User Guide

This document is used for introducing what is my model and how my model works.

Introduction

As the continental shelf is relatively shallow and due to the warm and temperate climate near the continental shelves the fish breed near the continental shelves. Continental shelf is the richest part of the ocean, with the world's most important fishing grounds. However, overfishing has become a quite hot topic currently which would be a disaster for the ecology cycle at that certain district.

Artificial Island at sea is also a quite popular phrase in the world. They can be used to build airport which would not produce noise pollution in urban; easy to solve the pollution problem produced by large-scale cooling power provider; new city for people to live in and so on. However, the location's selection and its size are all have a big impact to the surrounding marine ecosystem.

On the other part, with the rapid development of the modern agriculture and industry and increase of population, a large amount of waste are discarded into the sea which causing serious pollution of the oceans. These pollutions are mainly oil pollution, heavy metal pollution, organic pollution and so on. These pollutions would mainly impact on producers like plankton. Even though the ocean has self-clean mechanism, this would need quite a while.

What to learn

In my models, there are two main focuses. The first is how would human beings' behaviors impact on the ecosystem at continental shelf. In this study, I involved in 3 factors in total: building an island on the sea surface, fishing with boats moving around, emit wastes and pollution to the sea.

The second is the fishes' behavior. In this study, I implemented a lot of fishes' normal habits and its relationship with predators. I observe their moving patterns under several varied different situations. I also try to implement another kind of flock for schooling which base on the fish-swam algorithm for an addition model.

What are the rules for my model

For forage fishes: it has the option to form a flock to act and move together which in the real world would help fish for reducing the resistance produced by water and would also help forage fishes to escape from its predators. Besides the flock feature, the fishes can also choose avoid action to detect nearby predators and escape to another direction. Every move would reduce their energy by one and if the possibility is big enough, they can reproduce which would cost them half energy. The fish-reproduce-percent slider controls the hatch possibility. The fishes can eat seaweed and gain energy. And the energy is also determined by a slider named fish-gain-from-food. There is also an option that make the fishes can only reproduce at some certain places which called marine migrations in real world. They cannot access any place which has occupied by human(the island).

For predators: They can chase after the forage fishes for food and if there is no fish nearby but some other predators nearby, they would fight with each other and one of them would die. Predators can eat fishes to gain energy and reproduce at a certain possibility that would lose half of its energy. If the age of predator is over 10 or its energy is less than 5, it would die. Every move would also make predator's age plus one.

For human beings: there is an option to decide whether the human would be involved in this ecosystem. If human-involved is false, the system would only have predators and forage fishes which would form a balanced ecosystem. If human-involved is true, the system would have boats moving around and catching predators and fishes. The boats' speed is higher than fishes and when there is a predator nearby, the boat would prefer catching a predator rather than all the fishes in radius 3.

Human are also available to choose place to create island on the surface of the sea or emit the wastes into the ocean. While the pollution can be self-cleaned by the ocean, this process would take some time.

For plankton: Their color is green. Forage fishes are feed on the planktons. And planktons can regrow randomly in a certain amount of time. When they are eaten by the fishes, they would disappear and pcolor would go back to blue. If the ocean were polluted, the plankton would never grow at that part.

Justification for the rules

For forage fishes:

In a real marine ecosystem, small fishes would form a flock for three reasons: 1. Make the process of seeking for more food; 2. Confuse its predators with huge amount to have a higher survival possibility; 3. Forming a flock and after its teammates would reduce the resistance produced by the water while moving. If a predator were coming nearby, the small fishes would all react as avoid and escape. And when the predator is gone, they would form a schooling again. In the real world, forage fish often make great migrations between their spawning, feeding and nursery grounds. Schools of a particular stock usually travel in a triangle between these grounds. For example, one stock of herrings has their spawning ground in southern Norway, their feeding ground in Iceland, and their nursery ground in northern Norway. Wide triangular journeys such as these may be important because forage fish, when feeding, cannot distinguish their own offspring. For example, Salmon is one of these fishes that would make such great migrations for reproducing. To simplify my model, I make all the grounds to be the sources as the only places that forage fishes can reproduce.

For predators:

In the real world, if there were enough fishes around, they would prefer chasing and eating the fishes. Otherwise, they would defense their place and fight with other predator until one of die or escape. Also, they would gain energy from their food to maintain their normal living. The predators would reproduce quite low numbers of small predators comparing to the forage fishes'. And they would also face the fight for space problem. Predators would die if they do not have any food for a long time or if they are too old to fight for place and food.

For human's fishing:

Apparently, big fish like sharks and tuna are more expensive and more popular in human market. So fisherman would have a preference on catching the predators in the real world. They would move around and if there were any predator around, they would catch the predators. If there were only small fishes around, they would catch big amounts of them instead.

For plankton:
They are the main food for forage fishes and it's also the role as producer in the real world. So with water and sunshine, they would reproduce randomly by themselves.
The plankton would have two features influenced by the pollution: 1. Rapidly grow and use out all the oxygen in the water and make the fishes die for cannot breathe. 2. Die out at that certain place and do not grow until it returns to the clean state. As my model does not take oxygen into account, we only focus on the second rule.

How to interact with my model

The first step to study how will human would affect a system, we need to have the precondition that the whole ecosystem is balanced.
So first, we have to set my model to be balanced only with the fish, predators and planktons. This is easy to achieve.
For second step, we can try flock? slider or chase? Slider to see whether these natural features would make one side has any advantage.
For third step, we can draw island on the screen and see how the size of the island affects the whole ecosystem.
For the following steps, we can try draw the source for forage fishes or draw the pollution.
Then we can combine these three features to see the impact. For example, we can draw the island surround the reproduce source which makes no forage fishes can reach the source for reproducing and see what is the result. Or we can draw four sources and a straight island cross them.
There are a lot of interesting features and phenomena exist in my model.

For the HubNet project, we can control a boat and moving around for fishing which follow the rules. In this project, we can clearly sense that only add one boat, there would merely have affects on the whole ecosystem. But when users are growing and moving their boats chasing after the predators (which is more valuable in my definition), the predators would die out pretty quickly. And if the users' amount is big enough, we can fish all the forage fishes also(it would a little difficult, for you have possibility for catching nothing and the fishes are moving pretty fast).

In my additional little model, I try another kind of flock----schooling. In this behavior, it has a specific algorithm named artificial fish-swam algorithm as following:

Algorithm 1 fish swarm intelligent algorithm

```
Input: m, l, u, nfe_max, ε, δ, μ_δ, θ, η
iteration ← 1; τ ← 1
(x^1, ..., x^m) ← Initialize()
while termination criteria are not satisfied do
   for i = 1, ..., m do
      Compute the "visual"
      if visual scope is empty then
         y^i ← Random(x^i)
      else
         if visual scope is crowded then
            y^i ← Search(x^i)
         else
            if central point is better than x^i then
               y_1^i ← Swarm(x^i)
            else
               y_1^i ← Search(x^i)
            end if
            if best function value is better than f(x^i) then
               y_2^i ← Chase(x^i)
            else
               y_2^i ← Search(x^i)
            end if
            y^i ← arg min{f(y_1^i), f(y_2^i)}
         end if
      end if
   end for
   for i = 1, ..., m do
      x^i ← Select(x^i, y^i)
   end for
   if iteration > τm then
      if "stagnation" occurs then
         Randomly choose a point x^l
         y^l ← Leap(x^l)
      end if
      τ ← τ + 1
      δ = μ_δ δ
   end if
   iteration ← iteration + 1
end while
```

As the time limits, I only make three simple behaviors: searching behavior, chasing

behavior, leaping behavior. And the definition is as following:
searching behavior - when the fish discovers a region with more food, it will go directly and quickly to that region;
chasing behavior - when a fish in the swarm discovers food, the others will find the food dangling after it;
leaping behavior - when fish stagnates in a region, a leap is required to look for food in other regions.

In these three behaviors, I make some parameters into real integer for simplify the model.

And with this model, we can study the fishes' patterns especially with some extreme settings.

User Experience

1. Learner one:

   She actually is a student of biology. So she provided a lot of useful ideas.

   She tried on all the features and her feedback is more focused on the rules parts.

   She thought the roles introduced for fishes are too small. Forage fishes and predators is too far from simulating the marine system especially at the richest continental shelf. There are plenty kinds of fishes with more complex relationships among them rather than one specie can only eat one kind of food. Also, she suggested me to change the seaweed into plankton as food for forage fishes (which I have changed).

   She also introduced some brilliant ideas about fishes' behaviors. For example, the self-clean of the pollution and how pollution would affect the plankton rather than directly work on the forage fishes (I have applied both of these suggestions in my current model).

   There are also some other rules I am interested but did not have time: let the plankton's distribution follows the ocean current's flowing path and obverse how the fishes would act; introducing medium fishes which can feed on forage fishes, plankton and even large fishes (predators in my model); introduce coral reefs which is not only sensitive to temperatures but also pollutions. They would never recover once being damaged and so on.

2. Learner 2:

He is a computer science student.

He started with the main model. I have an introduction about my model at first. Then he tries this by himself. He first got confused by the button create and setup. After my explanation, he set up with 13 boats and watching the whole ecosystem reaches a balance. He asked some question about what are planktons and why they can regrow by time.

He changed some setting such like fish initial number and he found that there are only several cases that keep the whole system to be balanced while the relative factors are too many to make a good control.

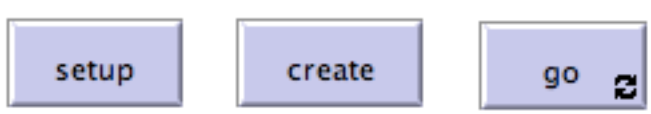
After this, he tried drawing an island on the screen and draws a reproduce source inside the island. Then based on the former balanced settings, he get a quick disappear of predators and forage fishes. The forage fishes were dying around the island but cannot get through. He is interest by this feature and ask about what is the fish migrations.

He also used the pollution feature, he agreed with the self-clean rules, but he thought maybe adding the spread of pollution would be more realistic.

At last, he tries the additional small model.

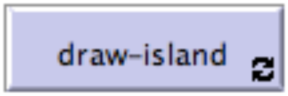
Guide for interface

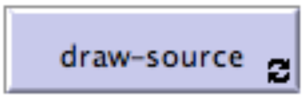
Main Model

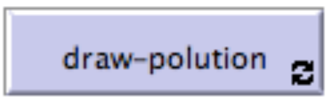


Setup: set up the planktons and ocean.

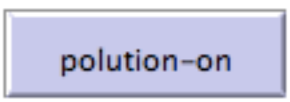
Create: create the forage fishes and predators and boats (if human-involoved) on the screen.
Go: keep on running.

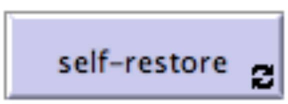




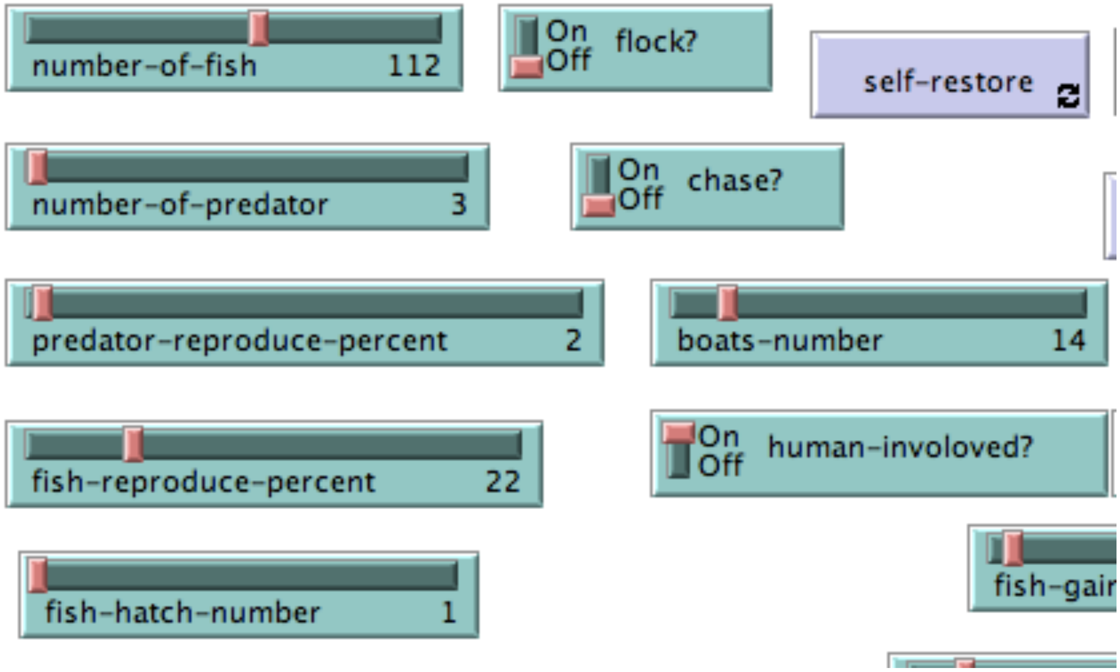


These three buttons are used for drawing island, reproduce source, pollutions on the screen. (You can choose mouse-down by deciding the drawing method)

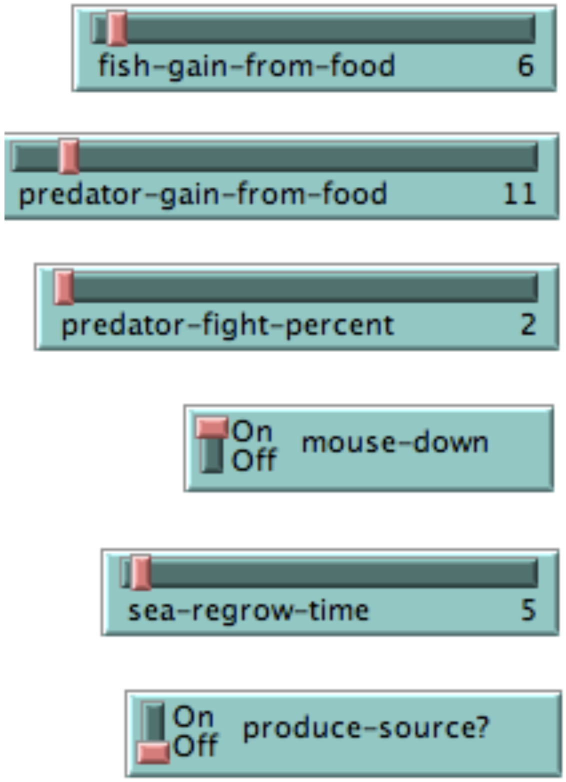




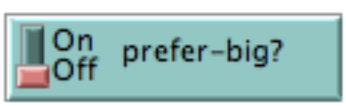
After drawing the pollution on the screen, you have to click on the pollution-on button to make the pollution "alive" in the system. When you decide to move on and see the self-clean by the ocean, you can click on the self-restore button to let the ocean clean the pollution by certain amount of time.



These are the sliders and switchers to control the fishes, predators and fishing behaviors.

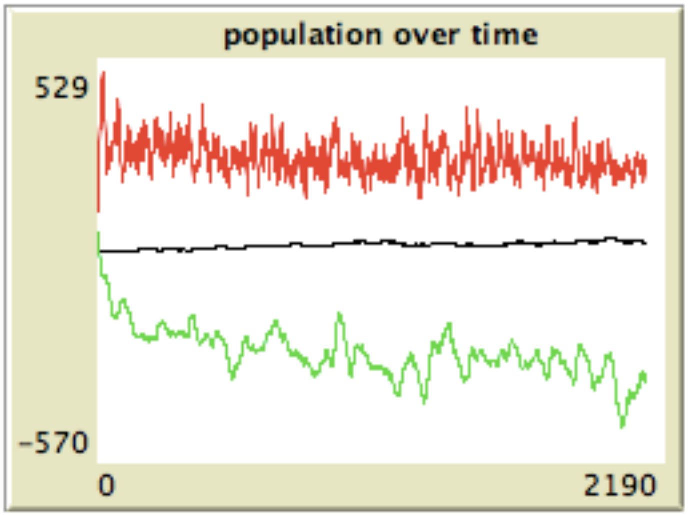


Other than the setting for fishes and predators, we use mouse-down to control the drawing method. And we use produce-source to decide whether to make the migration features on.

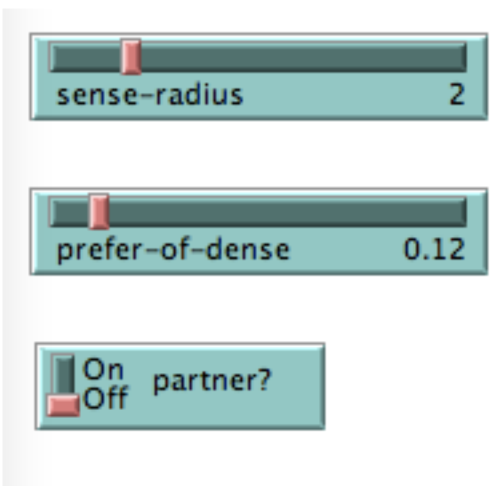


This is a slider that control whether the fishing by human has any preferences to hunt predators first.

And the following graph is the poster that informs users what is the total number for forage fishes, predators and plankton.



Addition Model



Sense-radius: is the furthest distance that fishes can sense.
Prefer-of-dense: is the factor determines that whether current fish would decide to get the nearby food based on how many other fishes are there.
Partner: is to choose whether to use chasing behavior or leaping behavior.