

Supplemental Table S2-1 Passage rate (mean \pm SD) averaged over all 8 pre-test periods and 8 test periods for bighead carp, common carp and largemouth bass exposed to five types of sound stimuli. “NS” indicates that total passage rates did not change significantly over the 8 periods ($p > 0.05$ [corrected for multiple comparisons]). If total passage rates changed over the 8 periods ($p < 0.05$), a “↑” denotes an increase in passage rates (i.e., habituation) while a “↓” denotes a decrease in passage rates (i.e., sensitization). The rate of significant increases/decreases in passage rates over time as measured by linear regression (i.e., slope of the fit line) is given in parentheses. N=8 trials each consisting of 10 naive bighead carp, common carp or largemouth bass were used for each stimulus.

Species	Stimulus	Average Passage Rate during Pre-Test Periods	Do Pre-Test Passages Change over Time?	Average Passage Rate during Test Periods	Do Test Passages Change over Time?
Bighead Carp	Outboard Motor Sound	21.69 (\pm 17.84)	NS ($p = 0.25$)	3.92 (\pm 5.46)	↓ ($p < 0.01$; slope = -0.97)
	Proprietary Sound	11.30 (\pm 7.73)	NS ($p = 0.70$)	2.25 (\pm 2.33)	NS ($p = 0.70$)
	Air Curtain	16.00 (\pm 11.99)	NS ($p = 0.60$)	6.75 (\pm 7.36)	NS ($p = 0.60$)
	Outboard Motor Sound & Air Curtain	12.97 (\pm 10.95)	↓ ($p < 0.01$; slope = -1.46)	0.67 (\pm 1.20)	NS ($p = 0.23$)
	Proprietary Sound & Air Curtain	9.05 (\pm 7.39)	NS ($p = 0.15$)	0.17 (\pm 0.61)	NS ($p = 0.15$)
Common Carp	Outboard Motor Sound	21.94 (\pm 8.47)	NS ($p = 0.05$)	12.86 (\pm 7.22)	NS ($p = 0.16$)
	Proprietary Sound	16.41 (\pm 6.72)	NS ($p = 0.33$)	3.13 (\pm 3.14)	NS ($p = 0.33$)
	Air Curtain	21.11 (\pm 6.84)	NS ($p = 0.06$)	7.80 (\pm 6.60)	NS ($p = 0.06$)
	Outboard Motor Sound & Air Curtain	19.81 (\pm 10.05)	NS ($p = 0.21$)	2.22 (\pm 2.55)	NS ($p = 0.21$)
	Proprietary Sound & Air Curtain	13.55 (\pm 8.62)	NS ($p = 0.08$)	0.05 (\pm 0.21)	NS ($p = 0.08$)
Largemouth Bass	Outboard Motor Sound	8.61 (\pm 5.53)	↓ ($p < 0.01$; slope = -0.69)	5.14 (\pm 5.01)	↓ ($p = 0.02$; slope = -0.44)
	Proprietary Sound	6.14 (\pm 4.53)	↓ ($p < 0.01$; slope = -0.94)	3.22 (\pm 3.46)	NS ($p = 0.14$)
	Air Curtain	11.77 (\pm 6.13)	↓ ($p < 0.01$; slope = -0.95)	3.17 (\pm 1.99)	NS ($p = 0.28$)
	Outboard Motor Sound & Air Curtain	8.25 (\pm 4.70)	↓ ($p < 0.01$; slope = -1.13)	1.89 (\pm 1.85)	NS ($p = 0.46$)
	Proprietary Sound & Air Curtain	7.86 (\pm 6.27)	↓ ($p < 0.01$; slope = -0.88)	0.98 (\pm 1.58)	NS ($p = 0.33$)

Supplemental Table S2-2. Statistical analyses (ANOVA; linear regression), with “fish group number” entered as a random effect, examining the impact of six stimuli on the passage rates of bighead carp, common carp and largemouth bass within the laboratory flume. If a treatment effect was significant ($p < 0.05$), we conducted a series of Bonferroni corrected t-tests comparing matched pre-test and test values for each of the 8 test numbers (i.e., exposures).

Bighead Carp – Passage Rates						
	Statistical Test	Effects	df	df den	F	P
Control	ANOVA: Pre-Test	Test Number	7	49	0.71	0.66
Outboard Motor Sound	2-way ANOVA	Treatment	1	105	12.86	< 0.01
		Test Number	7	105	2.71	0.01
		Treatment x Test Number	7	105	0.77	0.62
	ANOVA: Pre-Test	Test Number	7	49	1.35	0.25
	ANOVA: Test	Test Number	7	49	3.32	0.01
	Linear Regression: Test	Test Number	1	62	t=-3.52	< 0.01
Proprietary Sound	2-way ANOVA	Treatment	1	105	32.25	< 0.01
		Test Number	7	105	0.64	0.72
		Treatment x Test Number	7	105	0.67	0.70
Air Curtain	2-way ANOVA	Treatment	1	105	14.42	< 0.01
		Test Number	7	105	0.79	0.60
		Treatment x Test Number	7	105	0.73	0.65
Outboard Motor Sound + Air Curtain	2-way ANOVA	Treatment	1	105	24.09	< 0.01
		Test Number	7	105	3.89	< 0.01
		Treatment x Test Number	7	105	3.01	0.01
	ANOVA: Pre-Test	Test Number	7	49	3.60	< 0.01
	Linear Regression: Pre-Test	Test Number	1	62	t=-2.67	0.01
	ANOVA: Test	Test Number	7	49	3.61	< 0.01
	Linear Regression: Test	Test Number			t=-1.22	0.23
Proprietary Sound + Air Curtain	2-way ANOVA	Treatment	1	105	39.80	< 0.01
		Test Number	7	105	1.60	0.15
		Treatment x Test Number	7	105	0.72	0.65
Common Carp – Passage Rates						
Control	ANOVA: Pre-Test	Test Number	7	49	1.39	0.23
Outboard Motor Sound	2-way ANOVA	Treatment	1	105	5.11	0.03
		Test Number	7	105	2.66	0.01

		Treatment x Test Number	7	105	0.36	0.92	
	ANOVA: Pre-Test	Test Number	7	49	2.18	0.05	
	ANOVA: Test	Test Number	7	49	1.58	0.16	
Proprietary Sound	2-way ANOVA	Treatment	1	105	72.84	< 0.01	
		Test Number	7	105	0.65	0.71	
		Treatment x Test Number	7	105	1.17	0.33	
Air Curtain	2-way ANOVA	Treatment	1	105	48.65	< 0.01	
		Test Number	7	105	2.04	0.06	
		Treatment x Test Number	7	105	0.85	0.55	
Outboard Motor Sound + Air Curtain	2-way ANOVA	Treatment	1	105	104.07	< 0.01	
		Test Number	7	105	2.26	0.04	
		Treatment x Test Number	7	105	1.39	0.22	
		ANOVA: Pre-Test	Test Number	7	49	1.46	0.21
		ANOVA: Test	Trial Number	7	49	3.03	0.01
	Linear Regression: Test	Test Number		t=1.28	0.21		
Proprietary Sound + Air Curtain	2-way ANOVA	Treatment	1	105	93.00	< 0.01	
		Test Number	7	105	1.86	0.08	
		Treatment x Test Number	7	105	1.64	0.13	
Largemouth Bass – Passage Rates							
Control	ANOVA: Pre-Test	Test Number	7	49	1.56	0.17	
		Treatment	1	105	6.54	0.01	
Outboard Motor Sound	2-way ANOVA	Test Number	7	105	6.61	< 0.01	
		Treatment x Test Number	7	105	1.18	0.32	
		ANOVA: Pre-Test	Test Number	7	49	5.11	< 0.01
		Linear Regression: Pre-Test	Test Number	1	62	t=-3.08	< 0.01
		ANOVA: Test	Test Number	7	49	3.01	0.01
	Linear Regression: Test	Test Number	1	62	t=-2.38	0.02	
Proprietary Sound	2-way ANOVA	Treatment	1	105	39.51	< 0.01	
		Test Number	7	105	5.18	< 0.01	
		Treatment x Test Number	7	105	3.55	< 0.01	
		ANOVA: Pre-Test	Test Number	7	49	6.57	< 0.01
		Linear Regression: Pre-Test	Test Number	1	62	t=-4.85	< 0.01
		ANOVA: Test	Test Number	7	49	1.66	0.14

Air Curtain		Treatment	1	105	26.54	< 0.01
	2-way ANOVA	Test Number	7	105	3.48	< 0.01
		Treatment x Test Number	7	105	0.80	0.59
	ANOVA: Pre-Test	Test Number	7	49	2.81	0.02
	Linear Regression: Pre-Test	Test Number	1	62	t=-3.45	< 0.01
	ANOVA: Test	Test Number	7	49	1.28	0.28
Outboard Motor Sound + Air Curtain		Treatment	1	105	30.19	< 0.01
	2-way ANOVA	Test Number	7	105	4.13	< 0.01
		Treatment x Test Number	7	105	2.45	0.02
	ANOVA: Pre-Test	Test Number	7	49	6.43	< 0.01
	Linear Regression: Pre-Test	Test Number	1	62	t=-5.41	< 0.01
	ANOVA: Test	Test Number	7	49	0.97	0.46
Proprietary Sound + Air Curtain		Treatment	1	105	35.02	< 0.01
	2-way ANOVA	Test Number	7	105	3.53	< 0.01
		Treatment x Test Number	7	105	2.36	0.03
	ANOVA: Pre-Test	Test Number	7	49	4.63	< 0.01
	Linear Regression: Pre-Test	Test Number	1	62	t=-3.50	< 0.01
	ANOVA: Test	Test Number	7	49	1.19	0.33

Supplemental Table S2-3 Number of fish located within 1 m of the deterrent system (mean \pm SD) averaged over all 8 pre-test periods or 8 test periods for bighead carp, common carp and largemouth bass. Changes in the number of fish near the deterrent system during the course of the 8 test periods are noted. “NS” indicates that the number of fish did not change significantly following repeated exposure to sound ($p > 0.05$). If the number of fish within 1 m of the deterrent changed over the 8 test periods ($p < 0.05$), a “ \uparrow ” indicated an increase (i.e., habituation) while a “ \downarrow ” indicated a decrease (i.e., sensitization) in the number of fish near the deterrent. N=8 trials each consisting of 10 naïve bighead carp, common carp or largemouth bass were used for each stimulus.

Species	Stimulus	Average Number of Fish within 1 m of Deterrent during All Pre-Test Periods	Does the Number of Fish during Pre-Test Periods Change over Time?	Average Number of Fish within 1 m of Deterrent during All Test Periods	Does the Number of Fish during Test Periods Change over Time?
Bighead Carp	Outboard Motor Sound	1.30 (\pm 1.28)	NS ($p = 0.67$)	1.47 (\pm 2.13)	NS ($p = 0.67$)
	Proprietary Sound	0.77 (\pm 0.54)	NS ($p = 0.31$)	0.46 (\pm 0.46)	NS ($p = 0.31$)
Common Carp	Outboard Motor Sound	1.23 (\pm 0.62)	NS ($p = 0.21$)	1.23 (\pm 0.56)	NS ($p = 0.21$)
	Proprietary Sound	1.13 (\pm 0.58)	NS ($p = 0.73$)	0.69 (\pm 0.41)	NS ($p = 0.73$)
Largemouth Bass	Outboard Motor Sound	1.07 (\pm 0.69)	NS ($p = 0.48$)	1.19 (\pm 0.70)	NS ($p = 0.48$)
	Proprietary Sound	0.98 (\pm 0.72)	NS ($p = 0.35$)	0.71 (\pm 0.64)	NS ($p = 0.35$)

Supplemental Table S2-4. Statistical analyses (ANOVA), with “fish group number” entered as a random effect, examining the impact of three stimuli on the number of bighead carp, common carp and largemouth bass within 1 m of the deterrent system. If a treatment effect was significant ($p < 0.05$), we conducted a series of Bonferroni corrected t-tests comparing matched pre-test and test values for each of the 8 test numbers (i.e., exposures).

Bighead Carp – Number of Fish						
	Statistical Test	Effects	df	df den	F	P
Control	ANOVA: Pre-Test	Test Number	7	49	1.47	0.20
Outboard Motor Sound	2-way ANOVA	Treatment	1	105	4.47	0.04
		Test Number	7	105	0.71	0.67
		Treatment x Test Number	7	105	0.51	0.82
Proprietary Sound	2-way ANOVA	Treatment	1	105	7.40	0.01
		Test Number	7	105	0.28	0.96
		Treatment x Test Number	7	105	1.19	0.31
Common Carp – Number of Fish						
Control	ANOVA: Pre-Test	Test Number	7	49	0.09	0.99
Outboard Motor Sound	2-way ANOVA	Treatment	1	105	1.23	0.27
		Test Number	7	105	1.42	0.21
		Treatment x Test Number	7	105	0.52	0.82
Proprietary Sound	2-way ANOVA	Treatment	1	105	5.67	0.02
		Test Number	7	105	0.54	0.81
		Treatment x Test Number	7	105	0.63	0.73
Largemouth Bass – Number of Fish						
Control	ANOVA: Pre-Test	Test Number	7	49	0.77	0.62
Outboard Motor Sound	2-way ANOVA	Treatment	1	105	0.35	0.56
		Test Number	7	105	0.75	0.63
		Treatment x Test Number	7	105	0.94	0.48
Proprietary Sound	2-way ANOVA	Treatment	1	105	3.17	0.08
		Test Number	7	105	1.14	0.35
		Treatment x Test Number	7	105	0.64	0.72

Supplemental Table S2-5. Statistical analyses (ANOVA; paired comparisons), with “fish group number” entered as a random effect, examining the impact of the five sound stimuli on bighead carp, common carp and largemouth bass blockage efficiencies. For each species, paired comparisons between specific sound stimuli were used to answer the two questions.

Statistical Test		Effects	df	df den	F	P
Full Model	2-way ANOVA	Species	2	105	12.46	< 0.01
		Stimulus	4	105	29.13	< 0.01
		Species x Stimulus	8	105	4.58	< 0.01
Bighead Carp	t-test: outboard motor vs proprietary				0.19	0.85
	t-test: (sound + air) vs sound					
	Outboard motor sound				1.93	0.06
	Proprietary sound				2.68	0.01
	t-test: (sound + air) vs air curtain					
	Outboard motor sound				4.26	< 0.01
	Proprietary sound				5.21	< 0.01
t-test: (outboard motor + air) vs (proprietary sound + air)					0.95	0.35
Common Carp	t-test: outboard motor vs proprietary				5.18	< 0.01
	t-test: (sound + air) vs sound					
	Outboard motor sound				6.39	< 0.01
	Proprietary sound				2.83	0.01
	t-test: (sound + air) vs air curtain					
	Outboard motor sound				3.01	< 0.01
	Proprietary sound				5.00	< 0.01
t-test: (outboard motor + air) vs (proprietary sound + air)					3.13	< 0.01
Largemouth Bass	t-test: outboard motor vs proprietary				0.67	0.50
	t-test: (sound + air) vs sound					
	Outboard motor sound				3.58	< 0.01
	Proprietary sound				5.09	< 0.01
	t-test: (sound + air) vs air curtain					
	Outboard motor sound				0.45	0.65
	Proprietary sound				2.64	0.01
t-test: (outboard motor + air) vs (proprietary sound + air)					2.19	0.03

Supplemental Table S2-6. Statistical analyses (ANOVA; paired comparisons), with “fish group number” entered as a random effect, examining the impact of the two complex sound stimuli on bighead carp, common carp and largemouth bass deterrence efficiencies. For each species, paired comparisons between the outboard motor sound and the proprietary sound were used to determine which complex sound was most effective.

Statistical Test		Effects	df	df den	F	P
Full Model	2-way ANOVA	Species	2	38	4.08	0.03
		Stimulus	1	38	5.84	0.02
		Species x Stimulus	2	38	1.18	0.32
Bighead Carp	t-test: outboard motor vs proprietary				2.26	0.03
Common Carp	t-test: outboard motor vs proprietary				2.29	0.03
Largemouth Bass	t-test: outboard motor vs proprietary				1.56	0.13

Supplemental Table S3-1 Summary of studies examining the effect of multi-modal deterrents on fish behavior.

Type of Multi-Sensory Deterrent	Stimulus	Stimulus Description	Field/Lab	Species	Background Lighting	Behavioral Response	Reference
Sound + Air	Sound	proprietary sound (FGS), 50-600Hz	Field	Atlantic Salmon smolts	Day	30% blockage	Welton et al. 2002
	Air Curtain	consumption rate: 1 L/s/m					
	Sound	proprietary sound (FGS), 50-600Hz	Field	Atlantic Salmon smolts	Night	70% blockage	Welton et al. 2002
	Air Curtain	consumption rate: 1 L/s/m					
	Sound	proprietary sound (FGS), 20-2000Hz	Lab	Bighead carp	Day	95% blockage	Taylor et al. 2005
	Air Curtain	no description					
	Sound	proprietary sound (FGS), 500-2000Hz	Field	Bigheaded carp (target)	Day/Night	>99% blockage	Ruebush et al. 2012
	Air Curtain	pressure supplied: 25psi					
Sound	proprietary sound (Ovivo), 0-2000Hz	Lab (pond)	Walleye	Night	55% blockage	Flammang et al. 2014	
Air Curtain	consumption rate: 0.3 m ³ /min						
Sound	proprietary sound (Ovivo), 20-3000Hz	Lab	Sea Lamprey	Night	No blockage	Miehls et al. 2017	
Air Curtain	pressure supplied: 172 kPa						
Sound	proprietary sound (FGS), 20-2000Hz	Lab	Bighead Carp	Night	98% blockage, more effective than sound / air	Dennis et al. 2019	
Air Curtain	porous pipes: 1-5mm bubbles						
Air + Light	Light	strobe light: 5Hz	Lab	Spot	Day	63% reduction	Patrick et al. 1985
	Air Curtain	bubble wand					
	Light	strobe light: 5Hz	Lab	Spot	Night	85% reduction	Patrick et al. 1985
Air Curtain	bubble wand						
Light	strobe light: 5Hz	Lab	Menhaden	Day	67% reduction, more effective than light	Patrick et al. 1985	
Air Curtain	bubble wand						

Air + Light (cont)	Light	strobe light: 5Hz	Lab	Menhaden	<i>Night</i>	81% reduction, more effective than light	Patrick et al. 1985
	Air Curtain	bubble wand					
	Light	strobe light: 5Hz	Lab	White perch	<i>Day</i>	36% reduction	Patrick et al. 1985
	Air Curtain	bubble wand					
	Light	strobe light: 5Hz	Lab	White perch	<i>Night</i>	58% reduction, more effective than light	Patrick et al. 1985
	Air Curtain	bubble wand					
	Light	strobe light: 5Hz, 1 watt power	Lab	White perch	<i>Day</i>	35% avoidance, more effective than air	McIninch and Hocutt 1987
	Air Curtain	porous bars					
	Light	strobe light: 5Hz, 1 watt power	Lab	Spot	<i>Day</i>	70% avoidance, more effective than air	McIninch and Hocutt 1987
	Air Curtain	porous bars					
	Light	strobe light: 5Hz, 1 watt power	Lab	Atlantic manhaden	<i>Day</i>	65% avoidance, more effective than air or light	McIninch and Hocutt 1987
	Air Curtain	porous bars					
Light	Strobe light: 2, 5 or 10Hz; 0.8 uE/s/m	Lab	White perch	<i>Day</i>	35% reduction, more effective than air	Sager et al. 1987	
Air Curtain	mist bars						
Light	Strobe light: 2, 5 or 10Hz; 0.8 uE/s/m	Lab	White perch	<i>Night</i>	60% reduction, more effective than air or light	Sager et al. 1987	
Air Curtain	mist bars						
Light	Strobe light: 2, 5 or 10Hz; 0.8 uE/s/m	Lab	Spot	<i>Day</i>	60% reduction, more effective than air	Sager et al. 1987	
Air Curtain	mist bars						
Light	Strobe light: 2, 5 or 10Hz; 0.8 uE/s/m	Lab	Spot	<i>Night</i>	85% reduction, more effective than air	Sager et al. 1987	
Air Curtain	mist bars						
Light	Strobe light: 2, 5 or 10Hz; 0.8 uE/s/m	Lab	Atlantic manhaden	<i>Day</i>	67% reduction, more effective than air or light	Sager et al. 1987	
Air Curtain	mist bars						
Light	Strobe light: 2, 5 or 10Hz; 0.8 uE/s/m	Lab	Atlantic manhaden	<i>Night</i>	81% reduction, more effective than air or light	Sager et al. 1987	
Air Curtain	mist bars						

	Light Air Curtain	strobe light: 1Hz, visibility of 3.2km pressure supplied: 984.3 kg/m ²	Lab	Muskellunge	<i>Day</i>	No blockage	Stewart et al. 2014
	Light Air Curtain	strobe light: 1Hz, visibility of 3.2km pressure supplied: 984.3 kg/m ²	Lab	Muskellunge	<i>Night</i>	No blockage	Stewart et al. 2014
	Light Air Curtain	strobe light: 6 Hz pressure supplied: 172 kPa	Lab	Sea Lamprey	<i>Night</i>	No blockage	Miehls et al. 2017
Sound + Light	Sound	proprietary sound (Ovivo), 20-3000Hz	Lab	Sea Lamprey	<i>Night</i>	No blockage	Miehls et al. 2017
	Light	strobe light: 6 Hz					
	Sound	artificial sound: 20-20,000Hz	Lab	Port Jackson Shark	<i>Night</i>	Avoid; more effective than sound not light	Ryan et al. 2018
	Light	strobe light: 10Hz					
	Sound	artificial sound: 20-20,000Hz	Lab	Epaulette Shark	<i>Night</i>	Avoid; more effective than sound not light	Ryan et al. 2018
	Light	strobe light: 10Hz					
	Sound Light	artificial sound: 20-20,000Hz strobe light: 10Hz	Field	Great White Shark	<i>Day</i>	No avoidance	Ryan et al. 2018
Sound + Air + Light	Sound Air Curtain Light	proprietary cyclic sound, 500-2000Hz pressure supplied: 25psi constant or strobed light	Field	Bigheaded carp (target)	<i>Day/Night</i>	>99% blockage	Ruebush et al. 2012
	Sound Air Curtain Light	proprietary cyclic sound, 0-2000Hz consumption rate: 0.3 m ³ /min strobe light: 8 or 16 Hz, 650 lumen	Lab (pond)	Walleye	<i>Night</i>	<20% blockage, less effective than BAFF	Flammang et al. 2014
	Sound Air Curtain Light	proprietary cyclic sound, 5-600Hz consumption rate: 2 L/s/m strobe light: 3Hz	Field	Chinook Salmon	<i>Day</i>	75% blockage	Perry et al. 2014
	Sound Air Curtain Light	proprietary cyclic sound, 5-600Hz consumption rate: 2 L/s/m strobe light: 3Hz	Field	Chinook Salmon	<i>Night</i>	65% blockage	Perry et al. 2014
	Sound Air Curtain Light	proprietary sound (Ovivo), 20-3000Hz pressure supplied: 172 kPa strobe light: 6 Hz	Lab	Sea Lamprey	<i>Night</i>	No blockage	Miehls et al. 2017

Supplemental Table S3-2 Generalized linear mixed model (GLMM) results for bighead carp exposed to sound, air curtain (air), constant light (CL) or strobing light (SL), alone or in combination.

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to sound/light/air curtains reduce overall mean passage of fish? ($\alpha = 0.05/22 = 0.0023$)					
Sound: Pre-Test vs No Treatment Control	-0.2964	0.0657	-4.5100	-2.4264	0.0153
Sound: Test vs No Treatment Control	-1.4372	0.0778	-18.4720	-9.9381	< 0.0001
Air: Pre-Test vs No Treatment Control	-0.3744	0.0593	-6.3160	-3.3981	0.0007
Air: Test vs No Treatment Control	-1.1748	0.0662	-17.7490	-9.5491	< 0.0001
CL: Pre-Test vs No Treatment Control	-0.1746	0.0563	-3.1010	-1.6684	0.0953
CL: Test vs No Treatment Control	-1.8203	0.0725	-25.1160	-13.5126	< 0.0001
SL: Pre-Test vs No Treatment Control	-0.3522	0.0599	-5.881	-3.6328	0.0003
SL: Test vs No Treatment Control	-2.0437	0.0860	-23.7710	-14.6836	< 0.0001
Sound + Air: Pre-Test vs No Treatment Control	-0.0764	0.0676	-1.1310	-0.6085	0.5432
Sound + Air: Test vs No Treatment Control	-2.3711	0.1055	-22.4690	-12.0885	< 0.0001
Air + CL: Pre-Test vs No Treatment Control	0.0438	0.0625	0.7010	0.3771	0.7061
Air + CL: Test vs No Treatment Control	-1.8829	0.0957	-19.6670	-10.5810	< 0.0001
Air + SL: Pre-Test vs No Treatment Control	0.2095	0.0661	3.1710	1.9588	0.0501
Air + SL: Test vs No Treatment Control	-2.7220	0.1504	-18.0930	-11.1763	< 0.0001

Sound + CL: Pre-Test vs No Treatment Control	0.0958	0.0617	1.5510	0.8345	0.4040
Sound + CL: Test vs No Treatment Control	-1.4531	0.0803	-18.0890	-9.7320	< 0.0001
Sound + SL: Pre-Test vs No Treatment Control	-0.1246	0.0635	-1.9620	-1.2120	0.2255
Sound + SL: Test vs No Treatment Control	-2.9044	0.1460	-19.8950	-12.2894	< 0.0001
Sound + Air + CL: Pre-Test vs No Treatment Control	0.0646	0.0635	1.0160	0.5466	0.5847
Sound + Air + CL: Test vs No Treatment Control	-1.3097	0.0846	-15.4790	-8.3278	< 0.0001
Sound + Air + SL: Pre-Test vs No Treatment Control	0.1821	0.0692	2.6320	1.6258	0.1040
Sound + Air + SL: Test vs No Treatment Control	-2.4659	0.1410	-17.485	-10.8007	< 0.0001

Do passage rates change with repeated exposure to sound/light/air curtains? ($\alpha = 0.05/7 = 0.0071$)

No Treatment Control

Linear	0.0148	0.0085	1.7390	0.9356	0.3495
Quadratic	0.1535	0.0546	2.8080	1.5107	0.1309
Cubic	-0.0566	0.0565	-1.0010	-0.5385	0.5906
Quartic	0.1726	0.0568	3.0370	1.6339	0.1023
Quintic	0.1697	0.0578	2.9380	1.5807	0.1139
Sextic	-0.0638	0.0584	-1.0930	-0.5880	0.5565
Septic	-0.0587	0.0569	-1.0320	-0.5552	0.5789

Sound: Pre-Test Passage Rates

Linear	-0.0798	0.0126	-6.3170	-3.3986	0.0007
Quadratic	-0.0523	0.0843	-0.6200	-0.3336	0.7387
Cubic	0.0298	0.0803	0.3710	0.1996	0.8418
Quartic	-0.2863	0.0801	-3.5740	-1.9228	0.0545
Quintic	-0.0752	0.0784	-0.9590	-0.5160	0.6059
Sextic	0.1268	0.0779	1.6280	0.8759	0.3811
Septic	-0.0741	0.0825	-0.8990	-0.4837	0.6286

Sound: Test Passage Rates

Linear	-0.0257	0.0231	-1.1110	-0.5977	0.5500
Quadratic	-0.3381	0.1486	-2.2750	-1.2240	0.2210
Cubic	0.1357	0.1411	0.9610	0.5170	0.6052
Quartic	-0.1093	0.1480	-0.7390	-0.3976	0.6909
Quintic	-0.0470	0.1412	-0.3330	-0.1792	0.8578
Sextic	0.4248	0.1311	3.2400	1.7431	0.0813
Septic	0.1370	0.1390	0.9860	0.5305	0.5958

Air: Pre-Test Passage Rates

Linear	-0.0595	0.0115	-5.1650	-2.7788	0.0055
Quadratic	-0.0924	0.0748	-1.2360	-0.6650	0.5061
Cubic	0.0990	0.0744	1.3300	0.7155	0.4743

Quartic	-0.0665	0.0724	-0.9190	-0.4944	0.6210
Quintic	-0.0943	0.0725	-1.3000	-0.6994	0.4843
Sextic	-0.0923	0.0724	-1.2590	-0.6774	0.4982
Septic	-0.0365	0.0724	-0.5040	-0.2712	0.7862

Air: Test Passage Rates

Linear	-0.1030	0.0168	-6.1430	-3.3050	0.0010
Quadratic	0.1503	0.1108	1.3560	0.7295	0.4657
Cubic	0.3074	0.1113	2.7610	1.4854	0.1374
Quartic	-0.1394	0.1086	-1.2840	-0.6908	0.4897
Quintic	-0.0137	0.1104	-0.1240	-0.0667	0.9468
Sextic	-0.0905	0.1138	-0.7950	-0.4277	0.6689
Septic	-0.1778	0.1140	-1.5600	-0.8393	0.4013

CL: Pre-Test Passage Rates

Linear	-0.0585	0.0095	-6.1610	-3.3147	0.0009
Quadratic	-0.1366	0.0606	-2.2530	-1.2121	0.2255
Cubic	0.0408	0.0610	0.6690	0.3599	0.7189
Quartic	0.0427	0.0600	0.7120	0.3831	0.7016
Quintic	0.0815	0.0600	1.3590	0.7312	0.4647
Sextic	-0.0793	0.0599	-1.3230	-0.7118	0.4766

Septic	-0.0124	0.0581	-0.2130	-0.1146	0.9088
--------	---------	--------	---------	---------	--------

CL: Test Passage Rates

Linear	-0.1519	0.0218	-6.9760	-3.7531	0.0002
---------------	----------------	---------------	----------------	----------------	---------------

Quadratic	0.2933	0.1419	2.0670	1.1121	0.2661
-----------	--------	--------	--------	--------	--------

Cubic	-0.4930	0.1419	-3.4750	-1.8696	0.0615
-------	---------	--------	---------	---------	--------

Quartic	0.1434	0.1425	1.0060	0.5412	0.5884
---------	--------	--------	--------	--------	--------

Quintic	-0.1012	0.1427	-0.7090	-0.3815	0.7028
---------	---------	--------	---------	---------	--------

Sextic	0.0036	0.1429	0.0250	0.0135	0.9892
--------	--------	--------	--------	--------	--------

Septic	0.5394	0.1441	3.7440	2.0143	0.0440
--------	--------	--------	--------	--------	--------

SL: Pre-Test Passage Rates

Linear	-0.0688	0.0122	-5.6470	-3.4882	0.0005
---------------	----------------	---------------	----------------	----------------	---------------

Quadratic	-0.3351	0.0795	-4.2140	-2.6030	0.0092
-----------	---------	--------	---------	---------	--------

Cubic	0.0361	0.0754	0.4780	0.2953	0.7678
-------	--------	--------	--------	--------	--------

Quartic	-0.2466	0.0742	-3.3240	-2.0533	0.0400
---------	---------	--------	---------	---------	--------

Quintic	-0.1492	0.0717	-2.0820	-1.2861	0.1984
---------	---------	--------	---------	---------	--------

Sextic	0.1252	0.0698	1.7940	1.1082	0.2678
--------	--------	--------	--------	--------	--------

Septic	0.0592	0.0723	0.8190	0.5059	0.6129
--------	--------	--------	--------	--------	--------

SL: Test Passage Rates

Linear	-0.2412	0.0319	-7.5730	-4.6779	< 0.0001
---------------	----------------	---------------	----------------	----------------	--------------------

Quadratic	-0.2889	0.1911	-1.5110	-0.9334	0.3506
Cubic	-0.0573	0.1886	-0.3040	-0.1878	0.8510
Quartic	0.1606	0.2064	0.7780	0.4806	0.6308
Quintic	0.4445	0.1951	2.2790	1.4078	0.1592
Sextic	0.4748	0.1699	2.7950	1.7265	0.0843
Septic	-0.1375	0.1666	-0.8250	-0.5096	0.6103

Sound + Air: Pre-Test Passage Rates

Linear	-0.0386	0.0115	-3.3640	-1.8099	0.0703
Quadratic	0.1094	0.0749	1.4610	0.7860	0.4319
Cubic	0.1656	0.0748	2.2160	1.1922	0.2332
Quartic	0.0027	0.0764	0.0350	0.0188	0.9850
Quintic	-0.0606	0.0763	-0.7940	-0.4272	0.6692
Sextic	0.1050	0.0758	1.3850	0.7451	0.4562
Septic	-0.1058	0.0773	-1.3680	-0.7360	0.4617

Sound + Air: Test Passage Rates

Linear	-0.0443	0.0378	-1.1720	-0.6305	0.5284
Quadratic	-0.1569	0.2352	-0.6670	-0.3589	0.7197
Cubic	0.0803	0.2493	0.3220	0.1732	0.8625
Quartic	0.2964	0.2369	1.2510	0.6730	0.5010

Quintic	-0.1060	0.2441	-0.4340	-0.2335	0.8154
Sextic	-0.3177	0.2517	-1.2620	-0.6790	0.4971
Septic	-0.4434	0.2264	-1.9580	-1.0534	0.2922

Air + CL: Pre-Test Passage Rates

Linear	-0.0298	0.0120	-2.4780	-1.3332	0.1825
Quadratic	-0.3072	0.0777	-3.9510	-2.1257	0.0335
Cubic	0.1692	0.0759	2.2310	1.2003	0.2300
Quartic	-0.1317	0.0734	-1.7940	-0.9652	0.3344
Quintic	-0.0327	0.0723	-0.4520	-0.2432	0.8079
Sextic	-0.0450	0.0720	-0.6250	-0.3363	0.7366
Septic	-0.0400	0.0713	-0.5610	-0.3018	0.7628

Air + CL: Test Passage Rates

Linear	-0.2617	0.0339	-7.7210	-4.1540	< 0.0001
Quadratic	0.3228	0.2352	1.3720	0.7381	0.4605
Cubic	0.1364	0.2281	0.5980	0.3217	0.7477
Quartic	-0.8543	0.1907	-4.4800	-2.4103	0.0159
Quintic	-0.0543	0.1994	-0.2720	-0.1463	0.8837
Sextic	-0.7872	0.2262	-3.4800	-1.8723	0.0612
Septic	0.2357	0.2246	1.0490	0.5644	0.5725

Air + SL: Pre-Test Passage Rates

Linear	-0.0362	0.0124	-2.9250	-1.8068	0.0708
Quadratic	-0.1517	0.0771	-1.9680	-1.2157	0.2241
Cubic	0.1893	0.0777	2.4360	1.5047	0.1324
Quartic	0.1909	0.0821	2.3350	1.4424	0.1492
Quintic	0.1553	0.0804	1.9310	1.1928	0.2329
Sextic	0.2367	0.0760	3.1140	1.9236	0.0544
Septic	0.0235	0.0753	0.3120	0.1927	0.8472

Air + SL: Test Passage Rates

Linear	-0.2207	0.0581	-3.7970	-2.3455	0.0190
Quadratic	-0.0158	0.3611	-0.0440	-0.0272	0.9783
Cubic	0.5444	0.4251	1.2810	0.7913	0.4288
Quartic	0.3726	0.3386	1.1000	0.6795	0.4968
Quintic	-0.3998	0.3929	-1.0180	-0.6288	0.5295
Sextic	-0.7775	0.4603	-1.6890	-1.0433	0.2968
Septic	-0.8274	0.3636	-2.2750	-1.4053	0.1599

Sound + CL: Pre-Test Passage Rates

Linear	-0.0263	0.0120	-2.1810	-1.1734	0.2406
Quadratic	-0.5413	0.0771	-7.0170	-3.7752	0.0002

Cubic	0.4472	0.0733	6.1030	3.2835	0.0010
Quartic	-0.2040	0.0722	-2.8270	-1.5209	0.1283
Quintic	0.1584	0.0690	2.2950	1.2347	0.2169
Sextic	0.1354	0.0658	2.0570	1.1067	0.2684
Septic	0.0726	0.0665	1.0920	0.5875	0.5569

Sound + CL: Test Passage Rates

Linear	-0.1852	0.0277	-6.6950	-3.6020	0.0003
Quadratic	-0.4867	0.1749	-2.7830	-1.4973	0.1343
Cubic	0.0476	0.1675	0.2840	0.1528	0.8786
Quartic	-0.0818	0.1622	-0.5040	-0.2712	0.7862
Quintic	-0.0843	0.1552	-0.5430	-0.2921	0.7702
Sextic	0.0555	0.1482	0.3740	0.2012	0.8405
Septic	0.0897	0.1445	0.6200	0.3336	0.7387

Sound + SL: Pre-Test Passage Rates

Linear	-0.0811	0.0129	-6.2880	-3.8842	0.0001
Quadratic	-0.2764	0.0784	-3.5240	-2.1768	0.0295
Cubic	0.5187	0.0823	6.3060	3.8953	0.0001
Quartic	0.3009	0.0827	3.6400	2.2485	0.0245
Quintic	0.0914	0.0828	1.1030	0.6813	0.4957

Sextic	-0.0937	0.0809	-1.1580	-0.7153	0.4744
Septic	0.0040	0.0737	0.0540	0.0334	0.9734

Sound + SL: Test Passage Rates

Linear	-0.3238	0.0677	-4.7810	-2.9533	0.0031
Quadratic	-0.2346	0.4562	-0.5140	-0.3175	0.7509
Cubic	-0.0723	0.4031	-0.1790	-0.1106	0.9119
Quartic	-0.8364	0.3476	-2.4060	-1.4862	0.1372
Quintic	-0.5173	0.3206	-1.6140	-0.9970	0.3188
Sextic	-0.0252	0.3248	-0.0780	-0.0482	0.9616
Septic	-0.0194	0.3482	-0.0560	-0.0346	0.9724

Sound + Air + CL: Pre-Test Passage Rates

Linear	0.0004	0.0129	0.0300	0.0161	0.9872
Quadratic	-0.4884	0.0801	-6.0950	-3.2792	0.0010
Cubic	0.5099	0.0789	6.4660	3.4788	0.0005
Quartic	0.0772	0.0788	0.9800	0.5272	0.5981
Quintic	0.1700	0.0764	2.2240	1.1965	0.2315
Sextic	0.0948	0.0726	1.3050	0.7021	0.4826
Septic	-0.0340	0.0699	-0.4860	-0.2615	0.7937

Sound + Air + CL: Test Passage Rates

Linear	-0.3072	0.0281	-10.9300	-5.8804	< 0.0001
Quadratic	-0.1790	0.1624	-1.1020	-0.5929	0.5532
Cubic	0.9052	0.1795	5.0430	2.7132	0.0067
Quartic	0.3493	0.1851	1.8870	1.0152	0.3100
Quintic	-0.0169	0.1867	-0.0900	-0.0484	0.9614
Sextic	-0.0673	0.1794	-0.3750	-0.2018	0.8401
Septic	0.0125	0.1533	0.0810	0.0436	0.9652

Sound + Air + SL: Pre-Test Passage Rates

Linear	0.0059	0.0144	0.4100	0.2533	0.8000
Quadratic	-0.5181	0.0934	-5.5450	-3.4252	0.0006
Cubic	0.0937	0.0885	1.0590	0.6542	0.5130
Quartic	-0.2479	0.0854	-2.9030	-1.7932	0.0729
Quintic	0.0116	0.0820	0.1410	0.0871	0.9306
Sextic	0.0598	0.0797	0.7500	0.4633	0.6431
Septic	-0.0512	0.0807	-0.6350	-0.3922	0.6949

Sound + Air + SL: Test Passage Rates

Linear	-0.2598	0.0626	-4.1510	-2.5641	0.0103
Quadratic	-0.5417	0.3884	-1.3950	-0.8617	0.3889
Cubic	0.0740	0.3803	0.1950	0.1205	0.9041

Quartic	0.0131	0.3508	0.0370	0.0229	0.9817
Quintic	0.0891	0.3402	0.2620	0.1618	0.8715
Sextic	-0.2613	0.3332	-0.7840	-0.4843	0.6282
Septic	-0.1924	0.2972	-0.6470	-0.4000	0.6892

For a specific treatment, during which trial (1-8) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Sound

Pre-Test vs Test Trial 1	-1.4698	0.1689	-8.7000	-4.6807	< 0.0001
Pre-Test vs Test Trial 2	-1.4108	0.1576	-8.9540	-4.8173	< 0.0001
Pre-Test vs Test Trial 3	-1.0527	0.1349	-7.8040	-4.1986	< 0.0001
Pre-Test vs Test Trial 4	-0.9485	0.1587	-5.9790	-3.2167	0.0013
Pre-Test vs Test Trial 5	-1.1670	0.1765	-6.6130	-3.5578	0.0004
Pre-Test vs Test Trial 6	-0.8093	0.1489	-5.4340	-2.9235	0.0035
Pre-Test vs Test Trial 7	-1.2836	0.1763	-7.2810	-3.9172	0.0001
Pre-Test vs Test Trial 8	-0.9849	0.1851	-5.3210	-2.8627	0.0042

Air

Pre-Test vs Test Trial 1	-0.6372	0.1178	-5.4090	-2.9101	0.0036
Pre-Test vs Test Trial 2	-0.5486	0.1101	-4.9830	-2.6809	0.0073
Pre-Test vs Test Trial 3	-0.6706	0.1161	-5.7760	-3.1075	0.0019
Pre-Test vs Test Trial 4	-0.9713	0.1329	-7.3110	-3.9334	< 0.0001

Pre-Test vs Test Trial 5	-0.8712	0.1356	-6.4230	-3.4556	0.0005
Pre-Test vs Test Trial 6	-1.0236	0.1571	-6.5150	-3.5051	0.0005
Pre-Test vs Test Trial 7	-0.9396	0.1429	-6.5750	-3.5374	0.0004
Pre-Test vs Test Trial 8	-0.7429	0.1461	-5.0830	-2.7347	0.0062

CL

Pre-Test vs Test Trial 1	-0.8055	0.1020	-7.8990	-4.2497	< 0.0001
Pre-Test vs Test Trial 2	-1.6457	0.1354	-12.1550	-6.5395	< 0.0001
Pre-Test vs Test Trial 3	-1.9326	0.1631	-11.8500	-6.3754	< 0.0001
Pre-Test vs Test Trial 4	-1.4646	0.1316	-11.1280	-5.9870	< 0.0001
Pre-Test vs Test Trial 5	-2.1369	0.1761	-12.1330	-6.5277	< 0.0001
Pre-Test vs Test Trial 6	-1.4905	0.1465	-10.1720	-5.4726	< 0.0001
Pre-Test vs Test Trial 7	-1.7360	0.1714	-10.1300	-5.4500	< 0.0001
Pre-Test vs Test Trial 8	-1.9552	0.1918	-10.1950	-5.4850	< 0.0001

SL

Pre-Test vs Test Trial 1	-0.9722	0.1402	-6.9340	-4.2832	< 0.0001
Pre-Test vs Test Trial 2	-1.3378	0.1474	-9.0750	-5.6057	< 0.0001
Pre-Test vs Test Trial 3	-1.4850	0.1453	-10.2200	-6.3130	< 0.0001
Pre-Test vs Test Trial 4	-1.9086	0.1923	-9.9240	-6.1302	< 0.0001
Pre-Test vs Test Trial 5	-1.4300	0.1781	-8.0290	-4.9596	< 0.0001

Pre-Test vs Test Trial 6	-1.6311	0.1796	-9.0800	-5.6088	< 0.0001
Pre-Test vs Test Trial 7	-2.6805	0.2982	-8.9880	-5.5520	< 0.0001
Pre-Test vs Test Trial 8	-2.0883	0.2831	-7.3760	-4.5562	< 0.0001

Sound + Air

Pre-Test vs Test Trial 1	-2.3126	0.2341	-9.8770	-5.3139	< 0.0001
Pre-Test vs Test Trial 2	-2.4142	0.2529	-9.5460	-5.1358	< 0.0001
Pre-Test vs Test Trial 3	-2.3938	0.2334	-10.2580	-5.5189	< 0.0001
Pre-Test vs Test Trial 4	-2.1552	0.2420	-8.9050	-4.7910	< 0.0001
Pre-Test vs Test Trial 5	-1.7560	0.2045	-8.5890	-4.6210	< 0.0001
Pre-Test vs Test Trial 6	-2.6137	0.3121	-8.3750	-4.5058	< 0.0001
Pre-Test vs Test Trial 7	-2.2653	0.2624	-8.6330	-4.6446	< 0.0001
Pre-Test vs Test Trial 8	-2.4517	0.2688	-9.1210	-4.9072	< 0.0001

Air + CL

Pre-Test vs Test Trial 1	-1.0121	0.1559	-6.4920	-3.4927	0.0005
Pre-Test vs Test Trial 2	-0.6795	0.1175	-5.7840	-3.1118	0.0019
Pre-Test vs Test Trial 3	-2.1539	0.2070	-10.4050	-5.5980	< 0.0001
Pre-Test vs Test Trial 4	-1.9225	0.1953	-9.8420	-5.2951	< 0.0001
Pre-Test vs Test Trial 5	-2.4852	0.2600	-9.5600	-5.1434	< 0.0001
Pre-Test vs Test Trial 6	-2.6394	0.2985	-8.8410	-4.7565	< 0.0001

Pre-Test vs Test Trial 7	-1.8634	0.2067	-9.0170	-4.8512	< 0.0001
Pre-Test vs Test Trial 8	-2.6609	0.3268	-8.1410	-4.3799	< 0.0001

Air + SL

Pre-Test vs Test Trial 1	-2.2792	0.2544	-8.9600	-5.5347	< 0.0001
Pre-Test vs Test Trial 2	-2.5087	0.2776	-9.0360	-5.5816	< 0.0001
Pre-Test vs Test Trial 3	-2.6100	0.2672	-9.7670	-6.0332	< 0.0001
Pre-Test vs Test Trial 4	-2.7786	0.3104	-8.9510	-5.5291	< 0.0001
Pre-Test vs Test Trial 5	-2.4339	0.2690	-9.0490	-5.5897	< 0.0001
Pre-Test vs Test Trial 6	-4.4836	0.7104	-6.3110	-3.8984	0.0001
Pre-Test vs Test Trial 7	-2.8997	0.4188	-6.9240	-4.2770	< 0.0001
Pre-Test vs Test Trial 8	-3.4594	0.4536	-7.6260	-4.7107	< 0.0001

Sound + CL

Pre-Test vs Test Trial 1	-0.7259	0.1558	-4.6580	-2.5060	0.01221
Pre-Test vs Test Trial 2	-1.4275	0.1370	-10.4230	-5.6077	< 0.0001
Pre-Test vs Test Trial 3	-1.4724	0.1354	-10.8780	-5.8525	< 0.0001
Pre-Test vs Test Trial 4	-1.4077	0.1451	-9.6980	-5.2176	< 0.0001
Pre-Test vs Test Trial 5	-1.5952	0.1712	-9.3200	-5.0142	< 0.0001
Pre-Test vs Test Trial 6	-1.7692	0.1777	-9.9560	-5.3564	< 0.0001
Pre-Test vs Test Trial 7	-1.7417	0.2085	-8.3530	-4.4940	< 0.0001

Pre-Test vs Test Trial 8	-2.2547	0.2547	-8.8510	-4.7619	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Sound + SL

Pre-Test vs Test Trial 1	-1.8787	0.2189	-8.5810	-5.3006	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 2	-2.0801	0.2078	-10.0100	-6.1833	< 0.0001
---------------------------------	----------------	---------------	-----------------	----------------	--------------------

Pre-Test vs Test Trial 3	-2.2752	0.2237	-10.1710	-6.2828	< 0.0001
---------------------------------	----------------	---------------	-----------------	----------------	--------------------

Pre-Test vs Test Trial 4	-3.0361	0.3084	-9.8460	-6.0820	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 5	-3.4235	0.4144	-8.2610	-5.1029	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 6	-2.9535	0.4184	-7.0590	-4.3604	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 7	-2.3250	0.3489	-6.6630	-4.1158	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 8	-4.2708	0.7115	-6.0030	-3.7081	0.0002
---------------------------------	----------------	---------------	----------------	----------------	---------------

Sound + Air + CL

Pre-Test vs Test Trial 1	-0.2077	0.1442	-1.4400	-0.7747	0.4385
--------------------------	---------	--------	---------	---------	--------

Pre-Test vs Test Trial 2	-0.6392	0.1211	-5.2780	-2.8396	0.0045
---------------------------------	----------------	---------------	----------------	----------------	---------------

Pre-Test vs Test Trial 3	-0.8856	0.1193	-7.4210	-3.9926	0.0001
---------------------------------	----------------	---------------	----------------	----------------	---------------

Pre-Test vs Test Trial 4	-1.0309	0.1335	-7.7220	-4.1545	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 5	-1.6597	0.1745	-9.5090	-5.1159	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 6	-2.2514	0.2476	-9.0940	-4.8926	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 7	-2.2475	0.2914	-7.7120	-4.1491	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Pre-Test vs Test Trial 8	-2.0741	0.2260	-9.1770	-4.9373	< 0.0001
---------------------------------	----------------	---------------	----------------	----------------	--------------------

Sound + Air + SL					
Pre-Test vs Test Trial 1	-1.6781	0.2638	-6.3600	-3.9287	0.0001
Pre-Test vs Test Trial 2	-2.0087	0.2378	-8.4460	-5.2172	< 0.0001
Pre-Test vs Test Trial 3	-2.4394	0.2688	-9.0740	-5.6051	< 0.0001
Pre-Test vs Test Trial 4	-2.4263	0.2890	-8.3940	-5.1851	< 0.0001
Pre-Test vs Test Trial 5	-2.4658	0.2885	-8.5460	-5.2790	< 0.0001
Pre-Test vs Test Trial 6	-3.2645	0.4154	-7.8590	-4.8546	< 0.0001
Pre-Test vs Test Trial 7	-3.3673	0.4542	-7.4130	-4.5791	< 0.0001
Pre-Test vs Test Trial 8	-3.5373	0.5850	-6.0470	-3.7353	0.0002

Supplemental Table S3-3 Z-test results for comparisons between temporal trends (e.g., linear, quadratic, etc.) observed in the pre-test or test periods for light/sound/air curtain experiments relative to the no-treatment control. Significant z-values indicate either habituation (increased passage rates over time) or sensitization (decrease in passage rates over time) due to repeated exposure to the stimulus.

Contrasts of Interest ($\alpha = 0.05/22 = 0.0023$)	Z value	Pr ($> z$)
Sound: Pre-Test vs No Treatment Control [linear]	6.2241	< 0.0001
Sound: Test vs No Treatment Control [linear]	1.6454	0.0999
Air: Pre-Test vs No Treatment Control [linear]	5.1957	< 0.0001
Air: Test vs No Treatment Control [linear]	6.2567	< 0.0001
CL: Pre-Test vs No Treatment Control [linear]	5.7501	< 0.0001
CL: Test vs No Treatment Control [linear]	7.1244	< 0.0001
SL: Pre-Test vs No Treatment Control [linear]	5.6224	< 0.0001
SL: Test vs No Treatment Control [linear]	7.7545	< 0.0001
Sound + Air: Pre-Test vs No Treatment Control [linear]	3.7342	0.0002
Sound + Air: Test vs No Treatment Control [linear]	1.5254	0.1272
Air + CL: Pre-Test vs No Treatment Control [linear]	3.0329	0.0024
Air + CL: Test vs No Treatment Control [linear]	7.9114	< 0.0001
SL + Air: Pre-Test vs No Treatment Control [linear]	3.3924	0.0007
SL + Air: Test vs No Treatment Control [linear]	4.0107	< 0.0001
Sound + CL: Pre-Test vs No Treatment Control [quadratic]	7.3543	< 0.0001

Sound + CL: Test vs No Treatment Control [linear]	6.9025	< 0.0001
Sound + SL: Pre-Test vs No Treatment Control [cubic]	-5.7629	< 0.0001
Sound + SL: Test vs No Treatment Control [linear]	4.9625	< 0.0001
Sound + Air + CL: Pre-Test vs No Treatment Control [cubic]	-5.8376	< 0.0001
Sound + Air + CL: Test vs No Treatment Control [linear]	10.9683	< 0.0001
Sound + Air + SL: Pre-Test vs No Treatment Control [quadratic]	6.2077	< 0.0001
Sound + Air + SL: Test vs No Treatment Control [linear]	4.3467	< 0.0001

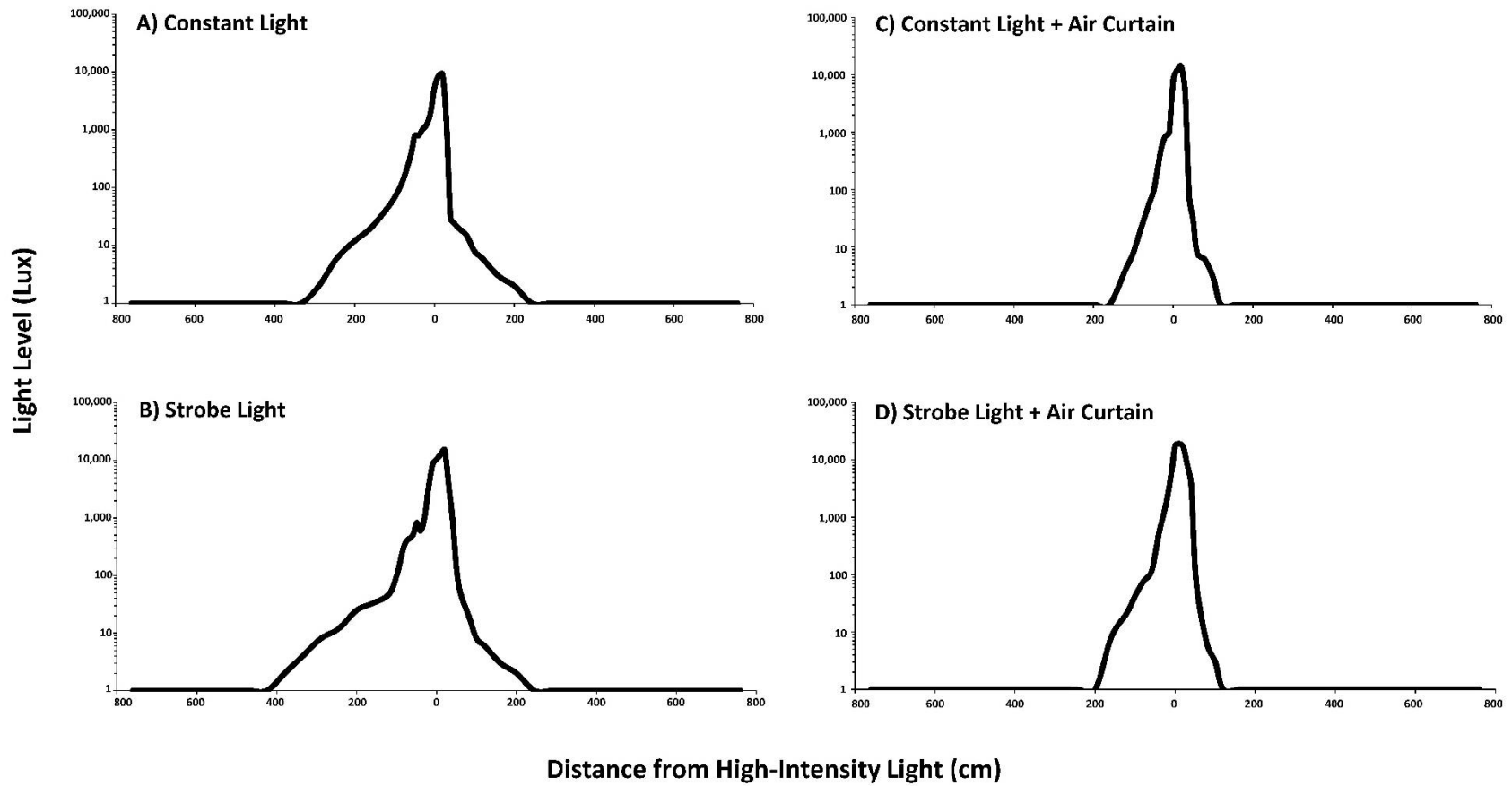
Supplemental Table S3-4 Z-test results for comparisons between mean passage rates during the test periods for all combinations of stimuli. Significant z-values indicate that the stimuli differ in their effectiveness to reduce passage rates.

Contrasts of Interest	Z value	Pr (> z)
Sound vs Air	-2.5687	0.0105
Sound vs CL	3.6025	0.0003
Sound vs SL	5.2298	< 0.0001
Sound vs [Sound + Air]	7.1244	< 0.0001
Sound vs [Air + CL]	3.6138	0.0003
Sound vs [SL + Air]	7.5875	< 0.0001
Sound vs [Sound + CL]	0.1422	0.8887
Sound vs [Sound + SL]	8.8687	< 0.0001
Sound vs [Sound + Air + CL]	-1.1093	0.267
Sound vs [Sound + Air + SL]	6.2016	< 0.0001
Air vs CL	6.5749	< 0.0001
Air vs SL	8.0062	< 0.0001
Air vs [Sound + Air]	9.6050	< 0.0001
Air vs [CL + Air]	6.0851	< 0.0001
Air vs [Air + SL]	9.4155	< 0.0001
Air vs [Sound + CL]	2.6742	0.0076
Air vs [Sound + SL]	10.7893	< 0.0001

Air vs [Sound + Air + CL]	1.2558	0.2077
Air vs [Sound + Air + SL]	8.0961	< 0.0001
CL + SL	1.9861	0.0466
CL vs [Sound + Air]	4.3028	< 0.0001
CL vs [CL + Air]	0.5214	0.6031
CL vs [Air + SL]	5.4006	< 0.0001
CL vs [Sound + CL]	-3.3941	0.0007
CL vs [Sound + SL]	6.65051	< 0.0001
CL vs [Sound + Air + CL]	-4.5828	< 0.0001
CL vs [Sound + Air + SL]	3.8828	0.0001
SL vs [Sound + Air]	2.4054	0.016
SL vs [CL + Air]	-1.2498	0.2113
SL vs [Air + SL]	3.9151	< 0.0001
SL vs [Sound + CL]	-5.0195	< 0.0001
SL vs [Sound + SL]	5.0795	< 0.0001
SL vs [Sound + Air + CL]	-6.0844	< 0.0001
SL vs [Sound + Air + SL]	2.3747	0.0178
[Sound + Air] vs [CL + Air]	-3.4274	0.0006
[Sound + Air] vs [Air + SL]	1.9100	0.0561

[Sound + Air] vs [Sound + CL]	-6.9239	< 0.0001
[Sound + Air] vs [Sound + SL]	2.9607	0.0031
[Sound + Air] vs [Sound + Air + CL]	-7.8488	< 0.0001
[Sound + Air] vs [Sound + Air + SL]	0.3680	0.7114
[CL + Air] vs [Air + SL]	4.7070	< 0.0001
[CL + Air] vs [Sound + CL]	-3.4404	0.0006
[CL + Air] vs [Sound + SL]	5.8515	< 0.0001
[CL + Air] vs [Sound + Air + CL]	-4.4875	< 0.0001
[CL + Air] vs [Sound + Air + SL]	3.2451	0.0012
[Air + SL] vs [Sound + CL]	-7.4425	< 0.0001
[Air + SL] vs [Sound + SL]	0.8702	0.3843
[Air + SL] vs [Sound + Air + CL]	-8.1843	< 0.0001
[Air + SL] vs [Sound + Air + SL]	-1.3878	0.1645
[Sound + CL] vs [Sound + SL]	8.7099	< 0.0001
[Sound + CL] vs [Sound + Air + CL]	-1.2294	0.2187
[Sound + CL] vs [Sound + Air + SL]	6.0569	< 0.0001
[Sound + SL] vs [Sound + Air + CL]	-9.4506	< 0.0001
[Sound + SL] vs [Sound + Air + SL]	-2.3082	0.0209
[Sound + Air + CL] vs [Sound + Air + SL]	6.8490	< 0.0001

Supplemental Fig S3-1 Light levels (lux) measured within 8 m of the high-intensity light bars for the constant light (A), strobing light (B), coupled constant light and air curtain (C), and coupled strobing light and air curtain stimuli (D) within the dimly-lit flume. Reported light measurements were taken at a 0.15 m depth along the midpoint of the flume. Background lux measurements in the dimly-lit flume were < 1 lux.



Supplemental Table SA-1. Summary of studies examining the effect of high-intensity lights on fish behavior.

Type of Light	Frequency (Hz)	Wavelength (nm)	Intensity	Duration	Field/Lab	Background Lighting	Species	Behavioral Response	Reference
	0	Unknown	3.5ft-candles	4 hrs	Field	Night	<i>Oncorhynchus tshawytscha</i>	Avoidance	Brett and MacKinnon 1953
	0	Unknown	3.5ft-candles	4 hrs	Field	Night	<i>Oncorhynchus clarkii</i>	No Avoidance	Brett and MacKinnon 1953
	0	Blue-filter	1550 lux	30 min	Lab	Night	<i>Alosa pseudoharengus</i>	Attraction	Haymes et al. 1984
	0	Blue-filter	Unknown	30 min	Field	Day	<i>Dorosoma cepedianum</i>	Attraction	Haymes et al. 1984
	0	Blue-filter	Unknown	30 min	Field	Night	<i>Dorosoma cepedianum</i>	Attraction	Haymes et al. 1984
Constant	0	Unknown	210 uE/m2s	30 min	Lab	Day (200uE/m2s)	<i>Oncorhynchus kisutch</i>	No Response	Nemeth and Anderson 1992
	0	Unknown	10 uE/m2s	30 min	Lab	Night (0.1uE/m2s)	<i>Oncorhynchus kisutch</i>	Active Swimming	Nemeth and Anderson 1992
	0	Unknown	210 uE/m2s	30 min	Lab	Day (200uE/m2s)	<i>Oncorhynchus tshawytscha</i>	No Response	Nemeth and Anderson 1992
	0	Unknown	10 uE/m2s	30 min	Lab	Night (0.1uE/m2s)	<i>Oncorhynchus tshawytscha</i>	Active Swimming	Nemeth and Anderson 1992
	0	Red	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	0	Orange	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	0	Yellow	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	0	Green	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	0	Blue (460nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Weak Attraction	Ford et al. 2018

	0	Green (540nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	0	Red (605nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Weak Attraction	Ford et al. 2018
	0	Blue (460nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	0	Green (540nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	0	Red (605nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
Constant	0	Blue	5.55 (μmoles/m2/s)	20 min	Lab	Day	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	0	Green	6.19 (μmoles/m2/s)	20 min	Lab	Day	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	0	Red	9.37 (μmoles/m2/s)	20 min	Lab	Day	<i>Oncorhynchus tshawytscha</i>	Deterred	Hansen et al. 2018
	0	White	7.15 (μmoles/m2/s)	20 min	Lab	Day	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	0	Blue	2.82 (μmoles/m2/s)	20 min	Lab	Night	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	0	Green	3.45 (μmoles/m2/s)	20 min	Lab	Night	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	0	Red	6.60 (μmoles/m2/s)	20 min	Lab	Night	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	0	White	4.39 (μmoles/m2/s)	20 min	Lab	Night	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
Strobe	1	Unknown	3.5ft-candles	4 hrs	Field	Night	<i>Oncorhynchus tshawytscha</i>	Avoidance (stronger than 0Hz response)	Brett and MacKinnon 1953
	1	Unknown	3.5ft-candles	4 hrs	Field	Night	<i>Oncorhynchus clarkii</i>	No Avoidance	Brett and MacKinnon 1953
	1	Unknown	Unknown	2 hrs	Lab	Day	<i>Esox masquinongy</i>	Escaped (Not Effective)	Stewart et al. 2014
	1	Unknown	Unknown	2 hrs	Lab	Night	<i>Esox masquinongy</i>	Escaped (Not Effective)	Stewart et al. 2014

	1	Blue (460nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Weak Attraction	Ford et al. 2018
	1	Green (540nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	1	Red (605nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Weak Deterrence	Ford et al. 2018
	1	Blue (460nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Weak Attraction	Ford et al. 2018
	1	Green (540nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	1	Red (605nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	2	Red	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	2	Orange	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	2	Yellow	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	2	Green	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
Strobe (cont.)	2	Blue	5.55 (μ moles/m ² /s)	20 min	Lab	Day	<i>Oncorhynchus tshawytscha</i>	No Response	Hansen et al. 2018
	2	Red	9.37 (μ moles/m ² /s)	20 min	Lab	Day	<i>Oncorhynchus tshawytscha</i>	Deterred (same as 0Hz)	Hansen et al. 2018
	5	Unknown	202 uE/m ² s	30 min	Lab	Day (200uE/m ² s)	<i>Oncorhynchus kisutch</i>	No Response	Nemeth and Anderson 1992
	5	Unknown	2 uE/m ² s	30 min	Lab	Night (0.1uE/m ² s)	<i>Oncorhynchus kisutch</i>	Avoidance	Nemeth and Anderson 1992
	5	Unknown	202 uE/m ² s	30 min	Lab	Day (200uE/m ² s)	<i>Oncorhynchus tshawytscha</i>	No Response	Nemeth and Anderson 1992
	5	Unknown	2 uE/m ² s	30 min	Lab	Night (0.1uE/m ² s)	<i>Oncorhynchus tshawytscha</i>	No Response	Nemeth and Anderson 1992
	5	Unknown	Unknown	<1 hr	Field	Day	Juv. salmonids	Avoidance (75% less entrainment)	Johnson et al. 2005
	5	Red	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016

	5	Orange	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	5	Yellow	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	5	Green	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	6	Unknown	6,585 lumens	4 hrs	Field	Night	<i>Osmerus mordax</i>	Deterred >21 meters	Hamel et al. 2008
	7.5	Unknown	2,634 lumens	4 hrs	Field	Night	<i>Osmerus mordax</i>	Deterred 15 meters	Hamel et al. 2008
	8	Unknown	650 lumens	16 hrs	Lab	Night	<i>Sander vitreus</i>	Escape (Not Blocked)	Flammang et al. 2014
	10	Red	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	10	Orange	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	10	Yellow	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	10	Green	Unknown	5 min	Field	Darkened	<i>Micropterus salmoides</i>	Deterred 4-6 meters	Sullivan et al. 2016
	16	Unknown	650 lumens	16 hrs	Lab	Night	<i>Sander vitreus</i>	Escape (Not Blocked)	Flammang et al. 2014
Strobe (cont.)	20	Blue (460nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Weak Attraction	Ford et al. 2018
	20	Green (540nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	20	Red (605nm)	Unknown	1 min	Lab	Day	<i>Acipenser transmontanus</i>	Weak Attraction	Ford et al. 2018
	20	Blue (460nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	20	Green (540nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	20	Red (605nm)	Unknown	1 min	Lab	Dark (<5 lux)	<i>Acipenser transmontanus</i>	Strong Attraction	Ford et al. 2018
	1-20	Unknown	11,274 lux	30 min	Lab	Day (0-66 lux)	<i>Cyprinus carpio</i> (adult)	Deterred 1-2 meters	Kim and Mandrak 2017

1-20	Unknown	11,274 lux	30 min	Lab	Day (0-66 lux)	<i>Ameiurus nebulosus</i> (adult)	Deterred 1-2 meters	Kim and Mandrak 2017
1-20	Unknown	11,274 lux	30 min	Lab	Day (0-66 lux)	<i>Micropterus salmoides</i> (adult)	Not Deterred	Kim and Mandrak 2017
1-20	Unknown	11,274 lux	30 min	Lab	Day (0-66 lux)	<i>Cyprinus carpio</i> (juvenile)	Not Deterred	Kim et al. 2019
1-20	Unknown	11,274 lux	30 min	Lab	Day (0-66 lux)	<i>Ictalurus punctatus</i> (juvenile)	Not Deterred	Kim et al. 2019

Supplemental Table SA-2. Generalized linear mixed model (GLMM) results for bighead carp exposed to Constant Light [0Hz], 5Hz Strobing Light and 12Hz Strobing Light in a dimly-lit flume [1 Lux].

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to light (Constant [0Hz], 5Hz Strobe or 12Hz Strobe) reduce mean passage of fish? ($\alpha = 0.05/6 = 0.0083$)					
Pre-Test 0Hz vs No Treatment Control	0.0506	0.1286	0.3930	0.2048	0.8415
Test 0Hz vs No Treatment Control	-1.5658	0.1442	-10.7930	-5.6246	< 0.0001
Pre-Test 5Hz vs No Treatment Control	-0.0256	0.1306	-0.1980	-0.1032	0.9203
Test 5Hz vs No Treatment Control	-1.5899	0.1441	-11.0330	-5.7496	< 0.0001
Pre-Test 12Hz vs No Treatment Control	-0.0014	0.1306	-0.0110	-0.0057	0.9920
Test 12Hz vs No Treatment Control	-1.3284	0.1407	-9.4420	-4.9205	< 0.0001
Do passage rates change with repeated exposure to light (or with time in the flume)? ($\alpha = 0.05/7 = 0.0071$)					
No Treatment Control					
Linear	-0.0265	0.0103	-2.5720	-1.3403	0.1803
Quadratic	-0.0421	0.0647	-0.6510	-0.3393	0.7339
Cubic	0.1044	0.0678	1.5400	0.8025	0.4237
Quartic	0.2443	0.0663	3.6870	1.9214	0.0549
Quintic	-0.0652	0.0676	-0.9870	-0.5018	0.6171

Sextic	-0.2002	0.0687	-2.9140	-1.5186	0.1285
Septic	0.0164	0.0639	0.2570	0.1339	0.8966

Constant Light [0Hz]: Pre-Test Passage Rates

Linear	-0.0637	0.0131	-4.8780	-2.5421	0.0111
Quadratic	-0.1280	0.0865	-1.4800	-0.7713	0.4413
Cubic	0.2601	0.0834	3.1190	1.6254	0.1052
Quartic	-0.3221	0.0809	-3.9820	-2.0751	0.0375
Quintic	0.1550	0.0800	1.9390	1.0105	0.3125
Sextic	-0.0575	0.0807	-0.7120	-0.3710	0.7114
Septic	0.0440	0.0829	0.5310	0.2767	0.7795

Constant Light [0Hz]: Test Passage Rates

Linear	-0.2262	0.0287	-7.8700	-4.1013	< 0.0001
Quadratic	0.6886	0.1784	3.8610	2.0121	0.0444
Cubic	0.7523	0.1954	3.8510	2.0069	0.0444
Quartic	0.2083	0.2121	0.9820	0.5117	0.6101
Quintic	0.2331	0.2168	1.0750	0.5602	0.5755
Sextic	0.0596	0.2133	0.2790	0.1454	0.8808
Septic	0.1131	0.2079	0.5440	0.2835	0.7795

5Hz Strobe Light: Pre-Test Passage Rates

Linear	-0.0459	0.0123	-3.5660	-1.8583	0.0629
Quadratic	-0.0361	0.0835	-0.4320	-0.2251	0.8181
Cubic	0.3074	0.0827	3.7180	1.9376	0.0524
Quartic	-0.0809	0.0833	-0.9710	-0.5060	0.6101
Quintic	0.1992	0.0827	2.4080	1.2549	0.2113
Sextic	0.0348	0.0819	0.4250	0.2215	0.8259
Septic	0.1134	0.0829	1.3690	0.7134	0.4777

5Hz Strobe Light: Test Passage Rates

Linear	-0.2670	0.0324	-8.2470	-4.2978	< 0.0001
Quadratic	0.0117	0.1929	0.0600	0.0313	0.9761
Cubic	0.1779	0.1980	0.8980	0.4680	0.6384
Quartic	0.1619	0.2172	0.7450	0.3882	0.6965
Quintic	0.4645	0.2103	2.2090	1.1512	0.2501
Sextic	0.2003	0.1896	1.0560	0.5503	0.5823
Septic	0.2434	0.1818	1.3390	0.6978	0.4839

12Hz Strobe Light: Pre-Test Passage Rates

Linear	-0.0260	0.0129	-2.0140	-1.0496	0.2937
Quadratic	-0.0166	0.0830	-0.2010	-0.1047	0.9203
Cubic	0.1590	0.0841	1.8890	0.9844	0.3271

Quartic	0.0223	0.0825	0.2700	0.1407	0.8889
Quintic	0.1490	0.0833	1.7890	0.9323	0.3524
Sextic	-0.1275	0.0845	-1.5100	-0.7869	0.4295
Septic	0.0038	0.0823	0.0460	0.0240	0.9840

12Hz Strobe Light: Test Passage Rates

Linear	-0.1769	0.0278	-6.3570	-3.3128	0.0019
Quadratic	-0.2882	0.1680	-1.7150	-0.8937	0.3735
Cubic	0.1599	0.1716	0.9320	0.4857	0.6241
Quartic	0.2816	0.1784	1.5780	0.8223	0.4122
Quintic	0.1074	0.1742	0.6170	0.3215	0.7490
Sextic	0.1201	0.1626	0.7390	0.3851	0.6965
Septic	0.0428	0.1518	0.2820	0.1470	0.8808

For a specific treatment, during which trial (1-8) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Constant Light [0Hz]

Pre-Test vs Test Trial 1	-0.6646	0.1459	-4.5550	-2.3737	0.0178
Pre-Test vs Test Trial 2	-1.2528	0.1354	-9.2540	-4.8225	< 0.0001
Pre-Test vs Test Trial 3	-1.3921	0.1683	-8.2720	-4.3108	< 0.0001
Pre-Test vs Test Trial 4	-1.5768	0.1971	-8.0000	-4.1690	< 0.0001
Pre-Test vs Test Trial 5	-1.9532	0.2449	-7.9760	-4.1565	< 0.0001

Pre-Test vs Test Trial 6	-2.1974	0.2719	-8.0820	-4.2118	< 0.0001
Pre-Test vs Test Trial 7	-2.4619	0.3138	-7.8460	-4.0888	< 0.0001
Pre-Test vs Test Trial 8	-1.3523	0.2046	-6.6090	-3.4441	0.0006

5Hz Strobe Light

Pre-Test vs Test Trial 1	-0.6724	0.1447	-4.6470	-2.4217	0.0155
Pre-Test vs Test Trial 2	-1.0797	0.1372	-7.8690	-4.1008	< 0.0001
Pre-Test vs Test Trial 3	-1.3803	0.1724	-8.0050	-4.1716	< 0.0001
Pre-Test vs Test Trial 4	-1.4664	0.1847	-7.9390	-4.1372	< 0.0001
Pre-Test vs Test Trial 5	-1.6247	0.2143	-7.5810	-3.9507	< 0.0001
Pre-Test vs Test Trial 6	-1.6459	0.2100	-7.8390	-4.0851	< 0.0001
Pre-Test vs Test Trial 7	-2.3976	0.3299	-7.2680	-3.7876	0.0002
Pre-Test vs Test Trial 8	-2.2480	0.2712	-8.2890	-4.3196	< 0.0001

12Hz Strobe Light

Pre-Test vs Test Trial 1	-0.8517	0.1527	-5.5760	-2.9058	0.0028
Pre-Test vs Test Trial 2	-1.1985	0.1551	-7.7290	-4.0278	< 0.0001
Pre-Test vs Test Trial 3	-0.9305	0.1576	-5.9040	-3.0767	0.0021
Pre-Test vs Test Trial 4	-1.0920	0.1616	-6.7560	-3.5208	0.0004
Pre-Test vs Test Trial 5	-1.3169	0.1757	-7.4970	-3.9069	< 0.0001
Pre-Test vs Test Trial 6	-1.3860	0.1974	-7.0220	-3.6594	0.0003

Pre-Test vs Test Trial 7	-1.9219	0.2520	-7.6250	-3.9736	< 0.0001
Pre-Test vs Test Trial 8	-1.9181	0.2334	-8.2190	-4.2832	< 0.0001

Supplemental Table SA-3. Generalized linear mixed model (GLMM) results for largemouth bass exposed to Constant Light [0Hz], 5Hz Strobing Light and 12Hz Strobing Light in a dimly-lit flume [1 Lux].

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to light (Constant [0Hz], 5Hz Strobe or 12Hz Strobe) reduce mean passage of fish? ($\alpha = 0.05/6 = 0.0083$)					
Pre-Test 0Hz vs No Treatment Control	-0.2494	0.1430	-1.7440		0.0812
Test 0Hz vs No Treatment Control	-1.0034	0.1490	-6.7330		< 0.0001
Pre-Test 5Hz vs No Treatment Control	-0.5925	0.1471	-4.0270		0.0001
Test 5Hz vs No Treatment Control	-1.6880	0.1590	-10.6190		< 0.0001
Pre-Test 12Hz vs No Treatment Control	-0.2916	0.1439	-2.0260		0.0427
Test 12Hz vs No Treatment Control	-2.1251	0.1651	-12.8750		< 0.0001
Do passage rates change with repeated exposure to light (or with time in the flume)? ($\alpha = 0.05/7 = 0.0071$)					
No Treatment Control					
Linear	-0.0540	0.0102	-5.2820		< 0.0001
Quadratic	-0.0355	0.0654	-0.5430		0.5870
Cubic	0.1333	0.0655	2.0340		0.0419
Quartic	0.0661	0.0668	0.9890		0.3229
Quintic	-0.0154	0.0664	-0.2320		0.8163

Sextic	0.0797	0.0652	1.2230	0.2214
Septic	0.0929	0.0651	1.4290	0.1531

Constant Light [0Hz]: Pre-Test Passage Rates

Linear	-0.0346	0.0146	-2.3780	0.0174
Quadratic	0.1246	0.0951	1.3110	0.1900
Cubic	-0.1824	0.0964	-1.8920	0.0585
Quartic	0.0113	0.0943	0.1200	0.9043
Quintic	-0.1661	0.0959	-1.7320	0.0832
Sextic	-0.1290	0.0983	-1.3130	0.1892
Septic	-0.0466	0.0969	-0.4810	0.6308

Constant Light [0Hz]: Test Passage Rates

Linear	0.1822	0.0278	6.5450	< 0.0001
Quadratic	-0.9591	0.1739	-5.5140	< 0.0001
Cubic	0.1184	0.1631	0.7260	0.4676
Quartic	-0.0566	0.1492	-0.3800	0.7041
Quintic	0.0267	0.1390	0.1920	0.8475
Sextic	-0.1019	0.1310	-0.7780	0.4367
Septic	0.0303	0.1201	0.2530	0.8006

5Hz Strobe Light: Pre-Test Passage Rates

Linear	-0.0939	0.0180	-5.2130	< 0.0001
Quadratic	0.1883	0.1145	1.6450	0.1001
Cubic	-0.1343	0.1193	-1.1260	0.2601
Quartic	0.1970	0.1190	1.6560	0.0978
Quintic	0.1802	0.1212	1.4860	0.1373
Sextic	-0.1239	0.1227	-1.0090	0.3128
Septic	0.0265	0.1179	0.2250	0.8218

5Hz Strobe Light: Test Passage Rates

Linear	-0.0042	0.0351	-0.1200	0.9043
Quadratic	-0.5585	0.2274	-2.4560	0.0141
Cubic	0.5357	0.2130	2.5150	0.0119
Quartic	-0.3258	0.2051	-1.5890	0.1121
Quintic	0.1819	0.1954	0.9310	0.3521
Sextic	0.1095	0.1887	0.5800	0.5618
Septic	-0.2004	0.1931	-1.0380	0.2993

12Hz Strobe Light: Pre-Test Passage Rates

Linear	-0.0613	0.0151	-4.0740	< 0.0001
Quadratic	0.1070	0.0980	1.0930	0.2746
Cubic	-0.1607	0.0995	-1.6150	0.1062

Quartic	0.0472	0.0976	0.4830	0.6288
Quintic	0.1742	0.0992	1.7560	0.0791
Sextic	-0.1419	0.1014	-1.3990	0.1618
Septic	-0.3376	0.0999	-3.3810	0.0007

12Hz Strobe Light: Test Passage Rates

Linear	-0.0286	0.0402	-0.7110	0.4769
Quadratic	-0.2948	0.2546	-1.1580	0.2469
Cubic	-0.1767	0.2590	-0.6820	0.4952
Quartic	0.4837	0.2411	0.2010	0.8410
Quintic	-0.4437	0.2442	-1.8170	0.0692
Sextic	-0.3340	0.2512	-1.3300	0.1835
Septic	-0.2076	0.2311	-0.8990	0.3689

For a specific treatment, during which trial (1-8) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Constant Light [0Hz]

Pre-Test vs Test Trial 1	-2.2757	0.2709	-8.4010	< 0.0001
Pre-Test vs Test Trial 2	-1.1560	0.1965	-5.8840	< 0.0001
Pre-Test vs Test Trial 3	-0.7730	0.1743	-4.4340	< 0.0001
Pre-Test vs Test Trial 4	-0.4380	0.1521	-2.8800	0.0040
Pre-Test vs Test Trial 5	-0.2999	0.1474	-2.0350	0.0418

Pre-Test vs Test Trial 6	-0.1867	0.1530	-1.2200	0.2223
Pre-Test vs Test Trial 7	-0.4649	0.1462	-3.1800	0.0015
Pre-Test vs Test Trial 8	-0.4385	0.1654	-2.6510	0.0080

5Hz Strobe Light

Pre-Test vs Test Trial 1	-2.2322	0.2914	-7.6600	< 0.0001
Pre-Test vs Test Trial 2	-0.9957	0.2004	-4.9700	< 0.0001
Pre-Test vs Test Trial 3	-0.4964	0.2028	-2.4480	0.0144
Pre-Test vs Test Trial 4	-1.1261	0.2345	-4.8020	< 0.0001
Pre-Test vs Test Trial 5	-1.0115	0.2203	-4.5910	< 0.0001
Pre-Test vs Test Trial 6	-0.9648	0.2395	-4.0280	< 0.0001
Pre-Test vs Test Trial 7	-0.9081	0.2581	-3.5190	0.0004
Pre-Test vs Test Trial 8	-1.0343	0.2536	-4.0780	< 0.0001

12Hz Strobe Light

Pre-Test vs Test Trial 1	-2.0794	0.2496	-8.3290	< 0.0001
Pre-Test vs Test Trial 2	-2.1814	0.2816	-7.7470	< 0.0001
Pre-Test vs Test Trial 3	-1.7245	0.2555	-6.7500	< 0.0001
Pre-Test vs Test Trial 4	-1.3624	0.2442	-5.5780	< 0.0001
Pre-Test vs Test Trial 5	-1.8754	0.2340	-8.0130	< 0.0001
Pre-Test vs Test Trial 6	-1.9696	0.3077	-6.4000	< 0.0001

Pre-Test vs Test Trial 7	-1.4307	0.2370	-6.0370	< 0.0001
Pre-Test vs Test Trial 8	-2.0447	0.3200	-6.3900	< 0.0001

Supplemental Table SA-4. Generalized linear mixed model (GLMM) results for bighead carp exposed to Constant Light [0Hz] and 5Hz Strobming Light in a well-lit flume [100 Lux].

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to light (Constant [0Hz] or 5Hz Strobe) reduce overall passage of fish? ($\alpha = 0.05/4 = 0.0125$)					
Pre-Test 0Hz vs No Treatment Control	0.2270	0.1251	1.8150		0.0695
Test 0Hz vs No Treatment Control	-1.6102	0.2053	-7.8430		< 0.0001
Pre-Test 5Hz vs No Treatment Control	0.1485	0.1234	1.2030		0.2290
Test 5Hz vs No Treatment Control	-0.3992	0.1374	-2.9050		0.0037
Do passage rates change with repeated exposure to light (or with time in the flume)? ($\alpha = 0.05/7 = 0.0071$)					
No Treatment Control					
Linear	-0.0466	0.0226	-2.0630		0.0391
Quadratic	0.0539	0.1459	0.3700		0.7117
Cubic	0.1469	0.1479	0.9940		0.3205
Quartic	0.0391	0.1469	0.2660		0.7900
Quintic	-0.0235	0.1482	-0.1590		0.8738
Sextic	-0.0552	0.1497	-0.3680		0.7126
Septic	-0.0792	0.1476	-0.5370		0.5915

Constant Light [0Hz]: Pre-Test Passage Rates

Linear	0.0008	0.0286	0.0290	0.9771
Quadratic	0.0629	0.1861	0.3380	0.7355
Cubic	0.1188	0.1867	0.6370	0.5244
Quartic	0.0220	0.1881	0.1170	0.9069
Quintic	-0.0418	0.1885	-0.2220	0.8245
Sextic	0.0127	0.1886	0.0670	0.9462
Septic	0.1820	0.1896	0.9600	0.3371

Constant Light [0Hz]: Test Passage Rates

Linear	0.0605	0.0783	0.7730	0.4397
Quadratic	0.0605	0.5469	0.1110	0.9120
Cubic	0.9407	0.5031	1.8700	0.0615
Quartic	-0.7505	0.4616	-1.6260	0.1039
Quintic	0.1140	0.4543	0.2510	0.8018
Sextic	-0.1072	0.4790	-0.2240	0.8229
Septic	-0.4189	0.5210	-0.8040	0.4214

5Hz Strobe Light: Pre-Test Passage Rates

Linear	0.0160	0.0277	0.5780	0.5634
Quadratic	0.0910	0.1819	0.5000	0.6170

Cubic	0.0289	0.1822	0.1580	0.8742
Quartic	-0.0452	0.1803	-0.2510	0.8020
Quintic	-0.0182	0.1818	-0.1000	0.9205
Sextic	-0.0611	0.1847	-0.3310	0.7408
Septic	-0.0631	0.1854	-0.3400	0.7337

5Hz Strobe Light: Test Passage Rates

Linear	0.1337	0.0425	3.1490	0.0016
Quadratic	-0.5612	0.2602	-2.1570	0.0310
Cubic	0.0763	0.2571	0.2970	0.7666
Quartic	0.2514	0.2570	0.9780	0.3280
Quintic	0.3060	0.2475	1.2370	0.2162
Sextic	0.1561	0.2315	0.6750	0.5000
Septic	0.1413	0.2161	0.6540	0.5132

For a specific treatment, during which trial (1-8) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Constant Light [0Hz]

Pre-Test vs Test Trial 1	-2.6392	0.7291	-3.6200	0.0003
Pre-Test vs Test Trial 2	-1.2880	0.3977	-3.2380	0.0012
Pre-Test vs Test Trial 3	-1.3857	0.4208	-3.2930	0.0010
Pre-Test vs Test Trial 4	-2.3669	0.6013	-3.9360	< 0.0001

Pre-Test vs Test Trial 5	-1.7920	0.5378	-3.3320	0.0009
Pre-Test vs Test Trial 6	-2.2334	0.6049	-3.6920	0.0002
Pre-Test vs Test Trial 7	-1.5037	0.4494	-3.3460	0.0008
Pre-Test vs Test Trial 8	-1.4885	0.4167	-3.5720	0.0004

5Hz Strobe Light

Pre-Test vs Test Trial 1	-1.2872	0.3980	-3.2340	0.0012
Pre-Test vs Test Trial 2	-0.9166	0.3403	-2.6930	0.0071
Pre-Test vs Test Trial 3	-0.6582	0.3169	-2.0770	0.0378
Pre-Test vs Test Trial 4	-0.2882	0.2877	-1.0020	0.3164
Pre-Test vs Test Trial 5	-0.2232	0.2729	-0.8180	0.4134
Pre-Test vs Test Trial 6	0.0354	0.2641	0.1340	0.8932
Pre-Test vs Test Trial 7	-0.7246	0.3036	-2.3860	0.0170
Pre-Test vs Test Trial 8	-0.3150	0.2675	-1.1780	0.2390

Supplemental Table SA-5. Generalized linear mixed model (GLMM) results for largemouth bass exposed to Constant Light [0Hz] and 5Hz Strobing Light in a well-lit flume [100 Lux].

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to light (Constant [0Hz] or 5Hz Strobe) reduce overall passage of fish? ($\alpha = 0.05/4 = 0.0125$)					
Pre-Test 0Hz vs No Treatment Control	0.3360	0.0937	3.5870		0.0003
Test 0Hz vs No Treatment Control	0.4949	0.0915	5.4110		< 0.0001
Pre-Test 5Hz vs No Treatment Control	0.0242	0.1020	0.2370		0.8125
Test 5Hz vs No Treatment Control	0.2087	0.0984	2.1220		0.0339
Do passage rates change with repeated exposure to light (or with time in the flume)? ($\alpha = 0.05/7 = 0.0071$)					
No Treatment Control					
Linear	-0.0119	0.0197	-0.6060		0.5442
Quadratic	0.0243	0.1275	0.1900		0.8489
Cubic	0.1412	0.1276	1.1070		0.2684
Quartic	0.0050	0.1283	0.0390		0.9687
Quintic	-0.0099	0.1283	-0.0770		0.9386
Sextic	0.0294	0.1280	0.2290		0.8185
Septic	-0.0869	0.1286	-0.6760		0.4991

Constant Light [0Hz]: Pre-Test Passage Rates

Linear	0.0052	0.0238	0.2200	0.8259
Quadratic	-0.2062	0.1523	-1.3540	0.1757
Cubic	0.2795	0.1500	1.8630	0.0624
Quartic	-0.0038	0.1510	-0.0250	0.9798
Quintic	0.0542	0.1483	0.3650	0.7149
Sextic	0.0921	0.1445	0.6380	0.5237
Septic	0.0353	0.1444	0.2440	0.8071

Constant Light [0Hz]: Test Passage Rates

Linear	-0.0107	0.0213	-0.5010	0.6162
Quadratic	-0.0313	0.1419	-0.2210	0.8254
Cubic	0.0377	0.1358	0.2770	0.7814
Quartic	-0.2187	0.1386	-1.5780	0.1146
Quintic	0.0505	0.1356	0.3720	0.7097
Sextic	0.1926	0.1331	1.4470	0.1478
Septic	0.2217	0.1419	1.5620	0.1183

5Hz Strobe Light: Pre-Test Passage Rates

Linear	0.0108	0.0288	0.3770	0.7064
Quadratic	-0.0760	0.1789	-0.4250	0.6711

Cubic	-0.1909	0.1829	-1.0440	0.2967
Quartic	0.2680	0.1928	1.3900	0.1645
Quintic	0.0707	0.1905	0.3710	0.7107
Sextic	0.2043	0.1819	1.1230	0.2613
Septic	0.0794	0.1782	0.4460	0.6558

5Hz Strobe Light: Test Passage Rates

Linear	-0.0414	0.0254	-1.6270	0.1037
Quadratic	0.1302	0.1673	0.7780	0.4364
Cubic	0.0390	0.1658	0.2360	0.8138
Quartic	-0.0513	0.1693	-0.3030	0.7620
Quintic	0.1650	0.1688	0.9770	0.3284
Sextic	0.0866	0.1681	0.5150	0.6063
Septic	-0.1391	0.1733	-0.8030	0.4221

For a specific treatment, during which trial (1-8) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Constant Light [0Hz]

Pre-Test vs Test Trial 1	0.3569	0.2201	1.6220	0.1049
Pre-Test vs Test Trial 2	0.2390	0.1926	1.2410	0.2147
Pre-Test vs Test Trial 3	0.0546	0.1896	0.2880	0.7734
Pre-Test vs Test Trial 4	0.0593	0.1969	0.3010	0.7632

Pre-Test vs Test Trial 5	-0.0933	0.2156	-0.4330	0.6653
Pre-Test vs Test Trial 6	0.3460	0.1924	1.7980	0.0722
Pre-Test vs Test Trial 7	0.2669	0.2123	1.2570	0.2088
Pre-Test vs Test Trial 8	0.0424	0.2039	0.2080	0.8354

5Hz Strobe Light

Pre-Test vs Test Trial 1	0.2724	0.2343	1.1630	0.2449
Pre-Test vs Test Trial 2	0.6245	0.2578	2.4230	0.0154
Pre-Test vs Test Trial 3	0.3316	0.2473	1.3410	0.1800
Pre-Test vs Test Trial 4	-0.0673	0.2579	-0.2610	0.7941
Pre-Test vs Test Trial 5	0.1178	0.2426	0.4860	0.6272
Pre-Test vs Test Trial 6	-0.1105	0.2357	-0.4690	0.6392
Pre-Test vs Test Trial 7	0.1827	0.2704	0.6760	0.4991
Pre-Test vs Test Trial 8	0.1251	0.2501	0.5000	0.6170

Supplemental Table SA-6: Z-test results for comparisons between the linear trend observed in the pre-test or test periods for light stimulus experiments relative to the linear trend observed during the No-Treatment Control. Significant z-values indicate either habituation (increased passage rates over time) or sensitization (decrease in passage rates over time) due to repeated exposure to the light stimulus.

Contrasts of Interest	Z value	Pr (> z)
Bighead Carp [1 Lux Background]: Linear ($\alpha = 0.05/6 = 0.0083$)		
Pre-Test 0Hz vs No Treatment Control	2.2323	0.0258
Test 0Hz vs No Treatment Control	6.5492	< 0.0001
Pre-Test 5Hz vs No Treatment Control	1.1752	0.2380
Test 5Hz vs No Treatment Control	7.0740	< 0.0001
Pre-Test 12Hz vs No Treatment Control	-0.0303	0.9761
Test 12Hz vs No Treatment Control	5.0731	< 0.0001
Largemouth Bass [1 Lux Background]: Linear ($\alpha = 0.05/6 = 0.0083$)		
Pre-Test 0Hz vs No Treatment Control	-1.0893	0.2757
Test 0Hz vs No Treatment Control	-7.9765	< 0.0001
Pre-Test 5Hz vs No Treatment Control	1.9285	0.0536
Test 5Hz vs No Treatment Control	-1.3624	0.1738
Pre-Test 12Hz vs No Treatment Control	0.4006	0.6892
Test 12Hz vs No Treatment Control	-0.6124	0.5419

Bighead Carp [100 Lux Background]: Linear ($\alpha = 0.05/4 = 0.0125$)		
Pre-Test 0Hz vs No Treatment Control	-1.3004	0.1936
Test 0Hz vs No Treatment Control	-1.3142	0.1902
Pre-Test 5Hz vs No Treatment Control	-1.7511	0.0801
Test 5Hz vs No Treatment Control	-3.7457	0.0002
Largemouth Bass [100 Lux Background]: Linear ($\alpha = 0.05/4 = 0.0125$)		
Pre-Test 0Hz vs No Treatment Control	-0.5535	0.5823
Test 0Hz vs No Treatment Control	-0.0414	0.9681
Pre-Test 5Hz vs No Treatment Control	-0.6506	0.5157
Test 5Hz vs No Treatment Control	0.1156	0.9045

Supplemental Table SA-7. Z-test results for comparisons between mean passage rates during the test periods for all combinations of light stimuli. Significant z-values indicate that the stimuli differ in their effectiveness to reduce passage rates.

Contrasts of Interest	Z value	Pr (> z)
Bighead Carp ($\alpha = 0.05/6 = 0.0083$)		
Constant Light [100 Lux] vs 5Hz Strobe [100 Lux]	-4.9021	< 0.0001
Constant Light [100 Lux] vs Constant Light [1 Lux]	-0.2168	0.8259
5Hz Strobe [100 Lux] vs 5Hz Strobe [1 Lux]	5.9797	< 0.0001
Constant Light [1 Lux] vs 5Hz Strobe [1 Lux]	0.1668	0.8650
Constant Light [1 Lux] vs 12Hz Strobe [1 Lux]	-1.1287	0.2585
5Hz Strobe [1 Lux] vs 12Hz Strobe [1 Lux]	-1.2979	0.1936
Largemouth Bass ($\alpha = 0.05/6 = 0.0083$)		
Constant Light [100 Lux] vs 5Hz Strobe [100 Lux]	2.1300	0.0332
Constant Light [100 Lux] vs Constant Light [1 Lux]	8.5690	< 0.0001
5Hz Strobe [100 Lux] vs 5Hz Strobe [1 Lux]	10.1436	< 0.0001
Constant Light [1 Lux] vs 5Hz Strobe [1 Lux]	3.1418	0.0017
Constant Light [1 Lux] vs 12Hz Strobe [1 Lux]	5.0438	< 0.0001
5Hz Strobe [1 Lux] vs 12Hz Strobe [1 Lux]	1.9070	0.05613

Supplemental Table SA-8. Z-test results for comparisons between species for each light stimulus. Significant z-values indicate that the stimulus is more effective at blocking passage rates for one species than the other species.

Contrasts of Interest	Z value	Pr (> z)
Constant Light [1 Lux] ($\alpha = 0.05$)		
Bighead Carp vs Largemouth Bass	-2.6641	0.0076
5Hz Strobe Light [1 Lux] ($\alpha = 0.05$)		
Bighead Carp vs Largemouth Bass	0.4576	0.6455
12Hz Strobe Light [1 Lux] ($\alpha = 0.05$)		
Bighead Carp vs Largemouth Bass	3.6728	0.0002
Constant Light [100 Lux] ($\alpha = 0.05$)		
Bighead Carp vs Largemouth Bass	-9.3657	< 0.0001
5Hz Strobe Light [100 Lux] ($\alpha = 0.05$)		
Bighead Carp vs Largemouth Bass	-3.5970	0.0003

Supplemental Table SA-9. Generalized linear mixed model (GLMM) results for common carp exposed to Constant Light [0Hz], 5Hz Strobging Light and 12Hz Strobging Light in dimly-lit flume [1 Lux].

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to light (Constant [0Hz], 5Hz Strobe or 12Hz Strobe) reduce overall passage of fish? ($\alpha = 0.05/6 = 0.0083$)					
Pre-Test 0Hz vs No Treatment Control	0.5400	0.1179	4.5810	2.4812	0.0131
Test 0Hz vs No Treatment Control	-0.6400	0.1232	-5.1950	-2.8137	0.0050
Pre-Test 5Hz vs No Treatment Control	0.4804	0.1179	4.0720	2.2055	0.0271
Test 5Hz vs No Treatment Control	-1.1113	0.1269	-8.7540	-4.7414	< 0.0001
Pre-Test 12Hz vs No Treatment Control	0.5727	0.1180	4.8590	2.6317	0.0085
Test 12Hz vs No Treatment Control	-0.4290	0.1220	-3.5170	-2.0674	0.0300
Do passage rates change with repeated exposure to light (or with time in the flume)? ($\alpha = 0.05/7 = 0.0071$)					
No Treatment Control					
Linear	-0.0296	0.0100	-2.9540	-1.5999	0.1096
Quadratic	0.0431	0.0647	0.6660	0.3607	0.7189
Cubic	-0.0783	0.0648	-1.2090	-0.6548	0.5157
Quartic	0.0429	0.0658	0.6510	0.3526	0.7263
Quintic	-0.0165	0.0657	-0.2510	-0.1359	0.8887

Sextic	0.0677	0.0650	1.0410	0.5638	0.5755
Septic	-0.0348	0.0655	-0.5320	-0.2881	0.7718

Constant Light [0Hz]: Pre-Test Passage Rate

Linear	-0.0354	0.0103	-3.4260	-1.8556	0.0629
Quadratic	-0.1644	0.0664	-2.4740	-1.3400	0.1803
Cubic	0.2710	0.0664	4.0840	2.2120	0.0271
Quartic	-0.0260	0.0648	-0.4020	-0.2177	0.8259
Quintic	-0.0452	0.0648	-0.6970	-0.3775	0.7040
Sextic	-0.0643	0.0650	-0.9890	-0.5357	0.5892
Septic	-0.1442	0.0636	-2.2680	-1.2284	0.2187

Constant Light [0Hz]: Test Passage Rate

Linear	0.0512	0.0202	2.5330	1.3719	0.1707
Quadratic	-0.5598	0.1263	-4.4320	-2.4005	0.0164
Cubic	0.3681	0.1262	2.9160	1.5794	0.1141
Quartic	0.0705	0.1186	0.5950	0.3223	0.7490
Quintic	-0.3855	0.1173	-3.2850	-1.7792	0.0751
Sextic	-0.2103	0.1170	-1.7970	-0.9733	0.3321
Septic	-0.3205	0.1067	-3.0020	-1.6259	0.1031

5Hz Strobe Light: Pre-Test Passage Rate

Linear	-0.0569	0.0100	-5.7050	-3.0899	0.0020
Quadratic	-0.0130	0.0643	-0.2020	-0.1094	0.9124
Cubic	0.1145	0.0642	1.7840	0.9663	0.3321
Quartic	0.0260	0.0650	0.4000	0.2166	0.8259
Quintic	-0.0712	0.0647	-1.1000	-0.5958	0.5485
Sextic	0.0734	0.0639	1.1490	0.6223	0.5353
Septic	-0.0345	0.0641	-0.5380	-0.2914	0.7718

5Hz Strobe Light: Test Passage Rate

Linear	-0.0994	0.0253	-3.9200	-2.1232	0.0340
Quadratic	-0.7269	0.1533	-4.7410	-2.5678	0.0102
Cubic	-0.1069	0.1520	-0.7040	-0.3813	0.7040
Quartic	0.2785	0.1531	1.8190	0.9852	0.3222
Quintic	0.1387	0.1466	0.9460	0.5124	0.6101
Sextic	0.1087	0.1349	0.8060	0.4365	0.6599
Septic	-0.1544	0.1237	-1.2480	-0.6759	0.4965

12Hz Strobe Light: Pre-Test Passage Rate

Linear	-0.0143	0.0100	-1.4340	-0.7767	0.4354
Quadratic	-0.2443	0.0637	-3.8370	-2.0782	0.0375
Cubic	0.1802	0.0632	2.8520	1.5447	0.1236

Quartic	-0.0147	0.0619	-0.2370	-0.1284	0.8966
Quintic	0.0502	0.0614	0.8180	0.4430	0.6599
Sextic	-0.0488	0.0610	-0.8010	-0.4338	0.6672
Septic	-0.1219	0.0596	-2.0450	-1.1076	0.2670

12Hz Strobe Light: Test Passage Rate

Linear	0.1425	0.0189	7.5510	4.0898	< 0.0001
Quadratic	-0.8422	0.1135	-7.4210	-4.0194	< 0.0001
Cubic	-0.1581	0.1129	-1.4010	-0.7588	0.4473
Quartic	0.3028	0.1119	2.7070	1.4662	0.1416
Quintic	0.0053	0.1072	0.0490	0.0265	0.9761
Sextic	-0.0312	0.0990	-0.3150	-0.1706	0.8650
Septic	-0.2623	0.0880	-2.9820	-1.6151	0.1052

For a specific treatment, during which trial (1-8) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Constant Light [0Hz]

Pre-Test vs Test Trial 1	-1.6665	0.1702	-9.7920	-5.3036	< 0.0001
Pre-Test vs Test Trial 2	-1.5915	0.1465	-10.8620	-5.8831	< 0.0001
Pre-Test vs Test Trial 3	-1.0823	0.1145	-9.4510	-5.1189	< 0.0001
Pre-Test vs Test Trial 4	-0.9691	0.1198	-8.0890	-4.3812	< 0.0001
Pre-Test vs Test Trial 5	-0.9262	0.1175	-7.8820	-4.2691	< 0.0001

Pre-Test vs Test Trial 6	-1.2798	0.1567	-8.1690	-4.4245	< 0.0001
Pre-Test vs Test Trial 7	-0.8408	0.1253	-6.7080	-3.6332	0.0003
Pre-Test vs Test Trial 8	-1.0847	0.1372	-7.9060	-4.2821	< 0.0001

5Hz Strobe Light

Pre-Test vs Test Trial 1	-1.6891	0.1494	-11.3050	-6.1230	< 0.0001
Pre-Test vs Test Trial 2	-1.6629	0.1526	-10.8950	-5.9010	< 0.0001
Pre-Test vs Test Trial 3	-1.5024	0.1350	-11.1290	-6.0277	< 0.0001
Pre-Test vs Test Trial 4	-1.3943	0.1407	-9.9130	-5.3691	< 0.0001
Pre-Test vs Test Trial 5	-1.0770	0.1310	-8.2210	-4.4527	< 0.0001
Pre-Test vs Test Trial 6	-1.3723	0.1523	-9.0130	-4.8816	< 0.0001
Pre-Test vs Test Trial 7	-1.9170	0.1954	-9.8100	-5.3133	< 0.0001
Pre-Test vs Test Trial 8	-2.1188	0.2116	-10.0160	-5.4249	< 0.0001

12Hz Strobe Light

Pre-Test vs Test Trial 1	-1.6279	0.1667	-9.7650	-5.2889	< 0.0001
Pre-Test vs Test Trial 2	-1.7546	0.1531	-11.4610	-6.2075	< 0.0001
Pre-Test vs Test Trial 3	-1.2063	0.1194	-10.100	-5.4704	< 0.0001
Pre-Test vs Test Trial 4	-0.8717	0.1110	-7.8540	-4.2539	< 0.0001
Pre-Test vs Test Trial 5	-0.4511	0.0920	-4.9020	-2.6550	0.0078
Pre-Test vs Test Trial 6	-0.5778	0.1083	-5.3360	-2.8901	0.0039

Pre-Test vs Test Trial 7	-0.6847	0.1124	-6.0940	-3.3006	0.0010
Pre-Test vs Test Trial 8	-0.8403	0.1190	-7.0620	-3.8249	0.0001

Supplemental Table SA-10. Z-test results for comparisons between mean passage rates during the test periods for common carp exposed to either a 0Hz Constant Light, 5Hz Strobe Light or a 12Hz Strobe Light tested in a dimly-lit flume. Significant z-values indicate that the stimuli differ in their effectiveness to reduce passage rates.

Contrasts of Interest	Z value	Pr (> z)
Common Carp ($\alpha = 0.05/3 = 0.0167$)		
Constant Light [1 Lux] vs 5Hz Strobe [1 Lux]	2.6647	0.0078
Constant Light [1 Lux] vs 12Hz Strobe [1 Lux]	-1.2169	0.2225
5Hz Strobe [1 Lux] vs 12Hz Strobe [1 Lux]	-3.8760	0.0001

Supplemental Table SA-11. Generalized linear mixed model (GLMM) results for bighead carp exposed to Constant Light [0Hz], 2Hz Strobming Light, 5Hz Strobming Light and 12Hz Strobming Light in a dimly-lit flume [1 Lux].

Fixed Effects	Estimate	Std. Error	Z value	Z value (corrected)	Pr (> z)
Does exposure to light (Constant [0Hz], 2Hz Strobe, 5Hz Strobe or 12Hz Strobe) reduce overall passage of fish? ($\alpha = 0.05/8 = 0.0063$)					
Pre-Test 0Hz vs No Treatment Control	0.1081	0.1396	0.7700	0.4099	0.6818
Test 0Hz vs No Treatment Control	-1.4980	0.1540	-9.7300	-5.1792	< 0.0001
Pre-Test 2Hz vs No Treatment Control	0.0898	0.1383	0.6500	0.3460	0.7263
Test 2Hz vs No Treatment Control	-1.8080	0.1521	-11.8900	-6.3290	< 0.0001
Pre-Test 5Hz vs No Treatment Control	0.0291	0.1400	0.2100	0.1118	0.9124
Test 5Hz vs No Treatment Control	-1.5350	0.1542	-9.9600	-5.3017	< 0.0001
Pre-Test 12Hz vs No Treatment Control	0.0482	0.1425	0.3400	0.1810	0.8572
Test 12Hz vs No Treatment Control	-1.2790	0.1518	-8.4200	-4.4819	< 0.0001
Do passage rates change with repeated exposure to light (or with time in the flume)? ($\alpha = 0.05/7 = 0.0071$)					
No Treatment Control					
Linear	-0.0265	0.0103	-2.5700	-1.3680	0.1707
Quadratic	-0.0422	0.0648	-0.6500	-0.3460	0.7263

Cubic	0.1044	0.0678	1.5400	0.8197	0.4122
Quartic	0.2443	0.0663	3.6800	1.9588	0.0500
Quintic	-0.0652	0.0677	-0.9600	-0.5110	0.6101
Sextic	-0.2002	0.0688	-2.9100	-1.5490	0.1211
Septic	0.0163	0.0640	0.2500	0.1331	0.8966

Constant Light [0Hz]: Pre-Test Passage Rate

Linear	-0.0637	0.0131	-4.8700	-2.5923	0.0096
Quadratic	-0.1280	0.0866	-1.4800	-0.7878	0.4295
Cubic	0.2601	0.0835	3.1200	1.6608	0.0969
Quartic	-0.3221	0.0809	-3.9800	-2.1185	0.0340
Quintic	0.1550	0.0800	1.9400	1.0327	0.3030
Sextic	-0.0575	0.0808	-0.7100	-0.3779	0.7040
Septic	0.0440	0.0830	0.5300	0.2821	0.7795

Constant Light [0Hz]: Test Passage Rate

Linear	-0.2262	0.0288	-7.8600	-4.1838	< 0.0001
Quadratic	0.6886	0.1786	3.8600	2.0547	0.0404
Cubic	0.7524	0.1956	3.8500	2.0493	0.0404
Quartic	0.2084	0.2124	0.9800	0.5216	0.6031
Quintic	0.2331	0.2171	1.0700	0.5696	0.5687

Sextic	0.0597	0.2136	0.2800	0.1490	0.8808
Septic	0.1131	0.2081	0.5400	0.2874	0.7718

2Hz Strobe Light: Pre-Test Passage Rate

Linear	0.0001	0.0118	0.0000	0.0000	1.0000
Quadratic	0.3586	0.0759	-4.7200	-2.5124	0.0121
Cubic	0.2269	0.0734	3.0900	1.6448	0.1010
Quartic	-0.1459	0.0717	-2.0300	-1.0806	0.2801
Quintic	0.1164	0.0699	1.6700	0.8889	0.3735
Sextic	0.0253	0.0686	0.3700	0.1969	0.8415
Septic	-0.1384	0.0687	-2.0100	-1.0699	0.2846

2Hz Strobe Light: Test Passage Rate

Linear	-0.1462	0.0314	-4.6500	-2.4752	0.0131
Quadratic	-0.2269	0.2075	-1.0900	-0.5802	0.5619
Cubic	-0.0855	0.1906	-0.4500	-0.2395	0.8103
Quartic	-0.3274	0.1967	-1.6600	-0.8836	0.3789
Quintic	-0.0240	0.1854	-0.1300	-0.0692	0.9442
Sextic	0.4499	0.1731	2.6000	1.3840	0.1676
Septic	0.1613	0.1915	0.8400	0.4471	0.6527

5Hz Strobe Light: Pre-Test Passage Rate

Linear	-0.0459	0.0129	-3.5600	-1.8950	0.0574
Quadratic	-0.0361	0.0836	-0.4300	-0.2289	0.8181
Cubic	0.3074	0.0828	3.7100	1.9748	0.0488
Quartic	-0.0810	0.0834	-0.9700	-0.5163	0.6031
Quintic	0.1992	0.0828	2.4100	1.2828	0.2006
Sextic	0.0347	0.0820	0.4200	0.2236	0.8259
Septic	0.1134	0.0830	1.3700	0.7292	0.4654

5Hz Strobe Light: Test Passage Rate

Linear	-0.2670	0.0324	-8.2400	-4.3861	< 0.0001
Quadratic	0.0116	0.1931	0.0600	0.0319	0.9761
Cubic	0.1778	0.1983	0.9000	0.4791	0.6312
Quartic	0.1619	0.2175	0.7400	0.3939	0.6965
Quintic	0.4645	0.2105	2.2100	1.1764	0.2380
Sextic	0.2001	0.1899	1.0500	0.5589	0.5755
Septic	0.2435	0.1820	1.3400	0.7133	0.4777

12Hz Strobe Light: Pre-Test Passage Rate

Linear	-0.0260	0.0129	-2.0100	-1.0699	0.2846
Quadratic	-0.0167	0.0831	-0.2000	-0.1065	0.9124
Cubic	0.1590	0.0843	1.8900	1.0060	0.3125

Quartic	0.0222	0.0826	0.2700	0.1437	0.8887
Quintic	0.1490	0.0834	1.7900	0.9528	0.3421
Sextic	-0.1276	0.0846	-1.5100	-0.8038	0.4237
Septic	0.0037	0.0824	0.0400	0.0213	0.9840

12Hz Strobe Light: Test Passage Rate

Linear	-0.1768	0.0279	-6.3500	-3.3801	0.0007
Quadratic	-0.2880	0.1682	-1.7100	-0.9102	0.3628
Cubic	0.1601	0.1718	0.9300	0.4950	0.6171
Quartic	0.2817	0.1787	1.5800	0.8410	0.4009
Quintic	0.1073	0.1744	0.6200	0.3300	0.7414
Sextic	0.1201	0.1628	0.7400	0.3939	0.6965
Septic	0.0429	0.1520	0.2800	0.1490	0.8808

For a specific treatment, during which trial (4-11) does exposure to light change passage rates? ($\alpha = 0.05/8 = 0.0063$)

Constant Light [0Hz]

Pre-Test vs Test Trial 1	-0.6646	0.1461	-4.5500	-2.4219	0.0155
Pre-Test vs Test Trial 2	-1.2528	0.1355	-9.2400	-4.9184	< 0.0001
Pre-Test vs Test Trial 3	-1.3920	0.1685	-8.2600	-4.3968	< 0.0001
Pre-Test vs Test Trial 4	-1.5766	0.1973	-7.9900	-4.2530	< 0.0001
Pre-Test vs Test Trial 5	-1.9534	0.2452	-7.9700	-4.2424	< 0.0001

Pre-Test vs Test Trial 6	-2.1972	0.2722	-8.0700	-4.2956	< 0.0001
Pre-Test vs Test Trial 7	-2.4619	0.3141	-7.8400	-4.1732	< 0.0001
Pre-Test vs Test Trial 8	-1.3524	0.2048	-6.6000	-3.5131	0.0005

2Hz Strobe Light

Pre-Test vs Test Trial 1	-1.1896	0.1762	-6.7500	-3.5930	0.0003
Pre-Test vs Test Trial 2	-1.6873	0.1680	-10.0400	-5.3442	< 0.0001
Pre-Test vs Test Trial 3	-1.6429	0.1594	-10.3100	-5.4880	< 0.0001
Pre-Test vs Test Trial 4	-1.9057	0.1990	-9.5700	-5.0941	< 0.0001
Pre-Test vs Test Trial 5	-2.3848	0.2281	-10.4600	-5.5678	< 0.0001
Pre-Test vs Test Trial 6	-1.7000	0.1813	-9.3800	-4.9929	< 0.0001
Pre-Test vs Test Trial 7	-2.1595	0.2305	-9.3700	-4.9876	< 0.0001
Pre-Test vs Test Trial 8	-2.5142	0.2779	-9.0500	-4.8173	< 0.0001

5Hz Strobe Light

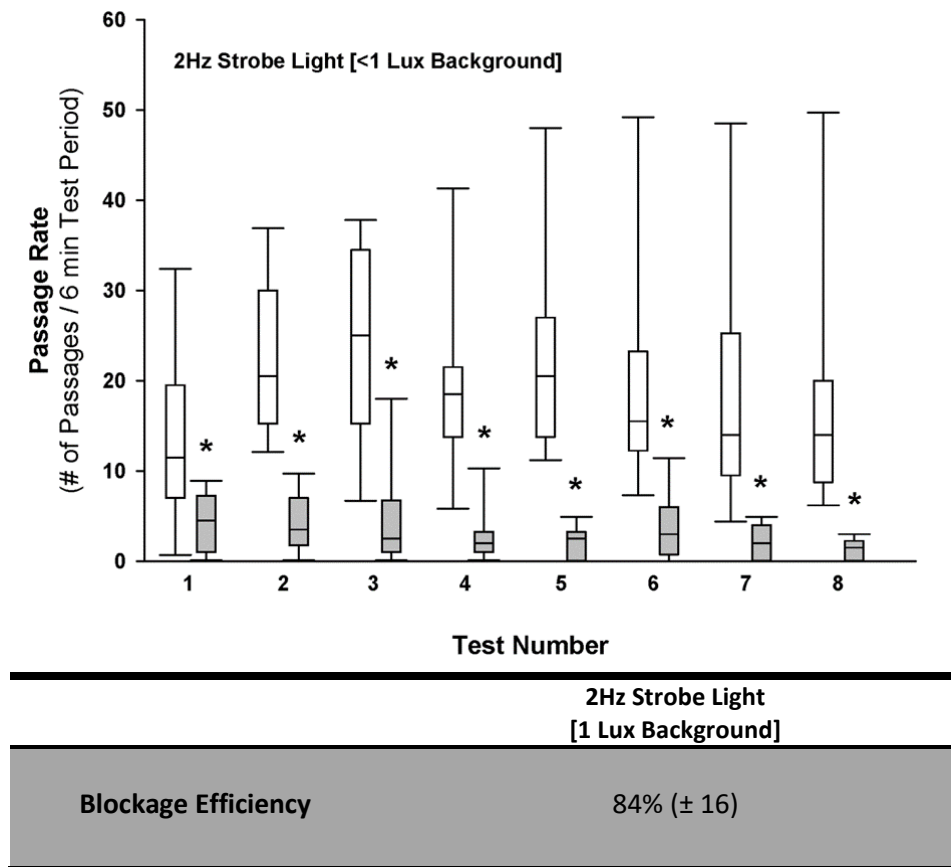
Pre-Test vs Test Trial 1	-0.6721	0.1449	-4.6400	-2.4698	0.0135
Pre-Test vs Test Trial 2	-1.0797	0.1374	-7.8600	-4.1838	< 0.0001
Pre-Test vs Test Trial 3	-1.3803	0.1726	-8.0000	-4.2584	< 0.0001
Pre-Test vs Test Trial 4	-1.4663	0.1849	-7.9300	-4.2211	< 0.0001
Pre-Test vs Test Trial 5	-1.6247	0.2146	-7.5700	-4.0295	< 0.0001
Pre-Test vs Test Trial 6	-1.6458	0.2102	-7.8300	-4.1679	< 0.0001

Pre-Test vs Test Trial 7	-2.3979	0.3303	-7.2600	-3.8645	0.0001
Pre-Test vs Test Trial 8	-2.2478	0.2715	-8.2800	-4.4074	< 0.0001
12Hz Strobe Light					
Pre-Test vs Test Trial 1	-0.8520	0.1529	-5.5700	-2.9649	0.0031
Pre-Test vs Test Trial 2	-1.1984	0.1553	-7.7200	-4.1093	< 0.0001
Pre-Test vs Test Trial 3	-0.9305	0.1578	-5.9000	-3.1405	0.0017
Pre-Test vs Test Trial 4	-1.0921	0.1618	-6.7500	-3.5930	0.0003
Pre-Test vs Test Trial 5	-1.3169	0.1759	-7.4900	-3.9869	< 0.0001
Pre-Test vs Test Trial 6	-1.3863	0.1977	-7.0100	-3.7314	0.0002
Pre-Test vs Test Trial 7	-1.9218	0.2524	-7.6100	-4.0508	< 0.0001
Pre-Test vs Test Trial 8	-1.9183	0.2337	-8.2100	-4.3701	< 0.0001

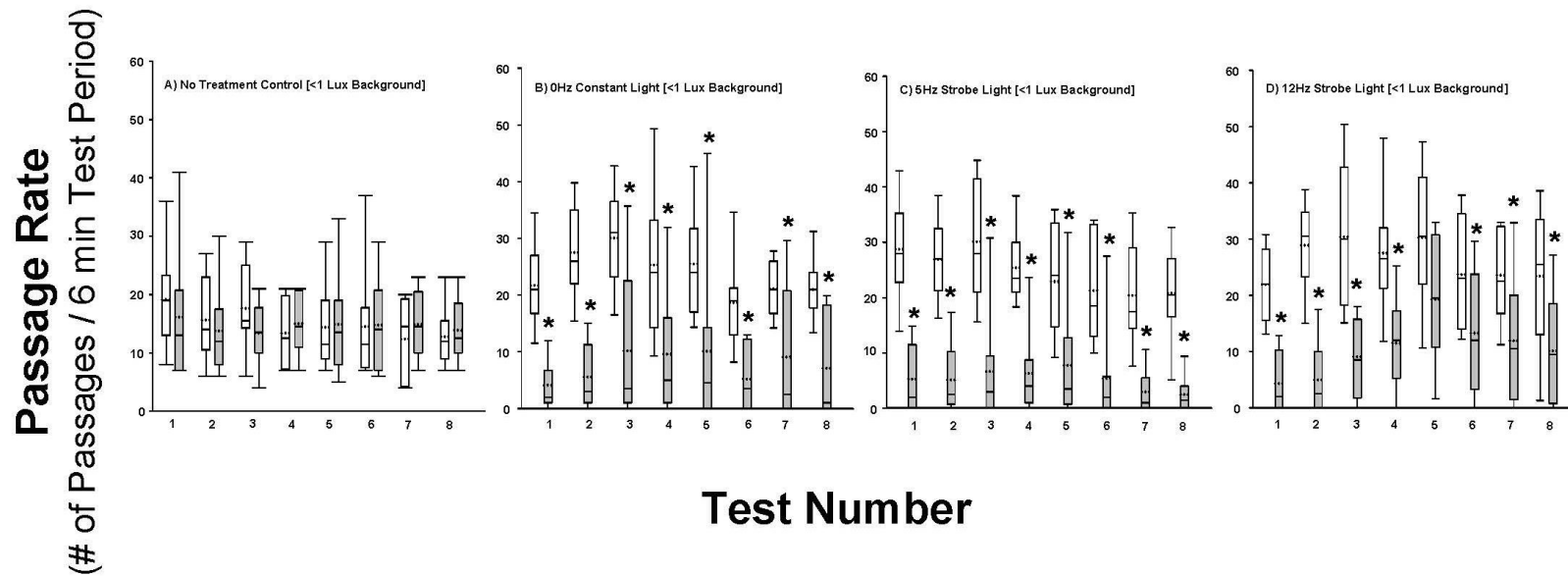
Supplemental Table SA-12. Z-test results for comparisons between mean passage rates during the test periods for all combinations of light stimuli. Significant z-values indicate that the stimuli differ in their effectiveness to reduce passage rates.

Contrasts of Interest	Z value	Pr (> z)
Bighead Carp ($\alpha = 0.05/9 = 0.0056$)		
2Hz Strobe [1 Lux] vs Constant Light [1 Lux]	1.4322	0.1527
2Hz Strobe [1 Lux] vs 5Hz Strobe [1 Lux]	-1.2604	0.2077
2Hz Strobe [1 Lux] vs 12Hz Strobe [1 Lux]	-2.4617	0.0139
Constant Light [100 Lux] vs 5Hz Strobe [100 Lux]	-4.9021	< 0.0001
Constant Light [100 Lux] vs Constant Light [1 Lux]	-0.2168	0.8259
5Hz Strobe [100 Lux] vs 5Hz Strobe [1 Lux]	5.9797	< 0.0001
Constant Light [1 Lux] vs 5Hz Strobe [1 Lux]	0.1668	0.8650
Constant Light [1 Lux] vs 12Hz Strobe [1 Lux]	-1.1287	0.2585
5Hz Strobe [1 Lux] vs 12Hz Strobe [1 Lux]	-1.2979	0.1936

Supplemental Fig SA-1. Passage rate and blockage efficiency for bighead carp during a test of a 2Hz white strobe light in a dimly-lit flume [1 Lux]. Box-and-whisker plots in each panel show the lower bound, 25th percentile, median (solid line), mean (dotted line), 75th percentile, and upper bound values for passage rates during pre-test periods (white bars) and test periods (gray bars) over the course of eight consecutive periods (i.e., test numbers). Asterisks denote differences between pre-test and test passage rates for that specific test number ($p < 0.05$ [corrected for multiple comparison]). Ten trials, each consisting of 10 naïve bighead carp, were conducted.



Supplemental Fig SA-2. Passage rate and blockage efficiency of common carp in a dimly-lit flume exposed one of 4 light conditions in a dimly-lit (1 Lux) background: A) no-treatment control; B) constant light [0Hz]; C) 5Hz strobing light and D) 12Hz strobing light. Box and whisker plots in each panel show the lower bound, 25th percentile, median (solid line), mean (dotted line), 75th percentile, and upper bound values for passage rates during pre-test periods (white bars) and test periods (gray bars) over the course of eight consecutive periods (i.e., test numbers). Asterisks denote differences between pre-test and test passage rates for that specific test period ($p < 0.05$ [corrected for multiple comparisons]). Ten trials, each consisting of 10 naïve common carp, were used to test each light stimulus. Common carp did not move in 100 Lux conditions.



	Constant Light [0Hz] [1 Lux Background]	5Hz Strobe Light [1 Lux Background]	12Hz Strobe Light [1 Lux Background]
Blockage Efficiency	47% (± 13) ^b	67% (± 14) ^a	35% (± 13) ^b

