Workshop Agenda

8:00 – 8:50  Registration
8:50 – 9:00  Welcome
9:00 – 9:30  Grey Snow Eagle House
9:30 – 10:00  Silence of the Clams
10:00 – 10:15  Refreshment Break
10:15 – 10:45  Landscaping for Water Gardens
10:45 – 11:15  Storm Water in the Garden
11: 15 – 11:45  VHS, KHV and GHV
1:00 – 1:30  Value Added Catfish Product
1:30 – 2:00  2007 Research
2:00 -  Oklahoma Aquaculture Assoc

Dr. Marvin Burns  Langston University
Victor Roubidoux  Iowa Nation
Chris Barnhart  Missouri State University
David Hillock  Oklahoma State University
Michael Holmes  Oklahoma State University
Andy Goodwin  U. of Arkansas Pine Bluff
Teresa Brown  Oklahoma State University
George Luker  Langston University

The Cooperative Extension Program at Langston University provides educational programs to individuals regardless of race, color, national origin, sex, age, religion or disability. Issued in furtherance of the Extension Work Act of September 29, 1977 in cooperation with the U.S. Department of Agriculture.
Grey Snow Eagle house
By Mr. Victor Roubidoux
Wildlife anager, Iowa Tribe of Oklahoma

The Eagle Protection Act
The Bald Eagle Protection Act began in 1940 with the passage of the eagle protection act. Later amended to include the golden eagle, the act makes it unlawful to import, export, take, sell, purchase, or barter any bald eagle or golden eagle, their parts, products, nests, or eggs. "Take" includes pursuing, shooting, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing the eagles.

Non-Releasable Regulation
Raptor rehabilitators, can only keep birds for eventual release to the wild. Once it becomes not releasable, we must Euthanize or place it with someone permitted for long term care.

Normally this means Educational permittees for Eagles. Many Eagles are warehoused by educational facilities.

Native American Permit
Native American Religious Use - Live Eagle

Allows any of the 562 Federally recognized tribes to obtain a permit (after meeting specific conditions) and build on Tribal property an Eagle Aviary, for non-releasable eagles.

Tribes will pick up the naturally molted feathers and hand out to tribal members for cultural and ceremonial purposes.

Can provide permanent home for a sacred bird

Eagle –Rehabilitation Permit

- For Injured or sick eagles
- For eventual release to the wild
- Requires specific and intensive training
- Time intensive
- Very rewarding
Eagle mortality

- Vehicles (Cars, trucks, trains, airplanes, etc.)
- Power lines, Windmill farms, and Radio/TV towers
- Deliberate shooting of eagles and their prey
- Poison bait (generally left for predators, or rodents)
- Pesticides - DDT, Avitrol (used by exterminators)
- Loss of Habitat – Forests and development
  - Encroachment of nesting and feeding areas
- Lead - Shot (now outlawed over waterfowl areas) and Sinkers.
- Mercury, Zinc other industrial pollutants

Grey Snow Eagle House

2006

REHABILITATION

The Beginning
Released:
June 10, 2006
VIC

CINNABAR

How Do You Catch an Eagle?

Regular Exams Are Required

THEGA

We Are EXPANDING!
NEW ADDITION

KEEP OKLAHOMA BEAUTIFUL AWARD

CONTACT INFORMATION
Grey Snow Eagle House
Victor Roubidoux
R.R. 1 Box 721
Perkins, Ok 74059
405-747-9725

FUTURE PLANS

QUESTIONS???
Silence of the Clams

By Chris Barnhart, Missouri State university

Native freshwater mussels
Order Unionoida, naiades, or “pearly mussels”
Not to be confused with:
- Introduced zebra mussels
- Introduced Asian clams
- Native fingernail clams

Native mussel life history

Fish host
Glochidia larvae
Adult mussel
Juvenile mussels
Gravid marsupial gills of *Lampsilis*

Life in the marsupium...

Blind clam’s bluff
How mussels put glochidia on fish….
Female *Lampsilis* “mantle flap” lure

*Lampsilis* – fish-mimics

Hosts: *Micropterus, Ambloplites*

*Villosa* – dancing crayfish mimics

Females rock repeatedly during lure display

Hosts: *Micropterus, Ambloplites*

*Villosa iris*
Mimicry – * Ptychodranchus* & blackfly host: darters

* P. subterraneum conglutinates
* Simulium pupa and larva
* P. occidentalis conglutinates

*Epioblasma* – fish trappers

Logperch stone-rolling behavior
Snuffbox mussel catches a host

6 gram fish, 2,237 glochidia attached

Mean mothers!

Juvenile mussels after leaving the host

Black sandshell (5 months)
Significance of native mussels

- Filter feeders on plankton and food for larger animals.
- Formerly incredibly abundant-the “passenger pigeons” of the rivers of North America.
- Economic resource- buttons & pearls.

Living water-filters

Shellfish buffet-raccoon midden on the Meramec River at Pacific.

Button shell harvest

1916~140 million pounds

Fig. 2. Mountains of shells rose up alongside the Mississippi as clammers made a living harvesting mussels to supply the button industry.

Historical abundance of native mussels

9,000 metric tons harvested from one bed, 3/4 km² area, over 3-year period (26 pounds/m²!)
Tennessee shell harvest 2002-2006
(~70% of total harvest)

<table>
<thead>
<tr>
<th>Year</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
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<tbody>
<tr>
<td>Harvesters</td>
<td>144</td>
<td>215</td>
<td>247</td>
<td>264</td>
<td>250</td>
</tr>
<tr>
<td>Dealers</td>
<td>11</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Tons</td>
<td>714</td>
<td>1,439</td>
<td>1,267</td>
<td>1,693</td>
<td>1,400</td>
</tr>
<tr>
<td>Millions S</td>
<td>$0.66</td>
<td>$1.5</td>
<td>$1.4</td>
<td>$2.4</td>
<td>$2.2</td>
</tr>
<tr>
<td>Shell Fee</td>
<td>$15,785</td>
<td>$35,049</td>
<td>$31,786</td>
<td>$32,985</td>
<td>$31,174</td>
</tr>
<tr>
<td>Average Wholesale price/lb</td>
<td>$0.47</td>
<td>$0.53</td>
<td>$0.56</td>
<td>$0.71</td>
<td>$0.83</td>
</tr>
</tbody>
</table>
Shells of their former selves...

- Of 297 known North American species...
- ~34 species extinct
- 75 federally endangered or threatened (6 in MO)
- 19 federal candidates (3 in MO)

Silence of the Clams?

Endangered Species in North America

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater Mussels</td>
<td>51%</td>
<td></td>
</tr>
<tr>
<td>Crayfish</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>Stonewallines</td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td>Freshwater Fish</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td>Amphibians</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td>Flowering Plants</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Cynocephalus</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>Fern, Fern Allies</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Tiger Beetles</td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Butterflies, Skippers</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Reptiles</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Dragonflies, Damselflies</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>Birds</td>
<td>14%</td>
<td></td>
</tr>
</tbody>
</table>

Of the 12 federally endangered animal species in Missouri, 6 are mussels.

3 more mussels are candidates for listing.

See any mussels in this picture?
Watersheds with one or more federally listed or candidate mussel species

Factors degrading rivers/imperiling native mussels
- Dams
- Erosion, siltation
- Water removal
- Pollution
- Altered fish communities
- Introduced species
- Overharvest

MUSSEL SPECIES RICHNESS AT NINE SITES ON SPRING RIVER

LEAD CONCENTRATIONS IN BIVALVE SOFT TISSUES FROM SPRING RIVER

Use of juveniles for toxicology research

Copper and ammonia are toxic to mussels at lower concentrations than other species (96-h EC50s)
EPA water quality criteria for copper and ammonia are 2-3X higher than "safe" levels for native mussels—not protective

CHV = mean of NOEC & LOEC
IC10 = 10% of test animals affected 28 day exposures

Water quality criteria are based on most sensitive species

T&E Mussels can facilitate river protection and restoration
• More stringent water quality criteria
• Endangered species facilitate funding for habitat restoration and protection
• Poster children?...

Mussels as poster children
• Life cycle is surprising and fascinating
• Shells are conveniently collected, stored, displayed, illustrate diversity
• Museums, aquariums, nature films show increasing interest, e.g. Tennessee Aquarium, National MR Aquarium, new Joplin Nature Center
Grow-out of juveniles for release & for research


<table>
<thead>
<tr>
<th>Species</th>
<th>River</th>
<th>Juveniles released</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink mussel (E)</td>
<td>Meramec R, MO</td>
<td>496,800</td>
</tr>
<tr>
<td>Fat spottedshrimp (E)</td>
<td>St. Francis system, AR</td>
<td>198,580</td>
</tr>
<tr>
<td>Scaleshell (E)</td>
<td>Meramec &amp; Gasconade R, MO</td>
<td>21,310</td>
</tr>
<tr>
<td>Neosho mussel (C)</td>
<td>Spring, Verdigris, Fall Rivers, MO, KS</td>
<td>1,785,560</td>
</tr>
<tr>
<td>Snuffbox (EE)</td>
<td>Bourbeuse R, MO</td>
<td>31,000</td>
</tr>
<tr>
<td>Black sandshell (SCC)</td>
<td>Meramec R, MO</td>
<td>484,940</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2,898,000</td>
</tr>
</tbody>
</table>

Summary

- Globally endangered mussel species are widespread in Missouri streams
- They are interesting and significant critters
- Mussel recovery requires actions that will benefit the entire aquatic community
- The protected status of mussels can facilitate funding for river protection and restoration.
Stormwater In the Garden

By Michael Holmes, Oklahoma State University

Rainwater Harvesting

The practice of capturing and storing rain to provide water for human use.

The practice was discarded as distribution systems improved and water supplies were thought to be unlimited.

System Components

- Catchments Area
- Conveyance
- Filtration
- Cistern
- Delivery System

Calculating Collection Volume

(Rule of Thumb)

For 1 inch of rain ... 600 gallons for 1,000 sq ft
Calculating Collection Volume

- 2400 sq ft house
- 2 inch rain event
- 2880 gallons

(Rule of Thumb)

For 1 inch of rain ...
600 gallons for 1,000 sq ft

Benefits of Rainwater Harvesting

1) Water Conservation Uses
   - Watering the Landscape
   - Grey Water
   - Drinking Water
     (filtered / purified)

2) Stormwater

Sizing the System

Rain Barrel
Cistern
Vault

Pacifica Co-Housing Community
Carrboro, NC

6,000 Gallons Cistern
Watering Community Gardens

Sizing the System

1. Annual Rainfall
2. Runoff Efficiencies
3. Potential Harvested Runoff
4. Irrigation Requirements
5. Water Budget
Sizing the System

1. Annual Rainfall
2. Runoff Efficiencies
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Benefits of Rainwater Harvesting

1) Water Conservation Uses
   - Watering the Landscape
   - Grey Water
   - Drinking Water (filtered / purified)

2) Stormwater

Challenges of Rainwater Harvesting

Water is Relative Inexpensive
Volume of Water Needed
Storage Size Needed
Will homeowners regularly use the cisterns?
What is a Rain Garden?

Design Considerations
- Maintenance
- Costs
- Benefits

Components

rho garden = bio-retention cell

best management practice that utilizes soil, plants, and microbes to treat storm water before it is infiltrated or discharged

Components
Drainage

A bio-retention system can be used as the main drainage system when the drainage area, or the site, is less than 5 acres. A larger site will require a more intense system.

Slope

Bio-retention systems are usually applied where the maximum slope is 5% or less. This ensures the movement of water without overflowing the system too fast.

Soil

Any type of soil is appropriate, but especially soil that is high in organic matter, which encourages percolation. Oklahoma clay soils may require an underground drain.

Groundwater

One of the most important benefits of a bio-retention system is the possibility of recharging groundwater. With this benefit comes the responsibility to separate the bottom of the retention basin from the water table. Intersection could cause groundwater contamination.

Treatment

Bio-retention treatment is accomplished by the pooling of the water on the surface of the system. This filters out sediment and suspended solids. Vegetation greatly contributes to the filtering process, and serves as a pretreatment component.

Treatment

To properly treat the water, a bio-retention system should be sized between 5 and 10% of the area treated.
Maintenance

- Care for the vegetation
- Removal of litter from mulch layer
- Inspection for sediment build up.
- Mulch replacement every two years

Benefits

- Re-charge of ground water
- Filtering and removal of pollutants
- Added green space
- Addition of habitat
- LEED accreditation points

Integrated Stormwater Systems

- Bioretention Cells
- Permeable
- Sand Filters
- Ponds

Rain gardens

Rain water harvesting
Integrated Environmental Research & Education Site (IERES)

{storm} water in the garden
rain gardens
rain water harvesting
VHS, KHV and GHV

By Andy Goodwin, University of Arkansas, Pine Bluff

Program
- The VHS Virus Story
- Changing Fish Health Regs
- Insights Into Fish Inspection Requirements
- The Goldfish Herpesvirus
- The Very Latest on KHV

I: Rainbow Trout Farms “Catastrophic Losses”

II. Wild Fish in Baltic Sea
No disease

III. VHS infection in Turbot
Europe, 1990s

Bleedings in head region and finn base
IVa: Wild Pacific salmon (no disease)

IV: Pacific Coast of Canada, Pilchard

2005 IVb

Summer 2005 Lake Ontario
- Drum by the ton
- Sporadic gobies and muskies

2006
- St Lawrence River
- Lake Ontario
- Lake Erie
- Lake St. Clair

Paul Bowser
Cornell
2007 (2005 Samples)
- Lake Huron
  - Lake Whitefish
  - Walleye
  - Chinook

2007
- Wisconsin
  - Lake Michigan
  - Lake Winnebago
- Other Inland Lakes
  - NY (Oneida)
  - MI

Known Distribution Through 2007

Where Did it Come From?
Most similar to recent isolates from the Atlantic coast of North America.
- Ballast Water
- Fish Migrations

Program
- The VHS Virus Story
- Changing Fish Health Regs
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Susceptible fish (28) can only leave a positive state (8) if tested free of VHS

Oklahoma *could* become a “positive state”

- Emerald Shiner
- Bluntnose Minnow
- Fathead Minnow*

APHIS VHS Emergency Rule

- The State “official competent authority” must certify that fish leaving the state comply with the testing requirements of the VHS rule

Who is the authority?
Are they ready?
Is there lab space?
What inspections will be required?
Program
- The VHS Virus Story
- Changing Fish Health Regs
- Insights Into Fish Inspection Requirements
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Lot vs Farm

Lot Inspection

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test only what you ship</td>
<td>21 days for tests</td>
</tr>
<tr>
<td>Biosecurity only for the</td>
<td>Test every lot to be shipped</td>
</tr>
<tr>
<td>unit of interest</td>
<td>Lot inspections expire very quickly</td>
</tr>
<tr>
<td></td>
<td>Off season testing is meaningless</td>
</tr>
<tr>
<td></td>
<td>Easy to miss a very low level infection</td>
</tr>
</tbody>
</table>
Farm

- Isolate entire farm
- Sample entire farm
- The whole farm is free

Farm Inspection

**Advantages**
- Ship any time without testing delays
- Less testing for farms with many lots and shipments
- Test during best seasons
- Test most susceptible species
- History builds high confidence

**Disadvantages**
- Must maintain biosecurity
  - Water supply
  - Imports

How Many?

<table>
<thead>
<tr>
<th>Lot Size (number of fish)</th>
<th>Number of Fish Required for Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10% APPL</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>23</td>
</tr>
<tr>
<td>250</td>
<td>25</td>
</tr>
<tr>
<td>500</td>
<td>26</td>
</tr>
<tr>
<td>2000</td>
<td>27</td>
</tr>
<tr>
<td>&gt;100,000</td>
<td>30</td>
</tr>
</tbody>
</table>

Number of fish needed to detect disease 95 times out of 100 present in just 2% of the population.

Who Collects?

- The farm
- Independent 3rd party
  - State or Federal official
  - DVM
  - DVM with specialized training
  - AFS-FHS Certified Inspector
Which Fish?
- All species present?
- All susceptible?
- Broodfish?
- Fry?
- All “lots”!

Who Reports?

Certification?
- A recognized authority asserts in writing that the inspection and biosecurity claims are valid

Certification?
- A recognized authority asserts in writing that the inspection and biosecurity claims are valid
Certifiers
- Bubba & Earl next door
- The testing laboratory
- FHS Certified Inspectors
- State or Federal Official
- DVM
- DVM + Training

Emergency Rule
(months)

Interim Rule
(many months)

Final Rule
(FOREVER)

Interim Rule Guesses
- Much more detail about testing requirements
- Resolution of “can fish from positive waters ever be claimed VHS negative”?
- Sorting out the dealer issue
- The AR Certification will certainly be sufficient

Program
- The VHS Virus Story
- Changing Fish Health Regs
- Insights Into Fish Inspection Requirements
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- The Very Latest on KHV

Cyprinid Herpesvirus-2 (CyHV-2)
CyHV-1 is Carp Pox

CyHV-3 is KHV

CyHV-2
Goldfish Hematopoietic Necrosis Virus
(Jung and Miyazaki, 1995)

Late Summer 2007

Summer 2007
- High mortality 1-2 weeks after moving young fish into indoor raceways
- “White head” or “gill lesions like KHV, and dry skin”
- Moribund fish $10^7$-$10^8$ copies CyHV-2/ug
- No other significant pathogens
- Histology: Severe focal gill necrosis & inflammation, inclusions and loss of superficial epithelium
- “White head” is anemia
Program

- The VHS Virus Story
- Changing Fish Health Regs
- Insights Into Fish Inspection Requirements
- The Goldfish Herpesvirus
- The Very Latest on KHV

CyHV-3: KHV

White Patches
Notched Nose

Columnaris

KHV is a Herpesvirus!
Killed by KHV

Its all about the temperature

Chicken Pox
A Herpes Virus
- Infection
- Proliferation
- Disease
- Recovery
- Stress
- Shingles
- Transmission

Disease
Stress

Survivor

Avoiding KHV
Inspection/Certification: Big problems!

Avoiding KHV
Quarantine at 75 F

Two Destinies
Carrier
Dead
Avoiding KHV
Quarantine at 75°F
Infected fish – Yes
Carriers – NO!

Avoiding KHV
Transmission:
Water, nets, people! Birds and turtles?

Avoiding KHV
Vaccination

Vaccines
- One is commercially available, but not yet licensed in the US
- It appears to be very effective
- All MagNoy koi and carp are now vaccinated
- Some fish disease experts still have concerns... Can vaccinated fish still spread the virus?

Treatment Option
- Elevate temp to 85°F
- Fish mount a strong immune response
- Mortality stops
- Survivors never get KHV again, but are carriers!
FAQ

- If you heat them up, many will survive. Some will survive even if you don’t.
- All the survivors are infected.
- Survivors may kill new fish
- Survivors can’t ever go to a show
- The same rules apply to goldfish

FAQ: Good News!

- The virus goes away in a week or two if there are no fish
- KHV is very sensitive to disinfectants, even detergent will do it

Andy Goodwin
Office 1-870-575-8137
Mobile 1-870-489-5997
E-mail agoodwin@uaex.edu

Aquaculture / Fisheries Center
University of Arkansas at Pine Bluff
Value Added Catfish Product

By Teresa Brown, Oklahoma State University

The NEW Catfish

Sometimes You CAN Teach an Old Fish New Recipes

**Ictalurus punctatus**
- Catfish industry only 42 years old
- Most abundant aquaculture species in U.S.
- 660 million pounds of catfish processed each year
- 5th most popular seafood item consumed

**Economic Impact**
- 80% of harvestable fish will have an off-flavor
- Producers can’t sell off-flavor fish
  - Product quality
- Processors will not accept off-flavor fish
  - Producer income < $0.05/lb
- Producer costs increase
  - Delayed harvest
  - Increased feeding cost
- Marketing
  - Imports
  - 16-23 million lost annually

**Cyanobacteria**
- Prokaryotic known as blue-green algae

**Positives**
- Producers oxygen in by product of photosynthesis
- Metabolize organic materials

**Negatives**
- Metabolic byproducts source of off-flavor

- 2-methylisoborneol (MIB)
  - Earthy muddy odor
  - Beets, roots and crops
- Geosmin
  - Musty odor
  - Natural in soil and fresh water

**MIB and Geosmin**
- Bicyclic tertiary alcohol compounds

**Hydroxyl groups**
- Hydrophilic
  - Provide solubility
- Terpenic compound
  - Impart volatile characteristics

Teresa Brown
Master of Science
Oklahoma State University
**MIB and Geosmin**

- Absorption < 24 hours
  - Gill during respiration
  - Skin
  - Ingestion
- Dual solubility
  - Accumulate in lipid rich tissues
- Human sensory detection limits
  - MIB: 0.06-200 ppb
  - Geosmin: 0.6-8 ppb

**Previous Research**

- Data from previous studies have indicated that acid protein solubilization can quantitatively reduce these off-flavors in catfish
- Muddy off-flavors and odors in catfish CAN be removed by a process known as protein solubilization
  - Acid/Alkaline
- Product
  - Ground fish
  - Must be re-formulated

**Objective**

- Amount that is removed has not yet proven to be sufficient enough that when formulated into a product, it will be acceptable for consumer consumption
- Can catfish be further processed to remove muddy off-flavors caused by MIB and Geosmin then formulated into a product?

**Stage 1: Determine Formulation Preference**

**Purpose:** Determine the most preferred coating for fish nugget
- Examine four different batters
- Most preferred batter will be used for stage 2
- Fish nuggets made from ground non-solubilized

**Sensory Test:** Paired Preference Choice

**Collection of Catfish**

- Retrieved ~60 pounds of live catfish from the culture ponds at Langston University
- Brought back to OSU for
  - Weight
  - Fillet
  - Cryovac vacuum pack
  - Blast frozen (-15.4°F) until further use

**Ground Fish Preparation**

- Partially thawed
- Cut fillet into 1” cubes
- Ground
  - Walk-in cooler
  - Temperature of fillet -2°C
Reformulated Fish Preparation

- Place 2 lbs ground fish in refrigerated bowl chopper
  - Vacuum (rancidly)
  - Set to 4°C

- Added
  - 1% Salt
  - 0.3% Tri-polyphosphates

- Add 1 cup of dry ice
  - Keep temperature below 60°F

Formulated Fish Protein

- Mix
  - Medium speed
  - 2 minutes

- Add 2.25% Puracal®
  - Antimicrobial agent

- Mix additional 1 minute

Preparation of Fish Product

- Dip batter in 4 different wet coatings
  - Coating A
  - Coating B
  - Coating C
  - Coating D

- Coating will be used to add flavor and color to nugget

Cooking Parameters

- Heated Canola oil to 350°F

- Take formed ball with coating and place into heated oil

- Fry for 2 minutes

Stage 1: Sensory Panel

- 20-30 Consumer who normally consume catfish evaluated 4 different coatings and determine which coating is most preferred

- Each panelist receives 6 pairs of 2 samples

- Panelist saw all possible combinations and forced to pick 1 in pairs

- Panelist indicates on the ballot which nugget in a given pair they prefer

Mobile Sensory Lab RV
Analysis of Results

• SAS ANOVA
  – Coating preference
  – Most preferred

• Preferred coatings will be selected for the next stage

Stage 2: Process Evaluation

Purpose: To determine if protein solubilization process affects the overall acceptability of catfish nugget. Creates an unexpected off-flavor in the fish product.

Compare ground catfish nugget with solubilized catfish nugget

Sensory Test: Consumer Preference Testing

Treatment of Fish

• Catfish (n=53/tank) divided into three treatments
  – Control
  – MIB
  – Geosmin

• Allowed to purge for 24 hours
  – 250 gallons re-circulated water

• Spiked with 1ppb target
  – MIB
  – Geosmin

• Absorption of MIB and geosmin for 24 hours

• Removed from tanks into ice coolers transported to OSU

Treatment of Fish

Protein Solubilization Isoelectric Precipitation

• Weight and length

• Electric fillet knife

• Fillets placed into 3 different tubes

• Chopped 2 inch squares

• ~9 lbs fillet recovery wt per tube
**Process Batches**

- 3 lbs ground vac pac
  - Non-Processed
    (Non Solubilized)
- 6 lbs ground
  - Processed
    (Solubilized)

**Protein Solubilization Isoelectric Precipitation**

- Weight and length
- Electric fillet knife
- Fishes placed into 3 different tube
- Chopped 2 inch squares
- ~3 lbs fillet recovery wt per tube

**Process Batches**

- 3 lbs ground vac pac
  - Non-Processed
    (Non Solubilized)
- 6 lbs ground
  - Processed
    (Solubilized)

**Protein Solubilization Acid**

- Aluminum tub
  - 40 lbs water
  - 6 lbs ice
- Reduce sample pH to 2.5
  - Phosphoric Acid
- Myofibril proteins
- Each sample (Control, MIB, Geosmin) treated as above

**Protein Solubilization Sieve Shaker**

- Collect Collagen
  - Skin, bones, fat
  - Weight
  - Sample Obtained
- Adjust pH to 5.5
  - NaOH Base
**Protein Solubilization Base**

- Solubilized protein
  - Cheese Cloth
  - Vat
  - Vac pac
- Waste Water
  - Vat
  - Sample Obtained

**Analyses Conducted**

- moisture
- ash
- fat
- protein
- collagen

- Geosmin and MIB GC:
  - Dr. Kevin Schrader
  - ARS-University of Mississippi

**Protein Solubilization**

**Stage 2: Sensory Panel**

- Nuggets were formulated using most preferred coating from stage 1
- Fish batter formulated:
  - 9% moisture content of each replication
  - 500 grams batch size
  - 6 gram nugget (49 nuggets)
  - 3 gram salt
  - 1 gram sodium bicarbonate
- 120 person panel evaluated 6 total samples

- Samples were examined on
  - Overall likeness
  - Flavor
  - Tenderness
6 different samples

- E: Catfish nugget from ‘normal flavor’ fish
- F: Catfish nugget from ‘normal flavor’ fish – acid/base processed
- G: Catfish nugget from ‘MIB flavor’ fish
- H: Catfish nugget from ‘MIB flavor’ fish – acid/base processed
- I: Catfish nugget from ‘Geosmin flavor’ fish
- J: Catfish nugget from ‘Geosmin flavor’ fish – acid/base processed

Results from Analysis

- Results from this study should demonstrate the acceptability of a product formulated with ‘processed’ protein
- Determine whether processing removes muddy off-flavors sufficiently to produce a consumer acceptable product

What's Next?

- Additional Options
  - Heat and Eat Product
    - Target 1/3 of Product to Retail Sales
  - Flavorings
  - Appearance
    - Fillet
    - Finger
    - Snack
  - Nutrients
    - Omega – 3 fatty acids

Acknowledgements

- Dr. Christina Dewitt
- Conrad Kleinholz
- George Luker
- Akhila Vasan, Sujitha Prasad, Lin Koh, Alisha Parsons, Claudia Cerruto-Noya, Tyler Tate

Producing a Consumer Acceptable Product from Off-flavor Channel Catfish

Supported by USDA CSREES 1890 Capacity Building Grant Program

A collaborative project between:

Department of Agriculture & Applied Sciences
Aquaculture Program

&

Department of Animal Science
By-product Utilization Laboratory
Growing Catfish for Live markets

By George Luker, Aquaculture Specialist
Langston university Aquaculture Program

Design

- 20 ponds
  - 0.25 Acre
  - Channel catfish
  5,000/l
  - Smallmouth buffalo
  - Bigmouth buffalo
  - Grass Carp
  - Freshwater Drum
  - Diffuser Aeration
  - PTO paddlewheel

- 32% commercial diet
  - ≤ 100 lbs/A fed day
  - 5 days/week
  - Multiple passes

- DO monitored daily
  - May – September
  - Adjust feed input

- Harvest
  - June & October
  - Two seine hauls
  - 1.625” grader

Result -- Mean +/− SD

<table>
<thead>
<tr>
<th>Sample</th>
<th>July</th>
<th>October</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Wt</td>
<td>0.56±0.1</td>
<td>0.8±0.16</td>
<td>0.67±0.09</td>
</tr>
<tr>
<td>Market LBS/A</td>
<td>2065±746</td>
<td>4407±791</td>
<td>6472±627</td>
</tr>
<tr>
<td>Market Wt</td>
<td>1.94±0.15</td>
<td>2.17±0.1</td>
<td>2.09±0.09</td>
</tr>
<tr>
<td>% Market #</td>
<td>24.2±9.5</td>
<td>43.6±6.6</td>
<td>34±4.5</td>
</tr>
<tr>
<td>% Market Wt</td>
<td>38.6±14.6</td>
<td>71.2±6.6</td>
<td>56±7</td>
</tr>
<tr>
<td>Sub-Mar Wt</td>
<td>0.96±0.16</td>
<td>0.67±0.09</td>
<td>0.67±0.02</td>
</tr>
<tr>
<td>Feed (lb/1000 A day)</td>
<td>68±5</td>
<td>78±7.2</td>
<td>71.9±2.6</td>
</tr>
<tr>
<td>Market FCR</td>
<td>2.79±0.09</td>
<td>0.84±0.2</td>
<td>1.37±0.21</td>
</tr>
<tr>
<td>Feed cost / LB</td>
<td>$4.39±0.16</td>
<td>$0.15±0.03</td>
<td>$0.2±0.03</td>
</tr>
</tbody>
</table>

Results Refinery

Top = Correlation Coefficient | Bottom = P value

- Ponds with greater July feed input:
  - Positive correlation with July production of market-weight fish and average size of market fish
  - Received less feed during fall season feeding

- July restock weight:
  - Negatively correlated with July market production
  - Positively correlated with October market production

- Ponds with greater October market weight production:
  - Lower July market production
  - Positively correlated with restock stock weight

Velly Interesting

- Feed was NOT a limiting factor
- OR
- Feed input equal, therefore, limited discrimination power
  - 2178±56/pond = 8712 lbs/Ayr = 9716 kg/ha/yr
Conclusions for Catfish Production Systems

- Develop an efficient grading system
  - Remove the top
    - Food size
    - Stockers
- Improve FCR
- Impress your Client(s)!

In-Pond Grader System

- David Heikes
  - UAPB
- Adjustable spacing
- Large farms
  - Large ponds
- Reduce dockage loss from over-under sized fish

‘Old’ Fish Stories

- Seine length = 1.5 times pond width
  - O.K. if
    - Pond is a new bathtub
    - Fish are novices
    - Have all day to seine
- Seine length = 2.5 times pond width
  - 50% improved catch rate
    - Mudline follows bottom contour more closely
    - Seine reel needed
- Catfish don’t eat or grow in cold weather
  - Develop a cool season strategy

Chaining
What we’ve Learned

- No measurable pond effect
  - Water quality
  - Fish health or appetite
- Seining
  - Reduces effort (less mud loading)
  - Improves catch rate
- BUT
  - Chain today
    - Seine 1 to 5 days later
    - Benefit gone after two weeks

Thanks!

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