Impacts of Invasive Asian Carps on Freshwater Ecosystems

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What are ‘Asian carps’?

- Bighead and silver carps
- Large-bodied planktivores
- Introduced in the 1970s
- Escaped into waterways

Bighead carp

Silver carp
# Global History of Introduction

<table>
<thead>
<tr>
<th>Species</th>
<th>Countries introduced</th>
<th>Countries with self-sustaining populations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bighead carp</td>
<td>74</td>
<td>19</td>
</tr>
<tr>
<td>Silver carp</td>
<td>87</td>
<td>23</td>
</tr>
</tbody>
</table>

![Bar chart showing the number of countries introduced per species and year of introduction](chart.png)
Reasons for Introduction Around World

Bighead Carp

Silver Carp

Aquaculture
Capture fisheries
Plankton control
Research
Sport/angling
SAV control
Accidental
Unknown
Extent of Distribution

- Reproducing in about 20 states
- Nonindigenous Species Database (http://nas.er.usgs.gov)
Quickly Became Abundant

- Exponential population growth
- Most abundant fish in some areas
Entry into the Great Lakes?

- Proximity to Lake Michigan
- Chicago Area Waterways
- Electrical barriers to deter movement
Fall 2010 (Oct 6 – Nov 24) sampling period:
Total Samples Collected for processing: 1140
Total Samples Processed (both species): 684
Total Samples Positive for Asian Carp: 21
CLICK HERE to see results table
Mandrak and Cudmore 2004

- Pictures based only on air temperature
- Lots of things besides air temperature control where fish live
Only free-flowing length considered
Food Resources?

- Cooke et al. (2010)
  - Asian carps need ~10 ug/L chlorophyll (without swimming or breeding)
  - Should do well in parts of Lake Erie
  - But not in open water of larger Great Lakes
- BUT – Flexible diets
- BUT – DO live on less, in some places like Lake Balaton, Hungary
Freshwater Ecosystem Service Impacts

- Provisioning Services
- Regulatory Services
- Cultural Services
- Supporting Services
Provisioning Services

- Quantity and quality of water for consumptive use
  - Drinking, domestic, industrial, agricultural
- Water for non-consumptive use
  - Power, transportation, navigation
- Aquatic organisms for food and medicine
Provisioning - Effects on Water Quality

- competition
- predation

Silver Carp

+ defecation

Nutrient Resources

+ predation release

Zooplankton

+ availability

Phytoplankton

- increase abundance
- increase biomass
- increase chlorophyll

Increase Phosphorus
Increase Nitrogen

Reduce size
Reduce abundance
Changed community
Provisioning – Transportation, Navigation, Water Quantity

Changing Course
About 100 years ago, Chicago reversed the flow of several waterways emptying into Lake Michigan.

Current flow-direction of reengineered waterways
<table>
<thead>
<tr>
<th>Region</th>
<th>Location</th>
<th>Native Species</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>China, Changshouhu Reservoir, Yangtze River</td>
<td>Sharpbelly</td>
<td>Li (2001)</td>
</tr>
<tr>
<td></td>
<td>China, Plateau lakes</td>
<td>Barbless carp</td>
<td>Xie &amp; Chen (2001)</td>
</tr>
<tr>
<td></td>
<td>China, Yunnan Province</td>
<td><em>Racoma taliensis, Cyprinus meglophthalimus, Anabarilius grahami, A. albrunops, A. polylepis</em></td>
<td>Yang (1996)</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Native clupeids</td>
<td>De Iongh &amp; Van Zon (1993)</td>
</tr>
<tr>
<td>Indian subcontinent</td>
<td>India, Gobin Sagar Reservoir</td>
<td>Catla, rohu, golden mahseen</td>
<td>Shetty et al. (1989)</td>
</tr>
<tr>
<td></td>
<td>India, Kulgarhi Reservoir</td>
<td>Catla, rohu</td>
<td>Dey et al. (1979)</td>
</tr>
<tr>
<td>Middle East</td>
<td>Aral basin</td>
<td>Aral barbel</td>
<td>Pavlovskaya (1995)</td>
</tr>
<tr>
<td></td>
<td>Israel</td>
<td>Tilapias</td>
<td>Spataru and Gophen (1985)</td>
</tr>
<tr>
<td>Europe</td>
<td>Poland</td>
<td>Roach, rudd</td>
<td>Wilkonska (1988)</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>Sunbleak, bleak, zander</td>
<td>Costa-Pierce (1992)</td>
</tr>
</tbody>
</table>
Provisioning – Aquatic Organisms

- Competition between paddlefish and bighead carp demonstrated in mesocosms (Schrank et al. 2003)

- Diet overlap between gizzard shad, bigmouth buffalo, and Asian carps (Schuyler et al. 2004)

- Reason to believe that planktivorous fishes will be affected – declines in zooplankton

- Declines in commercial harvest of native species
Regulatory Services

- Maintenance of water quality
  - Natural filtration, water treatment
- Buffering of flood flows
  - Erosion control through land/water interactions, flood control infrastructure
Cultural Services

- Recreation
  - River rafting, canoeing, kayaking, sport fishing, jet skiing, water skiing, boating, swimming

- Tourism

- Existence values
  - Personal satisfaction
Supporting Services

- Role in nutrient cycling and primary production
- Predator/prey relationships and ecosystem resilience
- Habitat for native species
Conclusions

- Have been and will be additional effects to freshwater ecosystem services
- Not a focus of study to date
- Not quantified
- Interaction of Asian carps with management goals will affect delivery of ecosystem services