Harvest and Transport - Rules of Thumb

- Reduce the number of stressors
- Reduce the severity of stressors
- Minimize the duration of stressors

REDUCE STRESS AS MUCH AS POSSIBLE!
<table>
<thead>
<tr>
<th>At the Hatchery</th>
<th>During Transportation</th>
<th>At the Stocking Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seined in pond</td>
<td>Crowding</td>
<td>Unloaded from hauling truck</td>
</tr>
<tr>
<td>Concentrated into seine</td>
<td>Agitation from vehicle movement</td>
<td>Δ Water temperature</td>
</tr>
<tr>
<td>Netted</td>
<td>Ammonia</td>
<td>Δ Water Chemistry</td>
</tr>
<tr>
<td>Go across sort table</td>
<td>Δ [DO]</td>
<td>Δ Water temperature</td>
</tr>
<tr>
<td>Concentrated into crane bucket</td>
<td>Δ Water Chemistry</td>
<td>Δ Water temperature</td>
</tr>
<tr>
<td>Put into hauling tank</td>
<td>Δ [Carbon dioxide]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Δ Water pH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Δ Water temperature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Δ Water temperature</td>
<td></td>
</tr>
</tbody>
</table>
Harvest

• Have a pre-determined plan in place

• Make sure fish are in suitable condition

• Ideally harvest during cooler temperatures or early morning

• Partially drain pond to concentrate fish then seine
  • Be sure there is proper aeration
Harvest

• Depending on pond size, can be done once or multiple times

• Pond can contain harvest basin where remaining fish can be concentrated and netted

• Get fish to the transport tank as quick as possible
Harvest from Ponds
Harvest - Seine Specifications

• Seine length 1.5X > pond width

• Seine depth 1.5-2X > pond depth

• Mesh size no smaller than that needed to catch minimum size fish

• Use a mud line with soft substrates to avoid lead submersion

Harvest - Net Construction

• Knotted vs knotless nets

• Tarred vs untarred nets
Harvest - Net Construction

Knotted Netting
- Can be repaired if damaged
- Cheaper than knotless
- Abrasion can promote scale loss

http://english.nittoseimo.co.jp/21/41/
Harvest - Net Construction

**Knotless Netting**

- Stronger than knotted
- Lighter than knotted
- Smoother and therefore less damaging to fish
- Difficult to repair

http://english.nittoseimo.co.jp/21/41/
Harvest - Net Construction

**Tarred Netting**
- Resists decay from sunlight and wear
- Abrasion can be harmful to small scaled fish
- Often used in the catfish industry

**Untarred Netting**
- Less stressful and damaging to small scaled fish
- Can have a short lifetime
Harvest - Practices for Small Scaled Fishes

- Have a plan in place
- Knotless and untarred netting
- Appropriately sized netting
- Appropriate water/air temperatures
Transport

Transport - Causes of Mortality

• Poor water quality

• Stress responses or physiological changes
  • Increase in metabolic rate
    • Accumulates toxic metabolites (lactic acid) and depletes energy reserves
    • Fish loses the ability to osmoregulate
  • Stressed-induced immunosuppression
    • Allows pathogens that would normally be resisted to initiate
Transport - Water Quality

- Temperature
- Dissolved Oxygen
- pH
- Ammonia
- Carbon dioxide
Transport - How to Reduce Stress

- Remove fish from feed at least 24 hrs prior to harvest
  - Allows for freshwater (reduces waste)
  - Eliminates digestion processes (saves energy)

- Have a transport plan in place - use a bag seine to temporarily hold fish

- Know the maximum density of your transport tanks

Transport - How to Reduce Stress

- In general, densities are lower for smaller fish, in warmer water, and for longer transit time

Table 2. Loading densities for largemouth bass.

<table>
<thead>
<tr>
<th>Fish Size (inches)</th>
<th>Loading Rate (pounds/gallon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>0.66</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>1</td>
<td>0.33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of Fish Pounds per 1,000 Fish</th>
<th>Transport Time In Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td>0.1</td>
<td>0.20</td>
</tr>
<tr>
<td>1.0</td>
<td>1.25</td>
</tr>
<tr>
<td>2.0</td>
<td>1.75</td>
</tr>
<tr>
<td>4.0</td>
<td>2.20</td>
</tr>
<tr>
<td>8.0</td>
<td>2.95</td>
</tr>
<tr>
<td>20.0</td>
<td>3.45</td>
</tr>
<tr>
<td>250.0</td>
<td>5.00</td>
</tr>
<tr>
<td>500.0</td>
<td>5.90</td>
</tr>
<tr>
<td>1,000.0</td>
<td>6.30</td>
</tr>
</tbody>
</table>

Transportation of Warmwater Fish, Gary L. Jensen. SRAC pub # 393
Transport - How to Move and Load Fish

- Do not overload nets
  - Can cause injury

- Compatible water temps

- Loading buckets
  - Wet transfer

- Monitor water quality

- Loading is often very stressful
Transport - Sorting Fish

- Graders
  - Need to separate sizes
  - How many fish per pound

- Styles
  - Panel
  - Floating

- Varying bar spacing

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Table 2. Bar grader size for channel catfish.

<table>
<thead>
<tr>
<th>Bar width in inches</th>
<th>Size retained in inches</th>
<th>Pounds/1,000 fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/32&quot;</td>
<td>3</td>
<td>8-10</td>
</tr>
<tr>
<td>3/16&quot;</td>
<td>4</td>
<td>18-20</td>
</tr>
<tr>
<td>5/32&quot;</td>
<td>5</td>
<td>32-35</td>
</tr>
<tr>
<td>7/32&quot;</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>9/64&quot;</td>
<td>7</td>
<td>93</td>
</tr>
<tr>
<td>11/64&quot;</td>
<td>8</td>
<td>112-140</td>
</tr>
<tr>
<td>13/64&quot;</td>
<td>11</td>
<td>750-1000</td>
</tr>
</tbody>
</table>

Table 3. Bar grader size for striped bass.

<table>
<thead>
<tr>
<th>Bar width in inches</th>
<th>Size retained in inches</th>
<th>Pounds/1,000 fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16&quot;</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>3/32&quot;</td>
<td>2½</td>
<td>-</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>3/64&quot;</td>
<td>3½</td>
<td>15</td>
</tr>
<tr>
<td>7/64&quot;</td>
<td>3¾</td>
<td>20</td>
</tr>
<tr>
<td>9/32&quot;</td>
<td>4</td>
<td>23</td>
</tr>
</tbody>
</table>

Table 4. Bar grader size for golden shiner.

<table>
<thead>
<tr>
<th>Bar width in inches</th>
<th>Size retained in inches</th>
<th>Pounds/1,000 fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16&quot;</td>
<td>1¼</td>
<td>3</td>
</tr>
<tr>
<td>3/32&quot;</td>
<td>1½</td>
<td>5</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>3/64&quot;</td>
<td>3½</td>
<td>13½</td>
</tr>
<tr>
<td>7/64&quot;</td>
<td>4</td>
<td>20-25</td>
</tr>
<tr>
<td>9/32&quot;</td>
<td>4½</td>
<td>30</td>
</tr>
<tr>
<td>13/64&quot;</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Larger than 1/8&quot;</td>
<td>5½</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 5. Bar grader size for fathead minnows.

<table>
<thead>
<tr>
<th>Bar width in inches</th>
<th>Size retained in inches</th>
<th>Pounds/1,000 fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16&quot;</td>
<td>1¼</td>
<td>3</td>
</tr>
<tr>
<td>3/32&quot;</td>
<td>1½</td>
<td>4</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>2¼</td>
<td>6</td>
</tr>
<tr>
<td>Larger than 1/8&quot;</td>
<td>2½</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Modified from Ludwig and Stone, 1997.

Source: Adapted from S. A. Fickinger, 1991.
Transport - Tanks

• Can be on truck or a trailer

• Construction
  • Wood, aluminum, fiberglass

• Most insulated to resist rapid temperature changes

• Sloped bottom to drain fish easily

• Water is heavy (8.3 lb/gal)- Match tank weight to truck or trailer
  • ¾-ton truck can pull a trailer with two 350-gal tanks or accommodate a 300-gal tank
Transport - Tanks

- Various sizes
  - 50-2,500 gallons
- Rounded corners
- Vents allow CO₂ to escape
- Baffles reduce water movement
- Drains

http://mfse.net/
Transport - Tank Aeration

• Ideal to have two systems

• Primary - bottled oxygen most common
  • For efficient use - fine pore diffusers
  • Heavy daily use or long distances - liquid oxygen more cost effective than gas

• Mechanical
  • Not as efficient as bottled oxygen
  • Causes foaming (interferes with CO₂ diffusion)
  • Best if used as the emergency backup

http://www.ag.auburn.edu/fish/mediagallery/2013/08/13/fish-transport-5/
Transport - Tank Aeration

• Agitators
  • Surface or deep water

• Deep water less damaging to small scaled fish

http://www.fountainpumpandsupply.com/fish_transport_aerators.html
Transport - Anesthetics

- Dissolve in the transport water
- Reduces the metabolic rate
- Reduces oxygen use
- Large doses can be lethal
Transport - Anesthetics

- Tricaine, MS-222, Finquel™

- Lowers water pH
  - Buffer with sodium bicarbonate

- 25-50 mg/L

- 21 day withdrawal time

Transport - Anesthetics

- **Quinaldine**
  - Dissolve in acetone prior to mixing with water
  - Low cost
  - Lowers pH
  - 15-60 mg/L
  - Not approved for food fish

Transport - Anesthetics

• CO₂
  • Need to adjust water pH to maintain specific levels
  • Long induction time
  • Low regulatory priority
  • Approved for food fish

https://www.midwestsupplies.com/new-20lb-co2-tank-empty
Transport - Anesthetics

- Clove oil
  - Eugenol
  - High margin of safety but long recovery time
  - 20 mg/L
  - NOT approved in the U.S.

- Aqui-S
  - 10-20 mg/L
  - Active ingredient isoegenol
  - Potential zero withdrawal time
  - Did not pass CVM review
    - Cancer in mice

https://www.primo.net.au/shop/AQUI-S/aqui-s-aquatic-anesthetic
Transport - Anesthetics

- Check regulations frequently
- [https://fishculture.fisheries.org/](https://fishculture.fisheries.org/)
- FDA website
  - Approved aquaculture drugs
Transport - Additives

• Salts
  • Helps decrease stress by reducing plasma-ion disturbances
  • NaCl most common
    • 5-10 g/L or 0.04-0.08 lbs/gal
    • 4-8 lbs of salt per 100 gallons
  • Low regulatory priority

Transport - Additives

• Ice
  • Important to control water temperature
  • ½-lb/gallon will drop water temperature ~10 °F
  • Avoid ice made form chlorinated tap water if possible

https://in8life.com/when-all-you-want-is-ice/
Transport - Shipping in Sealed Containers

- Successful with larvae and small fish

- Styrofoam shipping box with a heavy duty square plastic bag

- Pure oxygen introduced into the bag then sealed

- Anesthetics and salts can be added to the water

- Want to deliver within two days

https://zfin.org/zf_info/zfbook/chapt1/1.7.html
THE ULTIMATE FISH FOR CULTURE, TRANSPORTATION, FOOD PRODUCTION, AND SPORTFISHING

- teeth of a top carnivore
- helmet
- photosynthetic skin
- rubber bumper
- zipper for easy filleting
- high speed maneuvering fins
- high speed tail
THE PERFECT HAULING UNIT

- Ram air scoops
- Airline seats
- Fins for maneuvering
- Multiple hauling units
- Fish drain
- Rocket assist for hills
- Low pressure tires for soft ride

Wedemeyer, Fish Hatchery Management
Questions???

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