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Biomagnification/Bioaccumulation Computational Model Using NetLogo

PURPOSE:

This computational model is intended to demonstrate how micropollutants effect ecology via the living environment concepts of biomagnification and bioaccumulation. Specifically, this model shows how concentrations of a micropollutant change throughout an aquatic food chain.

The larvae (trophic level - primary consumers) consume a quantity of micropollutant allowed by their small size. Fish (trophic level – secondary consumer) consume multiple larvae and, with each, the micropollutant within that larvae. In other words, the micropollutant consumed by the fish is the total of all the micropollutant consumed by its prey, the larvae. Seals (trophic level – tertiary consumer) consume numerous fish, and with them, the micropollutants within that were received from the larvae. Sharks (trophic level – quaternary consumer) consume multiple seals, taking in the micropollutants from all species previous.

In other words, the concentration of micropollutant increases with trophic level. Given that humans are typically considered the top trophic level of many food chains, humans have the potential to consume a great deal of micropollutant.

BACKGROUND CONCEPT CONTEXT:

Micropollutants include tiny industrial materials, plastics (washing machine lint, microbeads found in face cleaners), toxins, chemicals (such as fertilizers and herbicides, like DDT), and fragments of larger original pollutants broken down by sunlight, wind, and waves. In addition, plastic pollutants can collect other pollutants, creating a multiplicative on consumers.

Micropollutants, once consumed, can remain trapped in the digestive tract or absorbed and incorporated into body tissues of the consumer. Then, micropollutents can block digestion, arrest or reduce development, impact reproduction, and impede survival mechanisms (such as predator or prey detection). These impacts have resulted in a reduction of many species.

Humans are not only the cause of biomagnification through their many forms of pollution, but can be on the final receiving end of the environmental effects as well. As humans are frequently the top most consumer of many food chains, all of the micropollutents consumed by all organisms previous end up in them. This is of particular concern with regard to oceanic mercury levels and Japan's dependence on the sea for food.

COMPUTATION MODEL INSTRUCTION:

You first select the Setup button on the top left of the interface. By clicking this button, there should show a blue background in the interface and there should be an amount of micropollutants, larvae, fish, seals, and sharks on the screen as based on the amount you chose on the sliders underneath the Setup button. But you cannot start the simulation with any of the larvae, fish, seals or sharks sliders starting at zero.

The next step is to then select the Go button. By selecting the go button, you should see all of the turtles move on the screen continuously. The larvae will be following and eating the micropollutants, the fish will be following and eating the larvae, the seals will be following and eating the fish and the sharks will be following and eating the seals. At the same time, the larvae will be moving away from the fish, the fish will be moving away from the seals and the seals will be moving away from the sharks.

As each breed is eating one another, you will see the boxes that track the number of the micropollutants, larvae, fish, seals and sharks go down. You can repopulate each type by selecting the Add Micropollutants, Add Larvae, Add Fish, Add Seals, and Add Sharks buttons. The amount of each can be manipulated by using the designated slider for each breed which should be labeled appropriately. By selecting the Go button, the breeds should be automatically added into the screen. If you select the Go Once button, then you will have to select the Add“Breed” button and then select Go Once again.

Also being tracked is the average amount of micropollutants consumed by each larvae, fish, seal, and shark. The averages are shown in different monitors for each average. The amount of micropollutants consumed by the fish is the average amount for each larvae multiplied by the amount of larvae consumed divided by the amount of larvae total. The formula for micropollutants consumed by the seals would be the same formula except the amount of fish consumed is multiplied to the equation as well. The formula for micropollutants consumed by the sharks is the same formula except you multiply the amount of seals eaten to the equation as well.

There is also a graph displaying the averages for micropollutants consumed by each breed. There is a legend and each line is a different color for each breed. The line keeps updating as each breed keeps eats its prey.