Preliminary Financial Feasibility Analysis of an Independent Marine Shrimp Hatchery Located in South Carolina

by

Raymond J. Rhodes[1]
Kathleen McGovern-Hopkins[2]
and
Craig L. Browdy[2]

Technical Report Number 80
December, 1992

[1] Economic Analysis and Seafood Marketing Program
Office of Fisheries Management
Division of Marine Resources
S.C. Wildlife & Marine Resources Department
P.O. Box 12559
Charleston, SC 29422-2559

and

[2] Waddell Mariculture Research and Development Center
Marine Resources Research Institute
Division of Marine Resources
S.C. Wildlife & Marine Resources Department
P.O. Box 809
Bluffton, SC 29910

This work was partially funded by the U.S. Department of Agriculture as administered by the Oceanic Institute/Gulf Coast Research Laboratory Consortium. The views expressed in this report do not necessarily reflect those of the U.S. Department of Agriculture, Oceanic Institute, or the S.C. Wildlife and Marine Resources Department. Any commercial product or trade name mentioned herein is not to be construed as an endorsement.

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SUMMARY

It is anticipated that prospective aquaculturists, investors, and perhaps lending institutions, will desire information on the financial feasibility of operating a commercial penaeid shrimp larviculture facility located in South Carolina (SC). The objective of this report is to present a preliminary projection of costs and income generated by an independent (i.e. not integrated with a SC shrimp grow-out enterprise) commercial hatchery operating in coastal SC. The hypothetical hatchery described in this report includes maturation and larval rearing (LR) systems consisting of ten 12.5-ton maturation tanks and 16 8-ton LR tanks housed in one large, prefabricated steel building with an overall area of about 13,300 ft^2. The total initial investment for constructing, equipping and operating this facility would be nearly $1 million. Total annual projected cash operating costs for a 75 million postlarvae (PL) per year output was $496,690. The annual, average cash cost per PL would be approximately $6.60/1,000 PL for this output. Projected net income after taxes was only $94,600 for the base case output of 75 million PL per year.

The ten-year (after-tax) internal rate of return (IRR), was 17%. For a base case after-tax discount rate of 20%, the projected ten-year net present value (NPV) was negative. The sensitivity analysis of selected variables suggests that the projected IRR and NPV are more sensitive to relative changes in PL market prices and PL output than in feed cost changes.

Based on this preliminary analysis, the negative NPV for the base case output of 75 million PL/year does indicate that this size of hatchery (i.e. less than 9 million PL/month) would not generate a postive return on equity if potential investors only based their investment upon a required rate of return of 20% or more after income taxes. Future research on SC shrimp hatcheries should include the financial feasibility of a larger hatchery (e.g. 20 million PL/month), integrating a marine shrimp nursery and/or grow-out operation with a hatchery facility.

The future demand for PL produced in SC is uncertain. Despite this uncertainty, a commercial hatchery located in South Carolina may have several advantages compared to hatcheries in other states or countries. SC shrimp farmers may prefer SC produced PL because of lower shipping stress and perhaps higher survival rates when the PL are initially stocked compared to PL from out-of-state suppliers. Other possible advantages for a SC hatchery include: 1) in-state technical support from the Waddell Mariculture Center (see Rhodes, 1992), 2) the possibility of developing a specialty market for *Penaues setiferus* PL, an indigenous species, purchased by SC live bait farmers, and/or 3) out-of-state PL suppliers may be more vulnerable to additional SC regulatory actions in the future.

INTRODUCTION

A small marine shrimp mariculture industry has developed in South Carolina (SC) producing about 600,000 pounds of whole shrimp in 1991, with an ex-pond value near $1.5 million. The profitability of SC's commercial shrimp businesses is dependent upon many factors including the availability of viable postlarvae (PL) at a competitive price. There is currently (1992) no commercial shrimp hatchery in SC. The SC farms have been generally dependent upon on out-of-state suppliers for PL of the species of choice, *Penaeus vannamei*, a non-indigenous marine

shrimp. During May and June, SC shrimp farmers purchase PL's from commercial out-of-state hatcheries and/or small amounts from a hatchery operated by the SC Wildlife and Marine Resources Department at the Waddell Mariculture Center (WMC) near Bluffton, South Carolina.

SC shrimp farmers have become apprehensive about the future supply and quality of imported PL. For example, in 1989, several farms had to reduce planned stocking densities and/or not stock all their ponds due to an apparent shortage of quality PL's (McGovern-Hopkins et al. 1991). Also, environmental concerns have increased in recent years regarding the perceived impacts of farming non-indigenous shrimp in the United States. Moreover, industry awareness has increased relative to possible negative impacts of shrimp diseases carried by PL from out-of-state hatcheries on commercial farm production. Consequently, as concerns have increased, research has been conducted to examine the technical and financial feasibility of producing commercial quantities of the indigenous *P. setiferus* and/or specific pathogen free (SPF) *P. vannamei* PL in the state of South Carolina (Browdy et al. 1991).

It is anticipated that prospective aquaculturists, investors, and perhaps lending institutions, will desire information on the financial feasibility of a commercial PL production facility located in South Carolina. Although several economic studies have analyzed maturation and/or hatchery systems for penaeid shrimp (e.g. Johns et al. 1981), no studies have analyzed the financial feasibility of penaeid larviculture in SC. The objective of this report is to present a preliminary projection of costs and income generated by an independent (i.e. not integrated with a SC shrimp grow-out enterprise) commercial hatchery operating in coastal South Carolina with enough capacity to produce some of the PL needed by SC farmers, about 45 million PL during a 8-10 week period in 1992 (Rhodes, 1992). Annual income statements and cash flows have been projected in order to estimate accounting profitability, return on equity capital, and net present value.

METHODS AND DATA

FACILITY DESIGN AND EQUIPMENT

The hypothetical facility described in this paper is based upon the commercial hatchery technology predominant in the Western hemisphere (Lawrence and Huner, 1987, McVey and Fox, 1983, and Treece and Yates, 1988). Production and cost estimates were predicated upon experience at the WMC hatchery (McGovern-Hopkins et al, 1991) and other commercial hatcheries in the US. In this analysis, the size and number of tanks were generally expanded compared to the WMC hatchery. This does not imply that the capacity of this hypothetical hatchery is the "optimal" design and/or capacity for South Carolina with regard to economies of scale or other considerations (e.g., PL purchase patterns).

Most of the hatchery, including maturation and larval rearing (LR) tanks, would be housed in one large, prefabricated steel building with an overall area of about 13,300 ft^2 (Fig. 1). The cost of this building with office space (Table 1) was based upon cost estimates in Kiley et al (1991) and cost estimates provided by companies specializing in prefabrication buildings.

Ten 12.5-ton maturation tanks and 16 8-ton LR tanks would be used in this facility. Three reservoir tanks capable of holding 212 tons of saltwater each would be used to store treated water. The salt-

water treatment system would include filter vessels and ultraviolet light sterilization. The saltwater heating system would include one titanium heat exchanger for each storage tank and an electric freshwater boiler. Costs for the saltwater filtration and heating system are based upon estimates from commercial vendors.

PRODUCTION ASSUMPTIONS

Production assumptions are summarized in Table 1. These data were used in estimating a base case PL output of 75 million over a nine month period. If the annual PL purchases by SC growers is about 45 million PL, this hatchery could produce approximately 38%, 17 PL million, during an 8 week period. It is assumed that this hatchery would export PL to growers in other states and/or countries (e.g., Mexico).

Stocking density of adult animals in maturation tanks would be 7/m^2 resulting in 50,000 nauplii per spawn and a spawning rate of 2% per night (Table 1). In the LR tanks, nauplii stocking density is set at 100/l with a survival of 50% from nauplii to PL_5.

MAJOR FINANCIAL AND OPERATING ASSUMPTIONS

Major financial and operating assumptions are provided in Table 2. The annual financial projections for this facility were generated using a Lotus 1-2-3 spreadsheet template prepared by Applied Analysis, Inc., (Leung and Rowland, 1989).

Actual production time (i.e. excluding hatchery preparation and "shut-down" time) is based upon a nine month season. A two year "learning curve" was approximated by assuming the PL output of the first and second operating years' output was 60% and 80%, respectively, of the base case PL output. It is assumed that all hatchery personnel (e.g., managers, technicians, etc.) would be employed all year (12 months). Broodstock feed would be comprised of fresh and frozen squid and bloodworms, with bloodworms comprising the largest component of the feed costs (Table 2).

The base case selling price of the PL, $9.00/1,000 PL F.O.B. the hatchery site, (Table 2) is based upon the authors' judgement. Historically SC growers have generally paid $10/1,000 or higher for out-of-state PL when survival rates and shipping costs are considered. This hatchery would only be capable of producing about 23%, 17 million PL, of it's annual output to sell to SC growers during the spring. Therefore, it is assumed this hatchery would need to sell over 70% of it's output to growers in other states and/or countries. Consequently, it was assumed lower out-of-state selling prices would reduce the annualized selling price to a level below $10/1,000 when competing with out-of-state PL sellers[1].

RESULTS

INITIAL INVESTMENT

The total initial investment for constructing, equipping and operating this facility would be nearly $1 million (Table 3). The steel building housing the facility would comprise 38% of the total equipment and construction costs, $568,820. In contrast, maturation and hatchery equipment, mainly tanks, would represent

[1] The sensitivity analysis in this report (see Table 5) includes selling prices higher and lower than $9/1,000.

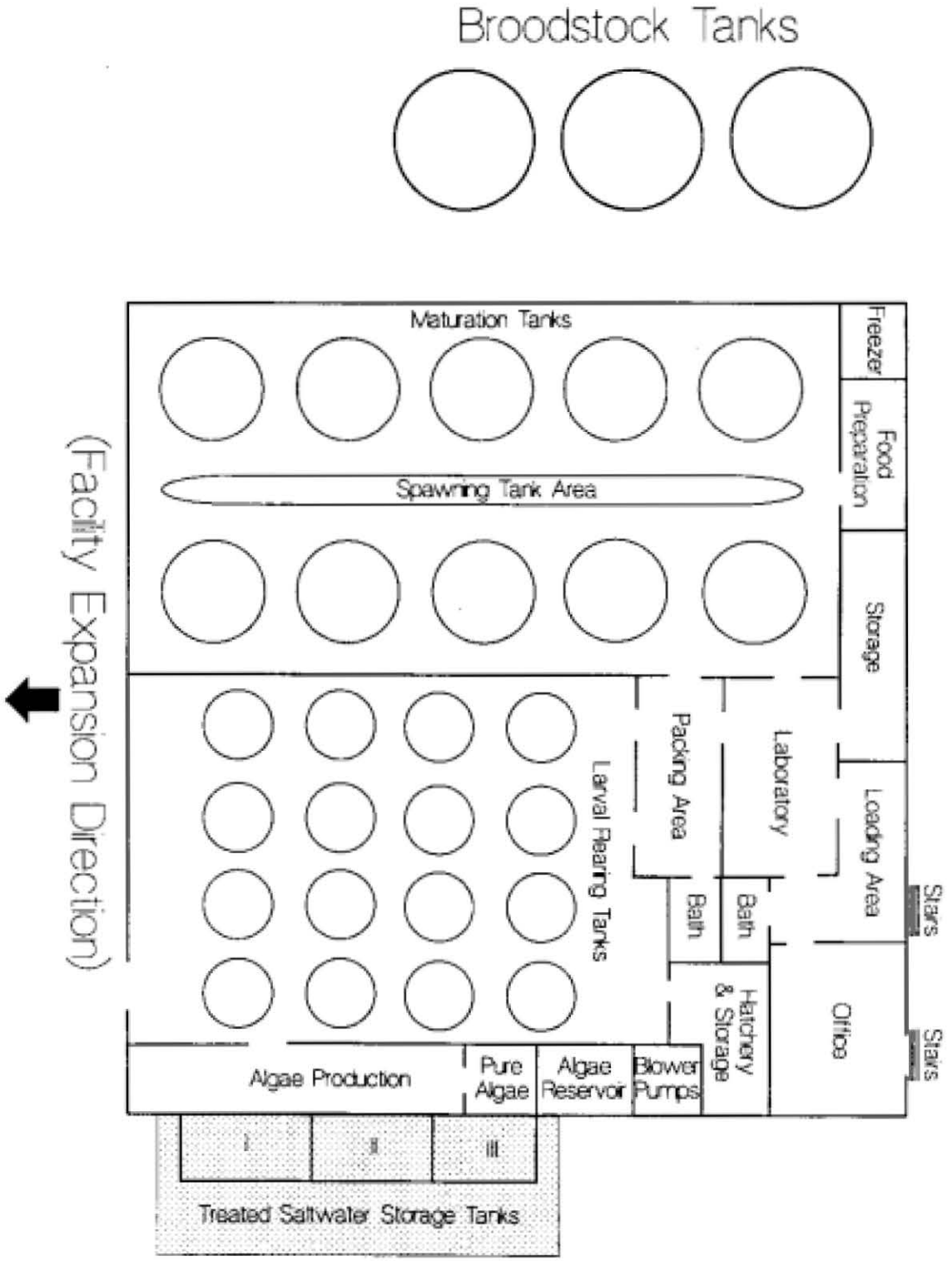

Figure 1. Generalized floor plan of a hypothetical marine shrimp hatchery located in South Carolina, U.S.A.

Table 1. Major base case production assumptions for a hypothetical marine shrimp hatchery in South Carolina.

Maturation and Hatchery Season: Approximately nine (9) months.
Maturation Output:
Active Animals (Sex Ratio 1:1): 1,111
Maturation Stocking Density: 7 animals/m^2
Nauplii per Spawn: 50,000
Spawning Rate Per Night: 2.0%
Total Nauplii Per Season: 1.5 X 10^8
Hatchery Output:
Nauplii Survival to PL: 50.0%
Nauplii Stocking Density: 100 animals/liter
Total PL Output Per Season: 7.5 X 10^7 (~8.3 million/month)

Table 2. Major base case financial and operational assumptions for a South Carolina shrimp hatchery.

Source of Construction and Annual Operating Capital 100% Equity
Electricity Cost: $US 0.065/KW
Postlarve Selling Price: $9/1,000
Depreciation Treatment: Straight-line
Bloodworm Cost for Broodstock: $US 62/kg
Discount Rate After Taxes: 15%
Corporate Income Tax Rate, State and Federal: 30%
"Learning Curve" During 1st and 2nd Year
Payroll Taxes and Insurance:
Hourly Wage Personnel: 21% of gross wages
Salary Personnel: 25% of gross salaries

about 13% of facility costs (Table 3).

It is assumed that this hatchery would draw its water from an estuarine water source. Estuarine waters in SC generally have a high level of suspended solids; consequently, a filtration system is need for treating raw saltwater for use in a penaeid shrimp hatchery (McGovern-Hopkins et al, 1991). Since SC saltwater temperatures from January through June are below 28°C, this hatchery would also require constant heating of hatchery's reservoir (head) water for at least 5 months. The saltwater source and treatment systems would comprise approximately 39% of the total facility costs (Table 3).

Table 3. **Summary of estimated initial investment for a hypothetical marine shrimp hatchery constructed in South Carolina.**

	Cost	Percent[1]	Useful Years
Hatchery/Maturation Building[2]	$118,750		15
Office & Laboratory Equipment	25,000		10
Project Planning & Permits	15,000		5
Land, 2 acres	10,000		N/A
Subtotal:	$168,750	36%	
Hatchery & Maturation Equipment:			
Maturation Tanks, 10	$ 10,000		10
Spawning Tanks, 25	5,000		10
Broodstock Holding Tanks, 2	2,400		5
Hatchery Tank Heaters, 16	8,800		5
Hatchery Tanks, 16	38,400		15
Pumps	8,500		5
Subtotal:	$ 73,100	15%	
Saltwater Source & Treatment System:			
Automatic Filtration System	$ 66,000		10
Heat Exchanger & Boiler	48,000		10
Storage Tanks, 3	39,300		15
Water Storage Shed	25,900		15
Saltwater Source Pumps, 3	2,700		5
Subtotal:	$181,750	39%	
Other Equipment:			
Diesel Back-up Generator, 1	$ 20,500		20
Pick-up Truck, 1	8,000		5
Phytoplankton Tanks, 60	8,400		5
Miscellaneous Equipment	6,400		5 to 10
Miscellaneous Tanks	2,680		10
Subtotal:	$ 45,980	10%	
Total Facility Cost:	$469,730		
Annual Cash Operating Cost:	$496,690		
Total Initial Investment	$966,420		

[1]Percent of "Total Facility Cost".
[2]The hatchery building includes the shrimp maturation facilities.

Table 4. Projected annual income statement for operating years three through ten, internal rate of return, and net present value for a hypothetical marine shrimp hatchery located in South Carolina.

Projected Annual Production:			
Hatchery (PL's in Thousands)			75,000
Maturation (Nauplii in Thousands)			150,000
	(In Thousands)		
Projected Annual Sales:		$675	
Projected Expenses		Percent of: Sales	Cost
Fuel & Utilities	$107.4	16%	20%
Feed	111.6	17%	21%
Broodstock Purchases	20.0	3%	4%
Hourly Wages[1]	98.8	15%	18%
Salaries[1]	120.0	18%	22%
Chemicals	16.7	2%	3%
Other Supplies	10.1	1%	2%
Contingencies	12.1	2%	2%
Depreciation	43.1	6%	8%
Total Projected Expenses:	$539.8	80%	100%
Projected Taxable Income:		$135.2	
Estimated Income Taxes:		$ 40.6	
Projected Income After Taxes:		$ 94.6	

Discounted Cash Flow Analysis[2]

10-Year Projected Internal Rate of Return: 16.9%

	After Tax Discount Rate			
	10%	15%	20%[3]	25%
10-Year Net Present Value:	+$147	+$35	-$49	-$114
	(In Thousands)			

[1] Includes payroll taxes, workman's compensation and fringe benefits.
[2] Annual cash operation costs were not included in this analysis.
[3] Base case.

OPERATING COSTS

Total annual projected operating expenses for 75 million PL/yr. output was $539,800 including depreciation (Table 4). The total annual projected cash operating cost was $496,690. The annual, average cash cost per PL would be approximately $6.62/1,000 PL for a 75 million PL/year output. Salaries and wages together comprised the largest percentage of operating expenses, 40% (Table 4). Utilities, principally electricity used in heating saltwater, represented 20% of total operating expenses. Feed, mainly bloodworms for broodstock feeding, comprised about 21% of projected operation expenses (Table 4).

PROJECTED NET INCOME AND DISCOUNTED CASH FLOW

Projected net income after taxes was $94,600 for the base case output of 75 million PL (Table 4). The projected net income (after taxes) per 1,000 PL was $1.26/1,000 PL.

The ten-year (after income taxes) internal rate of return (IRR) and net present value (NPV) were projected (Table 4). The IRR, 16.9%, was less than the base case after-tax discount rate, 20%. The projected ten-year NPV was negative, -$49,160, (Table 4)[2].

SENSITIVITY ANALYSIS

The sensitivity analysis of selected variables (Table 5) suggests that the projected IRR and NPV are more sensitive to relative changes in PL output and market prices than feed cost changes. For example, a 6% increase in the selling price of PL to $9.50/1,000 or a 5% increase in PL output would increase the projected IRR about 5 percentage points (Table 5), while a 10% decrease in feed costs would only result in a about a 2 percentage point increase in the IRR.

DISCUSSION

In this preliminary analysis, the negative NPV for the base case output of 75 million PL for nine months does indicate that this operation would not generate a postive return on equity if potential investors only based their investment upon a required rate of return of 20% or more after income taxes. The sensitivity analysis results suggest that increasing PL output by 5% relative to the base case would result in an IRR exceeding 20% (Table 5). In addition, the profitability of a SC based hatchery might be improved by expanding total annual PL output by increasing operating months and/or capacity. The financial feasibility of operating a larger facility needs to be investigated. For example, Johns et al. (1981) has shown that the ten-year NPV projected for Texas hatcheries should increase with scale and/or operating months.

Even if monthly output of a SC hatchery was expanded, the future demand for PL by SC growers will be critical to those considering the financial feasibility of funding and operating a commercial hatchery in SC. A recent study predicted that SC PL demand could reach 75 million PL/year by 1997 (Rhodes, 1992). This prediction is partially based upon expansion plans for a 160-acres shrimp farm on Edisto Island. It is not currently

[2] The before tax IRR for the base case is 24%, and the before tax NPV increases to $78,000 at a 20% discount rate. Most analyst would make the before tax discount rate higher than the after tax discount rate.

(1992) clear if other new shrimp farming sites will be developing in SC and/or if existing commercial farms will expand their acreage and/or stocking densities. Given this uncertainty in SC, it would be prudent for those evaluating the feasibility of establishing a hatchery in SC to also evaluate existing and potential markets for SC produced PL in other states and countries. Moreover, aggregate PL demand by US shrimp farms may not continue to increase in the future if current and perhaps future environmental regulations (House, 1992) constrain the expansion plans of companies wanting to grow-out marine shrimp in the US.

In contrast to the future demand uncertainty, a commercial hatchery located in South Carolina may have several marketing advantages compared to hatcheries in other states or countries. SC shrimp farmers may prefer SC produced PL because of lower shipping stress and perhaps higher survival rates when the PL are initially stocked compared to PL from out-of-state suppliers. Other

Table 5. Sensitivity analysis of the projected 10-year internal rate of return (IRR) and net present value (NPV at a 20% discount rate) to changes in feed costs, postlarvae (PL) output, and PL market prices for a hypothetical marine shrimp hatchery in South Carolina.

	After Estimated Income Taxes	
Variable	**NPV (in $1,000)**	**IRR**
Feed Cost:[1]		
Increased 10%	-$75	15.2%
Base Case	-$49	16.9%
Decreased 10%	-$23	18.6%
Decreased 20%	+$ 2	20.1%
Decreased 30%	+$28	21.7%
PL Output (Millions):		
82.5 X 10^6 (10%)	+$86	24.9%
78.8 X 10^6 (5%)	+$24	21.5%
75.0 X 10^6 (Base Case)	-$49	16.9%
71.3 X 10^6 (-5%)	-$105	13.0%
67.5 X 10^6 (-10%)	-$163	8.4%
PL Price/1,000:		
$ 8.00	-$244	0.8%
$ 8.50	-$147	10.0%
$ 9.00 (Base Case)	-$ 49	16.9%
$ 9.50	+$ 49	22.9%
$10.00	+$146	28.2%

[1] Percent change relative to the base case of "Feed" expenses.

possible advantages for a SC hatchery include: 1) in-state technical support from the WMC (see Rhodes, 1992), 2) the possibility of developing a specialty market for *P. setiferus* PL, an indigenous species, purchased by SC live bait farmers, and 3) out-of-state PL suppliers may be more vulnerable to additional SC regulatory actions in the future.

In addition, current efforts to develop a profitable nursery "headstart" system for use by SC growers might also lead to expansion of the in-state market "window" for PL while improving the profitability of grow-out operations. Moreover, the financial and market effects of integrating a hatchery with a nursery and/or grow-out operation needs to be analyzed for SC.

Profitability of SC marine shrimp grow-out operations is strongly influenced by survival rates (Rhodes, et al. 1987). Stokes et al. (1991) has reported a high degree of variability in grow-out performance (e.g. survival rates, harvest size, etc.) between different commercial hatcheries as well as between years for individual hatcheries. Research at the WMC and other laboratories is currently underway to develop high health, and genetically improved shrimp for the US private hatcheries (House, 1992). The transfer of these research driven improvements[3] in shrimp PL to US hatcheries might provide a marketing advantage for commercial hatcheries selling to US and foreign shrimp growers. Moreover, the marketing of high health PL for SC growers by SC hatchery may also improve the overall productivity of the SC shrimp farming industry.

ACKNOWLEDGEMENTS

We would like to thank Mr. David Whitaker and Mr. Steve Hopkins, for their review and comments on this report. Ms. Z. Florence Pender provided word processing support and Ms. Karen Swanson prepared the manuscript for publication.

Funding for this research was provided by the U.S. Department of Agriculture CSRS through a grant to the U.S. Marine Shrimp Farm Program.

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A total of 200 copies of this document was printed at a total cost of $126.96. The unit cost was $.634 per copy.