SAVING THE WOLVES OF ISLE ROYALE: IMPACT OF INTRODUCTION ON INBREEDING AND POPULATION SURVIVAL

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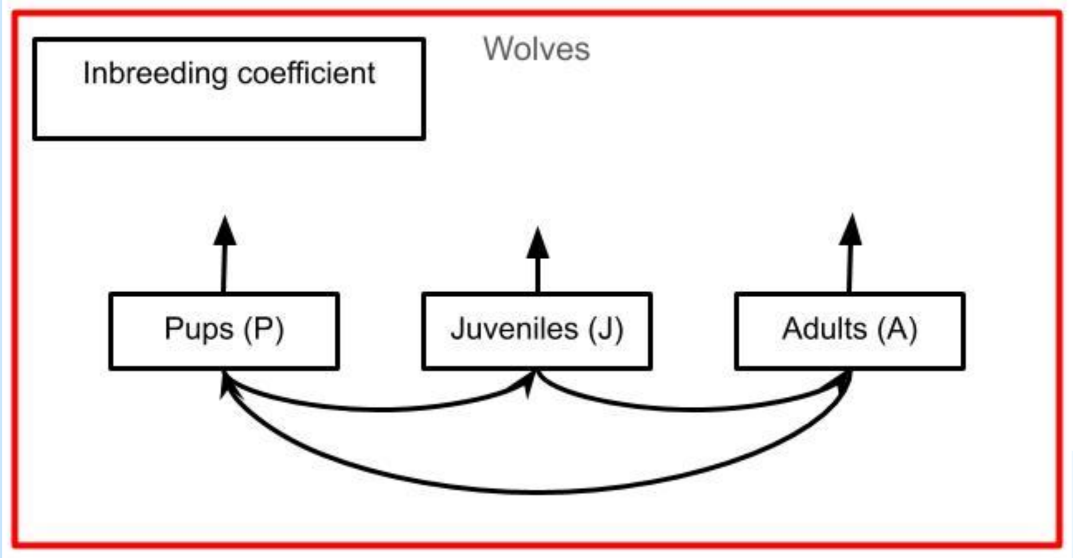
Introduction

Isle Royale is a remote island in the middle of Lake Superior that is home to wolves, moose, and biomass exclusively. The wolves prey exclusively on the moose, and the moose consume the island's trees and other plants. This system was relatively stable historically; however, the island's remoteness has resulted in limited interaction between the Isle Royale wolves and mainland wolves. As a result, genetic diversity has steadily dwindled over the years, leading to a crash in the population. Due to the dwindling wolf population, the National Park Service decided last fall to introduce new wolves to the island in an attempt to establish a healthy wolf population. They have introduced one new pair already, and plan to introduce 20-30 more over the next 3-5 years. The addition of the translocated wolves has caused a sudden increase in wolf population in 2019.

Though the predator-prey relationship between these two populations has been extensively studied, and there are even papers on the genetic decline of the wolves, there has yet to be a study modeling the the effects of the wolf reintroduction since it happened so recently. Our goal was to further develop models of wolf population decline, ensuring they accurately fit the Isle pre-introduction, and then incorporate the reintroduction as a sort of shock to the system. We set out to then examine what would happen to the wolf population both short-term and long-term in response to this shock, as well as what a larger or smaller introduction may produce.



Methods

$$\frac{dP}{dt} = i_b b(\tfrac{A}{2}) - P(i_p d_p))$$

Equation 1: Change in pups = impact from inbreeding*base birth rate*number of females - death due to natural causes (amplified by inbreeding)

$$\frac{dJ}{dt} = (1 - i_p d_p)P(1 - \tfrac{J}{K_j}) - (i_m d_j J)$$

Equation 2: Change in juveniles = pup survival - death due to natural causes (amplified by inbreeding)

$$\frac{dA}{dt} = (1 - i_m d_j)J(1 - \tfrac{A}{K_a}) - (i_m d_a A)$$

Equation 3: Change in adults = juvenile survival - death due to natural causes (amplified by inbreeding)

Symbol	Description	Default Value	Units	Reference
P0	initial pup population	8	wolves	National Park Service
J0	initial juvenile population	7	wolves	National Park Service
A0	initial adult population	4	wolves	National Park Service
Ka	carrying capacity of adults	15	wolves	National Park Service
Kj	carrying capacity of juveniles	20	wolves	National Park Service
F0	initial inbreeding	0	-	-

Symbol	Description	Default Value	Units	Reference
da	death rate of adults	0.2	per year	National Park Service
dj	death rate of juveniles	0.3	per year	National Park Service
dp	death rate of pups	0.6	per year	National Park Service
b	birth rate	5 (range: 4-6)	per year	National Park Service

Conclusion

- Introduction of new wolves decreased the inbreeding coefficient and thus increased the population for a brief period of time
- multiple introductions of at least 6 wolves was sufficient to stop the population from declining
- Though this result is in some ways promising for the Parks Service's plan to reintroduce new individuals to revive the Isle Royale population, it demonstrates that doing so may take an incredible amount of resources
- Isle Royale populations will fail whenever introductions stop occurring regularly
- Model suggests that wolf introduction is not a sustainable solution to preventing genetic collapse of the Isle Royale wolves

Results

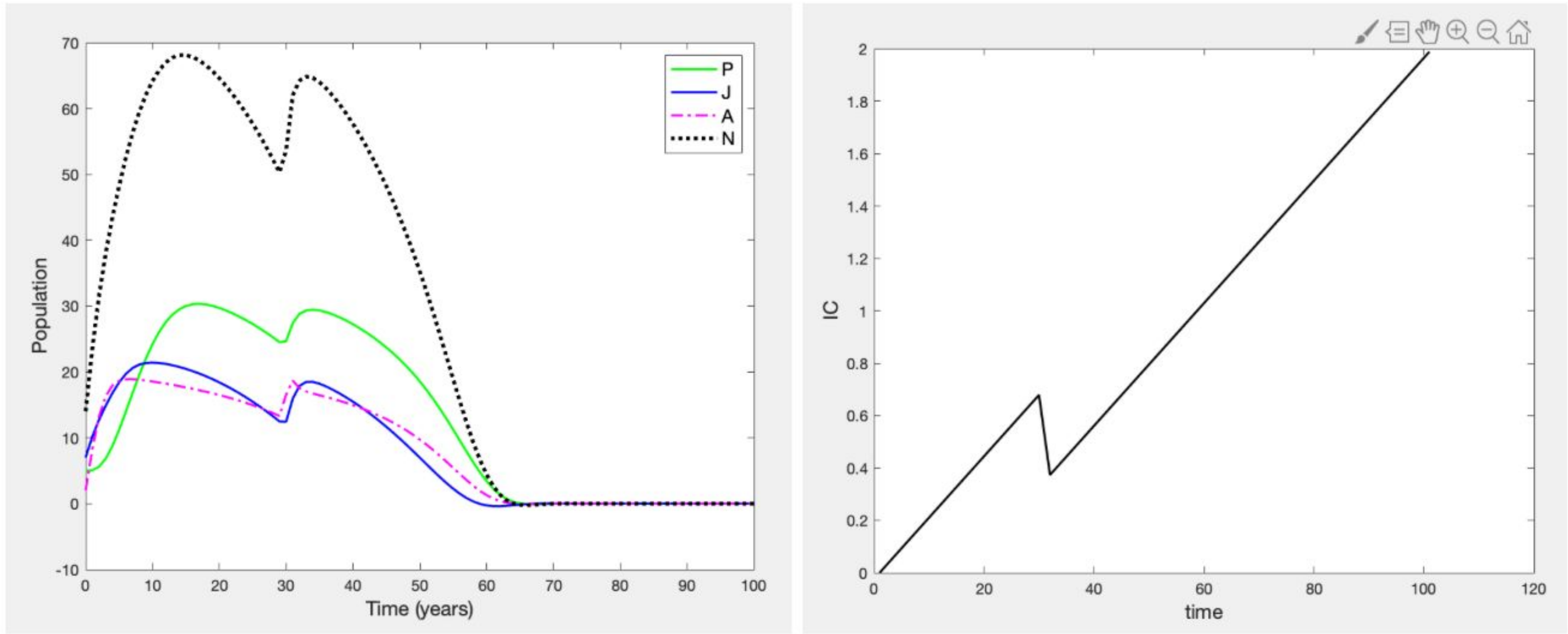


Figure 1: Graphs of populations and inbreeding coefficient with the introduction of 8 wolves at t=30 years
introduction of new wolves decreases the inbreeding coefficient and causes population to increase during that period, though the populations still ultimately crash even with high levels of wolf introduction.

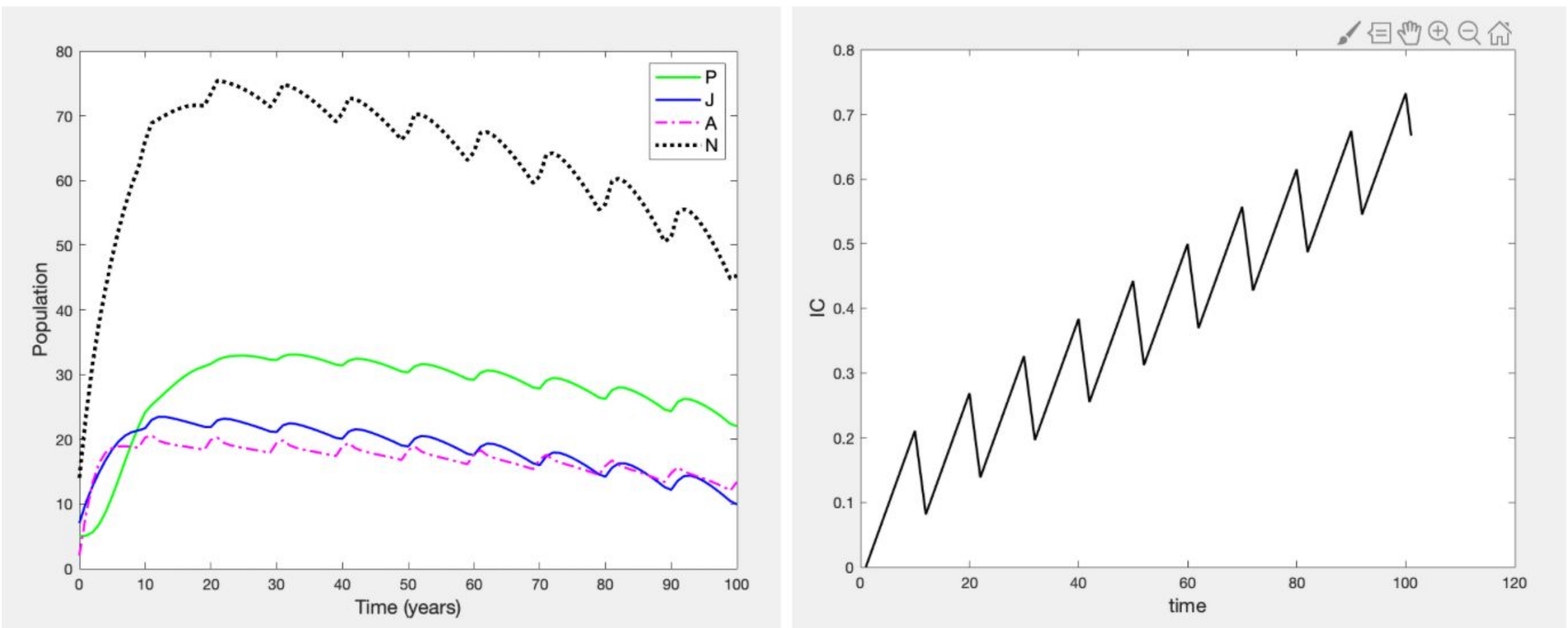


Figure 2: Graphs of populations and inbreeding coefficient with the introduction of 4 wolves every 10 years
Introduction of new wolves decreases the inbreeding coefficient. We can also see that multiple introductions of new wolves does help the population to stabilize over a long period of time.

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