

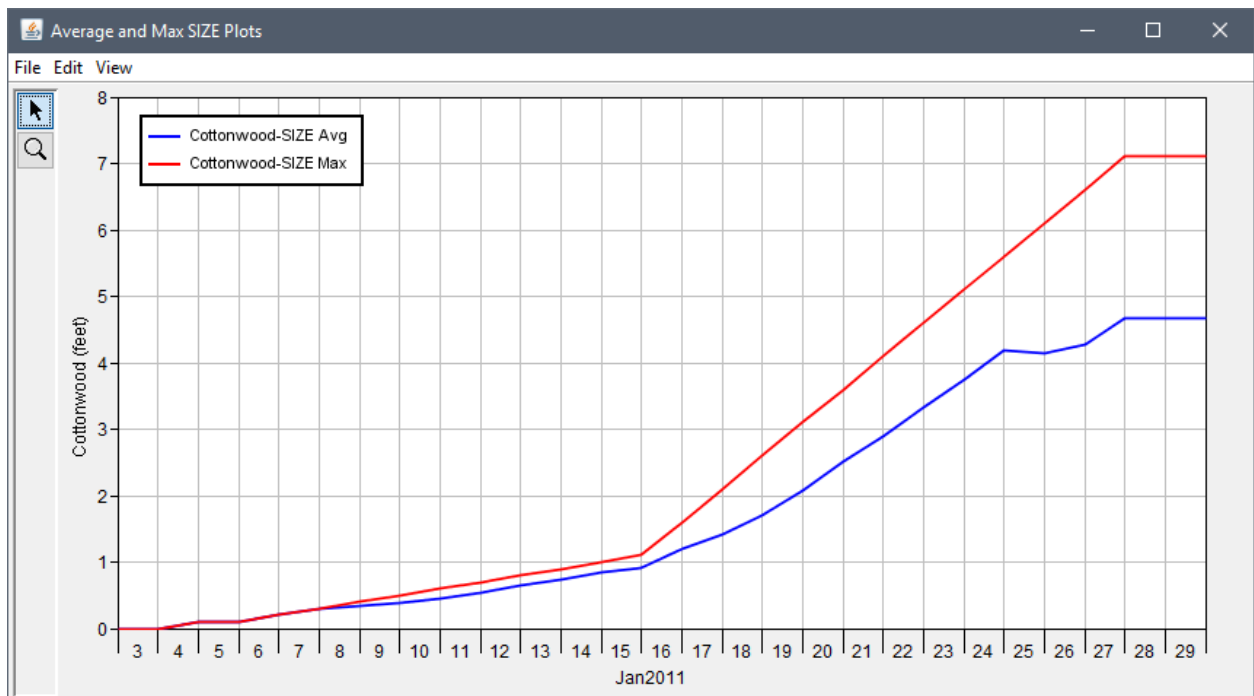
HEC-EFMSim Workshop - Solution

Simulation of Stationary and Mobile Communities

Part 1: Stationary Ecological Community Simulation

In this part of the workshop, students created a community called "Cottonwood" and defined rules to govern its recruitment and growth. This community was then simulated, producing a time series of spatial distributions and sizes for juvenile and seedling cottonwoods. A series of related questions was asked.

◇ How tall did the Cottonwoods get?



Time series of maximum and average size for the Cottonwood community.

From the size plot or via the **File | Tabulate** menu option in the plot window, the tallest of the Cottonwoods grew to a size of 7.1 feet. The average height of all cottonwoods was around 4.6 feet.

◇ Why did the Max Size series change slope on 15Jan?

The Max Size data changed slope on 15Jan because the first cottonwood seedling recruits graduated to the juvenile size class and therefore began growing at a higher rate.

◇ Why is the Average Size series different than the Max Size series?

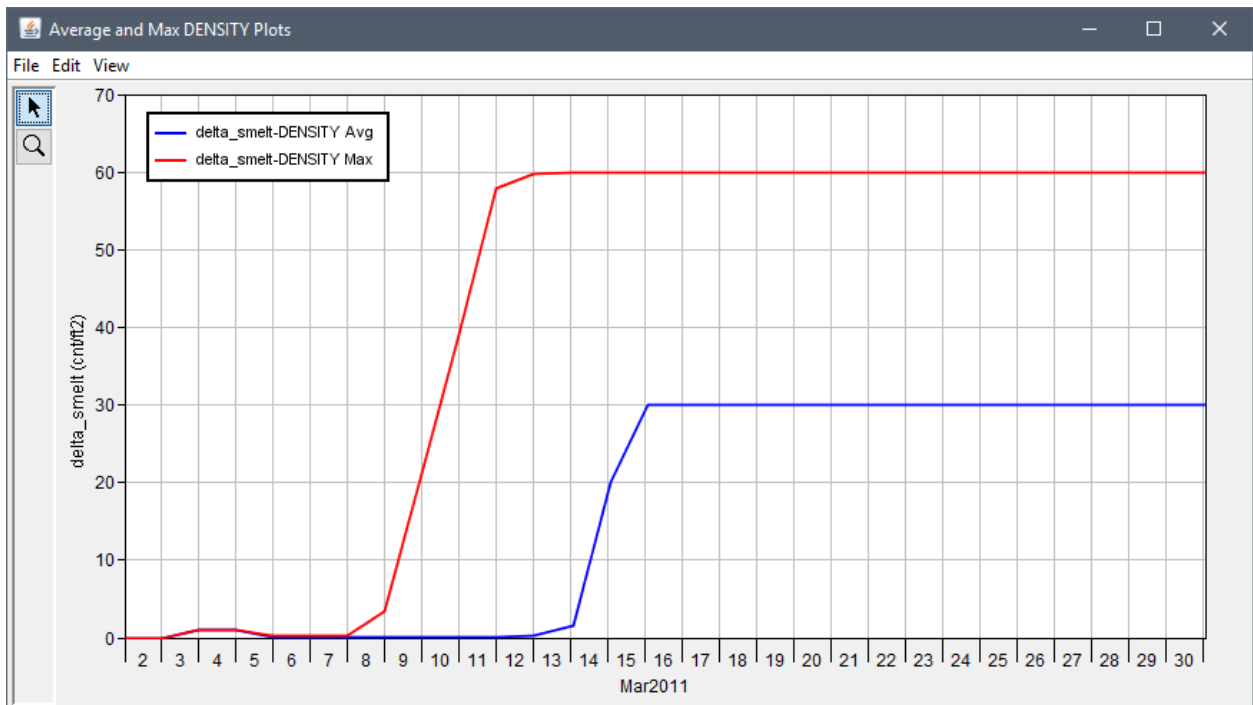
The Average Size data includes all Cottonwoods, including those recruited later in the simulation. All new seedlings begin at a user-defined size of 0.1 ft, which decreases the average size while the maximum size continues to increase as the first recruits keep growing.

Part 2: Mobile Ecological Community Simulations

1) Movement

- ◇ Based on the location of the element assigned in the Instinctual Rule, what do you imagine the Instinctual Attraction Layer will look like?

Since the Delta Smelt were recruited in the lower left corner of the map and the element that they are instinctually attracted to is near the upper right, the attraction layer should radiate outward from the upper right corner. The closer the smelt move to the upper right corner, the stronger the attraction will be.



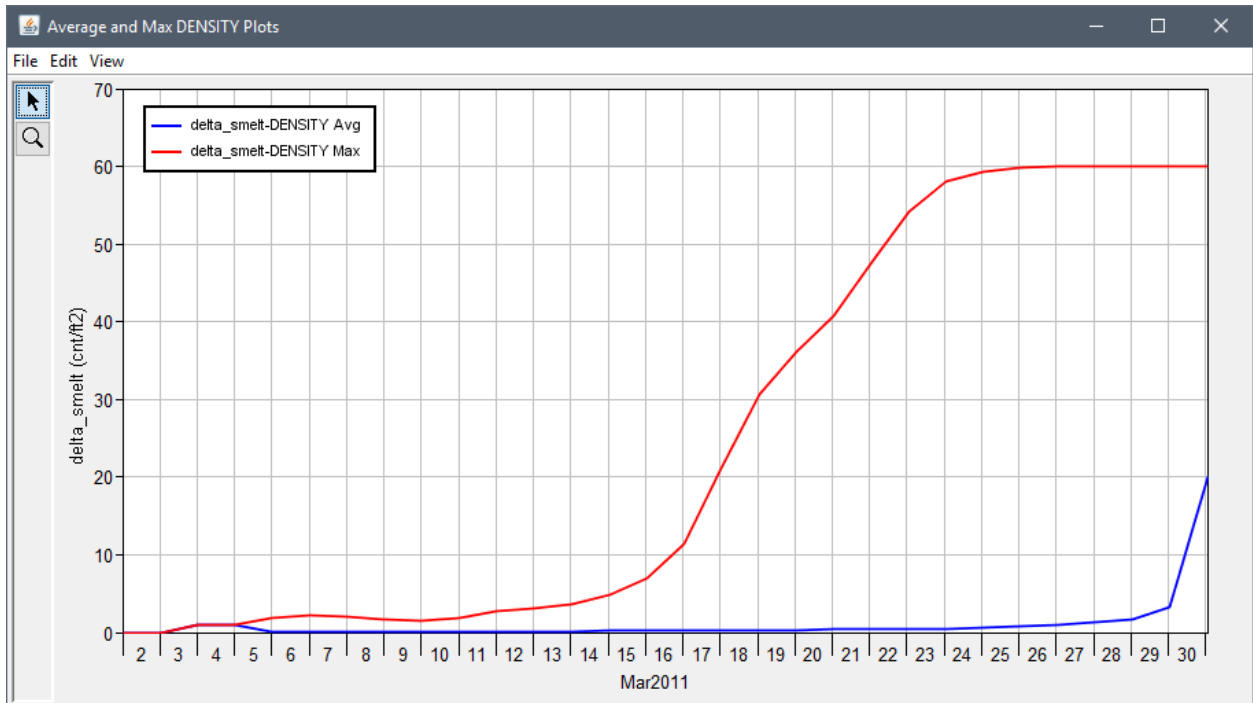
Time series of maximum and average density for the Delta Smelt community.

- ◇ When do most of the smelt make it to the location of instinctual attraction?

Most of the smelt arrive at the location of instinctual attraction by ~12Mar2011.

2) Movement Through a Medium

- ◇ What do you think the instinctual attraction layer will look like now? When do most of the smelt make it to the location of instinctual attraction? How does this differ from the Smelt_Move simulation? Why?



Time series of maximum and average **density** for the Delta Smelt community.

The instinctual attraction layer should look the same as before except it only applies to the stream network now. The attraction layer should radiate out from the upper right corner but it only goes through the stream since that is the path the fish will take. Most of the smelt arrive by ~25Mar2011. This occurs about two weeks later than it did in the simulation of movement that was not constrained by the medium. This is intuitive because, in moving through the medium, smelt were forced to travel a longer distance to reach the location of attraction.

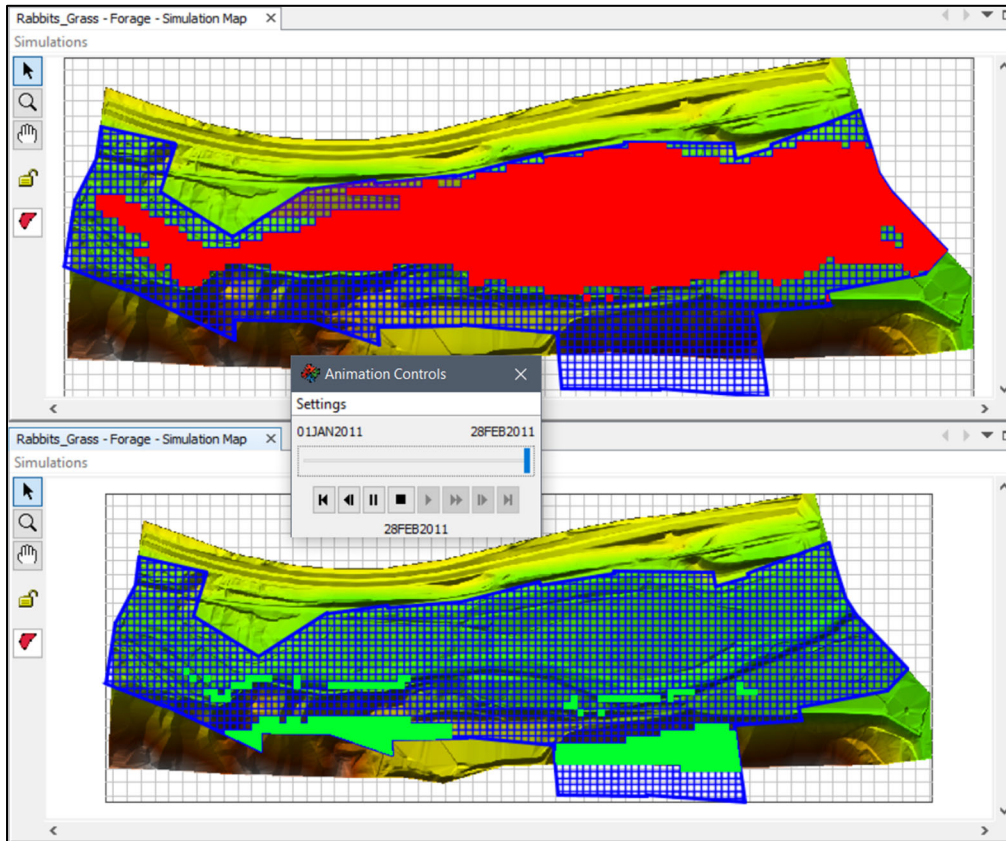
◇ According to the Density plot, what is the maximum density at the end of the simulation?

The maximum density peaked at around 60 individuals per square foot. In this simulation each element is 10,000 square feet, making the number of smelt around 600,000.

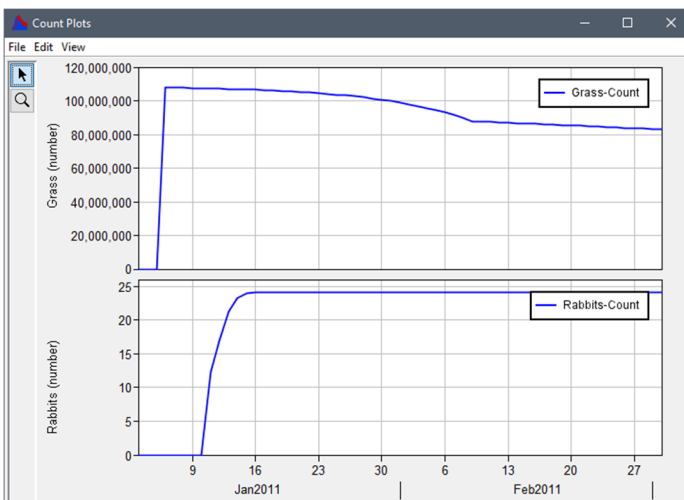
Part 3: Simulating Interactions between Ecological Communities

3) Foraging with a Small Radius

◇ How many rabbits moved from their original recruitment position? Why didn't the entire community move?



Distribution and sizes in the last simulated time step.

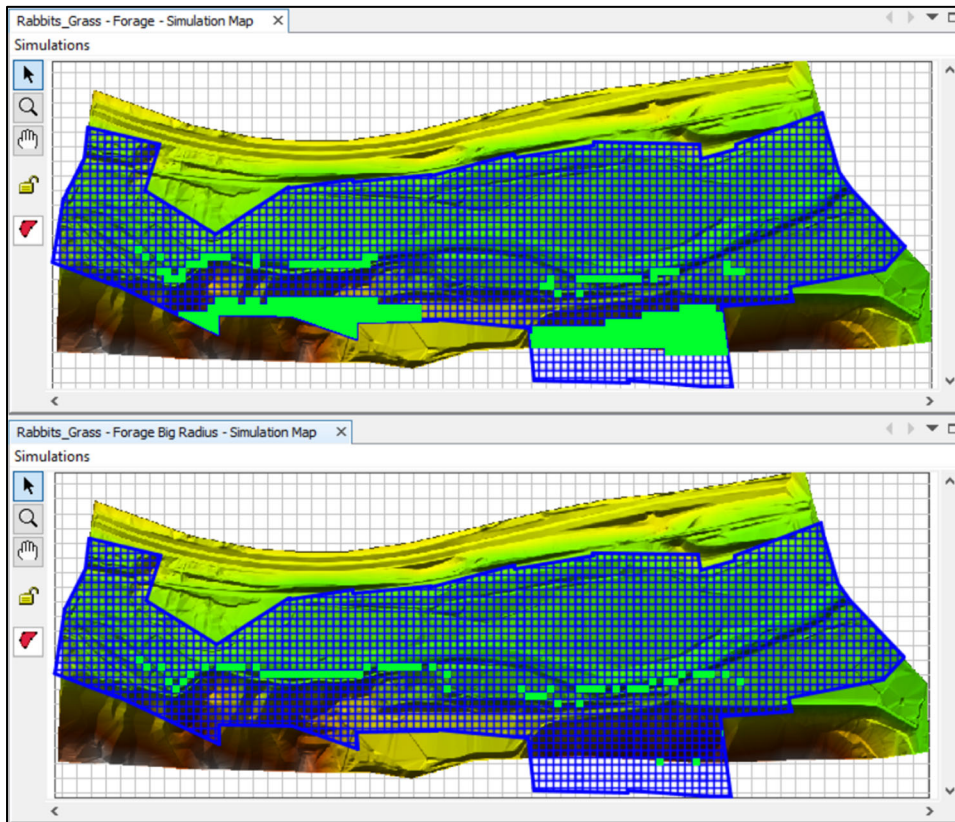


Time series of count for a specific area of the Rabbits community.

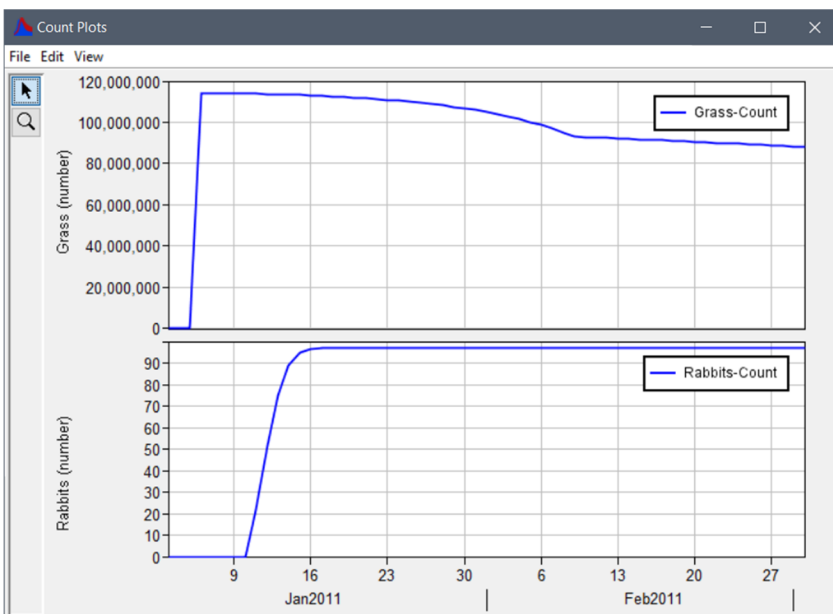
~24 rabbits moved from their original position. The radius of attraction for the Forage Rule was not large enough for the other rabbits to sense the forage opportunity.

4) Foraging with a Large Radius

◇ How many rabbits have now left their original recruitment position?



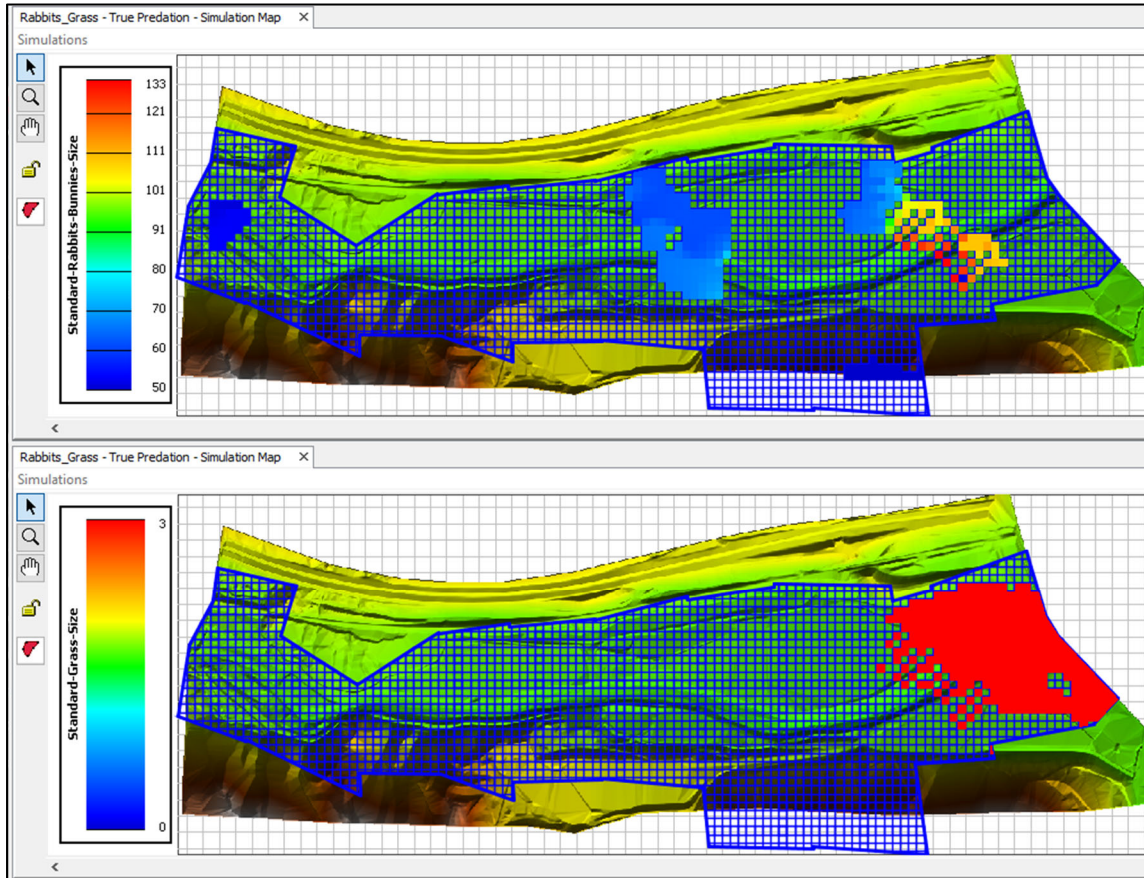
Time series of **count** for a specific area of the Rabbit community.



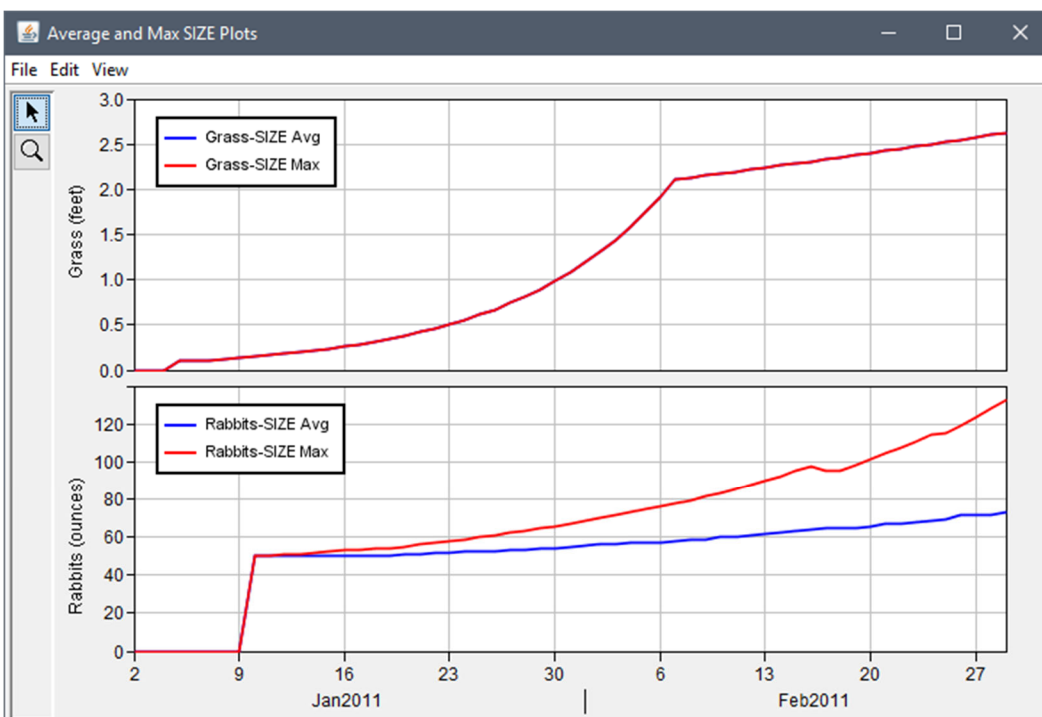
Distribution and **sizes** in the last simulated time step.

~97 rabbits have now left their original position.

5) Consumption by True Predation



Distribution and sizes in the last simulated time step.



Time series of size plot for True Predation simulation.

❖ *What were the maximum and average grass sizes at the last time step?*

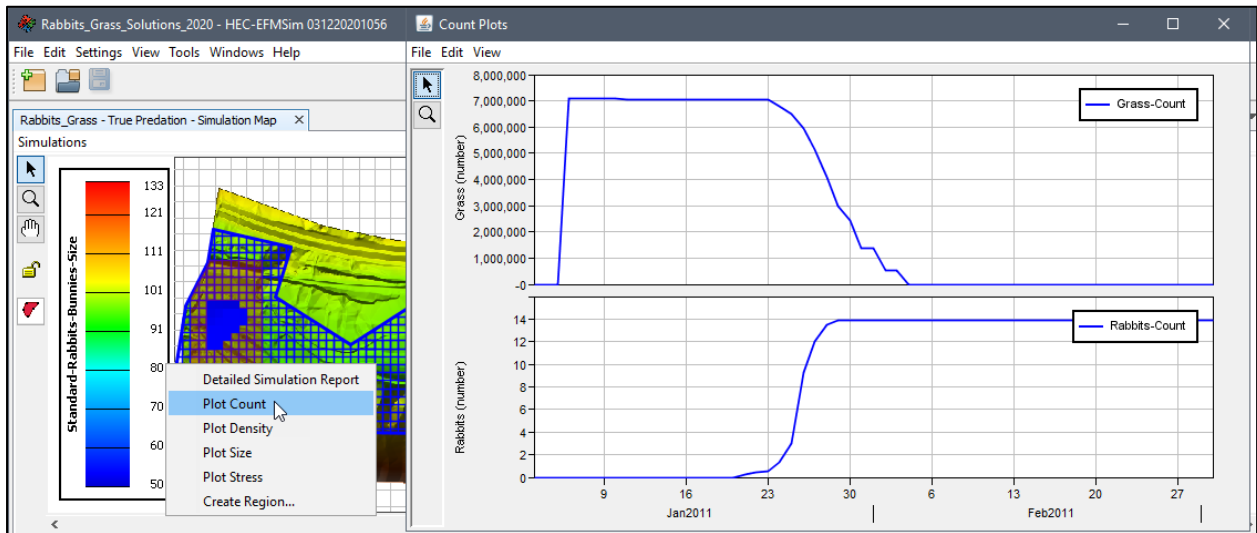
Maximum and average grass size was around 2.6 feet.

❖ *What were the maximum and average rabbit sizes at the last time step?*

Maximum rabbit size was 132.70 ounces. Average rabbit size at the last time step was just over 72 ounces (from Plot Size – Tabulate).

❖ *How many rabbits were left in the western part of the simulation plot? Why do you think they were cut off from the rest of the community?*

There were 14 rabbits left in the western part of the simulation plot. The radius of attraction became too large for them to sense once the nearby grass was completely consumed.

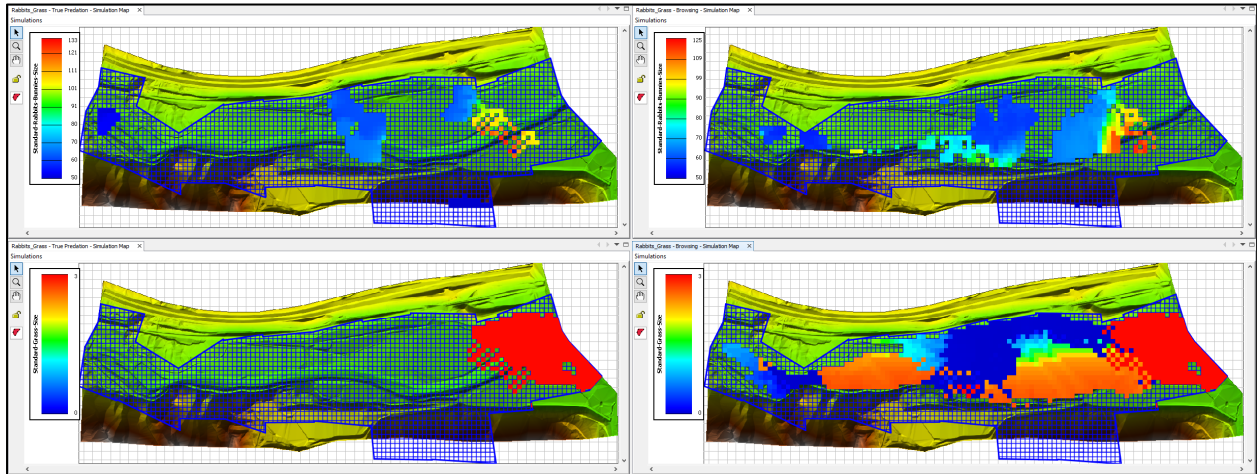


Time series of **count** plot for rabbits in western section.

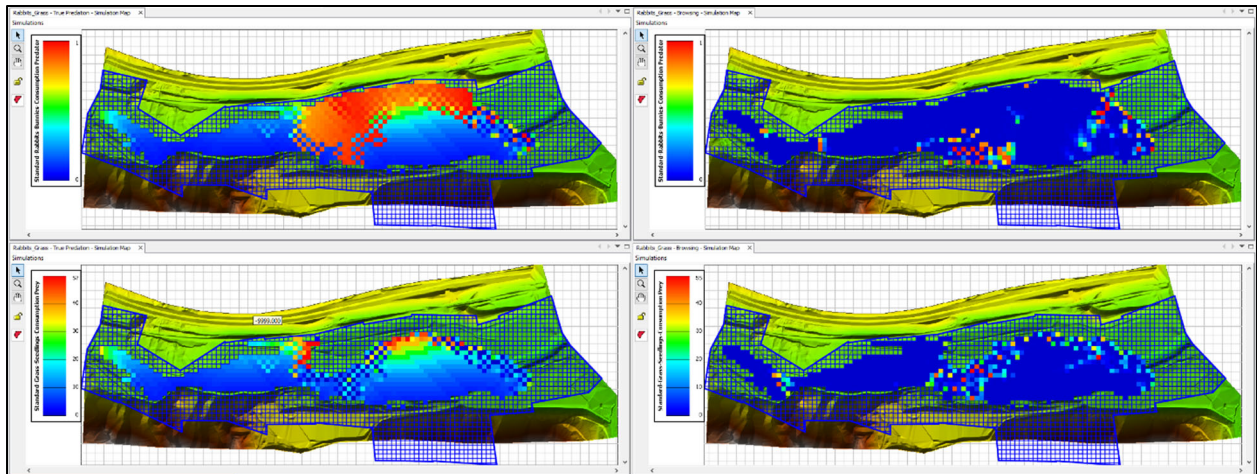
❖ *If the simulation were allowed to continue, what do you think would happen to the remaining grass? How would this effect the rabbit community?*

The remaining grass would be entirely consumed. The rabbits would have to find a new habitat with more grass or a new source of food within this habitat.

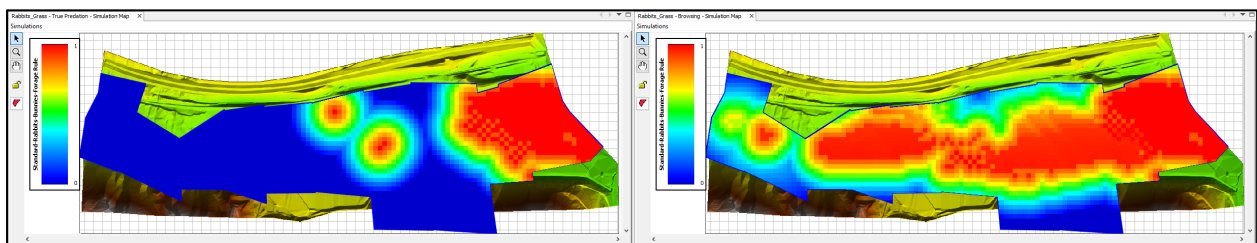
6) Consumption by Browsing



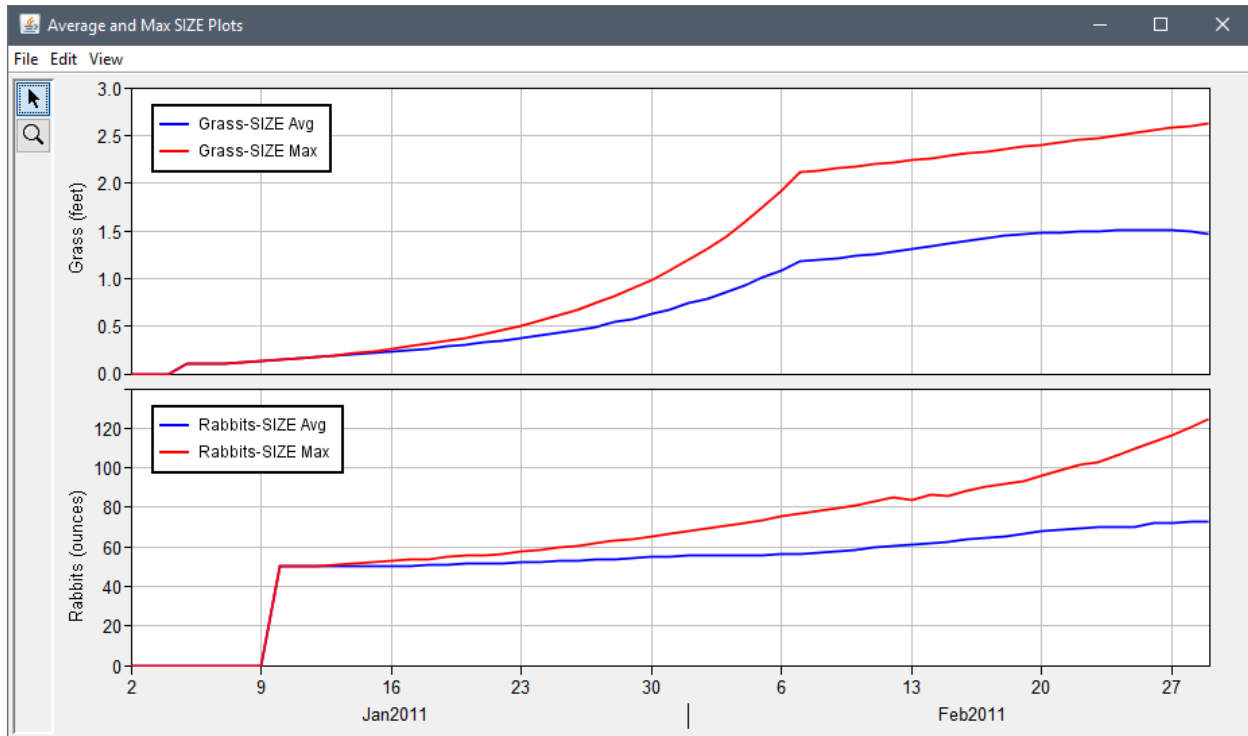
Distribution and sizes for both Predation (left) and Browsing (right) in the last simulated time step.



Consumption layers for predator/prey(seedlings) (top/bottom) for both Predation (left) and Browsing (right) in the last simulated time step.



Forage attraction layers for both Predation (left) and Browsing (right) in the last simulated time step.



Time series of **size** plot for Browsing simulation.

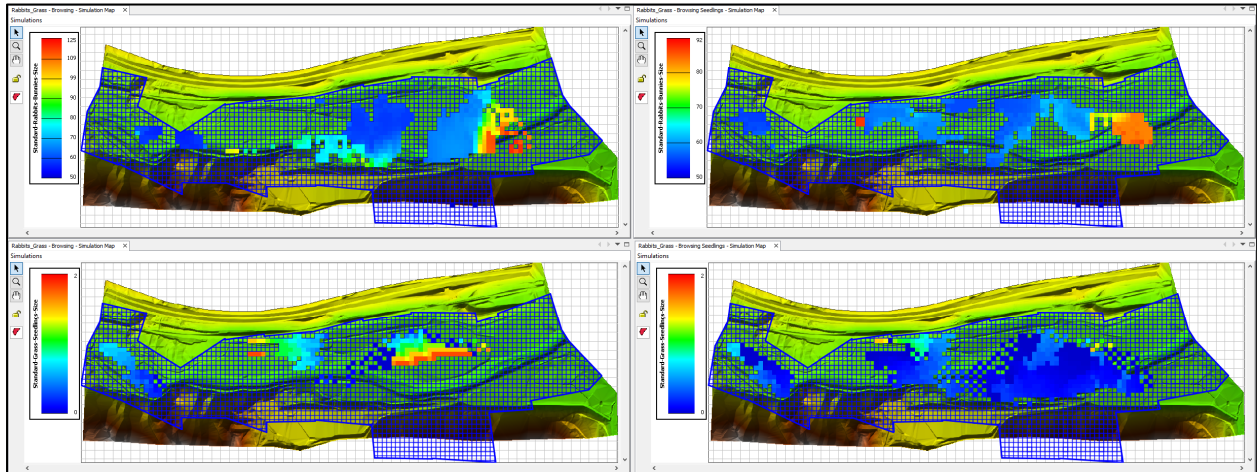
- ❖ What were the maximum and average sizes of the Grass community at the last time step? Are these values different from the True Predation values? Why or why not?

Maximum size of grass was still ~2.6 feet. Average grass size was around 1.5 feet. The maximum size is the same as in the True Predation alternative but the average has dropped by about a foot (2.6 → 1.5). Since the seedlings and adults can re-grow after they have been eaten down to the minimum size, the smaller sizes bring the average down.

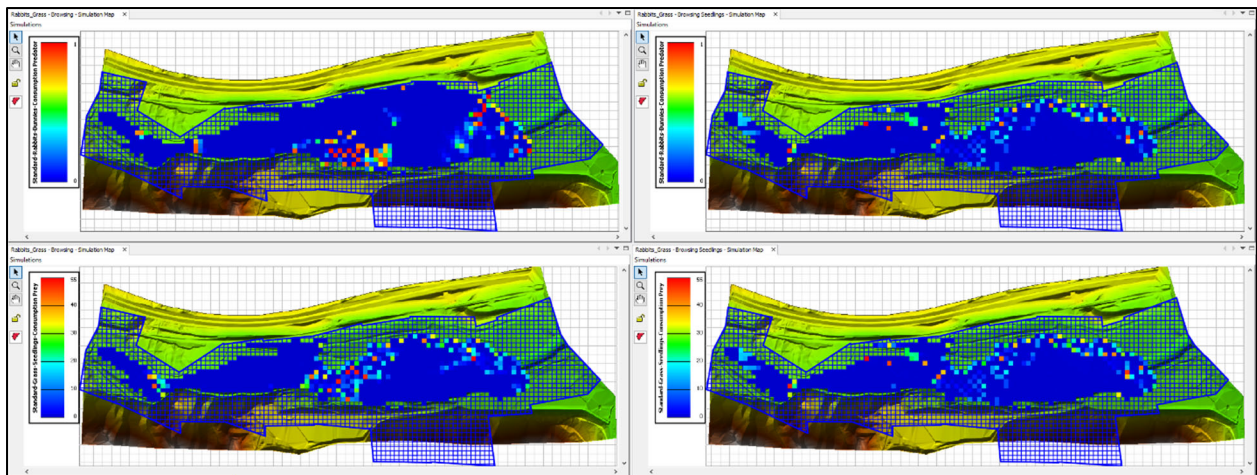
- ❖ What were the maximum and average sizes of the Rabbit community at the last time step? Are these values different from the True Predation values? Why or why not?

Maximum rabbit size was ~124 ounces and average rabbit size was ~72 ounces. The maximum size values were different from True Predation but not radically so. The average rabbit size differed by only 0.15 ounces between the two scenarios. Since the consumption rate and consumption efficiency did not change between alternatives, it makes sense that they will continue to eat about the same amount regardless of what it is that they are eating.

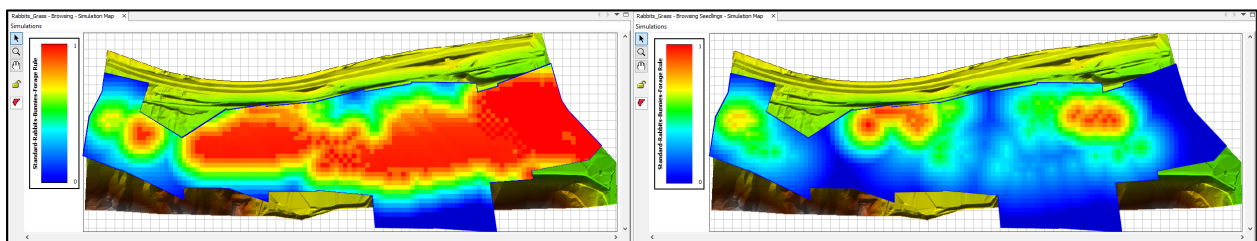
7) Consumption by Browsing Only Seedlings



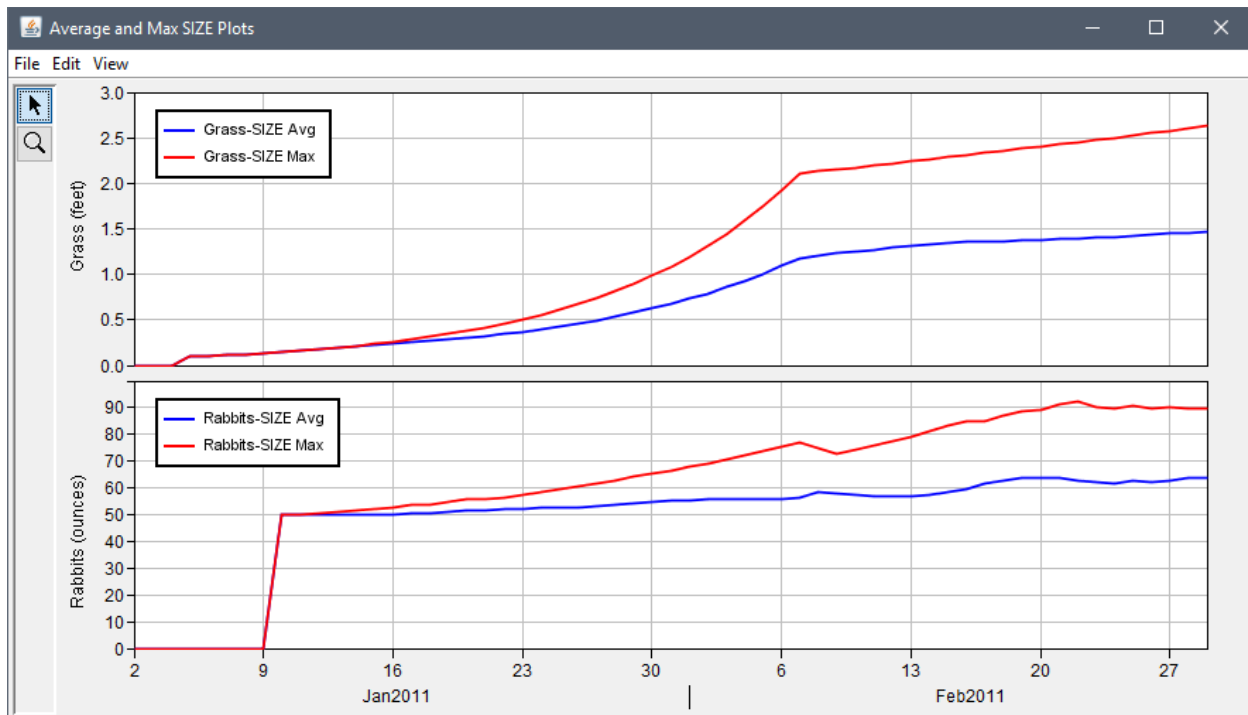
Distribution and sizes for both Browsing (left) and Browsing Seedlings (right) in the last simulated time step.



Consumption layers for predator/prey (top/bottom) for both Browsing (left) and Browsing Seedlings (right) in the last simulated time step.



Forage attraction layers for both Browsing (left) and Browsing Seedlings (right) in the last simulated time step.



Time series of **size** plot for Browsing Seedlings simulation.

- ◇ How does browsing only seedlings differ from browsing all size classes? Are the rabbits bigger or smaller?

Browsing only seedlings creates a supply shortage after a while because seedlings that graduate into adults are no longer available for consumption. This reduces the habitat available for browsing to just the areas nearby that the rabbits can move to in a short amount of time. The rabbits browsing all size classes had a maximum size around 124 oz while the rabbits browsing only seedlings maxed out at ~92 oz.

- ◇ Why does the Forage Attraction Layer for the rabbits change dramatically after February 7th? What happens on February 8th?

The Grass community graduates size classes on Feb 8th to become adults. Since the rabbits are only browsing seedlings, once the seedlings become adults the rabbits no longer want to eat them.