

2008-2009 Horizontal Diurnal Fish Passage Structure Study



*Albuquerque
Biological
Park*

SUBMITTED BY:
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DECEMBER 8, 2009

In collaboration with the Bureau of Reclamation (BOR), a study system was designed to test the feasibility of constructing a horizontal fish passage structure at diversion dams along the Middle Rio Grande. The study system was constructed and installed in the naturalized refugium. The system design consists of a 30.5-meter passage, made up of five 6.1-meter sections of 0.51-meter-diameter PVC pipe, with a columnar tank connected to the inflow end. This tank is 2 meters in diameter and 0.9 meter deep and contains a cage (trap) constructed out of 1.27-centimeter-thick sheet PVC and 0.64-centimeter mesh plastic screen. The system is partially submerged in the main channel of the refugium. Two discharge pipes from the refugium manifold were adapted to send water through the system at an adjustable rate.

During September 2007, the system was tested to find the most efficient setup and to determine if the Rio Grande silvery minnow (RGSM) would use the passage. These tests were conducted with a mesh cage connected to the outflow end of the pipe, keeping the fish contained in the system. In October 2007, the outflow cage was removed to begin trials using the general population of the refugium. The system was tested at the flow rates which were most effective during the initial tests conducted in September. Modifications were made in an attempt to direct the fish toward the passage pipe. In October and November 2007, fifty hour tests were conducted to determine the times of day that the system was most effective. Tests were also conducted to determine whether the addition of a predator-exclusion cage on the outflow end of the pipe would deter the fish from entering the system. This data, included in the 2007 Fish Passage Summary report (RGSM RABF 2008), was used to create a standard procedure for the 2008-2009 Rio Grande silvery minnow passage study to follow.

The monthly standard procedure used to obtain all data found in this report is as follows:

Day 1 ó 08:00 -Ready and or calibrate all the following equipment:

- In-Situ Troll 9000 multi parameter water quality meter.
- Marsh-McBirney Flo-Mate 2000 portable flow meter
- Hach Sension 2 pH meter
- YSI Professional Plus Dissolved Oxygen (DO) meter
- Hach 2100P portable turbidimeter
- Denver Instruments PK-202 digital scale
- Metric/English ruler

- Check all areas of fish passage structure for mechanical soundness.
- Set water velocity through fish passage structure at 0.30m/s making sure outflow gate is open.
- Set water depth in fish passage structure to 5 inches
- Purge pipe on passage structure
- Shut off discharge valve
- Close gates simultaneously if possible

Day 1 ó 09:00 -Open discharge valve

- Open both gates on passage structure
- Measure the following water quality parameters: Flow, Depth, Disolved Oxygen (DO), pH, Turbidity, Temperature, and NH3

- Day 1 ó 11:00 -Close discharge valve
- Check inflow cage for RGSM that have completed the passage
 - Count, weigh, and measure up to 50 fish in group
 - Transfer RGSM to holding cage
 - Purge pipe on passage structure for 5 minutes
 - Shut off discharge valve
 - Close gates simultaneously if possible
 - Check inflow cage for missed RGSM
 - Leave discharge valve closed
- Day 1 ó 13:00 -Open discharge valve
- Open both gates on passage structure
 - Measure the following water quality parameters: Flow, Depth, Dissolved Oxygen (DO), pH, Turbidity, Temperature, and NH₃
- Day 1 ó 15:00 -Close discharge valve
- Check inflow cage for RGSM that have completed the passage
 - Count, weigh, and measure up to 50 fish in group
 - Transfer RGSM to holding cage
 - Purge pipe one passage structure for 5 minutes
 - Shut of discharge valve
 - Close gates simultaneously if possible
 - Check inflow cage for missed RGSM
 - Leave discharge valve closed

After the initial set up of the system and monitoring equipment in the first hour, the subsequent bi-hourly procedure, listed above in hours 09:00 through 15:00, was repeated throughout the fifty hour study until the final hour which occurs on day three at 11:00. The Troll multi-parameter meter was set up to automatically take hourly readings as a baseline for the investigators to follow throughout the study. These readings were separate from the bi-hourly water quality statistics manually taken by investigators using the individual monitoring devices. The manually derived data was then recorded on data sheets and used in the passage summary reports.

The following summary includes all data derived during the twelve month Rio Grande silvery minnow diurnal horizontal pipe fish passage experiment. No hydraulic configurations were varied. The time of day and time of year were the independent variables. Fish were enumerated bi-hourly as they successfully passed fully through the pipe to the collection cage. Sub samples of Rio Grande silvery minnow were taken from the successfully passing fish. Up to 50 fish of the total collected within each two hour collection period were weighed and measured. A Health Index (HI) number, derived from Fultons condition factor ($K=(W/L^3)$), where K= Fultons condition factor, W = the weight of the fish and L is the length (Fulton 1911), was also calculated as W/L. After sub sampling, all successfully passing fish were placed into a cage within the naturalized refugium for the duration of the monthly test, in order to keep an accurate count of fish captured, versus fish in the refugium. After the full fifty hour test was completed, the successfully passing fish were returned to the population in the refugium. It is unlikely

that conditioning could have occurred due to the length of time between tests, and the alternation of days within each month that the tests took place.

A fifty hour horizontal passage test commenced on 29 May, 2008 at 09:00 and finished at 11:00 on 31 May, 2008. The test was conducted using an average flow rate of 0.32 m/s. One hundred forty six fish were caught in the inflow cage out of 3,647 total RGSM in the naturalized Refugium, equaling a 4% passage rate. Twelve fish were captured at 23:00 hours on 29 May, 25 fish were captured at 05:00 hours 30 May, 54 fish were captured at 23:00 hours on 30 May, and 55 fish were captured at 03:00 hours on 31 May. One hundred forty six fish, or 100% of the total captured were done so after sun down. No fish were caught during daylight hours. Four sub samples, totaling 100 fish, were removed from the inflow cage, weighed, and measured. The average fish weight was 3.26g. The average fish length was 56mm. The average Health Index (HI) of the fish was 0.058. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted May 29 – 31, 2008

Date	Time	Run time (hrs)	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
May 29	09-11:00	75°F/calm	0.33	8.50	85.9	7.87	8	20.1	0
May 29	13-15:00	84°F/calm	0.34	8.50	104.8	8.50	8	22.5	0
May 29	17-19:00	89°F/wind	0.34	8.50	98.0	8.82	8	25.6	0
May 29	21-23:00	79°F/calm	0.30	7.25	86.0	8.85	8	23.2	12

Date	Start time	Run time (hrs)	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
May 30	01-03:00	69°F/calm	0.30	7.25	82.7	8.64	8	21.5	25
May 30	05-07:00	57°F/calm	0.30	7.5	83.5	8.54	7	19.9	0
May 30	09-11:00	72°F/calm	0.29	6.5	95.0	8.52	9	19.2	0
May 30	13-15:00	84°F/calm	0.32	7.0	96.4	8.67	10	21.8	0
May 30	17-19:00	88°F/wind	0.33	7.5	92.0	8.77	na	24.2	0
May 30	21-23:00	74°F/calm	0.32	7.5	93.9	8.54	11	23	54

Date	Start time	Run time (hrs)	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
May 31	01-03:00	65°F/calm	0.31	6.5	93.7	8.68	13	21.4	55
May 31	05-07:00	57°F/calm	0.32	7.0	95.8	8.10	12	19.7	0
May 31	09-11:00	74°F/calm	0.31	7.5	104.1	8.37	13	19.0	0
Total/Avg.			0.32	7.5	93.1	8.53	10	21.6	146

Fish Sample Data – May 29, 2008			
Time	Weight (g)	Length (mm)	Health Index
23:00	3.39	55	0.062
	3.42	56	0.061
	2.65	53	0.050
	3.71	55	0.067
	3.04	53	0.057
	3.24	55	0.059
	3.09	54	0.057
	5.31	60	0.089
	2.91	53	0.055
	4.07	54	0.075
	2.26	51	0.044

Fish Sample Data – May 30, 2008			
Time	Weight (g)	Length (mm)	Health Index
03:00	2.69	53	0.051
	1.87	46	0.041
	2.85	54	0.053
	2.87	52	0.055
	2.85	52	0.055
	2.56	48	0.053
	2.57	55	0.047
	3.65	56	0.065
	2.74	54	0.051
	2.53	52	0.049
23:00	2.91	59	0.049
	5.64	64	0.088
	2.44	54	0.045
	3.73	60	0.062
	2.93	53	0.055
	4.55	59	0.077
	4.65	58	0.080
	3.01	57	0.053
	2.36	51	0.046
	1.71	47	0.036
	2.60	54	0.048
	2.96	54	0.055
	2.92	56	0.052

Fish Sample Data – May 30, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
23:00	3.44	55	0.063
	3.07	56	0.055
	3.73	61	0.061
	2.80	55	0.051
	3.49	60	0.058
	2.97	55	0.054
	2.76	55	0.050
	3.87	58	0.067
	2.60	54	0.048
	2.81	57	0.049
	2.94	58	0.051
	2.33	54	0.043
	2.92	56	0.052
	2.61	52	0.050
	2.86	55	0.052
	2.69	56	0.048
	5.66	64	0.088
	3.40	55	0.062
	1.88	47	0.040
	2.53	51	0.050
	3.15	56	0.056
	2.26	52	0.043
	2.50	54	0.046
	2.36	53	0.045
	1.84	51	0.036
	3.44	59	0.058
	2.67	54	0.049
	2.94	57	0.052
	2.76	57	0.048
	6.99	67	0.104
	3.51	60	0.059
	2.44	54	0.045
	3.18	58	0.055
	3.23	57	0.057
	2.21	53	0.042
	2.95	55	0.054
	2.37	52	0.046

Fish Sample Data – May 30, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
23:00	2.86	55	0.052
	2.69	56	0.048
	5.66	64	0.088
	3.40	55	0.062
	1.88	47	0.040
	2.53	51	0.050
	3.15	56	0.056
	2.26	52	0.043
	2.50	54	0.046
	2.36	53	0.045
	1.84	51	0.036
	3.44	59	0.058
	2.67	54	0.049
	2.94	57	0.052
	2.76	57	0.048
	6.99	67	0.104
	3.51	60	0.059
	2.44	54	0.045
	3.18	58	0.055
	3.23	57	0.057
	2.21	53	0.042
	2.95	55	0.054
	2.37	52	0.046

Fish Sample Data – May 31, 2008			
Time	Weight (g)	Length (mm)	Health Index
03:00	2.84	55	0.052
	6.74	66	0.102
	2.16	52	0.042
	2.55	56	0.046
	3.18	60	0.053
	3.71	59	0.063
	2.77	57	0.049
	2.51	55	0.046
	1.68	45	0.037
	2.38	52	0.046
	2.54	54	0.047
	6.44	66	0.098

Fish Sample Data – May 31, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
03:00	2.3	54	0.043
	2.35	54	0.044
	2.64	56	0.047
	2.63	53	0.050
	2.6	55	0.047
	4.16	57	0.073
	3.33	59	0.056
	5.19	63	0.082
	3.84	58	0.066
	2.26	53	0.043
	6.13	65	0.094
	3.76	56	0.067
	4.76	59	0.081
	3.16	54	0.059
	2.77	56	0.049
	2.38	52	0.046
	2.69	53	0.051
	2.77	55	0.050
	6.82	65	0.105
	2.21	52	0.043
	3.68	55	0.067
	3.66	56	0.065
	5.14	64	0.080
	2.73	53	0.052
	2.44	53	0.046
	5.41	58	0.093
	5.32	65	0.082
	3.29	58	0.057
	2.66	55	0.048
	2.31	54	0.043
	3.11	54	0.058
	6.14	59	0.104
	2.88	55	0.052
	3.20	53	0.060
	4.20	64	0.066
	5.69	63	0.090
	2.94	57	0.052
	3.09	57	0.054
Average	3.26	56	0.058

A fifty hour passage test commenced on 25 June, 2008 at 9:00 and finished at 11:00 on 27 June, 2008. The test was conducted using an average flow rate of 0.32 m/s. One hundred ninety four fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling approximately a 1% passage rate. One hundred sixty fish were captured at 11:00 hours on 25 June, 17 fish were caught at 15:00 hours on 25 June, 7 fish were caught at 03:00 hours on 26 June, and 10 fish were captured at 23:00 hours on the final day 26 June. One hundred seventy seven fish, or 91.2% of the captured fish were done so during daylight hours. Seventeen fish, or 8.7% of the captured fish were done so after sun down. Subsample data for the month of June was not available.

Summary of 50 hour RGSM passage test conducted June 25 – 27, 2008

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
June 25	01-03:00	75°F/calm	0.30	5.0	91.4	8.41	14	21.2	160
June 25	05-07:00	na	0.31	5.25	115.4	8.80	10	21.9	17
June 25	09-11:00	na	0.33	5.25	98.9	8.91	9	22.6	0
June 25	01-03:00	na	0.31	6.0	86.1	8.85	9	22.1	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
June 26	01-03:00	na	0.30	5.0	73.9	8.79	8	21.8	7
June 26	05-07:00	na	0.30	5.0	69.2	8.69	7	21.3	0
June 26	09-11:00	na	0.31	5.0	68.6	8.72	6	21.2	0
June 26	01-03:00	na	0.30	5.0	91.1	8.90	7	22.8	0
June 26	05-07:00	na	0.33	5.0	93.4	8.91	9	22.4	0
June 26	09-11:00	na	0.34	5.0	82.6	8.70	7	21.8	10

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
June 27	01-03:00	na	na	na	na	na	na	na	na
June 27	05-07:00	na	0.33	5.0	62.5	8.7	6	20.8	0
June 27	09-11:00	na	0.35	5.0	68.2	8.7	7	20.5	0
Total/Avg.			0.32	5.13	83.4	8.76	8	21.7	194

Fish Sample Data – June 25, 2008			
Time	Weight (g)	Length (mm)	Health Index
Subsample data not available			

Fish Sample Data – June 26, 2008			
Time	Weight (g)	Length (mm)	Health Index
Subsample data not available			

A partial fifty hour passage test commenced on 30 July, 2008 at 09:00 and finished at 11:00 on 30 July, 2008. The test was aborted after 10 hours due to a malfunction in the passage system involving an immediately irreparable intake cage, which was allowing passed fish to escape. The partial test was conducted at an average flow rate of 0.31 m/s. Approximately two hundred seventy eight (278) fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling a 1.4% passage rate. One hundred percent of the fish captured during the partial test were caught during daylight hours before the test was aborted. Three subsamples, totaling 65 fish, were removed from the inflow cage, weighed, and measured. The average fish weight was 0.26g. The average fish length was 26mm. The average Health Index (HI) of the fish was 0.010. Repairs were made to the equipment in the days following the aborted monthly passage test. This aborted test will be made up in the upcoming months in order to meet the 12 month study requirement. The data for this month will not be used in the final 12 month study statistics summary, however they have been included in this report to be used as background data for further studies.

Summary of partial 50 hour RGSM passage test conducted on July 30, 2008

Date	Start time	Run time (hrs)	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
July 30	09:00	79°F/calm	0.30	5.5	72.4	8.29	21	22.4	15
July 30	13:00	94°F/wind	0.31	5.5	95.6	8.67	19	23.2	250
July 30	17:00	100°F/calm	0.31	5.5	108.8	8.87	18	24.0	13
Total/Avg.			0.31	5.5	92.3	8.61	19	23.2	278

Fish Sample Data – July 30, 2008			
Time	Weight (g)	Length (mm)	Health Index
11:00	0.34	27	0.013
	0.26	25	0.010
	0.28	26	0.010
	0.27	27	0.010
	0.33	28	0.012
	0.60	35	0.017
	0.40	30	0.013
	0.53	32	0.017
	0.35	30	0.012
	0.29	28	0.010
	0.23	26	0.010
	0.40	28	0.014
	0.25	26	0.010
	0.56	31	0.018
	0.27	26	0.010
15:00	0.19	22	0.010

Fish Sample Data – July 30, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
15:00	0.21	23	0.010
	0.16	22	0.010
	0.18	22	0.010
	0.26	26	0.010
	0.18	23	0.010
	0.27	25	0.011
	0.26	26	0.010
	0.16	22	0.010
	0.18	22	0.010
	0.23	26	0.010
	0.21	25	0.010
	0.17	22	0.010
	0.20	24	0.010
	0.18	22	0.010
	0.25	25	0.010
	0.19	24	0.010
	0.28	26	0.010
	0.18	25	0.010
	0.23	24	0.010
	0.23	25	0.010
	0.17	23	0.010
	0.21	23	0.010
	0.21	23	0.010
	0.27	27	0.010
	0.24	25	0.010
	0.21	26	0.010
	0.29	26	0.011
	0.24	26	0.010
	0.25	27	0.010
	0.29	27	0.011
	0.27	26	0.010
	0.30	27	0.011
	0.13	21	0.006
	0.24	24	0.010
	0.25	27	0.010
	0.30	27	0.011
	0.27	26	0.010
	0.20	24	0.008
	0.20	24	0.008

Fish Sample Data – July 30, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
	0.40	29	0.014
	0.22	25	0.009
	0.21	24	0.009
	0.16	22	0.007
	0.22	26	0.008
	0.17	23	0.007
	0.15	22	0.007
	0.17	23	0.007
	0.25	24	0.010
	0.17	22	0.010
19:00	0.38	28	0.014
	0.60	30	0.020
	0.27	27	0.010
	0.23	25	0.009
	0.45	29	0.016
	0.22	35	0.006
Average	0.26	26	0.010

A fifty hour passage test commenced on 28 August, 2008 at 09:00 and finished at 11:00 on 30 August, 2008. The test was conducted using an average flow rate of 0.33 m/s. Five hundred sixty six fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling a 2.9% passage rate. Four hundred ten fish were captured at 23:00 hours on 28 August, 102 fish were captured at 03:00 on 29 August, 46 fish were caught at 05:00 on August 29, and 4 fish were captured at 11:00 on 29 August. Five hundred sixty two fish, or 99% of the total captured, were caught after sun down. Four fish, or 1% of the total captured, were caught during daylight hours. Three subsamples, totaling 146 fish, were removed from the inflow cage, weighed, and measured. The average fish weight was 1.16g. The average fish length was 36mm. The average Health Index (HI) of the fish was 0.025. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted August 28 – 30, 2008

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Aug 28	09-11:00	71°F/calm	0.32	5.0	66.5	7.87	17	21.8	0
Aug 28	13-15:00	87°F/wind	0.33	5.0	101.5	7.87	17	21.8	0
Aug 28	17-19:00	87°F/calm	0.31	5.0	115.0	7.87	16	22.7	0
Aug 28	21-23:00	83°F/wind	0.31	5.0	89.3	8.53	15	22.5	410

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Aug 29	01-03:00	76°F/wind	0.33	5.0	76.2	8.48	12	22.1	102
Aug 29	05-07:00	72°F/calm	0.36	5.0	67.2	8.34	13	21.7	46
Aug 29	09-11:00	74°F/wind	0.31	5.25	71.1	8.33	12	21.4	4
Aug 29	13-15:00	87°F/wind	0.32	5.0	101.5	8.69	12	22.1	0
Aug 29	17-19:00	89°F/wind	0.33	5.25	113.0	8.87	13	22.9	0
Aug 29	21-23:00	78°F/wind	0.33	5.0	91.4	8.76	14	22.7	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Aug 30	01-03:00	72°F/wind	0.35	5.0	74.0	8.61	9	22.5	2
Aug 30	05-07:00	65°F/calm	0.35	5.0	65.3	8.51	11	21.7	2
Aug 30	09-11:00	71°F/calm	0.33	5.0	71.6	8.46	11	21.4	0
Total/Avg.			0.33	5.04	84.9	8.40	13	22.1	566

Fish Sample Data – August 28, 2008			
Time	Weight (g)	Length (mm)	Health Index
23:00	0.58	33	0.018
	0.76	37	0.021
	0.42	29	0.014
	0.46	28	0.016
	0.63	32	0.020
	0.29	25	0.012
	4.74	66	0.072
	0.41	29	0.014
	0.37	25	0.015
	0.76	34	0.022
	0.33	26	0.013
	0.31	27	0.011
	0.62	32	0.019
	0.65	33	0.020
	0.57	32	0.018
	5.79	71	0.082
	0.39	28	0.014
	0.46	25	0.018
	0.41	28	0.015
	0.50	26	0.019
	0.36	26	0.014
	0.72	34	0.021

Fish Sample Data – August 28, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
23:00	0.85	38	0.022
	0.74	35	0.021
	0.27	25	0.011
	0.28	24	0.012
	0.64	34	0.019
	0.39	27	0.014
	0.70	35	0.020
	0.32	27	0.012
	0.34	25	0.014
	0.30	25	0.012
	0.51	31	0.016
	0.25	24	0.010
	0.59	32	0.018
	0.74	34	0.022
	4.18	60	0.070
	0.52	31	0.017
	0.42	28	0.015
	0.35	27	0.013
	0.81	35	0.023
	0.22	22	0.010
	0.44	31	0.014
	0.63	34	0.019
	0.88	38	0.023
	0.65	34	0.019
	0.91	38	0.024
	1.05	40	0.026
	1.26	43	0.029
	5.5	67	0.082

Fish Sample Data – August 29, 2008			
Time	Weight (g)	Length (mm)	Health Index
03:00	0.20	23	0.009
	0.53	30	0.018
	3.08	56	0.055
	0.69	33	0.021
	4.16	63	0.066
	0.79	36	0.022
	0.53	31	0.017

Fish Sample Data – August 29, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
3:00	0.92	38	0.024
	0.41	29	0.014
	1.23	43	0.029
	0.47	32	0.015
	0.53	33	0.016
	0.51	33	0.015
	0.70	35	0.020
	1.12	41	0.027
	0.41	29	0.014
	1.41	44	0.032
	1.10	39	0.028
	5.59	73	0.077
	3.68	62	0.059
	0.27	25	0.011
	0.58	32	0.018
	0.42	30	0.014
	0.92	37	0.025
	4.58	63	0.073
	0.64	35	0.018
	0.36	27	0.013
	0.32	25	0.013
	1.15	41	0.028
	0.51	31	0.016
	3.88	54	0.072
	0.67	33	0.020
	0.56	30	0.019
	0.92	38	0.024
	0.50	30	0.017
	0.77	35	0.022
	0.58	35	0.017
	0.45	30	0.015
	0.61	34	0.018
	0.46	27	0.017
	5.96	73	0.082
	3.96	63	0.063
	0.32	27	0.012
	3.84	60	0.064
	6.68	73	0.092
	3.75	62	0.060

Fish Sample Data – August 29, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
	0.31	26	0.012
	0.42	29	0.014
	0.82	37	0.022
	3.82	63	0.061
07:00	0.56	28	0.020
	0.58	29	0.020
	0.93	31	0.030
	0.77	31	0.025
	0.68	29	0.023
	0.85	29	0.029
	0.58	33	0.018
	5.53	71	0.078
	0.95	31	0.031
	0.32	26	0.012
	0.49	29	0.017
	0.25	27	0.009
	0.34	27	0.013
	1.07	36	0.030
	0.41	28	0.015
	0.41	30	0.014
	0.31	36	0.009
	0.47	31	0.015
	0.41	28	0.015
	5.10	65	0.078
	0.42	27	0.016
	0.88	38	0.023
	0.31	22	0.014
	0.33	24	0.014
	0.86	56	0.015
	0.52	31	0.017
	0.57	33	0.017
	0.46	28	0.016
	0.68	30	0.023
	4.96	65	0.076
	0.29	27	0.011
	0.46	31	0.015
	0.45	30	0.015
	3.93	62	0.063
	0.28	26	0.011

Fish Sample Data – August 29, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
07:00	0.61	33	0.018
	0.89	37	0.024
	0.25	27	0.009
	0.43	28	0.015
	0.79	34	0.023
	0.52	31	0.017
	0.43	28	0.015
	0.71	35	0.020
	0.32	28	0.011
	0.33	26	0.013
	5.18	68	0.076
Average	1.16	36	0.025

A fifty hour passage test commenced on 24 September, 2008 at 09:00 and finished at 11:00 on 26 September, 2008. The test was conducted using an average flow rate of 0.34 m/s. One hundred fourteen fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling a 2.9% passage rate. One fish was captured at 23:00 on 24 September, 4 fish were captured at 03:00 on 25 September, 100 fish were captured at 07:00 on 25 September, 2 fish were captured at 11:00 on 25 September, 1 fish was caught at 19:00 on 25 September, 2 fish were captured at 23:00 on 25 September, 1 fish was caught at 01:00 on 26 September, and 3 fish were captured at 7:00 on 26 September. One hundred eleven fish, or 97.4% of the total captured, were captured after sundown. Three fish, or 2.6% of the total captured, were caught during daylight hours. Three sub samples, totaling 54 fish, were removed from the inflow cage, weighed, and measured. The average fish weight was 0.79g. The average fish length was 34mm. The average Health Index (HI) of the fish was 0.020. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted September 24 – 26, 2008

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Sept 24	09-11:00	66°F/wind	0.30	5.0	68.1	8.03	15	18.6	0
Sept 24	13-15:00	85°F/wind	0.34	5.5	102.4	8.47	10	19.2	0
Sept 24	17-19:00	88°F/wind	0.34	5.0	117.3	8.64	10	20.0	0
Sept 24	21-23:00	75°F/wind	0.32	4.75	96.2	8.51	10	19.8	1

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Sept 25	01-03:00	66°F/calm	0.36	4.75	83.3	8.37	10	19.2	4
Sept 25	05-07:00	58°F/calm	0.36	4.75	77.4	8.26	8	18.7	100
Sept 25	09-11:00	67°F/wind	0.35	5.0	81.4	8.26	9	18.2	2
Sept 25	13-15:00	80°F/wind	0.36	4.75	112.3	8.59	9	19.0	0
Sept 25	17-19:00	83°F/wind	0.33	5.0	127	8.72	4	19.8	1
Sept 25	21-23:00	70°F/calm	0.34	4.75	103	8.62	10	19.6	2

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Sept 26	01-03:00	60°F/calm	0.35	4.75	86.8	8.49	9	19.0	1
Sept 26	05-07:00	56°F/calm	0.35	4.75	77.2	8.37	9	18.3	3
Sept 26	09-11:00	66°F/calm	0.36	5.0	78.9	8.36	11	17.9	0
Total/Avg.		26	0.34	4.9	93.2	8.44	10	19.0	114

Fish Sample Data – September 24, 2008			
Time	Weight (g)	Length (mm)	Health Index
23:00	0.65	35	0.019

Fish Sample Data – September 25, 2008			
Time	Weight (g)	Length (mm)	Health Index
03:00	0.36	30	0.012
	0.44	33	0.013
	0.30	27	0.011
	6.05	71	0.085
07:00	0.55	33	0.017
	0.84	37	0.023
	0.38	28	0.014
	0.29	27	0.011
	0.31	26	0.012
	0.62	33	0.019
	1.01	39	0.026
	0.92	33	0.028
	0.48	29	0.017
	0.32	27	0.012
	0.56	34	0.016
	0.30	27	0.011

Fish Sample Data – September 25, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
7:00	0.27	25	0.011
	0.40	28	0.014
	0.51	30	0.017
	0.45	29	0.016
	0.85	39	0.022
	1.33	44	0.030
	0.43	30	0.014
	0.62	33	0.019
	0.27	25	0.011
	0.41	29	0.014
	0.52	30	0.017
	0.57	33	0.017
	0.55	35	0.016
	0.47	31	0.015
	0.47	30	0.016
	0.40	31	0.013
	0.29	25	0.012
	0.48	31	0.015
	0.44	31	0.014
	0.56	33	0.017
	0.55	32	0.017
	0.49	32	0.015
	0.53	34	0.016
	0.52	34	0.015
	0.65	36	0.018
	0.21	29	0.007
	0.64	34	0.019
	0.96	38	0.025
	4.99	64	0.078
	0.50	23	0.022
	4.38	65	0.067
	0.49	33	0.015
	0.57	34	0.017
	0.61	36	0.017
	0.63	34	0.019
	0.30	26	0.012
	0.94	40	0.024
Average	0.79	34	0.020

A fifty hour passage test commenced on 22 October, 2008 at 09:00 and finished at 11:00 on 24 October, 2008. The test was conducted using an average flow rate of 0.29 m/s. Seven hundred fifty three (753) fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling a 3.9% passage rate. Eighteen fish were captured at 23:00 on 22 October, 685 fish were captured at 03:00 on 23 October, 9 fish were captured at 07:00 on 23 October, 27 fish were captured at 23:00 on 23 October, 8 fish were captured at 03:00 on 24 October, and 6 fish were caught at 07:00 on 24 October. Seven hundred fifty three, or 100% of the total were captured after sundown. Zero fish, or 0% of the total were captured during daylight. Five subsamples, totaling 109 fish, were removed from the inflow cage, weighed, and measured. The average fish weight was 2.66g. The average fish length was 50mm. The average Health Index (HI) of the fish was 0.044. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted October 22 – 24, 2008

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Oct 22	09-11:00	48°F/wind	0.31	4.75	71.0	7.70	7	12.9	0
Oct 22	13-15:00	56°F/calm	0.27	5.0	102.9	8.57	6	12.9	0
Oct 22	17-19:00	58°F/wind	0.27	5.0	107.2	8.69	5	12.9	0
Oct 22	21-23:00	47°F/wind	0.31	5.25	91.5	8.59	5	12.4	18

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Oct 23	01-03:00	37°F/calm	0.30	5.25	85.7	8.50	5	11.8	685
Oct 23	05-07:00	31°F/calm	0.31	5.25	85.7	8.42	5	11.0	9
Oct 23	09-11:00	42°F/calm	0.30	5.5	84.6	8.42	5	11.0	0
Oct 23	13-15:00	56°F/calm	0.28	5.5	101.3	8.69	4	10.8	0
Oct 23	17-19:00	62°F/calm	0.29	5.0	104.2	8.79	6	11.2	0
Oct 23	21-23:00	45°F/calm	0.29	5.5	97.3	8.67	4	10.9	27

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night	
Oct 24	13-15:00	42°F/Calm	0.29	5.5	91.5	8.58	4	10.3	8	
Oct 24	17-19:00	42°F/Calm	0.30	5.5	90.1	8.50	4	9.8	6	
Oct 24	21-23:00	42°F/Calm	0.31	5.0	87.2	8.51	4	9.3	0	
Total/Avg.			26	0.29	5.23	92.3	8.51	5	11.3	753

Fish Sample Data – October 22, 2008			
Time	Weight (g)	Length (mm)	Health Index
23:00	1.46	45	0.032
	0.85	38	0.022
	5.95	72	0.083
	1.84	48	0.038
	0.72	35	0.021
	0.85	36	0.024
	5.51	67	0.082
	8.06	77	0.105
	0.82	35	0.023
	1.73	47	0.037
	1.10	42	1.000
	1.10	39	0.028
	0.48	32	0.015
	4.57	65	0.070
	0.66	33	0.020
	0.95	38	0.025
	1.71	46	0.037
	0.4	28	0.014

Fish Sample Data – October 23, 2008			
Time	Weight (g)	Length (mm)	Health Index
03:00	0.83	36	0.023
	4.73	67	0.071
	7.94	78	0.102
	1.04	39	0.027
	0.72	36	0.020
	0.88	38	0.023
	1.48	46	0.032
	5.76	68	0.085
	6.10	71	0.086
	0.95	38	0.025
	2.49	53	0.047
	0.75	34	0.022
	1.79	43	0.042
	0.72	36	0.020
	5.02	68	0.074
	6.73	75	0.090
	1.83	48	0.038

Fish Sample Data – October 23, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
03:00	4.08	63	0.065
	0.73	34	0.021
	1.25	42	0.030
	4.68	68	0.069
	5.28	69	0.077
	1.45	46	0.032
	1.41	43	0.033
	0.38	28	0.014
	4.95	68	0.073
	6.63	69	0.096
	5.73	69	0.083
	5.47	66	0.083
	1.12	40	0.028
	1.04	38	0.027
	0.57	34	0.017
	1.17	41	0.029
	3.9	63	0.062
	5.28	67	0.079
	7.11	73	0.097
	1.57	46	0.034
	0.86	38	0.023
	1.16	41	0.028
	0.46	30	0.015
	1.46	46	0.032
	0.77	36	0.021
	0.79	36	0.022
	1.68	45	0.037
	4.47	65	0.069
	1.04	40	0.026
	0.95	38	2.500
	4.97	64	0.078
	5.84	68	0.086
	5.27	66	0.080
07:00	4.97	65	0.076
	6.06	68	0.089
	0.69	36	0.019
	0.72	38	0.019
	0.46	34	0.014
	0.57	35	0.016

Fish Sample Data – October 23, 2008 cont.			
Time	Weight (g)	Length (mm)	Health Index
7:00	0.35	29	0.012
	0.78	35	0.022
	0.53	33	0.016
23:00	3.90	68	0.057
	3.73	64	0.058
	0.85	38	0.022
	1.29	44	0.029
	6.36	71	0.090
	1.19	44	0.027
	2.08	50	0.042
	0.79	37	0.021
	0.94	40	0.024
	5.08	75	0.068
	5.34	69	0.077
	1.01	37	0.027
	5.81	74	0.079
	6.57	78	0.084
	1.10	40	0.028
	0.92	38	0.024
	1.60	47	0.034
	2.68	59	0.045
	3.07	68	0.045
	1.10	40	0.028
	1.11	43	0.026
	0.89	36	0.025
	0.80	37	0.022
	0.70	38	0.018
	0.85	39	0.022
	0.80	37	0.022

Time	Weight (g)	Length (mm)	Health Index
07:00	4.25	73	0.058
	8.02	78	0.103
	4.31	64	0.067
	4.69	66	0.071
	4.58	64	0.072
	6.64	73	0.091
Average	2.66	50	0.044

A fifty hour passage test commenced on 24 November, 2008 at 09:00 and finished at 11:00 on 26 November, 2008. The test was conducted using an average flow rate of 0.29 m/s. Four (4) fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling an approximate 0.002% passage rate. Four fish were captured at 03:00 on 26 November. Four fish, or 100% of the total were captured after sundown, A sample of 4 fish were removed from the inflow cage, weighed, and measured. The average fish weight was 1.03g. The average fish length was 41mm. The average Health Index (HI) of the fish was 0.025. No problems were reported with the fish passage system or monitoring equipment. The majority of the fish became inactive due to the changing weather and falling temperatures, and remained within the deep water artificial habitat provided for them within the refugium. Knowledge of this behavior has been established through monthly fish health monitoring in the refugium. This observation may explain the very low passage and capture rate displayed this month.

Summary of 50 hour RGSM passage test conducted November 24 – 26, 2008

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Nov 24	09-11:00	42°F/wind	0.30	5.5	102.7	8.18	6	5.6	0
Nov 24	13-15:00	57°F/calm	0.30	5.5	112.7	8.61	6	6.3	0
Nov 24	17-19:00	53°F/calm	0.31	5.5	112.7	8.67	5	6.7	0
Nov 24	21-23:00	39°F/calm	0.31	5.5	106.9	8.57	5	6.3	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Nov 25	01-03:00	35°F/calm	0.31	5.5	105.9	8.51	4	5.9	0
Nov 25	05-07:00	30°F/calm	0.30	5.75	104.6	8.45	4	5.4	0
Nov 25	09-11:00	37°F/calm	0.28	5.5	102.4	8.49	5	5.2	0
Nov 25	13-15:00	55°F/calm	0.30	5.5	117.0	8.70	4	5.7	0
Nov 25	17-19:00	52°F/calm	0.30	5.5	117.3	8.71	4	6.0	0
Nov 25	21-23:00	41°F/calm	0.29	5.0	108.9	8.61	4	5.8	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Nov 26	01-03:00	36°F/calm	0.29	5.0	103.2	8.54	4	5.5	4
Nov 26	05-07:00	34°F/calm	0.30	5.0	101.1	8.49	4	5.2	0
Nov 26	09-11:00	42°F/wind	0.30	5.0	107.9	8.51	4	5.1	0
Total/Avg.			0.29	5.37	107.9	8.54	4.5	5.75	4

Fish Sample Data – November 26, 2008			
Time	Weight (g)	Length (mm)	Health Index
03:00	0.97	38	0.026
	1.10	42	0.026
	0.98	41	0.024
	1.08	41	0.026
Average	1.03	41	0.025

The fifty hour passage test was not performed during the month of December, 2008 due to broken pipes in the passage system caused by cold weather. The broken pipes were replaced in the days following the scheduled test in order that the following months test could take place. The December test was made up later in 2009 in order to fulfill the requirements of a 12 month study.

A fifty hour passage test commenced on 28 January, 2009 at 9:00 and finished at 11:00 on 30 January, 2009. The test was conducted using an average flow rate of 0.29 m/s. Two (2) fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling an approximate 0.001% passage rate. One fish was caught at 19:00 on 28 January, and one fish was caught at 19:00 on 29 January. Two fish or 100% of the total were captured after sundown. No fish were captured during daylight. A sample of 2 fish was removed from the inflow cage, weighed, and measured. The average fish weight was 0.78g. The average fish length was 33mm. The average Health Index (HI) of the fish was 0.021. No problems were reported with the fish passage structure or monitoring equipment. The majority of the fish became inactive due to the changing weather and falling temperatures, and remained within the deep water artificial habitat provided for them within the refugium. Knowledge of this behavior has been established through monthly fish health monitoring in the refugium. This observation may explain the very low passage and capture rate displayed this month.

Summary of 50 hour RGSM passage test conducted January 28 – 30, 2009

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Jan 28	09-11:00	34°F/calm	0.31	5.0	102.8	8.01	6	4.5	0
Jan 28	13-15:00	49°F/wind	0.29	5.0	111.1	8.07	7	6.2	0
Jan 28	17-19:00	46°F/wind	0.30	5.0	112.9	8.49	7	6.6	1
Jan 28	21-23:00	na	0.29	4.75	107.1	8.44	7	5.8	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Jan 29	01-03:00	na	0.29	4.75	103.5	8.39	6	5.2	0
Jan 29	05-07:00	na	0.27	4.75	102.4	na	6	4.6	0
Jan 29	09-11:00	37°F/wind	0.28	4.75	103.5	na	7	4.0	0
Jan 29	13-15:00	46°F/wind	0.30	4.75	114.7	na	6	5.6	0
Jan 29	17-19:00	47°F/wind	0.29	4.75	114.1	na	5	6.0	1
Jan 29	21-23:00	37°F/calm	0.29	4.75	107.0	na	5	5.3	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Jan 30	01-03:00	33°F/calm	0.32	4.5	102.1	na	6	4.6	0
Jan 30	05-07:00	29°F/calm	0.30	4.5	101.3	na	4	4.0	0
Jan 30	09-11:00	36°F/calm	0.30	5.0	na	na	7	4.0	0
Total/Avg.			0.29	4.79	106.9	8.28	6.08	5.11	2

Fish Sample Data – January 28, 2009			
Time	Weight (g)	Length (mm)	Health Index
19:00	1.35	41	0.033

Fish Sample Data – January 29, 2009			
Time	Weight (g)	Length (mm)	Health Index
17:00	0.21	25	0.008
Average	0.78	33	0.021

A fifty hour passage test commenced on 25 February, 2009 at 9:00 and finished at 11:00 on 27 February, 2009. The test was conducted using an average flow rate of 0.30 m/s. Zero fish were caught in the inflow cage out of 19,348 total RGSM in the naturalized Refugium, equaling a 0.0% passage rate. Due to the winter season and the accompanying cold water temperatures the Rio Grande silvery minnow had become inactive, and remained in the artificial deep water habitat provided for them within the refugium. This observation may account for the lack of any fish passage or capture this month. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted February 25 – 27, 2009

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Feb 25	09-11:00	50°F/wind	0.27	4.75	99.1	8.29	9	9.6	0
Feb 25	13-15:00	70°F/wind	0.28	4.75	120.4	8.82	9	12.0	0
Feb 25	17-19:00	73°F/wind	0.30	4.75	126.1	8.94	10	12.9	0
Feb 25	21-23:00	62°F/wind	0.31	4.5	102.2	8.78	9	12.4	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Feb 26	01-03:00	59°F/wind	0.32	4.5	93.3	8.62	9	11.8	0
Feb 26	05-07:00	48°F/calm	0.32	4.5	93.1	8.51	8	11.0	0
Feb 26	09-11:00	56°F/wind	0.30	4.5	103.5	8.66	9	10.5	0
Feb 26	13-15:00	69°F/wind	0.28	4.75	127.1	8.92	8	12.7	0
Feb 26	17-19:00	68°F/wind	0.28	4.75	128.7	9.07	10	13.7	0
Feb 26	21-23:00	50°F/calm	0.30	4.75	102.8	8.91	9	12.8	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Feb 27	01-03:00	40°F/wind	0.29	5.0	94.1	8.70	9	11.7	0
Feb 27	05-07:00	35°F/calm	0.30	5.0	90.6	8.60	9	10.6	0
Feb 27	09-11:00	53°F/wind	0.30	4.75	99.7	8.73	8	9.9	0
Total/Avg.			0.30	4.71	106.2	8.73	8.92	11.66	0

Fish Sample Data – February 25-27, 2009			
Time	Weight (g)	Length (mm)	Health Index
No fish passage			

A fifty hour passage test commenced on 25 March, 2009 at 09:00 and finished at 11:00 on 27 March, 2009. The test was conducted using an average flow rate of 0.30 m/s. Zero fish were caught in the inflow cage out of 10,000 total RGSM in the naturalized Refugium, equaling a 0.0% passage rate. Due to the winter season and the accompanying cold water temperatures the Rio Grande silvery minnow had become inactive, and remained in the artificial deep water habitat provided for them within the refugium. This observation may account for the lack of any fish passage or capture this month. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted March 25 – 27, 2009

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Mar 25	09-11:00	42°F/Calm	0.32	4.75	97.0	8.32	7	11.8	0
Mar 25	13-15:00	59°F/Calm	0.30	4.75	117.2	8.93	8	13.5	0
Mar 25	17-19:00	62°F/Calm	0.28	5.0	123.3	9.02	7	15.2	0
Mar 25	21-23:00	54°F/Calm	0.31	5.0	105.7	8.96	6	14.4	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Mar 26	01-03:00	50°F/Calm	0.32	5.0	94.8	8.84	10	13.6	0
Mar 26	05-07:00	47°F/Calm	0.31	5.0	89.8	8.77	7	12.9	0
Mar 26	09-11:00	50°F/Calm	0.30	5.0	98.3	8.75	8	12.3	0
Mar 26	13-15:00	57°F/Calm	0.29	5.0	115.6	8.95	7	12.6	0
Mar 26	17-19:00	57°F/Calm	0.27	4.75	118.7	9.11	7	13.4	0
Mar 26	21-23:00	39°F/Calm	0.33	5.0	102.9	8.96	6	12.4	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
Mar 27	01-03:00	35°F/Calm	0.29	5.0	94.6	8.89	7	11.6	0
Mar 27	05-07:00	32°F/Calm	0.31	5.0	89.5	8.79	7	10.6	0
Mar 27	09-11:00	29°F/Calm	0.31	5.0	94.3	8.82	7	9.4	0
Total/Avg.			0.30	4.9	103.2	8.85	7.23	12.59	0

Fish Sample Data – March 25 - 27, 2009			
Time	Weight (g)	Length (mm)	Health Index
No fish passage			

A fifty hour passage test commenced on 22 April, 2009 at 09:00 and finished at 11:00 on 24 April, 2009. The test was conducted using an average flow rate of 0.30 m/s. One (1) fish was caught in the inflow cage out of 10,000 total RGSM in the naturalized Refugium, equaling a 0.001% passage rate. One fish, or 100% of the total was caught after sun down. Although more moderate temperatures were recorded in the refugium, the Rio Grande silvery minno remained nearly inactive in their deep water habitat. This observation may account for the minimal passage and capture rate for this month. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted April 22 - 24, 2009

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
April 22	09-11:00	56°F/Calm	0.30	4.5	94.1	7.8	7	16.1	0
April 22	13-15:00	76°F/Calm	0.30	5	120.1	8.72	6	18.8	0
April 22	17-19:00	80°F/calm	0.27	4.75	129.5	8.94	7	20.2	0
April 22	21-23:00	75°F/calm	0.29	5	99.8	8.86	7	19.6	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
April 23	01-03:00	na	0.32	5	81.5	8.64	7	18.8	0
April 23	05-07:00	na	0.31	5	78.7	8.46	7	17.9	0
April 23	09-11:00	72°F/Calm	0.27	4.75	96.8	8.58	5	17.3	0
April 23	13-15:00	80°F/Calm	0.28	4.75	127.1	8.87	7	19.5	0
April 23	17-19:00	80°F/Calm	0.31	4.75	133.8	9.11	7	21.2	0
April 23	21-23:00	64°F/Calm	0.32	4.5	100.9	9.01	8	20.4	1

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
April 24	01-03:00	50°F/Calm	0.30	5	84	8.72	8	19.2	0
April 24	05-07:00	46°F/Calm	0.33	5	87.2	8.57	8	18.0	0
April 24	09-11:00	62°F/Calm	0.31	4.5	95.4	8.67	5	19.1	0
Total/Avg.			0.30	4.8	102.2	8.69	6.8	18.9	1

Fish Sample Data – April 23, 2009			
Time	Weight (g)	Length (mm)	Health Index
23:00	1.99	47	0.042

A fifty hour passage test commenced on 20 May, 2009 at 09:00 and finished at 11:00 on 22 May, 2009. The test was conducted using an average flow rate of 0.30 m/s. One fish was caught in the inflow cage out of 10,000 total RGSM in the naturalized Refugium, equaling a 0.001% passage rate. One fish, or 100% of the total was caught during daylight. Although more moderate temperatures were recorded in the refugium, the Rio Grande silvery minnow remained nearly inactive in their deep water habitat. This observation may account for the minimal passage and capture rate for this month. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted May 20 - 22, 2009

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
May 20	09-11:00	72°F/Calm	0.28	3.5	94.1	7.98	23	19.7	0
May 20	13-15:00	84°F/Calm	0.29	4.75	112.0	8.78	22	21.2	1
May 20	17-19:00	86°F/Calm	0.28	5.0	119.6	8.98	25	22.0	0
May 20	21-23:00	70°F/Calm	0.29	5.0	91.4	8.83	26	21.6	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
May 21	01-03:00	67°F/Calm	0.32	5	77.1	8.67	24	21.0	0
May 21	05-07:00	61°F/Calm	0.29	5	71.1	8.49	22	20.5	0
May 21	09-11:00	66°F/Calm	0.29	5	85.2	8.45	21	20.0	0
May 21	13-15:00	76°F/Calm	0.28	5	115.8	8.87	23	20.7	0
May 21	17-19:00	74°F/Calm	0.31	5	119.9	9.01	25	20.8	0
May 21	21-23:00	67°F/Calm	0.30	5	93.7	8.97	25	20.6	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
May 22	01-03:00	57°F/Calm	0.31	5.0	75.3	8.79	26	20.1	0
May 22	05-07:00	59°F/Calm	0.30	5.0	74.3	8.63	22	19.5	0
May 22	09-11:00	62°F/Calm	0.31	5.0	78.5	8.61	23	19.2	0
Total/Avg.			0.30	4.9	92.9	8.70	23.6	20.5	1

Fish Sample Data – May 20, 2009			
Time	Weight (g)	Length (mm)	Health Index
15:00	0.41	26	0.015

A fifty hour passage test commenced on 17 June, 2009 at 09:00 and finished at 11:00 on 19 June, 2009. The test was conducted using an average flow rate of 0.30 m/s. Ten fish were caught in the inflow cage out of 10,000 total RGSM in the naturalized refugium, equaling a 0.01% passage rate. Three fish were captured at 07:00 on 18 June, one fish was caught at 11:00 on 18 June, and 6 fish were captured at 03:00 on 19 June. Three fish, or 30% of the total were caught after sundown. Seven fish, or 70% of the total were caught during daylight. A sample of 9 fish was removed from the inflow cage, weighed, and measured. The average fish weight was 1.81g. The average fish length was 50mm. The average Health Index (HI) of the fish was 0.035. No problems were reported with the fish passage structure or monitoring equipment.

Summary of 50 hour RGSM passage test conducted June 17 - 19, 2009

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
June 17	09-11:00	69°F/Calm	0.35	4.0	na	na	67	19.9	0
June 17	13-15:00	79°F/Calm	0.29	4.0	na	na	29	20.7	0
June 17	17-19:00	84°F/Calm	0.33	4.25	na	na	na	21.5	0
June 17	21-23:00	78°F/Calm	0.29	5.0	87	na	34	20.5	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
June 18	01-03:00	66°F/Calm	0.32	5.0	77.7	na	40	20.1	0
June 18	05-07:00	55°F/Calm	0.31	5.0	73.9	na	37	19.5	3
June 18	09-11:00	71°F/Calm	0.34	4.5	87.1	na	41	19.7	1
June 18	13-15:00	84°F/Calm	0.33	4.0	115.6	na	42	21.5	0
June 18	17-19:00	84°F/Calm	0.31	5.0	132.0	na	42	21.5	0
June 18	21-23:00	78°F/Calm	0.33	5.0	101.6	na	41	21.2	0

Date	Start time	Weather	Discharge (m/s)	Depth (in)	DO (% sat)	pH	Turbidity (ntu)	Temp (°C) at start	Fish caught Day/Night
June 19	01-03:00	60°F/Calm	0.32	5.0	85.5	na	38	20.6	6
June 19	05-07:00	54°F/Calm	0.29	4.5	80.2	na	41	19.8	0
June 19	09-11:00	71°F/Calm	0.31	4.5	96.9	na	38	19.6	0
Total/Avg.			0.32	4.6	93.8	na	40.8	20.5	10

Fish Sample Data – June 18, 2009			
Time	Weight (g)	Length (mm)	Health Index
07:00	1.89	49	0.039
	1.55	45	0.034
	1.81	51	0.035

Fish Sample Data – June 19, 2009			
Time	Weight (g)	Length (mm)	Health Index
03:00	1.61	55	0.029
	1.38	52	0.027
	1.93	49	0.039
	1.30	46	0.028
	2.73	54	0.051
	1.44	46	0.031
Average	1.74	50	0.035

The reportable statistics of the first twelve month naturalized refugium passage study are as follows: A final count of 1,791 fish passed successfully through the passage system out of a pool of 179,083 available Rio Grande silvery minnow, equaling a 10% success rate. The final sum of Rio Grande silvery minnow was derived by adding the total amount of fish in the naturalized refugium for each month. Of the 1,791 fish that successfully passed 1,603, or 90% of the total passed after sundown. This leaves 188 of the 1,791 passed fish, or 10% of the total that passed during daylight hours. Zero fish, or 0% of the total passed in air temperatures of 0 to 30°F. Six hundred ninety eight fish, or 38.9% of the total passed in temperatures of 31 to 40°F. Sixty one fish, or 3.4% of the total passed in temperatures of 41 to 50°F. One hundred sixty two fish, or 9% of the total passed in temperatures of 51 to 60°F. Forty two fish, or 2.3% of the total passed in temperatures of 61 to 70°F. Three hundred eighty two fish, or 21.3% of the total passed in temperatures of 71°F to 80°F. Four hundred twelve fish, or 23% of the total passed in temperatures of 81 to 90°F. Weather data was unavailable for thirty four fish, or 1.9%, of the total passed.

Fish Passage Temperature Data May 08 – June 09		
Temperature	Fish Passed	Percentage Passed
0-30°F	0	0%
31-40°F	698	38.9%
41-50°F	61	3.4%
51-60°F	162	9.1%
61-70°F	42	2.3%
71-80°F	382	21.4%
81-90°F	412	23.0%
91-100°F	0	0%
unavailable	34	1.9%
Total	1791	100%

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