Summary of Fish Culture Techniques in Solar-Algae Ponds

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Although the ultimate aim of the National Science Foundation sponsored closed-system aquaculture project is to write "The Compleat Guide to Solar-Algae Pond Fish Culture," we continue, in the meantime, to be inundated with inquiries about how to raise those funny fish in those whatchamacallit fish tanks. We hope, dear readers, that this short summary will at least partially satisfy your craving for information, pending publication of the "Compleat Guide."

Basic Strategy

Algae grow in sunlight and absorb toxic wastes. Fish eat algae, bottom detritus and added feeds. Bottom sediments (dead algae and fish wastes) are periodically removed.

Dimensions and Materials

Shape: Cylinder on flat base.
Dimensions: Ponds at NAI are 60" high by 57" inside diameter. Water volume is 2.4 cubic meters or 630 gallons.

Materials: Sides and base are light-transmitting fiberglass-reinforced polyester (FRP). Units can be purchased from Kalwall or assembled on site using .04" Kalwall Premium Sunlite or perhaps Lascolite (tedlar FRP). Seams can be sealed with water resistant epoxies such as Arcon 2795 resin combined with Versamid 140 catalysts.

Both outdoor ponds and those in greenhouses need wintertime insulation (vertical reflectors to the north and adjacent ground reflectors help too). An insulating air space can be created with a second layer of FRP around the sides, shimmed out at the top and bottom with rings of discarded garden hose or *1/2"* flexible plastic pipe. Insulate pond bottom with styrofoam. If pond is indoors, insulate the top with a conical FRP cover. If outdoors, flat lids can be made from sheets of closed-cell styrofoam reinforced with wood, or double-walled inner-ribbed acrylic or polycarbonate sheets (e.g., Tuffak-Twinwall or Acrylite SDP), edges sealed with wide tapes (e.g., duct, or Tuck). Consider wrap-around night insulation for climates with more than 6,000 degree days.

Algae

Introduce a wide range of wild algae species by adding a few ounces of the greenest pond-water available. Try several eutrophic (overly fertile) ponds. Alternatively, let the pond seed itself. Algae on the fish, along with exposure to spores from the air, are often sufficient to inoculate a pond with algae. Tilapia, grass carp and Israeli carp can keep the pond sides clean of algae.

Feeds

Leafy plants: Comfrey plants (35170 protein), vetch, purslane and alfalfa, among others. Comfrey *(Symphytum sp.)* can also be ground and dried into pellets for storable feeds.

Zooplankton: Excellent fish food, difficult to culture, they thrive in shaded water rich in organic matter. Zooplankton can also be established in fish ponds by partitioning fish out of an area where the zooplankton can't be eaten to extinction.

Insects: Caught by nets, conical fly traps or Hedlund's bug lights.

Red worms: See Jeff Parkin's "Some Other Friends of the Earth" in the *Journal 5, pp.* 69-72, for culturing methods. Our bedrun breeders come from Maryland." Feed the worms whole, or blended into ground. leaf pellets.

Rabbit feed. Essentially alfalfa and soy meal bound together with corn gluten (20% protein).

Trout feed: First three ingredients are soy meal, fish meal and ground corn (4070 protein).

FISH SPECIES AND FEEDING HABITS

FEED TYPES

Fish Species	*Planktonic Algae*	*Leafy Plants*	*Detritus*	*Zooplankton*	*Insects Worms*	*Rabbit Feed*	*Trout Feed*
Blue Tilapia *(Sarotheradon aureus)*	x	@	x	x	x	x	x
Tilapia hybrid *(S. mossambica f.* x *S. honorum m.)*	x	@	x	x	x	x	x
Sacramento River Blackfish *(Orthodon microlepidotis)*	x		x	x	x	?	x
Israeli or Mirror Carp *(Cyprinus carpio specularis)*		@	x	x	x	x	x
Grass Carp or White Amur *(Ctenopharyngodon idellus)*		@	x	x	x	x	x
Black, Brown & Yellow Bullheads (Ictalurus melas, nebulosa & natalis)			x	x	x		x

Tilapia die at temperatures below 54 degrees F. or 12 degrees C. @adult fish
Fish need to be introduced to new water carefully to avoid temperature and chemical shock. Put the fish in a plastic bag, puffed up and tied closed, with little water and mostly air.

Float the bag in the new water for half an hour (temperature acclimation). Then exchange 25 % of the fish's water, three times at ten-minute intervals (chemical acclimation). Release the fish.

Fish Densities
Upper limit about 20 kilograms or 45 pounds.
Optimal density is probably between 3 to 12 kg. or 7 to 2 6 lb.

Feeding Rates
Maximum (use whichever is lowest): 200 grams dry weight feed per day or daily dry weight feed at 5% of live fish weight (can be greater for fingerlings or fry) or all the food the fish can eat in three or four hours (use floating feeds to check this). Any feeding rate greater than the number of gm/day listed above tends to deplete oxygen in water.

Optimal: 50- 100 gm/day or 3% fish weight daily or most reliably, the amount of food the fish will eat in 15 minutes.

Minimum: Nothing but inedible organic inputs such as manure. The fish will eat the resulting algae, bacteria and zooplankton. Expect slow growth.

Growth Rates

The food conversion ratio (FCR) is the unit of dry weight feed required to grow one unit of wet weight fish. The FCR for tilapia eating Trout Chow ranges from .8 to 2.0. The tilapia FCR for rabbit feed ranges from 1.5 to 3.0.

The maximum recorded growth rate to date is 106 lb/yr (132 gm/day) over an 82 day trial conducted at Goddard College, using fresh insects for feed. Consistent good growth at NAI is 30-50 lb/yr (45 day 65 gm/day) over 100- trials using dry commercial feeds.

Aeration

In moderately fed ponds, aeration (air bubbling) to supply oxygen is usually needed from two to four hours after sunset to one to two hours after sunrise, except on cloudy days when aeration should begin near sunset. On cloudy days in heavily fed ponds, aeration is needed continuously.

The simplest aeration is to pump air through plastic tubes into air diffusing stones located near or on the pond bottom, An aquarium pump such as the 3 watt Metaframe Hush 1112 can supply two air stones with air. Two to four air stones are needed per pond. On a larger scale (a dozen or more ponds), consider a central air compressor such as the one-third horsepower Conde' air pump attached to flexible 3/4" plastic piping with smooth curves rather than right-angle bends.

Water Purification

Method #1: Remove bottom sediments and replace with fresh water. If feeding rates are heavy, replace the bottom 20% of the water column every one to three weeks. If feeding rates are light, replace 20% every four to twelve weeks. Irrigate plants with the pond water; it's loaded with nutrients. If you want to become scientific, find an old microscope and look at algae in mid-water samples. Replace bottom water more frequently after seeing major volumetric decreases in algae.

Method #2: Consider a constant fresh water trickle inflow, with an outflow siphoning up from the bottom. Make water replacement equal or exceed the rates described above.

Method #3: Install a sand filter or hydroponics trough just above the surface of pond and slowly flow water through it, preferably drawing from bottom waters. Sand filters out algae and some organics; the plant medium filters out this plus nitrate, ammonia and phosphate. Turn off the flow to the hydroponic filter during the day to allow the plant roots to dry, preventing root rotting problems. Use algae-laden sand from sand filter as plant fertilizer.

Lots of other untested possibilities exist: adjacent settling ranks, conical bottoms with a drain in the center, etc.

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