In 1962, Rachel Carson published 'Silent Spring', which drew attention to how the use of pesticides was indirectly decimating bird populations by causing thinning of egg-shells. This model illustrates how DDT in near-shore waters accumulates in a 'food chain' of phytoplankton, zooplankton, smelt, salmon, and pelicans.

Background

There is a general phenomenon that organisms use only a portion of the energy they consume for growth. The remaining consumed energy is 'burned off' in metabolism, or passes through the animal undigested. For example, let's consider a gazelle eating grass. For simplicity, we will say that 10% of the energy consumed by the cow is used for growth. In this case to grow a 100 kilogram gazelle, it would have to eat 1000 kilograms of grass. Similarly, in the case of lions eating gazelles, it would take 1000 kilograms of gazelle (or 10 gazelles) to grow a 100 kilogram lion. Connecting the energy transfer from the grass to the lion (through the gazelle), it takes 10,000 kilograms of grass to grow the 100 kilogram lion. This is what underlies **trophic level energetics**.

Some substances, such as heavy metals like mercury and some pesticides, are not broken down by the organism that consumes them, and remain in their tissues throughout their lives. Thus, the organism retains all of these compounds that were in what it ate. Connecting this with the trophic level dynamics, these substances accumulate in the organism to about 10 times the amount contained in the organisms it is eating. This phenomenon is call **biomagnification**, or **bioaccumulation**.

This model simplifies the energy dynamics of a marine ecosystem to a 'food chain' of phytoplankton > (eaten by) zooplankton > smelt > salmon > pelicans. The pesticide DDT has runoff from the land into this near shore habitat. It is absorbed by the phytoplankton, and accumulates in the higher trophic levels over time.

Using the Model

With a java-enabled web browser go to:

http://virtualbiologylab.org

Under the Conservation Ecology menu, click the 'Biomagnification model.

The model opens on a virtual shoreline. Phytoplankton and zooplankton drift by in the current, smelt and salmon swim around feeding on them, while pelicans attack the fish from above. The graphs below the world view show the current average concentration of DDT among individuals in each population. This starts at zero and builds up over time (note that the Y-axis scales are different in each case). In this model when an individual is eaten or dies it is replaced with a new young individual whose DDT concentration starts at zero. Because of this, there is more variability among the larger and longer-lived species. The level of DDT contamination can be adjusted while the model is running (e.g. to observe the effects of environmental cleanup).

Figure 1: Screen shot of the Biomagnification simulation

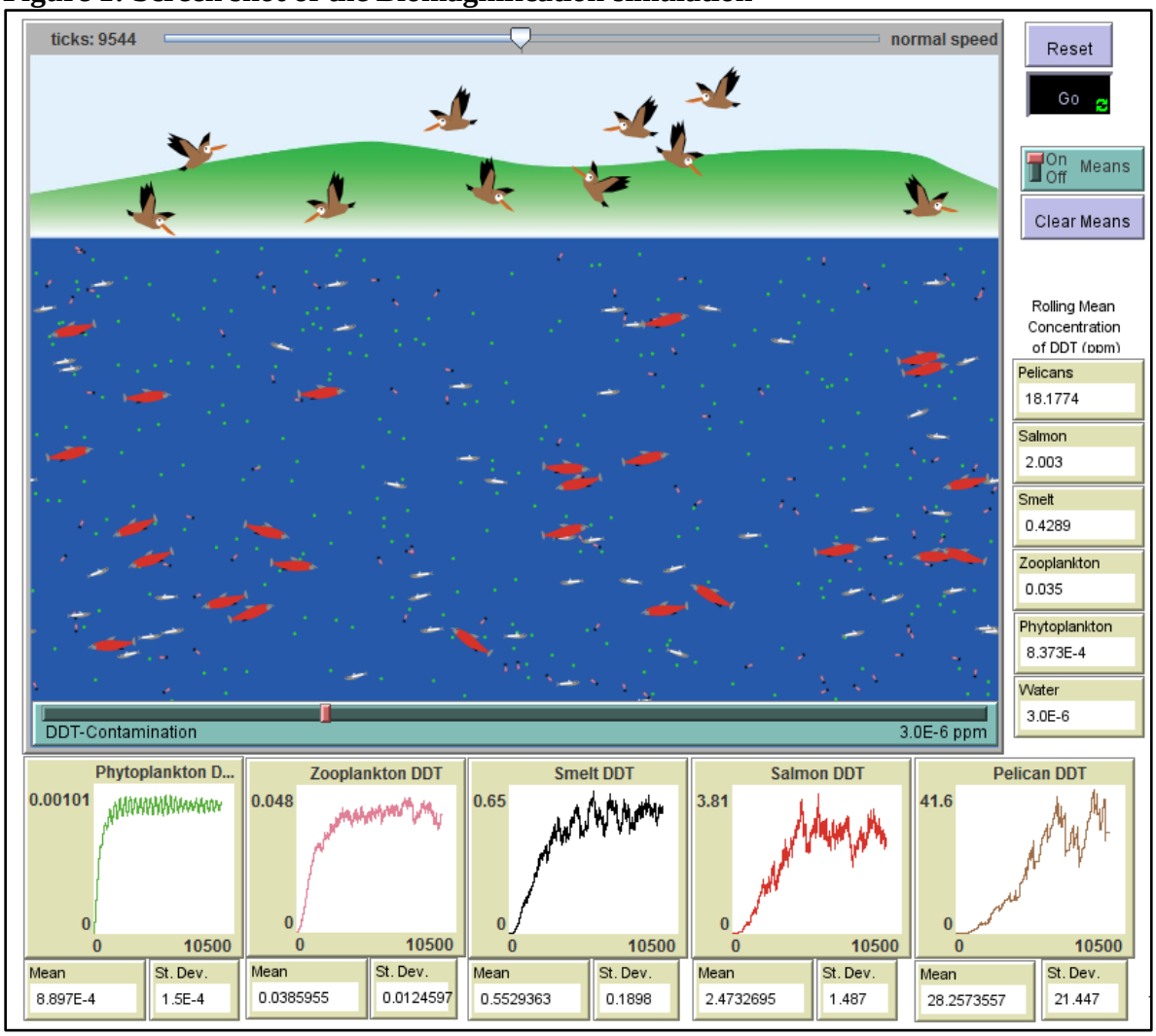

Table 1: Controls and reporters for the 'Microcosm' simulation

Control	**Effect**
Setup	Resets the model to the parameters shown
Go	Sets the model in motion
Means (switch)	Begins recording a rolling average of DDT level by species
Clear Means	Resets the rolling average
DDT Contamination	Slider which adjusts the level of DDT in the water
Reporter	**Description**
Rolling Mean	A' smoothed' quantification of DDT contamination by species
DDT concentration	(Graph) The current concentration of DDT (ppm) by species, means and standard deviations for the populations are displayed below

References

Carson, R. 1962. Silent Spring. Houghton Mifflin Co., Boston.