Iowa’s Walleye Culture Program

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DNR
Iowa’s Walleye Culture Program

**Fry:**
110-150 mil.

**Pond:**
500,000-1.2 mil.

**Extensive:**
100-150,000

**Advanced Intensive:**
200,000
Why walleye culture?

Demand for walleye

- Walleye are a valued as sportfish and as table fare.
- Cultured primarily for sport fishery enhancement.
  - Stock fry to advanced fingerlings.
- Market for all life stages - egg to adult.
- Limited food fish production in the US.
- Restaurant demand
  - Filled by Canadian walleye imports, pike perch imports.
Walleye culture

Challenges:

Pelleted feed necessary to reach food size economically.

Many attempts at rearing walleye on feed are initially unsuccessful.

Walleye have specialized environmental requirements. These requirements must be considered to achieve highest performance.

Techniques exist which result in good survival and growth rates on pelleted feeds.
Introduction

Walleye production on formulated feed.

- Consider challenging characteristics

- Feeding and culture techniques for walleye:
  - Fry culture.
  - Tandem Pond-tank culture.
    - Habituation.
    - Grow out to 10”.

- Bottleneck: feed acceptance.
Characteristics

Phototaxis
- Positive- posthatch to 21 days.
- Negative- 21 days through adulthood.

Tapetum lucidum
- Reflective surface at the back of the retina.
- Preadapted to life in low light environments (Moore 1944).
Characteristics

Gas bladder inflation – physoclistus
- Must be able to break surface tension to obtain air for initial inflation of gas bladder.

Diet
- Planktivorous fry
  - Fry 8-9 mm at hatch.
- Piscivorous fingerling to adult

Coolwater species.
- 68-77ºF for good growth rates.
- 77ºF optimal for growth (25ºC)
Intensive Fry Culture

Why fry culture?

• Closed system production.
  – Biosecurity.
  – Year round fingerling production.
  – Controlled environment.

• Smaller footprint than a pond.
• Consistent results (ideally).
• Technical
• Facility costs
Intensive Fry Culture

Two methods:

1. Artemia.
   - New York’s Oneida Hatchery production scale
   - 40 days of artemia, 10 day habituation to diets (50d)
   - New York State Diet formula for habituation
     - 30-50% mortality during habituation.
     - 25-30% survival from fry to 5 inches.
   - Better survival with EPAC CW diet and covered tanks with submerged light.
     - 20% mortality during habituation.
2. Dry diets.

- Research and pilot scale at Rathbun and ISU.
- First feed at 3 days post hatch.
- 50% to 80% survival at day 25 post hatch.
- 25 mm at 25 dph, 65°F

- Key techniques:
  - Surface spray
  - Turbid water
  - Low ambient light
  - Frequent feeding.
Intensive Fry Culture

Husbandry

• Culture Tanks: Circular, black walls, light colored bottom. Outlet screen size 0.71 mm.

• Surface spray: 100% gas bladder inflation.

• Turbid water: 70 NTU to reduce sidewall clinging, even distribution of fry.

• Low ambient light - 100 lux.

• Stocking rates 20 to 40 fry /L (75-150/gal).

• Otohime diets.
Intensive Fry Culture

Fry deformity

• It was speculated that early spawning caused deformity, however there are other causes.
• Nutritional deficiencies can cause many deformities and pathologies.
• Our research has associated deformities with diets at rates as high as 98%.
• Rare in pond-reared or artemia-fed walleye.
Tandem Pond-Tank Culture

Why pond–tank culture?

- Pond culture of fry.
  - Low maintenance.
  - Good techniques usually result in healthy fish.
  - Low labor.
  - Non technical facilities.
- Results can be inconsistent.
  - More of an art than science.
  - No biosecurity.
  - Weather.
Tandem Pond-Tank Culture

Rathbun’s System:

I. Pond Culture: Fry to 35 d
II. Habituation to Feed: to 25-30d
III. Grow-out: to 8+ inches (90 days)
Tandem Pond-Tank Culture

Rathbun Fish Hatchery: 200,000/yr
Five months, 9-10 inches,
80-85% survival fry to advanced fingerling.
Pond culture

- Ten one acre plastic-lined ponds
  - reinforced polypropylene
  - Kansas-style kettles

- Goals
  - 800 fish/lb; optimal for habituation (0.57g).
  - > 50% survival, (actual survival > 90%).
Pond culture

- Fry enumeration
  - Electronic fry counter
- Organic fertilization regime
  - Weekly additions.
- Zooplankton monitoring
  - 1x-2x/week

- Water Chemistry
  - Sampled 1-2x/week
  - DO/temp/pH
  - NO₃ & P
  - Ammonia
Pond culture

Weight vs. Stocking Density
Goal – 800 fish/lb (0.57g)

<table>
<thead>
<tr>
<th>Year</th>
<th>50K</th>
<th>75K</th>
<th>100K</th>
<th>150K</th>
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<tbody>
<tr>
<td>2002</td>
<td></td>
<td></td>
<td><strong>636</strong></td>
<td><strong>895</strong></td>
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<tr>
<td>2003</td>
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<td><strong>917</strong></td>
<td><strong>1029</strong></td>
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<tr>
<td>2004</td>
<td></td>
<td><strong>658</strong></td>
<td><strong>816</strong></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td><strong>769</strong></td>
<td><strong>968</strong></td>
<td></td>
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</table>

800 fish/lb optimal for habituation.
Habituation

Process of converting fingerlings from live prey to commercial diets.

Key developments:
- Fish size
- Environment
- Diets and feeding
- Disease management
Habituation

June
- Start: 1.75 in. L (45 mm).
- Finish: 3.5 in. L (90 mm).

Culture System:
- Indoor raceways
- 139 fish/ft³ (4,900 fish/m³)

Feeding Regime:
- Automatic feeders
- Feed every 5 minutes.
- 10 days of habituation diet
- Conversion to WG9206
Habituation

Fish size: Larger fish survive better

28-day survival at Rathbun Fish Hatchery.
Habituation

Eyes
- Eyes are very sensitive to light
- Escape light or stress may result

Dark – room Environment
- No overhead lighting eliminates shadows
- Submerged lights further reduce shadows
Habituation

Environment comparison

<table>
<thead>
<tr>
<th></th>
<th>Overhead lighting</th>
<th>Dark Room - Submerged Lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td>37.3</td>
<td>60.7</td>
</tr>
<tr>
<td>g/d</td>
<td>0.117</td>
<td>0.147</td>
</tr>
</tbody>
</table>

63% increase in habituation survival

- Increased growth rates
- Five evaluations, all favorable.
- Production practice since 2003
Habituation

Habituation Diets:

- Highly attractive and palatable.
- Costly, but offered for a short period.
- Significant effect on survival and length.

<table>
<thead>
<tr>
<th></th>
<th>Otohime C2</th>
<th>EPAC CW 8/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival (%)</td>
<td>88.3</td>
<td>73.5</td>
</tr>
<tr>
<td>Length (mm)</td>
<td>81.8</td>
<td>75.5</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>4.5</td>
<td>3.7</td>
</tr>
<tr>
<td>$/1000 walleye</td>
<td>$12.66</td>
<td>$6.71</td>
</tr>
</tbody>
</table>

Other Diets: BioKyowa, BioVita, Nutra HP, Nutra 2000, Gemma
Habituation

Common diseases:

- Columnaris
- Bacterial gill disease

Disease management:

1. Monitor
2. Identify
3. Treat – Diquat or Chloramine-T
Habituation History

2000-2007 Pivotal years
Research to improve culture techniques
• 2.4 fold increase in survival.
• Stability and Reliability.

Problem solved?
## Unexpected problem

### Performance:

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2006</th>
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</thead>
<tbody>
<tr>
<td><strong>Growout</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCR</td>
<td>1.87</td>
<td>2.04</td>
</tr>
<tr>
<td>Cannibalism</td>
<td>3.5%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Survival</td>
<td>92.7%</td>
<td>83.8%</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Habituation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cannibalism</td>
<td>19.2%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Survival</td>
<td>47.0%</td>
<td>67.6%</td>
</tr>
</tbody>
</table>
Evaluated grading

- Graded between habituation and growout.
- All tanks graded to remove big cannibals.
- Comparison of Control, Top 20% Grade, Pass through.
- Production scale – 3 outdoor tanks of 22,500 fish/tank.

[Chart showing length groups and percent frequency for Control, Top grade, and Pass through categories.]
## Grading results

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Pass through</th>
<th>Top Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival (%)</td>
<td>78.6</td>
<td>82.5</td>
<td>93.9</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>11.0</td>
<td>9.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Cannibalism (%)</td>
<td>10.4</td>
<td>8.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>1.8</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Feed &amp; Chemical $/fish</td>
<td>$0.53</td>
<td>$0.51</td>
<td>$0.43</td>
</tr>
</tbody>
</table>

Significantly improvement

- Cannibalism reduced 60%.
- Survival increased 20%. 

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Grading Plans

<table>
<thead>
<tr>
<th>Length Group (mm)</th>
<th>Percent Frequency</th>
</tr>
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<tbody>
<tr>
<td>&lt;58</td>
<td>20% Grow</td>
</tr>
<tr>
<td>58-60</td>
<td></td>
</tr>
<tr>
<td>61-63</td>
<td></td>
</tr>
<tr>
<td>64-66</td>
<td></td>
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<td>67-69</td>
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<td>70-72</td>
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<td>73-75</td>
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<td>76-78</td>
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<td>79-81</td>
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</tr>
<tr>
<td>82-84</td>
<td></td>
</tr>
<tr>
<td>85-87</td>
<td></td>
</tr>
<tr>
<td>88-90</td>
<td></td>
</tr>
<tr>
<td>91-93</td>
<td>60% Grow</td>
</tr>
<tr>
<td>94-96</td>
<td></td>
</tr>
<tr>
<td>97-99</td>
<td></td>
</tr>
<tr>
<td>100-102</td>
<td></td>
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<tr>
<td>&gt;103</td>
<td></td>
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</table>

20% Grow

20% Grow out

60% Grow
Grow-out

Growth period – July – October

3.75 in. to 8-10 inches

Culture System:

- 10 outdoor circular tanks
  - 46,000 gallons
- Stock 3.75 fish/ft$^3$
- Flow rate 350 gpm
- Liquid Oxygen
- Final density 1.2 lb/ft$^3$
Grow-out

Feed:
- Walleye Grower 9206.
- 20-22 hours/day.

Disease management:
1. Ichthyophthirius
   - Prophylactic formalin.
   - Researching formalin reduction.
2. Columnaris
   - Diquat used occasionally
3. Bacterial Gill Disease
   - Chloramine-T used occasionally
Cost breakdown

Non graded $0.97/fish
Graded : $0.87/fish
Northern Climates

Improved growth at Spirit Lake Fish Hatchery

Effects of environment and habituation diet.

Compared to Rathbun:
- Cooler water temps/shorter season.
- Overhead lighting
- Feeds EPAC diet.

2007 Trial
- Habituate with Otohime, Dark room
- Grow out with Dark room tank light.

Results:
- Habituation: 0.3 inch gain
- Grow out 0.5 inch gain
- 0.8 inch gain

<table>
<thead>
<tr>
<th>Year</th>
<th>Length (inch)</th>
</tr>
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<tbody>
<tr>
<td>2000</td>
<td>5.5</td>
</tr>
<tr>
<td>2001</td>
<td>5.2</td>
</tr>
<tr>
<td>2002</td>
<td>5.9</td>
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<tr>
<td>2003</td>
<td>5.3</td>
</tr>
<tr>
<td>2004</td>
<td>6.2</td>
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<tr>
<td>2005</td>
<td>6.7</td>
</tr>
<tr>
<td>2006</td>
<td>6.11</td>
</tr>
<tr>
<td>2007</td>
<td>7.5</td>
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</table>
Northern Climates

Rathbun 9-10” in 5 months (73.8°F)
Spirit Lake 6-7.5” in 4.5 months.
Commercial production in heated and enclosed systems.
Keys to Success

Pond

- Stocking density (50K/ac) and fertilization regime to achieve 600-800 fish/lb harvest size.

Habituation

- Dark Room Submerged Light Environment
- Habituation diet – Otohime C2

Grow-out

- Size grading
- Disease control
Keys to Success

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