

Development of a novel platform to control filter-feeding aquatic invasive fishes

Jon J. Amberg, Blake W. Sauey and Joel G. Putnam

United States Geological Survey

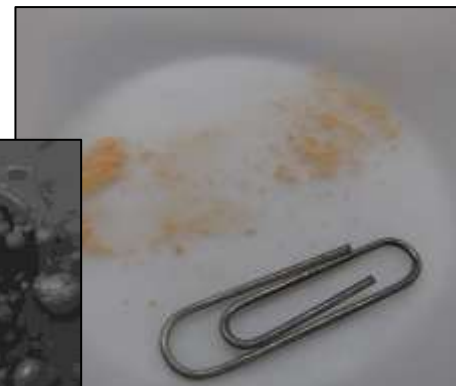
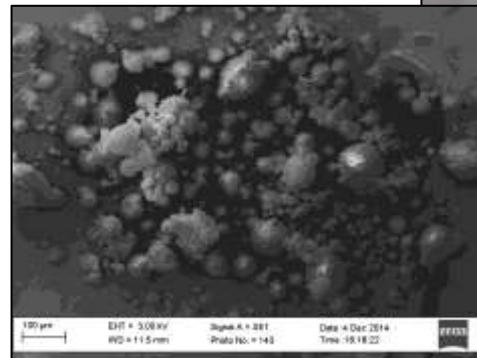
Upper Midwest Environmental Sciences Center

2630 Fanta Reed Road

La Crosse, Wisconsin

Outline

1. The problem
2. Finding an 'Achilles heal'
3. Particle development
4. Laboratory efficacy trials



The Problem

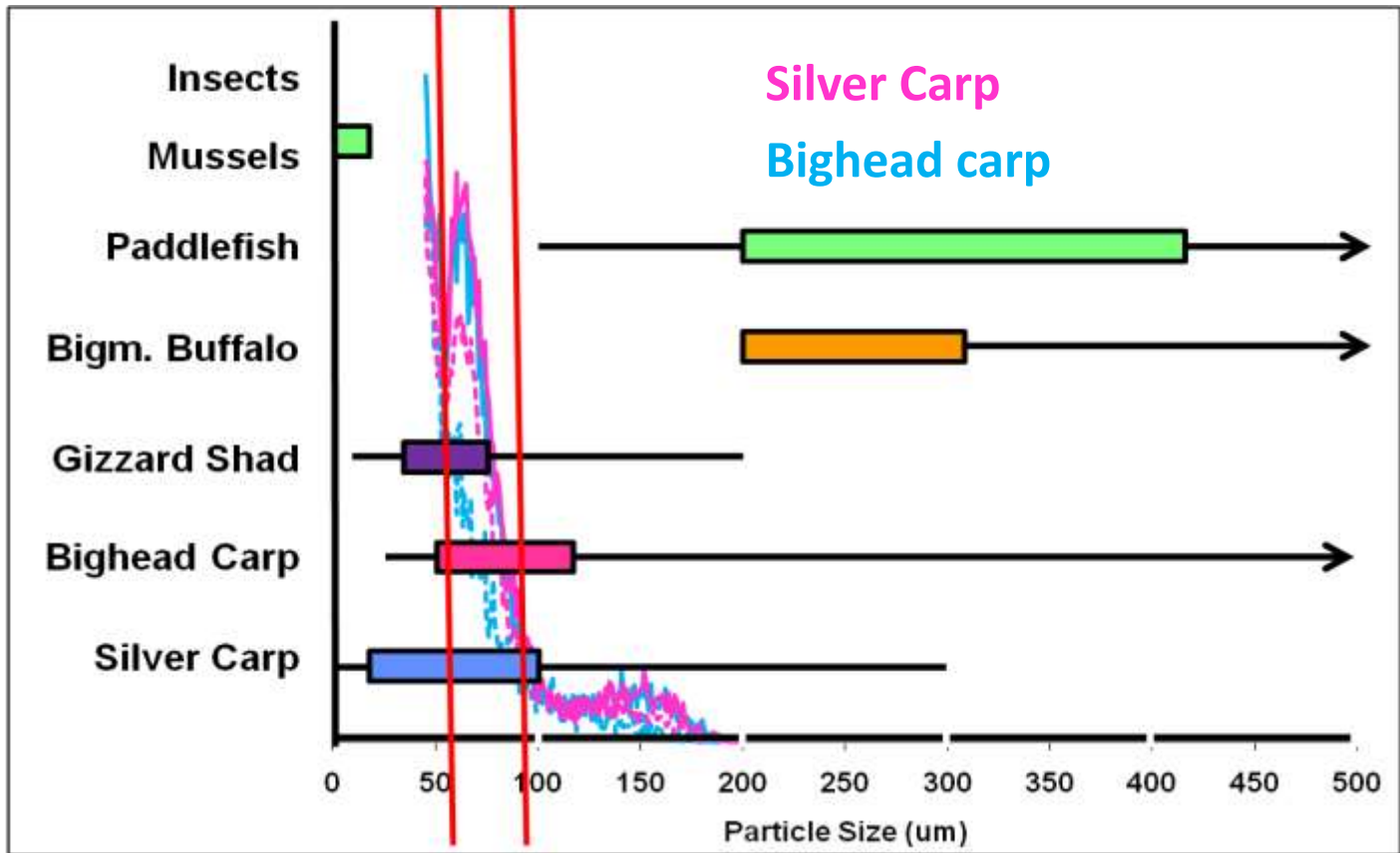
- Focused on the Bigheaded carps
 - Currently threaten the Great Lakes
- High population downstream in Illinois River
 - Increased pressure on barrier
- Limited number of tools
 - Broad spectrum piscicides
 - Impact native species



Finding the 'Achilles Heal'

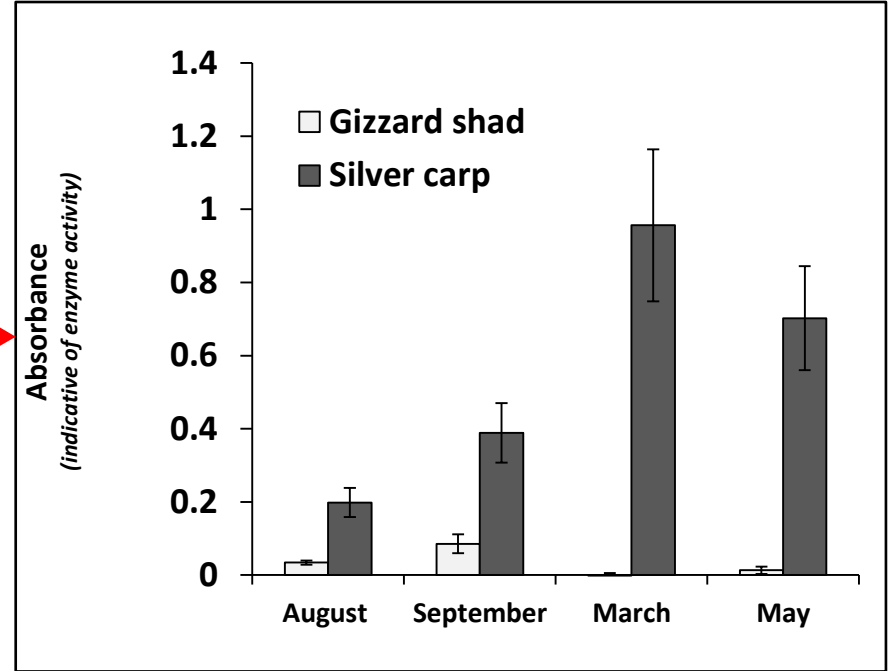
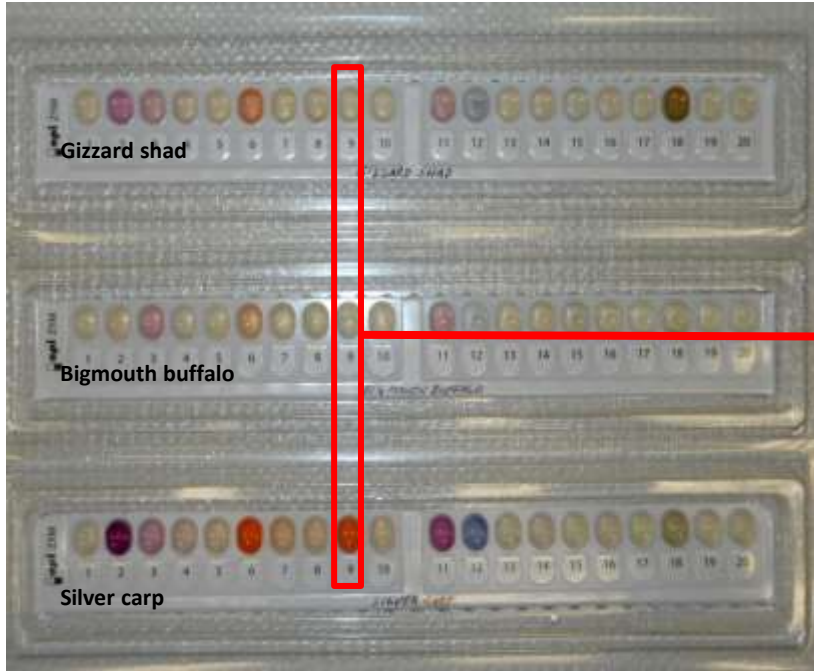
- Use a trait of the animal to your advantage
- Question - Can we take advantage of their filter-feeding strategy?
- Filter-feeders in Mississippi River?
- Conducted trials to identify size preference



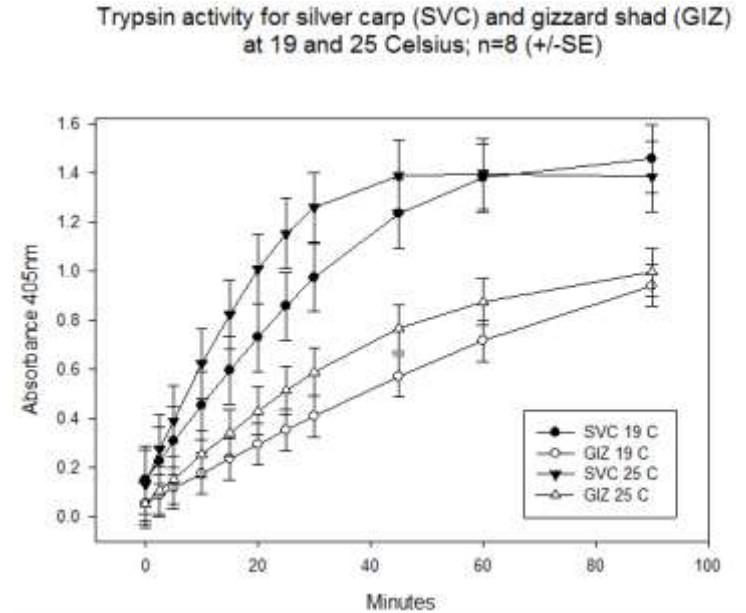
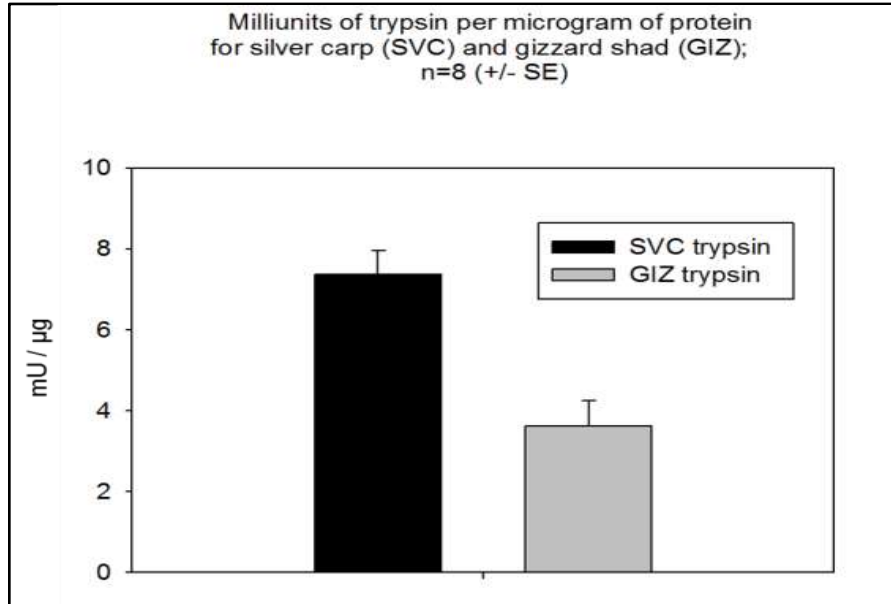


Increasing Selectivity

Identify digestive enzyme to release the control agent



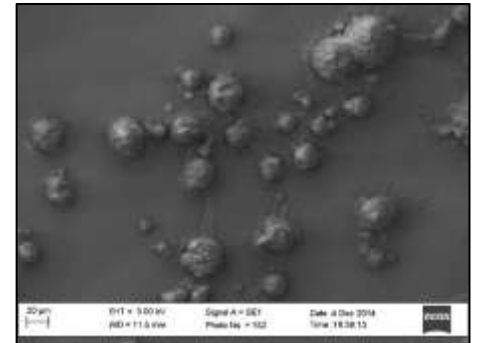
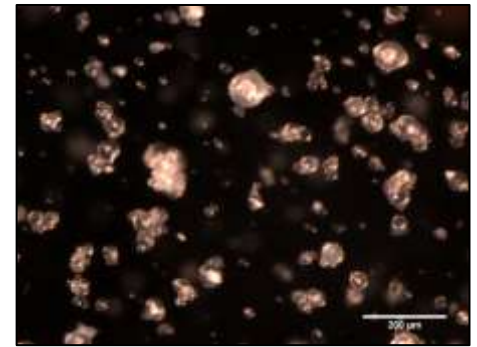
Validation



Oral Delivery Formulation

Need it to:

1. Hold the control agent
2. Appropriate size
3. Likely consumed
4. Release under the “right” conditions
5. Scalable



Industrial Processes

- Spray atomization
- Coacervation
- Co-extrusion
- Fluid bed coating



Concurrent Research

- Focus on the chemical
- Quantitative Structural Relationship Analysis (QSAR)
 - Models to predict toxicity
 - Identify potential new piscicides
 - Requires registration (yrs)
 - Current focus on delivering antimycin-A

Leaching of the Control Agent

Particle	% Leach
20% Antimycin A in beeswax core	0.02
Caster oil 0.09% Antimycin A palmitate core	1.41
Algae coated 0.18% Antimycin A palmitate core	1.28
Zein coated 0.18% Antimycin A palmitate core	1.33
Palmitate coated 4.11% Antimycin A beeswax core	0.05
Spirolina coated 20% Antimycin A in beeswax core	0.08
Zein coated 20% Antimycin A in beeswax core	0.04
Double coat - Zein on palmitate beeswax core	0.25

Efficacy Trials

- Mixed culture
 - Largemouth bass (LMB)
 - Bluegill (BLG)
 - Paddlefish (PAH)
 - Silver carp (SVC)
 - Bighead Carp (BHC)
- Temperature = 18°C
- Exposure to particles for 1 hr
- Mass to equal dosages of 0, 10, 20 and 40 mg ANT



Species-specificity

Mass (g)	SVC	BHC	BLG	LMB	PAH
0					
0.25					
0.5					
1					
LC50 (ppb)	0.65	0.35	0.16	0.2	0.001

Species-specificity

Mass (g)	SVC	BHC	BLG	LMB	PAH
0					0
0.25					0
0.5					20
1					100
LC50 (ppb)	0.65	0.35	0.16	0.2	0.001

Species-specificity

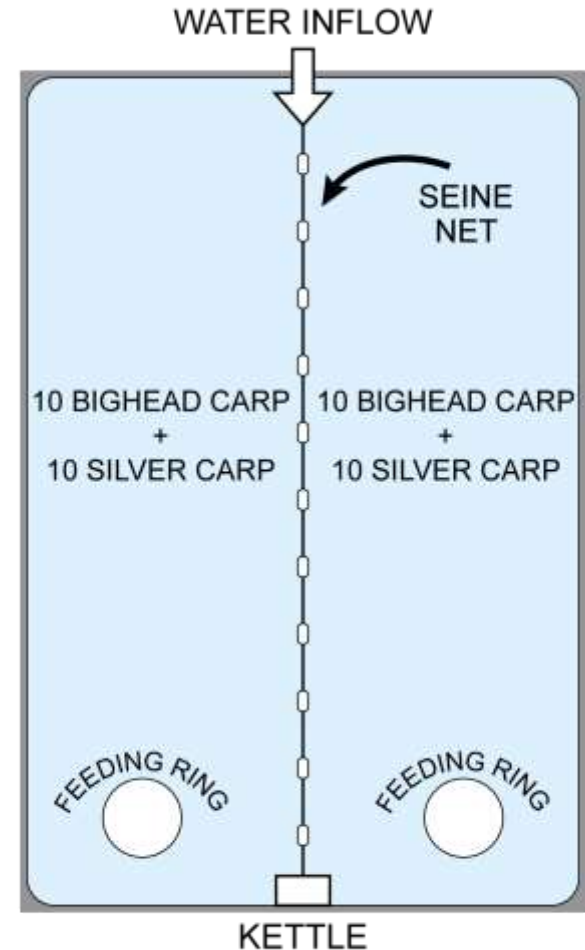
Mass (g)	SVC	BHC	BLG	LMB	PAH
0			0	0	0
0.25			0	0	0
0.5			0	0	20
1			20	100	100
LC50 (ppb)	0.65	0.35	0.16	0.2	0.001

Species-specificity

Mass (g)	SVC	BHC	BLG	LMB	PAH
0	0	0	0	0	0
0.25	0	0	0	0	0
0.5	100	100	0	0	20
1	100	100	20	100	100
LC50 (ppb)	0.65	0.35	0.16	0.2	0.001

Ponds trial in Fall 2015

- Conducted at the USGS-CERC in Columbia, MO
- 0.25 acre pond split lengthwise
- 10 SVC & 10 BHC on each side
 - 40 total fish
- Fish were exposed to 2 g of microparticle with a feeding attractant
- Survival monitored for 48 h



Ponds trial in Fall 2015

- Some BC mortalities within 24 hours
- Remaining BC appeared lethargic
 - Showed a loss of equilibrium
 - Did not actively eat for several days
- Need slight reformulation
 - Slight clumping
- Repeat pond trials spring 2016
- Initiate field trials in IL in late 2016 to early 2017



Conclusions

- Designed an oral delivery tool that:
 - Is the right size
 - Does not leach
 - Is scalable
- Selectively killed bigheaded carps in laboratory trails
- Limited success in pond trials
- Completed reformulation
- Pond trials are being conducted spring/summer 2016
 - Potential field trials within the year

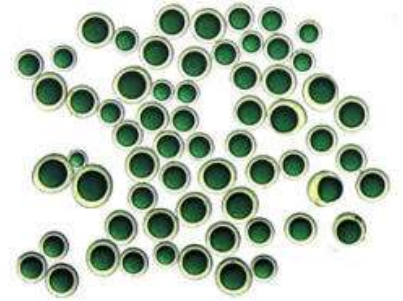


Photo source: SwRI

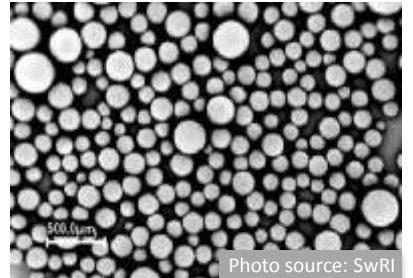


Photo source: SwRI



Acknowledgements



Microparticle formulations:

- Applied BioNutrition
- Southwest Research Institute

Animal collections:

- Illinois Natural History Survey

Antimycin production:

- Aquabiotics

Pond trials:

- Robin Calfee and crew at the Columbia Environmental Research Center

Funding:

- Great lakes Restoration Initiative
- USGS appropriated funds

