Conditioning Hatchery-Raised Bonytail and Razorbacks to Avoid Predators

Matt O'Neill
Bill Stewart

Improving survival of stocked fish

- Native fish species may be naïve to the fact that non-native predators are dangerous (i.e. Cox and Lima 2006)
- Adaptive forgetting (Ferrari et al. 2010)
- Prestocking conditioning suggested by many (i.e. Suboski and Templeton 1989, Ferno et al. 2011)

Improving stocked bonytail and razorback sucker survival

- Conditioning via exposure to active predators has been attempted for both razorback suckers and bonytail
- Training results in altered behavior, utilization of predator-free areas, and improved survival (Mueller and Carpenter 2006, Ward and Figiel 2013)
- Altered behavior may increase predation risk (Ward and Figiel 2013)

Goals

- Confirm that bonytail and razorbacks can be trained to recognize predators to improve survival
- Develop practical training techniques for large scale hatchery operations

Alarm substance

- Predator awareness is well documented in Ostariophysi, especially in cyprinids (von Frisch 1938; Pfeiffer 1963)
- Lately identified as chondroitin (Mathuru et al. 2012)
- Many controlled studies describe improved survival of trained fish for varying time periods (Frisen and Chivers 2006; Jachner and Rydez 2002)

http://en.wikipedia.org/wiki/Ostariophysi

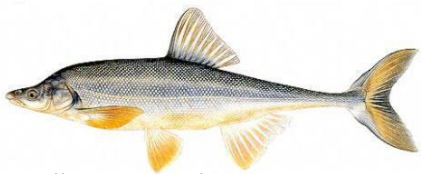
Methods

- Train fish: Expose prey fish to a **hindered** predator in conjunction with alarm substance
  - Provides both visual and chemical predator signal in conjunction with alarm pheromone
  - No predation occurs during training
- Document survival of trained fish compared to untrained fish

Botulinum Toxin Type A Complex

- Prevents the release of acetylcholine from neurons
- Paralyzes skeletal muscle
- Minimal travel between muscles (controlled spread)

Alarm Pheromone Collection



http://www.uitfwd.com/species.htm

4 Prey fish

500 mL water

Alarm Pheromone

1 Week Acclimation

http://www.uitfwd.com/species.htm

20 Prey fish

http://www.uitfwd.com/species.htm

20 Prey fish

Conditioning

http://www.uitfwd.com/species.htm

20 Prey fish

http://www.cgrove417.org/bachweb/final.ryan/largemouth.htm

1 Hindered Bass

Alarm Pheromone

http://www.uitfwd.com/species.htm

20 Prey fsih

20 Conditioned fish

20 Unconditioned fish

Modified Survival Trials

http://www.uitfwd.com/species.htm

20 Trained Bonytail

http://www.cgrove417.org/bachweb/final.ryan/largemouth.htm

4 Starved Largemouth

http://www.uitfwd.com/species.htm

20 Untrained Bonytail

24 Hours

Trained Bonytail

Untrained Bonytail

Trials

Predator species	Prey species	# prey per trial	# predators per trial	# of trials
Bass	Razorback	12	2	16
Catfish	Razorback	8	2	16
Mix	Razorback	8	1 each	16
Bass	Bonytail	20	4	16
Catfish	Bonytail	12	2	16
Mix	Bonytail	12	1 each	16

Predator and Prey Size Comparisons

Predator species	Prey species	Prey size: Mean Prey Standard Length ± Std Error		Student's t-test parameters			Predator size: Mean Predator Standard Length ± Std Error		Student's t-test parameters		
		Conditioned	Unconditioned	t value	df	p-value	Conditioned	Unconditioned	t value	df	p-value
Bass	Razorback	49.44 ± 2.31	49.67 ± 2.37	-0.07	10.85	0.95	279.13 ± 6.19	281.07 ± 3.31	-0.28	10.57	0.79
Catfish	Razorback	54.40 ± 0.84	54.06 ± 0.99	0.26	13.62	0.80	366.56 ± 13.37	369.06 ± 8.22	-0.16	11.63	0.88
Mix	Razorback	51.89 ± 0.63	52.50 ± 0.80	-0.60	13.31	0.56	347.13 ± 9.43	317.63 ± 6.00	2.27	7.00	0.06
Bass	Bonytail	74.23 ± 4.38	69.43 ± 4.23	0.79	13.98	0.44	267.47 ± 10.70	263.97 ± 9.92	0.24	13.92	0.81
Catfish	Bonytail	67.68 ± 1.32	66.63 ± 0.85	0.67	11.97	0.51	360.56 ± 9.43	363.88 ± 12.75	-0.21	12.90	0.84
Mix	Bonytail	65.21 ± 1.13	66.71 ± 0.80	-1.09	12.65	0.30	327.81 ± 10.88	321.06 ± 10.55	0.45	13.99	0.66

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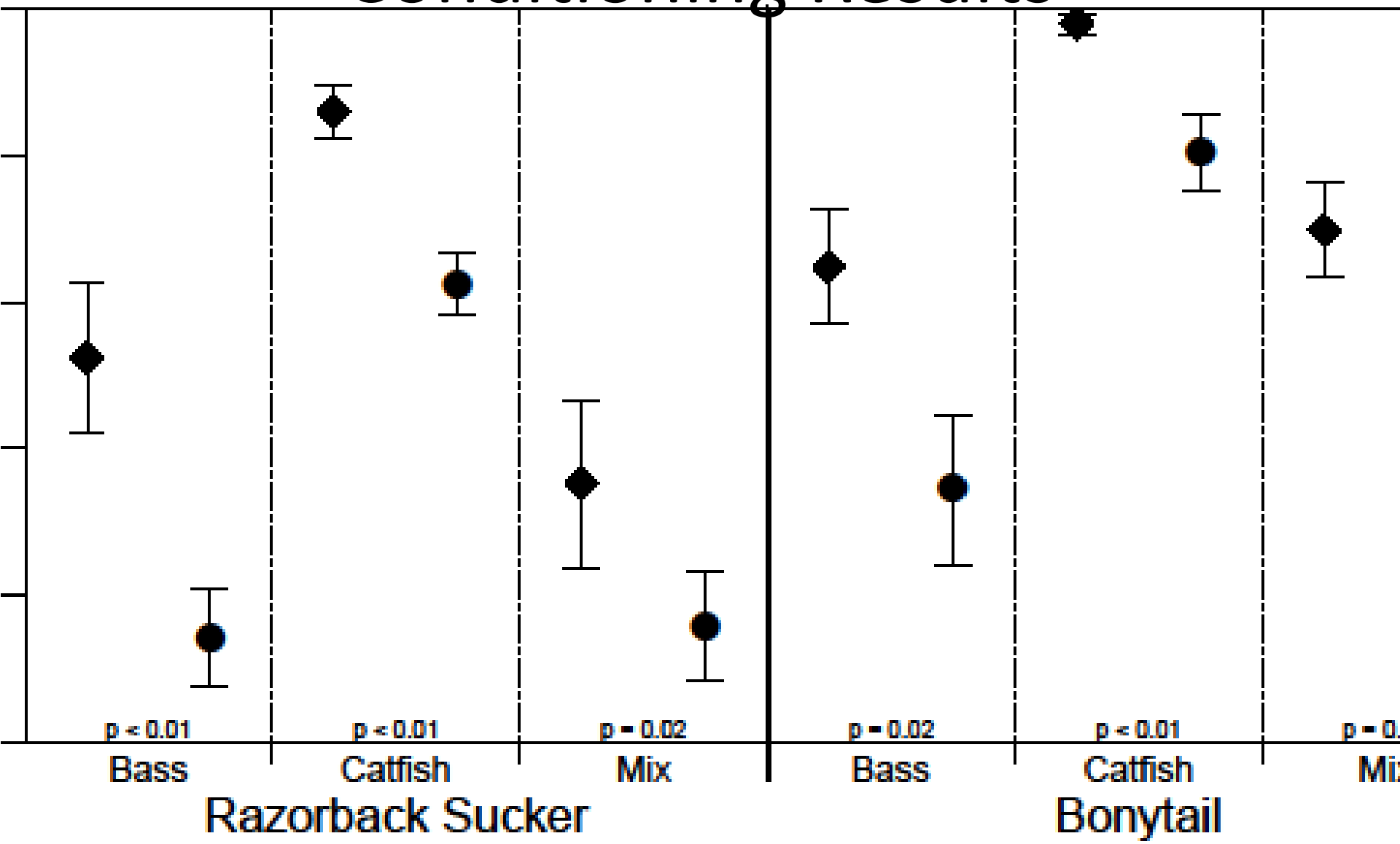
Conditioning Results



Size effects?

Predator species	Prey species	Prey size difference (post-trial SL - initial SL) Mean size difference (mm) ± Std Error		Student's t-test parameters		
		Conditioned	Unconditioned	t value	df	p-value
Bass	Razorback	2.39 ± 3.52	-3.54 ± 1.62	1.528	4.216	0.198
Catfish	Razorback	0.22 ± 0.62	0.96 ± 1.86	-0.379	7.293	0.716
Mix	Razorback	-0.20 ± 1.91	-1.45 ± 3.22	0.335	6.755	0.748
Bass	Bonytail	0.53 ± 0.42	1.19 ± 1.46	-0.437	5.823	0.678
Catfish	Bonytail	-0.31 ± 0.33	-0.07 ± 0.39	-0.462	11.657	0.653
Mix	Bonytail	-0.62 ± 0.49	-2.70 ± 2.21	0.919	5.484	0.397

Conclusions

- Confirm improved survival with minimal conditioning
- Novel technique is effective (large scale?)
- No size effect – large and small fish were captured equally and conditioning helped all sizes

Future directions

- Refine conditioning program
  - Effect of multiple trainings
  - Structure
  - Age at training
  - Active predators as better trainers
  - Can training override adaptive forgetting?

Valle Vista Golf Course

Kingman, AZ

- Replicated ponds for long-term experiments
  - Refine training technique
  - Examine retention of learned behavior

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Social Learning

- Naïve fish watch behavior of trained fish to learn about dangers (rather than being exposed to the danger themselves)
- May not need to train every fish
  - Social learning may allow naïve fish in the wild to learn from trained fish
  - Three-part training process may allow trained individuals to teach untrained fish
- Low “demonstrator” to “observer” improves survival of untrained fish (Vilhunen 2006)