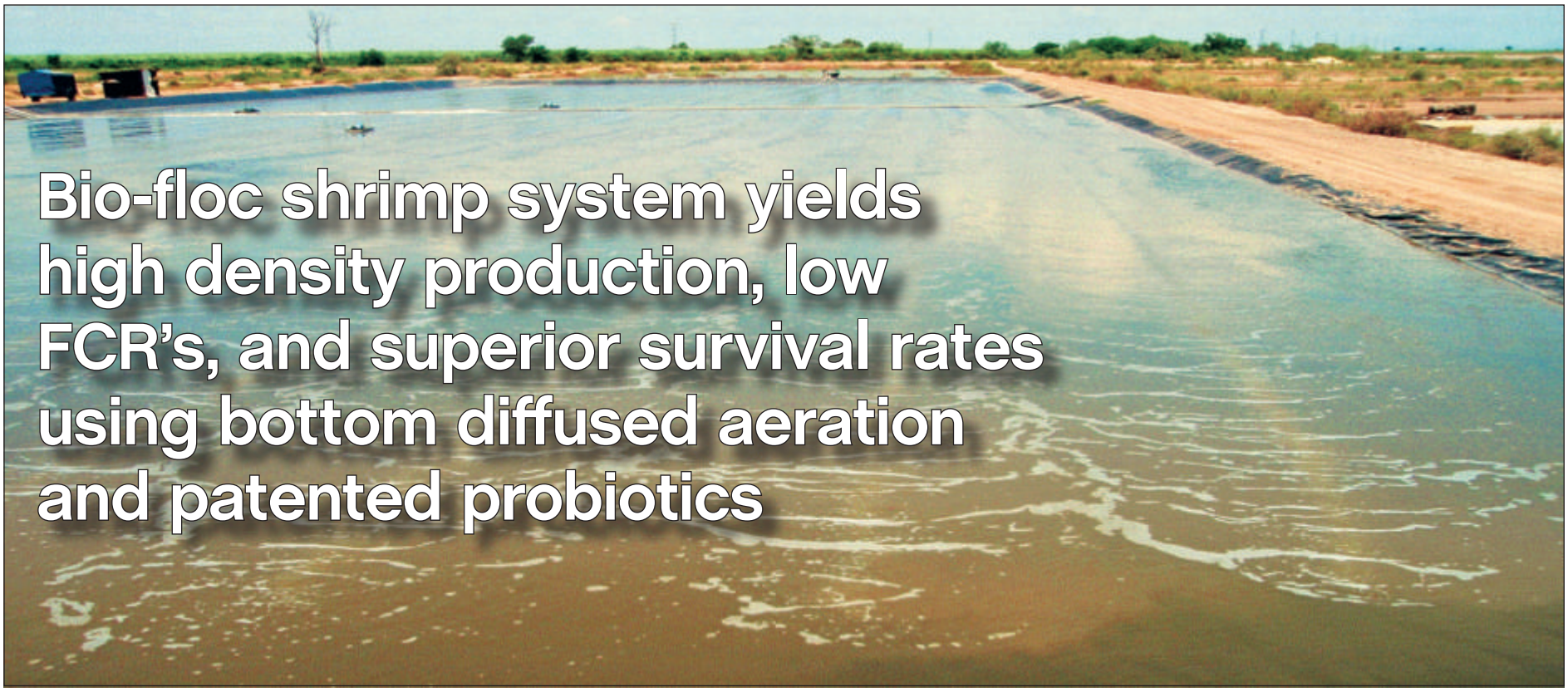


Bio-floc shrimp system yields high density production, low FCR's, and superior survival rates using bottom diffused aeration and patented probiotics

Charles "Sandy" Harris photos

Installing 9000 feet of air diffusion tubing.

by Charles "Sandy" Harris

SINALOA, MEXICO – SEA PRO is a commercial shrimp production company doing business on the Gulf of California, on the west coast of Mexico.

The Gulf of California coastline, north and south of the port of Toplobampo in Sinaloa state, supports more than 50,000 hectares of shrimp production ponds – principally in the states of Sonora and Sinaloa, but also south into the states of Nayarit, Colima, and Guerrero.

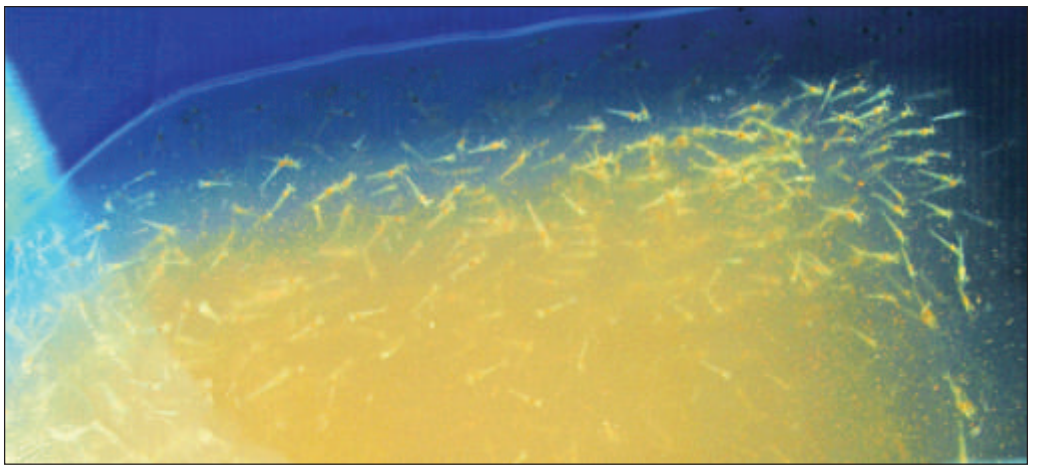
The majority of these Pacific west coast shrimp aquaculture farms employ traditional extensive or semi-intensive pond management production methods.

This includes heavy feeding of concentrated marine protein diets and diluting nutrient accumulation in the ponds via daily water exchange rates that normally average 10%-20% of pond volume during peak production.

With several years of commercial shrimp production experience, SEA PRO biologist Takeo Matsumoto began to evaluate options for improving routine shrimp farming

Charles "Sandy" Harris photo

650 scfm positive displacement blowers.



Charles "Sandy" Harris photo

700,000 PL15 Pacific white shrimp were stocked June 6 in the 11,500m3 bio-floc production pond, stocking rate: 80/m2 or 60/m3.

management practices.

SEA PRO concluded that traditional aquaculture practices employed in the region are not sustainable, principally due to the biosecurity problem of dealing with shrimp diseases – particularly White Spot.

In addition, excessive agricultural and municipal runoff, plus nutrients discharged from concentrated aqua farming activity, is producing eutrophication in the estuarine environments that are the primary water supplies to many regional shrimp farms.

And another critical factor with respect to industrial sustainability has been the continued increased cost of marine proteins that are incorporated into balanced shrimp diets.

Excessive market demand and overexploitation of Mexico's commercial Pacific fishery for the Monterrey sardine (*Sardinops sagax*) has this important marine protein resource declining.

In 2010, sardine meal was around $1,000 per ton – while the sustainability of current fishing pressure on the resource was being challenged by a consortium of six Mexican scientific institutions working to monitor Pacific and Gulf sardine fisheries.

Prices for balanced shrimp diets containing moderate levels of marine fish protein increased to record highs.

With shrimp market prices naturally declining during the economic downturn, while aquaculture feed prices continued an upward trend, addressing the question of "sustainability" appeared to be a debate that could no longer be ignored.

In 2009, biologist Matsumoto decided that a change in shrimp aquaculture production practices was fundamental to future SEA PRO business.

Recycling the nutrients discharged into the environment by traditional aquaculture systems, he believed, offered a promising opportunity to make a change.

See MEXICAN SHRIMP, next page

Charles "Sandy" Harris photos

Mexican shrimp

Continued from previous page

So production management for *in vitro* bioremediation of aquaculture nutrient wastes was planned.

This was to be an effort to reduce the requirements for costly high protein shrimp feed formulations, and at the same time,

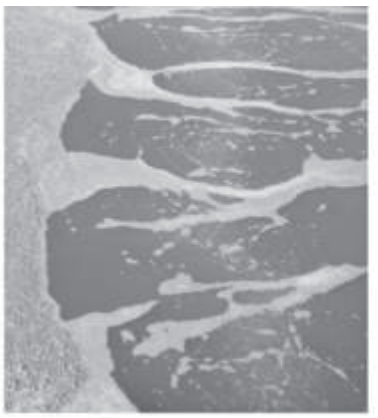
achieve significantly improved feed conversion ratios to enhance economic productivity of the shrimp farming enterprise.

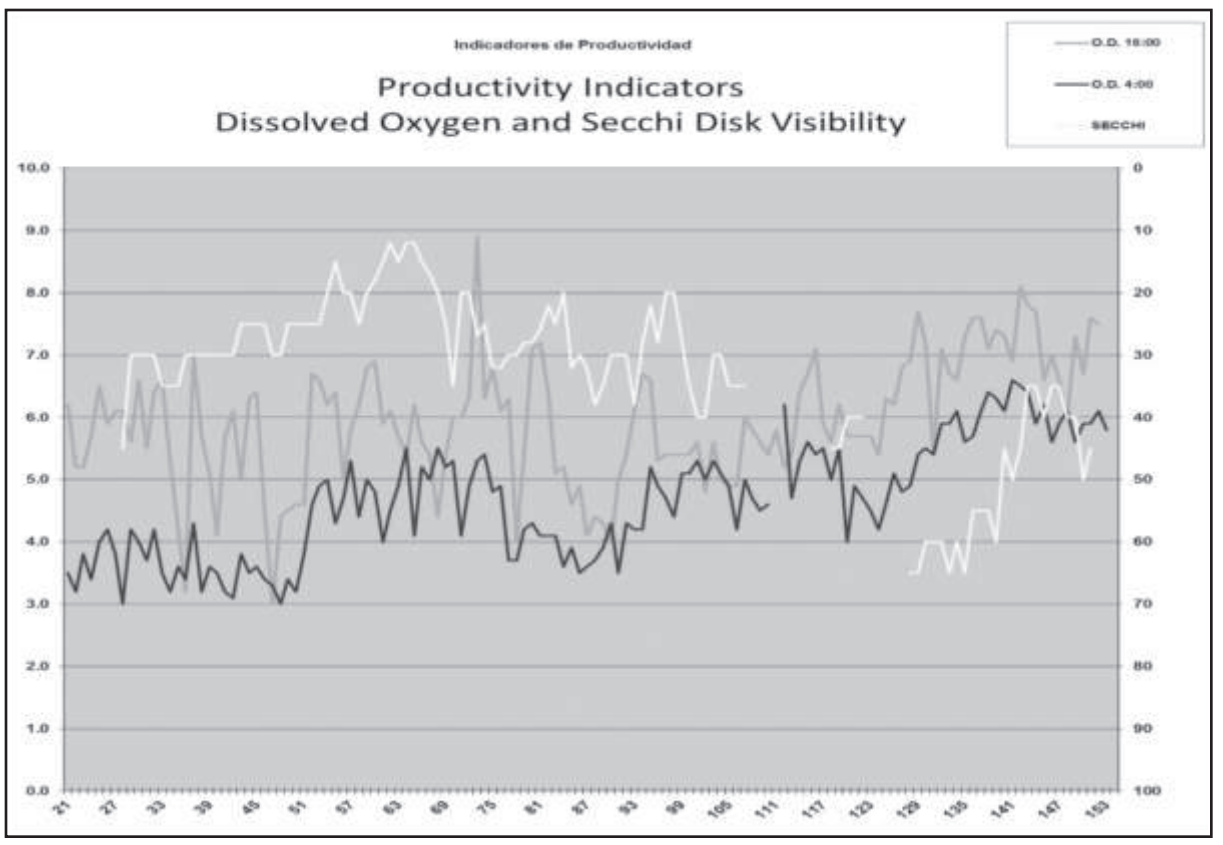
These factors provided sufficient motivation to build Mexico's first bio-floc shrimp production project.

In Mexico's northwestern coastal Gulf of California region, Construcción e Ingeniería Ambiental, SA de CV (CIASA) had been working to provide systems design engineering, procurement, and construction services for commercial aquaculture installations by specifying proprietary technologies that could competitively advance survival and production yields.

CIASA is the engineering/procurement/construction (EPC) contractor for a new 1,000-hectare aquafarm development along the Rio Fuerte in northern Sinaloa called "Project Paradise."

For several years, SEA PRO and CIASA had debated technology options but in 2009, finally joined forces to design and plan the first super-



Kgs feed consummed	13150
Kgs of shrimp harvested	9341
FCR	1.41: 1
Kgs of molasses applied	7869

Charles "Sandy" Harris photos

high-density closed bio-floc production system in northwest Mexico.

During early 2010, supplies and materials were procured and installations begun according to CIASA specifications. SEA PRO filled the pilot pond in May, 2010.

During the 2010 shrimp production cycle, the incidence of White Spot Virus Syndrome (WSSV) became prevalent in the region with an estimated 90 farms in Sonora experiencing significant losses as the disease reached into northern Sinaloa by early June, about the time SEA PRO was preparing to stock *L. vannamei* PL15 at super high densities not common to the regional industry.

By this time traditional producers were harvesting ponds at 8-10 grams to avoid losing the entire year 2010 harvest.

Prior to stocking, SEA PRO had elected to comply with consulting recommendations for applying routine biweekly treatments of LYMNOZYME® preblend probiotic formula provided for the bio-floc project by Keeton Industries of Wellington, CO.

LYMNOZYME® was selected as the preferred probiotic formulation to confront the possibility of a disease outbreak in the SEA PRO bio-floc trial since there were reports of improved biosecurity for shrimp farms in Ecuador, Brazil, and Vietnam.

50 gram granular packages were incubated for 48 hours in nutrient

See MEXICAN SHRIMP, next page

Mexican shrimp –

Continued from previous page
concentrated seawater obtained from the SEA PRO production pond and applied every 15 days – from stocking up to two weeks prior to harvest.

No bacterial disease problems or WSSV outbreaks were encountered.

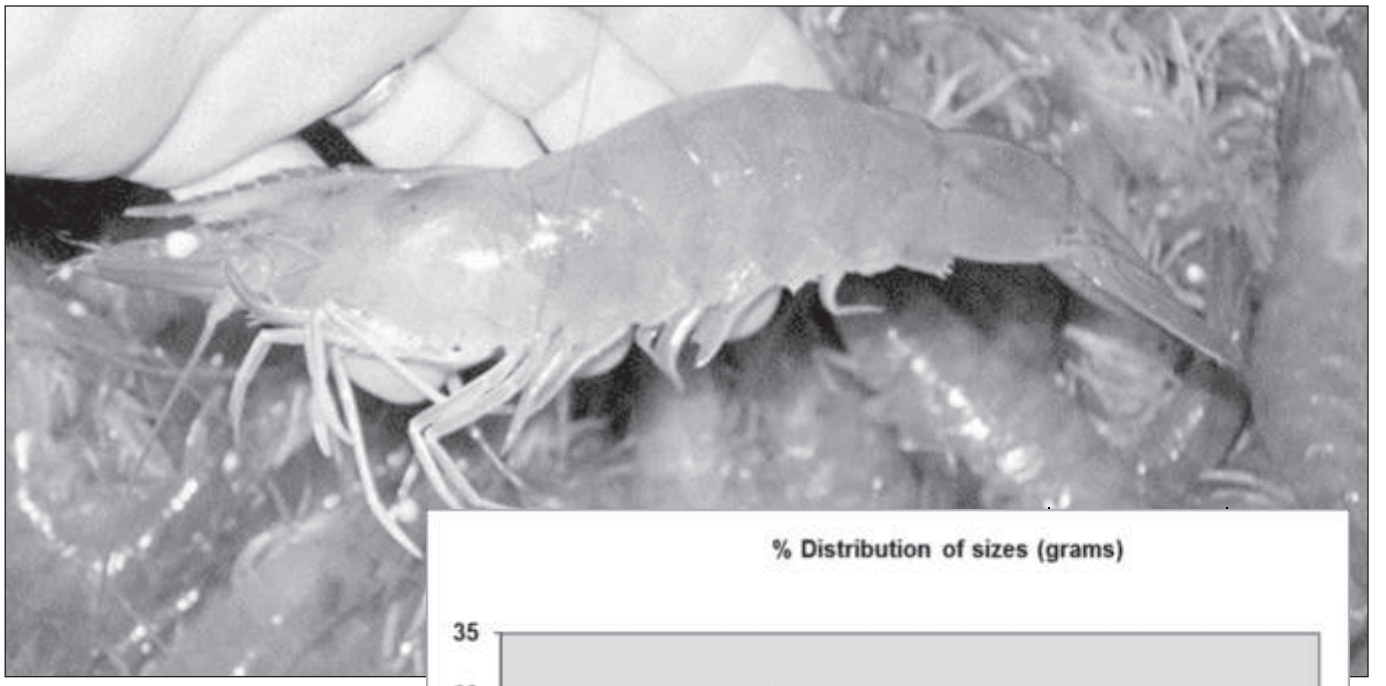
Of the 700,000 PL's stocked in June, following the final harvest in November Matsumoto reported a total shrimp biomass harvested to be 9,341 kilograms made up of 601,800 organisms for an approximate survival rate in excess of 85%.

By late August and early September, daytime water temperatures averaged 33°-35°C. With feeding rates in excess of 160 kgs/ha/day and the shrimp biomass exceeding 7+ tons/hectare, significant bacterial bio-floc on the pond surface was generated daily.

With salinity maintained at a 26 ppt average, and ammonia nitrogen maintained by balancing carbon inputs via added sugar cane molasses at an average of 1.5 mg/l, feed protein levels were reduced from 32% to 26% to lower feed costs.

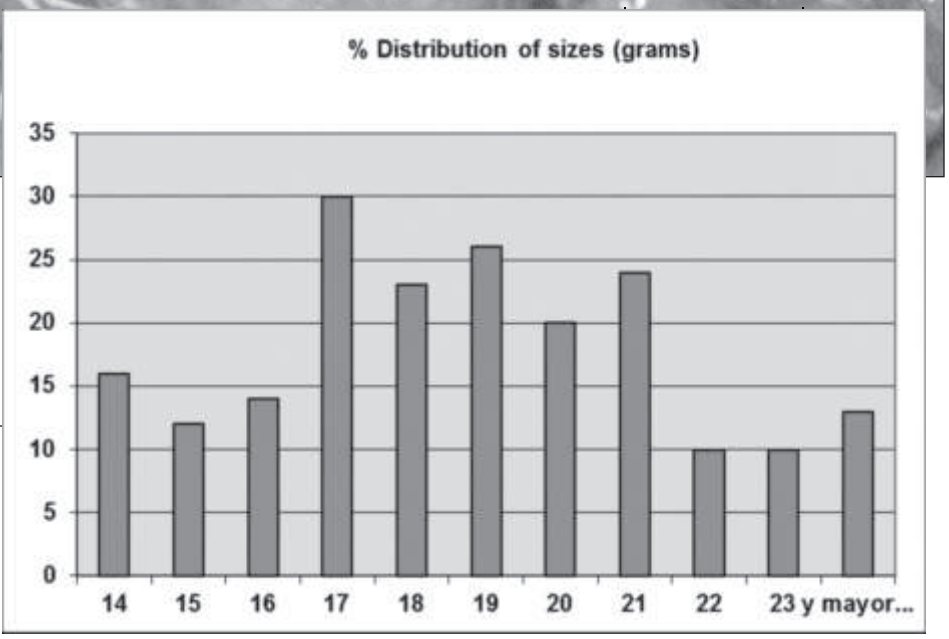
Due to heavy organic loading on a daily basis, and with ammonia nitrogen fluctuating in the closed system, SEA PRO elected to apply additional treatments of waste sludge reducer bacteria provided by Keeton Industries, using their WSR™ preblend of beneficial microbes.

The objective was to keep sludge production and ammonia levels under



Charles "Sandy" Harris photo

Pacific white shrimp harvested from SeaPro bio-floc system at Topolobampo, Gulf of California, Sinaloa, Mexico at 10.9 tons/hectare, Nov. 2010.



control while optimizing dissolved oxygen (DO) profiles for producing beneficial microbial bio-floc.

Feeding rates were managed by routine evaluation of multiple production parameters of DO, TAN levels, pH, temperature, and by incorporating feed consumption sampling trays, exhibiting an 8 gram animal by Aug. 13, 2010.

A final feed conversion ratio (FCR) was calculated at1.41:1, based on total round weight harvested and total feed applied – molasses application not included as part of the FCR calculation.

Partial harvesting was implemented with the initial harvest in September to service strong a national market demand for 12-15 gram whole shrimp.

The second harvest was in October for a special client order, and the final harvest was completed Nov. 5, as required by aquaculture sanitation agreements regarding biosecurity policies for regional WSSV management.

Charles "Sandy" Harris is a biologist and director of Construcción e Ingeniería Ambiental, SA de CV (CIASA) of Los Mochis, Sinaloa, Mexico.

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SEA PRO SHRIMP BIO-FLOC PRODUCTION SUMMARY

700,000 PL's stocked Harvest	Kgs Harvested	Average Weight Grams	Individual Count
Preharvest	3,500	12.58	278,219
Secondary harvest	1,000	16.76	59,666
Final harvest	4,841	18.34	263,959
Total harvested (Kgs)	9,341 601,844		601,844
Survival	86.0%		
Yield	**10,615 kgs/ha**		