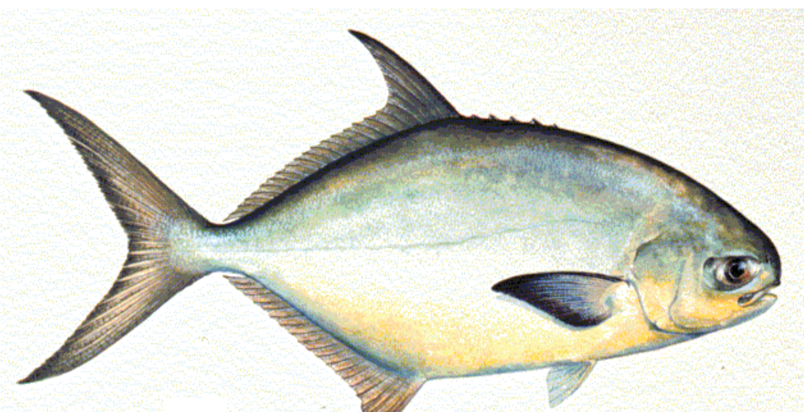
Economic Feasibility of Utilizing West Alabama Saline Groundwater to Produce Florida Pompano and Hybrid Striped Bass in a Recirculating Aquaculture System



< Florida Pompano

Hybrid Striped Bass >

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Economic Feasibility of Utilizing West Alabama Saline Groundwater to Produce Florida Pompano and Hybrid Striped Bass in Recirculating Aquaculture System

J. K Gorman, J. Adrian, and J. A. Chappell

INTRODUCTION

Aquaculture has an important impact on the economy of Alabama. In 2005 it generated total revenues of more than $120 million (USDA 2006), growing substantially from $59.6 million in 1998. When processing is included, the economic value increased to an estimated $498 million (Stevens et al. 2007).

Catfish production was the major contributor to aquaculture revenues, producing $98.4 million in 2005. Almost 95 percent of this revenue was generated from catfish sales outside Alabama, meaning that $143.1 million was new money entering the State's economy. In addition to the impact that aquacultural production has on the State's economy, other businesses rely on the fish and related aquatic products these farms produce.

Despite the growth of the aquaculture industry, Alabama's aquaculture sector has been under stress for several years. Producers and intermediary firms in the system face competition from others in the fish and seafood industry, both domestically and internationally, as well as from producers and marketers of other protein sources. Prices for aquaculture products have generally been depressed and input costs have been on the rise. Thus, profit margins have been thin to nonexistent.

Consequently, producers are interested in identifying and evaluating viable alternative uses for their resources, including atypical fish species and production systems. Catfish producers in West Alabama have been interested in utilizing the area's abundant high salinity artesian groundwater resources, and in 1999 catfish producers in Green County grew pacific white shrimp in ponds that ranged between 5 and 6 ppt salinity. The potential for culturing Florida pompano, hybrid striped bass, and southern flounder in high salinity pond water in West Alabama has also been explored (Brown 2007).

This study aims to identify and evaluate the technical and economic feasibility of an alternative production system that uses inland high-salinity groundwater to produce high-value marine fish for consumption.

BACKGROUND

Choice of Fish Specie

Florida pompano and hybrid striped bass were chosen as the primary species for the present study. Previous research by Brown (2007) evaluated the potential for culturing marine finfish using high salinity pond water in West Alabama. Florida pompano, hybrid striped bass, and southern flounder were placed in tanks at two locations. Water quality at both sites was similar with the exception of differing ion concentrations. Survival rates were 93.8 percent and 97.5 percent for hybrid striped bass, 0 percent and 80 percent for pompano, and 82.5 percent and 91.3 percent for flounder, respectively, at the two locations. Differing ion concentrations are thought to have caused total mortality of pompano at the first site.

Gorman is a former Graduate Research Assistant and Adrian is a Professor in the Department of Agricultural Economics and Rural Sociology, Auburn University. Chappell is a Professor in the Department of Fisheries and Allied Aquacultures, Auburn University.

Florida Pompano. The Southern Regional Aquaculture Center reports that pompano are commonly found in warm, shallow waters between Massachusetts and Brazil (Main et al. 2007). They can grow to 10 inches in length and weigh up to 8 pounds. They are a hardy fish that can withstand varying environmental conditions such as low levels of dissolved oxygen (4 mg/L) and salinities between 0 and 50 ppt. While being very tolerant of fluctuating oxygen levels and water salinities, they are a warm water specie that stresses easily when water temperatures fall. Death loss occurs when water temperatures reach between 50 and 53 degrees Fahrenheit or when rapid water temperature changes occur. Optimal growing temperatures range between 77 and 86 degrees Fahrenheit.

Pompano are one of the most valuable fish caught in the Gulf of Mexico. Charles Weirich (2006) reported that the average wholesale price of pompano was $7.42 per kilogram ($3.09 per pound) in 2003. McMaster noted a higher price in 2003, with “fair market values to the producer (fishermen) being between $3.50 and $5.50 per pound in the round” (McMaster 2003:3). He also reported that live markets presented more lucrative opportunities with prices of $10 per pound.

As of May 2008, Pompano Farms, LLC, was currently selling fresh, farmed pompano on ice at $8 per pound. Alternatively, prices paid to fishermen from 2000 to 2005, as reported by the National Marine Fisheries Service and adjusted for inflation, averaged $3.75 with $3.25 being the lowest average annual price and $3.98 being the highest average annual price (NOAA). This average price of $3.75 was the base price used in this study, but price per yield sensitivity analyses were conducted to capture the possible range of prices in other markets.

Pompano were selected for culture in this study because they tolerate low salinity waters. McMaster (2005) reported that Mariculture Technologies International (MTI) in Oak Hill, Florida, has successfully grown pompano in ponds fed by 19 ppt saline groundwater, measured at 15 ppt after heavy rain, with seemingly no adverse effects attributed to lower salinity. A slower growth rate was observed but it was attributed to the lack of climate control, because the water temperature plunged to as low as 56 degrees Fareinheight. In a subsequent publication, McMaster (2006) reported having measured pond salinities as low as 2 ppt with no recorded pompano mortality. Nystrom (2005) conducted a study in which pompano juveniles were cultured in both low salinity (5 ppt) and high salinity (30 ppt) conditions. He found no statistical difference in growth between the two groups of fish, although the group of fish reared in very low salinity waters (5 ppt) had to be treated twice for infections, routinely had higher nitrite readings, and involved more water exchange.

Another reason pompano were selected for culture evaluation was that they can be grown at high densities. McMaster reported that pompano have been produced at densities of 1 pound of fish per gallon of water. However, it is important to note that he does not recommend culturing fish at this density due to “mechanical limitations for maintaining proper water quality and feed delivery” (2003:10). Recirculating systems are designed to produce fish at very high densities, and it is only at these densities that these systems can be profitable.

Tilapia produced at the North Carolina State Fish Barn have been raised at densities of 0.66 pounds per gallon (NCDOA 2002) in a freshwater system while Zohar (2005) reported culturing Mediterranean gilthead seabream at 44 to 47 kg/cubic meter (almost 0.5 pound per gallon) in a saltwater recirculating system. For the current study, pompano were raised at a density of 0.5 pound per gallon, a density that many successful aquacultural producers meet or exceed (Timmons et al. 2001).

Finally, Florida pompano were chosen for this study because they are a fast growing specie of fish. Weirich (2006) reported that they reached a market size of 450 grams (1 pound) in as little as four to five months. McMaster (2008) reported that the total growth time from 1-gram hatchery fry to market size was seven months. However, by purchasing 10-gram fingerlings to stock and grow out to a market size of 453 grams (1 pound), the time was reduced to around five months or approximately 140 days. Ten-gram fingerlings are available from MTI at a price of $1.50 per fish. One-gram pompano fingerlings can be purchased from overseas at a price of $0.30 each (Chappell 2008). An additional eight weeks is required for these smaller fingerlings to reach market size, which means that fewer cohorts may be stocked and harvested in a year (6.5 rather than 8.6). Even so, the savings realized by purchasing the smaller pompano to stock may outweigh the increases in revenue that are realized by purchasing 10-gram fingerlings.

A criticism of pompano culture is that while pompano grow rapidly as juveniles, their growth rate slows and feed efficiency becomes very poor at around 250 g. McMaster (2003:11) reported that while feed conversion ratios (FCR) are historically around 3.1:1, recently developed diets and culture methods have “significantly outperformed the standard diet." On the other hand, Coburn et al. (2007) used a FCR of 2.2:1 for pond culture. While a favorable FCR is vital to the ultimate feasibility and profitability of an aquacultural operation, an FCR of 2.2:1 is drastically different from those used in previously published studies (McMaster 2008, Weirich 2006). Therefore, the base FCR used in this study was 3.1:1 though sensitivity analyses were conducted to evaluate the effect of alternative FCRs.

Hybrid striped bass were also evaluated as a potential specie for culture. Brown (2007) reported survival rates of 93.8 percent and 97.5 percent while culturing hybrid striped bass (palmetto bass) in tanks using saline groundwater in West Alabama. Hybrid striped bass were first successfully cultured in 1986. By 2005, hybrid striped bass food fish production was roughly 11 million pounds (USDA 2006). Farms in the Southeast produced almost 32 percent of this amount.

Hybrid striped bass can tolerate a wide range of water temperatures, generally from 4 to 33 degrees Celsius but optimal growth occurs between 25 and 27 degrees Celsius. They are also capable of surviving with low oxygen levels and can grow well in water salinities ranging from 0 to 25 ppt (Hodson 2008). Hybrid striped bass generally take two years to reach market size when cultured in ponds but may reach market weights in 12 months when cultured in optimal conditions provided by a recirculating tank system (Ohs et al. 2008).

Evaluating Profitability

As in the study by De Ionno et al., this study used a conservative approach to evaluate the profitability of producing pompano in a recirculating system, as there are few standards for feed conversion ratios, production cycles, or market prices. However, research and practices for hybrid striped bass are more established and this base of information was used in this study.

Feasibility analyses for the production facility were conducted using a 10-year planning horizon, "since it is unlikely that an aquaculture enterprise would be an attractive investment opportunity if it were not profitable after ten years" (De Ionno et al. 2006: 318). All operating costs and biological parameters were held constant over the period of analysis. This approach assumes no fluctuation, positive or negative, in the prices of inputs such as feed, energy, or juvenile fish or in markets and/or efficiency.

Operating costs such as electricity and liquid oxygen were calculated by comparing usage per hour per pound of fish produced at other recirculating aquaculture system facilities, assuming a steady state of production over 24 hours per day, seven days per week and applying prices provided by local suppliers. Costs for natural gas were calculated by consulting equipment suppliers on power usage and consulting local suppliers for prices.

Straight-line depreciation was used with the salvage value of assets assumed to be $0. De Ionno et al. state that, "it could be expected that [a large facility] would obtain some salvage value at the expiry of the project" (De Ionno et al. 2006:319). However, Timmons et al. suggested that any amount received for used equipment is likely to be minimal, possibly less than ten cents on the dollar, due to the specialized nature of such equipment.

As with many analyses of aquaculture ventures, land was presumed to be owned (Jeffs and Hooker 2006). This approach excludes the land value from the analysis so that the focus of the study will be only on the profitability of the recirculating aquaculture system facility.

It was assumed that 20 percent of the capital cost was financed by the fish farm owner/operator, while 80 percent of the investment was financed using a loan accruing interest at 8.5 percent over five years. An additional loan accruing interest of 8 percent was assumed to be used to cover 50 percent of operating costs, with the remainder covered by the investor.

Cash flow budgets were created to analyze the liquidity of the facility using the base FCR of 3.1:1. These statements depict the cash available to continue operation through time. Interest and principal payments were included, though depreciation was not, in order to strictly analyze the operation's cash position at any given year. A minimum $1,000 cash balance was maintained at all times.

When calculating net present value (NPV), net cash revenues were calculated by netting cash expenses from cash receipts, ignoring depreciation, interest, and principal payments. Depreciation is assumed to be a noncash expense and "already accounted for by the difference between the initial cost and terminal value of an investment," while interest and principal payments are not included because "investment analysis methods are used to determine the profitability of an investment without considering the method or amount of financing needed to purchase it" (Kay et al. 2004:283).

A discount rate of 15 percent was used with NPV analysis, which incorporates a 5 percent return on capital as the minimum alternative investment and a risk premium of 10 percent (De Ionno et al 2006: 318). This approach closely parallels the risk-free rate and risk premium of other investments as well as the 15 percent standard used "as a criterion for high risk investments of this type." Net present value was only calculated for scenarios that, through sensitivity analysis, showed the potential to provide positive cash flows, and hence, a positive NPV. That is, any scenarios that do not generate a positive NPV would not be considered an economic success at defined criteria (Thacker and Griffin 1994).

TECHNICAL SYSTEM

Research indicates that pompano show potential to be successfully cultured in salinities of 6 ppt as is found in West Alabama (Nystrom 2005). This saline level significantly decreases the costs associated with supplementing salt into the system in order to increase the water salinity. Currently, pompano are not cultured at salinities below 15 ppt. This study evaluated water at both 6 ppt and 15 ppt salinity. The recirculating system used in this study is designed to operate at varying salinities and allows for culture of any specie that can be cultured in low salinity water up to seawater (35 ppt) (Zolnar 2005).

The technical aspects of the system used in this analysis are based on an example system located at North Carolina State University that is used to produce tilapia (Losordo et al. 2000). The design of a system based on the North Carolina State system is described by Losordo while the economics of tilapia production in this system are evaluated by the North Carolina Department of Agriculture and Consumer Services.

The system used in this study resides in a 30- by 112-foot greenhouse and was designed to produce 1 pound of pompano from 1-gram fry. The greenhouse includes both a ventilation system with air flow fans, exhaust fans and shutters; a gas heating system; and a thermostat for temperature controls between 30 and 110 degrees Fahrenheit. The system consists of two quarantine tanks and four grow-out tanks, each made of fiberglass, Figure 1. The tanks are round with sloping bottoms in order to facilitate easy cleaning and also to generate a natural current flow that is desirable when producing marine finfish (Zohar 2005). The first quarantine tank (Q1) is 750 gallons, the second (N1) is 4,200 gallons, and the four grow-out tanks each hold 15,538 gallons, bringing the total volume of the system to 67,052 gallons, Table 1. This system is assumed to exchange 10 percent of its water volume each day.

Water is supplied to the system by a well approximately 1,300 feet deep that delivers saline water of 6 ppt to four, above-ground, polyurethane tanks that each hold 6,300 gallons of water. These tanks may be used to store four tanks' supply of 6 ppt salinity water. This approach provides 25,200 gallons of water readily available to replace the 6,803 gallons that is lost each day during operations, and also to provide excess water in any emergency that might require additional water. If culturing occurs at 6 ppt, this method provides three and a half days of water supply in reserve. The flow rate for this system is 250 gallons per minute, or one tank exchange per hour, as described by Zohar, and replaces 6,803 gallons of water from the system per day.

Water is drained from growth tanks through a center drain that runs through a particle trap to remove solids from the water, Figure 1. The water then travels through a drum screen filter and to the biosump. After leaving the biosump, water runs through an oxygen saturator, through the water heater, and then returns to the fiberglass tank from which it originated. A monitoring system, composed of sensors wired to a computer, constantly evaluates and controls temperature, salinity, and dissolved oxygen, and is connected to a modem that will send an alert for any abnormalities detected. Any sludge and wastewater that are not treated and returned to the tank are removed from the system to a 1-acre effluent pond.

To evaluate the feasibility of producing hybrid striped bass, the system described above was adapted. Due to the amount of time required for growout, four additional growout tanks were added; these were enclosed in an additional greenhouse along with extra water storage capacity and the associated equipment for each tank such as oxygen monitors, water heaters, and filtration mechanisms. The sizes of the first and second quarantine tanks were also increased to 2,350 and 6,790 gallons, respectively. Total water volume was increased to 133,444 gallons.

ECONOMIC ANALYSIS

Florida Pompano

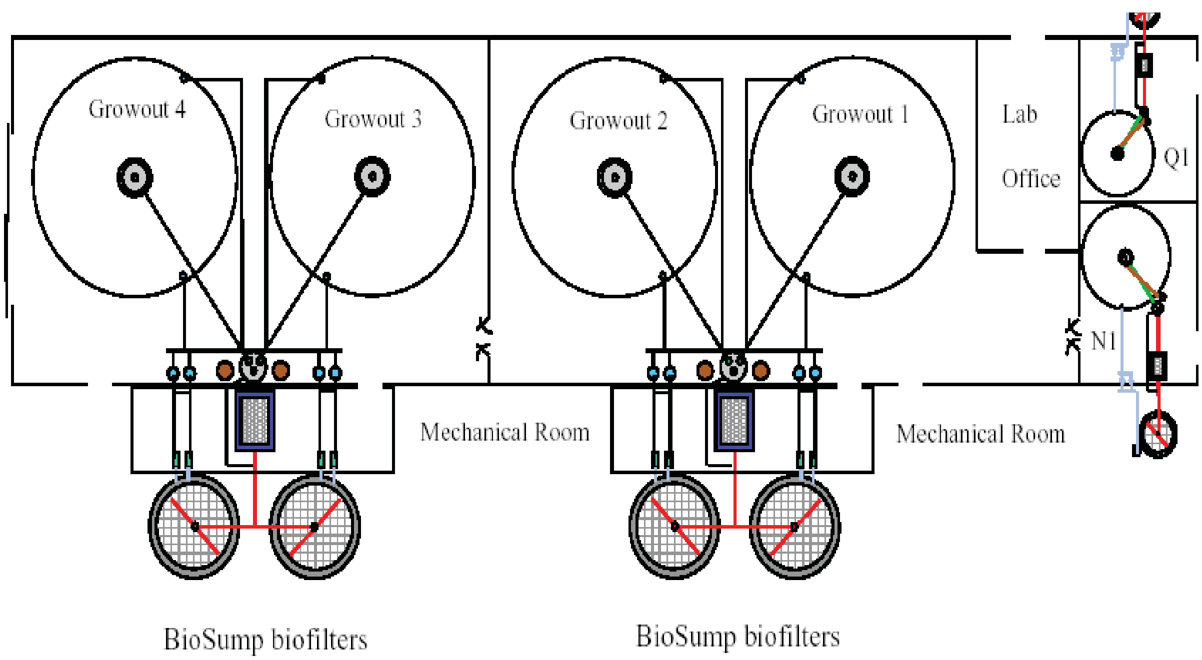
The economic feasibility of producing Florida pompano in both 6 ppt salinity (as currently available in Alabama) and also supplementing salt to produce pompano in salinity of 15 ppt was evaluated. Due to the high cost of purchasing supplemental salt (roughly $227.000), it was determined that supplementing to 15 ppt was not economically feasible without access to lucrative niche markets for the fish. However, if pompano can be cultured at 6 ppt, as research by Brown, McMaster, and Nystrom has shown to be possible, there is an opportunity for producers to take advantage of lucrative markets. The economic analysis of producing pompano in 6 ppt salinity is described below.

One-gram Florida pompano are assumed to be purchased at a price of $0.30 each in lots of 15,000 every fifty-six days and stocked at an initial density of 0.045 pound per gallon, which after eight weeks of growth to 10-gram fingerlings, becomes 0.44 pound per gallon, Table 1. A 95 percent survival rate is assumed. Fish are fed a diet of commercially available carnivorous fish feed available from Burris Mills/Cargill that is 46 percent protein. The feed is assumed to be delivered at a price of $0.45 per pound ($900 per ton) every six weeks to a 24-ton feed bin. Fingerlings are maintained for eight weeks in the first quarantine tank (Q1) and

Table 1. Parameters, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Parameter and unit	Amount
Number of growout tanks	4
Number of quarantine tanks	2
Total water volume (gallons)	67,052
Building size (sq ft)	3,360
Fish stocked per cohort	15,000
Cohorts stocked/harvested per year	6.5
Survival rate	95%
Fish harvested per cohort	14,250
Average size at harvest (pounds)	1
Feed conversion ratio	3.1
Avg. length of production cycle in days	252
Pounds harvested per tank	7,125
Pounds harvested, year 1 (6.5 tanks)	28,500
Pounds harvested, year 2 and following (13 tanks)	92,625
Cost of one gram pompano (each)	0.30
Electricity (kwh per pound of production)	2.54
Bank credit line int. rate for annual operating expenses	8%
Percent of capital financed by owner	20%
Bank interest rate for construction (5 year)	8.5%
Sale price ($/pound)	3.75

Figure 1. NCST Fishbarn Diagram: Recirculating system used as example for West Alabama saline groundwater to produce pompano and hybrid striped bass.



then moved into the second quarantine tank (N1) where they are held for an additional eight weeks, Figure 1. They are then moved into one of the 15,000 gallon grow-out tanks (Growout 1 – Growout 4) for another eight-week period until the group is split into two separate batches in 15,000 gallon tanks, where they will remain for approximately four to five more weeks, or until they reach a harvest weight of approximately 1 pound. One tank is harvested every four weeks in weekly intervals with 1,781 pounds harvested each week.

The total investment associated with a system capable of producing 92,625 pounds of pompano annually is $298,206 with annual depreciation of $40,462, using straight line depreciation and assuming a zero salvage value on all equipment, Table 2. Assets were assumed to be secured with 20 percent owner equity and the remaining 80 percent financed over five years at 8.5 percent, reflecting current credit markets. A loan to cover 80 percent of the initial investment is $238,565 and with an interest rate of 8 percent generates an annual interest payment of $11,021 for the facility, Table 3. Land (5 acres) was assumed to be previously owned.

Alternative recirculating systems are available for commercial aquaculture production at a substantially lower cost to the producer than that used in this analysis (Chappell 2008). However, no available literature discusses their ability to produce marine finfish. If the cost of the recirculating system could be decreased by $200,000 to $98,206, annual depreciation would decrease by $27,135 to $13,327 per year. Interest expense would also decrease by $15,129. This level represents a total savings of $0.31 per pound, assuming 95 percent survival and no loss of efficiency of the system.

Operating costs total $209,567 for year one while the system is building to full capacity (Table 4) and increase to $291,455 annually for year two and thereafter (Table 5). Fifty percent of the operating costs are financed through a short-term (one-year) loan at an interest rate of 8 percent, Table 3. This item adds an additional $9,973 in interest expense each year. Management was provided by a full-time owner/operator. Labor was provided by one full-time employee who was paid $10 per hour for eight hours each day. Employment taxes were evaluated at 1.45 percent for Medicare and 6.2 percent for Social Security as specified by the Internal Revenue Service. Property taxes were evaluated as Class III property at the State average of 43 mills. Total operating expenses for the production of pompano are $291,455 per year, Table 5. At this cost, and while receiving the stated price of $3.75 per pound, the operation generates total revenue of $347,344 and a return to land and management of $34,894, Table 4. The breakeven price of pompano raised under the stated conditions is $3.37 per pound.

Net income sensitivity analysis was conducted to evaluate the profitability of pompano production at different prices, yields, and feed conversion ratios, similar to the analysis presented on an Australian aquaculture facility, Table 6 (De Ionno et al. 2006). Prices fluctuate widely due to the lack of an established market for pompano, but reflect different prices received for live pompano and pompano on ice. All prices below $8 per pound are assumed to be paid for fresh pompano on ice, and are the most likely prices a producer would expect to receive, based on evidence presented in this study. Prices of $8 per pound or higher were evaluated to show the potential profitability of marketing live fish. While live fish markets present a great opportunity for a lucrative outlet, it is doubtful that a producer could sell 92,000 pounds of pompano by only relying on live markets, due to the information that is available on the volume of live seafood sold in major markets (Myers 2003). It is assumed that live markets exist and may be used as evidence presented suggests, but due to a lack of definitive information on details such as the volume of live pompano demanded, and information such as where and how to market large quantities of pompano, it is not reasonable to expect such returns without further information and analysis.

Sensitivity analyses show that with a feed conversion ratio of 3.1, pompano production has positive net returns to land and management of $7,253 when survival is 75 percent and market prices are $4 per pound, Table 6. If the FCR is enhanced to 2.75, pompano production has positive returns of $18,770 at 75 percent survival when the market price is $4 per pound. At 95 percent survival, net returns increase to $72,639 annually at a price of $4 per pound.

Further enhancing the FCR to 2.2, pompano production first has positive net returns of $2,939 at 95 percent survival and a market price of only $3 per pound, Table 6. If the market price increases to $4 per pound, the operation has positive net returns of $95,564 at 95 percent survival.

While dockside prices paid to fisherman were used as the base price paid to producers in this study, other marketing avenues present an opportunity for much higher prices and revenues. According to their website,

Table 2. Capital Outlay and Depreciation, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Item	Price	Units	Total	Years	Depreciation
Quarantine 1					
Q1 Tank (750 gallons)	930	1	930	7	133
pumps (1hp)	565	1	565	7	81
particle trap (Ecotrap)	1,942	1	1,942	7	277
titanium heat exchanger	723	1	723	7	103
oxygen saturator (35-65 gpm)	688	1	688	7	98
foam fractitionator	1,417	1	1,417	7	202
biosump	584	1	584	7	83
bio sump media	235	1.92	451	7	64
media blower	208	1	208	7	30
regenerative blower	912	1	912	7	130
drum screen filter	8,825	1	8,825	7	1,261
subtotal			17,246		2,464
Quarantine 2					
Q2 Tank (4200 gallons)	2,710	1	2,710	7	387
pumps (1hp)	565	2	1,130	7	161
particle trap (Ecotrap)	3,258	1	3,258	7	465
titanium heat exchanger	832	1	832	7	119
oxygen saturator (65-90 gpm)	1,323	2	2,646	7	378
foam fractitionator	1,417	1	1,417	7	202
bio sump	812	1	812	7	116
bio sump media	235	4.34	1,020	7	146
media blower	208	1	208	7	30
regenerative blower	912	1	912	7	130
drum screen filter	8,825	1	8,825	7	1,261
subtotal			23,770		3,396
Growout System					
Tanks (15538 gallons)	6,920	4	27,680	7	3,954
pumps (2hp)	1,808	8	14,464	7	2,066
particle trap (Ecotrap)	4,387	4	17,548	7	2,507
oxygen saturator (150-260 gpm)	1,255	8	10,040	7	1,434
foam fractitionator	8,895	4	35,580	7	5,083
bio sump	1,460	4	5,841	7	834
bio sump media	235	15.4	3,619	7	517
media blower	309	4	1,236	7	177
regenerative blower	912	2	1,824	7	261
drum screen filter	12,600	2	25,200	7	3,600
subtotal			143,032		20,433
System-wide equipment					
building (30' x 112' greenhouse)	14,358	1	14,358	10	1,436
water heating units	6,800	2	13,600	7	1,943
feed bins	4,285	1	4,285	7	612
feeders	385	6	2,310	7	330
gas generators	8,289	1	8,289	7	1,184
oxygen monitor	2,046	6	12,276	7	1,754
airlift pumps (for harvest)	8,000	1	8,000	7	1,143
misc. harvest equipment (nets, etc.)	1,000	1	1,000	7	143
misc. equipment	1,000	1	1,000	7	143
well	17,500	1	17,500	15	1,167
water tanks	2,885	4	11,540	7	1,649
1 acre effluent pond	10,000	1	10,000	15	667
subtotal			104,159		12,169
System Total			**288,206**		**38,462**
Truck	10,000	1	10,000	5	2,000
TOTAL			**298,206**		**40,462**

Pompano Farms of Oak Hill, Florida, sells whole, fresh pompano on ice at a price of $8 per pound, excluding shipping. At this market price, using the FCR of 3.1, returns to land and management are $428,551 annually at 95 percent survival, Table 6.

While income statements and associated sensitivity analysis show the operation's profitability potential, cash flow analysis is a more accepted tool of investment analysis when dealing with high-risk investments such as pompano production in a recirculating system (De Ionno et al. 2006). A cash flow budget was created to portray the operation's liquidity over a 10-year planning period using the specified FCR of 3.1 and the base market price of $3.75, when pompano are cultured in water of 6 ppt salinity. Starting with a beginning cash balance of $570,194 at the start of Year 1, the operation reaches a cumulative cash balance at Year 10 of $497,120, Table 7.

In order to evaluate the point at which the operation becomes an attractive investment, net cash revenues were calculated at each specified price and feed conversion ratio used in the profitability analysis that showed a positive return to land and management, from which the net present value (NPV) of the pompano farm could be calculated in each scenario. Each point at which NPV becomes positive is reported, as that is the combination of

Table 3. Operating Expenses, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Item	Unit	Cost	Units	Total
Feed	lb	0.45	287,138	129,212
One gram pompano	fish	0.30	97,500	29,250
Electricity	kwh	0.10	235,268	24,592
Liquid oxygen	100 cubic ft	4.91	703,950	34,564
Natural gas	ccf	2	1,518	2,417
Hired labor	hrs	10	2,080	20,800
Other (repairs, alarm, phone)				2,000
Marketing, promotion/travel				4,000
Insurance				2,500
Property tax	43 mills	43		67
Employment taxes				1,591
Interest: annual operating capital				9,973
fixed capital				11,021
Subtotal:				**271,988**

Table 4. Year One Income Statement, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Revenue	Amount	
28,500 1 lb pompano @ $3.75/lb	$106,875	
Total revenue		***$106,875***
Expenses		
Purchased feed	$64,606	
Purchased fingerlings	$29,250	
Other cash operating expenses		
Electricity	$24,592	
Oxygen	$17,282	
Natural gas	$2,417	
Labor	$20,800	
Sea salt	$0	
Other (repairs, phone)	$2,000	
Marketing, travel	$4,000	
Insurance	$2,500	
Property taxes	$67	
Employment taxes	$1,591	
Depreciation	$40,462	
Total operating expenses		***$209,567***
EBIT		($102,692)
Interest Expense	$20,995	
Net Income		($123,687)

Table 5. Year Two and Following Income Statement, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Revenue	Amount	
92,625 1 lb pompano @ $3.75/lb	$347,344	
Total revenue		***$347,344***
Expenses		
Purchased feed	$129,212	
Purchased fingerlings	$29,250	
Other cash operating expenses		
Electricity	$24,592	
Oxygen	$34,564	
Natural gas	$2,417	
Labor	$20,800	
Sea salt	$0	
Other (repairs, phone)	$2,000	
Marketing, travel	$4,000	
Insurance	$2,500	
Property taxes	$67	
Employment taxes	$1,591	
Depreciation	$40,462	
Total operating expenses		***$291,455***
EBIT		$55,889
Interest Expense	$20,995	
Net Income		$34,894

price, feed conversion ratio, and survival rate at which the investment covers costs and meets the risk factor of at least 15 percent, and the point at which the operation would be considered an economic success using the defined criteria (Thacker and Griffin1994).

Table 6. Net Income Sensitivity Analysis for 6 ppt Salinity Groundwater, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Survival	Yield	Price per pound						
	(lbs)	$3.00	$4.00	$5.00	$6.00	$7.00	$8.00	$10.00
Food Conversion Ratio 3.10								
75%	73,125	(65,872)	7,253	80,378	153,503	226,628	299,753	446,003
80%	78,000	(58,048)	19,952	97,952	175,952	253,952	331,952	487,952
85%	82,875	(50,223)	32,652	115,527	198,402	281,277	364,152	529,902
90%	87,750	(42,399)	45,351	133,101	220,851	308,601	396,351	571,851
95%	92,625	(34,574)	58,051	150,676	243,301	335,926	428,551	613,801
Food Conversion Ratio 2.75								
75%	73,125	(54,355)	18,770	91,895	165,020	238,145	311,270	457,520
80%	78,000	(45,763)	32,237	110,237	188,237	266,237	344,237	500,237
85%	82,875	(37,170)	45,705	128,580	211,455	294,330	377,205	542,955
90%	87,750	(28,578)	59,172	146,922	234,672	322,422	410,172	585,672
95%	92,625	(19,986)	72,639	165,264	257,889	350,514	443,139	628,389
Food Conversion Ratio 2.20								
75%	73,125	(36,256)	36,869	109,994	183,119	256,244	329,369	475,619
80%	78,000	(26,458)	51,542	129,542	207,542	285,542	363,542	519,542
85%	82,875	(16,659)	66,216	149,091	231,966	314,841	397,716	563,466
90%	87,750	(6,860)	80,890	168,640	256,390	344,140	431,890	607,390
95%	92,625	2,939	95,564	188,189	280,814	373,439	466,064	651,314

Table 7. Cash Flow Budget for 6 ppt Salinity Groundwater, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Beginning cash balance	570,194	1,000	1,000	1,000	1,000	15,366	111,717	208,068	304,419	400,769
Operating receipts										
Pompano sales	106,875	347,344	347,344	347,344	347,344	347,344	347,344	347,344	347,344	347,344
Total cash inflow	677,069	348,344	348,344	348,344	348,344	362,710	459,061	555,412	651,762	748,113
Operating expenses										
Feed expense	129,212	129,212	129,212	129,212	129,212	129,212	129,212	129,212	129,212	129,212
1 gram pompano	29,250	29,250	29,250	29,250	29,250	29,250	29,250	29,250	29,250	29,250
Instant ocean sea salt	0	0	0	0	0	0	0	0	0	0
Electricity	24,592	24,592	24,592	24,592	24,592	24,592	24,592	24,592	24,592	24,592
Liquid oxygen	34,564	34,564	34,564	34,564	34,564	34,564	34,564	34,564	34,564	34,564
Natural gas	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417
Labor	20,800	20,800	20,800	20,800	20,800	20,800	20,800	20,800	20,800	20,800
Marketing, promotion/travel	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Insurance	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Property tax	67	67	67	67	67	67	67	67	67	67
Employment taxes	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591
Other (repairs, alarm, phone)	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Total cash operating expenses	250,993	250,993	250,993	250,993	250,993	250,993	250,993	250,993	250,993	250,993
Capital expenditures										
Building	14,358									
Recirculating system	246,348									
Truck	10,000									
Well and pond	27,500									
Scheduled debt payments										
Current debt-principal	124,668	77,527	57,134	35,109	11,323	0	0	0	0	0
Current debt-interest	9,973	6,202	4,571	2,809	906	0	0	0	0	0
Noncurrent debt-principal	58,734	58,734	58,734	58,734	58,734					
Noncurrent debt-interest	11,021	11,021	11,021	11,021	11,021					
Total cash outflow	753,596	404,478	382,453	358,667	332,978	250,993	250,993	250,993	250,993	250,993
Cash available	(76,527)	(56,134)	(34,109)	(10,323)	15,366	111,717	208,068	304,419	400,769	497,120
New borrowing										
Current	77,527	57,134	35,109	11,323	0	0	0	0	0	
Ending cash balance:	1,000	1,000	1,000	1,000	15,366	111,717	208,068	304,419	400,769	497,120

In the case where production is in water of 6 ppt salinity and using an FCR of 3.1, NPV becomes positive at a market price of $4 per pound with 95 percent survival—$78,528, Table 8. That is, at the defined parameters, pompano production covers the identified costs, covers the 15 percent risk factor, and provides an additional $78,528. If the feed conversion ratio is improved to 2.75, NPV becomes positive at a price of $4 per pound with 85 percent survival—$40,045. Using the minimum expected FCR of 2.2, NPV is positive at a price of $4 per pound and 75 percent survival—$19,178.

Value-added. In order to add value to their product, some farms decide to process their own fish and market fillets. The Southern Regional Aquaculture Center reported in 1997, that small scale, on-farm processing adds a cost of $ 0.44 per pound to the producer (Lazur 1997). Adjusted for inflation, this translates to $ 0.60 per pound in 2008. Websites such as CharlestonSeafood.com offer fillets of wild-caught marine fish at prices ranging between $11.83 per pound for amberjack to $34.21 per pound for Chilean Seabass, with shipping costs added after the sale. Information on pompano fillet yields was not available, but catfish fillet yields are approximately 36 percent (Li 2001). At such a yield, 2.7 pounds of live pompano would provide 1 pound of processed fillets. At a breakeven price of $3.37 per pound of live fish, and adding the $0.60 per pound for processed fillets, this would equate to a break-even price of $9.70 per pound of fillets.

Live fish markets are another alternative to traditional marketing of fish to wholesalers. As stated earlier, Yonathan Zohar sold live guilthead seabream in the city of Baltimore at prices ranging between $12 per kilogram, or $5 per pound. Zohar's market research also shows that other high value species of marine fish—grouper, snapper, and flounder—bring prices ranging between $4.50 and $5.40 per pound.

Currently, there are two commercial producers of pompano on the market. One is the Pompano Farms, LLC, spawned from Mariculture Technologies International. They produce pond-raised pompano available for purchase in the months of November, December, and January, "or until supplies are gone." Prices are $8 per pound, whole on ice, which may be shipped, or $10 per pound live and may be picked up at the farm, as reported by their website. The other company in production of pompano is Dyer Aqua. They provide fresh pompano year round, in the form of whole fish or fillets. The company's website states that they have hatchery facilities located in Florida, but they ship fingerlings to their ocean pen grow-out facilities in the Bahamas, Panama, and soon, Belize.

Hybrid Striped Bass

Production of hybrid striped bass was also evaluated using 6 ppt salinity inland groundwater. Calculations were based on fingerlings being purchased in lots of 12,000 at a price of $0.25 per fingerling and stocked every

Table 8. Analysis of Net Present Value at 6 ppt Salinity Groundwater with Varying Feed Conversion Ratio, Survival, Yield, and Price, Marine Recirculating Aquaculture System for Pompano Production, West Alabama, 2008

Survival	Yield	Year 1	Years 2-5	Years 6-10	Net cash	NPV
	(lbs)	Price per pound ($4.00)				
Food Conversion Ratio 3.10						
75%	73,125	(160,993)	41,507	41,507	212,571	(265,979)
80%	78,000	(154,993)	61,007	61,007	394,071	(179,852)
85%	82,875	(148,993)	80,507	80,507	575,571	(93,725)
90%	87,750	(142,993)	100,007	100,007	757,071	(7,598)
95%	92,625	(136,993)	119,507	119,507	938,571	78,528
Food Conversion Ratio 2.75						
75%	73,125	(122,273)	80,227	80,227	599,767	(71,654)
80%	78,000	(122,306)	93,694	93,694	720,939	(15,804)
85%	82,875	(122,339)	107,161	107,161	842,111	40,045
90%	87,750	(122,372)	120,628	120,628	963,283	95,895
95%	92,625	(122,405)	134,095	134,095	1,084,455	151,744
Food Conversion Ratio 2.20						
75%	73,125	(104,175)	98,325	98,325	780,752	19,178
80%	78,000	(103,001)	112,999	112,999	913,989	81,083
85%	82,875	(101,827)	127,673	127,673	1,047,227	142,988
90%	87,750	(100,654)	142,346	142,346	1,180,464	204,893
95%	92,625	(99,480)	157,020	157,020	1,313,702	266,798

eight weeks, Table 9. After the initial eight weeks, the bass will be moved to the second quarantine tank. Eight weeks later, they will be moved to one of the growout tanks where they will stay for 16 weeks until they are split into two batches. These will be cultured for an additional 16 weeks, when they will be harvested at a density of 0.45 pounds per gallon. The system evaluated in this study can produce 87,750 pounds of fish per year, Table 9.

The initial investment associated with production of hybrid striped bass in a recirculating system is higher than that of pompano at $531,846, Table 10. The larger outlay for bass relative to pompano is due to the four extra tanks; related equipment such as biofilters, feeders, and oxygen monitors; and a larger greenhouse. However, due to lower operating expenses, the breakeven price for hybrid striped bass is $2.93 per pound. Annual depreciation is $50,576.

Since no hybrid striped bass are marketed in the first year, net income is a negative $216,885, Table 11. Subsequent years show a loss of $11,250 annually at a price of $2.80 per pound, Table 12. Depreciation (22 percent), feed (21 percent), and electricity (20 percent) are major cost items, comprising almost two-thirds of the total.

With the specified parameters and a market price of $2.80 per pound, the hybrid striped bass operation has a negative cash balance of $108,460 after 10 years, and a negative NPV of $1,213,851, Table 13. As with pompano, net income sensitivity analysis was conducted for hybrid striped bass. With pompano, different feed conversion ratios have been reported by different researchers and there is no industry standard since a minimal amount of commercial pompano production has occurred. However, hybrid striped bass have been in production for 20 years with a reported FCR of 1.8 (Brown 2007). Net income sensitivity analysis for hybrid striped bass can project the returns to land and management under varying survival rates as well as prices. At 90 percent survival and a price of $3 per pound, returns to land and management are $6,300, Table14. If prices reach $4 and $5 per pound (perhaps from a niche market), annual returns are $94,050 and $181,800, respectively, at 90 percent survival.

Analyses of net present values show that they first become positive at a market price of $3.50 when survival is 85 percent, $41,834, Table 15. That is, at a price of $3.50 with the FCR at 1.8 and the survival rate at 85 percent, hybrid striped bass production covers the defined costs and a 15 percent risk factor plus generates an additional $41,834. At 90 percent survival, NPV is $103,983 when the market price is $3.50 per pound.

While these numbers may seem profitable, it is important to note that market prices for hybrid striped bass in recent years have been below $3.00 per pound. Market prices in 2001 were reported between $2.50 and $2.75 per pound in the Southeastern United States. Also, the breakeven point in 2001 for pond-raised hybrid striped bass was $1.90 per pound (Lougheed and Nelson 2001).

Another key consideration from the budget analysis is that the owner/operator has not yet been compensated for his/her risks and capital. Thus, if the owner operator desires, for example $50,000, the bottom line for the net income statements for both species can effectively be further reduced by that amount. However, the NPV analyses do include a 15 percent risk premium.

Table 9. Parameters, Marine Recirculating Aquaculture System for Hybrid Striped Bass Production, West Alabama, 2008

Parameter and unit	Amount
Number of growout tanks	8
Number of quarantine tanks	2
Total water volume (gallons)	133,444
Total square footage (2 buildings @ 3,360)	6,720
Fish stocked per cohort	12,000
Cohorts stocked/harvested per yr	6.5
Survival rate	90%
Fish harvested per cohort	10,800
Average size at harvest (pounds)	1.25
Feed conversion ratio	1.8
Avg. length of production cycle in days	365
Pounds harvested per tank	6,750
Pounds harvested, year 1(6.5 tanks)	0
Pounds harvested, year 2 and on (13 tanks)	87,750
Cost of two gram hybrid striped bass (each)	0.25
Electricity (kwh per pound of production)	5.08
Bank credit line int. rate for annual op exp	8%
Percent of capital financed by owner	20%
Bank interest rate for construction (5 yr)	8.5%
Sale price ($/pound)	2.80

DISCUSSION

Recirculating aquaculture systems provide a method to partially control all the factors of aquacultural production as well as meet increasing demand for fish in an environmentally sustainable and efficient way. Analyses show that pompano and hybrid striped bass lack feasibility or are marginally feasible at specified base efficiency and price levels. Thus, successful use of Alabama's available high salinity inland groundwater to produce marine fish species depends on improved efficiency of operations to lower production costs and more effective marketing to improve price.

Table 10. Capital Outlay and Depreciation, Marine Recirculating Aquaculture System for Hybrid Striped Bass Production, West Alabama, 2008

Item	Price	Units	Total	Years	Depreciation
Quarantine 1					
Q1 Tank (2350 gallons)	1,870	1	1,870	7	267
pumps (1hp)	565	1	565	7	81
particle trap (Ecotrap)	1,942	1	1,942	7	277
titanium heat exchanger	723	1	723	7	103
oxygen saturator (65-90 gpm)	1,323	1	1,323	7	189
foam fractionator	1,417	1	1,417	7	202
biosump	584	1	584	7	83
bio sump media	235	2.43	571	7	82
media blower	208	1	208	7	30
regenerative blower	912	1	912	7	130
drum screen filter	8,825	1	8,825	7	1,261
subtotal			18,940		2,706
Quarantine 2					
Q2 Tank (6790 gallons)	3,820	1	3,820	7	546
pumps (1hp)	565	2	1,130	7	161
particle trap (Ecotrap)	3,258	1	3,258	7	465
titanium heat exchanger	832	1	832	7	119
oxygen saturator (65-90 gpm)	1,323	2	2,646	7	378
foam fractionator	1,417	1	1,417	7	202
bio sump	812	1	812	7	116
bio sump media	235	4.34	1,020	7	146
media blower	208	1	208	7	30
regenerative blower	912	1	912	7	130
drum screen filter	8,825	1	8,825	7	1,261
subtotal			2,4880		3,554
Growout System					
Tanks (15538 gallons)	6,920	4	27,680	7	3,954
pumps (2hp)	1,808	8	14,464	7	2,066
particle trap (Ecotrap)	4,387	4	17,548	7	2,507
oxygen saturator (150-260 gpm)	1,255	8	10,040	7	1,434
foam fractionator	8,895	4	35,580	7	5,083
bio sump	1,460	4	5,841	7	834
bio sump media	235	15.4	3,619	7	517
media blower	309	4	1,236	7	177
regenerative blower	912	2	1,824	7	261
drum screen filter	12,600	2	25,200	7	3,600
subtotal			286,064		20,433
System-wide equipment					
building (30’ x 112’ greenhouse)	14,358	2	28,717	10	2,872
heating units	6,800	4	27,200	7	3,886
feed bins	4,285	1	4,285	7	612
feeders	385	10	3,850	7	550
gas generators	8,289	1	8,289	7	1,184
oxygen monitor	2,046	10	20,460	7	2,923
airlift pumps (for harvest)	8,000	1	8,000	7	1,143
misc. harvest equipment (nets, etc.)	1,000	1	1,000	7	143
misc. equipment	1,000	1	1,000	7	143
well	17,500	1	17,500	15	1,167
water tanks	2,885	16	46,160	7	6,594
1 acre effluent pond	10,000	1	10,000	15	667
land (5 acres)	3,100	5	15,500		
subtotal			191,961		21,883
System Total			**521,846**		**48,576**
Truck	10,000	1	10,000	5	2,000
TOTAL			**531,846**		**50,576**

Table 11. Year One Income Statement, Marine Recirculating System for Hybrid Striped Bass Production, West Alabama, 2008

Revenue	Amount	
1.25 lb Bass @ $2.80/lb	$0	
Total revenue		***$0***
Expenses		
Purchased feed	$23,693	
Purchased fingerlings	$19,500	
Other cash operating expenses		
Electricity	$46,595	
Oxygen	$16,372	
Natural gas	$2,417	
Labor	$20,800	
Other (repairs, phone)	$2,000	
Marketing, travel	$4,000	
Insurance	$2,500	
Property taxes	$67	
Employment taxes	$1,591	
Depreciation	$50,576	
Total operating expenses		***$190,111***
EBIT		($190,111)
Interest Expense	$26,774	
Net Income		($216,885)

Table 12. Year Two and Following Income Statement, Marine Recirculating System for Hybrid Striped Bass Production, West Alabama, 2008

Revenue	Amount	
87,750 lbs, 1.25 lb bass @ $2.80/lb	$245,700	
Total revenue		***$***245,700
Expenses		
Purchased feed	$47,385	
Purchased fingerlings	$19,500	
Other cash operating expenses		
Electricity	$46,595	
Oxygen	$32,745	
Natural gas	$2,417	
Labor	$20,800	
Other (repairs, phone)	$2,000	
Marketing, travel	$4,000	
Insurance	$2,500	
Property taxes	$67	
Employment taxes	$1,591	
Depreciation	$50,576	
Total operating expenses		***$230,176***
EBIT		($15,524)
Interest Expense	$26,774	
Net Income		($11,250)

Table 13. Cash Flow Budget for 6 ppt Salinity Groundwater, Marine Recirculating Aquaculture System for Hybrid Striped Bass Production, West Alabama, 2008

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Operating expenses										
Feed expense	47,385	47,385	47,385	47,385	47,385	47,385	47,385	47,385	47,385	47,385
1 gram hybrid striped bass	19,500	19,500	19,500	19,500	19,500	19,500	19,500	19,500	19,500	19,500
Electricity	46,595	46,595	46,595	46,595	46,595	46,595	46,595	46,595	46,595	46,595
Liquid oxygen	32,745	32,745	32,745	32,745	32,745	32,745	32,745	32,745	32,745	32,745
Natural gas	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417
Labor	20,800	20,800	20,800	20,800	20,800	20,800	20,800	20,800	20,800	20,800
Marketing, promotion/travel	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Insurance	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Property tax	67	67	67	67	67	67	67	67	67	67
Employment taxes	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591
Other (repairs, alarm, phone)	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Principal payments	71,322	77,627	84,488	91,956	100,084					
Interest payments	33,429	27,125	20,264	12,796	4,668					
Total cash outflow	284,352	284,352	284,352	284,352	284,352	179,600	179,600	179,600	179,600	179,600
Cash inflow	0	245,700	245,700	245,700	245,700	245,700	245,700	245,700	245,700	245,700
Annual cash position	(284,352)	(38,652)	(38,652)	(38,652)	(38,652)	66,100	66,100	66,100	66,100	66,100
Cumulative cash position	(284,352)	(323,004)	(361,655)	(400,307)	(438,959)	(372,859)	(306,759)	(240,659)	(174,559)	(108,460)
Net present value	(1,213,851)									

Table 14. Net Income Sensitivity Analysis for 6 ppt Salinity Groundwater, Marine Recirculating System for Hybrid Striped Bass Production, West Alabama, 2008

Survival	Yield	Price per pound						
	(lbs)	$3.00	$4.00	$5.00	$6.00	$7.00	$8.00	$10.00
FCR 1.8								
75%	73,125	(29,678)	43,447	116,572	189,697	262,822	335,947	482,197
80%	78,000	(17,685)	60,315	138,315	216,315	294,315	372,315	528,315
85%	82,875	(5,693)	77,182	160,057	242,932	325,807	408,682	574,432
90%	87,750	6,300	94,050	181,800	269,550	357,300	445,050	620,550
95%	92,625	18,292	110,917	203,542	296,167	388,792	481,417	666,667

Table 15. Analysis of Net Present Value at 6 ppt Salinity Groundwater with Varying Feed Conversion Ratio, Survival, Yield, and Price, Marine Recirculating Aquaculture System for Hybrid Striped Bass Production, West Alabama, 2008

Survival	Yield	Year 1	Years 2-5	Years 6-10	Net cash	NPV
	(lbs)	——Price per pound ($3.50)——				
FCR 1.8						
75%	73,125	(197,704)	(20,517)	84,235	141,403	(82,465)
80%	78,000	(195,087)	(6,087)	98,665	273,890	(20,315)
85%	82,875	(192,469)	8,343	113,095	406,378	41,834
90%	87,750	(189,852)	22,773	127,525	538,865	103,983
95%	92,625	(187,234)	37,203	141,955	671,353	166,132

Total investment costs for facilities capable of producing pompano and hybrid striped bass are $298,206 and $531,846, respectively, with annual depreciation of $40,462 and $50,576. Operating costs for pompano and hybrid striped bass are, respectively, $291,455 and $230,176 annually; feed is the largest component.

At base levels, net income sensitivity analyses show that pompano production becomes profitable at $4 per pound while hybrid striped bass production shows positive returns at $3.00 per pound. However, at these levels, the owner/operator has not been compensated for his/her efforts and risks.

Analyses of market prices show that pompano often sells for between $7 and $10 per pound for live fish and fresh fillets and the hybrid striped bass price has declined to the vicinity of $2.00 per pound within the past ten years. Thus, pompano production could be an attractive investment if, as previous research indicates, pompano may be raised successfully in salinities of 6 ppt. NPV becomes positive at a market price of only $4 per pound, indicating the facility to be a profitable investment using the 15 percent risk criterion. However, the owner/operator has yet to be compensated.

It is recommended that additional study be conducted on exactly what water quality parameters are necessary in order to achieve favorable survival rates and growth efficiency. Brown (2007) reports survival rates of 80 percent for pompano at one site. With additional research, survival rates of 90 percent or greater should be achieved.

Historically, only a minimal supply of pompano has been available to consumers. At the beginning of this study, there was no company commercially producing Florida pompano. However, in recent months, both Pompano Farms as well as DyerAqua have started to culture and sell pompano commercially. Until recently, pompano were only available when caught from the ocean in limited amounts (less than 500,000 pounds per year) and at certain times of the year. While Pompano Farms has pompano available for only three months of the year, DyerAqua produces pompano year-round and is anticipating expanding production to two additional sites. With a larger amount of pompano available on a year-round basis, investment in an enterprise to produce pompano should be considered cautiously. An individual's success may depend largely on his/her experience in aquacultural production as well as his/her business management skills, especially in the areas of production efficiency and marketing.

Hybrid striped bass have been shown to thrive in the saline waters of West Alabama. Their tolerance of varying temperatures and salinities as well as their proven ability to be produced at high densities make them an interesting fish for production. This system requires an investment of $531,846 to produce 87,750 pounds of fish per year at 90 percent survival. The breakeven price is $2.93 per pound. While the break even price is lower than that for pompano, the fish generally commands a relatively low market price. It isn't until the price reaches $4.00 per pound that hybrid striped bass production becomes a somewhat attractive investment. The fish grows well in the saline waters of West Alabama, but low market prices raise questions relative to economic feasibility of production using a recirculating system.

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Alabama's Agricultural Experiment Station
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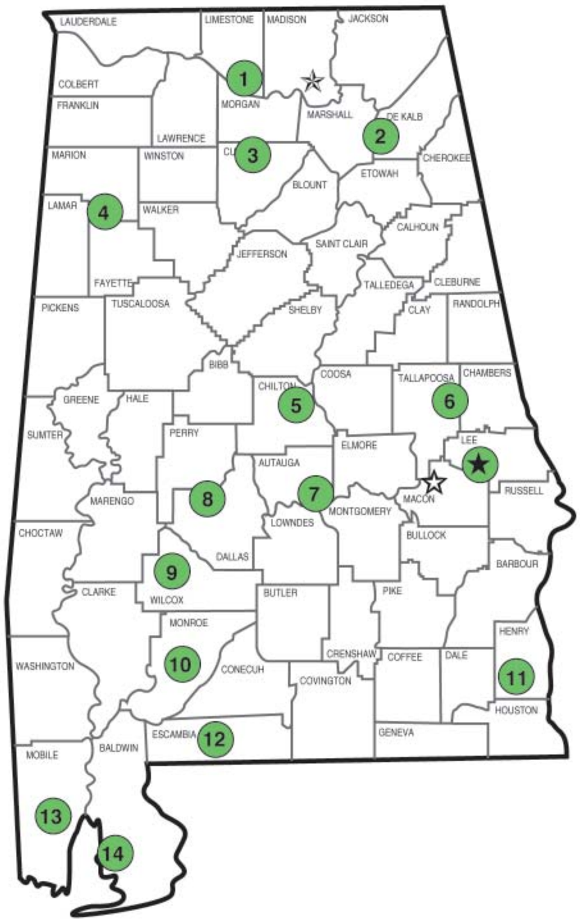
With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the state has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

- ★ Main Agricultural Experiment Station, Auburn.
- ☆ Alabama A&M University.
- ☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Research and Extension Center, Belle Mina.
2. Sand Mountain Research and Extension Center, Crossville.
3. North Alabama Horticulture Research Center, Cullman.
4. Upper Coastal Plain Agricultural Research Center, Winfield.
5. Chilton Research and Extension Center, Clanton.
6. Piedmont Substation, Camp Hill.
7. Prattville Agricultural Research Unit, Prattville.
8. Black Belt Research and Extension Center, Mari
9. Lower Coastal Plain Substation, Camden.
10. Monroeville Agricultural Research Unit, Monroev
11. Wiregrass Research and Extension Center, Hea
12. Brewton Agricultural Research Unit, Brewton.
13. Ornamental Horticulture Research Center, Sprin
14. Gulf Coast Research and Extension Center, Fair