Enterprise Budgets for Yellow Perch Production in Cages and Ponds in the North Central Region, 1994/95

by

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Technical Bulletin Series #111

In cooperation with USDA's Cooperative State Research, Education and Extension Service

USDA Grant #93-38500-8392
Purdue University 1993 Crossroads Initiative
May 1997

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Acknowledgments

The author would like to thank the research and extension staff in the North Central Region who participated in this project by providing expert opinions on production values for yellow perch upon which the budgets in this publication were based. These individuals spent valuable time filling out forms sent them to elicit their opinions, as well as conversing with the author in person and on the telephone. These individuals include: D. LaDon Swann, Purdue University; Paul B. Brown, Purdue University; Terrence B. Keyes, University of Nebraska; Don Garling, University of Michigan; and Jeffrey A. Malison, University of Wisconsin-Madison.

Other people who have contributed to the author's understanding of yellow perch fisheries and culture or who helped in the conceptualization of the budgets also deserve thanks. They include: Marshall A. Martin, Purdue University; Patrick D. O'Rourke, Illinois State University; Fred P. Binkowski, University of Wisconsin-Milwaukee; James M. Ebeling, The Ohio State University; Carole R. Engle, University of Arkansas at Pine Bluff; Doug Lipton, University of Maryland; Glen Musch, DeMotte, Indiana; and Chris Bennett, Bennett Fish Inc., Lorain, Ohio.

All assumptions and any errors or omissions in the production cost estimates and associated text are entirely the responsibility of the author.

Executive summary

This study reports the results of an investigation into the costs of culturing yellow perch for the food fish market in the North Central Region (NCR). Enterprise budgets were developed for both cage and pond production systems at two size levels, 5,000 and 50,000 pounds of production. Because only a handful of established yellow perch aquaculture operations currently exist in the NCR, hypothetical production systems were modeled. Production values used in the budgets (e.g., feed conversion ratio, death loss, stocking rate) were based on the expert opinion of research and extension personnel at various universities in the NCR who are familiar with yellow perch.

The production costs developed in this study suggest that larger systems, which can capture economies of size in investment and input costs, are likely to be economically feasible. The breakeven prices (cost per pound) for the larger cage and pond operations were similar and averaged about $2.00 per pound. This price is near the bottom of the range of monthly average wholesale market prices for yellow perch in the round reported by Lake Erie processors.

Smaller operations are much less likely to be economically feasible, especially if annual ownership costs per pound are high. (Ownership costs are annual costs associated with the ownership of capital investment items, such as levee ponds, and include interest, depreciation, repairs, taxes, and insurance.) This is the case for the small pond operation that has a breakeven price of $3.48 per pound. Annual ownership costs for this operation are $1.20 per pound compared to $0.12, $0.36, and $0.45 per pound for the larger cage, smaller cage, and larger pond operations, respectively. Smaller operations with reasonable per pound ownership costs might be profitable at high-end market prices (around $3.00 per pound). The small cage operation fits this category with a breakeven price of $2.80 per pound. These operations are more sensitive to adverse price and cost movements than larger operations. However, they can improve their likelihood of success by increasing the size at which they market their perch and by controlling operating costs, especially by decreasing input prices for feed and fingerlings.

Operating costs are similar for both types of production systems. Economies of size also exist for operating costs, but the effect is not as strong. Fingerlings and feed account for over 60 percent of total costs in all but the small pond operation. Transportation costs can dramatically affect delivered feed prices. Shipping costs are often determined more by shipment volume and ingenuity in arranging transportation and less by length of haul.

Despite the importance of size economies, it is not yet known which size of operation will yield the most profitable economies of size in either cage or pond production systems for yellow perch. A manager must take into account revenues as well as costs in determining the optimal size, input mix, and product mix of an enterprise. The lowest cost of production (or the highest amount of production) does not alone determine the most profitable operation.

Sensitivity analysis showed that changes in fingerling prices, feed prices, and market size of the fish have larger impacts on breakeven prices than do changes in the feed conversion ratio and death loss. In particular, fingerling price can have a substantial effect on enterprise profitability since yellow perch are marketed at such low weights.

Costs at other points in time and for other locations in the NCR may differ from the production costs estimated in this study. To provide guidance on the cost impacts of these potential differences, sensitivity analysis was conducted with alternative values for key budget variables (e.g., feed price, death loss, market price). Additionally, tables were developed containing estimates of delivered prices for feed and fingerlings at various locations in the NCR.

The cost and profitability estimates made in this study must be regarded as preliminary rather than conclusive. As the industry matures, historical data accumulate, and optimal culture methods and production systems are identified, these preliminary production cost estimates can be revised to incorporate the new information. In conjunction with better market information, expectations of industry profitability can also be updated.

While preliminary, the budgets produced in this study are useful for several purposes: 1) as a demonstration of the investment requirements, annual inputs, and costs necessary to undertake yellow perch cage and pond culture in the NCR in small and moderate sized systems; 2) as a basis for comparing costs among different sizes and types of production systems, locations, or species; 3) as a foundation for further budget development; 4) as a springboard for discussion among producers and university / government staff in various disciplines; 5) and as a guide for directing research toward those areas most likely to enhance the profitability of yellow perch aquaculture in the NCR.

Introduction

Yellow perch aquaculture

The development of culture methods for yellow perch has sparked interest throughout the North Central Region (NCR). Many researchers and industry entrepreneurs believe that this species holds tremendous potential for aquaculture in the region, from both production and marketing perspectives (Garling 1991; Williams and Starr 1991; Hushak, et al. 1992). This interest has grown as many have come to realize that an aquaculture industry in the region cannot successfully be built around a species, such as catfish, for which other regions of the country hold a comparative production advantage. Yellow perch has been a high-priority species for production-oriented research funded by the North Central Regional Aquaculture Center (NCRAC) since its inception. Some of the states in the region also have funded work on developing culture methods for yellow perch.

Economic research on yellow perch has been more limited. Some marketing and production studies were conducted at the University of Wisconsin during the 1970s (see Kayes 1991). More recently, NCRAC commissioned the development of production cost estimates for culturing yellow perch, walleye, and hybrid striped bass. The latter two species also have had high-priority status in NCRAC research funding. At about the same time, the state of Indiana, through the Purdue University Crossroads 1993 Initiative, provided funding for developing production cost estimates for species important to the state. In an interdisciplinary meeting of Purdue University faculty and staff working in aquaculture areas, it was decided to focus these efforts also on yellow perch. This publication presents the results from the research funded jointly through NCRAC and Purdue University.

The production cost estimates developed in this study should make a valuable contribution toward the advancement of yellow perch aquaculture in the North Central Region. These data are the first publicly available cost estimates which anyone can use for their particular pursuits related to yellow perch aquaculture whether they be production, marketing, teaching, research, extension, or lending. They provide persons with interest in yellow perch aquaculture with a realistic demonstration of the specific investment requirements, annual inputs, and costs necessary to undertake yellow perch cage and pond culture in the NCR in small and moderate systems. The budgets for different types and sizes of production systems allow their cost structures to be compared and thus identify which types and sizes of systems are most likely to be profitable. The sensitivity analysis results give guidance on which budget variables most greatly impact the bottom line. They also show how much or how little specific budget variables need to be improved (worsened) to approach or enhance (reduce) profitability.

The development of cost estimates enables the comparison of costs to market prices in order to determine economic feasibility. Publicly available costs and prices would be ideal for determining economic feasibility. Unfortunately, there are no publicly available yellow perch market prices at this time. However, the author was able to collect a limited amount of market information from private sources so that judgments on economic feasibility could be made in this study.

Those contemplating or operating yellow perch aquaculture enterprises can use this information in their own attempts to determine size of operation, production targets, type of culture system, investment and capital requirements, cost structure, profit potential, and resolve other management issues. The budgets explained and presented here should help aquaculturists understand the importance of developing budgets, the need for good record keeping, what kinds of records need to be kept, and how to develop budgets for themselves. The budgets may motivate producers to keep better records, develop their own budgets, and use the budgets for further financial analysis of their own enterprises. These types of management activities would be beneficial to the industry. Additionally, the biological production parameters used in the budgets will give producers a guide by which to evaluate the performance of their own systems.

Research and extension personnel in industry and government can use this cost information in determining recommendations for yellow perch culture and in their own evaluations of the potential for industry profitability. They can also use these data in contemplating the focus, scope, and direction of their own research, teaching, and extension activities regarding yellow perch aquaculture.

Persons making decisions regarding the lending of banking funds or venture capital also can use the cost data from this study. They can use the budgets as a rule-of-thumb from which to evaluate specific loan proposals and also as a general estimate of industry status and potential.

There are some secondary benefits from these production cost estimates as well. Much interdisciplinary interaction among research and extension personnel with economic or biological training was necessary for budget completion. This provided an opportunity for the development of working relationships across disciplines and to consider from differing perspectives the difficulties of yellow perch production. The completed cost estimates should provide a basis for further interdisciplinary discussion. They also provide information which can be used to guide research and extension funding decisions in the NCR. Improved communication, understanding, and decision making will all serve to enhance the viability of yellow perch aquaculture in the NCR.

The enterprise budget

One useful way to summarize production costs for an aquacultural enterprise is the enterprise budget. Basically, an enterprise budget is a management tool. It is a fundamental financial document which provides a summary and detailed estimate of all of the costs and resources associated with an enterprise for a fixed time period or production unit. The enterprise budget is fundamental because it serves as the foundation for all other cost and financial analysis. For this reason, the enterprise budget was chosen as the method in this study to communicate the production cost estimates developed for yellow perch. Following the cage and pond culture budgets is a section on sensitivity analysis. Sensitivity analysis is another management tool, based on the enterprise budget. With sensitivity analysis, the cost impacts of alternative budget prices, values, or assumptions are investigated.

An enterprise budget is a useful management tool, both during its development and upon its completion. The process of developing a budget forces the aquaculturist to think concretely and specifically about all input requirements and associated costs as they are expected to occur in the “real world.” In addition, the budget development process: (1) provides a vehicle for investigating, collecting, organizing, and analyzing cost information relevant to the long-term success of the business; (2) helps the aquaculturist think realistically and critically about the likelihood for success; (3) prepares the aquaculturist for dealing with bankers and other investors by providing the opportunity to become intimately familiar with all aspects of the enterprise; (4) allows the aquaculturist to be precise about costs in order to accurately project cash flow needs and generate other pro forma financial documents; and (5) enables the aquaculturist to make a reasonable prediction of a breakeven price. Aquaculturists who take the time and effort required to develop a good enterprise budget will benefit from that process and become better decision makers. Once the enterprise budget is completed, the budget can be used for guiding decisions in the enterprise, for comparing the relative profitability of alternative enterprises, and as a starting point for assessing financial impacts of alternative circumstances / decisions.

An enterprise budget has some limitations, however. The garbage in / garbage out principle applies to enterprise budgets. If its developer does not take the task seriously and makes too many wild guesses instead of doing the necessary but sometimes difficult or time-consuming work, then the budget will be useless or misleading.

Another important consideration is that an enterprise budget is an estimate made at a specific, fixed point in time, whereas, the "real world" is characterized by movement and change. (In graphic terms, an enterprise budget is like a snapshot, and the "real world" is like a full-length motion picture.) Input and resource costs can fluctuate rapidly, or they may simply creep up two to three percent per year. Production values (such as feed conversion ratio, death loss, feed intake, growth rate, etc.) can be hard to estimate precisely, and they can change over time, making the values difficult to track. Production systems can be difficult to model, especially if the aquaculturist has not kept good records or has not yet settled into a consistent production plan.

A third limitation is that every budget is enterprise specific. Published budgets, such as those presented later in this publication, will never take the place of aquaculturists developing their own budgets. Only self-produced budgets will reflect the unique set of circumstances (including physical location, management skills, water and land resources, capital availability, production knowledge, risk-taking behavior, marketing abilities, equipment items, system setup, production values) that exist within the context of a specific enterprise.

Methods and assumptions in the yellow perch budgets

In subsequent sections, enterprise budgets for the cage and pond culture of yellow perch are presented. The budgets were developed using the economic engineering approach. That is, hypothetical production systems were modeled and expert opinion was used to arrive at reasonable estimates of biological production values. A historical approach could not be used because of the limited number of producers in the industry. If there were as many perch producers as hog producers in the North Central Region, then a budget could have been developed, based on a producer survey, that would reflect an industry average. However, since an industry average does not exist for yellow perch, an alternative approach had to be used.

The experts used for this particular study were research and extension faculty and staff at various universities in the North Central Region who have expertise in the culture of yellow perch. Unfortunately, there are not many individuals who are familiar with the growout phase of yellow perch production. Thus, the amount of input was limited. As knowledge develops, production technologies become standardized, and the commercialization of yellow perch production grow, there will be more information and expertise to draw from. Then these initial studies can be modified and adapted to reflect the new realities. The consensus in the region, though, is that despite the current data limitations, there is a need for a baseline estimate of production costs.

There are a myriad of assumptions underlying the yellow perch budgets in this publication. Each assumption influences the production cost estimates. Therefore, the budget numbers are not applicable to every enterprise, but rather are guidelines. Specific assumptions and budget methodologies which are common to all the budgets are itemized below.

1. **Production.** It was assumed that advanced fingerlings (about 4-5 inches) are stocked at the beginning of the outdoor growing season (April). The fish are then grown out to market size (¼–⅓ pound) for the food fish market by the end of the growing season (October-November). In each budget, a cost is included for purchasing the advanced fingerlings at the time they are needed, but obviously that is only one alternative among many. Other alternatives may provide the producer with fingerlings at lower cost.

2. **Marketing.** It was assumed that the producer markets fresh yellow perch in the round to wholesale food fish buyers. ("In the round" means the fish are not processed, but put on ice as a fresh product.) There are many marketing alternatives. One or more of the others, especially the processing and selling of fillets, may provide the producer with a greater net return. Harvesting and marketing costs are based on the assumptions of icing down round yellow perch in polyethylene containers, placing the containers of fish and ice into a refrigeration unit in the bed of a pickup, and delivering the fish to a wholesale market. Labor charges were assumed for 26 days and 4 hours per day for the larger operation and 20 days and 1 hour per day for the smaller one. Ice requirements were calculated on the assumption that a 60 / 40 relationship exists between pounds of fish and pounds of ice. The pickup charge is calculated based on the estimated miles needed to deliver the fish within a 50-mile radius of the farm at a rate of 25 cents per mile.

3. **Land.** A land charge was assumed to reflect the opportunity cost of the land used for fish production. How to account for land costs is always a problematic part of any budget because ownership or rental arrangements and land values are so diverse. For the cage budgets, an opportunity cost of zero was assumed for the use of an existing farm pond, based on the underlying assumption that the aquaculturist is taking advantage of an unused, existing resource. This existing pond was assumed to be unsuitable for pond culture, but useable for cage culture. For the pond budgets, it was assumed that flat, uncluttered land is needed, and therefore that low production corn land (100 bushels per acre yield) would be converted to the pond production of perch. The use of the land for fish production implies foregoing the return that could have been obtained from growing corn on that land. Therefore, the annual land charge reflects this foregone return.

   Another land issue to be kept in mind by someone contemplating conversion of existing pond or corn acreage into aquaculture production is the impact on the land's value. In the case of cage culture in existing farm ponds, cage culture could prove deleterious to the pond's ecology, thus reducing the value of the pond. Constructing levee ponds on corn land could likewise devalue, perhaps substantially, the crop land converted. In addition, re-converting acreage with levee ponds back into tillable acres or developing it for some other alternative use would be expensive.

4. **Size of operation.** Two different sizes of operation were analyzed for each culture system: 5,000 pounds and 50,000 pounds of production. The purpose was to determine if the potential for economies of size exists in cage and pond culture of perch. Also, some

aquaculturists may be more interested in one size than the other. From another perspective, the enterprises were modeled based on the production target rather than a particular size of pond (as is true with most catfish budgets). One of the implications of this assumption is that the surface acreage of ponds and the cubic feet of cage space needed are determined by the production target rather than vice versa.

5. **Fingerlings.** The number of fingerlings needed for each operation is calculated within the budgets based on production level, harvest size of fish, and death loss assumptions. Since each operation uses at least 20,000 fingerlings (about the maximum size which can be transported in one shipment), the fingerling price per head is the same for all four operations. The cost per fingerling was taken from Appendix Table B2, which contains delivered prices for four-inch yellow perch fingerlings trained on feed from five suppliers to five locations in the North Central Region. The lowest delivered cost to Lafayette, Indiana (26.39 cents) was the price chosen for use in the budgets.

6. **Feed.** In this study, the budgets begin with feed conversion ratio, production target, and death loss assumptions, and use these to calculate the quantity of feed needed. In some other studies, the budgets start out with feed quantities, known from either actual production experience or generated through a fish growth model, and then calculate feed conversion ratios. Given the current limitations on culture data, using expected feed conversion ratios and other production values to estimate feed usage is a reasonable method. There were two additional considerations in how feed usage is calculated. One is that the weight of the fingerlings at stocking is not taken into account. Second, death loss is assumed to be a random event, spread out over the entire production cycle.

Fish nutritionists are currently recommending the use of trout feeds for culturing yellow perch. Feed prices were taken from Appendix Table B1, which displays delivered trout finishing feed prices from the plants of four feed manufacturers to five locations in the North Central Region. The cheapest price for the appropriate feed delivered to Lafayette, Indiana was chosen for each operation. Feed price varies by size of operation, mainly due to differences in transportation costs for different shipment sizes. Feed shipments were assumed to arrive every two months in all operations to ensure that feed quality is maintained. This requirement results in shipment sizes of approximately 19,000 pounds for the two larger operations and 2,000 pounds for the two smaller operations. It was assumed that feed for the larger operation is shipped at truckload freight rates, while the smaller operation’s shipments are so small as to require high-cost shipment by common carrier. Thus, the prices paid for feed by the larger operations were 30 to 40 percent less than the prices paid by the smaller operations, a considerable difference.

7. **Labor.** Labor was included as an explicit cost of production since there would be differences in labor usage by type and by size of production system. A charge for labor should be included in any budget, even if no one is paid, because there is always an opportunity cost of labor just as there is with capital. Labor was included in all the budgets in this study as an operating cost because it was assumed that the labor is hired only if production is actually undertaken for a given year, and only for the hours actually needed. It was assumed that

either the owner / operator had excess labor within his / her family, or that daily labor for the hours required could be hired strictly for the production season. Enough labor was allocated to each operation to account for average management of the operation including feeding and water testing. Based on expert opinion, it was assumed that the hours of labor per day would differ for each of the four operations as follows: 5,000 pound cage operation, 1.0 hours; 5,000 pound pond operation, 1.5 hours; 50,000 pound cage operation, 4.0 hours; and the 50,000 pound pond operation, 3.5 hours. For all of the enterprises, labor was assumed to be unskilled for 87.5 percent of the labor hours and semi-skilled for the remainder (12.5%). Differential wage rates were applied to each skill level.

8. **Electrical use for aeration.** The aerator(s) in each operation was assumed to run for six hours per day (midnight to 6:00 a.m.) during June and July. Ten percent of that total was added on to account for special aeration needs. The assumption of 1.0 kilowatts per horsepower per hour was used to calculate electricity costs for running the aerator(s) following the example of Crews and Jensen (1989). All aerators are 1.0 horsepower.

9. **Interest rates.** Annual capital costs of 12 and 9 percent were assumed for operating and investment capital, respectively. There is always a cost to using capital, whether it is owned or borrowed. If the capital is owned and invested in an aquaculture operation, then the cost to the capital owner is the foregone return that could have resulted from using that capital in an alternative investment such as a mutual fund, a certificate of deposit, or another business enterprise. If the capital is borrowed, then the capital cost would be the interest rate paid. In these budgets, a nominal, annual interest rate of 12 percent was used for operating capital, assuming that the operator takes out an operating loan at the beginning of the production period and repays it at the end. For investment capital, a real interest rate of 9 percent was assumed since most of the investment items have a useful life of five years or more. The 12 and 9 percent interest rates are reasonable, given U.S. economic conditions over the last several years; however, interest rates can fluctuate considerably over time.

10. **Market prices.** Publicly available market prices would be the appropriate ones to compare to the breakeven prices calculated in this study. Unfortunately, no comprehensive survey of yellow perch market prices has yet been undertaken. Neither is there a public market for yellow perch through which prices are discovered (such as the Chicago Board of Trade for establishing the price of #2 yellow corn). Nor does the U.S. Department of Agriculture collect and publicly report prices for yellow perch as they do for catfish and some other species of fish. The individual aquaculturist, on the other hand, could compare the breakeven price specific to his or her perch enterprise with the market prices he or she is able to negotiate with prospective buyers.

    Fortunately, monthly average wholesale prices for yellow perch sold in the round in 1994 and 1995 were available from several Lake Erie processors. These prices were assumed to be valid for the remainder of the 1990s given conditions in the Great Lakes yellow perch fisheries. The breakeven prices for the four budgets in this study were compared to these market prices to determine likelihood of economic feasibility. However, the volatility and unpredictability of the yellow perch fisheries of the Great

Lakes make it impossible to render long-term forecasts of market prices.

11. **Repairs, taxes, and insurance on investment items.** Annual costs for repairs, taxes, and insurance (RTI) were included for all investment items. These types of costs are typically associated with owning durable equipment. Following the example of livestock budgets developed at Purdue University, the yellow perch budgets assume that RTI costs will amount annually to 3.5 percent of the investment cost of a durable item, with repairs accounting for 2.0 percent, taxes 1.0 percent, and insurance 0.5 percent. Aquaculture budgets for other states and species suggest that 2.0 percent for repairs is a common assumption.

12. **Accounting procedure.** The budget cost structures reflect actual business conditions rather than IRS rules and regulations for farm enterprise accounting because state and federal tax codes are complex and mutable. Consequently, the years of useful life assumed for an investment item reflect the expected useful life of the item and not the IRS-allowable life. Aquaculturists should seek professional guidance when preparing their own budgets and tax statements.

13. **Location.** The budgets in this publication reflect costs and physical characteristics for Tippecanoe County, Indiana, where Purdue University is located. Since every budget is location specific, costs for other locations in the North Central Region will differ. Because feed and fingerlings comprise such a large portion of total costs, delivered prices for five different locations around the NCR were estimated and included in Appendix B.

14. **Annual ownership costs.** To arrive at total annual ownership costs, a charge for repairs, taxes, and insurance on total investment plus a land charge is added to the totals for depreciation and interest costs. Annual costs for depreciation and interest are calculated for individual investment items. Depreciation is calculated using the straight line method with no salvage value. Therefore, annual depreciation equals the total amount invested in the item divided by the useful life of the item. Annual interest is calculated as half the investment amount multiplied by the interest rate. Since the charge for repairs, taxes, and insurance is simply calculated by the investment amount times the RTI rate of 3.5 percent, the annual charge is calculated for the total amount of investment and not for each item individually.

15. **Annual operating costs.** Items included in the list of operating costs include only costs for items that are consumed within the production period, do not have a useful life beyond the production period, and vary with the level of production. Some budgets include all out-of-pocket costs as operating costs. However, these budgets are set up with only variable costs included as operating costs.

Cage culture enterprise budgets

Budget assumptions

Tables 1 (page 8) and 4 (page 12) set out the major production and marketing assumptions, assumed production values, and calculated production values (based on the assumed values) for the 5,000 and 50,000 pound operations, respectively. A discussion of the major assumptions which underlie all the budgets can be found in the Introduction.

The assumptions that are specific to the cage culture budgets as well as the few differences in the assumed production values between the two different sizes of operations follow:

- Use of existing farm ponds which have no alternative economic use;
- Pond size of 5 acres for the smaller operation and 50 acres for the larger operation;
- Death loss of 15% in the 5,000 pound operation and 10% in the 50,000 pound operation;
- Labor requirements of 1 hour per day in the smaller operation and 4 hours per day in the larger;
- Cage dimensions (cubic feet of space) of 5’x20’x4’ (400 ft^3) for the 5,000 pound operation and 10’x20’x5’ (1000 ft^3) for the 50,000 pound operation. Larger cages were assigned for the larger operation assuming that larger cages would be more advantageous both for the fish and for the operator.

Another major assumption is the physical configuration of each production system. The configurations for the cage culture systems can be found in Appendix Figures A1 and A2 for the smaller and larger size operations, respectively. The two configurations are quite different. In the 5,000 pound operation, the cages are in a row with space between their long sides and docks on either side of their short sides. The docks are

Table 1. Budget assumptions for food-size yellow perch: 5,000 lbs. production, cage culture, Indiana, 1994.

Assumed values		**Calculated values**	
Farm pond size (acres)	5	Targeted production (lbs.)	5,000
Production/acre (lbs.)	1000	<pond size × prodn/acre>	
Cage: 5'x20'x4' (cubic ft.)	400	Cubic feet space needed	2,000
Pounds per cuft of cage	2.5	<production / lbs. per cubic ft.>	
Fingerling size (ins.)	4.0	Total number of cages	5
Harvest size (lbs.)	0.30	<cubic ft. needed / cubic ft. per cage>	
Production time (mos.)	8.0	Number of harvested fish	16,667
Death loss	15%	<production / harvest size>	
Feed conversion ratio	2.00	Number of fingerlings	19,608
(lbs. feed per 1.0 lb. gain)		<No. fish / 1-death loss>	
Labor per day (hours)	1.0	Feed quantity (lbs.)	10,811
percent unskilled	87.5%	<(production × feed conversion)	
percent semi-skilled	12.5%	————————————	
Interest rates / capital charge		1 - (½× death loss)>	
Operating capital (nominal)	12%		
Investment capital	9%		
(real = nominal minus inflation)			
Investment repairs (2%), taxes (1%),			
and insurance rate	3.5%		

Major budget assumptions

Production assumption:
Stock advanced fingerlings to grow out in one season.
Marketing assumption:
Sell in the round, on ice, in wholesale markets, hauling in a refrigerator unit in a pickup bed.
Land assumption: Own the land, no other economic use, only land charge for property taxes

attached to the pond bank. One aerator services the entire production unit. For the larger operation, the cages are clustered in five groups of four cages with a dock in the middle of each cluster. Each of the five clusters has an electric aerator and is anchored by cable to the shore as well as two anchors from the dock to the pond bottom.

Investment and annual ownership costs

Tables 2 and 5 (page 13) detail the investment costs and ownership costs relevant to the 5,000 pound and 50,000 pound cage culture operations, respectively. The following is a summary of the most important investment items and the cost totals for each enterprise.

Table 2. Investment and annual ownership costs for food-size yellow perch: 5,000 lbs. production, cage culture, Indiana, 1994.

Equipment	Units (no.)	Unit cost ($)	Invest-ment ($)	Useful life (yrs.)	Annual deprec. ($)	Annual interest ($)
Production equipment						
Cages	5	338	1,690	7	241	76
Net treatment	2	40	80	5	16	4
Dock	1	1,100	1,100	10	110	50
Chemical test kit	1	28	28	7	4	1
Thermometer	1	10.5	11	7	2	0
Electric aerator	1	600	600	10	60	27
Electrical service	1	600	600	10	60	27
Scale	1	90	90	7	13	4
Dipnet	1	36	36	5	7	2
Miscellaneous	1	50	50	5	10	2
Harvesting/marketing equipment						
Dividing seine	1	50	50	5	10	2
Fish baskets	2	11	22	5	4	1
Containers for fish on ice	27	10	270	5	54	12
Refrigerator unit	1	3,000	3,000	5	600	135
Total investment			**$ 7,627**			
Total annual depreciation (Investment / useful life)						**$ 1,191**
Total annual interest (½ × investment × investment capital rate)						**$ 343**
Total annual repairs, taxes, and insurance (investment × investment R,T,I rate)						**$ 267**
Annual land charge (opportunity cost + property taxes)						**$ 15**
Total annual ownership cost						**$ 1,817**

Cages. Cage costs assume that the producer constructs the cages from purchased materials, including PVC pipe, netting, and steel bars. Cage parts and costs were based on those used by Pomeroy and Luke (1990).

Boat. A boat is included only for the larger operation, where one is needed for feeding, water testing, and harvesting.

Dock. Each size operation employs a dock, but quite differently. In the 5,000 pound operation, there are two 46’x3' docks that are anchored on shore and extend out into the water. The cages are suspended between the docks. The dock dimensions for the 50,000 pound operation are 22.5’x10’. Each of the five clusters has one dock from which four pens are suspended. All docks are assumed to be constructed by the operator from pressure-treated wood.

Water testing. To do chemical testing of the water, it was assumed that the producer purchases a thermometer and oxygen chemical test kits and refills for the 5,000 pound operation. For the larger operation, the producer invests in an oxygen / temperature meter with a probe.

Aerators. One aerator is required for the 5,000 pound operation, and five for the 50,000 pound operation. Each was assumed to be a one-horse-power aerator.

Electrical service connection. Electrical service was assumed to run 200 yards from the farmstead to the farm pond at a cost of $1.00 per foot, whether the service is above or below ground. For the larger operation, electrical service is also run from a beginning point at one of the clusters of cages around three-fourths of the circumference of the pond to reach the other four clusters.

Feed storage. Because of the volume of feed that must be stored for the 50,000 pound operation, it was assumed that a 100 square foot feed storage unit is constructed on the farm, perhaps near the pond. The shed is constructed by the producer, using a shed kit from a local hardware store, and modified as needed.

Harvesting and marketing equipment. Equipment for harvesting and marketing are distinguished from production equipment and include a homemade divider (made from a seine with metal rods on the sides) to crowd the fish into a portion of each cage, fish baskets, polyethylene containers in which to haul iced fish in the round to market, and a refrigeration unit which fits in the bed of a pickup truck. The size and number of items vary by operation size. Also, for the smaller operation, the pickup truck was assumed to be a smaller-size truck, while the truck used in the larger operation was assumed to be full size. The refrigeration units vary in cost by the size needed.

Land. In the cage culture operations it was assumed that the aquaculturist is taking advantage of an existing resource, a farm pond, with no alternative economic use (including pond culture). As a result, no opportunity cost was charged for the land, although there is still a property tax assessment of $3 per acre per year. Also, no pond construction charge was included since the pond was assumed to be either a natural pond or a man-made pond previously constructed for other purposes.

Total investment and annual ownership costs. The total investment is $7,627 for the 5,000 pound operation and $28,099 for the 50,000 pound operation. For the 5,000 pound enterprise, 3 of the 14 investment items (21%) have a total investment cost greater than $1,000. These items include cages, docks, and a refrigerator unit. Five of the 19 investments items (26%) in the 50,000 pound enterprise have investment outlays greater than $1,000, including cages, docks, aerators, electrical service, and the refrigerator unit.

Table 3. Operating and total costs for food-size yellow perch: 5,000 lbs. production, cage culture, Indiana, 1994.

Item	Unit	Unit cost	Number of units	Annual cost	Cost per lb.	Percent total cost
Production costs						
Fingerlings	head	$0.2639	19,608	$5,175	$1.03	36.9%
Feed	lb.	0.3457	10,811	3737	0.75	26.7%
Oxygen refill kit	each	19.00	2	38	0.01	0.3%
Chemicals	cage	26.00	5	130	0.03	0.9%
Electricity	kwh	0.08	402	34	0.01	0.2%
Labor (unskilled)	hour	6.00	210	1260	0.25	9.0%
Labor (semi-skilled)	hour	10.00	30	300	0.06	2.1%
Harvesting/marketing costs						
Ice	lb.	0.10	3,333	333	0.07	2.4%
Labor	hour	6.00	20	120	0.02	0.9%
Pickup charge	mile	0.25	600	150	0.03	1.1%
Overall costs						
Miscellaneous	each	1.00	20	20	0.00	0.1%
Interest (Operating capital)	$	8.00%	11,297	904	0.18	6.4%
Total operating costs				$12,201		87.0%
Breakeven price — operating costs					$2.44	
Annual ownership costs						
Depreciation				$1,191	$0.24	8.5%
Investment interest				343	0.07	2.4%
Repairs, taxes, and insurance				267	0.05	1.9%
Land				15	0.00	0.1%
Total annual ownership costs				$1,817	$0.36	13.0%
Total annual costs				$14,017		100.0%
Breakeven price — total costs					$2.80	

Although the targeted production of the larger operation is 10 times that of the smaller operation, the total investment is only 3.68 times larger. Similarly, total annual ownership costs in the larger operation ($6,013) are 3.31 times larger than the costs for the smaller operation ($1,817).This suggests economies of size in going from the smaller to the larger cage operation.

Operating costs

Operating costs are itemized in Tables 3 and 6 (page 14) for the 5,000 pound and 50,000 pound operations, respectively. Assumptions and budget methodologies involving operating costs are similar for all cage and pond operations. Therefore, these are discussed in the Introduction. Feed prices, however, differ by type of culture system and by size of operation. The cage culture systems use sinking feeds with delivered

Table 4. Budget assumptions for food-size yellow perch: 50,000 lbs. production, cage culture, Indiana, 1994.

Assumed values		Calculated values	
Farm pond size (acres)	50	Targeted production (lbs.)	50,000
Production/acre (lbs.)	1000	<pond size × prodn/acre>	
Cage: 10’x20’x5' (cubic ft.)	1000	Cubic feet space needed	20,000
Pounds per cuft of cage	2.5	<production / lbs. per cubic ft.>	
Fingerling size (ins.)	4.0	Total number of cages	20
Harvest size (lbs.)	0.30	<cubic ft. needed / cubic ft. per cage>	
Production time (mos.)	8.0	Number of harvested fish	166,667
Death loss	10%	<production / harvest size>	
Feed conversion ratio (lbs. feed per 1.0 lb. gain)	2.00	Number of fingerlings	185,185
		<No. fish / 1-death loss>	
Labor per day (hours)	4.0	Feed quantity (lbs.)	105,263
percent unskilled	87.5%	<(production × feed conversion) / 1 - (1/2 × death loss)>	
percent semi-skilled	12.5%		
Interest rates / capital charge			
Operating capital (nominal)	12%		
Investment capital (real = nominal minus inflation)	9%		
Investment repairs (2%), taxes (1%), and insurance rate	3.5%		

Major budget assumptions

Production assumption:
Stock advanced fingerlings to grow out in one season.

Marketing assumption:
Sell in the round, on ice, in wholesale markets, hauling in a refrigerator unit in a pickup bed.

Land assumption:
Own the land, no other economic use, only land charge for property taxes.

prices for the 5,000 and 50,000 pound operations of 34.57 and 21.13 cents per pound, respectively.

Total operating costs vary from $12,201 for the smaller, 5,000 pound operation to $89,966 for the larger, 50,000 pound operation. Operating costs account for 87.0 percent and 93.7 percent of total costs, respectively. The operating cost items contributing the largest share to total costs include fingerlings and feed. Together, these two items account for 63.7 percent of total costs in the 5,000 pound operation and 73.2 percent in the 50,000 pound operation. No other budget items account for more than 10 percent of total costs. Economies of size occur for operating costs as well as investment and ownership costs for cage culture. While the larger operation produces 10 times as many fish as the smaller one, its operating costs are only 7.37 times higher.

Total costs and breakeven prices

Total costs. Like operating costs and ownership costs, total cost levels for the two sizes of cage culture operations reveal economies of size in cage culture. Total annual costs for the smaller operation equal $14,017 and those for the larger operation total $95,979. The figure for the larger operation is 6.85 times that for the smaller operation.

Breakeven prices. Breakeven prices, or total costs per pound, also are substantially different between the two sizes of cage culture operations. The breakeven price for total costs is $2.80 per pound for the smaller operation and $1.92 per pound for the larger operation. The $1.92 per pound breakeven price estimated in the budget for the larger cage operation is lower than the

Table 5. Investment and annual ownership costs for food-size yellow perch: 50,000 lbs. production, cage culture, Indiana, 1994.

Equipment	Units (no.)	Unit cost ($)	Invest-ment ($)	Useful life (yrs.)	Annual deprec. ($)	Annual interest ($)
Production equipment						
Cages	20	480	9,600	10	960	432
Net treatment	1	377	377	5	75	17
Boat winches (hand)	2	28	56	5	11	3
Anchors	10	25	250	7	36	11
Polyethylene rope	1	34	34	7	5	2
Cable	1	150	150	7	21	7
Dock	5	550	2,750	20	138	124
Boat	1	500	500	10	50	23
Oxygen/temp meter	1	338	338	10	34	15
Electric aerator	5	600	3,000	10	300	135
Electrical service	1	1,987	1,987	10	199	89
Feed storage	1	800	800	5	160	36
Scale	1	190	190	7	27	9
Dipnets	2	36	72	5	14	3
Miscellaneous	1	150	150	5	30	7
Harvesting/marketing equipment						
Dividing seine	2	75	150	7	21	7
Fish baskets	10	9.5	95	7	14	4
Containers for fish on ice	60	10	600	5	120	27
Refrigerator unit	1	7,000	7,000	5	1400	315
Total investment		**$**	**28,099**			
Total annual depreciation (Investment / useful life)						**$ 3,615**
Total annual interest (1/2 × Investment × Investment capital rate)						**$ 1,264**
Total annual repairs, taxes, and insurance (Investment × Investment R,T,I Rate)						**$ 983**
Annual land charge (Opportunity cost + Property taxes)						**$ 150**
Total annual ownership cost						**$ 6,013**

lowest reported wholesale price. Thus, a larger cage culture operation with similar assumptions and cost structure appears to be economically feasible for the North Central Region for the remainder of the 1990s.

The economic feasibility of the smaller cage culture operation, however, is questionable. The $2.80 per pound breakeven price falls near the top of the range of reported wholesale prices. If the goal of the aquaculturist with a 5,000 pound cage culture enterprise is a profit-generating venture, then the enterprise probably should not be undertaken unless the aquaculturist is able to manage costs closer to $2.00 per pound. However, if the goal is to learn more about culturing yellow perch before investing in a larger operation, then starting with a smaller operation, even though potentially unprofitable, may be justified. The aquaculturist would then have to decide if the benefit of acquiring knowledge of yellow

Table 6. Operating and total costs for food-size yellow perch: 50,000 lbs. production, cage culture, Indiana, 1994.

Item	Unit	Unit cost	Number of units	Annual cost	Cost per lb.	Percent total cost
Production costs						
Fingerlings	head	$0.2639	185,185	$48,870	$0.98	50.9%
Feed	lb.	0.2113	105,263	22,242	0.44	23.2%
Chemicals	cage	64.95	20	1,299	0.03	1.4%
Electricity	kwh	0.08	2,010	168	0.00	0.2%
Labor (unskilled)	hour	6.00	840	5,040	0.10	5.3%
Labor (semi-skilled)	hour	10.00	120	1,200	0.02	1.3%
Harvesting/marketing costs						
Ice	lb.	0.10	33,333	3,333	0.07	3.5%
Labor	hour	6.00	104	624	0.01	0.7%
Pickup charge	mile	0.25	1,800	450	0.01	0.5%
Overall costs						
Miscellaneous	each	1.00	75	75	0.00	0.1%
Interest (Operating capital)	$	8.00%	83,301	6,664	0.13	6.9%
Total operating costs				$89,966		93.7%
Breakeven price — operating costs					$1.80	
Annual ownership costs						
Depreciation				$3,615	$0.07	3.8%
Investment Interest				1264	0.03	1.3%
Repairs, taxes, and insurance”				983	0.02	1.0%
Land				150	0.00	0.2%
Total annual ownership costs				$6,013	$0.12	6.3%
Total annual costs				$95,979		100.0%
Breakeven price — total costs					$1.92	

perch culture is worth the risk of losing money on the small operation.

Because of the diversity of opinion about how to account for the cost of land, a short discussion of the impacts of alternative land assumptions is merited. For the purposes of this study it was assumed that the aquaculturist already had an unused, existing pond. However, this is but one of several plausible assumptions that could have been used. For the 5,000 pound cage operation in the five-acre pond, the assumption used is quite reasonable. And, so little land is involved that even if it were rented or purchased specifically for aquacultural use, the cost would be minimal. For the 50,000 pound cage operation with a 50-acre pond, the assumption becomes somewhat strained. Therefore, some alternative assumptions and their impacts on annual ownership costs and breakeven price were briefly examined.

The results show little effect on breakeven prices from increased land charges. Suppose, in the extreme, that the aquaculturist purchased 50 acres of pond in which to produce 50,000 pounds annually. If the cost per acre were $500 and the aquaculturist included an annual 30-year mortgage and interest payment in the budget, the annual land charge would be about $2,500. This level of land charge translates into a breakeven price of $1.97 per pound-only 5 cents per pound higher than the original $1.92 breakeven price.

Pond culture enterprise budgets

Budget assumptions

The assumptions which underlie the pond culture budgets for the 5,000 and 50,000 pound operations are found in Tables 7 (page 16) and 10, (page 19) respectively. A discussion of the assumptions which are common to all the budgets can be found in the Introduction.

The assumptions specific to the pond culture budgets as well as the few differences in the assumed production values between the two different sizes of operations follow:

- Ponds constructed for fish production on low-quality corn land (100 bu. / acre);
- One pond in the smaller operation and four ponds in the larger operation; and
- Labor requirements of 1.5 hours per day for the smaller operation and 3.5 hours per day for the larger.

Pond layout

As in the cage culture scenario, the physical configurations of the pond production systems are important and differ somewhat between the two sizes of operations. Appendix Figure A3 shows the configuration for one pond for the 5,000 pound operation. Based on the assumed production rate of 3,000 pounds per acre, a 1.67 surface acre, square pond was chosen. It was assumed that the land needed for this pond size is 1.84 acres. Accompanying the pond are one well and one ditch.

Appendix Figure A4 shows the configuration for the pond setup for the 50,000 pound pond operation. The hypothetical setup was chosen to include four ponds that just accommodate the level of production. Each pond has 4.17 surface acres of water, while the total land required is 17.78 acres. Square ponds were chosen to minimize pond construction costs by taking advantage of common levees and shape. Pond size is small enough to preclude problems with managing square ponds. In this setup, there is one well in the center of the four ponds and two ditches to minimize the amount of drainpipe required.

For both ponds the levees are constructed to the same dimensions, as shown in Appendix Figures A3 and A4. The crown width is 12 feet and the depth 6.5 feet, with slopes of 3:1 for exterior sides and 2:1 for interior sides. The ditches are as-

Table 7. Budget assumptions for food-size yellow perch: 5,000 lbs. production, pond culture, Indiana, 1994.

Assumed values		Calculated values	
Pond size (acres)	1.6667	Targeted production (lbs.)	5,000
Production/acre (lbs.)	3000	<pond size × prodn/acre>	
Number of ponds	1	Number of harvested fish	15,152
Fingerling size (ins.)	4.0	<production/harvest size>	
Harvest size (lbs.)	0.33	Number of fingerlings	15,949
Production time (mos.)	7.0	<No. fish/1-death loss>	
Death loss	5%	Feed quantity (lbs.)	9,231
Feed conversion ratio	1.80	<(production × feed conversion)	
(lbs. feed per 1.0 lb. gain)		————————————	
Labor per day (hours)	1.5	1 - (1/2 × death loss)>	
percent unskilled	87.5%		
percent semi-skilled	12.5%		
Interest rates/capital charge			
Operating capital (nominal)	12%		
Investment capital (real = nominal minus inflation)	9%		
Investment repairs (2%), taxes (1%), and insurance rate	3.5%		

Major budget assumptions

Production assumption:
Stock advanced fingerlings to grow out in one season.

Marketing assumption:
Sell in the round, on ice, in wholesale markets, hauling in a refrigerator unit in a pickup bed.

Land assumption:
Own the land, 100 bu/A corn land so land charge includes forgone return on corn production.

sumed to be eight feet away from the base of the exterior sides of the levees.

Investment and annual ownership costs

Table**s** 8 (page 17) and 11 (page 20) contain the details of investment items and their related ownership costs relevant to the 5,000 and 50,000 pound pond culture operations, respectively. The following is a summary of the assumptions related to facilities and equipment and the total costs for each enterprise.

Pond construction. The number of cubic yards of dirt needed for levee construction was calculated for each operation. The levees with one exterior and one interior side require 6.8 cubic yards per running foot of levee, while levees with two interior sides require 6.02 cubic yards per running foot. Each side of a 4.17 acre pond, is 440 feet in length, while the length of each side in the 1.67 acre pond is 283 feet. For the 5,000 pound operation there are 1,134 running feet of exterior / interior levees for a total of 7,711 cubic yards of dirt required for levee construction. For the 50,000 pound operation, there are eight exterior / interior levees totaling 3,520 running feet and 4 interior / interior levees requiring 1,760 running feet. A total of 34,534 cubic yards is required for levee construction.

Levee construction costs were discussed with three local contractors to determine a reasonable estimate for the local area. There was some

Table 8. Investment and annual ownership costs for food-size yellow perch: 5,000 lbs. production, pond culture, Indiana, 1994.

System equipment	Units (no.)	Unit cost ($)	Invest-ment ($)	Useful life (yrs.)	Annual deprec. ($)	Annual interest ($)
Pond & water supply investment						
Levees (cu.yds.)	7,711	3.50	26,989	20	1349	1214
Drainpipe (12 ft)	64	6.60	422	20	21	19
Drain/valve	1	289	289	20	14	13
Anti-seep collars	2	230	460	20	23	21
Well & pump	1	4,850	4,850	20	243	218
Grass seed (lbs)	2.5	1.70	4	20	0	0
Gravel (tons)	39.5	11.00	435	20	22	20
Production equipment						
Chemical test kit	1	28	28	20	1	1
Thermometer	1	10.5	11	7	2	0
Electric aerator	1	700	700	10	70	32
Electrical service	1	600	600	10	60	27
Scale	1	90	90	7	13	4
Dipnet	1	36	36	5	7	2
Waders	1	95	95	10	10	4
Miscellaneous	1	50	50	5	10	2
Harvesting/marketing equipment						
Seine	1	832	832	5	166	37
Fish baskets	2	11	22	5	4	1
Containers for fish on ice	27	10	270	5	54	12
Refrigerator unit	1	3,000	3,000	5	600	135
Total investment		**$**	**39,182**			
Total annual depreciation (Investment / Useful life)					**$**	**2,670**
Total annual interest (1/2 × Investment × Investment capital rate)					**$**	**1,763**
Total Annual repairs, taxes, and insurance (Investment × Investment R,T,I rate)					**$**	**1,371**
Annual land charge (Opportunity cost + Property taxes)					**$**	**190**
Total annual ownership cost					**$**	**5,994**

Table 9. Operating and total costs for food-size yellow perch: 5,000 lbs. production, pond culture, Indiana, 1994.

Item	Unit	Unit cost	Number of units	Annual cost	Cost per lb.	Percent total cost
Production costs						
Fingerlings	head	$0.2639	15,949	$4,209	$0.84	24.2%
Feed	lb.	0.3690	9,231	3,406	0.68	19.6%
Oxygen refill kit	each	19.00	2	38	0.01	0.2%
Chemicals	acre	60.00	1.67	100	0.02	0.6%
Electricity						
Aeration	kwh	0.0835	804	67	0.01	0.4%
Pumping	each	83.00	1	83	0.02	0.5%
Labor (unskilled)	hour	6.00	276	1,654	0.33	9.5%
Labor (semi-skilled)	hour	10.00	39	394	0.08	2.3%
Mower charge	each	100.00	1	100	0.02	0.6%
Harvesting/marketing costs						
Ice	lb.	0.10	3,333	333	0.07	1.9%
Labor	hour	6.00	20	120	0.02	0.7%
Pickup charge	mile	0.25	600	150	0.03	0.9%
Overall costs						
Miscellaneous	each	1.00	20	20	0.00	0.1%
Interest (Operating capital)	$	7.00%	10,674	747	0.15	4.3%
Total operating costs				**$11,421**		**65.6%**
Breakeven price — operating costs					$2.28	
Annual ownership costs						
Depreciation				$2,670	$0.53	15.3%
Investment interest				$1,763	$0.35	10.1%
Repairs, taxes, and insurance				$1,371	$0.27	7.9%
Land				$190	$0.04	1.1%
Total annual ownership costs				**$5,994**	**$1.20**	**34.4%**
Total annual costs				**$17,416**		**100.0%**
Breakeven price — total costs					$3.48	

variability in estimated costs, but overall they were considerably higher than costs listed in catfish budgets from southern states. Costs per cubic yard of dirt moved were also estimated to be higher for the smaller operation since overhead costs would be spread out over fewer units. The cost for constructing one small pond for the 5,000 pound operation was estimated to be $3.50 per cubic yard, while the cost for constructing the four larger ponds was estimated to be $2.75 per cubic yard. These costs are based on the assumption that no dirt would have to be hauled to the site. Pond construction costs can vary considerably based on topography and soil type as well as contractor. A site visit is necessary to accurately estimate costs for a specific location.

Table 10. Budget assumptions for food-size yellow perch: 50,000 lbs. production, pond culture, Indiana, 1994.

Assumed values		Calculated values	
Pond size (acres)	4.1667	Targeted production (lbs.)	50,000
Production/acre (lbs.)	3000	<pond size × prodn/acre>	
Number of ponds	4	Number of harvested fish	151,516
Fingerling size (ins.)	4.0	<production/harvest size>	
Harvest size (lbs.)	0.33	Number of fingerlings	159,491
Production time (mos.)	7.0	<No. fish/1-death loss>	
Death loss	5%	Feed quantity (lbs.)	92,308
Feed conversion ratio	1.80	<(production × feed conversion)	
(lbs. feed per 1.0 lb. gain)		————————————	
Labor per day (hours)	3.5	1 - (1/2 × death loss)>	
percent unskilled	87.5%		
percent semi-skilled	12.5%		
Interest rates / capital charge			
Operating capital (nominal)	12%		
Investment capital (real = nominal minus inflation)	9%		
Investment repairs (2%), taxes (1%), and insurance rate	3.5%		

Major budget assumptions

Production assumption:
Stock advanced fingerlings to grow out in one season.
Marketing assumption:
Sell in the round, on ice, in wholesale markets, hauling in a refrigerator unit in a pickup bed.
Land assumption:
Own the land, 100 bu/A corn land so land charge includes forgone return on corn prodn.

Drainpipe, valves, collars. Pipe for both water inlet and outflow to the ditches was assumed to be 12-inch, low pressure, PVC pipe. Per pond (all sizes), the amount of inlet pipe needed was estimated to be 8 feet, and the amount of drainpipe estimated at 56 feet. It was further assumed that each pond requires one drain or valve and two anti-seep collars on the drainpipe.

Well and pump. Discussions with local well drilling companies revealed that there is no "average" depth of well for the local area (Tippecanoe County, Indiana). Therefore, it was assumed that the well is drilled to a depth of 100 feet, but that the water rises up to 50 feet below the surface and is pumped from that level. Required well pumping capacity was assumed to be 30 gallons per minute (gpm) per water surface acre. Accordingly, the 5,000 pound operation requires a 50 gpm well, which is achieved with a 5-inch well and a 3-horsepower pump. For the 50,000 pound operation, a 500 gpm well is required, which necessitates a 10-inch well and a 25-horsepower pump. The unit costs given in the budgets include drilling, casing, screen, pump, and installation.

Grass seed. It was estimated that 11.6 percent of the land area requires grass cover. Sodding would be a high-cost way to achieve this, so it was assumed that the grass would be seeded instead. For the 50,000 pound operation there are 74,568 square feet requiring 20 pounds of grass seed. For the 5,000 pound operation there are 6,988 square feet necessitating 2.3 pounds of seed.

Table 11. Investment and annual ownership costs for food-size yellow perch: 50,000 lbs. production, pond culture, Indiana, 1994.

System equipment	Unit Units (no.)	Invest- cost ($)	Useful ment ($)	Annual life (yrs.)	Annual deprec. ($)	interest ($)
Pond & water supply investment						
Levees (cu.yds.)	34,534	2.75	94,969	20	4748	4274
Drainpipe (12 ft)	256	6.60	1,690	20	84	76
Drain/valve	4	289	1,156	20	58	52
Anti-seep collars	8	230	1,840	20	92	83
Well & pump	1	15,225	15,225	20	761	685
Grass seed (lbs)	20	1.70	34	20	2	2
Gravel	122	11.00	1,342	20	67	60
Production equipment						
ATV, 4-wheeler	1	5,000	5,000	7	714	225
Boat	1	500	500	10	50	23
Oxygen/temp meter	1	338	338	10	34	15
Electric aerator	8	700	5,600	10	560	252
Electrical service	1	600	600	10	60	27
Feeder	1	1,650	1,650	7	236	74
Feed storage	1	800	800	5	160	36
Scale	1	190	190	7	27	9
Dipnets	2	36	72	5	14	3
Waders	1	95	95	10	10	4
Miscellaneous	1	150	150	5	30	7
Harvesting/marketing equipment						
Seine	1	1,293	1,293	7	185	58
Fish baskets	10	10	95	7	14	4
Containers	60	10	600	5	120	27
Refrigerator unit	1	7,000	7,000	5	1400	315
Total investment		**$**	**140,238**			
Total annual depreciation (Investment/Useful Life)					**$**	**9,426**
Total annual interest (½ × investment × investment capital rate)					**$**	**6,311**
Total annual repairs, taxes, and insurance (Investment × investment R,T,I rate)					**$**	**4,908**
Annual land charge (Opportunity cost + property taxes)					**$**	**1,830**
Total annual ownership cost					**$**	**22,475**

Gravel. Some gravel needs to be laid by the ponds to ensure all-weather access. For the single pond, the top of one levee is graveled. For the four larger ponds, one entire length of interior / interior levee, which borders all four ponds, is graveled.

Boat. A boat is needed only for the larger operation. It is used for water testing and harvesting.

4-wheel ATV. An ATV is necessary only for the 50,000 pound production unit. Its main function is to pull a feed blower. It may also be useful for transportation around the pond site, water testing, harvesting, etc. A basic model with 4-wheel drive costs about $5,000.

Feeding system. Feeding in the smaller operation is accomplished through hand feeding. For the larger system, however, it was assumed that a blower feeder is purchased. Farmboys Industries Inc. sells different sizes of such feeders. The smallest of these, with a 500-pound capacity, would be adequate for this operation.

Feed storage. Because of the volume of feed that must be stored for the 50,000 pound pond operation, it was assumed that a 100 square foot feed storage unit is constructed on the farm, perhaps near the ponds. The shed is constructed by the producer, using a shed kit from a local hardware store, and modified as needed.

Electrical service connection. As in the cage culture systems, electrical service was assumed to run 200 yards from the farmstead to the ponds at a cost of $1.00 per foot, whether the service is above or below the ground. For the larger pond operation, the electrical service runs to a spot in the middle of the four ponds, where the well is located.

Water testing. The investment in water testing equipment is the same for the pond production systems as for the cage systems. To do chemical testing of the water, it was assumed that the producer purchases a thermometer and oxygen chemical test kits and refills for the 5,000 pound operation. For the larger operation, the producer invests in a meter with probe which measures both temperature and oxygen levels.

Aerators. Aerators are required for managing dissolved oxygen and temperature levels. One 2-horsepower aerator suffices for the 1.67-acre pond in the smaller operation, while two 2-horsepower aerators are needed for each of the 4.17-acre ponds in the larger operation.

Harvesting and marketing equipment. Equipment for harvesting and marketing are distinguished from production equipment and are identical to those assumed for the cage operations, with the exception that one large seine is needed for harvesting in each pond operation. The seine for the 1.67-acre pond in the small operation was assumed to be 354 feet long and the seine for the 4.17-acre ponds was assumed to be 550 feet. Otherwise, both seines were assumed to be 10 feet deep, with a one-inch square mesh size, and twine size of 15.

As with the cage operations, equipment needs for harvesting and marketing include fish baskets, polyethylene containers in which to haul iced fish in the round to market, and a refrigeration unit which fits in the bed of a pickup. The size and number of items vary by operation size. Also, for the smaller operation the truck was assumed to be a smaller-size pickup, while the truck used in the larger operation was assumed to be a full-size pickup. Thus, the refrigeration units vary in cost by the size needed.

Land. In the pond culture operations it was assumed that the operator plans to convert owned, poorly yielding, flat, corn land into levee ponds. Since there is a viable economic alternative for the use of the land, growing corn, the annual opportunity cost is $93 per acre based on the estimated net return above operating costs for raising corn. In addition, there is an annual property tax assessment of $9.90 per acre.

Total investment and annual ownership costs. Total investment is $39,182 for the 5,000 pound operation and $140,238 for the 50,000 pound operation. For the 5,000 pound enterprise, 3 of the 19 investment items (16%) have an investment outlay greater than $1,000. These items include levee construction, well and pump, and refrigerator unit. Eleven of the 22 investment items (50%) in the 50,000 pound enterprise have investment outlays greater than $1,000, including levee construction, drainpipe, drain / valve, anti-seep collars, well and pump, gravel, ATV, aerators, feeder, seine, and refrigerator unit. Total investment in the larger operation is 3.58 times higher than the investment in the smaller operation.

Annual ownership costs for the 5,000 and 50,000 pound operations are $5,994 and $22,475. These fixed costs account for 34.4 and 21.0 percent of total annual costs, respectively. On a per pound basis, annual ownership costs are $1.20 and $0.45, respectively. Similar to investment costs, annual ownership costs for the larger operation are 3.75 times higher than for the smaller operation. Since the production level is 10 times higher, this suggests substantial economies of size for the larger operation..

Operating costs

Operating costs are itemized in Tables 9 (page 18) and 12 (page 23) for the 5,000 and 50,000 pound operations, respectively. Assumptions and budget methodologies involving operating costs are very similar for all cage and pond operations. Therefore, these are discussed in the Introduction with the exception of a few pond-specific operating costs which are addressed below.

Feed. Feed prices differ by type of culture system and by size of operation. The pond culture systems use floating feeds. The delivered feed price assumed for the larger operation is 26.55 cents per pound, compared to 36.90 cents per pound for the smaller operation.

Electricity. A cost estimate for pumping water into the ponds was made based on per acre pumping costs from other budget publications. Furthermore, it was assumed that the ponds are drained and filled only once every four years. Pumping costs for the 5,000 and 50,000 pound operations were assumed to be $200 per acre and $150 per acre, respectively. These rates were multiplied times the number of surface acres, then divided by four to reflect annual charges.

Mower. Rather than invest in a mower for such a relatively small acreage, it was assumed that a mower used in other farm operations is used to mow the pond levees. Accordingly, an annual charge is included for mower use based on the assumption of mowing 12 times per year.

Total operating costs. Operating costs total $11,421 for the smaller, 5,000 pound operation and $84,604 for the larger, 50,000 pound operation, and account for 65.6 and 79.0 percent of total costs, respectively. The operating cost items contributing the largest share to total costs are fingerlings and feed. Together, these two items account for 43.8 percent of total costs in the 5,000 pound operation and 62.2 percent in the 50,000 pound operation. No other operating budget items account for more than 10 percent of total costs except for labor in the 5,000 pound operation budget, which accounts for 11.8 percent.

Economies of size occur for operating costs as well as investment and ownership costs for cage culture. While the larger operation produces 10 times as many fish as the smaller one, its operating costs are only 7.41 times higher.

Table 12. Operating and total costs for food-size yellow perch: 50,000 lbs. production, pond culture, Indiana, 1994.

Item	Unit	Unit cost	Number of units	Annual cost	Cost per lb.	Percent total cost
Production costs						
Fingerlings	head	$0.2639	159,491	$42,090	$0.84	39.3%
Feed	lb.	0.2655	92,308	24,508	0.49	22.9%
Chemicals	acre	60.00	16.67	1,000	0.02	0.9%
Fuel, ATV	gal.	1.00	450	450	0.01	0.4%
Electricity						
Aeration	kwh	0.0835	6,432	537	0.01	0.5%
Pumping	each	625.00	1	625	0.01	0.6%
Labor (unskilled)	hour	6.00	643	3,859	0.08	3.6%
Labor (semi-skilled)	hour	10.00	92	919	0.02	0.9%
Mower charge	each	600.00	1	600	0.01	0.6%
Harvesting/marketing costs						
Ice	lb.	0.10	33,333	3,333	0.07	3.1%
Labor	hour	6.00	104	624	0.01	0.6%
Pickup charge	mile	0.25	1,800	450	0.01	0.4%
Overall costs						
Miscellaneous	each	1.00	75	75	0.00	0.1%
Interest (Operating capital)	$	7.00%	79,069	5,535	0.11	5.2%
Total operating costs				**$84,604**		**79.0%**
Breakeven price — operating costs					$1.69	
Annual ownership costs						
Depreciation				$9,426	$0.19	8.8%
Investment interest				$6,311	$0.13	5.9%
Repairs, taxes, and insurance				$4,908	$0.10	4.6%
Land				$1,830	$0.04	1.7%
Total annual ownership costs				**$22,475**	**$0.45**	**21.0%**
Total annual costs				**$107,079**		**100.0%**
Breakeven price — total costs					$2.14	

Total costs and breakeven prices

Total costs. Total annual costs equal $17,416 for the smaller operation, and $107,079 for the larger operation. Like operating costs and ownership costs, total cost levels for the two sizes of pond culture operations suggest economies of size in pond culture. Annual total costs for the larger operation are 6.15 times more than total costs for the smaller operation while the production level is ten times higher.

In the 5,000 pound operation, depreciation and interest on investment items each account for over 10 percent of total costs, 15.3 and 10.1 percent, respectively. This is not true for the 50,000 pound operation.

Breakeven prices. Breakeven prices also are substantially different by size of operation. The breakeven price is $3.48 per pound for the smaller operation and $2.14 per pound for the larger operation. The $2.14 per pound breakeven price estimated in the budget for the larger pond operation is lower than most of the reported monthly wholesale prices. Thus, a larger pond culture operation with similar assumptions and cost structure appears to be economically feasible for the North Central Region. The economic feasibility of the smaller pond culture operation, however, is highly questionable. The $3.48 per pound breakeven price is almost 50 cents above the highest reported wholesale price. Additionally, annual ownership costs are quite high ($1.20 per pound), compared to the larger operation ($0.45 per pound).

As with the smaller cage culture operation, if the goal of the aquaculturist with a 5,000 pound pond enterprise is a profit-generating venture, then this enterprise should not be undertaken. However, if the goal is to learn more about culturing yellow perch, then turning a profit becomes secondary to the knowledge gained. The aquaculturist would then have to decide if the benefit of acquiring knowledge of yellow perch culture in a small pond system is worth the cost of losing money on the operation until he / she decides to expand the size of the operation. However, the investment costs of constructing a levee fish pond are considerably higher than the costs of constructing cages and docks. In the end, only the individual aquaculturist can assess the cost versus the benefit.

As with cage culture, a brief discussion is merited regarding alternative land assumptions and their impacts on annual ownership costs and breakeven prices. A brief investigation of alternative assumptions reveals that impacts on annual ownership costs and breakeven prices are minimal. Suppose, in the worst case, that an aquaculturist pays $1,000 per acre to purchase the 18 acres needed to construct the 50,000 pound pond culture operation. Suppose further that the aquaculturist decides to include in the budget an annual principal and interest payment on a 30-year land mortgage. The annual ownership cost resulting from this land charge assumption is about $1,800-virtually identical to the land charge resulting from the opportunity cost assumption.

An area of diverse opinion regarding the costs of pond production is the cost per cubic yard of constructing pond levees. Conducting sensitivity analysis with alternative construction costs shows modest impacts on breakeven prices for the 5,000 pound operation, and even smaller impacts for the 50,000 pound operation. For example, in the 5,000 pound operation budget, the levee construction charge per cubic yard of $3.50 results in a breakeven price of $3.48 per pound. Decreasing the cost per cubic yard to $2.50, and then to $1.50, results in breakeven prices of $3.28 and $3.08 per pound, respectively. Increasing the cost to $4.50 per cubic yard gives a breakeven price of $3.68 per pound. For the 50,000 pound operation the initial levee construction cost is lower and the breakeven price is almost 50 percent smaller. Levee construction costs per cubic yard of $3.75, $2.75 (the cost used in the budget), $1.75, and $1.25 result in breakeven prices per pound of $2.23, $2.14 (budget number), $2.05, and $2.01, respectively.

Sensitivity analysis

Another useful management tool, one that is based on the enterprise budget, is sensitivity analysis. Sensitivity analysis involves the use in the budget of alternative assumptions or values for market prices, production costs, or biological production parameters to calculate and assess their impacts on total costs, breakeven price, breakeven yield, or net returns. Analyzing the enterprise budget for its sensitivity to changes in assumptions or values is useful for: evaluating the profitability of budget alternatives or deviations; guiding business decisions; exploring the range of enterprise profitability in order to make appropriate management decisions (such as on size of operation or limit on feed costs); and determining the relative importance of budget items and production parameters on profitability so that scarce resources can be focused on the most important areas.

Sensitivity analysis can be conducted in different ways. One method is to vary one budget item at a time by various magnitudes and in different directions. Another method is to vary budget items (one at a time) by similar percentages to examine their relative impact on costs of production. A third method involves changing two or more related variables at the same time, especially where tradeoffs occur in production relationships or input combinations (for example, stocking rate and death loss), to assess the bottom-line impact of the various combinations.

Opposite is a table of the sensitivity of net returns to changes in market price. Net returns are defined as total revenue (market price x market quantity) less total costs (breakeven price x market quantity). Alternative market prices were used in this sensitivity analysis rather than picking a single price as "the" market price for yellow perch and including that price in the enterprise budget.

Table 13 reveals how various market prices could affect the profitability of each operation and what magnitudes of net returns could be expected from each operation. For the range of market prices given, the two 5,000 pound operations do not appear to be profitable. The magnitude of the losses, however, is relatively small. Conversely, both 50,000 pound operations appear to show a profit throughout most of the range of market prices, and the magnitude of the potential profits is relatively large. However, for the larger operations, the magnitude of loss, even for a 50-cent adverse price movement, could be significant.

In this study, sensitivity analysis is employed as a way to circumvent the limitation of being able to use only one value at a time in an enterprise budget. Following are tables of sensitivity

Table 13. Sensitivity analysis of net returns to market price, by production system and size of operation.

Wholesale market price for yellow perch in the round (per lb)	Production system, size, and breakeven price (per lb.)			
	Cage culture		Pond culture	
	5,000 lbs. $2.80	50,000 lbs. $1.92	5,000 lbs. $3.48	50,000 lbs. $2.14
$1.50	($6,500)	($21,000)	($9,900)	($32,000)
$1.75	($5,250)	($8,500)	($8,650)	($19,500)
$2.00	($4,000)	$4,000	($7,400)	($7,000)
$2.25	($2,750)	$16,500	($6,150)	$5,500
$2.50	($1,500)	$29,000	($4,900)	$18,000
$2.75	($250)	$41,500	($3,650)	$30,500
$3.00	$1,000	$54,000	($2,400)	$43,000
$3.25	$2,250	$66,500	($1,150)	$55,500
$3.50	$3,500	$79,000	$100	$68,000

analysis for each production system by size of operation (Tables 14–17, pages 27–33). Several key items from the budgets were varied to determine their impacts on breakeven prices. The results suggest how profitability might change if an input price or production assumption were to deviate from what was assumed in the enterprise budgets.

One general observation from the sensitivity analysis results is that impacts on breakeven prices, in terms of dollars per pound, are remarkably similar regardless of the type of production system or size of operation. The similarities are even more striking between the two sizes of the same production system even though their initial breakeven prices are quite different. Using the (a) portion of each table to illustrate this phenomenon, one can see that a 5-cent per pound increase in feed price increases breakeven prices per pound for both pond culture operations by 9-10 cents and for both cage culture operations by 11-12 cents. Insights about the impacts of individual budget items are summarized below.

Because of the small weight at which yellow perch are typically marketed, it was hypothesized that fingerling price levels would greatly affect breakeven prices and that fluctuations in fingerling price would cause significant changes in breakeven prices. The cost of fingerlings represents the single largest budget item based on proportion of total annual cost (ranging from 24-51 percent). The results of sensitivity analysis reveal that changes in fingerling price can substantially alter breakeven prices (Tables 14–17). A high fingerling price can be ruinous for a yellow perch aquaculture operation. This is a good example of how an aquaculture operation can fail to be a profitable concern even if the aquaculturist has extraordinary biological skills. The aquaculturist must be able to obtain quality fingerlings at a profitable price either through the use of biological skills to produce his / her own fingerlings or through the use of management skills to purchase fingerlings.

Fingerling prices are included in three of the four sub-components of the sensitivity analysis, appearing in combination with feed price, market size, and death loss. Results clearly show significant effects on breakeven prices from changes in the fingerling price. Typically, a 5 cents per head change in the fingerling price will generate a change in the breakeven price between 17 and 30 cents per pound. There are two perspectives from which to view this large influence of fingerling price. On the one hand, an operation with lower fingerling prices can withstand more budget adversity in other areas and still be profitable. Conversely, an operation that is operating near or outside the bounds of profitability can greatly improve its chances of economic survival simply by decreasing the price it pays for fingerlings.

Feed price changes also have a significant impact on breakeven prices, but the magnitude of the impact is not as great as it is for fingerling price changes. A 10 cents per pound reduction in the price paid for feed (which is roughly the difference in feed prices paid by the larger versus the smaller yellow perch operations in these budgets) commonly results in a decline in the breakeven price of about 15 cents per pound at lower feed conversion ratios, 30 cents per pound at higher feed conversion ratios, and 22 cents per pound for the feed conversion ratios used in the budget.

Together, fingerling and feed costs account for more than 60 percent of total annual costs in three of the four yellow perch budgets in this study. For the two larger operations which have breakeven prices around $2.00 per pound, there are many combinations of feed and fingerling prices which yield breakeven prices lower than $2.20 per pound (see Tables 15(a) and 17(a)). There are a few potentially profitable combinations for the marginally feasible, smaller cage

Table 14a–d. Sensitivity analysis of breakeven price to alternative prices and production values: 5,000 lb. cage culture operation.

(a) Breakeven price ($/lb.) by alternative fingerling prices and feed prices

	Fingerling price ($/head)						
Feed price ($/lb.)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	1.77	1.98	2.19	2.40	2.62	2.83	3.04
0.25	1.89	2.10	2.31	2.52	2.73	2.94	3.16
0.30	2.00	2.21	2.43	2.64	2.85	3.06	3.27
0.35	2.12	2.33	2.54	2.75	2.97	3.18	3.39
0.40	2.24	2.45	2.66	2.87	3.08	3.29	3.51
0.45	2.35	2.56	2.78	2.99	3.20	3.41	3.62

(b) Breakeven price ($/lb.) by alternative fingerling prices and market sizes

	Fingerling price ($/head)						
Market size (lbs./fish)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	2.32	2.64	2.96	3.27	3.59	3.91	4.23
0.25	2.19	2.45	2.70	2.96	3.21	3.46	3.72
0.30	2.11	2.32	2.53	2.74	2.96	3.17	3.38
0.33	2.07	2.26	2.46	2.65	2.84	3.03	3.23
0.35	2.05	2.23	2.41	2.59	2.77	2.96	3.14
0.40	2.00	2.16	2.32	2.48	2.64	2.80	2.96
0.45	1.97	2.11	2.25	2.39	2.53	2.67	2.82
0.50	1.94	2.07	2.19	2.32	2.45	2.58	2.70

(c) Breakeven price ($/lb.) by alternative feed conversion ratios and feed prices

	Feed conversion ratio (lbs. feed / 1.0 lb. gain)						
Feed price ($/lb.)	**1.30**	**1.40**	**1.50**	**1.60**	**1.70**	**1.80**	**1.90**
0.20	2.30	2.32	2.35	2.37	2.39	2.42	2.44
0.25	2.38	2.40	2.43	2.46	2.49	2.52	2.55
0.30	2.45	2.49	2.52	2.56	2.59	2.63	2.66
0.35	2.53	2.57	2.61	2.65	2.69	2.73	2.77
0.40	2.60	2.65	2.70	2.74	2.79	2.84	2.88
0.45	2.68	2.73	2.78	2.84	2.89	2.94	2.99

Table 14 continued next page

Table 14 continued

Feed price ($/lb.)	Feed conversion ratio (lbs. feed / 1.0 lb. gain) 2.00	2.10	2.20	2.30	2.40	2.50	2.60
0.20	2.46	2.49	2.51	2.53	2.56	2.58	2.60
0.25	2.58	2.61	2.64	2.67	2.70	2.73	2.76
0.30	2.70	2.73	2.77	2.80	2.84	2.87	2.91
0.35	2.81	2.85	2.90	2.94	2.98	3.02	3.06
0.40	2.93	2.98	3.02	3.07	3.12	3.16	3.21
0.45	3.05	3.10	3.15	3.20	3.26	3.31	3.36

(d) Breakeven price ($/lb.) by alternative fingerling prices and death loss

Death loss	Fingerling price ($/head) 0.10	0.15	0.20	0.25	0.30	0.35	0.40
0%	1.99	2.17	2.35	2.53	2.71	2.89	3.07
5%	2.02	2.21	2.40	2.59	2.78	2.97	3.16
10%	2.06	2.26	2.46	2.66	2.86	3.06	3.26
15%	2.11	2.32	2.53	2.74	2.96	3.17	3.38
20%	2.16	2.38	2.61	2.83	3.06	3.28	3.51
25%	2.21	2.45	2.69	2.93	3.17	3.41	3.65
30%	2.27	2.53	2.79	3.04	3.30	3.56	3.81
35%	2.34	2.61	2.89	3.17	3.45	3.72	4.00
40%	2.41	2.71	3.01	3.31	3.61	3.91	4.21
45%	2.50	2.82	3.15	3.48	3.81	4.13	4.46
50%	2.59	2.95	3.31	3.67	4.03	4.39	4.75

operation. However, even the lowest feed price cannot counterbalance the devastating effect of a high-end fingerling price. Conversely, when fingerling prices are low, profitable breakeven prices can be realized throughout most or all of the given range of feed prices.

Larger market size reduces the breakeven cost of producing yellow perch by spreading the fingerling cost over more ounces of each marketable fish. This is very important in maintaining a profitable bottom line if fingerling costs are high. The difference in breakeven prices between marketing fish at four fish to the pound (0.25 pounds each) versus three fish to the pound (0.33 pounds each) is only 11 cents per pound when the fingerling price is 10 cents per head, but jumps to 40 cents per pound when the fingerling price increases to 35 cents per head. Thus, a market size of four fish to the pound can quickly become unprofitable as fingerling price increases.

The feed conversion ratio (FCR) appears to have only a small impact on the breakeven price. Adding a pound to the FCR, say from 1.50 to 2.50 pounds of feed per one pound of gain, typically increases breakeven price about 23 cents per pound. The feed price has a much larger impact on the breakeven price than does the feed conversion ratio.

Table 15a-d. Sensitivity analysis of breakeven price to alternative prices and production values: 50,000 lb. cage culture operation.

(a) Breakeven price ($/lb.) by alternative fingerling prices and feed prices

	Fingerling price ($/head)						
Feed price ($/lb.)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	1.24	1.44	1.64	1.84	2.04	2.24	2.44
0.25	1.35	1.55	1.75	1.95	2.15	2.35	2.55
0.30	1.47	1.67	1.87	2.07	2.27	2.47	2.67
0.35	1.58	1.78	1.98	2.18	2.38	2.58	2.78
0.40	1.69	1.89	2.09	2.29	2.49	2.69	2.89
0.45	1.81	2.01	2.21	2.41	2.61	2.81	3.01

(b) Breakeven price ($/lb.) by alternative fingerling prices and market sizes

	Fingerling price ($/head)						
Market size (lbs./fish)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	1.46	1.76	2.06	2.36	2.66	2.96	3.26
0.25	1.34	1.58	1.82	2.06	2.30	2.54	2.78
0.30	1.26	1.46	1.66	1.86	2.06	2.26	2.46
0.33	1.23	1.41	1.59	1.77	1.95	2.14	2.32
0.35	1.21	1.38	1.55	1.72	1.89	2.06	2.24
0.40	1.16	1.31	1.46	1.61	1.76	1.91	2.06
0.45	1.13	1.26	1.40	1.53	1.66	1.80	1.93
0.50	1.10	1.22	1.34	1.46	1.58	1.70	1.82

(c) Breakeven price ($/lb.) by alternative feed conversion ratios and feed prices

	Feed conversion ratio (lbs. feed / 1.0 lb. gain)						
Feed price ($/lb.)	**1.30**	**1.40**	**1.50**	**1.60**	**1.70**	**1.80**	**1.90**
0.20	1.73	1.76	1.78	1.80	1.83	1.85	1.87
0.25	1.81	1.84	1.87	1.89	1.92	1.95	1.98
0.30	1.88	1.92	1.95	1.98	2.02	2.05	2.09
0.35	1.96	2.00	2.04	2.08	2.12	2.16	2.20
0.40	2.03	2.08	2.12	2.17	2.21	2.26	2.30
0.45	2.10	2.16	2.21	2.26	2.31	2.36	2.41

	Feed conversion ratio (lbs. feed / 1.0 lb. gain)						
Feed price ($/lb.)	**2.00**	**2.10**	**2.20**	**2.30**	**2.40**	**2.50**	**2.60**
0.20	1.89	1.92	1.94	1.96	1.98	2.01	2.03
0.25	2.01	2.04	2.06	2.09	2.12	2.15	2.18
0.30	2.12	2.16	2.19	2.22	2.26	2.29	2.33
0.35	2.23	2.27	2.31	2.35	2.39	2.43	2.47
0.40	2.35	2.39	2.44	2.49	2.53	2.58	2.62
0.45	2.46	2.51	2.56	2.62	2.67	2.72	2.77

Table 15 continued next page

Table 15 continued

(d) Breakeven price ($/lb.) by alternative fingerling prices and death loss

	Fingerling price ($/head)						
Death loss	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0%	1.20	1.38	1.56	1.74	1.92	2.10	2.28
5%	1.23	1.42	1.61	1.80	1.99	2.18	2.37
10%	1.26	1.46	1.66	1.86	2.06	2.26	2.46
15%	1.30	1.51	1.72	1.94	2.15	2.36	2.57
20%	1.34	1.57	1.79	2.02	2.24	2.47	2.69
25%	1.39	1.63	1.87	2.11	2.35	2.59	2.83
30%	1.43	1.69	1.95	2.21	2.46	2.72	2.98
35%	1.49	1.77	2.04	2.32	2.60	2.88	3.15
40%	1.55	1.85	2.15	2.45	2.75	3.05	3.35
45%	1.63	1.95	2.28	2.61	2.94	3.26	3.59
50%	1.71	2.07	2.43	2.79	3.15	3.51	3.87

Table 16a-d. Sensitivity analysis of breakeven price to alternative prices and production values: 5,000 lb. pond culture operation.

(a) Breakeven price ($/lb.) by alternative fingerling prices and feed prices

	Fingerling price ($/head)						
Feed price ($/lb.)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	2.59	2.76	2.93	3.10	3.27	3.44	3.61
0.25	2.69	2.86	3.03	3.20	3.37	3.54	3.71
0.30	2.79	2.96	3.13	3.30	3.47	3.64	3.81
0.35	2.89	3.06	3.23	3.40	3.57	3.74	3.91
0.40	2.98	3.16	3.33	3.50	3.67	3.84	4.01
0.45	3.08	3.25	3.42	3.60	3.77	3.94	4.11

(b) Breakeven price ($/lb.) by alternative fingerling prices and market sizes

	Fingerling price ($/head)						
Market size (lbs./fish)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	3.15	3.43	3.71	3.99	4.27	4.55	4.83
0.25	3.03	3.26	3.48	3.71	3.93	4.16	4.38
0.30	2.96	3.15	3.33	3.52	3.71	3.90	4.08
0.33	2.92	3.09	3.26	3.44	3.61	3.78	3.95
0.35	2.90	3.07	3.23	3.39	3.55	3.71	3.87
0.40	2.86	3.00	3.15	3.29	3.43	3.57	3.71
0.45	2.83	2.96	3.08	3.21	3.33	3.46	3.58
0.50	2.81	2.92	3.03	3.15	3.26	3.37	3.48

Table 16 continued next page

Table 16 continued

(c) Breakeven price ($/lb.) by alternative feed conversion ratios and feed prices

Feed price ($/lb.)	Feed conversion ratio (lbs. feed / 1.0 lb. gain) 1.30	1.40	1.50	1.60	1.70	1.80	1.90
0.20	3.04	3.06	3.08	3.11	3.13	3.15	3.17
0.25	3.11	3.14	3.17	3.19	3.22	3.25	3.28
0.30	3.18	3.22	3.25	3.28	3.31	3.35	3.38
0.35	3.25	3.29	3.33	3.37	3.41	3.45	3.48
0.40	3.32	3.37	3.41	3.46	3.50	3.54	3.59
0.45	3.40	3.45	3.49	3.54	3.59	3.64	3.69

Feed price ($/lb.)	Feed conversion ratio (lbs. feed / 1.0 lb. gain) 2.00	2.10	2.20	2.30	2.40	2.50	2.60
0.20	3.19	3.22	3.24	3.26	3.28	3.30	3.32
0.25	3.30	3.33	3.36	3.39	3.41	3.44	3.47
0.30	3.41	3.45	3.48	3.51	3.54	3.58	3.61
0.35	3.52	3.56	3.60	3.64	3.68	3.71	3.75
0.40	3.63	3.68	3.72	3.76	3.81	3.85	3.90
0.45	3.74	3.79	3.84	3.89	3.94	3.99	4.04

(d) Breakeven price ($/lb.) by alternative fingerling prices and death loss

Death loss	Fingerling price ($/head) 0.10	0.15	0.20	0.25	0.30	0.35	0.40
0%	2.89	3.05	3.21	3.37	3.54	3.70	3.86
5%	2.92	3.09	3.26	3.44	3.61	3.78	3.95
10%	2.96	3.14	3.32	3.50	3.68	3.86	4.04
15%	3.00	3.19	3.38	3.58	3.77	3.96	4.15
20%	3.05	3.25	3.45	3.66	3.86	4.06	4.26
25%	3.10	3.31	3.53	3.75	3.96	4.18	4.39
30%	3.15	3.38	3.62	3.85	4.08	4.31	4.54
35%	3.21	3.46	3.71	3.96	4.21	4.46	4.71
40%	3.28	3.55	3.82	4.09	4.36	4.63	4.90
45%	3.36	3.65	3.95	4.24	4.54	4.83	5.13
50%	3.45	3.77	4.10	4.42	4.75	5.07	5.39

Table 17a-d. Sensitivity analysis of breakeven price to alternative prices and production values: 50,000 lb. pond culture operation.

(a) Breakeven price ($/lb.) by alternative fingerling prices and feed prices

	Fingerling price ($/head)						
Feed price ($/lb.)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	1.45	1.62	1.79	1.96	2.14	2.31	2.48
0.25	1.55	1.72	1.89	2.06	2.23	2.40	2.58
0.30	1.65	1.82	1.99	2.16	2.33	2.50	2.67
0.35	1.75	1.92	2.09	2.26	2.43	2.60	2.77
0.40	1.85	2.02	2.19	2.36	2.53	2.70	2.87
0.45	1.95	2.12	2.29	2.46	2.63	2.80	2.97

(b) Breakeven price ($/lb.) by alternative fingerling prices and market sizes

	Fingerling price ($/head)						
Market size (lbs./fish)	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0.20	1.80	2.09	2.37	2.65	2.93	3.21	3.49
0.25	1.69	1.92	2.14	2.37	2.59	2.82	3.04
0.30	1.62	1.80	1.99	2.18	2.37	2.55	2.74
0.33	1.58	1.75	1.92	2.09	2.26	2.44	2.61
0.35	1.56	1.72	1.88	2.05	2.21	2.37	2.53
0.40	1.52	1.66	1.80	1.94	2.09	2.23	2.37
0.45	1.49	1.62	1.74	1.87	1.99	2.12	2.24
0.50	1.47	1.58	1.69	1.80	1.92	2.03	2.14

(c) Breakeven price ($/lb.) by alternative feed conversion ratios and feed prices

	Feed conversion ratio (lbs. feed / 1.0 lb. gain)						
Feed price ($/lb.)	**1.30**	**1.40**	**1.50**	**1.60**	**1.70**	**1.80**	**1.90**
0.20	1.90	1.92	1.95	1.97	1.99	2.01	2.03
0.25	1.97	2.00	2.03	2.06	2.08	2.11	2.14
0.30	2.05	2.08	2.11	2.14	2.18	2.21	2.24
0.35	2.12	2.15	2.19	2.23	2.27	2.31	2.35
0.40	2.19	2.23	2.28	2.32	2.36	2.41	2.45
0.45	2.26	2.31	2.36	2.41	2.46	2.51	2.56

	Feed conversion ratio (lbs. feed / 1.0 lb. gain)						
Feed price ($/lb.)	**2.00**	**2.10**	**2.20**	**2.30**	**2.40**	**2.50**	**2.60**
0.20	2.06	2.08	2.10	2.12	2.14	2.17	2.19
0.25	2.17	2.19	2.22	2.25	2.28	2.30	2.33
0.30	2.28	2.31	2.34	2.37	2.41	2.44	2.47
0.35	2.39	2.42	2.46	2.50	2.54	2.58	2.62
0.40	2.50	2.54	2.58	2.63	2.67	2.71	2.76
0.45	2.60	2.65	2.70	2.75	2.80	2.85	2.90

Table 17 continued next page

Table 17 continued

(d) Breakeven price ($/lb.) by alternative fingerling prices and death loss

	Fingerling price ($/head)						
Death loss	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**
0%	1.55	1.71	1.88	2.04	2.20	2.36	2.52
5%	1.58	1.75	1.92	2.09	2.26	2.44	2.61
10%	1.61	1.80	1.98	2.16	2.34	2.52	2.70
15%	1.65	1.84	2.03	2.22	2.41	2.60	2.80
20%	1.69	1.89	2.10	2.30	2.50	2.70	2.91
25%	1.73	1.95	2.17	2.38	2.60	2.81	3.03
30%	1.78	2.01	2.24	2.48	2.71	2.94	3.17
35%	1.84	2.08	2.33	2.58	2.83	3.08	3.33
40%	1.90	2.17	2.44	2.71	2.98	3.25	3.52
45%	1.97	2.26	2.56	2.85	3.14	3.44	3.73
50%	2.05	2.37	2.70	3.02	3.34	3.67	3.99

Death loss changes do not appear, in the (d) subsections of Tables 14-17, to have a major impact on breakeven prices as long as fingerling prices are low. However, this impact becomes more substantial as the fingerling price climbs into the higher end of the range. This makes intuitive sense since a death loss of X percent means buying about X percent more fingerlings in order to achieve the target output. The cost of the additional fingerlings can become quite burdensome if fingerling prices are high.

Comparison of enterprises

It is useful to examine some of the major differences in the budgets from the four operations analyzed. Table 18 was created to summarize and facilitate the comparison of the major budget results for the four operations.

Budget figures summarized in Table 18 show that investment costs are considerably higher for pond production than for cage production. This is also true for annual ownership costs. However, when considering annual ownership costs on a per pound basis, only the 5,000 pound pond operation has a substantially higher cost level. This operation has an annual ownership cost of $1.20 per pound compared to costs less than $0.50 per pound for the larger pond operation and both cage operations.

The economies of size in investment and ownership are quite strong and similar for both pond and cage culture systems. For example, although production in the larger operations is 10 times the level of production in the smaller operations, the investment and annual ownership costs are less than 4 times the costs of the smaller operations.

Operating costs are strikingly similar between cage and pond production systems for comparable levels of output. While economies of size exist for operating costs in both production systems, they are not nearly as strong as the economies associated with investment costs. Operating costs of the larger operations are about 7.4 times those of the smaller operations.

Total annual costs are close to $100,000 for the 50,000 pound operations and less than $20,000 for the 5,000 pound operations. Total costs per pound (breakeven price) are quite similar for the larger operations and much lower than their small operation counterparts. Breakeven prices are not at all similar between the small cage and pond enterprises, with the small pond breakeven price almost 25 percent higher. While the distribution of total costs between operating costs and ownership costs is quite different in each of the four operations, there are some obvious patterns. Operating costs account for a higher proportion of total costs in the cage than in the pond culture operations and in the larger operations than in the smaller ones.

The economies of size in total costs are slightly better for pond production. However, substantial economies of size are obtainable for both cage and pond culture systems by expanding output. Despite the importance of size economies, it is not known at this time what the optimal size of operation is. Additional biological and economic analysis of various sizes of operations for different types of culture systems is needed.

A word of caution is warranted here for those who are tempted to interpret the budget numbers too literally. For instance, someone might look at the breakeven prices and conclude that a large-scale cage culture system is the most profitable size and type of operation. In reality, the technical information available on yellow perch growth performance in either a cage culture or levee pond production system is not sufficient to make such a definitive determination. Further research and commercial experience culturing yellow perch will show whether the values assumed in these budgets are feasible or not. The key lessons from this study are more general and include: (1) investment costs are much higher for pond versus cage culture systems but this effect can be tempered by building a pond system large enough to take advantage of size economies; (2) significant economies of size appear to exist for both types of culture systems such that larger operations are much more likely to be profitable; and (3) fingerling prices will substantially affect firm profitability.

Table 18. Summary of selected budget results by production system and size of operation.

	Production system and size of operation			
	Cage culture		Pond culture	
Budget category	**5,000 lbs.**	**50,000 lbs.**	**5,000 lbs.**	**50,000 lbs.**
Total investment	$7,627	$28,099	$39,182	$140,238
Total annual ownership costs	$1,817	$6,013	$5,994	$22,475
Per pound annual ownership costs	$0.36	$0.12	$1.20	$0.45
Total operating costs	$12,201	$89,966	$11,421	$84,604
Per pound operating costs	$2.44	$1.80	$2.28	$1.69
Total annual costs	$14,017	$95,979	$17,416	$107,079
Breakeven price	$2.80	$1.92	$3.48	$2.14
Percent of total cost				
Operating costs	87.0%	93.7%	65.6%	79.0%
Ownership costs	13.0%	6.3%	34.4%	21.0%

Economies of scale: Quantity of production is 10 times greater in larger versus smaller operations

	Cage	**Pond**
Investment costs	3.68	3.58
Ownership costs	3.31	3.75
Operating costs	7.37	7.41
Total costs	6.85	6.15

Comparison of yellow perch and catfish aquaculture

When looking at the yellow perch budgets in this study, the reader might be taken aback at production costs over $2.00 per pound, especially if s/he is familiar with southern catfish budgets which show total costs per pound under $1.00. Specifically, total costs per pound are $0.63 for catfish (Keenum and Waldrop 1988) and $2.14 for yellow perch in the 50,000 pound pond enterprise. Two M.S. theses completed in the 1990s in the NCR also reported aquaculture production costs above $1.00 per pound. Brown (1994) developed costs for trout production in the NCR and estimated them to be from $1.57 to $3.07 per pound depending on firm size. Scott (1990) calculated the cost to produce catfish in levee ponds in Indiana as $2.12 per pound. What could account for such a large difference in production costs between the two regions?

Part of the answer has to do with the structural characteristics of the two industries. One characteristic is firm size. The breakeven price of $0.63 reported by Keenum and Waldrop (1988) corresponds to a farm size of a half section (320 acres). Many farms are even larger than this. These sizes of firms are able to take significant advantage of size economies. By contrast, the 50,000 pound yellow perch pond enterprise uses less than 18 acres of land. It is likely that there are further size economies to be exploited in yellow perch production.

Industry concentration is another characteristic. Catfish is the largest aquaculture industry in the United States. Over 75 percent of U.S. production is located in Mississippi, with virtually all of this production concentrated in the Delta region of the state (Keenum and Waldrop 1988). In 1990, 314 catfish producers in Mississippi generated $323 million in sales using 92,500 pond acres (Harvey 1991). Conversely, 41 yellow perch producers were located in four states of the NCR in 1990 and achieved total sales of $63,000 (Hushak 1993). For all species cultured in the NCR there are 286 producers throughout all 12 states selling $18.7 million worth of aquaculture products (Hushak 1993). Supporting the Mississippi Delta catfish producers were three major catfish feed mills and virtually all domestic processing facilities, all located in the Delta region (Keenum and Waldrop 1988). Given the relatively larger output and concentration of the catfish industry, it would be expected that inputs such as feed and fingerlings would be lower in cost because of the availability and competition among input suppliers. In fact, Keenum and Waldrop (1988) report that a high level of industry infrastructure has grown up in the Delta to support the catfish industry.

In their definitive study of costs for Mississippi catfish production, Keenum and Waldrop (1988) use feed and fingerling prices of 12.25 cents per pound and 7.5 cents per head. In the budget for the 50,000 pound yellow perch pond operation, feed and fingerling prices were 26.55 cents per pound and 26.39 cents per head. Since operating costs in both catfish and yellow perch operations account for approximately 80 percent of total annual costs, these substantial differences in feed and fingerling prices account for a major portion of the difference in total costs. It can be expected that as the yellow perch aquaculture industry expands and matures, feed and fingerling prices would decline. However, given other regional and special factors, the prices for these yellow perch inputs may not reach as low as the catfish inputs.

Pond construction costs also are substantially lower in the Mississippi Delta than in the North Central Region. Keenum and Waldrop determined that the prevailing cost in the Delta of constructing ponds was 60 cents per cubic yard of earth moved, while this figure was assumed to be

$2.75 per cubic yard for pond construction in Tippecanoe County, Indiana. The difference in price possibly could be attributed partially to the levelness and suitability of Delta soils to pond construction and partially to the specialization and competition among contractors in the Delta region.

Labor costs are substantially higher in the catfish budgets than in the yellow perch budgets. For operations of the size common in the Delta region, full-time, salaried personnel are employed on a yearly basis. Even in the larger yellow perch pond operation, however, only part-time, hourly labor is required, and only for a portion of the year. Labor in the catfish budgets accounts for 12.05 percent of total costs compared to 4.5 percent for the 50,000 pound yellow perch pond budget. It would be expected that as yellow perch operations expand in size that full-time, salaried labor will be required which will raise labor costs for producing yellow perch.

The cost structure for yellow perch aquaculture in the North Central Region is different from and should be expected to continue to differ from the cost structure of catfish aquaculture in the Southern Region. Many factors form the basis for a unique cost structure including: 1) species peculiarities, 2) sport fisheries and / or commercial fisheries for wild fish of the same species, 3) regional agricultural context, 4) regional climate, and 5) regional economic context. These five factors constitute some of the elements which make up the complete context within which the yellow perch and catfish aquaculture industries operate. The disparity in industry maturity likely accounts for a large portion of the current differences in cost structure. Over time, the cost structures for the yellow perch and catfish industries should converge toward levels that reflect other regional differences.

Conclusions

The production costs estimated in this study for cage and pond culture of yellow perch in the North Central Region suggest that larger systems capture economies of size and are likely to be economically feasible. Smaller operations are much less likely to be economically feasible, especially if annual ownership costs per pound are high. Smaller operations with reasonable per pound ownership costs can improve their likelihood of success by increasing the size at which they market their yellow perch and by controlling operating costs, especially by decreasing input prices for feed and fingerlings.

The breakeven prices for the larger cage and pond operations (50,000 pounds production) were similar and averaged about $2.00 per pound. This price level is near the bottom of the range of monthly average wholesale market prices reported by Lake Erie processors. Thus, operations with similar cost structures could be expected to enjoy long-term profitability as long as market prices do not make a major downward turn. Budget results suggest significant economies of size for larger yellow perch operations. Both of the larger systems modeled were able to take advantage of these economies, especially in the areas of investment and annual ownership costs. Unfortunately, at this stage in the yellow perch industry of the NCR, the optimal size of operation is not known for either cage or pond production systems. This will require more detailed biological research and economic analysis.

The smaller cage culture operation, with a breakeven price of $2.80 per pound, can also be profitable if market prices are closer to $3.00 per pound which is at the top end of the reported price range. This operation, though, is much more sensitive to adverse price and cost movements. However, reductions in feed and fingerlings prices paid can improve profitability significantly in the smaller cage operations. The smaller pond operation, on the other hand, has such a high breakeven price ($3.48 per pound) because of substantial investment and annual ownership costs, that it is unlikely that this type of operation could be profitable in the long term. To do so, market prices would have to remain high and budget items such as biological production parameters, input prices, and investment costs would have to become much more favorable.

Operating costs are quite similar for both types of production systems at comparable output levels. They vary mostly by size of operation. Economies of size do exist for operating costs as well as investment costs, but the effect is not nearly as strong. Fingerlings and feed account for over 60 percent of total costs in all but the small pond operation. Transportation costs can dramatically affect delivered feed prices, and are often determined more by shipment volume and ingenuity in arranging transportation than by length of haul.

Sensitivity analysis of net returns for alternative market prices revealed that over the range of market prices explored, net returns are typically negative for the 5,000 pound operations and positive for the 50,000 pound operations. For the smaller operations, the magnitudes of losses or gains are relatively small, but for the larger operations they are quite large. Picking a conservative market price level of $2.25 per pound, the two smaller operations show losses of $2,750 for the cage and $6,150 for the pond systems. The larger operations show profits of $16,500 for the cage and $5,500 for the pond systems. However, even a modest price drop of $0.25 per pound (from $2.25 to $2.00 per pound) causes the net returns to the larger operations to plunge by $12,500. This causes a net loss of $7,000 for the pond operation and a much smaller positive return for the cage operation of $4,000.

Sensitivity analysis of breakeven prices for alternative of budget item values showed that fingerling prices, feed prices, and the market size of the fish have larger impacts than do feed conversion ratio and death loss. In particular, the fingerling price can have a substantial effect on enterprise profitability. Because yellow perch are marketed at such low weights, the total cost of purchasing fingerlings accounts for a large portion of total annual costs, ranging from 24 to 51 percent. Sensitivity analysis also suggests that varying the fingerling price can cause substantial changes in the breakeven price, about double the impact of a similar change in feed price.

The costs of production for yellow perch developed through these budgets are valid for similar operations in Tippecanoe County, Indiana in the mid 1990s. Costs at other points in time and for other locations in the North Central Region may differ. Two investigations were performed to help offset the limitations of time and location specificity. First, sensitivity analysis was conducted with alternative values for budget items (e.g. feed price, death loss, market price) that might occur over space and time. Second, tables of delivered prices for feed and fingerlings, the two most important cost items, were developed to demonstrate how these prices might vary in different parts of the NCR. However, each aquaculturist must develop site-specific individualized budgets. The budgets presented in this study can serve only as a guide.

The cost estimates in this study are based on production values (e.g. stocking rates, death loss, length of production cycle, feed conversion ratio) which were generated from expert opinion rather than a body of historical data from actual commercial production experience. Also, optimal yellow perch culture methods and production systems have yet to be fully identified at this time. Nor have markets for aquacultured yellow perch been fully explored or developed. Therefore, the reader must treat the cost and profitability estimates made in this study as tentative rather than conclusive. As the industry matures and historical data accumulate, these prototypal budgets can be revised to incorporate new information. Then, in conjunction with better market information, expectations of industry profitability can be updated as well.

Despite some limitations, the budgets produced in this study are useful for many people in the North Central Region including current yellow perch producers, those contemplating production, biological and non-biological researchers, extension personnel, and government employees. The budgets not only provide cost and profitability estimates based on current best information, they also serve: 1) as a demonstration of the facilities and equipment, investments, and annual costs necessary to undertake yellow perch aquaculture enterprises similar to those modeled; 2) as a point of comparison between costs for similar operations at different locations and points in time; 3) as a basis for comparing costs for different species in the same or other regions; 4) as a foundation for further budget development; 5) as a springboard for discussion among researchers and producers with different academic training and experience; 6) and as a guide for directing research toward those areas most likely to have a significant impact on the profitability of a yellow perch aquaculture enterprise.

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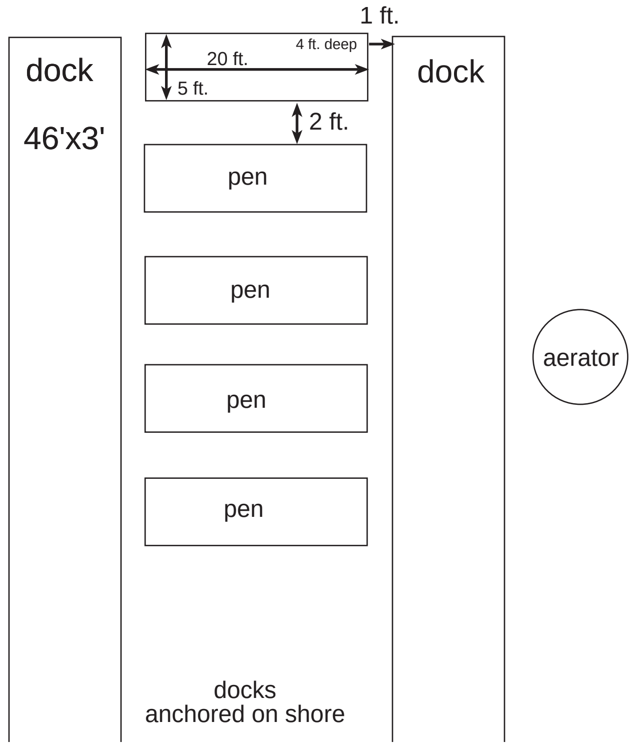
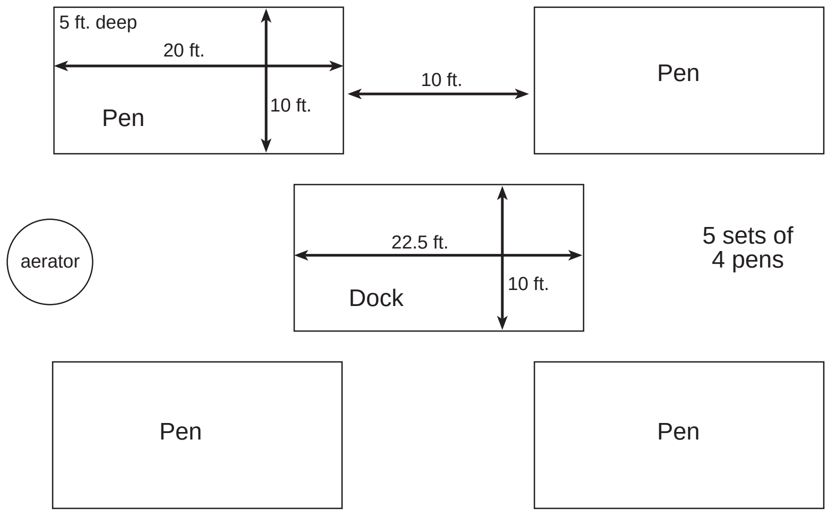
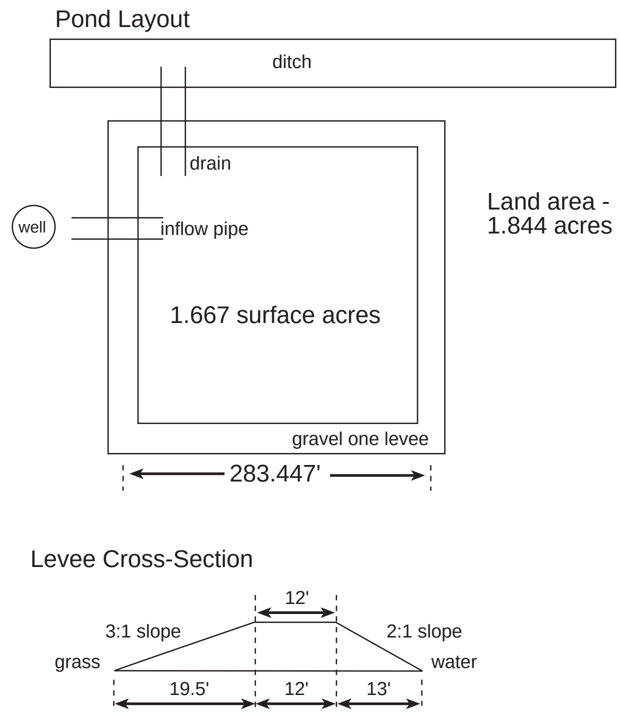
Appendix A. Physical configuration of production systems



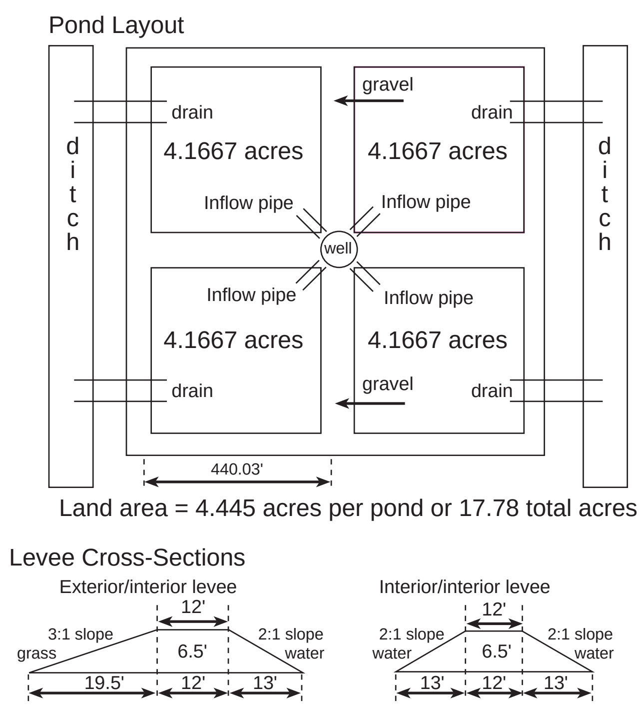
Appendix Figure A1. Physical configuration of cage culture for 5,000 lbs. production.



Appendix Figure A2. Physical configuration of cage culture for 50,000 lbs. production.



Appendix Figure A3. Physical configuration of pond culture for 5,000 lbs. production.



Appendix Figure A4. Physical configuration of pond culture for 50,000 lbs. production.

Appendix B. Delivered prices for feed and fingerlings in the North Central Region

Appendix Figure B1. Five locations in the North Central Region for which delivered prices of feed and fingerlings were calculated.

Appendix Table B1. Delivered feed prices for trout finishing diets (38% or 40% protein, 50 lb. bags) for five locations in the North Central Region, by manufacturer and order volume, August-October 1994.

	Grand Island, NE	Fergus Falls, MN	(rural) Madison, WI	Lafayette, IN	(rural) Akron, OH
			cents/lb.		
Firm A	(FOB price 24.75¢/lb. at MN plant and 25.50¢/lb. at IN plant; 3/16" extruded nugget, 40% protein, floating)				
45,000 lbs. (truckload)	26.35	25.65	25.95	26.55	27.15
Firm B	(FOB price 30.2¢/lb. at IN plant; extruded pellet 3/16" × 3/16" and 1/8" × 1/4", 40% protein, floating)				
3,000 lbs.	43.63	40.60	37.70	36.90	37.45
5,000 lbs.	38.26	36.44	34.70	34.77	35.65
10,000 lbs.	27.29	35.20	33.70	33.51	34.94
45,000 lbs. (truckload)	32.07	32.17	31.31	30.84	30.98
Firm C	(FOB price 25¢/lb. at UT plant; all pellet sizes; 3/32" - 3/8" pellets, 40% protein, sinking; add 2¢/lb. for floating extruded pellets, 3.5 mm and larger)				
3,000 lbs.	39.50	39.50	39.50	41.60	41.60
5,000 lbs.	37.50	37.50	37.50	39.50	39.50
45,000 lbs. (truckload)	28.50	29.00	29.00	29.50	29.75
Firm D	(FOB price 18.8¢ - 25.3¢/lb. at PA plant; depending on order volume and pellet size, 3/32" - 3/16" pellets, 38% protein, sinking)				
3,000 lbs.	37.60	38.83	35.40	34.57	33.03
5,000 lbs.	35.18	36.18	33.44	32.74	31.52
10,000 lbs.	32.52	33.43	30.89	30.28	29.17
45,000 lbs. (truckload)	22.24	22.24	21.19	21.13	20.41

Appendix Table B2. Delivered prices per fingerling for advanced yellow perch fingerlings trained on feed for five locations in the North Central Region, by producing company in 20,000 lots, August-October, 1994.

	Grand Island, NE	Fergus Falls, MN	(rural) Madison, WI	Lafayette, IN	(rural) Akron, OH
Firm A	(4-5", 22¢ each (discounted price for 10,000 or more fingerlings), average shipping cost $0.925 per loaded mile)				
Miles	206	845	774	950	1215
Shipping	0.95¢	3.91¢	3.58¢	4.39¢	5.62¢
Delivered price	22.95¢	25.91¢	25.58¢	26.39¢	27.62¢
Firm B	(Average price of 38¢ each for: 1/2 fingerlings of 3-4" size @ 33¢, 1/2 fingerlings of 4-6" size @ 43¢, prices are for order volumes of more than 1,000 fingerlings, average shipping cost $0.875 per loaded mile)				
Miles	800	765	329	266	349
Shipping	3.5¢	3.35¢	1.44¢	1.16¢	1.53¢
Delivered price	41.5¢	41.35¢	39.44¢	39.16¢	39.53¢
Firm C	(3½-4½", 29¢ each, $1 per loaded mile)				
Miles	740	705	269	206	345
Shipping	3.7¢	3.53¢	1.34¢	1.03¢	1.72¢
Delivered price	32.7¢	32.53¢	30.34¢	30.03¢	30.72¢
Firm D	(3-5", 25¢ each, $1.25 per loaded mile)				
Miles	1045	1066	560	408	36
Shipping	6.53¢	6.66¢	3.5¢	2.55¢	0.22¢
Delivered price	31.53¢	31.66¢	28.5¢	27.55¢	25.22¢
Firm E	(Average price 32¢ each for: ½ fingerlings of 3-4" size @ 15¢, ½ fingerlings of 4-5" size @ 50¢, various independent haulers for delivery, estimate $1.25 per loaded mile)				
Miles	568	501	0	264	529
Shipping	3.55¢	3.13¢	0¢	1.65¢	3.31¢
Delivered price	36.05¢	35.63¢	32.5¢	34.15¢	35.81¢

Series Editor: Joseph E. Morris, Associate Director,
North Central Regional Aquaculture Center.

Design by Dennis Melchert, Ames Best Communications

Originally published by Iowa State University, Ames, Iowa