Appendix VIII
In-Stream Analyses Technical Memo

1.0 INTRODUCTION AND OBJECTIVE

The Suwannee River Water Management District (District) is tasked with developing minimum flows and levels (MFL) on both lentic and lotic water bodies within its boundary. Each year, the District produces the MFL Priority List which lists water bodies for which an MFL will be determined within a specified time frame. The purpose of an MFL is to protect a specified water body from what is known as “significant harm.” In order to address this, the District has adopted a threshold of no more than a 15% reduction for in-channel habitat before “significant harm” is reached.

The Suwannee River is approximately 246 miles long and represents the second largest river system in Florida. Its headwaters originate in the Okefenokee Swamp in southeastern Georgia and flows south and southwest toward the Gulf of Mexico. Decaying vegetation in the Okefenokee Swamp is responsible for the river’s tannic color, which is maintained as the river flows south. The middle portion of the Suwannee River stretches 92 miles from the town of Ellaville south to Wilcox, near Fanning Springs, and is the focus of MFL efforts (**Figure 1**).

This memo describes the in-stream biological assessment that Wood Environment & Infrastructure Solutions Inc. (Wood) conducted for the Middle Suwannee River (MSR) as part of a larger ongoing effort to support minimum flows and levels determinations for the MSR. The primary purpose of this assessment is to describe the biology of the study reach and general and specific hydrologic indicators for associating metrics for biological integrity or habitat suitability and sustainability to flow. This effort focuses on listed species, relevant habitats, and forage species, but expands to other biological assemblages as needed to assess a broad range of flow conditions. A specific species that was reviewed and considered in the establishment of the MFL is the Gulf sturgeon (*Acipenser oxyrinchus desotoi*). Specific tasks conducted include a listed species review using available biological databases and resources; relevant physical habitat modeling; baseline fish, manatee, and recreational passage assessments at the river’s critical shoals, using the existing HEC–RAS model and the gap-filled gage records; and bankfull discharge estimates of select spring runs (Allen Mill Pond, Otter, Peacock) and each run’s channel dimensions and elevations near the natural breaches maintained by this discharge as well as fish passage statistics estimated at those openings. The following sections describe the methods utilized and the results of the assessments.

Figure 1. Map of the Suwannee River outlining the MSR project area

2.0 METHODS / DATA COMPILATION

2.1 Listed Species

The District and Wood conducted a review of the documented and potential listed species inhabiting the Middle Suwannee River through relevant database searches and through communication with the Florida Fish and Wildlife Conservation Commission (FFWCC). The Florida Natural Areas Inventory (FNAI) Biodiversity Matrix map server was accessed to determine the occurrence of rare species in the Middle Suwannee River proper, and the adjacent floodplain between Ellaville and Fanning Springs (http://www.fnai.org/biointro.cfm). The Biodiversity Matrix includes species and natural communities tracked by FNAI, including federally listed species.

Screening methods were analogous to a spatial union in ArcGIS, where the river was combined with adjacent one square-mile units from the matrix. Their respective species occurrences (attributes) were joined for an inventory of listed and rare species. Occurrence status of species and communities are defined as:

- **Documented** - There is a documented occurrence in the FNAI database of the species or community within this Matrix Unit.
- **Documented-Historic** - There is a documented occurrence in the FNAI database of the species or community within this Matrix Unit; however, the occurrence has not been observed/reported within the last twenty years.
- **Likely** - The species or community is known to occur in this vicinity, and is considered likely within this Matrix Unit because: 1. a documented occurrence overlaps this and adjacent Matrix Units, but the documentation isn't precise enough to indicate which of those Units the species or community is actually located in; or 2. there is a documented occurrence in the vicinity and there is suitable habitat for that species or community within this Matrix Unit.
- **Potential** - This Matrix Unit lies within the known or predicted range of the species or community based on expert knowledge and environmental variables such as climate, soils, topography, and landcover.

In addition to the database search, the District communicated with Gary Warren of the FFWCC. In 2014, Mr. Warren compiled a list and references of imperiled freshwater invertebrate species of the Suwannee basin for the District.

Following the compilation of species lists, in order to be certain that the status of listed, candidate, and petitioned species is up-to-date for the current MFL(s), a search was conducted using the U.S. Fish and Wildlife Service's (USFWS) At-Risk Species data provided by USFWS (personal communication, Ashleigh Blackford - USFWS, 12/6/2021). According to the USFWS, biologists commonly refer to species as "at-risk" if they face possible extinction, or extirpation from a geographic area. For the purposes of their conservation strategy, the Service's Southeast Region has defined "at-risk species" as those species that have either been proposed for listing, are candidates for listing, or have been petitioned for listing (USFWS 2021a).

2.2 Habitat Modeling

In-stream physical habitat modeling was performed for the MSR using the System for Environmental Flow Analysis (SEFA) software (Aquatic Habitat Analysts, Inc. 2012), which is a Windows-based program developed as a tool for use in studies that utilize the Instream Flow Incremental Methodology (IFIM). It contains hydraulic, instream habitat, and time series models and can be used in the development of flow recommendations. The program allows for the alteration of flows to demonstrate the effects on habitat availability (shown as area weighted suitability) for species and life stages of interest in the body of water (Jowett et.al 2014).

2.2.1 Site Selection and Field Measurements

Five sites were chosen for SEFA data collection in the Middle Suwannee River based on characteristic representation, access, and diversity of habitat area (**Figure 2**). Project staff collected data at five transects within each of the sites under three different flow/stage conditions (low flow, medium flow, and high flow) ranging from 2,343 to 9,673 cfs between May and September 2013 (**Table 1**). The team collected the necessary survey, velocity, discharge, water depth, and substrate/cover values (based on the Gore classification system) at each transect. Transects were established to assure the natural variability in habitat substrates and meso-habitats (pools, riffles, runs) would be sampled in each area. The river presents repeating sequences of deep (pool), transitional (run), and shallow (riffle/shoal) areas that are thus captured in the sample area. Although each sampling area is defined by the name of its dominant shoal, it is important to understand that the SEFA analysis covers a complete gamut of meso-habitats (not just shoals/riffles) at each area. Recorded data were utilized in the hydraulic, instream habitat, and time series models of the river. The 2x highest measured flow was utilized to establish the upper validity limits of the area weighted suitability versus flow (AWS-FLOW) relationships developed in SEFA for the five sites, while 1/2x lowest measured flow was utilized to establish the lower validity limits of the AWS-Flow relationships (**Table 1**).

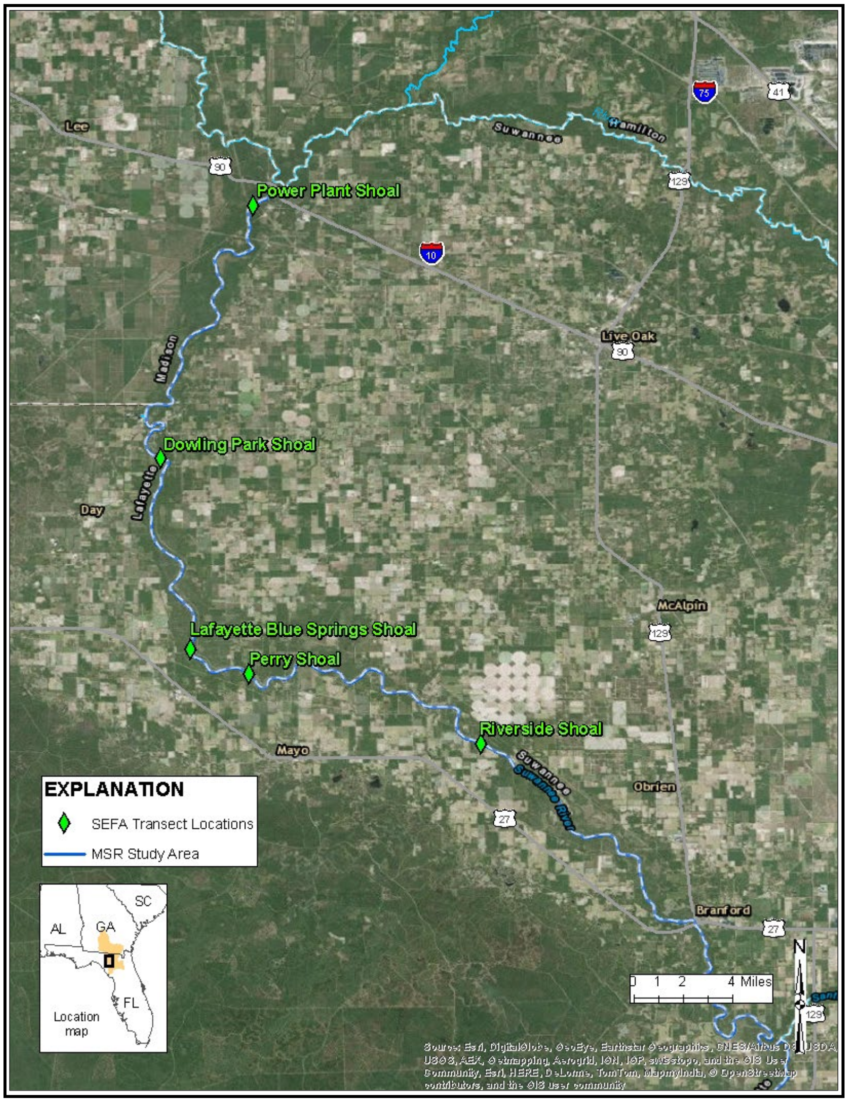


Figure 2. Map of selected sites for SEFA data collection in the Middle Suwannee River

Table 1. Discharge rates for Low, Medium, and High Flow Events

Site	Mean Measured Discharge (cfs)			Range of Discharge for Model (cfs)	
	Low Flow Event (Dec 2013)	Medium Flow Event (May 2013)	High Flow Event (Aug 2013)	1/2x lowest measured	2x highest measured
Powerplant Shoal (1)	2,343	5,332	7,778	1,172	15,556
Dowling Park (1)	2,447	5,538	8,263	1,224	16,526
Lafayette Springs (2)	2,700	5,641	8,762	1,350	17,524
Perry Springs (2)	2,763	5,440	8,729	1,382	17,458
Riverside (2)	3,079	5,842	9,673	1,540	19,346

(1) closest compliance gage is Ellaville, with applicable model flow ranges during times of data collection of 1,324 to 16,370 cfs

(2) closest compliance gage is Branford, with applicable model flow ranges during times of data collection of 1,730 to 22,600 cfs

2.2.2 Habitat Suitability Curves

Forty-six sets of habitat suitability curves of various species, life stages, and guilds were incorporated into the instream habitat model (**Table 2**). The habitat suitability curve (HSC) data utilized were provided to Wood by the District and the Florida Fish and Wildlife Conservation Commission (FWC). Most of these curve sets have been applied in previous MFL analyses and can be found in **Appendix A**. For this study, the velocity, depth, and substrate/cover preference criteria for each species and life stage were utilized in the calculation of the area weighted suitability versus flow relationship (AWS-Flow). Substrate/cover preference was ranked using the 18 class Gore system.

Table 2. Habitat Suitability Curve Sets used in the analysis

Species or Group	Life Stage
Suwannee Bass	Adult, Juvenile, Spawning
Redbreast Sunfish	Adult, Juvenile, Spawning, Fry
Habitat Guilds	Shallow/Slow, Shallow/Fast, Deep/Slow, Deep/Fast
Channel Catfish	Adult, Juvenile, Juvenile (spring, summer, fall), Spawning, Fry
Darters	Generic (adult), Blackbanded (adult)
Macroinvertebrates	Ephemeroptera, Plecoptera, Trichoptera, EPT Total, *Pseudocloeon ephippiatum* (nymph),
	Hydropsychidae Total, *Tvetenia vitracies* (larvae), Benthic Macroinvertebrates (low grad)
Largemouth Bass	Adult, Juvenile, Spawning, Fry
Bluegill	Adult, Juvenile, Spawning, Fry
Spotted Sunfish	Adult, Juvenile, Spawning, Fry
Cyprinidae	Adult
Gulf Sturgeon	Juvenile, Adult*
Metallic Shiner	Adult
Spotted Sucker	Juvenile, Adult

*The HSC set for *Gulf Sturgeon – Adult* is treated as Spawn since Gulf sturgeon adults enter the Suwannee River for the purpose of Spawning (see **Table 4**).

2.2.3 SEFA Calculation Settings

SEFA Version 1.8, build 2, was used for this study. The settings utilized in the SEFA model are discussed in this section.

Hydraulic Habitat Options

The following Hydraulic Habitat Options were utilized in the analysis.

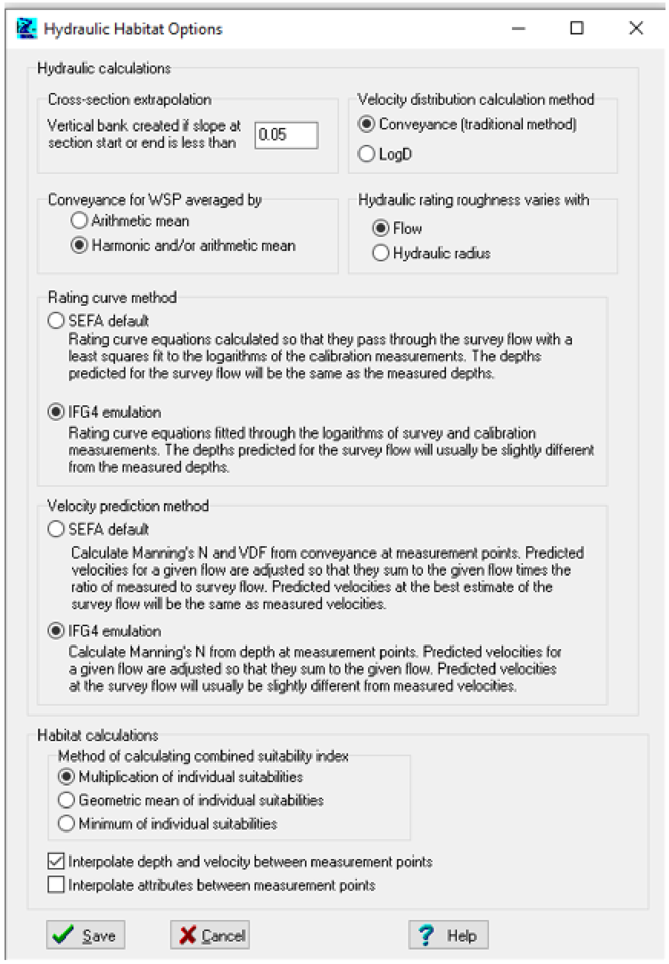


Figure 3. SEFA Calculations settings: Hydraulic Habitat Options

Instream Habitat Model Calibration

The three measured stage/discharge values were used to establish log-log rating relationships for each transect in the SEFA program. The rating curves and velocity prediction were each calculated with IFG4 emulation, the same method applied by the Physical Habitat Simulation (PHABSIM) model (Jowett et.al 2014; Milhous and Waddle 2001).

Habitat Calculations

For calculation of the AWS-FLOW relationship, the built in SEFA Substrate suitability criteria was not used; instead, the 18 class Gore substrate/cover system was used (see **Appendix A Table A-1**). The Gore substrate/cover classifications are not necessarily continuous, thus the option for *Interpolate attributes between measurement points* was not selected (see **Figure 3**) (Jowett, Payne, & Milhous, 2020). The option to not interpolate attributes was not an option on some earlier versions of SEFA.

Metallic Shiner (MESH) and Spotted Sucker Fish (SPSK) did not use Gore Codes for substrate/cover in the HSC sets provided by the District; instead they used a different system. The cross-section surveys entered into SEFA by the District are in Gore Codes for substrate/cover (labeled as the INDEX attribute in SEFA). Since Metallic Shiner and Spotted Sucker Fish use a different coding system for substrate/cover, the INDEX attribute for substrate/cover was excluded in the SEFA AWS-FLOW relationship for these two species.

Reach Habitat

The 2x highest measured flow was utilized to establish the upper validity limits of the AWS-FLOW relationships for the five sites (**Table 1**). For Riverside Shoal the upper limit of the AWS-Flow relationship was set at 20,000 cfs, all other sites were set at 18,000 cfs. **Figure 4** shows the Reach Habitat settings used for creating the AWS-FLOW relationship; note that this is for Dowling Park Shoal so the flow range maximum is set to 18,000 cfs. A flow increment of 100 cfs was used for all five sites.

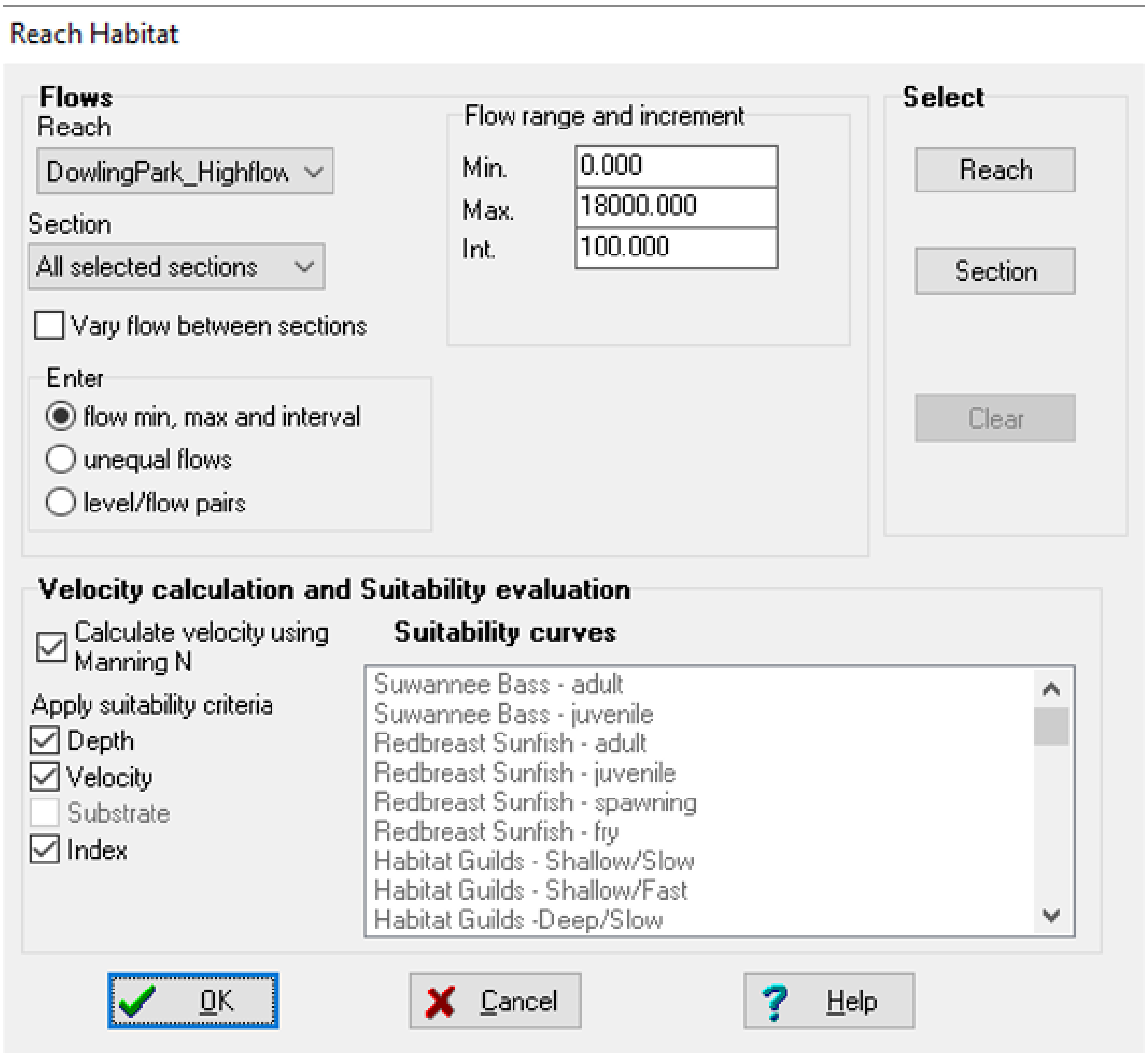


Figure 4. SEFA Calculations settings: Reach Habitat

2.2.4 Time Series Flow

Reference Timeframe Flow (RTF) records from WY 1933 to 2015 were derived for the closest HEC-RAS river station to each of the five shoal transects using HEC-RAS model output for the two compliance gages. The USGS Ellaville gage (02319500) was used to translate flows to the HEC-RAS stations closest to the Power Plant shoal and Dowling Park shoal sites, and the USGS Branford gage (02320500) was used to translate flows to the HEC-RAS stations closest to the Lafayette Blue, Perry, and Riverside shoal sites based upon proximity to gage (**Table 3**). Flows were translated from the compliance gages to the five SEFA shoals by plotting the HEC-RAS model output results of the applicable compliance gage and HEC-RAS station to develop a rating curve that could subsequently be used to derive a time series flow for each shoal. The rating curves developed for each shoal are provided in **Appendix A**, along with a table providing the model output results used in each rating curve. Note that SEFA only includes flow values ranging from half the lowest flow collected to two times the highest flow collected during SEFA data collection per SEFA's convention, see **Table 1** (Jowett et al., 2014). The flow duration curves for the RTFs and flow reduction scenarios of 5%, 10%, 15%, 20%, and 25% are found in **Appendix A**.

Table 3. HEC-RAS River Station Associated with SEFA Shoal

Site	USGS Gauge	HEC-RAS Station
Power Plant	Ellaville (02319500)	126.58
Dowling Park	Ellaville (02319500)	111.18
LAF Blue	Branford (02320500)	102.89
Perry	Branford (02320500)	100.23
Riverside	Branford (02320500)	89.24

2.2.5 Flow Reduction Approach

This approach involved a comparison of the mean area weighted suitability (AWS) associated with the RTF and the mean AWS associated with various percent reductions in flow. Flow reduction scenarios of 5%, 10%, 15%, 20%, and 25% were chosen and utilized for all species and life stage curves listed in **Table 2** to determine if any species and/or life stages showed significant decrease (i.e., 15% difference) in mean AWS between the RTF and reduced flow scenario conditions. This comparison was done for the entire year, or for specific months for spawn and fry when indicated in **Table 4**. Additionally, as shown in **Table 2**, Channel Catfish – Juvenile has separate HSC sets available for the seasons of Spring, Summer, and Fall; thus, these were applied to flows occurring only during the corresponding seasonal months.

Table 4. Seasonality of Relevant Fish Species Spawning & Fry

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Spawning Reference
Gulf sturgeon													Chapman & Carr, 1995; Sulak & Randal, 2009
Suwannee bass													Strong et al. 2010
Largemouth bass			X	X	X	X	X						Rogers & Allen 2010
Bluegill sunfish				X	X	X	X	X	X	X	X		Bass Fishing Florida 2021b
Channel catfish				X	X	X	X						Chapman 2018
Redbreast sunfish					X	X	X	X	X				Bass Fishing Florida, 2021c
Spotted sunfish			X	X	X	X	X	X	X	X			Hill & Cichra, 2005

Note(s):

- Teal fill = spawning months, X = fry months (Source for fry seasonality is personal communication with Eric Nagid - FFWCC, September 2021)
- The HSC set for *Gulf Sturgeon – Adult* is treated as Spawn since Gulf sturgeon adults enter the Suwannee River for the purpose of Spawning

2.3 Fish/Manatee/Recreation Passage

Shallow shoal areas located throughout the Middle Suwannee River can present a potential issue for the passage of fish, manatees, and boats during low flow. Shoals along the MSR are typically comprised of limestone outcroppings that can become exposed during lower flows, with water moving around the higher portions of the shoal (**Figure 5**). To assess passage concerns, shoals within the MSR were identified by field reconnaissance and by examining the MSR HEC-RAS model river profile output for the highest points (**Figure 6**). The most prominent shoals were selected for further analysis, including the five shoal locations used in the SEFA analysis (Powerplant, Dowling Park, Lafayette Blue, Perry, and Riverside shoals) and 11 cross-sections selected from the HEC-RAS profile (126.58, 125.63, 96.53, 96.08, 95.56, 93.79, 87.17, 87.11, 86.66, 85.08, and 84.93) (**Figure 6** and **Figure 7**). Stationing and elevation data were extracted from the HEC-RAS model for these stations of interest. These cross-sectional data were then used to determine the elevations that allow passage for various passage considerations.

a) b)

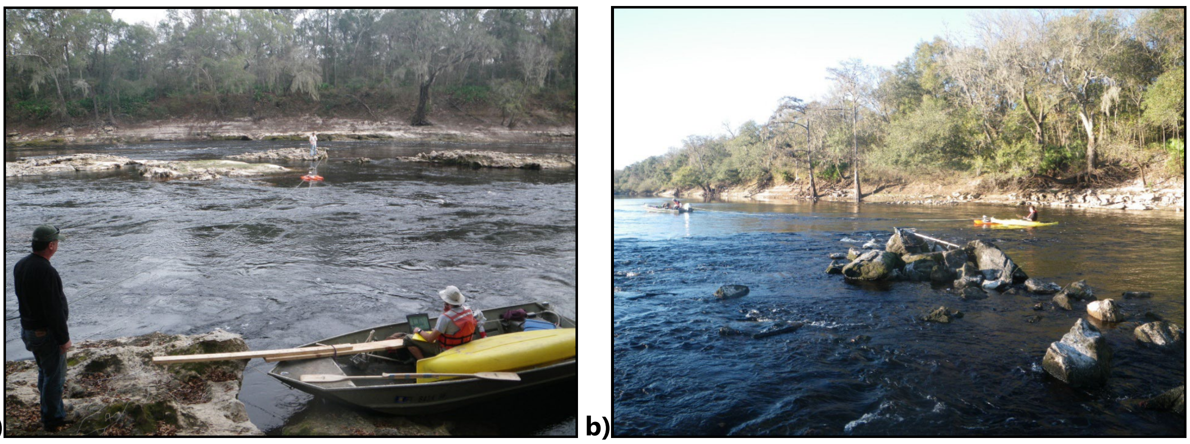


Figure 5. Examples of river shoals: (a) Powerplant Shoal 12/13/2013 (b) Riverside Shoal 12/12/2013

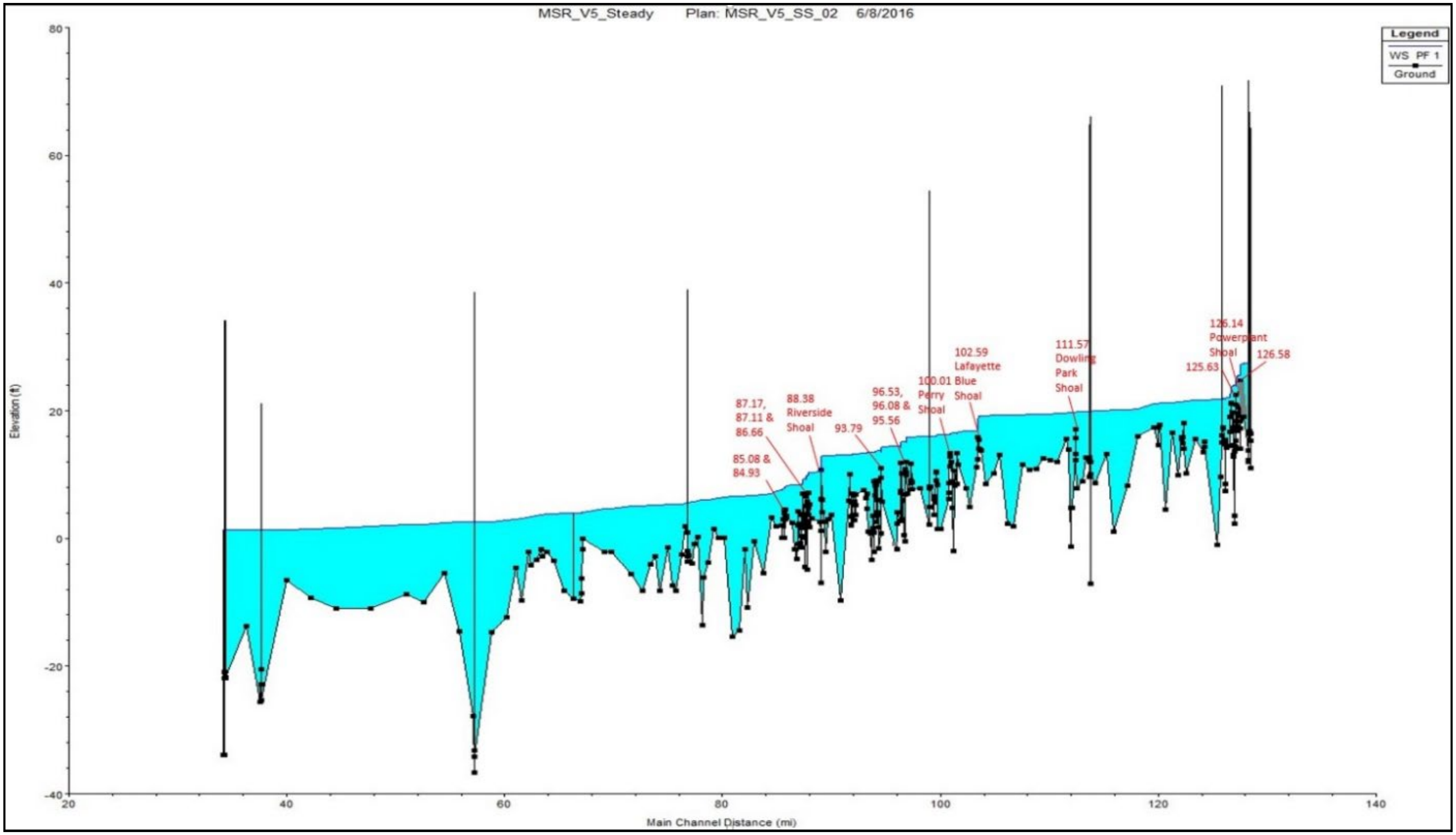


Figure 6. HEC-RAS profile for use in Identifying Shoals

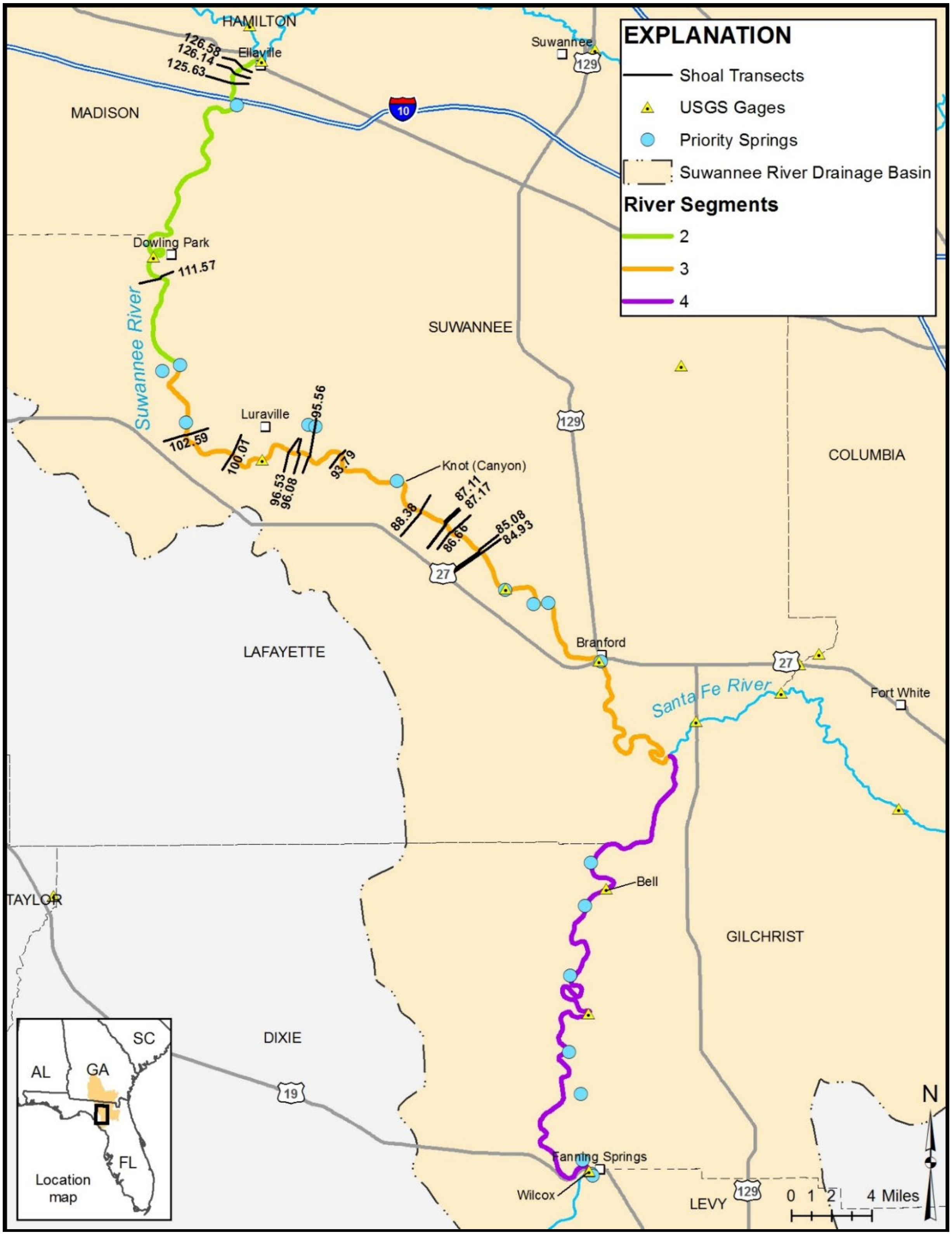


Figure 7. Map of Selected shoals for Passage Analyses

2.3.1 Fish Passage

For general fish passage, the elevation at which at least 0.8 feet of water would collectively cover a channel width of 25%, with single blocks no less than 10%, was determined. This follows parameters used in the Lower Santa Fe and Ichetucknee Rivers MFL Re-evaluation Report, citing Thompson, 1972 (HSW, 2021). This block approach ensures that schools of fish have sufficient width to pass through the shoal. Channel width was determined by using the width at the bankfull elevation. Bankfull elevations for each cross-section were determined using a regression based on field indicators for the MSR (**Table 5**). This method was deemed preferable to a top-of-bank approach because top-of-bank is highly variable along the river. Once the general fish passage elevation was determined for each assessed cross-section, the HEC-RAS model was used to determine the flow associated with that elevation. Of the assessed shoals, the shoal with the flow with the lowest exceedance was determined to be the "limiting" shoal for general fish passage. The flow associated with the limiting shoal was then interpolated with the appropriate compliance gage (Ellaville when above RM 90 or Branford when below RM 90) to determine a general fish passage MFL.

Table 5. Bankfull Elevations used for Passage Assessments

Station (River Mile)	BKF Elevation (ft, NAVD)*
126.58	35.21
126.14	35.06
125.63	34.87
111.57	29.81
102.59	26.58
100.01	25.65
96.53	24.40
96.08	24.23
95.56	24.05
93.79	23.41
88.38	21.59
87.17	21.24
87.11	21.22
86.66	21.10
85.08	20.65
84.93	20.60

*Equation used to determine bankfull elevation upstream of River Mile 90: -10.354+0.36x, where x = river mile; Equation used to determined bankfull elevation downstream of River Mile 90: -3.55+0.2844x, where x = river mile

To determine Gulf sturgeon passage, the elevation at which at least 3 feet of water covers 15 feet of streambed was determined. This follows parameters use in the Lower Santa Fe and Ichetucknee Rivers MFL Re-evaluation Report, citing personal communication with M. Randall, 2013 (HSW, 2021). Once the sturgeon passage elevation was determined for each assessed cross-section, the HEC-RAS model was used to determine the flow associated with that elevation. Of the assessed shoals, the shoal with the flow with the lowest exceedance was determined to be the limiting shoal for sturgeon passage. The flow associated with the limiting shoal was then interpolated with the appropriate compliance gage to determine a sturgeon passage MFL. Sturgeon travel up and down the Suwannee at certain times of year, so the critical flow was further assessed by season (February-April and September-November).

2.3.2 Manatee Passage

Currently manatees appear to be infrequent in the MSR, particularly upstream of Branford due to major shoals (**Figure 7**). Manatees are known to travel up the Suwannee River into the Santa Fe River and into the Ichetucknee River, which has large SAV meadows. Ichetucknee Springs State Park maintains manatee sighting records with over 450 sightings recorded to date; while only five manatee sightings have been recorded at Troy Springs State Park (based on OFS database; WSI, 2021). Parks along the MSR (Troy Springs, Peacock Springs, Lafayette Blue, and Suwannee River State Parks) either have not documented manatee sightings as rigorously as has been done in Ichetucknee or manatees infrequently travel upstream of Branford. manatee passage is not a critical concern in the MSR. The Suwannee River Springs complex, which includes Hart, Troy, Otter, and other springs, is listed in the FWC's Warm-Water Action Plan as a secondary refuge with unpredictable manatee use (Valade et al, 2020). The use and importance of the Suwannee River Springs Complex as a warm-water refuge is likely to increase in the near future as power plant thermal discharges are reduced or eliminated (personal communication, Eric Nagid - FFWCC, 7/1/2021). The elevation determined for Gulf sturgeon passage, at which at least 3 feet of water covers 15 feet of streambed (HSW, 2021), should provide sufficient water depth for the safe passage of manatees.

2.3.3 Recreational Passage

The Suwannee River is designated an Outstanding Florida Water (OFW). Recreational activities such as canoeing, kayaking and small power boating are popular in the MSR. Shallow shoals may pose a challenge to boaters, and the District's Suwannee River Wilderness Trail guide warns that "shoals above Walker Tract Launch (located at River Mile 83.7) could damage boat motors during low water periods" (**Figure 8**). To determine recreational boating passage, different criteria were used for different types of vessels. For canoes and kayaks, a depth of 1.5 feet over a width of 15 feet was used, which is consistent with what was used in other District MFL documents. For small motor boats, a depth of two feet over a 30 foot width was used, to account for the outboard motor and to allow for the passage of two 15-foot boats passing sideways, which is also consistent with what has been used in other MFL documents. Once the canoe/kayak and small motor boat critical elevations were determined for each assessed cross-section, the HEC-RAS model was used to determine the flows associated with those elevations. Of the assessed, the shoal with the flow with the lowest exceedance was determined to be the limiting shoal for canoe/kayak passage and for small motor boat passage. The flow associated with the limiting shoal was then interpolated with the appropriate compliance gage (Ellaville when above RM 90 or Branford when below RM 90) to determine both a canoe/kayak passage MFL and a small motor boat passage MFL.

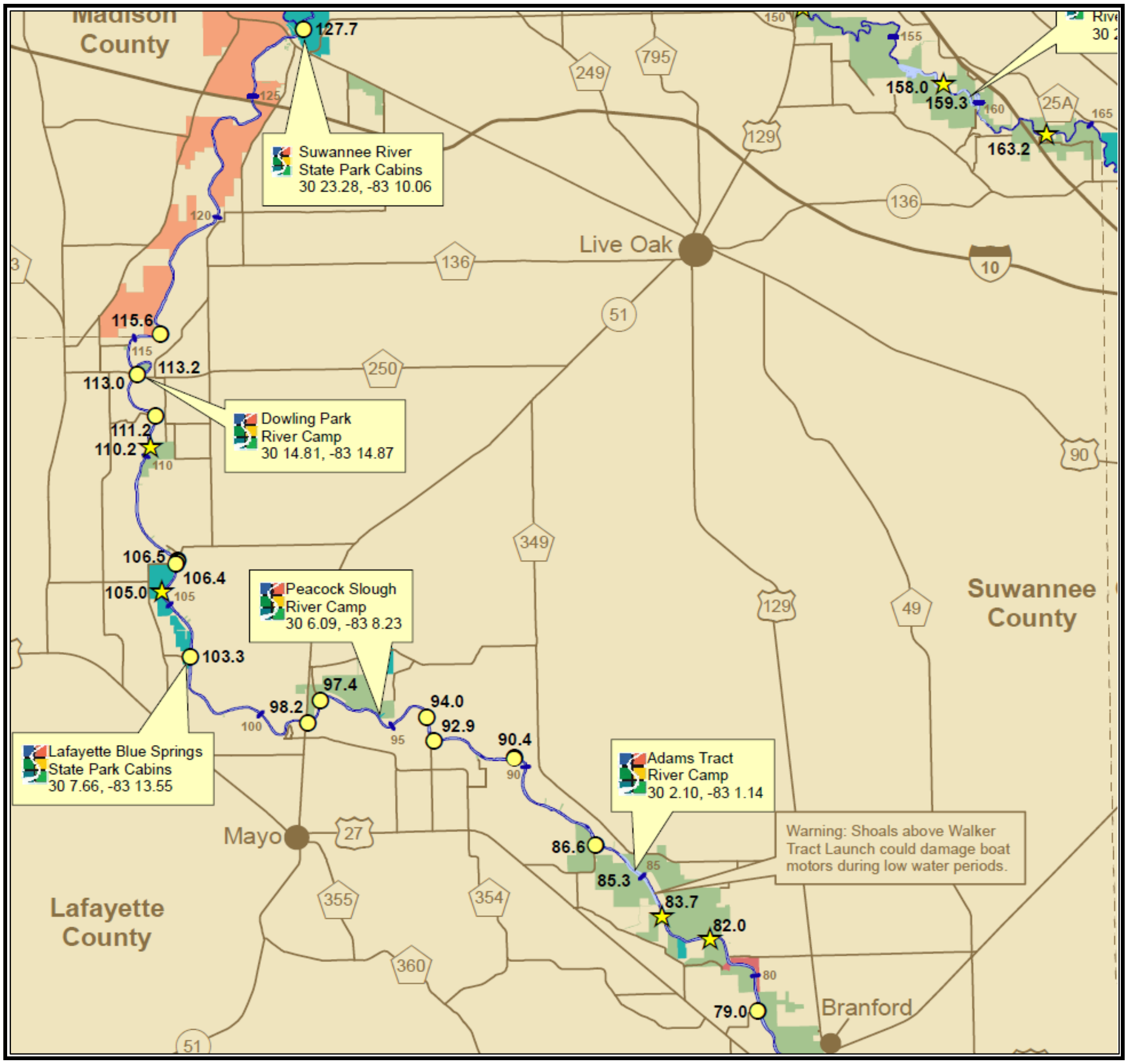


Figure 8. Suwannee River Wilderness Trail Guide showing warning near RM 85 (http://www.srwmd.state.fl.us/documentcenter/home/view/31)

2.3.4 Spring Runs

Spring runs provide a two-way exchange of flow and fish through the opening to the river. Flow out of spring run is perennial, while flow into the spring run from the river is sporadic. Straighter spring runs are dominated by spring flow, while more sinuous spring runs (i.e. Rock Sink) are more dominated by river flows. Wood estimated the bankfull discharge of select spring runs (Allen Mill Pond, Otter, Peacock) and each run's channel dimensions and elevations near the natural breaches, as these openings to the river are maintained by the bankfull discharge. Previously collected survey data were used to determine the bankfull channel dimension. Data from flow measurements taken at various stages were used to calculate a Manning's n, the roughness of the channel. Specifically, velocity, area, wetted perimeter, and slope were used (**Equation 1**). The appropriate Manning's n was then used in conjunction with the bankfull channel dimension to estimate the bankfull flow (**Equation 2**).

Equation 1

$$n = kn / v * R^{2/3} * S^{1/2}$$

Where
v = cross-sectional mean velocity (ft/s)
kn = 1.486 for English units
n = Manning coefficient of roughness
R = hydraulic radius (ft) = Area / wetted perimeter
S = slope of channel (ft/ft)

Equation 2

$$Q = A v = A * kn / n * R^{2/3} * S^{1/2}$$

Where
Q = volume flow (ft3/s)
A = cross-sectional area of flow (ft2)

While a spring run's bankfull discharge maintains an opening to the river for the exchange of flow and fish, the river itself can reach levels at which fish can travel from the main river channel into the spring run via the opening and ultimately providing access to MSR floodplain habitats. Fish passage statistics were estimated at the openings of the same three select spring runs (Allen Mill Pond, Otter, Peacock) using the previously described criteria and methods for general fish passage (0.8 foot depth over 25% of the channel width with no single block less than 10%). The critical stage determined for each spring run was then assessed at the closest HEC-RAS cross-section in the main river channel to determine the (river) flow associated with that elevation, which is the limiting elevation of fish passage from the main river into each spring run assessed. The flow associated with each spring run was then interpolated with the appropriate compliance gage (Ellaville when above RM 90 or Branford when below RM 90) to determine a spring fish passage MFL.

3.0 RESULTS

3.1 Listed Species

3.1.1 FNAI Biodiversity Matrix Screening

Documented, Documented-Historic, Likely, and Potential species determined from the screening exercise are summarized in **Table 6, Table 7**, **Table 8**, and **Table 9** respectively. The FFWCC maintains the state list of animals designated as Federally designated Endangered or Threatened, State designated Threatened, or State-designated Species of Special Concern, in accordance with Rules 68A-27.003, and 68A-27.005, respectively, Florida Administrative Code (F.A.C.), https://www.flrules.org/Default.asp. It is important to note that the State does not have a separate State designation for endangered animals, but rather has adopted the USFWS's list of endangered animals. The State lists of plants, which are designated Endangered, Threatened, and Commercially Exploited, are administered and maintained by the Florida Department of Agriculture and Consumer Services (FDACS) via Chapter 5B-40, F.A.C. This list of plants can be obtained at https://www.fdacs.gov/Forest-Wildfire/Our-Forests/Forest-Health/Florida-Statewide-Endangered-and-Threatened-Plant-Conservation-Program/Florida-s-Federally-Listed-Plant-Species.

Table 6. Documented occurrences of listed and rare species in the Middle Suwannee River and adjacent floodplain

Scientific Name	Common Name	Global Rank	State Rank	Federal Listing	State Listing
Acipenser oxyrinchus desotoi	Gulf sturgeon	G3T2T3	S2?	LT	FT
Aphodius aegrotus	Small pocket gopher Aphodius beetle	G3G4	S3?	N	N
Aphodius hubbelli	Hubbell's pocket gopher Aphodius beetle	GNR	S3?	N	N
Aphodius laevigatus	Large pocket gopher Aphodius beetle	G3G4	S3?	N	N
Aramus guarauna	Limpkin	G5	S3	N	N
Drymarchon couperi	Eastern indigo snake	G3	S3	LT	FT
Egretta caerulea	Little blue heron	G5	S4	N	ST
Elanoides forficatus	Swallow-tailed kite	G5	S2	N	N
Eptesicus fuscus	Big brown bat	G5	S3	N	N
Eudocimus albus	White ibis	G5	S4	N	N
Falco sparverius paulus	Southeastern American kestrel	G5T4	S3	N	ST
Gopherus polyphemus	Gopher tortoise	G3	S3	C	ST
Macrochelys suwanniensis	Suwannee alligator snapping turtle	G1G2	S1S2	PT	ST
Mycotrupes gaigei	North peninsular Mycotrupes beetle	G2G3	S2S3	N	N
Peucaea aestivalis	Bachman's sparrow	G3	S3	N	N

Phyllanthus liebmannianus ssp. platylepis	Pinewoods dainties	G4T2	S2	N	E
Pseudemys concinna suwanniensis	Suwannee cooter	G5T3	S3	N	N
Pteroglossaspis ecristata	Giant orchid	G2G3	S2	N	T
Ptomaphagus geomysi	Elongate pocket gopher Ptomaphagus Beetle	G2G3	S2	N	N
Ptomaphagus schwarzi	Schwarz' pocket gopher Ptomaphagus beetle	G3	S3	N	N
Pycnanthemum floridanum	Florida Mountain-mint	G3	S3	N	T
Utterbackia peninsularis	Peninsular floater	G2G3	S2S3	N	N

Table data sources: FNAI 2019, FNAI 2021a

Explanation of ranks and listings (FNAI 2021b):

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.
G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.
G3 = Either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.
G4 = Apparently secure globally (may be rare in parts of range).
G5 = Demonstrably secure globally.
G#T# = Rank of a taxonomic subgroup such as a subspecies or variety; the G portion of the rank refers to the entire species and the T portion refers to the specific subgroup; numbers have same definition as above (e.g., G3T1)
S1 = Critically imperiled in Florida because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.
S2 = Imperiled in Florida because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.
S2? = Possibly imperiled in Florida because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.
S3 = Either very rare and local in Florida (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.
S3? = Possibly either very rare and local in Florida (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.
S4 = Apparently secure in Florida (may be rare in parts of range).
N = Not currently listed, nor currently being considered for listing.
E = Endangered: species in danger of extinction throughout all or a significant portion of its range.
T = Threatened: species likely to become Endangered within the foreseeable future throughout all or a significant portion of its range.
PT = Proposed threatened, currently being considered for listing.
C = Candidate species for which federal listing agencies have sufficient information on biological vulnerability and threats to support proposing to list the species as Endangered or Threatened.
SAT = Treated as threatened due to similarity of appearance to a species which is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.
ST = State population listed as Threatened by the FFWCC. Defined as a species, subspecies, or isolated population which is acutely vulnerable to environmental alteration, declining in number at a rapid rate, or whose range or habitat is decreasing in area at a rapid rate and as a consequence is destined or very likely to become an endangered species within the foreseeable future.
FT(S/A) = Federal Threatened due to similarity of appearance
FT/LT = Listed as Threatened Species at the Federal level by the U. S. Fish and Wildlife Service
FE/LE = Listed as Endangered Species at the Federal level by the U. S. Fish and Wildlife Service

Table 7. Documented-Historic occurrences of listed and rare species in the Middle Suwannee River and adjacent floodplain

Scientific Name	Common Name	Global Rank	State Rank	Federal Listing	State Listing
Ameiurus serracanthus	Spotted bullhead	G3	S3	N	N
Crotalus adamanteus	Eastern diamondback rattlesnake	G4	S3	N	N
Crotalus horridus	Timber rattlesnake	G4	S3	N	N
Drymarchon couperi	Eastern indigo snake	G3	S3	LT	FT
Dryobates villosus	Hairy woodpecker	G5	S3	N	N
Gopherus polyphemus	Gopher tortoise	G3	S3	C	ST
Hydroperla phormidia	A stonefly	G3	S2	N	N
Medionidus walkeri	Suwannee moccasinshell	G1	S1	LT	FT
Micropterus notius	Suwannee bass	G3	S3	N	N
Podomys floridanus	Florida mouse	G3	S3	N	N
Pseudemys concinna suwanniensis	Suwannee cooter	G5T3	S3	N	N
Selonodon simplex	Simple Cebrionid beetle	G1	S1	N	N

Table 8. Likely occurrences of listed and rare species in the Middle Suwannee River and adjacent floodplain

Scientific Name	Common Name	Global Rank	State Rank	Federal Listing	State Listing
Acipenser oxyrinchus desotoi	Gulf sturgeon	G3T2T3	S2?	LT	FT
Drymarchon couperi	Eastern indigo snake	G3	S3	LT	FT
Forestiera godfreyi	Godfrey's swampprivet	G2	S2	N	E
Gomphus geminatus	Twin-striped clubtail	G3G4	S3	N	N
Gopherus polyphemus	Gopher tortoise	G3	S3	C	ST
Medionidus walkeri	Suwannee moccasinshell	G1	S1	LT	FT
Mycteria americana	Wood stork	G4	S2	LT	FT
Procambarus pallidus	Pallid cave crayfish	G2G3	S2S3	N	N
Pycnanthemum floridanum	Florida mountain-mint	G3	S3	N	T
Trichechus manatus	West Indian manatee	G2	S2	LT	FT
Ursus americanus floridanus	Florida Black Bear	G5T4	S4	N	N

Table 9. Potential occurrences of listed and rare species in the Middle Suwannee River and adjacent floodplain

Scientific Name	Common Name	Global Rank	State Rank	Federal Listing	State Listing
Agrimonia incisa	Incised groove-bur	G3	S2	N	T
Alligator mississippiensis	American alligator	G5	S4	SAT	FT(S/A)
Ambystoma tigrinum	Tiger salamander	G5	S3	N	N
Ameiurus serracanthus	Spotted bullhead	G3	S3	N	N
Amphiuma pholeter	One-toed amphiuma	G3	S3	N	N
Andropogon arctatus	Pine-woods bluestem	G3	S3	N	T
Antigone canadensis pratensis	Florida sandhill crane	G5T2	S2	N	ST
Athene cunicularia floridana	Florida burrowing owl	G4T3	S3	N	ST
Carex chapmannii	Chapman's sedge	G3	S3	N	T
Corynorhinus rafinesquii	Rafinesque's big-eared bat	G3G4	S1	N	N
Crotalus adamanteus	Eastern diamondback rattlesnake	G4	S3	N	N
Cyprinella leedsi	Bannerfin shiner	G4	S3	N	N
Dermochelys coriacea	Leatherback sea turtle*	G2	S2	LE	FE
Dromogomphus armatus	Southeastern spinyleg	G4	S3	N	N
Drymarchon couperi	Eastern indigo snake	G3	S3	LT	FT
Dryobates borealis	Red-cockaded woodpecker	G3	S2	LE	FE
Egretta caerulea	Little blue heron	G5	S4	N	ST
Egretta tricolor	Tricolored heron	G5	S4	N	ST
Eudocimus albus	White ibis	G5	S4	N	N
Forestiera godfreyi	Godfrey's swampprivet	G2	S2	N	E
Gopherus polyphemus	Gopher tortoise	G3	S3	C	ST
Gymnopogon chapmanianus	Chapman's skeletongrass	G3	S3	N	N
Heterodon simus	Southern hognose snake	G2	S2S3	N	N
Lampropeltis extenuata	Short-tailed snake	G3	S3	N	ST
Leitneria floridana	Corkwood	G3	S3	N	T
Lithobates capito	Gopher frog	G3	S3	N	N
Litsea aestivalis	Pondspice	G3?	S2	N	E
Macrochelys suwanniensis	Suwannee alligator snapping turtle	G1G2	S1S2	PT	ST
Macromia alleghaniensis	Allegheny River cruiser	G4	S1	N	N
Magnolia ashei	Ashe's magnolia	G2	S2	N	E
Matelea floridana	Florida spiny-pod	G2	S2	N	E
Micropterus notius	Suwannee bass	G3	S3	N	N
Mustela frenata olivacea	Southeastern weasel	G5T4	S3?	N	N

Myotis austroriparius	Southeastern bat	G4	S3	N	N
Neovison vison halilimnetes	Gulf salt marsh mink	G5T2	S2	N	N
Peucaea aestivalis	Bachman's sparrow	G3	S3	N	N
Phyllanthus liebmannianus ssp. platylepis	Pinewoods dainties	G4T2	S2	N	E
Physostegia godfreyi	Apalachicola dragon-head	G3	S3	N	T
Platanthera integra	Yellow fringeless orchid	G3G4	S3	N	E
Podomys floridanus	Florida mouse	G3	S3	N	N
Procambarus pallidus	Pallid cave crayfish	G2G3	S2S3	N	N
Pseudemys concinna suwanniensis	Suwannee cooter	G5T3	S3	N	N
Pteroglossaspis ecristata	Giant orchid	G2G3	S2	N	T
Pycnanthemum floridanum	Florida mountain-mint	G3	S3	N	T
Rhexia parviflora	Small-flowered meadowbeauty	G2	S2	N	E
Salix floridana	Florida willow	G2	S2	N	E
Selonodon simplex	Simple Cebrionid beetle	G1	S1	N	N
Sideroxylon lycioides	Buckthorn	G5	S2	N	E
Spigelia loganioides	Pinkroot	G2Q	S2	N	E
Ursus americanus floridanus	Florida black bear	G5T4	S4	N	N

Notes:

- ***While** the leatherback sea turtle was captured by the FNAI biodiversity matrices that overlap with the MSR and adjacent floodplain, this species is unlikely to be found in this area due to their habitat and foraging requirements (FFWCC 2021a).

The preceding species occurrences represent the river main stem, as well as several natural floodplain communities, including alluvial forest, aquatic cave, bird rookery, blackwater stream, bottomland forest, floodplain swamp, mesic flatwoods, sandhill, scrub, spring-run stream, upland hardwood forest, upland pine, and xeric hammock. If fluvial dynamics are instrumental in creating and maintaining adjacent surfaces/communities, then it may be important to consider their support of listed, rare, and non-aquatic/wetland-dependent species and commensals in this MFL. The indigo snake (*Drymarchon couperi*) shown in **Figure 9**, for example, was photographed within the 10-year floodplain in the Peacock Springs Conservation Area. The same area photographed is mined with gopher tortoise (*Gopherus polyphemus*) burrows.

Figure 9. Eastern indigo snake at Peacock Springs Conservation Area, October 29, 2014

3.1.2 Freshwater Invertebrates

Table 6 through **Table 9** detail a total of 14 invertebrate species identified by FNAI as having the potential to occur in the MSR and adjacent floodplain based on FNAI's occurrence data. Of those 14 species identified by FNAI, one species is federally listed as threatened, the Suwannee moccasinshell (*Medionidus walkeri*). The rest of the species identified by FNAI are listed as living within the MSR habitat but are not currently listed as threatened or endangered at the state or federal level.

In 2014, Gary Warren of the FFWCC provided a list of 47 freshwater invertebrate species that the (FWC) consider to be imperiled in the Suwannee River basin, including only mussels, snails, crustaceans, and insects (**Table 10**). The designation of the species that were provided have been updated in **Table 10** to reflect the current statues. Species that both FNAI and FFWCC identified include the southeastern spinyleg (*Dromogomphus armatus*), *Hydroperla phormidia*, Suwannee moccasinshell, Pallid Cave crayfish (*Procambarus pallidus*), and peninsular floater (*Utterbackia peninsularis*). Of the 47 species identified by FFWCC, one species is federally designated as endangered: the oval pigtoe (*Pleurobema pyriforme*) mussel. Two species are federally designated as threatened: the squirrel chimney cave shrimp (*Palaemonetes cummingi*) and the Suwannee moccasinshell. The Suwannee moccasinshell is described in more detail below. The squirrel chimney cave shrimp has only been found in the Squirrel Chimney sinkhole near Gainesville, Alachua County, Florida and for which scant records exist. Six species are under review for federal listing: Ichetucknee siltsnail (*Floridobia mica*), Santa Fe cave crayfish (*Procambarus erythrops*), Pallid Cave crayfish, Spider Cave crayfish (*Troglocambarus maclanei*), Florida cave amphipod (*Crangonyx grandimanus*), and Hobbs' cave amphipod (*Crangonyx hobbsi*). These species are still under review and were proposed under a petition from the Center for Biological Diversity to list 404 aquatic, riparian, and wetland species from the Southeast as endangered or threatened with critical habitat (Center for Biological Diversity 2010; Federal Register 2011). The Santa Fe cave crayfish has been listed as state-designated threatened in Florida (FFWCC 2021b). Nine of the remaining species are designated as a Species of Greatest Conservation Need (SGCN) and the rest are not listed (FFWCC 2019). The SGCN designation prioritizes these species for research but carries no regulatory authority. Additional information regarding the SGCN designations is provided in Florida's State Wildlife Action Plan (FFWCC 2019). Most species in this list may occur in the upper and middle Suwannee, but some, such as the Ichetucknee siltsnail, do not occur in the main stem of the river.

Table 10. Imperiled Freshwater Invertebrate Species of the Suwannee River Basin

Group/Taxon	Common Name	Designation
Mussels (Unionidae)		
Lampsilis floridensis	Florida sandshell	--
Medionidus walkeri	Suwannee moccasinshell	SGCN; Federally Threatened
Pleurobema pyriforme	Oval pigtoe	SGCN; Federally Endangered
Quadrula kleiniana	Florida mapleleaf/Suwannee pigtoe	SGCN
Utterbackia peninsularis	Peninsular floater	--
Villosa villosa	Downy rainbow	--
Snails (Littorinimorpha)		
Floridobia mica	Ichetucknee siltsnail	SGCN; Federal Listing Status Under Review
Crayfish (Astacidae)		
Procambarus erythrops	Santa Fe cave crayfish	SGCN; State threatened; Federal Listing Status Under Review
Procambarus lucifugus ssp. alachua	Alachua light fleeing cave crayfish	SGCN
Procambarus pallidus	Pallid Cave crayfish	SGCN; Federal Listing Status Under Review
Troglocambarus maclanei	Spider Cave crayfish	SGCN; Federal Listing Status Under Review
Cave Shrimp (Palaemonidae)		
Palaemonetes cummingi	Squirrel Chimney Cave shrimp	SGCN; Federally Threatened
Amphipods (Crangonyctidae)		
Crangonyx grandimanus	Florida cave amphipod	SGCN; Federal Listing Status Under Review
Crangonyx hobbsi	Hobbs' cave amphipod	SGCN; Federal Listing Status Under Review
Isopods (Asellidae)		
Caecidotea hobbsi	Florida cave isopod	--
Remasellus parvus	Swimming little Florida cave isopod	SGCN
Mayflies (Ephemeroptera)		
Baetidae		
Acentrella parvula		--
Pseudocentroptiloides usa		--

Group/Taxon	Common Name	Designation
Baetiscidae		
Baetisca gibbera	A mayfly	SGCN
Baetisca obese		--
Behningiidae		
Dolania americana	American sand-burrowing mayfly	SGCN
Caenidae		
Sparbarus maculatus		--
Ephemeridae		
Hexagenia limbata		--
Isonychiidae		
Isonychia sicca		--
Leptohyphidae		
Asioplax dolani	A mayfly	SGCN
Leptophlebiidae		
Leptophlebia bradleyi		--
Neoephemeridae		
Neoephemera compressa		--
Polymitarcyidae		
Ephoron sp.		--
Pseudironidae		
Pseudiron centralis		--
Dragonflies (Anisoptera)		
Cordulegaster sayi	Say's spiketail	SGCN
Dromogomphus armatus	Southeastern spinyleg	--
Neurocordulia obsoleta	Umber shadowfly	--
Progomphus alachuensis	Tawny sanddragon	--
Damselflies (Zygoptera)		
Lestes inaequalis	Elegant spreadwing	--
Nehalennia pallidula	Everglades sprite	--
Caddisflies (Trichoptera)		
Hydroptila berneri		--
Hydroptila wakulla	Wakulla Springs vari-colored microcaddisfly	SGCN
Nectopsyche tavara		--
Oecetis daytona		--
Oecetis porter		--
Triaenodes furcella		--
Chimarra florida		--
Agrypnia vestita	Unbanded Agrypnia caddisfly	SGCN
Cernotina truncona		--
Agarodes libalis		--
Stoneflies (Plecoptera)		
Helopicus bogaloosa		--
Hydroperla phormidia		--

Table Sources:

- Imperiled Freshwater Invertebrate Species of the Suwannee River Basin Table, Gary Warren of the FFWCC, 2014
- USFWS Environmental Conservation Online System (USFWS 2021b)
- Table 4B: Florida's Species of Greatest Conservation Need from Florida's State Wildlife Action Plan (FFWCC 2019)
- Florida's Endangered and Threatened Species (FFWCC 2021b)

3.1.3 At-Risk Species Finder

One query was run using the USFWS At-Risk Species Finder database to develop a list of petitioned or candidate species that may occur in the project area: "State Range". The query results are provided in **Table 11** and **Appendix B**, respectively. According to the database search, crayfish represent the animal taxon with the highest number of petitioned species, all of which are addressed in the petition from the Center for Biological Diversity to list 404 (Center for Biological Diversity 2010; Federal Register 2011).

Table 11. USFWS at risk species count by taxon for Florida, as of December 6, 2021

Taxon	Count-All Taxa
Amphibian	4
Amphipod	2
Bee	2
Bird	2
Butterfly	5
Caddisfly	4
Crayfish	15
Dragonfly	5
Mammal	5
Mussel	2
Plant	28
Reptile	13
Snail	2

The USFWS is currently conducting an in-depth status review of rare southeastern aquatic, riparian and wetland animal and plant species to determine if any or all of them warrant federal protection as a threatened or endangered species under the Endangered Species Act (ESA). The original petition from the Center for Biological Diversity to list 404 aquatic, riparian, and wetland species from the Southeast as endangered or threatened with critical habitat is available at the following website: https://ecos.fws.gov/docs/tess/petition/297.pdf and can be found in the Federal Register Vol. 76 (No. 187) September 27, 2011: 59836- 59862. Although active petitions may not be addressed by USFWS prior to development of this MFL, it is important to note that an active petition exists to revise critical habitat for the West Indian Manatee (*Trichechus manatus*). Furthermore, a previous petition to down-list the West Indian manatee and subspecies thereof from endangered to threatened was approved (Federal Register, 2017). Active petitions also address upland species found and observed within the MSR floodplain study area, including the eastern diamondback rattlesnake (*Crotalus adamanteus*) and the gopher tortoise (*Gopherus polyphemus*); petitions-received may be searched at the following: https://ecos.fws.gov/ecp/report/table/petitions-received.html.

3.1.4 Species-Specific Information

Additional information regarding several relevant in-stream listed species are provided in the following sections.

<u>*Gulf Sturgeon*</u>

The Gulf sturgeon (*Acipenser oxyrinchus desotoi)*, listed as threatened by the USFWS, is an iconic fish of the Suwannee River. The Gulf sturgeon is an anadromous fish (breeding in freshwater after migrating upriver from marine and estuarine environments), which inhabits coastal rivers from Louisiana to Florida during warmer months and winters in estuaries, bays, and the Gulf of Mexico (68 FR 13370). With the exception of the Suwannee River, dams, pollution, and overfishing have severely depleted most stocks of Gulf sturgeon (Carr et al, 1996). The Suwannee River main stem, beginning from its confluence with Long Branch Creek in Hamilton County, downstream to the mouth of the Suwannee River, has been federally designated as critical habitat for the Gulf sturgeon, falling under the joint jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (50 CFR 226.214) (**Figure 10**).

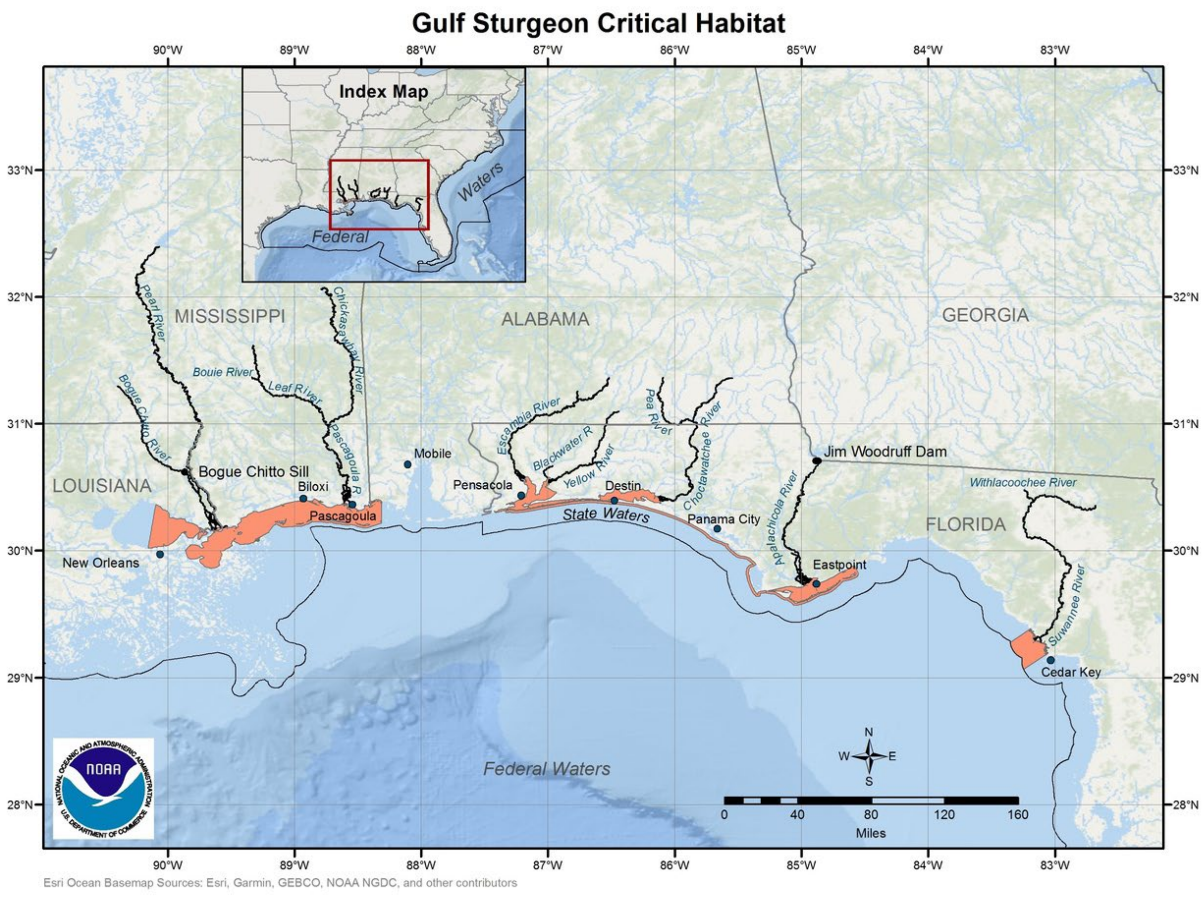


Figure 10. Federally-designated critical habitat for the Gulf sturgeon
(https://www.fisheries.noaa.gov/resource/map/gulf-sturgeon-critical-habitat-map-and-gis-data)

Adult Gulf sturgeon range from 4 to 8 feet in length, with adult females larger than males (68 FR 13370). They can weigh up to 300 pounds and have dorso-ventral body depths of 12 to 18 inches. These dimensions generally define the passage depth and channel width requirements for Gulf sturgeon. Food habits of the adult Suwannee River population focus primarily on brachiopods, followed by amphipods, brittle stars, and other smaller prey (Price, 2019). Feeding areas for Gulf sturgeon are focused on the Suwannee estuary benthic habitats with a near absence of feeding during spawning.

The MSR is important to Gulf sturgeon both as a passageway to and from spawning grounds located in the upper reaches of the Suwannee and as a “holding area” where sturgeon reside during their time in the river. Peak migrations from the Gulf of Mexico into the Suwannee River occur during March and April, and soon after they enter the river, adult fishes move into the upper reaches of the river and spawn (Chapman and Carr, 1995). Sturgeon require gravel substrate for spawning, which is rare in the Suwannee, and there are only 4 documented spawning grounds in the Suwannee mainstem, all located upstream of the Middle Suwannee River study area (Sulak & Randall, Q&A) (**Figure 11**). Following spring spawning, adults descend downriver and congregate with immature fish and non-spawning adults for most of the year (8 to 9 months) in holding areas, which are river reaches that appear to have hydrodynamic characteristics favorable to sturgeon (Randall & Sulak, 2007). There are 8 distinct holding areas along the Suwannee mainstem, 5 of which are located within the Middle Suwannee River (**Figure 12**). Note that the holding area at RKM 55 (RM 34) is located downstream of the mouth of Fanning Springs, which is located just outside the project area.

During their time in the holding areas, Gulf sturgeon movement and feeding activity essentially ceases, which is probably important to energy conservation (Sulak et al. 2007). A typical sturgeon holding area on the Suwannee consists of a 1,600 to 6,500 ft long, ten to 13 ft deep, sand-bottom run lying just downstream of a 13 to 23 ft deep scour hole and is further limited downstream by a three to seven ft deep sand shoal (Sulak et al., 2007). Some holding areas occur near a named spring, such as Anderson Spring, Pothole Spring, and Fanning Spring, and some occur near river confluences (such as the confluence with the Santa Fe River) and major river bends. Spring outflows, like river confluences and river bends, are an important erosional agent over time, scouring deep holes that can become holding areas (Sulak & Randall, 2009). These geomorphic associations with holding areas indicate features maintained by interactions between fluvial forces and sediment transport that occur mainly during bankfull and flood events in the river, thus adding bearing on maintaining these processes for the direct benefit of sturgeon. It also indicates that maintaining spring flows as scour agents may be important.

A second smaller spawning event occurs in September-October (Sulak & Randal, 2009, citing unpublished USGS). Then as river water temperatures cool in the fall, starving adult and immature sturgeon migrate back to the Gulf from September through November to forage in the productive waters (Price, 2019). As part of the MFLs assessment, Gulf sturgeon passage depths were assessed at prominent shoals along the MSR to determine the limiting shoal and associated flow for sturgeon passage. Both the February-April and the September-November migrations were further assessed for seasonality.

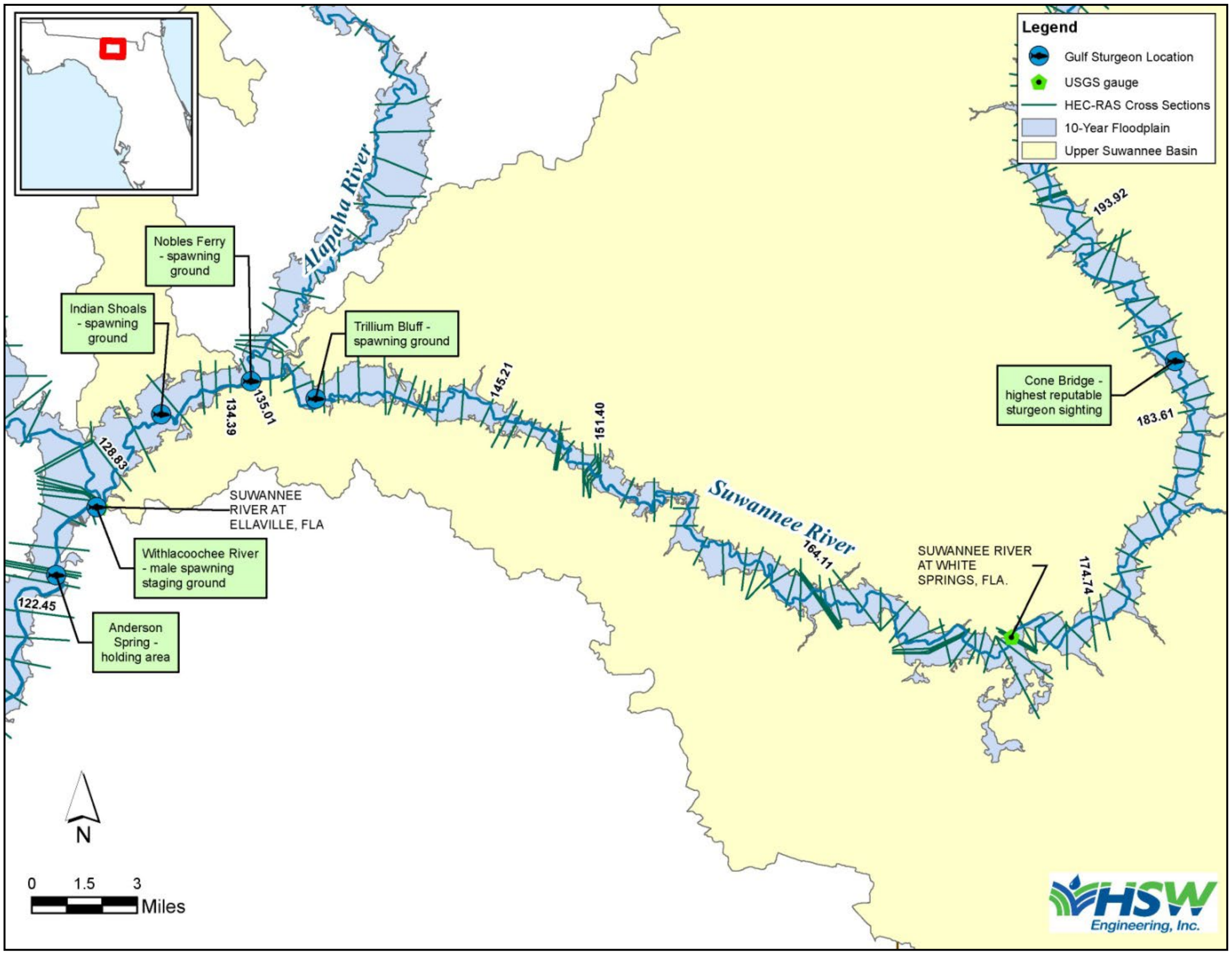


Figure 11. Gulf sturgeon spawning locations
(HSW, 2016)

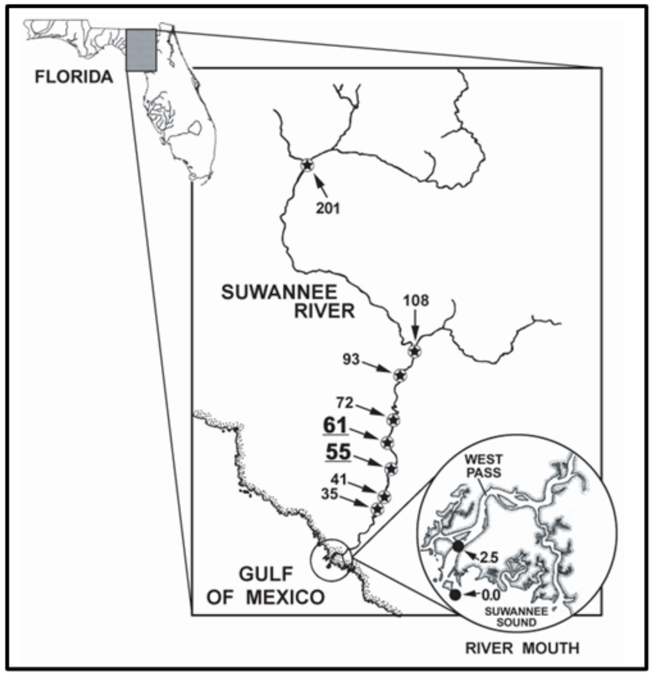


Figure 12. Gulf sturgeon holding areas (by river kilometer) (From Sulak et al. 2007)

Suwannee Bass

The Suwannee Bass (*Micropterus notius*) is not listed as a threatened or endangered species; however, it is listed as S3 under the FNAI State Element Rank. An S3 rank is assigned by FNAI to species that are "*either very rare and local in Florida (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors*" (FNAI 2021b).

The Suwannee Bass is a heavy-bodied bass, which inhabits rivers in northern Florida up to southern Georgia (FFWCC 2021c). The Suwannee Bass is differentiated from the largemouth bass by the presence of teeth on the tongue (FNAI 2018), and the upper jaw does not extend beyond the eye. The Suwannee Bass typically occurs in rivers with limestone or woody armoring where the current is moderate to fast (FFWCC 2021c). Adult Suwannee bass measure between 12 to 16 inches and have a similar coloration to the largemouth bass (FNAI 2018, FFWCC 2021c). Preferred habitat for the Suwannee bass is characterized by neutral or basic water occurring near springs connected to the limestone aquifer (FNAI 2018). Based on the preferred habitat, the MSR provides important and stable habitat for the Suwannee bass. Within the Suwannee River, this species is most common in the middle reach of the river, occasionally found in the coastal portion of the river, and rarely found in the upper reaches near the Okefenokee Swamp (FNAI 2018).

West Indian Manatee

The threatened West Indian manatee, or Florida manatee (*Trichechus manatus latirostris*), utilizes portions of the Suwannee River. While the US Fish and Wildlife Service has not established any portion of the Suwannee River as critical habitat and none of the MSR springs has been identified as significant thermal refugia for manatees, the basin's springs and submerged aquatic vegetation are important resources available for manatees. The Suwannee River Springs complex, which includes Hart, Troy, Otter, and other springs, is listed in the FWC's Warm-Water Action Plan as a secondary refuge with unpredictable manatee use (Valade et al, 2020). The use and importance of the Suwannee River Springs Complex as a warm-water refuge is likely to increase in the near future as power plant thermal discharges are reduced or eliminated (personal communication, Eric Nagid - FFWCC, 7/1/2021). The secondary refuge classification is described in the Action Plan as follows:

- *"Site is established with either predictable or unpredictable use by manatees. Site is regionally important.*
- *Thermal quality is typically medium or low and may be unreliable in cold weather and is unreliable in severe weather*
- *Typically, medium or low manatee use in mild or cold weather, but low or no manatee use in severe weather.*
- *Site is often a low flow spring, inconsistent power plant or passive thermal basin."*

As mentioned in **Section 2.3**, currently manatees appear to be infrequent in the MSR, particularly upstream of Branford. Manatees are known to travel up the Suwannee River into the Santa Fe River and into the Ichetucknee River, which has large SAV meadows. Ichetucknee Springs State Park maintains manatee sighting records with over 450 sightings recorded to date; while only five manatee sightings have been recorded at Troy Springs State Park (based on OFS database; WSI, 2021). Parks along the MSR (Troy Springs, Peacock Springs, Lafayette Blue, and Suwannee River State Parks) either have not documented manatee sightings as rigorously as has been done in Ichetucknee or manatees infrequently travel upstream of Branford.

<u>Oval Pigtoe Mussel</u>

The federally endangered oval pigtoe mussel is a unionid mussel that has been found historically in the Suwannee River basin. The oval pigtoe occurs in small to medium-sized creeks to small rivers where it inhabits silty sand to sand and gravel substrates, usually in slow to moderate current (Williams & Butler, 1994). Stream channels appear to offer the best habitat for this species. The basin status survey located 85% of the specimens in sandy substrates associated with either detritus, or clay, or silt, or cobble (Brim & Williams, 2000). In the Suwannee River drainage, specimens of the oval pigtoe were associated with sandy mud and coarse sand sediments with little to no detritus (Blalock-Herod, 2000). Little is known regarding the habitat requirements of the oval pigtoe. The larvae (glochidia) of mussels, however, are parasitic, living typically on the gills of fins of a host fish. Williams and O'Brien (2002) considered only the sailfin shiner, *Pleronotropis hypselopterus*, as a primary host fish, but were also able to transform juvenile specimens on the gills of eastern mosquitofish (*Gambusia affinis*) and guppies (*Poecilia reticulata*) in the laboratory. The sailfin shiner now belongs to a species complex that was phylogenetically divided into 5 species (Mayden and Allen, 2015) and the species which occurs in the Suwannee River is now considered to be the metallic shiner (*Pteronotropis metallicus*). The metallic shiner is generally common and occurs from the Apalachicola River east to the St. Mary's River and south to the Alafia River in Florida (Robins et al., 2018). Metallic shiners prefer habitat near vegetation and woody debris in sandy and muddy pools and runs of headwaters, creeks, and small to medium rivers (Robins et al., 2018). The metallic shiner was used as a surrogate for the occurrence and protection of the oval pigtoe (and other mussels) in this MFL.

Critical habitat for the oval pigtoe was proposed in 2006 (71 FR 32746) and the final rule published in 2007 (72 FR 64286). Critical habitat for this species within the SRWMD is limited to segments of the Santa Fe and New Rivers (72 FR 64286).

Suwannee Moccasinshell

The Suwannee moccasinshell is a small freshwater mussel endemic to the Suwannee River Basin in Florida and Georgia. In 2012, the Suwannee Moccasinshell was rediscovered after a 16-year hiatus between collections (Johnson et al. 2016). Subsequently, this species was listed as federally threatened under the Endangered Species Act in October 2016 (81 FR 69417). In 2019, the USFWS proposed designating the mainstem Suwannee River, additional portions of the Santa Fe River, and the Withlacoochee River, as critical habitat for the Suwannee Moccasinshell (84 FR 65325). In 2021, the final rule was published for the designation of critical habitat along approximately 116 miles of the Suwannee River, 27 miles of Upper Santa Fe River, and 47 miles of the Withlacoochee River (86 FR 34979).

The Suwannee moccasinshell typically inhabits small to large rivers where it lives in bottom substrates composed of fine sand or sand with some gravel, in areas with slow to moderate current. Individuals are often found near embedded logs and other stable woody material which may provide a flow refuge and shelter. The Suwannee moccasinshell's historical range includes the lower and middle Suwannee River and the Santa Fe River sub-basin in Florida, and the lower reach of the Withlacoochee River in Florida and Georgia. Its range has declined in recent decades, and it is presently known only from the Suwannee River main channel and the lower Santa Fe River in Florida (downstream of the rise). A map showing Suwannee moccasinshell historical and recent distribution is provided below (**Figure 13**). Holcomb et al. (2018) studied hydrologic factors influencing the presence of the Suwannee moccasinshell and found that this species was more likely to be found in areas where upstream springs had cumulative discharge inputs exceeding 28 cubic meters per second. Furthermore, on June 3, 2021, one live individual was observed at the Ruth Springs Conservation Area, along the shore of the Suwannee River downstream of Ruth Springs (personal communication, Sky Notestein - SRWMD, 6/7/2021).

Its numbers and range appear to be considerably lower now than a few decades ago. The primary reason for the Suwannee moccasinshell's decline is habitat degradation due to polluted stormwater runoff, wastewater discharges, and reduced flows. Detailed biological and threat assessment information for the Suwannee moccasinshell can be found in the designation of critical habitat rule available online at: https://www.govinfo.gov/content/pkg/FR-2021-07-01/pdf/2021-13196.pdf.

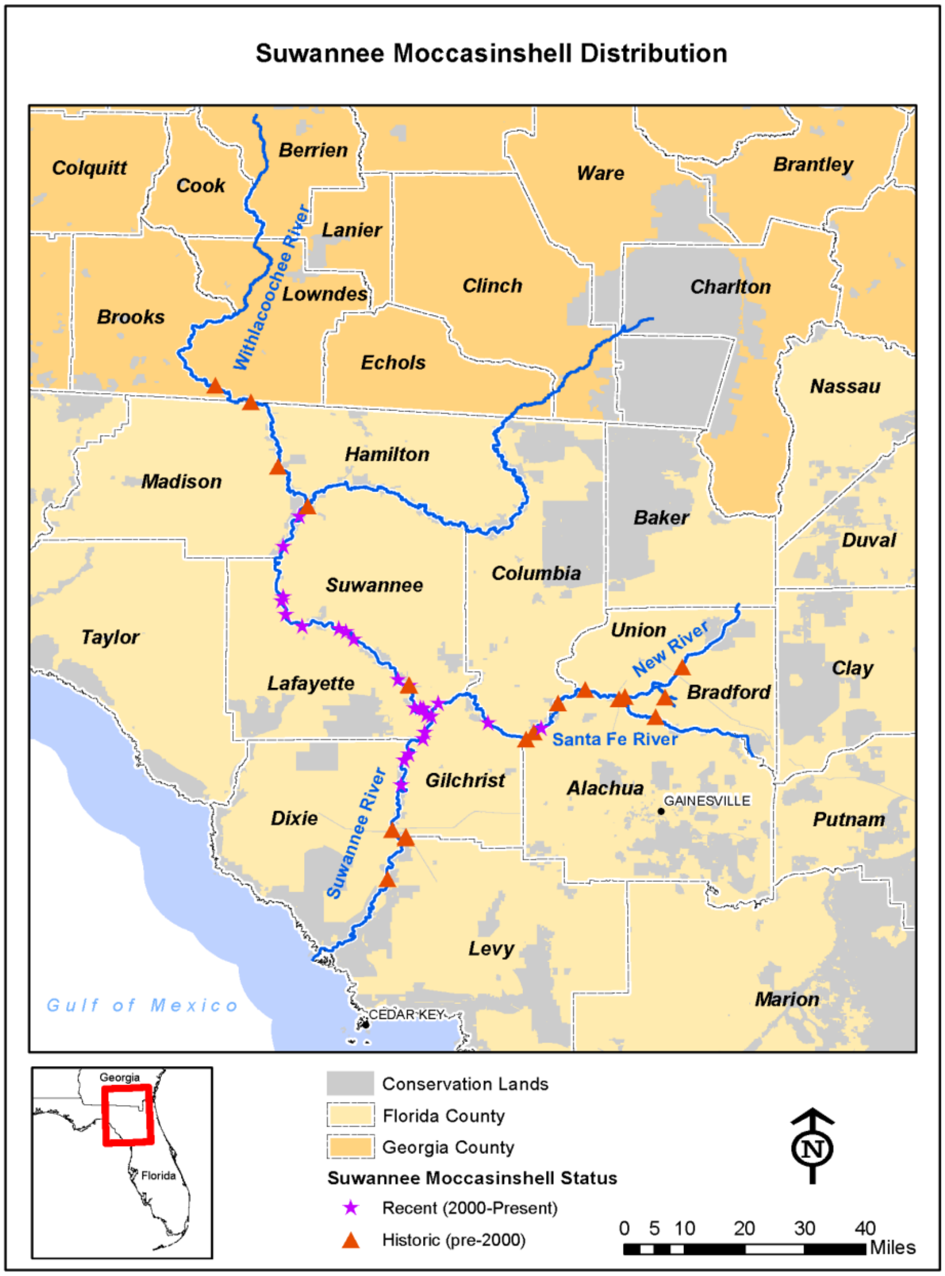


Figure 13. Suwannee moccasinshell distribution

3.2 Habitat Modeling

Physical habitat modeling was performed for the MSR using SEFA software to characterize the relationship between instream habitat suitability and flow. The model was run for 47 species/life stages to determine the change in average area weighted suitability (AWS) for the truncated RTF flow time-series at various flow reduction scenarios from the RTF flows (5%, 10%, 15%, 20%, 25%). **Table 12** summarizes the species/life stages at each shoal that exhibited a 15% decrease in AWS associated with at least one of the flow reduction scenarios run in SEFA, as denoted in purple. A linear interpolation was then used to determine the allowable percent flow reduction associated with each species exhibiting a 15% decrease in AWS. The allowable percent flow reduction falls between the first flow reduction scenario exhibiting a greater than 15% change in AWS and the preceding flow reduction scenario.

Table 12. Percent flow reduction across the RTF period of record and associated percent change in the area weighted suitability for relevant species, guilds, and life stages

USGS Gage	Site	Species/Life Stage	% Change in AWS Resulting from Various RTF Flow Reduction Scenarios: 5% RTF Flow Reduction	10% RTF Flow Reduction	15% RTF Flow Reduction	20% RTF Flow Reduction	25% RTF Flow Reduction	RTF AWS Mean (ft2/ft)	Reduced AWS Mean (ft2/ft)	Allowable Percent Flow Reduction*	Hydrologic Shift (cfs)**
Ellaville	Power Plant	Habitat Guild Deep/Slow	-4.8	-9.6	-14.4	-19.1	-23.9	2.57	2.18	**15.7**	**600**
		Largemouth Bass Adult	-3.8	-7.9	-12.2	-16.7	-21.7	*0.58*	*0.5*	18.2	696
		Largemouth Bass Fry	-4.0	-7.5	-11.3	-16.2	-19.8	*0.07*	*0.06*	18.9	722
		Bluegill Fry	-2.7	-5.6	-9.1	-12.6	-15.8	*0.17*	*0.14*	23.9	914
	Dowling Park	Gulf Sturgeon Adult	-3.8	-7.7	-11.8	-16.0	-20.5	84.97	72.17	18.9	722
Branford	Lafayette Blue	Largemouth Bass Fry	-4.4	-10.1	-15.1	-20.0	-24.4	*0.04*	*0.03*	14.9	744
		Largemouth Bass Adult	-4.3	-9.0	-14.0	-19.3	-25.0	*0.49*	*0.42*	16.0	799
		Gulf Sturgeon Adult	-3.7	-7.6	-11.7	-16.0	-20.6	126.56	107.52	**18.9**	**944**
		Habitat Guild Deep/Slow	-3.1	-6.2	-9.5	-13.1	-17.0	3.95	3.36	22.6	1129
	Perry	*no limiting species*									
	Riverside	Largemouth Bass Adult	-3.3	-6.8	-10.5	-14.5	-18.7	2.15	1.83	20.7	1034
		Habitat Guild Deep/Slow	-3.3	-6.7	-10.3	-14.1	-18.0	4.55	3.86	21.3	1064

Notes:

- Purple denotes a violation in the 15% habitat reduction.
- **Bold** denotes limiting species for applicable compliance gage
- *Italics* denote species/life stages with less than 1 ft^2/ft of usable habitat; these species/life stages should not be used to determine MFLs
- *Based on linear interpolation to derive the relative flow reduction associated with a 15% reduction in RTF AWS
- **Derived by applying the allowable percent flow reduction to the median RTF flow.

Among the five sites sampled for this study, the Perry Shoal area did not have any species/life stages with more than 15% reduction in AWS upon reductions in the flow record. Bluegill, largemouth bass, Gulf sturgeon, and one habitat guild (deep/slow) had AWS reductions greater than 15% with flow reductions among the four remaining sites (**Table 12**). Of the species and life stages listed above, the largemouth bass fry at Lafayette Blue shoal is the most restrictive in terms of percent reduction of the flow record. However, since the site showed very little initial area weighted suitability (i.e., 0.04 ft^2/ft) for this species and life stage, the deep/slow guild at Power Plant shoal was selected as the most limiting species. This is applicable to the portion of the river above RM 90. A flow reduction of 15.7% for the deep/slow guild at Power Plant shoal showed a greater than 15% reduction in AWS. The use of linear interpolation on flow reductions between 15-20% at the Ellaville gage indicate that the most deleterious effects to habitat area begin to occur at 15.7%. Thus, any flow reduction greater than 15.7% would violate the habitat reduction threshold. As previously mentioned, the range of flows for which this percent reduction is applicable is from 1,324 to 16,370 cfs at the Ellaville gage. The hydrologic shift, determined by applying the percent reduction to the median Ellaville RTF flow of 3,822 cfs, is 600 cfs.

For the entire RTF period of record, the critical species/life stage below RM 90 is the Gulf sturgeon adult at Lafayette Blue shoal. The use of linear interpolation on flow reductions between 15-20% at the Branford gage indicates that the most deleterious effects to Gulf sturgeon adult habitat area begin to occur at 18.9%. Thus, any flow reduction greater than 18.9% would cause a greater than 15% reduction in the species' habitat. As previously mentioned, the range of flows for which this percent reduction is applicable is from 1,730 to 22,600 cfs at the Branford gage. The hydrologic shift, determined by applying the percent reduction to the median Branford RTF flow of 4,993 cfs, is 944 cfs.

As shown in **Table 4**, certain species have seasonality for spawn and fry. Hence, the analysis for change in AWS was also run for RTF flow records corresponding to the relevant months. This was also done for Channel Catfish – Juvenile, since there are HSC sets available for Spring, Summer, and Fall, see **Table 2**. **Table 13** provides the results of the seasonal analysis. None of the resulting allowable percent flow reductions from the seasonal runs was less than those identified using the full period of record (**Table 12**). Note that species/life stages with less than 1ft^2/ft of usable habitat are not used to determine MFLs.

Table 13. Percent flow reduction across specific life stage seasonality of the RTF period of record and associated percent change in AWS

USGS Gauge	Site	Species/Life Stage	Applicable Months	Baseline RTF AWS Mean (ft²/ft)	*Allowable Percent Flow Reduction of RTF	**Reduced RTF AWS Mean (ft²/ft)	***Difference in Allowable % Reduction of RTF based on Full period of record & Seasonality
Ellaville	Power-plant	Bluegill-Fry	April, May, June, July, August, September, October, November	*0.16*	18.1%	0.14	5.80%
	Power-plant	Largemouth Bass-Fry	March, April, May, June, July	0.08	21.6%	0.07	-2.70%
	Power-plant	Gulf Sturgeon-Adult (spawn applied)	March, April, September, October	56.54	29.0%	48.02	-2.40%
	Dowling Park	Gulf Sturgeon-Adult (spawn applied)	March, April, September, October	93.91	20.6%	79.8	-1.70%
Branford	Lafayette Blue	Largemouth Bass-Fry	March, April, May, June, July	*0.04*	13.6%	0.04	1.30%
	Lafayette Blue	Gulf Sturgeon-Adult (spawn applied)	March, April, September, October	138.88	20.8%	117.95	-1.90%
	Perry	None	not applicable	not applicable	not applicable	not applicable	not applicable
	Riverside	Gulf Sturgeon-Adult (spawn applied)	March, April, September, October	129.37	27.7%	109.88	-1.90%

Notes

Italics in "Baseline RTF AWS Mean" column denotes species/life stages with less than 1ft²/ft of usable habitat; these species/life stages should not be used to determine MFLs.

*Reduction of RTF that corresponds to a 15% decrease in AWS from RTF Baseline conditions.

**Derived by applying the allowable percent flow reduction to the median RTF flow.

***Negative # means Full Period of Record is more restrictive than Seasonal, & vice-versa.

3.3 Fish/Manatee/Recreation Passage

3.3.1 Fish Passage

The critical stage determined for general fish passage at each of the selected shoals is provided in **Table 14**. Of the 16 shoals assessed for, 11 had critical stages for general fish passage falling below the stage associated with the HEC-RAS model's 99.9% flow exceedance profile, indicating that passage is not a concern at these shoals. Station 87.17 had the lowest exceedance (90.5%) and was thus classified as the limiting shoal for general fish passage. The flow associated with this exceedance is 1,302 cfs at the Ellaville gage and 2,042 cfs at the Branford gage. This shoal falls downstream of RM 90, and therefore Branford would be considered the compliance gage for this shoal. The limiting shoal for the section of river above RM 90 is Station 102.59, which has a flow at Ellaville of 1,044. Graphs depicting the critical stage for each cross-section assessed are provided in **Appendix C**.

Table 14. General Fish Passage Results

HEC-RAS Station (RM)	Critical stage (>0.8ft over 25% of channel)	Avg Depth (ft)	Max Depth (ft)	Flow Exceedance (%)	Ellaville Q (cfs)	Branford Q (cfs)
126.58	26.87	0.62	2.17	99.9	639.3	1320
126.14	24.80	1.24	2.25	99.7	697.0	1336.7
125.63	23.27	0.87	2.04	99.3	785.5	1395
111.57	18.87	0.84	1.71	99.9	639.3	1320
102.59	18.66	0.78	2.86	95.4	1044.7	1702.9
100.01	15.15	0.85	1.75	99.9	639.3	1320
96.53	13.84	0.96	2.12	99.9	639.3	1320
96.08	14.76	0.89	2.80	99.9	639.3	1320
95.56	13.44	0.93	1.53	99.9	639.3	1320
93.79	13.64	1.12	2.61	99.6	737.0	1352.5
88.38	12.36	0.75	1.56	99.9	639.3	1320
87.17	10.82	1.31	3.63	90.5	1301.9	2042.2
87.11	9.29	1.59	3.53	99.9	639.3	1320
86.66	8.64	0.92	1.58	99.9	639.3	1320
85.08	8.52	1.33	4.07	99.9	639.3	1320
84.93	6.10	0.93	1.61	99.9	639.3	1320

*Highlighted values indicate critical flow for appropriate compliance gage (Ellaville for stations upstream of RM 90 and Branford for stations downstream of RM 90)

The critical stage determined for Gulf sturgeon passage at each of the selected shoals is provided in **Table 15**. Of the 16 shoals assessed for, four had critical stages for sturgeon passage falling below the stage associated with the HEC-RAS model 99.9% flow exceedance profile, indicating that passage is not a concern at these shoals. Station 88.38 (Riverside Shoal) had the lowest exceedance (73.2%) and was thus classified as the limiting shoal for Gulf sturgeon passage. The flow associated with this exceedance is 2,120 cfs at the Ellaville gage and 3,044 cfs at the Branford gage. This shoal falls downstream of RM 90, and therefore Branford would be considered the compliance gage for this shoal. The limiting shoal for the section of river above RM 90 is Station 102.59, which has a flow at Ellaville of 1,998. Graphs depicting the critical stage for each cross-section assessed are provided in **Appendix C**. Critical flows for Gulf sturgeon were further assessed by looking at seasonality to account for the two migrations (February-April and September-November).

Table 15. Sturgeon Passage Results

HEC-RAS Station (RM)	Critical stage (>3ft over 15ft)	Avg Depth (ft)	Max Depth (ft)	Flow Exceedance (%)	Ellaville Q (cfs)	Branford Q (cfs)
126.58	28.18	1.81	3.48	86.4	1502.8	2310.4
126.14	25.81	1.70	3.26	81.9	1713.8	2581.3
125.63	24.60	1.95	3.37	81.7	1720.2	2589.4
111.57	20.42	1.96	3.26	95	1070	1730
102.59	19.25	1.36	3.45	75.8	1997.9	2908.9
100.01	16.47	2.06	3.07	99.6	743.4	1355
96.53	14.89	1.75	3.17	99.9	639.3	1320
96.08	16.20	2.10	4.24	94.0	1120.3	1797.7
95.56	15.00	2.01	3.09	91.4	1259.6	1985.2
93.79	14.50	1.53	3.47	93.3	1158.6	1849.3
88.38	13.86	1.91	3.06	73.2	2119.6	3043.6
87.17	10.50	1.12	3.31	94.9	1077.027	1739.5
87.11	9.40	1.65	3.64	99.9	639.3	1320
86.66	10.15	1.95	3.09	91.1	1272.9	2003.2
85.08	7.63	1.24	3.18	99.9	639.3	1320
84.93	7.59	1.98	3.10	99.9	639.3	1320

*Highlighted values indicate critical flow for appropriate compliance gage (Ellaville for stations upstream of RM 90 and Branford for stations downstream of RM 90)

3.3.2 Manatee Passage

As previously mentioned, because manatees are rarely sighted upstream of Branford where shoals are a concern, manatee passage is not a critical concern in the MSR. The MFL for Gulf sturgeon passage is sufficient for manatee passage.

3.3.3 Recreational Passage

The critical stage determined for canoe/kayak passage and for small motor boat passage at each of the selected shoals is provided in **Table 16** and **Table 17**, respectively. Of the 16 shoals assessed for canoe/kayak passage, 15 had critical stages for passage falling below the stage associated with the HEC-RAS model 99.9% flow exceedance profile, indicating that passage is not a concern for canoe/kayak passage on the MSR. Station 125.63 had the lowest exceedance (99.7%) for canoe/kayak passage. The flow associated with the canoe/kayak exceedance is 704 cfs at the Ellaville gage and 1,340 cfs at the Branford gage. This shoal falls upstream of RM 90, and therefore Ellaville would be considered the compliance gage for this shoal. There are no limiting shoals for the section of river below RM 90 for canoe/kayak passage.

For small motor boat passage, half of the 16 shoals had critical stages for small boat passage falling below the stage associated with the HEC-RAS model 99.9% flow exceedance profile, indicating that passage is not a concern at these shoals for small motor boats. Station 102.59 had the lowest exceedance (77.7%) and was thus classified as the limiting shoal for small motor boat passage. The flow associated with the small motor boat exceedance is 1,908 cfs at the Ellaville gage and 2,809 cfs at the Branford gage. This shoal falls upstream of RM 90, and therefore Ellaville would be considered the compliance gage for this shoal. The limiting shoal for the section of river below RM 90 is Station 88.38, which has a flow at Branford of 1,778. Graphs depicting the critical stage for each cross-section assessed are provided in **Appendix D**.

Table 16. Canoe/Kayak Passage Results

HEC-RAS Station (RM)	Critical stage (>1.5ft over 15ft)	Avg Depth (ft)	Max Depth (ft)	Flow Exceedance (%)	Ellaville Q (cfs)	Branford Q (cfs)
126.58	26.77	0.73	2.07	99.9	639.3	1320
126.14	24.31	0.86	1.76	99.9	639.3	1320
125.63	23.22	0.82	1.98	99.7	704.0	1339.4
111.57	18.92	0.89	1.76	99.9	639.3	1320
102.59	17.71	0.54	1.91	99.9	639.3	1320
100.01	14.97	0.73	1.57	99.9	639.3	1320
96.53	13.45	0.70	1.73	99.9	639.3	1320
96.08	14.70	0.86	2.74	99.9	639.3	1320
95.56	13.56	1.05	1.65	99.9	639.3	1320
93.79	13.00	0.90	1.97	99.9	639.3	1320
88.38	12.36	0.75	1.56	99.9	639.3	1320
87.17	9.04	0.90	1.85	99.9	639.3	1320
87.11	7.68	0.93	1.92	99.9	639.3	1320
86.66	8.65	0.93	1.59	99.9	639.3	1320
85.08	6.13	1.04	1.68	99.9	639.3	1320
84.93	6.09	0.92	1.60	99.9	639.3	1320

*Highlighted values indicate critical flow for appropriate compliance gage (Ellaville for stations upstream of RM 90 and Branford for stations downstream of RM 90)

Table 17. Small Boat Passage Results

HEC-RAS Station (RM)	Critical stage (>2ft over 30ft)	Avg Depth (ft)	Max Depth (ft)	Flow Exceedance (%)	Ellaville Q (cfs)	Branford Q (cfs)
126.58	27.83	1.49	3.13	92.7	1187.4	1888.1
126.14	25.20	1.37	2.65	96.1	1005.8	1661
125.63	23.99	1.56	2.76	87.4	1454.3	2245.7
111.57	19.54	1.15	2.38	99.9	639.3	1320
102.59	19.10	1.21	3.30	77.7	1907.9	2809.3
100.01	15.60	1.28	2.20	99.9	639.3	1320
96.53	14.60	1.49	2.88	99.9	639.3	1320
96.08	15.24	1.35	3.28	99.9	639.3	1330
95.56	14.24	1.51	2.33	99.9	659.8	1325
93.79	13.50	1.05	2.47	99.9	639.3	1320
88.38	13.19	1.34	2.39	94.3	1105.5	1777.7
87.17	9.80	1.20	2.61	99.9	639.3	1320
87.11	8.67	1.22	2.91	99.9	639.3	1320
86.66	9.19	1.17	2.13	99.9	639.3	1320
85.08	6.71	1.40	2.26	99.9	639.3	1320
84.93	7.63	2.02	3.14	99.9	639.3	1320

*Highlighted values indicate critical flow for appropriate compliance gage (Ellaville for stations upstream of RM 90 and Branford for stations downstream of RM 90)

3.3.4 Spring Runs

Reliable estimations of bankfull discharge at select spring runs (Allen Mill Pond, Peacock, Otter) were attempted in order to determine the flows that maintain openings between the main river channel and the spring run, which allow for a two-way exchange of flow and fish. Wood attempted a simple approach to estimate bankfull discharge using the best available information, including cross-sectional data collected during ground surveys and known velocity-area measurements collected during flow monitoring events, but the information was not sufficient based on significant sensitivity of Manning's n to longitudinal and vertical gradients within each spring system. Therefore, bankfull discharge within these spring runs could not be determined at this time. Additional data will be required to make this determination.

Critical elevations for fish passage from the river into select spring runs with available cross-sectional data near the spring run outlet (Allen Mill Pond, Peacock, Otter) were determined (**Table 18**). Peacock Springs had the lowest exceedance (27%), while the river to spring interaction at Otter Springs is perennially passable.

Table 18. River to Spring Run Fish Passage Results

HEC-RAS Station (RM)	Critical stage (>0.8ft over 25% of channel)	Avg Depth (ft)	Max Depth (ft)	Flow Exceedance (%)	Ellaville Q (cfs)	Branford Q (cfs)
105.88 (2000 ft upstream of AMP outlet)	21.92	0.70	2.29	57.9	3009.1	4083.8
105.36 (800 ft downstream of AMP outlet)	21.92	1.24	2.25	57.1	3079.2	4164.12
95.62 (at Peacock outlet)	22.67	0.87	2.04	27.5	7452.5	8377.6
39.76 (3,330 ft downstream of Otter outlet)	1.16	0.84	1.71	99.9	639.3	1320

4.0 SUMMARY AND CONCLUSIONS

The Middle Suwannee River provides important riverine and floodplain habitat to a host of animal and plant species, some of which are listed as federally threatened or endangered by the USFWS, including the West Indian manatee, Gulf sturgeon, oval pigtoe, squirrel chimney cave shrimp, woodstork, eastern indigo snake, and Godfrey's swampprivet (**Table 7**, **Table 8**, **Table 9**, **Table 10**, and **Table 11**). This Outstanding Florida Water also provides enjoyable recreational opportunities, including canoeing, kayaking, and small motor boating. The goal of setting a variety of MFLs for the MSR is to protect the suite of hydrologic regimes that support these metrics. Various in-stream metrics, including habitat suitability, fish passage, and recreation were assessed to determine the critical stages and flows associated with these metrics to be used in the development of MFLs for the Middle Suwannee River. A summary of the limiting metrics assessed in this memo and the associated maximum allowable percent flow reductions determined for those metrics is provided in **Table 19**.

Table 19. Summary Table of Assessed Water Resource Values for MSR MFL Development

WRV	Metric	Parameters	Ellaville Gage	Branford Gage
			Critical Flow (cfs)	Critical Flow (cfs)
Habitat Suitability	Habitat Guild – Deep/Slow: (Full period of record)	15% reduction in mean AWS	1,324 to 16,370	N/A
	Gulf Sturgeon – Adult: (Full period of record)	15% reduction in mean AWS	N/A	1,629 to 20,323
Fish Passage	General Fish Passage	0.8 foot deep over 25% of width, with no single block <10%	1,045	2,042
	Gulf Sturgeon Passage	3 feet deep over 15 foot width	1,998	3,044
	Fish Passage in/out Allen Mill Pond Spring	0.8 foot deep over 25% of width, with no single block <10%	3,079	N/A
	Fish Passage in/out Peacock Springs	0.8 foot deep over 25% of width, with no single block <10%	7,453	N/A
	Fish Passage in/out Otter Springs	0.8 foot deep over 25% of width, with no single block <10%	N/A	1,320
Recreation	Canoe/Kayak Passage	1.5 feet deep over 15 foot width	704	None limiting
	Small Motor Boat Passage	2 feet deep over 30 foot width	1,908	1,778

5.0 REFERENCES CITED

Listed Species

Blalock-Herod, H.N. 2000. Community Ecology of Three Freshwater Mussel Species (Bivalvia: Unionidae) from the New River, Suwannee Drainage, Florida. University of Florida. Gainesville, FL: Unpublished Master's Thesis.

Brim, B.J., and Williams, J.D. 2000. Unionid Mollusks of the Apalachicola Basin in Alabama, Florida, and Georgia. Bulletin of the Alabama Museum of Natural History No. 22.

Carr, S.H., Tatman, F. and F.A. Chapman. 1996. Observations on the natural history of the Gulf of Mexico sturgeon (Acipenser oxyrinchus de sotoi Vladykov 1955) in the Suwannee River, southeastern United States. Ecology of Freshwater Fish 5: 169-174.

Center for Biological Diversity. 2010. Petition to List 404 Aquatic, Riparian And Wetland Species From The Southeastern United States As Threatened Or Endangered Under The Endangered Species Act. April 20, 2010. Website: https://ecos.fws.gov/docs/tess/petition/297.pdf. Accessed June 2021.

Chapman, F.A. and Carr, S.H. 1995. Implications of early life stages in the natural history of the Gulf of Mexico Sturgeon, Acipenser oxyrinchus de sotoi. Environmental Biology of Fishes 43: 407-413

Federal Register March 19, 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule.

Federal Register. 2011. Endangered and Threatened Wildlife and Plants; Partial 90-Day Finding on a Petition To List 404 Species in the Southeastern United States as Endangered or Threatened With Critical Habitat. Vol. 76, No. 187, September 27, 2011: 59836-59862.

Federal Register. 2015. Endangered and Threatened Wildlife and Plants; Proposed Threatened Species Status for the Suwannee Moccasinshell. Vol. 80, No. 193, October 6, 2015: 60335-60348.

Federal Register. 2016. Endangered and Threatened Wildlife and Plants; Threatened Species Status for Suwannee Moccasinshell. Vol. 81, No. 194, October 6, 2016: 69417-69425.

Federal Register. 2017. Endangered and Threatened Wildlife
and Plants; Reclassification of the West Indian Manatee From Endangered to Threatened. Vol. 82, No. 64, April 5, 2017: 16668-16704.

Federal Register. 2019. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Suwannee Moccasinshell. Vol. 84, No. 229, November 27, 2019: 65325-65345.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2019. Florida's Wildlife Legacy Initiative: Florida's State Wildlife Action Plan. Tallahassee, Florida. Website: https://myfwc.com/media/22767/2019-action-plan.pdf. Accessed October 2021.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2021a. Leatherback sea turtle Species Profile. Website: https://myfwc.com/wildlifehabitats/profiles/reptiles/sea-turtles/leatherback-turtle/. Accessed August 2021.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2021b. Florida's Endangered and Threatened Species, Updated June 2021. Website: https://myfwc.com/media/1945/threatened-endangered-species.pdf. Accessed October 2021.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2021c. Suwannee Bass Species Profile. Website: https://myfwc.com/wildlifehabitats/profiles/freshwater/suwannee-bass/. Accessed April 2021.

Florida Natural Areas Inventory (FNAI). 2019. FNAI – Element Tracking Summary. Website: https://www.fnai.org/PDF/Element_tracking_summary_current.pdf. Accessed May 2021.

Florida Natural Areas Inventory (FNAI). 2021a. FNAI Biodiversity Matrix Map Server, reports generated on 2021-08-29. Website accessed August 2021: https://www.fnai.org/BiodiversityMatrix/index.html

Florida Natural Areas Inventory (FNAI). 2021b. Explanations & Definitions, Elements and Element Occurrences. Website: https://www.fnai.org/ranks.cfm. Accessed April 2021.

HSW. 2016. Minimum Flows and Levels Assessment for the Upper Suwannee River and Priority Springs. Draft Report, Prepared by HSW Engineering, Inc., Tampa, FL., 163 pp.

Mayden, R.L. and J. Allen. 2015. Phylogeography of Pteronotropis signipinnis, P. euryzonus, and the P. hypselopterus complex (Teleostei: Cypriniformes), with comments on diversity and history of the gulf and Atlantic coastal streams. BioMed Research International 2015:1–25 pp.

O'Brien, C.A. and Williams, J.D. 2002. Reproductive biology of four freshwater mussels (Bivalvia: Unionidae) endemic to eastern Gulf Coastal Plain drainages of Alabama, Florida, and Georgia. American Malacological Bulletin Vol. 17:147–158 pp.

Price, M. 2019. Behaviors of Gulf Sturgeon Inferred from Acoustic Telemetry in the Suwannee River, Florida. Unpublished Master's Thesis. University of Florida.

Randall, M.T. and Sulak, K.J. 2007. Relationship between Recruitment of Gulf Sturgeon and Water Flow in the Suwannee River, Florida. American Fisheries Society Symposium 56:000–000

Robins R.H., L.M. Page, J.D Williams, Z.S Randall, and G.E. Sheehy. 2018. Fishes in the Fresh Waters of Florida: An Identification Guide and Atlas. University of Florida Press, Gainesville, Florida, 467 pp.

Sulak, K.J., Brooks, R.A., and Randall, M.T. 2007. Seasonal Refugia and Trophic Dormancy in Gulf Sturgeon: Test and Refutation of the Thermal Barrier Hypothesis. American Fisheries Society Symposium 56:000-000.

Sulak, K.J. and Randall, M.T. The Gulf Sturgeon in the Suwannee River: Life History Questions & Answers.

U.S. Fish and Wildlife Service (USFWS). 2021a. At-risk species conservation. Last updated: January 11, 2021. Website: https://www.fws.gov/southeast/endangered-species-act/at-risk-species/. Accessed December 2021.

U.S. Fish and Wildlife Service (USFWS). 2021b. ECOS Environmental Conservation Online System. FWS-Listed U.S. Species by Taxonomic Group - All Animals. Website: https://ecos.fws.gov/ecp/report/species-listings-by-tax-group?statusCategory=Listed&groupName=All%20Animals. Accessed October 2021.

Valade, J., R. Mezich, K. Smith, M. Merrill and T. Calleson (editors). 2020. Florida Manatee Warm-Water Action Plan. U.S. Fish & Wildlife Service and Florida Fish and Wildlife Conservation Commission. 43pp.

Williams, J.D., and Butler, R.S. 1994. Class Bivalvia, Freshwater Bivalves. Pp 53-128, pp 740-742 in R. Ashton, ed., Rare and Endangered Biota of Florida (Vol. 6. Invertebrates). Gainesville, FL: University of Florida Press.

<u>Habitat Modeling</u>

Aquatic Habitat Analysts, Inc. 2016. SEFA: System for Environmental Flow Analysis (Version 1.2 build 29). Available from http://sefa.co.nz/.

Bass Fishing Florida. 2021b. Bluegill. Species of Fish in Florida. Website: https://bassfishingfl.com/species/bluegill/. Accessed April 2021.

Bass Fishing Florida. 2021c. Redbreast Sunfish. Species of Fish in Florida. Website: https://bassfishingfl.com/species/redbreast-sunfish/. Accessed April 2021.

Chapman, Frank A. 2018. Farm-Raised Channel Catfish. Frank A. Chapman, associate professor, School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences; UF/IFAS Extension, Gainesville, FL 32611. Website: https://edis.ifas.ufl.edu/fa010. Accessed April 2021.

Chapman, F.A. and S.H. Carr, 1995. Implications of early life stages in the natural history of the Gulf of Mexico sturgeon, *Acipenser oxyrinchus desotoi*. Environ. Biol. Fishes 43(4):407-413.

Google, Inc. 2015. Google Earth (Version 7.1.5.1557) [Software]. Available from https://www.google.com/earth/.

Hill, J. E., & Cichra, C. E. (2005). Biological Synopsis of Five Selected Florida Centrarchid Fishes with an Emphasis on the Effects of Water Level Fluctuations. Palatka, FL: St. Johns River Water Management District. Retrieved from http://static.sjrwmd.com/sjrwmd/secure/technicalreports/SP/SJ2005-SP3.pdf

HSW. 2021. Minimum Flows and Minimum Water Levels Re-evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs. Final Report, Prepared by HSW Engineering, Inc., Tampa, FL. 140 pp.

Jowett, I., T. Payne, and R. Milhous. 2014. SEFA: System for Environmental Flow Analysis Software Manual Version 1.21. Aquatic Habitat Analysts, Inc. 233 p.

Jowett, I., Payne, T., & Milhous, R. (2020). Interpolation between point measurements. In SEFA - System for Environmental Flow Analysis - Software Manual, Version 1.8.

Milhous, R.T. and T.J. Waddle. 2001. PHABSIM for Windows User's Manual and Exercises. Open File Report 01-340. Fort Collins, CO: Midcontinent Ecological Science Center. 288p

Nagid, E. (2020). Draft Report Summarizing Review and Compilation of All Existing Habitat Suitability Curves Being Used in Florida. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. Southwest Florida Water Management District.

Nagid, E. J., Tuten, T., & Johnson, K. G. (2014). Gum Springs fish community assessment and habitat suitability curve development, Final Report to the Southwest Florida Water Management District. Fish and Wildlife Research Institue, Florida Fish and Wildlife Conservation Commission, Gainesville, FL. doi:FWC/FWRI File Code: F2866-12-14-F

Rogers, M.W, & M.S. Allen. 2010. Simulated Influences of Hatching-Date Dependent Survival on Year Class Composition and Abundance. The Open Fish Science Journal, 2010, 3, 169-179.

Strong, W. A., Nagid, E. J., & Tuten, T. (2010, December 1). Observations of Physical and Environmental Characteristics of Suwannee Bass Spawning in a Spring-Fed Florida River. Southeastern Naturalist, 9(4), 699-710. doi:http://dx.doi.org/10.1656/058.009.0405

Sulak, K.J., and Randall, M., 2009, The Gulf Sturgeon in the Suwannee River—Questions and Answers: U.S. Geological Survey General Information Product 72, 12 p.

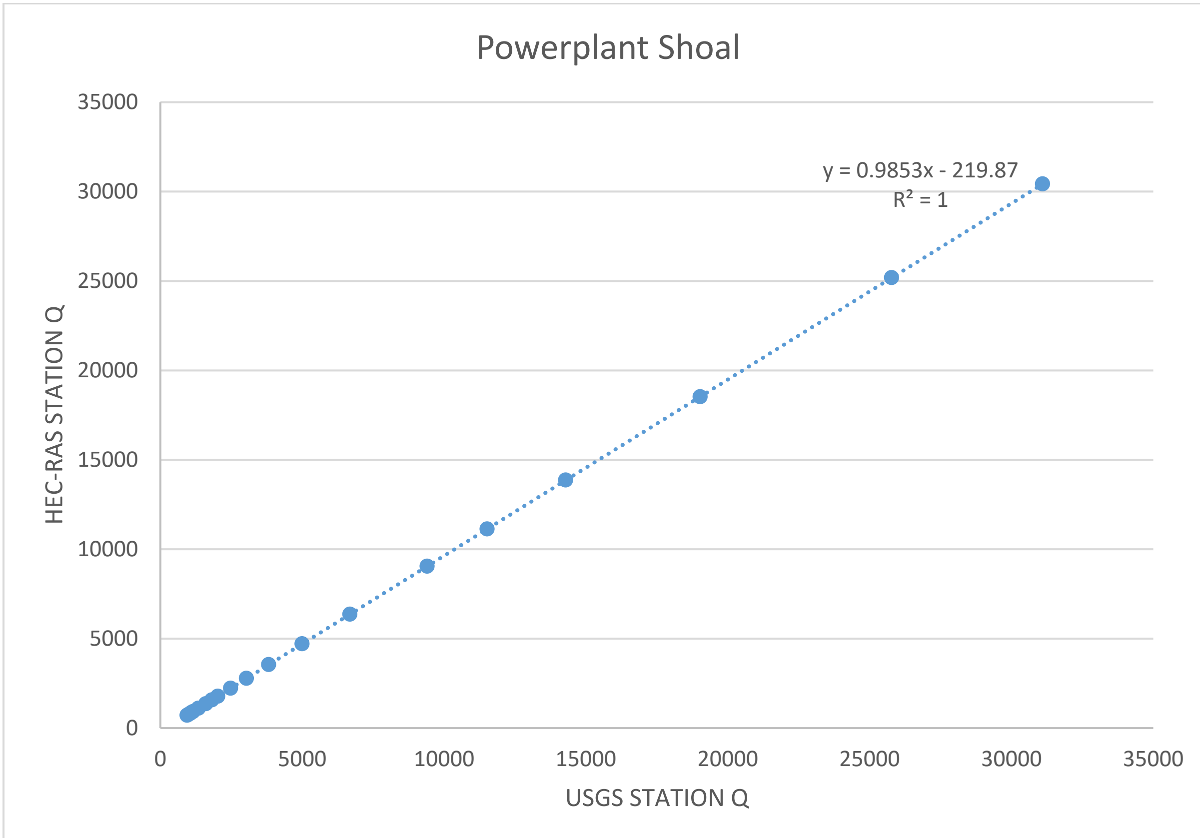
Thompson, Ken. 1972. Determining Stream Flow for Fish Life. Presented at Pacific Northwest River Basins Commission, Instream Flow Requirement Workshop. March 15-16, 1972.

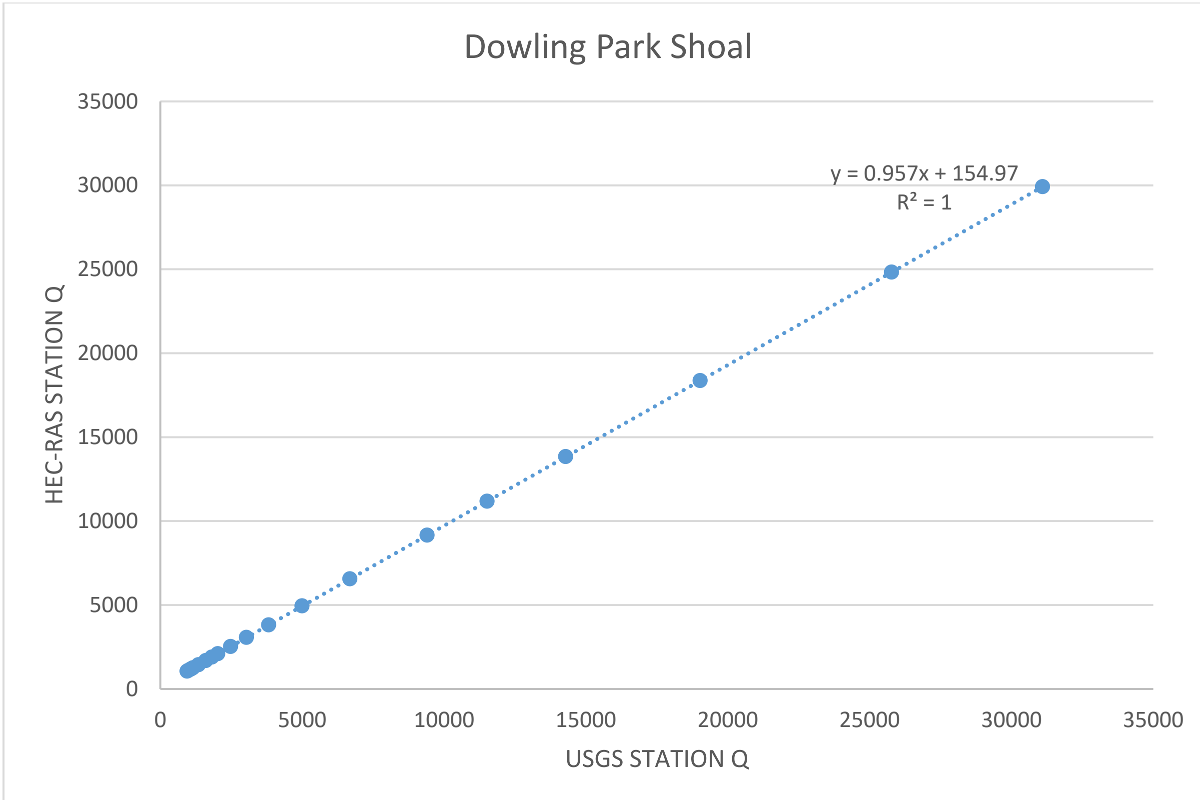
Appendix A
SEFA

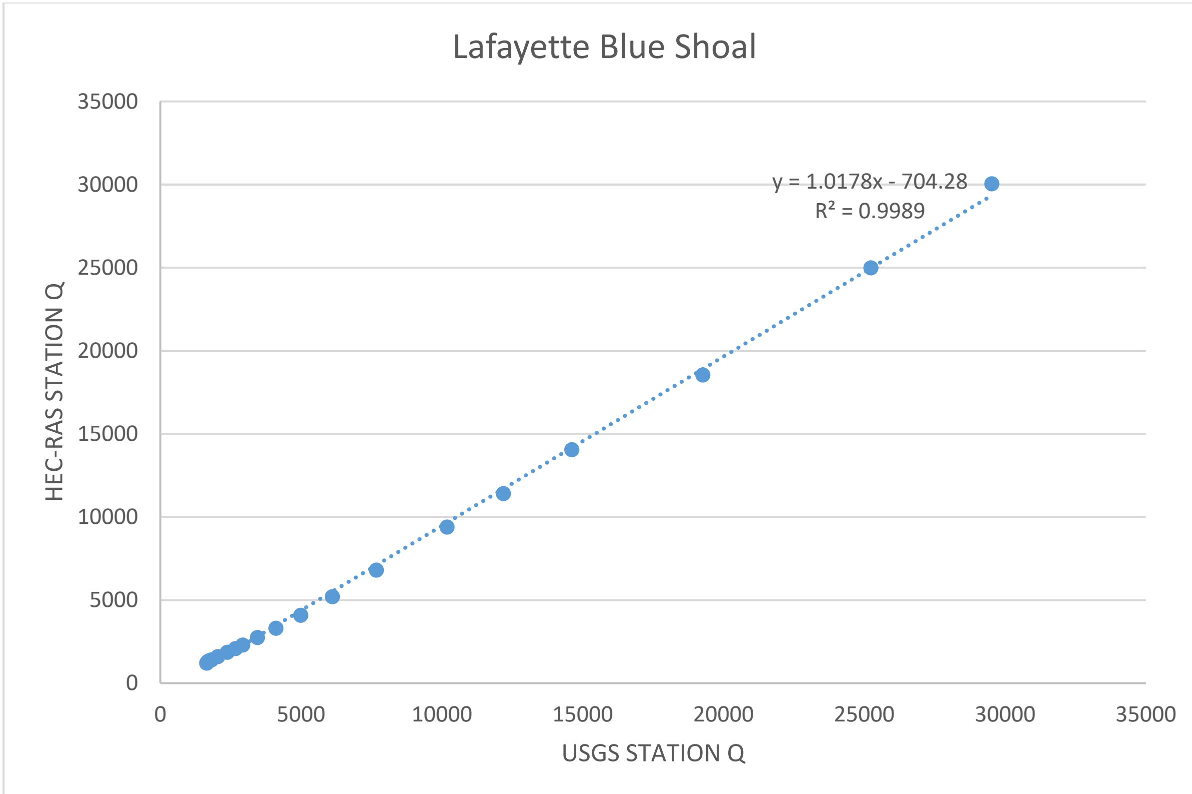
Rating Curves Used for Flow Translation

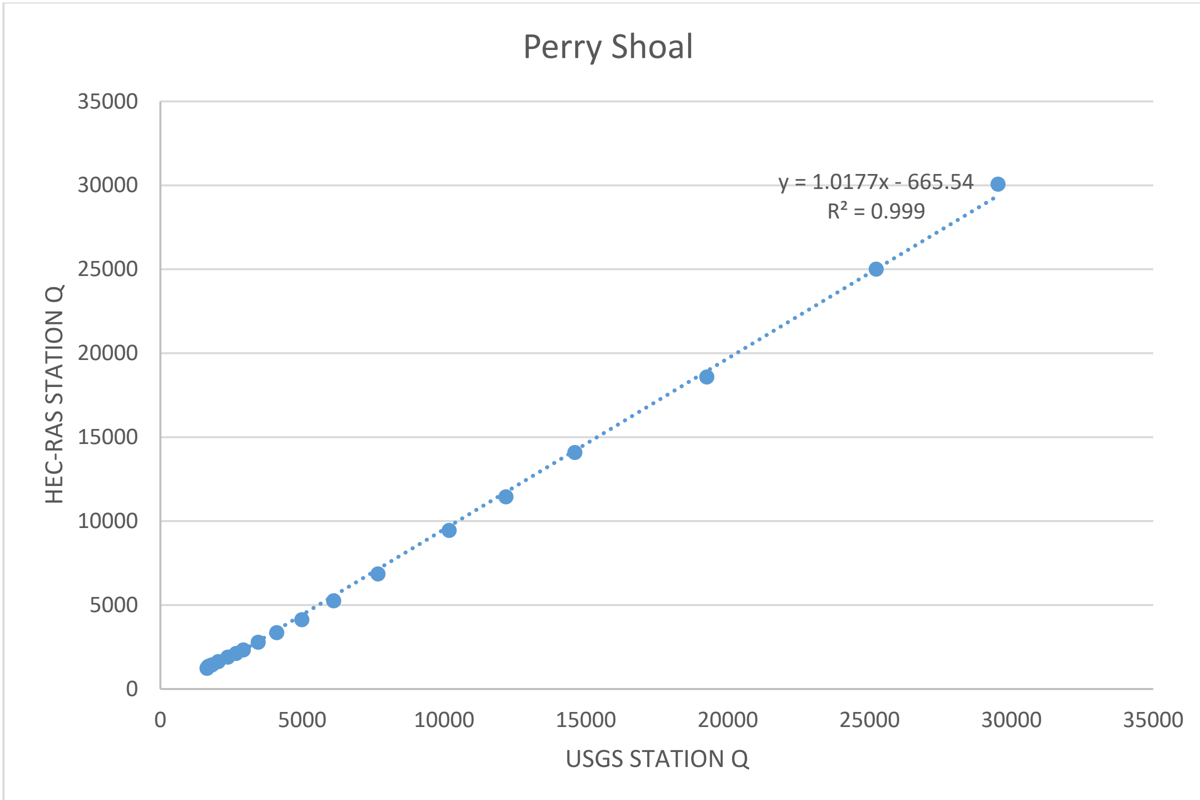
Table A-1. HEC-RAS model output for compliance Gages and HEC-RAS stations closest to SEFA shoals

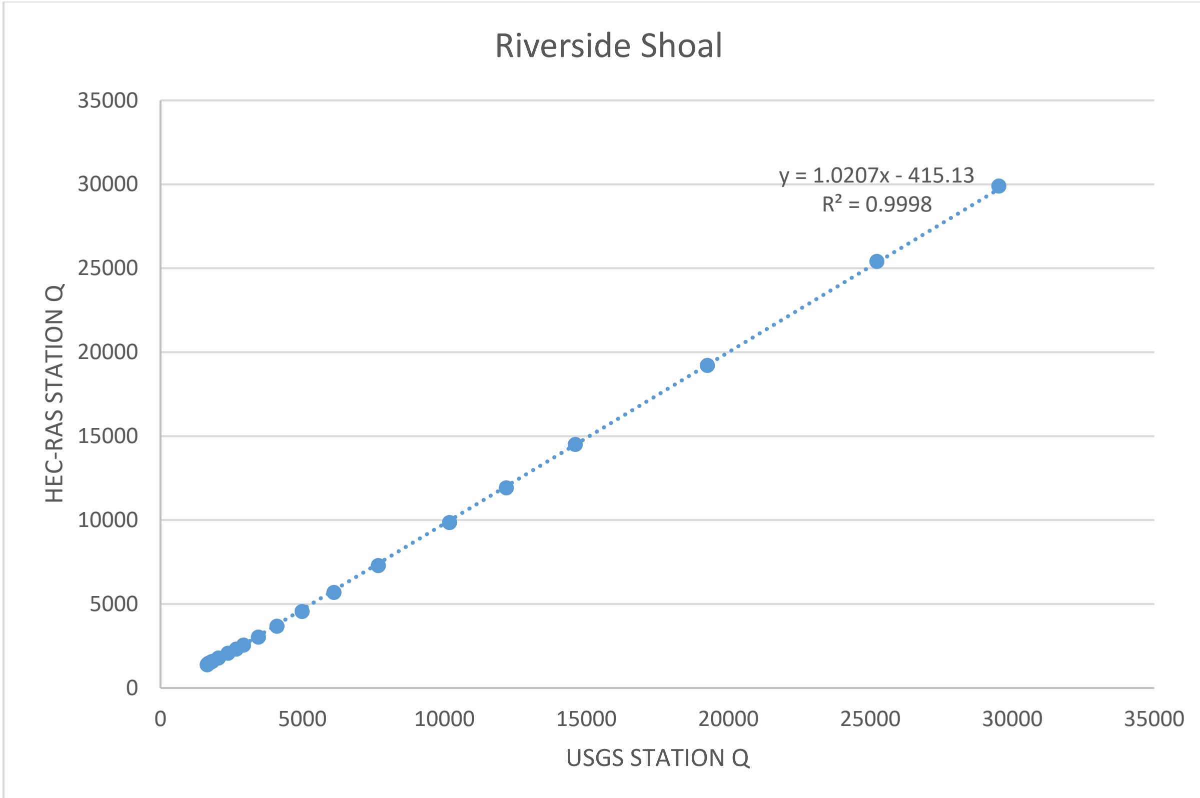
Flow Scenario ID	Percent Time Indicated Flow is Exceeded	Flow (cfs)						
		02319500 Ellaville	02320500 Branford	Station 126.58 (Powerplant)	Station 111.18 (Dowling Park)	Station 102.89 (Lafayette Blue)	Station 100.23 (Perry)	Station 89.24 (Riverside)
1	99.9	950	1651	717	1062	1194	1222	1374
2	99.8	988	1665	754	1099	1233	1261	1403
3	99.5	1059	1698	824	1167	1304	1333	1460
4	99	1099	1755	863	1205	1345	1374	1505
5	98	1155	1831	918	1258	1401	1432	1572
6	95	1347	2049	1108	1443	1595	1626	1772
7	90	1605	2383	1362	1691	1854	1888	2063
8	85	1822	2678	1576	1899	2073	2109	2310
9	80	2033	2930	1783	2101	2284	2322	2544
10	70	2480	3456	2224	2530	2732	2775	3023
11	60	3042	4111	2778	3070	3295	3343	3675
12	50	3822	4993	3547	3819	4071	4124	4544
13	40	5003	6116	4709	4945	5191	5243	5682
14	30	6689	7682	6369	6556	6793	6843	7287
15	20	9412	10189	9053	9163	9387	9434	9843
16	15	11524	12190	11134	11184	11397	11442	11916
17	10	14294	14618	13864	13836	14036	14078	14494
18	5	19034	19270	18531	18363	18538	18574	19210
19	2	25784	25241	25186	24833	24975	25004	25398
20	1	31103	29537	30426	29921	30036	30060	29890


Powerplant Shoal
y = 0.9853x - 219.87
R² = 1
HEC-RAS STATION Q
USGS STATION Q
0
5000
10000
15000
20000
25000
30000
35000


Dowling Park Shoal
y = 0.957x + 154.97
R² = 1
HEC-RAS STATION Q
USGS STATION Q
0
5000
10000
15000
20000
25000
30000
35000


Lafayette Blue Shoal
y = 1.0178x - 704.28
R² = 0.9989
HEC-RAS STATION Q
USGS STATION Q
0
5000
10000
15000
20000
25000
30000
35000


Perry Shoal
35000
30000
25000
20000
15000
10000
5000
0
HEC-RAS STATION Q
y = 1.0177x - 665.54
R² = 0.999
0
5000
10000
15000
20000
25000
30000
35000
USGS STATION Q


Riverside Shoal
y = 1.0207x - 415.13
R² = 0.9998
HEC-RAS STATION Q
USGS STATION Q
0
5000
10000
15000
20000
25000
30000
35000

Flow Duration Curves

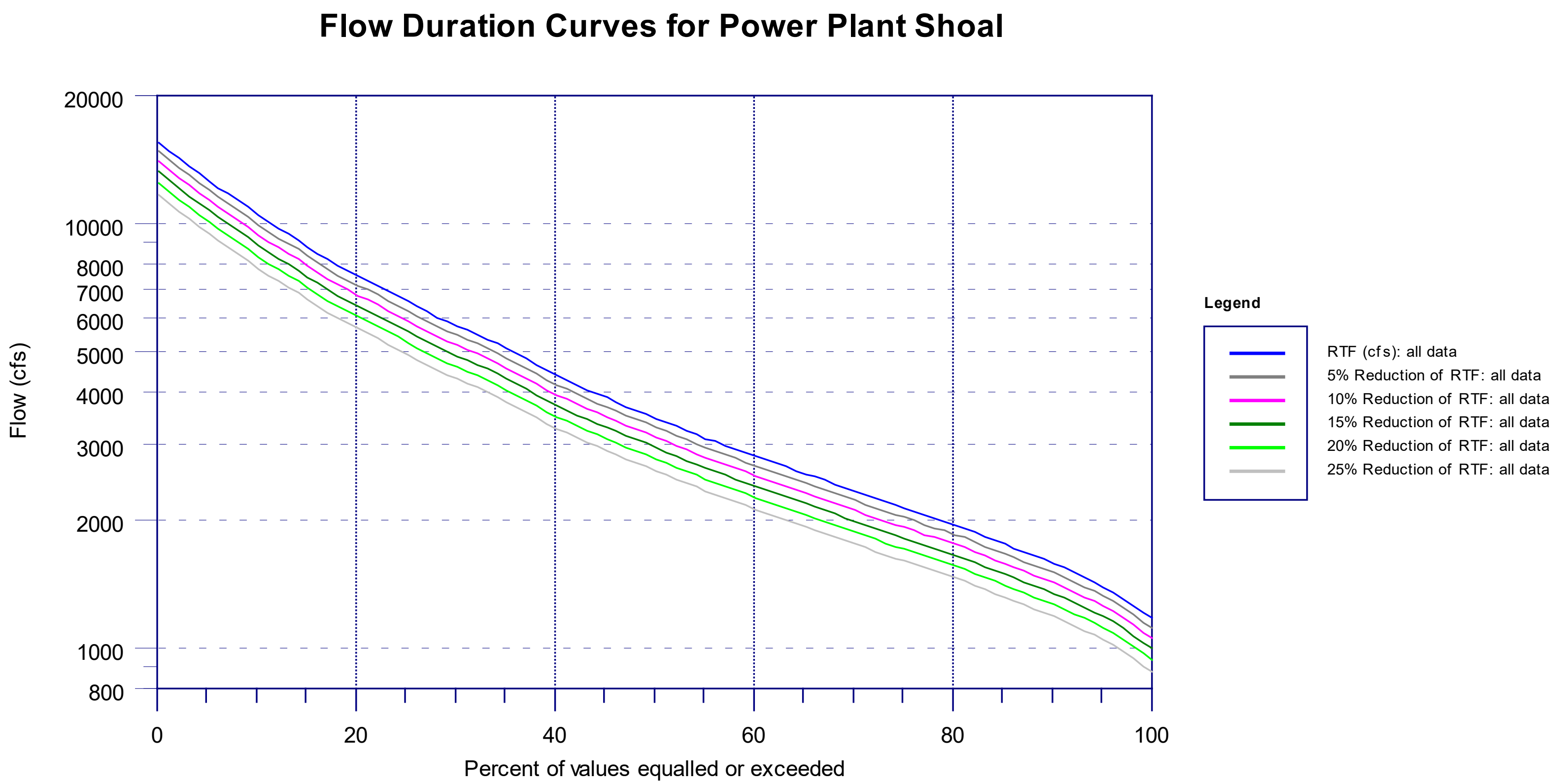


Figure A1. Flow duration curves for Power Plant shoal comparing the reference time-series flow (RTF) and various RTF flow reduction scenarios. RTF flow records from WY 1933 to 2015 were derived for the closest HEC-RAS station to the shoal of interest using HEC-RAS model output for the applicable compliance gage. Note that the flow records were truncated to only include flow values ranging from half the lowest flow collected during SEFA data collection to two times the highest flow collected, as per convention for the SEFA. HEC-RAS river station associated with SEFA site: 126.58; USGS gage associated with SEFA site: Ellaville (02319500).

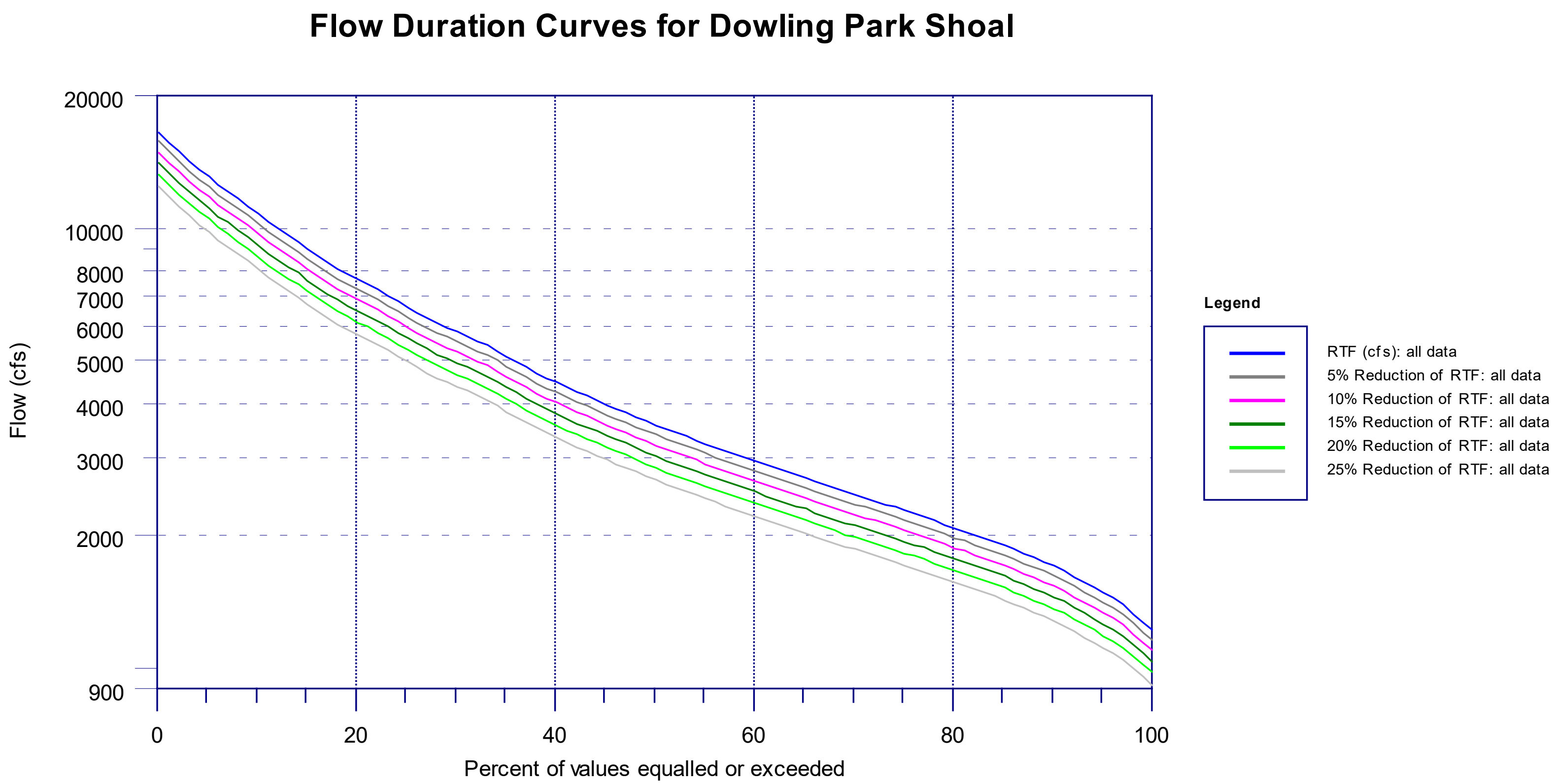


Figure A2. Flow duration curves for Dowling Park shoal comparing the reference time-series flow (RTF) and various RTF flow reduction scenarios. RTF flow records from WY 1933 to 2015 were derived for the closest HEC-RAS station to the shoal of interest using HEC-RAS model output for the applicable compliance gage. Note that the flow records were truncated to only include flow values ranging from half the lowest flow collected during SEFA data collection to two times the highest flow collected, as per convention for the SEFA. HEC-RAS river station associated with SEFA site: 111.18; USGS gage associated with SEFA site: Ellaville (02319500).

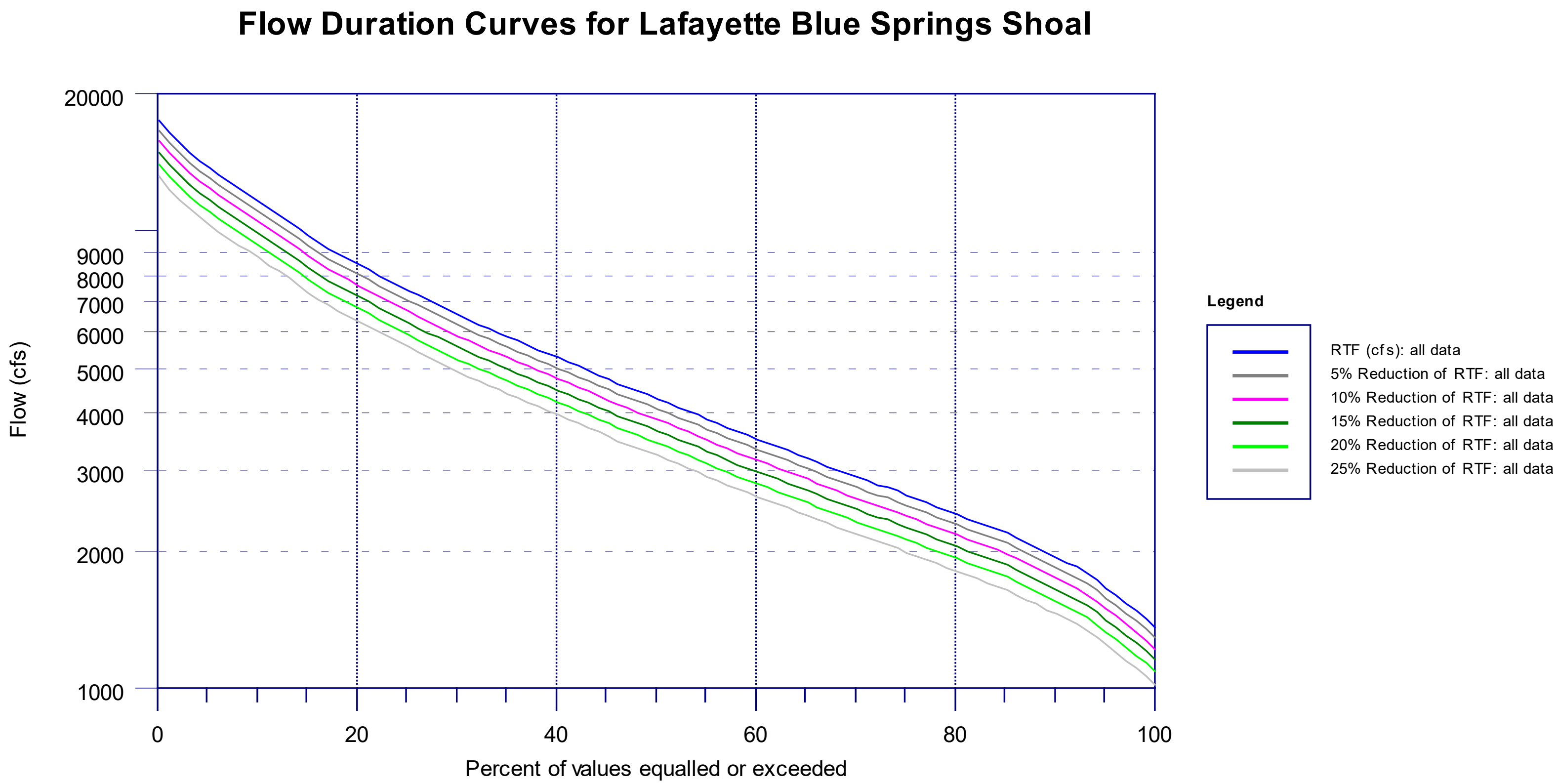


Figure A3. Flow duration curves for Lafayette Blue Springs shoal comparing the reference time-series flow (RTF) and various RTF flow reduction scenarios. RTF flow records from WY 1933 to 2015 were derived for the closest HEC-RAS station to the shoal of interest using HEC-RAS model output for the applicable compliance gage. Note that the flow records were truncated to only include flow values ranging from half the lowest flow collected during SEFA data collection to two times the highest flow collected, as per convention for the SEFA. HEC-RAS river station associated with SEFA site: 102.89; USGS gage associated with SEFA site: Branford (02320500).

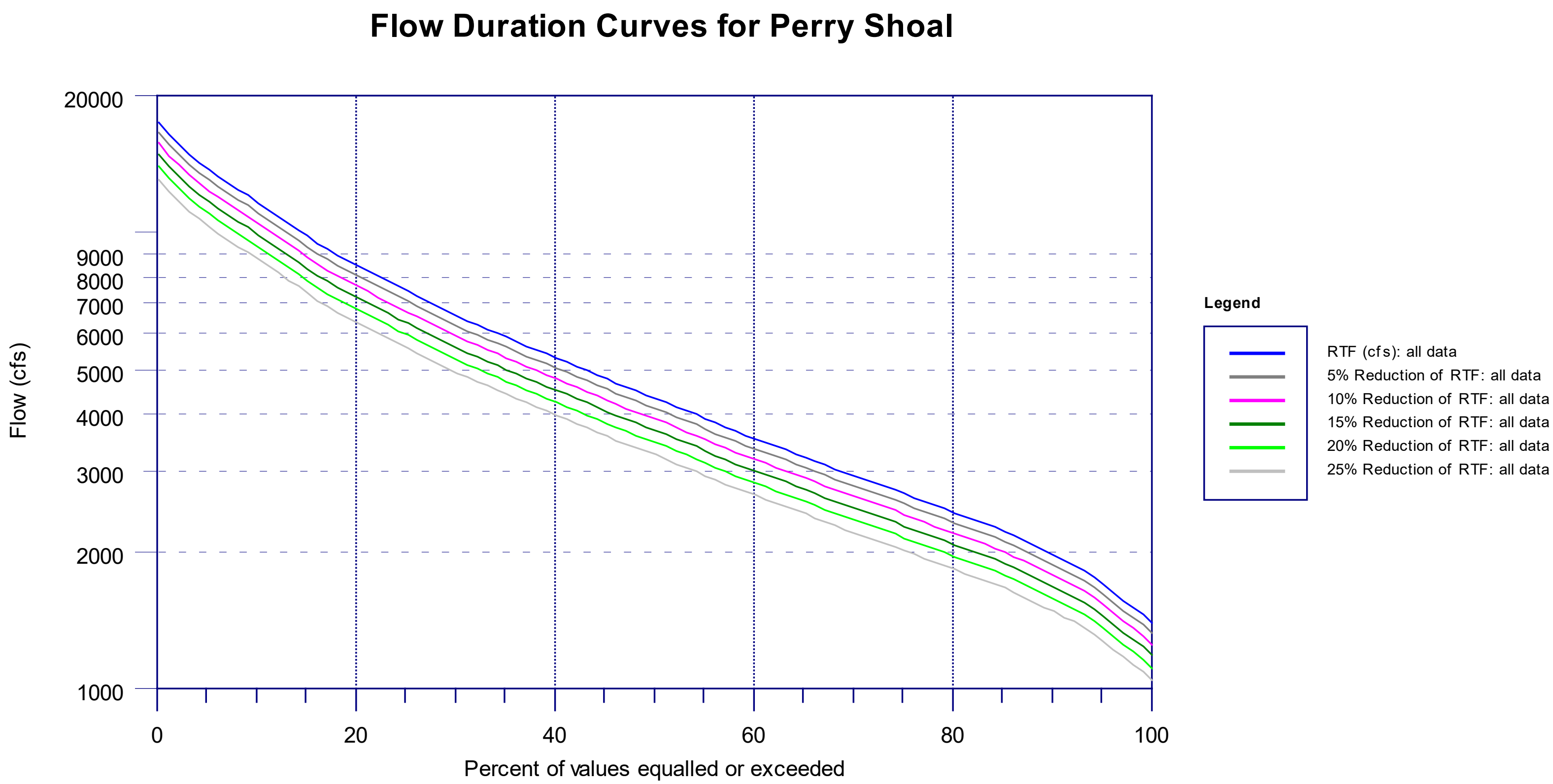


Figure A4. Flow duration curves for Perry shoal comparing the reference time-series flow (RTF) and various RTF flow reduction scenarios. RTF flow records from WY 1933 to 2015 were derived for the closest HEC-RAS station to the shoal of interest using HEC-RAS model output for the applicable compliance gage. Note that the flow records were truncated to only include flow values ranging from half the lowest flow collected during SEFA data collection to two times the highest flow collected, as per convention for the SEFA. HEC-RAS river station associated with SEFA site: 100.23; USGS gage associated with SEFA site: Branford (02320500).

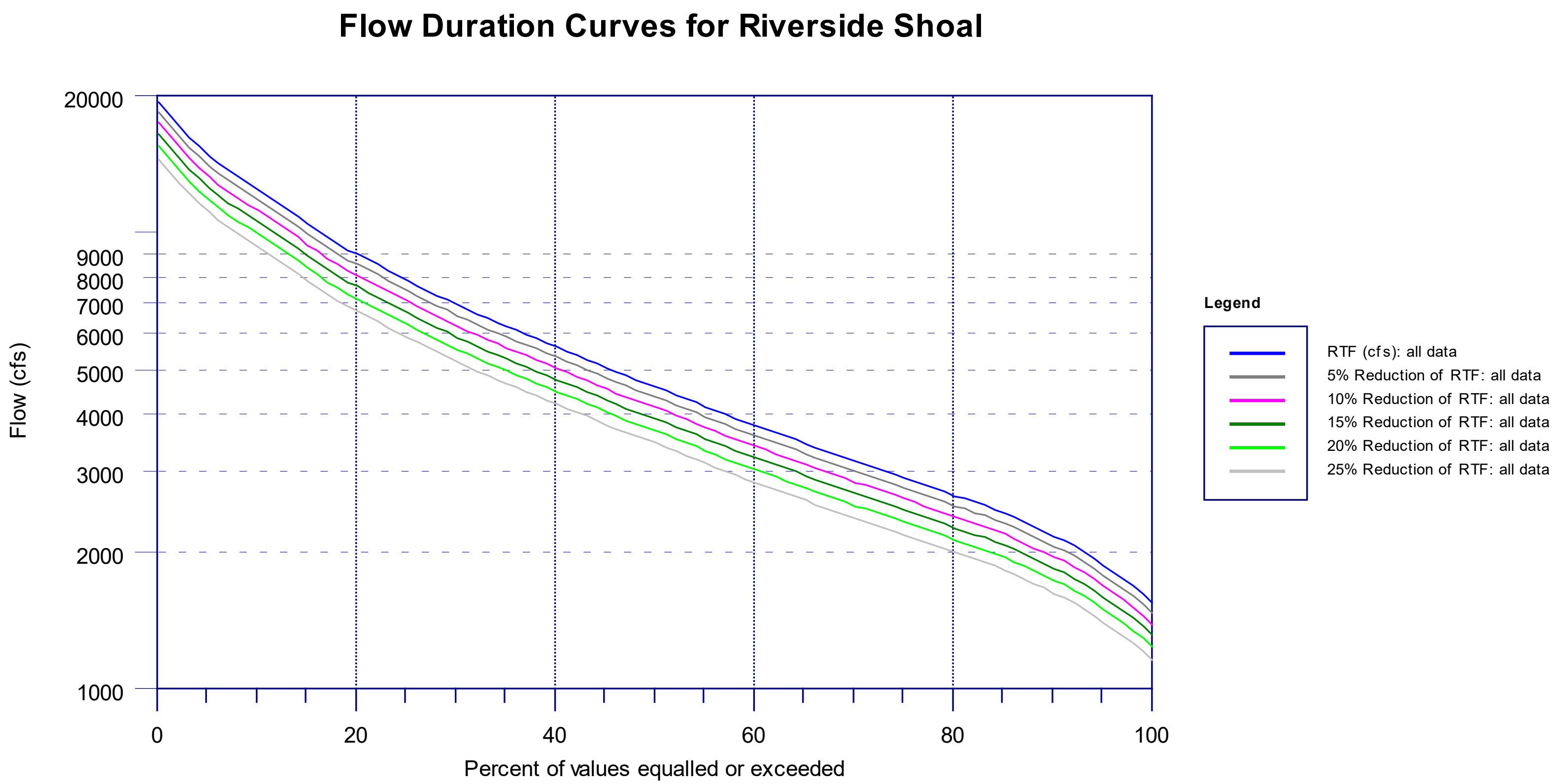


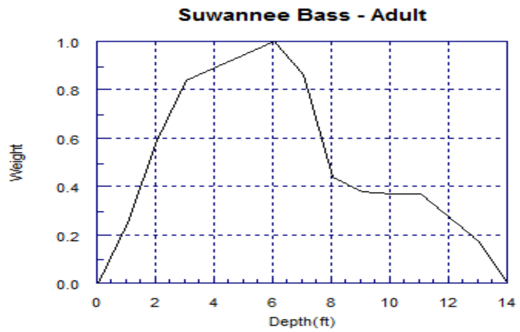
Figure A5. Flow duration curves for Riverside shoal comparing the reference time-series flow (RTF) and various RTF flow reduction scenarios. RTF flow records from WY 1933 to 2015 were derived for the closest HEC-RAS station to the shoal of interest using HEC-RAS model output for the applicable compliance gage. Note that the flow records were truncated to only include flow values ranging from half the lowest flow collected during SEFA data collection to two times the highest flow collected, as per convention for the SEFA. HEC-RAS river station associated with SEFA site: 89.24; USGS gage associated with SEFA site: Branford (02320500).

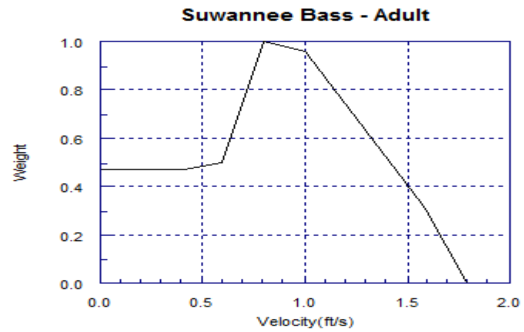
Habitat Suitability Curves

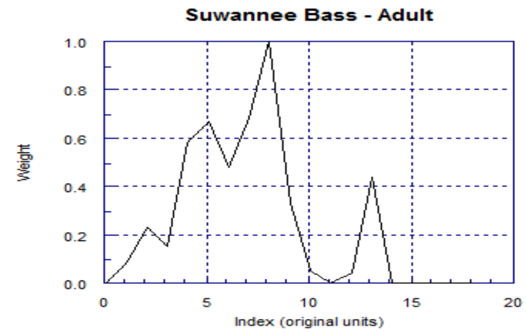
Table A-2. Gore Substrate/Cover Classification

Code	GORE Substrate/Cover Classification (referred to as *Index* in the HSC sets below)
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

Notes: The cross-section surveys conducted at each site were entered into SEFA by the District and use the Gore classification codes for substrate/cover (labeled as the INDEX attribute in SEFA). The HSC sets provided by the District and FWC use the Gore classification, except for two species: Metallic Shiner (MESH) and Spotted Sucker Fish (SPSK). Since Metallic Shiner and Spotted Sucker Fish use a different coding system for substrate/cover, the INDEX attribute for substrate/cover was excluded in the SEFA AWS-FLOW relationship for these two species.


Suwannee Bass - Adult
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0 2 4 6 8 10 12 14
Depth(ft)


Suwannee Bass - Adult
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0
Velocity(ft/s)


Suwannee Bass - Adult
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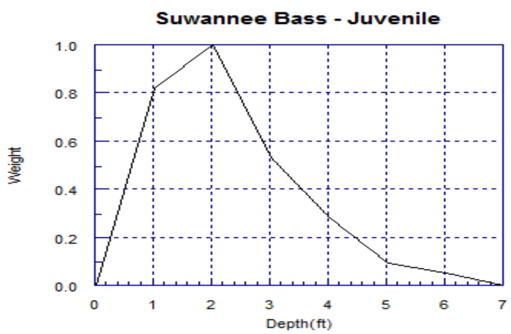
0.4
0.2
0.0
0 5 10 15 20
Index (original units)


Suwannee Bass - Juvenile
Weight
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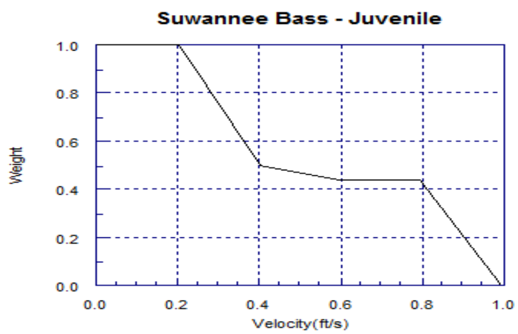
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7
Depth(ft)


Suwannee Bass - Juvenile
Weight
1.0
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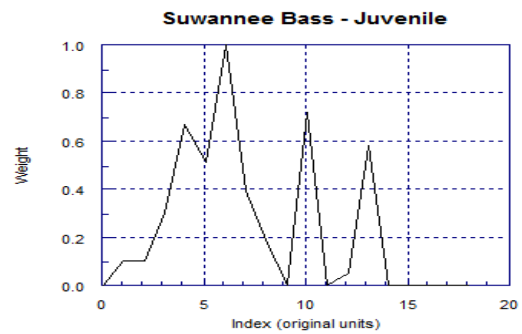
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0
Velocity(ft/s)


Suwannee Bass - Juvenile
Weight
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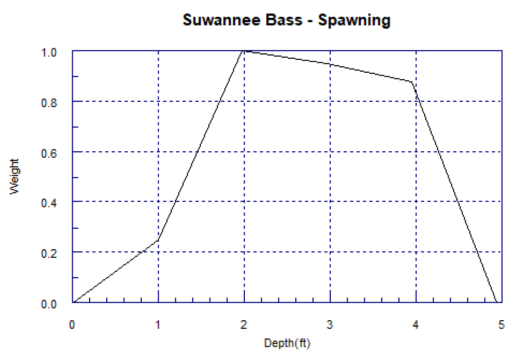
0.4
0.2
0.0
0 5 10 15 20
Index (original units)


Suwannee Bass - Spawning
Weight
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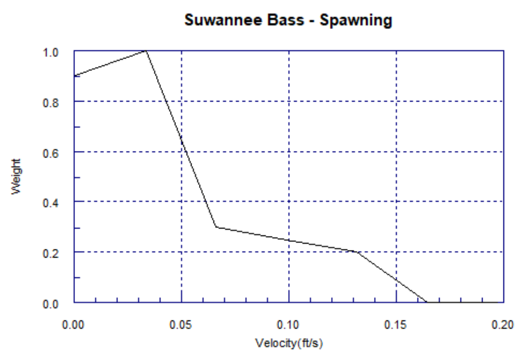
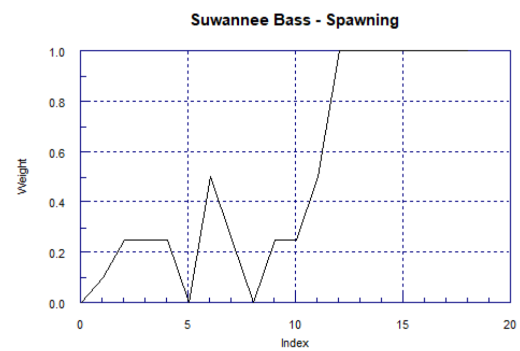
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5
Depth(ft)


Suwannee Bass - Spawning
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.00 0.05 0.10 0.15 0.20
Velocity(ft/s)


Suwannee Bass - Spawning
Weight
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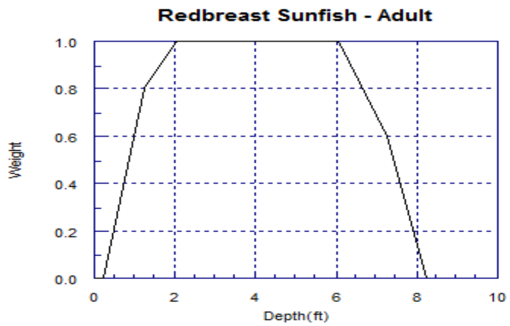
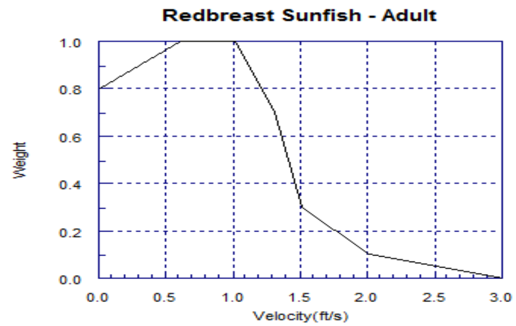
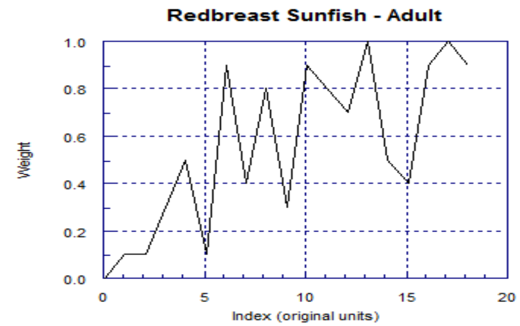
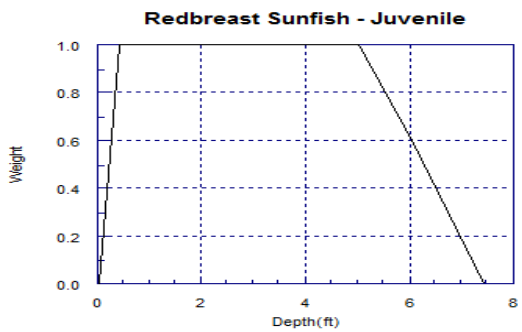
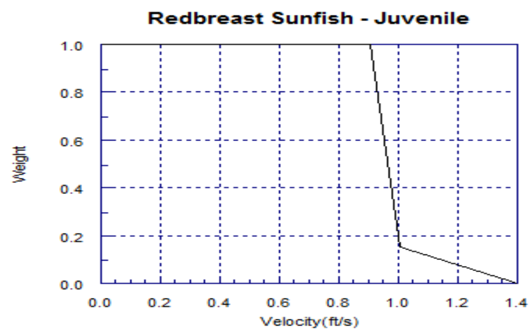
0.8
0.6
0.4
0.2
0.0
0 5 10 15 20
Index

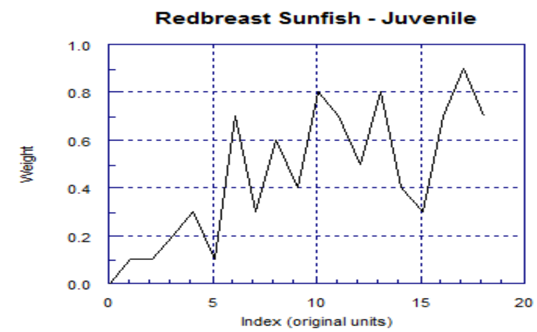

Redbreast Sunfish - Adult
Weight
Depth(ft)

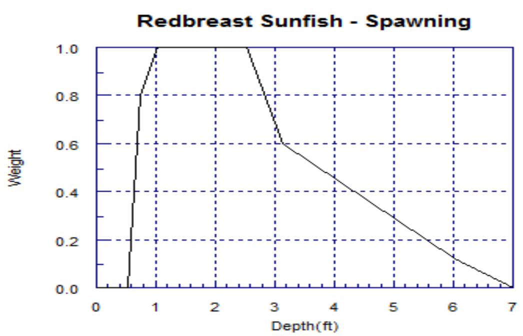

Redbreast Sunfish - Adult
Weight
Velocity(ft/s)

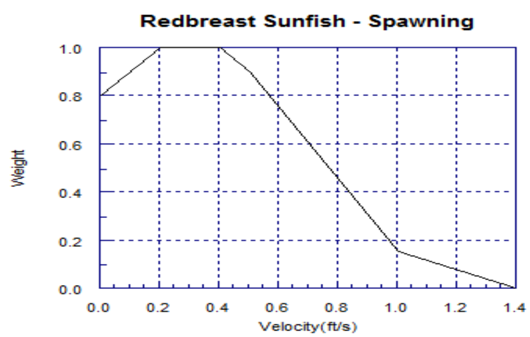

Redbreast Sunfish - Adult
Weight
Index (original units)

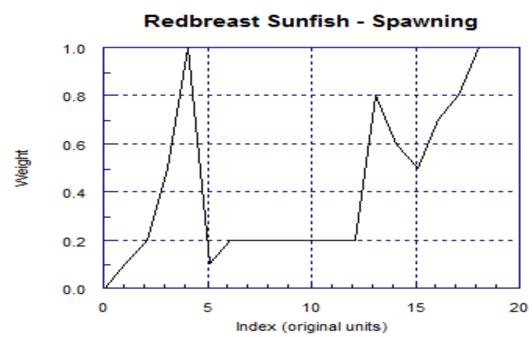

Redbreast Sunfish - Juvenile
Weight
Depth(ft)


Redbreast Sunfish - Juvenile
Weight
Velocity(ft/s)

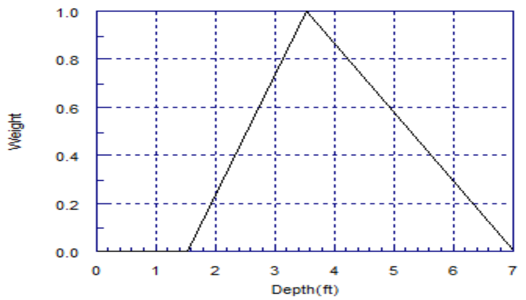

Redbreast Sunfish - Juvenile
Weight
Index (original units)


Redbreast Sunfish - Spawning
Weight
Depth(ft)

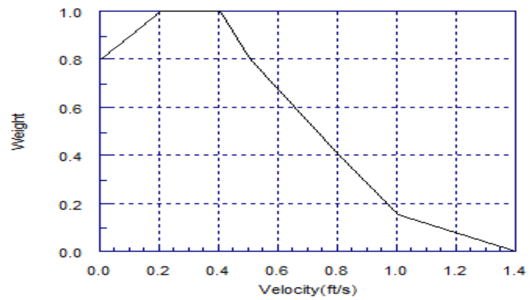

Redbreast Sunfish - Spawning
Weight
Velocity(ft/s)


Redbreast Sunfish - Spawning
Weight
Index (original units)

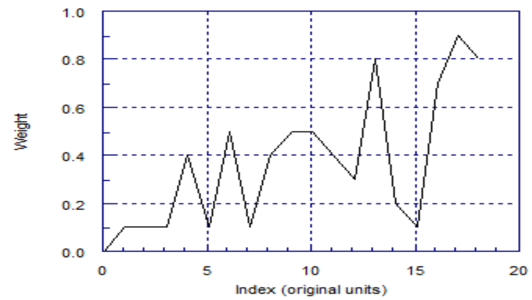
Redbreast Sunfish - Fry



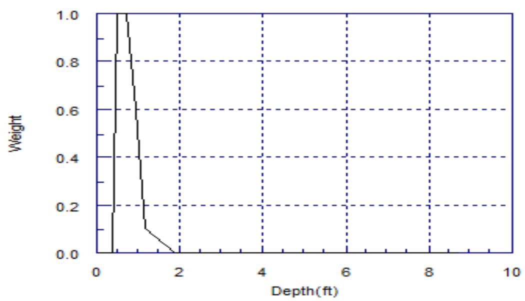
Redbreast Sunfish - Fry



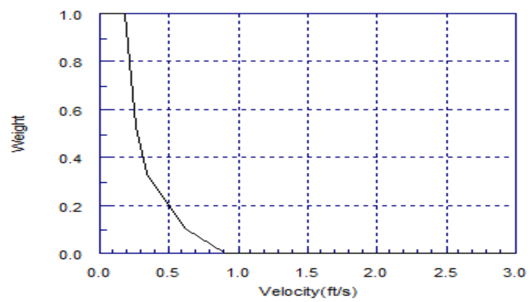
Redbreast Sunfish - Fry



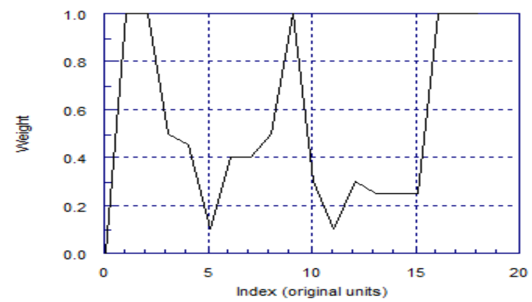
Habitat Guilds - Shallow/Slow



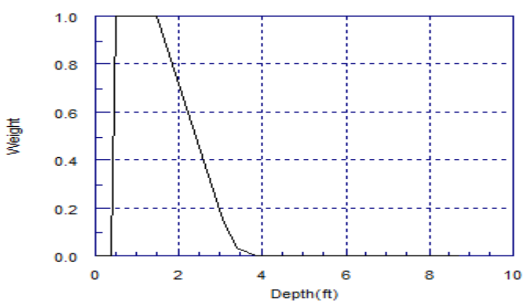
Habitat Guilds - Shallow/Slow



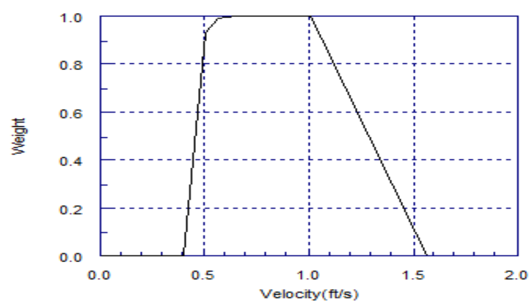
Habitat Guilds - Shallow/Slow



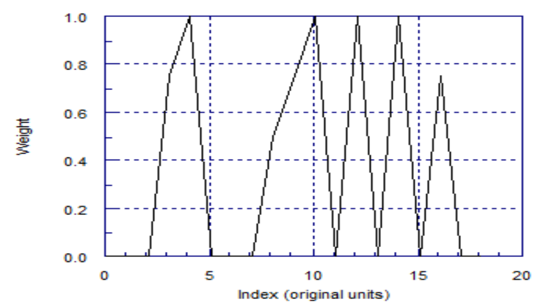
Habitat Guilds - Shallow/Fast

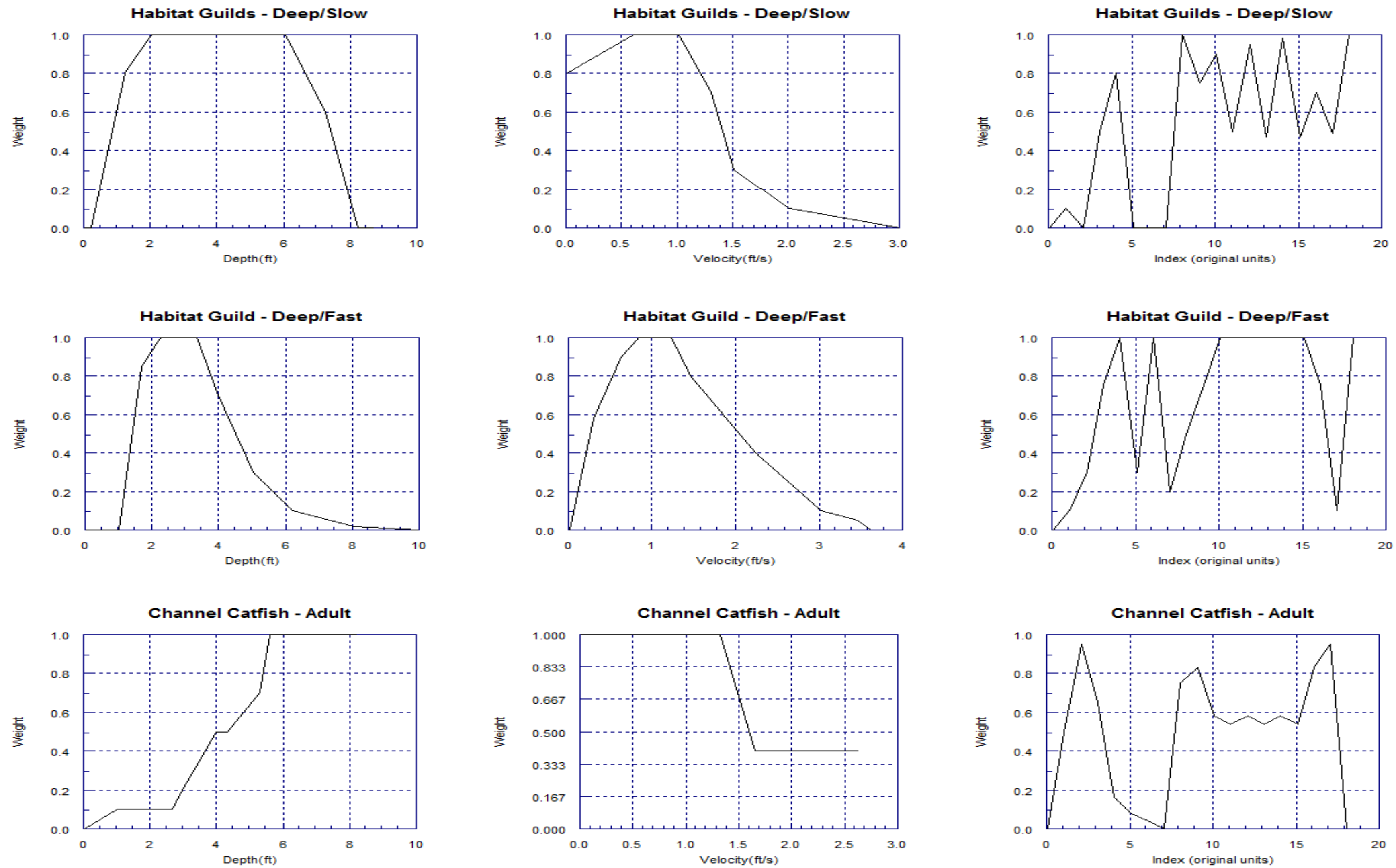


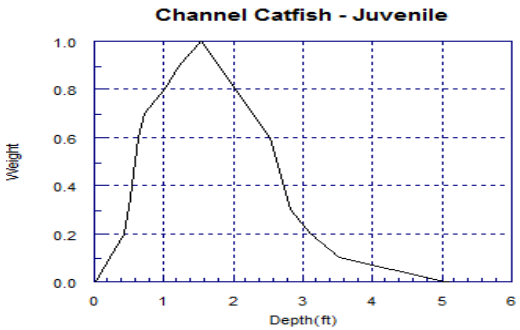
Habitat Guilds - Shallow/Fast

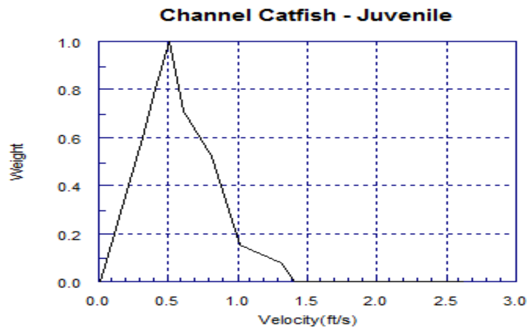


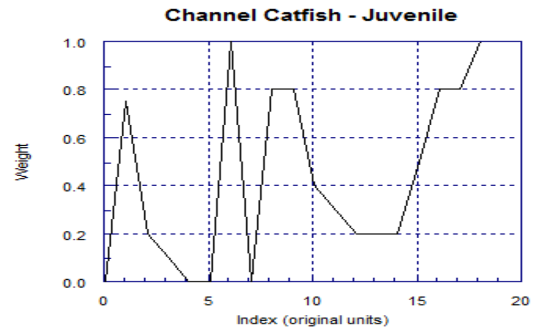
Habitat Guilds - Shallow/Fast

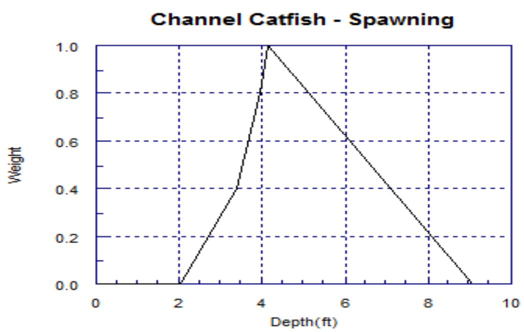


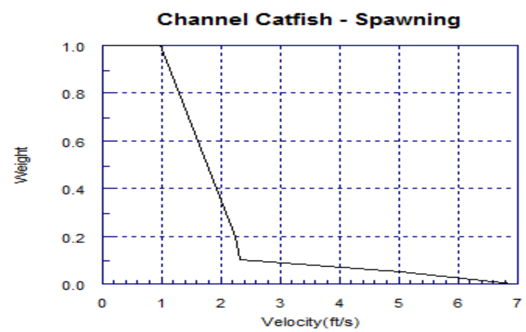

Habitat Guilds - Deep/Slow
Weight
Depth(ft)
Habitat Guilds - Deep/Slow
Weight
Velocity(ft/s)
Habitat Guilds - Deep/Slow
Weight
Index (original units)
Habitat Guild - Deep/Fast
Weight
Depth(ft)
Habitat Guild - Deep/Fast
Weight
Velocity(ft/s)
Habitat Guild - Deep/Fast
Weight
Index (original units)
Channel Catfish - Adult
Weight
Depth(ft)
Channel Catfish - Adult
Weight
Velocity(ft/s)
Channel Catfish - Adult
Weight
Index (original units)

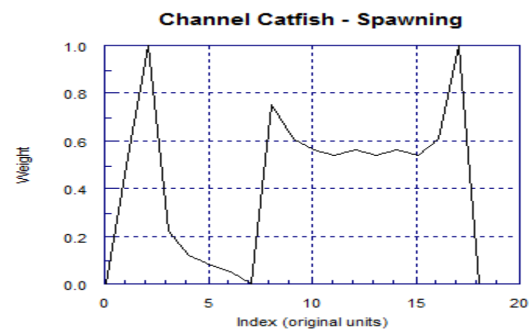

Channel Catfish - Juvenile
Weight
Depth(ft)

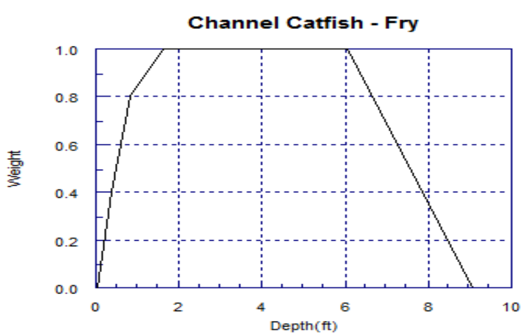

Channel Catfish - Juvenile
Weight
Velocity(ft/s)

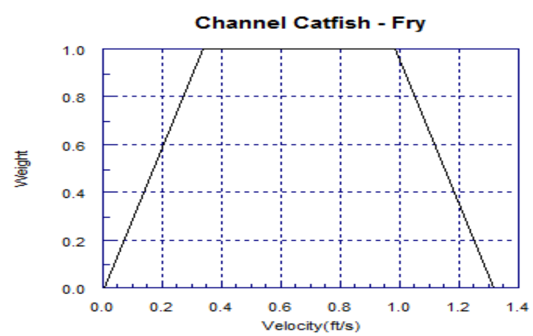

Channel Catfish - Juvenile
Weight
Index (original units)

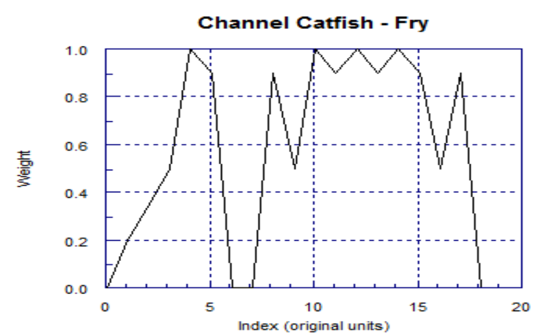

Channel Catfish - Spawning
Weight
Depth(ft)


Channel Catfish - Spawning
Weight
Velocity(ft/s)

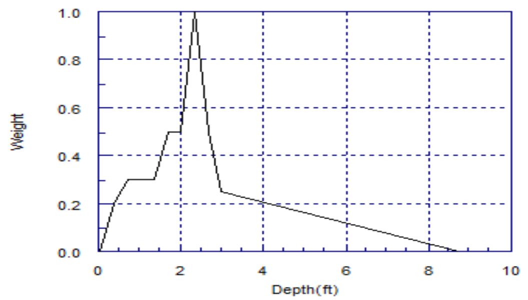

Channel Catfish - Spawning
Weight
Index (original units)


Channel Catfish - Fry
Weight
Depth(ft)

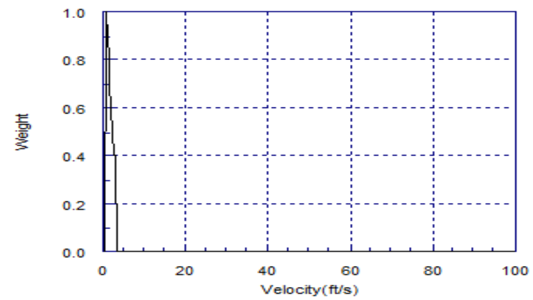

Channel Catfish - Fry
Weight
Velocity(ft/s)


Channel Catfish - Fry
Weight
Index (original units)

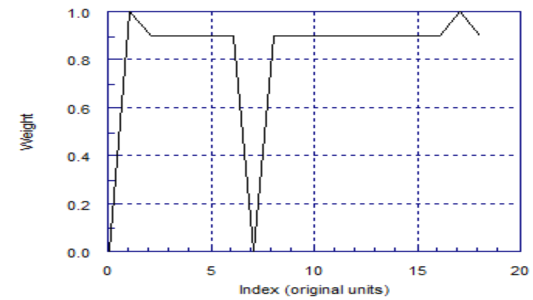
Channel Catfish - Juvenile (Spring)



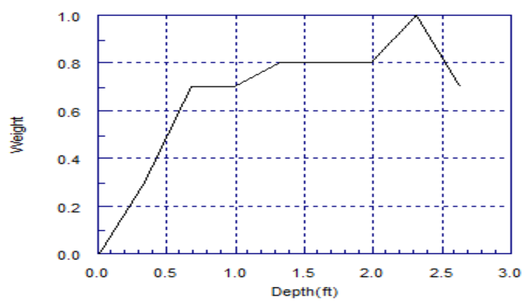
Channel Catfish - Juvenile (Spring)



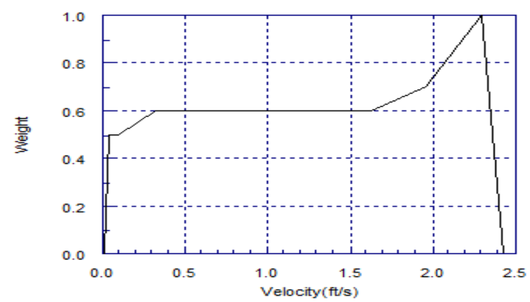
Channel Catfish - Juvenile (Spring)



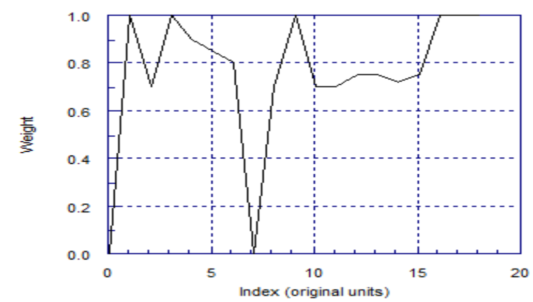
Channel Catfish - Juvenile (Summer)



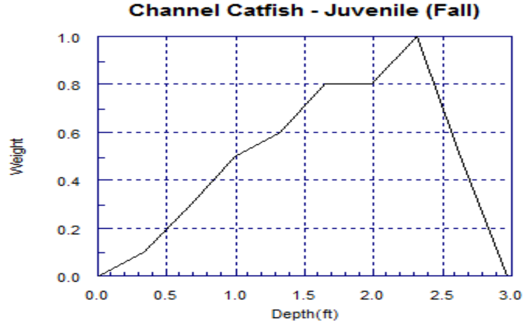
Channel Catfish - Juvenile (Summer)



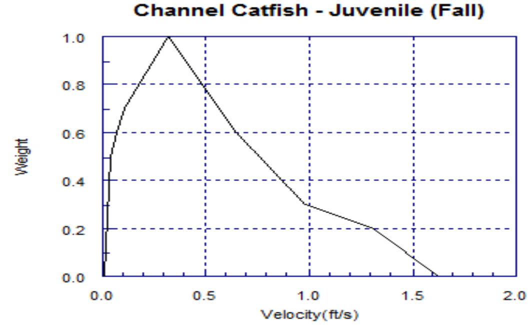
Channel Catfish - Juvenile (Summer)



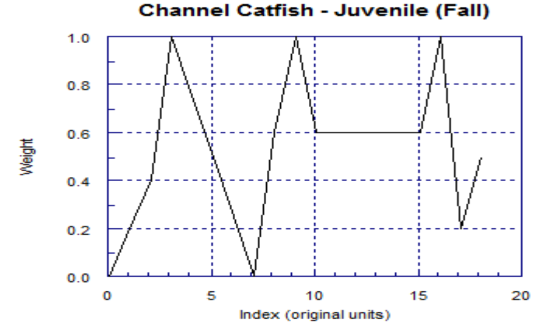
Channel Catfish - Juvenile (Fall)

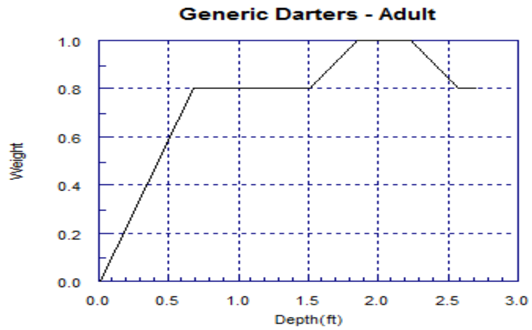


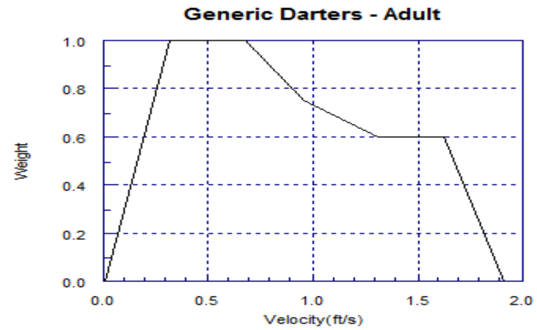
Channel Catfish - Juvenile (Fall)

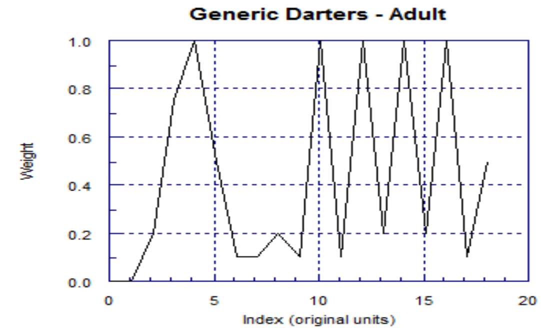


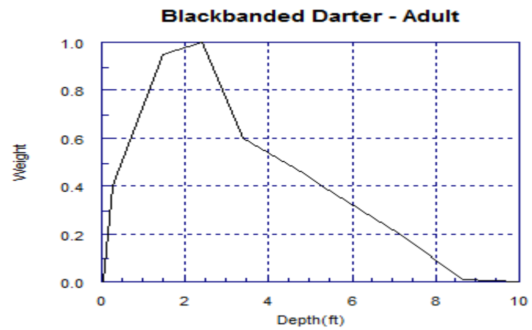
Channel Catfish - Juvenile (Fall)

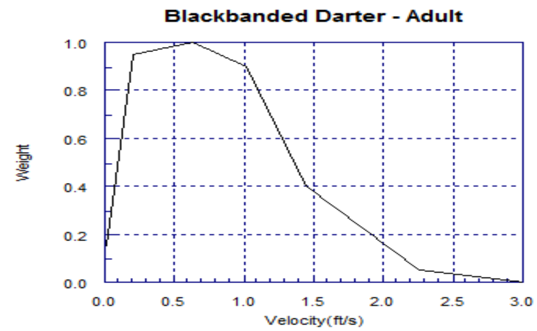


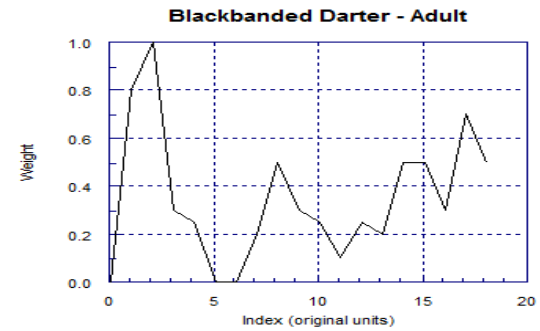

Generic Darters - Adult
Weight
Depth(ft)

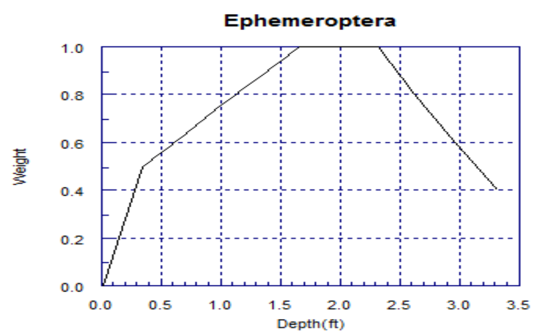

Generic Darters - Adult
Weight
Velocity(ft/s)

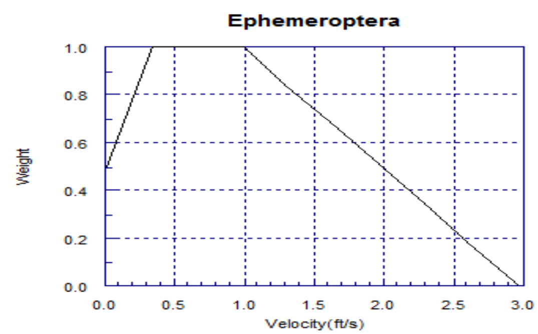

Generic Darters - Adult
Weight
Index (original units)

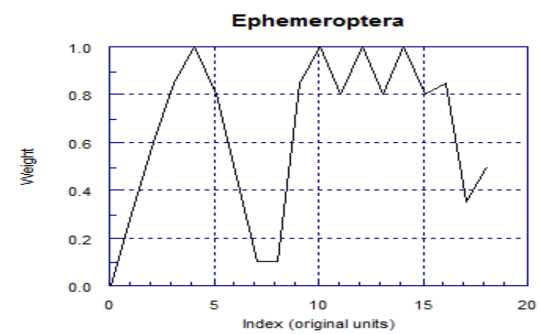

Blackbanded Darter - Adult
Weight
Depth(ft)

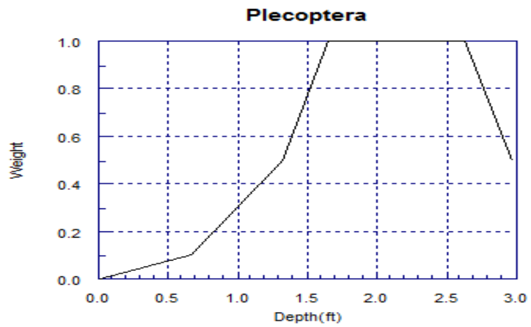

Blackbanded Darter - Adult
Weight
Velocity(ft/s)

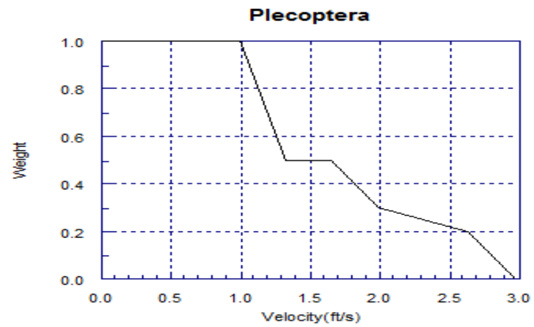

Blackbanded Darter - Adult
Weight
Index (original units)

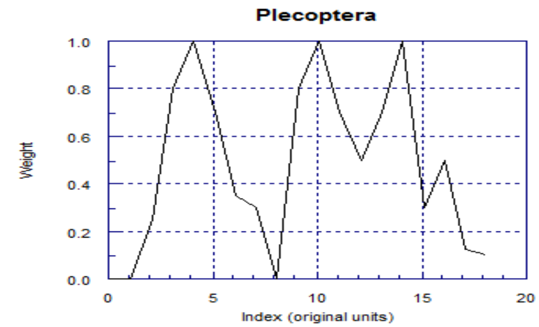

Ephemeroptera
Weight
Depth(ft)

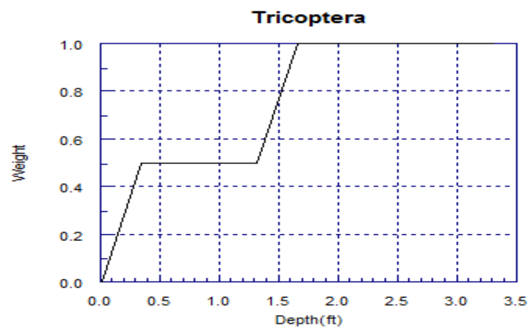

Ephemeroptera
Weight
Velocity(ft/s)

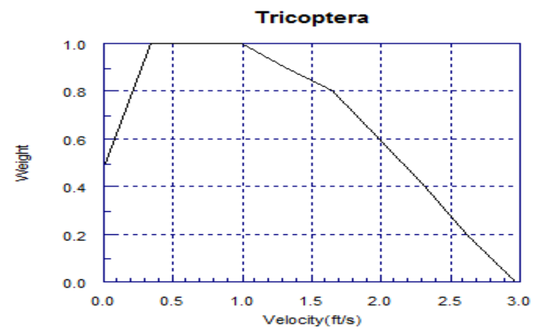

Ephemeroptera
Weight
Index (original units)

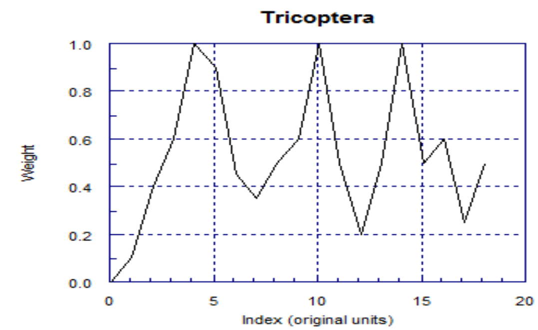

Plecoptera
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Depth(ft)

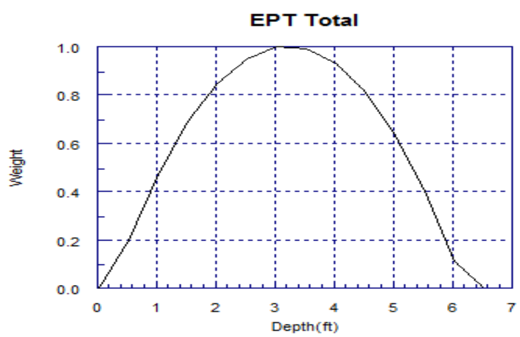

Plecoptera
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Velocity(ft/s)

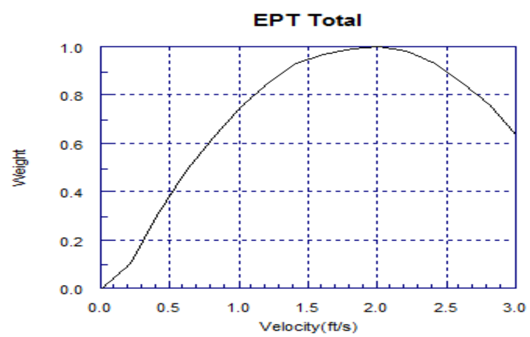

Plecoptera
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0 5 10 15 20
Index (original units)

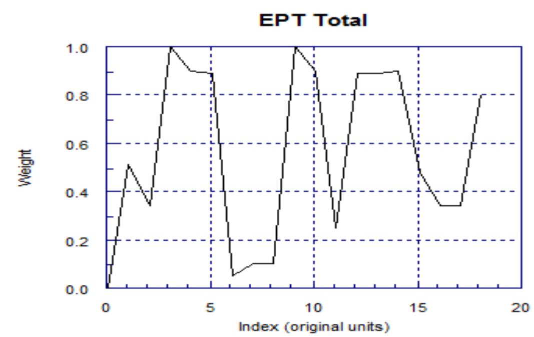

Tricoptera
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
Depth(ft)

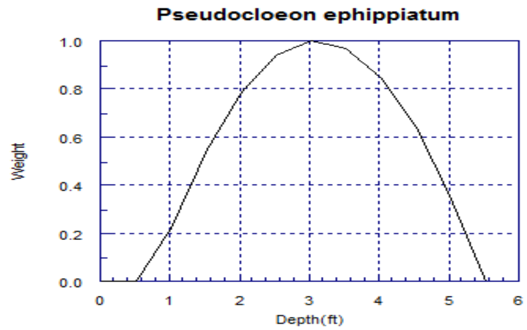

Tricoptera
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Velocity(ft/s)

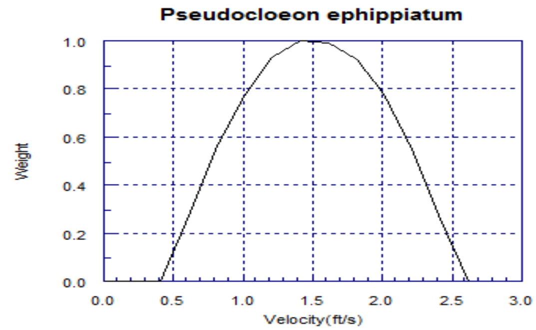

Tricoptera
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0 5 10 15 20
Index (original units)

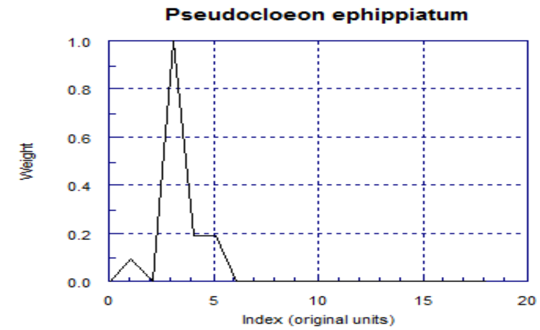

EPT Total
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7
Depth(ft)

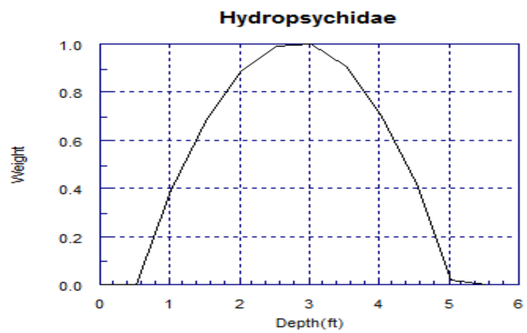

EPT Total
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Velocity(ft/s)

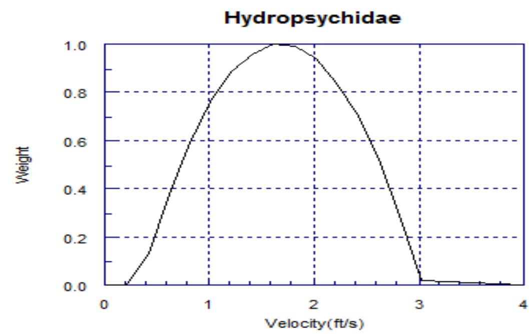

EPT Total
Weight
1.0
0.8
0.6
0.4
0.2
0.0
0 5 10 15 20
Index (original units)

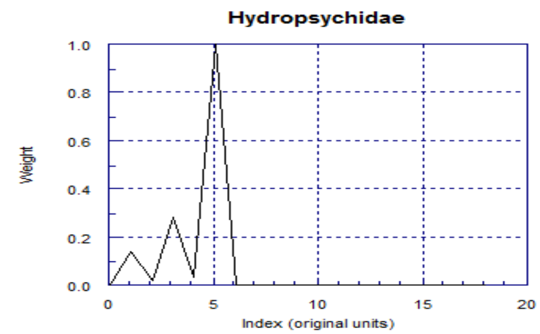

Pseudocloeon ephippiatum
Weight
Depth(ft)

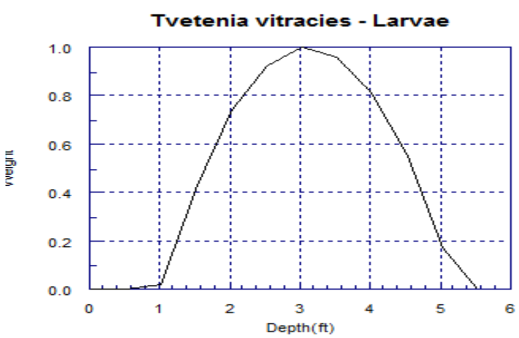

Pseudocloeon ephippiatum
Weight
Velocity(ft/s)

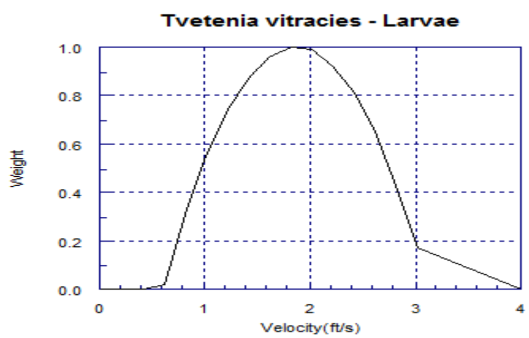

Pseudocloeon ephippiatum
Weight
Index (original units)

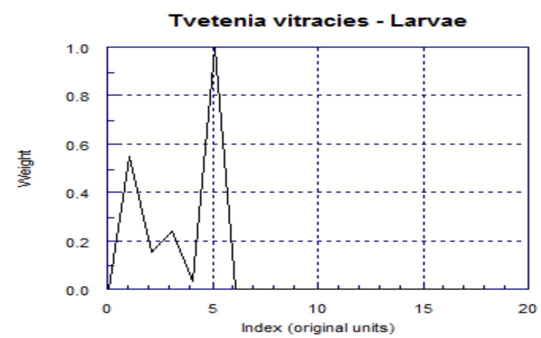

Hydropsychidae
Weight
Depth(ft)


Hydropsychidae
Weight
Velocity(ft/s)

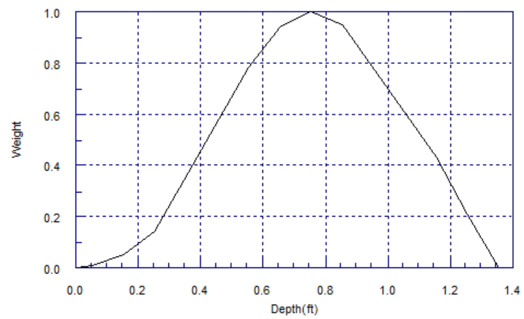

Hydropsychidae
Weight
Index (original units)


Tvetenia vitracies - Larvae
Depth(ft)

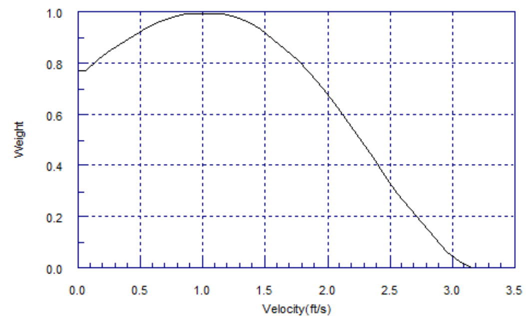

Tvetenia vitracies - Larvae
Weight
Velocity(ft/s)


Tvetenia vitracies - Larvae
Weight
Index (original units)

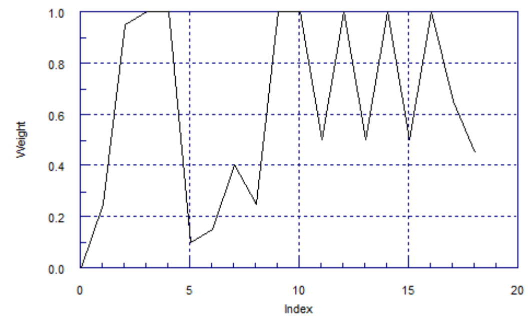
Benthic Macroinvertebrates - Low Grad



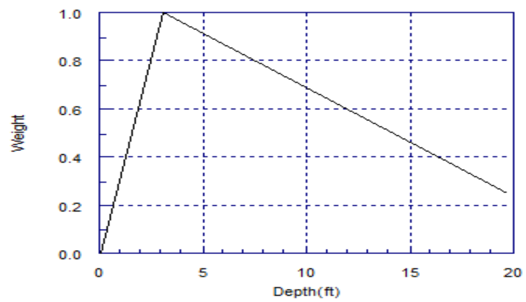
Benthic Macroinvertebrates - Low Grad



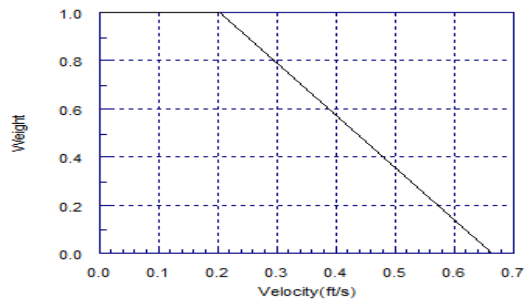
Benthic Macroinvertebrates - Low Grad



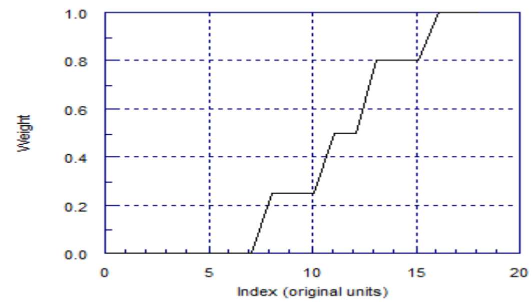
Largemouth Bass - Adult



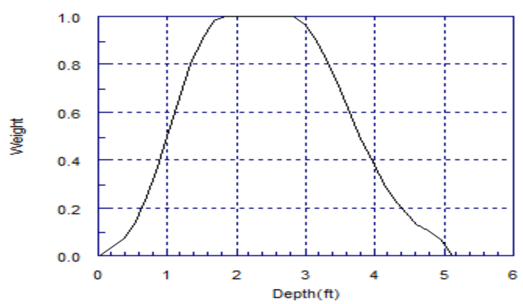
Largemouth Bass - Adult



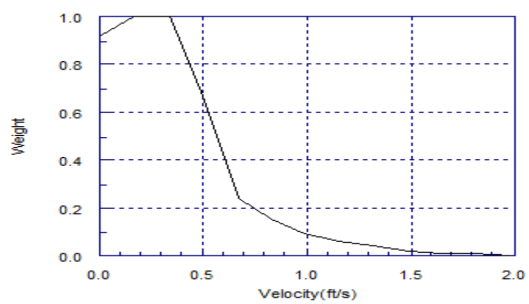
Largemouth Bass - Adult



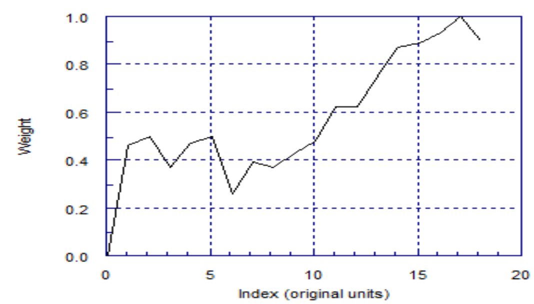
Largemouth Bass - Juvenile

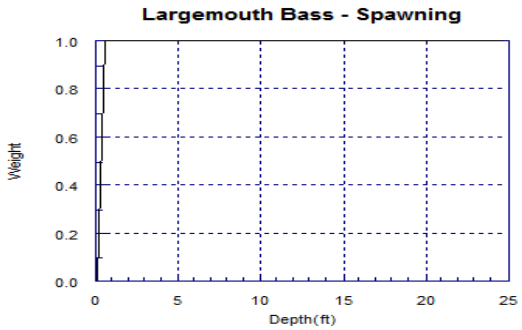


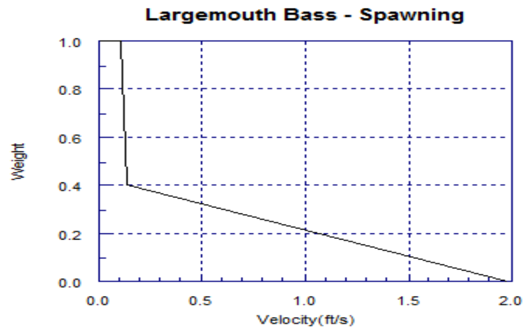
Largemouth Bass - Juvenile

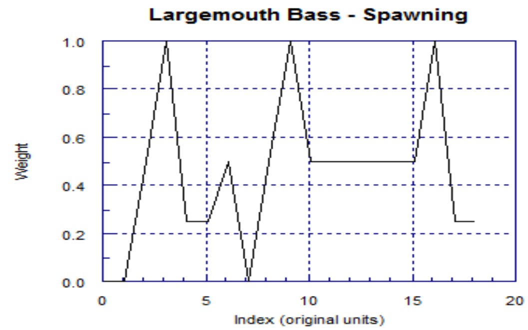


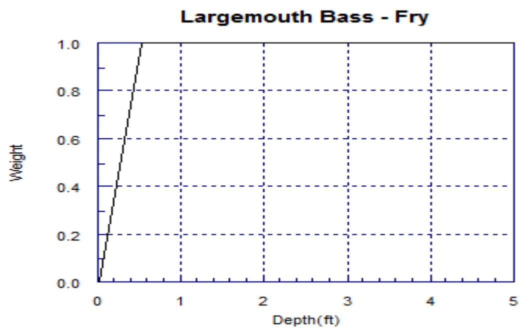
Largemouth Bass - Juvenile

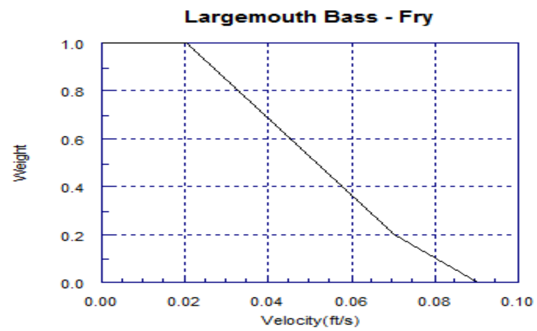


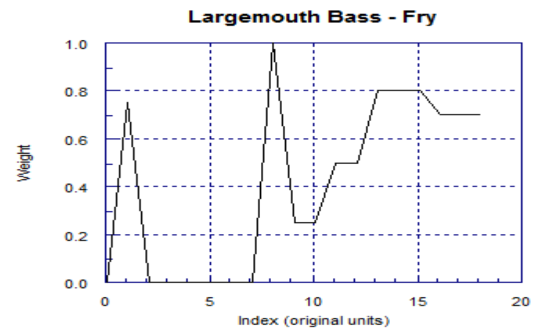

Largemouth Bass - Spawning
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0 5 10 15 20 25
Depth(ft)

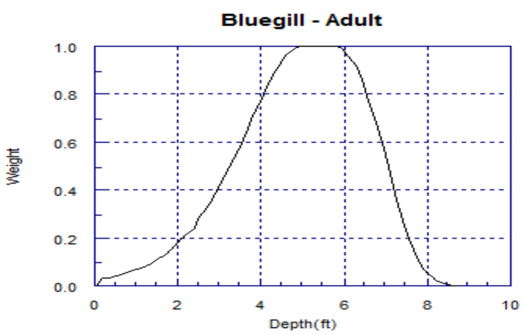

Largemouth Bass - Spawning
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0.0 0.5 1.0 1.5 2.0
Velocity(ft/s)

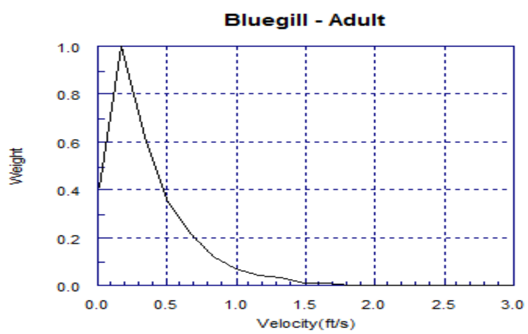

Largemouth Bass - Spawning
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0 5 10 15 20
Index (original units)

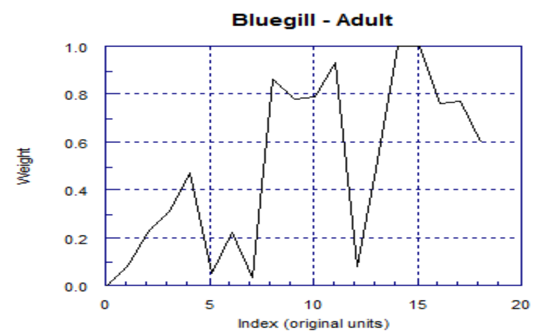

Largemouth Bass - Fry
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0 1 2 3 4 5
Depth(ft)

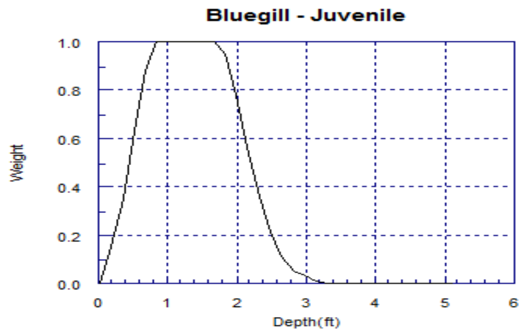

Largemouth Bass - Fry
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0.00 0.02 0.04 0.06 0.08 0.10
Velocity(ft/s)

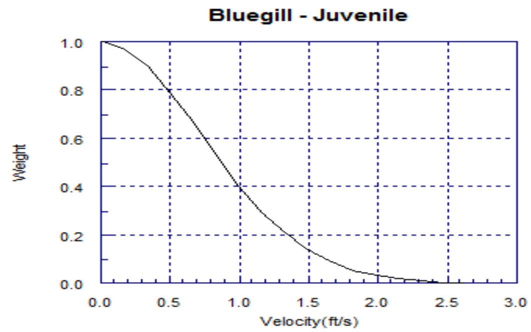

Largemouth Bass - Fry
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0 5 10 15 20
Index (original units)

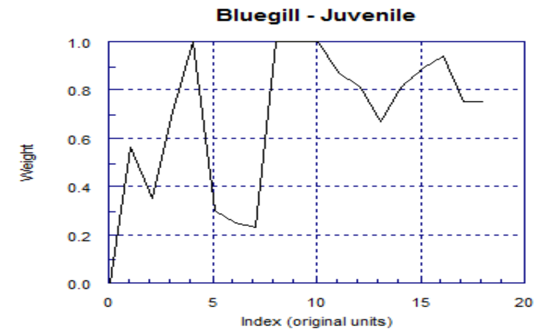

Bluegill - Adult
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0 2 4 6 8 10
Depth(ft)

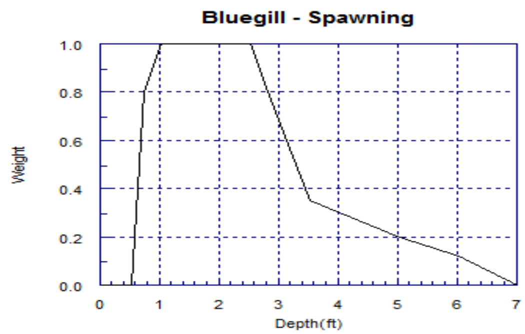

Bluegill - Adult
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Velocity(ft/s)

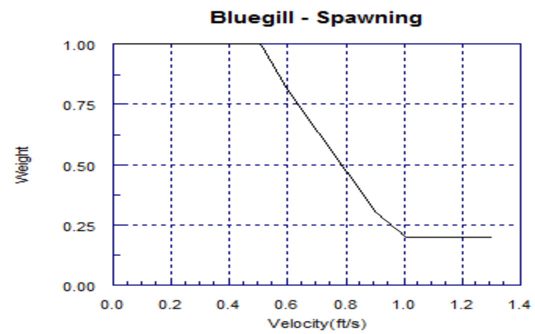

Bluegill - Adult
Weight
1.0 0.8 0.6 0.4 0.2 0.0
0 5 10 15 20
Index (original units)

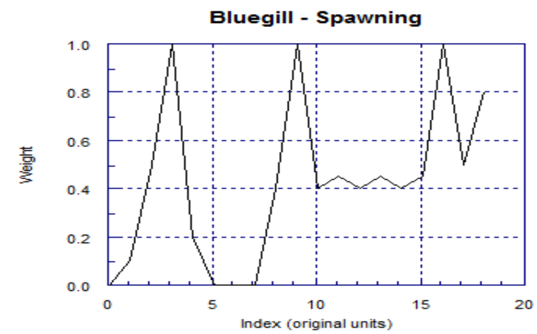

Bluegill - Juvenile
Weight
Depth(ft)

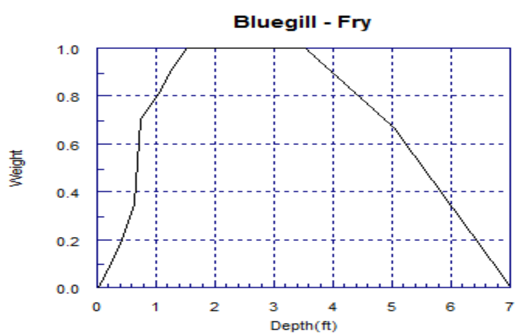

Bluegill - Juvenile
Weight
Velocity(ft/s)

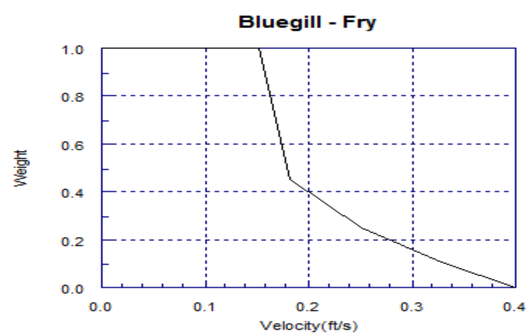

Bluegill - Juvenile
Weight
Index (original units)

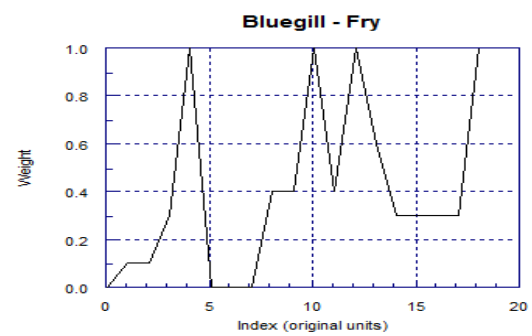

Bluegill - Spawning
Weight
Depth(ft)


Bluegill - Spawning
Weight
Velocity(ft/s)

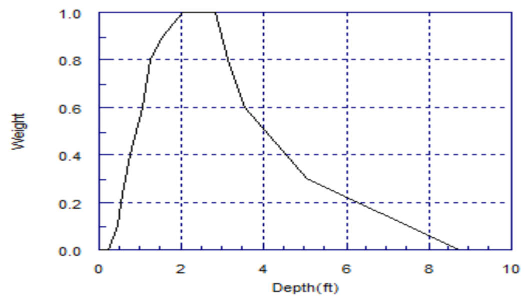

Bluegill - Spawning
Weight
Index (original units)


Bluegill - Fry
Weight
Depth(ft)

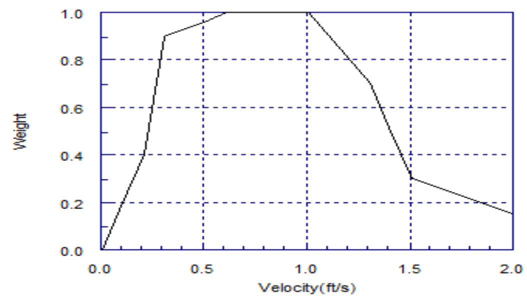

Bluegill - Fry
Weight
Velocity(ft/s)


Bluegill - Fry
Weight
Index (original units)

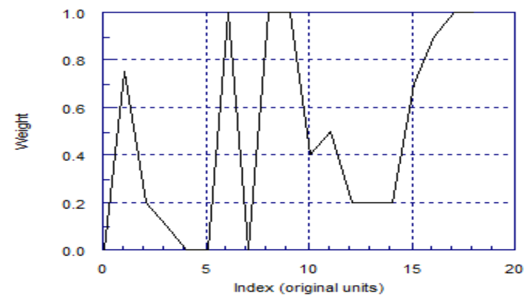
Spotted Sunfish - Adult



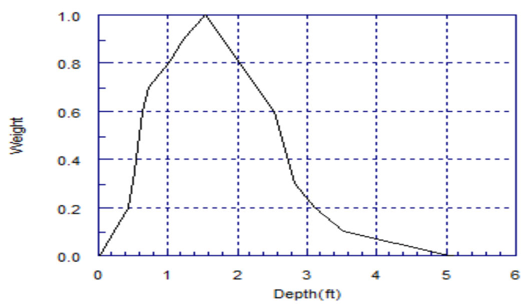
Spotted Sunfish - Adult



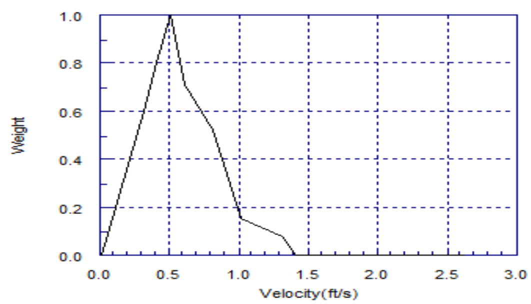
Spotted Sunfish - Adult



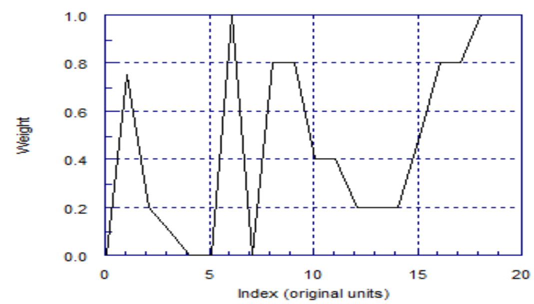
Spotted Sunfish - Juvenile



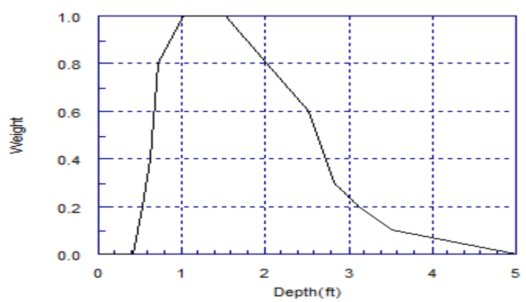
Spotted Sunfish - Juvenile



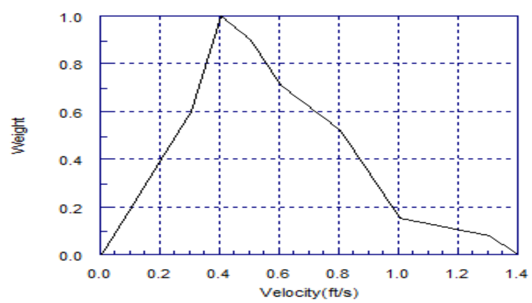
Spotted Sunfish - Juvenile



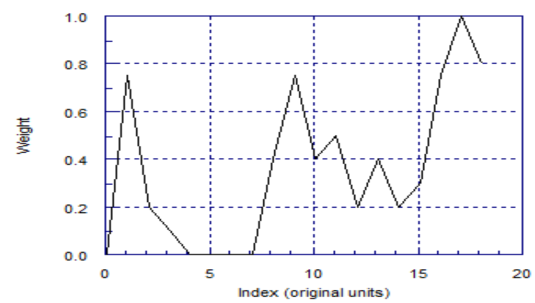
Spotted Sunfish - Spawning

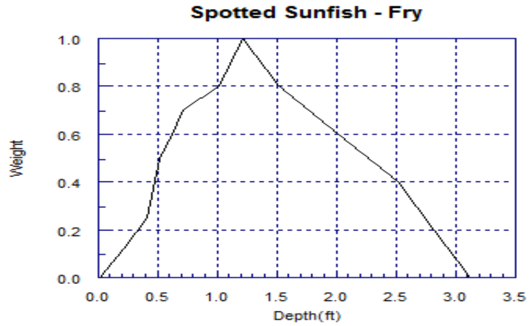


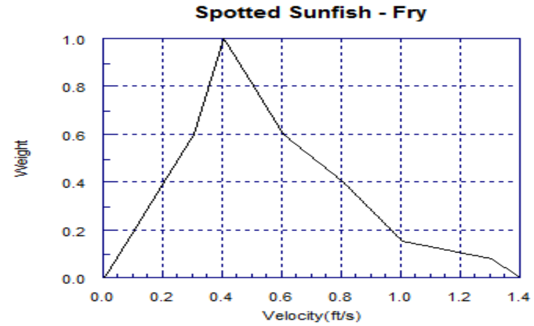
Spotted Sunfish - Spawning

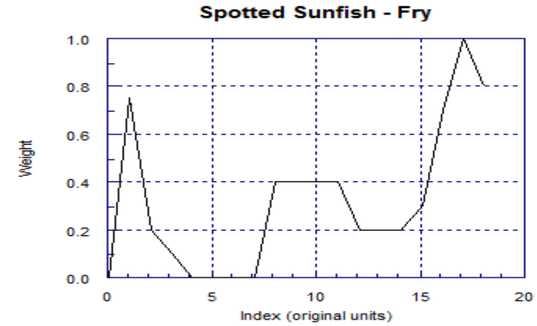


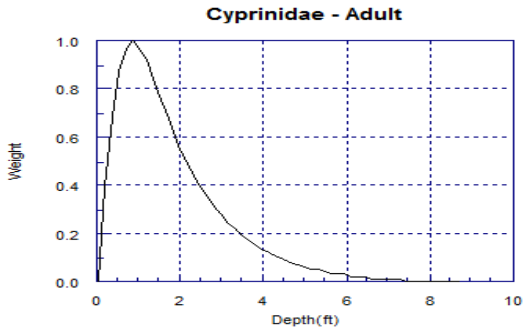
Spotted Sunfish - Spawning

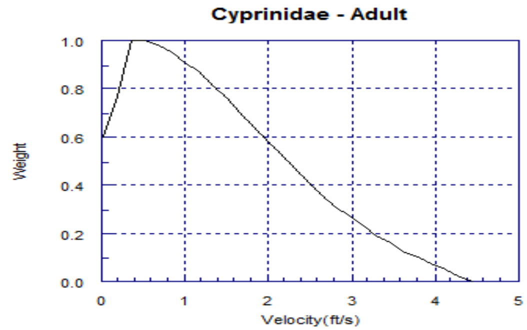


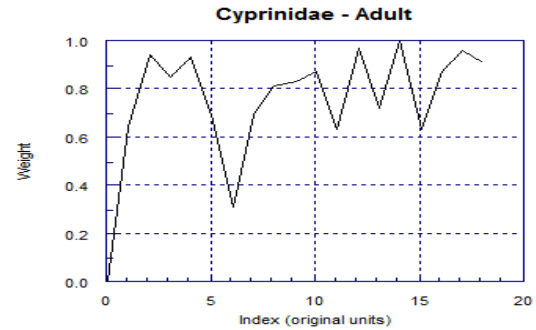

Spotted Sunfish - Fry
Weight
Depth(ft)

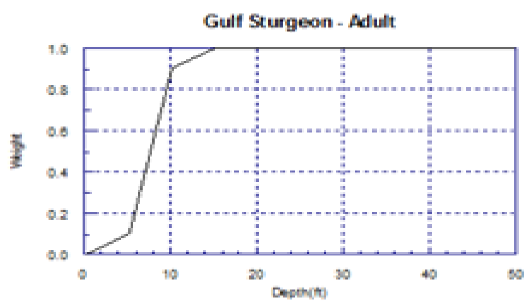

Spotted Sunfish - Fry
Weight
Velocity(ft/s)

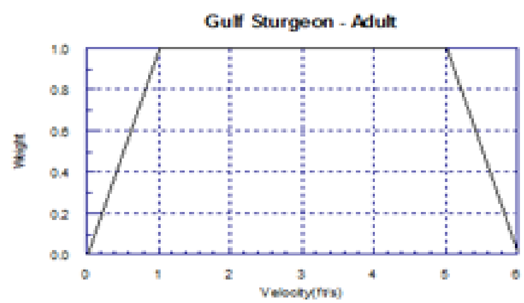

Spotted Sunfish - Fry
Weight
Index (original units)

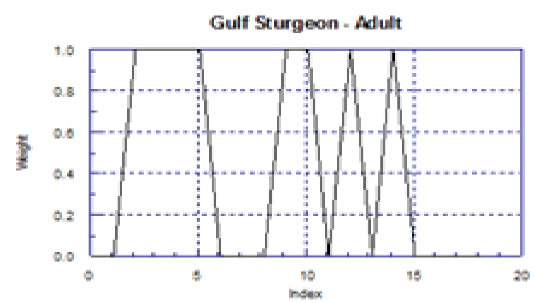

Cyprinidae - Adult
Weight
Depth(ft)


Cyprinidae - Adult
Weight
Velocity(ft/s)

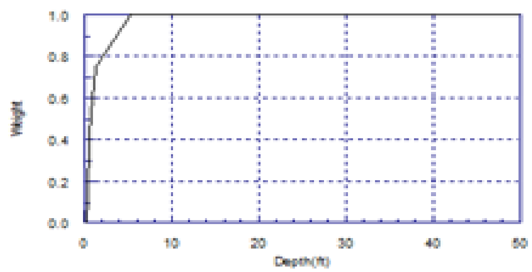

Cyprinidae - Adult
Weight
Index (original units)


Gulf Sturgeon - Adult
Weight
Depth(ft)

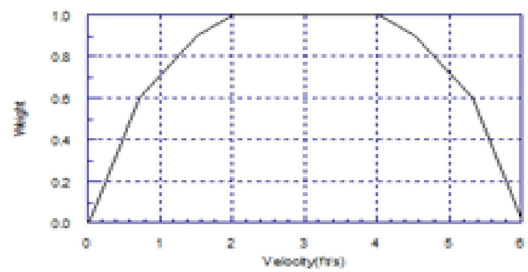

Gulf Sturgeon - Adult
Weight
Velocity(ft/s)


Gulf Sturgeon - Adult
Weight
Index

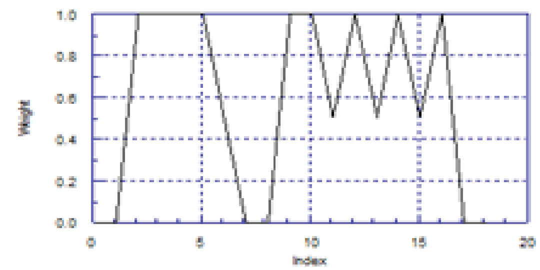
Gulf Sturgeon - Juvenile



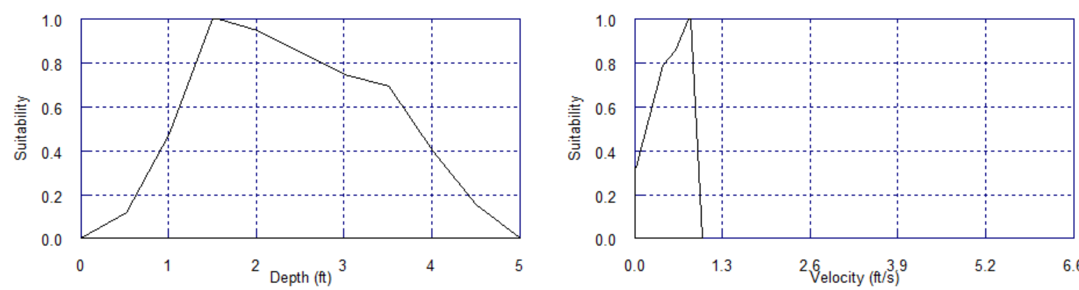
Gulf Sturgeon - Juvenile



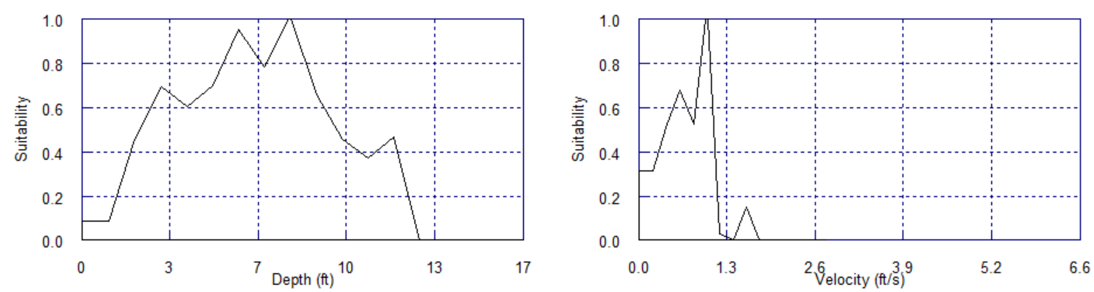
Gulf Sturgeon - Juvenile



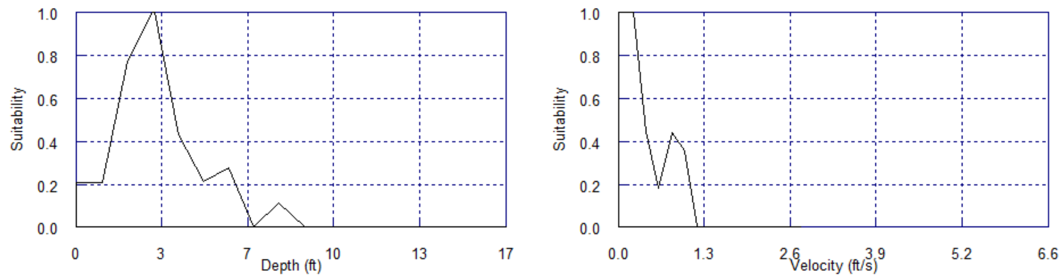
Metallic Shiner (MESH) - Adult



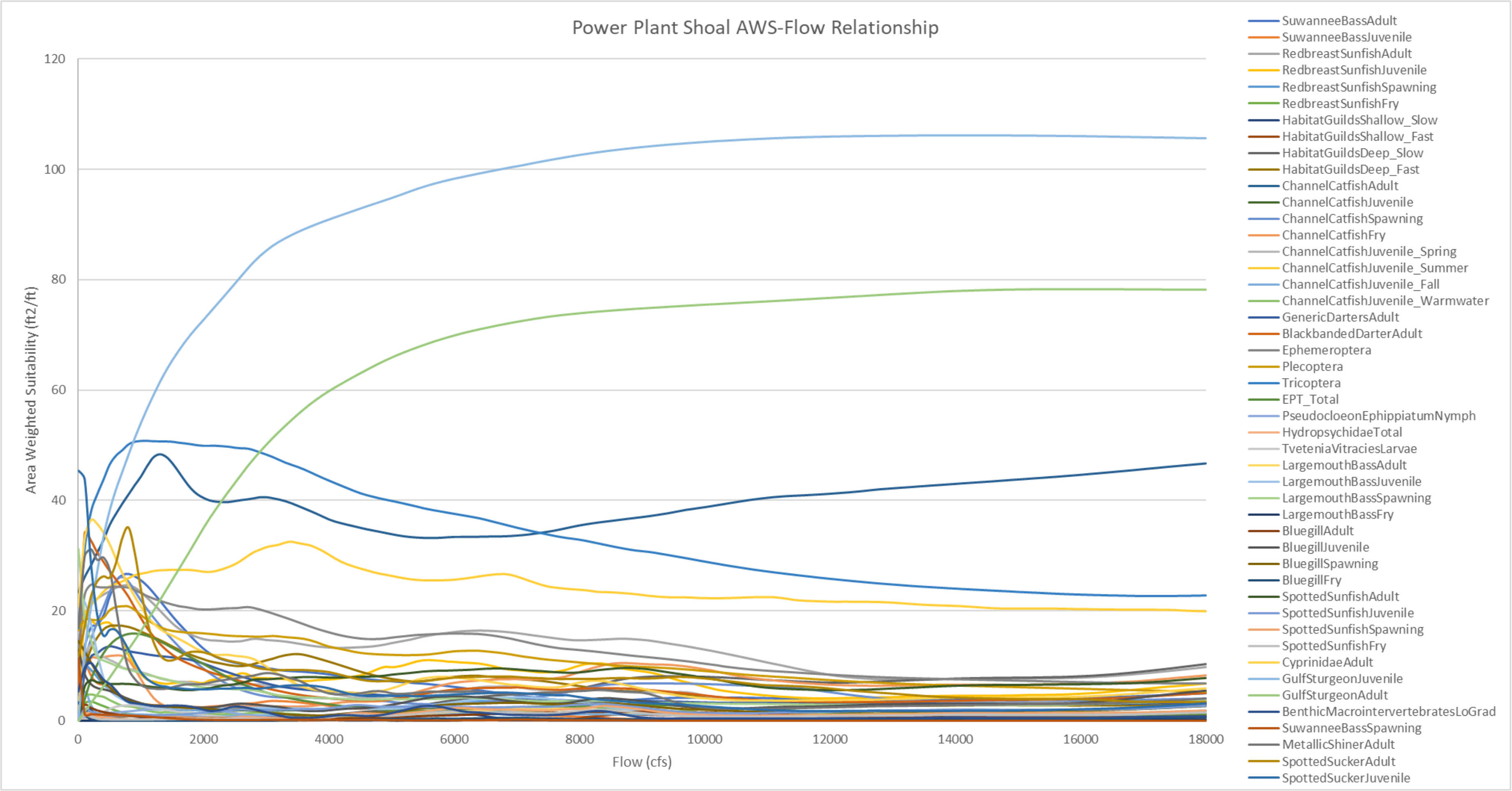
Spotted Sucker (SPSK) - Adult

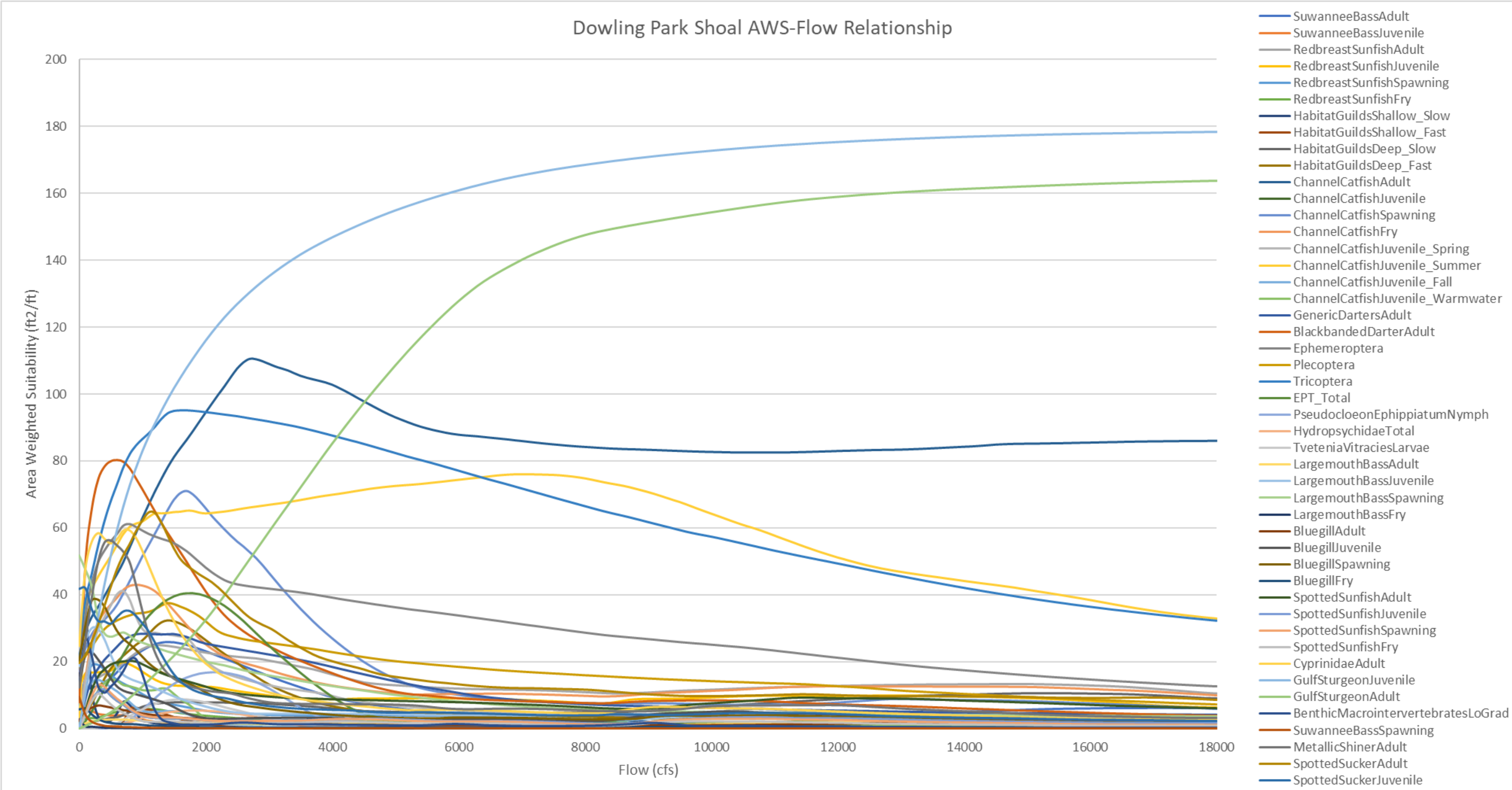


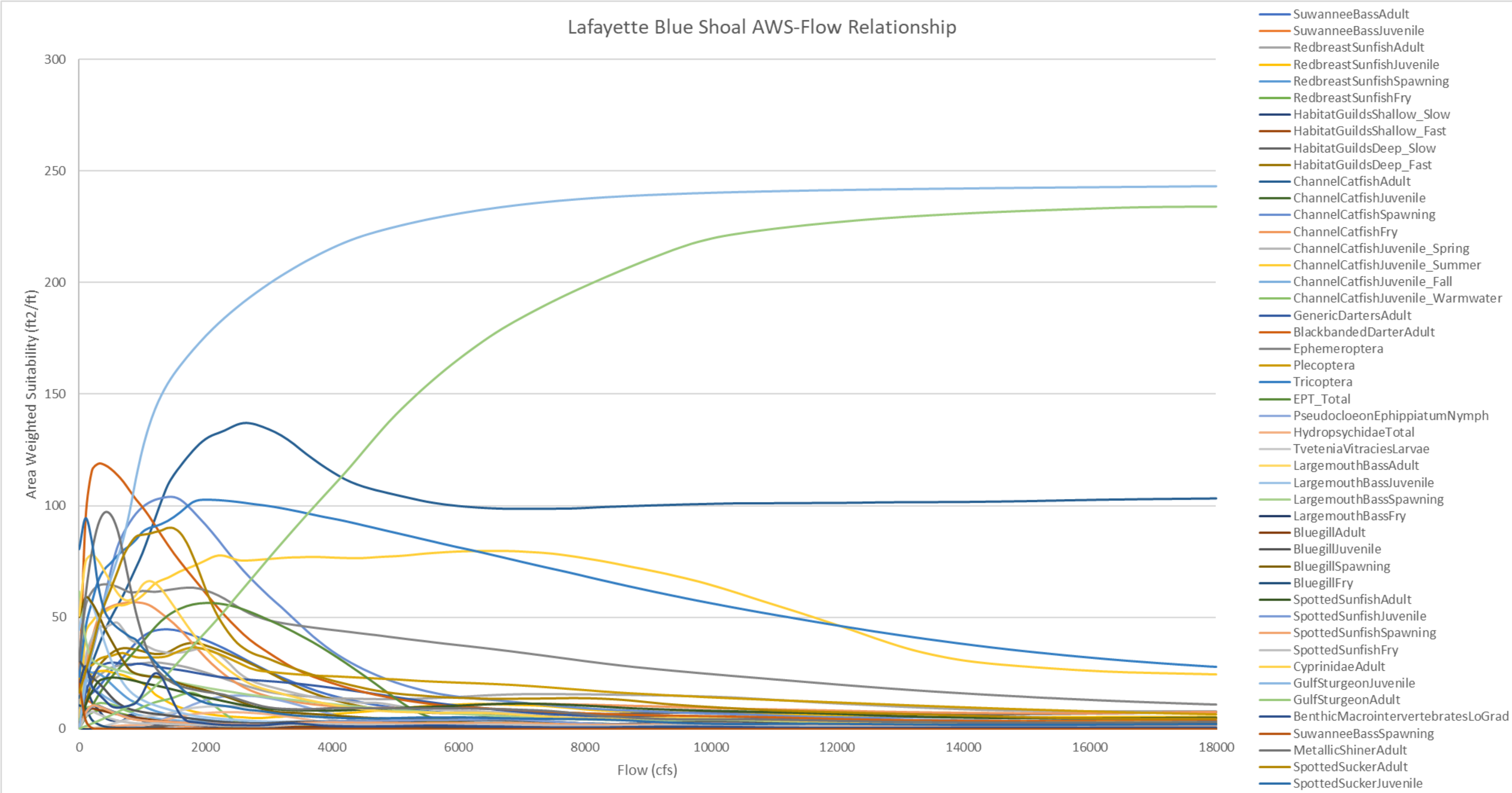
Spotted Sucker (SPSK) - Juvenile

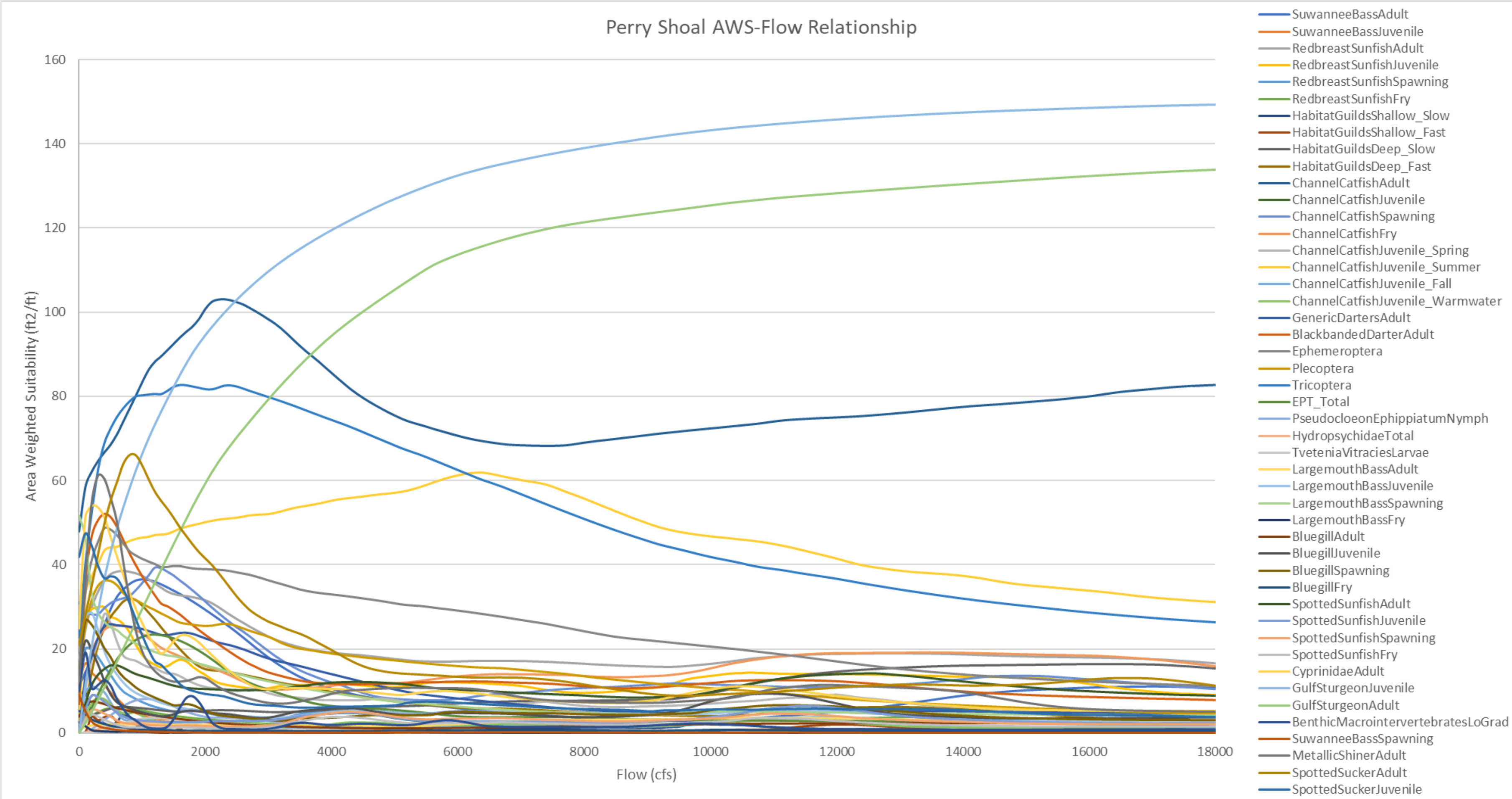


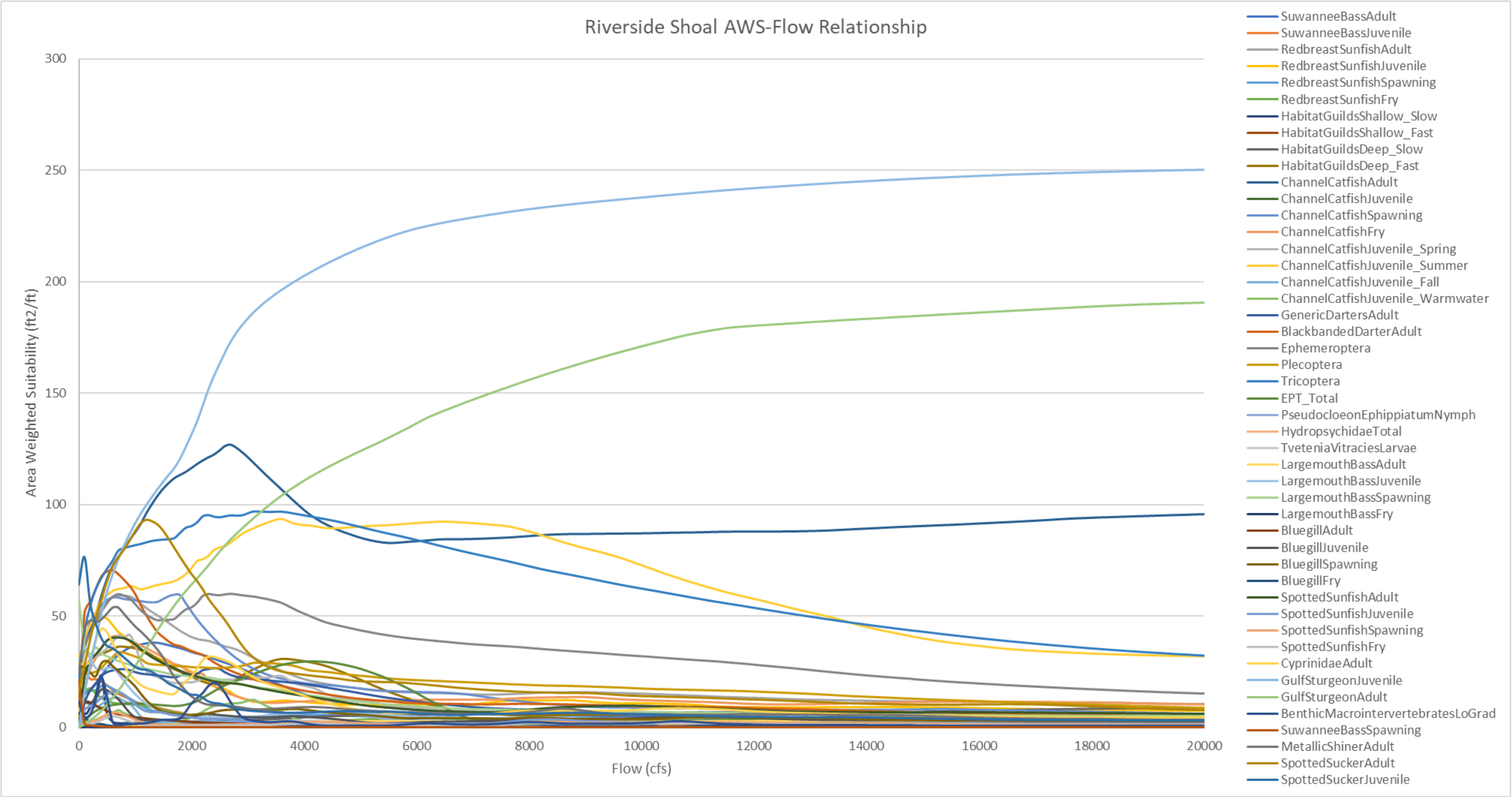
AWS-FLOW Relationships


Power Plant Shoal AWS-Flow Relationship
Area Weighted Suitability (ft2/ft)
Flow (cfs)
0
20
40
60
80
100
120
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
SuwanneeBassAdult
SuwanneeBassJuvenile
RedbreastSunfishAdult
RedbreastSunfishJuvenile
RedbreastSunfishSpawning
RedbreastSunfishFry
HabitatGuildsShallow_Slow
HabitatGuildsShallow_Fast
HabitatGuildsDeep_Slow
HabitatGuildsDeep_Fast
ChannelCatfishAdult
ChannelCatfishJuvenile
ChannelCatfishSpawning
ChannelCatfishFry
ChannelCatfishJuvenile_Spring
ChannelCatfishJuvenile_Summer
ChannelCatfishJuvenile_Fall
ChannelCatfishJuvenile_Warmwater
GenericDartersAdult
BlackbandedDarterAdult
Ephemeroptera
Plecoptera
Tricoptera
EPT_Total
PseudocloeonEphippiatumNymph
HydropsychidaeTotal
TveteniaVitraciesLarvae
LargemouthBassAdult
LargemouthBassJuvenile
LargemouthBassSpawning
LargemouthBassFry
BluegillAdult
BluegillJuvenile
BluegillSpawning
BluegillFry
SpottedSunfishAdult
SpottedSunfishJuvenile
SpottedSunfishSpawning
SpottedSunfishFry
CyprinidaeAdult
GulfSturgeonJuvenile
GulfSturgeonAdult
BenthicMacrointervertebratesLoGrad
SuwanneeBassSpawning
MetallicShinerAdult
SpottedSuckerAdult
SpottedSuckerJuvenile


Dowling Park Shoal AWS-Flow Relationship
Area Weighted Suitability (ft2/ft)
Flow (cfs)
0
20
40
60
80
100
120
140
160
180
200
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
SuwanneeBassAdult
SuwanneeBassJuvenile
RedbreastSunfishAdult
RedbreastSunfishJuvenile
RedbreastSunfishSpawning
RedbreastSunfishFry
HabitatGuildsShallow_Slow
HabitatGuildsShallow_Fast
HabitatGuildsDeep_Slow
HabitatGuildsDeep_Fast
ChannelCatfishAdult
ChannelCatfishJuvenile
ChannelCatfishSpawning
ChannelCatfishFry
ChannelCatfishJuvenile_Spring
ChannelCatfishJuvenile_Summer
ChannelCatfishJuvenile_Fall
ChannelCatfishJuvenile_Warmwater
GenericDartersAdult
BlackbandedDarterAdult
Ephemeroptera
Plecoptera
Tricoptera
EPT_Total
PseudocloeonEphippiatumNymph
HydropsychidaeTotal
TveteniaVitraciesLarvae
LargemouthBassAdult
LargemouthBassJuvenile
LargemouthBassSpawning
LargemouthBassFry
BluegillAdult
BluegillJuvenile
BluegillSpawning
BluegillFry
SpottedSunfishAdult
SpottedSunfishJuvenile
SpottedSunfishSpawning
SpottedSunfishFry
CyprinidaeAdult
GulfSturgeonJuvenile
GulfSturgeonAdult
BenthicMacrointervertebratesLoGrad
SuwanneeBassSpawning
MetallicShinerAdult
SpottedSuckerAdult
SpottedSuckerJuvenile


Lafayette Blue Shoal AWS-Flow Relationship
Area Weighted Suitability (ft2/ft)
0
50
100
150
200
250
300
Flow (cfs)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
SuwanneeBassAdult
SuwanneeBassJuvenile
RedbreastSunfishAdult
RedbreastSunfishJuvenile
RedbreastSunfishSpawning
RedbreastSunfishFry
HabitatGuildsShallow_Slow
HabitatGuildsShallow_Fast
HabitatGuildsDeep_Slow
HabitatGuildsDeep_Fast
ChannelCatfishAdult
ChannelCatfishJuvenile
ChannelCatfishSpawning
ChannelCatfishFry
ChannelCatfishJuvenile_Spring
ChannelCatfishJuvenile_Summer
ChannelCatfishJuvenile_Fall
ChannelCatfishJuvenile_Warmwater
GenericDartersAdult
BlackbandedDarterAdult
Ephemeroptera
Plecoptera
Tricoptera
EPT_Total
PseudocloeonEphippiatumNymph
HydropsychidaeTotal
Tvetenia VitraciesLarvae
LargemouthBassAdult
LargemouthBassJuvenile
LargemouthBassSpawning
LargemouthBassFry
BluegillAdult
BluegillJuvenile
BluegillSpawning
BluegillFry
SpottedSunfishAdult
SpottedSunfishJuvenile
SpottedSunfishSpawning
SpottedSunfishFry
CyprinidaeAdult
GulfSturgeonJuvenile
GulfSturgeonAdult
BenthicMacrointervertebratesLoGrad
SuwanneeBassSpawning
MetallicShinerAdult
SpottedSuckerAdult
SpottedSuckerJuvenile


Perry Shoal AWS-Flow Relationship
Area Weighted Suitability (ft2/ft)
Flow (cfs)
0
20
40
60
80
100
120
140
160
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
SuwanneeBassAdult
SuwanneeBassJuvenile
RedbreastSunfishAdult
RedbreastSunfishJuvenile
RedbreastSunfishSpawning
RedbreastSunfishFry
HabitatGuildsShallow_Slow
HabitatGuildsShallow_Fast
HabitatGuildsDeep_Slow
HabitatGuildsDeep_Fast
ChannelCatfishAdult
ChannelCatfishJuvenile
ChannelCatfishSpawning
ChannelCatfishFry
ChannelCatfishJuvenile_Spring
ChannelCatfishJuvenile_Summer
ChannelCatfishJuvenile_Fall
ChannelCatfishJuvenile_Warmwater
GenericDartersAdult
BlackbandedDarterAdult
Ephemeroptera
Plecoptera
Tricoptera
EPT_Total
PseudocloeonEphippiatumNymph
HydropsychidaeTotal
TveteniaVitraciesLarvae
LargemouthBassAdult
LargemouthBassJuvenile
LargemouthBassSpawning
LargemouthBassFry
BluegillAdult
BluegillJuvenile
BluegillSpawning
BluegillFry
SpottedSunfishAdult
SpottedSunfishJuvenile
SpottedSunfishSpawning
SpottedSunfishFry
CyprinidaeAdult
GulfSturgeonJuvenile
GulfSturgeonAdult
BenthicMacrointervertebratesLoGrad
SuwanneeBassSpawning
MetallicShinerAdult
SpottedSuckerAdult
SpottedSuckerJuvenile

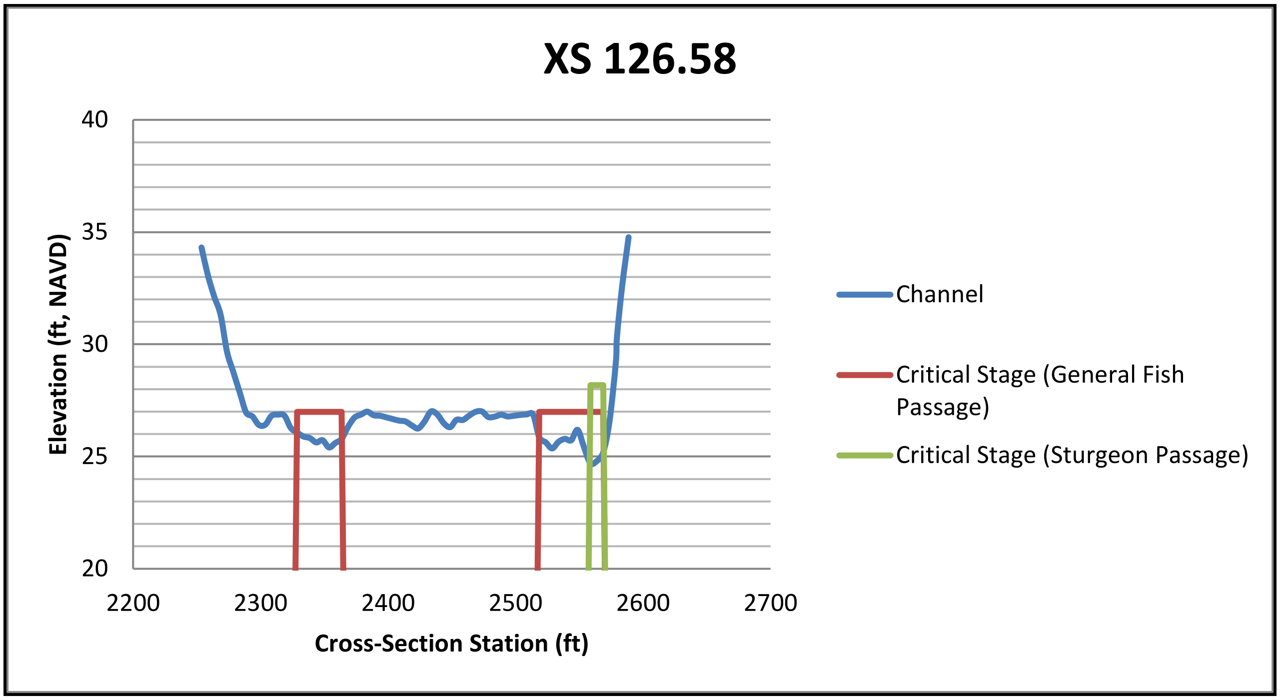

Riverside Shoal AWS-Flow Relationship
Area Weighted Suitability (ft2/ft)
Flow (cfs)
0
50
100
150
200
250
300
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
SuwanneeBassAdult
SuwanneeBassJuvenile
RedbreastSunfishAdult
RedbreastSunfishJuvenile
RedbreastSunfishSpawning
RedbreastSunfishFry
HabitatGuildsShallow_Slow
HabitatGuildsShallow_Fast
HabitatGuildsDeep_Slow
HabitatGuildsDeep_Fast
ChannelCatfishAdult
ChannelCatfishJuvenile
ChannelCatfishSpawning
ChannelCatfishFry
ChannelCatfishJuvenile_Spring
ChannelCatfishJuvenile_Summer
ChannelCatfishJuvenile_Fall
ChannelCatfishJuvenile_Warmwater
GenericDartersAdult
BlackbandedDarterAdult
Ephemeroptera
Plecoptera
Tricoptera
EPT_Total
PseudocloeonEphippiatumNymph
HydropsychidaeTotal
TveteniaVitraciesLarvae
LargemouthBassAdult
LargemouthBassJuvenile
LargemouthBassSpawning
LargemouthBassFry
BluegillAdult
BluegillJuvenile
BluegillSpawning
BluegillFry
SpottedSunfishAdult
SpottedSunfishJuvenile
SpottedSunfishSpawning
SpottedSunfishFry
CyprinidaeAdult
GulfSturgeonJuvenile
GulfSturgeonAdult
BenthicMacrointervertebratesLoGrad
SuwanneeBassSpawning
MetallicShinerAdult
SpottedSuckerAdult
SpottedSuckerJuvenile

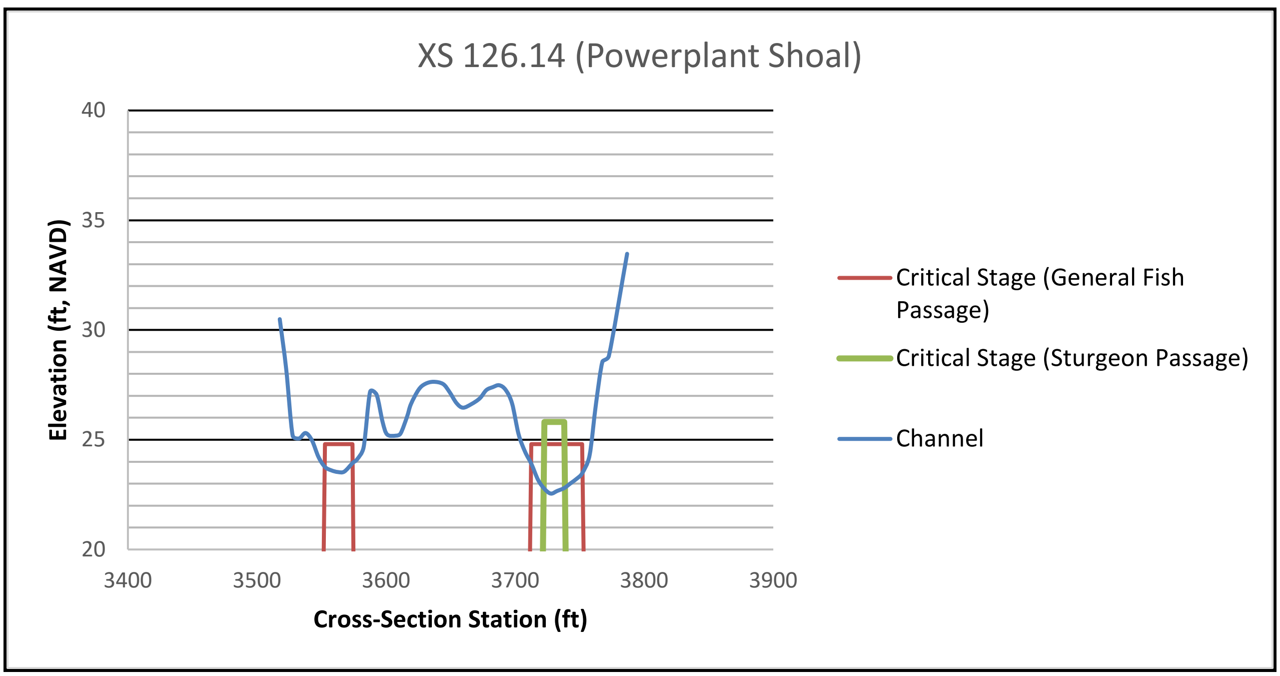
Appendix B
Listed Species

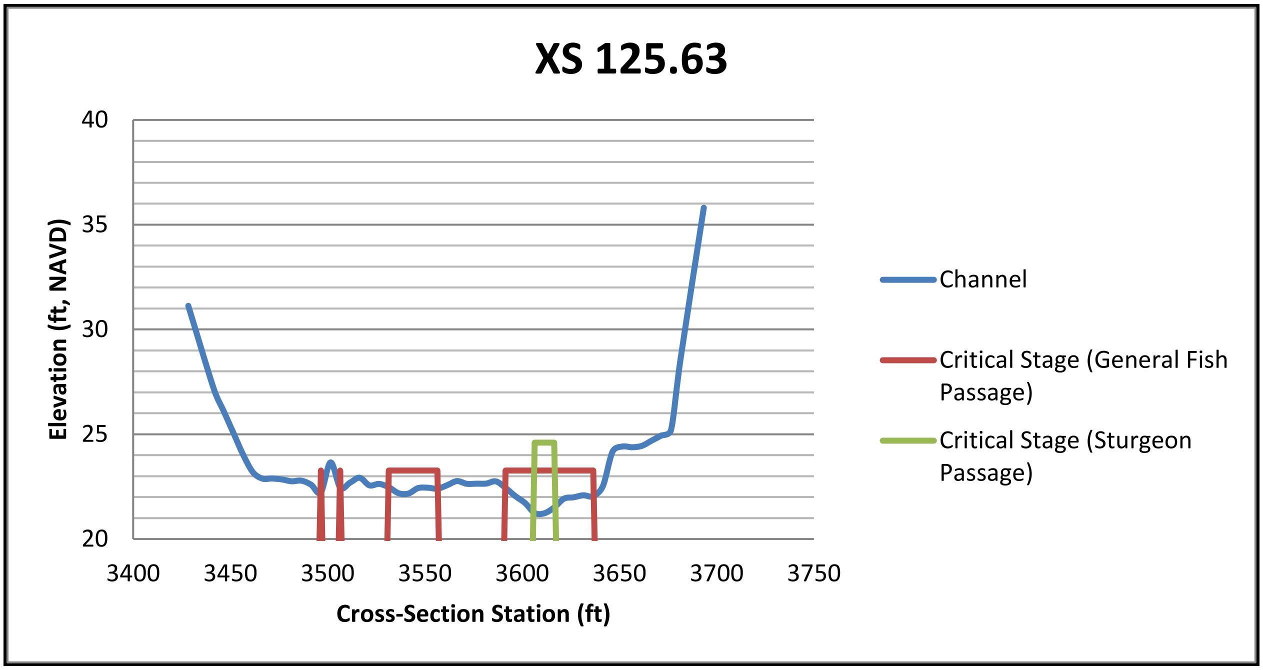
APPENDIX B. U.S. Fish & Wildlife Service At-Risk Species Finder "Species by State", as of November 6, 2021					
Scientific Name	**Common Name**	**Taxon**	**Status**	**Range**	**Lead Office**
Eurycea chamberlaini	Chamberlain's dwarf salamander	Amphibian	At-risk	AL, FL, GA, NC, SC	Charleston
Haideotriton wallacei	Georgia blind salamander	Amphibian	At-risk	FL, GA	Athens
Lithobates capito	Gopher frog	Amphibian	At-risk	AL, FL, GA, NC, SC, TN	Charleston
Pseudobranchus striatus lustricolus	Gulf Hammock dwarf siren	Amphibian	At-risk	FL, GA	Athens
Crangonyx grandimanus	Florida cave amphipod	Amphipod	At-risk	FL	Jacksonville
Crangonyx hobbsi	Hobb's cave amphipod	Amphipod	At-risk	FL	Jacksonville
Hesperapis oraria	Gulf Coast solitary bee	Bee	At-risk	FL	Panama City
Osmia calaminthae	Blue Calamintha bee	Bee	At-risk	FL	Vero Beach
Ammodramus caudacutus	Saltmarsh sparrow	Bird	At-risk	CT, DE, FL, GA, MA, MD, ME, NC, NH,	New England
Vermivora chrysoptera	Golden-winged warbler	Bird	At-risk	AL, AR, CO, CT, DC, DE, FL, GA, IA, IL,	Minnesota-Wisconsin
Atrytone arogos arogos	Eastern beard grass skipper	Butterfly	At-risk	AL, FL, GA, LA, MS, NC, NJ, NY, SC,	New Jersey
Callophrys irus	Frosted Elfin butterfly	Butterfly	At-risk	AL, AR, CT, DC, DE, FL, GA, IL, IN, KS,	New York
Danau plexippus plexippus	Monarch butterfly	Butterfly	Candidate	AL, AR, AZ, CA, CO, CT, DE, FL, GA,	TBD
Euphyes dukesi calhouni	Dukes' skipper	Butterfly	At-risk	FL	Jacksonville
Euphyes pilatka klotsi	Palatka skipper sawgreass or Knot's skipper	Butterfly	At-risk	FL	Vero Beach
Agarodes logani	Logan's Agarodes caddisfly	Caddisfly	At-risk	FL	Panama City
Hydroptila sykorai	Sykora's Hydroptila caddisfly	Caddisfly	At-risk	FL	Panama City
Oecetis parva	Little Oecetis longhorn caddisfly	Caddisfly	At-risk	AL, FL	Jacksonville
Triaenodes tridontus	Three-tooth long-horned caddisfly (triaenodes)	Caddisfly	At-risk	AL, FL, OK	Tulsa
Cambarellus blacki	Cypress crayfish	Crayfish	At-risk	AL, FL	Panama City
Procambarus acherontis	Orlando cave crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus apalachicolae	Coastal Flatwoods crayfish	Crayfish	At-risk	FL	Panama City
Procambarus attiguus	Silver Glen Springs crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus delicatus	Bigcheek cave crayfish	Crayfish	At-risk	FL,	Jacksonville
Procambarus econfinae	Panama City crayfish	Crayfish	Proposed threatened	FL	Panama City
Procambarus erythrops	Sante Fe cave crayfish	Crayfish	At-risk	FL	Vero Beach
Procambarus franzi	Orange Lake cave crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus leitheuseri	Coastal Lowland cave crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus lucifugus	Florida cave crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus lucifugus lucifugus	Withaloochee light-fleeing cave crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus milleri	Miami cave crayfish	Crayfish	At-risk	FL	Vero Beach
Procambarus morrisi	Putnam County cave crayfish	Crayfish	At-risk	FL	Jacksonville
Procambarus pallidus	Pallid cave crayfish	Crayfish	At-risk	FL	Jacksonville
Troglocambarus maclanei	Spider cave crayfish	Crayfish	At-risk	FL	Jacksonville
Gomphus westfalli	Westfall's clubtail	Dragonfly	At-risk	FL	Panama City
Libellula jesseana	Purple skimmer	Dragonfly	At-risk	FL	Jacksonville
Ophiogomphus australis	Southern snaketail	Dragonfly	At-risk	FL, LA, MS	Jackson
Somatochlora calverti	Calvert's emerald	Dragonfly	At-risk	AL, FL, SC	Charleston
Stylurus potulentus	Yellow-sided clubtail	Dragonfly	At-risk	FL, MS	Jackson
Blarina brevicauda shermani	Sherman's short-tailed shrew	Mammal	At-risk	FL	Vero Beach
Myotis lucifugus	Little brown bat	Mammal	At-risk	AK, AL, AR, CN, DC, DE, FL, GA, IA, IL,	Region 3
Oryzomys palustris sanibeli	Sanibel Island rice rat	Mammal	At-risk	FL	Vero Beach
Perimyotis subflavus	Tricolored bat	Mammal	At-risk	AL, AR, CO, CT, DC, DE, FL, GA, IA, IL,	Region 3
Sigmodon hispidus insulicola	Insular hispid cotton rat	Mammal	At-risk	FL	Vero Beach
Anodontoides radiatus	Rayed creekshell	Mussel	At-risk	AL, FL, GA, LA, MS	Panama City
Elliptio arctata	Delicate spike	Mussel	At-risk	AL, FL, GA, MS	Athens
Aeschynomene pratensis	Meadow Joint-Vetch	Plant	At-risk	FL	Vero Beach
Baptisia megacarpa	Apalachicola wild indigo	Plant	At-risk	AL, FL, GA,	Daphne
Coreopsis integrifolia	Ciliate-leaf tickseed	Plant	At-risk	FL, GA, SC	Athens
Eriocaulon nigrobracteatum	Blackbract pipewort	Plant	At-risk	FL	Panama City
Fundulus jenkinsi	Venus flytrap	Plant	At-risk	AL, FL, LA, MS, TX	Panama City
Hartwrightia floridana	Hartwrightia	Plant	At-risk	FL, GA	Jacksonville
Hymenocallis henryae	Henry's spider-lily	Plant	At-risk	FL	Panama City
Hypericum edisonianum	Edison's ascyrum	Plant	At-risk	FL	Vero Beach
Hypericum lissophloeus	Smooth-barked St. John's wort	Plant	At-risk	FL	Panama City
Lepidostoma morsei	Morse's little plain brown sedge	Plant	At-risk	FL, MS, NJ, TX	Jackson
Lilium iridollae	Panhandle lily	Plant	At-risk	AL, FL	Panama City
Lindera subcoriacea	Bog spicebush	Plant	At-risk	AL, FL, GA, LA, MS, NC, SC, VA	Jackson
Linum westii	West's flax	Plant	At-risk	FL	Panama City
Lobelia boykinii	Boykin's lobelia	Plant	At-risk	AL, DE, FL, GA, MD, MS, NC, NJ, SC	Athens
Ludwigia ravenii	Raven's seedbox	Plant	At-risk	FL, NC, SC, VA	Raleigh
Lythrum curtissii	Curtiss' loosestrife	Plant	At-risk	FL, GA	Panama City
Lythrum flagellare	Lowland Loosestrife	Plant	At-risk	FL	Vero Beach
Minuartia godfreyi	Godfrey's stitchwort	Plant	At-risk	AL, FL, NC, SC, TN	Raleigh
Najas filifolia	Narrowleaf naiad	Plant	At-risk	FL, GA	Athens
Potamogeton floridanus	Florida pondweed	Plant	At-risk	FL	Panama City
Rhexia parviflora	White meadowbeauty (small-flower)	Plant	At-risk	AL, FL	Panama City
Rhexia salicifolia	Panhandle meadowbeauty	Plant	At-risk	AL, FL	Panama City
Rhynchospora crinipes	Hairy-peduncled beakrush	Plant	At-risk	AL, FL, MS, NC	Jackson
Rudbeckia auriculata	Eared coneflower	Plant	At-risk	AL, FL, GA	Daphne

APPENDIX B. U.S. Fish & Wildlife Service At-Risk Species Finder "Species by State", as of November 6, 2021					
Scientific Name	**Common Name**	**Taxon**	**Status**	**Range**	**Lead Office**
Salix floridana	Florida willow	Plant	At-risk	FL, GA	Jacksonville
Sarracenia rubra ssp. gulfensis	Gulf sweet pitcherplant	Plant	At-risk	FL	Panama City
Sideroxylon thornei	Georgia bully (swamp buckthorn)	Plant	At-risk	AL, FL, GA	Athens
Xyris longisepala	Karst pond xyris (Kral's yellow-eyed grass)	Plant	At-risk	AL, FL	Panama City
Clemmys guttata	Spotted turtle	Reptile	At-risk	CT, DC, DE, FL, GA, IL, IN, MA, MD,	Chesapeake Bay
Crotalus adamanteus	Eastern diamondback rattlesnake	Reptile	At-risk	AL, FL, GA, LA, MS, NC, SC	Jacksonville
Diadophis punctatus acricus	Key ringneck snake	Reptile	Proposed threatened	FL	Vero Beach
Eumeces egregius egregius	Florida keys mole skink	Reptile	At-risk	FL	Vero Beach
Gopherus polyphemus	Gopher tortoise	Reptile	At-risk	AL, FL, GA, SC	Jacksonville
Graptemys ernsti	Escambia map turtle	Reptile	At-risk	AL, FL	Daphne
Lampropeltis getula meansi	Apalachicola common kingsnake	Reptile	At-risk	FL,	Panama City
Macrochelys suwanniensis	Suwannee alligator snapping turtle	Reptile	Proposed threatened	FL, GA	Panama City
Pituophis melanoleucus mugitus	Florida pine snake	Reptile	At-risk	AL, FL, GA, SC	Charleston
Pseudemys nelsoni	Florida red-bellied turtle - FL Panhandle	Reptile	At-risk	FL	Panama City
Sceloporus woodi	Florida scrub lizard	Reptile	At-risk	FL	Jacksonville
Stilosoma extenuatum	Short-tailed snake	Reptile	At-risk	FL	Jacksonville
Tantilla oolitica	Rim rock crowned snake	Reptile	Proposed threatened	FL	Vero Beach
Cincinnatia parva	Pygmy siltsnail	Snail	At-risk	FL	Jacksonville
Cincinnatia ponderosa	ponderous siltsnail	Snail	At-risk	FL	Jacksonville

Appendix C
Fish Passage


XS 126.58
Elevation (ft, NAVD)
40
35
30
25
20
2200
2300
2400
2500
2600
2700
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)


XS 126.14 (Powerplant Shoal)
Elevation (ft, NAVD)
40
35
30
25
20
3400
3500
3600
3700
3800
3900
Cross-Section Station (ft)
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)
Channel


XS 125.63
Elevation (ft, NAVD)
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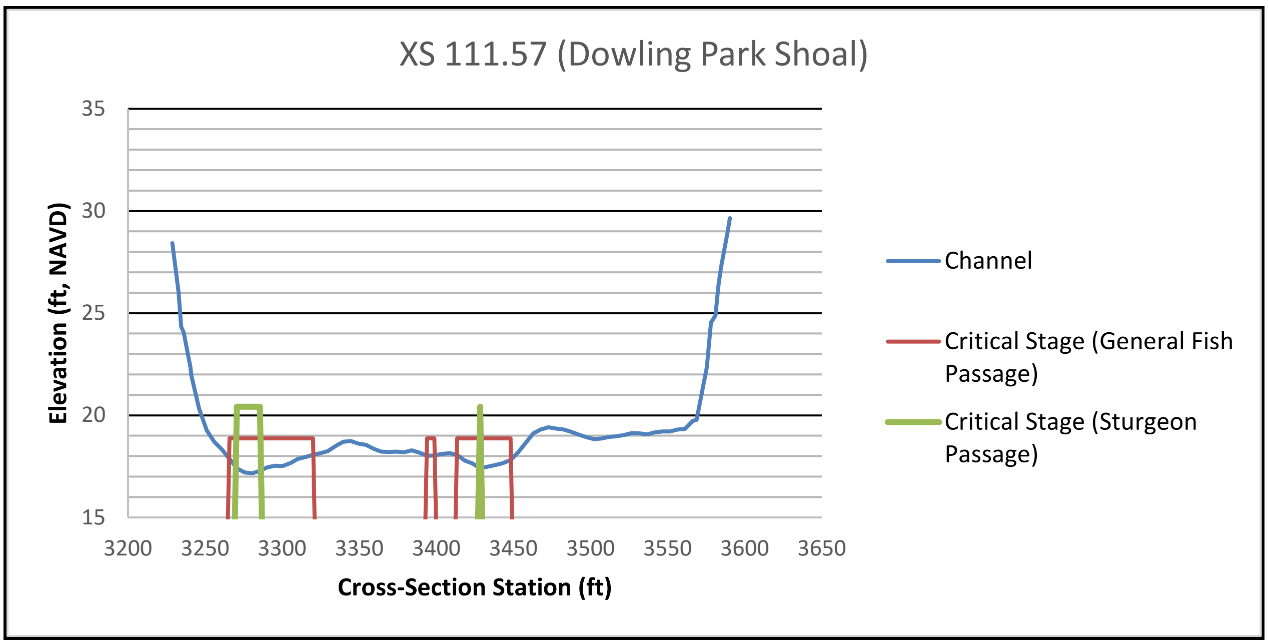
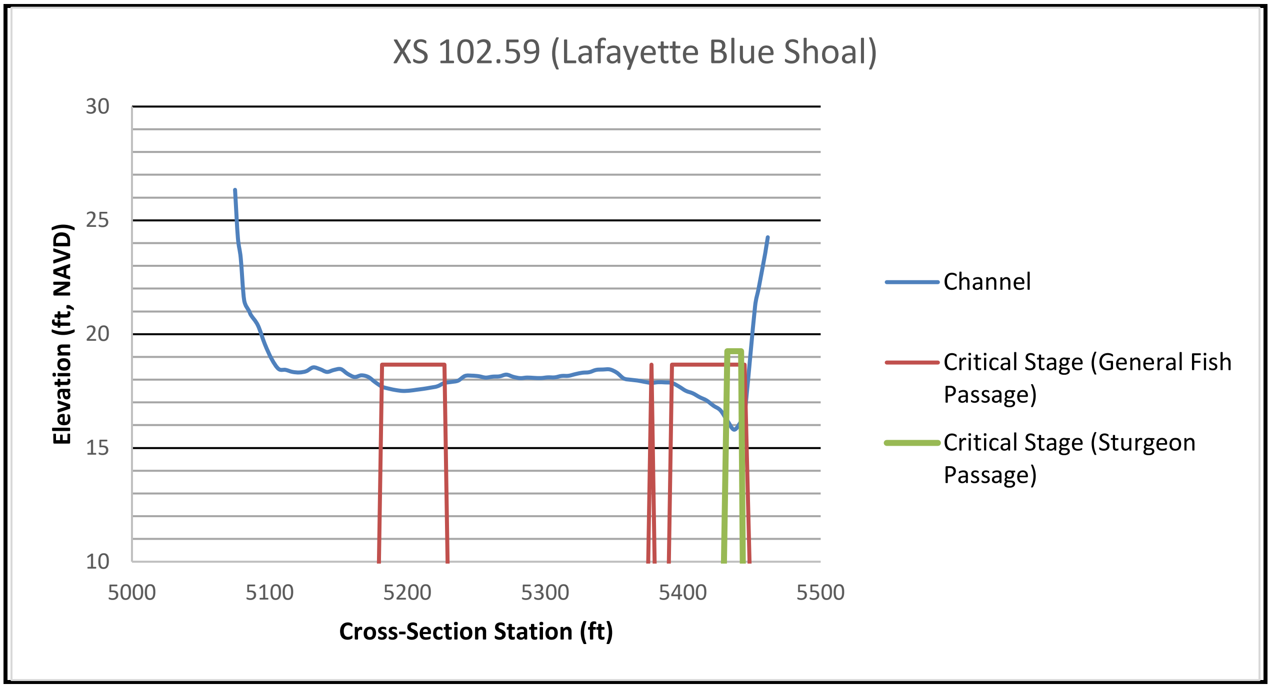
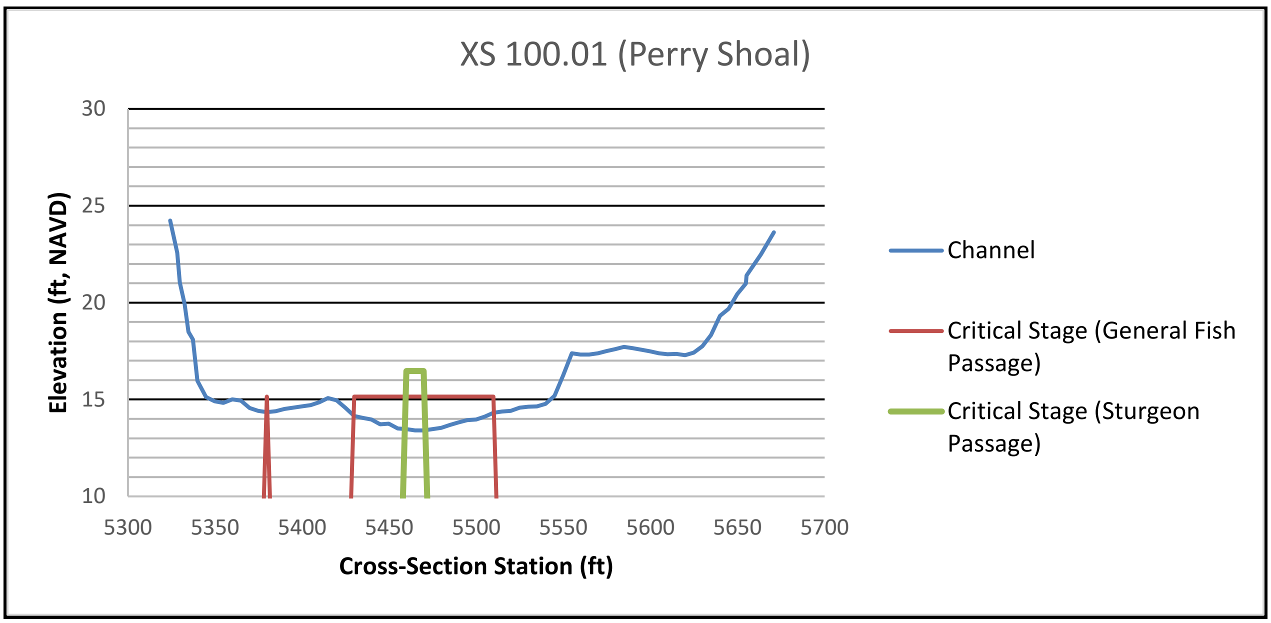
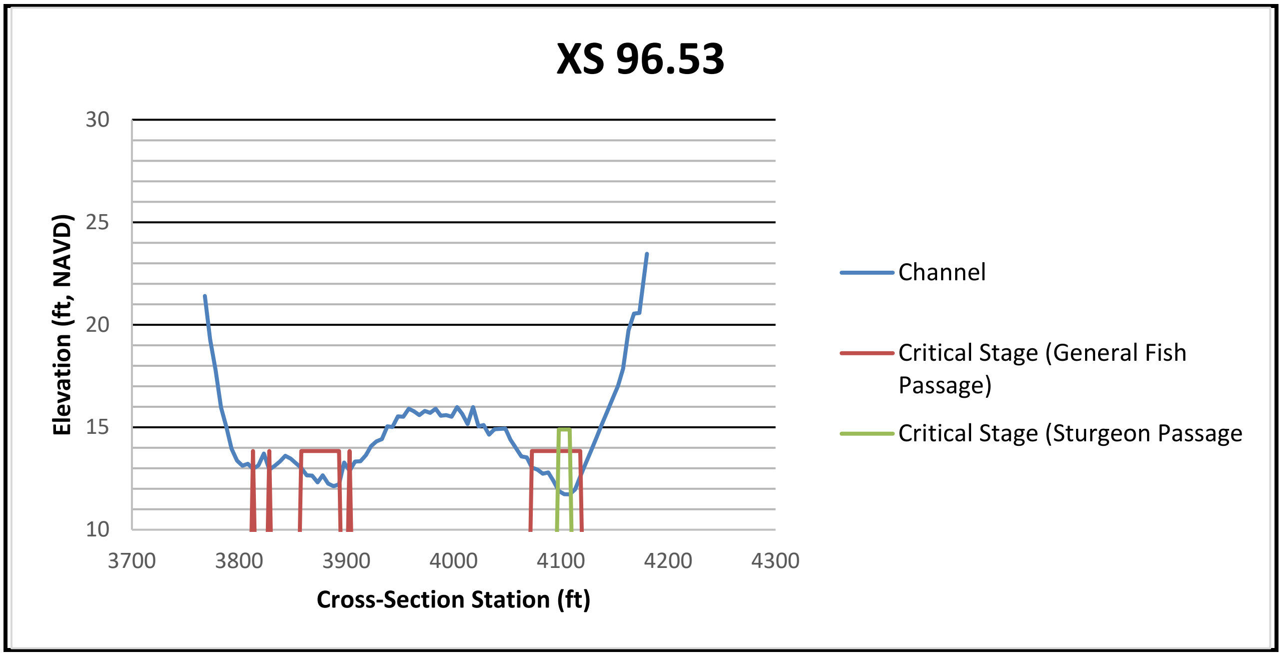
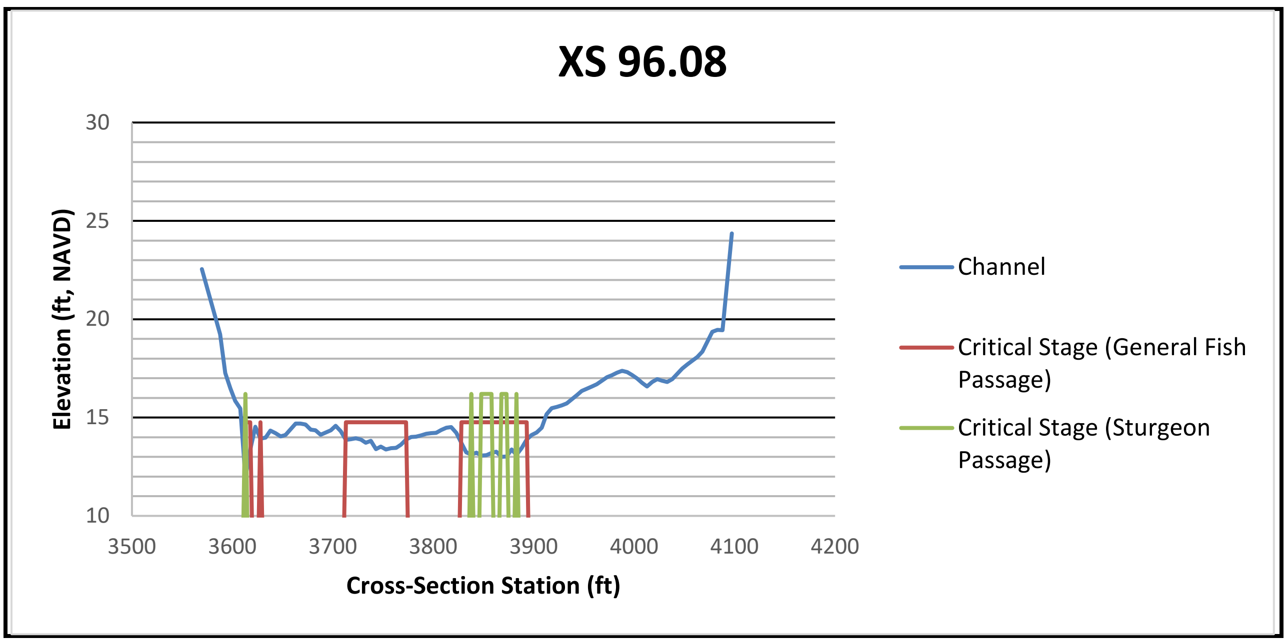
35
30
25
20
3400
3450
3500
3550
3600
3650
3700
3750
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

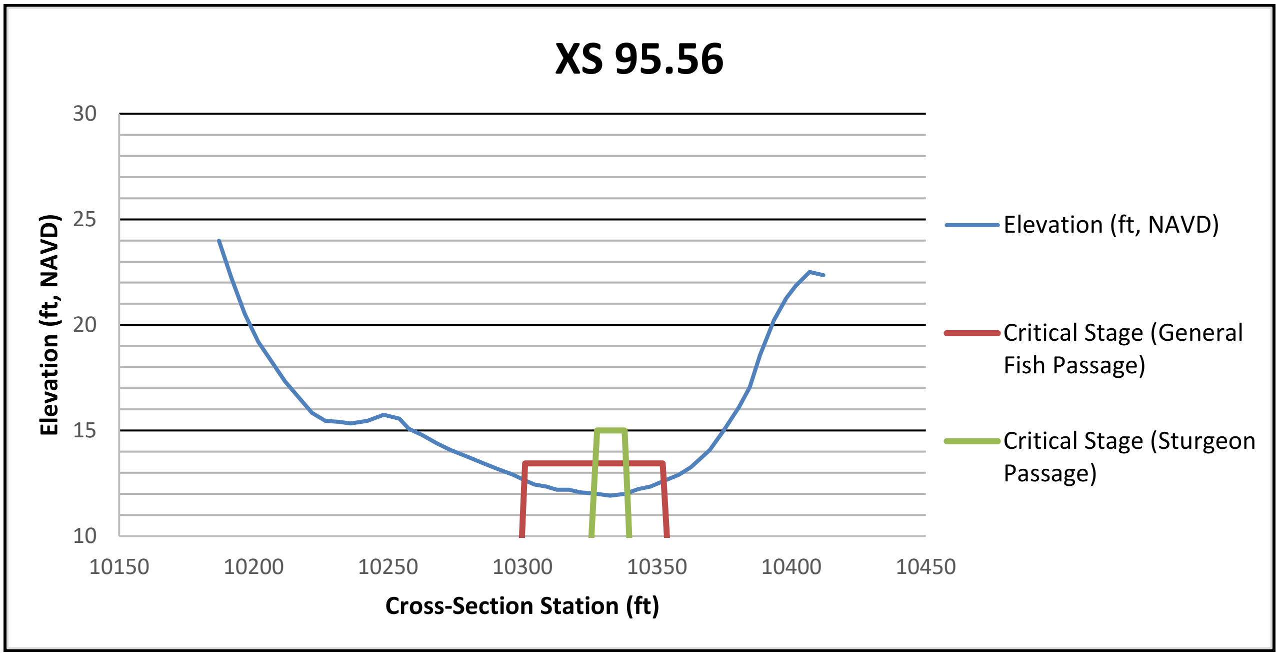

XS 111.57 (Dowling Park Shoal)
Elevation (ft, NAVD)
35
30
25
20
15
3200
3250
3300
3350
3400
3450
3500
3550
3600
3650
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

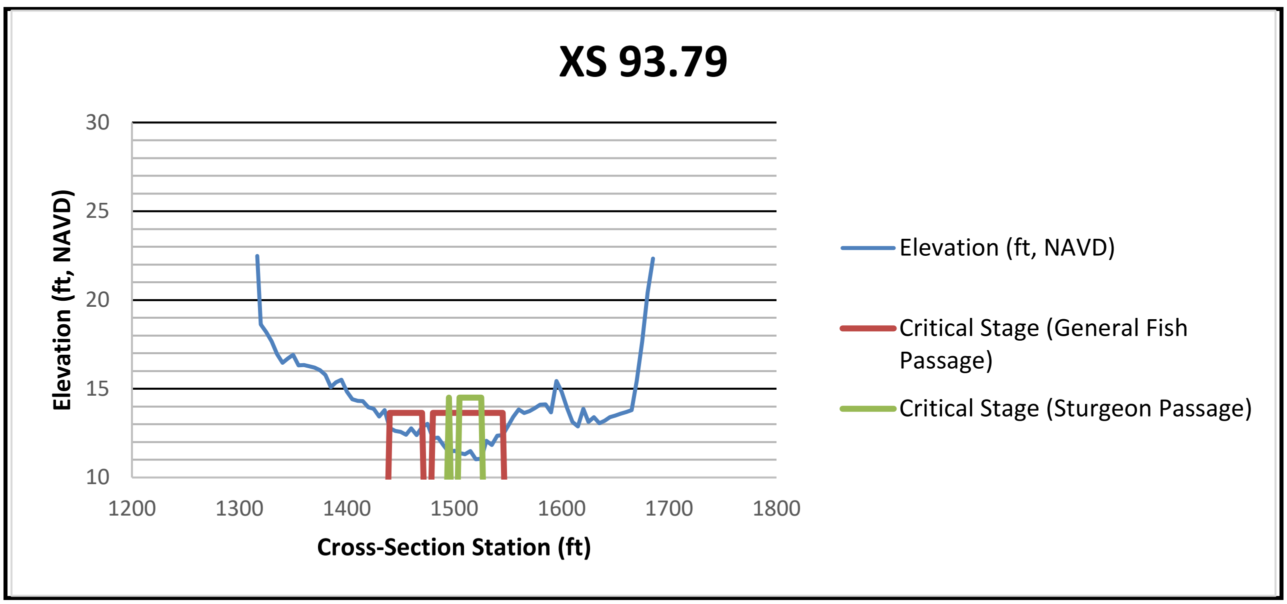

XS 102.59 (Lafayette Blue Shoal)
30
25
20
15
10
Elevation (ft, NAVD)
5000
5100
5200
5300
5400
5500
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

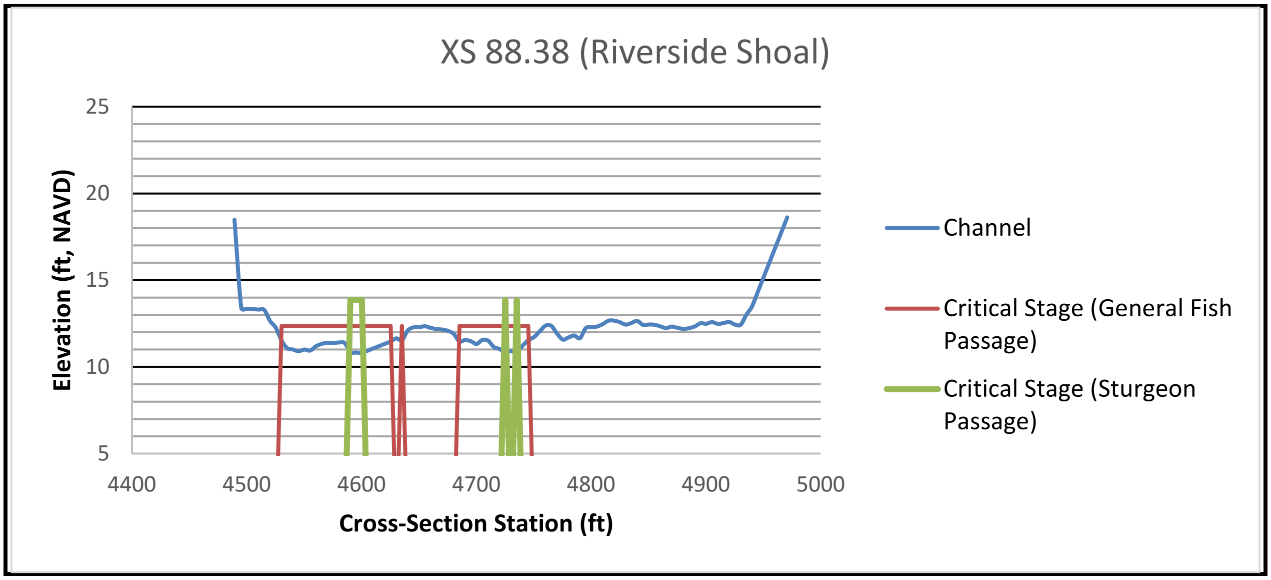

XS 100.01 (Perry Shoal)
30
25
20
15
10
Elevation (ft, NAVD)
5300
5350
5400
5450
5500
5550
5600
5650
5700
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

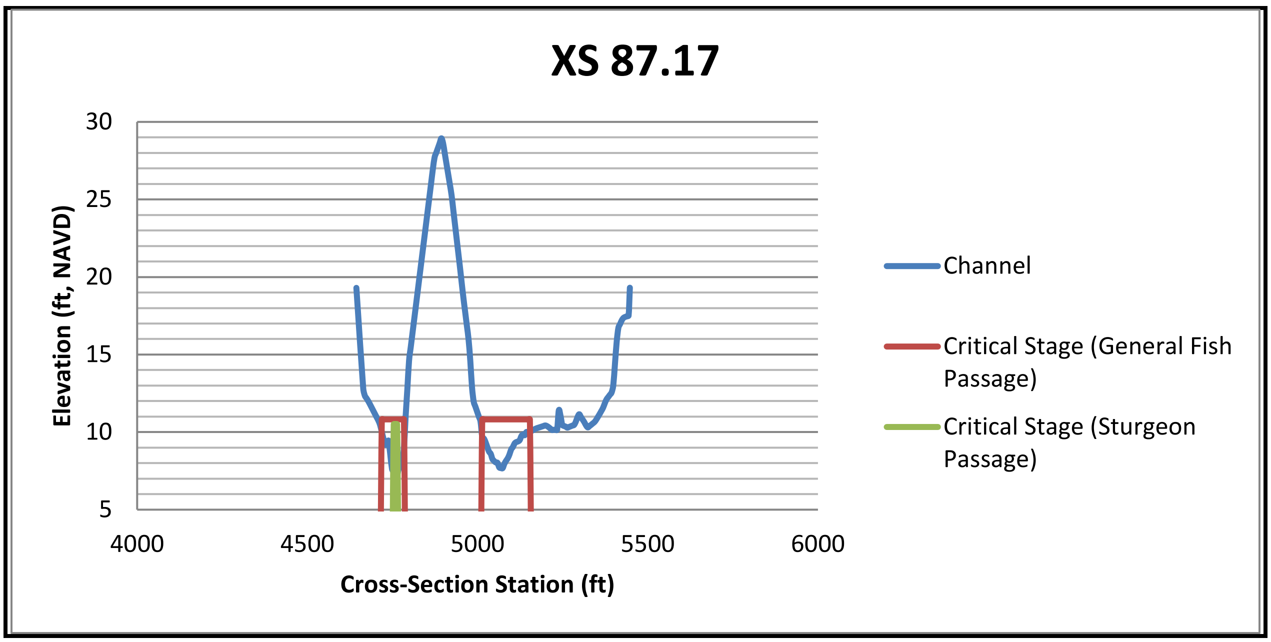

XS 96.53
Elevation (ft, NAVD)
30
25
20
15
10
3700
3800
3900
4000
4100
4200
4300
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage

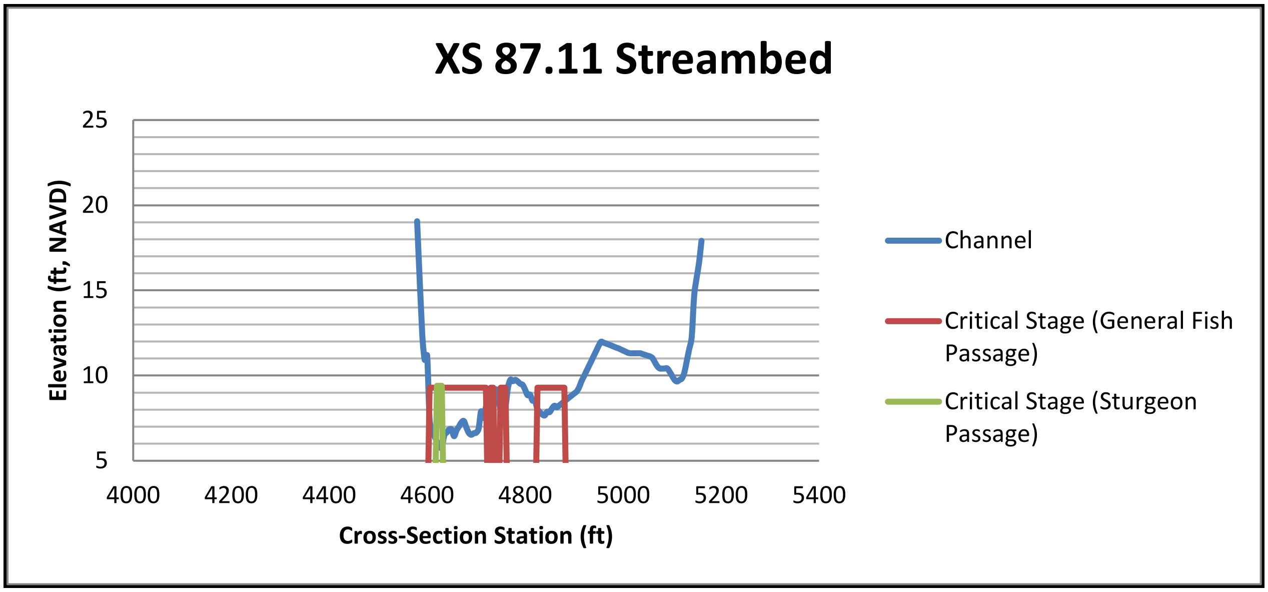

XS 96.08
Elevation (ft, NAVD)
30
25
20
15
10
3500
3600
3700
3800
3900
4000
4100
4200
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

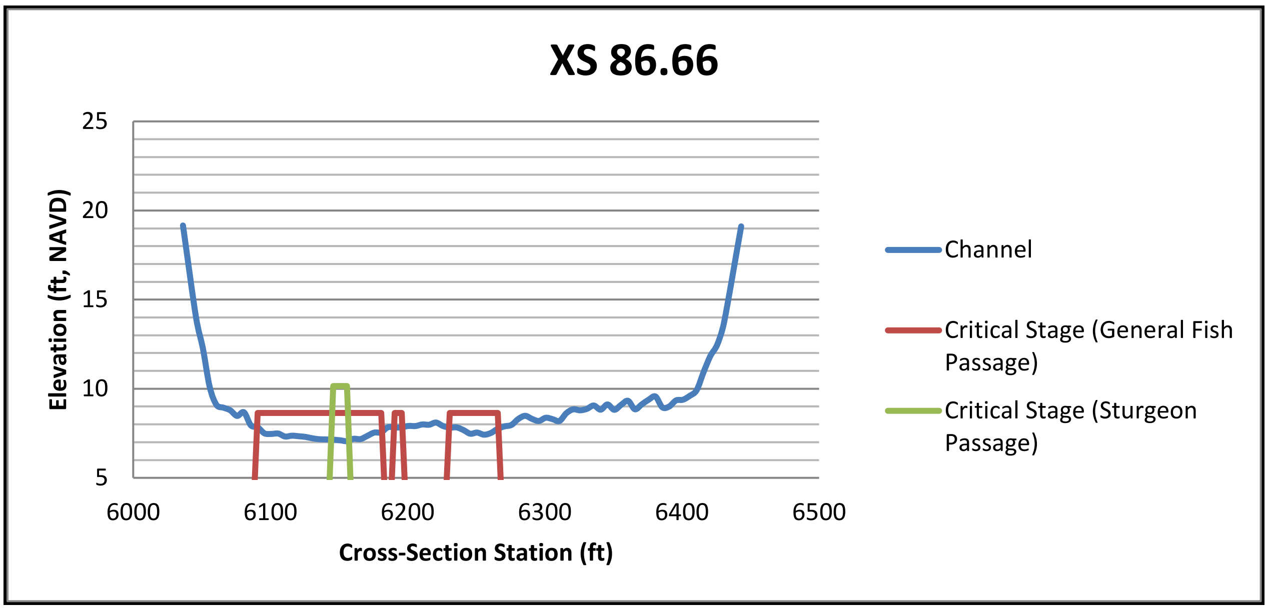

XS 95.56
Elevation (ft, NAVD)
30
25
20
15
10
10150
10200
10250
10300
10350
10400
10450
Cross-Section Station (ft)
Elevation (ft, NAVD)
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

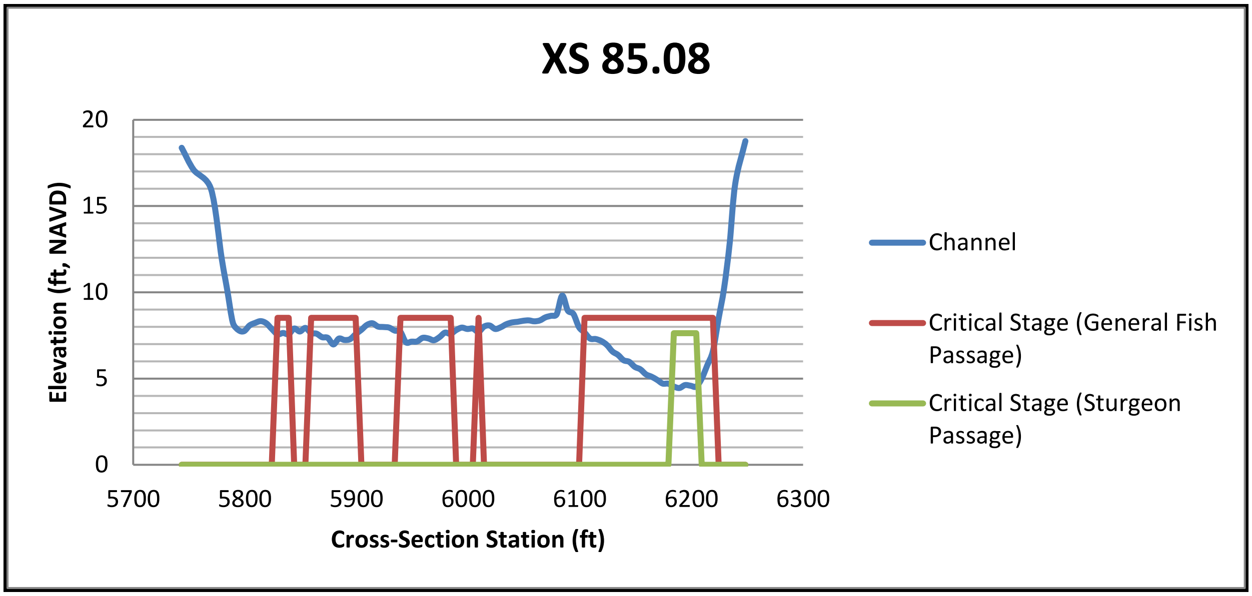

XS 93.79
Elevation (ft, NAVD)
30
25
20
15
10
1200
1300
1400
1500
1600
1700
1800
Cross-Section Station (ft)
Elevation (ft, NAVD)
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

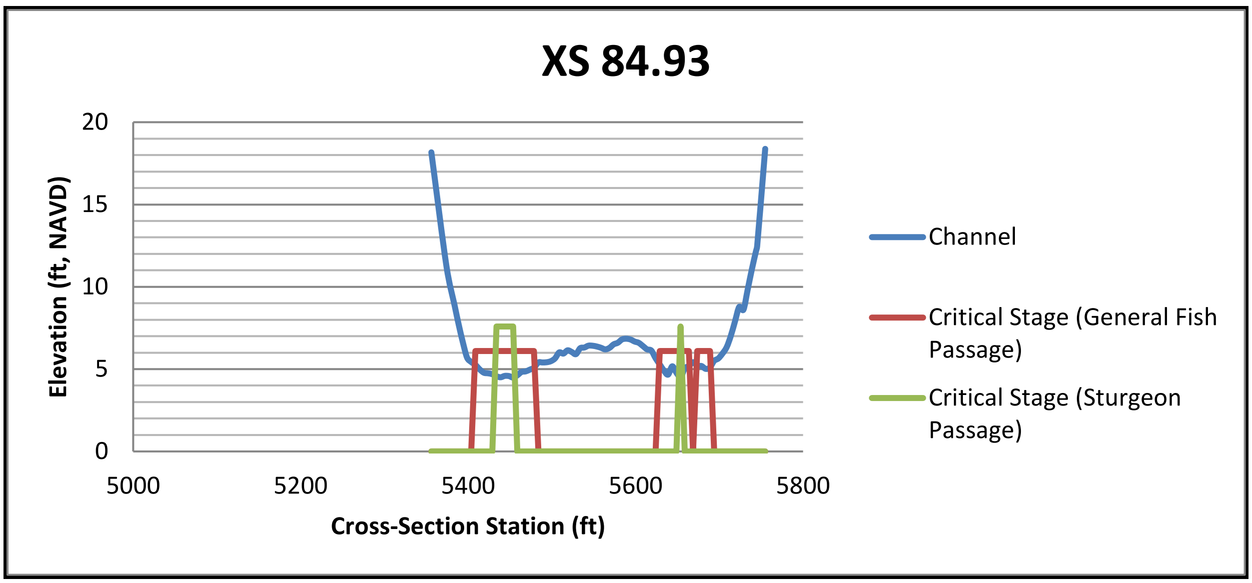

XS 88.38 (Riverside Shoal)
Elevation (ft, NAVD)
25
20
15
10
5
4400
4500
4600
4700
4800
4900
5000
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)


XS 87.17
Elevation (ft, NAVD)
30
25
20
15
10
5
4000
4500
5000
5500
6000
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

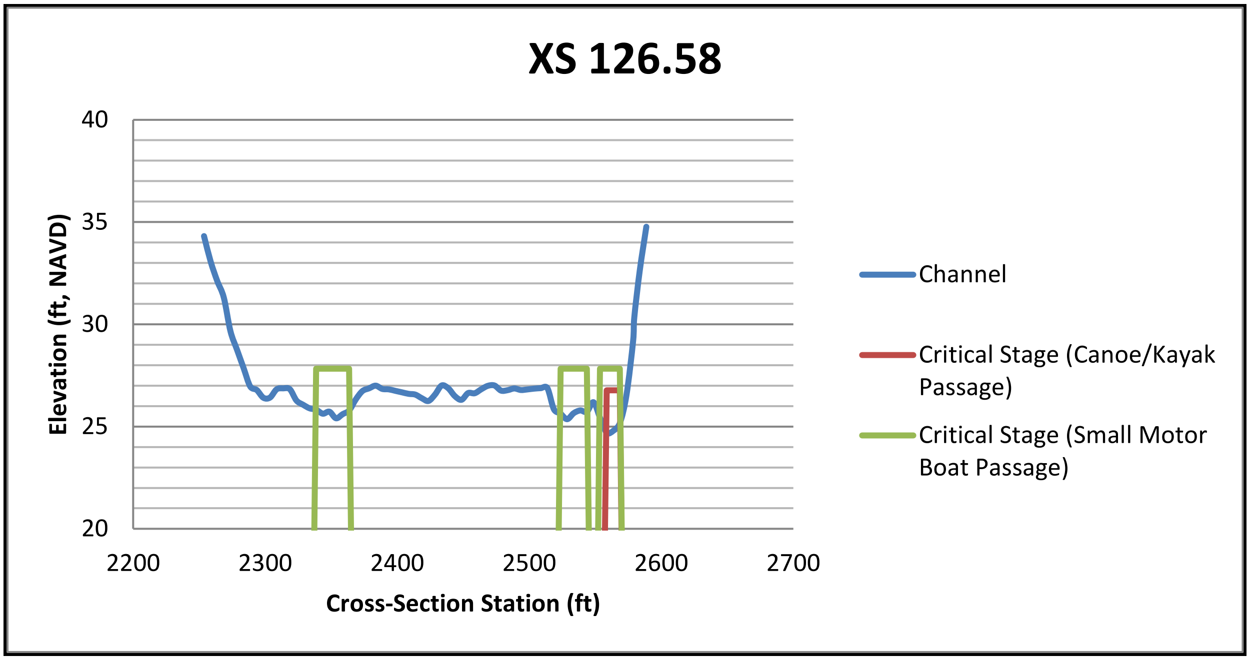

XS 87.11 Streambed
Elevation (ft, NAVD)
25
20
15
10
5
4000
4200
4400
4600
4800
5000
5200
5400
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

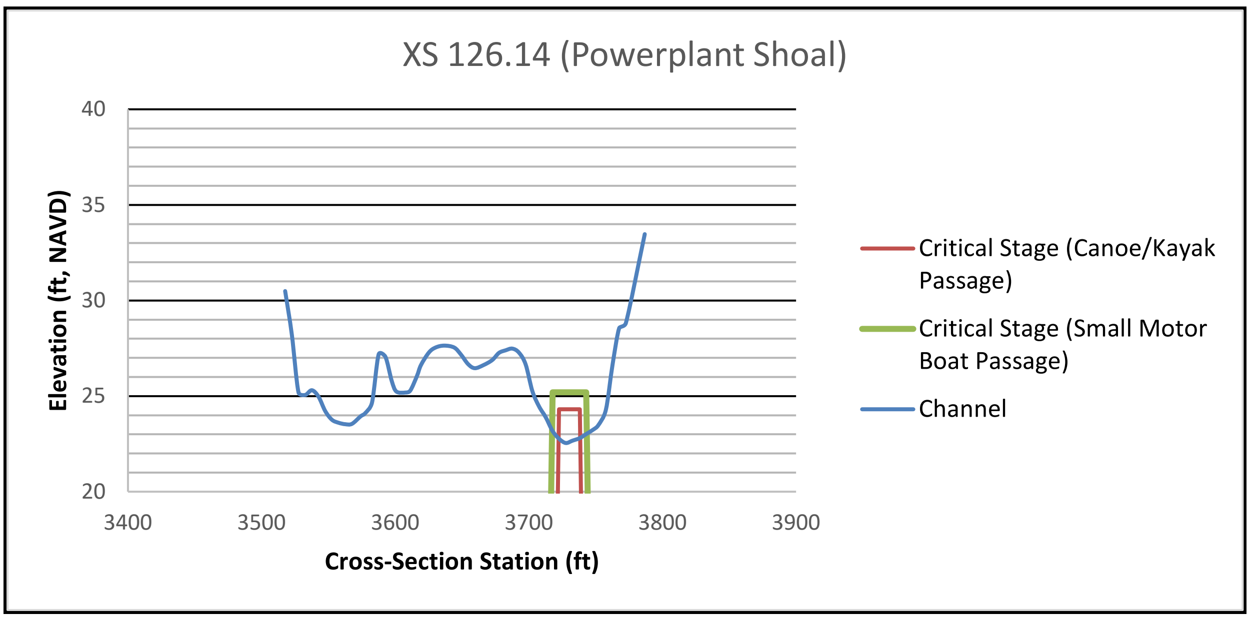

XS 86.66
Elevation (ft, NAVD)
25
20
15
10
5
6000
6100
6200
6300
6400
6500
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

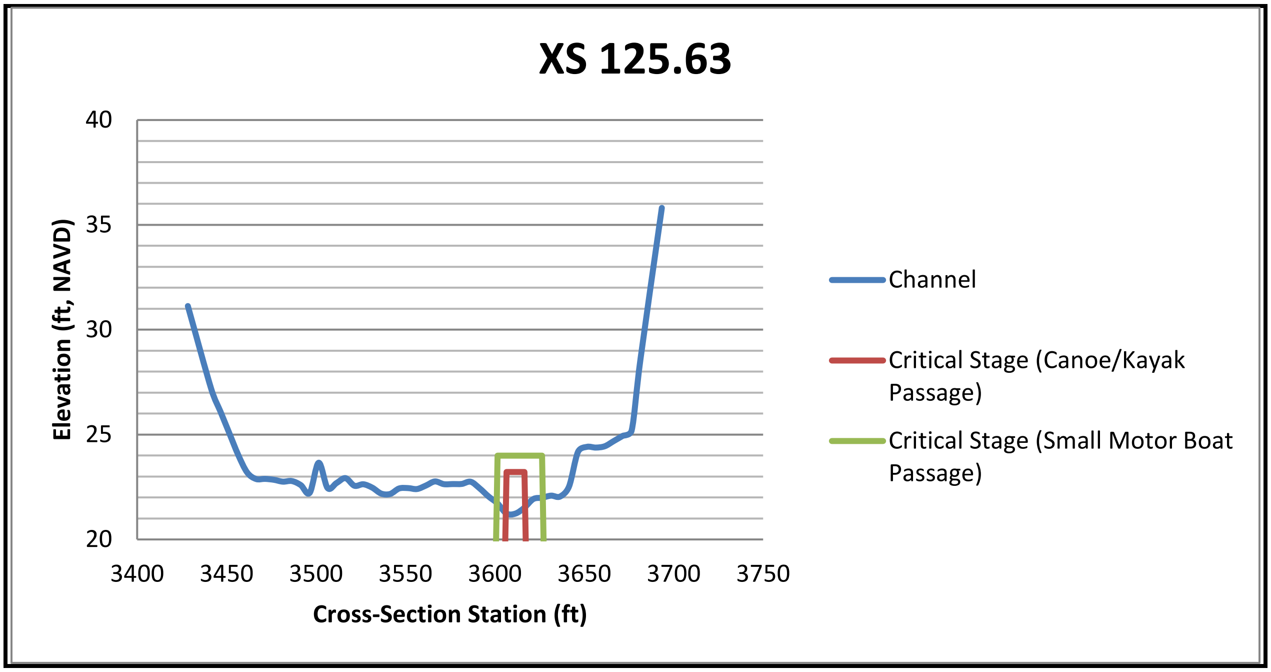

XS 85.08
Elevation (ft, NAVD)
20
15
10
5
0
5700
5800
5900
6000
6100
6200
6300
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)


XS 84.93
Elevation (ft, NAVD)
20
15
10
5
0
5000
5200
5400
5600
5800
Cross-Section Station (ft)
Channel
Critical Stage (General Fish Passage)
Critical Stage (Sturgeon Passage)

Appendix D
Boat Passage


XS 126.58
Elevation (ft, NAVD)
40
35
30
25
20
2200
2300
2400
2500
2600
2700
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)


XS 126.14 (Powerplant Shoal)
Elevation (ft, NAVD)
40
35
30
25
20
3400
3500
3600
3700
3800
3900
Cross-Section Station (ft)
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)
Channel


XS 125.63
Elevation (ft, NAVD)
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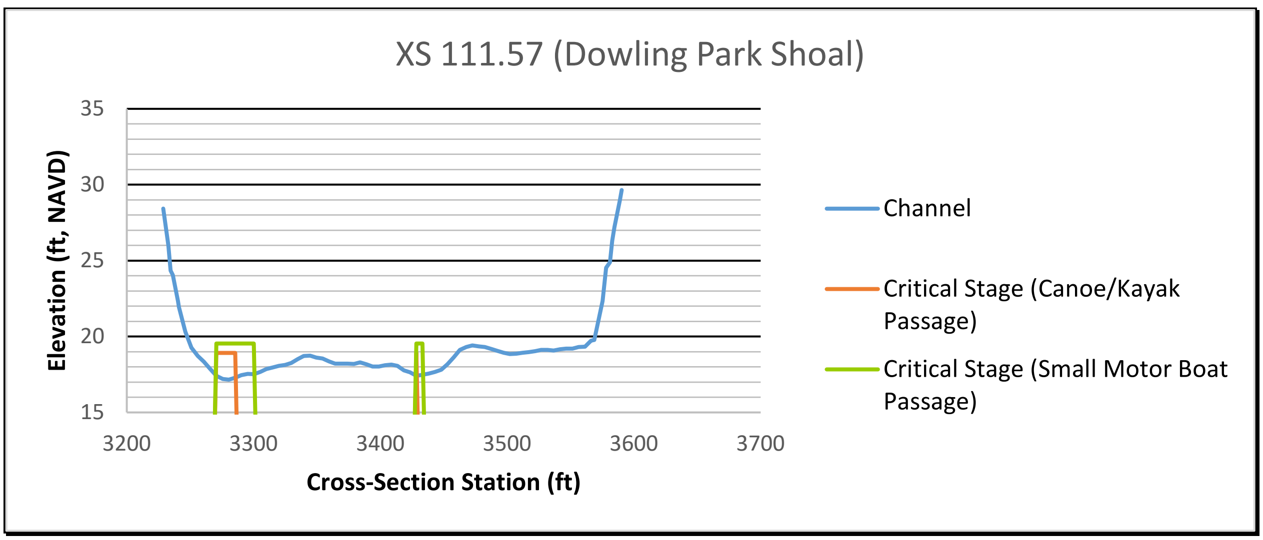
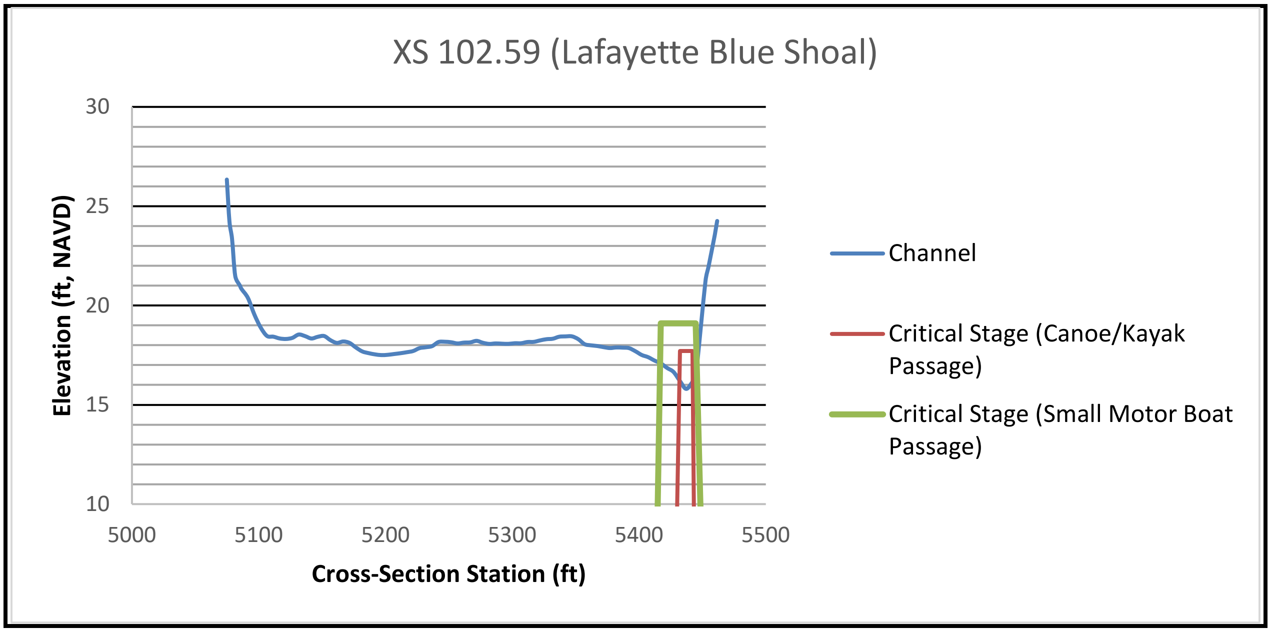
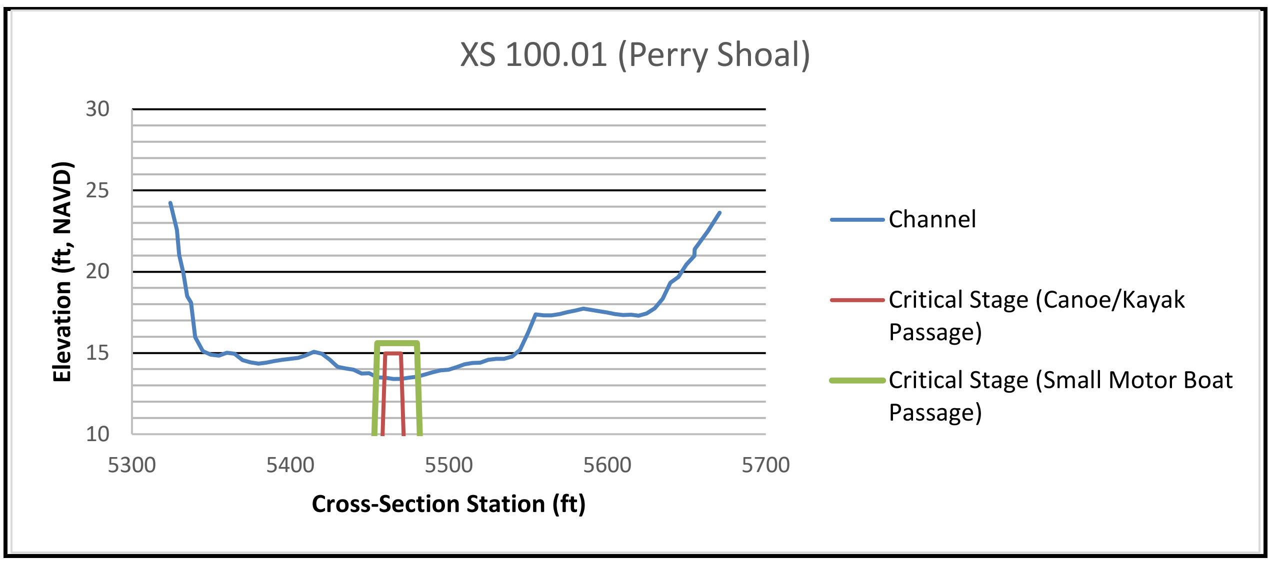
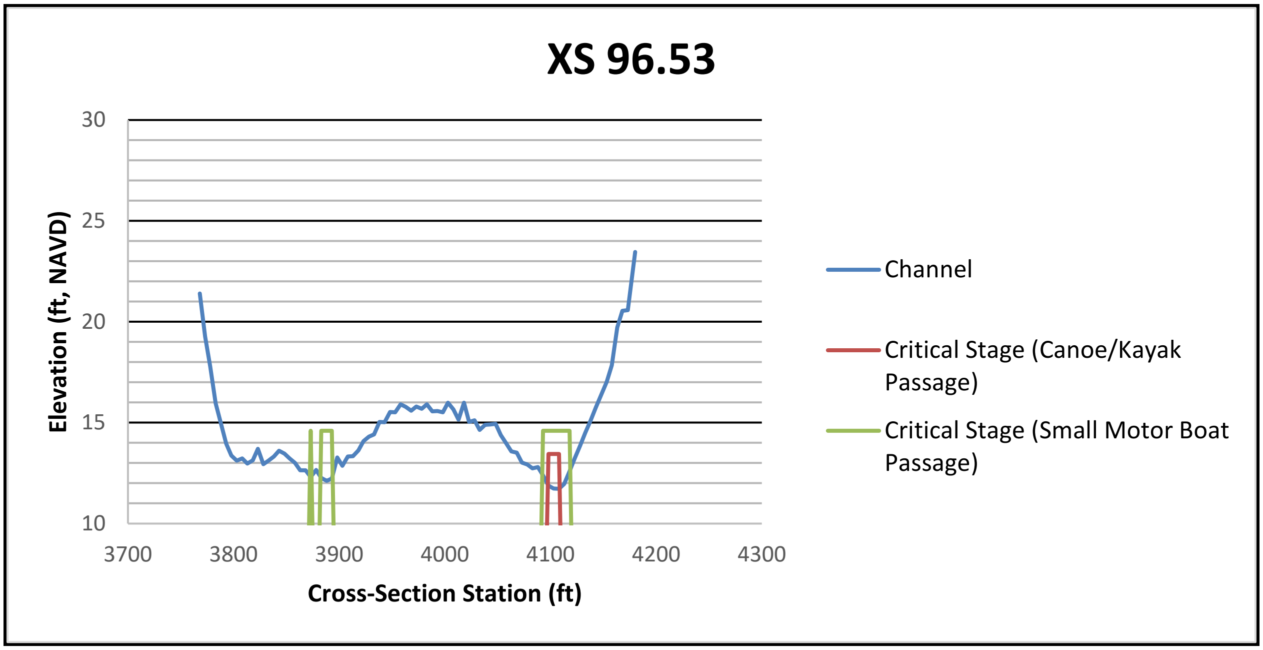
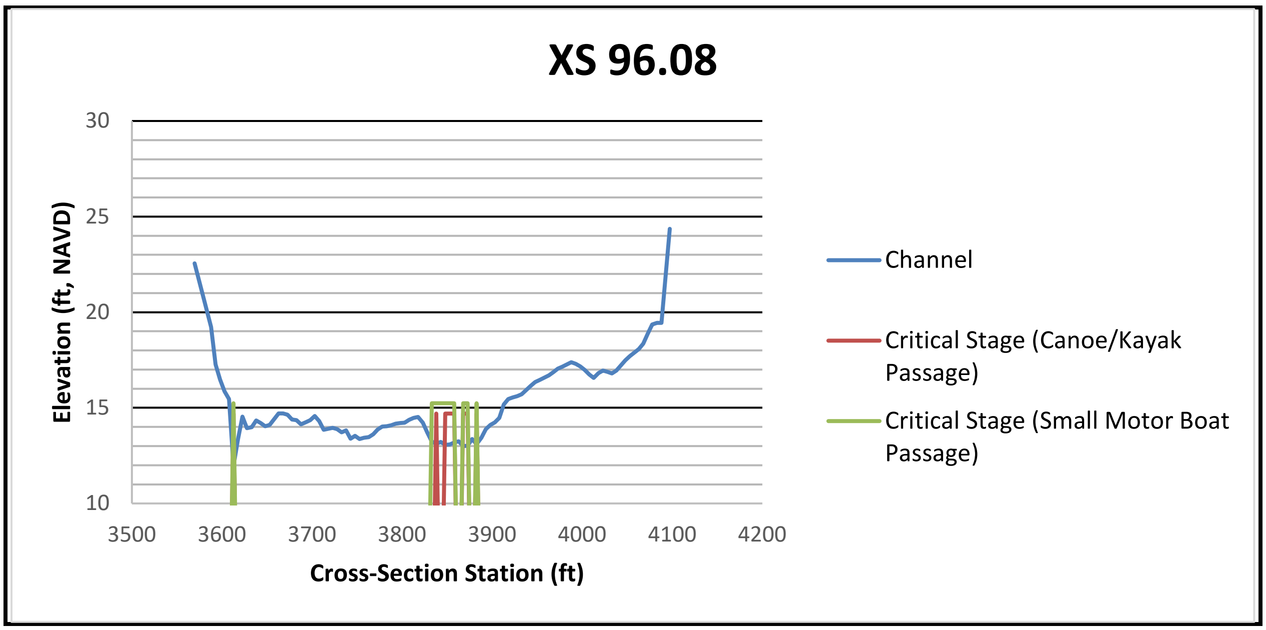
35
30
25
20
3400
3450
3500
3550
3600
3650
3700
3750
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

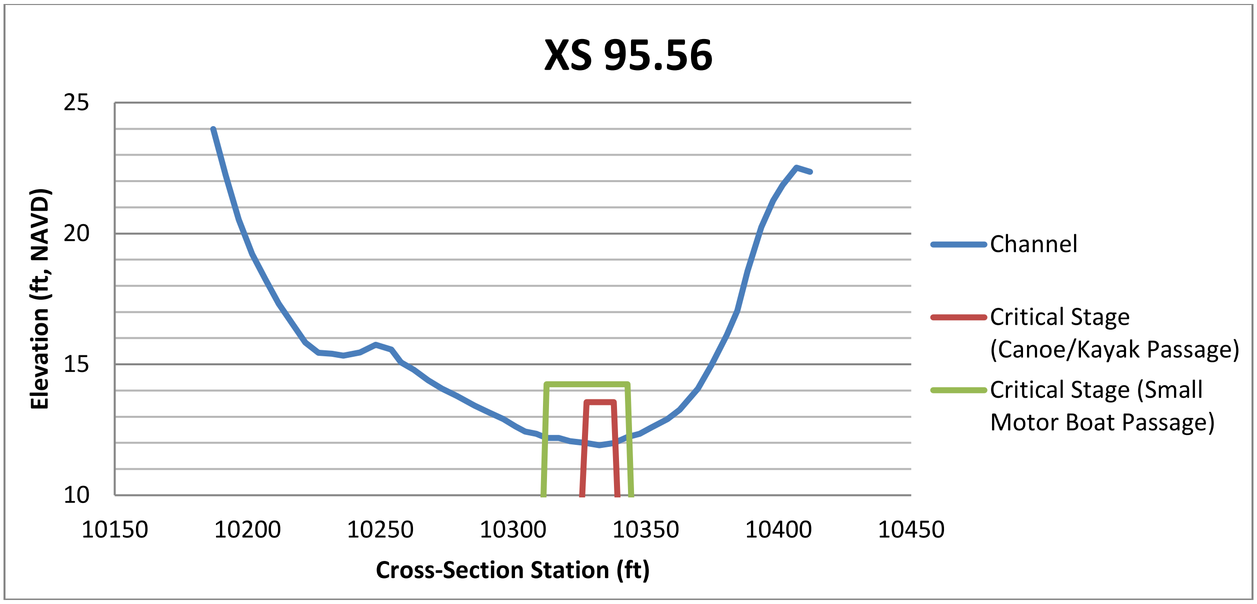

XS 111.57 (Dowling Park Shoal)
Elevation (ft, NAVD)
35
30
25
20
15
3200
3300
3400
3500
3600
3700
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

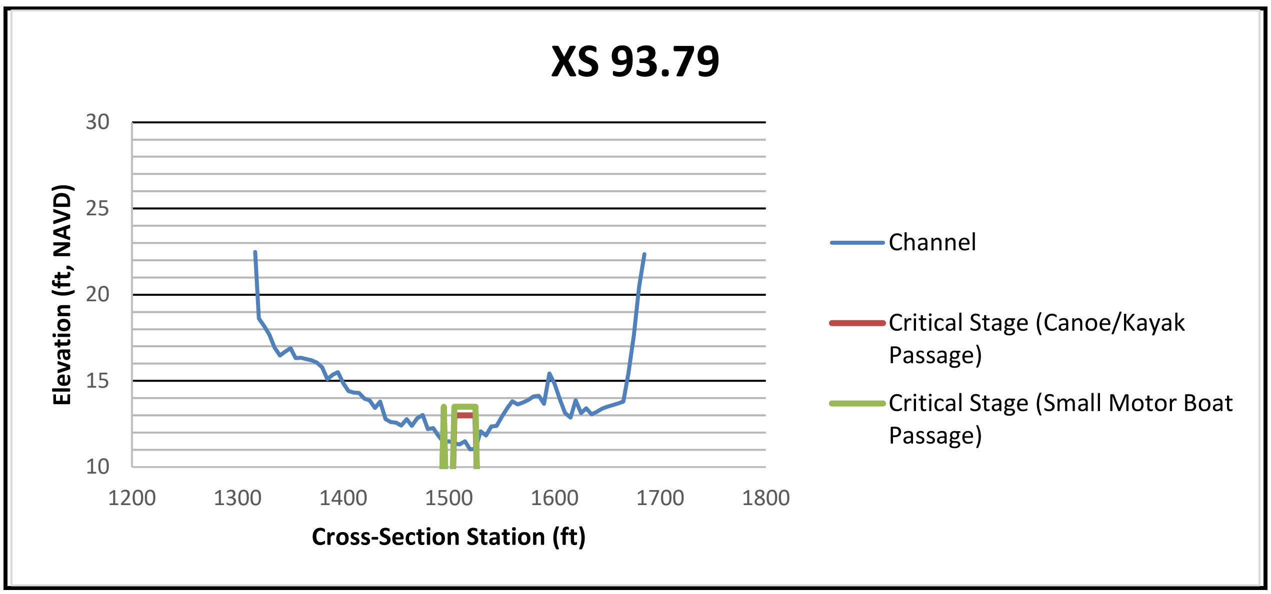

XS 102.59 (Lafayette Blue Shoal)
Elevation (ft, NAVD)
30
25
20
15
10
5000
5100
5200
5300
5400
5500
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

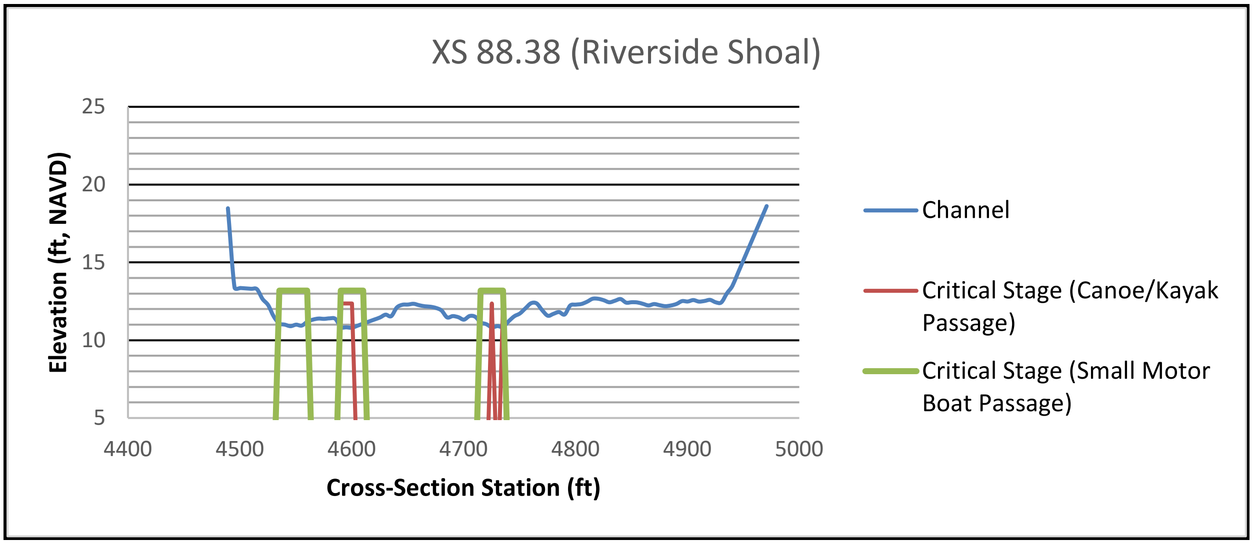

XS 100.01 (Perry Shoal)
Elevation (ft, NAVD)
30
25
20
15
10
5300
5400
5500
5600
5700
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

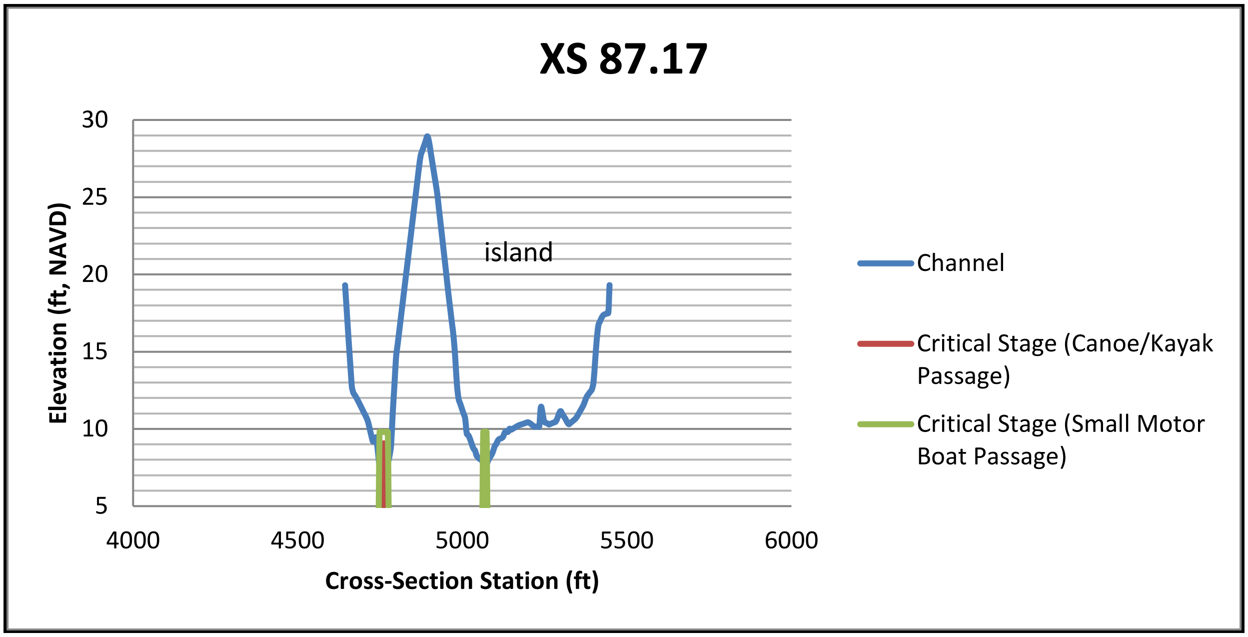

XS 96.53
Elevation (ft, NAVD)
Cross-Section Station (ft)
30
25
20
15
10
3700
3800
3900
4000
4100
4200
4300
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

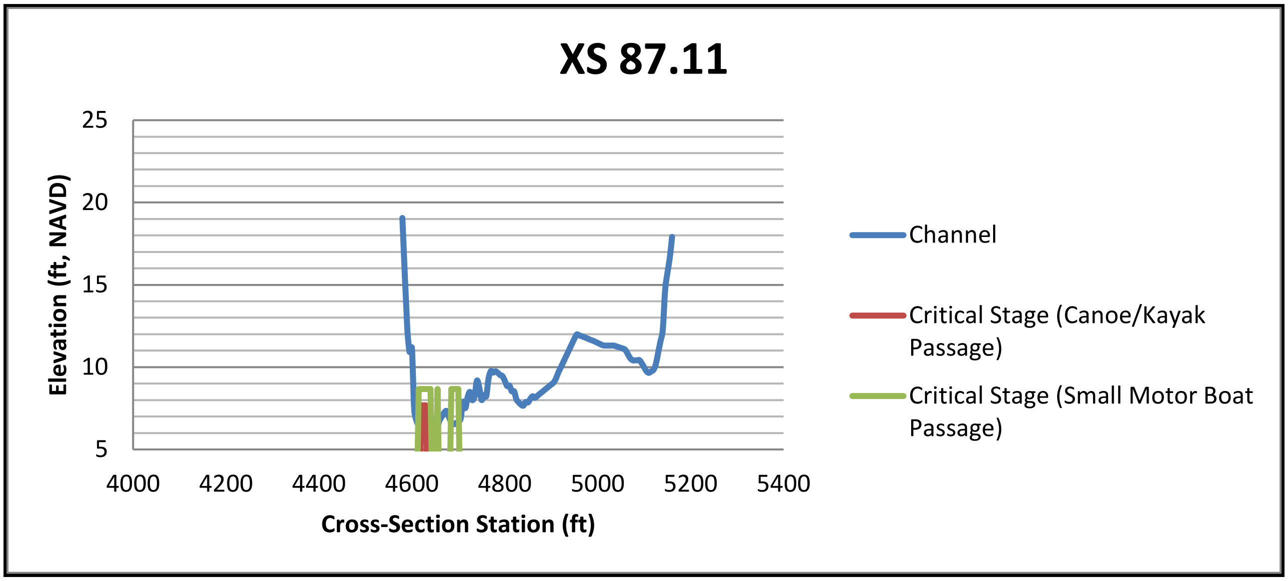

XS 96.08
Elevation (ft, NAVD)
Cross-Section Station (ft)
30
25
20
15
10
3500
3600
3700
3800
3900
4000
4100
4200
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

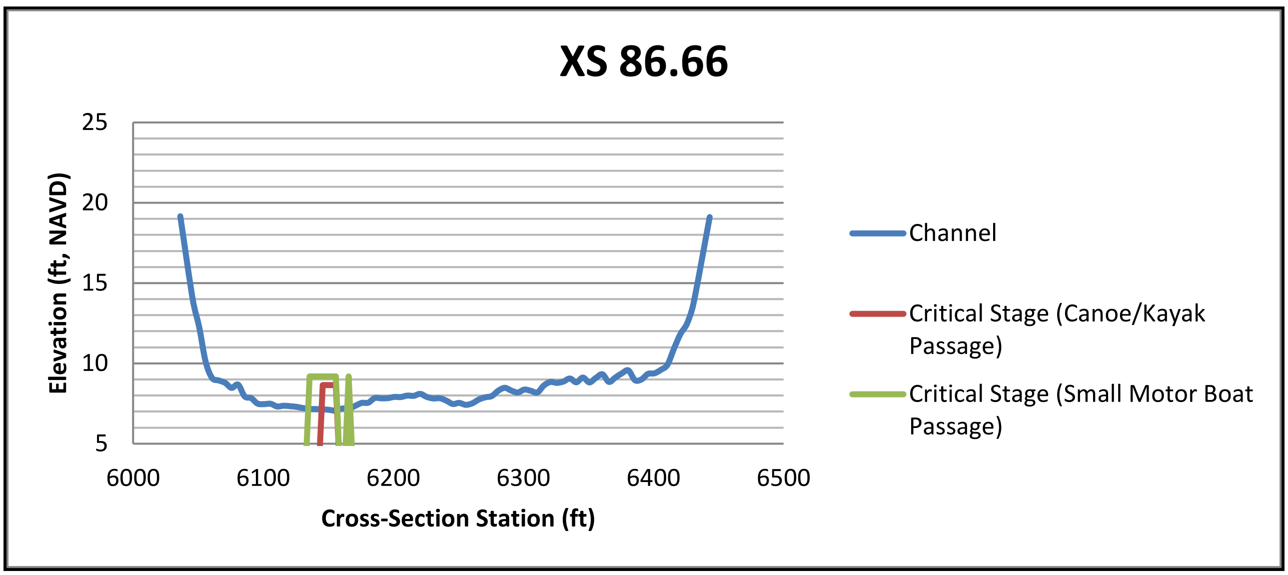

XS 95.56
Elevation (ft, NAVD)
25
20
15
10
10150
10200
10250
10300
10350
10400
10450
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

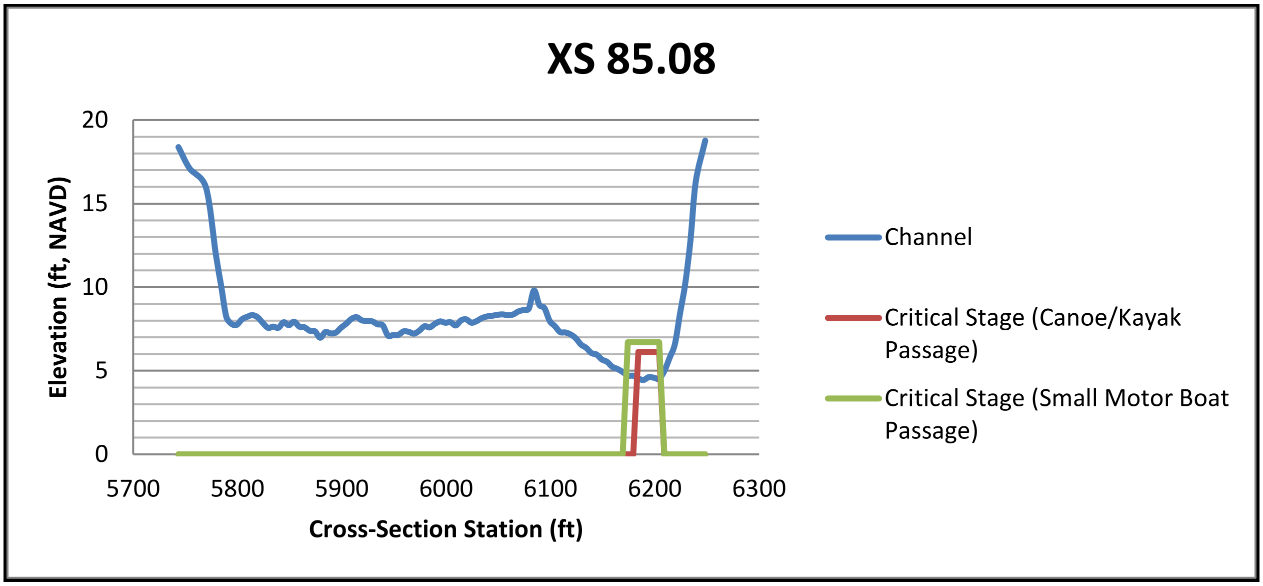

XS 93.79
Elevation (ft, NAVD)
30
25
20
15
10
1200
1300
1400
1500
1600
1700
1800
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)

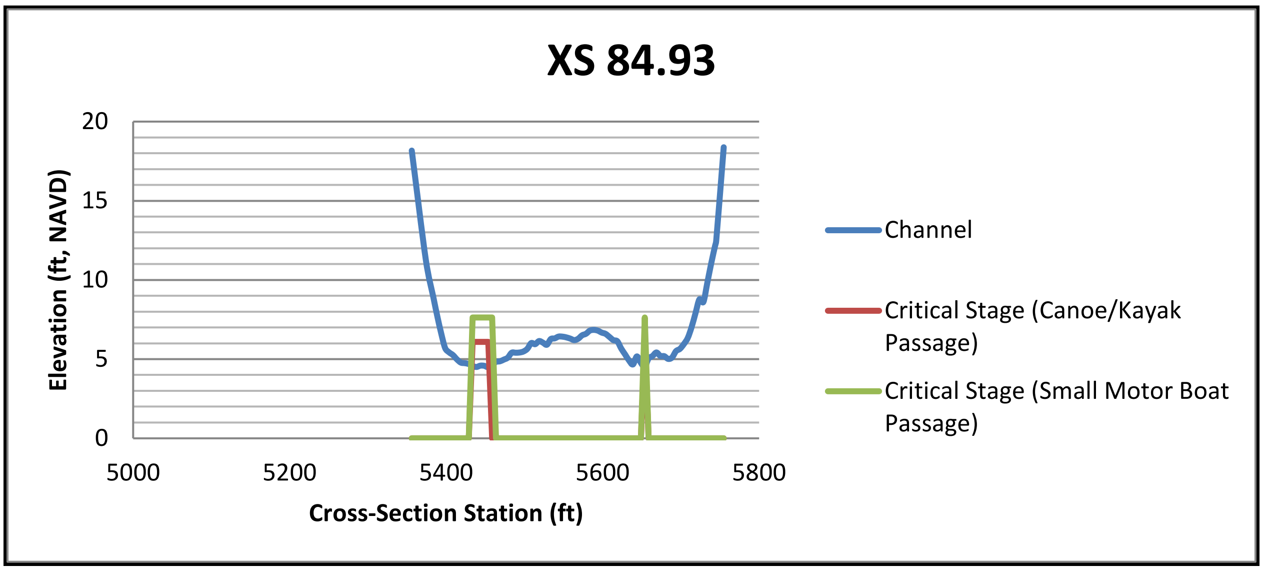

XS 88.38 (Riverside Shoal)
Elevation (ft, NAVD)
25
20
15
10
5
4400
4500
4600
4700
4800
4900
5000
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)


XS 87.17
Elevation (ft, NAVD)
30
25
20
15
10
5
4000
4500
5000
5500
6000
island
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)


XS 87.11
Elevation (ft, NAVD)
25
20
15
10
5
4000
4200
4400
4600
4800
5000
5200
5400
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)


XS 86.66
Elevation (ft, NAVD)
25
20
15
10
5
6000
6100
6200
6300
6400
6500
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)


XS 85.08
20
15
10
5
0
Elevation (ft, NAVD)
5700
5800
5900
6000
6100
6200
6300
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)


XS 84.93
20
15
10
5
0
Elevation (ft, NAVD)
5000
5200
5400
5600
5800
Cross-Section Station (ft)
Channel
Critical Stage (Canoe/Kayak Passage)
Critical Stage (Small Motor Boat Passage)