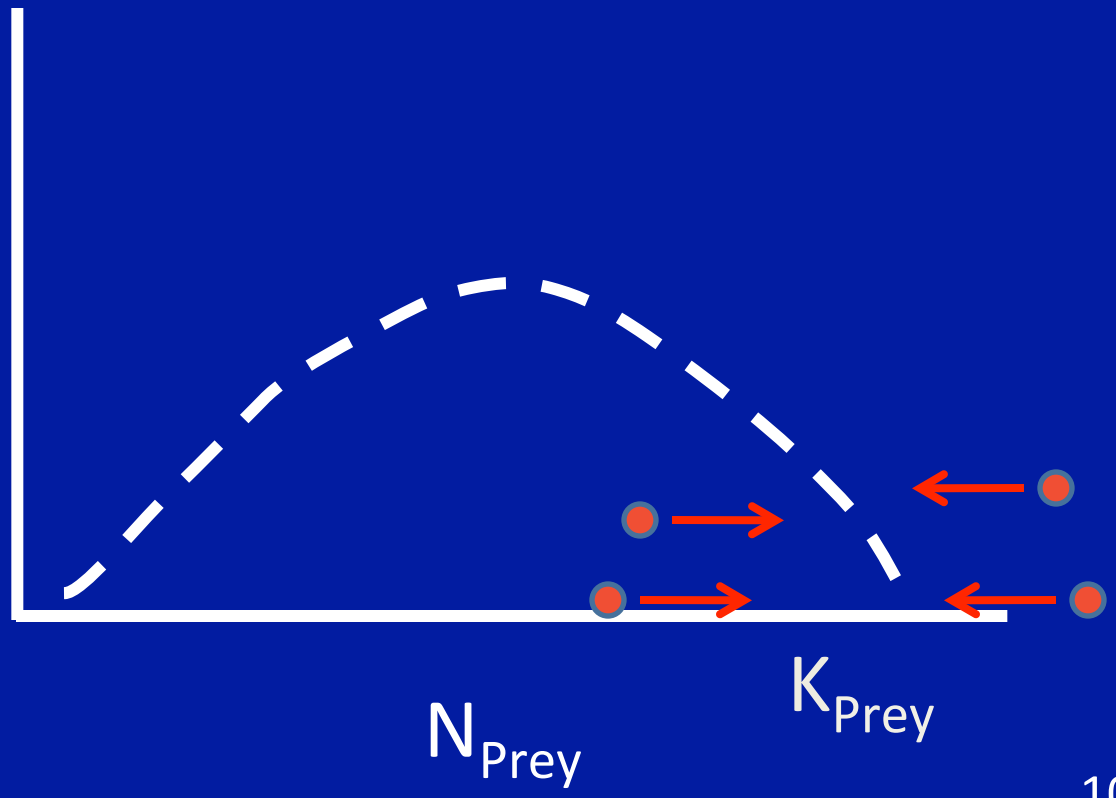


Lotka Volterra predator-prey model

- Rosenzweig and MacArthur (1963) modifications

When predators are absent, prey can increase or decrease normally



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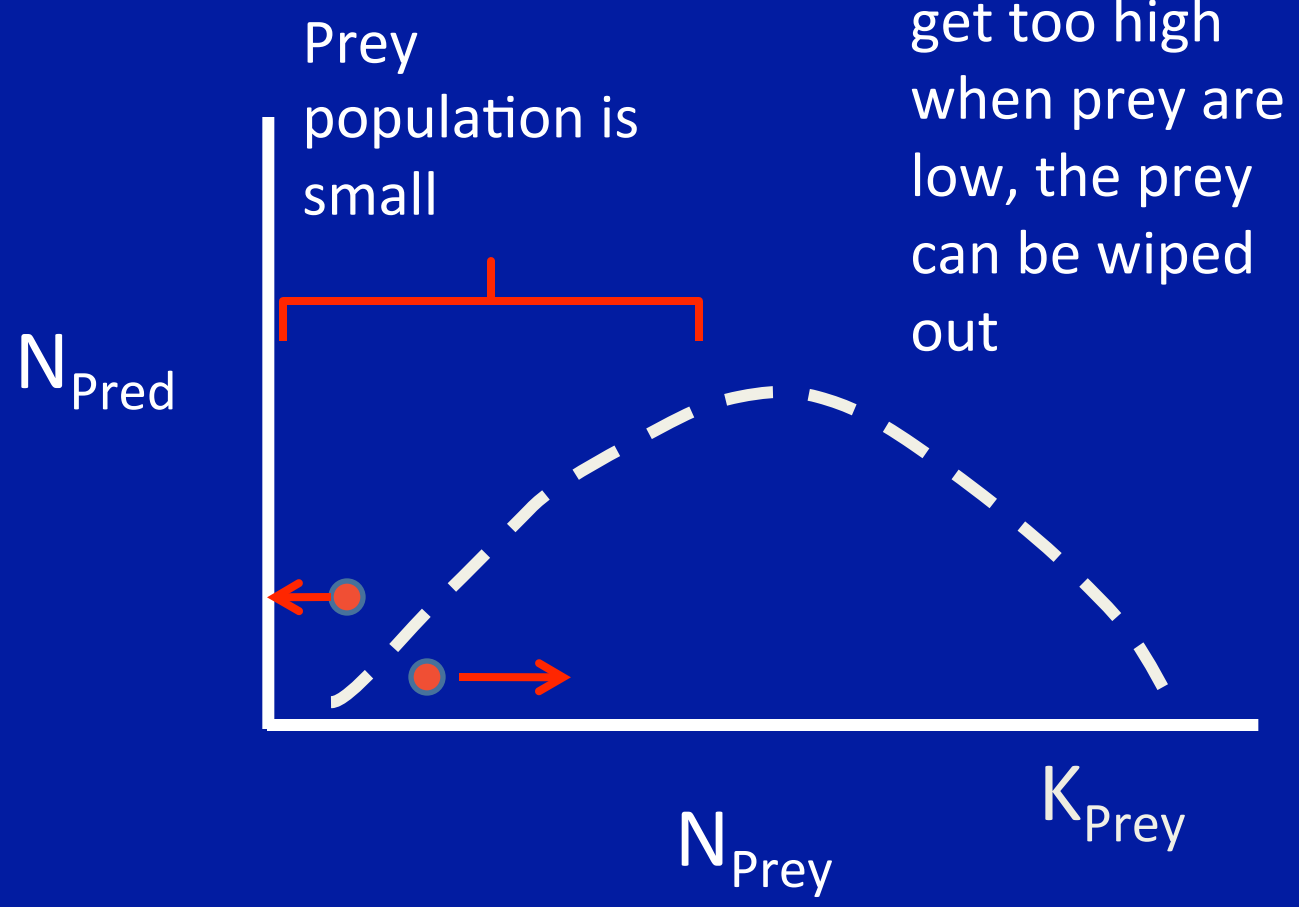

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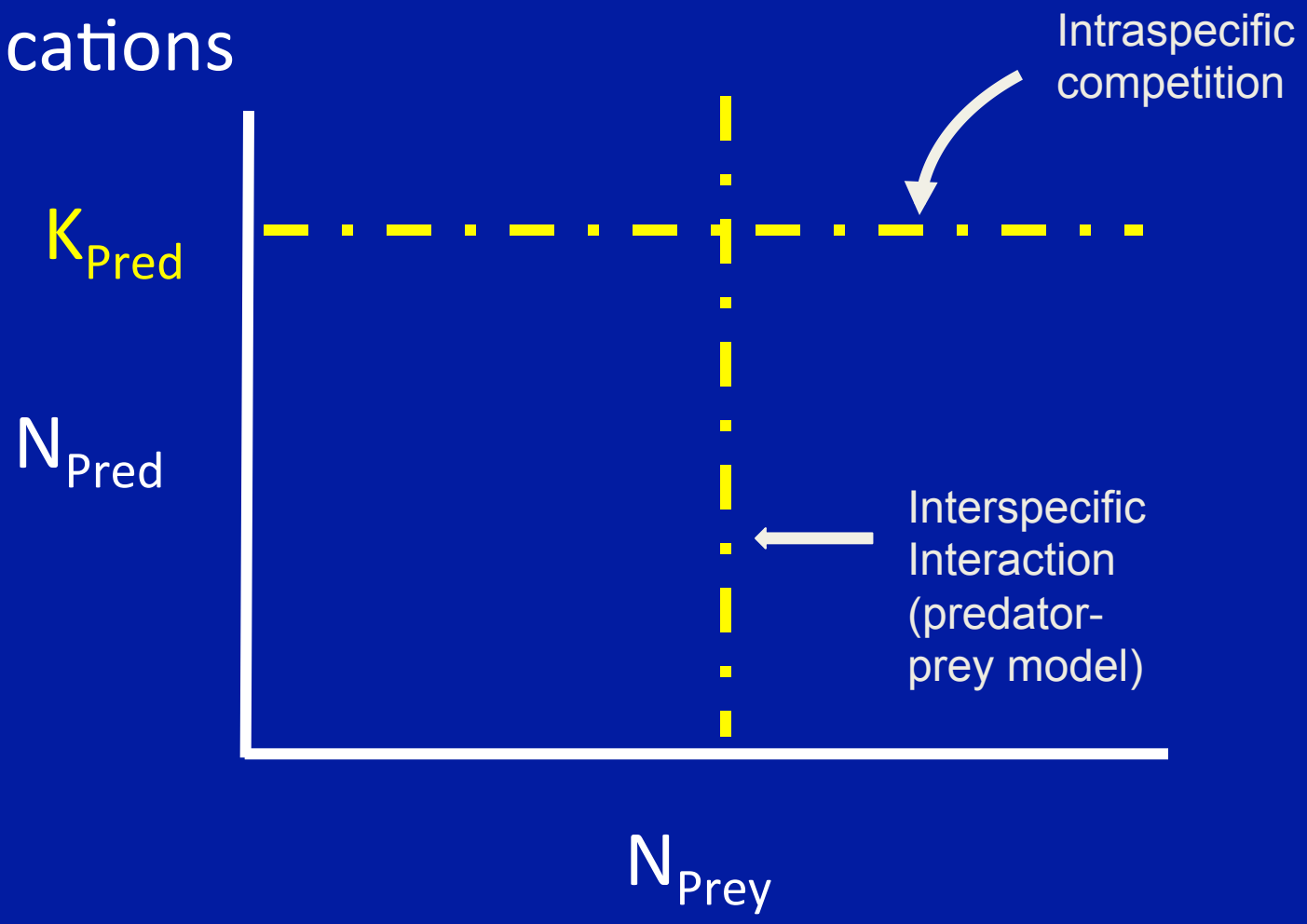

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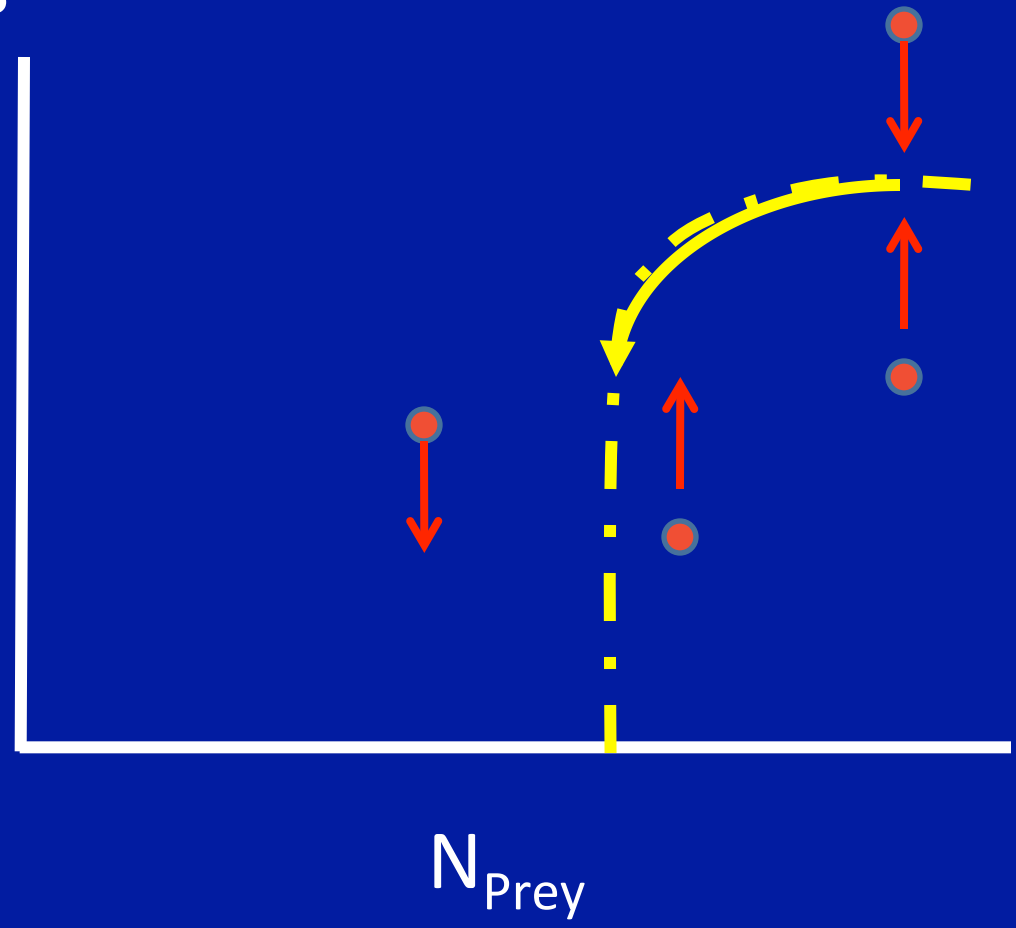

When prey is above the minimum, the predator population will increase or decrease normally

Lotka Volterra predator-prey model

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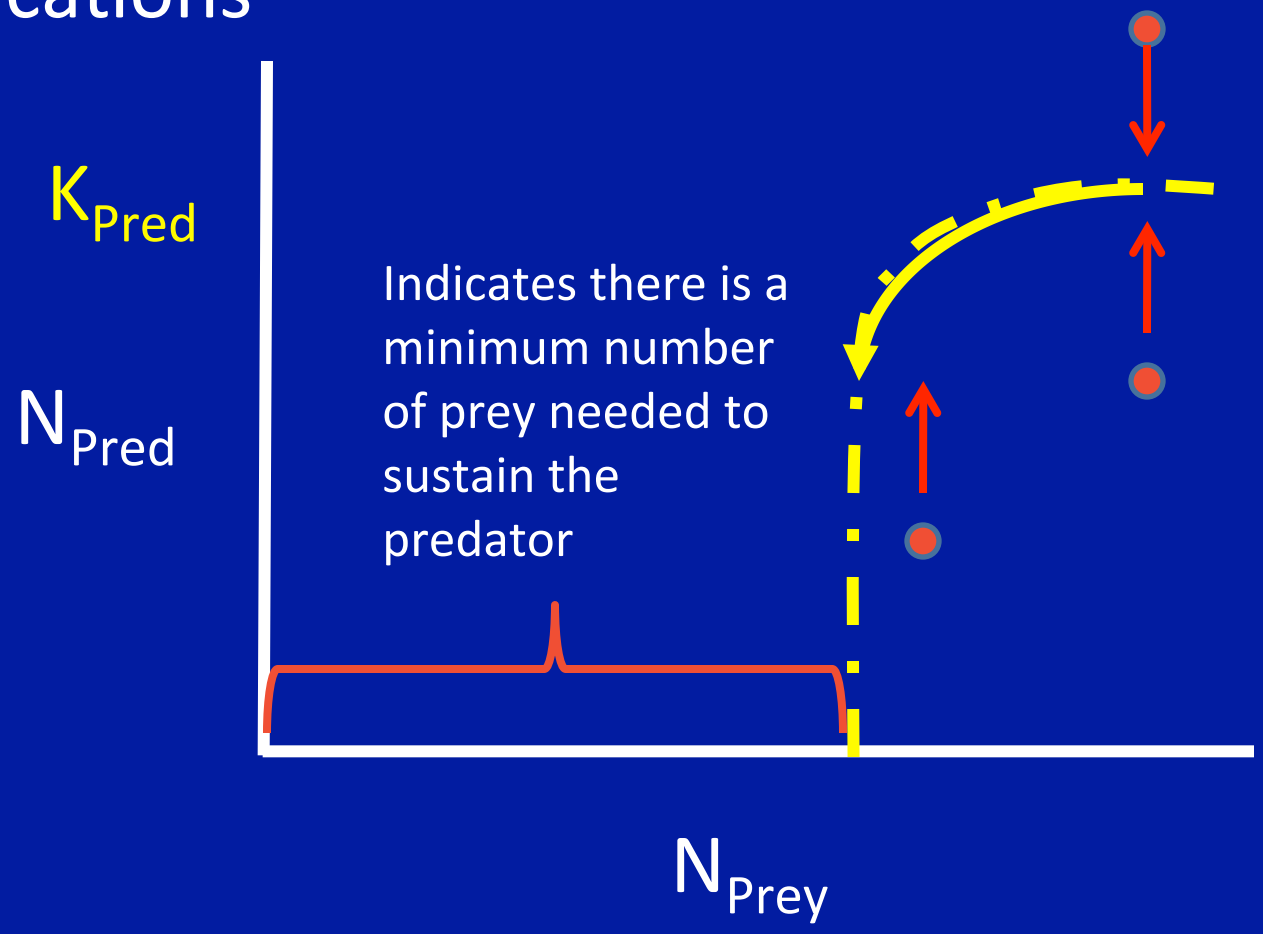

Lotka Volterra vector model

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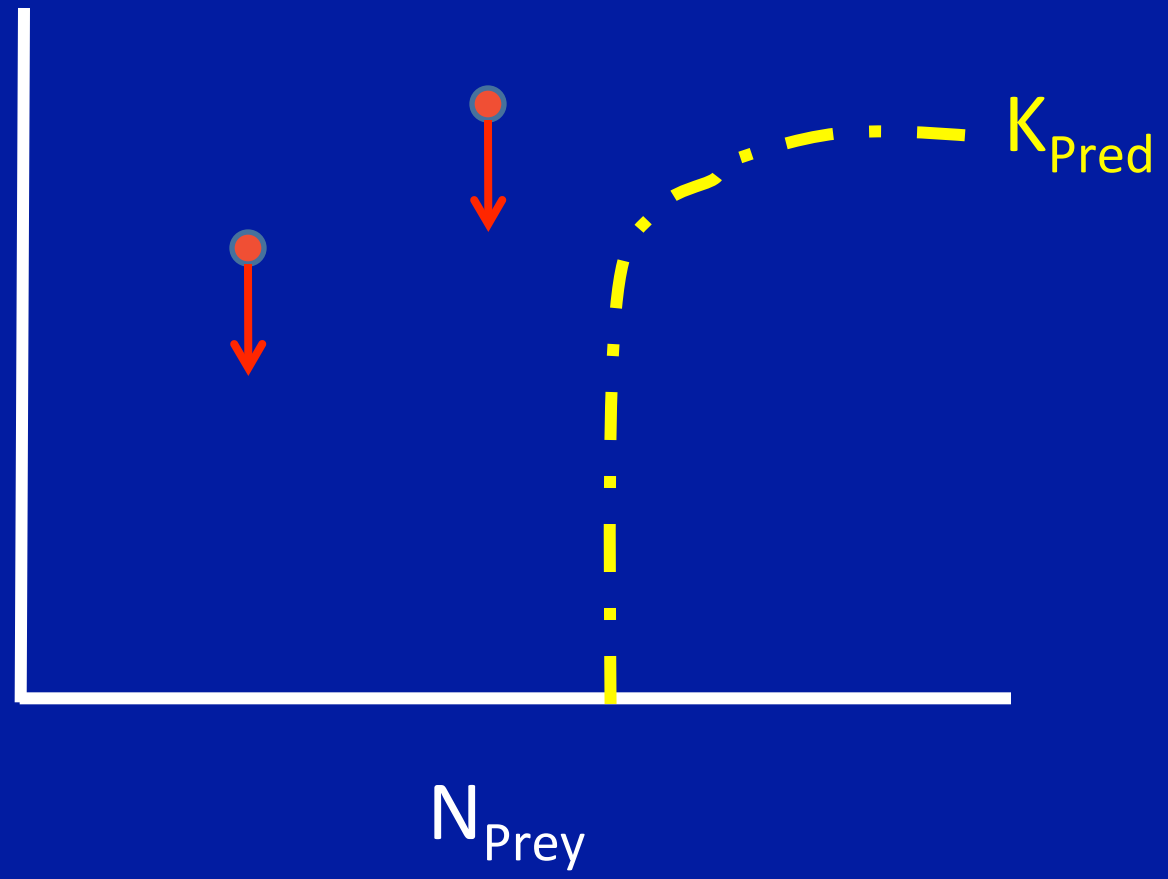

When prey is below the minimum, the predator population will always decrease

Lotka Volterra vector model

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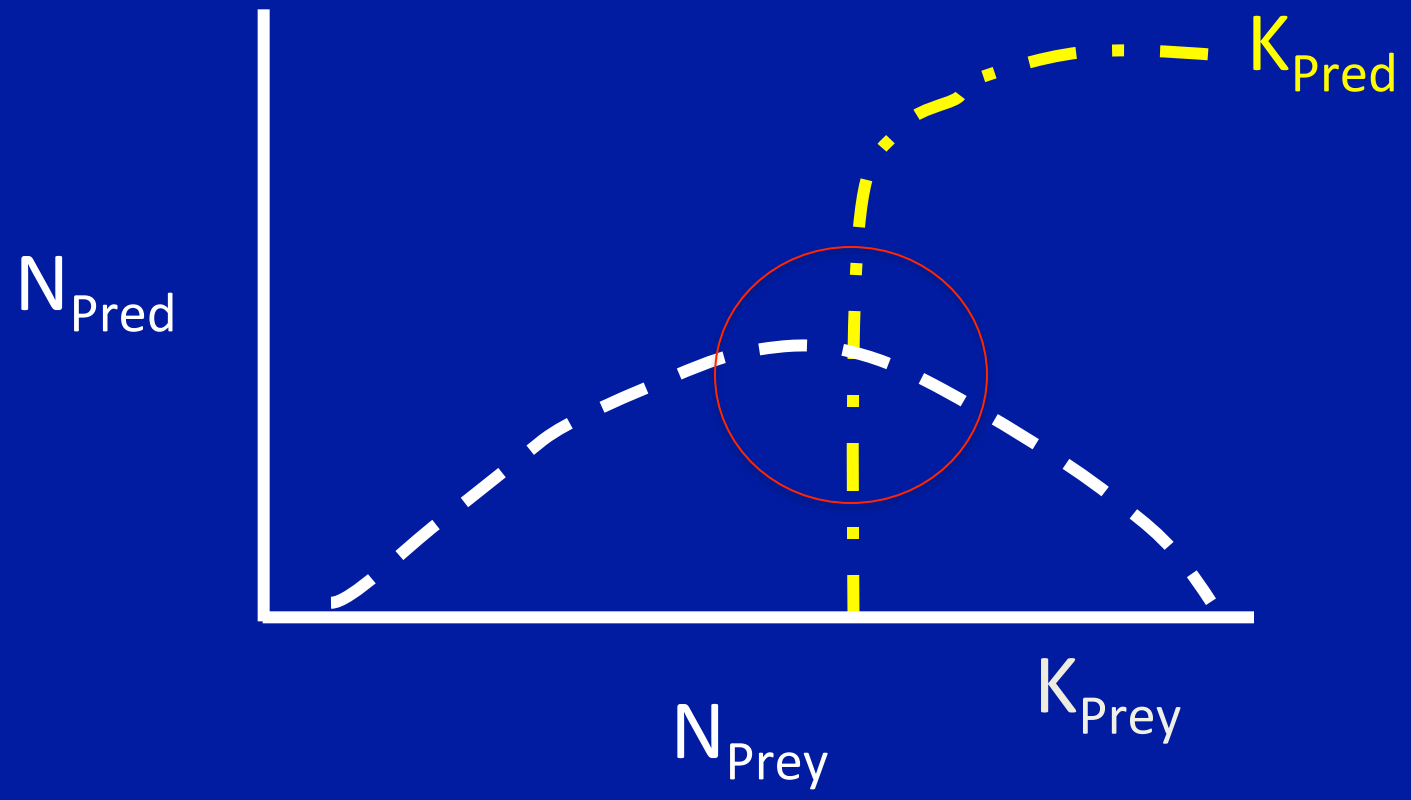

Lotka Volterra vector model

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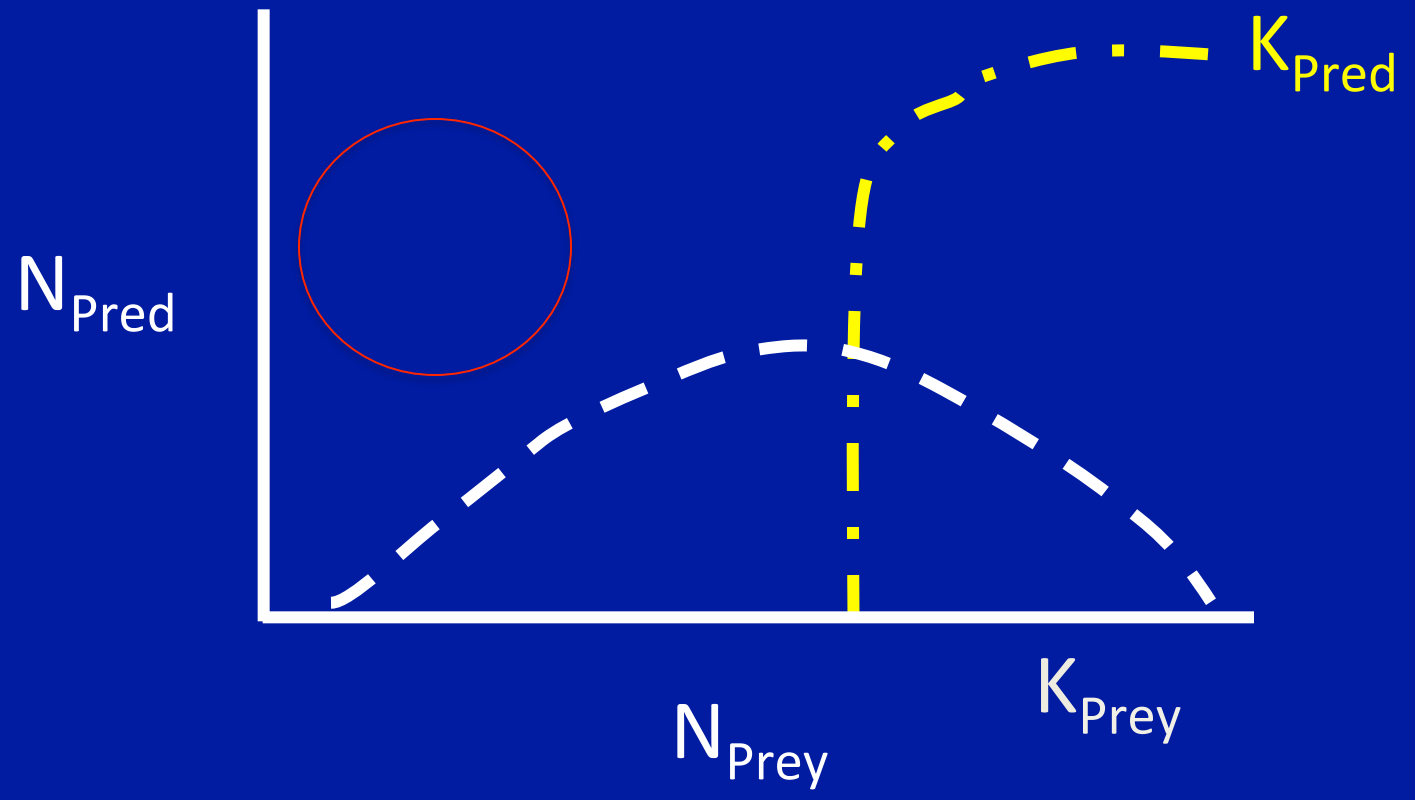

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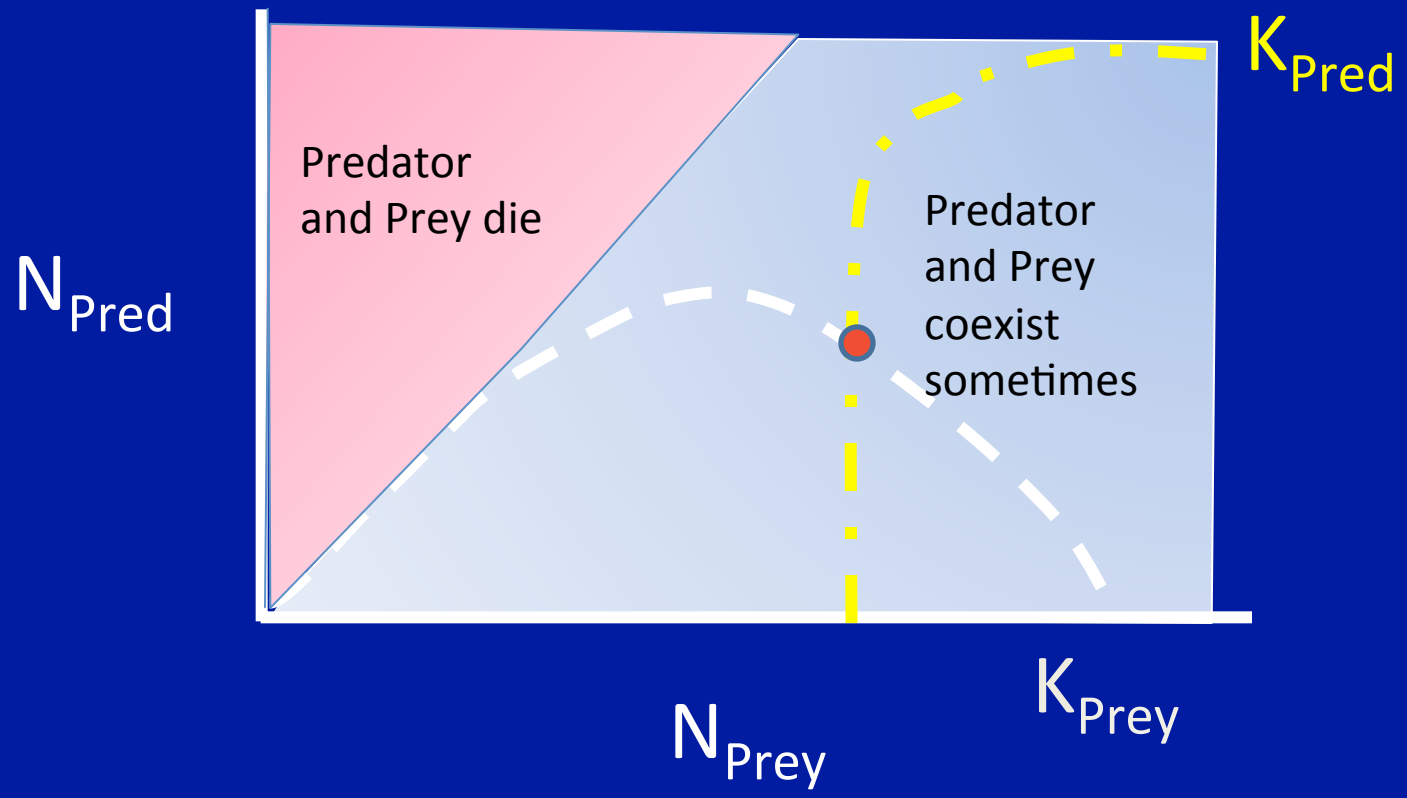
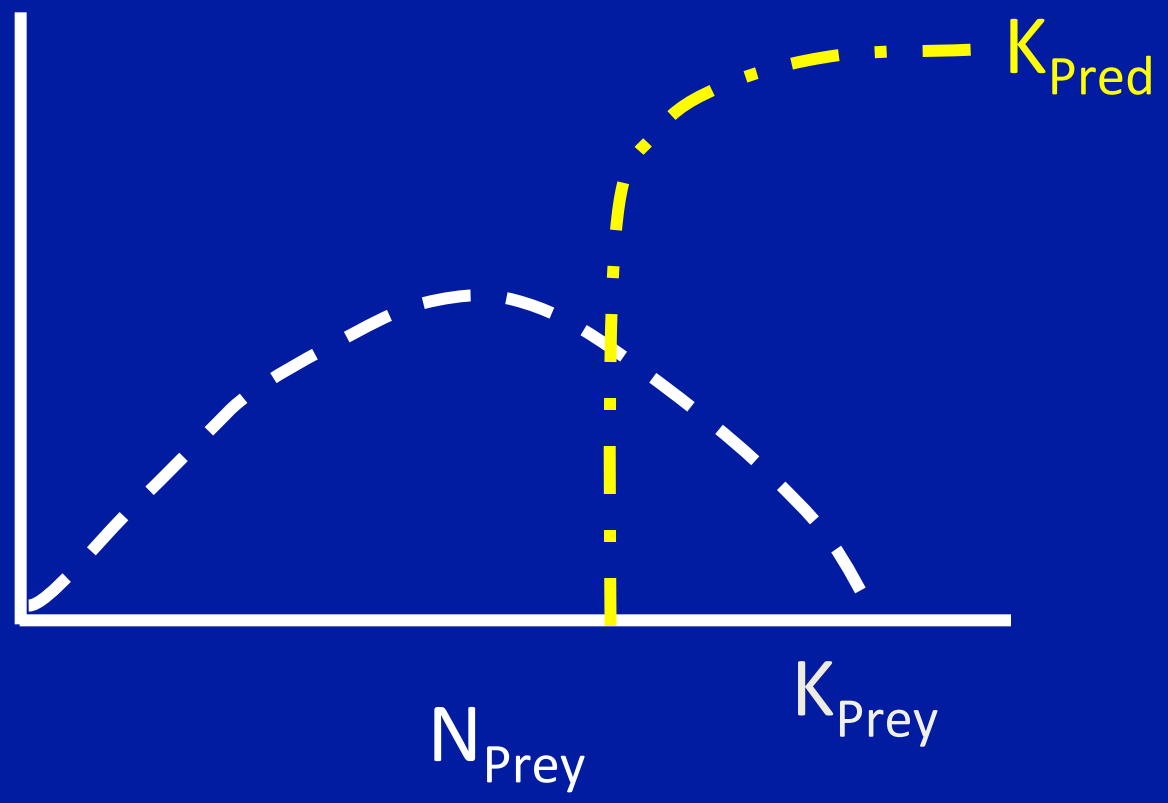


Lotka Volterra predator-prey model

Let's see what happens if the predator is really good at catching prey?



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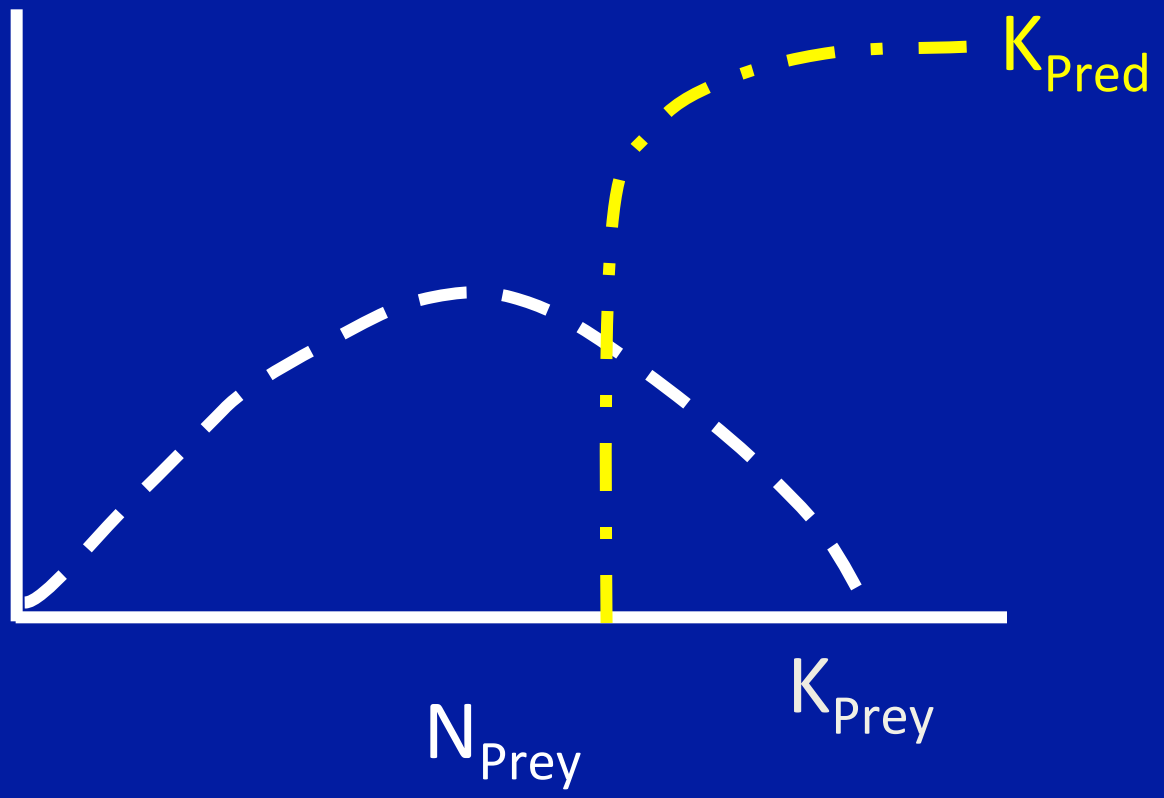

$dP/dt = \beta VP - qP$

Predator iscoline occurs at

$V = q/\beta$

Rosenzweig and MacArthur (1963) modifications

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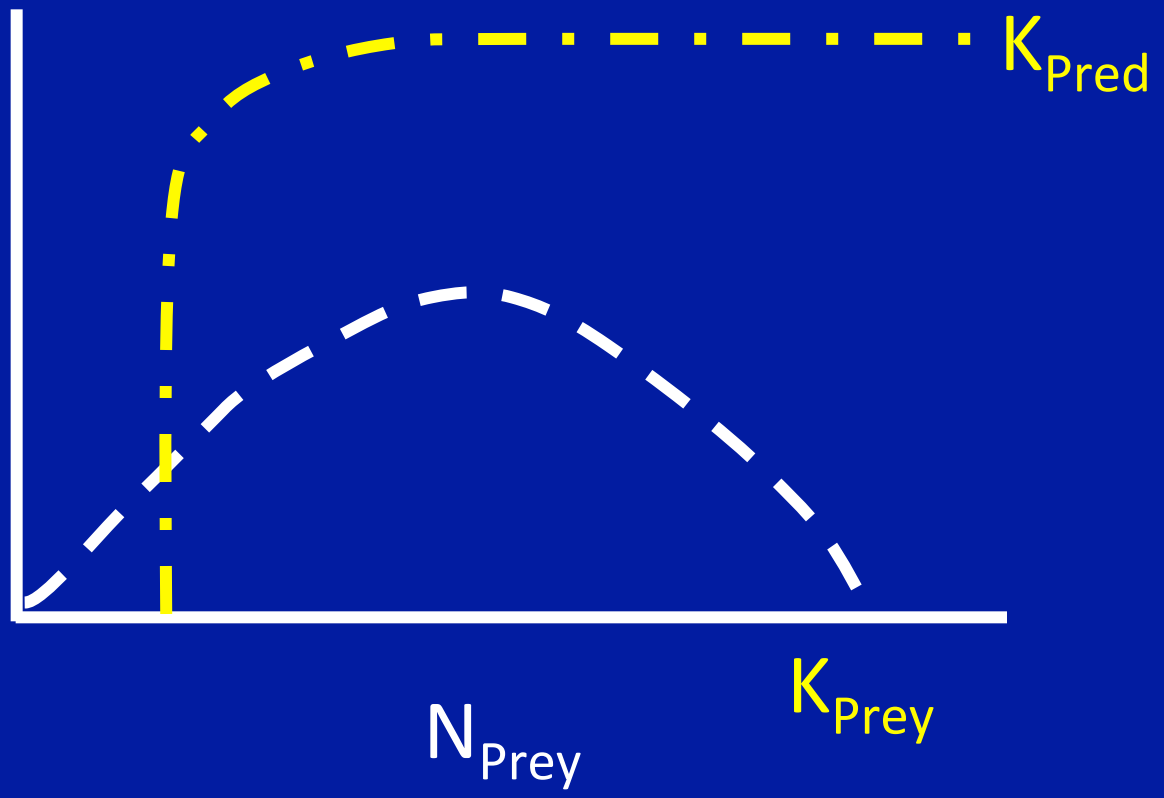

$dP/dt = \beta VP - qP$

Predator iscoline occurs at

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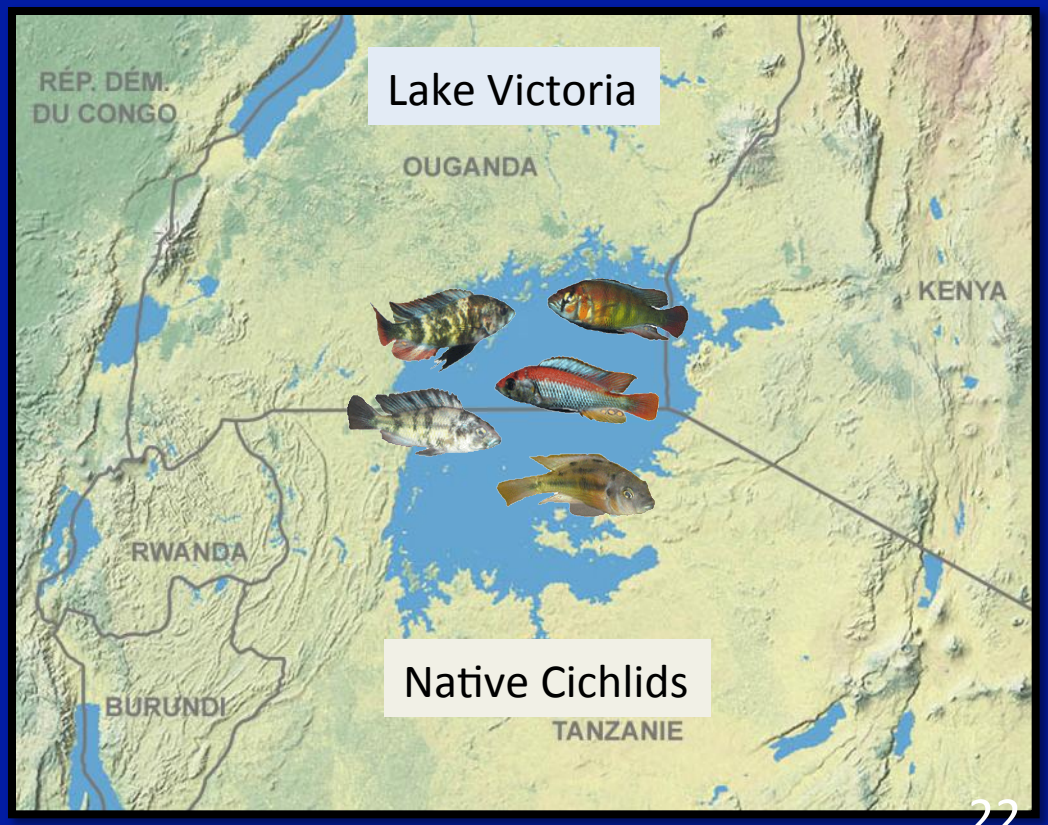
So what do you think might happen if you introduce a very efficient predator into a system?

Nile Perch



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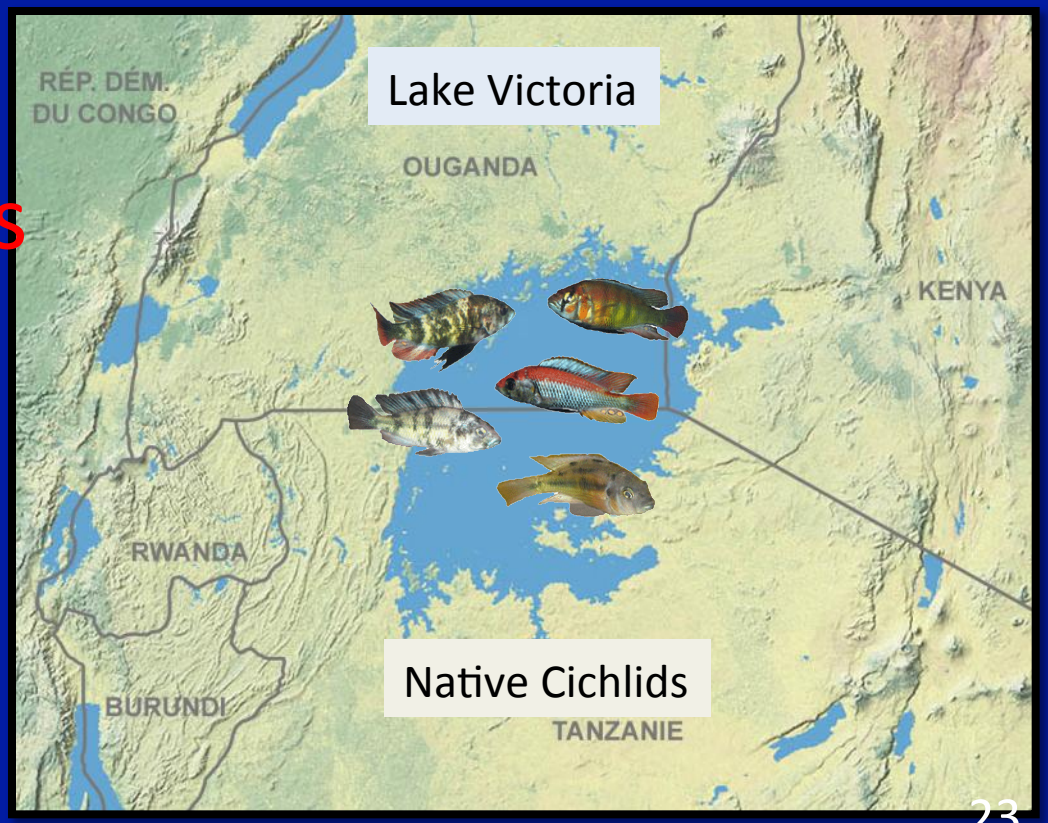
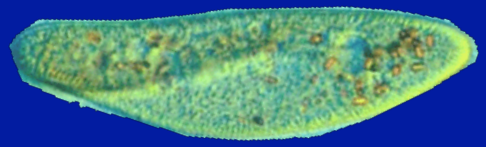
Nile Perch

OVER 100 Species of cichlids were eliminated!

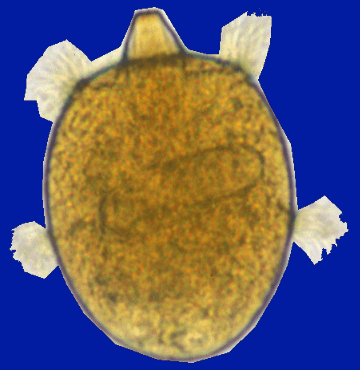


Famous Predator – Prey Experiments

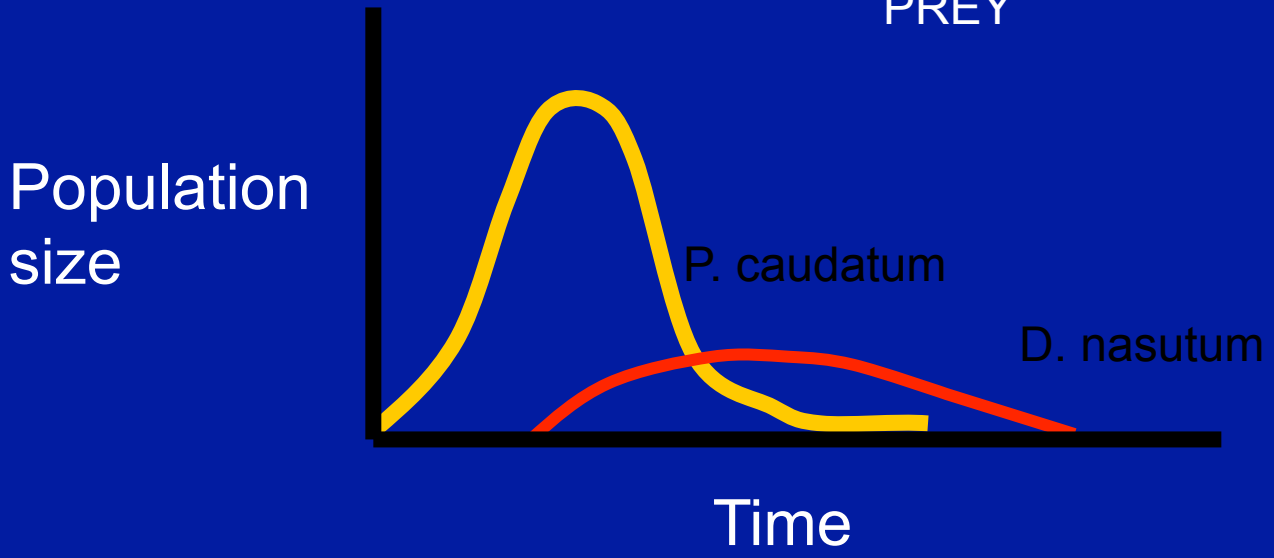
- Gause 1934



Paramecium caudatum
PREY



Didinium nasutum
PREDATOR



Photos by Marcel Holyoak

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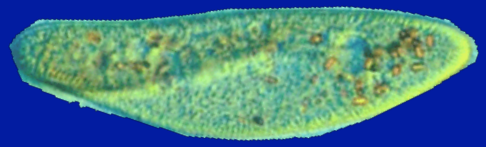

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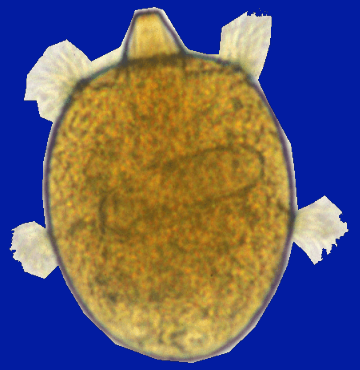

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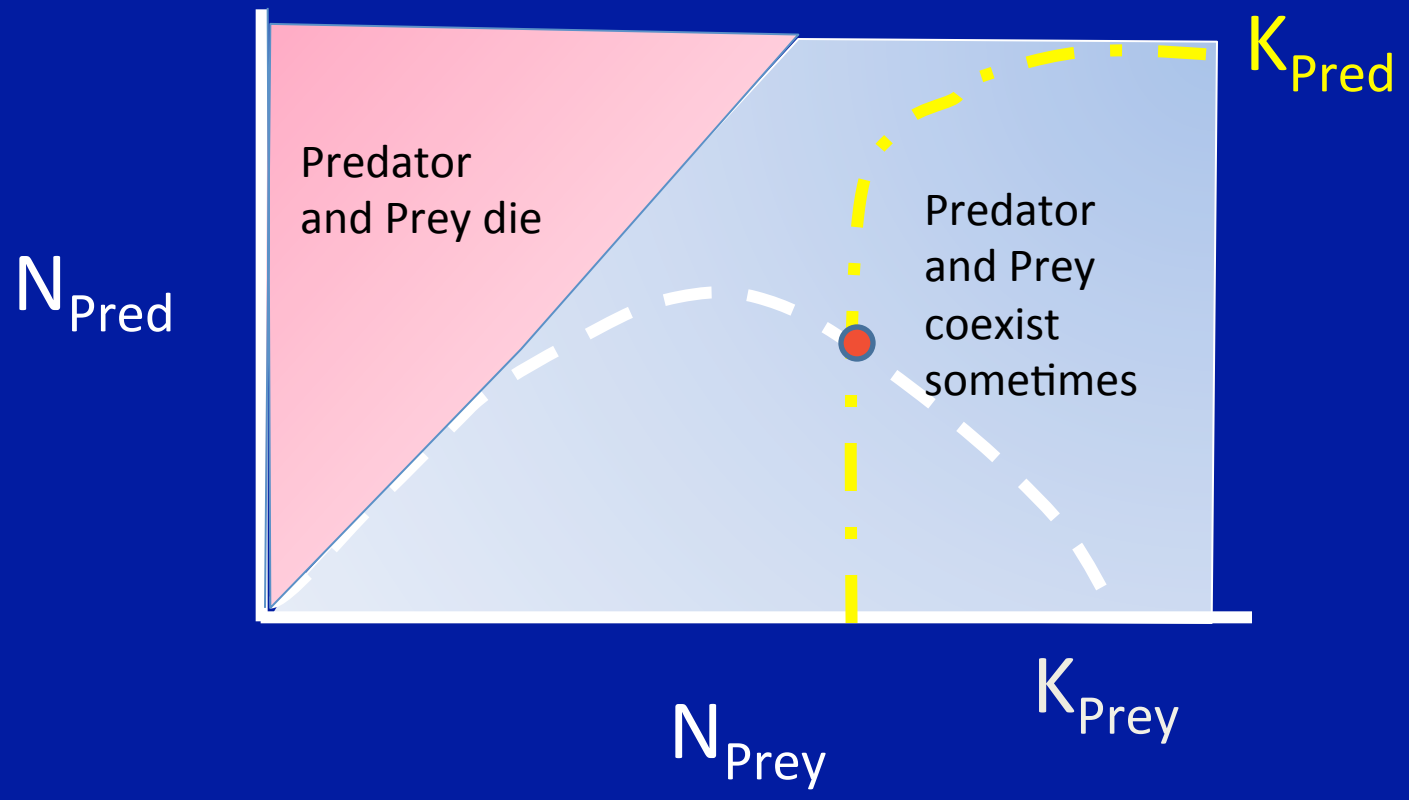
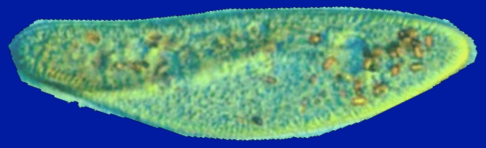


Famous Predator – Prey Experiments

- Gause 1934
  - Allowed immigration of prey



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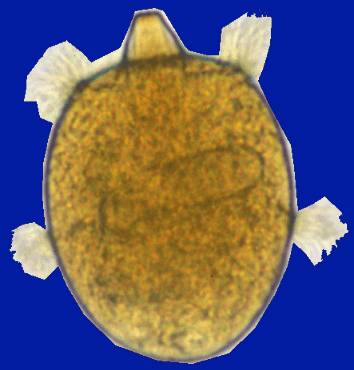
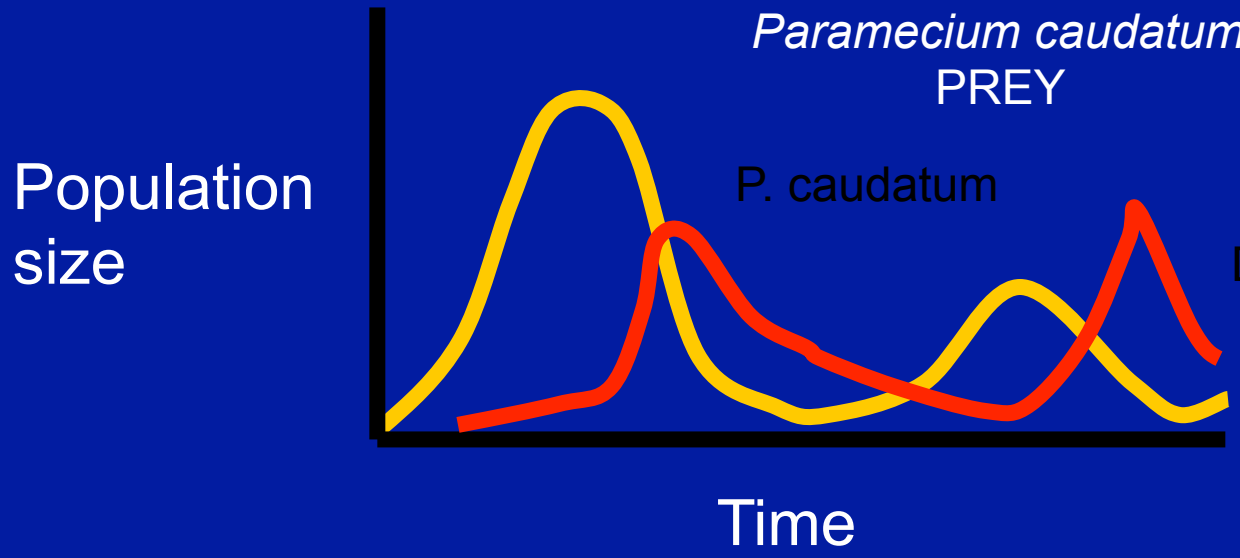
PREY



Didinium nasutum
PREDATOR



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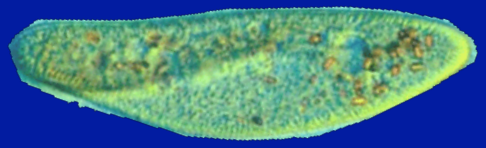
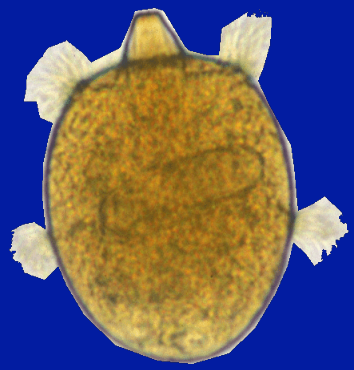


Paramecium caudatum
PREY



Didinium nasutum
PREDATOR

Populatio
size

nasutum

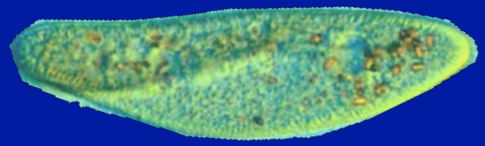
BOTH SURVIVED!

Time

Photos by Marcel Holyoak

Famous Predator – Prey Experiments

- Gause 1934
  - Sediment in bottom



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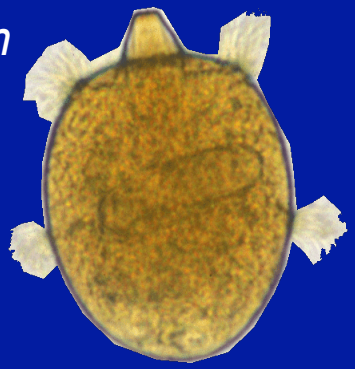
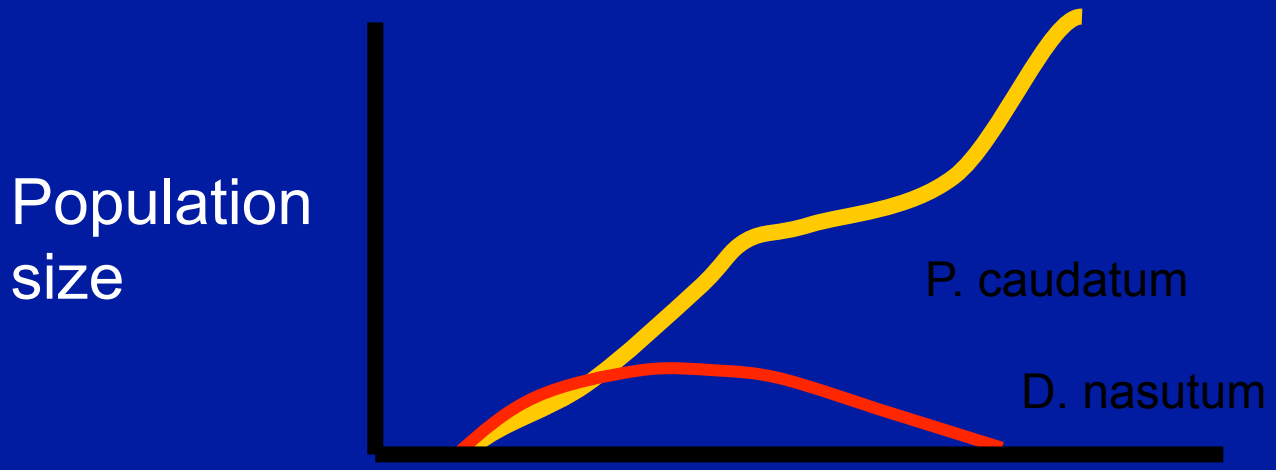


Didinium nasutum
PREDATOR



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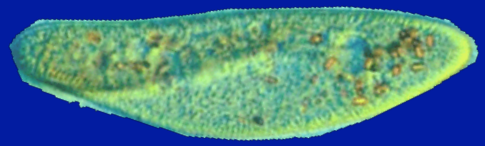

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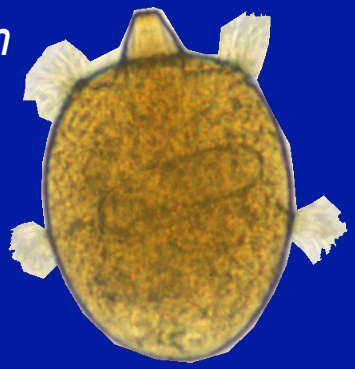


Didinium nasutum
PREDATOR

Populatio
size

Prey survived
Predator died!

Time

Photos by Marcel Holyoak

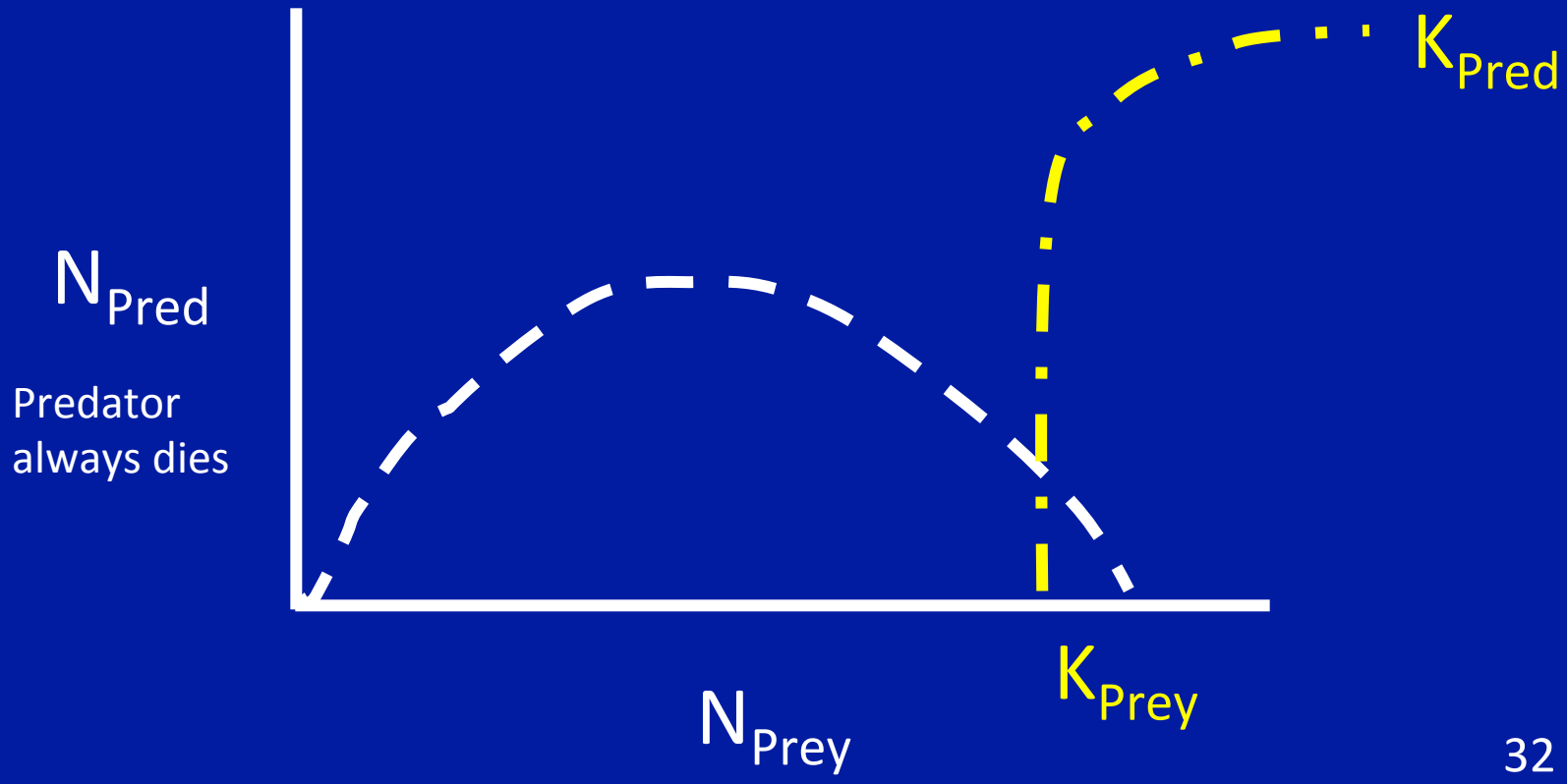
What did the sediment do?

- Provided a refuge that would allow the population of *Paramecium caudatum* to increase without having the predator

http://www.gov.im/lib/images/iomfinance/landscapes/refuge.jpg

Rosenzweig and MacArthur model

- With refuge
- In essence, the predator becomes extremely inefficient because only small portion of prey are accessible



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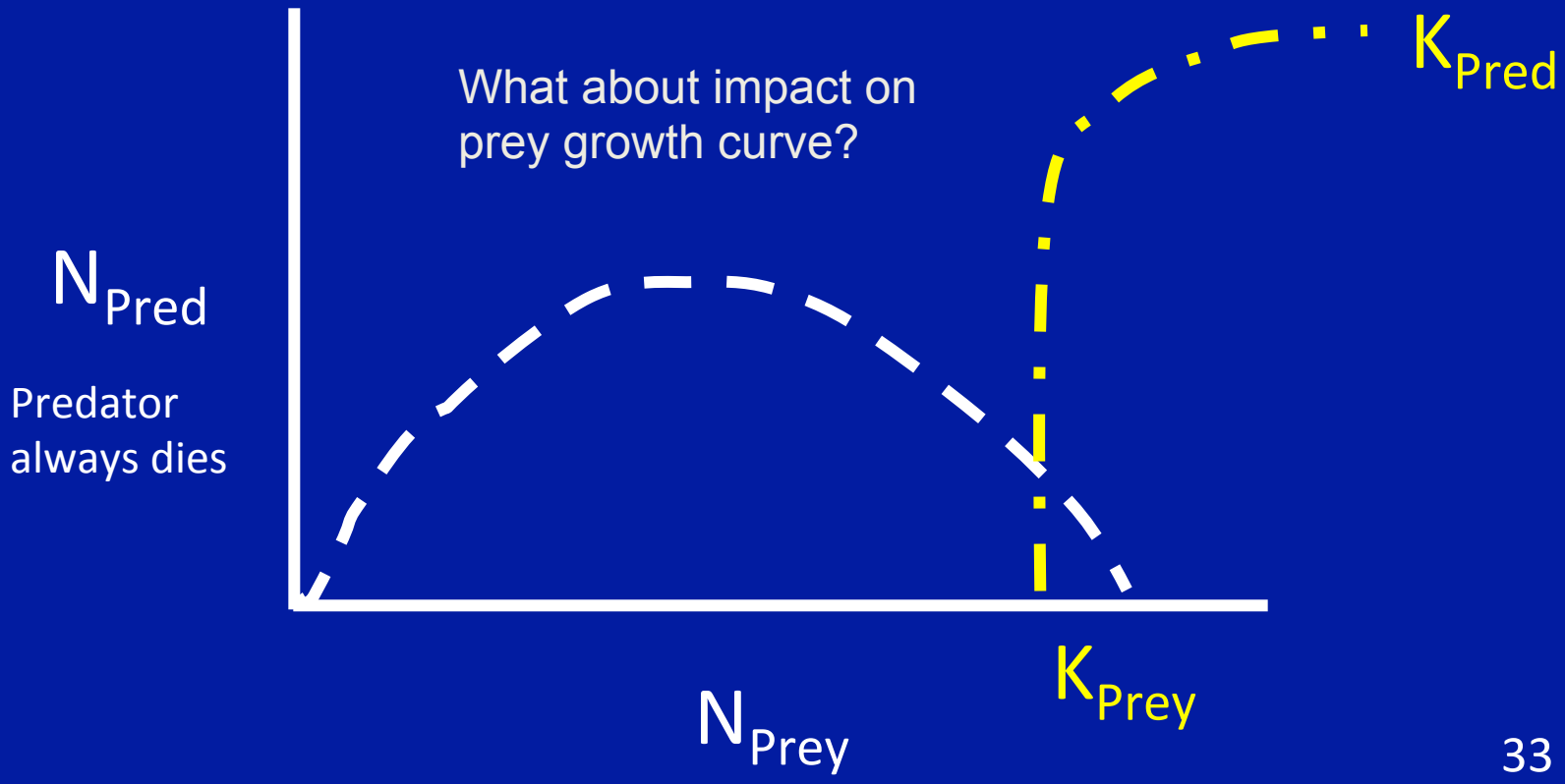
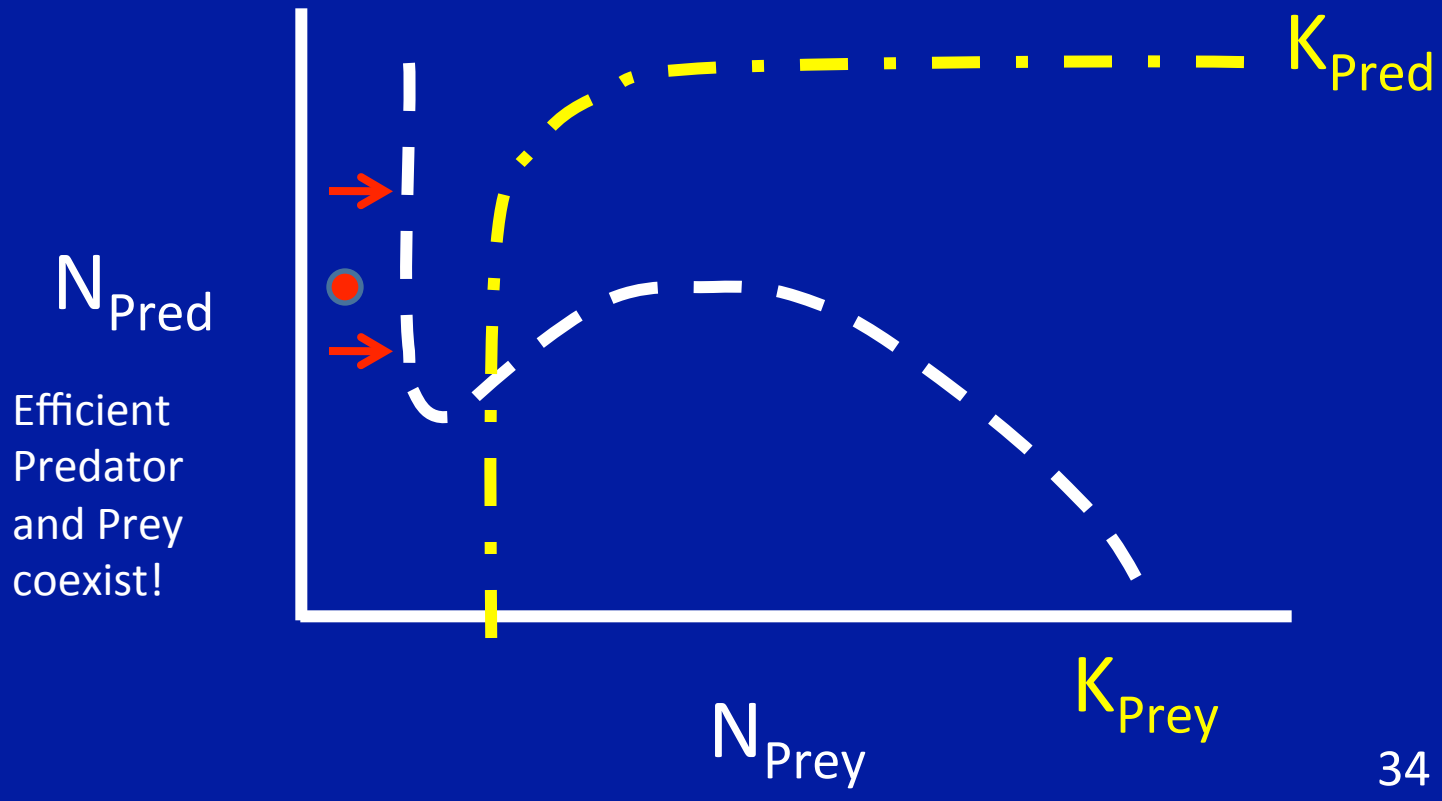


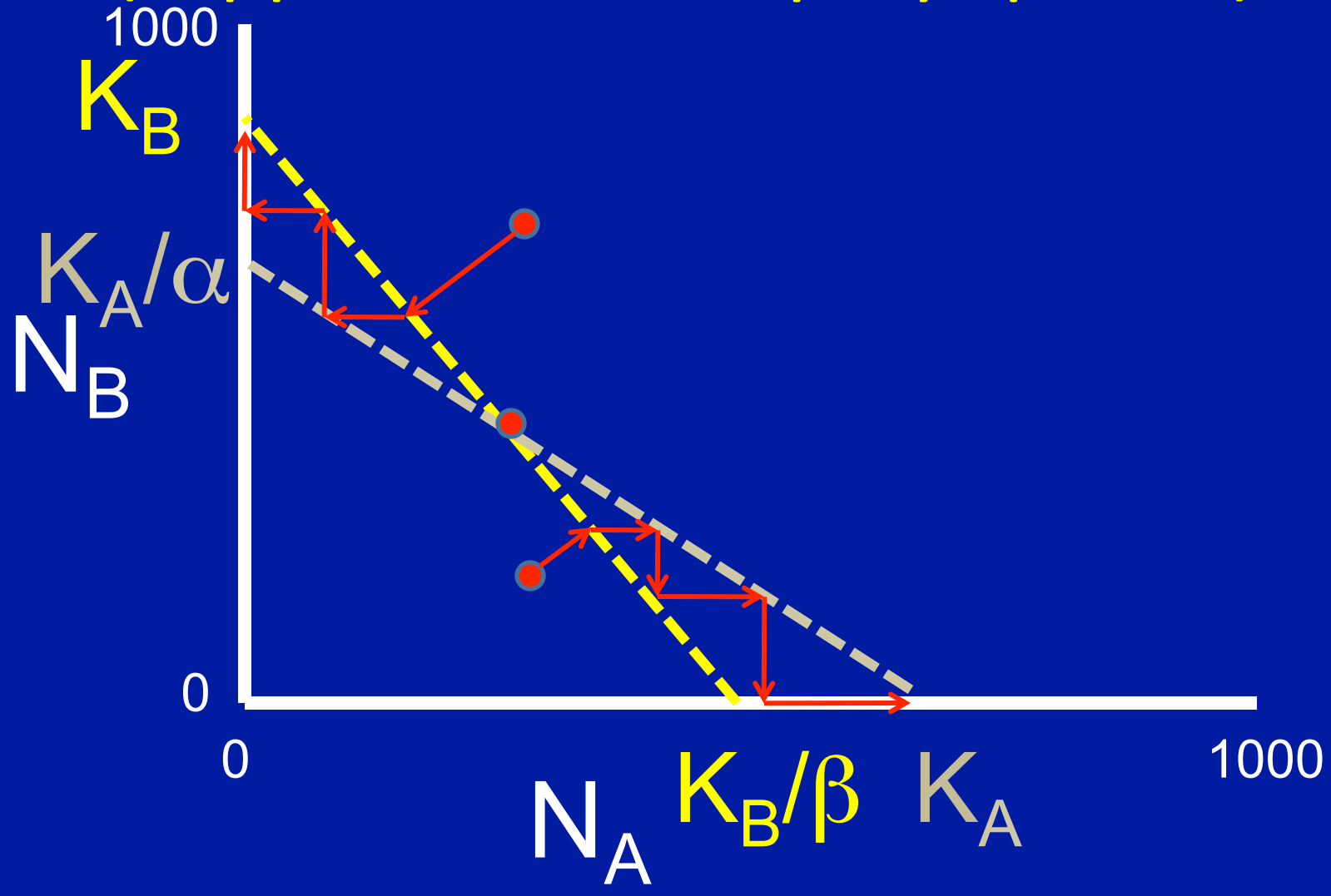
Rosenzweig and MacArthur model

- With refuge
- A certain amount of the prey population will never be preyed upon so they can always reproduce regardless of the presence of the predator



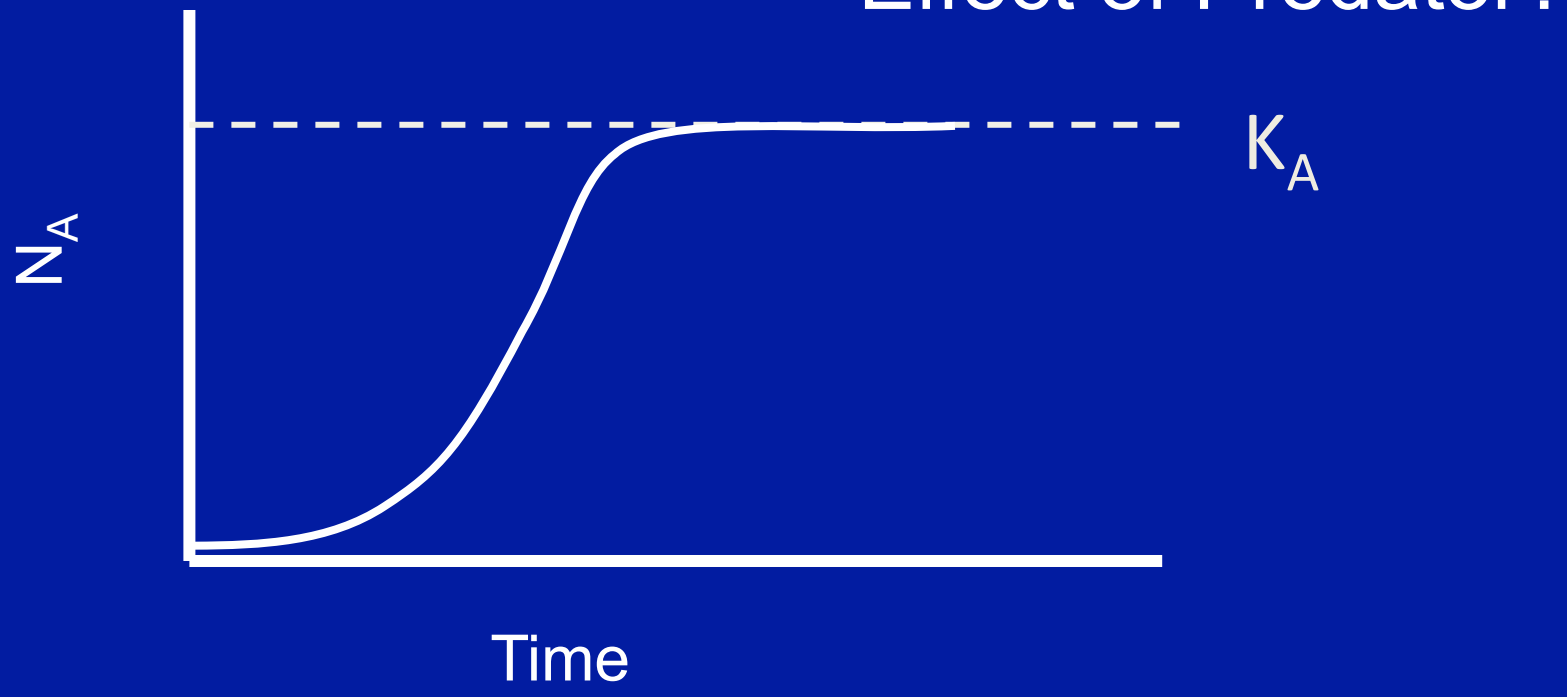
How does predation affect competition?

Vector Plot - two strong competitors (suppose both are prey species)



Switching

Effect of Predator?



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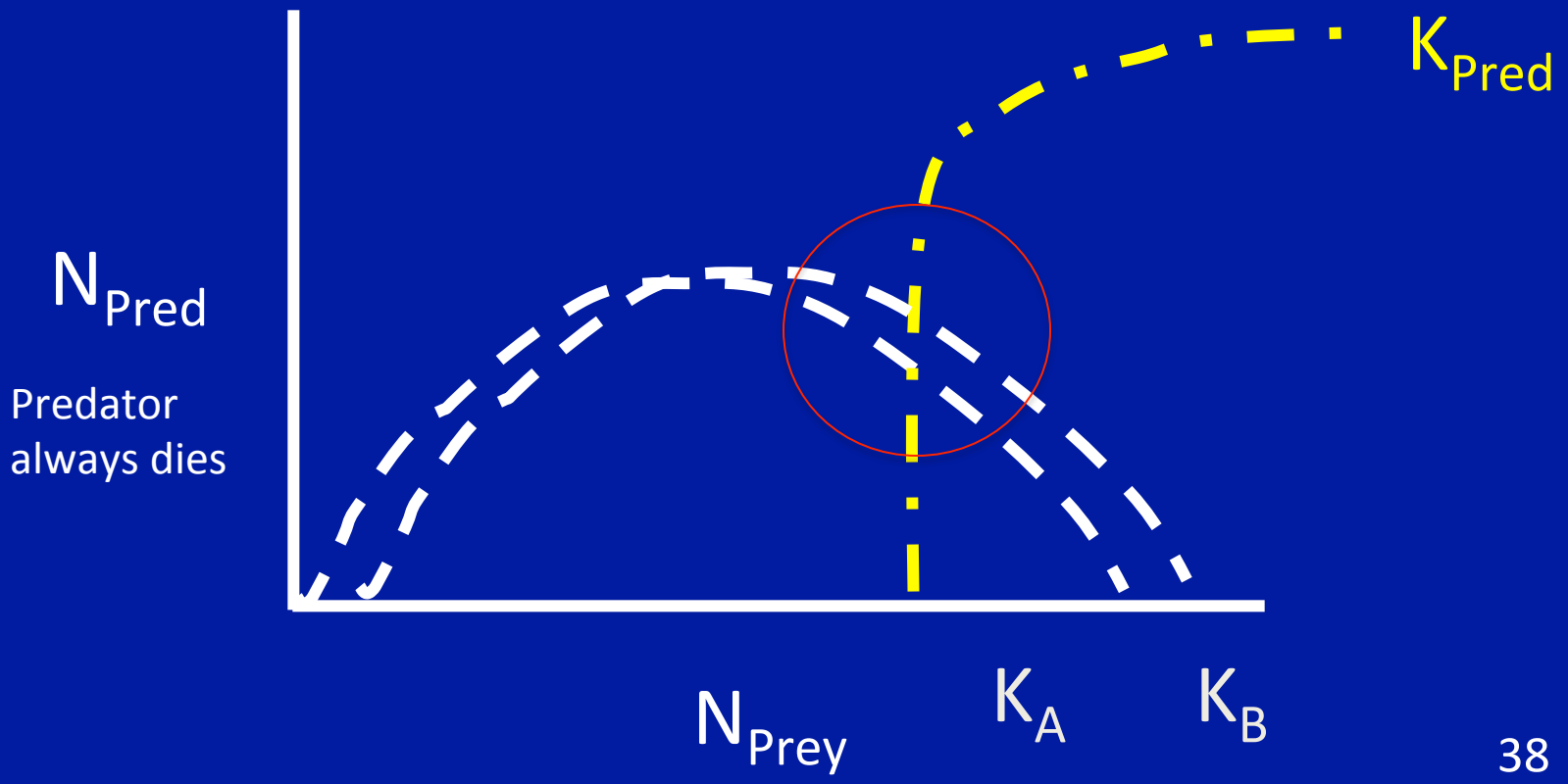
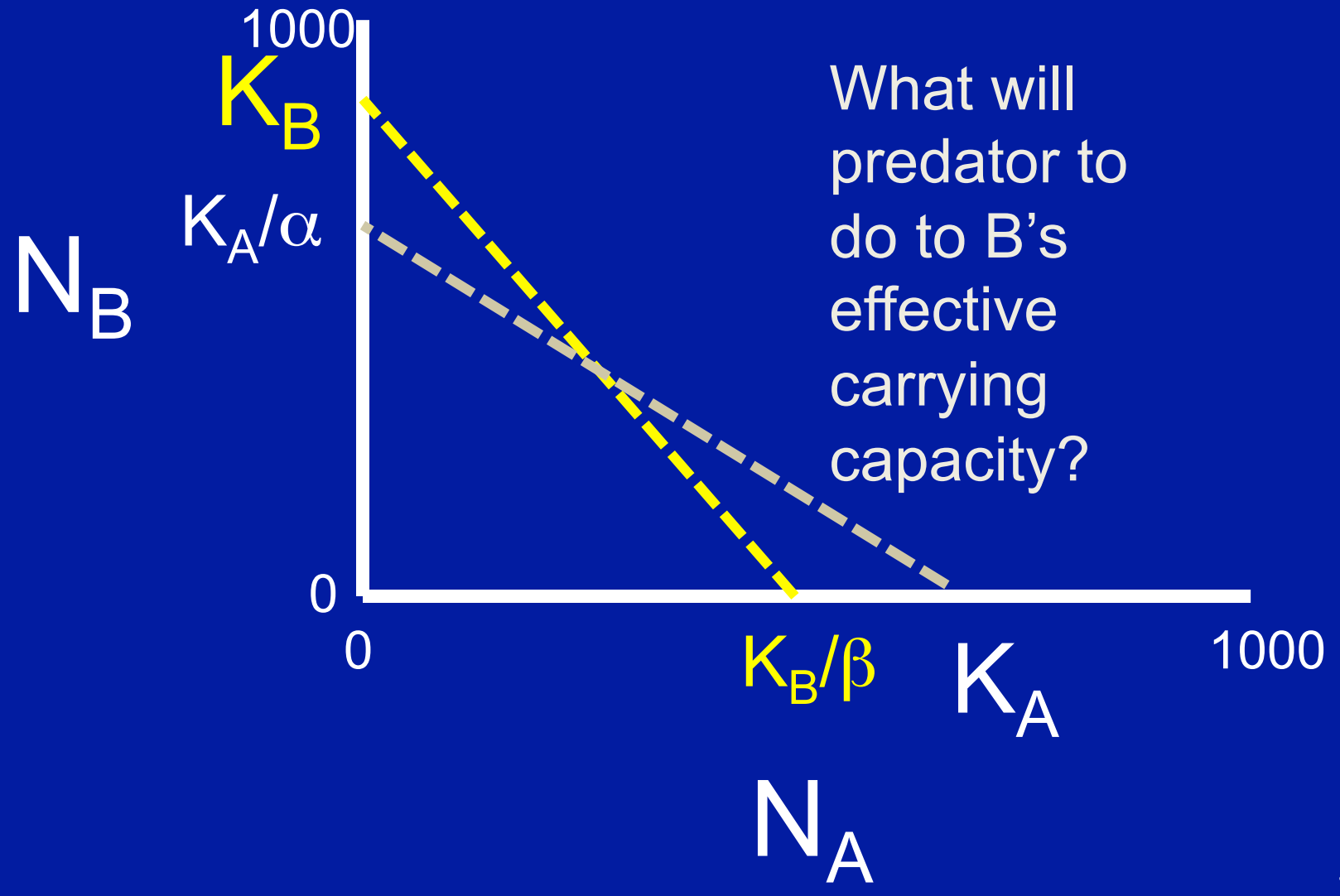
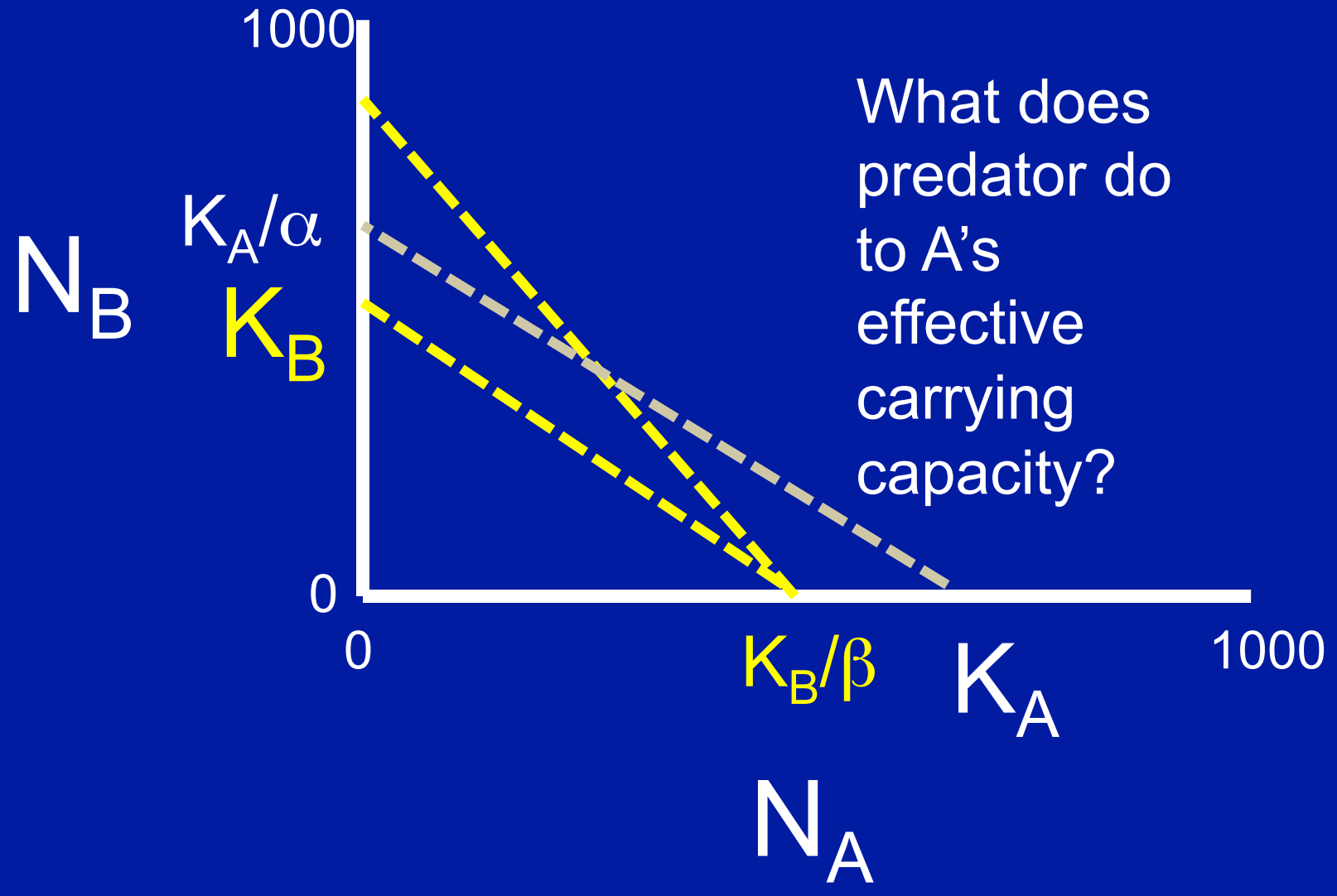


Vector Plot - Let's look at two strong competitors



What will predator to do to B's effective carrying capacity?

Vector Plot - Let's look at two strong competitors



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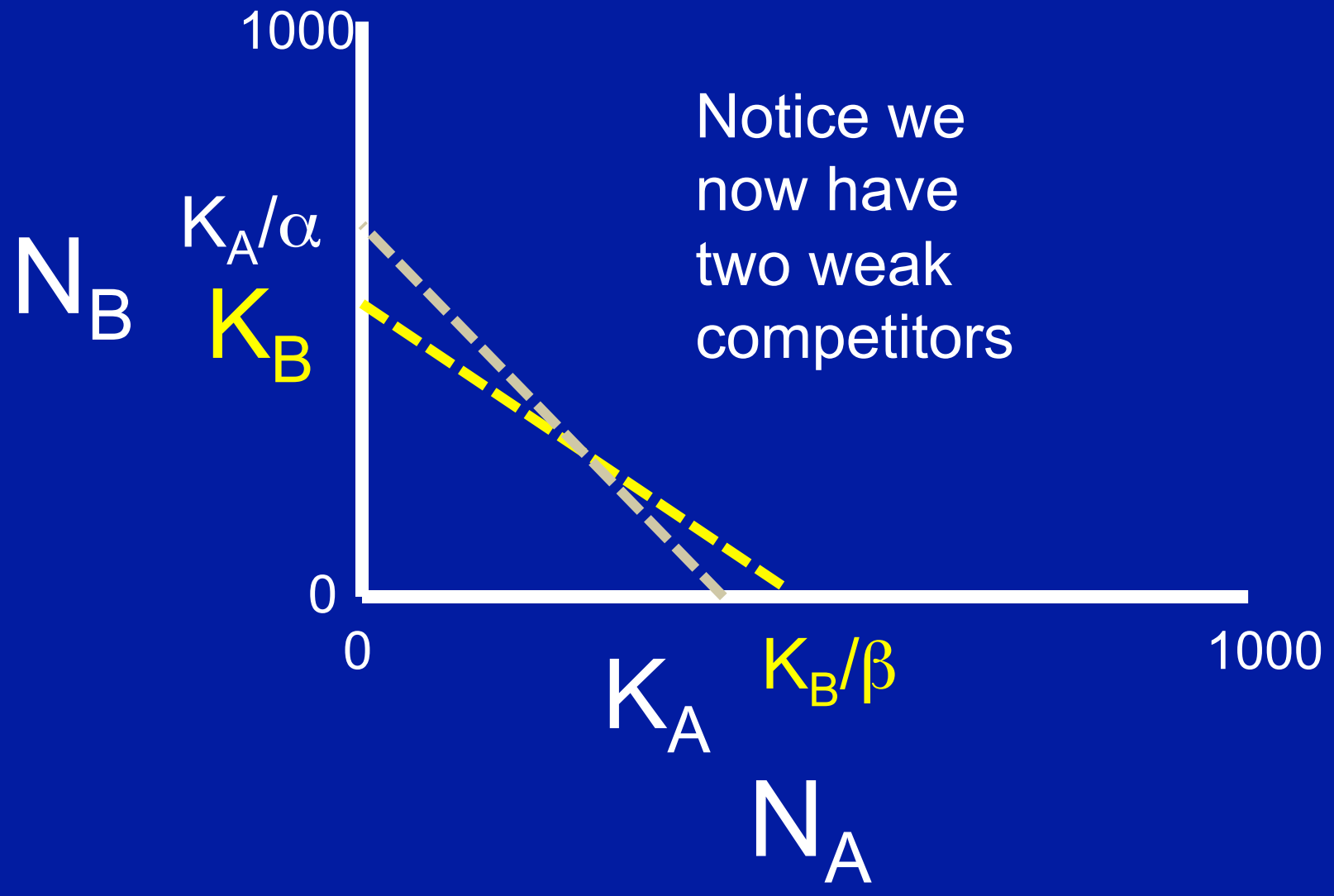

Predators regulating prey can increase prey coexistence

- If the predator can switch and has a large enough impact on the prey, the predator can coexist with both prey.

Keystone Predator

- The presence of the predator allows competing species to coexist.

http://nathistoc.bio.uci.edu/Molluscs/Mytilus1a.jpg

http://www.dereila.ca/dereilaimages/weedy2.jpg