PHABSIM Appendix

IFIM/PHABSIM PROTOCOL - Gum Springs

Started with IFG4 deck/file containing all transects and all calibration sets. These were entered from downstream to upstream with a dummy transect.

Two sets of transects were examined:

- Gamble Creek downstream of the USGS gaging station with data from low flow measurement of 13.01 cfs, a medium flow of 22.62 cfs, and a high flow of 25.082 cfs. Because of the closeness of medium and high flows, the simulation was unable to create a realistic stage-discharge relationship and the decision was made to not continue with this simulation.
- Gamble Creek upstream of the USGS gaging station with data from low flow (6.52 cfs), medium flow (12.43 cfs) and high flow (23.99 cfs). The range of simulated flows ranged from 2.6 cfs to 48 cfs.

The simulated flow ranges used in the time-series analysis were from gaging records between 1970 and 1999, essentially the most recent dry AMO period.

The following codes were entered on the N/S lines:

CODE	**DESCRIPTION**
0	**Delimiter**
1	No cover and silt **or** terrestrial vegetation
2	No cover and sand
3	No cover and gravel
4	No cover and cobble
5	No cover and small boulder
6	No cover and boulder, angled bedrock, or woody debris
7	No cover and mud or flat bedrock

8	Overhead vegetation and terrestrial vegetation
9	Overhead vegetation and gravel
10	Overhead vegetation and cobble
11	Overhead vegetation and small boulder, boulder, angled bedrock, or woody debris
12	Instream cover and cobble
13	Instream cover and small boulder, boulder, angled bedrock, or woody debris
14	Proximal instream cover and cobble
15	Proximal instream cover and small boulder, boulder, angled bedrock, or woody debris
16	Instream cover or proximal instream cover and gravel
17	Overhead vegetation or instream cover or proximal instream cover and silt or sand
18	Aquatic Vegetation – macrophytes
100	**Delimiter**

The IFG4 predicted WSL's were placed in a (hand-made) table to be compared with observed WSL's for the given discharges on the CAL lines. The predicted WSL's were all within 0.2 ft of the observed values [accepted surveying error for the "tourch" technique] and IFG4 was considered to be an adequate predictor.

A second discharge is added to each CAL line (see A.51 from the PHABSIM user's manual). This second discharge is the calculated flow for that transect using the velocities measured. This is used as a secondary adjustment factor when predicting velocities and roughness coefficients.

The IFG4 input decks/files were then converted to several IFG4 input decks/files, each with a single velocity set, corresponding to measured calibration sets. The simulated discharges overlap but encompass the measured discharge for that calibration set.

	USGSA. in4	USGSB.in4	USGSC.in4
Simulated Discharge Range	18 – 54 cfs	46 – 104 cfs	96 – 190 cfs
	SPGHA.in4	SPGHB.in4	SPGHC.in4
Simulated Discharge Range	14.3 – 42 cfs	34 – 92 cfs	84 – 175 cfs
	HSPGA.in4	HSPGB.in4	
Simulated Discharge Range	1.1 – 23 cfs	19 – 154 cfs	
	SHOALA.in4	SHOALB.in4	SHOALC.in4
Simulated Discharge Range	14.9 – 43 cfs	39 – 80 cfs	68 – 224 cfs

For each *.IN4 model, an IFG4 run was made. VAF (Velocity Adjustment Factor) values are checked. The slope of the VAF values must be positive. The VAF value at the discharge for which the velocity set is given should be between 0.85 and 1.15. Ideally, such a tight fit allows expansion of the simulation beyond .4 x the lowest discharge and 2 x the highest discharge. If the VAF values are low, no such expansion is recommended.

- Where VAF slope was a problem for a particular transect, WSL's are adjusted up or down [usually lowering WSL increases VAF value and increasing WSL decreases VAF value for given discharge] (based upon the range of WSL's [right bank, center, and left bank] measured in the field).

In all cases, VAF values were found to be acceptable, but low, since all slopes were positive (ranging from 0.714 to 1.172 in each case).

[Note: the table of VAF values is presented after adjustment of Manning's "n" values for some data points]

Discharge	USGSa	USGSb	USGSc
45.5	1.099	0.896	0.847
63.5	1.125	0.906	0.671
91.2	1.15	0.917	0.51 *
Discharge	SPGHa	SPGHb	SPGHc
35.7	0.988	0.975	0.859
45.08	0.998	0.991	0.892
83.65	1.05	1.07	1.001
Discharge	HEADa	HEADb	
Tr1 2.78	1.00	0.539	
Tr1 14.04	1.63	0.759	
Tr1 27.01	1.95	0.815	
Tr2 2.78	.868	0.753	
Tr2 14.04	1.399	0.859	
Tr2 27.01	1.93	0.988	
Tr3 2.78	0.893	0.459	
Tr3 14.04	0.945	0.922	
Tr3 27.01	0.937	1.06	
Discharge	SHOALa	SHOALb	SHOALc
37.26	1.04	0.892	1.324
64.33	0.979	0.759	1.117

112.87	0.857	0.718	0.996

* Unreliable simulation at high flows; may not be critical to MFL evaluation

After each *.IN4 file/model was calibrated to produce the best VAF's possible, the roughness values ("n") **calculated by IFG4** for each transect was checked. Those with values greater than 0.2 are chosen for adjustment. For each transect with some "n" values greater than 0.2, the mean value for "n" is calculated. Those "n" values above the median value are replaced with the mean value on the NS lines of the *.IN4 deck/file. This approach tries to adjust the worst problems without making drastic changes in WSL predictions and it is transect-specific [as compared to creating an NMAX line]. Professional judgment was also used, in some cases, to adjust other "n" values, where appropriate.

After "n" adjustments, IFG4 was run, again, with the adjusted roughness values and particular attention was placed on the predictions of velocities at the highest discharges. Each IFG4 output was checked for velocity "hot spots" at the high discharge simulations. Where predicted velocities exceeded 4.5 fps in a single cell **and** adjacent cells had low velocities, higher "n" values for that vertical/cell were added to the NS lines in the *.IN4 deck/file. This inserted "n" value was usually derived from the "n" values predicted by IFG4 for adjacent cells. When several contiguous cells had velocities that ranged from 3 to 6 fps (especially at high discharges), they were considered to be acceptable (i.e., **not** hot spots).

HABTAV was run with the appropriate HSI models for the "A", "B", "C", etc., models and the ZHAQF output files were examined. These contained habitat (WUA) versus discharge relationships for overlapping discharge ranges.

The overlapping ZHAQF values were combined on a spreadsheet (XCEL or SigmaPlot) into a single habitat versus discharge relationship. Weighted averages were used to combine the overlapping WUA values (these were different since different VAF values to adjust predicted velocities were not the same for comparable discharges in different runs). When an abrupt "jump" in the relationship occured, a plot of WUA/Q values is created and a curve smoothing routine (usually a third or fourth-order polynomial regression in SigmaPlot) was used for those values.

The WAU / Discharge results were prepared for the final report of WUA and Discharge and were the values used for time-series analysis.

Time-Series Analysis

Only one set of discharge data was assessed, from 1970-1999 [roughly equivalent to Dry AMO Years (1970 – 1994)].

The TSLIB (time-series library) from the USGS Mid-Continent Research Laboratories was used to conduct the analysis.

Monthly discharge files were created for existing conditions, 10% monthly flow reductions, 20% monthly flow reductions, 30% monthly flow reductions, and 40% monthly flow reductions. For each set of discharge conditions, a monthly time-series was created as the amount of habitat (WUA) available for each discharge for each month. HAQ files (habitat availability) were created for the high discharge events by linear (first-order regression) or curvilinear (second-order polynomial regression) fits. Duration analysis was then accomplished through the percentage of time that the average and median habitat values were met or exceeded for each month over the period of record. Comparisons to existing conditions were made to evaluate the amount of habitat gain or loss under conditions of reduced flow.

For Gum Springs, the time series analysis ranged over discharges from 10 cfs to 335 cfs, between the years 1968 and 2009.

During this analysis, habitat suitability curves for both “catalog” (USGS Blue Books of habitat suitability) and locally derived HIS’s were compared. Although the catalog and locally derived curves were quite similar, there was sufficient difference in at least one category of local preference (usually in substrate/cover preference, more often than not) that the predicted amount of available habitat was an order of magnitude less for Florida curves as opposed to catalog curves. This result supports conclusions by Gore and Nestler (1988) and Gore et al. (2001) who have indicated that habitat-specific derivations of suitability curves are the most appropriate application for this type of analysis.

The following habitat suitability criteria were used:

Habitat Guilds:

1. Shallow-Slow
2. Shallow-Fast
3. Deep-Slow
4. Deep-Fast

Largemouth Bass

1. Adult
2. Juvenile
3. Spawning
4. Fry

Bluegill

1. Adult
2. Juvenile
3. Spawning
4. Fry

Spotted Sunfish

1. Adult
2. Juvenile
3. Spawning
4. Fry

Benthic Macroinvertebrates

1. Total Community Diversity

Cyprinidae (minnows)

2. Combined all life stages

Since predictions of less initial habitat availability are predicted in the PHABSIM runs for Florida curves, losses in smaller amounts of habitat result in larger incremental gains or losses in habitat. [For example if the catalog curves predict 2350 square feet of habitat under existing conditions (per 1000 linear feet of river) and the time series predicts a loss of 50 square feet of habitat, this results in a 3% habitat loss; however, if Florida curves for the same species predict only 235 square feet of habitat under existing conditions and the time series predicts only a loss of 20 square feet of habitat, the result is a 9% loss]. It should not be surprising, then, that some habitat gain / loss analyses are dramatically different using locally derived habitat information where a much lower initial habitat availability is predicted.

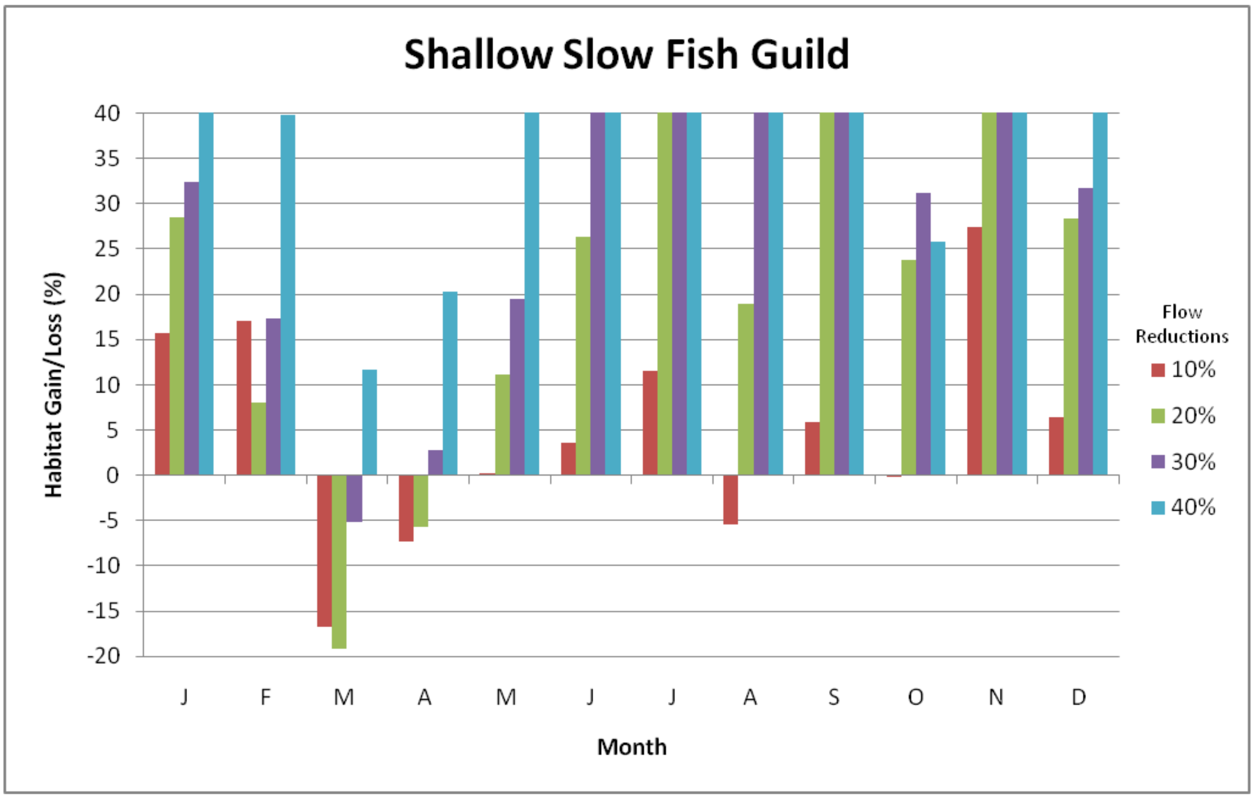
References:

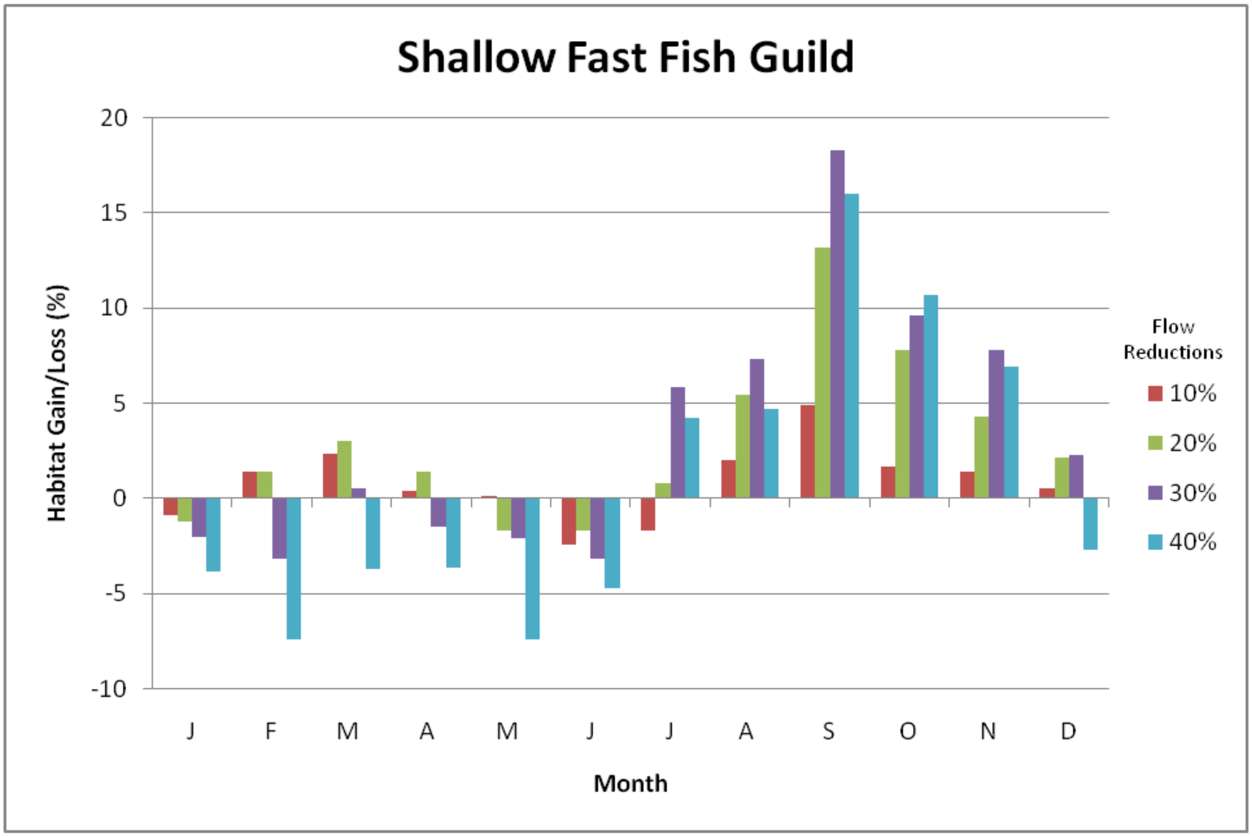
Gore, J.A., and J.M. Nestler. 1988. Instream flow studies in perspective. *Regulated Rivers* 2: 93-101.

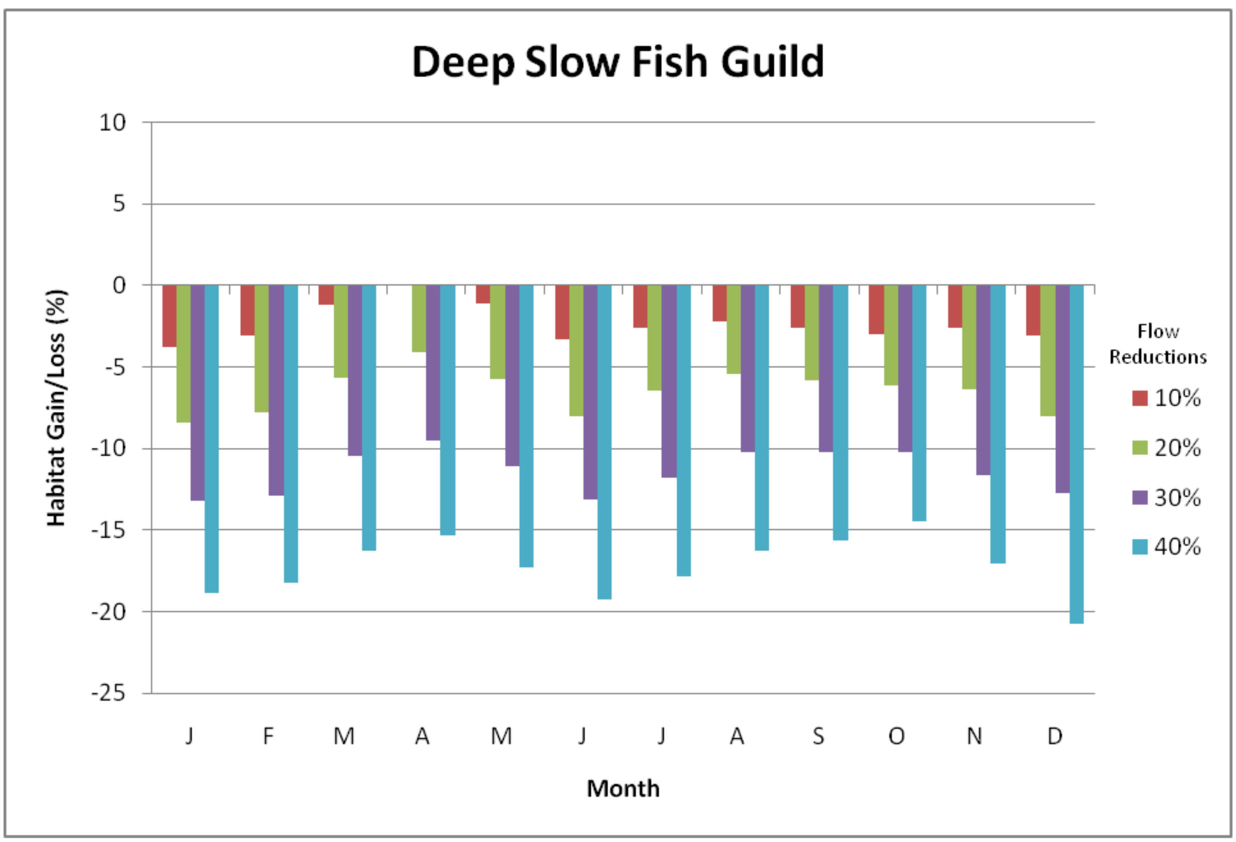
Gore, J.A., J.B. Layzer, and J. Mead. 2001. Macroinvertebrate instream flow studies after 20 years: a role in stream and river restoration. *Regulated Rivers* 17: 527-542.

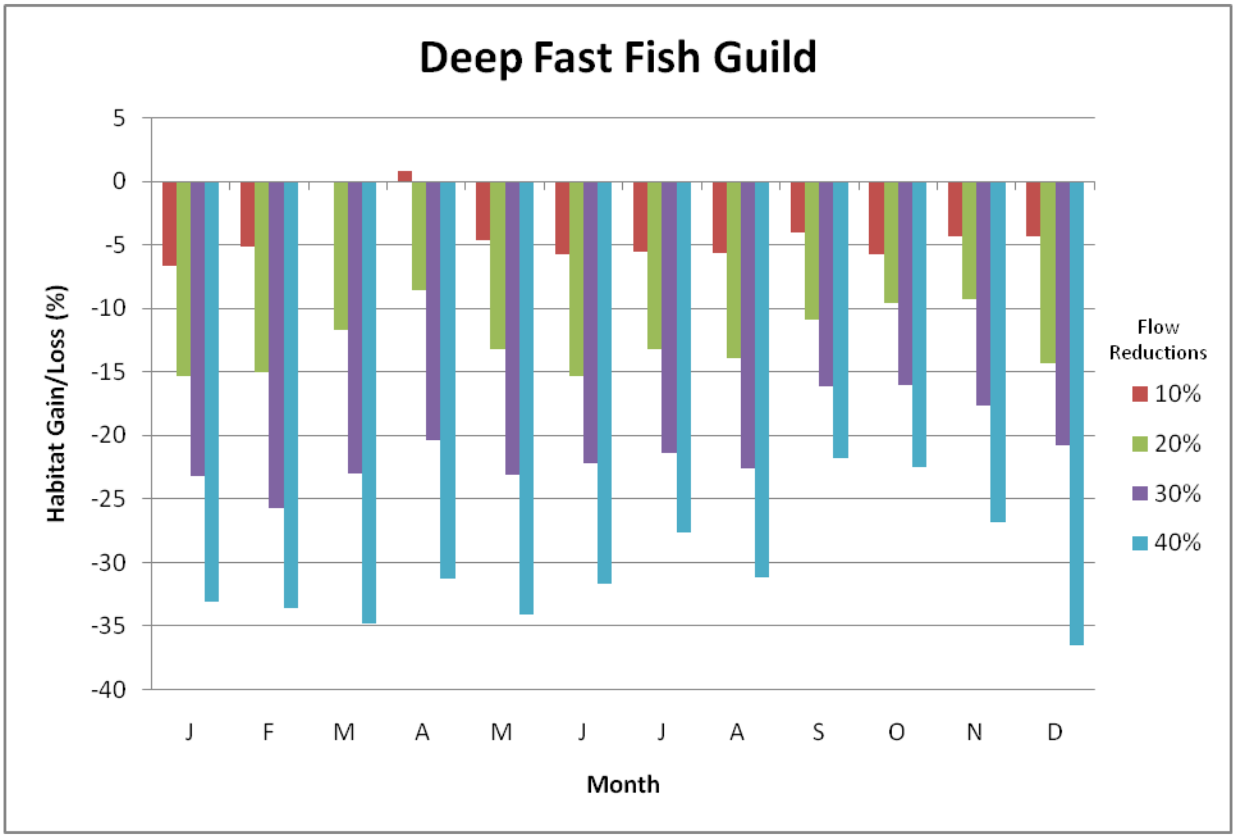
PHABSIM analysis, when given hydrologic data and habitat preferences, establishes a relationship between hydrology and WUA which allows examination of habitat availability in terms of the historic and altered flow regimes. Determining from these data the amount of loss, or deviation from the optimum, that a system is capable of withstanding is based on professional judgment. For the purpose of minimum flows and levels development, we have defined percent-of-flow reductions that result in 15% reduction in habitat from historic conditions as limiting factors. This representation was determined by combining the WUA for all PHABSIM sites for each species, life stage, or guild. The inference is made that the entire study reach is represented equally by the selected PHABSIM sites, which was also the intention when establishing sites. In addition, PHABSIM is typically utilized by the District to determine allowable flow reductions for Block 1 and Block 2 period of the year, utilizing inundation of floodplain features for Block 3 analyses. Wet season months (August, September, October, and November) were not included within this specific analysis due to the base flows being dominated by overland flows. Staff considers the baseflow that feeds Gum Slough Spring Run susceptible to anthropogenic impacts, not overland flows.

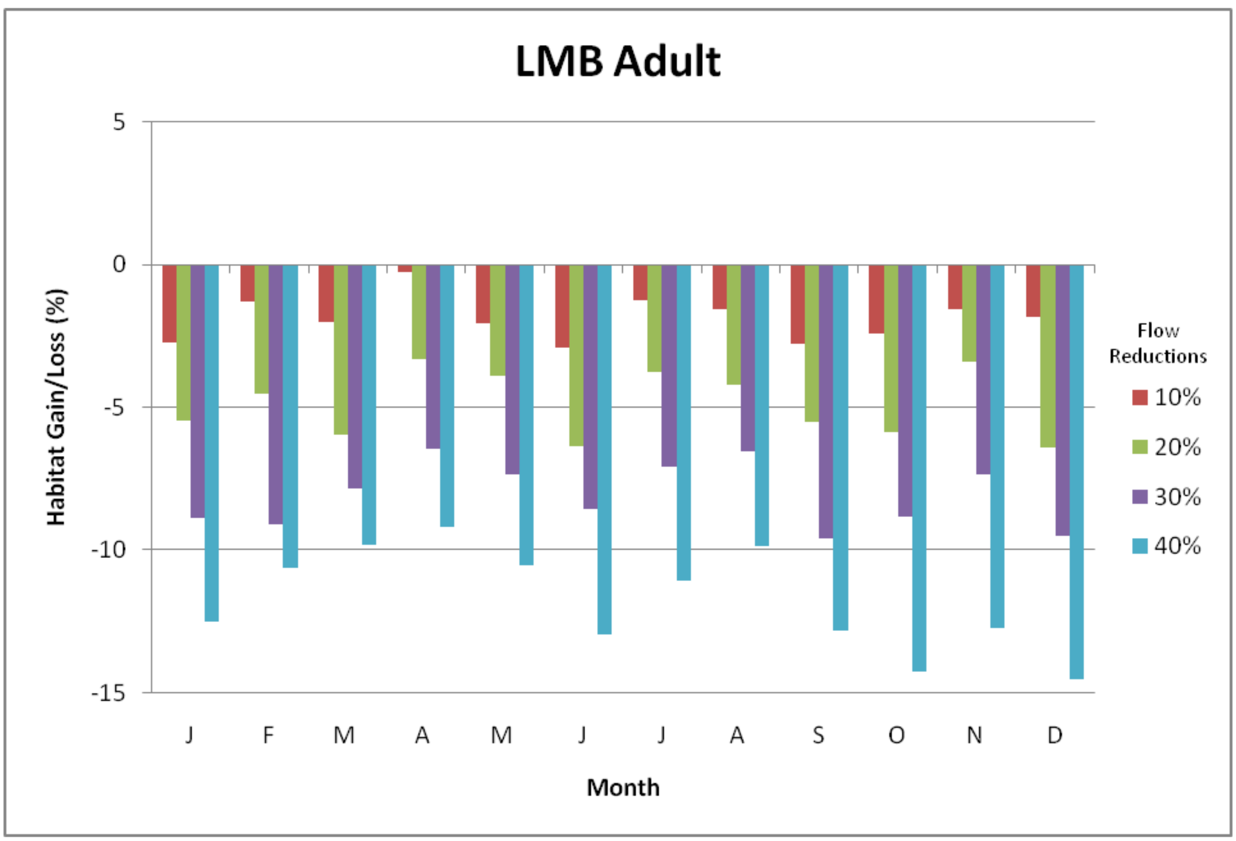
Below are graphics generated for visual inspection of PHABSIM output. They are arranged by species and depict total weighted usable area for the entire reach of the study (all sites combined).

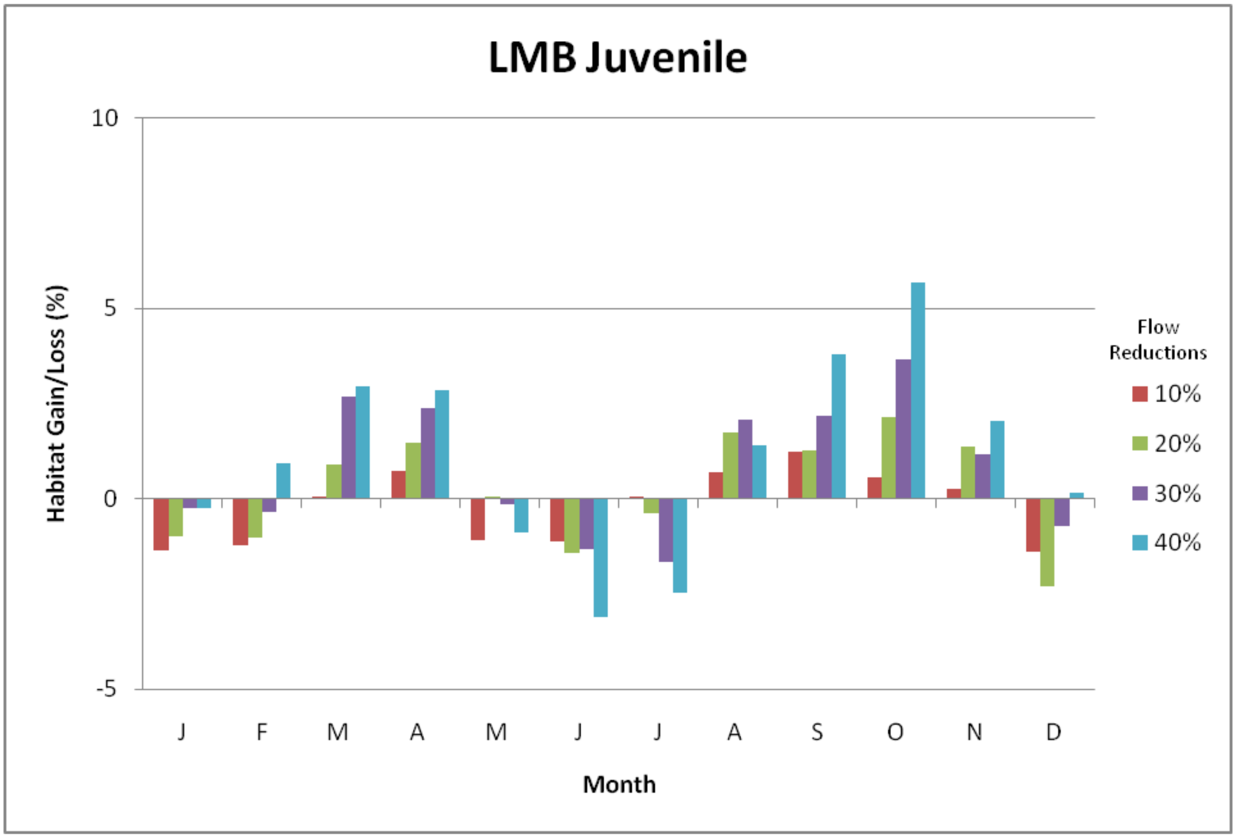



Shallow Fast Fish Guild
Habitat Gain/Loss (%)
20
15
10
5
0
-5
-10
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

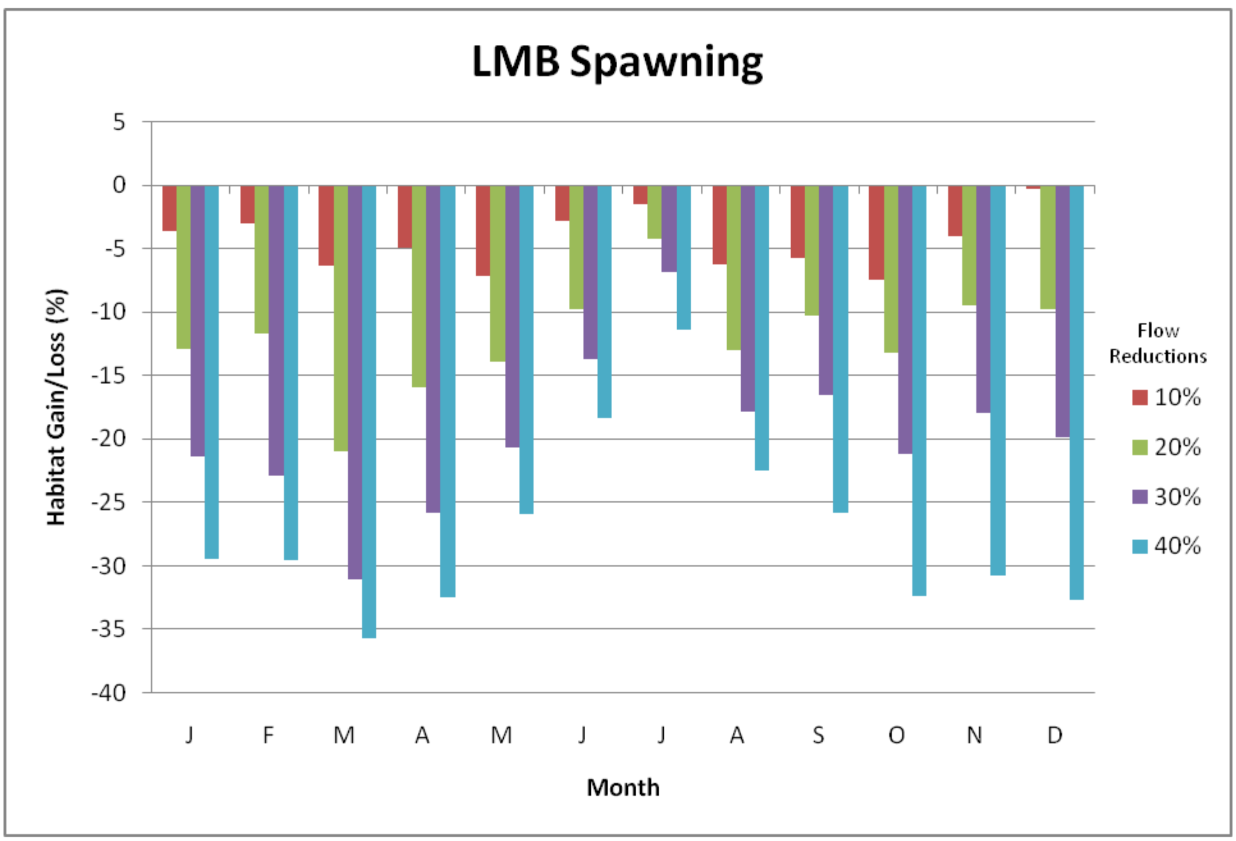

Deep Slow Fish Guild
Habitat Gain/Loss (%)
10
5
0
-5
-10
-15
-20
-25
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%


Deep Fast Fish Guild
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Habitat Gain/Loss (%)
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

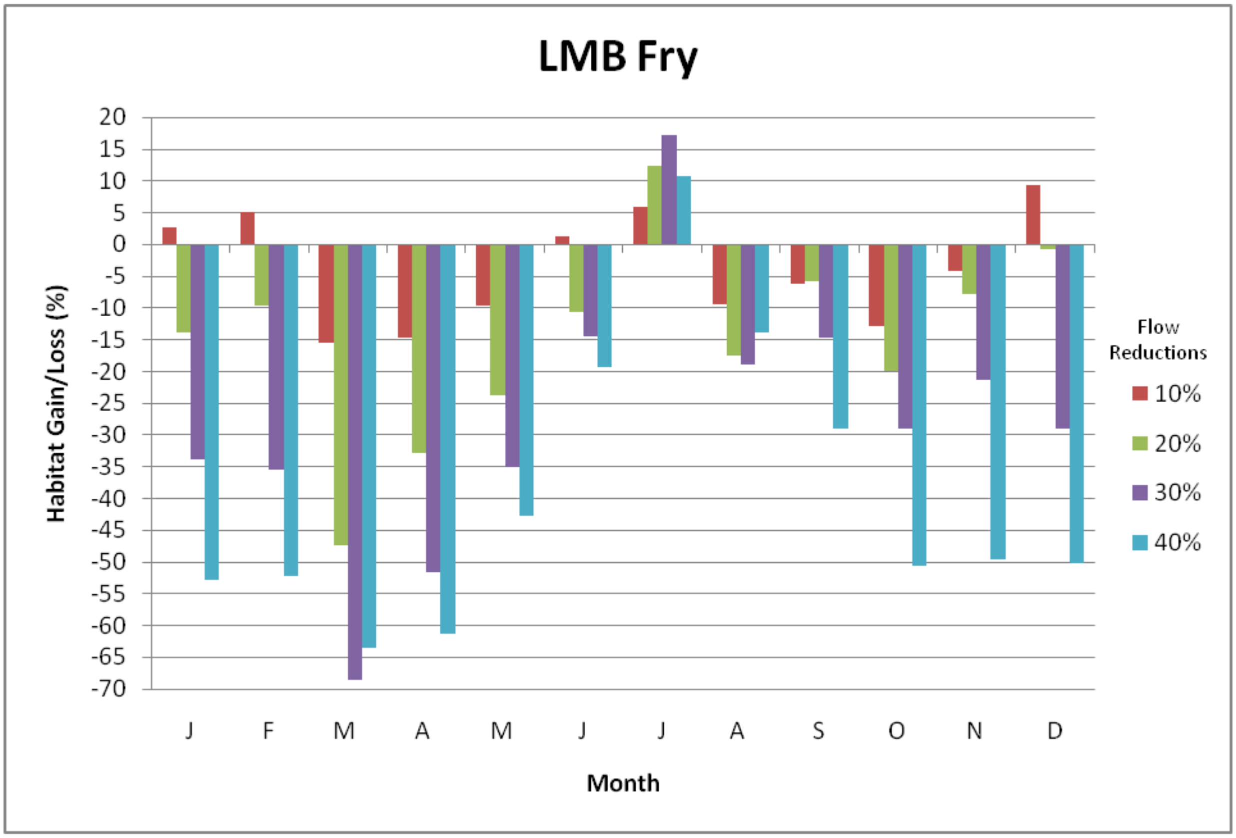

LMB Adult
5
0
-5
-10
-15
Habitat Gain/Loss (%)
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

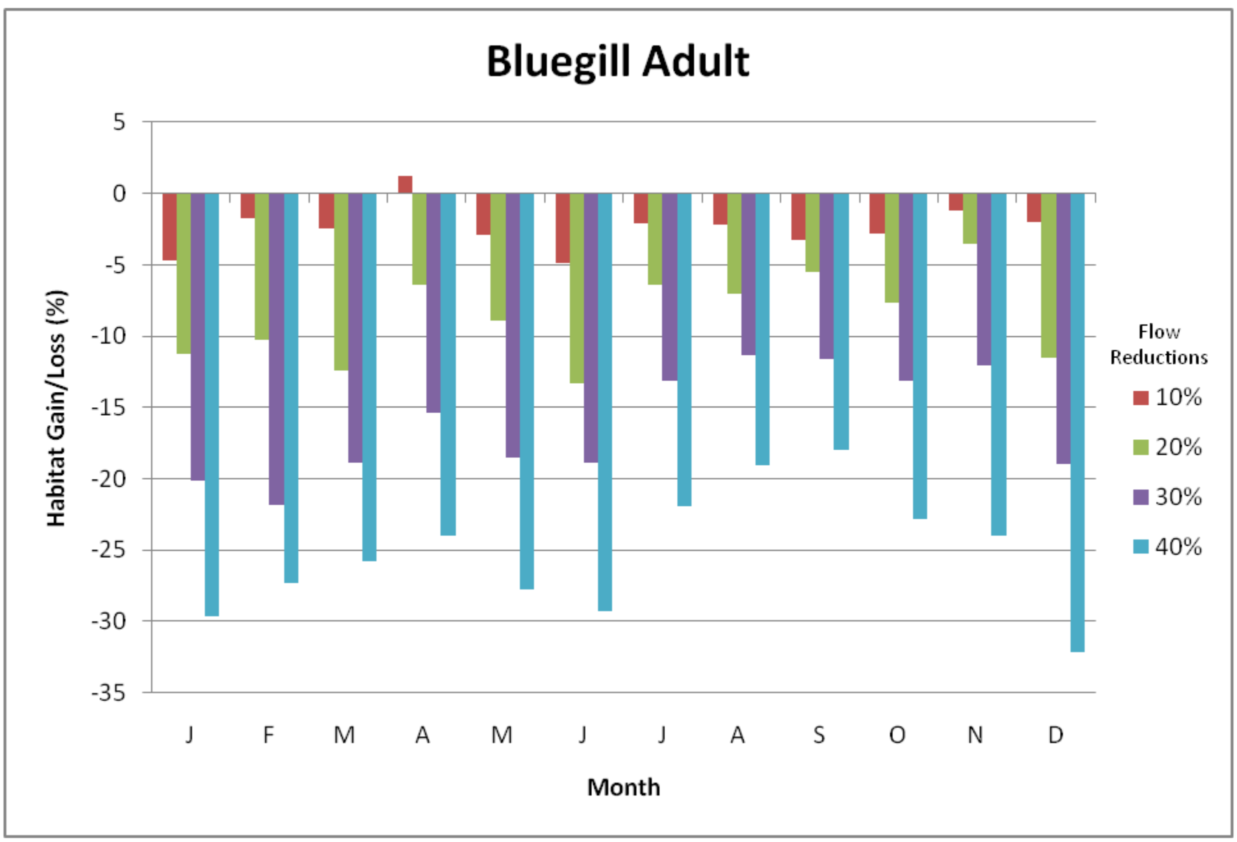


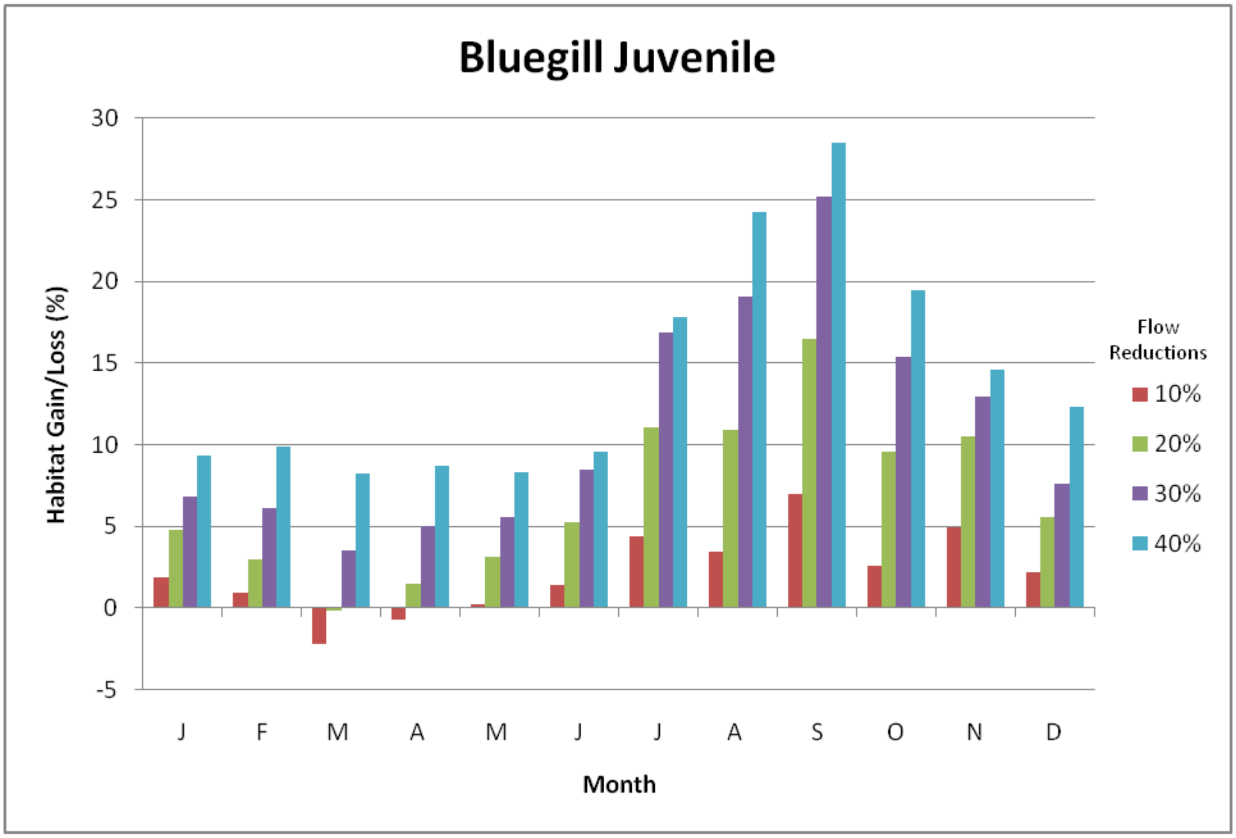
LMB Juvenile
10
5
0
-5
Habitat Gain/Loss (%)
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

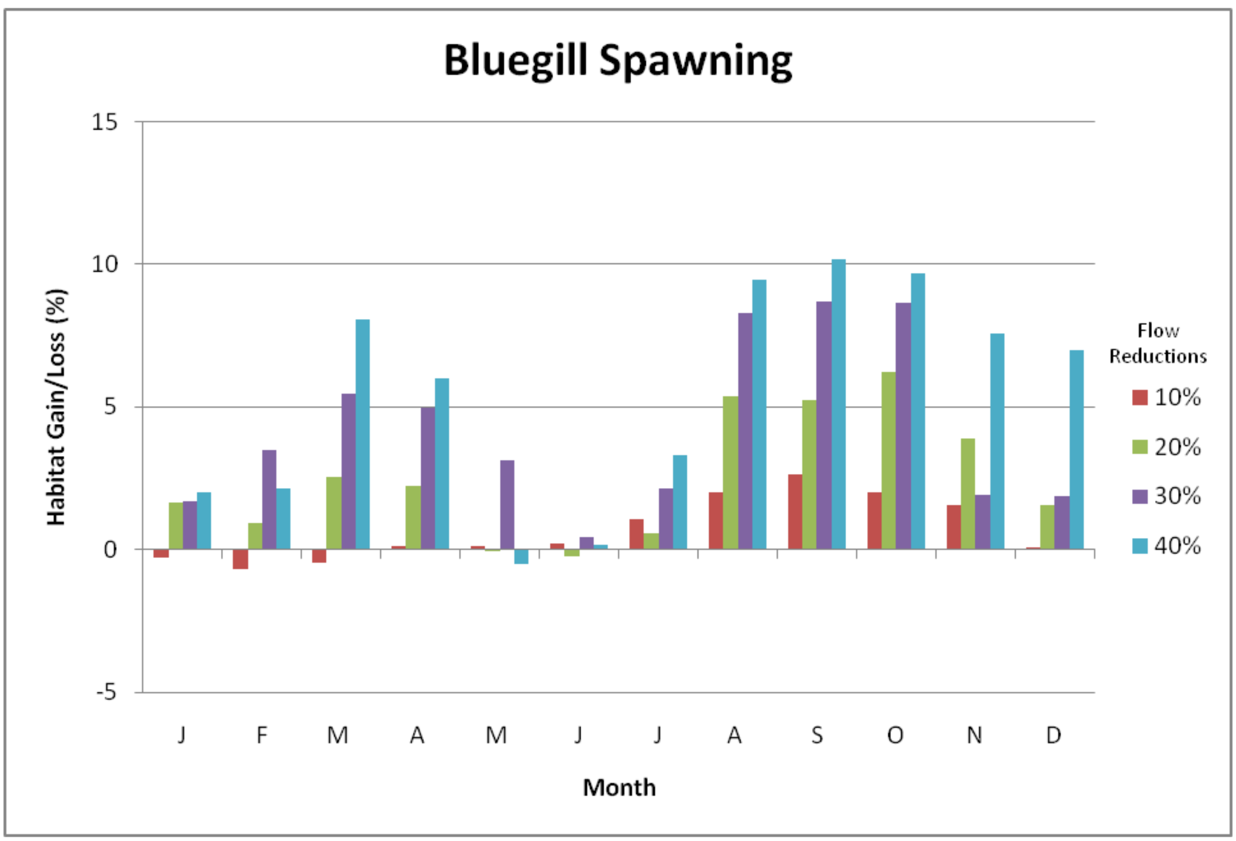


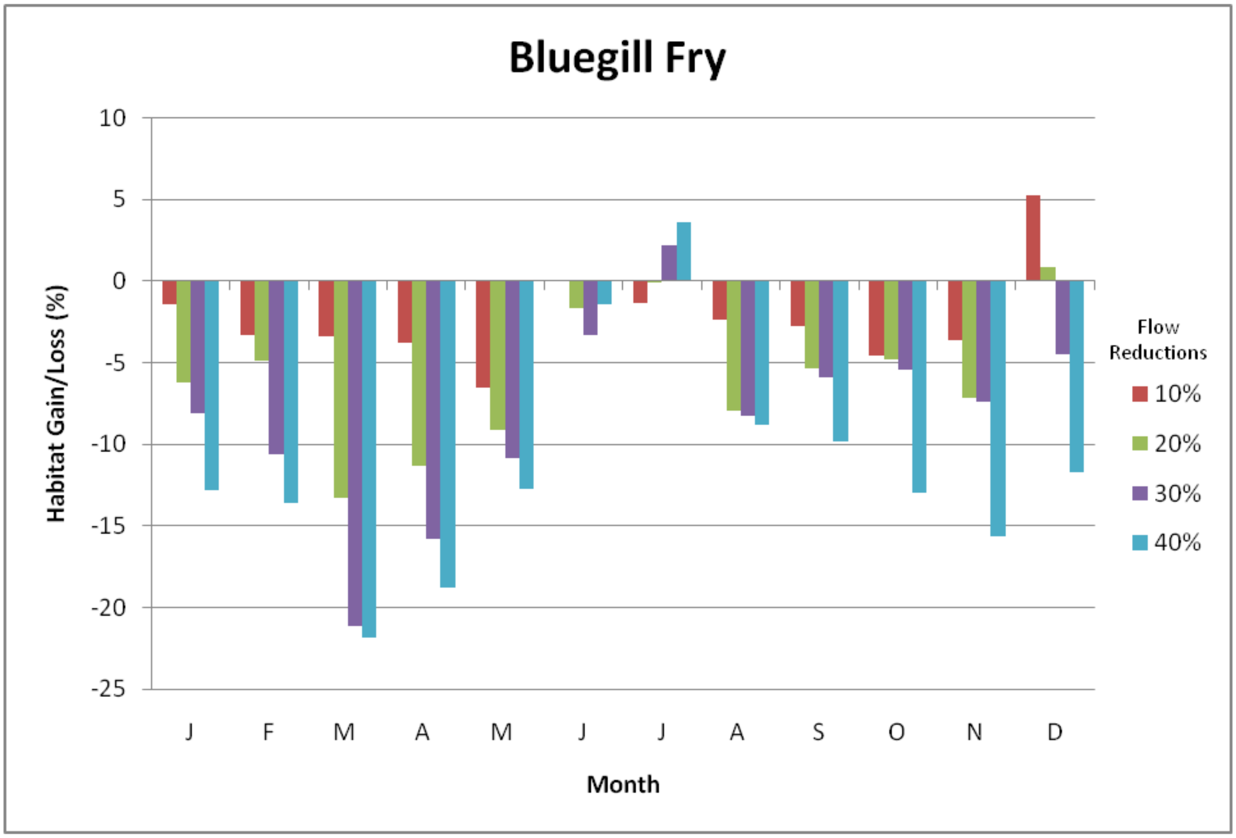
LMB Spawning
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Habitat Gain/Loss (%)
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

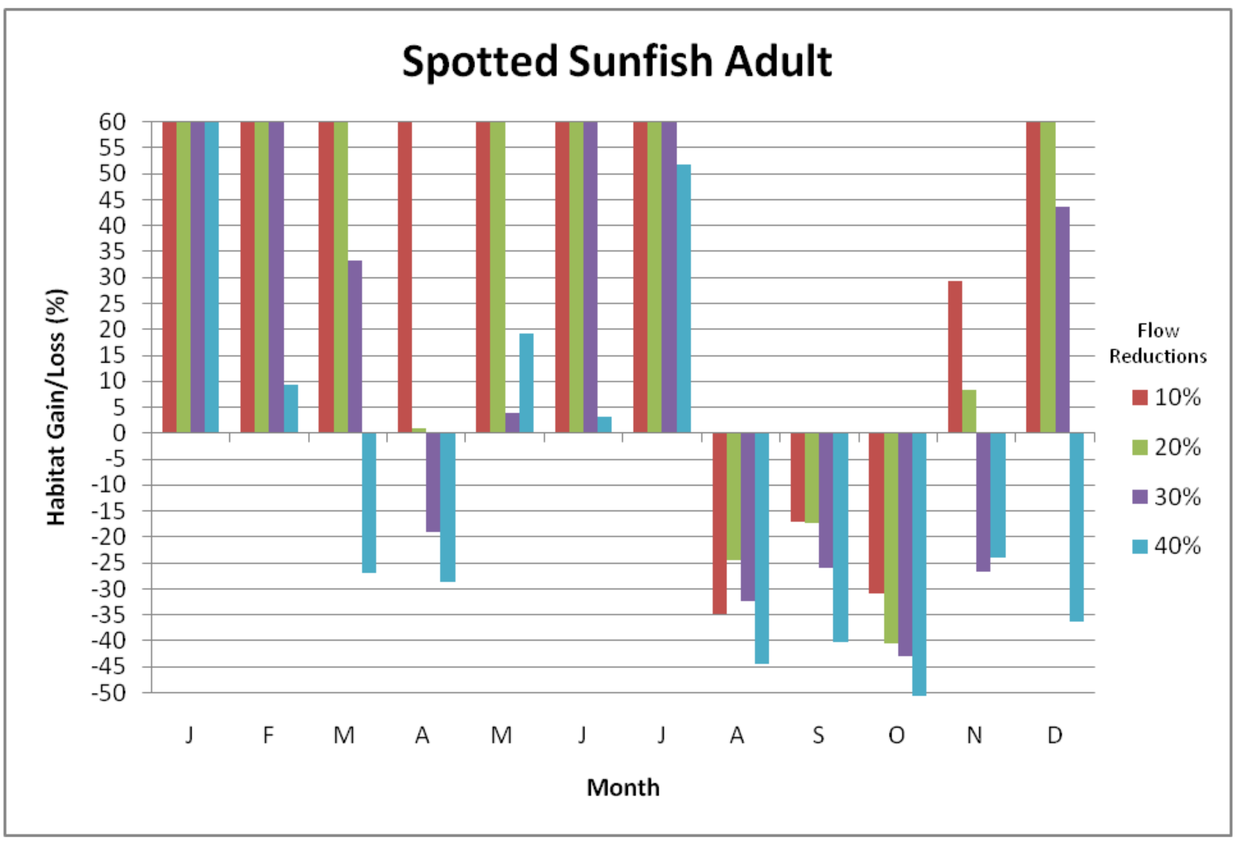

LMB Fry
Habitat Gain/Loss (%)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

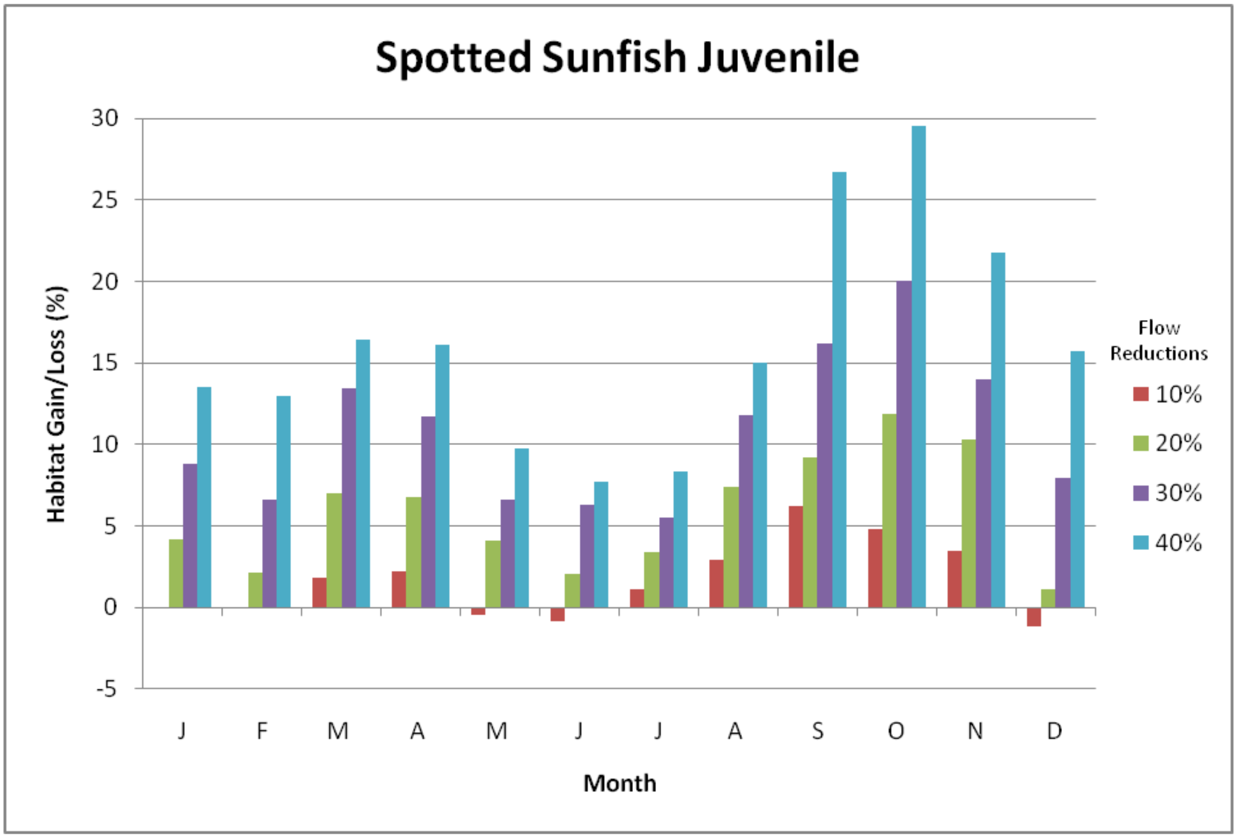

Bluegill Adult
Habitat Gain/Loss (%)
5
0
-5
-10
-15
-20
-25
-30
-35
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%


Bluegill Juvenile
30
25
20
15
10
5
0
-5
Habitat Gain/Loss (%)
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

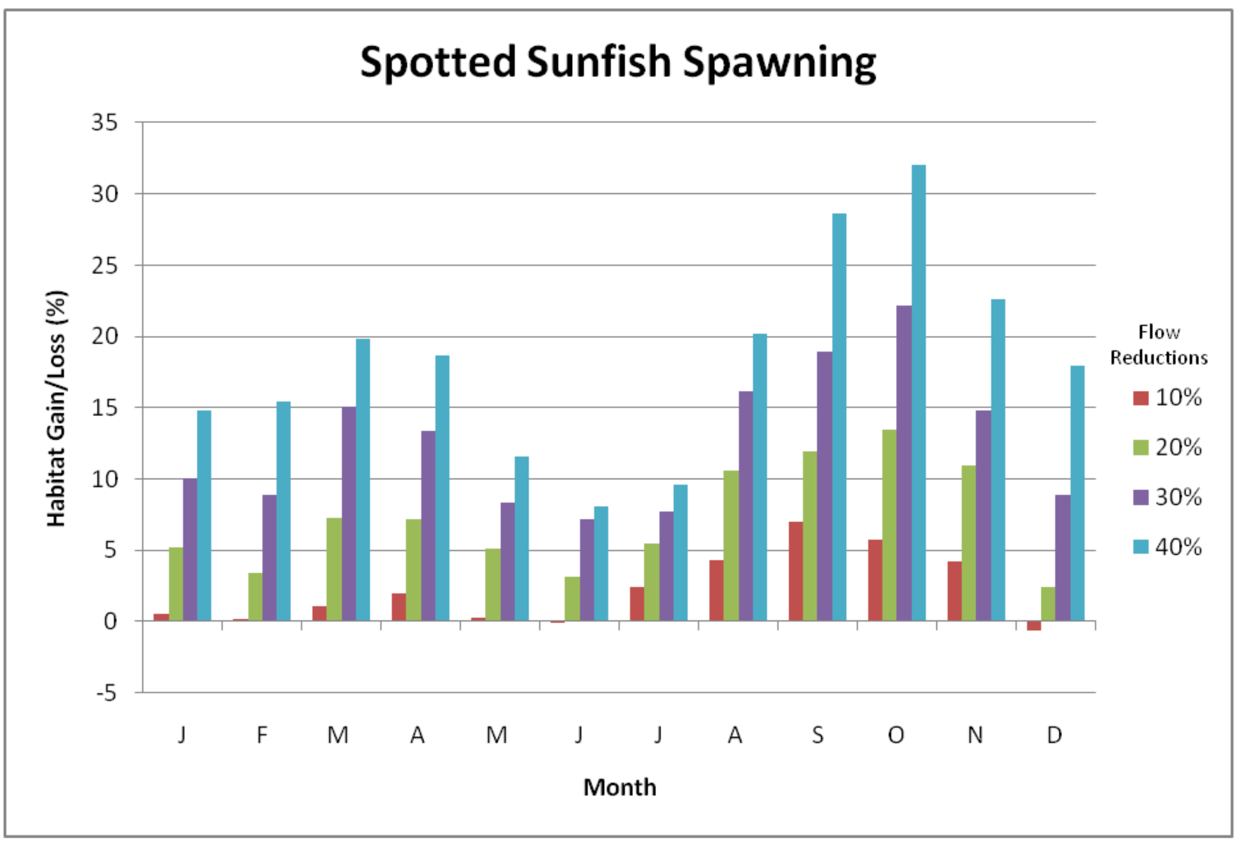

Bluegill Spawning
15
10
5
0
-5
Habitat Gain/Loss (%)
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%


Bluegill Fry
Habitat Gain/Loss (%)
10
5
0
-5
-10
-15
-20
-25
J F M A M J J A S O N D
Month
Flow Reductions
10%
20%
30%
40%

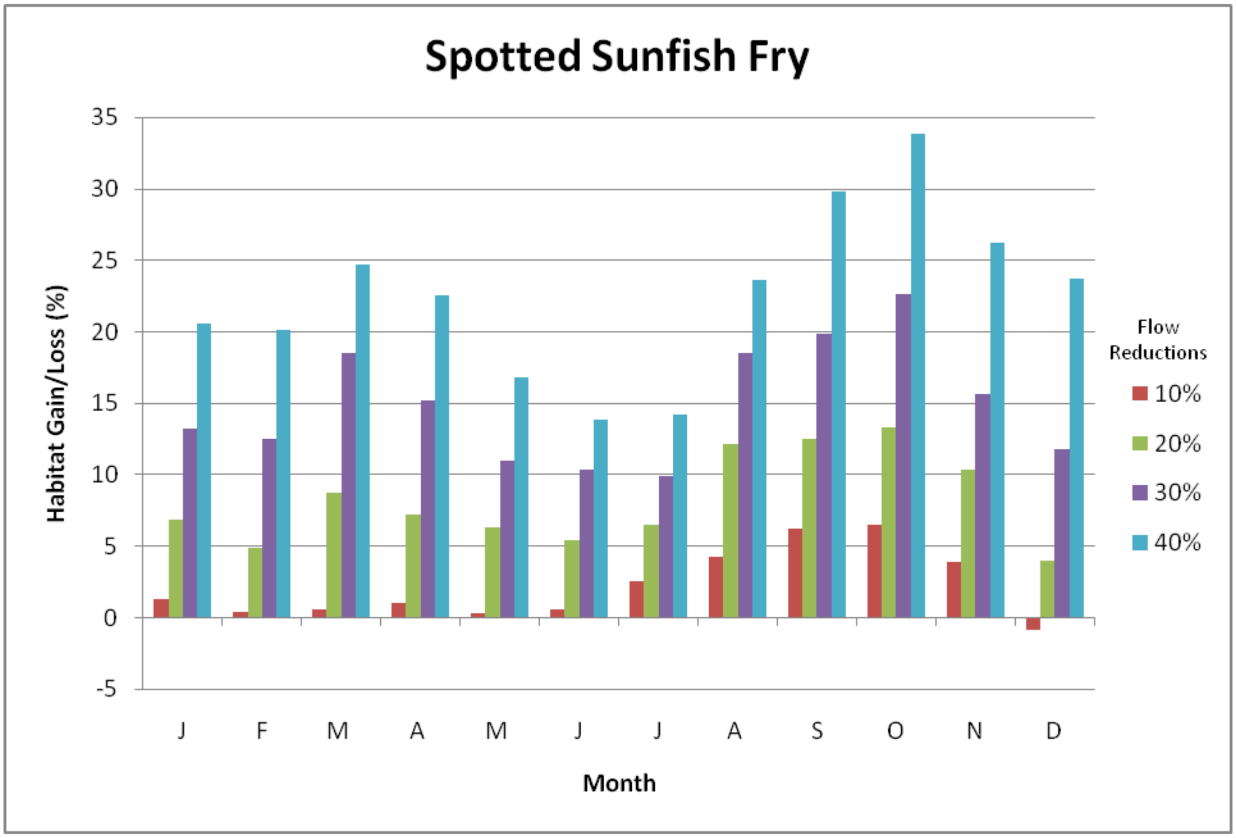

Spotted Sunfish Adult
Habitat Gain/Loss (%)
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
J F M A M J J A S O N D
Month
Flow Reductions
10%
20%
30%
40%

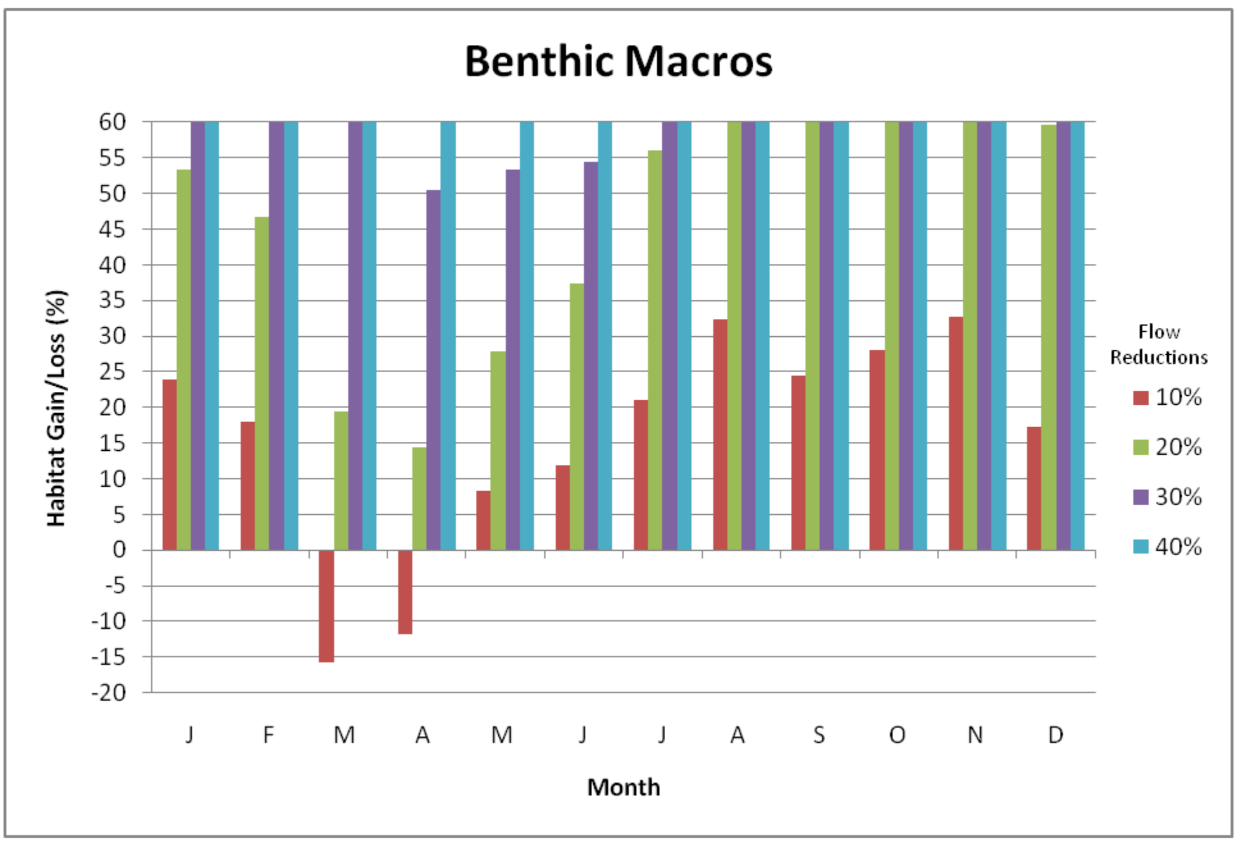


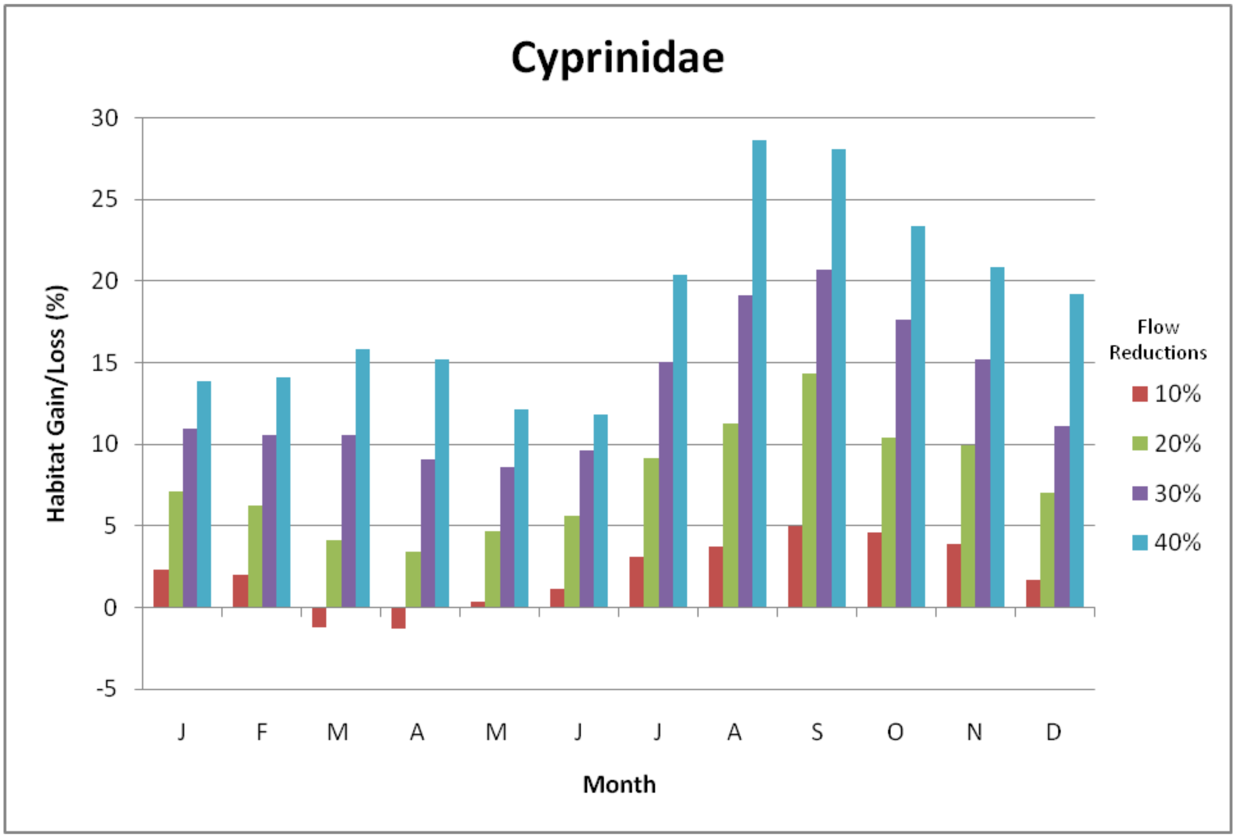
Spotted Sunfish Juvenile
Habitat Gain/Loss (%)
30
25
20
15
10
5
0
-5
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%



Spotted Sunfish Spawning
Habitat Gain/Loss (%)
35
30
25
20
15
10
5
0
-5
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%


Spotted Sunfish Fry
Habitat Gain/Loss (%)
35
30
25
20
15
10
5
0
-5
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%


Benthic Macros
Habitat Gain/Loss (%)
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%



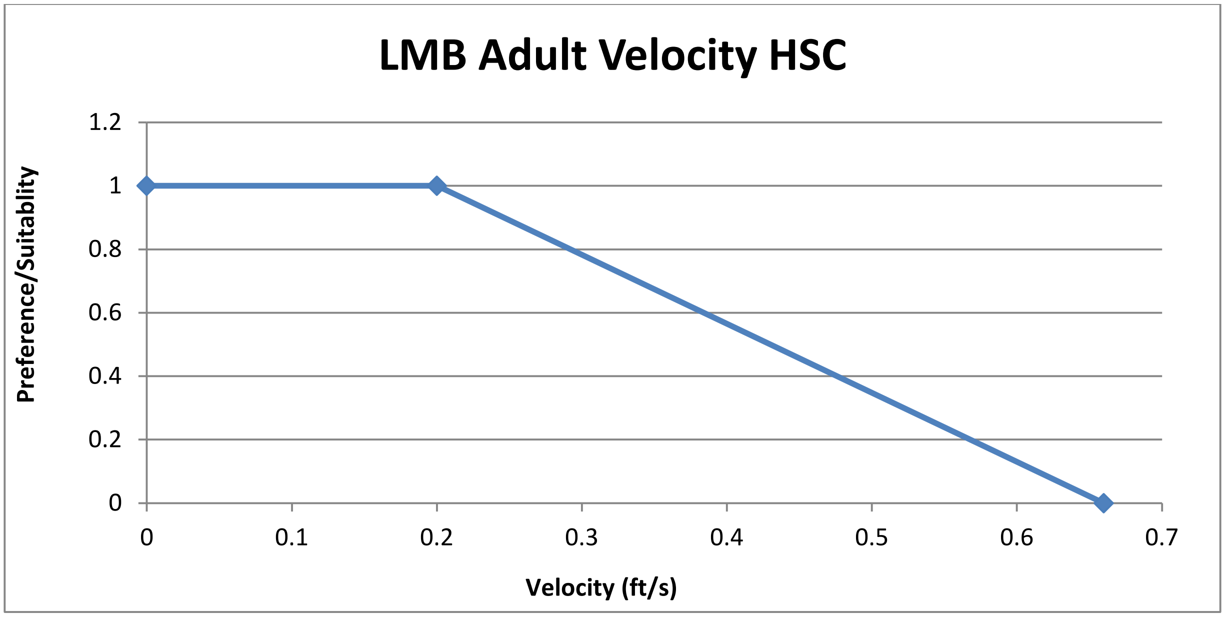
Cyprinidae
Habitat Gain/Loss (%)
30
25
20
15
10
5
0
-5
J
F
M
A
M
J
J
A
S
O
N
D
Month
Flow Reductions
10%
20%
30%
40%

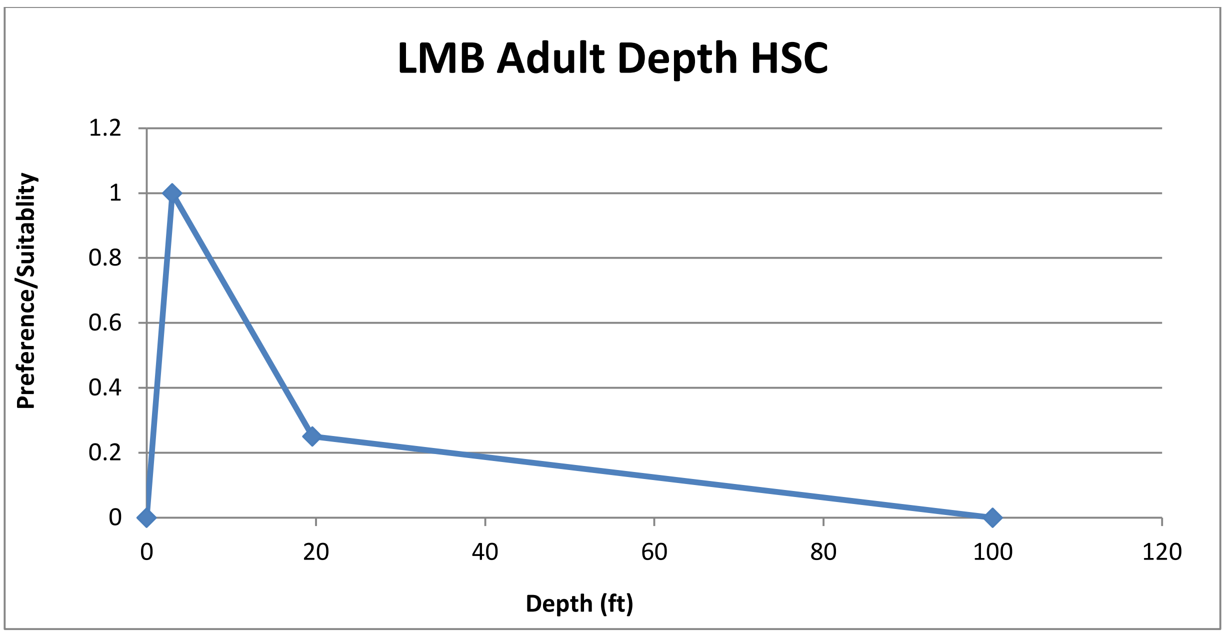
PHABSIM Habitat Suitability Curve Appendix

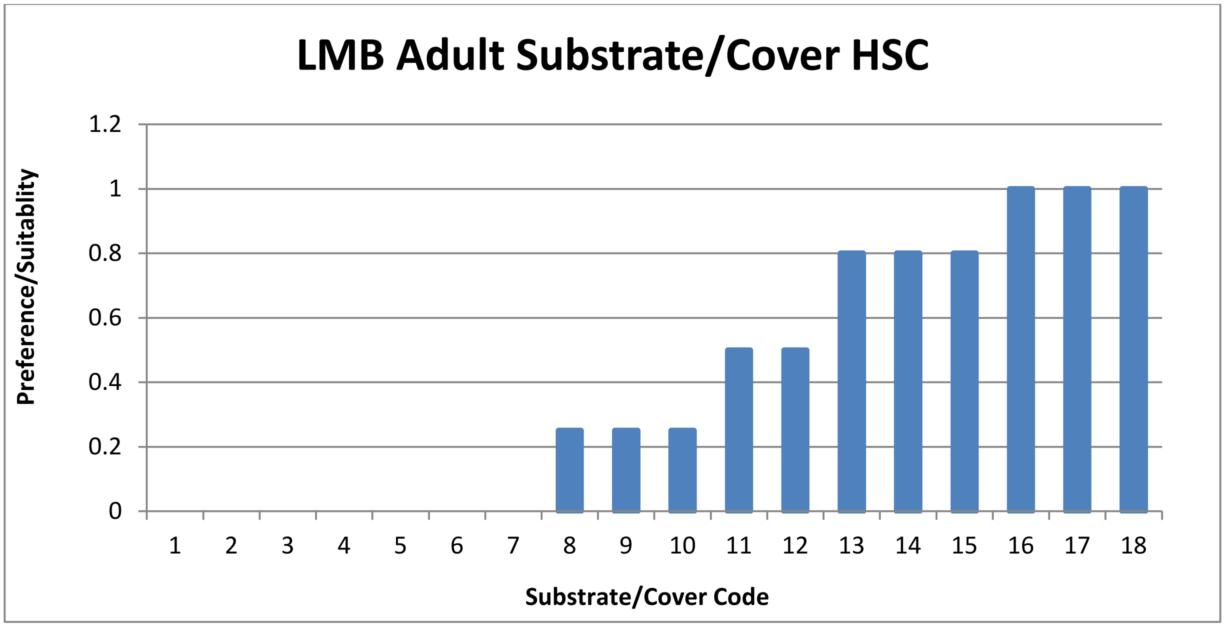
This appendix contains HSCs for all species/life stages/guilds used in the PHABSIM model for the Upper and Middle Withlacoochee River MFL development. Also included are the appropriate substrate/cover codes.

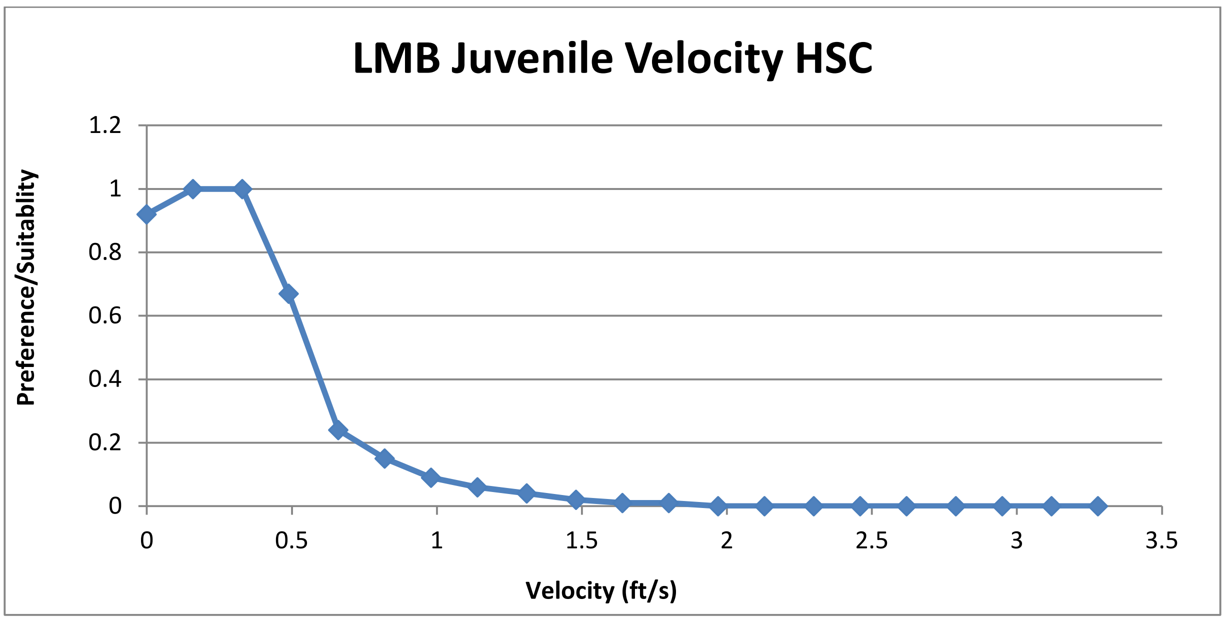
Substrate / Cover Codes

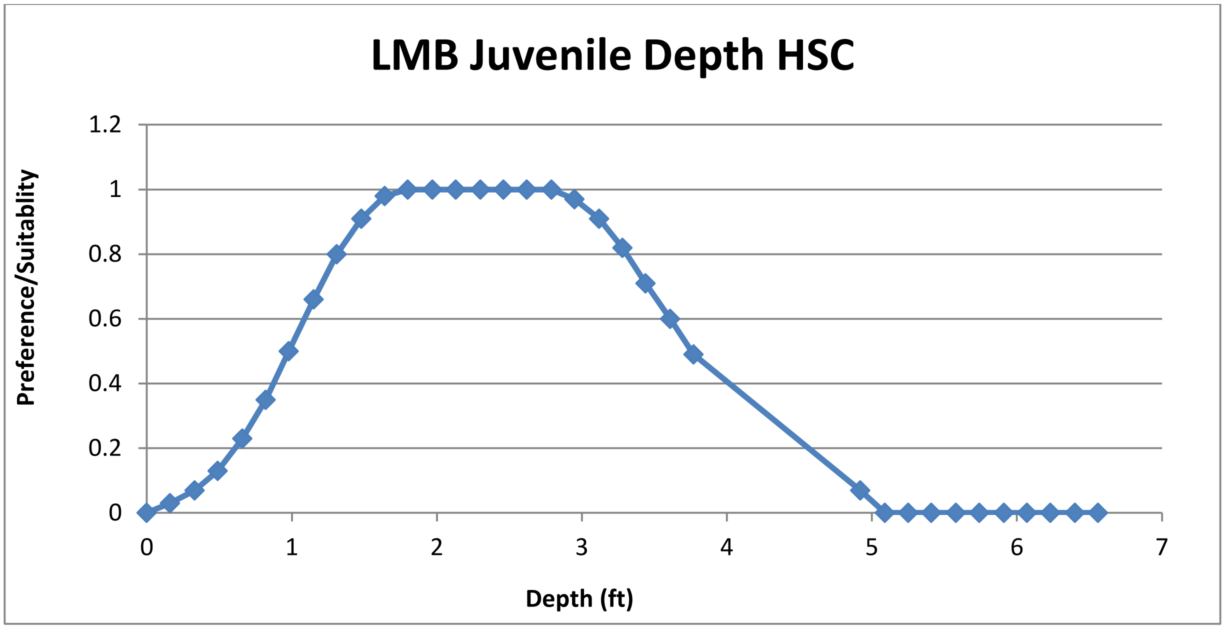
CODE	COVER	SUBSTRATE
1	No Cover	and silt or terrestrial vegetation
2	No Cover	and sand
3	No Cover	and gravel
4	No Cover	and cobble
5	No Cover	and small boulder
6	No Cover	and boulder, angled bedrock, or woody debris
7	No Cover	and mud or flat bedrock
8	Overhead Veg	and terrestrial vegetation
9	Overhead Veg	and gravel
10	Overhead Veg	and cobble
11	Overhead Veg	and small boulder, angled bedrock or woody debris
12	Instream	and cobble
13	Instream	and small boulder, angled bedrock or woody debris
14	Proximal	and cobble
15	Proximal	and small boulder, angled bedrock or woody debris
16	Instream or Proximal	and gravel
17	Overhead, Instream, or Proximal	and silt or sand
18	Aquatic Veg	aquatic vegetation - macrophytes

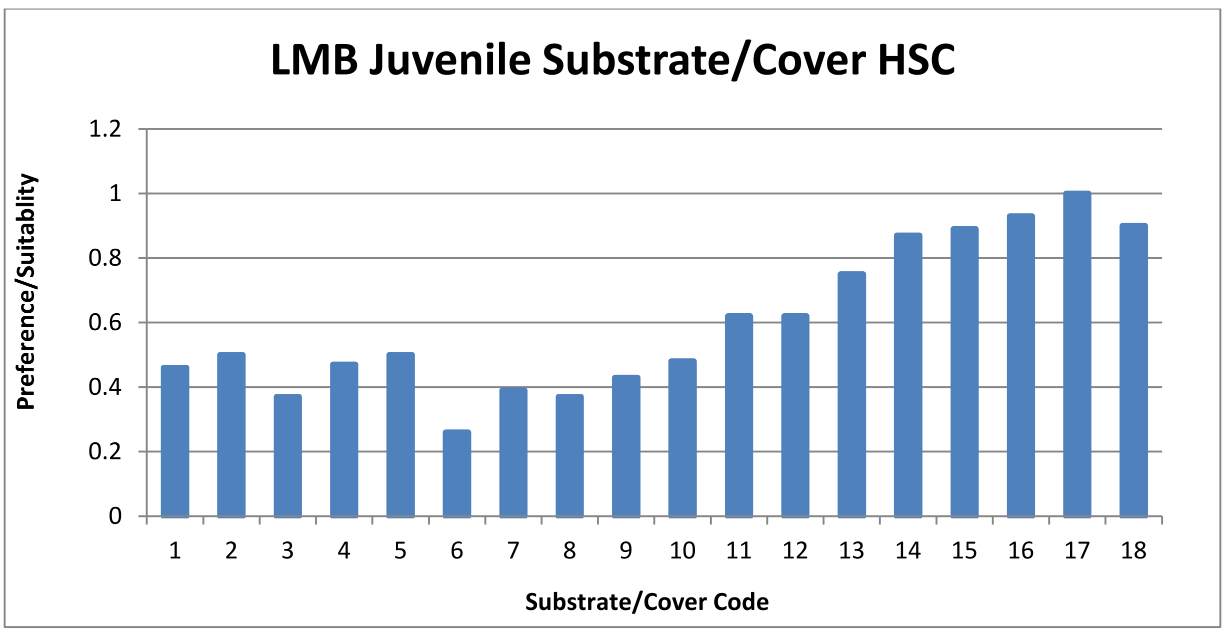

LMB Adult Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Velocity (ft/s)

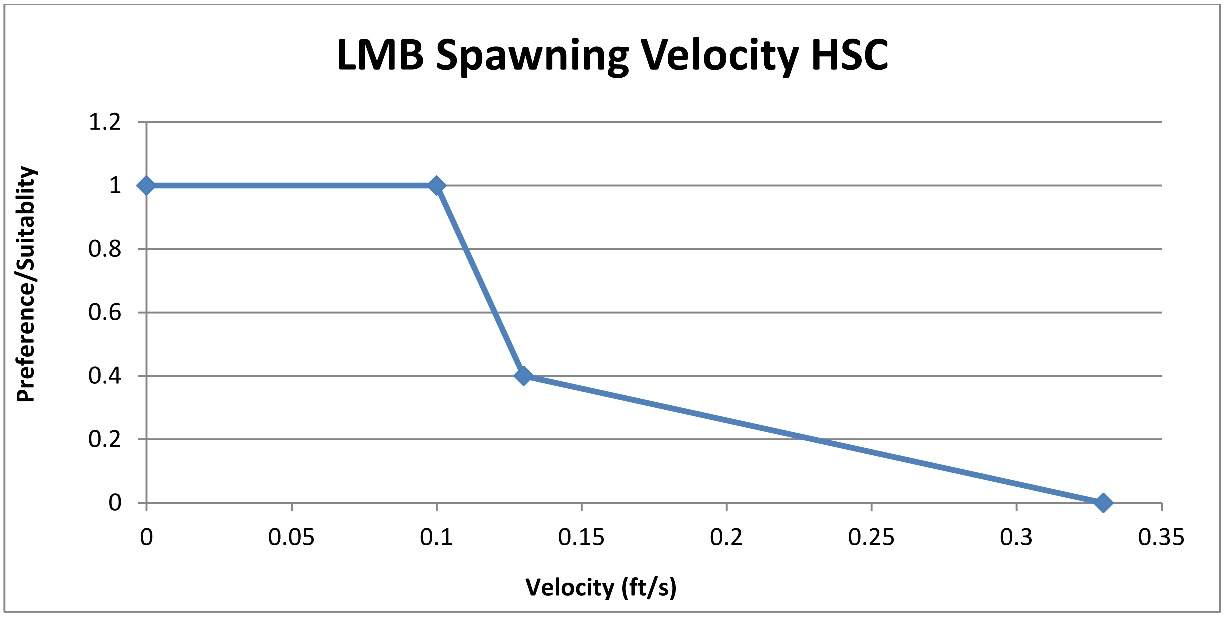

LMB Adult Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Depth (ft)

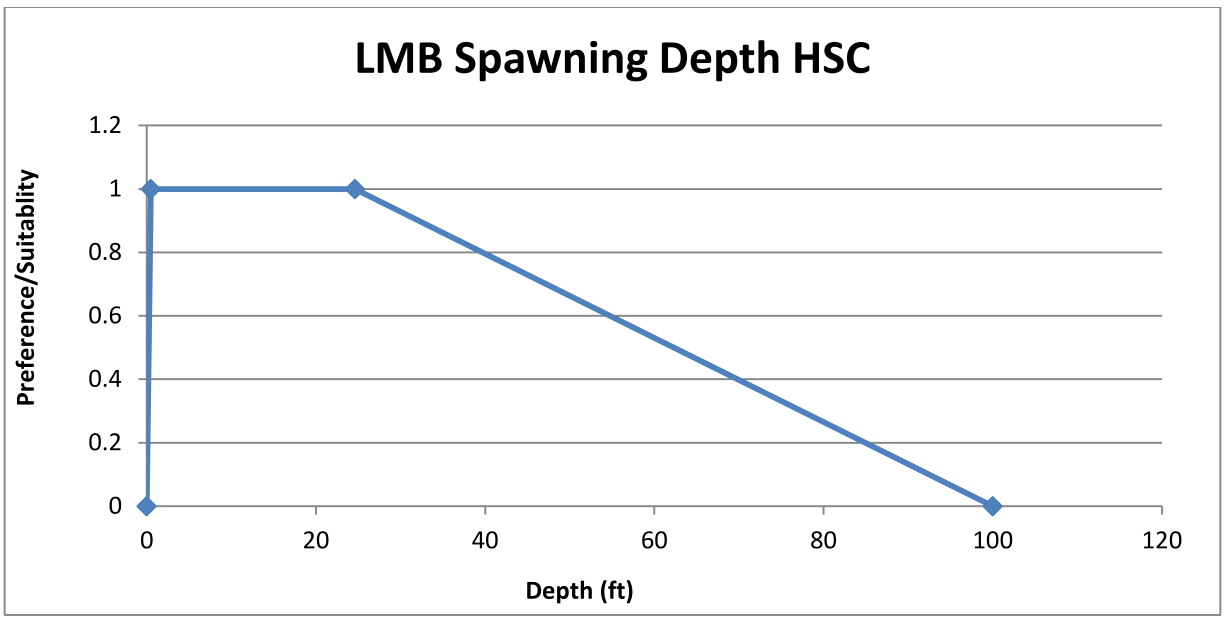

LMB Adult Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code

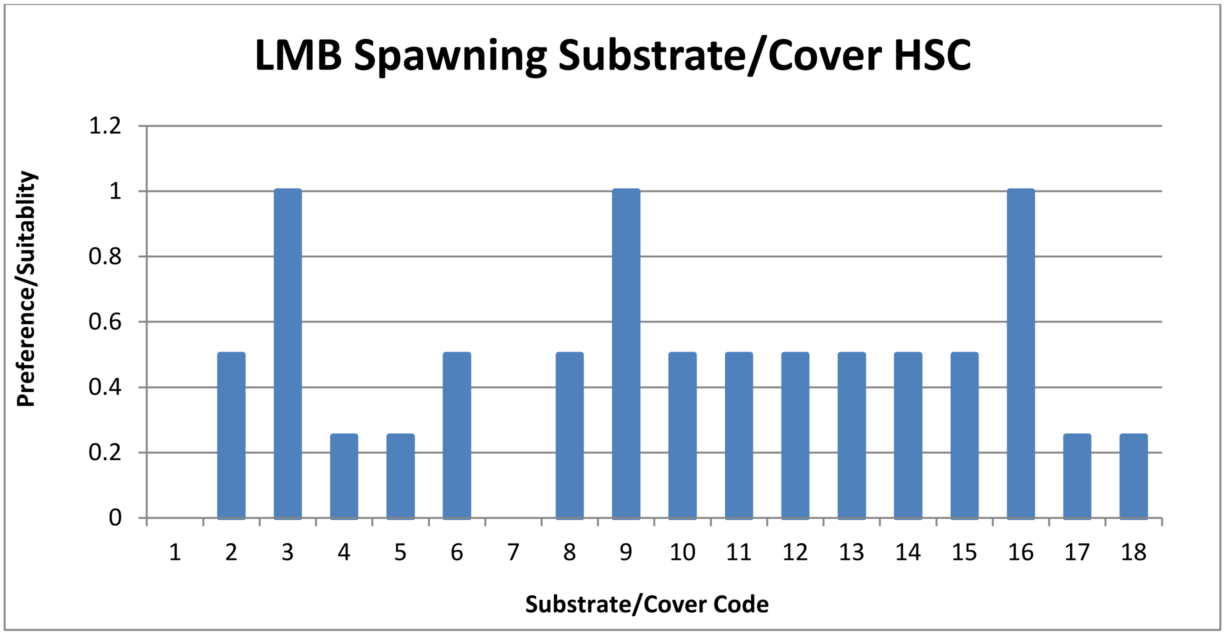

LMB Juvenile Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 0.5 1 1.5 2 2.5 3 3.5
Velocity (ft/s)

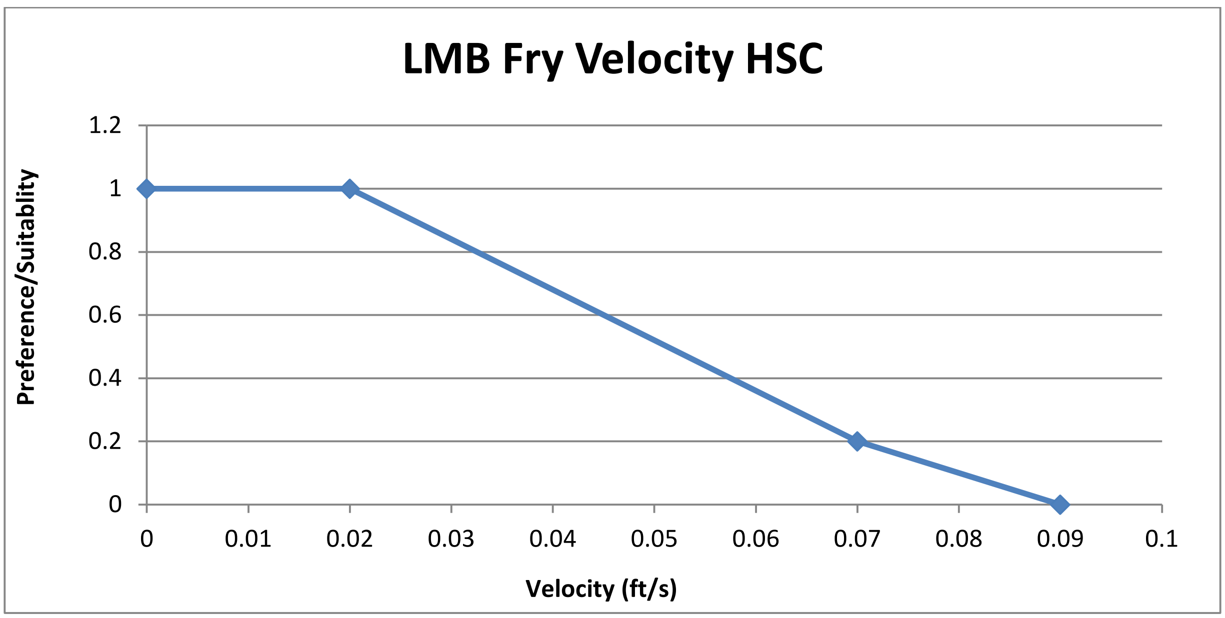

LMB Juvenile Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
Depth (ft)

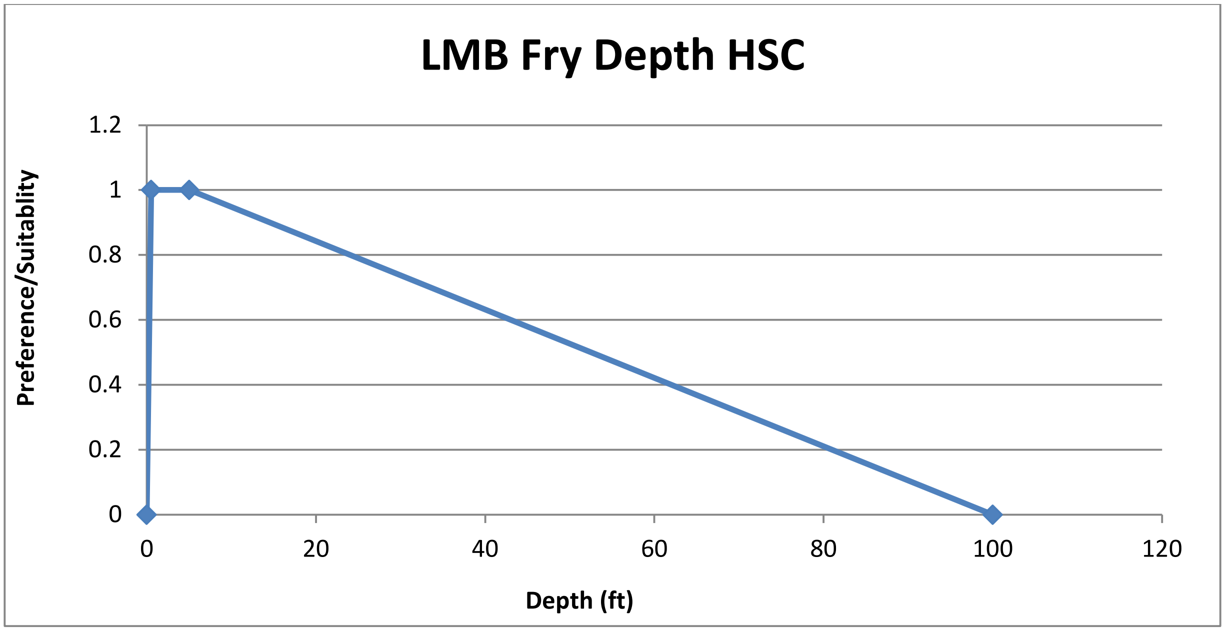

LMB Juvenile Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Substrate/Cover Code


LMB Spawning Velocity HSC
1.2
1
0.8
0.6
0.4
0.2
0
Preference/Suitablity
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
Velocity (ft/s)

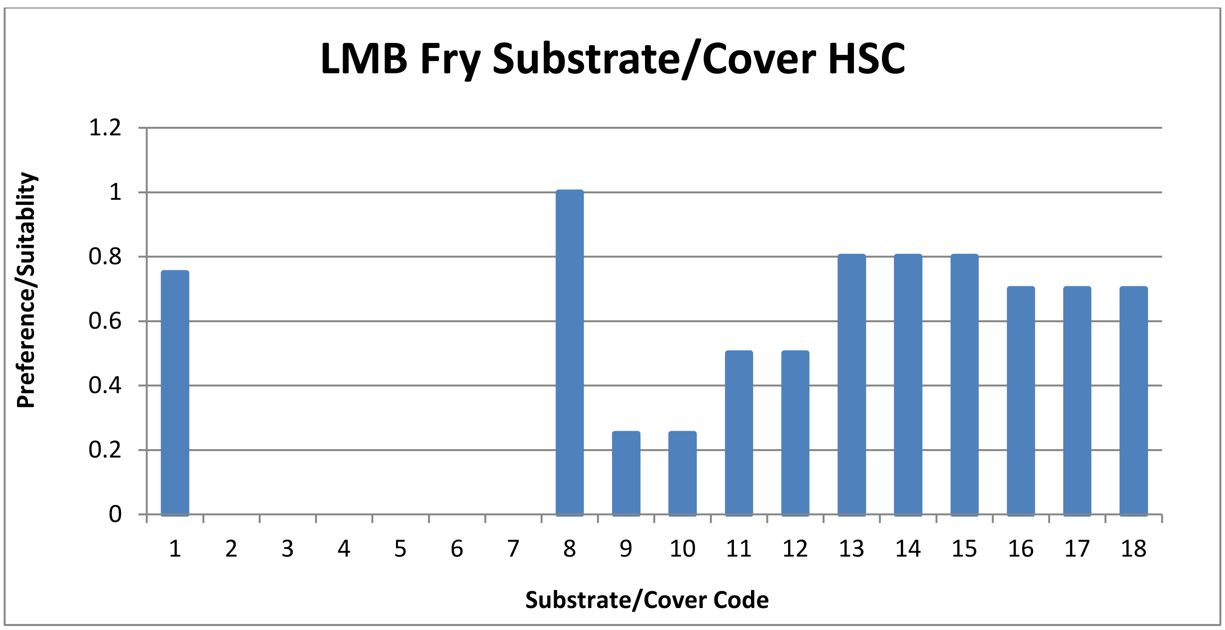

LMB Spawning Depth HSC
1.2
1
0.8
0.6
0.4
0.2
0
Preference/Suitablity
0
20
40
60
80
100
120
Depth (ft)


LMB Spawning Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code

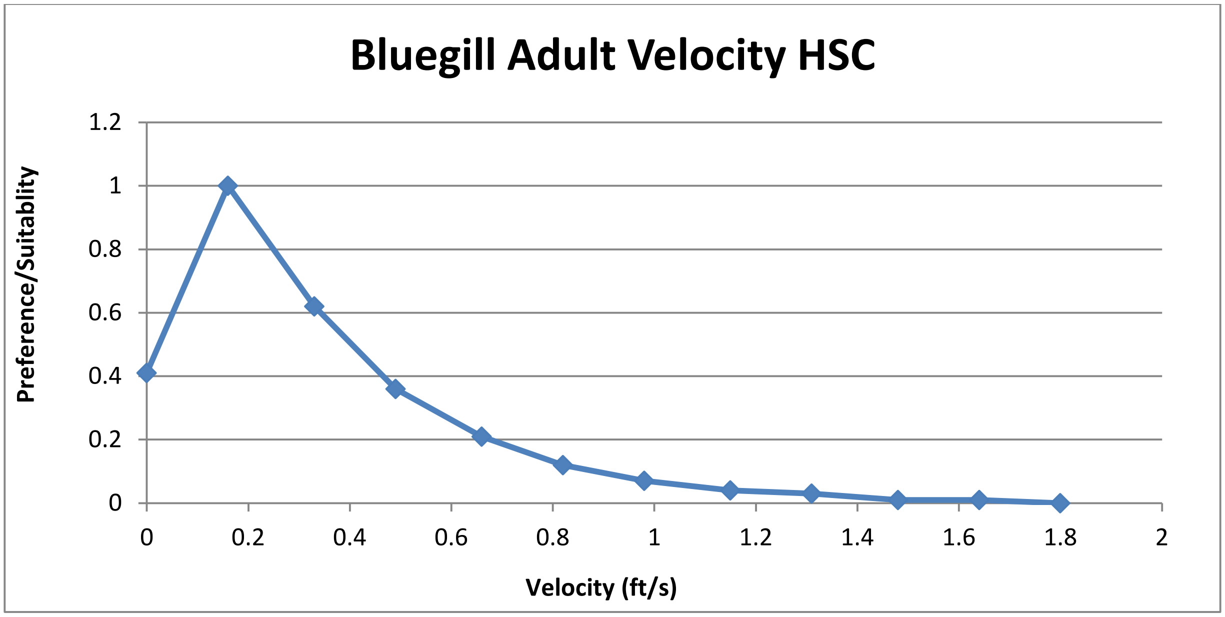

LMB Fry Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
Velocity (ft/s)

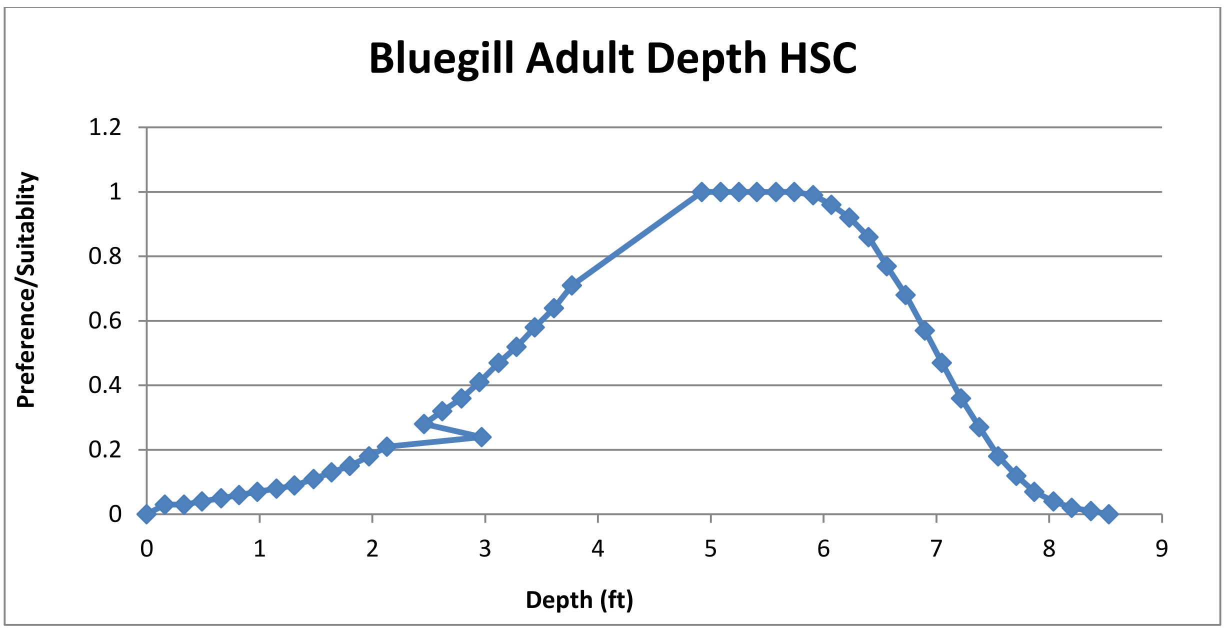


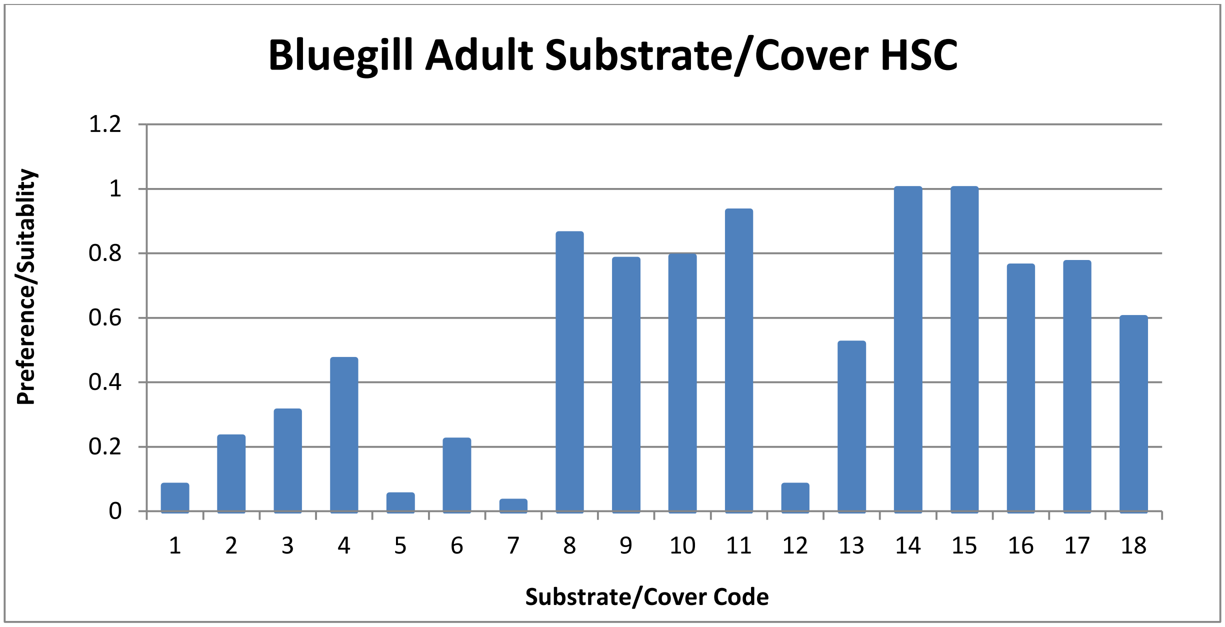
LMB Fry Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Depth (ft)

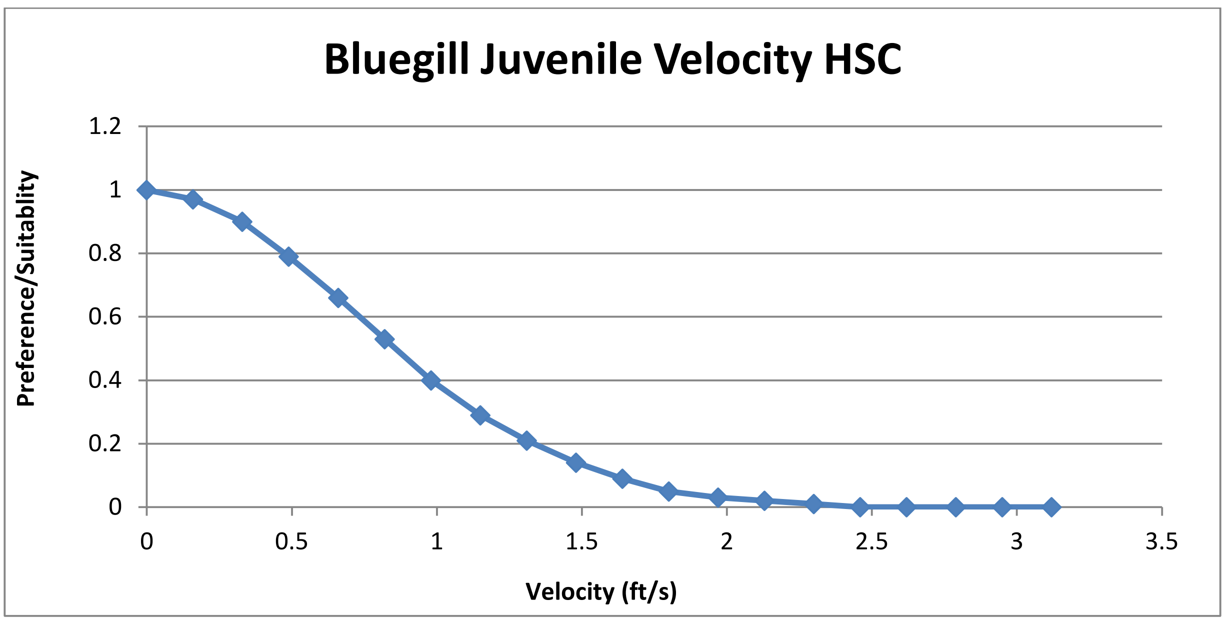


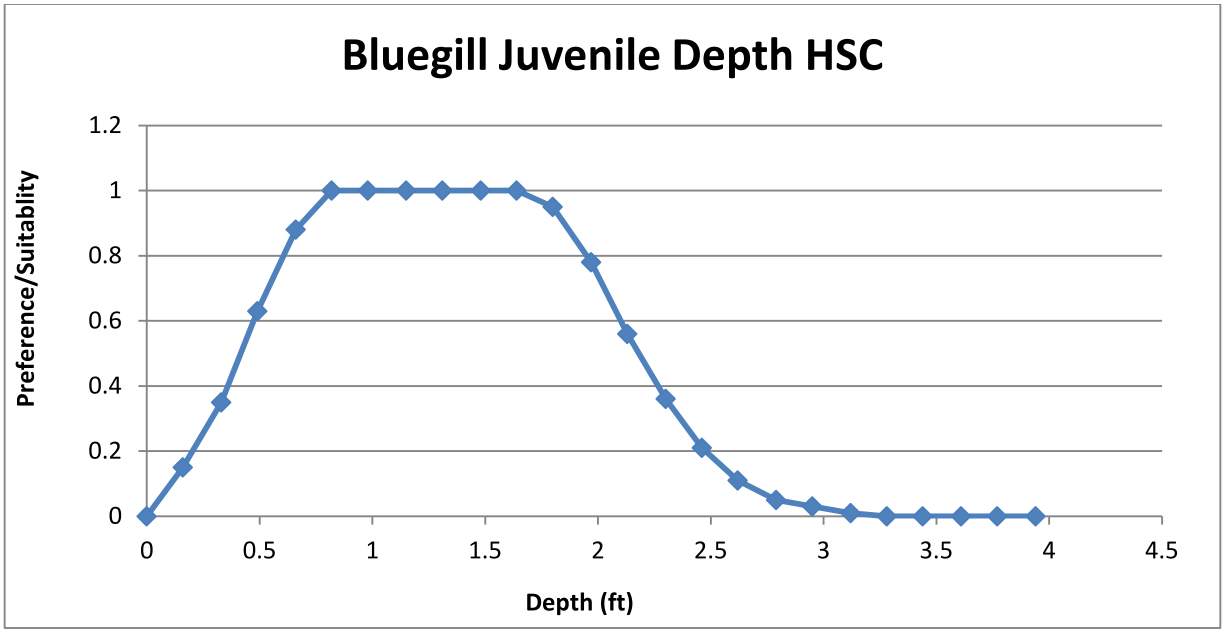
LMB Fry Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code

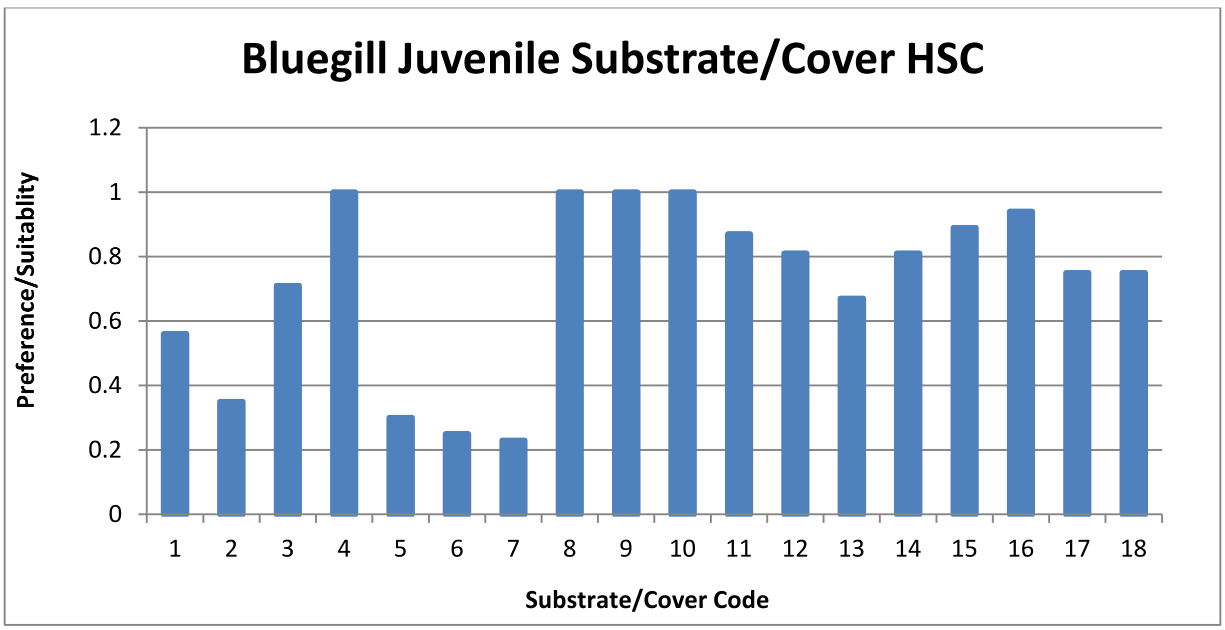

Bluegill Adult Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Velocity (ft/s)

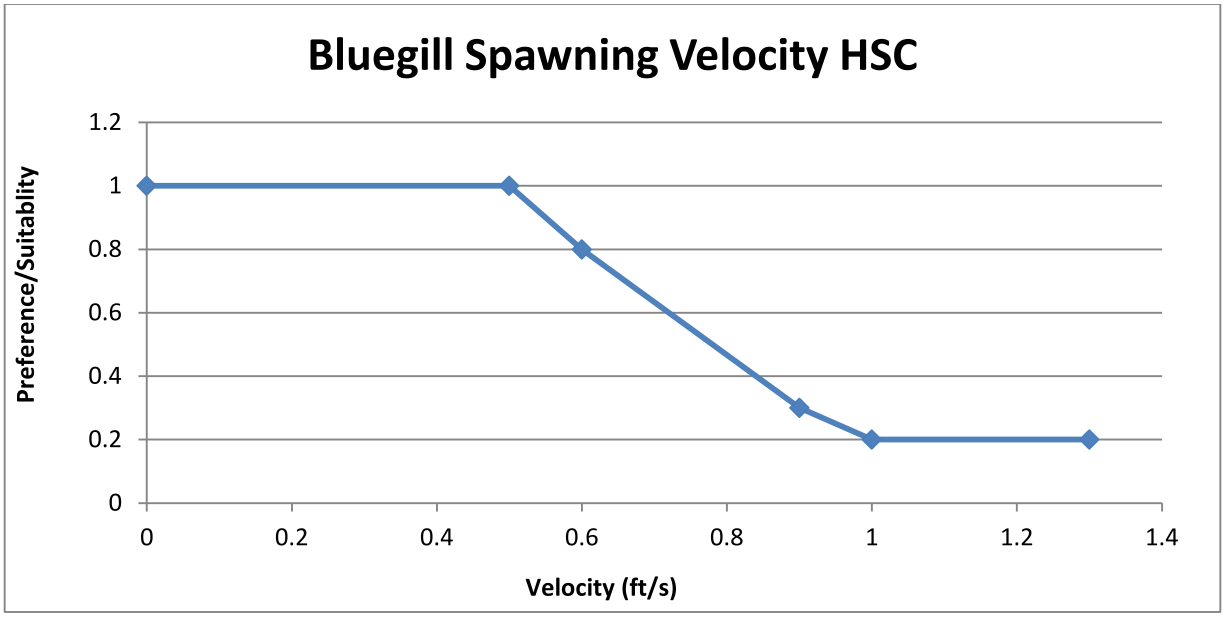

Bluegill Adult Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8
9
Depth (ft)


Bluegill Adult Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Substrate/Cover Code

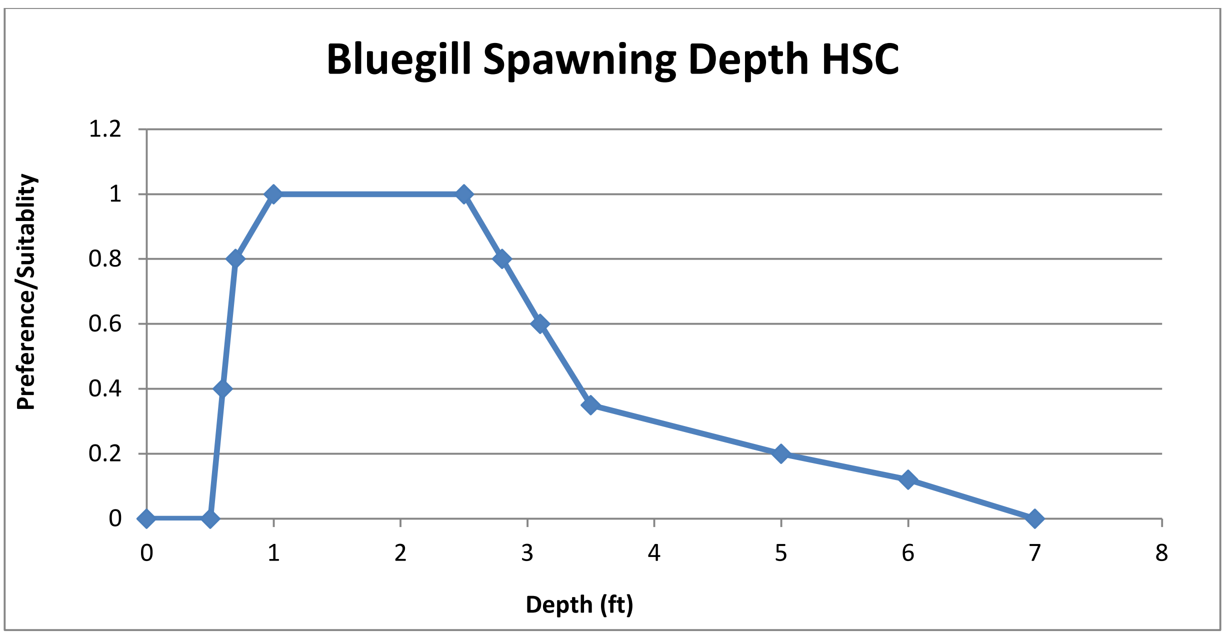

Bluegill Juvenile Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
Velocity (ft/s)


Bluegill Juvenile Depth HSC
Preference/Suitablity
Depth (ft)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

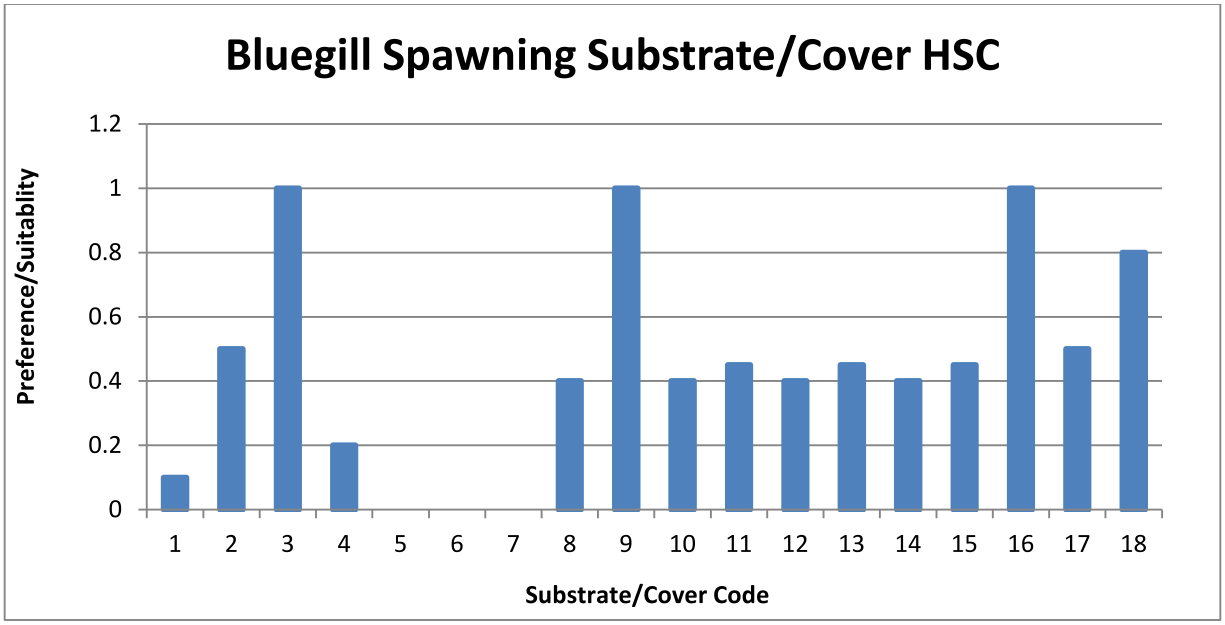

Bluegill Juvenile Substrate/Cover HSC
Preference/Suitablity
Substrate/Cover Code
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

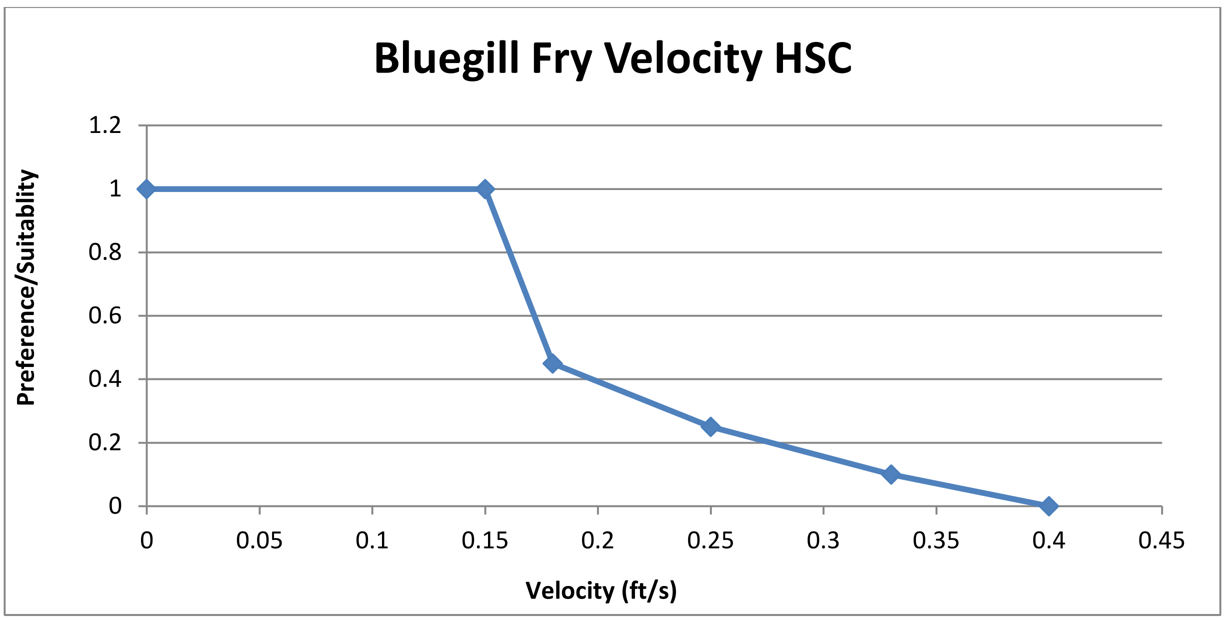


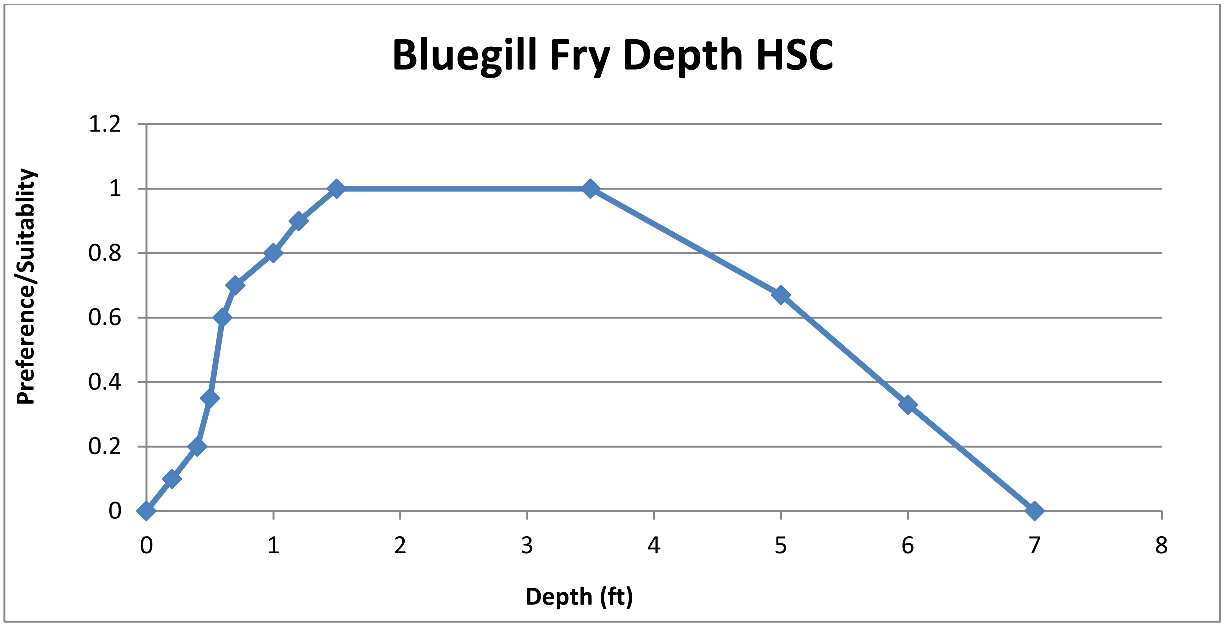
Bluegill Spawning Velocity HSC
Preference/Suitablity
Velocity (ft/s)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4

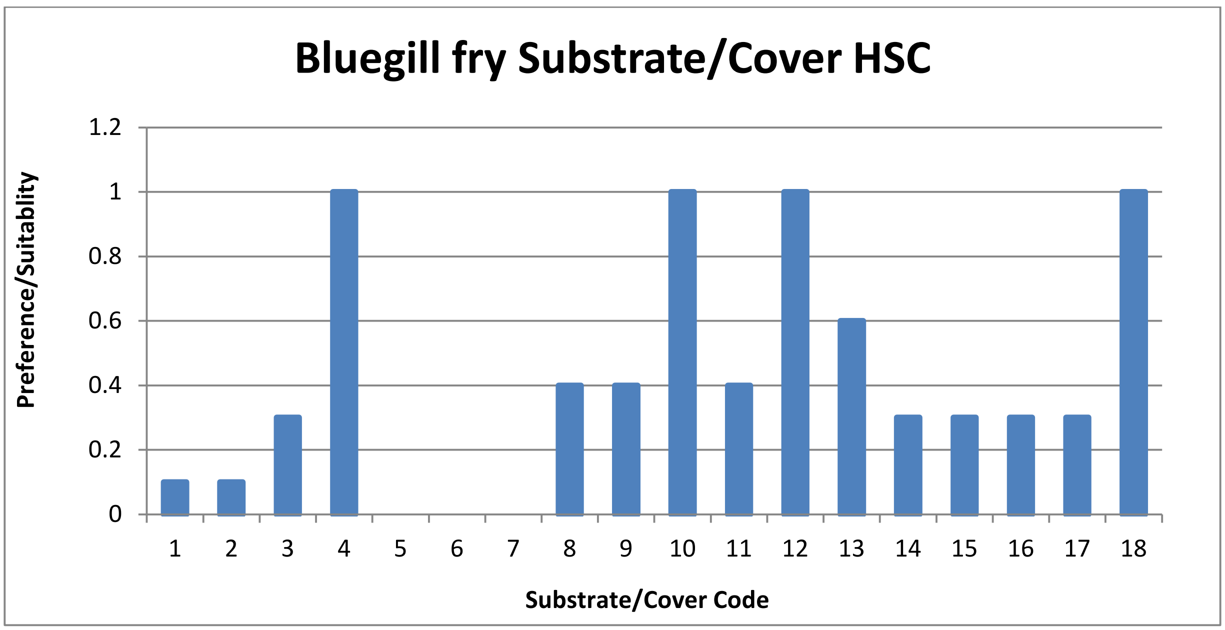


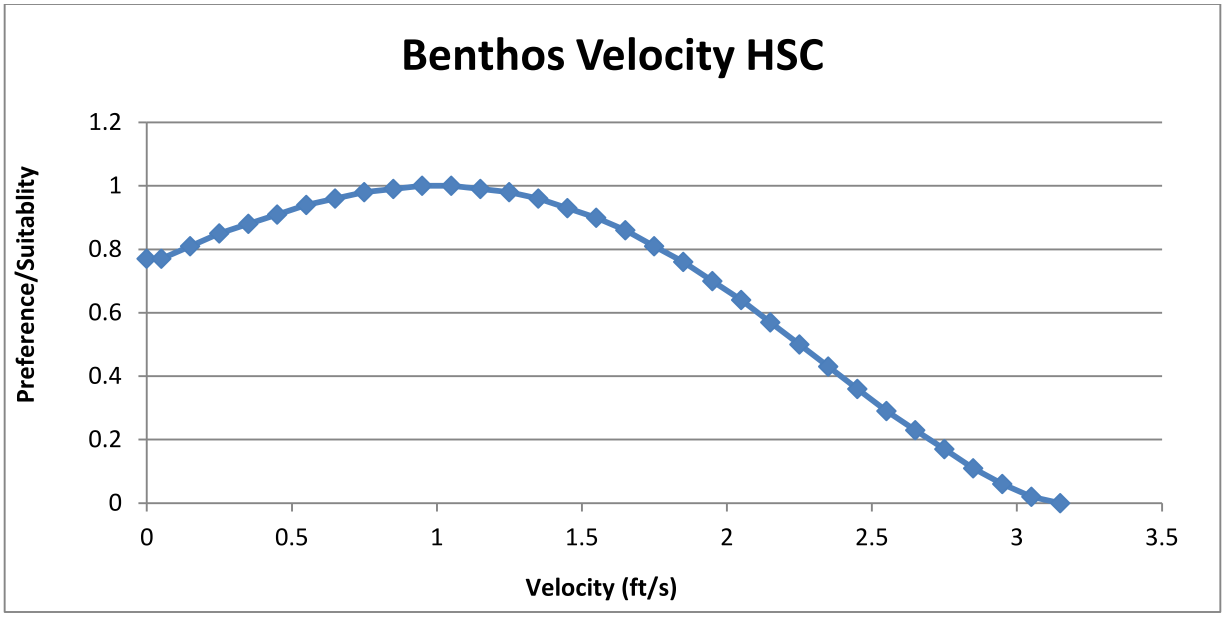
Bluegill Spawning Depth HSC
Preference/Suitablity
Depth (ft)
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8

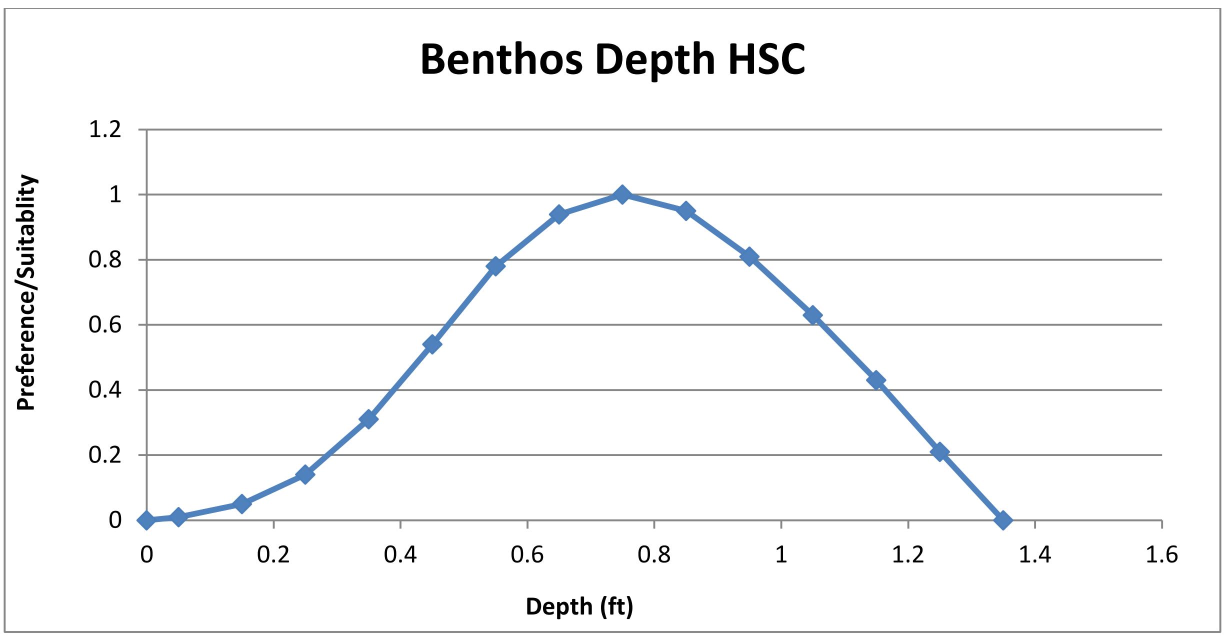

Bluegill Spawning Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code

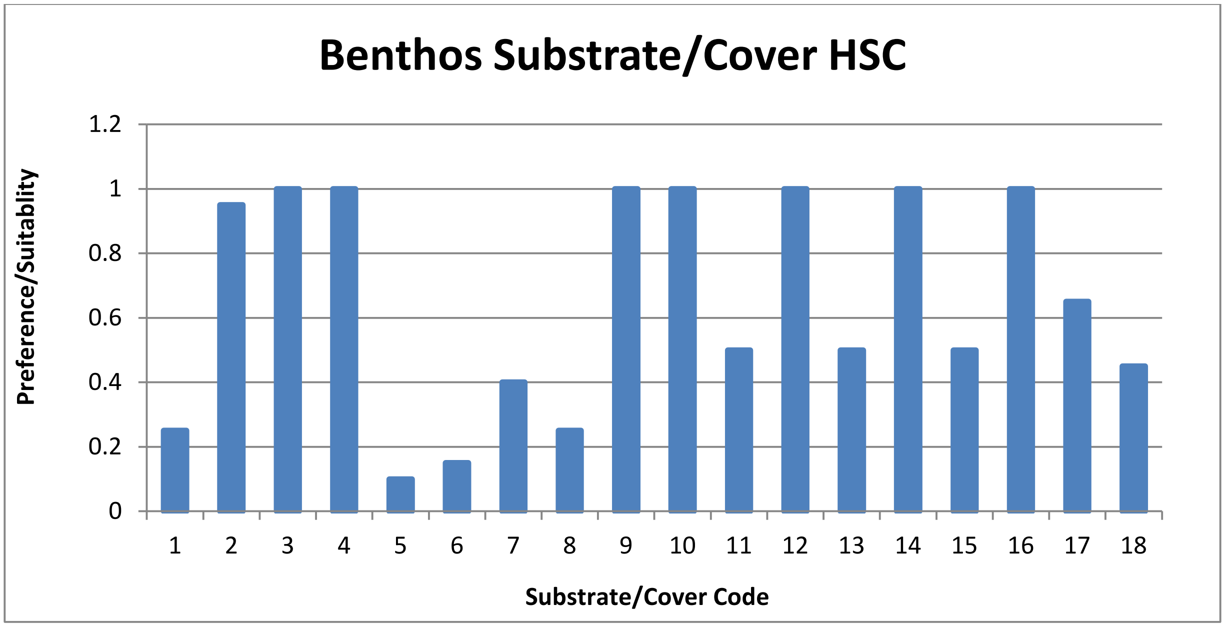

Bluegill Fry Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45
Velocity (ft/s)

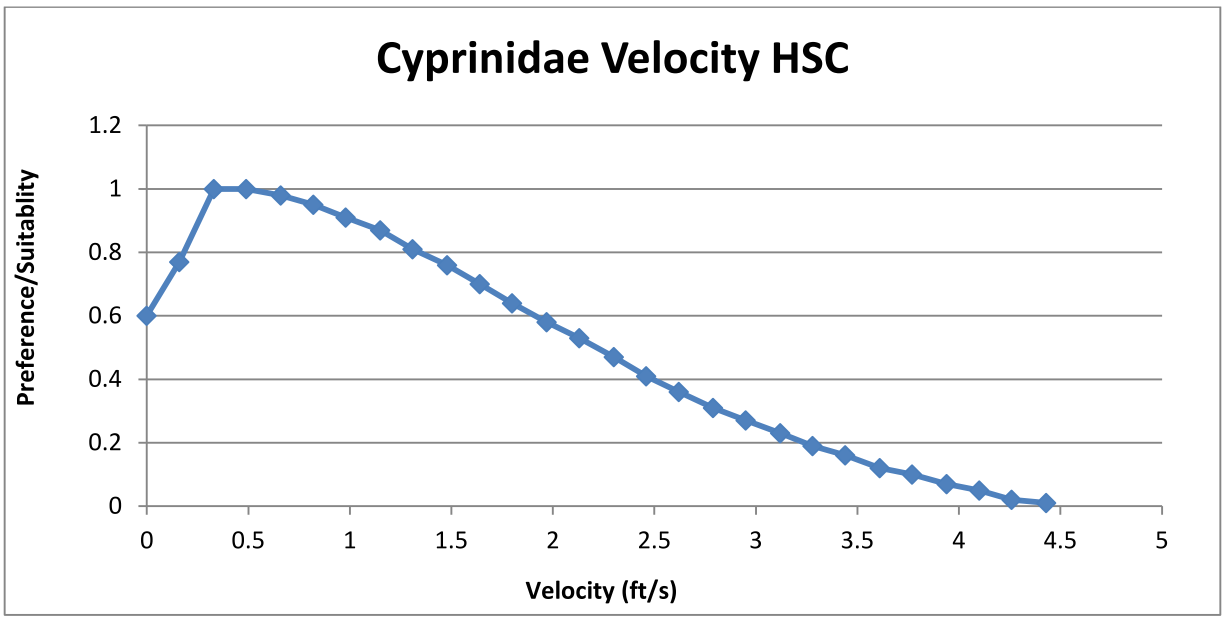

Bluegill Fry Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8
Depth (ft)

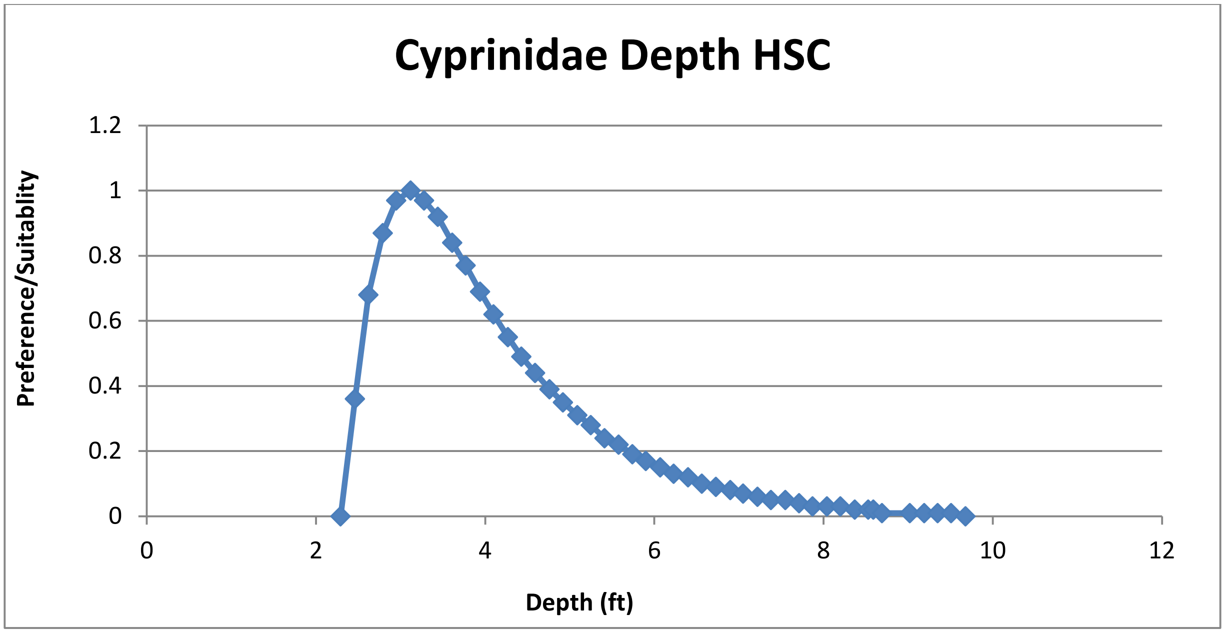

Bluegill fry Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code

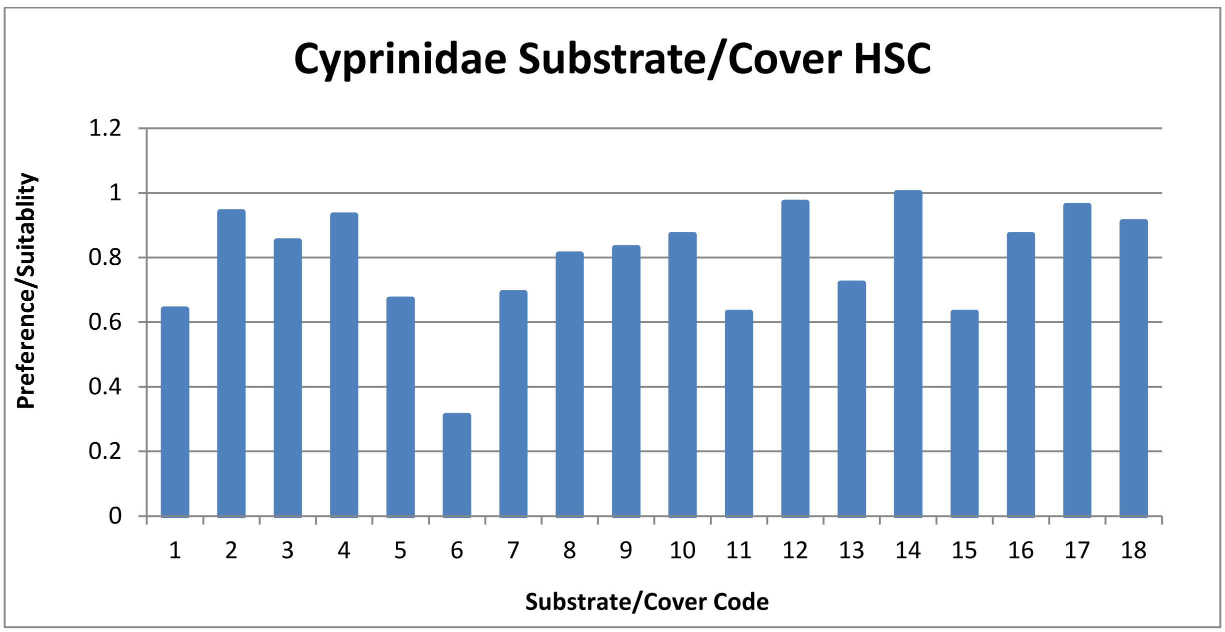

Benthos Velocity HSC
Preference/Suitablity
Velocity (ft/s)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5

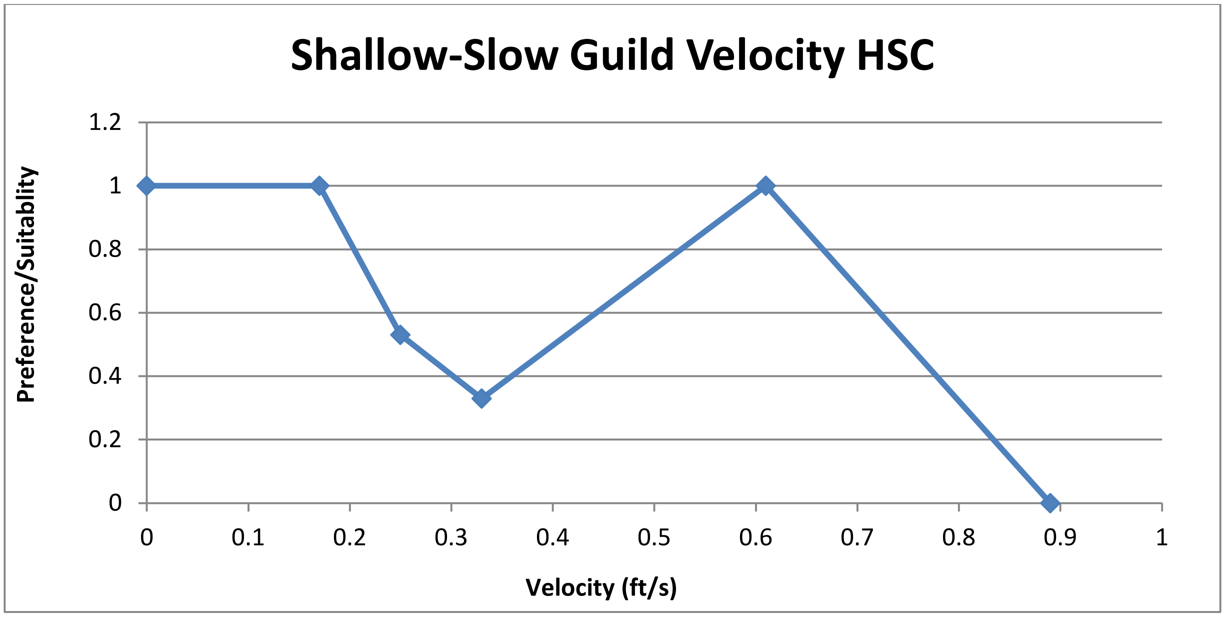

Benthos Depth HSC
Preference/Suitablity
Depth (ft)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

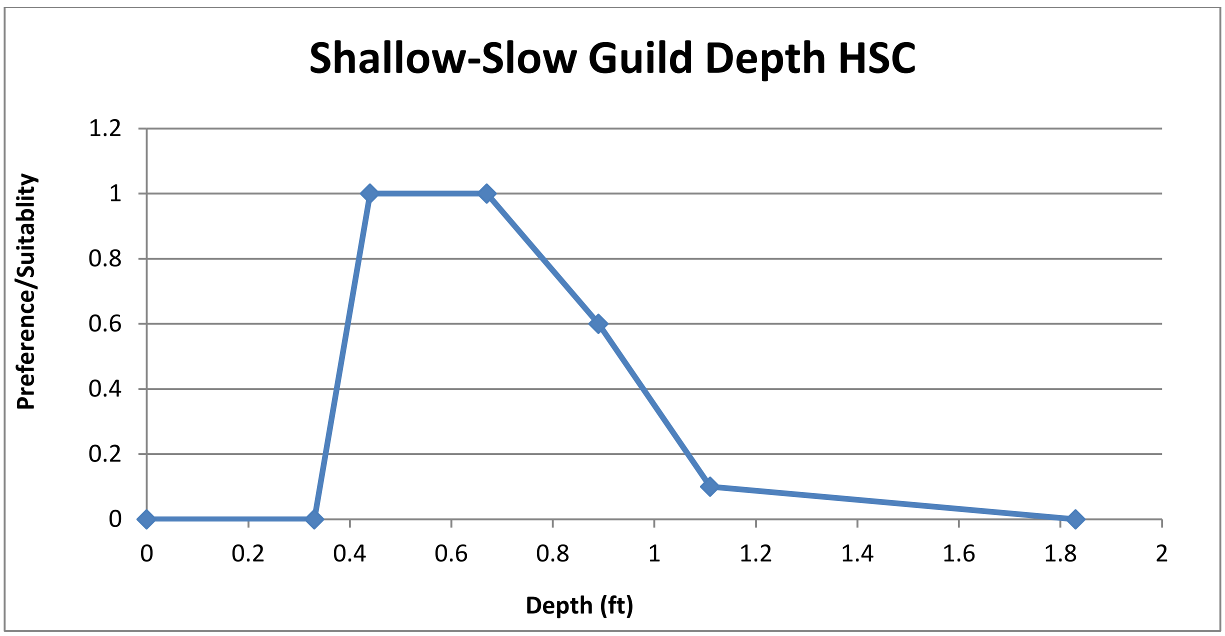

Benthos Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Substrate/Cover Code

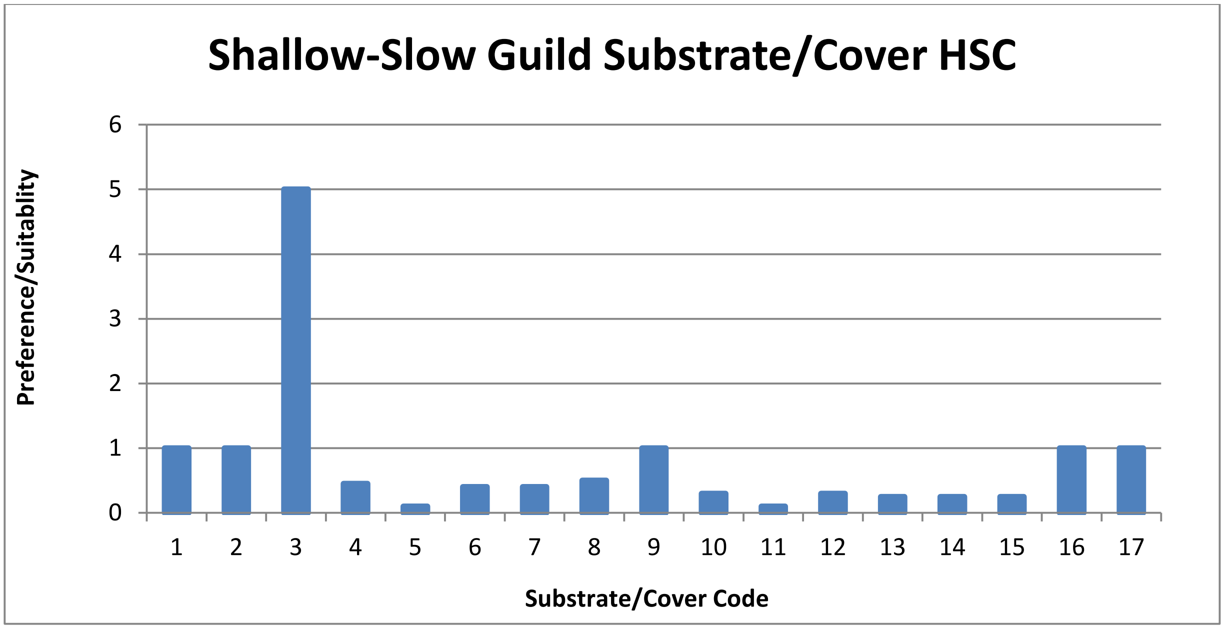

Cyprinidae Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Velocity (ft/s)

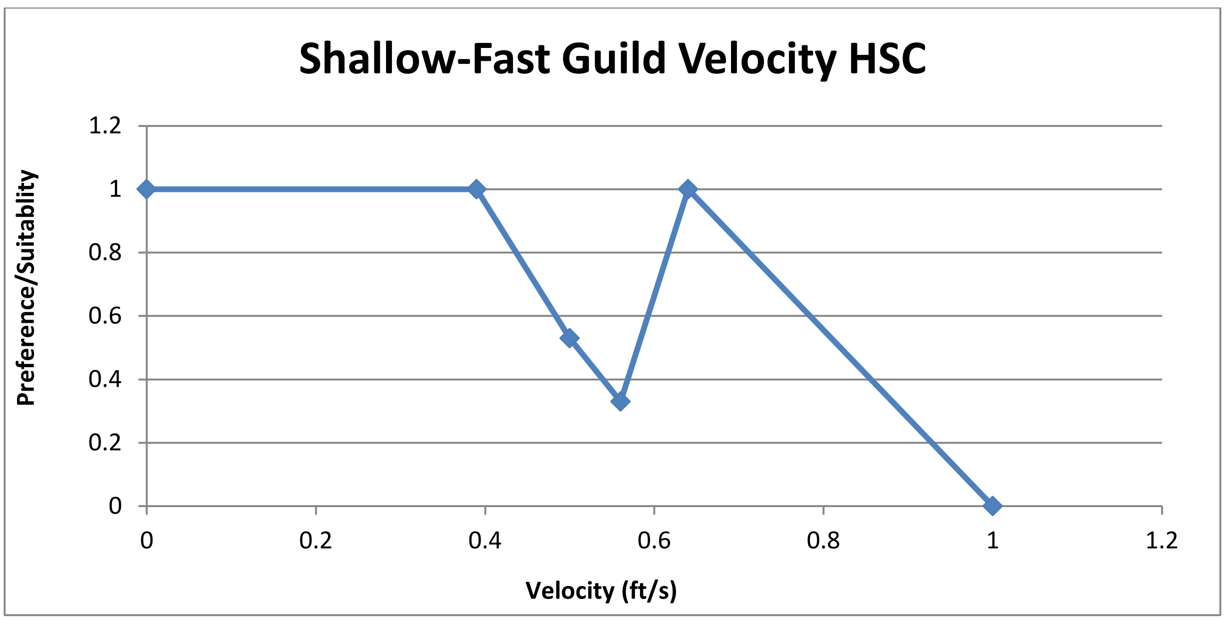

Cyprinidae Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
Depth (ft)

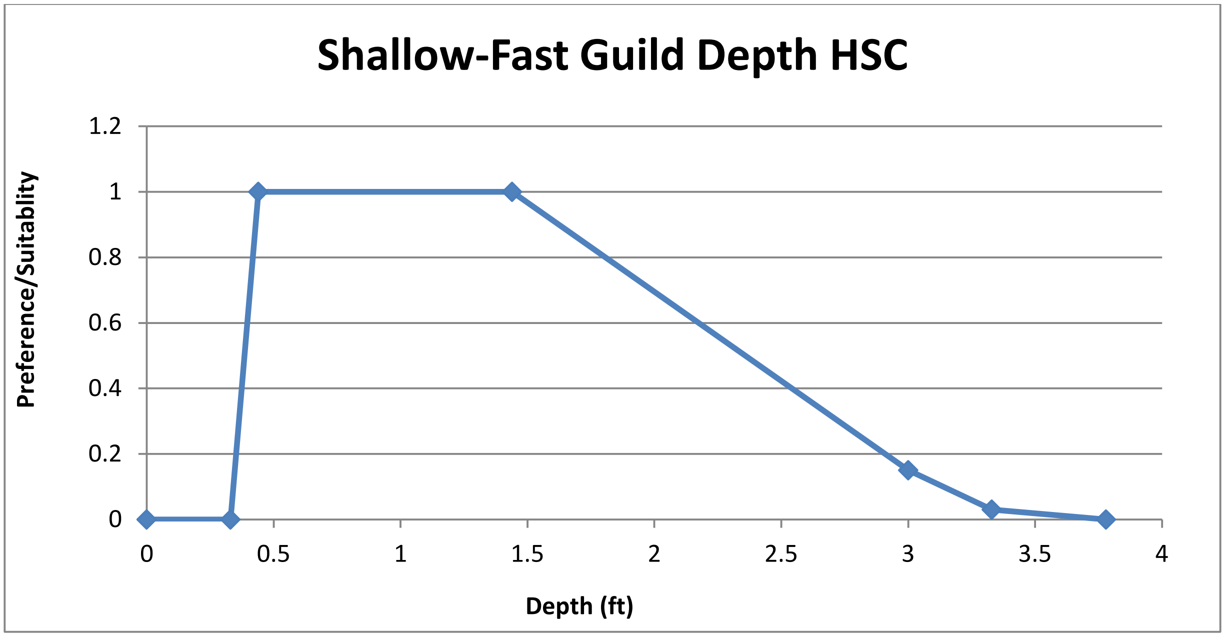

Cyprinidae Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Substrate/Cover Code

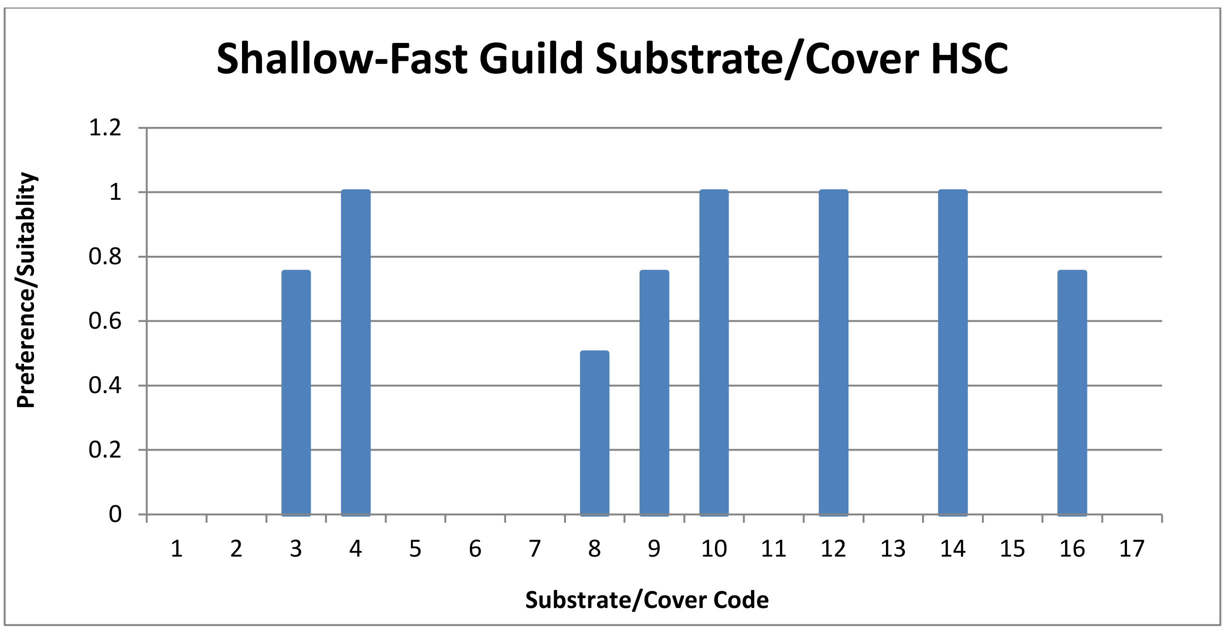

Shallow-Slow Guild Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Velocity (ft/s)

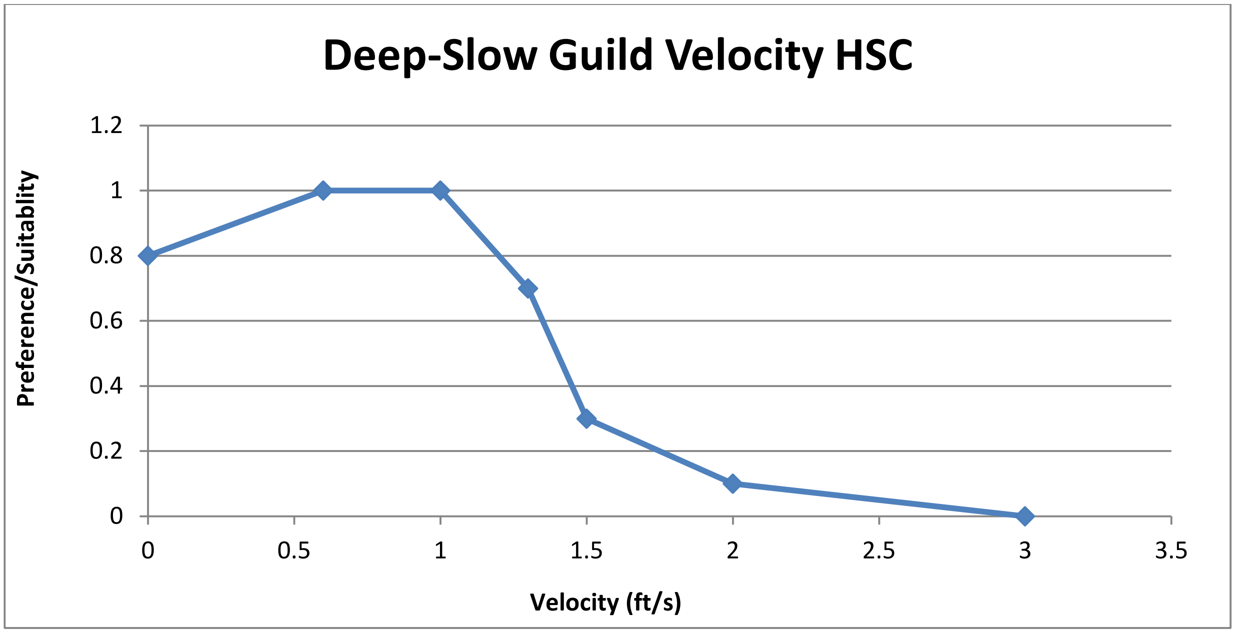

Shallow-Slow Guild Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Depth (ft)

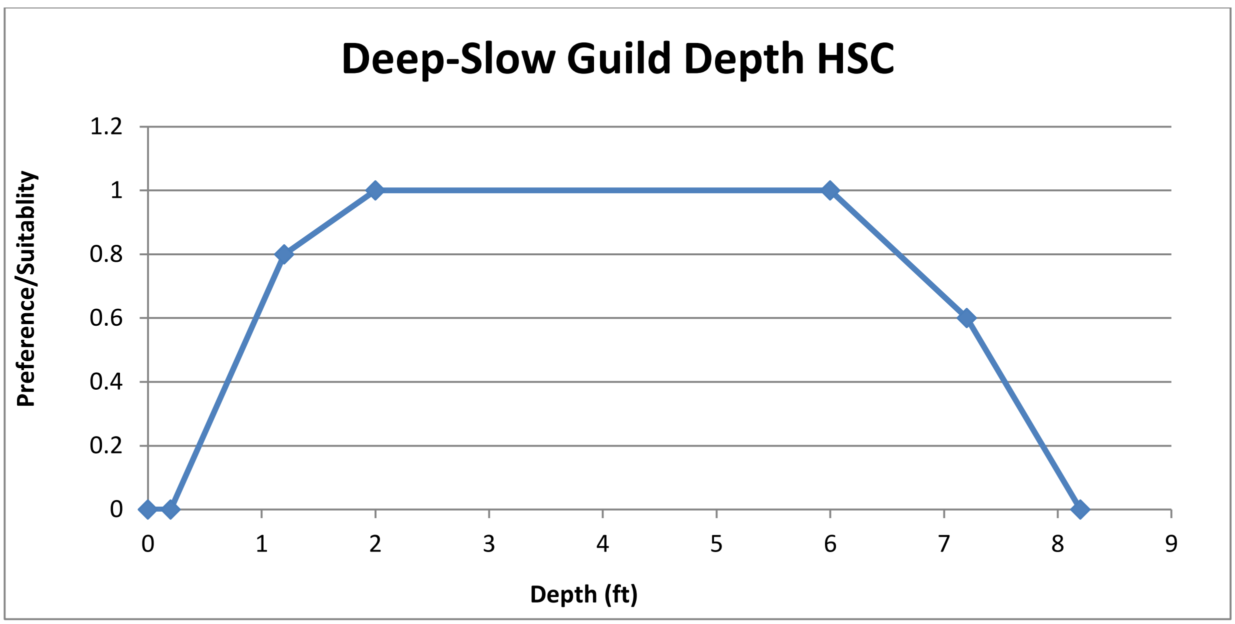

Shallow-Slow Guild Substrate/Cover HSC
Preference/Suitablity
0
1
2
3
4
5
6
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Substrate/Cover Code

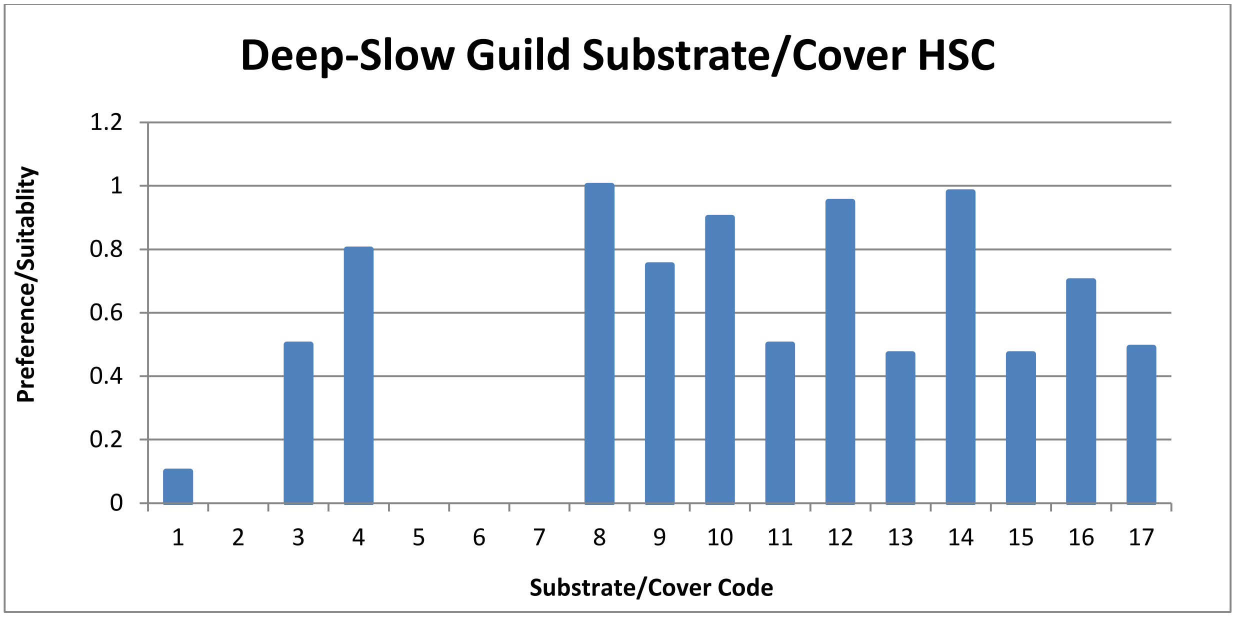

Shallow-Fast Guild Velocity HSC
Preference/Suitablity
0
0.2
0.4
0.6
0.8
1
1.2
0
0.2
0.4
0.6
0.8
1
1.2
Velocity (ft/s)

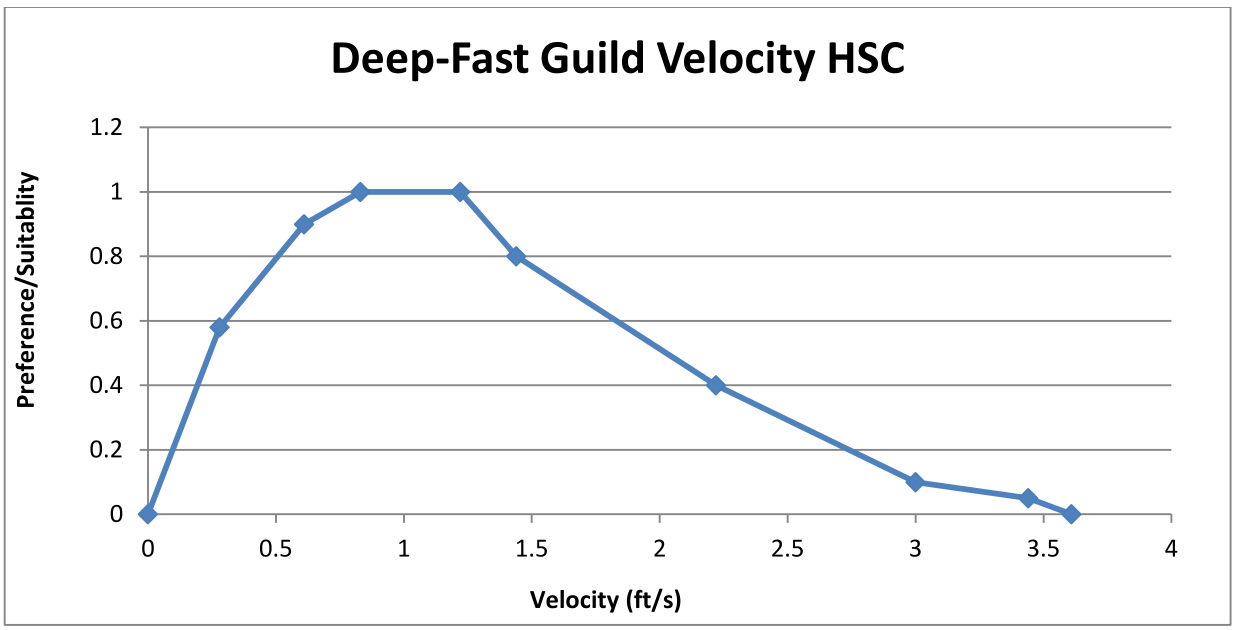

Shallow-Fast Guild Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Depth (ft)

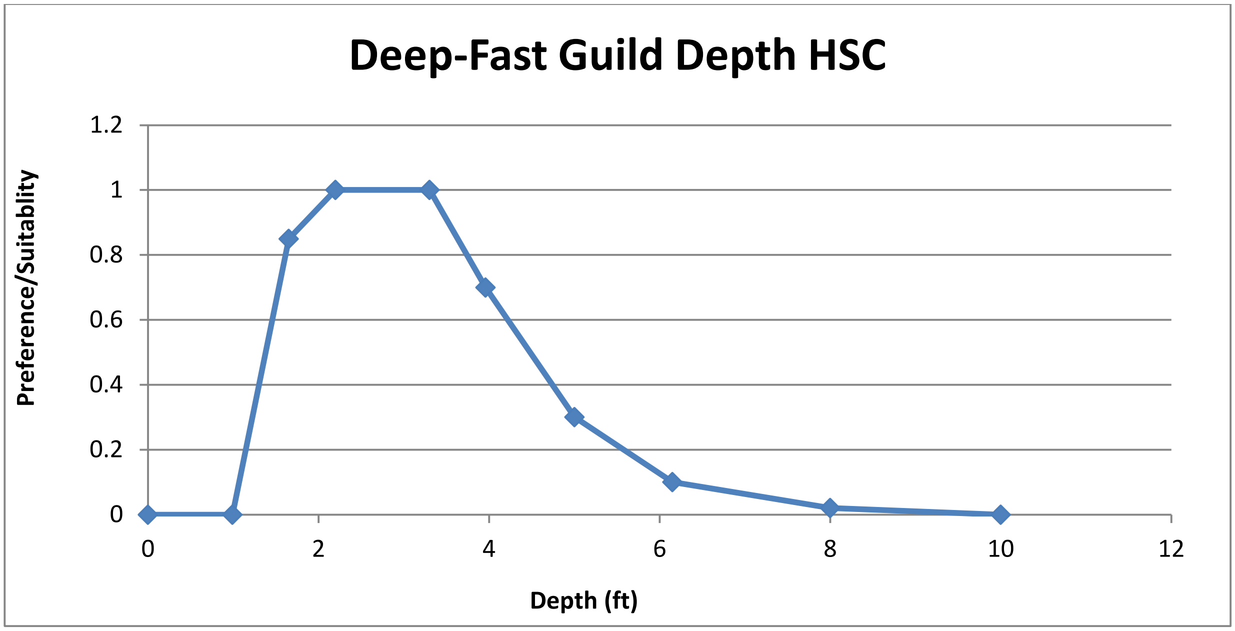

Shallow-Fast Guild Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Substrate/Cover Code

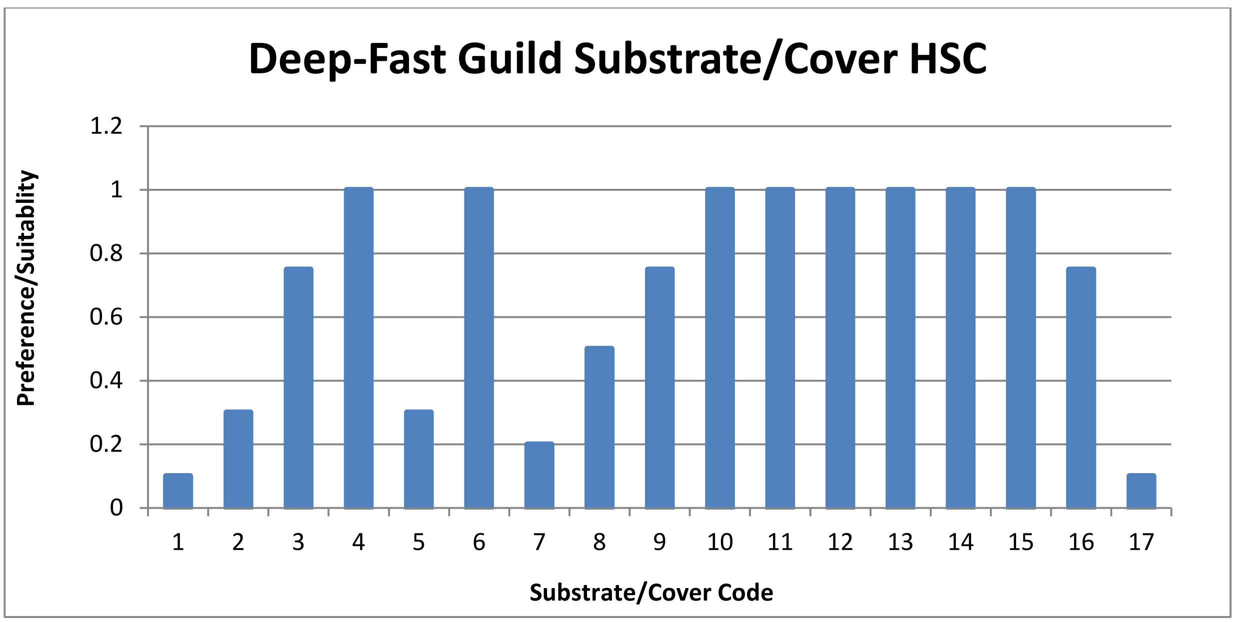

Deep-Slow Guild Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
Velocity (ft/s)


Deep-Slow Guild Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8
9
Depth (ft)


Deep-Slow Guild Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Substrate/Cover Code


Deep-Fast Guild Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 0.5 1 1.5 2 2.5 3 3.5 4
Velocity (ft/s)


Deep-Fast Guild Depth HSC
Preference/Suitablity
Depth (ft)
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12


Deep-Fast Guild Substrate/Cover HSC
Preference/Suitablity
Substrate/Cover Code
1.2
1
0.8
0.6
0.4
0.2
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1
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4
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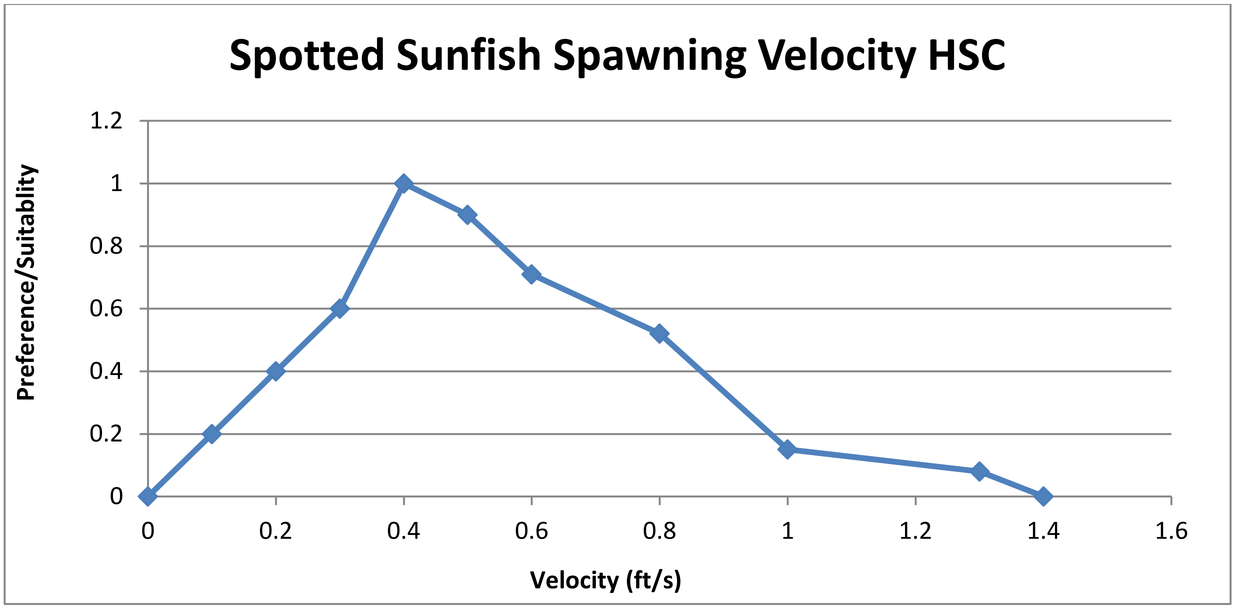
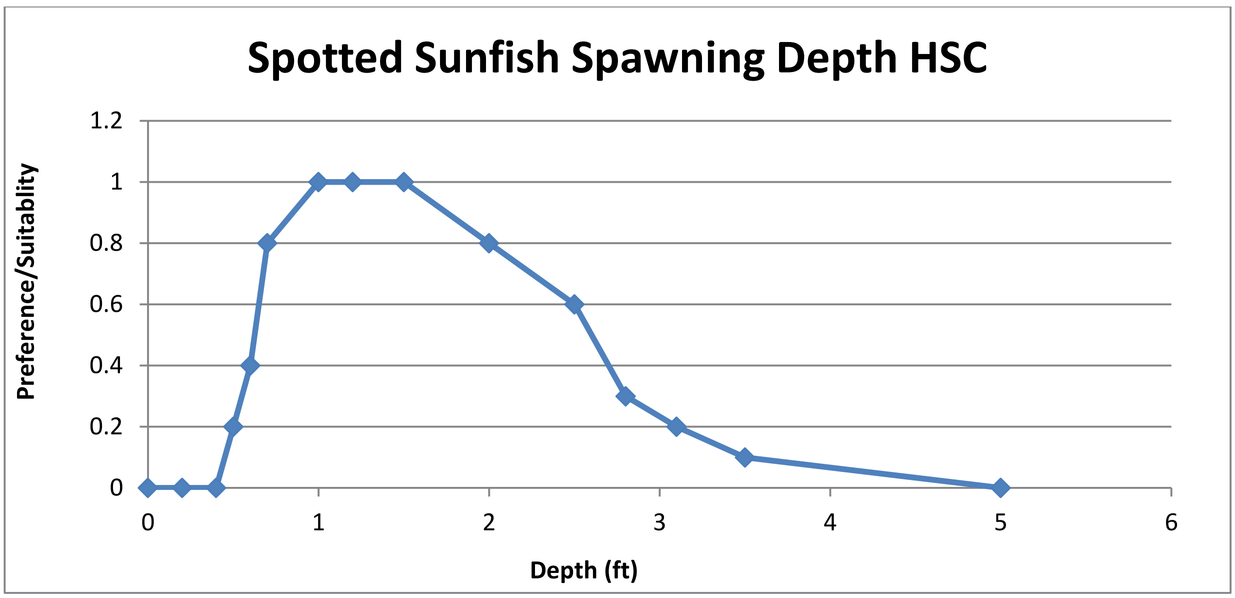
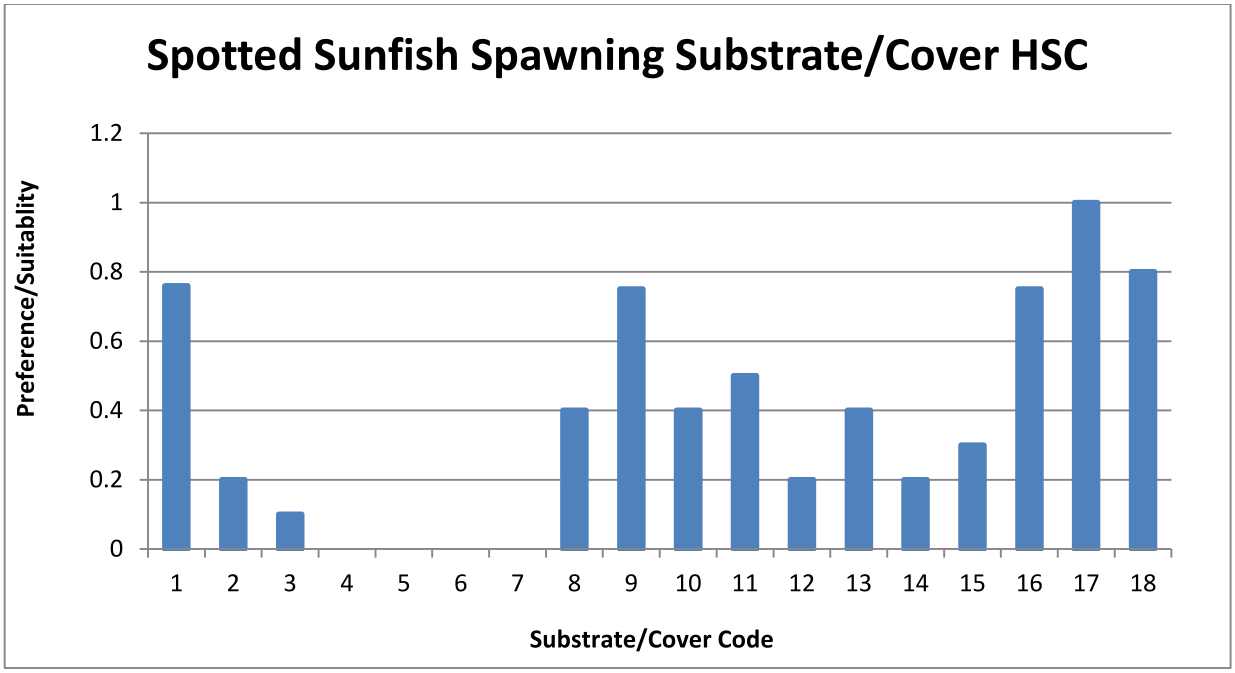
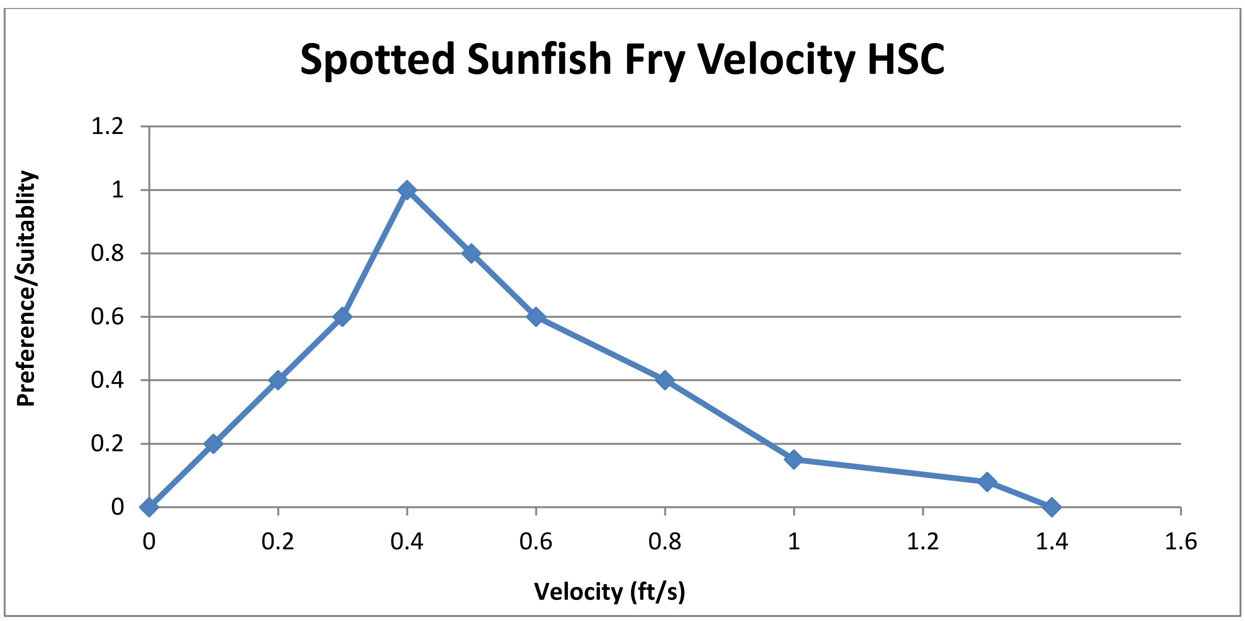
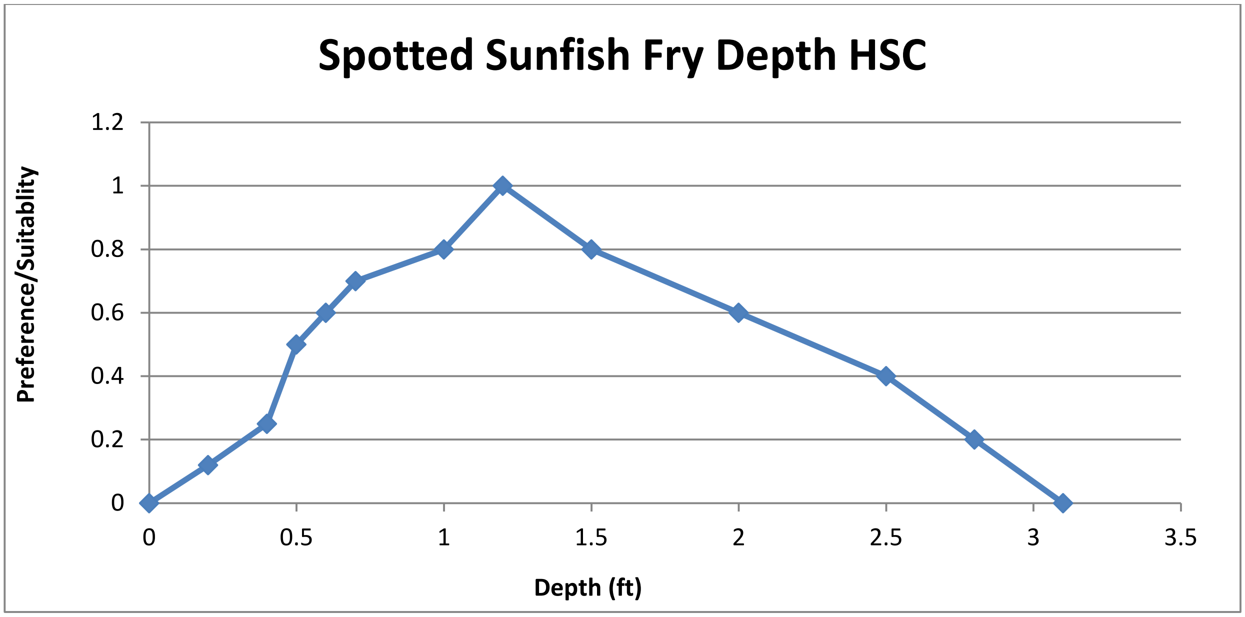
13
14
15
16
17

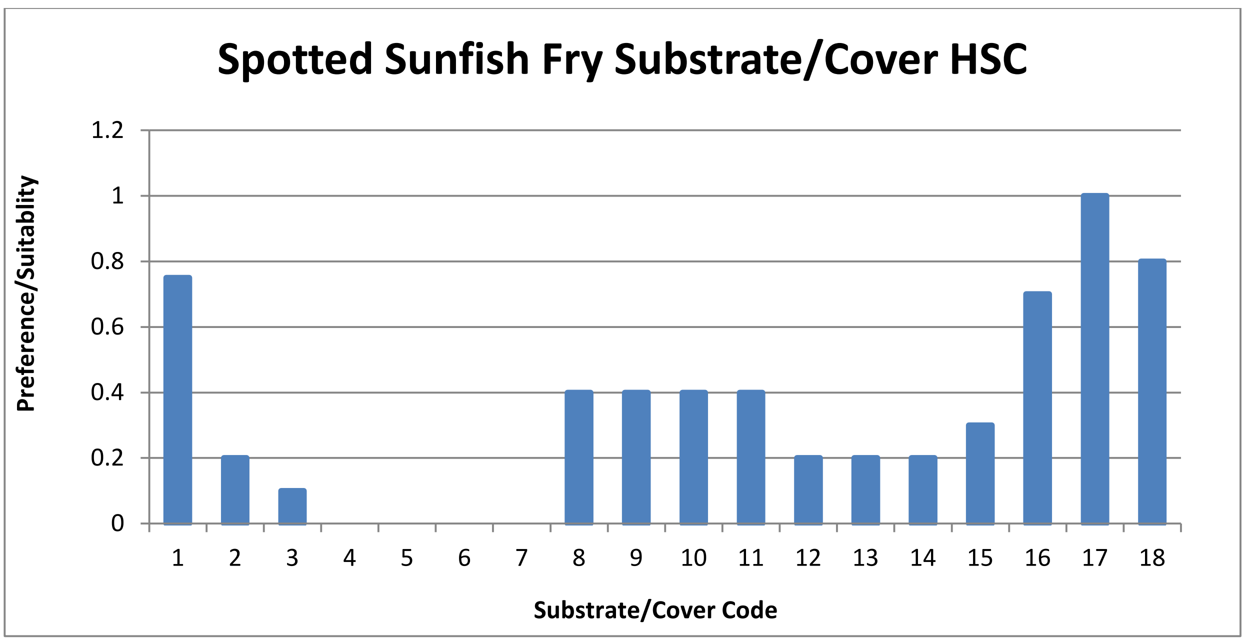

Spotted Sunfish Spawning Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Velocity (ft/s)

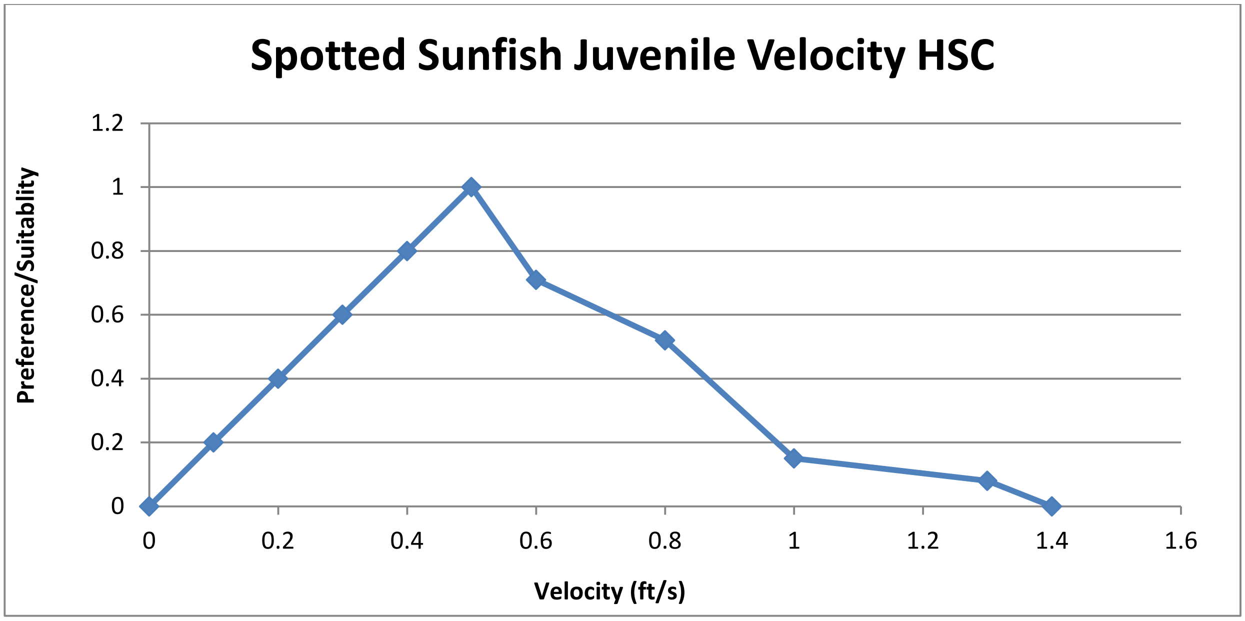

Spotted Sunfish Spawning Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
Depth (ft)

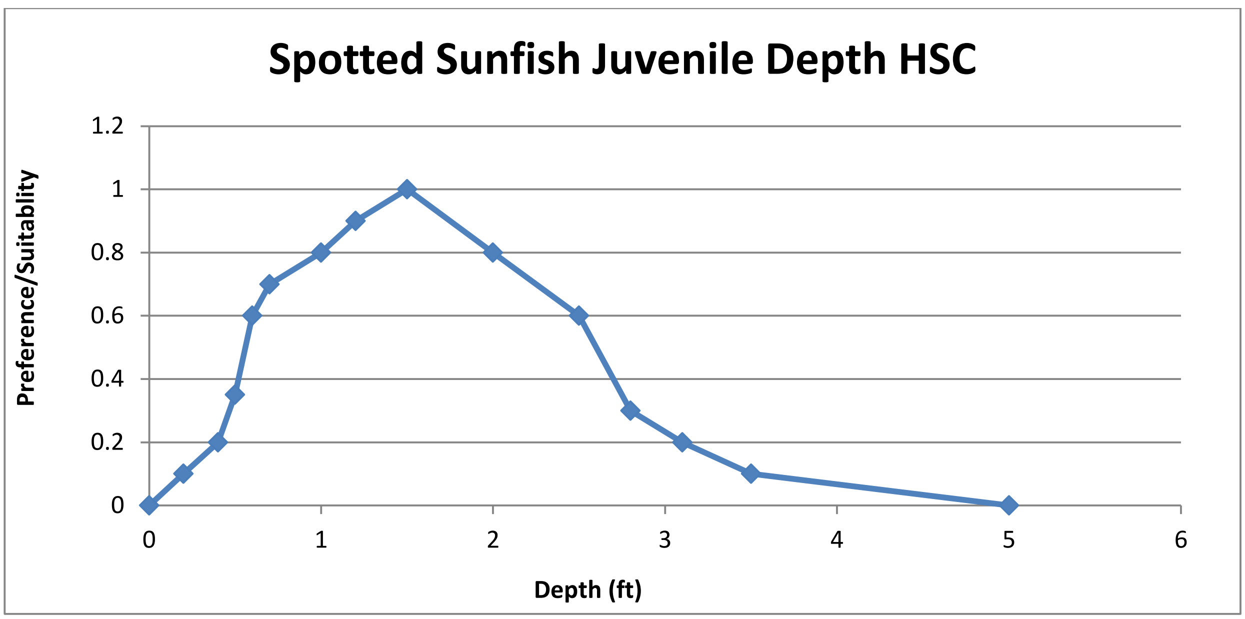

Spotted Sunfish Spawning Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code

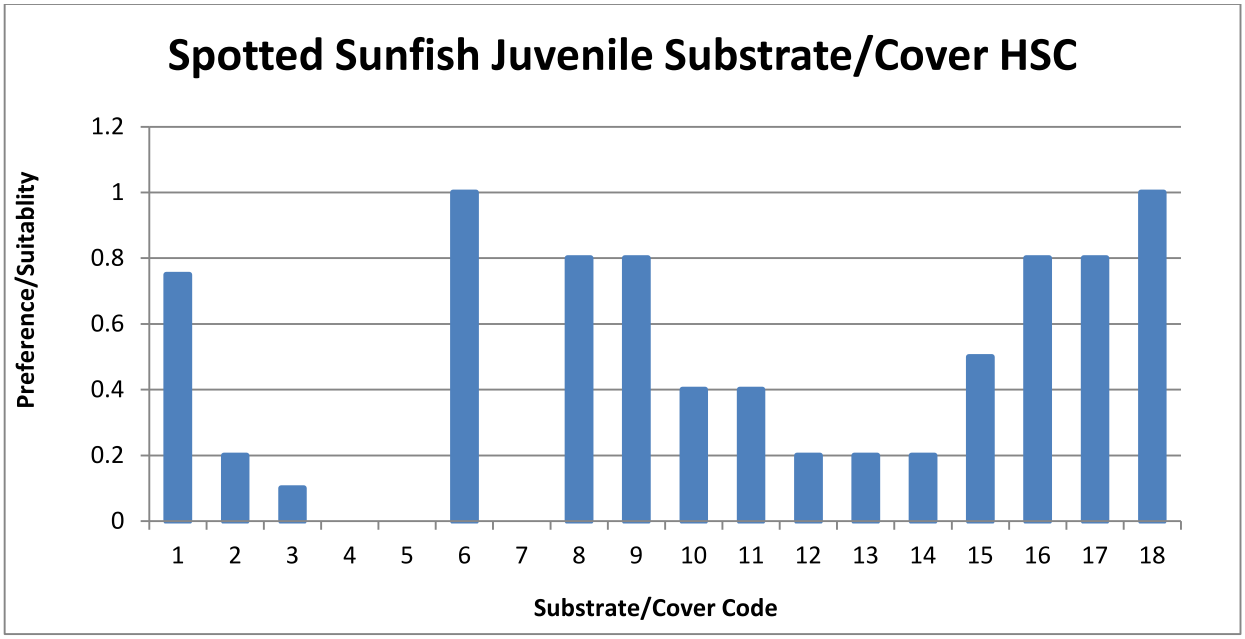

Spotted Sunfish Fry Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6
Velocity (ft/s)

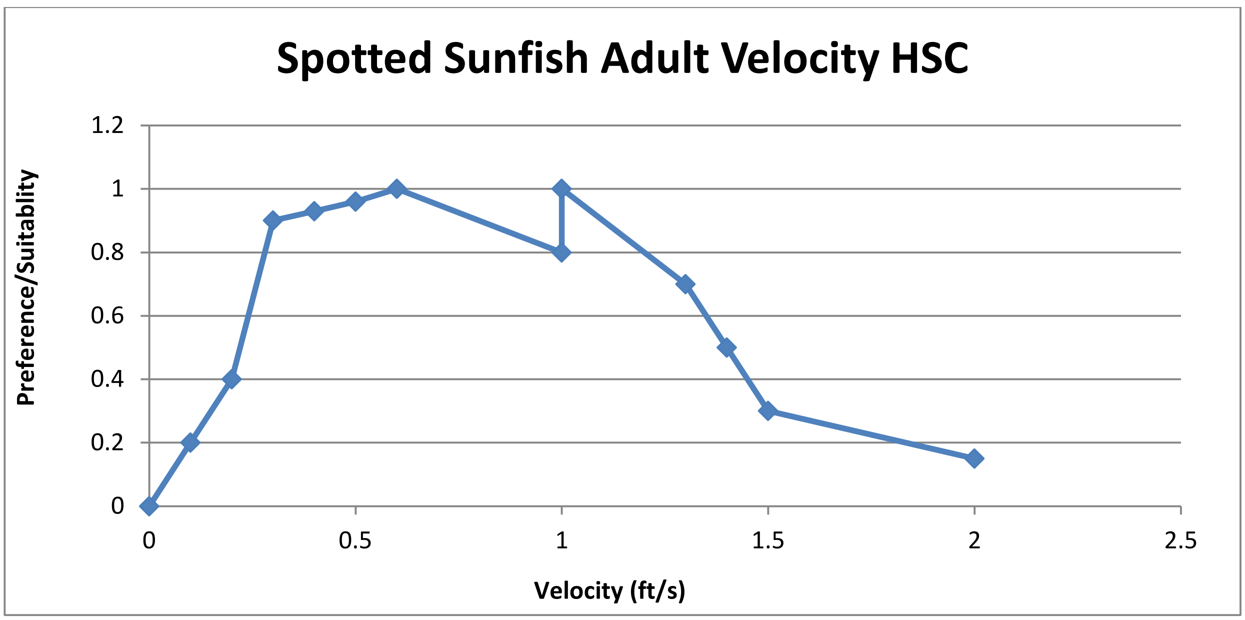

Spotted Sunfish Fry Depth HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
Depth (ft)

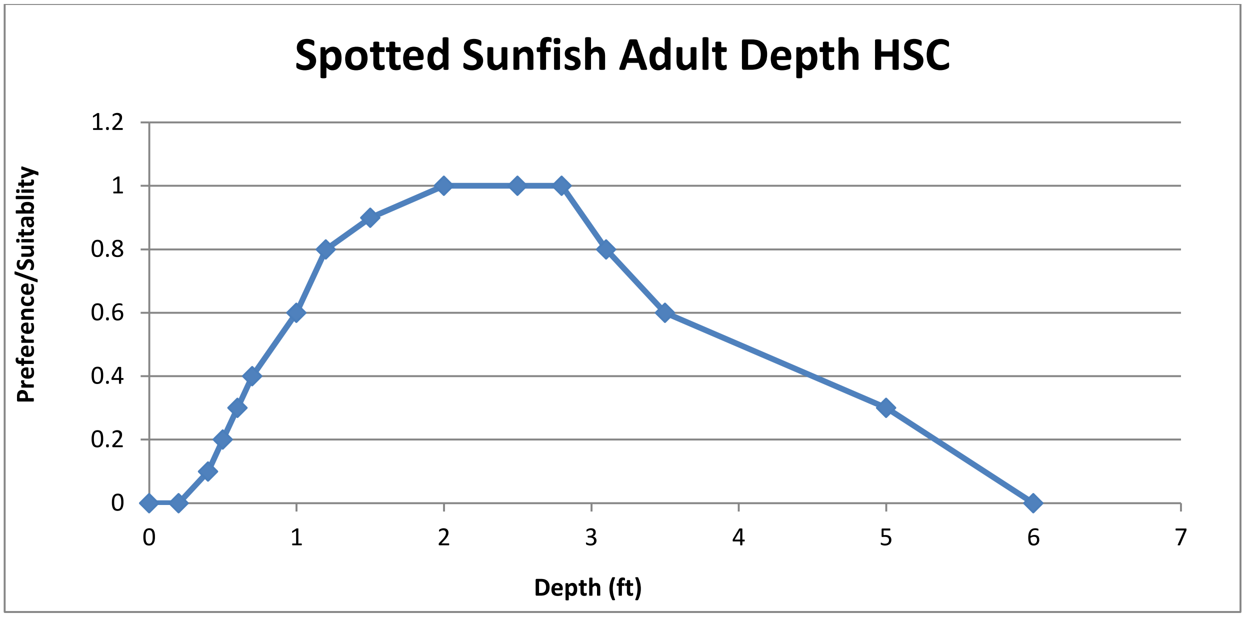

Spotted Sunfish Fry Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Substrate/Cover Code

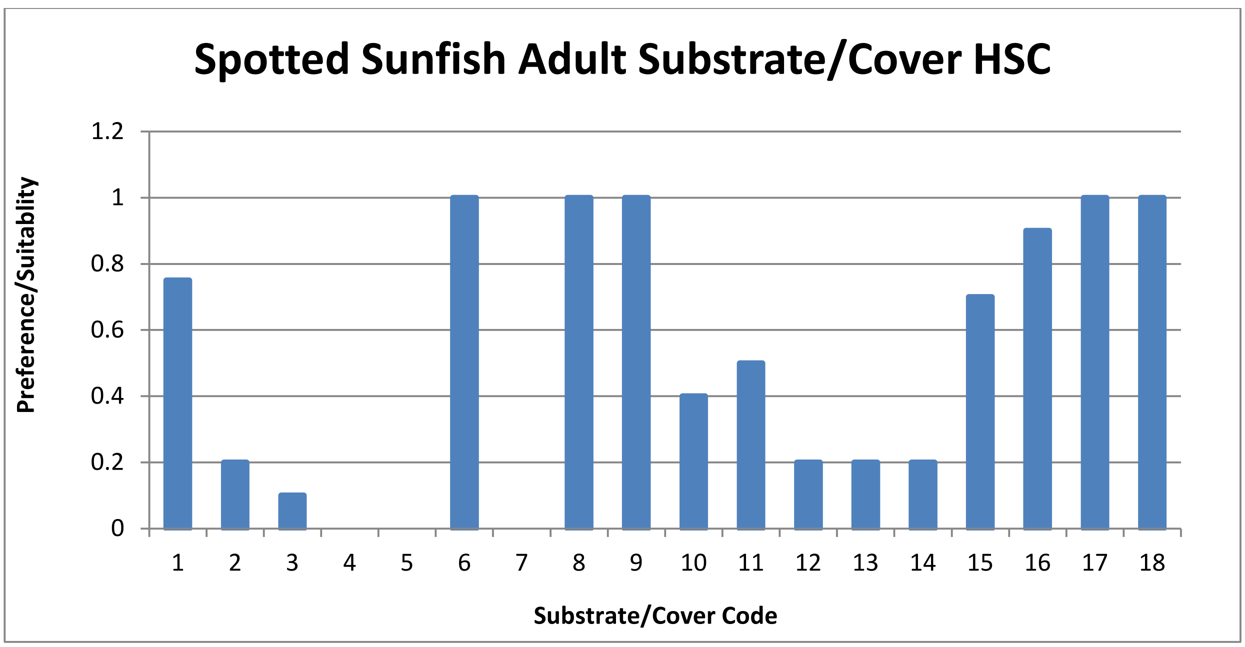

Spotted Sunfish Juvenile Velocity HSC
Preference/Suitablity
Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6


Spotted Sunfish Juvenile Depth HSC
Preference/Suitablity
Depth (ft)
0
1
2
3
4
5
6


Spotted Sunfish Juvenile Substrate/Cover HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Substrate/Cover Code


Spotted Sunfish Adult Velocity HSC
Preference/Suitablity
1.2
1
0.8
0.6
0.4
0.2
0
0 0.5 1 1.5 2 2.5
Velocity (ft/s)


Spotted Sunfish Adult Depth HSC
Preference/Suitablity
Depth (ft)
1.2
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7


Spotted Sunfish Adult Substrate/Cover HSC
Preference/Suitablity
Substrate/Cover Code
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18