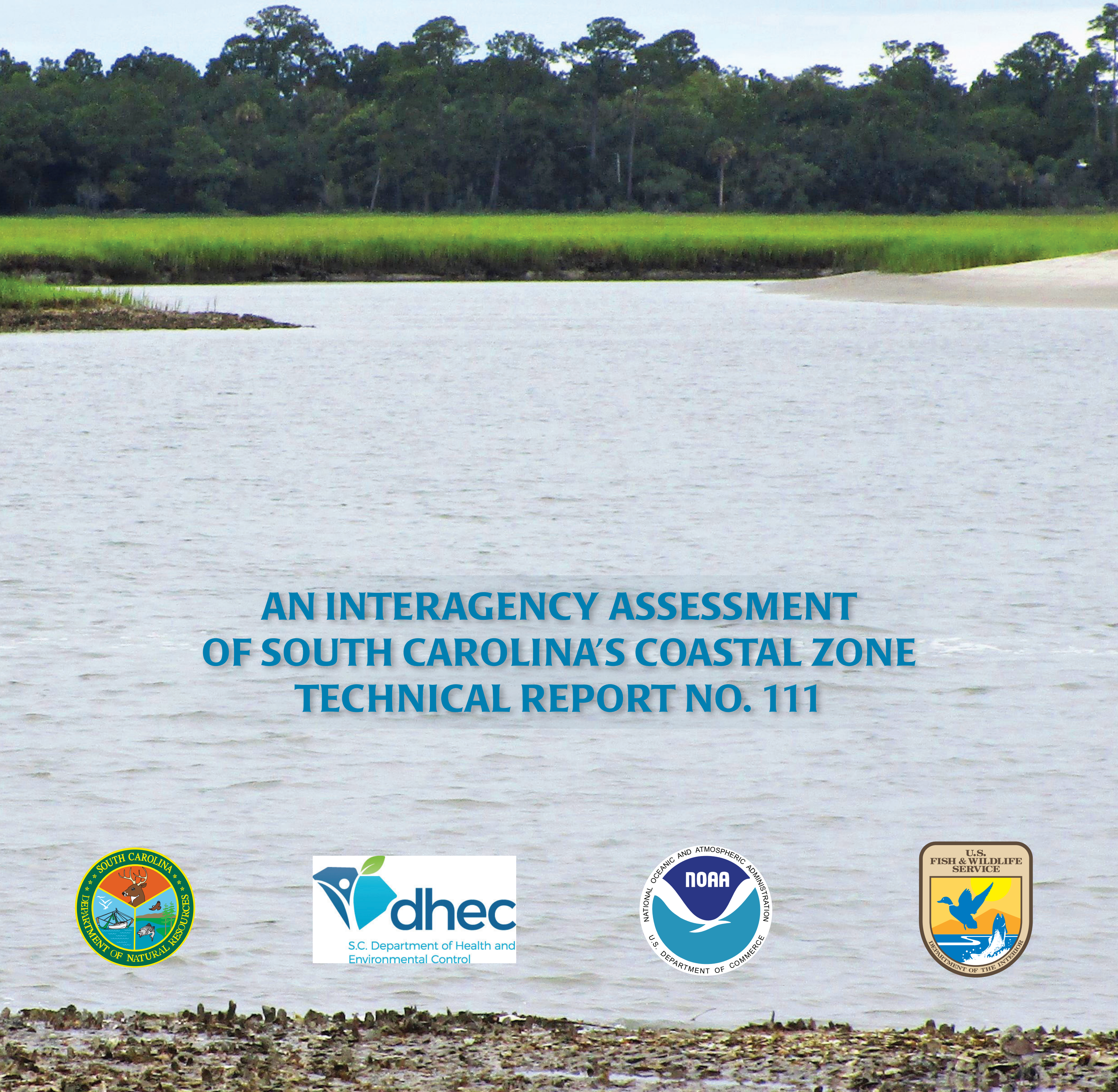
# THE CONDITION OF SOUTH CAROLINA'S ESTUARINE AND COASTAL HABITATS DURING 2017-2018



## AN INTERAGENCY ASSESSMENT OF SOUTH CAROLINA'S COASTAL ZONE

## TECHNICAL REPORT NO. 111

South Carolina Department of Natural Resources

dhec S.C. Department of Health and Environmental Control

National Oceanic and Atmospheric Administration, U.S. Department of Commerce

U.S. Fish & Wildlife Service, Department of the Interior

# The Condition of South Carolina's Estuarine and Coastal Habitats During 2017-2018

## Technical Report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# INTRODUCTION

South Carolina's extensive coastal zone provides a setting for residents and tourists to enjoy and supports an abundance of natural resources. In 2011, a total of 305,063 anglers collectively spent over 2 million days saltwater fishing in our state (Southwick Associates, 2012). In 2016, the state's coastal recreational and commercial fisheries contributed in excess of $292 million and $55 million in economic impact, respectively (National Marine Fisheries Service, 2018). In 2018, tourism expenditures in South Carolina's eight coastal counties exceeded $9.3 billion (U.S. Travel Association, 2019). A variety of sensitive estuarine areas provide attractive viewscapes while also serving as nursery or primary habitat for important fishery and ecotourism-linked wildlife resources. Thus, it is critical to protect South Carolina's coastal habitats from degradation.

As in most coastal states, the population in the coastal counties of South Carolina has been rapidly increasing in recent years. It is estimated that over 1.4 million people were living in South Carolina's eight coastal counties in 2018 (U.S. Census Bureau, 2020). This number is expected to increase to over 1.8 million people by 2030 (South Carolina Budget and Control Board, 2020). The associated expansion of housing, roads, and commercial and industrial infrastructure, combined with increased recreational utilization of our coastal waters, may result in increased risk for serious impacts to South Carolina's coastal habitats.

The South Carolina Estuarine and Coastal Assessment Program (SCECAP) was established in 1999 to begin evaluating the overall health of the state's estuarine habitats on a periodic basis using a combination of water quality, sediment quality, and biotic condition measures. This collaborative program involves the South Carolina Department of Natural Resources (SCDNR) and the South Carolina Department of Health and Environmental Control (SCDHEC) as the two lead state agencies, as well as the National Oceanic and Atmospheric Administration's National Ocean Service (NOAA/NOS) laboratories located in Charleston (National

***Urban sprawl is one of the primary threats to the quality of South Carolina's estuarine habitats.***

Centers for Coastal Ocean Science Charleston Laboratory and the Hollings Marine Laboratory). The U.S. Environmental Protection Agency (USEPA) Gulf Ecology Division in Gulf Breeze, FL became actively involved in SCECAP shortly after the inception of the program and utilized SCECAP data from 2000-2006 and again in 2010 in their National Coastal Condition Assessment (NCCA) Program.

SCECAP represents an expansion of ongoing monitoring programs being conducted by both state and federal agencies and ranks among the first in the country to apply a comprehensive, ecosystem-based assessment approach for evaluating coastal habitat condition. While the NCCA Program provides useful information at the national and regional scale through their National Coastal Condition Reports (NCCR) *(https://www.epa.gov/national-aquatic-resource-surveys/national-coastal-condition-reports),* many of the thresholds used for the national report are not as appropriate as thresholds developed specifically for South Carolina. Additionally, the SCECAP initiative collects data for parameters that are not collected by NCCA, collects data on a yearly basis, and provides data on multiple species of young of year fish that are used in stock assessments.

There are several critical attributes of the SCECAP initiative that set it apart from other ongoing monitoring programs being conducted in South Carolina by SCDHEC (primarily focused on water quality) and SCDNR (primarily focused on fishery stock assessments). These include: (1) sampling sites throughout the state's estuarine habitats using a statistical survey approach that complements both agencies' ongoing programs involving fixed station monitoring networks, (2) using integrated measures of environmental and biological condition that provide a more complete evaluation of overall habitat quality, and (3) monitoring tidal creek habitats in addition to the larger open water bodies that have been sampled traditionally by both agencies. This last component is of particular importance because tidal creek habitats serve as important nursery areas for most of the state's economically valuable species and often represent the first point of entry for runoff from upland areas. Thus, tidal creek systems can provide an early indication of anthropogenic stress (Sanger et al., 1999a, b; Lerberg et al., 2000; Van Dolah et al., 2000; 2002; 2004; Holland et al., 2004; Sanger et al., 2015).

This technical report is part of a series of bi-annual reports describing the status of South Carolina's estuarine habitats. The 2017-2018 SCECAP report, as well as all reports for previous survey periods, can be obtained from the SCECAP website at *http://www.dnr.sc.gov/marine/scecap/*. Raw and summarized data from these surveys can be requested by contacting the Principal Investigator (Denise Sanger; SangerD@dnr.sc.gov).

***Long-term monitoring programs such as SCECAP must find a balance between using the same methods and measures for consistency across time, and incorporating new methods and measures as they are developed and proven.***

# METHODS

The sampling and analytical methods used for SCECAP are fully described in the first SCECAP report (Van Dolah et al., 2002). Some of the analytical methods have been modified and are fully described by Bergquist et al. (2009) and in this report. This program uses methods consistent with SCDHEC's water quality monitoring program methods in effect at the time of sample collection (SCDHEC, a-d) and the USEPA's National Coastal Condition Assessment (NCCA) Program *(https://www.epa.gov/national-aquatic-resource-surveys/ncca)*. Long-term monitoring programs such as SCECAP must find a balance between using the same methods and measures for consistency across time, while incorporating new methods and measures as they are developed and proven.

## 2.1. Sampling Design

From 1999-2006, 50-60 stations were sampled annually, but a change in funding led to smaller annual sampling efforts beginning in 2007 with a total of 30 stations sampled each year. Sampling sites extend from the Little River Inlet at the South Carolina-North Carolina border to the Savannah River at the South Carolina-Georgia border, and from the saltwater-freshwater interface to near the mouth of each estuarine drainage basin. Half of the stations each year are randomly placed in tidal creeks (defined as water bodies < 100 m wide, and generally > 10 m wide, from marsh bank to marsh bank), and the other half are randomly placed in the larger open water bodies that form South Carolina's tidal rivers, bays, and sounds. Stations sampled in 2017-2018 are shown in Figure 2.1.1 and listed in Appendix 1. By surface

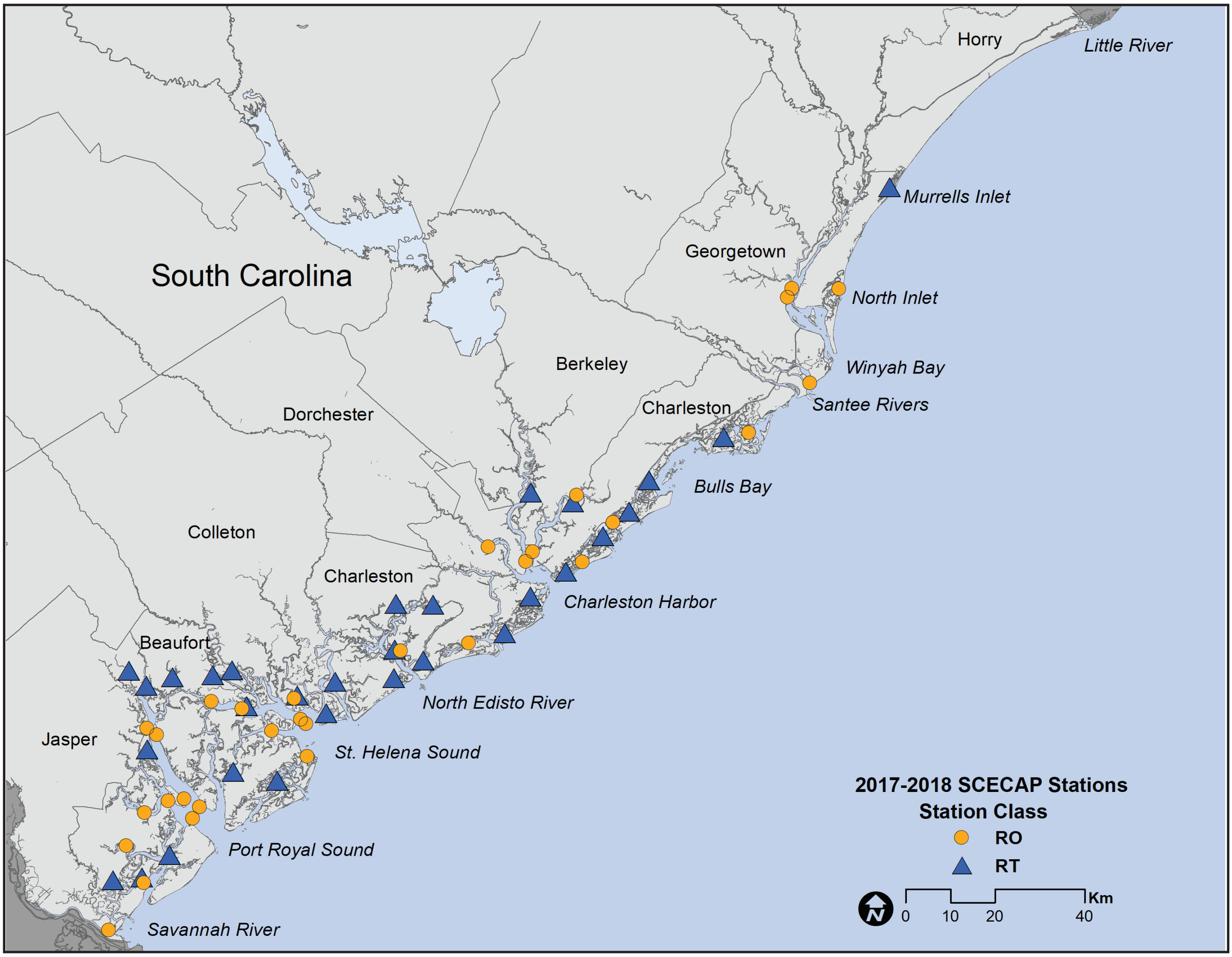



*Figure 2.1.1. Locations of stations sampled during 2017 and 2018. RO = open water and RT = tidal creek.*

area, approximately 17% of the state's estuarine water represents creek habitat, and the remaining 83% represents the larger open water areas (Van Dolah et al., 2002). Stations within each habitat type are selected using a Generalized Random Tessellation Stratified (GRTS) spatially-balanced survey design (Stevens, 1997; Stevens and Olsen, 1999), with new station locations assigned each year.

The primary sampling period for all sampling components is during the summer (late June through early September). The summer period was selected because it represents a period when some water quality variables may be limiting to biota, and it is a period when many fish and crustacean species of concern utilize the estuary for nursery habitat. In addition, SCDHEC samples the same 15 tidal creek and 15 open water sites for their monthly monitoring throughout the calendar year for selected water quality measures to meet that agency's mandates (data not reported here). Most measures of water and sediment quality and biological condition are collected within a 2-3 hr time period around low tide. All data are validated using a rigorous quality assurance process. A copy of the Quality Assurance Project Plan is maintained at the SCDNR Marine Resources Research Institute. Methods described in the following sections apply to all SCECAP survey periods.

## 2.2. Water Quality Measurements

Time-series measurements of temperature, salinity, dissolved oxygen (DO) and pH are obtained from the near-bottom waters of each site using YSI Model 6920 multiprobes logging at 15 min intervals for 25 hrs to assess conditions over two full tidal cycles, representing both day and night conditions. Both SCDHEC and SCDNR field staff also collect an instantaneous measure of these parameters at several depths (0.3 m beneath the surface, in the middle of the water column, and 0.3 m above the bottom) during the primary site visit. Other primary water quality measures that are collected from near-surface waters include total nitrogen (TN; sum of nitrate/nitrite and total Kjeldahl nitrogen (TKN)), total phosphorus (TP), chlorophyll *a* (Chl-*a*), and fecal coliform bacteria. Secondary water quality measures are also collected from near-surface waters, including water clarity based on a Secchi disk measurement. Data for the secondary water quality measures are available upon request but are not described in this report because these measures are not included in the SCECAP Water Quality Index (WQI) or have no state water quality standards.

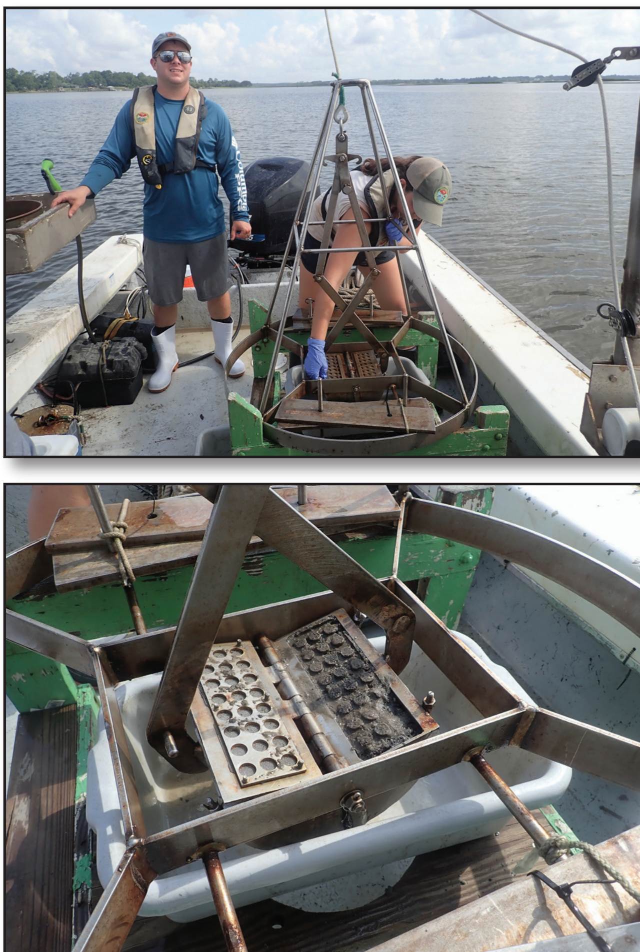
All nutrient and chlorophyll *a* samples for laboratory analyses are collected by rinsing an intermediate collection vessel three times with site water, inverting and inserting the collection vessel to a depth of 0.3 m, and then filling the collection vessel at that depth. Water for nutrient samples is then poured directly into sample bottles containing an acid preservative. Water for chlorophyll *a* samples is stored in the original collection vessel. Sample bottles for fecal bacteria are inverted, inserted to a depth of 0.3 m, and filled directly with site water. The bottles are stored on ice until they are returned to the laboratory for further processing. Bacteria samples and total nutrients are processed by SCDHEC using the standardized procedures in effect at the time of sample collection or analysis (SCDHEC, b-d). In 2011-2018, SCDHEC TKN values sampled concurrently with SCECAP were not available for many sites, resulting in our not being able to calculate TN; therefore, 2011-2018 TN and TP values were calculated by taking an average of the SCDHEC data that were collected at those sites during the months of June, July, and August during the same year as SCECAP sampling.

*Time-series measurements of near-bottom water quality are collected using a YSI multiprobe deployed inside a protective PVC tube, in combination with weights, floats, and lines.*

## 2.3. Sediment Quality Measurements

At least four bottom sediment samples are collected at each station using a stainless steel 0.04 $m^2$ Young grab deployed from an anchored boat that is repositioned between sample collections. The surficial sediments (upper 2 cm) of four or more grab samples are homogenized on-site in a stainless-steel bowl and placed in pre-cleaned containers for analysis of silt and clay content, total organic carbon (TOC), porewater total ammonia nitrogen (TAN), contaminants, and sediment toxicity. All sediment samples are kept on ice while in the field and then stored either at 4°C (toxicity, TAN) or frozen (contaminants, silt and clay content, TOC) until analyzed. Particle size analyses are performed using a modification of the pipette method described by Plumb (1981). Porewater TAN is measured using a Hach Model 700 colorimeter, and TOC is measured by GEL Laboratories in Charleston, SC. Contaminants measured in sediment include 22 metals, 89 polycyclic aromatic hydrocarbons (PAHs), 91 polychlorinated biphenyls (PCBs), 14 polybrominated diphenyl ethers (PBDEs) and 25 pesticides. All contaminants are analyzed by the NOAA/NOS National Centers for Coastal Ocean Science Charleston Laboratory using procedures similar to those described by Kucklick et al. (1997), Long et al. (1997), Balthis et al. (2012), and Chen et al. (2012). A subset of the sediment contaminant concentrations are used to calculate a mean Effects Range Median quotient (mERMq) which provides a convenient measure of sediment contamination on a biological impact basis for 24 compounds for which there are effects guidelines (Long and Morgan, 1990; Long et al., 1995; 1997; Hyland et al., 1999; 2003).

Sediment toxicity is assessed by the Microtox® solid-phase bioassay, which uses a photoluminescent bacterium (*Vibrio fischeri*) and protocols described by the Microbics Corporation (1992). In past reports, a 7-day juvenile clam growth assay using *Mercenaria mercenaria* and protocols described by Ringwood and Keppler (1998) was also incorporated in the toxicity component of the Sediment Quality Index (SQI), but results from the clam growth assay were not robust for 2011-2016 due to supply limitations, overall low growth rate, and/or high clam mortality in the control samples, and this assay was discontinued after 2016. In some earlier survey periods, a 10-day whole sediment amphipod assay was performed as a third toxicity measure. The amphipod assay has generally proven to be very insensitive for South Carolina sediments and has not been retained as part of the suite of toxicity measures for the SCECAP program. The Microtox® assay may yield false positive results; to limit the effect of this possibility, the assays were scored as fair for a positive toxicity result and good for a negative result in the sediment toxicity component of the SQI.



*A Young grab is used to collect samples for sediment quality and benthic biological condition.*

### 2.4. Biological Condition Measurements

Two whole samples collected by Young grab are each washed through a 0.5 mm sieve to collect the macrobenthic invertebrate fauna, which are then preserved in a 10% formalin/seawater solution containing Rose Bengal stain. All organisms from the two grabs are identified either to the species level or to the lowest practical taxonomic level if the specimen is too damaged or immature for accurate identification. A reference collection of benthic species collected for this program is maintained at the SCDNR Marine Resources Research Institute. The benthic data are incorporated into a Benthic Index of Biotic Integrity (B-IBI), based on number of taxa, abundance, dominance, and percent sensitive taxa (Van Dolah et al., 1999) which is used as the Biological Condition Index (BCI).

Fish and large invertebrates are collected by trawl at each site following benthic sampling to evaluate near-bottom community composition. Two replicate trawl tows, pulled in the same

*Two whole samples collected by Young grab are each washed through a 0.5 mm sieve to collect organisms living in the sediment.*

direction as tidal flow, are made sequentially at each site using a 4-seam trawl (5.5 m foot rope, 4.6 m head rope and 1.9 cm bar mesh throughout). Trawl tow lengths are standardized to 0.5 km for open water sites and 0.25 km for creek sites. Occasionally, due to site limitations, actual tows are slightly shorter than target tow lengths; when that occurs, actual tow length is recorded, and data from that trawl are only included in analyses if the tow was at least 50% of the target tow length. Fish, squid, large crustaceans, and horseshoe crabs captured are identified to the species or genus level, counted, and checked for gross pathologies, deformities, or external parasites. Up to 30 individuals of each taxon are measured to the nearest centimeter. Most trawl organisms are released on site after identification and enumeration, with the exception of a small number of organisms that are brought back to the lab to confirm identification or for research use. Mean abundances are corrected for the total area swept by the two trawl tows using the formula described by Krebs (1972). Concentrations of contaminants in fish tissue were assessed from 2000-2006 and again in 2010, but tissue contaminant samples are no longer collected by SCECAP due to funding constraints.

## 2.5. Integrated Indices of Estuarine Habitat Condition

One of the primary objectives of SCECAP is to develop integrated measures of estuarine condition that synthesize the program's large and complex environmental datasets. Such measures provide natural resource managers and the general public with simplified statements about the status and trends of the condition of South Carolina's coastal zone. Similar approaches have been developed by federal agencies for their National Coastal Condition Reports (USEPA, 2001; 2004; 2006) as well as by a few states and other entities using a variety of approaches (Carlton et al., 1998; Chesapeake Bay Foundation, 2007; Partridge, 2007).

SCECAP computes four integrated indices describing different components of the estuarine ecosystem: water quality, sediment quality, biological condition and overall habitat quality. The WQI combines four measures, the SQI combines three measures, and the BCI includes only the B-IBI (Table 2.5.1). These three indices are then combined into a single integrated Habitat Quality Index (HQI). The integrated indices facilitate communication of multi-variable environmental data to the public and provide a more reliable tool than individual measures (such as DO, pH, etc.) for assessing estuarine condition. For example, one location may have degraded DO but normal values for all other measures of water quality, while a second location has degraded levels for the

*Table 2.5.1. Individual measures comprising the integrated Water Quality, Sediment Quality, and Biological Condition indices.*

| Water Quality Index | Sediment Quality Index | Biological Condition Index |
|---|---|---|
| Dissolved Oxygen | Contaminants (mERMq) | B-IBI |
| Fecal Coliform Bacteria | Toxicity (Microtox®) | |
| pH (salinity-corrected) | Total Organic Carbon | |
| Eutrophic Index | | |
| Total Nitrogen | | |
| Total Phosphorus | | |
| Chlorophyll *a* | | |

majority of water quality measures. If DO were the only measure of water quality used, both locations would be classified as having degraded condition with no basis for distinguishing between the two locations. However, an index that integrates multiple measures would likely not classify the first location as degraded yet detect the relatively greater degradation at the second location.

Current methods for calculating the four integrated indices are described in detail in the 2005-2006 SCECAP report (Bergquist et al., 2009). Broadly, each individual measure taken at a sampled station and used to calculate the integrated indices is given a score of "good," "fair," or "poor." The thresholds used for scoring each measure are listed in Appendix 2. In the various graphics and tables of this report, these scores are depicted as green, yellow, and red, respectively. Thresholds for defining conditions as good, fair, or poor are based on 2008 state water quality standards (SCDHEC, a), published findings (Hyland et al., 1999 for mERMq; Van Dolah et al., 1999 for benthic condition; and Ringwood et al., 1997 for sediment toxicity), or percentiles of a historical database for the state based on SCECAP measurements collected from 1999-2006 (Bergquist et al., 2009). Each measure is given a numerical score (5, 3, and 0 for scores of good, fair, and poor, respectively) and the numerical scores of the individual measures are averaged into an integrated index value (described in general terms in Van Dolah et al., 2004). The Water Quality, Sediment Quality, and Biological Condition indices are likewise given a score of good, fair, or poor using methods described in Van Dolah et al. (2004). The resulting numerical scores for the WQI, SQI, and BCI are then averaged into an overall Habitat Quality Index as shown in Table 2.5.2.

It is important to note that as new information has become available, the calculation methodology used by SCECAP has been modified. Modifications include changes in the individual measures used in the integrated indices, threshold values, scoring processes, and methods used to address missing data. While these changes often do not result in very large changes in data interpretation, the results presented in this report for earlier years may not exactly match those in the previously published reports. However, the current report does reflect the updated data analysis approach applied to all previous survey periods.

*Table 2.5.2. Summary of possible index values and scores for the integrated Habitat Quality Index, based on combinations of scores from the Water Quality Index, the Sediment Quality Index, and the Biological Condition Index.*

| Component Index Scores | | | Habitat Quality Index (Average) | HQI Score |
|---|---|---|---|---|
| A | B | C | | |
| 0 | 0 | 0 | 0.00 | Poor (0) |
| 3 | 0 | 0 | 1.00 | Poor (0) |
| 5 | 0 | 0 | 1.67 | Poor (0) |
| 3 | 3 | 0 | 2.00 | Poor (0) |
| 5 | 3 | 0 | 2.67 | Fair (3) |
| 5 | 5 | 0 | 3.33 | Fair (3) |
| 3 | 3 | 3 | 3.00 | Fair (3) |
| 5 | 3 | 3 | 3.67 | Fair (3) |
| 5 | 5 | 3 | 4.33 | Good (5) |
| 5 | 5 | 5 | 5.00 | Good (5) |

## 2.6. The Presence of Litter

Litter is one of the more visible signs of habitat degradation. While the incidence of litter is not used in the overall Habitat Quality Index, the presence of litter in the trawl or on the banks for 250 meters on each side of the station is recorded.

## 2.7. Data Analysis

Use of the statistical survey sampling design provides an opportunity to estimate, with confidence limits, the proportion of South Carolina's estuarine water classified as being in good, fair, or poor condition. These estimates are obtained through analysis of the cumulative distribution function (CDF) using procedures described by Diaz-Ramos et al. (1996) and using programs developed within the R statistical software environment *(http://www.R-project.org/)*. The percent of the state's overall estuarine habitat scoring as good, fair, or poor for individual measures and for each of the indices is calculated after weighting the analysis by the proportion of the state's estuarine habitat represented by tidal creek (17%) and open water (83%) habitat. In the past, SCECAP used continuous values in these analyses when possible, but this methodology was modified to use only categorical scores in order to improve 1) consistency with reporting by the SCDHEC Ambient Surface Water Quality Monitoring Network, and 2) calculation of the 95% confidence limit for each estimate. Additionally, the difference in scores between tidal creek and open water habitats is now well-established in South Carolina (Van Dolah et al., 2002; 2004; 2006; 2013; Bergquist et al., 2009; 2011; Appendix 2). For brevity, graphical summaries in this report are primarily limited to overall estuarine habitat condition (tidal creek and open water combined). SCECAP data are stored in a relational database.

*South Carolina's wildlife need good water quality.*

# RESULTS AND DISCUSSION

## 3.1. Water Quality

SCECAP collects a wide variety of water quality parameters each year as part of the overall investigation of estuarine habitat quality. Poor water quality measures, if observed repeatedly in a watershed, can provide an early warning of impaired habitat, especially related to nutrient enrichment and bacterial problems. Six parameters are considered to be the most relevant with respect to biotic health and human uses and have been incorporated into a WQI developed by SCECAP. These include: 1) dissolved oxygen (DO), which is critical to healthy biological communities and can reflect organic pollution; 2) pH, which measures the acidity of a water body and can indicate the influence of various kinds of human input, such as atmospheric deposition from industry and vehicle emissions, runoff from land sources, etc.; 3) fecal coliform bacteria, which are an indicator of potential human pathogens; and 4) a combined measure of total nitrogen (TN), total phosphorus (TP), and chlorophyll *a* (Chl-*a*), which provides a composite measure of the potential for a water body to be experiencing nutrient enrichment and/or associated algal blooms. These latter three measures (TN, TP, and Chl-*a*) are combined into a Eutrophic Index, which is incorporated as one quarter of the weight of the overall WQI.

Applying the WQI to 2017-2018 survey data, 95% of the state's estuarine habitat scored as being in good condition, 4% scored as fair, and 1% scored as poor (Figure 3.1.1). For the 2017-2018 survey, none of the four component measures of the WQI had more than 1% of the coastal habitat rating as poor. The proportion of the state's overall estuarine habitat with good water quality has remained fairly constant from the 2013-2014 survey through the 2017-2018 survey, ranging from 91% to 95% (Figure 3.1.2).

As has been observed throughout the entire 1999-2018 SCECAP program, tidal creek habitat in 2017-2018 showed more variable and overall lower water quality compared to open water habitats (Table 3.1.1; Figure 3.1.3; Appendix 2).

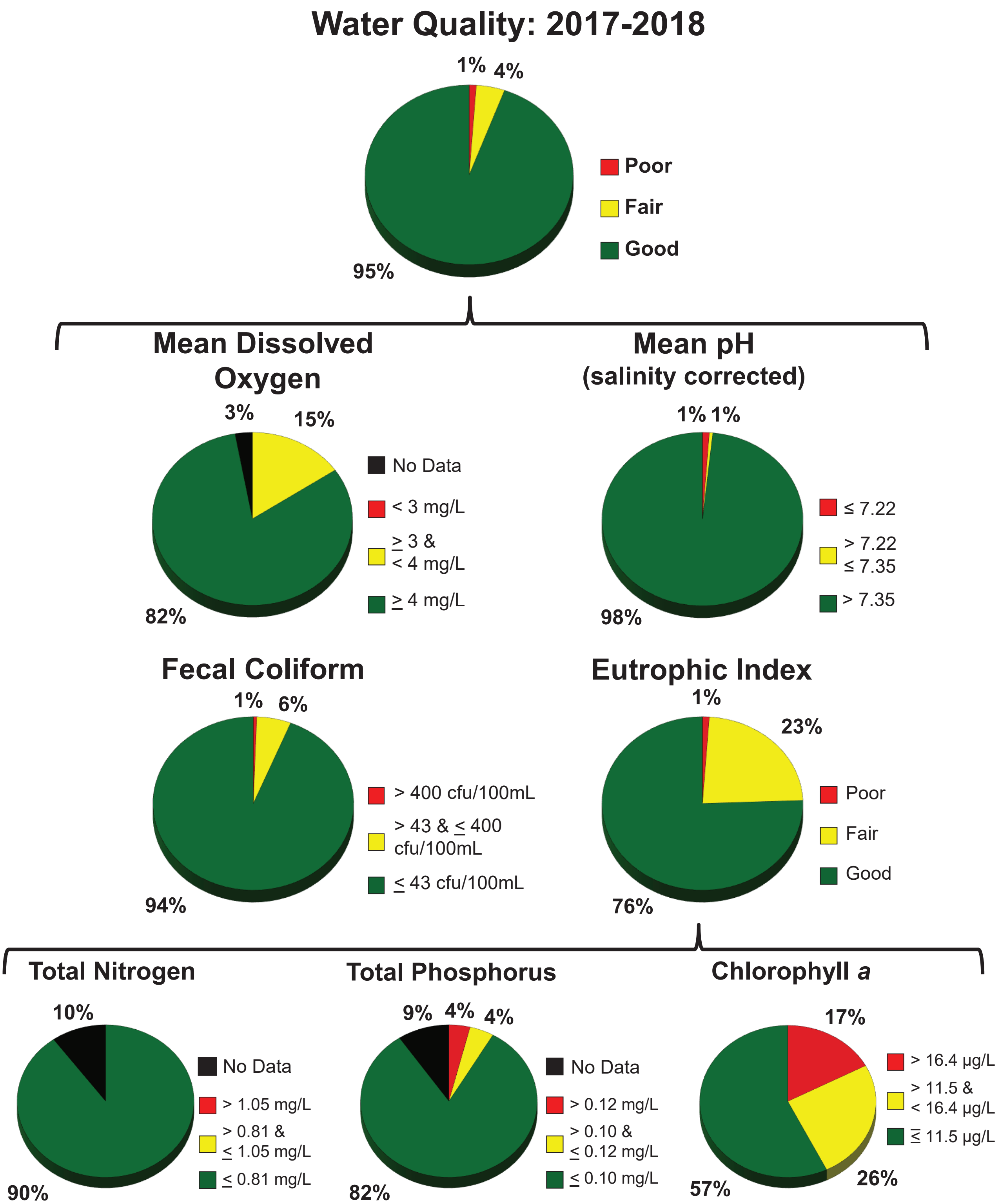



*Figure 3.1.1. Percentage of the state's estuarine habitat that scored as good, fair or poor for the Water Quality Index and the component parameters that comprise the index. Percentage is based on data obtained from 30 stations for each habitat during 2017 and 2018.*

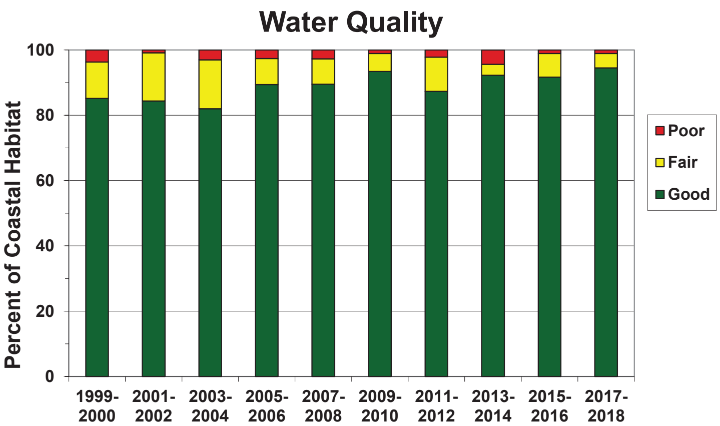



*Figure 3.1.2. Percent of coastal waters corresponding to each Water Quality Index category by survey period.*

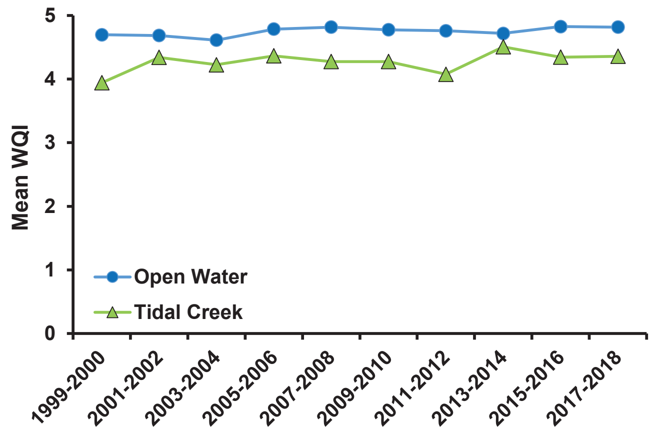



*Figure 3.1.3. Water Quality Index scores observed by survey period and habitat type.*

During the 2017-2018 survey, 97% and 83% of open water and tidal creek habitat, respectively, scored as good on the WQI (Appendix 2).

The distribution of stations for the 2017-2018 survey period with good, fair, or poor WQI scores are shown in Figures 3.1.4, 3.1.5, 3.1.6 and Appendix 3. Two of the 60 stations sampled in 2017-2018 had poor WQI, and both were tidal creek stations sampled in 2018 (Appendix 3). The first station with poor water quality (RT18171), due to poor or fair scores for DO, TP, and pH, is located in the Tulifinny River in Jasper County. Seven nearby historic tidal creek stations (within 6 km of RT18171), sampled in 2000-2013, scored poor or fair for the WQI; the most commonly shared compromised measures included elevated TN and TP and depressed DO and pH. The second station with poor water quality (RT18183) is located in Barnwell Creek in Beaufort County, which drains into Wimbee Creek. Of the 12 past tidal creek stations located within 6 km of RT18183, only 3 scored poor or fair for the WQI; however, at least half of those 12 stations scored poor or fair for DO, TP, and/or pH. In 2017-2018, 1 of the 30 open water stations and 3 of the 30 tidal creek stations had fair WQI scores.

When considering all years (1999-2018), portions of the state with a relatively high incidence of fair to poor water quality are concentrated in Winyah Bay; Santee Delta region; tidal creeks around Bulls Bay; Ashley River; drainage basins associated with the Dawhoo, Ashepoo, Combahee, and Broad Rivers; Jenkins Creek; and upstream portions of the New River and Wright River (Figures 3.1.4, 3.1.5, 3.1.6).

## 3.2. Sediment Quality

Sediment quality measurements remain an essential component of our overall estuarine habitat quality assessment because sediments: 1) support invertebrate communities that form the base of the food web for many other species of concern, 2) exchange nutrients and gases with overlying water in support of overall estuarine function, and 3) serve as a sink for many contaminants which can accumulate over time, providing a better measure of long-term exposure to contaminants in an area. Although many sediment quality measures are collected by SCECAP, the three component measures of the SQI considered to be the most indicative of sediment condition are 1) a combined measure of 24 organic and inorganic contaminants that have published biological effects thresholds (mERMq; Long and Morgan, 1990; Long et al., 1995; 1997; Hyland et al., 1999; 2003), 2) a measure of sediment toxicity based on the Microtox® bioassay that indicates whether contaminants are present at concentrations that

*Table 3.1.1. Summary of mean water quality measures observed in tidal creek and open water habitats during each year of the SCECAP survey. Blue highlight indicates those measures included in the Water Quality Index.*

| Measure | Habitat | Year | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Water Quality Index | Open | 4.56 | 4.83 | 4.64 | 4.73 | 4.57 | 4.66 | 4.77 | 4.80 | 4.78 | 4.85 | 4.90 | 4.65 | 4.58 | 4.93 | 4.72 | 4.72 | 4.90 | 4.75 | 4.83 | 4.80 |
| | Creek | 4.02 | 3.86 | 4.28 | 4.40 | 4.25 | 4.20 | 4.38 | 4.35 | 4.45 | 4.10 | 4.65 | 3.90 | 4.52 | 3.63 | 4.42 | 4.60 | 4.23 | 4.46 | 4.48 | 4.23 |
| Dissolved Oxygen (mg/L) | Open | 4.86 | 5.01 | 4.96 | 5.10 | 4.97 | 5.41 | 5.13 | 5.11 | 5.49 | 5.62 | 5.54 | 5.05 | 4.99 | 5.07 | 5.32 | 5.09 | 5.21 | 5.32 | 5.12 | 5.06 |
| | Creek | 4.00 | 4.12 | 4.45 | 4.51 | 4.58 | 5.10 | 4.12 | 4.33 | 4.53 | 4.50 | 4.41 | 4.12 | 4.59 | 3.40 | 4.40 | 4.65 | 4.51 | 4.83 | 4.51 | 4.38 |
| pH | Open | 7.58 | 7.53 | 7.67 | 7.71 | 7.39 | 7.75 | 7.59 | 7.68 | 7.68 | 7.68 | 7.63 | 7.58 | 7.59 | 7.62 | 7.43 | 7.53 | 7.60 | 7.56 | 7.64 | 7.55 |
| | Creek | 7.52 | 7.43 | 7.56 | 7.53 | 7.31 | 7.36 | 7.30 | 7.48 | 7.43 | 7.49 | 7.49 | 7.37 | 7.52 | 7.33 | 7.27 | 7.47 | 7.39 | 7.40 | 7.43 | 7.35 |
| Fecal Coliform (cfu/100mL) | Open | 47 | 11 | 14 | 9 | 25 | 17 | 12 | 24 | 17 | 13 | 19 | 10 | 23 | 6 | 21 | 38 | 3 | 15 | 4 | 13 |
| | Creek | 30 | 55 | 35 | 25 | 74 | 87 | 29 | 65 | 14 | 32 | 5 | 27 | 25 | 158 | 58 | 21 | 76 | 64 | 20 | 86 |
| Total Nitrogen (mg/L) | Open | 0.51 | 0.58 | 0.66 | 0.52 | 0.84 | 0.52 | 0.57 | 0.20 | 0.26 | 0.52 | 0.57 | 0.25 | 0.39 | 0.32 | 0.63 | 0.35 | 0.52 | 0.69 | 0.42 | 0.35 |
| | Creek | 0.69 | 0.75 | 0.72 | 0.58 | 0.72 | 0.64 | 0.67 | 0.20 | 0.32 | 0.65 | 0.62 | 0.32 | 0.21 | 0.48 | 0.56 | 0.38 | 0.61 | 0.46 | 0.38 | 0.39 |
| Total Phosphorus (mg/L) | Open | 0.08 | 0.06 | 0.06 | 0.05 | 0.06 | 0.08 | 0.08 | 0.07 | 0.06 | 0.05 | 0.07 | 0.09 | 0.09 | 0.05 | 0.06 | 0.07 | 0.06 | 0.08 | 0.06 | 0.07 |
| | Creek | 0.09 | 0.10 | 0.09 | 0.06 | 0.09 | 0.12 | 0.08 | 0.07 | 0.06 | 0.09 | 0.09 | 0.09 | 0.09 | 0.06 | 0.08 | 0.08 | 0.06 | 0.09 | 0.07 | 0.08 |
| Chlorophyll *a* (µg/L) | Open | 10.3 | 9.1 | 10.1 | 10.1 | 6.9 | 8.4 | 7.7 | 7.4 | 11.0 | 9.2 | 7.2 | 9.2 | 8.7 | 7.6 | 2.9 | 6.6 | 9.2 | 8.8 | 11.3 | 11.2 |
| | Creek | 12.6 | 12.5 | 10.8 | 9.7 | 11.6 | 12.0 | 8.0 | 10.1 | 10.9 | 8.9 | 7.8 | 12.1 | 9.7 | 8.6 | 4.9 | 5.9 | 9.8 | 12.3 | 14.7 | 12.7 |
| Temperature (°C) | Open | 30.2 | 29.4 | 29.5 | 29.1 | 28.5 | 29.1 | 30.0 | 29.7 | 29.8 | 29.0 | 28.5 | 30.8 | 30.1 | 29.9 | 28.9 | 29.1 | 29.7 | 30.8 | 29.4 | 28.9 |
| | Creek | 30.1 | 29.8 | 29.5 | 29.0 | 29.0 | 29.6 | 29.9 | 30.2 | 30.3 | 29.9 | 29.9 | 31.2 | 30.7 | 29.8 | 29.3 | 29.6 | 30.3 | 30.7 | 29.8 | 29.7 |
| Salinity (ppt) | Open | 26.2 | 28.1 | 28.2 | 31.0 | 19.9 | 28.4 | 25.9 | 31.1 | 30.3 | 31.3 | 26.4 | 30.8 | 30.5 | 29.1 | 21.1 | 24.6 | 30.4 | 25.9 | 27.7 | 24.6 |
| | Creek | 31.1 | 31.5 | 29.4 | 32.1 | 20.8 | 26.2 | 23.2 | 32.3 | 29.3 | 32.0 | 30.9 | 29.7 | 34.2 | 30.7 | 19.7 | 28.9 | 30.0 | 26.6 | 27.8 | 23.0 |

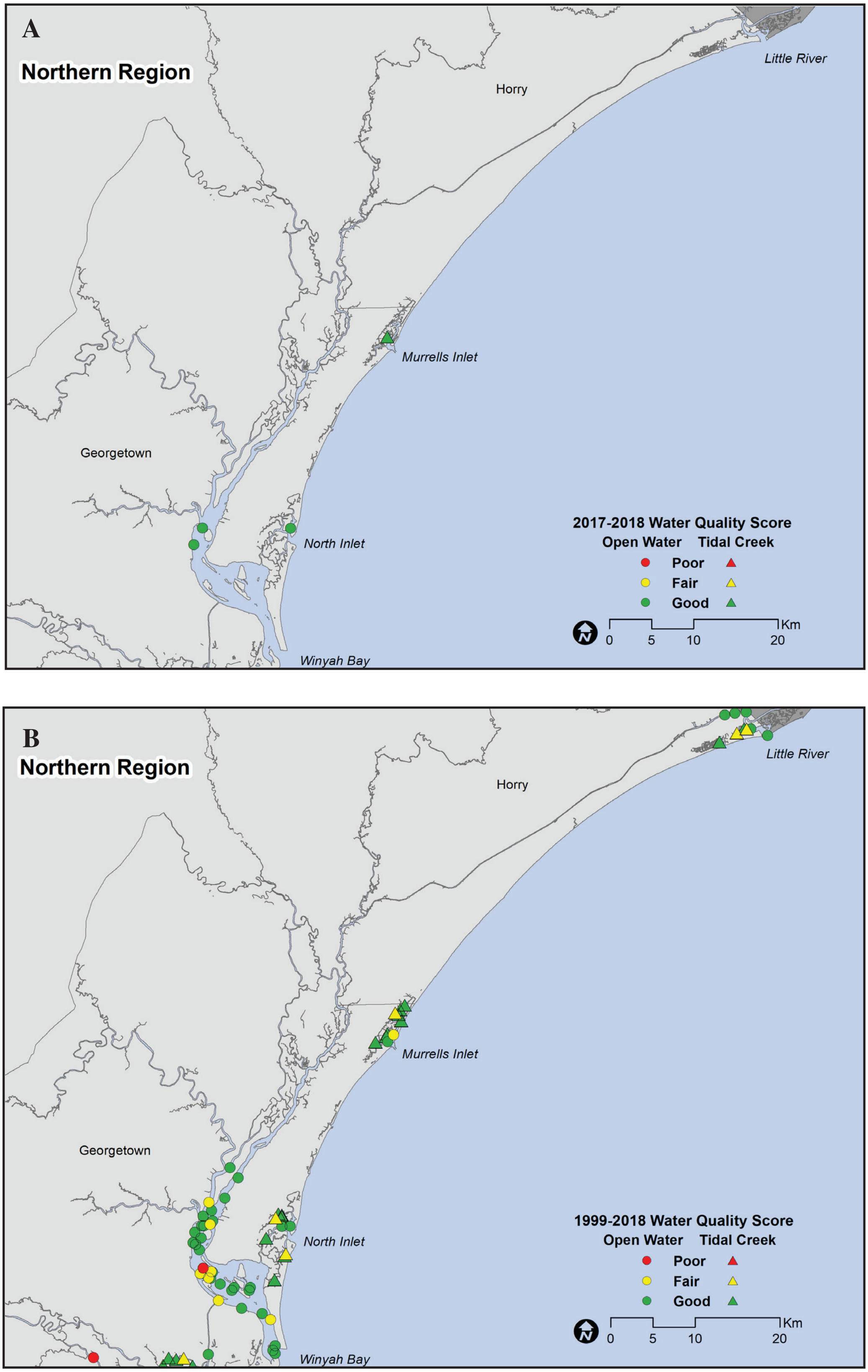



*Figure 3.1.4. Distribution of stations with good, fair, or poor scores for the Water Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the northern region of South Carolina.*

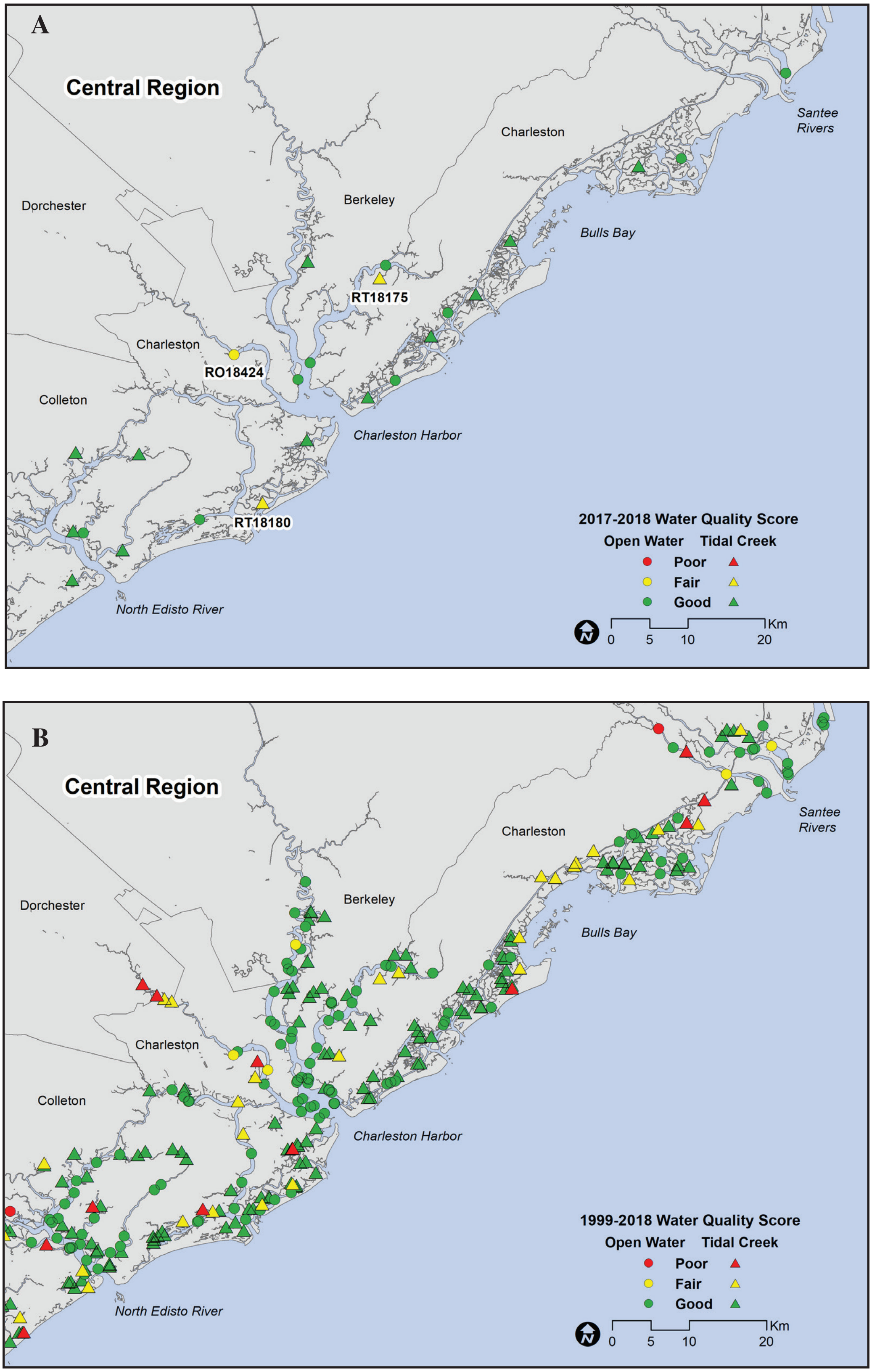



*Figure 3.1.5. Distribution of stations with good, fair, or poor scores for the Water Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the central region of South Carolina. Stations from 2017-2018 with fair or poor WQI scores are labeled (A).*

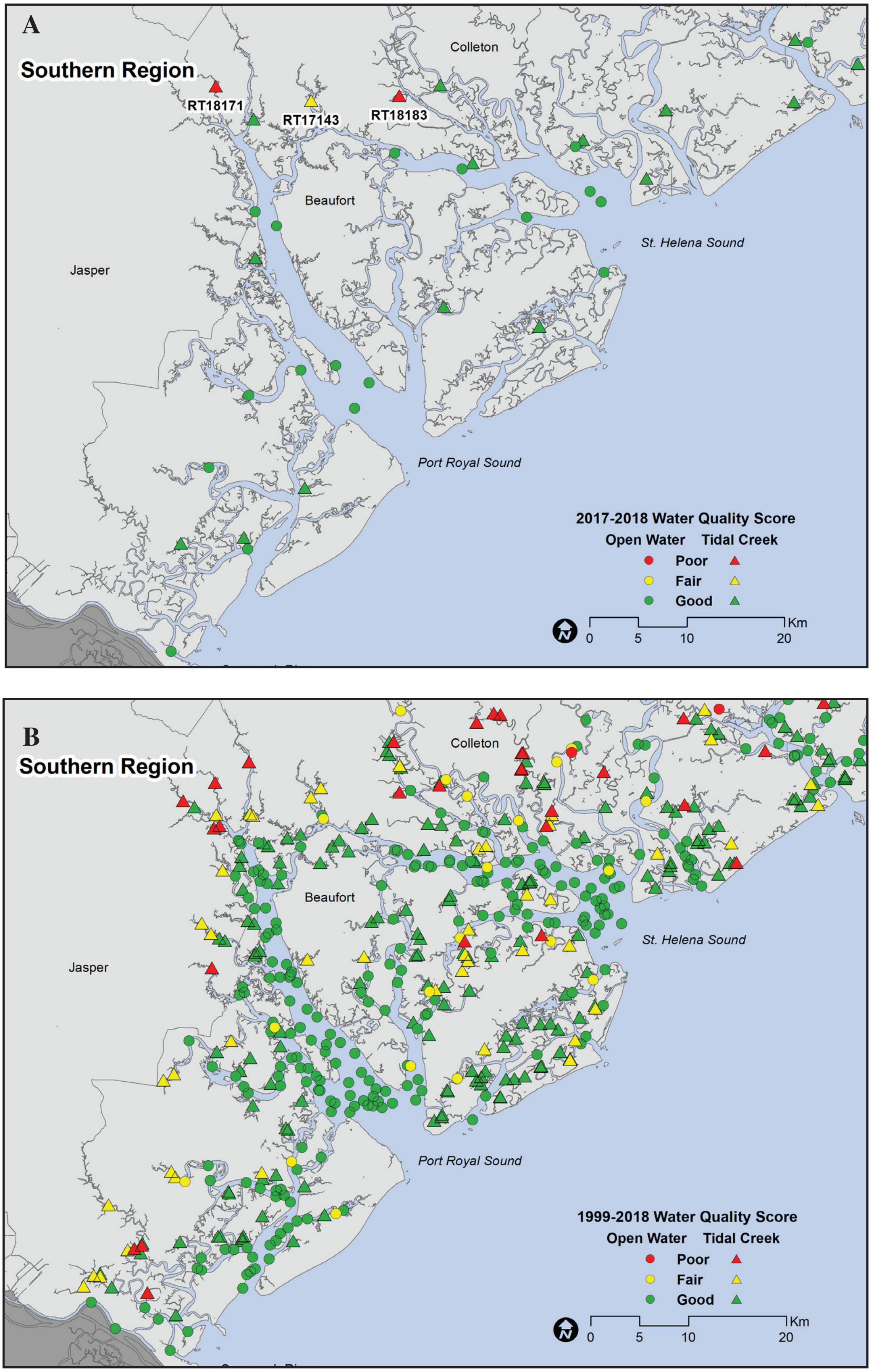



*Figure 3.1.6. Distribution of stations with good, fair, or poor scores for the Water Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the southern region of South Carolina. Stations from 2017-2018 with fair or poor WQI scores are labeled (A).*

have adverse biological effects, and 3) TOC, which can have several adverse effects on bottom-dwelling biota and provides a good predictor of benthic community condition (Hyland et al., 2005).

During the 2017-2018 survey using the SQI, 86% of South Carolina's estuarine habitat had sediment in good condition, with 6% in fair condition and 8% in poor condition (Figure 3.2.1). Throughout the 1999-2018 time frame, the percentage of estuarine habitat with good sediment quality started high (88%) in 1999-2000, fell to its lowest levels in 2001-2004 (75-79%), and steadily improved from 2009-2010 (83%) through 2015-2016 (92%). The percentage of estuarine habitat with good SQI declined slightly in the 2017-2018 survey, to 86% (Figure 3.2.2). Hurricanes Matthew (October 2016) and Irma (September 2017) impacted the South Carolina coast in the fall preceding the 2017 and 2018 SCECAP sampling seasons, respectively; a relationship between increased precipitation in the year preceding sampling and decreased SQI has been observed in the SCECAP dataset. Mean SQI was lower at tidal creek sites than at open water sites in 2017-2018, a difference consistent with a subset of past survey periods (Figure 3.2.3).

Six stations scored as having poor sediment

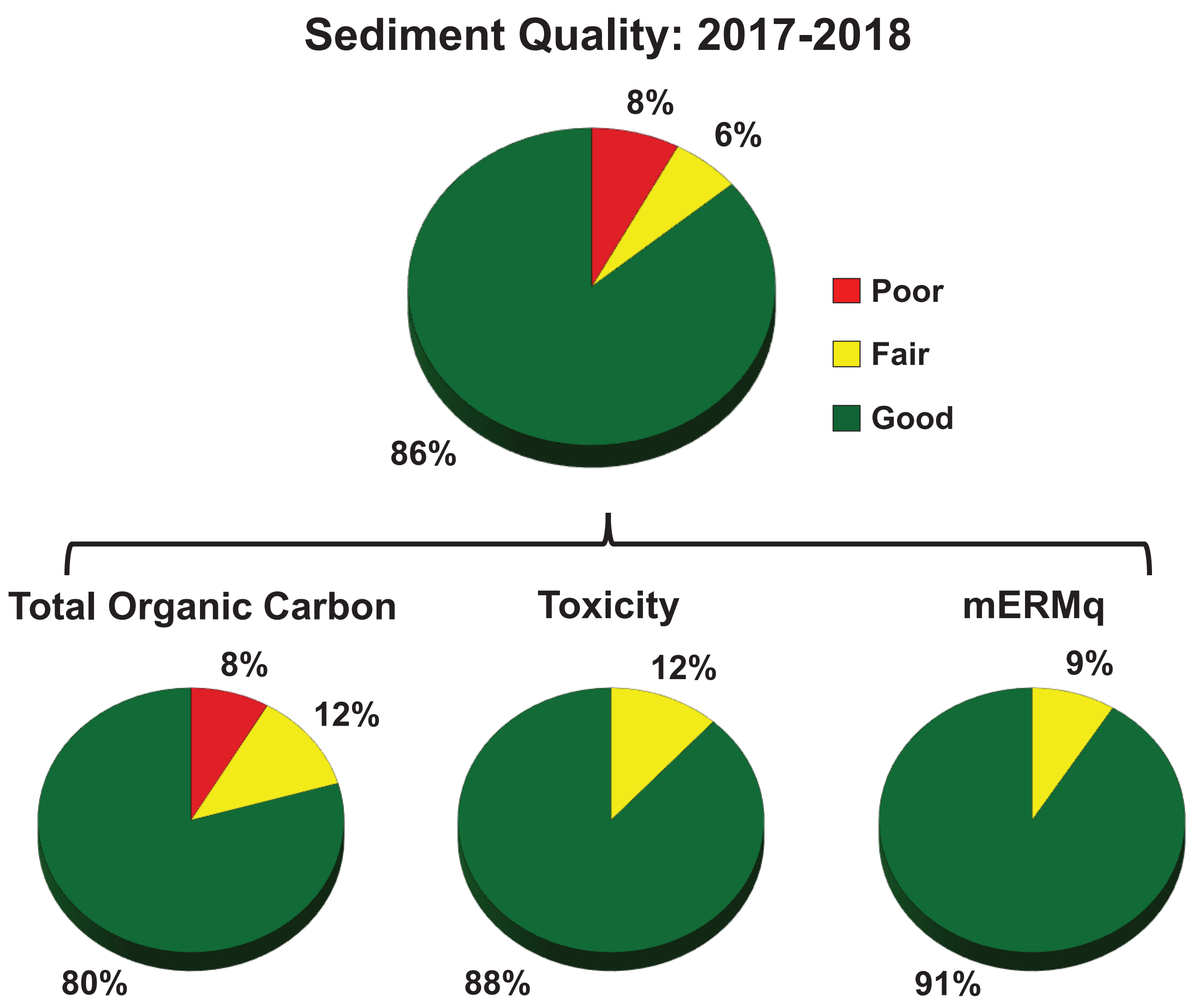



*Figure 3.2.1. Percentage of the state's estuarine habitat that scored as good, fair or poor for the Sediment Quality Index and the component parameters that comprise the index. Percentage is based on data obtained from 30 stations for each habitat during 2017 and 2018.*

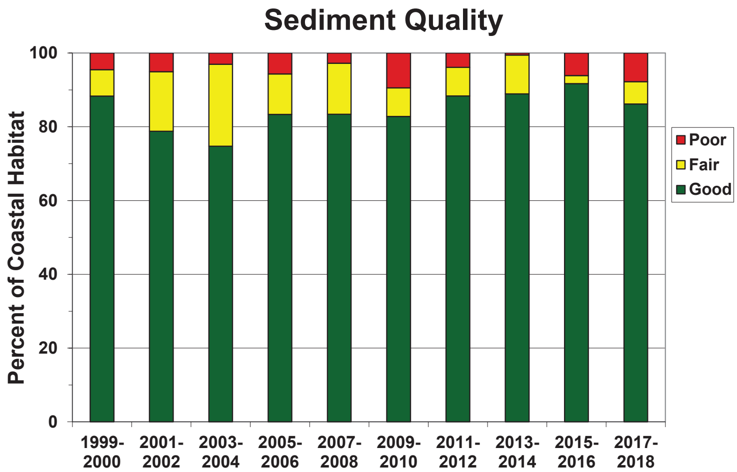



*Figure 3.2.2. Percent of coastal waters corresponding to each Sediment Quality Index category by survey period.*

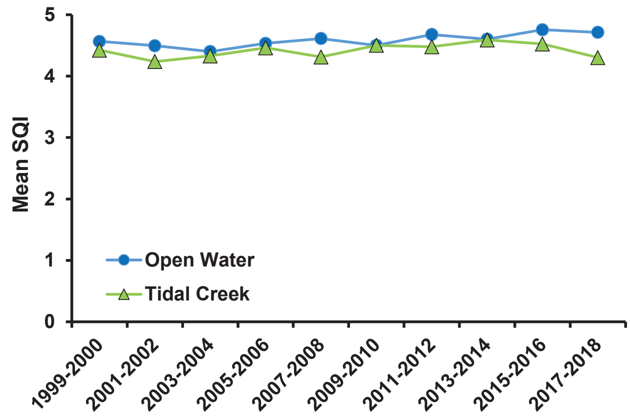
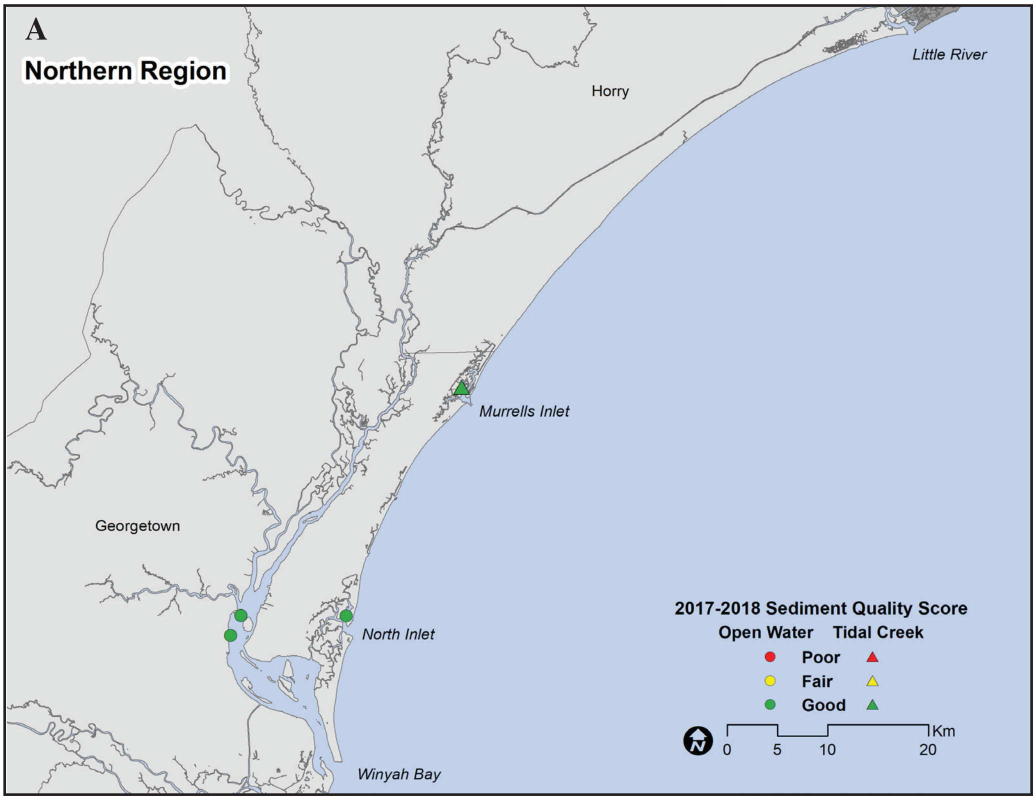



*Figure 3.2.3. Sediment Quality Index scores observed by survey period and habitat type.*

quality in the 2017-2018 survey, all of which were sampled in 2017: 2 open water sites and 4 tidal creek sites (Figures 3.2.4, 3.2.5, 3.2.6; Appendix 3). The open water sites with poor sediment quality are located in Horsehead Creek near Cape Romain Harbor (RO17403) and the Charleston Harbor at the mouth of the Wando River (RO17396). The tidal creek sites with poor sediment quality are located in Yellow House Creek (which drains into the Cooper River; RT17148), an unnamed creek between Bull Island and the Intracoastal Waterway (ICW; RT17153), Schooner Creek between James Island and Morris Island (RT17152), and an unnamed creek between the Combahee River and Schooner Channel (RT17155). All 6 of the sites with poor sediment quality scored poor for TOC, 5 of the sites scored fair for mERMq, and 3 of the sites scored fair for toxicity. Poor sediment quality has been previously observed in portions of the Charleston Harbor and Cooper River. However, this was the first time that poor sediment quality has been observed in an open water station near Cape Romain, although a few tidal creek stations along the ICW in the area near Cape Romain and Bulls Bay have received a score of poor for sediment quality in the past. In the area between Morris Island, Long Island, and James Island, a total of 10 tidal creek stations have been sampled for SCECAP since 1999, but this was the first time that poor sediment quality was observed in a tidal creek there. In the Combahee River near RT17155 there are two open water stations previously sampled for SCECAP; the closest station, sampled in 2002, received an SQI score of good, but a Combahee River station approximately 5 km downstream from RT17155 sampled in 2015 received an SQI score of poor. In 2017-2018, 7 of the 60 SCECAP stations scored as having fair SQI scores, and 6 of the 7 were tidal creek stations.

When all survey periods are considered collectively, areas with clusters of poor to fair SQI scores were observed in Winyah Bay; Santee Delta region; Cape Romain and Bulls Bay area; Cooper River and Charleston Harbor; North Edisto, Dawho, and South Edisto Rivers; portions of the Combahee River and its drainages; creeks north of Whale Branch; and the New, Wright, and Savannah Rivers (Figures 3.2.4, 3.2.5, 3.2.6).



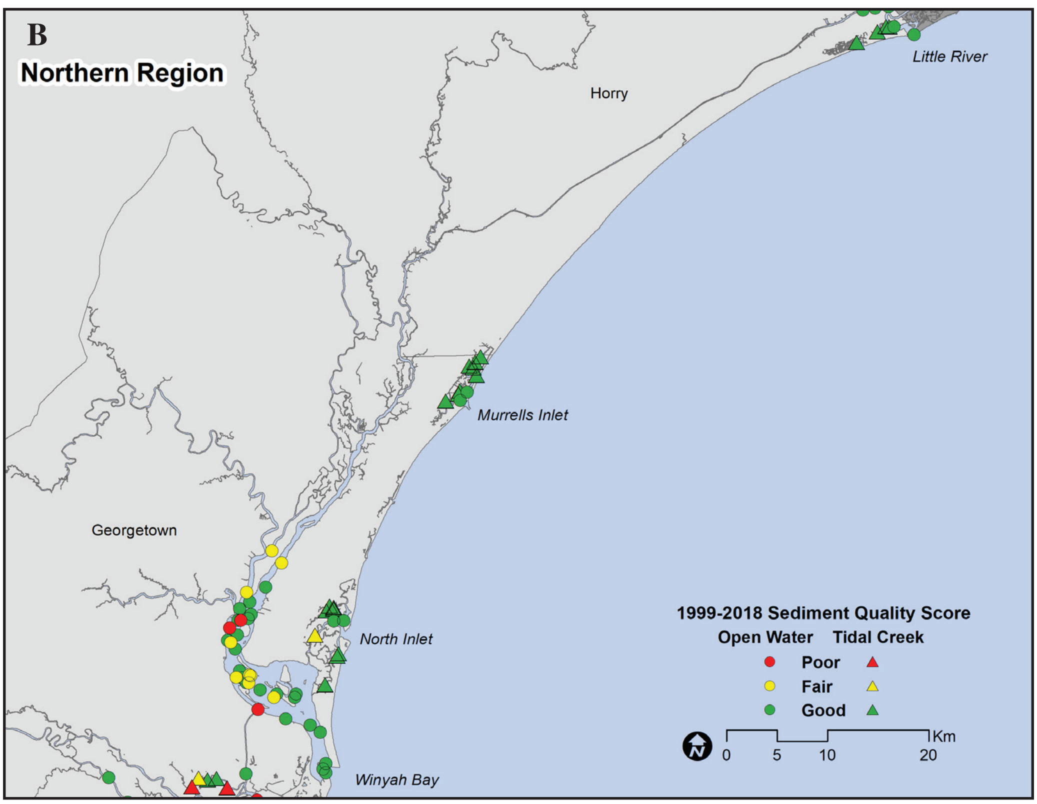
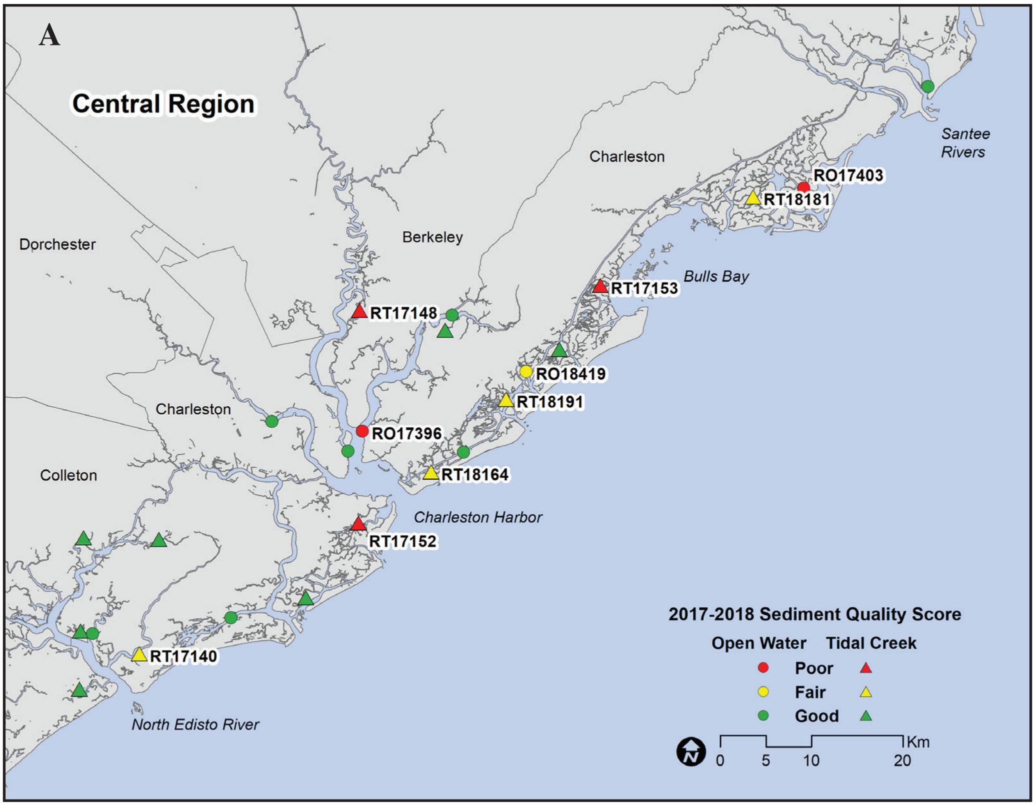




*Figure 3.2.4. Distribution of stations with good, fair, or poor scores for the Sediment Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the northern region of South Carolina.*



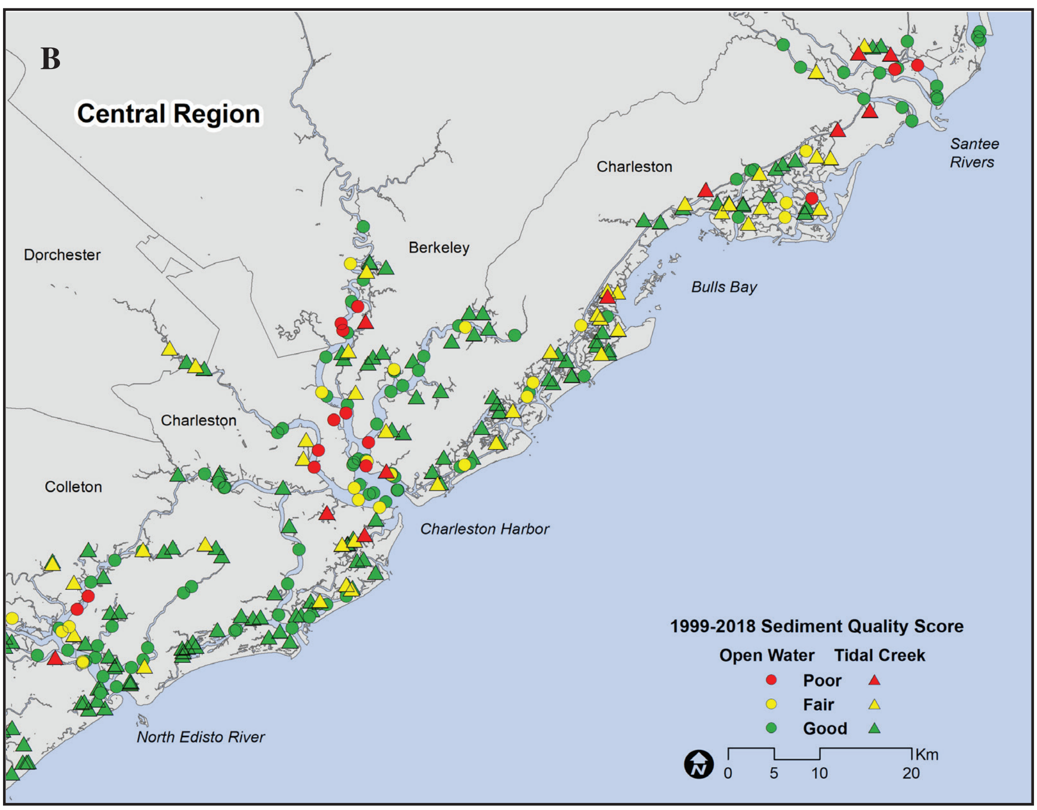




*Figure 3.2.5. Distribution of stations with good, fair, or poor scores for the Sediment Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the central region of South Carolina. Stations from 2017-2018 with fair or poor SQI scores are labeled (A).*

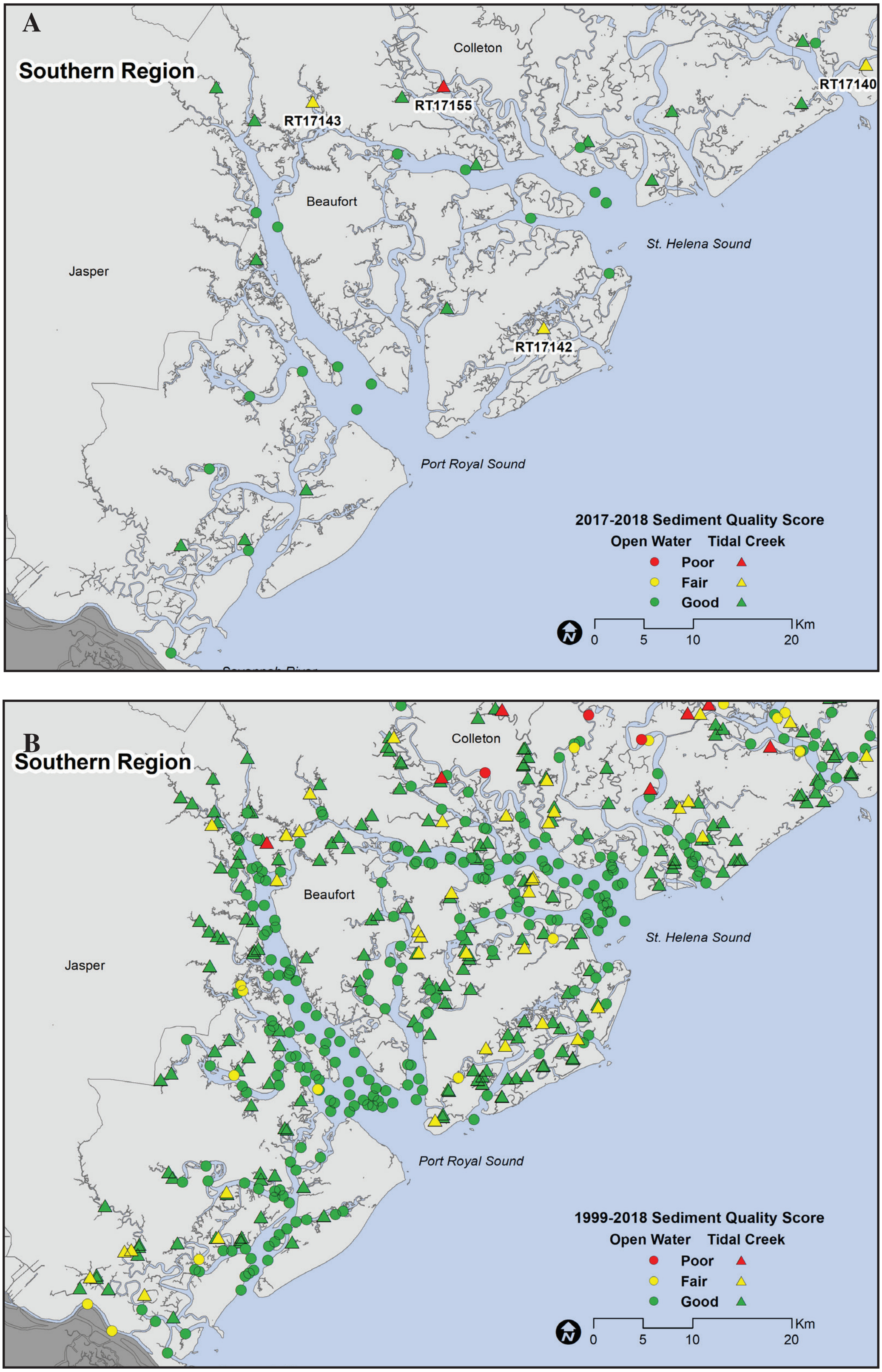



*Figure 3.2.6. Distribution of stations with good, fair, or poor scores for the Sediment Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the southern region of South Carolina. Stations from 2017-2018 with fair or poor SQI scores are labeled (A).*

*Table 3.2.1. Summary of mean sediment quality measures observed in tidal creek and open water habitats during each year for the SCECAP survey. Blue highlight indicates those measures included in the Sediment Quality Index.*

| | | Year | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Measure | Habitat | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Sediment Quality Index | Open | 4.52 | 4.61 | 4.59 | 4.40 | 4.43 | 4.37 | 4.53 | 4.53 | 4.53 | 4.69 | 4.40 | 4.60 | 4.71 | 4.64 | 4.73 | 4.47 | 4.56 | 4.96 | 4.60 | 4.82 |
| | Creek | 4.43 | 4.41 | 4.17 | 4.30 | 4.26 | 4.40 | 4.33 | 4.59 | 4.16 | 4.47 | 4.78 | 4.22 | 4.84 | 4.11 | 4.36 | 4.82 | 4.38 | 4.67 | 4.02 | 4.58 |
| Total Organic Carbon (%) | Open | 0.86 | 0.63 | 0.94 | 0.84 | 0.74 | 0.88 | 0.70 | 0.77 | 0.79 | 0.70 | 1.15 | 0.62 | 0.89 | 0.75 | 0.45 | 1.20 | 1.35 | 0.81 | 1.93 | 0.99 |
| | Creek | 1.08 | 1.33 | 1.30 | 1.39 | 1.30 | 1.12 | 1.48 | 1.03 | 1.71 | 1.06 | 1.08 | 1.35 | 0.43 | 1.67 | 1.85 | 0.86 | 2.24 | 2.05 | 3.72 | 2.60 |
| mERMq | Open | 0.013 | 0.013 | 0.013 | 0.017 | 0.014 | 0.015 | 0.013 | 0.017 | 0.013 | 0.014 | 0.213 | 0.018 | 0.020 | 0.014 | 0.019 | 0.017 | 0.011 | 0.008 | 0.011 | 0.006 |
| | Creek | 0.015 | 0.014 | 0.017 | 0.015 | 0.018 | 0.016 | 0.018 | 0.013 | 0.022 | 0.015 | 0.011 | 0.025 | 0.016 | 0.020 | 0.023 | 0.013 | 0.016 | 0.013 | 0.016 | 0.010 |
| Microtox® Bioassay (% toxic) | Open | 37.9 | 40.0 | 26.7 | 43.3 | 46.7 | 53.3 | 40.0 | 24.0 | 33.3 | 20.0 | 20.0 | 33.3 | 6.7 | 33.3 | 6.7 | 33.3 | 20.0 | 6.7 | 0.0 | 20.0 |
| | Creek | 51.9 | 50.0 | 60.0 | 46.7 | 56.7 | 50.0 | 36.0 | 28.0 | 42.9 | 40.0 | 20.0 | 33.3 | 0.0 | 40.0 | 20.0 | 6.7 | 6.7 | 6.7 | 26.7 | 13.3 |
| Silt & Clay (%) | Open | 22.3 | 15.1 | 23.0 | 20.5 | 15.4 | 24.2 | 17.7 | 17.9 | 22.7 | 18.7 | 26.8 | 15.8 | 16.4 | 21.5 | 12.3 | 29.1 | 18.9 | 10.6 | 18.1 | 7.9 |
| | Creek | 32.0 | 31.8 | 30.3 | 30.9 | 34.3 | 26.0 | 37.4 | 21.0 | 40.7 | 23.4 | 27.6 | 26.9 | 15.2 | 42.0 | 36.8 | 21.3 | 39.4 | 31.8 | 37.7 | 21.7 |
| Total Ammonia Nitrogen (mg/L) | Open | 2.62 | 2.91 | 2.51 | 3.64 | 3.22 | 4.13 | 1.95 | 2.09 | 1.69 | 3.44 | 3.24 | 1.96 | 1.99 | 2.46 | 2.03 | 5.89 | 1.81 | 1.03 | 2.92 | 1.39 |
| | Creek | 2.79 | 3.06 | 3.46 | 2.75 | 4.74 | 2.17 | 2.48 | 2.16 | 2.04 | 2.23 | 2.97 | 3.62 | 1.04 | 4.49 | 2.21 | 1.45 | 2.27 | 2.87 | 2.70 | 1.59 |

## 3.3. Biological Condition

*Benthic Communities*

Benthic macrofauna serve as ecologically important components of the food web by consuming detritus, plankton, and smaller organisms living in the sediments and in turn serve as prey for fish, shrimp, and crabs. Benthic macrofauna are also relatively sedentary, and many species are sensitive to changing environmental conditions. As a result, these organisms are important biological indicators of water and sediment quality and are useful in monitoring programs to assess overall coastal and estuarine health (Hyland et al., 1999; Van Dolah et al., 1999). The BCI, which is used to score estuarine habitat in terms of benthic community quality, is based upon the Benthic Index of Biotic Integrity (B-IBI; Van Dolah et al., 1999).

During the 2017-2018 survey, using the BCI, 89% of the state's estuarine habitat scored as good condition, 10% as fair, and 1% as poor (Figure 3.3.1). In contrast to the WQI and SQI results, which have consistently shown the best results (in terms of percent of the habitat scoring good) for the full 1999-2018 survey in recent years, the percent of coastal habitat scored as being in good Biological Condition was relatively low in past two survey periods (69% in 2013-2014 and 73% in 2015-2016; Figure 3.3.2), and then returned to levels comparable to those observed in 2007-2012 in 2017-2018 (89%), due to an increase in mean B-IBI at both open water and tidal creek stations. As in most previous surveys, mean B-IBI values were higher in open water habitats than in tidal creeks in 2017-2018 (Figure 3.3.3; Table 3.3.1). The relatively lower B-IBI values often seen in tidal creek habitats likely reflects the more stressful conditions of shallow tidal creek systems compared to tidal rivers and bays.

The B-IBI provides a convenient, broad index of benthic community condition, but because this index combines four measures into a single value, it does not provide detailed information on community composition. While some of the benthic community measures shown in Table 3.3.1 do not explicitly identify degraded conditions, they do allow the comparison of community characteristics among habitats and through time. Traditional community descriptors such as total faunal density, number of species (species richness), species evenness (J'), and species diversity (H') can be lower in more stressful environments. This is because fewer and fewer species within a community can tolerate increasingly stressful conditions, such as those caused by decreasing dissolved oxygen or increasing sediment contamination. Using published literature, species that are sensitive to pollution can be identified in order to examine potential patterns in estuarine contamination. As with the more traditional indices above, open water habitats typically supported significantly higher densities and percentages of sensitive fauna than tidal creek habitats (Table 3.3.1). Taxonomic groups, such as amphipods, mollusks and polychaetes, occupy a diverse range of habitats, but relative to each other, vary predictably with environmental conditions. For example, polychaetes tend to dominate the communities of shallow, muddy tidal creek habitats whereas amphipods and mollusks become increasingly more abundant in sandier oceanic environments (Little, 2000). A comparison between tidal creek and open water habitats support these expected patterns, with the densities and proportions of amphipods and mollusks typically being higher in open water habitats and the proportion of polychaetes being higher in tidal creek habitats (Table 3.3.1).

The distribution of stations with good, fair, or poor BCI scores during the 2017-2018 survey period is shown in Figures 3.3.4, 3.3.5, 3.3.6 and Appendix 3. Only 1 of the 60 stations sampled in 2017-2018 scored as poor for the BCI: a tidal creek station (RT18171) located in Jasper County's Tulifinny River. RT18171 received a good score on the SQI but a poor score on the WQI due to elevated TP and depressed pH and DO (Appendix 3), which likely contributed to a stressful environment for benthic fauna. In 2017-2018, 9 of the 30 tidal creek stations scored fair on the BCI, compared to 2 of 30 open water stations.

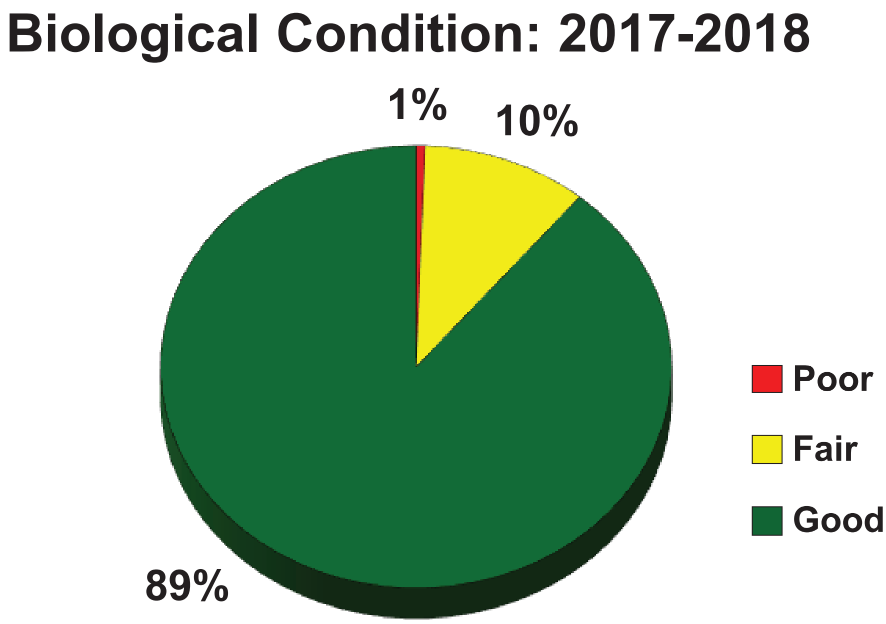



*Figure 3.3.1. Percentage of the state's estuarine habitat that scored as good, fair or poor for the Biological Condition Index. Percentage is based on data obtained from 30 stations for each habitat during 2017 and 2018.*

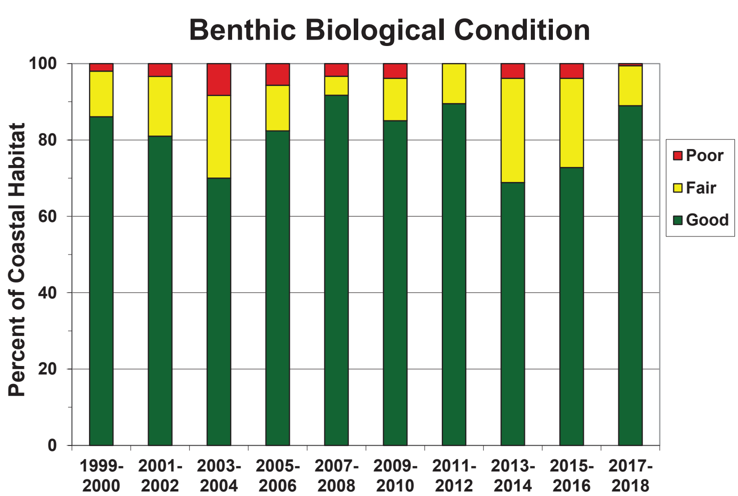



*Figure 3.3.2. Percent of coastal waters corresponding to each Biological Condition Index category by survey period.*

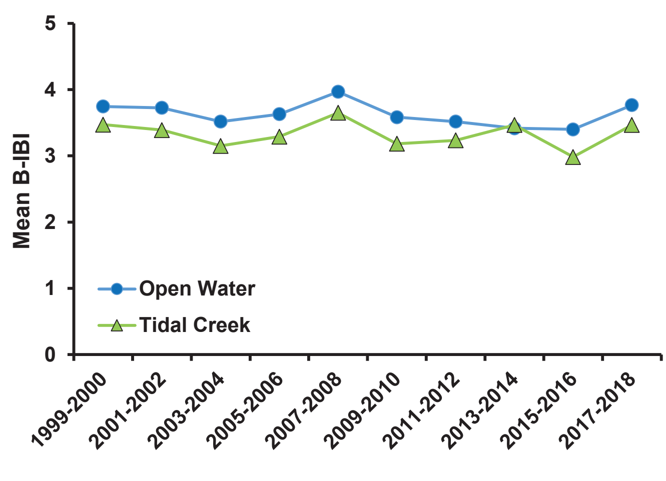
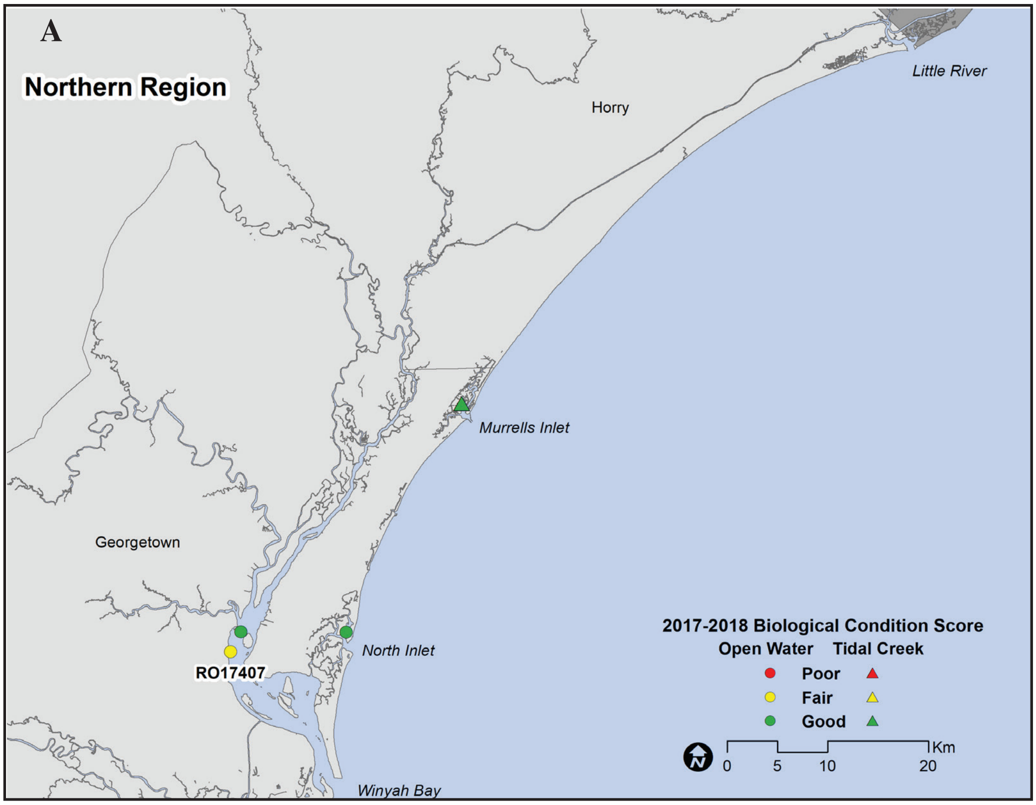



*Figure 3.3.3. Benthic Index of Biological Integrity scores observed by survey period and habitat type.*

*Table 3.3.1. Summary of mean benthic biological measures observed in tidal creek and open water habitats during each year of the SCECAP survey. Blue highlight indicates the measure included in the Biological Condition Index.*

| Measure | Habitat | Year | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Biological Condition Index | Open | 4.62 | 4.73 | 4.50 | 4.63 | 4.00 | 4.30 | 4.68 | 4.32 | 4.53 | 5.00 | 4.40 | 4.87 | 5.00 | 4.73 | 4.60 | 3.87 | 4.47 | 4.27 | 4.73 | 5.00 |
| | Creek | 4.37 | 4.77 | 4.32 | 4.23 | 3.97 | 4.33 | 4.20 | 4.52 | 4.40 | 4.73 | 4.87 | 3.80 | 4.47 | 4.33 | 4.07 | 4.73 | 4.07 | 4.33 | 4.33 | 4.13 |
| B-IBI (Carolinian Province) | Open | 3.76 | 3.73 | 3.55 | 3.90 | 3.48 | 3.55 | 3.74 | 3.52 | 3.93 | 4.00 | 3.50 | 3.67 | 3.57 | 3.47 | 3.77 | 3.07 | 3.57 | 3.23 | 3.87 | 3.67 |
| | Creek | 3.24 | 3.70 | 3.38 | 3.40 | 3.08 | 3.22 | 3.04 | 3.54 | 3.37 | 3.93 | 3.57 | 2.80 | 3.37 | 3.10 | 2.97 | 3.97 | 2.90 | 3.07 | 3.53 | 3.40 |
| Overall Density | Open | 5354 | 6292 | 4095 | 7198 | 4236 | 4127 | 5282 | 4513 | 6873 | 8626 | 2698 | 3288 | 4616 | 2377 | 5893 | 2938 | 4319 | 2386 | 5482 | 6801 |
| (individuals/$m^2$) | Creek | 2363 | 4659 | 4710 | 5001 | 3198 | 2863 | 2282 | 5060 | 3008 | 6395 | 2843 | 2133 | 2222 | 6328 | 2267 | 4563 | 1997 | 2388 | 6473 | 4656 |
| Number of Species | Open | 25.9 | 22.1 | 17.5 | 26.7 | 18.9 | 18.7 | 21.1 | 19.0 | 22.5 | 23.8 | 15.3 | 19.1 | 15.9 | 14.4 | 20.0 | 14.0 | 21.0 | 13.9 | 20.0 | 16.3 |
| | Creek | 14.8 | 19.8 | 17.5 | 20.7 | 14.4 | 15.8 | 12.0 | 22.2 | 14.1 | 23.3 | 15.6 | 10.7 | 15.2 | 14.7 | 10.9 | 22.6 | 10.8 | 12.0 | 16.9 | 19.4 |
| Species Evenness (J') | Open | 0.76 | 0.70 | 0.72 | 0.73 | 0.73 | 0.74 | 0.74 | 0.77 | 0.69 | 0.68 | 0.78 | 0.79 | 0.74 | 0.74 | 0.66 | 0.80 | 0.73 | 0.74 | 0.71 | 0.67 |
| | Creek | 0.72 | 0.69 | 0.71 | 0.70 | 0.72 | 0.72 | 0.75 | 0.67 | 0.74 | 0.72 | 0.72 | 0.67 | 0.76 | 0.62 | 0.66 | 0.75 | 0.72 | 0.74 | 0.68 | 0.66 |
| Species Diversity (H') | Open | 3.30 | 2.81 | 2.74 | 3.14 | 2.67 | 2.84 | 2.94 | 2.99 | 2.94 | 2.99 | 2.72 | 3.17 | 2.72 | 2.68 | 2.70 | 2.67 | 2.99 | 2.54 | 2.84 | 2.48 |
| | Creek | 2.59 | 2.85 | 2.78 | 2.78 | 2.33 | 2.65 | 2.41 | 2.75 | 2.64 | 3.03 | 2.72 | 2.07 | 2.81 | 2.22 | 2.07 | 3.19 | 2.30 | 2.53 | 2.61 | 2.62 |
| Percent Sensitive Taxa | Open | 13.4 | 26.8 | 19.6 | 16.5 | 16.5 | 24.1 | 19.6 | 17.9 | 19.8 | 19.6 | 14.1 | 14.8 | 14.8 | 23.3 | 13.7 | 11.7 | 17.7 | 18.4 | 30.4 | 31.4 |
| | Creek | 10.0 | 16.5 | 12.0 | 8.2 | 11.5 | 8.9 | 13.5 | 14.6 | 14.4 | 14.3 | 15.4 | 9.8 | 18.3 | 8.5 | 5.9 | 22.8 | 9.1 | 4.6 | 15.9 | 8.4 |
| Percent Amphipods | Open | 10.9 | 18.6 | 12.7 | 13.2 | 17.5 | 17.5 | 16.3 | 12.7 | 13.7 | 9.5 | 12.3 | 15.6 | 8.7 | 16.4 | 12.6 | 10.4 | 12.3 | 15.5 | 24.3 | 16.9 |
| | Creek | 6.1 | 11.8 | 4.5 | 5.3 | 7.9 | 4.5 | 12.9 | 10.4 | 13.7 | 14.2 | 8.6 | 1.6 | 5.9 | 6.7 | 7.0 | 7.0 | 8.5 | 9.1 | 10.4 | 3.6 |
| Percent Mollusks | Open | 5.9 | 7.9 | 10.0 | 9.6 | 7.8 | 8.5 | 2.8 | 10.6 | 6.4 | 6.3 | 7.9 | 5.2 | 12.1 | 9.2 | 3.9 | 7.8 | 8.3 | 6.7 | 8.1 | 5.1 |
| | Creek | 3.5 | 6.0 | 5.7 | 6.2 | 5.6 | 4.9 | 1.8 | 5.0 | 4.5 | 3.5 | 5.0 | 2.0 | 8.1 | 2.4 | 3.3 | 9.6 | 3.2 | 5.4 | 6.1 | 3.4 |
| Percent Polychaetes | Open | 56.3 | 54.3 | 60.3 | 57.2 | 52.3 | 50.3 | 56.7 | 50.3 | 54.2 | 59.8 | 50.2 | 61.5 | 60.9 | 50.0 | 62.0 | 46.6 | 64.0 | 44.0 | 48.6 | 45.4 |
| | Creek | 68.8 | 57.8 | 69.7 | 70.9 | 53.4 | 70.9 | 59.4 | 68.5 | 59.4 | 65.0 | 59.4 | 73.0 | 76.3 | 73.6 | 62.6 | 63.6 | 71.3 | 63.7 | 58.8 | 66.9 |
| Percent Other Taxa | Open | 26.8 | 19.3 | 16.9 | 20.0 | 22.4 | 23.8 | 24.2 | 26.4 | 25.7 | 24.4 | 29.7 | 17.7 | 18.3 | 24.4 | 21.5 | 35.2 | 15.4 | 33.7 | 19.0 | 32.6 |
| | Creek | 21.6 | 24.4 | 20.0 | 17.6 | 33.2 | 19.7 | 25.8 | 16.0 | 22.4 | 17.3 | 27.0 | 23.4 | 9.6 | 17.3 | 27.1 | 19.8 | 17.1 | 21.8 | 24.8 | 26.1 |



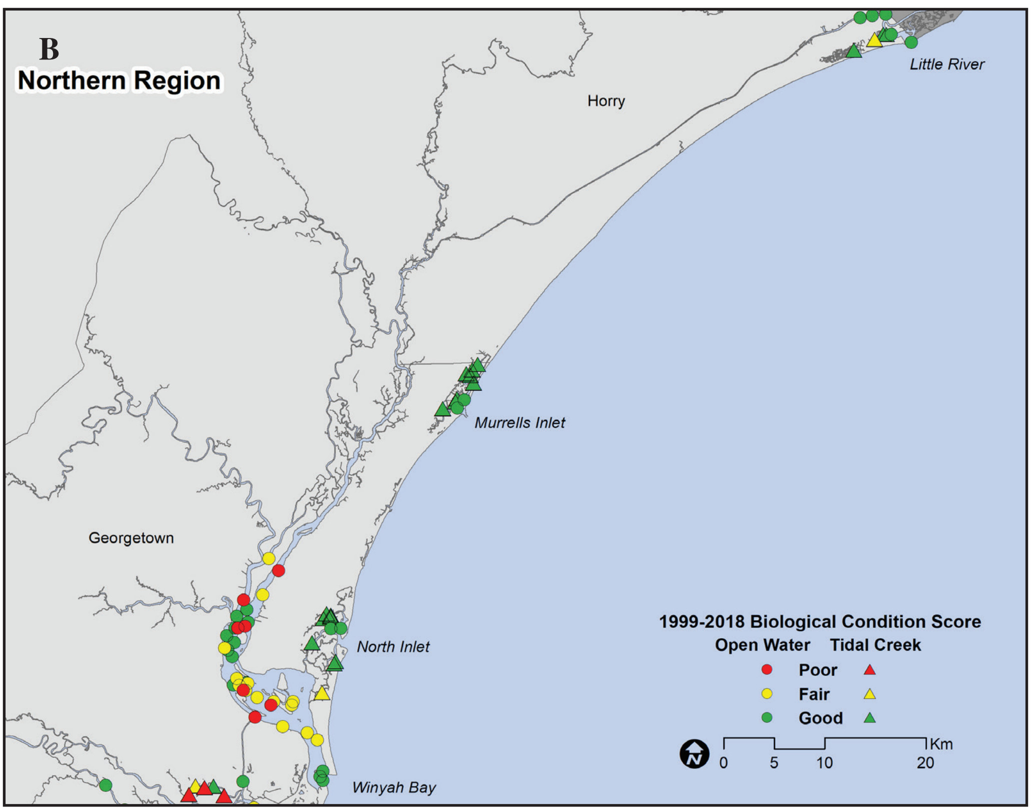




*Figure 3.3.4. Distribution of stations with good, fair, or poor scores for the Biological Condition Index during the 2017-2018 (A) and 1999-2018 (B) periods for the northern region of South Carolina. Stations from 2017-2018 with fair or poor BCI scores are labeled (A).*

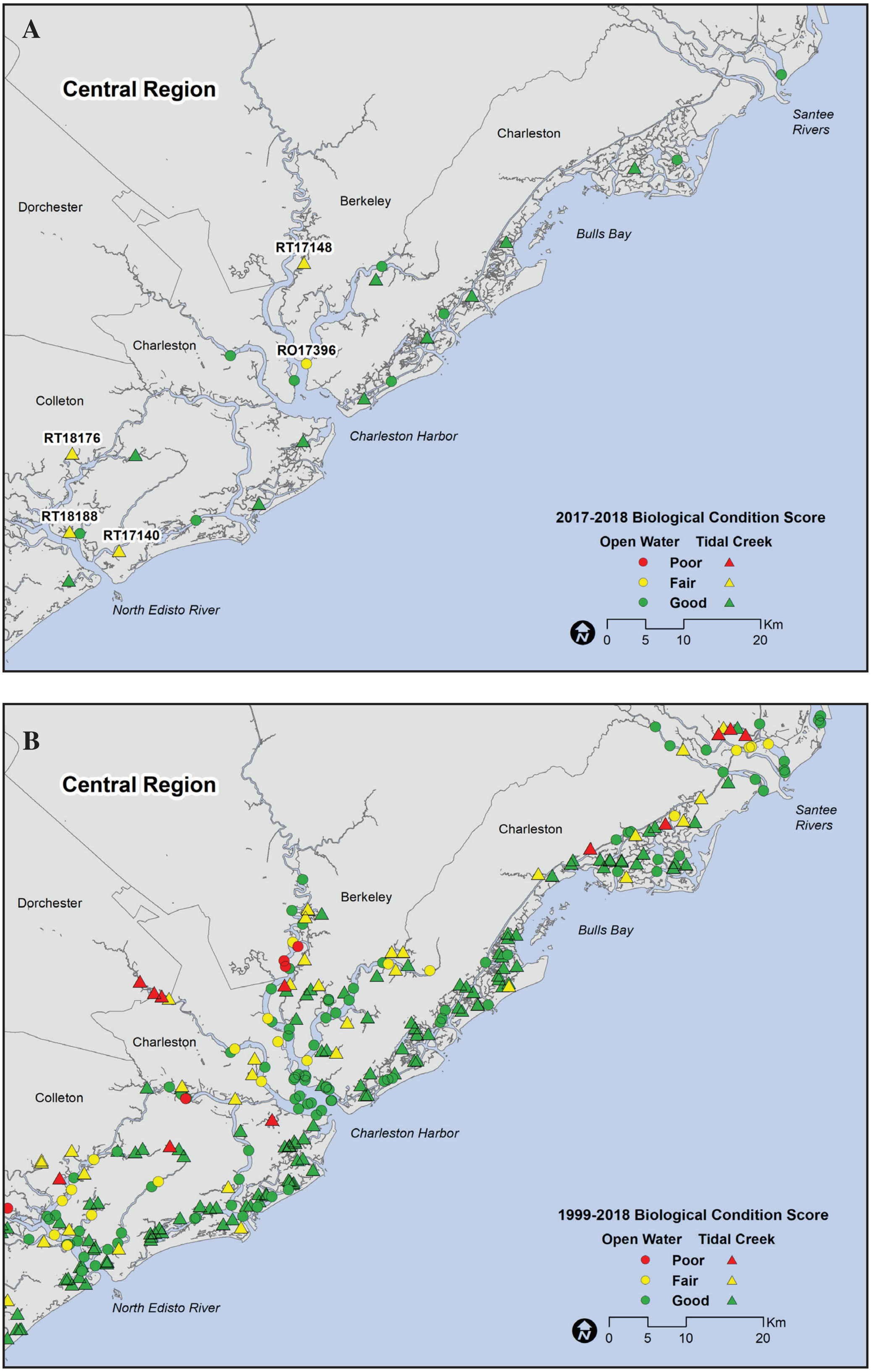



*Figure 3.3.5. Distribution of stations with good, fair, or poor scores for the Biological Condition Index during the 2017-2018 (A) and 1999-2018 (B) periods for the central region of South Carolina. Stations from 2017-2018 with fair or poor BCI scores are labeled (A).*

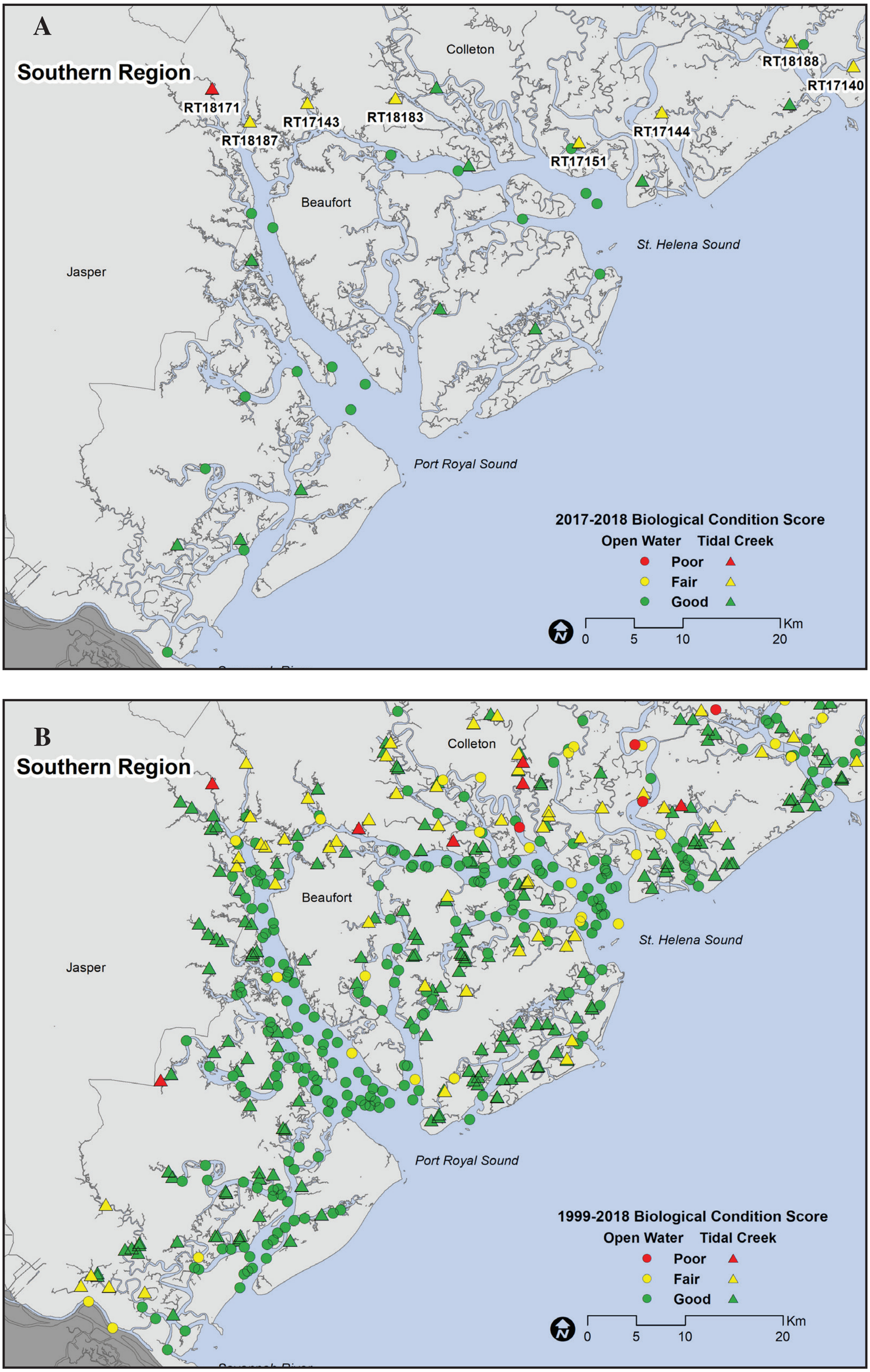



*Figure 3.3.6. Distribution of stations with good, fair, or poor scores for the Biological Condition Index during the 2017-2018 (A) and 1999-2018 (B) periods for the southern region of South Carolina. Stations from 2017-2018 with fair or poor BCI scores are labeled (A).*

Historically, poor to fair BCI scores have been observed in Winyah Bay; Santee Delta region; creeks near the ICW by Cape Romain; the upper Wando River; the Cooper and Ashley Rivers; the Edisto and Dawho Rivers; Combahee River drainages; creeks near Whale Branch; and the Wright and Savannah Rivers (Figures 3.3.4, 3.3.5, 3.3.6).

*Fish and Large Invertebrate Communities*

South Carolina's estuaries provide food, habitat, and nursery grounds for diverse communities including fish and large invertebrates such as shrimp and blue crab (Joseph, 1973; Mann, 1982; Nelson et al., 1991). These communities include many important species that contribute significantly to the state's economy and the well-being of its citizens. Estuaries present naturally stressful conditions that limit species' abilities to use this habitat. Add to that human impacts, such as commercial and recreational fishing, coastal urbanization, and habitat destruction, and the estuarine environment can change substantially, leading to decreases in abundances of important fish and invertebrate species.

Densities of fish (finfish, sharks, rays), decapods (crabs, shrimp), and all fauna combined (fish, squid, decapods, and horseshoe crabs) were generally higher in tidal creek habitats compared to open water habitats (Table 3.3.2). This likely reflects the importance of shallower creek habitats as refuge and nursery habitat for many of these species. Due to the often very uneven distribution of organisms in estuaries which can result in one or two very large catches strongly influencing a survey period mean, overall trawl capture densities were summarized by habitat and survey period in two ways: (1) calculating the mean of trawl densities across all stations in each survey period, and (2) identifying the median of trawl densities across all stations in each survey period. For the most part, the trends in overall trawl capture density over time and by habitat were similar across both summarization methods (Figure 3.3.7). Trawl capture densities of all fauna combined in both tidal creek and open water habitats were at their highest levels from 1999-2006, underwent a sharp

*Fish and large invertebrates are collected by trawl and measured at each site.*

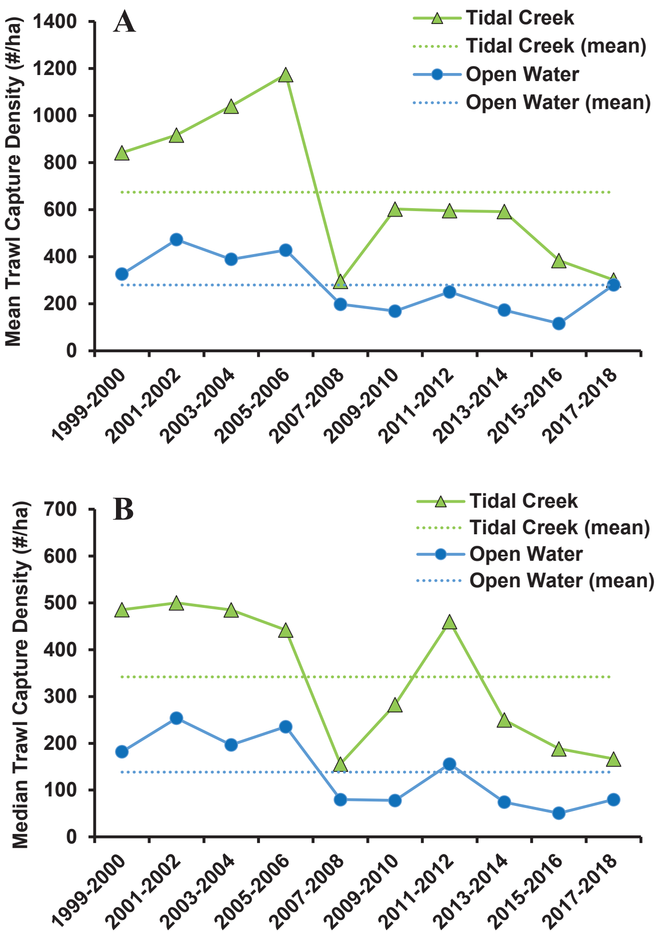



*Figure 3.3.7. Mean (A) and median (B) overall trawl capture density (# individuals captured per hectare) observed by survey period and habitat type. The dashed lines represent the means of the annual mean densities (A) and the means of the annual median densities (B) observed for the full 1999-2018 survey period by habitat type.*

decline in 2007-2008, and then ranged between low and medium densities from 2009-2018 with a temporary increase in density in the 2011-2012 survey period. The lowest overall densities in both open water and tidal creek habitats were observed in 2015 (Table 3.3.2), driven by low densities of fishes and white shrimp *(Penaeus setiferus)*.

SCECAP provides a fishery-independent assessment of several of South Carolina's commercially and recreationally important fish and crustacean species. Of these, the most common species collected by SCECAP include the fishes spot *(Leiostomus xanthurus)*, Atlantic croaker *(Micropogonias undulatus)*, and weakfish *(Cynoscion regalis)*; and the crustaceans white shrimp, brown shrimp *(Penaeus aztecus)*, and Atlantic blue crab *(Callinectes sapidus)*. Spot, white shrimp, brown shrimp, and Atlantic blue crabs were generally more abundant in tidal creek habitats, whereas Atlantic croaker and weakfish were generally more abundant in open water habitats (Table 3.3.2). In a recent detailed analysis of spot, Atlantic croaker and weakfish catches, Sanger et al. (2020) found evidence that SCECAP captures of Atlantic croaker from 1999-2018 have remained fairly constant through time, while both weakfish and spot show decreasing trends, due to a decrease in the percent of stations where these species were caught over time as well as a decrease in their abundances at the stations where they were caught.


*Shrimp, crabs, and many fish species are dependent upon estuarine habitat for survival. In turn, fishermen are dependent upon good estuarine habitat quality for their livelihood.*

### 3.4. Incidence of Litter

As the coastline of South Carolina changes and more people access our shorelines and waterways, the incidence of litter (plastic bags and bottles, abandoned crab traps, etc.) is likely to increase. The primary sources of litter include storm drains, roadways and recreational and commercial

*Table 3.3.2. Summary of fish and large invertebrate biological measures observed in tidal creek and open water habitats during each year of the SCECAP survey. Fish include finfish, sharks, and rays. Large invertebrates include decapods, horseshoe crabs, and squid. All Density (and No. Species) measures represent mean density (and mean number of species per station), with the exception of "Overall Density: Median". Densities are in units of individuals/hectare.*

| Measure | Habitat | Year | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Overall Density: Mean | Open | 329 | 324 | 389 | 557 | 325 | 453 | 381 | 476 | 281 | 116 | 91 | 247 | 325 | 177 | 155 | 191 | 67 | 166 | 111 | 449 |
| | Creek | 831 | 853 | 698 | 1137 | 760 | 1321 | 738 | 1611 | 296 | 295 | 329 | 876 | 387 | 804 | 656 | 528 | 244 | 524 | 318 | 285 |
| Overall Density: Median | Open | 149 | 216 | 181 | 326 | 196 | 197 | 232 | 239 | 123 | 36 | 43 | 112 | 199 | 112 | 58 | 91 | 51 | 51 | 69 | 91 |
| | Creek | 565 | 406 | 399 | 601 | 467 | 503 | 500 | 384 | 196 | 116 | 123 | 442 | 384 | 536 | 333 | 167 | 217 | 159 | 167 | 167 |
| No. Species | Open | 7.8 | 7.5 | 8.0 | 9.2 | 7.2 | 8.3 | 8.2 | 7.9 | 8.4 | 5.6 | 4.7 | 7.6 | 8.5 | 5.8 | 5.9 | 4.9 | 4.4 | 5.3 | 5.2 | 6.5 |
| | Creek | 8.6 | 9.6 | 8.2 | 9.4 | 8.5 | 9.5 | 9.3 | 8.1 | 7.1 | 6.1 | 6.3 | 9.3 | 8.4 | 9.5 | 7.7 | 7.2 | 5.5 | 6.5 | 6.1 | 7.1 |
| Fish Density | Open | 202 | 198 | 203 | 297 | 178 | 218 | 196 | 237 | 154 | 92 | 37 | 99 | 178 | 73 | 86 | 100 | 43 | 74 | 44 | 348 |
| | Creek | 314 | 373 | 319 | 273 | 299 | 331 | 308 | 171 | 99 | 196 | 98 | 180 | 183 | 282 | 111 | 157 | 94 | 119 | 112 | 145 |
| No. Fish Species | Open | 5.3 | 5.0 | 5.7 | 6.5 | 5.4 | 5.9 | 5.7 | 5.9 | 6.1 | 4.1 | 3.5 | 4.8 | 6.3 | 3.8 | 4.3 | 3.4 | 2.9 | 3.5 | 3.6 | 3.9 |
| | Creek | 5.8 | 6.6 | 5.7 | 6.7 | 6.0 | 6.4 | 6.4 | 5.8 | 4.9 | 4.0 | 4.5 | 6.1 | 5.7 | 6.7 | 5.3 | 5.5 | 3.1 | 4.2 | 3.6 | 4.9 |
| Decapod Density | Open | 89 | 96 | 171 | 248 | 137 | 211 | 166 | 226 | 111 | 16 | 53 | 138 | 138 | 99 | 64 | 89 | 21 | 85 | 59 | 94 |
| | Creek | 476 | 425 | 346 | 788 | 429 | 945 | 385 | 1417 | 182 | 74 | 207 | 678 | 188 | 510 | 538 | 354 | 140 | 396 | 187 | 123 |
| No. Decapod Species | Open | 1.7 | 1.8 | 1.7 | 2.0 | 1.5 | 1.6 | 1.8 | 1.4 | 1.5 | 0.9 | 1.1 | 2.0 | 1.7 | 1.7 | 1.3 | 1.2 | 0.9 | 1.3 | 1.1 | 2.0 |
| | Creek | 2.0 | 2.2 | 1.8 | 2.0 | 2.0 | 2.4 | 2.4 | 1.7 | 1.8 | 1.5 | 1.1 | 2.4 | 2.0 | 2.3 | 2.0 | 1.1 | 1.8 | 1.8 | 2.1 | 1.7 |
| Spot Density | Open | 7 | 18 | 67 | 27 | 23 | 50 | 57 | 29 | 12 | 21 | 1 | 11 | 52 | 2 | 7 | 4 | 1 | 7 | 3 | 72 |
| | Creek | 72 | 131 | 112 | 39 | 71 | 95 | 147 | 24 | 13 | 44 | 29 | 41 | 32 | 58 | 16 | 51 | 13 | 7 | 13 | 16 |
| Croaker Density | Open | 3 | 48 | 37 | 112 | 71 | 25 | 27 | 27 | 51 | 5 | 5 | 11 | 31 | 14 | 12 | 24 | 10 | 15 | 2 | 73 |
| | Creek | 9 | 8 | 16 | 18 | 12 | 6 | 6 | 1 | 14 | 1 | 11 | 27 | 3 | 10 | 20 | 9 | 8 | 4 | 8 | 10 |
| Weakfish Density | Open | 12 | 24 | 23 | 42 | 3 | 52 | 11 | 14 | 11 | 11 | 2 | 8 | 9 | 4 | 3 | 20 | 1 | 7 | 4 | 23 |
| | Creek | 14 | 6 | 4 | 12 | 3 | 3 | 8 | 2 | 8 | 4 | 4 | 2 | 2 | 6 | 5 | 2 | 0 | 3 | 1 | 7 |
| Blue Crab Density | Open | 2 | 8 | 1 | 1 | 3 | 3 | 3 | 6 | 0 | 0 | 0 | 1 | 3 | 1 | 1 | 2 | 0 | 1 | 0 | 4 |
| | Creek | 4 | 22 | 5 | 5 | 11 | 18 | 21 | 9 | 10 | 3 | 0 | 14 | 5 | 123 | 10 | 1 | 2 | 7 | 6 | 4 |
| Brown Shrimp Density | Open | 8 | 42 | 108 | 69 | 51 | 34 | 46 | 34 | 63 | 9 | 10 | 47 | 23 | 25 | 16 | 74 | 10 | 29 | 9 | 20 |
| | Creek | 127 | 69 | 97 | 135 | 67 | 128 | 150 | 41 | 27 | 37 | 13 | 105 | 35 | 40 | 23 | 10 | 42 | 3 | 15 | 30 |
| White Shrimp Density | Open | 77 | 42 | 56 | 166 | 78 | 173 | 111 | 184 | 43 | 6 | 42 | 88 | 110 | 69 | 46 | 12 | 11 | 54 | 48 | 56 |
| | Creek | 339 | 323 | 238 | 631 | 348 | 792 | 208 | 1364 | 143 | 25 | 193 | 544 | 141 | 342 | 502 | 342 | 95 | 382 | 159 | 85 |

activities on or near our waterways. Beyond the visual impact, litter contributes to the mortality of wildlife through entanglement, primarily with fishing line and fishing nets, and through ingestion of plastic bags and other small debris particles. Additionally, invasive species may be spread through the movement of litter from one area to another.

During the 2017-2018 survey period, litter was visible in 26% of our state's estuarine habitat. When each habitat type is considered separately, litter was visible in 20% of the tidal creek and 27% of the open water stations. The percentage of estuarine habitat with visible litter in 2017-2018 was the second highest, after the 2007-2008 survey period when visible litter hit its peak at 34%. For all other survey periods the percentage of estuarine habitat with visible litter was less than 20%.

### 3.5. Overall Habitat Quality

Using the HQI for the 2017-2018 assessment period, 90% of South Carolina's coastal estuarine habitat (tidal creek and open water habitats combined) was in good condition (Figure 3.5.1). Only 1% of the coastal estuarine habitat was considered to be in poor condition, and 9% in fair condition. The percent of coastal habitat in good condition has fluctuated over time; the survey period with the lowest percent of habitat with good HQI was in 2003-2004 (77%), and the highest periods were in 2007-2008 and 2011-2012 (92-93%; Figure 3.5.2). When the two habitats were considered separately, a greater percentage of tidal creek habitat during the 2017-2018 survey was in fair to poor condition (23% fair, 3% poor) as compared to open water habitats (7% fair, 0% poor; Appendix 2). This difference between habitat quality in tidal creek and open water habitats observed in 2017-2018 is consistent with previous SCECAP surveys (Figure 3.5.3).

During the 2017-2018 survey period, SCECAP stations with fair or poor habitat quality were located from Cape Romain down to the inland portions of St. Helena Sound and Port Royal Sound (Figures 3.5.4, 3.5.5, 3.5.6; Appendix 3). Only 1 of the 60 sites sampled in 2017-2018, a tidal creek station, scored poor on the HQI. The poor habitat quality site was located in the Tulifinny River (RT18171), up near the headwaters of Port Royal Sound. RT18171 scored poor on both the WQI and the BCI, but good on the SQI. A number of tidal creek stations sampled in this area in the past have scored fair on the HQI, but this was the first poor HQI score in the Port Royal Sound watershed. Nine of the 60 stations were observed to have fair habitat quality during the 2017-2018 survey.

Stations in Winyah Bay; Santee Delta region; Cooper and Ashley Rivers; Dawho River region; Combahee River drainages; inland drainages of the Broad River; and New, Wright, and Savannah Rivers historically show a persistent pattern of degraded habitat quality (Figures 3.5.4, 3.5.5, 3.5.6). Winyah Bay, Charleston Harbor, and the Savannah River area all have a history of industrial activity and/or high-density urban development that likely contributed to the degraded conditions in these areas. It is interesting to note that in 2017-2018, all of the Winyah Bay stations scored good on the HQI. The causes of degraded habitat quality in the Santee Delta, areas draining into St. Helena Sound (home to the Ashepoo-Combahee-Edisto (ACE) Basin National Estuarine Research Reserve (NERR), and in the headwaters of the Port Royal Sound are not entirely clear.

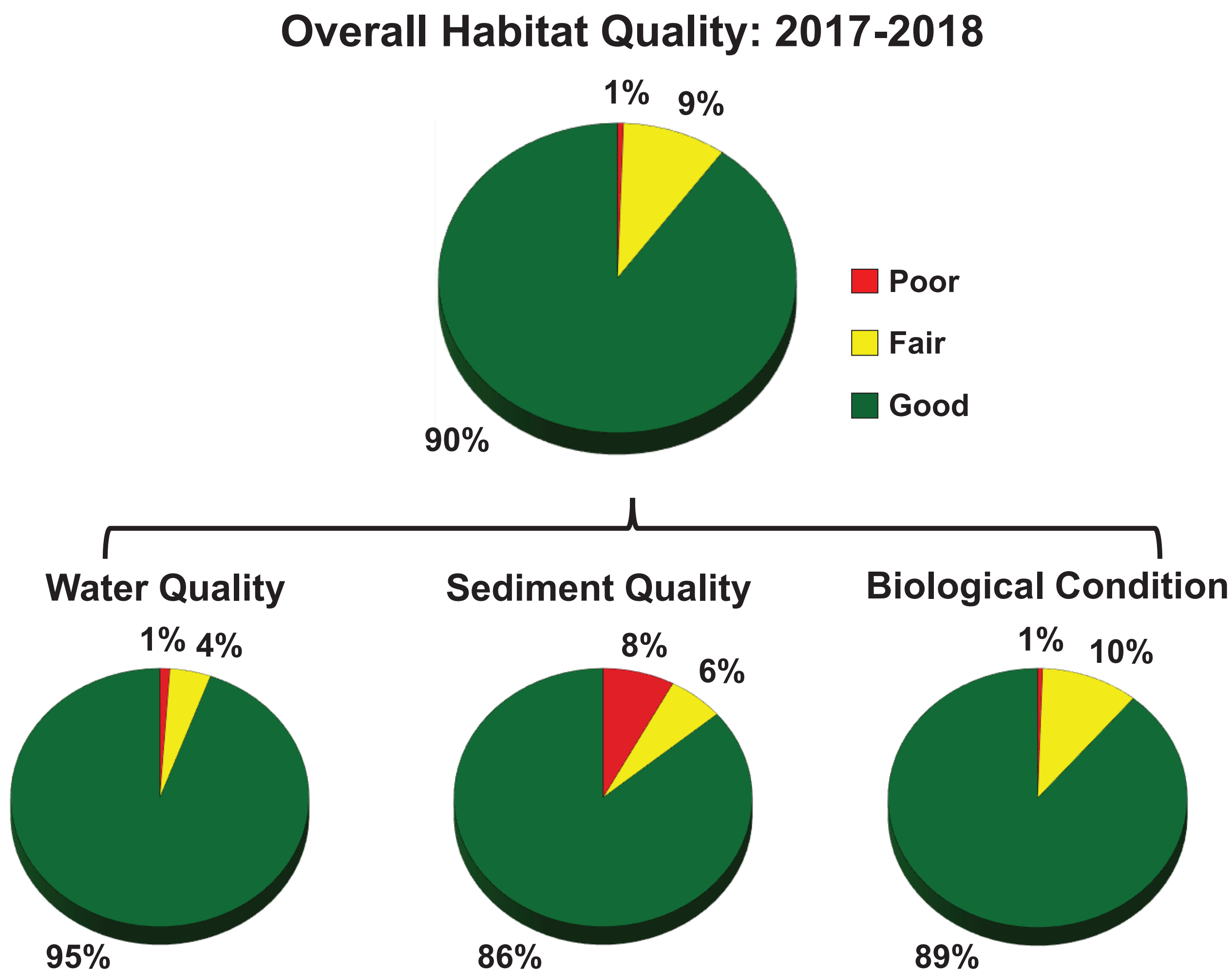



*Figure 3.5.1. Percentage of the state's estuarine habitat that scored as good, fair or poor for the Habitat Quality Index and the component indices that comprise the index. Percentage is based on data obtained from 30 stations for each habitat during 2017 and 2018.*

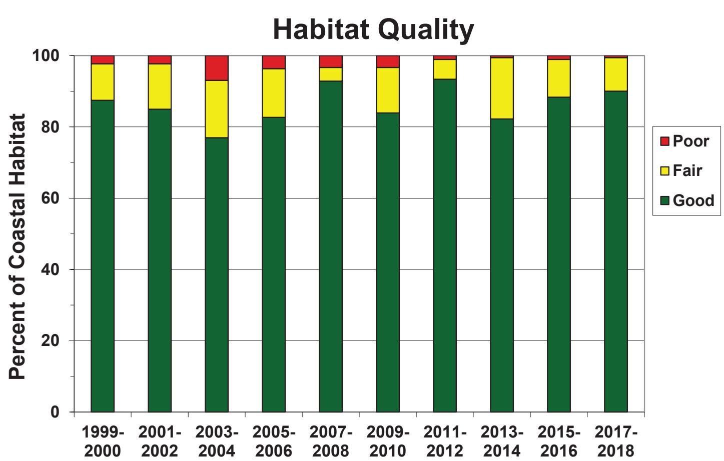



*Figure 3.5.2. Percent of coastal waters corresponding to each Habitat Quality Index category by survey period. The Habitat Quality Index is calculated as the average of the Water Quality Index, Sediment Quality Index, and Biological Condition Index.*

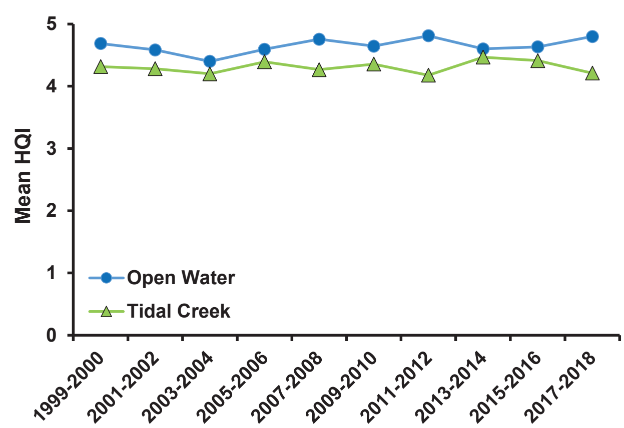
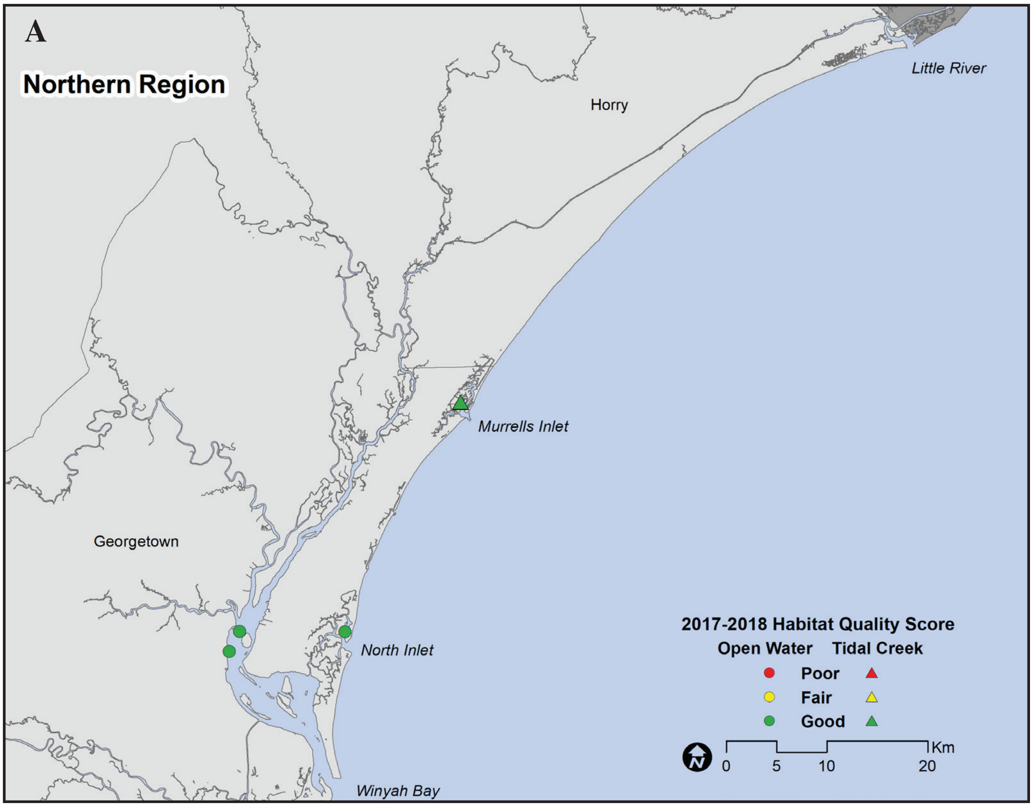



*Figure 3.5.3. Habitat Quality Index scores observed by survey period and habitat type.*



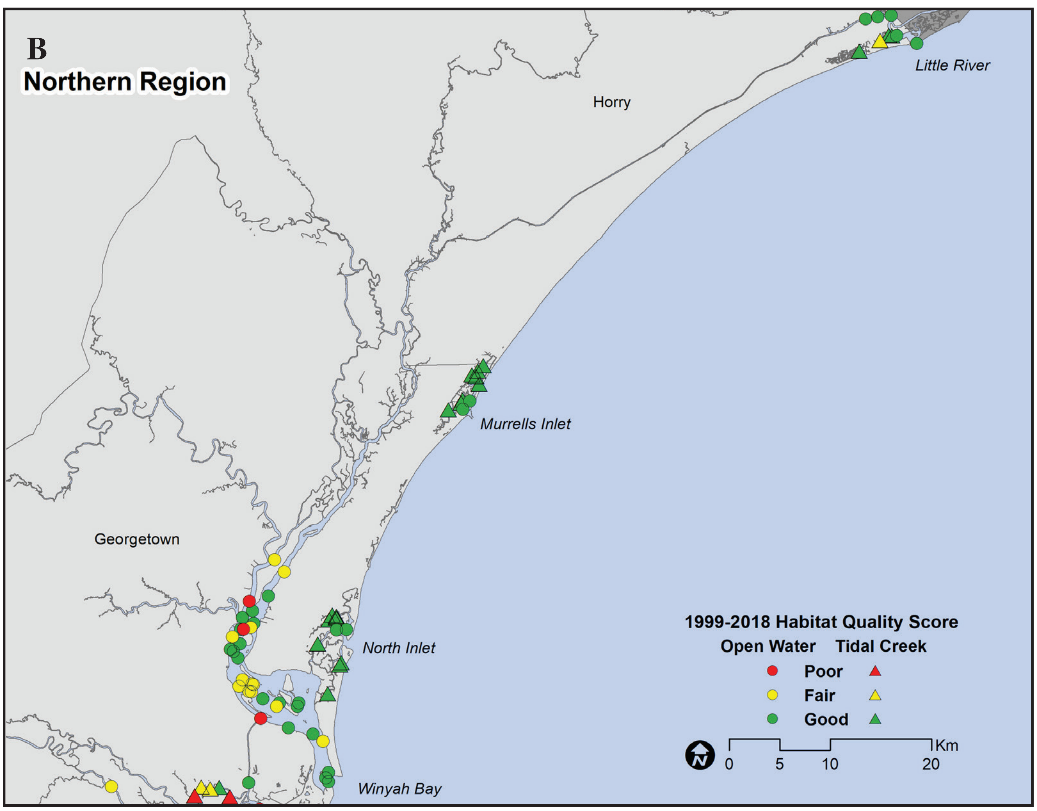




*Figure 3.5.4. Distribution of stations with good, fair, or poor scores for the Habitat Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the northern region of South Carolina.*

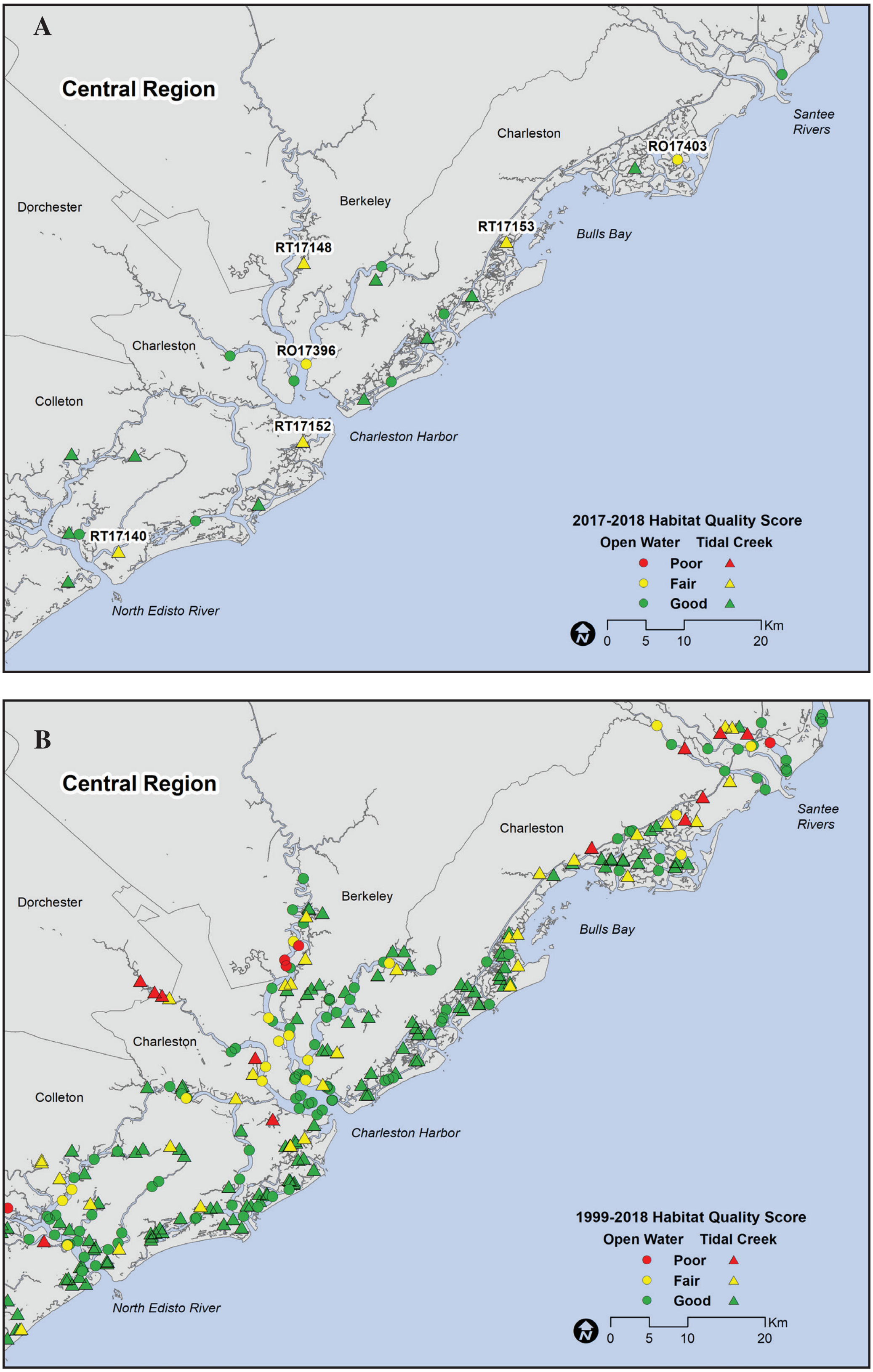



*Figure 3.5.5. Distribution of stations with good, fair, or poor scores for the Habitat Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the central region of South Carolina. Stations from 2017-2018 with fair or poor HQI scores are labeled (A).*

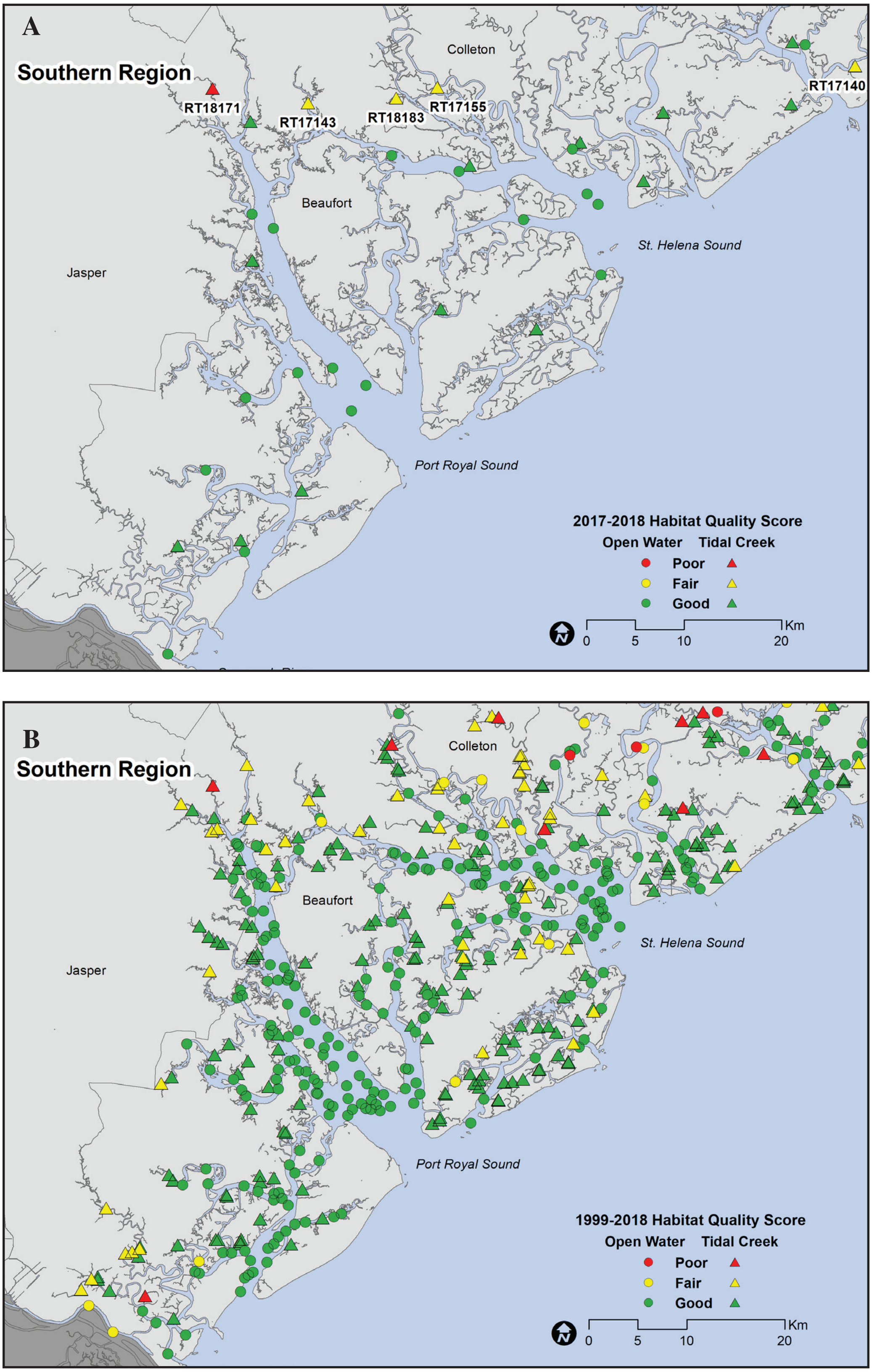



*Figure 3.5.6. Distribution of stations with good, fair, or poor scores for the Habitat Quality Index during the 2017-2018 (A) and 1999-2018 (B) periods for the southern region of South Carolina. Stations from 2017-2018 with fair or poor BCI scores are labeled (A).*

### 3.6. Program Uses and Activities

SCECAP continues to be an effective collaboration between the SCDNR, SCDHEC, and NOAA to assess the condition of South Carolina's coastal environment. The results of these assessments have been used extensively in research, outreach, and planning by staff from these and other institutions and organizations.

Now that the SCECAP program has collected 20 years of data, project researchers are exploring how factors like coastal development, impervious cover, precipitation, drought, and severity of winter weather impact estuarine environmental quality. Early results suggest that changes in seasonal precipitation patterns may compound the impacts that impervious cover has on adjacent estuaries.

SCECAP data have also recently been used to assess relative prey availability for sturgeon in the upper Cooper River. On an ongoing basis, SCDNR staff mine the SCECAP database for updated fishery-independent information regarding the status of various crustacean species as part of the Marine Resources Division's annual assessment of stocks.

Finally, the SCECAP database provides complementary data on the distribution and relative abundance of key recreational species (e.g., spot, Atlantic croaker, weakfish) using unbiased sampling at a broad array of sites representing tidal creek and open water estuarine habitats. These data complement information obtained from other SCDNR programs (e.g., inshore recreational finfish program, SEAMAP), by sampling in areas those programs do not target, by monitoring young of the year abundances for multiple recreationally important finfish species (a life stage not targeted by other fisheries monitoring programs), and by collecting a wealth of environmental data that can be used to relate stock condition to the health of estuarine systems. Weakfish, Atlantic croaker, and spot abundance data from SCECAP are reported in the annual SCDNR Compliance Reports to the Atlantic States Marine Fisheries Commission (ASMFC).

The program maintains sampling at a minimum of 30 sites each year to provide for a total of 60 sites (30 tidal creek, 30 open water) for each two-year assessment period. This is considered to be the minimum effort required to make statistically defensible assessments of condition for the coastal waters of our state. Continuing this program on a long-term basis will provide valuable information on trends in estuarine condition that are likely to be affected by continued coastal development.

# ACKNOWLEDGMENTS

The credit for the immense amount of work involved in planning a project of this size, collecting, processing, analyzing the data, and finally writing this report goes to many people. Some have been involved since its inception in 1999 while others may have only been involved for a summer. Either way, the project cannot be completed without the dedicated efforts of these individuals. We would like to thank Martin Levisen and Andrew Tweel for leading the SCECAP field efforts during the 2017 and 2018 seasons, respectively. Tony Olsen and staff at the USEPA NHEERL, Corvallis, OR assisted in developing the sampling design and CDF routines used in the analysis. The bulk of the field work falls on two groups, the staff of the SCDNR's Environmental Research Section (ERS) and SCDHEC's Aquatic Science Programs. In addition to the authors, SCDNR field teams included Catharine Parker, Aaron Burnette, Leona Forbes, Norm Shea, Joseph Cowan, Steve Burns, Stacie Crowe, Kimberly Sitta, Nicole King, Meghan Reilly, Lloyd Hill, Breanne Hanson, and Semaj Fielding. Once the diverse array of samples arrived back at the lab at the end of a field day, they were distributed to laboratories at SCDNR (where benthic community, sediment, and chlorophyll *a* samples were processed by ERS staff and Cameron Doll) and to the laboratories of collaborating agencies. Staff at the NOAA /NOS National Centers for Coastal Ocean Science Charleston Laboratory processed sediment chemistry and toxicology assays (Brian Shaddrix, LouAnn Reed, and Katy Chung). Staff at the SCDHEC Bureau of Environmental Health Services, Analytical and Radiological Environmental Services Division that processed the nutrient and fecal samples included Susan Jackson and Carey Merriweather (Central Lab) and Jacqueline Adams and Sharon Gilbert (Region 7 ECQ Trident Lab). Jessica L. Elmore with SCDNR Graphics generated the layout of this report.

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Appendix 1. Summary of station locations and dates sampled in 2017 through 2018. Open water stations have the prefix "RO" and tidal creek stations have the prefix "RT".

**SCECAP 2017**
**Station Information -- Open Water**

| Station | Station Type | Latitude Decimal Degrees | Longitude Decimal Degrees | Station Depth (meters) | Date Sampled | County | Development Code* | Approximate Location |
|---|---|---|---|---|---|---|---|---|
| RO17395 | Open | 33.14812 | -79.23876 | 2.4 | 8/08/2017 | Georgetown | NDV | North Santee Bay; 580 yds SW of shellfish site 06A-04A |
| RO17396 | Open | 32.81560 | -79.90708 | 3.7 | 7/18/2017 | Charleston | R<1 | Mouth of Wando River; 300 yds NW of Remley's Point |
| RO17397 | Open | 32.46346 | -80.82922 | 4.9 | 8/01/2017 | Beaufort | R>1 | Mouth of Boyd Creek; 175 yds SE of shellfish site 17-02 |
| RO17398 | Open | 32.28151 | -80.72129 | 6.4 | 8/01/2017 | Beaufort | R>1 | Port Royal Sound; off mouth of Skull Creek / ICW |
| RO17399 | Open | 32.50255 | -80.60316 | 5.5 | 7/11/2017 | Beaufort | R<1 | Coosaw River; 930 yds SE of red marker 192 |
| RO17400 | Open | 32.92906 | -79.80038 | 3.7 | 7/18/2017 | Charleston | R<1 | Wando River; 220 yds SSE of confluence with Guerin Creek |
| RO17401 | Open | 32.32132 | -80.74160 | 3.0 | 8/01/2017 | Beaufort | R>1 | Broad River; 5 miles SE of SC170 bridge |
| RO17403 | Open | 33.04993 | -79.38642 | 3.0 | 7/19/2017 | Charleston | NDV | Horsehead Creek; 0.65 miles from Cape Romaine Harbor |
| RO17404 | Open | 32.63261 | -80.06266 | 3.7 | 7/26/2017 | Charleston | R<1 | Kiawah River; 760 yds SSW of end of Marie Michael Rd |
| RO17405 | Open | 32.29380 | -80.83621 | 4.3 | 8/02/2017 | Beaufort | R>1 | Colleton River; 440 yds NNW of mouth of Sawmill Creek |
| RO17406 | Open | 32.45780 | -80.53305 | 4.0 | 7/12/2017 | Beaufort | R<1 | Morgan River; 0.5 miles NNW of Eddings Point |
| RO17407 | Open | 33.32168 | -79.28920 | 2.7 | 8/08/2017 | Georgetown | I<1 | Winyah Bay; 615 yds NW of red marker 34 |
| RO17408 | Open | 32.79358 | -79.78892 | 1.2 | 7/19/2017 | Charleston | R<1 | Hamlin Creek |
| RO17409 | Open | 32.15175 | -80.83775 | 3.7 | 8/02/2017 | Beaufort | R<1 | Cooper River; 210 yds NNE of Haig Point Rd |
| RO17410 | Open | 32.47150 | -80.45161 | 4.6 | 7/11/2017 | Beaufort | R>1 | St. Helena Sound; 700 yds NE of red buoy 12 |

* Development codes: NDV = no development visible, R<1 = residential less than 1 km away, R>1 = residential greater than 1 km away, I<1 = industrial site less than 1 km away, I>1 = industrial site located greater than 1 km away.

**SCECAP 2017**
**Station Information -- Tidal Creeks**

| Station | Station Type | Latitude Decimal Degrees | Longitude Decimal Degrees | Station Depth (meters) | Date Sampled | County | Development Code* | Approximate Location |
|---|---|---|---|---|---|---|---|---|
| RT17140 | Creek | 32.59769 | -80.17042 | 1.8 | 7/25/2017 | Charleston | R<1 | Unnamed creek off Bohicket Creek near Jenkins Point |
| RT17142 | Creek | 32.35673 | -80.51958 | 3.0 | 7/12/2017 | Beaufort | R>1 | Middle Creek from Harbor River to Story River |
| RT17143 | Creek | 32.56623 | -80.76791 | 3.4 | 7/11/2017 | Beaufort | R<1 | Mouth of creek; SSW of shellfish site 14-18 |
| RT17144 | Creek | 32.55613 | -80.38024 | 4.0 | 7/12/2017 | Charleston | R<1 | Bailey Creek; 305 yds west of the south end of Meggett Pt Rd |
| RT17146 | Creek | 32.42090 | -80.82919 | 2.4 | 8/01/2017 | Beaufort | R>1 | Buzzard Island Creek; 560 yds west of Buzzard Island |
| RT17148 | Creek | 32.93453 | -79.90938 | 2.1 | 7/18/2017 | Berkeley | I>1 | Yellow House Creek; 200 yds SSE of dock |
| RT17149 | Creek | 32.89378 | -79.67556 | 1.2 | 7/19/2017 | Charleston | R>1 | Unnamed Creek between Price Creek and ICW |
| RT17150 | Creek | 32.15699 | -80.91077 | 2.4 | 8/02/2017 | Beaufort | NDV | Unnamed Creek to Cooper River; 330 yds south of Bluff Island |
| RT17151 | Creek | 32.52880 | -80.47099 | 2.7 | 7/12/2017 | Colleton | NDV | Unnamed creek to Ashepoo Coosaw Cut / ICW |
| RT17152 | Creek | 32.72474 | -79.91299 | 4.3 | 7/18/2017 | Charleston | R<1 | Schooner Creek |
| RT17153 | Creek | 32.95636 | -79.62682 | 2.1 | 7/19/2017 | Charleston | R>1 | Unnamed creek between Bulls Bay and ICW |
| RT17155 | Creek | 32.58028 | -80.62679 | 3.7 | 7/11/2017 | Beaufort | NDV | Unnamed creek between Combahee River and Schooner Channel |
| RT17156 | Creek | 32.71026 | -80.14641 | 4.3 | 7/25/2017 | Charleston | R<1 | Church Creek |
| RT17160 | Creek | 32.56308 | -80.24065 | 1.8 | 7/25/2017 | Charleston | R<1 | Ocella Creek |
| RT17162 | Creek | 32.20807 | -80.77594 | 4.0 | 8/02/2017 | Beaufort | R<1 | Jarvis Creek; 490 yds from the mouth |

* Development codes: NDV = no development visible, R<1 = residential less than 1 km away, R>1 = residential greater than 1 km away, I<1 = industrial site less than 1 km away, I>1 = industrial site located greater than 1 km away.

**SCECAP 2018**
**Station Information -- Open Water**

| Station | Station Type | Latitude Decimal Degrees | Longitude Decimal Degrees | Station Depth (meters) | Date Sampled | County | Development Code* | Approximate Location |
|---|---|---|---|---|---|---|---|---|
| RO18411 | Open | 33.33768 | -79.16539 | 2.1 | 7/10/2018 | Georgetown | R>1 | Debidue Creek |
| RO18412 | Open | 32.79589 | -79.92419 | 7.6 | 8/21/2018 | Charleston | I<1 | Town Creek; 395 yards SE of Libery Square Pier |
| RO18413 | Open | 32.45053 | -80.80592 | 5.0 | 8/14/2018 | Beaufort | R<1 | Broad River; 0.5 miles NNW of shellfish site 17-04A |
| RO18414 | Open | 32.30521 | -80.70535 | 6.1 | 7/25/2018 | Beaufort | R>1 | Broad River; 0.7 miles SSW of shellfish site 17-13 |
| RO18415 | Open | 32.51747 | -80.67658 | 2.4 | 8/07/2018 | Beaufort | NDV | Whale Branch; 1.0 miles NW of shellfish site 14-12A |
| RO18417 | Open | 32.31701 | -80.77953 | 5.5 | 7/25/2018 | Beaufort | R<1 | Chechessee River; 0.8 miles SSE of mouth of Colleton River |
| RO18418 | Open | 32.40629 | -80.44897 | 6.1 | 8/28/2018 | Beaufort | R<1 | Harbor River; 525 yards NE of US 21 bridge |
| RO18419 | Open | 32.87250 | -79.71465 | 1.2 | 7/11/2018 | Charleston | R>1 | Whiteside Creek; 300 yards NW of mouth |
| RO18420 | Open | 32.61802 | -80.22444 | 6.1 | 8/22/2018 | Charleston | R<1 | Leadenwah Creek; 460 yards SW of shellfish site 12B-12 |
| RO18421 | Open | 32.05703 | -80.92113 | 6.7 | 7/24/2018 | Jasper | I>1 | Wright River; 0.9 miles NW of shellfish site 19-27 |
| RO18422 | Open | 32.52264 | -80.47945 | 2.1 | 8/08/2018 | Colleton | NDV | Rock Creek; 390 yards SE of mouth of Ashepoo Coosaw Cutoff |
| RO18423 | Open | 33.33958 | -79.27779 | 4.4 | 7/10/2018 | Georgetown | R<1 | Winyah Bay; 0.85 miles south of Morgan Park Beach |
| RO18424 | Open | 32.82597 | -80.01295 | 1.2 | 8/21/2018 | Charleston | R<1 | Ashley River; 0.86 miles SSE of County Farm Boat Ramp |
| RO18425 | Open | 32.22718 | -80.87985 | 2.7 | 7/24/2018 | Beaufort | R<1 | May River; 1.0 miles SW of May River public boat dock |
| RO18426 | Open | 32.48123 | -80.46343 | 7.0 | 8/08/2018 | Beaufort | R>1 | St. Helena Sound at mouth of Coosaw River |

* Development codes: NDV = no development visible, R<1 = residential less than 1 km away, R>1 = residential greater than 1 km away, I<1 = industrial site less than 1 km away, I>1 = industrial site located greater than 1 km away.

**SCECAP 2018**
**Station Information -- Tidal Creeks**

| Station | Station Type | Latitude Decimal Degrees | Longitude Decimal Degrees | Station Depth (meters) | Date Sampled | County | Development Code* | Approximate Location |
|---|---|---|---|---|---|---|---|---|
| RT18164 | Creek | 32.77443 | -79.82774 | 4.0 | 8/21/2018 | Charleston | R<1 | Conch Creek; 202 yards east of shellfish site 09A-17A |
| RT18169 | Creek | 33.54044 | -79.03772 | 0.9 | 7/10/2018 | Georgetown | R<1 | Woodland Creek; 0.5 miles SSE of shellfish site 04-31 |
| RT18171 | Creek | 32.57967 | -80.87225 | 1.6 | 8/14/2018 | Jasper | R<1 | Tulifinny River; 440 yds NNE of the end of Gregorie Neck Rd |
| RT18175 | Creek | 32.91436 | -79.80927 | 1.2 | 8/21/2018 | Charleston | R<1 | Wagner Creek; 172 yards NE of circular drive off Darts Cove Way |
| RT18176 | Creek | 32.71278 | -80.23441 | 1.5 | 8/22/2018 | Charleston | R<1 | Oyster House Creek |
| RT18178 | Creek | 32.16244 | -80.84213 | 5.8 | 7/24/2018 | Beaufort | R>1 | Unnamed creek to Cooper River |
| RT18179 | Creek | 32.37542 | -80.62399 | 1.8 | 7/25/2018 | Beaufort | R<1 | Unnamed creek connecting Cowen Creek with Capers/Wallace Creek |
| RT18180 | Creek | 32.65163 | -79.97543 | 5.0 | 7/31/2018 | Charleston | R<1 | Cole Creek; Upstream point near confluence of three creeks |
| RT18181 | Creek | 33.04181 | -79.44653 | 1.8 | 7/11/2018 | Charleston | R>1 | Papas Creek; 450 yards NW of confluence with Nellie Creek |
| RT18183 | Creek | 32.57048 | -80.67175 | 0.6 | 8/07/2018 | Beaufort | NDV | Barnwell Creek; 0.5 miles SSW from Winbee Creek Boat Landing |
| RT18186 | Creek | 32.50797 | -80.59177 | 0.9 | 8/07/2018 | Beaufort | NDV | Unnamed creek to Coosaw River; 630 yards NNW of confluence |
| RT18187 | Creek | 32.54919 | -80.83092 | 4.6 | 8/14/2018 | Beaufort | R<1 | Haulover Creek; 4 miles SSW of Sheldon |
| RT18188 | Creek | 32.62054 | -80.23862 | 3.4 | 8/22/2018 | Charleston | R>1 | Unnamed creek to Leadenwah Creek; 3.0 miles NW of Rockville |
| RT18190 | Creek | 32.49313 | -80.40231 | 4.0 | 8/08/2018 | Colleton | NDV | Unnamed creek to Jefford Creek; 4.6 miles WNW of Edisto Beach |
| RT18191 | Creek | 32.84533 | -79.73869 | 1.5 | 7/11/2018 | Charleston | R>1 | Unnamed creek at Bullyard Sound; 475 yards west of shellfish site 08-04 |

* Development codes: NDV = no development visible, R<1 = residential less than 1 km away, R>1 = residential greater than 1 km away, I<1 = industrial site less than 1 km away, I>1 = industrial site located greater than 1 km away.

Appendix 2. Summary of the criteria and amount of open water and tidal creek habitat scoring as good, fair or poor for each SCECAP parameter and index for 2017 through 2018.

| Index / Parameter | Criteria | | | 2017-2018 Survey | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Percent of Open Water Habitat | | | Percent of Tidal Creek Habitat | | |
| | Poor | Fair | Good | Poor | Fair | Good | Poor | Fair | Good |
| **WATER QUALITY** | | | | | | | | | |
| Water Quality Index | | | | 0 | 3 | 97 | 7 | 10 | 83 |
| Dissolved Oxygen (mg/L) | < 3 | 3 ≤ x < 4 | ≥ 4 | 0* | 10* | 87* | 0 | 43 | 57 |
| pH (salinity corrected) | ≤ 7.22 | 7.22 < x ≤ 7.35 | > 7.35 | 0 | 0 | 100 | 7 | 3 | 90 |
| Fecal Coliform (cfu/100mL) | > 400 | 43 < x ≤ 400 | ≤ 43 | 0 | 3 | 97 | 3 | 17 | 80 |
| Eutrophic Index | | | | 0 | 23 | 77 | 7 | 23 | 70 |
| Total Nitrogen (mg/L) | > 1.05 | 0.81 < x ≤ 1.05 | ≤ 0.81 | 0*** | 0*** | 90*** | 0*** | 0*** | 90*** |
| Total Phosphorus (mg/L) | > 0.12 | 0.10 < x ≤ 0.12 | ≤ 0.10 | 3*** | 3*** | 83*** | 7** | 10** | 77** |
| Chlorophyll *a* (µg/L) | > 16.4 | 11.5 < x ≤ 16.4 | ≤ 11.5 | 17 | 23 | 60 | 20 | 37 | 43 |
| | | | | | | | | | |
| **SEDIMENT QUALITY** | | | | | | | | | |
| Sediment Quality Index | | | | 7 | 3 | 90 | 13 | 20 | 67 |
| Contaminants (mERMq) | > 0.058 | 0.020 < x ≤ 0.058 | ≤ 0.020 | 0 | 7 | 93 | 0 | 20 | 80 |
| Toxicity | | positive | negative | 0 | 10 | 90 | 0 | 20 | 80 |
| Sediment TOC (%) | > 5 | 3 ≤ x ≤ 5 | < 3 | 7 | 10 | 83 | 17 | 23 | 60 |
| | | | | | | | | | |
| **BIOLOGICAL CONDITION** | | | | | | | | | |
| Benthic-IBI | < 2 | 2 ≤ x < 3 | ≥ 3 | 0 | 7 | 93 | 3 | 30 | 67 |
| | | | | | | | | | |
| **HABITAT QUALITY** | | | | | | | | | |
| Habitat Quality Index | < 2.67 | 2.67 ≥ x ≥ 3.67 | > 3.67 | 0 | 7 | 93 | 3 | 23 | 73 |

* Data from one station was missing. ** Data from two stations were missing. *** Data from three stations were missing.

Appendix 3. Summary of the Water Quality, Sediment Quality, Biological Condition, and Habitat Quality Index scores and their component measure scores by station for 2017 through 2018. Green represents good condition, yellow represents fair condition, and red represents poor condition. The actual Habitat Quality Index score is shown to allow the reader to see where the values fall within the above general coding criteria. See text for further details on the ranges of values representing good, fair, and poor for each measure and index score.

| Station | Water Quality | | | | | | | | Sediment Quality | | | | Biological Condition | Habitat Quality | County | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dissolved Oxygen | Fecal Coliform | pH | Total Nitrogen | Total Phosphorus | Chlorophyll *a* | Eutrophic Index | Water Quality Index | Toxicity | Sediment TOC | Contaminants | Sediment Quality Index | Biological Index (B-IBI) | Habitat Quality Index | | |
| RO17395 | | | | | | | 3 | 5 | | | | 5 | 5 | 5.0 | Georgetown | North Santee Bay; 580 yds SW of shellfish site 06A-04A |
| RO17396 | | | | | | | 5 | 5 | | | | 0 | 3 | 2.7 | Charleston | Mouth of Wando River; 300 yds NW of Remley's Point |
| RO17397 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Mouth of Boyd Creek; 175 yds SE of shellfish site 17-02 |
| RO17398 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Port Royal Sound; off mouth of Skull Creek / ICW |
| RO17399 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Coosaw River; 930 yds SE of red marker 192 |
| RO17400 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Wando River; 220 yds SSE of confluence with Guerin Creek |
| RO17401 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Broad River; 5 miles SE of SC170 bridge |
| RO17403 | | | | | | | 5 | 5 | | | | 0 | 5 | 3.3 | Charleston | Horsehead Creek; 0.65 miles from Cape Romaine Harbor |
| RO17404 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Kiawah River; 760 yds SSW of end of Marie Michael Rd |
| RO17405 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Colleton River; 440 yds NNW of mouth of Sawmill Creek |
| RO17406 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Morgan River; 0.5 miles NNW of Eddings Point |
| RO17407 | | | | | | | 3 | 5 | | | | 5 | 3 | 4.3 | Georgetown | Winyah Bay; 615 yds NW of red marker 34 |
| RO17408 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Hamlin Creek |
| RO17409 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Cooper River; 210 yds NNE of Haig Point Rd |
| RO17410 | | | | | | | 3 | 5 | | | | 5 | 5 | 5.0 | Beaufort | St. Helena Sound; 700 yds NE of red buoy 12 |
| RT17140 | | | | | | | 5 | 5 | | | | 3 | 3 | 3.7 | Charleston | Unnamed creek off Bohicket Creek near Jenkins Point |
| RT17142 | | | | | | | 5 | 5 | | | | 3 | 5 | 4.3 | Beaufort | Middle Creek from Harbor River to Story River |
| RT17143 | | | | | | | 3 | 3 | | | | 3 | 3 | 3.0 | Beaufort | Mouth of creek; SSW of shellfish site 14-18 |
| RT17144 | | | | | | | 3 | 5 | | | | 5 | 3 | 4.3 | Charleston | Bailey Creek; 305 yds west of the south end of Meggett Pt Rd |
| RT17146 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Buzzard Island Creek; 560 yds west of Buzzard Island |
| RT17148 | | | | | | | 5 | 5 | | | | 0 | 3 | 2.7 | Berkeley | Yellow House Creek; 200 yds SSE of dock |
| RT17149 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Unnamed Creek between Price Creek and ICW |
| RT17150 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Unnamed Creek to Cooper River; 330 yds south of Bluff Island |
| RT17151 | | | | | | | 3 | 5 | | | | 5 | 3 | 4.3 | Colleton | Unnamed creek to Ashepoo Coosaw Cut / ICW |
| RT17152 | | | | | | | 5 | 5 | | | | 0 | 5 | 3.3 | Charleston | Schooner Creek |
| RT17153 | | | | | | | 3 | 5 | | | | 0 | 5 | 3.3 | Charleston | Unnamed creek between Bulls Bay and ICW |
| RT17155 | | | | | | | 5 | 5 | | | | 0 | 5 | 3.3 | Beaufort | Unnamed creek between Combahee River and Schooner Channel |
| RT17156 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Church Creek |
| RT17160 | | | | | | | 3 | 5 | | | | 5 | 5 | 5.0 | Charleston | Ocella Creek |
| RT17162 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Jarvis Creek; 490 yds from the mouth |

| Station | Water Quality: Dissolved Oxygen | Water Quality: Fecal Coliform | Water Quality: pH | Water Quality: Total Nitrogen | Water Quality: Total Phosphorus | Water Quality: Chlorophyll *a* | Water Quality: Eutrophic Index | Water Quality: Water Quality Index | Sediment Quality: Toxicity | Sediment Quality: Sediment TOC | Sediment Quality: Contaminants | Sediment Quality: Sediment Quality Index | Biological Condition: Biological Index (B-IBI) | Habitat Quality: Habitat Quality Index | County | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RO18411 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Georgetown | Debidue Creek |
| RO18412 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Town Creek; 395 yards SE of Libery Square Pier |
| RO18413 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Broad River; 0.5 miles NNW of shellfish site 17-04A |
| RO18414 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Broad River; 0.7 miles SSW of shellfish site 17-13 |
| RO18415 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Whale Branch; 1.0 miles NW of shellfish site 14-12A |
| RO18417 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Chechessee River; 0.8 miles SSE of mouth of Colleton River |
| RO18418 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Harbor River; 525 yards NE of US 21 bridge |
| RO18419 | | | | | | | 3 | 5 | | | | 3 | 5 | 4.3 | Charleston | Whiteside Creek; 300 yards NW of mouth |
| RO18420 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Charleston | Leadenwah Creek; 460 yards SW of shellfish site 12B-12 |
| RO18421 | | | | | | | 3 | 5 | | | | 5 | 5 | 5.0 | Jasper | Wright River; 0.9 miles NW of shellfish site 19-27 |
| RO18422 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Colleton | Rock Creek; 390 yards SE of mouth of Ashepoo Coosaw Cutoff |
| RO18423 | | | | | | | 3 | 5 | | | | 5 | 5 | 5.0 | Georgetown | Winyah Bay; 0.85 miles south of Morgan Park Beach |
| RO18424 | | | | | | | 3 | 3 | | | | 5 | 5 | 4.3 | Charleston | Ashley River; 0.86 miles SSE of County Farm Boat Ramp |
| RO18425 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | May River; 1.0 miles SW of May River public boat dock |
| RO18426 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | St. Helena Sound at mouth of Coosaw River |
| RT18164 | | | | | | | 5 | 5 | | | | 3 | 5 | 4.3 | Charleston | Conch Creek; 202 yards east of shellfish site 09A-17A |
| RT18169 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Georgetown | Woodland Creek; 0.5 miles SSE of shellfish site 04-31 |
| RT18171 | | | | | | | 3 | 0 | | | | 5 | 0 | 1.7 | Jasper | Tulifinny River; 440 yds NNE of the end of Gregorie Neck Rd |
| RT18175 | | | | | | | 5 | 3 | | | | 5 | 5 | 4.3 | Charleston | Wagner Creek; 172 yards NE of circular drive off Darts Cove Way |
| RT18176 | | | | | | | 5 | 5 | | | | 5 | 3 | 4.3 | Charleston | Oyster House Creek |
| RT18178 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Unnamed creek to Cooper River |
| RT18179 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Unnamed creek connecting Cowen Creek with Capers/Wallace Creek |
| RT18180 | | | | | | | 0 | 3 | | | | 5 | 5 | 4.3 | Charleston | Cole Creek; Upstream point near confluence of three creeks |
| RT18181 | | | | | | | 5 | 5 | | | | 3 | 5 | 4.3 | Charleston | Papas Creek; 450 yards NW of confluence with Nellie Creek |
| RT18183 | | | | | | | 0 | 0 | | | | 5 | 3 | 2.7 | Beaufort | Barnwell Creek; 0.5 miles SSW from Winbee Creek Boat Landing |
| RT18186 | | | | | | | 5 | 5 | | | | 5 | 5 | 5.0 | Beaufort | Unnamed creek to Coosaw River; 630 yards NNW of confluence |
| RT18187 | | | | | | | 5 | 5 | | | | 5 | 3 | 4.3 | Beaufort | Haulover Creek; 4 miles SSW of Sheldon |
| RT18188 | | | | | | | 5 | 5 | | | | 5 | 3 | 4.3 | Charleston | Unnamed creek to Leadenwah Creek; 3.0 miles NW of Rockville |
| RT18190 | | | | | | | 3 | 5 | | | | 5 | 5 | 5.0 | Colleton | Unnamed creek to Jefford Creek; 4.6 miles WNW of Edisto Beach |
| RT18191 | | | | | | | 5 | 5 | | | | 3 | 5 | 4.3 | Charleston | Unnamed creek at Bullyard Sound; 475 yards W of shellfish site 08-04 |

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