World Shrimp Farming today: Disease, Disruption, and Change

Robins McIntosh
Charoen Pokphand Foods, Public Company
Bangkok Thailand

Disruptions drive beneficial change

This is a 40 gram shrimp cultured in 100 days
It was harvested with 28 tons/ha of the same
In less than 100 days
July 2016, after EMS had destroyed Thailand

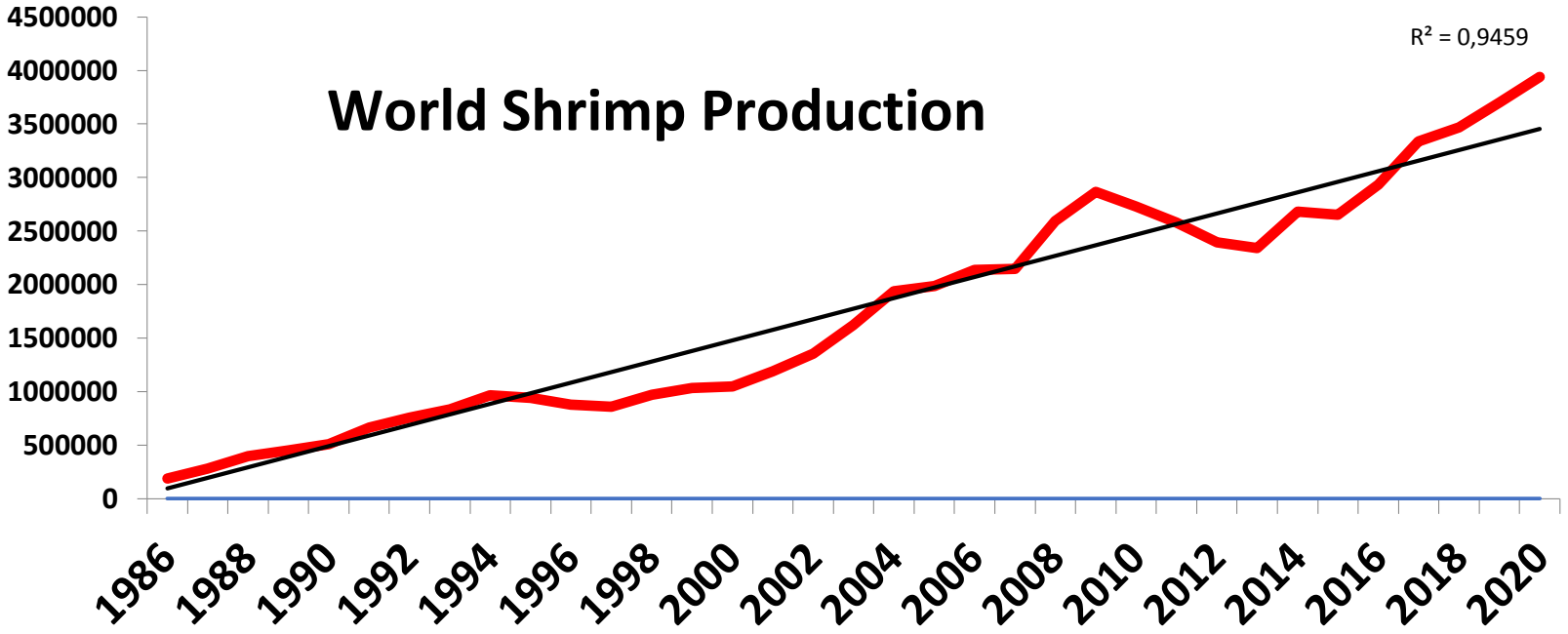

Another typical 38 gram shrimp harvest
100 day culture
FCR 1.7

This is a 160 gram shrimp cultured in 160 days:

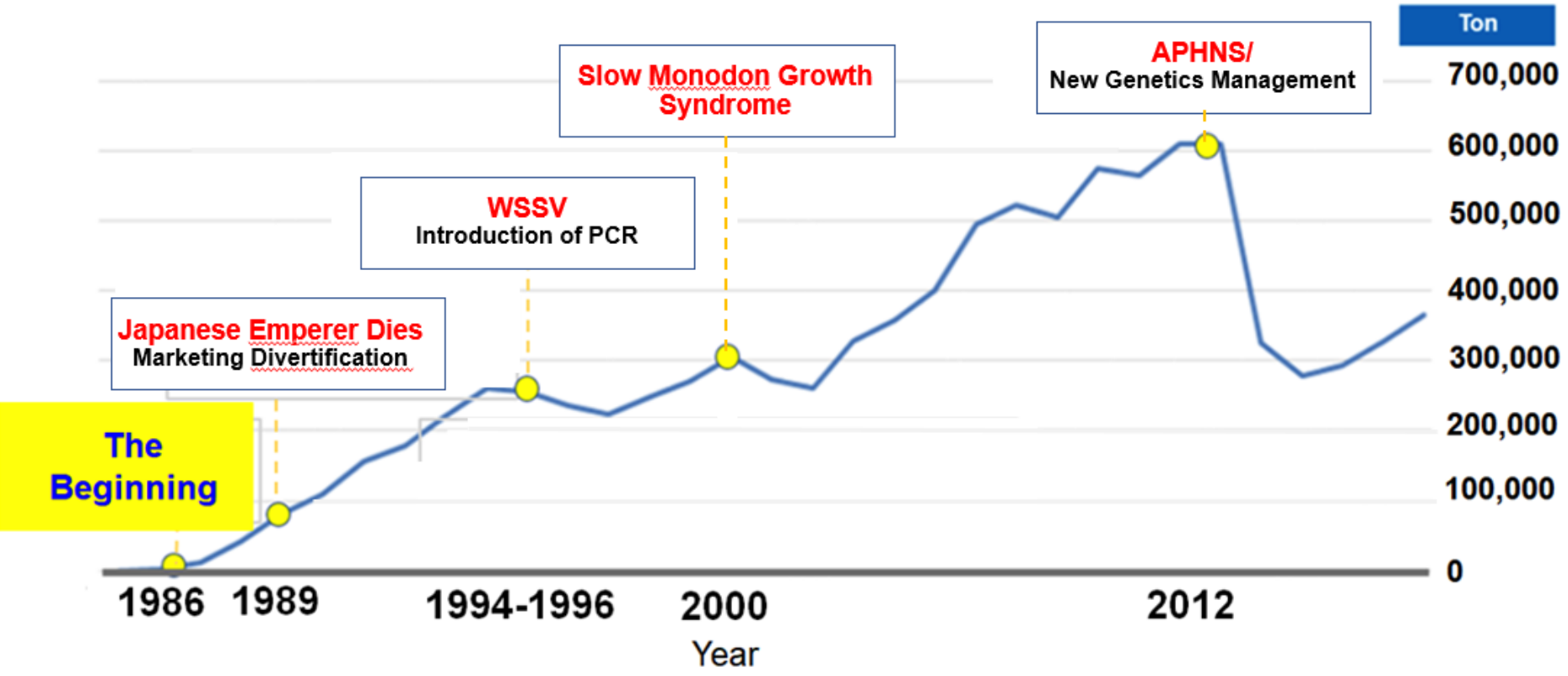
Johor Malaysia, 5 tons/hectare (final harvest)

2016- post EMS

Trend line since 1986 does interesting job of predicting weakening and strengthening of price



Overcoming the Challenges: Evolution of an Industry



Shrimp Price History:

The trend line is down with efficiency; but sometimes during a "crisis" supply is reduced below demand and prices spike until supply is re-established

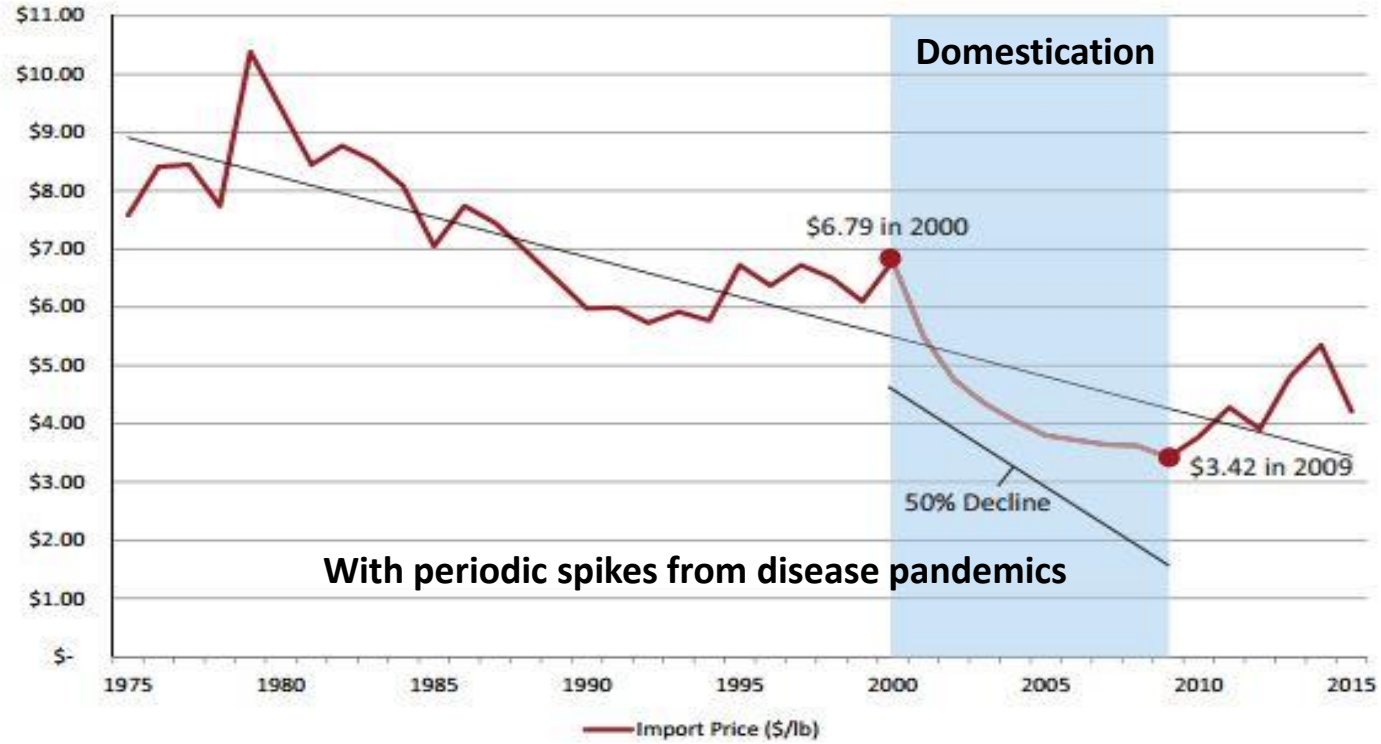
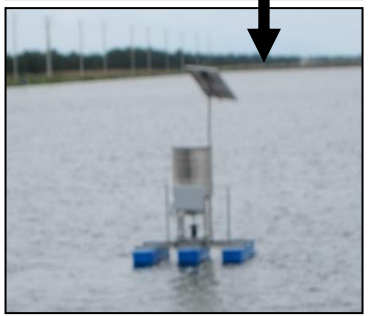


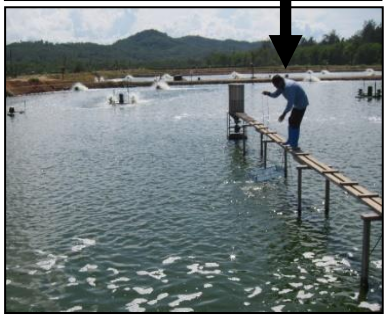
FIGURE 3.
U.S. Shrimp Import Price (Adjusted to 2015 Dollars), 1975–2015

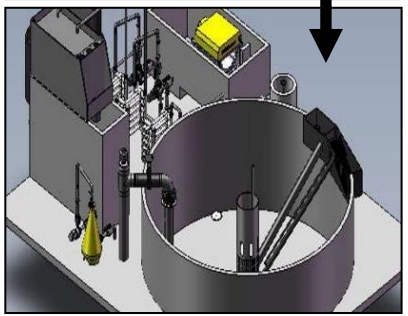
SOURCE:
NOAA-NMFS (2016a)

There has always been “Evolution” in response to shrimp market economics

Extensive	*Semi-Intensive*	*Intensive*	*Hyper-intensive*
Land availability/ low land cost	Land Cost/ Elevations	Land Cost/ Availability	Resource Availability/ Sustainability



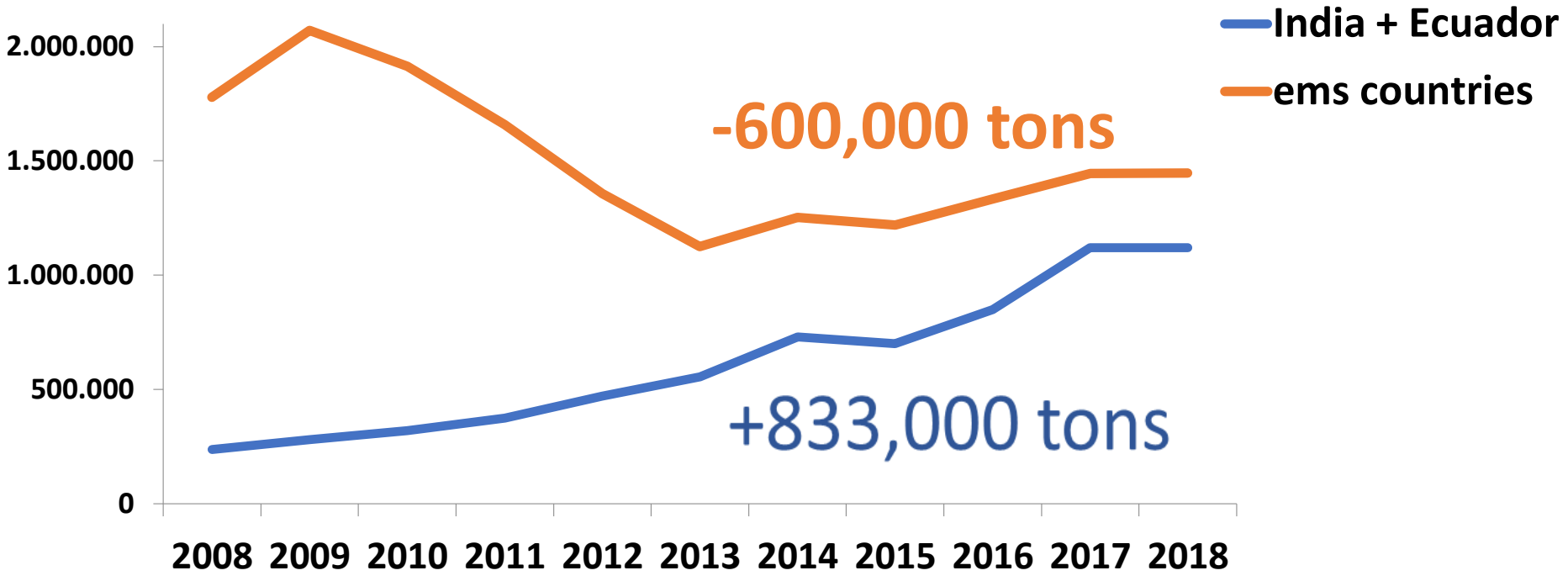




1987 %	50	35	15	0	290.000
2017 %	21	15	60	2	3,300,000

Ecuador and India Emerge as new Production Leaders

As Asia/Mexico sank: world prices increase and investment is incentivized

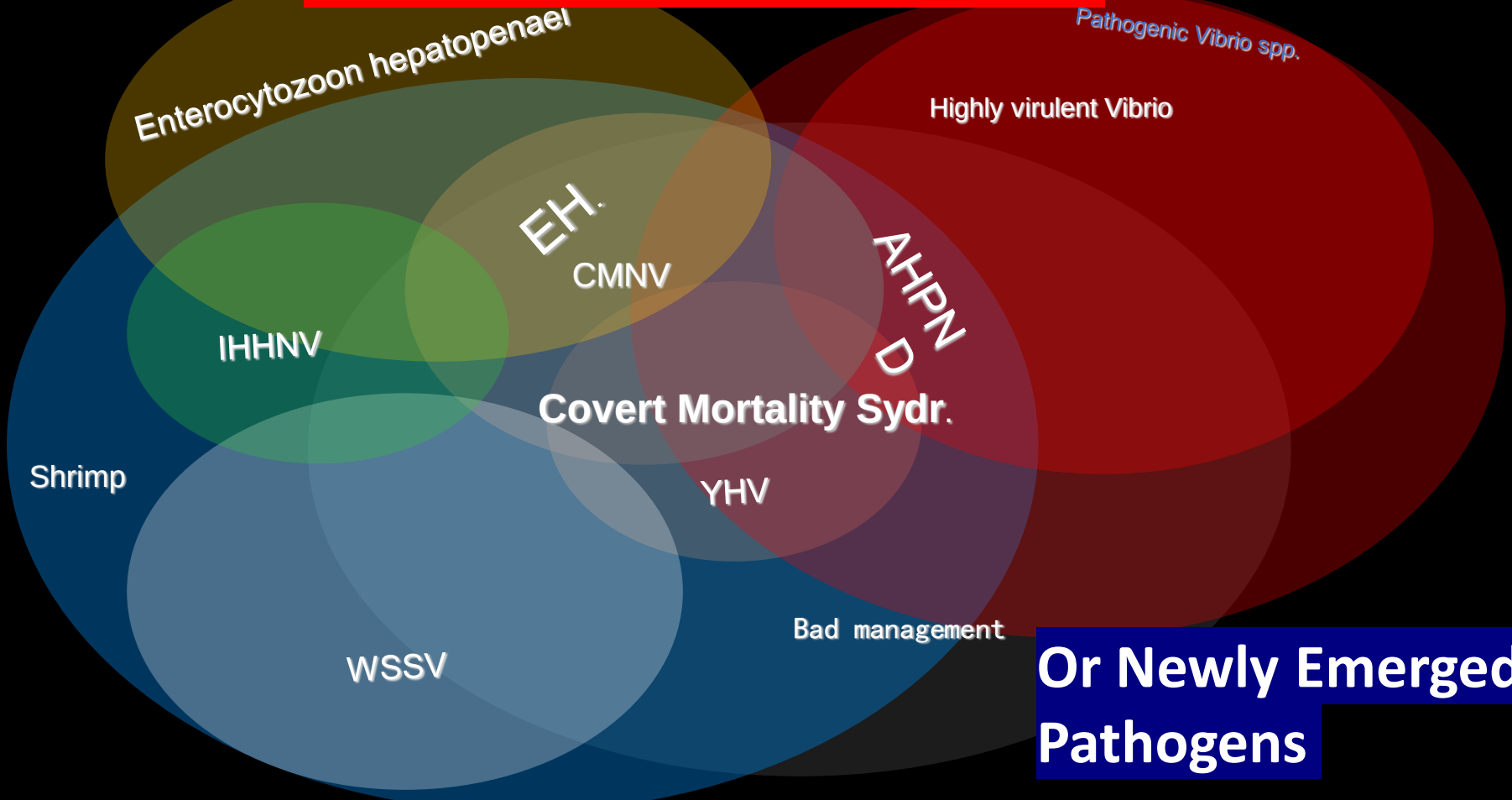


A cautionary tale:

2003-2010: Feeling Un-stoppable

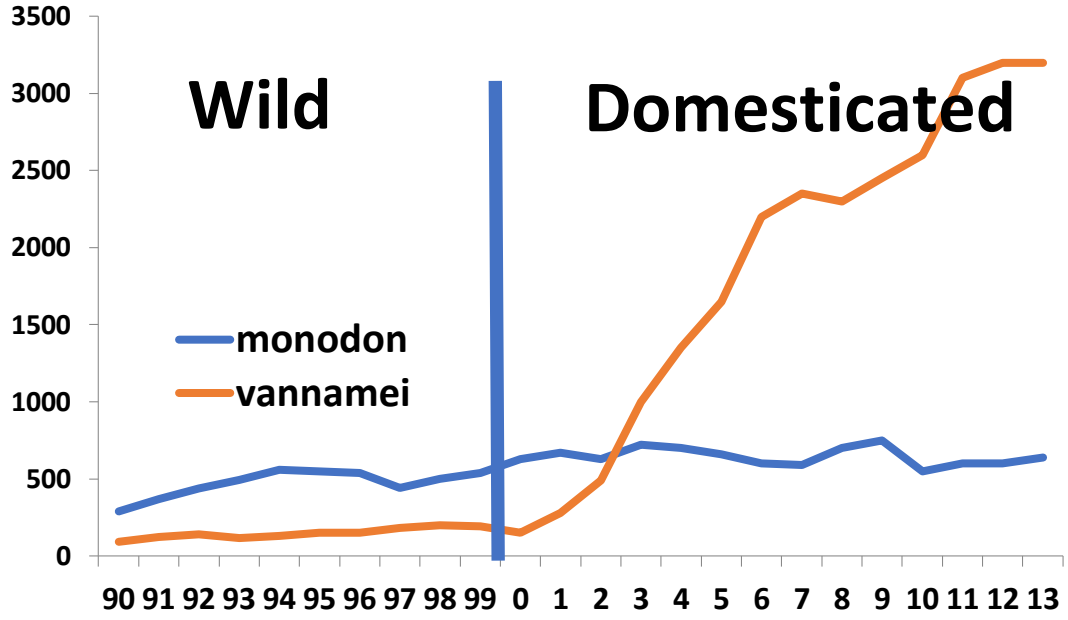

Why???????
2009-2013?: Wipe-out

Was it New Pathogens



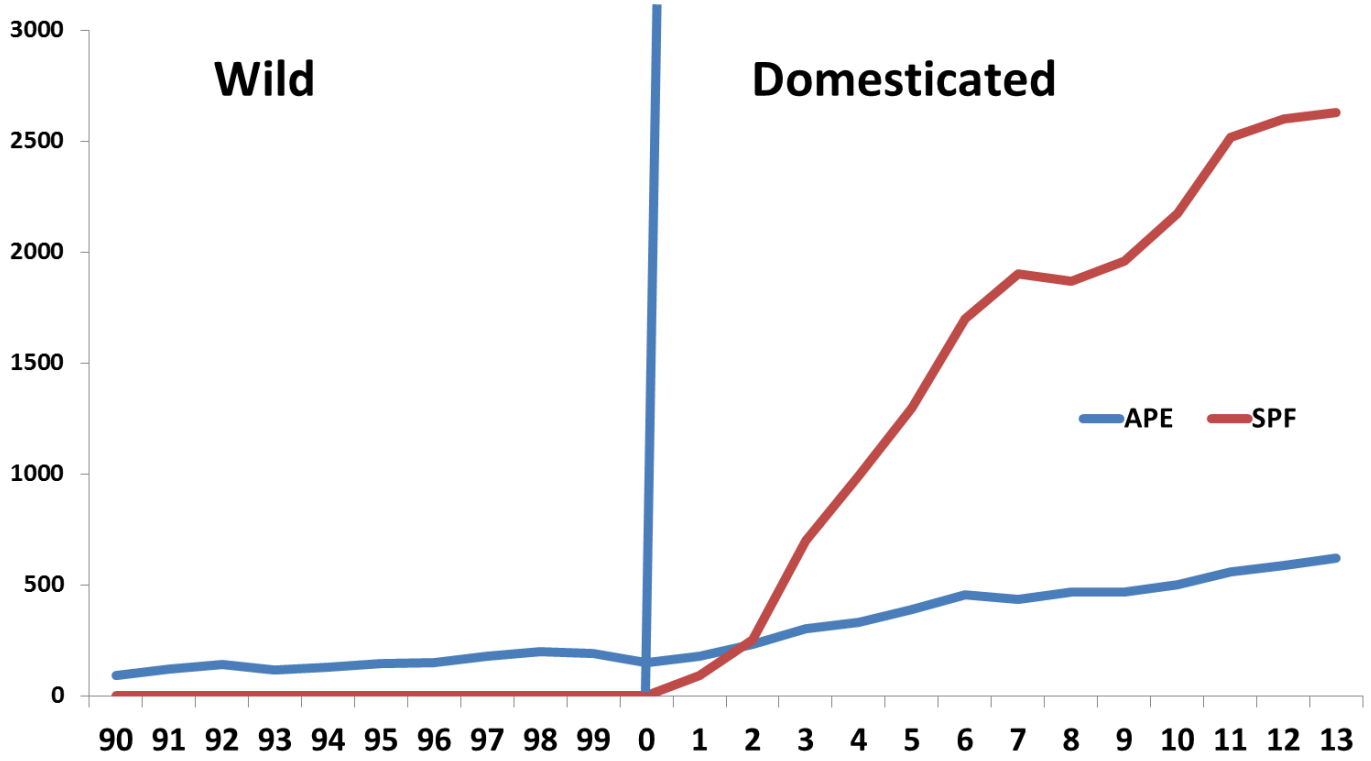
Or Newly Emerged Pathogens

History of the Success 2003-2010



1999: The year where domestication became a dominant theme in Shrimp

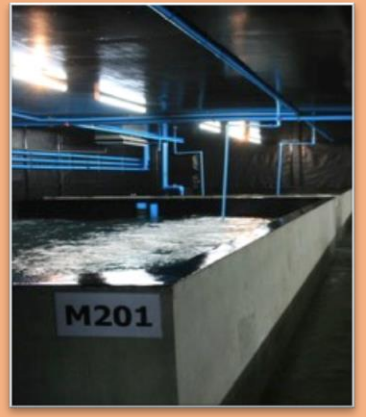
Triggered by the use of SPF shrimp on a wide commercial scale plus Pond Bio-security



Modernization of Shrimp Hatcheries

The Old

The New



Bio-secure, more efficient

Broodstock development / Multiplication (SPF and Nucleus Breeding Concepts)

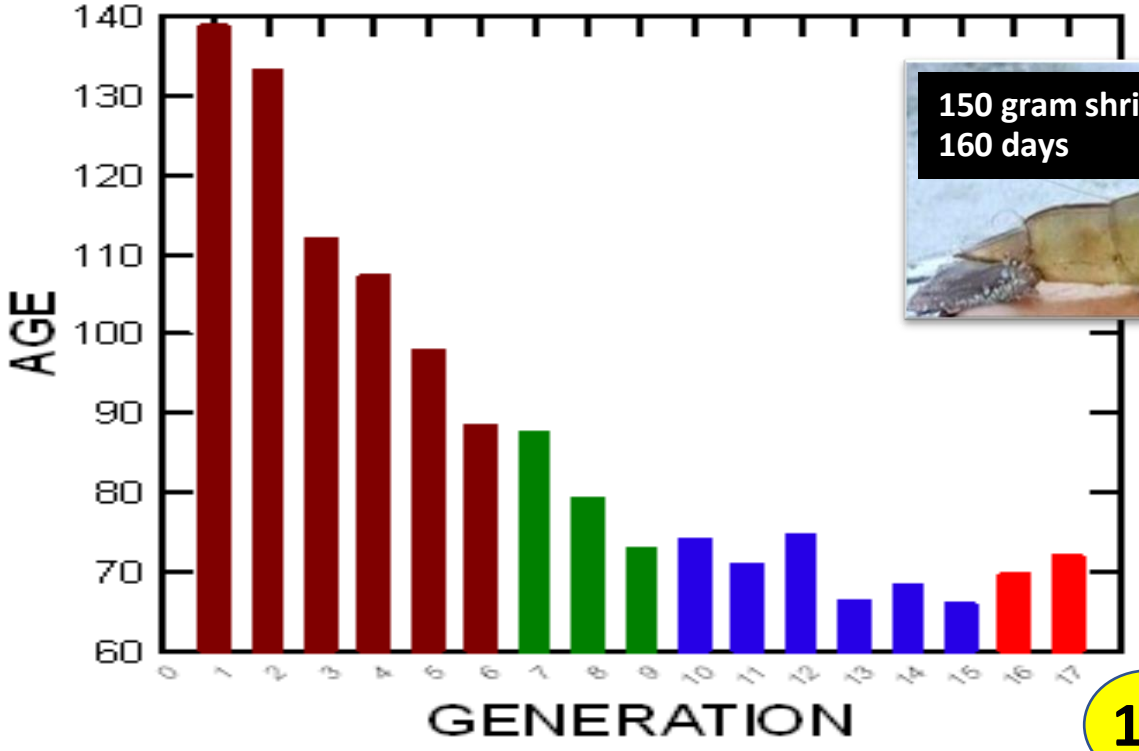
18 generations of breeding

Family

Individuals

Breeding Centers: Inland, Enclosed, zero exchange

Breeding has resulted in significantly lower cost production



Target = 24 g

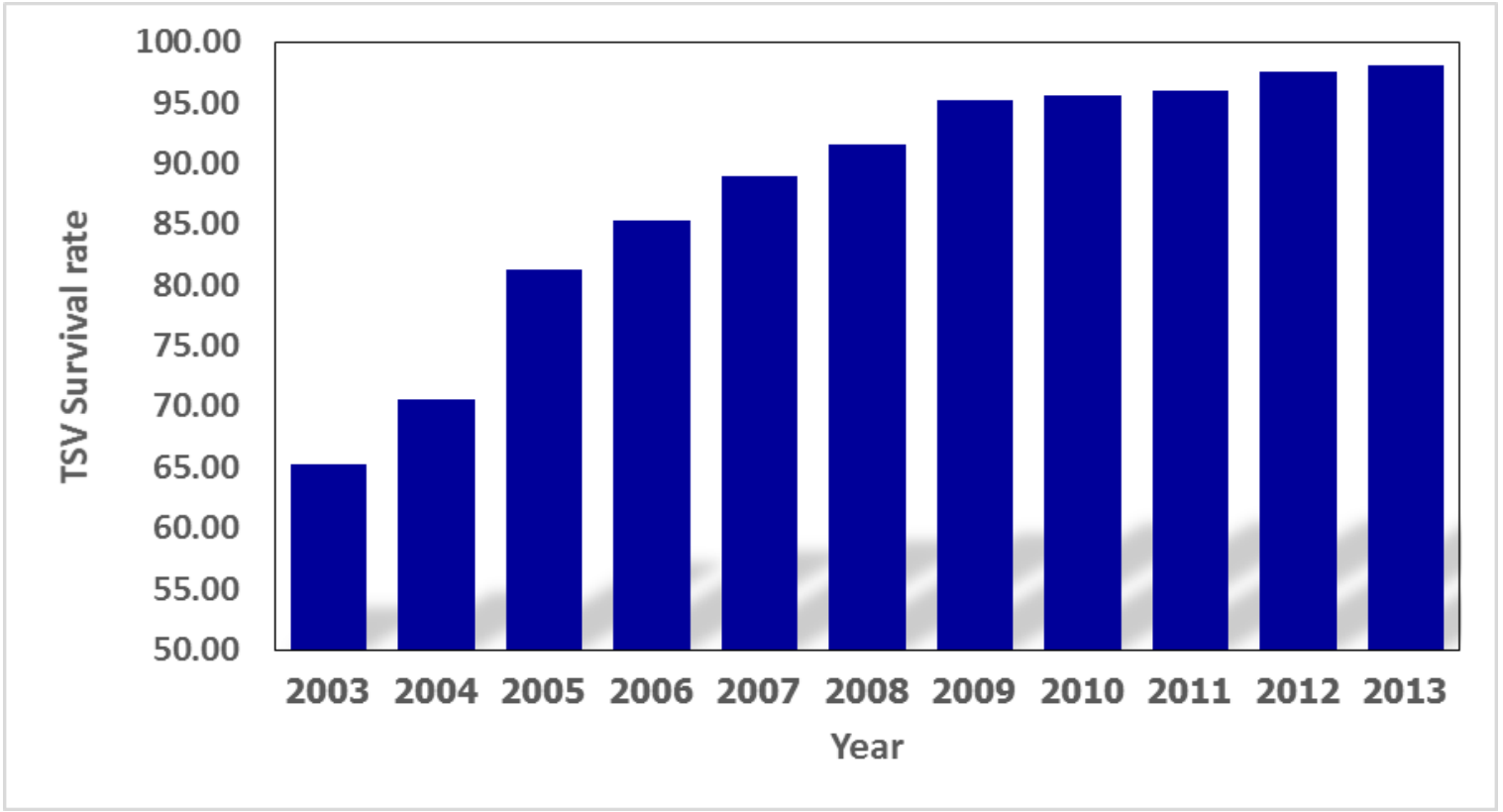
Target = 26 g

Target = 28 g

Target = 30 g

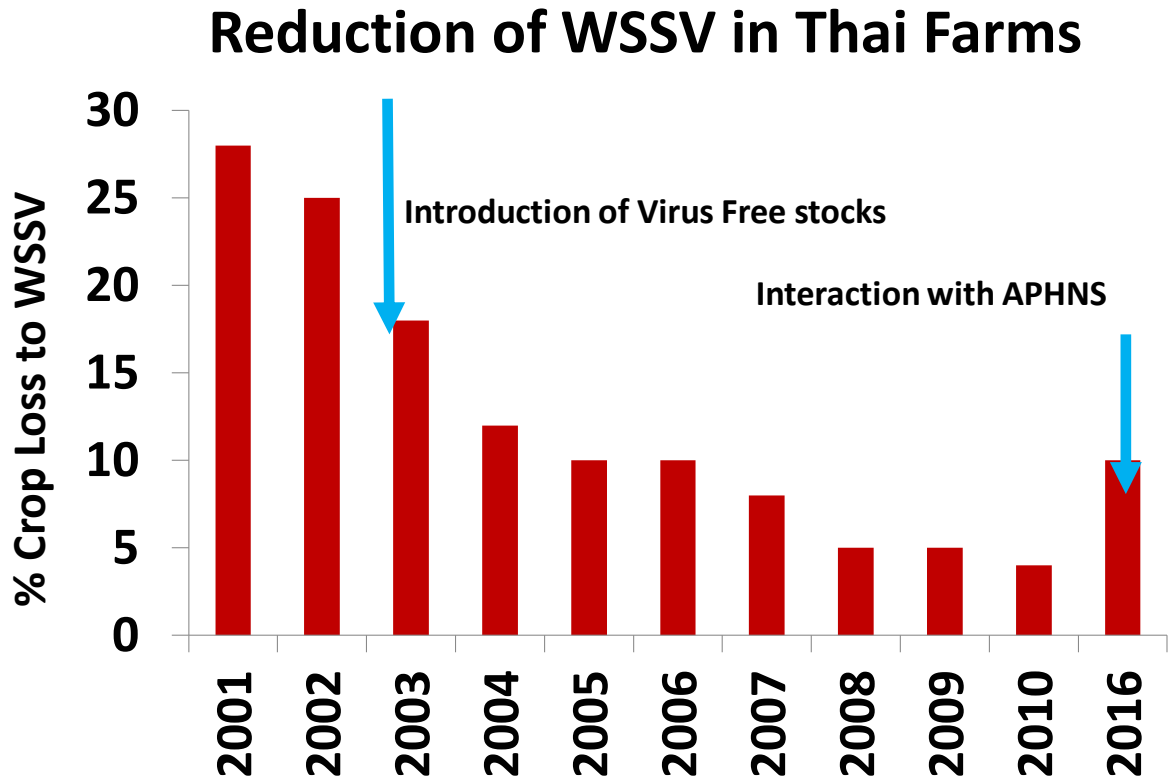
18

And not just GROWTH; but tolerance to specific issues like TSV developed



Visually you can see the changes in the Animal

SPF stocks are important for Bio-security



And with “healthy shrimp” antibiotics are not necessary

PRE- DOMESTICATION

POST –SPF DOMESTICATION

Re-design of farms, ponds and management
(Pond and Farm Bio-security developed)

The Old

The New

Sometimes around 2009: subtle changes!

Chlorine

Molasses/
probiotics

Blue Green Algae

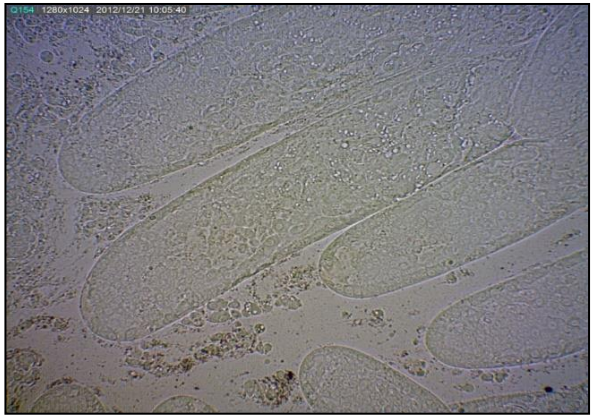
Environment/Climate

Farms had early mortality and hatcheries began reporting strangulated HP tubules– also seen in farm shrimp

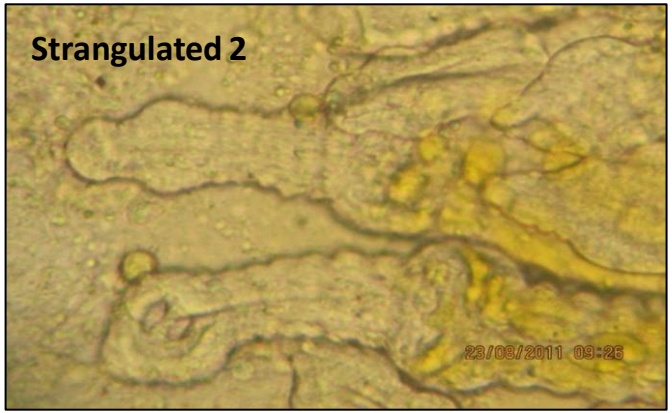
Die Early

Strangulated 1

Normal



Strangulated 2

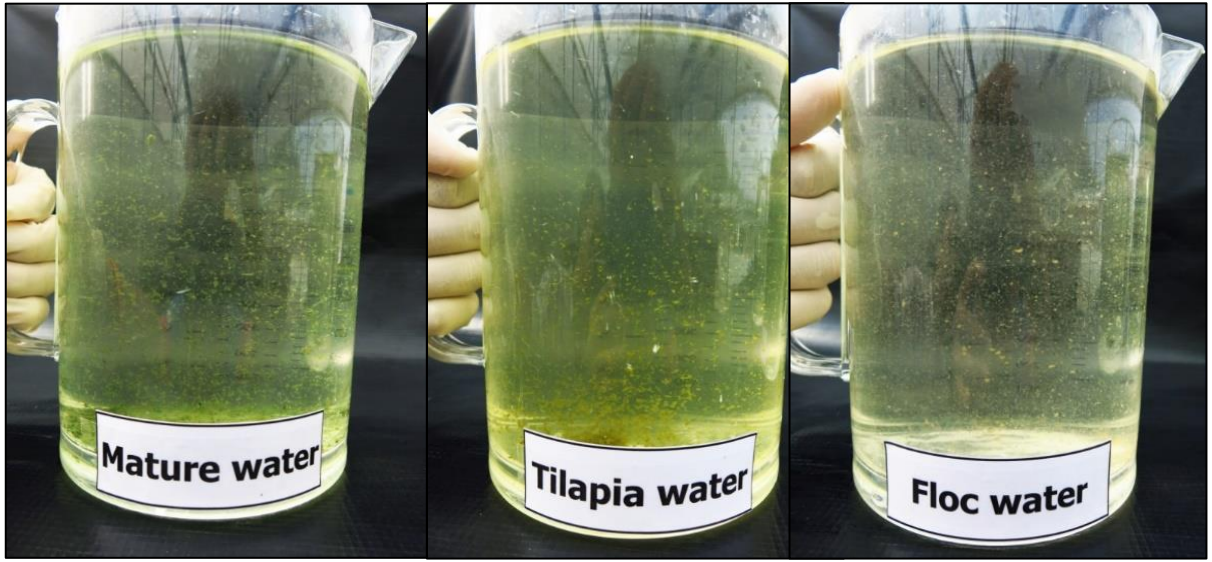


Loss of Aquaculture and Pond Ecology Fundamentals

Microbial Diversity is Important for Healthy Pond Systems

High Mortality

Low Mortality



A new Life; Re-Learning to Grow Shrimp

Not abandoning the principals: SPF and Biosecurity

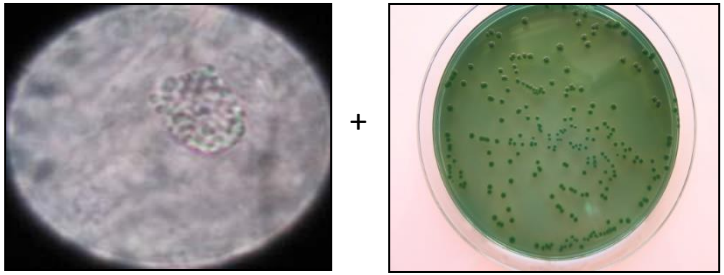
AHPNS is a Toxicosis from the environment

=

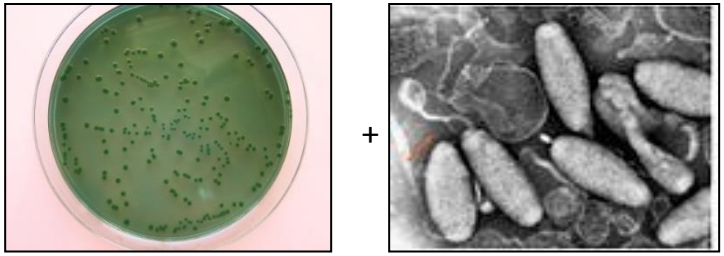
Pir Toxin I and Pir Toxin 2

Produced on plasmids in Vibrio bacteria: not a virus

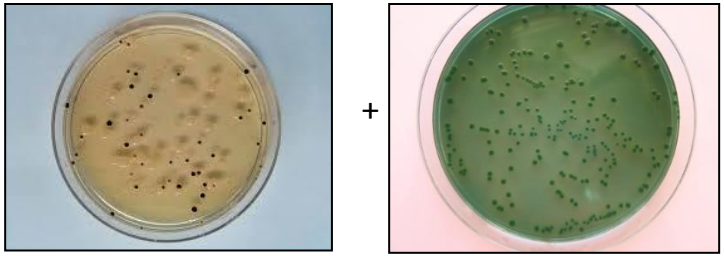
EMS is complicated
Not a singular infection in a test tube



EHP + AHPNS

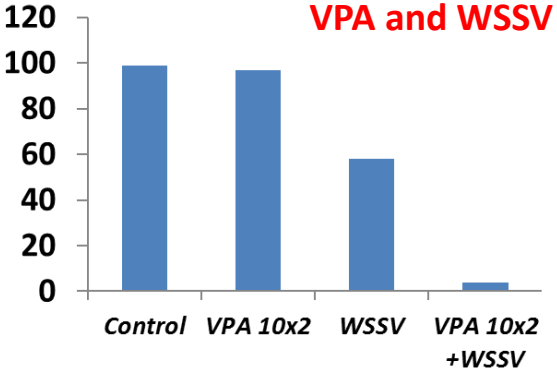


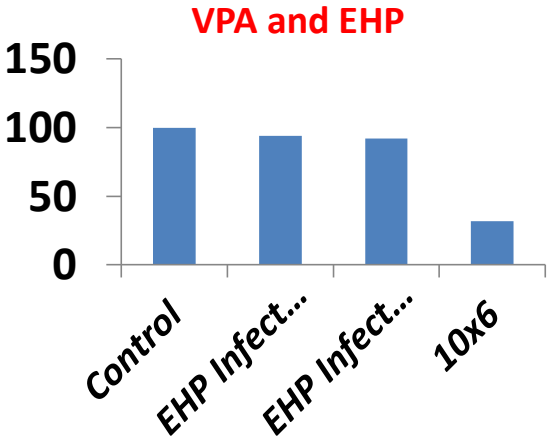
AHPNS + WSSV

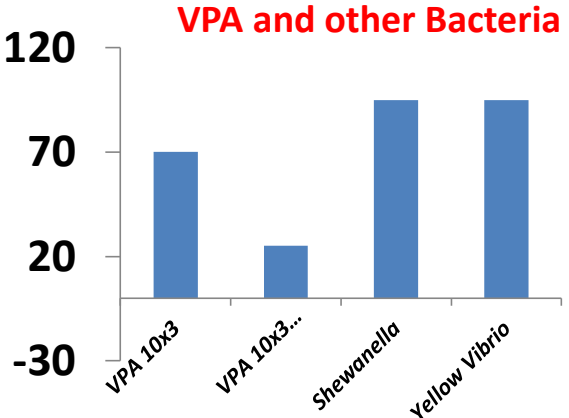


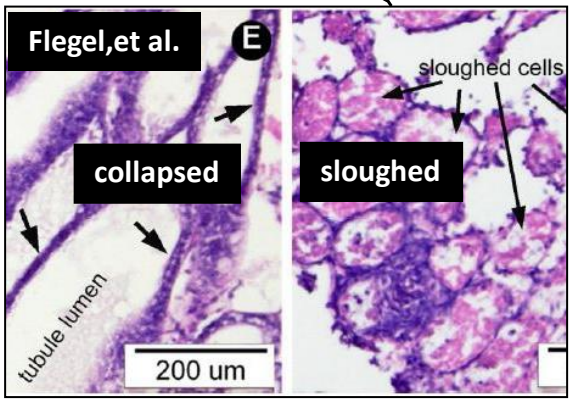
Shewanella + AHPNS

We now understand that Aphns and EHP occur in The Real world and not in a test tube.



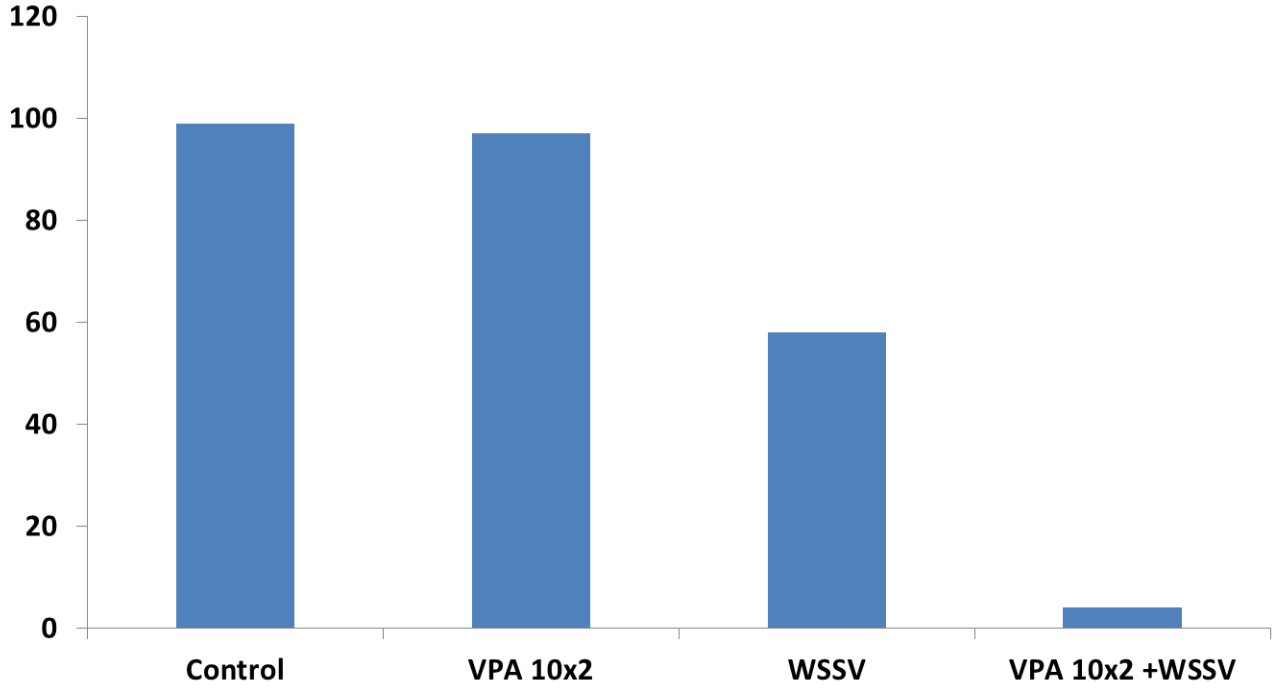






Pir I and II required: 5 ug vs 10 mg toxin

WSSV- AHPNS Interaction

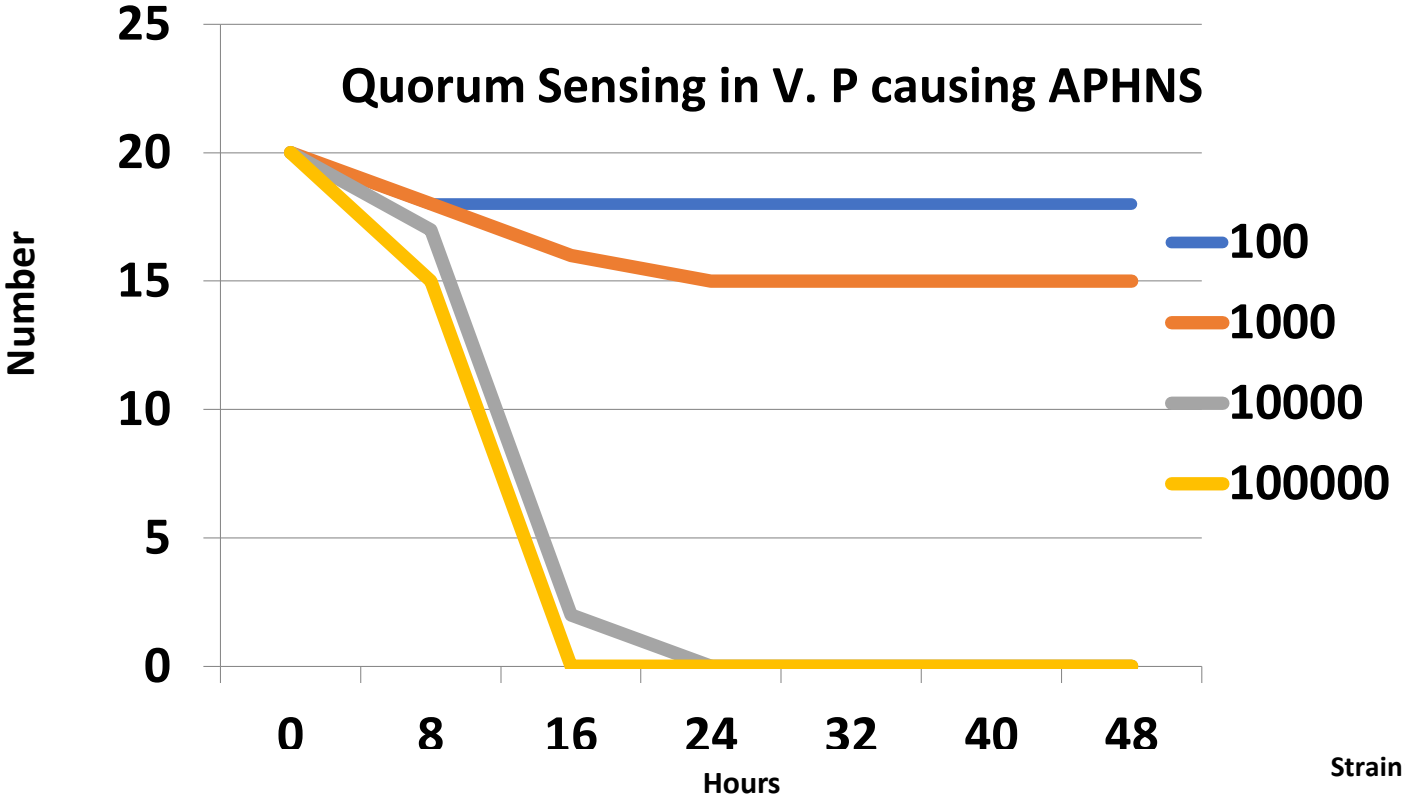


29.5C

7 day challenge

P<.0002

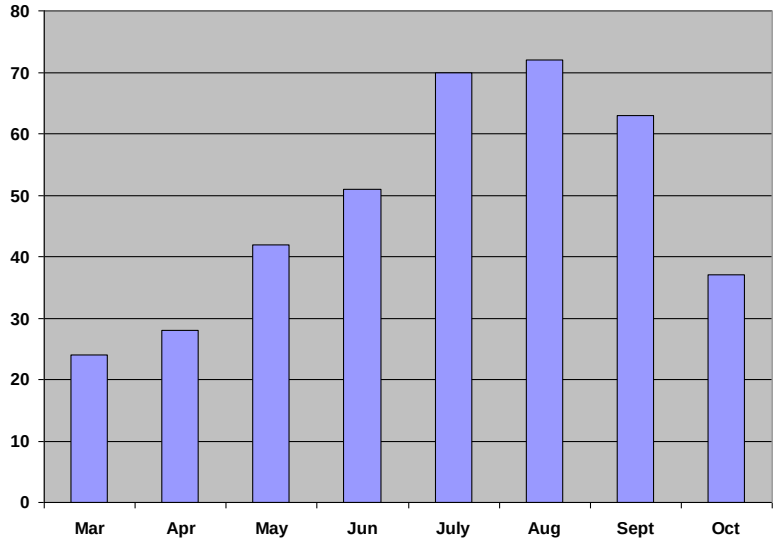
Learning about Quorum Sensing: Bacterial Density is important– not exclusion



Strain: P1/1

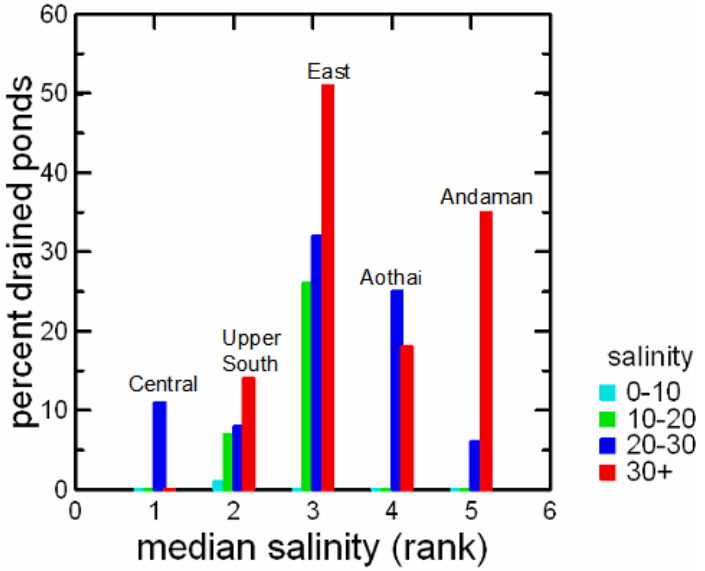
Bacteria have an ecology:
"temperature and salinity effects the bacteria growth"

Temperature: seasonality of APHNS



Fujian, China Failure Rate: 2010

Salinity: effect on AHPNS



Nutrients effects on APHNS bacteria growth and survival of shrimp

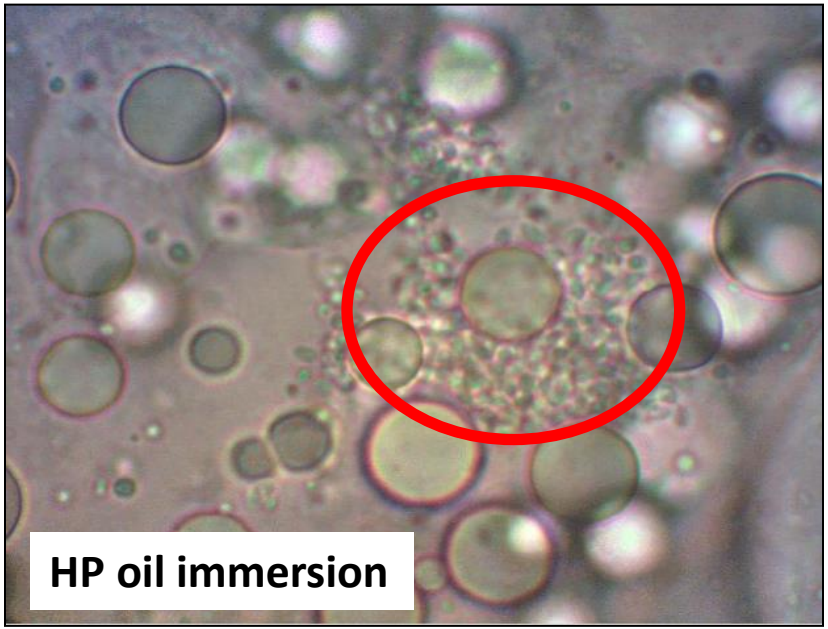
	Survival 72 hours	24 Hrs	48 Hrs	72 Hours
Seawater	80	<10x3	10x4	10x3
TSB/20ppt	20	10x3	10x6-7	10x7
SW, Moll, NH3	25	10x4	10x7	10x6
SW, Moll, NH3, Fe	12	10x5	10x6	10x6

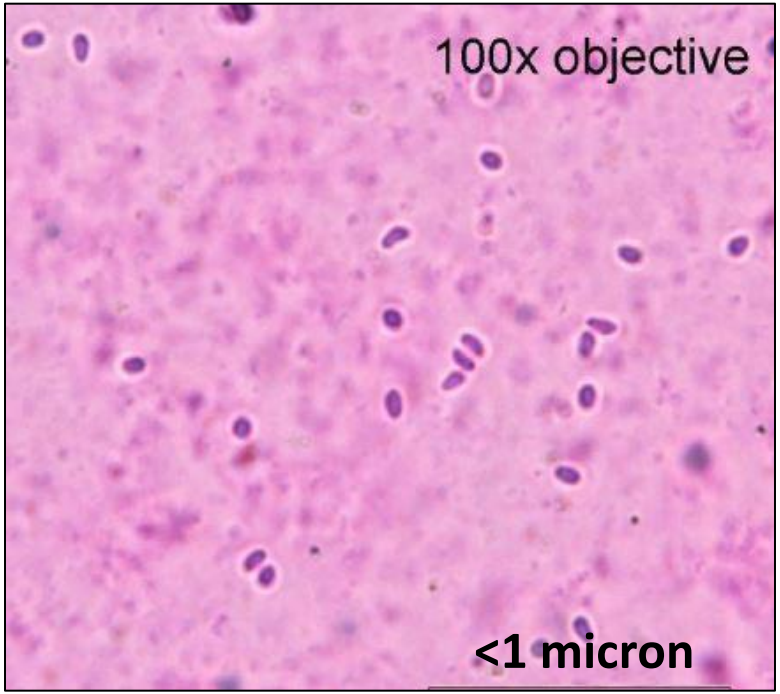
Where is the lethal toxin:

sludge, molts, old feed, dying plankton

And ***Vannamei*** Shrimp will ingest this material

Enterocytozoon hepatopenaei spores





EHP causes losses through slow growth and high FCR

Slow Growth/ High CV

Loose Shells

The APHNS (EMS), EHP Pandemic
More Culture Control, New Genetics

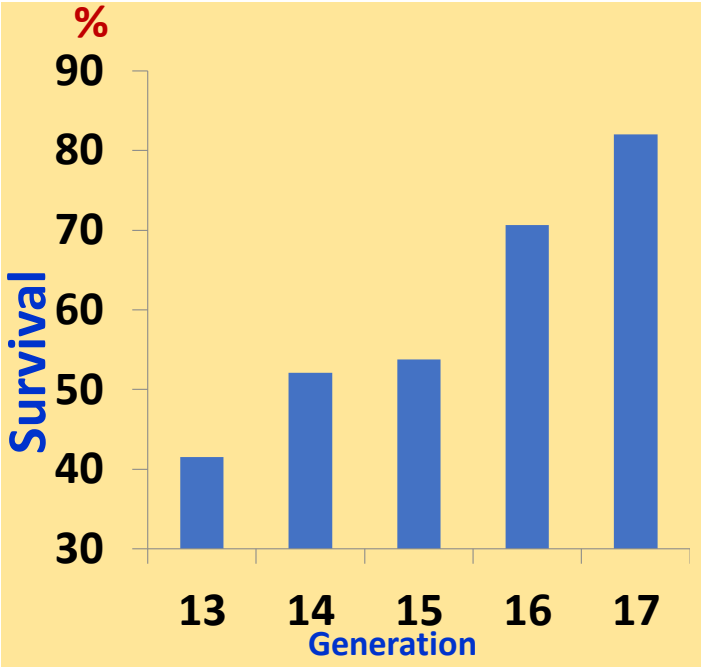
2014

2018

Smaller Ponds

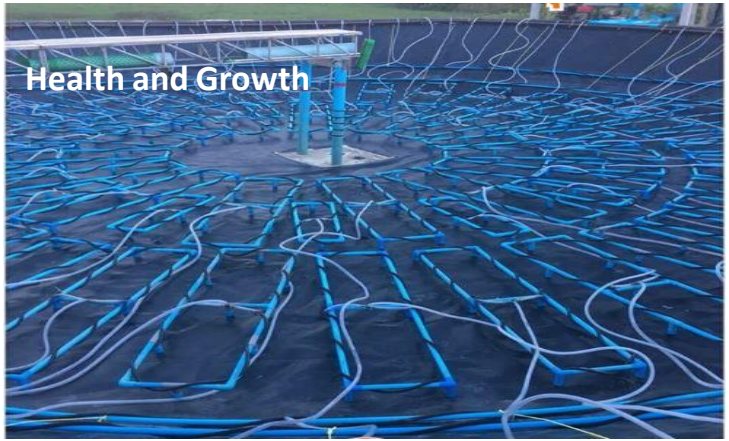
Shrimp Toilets

More Aeration



Breeding has significantly increased pond survivals

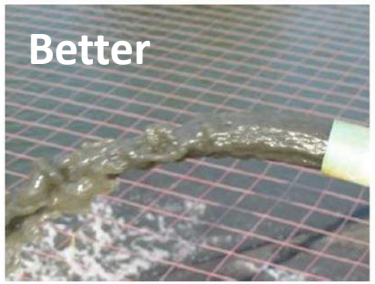
Pond innovations: solutions for specific Issues



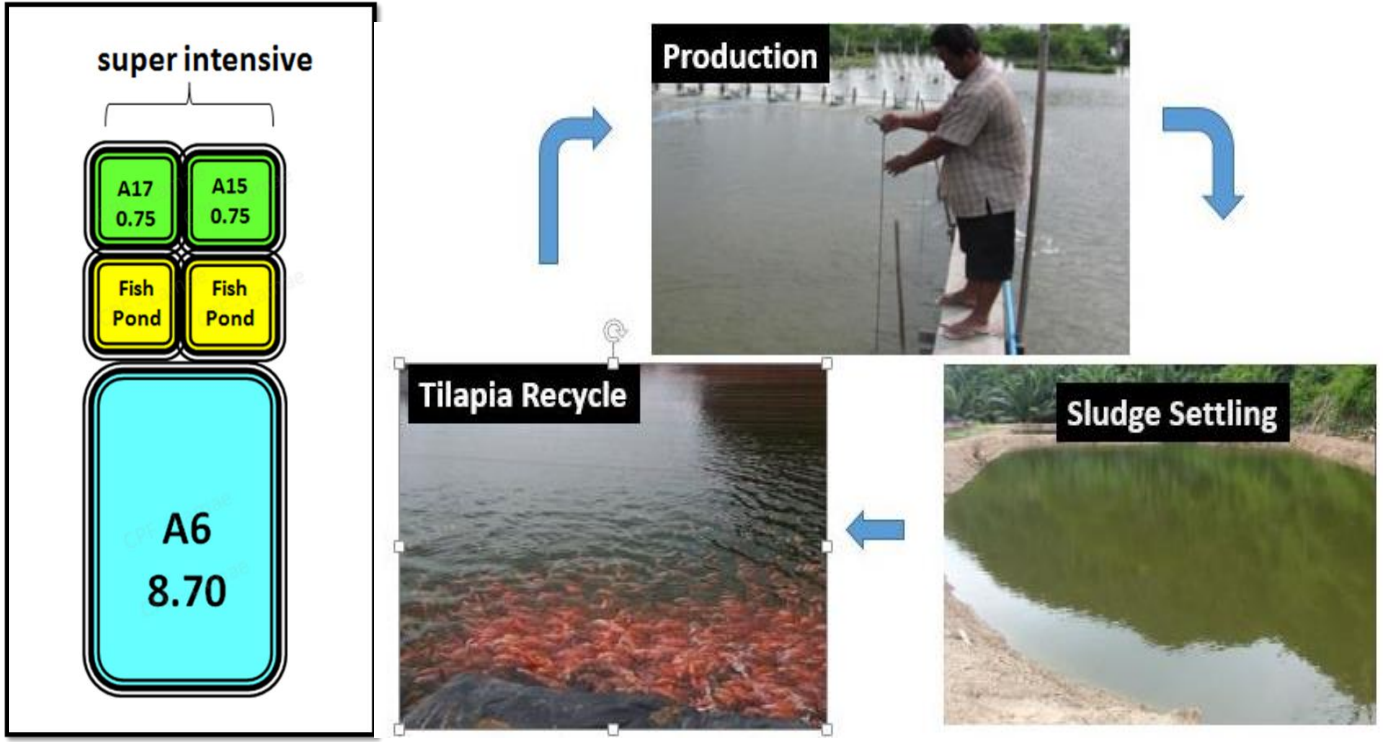
Use of Shrimp Pond Toilet to quickly flush sludge, old feed and molts from Pond

The Toilet:

The flush

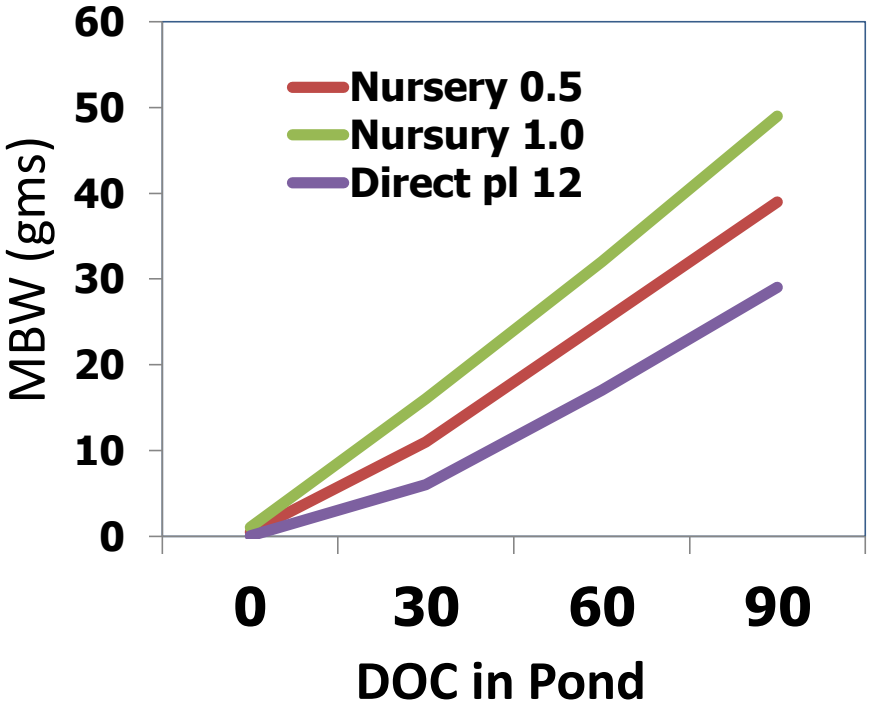


Use SMALLER PONDS, HIGHER AERATION, CLOSED, with more bottom Flushing



Nursery Technology:

More toxin tolerance, larger size harvests



18 day - 0.4 gms

28 day - >1.0 gms

Many successful Farms today in Thailand:
Toilets, Flush, Aeration, Feeders

CP Lamae Farm Layout

TOTAL FARM AREA			
PRIMARY TREAT(PT)	14.49	RAI	10%
RESERVOIR (RV)	18.84	RAI	13%
CULTURE POND	115.20	RAI	78%
	148.53		

TOTAL FARM AREA			
PRIMARY TREAT(PT)	23.00	RAI	16%
RESERVOIR (RV)	67.00	RAI	46%
CULTURE POND	54.50	RAI	38%
	144.50		

With Change; todays farm has greater profits than before AHPNS

	2010	2014	2016
% Culture Pond	77	77	38
DOC	87	59	81
Stock Density /m2	110	79	135
Failure Rate %	0.00	58	0.00
Survival	91	30.5	89
ADG gm/day	0.175	0.28	0.30
MBW	15.5	16.5	25.0
Yield (kg/ha/day)	190	156	333
Pl Efficiency tons/mill	13.6	5	21
Total tons	940	108	728
Cost USD/kg (direct)	2.80	13.90	3.25
Farm Profit mill. USD	1.6	-0.80	2.1

Vietnam Improved pond systems:

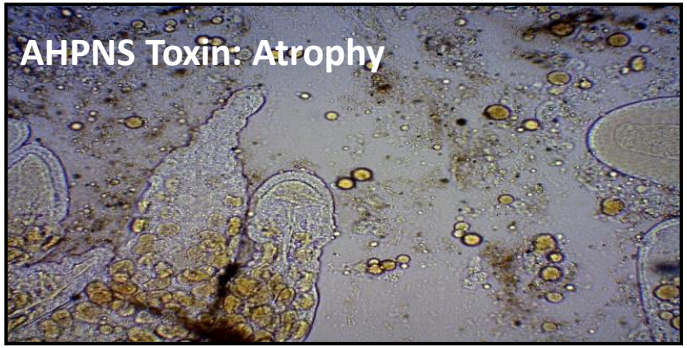
-Smaller ponds, more efficient water exchange
-Shading
-Trend to shallower; not deeper ponds
-Higher aeration

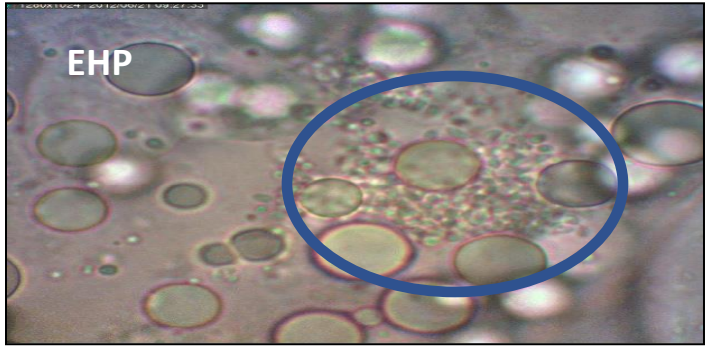
And the Americas: Guatemala, Brazil, Peru

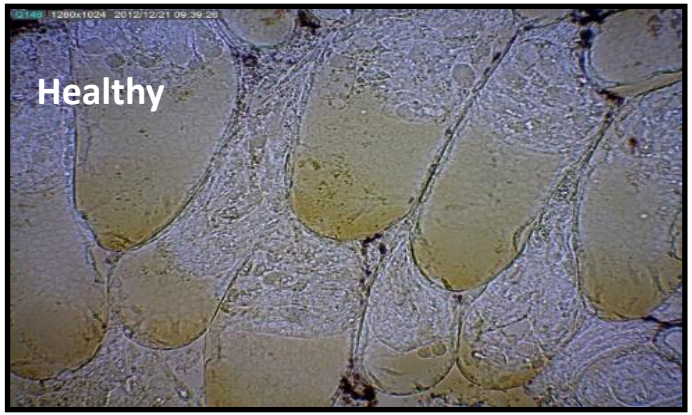
Summary of trends to “pond efficiency”

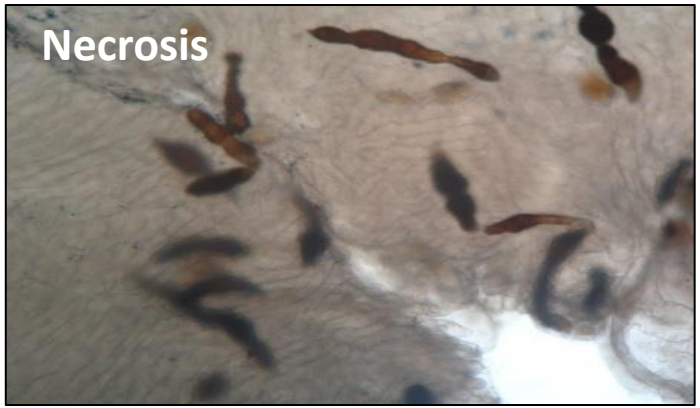
- Smaller Ponds: 1000-4000M2
- Central Sumps for continuous removal of wastes
- Higher water exchanges
- Higher aeration
- Depth- more reducing depth than increasing depth
- Temperature stabilization: shade cloth
- Use of settling, treatment, fish for recycle of exchange water
- Use of Ground water when available (no need disinfectants, etc)
- Liners- reduced pond down time, cleanup ease
- Nurseries- faster growth in pond; more cycles per year
- Diets formulated for the higher growth potentials

Without Healthy Post Larvae: Genetics don't mean very much







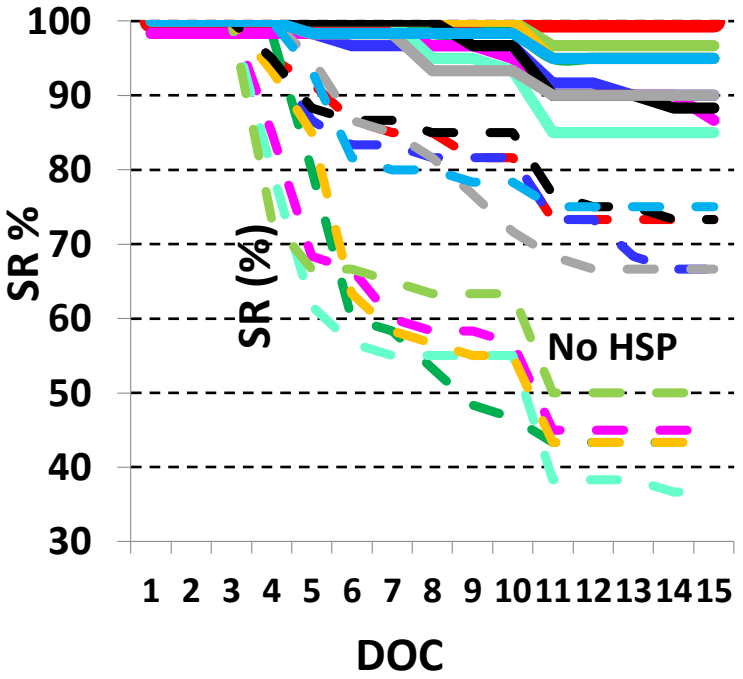


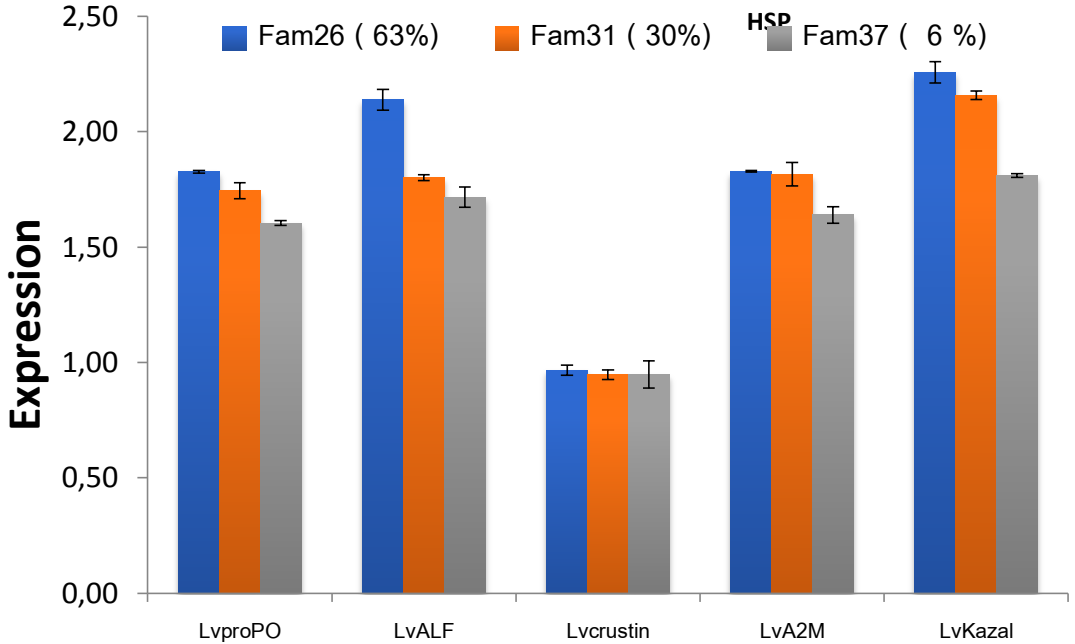
Careful what we call Genetic

Parameter	SPR I	SPR II	SPR III	SPF	SPF +
AHPNS CHALLENGE	**21**	**60**	**55**	**62**	**78**
MBW DOC 35	**3.6**	**2.5**	**2.2**	**4.8**	**4.8**
MBW DOC 80	**17.5**	**15.5**	**13.5**	**29.6**	**29.6**

Spf + = up-regulated

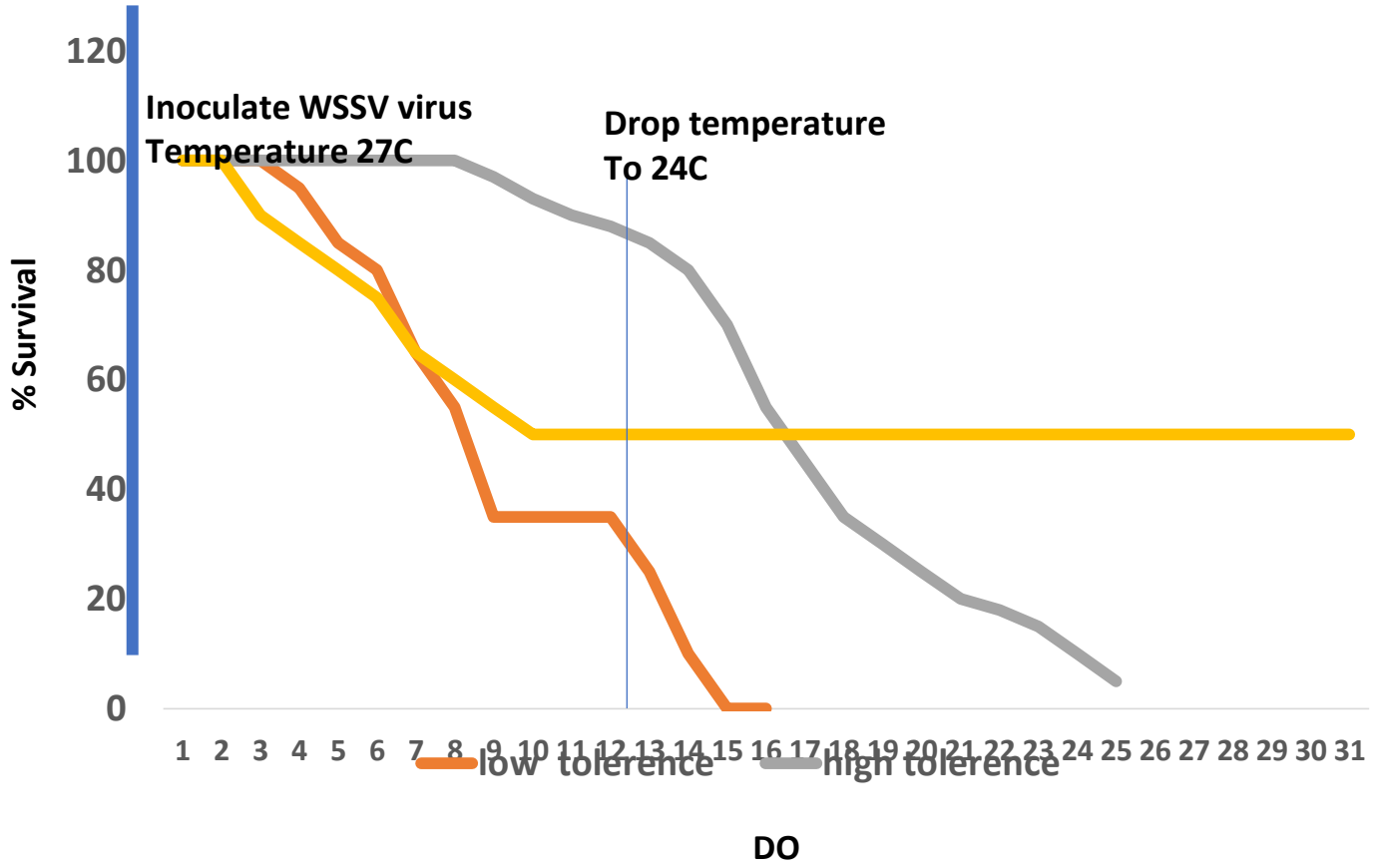
Expression of the Genes already in the Shrimp effects Survival and challenges!!!



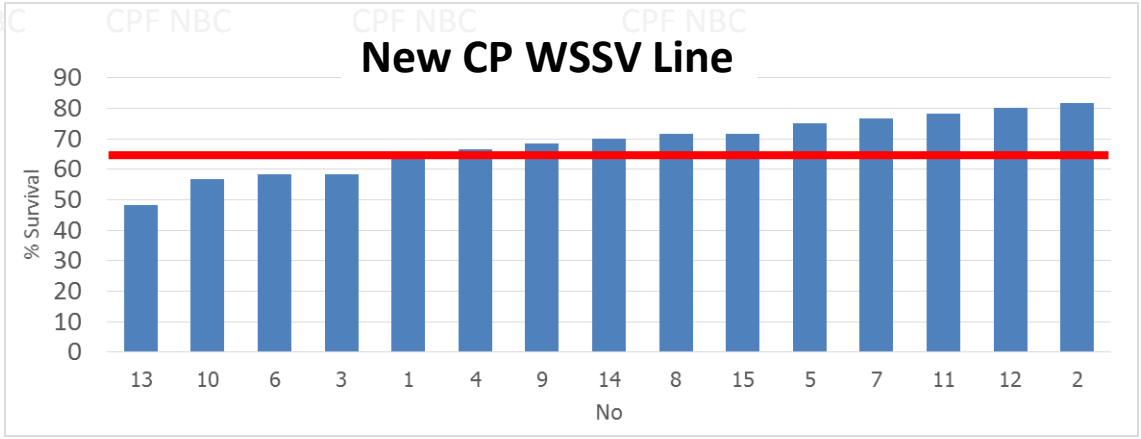


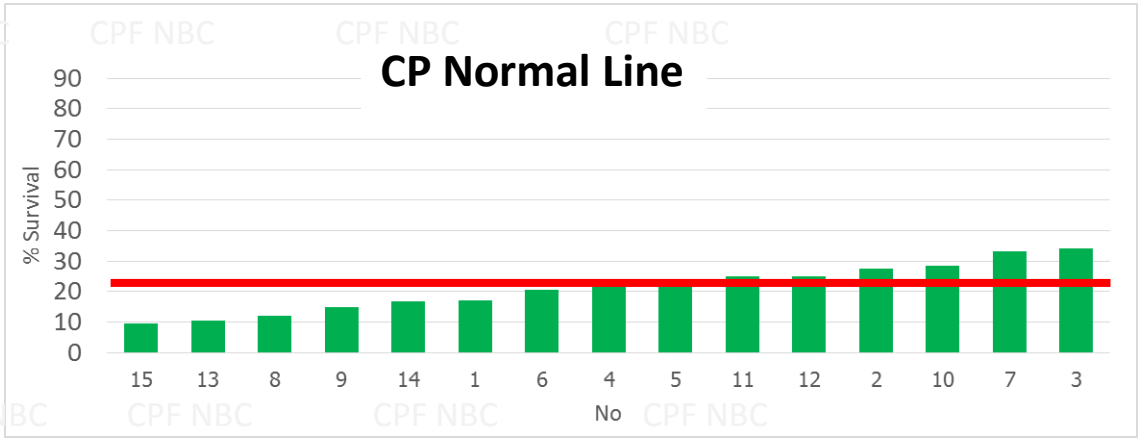
Tolerance is not Resistance

Comparison of WSSV Tolerance and Resistance

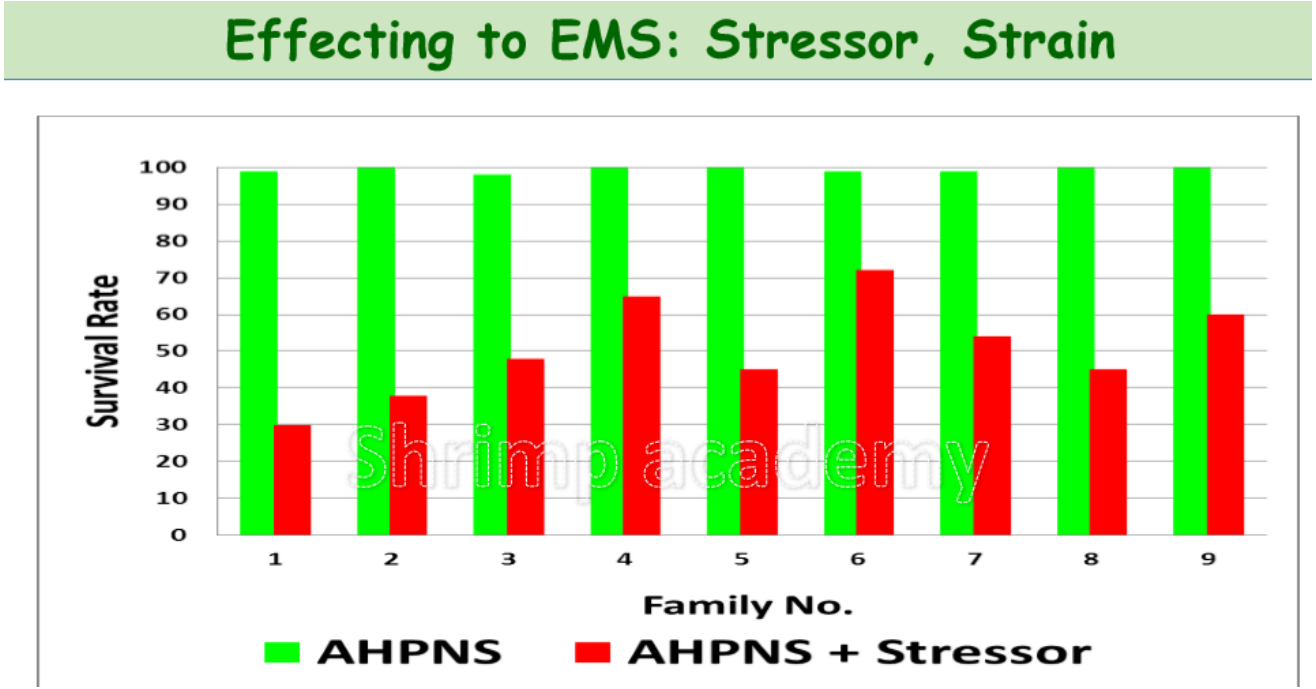


Development on WSSV Tolerance (SPF only)

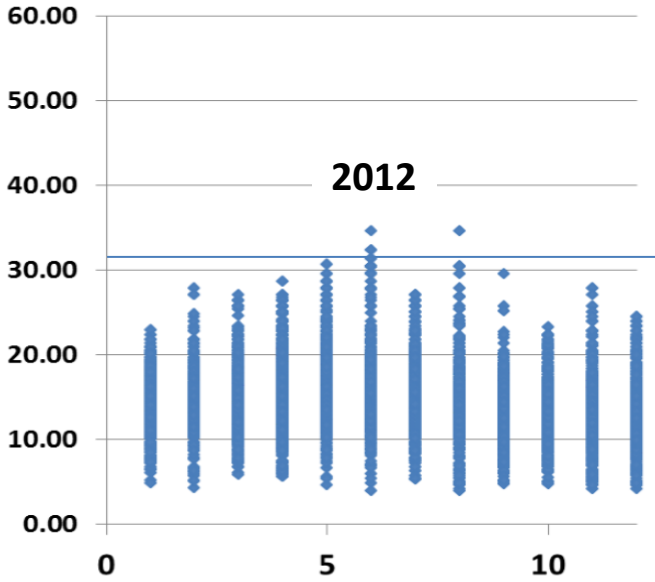




Conditions within the pond (stresses) effect gene expression!!!

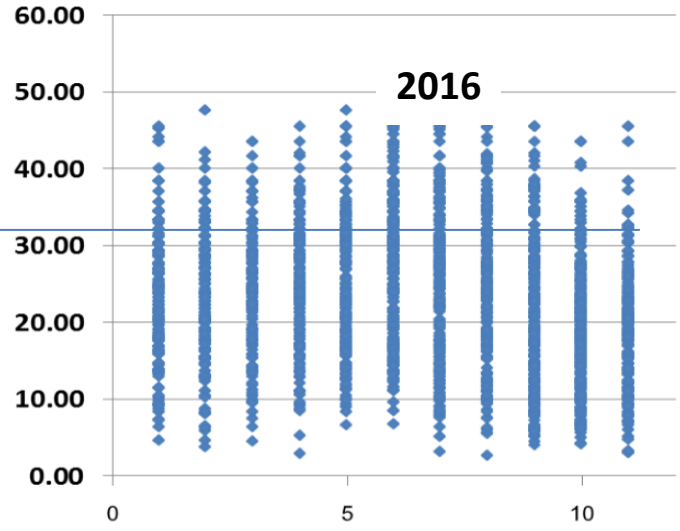


Increased Performance through genetics?



2012

MBW: 14.5 GMS
YIELD: 10.4 MTONS/HA
ADG: 0.18 GMS/DAY

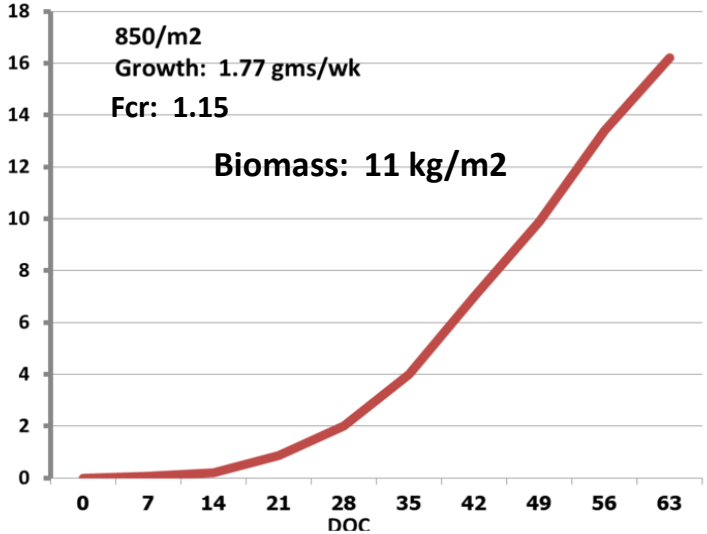


2016

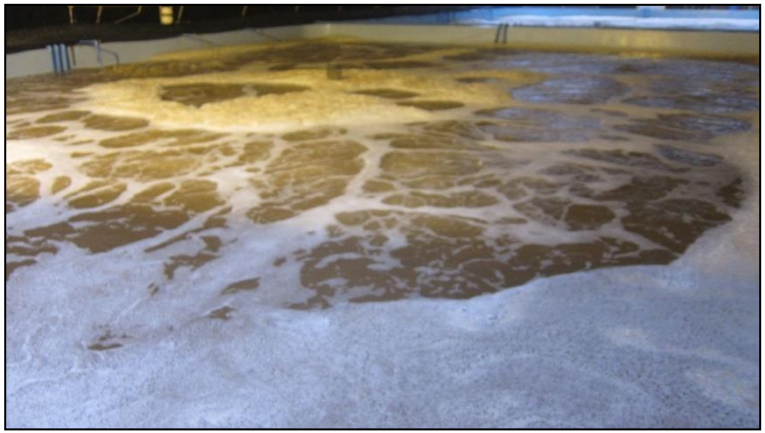
MBW: 24.1 GMS
YIELD: 21,300 KGS/HA
ADG: 0.31 GMS/DAY

The Industry will evolve towards "Sustainable Intensification"

Producing more from Less



Less Land, more shrimp;
Higher water efficiencies
Higher Feed Efficiencies
Higher Survivals
LOWER COSTS



CPF