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Abstract

The Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute (FWRI), has conducted estuarine surveys since 1989 (seasonally) and since 1996 (monthly) in estuarine systems along the northern Gulf of Mexico. In 2008, seagrass surveys in the polyhaline reaches of several estuarine systems were developed to improve abundance indices for estuarine-dependent reef fish. These fisheries independent datasets were used to develop four separate abundance indices for Gray Snapper (*Lutjanus griseus*): age 0 (≤ 100 mm SL) from monthly collections (1998-2015), age 0 from seagrass surveys (2008-2015), age 1 (101-250 mm SL) from monthly collections (1996-2015) and age 1 from seagrass surveys (2008-2015). Appropriate estuarine systems and gears, as determined by abundance of defined size classes, were combined for each index by using a weighting factor that takes into account differences between the proportion of available area and the proportion of sets completed within each sampling universe.

Survey Designs

FWRI long-term fishery-independent monitoring (FIM)

A stratified-random sampling design was employed to allocate sampling within each estuary. Sampling effort was allocated among spatial zones based on geographic and logistical criteria that defined areas of biological and hydrological homogeneity. Sampling sites were further stratified by habitat type depending on the estuary and gear type used. Sampling effort in each stratum for each estuary was proportional to the total number of potential sampling sites available. All sampling sites were selected randomly without replacement; this procedure was conducted each season from 1989-1995 and each month from 1996-2015. Estuaries sampled during long-term FWRI FIM surveys include Apalachicola Bay, Cedar Key, Tampa Bay, and Charlotte Harbor (Figure 1, Flaherty et al. 2014).

Gear:

- 21.3-m × 1.8-m center-bag haul seine with 3.2-mm nylon mesh.
    - Bay deployments: Deployed in shallow (≤ 1.8 m) shoreline (gr = 19) and offshore (gr = 20) bay habitats, the 21.3-m seine was pulled a distance of 9.1 m with a width of 15.5 m between the seine poles, sampling an area of approximately 140 m^2. Seines were deployed along estuarine shorelines to sample areas with emergent

vegetation, mangrove fringes, seawalls, and beaches. Seines were deployed offshore to sample flats at least 5 m from the shoreline; in all estuaries except Cedar Key, these deployments were stratified by the presence or absence of submerged aquatic vegetation (SAV; presence was defined as ≥ 25% SAV cover).

- River deployments (gr = 23): 21.3-m seines were deployed from the stern of a boat in a semi-elliptical pattern and retrieved onto shore, sampling an area of approximately 68 m^2. Seines were deployed along river shorelines to sample areas with emergent vegetation, mangrove fringes, seawalls, and beaches.

- 183-m × 2.5-m center-bag haul seine with 38-mm stretched nylon mesh: The seine was deployed by boat, set in a rectangular shape along the shoreline with a maximum depth of 2.5 m at the bag, and retrieved by hand. The dimensions of the area sampled by the net (approximately 40 m × 103 m = 4,120 m^2) were standardized by marking 40 m from each end of the net to designate the corner locations of the rectangular set. In Tampa Bay and Charlotte Harbor, these deployments were stratified based on the presence or absence of overhanging vegetation (presence of overhanging vegetation was defined as ≥ 10% cover along the shoreline).

FWRI seagrass surveys

Results from studies in the eastern Gulf (Koenig and Coleman 1998; Fitzhugh et al. 2005; Casey et al. 2007) were used to design a complementary FWRI FIM survey to enhance our ability to characterize populations of juvenile Gag *Mycteroperca microlepis* and other estuarine-dependent, seagrass-associated fishes, including Gray Snapper. Available bathymetry and SAV-coverage (Yarbro 2013) data were used to define a sampling universe of 0.2-km X 0.2-km sampling units that contained seagrass habitats from which monthly sampling sites were randomly selected (ArcGIS: Hawth's tools random selection method). The universe was updated periodically as new seagrass mapping data became available, and appropriate conditions were verified at the time of sampling. From 2008-2015, these surveys sampled polyhaline seagrass habitats (i.e., salinities generally >18 psu; SAV covering more than 50% of the bottom sampled) that had been underrepresented in FWRI FIM surveys before 2008 (Switzer et al. 2012, Flaherty-Walia et al. 2015). Estuaries sampled during seagrass surveys include St. Andrew Bay, Apalachicola Bay, Tampa Bay, and Charlotte Harbor (Figure 1). Although the Big Bend area was sampled as well, these data were not included since only trawls were used and Gray Snapper were not frequently collected.

Gear:

- 183-m × 2.5-m center-bag haul seine with 38-mm stretched nylon mesh: Unlike routine monitoring in which the seine was set and pursed together along a shoreline, the seine was set parallel to seagrass shoals (≤0.5 m deep, often exposed) not associated with a shoreline during seagrass sampling. Seines were set on shoals where the difference (slope) between the wing depth (depth at which the ends of the seine were joined together along the shoal, the shallowest portion of the net deployment) and the bag depth (the deepest portion of the net) was at least 0.5 m (DeAngelo et al. 2014).
- 6.1-m otter trawl (38-mm stretched mesh) with a 3-mm mesh liner in the cod end: The trawl was used to sample deep seagrass habitats in waters between 1.0 m and 7.6 m deep and was towed for 5 minutes and approximately 0.1 nm (185 m), sampling an area of

approximately 741 m^2. In waters less than 1.8 m deep, the trawl was towed in an arc to prevent disturbance of the sampled substrate by prop wash. Actual distance towed was measured by differential GPS, and measurement ended as soon as net retrieval began. All monthly sampling in these seagrass habitats was conducted from May through November, the period of peak estuarine occupancy by juvenile reef fish, including Gray Snapper (Switzer et al. 2012; Flaherty et al. 2014).

For both survey designs, all Gray Snapper collected in each sample were identified and enumerated, and as many as 40 randomly selected individuals per sample were measured to the nearest mm standard length (SL). Location, date, time, and water depth at the bag of the net were recorded at each sampling site. Temperature (° C) and salinity (psu) were recorded at the surface and at 1.0-m depth intervals and were averaged for each sample. Habitat variables (shore type and percentage cover of submerged aquatic vegetation (SAV)) were recorded at the time of sampling for each net set.

Data

A total of 41,430 stations were sampled from 1989-2015 using 21.3-m seines (Tables 1-2) and 16,609 stations were sampled from 1996-2015 using 183-m seines (Table 3) during FWRI long-term FIM in Apalachicola Bay, Cedar Key, Tampa Bay, and Charlotte Harbor. During FWRI seagrass surveys from 2008-2015, a total of 1,140 stations were sampled with 183-m seines (Table 4) and 1,823 stations were sampled with 6.1-m otter trawls (Table 5) in St. Andrew Bay, Apalachicola Bay, Tampa Bay, and Charlotte Harbor.

Data Exclusions

Data for the FWRI long-term FIM surveys were limited to monthly sampling (1996-2015) in estuarine systems in which the annual proportion positive sets were greater than 5% in most years. Data from the 21.3-m seines from 1996 and 1997 were omitted since shoreline seines were not incorporated and Apalachicola Bay and Cedar Key were not sampled. Age 0 indices only included data from the recruitment window of July-December (Flaherty et al. 2014). Only data from Tampa Bay and Charlotte Harbor were included in the Age 1 indices due to low numbers of this size class collected in the northern estuaries (Tables 3-5, Flaherty et al. 2014, Flaherty-Walia et al. 2015). Tables 6-11 summarize the data included in each index including number of sets, proportion positive, and number of Gray Snapper collected by year, gear, and estuary.

Index Construction

Based on previous research, monthly length-frequency distributions, gear type, and gear selectivity (Starck and Schroeder 1971; Manooch and Matheson 1981; Domeier et al. 1996, Flaherty et al. 2014, Flaherty-Walia et al. 2015), two age classes were defined by size class: Age 0 Gray Snapper (≤100 mm SL) collected during the recruitment window of July-December and Age 1 Gray Snapper (101–250 mm SL) collected over all months. Annual Indices of Abundance (IOA) of Gray Snapper combined over estuarine systems for each age class and monitoring type (FWRI long-term FIM or seagrass surveys) were constructed using generalized linear modeling

analyses. Indices were calculated as individuals per haul using a weighting factor that represented a ratio of the proportion of total area sampleable that occurred within each estuarine sampling area to the proportion of total sampling effort that occurred within each area to account for non-proportional sampling across estuarine areas (weighting factor = (estuarine sampling area/total sampling area)/(sets per estuary/total sets)). Class variables included in the model included year, bay system, month, shore type (overhanging vegetation, emergent vegetation, terrestrial vegetation, manmade structure, none), SAV percentage (divided into bins of 10%), and quantiles of water depth, temperature, and salinity as calculated by the reduced dataset. When more than one gear type was included in the model, area sampled (effort) over 100 m^2 was incorporated as a covariate. The relative abundance of Gray Snapper represents count data, the distribution of which is bound by zero and therefore often highly nonnormal. Accordingly, generalized linear models based on the Poisson distribution and the negative binomial distribution were fit to the data, and residual diagnostics and goodness-of-fit statistics were examined to determine the most appropriate model. For all four indices, the model based on the negative binomial distribution was the most appropriate. With the exception of year, bay system, and variables associated with significant interactions, variables that were not significant ($\alpha = 0.05$) and did not improve model fit based on the AIC value were removed, and the analysis was repeated until the most parsimonious model remained. For each age class and survey combination, annual least square means (± SE) and annual coefficients of variation (mean ± SD) were calculated. Because standard deviations associated with annual least-square-means from GLM analyses are not directly available, we created a sampling distribution by repeatedly (n = 10,000) calculating a random deviate from the standard normal distribution ($\mu = 0$, $\sigma^2 = 1$). These deviates were then multiplied by the standard error, and products were added to the least square mean to generate the sampling distribution from which standard deviations were calculated. All analyses were fit using the GLIMMIX procedure and SAS software (SAS Institute 2006).

Results and Discussion

Distribution and Size

The distribution of Gray Snapper collected during FWRI long-term FIM surveys is presented in Figures 2-6, with annual abundance and distribution presented in the Appendix Figures A1-A2. The distribution of Gray Snapper collected during FWRI seagrass surveys is presented in Figures 7-11, with annual abundance and distribution presented in the Appendix Figures A3-A4. Age 0 Gray Snapper occur in all estuaries sampled along the West Florida Shelf, but age 1 Gray Snapper were rarely captured in the northern estuaries. The length frequency distribution of all Gray Snapper collected by gear and estuary and the subset used in the relative abundance indices are shown in Figures 12 and 13, respectively.

Indices of Abundance

For all abundance indices for Gray Snapper, year, bay, month, SAV percentage, and depth were retained in the model (Tables 12-15). The interaction between year and bay was significant in all models except for age 1 Gray Snapper collected during FWRI seagrass surveys, while temperature and salinity were retained in all models except for age 0 Gray snapper collected

during FWRI seagrass surveys. Shore type was retained in both FWRI long-term FIM models. Tables 12-15 summarize type III tests of fixed effects and the final set of variables used in each model and their significance. Annual abundance indices and boot-strapped coefficients of variation are presented in Tables 16-19 and Figures 14-15.

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Table 1. Annual sampling effort and proportion positive of Gray Snapper collected during FWRI long-term FIM surveys using a 21.3-m seine along riverine shorelines (gr = 23) within Apalachicola Bay (AB), Cedar Key (CK), Tampa Bay (TB), and Charlotte Harbor (CH). Monthly sampling began in 1996.

	Bay							
	AB		CK		TB		CH	
Year	# Sets	Positive	# Sets	Positive	# Sets	Positive	# Sets	Positive
1989					48	0.063	23	
1990					93		69	
1991					90	0.044	90	0.011
1992					96	0.01	96	0.01
1993					108	0.019	72	0.028
1994					108	0.009	72	0.028
1995					96		64	
1996			31	0.097	288	0.014	176	0.028
1997			72	0.097	289	0.042	192	0.042
1998			108	0.019	212	0.019	96	0.031
1999			108	0.102	264	0.011	96	0.042
2000	42	0.071	108	0.083	264	0.053	96	0.01
2001	168	0.06	163	0.061	264	0.068	96	0.01
2002	168	0.089	168	0.071	264	0.027	96	0.031
2003	156	0.013	168	0.036	264	0.023	142	0.035
2004	156	0.083	168	0.036	264	0.08	372	0.027
2005	156	0.013	168	0.054	264	0.042	372	0.03
2006	156	0.103	168	0.042	264	0.045	372	0.022
2007	155	0.039	168	0.083	264	0.091	372	0.03
2008	156	0.038	168	0.06	288	0.042	180	0.039
2009	156	0.038	168	0.107	288	0.042	180	0.022
2010	156	0.032	168	0.012	312	0.045	96	0.063
2011	156	0.032	168	0.03	312	0.019	96	0.031
2012	156	0.071	168	0.101	312	0.032	96	0.083
2013	156	0.006	168	0.048	312	0.083	96	0.031
2014	156	0.064	168	0.054	318	0.053	96	0.094
2015	156	0.019	168	0.054	336	0.065	96	0.073
Total	2405		2942		6282		3900	

Table 2. Annual sampling effort and proportion positive of Gray Snapper collected during FWRI long-term FIM surveys using a 21.3-m bay seine (grs = 19 and 20 combined) within Apalachicola Bay (AB), Cedar Key (CK), Tampa Bay (TB), and Charlotte Harbor (CH). Monthly sampling began in 1996.

	Bay							
	AB		CK		TB		CH	
Year	# Sets	Positive	# Sets	Positive	# Sets	Positive	# Sets	Positive
1989					186	0.032	183	0.055
1990					198	0.01	153	0.072
1991					240	0.146	144	0.111
1992					240	0.054	144	0.139
1993					240	0.029	144	0.083
1994					240	0.029	192	0.094
1995					120	0.042	94	0.138
1996			84	0.012	361	0.042	197	0.086
1997			144	0.007	358	0.059	192	0.167
1998	76	0.053	144		300	0.02	288	0.042
1999	96	0.052	144	0.021	300	0.057	288	0.115
2000	96	0.052	144	0.021	300	0.053	288	0.076
2001	240	0.063	243	0.016	300	0.077	288	0.135
2002	240	0.042	252	0.048	300	0.073	288	0.135
2003	240	0.067	252	0.024	300	0.037	332	0.151
2004	240	0.096	252	0.008	300	0.07	552	0.13
2005	240	0.042	252	0.016	408	0.02	552	0.065
2006	240	0.058	252	0.036	408	0.037	552	0.118
2007	240	0.033	252	0.02	408	0.051	552	0.176
2008	240	0.029	252	0.004	408	0.039	480	0.144
2009	240	0.013	252	0.02	408	0.059	480	0.115
2010	240	0.063	252	0.032	408	0.039	408	0.081
2011	240	0.05	252	0.012	408	0.025	408	0.056
2012	240	0.067	252	0.032	408	0.076	408	0.164
2013	240	0.058	252	0.008	408	0.051	408	0.11
2014	240	0.104	252	0.032	408	0.074	408	0.142
2015	240	0.033	252	0.016	408	0.059	408	0.13
Total	3868		4431		8771		8831	

Table 3. Annual sampling effort and proportion positive of Gray Snapper collected during FWRI long-term FIM surveys using a 183-m shoreline seine within Apalachicola Bay (AB), Cedar Key (CK), Tampa Bay (TB), and Charlotte Harbor (CH).

	Bay							
	AB		CK		TB		CH	
Year	# Sets	Positive	# Sets	Positive	# Sets	Positive	# Sets	Positive
1996					180	0.056	132	0.144
1997			95	0.021	240	0.075	204	0.289
1998	163	0.031	120	0.017	240	0.046	204	0.201
1999	288	0.028	192	0.047	240	0.058	204	0.176
2000	288	0.028	192	0.063	235	0.132	204	0.225
2001	216	0.014	192	0.021	240	0.033	204	0.24
2002	216	0.028	192	0.042	240	0.142	204	0.348
2003	216	0.014	192	0.021	240	0.088	216	0.208
2004	216	0.028	192	0.057	240	0.079	276	0.199
2005	216	0.019	192	0.031	240	0.058	276	0.239
2006	216	0.042	192	0.005	240	0.05	276	0.17
2007	216	0.046	192	0.052	240	0.146	276	0.409
2008	216	0.019	192	0.036	240	0.175	276	0.301
2009	216	0.009	192	0.036	240	0.129	240	0.283
2010	216	0.028	192	0.021	240	0.075	204	0.23
2011	216	0.019	192	0.042	240	0.063	204	0.137
2012	216	0.042	192	0.078	240	0.183	204	0.235
2013	216	0.032	192	0.063	240	0.221	204	0.373
2014	216	0.005	192	0.036	240	0.175	204	0.314
2015	216	0.028	192	0.031	240	0.208	204	0.333
Total	3979		3479		4735		4416	

Table 4. Annual sampling effort and proportion positive of Gray Snapper collected during FWRI seagrass surveys using 6.1-m otter trawls within St. Andrew Bay (SA), Apalachicola Bay (AB), Tampa Bay (TB), and Charlotte Harbor (CH). Sampling occurs from May – November.

	Bay							
	SA		AB		TB		CH	
Year	# Sets	Positive	# Sets	Positive	# Sets	Positive	# Sets	Positive
2008	42	0.143	56	0.107	90	0.3	70	0.643
2009	42	0.143	56	0.089	70	0.414	56	0.554
2010	42	0.214	56	0.054	70	0.043	56	0.357
2011	42	0.119	56	0.089	70	0.171	56	0.554
2012	39	0.333	56	0.143	70	0.557	56	0.768
2013	42	0.19	56	0.107	70	0.557	56	0.607
2014	42	0.357	56	0.143	70	0.443	56	0.696
2015	42	0.31	56	0.018	70	0.514	56	0.643
Total	333		448		580		462	

Table 5. Annual sampling effort and proportion positive of Gray Snapper collected during FWRI seagrass surveys using the 183-m shoal seine within St. Andrew Bay (SA), Apalachicola Bay (AB), Tampa Bay (TB), and Charlotte Harbor (CH). Sampling occurs from May – November.

	Bay							
	SA		AB		TB		CH	
Year	# Sets	Positive	# Sets	Positive	# Sets	Positive	# Sets	Positive
2008	21	0.333	28	0.036	63	0.381	49	0.653
2009	21	0.238	28		49	0.531	42	0.786
2010	21	0.095	28	0.071	49	0.245	42	0.405
2011	21	0.048	28		49	0.286	42	0.333
2012	20	0.4	28	0.179	49	0.469	42	0.643
2013	21	0.429	28	0.071	49	0.796	42	0.667
2014	21		28		49	0.633	42	0.714
2015	21	0.095	28	0.036	49	0.571	42	0.833
Total	167		224		406		343	

Table 6. Subset of data included in the annual index for age-0 Gray Snapper collected during FWRI long-term FIM surveys using a 21.3-m seine along riverine shorelines (gear = 23). Annual sampling effort, proportion positive, and total number of age-0 Gray Snapper collected within Apalachicola Bay (AB), Cedar Key (CK), Tampa Bay (TB), and Charlotte Harbor (CH) are summarized.

	Bay							
	AB		CK		TB		CH	
Year	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected
1998	.	.	54 (0.037)	3	131 (0.008)	1	48 (0)	0
1999	.	.	54 (0.111)	6	132 (0.023)	3	48 (0.042)	2
2000	30 (0.067)	4	54 (0.056)	3	124 (0.024)	3	48 (0)	0
2001	48 (0.083)	22	54 (0.111)	15	116 (0.103)	25	48 (0)	0
2002	48 (0.292)	21	69 (0.116)	12	114 (0.035)	4	48 (0)	0
2003	78 (0.026)	2	84 (0.071)	17	105 (0)	0	48 (0.021)	1
2004	78 (0.167)	21	84 (0.060)	9	116 (0.112)	17	48 (0.063)	7
2005	78 (0.026)	3	84 (0.071)	11	114 (0.018)	2	48 (0.021)	1
2006	78 (0.205)	36	84 (0.060)	9	121 (0.074)	10	48 (0)	0
2007	78 (0.077)	14	84 (0.107)	18	127 (0.071)	9	48 (0.083)	4
2008	78 (0.077)	7	84 (0.060)	9	138 (0.014)	2	48 (0.042)	2
2009	78 (0.077)	7	84 (0.190)	39	138 (0.029)	5	48 (0.083)	6
2010	78 (0.064)	5	84 (0.024)	3	132 (0.030)	5	48 (0.042)	3
2011	78 (0.064)	7	84 (0.060)	10	132 (0.023)	4	48 (0)	0
2012	78 (0.128)	13	84 (0.083)	8	132 (0.030)	5	48 (0.083)	7
2013	78 (0.013)	1	84 (0.012)	1	132 (0.030)	5	48 (0)	0
2014	78 (0.128)	19	84 (0.107)	13	150 (0.073)	15	48 (0.104)	5
2015	78 (0.013)	1	84 (0.071)	7	168 (0.012)	2	48 (0)	0
Total	1140 (0.094)	183	1377 (0.078)	193	2322 (0.042)	117	864 (0.058)	38

Table 7. Subset of data included in the annual index for age-0 Gray Snapper collected during FWRI long-term FIM surveys using a 21.3-m seine deployed in offshore bay habitats (gear = 20). Annual sampling effort, proportion positive, and total number of age-0 Gray Snapper collected within Apalachicola Bay (AB), Cedar Key (CK), Tampa Bay (TB), and Charlotte Harbor (CH) are summarized.

	Bay							
	AB		CK		TB		CH	
Year	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected
1998	24 (0.125)	10	72 (0)	0	120 (0.025)	3	71 (0.028)	3
1999	24 (0.125)	7	72 (0.042)	3	120 (0.100)	36	72 (0.236)	38
2000	24 (0.167)	11	72 (0.042)	9	120 (0.050)	16	71 (0.099)	12
2001	67 (0.149)	29	72 (0.028)	6	119 (0.143)	52	72 (0.153)	69
2002	66 (0.106)	25	72 (0.028)	2	119 (0.084)	37	72 (0.139)	73
2003	66 (0.136)	60	72 (0.056)	6	114 (0.061)	24	74 (0.243)	78
2004	66 (0.182)	77	72 (0.028)	2	118 (0.093)	45	78 (0.269)	94
2005	66 (0.076)	10	72 (0)	0	118 (0.042)	6	78 (0.077)	12
2006	66 (0.167)	55	72 (0.069)	27	116 (0.069)	19	78 (0.231)	47
2007	66 (0.061)	6	72 (0.028)	3	120 (0.033)	9	78 (0.167)	22
2008	66 (0.076)	11	72 (0)	0	120 (0.042)	10	78 (0.179)	26
2009	66 (0.030)	10	72 (0.042)	3	120 (0.083)	34	78 (0.179)	41
2010	66 (0.091)	105	71 (0.070)	9	118 (0.042)	26	78 (0.167)	24
2011	66 (0.076)	38	72 (0.028)	4	120 (0.033)	7	78 (0.038)	5
2012	66 (0.106)	29	72 (0.014)	1	120 (0.092)	20	78 (0.256)	131
2013	66 (0.121)	13	72 (0)	0	120 (0.058)	17	78 (0.090)	29
2014	66 (0.212)	30	72 (0.042)	3	119 (0.109)	51	78 (0.128)	43
2015	66 (0.045)	3	72 (0.014)	1	118 (0.068)	13	78 (0.115)	29
Total (Average)	1063 (0.114)	529	1295 (0.038)	79	2139 (0.068)	425	1368 (0.155)	776

Table 8. Subset of data included in the annual index for age-0 Gray Snapper collected during FWRI long-term FIM surveys using a 21.3-m seine deployed along bay shorelines (gear = 19). Annual sampling effort, proportion positive, and total number of age-0 Gray Snapper collected within Apalachicola Bay (AB), Cedar Key (CK), Tampa Bay (TB), and Charlotte Harbor (CH) are summarized.

	Bay							
	AB		CK		TB		CH	
Year	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected
1998	24 (0.042)	5	.	.	30 (0.033)	1	72 (0.042)	3
1999	24 (0.083)	18	.	.	30 (0.167)	18	72 (0.125)	49
2000	24 (0.042)	1	.	.	30 (0.167)	7	73 (0.123)	36
2001	53 (0.094)	36	54 (0.037)	4	30 (0.200)	16	72 (0.250)	141
2002	54 (0.056)	15	54 (0.167)	40	30 (0.167)	16	72 (0.153)	24
2003	54 (0.130)	11	54 (0.037)	7	30 (0.100)	7	74 (0.216)	73
2004	54 (0.204)	31	54 (0)	0	29 (0.138)	21	78 (0.167)	43
2005	54 (0.093)	9	54 (0.056)	3	84 (0.036)	3	78 (0.115)	24
2006	54 (0.056)	24	54 (0.074)	5	80 (0.075)	11	78 (0.192)	34
2007	54 (0.074)	17	54 (0.037)	3	83 (0.133)	25	78 (0.141)	17
2008	54 (0.037)	3	54 (0.019)	1	82 (0.085)	12	78 (0.103)	14
2009	54 (0.019)	5	54 (0.019)	1	81 (0.148)	40	78 (0.269)	45
2010	54 (0.167)	44	55 (0.055)	3	83 (0.096)	14	78 (0.077)	20
2011	54 (0.130)	29	54 (0.019)	4	84 (0.071)	25	78 (0.103)	15
2012	54 (0.148)	16	54 (0.056)	9	84 (0.119)	27	78 (0.282)	97
2013	54 (0.093)	10	54 (0.019)	1	84 (0.095)	15	78 (0.128)	46
2014	54 (0.204)	51	54 (0.093)	13	84 (0.131)	37	78 (0.231)	32
2015	54 (0.093)	24	54 (0.019)	1	84 (0.071)	10	78 (0.141)	39
Total (Average)	881 (0.098)	349	649 (0.05)	95	1122 (0.113)	305	1371 (0.159)	752

Table 9. Subset of data included in the annual index for age-1 Gray Snapper collected during FWRI long-term FIM surveys using 183-m shoreline seines (gear = 160). Annual sampling effort, proportion positive, and total number of age-1 Gray Snapper collected within Tampa Bay (TB) and Charlotte Harbor (CH) are summarized.

	Bay			
	TB		CH	
Year	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected
1996	180 (0.044)	11	125 (0.112)	47
1997	240 (0.075)	25	204 (0.250)	137
1998	240 (0.042)	16	204 (0.191)	165
1999	240 (0.046)	31	204 (0.162)	160
2000	235 (0.106)	81	204 (0.172)	169
2001	240 (0.033)	14	204 (0.201)	194
2002	240 (0.113)	192	204 (0.294)	295
2003	239 (0.071)	42	204 (0.191)	186
2004	239 (0.075)	75	204 (0.147)	160
2005	234 (0.056)	21	204 (0.206)	198
2006	240 (0.033)	28	204 (0.132)	86
2007	240 (0.125)	423	204 (0.328)	1124
2008	240 (0.154)	90	204 (0.245)	276
2009	240 (0.113)	81	204 (0.235)	235
2010	240 (0.050)	20	204 (0.211)	122
2011	240 (0.038)	12	204 (0.132)	219
2012	240 (0.154)	106	204 (0.216)	219
2013	240 (0.133)	133	204 (0.328)	628
2014	240 (0.163)	183	204 (0.265)	226
2015	240 (0.188)	255	204 (0.294)	712
Total (Average)	4727 (0.091)	1839	4001 (0.216)	5557

Table 10. Subset of data included in the annual index for age-0 Gray Snapper collected during FWRI seagrass surveys using 6.1-m otter trawls. Annual sampling effort, proportion positive, and total number of age-0 Gray Snapper collected within St. Andrew Bay (SA), Apalachicola Bay (AB), Tampa Bay (TB), and Charlotte Harbor (CH) are summarized.

	Bay							
	SA		AB		TB		CH	
Year	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected
2008	21 (0.143)	3	25 (0.12)	3	36 (0.111)	12	28 (0.143)	5
2009	28 (0.143)	4	31 (0.097)	6	50 (0.240)	22	38 (0.316)	35
2010	29 (0.310)	21	34 (0.088)	5	50 (0.040)	5	39 (0.282)	26
2011	30 (0.167)	7	39 (0.128)	29	50 (0.020)	11	40 (0.275)	25
2012	27 (0.444)	28	37 (0.108)	10	50 (0.380)	82	40 (0.450)	62
2013	30 (0.233)	18	40 (0.075)	5	50 (0.280)	47	40 (0.175)	14
2014	30 (0.500)	55	40 (0.200)	47	40 (0.240)	15	40 (0.325)	46
2015	30 (0.233)	16	40 (0.025)	1	50 (0.140)	22	40 (0.2)00	17
Total (Average)	225 (0.272)	152	286 (0.105)	106	386 (0.181)	216	305 (0.271)	230

Table 11. Subset of data included in the annual index for age-1 Gray Snapper collected during FWRI seagrass surveys using 6.1-m otter trawls (gear = 300) and 183-m shoal seines (gear = 160). Annual sampling effort, proportion positive, and total number of age-1 Gray Snapper collected within Tampa Bay (TB) and Charlotte Harbor (CH).

	Bay							
	TB				CH			
	shoal seine		trawl		shoal seine		trawl	
Year	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected	No. sets (proportion positive)	No. collected
2008	42 (0.524)	68	44 (0.409)	46	41 (0.683)	194	38 (0.763)	102
2009	49 (0.449)	99	69 (0.232)	36	40 (0.725)	137	53 (0.509)	116
2010	49 (0.143)	56	70 (0)	0	39 (0.410)	58	51 (0.275)	34
2011	49 (0.245)	48	70 (0.100)	9	41 (0.317)	100	56 (0.482)	101
2012	49 (0.367)	115	70 (0.329)	77	42 (0.643)	257	56 (0.661)	180
2013	49 (0.449)	101	70 (0.357)	117	42 (0.619)	362	56 (0.571)	231
2014	49 (0.612)	136	70 (0.343)	95	41 (0.707)	176	56 (0.589)	137
2015	49 (0.551)	218	70 (0.457)	168	42 (0.762)	578	56 (0.589)	220
Total (Average)	385 (0.418)	841	533 (0.318)	548	328 (0.608)	1862	422 (0.555)	1121

Table 12. Type 3 tests of fixed effects for the negative binomial model for age 0 Gray Snapper collected in FWRI long-term FIM surveys using 21.3-m seines from July-December, 1998-2015, within Apalachicola Bay, Cedar Key, Tampa Bay, and Charlotte Harbor.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
Bay*Year	51	15381	3.08	<.0001
Year	17	15381	9.07	<.0001
Bay	3	15381	31.3	<.0001
Month	5	15381	80.45	<.0001
Shore type	5	15381	14.17	<.0001
SAV percentage	11	15381	75.17	<.0001
Temperature	3	15381	4.22	0.0055
Salinity	3	15381	2.54	0.0544
Depth	3	15381	11.57	<.0001

Table 13. Type 3 tests of fixed effects for the negative binomial model for age 0 Gray Snapper collected in FWRI seagrass surveys using 6.1-m otter trawls from May-November, 2008-2015, within St. Andrew Bay, Apalachicola Bay, Tampa Bay, and Charlotte Harbor.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
Bay*Year	21	1152	2.16	0.0018
Year	7	1152	4.67	<.0001
Bay	3	1152	1.8	0.1457
Month	4	1152	2.55	0.0377
SAV percentage	5	1152	5.2	<.0001
Depth	3	1152	16.19	<.0001

Table 14. Type 3 tests of fixed effects for the negative binomial model for age 1 Gray Snapper collected during FWRI long-term FIM surveys using 183-m shoreline seines from January-December, 1996-2015 Tampa Bay and Charlotte Harbor.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
Bay*Year	19	8383	3.15	<.0001
Year	19	8383	16.45	<.0001
Bay	1	8383	268.29	<.0001
Month	11	8383	47.78	<.0001
Shore type	5	8383	9.91	<.0001
SAV percentage	11	8383	9.31	<.0001
Temperature	3	8383	5.1	0.0016
Salinity	3	8383	33.66	<.0001
Depth	3	8383	38.69	<.0001

Table 15. Type 3 tests of fixed effects for the negative binomial model for age 1 Gray Snapper collected in FWRI seagrass surveys using 183-m shoal seines and 6.1-m otter trawls from May-November, 2008-2015, within Tampa Bay and Charlotte Harbor.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
Year	7	1634	27.54	<.0001
Bay	1	1634	60.17	<.0001
Month	6	1634	15.53	<.0001
SAV percentage	5	1634	10.11	<.0001
Temperature	3	1634	7.34	<.0001
Salinity	3	1634	5.55	0.0009
Depth	3	1634	2.6	0.0508
Effort	1	1634	96.36	<.0001

Table 16. Index of abundance developed using the negative binomial model for age 0 Gray Snapper collected in FWRI long-term FIM surveys using 21.3-m seines from July-December, 1998-2015, within Apalachicola Bay, Cedar Key, Tampa Bay, and Charlotte Harbor. The nominal frequency of occurrence, the number of samples (N), the least squares mean (Mean, number per set) and standard error (SE), the coefficient of variation on the mean (CV), lower and upper confidence limits (LCL and UCL), and the scaled mean are listed.

Survey year	Frequency	N	Mean	SE	CV	LCL	UCL	Scaled Mean
1998	0.0248	646	0.0264	0.0082	0.3174	0.0144	0.0484	0.1740
1999	0.0957	648	0.1453	0.0343	0.2406	0.0915	0.2307	0.9568
2000	0.0642	670	0.108	0.0228	0.2151	0.0714	0.1634	0.7112
2001	0.1155	805	0.2257	0.0379	0.1693	0.1623	0.3137	1.4862
2002	0.1015	818	0.2599	0.0428	0.1660	0.1883	0.3589	1.7114
2003	0.0879	853	0.1757	0.0288	0.1651	0.1274	0.2422	1.1570
2004	0.1234	875	0.2724	0.0441	0.1621	0.1984	0.374	1.7938
2005	0.0506	928	0.0702	0.0144	0.2059	0.047	0.1049	0.4623
2006	0.1076	929	0.205	0.0317	0.1581	0.1514	0.2777	1.3499
2007	0.0839	942	0.1572	0.0267	0.1720	0.1127	0.2194	1.0352
2008	0.0599	952	0.0721	0.0141	0.1966	0.0491	0.1057	0.4745
2009	0.0988	951	0.2073	0.0322	0.1558	0.1528	0.2811	1.3651
2010	0.0720	945	0.1344	0.0226	0.1675	0.0967	0.1869	0.8850
2011	0.0517	948	0.0808	0.015	0.1891	0.0561	0.1163	0.5319
2012	0.1129	948	0.2143	0.0378	0.1780	0.1516	0.3029	1.4112
2013	0.0549	948	0.0581	0.0179	0.3168	0.0318	0.1063	0.3827
2014	0.1244	965	0.2234	0.0371	0.1663	0.1613	0.3093	1.4711
2015	0.0540	982	0.0973	0.0189	0.1940	0.0666	0.1423	0.6407

Table 17. Index of abundance developed using the negative binomial model for age 0 Gray Snapper collected in FWRI seagrass surveys using 6.1-m otter trawls from May-November, 2008-2015, within St. Andrew Bay, Apalachicola Bay, Tampa Bay, and Charlotte Harbor. The nominal frequency of occurrence, number of samples (N), the least squares mean (Mean, number per set) and standard error (SE), the coefficient of variation on the mean (CV), lower and upper confidence limits (LCL and UCL), and the scaled mean are listed.

Survey year	Frequency	N	Mean	SE	CV	LCL	UCL	Scaled mean
2008	0.1273	110	0.124	0.04459	0.3712	0.06124	0.2511	0.4185
2009	0.2109	147	0.2365	0.0657	0.2836	0.1371	0.4079	0.7982
2010	0.1645	152	0.1752	0.04856	0.2842	0.1017	0.3018	0.5913
2011	0.1384	159	0.248	0.06512	0.2667	0.1481	0.4151	0.8370
2012	0.3442	154	0.5255	0.1219	0.2345	0.3333	0.8284	1.7735
2013	0.1938	160	0.2907	0.0727	0.2533	0.1779	0.4748	0.9811
2014	0.3000	160	0.6069	0.131	0.2203	0.3974	0.927	2.0483
2015	0.1438	160	0.1636	0.05595	0.3571	0.08361	0.32	0.5521

Table 18. Index of abundance developed using the negative binomial model for age 1 Gray Snapper collected in FWRI long-term FIM surveys using 183-m shoreline seines from January-December, 1996-2015, within Tampa Bay and Charlotte Harbor. The nominal frequency of occurrence, number of samples (N), the least squares mean (Mean, number per set) and standard error (SE), the coefficient of variation on the mean (CV), lower and upper confidence limits (LCL and UCL), and scaled mean are listed.

Survey year	Frequency	N	Mean	SE	CV	LCL	UCL	Scaled mean
1996	0.0721	305	0.0954	0.0312	0.3336	0.0503	0.1810	0.2443
1997	0.1554	444	0.1722	0.0443	0.2582	0.1040	0.2852	0.4410
1998	0.1104	444	0.1953	0.0503	0.2623	0.1179	0.3237	0.5001
1999	0.0991	444	0.1815	0.0422	0.2363	0.1151	0.2863	0.4648
2000	0.1367	439	0.1709	0.0365	0.2124	0.1124	0.2598	0.4377
2001	0.1104	444	0.1324	0.0335	0.2587	0.0807	0.2173	0.3391
2002	0.1959	444	0.4471	0.0882	0.1985	0.3036	0.6582	1.1450
2003	0.1264	443	0.3802	0.0864	0.2292	0.2435	0.5937	0.9736
2004	0.1084	443	0.3914	0.0857	0.2236	0.2548	0.6011	1.0023
2005	0.1256	438	0.2713	0.0664	0.2493	0.1679	0.4383	0.6948
2006	0.0788	444	0.1563	0.0377	0.2434	0.0975	0.2507	0.4003
2007	0.2185	444	1.0281	0.2119	0.2077	0.6864	1.5398	2.6328
2008	0.1959	444	0.5772	0.1212	0.2137	0.3825	0.8710	1.4781
2009	0.1689	444	0.3775	0.0788	0.2113	0.2508	0.5683	0.9667
2010	0.1239	444	0.1544	0.0365	0.2401	0.0971	0.2453	0.3954
2011	0.0811	444	0.1065	0.0292	0.2778	0.0622	0.1823	0.2727
2012	0.1824	444	0.3158	0.0604	0.1930	0.2170	0.4594	0.8087
2013	0.2230	444	0.8132	0.1629	0.2021	0.5491	1.2043	2.0825
2014	0.2095	444	0.5452	0.1078	0.1987	0.3701	0.8032	1.3962
2015	0.2365	444	1.2979	0.2444	0.1928	0.8972	1.8774	3.3238

Table 19. Index of abundance developed using the negative binomial model for age 1 Gray Snapper collected in FWRI seagrass surveys from May-November, 2008-2015, within Tampa Bay and Charlotte Harbor. The nominal frequency of occurrence, number of samples (N), the least squares mean (Mean, number per set) and standard error (SE), the coefficient of variation on the mean (CV), lower and upper confidence limits (LCL and UCL), and scaled mean are listed.

Survey year	Frequency	N	Mean	SE	CV	LCL	UCL	Scaled mean
2008	0.5879	165	1.1377	0.1722	0.1534	0.8455	1.5309	0.8585
2009	0.4455	211	0.8250	0.1134	0.1381	0.6301	1.0803	0.6225
2010	0.1770	209	0.3231	0.0517	0.1612	0.2361	0.4423	0.2438
2011	0.2731	216	0.5596	0.0818	0.1457	0.4201	0.7454	0.4223
2012	0.4839	217	1.3049	0.1591	0.1217	1.0273	1.6574	0.9846
2013	0.4839	217	2.2417	0.2827	0.1265	1.7505	2.8707	1.6915
2014	0.5370	216	1.3629	0.1690	0.1242	1.0686	1.7381	1.0284
2015	0.5714	217	2.8471	0.3346	0.1183	2.2610	3.5852	2.1483

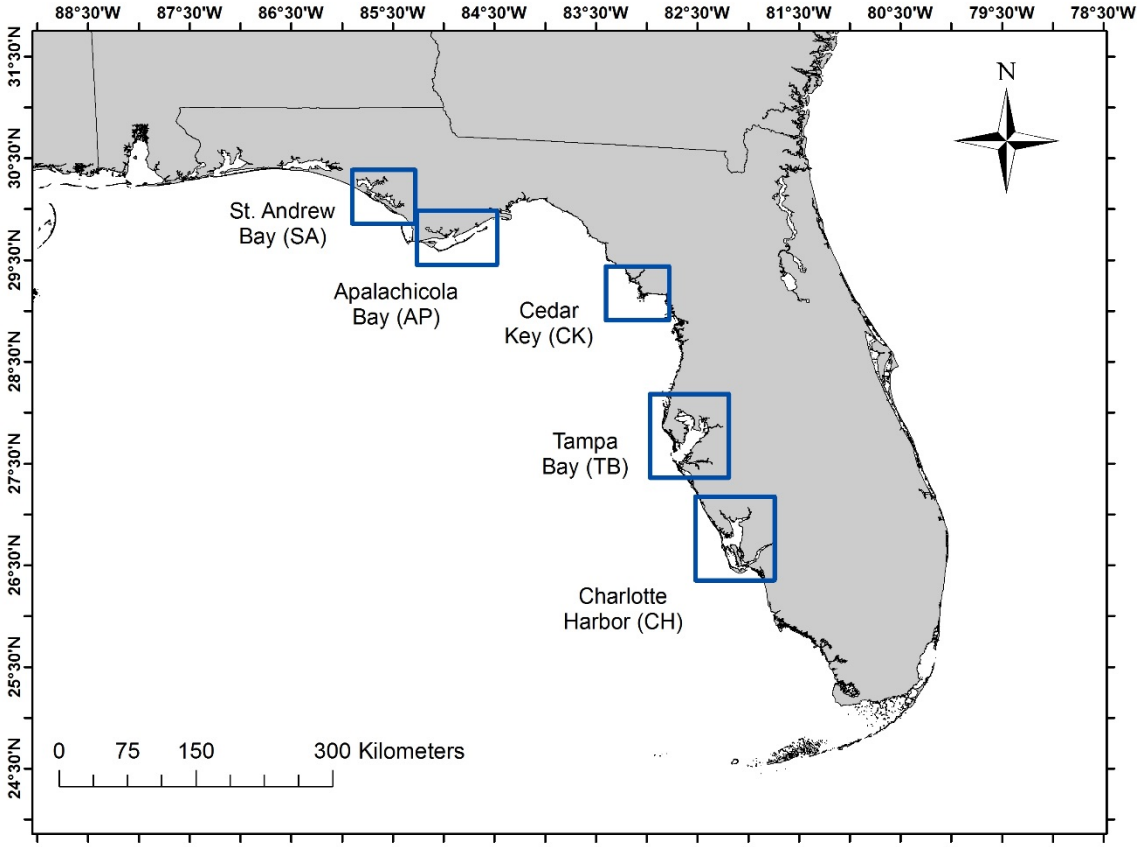


Figure 1. Map of estuaries within which FWRI seine and trawl surveys were conducted.

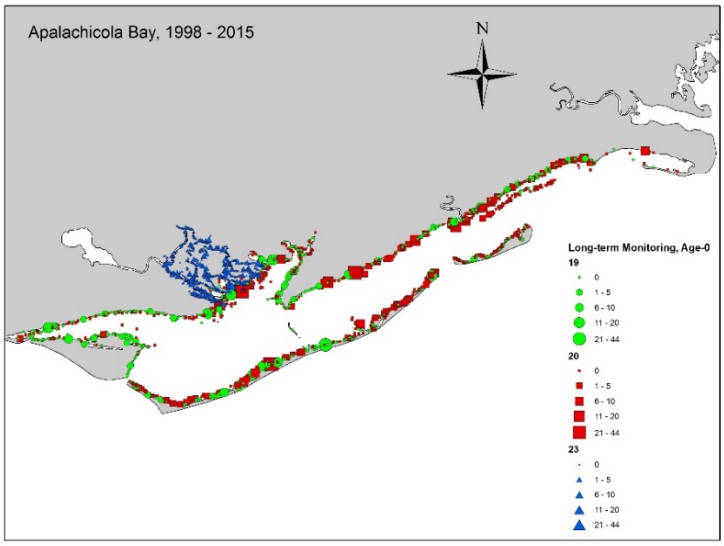


Figure 2. Stations sampled in Apalachicola Bay from 1998 – 2015 during FWRI long-term FIM surveys using a 21.3-m seine along bay shorelines (gear = 19), offshore bay habitats (gear = 20), and riverine shorelines (gear = 23). Symbols represent the total number of age-0 Gray Snapper collected per set.

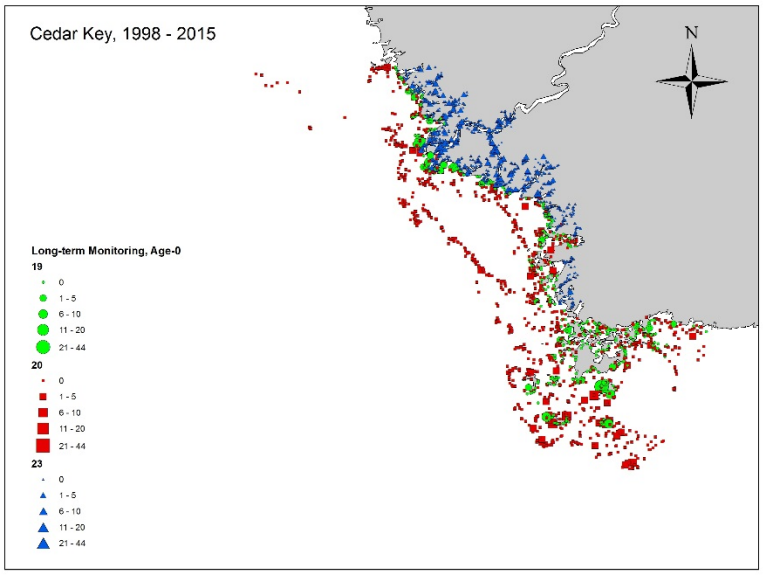


Figure 3. Stations sampled in Cedar Key from 1998 – 2015 during long-term FWRI surveys using a 21.3-m seine along bay shorelines (gear = 19), bay offshore habitats (gear = 20), and riverine shorelines (gear = 23). Symbols represent the total number of age-0 Gray Snapper collected per set.

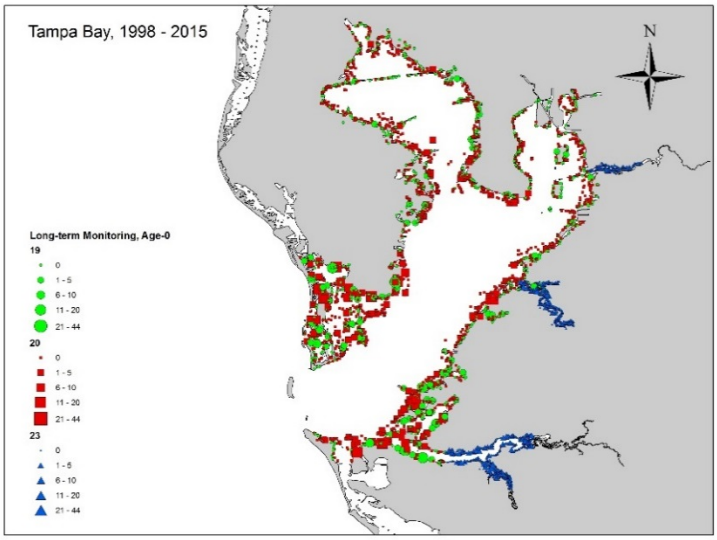


Figure 4. Stations sampled in Tampa Bay from 1998 – 2015 during long-term FWRI surveys using a 21.3-m seine along bay shorelines (gear = 19), bay offshore habitats (gear = 20), and riverine shorelines (gear = 23). Symbols represent the total number of age-0 Gray Snapper collected per set.

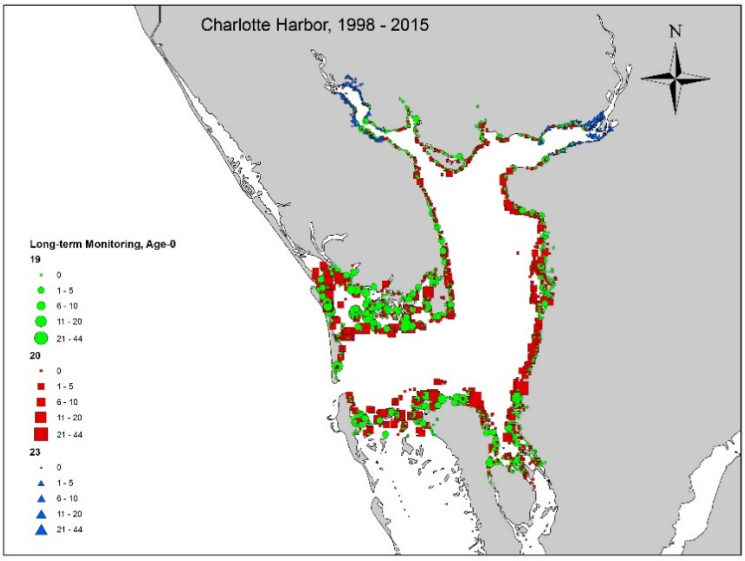


Figure 5. Stations sampled in Charlotte Harbor from 1998 – 2015 during long-term FWRI surveys using a 21.3-m seine along bay shorelines (gear = 19), bay offshore habitats (gear = 20), and riverine shorelines (gear = 23). Symbols represent the total number of age-0 Gray Snapper collected per set.

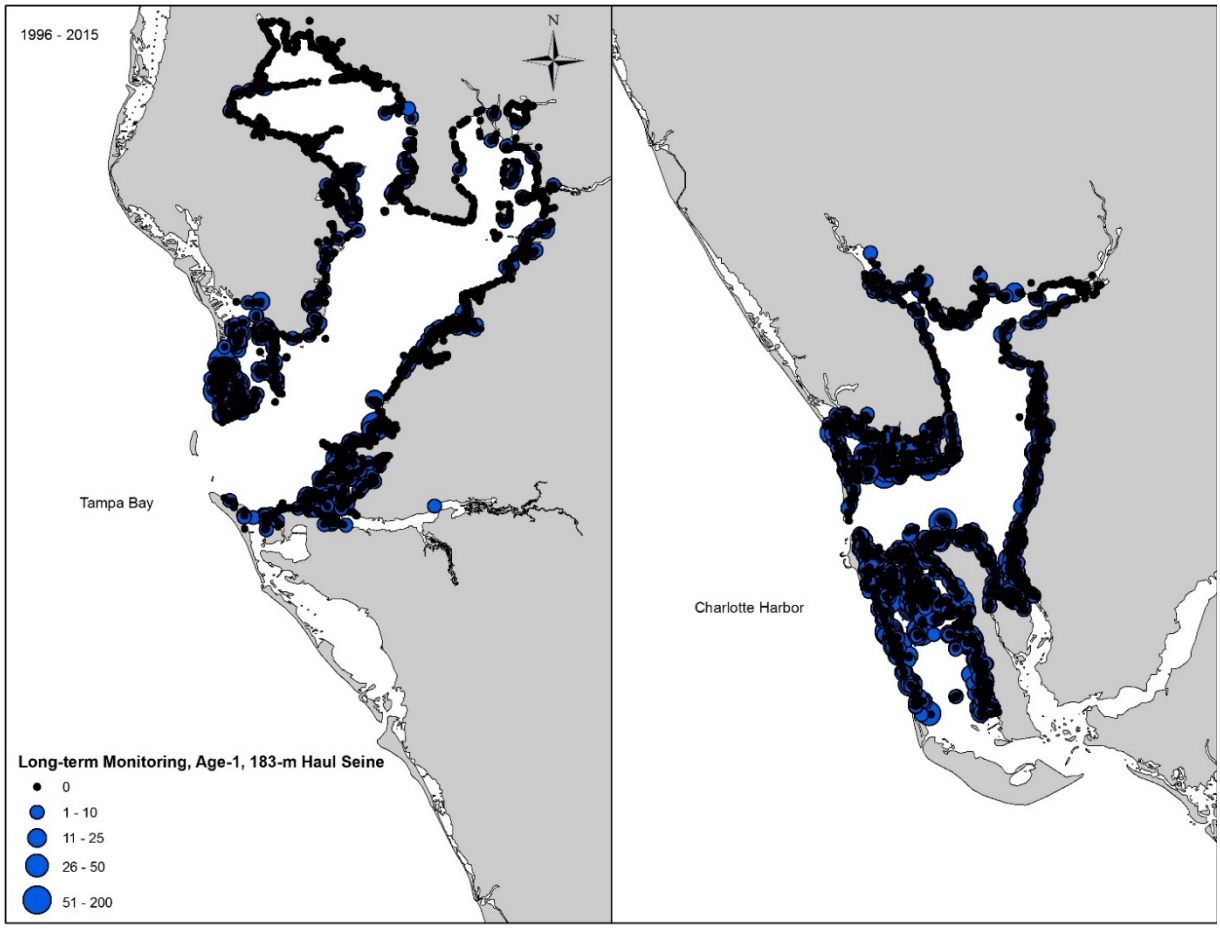


Figure 6. Stations sampled in Tampa Bay and Charlotte Harbor from 1996 – 2015 during FWRI long-term FIM surveys using a 183-m shoreline seine. Symbols represent the total number of age-1 Gray Snapper collected per set.

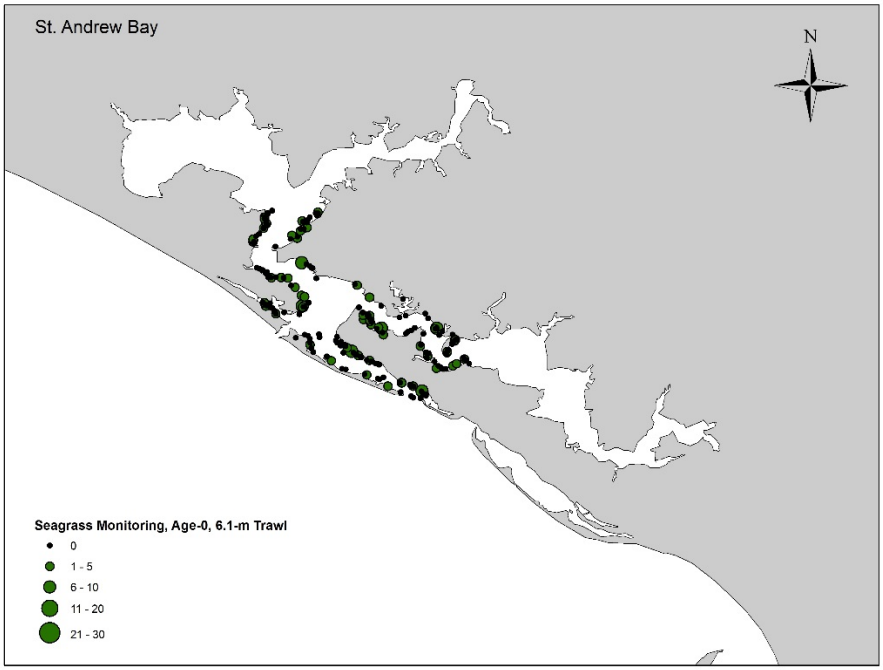


Figure 7. Stations sampled in St. Andrew Bay from 2008 – 2015 during FWRI seagrass surveys using a 6.1-m otter trawl. Symbols represent the total number of age-0 Gray Snapper collected per set.

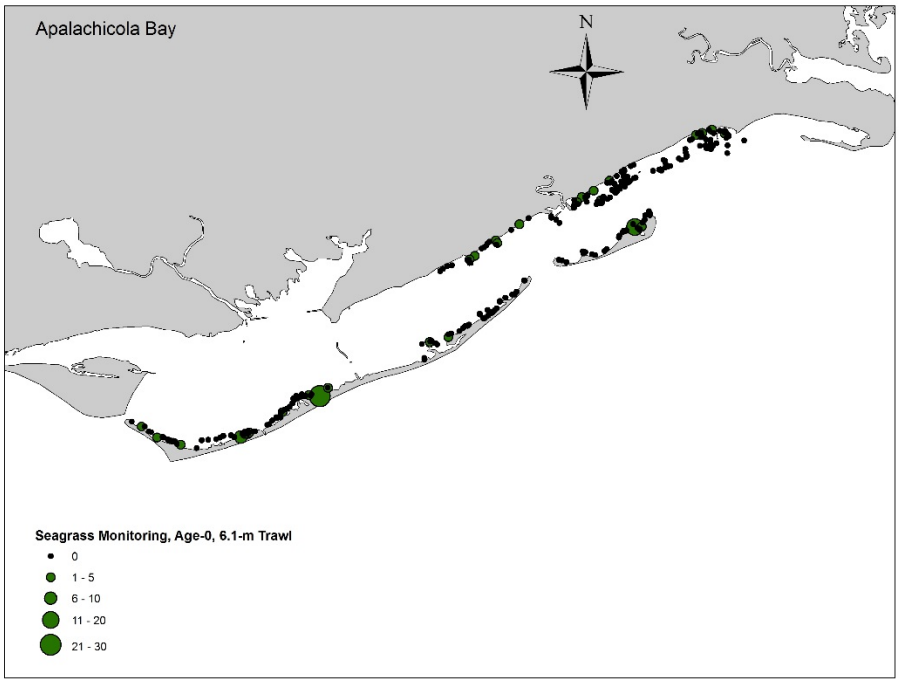


Figure 8. Stations sampled in Apalachicola Bay from 2008 – 2015 during FWRI seagrass surveys using a 6.1-m otter trawl. Symbols represent the total number of age-0 Gray Snapper collected per set.

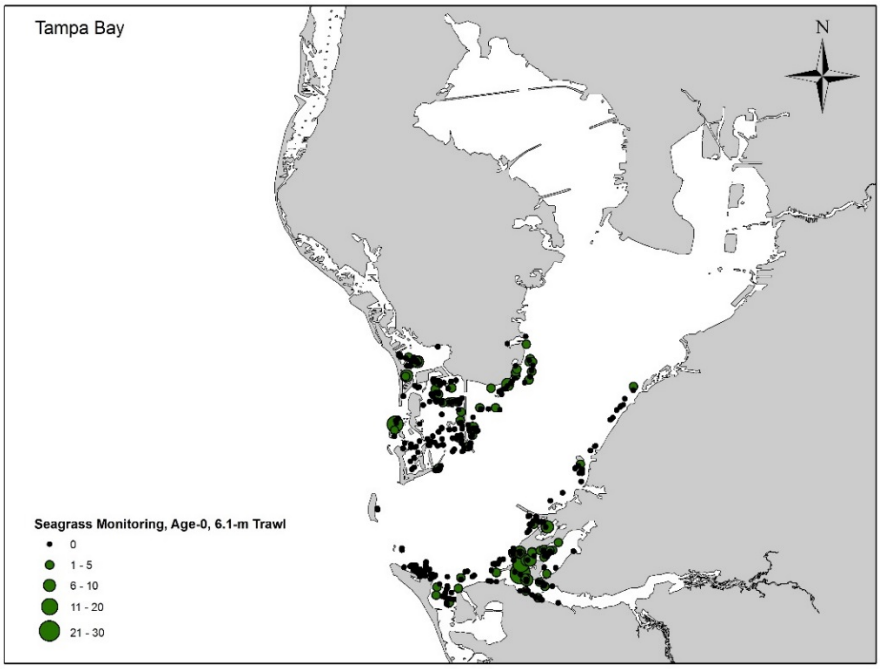


Figure 9. Stations sampled in Tampa Bay from 2008 – 2015 during FWRI seagrass surveys using a 6.1-m otter trawl. Symbols represent the total number of age-0 Gray Snapper collected per set.

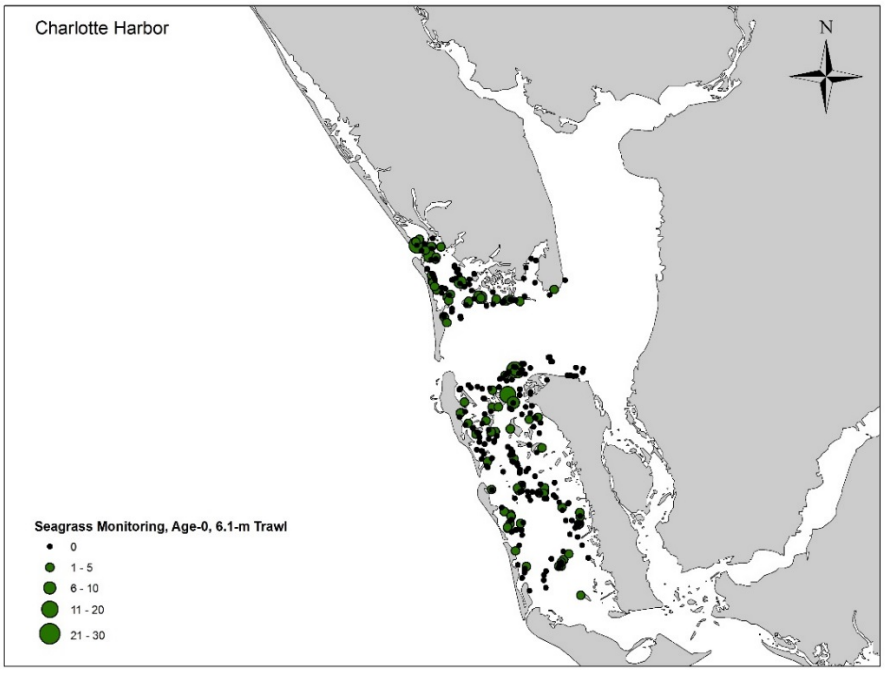


Figure 10. Stations sampled in Charlotte Harbor from 2008 – 2015 during FWRI seagrass surveys using a 6.1-m otter trawl. Symbols represent the total number of age-0 Gray Snapper collected per set.

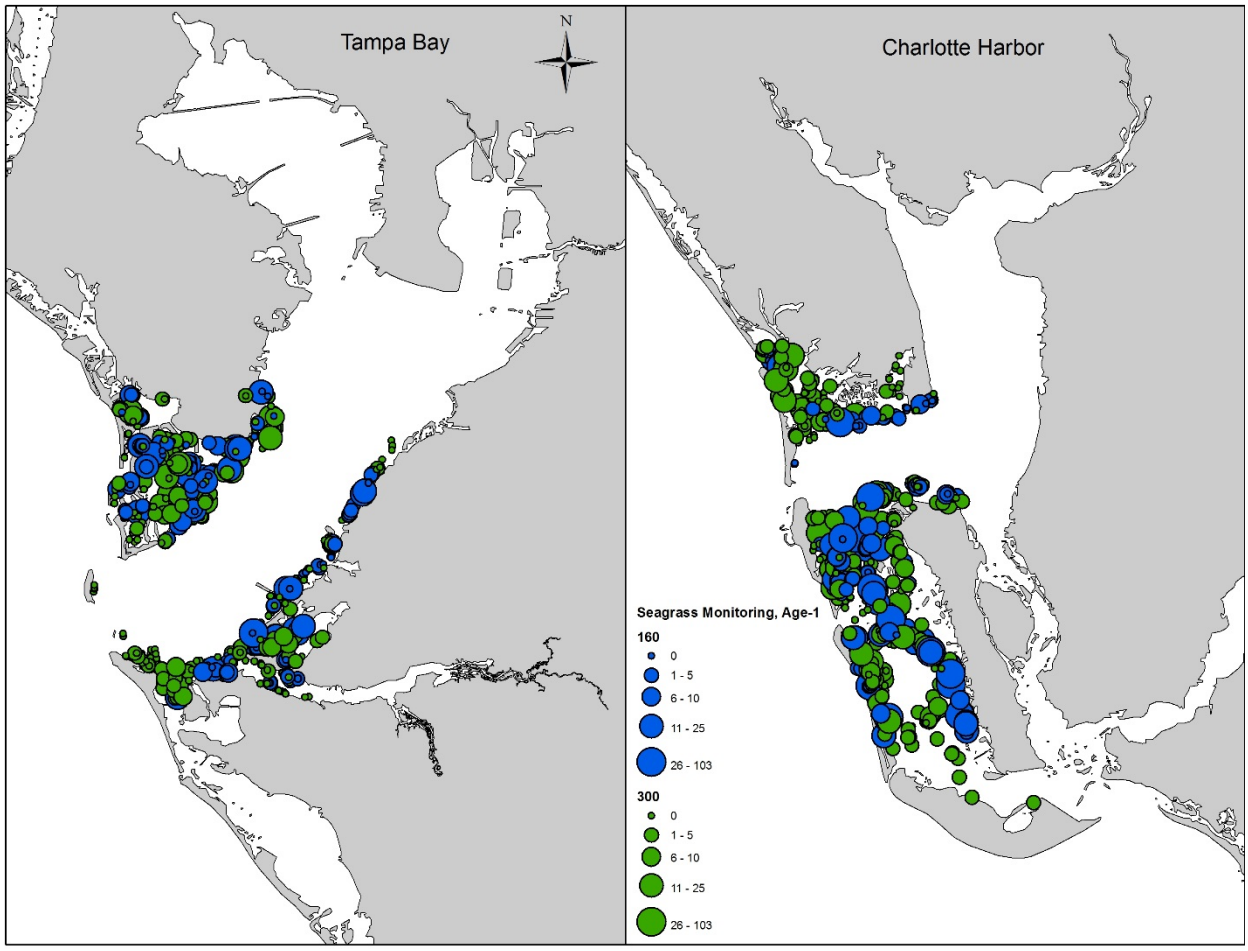


Figure 11. Stations sampled in Tampa Bay and Charlotte Harbor from 2008 – 2015 during FWRI seagrass surveys using a 183-m shoal seine (gear = 160) and a 6.1-m otter trawl (gear = 300). Symbols represent the total number of age-1 Gray Snapper collected per set.

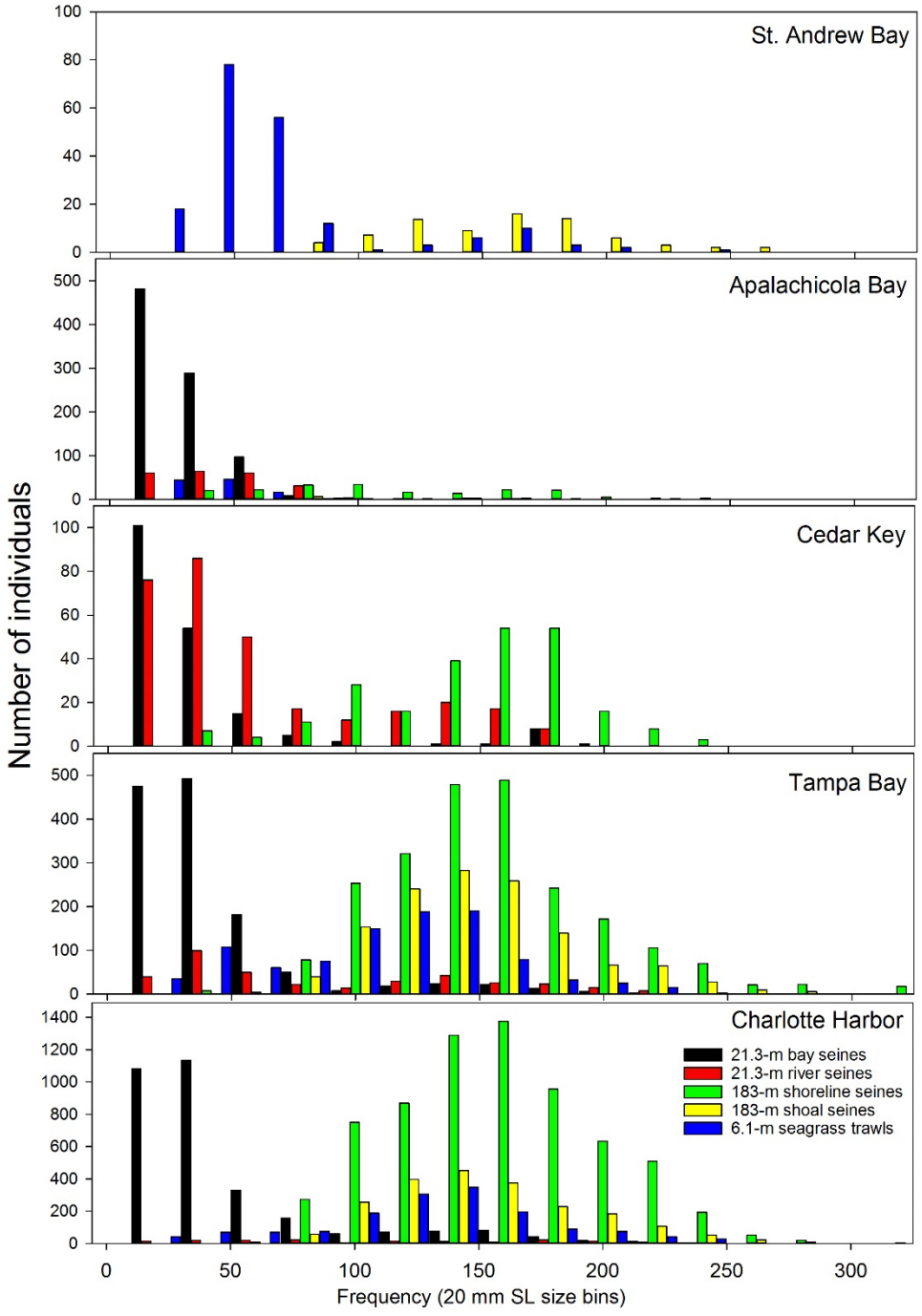


Figure 12. Length frequency distribution of Gray Snapper collected during FWRI long-term FIM surveys and seagrass surveys within St. Andrew Bay, Apalachicola Bay, Cedar Key, Tampa Bay, and Charlotte Harbor. This distribution includes all years, months and sizes for each gear and estuary. Note that bay deployments for the 21.3-m seine are combined in this figure.

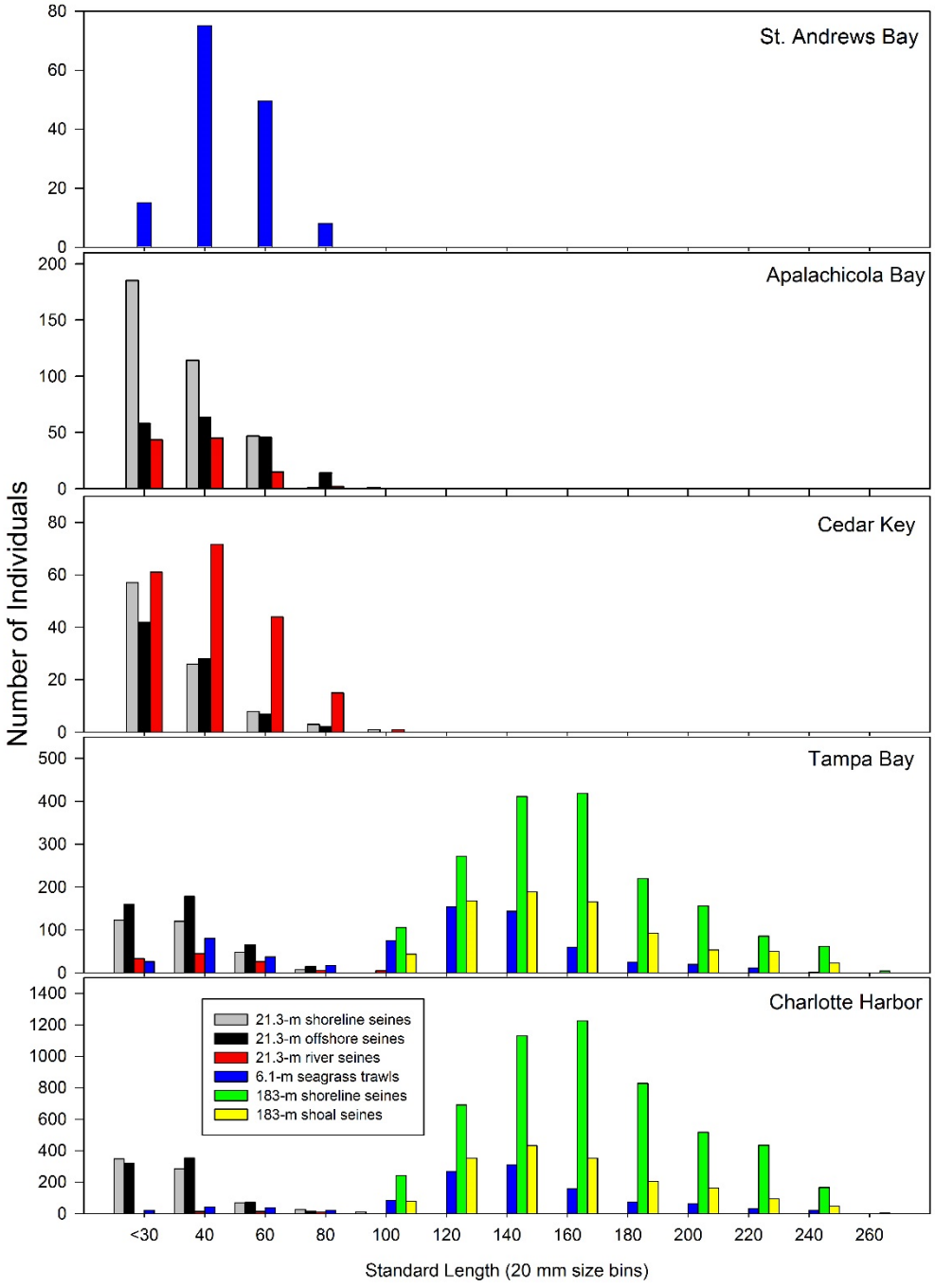


Figure 13. Length frequency distribution of Gray Snapper collected during FWRI long-term FIM surveys and seagrass surveys within St. Andrew Bay, Apalachicola Bay, Cedar Key, Tampa Bay, and Charlotte Harbor. This distribution includes the subset of data included in the indices and separates 21.3-m bay seines into shoreline and offshore deployments.

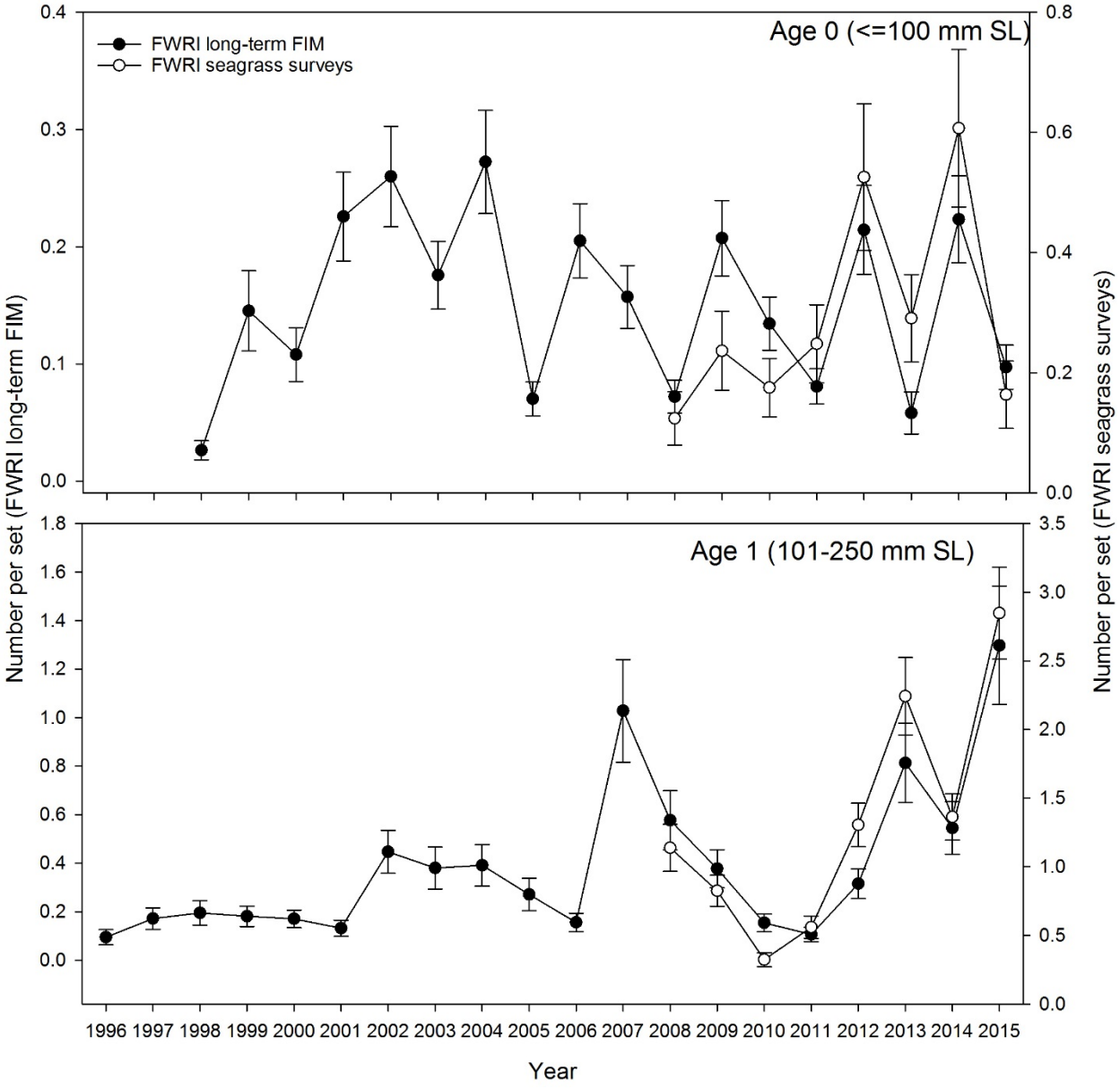


Figure 14. Indices of abundance (least square means ± SE) for Age 0 (top panel) and Age 1 (bottom panel) Gray Snapper collected during FWRI seine and trawl surveys in northeastern Gulf of Mexico estuaries.

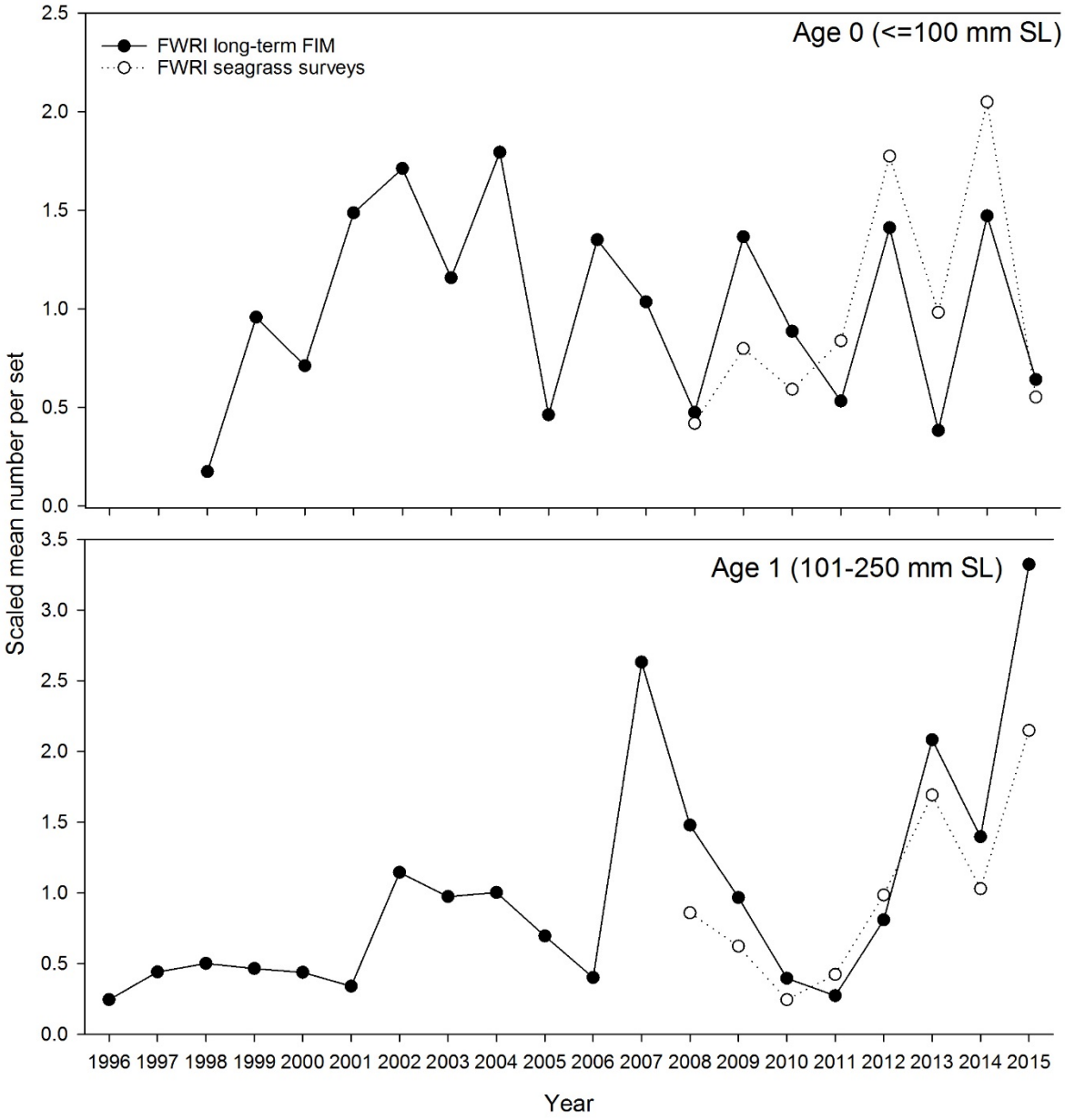
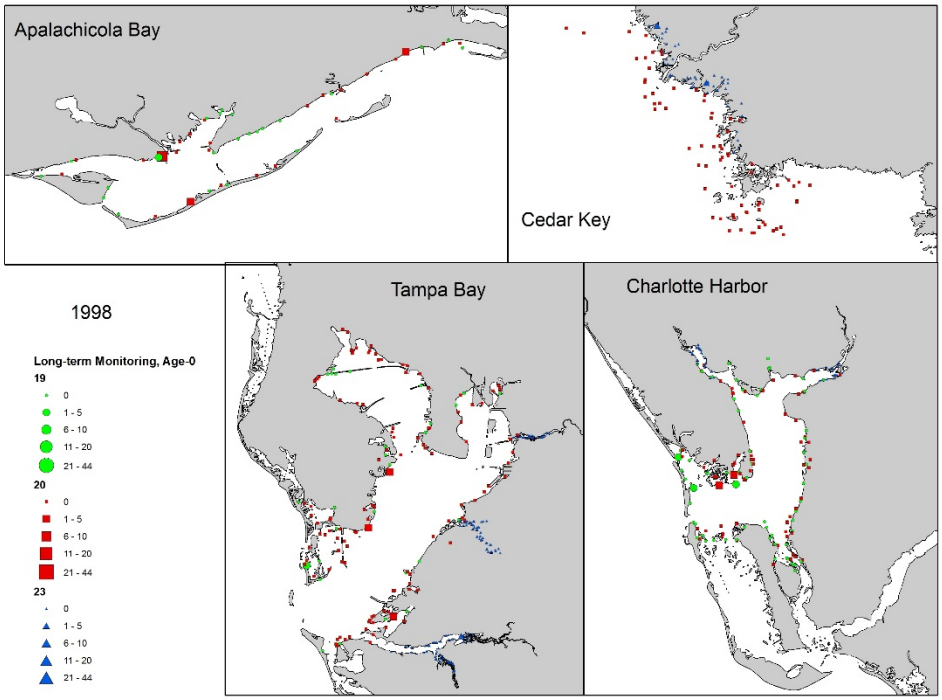
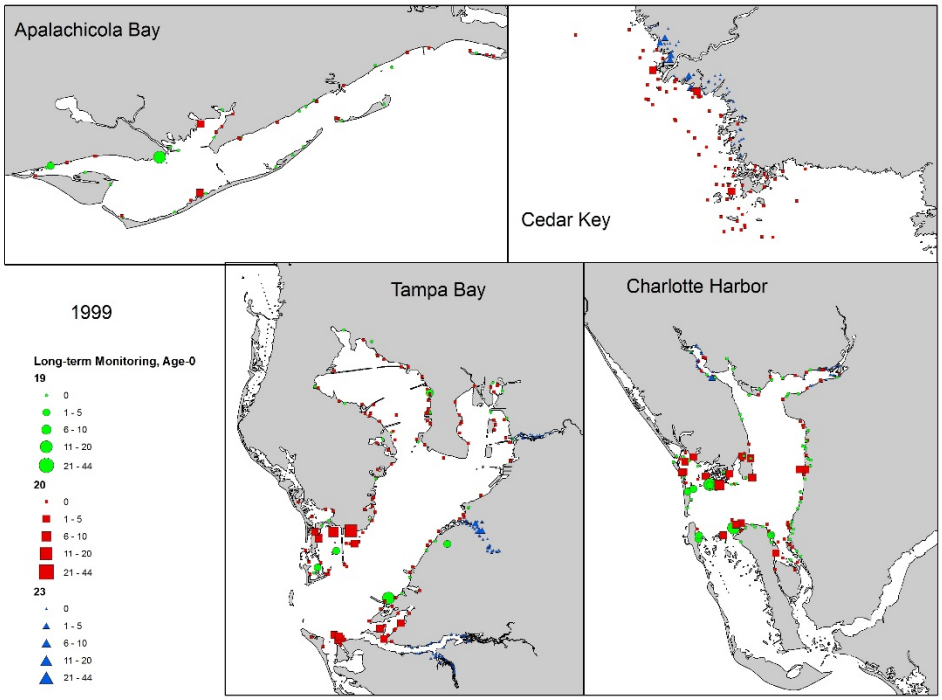


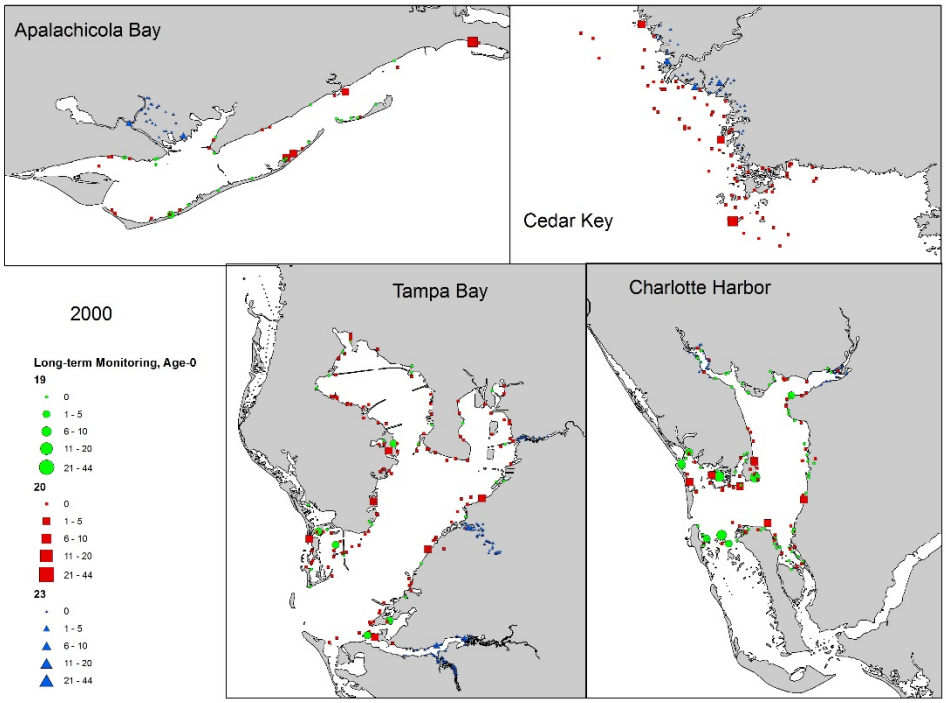
Figure 15. Indices of abundance (scaled mean) for Age 0 (top panel) and Age 1 (bottom panel) Gray Snapper collected during FWRI seine and trawl surveys in northeastern Gulf of Mexico estuaries.

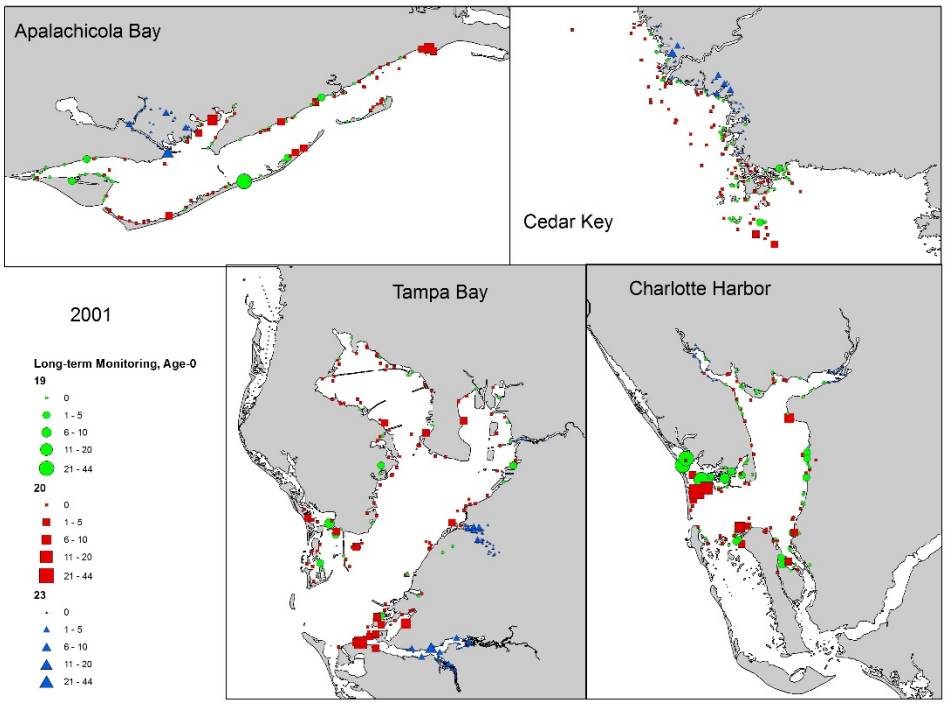
Appendix

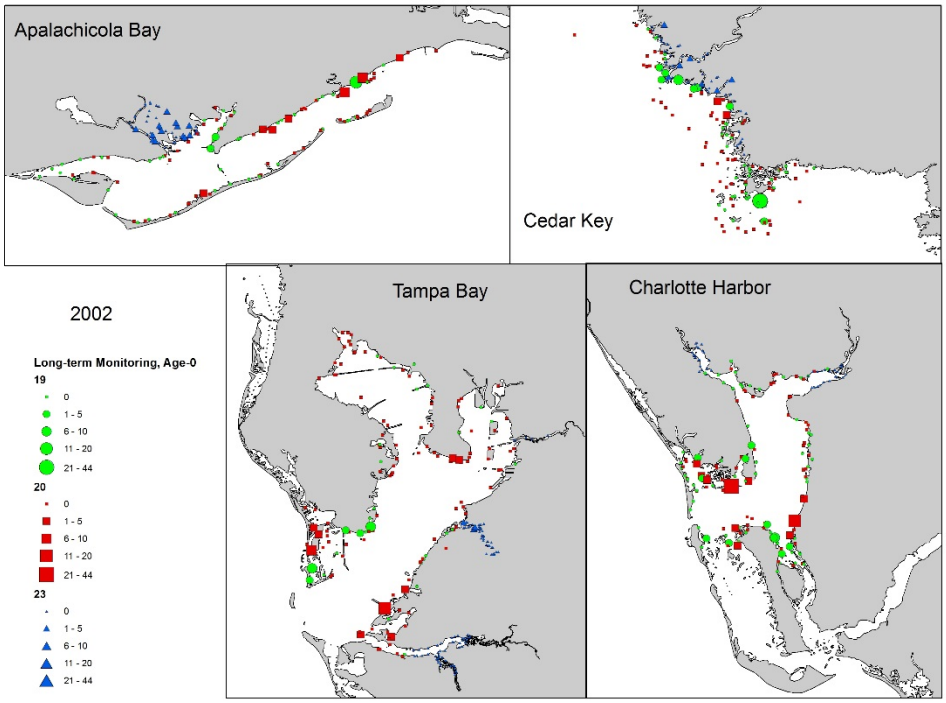
Figure A1. Annual distribution of stations sampled (1998 - 2015) during FWRI long-term FIM surveys using a 21.3-m seine along bay shorelines (gear = 19), bay offshore habitats (gear = 20), and riverine shorelines (gear = 23). Symbols represent the total number of age-0 Gray Snapper collected per set.

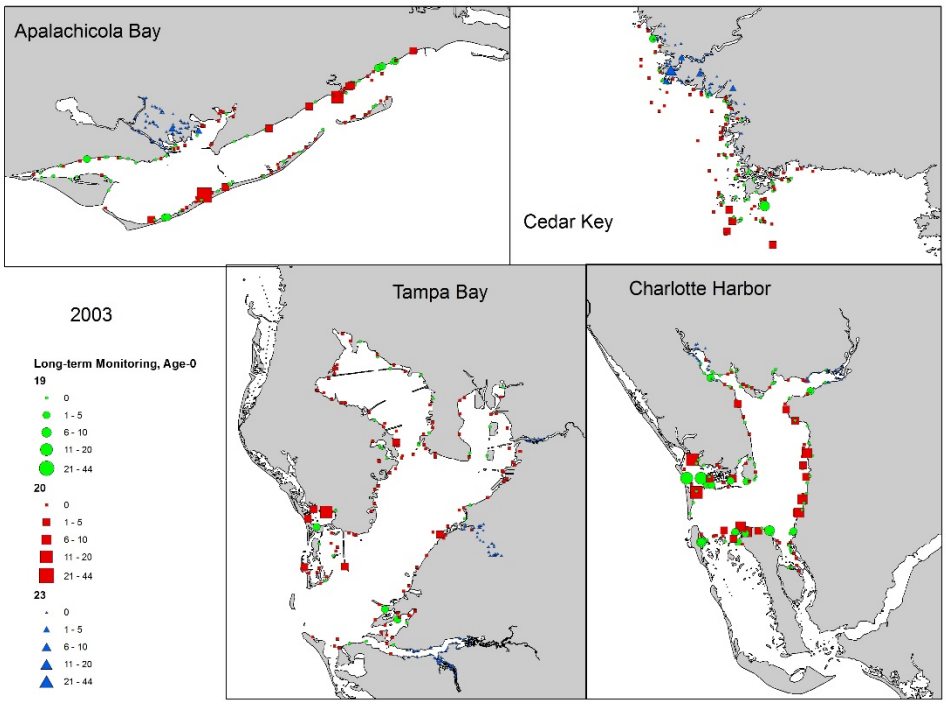


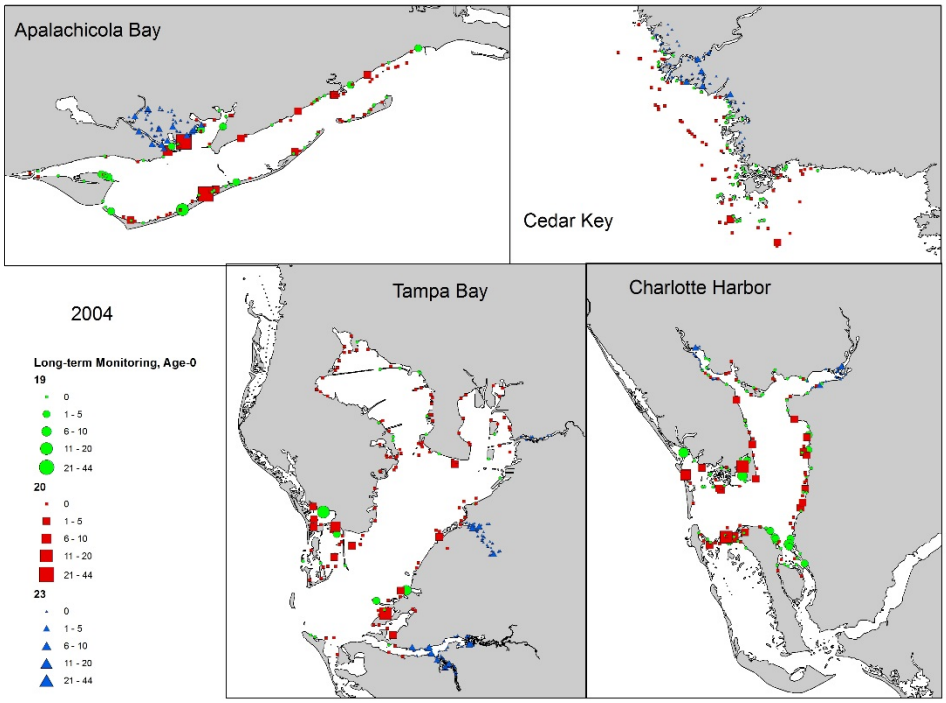


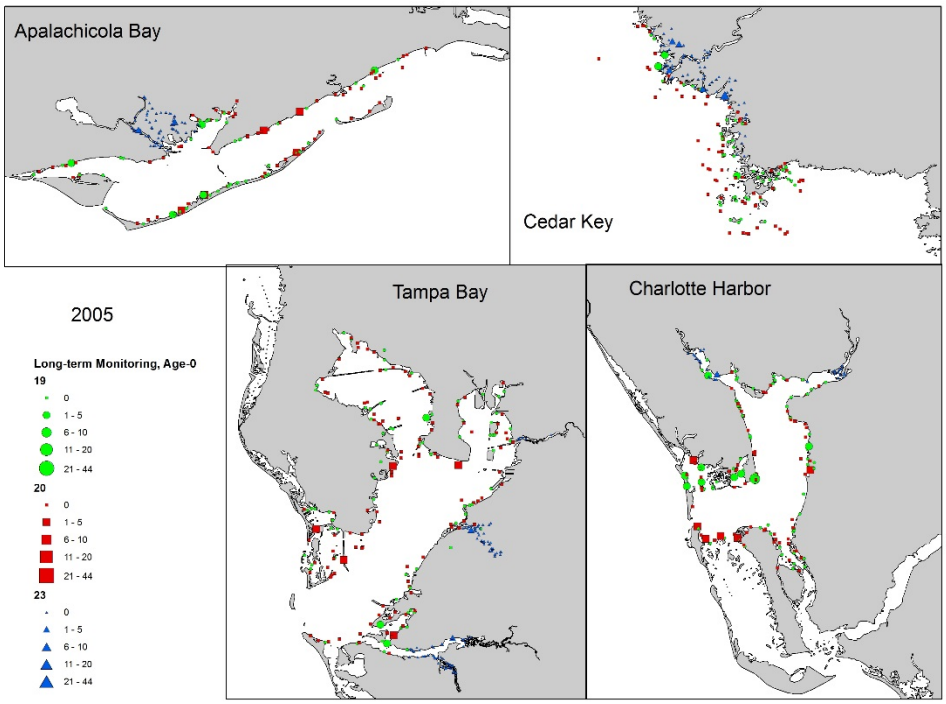

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2000
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

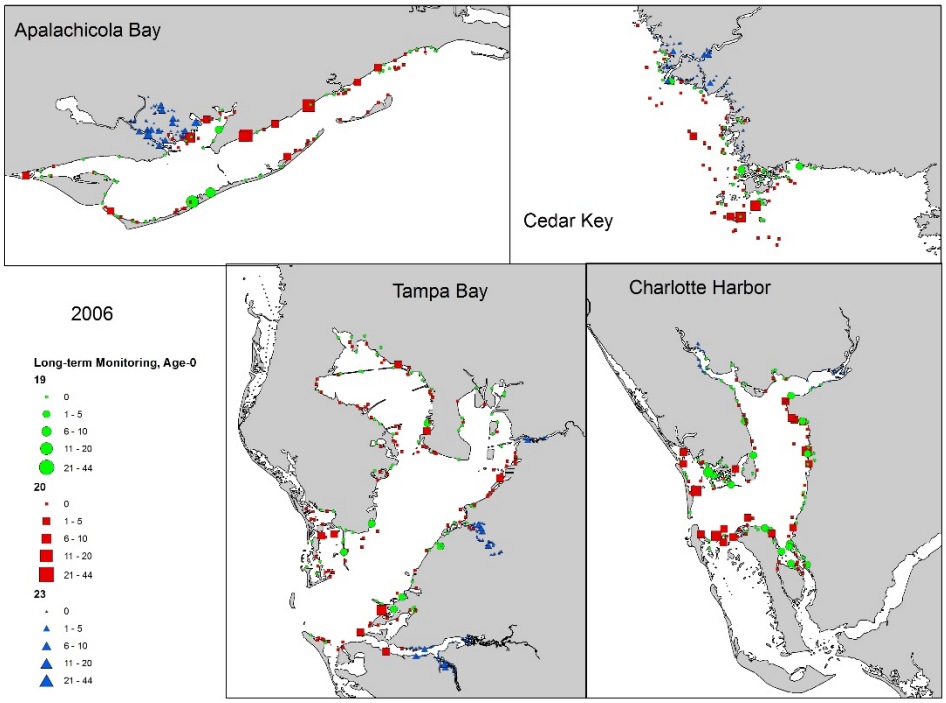

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2001
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

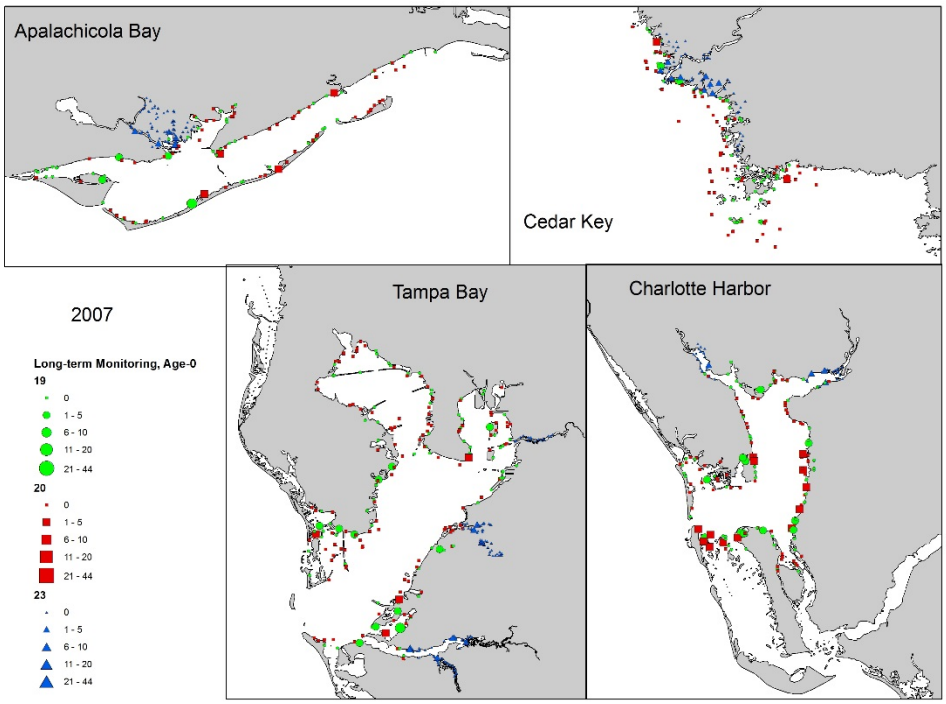

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2002
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

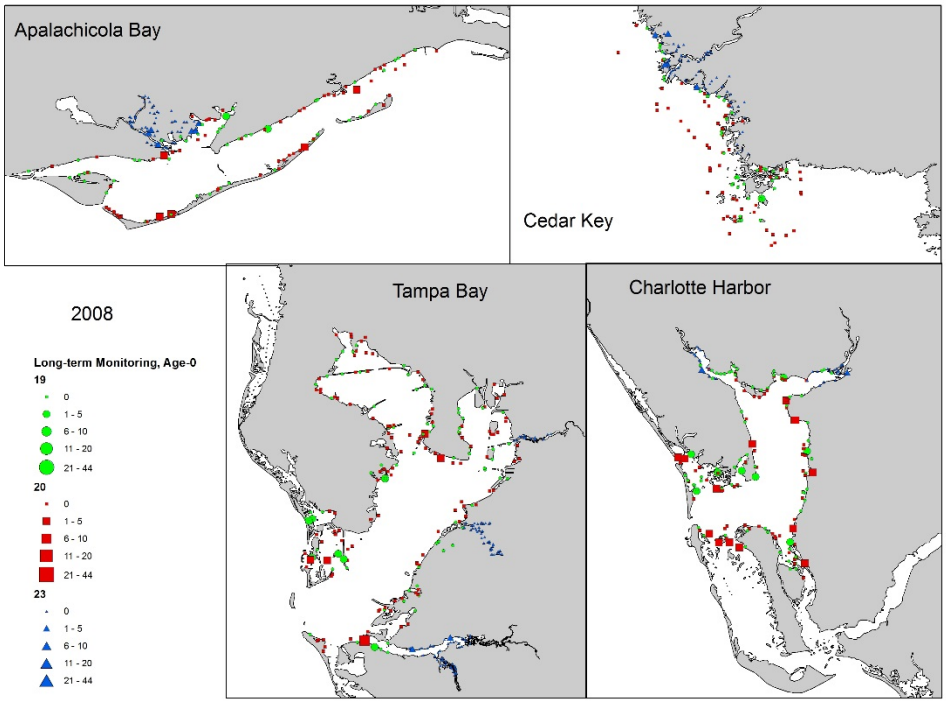

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2003
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

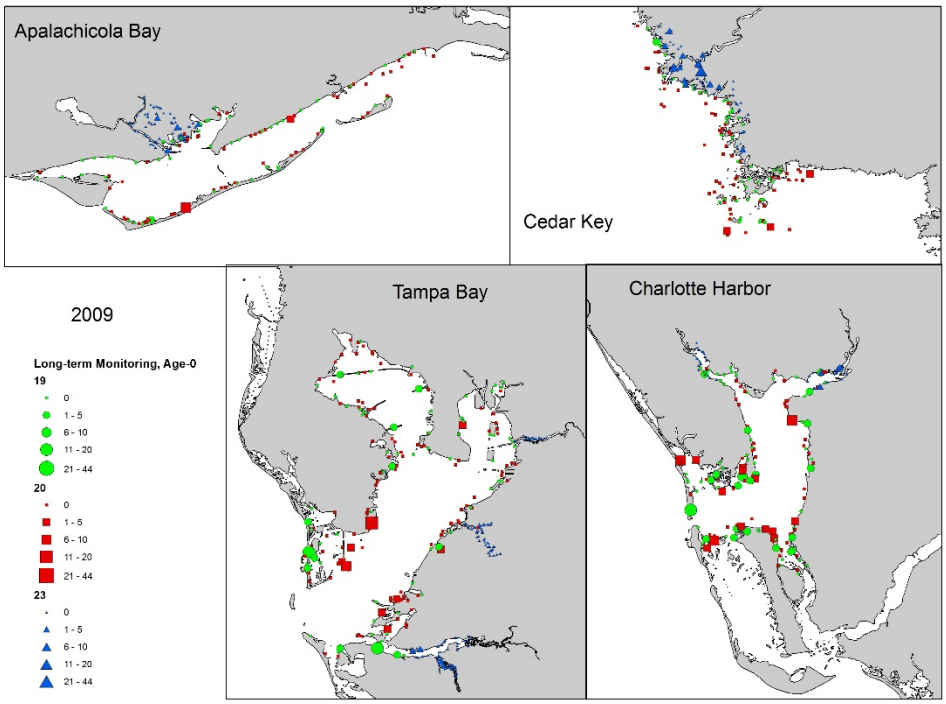

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2004
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

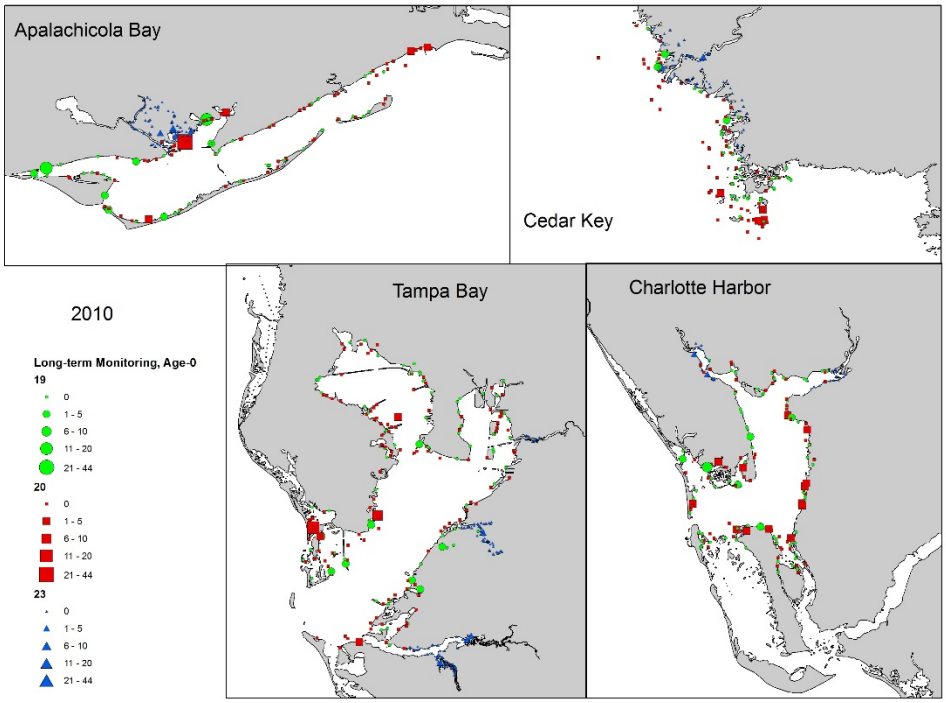

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2005
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

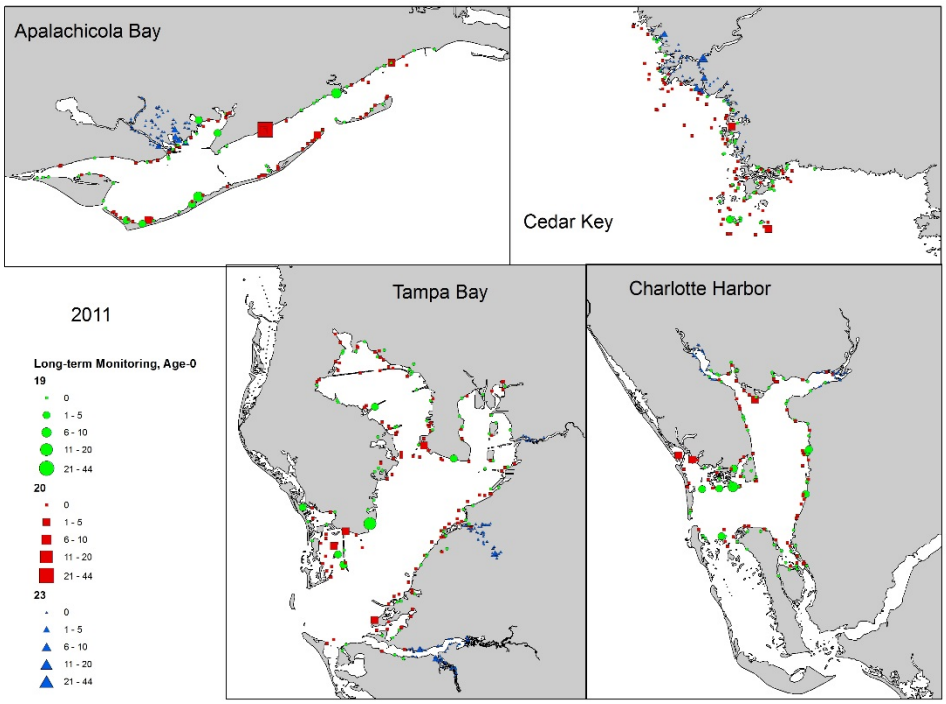

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2006
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

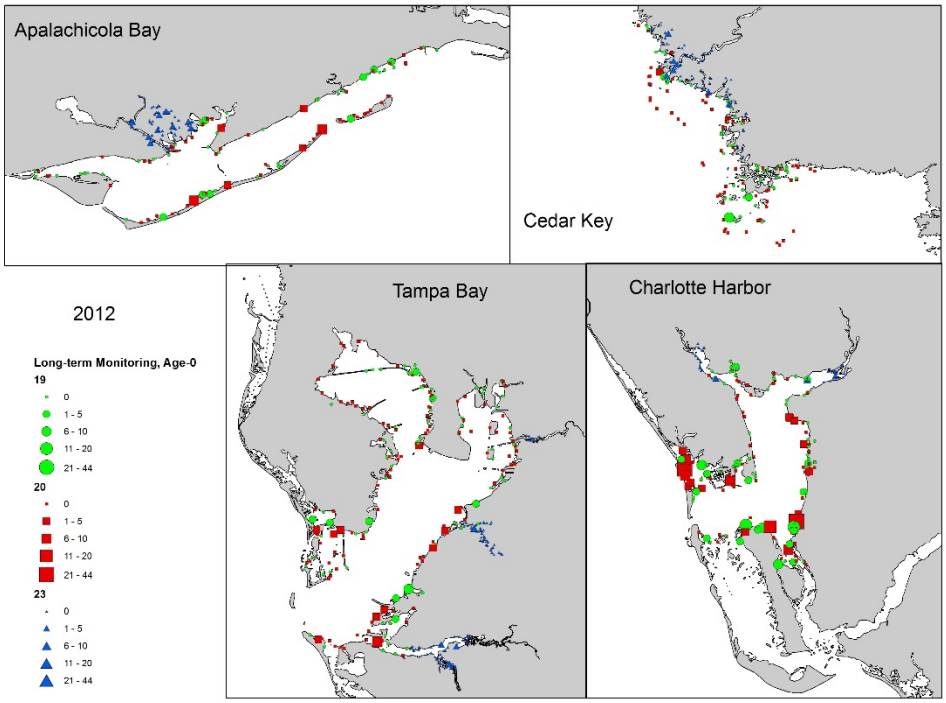

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2007
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

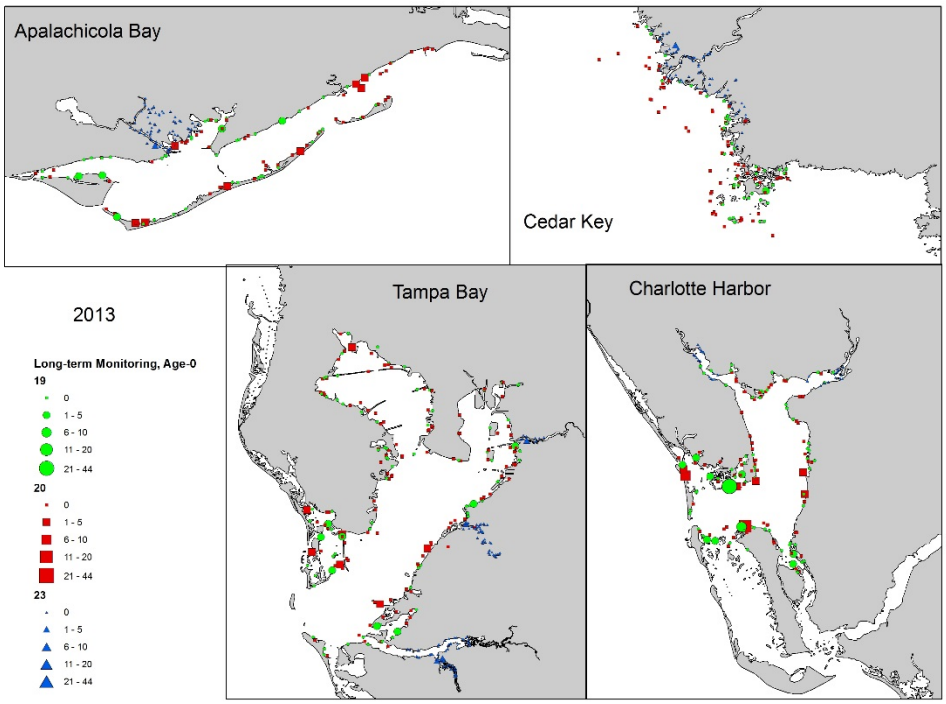

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2008
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

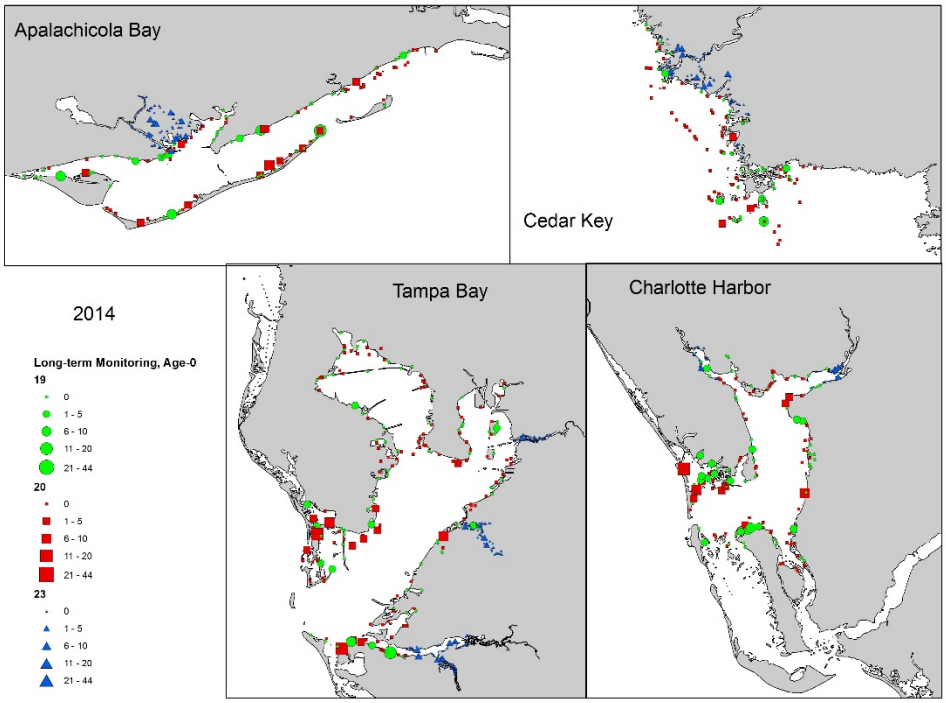

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2009
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44


Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2010
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44


Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2011
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44


Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2012
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44


Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2013
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44


Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2014
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

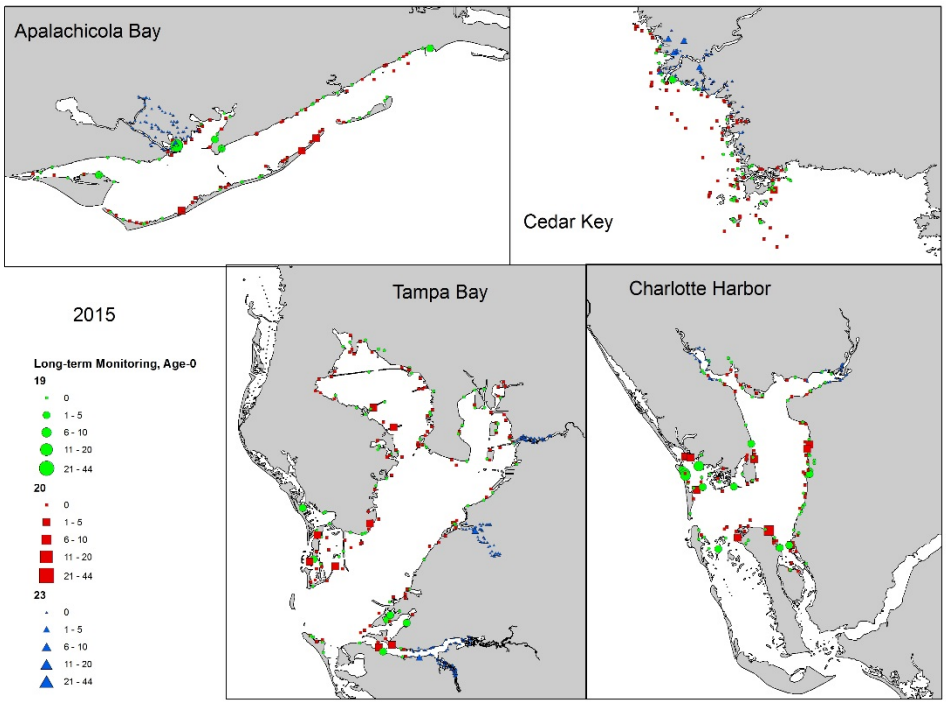
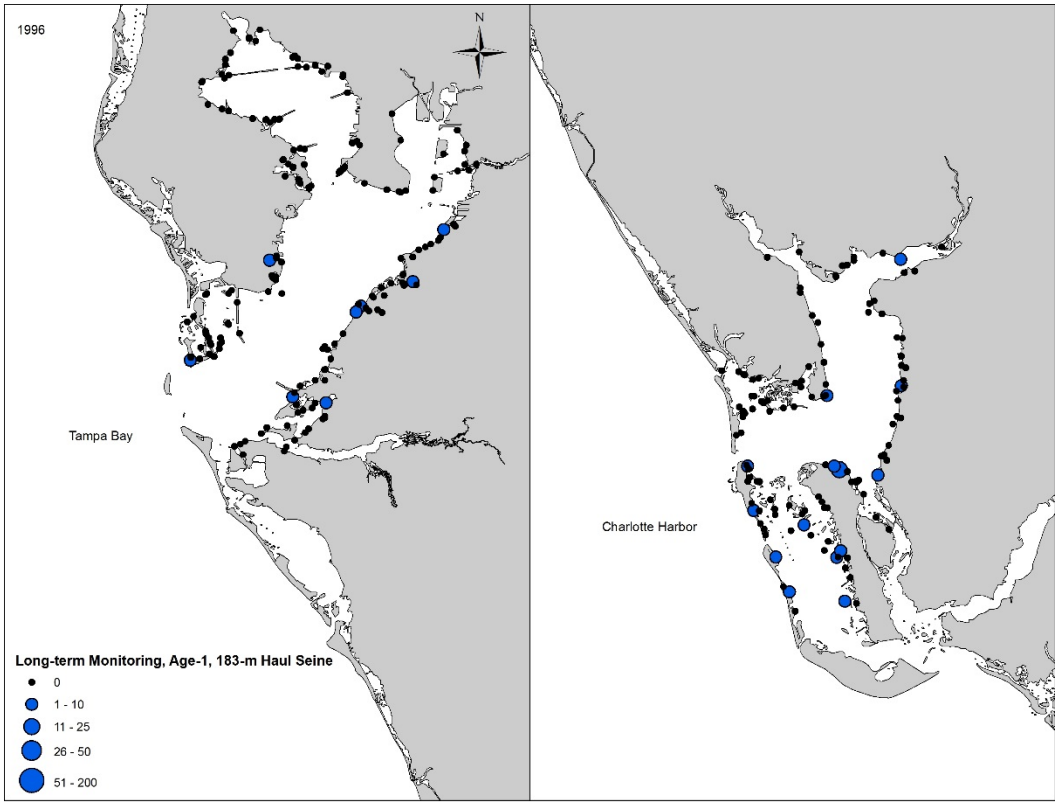
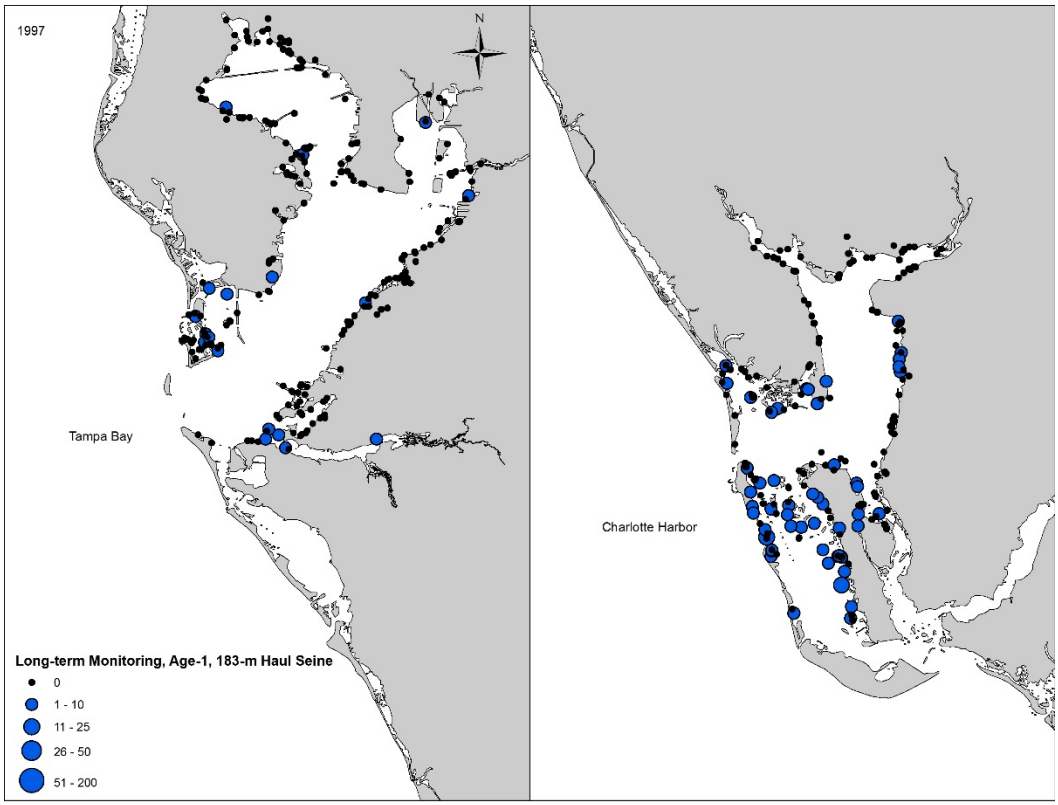
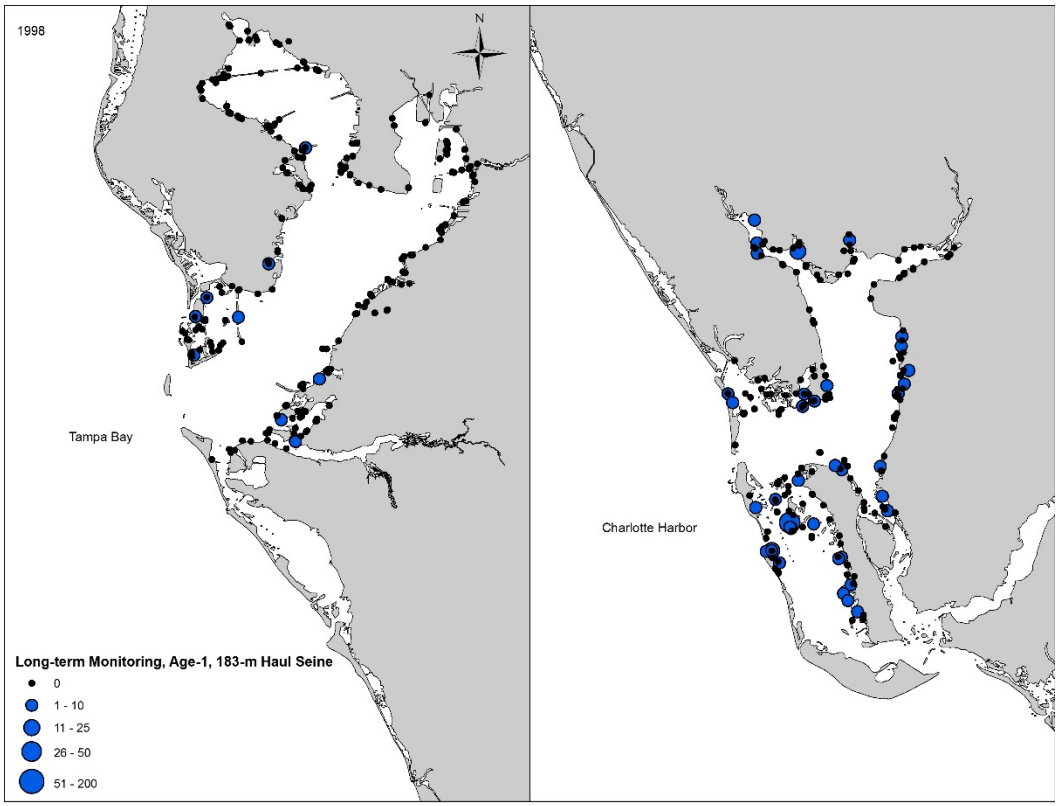
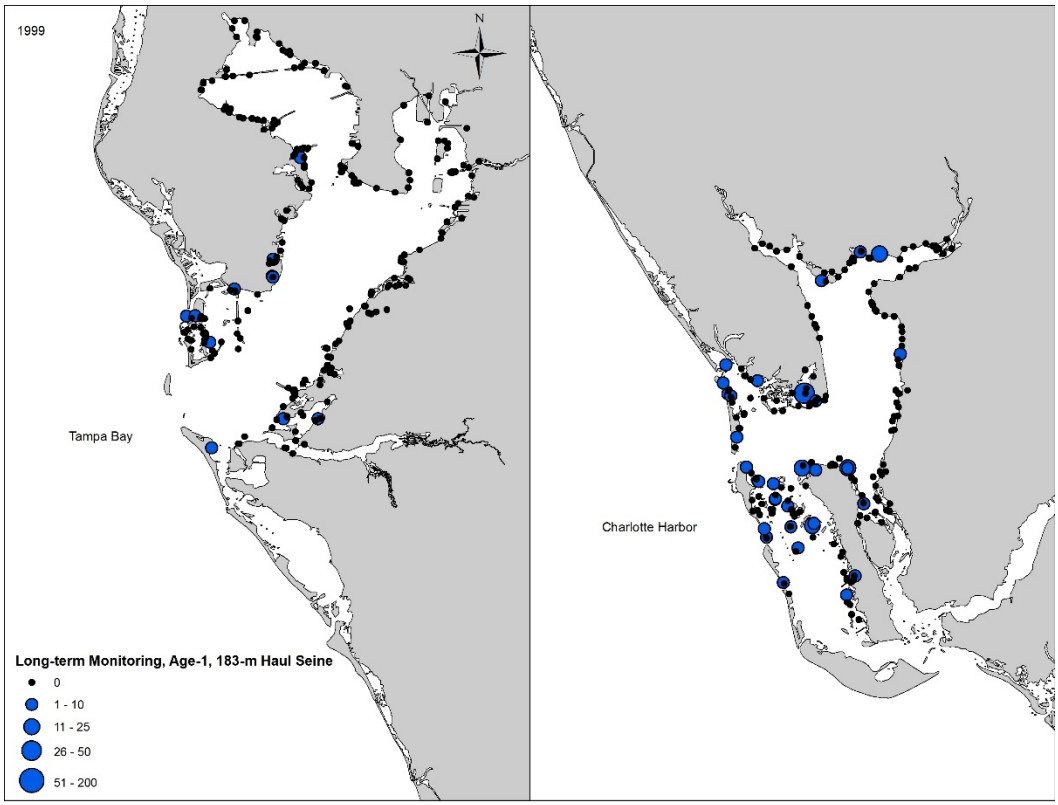

Apalachicola Bay
Cedar Key
Tampa Bay
Charlotte Harbor
2015
Long-term Monitoring, Age-0
19
0
1 - 5
6 - 10
11 - 20
21 - 44
20
0
1 - 5
6 - 10
11 - 20
21 - 44
23
0
1 - 5
6 - 10
11 - 20
21 - 44

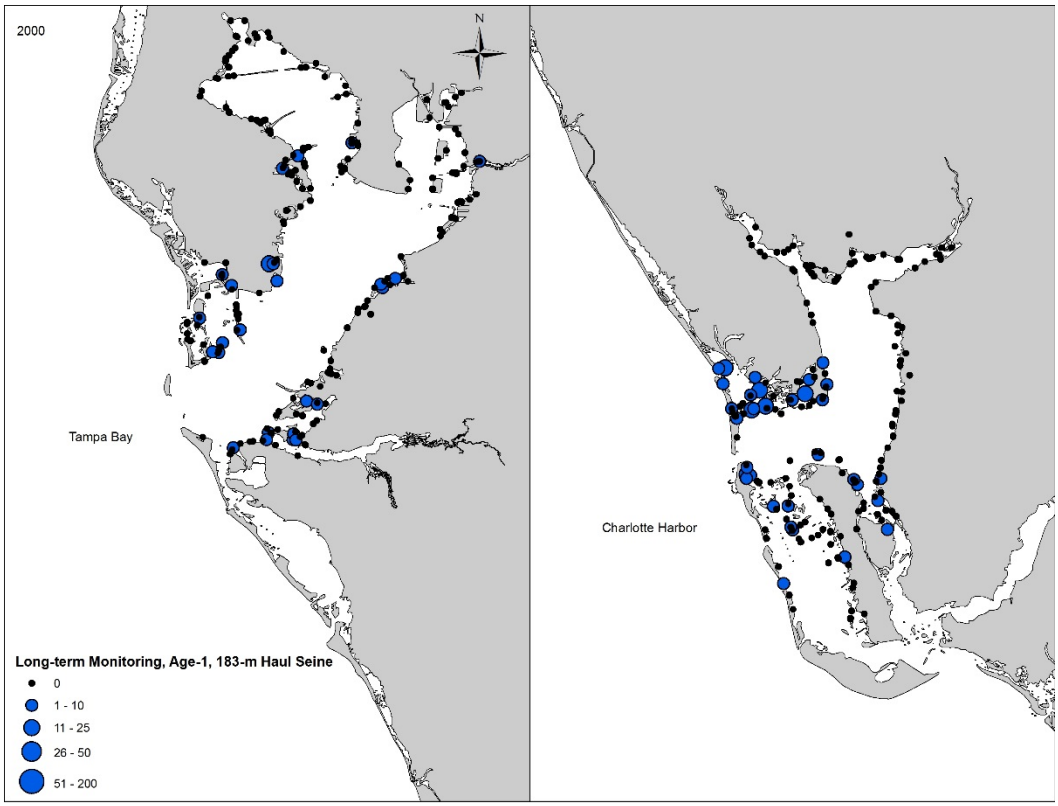
Figure A2. Annual distribution of stations sampled (1996 - 2015) during FWRI long-term FIM surveys using a 183-m shoreline seine. Symbols represent the total number of age-1 Gray Snapper collected per set.

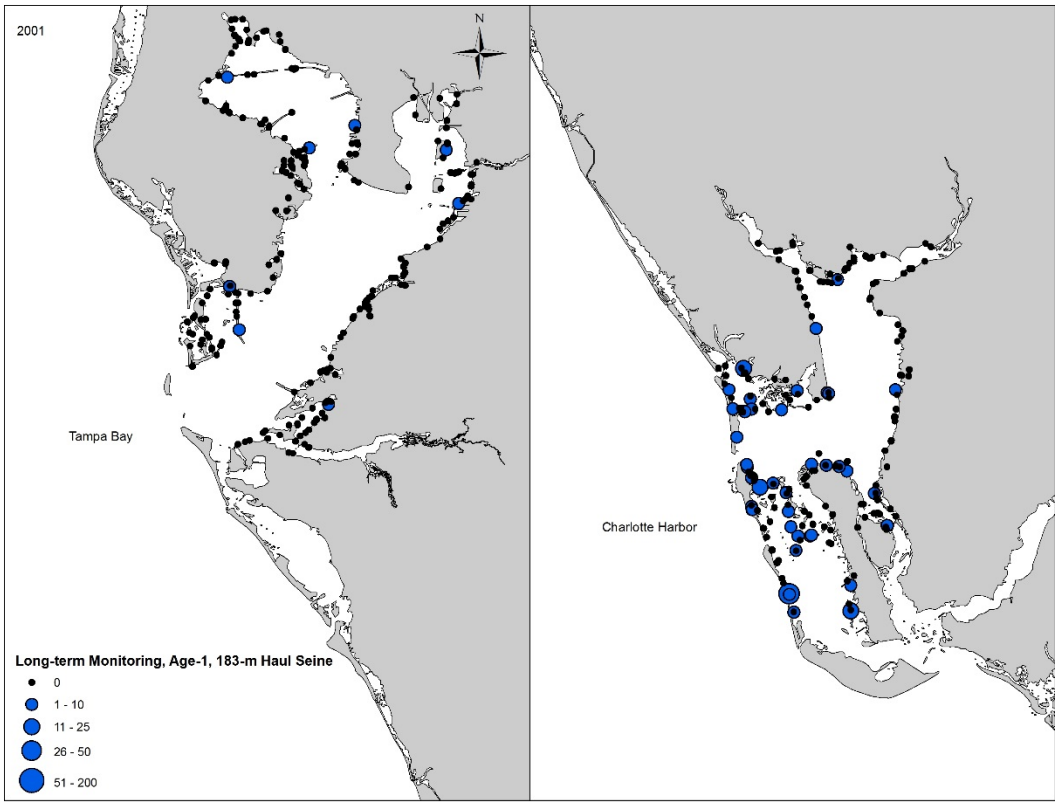


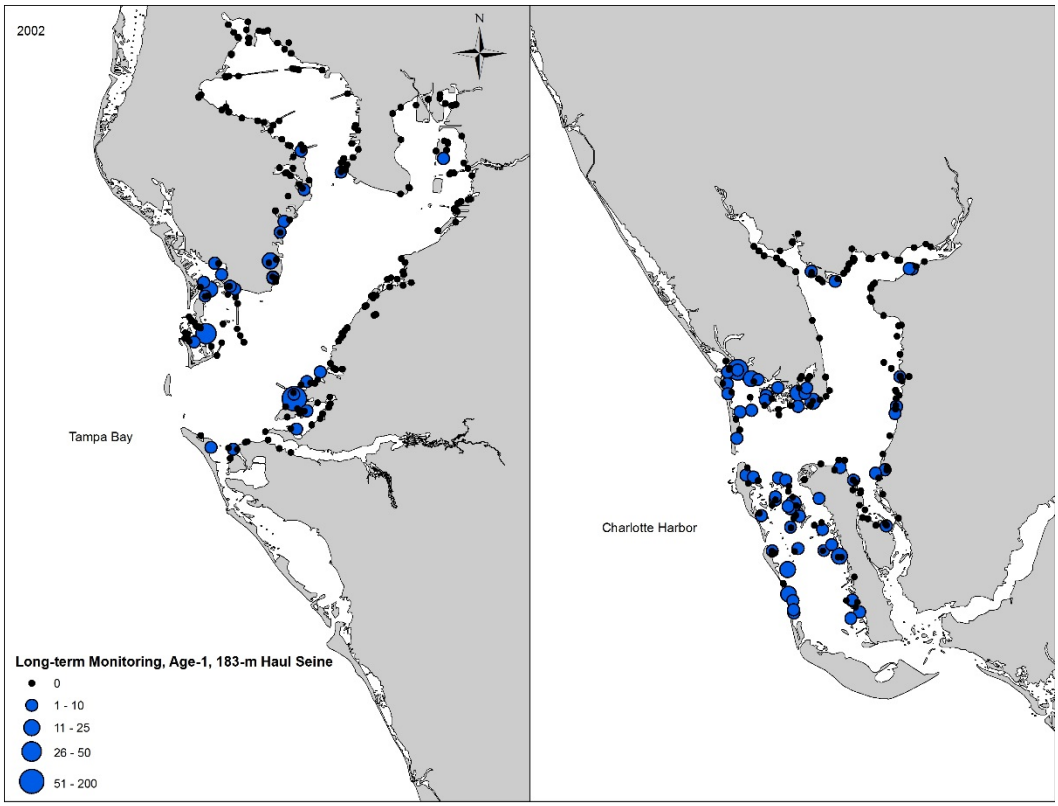

1997
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200

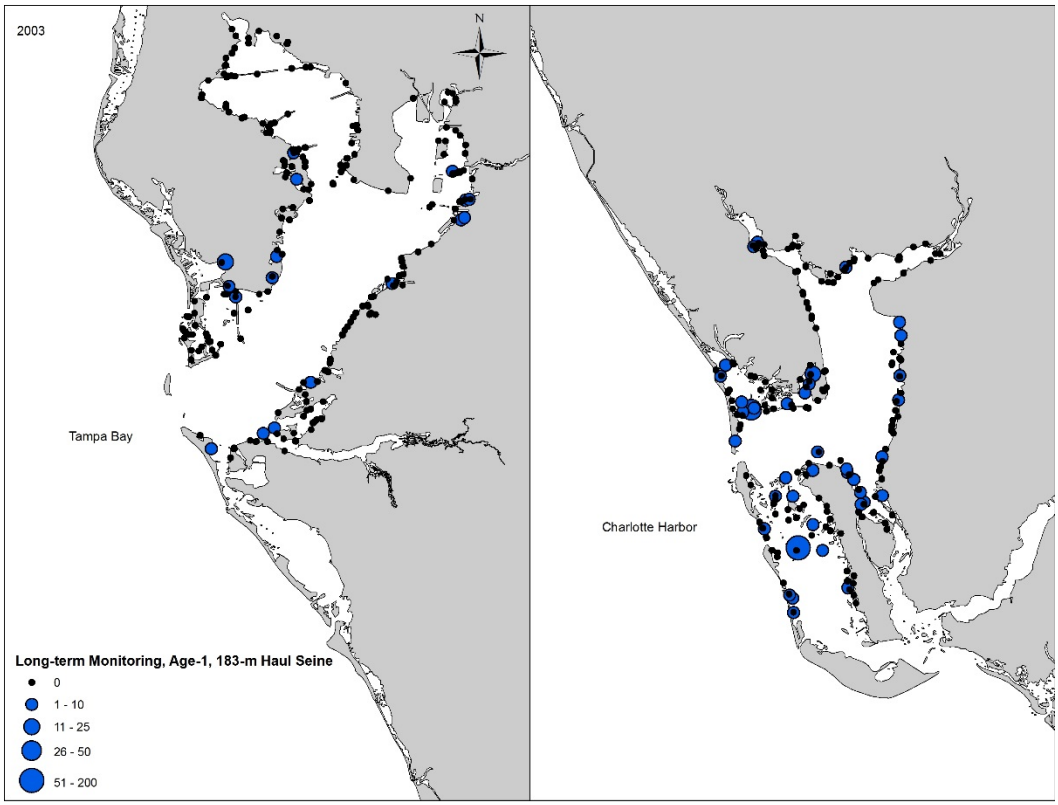

1998
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200

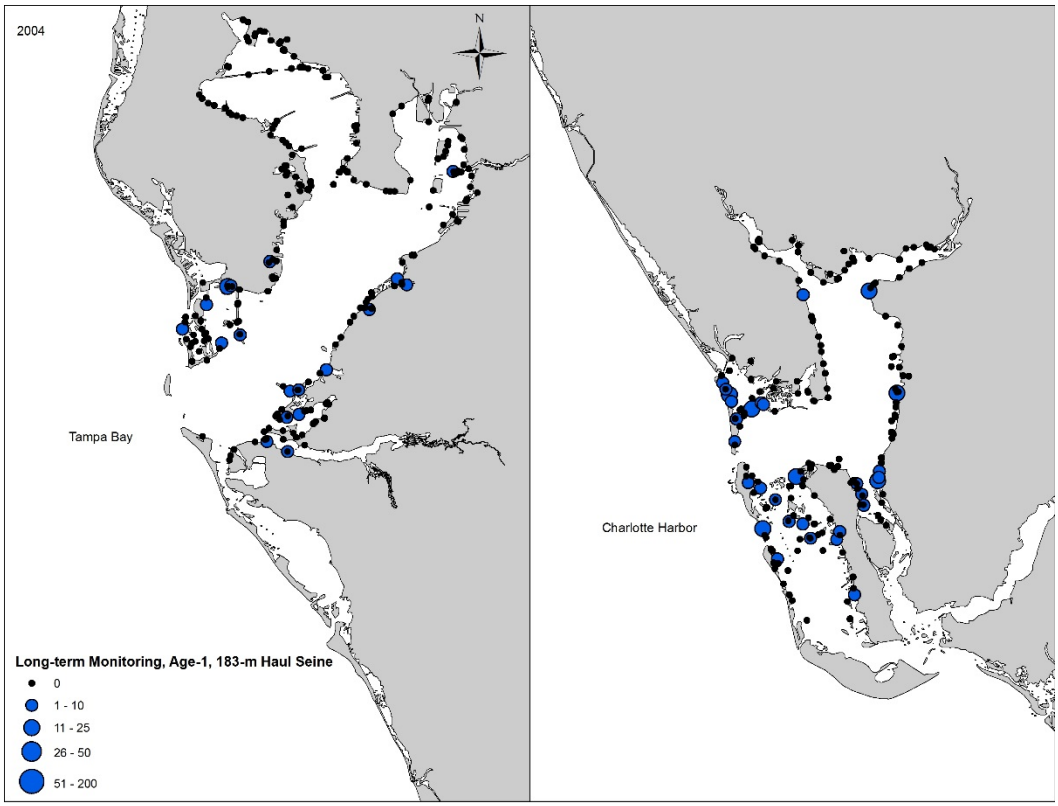

1999
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200

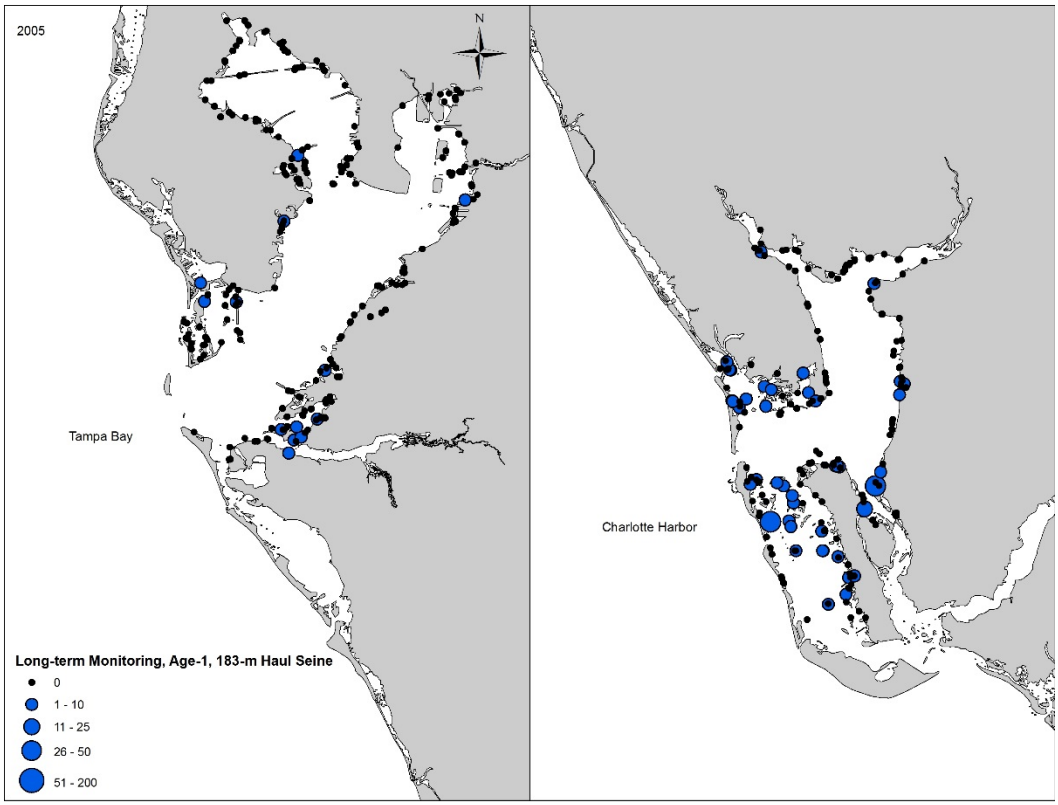

2000
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200

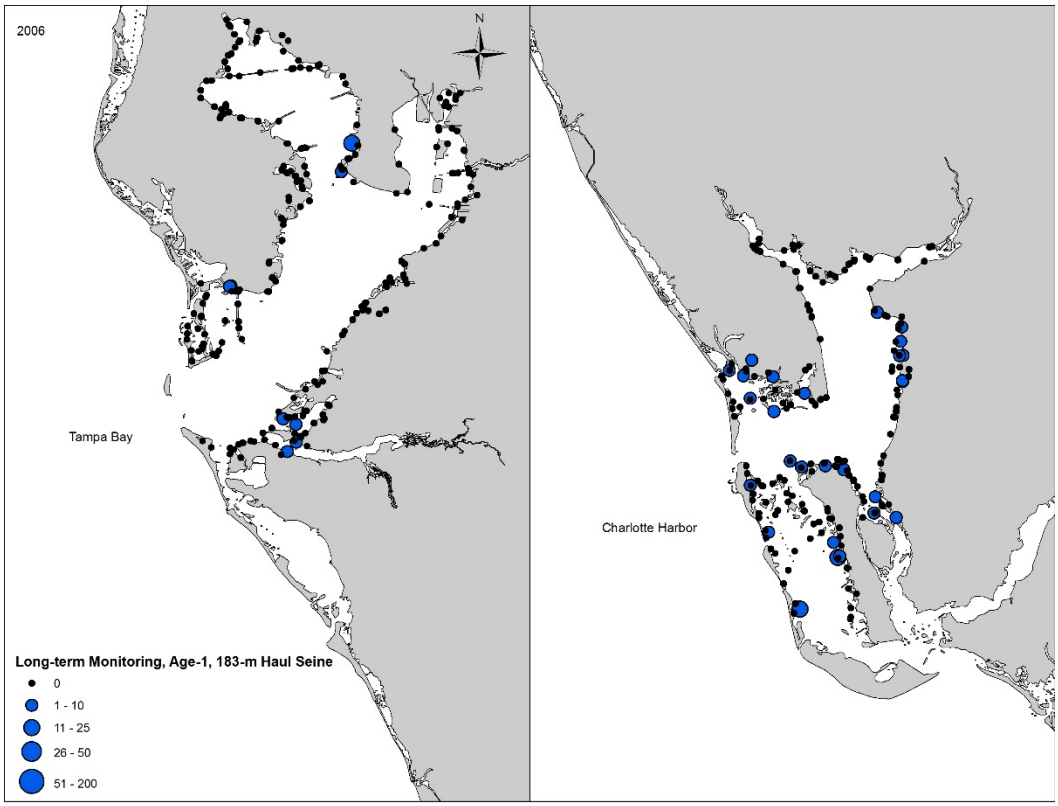

2001
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2002
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2003
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2004
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2005
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200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Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
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11 - 25
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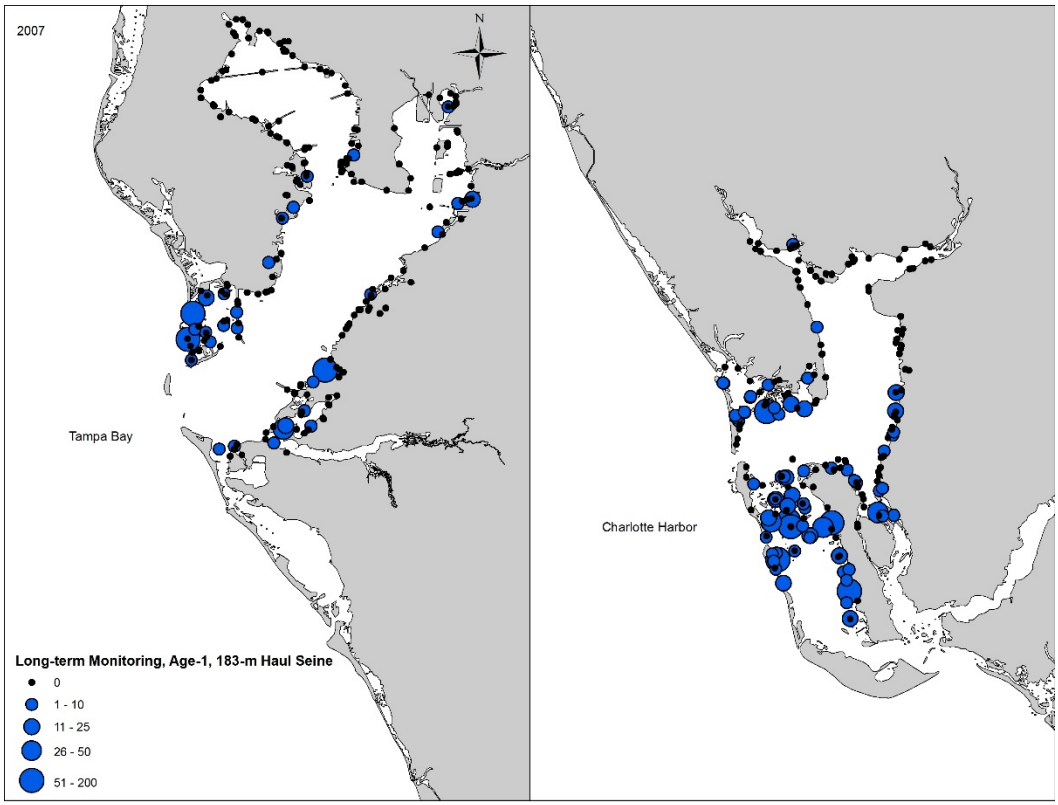
51 - 200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Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
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1 - 10
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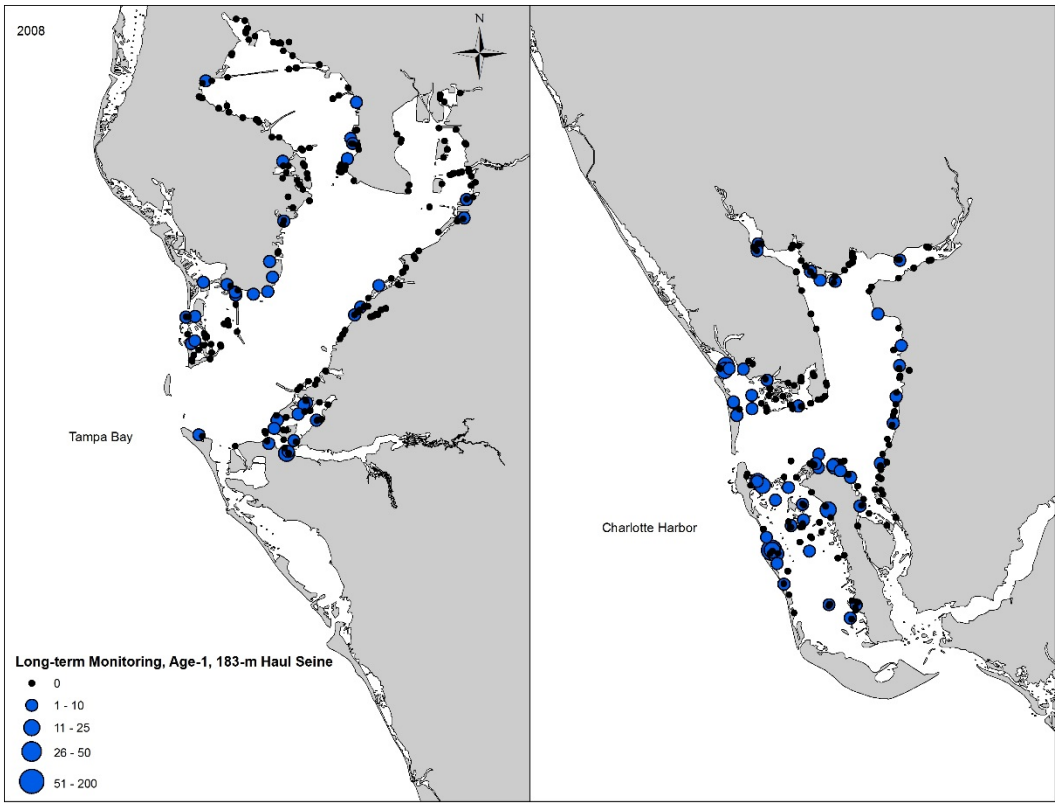
51 - 200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Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
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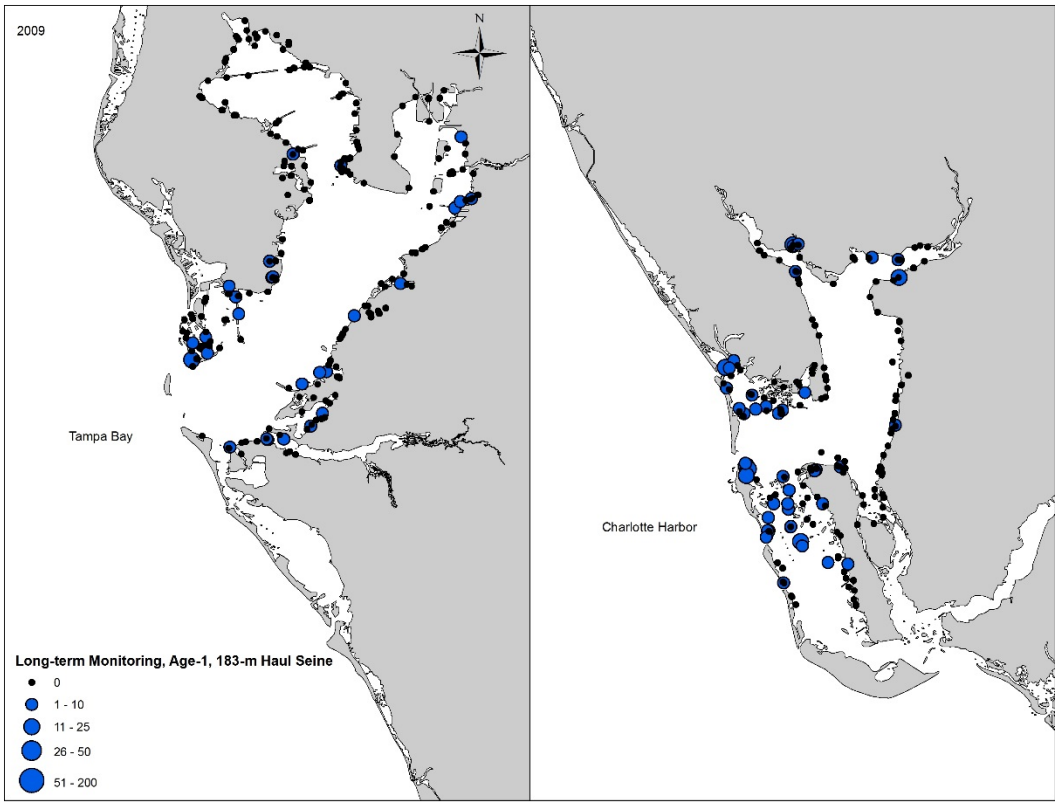
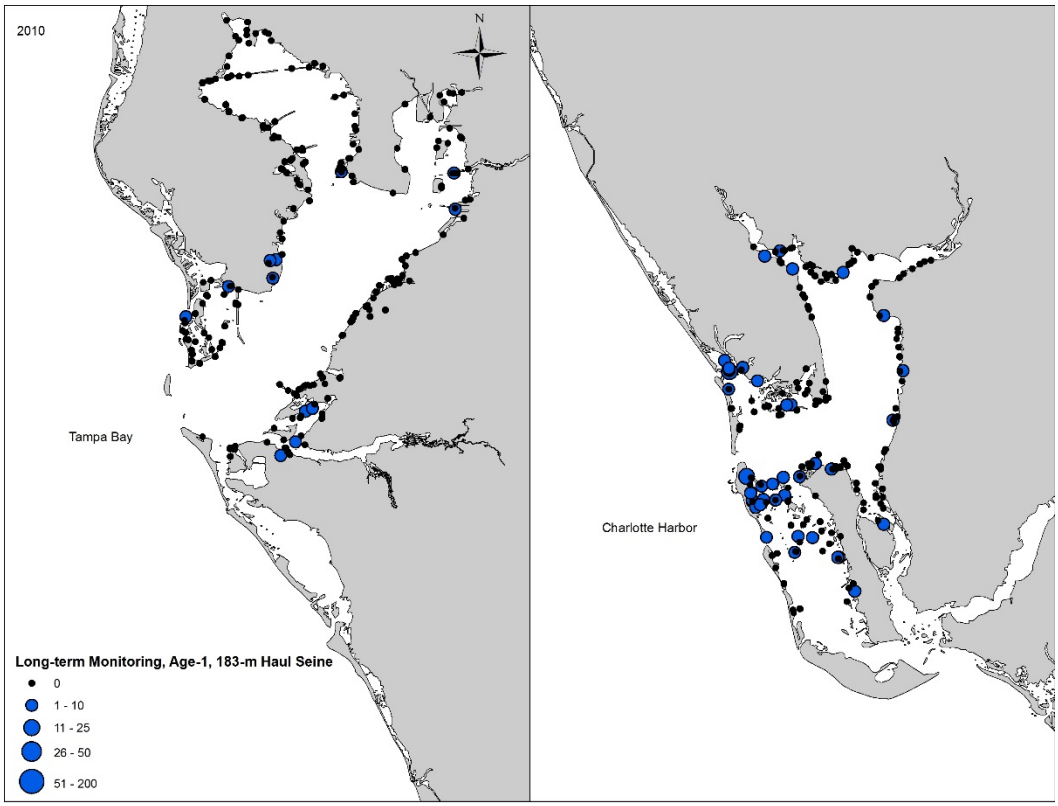
51 - 200


2009
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200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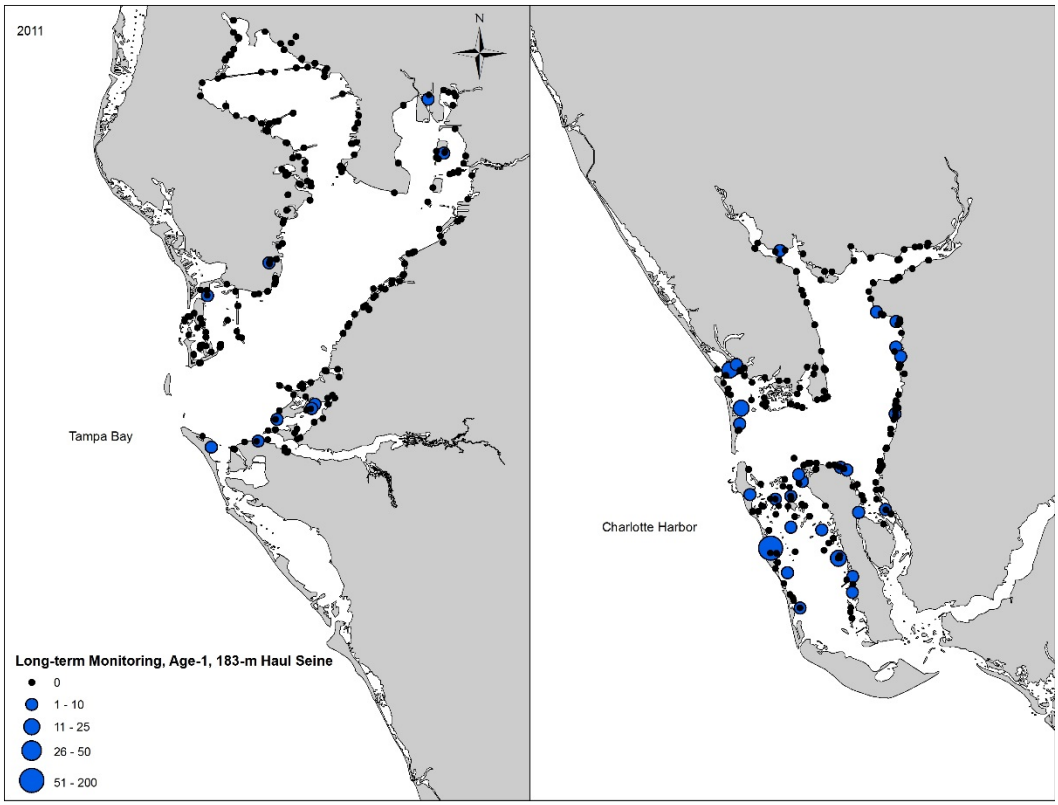
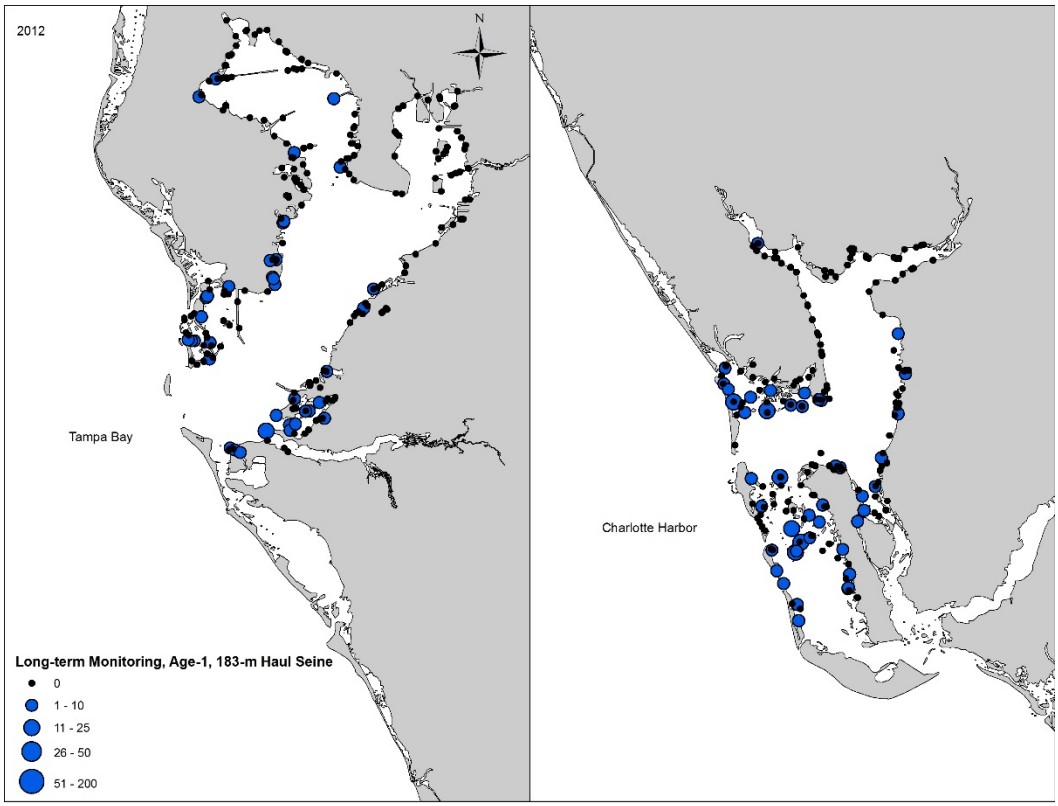
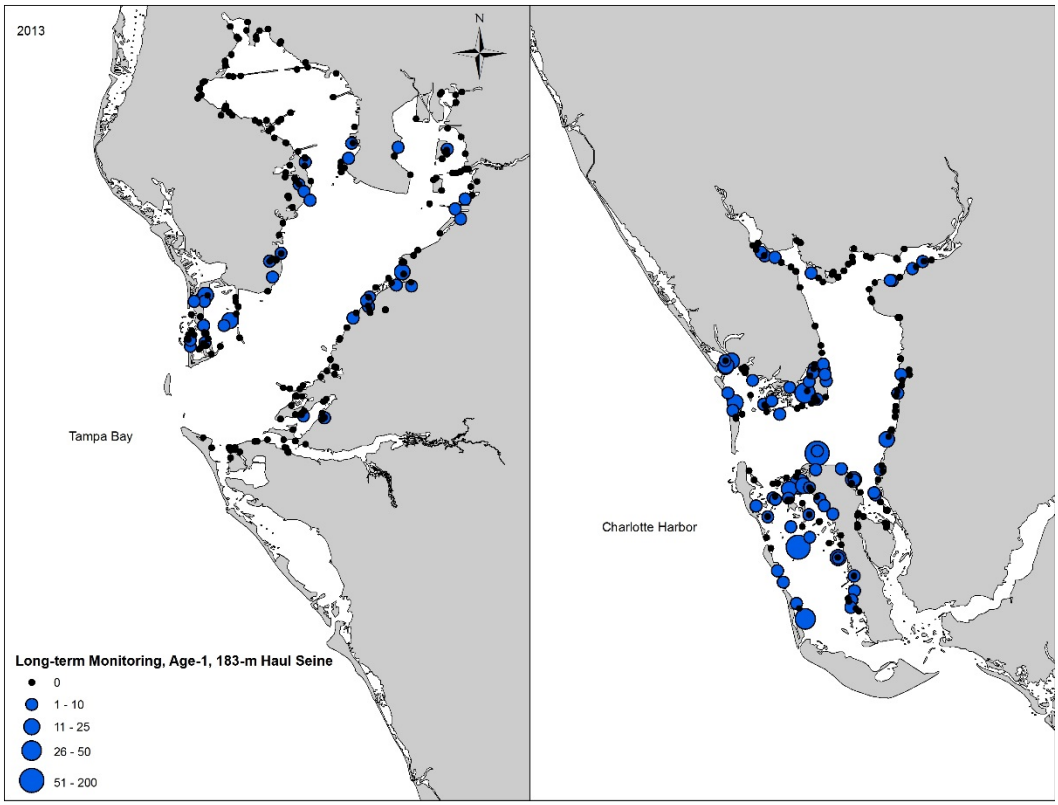
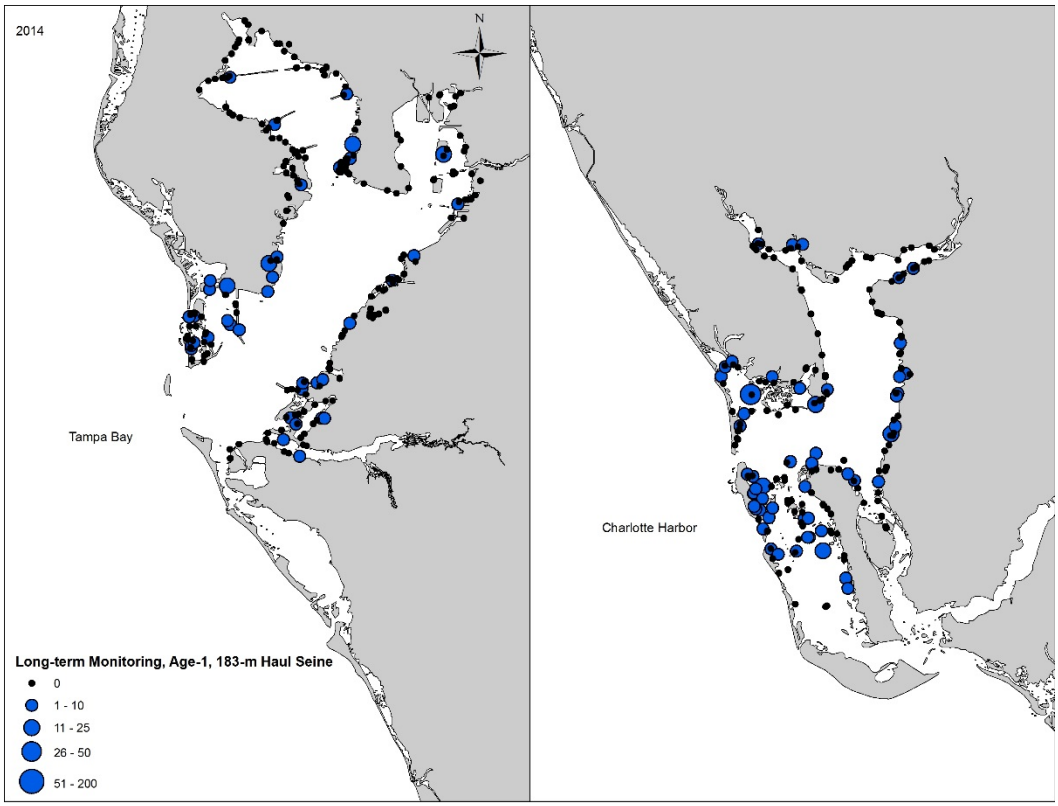
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2011
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2012
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2013
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200


2014
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200

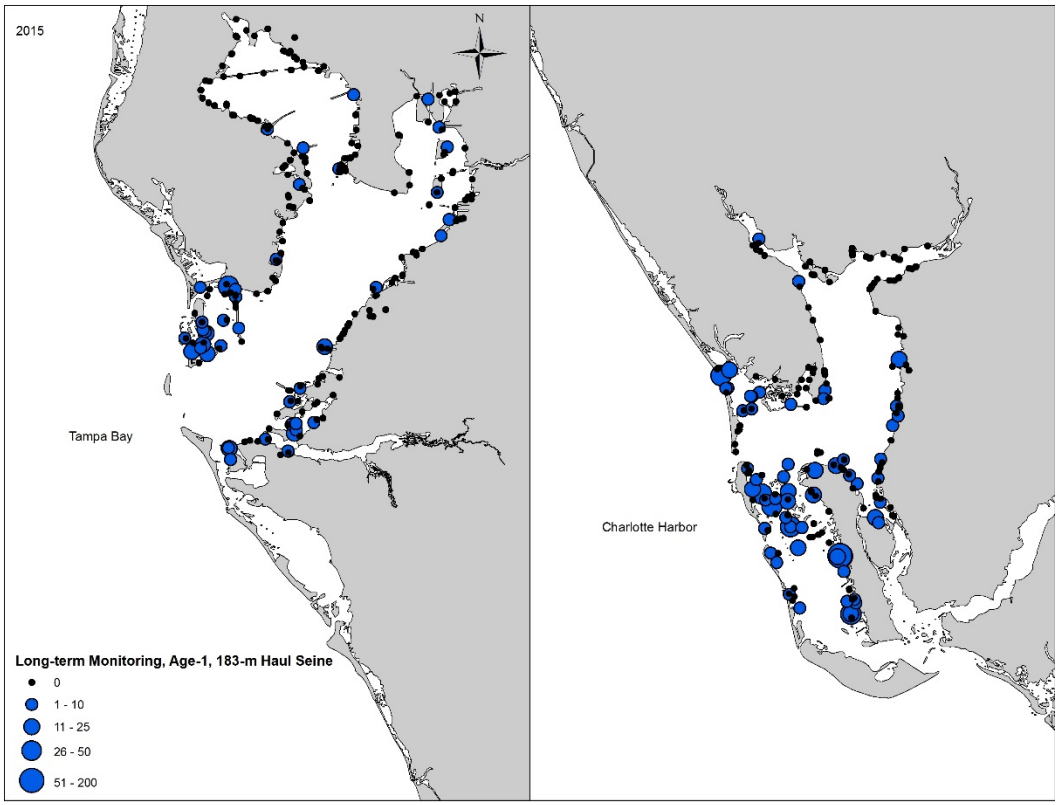
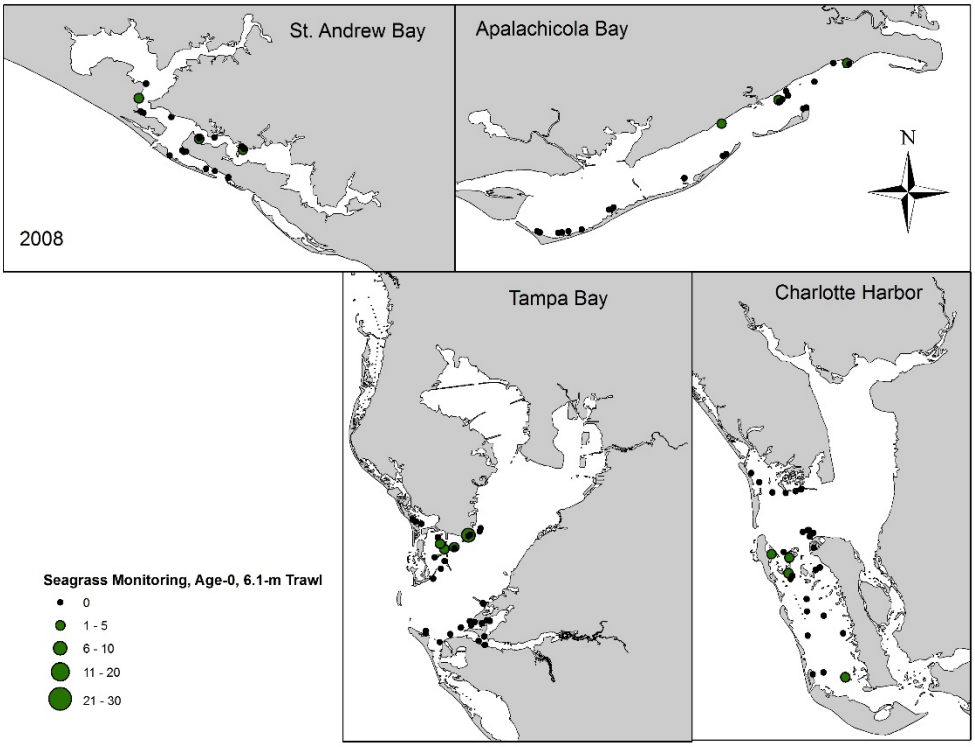
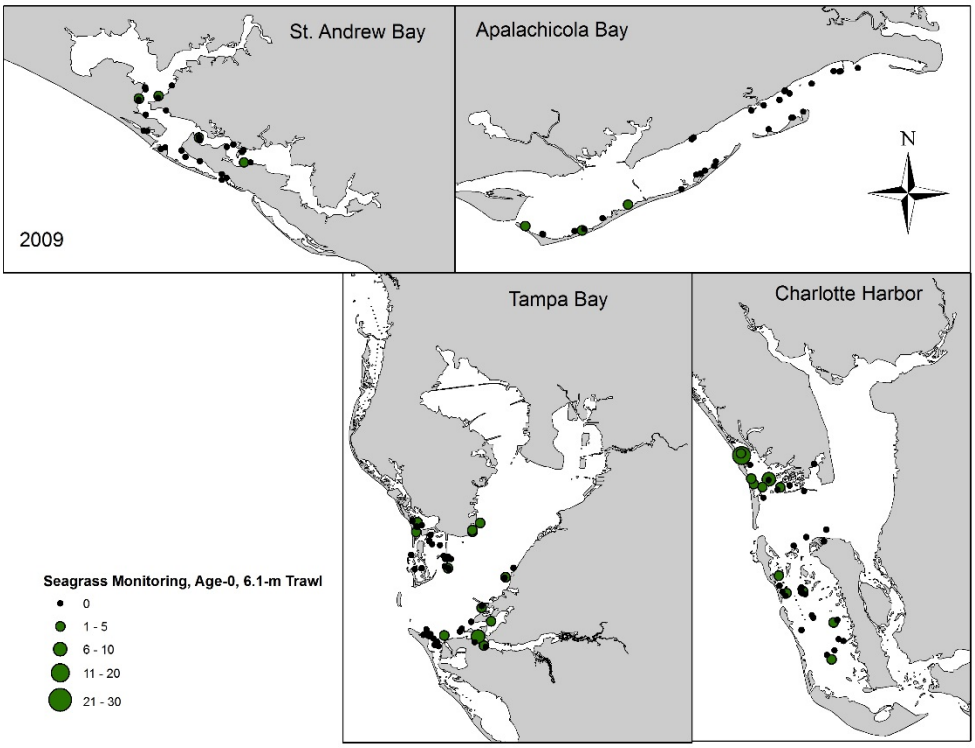
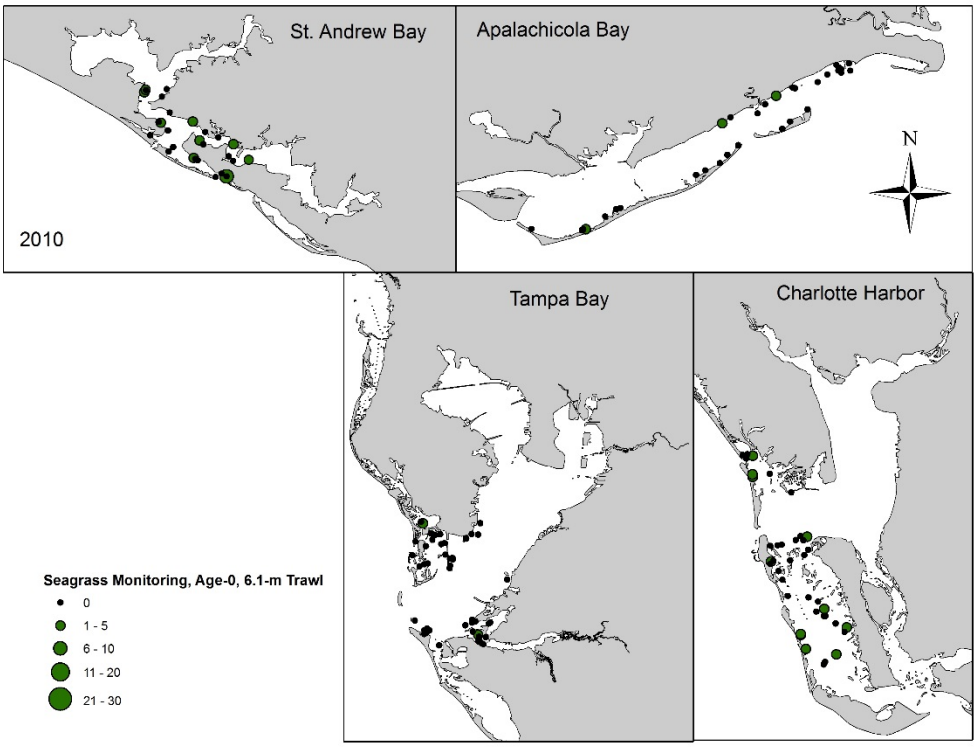
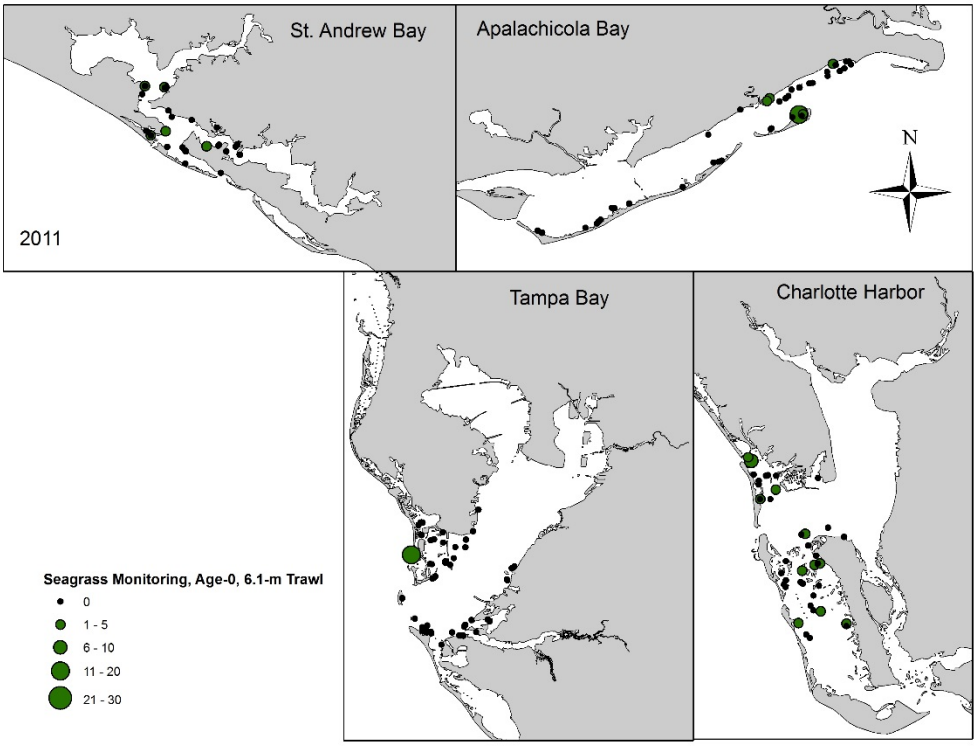

2015
N
Tampa Bay
Charlotte Harbor
Long-term Monitoring, Age-1, 183-m Haul Seine
0
1 - 10
11 - 25
26 - 50
51 - 200

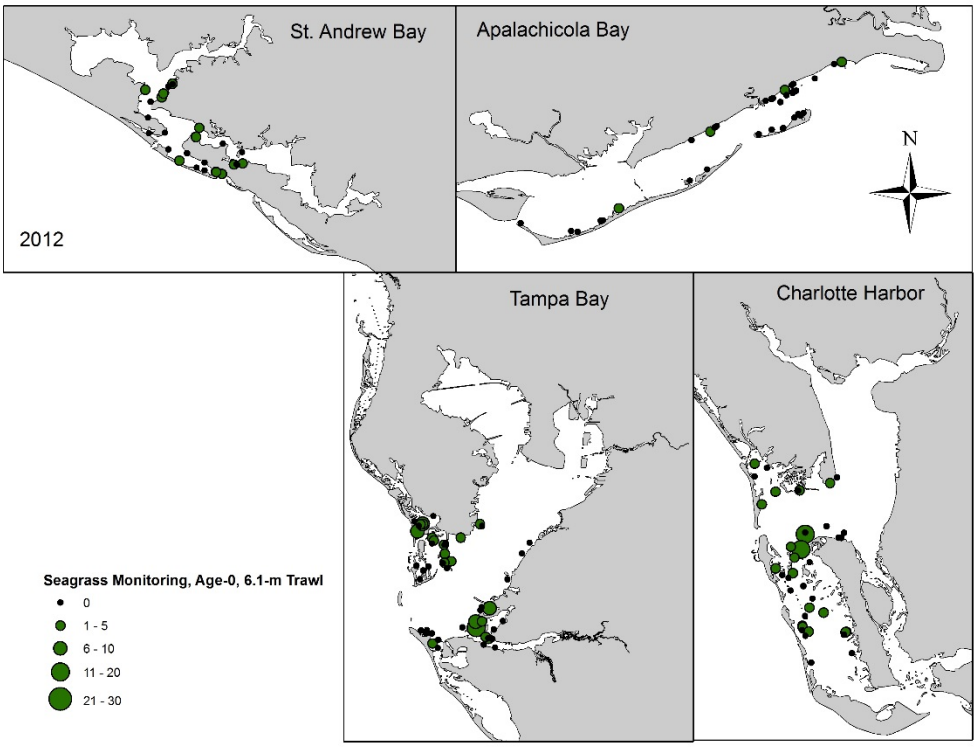
Figure A3. Annual distribution of stations sampled (2008 - 2015) during FWRI seagrass surveys using a 6.1-m otter trawl. Symbols represent the total number of age-0 Gray Snapper collected per set.

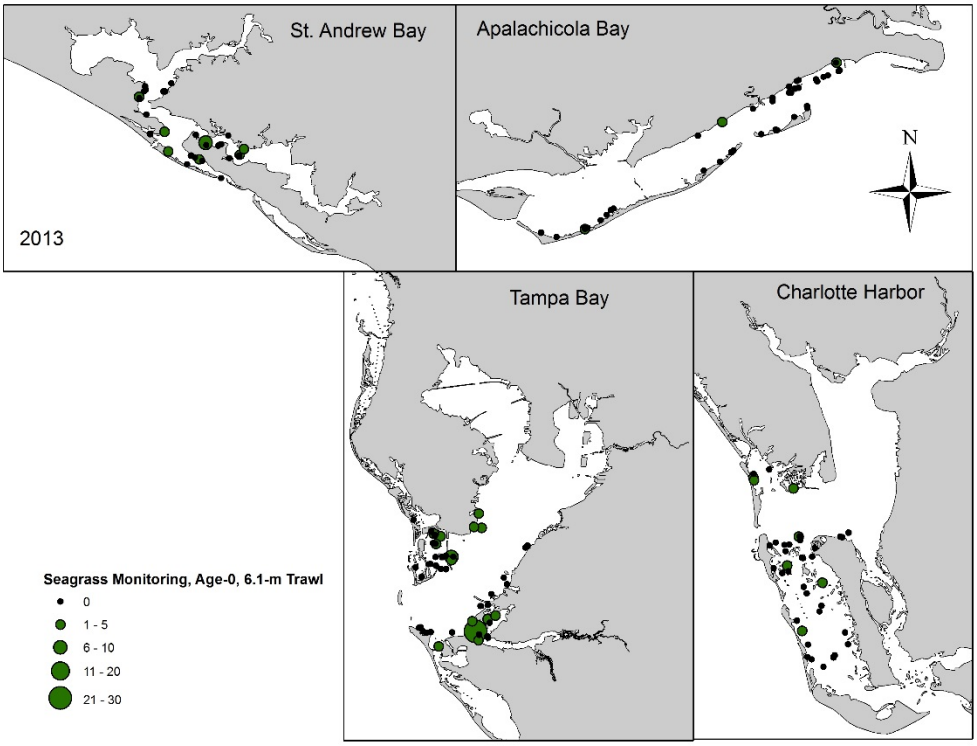


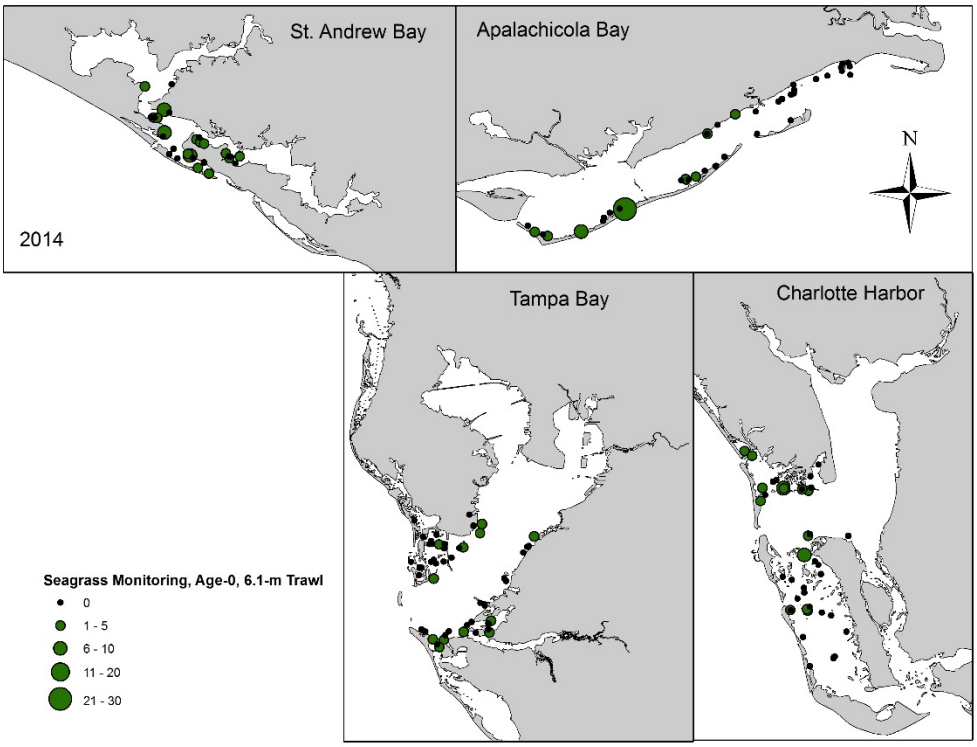



St. Andrew Bay
Apalachicola Bay
N
2010
Tampa Bay
Charlotte Harbor
Seagrass Monitoring, Age-0, 6.1-m Trawl
0
1 - 5
6 - 10
11 - 20
21 - 30


St. Andrew Bay
Apalachicola Bay
N
2011
Tampa Bay
Charlotte Harbor
Seagrass Monitoring, Age-0, 6.1-m Trawl
0
1 - 5
6 - 10
11 - 20
21 - 30


St. Andrew Bay
Apalachicola Bay
N
2012
Tampa Bay
Charlotte Harbor
Seagrass Monitoring, Age-0, 6.1-m Trawl
0
1 - 5
6 - 10
11 - 20
21 - 30


St. Andrew Bay
Apalachicola Bay
N
2013
Tampa Bay
Charlotte Harbor
Seagrass Monitoring, Age-0, 6.1-m Trawl
0
1 - 5
6 - 10
11 - 20
21 - 30


St. Andrew Bay
Apalachicola Bay
N
2014
Tampa Bay
Charlotte Harbor
Seagrass Monitoring, Age-0, 6.1-m Trawl
0
1 - 5
6 - 10
11 - 20
21 - 30

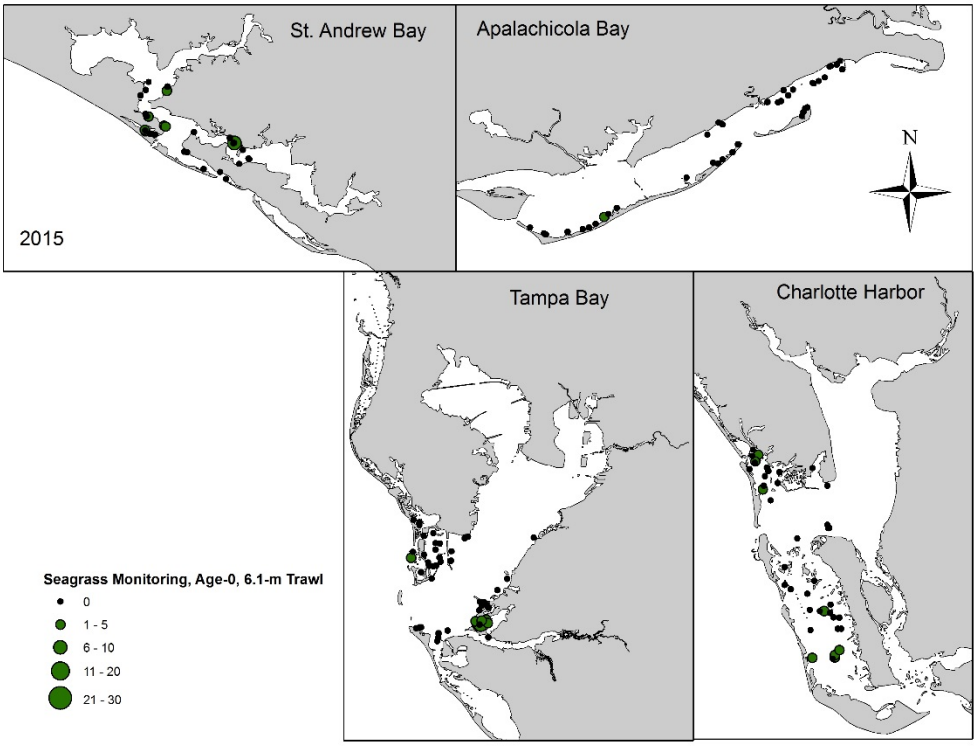
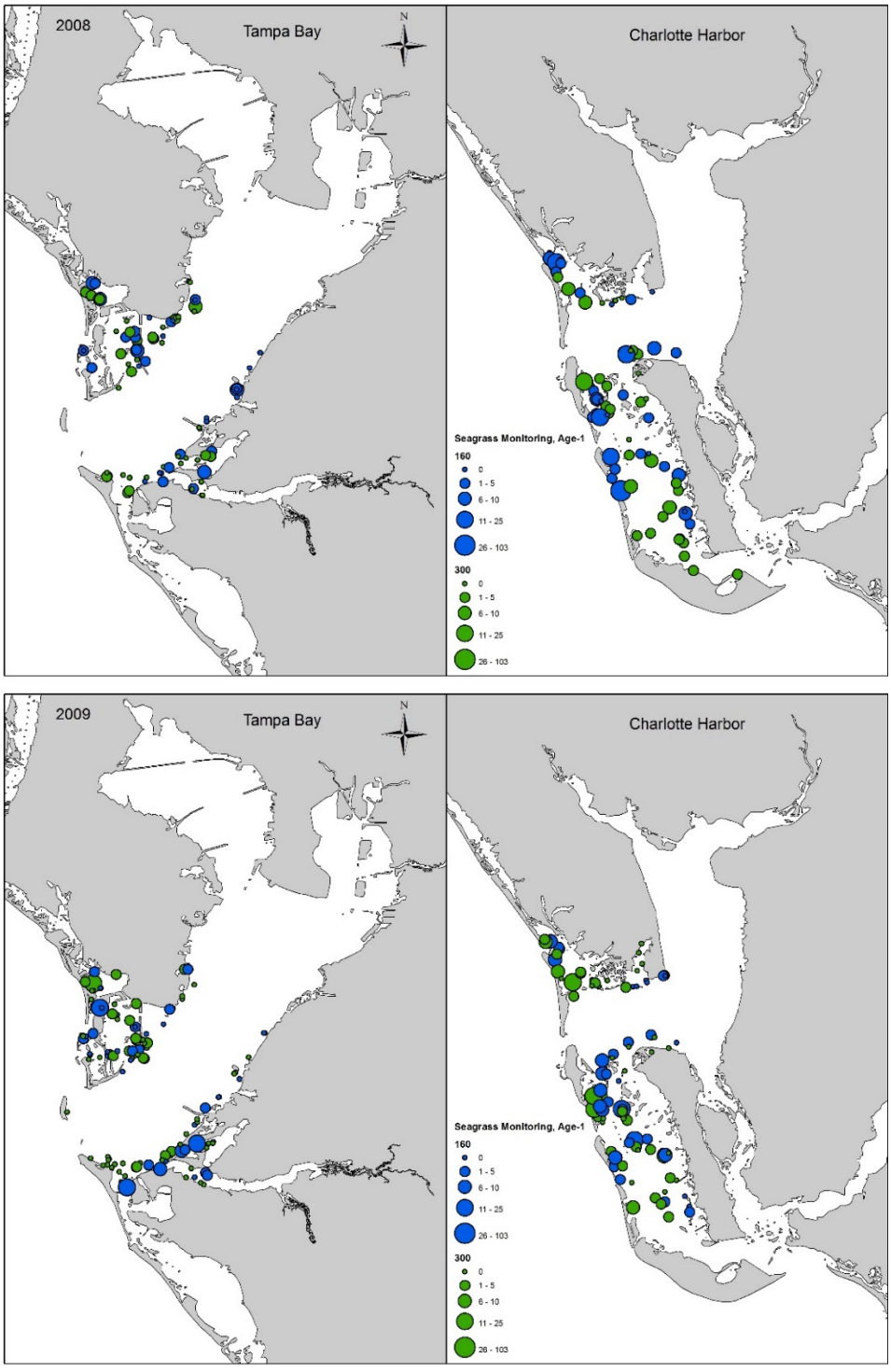
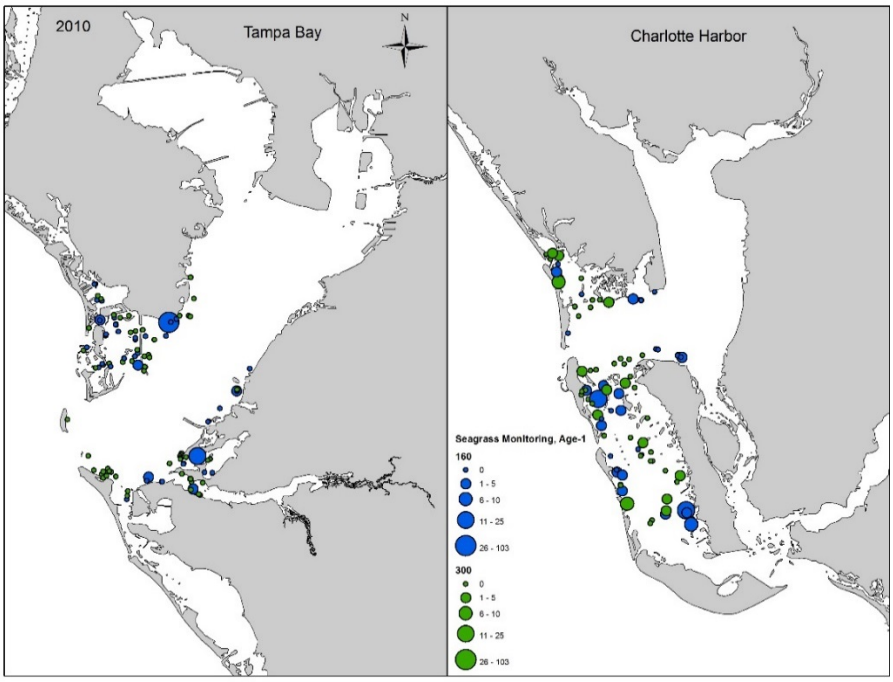
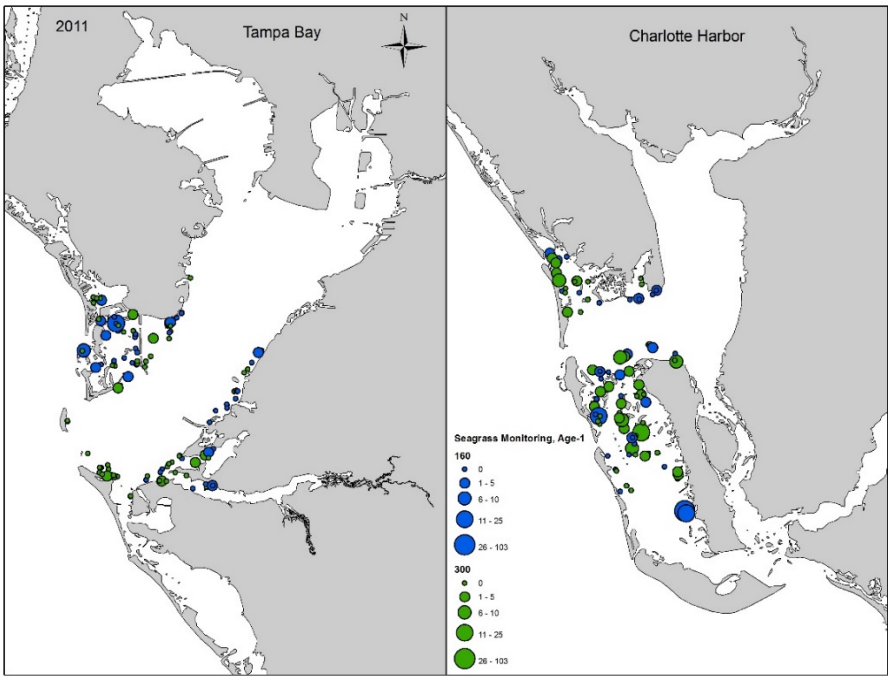
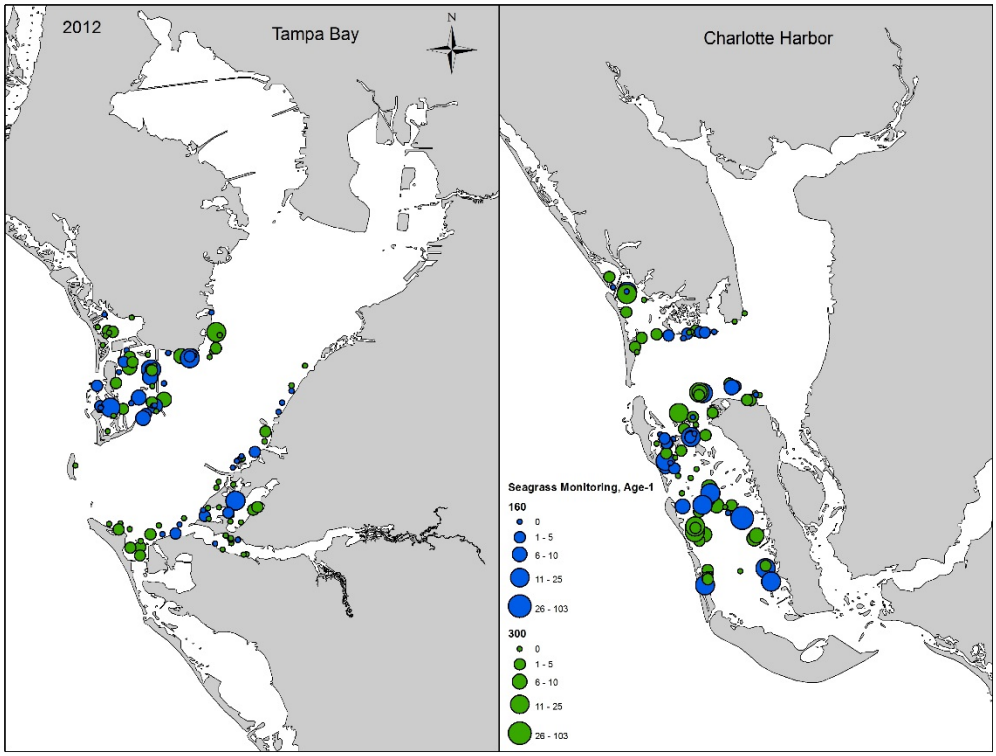

St. Andrew Bay
Apalachicola Bay
N
2015
Tampa Bay
Charlotte Harbor
Seagrass Monitoring, Age-0, 6.1-m Trawl
0
1 - 5
6 - 10
11 - 20
21 - 30

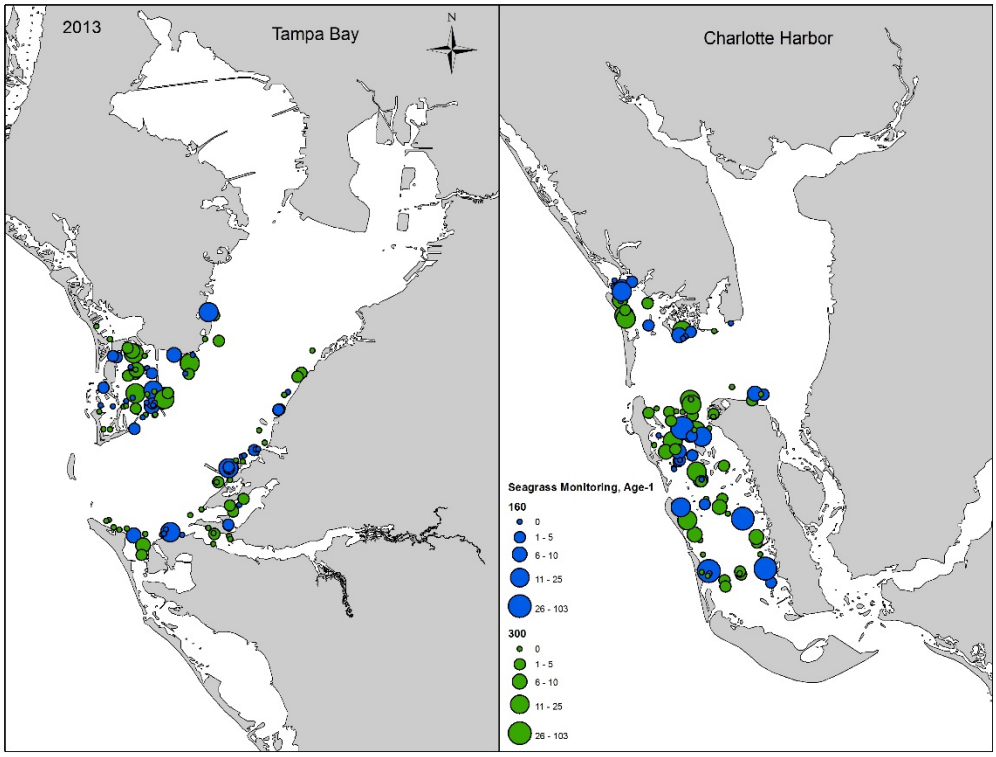
Figure A4. Annual distribution of stations sampled (2008 - 2015) in Tampa Bay and Charlotte Harbor from 2008 – 2015 during FWRI seagrass surveys using a 183-m shoal seine (gear = 160) and a 6.1-m otter trawl (gear = 300). Symbols represent the total number of age-1 Gray Snapper collected per set.

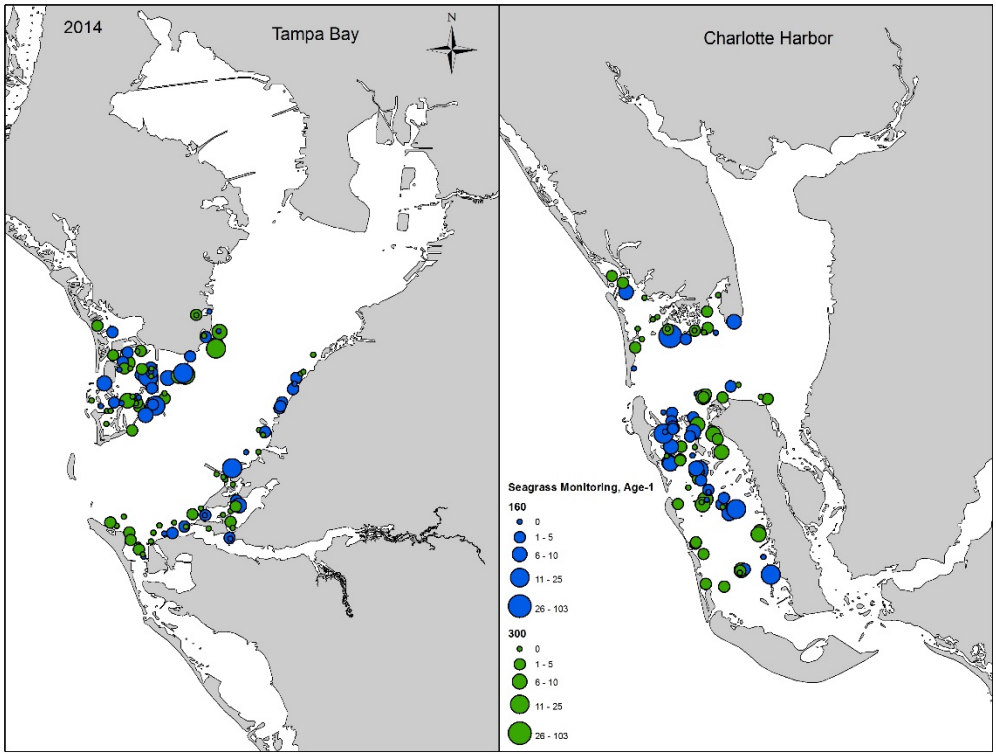


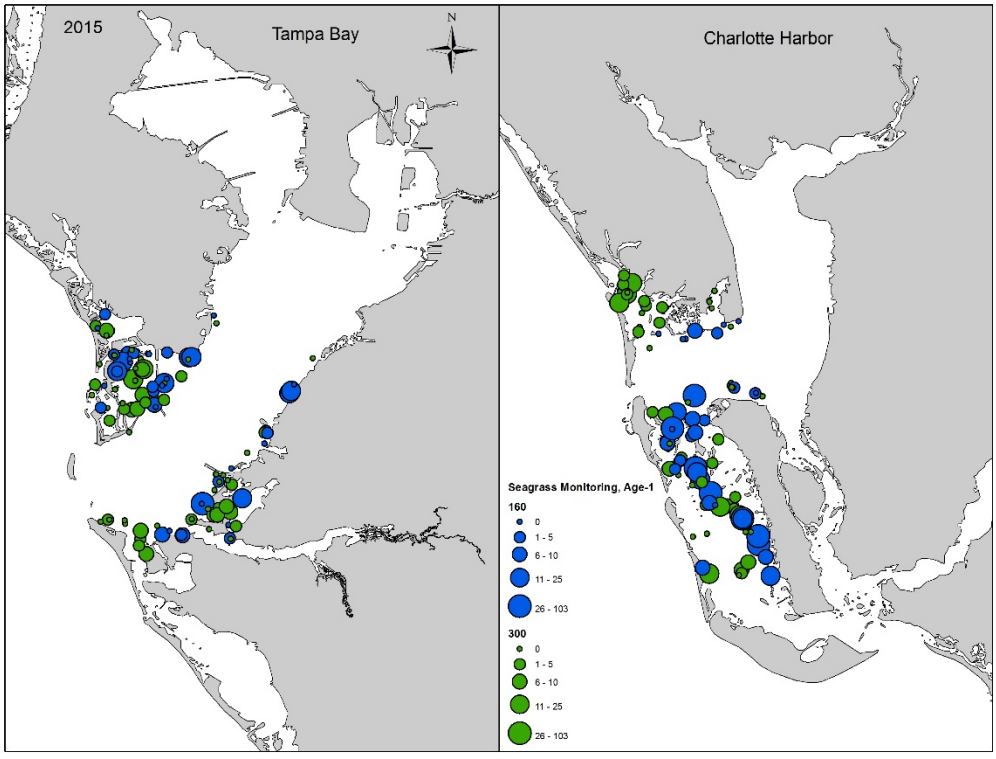

2010
Tampa Bay
N
Charlotte Harbor
Seagrass Monitoring, Age-1
160
0
1 - 5
6 - 10
11 - 25
26 - 103
300
0
1 - 5
6 - 10
11 - 25
26 - 103


2011
Tampa Bay
N
Charlotte Harbor
Seagrass Monitoring, Age-1
160
0
1 - 5
6 - 10
11 - 25
26 - 103
300
0
1 - 5
6 - 10
11 - 25
26 - 103


2012
Tampa Bay
N
Charlotte Harbor
Seagrass Monitoring, Age-1
160
0
1 - 5
6 - 10
11 - 25
26 - 103
300
0
1 - 5
6 - 10
11 - 25
26 - 103


2013
Tampa Bay
N
Charlotte Harbor
Seagrass Monitoring, Age-1
160
0
1 - 5
6 - 10
11 - 25
26 - 103
300
0
1 - 5
6 - 10
11 - 25
26 - 103


2014
Tampa Bay
N
Charlotte Harbor
Seagrass Monitoring, Age-1
160
0
1 - 5
6 - 10
11 - 25
26 - 103
300
0
1 - 5
6 - 10
11 - 25
26 - 103


2015
Tampa Bay
N
Charlotte Harbor
Seagrass Monitoring, Age-1
160
0
1 - 5
6 - 10
11 - 25
26 - 103
300
0
1 - 5
6 - 10
11 - 25
26 - 103