MORE *ARTEMIA* USE IMPROVES HATCHERY, NURSERY, AND GROW-OUT OUTCOMES

A SUMMARY OF TRIALS ON *L. VANNAMEI*

GREAT SALT LAKE ARTEMIA

IMPACTS OF ARTEMIA DIETARY LEVELS

1. Impacts in the Hatchery Cycle (UoI Trials 3 and 4)

2. Impacts in the Nursery Cycle (UoI Trials 4 and 5)

3. Transportation Stress Test (UAPB trial 2)
   - Heat shock Proteins and Immune Response

4. Suggested Benefits in the Grow-out Cycle (Field Trial Aqua Biomar)
   - Preliminary Field Trial in Mexico (hatchery and grow-out)

5. Impacts on Macrobrachium Rosenbergii post larvae field trial

6. Impact of Artemia stages (U – I1 – I2) and Artemia dietary levels (UAPB trial 4)

7. Meat ball trial

8. Ecuador hatchery trials (3 trials)

9. Vietnam hatchery/grow-out (1 trial)

INCREASED ARTEMIA USE

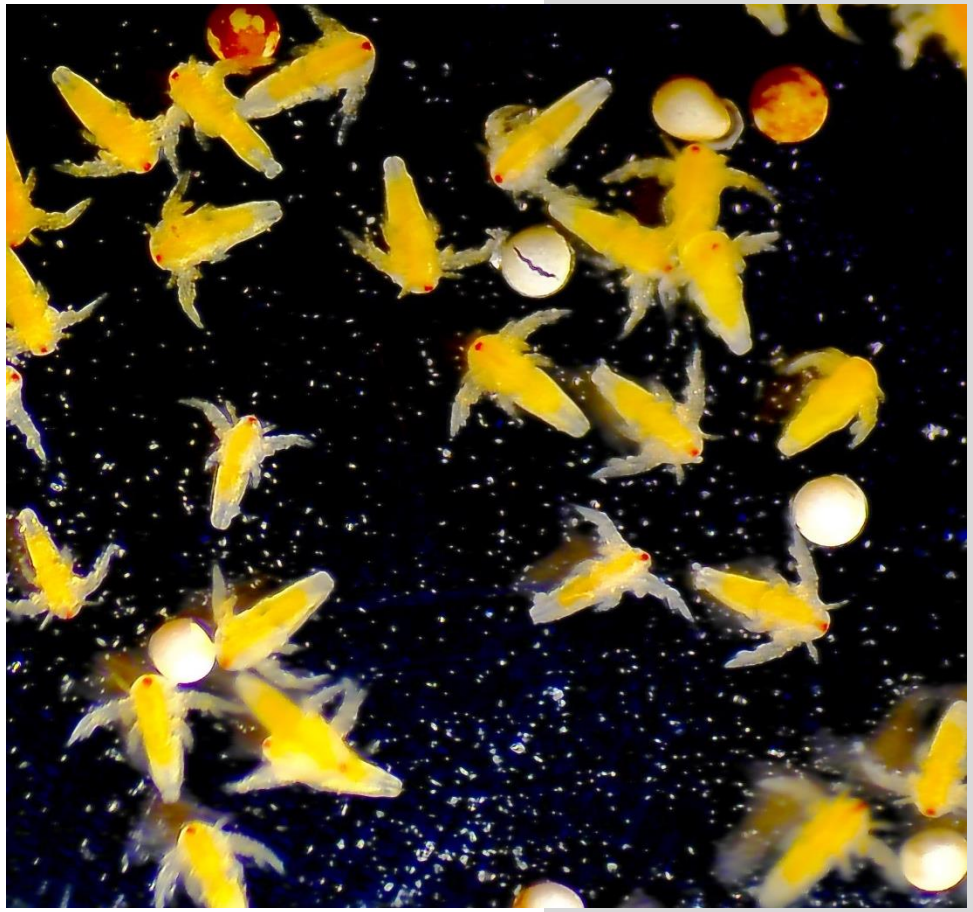
A SERIES OF TRIALS

Research Facilities

- **hatchery**
- **nursery**

Commercial Production Facilities

- **hatchery**
- **nursery**
- **Grow-out**



INCREASED ARTEMIA USE

OUTLINE

- **Research Facilities**
  - ***University of Idaho***
    - Alpha and Beta trials: hatchery cycle (N to PL15)
    - Nursery trial (PL12 to PL25)
  - **University of Idaho at Pine Bluff**
    - Stress testing related to Artemia
- **Commercial trials**
  - Hatchery trial Mexico
  - Hatchery trials in Ecuador
  - Hatchery through grow-out in Vietnam (university-commercial)

ARTEMIA USE RATE TRIALS

UNIVERSITY OF IDAHO

First series of tests on optimizing Artemia use in *L. vannamei* culture

Scoping trial for **hatchery cycle** tests

Follow up trials on hatchery and **nursery** age PLs

Dr. Yathish Ramena, Thomas Bosteels, Frank Martorana

GREAT SALT LAKE ARTEMIA

UNIVERSITY OF IDAHO

ALPHA TRIAL

N to PL15 (Hatchery)

11.4 liter recirculating tanks, 8 replicates per treatment

Stocked to 36 vannamei nauplii per liter

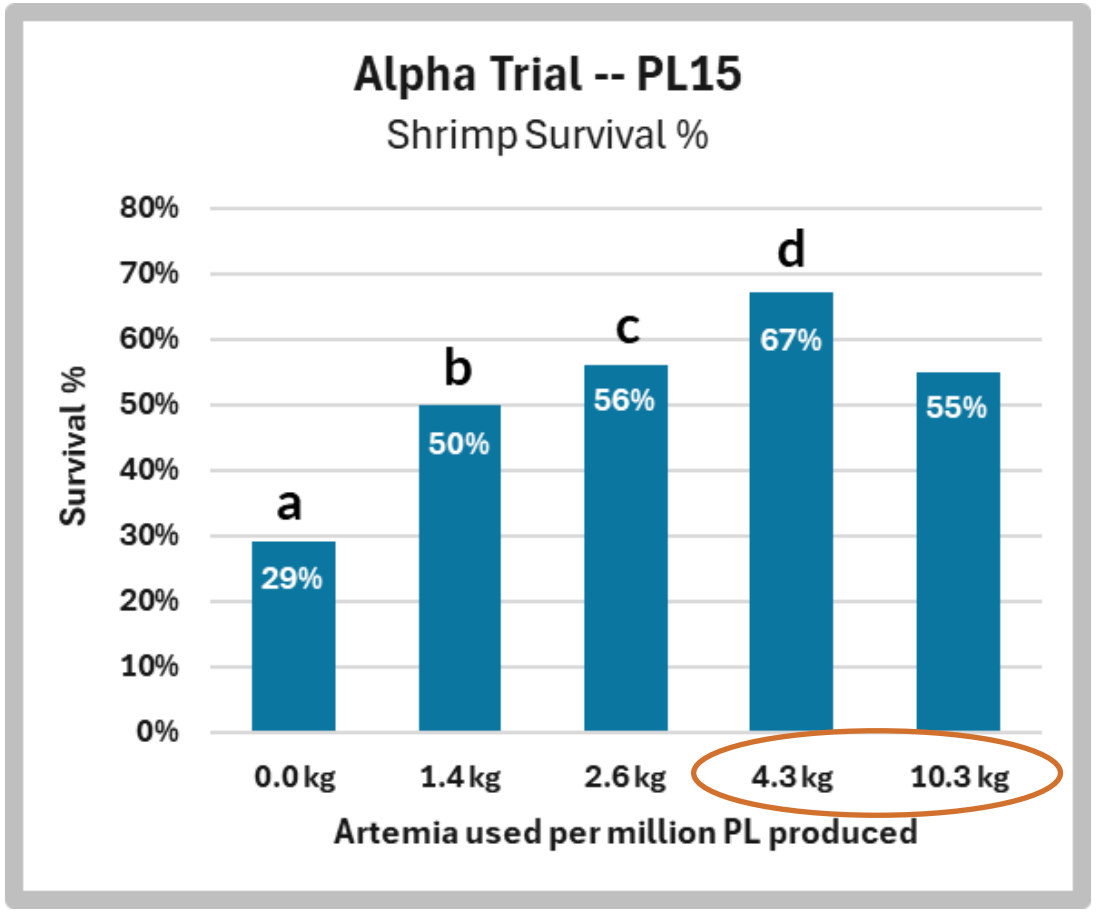
Co-fed to satiation with a high-quality MP diet

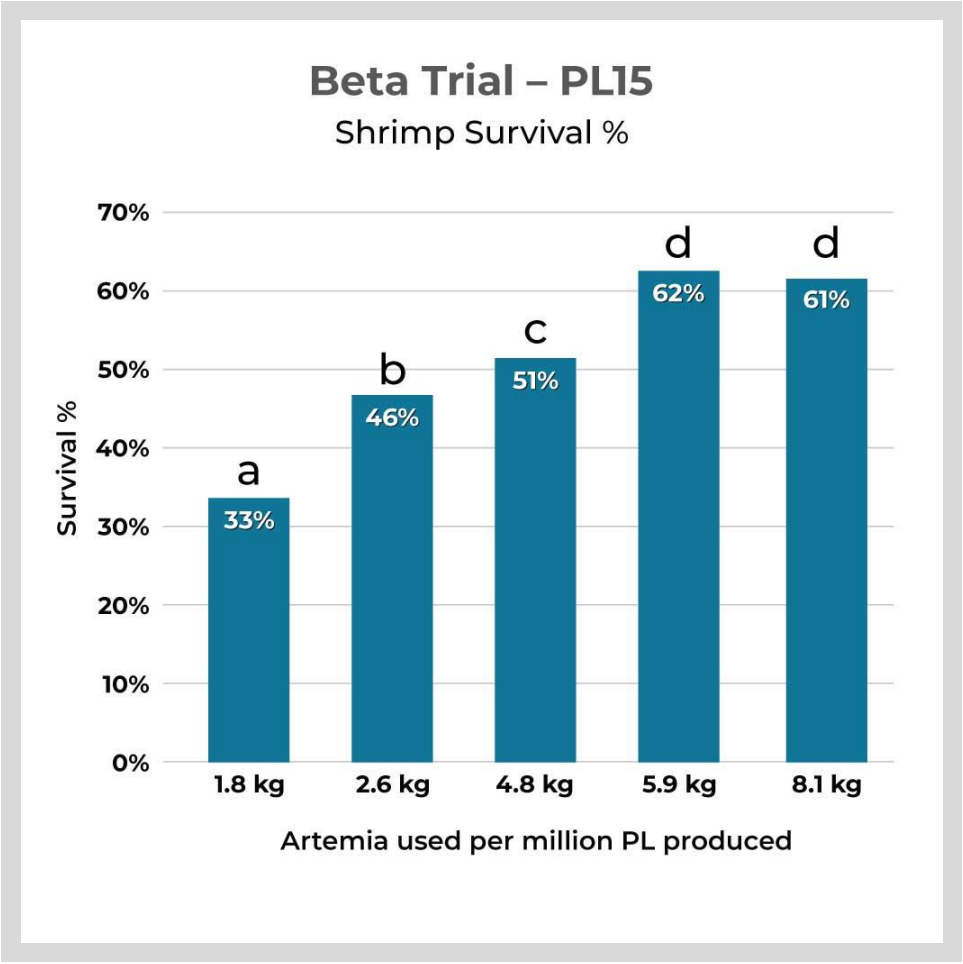
Results:

Survival rate increases with Artemia use rate

No difference in PL size, stress tolerance, muscle gut ratio

Greater resolution between 4kg and 10kg is needed





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BETA TRIAL

N to PL15 (Hatchery)

Stocking density increased to 57 vannamei nauplii per liter

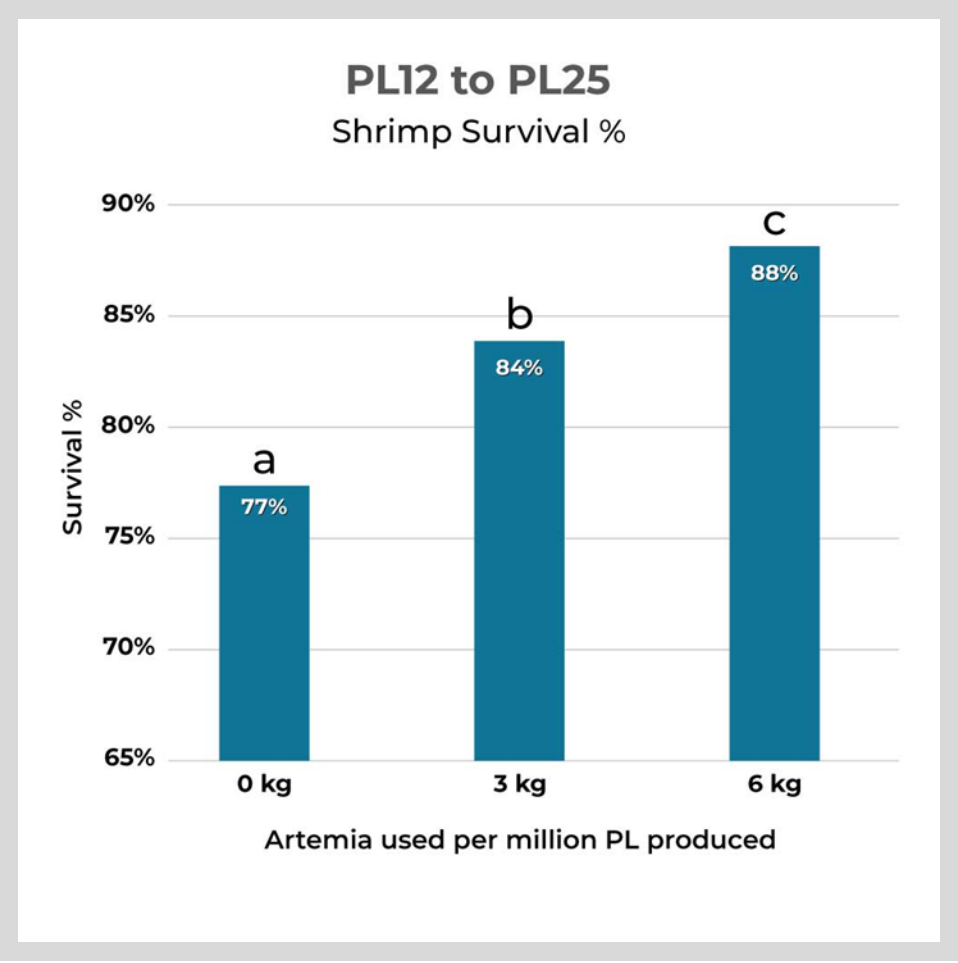
Artemia feeding rates to define response in the 2kg to 8kg per million range

Results:

No difference in PL size, stress tolerance

Survival again increases with Artemia use rate

- Peaks at approximately **6kg per million PL**
- No further gains above this



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NURSERY TRIAL

PL15 to PL25

PL12 reared using flake feed and a low Artemia use rate

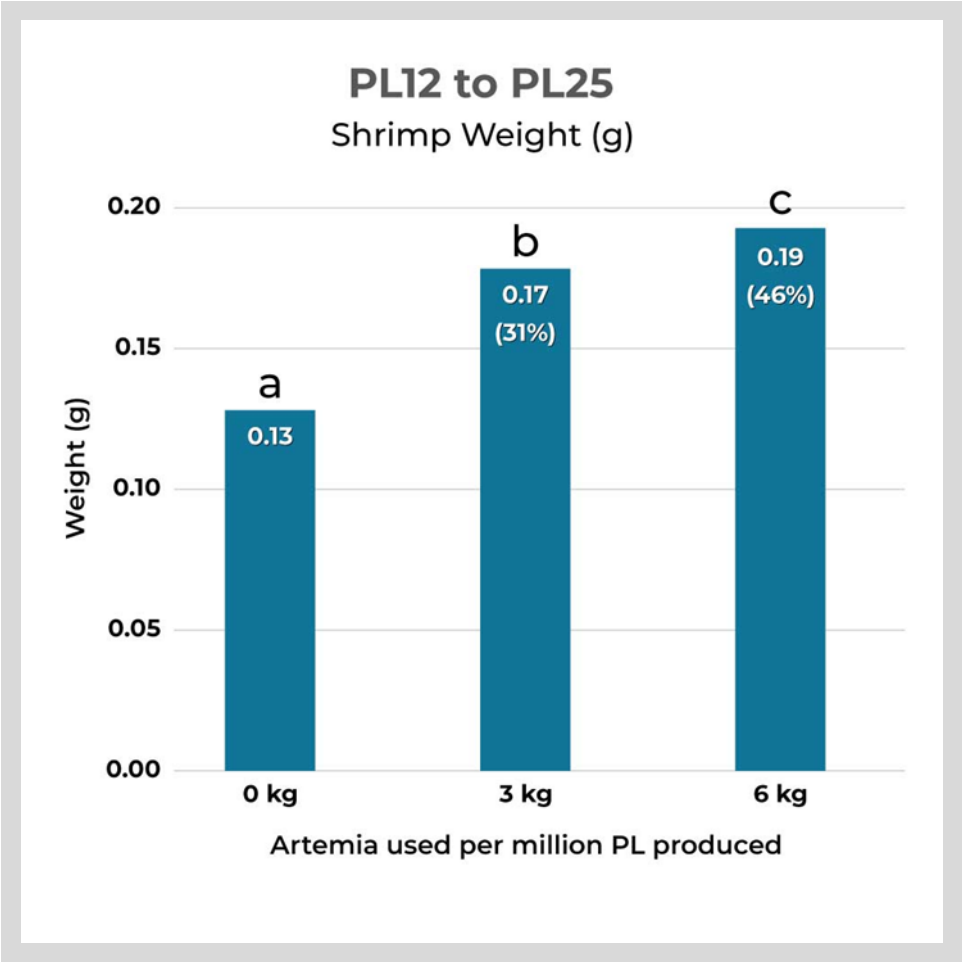
17.5 PL per liter

Co-feeding of MP feeds with 0, 3, or 6kg Artemia per million PL

Results:

Compared to PLs fed no Artemia in nursery cycle:

- Survival is **7% higher** for PLs fed **3kg** Artemia per million
- Survival is **11% higher** for PLs fed **6kg** Artemia per million



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NURSERY PHASE

PL15 to PL25

Compared to PLs fed no Artemia in nursery cycle:

- PLs fed **3kg** Artemia per million are **31% larger**
- PLs fed **6kg** Artemia per million are **46% larger**
- PLs fed 6kg are 12% larger than those fed 3kg

The resulting biomass at PL25 is 60% higher for the 6kg treatment than control, 17% higher than the 3kg treatment.

VIETNAM UNIVERSITY TRIAL

HATCHERY AND GROWOUT

GREAT SALT LAKE ARTEMIA

University of Can Tho College of Aquaculture and Fisheries

- Drs. Nguyen Van Hoa & Chau Tai Tao

Hatchery, Nursery & Growout

- More Artemia given in hatchery and nursery
- Results measured through the growout cycle

GREAT SALT LAKE ARTEMIA

VIETNAM HATCHERY AND GROWOUT

TRIAL DESIGN

Control: 3kg in hatchery + 0kg nursery = **3kg** total

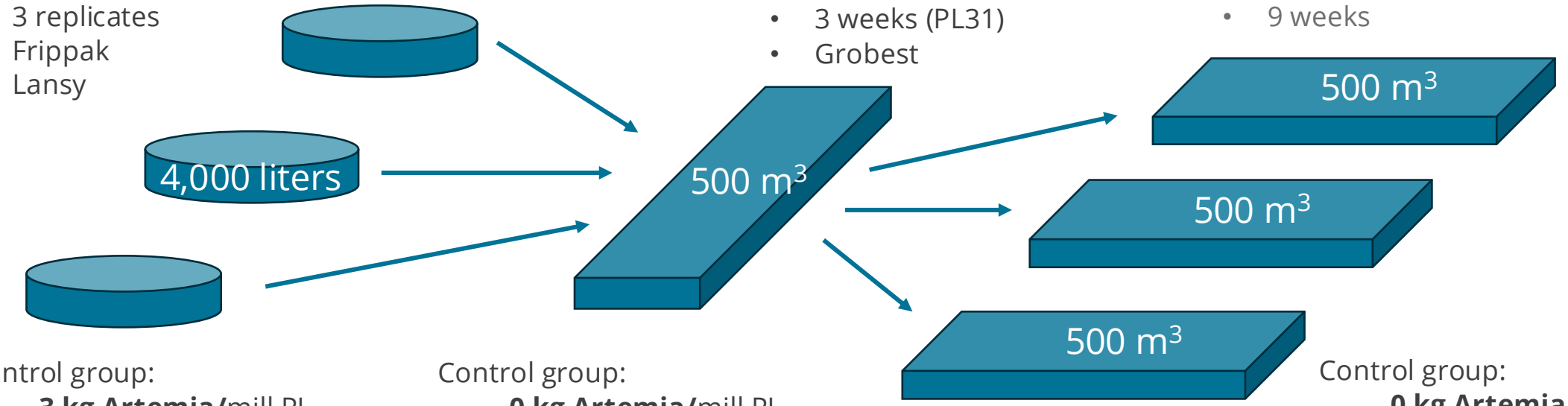
Trial: 6kg in hatchery + **3kg** nursery = **9kg** total

Vinh Chau Artemia—local to experiment, but expensive

Hatchery
- 200 n/l
- 3 replicates
- Frippak
- Lansy

Nursery
- 1000 PL12/m^3
- 3 weeks (PL31)
- Grobest

Growout
- 150 PL31/m^3
- 9 weeks



Control group:
3 kg Artemia/mill PL
Trial group:
6 kg Artemia/mill PL

Control group:
0 kg Artemia/mill PL
Trial group:
3 kg Artemia/mill PL

Control group:
0 kg Artemia
Trial group:
0 kg Artemia

Only Grobest feed

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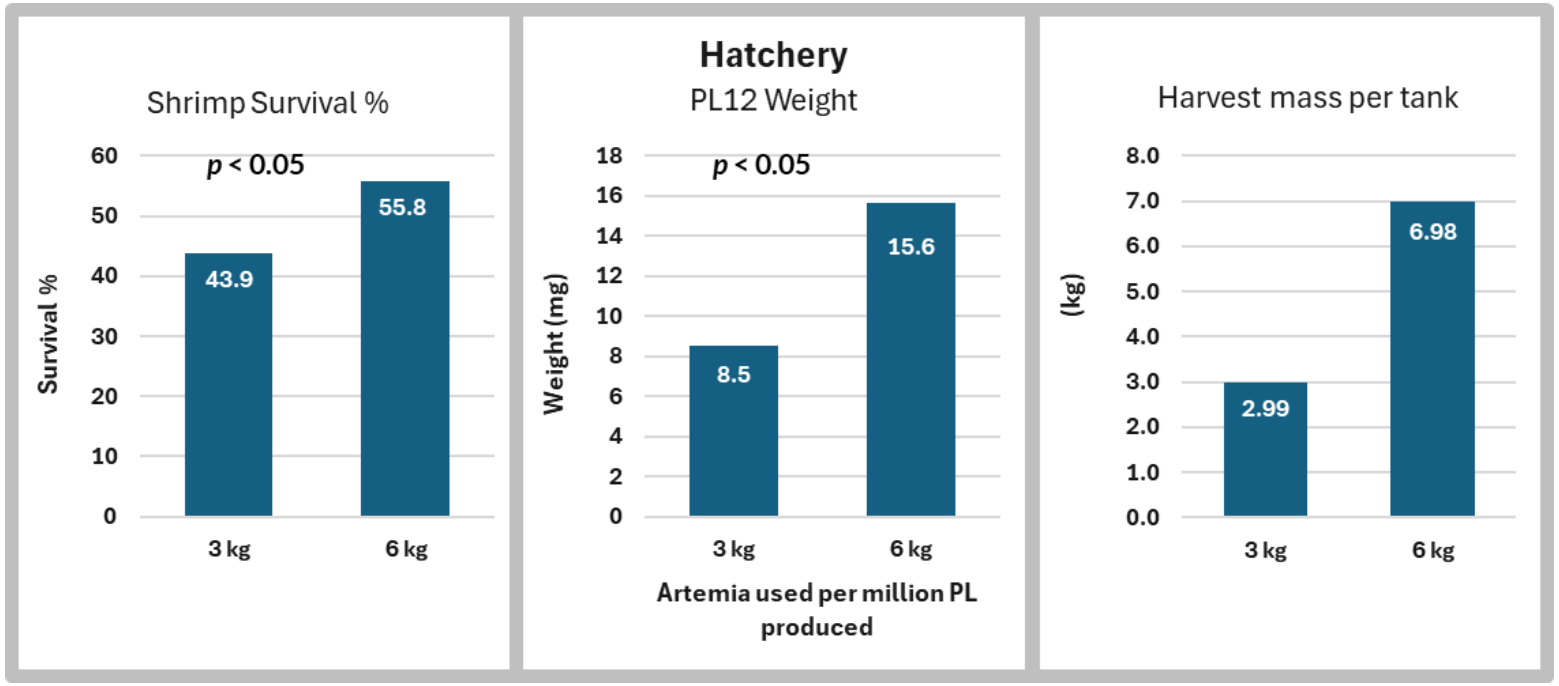
VIETNAM HATCHERY AND GROWOUT

HATCHERY RESULTS



Hatchery cycle results (PL12)

Survival

- **+27%** higher

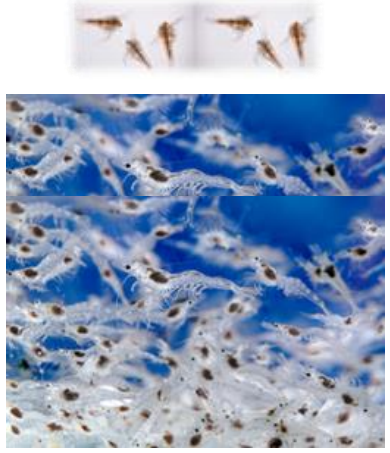
PL weight

- **+83.5%** higher

Harvested biomass per tank

- **+133%** higher

3kg Artemia/mill
3kg vannamei PL/tq



6kg Artemia/mill
7kg vannamei PL/tq

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VIETNAM HATCHERY AND GROWOUT

GROWTH, WEEKS 1 TO 13

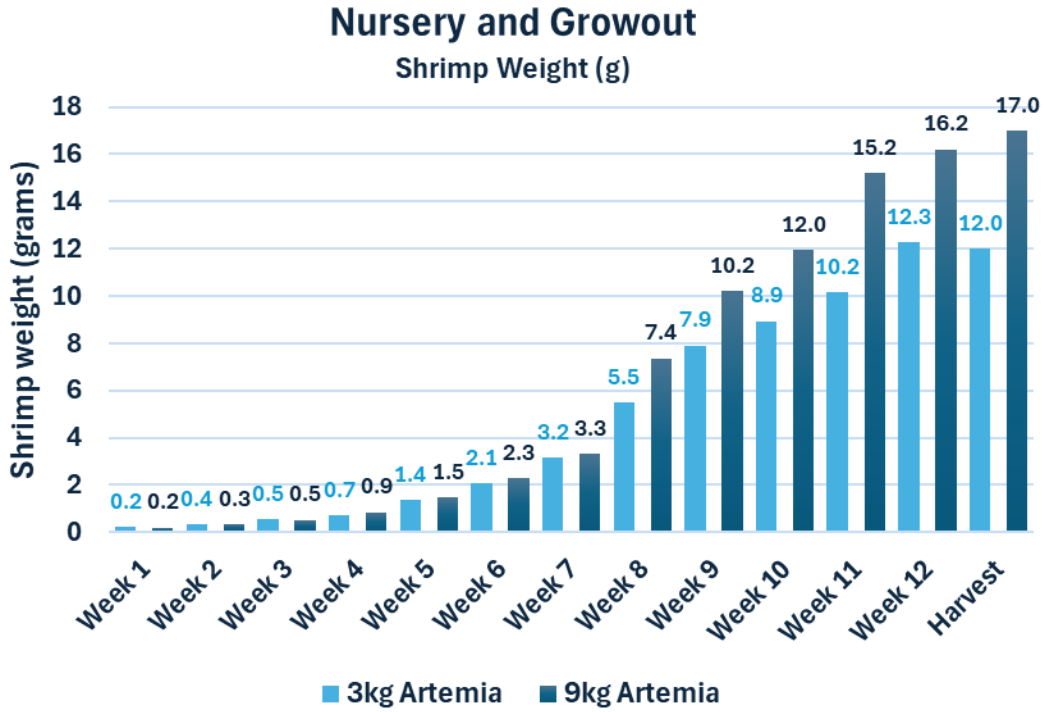
Nursery (3 weeks)

- 0.85 grams per shrimp (more Artemia)
- 0.73 grams per shrimp (less Artemia)

Growout

Large differences start at week 8

Shrimp are **42% larger** at harvest if fed 9kg Artemia in hatchery & nursery



17 grams

12 grams

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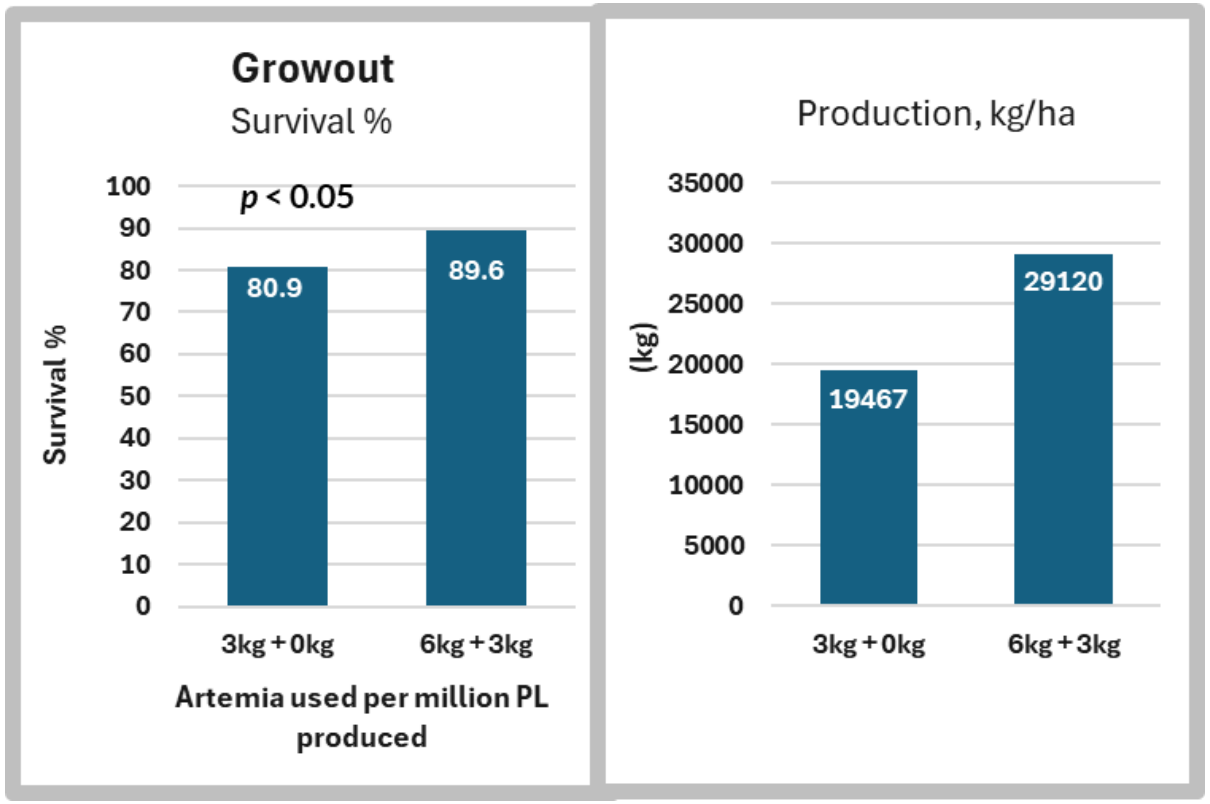
VIETNAM HATCHERY AND GROWOUT

HARVEST RESULTS



Survival

- 8.3% higher survival

Production

- Much faster growth
- Larger shrimp
- 50% higher production per unit area

More Artemia in hatchery and nursery resulted in 50% more shrimp biomass at harvest

Legacy effect of Artemia

- The benefit of Artemia in the hatchery and nursery continues through growout and to harvest for market

GREAT SALT LAKE ARTEMIA

VIETNAM HATCHERY AND GROWOUT

PRELIMINARY ECONOMICS

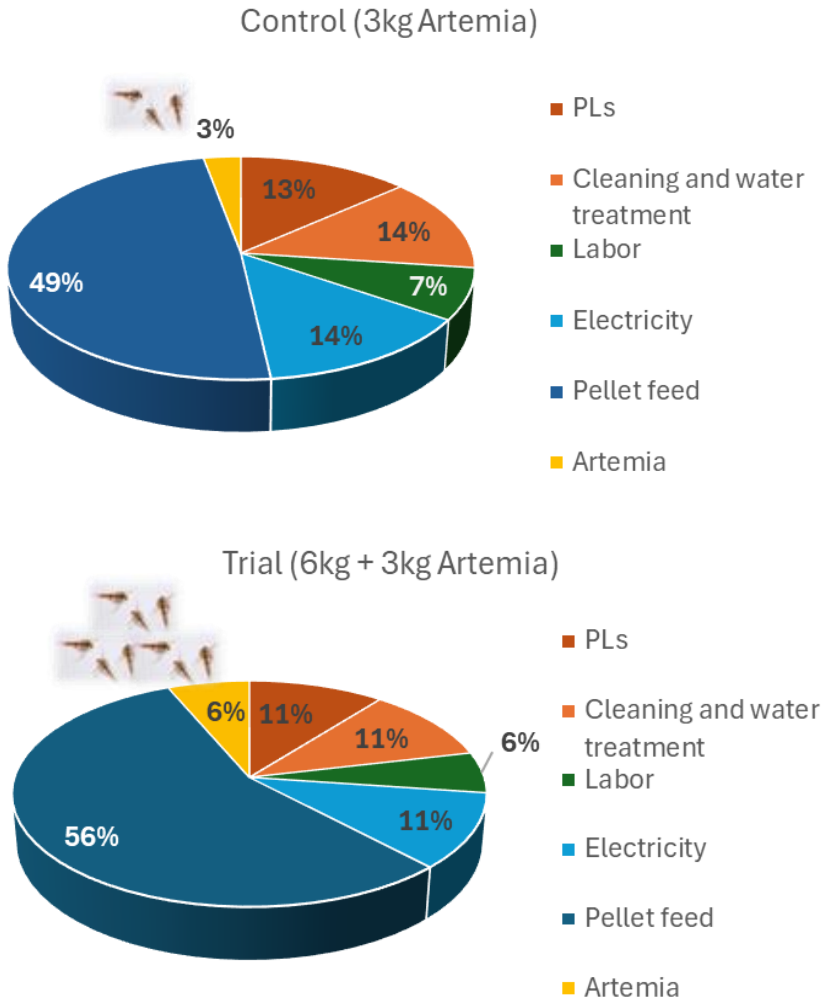
Hatchery

- Artemia $320 (Control), $640 (Trial) per 500,000 PL12
- Hatchery at University; economics differ from commercial

Nursery + Growout

- Outdoor commercial scale
- Artemia was 3% (Control), and 6% (Trial) of total production costs
- Higher pellet feed costs in Trial (more and larger shrimp)

Total Costs in Nursery and Growout + all Artemia



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VIETNAM HATCHERY AND GROWOUT

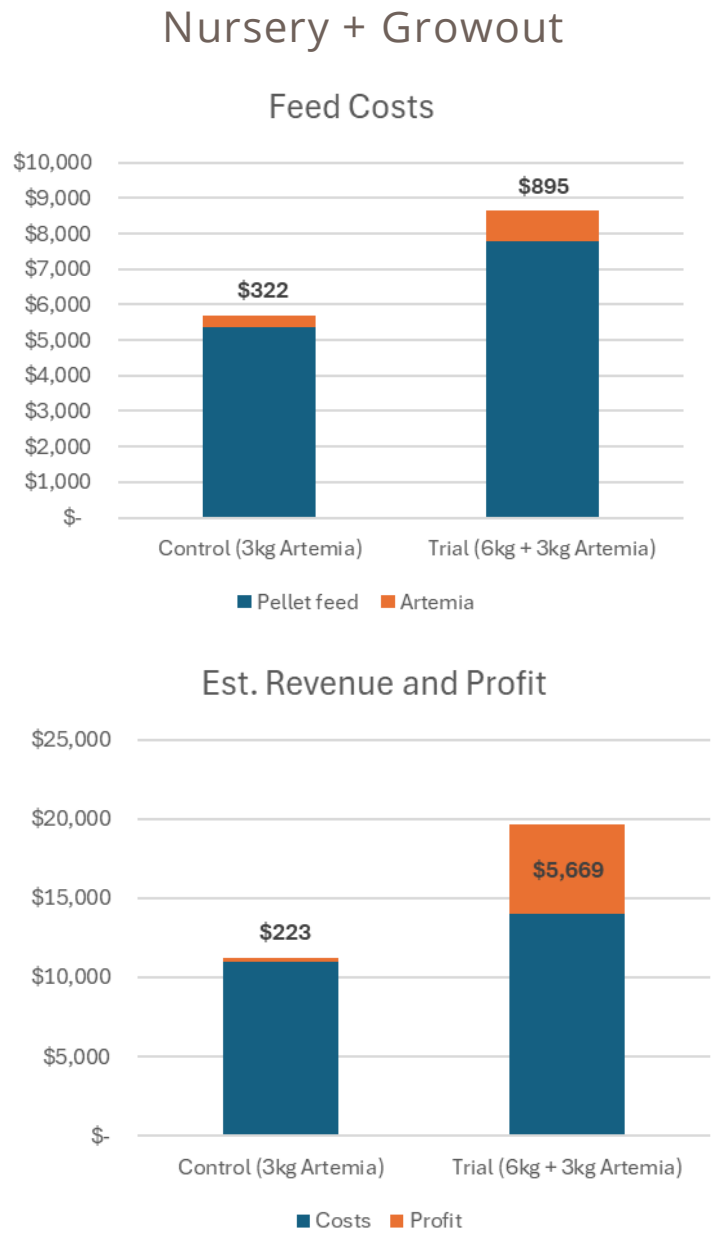
PRELIMINARY ECONOMICS

Feed costs

- $ Pellet feed >> $ Artemia

Profits

- More Artemia = larger shrimp and more shrimp at harvest
- Larger shrimp get higher prices in Vietnam market
- Profits **$5400 (24x) higher** with more Artemia in this trial
- High return on investment (ROI) with Artemia
  - **$9** profit for every **$1** spent on more Artemia



ARTEMIA USE RATE TRIALS

ECUADOR COMMERCIAL

2 **hatchery cycle** trials in 2025: March and October

Partners:

Laboratorio Semacua, Anconcito
- Jorge Espinoza
- Gabriel Vergara

Prilabsa
- Jenny Arauz
- Karen Menoscal

GREAT SALT LAKE ARTEMIA

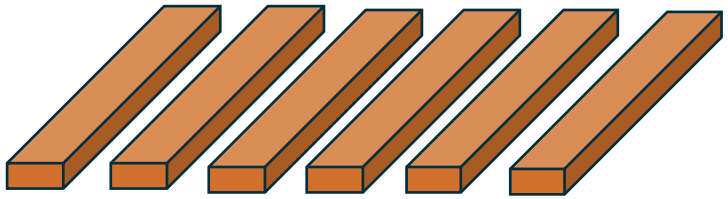
ECUADOR HATCHERY TRIALS

TRIAL DESIGN

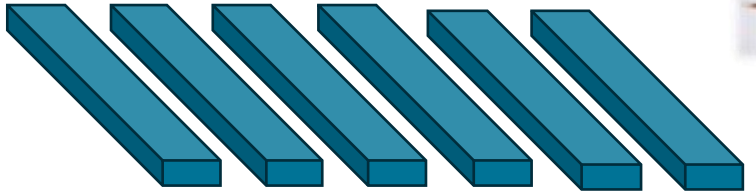
2 trials at Semacua
- March 2025
- October 2025

Control: 2kg per million PL12
1kg GSL Artemia nauplii
1kg GSL Artemia decap *huevos*

Trial: 5.5kg per million PL12
4.5kg GSL Artemia nauplii
1kg GSL Artemia decap *huevos*



20,000 liter hatchery tanks
6 tanks per treatment
~130 vannamei nauplii/liter



Artemia nauplii fed Z3 to PL4

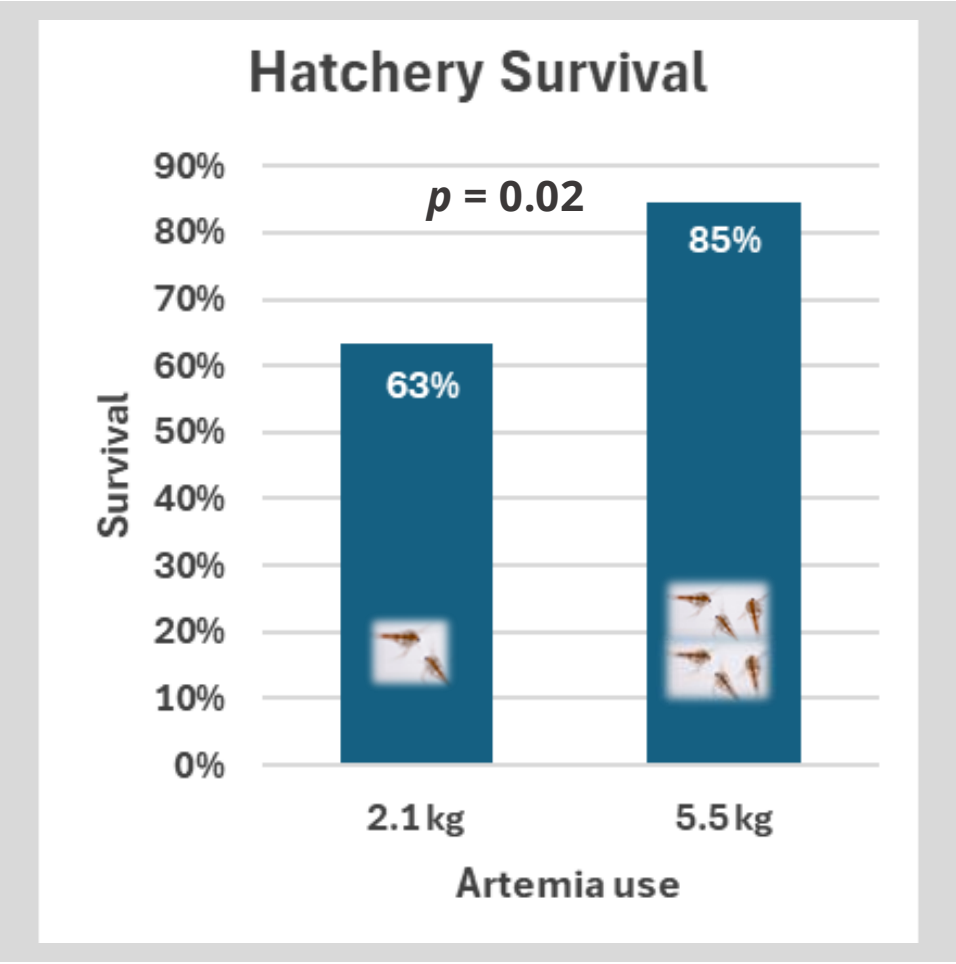
Decapsulated fed PL1 to PL8

- High quality PL diets
- Important: fed to satiation. More feed was provided if needed to support the higher survival & larger PL size

Artemia nauplii fed Z3 to PL6

Decapsulated fed PL1 to PL8

GREAT SALT LAKE ARTEMIA



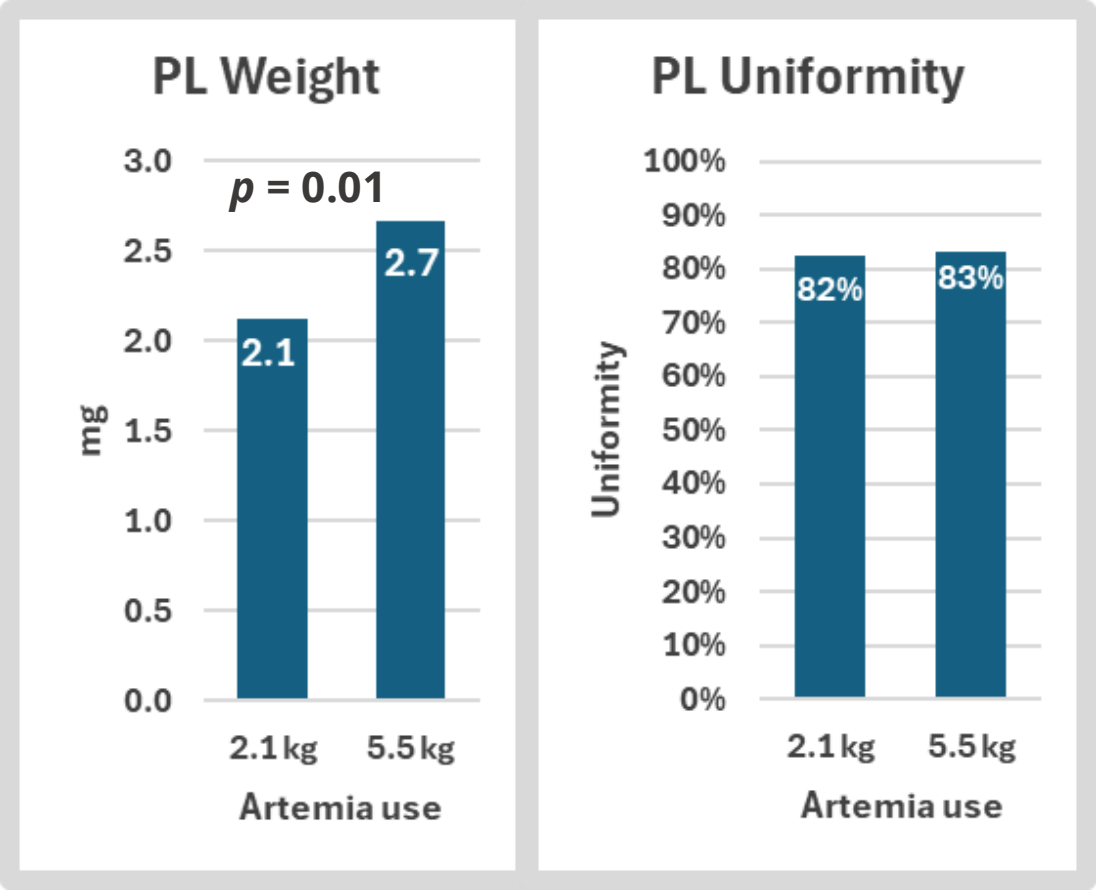
ECUADOR COMMERCIAL TRIALS

HATCHERY, MARCH 2025

Results:

Higher survival

35% more PLs to sell from the same size tanks



ECUADOR COMMERCIAL TRIALS

HATCHERY, MARCH 2025

PL Weight

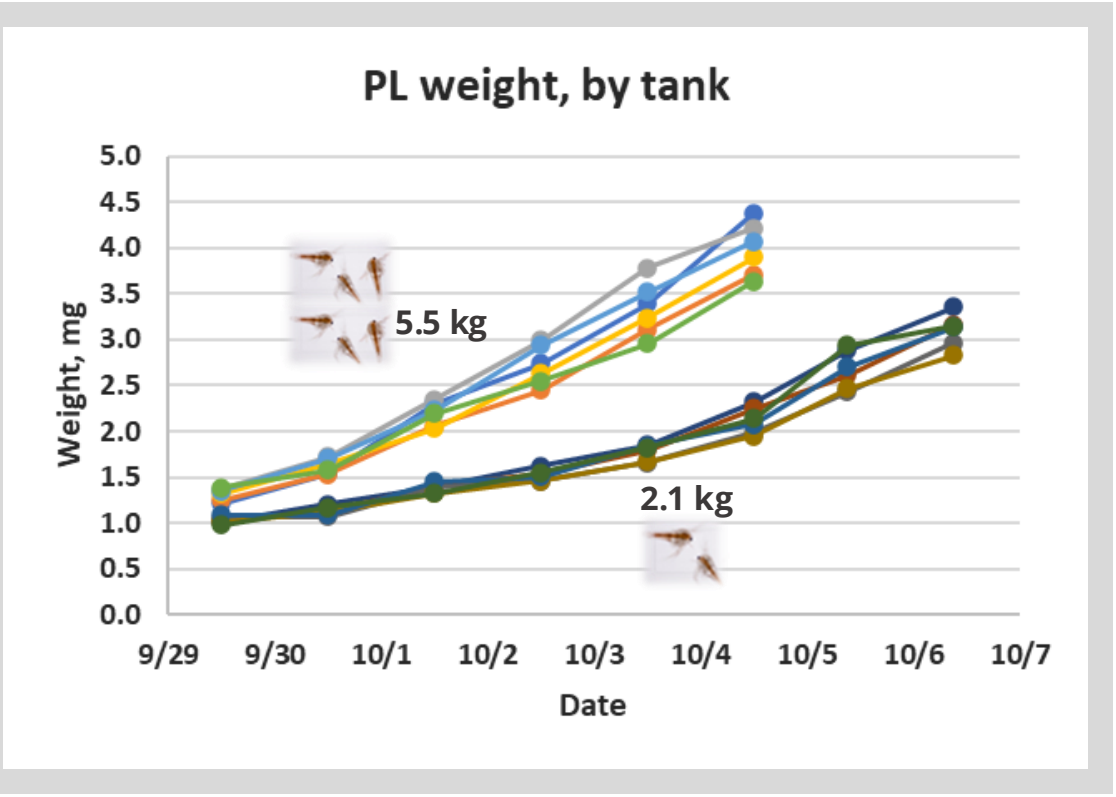
- Larger PLs. **29% higher weight**

Uniformity

- Uniformity of the PLs were not compromised to achieve this

Early Harvest

- Harvest could occur **2 days earlier** for the 5.5kg Artemia group



ECUADOR COMMERCIAL TRIALS

HATCHERY, OCTOBER 2025

Daily measurements of PL size and weight from PL4 to harvest

- Faster growth in all 6 Trial tanks
- At PL9: **nearly twice as large** with more Artemia
- Harvest **2-3 days earlier** than the 2.1kg.
- 2 – 3 days of production costs saved
- Faster cycles

GREAT SALT LAKE ARTEMIA

ECUADOR COMMERCIAL TRIALS

HATCHERY, OCTOBER 2025

PL size on same day

Tomota imaging software

5.5kg Artemia

2.1kg Artemia

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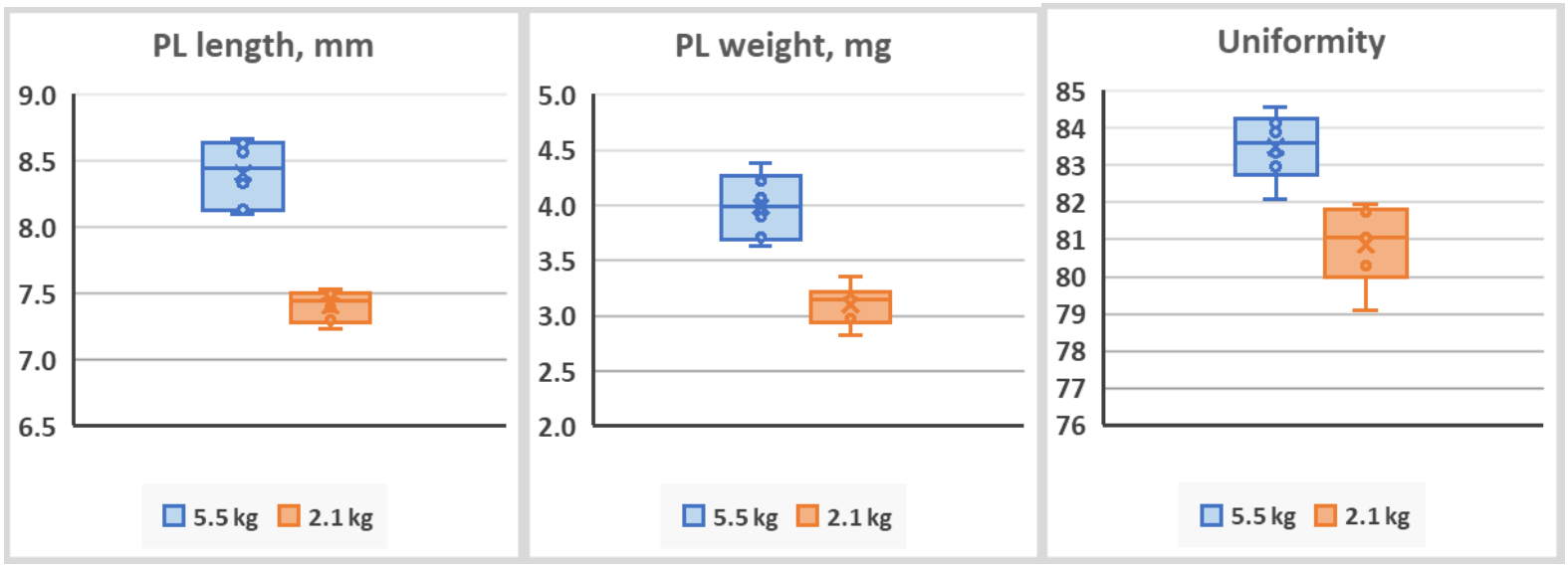
ECUADOR COMMERCIAL TRIALS

HATCHERY, OCTOBER 2025



At harvest

Survival was similar (72% vs 70%)

5.5kg Artemia PLs still nearly **30% larger** at harvest, despite control group having another 2-3 days to grow

Uniformity slightly higher

GREAT SALT LAKE ARTEMIA

ECUADOR COMMERCIAL TRIALS

PRELIMINARY ECONOMICS

March 2025 trial

Artemia cost $3900 more

Higher survival = **3,400,000 more PL** at harvest

$1.95/1000PL = $6,675 more revenue

Profit from using more Artemia: **$2800**

Earlier harvest: **2 days saved**

October 2025 trial

Survival only 2% higher—only $500 more revenue.

But, PLs much larger

Much more biomass. Kg vs kg

The farm benefits from larger, healthier PL

Earlier harvest: **3 days saved**

The benefit of more Artemia

Higher survival

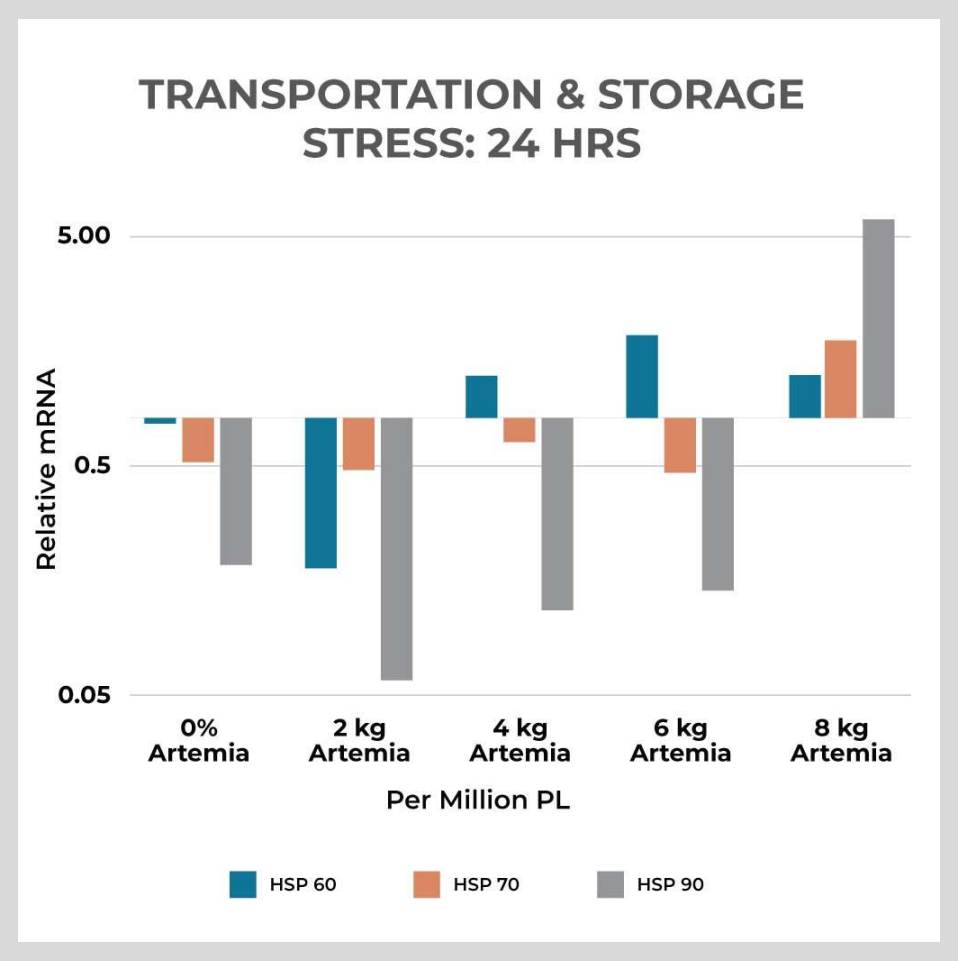
- Good for the hatchery. More PLs to sell, more revenue

Faster growth

- Good for the hatchery. Shorter production, saved costs
- Good for the farm. Larger PLs.

How much does 2-3 days earlier harvest save your hatchery?

GREAT SALT LAKE ARTEMIA



HEAT SHOCK PROTEINS

The Heat Shock Protein study, conducted at UAPB, reveals a **positive correlation** between Artemia feeding and the upregulation of mRNA expression of heat shock proteins, commonly known as molecular chaperones.

HSP60, HSP70 and HSP90 all show **significant improvement** (PL1–PL15 stages) when more Artemia is used in the feed regimen – improving cell protection and defense against stress.

GREAT SALT LAKE

MANAGEMENT FOR FUTURE ARTEMIA SUPPLY

Management is important for saline lakes

- Many saline lakes are not managed well

Great Salt Lake is different

- Management is active, adaptive, and works to preserve the Artemia ecosystem
- Government, business, and citizen groups work together
- Science, policy, and law

SUSTAINABLE

HARVEST MANAGEMENT

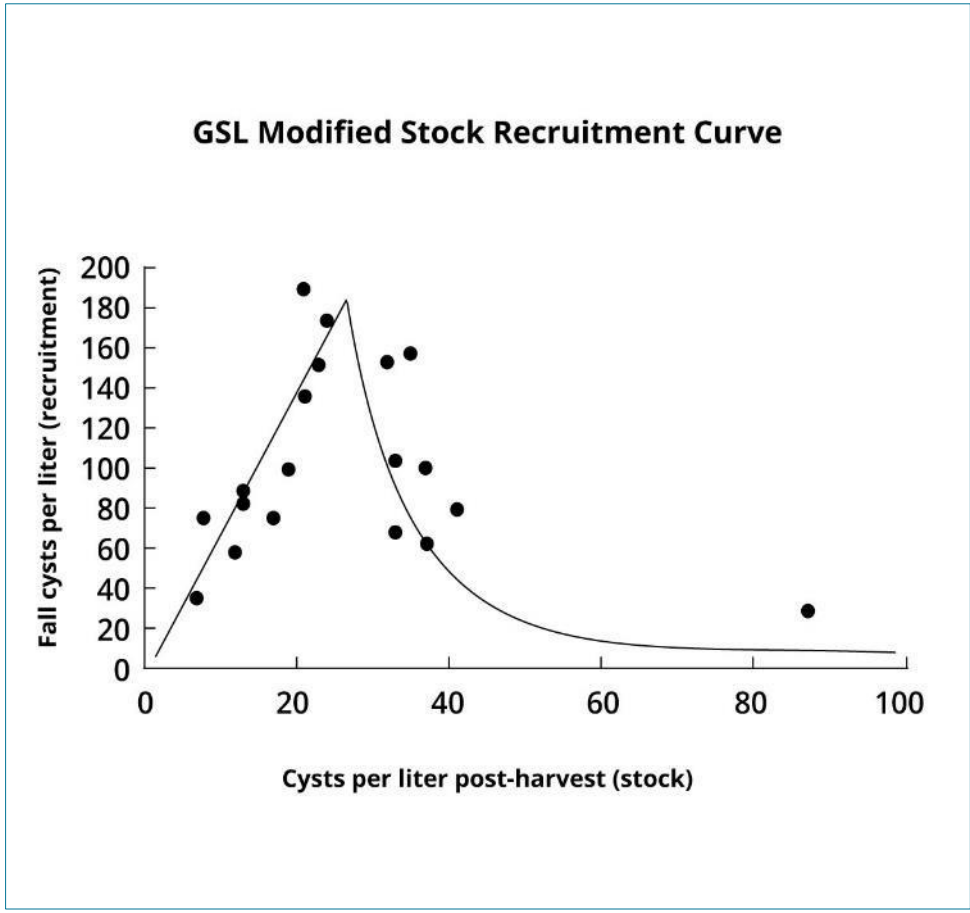
Harvest management initiated in 1996 by the Utah Division of Wildlife Resources in cooperation with the Artemia harvesting industry

Introduction in 1997 of harvest management based on a **stock recruitment curve**, a modified Ricker Curve

- Density dependent arm and a food dependent arm
- Optimal escapement stock of 21 cysts per liter
- Adaptive

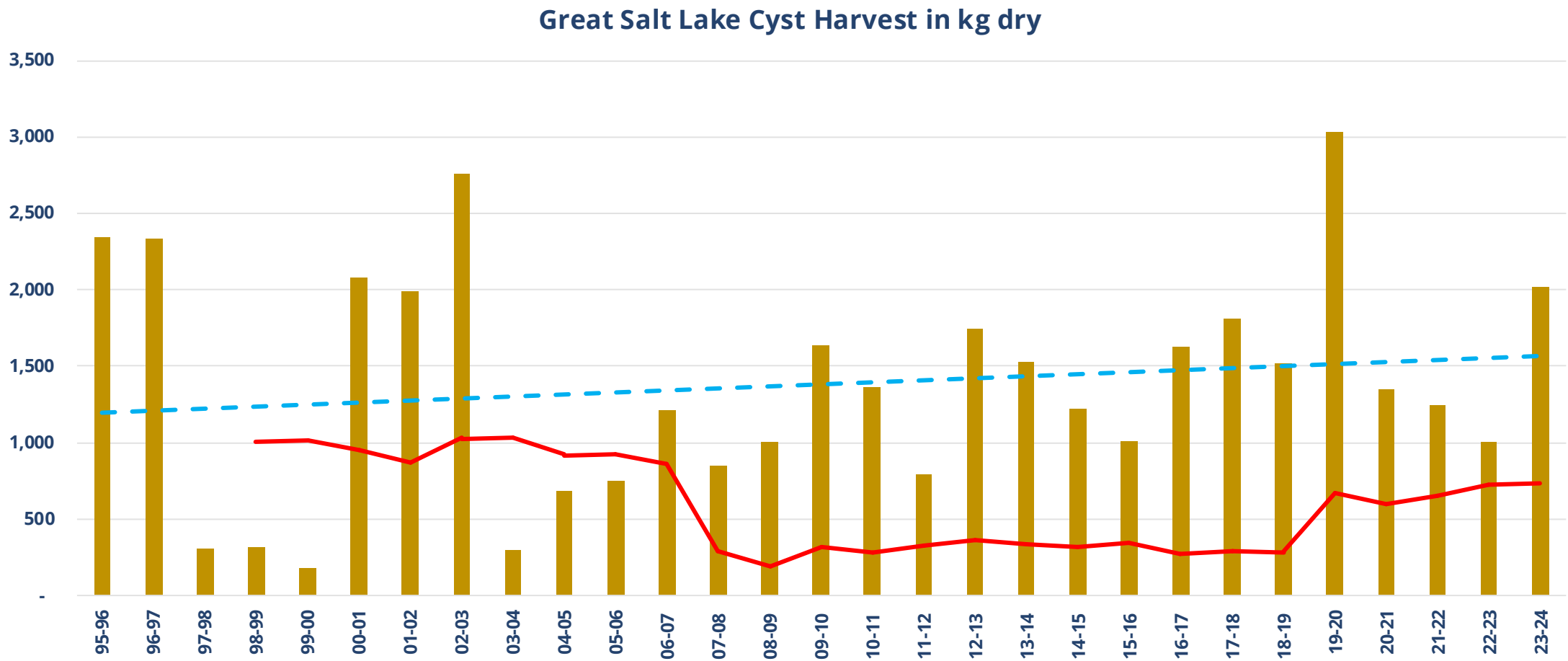
Harvest management has been researched for **nearly 3 decades**

- Detailed in Belovsky et al. 2011 and in Belovsky and Perchon, 2019



GREAT SALT LAKE ARTEMIA

SUSTAINABLE HARVEST MANAGEMENT



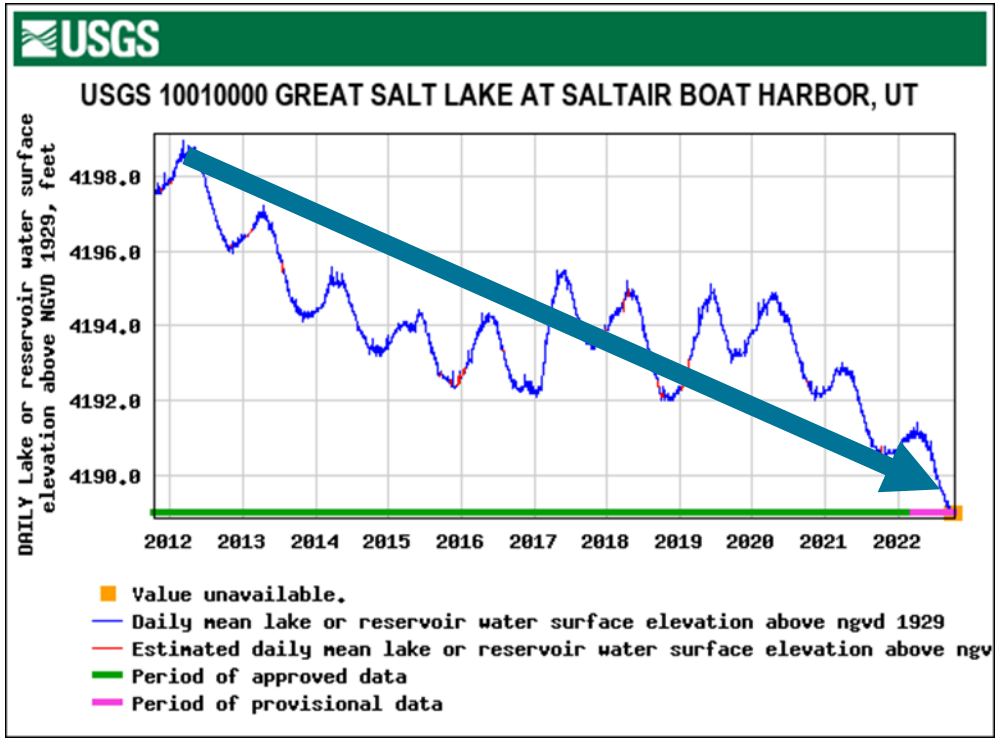
Sustainable harvest management implemented in 1996 has resulted in a stable Artemia population on Great Salt Lake

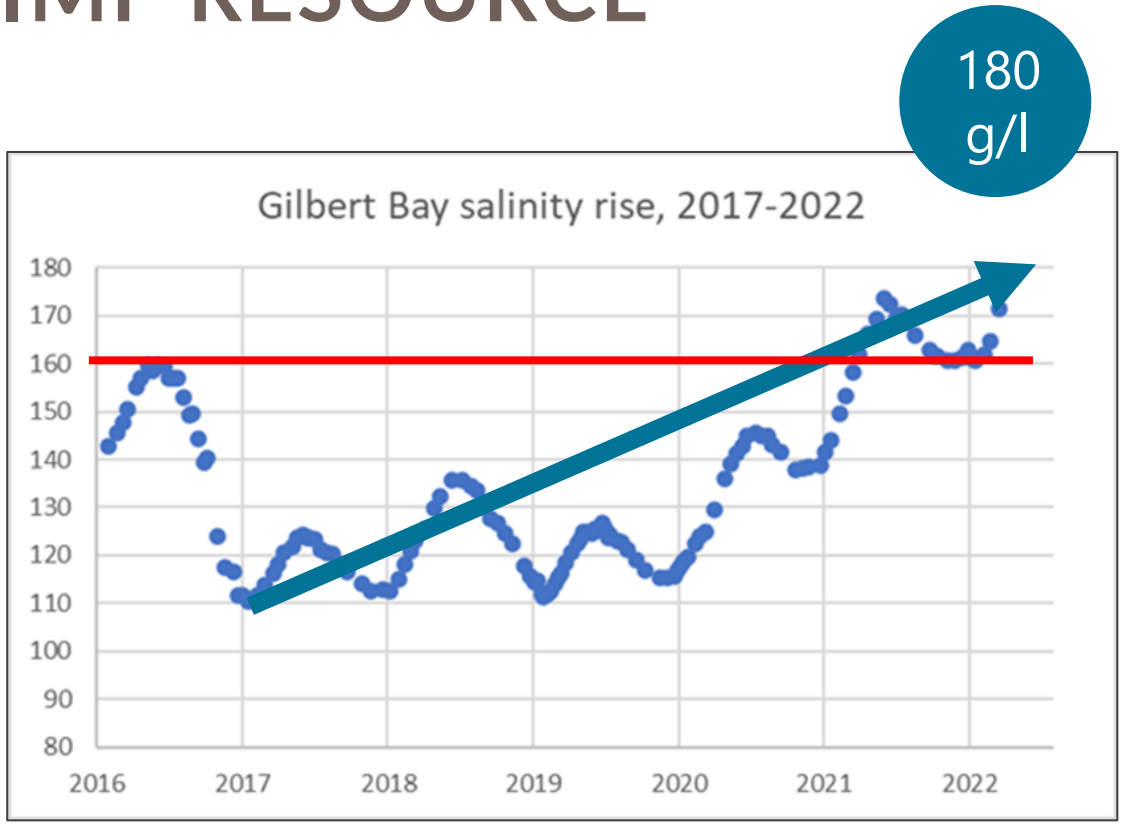
GREAT SALT LAKE

SALINITY MANAGEMENT

GREAT SALT LAKE ARTEMIA

LAKE LEVEL EFFECTS ON BRINE SHRIMP RESOURCE



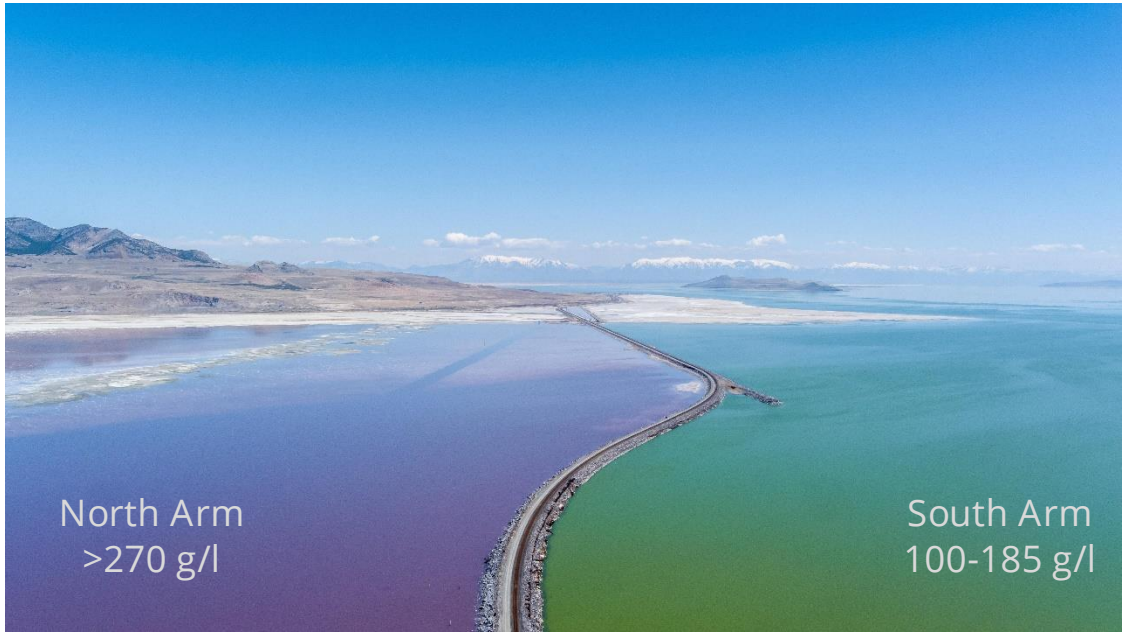


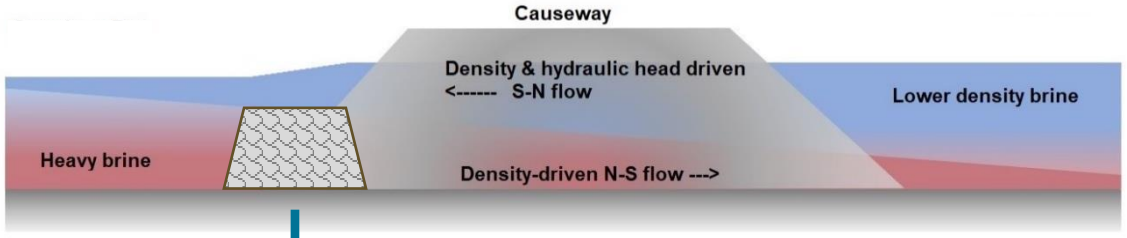
WHAT IS THE
SOLUTION?

A combination of **Active Salinity Management** and increased **Water Supply**

GREAT SALT LAKE ARTEMIA

DENSITY STRATIFIED FLOW ACROSS THE CAUSEWAY

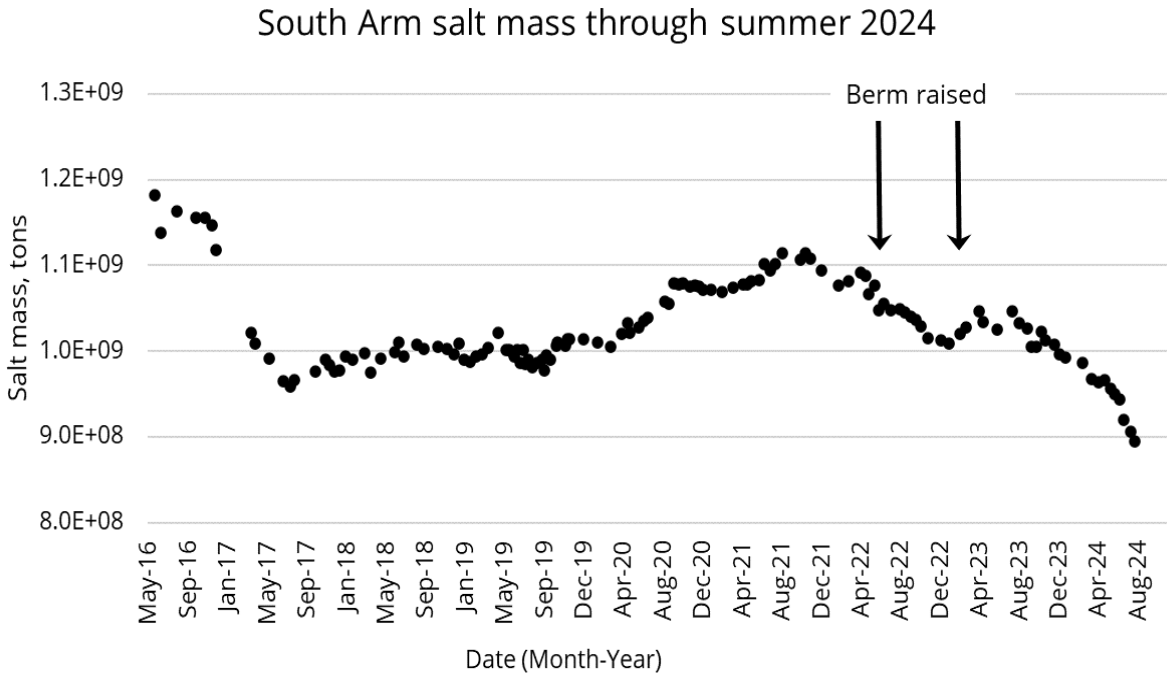




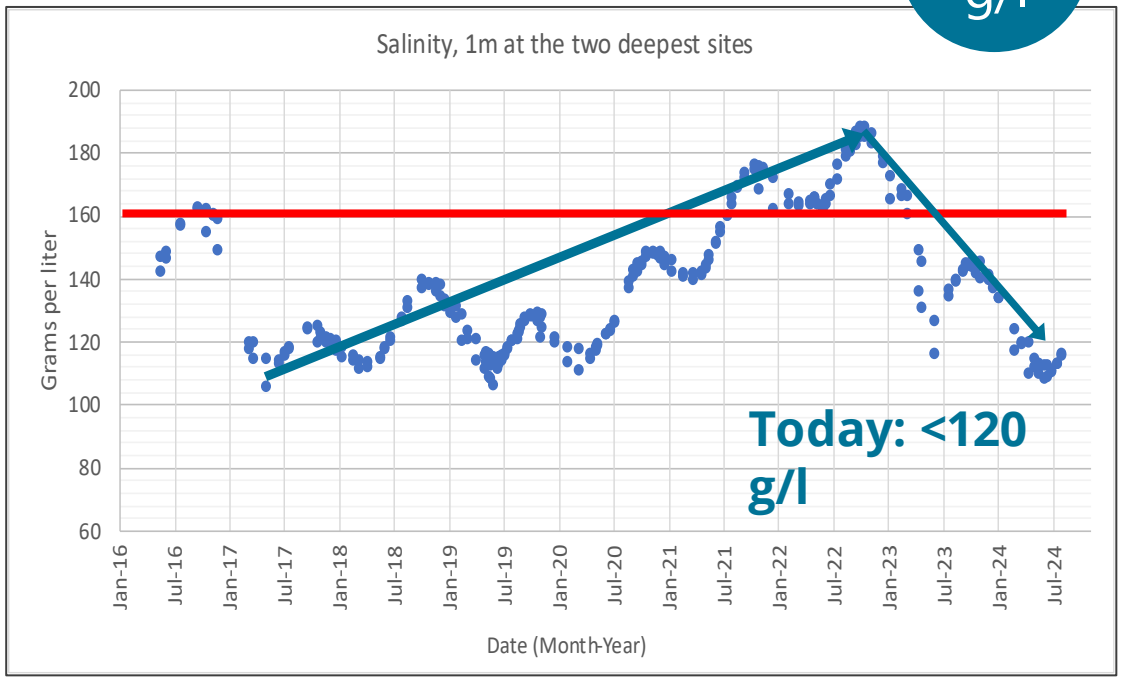
- Flow through the culverts is bidirectional, driven by density and elevation differences

GREAT SALT LAKE ARTEMIA

LAKE LEVEL EFFECTS ON BRINE SHRIMP RESOURCE



180 g/l



FINAL

THOUGHTS

Hatchery - Multiple trials show significant shrimp survival and growth increases at PL12-15 stage when using up to 6 kg of Artemia per million PL produced.

Nursery – Including Artemia in the nursery cycle significantly improves survival and weight gain

Growout – The benefits of Artemia use in the nursery and hatchery cycle carry through the grow out cycle, showing a legacy effect of Artemia use in earlier culture stages

Cost:benefit ratio at growout– As the value and investment into each shrimp increases along the production cycle, gains in survival and size become more valuable

Further research– Detailed economic analysis, HSPs, stress tolerance, and immune response