APPENDIX E

SEA LEVEL RISE EVALUATION FOR THE TIDAL PORTION OF THE STEINHATCHEE RIVER

STEINHATCHEE RIVER, FLORIDA

SUWANNEE RIVER WATER MANAGEMENT DISTRICT
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1.0   INTRODUCTION

1.1   PROJECT BACKGROUND AND OBJECTIVES

The Suwannee River Water Management District (SRWMD) is performing a minimum flow and level (MFL) analysis for the Steinhatchee River. The evaluation of the impacts of sea level rise on estuarine resources is a component of the MFL analyses. A key element is the impact sea level rise has on the change in salinity associated with higher offshore water levels. Appendix B provided a report that outlined the development, calibration and application of a hydrodynamic model for the tidal portions of the Steinhatchee River. This model was used to evaluate the impacts of sea level rise on salinity conditions. The results are presented in the following sections.

1.2   REPORT OUTLINE

Following this introduction, the report is broken down into two sections. Section 2 presents the assumptions utilized in the sea level rise run. Section 3 presents the results of the comparison of the sea level rise to the baseline condition.

2.0   HYDRODYNAMIC MODEL OVERVIEW AND SEA LEVEL RISE RUN INPUTS

This section provides a summary description of the hydrodynamic model as outlined in detail in Appendix B, along with the model inputs utilized in the sea level rise run.

2.1   EFDC MODEL DESCRIPTION

The Environmental Fluid Dynamics Code (EFDC) model used in this project is a general purpose modeling package for simulating two- and three-dimensional flow, transport and biogeochemical processes in surface water systems, including rivers, lakes, estuaries, reservoirs, wetlands and nearshore to shelf-scale coastal regions. The EFDC model was developed by Dr. John Hamrick at the Virginia Institute of Marine Science and is considered public domain software. EFDC is currently supported by the U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD), EPA Region 4, and EPA Headquarters. A link to the EPA website for the EFDC model is https://www.epa.gov/exposure-assessment-models/efdc. Additionally, the Florida Department of Environmental Protection (FDEP) and the Water Management Districts (WMDs) throughout the state have used this model extensively. Specific examples of FDEP and WMD applications of EFDC include Indian River Lagoon [St. Johns River Water Management District (SJRWMD)], tidal portions of the St. Johns River (SJRWMD), Florida Bay [South Florida Water Management District (SFWMD)], tidal Caloosahatchee River (FDEP), Pensacola and Escambia Bay (FDEP), the tidal Suwannee River [U.S. Geological Survey (USGS) for SRWMD], the tidal Aucilla River (SRWMD), and the tidal Econfina River (SRWMD).

As stated previously, the EFDC model development and calibration is outlined in detail within Appendix B. For this appendix, to provide context, the model grid and bathymetry utilized for the sea level rise simulations are presented in Figures 2-1 and 2-2. This provides some basic context for the sea level rise simulations. The grid covers a large portion of the offshore area at the mouth of the Steinhatchee River and the full tidal length of the Steinhatchee all the way up to Steinhatchee Falls. Section 2.2 presents the revised offshore water level conditions utilized for the sea level rise runs. This boundary condition was applied to the most offshore grids shown in Figure 2-1.
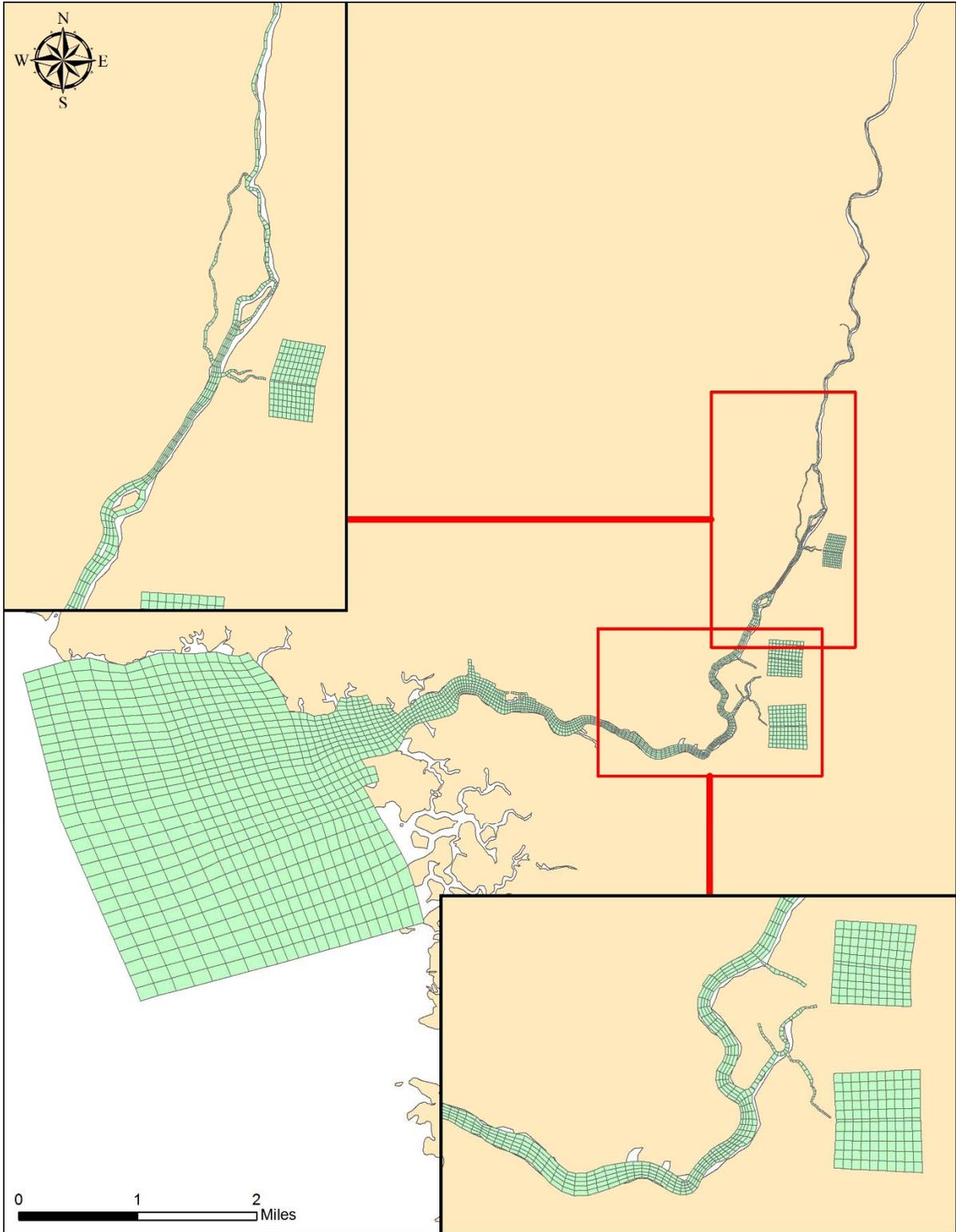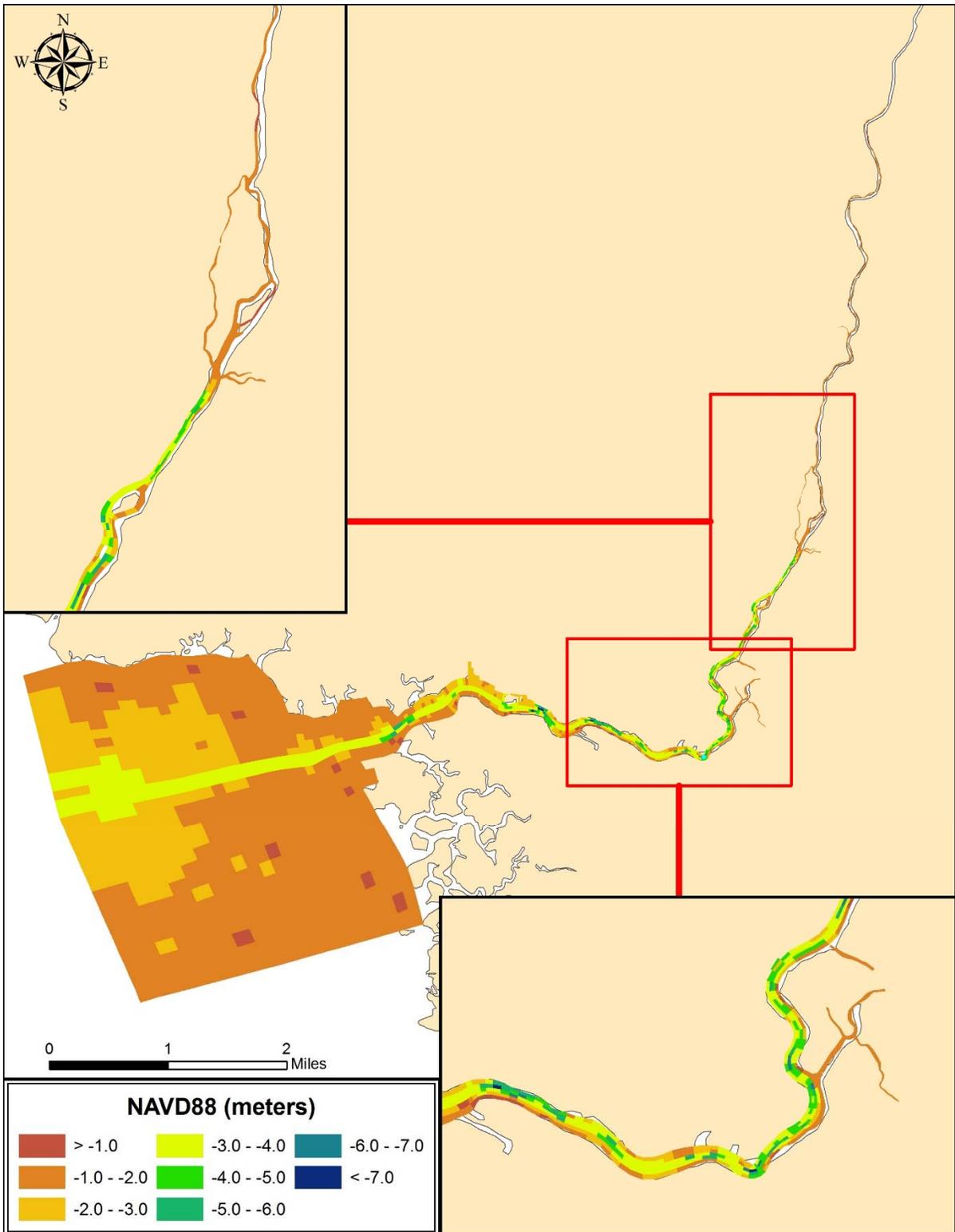
Figure 2-1. Steinhatchee River model grid.

Figure 2-2. Steinhatchee River model bathymetry.

2.2   SEA LEVEL RISE INPUTS

Per the scope of work for the sea level rise runs, the offshore boundary condition from the baseline scenario run outlined in Appendix B was increased a total of 5.1 inches. The process used to determine the amount of rise followed that used by SWFWMD for the Chassahowitzka River (SWFWMD 2012, USACE 2011), with the rise projected to 2035 instead of 2030. A sea level rise intermediate projection of 5.1 inches from 2015 to 2035 was computed using Equation 1.

$$\text{Rise (in meters)} = 0.0017\,(t_2 - t_1) + b(t_2^2 - t_1^2) \qquad \text{Equation 1}$$

where:

t_1 = time between 2015 and 1992

t_2 = time between projection date (2035) and 1992

b = constant

For the flow reduction scenario runs presented for the MFL, a 4-year period, which reflected the general flow conditions in the system, was selected. This period was from October 1, 1995 through September 30, 1999. For the sea level rise runs, the baseline condition scenario (the full 4 years with no flow reduction) was utilized. Using this model run set, the offshore boundary condition was modified by applying a static 5.1-inch increase in the offshore boundary forcing. Figure 2-3 presents an example plot of the sea level rise boundary condition compared with the baseline condition for a 3-month period in 1995. This was the only input that was changed for the sea level rise simulation. All other inputs were held constant.
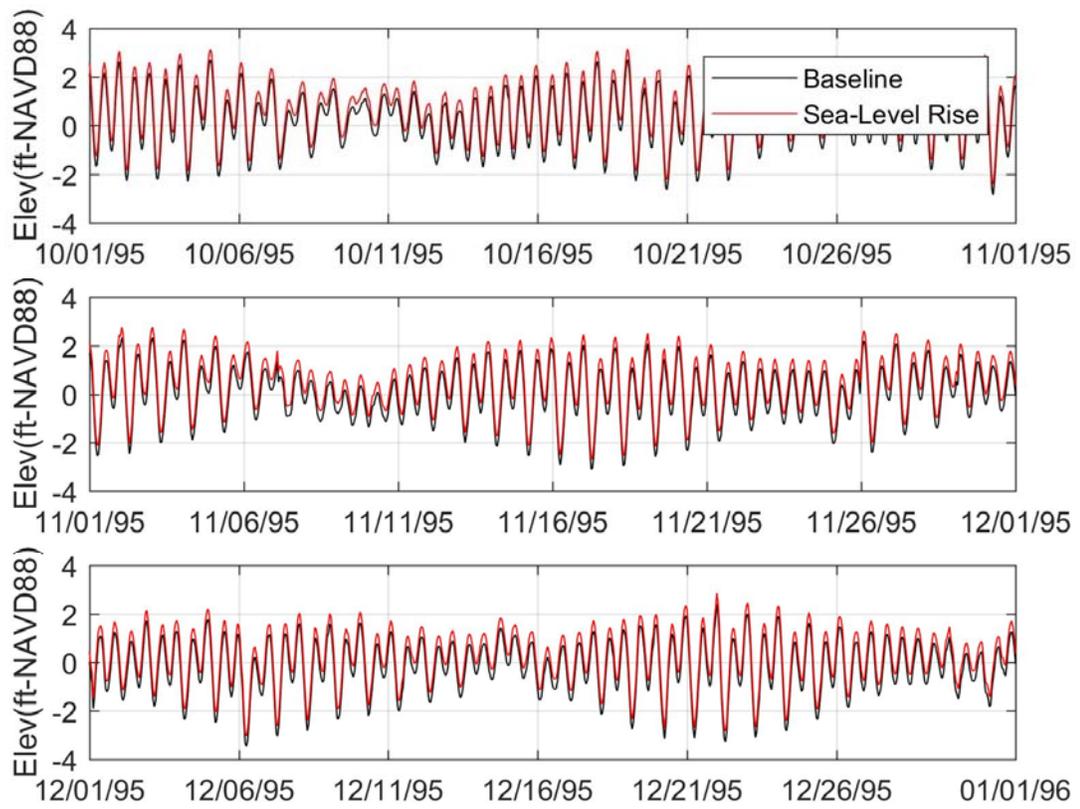
Figure 2-3. Offshore water level boundary condition for Baseline and Sea Level Rise Runs
(10/01/95 through 01/01/96)

3.0   SEA LEVEL RISE SIMULATION RESULTS

The following sections provide results from the sea level rise simulations. The graphics presented and the text provided are consistent with those presented in the main MFL document for the flow reduction scenarios.

3.1   <u>OFFSHORE SCALLOP HABITAT</u>

In Section 6.1.2 of the main report, a key habitat identified for protection is the offshore or estuarine scallop habitats. The critical salinity range identified for protection was from 23 parts per thousand (ppt) to 26 ppt. Additionally, it was identified that the critical time period for protection was October to December. As scallops generally reside in bottom waters, the bottom area for salinity was identified as the criteria for protection.

Figure 3-1 present maps showing the mean bottom salinities in the offshore area of the model grid for the model period, comparing the baseline and sea level rise run. Scallop habitats, as defined in the MFL document, are exclusively located offshore of the river mouth, so the evaluation of these grids is critical. These plots show some change in the salinity conditions, with the higher salinities pushing inward under the sea level rise run, but these changes are not significant.

As a secondary look, impacts of sea level rise on the defined habitat and time period for scallops was done by looking at bottom habitat area changes during the months of October to December for the range of salinity between 23 ppt and 26 ppt. It is important to note that this analysis considers all habitat areas, including those inside the mouth and includes all the model grid up to RM 6.0. This provides a highly conservative evaluation of the potential impacts of sea level rise. Figures 3-2 and 3-3 present time series and cumulative distribution functions (CDFs) for the model period under the baseline and sea level rise scenarios. The CDF plots are for the October to December season and show that no significant impact on this resource from sea level rise.
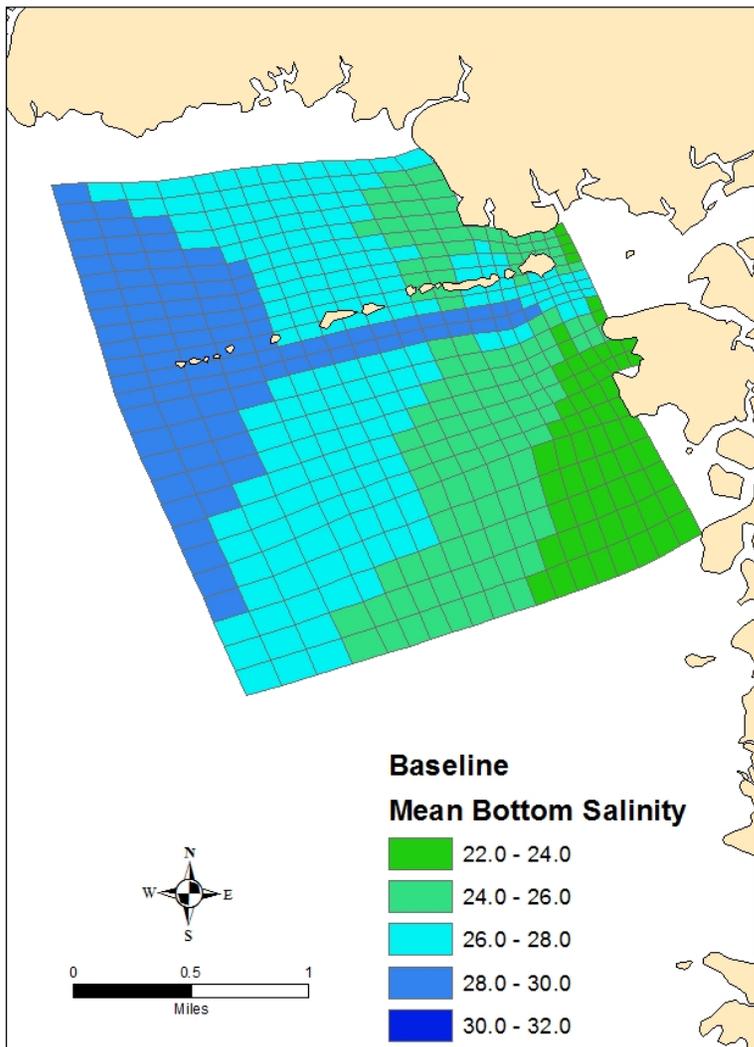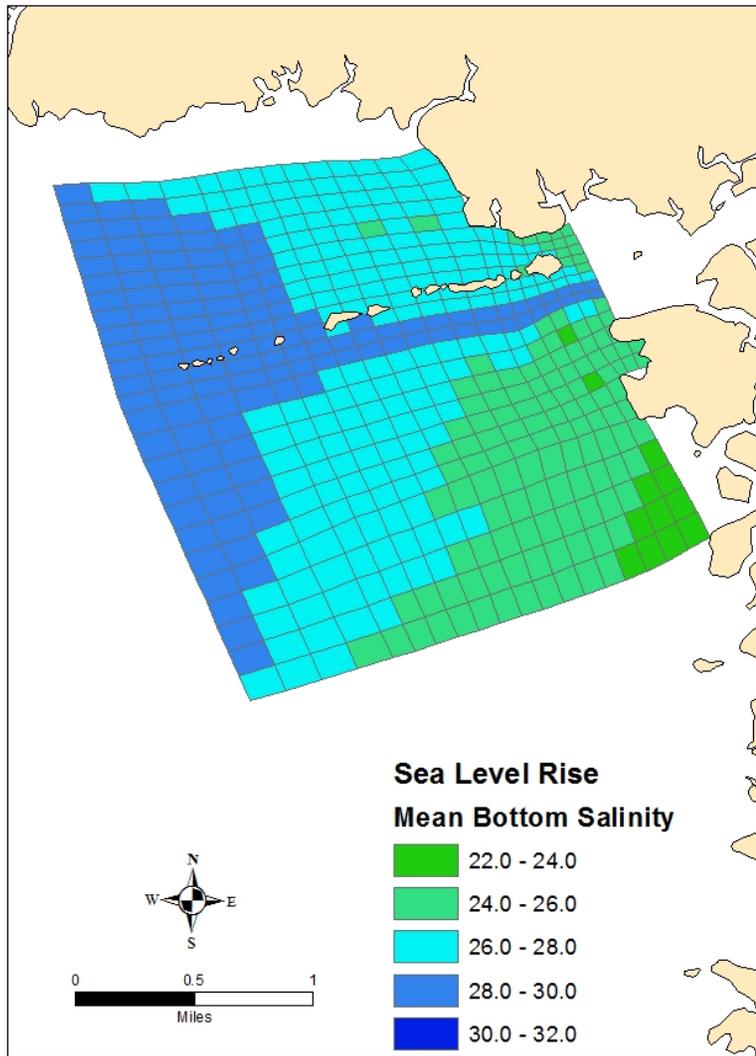
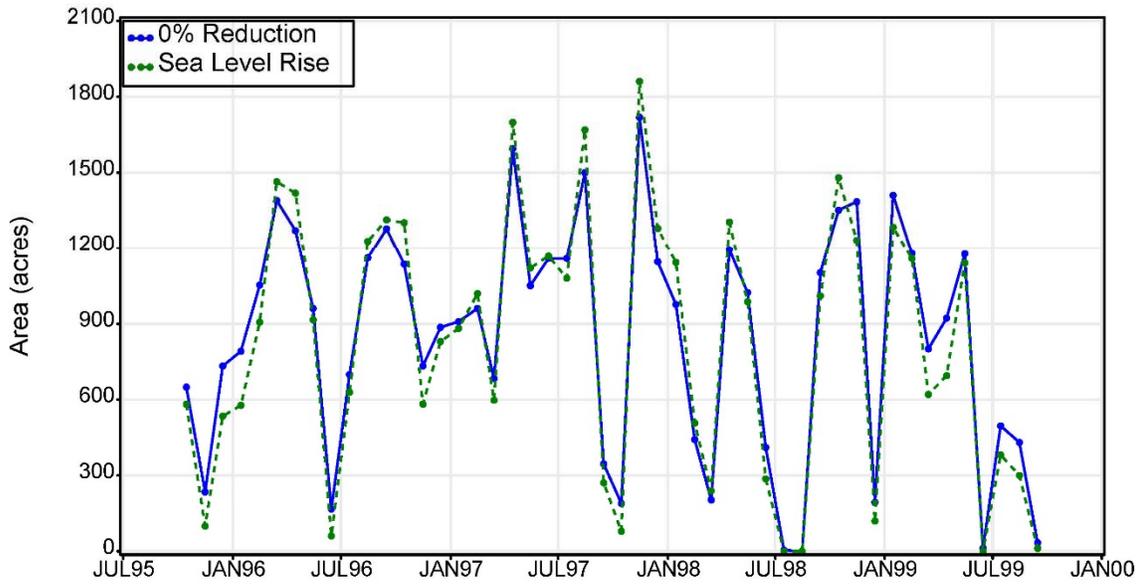*Figure 3-1. Mean bottom salinities in offshore area for Baseline Run and Sea Level Rise Run*

Figure 3-2. Time series of mean bottom area for baseline compared to sea level rise condition (23 to 26 ppt range)
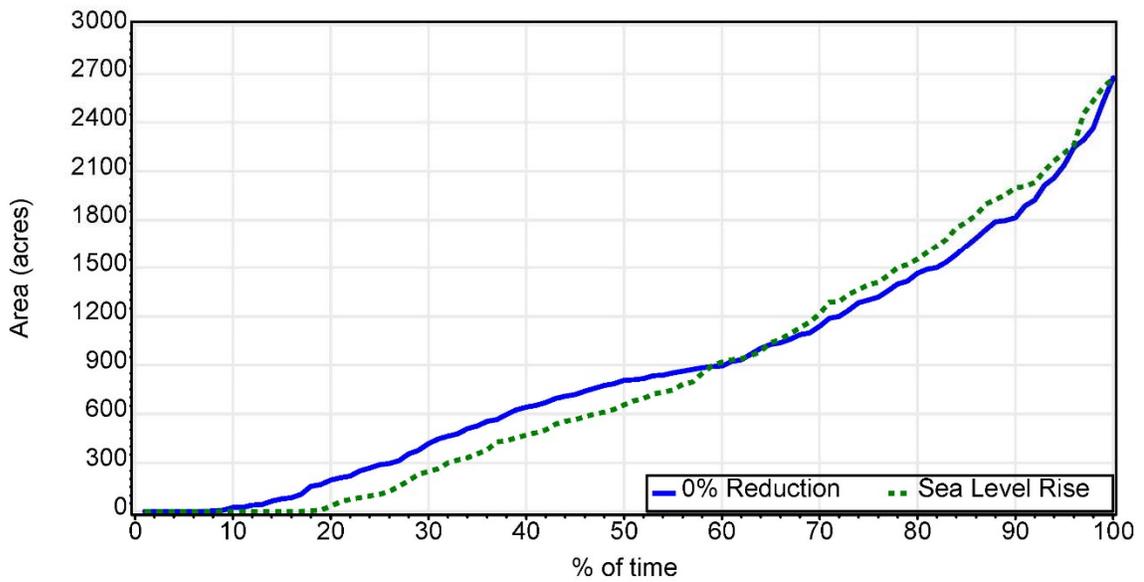

Figure 3-3. Cumulative distribution function of mean bottom area for baseline compared to sea level rise condition (23 to 26 ppt range).

3.2 RIVER/ESTUARINE HABITAT

The Steinhatchee River MFL for salinity was based on the responses in the river as indicated by the output from the model runs for the series of flow reductions (5 percent, 10 percent, 20 percent, and 30 percent) and the estimated differences from the base model scenario. The responses included the bottom habitat (area), the estuarine water column habitat (volume), and shoreline habitat [river miles (RMs)]. The analyses were all based on grids within the model below RM 6.0. A similar set of analyses was done for the sea level rise scenario in comparison with the baseline. The following provides brief discussions of the results. The discussion of the changes seen in the sea level rise is presented in the context of how the changes relate to changes seen in the flow reduction runs. Three salinity ranges were examined, which is consistent with the analyses done for the MFL. The ranges are less than 5.0 ppt, less than 2.0 ppt, and at 0 ppt.

Figures 3-4 through 3-6 present the time series of mean monthly river bottom area, water column volume, and shoreline length for these three salinity range conditions discussed. Figures 3-7 through 3-9 present the cumulative distribution functions for the same metric (bottom area, volume, and shoreline length), for the same salinity ranges. Tables 3-1 through 3-3 present a summary of the comparisons of the median river volume, bottom area, and shoreline length between the baseline run and the sea level rise run.

The changes are similar to those seen for the flow reduction scenarios, i.e., a net reduction in the overall habitat. Comparing changes seen for the sea level rise runs with the flow reduction runs shows that the 5.1-inch sea level rise has a similar effect to a 20 percent reduction in the flow.
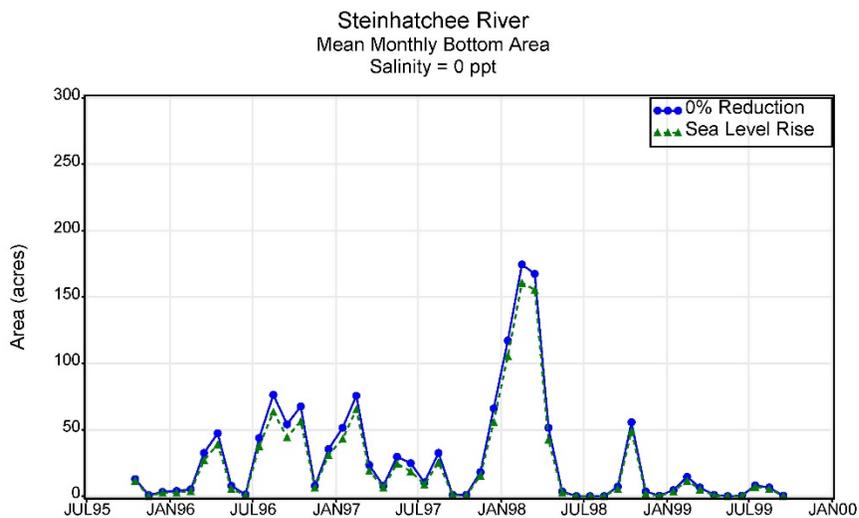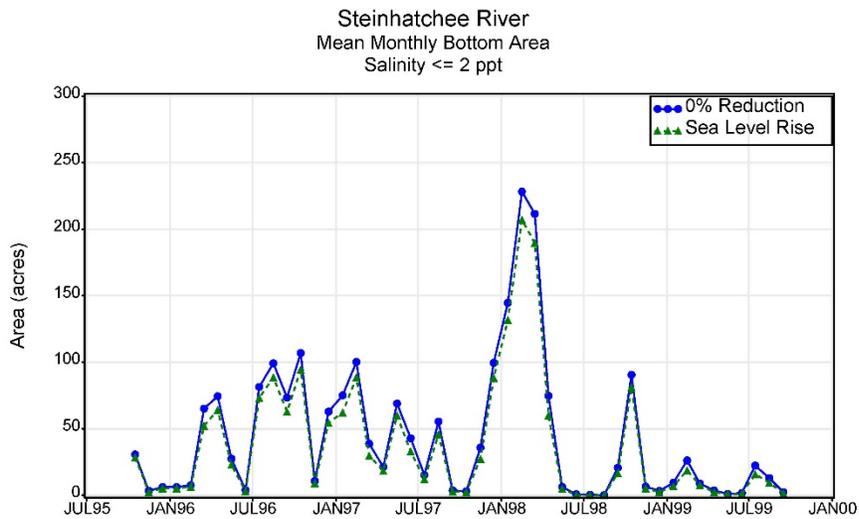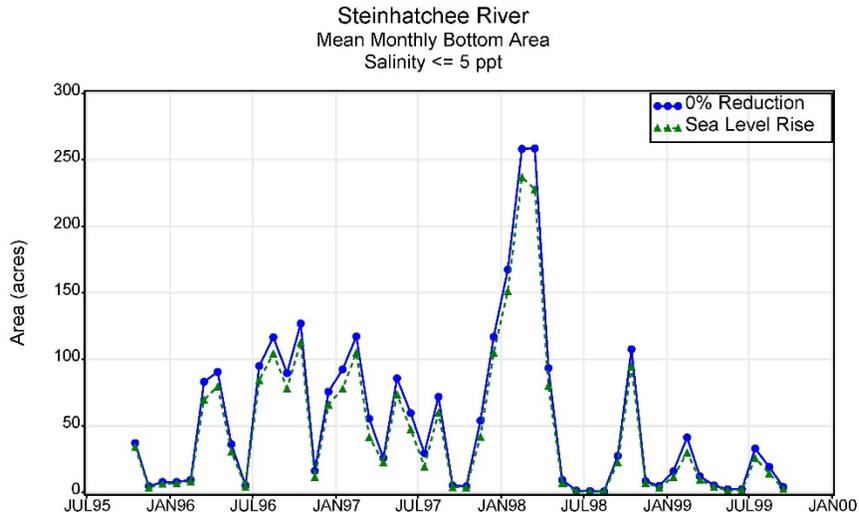
Figure 3-4. Time series of mean bottom area for baseline compared to sea level rise condition (≤5 ppt, ≤2 ppt, 0 ppt)
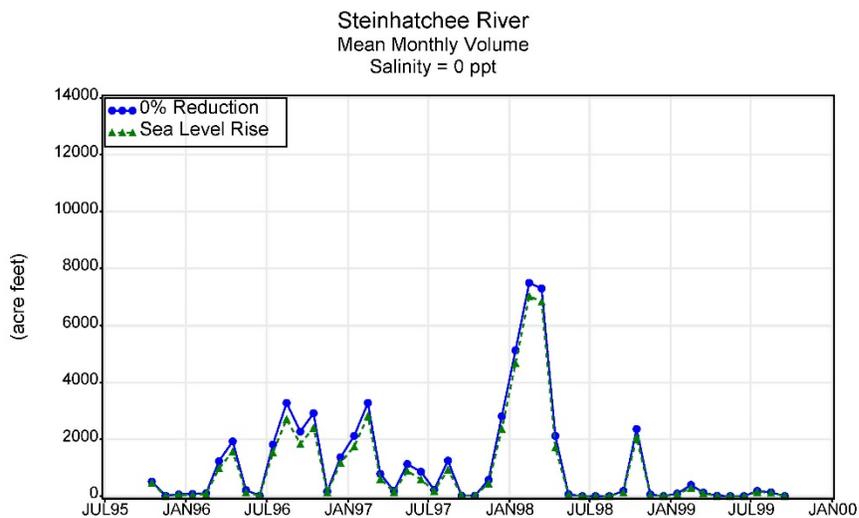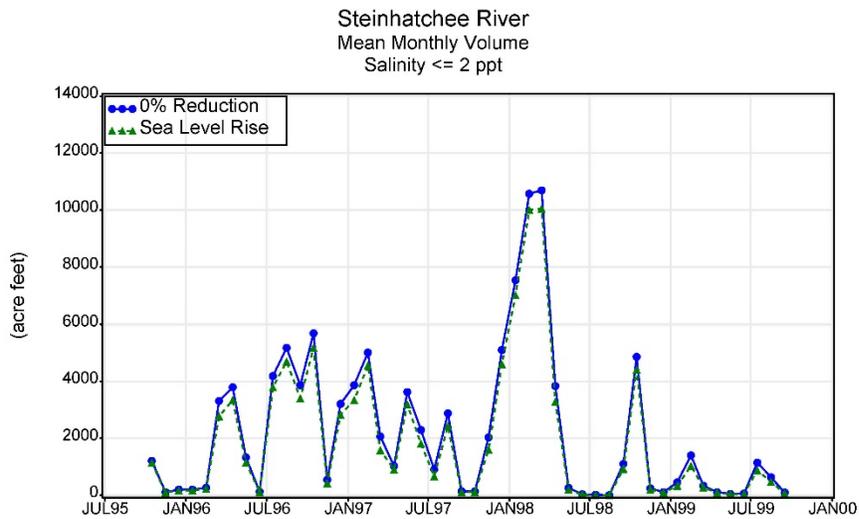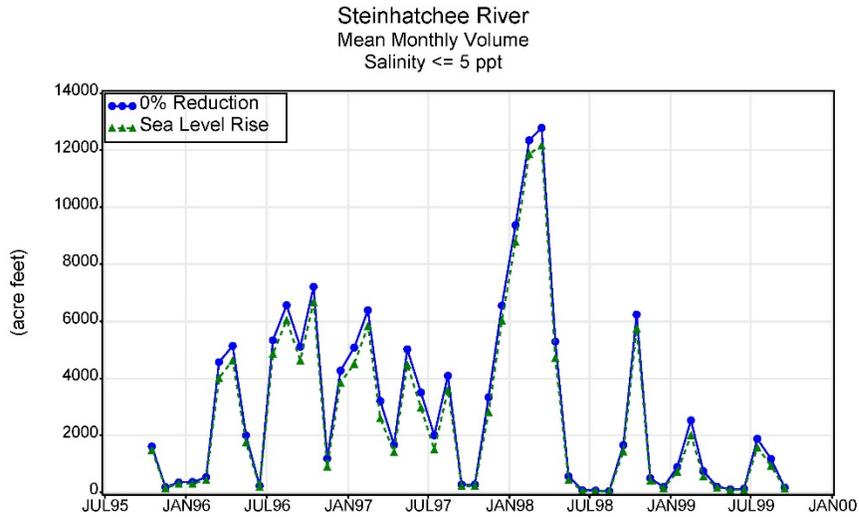
Figure 3-5. Time series of habitat volume for baseline compared to sea level rise condition
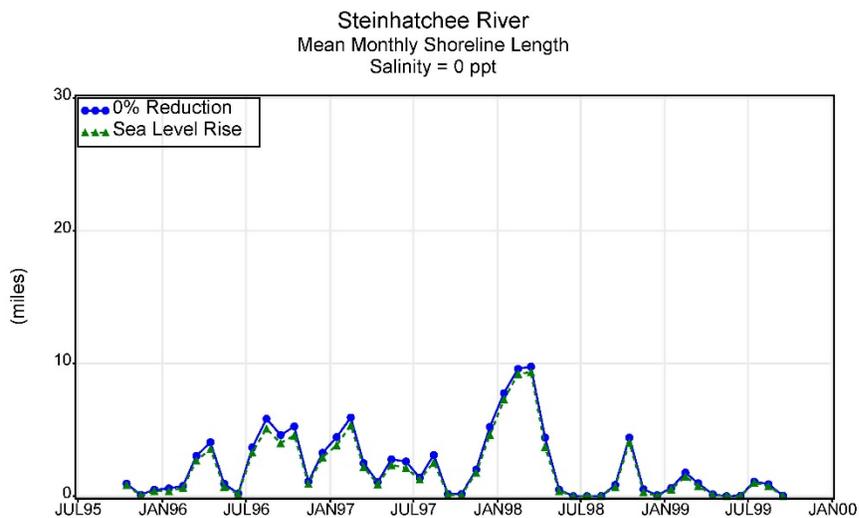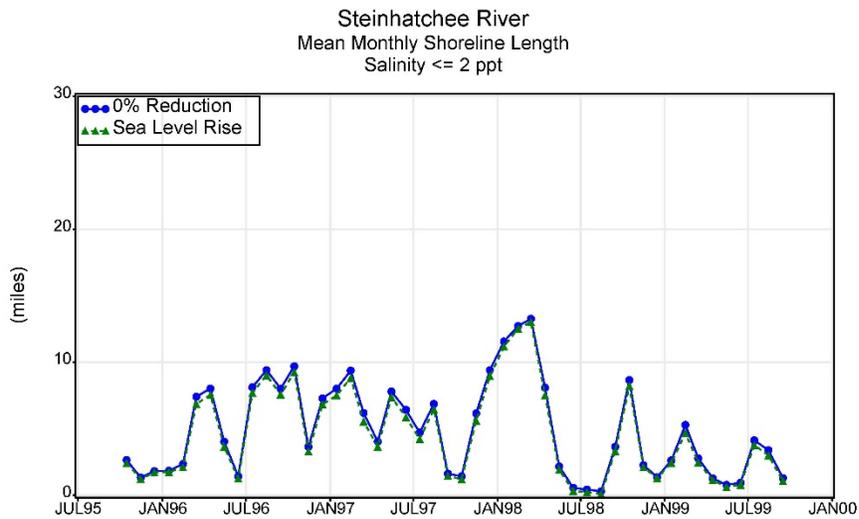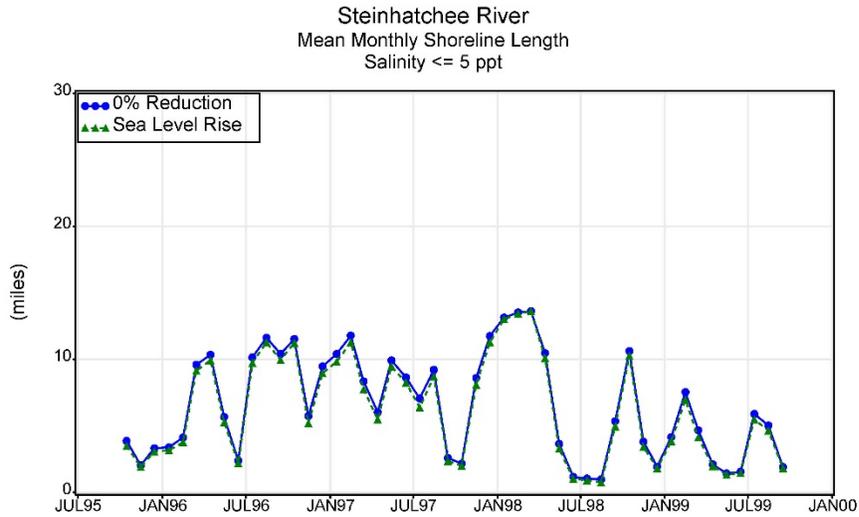(≤5 ppt, ≤2 ppt, 0 ppt)

Figure 3-6. Time series of shoreline length for baseline compared to sea level rise condition (≤5 ppt, ≤2 ppt, 0 ppt)
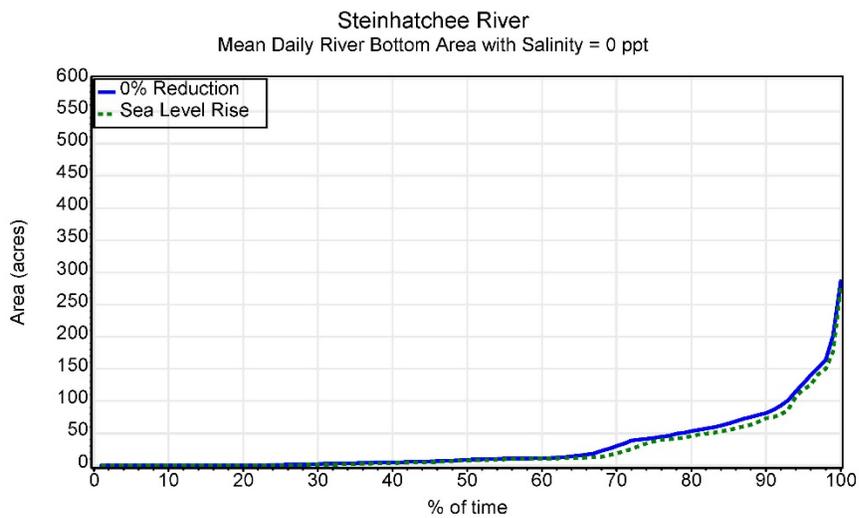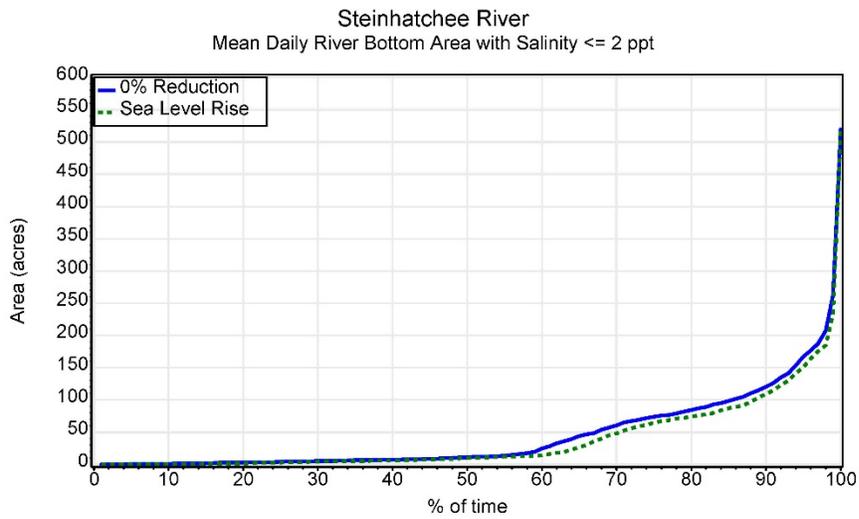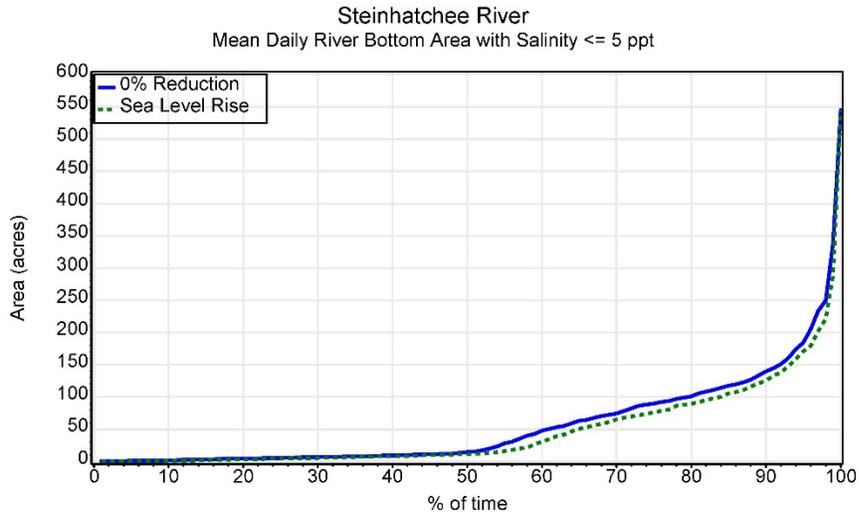
Figure 3-7. CDF of mean bottom area for baseline compared to sea level rise condition (≤5 ppt, ≤2 ppt, 0 ppt)
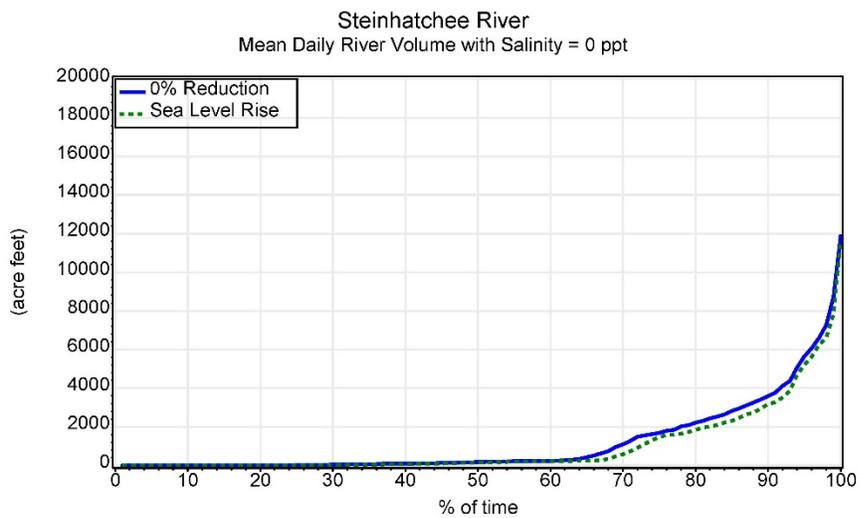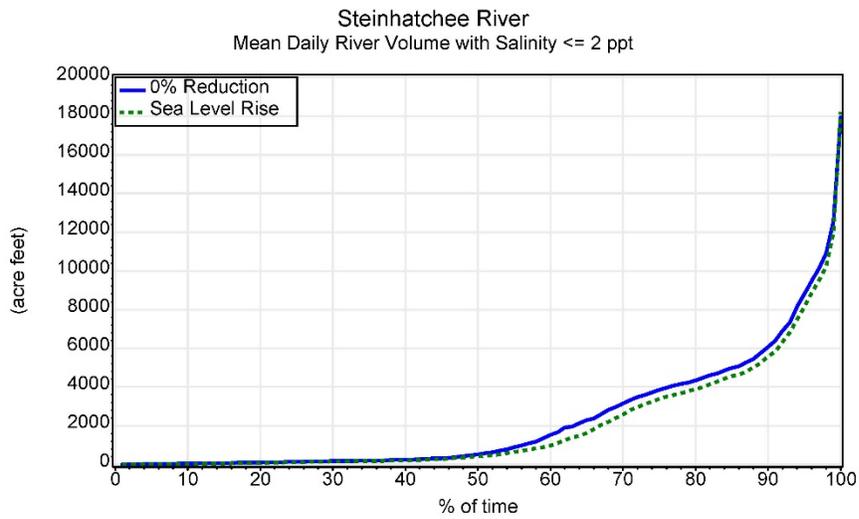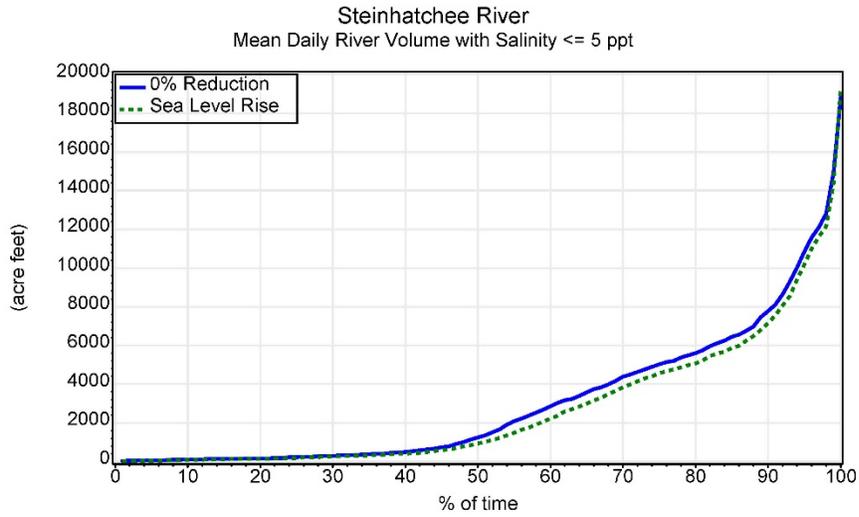
3-6

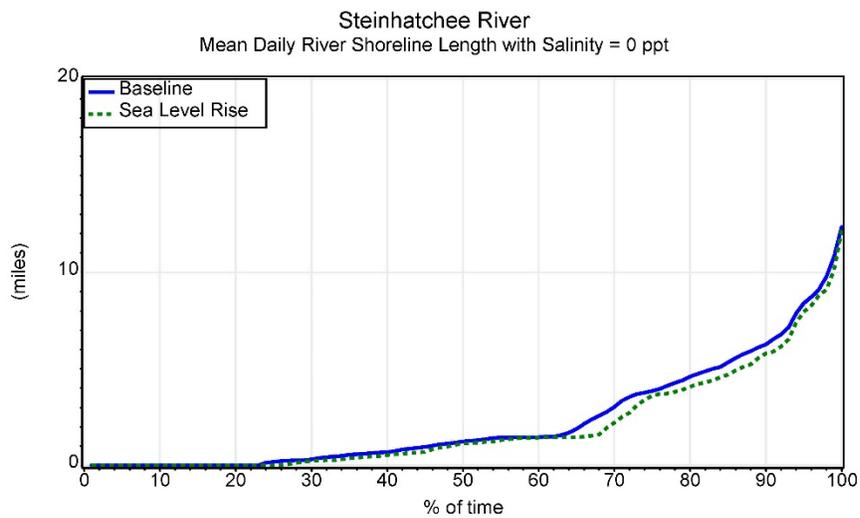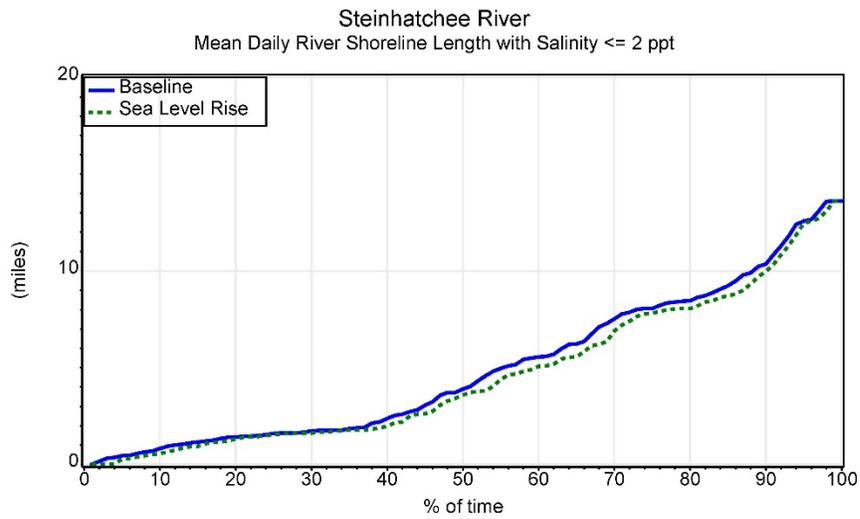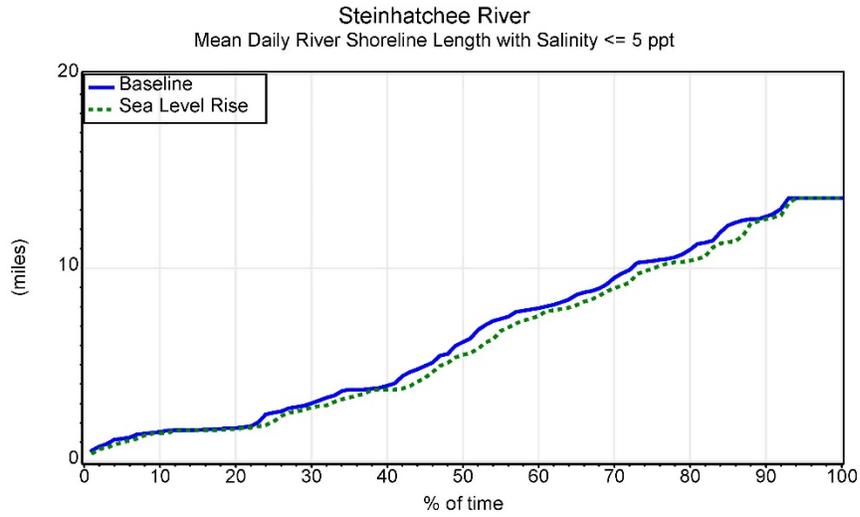*Figure 3-8. CDF of habitat volume for baseline compared to sea level rise condition (≤5 ppt, ≤2 ppt, 0 ppt)*

Figure 3-9. CDF of shoreline length for baseline compared to sea level rise condition (≤5 ppt, ≤2 ppt, 0 ppt)

Table 3-1. Comparison of median 0 percent flow reduction volume to the median volumes by critical salinity for the Sea Level Rise Run

Scenario	Statistic	0 ppt	0 – 2 ppt	0 – 5 ppt
Baseline	Volume (acre-ft)	173	505	1,246
Sea Level Rise	Volume (acre-ft)	152	418	930
	% Difference	-12.1%	-17.2%	-25.4%

Table 3-2. Comparison of median 0 percent flow reduction bottom area to the median bottom areas by critical salinity for the Sea Level Rise Run

Scenario	Statistic	0 ppt	0 – 2 ppt	0 – 5 ppt
Baseline	Bottom Area (acres)	8.59	10.98	14.4
Sea Level Rise	Bottom Area (acres)	7.44	9.74	11.45
	% Difference	-13.4%	-11.3%	-20.5%

Table 3 3. Comparison of median 0 percent flow reduction shoreline length to the median shoreline lengths by critical salinity for the Sea Level Rise Run

Scenario	Statistic	0 ppt	0 – 2 ppt	0 – 5 ppt
Baseline	Shoreline Length (miles)	1.24	3.91	6.19
Sea Level Rise	Shoreline Length (miles)	1.12	3.59	5.51
	% Difference	-9.3%	-8.0%	-11.0%

4.0   REFERENCES

Southwest Florida Water Management District (SWFWMD). 2012. Recommended Minimum Flows for the Chassahowitzka River System. Brooksville, FL.

U.S. Army Corps of Engineers (USACE). 2011. Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs. Circular No. 1165-2-212. http://140.194.76.129/publications/eng-circulars/EC_1165-2-212_2011Nov/EC_1165-2-212_2011Nov.pdf.