Time series observations: hydrography, nutrients, and microbial, phytoplankton and zooplankton communities from the Skidaway River Estuary on the southeastern Atlantic coast of Georgia from 1986-2011 (SRiMP project)

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Project
» Skidaway River Monitoring Program (SRiMP)

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Dataset Description

The Skidaway River Monitoring Program (SRiMP) was initiated in 1986 and includes time series observations of hydrography, nutrients, auto- and heterotrophic microbial communities, phytoplankton, micro- and mesozooplankton, representative gelatinous zooplankton, and dissolved oxygen in a weekly to monthly resolution.

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Methods & Sampling

Meteorological data are being continuously recorded by the SKiO weather station (http://weather.skio.usg.edu) which is located ~250 meters from the SRiMP sampling site. Actual meteorological data that include temperature, dew point, heat index, wind chill factor, relative humidity, barometric pressure, rainfall since midnight, wind direction, wind speed, peak wind gust, solar radiation, highest and lowest temperature since midnight, sunrise, sunset are utilized from the SKIO weather station using the SKIO Metric Mobile Weather application (weather.skio.usg.edu/metric/mini.html). In addition, historic meteorological data from an underground weather web page (http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KGASAVAN23) is included for a broader dataset.

Tidal stage (high, low and mid tide) and time determination has been extrapolated to local tide predictions by adding + 38 minutes to the data for the Tybee Lighthouse, Savannah River Entrance (station ID 8670892; 32.0333° N; 80.9017° W), which is located about 10 km from the SRiMP site. Corresponding heights of tidal stage are now recorded from Isle of Hope, Skidaway River (31.9833° N; 81.0500° W), located ca. 1.5 km from the SRiMP sampling site (http://tides.mobilegeographics.com/locations/2824.html).

Surface water temperature was measured weekly using a standard mercury thermometer (+- 0.1 ° C) as was surface salinity which used an AGE model 2100 salinometer from 1986 to 1996. From February 2004 until July 2011, water temperature, salinity, and dissolved oxygen (DO) were measured using a YSI Model 556 multi-probe system. From September 2011 until present, a multi-probe MANTA-2 (EUREKA Environmental Engineering, Austin, TX, USA) has been included to measure depths profiles of temperature, salinity, pH, conductivity, turbidity, in situ chlorophyll fluorescence and DO. The oxygen probe measurements are regularly (at least monthly) compared and calibrated (if necessary) against the high-precision Winkler titrations using a (Parsons et al., 1984; Hansen, 1999) and a Brinkmann Metrohm titrator. Also, monthly manual measurement of water surface temperature (standard mercury thermometer precision +- 0.1 °C), surface salinity (American Optical Refractometer; +- 0.2 psu or ppt), pH, and electrical conductivity (Hi 2550 pH/ORP & EC/TDS Meter, HANNA instruments, Smithfield, RI, USA) are standard protocol. Since early 2011, we have included weekly

Secchi depth measurements in the SRiMP program.

From 1986 to 2011 the surface waters adjacent to the main dock of the Skidaway Institute of Oceanography were sampled using an acid cleaned bucket or a Niskin bottle at connective slack high and low waters on the same day. From 2011, water sampling of the Skidaway River Estuary is been performed at high tide in 1m depth using a Niskin bottle. Ctenophores are sampled at mid-tide the same day (method see below).

Sample water for the analyses of inorganic nutrients (PO4, Si(OH)4, NH4, NO3, NO2) is filtered through acid washed and pre-rinsed GFF filters using acid cleaned plastic syringes, and either analyzed fresh or stored at -20 °C in acid cleaned PE-bottles. Nutrient analyses were performed on automated procedures using a Technicon Auto Analyzer II; 0.1 µM precision (Gilbert and Loder 1977, Verity et al. 1993) while TDN was determined using persulfite digestion. DON was calculated as the difference between TDN and summed inorganic nitrogen (Solarzano and Sharp 1980, Valderrama 1981).
From 2011, dissolved nutrient concentrations [NO2/NO3, NH4, DON, PO4, Si(OH)4] are determined by contract with the nutrient analysis laboratory overseen by Dr. S. Joyce at the University of Georgia, Athens, GA. Continuing from mid 2011 to present, water samples for DIC and delta 13/12 C isotope ratios of 0.02 nylon filtered water samples is analyzed inhouse using a Mass Spectrometer (Thermo Scientific) in the lab of Dr. Jay Brandes (Skidaway Island Scientific Stable Isotope Laboratory, SISSIL). TDN and DOC concentrations of 0.2 µm filtered water samples are processed at SkIO by the lab of Dr. Aron Stubbins using a Total Organic Carbon Analyzer with a Total Nitrogen Measuring Unit (TOC-V and TNM-I, Shimadzu Scientific Instruments, Columbia, ML, USA).

Samples to determine the organic particulate fractions of carbon and nitrogen, i.e. POC and PON are filtered at low vacuum pressure (10 cm Hg) onto pre-combusted (450 °C for 4 h) 25 mm GF/F filters (Whatman). These filters are transferred to pre-combusted foil sheets and stored frozen at - 20 °C until analysis. In the past, filter samples were freeze-dried and combusted using a Fisons NA1500 NCS Series 2 CHNS analyzer and 2.5-Bis (5tert-butyl-2-benzo-oxazol-2-yl) thiophene (BBOT) standards (Verity 2002). Presently, POC and PON amounts and delta 13/12 C and 15/14 N isotope ratios are measured in house using a FLASH 2000 series CHNS/O elemental analyzer (Thermo Scientific) purchased in 2009.

Total viral abundance is determined by direct epifluorescence microscopic counting and quasi-automated image analysis (Shopov et a. 2000) using custom Skipper software (http://www.skipperimaging.com). Water samples are pre-filtered through 0.2 µm PC and then filtered onto 0.02 µm Anodisc filter and stained with SYBR Gold (Nobel and Fuhrman 1998).

Total bacteria abundance is determined by direct epifluorescence microscopic counting after staining with the DNA-specific fluorochrome DAPI following standard procedures (Porter and Feig 1980; Williams et al. 1998). Counting is facilitated by Bacteria data represent DAPI stained cells enumerated using epifluorescence microscopy, semiquasi-automated image analysis (Shopov et al. 2000) and custom Skipper software (http://www.skipperimaging.com) (Verity et al. 2006).

Total and fecal coliform bacteria concentration is determined using standard total coliform (method 9221B) and fecal coliform (method 9221E) procedures (Clesceri et al. 1998). Enterococci concentrations are determined using EPA method 1600.

Total and size fractionated (less and greater than 8 µm) phytoplankton chlorophyll-a concentrations are determined fluorometrically in house (lab of Dr. Jim Nelson) following the acetone extraction method as described by Parsons et al. (1984). From 2011, 0.2 µm and 8 µm PC filters are used for total and > 8µm fractions of chl-a analyses, respectively, following the acetone extraction overnight method as described for cellulose acetate filters in Nejstgaard et al. (2006) and compared to the chl-a in situ fluorescence readings of the MANTA-2 multiprobe.

Abundance and biomass of nanoplankton taxonomic groups are determined using true-color epifluorescence image analyzed microscopy. Water samples are fixed with glutaraldehyde and stained with proflavine-DAPI (Verity and Sieracki, 1993; Shopov et al., 2000). This protocol has been used since 1986 with the custom Skipper software (www.skio.usg.edu/?p=research/bio/veritylab/ip); (Verity and Borkman 2010). Since 2011, the program Image Pro-Plus (Media Cybernetics) is utilized to determine auto- and heterotrophic organisms. In addition, a detailed assessment of the microplanktonic community composition (including ciliates) is mapped four times per year using classical microscopic sedimentation techniques (Utermöhl 1958) after Lugol's fixation. Currently, emphasis is focused on flagellates vs. diatoms as indicators of environmental quality, with attention to potential harmful algal groups.

Since 2012, a variety of flow cytometric instruments are utilized to quantify picoplankton and larger microplankton including diatoms and dinoflagellates in our SRiMP program. Picoplankton analysis is performed

by Dr. Liz Mann using a FacsCalibur (BD Biosciences, San Jose, CA, USA) in house. Additionally, we employ a state of the art CytoSense benchtop flow cytometer equipped with an imaging system and wide (1.5 mm) flow-cell uniquely capable of rapid analysis of live cells including large and chain-forming species (up to 4 mm long) such as diatoms and dinoflagellates (CytoBouy b.v., Woerden, the Netherlands, http://www.cytobuoy.com) performed in house by Dr. Jens Nejstgaard.

During the first decade, dominant copepods (Acartia spp.) were collected at the same sample site in approximately 6 week intervals by net tows (153 µm nylon mesh net, diameter 30 cm, length 150 cm). The net was towed for 15 minutes during maximum flood tide and again during ebb tide. Volume filtered for each tow was calculated from a flowmeter (General Oceanics) mounted in the mouth of the net. The content of the cod end was preserved in 3 % buffered formalin and stored at room temperature until counting under a dissecting microscope. Since 2011, net tows (65 µm mesh size, diameter 30 cm, length 100 cm) are collected at the same sample site in weekly intervals to determine copepods + eggs (mainly Acartia tonsa) abundances. The net is towed from 5 m to the surface during maximum flood tide. The sample is preserved in 3 % formalin and stored in the refrigerator (4 °C) until counting under a dissecting microscope.

Ctenophores (Mnemiopsis leidyi and Beroe sp.) are quantified weekly to monthly. Samples are collected using a 0.5 m zooplankton net (153 µm) fitted with a TSK flowmeter for ctenophores and jellies, and hauled obliquely from near-bottom to the surface for 5 minutes repeated trips through the water column. Ctenophore/jelly samples are sorted live in the lab immediately. Depending on taxa, various morphometric and volumetric measurements are recorded. Morphometric measurements are facilitated using a zoom stereoscope, e.g. trunk length, lobe or bell diameter, body width.

Data Processing Description

Aside from Quality Control and Quality Assurance (QA/QC) the SRiMP dataset has not been processed post analytical collection. Quarterly, all data entered into the SRiMP dataset is independently reviewed by a qualified technician or PI to assure that data is within expected ranges defined by historical values of a particular value. If individual data entries are out of range the data is scrutinized for obvious errors associated with the analytical process and/or data entry errors. If no obvious problems with the data are discovered the data is left in the dataset.

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Parameters

Parameter	Description	Units
Year	year of sampling	YYYY
Sample_ID	Sample ID	text
Date	date of sampling	YYYYMMDD
Time	Time as HHMMSS	HHMMSS
Tide	Tidal Stage: HT = hight tide MT = mid tide LT = low tide	text
Tide_Height	Predicted sea level at high and low tide	mm
Day_of_the_week	Day of the week	text
Time_AmPm	Time as HH:MM:SS AM or PM	HH:MM:SS AM or PM
Day_Number	Day number (day 0 = 8/26/1986)	integer
Location	Sampling location: main dock fuel dock MECA dock MECA Boat	text
Lat	Sample Station Latitude (South is negative)	decimal degrees

Lon	Sample Station Longitude (West is negative)	decimal degrees
Collection_Type	Collection type: Water sample appendicularians ctenophores	text
Comments	Comments	text
Weather	Weather description	text
Air_Temp	Air Temperature	degrees Celsius
Dew_Point	Dew Point	degrees Celsius
Heat_Index	Heat Index	degrees Celsius
Wind_Chill	Wind Chill Factor	degrees Celsius
Rel_Humidity	Relative Humidity	percentage
Bar_Pressure	Barometric Pressure	kPa
Rainfall	Rainfall since Midnight	mm
Wind_Direction	Wind Direction (N W S E)	text
Wind_Speed	Wind Speed	km/h
Peak_Wind_Gust	Peak Wind Gust	km/h
Solar_Radiation	Solar Radiation	W/m2
High_Temp	Highest Temperature since Midnight	degrees Celsius
Low_Temp	Highest Temperature since Midnight	degrees Celsius
Sunrise	Sunrise	HH:MM:SS AM or PM
Sunset	Sunset	HH:MM:SS AM or PM
Irradiance	Irradiance at 1m depth in percent of incident irradiance Io	perentage Io
Sampling_Depth	Sampling Depth	meters
Secchi_Depth	Secchi depth	meters
Turbidity_MANTA_2	Turbidity MANTA-2 (EUREKA Environmental)	NTU
Rainfall_Actual	actual rainfall	inches
Precipitation_week	Precipitation per previous week	mm/week
Ogeechee_River_Discharge	Ogeechee River Discharge	m3/s
pH_lab_115	pH laboratory 115	number
pH_MANTA_2	pH MANTA-2 (EUREKA Environmental)	number
Salinity	Salinity using a refractometer	ppt
Salinity_MANTA_2	Salinity measured with MANTA-2	ppt
Specific_Conductance	Specific Conductance	mS/cm
Specific_Conductance_MANTA_2	Specific Conductance MANTA-2	mS/cm
Water_Temperature	Water Temperature measured with a mercury thermometer	degrees Celsius
Water_Temperature_MANTA_2	Water Temperature measured with MANTA-2	degrees Celsius
DO_YSI_556__MANTA_2	Dissolved Oxygen concentration (YSI-556 or MANTA-2)	mg/l

DO_percent_sat_YSI_556__MANTA_2	Saturated Dissolved Oxygen (YSI-556 or MANTA-2) in percent	percentage
DO_YSI_for_Winklers	Dissolved Oxygen concentration using YSI-556 for intercalibration with Winklers	mg/l
DO_Winkler	Dissolved Oxygen using Winkler Method	mg/l
DON	Dissolved Organic Nitrogen	umol N/l
TDN	Total Dissolved Nitrogen	umol N/l
TDN_StdDev	Total Dissolved Nitrogen Standard Deviation	umol N/l
NO3	Nitrate	umol N/l
NO3_StdDev	Nitrate Standard Deviation	umol N/l
NO2	Nitrite	umol N/l
NO2_StdDev	Nitrite Standard Deviation	umol N/l
NOx	Nitrate +Nitrite	umol N/l
NH4	Ammonium	umol N/l
NH4_StdDev	Ammonium Standard Deviation	umol N/l
T_DIN	Total Dissolved Inorganic Nitrogen (NOx + NH4)	umol N/l
Si_OH_4	Silicate	umol Si/l
Si_StdDev	Silicate Standard Deviation	umol Si/l
PO4	Phosphate	umol P/l
PO4_StdDev	Phosphate Standard Deviation	umol P/l
DIC	Dissolved Inorganic Carbon	mmol C/l
DIC_StdDev	Dissolved Inorganic Carbon Standard Deviation	mmol C/l
delta_13C_DIC	Delta Carbon-13 Isotope of DIC	percentage
StdDev_13C_DIC	Delta Carbon-13 Isotope of DIC Standard Deviation	percentage
Deut_Hydro	Deuterium to Hydrogen ratio	percentage
Oxygen_18O	Delta Oxygen-18 isotope	percentage
DOC	Dissolved Organic Carbon	umol C /l
POC	Particulate Organic Carbon	ug /l
delta_13C_POC	Delta Carbon-13 Isotope of POC	percentage
PON	Particulate Organic Nitrogen	ug /l
delta_15N_PON	Delta Nitrogen-15 Isotope of PON	percentage
DIN_PO4	Dissolved inorganic Nitrogen to Phosphate mass ratio	mol/mol
DIN_Si	Dissolved Inorganic Nitrogen to Si(OH)4 mass ratio	mol/mol
TDN_PO4	Total Dissolved Nitrogen to Phosphate mass ratio	mol/mol
TDN_Si	Total Dissolved Nitrogen to Si(OH)4 mass ratio	mol/mol
Chla_total_MANTA_2	Total Chlorophyll-a concentration using MANTA-2	ug/l

Chla_total_GFF	Total Chlorophyll-a filtered on GFF	ug/l
Chla_total_GFF_StdDev	Toyal Chlorophyll-a filtered on GFF Standard Deviation	ug/l
Chla_total_PC	Total Chlorophyll-a filtered on Polycarbonate filters 0.2 um	ug/l
Chla_total_PC_StdDev	Total Chlorophyll-a filtered on PC 0.2 um Standard Deviation	ug/l
Phaeo_total	Total Phaeophytin filtered on GFF	µg/l
Phaeo_StdDev	Total Phaeophytin filtered on GFF Standard Deviation	ug/l
Phaeo_PC_total	Phaeophytin total filtered on PC 0.2 um	ug/l
Phaeo_PC_StdDev	Phaeophytin total filtered on PC 0.2 um Standard Deviation	ug/l
Chla_gt8	Chlorphyll-a greater than 8 um GFF (calculated)	ug/l
Chla_lt8	Chlorphyll-a less than 8 um GFF (measured)	ug/l
Chla_gt8_PC	Chlorphyll-a greater than 8 um PC (measured)	ug/l
Chla_gt8_PC_StdDev	Chlorphyll-a greater than 8 um PC (measured) Standard Deviation	ug/l
Phaeo_gt8_PC	Phaeophytin greater than 8 um PC (measured)	ug/l
Phaeo_gt8_PC_StdDev	Phaeophytin greater than 8 um PC (measured) Standard Deviation	ug/l
Chla_lt8_PC	Chlorphyll-a less than 8 um PC (calculated)	ug/l
Chla_lt8_PC_StdDev	Chlorphyll-a less than 8 um PC (calculated) Standard Deviation	ug/l
Phaeo_lt8_PC	Phaeophytin less than 8 um PC (calculated)	ug/l
Phaeo_lt8_PC_StdDev	Phaeophytin less than 8 um PC (calculated) Standard Deviation	ug/l
Chla_gt8_to_total	Ratio of Chlorphyll-a less than 8 um to total Chl-a	ug/ug
Chla_lt8_to_total	Ratio of Chlorphyll-a greater than 8 um to total Chl-a	ug/ug
C_N_mass	POCC to PON mass ratio	ug/ug
C_N_molar	POC to PON molar mass ratio	mol/mol
C_Chla	Carbon to Chlorophyll-a mass ratio	ug/ug
N_Chla	Nitrogen to Chlorophyll-a mass ratio	ug|ug
Viruses	Viruses abundance	viruses/ml
Viruses_StDev	Viruses abundance standard deviaton	viruses/ml
Bacteria	Bacteria abundance	10^6 cells/ml
Bacteria_DAPI_Autocount	Bacteria abundance using DAPI Autocount	10^6 cells/ml
Bacteria_DAPI_Autocount_SD	Bacteria DAPI Autocount Std Dev	10^6 cells/ml

Pnano	Photosynthetic Nanoplankton abundance	10^3 cells/ml
Hnano	Heterotrophic Nanoplankton abundance	10^3 cells/ml
Hdino	Heterotrophic Dinoflagellates abundance	cells/ml
Cyano	Cyanobacteria	cells/ml
Diatoms	Diatom abundance	cells/ml
Ciliates	Ciliate abundance	cells/ml
Acartia_tonsa	Acartia tonsa abundance	individuals/l
Pn_plus_Hn	Phototrophic plus Heterotrophic Nanoplankton	10^3 cells/ml
Hnano_Bac	Ratio of Heterotrophic Nanoplankton to Bacteria	10^3 cells/10^6 cells
Cil_Pnano	Ratio to Ciliate to Photosynthetic Nanoplankton	cells/10^3 cells
Acartia_Ciliates	Ratio of Acartia to Ciliate (x10^-3) abundance	individuals/inividuals x10^3
Acartia_to_Total_Chla	Ratio of Acartia to Total Chloriphyll-a	inividuals/ug
Cil_to__Pn_plus_Hn	Ratio of Ciliates to Phototrophic plus Heterotrophic Nanoplankton	cells/10^3 cells
Cil_Bac	Ratio of Ciliates to Bacteria	cells/10^6 cells
Cil__Pn_plus_Hn_plus_Bac	Ratio of ciliates to Phototrophic plus Heterotrophic Nanoplankton plus Bacteria	Cells/10^3 10^6 cells
Acartia_to_Chla_gt8	Ratio of Acartia to Chloriphyll-a greater than 8 um	inividuals/ug
Pnana_to_Chla_lt8	Ratio of Phtottrophic Nanoflagellates to Chlorphyll-a greater than 8 um	cellsx10^3/ug
Chlagt8_Chlatotal__Chlalt8_chlatotal_xChlatotal	Ratio of Chlorphyll-a greater than 8 um to total Chl-a divided by ratio of Chlorphyll-a less than 8 um to total Chl-a multiplied by total Chl-a	ug/l
Appendicularians	Appendicularian abundance	individuals/m3
Appendicularians_StdDev	Appendicularian abundance Standard Deviation	individuals/m3
Appendicularia_trunk_length	Appendicularia trunk length	mm
Appendicularia_trunk_length_StdDev	Appendicularia trunk length Standard Deviation	mm
Appendicularian_trunk_and_tail_length	Appendicularian trunk and tail length	mm
Appendicularian_trunk_and_tail_length_StdDev	Appendicularian trunk and tail length Standard Deviation	mm
Total_Mnemiopsis	Total Mnemiopsis abundance	individuals/m3
Total_Mnemiopsis_StdDev	Total Mnemiopsis abundance Standard Deviation	individuals/m3
Mnemiopsis_0_to_1cm	Mnemiopsis 0 to 1 cm long	individuals/m3
Mnemiopsis_0_to_1cm_StdDev	Mnemiopsis 0 to 1 cm long Standard Deviation	individuals/m3
Mnemiopsis_1point1_to_2cm	Mnemiopsis 1.1 to 2 cm long	individuals/m3

Mnemiopsis_1point1_to_2cm_StdDev	Mnemiopsis 1.1 to 2 cm long Standard Deviation	individuals/m3
Mnemiopsis_2point1_to_3cm	Mnemiopsis 2.1 to 3 cm long	individuals/m3
Mnemiopsis_2point1_to_3cm_StdDev	Mnemiopsis 2.1 to 3 cm long Standard Deviation	individuals/m3
Mnemiopsis_3point1_to_4cm	Mnemiopsis 3.1 to 4 cm long	individuals/m3
Mnemiopsis_3point1_to_4cm_StdDev	Mnemiopsis 3.1 to 4 cm long Standard Deviation	individuals/m3
Mnemiopsis_4point1_to_5cm	Mnemiopsis 4.1 to 5 cm long	individuals/m3
Mnemiopsis_4point1_to_5cm_StdDev	Mnemiopsis 4.1 to 5 cm long Standard Deviation	individuals/m3
Mnemiopsis_5point1_to_6cm	Mnemiopsis 5.1 to 6 cm long	individuals/m3
Mnemiopsis_5point1_to_6cm_StdDev	Mnemiopsis 5.1 to 6 cm long Standard Deviation	individuals/m3
Mnemiopsis_6point1_to_7cm	Mnemiopsis 6.1 to 7 cm long	individuals/m3
Mnemiopsis_6point1_to_7cm_StdDev	Mnemiopsis 6.1 to 7 cm long Standard Deviation	individuals/m3
Mnemiopsis_7point1_to_8cm	Mnemiopsis 7.1 to 8 cm long	individuals/m3
Mnemiopsis_7point1_to_8cm_StdDev	Mnemiopsis 7.1 to 8 cm long Standard Deviation	individuals/m3
Mnemiopsis_8point1_to_9cm	Mnemiopsis 8.1 to 9 cm long	individuals/m3
Mnemiopsis_8point1_to_9cm_StdDev	Mnemiopsis 8.1 to 9 cm long Standard Deviation	individuals/m3
Mnemiopsis_9point1_to_10cm	Mnemiopsis 9.1 to 10 cm long	individuals/m3
Mnemiopsis_9point1_to_10cm_StdDev	Mnemiopsis 9.1 to 10 cm long Standard Deviation	individuals/m3
Mnemiopsis_10point1_to_11cm	Mnemiopsis 10.1 to 11 cm long	individuals/m3
Mnemiopsis_10point1_to_11cm_StdDev	Mnemiopsis 10.1 to 11 cm long Standard Deviation	individuals/m3
Total_Beroe	Total Beroe abundance	individuals/m3
Total_Beroe_StdDev	Total Beroe abundance Standard Deviation	individuals/m3
Beroe_0_to_1cm	Beroe 0 to 1 cm long	individuals/m3
Beroe_0_to_1cm_StdDev	Beroe 0 to 1 cm long Standard Deviation	individuals/m3
Beroe_1point1_to_2cm	Beroe 1.1 to 2 cm long	individuals/m3
Beroe_1point1_to_2cm_StdDev	Beroe 1.1 to 2 cm long Standard Deviation	individuals/m3
Beroe_2point1_to_3cm	Beroe 2.1 to 3 cm long	individuals/m3
Beroe_2point1_to_3cm_StdDev	Beroe 2.1 to 3 cm long Standard Deviation	individuals/m3
Beroe_3point1_to_4cm	Beroe 3.1 to 4 cm long	individuals/m3
Beroe_3point1_to_4cm_StdDev	Beroe 3.1 to 4 cm long Standard Deviation	individuals/m3
Beroe_4point1_to_5cm	Beroe 4.1 to 5 cm long	individuals/m3
Beroe_4point1_to_5cm_StdDev	Beroe 4.1 to 5 cm long Standard Deviation	individuals/m3

Beroe_5point1_to_6cm	Beroe 5.1 to 6 cm long	individuals/m3
Beroe_5point1_to_6cm_StdDev	Beroe 5.1 to 6 cm long Standard Deviation	individuals/m3
Beroe_6point1_to_7cm	Beroe 6.1 to 7 cm long	individuals/m3
Beroe_6point1_to_7cm_StdDev	Beroe 6.1 to 7 cm long Standard Deviation	individuals/m3
Beroe_7point1_to_8cm	Beroe 7.1 to 8 cm long	individuals/m3
Beroe_7point1_to_8cm_StdDev	Beroe 7.1 to 8 cm long Standard Deviation	individuals/m3
Beroe_8point1_to_9cm	Beroe 8.1 to 9 cm long	individuals/m3
Beroe_8point1_to_9cm_StdDev	Beroe 8.1 to 9 cm long Standard Deviation	individuals/m3
Beroe_9point1_to_10cm	Beroe 9.1 to 10 cm long	individuals/m3
Beroe_9point1_to_10cm_StdDev	Beroe 9.1 to 10 cm long Standard Deviation	individuals/m3
Beroe_10point1_to_11cm	Beroe 10.1 to 11 cm long	individuals/m3
Beroe_10point1_to_11cm_StdDev	Beroe 10.1 to 11 cm long Standard Deviation	individuals/m3

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Instruments

Dataset-specific Instrument Name	SKiO Weather Station
Generic Instrument Name	Automated Weather Station
Dataset-specific Description	SKiO Weather Station
Generic Instrument Description	Land-based AWS systems are designed to record meteorological information.

Dataset-specific Instrument Name	BD FACSCalibur flow cytometer
Generic Instrument Name	BD FACSCalibur Flow Cytometer
Dataset-specific Description	BD FACSCalibur flow cytometer Since 2012, a variety of flow cytometric instruments are utilized to quantify picoplankton and larger microplankton including diatoms and dinoflagellates in our SRiMP program. Picoplankton analysis is performed by Dr. Liz Mann using a FacsCalibur (BD Biosciences, San Jose, CA, USA) in house. Additionally, we employ a state of the art CytoSense benchtop flow cytometer equipped with an imaging system and wide (1.5 mm) flow-cell uniquely capable of rapid analysis of live cells including large and chain-forming species (up to 4 mm long) such as diatoms and dinoflagellates (CytoBouy b.v., Woerden, the Netherlands, http://www.cytobuoy.com) performed in house by Dr. Jens Nejstgaard.
Generic Instrument Description	The FACSCalibur flow cytometer is an autonomous benchtop flow cytometer designed for routine cell analysis, assay development, verification and identification of cellular populations. It is equipped with a blue (488 nm) air-cooled argon laser and a red (635 nm) diode laser. For each particle (cell), five optical parameters can be recorded from the 488 nm laser beam excitation: two light scatter signals, namely forward and right angle, and three fluorescences corresponding to emissions in green (530/30 nm BP), orange (585/42 nm BP) and red (670 nm LP) wavelength ranges. A far red fluorescence (661/16 nm BP) induced by the red diode can also be recorded. Data are analysed using BD Biosciences CellQuest software. Optional features include a cell sorting option, allowing users to identify and isolate a population of interest and a HTS option (High-throughput (HT) or Standard (STD) mode), where sample volumes range from 2-10 microlitres in HT mode and 2-200 microlitres in STD mode. An optional BD FACS Loader tube-lifter can be used to verify tube position and rack identification. The instrument has a capture rate of 300 cells per second, supports 40 (12 x 75 mm) tubes per rack, and has an operating temperature ranging from 16-29 degC.

Dataset-specific Instrument Name	bucket
Generic Instrument Name	bucket
Dataset-specific Description	From 1986 to 2011 the surface waters adjacent to the main dock of the Skidaway Institute of Oceanography were sampled using an acid cleaned bucket or a Niskin bottle
Generic Instrument Description	A bucket used to collect surface sea water samples.

Dataset-specific Instrument Name	Thermo Scientific FLASH 2000 series CHNS/O elemental analyzer
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	Thermo Scientific FLASH 2000 series CHNS/O elemental analyzer Presently, POC and PON amounts and delta 13/12 C and 15/14 N isotope ratios are measured in house using a FLASH 2000 series CHNS/O elemental analyzer (Thermo Scientific) purchased in 2009
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	CytoSense benchtop flow cytometer
Generic Instrument Name	CytoSense flow cytometer
Dataset-specific Description	CytoSense benchtop flow cytometer Since 2012, a variety of flow cytometric instruments are utilized to quantify picoplankton and larger microplankton including diatoms and dinoflagellates in our SRiMP program. Picoplankton analysis is performed by Dr. Liz Mann using a FacsCalibur (BD Biosciences, San Jose, CA, USA) in house. Additionally, we employ a state of the art CytoSense benchtop flow cytometer equipped with an imaging system and wide (1.5 mm) flow-cell uniquely capable of rapid analysis of live cells including large and chain-forming species (up to 4 mm long) such as diatoms and dinoflagellates (CytoBouy b.v., Woerden, the Netherlands, http://www.cytobuoy.com) performed in house by Dr. Jens Nejstgaard.
Generic Instrument Description	The CytoSense is a portable, benchtop autonomous flow cytometer designed for phytoplankton species classification and analysis of filamentous algae. It can also be used in situ to reveal temporal and spatial phytoplankton variability. It can be remotely controlled, and has been specifically designed to record the optical pulse shapes of suspended particles between

Dataset-specific Instrument Name	TSK flowmeter
Generic Instrument Name	Flow Meter
Dataset-specific Description	TSK flowmeter Samples are collected using a 0.5 m zooplankton net (153 µm) fitted with a TSK flowmeter for ctenophores and jellies
Generic Instrument Description	General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc.

Dataset-specific Instrument Name	General Oceanics Flow Meter
Generic Instrument Name	Flow Meter
Dataset-specific Description	General Oceanics Flow Meter Volume filtered for each tow was calculated from a flowmeter (General Oceanics) mounted in the mouth of the net
Generic Instrument Description	General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc.

Dataset-specific Instrument Name	Thermo Scientific Mass Spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Continuing from mid 2011 to present, water samples for DIC and delta 13/12 C isotope ratios of 0.02 nylon filtered water samples is analyzed inhouse using a Mass Spectrometer (Thermo Scientific) in the lab of Dr. Jay Brandes (Skidaway Island Scientific Stable Isotope Laboratory, SISSIL)
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Hi 2550 pH/ORP & EC/TDS Meter
Generic Instrument Name	Multi Parameter Bench Meter
Dataset-specific Description	Hi 2550 pH/ORP & EC/TDS Meter
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and Temperature with one device.

Dataset-specific Instrument Name	Niskin bottle
Generic Instrument Name	Niskin bottle
Dataset-specific Description	From 1986 to 2011 the surface waters adjacent to the main dock of the Skidaway Institute of Oceanography were sampled using an acid cleaned bucket or a Niskin bottle
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

Dataset-specific Instrument Name	Technicon Auto Analyzer II
Generic Instrument Name	Nutrient Autoanalyzer
Dataset-specific Description	Technicon Auto Analyzer II Nutrient analyses were performed on automated procedures using a Technicon Auto Analyzer II; 0.1 µM precision
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

Dataset-specific Instrument Name	Phytoplankton Net
Generic Instrument Name	Phytoplankton Net
Dataset-specific Description	During the first decade, dominant copepods (Acartia spp.) were collected at the same sample site in approximately 6 week intervals by net tows (153 µm nylon mesh net, diameter 30 cm, length 150 cm Samples are collected using a 0.5 m zooplankton net (153 µm) fitted with a TSK flowmeter for ctenophores and jellies
Generic Instrument Description	A Phytoplankton Net is a generic term for a sampling net having mesh size of 150 microns or less that is used to collect phytoplankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	American Optical Refractometer
Generic Instrument Name	Refractometer
Dataset-specific Description	American Optical Refractometer; +- 0.2 psu or ppt
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	AGE Model 2100 Salinometer
Generic Instrument Name	Salinometer
Dataset-specific Description	Surface salinity was measured with an AGE model 2100 salinometer from 1986 to 1996
Generic Instrument Description	A salinometer is a device designed to measure the salinity, or dissolved salt content, of a solution.

Dataset-specific Instrument Name	Secchi Disc
Generic Instrument Name	Secchi Disc
Dataset-specific Description	Since early 2011, weekly Secchi depth measurements were included in the SRiMP program
Generic Instrument Description	Typically, a 16 inch diameter white/black quadrant disc used to measure water optical clarity

Dataset-specific Instrument Name	Shimadzu TNM-I Total Nitrogen Analyzer
Generic Instrument Name	Total Nitrogen Analyzer
Dataset-specific Description	TDN and DOC concentrations of 0.2 µm filtered water samples are processed at SkIO by the lab of Dr. Aron Stubbins using a Total Organic Carbon Analyzer with a Total Nitrogen Measuring Unit (TOC-V and TNM-I, Shimadzu Scientific Instruments, Columbia, ML, USA)
Generic Instrument Description	A unit that accurately determines the nitrogen concentrations of organic compounds typically by detecting and measuring its combustion product (NO). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/totalnit.pdf

Dataset-specific Instrument Name	Shimadzu TOC-V Analyzer
Generic Instrument Name	Total Organic Carbon Analyzer
Dataset-specific Description	TDN and DOC concentrations of 0.2 µm filtered water samples are processed at SkIO by the lab of Dr. Aron Stubbins using a Total Organic Carbon Analyzer with a Total Nitrogen Measuring Unit (TOC-V and TNM-I, Shimadzu Scientific Instruments, Columbia, ML, USA)
Generic Instrument Description	A unit that accurately determines the carbon concentrations of organic compounds typically by detecting and measuring its combustion product (CO2). See description document at: http://bcodata.whoi.edu/LaurentianGreatLakes_Chemistry/bs116.pdf

Dataset-specific Instrument Name	Multi-Probe MANTA-2
Generic Instrument Name	Water Quality Multiprobe
Dataset-specific Description	Multi-Probe MANTA-2 From September 2011 until present, a multi-probe MANTA-2 (EUREKA Environmental Engineering, Austin, TX, USA) has been included to measure depths profiles of temperature, salinity, pH, conductivity, turbidity, in situ chlorophyll fluorescence and DO.
Generic Instrument Description	An instrument which measures multiple water quality parameters based on the sensor configuration.

Dataset-specific Instrument Name	Standard Mercury Thermometer
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	1986 to 1996 Surface water temperature was measured weekly using a standard mercury thermometer (+- 0.1 ° C)
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

Dataset-specific Instrument Name	Winkler Oxygen Titrator
Generic Instrument Name	Winkler Oxygen Titrator
Dataset-specific Description	The oxygen probe measurements are regularly (at least monthly) compared and calibrated (if necessary) against the high-precision Winkler titrations using a (Parsons et al., 1984; Hansen, 1999) and a Brinkmann Metrohm titrator
Generic Instrument Description	A Winkler Oxygen Titration system is used for determining concentration of dissolved oxygen in seawater.

Dataset-specific Instrument Name	YSI Model 556 multi-probe system
Generic Instrument Name	YSI Professional Plus Multi-Parameter Probe
Dataset-specific Description	From February 2004 until July 2011, water temperature, salinity, and dissolved oxygen (DO) were measured using a YSI Model 556 multi-probe system YSI Model 556 multi-probe system
Generic Instrument Description	The YSI Professional Plus handheld multiparameter meter provides for the measurement of a variety of combinations for dissolved oxygen, conductivity, specific conductance, salinity, resistivity, total dissolved solids (TDS), pH, ORP, pH/ORP combination, ammonium (ammonia), nitrate, chloride and temperature. More information from the manufacturer.

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Deployments

Skidaway_River_Estuary

Website	https://www.bco-dmo.org/deployment/58781
Platform	Skidaway Institute for Oceanography Main Dock
Start Date	1986-08-26
End Date	2011-12-19
Description	/*-->*/ /*-->*/ Skidaway River Estuary, from the main dock of Skidaway Institute of Oceanography (SkIO), Georgia, USA Skidaway River Estuary is a well mixed, warm, tidal influenced estuary located at the southeastern Atlantic coast of Georgia, USA, 31 59 N; 81 01 W. Water samples were taken at the surface in a depth of 0-1m. Skidaway Institute for Oceanography - Sampling Locations: Main Dock, Fuel Dock, MECA Dock and the MECA Boat. Most of the sampling is, and has been done, at the Main Dock: 31°59'23.96"N, 81°01' 21.09"W Some sampling has been performed at the: Fuel Dock: 31°59'25.19"N, 81°01' 17.40"W MECA Dock: 31°59'21.48"N, 81°01' 26.62" MECA Boat: 31°59'27.66"N, 81°01' 31.93"W to 31°59'30.68"N, 81°01'13.05" Image of Sampling Locations

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Project Information

Skidaway River Monitoring Program (SRiMP)

Website: http://www.skio.usg.edu/?p=research/bio/srimp/index

Coverage: Skidaway River Estuary, Savannah, Georgia USA

In estuaries of the South Atlantic Bight, one of the longest and most extensive datasets of plankton and bacteria biomass and composition is from the Skidaway River and the associated Wassaw Sound estuarine system in Georgia. Wassaw Sound is a tidally dominated, bar-built estuary surrounded by extensive stands of salt marsh. Although pristine compared to industrially impacted waterways such as the Savannah River and Charleston Harbor, residential development and population density around the Wassaw Sound system have been increasing rapidly.

Since 1986 the Skidaway River Monitoring Program (SRiMP) has maintained a time series observation dataset of hydrography, nutrients, phytoplankton, heterotrophic microbial communities, mesozooplankton, representative gelatinous nekton, and dissolved oxygen. Samples have been collected approximately weekly from the main dock at the Skidaway Institute of Oceanography. The start of the program was coincident with the rapid development of Skidaway Island, Georiga USA that has transformed a marsh and maritime forest covered ancient barrier island to an island dominated by a residential luxury golf course community. Population growth in the 1980's was as high as 25% annually, but has since declined to <3% annually as island development has neared completion. Evidence from the SRiMP study support the hypothesis of causative linkages between human population growth, nutrient loading, and ecosystem alteration.

The long-term goal of this project is to understand how warm, well-mixed, subtropical estuaries vary their plankton community structure, function, and net ecosystem metabolism in response to increasing anthropogenic nutrient loading and natural environmental forcing. The approach is to continue a unique, long-term (19 years), temporally intensive (sampling twice per week) record in the Skidaway River estuary (Georgia, USA) of hydrography, nutrients, plankton and microbial communities, dissolved oxygen, and important living and non-living components of particulate matter. The record to date documents changes caused by cultural eutrophication throughout the food web from bacteria to copepods; independently collected evidence shows major declines in commercial catches of fin- and shellfish. Commonly accepted conceptual models and limited local evidence support the notion that gelatinous predators may benefit from the enhanced microbial food web and from decreased competition from vertebrates and invertebrates. These data will be used to evaluate estuarine biological and chemical responses to, and potential recovery from, the by-products of increasing human occupation of the coast, as well as chronic (long-term warming, rising sea level, extended drought or wet periods) and stochastic (tropical storms) patterns in natural phenomena. Questions to be addressed fall into two basic categories: (a) how do plankton communities (individual taxa and bulk properties) respond in structure and function to early stages of eutrophication that include changes in concentrations and ratios of all major inorganic and organic nutrients, and (b) are such changes consonant with accepted ecological theory for estuarine ecosystems?

The working hypothesis is that changes in nutrient loading have altered the competitive balance among phytoplankton, bacteria, and associated microbial communities, thus impacting higher trophic levels. A major corollary is that changes in food web structure at the lower levels are driving a long-term shift from oxic towards hypoxic conditions, i.e. from autotrophy to net heterotrophy. These lower oxygen concentrations may facilitate the development of gelatinous predators communities to fill the void caused by declines in fin- and shellfish. This study aims to provide sound scientific data on historic and contemporary patterns in plankton community structure, ecosystem function, and relationships to environmental variables, including trends in dissolved oxygen, as well as the quantitative basis to evaluate basic ecological hypotheses regarding estuarine ecosystems.

Skidaway Institute for Oceanography - Sampling Locations - Main Dock, Fuel Dock, MECA Dock and the MECA Boat.

Most of the sampling is, and has been done, at the Main Dock: 31°59'23.96"N, 81°01' 21.09"W

Some sampling has been performed at the:
Fuel Dock: 31°59'25.19"N, 81°01' 17.40"W
MECA Dock: 31°59'21.48"N, 81°01' 26.62"
MECA Boat: 31°59'27.66"N, 81°01' 31.93"W to 31°59'30.68"N, 81°01'13.05"

Image of Sampling Locations

Funded as NSF-OCE Award #0545312: Patterns of Ecosystem Function and Trophic Status in

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Funding

Funding Source	Award
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