Something Fishy

Adventures in Supercomputing Challenge

Final Report

March 30, 06

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Table of Contents

Introduction

Every day, at least one species of animal becomes extinct. Sometimes man is to blame, sometimes he is not. It seems that no matter what we do, they keep slipping away. Every little thing a person does to try and help, helps a million. That's exactly what team 21 is trying to do, help.

Executive Summary

Why and how is the Silvery Minnow population becoming endangered in the Rio Grande River?

At least 25 miles of the Rio Grande have dried up and that is the minnows' main habitat. Biologists think the Rio Grande is drying up because of siltation and turbidity. Siltation and turbidity occur when large amounts of silt are washed into a river. Biologists need to find out a way to help the Minnow population grow back to their original number. Minnows are very important to the environment because they are a source of food for other animals within the food chain. If they can find a way to help the Minnow population get back to their original number it will save the Minnow population. Minnows also are a good indicator of the health of a river. A healthy environment supports healthy species.

Why is this happening?

The Rio Grande is strongly affected by irrigation and by contributions to tributaries; the way the water flows into the river changes a lot based on the amount of precipitation at a given time. Native American has used beneficiary irrigation systems beginning in the upper basin's water sources. Around 1994, scientists noticed that water shortages started were starting to appear in New Mexico changing the amount of water in the river The historic range of the Silvery Minnow was from Espanola, New Mexico, above Santa Fe, and to the Rio Grande at the Golf of Mexico, and the Silvery Minnow was also found in Pecos River. Today however, that range is restricted to about 170 miles from Elephant Butte Reservoir to Cochiti Dam.

1994 was the year the U.S. Fish and Wildlife service discovered that the Silvery Minnow was endangered under the Endangered species act. Threats to the Silvery Minnows include: prolonged flow diversions, channelization, regulation of the river's flow for irrigational needs, bad water quality, competition and/or predation by non-native fish and siltation and turbidity in the river. Several modeling tools are used to map and analyze data about the Rio Grande. Science and technology can promote informed decisions in future development of the Rio Grande.

The Project:

In order to solve the minnow's problem our team has used starlogo to model how the Silvery Minnows are becoming endangered and how people should help the silvery minnow. We hope to find out if small changes in the environment such as more food, more rain, and, faster breeding can make a difference in the minnow population. We are also including problems such as siltation and drought to make the project as precise as possible. In the model the fish swim, eat, and die as they hit the banks of the river. The banks expand and contract as it rains and as the river dries. The fish eat crab larvae and depend on high number of them as well as wide peaceful banks, when the larva's population declines, so does the minnows.' At the same time, banks of the river are slowly closing in. If a fish finds itself on the riverbank, it will die. Fortunately for the minnows, there is a way to fight this: plant growth. As algae in the water grow, it erodes at the riverbank, and, when the larvae eat it, more water is added to the river. Limitations of this project are that we have narrowed a model to specific types of variables. We are not taking into account that minnows can die from other illnesses or become eaten by other species.

Statement of the Problem

The minnow is a small fish that averages 76 to 124 millimeters in length. It has a short, bluntly triangular head. Spawning males are light yellow along the sides and lower fins. The fish is otherwise silvery with a dark, broad stripe running along the lateral line.

For fifty years, the silvery minnow swam the length of the Rio Grand and its major tributary, the Pecos River. Because of farming, drought, and over population along the river, the water has become polluted and its level has dropped. The fish is now found only in pockets of a single 170 mile stretch of the middle Rio Grande in central New Mexico. Its population is now dramatically declining. 1995 more than half the fish in the middle Rio Grande were silvery minnows. Today, the minnows only account for less than half of the fish there. At least 25 miles of the Rio Grande have dried up and was minnows' main habitat. Biologists think the Rio Grande is drying up because of siltation and turbidity. Biologists need to find out a way to help the Minnow population grow back to their original number. Minnows are very important to the environment because they are a source of food for other animals. If they can find a way to help the Minnow population get back to their original number it will save the Minnow population.

In this project, we are attempting to find a way to keep the population of the silvery minnows from declining and hopefully increasing in the future.

We also are not taking into consideration that deals with the habitat such as vegetation overgrowth. We are not counting other population growth like how many eggs can hatch within a given season.

Project Description

We are modeling the minnow's habitat during wet and dry times of the year. We are hoping to create a safe habitat for the minnow population. We started out with four crabs and one fish the number of fish and crabs fluxed up and down in relation to the amount of land and algae in the river. The fishes and crabs both have different modes of behavior

Starlogo code so far:

Turtle Procedures

```
to fish-setup
        setshape fish
        set color cyan
end

to dirt-setup
        setshape dirt
        set color blue
end

to crab-setup
        setshape crab
        set color red
end

to unspec-setup
        setshape unspec
        set color blue
end

to fish-swim
        fd random 2
        if pc-ahead = brown [
                rt 180
                rt random 90
                lt random 90
        ]
        fd random 2
        if pc = brown [
                die
```

```
        ]
        lt random 90
        rt random 90
        if count-crabs-here > 1 [
        grab one-of-crabs-here
        [kill partner
         hatch [fd 1]]]
end

to crab-swim
        fd random 2
        if pc = green [hatch[fd 1]]
        if pc = green [hatch[fd 1]]
        if pc = green [stamp blue]
        if pc-ahead = violet [lt 180]
        fd random 2
        lt random 90
        rt random 90
        if pc = violet [die]
        fd random 2
end

to unspec-swim
        fd random 2
        rt random 90
        lt random 90
        fd random 2
        stamp green
        if pc = green [set color green]
        if pc = brown [set color brown]
        if pc = blue [set color blue]
        if pc = violet [set color violet]
end

to dirt-swim
        fd random 2
        rt random 90
        lt random 90
        fd random 2
        if pc-ahead = brown [stamp brown]
        if pc = brown [setc brown]
        if pc = green [setc green]
        if pc = blue [setc blue]
end
```

Observer Procedures

```
breeds [fishes crabs unspecs dirts]

to setup
ct
setbg blue
ask-patches [if xcor < -24 [setpc brown]]
ask-patches [if xcor > 24 [setpc brown]]
create-dirts numdirts
create-fishes numfishes
create-crabs numcrabs
create-unspecs numunspecs
ask-dirts [dirt-setup]
ask-fishes [fish-setup]
ask-crabs [crab-setup]
ask-unspecs [unspec-setup]
end

to go
        ask-turtles [
        if breed = dirts [dirt-swim]
        if breed = fishes [fish-swim]
        if breed = unspects [unspec-swim]
        if breed = crabs [crab-swim]
        ]
end
```

Results

First try: we started with 3 crabs, 1 fish, 3 unspects and 30 dirts. The fish died within half a minute. Our hypothesis failed. Second try: We started with 1 fish, 3 crabs, 3 unspects and 30 dirts. The fish population did not increase until the crab population reached 600 and climbing. As the fish population climbed the crabs steady population declined to about 185. At about 140 seconds the fish and crab population met and equaled out for about 10 seconds. At around 180 seconds the banks of the river showed signs of closing in on the fish. At 240 seconds the crab population is at 200 and the fish population is at 1,000. 260 seconds the fish population rises and crab population drops. The fish population reaches its highest point of 1,200. Our hypothesis failed.

Recommendations

We need to slope the banks to try and slow the river down. Slowing the river is crucial to restoring habitat and calm pools for the endangered Rio Grande silvery minnow. Another solution that presents itself is adding more rain to the

environment. This will slow the siltation process significantly and ultimately save the minnows

Most Significant Achievement

The Rio Grand is very polluted and has major pollution problems. The minnows and other species that call this river their home have a lot of problems that work against their ability to survive. The most significant in this project has been trying to show how silvery minnows are dealing with the difficulties of living in the Rio Grand. We have worked very hard trying model after model that can help the minnows to survive. Though our model, we have shown that scientists need to work hard to keep every thing in balance for the benefit of this tiny fish, the Silvery minnow.

Conclusion

Around 16 iterations the two species meet equilibrium. If it wasn't for the climate change due to the unspecs modeling the siltation of silt on the banks. To keep the minnows from dying, the climate would have to stop changing in real life.