# Computer Simulation of a Solar Pond

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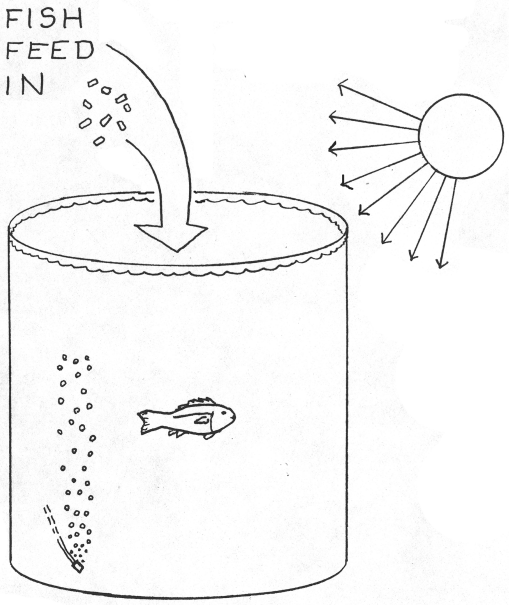
## The Biology and Chemistry of Solar Aquaculture

For aquaculture research, solar ponds can be treated like very large test tubes. Two solar ponds can be placed side-by-side and tested against each other by treating one different than the other. Or 10 solar ponds can be tested at once, with 10 different treatments. The biological activity in each one will be different than the others, and the fish will be observed to grow faster or more efficiently in one than another.

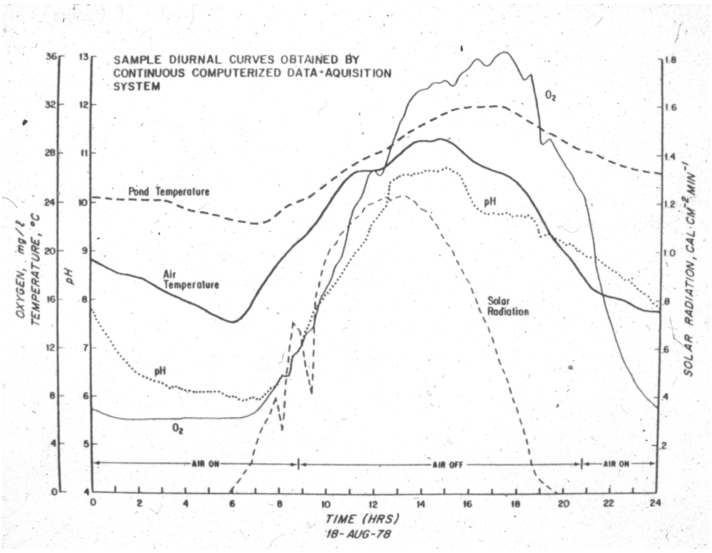



From 1974 to 1986, New Alchemy used this test tube approach with the aim of learning how to grow fish for human food Experiments were done with different kinds of fish, numbers and sizes of fish, types of fish feeds, rates of feeding, methods of aerating, amounts of reflected sunlight, and a myriad other factors.

The simplest variables to test are the fish in the pond(type, size, number), and the kinds and amounts of fish food fed to the fish. Other variables that can be controlled are rates of aeration, rates of harvest of fish, and periodic adding of fresh water.

Some other important variables are not so easy to control, such as the amount of sunlight each day. The aquatic ecosystem in a solar pond is greatly affected by sunlight. With more sunlight, the water gets warmer, biological activity increases, the algae make more oxygen and take up more carbon dioxide, and the water chemistry changes. All these things affect how well the fish grow.

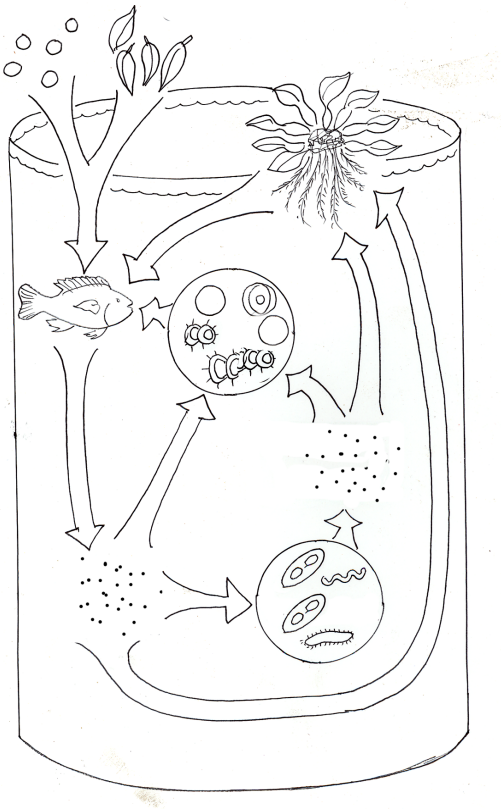
Over a 24 hour period. the effects of sunlight on a solar pond reveals a daily cycle of warming and cooling and changes in oxygen land pH levels of the water. Sunny days show different patterns than cloudy days. And the fish grow at different rates, depending on their temperature and water chemistry.

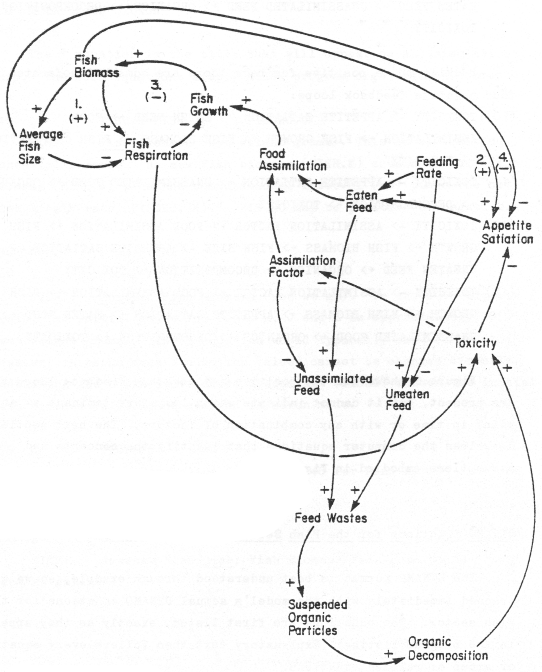


# Using Computer Models To Study Aquaculture

After years of careful observation, analysis, and diligent precise measurements, New Alchemy's aquaculturalists gained a detailed understanding of the processes in a solar pond. But the processes are astonishingly complex, and often involve a web of non-linear interactions that are too complex for a person's brain to calculate or predict.

So to refine their understanding of the thermodynamics and biochemistry of the solar ponds, New Alchemy's researchers constructed a mathematical model of the interactions within a solar pond. The value of a modeling approach is that, if one can craft a model that is accurate in its rates and interactions, the model can be used in predictive ways to test how well a future pond might do if managed in a particular way.

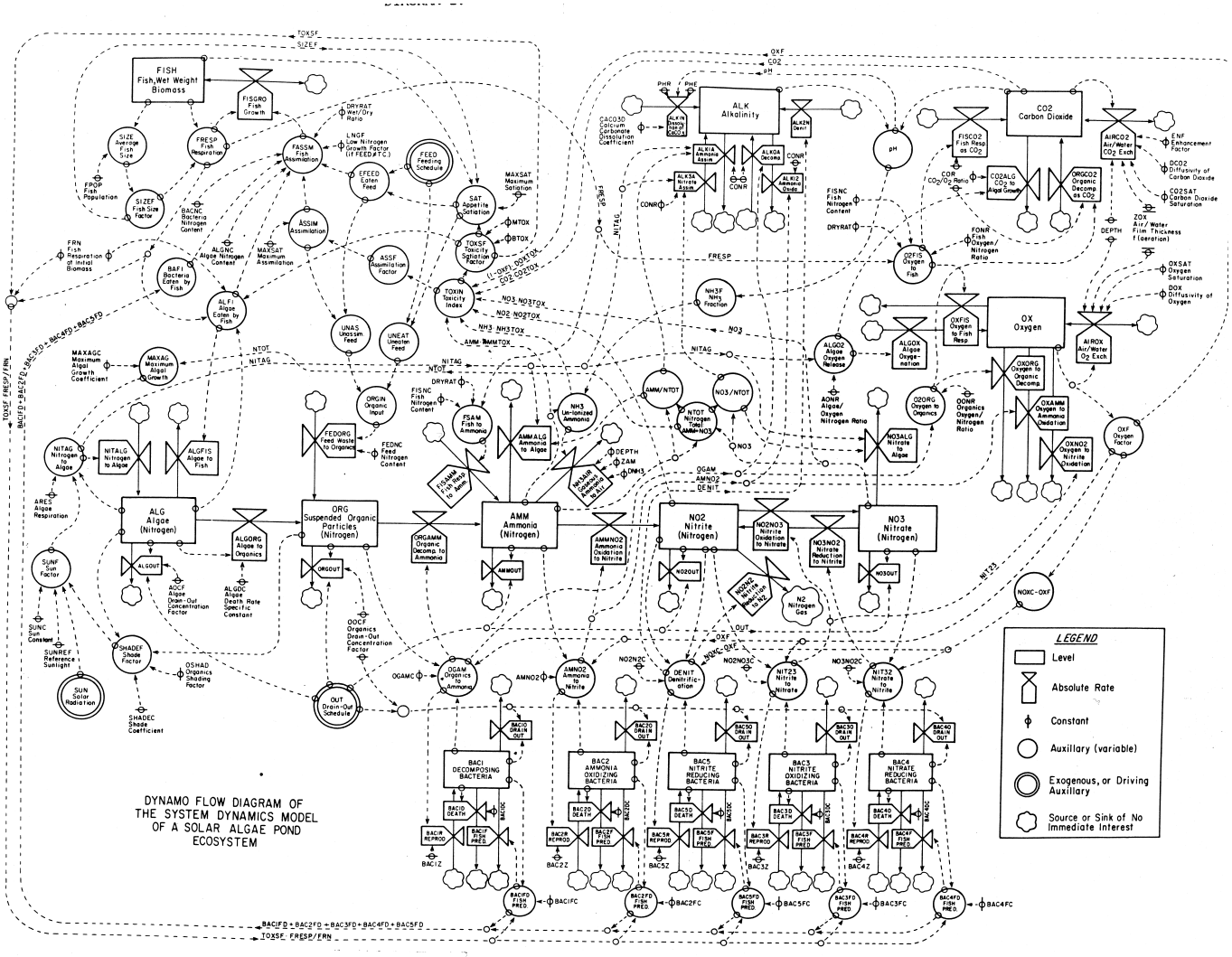





They started with a simple model of the most obvious patterns of cause and effect. For example - adding fish food caused the fish to grow, but gradually accumulated wastes that slowed the growth down. Each cause and effect
Was entered into the model as a mathematical rate, that changed as temperature or oxygen or light levels changed.

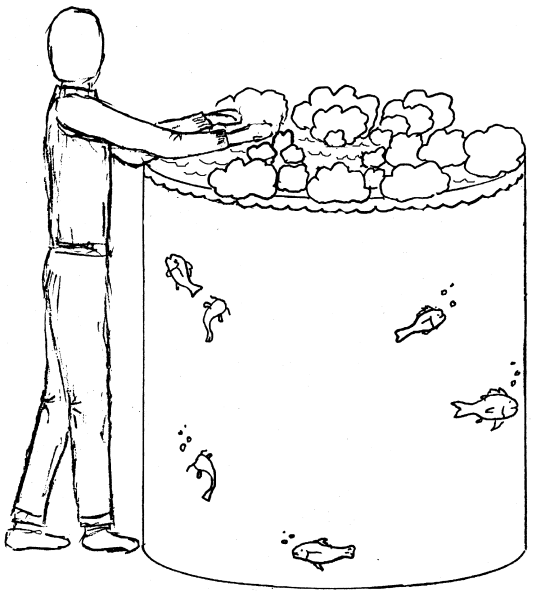
The model was gradually improved and made more detailed, and was tested against reality by entering data from real solar ponds to see if the model was accurate enough to reproduce what actually happened.

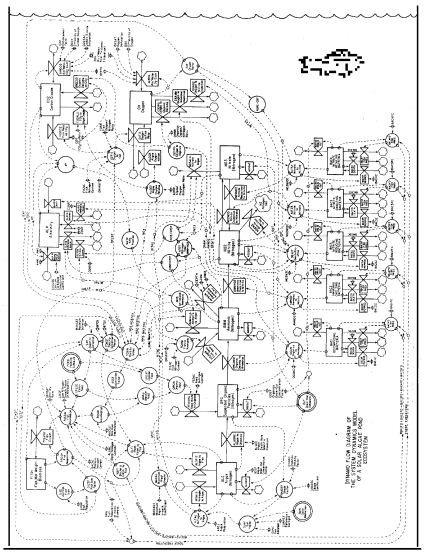
Eventually the computer model was good enough to accurately simulate the workings of a real solar pond. A hypothetical solar pond could be started with a certain number of fish, fed daily with a certain amount of fish feed, aerated at a certain rate, and impacted by typical patterns of sunlight and temperatures. The growth of fish in the computer model's virtual pond was found to closely resemble what actually happened in a real pond under the same conditions. The model can be run to simulate several months of time to find out how well the fish would grow, and whether any bad water quality would develop.






A Mathematical Model of Aquatic Reality in a Solar Pond





One of the implications of having an accurate simulation model is that it can be used to predict in advance how well an aquaculture pond would perform in some hypothetical location, say a sunny sidewalk in Philadelphia , or a backyard in Brooklyn.  Plug in the expected average weather, add whether the pond gets extra light reflected from a nearby wall, and see how much fish could be grown there.