

Technical Support Document for U.S. EPA's Proposed Rule for Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and South Florida Inland Flowing Waters

Volume 1: Estuaries

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Disclaimer

This document supports the U.S. Environmental Protection Agency's (hereafter EPA or the Agency) numeric nutrient criteria proposed on November 30, 2012, pursuant to section 303(c)(4) of the Clean Water Act (CWA) (Title 40 of the *Code of Federal Regulations* [CFR] section 131.43). The information provided herein does not substitute for the CWA or EPA's regulations; nor is this document a regulation itself. Thus, this document cannot and does not impose any legally binding requirements on EPA, states, authorized tribes, the regulated community, or any other party, and might not apply to a particular situation or circumstance.

Contents

1. Methods Used to Derive Numeric Nutrient Criteria for Florida Estuaries	1
1.1. Deriving Numeric Criteria to Protect Designated Uses in Estuarine Waters	1
1.2. Nutrient-Sensitive Biological Endpoints and Water Quality Targets Used to Derive Numeric Nutrient Criteria	3
1.2.1. Water Clarity Targets Based on Seagrass Depth of Colonization	5
1.2.2. Maintenance of Balanced Algal Populations	11
1.2.3. DO Targets	13
1.3. Classification and Segmentation	15
1.3.1. Classification	15
1.3.2. Segmentation	18
1.4. Analytical Approaches Used to Derive Numeric Nutrient Criteria for Florida Estuaries	19
1.4.1. Water Quality Simulation Modeling	21
1.4.2. Statistical Models (Stressor-Response)	31
1.4.3. Data Sources	38
1.5. Application of Analytical Approaches for Numeric Nutrient Criteria Derivation	39
1.6. Analytical Approach Used to Derive Numeric Nutrient Criteria for the Protection of Downstream Estuaries	40
1.6.1. Introduction	40
1.6.2. Analytical Approaches for DPV Derivation	41
1.7. References	44
2. Estuary-Specific Numeric Nutrient Criteria and Downstream Protective Values	53
2.1. Perdido Bay	53
2.1.1. Proposed Numeric Nutrient Criteria	53
2.1.2. General Characteristics	53
2.1.3. Data Used	56
2.1.4. Segmentation	56
2.1.5. Water Quality Targets	58
2.1.6. Results of Analyses	59
2.1.7. Application of Analyses for Proposed Numeric Nutrient Criteria	60
2.1.8. Downstream Protective Values	61
2.1.9. References	61
2.2. Pensacola Bay	63

2.2.1.	Proposed Numeric Nutrient Criteria	63
2.2.2.	General Characteristics	63
2.2.3.	Data Used.....	67
2.2.4.	Segmentation.....	67
2.2.5.	Water Quality Targets.....	69
2.2.6.	Results of Analyses.....	70
2.2.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	71
2.2.8.	Downstream Protective Values.....	72
2.2.9.	References.....	73
2.3.	Choctawhatchee Bay.....	75
2.3.1.	Proposed Numeric Nutrient Criteria	75
2.3.2.	General Characteristics	75
2.3.3.	Data Used.....	79
2.3.4.	Segmentation.....	79
2.3.5.	Water Quality Targets.....	81
2.3.6.	Results of Analyses.....	82
2.3.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	87
2.3.8.	Downstream Protective Values.....	88
2.3.9.	References.....	88
2.4.	St. Andrews Bay	90
2.4.1.	Proposed Numeric Nutrient Criteria	90
2.4.2.	General Characteristics	90
2.4.3.	Data Used.....	94
2.4.4.	Segmentation.....	94
2.4.5.	Water Quality Targets.....	96
2.4.6.	Results of Analyses.....	97
2.4.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	104
2.4.8.	Downstream Protective Values.....	105
2.4.9.	References.....	106
2.5.	St. Joseph Bay.....	107
2.5.1.	Proposed Numeric Nutrient Criteria	107
2.5.2.	General Characteristics	108
2.5.3.	Data Used.....	111
2.5.4.	Segmentation.....	111
2.5.5.	Water Quality Targets.....	113
2.5.6.	Results of Analyses.....	114

2.5.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	116
2.5.8.	Downstream Protective Values.....	117
2.5.9.	References.....	118
2.6.	Apalachicola Bay.....	120
2.6.1.	Proposed Numeric Nutrient Criteria.....	120
2.6.2.	General Characteristics.....	120
2.6.3.	Data Used.....	124
2.6.4.	Segmentation.....	124
2.6.5.	Water Quality Targets.....	126
2.6.6.	Results of Analyses.....	127
2.6.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	128
2.6.8.	Downstream Protective Values.....	129
2.6.9.	References.....	129
2.7.	Alligator Harbor.....	132
2.7.1.	Proposed Numeric Nutrient Criteria.....	132
2.7.2.	General Characteristics.....	132
2.7.3.	Data Used.....	134
2.7.4.	Segmentation.....	135
2.7.5.	Water Quality Targets.....	137
2.7.6.	Results of Analyses.....	138
2.7.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	139
2.7.8.	Downstream Protective Values.....	139
2.7.9.	References.....	140
2.8.	Ochlockonee Bay.....	142
2.8.1.	Proposed Numeric Nutrient Criteria.....	142
2.8.2.	General Characteristics.....	142
2.8.3.	Data Used.....	146
2.8.4.	Segmentation.....	146
2.8.5.	Water Quality Targets.....	148
2.8.6.	Results of Analyses.....	149
2.8.7.	Application of Analyses for Proposed Numeric Nutrient Criteria.....	150
2.8.8.	Downstream Protective Values.....	152
2.8.9.	References.....	152
2.9.	Big Bend.....	155
2.9.1.	Proposed Numeric Nutrient Criteria.....	155
2.9.2.	General Characteristics.....	155

2.9.3. Data Used.....	158
2.9.4. Segmentation.....	159
2.9.5. Water Quality Targets.....	161
2.9.6. Results of Analyses.....	162
2.9.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	164
2.9.8. Downstream Protective Values.....	167
2.9.9. References.....	168
2.10. Suwannee Sound.....	171
2.10.1. Proposed Numeric Nutrient Criteria.....	171
2.10.2. General Characteristics.....	171
2.10.3. Data Used.....	174
2.10.4. Segmentation.....	174
2.10.5. Water Quality Targets.....	176
2.10.6. Results of Analyses.....	177
2.10.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	179
2.10.8. Downstream Protective Values.....	180
2.10.9. References.....	180
2.11. Springs Coast.....	183
2.11.1. Proposed Numeric Nutrient Criteria.....	183
2.11.2. General Characteristics.....	183
2.11.3. Data Used.....	187
2.11.4. Segmentation.....	188
2.11.5. Water Quality Targets.....	190
2.11.6. Results of Analyses.....	191
2.11.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	196
2.11.8. Downstream Protective Values.....	199
2.11.9. References.....	200
2.12. Clearwater Harbor/St. Joseph Sound.....	203
2.12.1. Proposed Numeric Nutrient Criteria.....	203
2.12.2. Downstream Protective Values.....	203
2.13. Tampa Bay.....	203
2.13.1. Proposed Numeric Nutrient Criteria.....	203
2.13.2. Downstream Protective Values.....	203
2.14. Sarasota Bay.....	204
2.14.1. Proposed Numeric Nutrient Criteria.....	204
2.14.2. Downstream Protective Values.....	205

2.15. Charlotte Harbor/Estero Bay.....	205
2.15.1. Proposed Numeric Nutrient Criteria	205
2.15.2. Downstream Protective Values.....	205
2.16. Lake Worth Lagoon/Loxahatchee.....	207
2.16.1. Proposed Numeric Nutrient Criteria	207
2.16.2. General Characteristics	207
2.16.3. Data Used.....	211
2.16.4. Segmentation.....	212
2.16.5. Water Quality Targets.....	213
2.16.6. Results of Analyses.....	213
2.16.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	219
2.16.8. Downstream Protective Values.....	221
2.16.9. References.....	221
2.17. St. Lucie Estuary.....	224
2.17.1. Proposed Numeric Nutrient Criteria	224
2.17.2. General Characteristics	224
2.17.3. Data Used.....	228
2.17.4. Segmentation.....	228
2.17.5. Water Quality Targets.....	229
2.17.6. Results of Analyses.....	229
2.17.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	234
2.17.8. Downstream Protective Values.....	235
2.17.9. References.....	235
2.18. Indian River Lagoon	237
2.18.1. Proposed Numeric Nutrient Criteria	237
2.18.2. General Characteristics	238
2.18.3. Data Used.....	242
2.18.4. Segmentation.....	242
2.18.5. Water Quality Targets.....	244
2.18.6. Results of Analyses.....	245
2.18.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	251
2.18.8. Downstream Protective Values.....	252
2.18.9. Alternate Analyses	253
2.18.10. References	257
2.19. Halifax River.....	260
2.19.1. Proposed Numeric Nutrient Criteria	260

2.19.2. General Characteristics	260
2.19.3. Data Used.....	264
2.19.4. Segmentation.....	264
2.19.5. Water Quality Targets.....	266
2.19.6. Results of Analyses.....	266
2.19.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	268
2.19.8. Downstream Protective Values.....	269
2.19.9. Alternate Analysis.....	270
2.19.10. References	271
2.20. Guana, Tolomato, Matanzas, Pellicer System	273
2.20.1. Proposed Numeric Nutrient Criteria	273
2.20.2. General Characteristics	274
2.20.3. Data Used.....	278
2.20.4. Segmentation.....	278
2.20.5. Water Quality Targets.....	280
2.20.6. Results of Analyses.....	280
2.20.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	282
2.20.8. Downstream Protective Values.....	283
2.20.9. Alternate Analysis.....	285
2.20.10. References	285
2.21. St. Johns River	288
2.21.1. Proposed Numeric Nutrient Criteria	288
2.21.2. General Characteristics	288
2.21.3. Data Used.....	291
2.21.4. Segmentation.....	291
2.21.5. Water Quality Targets.....	293
2.21.6. Results of Analyses.....	293
2.21.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	297
2.21.8. Downstream Protective Values.....	297
2.21.9. Alternate Analysis.....	298
2.21.10. References	299
2.22. Nassau River/Big Talbot.....	303
2.22.1. Proposed Numeric Nutrient Criteria	303
2.22.2. General Characteristics	303
2.22.3. Data Used.....	306
2.22.4. Segmentation.....	306

2.22.5. Water Quality Targets.....	308
2.22.6. Results of Analyses.....	308
2.22.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	309
2.22.8. Downstream Protective Values.....	310
2.22.9. References.....	310
2.23. St. Marys River/Amelia River	312
2.23.1. Proposed Numeric Nutrient Criteria	312
2.23.2. General Characteristics	312
2.23.3. Data Used.....	315
2.23.4. Segmentation.....	316
2.23.5. Water Quality Targets.....	317
2.23.6. Results of Analyses.....	317
2.23.7. Application of Analyses for Proposed Numeric Nutrient Criteria.....	318
2.23.8. Downstream Protective Values.....	319
2.23.9. References.....	319
3. Other Analyses: Tidal Creeks and Marine Lakes	322
3.1. Tidal Creeks.....	322
3.1.1. Derivation of Numeric Nutrient Criteria for Tidal Creeks	323
3.2. Marine Lakes	324
3.2.1. Definition and Classification	325
3.2.2. Water Quality.....	327
3.2.3. Response to Nutrients: Comparison of Inland and Marine Lakes	328
3.2.4. Proposed Numeric Nutrient Criteria for Marine Lakes	331
3.2.5. Application of the Inland Lake Criteria to 50 Marine Lakes.....	331
3.3. References.....	332
Appendix A: Estuary System Descriptions	
Appendix B: Statistical (Stressor-Response) Analysis	
Appendix C: Watershed Hydrology and Water Quality Modeling Report for Florida Watersheds	
Appendix D: Hydrodynamic and Water Quality Modeling Report for Nutrient Criteria for Florida Estuary Systems	
Appendix E: Uncertainty Analysis for Water Quality Simulation Modeling	
Appendix F: Marine Lakes Analysis and Supporting Data	
Appendix G: Supporting Material for Alternate Analyses	

Figures

Figure 1-1. Schematic of methods used by EPA to derive the light attenuation coefficient (K_d) to reach a numeric nutrient criteria.....	7
Figure 1-2. The approach for computing seagrass depth of colonization, illustrated for segment 0409 in St. Andrews Bay. (A) Seagrass coverage in the segment in 1953 (patchy seagrass = orange; continuous seagrass = green). (B) Bathymetric soundings within 1 km of the seagrass. Symbols are colored based on proximity to seagrass (green = in continuous seagrass; orange = in patchy seagrass; grey = not in seagrass. (C) A close-up from the scene in (B) illustrating the density of bathymetric soundings.....	9
Figure 1-3. Proportion of soundings in seagrass based on the 1953 seagrass coverage, grouped by 25 cm depth bins for segment 0409 (St. Andrews Bay). The maximum proportion of soundings in seagrass was 65 percent. The depth at which this was reduced by half is 1.3 m below mean lower low water. The local difference between mean lower low water and mean tide level is 0.22 m, based on NOAA tide gauge 8729179. Therefore, the depth of colonization for this segment in 1953 was 1.52 m.....	9
Figure 1-4. Delineation of estuarine waters in Florida and their associated watershed boundaries by color; the watershed for south Florida estuaries is shown in white	17
Figure 1-5. Linkage between LSPC, EFDC, and WASP7 models	22
Figure 1-6. Location of Florida watersheds and their watershed numbers	23
Figure 1-7. Estuary model sensitivity of chl-a to nutrient changes	29
Figure 1-8. Estuary model sensitivity of light attenuation coefficient (K_d) to nutrient changes	30
Figure 1-9. Estuary model sensitivity of water column DO to nutrient changes.....	30
Figure 1-10. Example of estimated relationship between chl-a and light attenuation coefficient (K_d). Red horizontal line shows light attenuation coefficient corresponding with seagrass depth of colonization target for the segment. Red vertical arrow show annual geometric mean chl-a concentration predicted to be associated with light attenuation coefficient target. Green line segment shows the 5 th to 95 th percentile range of observed annual geometric mean values for chl-a. Open circles show measured annual average values of light attenuation coefficient (adjusted for the effect of turbidity and color) and chl-a.	33

Figure 1-11. Example of model of the relationship between annual geometric mean chl-a concentration and bloom frequency. Open circles: observed annual frequency of chl-a concentrations exceeding 20 µg/L versus annual geometric mean chl-a concentration for the same year; solid black line: modeled relationship between mean chl-a concentration and bloom frequency; horizontal red line: targeted bloom frequency of 10%; vertical red arrow: annual geometry mean chl-a concentration associated with targeted bloom frequency; green line segment: 5 th to 95 th percentile range of observed annual geometric mean chl-a concentrations.....	34
Figure 1-12. Estimates of the slopes between light attenuation coefficient and chl-a in different estuarine segments. Two panels from top to bottom show Northwest and Eastern estuaries. Vertical lines show estimates of the 90% confidence intervals on each slope, open circles show mean estimate of slope.	35
Figure 1-13. Example of estimated stressor-response relationship between TN and chl-a. Blue line: segment mean relationship. Grey lines: relationships estimated within different stations. Red horizontal line shows the chl-a criterion associated with the water clarity endpoint for each segment. Green line segment shows the 5 th to 95 th percentile range of observed annual geometric mean TN values. Open circles show observed values of annual geometric mean chl-a and TN.	36
Figure 1-14. Estimates of the slope of the linear relationship between annual geometric mean TN and chl-a among different segments. Two panels from top to bottom show Northwest and Eastern estuaries. Open circles: mean estimate of slope; vertical lines: estimated 90% confidence intervals.	37
Figure 1-15. Estimates of the slope of the linear relationship between annual geometric mean TP and chl-a among different segments. Two panels from top to bottom show Northwest and Eastern estuaries. Open circles: mean estimate of slope; vertical lines: estimated 90% confidence intervals.	38
Figure 1-16. Dilution model approach schematic. Calculation of TP DPVs for GTMP. Black diamond shows seawater conditions, filled green circles show proposed TP criterion values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TP concentrations and salinities.....	43
Figure 2-1. Results of Perdido Bay segmentation	57
Figure 2-2. Seagrass distribution in Perdido Bay in 1940	58
Figure 2-3. Results of Pensacola Bay segmentation	68
Figure 2-4. Seagrass coverage for Pensacola Bay in 1960	69
Figure 2-5. Results of Choctawhatchee Bay segmentation	80
Figure 2-6. Map of 1992 Seagrass coverage in Choctawhatchee Bay. Seagrass is indicated as continuous (green) or discontinuous (teal). Estuary segmentation scheme is indicated in grey. Irregular north-south lines in central and eastern Choctawhatchee Bay are bridges.....	81

Figure 2-7. Relationships between annual geometric light attenuation coefficient (K_d) and chl-a in Choctawhatchee Bay. Solid black line: segment-wide relationship; red horizontal line: K_d target; red vertical arrow: chl-a concentrations associated with K_d target; green line segment: 5 th to 95 th percentile range of chl-a concentrations, open circles: observed annual geometric mean K_d and chl-a concentrations.	83
Figure 2-8. Estimates of annual geometric chl-a concentrations associated with bloom frequency of 0.1 in Choctawhatchee Bay. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5 th to 95 th percentile range of observed data.	84
Figure 2-9. Relationships between TP and chl-a in Choctawhatchee Bay. Open circles: observed annual average values of TP and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TP criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TP and chl-a, grey lines: estimated station-specific relationships between TP and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TP concentrations.	85
Figure 2-10. Relationships between TN and chl-a in Choctawhatchee Bay. Open circles: observed annual average values of TN and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TN and chl-a, grey lines: estimated station-specific relationships between TN and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN concentrations.	86
Figure 2-11. Results of St. Andrews Bay segmentation	95
Figure 2-12. Map of the 1953 seagrass distribution in St. Andrews Bay. The boundaries of EPA estuary segments are plotted in light grey.	97
Figure 2-13. Relationships between annual geometric K_d and chl-a in St. Andrews Bay. Solid black line: segment-wide relationship; red horizontal line: K_d target; red vertical arrow: chl-a concentrations associated with K_d target; green line segment: 5 th to 95 th percentile range of chl-a concentrations, open circles: observed annual geometric mean K_d and chl-a concentrations.	100
Figure 2-14. Relationships between TP and chl-a in St. Andrews Bay. Open circles: observed annual average values of TP and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TP criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TP and chl-a, grey lines: estimated station-specific relationships between TP and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TP concentrations.	102

Figure 2-15. Relationships between TN and chl-a in St. Andrews Bay. Open circles: observed annual average values of TN and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TN and chl-a, grey lines: estimated station-specific relationships between TN and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN concentrations.....	103
Figure 2-16. Results of St. Joseph Bay segmentation.....	112
Figure 2-17. 1992 seagrass coverage in St. Joseph Bay	113
Figure 2-18. Modeled relationship between K_d and chl-a. Open circles: annual geometric means of K_d and chl-a, solid line: estimated mean relationship, red horizontal line: K_d target, vertical red arrow: criterion value associated with stressor-response relationship.	115
Figure 2-19. Modeled relationship between bloom frequency and chl-a. Solid black line: modeled mean relationship. Open circles: observed annual geometric means. Dashed horizontal line: 10 percent bloom frequency endpoint. Green line segment: 5 th to 95 th percentile range of observed data.	116
Figure 2-20. Relationships between TN, TP, and chl-a in St. Joseph Bay. Open circles: observed annual average values of TN and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	116
Figure 2-21. Results of Apalachicola Bay segmentation.....	125
Figure 2-22. 1992 seagrass coverage for Apalachicola Bay	126
Figure 2-23. Results of Alligator Harbor segmentation.....	136
Figure 2-24. Seagrass coverage in the vicinity of Alligator Harbor in 1992. A seagrass area was associated with an offshore sand bar approximately 3 nautical miles from the coast. The apparent western limit of seagrass at the boundary of segments 0702 and 0703 likely results from the spatial limits of the seagrass coverage data, rather than the seagrass itself.....	137
Figure 2-25. Results of Ochlockonee Bay segmentation.....	147
Figure 2-26. Seagrass coverage in the vicinity of Ochlockonee Bay in 1992. Green and orange indicate seagrass delineated as continuous and patchy, respectively.	148
Figure 2-27. Results of Big Bend segmentation	160
Figure 2-28. Seagrass coverage in 1992 in the vicinity of the Fenholloway River	161
Figure 2-29. Seagrass coverage in 1992 between the Steinhatchee River and the Suwannee River	162
Figure 2-30. Results of Suwannee Sound segmentation.....	175

Figure 2-31. Seagrass coverage in the vicinity of the Suwannee River in 2001. Green and orange indicate continuous and patchy seagrass coverage, respectively.	176
Figure 2-32. Modeled relationship between bloom frequency and TN, TP, and chl-a in Suwannee Sound. Solid black line: modeled mean relationship. Open circles: observed annual geometric means. Dashed horizontal line: 10 percent bloom frequency endpoint. Green line segment: 5 th to 95 th percentile range of observed data.	178
Figure 2-33. Relationships between TN, TP, and chl-a in Suwannee Sound. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	179
Figure 2-34. Results of Springs Coast segmentation	189
Figure 2-35. Relationships between phytoplankton blooms and annual geometric mean chl-a in Crystal River (0812 and 0813) and Waccasassa River (0815). Open circles: observed annual geometric mean chl-a and bloom frequency; red horizontal line: targeted bloom frequency of 10 percent; red vertical arrow: chl-a concentration corresponding to targeted bloom frequency; green line segment: 5 th to 95 th percentile range of observed data.	194
Figure 2-36. Relationships between TN, TP, and chl-a in Crystal River and Waccasassa River. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	195
Figure 2-37. Results of Lake Worth Lagoon/Loxahatchee segmentation	212
Figure 2-38. Relationships between annual corrected geometric K _d and chl-a in the Loxahatchee River. Solid black line: segment-wide relationship; red horizontal line: K _d target; red vertical arrow: chl-a concentrations associated with K _d target; green line segment: 5 th to 95 th percentile range of chl-a concentrations, open circles: observed annual geometric mean K _d , corrected for the effects of color and turbidity, and chl-a concentrations.....	216
Figure 2-39. Estimates of annual geometric chl-a concentrations associated with bloom frequency of 0.1 in the Loxahatchee River. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5 th to 95 th percentile range of observed data.	217

Figure 2-40. Relationships between TN, TP, and chl-a in the Loxahatchee River. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	218
Figure 2-41. Results of St. Lucie Estuary segmentation.....	228
Figure 2-42. Relationships between corrected annual geometric K_d and chl-a in segment 1401, St. Lucie Estuary. Solid black line: segment-wide relationship; red horizontal line: K_d target; red vertical arrow: chl-a concentrations associated with K_d target; green line segment: 5 th to 95 th percentile range of chl-a concentrations, open circles: observed annual geometric mean K_d , corrected for the effects of color and turbidity, and chl-a concentrations.....	231
Figure 2-43. Estimates of annual geometric chl-a concentrations associated with bloom frequency of 0.1 in St. Lucie. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5 th to 95 th percentile range of observed data.	232
Figure 2-44. Relationships between TN, TP, and chl-a in St. Lucie Estuary. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	233
Figure 2-45. Results of Indian River Lagoon segmentation.....	243
Figure 2-46. Relationships between chl-a and corrected K_d in Indian River Lagoon. Red horizontal line shows K_d corresponding with water clarity target. Red vertical arrow show annual geometric mean chl-a concentration predicted to be associated with K_d target. Green line segment shows the 5 th to 95 th percentile range of observed geometric mean values for chl-a. Open circles: observed values of K_d corrected for the effects of turbidity and color.	246
Figure 2-47. Estimates of annual geometric chl-a concentrations associated with bloom frequency in Indian River Lagoon. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5 th to 95 th percentile range of observed data.	247

Figure 2-48. Relationships between TP and chl-a in Indian River Lagoon. Open circles: observed annual average values of TP and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TP criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TP and chl-a, grey lines: estimated station-specific relationships between TP and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TP concentrations.....	249
Figure 2-49. Relationships between TN and chl-a in Indian River Lagoon. Open circles: observed annual average values of TN and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN criterion associated with chl-a criterion, blue line: estimated segment-wide relationship between TN and chl-a, grey lines: estimated station-specific relationships between TN and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN concentrations.....	250
Figure 2-50. Calculation of TN DPVs for Indian River Lagoon. Black diamond shows seawater conditions, filled green circles show proposed TN criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TN concentrations and salinities.	252
Figure 2-51. Calculation of TP DPVs for Indian River Lagoon. Black diamond shows seawater conditions, filled green circles show proposed TP criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TP concentrations and salinities.	252
Figure 2-52. Results of Halifax River segmentation	265
Figure 2-53. Modeled relationship between bloom frequency and chl-a in the Halifax River. Solid black line: modeled mean relationship. Open circles: observed annual geometric means. Red horizontal line: 10 percent bloom frequency endpoint. Green line segment: 5 th to 95 th percentile range of observed data.....	267
Figure 2-54. Relationships between TN, TP, and chl-a in the Halifax River. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	268
Figure 2-55. Calculation of TN DPVs for the Halifax River. Black diamond shows seawater conditions, filled green circles show proposed TN criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TN concentrations and salinities.	269
Figure 2-56. Calculation of TP DPVs for the Halifax River. Black diamond shows seawater conditions, filled green circles show proposed TP criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TP concentrations and salinities.	270
Figure 2-57. Results of GTMP Estuary segmentation	279

Figure 2-58. Estimates of annual geometric chl-a concentrations associated with bloom frequency of 0.1 in GTMP. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5 th to 95 th percentile range of observed data.	281
Figure 2-59. Relationships between TN, TP, and chl-a in GTMP. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TN and TP concentrations.	282
Figure 2-60. Calculation of TN DPVs for GTMP. Black diamond shows seawater conditions, filled green circles show proposed TN criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TN concentrations and salinities. Filled blue circle shows TN criteria computed for segment 1702.	284
Figure 2-61. Calculation of TP DPVs for GTMP. Black diamond shows seawater conditions, filled green circles show proposed TP criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TP concentrations and salinities.	284
Figure 2-62. Results of St. Johns Estuary segmentation.	292
Figure 2-63. Estimates of annual geometric chl-a concentrations associated with bloom frequency of 0.1 in the St. Johns. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5 th to 95 th percentile range of observed data.	295
Figure 2-64. Relationships between TP, TN, and chl-a in St Johns. Open circles: observed annual average values of TP, TN, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TP and TN criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TP, TN, and chl-a, grey lines: estimated station-specific relationships between TP, TN, and chl-a, green line segment: 5 th to 95 th percentile range of observed annual geometric mean TP and TN concentrations.	296
Figure 2-65. Results of Nassau River/Big Talbot Estuary segmentation	307
Figure 2-66. Results of St. Marys River/Amelia River segmentation	316
Figure 3-1. Locations of the 50 candidate marine lakes used in the assessment (yellow), including the 12 lakes designated in state water quality standards (red)	326

Figure 3-2. Chl-a–nutrient relationships for TN (a) and TP (b) for clear (< 40 PCU) marine lakes (N = 52 lake years for 11 lakes) (filled circles), as compared to clear inland lakes (crosses). Horizontal arrows show inland chl-a criteria (solid: low alkalinity; dashed: high alkalinity), and vertical arrows show range of TN and TP inland criteria.329

Figure 3-3. Chl-a–nutrient relationships for TN (a) and TP (b) for colored (> 40 PCU) marine lakes (N = 79 lake years for 22 lakes) (filled circles), as compared to inland lakes with moderate (40–140 PCU) (crosses) and high color (> 140 PCU) (triangles). Horizontal arrows show inland chl-a criteria (20 µg/L), and vertical arrows show range of TN and TP inland criteria.330

Tables

Table 1-1. Terminology to describe endpoints and targets	3
Table 1-2. Summary of estuary system classification and endpoints	4
Table 1-3. Identification of estuarine systems in Florida	16
Table 1-4. Segments derived for each estuary system	19
Table 1-5. Summary of estuary system segmentation, endpoints, and analytical methods	20
Table 1-6. Relationship between estuary systems, EFDC and WASP7 estuary models, and LSPC watershed models	24
Table 1-7. Calibration/validation ratings for EFDC/WASP7 applications for Florida estuaries	26
Table 1-8. Relative errors and statistical targets for hydrologic calibration (Lumb et al. 1994)	26
Table 1-9. Data sources for empirical and water quality simulation modeling	39
Table 2-1. Proposed numeric nutrient criteria for Perdido Bay segments	53
Table 2-2. Data sources specific to Perdido Bay models	56
Table 2-3. Perdido Bay seagrass depth and water clarity targets by segment	58
Table 2-4. Average load contributions from the Perdido watershed (2002–2009)	59
Table 2-5. Water quality targets met for Perdido Bay based on mechanistic modeling	60
Table 2-6. Summary of candidate criteria for Perdido Bay derived from mechanistic modeling	60
Table 2-7. Proposed and candidate numeric nutrient criteria for Perdido Bay segments	61
Table 2-8. Proposed DPVs for Perdido Bay	61
Table 2-9. Proposed numeric nutrient criteria for Pensacola Bay segments	63
Table 2-10. Data sources specific to Pensacola Bay models	67
Table 2-11. Pensacola Bay seagrass depth and water clarity targets by segment	69
Table 2-12. Average load contributions from the Pensacola watershed (2002–2009)	70
Table 2-13. Water quality targets met for Pensacola Bay based on mechanistic modeling	71
Table 2-14. Summary of candidate criteria for Pensacola Bay derived from mechanistic modeling	71
Table 2-15. Proposed and candidate numeric nutrient criteria for Pensacola Bay segments	72
Table 2-16. Proposed DPVs for Pensacola Bay	72
Table 2-17. Proposed numeric nutrient criteria for Choctawhatchee Bay segments	75
Table 2-18. Data sources specific to Choctawhatchee Bay models	79

Table 2-19. Choctawhatchee Bay seagrass depth and water clarity targets by segment	81
Table 2-20. Average load contributions from the Choctawhatchee watershed (2002–2009).....	82
Table 2-21. Water quality targets met for Choctawhatchee Bay based on mechanistic modeling	82
Table 2-22. Summary of candidate criteria for Choctawhatchee Bay derived from mechanistic modeling.....	83
Table 2-23. Summary of candidate chl-a criteria. No seagrass present in segment 0301, so no chl-a criteria associated with clarity was calculated. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of chl-a values, or less than the lower bound of chl-a values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.	84
Table 2-24. Summary of candidate TN and TP criteria in Choctawhatchee Bay. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of observed values, or less than the lower bound of observed values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.	87
Table 2-25. Proposed and candidate numeric nutrient criteria for Choctawhatchee Bay segments	87
Table 2-26. Proposed DPVs for Choctawhatchee Bay	88
Table 2-27. Proposed numeric nutrient criteria for St. Andrews Bay segments.....	90
Table 2-28. Data source specific to St. Andrews Bay models.....	94
Table 2-29. St. Andrews Bay seagrass depth and water clarity targets by segment.....	96
Table 2-30. Average load contributions to St. Andrews Bay from the St. Andrews watershed (2002–2009)	98
Table 2-31. Water quality targets met for St. Andrews Estuary based on mechanistic modeling.....	98
Table 2-32. Summary of candidate criteria for St. Andrews Estuary derived from mechanistic modeling.....	99
Table 2-33. Summary of candidate chl-a criteria in St. Andrews Bay. Sufficient data were not available in segments 0402 and 0406, so no chl-a criteria were calculated. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of chl-a values, or less than the lower bound of chl-a values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.	101

Table 2-34. Summary of candidate TN and TP criteria in St. Andrews Bay. No data were available in segments 0402 and 0406. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of observed values, or less than the lower bound of observed values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.	104
Table 2-35. Proposed and candidate numeric nutrient criteria for St. Andrews Bay segments	105
Table 2-36. Proposed DPVs for St. Andrews Bay	105
Table 2-37. Proposed numeric nutrient criteria for St. Joseph Bay	107
Table 2-38. Data source specific to St. Joseph Bay models	111
Table 2-39. St. Joseph Bay seagrass depth of colonization and water clarity targets.....	113
Table 2-40. Average load contributions to St. Joseph Bay from the St. Andrews watershed (2002–2009)	114
Table 2-41. Water quality targets met for St. Joseph Bay based on mechanistic modeling	115
Table 2-42. Summary of candidate criteria for St. Joseph Bay derived from mechanistic modeling.....	115
Table 2-43. Proposed and candidate numeric nutrient criteria for the St. Joseph Bay segment.....	117
Table 2-44. Proposed DPVs for St. Joseph Bay	117
Table 2-45. Proposed numeric nutrient criteria for Apalachicola Bay segments	120
Table 2-46. Data sources specific to Apalachicola Bay models	124
Table 2-47. Apalachicola Bay seagrass depth and water clarity targets by segment. Estimates of K_d (CDOM) were computed from color data in the IWR Run 40 database.	126
Table 2-48. Average load contributions from the Apalachicola watershed (2002–2009).....	127
Table 2-49. Water quality targets met for Apalachicola Bay based on mechanistic modeling.....	128
Table 2-50. Summary of candidate criteria for Apalachicola Bay derived from mechanistic modeling.....	128
Table 2-51. Proposed and candidate numeric nutrient criteria for Apalachicola Bay segments	129
Table 2-52. Proposed DPVs for Apalachicola Bay	129
Table 2-53. Proposed numeric nutrient criteria for Alligator Harbor segments.....	132
Table 2-54. Data sources specific to Alligator Harbor models.....	135
Table 2-55. Average load contributions to Alligator Harbor from the Apalachee watershed (2002–2009)	138

Table 2-56. Water quality targets met for Alligator Harbor based on mechanistic modeling.....	138
Table 2-57. Summary of candidate criteria for Alligator Harbor derived from mechanistic modeling.....	139
Table 2-58. Proposed and candidate numeric nutrient criteria for Alligator Harbor segments	139
Table 2-59. Proposed DPVs for Alligator Harbor	140
Table 2-60. Proposed numeric nutrient criteria for Ochlockonee Bay segments	142
Table 2-61. Data sources specific to Ochlockonee Bay models	146
Table 2-62. Ochlockonee Bay seagrass depth and water clarity targets by segment	148
Table 2-63. Average load contributions to Ochlockonee Bay from the Apalachee watershed (2002–2009)	149
Table 2-64. Water quality targets met for Ochlockonee Bay based on mechanistic modeling.....	150
Table 2-65. Summary of candidate criteria for Ochlockonee Bay derived from mechanistic modeling.....	150
Table 2-66. Proposed and candidate numeric nutrient criteria for St. Marks River/St. Marks Offshore segments.....	151
Table 2-67. Proposed and candidate numeric nutrient criteria for Ochlockonee-St. Marks Offshore/Ochlockonee Bay/Ochlockonee Offshore segments	151
Table 2-68. Proposed DPVs for Ochlockonee Bay	152
Table 2-69. Proposed numeric nutrient criteria for Big Bend segments.....	155
Table 2-70. Data sources specific to Big Bend models	159
Table 2-71. Big Bend seagrass depth and water clarity targets by segment.....	161
Table 2-72. Average load contributions to Big Bend from the Econfina watershed (2002–2009).....	163
Table 2-73. Average load contributions to Big Bend from the Apalachee watershed (2002–2009).....	163
Table 2-74. Water quality targets met for Big Bend based on mechanistic modeling	164
Table 2-75. Summary of candidate criteria for Big Bend derived from mechanistic modeling.....	164
Table 2-76. Proposed and candidate numeric nutrient criteria for the Steinhatchee Offshore segment.....	165
Table 2-77. Proposed and candidate numeric nutrient criteria for Steinhatchee River/Steinhatchee Offshore segments.....	165
Table 2-78. Proposed and candidate numeric nutrient criteria for the Steinhatchee-Fenholloway Offshore segment.....	166

Table 2-79. Proposed and candidate numeric nutrient criteria for Fenholloway/Fenholloway Offshore segments	167
Table 2-80. Proposed and candidate numeric nutrient criteria for Econfina/Econfina Offshore segments	167
Table 2-81. Proposed DPVs for Big Bend	168
Table 2-82. Proposed numeric nutrient criteria for Suwannee Sound segments	171
Table 2-83. Data sources specific to Suwannee Sound models	174
Table 2-84. Suwannee Sound seagrass depth and water clarity targets by segment	176
Table 2-85. Average load contributions from the Springs Coast watershed	177
Table 2-86. Water quality targets met for Suwannee Sound based on mechanistic modeling	177
Table 2-87. Summary of candidate criteria for Suwannee Sound derived from mechanistic modeling	178
Table 2-88. Proposed and candidate numeric nutrient criteria for the Suwannee Sound segment	180
Table 2-89. DPVs for Suwannee Sound	180
Table 2-90. Proposed numeric nutrient criteria for Springs Coast segments	183
Table 2-91. Data sources specific to Springs Coast models	188
Table 2-92. Springs Coast seagrass depth and water clarity targets by segment	190
Table 2-93. Average load contributions from the Waccasassa watershed	191
Table 2-94. Average load contributions from the Withlacoochee watershed	191
Table 2-95. Average load contributions from the Crystal watershed	192
Table 2-96. Water quality targets met for Springs Coast based on mechanistic modeling	192
Table 2-97. Summary of candidate criteria for Springs Coast derived from mechanistic modeling	193
Table 2-98. Summary of TN, TP, and chl-a criteria derived by statistical analysis for Crystal River and Waccasassa River. Criteria values with asterisks represent either the upper or lower bound of observed values	196
Table 2-99. Proposed and candidate numeric nutrient criteria for Anclote River and offshore segments	196
Table 2-100. Proposed and candidate numeric nutrient criteria for Pithlachascotee River and offshore segments	197
Table 2-101. Proposed and candidate numeric nutrient criteria for Weeki Wachee segments	197
Table 2-102. Proposed and candidate numeric nutrient criteria for Chassahowitzka segments	198

Table 2-103. Proposed and candidate numeric nutrient criteria for Crystal River and Homosassa segments	199
Table 2-104. Proposed and candidate numeric nutrient criteria for Waccasassa River Offshore segments	199
Table 2-105. Proposed DPVs for Springs Coast.....	200
Table 2-106. Newly-approved State water quality standards for Clearwater Harbor/St. Joseph Sound.....	203
Table 2-107. Proposed DPVs for Clearwater Harbor/St. Joseph Sound.....	203
Table 2-108. Newly-approved State water quality standards for Tampa Bay	204
Table 2-109. Proposed DPVs for Tampa Bay	204
Table 2-110. Newly-approved State water quality standards for Sarasota Bay	205
Table 2-111. Proposed DPVs for Sarasota Bay	205
Table 2-112. Newly-approved State water quality standards for Charlotte Harbor/Estero Bay.....	206
Table 2-113. Proposed DPVs for Charlotte Harbor.....	206
Table 2-114. Proposed DPVs for Lemon Bay	207
Table 2-115. Proposed numeric nutrient criteria for Lake Worth/Loxahatchee segments	207
Table 2-116. Data source specific to Lake Worth Lagoon and Loxahatchee River models	211
Table 2-117. Lake Worth Lagoon/Loxahatchee seagrass depth and water clarity targets by segment.....	213
Table 2-118. Average load contributions to Lake Worth Lagoon from the Indian River watershed (2002–2009)	214
Table 2-119. Average load contributions to Loxahatchee River from the Indian River watershed (2002–2009)	214
Table 2-120. Water quality targets met for Lake Worth Lagoon based on mechanistic modeling.....	215
Table 2-121. Water quality targets met for Loxahatchee Estuary based on mechanistic modeling.....	215
Table 2-122. Summary of candidate criteria for Lake Worth Lagoon derived from mechanistic modeling.....	215
Table 2-123. Summary of candidate criteria for Loxahatchee derived from mechanistic modeling.....	216
Table 2-124. Summary of candidate chl-a criteria in the Loxahatchee River. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of chl-a values, or less than the lower bound of chl-a values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.....	217

Table 2-125. Summary of candidate TN and TP criteria in the Loxahatchee River. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of observed values, or less than the lower bound of observed values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.....	219
Table 2-126. Proposed and candidate numeric nutrient criteria for Lake Worth Lagoon segments	220
Table 2-127. Proposed and candidate numeric nutrient criteria for Loxahatchee River segments	220
Table 2-128. Proposed DPVs for Lake Worth Lagoon.....	221
Table 2-129. Proposed DPVs for Loxahatchee River.....	221
Table 2-130. Proposed numeric nutrient criteria for St. Lucie segments	224
Table 2-131. St. Lucie seagrass depth and water clarity targets by segment.....	229
Table 2-132. Average load contributions from the Indian River watershed (2002–2009).....	230
Table 2-133. Water quality targets met for the St. Lucie Estuary based on mechanistic modeling.....	230
Table 2-134. Summary of candidate criteria for the St. Lucie Estuary derived from mechanistic modeling.....	230
Table 2-135. Summary of candidate chl-a criteria in St. Lucie Estuary. No water clarity targets were available in segments 1402 and 1403, so no chl-a criteria were calculated based on clarity. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of chl-a values, or less than the lower bound of chl-a values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.	232
Table 2-136. Summary of candidate TN and TP criteria for St. Lucie Estuary. Asterisks indicate criteria based on the upper or lower bounds of available data.....	234
Table 2-137. Proposed and candidate numeric nutrient criteria for St. Lucie segments	234
Table 2-138. Proposed DPVs for St. Lucie.....	235
Table 2-139. Proposed numeric nutrient criteria for Indian River Lagoon segments	237
Table 2-140. Data sources specific to Indian River Lagoon models	242
Table 2-141. Indian River Lagoon seagrass depth and water clarity targets by segment.....	244
Table 2-142. Summary of candidate chl-a criteria in Indian River Lagoon. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of chl-a values, or less than the lower bound of chl-a values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.....	248

Table 2-143. Summary of candidate TN and TP criteria for Indian River Lagoon. Values with asterisks indicate that the predicted candidate criterion was greater than the upper bound of observed values, or less than the lower bound of observed values used in estimating the empirical relationship, so listed criterion is based on the upper or lower bound of the data.....	251
Table 2-144. Proposed and candidate numeric nutrient criteria for Indian River Lagoon segments	251
Table 2-145. Proposed DPVs for Indian River Lagoon.....	253
Table 2-146. Annual mean turbidity (NTU), chl-a concentration (µg/L), and color (PCU) from both the optical model and RSY method. Adapted from Steward et al. (2010a).....	254
Table 2-147. Mosquito Lagoon annual median chl-a targets and model-predicted concentration limits for TN and TP (Steward et al. 2010b)	256
Table 2-148. Proposed numeric nutrient criteria for Halifax River segments	260
Table 2-149. Proposed and candidate numeric nutrient criteria for Halifax River segments.....	269
Table 2-150. DPVs for TN and TP for the Halifax River.....	270
Table 2-151. SJRWMD-proposed annual median chl-a targets and reference period approach TN and TP concentrations (Steward et al. 2010).....	271
Table 2-152. Proposed numeric nutrient criteria for GTMP River Estuary segments.....	273
Table 2-153. Data sources specific to GTMP System models.....	278
Table 2-154. Summary of candidate criteria for GTMP. TN criterion for segment 1702 is based on dilution model. Asterisks indicate that criteria are based on the upper or lower bound of observed data.	282
Table 2-155. Proposed and candidate numeric nutrient criteria for Guana, Tolomato, Matanzas, Pellicer segments.....	283
Table 2-156. Proposed DPVs for TN and TP for GTMP	284
Table 2-157. SJRWMD-proposed TME loading limits for TN, TP, and chl-a according to reference period results (adapted from Steward et al. 2010a)	285
Table 2-158. Proposed numeric nutrient criteria for St. Johns River segments	288
Table 2-159. Data sources specific to St. Johns River models	291
Table 2-160. Summary of candidate criteria for St. Johns derived from mechanistic modeling.....	294
Table 2-161. Proposed and candidate numeric nutrient criteria for St. Johns River segments	297
Table 2-162. Proposed DPVs for St. Johns River.....	298
Table 2-163. Proposed numeric nutrient criteria for Nassau River/Big Talbot segments	303
Table 2-164. Data sources specific to Nassau River/Big Talbot models.....	306

Table 2-165. Average load contributions from the Nassau watershed (2002–2009)	308
Table 2-166. Water quality targets met for Nassau River/Big Talbot based on mechanistic modeling.....	309
Table 2-167. Summary of candidate criteria for Nassau River/Big Talbot derived from mechanistic modeling.....	309
Table 2-168. Proposed and candidate numeric nutrient criteria for Nassau River/Big Talbot segments.....	310
Table 2-169. Proposed DPVs for Nassau River/Big Talbot	310
Table 2-170. Proposed numeric nutrient criteria for St. Marys River/Amelia River segments	312
Table 2-171. Data sources specific to St. Marys River/Amelia River models	315
Table 2-172. Average load contributions from the St. Marys watershed (2002–2009)	317
Table 2-173. Water quality targets met for St. Marys River/Amelia River based on mechanistic modeling.....	318
Table 2-174. Summary of candidate criteria for St. Marys River/Amelia River derived from mechanistic modeling.....	318
Table 2-175. Proposed and candidate numeric nutrient criteria for St. Marys River/Amelia River segments	319
Table 2-176. Proposed DPVs for St. Marys River/Amelia River.....	319
Table 3-1. Geometric mean (\pm 1 GSD) values for water quality parameters derived from the geometric mean values for each lake; n = number of lakes. Confidence intervals were not possible for the single lake (Deer Lake) in the Class III freshwater category, however geometric mean values for Deer Lake are listed.....	327
Table 3-2. EPA's numeric nutrient criteria derived for inland freshwater lakes (USEPA 2010) and applied to marine lakes.....	331
Table 3-3. Number of lakes that meet, exceed, or are in range of the inland freshwater lake criteria; in parentheses are the number of lakes where chl-a, TN, and TP met the test for receiving potentially modified nitrogen and phosphorus criteria.....	332

Abbreviations and Acronyms

%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
ADEM	Alabama Department of Environmental Management
BOD	biochemical oxygen demand
CaCO ₃	calcium carbonate
CBOD	carbonaceous biochemical oxygen demand
CDOM	colored dissolved organic matter
CE-QUAL-ICM	three-dimensional eutrophication model
CFR	Code of Federal Regulations
cfs	cubic feet per second
chl-a	chlorophyll <i>a</i>
CWA	Clean Water Act
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen
DON	dissolved organic nitrogen
DPVs	downstream protective values
DRP	dissolved reactive phosphorus
EFDC	Environmental Fluid Dynamics Code
EPA	United States Environmental Protection Agency
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDNR	Florida Department of Natural Resources
FFWCC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GAEPD	Georgia Environmental Protection Division
GIS	geographic information system
GLUT	Georgia Land Use TrendsGMFR
GSD	geometric standard deviation
GTMNERR	Guana-Tolomato-Matanzas National Estuarine Research Reserve
GTMP	Guana, Tolomato, Matanzas, Pellicer
HAB	harmful algal bloom
HUC12	12-digit hydrologic units
HUC8	8-digit hydrologic units
IWR	Impaired Waters Rule

<i>K. brevis</i>	<i>Karenia brevis</i>
K _d	light attenuation coefficient
lbs	pounds
LSPC	Loading Simulation Program in C++
m	meter
m ³ /s	cubic meters per second
mg/L	milligrams per liter
mgd	million gallons per day
µg/L	micrograms per liter
µM	micromoles
µmhos	micromhos
NEP	National Estuary Program
NH ₃	ammonia
NH ₄	ammonium
NHD	National Hydrography Dataset
NO ₂	nitrite
NO ₃ +NO ₂	nitrate+nitrite
NO ₃	nitrate
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
NFWMD	Northwest Florida Water Management District
OFW	Outstanding Florida Water
PO ₄	orthophosphate or phosphate
ppb	parts per billion
ppt	parts per thousand
PCU	platinum-cobalt unit
PLSM	Pollutant Load Simulation Model
PSU	practical salinity unit
RSY	reference segment year
S	normalized sensitivity coefficient
SAV	submerged aquatic vegetation
SBEP	Sarasota Bay Estuary Program
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SOD	sediment oxygen demand

SRP	soluble reactive phosphorus
SRWMD	Suwannee River Water Management District
SSAC	Site-Specific Alternative Criteria
STORET	STORage and RETrieval of Water-Related Data
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management
TAC	Technical Advisory Committee
TBEP	Tampa Bay Estuary Program
TBNMC	Tampa Bay Nitrogen Management Consortium
TDN	total dissolved nitrogen
TDP	total dissolved phosphorus
TKN	total Kjeldhal nitrogen
TMDL	total maximum daily load
TME	Tolomato–Matanzas Estuary
TN	total nitrogen
TP	total phosphorus
TSD	Technical Support Document
TSI	Trophic State Index
TSS	total suspended solids
U.S.	United States
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WASP7	Water Quality Analysis Simulation Program Version 7.3
WBID	water body identification number
WSE	water surface elevation
WWTF	wastewater treatment facility
WWTP	wastewater treatment plant
Z _c	depth of colonization

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2.20. Guana, Tolomato, Matanzas, Pellicer System

2.20.1. Proposed Numeric Nutrient Criteria

Proposed numeric nutrient criteria for TN, TP, and chl-a in Guana, Tolomato, Matanzas, and Pellicer (GTMP)⁹⁰ River Estuary segments are summarized in Table 2-152.

Table 2-152. Proposed numeric nutrient criteria for GTMP River Estuary segments

Segment Name	Segment Number	TN (mg/L)	TP (mg/L)	Chl-a (µg/L)
Tolomato River	1701	0.77	0.144	9.5
Matanzas River	1702	0.53	0.108	6.1

⁹⁰ The Guana, Tolomato, Matanzas, and Pellicer River Estuary is also called GTM Estuary.

2.20.2. General Characteristics

2.20.2.1. System Description

The GTMP River Estuary is on the northeast coast of Florida near St. Augustine in St. Johns and Flagler counties (Haydt and Frazel 2003).⁹¹ The GTMP Estuary is a long, narrow, marshy, tidal lagoon between mainland Florida and barrier beaches to the east. The GTMP Estuary connects through the Intracoastal Waterway to the St. Johns River Estuary to the north and the Halifax River Estuary to the south and directly to the Atlantic Ocean via two inlets—the St. Augustine Inlet to the north and the Matanzas Inlet to the south (FDEP 2008). The GTMP Estuary is a shallow estuary approximately 50 mi (80 km) long and has an average width of 0.5 mi (0.8 km) in St. Johns County and 0.2 mi (0.3 km) in Flagler County. The GTMP watershed area (395 mi² [1,023 km²]) to estuary area (17 mi² [44 km²]) ratio is approximately 23-to-1, indicative of a potentially large volume of runoff to a proportionally small receiving estuarine system (Steward et al. 2010a).

A large portion of the GTMP Estuary is within the boundaries of the Guana-Tolomato-Matanzas National Estuarine Research Reserve (GTMNERR). The reserve covers an area approximately 101 mi² (261 km²), including salt marsh and tidal wetlands, estuarine lagoons, upland habitat, and offshore seas (FDEP 2009; Frazel 2009).

The GTMP Estuary has undergone significant hydromodification. In 1961 the Guana Dam was built along with a series of smaller canals and dams for improved fishing and hunting. In addition, the Intracoastal Waterway was constructed through the Northern Coastal Basin, connecting many of those estuaries through canals, and requiring continual maintenance with dredging to keep channels clear. Other hydromodifications have included mosquito ditching, dikes, wells, drainage ditches, and land clearing (FDEP 2008; Frazel 2009).

The GTMNERR watershed is characterized by a humid, subtropical, marine climate with heavy rainfall in the summers and mild, dry winters (Frazel 2009). Whereas prevailing winds are easterly, winds from all directions are fairly common. Periodic thunderstorms, northeasters, tropical storms, and hurricanes occur in the GTMP Estuary. In 2004 three tropical storms passed through the area causing extensive beach erosion in St. Augustine (Frazel 2009).

Despite significant population growth, the watershed remains largely undeveloped with around 80 percent of the overall area in forests, wetlands, or surface water in 2000 (SJRWMD 2011b). Urban and residential development is most prevalent in the north Matanzas watershed around St. Augustine (28.1%) (Steward et al. 2010a). The population is centered along the coast and surrounding waterways, with the largest communities bordering the GTMP Estuary (US Census Bureau 2012).

Two ocean inlets, the St. Augustine and Matanzas, and the Intracoastal Waterway connections to the north and south provide tidal flushing and create three tidal nodes in the GTMP Estuary where net flow is zero (Steward et al. 2010a). Both inlets allow substantial tidal exchange, with

⁹¹ The information presented in this system description was compiled to summarize local information pertaining to the proposed numeric nutrient criteria for this estuary. For more information on EPA's process of delineating, segmenting, and deriving numeric nutrient criteria for this estuary, please see Section 1.3.

an average tidal amplitude of around 4.10 ft (1.25 m) (Frazel 2009; Steward et al. 2010a). Closer to the tidal nodes, the tidal amplitude decreases greatly (Haydt and Frazel 2003).

Research in the GTMP Estuary has shown that water residence time is useful in explaining nutrient concentration spatial variations and phytoplankton populations (Phlips et al. 2004; Sheng et al. 2008). Philips et al. (2004) and Sheng et al. (2008) estimated residence times or residence time indices for each estuary segment. As noted in both studies, tidal flushing is the primary mode of water exchange in the Halifax River Estuary and GTMP Estuary; the flushing time for segments is faster closer to the inlets, and residence time is shorter.

2.20.2.2. Impaired Waters⁹²

Nine Class II and Class III marine WBIDs in the GTMP Estuary have been listed for a nutrient-related parameter on Florida's CWA section 303(d) list approved by EPA. Of the nine WBIDs, five are Class II WBIDs, and four are Class III marine WBIDs. Of the five Class II WBIDs, three are impaired for DO (WBIDs 2363F, 2363I, and 2451), one is impaired for nutrients and chl-a (WBID 2320F), and one is impaired for nutrients, chl-a, and DO (WBID 2320). Of the four Class III marine WBIDs, three are impaired for DO (WBIDs 2363H, 2400, and 2491), and one is impaired for nutrients, chl-a, and DO (WBID 2320A).⁹³ No Class II or Class III marine WBIDs with nutrient-related TMDLs are documented for this region.⁹⁴

The GTMP Estuary was designated a priority water under the SWIM Act. In 2003 a SWIM plan was completed, which created a framework for projects to be completed to reduce point and nonpoint source nutrient contributions (Haydt and Frazel 2003).

2.20.2.3. Water Quality

Nonpoint sources have been estimated to contribute approximately 68 percent of the overall nutrient loading, followed by wastewater treatment dischargers, which contribute 27 percent (Steward et al. 2010a). Septic tanks are also prevalent in some areas of the GTMP Estuary and have been identified as a potential source of nutrients to surface waters (FDEP 2008; SJRWMD 2000b).

Median DO readings at SJRWMD sites at Tolomato River and Pellicer Creek were 6.0 and 4.2 mg/L, respectively, between 1996 and 2011. Median DO levels in the upper and lower Matanzas River are both approximately 6.5 mg/L (SJRWMD 2011a). The extent to which DO concentrations in the GTMP Estuary are influenced by anthropogenic nutrient inputs,

⁹² For more information about the data source, see Volume 1, Appendix A.

⁹³ The nutrient-related 303(d) list was a compilation of EPA-approved 303(d) listing information for nutrients, chl-a, and DO provided in three decision documents: September 2, 2009, Basin Groups 1, 2, and 5 EPA Decision Document (http://www.epa.gov/region4/water/tmdl/florida/documents/fl09303d_decisiondoc_090209.pdf); May 13, 2010, Basin Group 3 EPA Decision Document (http://www.epa.gov/region4/water/tmdl/florida/documents/fl303d_%20partialapproval_decision_docs051410.pdf); and the December 21, 2010, Basin Group 4 EPA Decision Document (http://www.epa.gov/region4/water/tmdl/florida/documents/group_4_final_dec_doc_and_partial_app_letter_12_21_10.pdf).

⁹⁴ TMDLs were identified in February 2011 by compiling nutrient-related draft/final TMDLs from the following three sources: FDEP TMDL website (<http://www.dep.state.fl.us/water/tmdl/index.htm>); EPA Region 4 website (<http://www.epa.gov/region4/water/tmdl/florida/index.html>); EPA National WATERS expert query tool (http://www.epa.gov/waters/tmdl/expert_query.html).

biochemical oxygen demand (BOD) inputs, and import of low-DO water from freshwater streams has not been determined (FDEP 2008).

Phlips et al. (2004) reported mean chl-a concentrations at four sampling locations in the GTMNERR from monthly samples taken May 2002 through August 2003. Overall, chl-a concentrations were lower for GTMP sites than for other sites sampled in estuaries farther north on Florida's Atlantic Coast. Among the four sites studied by Phlips et al. (2004), mean chl-a concentrations were lowest at the San Sebastian and Fort Matanzas sites. Chl-a concentrations at all sites were generally elevated during summer months, associated with increased temperature, increased nutrient loading (wet season), or a combination of the two (Phlips et al. 2004). Median and mean chl-a concentrations measured in North Matanzas, South Matanzas, and Tolomato were low (maximum wet season medians of 4.0–6.4 µg/L), and few samples exceeded 12 µg/L (Steward et al. 2010a).

Steward et al. (2010a) also report turbidity ranges for water quality monitoring locations along the GTMP Estuary from 1986–2009. The Tolomato region had the highest median value (9.4 NTU) compared to the North Matanzas (7.5 NTU) and South Matanzas (7.8 NTU) regions, but the differences were within confidence intervals. Wet-season turbidity was higher than dry-season turbidity at all stations, with seasonal differences in the 1–4 NTU range. The highest turbidities (both wet and dry season) occurred at sampling locations with little or no tidal influence (the southernmost sampling point in the Intracoastal Waterway). High turbidity throughout the GTMP Estuary is consistent with other estuaries along the south Atlantic Coast with limited tidal connections (Steward et al. 2010a).

There were statistically significant increasing trends in TP and chl-a concentrations over a 23-year period (1986–2009) in the GTMP Estuary. The early portion of the time series coincided with several drought years, during which concentrations would have been lower because of reduced nutrient inputs. Long-term median and mean TP concentrations were 0.072–0.084 and 0.087–0.10 mg/L, respectively. For the same period, TN concentrations were similar throughout the estuary, with the exception of the southernmost station where the TN concentrations were significantly higher. The long-term median and mean TN concentrations in the GTMP Estuary were 0.41–0.53 and 0.43–0.58 mg/L, respectively (Steward et al. 2010a).

2.20.2.4. Biological Characteristics

The GTMP Estuary is primarily characterized by tidal salt marshes and oyster reefs (Dame et al. 2000; Sargent et al. 1995; Steward et al. 2010a). Wetlands compose about one-third of the overall area of the GTMP Estuary watershed (Steward et al. 2010a). Salt marshes are the predominant wetland community and make up about 20 percent of the overall land cover of the GTMNERR (Frazel 2009). SAV is largely absent, as it is in much of northeastern coastal Florida, from lack of suitable habitat and elevated turbidity (Dame et al. 2000; Sargent et al. 1995; Steward et al. 2010a).

Documented impacts on shoreline vegetation in the GTMP Estuary have been linked to factors other than anthropogenic nutrient loading. Shoreline erosion and resultant loss of shoreline habitat occurs at relatively high rates in many places along the Intracoastal Waterway, which runs through GTMNERR (Price 2005).

Oyster populations occur along the full length of the GTMNERR. As of 2009, two delineated shellfish harvest areas in the GTMNERR allowed limited recreational oyster and hard clam harvesting. In addition, four active aquaculture leases for oysters and two leases for hard clams exist (Frazel 2009). Inclusion in the GTMNERR and other reserves has likely helped preserve these oyster reefs (Steward et al. 2010b).

Phytoplankton abundance in the GTMP is primarily regulated by a balance between water residence time and nutrient loading, with water residence time determined by multiple factors including proximity to inlets, freshwater inputs, and vertical mixing (Phlips et al. 2004). In the 2002–2003 study conducted by Phlips et al. (2004), the authors attribute low chl-a concentrations (as a surrogate measure for phytoplankton crop) in the vicinity of the GTMP Estuary to its close proximity to tidal inlets and lower residence time.

Frazel (2009) reported that little research has been done on plankton communities in the GTMNERR, but that there are periodic blooms of *K. brevis* (a ride tide organism) on Florida's east coast. A *K. brevis* bloom occurred in GTMNERR waters in October 2007 (Frazel 2009). Abbott et al. (2009) classified the GTMP Estuary and associated coastal waters as affected by toxins associated with HABs, including neurotoxic shellfish poisoning. Blooms can arise from either chronic or episodic nutrient loading (Heisler et al. 2008).

A study conducted for the SJRWMD in 2000 included five benthic macroinvertebrate sampling sites in the GTMP Estuary. While the coverage was limited, all five sites had moderate to high species diversity scores (Shannon-Weiner Diversity Index).⁹⁵ The three southern sites exhibited species compositions that were dominated by pollution-tolerant species, indicating the possible presence of pollutants in Moultrie Creek, Pellicer Creek, and the South Matanzas River. The two sites in the northern areas on the North Matanzas River and the Tolomato River had low-tolerant taxa dominance (SJRWMD 2000a).

Research has identified 303 fish species in the GTMNERR. A number of commercially important species are in the estuary, as are many recreationally valuable sport fish (Frazel 2009). Twenty-five accounts of fish kills resulting from algae or red tide were reported from 2000 to 2010 in Flagler and St. Johns counties, some of which were not in the GTMP Estuary. Overall, 68 percent of those reports were the result of a red tide event in 2007 that was documented to have drifted into the GTMP Estuary from further north up the Atlantic Coast (FFWCC 2011; Frazel 2009).

For a more detailed summary of this water body, see Volume 1, Appendix A.

⁹⁵ Shannon-Weiner Species Diversity Index is “a calculated index value expressing the degree of species diversity in a given sample or group of samples. The calculation is influenced by both the number of species present as well as the evenness of abundance among the species. Values generally range from 0 to 5, with values at the high range indicating high species diversity” (SJRWMD 2000a).

2.20.3. Data Used

Several data sources specific to the GTMP System were used in addition to those sources described in Section 1.4.3, as summarized in Table 2-153.

Table 2-153. Data sources specific to GTMP System models

Data	Source	Location Used
Hydrologic group soils data	St. Johns River Water Management District (SJRWMD 2011c)	Daytona watershed model
FDEP Level III Florida Land Use	St. Johns River Water Management District (SJRWMD 2006)	Daytona watershed model

2.20.4. Segmentation

The GTMP system was divided on the basis of its geomorphological structure and the different river systems feeding into it. Figure 2-57 shows the resulting two segments for the GTMP Estuary system.

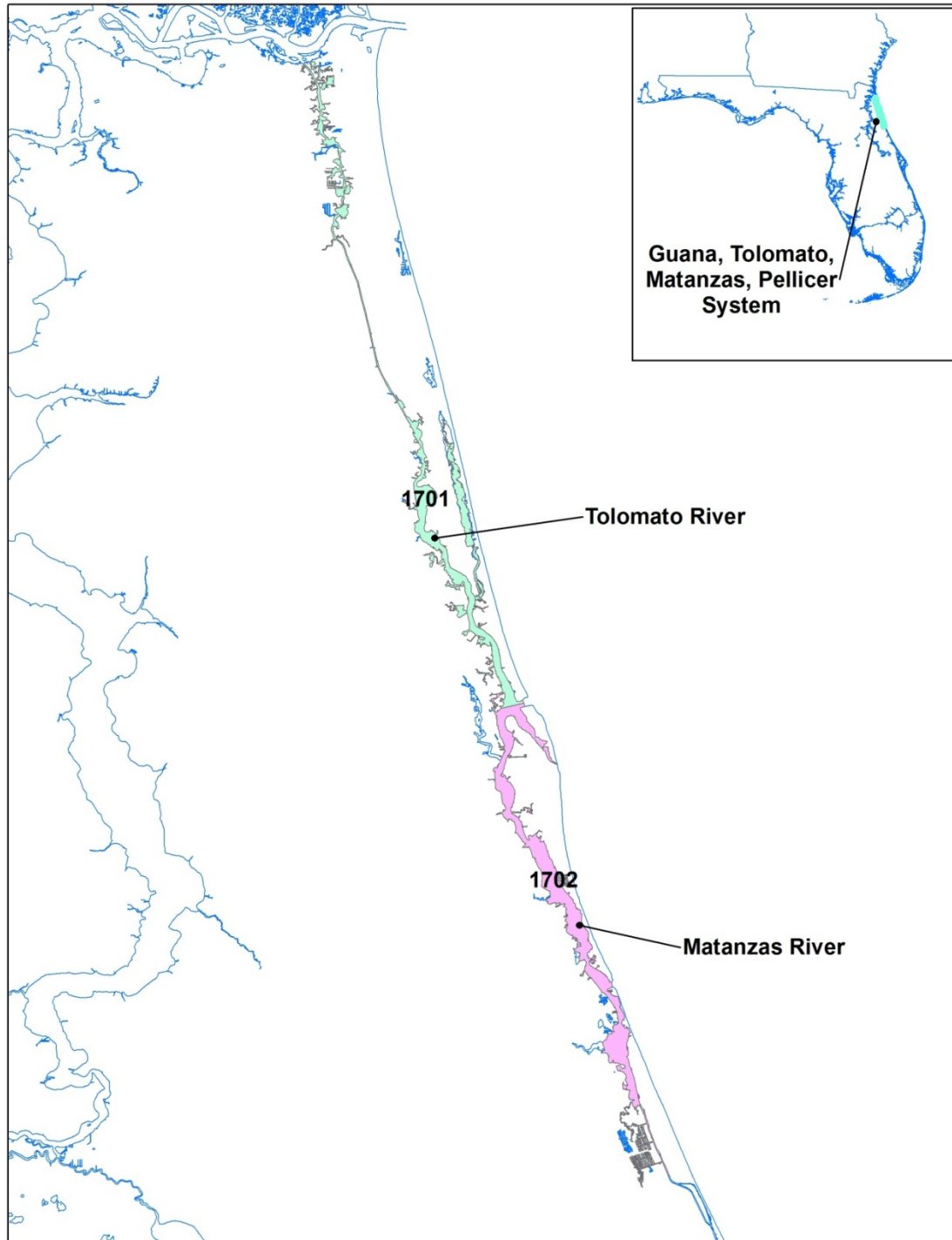


Figure 2-57. Results of GTMP Estuary segmentation

2.20.5. Water Quality Targets

2.20.5.1. Seagrass Depth and Water Clarity Targets

Seagrass is not historically present in the GTMP Estuary.

2.20.5.2. Chlorophyll a Target

To prevent nuisance algal blooms and protect the estuary's designated uses, chl-a levels must not exceed 20 µg/L more than 10 percent of the time. The rationale for that target is provided in Section 1.2.2.

2.20.5.3. Dissolved Oxygen Targets

On the basis of the rationale that sufficient DO is necessary to protect aquatic life, as described in Section 1.2.3, the following DO targets were established:

- Minimum allowable DO of 4.0 mg/L as a water column average for each estuary segment 90 percent of the time over the simulation's time span
- Daily average DO of 5.0 mg/L as a water column average for each estuary segment 90 percent of the time over the simulation's time span
- Minimum 3-hour average DO of 1.5 mg/L in the bottom two layers for each estuary segment over the simulation's time span

2.20.6. Results of Analyses

2.20.6.1. Mechanistic Model Analysis

The GTMP system was not evaluated using mechanistic model analysis.

2.20.6.2. Statistical Model Analysis

Analysis of available empirical data indicated a strong relationship between the bloom frequency endpoint and annual geometric mean chl-a concentration (Figure 2-58). In both segments, the derived chl-a concentration was greater than the upper bound of the observed annual geometric mean, so chl-a criteria are based on this upper bound.

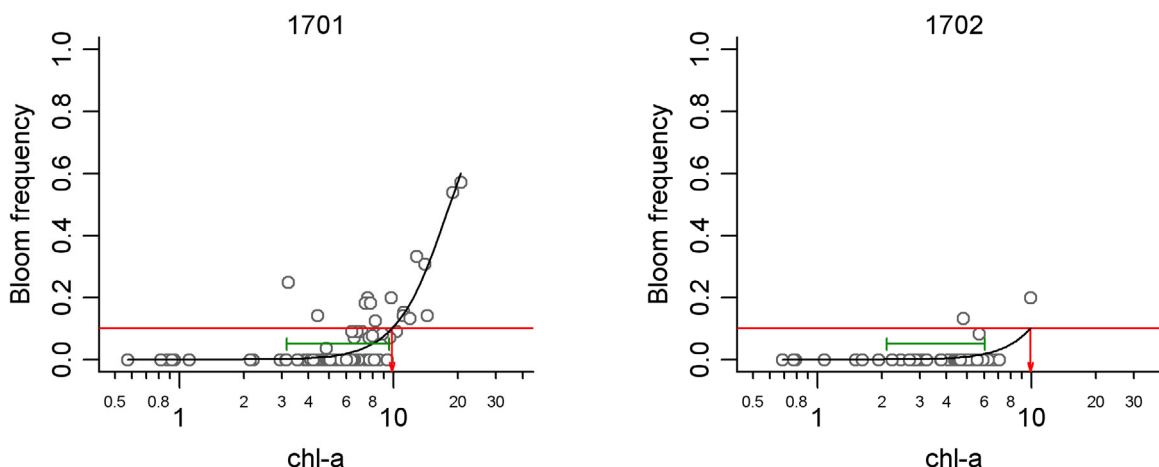


Figure 2-58. Estimates of annual geometric chl-a concentrations associated with bloom frequency of 0.1 in GTMP. Red horizontal line: bloom frequency of 0.1, red vertical arrow: annual geometric mean chl-a concentration associated with 0.1 bloom frequency, green line segment: 5th to 95th percentile range of observed data.

In general, chl-a concentrations increased with increasing concentrations of TN and TP. However, in segment 1702, a negative correlation between TN and chl-a was observed, suggesting that TN in this segment is primarily composed of recalcitrant forms (Figure 2-59). TN and TP concentrations that were associated with the candidate chl-a criterion were all greater than the upper bound of observed annual geometric means, and therefore, proposed criteria were based on the upper bound (Table 2-154). A TN criterion in segment 1702 was based on the dilution model described below.

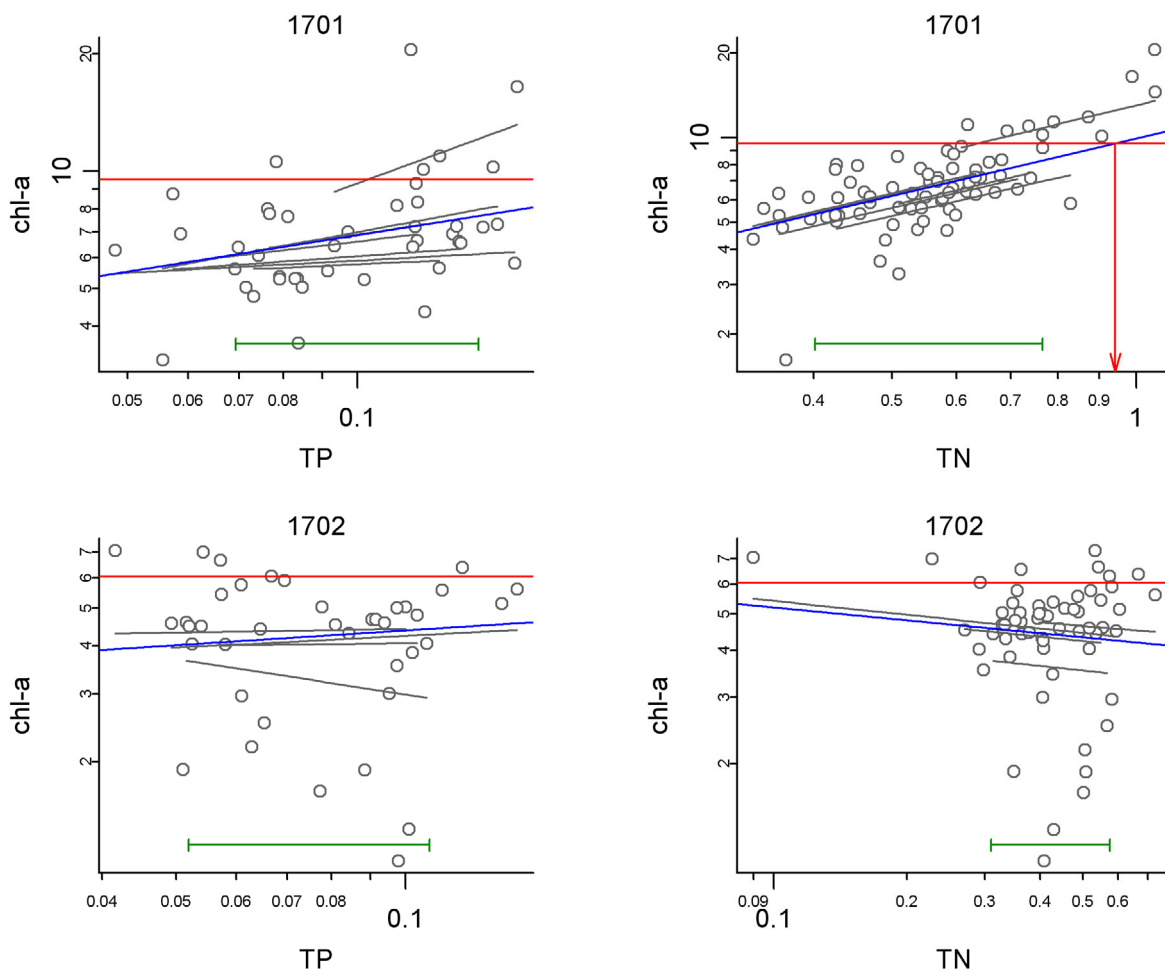


Figure 2-59. Relationships between TN, TP, and chl-a in GTMP. Open circles: observed annual average values of TN, TP, and chl-a, red horizontal line: chl-a criterion, red vertical arrow: TN and TP criteria associated with chl-a criterion, blue line: estimated segment-wide relationship between TN, TP, and chl-a, grey lines: estimated station-specific relationships between TN, TP, and chl-a, green line segment: 5th to 95th percentile range of observed annual geometric mean TN and TP concentrations.

Table 2-154. Summary of candidate criteria for GTMP. TN criterion for segment 1702 is based on dilution model. Asterisks indicate that criteria are based on the upper or lower bound of observed data.

Segment	TN (mg/L)	TP (mg/L)	Chl-a (μg/L)
1701	0.77*	0.144*	9.5*
1702	0.53	0.108*	6.1*

2.20.7. Application of Analyses for Proposed Numeric Nutrient Criteria

In GTMP data were sufficient to use statistical modeling analyses as the primary line of evidence when deriving criteria. Seagrass has not been historically present in GTMP, so EPA evaluated the following endpoint in the statistical modeling approach: chl-a concentrations associated with balanced phytoplankton biomass. Through evaluating the observed data, EPA found that, in

some segments, the TN, TP, and chl-a concentrations associated with achieving the chl-a target were greater than the range of TN, TP, or chl-a concentrations observed in the available data for GTMP. For these segments, EPA is proposing to set numeric nutrient criteria derived from statistically modeled relationships at the upper bound of the distribution of available data instead of deriving criteria outside the range of data observations (see Volume 1, Appendix B). This approach defines criteria values that maintain balanced natural populations of aquatic flora and fauna within the limits of available data.

Proposed numeric nutrient criteria for TN, TP, and chl-a in GTMP segments are summarized in Table 2-155.

Table 2-155. Proposed and candidate numeric nutrient criteria for Guana, Tolomato, Matanzas, Pellicer segments

SEGMENT	SEGMENT ID	Proposed Criteria			Statistical Modeling		
		TN (mg/L)	TP (mg/L)	Chl-a (µg/L)	TN (mg/L)	TP (mg/L)	Chl-a (µg/L)
Tolomato River	1701	0.77	0.144	9.5	0.77	0.144	9.5
Matanzas River	1702	0.53	0.108	6.1	0.53	0.108	6.1

2.20.8. Downstream Protective Values

In GTMP mechanistic models were not available to derive DPVs for TN and TP. In lieu of the preferred approach, a mixing/dilution model was applied to calculate the allowable freshwater TN and TP load. This mixing/dilution model assumes that TN and TP loads in freshwater mix conservatively with saline seawater. Using this assumption, the model predicts freshwater concentrations necessary to achieve proposed nutrient criteria in each segment (Figure 2-60 and Figure 2-61). DPVs are tabulated in Table 2-156.

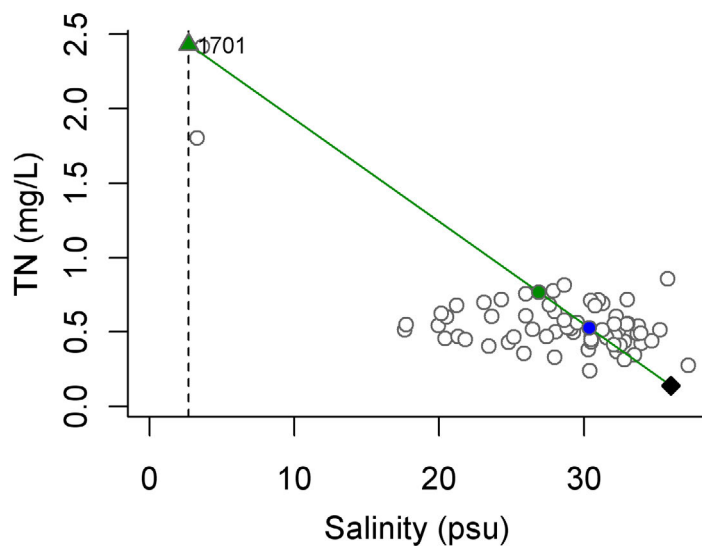


Figure 2-60. Calculation of TN DPVs for GTMP. Black diamond shows seawater conditions, filled green circles show proposed TN criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TN concentrations and salinities. Filled blue circle shows TN criteria computed for segment 1702.

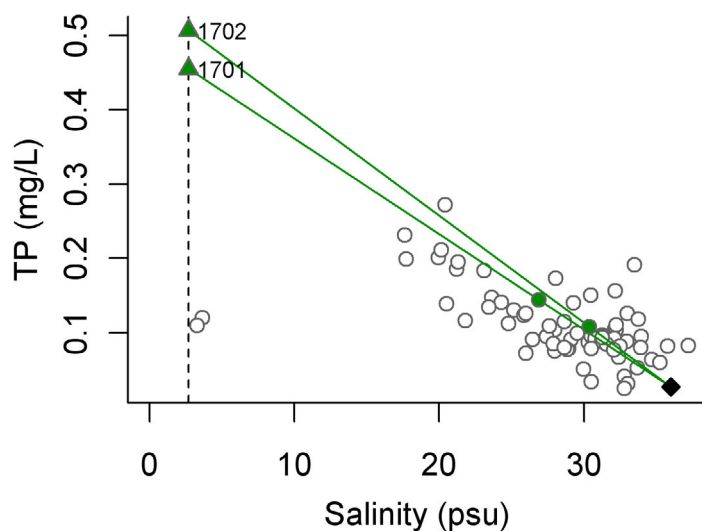


Figure 2-61. Calculation of TP DPVs for GTMP. Black diamond shows seawater conditions, filled green circles show proposed TP criteria values for each segment, and green triangles show calculated DPVs. Open circles show observed long-term station average TP concentrations and salinities.

Table 2-156. Proposed DPVs for TN and TP for GTMP

Segment	DPV (TP) (mg/L)	DPV (TN) (mg/L)
1701	0.455	2.43
1702	0.507	2.43

2.20.9. Alternate Analysis

2.20.9.1. Tolomato–Matanzas Estuary

SJRWMD submitted documents to EPA suggesting approaches to derive numeric criteria for the Tolomato–Matanzas Estuary (TME). A weight-of-evidence approach using several analytical techniques was proposed to derive numeric criteria (Table 2-157). The techniques included a reference period analysis, chl-a versus concentration of TN or TP regression analyses, and two general models (Dettmann 2001; Steward and Lowe 2010).

TN and TP loading, chl-a target concentrations, and TN and TP concentration criteria were based on an approach that analyzed water quality and estimated loading during a reference period from 2000 to 2009. The period of reference was selected on the basis of a desirable TSI score (< 50), rainfall amounts typical of average conditions, and completeness of the data record. Criteria magnitudes were proposed as an annual median or mean and a maximum wet-season (June–September) median or mean. The reference period approach results were supported by an additional line of evidence using regression analyses of chl-a versus TN and TP. Target chl-a values were based on the reference period analyses. The general nutrient models of Steward and Lowe (2010) and Dettmann (2001) were also used as an additional method by which to estimate loading limits and concentrations associated with those limits. Documentation of SJRWMD-proposed numeric nutrient criteria and methods for their derivation can be found in Volume 1, Appendix G.

Table 2-157. SJRWMD-proposed TME loading limits for TN, TP, and chl-a according to reference period results (adapted from Steward et al. 2010a)

Estuary Segment	Chl-a (µg/L) median (mean)	TN (mg/L) median (mean)	TP (mg/L) median (mean)
Tolomato	4.5 (5.3)	0.52 (0.56)	0.085 (0.096)
North Matanzas	3.1 (3.5)	0.37 (0.41)	0.073 (0.083)
South Matanzas	4.3 (5.0)	0.45 (0.49)	0.089 (0.103)

2.20.10. References

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