Predator Mayhem

New Mexico

Supercomputing Challenge

Final Report

April 3, 2013

Team #35

Down To Earth School

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Executive Summary

We are investigating the problem of exotic animals being released into an ecosystem where they do not belong. Our project idea was inspired by the invasive python problem that Florida is having. Burmese Pythons have been threatening the area for a long time, but now with the African Rock Python there is a larger problem. Organizations and scientists are afraid that this new snake will breed with the Burmese Python and create a “Super Breed”. When an exotic animal is released into the wrong ecosystem it can endanger the people, animals, and even vegetation. They can also bring new diseases, viruses and infections with them. Everything in the ecosystem can be endangered. Invasive species have threatened almost everywhere in the United States. Most U.S. residents are not aware of these problems and get exotic animals to own as pets. Sometimes they realize that they cannot take care of them and let them go. We want to work on reducing these problems by bringing awareness to other about what damage invasive species can cause.

Introduction and Problem Statement

Our project is focusing on what effects exotic animals may have on an ecosystem. One of the bigger parts of our project is the possibility of the exotic animal breeding with a local or previously introduced exotic one. Both animals may have characteristics that if mixed could be dangerous and could make a “Super Breed”. We picked the topic of our project because of the problem that Florida is having with two breeds of pythons being released. Florida residents are afraid that the two exotic pythons will breed and produce a new snake which has both the more threatening characteristics of each snake. The Burmese Python is big and Rock Python is very aggressive. The offspring could possibly be more dangerous due to hybrid vigor. Hybrid vigor is an animal that inherits all the stronger characteristics of its parents.

People have tried to correct the problem. Hunters, rangers, the U.S. Fish And Wildlife Service and other agencies have tried to reduce the population of pythons. On the most recent hunt of the Python Challenge, an act that got a large amount of the hunters in Florida together to catch Burmese Pythons, they got 1,600 hunters and only managed to capture and kill 68 of the snakes. There have been and are more situations throughout the U.S. and throughout the world. Some of our local problems involve bullfrogs and crawdads in the Gila River. We have a organization in Silver City doing a smaller version of the Python Challenge to get rid of them.

Exotic animals are a threat everywhere in the world. Hawaii and Florida are two states in the United States that have prolonged problems. Invasive animals can harm an ecosystem in several ways. They put people and other species in danger, and they can change several regular patterns in food webs and chains. They change basic factors of an area. Almost always they modify our ecosystem for the worst. (Appendix 1)

Many people own exotic animals, which is another reason that we decided to pursue this area. One of the reasons that exotic animals end up in an ecosystem is that some people decide to buy these pets and later realize that they cannot take care of them. We hope to examine the effects that an exotic animal may have on an ecosystem through our model.

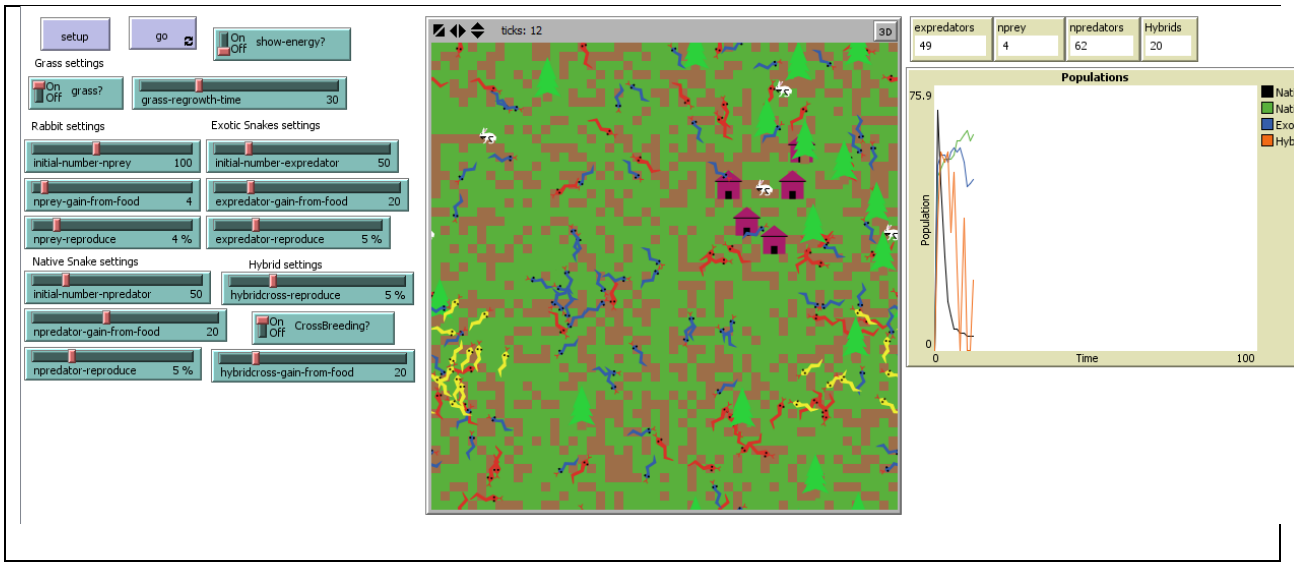
The Model

We used NetLogo to create our model. We are showing in this model the effects that an exotic animal species could have on an ecosystem and what would happen if it bred with another exotic animal. We based some of the factors in our model from the *Sheep and Wolves* model available in the NetLogoModels Library.

We first released the exotic predator into the ecosystem. Then we made it collide with other animals and see the effects that it has. If it runs into another predator, then we had it breed. The agent that is produced from the local predator and the exotic predator was a new hybrid. The model starts out with only 3 different agents: native predators, native prey, and the exotic predators. The native predator shape is a blue snake, the exotic predator is a red snake, and the native prey is rabbits. We created the shapes ourselves. Each agent has a different reaction when meeting another species of agent.

The world consists of an area forest in which we have a few houses that represent a town and some trees that represent the forest.. The background of the interface is set so that it is green, representing grass, until the agents eat the grass and the patch turns brown. We have set the agents on random so that they bounce around in an undetermined way. Each agent starts out with an energy of 50 points. With each step it takes it loses 1 point of its energy. Agents can gain energy by eating either grass or native prey, with net gain from food set on a slider.

Reproduction occurs randomly based on the reproduction rate slider. If crossbreeding is selected, the two predators will produce a hybrid. This snake is yellow. You can change how many of each breed you want, how much they gain from food, and the chance of reproduction between the predators with the sliders. You also have the option of turning the grass on and off or how fast it grows back.



Results

When we started collecting data from our model it created an inverse relationship usually seen with predator and prey. Then we introduced 10 exotic predators and we saw that the exotic died out, the prey stayed up and the predators were in the middle. Then we brought in 20 exotic predators and all the population changed together. When we introduced amounts of 30, 40, and 50 exotics all the population change together as well. Then we introduced the hybrid and added 10 exotic predators into the equation the exotic predator and the hybrid die out and the prey and the predator go back to the inverse relationship. When we added 20 exotic predators and them and the hybrid died out and the prey explode and the predators stay low. When we added 30

exotic predators and the same thing happened for when we added 20. Then when we added 40 exotics everything died out and the prey shot up. Then when we added 50 exotics and the exotics took the predators place in the inverse relationship and everything died out. (Appendix 2)

Conclusion

Some parts of our hypothesis were supported but several parts were not supported. When we released 10 of the exotics they died out. We thought that they would immediately start to decrease they prey population. Instead they prey population seemed to be the population that increased the most. Both the exotics and the local predators died out. Perhaps this was because there was too much competition among the predators. When we released the hybrid they died as well. We thought they would thrive. When the hybrid and exotic predators died out, the native prey and predators were able to return to their typical relationship. It definitely affected the local predator the most, often killing them out. But right after they had eliminated the predators they died off themselves. It did affect the ecosystem in a negative way but not in the way that we expected it to.

Significant Achievement

We feel that our best achievement in the project is the model. Using netlogo was difficult and confusing but our model came together in the end. We also think that making this model could help other people realize that invasive species are dangerous. Some of the research we found was very interesting and we found we learned a lot while doing this project. We hope that in some way it will encourage people not to own exotic animals and to be aware of the problems exotic animals can cause to an ecosystem. If you want to help reduce invasive species issues you

can clean any outdoor equipment that you brought to another area to keep insects and plant parts away, make sure that your firewood is from the area, be able to identify your local species, don't plant invasive species in your private garden and plant as many native species as you can.

Acknowledgements

Our teacher, Shanon Muehlhausen were very helpful throughout the project. Our mentor Maia Chaney deserves a very big thank you from all of us for being so supportive.

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Appendix 1 - Background Research

The definition for invasive species is a non-native variety of a plant or animal. When the term “invasive” is used it usually means that they have took over or changed an ecosystem for the worse. They can be any kind of organism such as amphibians, plants, insects, fish, fungus, bacteria and even eggs and seeds. They can reproduce aggressively and spread rapidly and cause harm to any ecosystem.

When an exotic animal is introduced into a new ecosystem it may not have any enemies or predators. It can easily take over an area by breeding. If the exotic animal is strong, big or aggressive, other local animals might not have the ability to defend themselves against the invader. Some of the direct threats to an ecosystem are the killing of native species and preventing native species from reproducing or preying on their young. They threaten basically everything in an ecosystem. They often contribute to and cause diseases in livestock and humans, harm harvest, and the loss of domestic wildlife, aquatic vertebrates, and tree species. They can change a food web or chain, often they leave small amounts or no food for the native animals, and sometimes they can even change basic conditions in an ecosystem such as the soil or strength of wildfires. They are also a threat to any endangered animals. 40% of the endangered species on the U.S. Department Interior's lists are threatened because of non-native species. Even though some exotic species can be a good inexpensive food source they can still cause damage if they escape.

Invasive species can spread speedily and sharply. Ordinarily humans are the reason that they spread, usually accidentally. The most common way that invasive species travel is on a water vessel. Aquatic species are carried across a distance in the ballast tanks which is filled with water to balance and stabilize the ship. The marine organisms are pumped in with the water from

the body of water. Insects are transported by wood things like crates where products are being shipped across the world. Some people buy potted plants that are actually not native but don't realize it and plant them in the ground. Selling invasive plants is also not a flourishing thing to do. The most common way that exotic animals get transported through pet expos and trades. Natural disasters often cause invasive species.

Invasive species were even a problem 500 years ago. When the pilgrims arrived at Plymouth in 1620, several nonnative rodents like *Rattus* and *Mus Musculus*, had traveled along with them. The problem started to become more sever in the 18th and 19th century when people started to trade pets.

Surprisingly, non-native species are sometimes helpful to an ecosystem and to our economy. 98% of the food grown in USA comes from a non-native species of wheat, barley, cattle, and poultry. There is a nonnative honeybee that broadly helps flower pollination and growing agriculture. The United States economy has increased by $500 billion because of non-native species.

Rats have posed a gigantic threat to threat to the world. They are mostly harmful to our economy. $19 billion is used for the damage rats cause alone a year. Damage done by alien insects costs us another $20 billion a year. In the United States 30,00 exotic species cost us $123 billion dollars per year. This formed a nickname for USA, “the land of a billion rats”.

Since global warming changes the temperature, snow and rain patterns it makes it assertable for some invasive species to be in certain places. This is mostly affecting the plants. When local plants are weakened from loss of water, invasive animals can take control. Sometimes if an invasive plant is in an area it makes it easier for other invasive animals to enter the same ecosystem.

Every state in the U.S. has some extent of bio invader problems. The two states that were affected most were Florida and Hawaii. They are the states most prone to getting exotic animals because they are both mostly surrounded by water and both have semi-tropical temperatures.

Hawaii is isolated and doesn't get much connection to the outside world. Because of this they have had several organisms that have lived nowhere else on earth. They have the highest extinction rate in the United States. Several unique species in Hawaii have died off. Non-native rats, feral cats, dogs and mongooses have killed various types of birds. The feral pigs have changed the landscapes.

Florida has a very semi-tropical climate which makes it possible for a variety of non-indigenous species to invade. It is isolated and that also contributes. 42% of reptiles, 23% of mammals, 22% of amphibians, 16% of fishes, 15% of flora and 5% of birds are non-native. Non-native species can effect the fishing and water sports, the reduction of species diversity, changes in an ecosystem and the change of state in wildlife environment.

There is an organization in Ohio called outreach for animals. They travel around to different places to find exotic animals that are not in stable and capable homes. After they find the animal they will find a facility that is firm and put the exotic animal there. Their leader is Tim Harrison. Since it is legal in Ohio to own exotic animals they can't force the owners to give their pets up. Since they also believe that exotic animals are a threat, they made a movie about their program. It is called "The Elephant In The Living Room".

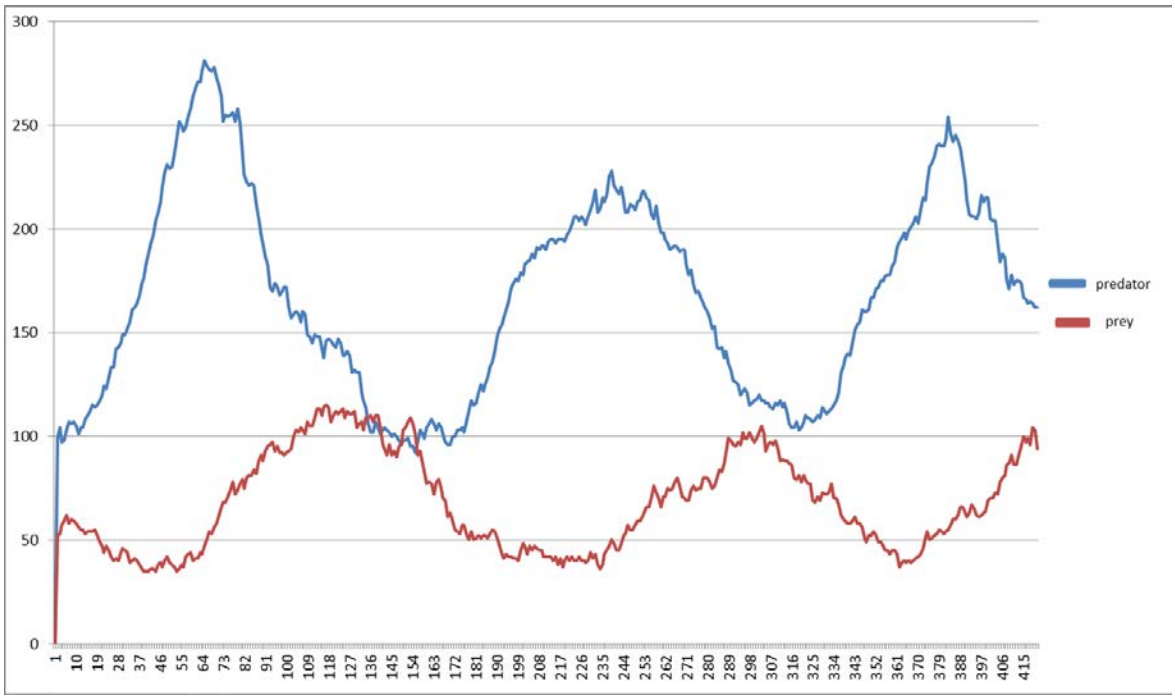
The giant toad is a one of the biggest invasive amphibians. It comes from Texas, Central America, and Brazil. It has invaded places like Australia, Fiji, Guam, Hawaii, Japan, New Guinea, the Philippines, the Soloman Islands, Tonga, several islands in the West Indies, and southern Africa. In 1955 someone accidentally released 100 frogs into the area of Miami

International Airport. There is now a population of frogs there. The population spread and is now throughout southern Florida. They live in parks such as the Everglades National Park.

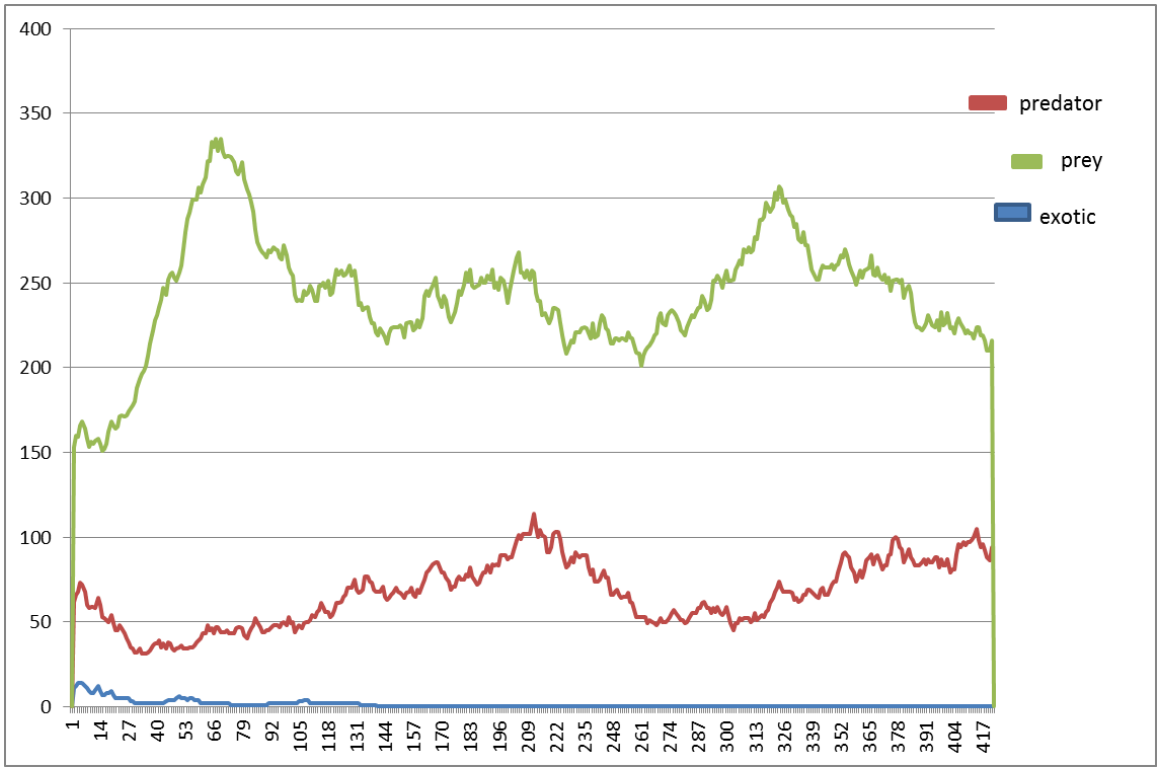
There are several invasive bird species that are known in the United States. The *Melopsittacus undulatus* commonly known as the budgie is local a animal in Australia and are popular as caged birds. They are invasive to Florida, because they can often escape. The *Myopsitta monachus* is commonly known as the Monk parakeet and is native to South America. They have populations in various cities around the United States, one of them being Austin, Texas. They are considered pests because of all the damage they do to crops and fruits. It also competes with other bird species to collect food sources. It is known for being very aggressive. The biological science impact of these birds is unknown.

The *Passer domesticus* commonly known as the house sparrow was intentionally introduced into North America in the 1850's and 60's. They released into several different places at several different times. In 1853 a unit of 100 birds from England was released in Brooklyn, New York. They did this because they thought that birds could control the Kanker worm problem. Obviously they ended up making things worse.

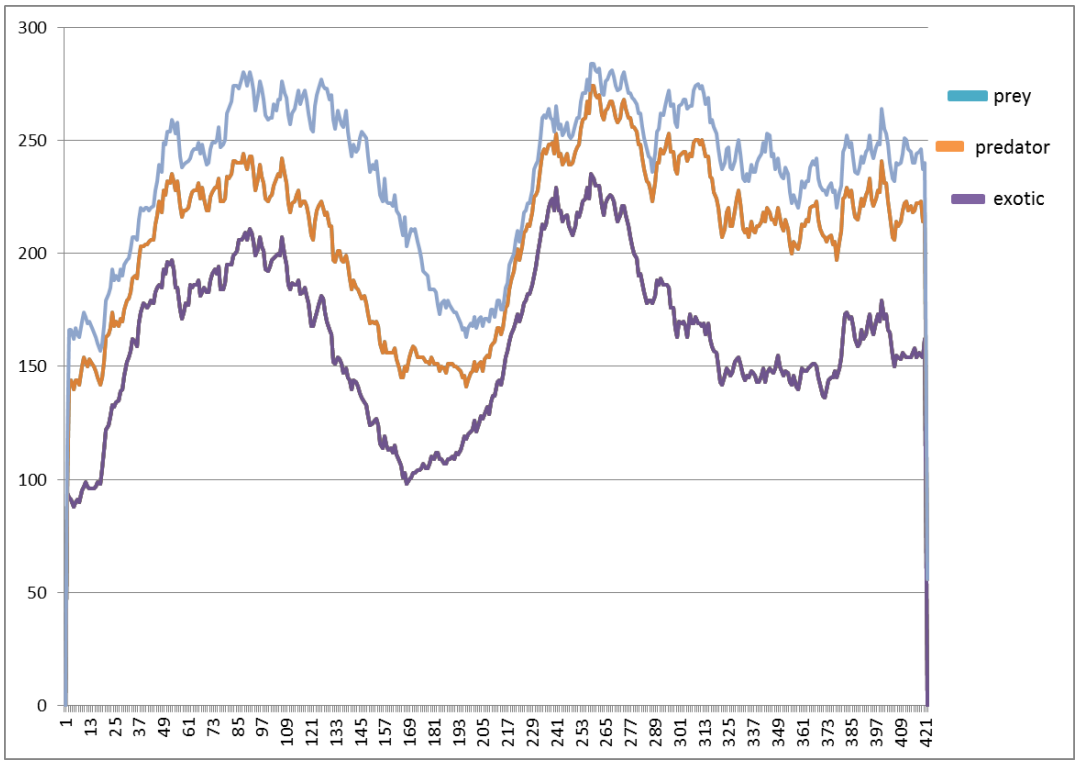
Appendix 2 – Result Charts



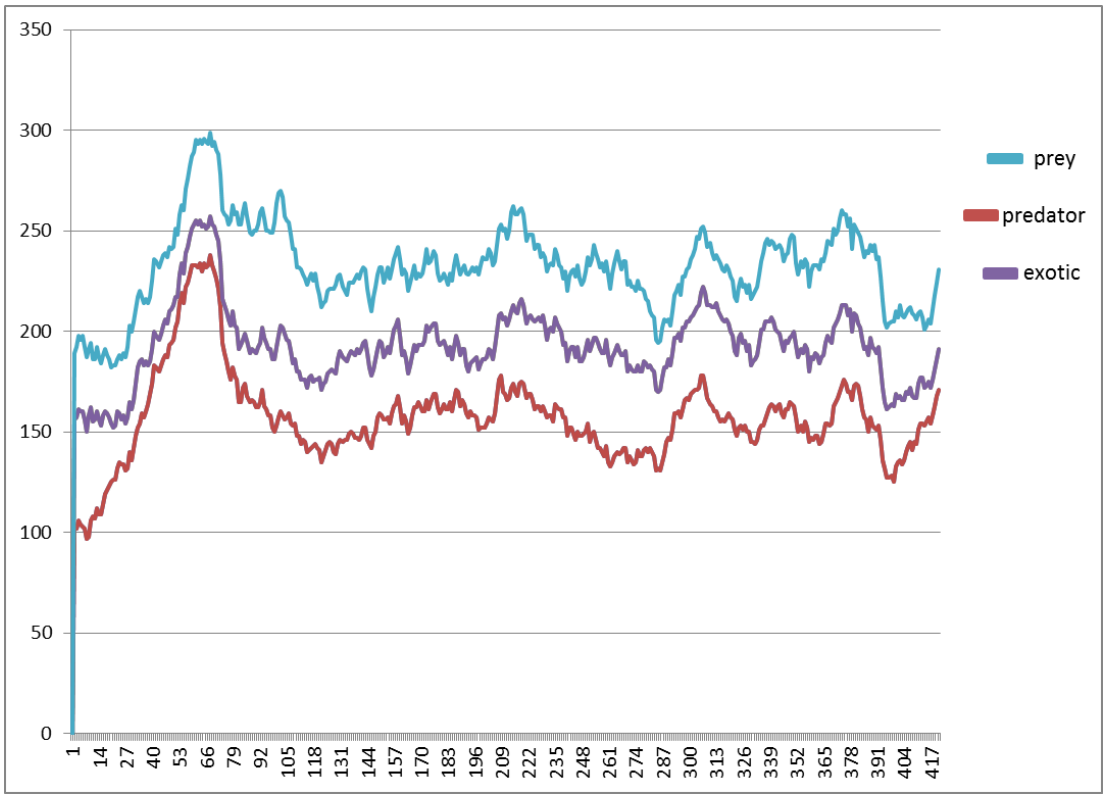
Run 0. Only native predators and prey.



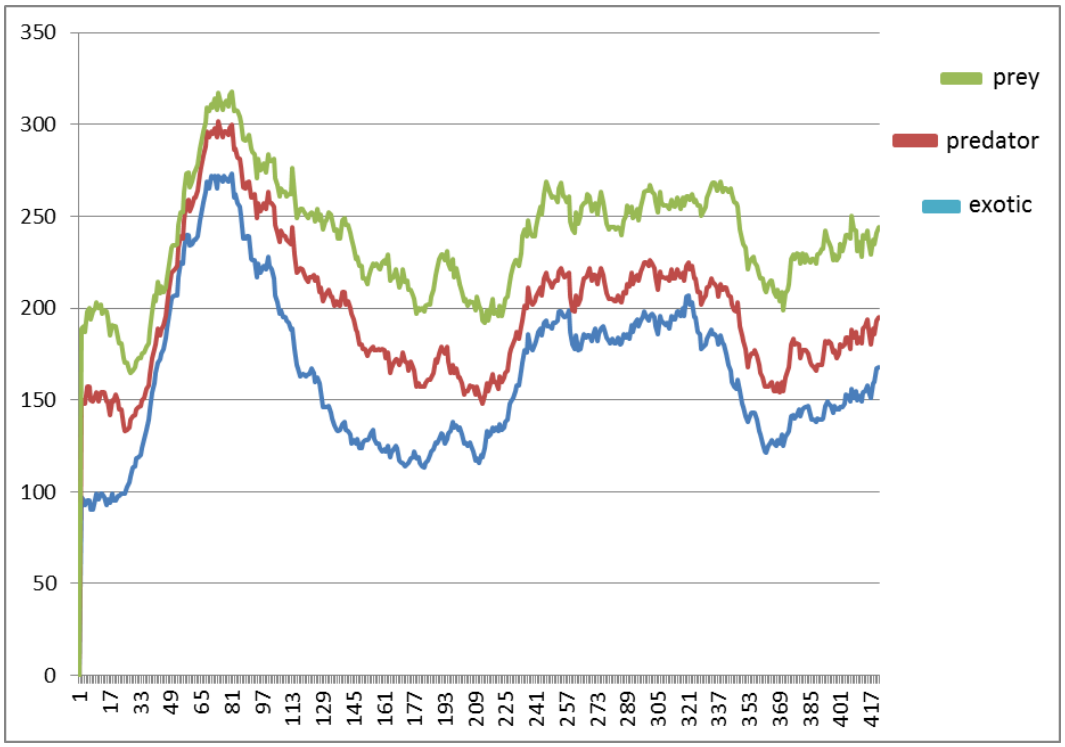
Run 1. 10 exotic predators introduced.



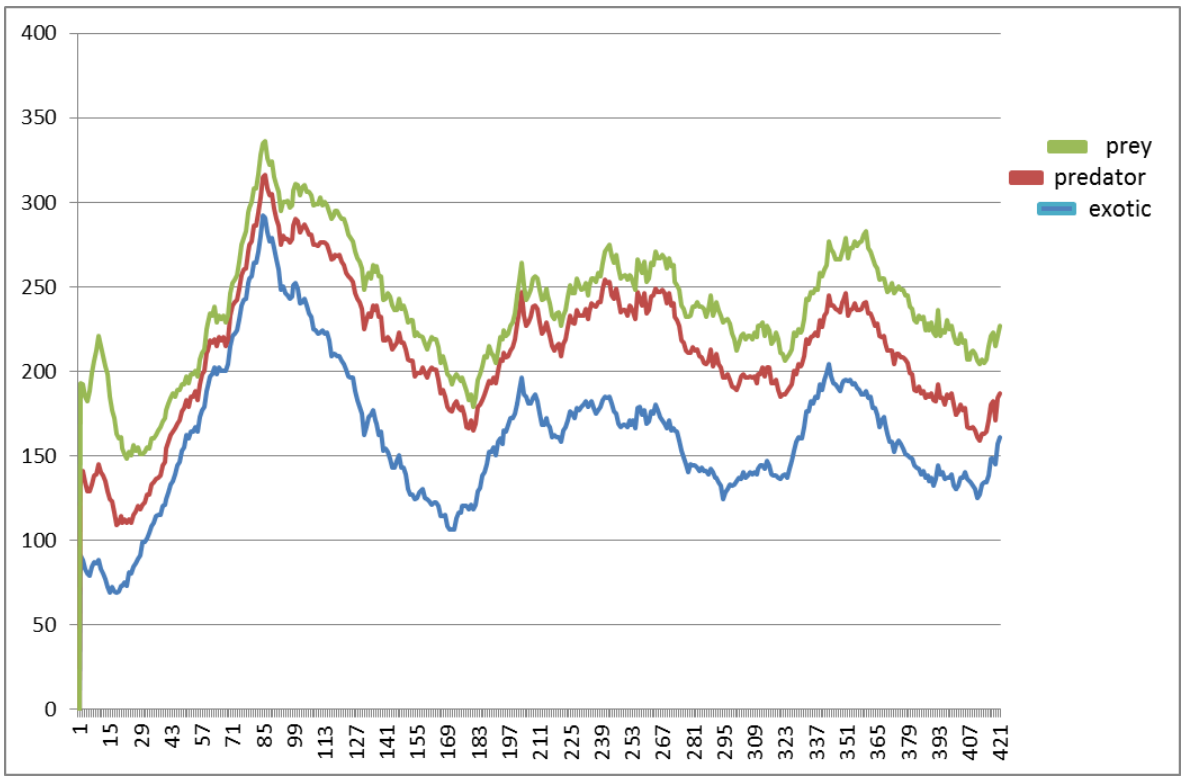
Run 2. 20 exotic predators introduced.



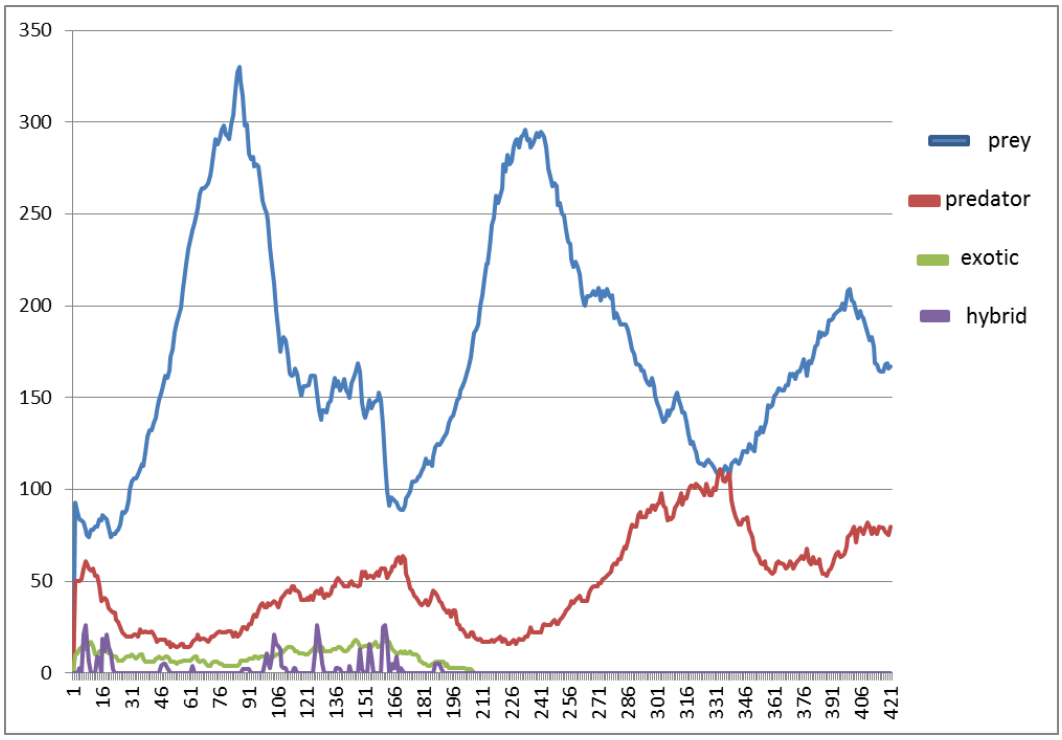
Run 3. 30 exotic predators introduced.



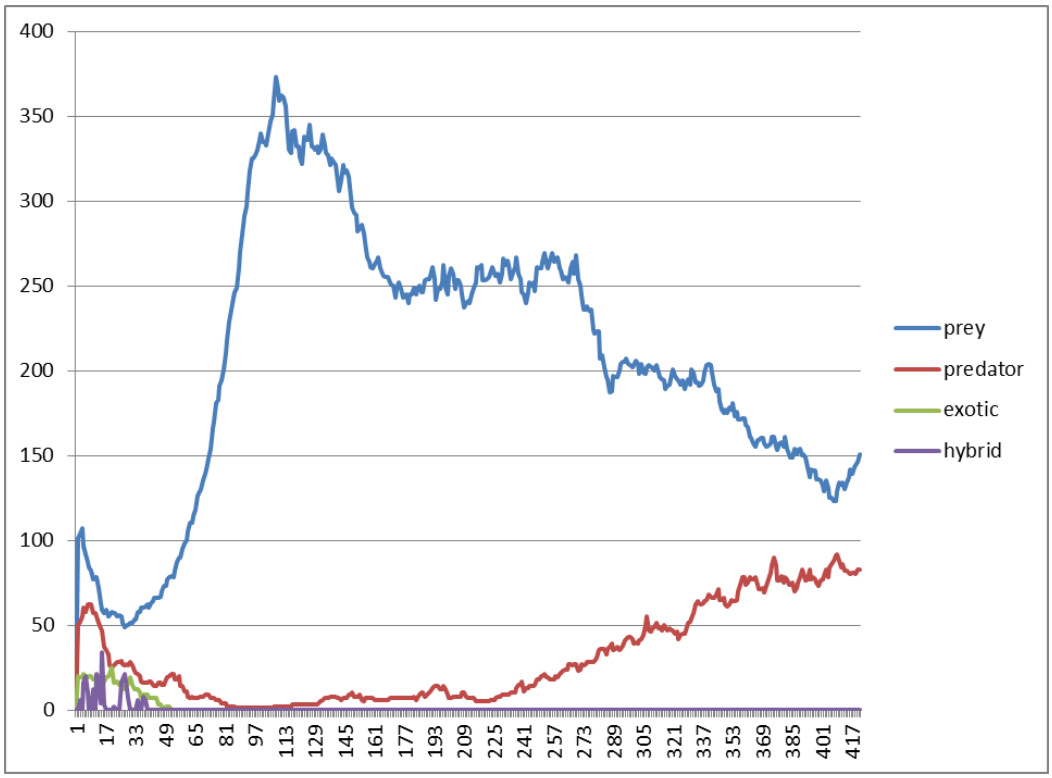
Run 4. 40 exotic predators introduced.



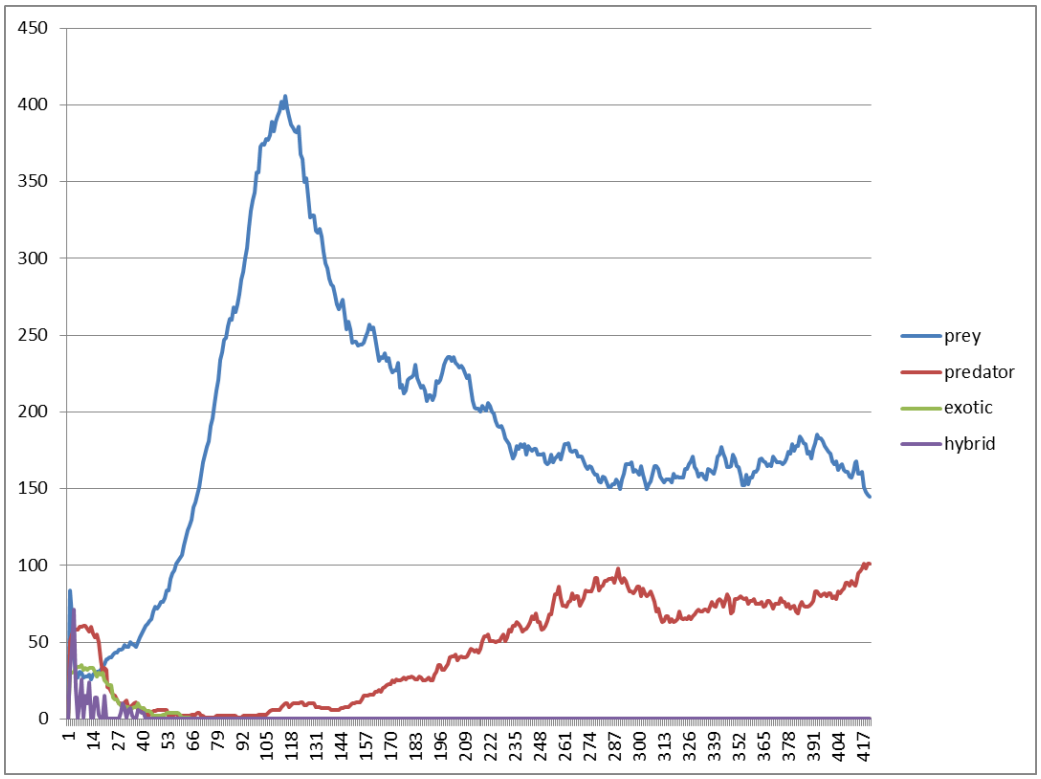
Run 5. 50 predators introduced.



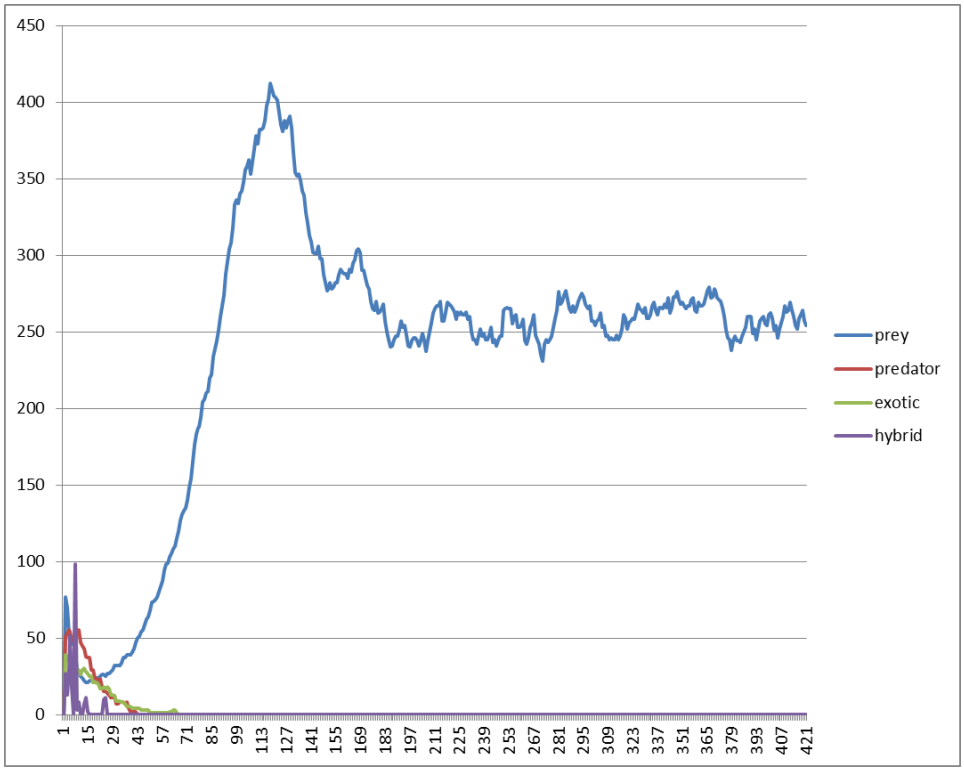
Run 6. 10 exotic predators introduced, producing hybrids.



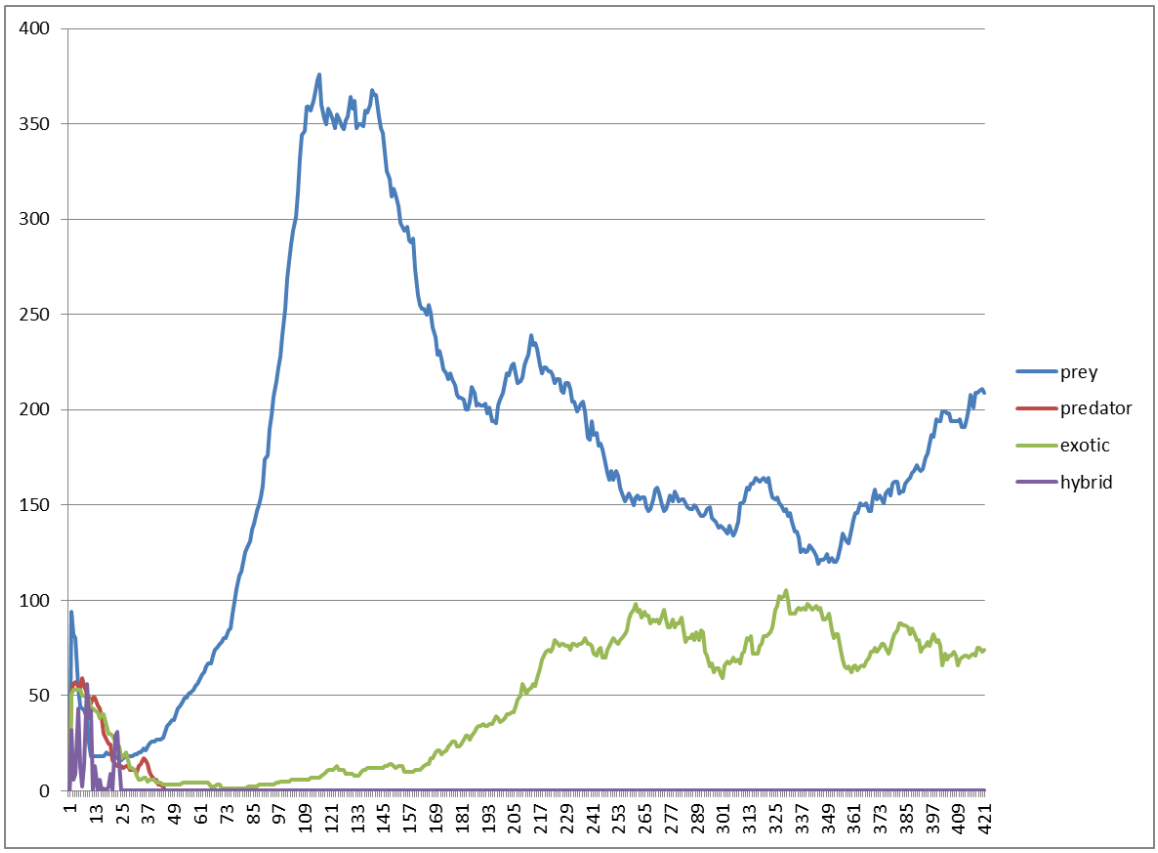
Run 7. 20 exotic predators introduced, producing hybrids.



Run 8. 30 exotic predators introduced, producing hybrids.



Run 9. 40 exotic predators introduced, producing hybrids.



Run 10. 50 exotic predators introduced, producing hybrids.

Appendix 3 – Program Code

```
globals [grass]  ;; keep track of how much grass there is

breed [nprey a-nprey]
breed [expredators expredator]
turtles-own [energy]
patches-own [countdown]
breed[houses house]
breed[trees tree]
breed [npredators npredator]
breed [hybridcross a-hybridcross]

to setup

  __clear-all-and-reset-ticks

   set-default-shape hybridcross "hybrid s"

   set-default-shape npredators "nsnake"
   create-npredators initial-number-npredator  ;; create the npredators, then initialize their
variables
   [
    set color blue
        set size 4 ;; easier to see
    set energy random (2 * npredator-gain-from-food)
    setxy random-xcor random-ycor
  ]



  set-default-shape nprey "rabbit"
  create-nprey initial-number-nprey  ;; create the nprey, then initialize their variables
  [
    set color white
    set size 2  ;; easier to see
    set label-color blue
    set energy random (2 * nprey-gain-from-food)
    setxy random-xcor random-ycor
  ]
  set-default-shape expredators "xsnake"
  create-expredators initial-number-expredator  ;; create the expredators, then initialize their
variables
  [
    set color red
    set size 4 ;; easier to see
```

```
  set energy random (2 * expredator-gain-from-food)
  setxy random-xcor random-ycor
]
display-labels


  set-default-shape houses "house"
 create-houses 1
[set color magenta
  set size 3.5
  setxy 15 14]

  set-default-shape houses "house"
create-houses 1
  [set color magenta
  set size 3.5
  setxy 9 6]

  set-default-shape houses "house"
create-houses 1
  [set color magenta
  set size 3.5
  setxy 7 10]

  set-default-shape houses "house"
create-houses 1
  [set color magenta
  set size 3.5
  setxy 12 4]

  set-default-shape houses "house"
create-houses 1
  [set color magenta
  set size 3.5
  setxy 14 10]

set-default-shape trees "tree pine"
  create-trees 15
 [set color green
    set size 5
    setxy random-xcor random-ycor]

  ask patches [ set pcolor brown]
;; check GRASS? switch.
;; if it is true, then grass grows and the nprey eat it
;; if it false, then the nprey don't need to eat
```

```
  if grass? [
    ask patches [
      set countdown random grass-regrowth-time ;; initialize grass grow clocks randomly
      set pcolor one-of [green brown]
    ]]
end

to go
  if not any? turtles [ stop ]
  ask nprey [
    move
    if grass? [
      set energy energy - 1  ;; deduct energy for nprey only if grass? switch is on
      eat-grass
    ]
    death
    reproduce-nprey
  ]
  ask npredators
   [
    move
    set energy energy - 1  ;; npredators lose energy as they move
    npcatch-nprey
    death
    reproduce-npredator
  ]


  ask expredators [
    move
    set energy energy - 1  ;; expredators lose energy as they move
    epcatch-nprey
    death
    reproduce-expredators
   if crossbreeding? [ hybrid-cross ]
  ]

  if grass? [ ask patches [ grow-grass ] ]
  tick

  display-labels
    if ticks = 420 [stop]
end

to move  ;; turtle procedure
  rt random 50
```

```
  lt random 50
  fd 1
end

to eat-grass  ;; nprey procedure
  ;; nprey eat grass, turn the patch brown
  if pcolor = green [
    set pcolor brown
    set energy energy + nprey-gain-from-food  ;; nprey gain energy by eating
  ]

end

  to reproduce-npredator  ;; npredator procedure
  if random-float 100 < npredator-reproduce [  ;; throw "dice" to see if you will reproduce
    set energy (energy / 2)               ;; divide energy between parent and offspring
    hatch 1 [ rt random-float 360 fd 1 ]   ;; hatch an offspring and move it forward 1 step
  ]
end

to reproduce-nprey  ;; nprey procedure
  if random-float 100 < nprey-reproduce [  ;; throw "dice" to see if you will reproduce
    set energy (energy / 2)               ;; divide energy between parent and offspring
    hatch 1 [ rt random-float 360 fd 1 ]   ;; hatch an offspring and move it forward 1 step
  ]
end

to reproduce-expredators  ;; expredator procedure
  if random-float 100 < expredator-reproduce [  ;; throw "dice" to see if you will reproduce
    set energy (energy / 2)              ;; divide energy between parent and offspring
    hatch 1 [ rt random-float 360 fd 1 ]  ;; hatch an offspring and move it forward 1 step
  ]
end

to epcatch-nprey  ;; expredator procedure
  let prey one-of nprey-here                  ;; grab a random nprey
  if prey != nobody                          ;; did we get one?  if so,
    [ ask prey [ die ]                       ;; kill it
      set energy energy + expredator-gain-from-food ] ;; get energy from eating
end

to npcatch-nprey  ;; npredator procedure
  let prey one-of nprey-here                  ;; grab a random nprey
  if prey != nobody                          ;; did we get one?  if so,
    [ ask prey [ die ]                       ;; kill it
      set energy energy + npredator-gain-from-food ] ;; get energy from eating
```

```
end



to death  ;; turtle procedure
  ;; when energy dips below zero, die
  if energy < 0 [ die ]
end

to grow-grass  ;; patch procedure
  ;; countdown on brown patches: if reach 0, grow some grass
  if pcolor = brown [
    ifelse countdown <= 0
      [ set pcolor green
        set countdown grass-regrowth-time ]
      [ set countdown countdown - 1 ]
  ]
end

to hybrid-cross
  ask expredators
  [
    if any? other turtles-here with [color = blue]
    [hatch 1
      set breed hybridcross
      set color yellow
      set size 4]
  ]
  hybridgo
     end

to hybridgo
  ask hybridcross
   [
    move
    set energy energy - 1  ;; hybrids lose energy as they move
    hbcatch-nprey
    death

    reproduce-hybridcross
  ]
end

to reproduce-hybridcross  ;; expredator procedure
  if random-float 100 < hybridcross-reproduce [  ;; throw "dice" to see if you will reproduce
    set energy (energy / 2)               ;; divide energy between parent and offspring
```

```
    hatch 1 [ rt random-float 360 fd 1 ]  ;; hatch an offspring and move it forward 1 step
  ]
end

to hbcatch-nprey  ;; expredator procedure
  let prey one-of nprey-here                  ;; grab a random nprey
  if prey != nobody                           ;; did we get one?  if so,
    [ ask prey [ die ]                        ;; kill it
      set energy energy + hybridcross-gain-from-food] ;; get energy from eating
end

to display-labels
  ask turtles [ set label "" ]
  if show-energy? [
    ask npredators [ set label round energy ]
    ask expredators [ set label round energy ]
    if grass? [ ask nprey [ set label round energy ] ]
  ]
end
```