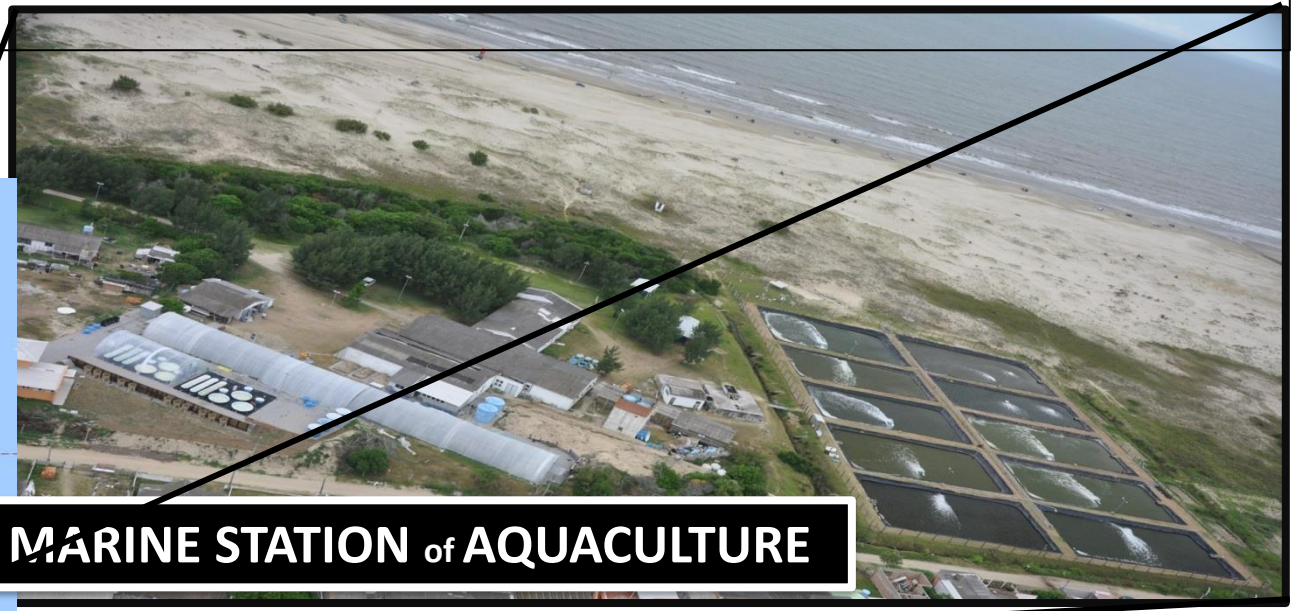
All Atlantic Ocean Sustainable Profitable and Resilient Aquaculture

EVOLUTION OF THE STOCKING DENSITIES FROM INTENSIVE TO HYPERINTENSIVE CULTURE OF *Litopenaeus vannamei* IN BFT SYSTEM

W. Wasielesky*, L. Silveira, D. Krummenauer, V. Rosas, G. Fóes, A. Cardoso, G. Lara, A. Bezerra, A. Silva, C. Froes; M. Holanda, L. Poersch.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863034.

Federal University of Rio Grande (FURG) - Southern Brazil



MARINE STATION of AQUACULTURE

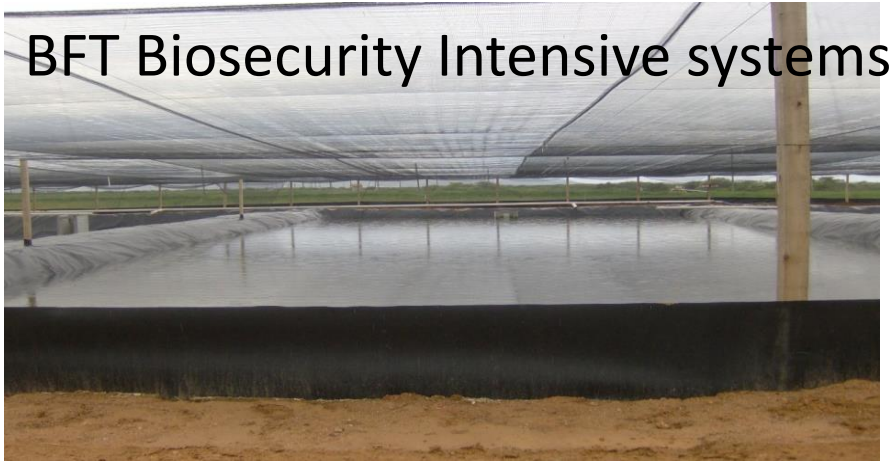
MARINE STATION of AQUACULTURE

Since 2005

Wilson Wasielesky
Luis Poersch
Geraldo Fóes
Dariano Krummenauer
Alessandro Cardoso
PosDocs, PhD and MSc students (40)

BIOFLOC – Intensive systems

FACILITIES: Lined pond and Raceways



Marine Station of Aquaculture –
Fed. Univ. of Rio Grande - Brazil

Evolution/Historic of marine shrimp culture: Stocking densities

Shrimp culture in 80´s

Low stocking densities – 3 or 7 or 10/m²

Low productivities:
0.3-1.0 ton/ha/harvest
=
30 – 100 g/ m²/harvest

Shrimp culture in 90´s

Higher stocking densities – from 10 to 30/m²

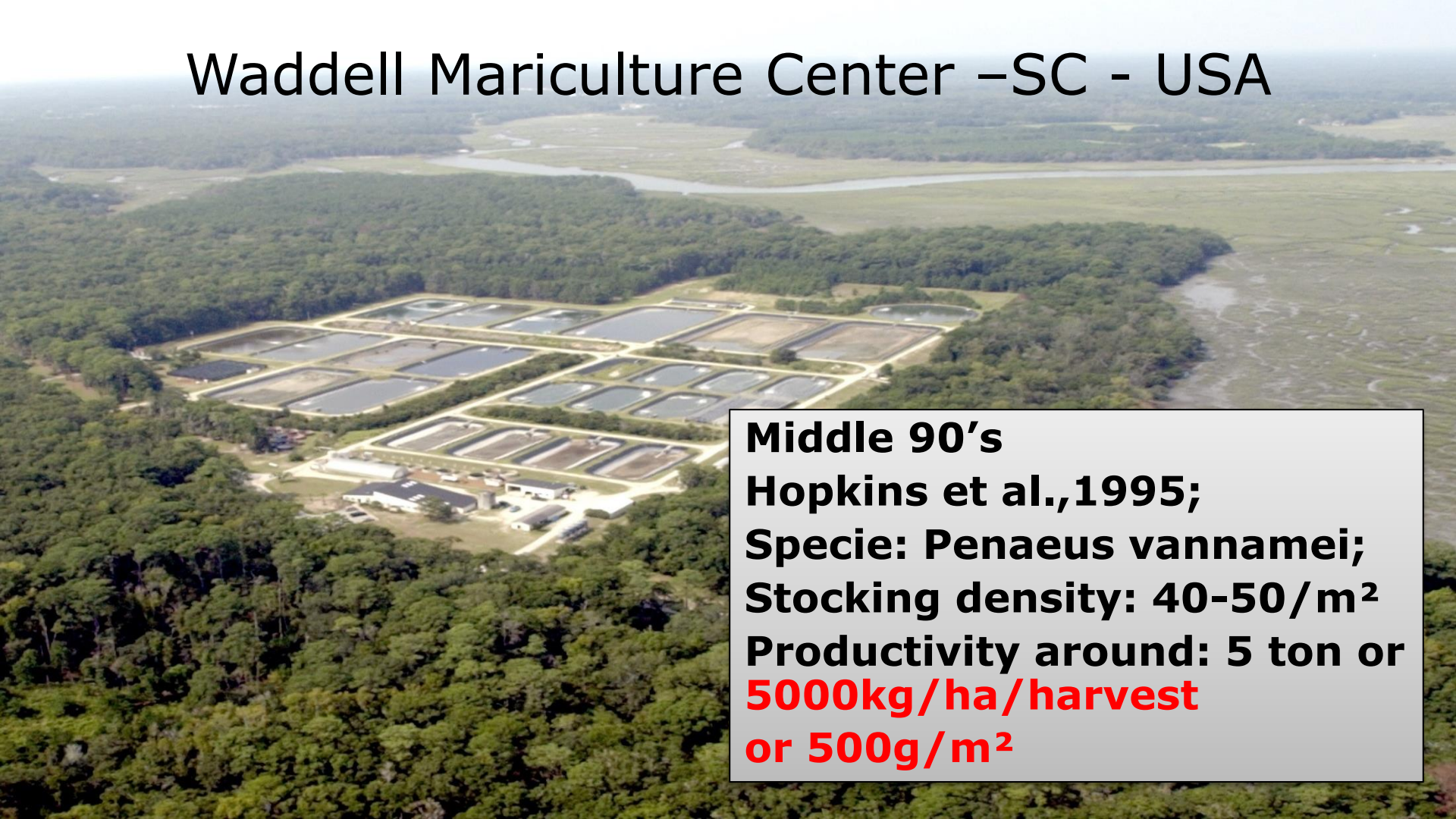
Productivities:

1.0 to 2.0 ton/ha/harvest

=

100 – 200g/m²/harvest

Waddell Mariculture Center –SC - USA



Middle 90's
Hopkins et al.,1995;
Specie: Penaeus vannamei;
Stocking density: 40-50/m²
Productivity around: 5 ton or 5000kg/ha/harvest or 500g/m²

Browdy, 2001:

-Belize Aquaculture

-Intensive system based in bioflocs – 100 to 150 / m²

-15 ton/ha/harvest = 1.5 kg/m²

Belize Aquaculture


BFT System : Asian Southeast Last 12 years
(Lined ponds from 0.2 to 2.0 ha)
Indonesia, Thailand, others
Production from 1 to 2 kg/m²
Equivalent to 10 to 20 ton/ha
Indonesia: Wasielesky, 2013


Greenhouse for
BFT system in
WMC, SC, USA
US Marine
Shrimp Farming
Program
2000

WMC Raceway Harvest Data

	Nov. 2000		Jan. 2002			Mar. 2003	Nov. 2004
Days	140	140	132	132	140	76*	113
Density (shrimp/m²)	200	200	300	300	300	300	420
Final Weight (g)	19.3	18.9	14.6	15.4	17.1	16.6	21.0
Survival (%)	60.1	63.9	70.5	71.7	55.2	91	79.5
Productivity (kg/m²)	2.3	2.4	3.1	3.3	2.8	4.5	6.8
FCR	2.8	2.8	1.8	2.0	1.9	1.5	1.9

Stokes et al 2004

Highest production in raceways (USA)

2008 - In Oceanic Institute (Hawaii, EUA), **Otoshi *et al*. reported 10.3 kg/ m^2 (103 ton/ha)** . Initial stocking density of 828 Shrimp/m^2 (Final stocking density of 562 shrimp/m^2 .

2009 – **Samocha, et al reported production up to 9.75 kg/m3** in Corpus Christi (Texas) with initial stocking density of 530/m^3

Relationships with stocking density

Cannibalism

Stress

Density-dependent effect

Temperature

Competition for food

Water quality(nitrogen, oxygen, etc.)

Inverse relationship Growth

Artificial substrates reduce relatively stocking density

Inverse relationship Survival

Turbidity /transparency

Compensatory growth with density reduction - Multiphase systems

Compensatory growth with density reduction - Partial harvesting

JOURNAL OF THE
WORLD AQUACULTURE SOCIETY

Vol. 42, No. 5
October, 2011

Superintensive Culture of White Shrimp, *Litopenaeus vannamei*, in a Biofloc Technology System in Southern Brazil at Different Stocking Densities

DARIANO KRUMMENAUER

Estação Marinha de Aquacultura, Instituto de Oceanografia, Universidade Federal do Rio Grande – FURG, Rio Grande, RS 96201-900, Brazil

SILVIO PEIXOTO AND RONALDO OLIVEIRA CAVALLI

Departamento de Aquicultura e Pesca, Universidade Federal Rural de Pernambuco - UFRPE, Recife, PE 52171-900, Brazil

LUIS HENRIQUE POERSCH AND WILSON WASIELESKY, JR.[1]

Effect of stocking densities - Carried out in 2007
Published in 2011

TABLE 1. *Performance parameters of* Litopenaeus vannamei *cultured in a bioflocs technology system at different stocking densities over 120 d.*[1]

	150 shrimp/m^2	300 shrimp/m^2	450 shrimp/m^2
Initial weight (g)	0.96 ± 0.28^a	0.96 ± 0.28^a	0.96 ± 0.28^a
Final weight (g)	15.6 ± 1.70^a	16.8 ± 0.93^a	9.0 ± 1.20^b
Survival (%)	92.0 ± 2.55^a	81.2 ± 3.09^b	75.0 ± 3.74^c
Biomass (kg/tank)	150.7 ± 25.0^a	286.5 ± 39.5^b	212.6 ± 44.8^c
FCR	1.40 ± 0.09^a	1.29 ± 0.05^a	2.41 ± 0.55^b
WGR (g/wk)	0.85 ± 0.06^a	0.92 ± 0.03^a	0.47 ± 0.09^b
Productivity (kg/m^2)	2.15 ± 3.8^a	4.09 ± 6.8^b	3.04 ± 7.0^c

FCR = feed conversion rate, WGR = weekly growth rate.

[1]Values are means of replicates ± standard deviation. Different superscripts in the same row indicate significant differences ($P < 0.05$).


How to increase stocking densities???

Improvements in Biofloc Systems management

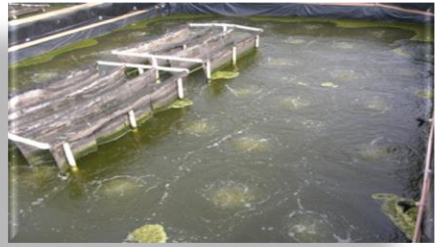
Culture facilities
The use of microbial loop
Nitrification process
Alkalinity/pH/CO_2
TSS
Aeration Systems
Vertical substrates
Water management
Reuse of water
Stocking densities
Feeding management
Probiotics

It was started to develop new technologies of each part of the system

Greenhouse enclosed raceways for shrimp culture in superintensive biofloc system.

Marine Station of Aquaculture - FURG, Brazil.

Better biofloc formation, nitrification process and shrimp biomass was about 60% higher in blower (Diffused-air).



>

>

Aquacult Int (2017) 25:147–162
DOI 10.1007/s10499-016-0019-8

CrossMark

The use of different aerators on *Litopenaeus vannamei* biofloc culture system: effects on water quality, shrimp growth and biofloc composition

Gabriele Lara[1] · Dariano Krummenauer[1] · Paulo C. Abreu[1] · Luís H. Poersch[1] · Wilson Wasielesky Jr.[1]

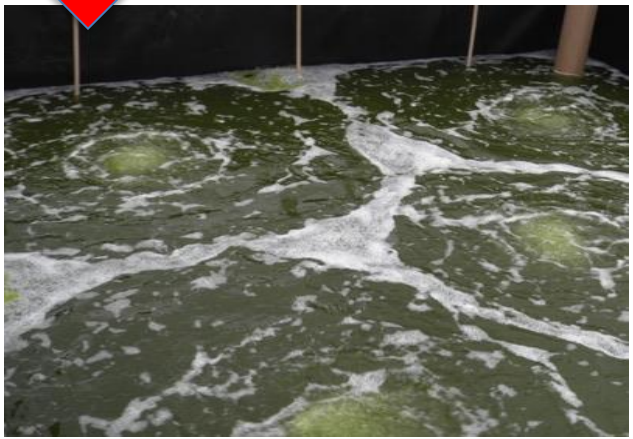
Received: 13 August 2015 / Accepted: 9 May 2016 / Published online: 18 May 2016
© Springer International Publishing Switzerland 2016

Abstract This study evaluated the effects of different aeration types on water quality, shrimp

Mixed aeration system: Injector (a^3) and aerotubes

Vertical and horizontal movement of water

Vertical movement of water



Brazil Study Results Encouraging For Injector Aeration In Super-Intensive Shrimp Culture

Dariano Krummenauer, Ph.D.
Laboratório de Carcinocultura
Instituto de Oceanografia
Universidade Federal do Rio Grande
Rio Grande (R.S.), 96201-900, Brazil
darianok@gmail.com

Bob Advent
Advent Environmental Systems LLC
Lake Mary, Florida, USA

Carlos Gaona, Ph.D.
Geraldo Foes, Ph.D.
Aline Bezerra, M.S.
Alessandro Cardozo, Ph.D.
Luis Poersch, Ph.D.
Wilson Wasielesky, Jr., Ph.D.
Laboratório de Carcinocultura
Instituto de Oceanografia
Universidade Federal do Rio Grande

Global Aquaculture Advocate September/October 2015

Total Suspended Solids control

Aquaculture Research

Aquaculture Research, 2015, 1–10 doi: 10.1111/are.12949

Effect of different total suspended solids levels on a *Litopenaeus vannamei* (Boone, 1931) BFT culture system during biofloc formation

Carlos Augusto Prata Gaona[1], Marcos Souza de Almeida[1], Veronica Viau[2], Luis Henrique Poersch[1] & W...

[1]Marine Station ...
[2]Biology of Repr...
University of Bue...

Correspondence:
C.P. 474, Rio Gran...

Aquacult Int
DOI 10.1007/s10499-016-9983-2

Biofloc management with different flow rates for solids removal in the *Litopenaeus vannamei* BFT culture system

Carlos Augusto Prata Gaona[1] · Fabiane da Paz Serra[1] · Plínio Schmidt Furtado[1] · Luis Henrique Poersch[1] · Wilson Wasielesky Jr.[1]

TSS<400mg/L

SS<20 ml/L

Effect of Solids Removal on Production of Shrimp

The Effect of Solids Removal on Water Quality, Growth and Survival of *Litopenaeus vannamei* in a Biofloc Technology Culture System

C.A.P. Gaona, L.H. Poersch, D. Krummenauer, G.K. Foes, W.J. Wasielesky

Universidade Federal do Rio Grande – Instituto de Oceanografia – Programa de Pós-graduação em Aquicultura. C.P. 474, CEP: 96201-900, Rio Grande, RS, Brazil. e-mail: carlosgaona@ig.com.br

Keywords: Biofloc, *Litopenaeus vannamei*, solids removal, suspended solids, clarification

International Journal of Recirculating Aquaculture

TSS were kept below 400 mg/L

Tool: Settling tanks (clarifiers)

entrance exit

Control of Alkalinity/pH/CO_2

Contents lists available at SciVerse ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Effect of calcium hydroxide, carbonate and sodium bicarbonate on water quality and zootechnical performance of shrimp *Litopenaeus vannamei* reared in bio-flocs technology (BFT) systems

Plínio S. Furtado, Luís H. Poersch, Wilson Wasielesky Jr. *

Marine Station of Aquaculture, Institute of Oceanograph

Application of different doses of calcium hydroxide in the farming shrimp *Litopenaeus vannamei* with the biofloc technology (BFT)

Plínio S. Furtado · Carlos A. P. Gaona · Luis H. Poersch · Wilson Wasielesky Jr.

Received: 20 June 2013 / Accepted:
© Springer Science+Business Medi

Abstract The reduction in al

Aquacult Int (2015) 23:345–358
DOI 10.1007/s10499-014-9819-x

The effect of different alkalinity levels on *Litopenaeus vannamei* reared with biofloc technology (BFT)

Plínio S. Furtado · Luis H. Poersch · Wilson Wasielesky Jr.

Alk >150mg$CaCO_3$/L

pH about 7.8 (7.4-8.2)

< 20 mgCO_2/L (5)

Vertical substrates
(Needlona)

Effects on nitrification, feeding and stocking densities

The amount of vertical substrates would be 100 % of lateral surface of the RW

Aquacult Int
DOI 10.1007/s10499-017-0151-0

The use of biofilm and different feeding rates in biofloc culture system: the effects in shrimp growth parameters

Gabriele Lara[1] · Marcelo Honda[1] · Luís Poersch[1] · Wilson Wasielesky Jr.[1]

Received: 1 Aug
© Springer Inter

Aquacult Int (2016) 24:921–930
DOI 10.1007/s10499-015-9961-0

Biofilm versus biofloc: Are artificial substrates for biofilm production necessary in the BFT system?

Lise M. H. Ferreira[1] · Gabriele Lara[1] · Wilson Wasielesky Jr.[1] · Paulo Cesar Abreu[1]

Received: 24 March 2015 / Accepted: 24 November 2015 / Published online: 7 December 2015
© Springer International Publishing Switzerland 2015

Water management – Reuse of biofloc water for better nitrification

JOURNAL OF THE
WORLD AQUACULTURE SOCIETY

Vol. 45, No. 1
February, 2014
doi: 10.1111/jwas.12093

The Reuse of Water on the Culture of Pacific White Shrimp, *Litopenaeus vannamei*, in BFT System

DARIANO KRUMMENAUER[1]

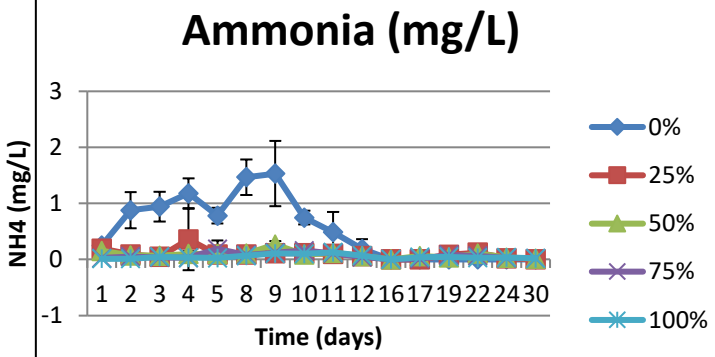
Laboratório de Carcinocultura, Instituto de Oceanografia - Estação Marinha de Aquacultura, Universidade Federal do Rio Grande (FURG), Rio Grande 96201-900, RS, Brazil

TZACHI SAMOCHA

Texas A&M AgriLife Research Mariculture Laboratory at Flour Bluff, 4301 Waldron Road, Corpus Christi, Texas 78418, USA

LUIS POERSCH, GABRIELE LARA AND WILSON WASIELESKY JR.

Laboratório de Carcinocultura, Instituto de Oceanografia - Estação Marinha de Aquacultura, Universidade Federal do Rio Grande (FURG), Rio Grande 96201-900, RS, Brazil



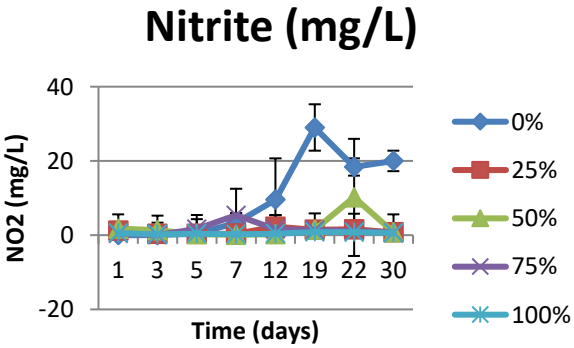


TABLE 3. *Performance parameters of* Litopenaeus vannamei *in a 30-d study with no water exchange and with biofloc-rich water.*[1]

	Percent enrichment with biofloc-rich water				
	0	25	50	75	100
Final weight (g)	7.37 ± 0.11^{a}	8.30 ± 0.11^{b}	8.28 ± 0.09^{b}	8.42 ± 0.13^{b}	8.01 ± 0.10^{b}
Survival (%)	92.13 ± 6.5^{a}	91.0 ± 4.2^{a}	90.93 ± 4.1^{a}	91.60 ± 6.24^{a}	99.06 ± 4.49^{a}
Weekly growth rate (g)	0.90 ± 0.01^{a}	1.12 ± 0.02^{b}	1.11 ± 0.02^{b}	1.14 ± 0.03^{b}	1.05 ± 0.02^{b}
Feed conversion ratio	1.52 ± 0.12^{a}	1.23 ± 0.18^{b}	1.19 ± 0.17^{b}	0.84 ± 0.19^{b}	1.09 ± 0.21^{b}
Yield/kg/m^3	2.12 ± 0.31^{a}	2.35 ± 0.40^{a}	2.35 ± 0.59^{a}	2.41 ± 0.55^{a}	2.48 ± 0.67^{a}

[1]Values are means of replicates ± SD. Different superscripts in the same row indicate significant differences ($P < 0.05$).

Probiotics to avoid vibrio infection

Journal of Applied Aquaculture, 26:370–379, 2014
Copyright © Taylor & Francis Group, LLC
ISSN: 1045-4438 print/1545-0805 online
DOI: 10.1080/10454438.2014.965575

Taylor & Francis
Taylor & Francis Group

The Effect of Probiotics in a *Litopenaeus vannamei* Biofloc Culture System Infected with *Vibrio parahaemolyticus*

DARIANO KRUMMENAUER[1], LUIS POERSCH[1], LUIZ A. ROMANO[2], GABRIELE R. LARA[1], PEDRO ENCARNAÇÃO[3], and WILSON WASIELESKY, JR.[1]

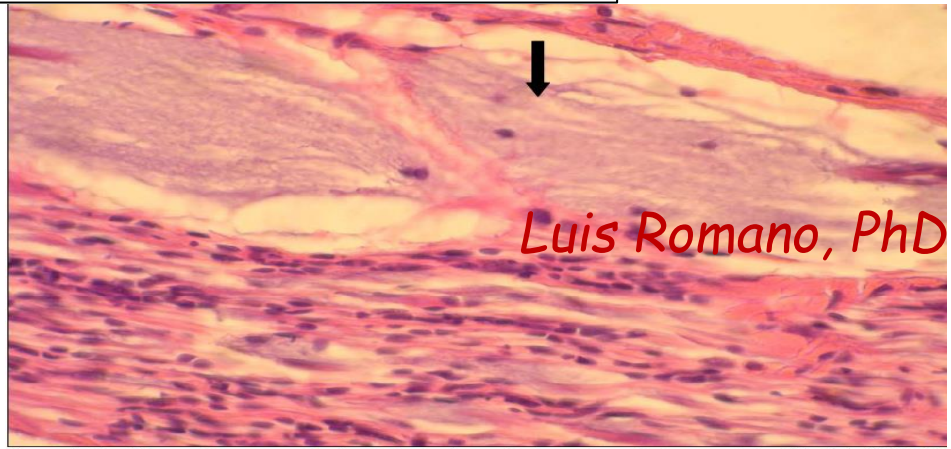
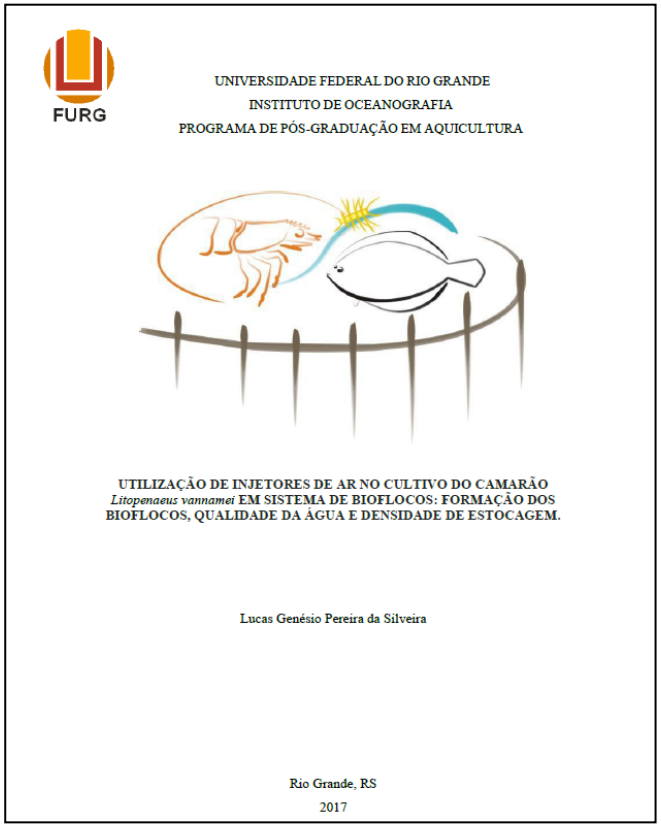


Figura 3: Cordón nervioso con colonias de bacterias azuladas pertenecientes a vobrios (flecha). H-E 20 X



FURG

UNIVERSIDADE FEDERAL DO RIO GRANDE
INSTITUTO DE OCEANOGRAFIA
PROGRAMA DE PÓS-GRADUAÇÃO EM AQUICULTURA

UTILIZAÇÃO DE INJETORES DE AR NO CULTIVO DO CAMARÃO *Litopenaeus vannamei* EM SISTEMA DE BIOFLOCOS: FORMAÇÃO DOS BIOFLOCOS, QUALIDADE DA ÁGUA E DENSIDADE DE ESTOCAGEM.

Lucas Genésio Pereira da Silveira

Rio Grande, RS
2017

Master Thesis

Including new management and technologies

400 shrimp/m²
500 shrimp/m²
600 shrimp/m²

Received: 25 July 2019 | Revised: 30 March 2020 | Accepted: 25 April 2020

DOI: 10.1111/jwas.12718

Check for updates

APPLIED STUDIES

Journal of the World Aquaculture Society

WILEY

Hyperintensive stocking densities for *Litopenaeus vannamei* grow-out in biofloc technology culture system

Lucas Genesio P. da Silveira | Dariano Krummenauer | Luís H. Poersch | Victor Torres Rosas | Wilson Wasielesky Jr

Instituto de Oceanografia, Programa de Pós-Graduação em Aquicultura – Laboratório de Carcinocultura, Universidade Federal do Rio Grande (FURG), Rio Grande, Brazil

Correspondence
Wilson Wasielesky, Instituto de Oceanografia, Programa de Pós-Graduação em Aquicultura – Laboratório de Carcinocultura, Universidade Federal do Rio Grande (FURG), Rio Grande

Abstract

Searching for potential increases in shrimp yields, this study evaluated the effects of different stocking densities on water quality and production performance of juvenile shrimp, *Litopenaeus vannamei*, reared on a biofloc-dominated system throughout 77 days. The organisms (1.27 ± 0.54 g) were stocked at three densities, 400 (T400), 500 (T500), and

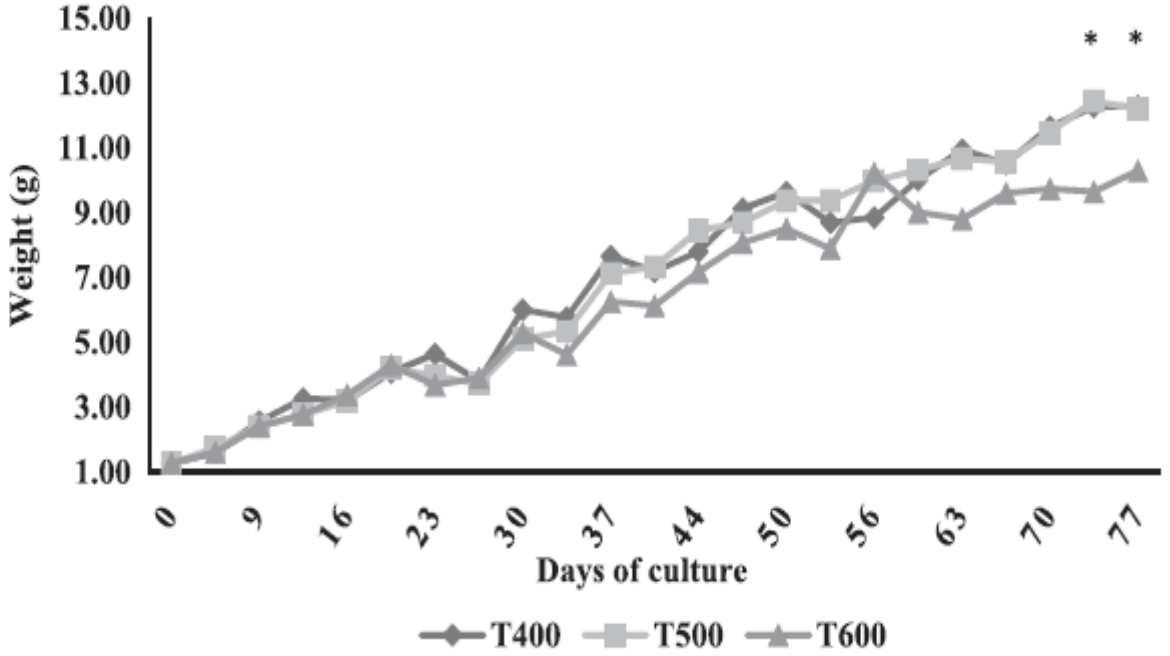


FIGURE 1 Shrimp growth at different stocking densities in a BFT system, represented by mean weight as a function of *Litopenaeus vannamei* grow-out. (*) Indicate that a significant differences ($p < .05$) were observed by the one-way analysis of variance

Table 2 - Means and Standard deviation of the *L. vannamei* zootechnical performance parameters during 78 days BFT grow-out with different stocking densities. Initial and final weight (g), final biomass (Kg $tank^{-1}$), weekly growth (g $week^{-1}$), feed conversion rate (FCR), survival (%), and yields.

	Treatments		
Parameters	T400	T500	T600
Initial Weight	1.27 ± 0.54	1.27 ± 0.54	1.27 ± 0.54
Final Weight	12.3 ± 5.53[a]	12.2 ± 3.89[a]	10.2 ± 3.49[b]
Initial Biomass	17.78	22.22	26.67
Final Biomass	140.83 ± 1.91[b]	162.97 ± 0.16[ab]	174.35 ± 13.57[a]
Weekly Growth	1.10 ± 0.11	1.09 ± 0.02	0.90 ± 0.08
FCR	1.79 ± 0.02	1.82 ± 0.02	2.09 ± 0.20
Survival	82.31 ± 9.13	76.67 ± 2.31	81.05 ± 11.08
Yield (Kg m^{-2})	3.52 ± 0.05[b]	4.02 ± 0.06[ab]	4.22 ± 0.40[a]
Yield (Kg m^{-3})	4.39 ± 0.07[b]	5.03 ± 0.08[ab]	5.27 ± 0.49[a]

[(1)]Different superscripts in the same row indicate significant differences according to the Tukey test (α = 0.05).

No significant differences between 500 and 600/m^2

How to increase productivity in BFT Systems?

Pond/size	System	Energy Input		Density	Partial	Harvest				Production		FCR		SR	Energy Efficiency -kg/HP	
		(Pond)	(Ha)	(M2)		DoC	Biomas (Kg)	Size No/kg	MBW (gr)	Kg/Pd	Kg/Ha	GP	Feed	(%)	Std Capacity	Efficiency
1	Phyto	16 (PW)	27 (PW)	100	1	118	434	47	21.28							
5896 m2					Final	127	11,027	43	23.26	11,461	19,439	0	1.60	75.72	560*	720
2	Bio Floc	18 (PW)	31 (PW)	145	1	108	2,092	59	16.95							
5896 m2					2	121	1,016	55	18.18	13,508	22,910	0.59	1.20	84.07	680*	739
					Final	131	10,400	52	19.23							
3	Bio Floc	18 (PW)	30 (PW)	146	1	109	2,108	56	17.86							
5940 m2					2	122	999	50	20.00	14,386	24,219	0.56	1.14	80.95	680*	807
					Final	130	11,279	47	21.28							
4	Bio Floc	16 (PW)	34 (PW)	257	1	85	1,962	93	10.75							
4704 m2					2	99	1,896	75	13.33							
					3	113	1,871	62	16.13	17,963	38,229	0.58	1.12	86.54	680*	1,124
					4	127	2,587	56	17.86							
					5	134	2,475	53	18.87							
					Final	155	7,192	47	21.28							
5	Bio Floc	9 (PW)	36 (PW)	280	1	84	924	86	11.63							
2,500 m2		3 (BL)	12 (BL)		2	99	1,455	74	13.51							
					3	113	1,324	61	16.39	12,371	49,484	0.48	1.11	102.35	680*	1,031
					4	127	1,448	57	17.54							
					5	134	1,043	54	18.52							
					Final	155	6,177	50	20.00							
6	Bio Floc	7 (PW)	28 (PW)	145	1	110	1,166	51	19.61							
2500 m2		3 (BL)	12 (BL)		2	124	367	49	20.41	6,545	26,180	0.50	1.10	86.35	680*	655
					Final	127	5,012	47	21.28							
7	Bio Floc	9 (PW)	36 (PW)	145	1	110	892	61	16.39							
2500 m2		3 (BL)	12 (BL)		2	124	323	57	17.54	6,615	26					
					Final	130	5,400	54	18.52							
										82,849	29					

Nyan Taw, 2008

Nyan Taw (2008) and Wasielesky et al (2013) detected important effects of compensatory growth for *L. vannamei* in intensive and nursery BFT systems

Nursery of *Litopenaeus vannamei* Reared in a Biofloc System: The Effect of Stocking Densities and Compensatory Growth

Author(s): Wilson Wasielesky , Jr., Charles Froes , Geraldo Fóes , Dariano Krummenauer , Gabriele Lara and Luis Poersch

Source: Journal of Shellfish Research, 32(3):799-806. 2013.

Published By: National Shellfisheries Association

DOI: http://dx.doi.org/10.2983/035.032.0323

URL: http://www.bioone.org/doi/full/10.2983/035.032.0323

Aquaculture 546 (2022) 737408

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aquaculture

The effect of partial harvest on production and growth performance of *Litopenaeus vannamei* reared in biofloc technologic system

Lucas Genésio Pereira Da Silveira *, Dariano Krummenauer, Luís Henrique Poersch, Geraldo Kipper Fóes, Victor Torres Rosas, Wilson Wasielesky Jr

Universidade Federal do Rio Grande (FURG), Instituto de Oceanografia, Programa de Pós-Graduação em Aquicultura, Laboratório de Carcinocultura, Rio Grande, RS, Brazil

Objective

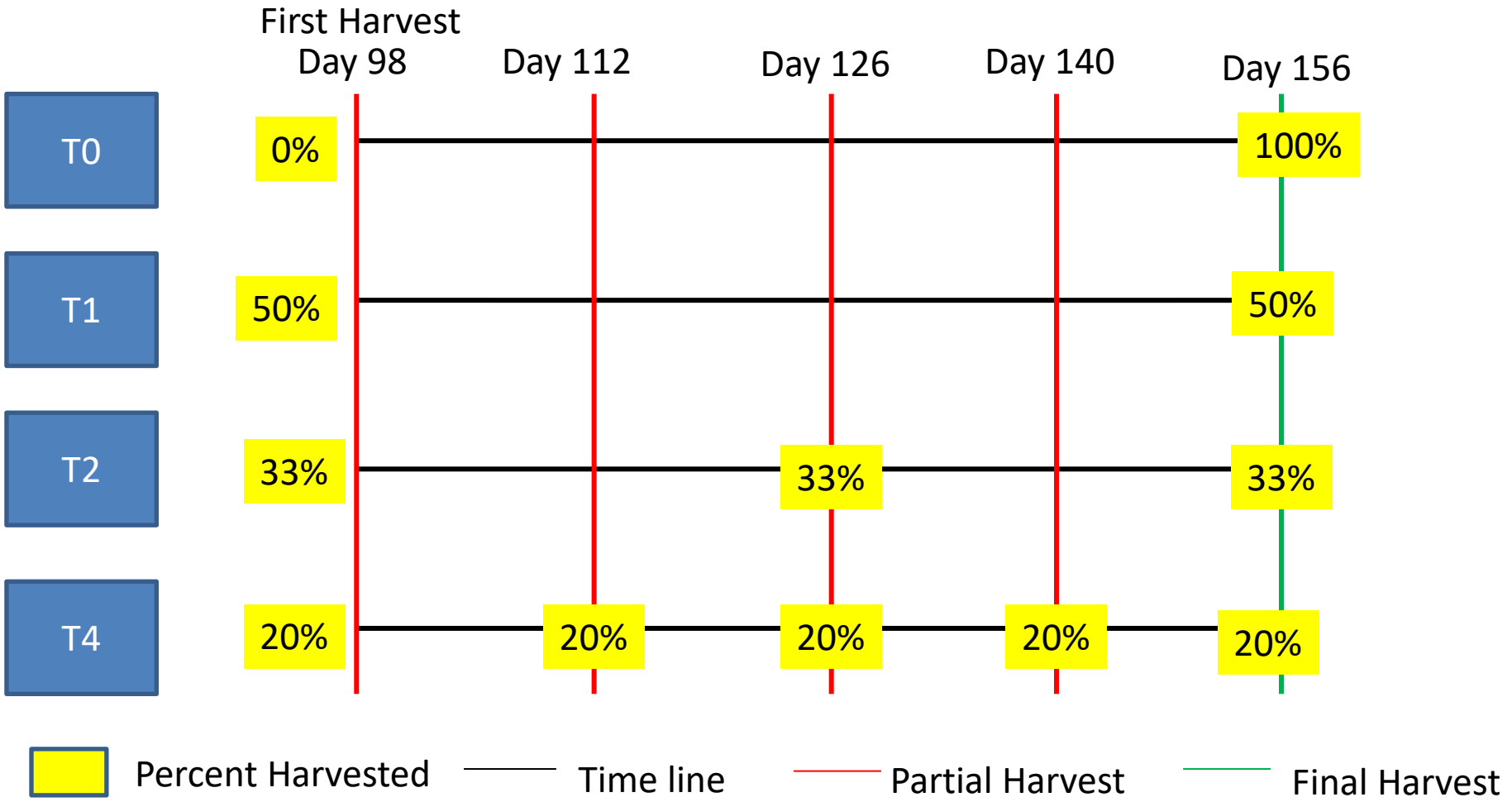
The aim of this study was to evaluate the effect of partial harvest and possible occurrence of compensatory growth of *Penaeus vannamei* in a superintensive biofloc culture system.

Materials and Methods

• Twelve 35.000 L lined greenhouse enclosed raceways

- **Initial stocking density: 500 shrimp/m²;**
- Initial weight: 0.01 g;
- Culture length: 154 days;
- 1st Partial harvest: Day 98;
- 1st Partial harvest weight: 9.7 g.

EXPERIMENTAL DESIGN

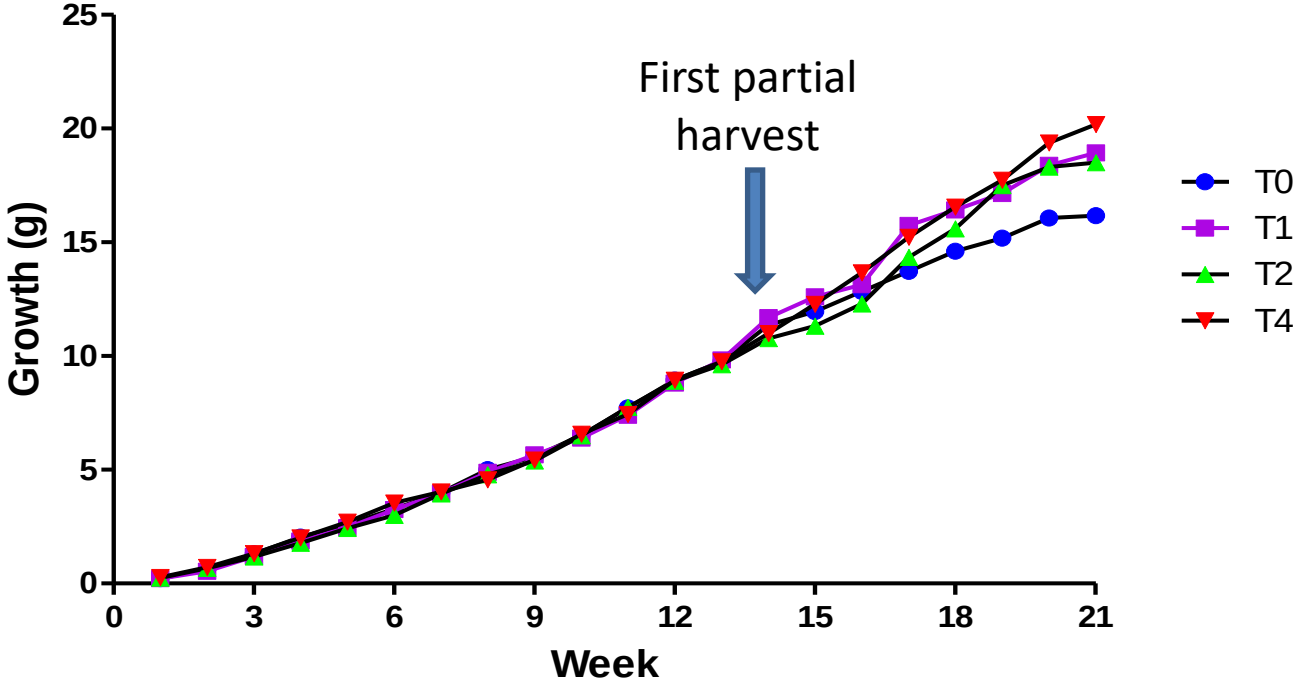


Harvest

Hand Net for partial harvest.

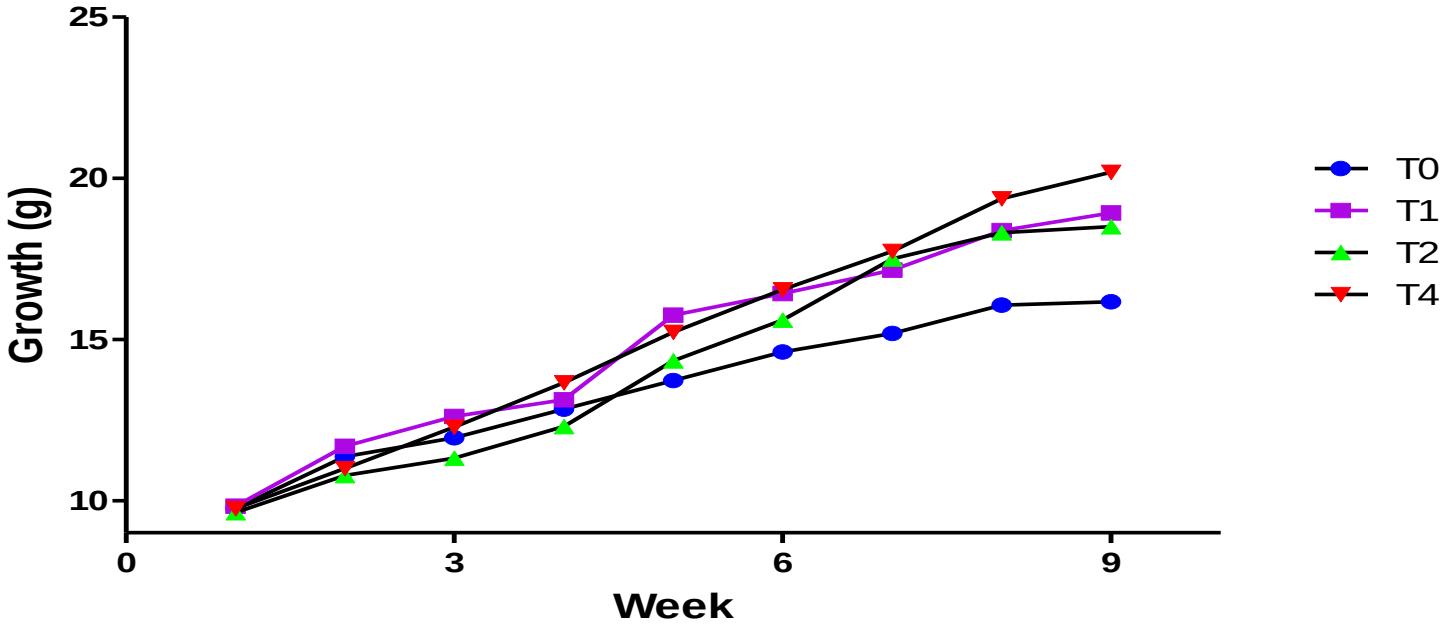
Conical net for final harvest.

Results - Growth



In day 98 it was possible to start to detect differences in growth rates

Results after the first partial harvest



Growth was higher in partial harvest treatments ($P<0.05$).

Results

Treatment	Stocking Density	Harvest	Days	Harvest Weight (g)	Biomass	kg/m² Cumulative	Survival
0	500	F	154	16.36	122.01	3.48	43.67
1	500	1	98	9.75	73.00	2.08	90.95
	250	F	154	18.93	132.06	5.85	
2	500	1	98	9.63	49.36	1.41	90.56
	335	2	126	14.34	75.72	3.57	
	170	F	154	18.50	92.82	6.22	
4	500	1	98	9.75	29.93	0.85	85.04
	400	2	112	12.28	50.69	2.30	
	300	3	126	15.23	36.75	3.35	
	200	4	140	17.74	57.02	4.98	
	100	F	154	20.19	40.55	6.14	

Results

Treatment	Stocking Density	Harvest	Days	Harvest Weight (g)	Biomass	kg/m² Cumulative	Survival
0	500	F	154	16.36	122.01	3.48	43.67
1	500	1	98	9.75	73.00	2.08	90.95
	250	F	154	18.93	132.06	5.85	
2	500	1	98	9.63	49.36	1.41	90.56
	335	2	126	14.34	75.72	3.57	
	170	F	154	18.50	92.82	6.22	
4	500	1	98	9.75	29.93	0.85	85.04
	400	2	112	12.28	50.69	2.30	
	300	3	126	15.23	36.75	3.35	
	200	4	140	17.74	57.02	4.98	
	100	F	154	20.19	40.55	6.14	

Results

Treatment	Stocking Density	Harvest	Days	Harvest Weight (g)	Biomass	kg/m² Cumulative	Survival
0	500	F	154	16.36	122.01	3.48	43.67
1	500	1	98	9.75	73.00	2.08	90.95
	250	F	154	18.93	132.06	5.85	
2	500	1	98	9.63	49.36	1.41	90.56
	335	2	126	14.34	75.72	3.57	
	170	F	154	18.50	92.82	6.22	
4	500	1	98	9.75	29.93	0.85	85.04
	400	2	112	12.28	50.69	2.30	
	300	3	126	15.23	36.75	3.35	
	200	4	140	17.74	57.02	4.98	
	100	F	154	20.19	40.55	6.14	

Results

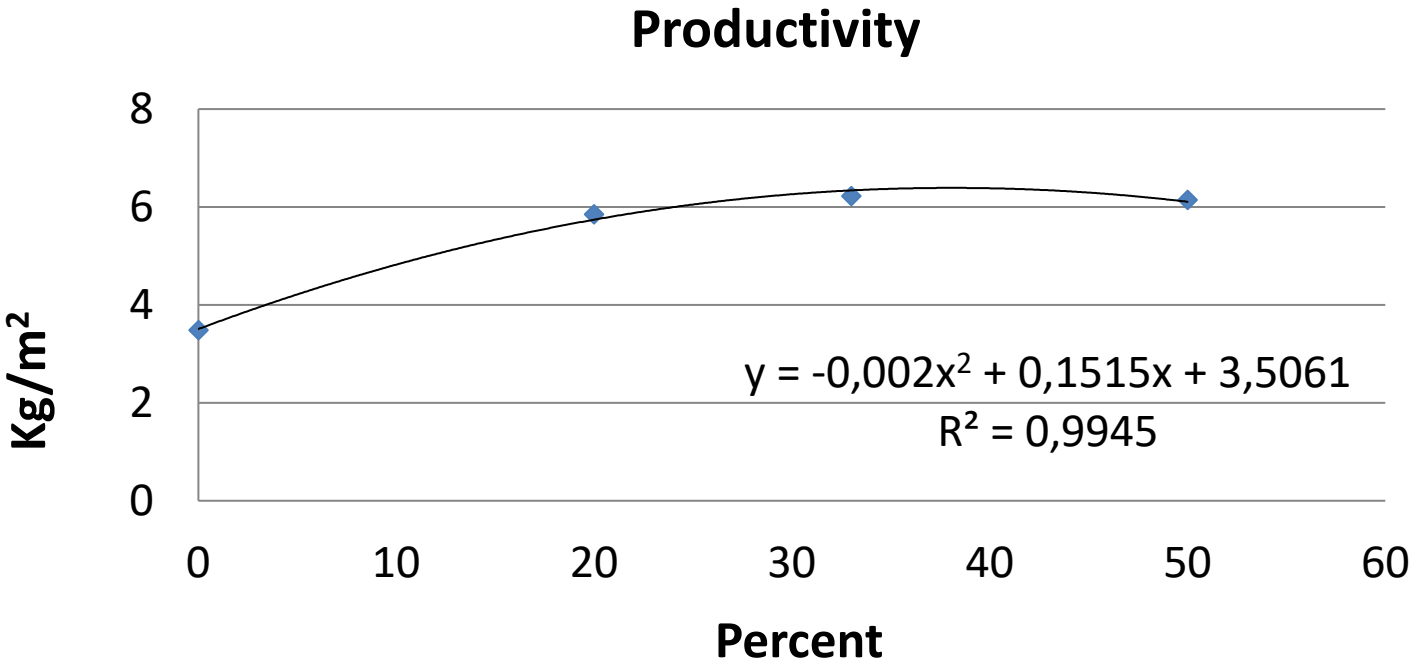
Treatment	Stocking Density	Harvest	Days	Harvest weight	Biomass	kg/m² Cumulative	Survival
0	500	F	154	16.36	122.01	3.48	43.67
1	500	1	98	9.75	73.00	2.08	90.95
	250	F	154	18.93	132.06	5.85	
2	500	1	98	9.63	49.36	1.41	90.56
	335	2	126	14.34	75.72	3.57	
	170	F	154	18.50	92.82	6.22	
4	500	1	98	9.75	29.93	0.85	85.04
	400	2	112	12.28	50.69	2.30	
	300	3	126	15.23	36.75	3.35	
	200	4	140	17.74	57.02	4.98	
	100	F	154	20.19	40.55	6.14	

Results

Treatment	Partial Harvest (%)	Survival	Biomass (Kg)	Productivity (Kg/m^2)
T0 – 1F	0%	48.23%	135.02	**3.85**
T1 – 1P1F	50%	90.95%	205.09	**5.85**
T2 – 2P1F	33%	90.56%	217.90	**6.22**
T4 – 4P1F	20%	85.07%	214.89	**6.14**

Better results in partial harvest treatments ($P<0.05$)

Quadratic Regression



According to the quadratic regression a partial harvest of 38% would give us the best productivity

What percentage should be collected by partial harvest on raceways?

Number of partial harvest	Final harvest	Total number of harvest	Percentage
0	1	1	100%
1	1	2	50%
2	1	3	33%
3	1	4	25%
4	1	5	20%
5	1	6	16.6%
6	1	7	14.3%
7	1	8	12.5%
8	1	9	11.1%
9	1	10	10%

33% is closer to 38% detected in quadratic regression.

About 1/3 each harvest!

Conclusion

The results confirm that is possible to increase productivity in a superintensive shrimp BFT culture applying partial harvests (about 1/3), due to compensatory growth stimulated by periodic reductions of initial stocking densities.

Aquaculture International
https://doi.org/10.1007/s10499-022-00879-7

Establishing the most productive stocking densities for each stage of a multi-phase shrimp culture in BFT system

Lucas Genésio Pereira da Silveira[1] · Victor Torres Rosas[2] · Dariano Krummenauer[1] · Charles Fróes[1] · Adriana da Silva[1] · Luís Henrique Poersch[1] · Geraldo Fóes[1] · Wilson Wasielesky Jr[1]

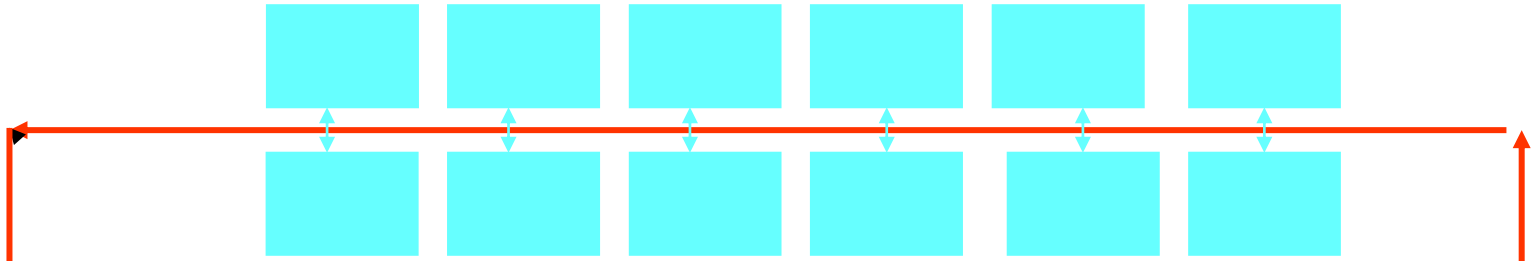
Received: 2 June 2021 / Accepted: 2 April 2022
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2022

Otoshi et al 2007:

Shrimp Behavior May Affect Culture Performance
At Super-Intensive Stocking Densities

… the results showed
that crowding behavior associated
with high density
may have negatively impacted
shrimp growth, irrespective
of water quality????

Recirculation of 48 times per day (2 X / hour)



- BFT culture in a Raceway with mature bioflocs
- Macrocosm to keep same BFT water quality for all treatments (Different stocking densities)

Design Experimental

Phase 1: Post Larvae - 0,002g
Stocking densities: 3750, 7500, 11250 e 15000 /m^3

Phase 2: Juveniles de 1,04 g
Stocking densities: 750, 1125, 1500, 1875 e 2250/m^3

Phase 3: Juveniles de 6,09 g
Stocking densities: 500, 750, 1000, 1250 e 1500/m^3.

Phase 4: Juveniles de 12,51 g
Stocking densities: 375, 750, 1125 e 1500/m^3.

- Each phase lasted 40 days.

Table 1. Water quality parameters of each experimental phase of *Litopenaeus vannamei* culture in BFT system under different stocking densities.

	Phase 1	Phase 2	Phase 3	Phase 4
Temperature (ºC)	29.3 ± 2.1	28.3 ± 1.7	27.2 ± 2.7	28.7 ± 2.4
pH (minimum)	7.1 ± 0.9	7.2 ± 1.2	7.3 ± 1	7.2 ± 1.1
D.O. ($mg.L^{-1}$)	6.23 ± 0.7	4.6 ± 0.5	5.36 ± 0.9	4.86 ± 0.4
Salinity ($g.L^{-1}$)	33.3 ± 0.3	33.5 ± 0.5	33.2 ± 0.2	32.4 ± 0.1
TSS ($mg.L^{-1}$)	280 ± 56.1	254 ± 99.2	372 ± 70.2	259 ± 66.1
SS ($ml.L^{-1}$)	25.4 ± 0.2	20.8 ± 0.5	26.9 ± 0.6	21.3 ± 0.8
TA-N ($mg.L^{-1}$)	0.19 ± 0.12	0.21 ± 0.17	0.32 ± 0.15	0.12 ± 0.09
NO^{-}_{2}-N ($mg.L^{-1}$)	2.85 ± 1.15	3.51 ± 1.36	4.22 ± 1.8	0.56 ± 0.14
NO^{-}_{3}-N ($mg.L^{-1}$)	8.3 ± 2.7	10.2 ± 3.0	13.4 ± 4.5	19.3 ± 7.2

Phase 1 - PLs

	T3750	T7500	T11250	T15000
IW (g)	0.002 ± 0.001	0.002 ± 0.001	0.002 ± 0.001	0.002 ± 0.001
FW (g)	0.59 ± 0.1 a	0.43 ± 0.1 b	0.39 ± 0.1 b	0.30 ± 0.1 c
FCR	0.98 ± 0.1 a	1.01 ± 0.1 a	1.21 ± 0.2 a	1.65 ± 0.1 b
S (%)	95.3 ± 2.26 a	94.4 ± 6.13 a	94.3 ± 2.23 a	84.5 ± 5.16 b
Yield ($kg.m^{-3}$)	2.12 ± 0.3 c	3.01 ± 0.5 b	4.04 ± 0.5 a	3.93 ± 0.4 a

Phase 2 – from 1 to 6 g

	T750	T1125	T1500	T1875	T2250
IW (g)	1.04 ± 0.1	1.04 ± 0.1	1.04 ± 0.1	1.04 ± 0.1	1.04 ± 0.1
FW (g)	6.37 ± 0.7 a	6.11 ± 0.8 a	5.70 ± 0.9 a	5.17 ± 1.1 b	5.12 ± 0.9 b
FCR	1.56 ± 0.2 a	1.31 ± 0.1 a	1.55 ± 0.2 a	1.89 ± 0.4 a	2.45 ± 0.6 b
S (%)	85.2 ± 7.4 a	89.1 ± 9.7 a	88 ± 16.8 a	65.5 ± 8.5 b	60.3 ± 15.9 b
Yield ($kg.m^{-3}$)	4.06 ± 0.3 c	6.12 ± 1.1 b	7.52 ± 1.5 a	6.35 ± 0.8 b	6.95 ± 0.9 ab

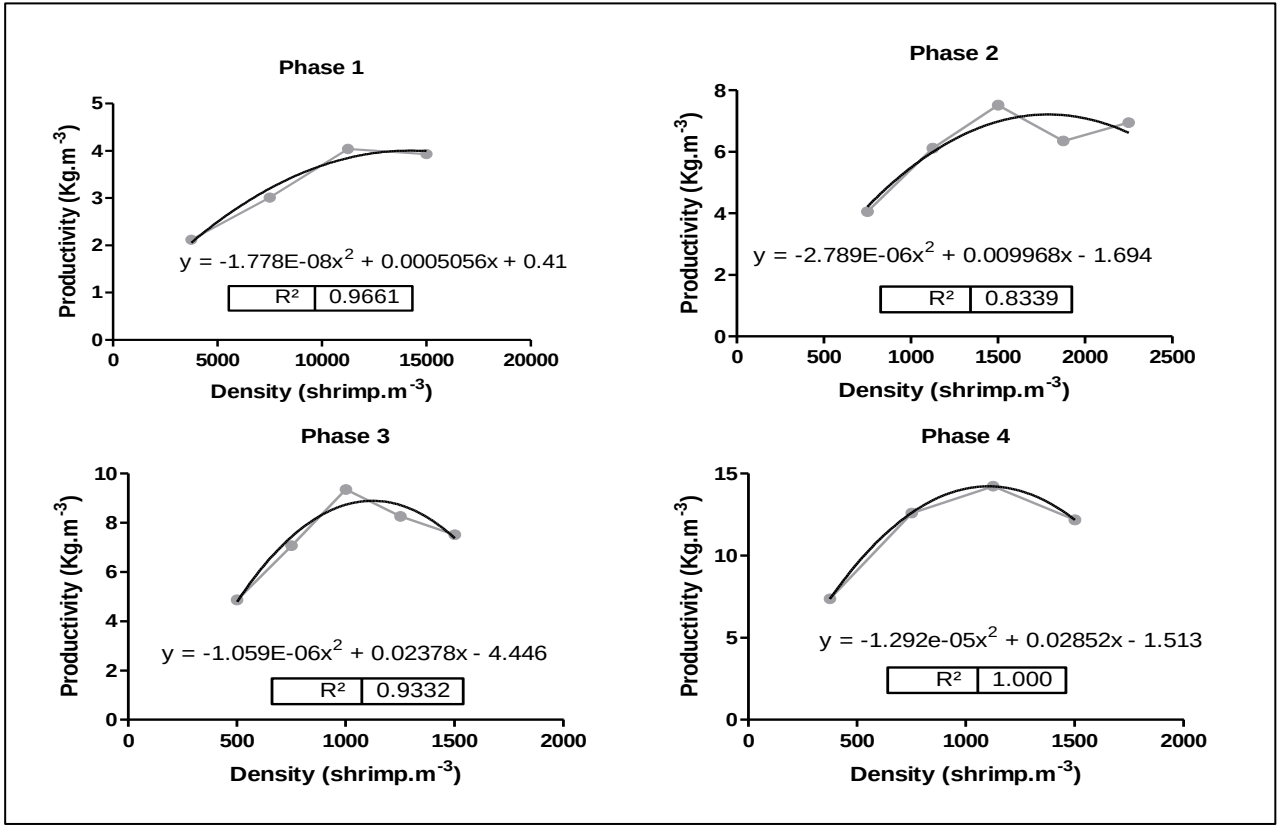
Phase 3 – from 6 to 12g

	T500	T750	T1000	T1250	T1500
IW (g)	6.09 ± 0.7	6.09 ± 0.7	6.09 ± 0.7	6.09 ± 0.7	6.09 ± 0.7
FW (g)	11.04 ± 0.9 a	10.17± 0.87 b	10.29 ± 2.1 b	10.54 ± 1.87 b	9.68 ± 1.77b
FCR	1.18 ± 0.5 a	1.29 ± 0.4 a	1.39 ± 0.6 a	1.85 ± 0.3 b	1.98 ± 0.5 b
S (%)	88.3 ± 7.2 a	92.8 ± 6.3 a	91.1 ± 10.1 a	62.6 ± 1.2 b	54.06 ± 8.1 c
Yield (kg.m^{-3})	4.87 ± 0.5 c	7.07 ± 0.4 b	9.35 ± 1.0 a	8.26 ± 0.9 a	7.51 ± 0.7 ab

Phase 4: From 12 to 18g

	T375	T750	T1125	T1500
IW (g)	12.51 ± 1.3	12.51 ± 1.3	12.51 ± 1.3	12.51 ± 1.3
FW (g)	20.27 ± 1.5 a	17.58 ± 1.9 b	17.31 ± 1.9 b	17.16 ± 1.7 b
FCR	1.51 ± 0.1 a	1.73 ± 0.1 b	1.78 ± 0.03 b	2.01 ± 0.1 c
S (%)	97.1 ± 1.3 a	95.9 ± 3.9 a	73.2 ± 12.7 b	47.5 ± 15.9 c
Yield ($kg.m^{-3}$)	7.37 ± 0.8 c	12.59± 1.0 b	14.23 ± 1.1 a	12.18 ± 1.1 b

Quadratic regressions were applied to determine the maximum "carrying capacity" when excluding the effect of water quality



The maximum carrying capacity in different growout phase in superintensive BFT culture.

Table 1: Stocking density, survival and Biomass of *L. vannamei* in different phase.

	Density (shrimp/m^3)	Survival (%)	Biomass (Kg/m^3)
Phase 1	11,250	94.3	4.05
Phase 2	1,500	88.0	7.52
Phase 3	1,000	91.1	9.35
Phase 4	750	95.9	12.59

Conclusions

- Nowadays …… from 4 to 6 kg/m³
- Future ……..We can think about in productions ranging from 10 a 15 Kg/m³
- Anyway, several technologies should be developed to improve the productivities yet!

Ackowledgements

FINANCIAL SUPPORT

CAPES

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

FAPERGS

FINEP
FINANCIADORA DE ESTUDOS E PROJETOS
MINISTÉRIO DA CIÊNCIA E TECNOLOGIA

SUPPORTERS

all-aqua
aeration®

Aquatec
Larvicultura de Camarão Marinho

Guabi
Aqua

REVISAN®

Thank you!

Dr. Wilson Wasielesky Jr.

manow@mikrus.com.br

astral@norceresearch.no

astral-project.eu

@ASTRAL_H2020

ASTRALH2020

astral-h2020project

ASTRAL_H2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863034.


Obrigado pela atenção!
manow@mikrus.com.br