Inland Shrimp Production in the Southern U.S.

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Marine Shrimp Farming

- Shrimp farming as we know it started in the 1970s
- Shrimp are cultured in over 60 countries
  - 55% of global shrimp supplies are from aquaculture
  - Employs millions of people worldwide, either directly or indirectly
  - Generates >12 billion dollars annually

World Production

- Asia (82%; 2,800,000 MT)
  - China, Vietnam, Thailand, Indonesia, Malaysia, India, Bangladesh, and many others
- Latin America (16%; 534,000 MT)
  - Ecuador, Brazil, Colombia, Peru, Venezuela, Mexico, Nicaragua, Honduras, Guatemala, Panama
- Rest of the World (1%; 50,000 MT)

U.S. Shrimp Production - 2015

U.S. mainland: 3,789,835 lbs from 1,274 acres

- **Alabama: 376,700 lbs (142 acres)**
- Florida: 423,410 lbs (112 acres)
- Texas: 2,989,725 lbs (1,020 acres)

Does not include biofloc facilities in the midwest or eastern U.S., Hawaii, or Saipan.

Source: Granvil Treece, Treece & Associates, Lampasas, Texas

Inland Aquaculture

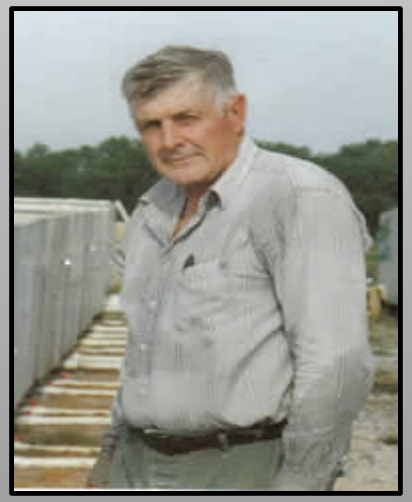
- Coastal vs. Inland Aquaculture
  - 61% of fish and seafood cultured worldwide is cultured inland
  - A large percentage of inland aquaculture occurs in low salinity water, often with euryhaline marine species

Pacific white shrimp
Litopenaeus vannamei

- Euryhaline shrimp ideally suited for culture in low salinity water
  - Can tolerate 0.5-50 ppt salinities
- Cultured worldwide in low salinity environments
- 85% of shrimp cultured in Asia and nearly 100% of shrimp cultured in South America are *L. vannamei*!

Low salinity aquaculture in the US

- West Alabama has an abundance of low salinity (2 – 11 ppt) artesian ground water not suitable for traditional aquaculture
- Several other states also have access to low salinity water (TX, AZ, AR, MS, and several other states)
- Since 1999, these waters have been utilized by a handful of west Alabama farmers to culture marine shrimp (*L. vannamei*)



Alabama Shrimp Industry

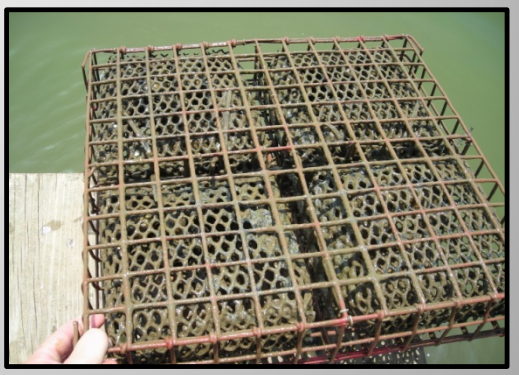
- Semi-intensive pond production (5 farms, ~200 acres)
  - Small compared to catfish (77 farms, 17,450 acres)
- Cost of production (fixed and variable costs): $2.50-3.00/lb
- Farmers sell shrimp to the public for $5.00-$5.50/lb typically 12-20 count, head on (8-11 count $6.00/lb)
- One farmer is having his shrimp processed by a seafood processor and is selling his product throughout the U.S. and Canada (grocery stores like Whole Foods)
  - His product has been certified “Green” by the Monterrey Bay Aquarium

www.birminghamnews.com

Other species cultured in AL pond water since 2006 >150 miles north of the Gulf of Mexico

Florida pompano

southern flounder



oysters

striped mullet

blue crab

Also red drum, bull minnows, freshwater prawns, hybrid striped bass

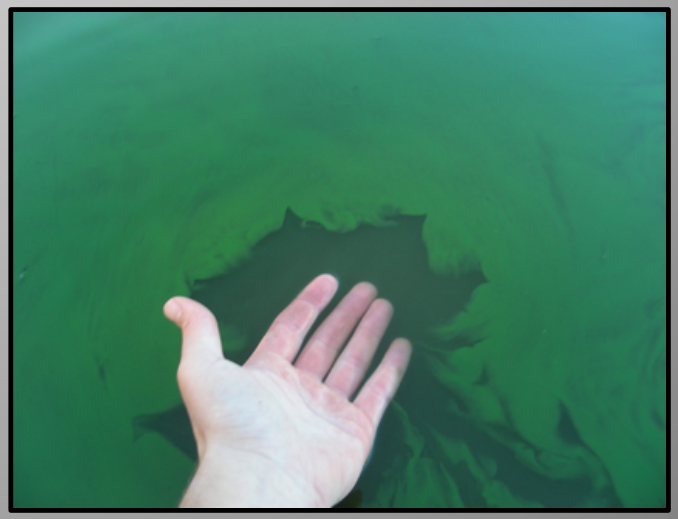
Alabama shrimp & catfish farm

Advantages of Pond Production

- Availability of inland saline water not suitable for Agriculture
- Availability of ponds and technical expertise
- Natural productivity
- Some diseases are less likely to occur
- Local market
- Lower cost of production

Disadvantages of Pond Production

- Salinization of fresh water resources (drain harvesting)
- Problematic algae (blue green algae, golden algae)
  - Off flavor, toxins
- Ionic composition of the water
  - Expensive to fertilize with potassium and magnesium
- Predators
- Long distance from hatcheries
- All of the product is harvested in 4-6 weeks of the year! (must sell immediately or freeze)



www.wilsonlab.org/photos

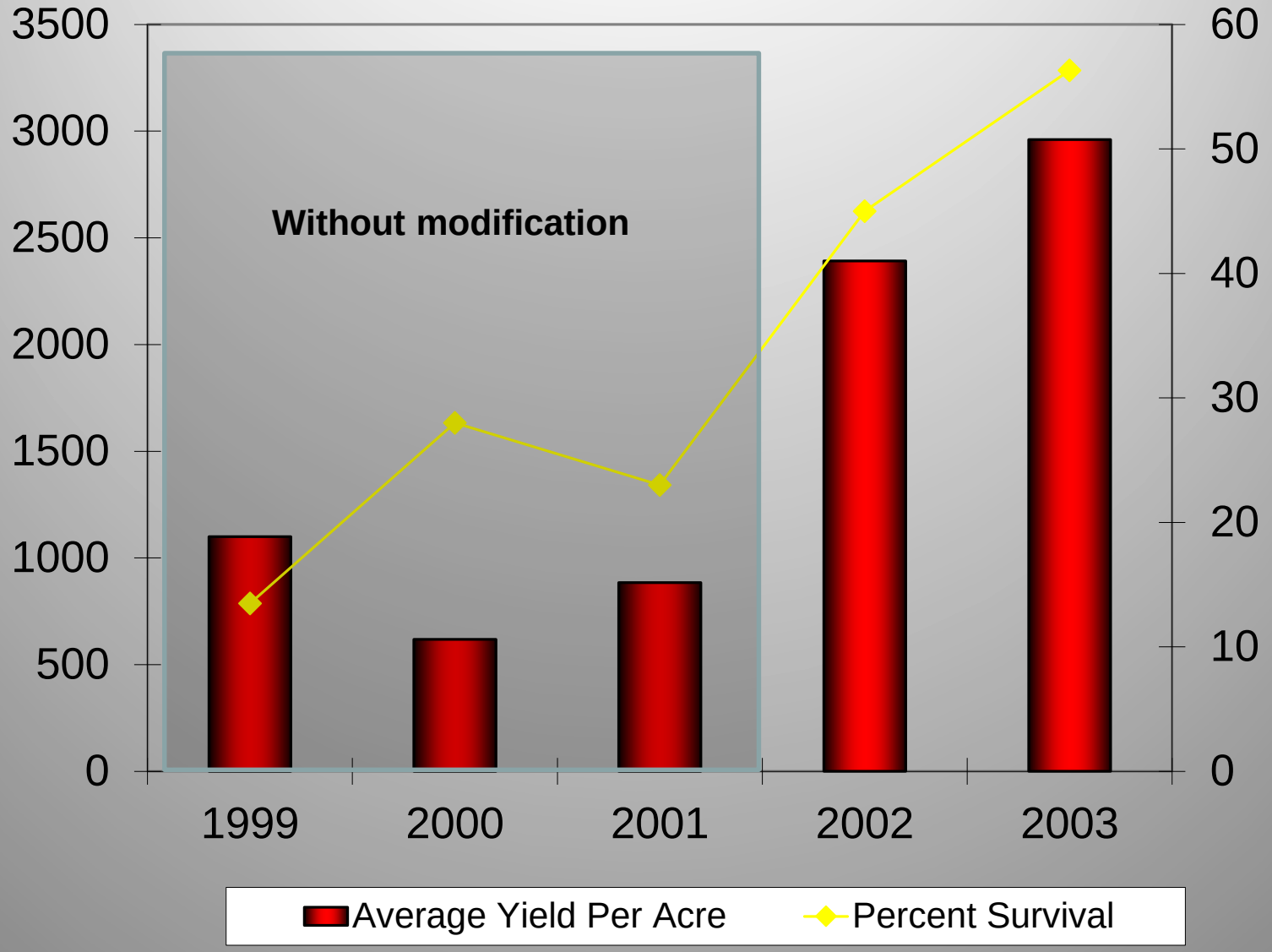
Current Culture Paradigm: U.S. low salinity shrimp production in ponds

- **Mar - Apr**……...Prepare greenhouses, fertilize ponds
  May - June……...Obtain post-larvae from hatchery; acclimation of post-larvae to low salinity water; stocking
- **June - Oct**…….Growout
- **Sept - Oct**……..Harvest
- **Nov - Feb**……...Repair equipment; prepare for next year

Initial Problems

- High and/or variable mortality
  - Poor survival at the end of the production cycle (<30%)
  - Those that survived grew!

Yield


3500
3000
2500
2000
1500
1000
500
0
60
50
40
30
20
10
0
Without modification
1999
2000
2001
2002
2003
Average Yield Per Acre
Percent Survival

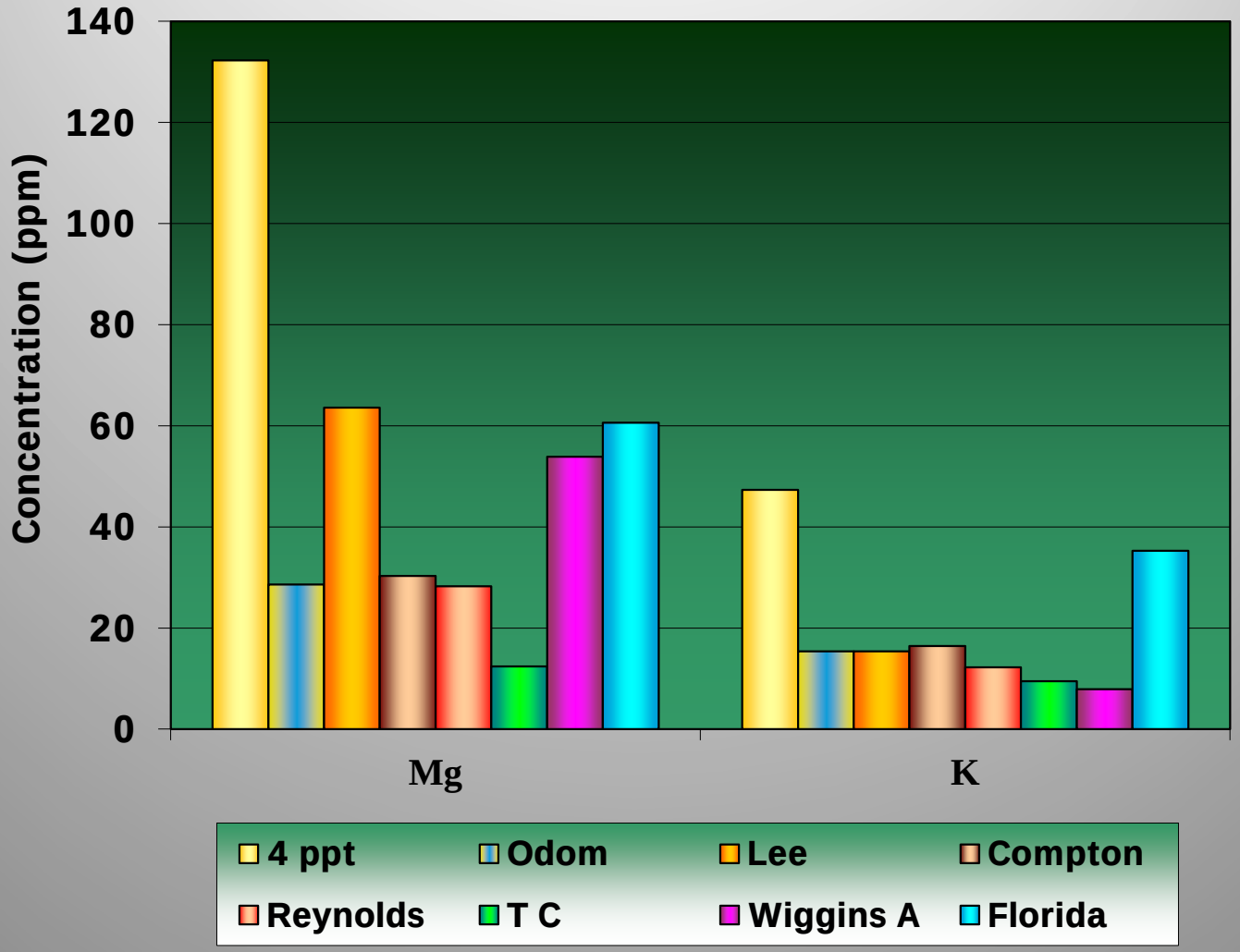
Current status – Low salinity culture

Remediation techniques have been developed for post-larval stages as well as for juvenile and adult stages of production. Average production 2,000 – 5,000 lbs/acre

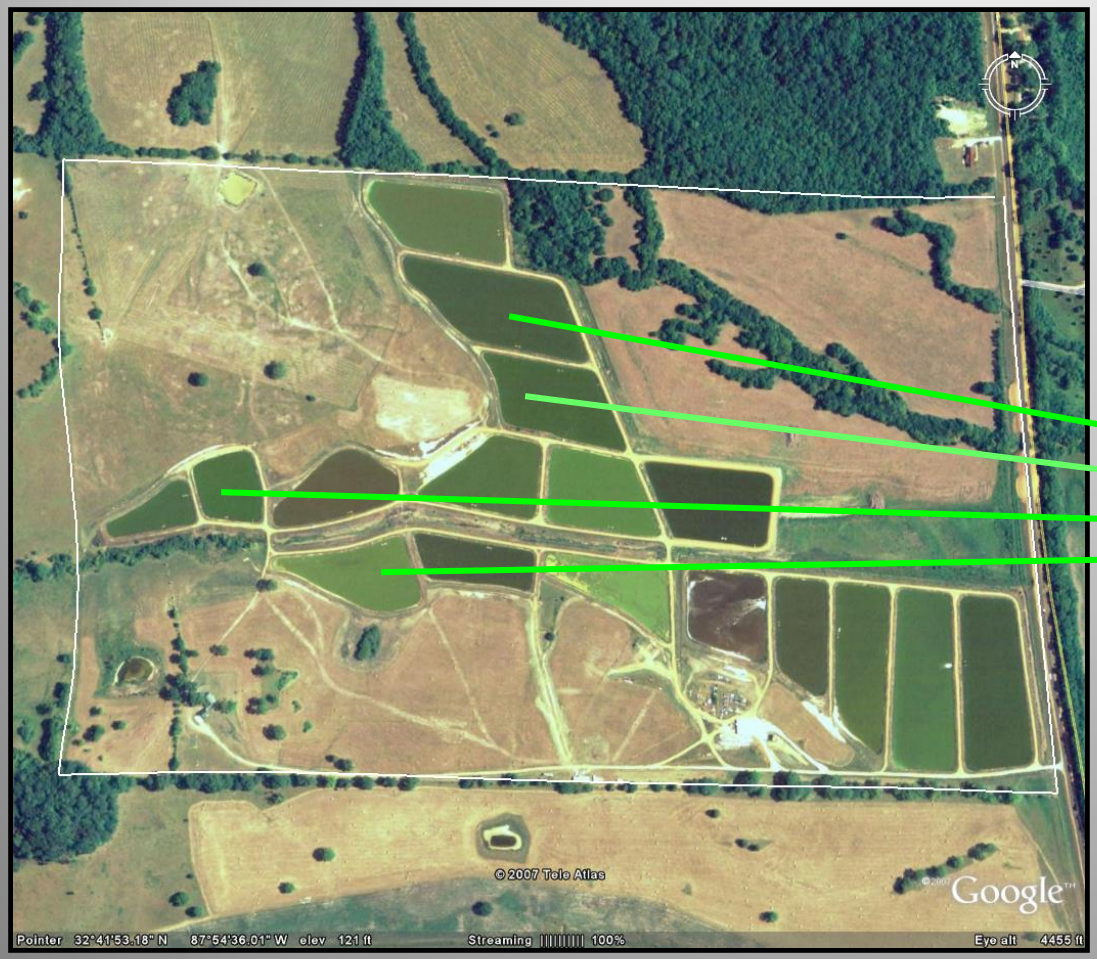
Two basic strategies have been investigated:

1. Modification of the pond water
2. Modification of diets (dietary supplements) which was not successful

Bioassays were conducted with various water sources



Bioassays



Pond water was obtained from different ponds to conduct 24 and 48 hour survival bioassays of PLs and correlated to ionic profiles

Summary

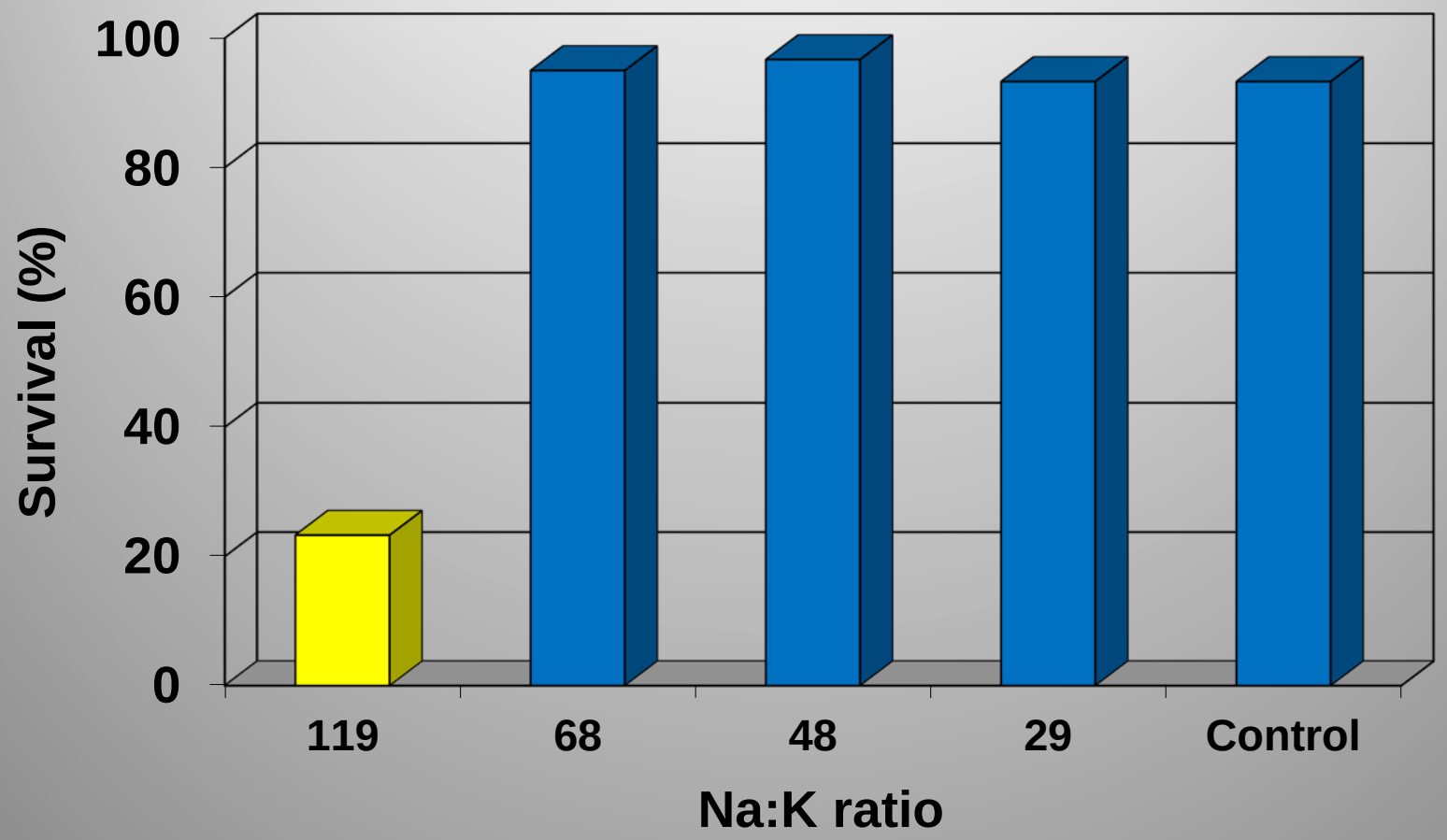
- Bioassays revealed that **deficiencies** in aqueous **potassium (K)** and **magnesium (Mg)** appeared to be the major problem
- Post-larvae survived the acclimation process better if stocked at an **age greater than PL_{15}**
- Between pond ionic composition is not a major factor
- Stocking mortality occurs early < 7 day
  - (no difference in weekly survival out to 28 days)

Na:K ratios

- The ionic ratio of sodium (Na) to potassium (K) in the water appears to be more important than pond water salinity
- Potassium is required at the appropriate ratio for the proper function of the Na/K ATPase, which is important for osmoregulation in crustaceans
- Improper Na:K ratios lead to osmotic stress which has a subsequent effect on growth and survival of shrimp
  - If culture water has very low Na:K ratios shrimp can be lethargic shrimp, swimming erratically

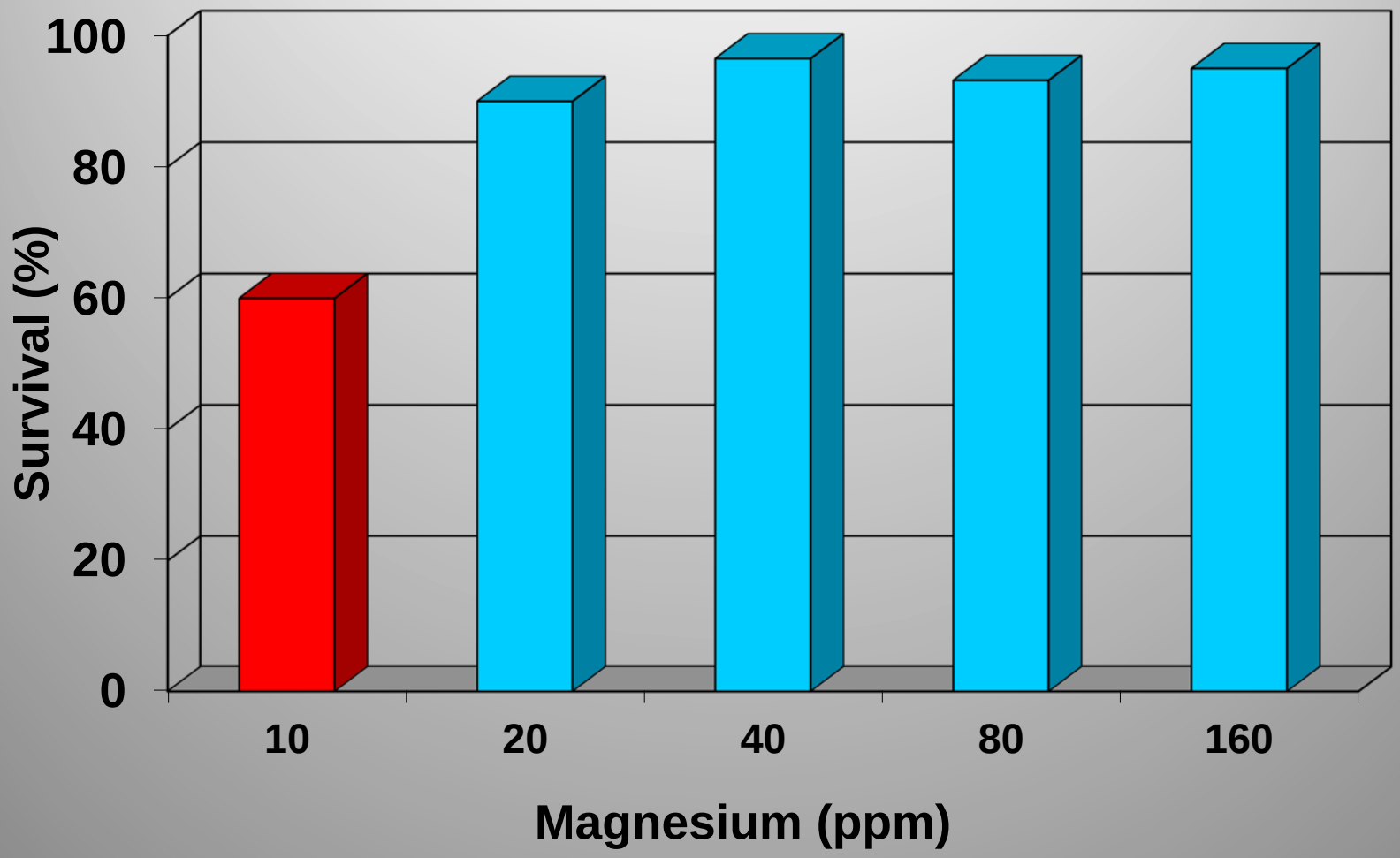
Take home: Be <u>extremely</u> careful if you try to make your own salt water! Better yet, use reconstituted seawater products

Aqueous ionic Na:K ratio



Note: control = diluted reconstituted seawater

Aqueous Magnesium



Fertilizers

- Farmers must conduct an ion profile analysis for each pond every year to determine fertilization rates (K, Mg) as levels will vary from year to year due to leaching, soil adsorption, and other factors
  - Typically 3 times per year (prior to fertilizer application, 2-3 weeks after fertilizer application, and half-way through the production cycle)

Fertilizers

<u>Muriate of potash ($325/ton)</u>

potassium chloride

50% K, 45% Cl

<u>K-Mag®</u> ($380/ton)

potassium magnesium sulfate

17.8% K, 10.5% Mg, 63.6% SO_4

Recommendation

- At present, shrimp farmers have been maintaining ionic **Na:K** ratios as close as possible to the ratio found in seawater (28:1)
- Farmers try to maintain **magnesium** at 20 ppm or higher
- Farmers in AL have been successful using these techniques culturing *L. vannamei* in low salinity waters with salinities down to 1 ppt
- *Note: In biofloc systems where reconstituted seawater is utilized Na:K ratios and magnesium levels are typically* ***<u>not</u>*** *a problem*

Artificial Seawater

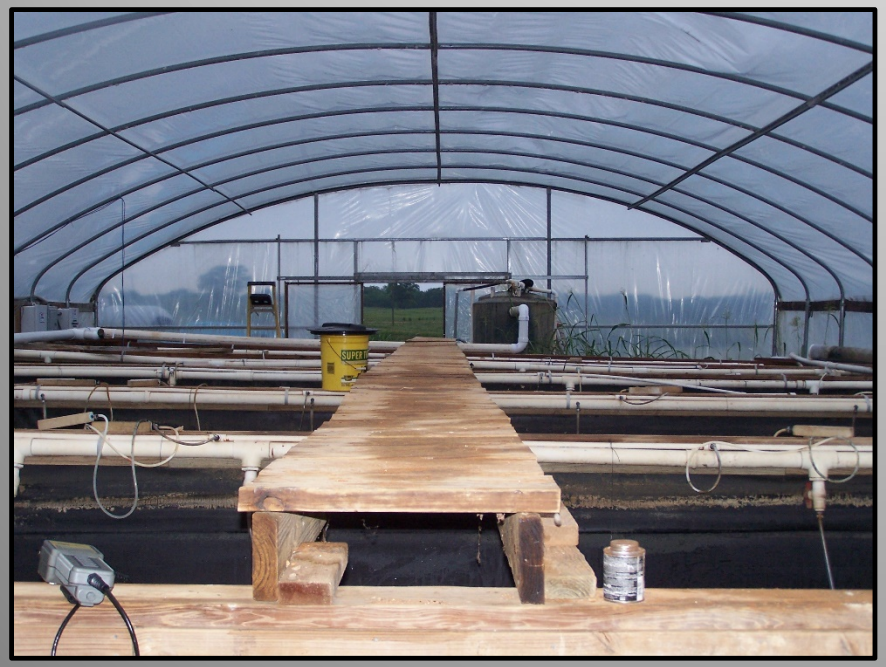
- During acclimation, farmers utilize reconstituted seawater (typically Crystal Sea Salt or Instant Ocean)
- To save money, in some instances farmers have made their own salt mixtures with limited success

Acclimation & Stocking

- Ponds fertilized to ensure adequate levels of K and Mg
- Farmers in west Alabama have achieved the greatest success by obtaining PL_{10-12} from the hatchery and holding them in nursery tanks located in greenhouses for 7-21 days prior to stocking (stocking a PL_{17}-PL_{22} shrimp)
- During this period salinity is reduced from 15 ppt to the desired target salinity
- If possible, the target salinity should be reached at least 48 hours prior to stocking
- **Best results have been achieved when pond water temperatures are greater than 70-72°F**

Acclimation & Stocking

- Stocking rates: 100,000 – 120,000 shrimp/acre
  - The largest farm (79 acres) typically stocks 8-9 million shrimp
  - Average pond size is 4 acres (400,000 – 500,000 shrimp)



Acclimation & Stocking

- It is necessary to acclimate shrimp to the target salinity and temperature at the pond bank for each individual pond
- It is best to be patient and take adequate time during this process
- Water is exchanged slowly between the tank and pond over the course of several hours

Growout

- Shrimp are sampled weekly by commercial producers to track growth
- Shrimp are offered a 36% protein feed at rates of 75 lbs/acre per day (fed twice daily)
  - FCRs average approximately 1.5-1.8
- Only 1/5 shrimp farmers in AL is using an automated oxygen monitoring system!
- Production season runs from May-October

Harvest







2155
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Alternative pond-based production systems

Alternative pond-based production systems

There are currently three commercial split ponds being used for shrimp production in AL

Current challenges – Semi-intensive ponds

- Quality of post-larvae
- Toxic blue green algae / golden algae
- Water quality (extremely high pH)
- “Late term” mortality (>20 g)
- Disease issues
- Predation (water birds; green sunfish)

Research Opportunities – Auburn University

- “Least cost” salt formulations (USDA Small & Medium Farms proposal with Kentucky State University/Purdue University)
- Alternative production systems (USDA SBIR proposal)
- Commercial implementation of automated feeding systems (Saltonstall Kennedy proposal)
- The influence of probiotics on algae populations and water quality (SARE funding obtained by shrimp producers)
- The influence of high pH on shrimp survival

Conclusions

- Semi-intensive shrimp production in inland low salinity ponds has excellent potential in the southern U.S.
- Failure to expand has been due to a number of factors including risk, lack of technical expertise, high startup costs, variable survival, and a lack of market development

Tips that may benefit biofloc producers

- Acclimation
  - Make sure to use reconstituted seawater (don't try to make your own salt)
    - If in doubt send a water sample to a commercial lab!
  - Be sure to take extreme care to acclimate shipments of shrimp to your facility's culture water (temperature and salinity)
  - Wait until post-larvae are PL_{15} or older before acclimating to lower salinities
  - Reduce salinity slowly!

Tips that may benefit biofloc producers

- Take time to properly weigh your shrimp prior to stocking to make sure you stock at a correct density
  - Alabama shrimp producers will typically weigh >2,000 post-larvae per holding tank to get an accurate weight each day that they stock
- Due to “late term” mortality some producers in TX and FL are harvesting shrimp before they get too big (>20 g)
- Buying artificial sea salt in bulk will cut costs (AL shrimp farmers buy this product as a group)

Final word of advice

AISPA (Alabama Inland Shrimp Producers Association)

- One key to success for Alabama shrimp farmers has been frequent communication, meetings, and free sharing of information
- Collectively have banded together and secured funding (SARE) for research and development
- Have been involved politically
- Have actively sought to involve Alabama Cooperative Extension (Auburn University) in research and technology transfer

Working together to address challenges will increase the likelihood of success of your industry!

Acknowledgments

- Allen Davis, Imad Saoud, Claude Boyd, Darryl Jory, Granvil Treece, Greg Whitis, Ben Beck
- Alabama Fish Farming Center
- Greene Prairie Aquafarm
- Alabama Inland Shrimp Producers Association

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