Chemical Espionage: The AA Catch-22

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Thinking

The Catch-22

The Common Predator

The Wasps

GOAL

1.)Determine the trade-offs and balance of interests between the male/female butterflies, the common predator, and the parasitic wasps.

&

2.)Deduce a long term trend

Predatory Impact in Safety Equation

Two competing pressures on the butterfly population:

The One-for-One:
The Common Predator

The All-for-One:
The Parasitic Wasps

$$r = 6.75(x^2 - x^3)$$

$$0 \le x \le 1,\ 0 \le r \le 1.$$

Balance in Safety and its Derivative

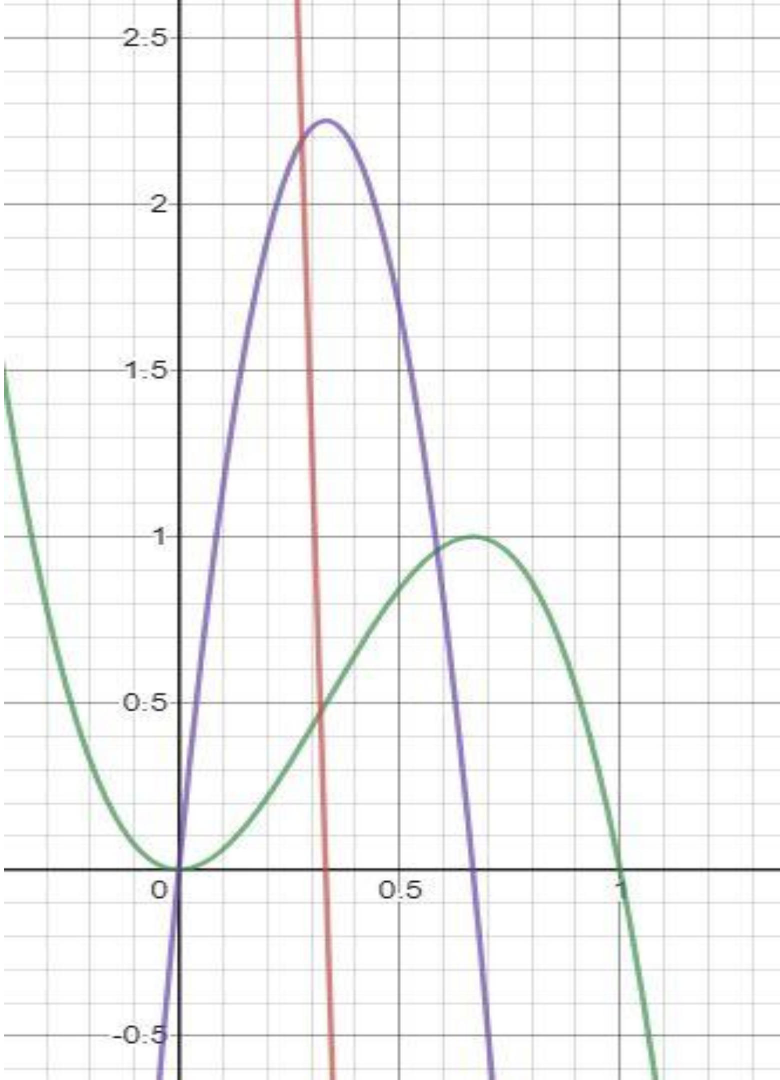
The Derivative Test

$$r = 6.75\left(x^2 - x^3\right)$$

$$r' = 6.75\left(2x - 3x^2\right)$$

$$r'' = 6.75\left(2 - 6x\right)$$

The decay function r, its derivative r’, and its second derivative r’’



NELSON, NZ CASE STUDY

100% ERADICATION

So there is DATA!

MATHEMATICAL MODEL FOR THE NELSON CASE

$$population = \left(decay\ due\ to\ P_c\ and\ P_w\right)\frac{\delta y}{\delta AA} - external\ decay$$

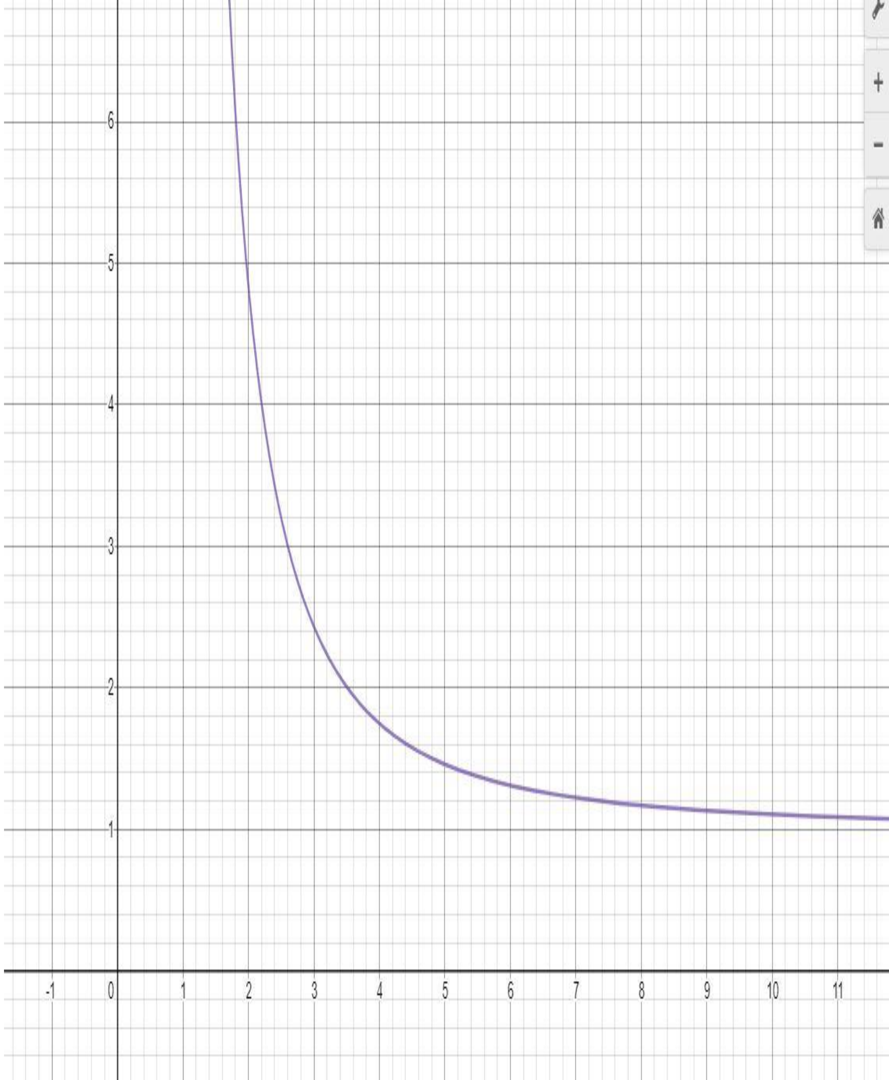
$$0 = \left(6.75x^2 - 6.75x^3\right)y' - 134$$

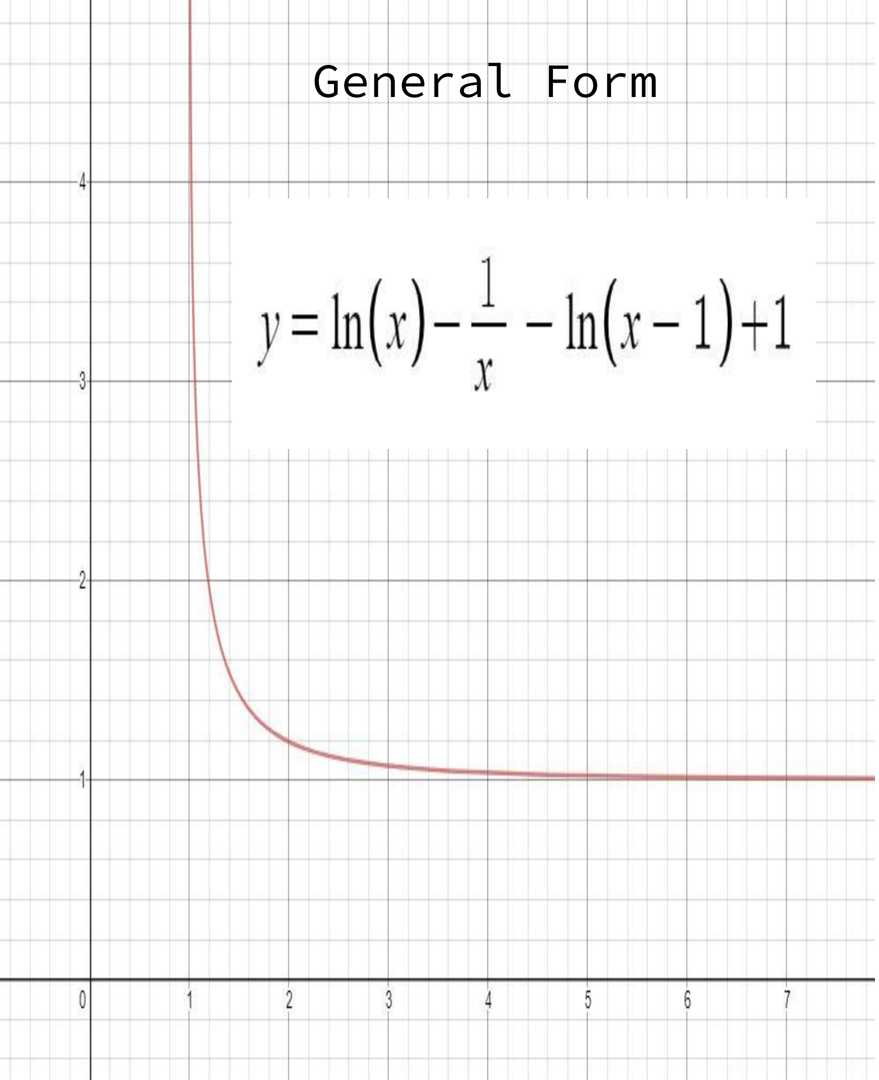
SOLVING THE DIFFERENTIAL

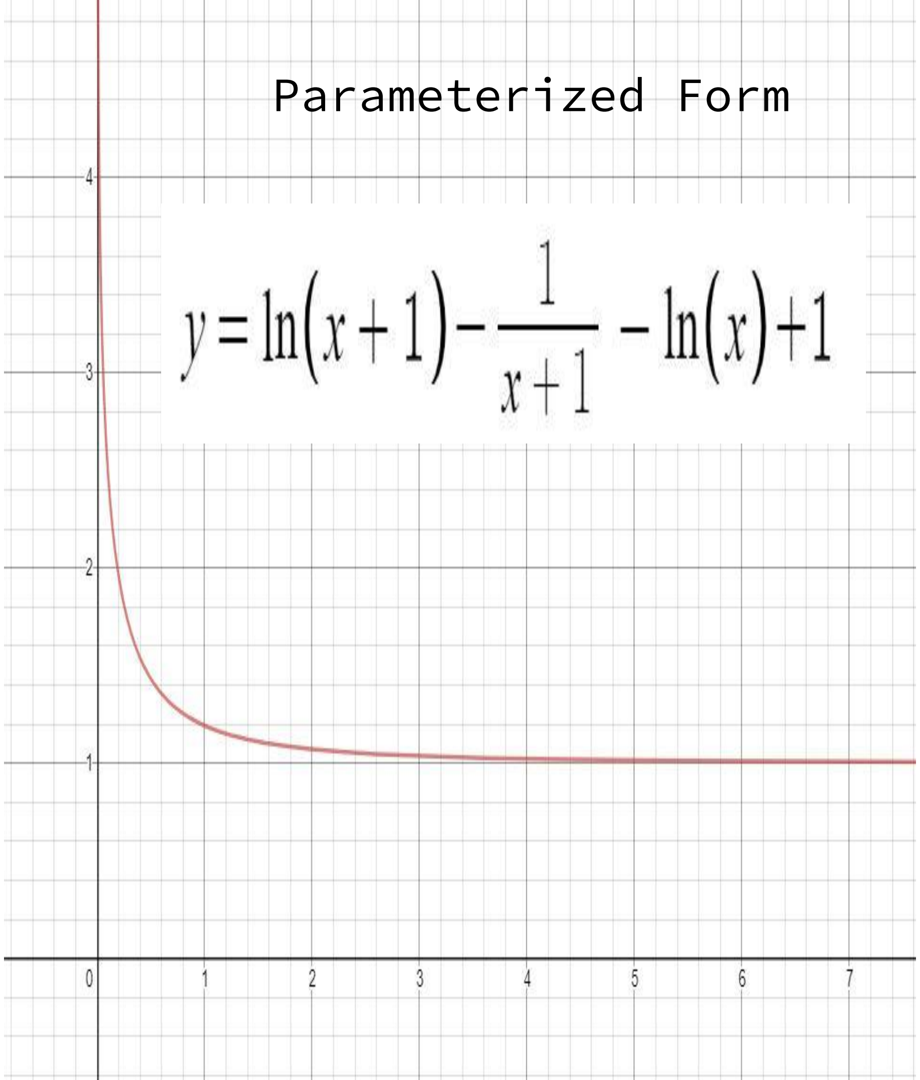
- SIMIODE Technique Narratives
  - Regular Perturbation
  - Taylor Series Expansion
  - **Separability of the Equation**

Nelson Case Solution:

$$y = 19.85\left[\ln(x) - \frac{1}{x} - \ln(x-1)\right] + 1$$

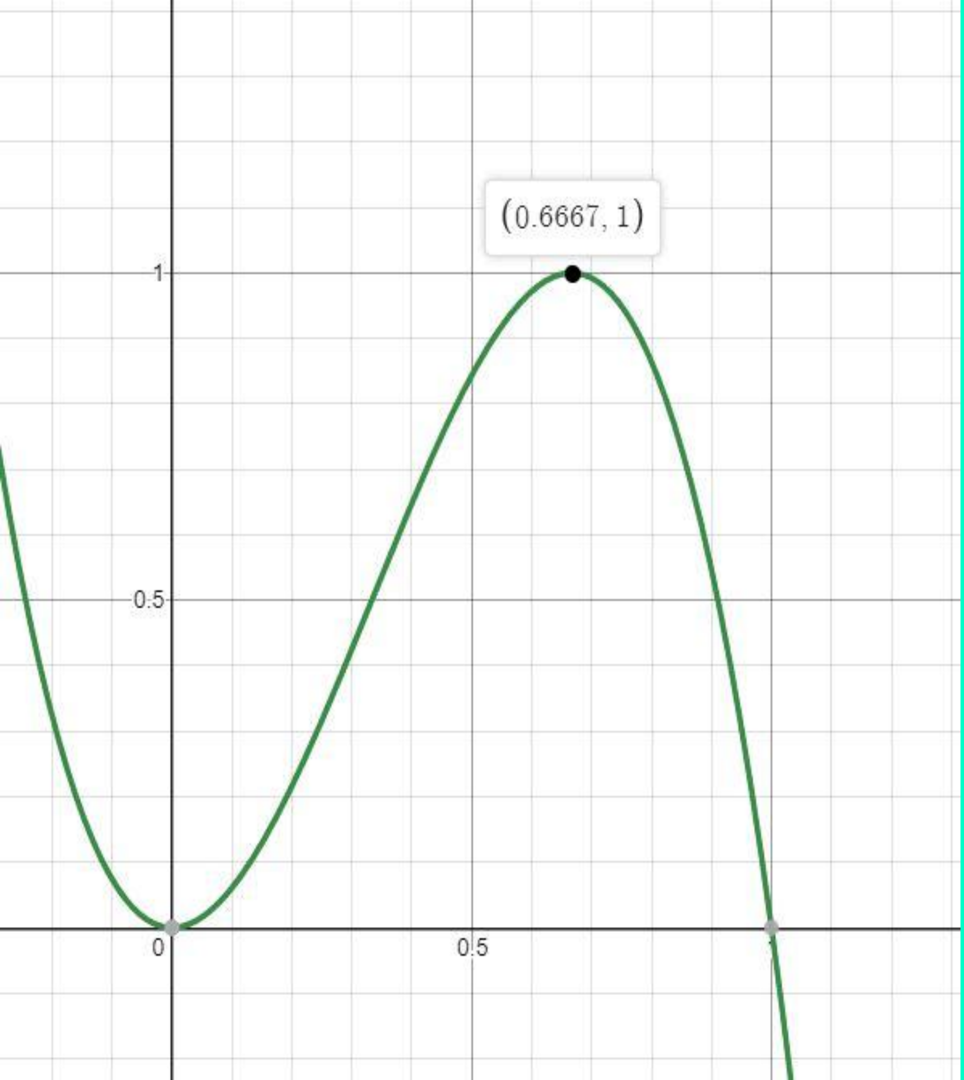



General Form
$y = \ln(x) - \frac{1}{x} - \ln(x-1) + 1$
0
1
2
3
4
5
6
7
1
2
3
4


Parameterized Form
$y = \ln(x+1) - \frac{1}{x+1} - \ln(x) + 1$
0
1
2
3
4
5
6
7
1
2
3
4

The Additional Issue

“Suppose the female butterfly could detect a male butterfly’s propensity to use the anti-aphrodisiac prior to mating. What should her strategy be in choosing a mate?”



Her strategy in picking a male should, on average, choose an anti-aphrodisiac producing male 2 times out of 3. Safety is maximized at this two-thirds point.

Why 0.667?

In our safety function, anti-aphrodisiac is our input, bounded between 0 and 1. 0 represents zero use of AA, 1 represents every male using AA.

Our output is safety, with 0 being minimal safety, total eradication, and 1 being maximum safety, the highest survival rate possible, not necessarily 100%.

CONCLUSIONS

CITATIONS

https://u.osu.edu/pinningblock/tag/parasitic-wasps/

https://www.flickr.com/photos/sankhasphotography/5790117585

https://www.pinterest.com/pin/130674826661785188/

https://www.adriandaveybirdphotography.co.uk/_photo_15782801.html

https://www.stuff.co.nz/environment/86754492/successful-eradication-of-great-white-butterfly-in-nelson-world-first

For all graphs included in presentation - https://www.desmos.com/calculator