Virginia Journal of Science
Volume 57 Number 3
Fall 2006

A Decade of Changes for Virginia Freshwater Aquaculture (1993 – 2003)

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ABSTRACT

Aquaculture surveys were designed and initiated along with the writing of the State Aquaculture Plan during 1993 to 1995. The first Virginia Aquaculture Survey, conducted for the production year 1993, established the status of both freshwater and marine commercial industries. Subsequent surveys were conducted to trace industry developments relevant to production aspects and economic impacts. Survey data from Virginia Agricultural Statistics Service Reports for 1993, 1995, 1997, and 2003 summarize a decade of Virginia freshwater aquaculture information. Significant changes in sales among the principal aquaculture species occurred over the 10-year period. The 1993 freshwater aquaculture value of $2.8 million increased to $6.0 million in 2003; however, the increase was due to $4.2 million in tilapia sales. Thus, the balance of $1.8 million is actually a decrease by $1 million for 2003 sales when compared to 1993. Losses in trout sales account for the $1 million decrease in 2003. Catfish and hybrid striped bass production and sales remained low and declined during the 10-year period.

INTRODUCTION

Prior to the mid-1980s, Virginia freshwater aquaculture production was limited primarily to rainbow trout (*Oncorhynchus mykiss*). During that era, freshwater trout sales for live stocking in private streams and commercial markets are estimated to have been less than $2 million annually. Beginning in the late-1980s, a period of growth and development with warm water aquaculture began as a result of research and extension program emphasis at Virginia State University (VSU) and Virginia Polytechnic Institute and State University (VPI) universities. State funding for aquaculture activities in the Commonwealth commenced with the "Aquaculture Initiative" in 1987. Hybrid striped bass (*Morone saxatilis* x *M. chrysops*) and channel catfish (*Ictalurus punctatus*) were the primary species studied for commercial production in farm pond and cage culture operations. Aquaculture research was conducted concurrently at Virginia's land grant universities, cooperatively with other institutions and government agencies.

The Virginia Department of Agriculture and Consumer Services (VDACS) developed an Aquaculture Plan for the Commonwealth of Virginia beginning in 1993 (Newton 1995). As a result of activities associated with the State Plan, the first Virginia Aquaculture Survey was conducted for the production year 1993. Goals of this comprehensive state survey were to determine the status and to establish a production benchmark for both freshwater and marine aquaculture industries. Subsequent surveys were conducted to follow aquaculture growth and related developments effecting industry value and agricultural impacts.

Three additional surveys have been conducted since 1993 that have updated Virginia freshwater and marine aquaculture production and sales. Virginia aquaculture production was included in a national census of aquaculture by the U. S. Department

of Agriculture, National Agricultural Statistics Service (NASS 2000). Virginia ranked number ten in the 1998 Census Report with nearly $25 million in sales primarily because soft-shell crabs (*Callinectes sapidus*) were considered to be an aquaculture product. If soft-shell crabs were not considered to be aquaculture products, Virginia would not be listed as a top aquaculture producing state.

METHODS

Formats of subsequent survey instruments were similar to the original instrument developed at the time of the State Aquaculture Plan by Jim Lawson, Deputy State Statistician, Virginia Agricultural Statistics Service (VASS) and the author. Surveys were conducted by VASS using mailings, telephone calls, and farm site visits to contact producers. All data provided by industry are protected by confidentiality regulations established by the U. S. Department of Agriculture and the National Agricultural Statistics Service (USDA regulations, Title 7, Chapter 55, Section 2276). Virginia Aquaculture Survey Reports for 1993, 1995, 1997, and 2003 are available from the Virginia Agricultural Statistics Service (K. Barnes, State Statistician, VASS, Richmond, Virginia, personal communication). Because of the small number of producers for various secondary species, VASS designated an "All Other Species" category that included tilapia sales with bait fish, ornamental fish, game fish, grass carp (*Ctenopharyngodon idella*), crayfish (*Procambarus* spp.) and other aquatic products. The Virginia Department of Game and Inland Fisheries application for tilapia importation lists four species and their hybrids allowed in the state. Unfortunately, applicants often just list *Tilapia spp.* or hybrid tilapia if they do not know what they are importing (Mr. Ron Southwick, Assistant Chief of Fisheries (for Aquaculture), Virginia Department of Game and Inland Fisheries, Richmond, Virginia). Information from Survey Reports was used to make comparisons, observations, and interpretations as they related to changes that occurred in Virginia aquaculture over a 10-year period. Because pounds were the unit of measure for food fish sales in the Reports, as well as the system used by industry, this article has maintained the same system to facilitate industry accessibility.

RESULTS AND DISCUSSION

The Virginia Agricultural Statistics Service has tracked the Virginia aquaculture industry by conducting producer surveys since 1993. Each Survey Report has provided information on both marine and freshwater industry sales. A review of freshwater aquaculture sales from 1993 to 2003 reveals the greatest increase in sales occurred soon after passage of the 1992 Virginia Aquaculture Development Act (Table 1). The Aquaculture Development Act also established a Governor appointed Aquaculture Advisory Board. The Virginia Aquaculture Plan was developed beginning in 1993 and published in 1995 by the Virginia Department of Agriculture and Consumer Services. Also, several industry producer associations were formed during the early 1990s. These activities had a positive impact upon aquaculture awareness and encouraged significant expansion of aquaculture during the mid-1990s (Newton 1995).

Production and sales comparisons for cultured species indicated that the principal freshwater species are channel catfish, hybrid striped bass, rainbow trout, and tilapia. Production and sales information for "all other species," which also included tilapia in the 1995, 1997, and 2003 Surveys were grouped by VASS due to USDA privacy

concerns and disclosure regulations. These concerns (USDA Title 7, Chapter 55, Section 2276) required tilapia sales to be combined with the "all other aquaculture species group," which includes ornamental, game fish, baitfish and other aquatic sales.

A statewide Aquaculture Initiative in research and extension started in 1987 through designated funding by the Virginia General Assembly. The Initiative began with funds for VSU, VPI, and Virginia Institute of Marine Science (VIMS) to provide research and extension support for aquaculture industry development in the Commonwealth. Hybrid striped bass was designated the "species of interest" for aquaculture production in the Commonwealth. Support for hybrid striped bass was primarily due to a low and declining population of native striped bass in the Chesapeake Bay. At about the same time, there was increasing popularity with hybrid striped bass for both recreational fishing and farm-raised food fish production. Striped bass domestication and hybridization research also was underway in other southern states during this time (Newton and Nerrie 1989). Survey data indicate that hybrid striped bass gross sales averaged $ 30,844 for the 4 years in which surveys were conducted (Table 1). The percentage of total freshwater sales for bass has remained very low and declined from 1.3% in 1993 to 0.5% in 2003.

Based upon the 1993 through 2003 surveys, catfish production averaged 19,000 pounds annually, with $30,797 average gross sales (Table 1). Overall, the catfish percentage of total freshwater sales has remained very low and declined from 1.2% in 1993 to 0.4% in 2003. In contrast to catfish farming in more southern states, Virginia aquaculture production has been limited to small operations in farm ponds or small cages floated in farm ponds. No large-scale catfish production facility has been developed in Virginia. Marketing has consistently been blamed for lack of growth among Virginia catfish operations, thus hesitancy remains toward new investments beyond small-scale operations.

Trout production declined from just over one million pounds annually during 1993 to 1997 to approximately 670,000 pounds for the 2003 report year (Table 2). Causes for production declines during this 6-year period are believed to be due to: 1) a series of drought years, 2) an increase in restrictive regulations, and 3) facilities going out of business. Gross sales of trout declined from a steady $2.3 million during the 1990s to $1.3 million for the year 2003, with the decline in sales directly related to production decreases.

Tilapia production soared during the 10-year period, to become the number one freshwater aquaculture species produced and sold in the Commonwealth of Virginia. Reported sales of tilapia began with the figure of $27,000 in 1993. Based upon study of the Survey Reports and the author's experience with Virginia aquaculture, it is estimated that the "all other aquaculture species group" sales have averaged about $500,000 for the years 1995, 1997, and 2003. Thus, by subtracting this figure within each Report, tilapia sales have shown an almost 50% increase from $2.3 million in 1995 to $4.2 million in 2003 (Table 2). These estimates are somewhat similar to North Carolina reports, where tilapia sales were about $3 million in 2004 (T. Losordo, Aquaculture Extension Specialist, North Carolina State University, personal communication). The percentage decline in trout from 81% of freshwater sales in 1993 to 22% in 2003 was offset by an increase in tilapia sales by over 70% for the 2003 report year (Table 1). The decrease in reported trout sales by $1 million in 2003 is believed to be independent of increases in tilapia sales. Trout and tilapia sales were

TABLE 1. Gross freshwater aquaculture sales as reported by Virginia Agricultural Statistics Service Surveys (m = million). Tilapia sales for 1995 1997, and 2003 based on an estimate of $500,000 in sales, each year, for "Tilapia & all others" which includes ornamental and baitfish.

Survey Year	Gross Sales in Dollars						Percentage of Total Gross Sales				
	Total Sales	Hybrid Striped Bass	Channel Catfish	Trout	Tilapia	Tilapia & Others	Hybrid Striped Bass	Channel Catfish	Trout	Tilapia[1]	
1993	$2.8m	$35,846	$23,896	$2.3m	$27,150	$432,310	1.3	1.2	80.8	0.8	
1995	$5.2m	$41,986	$33,035	$2.3m	$2.3m	$2.8m	0.8	0.6	44.0	44.0	
1997	$5.3m	$16,782	$36,173	$2.3m	$2.5m	$3.0m	0.3	0.7	43.4	47.1	
2003	$6.0m	$28,791	$21,087	$1.3m	$4.2m	$4.7m	0.5	0.4	21.6	69.9	

[1]Estimated.

about the same in 1995 and 1997, however, reported tilapia sales were more than three times higher than trout sales in 2003 (Table 1).

There was no general pattern related to the levels of intended production increases documented in each survey (Table 2). For instance, hybrid striped bass production has not developed by the large percentages indicated, especially the 592% increase projected for the future in 1997. In contrast, tilapia production has increased far beyond the 1% projection indicated in the 2003 survey Report.

Industry Production Losses:

The four major causes of freshwater industry losses were weather, water quality, disease, and predation (Table 3). These factors are inter-related, because each of these losses may be affected or influenced by the other causes. For example, poor water quality can increase the severity of certain diseases. Also, there is no control over weather losses; either floods or drought can cause major fish losses, especially for trout producers. On average, predation accounts for approximately one-fifth of all freshwater losses. This is a category where control measures are usually costly relative to benefits gained.

In many cases, fish losses result from protected predatory species; this is particularly the case with herons, cormorants, waterfowl, and other migratory birds. Supplemental information regarding industry concerns was received on surveys during the expansion era of the 1990s. Anonymous comments were received from 25 percent of the producers surveyed in 1993, 1995, and 1997. Comments were reviewed and provided to the Aquaculture Advisory Board, industry producer associations, and government agencies to further assist with aquaculture growth and development in the Commonwealth (Newton and Lawson 1998).

Primary Aquaculture Species:

Hybrid Striped Bass

The largest sales year reported for hybrid striped bass was $42,000 in 1995. Percentage of total freshwater sales has ranged from 1.3% in 1993 to 0.3% in 1997. Production and sales figures (Table 2) reveal that hybrid striped bass culture has not developed as expected in Virginia. In contrast to Virginia industry sales, the North Carolina hybrid striped bass industry value was $7 million in 2004 (T. Losordo, Aquaculture Extension Specialist, North Carolina State University, personal communication). The primary difference between Virginia and North Carolina hybrid bass production is related to the water source. The Castle-Haynes aquifer used to produce North Carolina hybrid striped bass is an excellent ground water source that has high mineral content and low salinity. In contrast, hybrid bass production in Virginia is compromised in low alkalinity, soft-water farm ponds.

Channel Catfish

Reported catfish production was consistently low over the ten-year survey period. Percentage of total freshwater sales for catfish declined from a low level of 1.2% in 1993 to 0.4% in 2003. Even if production intentions of a 38% increase for 2004 are met, total gross sales will be raised by only $8,000. Total dollar value increase projected for hybrid striped bass and catfish combined is approximately $15,000 for the 2004 production year. This would raise the industry value for these two warm water aquaculture species to approximately $65,000. In stark contrast, the combined 2004 value reported by North Carolina for catfish and bass was $32 million (T. Losordo, Aquaculture Extension Specialist, North Carolina State University, personal

TABLE 2. Production and intended increases in production of freshwater aquaculture species as reported in Virginia Agricultural Statistics Service surveys (m = million). Hybrid striped bass production was not reported in 2003.

	Pounds Produced			Percentage Intended Production Increases			
Survey Year	Hybrid Striped Bass	Channel Catfish	Trout	Hybrid Striped Bass	Channel Catfish	Trout	Tilapia[1]
1993	13,137	22,270	1.2m	241	223	7	10
1995	11,750	16,695	1.2m	245	9	6	59
1997	5,128	19,503	1.1m	592	17	1	115
2003	----	17,721	670,000	24	38	12	1

1 Estimated

communication). The Virginia aquaculture industry would be well served by exploring the reasons behind this huge difference in industry values between adjoining states.

Rainbow Trout

Rainbow trout culture is the oldest established freshwater aquaculture industry in Virginia and the United States. Rainbow trout is the principal cultured species; however, brook trout (*Salvelinus fontinalis*), the only trout native to Virginia, brown (*Salmo trutta*), and golden rainbow trout (*O. mykiss aquabonita*) (Nelson, *et al.* 2004) are also produced in Virginia. From the late 1980s into the mid-1990s, gross sales of freshwater trout were steady at about $2.3 million annually (Table 1). A decline in production and sales occurred during 1997 to 2003. Annual sales reported for 2003 was down one million dollars from previous report years. The percentage decrease in trout sales has been offset by an increase in tilapia sales. Although trout sales have decreased to $1.3 million, the industry contribution is still large when compared with the combined sales of hybrid bass and catfish at $50,000.

Tilapia

Tilapia and rainbow trout have traded places with regard to percentage and volume of freshwater sales in Virginia. Tilapia sales increased by $4 million from 1993 to 2003, while trout sales decreased by $1 million dollars from 1993 to 2003. In North Carolina, where tilapia may be reared in ponds as well as indoor facilities, sales were about $3 million in 2004. As stated earlier, most Virginia tilapia production is by only a few large producers. At this writing, tilapia is the number one freshwater aquaculture species produced and sold in the Commonwealth of Virginia. Nationally, tilapia imports were 249 million pounds in 2004, up 25% over 2003 and 68% higher than 2002. The amount of foreign produced tilapia required to supply the U. S. market was about 500 million pounds of live fish in 2004 (Harvey 2005).

All Other SpeciesSales of baitfish, ornamentals, game fish, and others in this category have remained stable over the 10-year report period with an estimated value

TABLE 3: Percentage of freshwater aquaculture losses by cause.

Cause of Fish Loss	1993	1995	1997	2003
Weather	15	10	48	12
Water quality	20	12	4	9
Predation	15	18	18	26
Disease	17	25	24	35
Theft	8	--	--	1
All Others	25	35	6	17

of one-half million dollars annually. While most of these sales were from baitfish, an increase is expected in ornamental and game fish sales in the future.

CONCLUSIONS

Aquaculture surveys conducted from 1993 to 2003 reflect numerous changes in Virginia aquaculture. Currently, the principal freshwater aquaculture species, ranked according to sales value, are tilapia, rainbow trout, hybrid striped bass, and channel catfish. It is doubtful that unreported information would significantly change the remarkable trends revealed by comparison of these four surveys conducted over a decade. Rather, this series of surveys has set baselines and revealed industry trends. It is apparent that small-scale farm pond and cage operations with channel catfish and hybrid striped bass have yet to develop in Virginia. Rainbow trout sales have declined over 60% due to environmental and regulatory impacts. Tilapia dominates as the number one freshwater cultured species and remains in a growth phase for Virginia aquaculture. Therefore, more consideration of the reasons for the observed industry changes and of the present nature of the "small-scale approach" to aquaculture could enhance developments and help lead to successful establishment of aquaculture in the Commonwealth.

ACKNOWLEDGMENTS

Appreciation is expressed to Kevin Barnes, State Statistician, and to Jason Jones and Kevin Harding, Statisticians of the Virginia Agricultural Statistics Service for technical assistance and review of this manuscript. Jim Lawson, former Deputy State Statistician, led in the development of Virginia aquaculture industry surveys. Robins Buck, Project Manager, Agribusiness Development Services VDACS, provided support for each survey. Bryan Plemmons and Dr. Bonnie Brown were instrumental in the development of the Virginia Aquaculture Plan and have served in numerous leadership roles for the Virginia aquaculture industry.

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