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Agricultural Development and Diversification (ADD) Program
1994 Grant Final Report

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Grant Title Economic Feasibility of the Intensive Aquaculture of Yellow Perch

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Wisconsin Department of Agriculture, Trade and Consumer Protection
Division of Marketing, Wisconsin Farm Center
Agricultural Development and Diversification (ADD) Grant #L94022

"Economic Feasibility of the Intensive Aquaculture of Yellow Perch"

Summary of Final Report
May 15, 1997

Grantee: Rick Wehrle
New London, WI

The objective of this project was to study the "operating profit" economic return for the production of yellow perch using the simple single pump recirculation system, the soundness and dependability of the system and to determine the capital and operation expenses of the system.

As a result of this project Wehrle concluded that the single pump recirculation system was a sound facility to raise yellow perch, but needed several modification to be economically viable. In particular, he suggests raising the fish in a series of smaller tanks rather than a single tank. Fish could then be moved from one tank to another, keeping fish of similar size in groups. This may reduce the predation of smaller fish by larger fish and may increase the growth rate for each group of fish.

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Final Report is 14 pages.

Economic Feasibility of the Intensive Aquaculture of Yellow Perch

Project Leader: Rick Wehrle

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WDATCP Contract Number: L94022

Project start: May 1, 1995
Project completion: December 1, 1996

Objectives of The Project

1. Determine the economic return for the production of Yellow Perch using a simple single pump recirculating system. The criteria being used to determine the economic return is "operating profit". This excludes the cost of the start-up capital. Before a larger investment would be made,one would need to determine the return on the capital investment.

2. Determine the soundness, dependability, and advantages & disadvantages of a single pump recirculating system.

3. Accurately determine the capital & operation expenses for this system.

Overview of Project

The fish were purchased @ 1.5" in length from a hatchery in New London, WI. These fish were naturally spawned and raised to the 1.5" length in ponds. Therefore, the fish were naturally feeding on zooplankton and needed to be converted to commercial food. Once the conversion to commercial food was completed, growing-out of the fish required maintaining water quality, establishing feeding schedules, and maintaining water temperature. The duration of the project was 16 months.

This system was designed to have specific advantages over larger more expensive systems. The main advantages of this system are:

- Low water consumption-no effluent treatment required
- Low energy consumption
- Low initial and maintenance investment required
- Potential as add-on or conversion agriculture for dairy industry

Overall the outlook for this industry looks extremely promising. Yellow Perch are in high demand and established markets exist. Natural populations continue to decline and therefore, the opportunity exists to meet this demand through aquaculture.

Design of System (attachment A)

Preparation of Area For Installation

The area where the main tank and filters were going to be set needed to prepared. A concrete barn trough was in place and needed to be removed and the floor patched and made flat. Concrete is the best surface to work on. It provides a strong support and will not allow the metal main tank ring or the filter support to sink and possibly shift. Additionally, any water accumulation can be swept clean and mud will not form as it would on a dirt floor. A place to push or sweep water for drainage is desirable. A barn gutter was present in the barn I was working in and provided a good place for water to drain. Expect that water will be on the floor at different times. This may be when cleaning filters or possibly from leaks or overfills however, no matter how you plan to have no water spillage, *it will occur.*

Electrical upgrading was required in the barn I was working in. I was capable of doing this myself however, seeing water is around with electricity, make sure that the electric system around the tanks is properly installed. Also ground fault interrupters should be used.

Main tank

The system constructed consisted of a round tank 8.5' in diameter with a 4' side wall. The tank wall construction was made from 14 gauge non-galvanized sheet steel. Sheet steel is sold by 4' X 10' lengths which weigh approximately 160 lbs. These lengths were cut in half to 4' X 5' and then rolled to the approximate arc of 8.5' in diameter. This made an 80 lb piece which could be handled and positioned. 3-10' lengths were purchased and cut and rolled resulting in 6-5' pieces. The 4' X 5' pieces were overlapped by approximately 6" and drilled with 3/8" holes. 3 holes were positioned along each overlapped seam. The sections were then bolted together to make a free standing ring. The bolts were inserted with the round ends toward the inside of the tank where the liner was placed. Care must be taken that there are no burrs or sharp edges left on the inside liner side of the ring. The outside ring must be leveled to assure a level water line around the edge. I did not paint or coat the ring. This could be done as long as the paint was thoroughly dry before the liner was inserted or galvanized steel could be used. The tank will sweat and condense on the outside if the outside air temperature is moist and warmer than the water/metal ring temperature. This will cause corrosion of the outside metal ring. This is not a problem with 14 gauge steel which can be cleaned and sanded between batches of fish. If thinner steel is used and corrosion begins, strength could become an issue. 14 gauge steel is recommended if using flat non-corrugated steel. The thicker 14 gauge steel also allows for support from the side walls and cross members of wood or metal can be placed across the 8.5' diameter as supports for pipes, feeder, covers, etc. without worrying about collapsing the side walls.

The tank ring bottom was filled with sand. This was done to make a soft non-abrasive surface to lay the liner against. In addition, the sand was molded to be higher at the side walls and taper to the middle to make a conical bottom to the tank. This is desirable for solids removal in the tank as the solids tend to collect toward the lower center of the tank.

Liner

The liner used was a 30ml high density polyethylene liner. This liner was fabricated and donated by YUNKER PLASTICS INC. Lake Geneva, WI. This black liner material is extremely strong and durable and puncture resistant. The liner is fabricated in the round dimensions of the tank. This is much better than trying to lay a flat liner in the round tank ring which causes large folds along the sides. The black color (I have heard) is used so the fish can hide easier. This calms the fish and prevents spooking. I personally do not know if this is true. The black color does make it difficult to see the fish in the tank. Direct top-lights work the best with the black liner to see the fish. One advantage to the black color liner would be if the tank was exposed to sunlight and solar heating was desired. Over this project the liner has performed excellent and no leaking or puncturing has occurred.

Lighting

One single spot light on a timer was used for the main lighting in the tank. The light was positioned to one side of the tank providing dim light on the opposite side of the tank. This allowed the fish to avoid the direct light and hide on the darker side of the tank which they commonly did. Feeding was done directly under the light and allowed for the fish to see the food as it was added in the tank.

Pump

A single submersible type of pump was used in this system. The importance of a good quality pump for this type of system cannot be understated. The pump is the heart of the system and if it fails, you will fail. This pump supplies both the filtration & spray-bar water. Some general guide lines to consider when selecting a pump for your system are as follows:

- Generally there is a trade-off on expense of the pump with the volume capability.
- As the volume capacity increases the energy consumption usually increases.
- Get a pump that is rated for continuous-duty.
- Submersible pumps throw heat into the water this is OK if desired
- If a submersible pump is used get the encapsulated version and not the oil-filled version. The oil can leak and kill fish or short out the pump and cause an electrical hazard.
- When looking at the volume capacity remember to consider the head (height of pumping)

Sizing of the pump for the system:

Tank size in gallons	1100 gallons
Water exchanges/hr through filtration	1 time
Minimum volume @ 5ft head	**1100gallons/hr**
(5 ft head is level of water in filtration)	**18 gallons/min**

Energy consumption of the pump:

Rated Amps on the pump	2.4 amps
Amps X volts (115 volts) = Watts	276 watts
÷ 1000 for Kilowatts	.276 KW
X 720 hrs/month	198 KWHR
approx. $.06/KWHR	
Approximate cost to operate/month	**$11.92/month**

Another important consideration of the pump is the inlet screen available on the pump. It was necessary for me to increase the surface area of the pump intake to reduce the flow into the pump. The 1.5" fingerlings can easily be either sucked into or up against the inlet of the pump killing them. I increased the inlet size by placing the pump inside a 5 gallon pail and than covering the top opening with window screen. This reduced the flow enough to stop the fingerlings from being sucked up against the inlet.

Bio-Filtration

The system design used a two stage bead filter setup positioned vertically along side of the main-tank. The first stage filter is an up-flow bead filter. The poly beads used in the filters have a lower density than water so they float up in the filter on top of the water. The water enters the first stage filter through a hose which is positioned below the bead level at the bottom of the filter. The water flows up through the beads in the filter and then exits the 1st filter by cascading out of an outlet pipe at the top of the filter. This 1st filter is filled approximately 2/3 of its capacity with the poly beads. The exiting water enters the second "trickle filter" at the top and then trickles down through the 2nd filter which is also filled with poly beads. The water exits the 2nd filter at the bottom and goes back into the main tank. The water exit in the 2nd filter is large enough to drain and not allow for the water level to build. This is important for the bio-conversion of ammonia in the 2nd filter. The 2nd filter is filled approximately ¾ of its capacity with the poly beads.

The main function of the 1st up-flow filter is for suspended solids removal. This filter also provides some bio-filtration of ammonia however, agitation of this filter during cleaning can damage the bio-film on the surface of the beads reducing the efficiency for ammonia conversion. This is the reason that the second "trickle filter" is used.

The solid waste settles towards the center of the conical shaped bottom of the main tank. The submersible pump is positioned in the center of the main tank to maximize picking up the solids in the tank. This waste containing water mixture is pumped into the 1st filter and flows up through the beads. As the water/waste mixture flows up through the beads, the fluid flow is slowed in the small void spaces between the beads. This actually allows the suspended solids to be settled out in this filter. This filter also contains an agitation prop that is driven by a motor positioned over the top of the filter. This prop is positioned toward the bottom of the filter to agitate the lower most "dirtiest" beads. Once daily, the flow is stopped to the filter and the beads are agitated. After the agitation, the beads are left undisturbed for approximately 5 min. This allows for any solids removed from the beads to settle in the bottom of this filter. The filter is then tapped from the bottom to remove the concentrated waste.

The 2nd filter is mainly for bio-conversion. This filter is not agitated which allows for the growing of the ammonia conversion bacteria on the surface of the beads. Again, the fluid must drain almost completely as to allow for air (oxygen) to be present in the filter.

Conditioning of the Bio-Filters
The bio-filters must be conditioned prior to the introduction of fish into the system. This is to establish the necessary bacteria for the breaking down of the ammonia waste. This conditioning period is generally about 1 month. Different references state different amounts of time for conditioning of filters. I believe it is better to be safe than sorry so 1 month is a safe period of time. I conditioned the filters by adding small amounts of food to the running system 1 month prior to the introduction of the fish. I also added water from an aquarium which was established for a long period of time and I was confident it did not contain any diseases or parasites. I also started monitoring the water at this time for un-ionized ammonia. Be certain that the ammonia levels are not high before the introduction of the fish.

Construction of the Bio-Filters
The filters were constructed from 55 gallon plastics drums. I found drums with thick side walls and good non-leaking covers. The covers should be the type held with clamp rings for easy access into the filter. Drums that were designed for food hauling are preferred to prevent the danger of contamination from chemicals. The drums I purchased had been used for apple juice concentrate and worked excellent. PVC fittings are used to make plumbing connections into the drums. The pluming connection holes are drilled into the drum with a hole-saw which is slightly under the dimensions of the threads on the PVC fittings. The poly drum is soft enough to allow the PVC fitting to be screwed into it. Do not cross thread the fitting when screwing it into the drum. Once assembled, the fittings are sealed with silicone sealant. Use a sealant that is suitable for under water use. PVC bulk head fittings can be purchased however, they are very expensive.

It is important that each exit tube be designed to allow water out but keep the poly beads in. The exits can be covered with screen however, enough surface area must be allowed so the screen will not clog. If just the 1 ½" exit tube is covered with screen it will clog and need to be flushed.

Support Stand For Filters

The supports used to hold the filters must be constructed strong enough to hold a large amount of weight. A 55 gallon drum with water filled to the top weighs 440 lbs. A drum full of poly beads weighs almost as much. Also, the filter support will at some time most likely get wet. Therefore, make the support of good sturdy wood or metal and seal it to make it water proof. I made sure that the vertical height of the support with the filter placed on top of it still allowed room to service the filter from the top. I was working in an old dairy barn that had low ceiling clearance in the lower level and I could have used more clearance height that was not available. Make sure where the tank is placed there is enough vertical height if installing a vertical filter design.

Overall Plumbing Connections

Initially 1" PVC plumbing was used for the water supplies into the filters, water heating system, and the spray aeration. Problems were experienced with freezing and cracking with the PVC plumbing. I then switched to flexible ¾" garden hose. This was easier to handle and move and no damage with freezing could occur. I bought inexpensive garden hose T & Y fittings. I found the largest selection in fittings in the spring time when the garden supplies were most available. It is a good idea to buy extra fittings to have available. Check the valve fittings to make sure that the orifices through them are large enough so the flow is not restricted. PVC valves can be adapted seeing they have larger orifices.

Water Heating System

A conventional 34K BTU LP hot water heater was used for the water heating system. The building where the tank was housed was not heated. I have heard of both heating the water or heating the building housing the water tanks. Both systems have pro's and con's. Heating the water is more efficient due to the heat capacity of water being extremely high. Heating the building is more comfortable for working and is easier to avoid freezing problems especially in the filters. Heating the building is more expensive than heating the water.

A LP gas hot water heater was selected due to the operating cost being less expensive than an electric water heater. The flow into the heating system came out of the main tank before going through the filter system. Due to this placement in the flow, it was necessary to flush the water heater once per week to remove the sediment collection from the heater. 100 lb LP cylinders were used for the LP gas. A larger LP tank should have been considered to minimize the handling of the LP cylinders. Be careful that the venting of the water heater is done properly to avoid carbon monoxide problems.

The tank, filters, and all the plumbing was insulated to prevent heat loss. The tank had insulation placed in the bottom before the liner was installed and the sides and top were covered with Styrofoam insulation. Most of the heat loss in a tank occurs from the top due to evaporation. This is noted in all the engineering texts. Therefore, spend the most time designing and building a good sealing cover for the tank. Styrofoam insulation works well for this purpose. It is water resistant and seals fairly well over the top of the tank. Fiberglass insulation was used to wrap the filters and did not work as well when it got wet.

Spray-bar Aeration

A spray bar was used for aeration in the system with a regenerating blower as a back up. At first lawn sprinkler nozzles were used off of a main manifold for the spray bar. These nozzles clogged badly and needed constant cleaning to keep them spraying adequately. I next switched to a 1" PVC pipe with ¼" holes drilled along both sides of it. This sprayed streams of water out along the top of the tank and reduced the clogging. Approximately once per month the pipe needed to be removed and cleaned. Oxygen levels were monitored and always found to be in the 6-7ppm range so the spray aeration seemed to be adequate for the system.

Safety

I thought is was necessary to mention safety in this report just to make people aware of some of the dangers with these systems. The first potential danger is the tank itself. The tank depths (mine being 4') can easily be over the head of a small child. Secure the tank so that a small child could not possibly fall into the tank. A good cover that cannot easily be opened is one possible solution. The second potential danger is in having electricity present with lots of water around. Make sure that all electrical connections are properly installed and grounded. Also make sure to use ground fault interrupters on all the outlets.

Fish Behavior

Initial Stocking

It was necessary to have my tank ready and filled in May. This included having the water filled and circulating through the filters and warming. I also started conditioning the bio-filters at this time. I started contacting the hatchery where I planed on getting the fish in March to make sure that I was on his list. It is a good idea to have a back up hatchery lined up also in case something goes wrong with the 1st hatchery's supply. There are not many suppliers of Perch fingerlings so do your calling early and check out the hatchery with other people raising Perch so you don't get stuck with a tank and no fish to put in it.

After the water is warmed and the filters conditioned, approximately June 1st. The next thing to do is wait for the hatchery to call. Seeing the spawning of the fish is done in ponds, it is extremely weather/temperature dependent and can vary in when the fish will be ready. Over the few years I have done this, I have seen the fish ready at the 1.5" size anywhere from the 2nd week in June to the 1st week of July. Once the call is received, work with the hatchery to attempt to match the tank water temperature to the pond or hauling truck temperature. I tried to keep it within 3° which was suggested by the hatchery. The fingerlings are very delicate and cannot tolerate larger temperature changes.

Due to the small amount of fingerlings that I was purchasing (2000) and the close proximity to the hatchery, I was able to haul the fingerlings in oxygen packed plastic bags. The bags are placed in coolers to maintain the water temperature which works very well. In addition, salt is added to the water for hauling the fish. The amounts of salt to add are mentioned in a number of articles which have been published. If larger numbers of fish are purchased or the distance to the hatchery is great, a hauling truck from the hatchery may be necessary.

Inspect the fish you are purchasing. Make sure they are at least the 1.5" size. If they are smaller you will have an even more difficult time converting them to commercial food. Also, make sure that the range of size is not too extreme. I would suggest about a ½" range in length from the biggest to the smallest. The fish I purchased for this experiment ranged in size approximately ±1" with a few culprits in the 3" range. This promotes cannibalism in the fish which you will see is the largest problem in the raising of these fish. You may have to accept some lower quality or a larger size range than desired due to the small number of hatcheries that are dealing with Perch.

Once the fish are to the tank the plastic bags are floated in the tank to slowly allow the temperatures to equilibrate. I did not float the bags too long (approximately 5 min) due to the oxygen concentration dropping in the bags. The bags are then opened and the fish allowed to swim out. Make sure to check in the bags so that all the fish are removed.

Conversion to Commercial Food

Once placed in the tank, the fingerlings tended to congregate along the side walls by the surface of the tank. I used spray bar aeration which caused current along the top of the tank. The fish tended to congregate in the eddies formed along the side walls by the current. This made the location of the fish fairly easy in my case.

I initially had intended on using zooplankton raised in green tanks for the conversion of the fish to commercial food. I had did this in the past for other batches of fish I had raised. In the past I would start the fish on zooplankton water from green tanks and then start converting them on commercial tropical fish flake food mixed with #1 trout starter. Initially, the food was 100% flake tropical fish food. Next a 50/50 blend of #1 trout starter and the tropical fish food was used. Finally, 100% #1 trout starter was used. With this group of fingerlings the fish started eating the tropical flake food immediately when it was added to the tank. The fish were eating aggressively enough that the decision was made to not attempt to use green tank water for the conversion. The flake food was added to the tank along the edges and in the eddies where the fish schools were located. Small amounts of food (a palm full) were added twice a day (morning & night). The conversion to 100% #1 trout starter from the flake food was completed over approximately 3 weeks. The conversion rate appeared to be reasonable for the experiment with a 20% loss (400 fish) due to the conversion to commercial food. Some of this loss could possibly be due to the high inlet flow of the pump which sucked some fish against the inlet screen. This was corrected once discovered during this conversion period.

Cannibalism

Cannibalism is the largest problem in attempting to grow out Yellow Perch in a single recirculating tank system. The losses experienced due to cannibalism in this experiment were extensive. The only solution seen for this problem is to remove the larger more aggressive fish from the smaller fish. The best possible method for doing this would be to use a series of smaller tanks compared to one large grow out tank. The fish could then be size sorted and moved through the series of tanks and finally placed into a large grow out tank for finishing the grow out cycle.

The cannibalism I experienced with the fish was aggravated due to the large range in sizes of the fish purchased. There were approximately 5-6 fish in the 3-4" range when initially stocked into the tank. The larger fish did not eat at the surface with the smaller fish and stayed primarily near the bottom of the tank. These larger fish were relying primarily on cannibalism to survive. This could be seen when feeding the fish. As the smaller fish were feeding aggressively on the top of the tank the larger fish would come out from the lower tank and strike the smaller fish. This was witnessed a number of times. Once identified, the larger fish were removed from the smaller ones. Throughout this project the loss due to cannibalism was 70% or (1400) of the starting fish. The problem seemed to get better as all the fish reached a larger size (3-4") however, it may just have been harder to identify at this time.

Other mortality

Little other mortality was observed in the fish. No disease was experienced with the fish and the health of the fish remained good. Usually when other mortality happened the dead fish were observed either on the pump screen or along the bottom of the tank. Contrary to belief, the dead fish do not float (at least not at first) but instead sink to the bottom of the tank. They are usually observed by seeing their lighter under bellies turned up towards the top of the tank. The fish will float up to the top of the tank over time.

Growth Rate and Feeding in the System

All of the feeding for this project was done by hand. The feed was added twice per day and sprinkled under where the light was located in the tank. Higher growth rates could possibly be achieved by using either automated or demand feeders for a more constant addition of feed into the tank. This would need to be experimented with to see if the growth rates are actually increased.

The food used for the project was Zigler Bros. 35% protein trout food. The fish were started on #1 trout starter and than moved to a #4 crumble. Finally the fish were fed the 1/8" pellets. The food was obtained from Rushing Waters Trout Farm, Palmyra, WI. It was necessary for me to drive to Palmyra to get the food. This was the only small supply of high quality trout food that was available in the state at the time of the project. For aquaculture to grow in the state it will be necessary to obtain good quality food in the state. Possibly, costs could be reduced by farmers joining together to increase the purchasing power of the smaller farmers.

As seen by the sample population of fish at the end of the 18 month project **(attachment B)**, inconsistency in growth rates of the fish is another large problem. This problem could possibly be helped by size sorting the fish in a series of growing tanks. This may give the less aggressive fish a better opportunity to feed without competing with the larger fish. Again, this would need to experimented with to see if the growth consistency improves.

Analysis of costs **(Attachment C)**

Operating Expenses

Facilities rental costs were the largest operating expense at 75% of the operating costs Energy was 8% of the operating costs. This is misleading due to the water temperature being allowed to drop and the tank go dormant for 3 months during the hard winter (Dec-Feb). The food costs were 3.4% of the operating costs. Again, this percentage is somewhat misleading due to the tank shutdown for 3 months. The travel expenses were 6.4% of the operating costs. This mileage rate is the government rate for tax purposes and the actual expenses generated are believed to be less than this. The fingerling costs were 7.5% of the operating expenses.

If some general assumptions are made, the following example results:

Assume that the facility is owned and you are not paying yourself a salary.

Fingerling Cost	$200	26%	
Food Cost	$180	24%	
Energy LP gas Water Heating	$255	33%	**Combined Energy 50%**
Energy Electricity	$128	17%	

Total $763/1000gallons

It is believed that these cost assumptions are more realistic. These assumptions are based on if the facility is owned and a rental charge is not being used, and you are not paying a salary to yourself or someone else.

Final Fish Count & Value

Starting # of Fingerlings	**2000**
Converting to Commercial Food	**-400**
Cannibalism	**-1400**

Total 200 fish at the end of the project
Average size was 5.43 inches
Highest value for stocking approx. $200

Profitability Outlook
Overall the expenses of running a recirculating system such as this one are higher than expected. The major contributors to the expenses are the energy costs and the major energy expense is in heating the water.

Profit Calculations

Density lbs fish/gal	lbs fish in 1000 gal.	Number of Fish @ .33 lbs/fish	Value of Fish @ $1.80/lb	Approximate ** Operating Costs	Operating Profit ($)	Operating % Profit
0.1	100	303	$180	$763	-$583	-76%
0.2	200	606	$360	$763	-$403	-53%
0.3	300	909	$540	$763	-$223	-29%
0.4	400	1212	$720	$763	-$43	-6%
0.5	500	1515	$900	$763	$137	18%
0.6	600	1818	$1,080	$763	$317	42%
0.7	700	2121	$1,260	$763	$497	65%
0.8	800	2424	$1,440	$763	$677	89%
0.9	900	2727	$1,620	$763	$857	112%
1	1000	3030	$1,800	$763	$1,037	136%

** This approximate operating cost for a 1000gal tank comes from this experiment and than making assumptions based on the experiment.

Note: These % profit numbers are based only on operating expenses and not any capital expenses.

What is Needed to Increase Profitability

1. *Eliminate cannibalism of the fish in the tank.* One possible method of doing this is to raise the fish in a series of tanks as opposed to one large grow out tank. The fish could than be easily size sorted and moved into the next tank as they grow and separated from fish of other sizes. 70% of the starting fish were lost to cannibalism. If cannibalism cannot be stopped in the fish the profitability of this type of aquaculture for Yellow Perch is doubtful.

2. *Hatch the fish yourself.* This is currently being done by the Sea Grant Institute in Milwaukee. This will increase the profits by allowing you to start with more fish initially and make up for losses by increasing the starting fish numbers. It will be difficult for a producer to be profitable if they need to pay $.10/fish at the start. This would also allow you to absorb or reduce the fish losses during the conversion of the fish to commercial food. The Sea Grant Institute claims that the fish spawned in tanks are already converted to commercial food.

3. *Increase the growth rate and reduce growth inconsistency.* Again, this could possibly be helped by moving to a series of smaller tanks. The tanks would be approximately 200-300 gal and would all be connected to one central filter system. If 3 tanks were used this would increase the total water volume to 900 gal. This would be more stable than a single tank at 200-300 gal. One large grow out tank could then be used for the final finishing of the fish. By the elimination of the larger fish in a series of tanks the competition for food could be reduced and the rate of growth possibly increased.

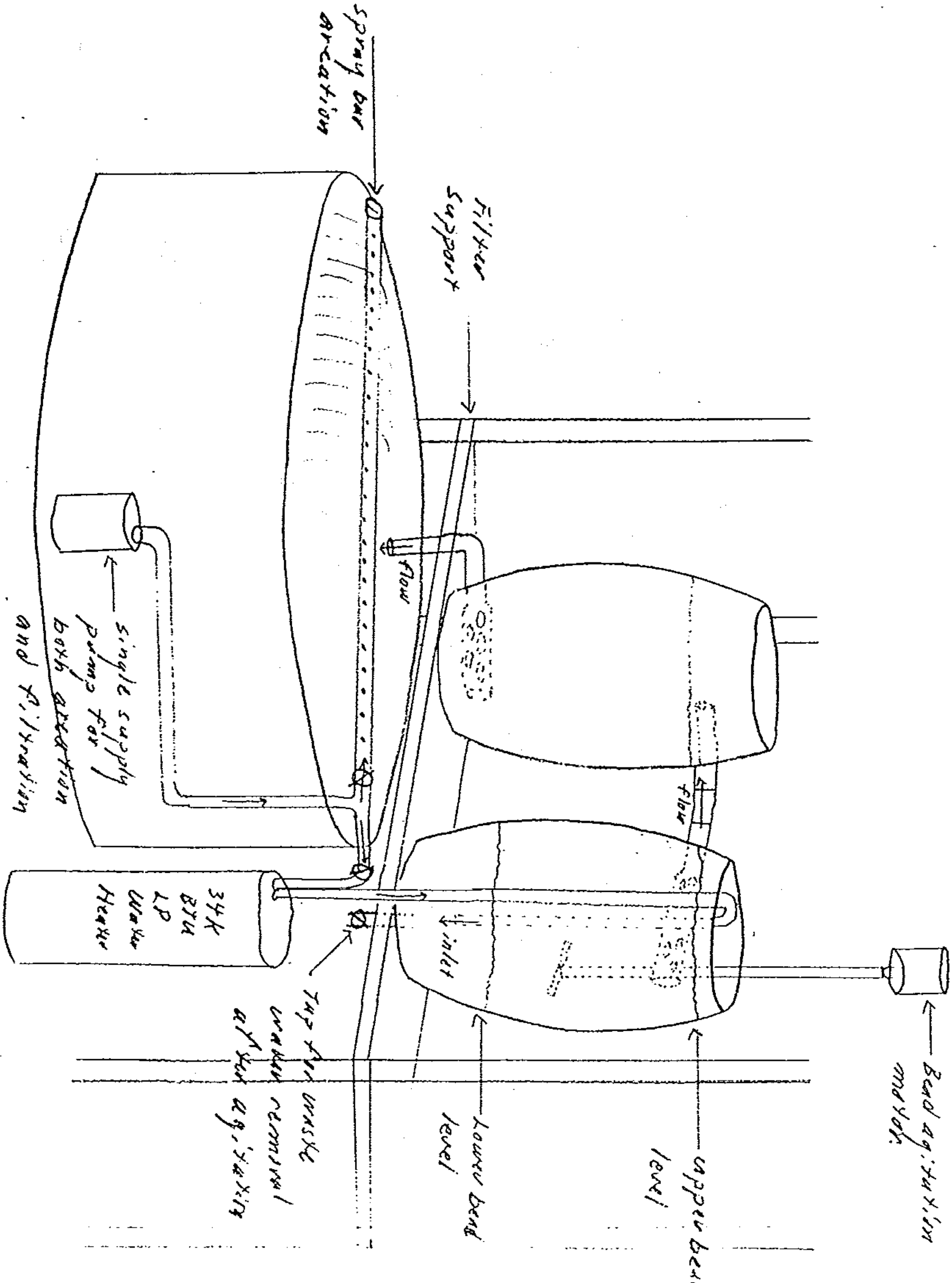
4. *Reduce operating expenses especially water heating.* The heating of the water is believed to be the single greatest operating expense. Some possible methods for reducing these costs include the allowing of the tank water to cool down during the winter months. This would add more time to the grow out cycle however, this may not be a negative if tank space is available and the electrical pumping costs are low.

Next Steps & Plans

Attempt to tank spawn Yellow Perch. I believe with other farmers attempting to raise Yellow Perch as a food fish, the market for fingerlings will increase. The fingerlings could also be sold for pond stocking for recreational fishing. This would provide some income for experimenting with other species of fish.

Experiment with other species of fish for recirculating systems. I believe the system I have designed is sound for fish production. However, I question if Yellow Perch can be raised as a food fish at a profit in these types of systems. The main reason for this is the need to heat the water or a structure for these systems.

Attachment A



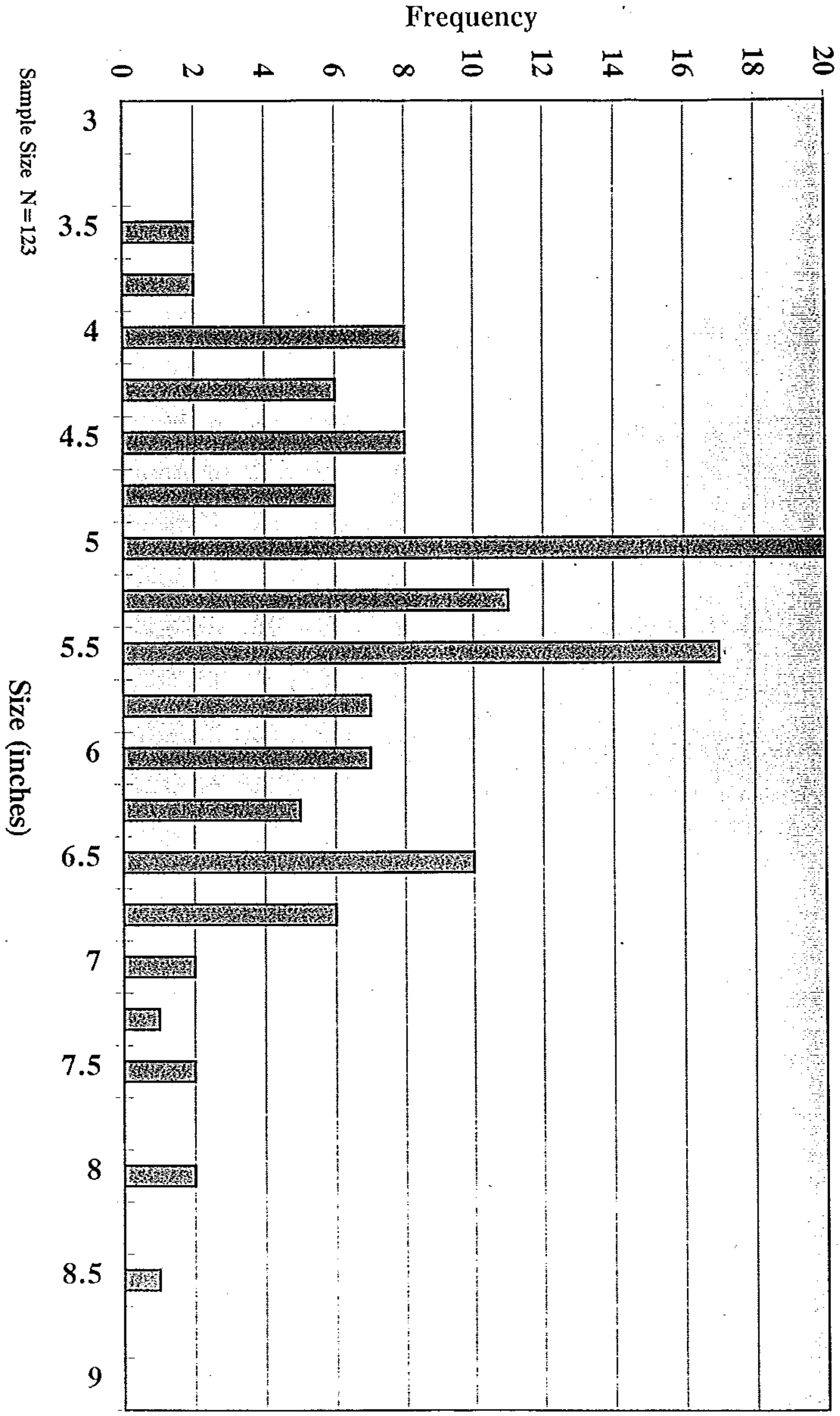
Economic Feasibility of the Intensive Aquaculture of Yellow Perch
Rick Wehrle 12/1/96

Attachment B

Economic Feasibility of the Intensive Aquaculture of Yellow Perch - Rick Wehrle

Fish Size Distribution

Average 5.43"
Std Dev. 0.99"



Project Budget   Final Cost Analysis

Economic Feasibility of the Intensive Aquaculture of Yellow Perch
Requestor: Rick Wehrle
Duration 16 months

Item	Requested Funds	Applicant $ Matching	Total $	Actual Spending Totals	Start up Capital	Operating Cost
Salary & Wages	$0	$2,000	$2,000	**	**	**
Consultant/Veterinary	$20	$0	$20	$20		$20
Travel & Telephone	$200	$200	$400	$172		$172
Equipment Lease/Rental						
Existing System	$0	$1,000	$1,000	$1,000	$1,000	
2250 watt back up generator	$314	$0	$314	$370	$370	
SV-33 Re-Gen Blower	$335	$0	$335	$335	$335	
Update Main Tank						
metal exterior	$244	$0	$244	$243	$243	
S1200TV pump	$108	$0	$108	$108	$108	
34K BTU heater	$202	$0	$202	$195	$195	
Materials & Supplies						
Plumbing & Insulation	$75		$75	$75	$75	
Fingerlings cost	$180	$0	$180	$200		$200
Food cost	$180	$0	$180	$90		$90
Energy Cost	$362	$0	$362	$253		$253
Facilities	$2,000	$2,000	$4,000	$4,159		$4,159
TOTALS	$4,220	$5,200	$9,420	$7,220	$2,326	$4,894

** Eliminated for analysis (Your time is free)