PhD Defence

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- **Author: Licentiate Scott Glen Cole**, SLU
- **Thesis: Environmental Compensation is not for the Birds.** Assessing Social welfare impacts of resource-based environmental compensation
- **Opponent: Professor Patrik Söderholm, LTU**
- **PhD Committee:**
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  - **Professor Per Olov Johansson**, Stockholm School of Economics
  - **Dr. Torgeir Nygård**, Norwegian Institute for Nature Research
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- **Chair: Professor Peter Lohmander**, SLU

Some comments on the dissertation by Scott G. Cole

By
Peter Lohmander
2012-05-18

Citation (Study 1, page 14):

- ”This study relies on a simplified model that assumes recovery is a function of each *collided bird’s* remaining life expectancy, rather than population density.”

- ”A more sophisticated population model is underway.”

- ”One of the model´s assumptions is constant survival rates before and efter the damage,…”

Comment by Peter Lohmander:

- **Models for population growth *with density dependence* were developed more than 160 years ago.**

- **It seems irrational to assume that population density (competition for food and space) does not influence the birds. (In ecology, population density is a very important variable.)**

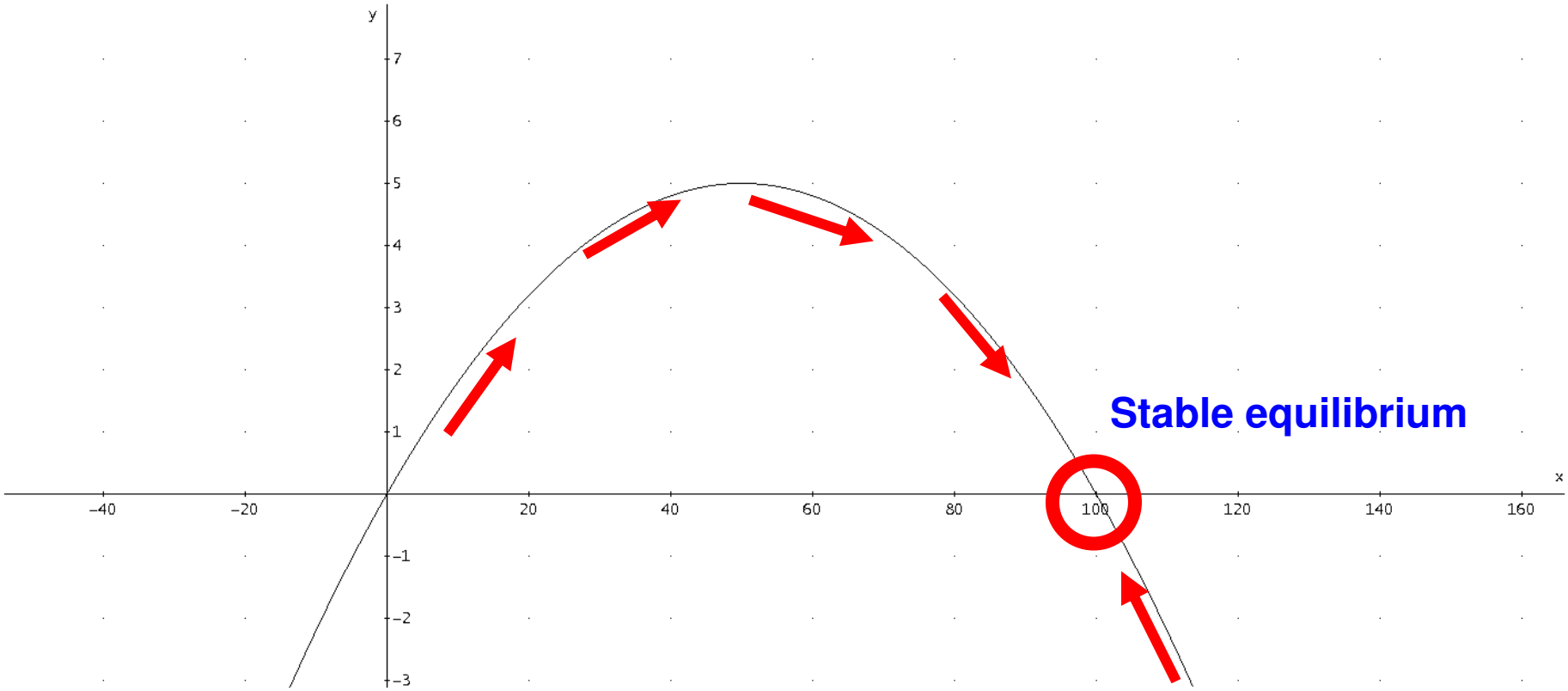
- **Without density dependence, the population can expand to infinity (which does not happen in reality).**

From Wikipedia, the free encyclopedia:

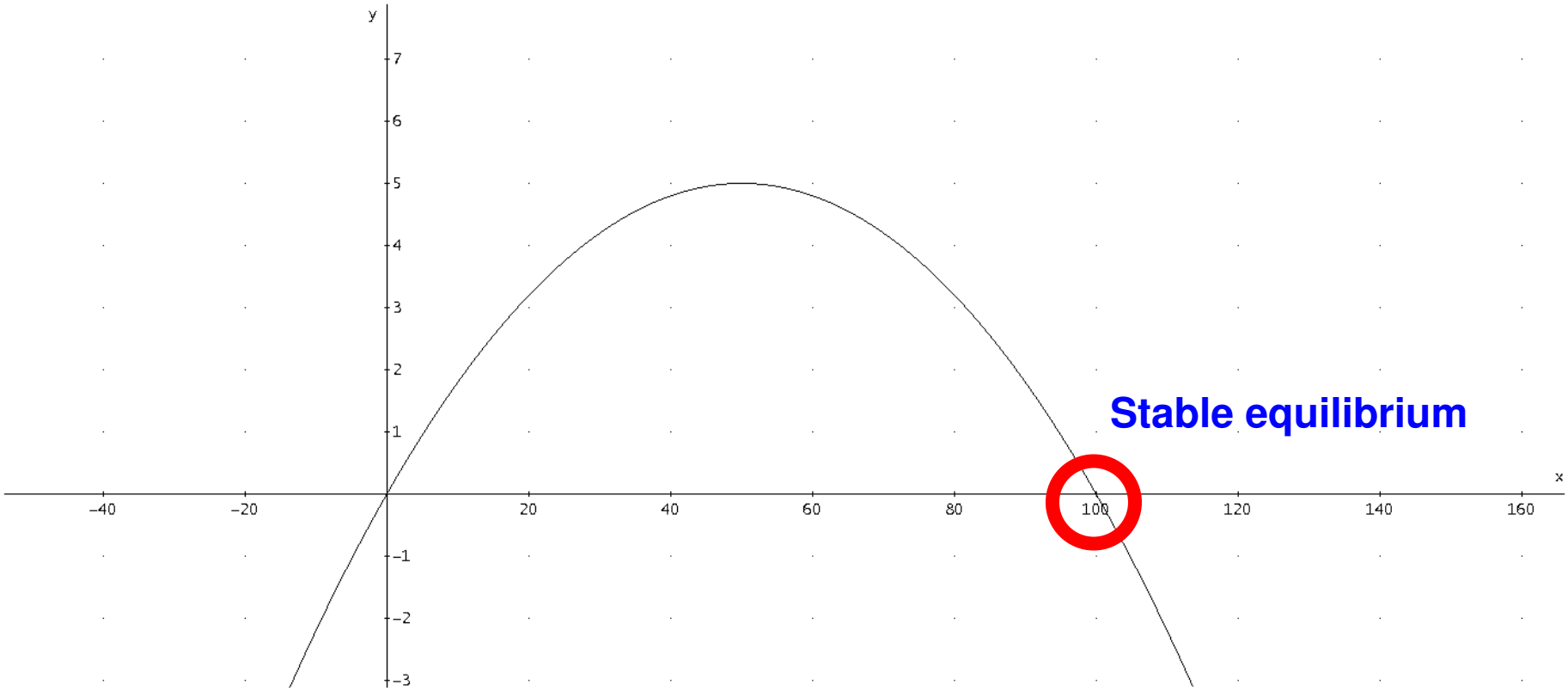
- A **logistic function** or **logistic curve** is a common sigmoid curve, given its name in 1844 or 1845 by Pierre François Verhulst who studied it in relation to population growth. A generalized logistic curve can model the "S-shaped" behaviour (abbreviated S-curve) of growth of some population *P*.

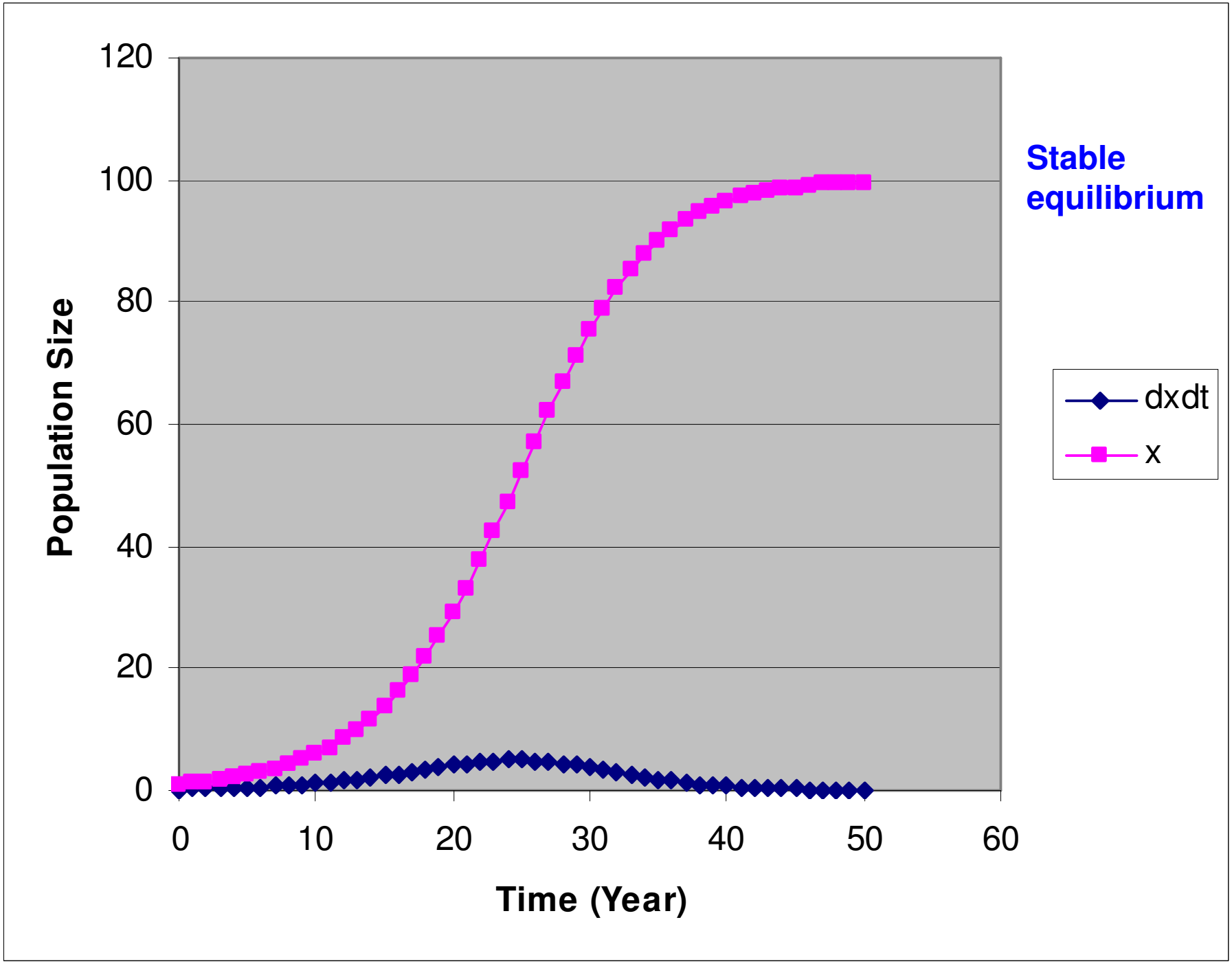
$$\frac{dx}{dt} = sx\left(1 - \frac{x}{K}\right)$$

$$y = \frac{dx}{dt} = sx\left(1 - \frac{x}{K}\right)$$

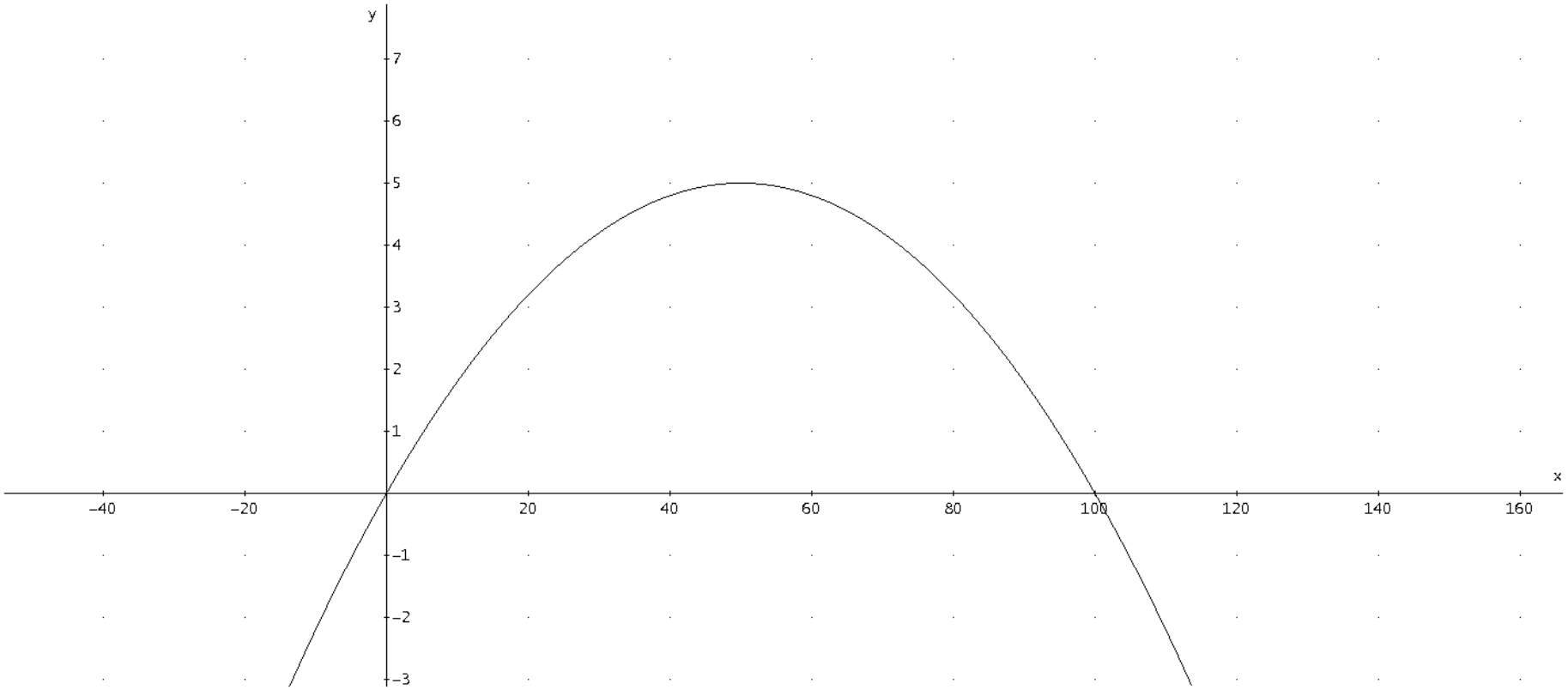


$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right)$$



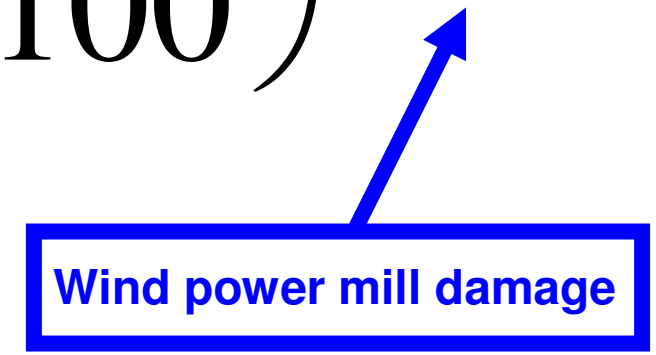

120
100
80
60
40
20
0
Population Size
0
10
20
30
40
50
60
Time (Year)
Stable equilibrium
dxdt
x

$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right)$$



My suggestion:

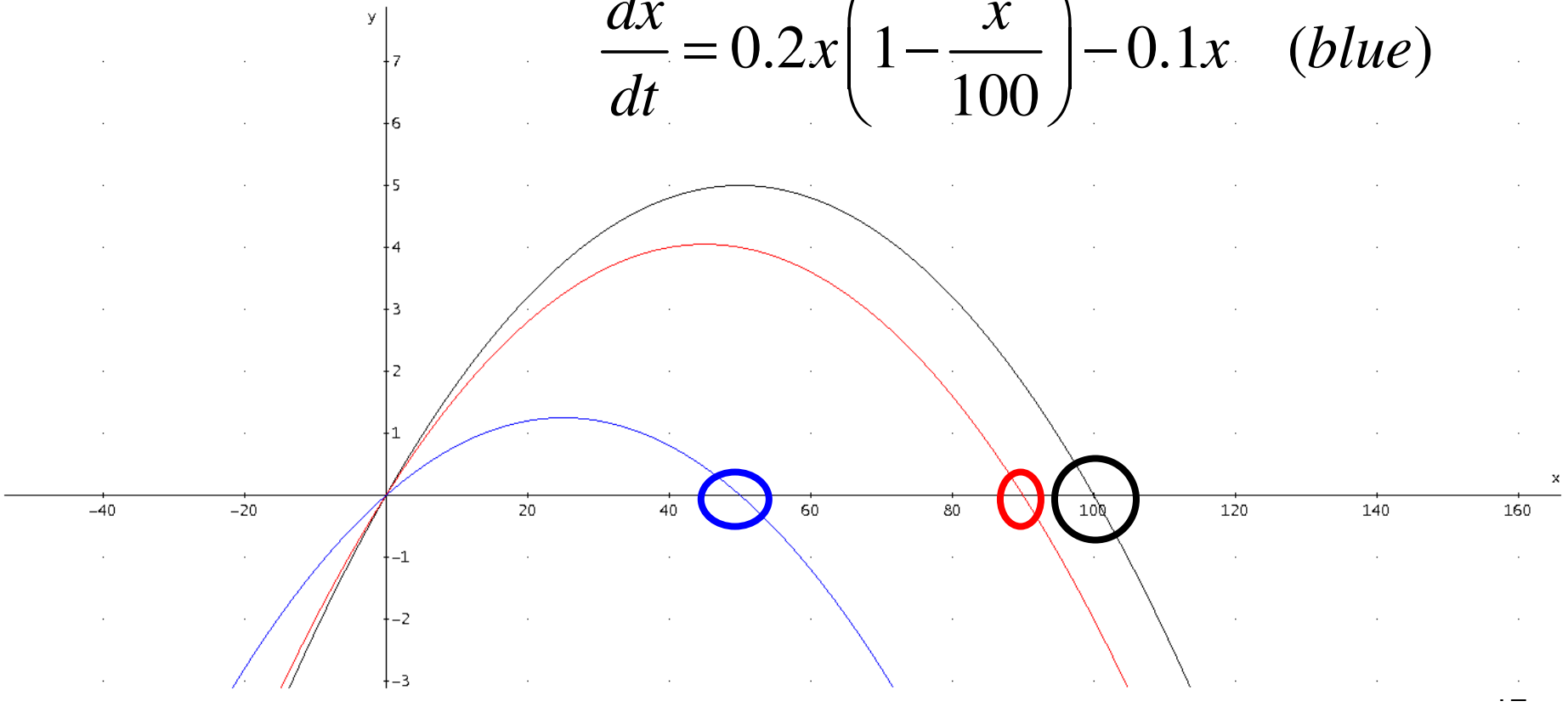
$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right) - mx$$



$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right) \qquad (black)$$

$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right) - 0.02x \qquad (red)$$

$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right) - 0.1x \qquad (blue)$$



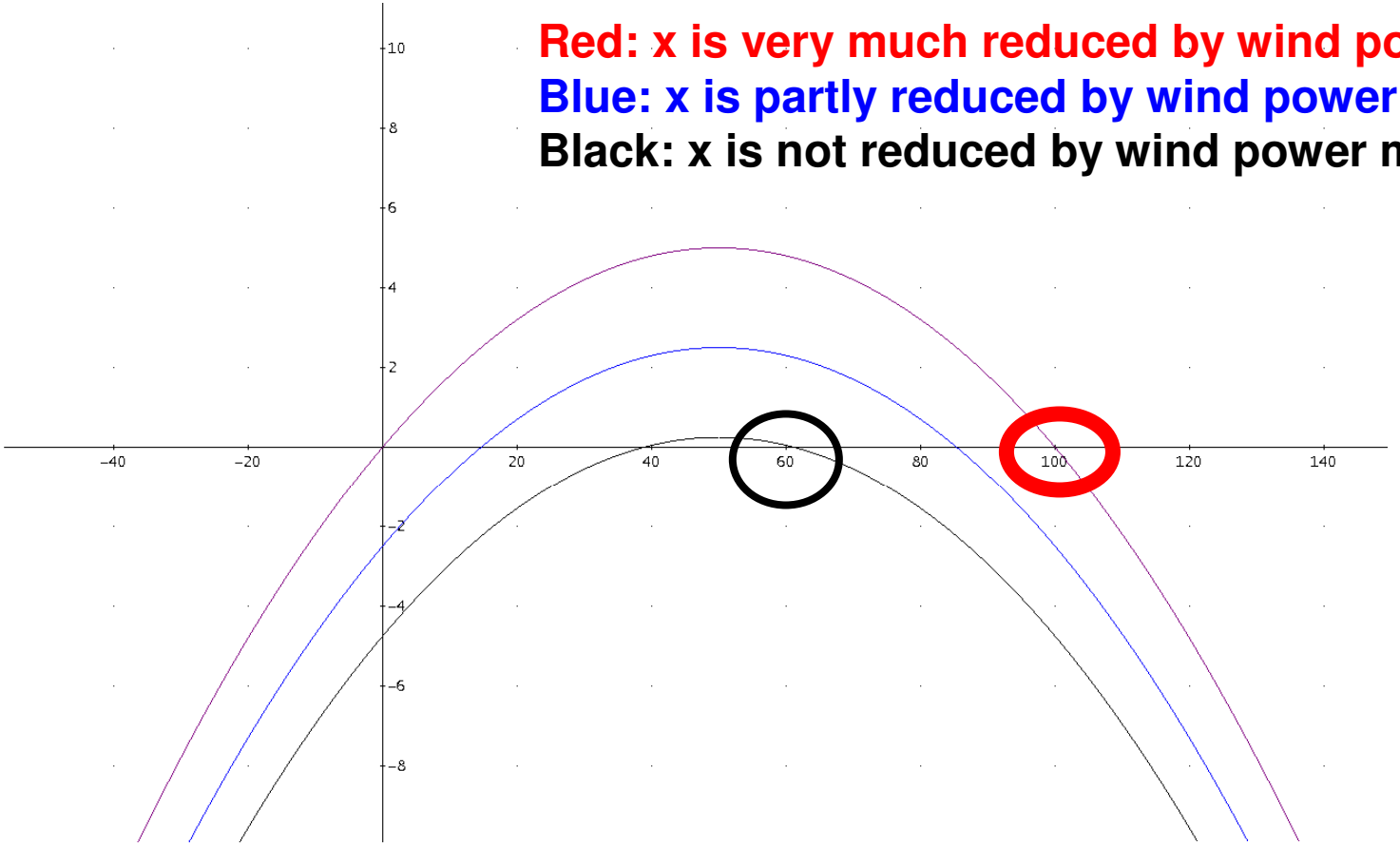
Citation (Paper 3, page 4):

- ”The value of the debet/credit …is measured relative to the pre-damage of prerestoration levels of the resource and can be captured in monetary or non-monetary terms (Cole and Kriström 2008b).”

Comment by Peter Lohmander: In the ecological system, several predators are competing for similar prey. If the population of one predator species is reduced by a specific disturbance, other predators may expand.

y is the population size of another predator, competing for the same prey.

dy/dt



Red: x is very much reduced by wind power mills
Blue: x is partly reduced by wind power mills
Black: x is not reduced by wind power mills

y

$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right) - mx$$

Raptors are very efficient lemming hunters.
They are however sensitive to over population (population density) because of other reasons. Furthermore, they are damaged by wind power mills.

$$\frac{dy}{dt} = 0.2y\left(1 - \frac{y}{100}\right) - nx$$

Simple case:

Both predators x (raptors) and y (polar foxes) eat lemmings.

y does not fly and is not directly affected by wind power stations.

y is indirectly affected by wind power mills since x is damaged by them, which reduces the competition for lemmings.

Raptors are directly affected by wind power stations.

$$\begin{cases} \dfrac{dx}{dt} = 0.2x\left(1 - \dfrac{x}{100}\right) - \boxed{mx} \\ \dfrac{dy}{dt} = 0.2y\left(1 - \dfrac{y}{100}\right) - \boxed{nx} \end{cases}$$

Polar foxes are indirectly affected by wind power mills via the effect on the raptors, that are competitors, eating lemmings.

Equilibrium conditions

$$\begin{cases} \dfrac{dx}{dt} = 0.2x\left(1-\dfrac{x}{100}\right) - mx = 0 \\ \dfrac{dy}{dt} = 0.2y\left(1-\dfrac{y}{100}\right) - nx = 0 \end{cases}$$

$$\frac{dx}{dt} = 0.2x\left(1 - \frac{x}{100}\right) - mx = 0$$

$$0.2x - 0.002x^2 - mx = 0$$

$$(0.2 - m)x - 0.002x^2 = 0$$

$$(0.2 - m) - 0.002x = 0$$

$$(0.2 - m) = 0.002x$$

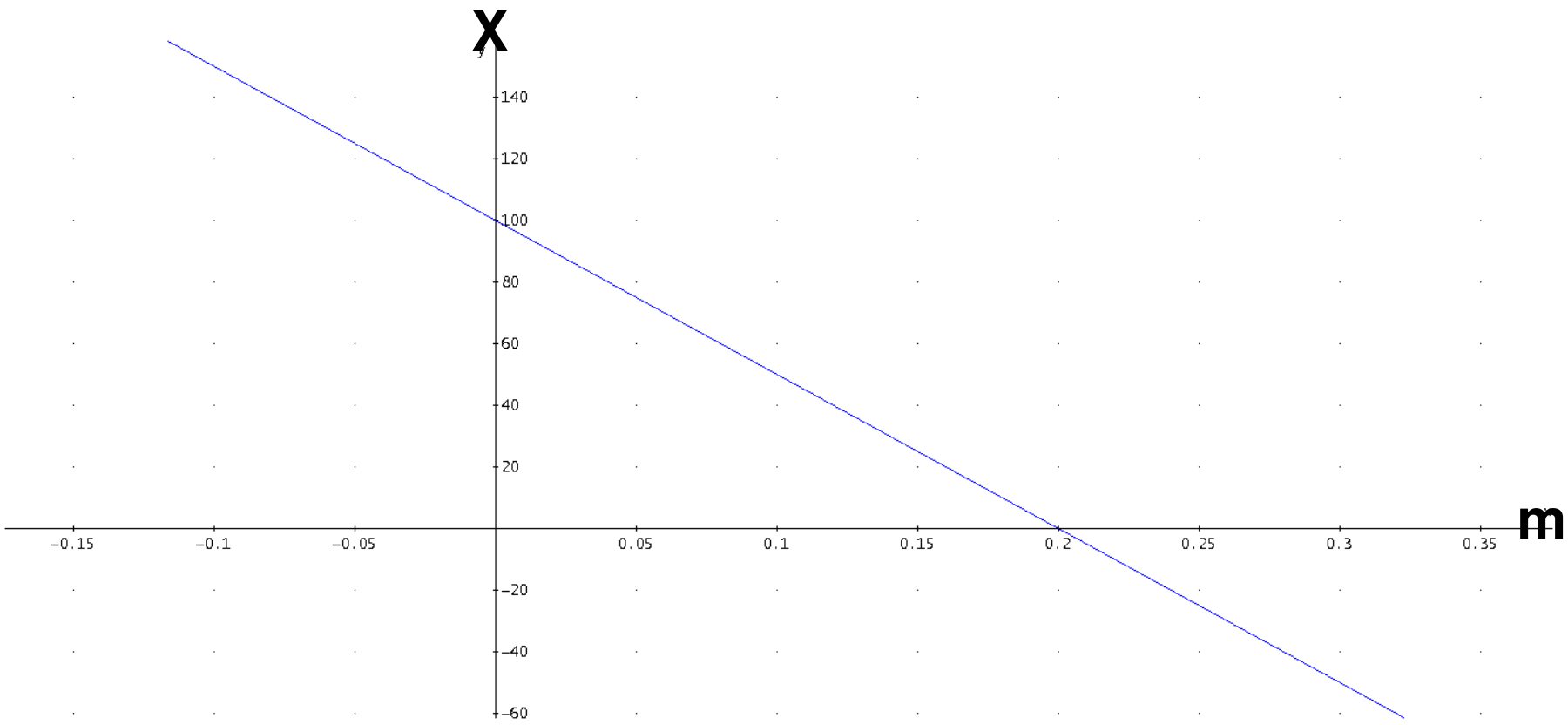
$$x = \frac{0.2 - m}{0.002}$$

$$\boxed{x = 100 - 500m}$$

Equilibrium raptor population as a function of the wind power mill damage parameter m.

Equilibrium raptor population as a function of the wind power mill damage parameter m.

$$x = 100 - 500m$$



$$\begin{cases} \dfrac{dx}{dt} = 0.2x\left(1-\dfrac{x}{100}\right) - mx = 0 \\ \dfrac{dy}{dt} = 0.2y\left(1-\dfrac{y}{100}\right) - nx = 0 \end{cases}$$

$$\begin{cases} x = 100 - 500m \\ \dfrac{dy}{dt} = 0.2y\left(1 - \dfrac{y}{100}\right) - nx = 0 \end{cases}$$

$$\begin{cases} x = 100 - 500m \\ \dfrac{dy}{dt} = 0.2y\left(1 - \dfrac{y}{100}\right) - n\left(100 - 500m\right) = 0 \end{cases}$$

$$0.2y\left(1-\frac{y}{100}\right)-n(100-500m)=0$$

$$0.2y\left(1-\frac{y}{100}\right)-n(100-500m)=0$$

$$0.2y-0.002y^2-n(100-500m)=0$$

$$-100y+y^2+500n(100-500m)=0$$

$$\boxed{y^2-100y+500n(100-500m)=0}$$

$$y^2 - 100y + 500n(100 - 500m) = 0$$

$$y = \frac{-(-100)}{2} \underset{(-)}{+} \sqrt{\left(\frac{-(-100)}{2}\right)^2 - 500n(100 - 500m)}$$

$$y = 50 \overset{+}{\underset{(-)}{}} \sqrt{2500 - 500n(100 - 500m)}$$

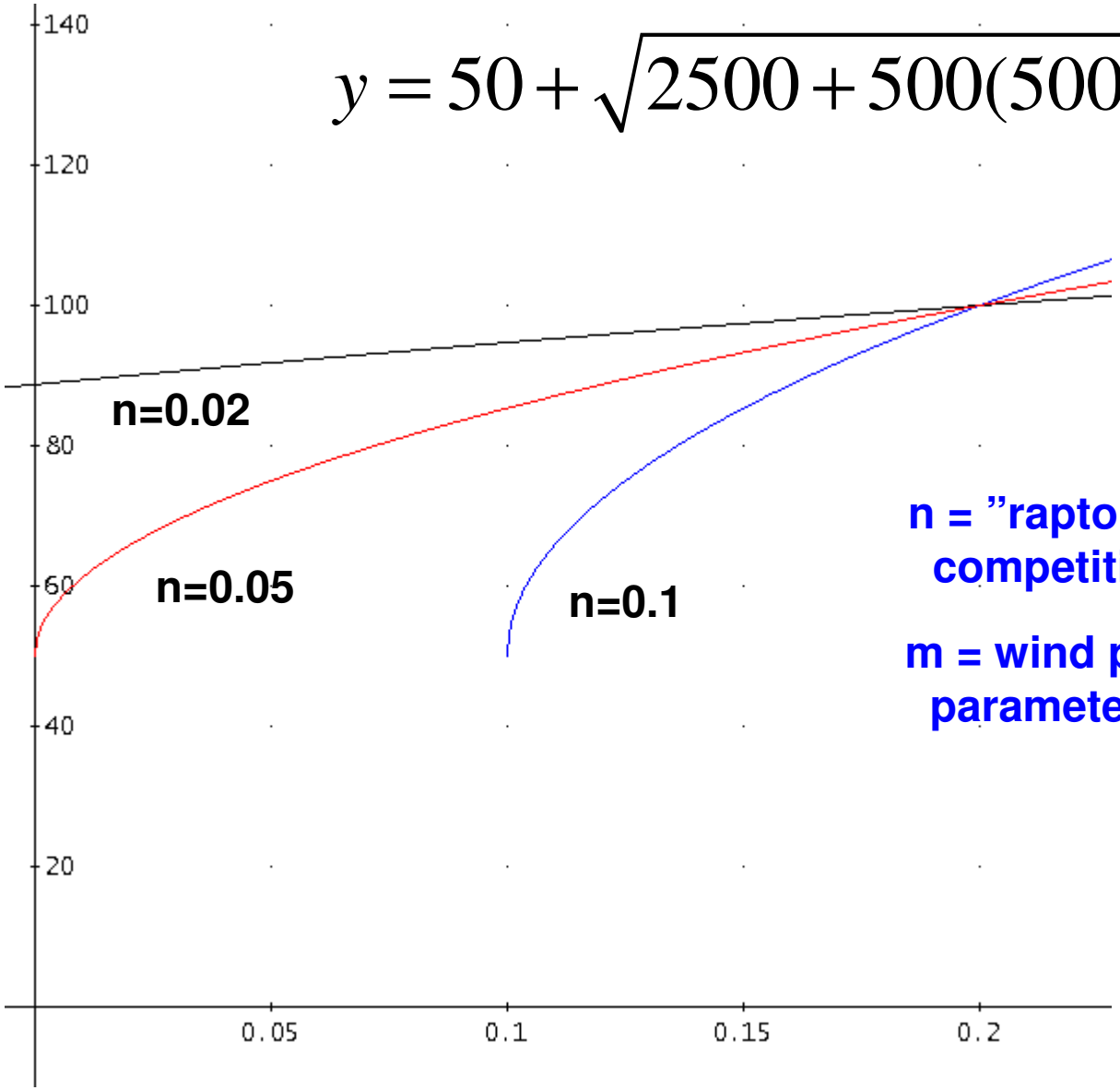
$$y = 50 \overset{+}{\underset{(-)}{}} \sqrt{2500 + 500(500m - 100)n}$$

$$y = 50 + \sqrt{2500 + 500(500m - 100)n}$$

Equilibrium polar fox population size, y, as a function of the wind power mill damage parameter of relevance to raptors, m, and the ”raptor-polar fox – lemming” competition parameter, n.

y = polar fox population equilibrium

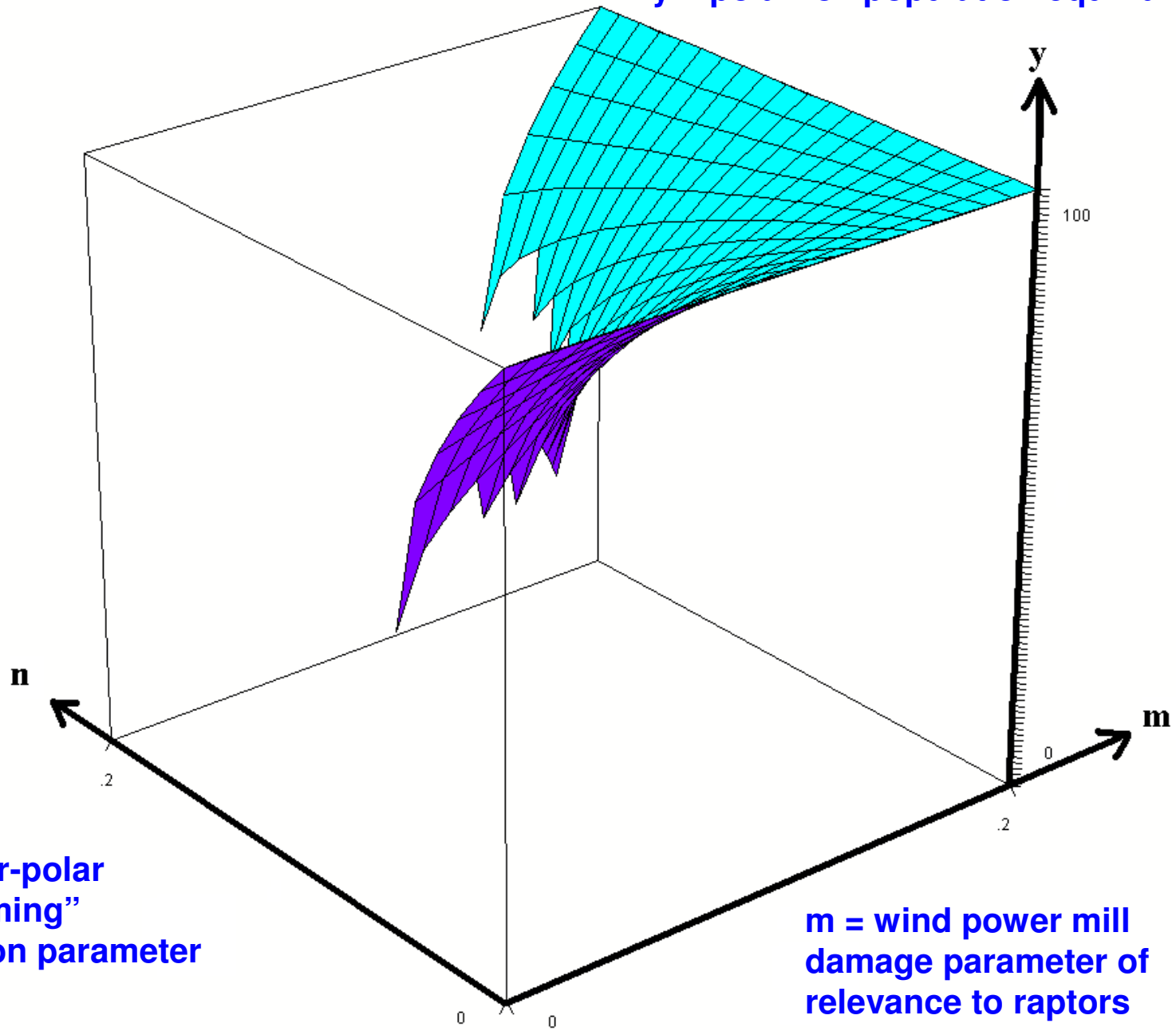
$$y = 50 + \sqrt{2500 + 500(500m - 100)n}$$



n = ”raptor-polar fox – lemming” competition parameter

m = wind power mill damage parameter of relevance to raptors

y = polar fox population equilibrium



n = ”raptor-polar fox – lemming” competition parameter

m = wind power mill damage parameter of relevance to raptors

Observations:

- Polar foxes are considered valuable but they are not damaged by the wind power mills.
- Wind power mills may reduce the population of raptors. (We may calculate the ”environmental cost” of this effect.)
- However, with less raptors, more lemmings become available for the polar foxes. This increase the polar fox population, which represents an ”environmental revenue”.
- The ”net result” of the wind power mill is affected by the raptor population and the polar fox population.
- **We should never investigate the populations separately.**