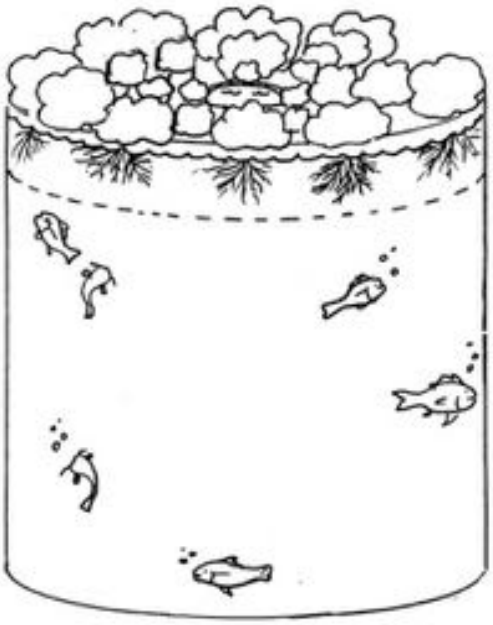
Zweig-Pond Aquaponics

Earle Barnhart 2018

Growing Fish and Lettuce in Solar Ponds

From 1971 to 1991 New Alchemy Institute researched growing edible fish on a household scale. The goal was to grow high-quality fish protein in a small, clean, controllable pond, using home-scale technology and minimum fossil fuels. After many years' inspired trial and error, backed by meticulous science, they developed techniques for fish culture in solar ponds - large transparent cylinders of water for aquaculture. The most sophisticated version of solar pond aquaculture was developed by Ron Zweig. Fish are grown in a solar pond and lettuce grows hydroponically on the surface.



- Hydroponic lettuce on floating styrofoam channels
- Central opening for feeding fish
- Screen to prevent fish from eating lettuce roots
- Fish production in pond below hydroponics

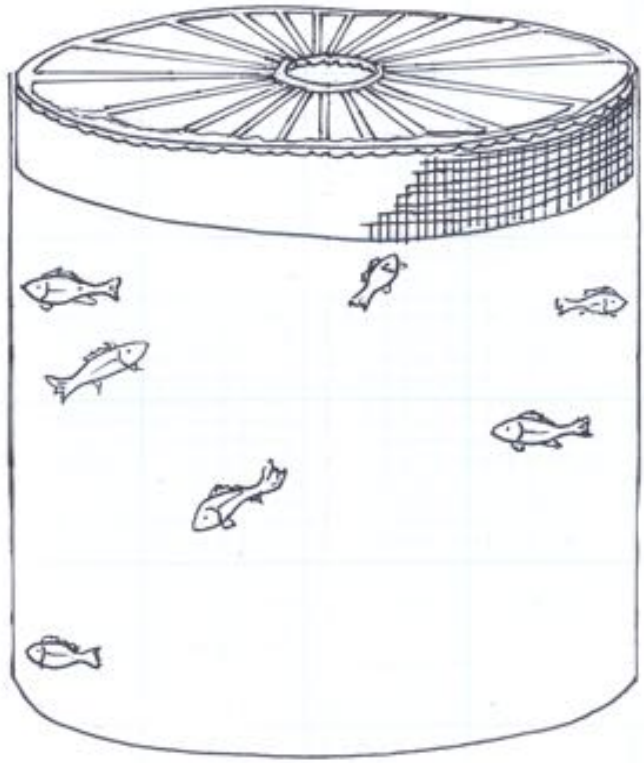
An advantage of this system is the minimal structure involved - a pond, 3 continuous aerators (which are essential), and a floating foam tray structure. No water pumps, no piping, no filters, no clarifiers, no plant troughs, and no rooting media.

Also, the pond is biologically very stable after the first 2 weeks, after the roots of the lettuce become covered with denitrifying bacteria and aquatic micro-organisms. After week 4 the lettuce removes nearly all dissolved nitrate, eliminating growth of algae in the water. When the pond is working properly, the water is clear.

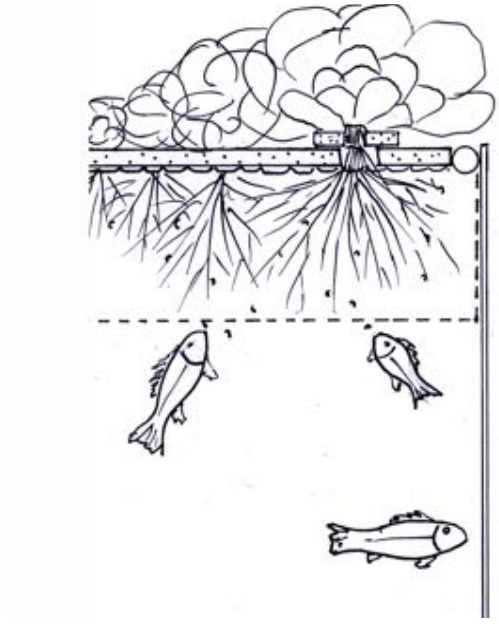
Zweig-Pond Design

The lettuce are grown in channels on a floating tray. In the center is an opening that lets fish come up for fish food. The lettuce roots are protected from being eaten by the fish with plastic screen.

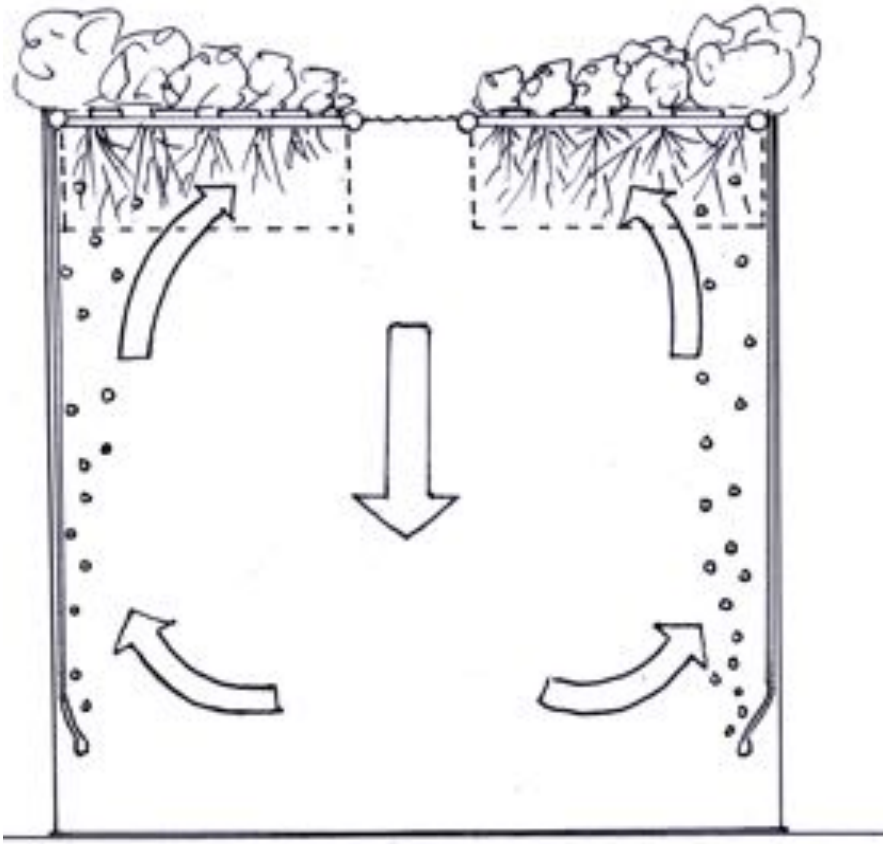
Small 2-week-old lettuce plants are started at the center of the pond and as they grow larger are moved outward along the channels toward the edge. The lettuce is harvested from around the top of the solar pond. Sixteen lettuce plants can be harvested each week.



With good daily sunlight, the lettuce at the edge of the pond is harvested after growing for 6 weeks. Each lettuce head weighs about 450 g.



Three air lines with bubblers are placed around the sides of the pond, near the bottom. Constant aeration adds oxygen to the water and makes the water constantly circulate through the roots of the lettuce plants

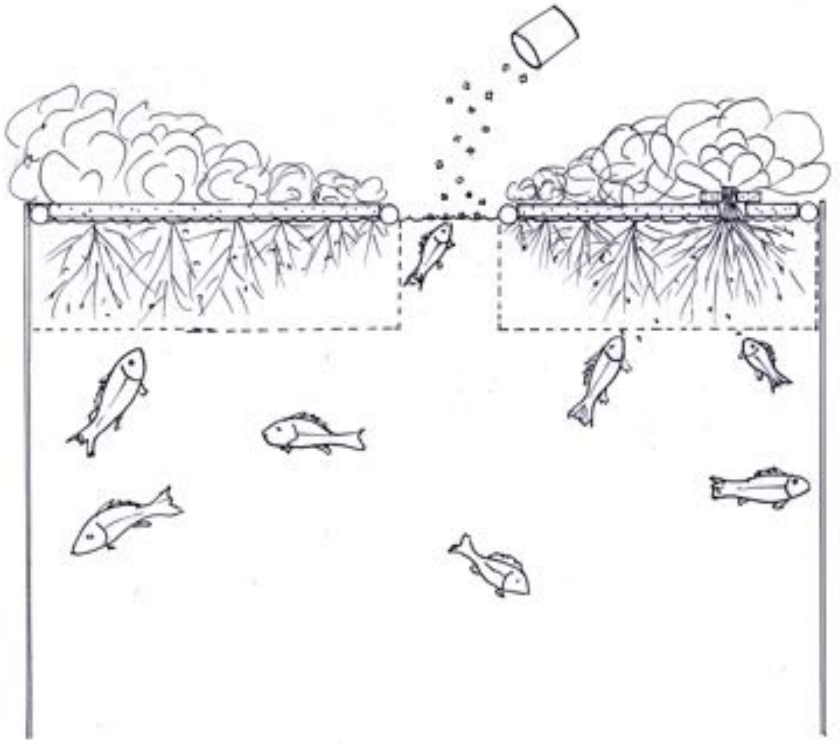


The many fish all need oxygen all of the time, more than can come in naturally from the water surface.

Note that maintaining aeration to 3 air bubblers that are 4 ½ feet deep, continuously, without fail, for months-to-years is much harder that it seems.

If the aeration stops, the fish can survive for only a day. The lettuce tray should be removed soon if aeration is not fixed.

Fish eat fish food at the center opening. They also eat aquatic organisms that live among the roots of the lettuce. The lettuce roots filter particulates out of the water, which are then eaten by bacteria, zooplankton, nematodes, midge larvae, copepods and others.



The roots also function as a surface for nitrifying bacteria, (Nitrosomonas and Nitrobacter) which controls and converts dissolved ammonia to nitrate, which is then taken up by the plants as fertilizer.

A Zweig Pond starts with 5.5 kg fish in a 5' high, 5' diameter, translucent fiberglass cylinder containing 700 gallons of water. The pond should be in a sunny location. The fish are fed daily for maximum growth (commercial trout chow fish food at 3% of their body weight per day to a maximum of 990 g.), and the nutrient wastes of the fish in the water are absorbed by the growing lettuce. Removing waste nutrients from the water promotes better growth of the fish. Aerators bubble air into the pond water continuously. Each week 500 g. dolomitic lime is added to the pond, to provide magnesium that the lettuce needs that is not in the feed. Each week an additional 500 g. normal lime is added to maintain high alkalinity. Each week 20% of the water is removed, and replaced with 20% fresh water.

Edible fish are harvested monthly or seasonally. To harvest the fish, the entire hydroponics apparatus is lifted out of the pond.

Tests were carried out growing tilapia and growing yellow bullhead catfish. Catfish can tolerate lower temperatures than tilapia. Weekly growth of fish is about 580 g. (@ 60% edible = about ¾ pound)

Follow the Nutrients

Though not obvious, in a Zweig Pond there is a critical successful balance between the amount of fish in the pond, and the amount of fertilizer needed by the lettuce that will fit on top. The correct amount of fish is 5.5 kg (the total weight of all the fish, which can be many small fish or fewer larger fish). When fish eat fish food, about 60% of the nutrients in the fish food become fish waste (dissolved and particulate) Enough fish must be grown in the pond (and fed 3% of body weight daily) to produce enough waste nutrients in the water for the growing lettuce. The amount of nutrients added in the fish food each week has to be the same amount as the nutrients removed in the harvested lettuce each week.

This balance between amount of fish feed added and nutrients in the crop that is harvested is misjudged in many aquaponics systems. If the number of fish is too small (or the feed to them is too little) or the area of hydroponic plants too large, there will not be enough nutrients for the plants to grow well. No matter how fast or slow the water is circulated to the plants, it will not be enough altogether for continuous production.

Simple, Compact, Modular, Mobile

Solar pond aquaculture also have the advantage of being simple, modular units that are movable. They can be placed in any sunny location which can have an air supply for the bubblers in the pond. They have been tested successfully outdoors and in passive solar greenhouses.

References:

(see) www.newalchemists.net

"An Integrated Fish Culture Hydroponic Vegetable Production System" Ronald D. Zweig AQUACULTURE MAGAZINE May/June, 1986 pp 34-40