APPENDIX C

USE OF THE SYSTEM FOR ENVIRONMENTAL FLOW ANALYSIS (SEFA) SOFTWARE IN A MINIMUM FLOWS AND LEVELS (MFL) STUDY OF THE STEINHATCHEE RIVER

STEINHATCHEE RIVER, FLORIDA

SUWANNEE RIVER WATER MANAGEMENT DISTRICT
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Introduction

The Suwannee River Water Management 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, on which listed water bodies will be given an MFL within a specific 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.

SEFA is a Windows-based program that was 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 the availability of habitat (shown as area weighted suitability) for species of interest in the body of water (Jowett et al. 2014).

Methods

Study Area

The Steinhatchee River originates from Mallory Swamp located near the town of Mayo in Lafayette County, FL. The river travels approximately 35 miles south, where it flows into the Gulf of Mexico. Along this route, the river flows underground and reemerges at the Steinhatchee River Rise near the town of Tennille. Fishing and scalloping are two important recreational uses of the Steinhatchee River.

The study area encompasses a 0.6-mile stretch of the Steinhatchee River above the sink. Fourteen sites were chosen in early 2016 based on characteristic representation, ease of access, and diversity of habitat in the river (Figure 1). No data collection occurred at these sites with the exception of supplemental in-channel bathymetry for the HEC-RAS model, which was used in calibration of the SEFA model. HEC-RAS data were incorporated into the hydraulic, instream habitat, and time series models of the river.

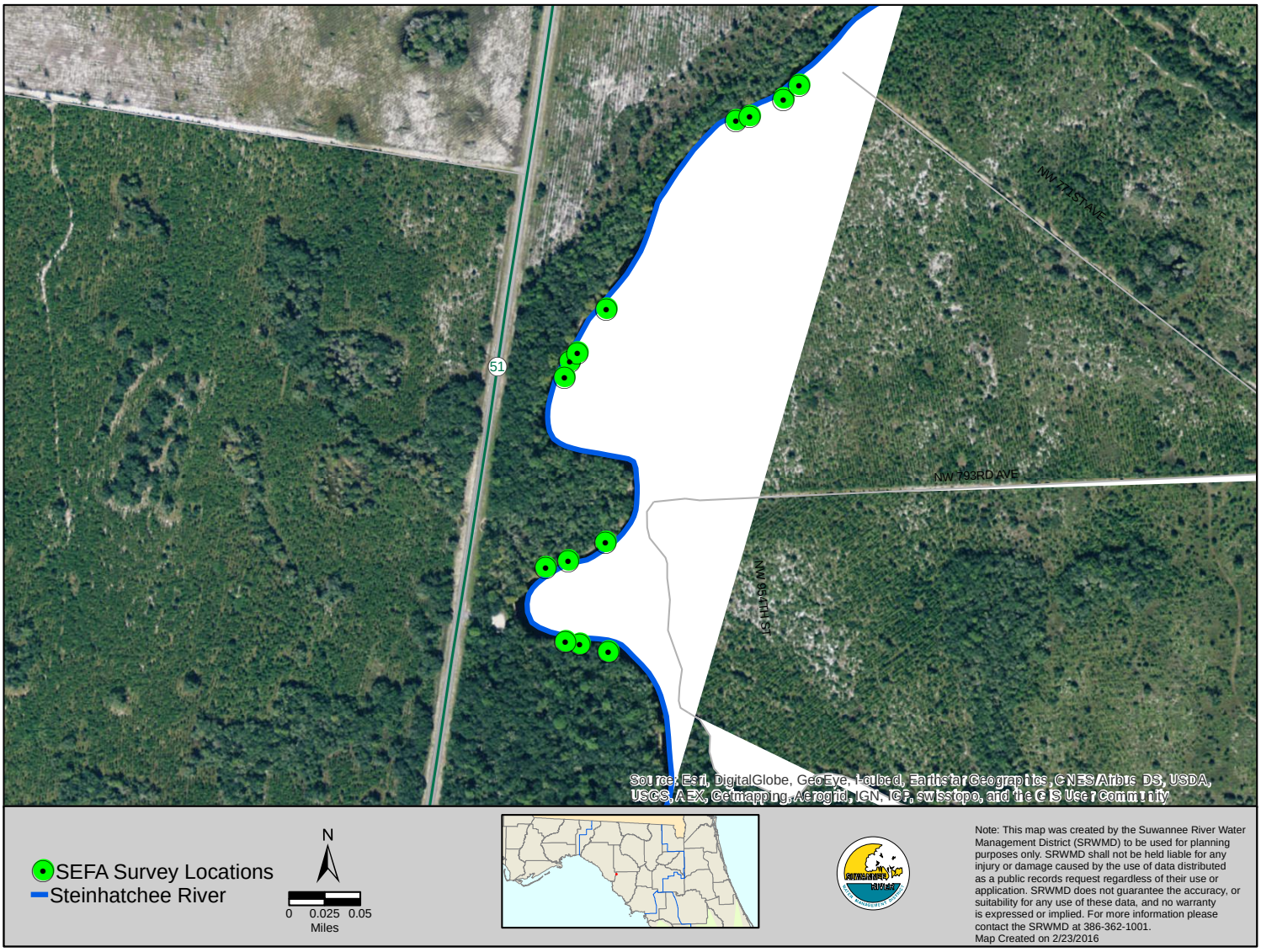

Figure 1. Map of the Steinhatchee River study area with surveyed transect locations.

Instream Habitat Model Calibration

A HEC-RAS model was developed to simulate the necessary stage/discharge relationships over six different flow scenarios along with the velocities at specific points across each transect under the highest flow regime. These model calibration values were then used to establish log-log rating relationships for each transect in the SEFA program. The rating curves were each calculated with Instream Flow Group model 4 (IFG4) emulation, the same method applied by the Physical Habitat Simulation model (PHABSIM) (Jowett et al. 2014; Milhous and Waddle 2001). Since no *in situ* data were collected, the substrate index codes were absent in the final calculation of the area weighted suitability for each species and life stage.

Habitat Suitability Curves

Forty habitat suitability curves of various species and life stages were incorporated into the instream habitat model (Table 1). All of these curves have been applied in previous MFL analyses. Note that only the velocity and depth criteria for each species and life stage were taken into account in the calculation of preference habitat.

Table 1. Habitat Suitability Curves used in the MFL analysis.

Species or Group	Life Stage
Suwannee Bass	Adult, Juvenile
Redbreast Sunfish	Adult, Juvenile, Spawning, Fry
Habitat Guilds	Shallow/Slow, Shallow/Fast, Deep/Slow, Deep/Fast
Channel Catfish	Adult, Juvenile, Juvenile (spring, summer, fall, warm water), Spawning, Fry
Darters	Generic, Blackbanded
Macroinvertebrates	Ephemeroptera, Plecoptera, Trichoptera, EPT Total, *Pseudocloeon ephippiatum*, Hydropsychidae - Total, *Tvetenia vitracies*
Largemouth Bass	Adult, Juvenile, Spawning, Fry
Bluegill	Adult, Juvenile, Spawning, Fry
Spotted Sunfish	Adult, Juvenile, Spawning, Fry
Cyprinidae	Adult

Time Series Flow

Discharge data from the USGS gage 02324000 (Steinhatchee River near Cross City, FL) were utilized in the time series analysis portion of the SEFA program (Table 2). The range of flows used in this analysis dated between March 1, 1950 and September 30, 2015. Appendix Figure A1 contains the flow duration curve along with the associated percent reductions to the flow record at the USGS gage.

Table 2. Flow statistics for the USGS gage 02324000 – Steinhatchee River near Cross City, FL.

Statistic	Value
Sample size	23955
Minimum	1.4
Maximum	16400
Mean	299.54
Median	101
Standard deviation (denom. = n-1)	525.28

Flow Reduction Approach

This approach involved a straight percent reduction of each discharge measurement value in the historical period-of-record. Reductions used in the discharge record ranged from 5% to 30%. Flows were reduced by ascending stepwise percentages until the difference between the

reduced and historic discharge records revealed a less than 15% reduction in the calculated mean of the area weighted suitability.

Results and Discussion

Channel catfish juvenile along with spotted sunfish juvenile, spawning, and fry are all deemed critical species in this study (Table 3). Duration curves containing the area weighted suitability and percent reductions across the historic flow record are presented in Appendix Figures A2-A5.

Table 3. Summary of critical species and maximum allowable reduction in flow. Red type denotes a value of greater than 15%.

	Reductions					
Species / Life Stage	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**
Channel Catfish - Juvenile	-2.44	-4.27	-7.32	-9.76	-12.20	-15.24
Spotted Sunfish - Juvenile	-2.44	-4.27	-7.32	-9.76	-12.20	-15.24
Spotted Sunfish - Spawning	-2.42	-4.85	-7.27	-9.70	-12.73	-15.76
Spotted Sunfish - Fry	-2.26	-4.51	-6.77	-9.77	-12.03	-15.04

The use of linear interpolation on flow reductions between 25-30% indicate that spawning spotted sunfish are the most restrictive species and life stage, with the most deleterious effects to habitat occurring at the 29% flow reduction scenario. Thus, any flow reduction greater than 28% would cause a greater than 15% reduction in the species' habitat.

References

Aquatic Habitat Analysts, Inc. 2012. SEFA: System for Environmental Flow Analysis (Version 1.2 build 31). Available from http://sefa.co.nz/.

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.

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.

SEFA Report

Appendix

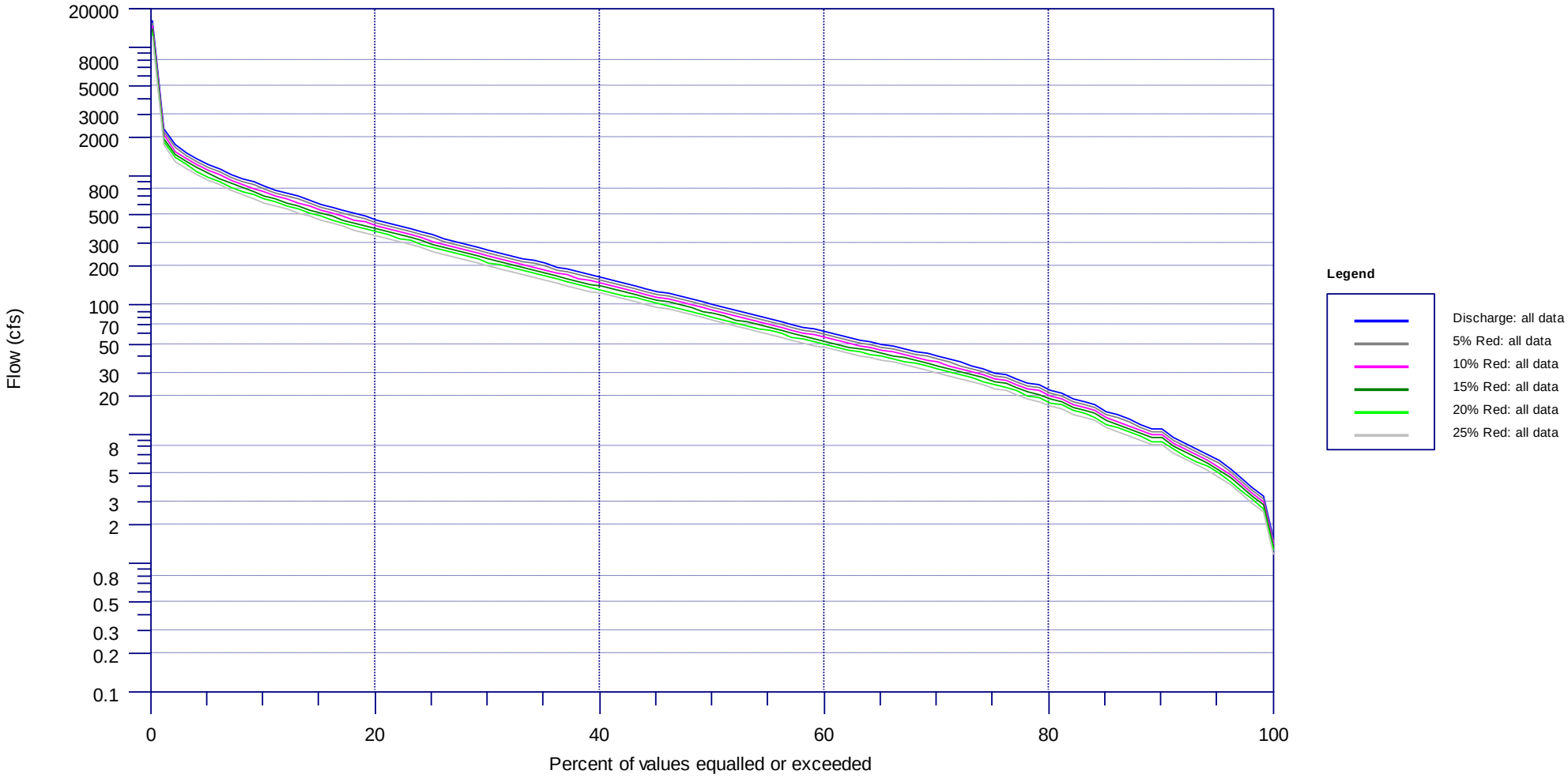

Figure A1. Flow duration curve comparing the baseline and percent reduced flow records for USGS gage 02324000 (Steinhatchee River near Cross City).

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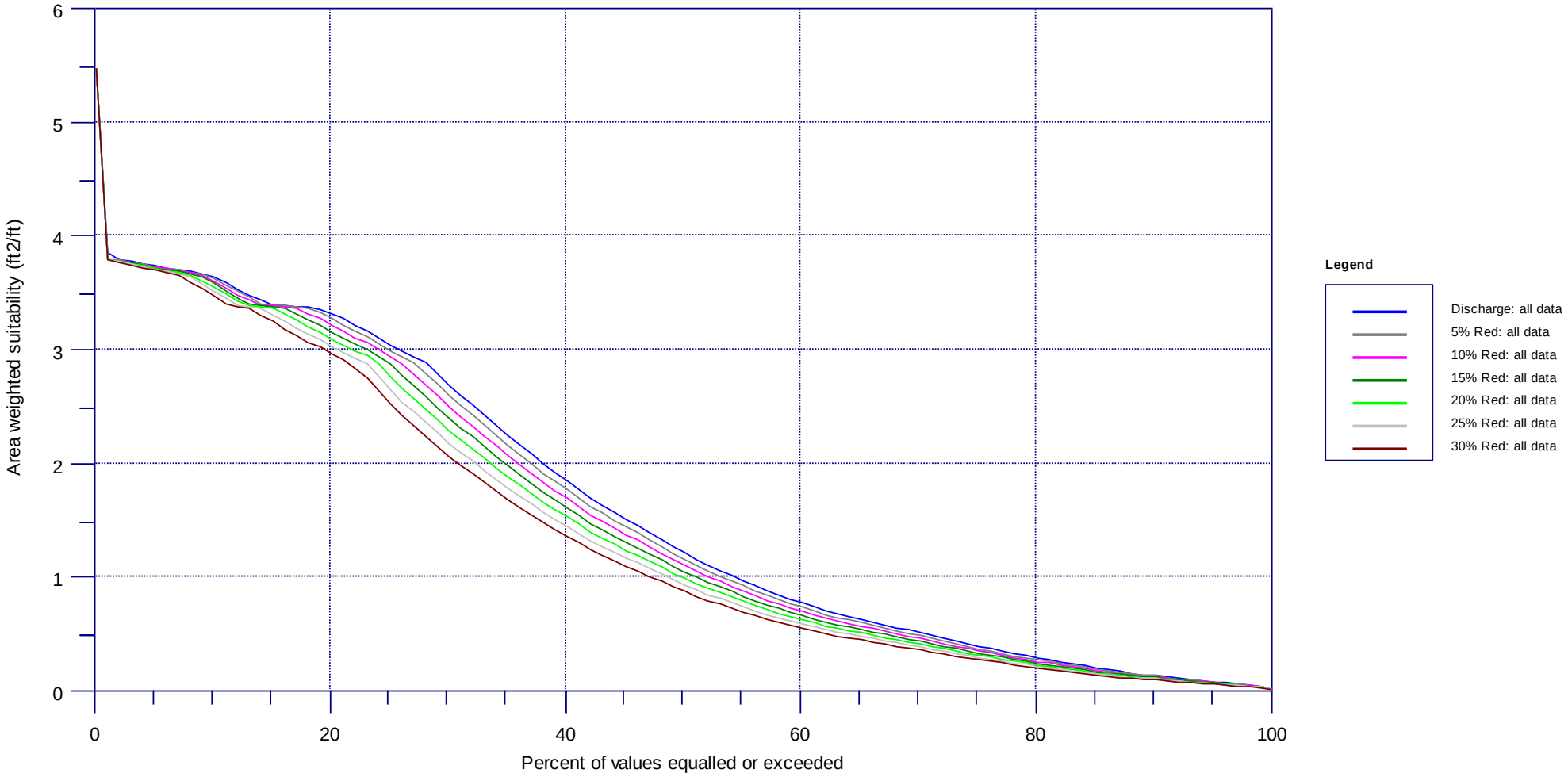

Figure A2. Area weighted suitability duration curves with baseline discharge including the various percent reductions for channel catfish juvenile.

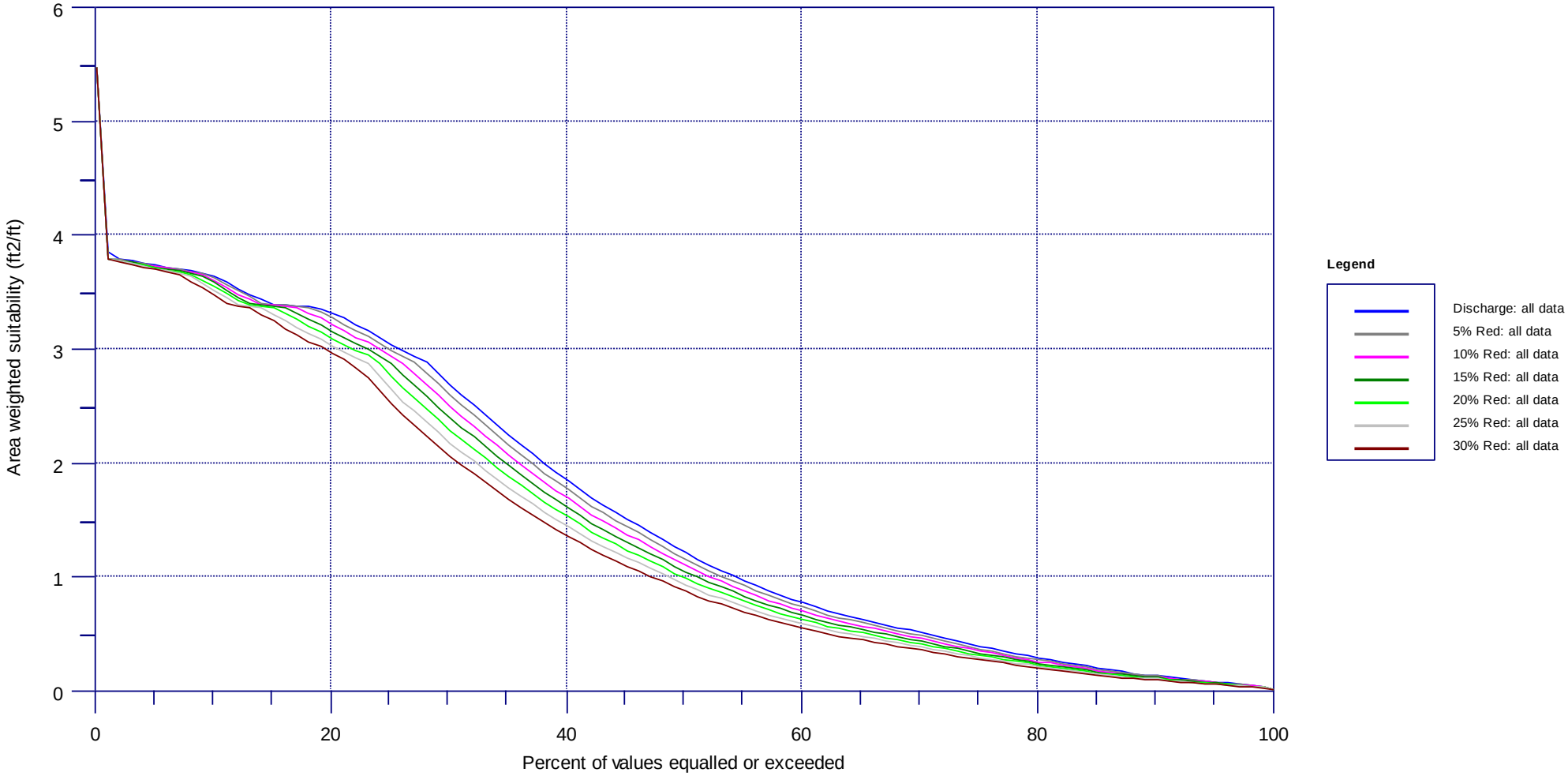

Figure A3. Area weighted suitability duration curves with baseline discharge including the various percent reductions for spotted sunfish juvenile.

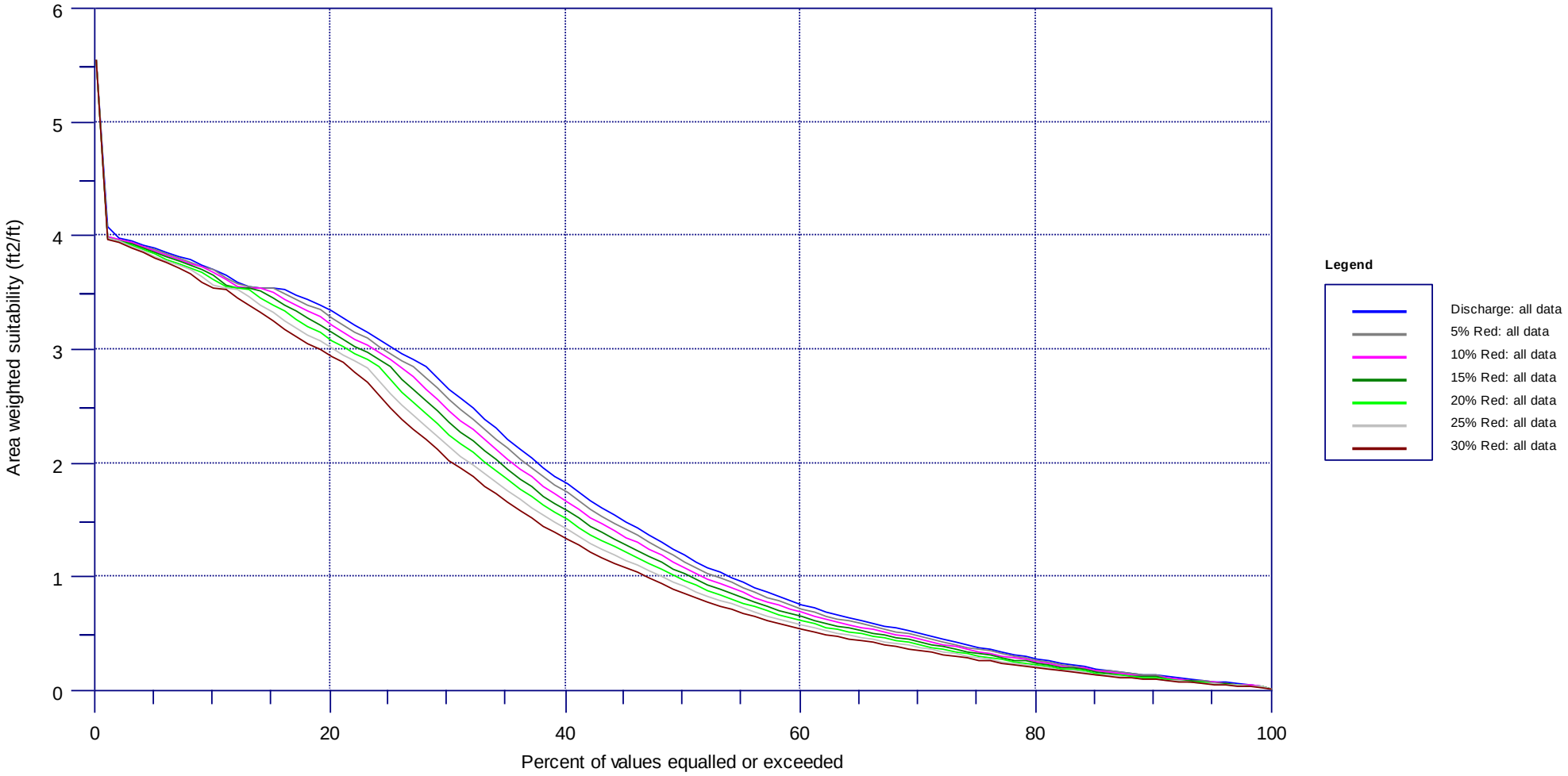

Figure A4. Area weighted suitability duration curves with baseline discharge including the various percent reductions for spotted sunfish spawning.

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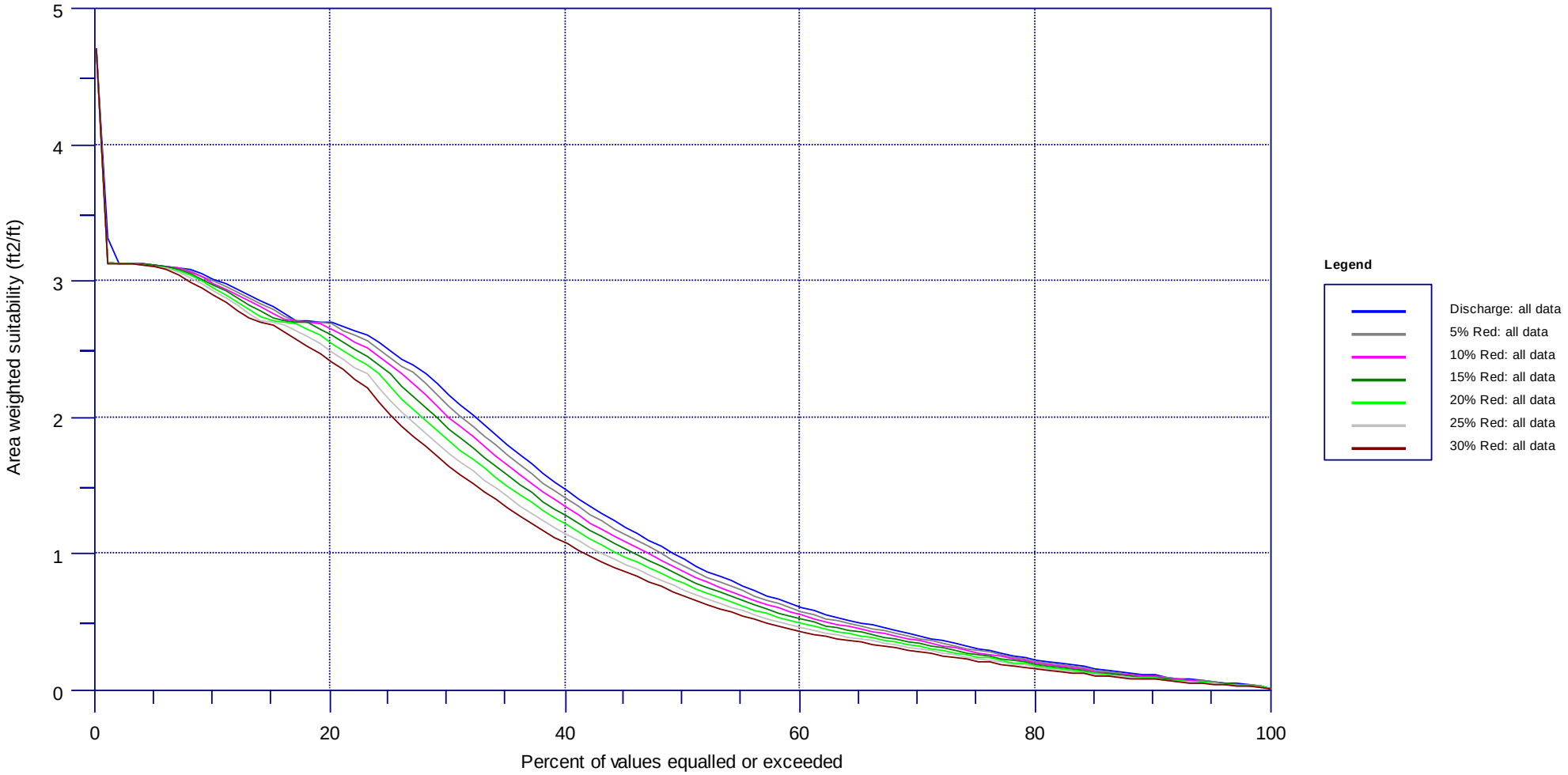

Figure A5. Area weighted suitability duration curves with baseline discharge including the various percent reductions for spotted sunfish fry.