



THE TEXAS AQUACULTURE INDUSTRY - 2017
(62 pages)
Compiled By
Granvil D. Treece

TREECE & ASSOCIATES
TREECE & ASSOCIATES

WORLD AQUACULTURE CONSULTANTS

927 P. R. 1236
Lampasas, TX 76550
(979) 774-7778 gdtreece@hotmail.com

The 2016 Texas aquaculture production for the 5-top species in the state is estimated to be 30 million pounds, worth approximately US \$60 million, generating an estimated \$360 million/yr economic impact on state's economy when jobs, feed, and other economic benefits are included. A factor of 6X is used for the impact.

Five top aquaculture crops in Texas in 2016

Species / # farms / Acres / Production in lbs./ Estimate Value

Catfish /39-42 /2,450-2,475 ac. / 22 million lbs./ \$ 26.95 million

Marine Shrimp / 10 farms / 990 ac. / 2,957,438 lbs. / \$8,280,826 (from Dr. Ya-Sheng Juan, TPWD, Jan. 2017)

Hybrid Striped Bass / 11 farms / 1,900 ac. / 2,652,000 lbs / \$9,017,000 (From Dr. Todd Sink, TAMU, 2016)

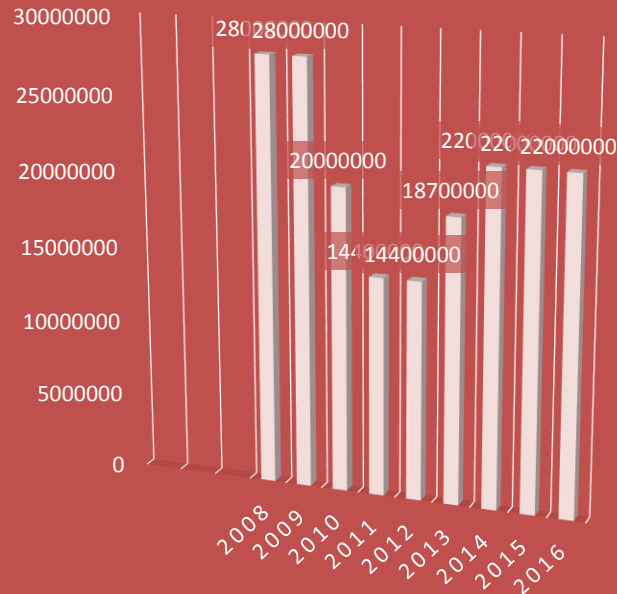
Red Drum / 5 farms / 1,100 ac. / 2.0 to 2.3 million lbs. / \$6.9-7.3 million (Pounds and value from Dr. Todd Sink, TAMU, 2016 and acres from Jim Ekstrom 2016)

Water Gardens / Operators ? / Production ?/ estimated retail sales \$7,000,000+

Production Details

According to Dr. Todd Sink at TAMU (2016) we had 11 Hybrid striped bass producers – 6 traditional pond culture and 5 tank producers (mainly aquaponics). Pond producers raised 2.64 million lbs, tank producers raised 12,800 lbs for a total of 2.652 million lbs. The fish are selling between \$3.25 and 3.50 per lb. Todd Sink adds (2016) that red drum producers are contending with the fact that there are more redfish along to Texas and Louisiana coast than there have been at any other time in recorded history, commercial harvest quotas for wild fish are increasing, and angler bag limits and angler success have been increasing, so there is less demand for redfish. HSB production has been rising while red drum production has been static or even declining slightly. I would estimate the redfish production at around 2 to 2.3 million pounds and a value of \$6.9 to \$7.3 million. According to Jim Ekstrom (personal communication 2016) there are 1,100 acres of red drum ponds in operation in Texas in 2016.

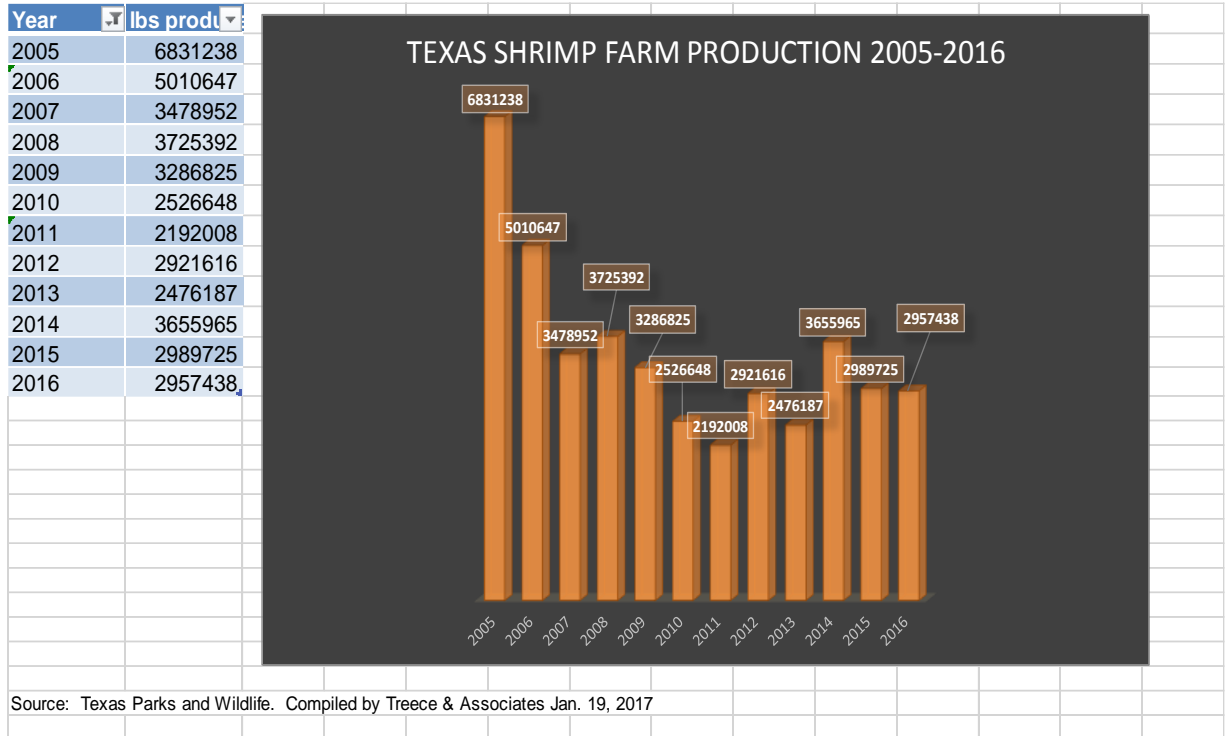
TEXAS CATFISH FARM PRODUCTION IN MILLIONS OF LBS. OVER 9 YEARS



According to Todd Sink if we include the catfish sport fish stockers and fee fishing operations, there are between 45 to 55 catfish producers. The fish stockers and fee fish operations are smaller and generally range in size from 3 acres to 10 acres. In 2014 Todd Sink and Peter Woods reported 39-42 producers on 2,450-2,475 ac. producing 22 million lbs. worth an estimated \$ 26.95 million and the estimation for 2015 and 2016 is about the same. Sink said on Jan. 30, 2017, "If anything production for catfish was 2-3% higher in 2016 than in 2015 as there was longer growing season due to mild 2014-2015 winter, few disease issues, plenty of water, and less severe Summer temperatures than in 2015. I have not heard of any real significant removal of acreage, although some did change hands." So for now, we will leave the estimate the same for 2016 as it was for 2015, at least until it can be updated with solid information. Peter Woods, Fisheries Specialist in Bay City stated on Jan. 31, 2017, "Catfish acres – 1,880 (down here, meaning middle coast of Texas – I don't really know what is going up north). Pounds produced in 2016 – roughly 18 million pounds (9,500 lb/acre/yr) Estimated value – \$20 million (\$1.14/lb)."

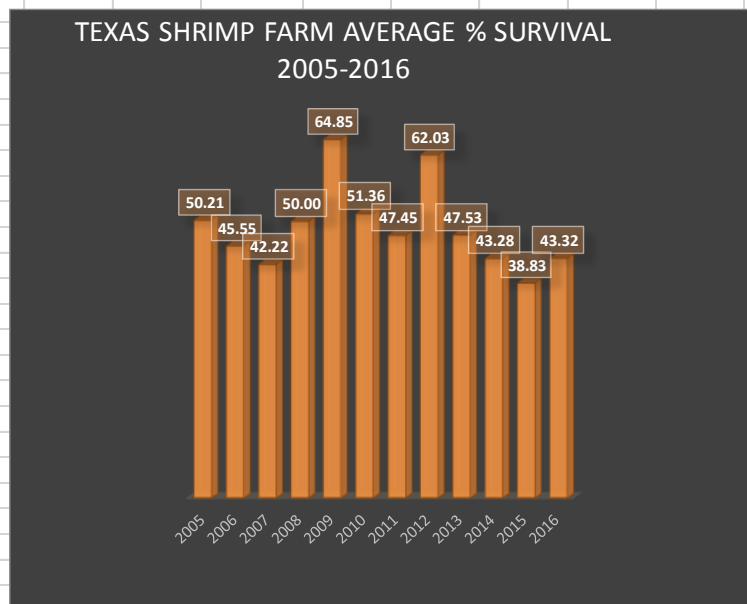
Pacific White Shrimp (*Litopenaeus vannamei*) culture in Texas peaked in 2003 when it set a state production record at 4,081 metric tons (9 million pounds worth \$18 million farm-gate). The industry production declined until 2011 and seems to have stabilized now each year at around 2.5 to 2.9 million pounds.

There were 2.9 million pounds produced on 10 Texas farms and 990 acres in 2016, worth approximately \$8.3 million.



Over the last 24 years, the Texas marine shrimp aquaculture industry has produced 104,018,335 lbs of shrimp with a farm-gate value of approximately \$272,728,634 contributing an estimated 6-fold amount or \$1,636,371,804 to the state's economy. The 2015 farm gate price was again \$2.80/lb, and Texas Parks and Wildlife estimated is the same for 2016 (\$2.80/lb at the farm). The state survival average was low at 47% in 2013 and even lower at 43% in 2014 and even lower again in 2015 at 38.83%. The average Texas shrimp survival in 2016 was 43%. This survival did not reflect what happened on most farms. Bowers, the largest farm, stocks advanced PLs from an indoor biofloc nursery twice a year on his 350 acre farm and expects smaller shrimp, but his survival was highest in the state at 54%. The reasoning seems to be working better than on the other farms because their survivals ranged from 1.7% to a high of 32%. The majority of farms experienced chronic mortality in growout, especially if they kept the shrimp in the ponds the whole growing season. Average survivals for the farms over the last 12 years can be seen in the graph below.

Year	% Survival
2005	50.21
2006	45.55
2007	42.22
2008	50.00
2009	64.85
2010	51.36
2011	47.45
2012	62.03
2013	47.53
2014	43.28
2015	38.83
2016	43.32



Source: Texas Parks and Wildlife. Compiled by Treece & Associates, January 2017

Aquatic Plants

The Texas Aquaculture Industry also has a large aquatic plant or water garden industry, with very large ornamental fish sales. It was last estimated that retail water gardens generate 7 million dollars in sales annually in Texas, but this industry has probably grown some since that estimate several years ago. Bait fish, as well as stocker fish for recreational ponds are also big business in Texas.

Several tilapia farms in the state have historically produced about 500,000 pounds of fish annually. But the largest tilapia farm in the state, Simaron, was for sale in 2011-2013 and only produced about 100,000 lbs. The total tilapia production for the state from 2 producers was 150,000 lbs in 2011, worth \$277,500, according to Dr. Ya Sheng Juan of Texas Parks and Wildlife. Similar figures have continued into 2013 and 2014. Imports from China and Costa Rica are hard to compete with. KAAPA Aqua Farms got into tilapia and hydroponics in 2014 but their 2016 newsletter states that they had trouble getting the prices they wanted in the market for both. KAAPA closed and did not stock in 2016. Austwell Aqua Farms also produces tilapia as well, along with catfish and has been profitable for the last 12 years according to the owner.

A list of aquaculture facilities licensed for aquaculture by the Texas Dept. of Agriculture (TDA) can be found on the TDA web site. Contacts at TDA are: Thomas (Rick) Garza, Texas Department of Agriculture, Coordinator for the Commodity Programs, Phone (512) 936-2430. fax (888) 215-4883, email: Rick.garza@TexasAgriculture.gov. Kerry Cowlshaw. Regulatory Program Specialist. Phone (512) 463-7400. Email: Kerry.Cowlshaw@TexasAgriculture.gov. Joe Benavides. Regulatory Branch Chief Texas Department of Agriculture. Phone (512) 463-5706.

All Texas Aquaculture Production – 2016

Product / #Operators / Acres under water / Estimated Production (lbs) / Value (US\$)

Cattfish /39-42 /2,450-2,475 ac. / 22 million lbs./ \$ 26.95 million

Hybrid Striped Bass / 11 farms / 1,900 ac. / 2,652,000 lbs / \$9,017,000 (From Dr. Todd Sink, TAMU, 2016)

Marine Shrimp / 10/ 990 ac. / 2,957,438 lbs. / \$8,280,826 (from Dr. Ya-Sheng Juan, TPWD, Jan. 2017)

Red Drum / 5 / 1,100 total ac./ 2.0-2.3 million lbs. / \$6.9-7.3 million (Production from Dr. Todd Sink, TAMU, 2016 and acres from Jim Ekstrom 2016)

Water Gardens / Operators ? / Production ?/ retail sales \$7,000,000+

Aquatic Nurseries / 5 / Ac. ? / \$ Value ?

(*)Sportfish (not red drum) / 44 farms / 576 ac. /13,275,000 fish sold/ \$4,182,000

(Sportfish information from USDA)

(*) Trout /3 farms/ ? acres/value? (per USDA)

Crawfish / 20 / 1,500 ac. / 800,000 lbs. / \$1,000,000 (also included under Crustaceans and information from USDA)

Tilapia (food fish) / 3 operators / 150,000 lbs. / \$277,500 (estimated using data from TPWD)

Tilapia (recreational stocking) /13 operators / Ac. ?/ lbs. ? / \$ Value ?

(*)Ornamentals / 27 operators / 40 ac. / lbs. ? / \$892,000 (USDA)

(*)Baitfish / 25 operators / 20 ac. / 81,000lbs. / \$398,000 (USDA)

Alligators / 12 operators / ac. ? / lbs. ? / \$100,000 (USDA)

(*) Other food fish 20 farms/6,916,000 lbs/ \$14,692,000 (USDA)

(*)Other aquaculture products/16 farms/ only 5 farms responded to USDA survey

(*)- Indicates that information was derived from USDA aquaculture survey conducted nationwide and those numbers are historically over-estimated.

2016 Texas aquaculture production: Estimated totals from approximately 180 operations on TDA aquaculture licenses list / estimated 30 million pounds,/ worth US \$60 million from the 5 top production species. Estimated \$360 million/yr total economic impact on state's economy when jobs, feed, and other economic benefits are included

Catfish Production in Texas 2008-2016

45 producers in 2008, 3,500 acres, 28 million pounds, worth \$22.4 million.

45 producers in 2009, 3,500 acres, 28 million pounds, worth \$22.4 million.

40 producers in 2010, 3,000 acres, 20 million pounds, worth \$16 million.

30 producers in 2011, 2,160 acres, 14.4 million pounds, worth \$14.4 million

30 producers in 2012, about same as 2011.

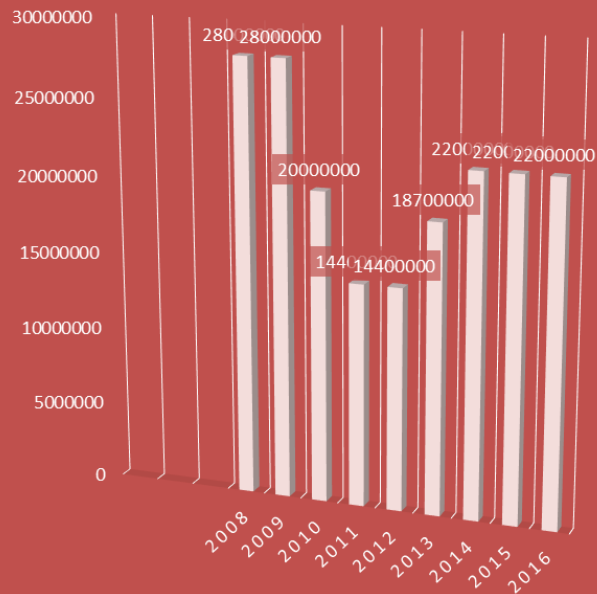
26 producers in 2013, 2,200 acres, 18.7 million pounds, worth \$19.6 million

39-42 producers, in 2014, 2,450-2,475 acres, 22,040,000 lbs.-22,185,000 lbs., worth \$26.95 million.

About same estimated for 2015.

About 40 producers in 2016, 1,800 acres along central coast of Texas with 18 million pounds produced worth \$20 million (\$1.14/lb.). 9,500 lb./ac./yr. North Texas production needs to be added to this, so 2016 production is similar to 2015, maybe even slightly higher.

TEXAS CATFISH FARM PRODUCTION IN MILLIONS OF LBS. OVER 9 YEARS



Google Earth Photo of a Catfish farm west of Danevang.



Catfish, southwest of Palacios off Well Point Road



Charlie Chan's Austwell Aqua Farm, (catfish and tilapia in greenhouses) near Austwell and Aransas Wildlife Refuge. Farm for Sale. Charlie would like to retire.





Feed manufacturing and sales is big business in Texas. Rangen Feeds has an aquaculture feed plant in Angleton, Texas, but there are other companies outside Texas that sell to the market, such as Zeigler Feeds of PA. and Cargill/Nutrina with plant in Giddings, Texas and Franklinton, Louisiana.



Aquaculture Feed Companies That Serve Texas

1. ARKAT Nutrition. Arkansas. Reed Breedlove. Tel. (870) 355-2220.
Email: reed@arkat.com.
2. Cargill/Animal Nutrition.
David Hines Senior Consultant Cargill Animal Nutrition. Tel. Office (979) 345-4853. Fax (985) 839-3404 Cell (713) 899-9979. Plant (985) 839-3400. Toll free (800) 928-2782 E-mail: david_hines@cargill.com.
3. Melick Aquafeed, llc.
880 82W, Greenville Mississippi, 38701
Roy Reich. Toll Free 800-358-6595, Tel. 662-390-9984. Cell 570-854-5304.
4. Rangen Feeds. Angleton, Texas.
Randel Ethredge. Cell (210) 241-8026. Email: [<reringen@sbcglobal.net>](mailto:reringen@sbcglobal.net).
5. Zeigler Feeds. Gardeners, PA.
Cheryl Shew, Global Shrimp Sales Specialist
Zeigler Bros. Inc.
Tel: 717-677-6181 ext. 325. 717-677-3004 direct line
Cell 717-968-6912. Fax: 717-677-6826
Email: cshew@zeiglerfeed.com.

There were 44,000 tons or 88,000,000 million pounds of aquaculture feed sold in Texas in 2007, according to an estimation from production and using an average of 2:1 FCR, and also from feed sales requested by TDA of each of the major aquaculture feed mills supplying Texas aquaculture. The Texas Dept. of Agriculture (Jason Fenton, Federal Liaison Officer for TDA) gathered this information for the USDA trade adjustment assistance program. It was learned that FCRs vary highly among species. For example: average catfish FCR is 2.4 to 2.9; tilapia 2:1; red drum 2:1; hybrid striped bass 2.6 and higher; shrimp 1.8. USDA, FSA TAAF, re-authorized in 2010.

<http://www.apfo.usda.gov/FSA/webapp?area=home&subject=prsu&topic=mpp-ta>
The benefit for trade adjustment was \$12,000 to each qualifying farmer (\$24,000 farmer and wife). The farmers had to show receipts for a minimum 25% increase in feed at local Farm Service Agency office and fill out application. They then did some local training hours or could do the lessons on the Internet. University of MN. organized the whole program for USDA FSA and paid consultants to do the training in the field and sent consultants to Maine for workshop to learn their Business Management procedures. As one of their business management consultants, the present author assisted 60 catfish and shrimp farms around the country complete business plans to qualify for full benefits. I enjoyed visiting all the farms again and working directly with the farmers. At the same time USDA

FSA gave benefits to qualifying shrimp farmers, they also had a shrimp harvest industry program, as well as separate programs for lobster farmers and blueberry farmers, all of which were considered to have been impacted by unfair trade practices or high prices.

Most of the catfish fingerlings in Texas come from out of state.



The average catfish is harvested after 14 to 18 months and ranges between 1.5 lbs and 3 lbs each (photo from M. Masser).



Filleting Channel catfish and fillets on ice. (Photos from M. Masser and the Catfish Institute web site)

Catfish nuggets (\$1.69/lb), catfish fillets (\$3.69/lb) and catfish belly strips (\$2.99/lb) are offered at a Seafood Market in Corpus Christi. Also on the same counter is Basa catfish fillets, imported from Viet Nam for \$4.99/lb.



Catfish fillets can be packaged for retail sales and frozen (Catfish Institute).



The big challenges in the catfish industry are:

- Commodity market and competing with imports
- Fungus that occurs in the hatchery
- “Hamburger gill” which is a disease in growout
- Ammonia toxicity in fish transport
- Keeping O2 at saturation level in the hatchery
- Toxic algae (Golden Algae, Dinoflagulates, Blue Green Algae)
- Off-flavor
- High cost of feed
- High cost of power
- Threat of increasing water costs and availability
- Marketing- whether to sell fresh or add value and sell for higher price
- Packaging- offer something different to attract customers

Catfish Off-Flavor

Chilling the harvested animal may suppress the volatility of the compounds so that it is less detectable, but it does not get rid of the compounds. When the animal is warmed up or cooked, it will evolve again. The only solution is to get rid of the algae (if that is the source of the compounds) or move the animals to water that doesn't contain the compounds. The latter usually isn't feasible, and the former is difficult. Water exchange may help, but not usually in ponds unless it's a massive and efficient exchange. Chemical applications to thin the algae bloom is what is usually used in the catfish industry (copper sulfate or Diuron). Southern Regional Aquaculture Center (SRAC) has bulletins on this. The catfish and hybrid striped bass growers taste the fish before harvesting. Further treatment may be necessary if the fish are not “On-Flavor”.

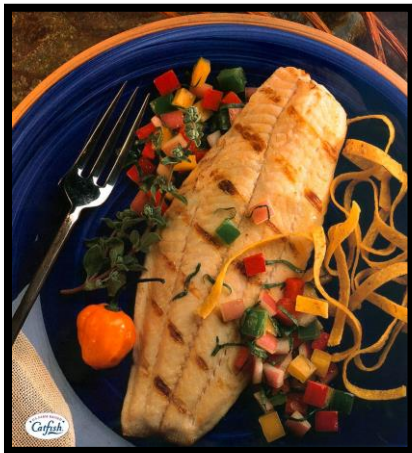
Catfish fry



Fish Processing Plant



Water monitoring system



Hybrid Striped Bass

Hybrid striped bass on ice (below)



The Hybrid Striped Bass growers in the US are listed below:

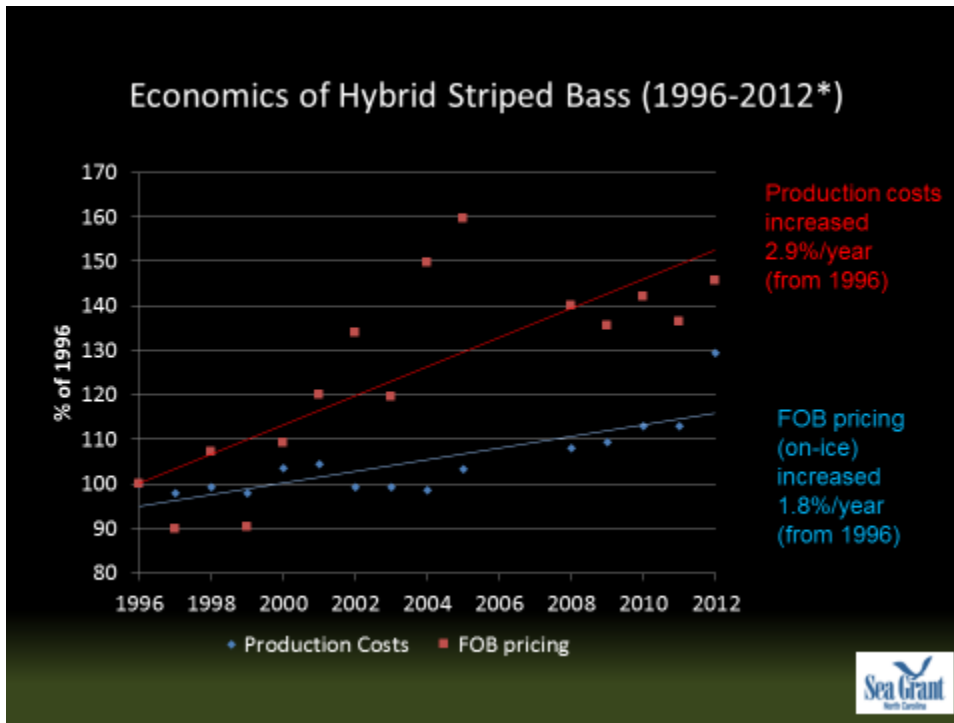
Pennsylvania	Susquehanna Aquaculture	Kaci Yeager
Delaware	Delmarva	Skip Bason
North Carolina	Artesian Aquafarms	Gary Sawyer
North Carolina	Austin Bros.	Scott Austin
North Carolina	Carolina Fisheries	Lee Brothers
North Carolina	Castle Hayne Fisheries	Nancy Sugg
North Carolina	White Rock	Ted Davis
North Carolina	Esau Farm	Ted Davis (2)
North Carolina	Island Fisheries	Ronnie Watson
North Carolina	Cypress Swamp	Jimbo Ireland

North Carolina	Vanguard Farms	Ron Groover
North Carolina	Roanoke Fish farms	Craig Perry
North Carolina	Pamlico Fish Farm	Scott Deal
North Carolina		Luther Wayne Toler
North Carolina	Aurora Fisheries	Marshall Daw
North Carolina	Pungo Farms	George Sugg
North Carolina	Westside fisheries	Billy Watson
North Carolina	Little River Farms	Robin Sanderson
North Carolina	Carolina Flounder	Keith Hairr
South Carolina	Southland Fisheries	David Burnside
Florida	Anguilla Fish Farm	Dugan Whiteside
Florida	12 Oaks Farm	Robert Moore
Mississippi	Nature's Catch Inc.	Jim Ekstrom
Arkansas	Keo Fish Farms	Mike Freeze
Texas	Ekstrom Enterprises	Jim Ekstrom
Texas	Kubecka Aquaculture	Mark Kubecka
Texas	St. Martin Seafood Partnership	Tanh Nguyen
Texas	Jr.'s Fish Farm	J.R. Nguyen
Texas	Holub Farms (has land leased from Bowers)	Chase Holub
Texas		Saha
Colorado	Colorado Catch	Tyler Faucette
Arizona		Tark Rush
Colorado	Agregy Renewables LLC	Benjamin Brant
Indiana	Advanced Aquacultural Technologies	Gary Miller

Because of labor, very little of the farmed fish is sold processed into fillets. Most fish are sold on ice, but some are sold live. In 2010 the average farm gate price live at farm was \$4.14/lb and the price on ice at the farm was \$3.14/lb. In 2015 the fish sold for \$3.25-3.50/lb in Texas at farm gate.

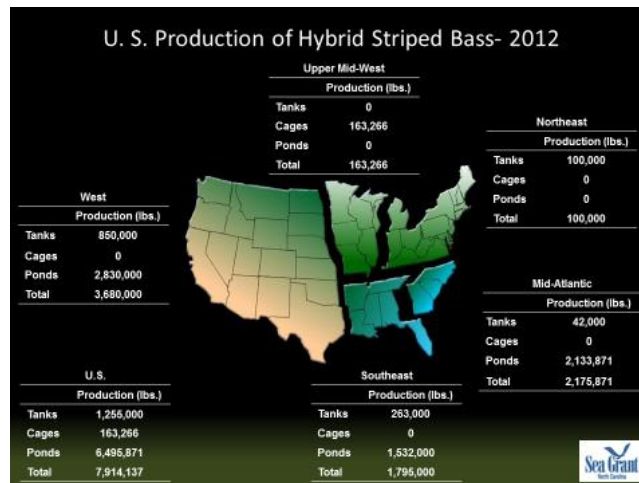
Generally, most open pond production facilities for hybrid striped bass produce in the range of 3,000 to 3,500 lbs per acre and it takes longer than a year to get the fish to grow to market size. Average US farm production cost and FOB farm prices are below:

<u>Year</u>	<u>Production cost</u>	<u>FOB Farm price/lb</u>
1996	1.95	\$2.78
1997	1.75	2.72
1998	2.09	2.76
1999	1.76	2.72
2000	2.13	2.88
2001	2.34	2.90
2002	2.61	2.76
2003	2.33	2.76
2004	2.92	2.74
2005	3.11	2.87
2008	2.73	3.00
2009	2.64	3.04
2010	2.77	3.14
2015	?	3.25-3.50
2016	?	3.50



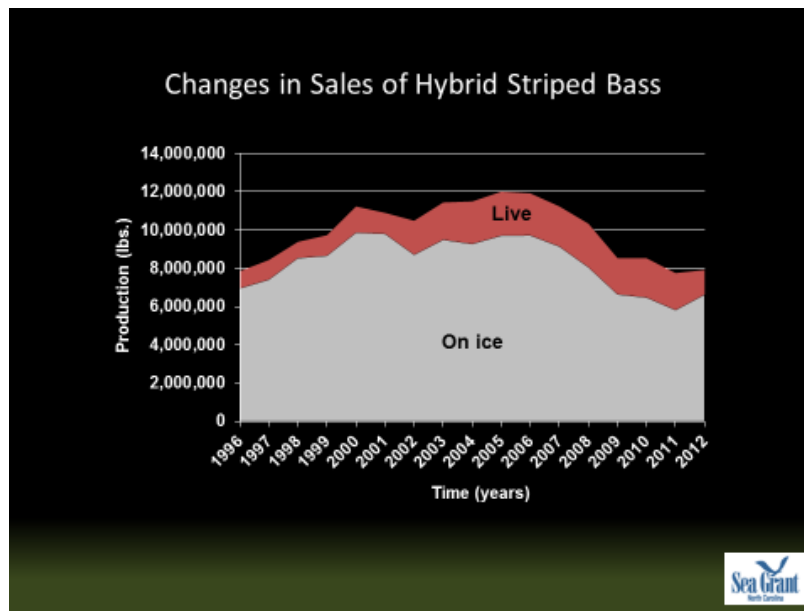
Source: Marc Turano, North Carolina Sea Grant

There were 7,914,137 lbs of Hybrid Striped Bass produced in the US in 2012. 3,680,000 lbs were produced in western states, of which 2,830,000 lbs were produced in ponds and most of that was produced in Texas. See figure below.

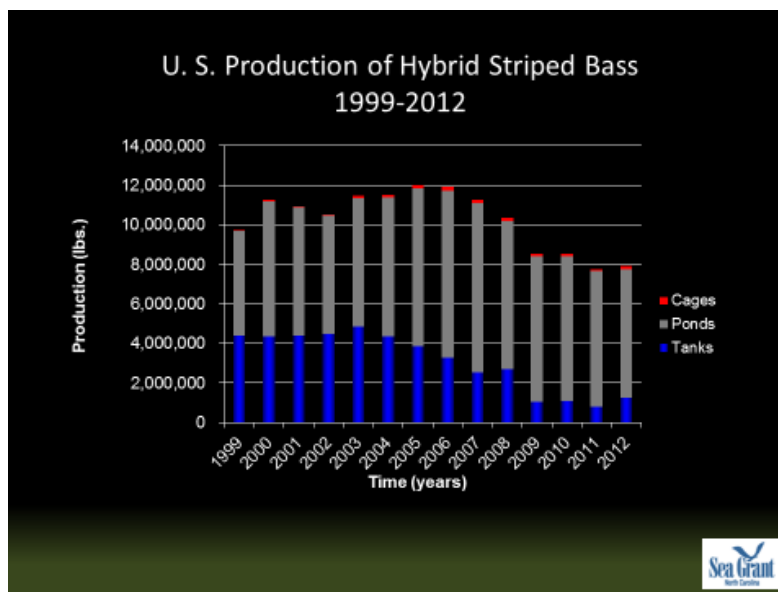


Source: Marc Turano, North Carolina Sea Grant

Changes in Sales (1996-2012) of HSB in US can be seen below.




Source: Marc Turano, NC Sea



Source: Marc Turano, North Carolina Sea Grant (above and below)

Percent Changes in Production Costs of Farmed Hybrid Striped Bass

Cost	Increase	Decrease
Electrical	6.7%	
Feed	16.9%	
Fingerlings Phase I	5.5%	
Fingerlings Phase II	7.3%	
Production Labor	8.5%	
Other labor	4.8%	
Packaging	7.5%	
Distribution	2.4%	
Maintenance	9.3%	
Supplies	7.3%	
Chemicals	6.7%	
Insurance	11.7%	




Source: Marc Turano, North Carolina Sea Grant

Summary

- Slight increase in production
- Future production projected to increase
- Prices increasing
 - Production costs increasing

Industry farm-gate value (no multiplier)

Category	Value
On-ice (farm)	\$23.8 million (+\$2.4 million)
Live (farm)	\$5.7 million (-\$2.2 million)
Fry	\$400K (-\$15K)
Fingerlings	\$2.4 million (-700K)
Total	\$32.3 million (-\$600K)

Harvest size hybrid striped bass (photo from M. Masser)



The 2012 production and price data for Texas was 2.9 million pounds produced by Ekstrom Enterprises and the live fish price at the farm was \$4.50/lb, but most were sold fresh on ice either at \$3.10/lb at farm or \$3.45/lb delivered. The other Hybrid Striped Bass farms in Texas produced 573,000 lbs and were sold fresh at the farm for \$2.60/lb.

2.9 million pounds sold @\$3.10/lb = \$8,990,000

573,000 pounds sold @ \$2.60/lb = \$1,489,800

Total estimated HSB production for Texas in 2012 is 3,473,000 lbs worth \$10,479,800 (per Marc Turano, NC Sea Grant, in HSB survey and report for HSB association).

In 2016, Todd Sink estimates 2.652 million pounds worth \$9,017,000.



Aerial of the first farm built by Silver Streak Bass Company (aerial by Glen Frels)



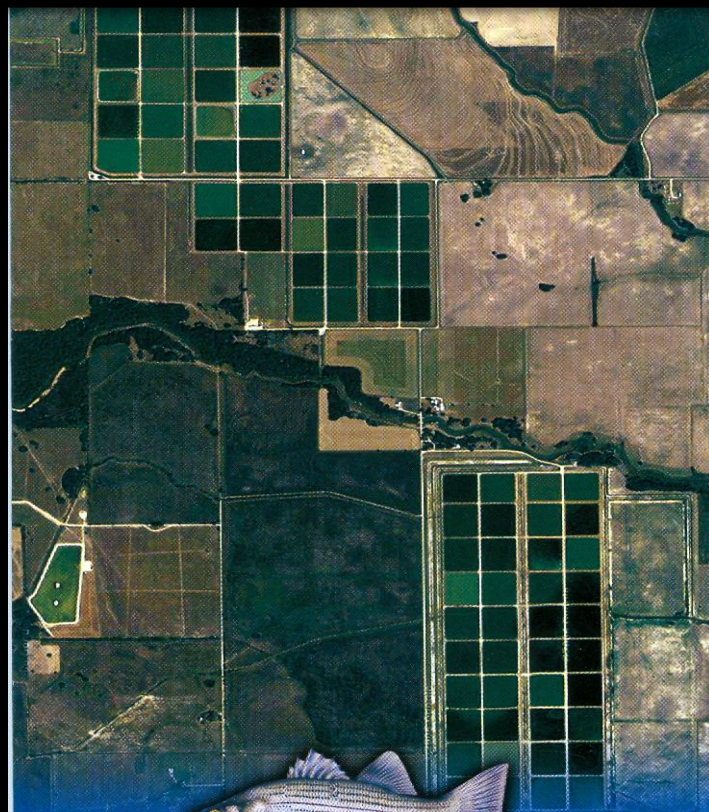
Recreational fishing (photos from Jim Ekstrom and fish from Silver Streak stocks)

With its expansion to 850 acres of ponds, Silver Streak Bass Company was considered the second largest hybrid striped bass farm in the USA, owned by Jim Ekstrom. Then in 2009 Kent Sea Farms in California got out of the HSB business, leaving Silver Streak Bass Company as the largest farm in the USA. Silver Streak now has 1,000 acres in ponds and a state-of-the-art fish sorting and packing plant in El Campo which follows the FDA HACCP protocol. Silver Streak also provides recreational fish stocks. Jim Ekstrom's Silver Streak Bass Company employs 35 workers with an approximate \$1million payroll. The water source for the farm is from rural water wells. It takes about two years to grow fish to average of 3 pounds. www.silverstreakbass.com





SILVER STREAK[®]
FARM-RAISED HYBRID STRIPED BASS



***Need more reasons to feature Silver Streak
Farm-Raised Hybrid Striped Bass?***

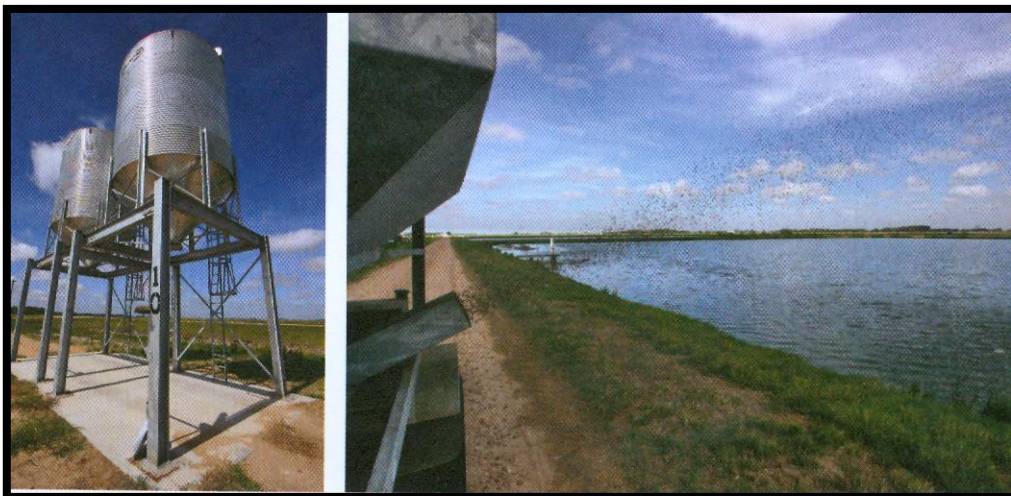
*Give us a call. We'll tell you all
about why it just makes good sense.*

Silver Streak Bass Company
P. O. Box 499
Danevang, TX 77432
979.543.8989 ~ Fax 979.543.8840
www.silverstreakbass.com



9 pound hybrid striped bass farm-raised (Courtesy of Jim Ekstrom, Ekstrom Enterprises 2-5-15)

44% of total cost is feed, and 68% of the production cost. The average feed cost from 2005 to 2009 was \$643/ton or \$0.32/lb. HSB feed average cost for 2003-2007 was \$.275/lb or \$550/ton. HSB feed in 2008 was \$0.38/lb or \$774/ton, a \$224/ton increase over '03-'07 average or a 40.6% increase. FCR for hybrid striped bass is high (above 2.6:1 and comparable with catfish FCRs).

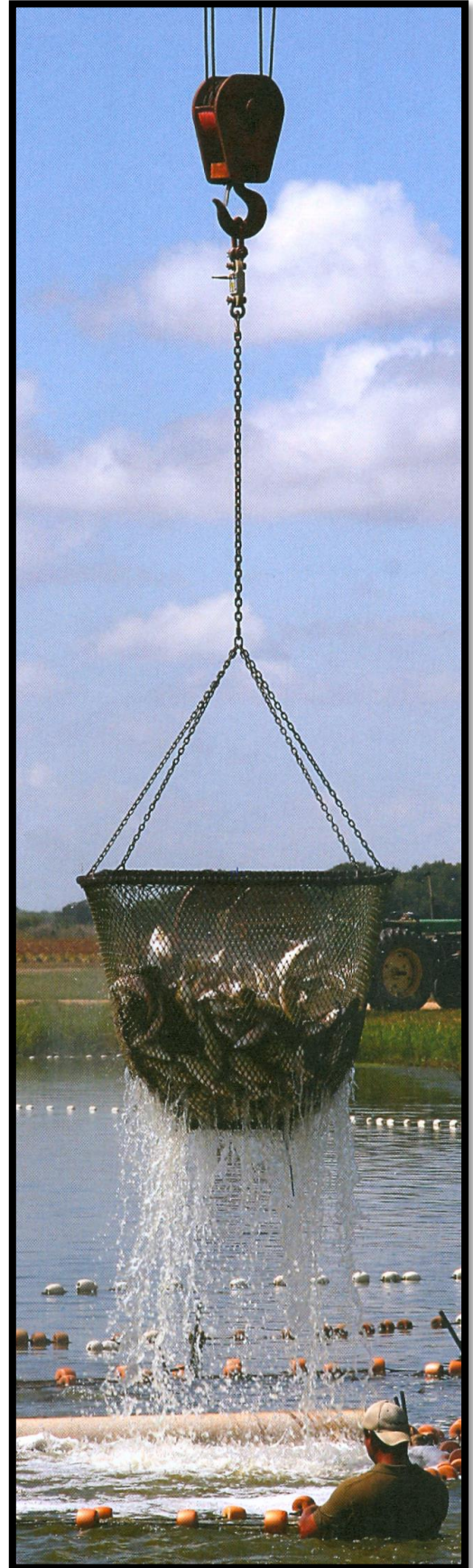




979-543-8989
info@silverstreakbass.com



- NO ANTIBIOTICS
- NO HORMONES
- NO MERCURY







Silver Streak Bass Co. state-of-the-art fish sorting and packing plant, located in the Business Park off Hwy. 59 in El Campo, Texas operates using FDA's HACCP protocol.

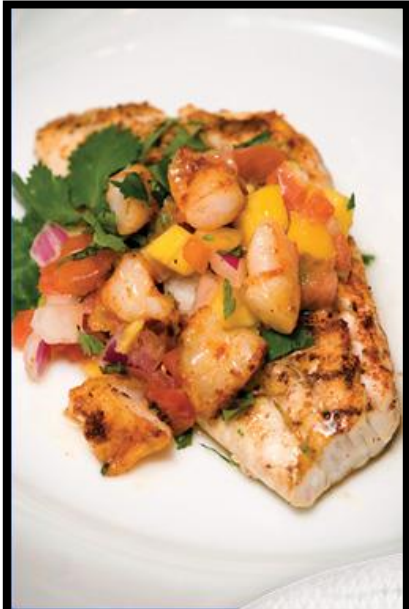




Waxed box with fish and shaved ice



Fish are sold all over the USA, fresh, packed in ice



979-543-8989
info@silverstreakbass.com



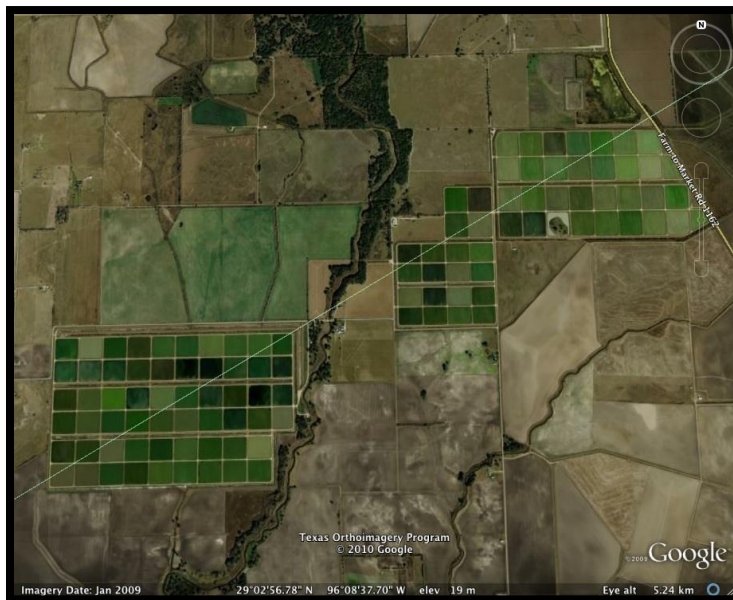
**A FISH
WITHOUT SEASONS**

Same quality, same availability...
spring, summer, fall & winter



All above photos from Silver Streak Bass Company's brochure.

Google Earth photo of Silver Streak Bass Company's 1,500 acres of land and approximately 1,000 acres of ponds East of Danevang.



Red Drum in Texas 2011-2016

One of the shrimp farms shifted most of its production to red fish in 2008. There were five commercial red drum (*Sciaenops ocellatus*) facilities on the Texas coast in 2015 producing fish in a total pond acreage of 1,100 (some fingerling ponds, but mostly growout ponds). The product totaled an estimated 2 to 2.5 million pounds in 2010, worth \$US 6,950,000, depending upon whom you talk to in the industry. Jim Ekstrom estimated 2.5 million pounds of red drum for the state in 2010, and updated that production estimate to 3.25 million pounds for 2011 (personal communication with Jim Ekstrom, 2012. 2013 and 2014 is estimated the same, at 5 farms, 710 acres, 3.25 million pounds, worth \$9 million. 2015 is estimated at 2 million pounds from 5 farms, worth \$6.9 million. The 1,100 acre production came from personal communication with Jim Ekstrom, May 2016.

KAAPA was raising red fish and had a hatchery, but closed their operation in Bayview in 2016. The winter in 2014 was a bad one for red fish producers and it takes time to build fish production back up, but remaining farms are coming back strong.

Some Historical Notes on Red Drum in Texas

In 2010 and 2011 some of the farms said they had fish backed up and couldn't sell them because of the BP oil blowout affecting the tourist trade on the Gulf. Since the BP incident caused a slow sales year, the numbers in 2010 don't reflect a good production model for the state. 2011 was better with 3.25 million pounds produced, even though there were some fish killed by a late winter cold snap in 2011. Matt Benner in Port Lavaca said they produced 350,000 lbs of redfish in 2010. He predicted their farm would grow fish in 120 acres in 2011 and produce 5,500 lbs/ac or 660,000 lbs of fish in 2011.

Seaside Aquaculture, the oldest red drum farm in Palacios, has 205 total acres in culture (175 acres in growout ponds and 30 acres in fingerling ponds). The industry average production in 2007 -2009 was 10,000 lbs./ac., but this was not per year, since it takes longer than 12 months to raise redfish to 3 pounds in size. 6,000 lbs/ac is more of an industry average for red drum production in Texas. The farms raised their farm gate price in 2008 from \$2.30/lb to \$2.40/lb. and the price in 2009 was \$2.78/lb farm gate, whole fish on ice at the farm. Much of their product is sold whole on ice in the Houston and Austin markets (personal communication with Dr. David Dunseth, manager at Seaside Aquaculture in Palacios, March, 2008, and retired in Jan. 2009). Two shrimp farms converted to red drum culture. Harlingen Shrimp Farms, Ltd. in Bayview converted part of its shrimp hatchery to a red drum hatchery in 2006 and had their first fish produced in 2009. They produced about 300,000 lbs of shrimp on 157 acres in 2010, but the redfish totals were not available. Their best production of redfish was 14,000

lbs per acre over an 18 to 24 month growout. HSF harvested their last two redfish ponds in April 2011 and said that they were not planning to restock unless a new ownership occurred. They maintained one tank of broodstock red drum, just in case they needed to start fish production again. A joint venture between HSF and Aqua Ventures Alliance of Iowa in the summer of 2011 produced 285,000 lbs of shrimp from 127 acres, but no red drum were stocked in 2011. The HSF farm was purchased by KAAPA Aqua Ventures Alliance (KAVA) in 2012 and their plan is to continue to raise marine shrimp and red drum. R&G Shrimp Co. in Port Lavaca dropped marine shrimp culture and tried hybrid striped bass in 2006 and 2007 and shifted to red drum in 2007 on the 200-acre farm outside Port Lavaca, but only stocked a portion of that. R&G also has a red drum hatchery and is selling red drum fry and fingerlings. They still have a pond or two in hybrid striped bass, but appears to be concentrating on red drum culture in 2011, as stated above on 120 acres of fish ponds. They are selling red drum to Ekstrom Enterprises plant in El Campo, which is marketing the fish under the Copper Shoals brand. There is a new red drum farm outside Palacios, near the airport, which is inland. This is a small operation with several ponds and a 20 feet diameter circular tank, located on turtle creek. Mr. Nassir Kreshy is the owner of this growing farm which started in 2008. Nassir worked with Dr. Connie Arnold at UTMSI/FAML in Port Aransas before Connie retired. Nassir worked at the redfish farm in Bacliff (HarvestFresh Seafood) before it closed and he was in the Caribbean raising red drum a few years before returning to Palacios to build his own farm. In speaking to Nassir, he informed me that he was successful in getting additional financing and will be expanding operations. New financing was obtained to enable expansion of the farm and new ponds were seen along Highway 35 in 2011 and 2012.

Lonestar Aquafarms, Ltd. was a 200 acre redfish farm outside Palacios, and was managed and partially owned by John Turner. According to Turner, it produced about 25,000 lbs. of whole redfish per week when operations were going well. Turner sold his percentage of the farm to the major share holders (Appling Farms and Appling Interests, Ltd.), and Ekstrom Enterprises assumed the management of the farm in 2011 under the name of Apeks Aquaculture, LLC, with David Maus managing the farm.

Redfish Hatchery and Implement/Sorting Building in Jackson County



Aerial of farm outside Palacios in Jackson County



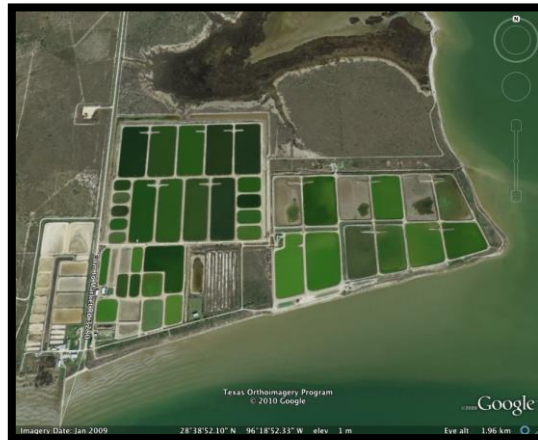
R&G Port Lavaca, 2009 (below)



R&G Port Lavaca, 2010



Seaside Aquaculture and Perry R. Bass Marine R&D (TPWD) 2010 below – red drum



In earlier years producers averaged between 6,500 to 7,000 lbs. per acre, up to 8,500 lbs./ac. But more recently the average producer is able to generate almost 10,000 lbs of fish per acre per year. It takes between 18 to 24 months to grow red drum to market size. The breakeven price for producers has been around 3,500 lbs. per acre, but has increased more recently due to fuel and feed cost increases.

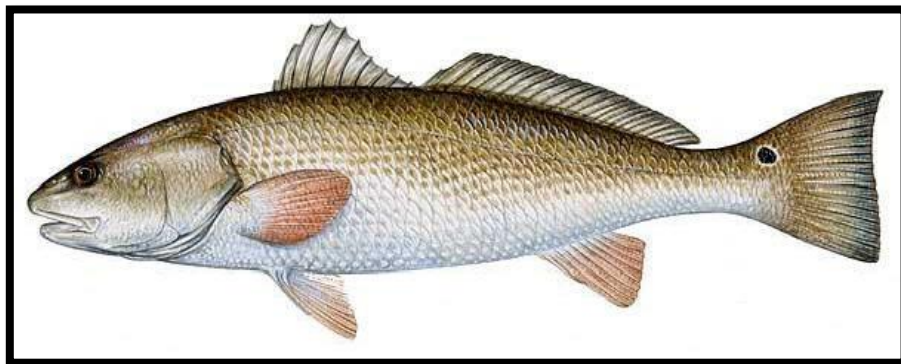
Dr. David Dunseth, Manager Seaside Aquaculture for many years and is now retired, stated that in 2008 he had no major problems on their redfish farm. Toxic algae is still a small problem, but he said it seemed to hit the new ponds more than the older "seasoned" ponds. Their farm-gate fish prices are seemingly keeping pace with the inflationary production costs, and they are passing a rate increase on to customers in April 2009 (from \$2.30/lb to \$2.40/lb) and he said customers understand the need to do so. He said that they seem to have the diseases and parasites under control. The farm-gate price went up to \$2.78/lb in 2009, and one of the state's newer farms was actually getting \$3.15/lb for whole red fish on a consistent basis because they could offer 25,000 lbs. of product year-round. Most of the red drum produced in Texas are being marketed by Ekstrom Enterprises in El Campo, under the Copper Shoels trade name. Photos below: Seining redfish fingerlings at Seaside Aquaculture and redfish fry.



Red drum will freeze in shallow ponds so producers provide the fish with a thermal refuge in one section of the pond, which is smaller, and warmer ground water is pumped on top of the salt water to provide a blanket or thermal barrier to help fish survive colder temperatures. There were some fish lost in the Palacios area in 2011 and 2013-2014 due to cold weather (personal communication with David Maus).



Thermal refuse for fish with groundwater inlet.



1.5 to 3 pound red drum is the preferred harvest size (photo Michael Masser), for a fillet that fits on a plate. However Fritz Jaenike said they sold larger fish in South Texas.

Feed Silos at Seaside Aquaculture (red drum farm outside Palacios)



Jeff Vu, the owner at Seaside reported an excellent fingerling production from one small fingerling pond of 17,000 fish. Seaside generally harvests about 10,000 lbs of fish each Monday, sorts according to size if necessary, then sells to wholesaler whole on ice. The fish house, wholesaler or even restaurant picks the fish up at the farm. The farm generally does not deliver any fish.

The regulatory climate is still not conducive for the expansion of aquaculture in the USA, especially along the Texas coast. So most likely any expansion into red drum culture in Texas will come from existing shrimp farms that are already built and permitted by the state.

A detailed 30 page report by Treece and Adami on red drum culture in Texas and can be found in CABI's Aquaculture Compendium. Web link: <http://www.cabi.org/compendia/ac/index.asp>. Additional fact sheets on the biology and culture of red drum can be found at the SRAC web link <http://srac.tamu.edu/>.

Commonly Known Red Drum Farm Design Criteria and Technology

1. Fry and Fingerling/Nursery ponds are 1 to 2 acres in size.
2. 1:1 ratio Fry ponds to Fingerling ponds
3. Growout ponds 5 acres in size.
4. 15% nursery ponds to 85% growout ponds.
5. Hatchery has two 3,000 gallon fiberglass broodstock tanks.
6. Brood put on 150 day maturation cycle, Nov. to June.
7. When the temp. is 23 degrees C and light is 10 hrs/day, spawning starts.
8. 6 brood fish in each 3,000 gallon tank, 20- 30 lb each or 35 inch to 45 inch fish.

9. Male to Female ratio is 1:1.
10. Domesticated red fish will take 4 years to grow to brood size.
11. 3 lb fish takes 18 months, and 30 months to maturity.
12. Generally only discharge in growout ponds when conditions warrant or require it due to poor water quality or toxic algae.
13. Hatchery requires high salinity. It takes about 32 ppt to float the eggs.
14. Broodstock spawn for six months and eggs are harvested weekly.
15. 1 to 2 million eggs per week.
16. Eggs are incubated in 100-gallon tanks with 1- 2 liters/minute flow.
17. Eggs hatch in 24 hours at 28 degrees C.
18. Fry in 36 hours.
19. After another 12 hours pond water can be added at lower salinity.
20. Follow nursery routine published by TPWD at Perry R. Bass Marine Finfish Research Center in Palacios.
21. Feed trout starter and 1/16 inch feed to start.
22. Stock 400,000 fry/ac in nursery and water is filtered to 500 microns.
23. Stock 40,000 fingerlings/ac. (3,000 to 8,000 lbs/ac)
24. Stock 4,000 fish/ac. for growout to obtain 10,000 lb/ac yield.
25. 3 stage production (fry, fingerling, growout), with no fish grading.
26. Use 2.5 hp/ac aeration
27. 44/13 feed (US\$0.41/lb).
28. Use sinking feed until Fry, then switch to floating feed.
29. Feed according to temperature (ie. If temp. is 50 to 59 degrees, only feed every other day; above 68 degree F use floating feed; below 68 degrees F use sinking feed.)
30. Current farm gate price for red drum is now \$2.78/lb to \$3.15/lb, whole on ice at the farm, and one farm that can produce fish year-round can demand \$3.15/lb.

Marine Fish Hatcheries and Researchers in the USA (R&D government, university and commercial)

Wallace Jenkins
South Carolina Wildlife & Marine Resources Department
Tel. (843)953-9835

Jeffery Lotz
Gulf Coast Research Lab
Tel. (228) 872-4247

Chris Young
Florida DNR
Chris.Young@MyFWC.com
Tel. (941)723-4505

Ken Leber
Florida
Mote Marine Lab
Tel. (941)388-4441

Dr. Robert Vega and Robert Adami, Jr.
Texas Parks and Wildlife Dept.
Natural Resource Specialist V
4300 Waldron Rd.
Corpus Christi, Texas 78418
Tel. (361)939-8745
TPWD also has hatcheries in Palacios (Perry R. Bass Marine Finfish Research)
and Lake Jackson (Sea Center)

Jeff Kaiser
UTMSI/FAML
Port Aransas, Texas
Tel. (361) 749-6827
Email: jeff.kaiser@mail.utexas.edu

Dr. Allen Davis
Dept. of Fisheries and Allied Aquacultures
Auburn University
Auburn, Alabama 36849-5419. Tel. (334) 844-9312. Email:
davisda@auburn.edu

Auburn also does marine finfish research at the Claude Peteet Mariculture
Center, a state-owned fish hatchery in Gulf Shores, Al.

Dr. Daniel Benetti RSMAS/MAF University of Miami 4600 Rickenbacker
Causeway Miami, FL 33149. Tel. (305)421-4889.
Email: dbenetti@rsmas.miami.edu

Michael Schwarz, Virginia Tech. Email: mschwarz@vt.edu.

Apeks Aquaculture, Palacios, Texas (David Maus, manage. Email: David Maus
dmaus@eksent.com. 200 acre commercial red drum farm and hatchery.

Seaside Aquaculture, Palacios, Texas (Jeff Vu, manager. Tel. 361 550-9470).
200 acre red drum farm and hatchery.

R&G. Port Lavaca, Texas (Matt Benner, owner. Email: rgshrimp@hotmail.com
200 acre red drum farm and hatchery, also raises hybrid striped bass.

Fish Processors in the State of Texas

Austin Seafoods, Austin, Tx. Steven Curtis, 512-476-3494 (Buys fish to process).
Bowers Shrimp and Catfish, Palacios Reed Bowers. 361-972-2414.
Groomer's Seafood, San Antonio, Tx. 210-377-3474 (Buys fish to process).
Quality Seafoods, Austin, Tx., Carol Huntsberger, 512-452-3820 (Buys fish to process)
Seabrook Seafoods, Seabrook, Tex. Buys fish to process.

Additional Fish Buyers in Texas and Elsewhere

Freedman Distributors, Richard Francis (800) 375-5444
Fulton Seafood, Ernest Swick (713) 227-7311
Formosa Seafood, Jesse? (214) 631-5903 (Dallas)
Glazier Foods, Matt Starkey (832) 375-6192
Louisiana Foods, Chris Herald (713) 501-8544
Marin Foods, Varunee Chinnalai (800) 800-8889
Sysco, Gregg, Amy, Mike? (832) 754-6029
Texas Quality Seafood, Jerry Yu (713) 592-9890
Kim Son restaurant chain in Houston has a big food processing warehouse downtown. They purchase whole fresh on ice fish for processing for big wedding parties. Tuan Dinh Nguyen manager, (281) 242-3500.
Silver Streak Bass Co., El Campo Plant, El Campo Industrial Park. 979-543-8989. In some cases, buys fish to resell. Does some sorting to size, but no processing.

Ornamental Fish

According to the latest U.S. Dept. of Agriculture Census of Agriculture, published in 2009, there are 684 Ornamental Fish Farms in the USA, producing US\$61,049,000 worth of fish yearly. Their survey found 27 Ornamental Fish Farms in Texas, producing US\$892,000 worth of fish yearly; 18 farms in Hawaii producing US\$2,418,000 worth of fish/yr; and 203 farms in Florida producing US\$32,192,000 worth of fish. Florida produces half of the ornamental fish in the USA.

According to Brian Brawner of R&B Aquatic Distribution, Inc., Boerne, Texas, 15 of those commercial 'Ornamental' producers in the state of Texas operate on an estimated 40 acres and there are also over 100 garage or small shop producers. There are approximately 530 retail shops and 20 wholesalers

whom handle tropical fish, not counting Walmart stores and other large chains that handle aquarium fish (Livebearers – platies, guppies, swordtails, mollies, etc., and Egg-layers – gouramis, danids, barbs, tetras, cichlids, etc.). Standard production ponds for tropicals are 80 ft. X 20 ft. X 5 ft. deep. Koi and goldfish ponds are often larger.

Koi “King” of the pool fish (*Cyprinus carpio*) or *Common carp* are popular water garden fish. They were bred in Japan for almost 2,000 years. They are prized for spectacular color patterns and grow according to the size of the pool. Some grow to 3 to 4 feet long and can live 70 to 100 years. However, they do have a tendency to uproot and eat plants

The ornamental Koi (*Cyprinus carpio*) in Texas.(photos of ornamentals from P. Woods).



Goldfish (*Carassius auratus*) or Asian carp (below) are found in two basic types (scaled and scale-less fish). Some of the scaled goldfish are Comet, Japanese Fantail, Black Chinese Moor, and some of the scale-less goldfish are Shubunkins and Calico Fantails. Most of the high quality goldfish are bred in China.





An example of an ornamental fish farm in Texas is Brett's Fish Farm:



Questions asked Brett Rowley concerning ornamental fish culture to obtain a better understanding of its operations in Texas

1. Could a person produce ornamental fish on an existing tilapia farm?

The answer is yes. Standard production ponds for tropicals are generally in the size of 80 ft. X 20 ft. X 5 ft. deep. Koi and goldfish ponds are often larger. Brett's Fish Farm (an ornamental farm in Texas, raising mostly koi since 1992) is located on an old catfish farm. Depending on the production scenario, some "old fish farms" make better ornamental farms than others. Also, some types of ornamental fish lend themselves better to polyculture systems than others. For example, some farms raise tilapia in cages or in tanks, and koi are raised outside the cages in the same tanks or ponds. Some other "tricks-of-the-trade" are the same fish that are sold in restaurants as "farm raised catfish", mostly from Viet Nam (basa) and China, are sold in pet shops in the US as an "iridescent shark" (*Pangassius sp.*), and the producers receive more money for a smaller fish. The same hatchery can produce both.

2. Feed costs? Generally speaking, feed costs would be less to feed ornamentals than it would be for full growout of intensive shrimp or tilapia production because you don't generally grow massive quantities or pounds of ornamentals to adult size unless you want to produce broodstock. You generally sell the fish before they reach maturity and have less quantities of feed invested into the animal when they are sold. However; it depends upon the ornamental species you want to raise.

That being said, it is not always true on feed costs. Some of the esoteric feeds and food items fed to koi cost \$US50/kilo and more. High-end koi food, even in bulk can cost as much as \$US40/kilo. So even though the amounts or quantities fed might be much less, and the numbers of ornamental fish would be less in the ponds, the cost per animal, as a percentage of total cost of the end product, might be the same, or even more. So, it depends upon the specific species you are raising, and when you sell it. With koi, you generally get more when you sell it as an adult, so you might have lots of money in it by the time it is full grown.

Other species may have similar situations. For example, if you are required to operate a different culture system, on the same farm, to produce live foodstuffs, such as live feeds or plankton, it drives the costs up. Some farms have plankton production ponds and they harvest live plankton for feed. Trying to purchase live feeds is very expensive, and even some of the frozen feeds are expensive. Check the price of frozen krill, processed cyclops, even brine shrimp eggs (of good quality), and they are all very expensive to purchase as feeds. These are commonly used feeds for optimum production of ornamental fish.

3. Tropical ornamental culture is a business that is generally more hatchery oriented and is generally associated with producing large numbers of fingerlings and younger fish for sale, not large numbers of pounds of fish. Most tropical producers have a large number of tanks and stimulate brood stock of multiple species to reproduce. They raise the young and sell them before they grow up completely. So there is less time and feed invested in the product, and as a general rule-of-thumb, the price received per fish is greater than the price per pound received for a fish-for-human-consumption production farm.

That being said, there are some places that are just retail centers, such as Burt Nicol's Water Garden Gems. Water Garden Gems is generally a retailer and does not really have a "hatchery or farming operation", only a large holding facility associated with a retail operation. Many ornamental fish are sold as juveniles, but many are also not sold until they are adults. Koi bring the most money as fully mature adults. Many are sold as juveniles, also.

Goldfish, OTOH, are largely sold as adults, and not so many juveniles are sold, so more of an investment would be made with this species before it is sold. Other ornamentals, like African cichlids, are sold both as juveniles and adults. But, most of those types are produced indoors. In some cases you will find a divided production scenario where a hatchery provides offspring to outlying farms to grow out.

4. What are the main species of ornamentals and what is demanded most from the US market?

Livebearers – platies, guppies, swordtails, mollies, etc., and Egg-layers – gouramis, danids, barbs, tetras, and cichlids. Some types of Koi or goldfish (OTOH) are desired in the US market.

Goldfish (*Carassius auratus*) or Asian carp are found in two basic types (scaled and scale-less fish) on the US market. Some of the scaled goldfish found in the US market are Comet, Japanese Fantail, Black Chinese Moor, and some of the scale-less goldfish are Shubunkins and Calico Fantails. Most of the high quality goldfish are bred in China. High quality koi are available from some US producers such as Brett's Fish Farm in Texas. "Coldwater ornamentals" aka "pond fish" which would include koi, goldfish, longfinned koi, white clouds, rudd, tench, crucians, and sturgeons, are all popular species in US. "Tropicals" also make up a very large US market. Koi are popular fish for water gardens in the US market, but it takes a lot of physical effort and equipment to support them (big pond or pool, good filter equipment, etc.). A larger market exists in the US for goldfish, and tropical aquarium fish is a larger market still in the US. Saltwater tropicals are also in high demand, but are limited in market similar to koi by the need for special habitats.

5. Where is the main target market in the USA?

Major cities like Miami, Houston, Los Angeles, etc. are major entry points for imports. There are some marketing channels that you have to go through or penetrate or have special access to be able to sell. Aquaculture Magazine's Buyer's Guide and Industry Directory lists a number of ornamental and tropical fish producers, suppliers and importers.

For what would be called "coldwater ornamentals" which would include koi, goldfish, longfinned koi, white clouds, rudd, tench, crucians, sturgeons, etc. and exclude "tropicals", the market is primarily, ultimately, US homeowners. Homeowners with landscaped yards and fish ponds and those fish are generally sold through retailers, like Burt Nicol's Water Garden Gems in Marion, Texas, or

even provided by the companies doing the landscape work. Burt is just a retailer, so he purchases his fish from a producers at wholesale and holds them until they sell retail. The intermediate market is the local koi shop, garden center, fish shop, water garden store, etc.

6. What type of clients would you sell ornamentals?

Walmart or other large chains are probably out of the picture, unless you can come in as a low bidder. It will no doubt take a variety of clients to buy all the production from a good size farm, so you may sell part to wholesalers in the US such as Burt Nicols and get a low bid for Walmart. For US producers, most can't come in as low bidder and can't afford to sell to Walmart, Petsmart, Petco or other large chains. Most of their customers will fall into two categories...retail, direct to collectors and wholesale, to shops, stores, and distributors.

The direct to consumer (collector) market is for the highest quality fish. These are sold at the farm gate, but also at shows, exhibitions, seminars, etc. Also sales can be made over the internet. Internet sales could be developed into a large business for you if proper delivery methods such as UPS, DHL, FEDEX, are available from your farm site to the market in an over-night guaranteed delivery.

The wholesale market in the US is generally for the lower grade fish in larger quantities. These might go to small, family-owned "Mom and Pop" outfits, retail store fronts, distributors, and other fish farms.

Walmart, Petsmart, PETCO, and other chains are pretty much out of reach to the average US producer, especially the Texas producers. Mainly because those operations buy from the lowest bidder, usually China, Isreal, SE Asia, Costa Rica, Colombia, and are notoriously slow in paying and they are a distribution nightmare (10 fish per store X 3000 stores).

7. How much does the market usually pay, in general, for wholesale of the different species?

There are price lists circulated for the species. There are wholesale price lists for the various wild caught ornamentals from Colombian jungles. Koi can sell for around \$0.20 or so and up. Some years back, 4" pond koi were selling at US farms for around \$2.25 each (wholesale). Now the same fish brings about \$0.35 or so. So Chinese and other foreign competition has brought the farm gate prices down considerably and the producers must be able to adjust accordingly.

To high-end dealers, some producers in Texas are able to sell koi (8 to 10 inches in size) for as much as \$150 each, but there are very few of these sales made according to sources in the industry.

8. What is the cost to produce those species?

Costs are very high. Land, water, fuel, electricity, labor, feed, etc, in the US, have gone up rapidly in recent years, while the wholesale prices of most ornamental fish have fallen in the US market.

9. Where is main ornamental competition?

Growers in Florida, Costa Rica, China, Japan, wild fish caught in the jungles of Brazil or Colombia. There are 15 ornamental producers in Texas. However, the biggest competition will be China. Japan to some extent would also be in competition, but only at the high end. There are many producers, competing in some cases for the same markets, but that is the case with all of the areas of aquaculture. There are many more producers, especially of tropical ornamentals, in Florida than in Texas.

Big producers of coldwater ornamentals are also in North Carolina, Virginia, New Jersey, Arkansas, Missouri, Maryland, California, Alabama, Oregon, and Washington state.

For specific names of producers, and buyers, such as B& B Aquatics (Ky), Bassinger Wholesale (Tx), Billy Bland Fishery Inc. (Ar), consult Aquaculture Magazine's Buyer's Guide and Industry Directory.

10. What would it take, total investment, to set up an ornamental farm to produce ornamental fish? Say if you already had a tilapia farm and wanted to convert to ornamentals --- what would it take?

The total cost, obviously is going to depend upon the size of the farm and what production level you wanted to achieve. With existing tilapia ponds, depending upon their size, the ponds would most likely have to be down-sized to have an optimum size for tropicals, but maybe not if you wanted to raise koi. That construction could be estimated for the specific site. It took \$20,000 for Brett Rowley, almost fifteen years ago, to convert an old catfish farm into a koi farm, but he had less than ideal size ponds and less than optimum location and water quality.

For a completed ornamental farm, you can find a koi and goldfish farm for

sale in Alabama right now (Price's Fish Farm) for comparison. They are an older farm operation, but they are not known for the "top quality" fish. They sell mostly wholesale. The price is probably in the low \$US millions for the whole business, including land, ponds, buildings, and list of their buyers.

11. Where would you buy broodstock to get started in the business?

Another tough question to answer with the ornamental disease issues nowadays such as KHV. But for koi, in Japan for sure. Here in the US, you can purchase top quality broodstock from Brett Rowley and others. For top end breeders, maybe some other places. Brett's Fish Farm does have some of the finest koi breeding stock outside of Japan. They are healthy, virus free, proven producers of prizewinners, best blood lines, etc. etc. for sale for a lot less than other producers.

12. Cost of broodstock?

Koi: Brett Rowley told me that he doubts that it could be done again, but in 1992, when he got started, he purchased 47 top quality Japanese breeder koi for \$100,000. Nowadays, a good female in a popular breed will cost \$8000 to \$35,000 or so. Males can be purchased for as little as \$1000 each, or \$2500 for a real good one.

Brett Rowley collects broodstock several different ways. Mostly he buys from Japan. Sometimes he takes a fish from a collection, a very good example of a breed he is presently pursuing. Sometimes he buys one from a domestic breeder. He again emphasized that nowadays you can't be too careful where you buy fish, with KHV and other diseases ever-present and capable of wiping your business out rapidly.

Other varieties and species of tropicals are the same as koi. Just like anything else; dogs, cows, horses, birds; whatever you breed, a good brood animal costs a lot of money. Poor brood animals are never worth it.

Aquatic Plant Production Industry in Texas

Aquatic Plant nurseries and Water Gardens (retail outlets) make up a very large portion of the aquaculture industry in Texas.



Water lily. (photo from M. Masser)

Typical water garden plants are Bog Plants and Lilies. Large water garden centers typically sell as many as 60 different species of Bog Plants. Some centers may commonly sell as many as 80 varieties of lilies, including Hardies – day bloomers and Tropicals – day and night bloomers. Other common plants for water gardens are sedges, rushes, Papyrus and floating plants.

It is estimated that more than one out of every 10 homes in Europe has a water garden and about one of every 100 homes in the USA has a water garden. Water garden design and landscaping is a growing industry in Texas. The water garden industry in Texas is estimated to generate 7 million dollars a year in sales. There seems to be room for growth in most if not all segments of the industry (pond construction and set-up, fish production, plant production and retail sales).



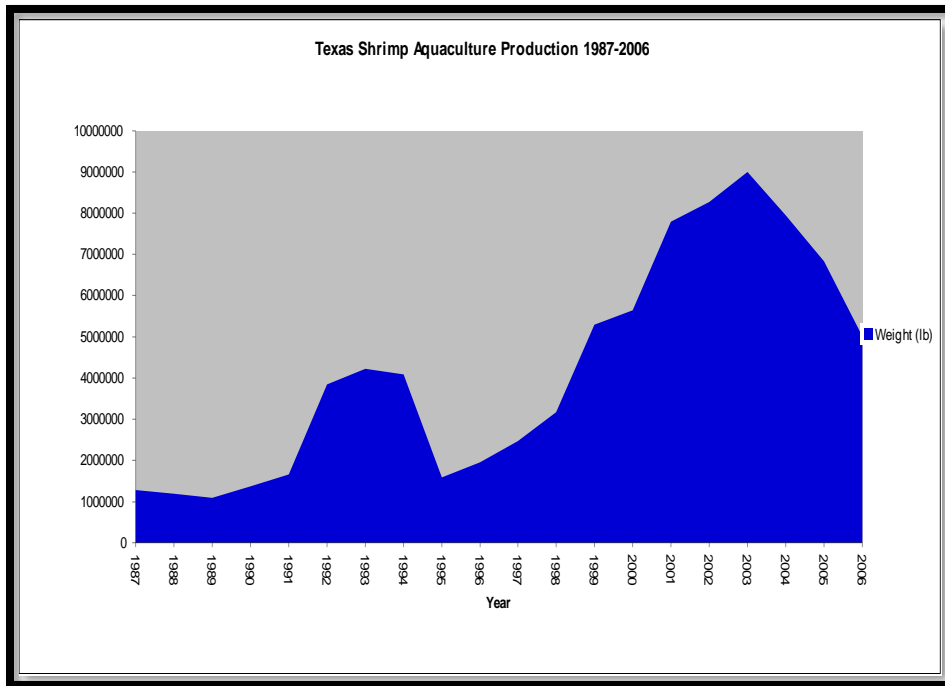
Water Garden photos from Peter Woods and Michael Masser.

Commercial Marine Shrimp Farming in Texas

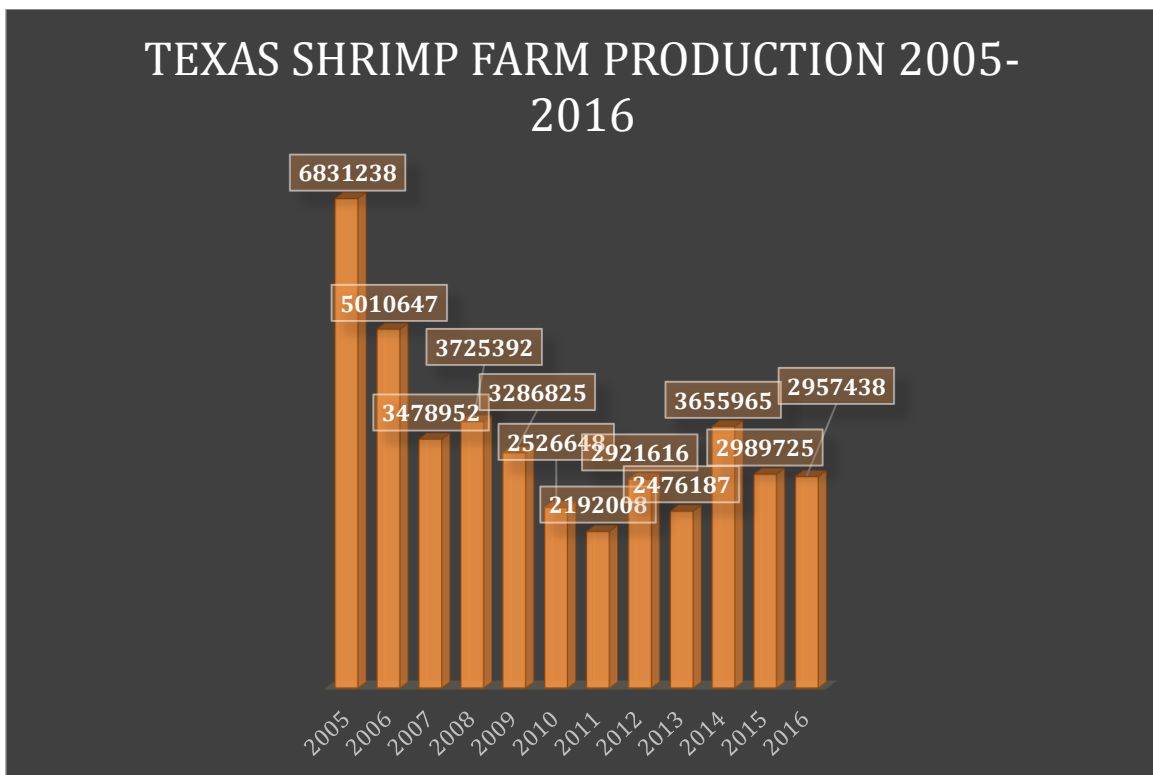


Historical Notes on Salt Water Shrimp in Texas

Raised with high standards and constant control, farm-raised shrimp offer consumers an excellent choice of seafood. In 2004, the drop in production was due partly to the Taura Syndrome Virus (TSV) in South Texas and fewer ponds were stocked because of lower prices. TSV has not returned to the state since. There were then approximately 3,000 acres of shrimp culture ponds in Texas with approximately 479 ponds constructed, but not all were being used. Only 2,343 acres were stocked in 2004 and even fewer (1,906) were stocked in 2005. 1,601 acres were used to grow shrimp in 2006, and 1,248 acres were stocked in 2007. The graph below shows Texas shrimp aquaculture production from 1987 to 2006, and the decline starting in 2004, which continued until 2011, and leveled off around 2.5 to 2.9 million pounds annually.



Above, Historical data from Texas Parks & Wildlife, saved and compiled by Treece



Source Texas production: Dr. Ya-Sheng Juan, Texas Parks and Wildlife Dept., Brownsville, Texas and compiled by Treece & Associates.



Global Blue Technologies on Port Bay near Rockport, Texas. Two growout cells and a hatchery capable of producing 18 million PLs/yr.



Commercial indoor shrimp nursery in Texas using biofloc (courtesy of Tim Morris at Bowers Shrimp, 2015).

Eight concrete raceways patterned after the 100 m³ TAMU Flour Bluff raceways (courtesy of Tim Morris at Bowers Shrimp, 2015)



The first year the nursery operated from Feb. 18 to Aug. 28, 2013 and produced 29 raceways of shrimp during 5 cycles, resulting in 20 million juveniles for head starting ponds. Results can be seen in Table below.

Table. Summary of first year nursery results at Bowers Shrimp (courtesy of Tim Morris, 2015)

Summary of first year nursery cycles in eight 125 m³ raceways from Feb-Aug 2013

Cycle	RWs (#/cycle)	Duration (days)	Temp (C)	Av. Wt. (g)	Survival (%)	FCR	Yield (kg/m ³)
1	8	48	25.7	0.17	67	0.95	1.1
2	2	27	25.0	0.10	76	1.05	0.8
3	3	22	25.9	0.05	136	1.1	0.5
4A	2	49	29.5	1.22	44	1.1	4.0
4B	6	41	29.6	0.74	44	1.07	3.1
5	8	25	30.0	0.18	72	0.96	1.2

Their goals with the biofloc nursery were to take advantage of the low cost of electricity in the smaller, insulated space; extend production period in the ponds; increase final weights of the shrimp from ponds; take advantage of compensatory growth; reduce the necessity for promoting zooplankton blooms (saving on fertilization costs); and to increase the overall farm production. As reported by Morris (2015, 45th Annual Texas Aquaculture Assoc. conference) Bowers Shrimp was even more successful with the nursery operation during the second year (see Table below).

Table. Summary of second year nursery results at Bowers Shrimp (courtesy of Tim Morris, 2015)

**Summary of second year nursery cycles in eight
100 m³ raceways from Feb-Aug 2014**

Cycle	RWs (#/cycle)	Duration (days)	Temp (C)	Av. Wt. (g)	Survival (%)	FCR
1	8	30	25.0	0.10	82	2.7
2	4	15	27.1	0.05	98	1.6
3	8	19	28.0	0.08	86	1.3
4	4	23	28.9	0.10	94	1.4
5	4	20	29.8	0.08	95	1.9
6	4	20	30.0	0.10	82	1.7
7	4	16	30.2	0.04	77	2.7
Average of 36 individual RWs		21	28.0	0.08	86.8	1.9

The second year (2014) the nursery produced 41 million juveniles in 36 individual raceways, with an average 21 day cycle resulting in a nursery survival of 87%. This success allowed the farm to double crop 220 acres. They farmed a total of 590 acres in 2014, 70 acres more than in 2013, producing a total of 2,195,730 pounds of head-on shrimp with a 59% survival rate in growout.

A few of the key devices that helped them achieve that success in the nursery were: a sump drain harvest designed for handling juveniles (Figure below); a³ air injection nozzles (Figure below) to be described in more detail later

in this manual; and a solids removal device (Figure below), to be described in more detail later in this manual.

Figure. Drain harvest for juvenile shrimp from the biofloc raceways at Bowers Shrimp.



Figure. a³ air injection nozzle from Aqua Aeration, Orlando, Florida.



Figure. Solids removal device used in the biofloc juvenile shrimp raceways at Bowers Shrimp



When the shrimp have been in the greenhouse 21 days they are released into the open pond. The nursery allows flexibility of stocking any pond on the farm and holding PLs and juveniles until the water temperature is at least 24 degrees C. in the ponds or if the pond water needs to mature longer then the PLs are held until there are optimum conditions for stocking.



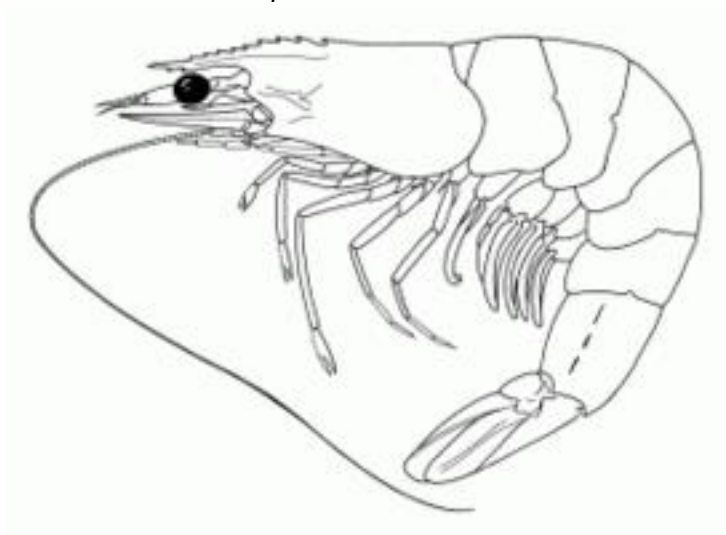


MONTEREY BAY AQUARIUM®

Seafood WATCH

Pacific white shrimp

Litopenaeus vannamei



(Image courtesy of FishSource, 2013)

United States

Outdoor Ponds, Indoor Raceways, Recirculating Aquaculture Systems (RAS)

Granvil Treece, Consulting Research

The present author completed an assessment for Monterey Bay Aquarium Seafood Watch Program on the US Marine Shrimp Farming Industry. A 64 page assessment report was submitted resulting in MBASWP classifying the US Shrimp Farming Industry as a “Best Choice”, and rated it “Green”. The assessment was done strictly by a very objective assessment scoring method developed by MBASWP.

Final Seafood Recommendation

Pacific white shrimp (*Litopenaeus vannamei*)

United States of America

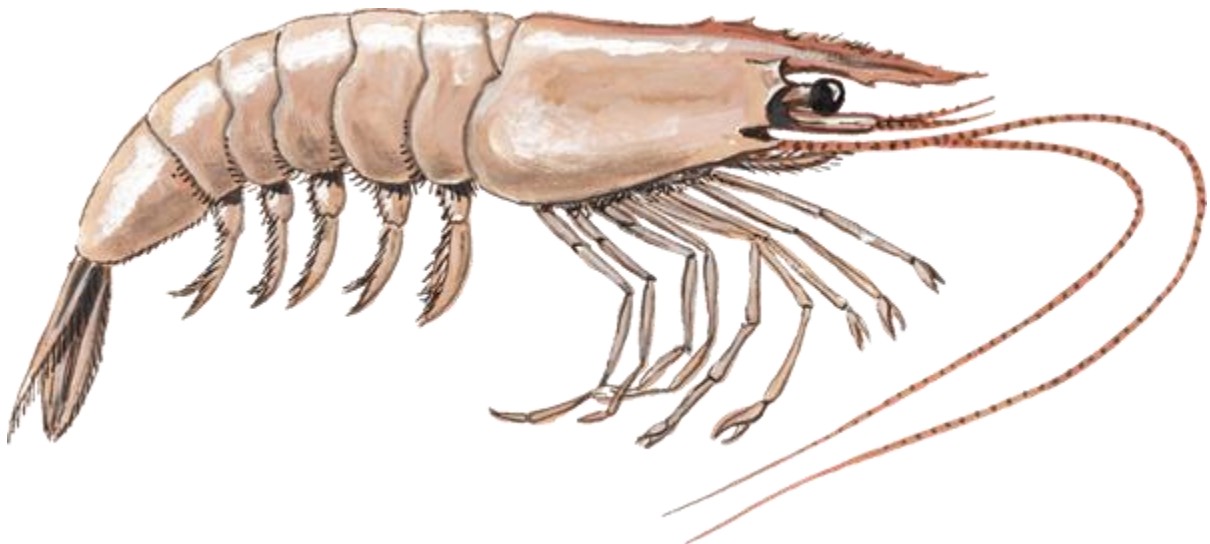
Outdoor Ponds, Indoor Raceways, Recirculating Aquaculture Systems (RAS)

Summary

Pacific white shrimp farmed in the United States receives a final numerical score of 7.01 and with no red criteria the overall recommendation is **“Green”**.

The pdf. Of the full report is available on the Seafood Watch web site at:

http://www.seafoodwatch.org/-/m/sfw/pdf/reports/mba_seafoodwatch_usfarmedshrimpreport.pdf



BEST CHOICE



- Market Names

(Pacific White & West Coast White Shrimp, Ebi)

- Method:

Farmed in Fully Recirculating Systems or Inland Ponds or Open System

- Location: US

Crawfish

There are approximately 20 crawfish producers in the state on 1,500 acres, producing around 800,000 lbs/yr., worth \$1 million.



Red Swamp crawfish above (Photo from Dr. Ray McClain)



Crawfish Pond and aeration (Photos from Ray McClain)

Harvested crawfish on ice (Photo from Ray McClain)



Boiling Crawfish



Boiled crawfish (Photo from Dr. Ray McClain)

“Texas CRAWDADS”, by Dr. Ken Johnson and Nathan K. Johnson.

<http://www.texasrawdads.com/>

There is an Internet link to the Louisiana Crawfish Production Manual, produced by LSU. This manual covers many important aspects on the culture of crawfish, located at: http://www.lsuagcenter.com/en/crops_livestock/aquaculture/crawfish/.

The publication is free and the direct link to the manual is:

http://www.lsuagcenter.com/en/crops_livestock/aquaculture/crawfish/Crawfish+Production+Manual.htm

There is a publication entitled “Projected Commodity Costs and Returns, Crawfish Production in Louisiana” from the Farm Management Research & Extension Department of Agricultural Economics & Agribusiness, LSU Ag Center, A.E.A. Information Series No. 257 - by Robert W. Boucher and Jeffrey M. Gillespie. This publication provides the projected costs and returns for crawfish production in Louisiana.

US Aquaculture Promotion by the National Aquaculture Association (NAA)

In 2016 the NAA produced and released a series of fact sheets, brochures and information white papers about the US aquaculture industry. These publications can be accessed from the NAA web site:

<http://thenaa.net/publications>.

Current World and US Status of Seafood Consumption

Global per capita fish consumption rose above 20 kilograms a year (FAO, 2016).

FAO’s latest “State of World Fisheries and Aquaculture” [report](http://www.fao.org/news/story/en/item/421871/icode/) (see web link: <http://www.fao.org/news/story/en/item/421871/icode/>) states that global per capita fish consumption has risen to above 20 kilograms a year for the first time, thanks to stronger aquaculture supply, among other factors.

But in the [U.S. seafood consumption](http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus14/documents/09_PerCapita2014.pdf) (see web link

http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus14/documents/09_PerCapita2014.pdf.) has declined since its historic high in 2006 and lags far behind much of the world in [per capita consumption](https://www.statista.com/statistics/264327/per-capita-consumption-of-fishery-products-by-country/).

<https://www.statista.com/statistics/264327/per-capita-consumption-of-fishery-products-by-country/>

Appreciation is given to the following people for providing information on 2016 production estimates in Texas:

1. Todd Sink, Ph.D. Assistant Professor, Dept. of Wildlife and Fisheries Science Texas A&M University, College Station, Texas
2. Peter Woods, Fisheries Specialist, Texas AgriLife Extension, Bay City, Texas
3. Dr. Ya-Sheng Juan, Texas Parks and Wildlife Department, Brownsville, Texas
4. Jim Ekstrom, Ekstrom Enterprises, El Campo, Texas.