Fall 2018 Update: Annual Condition of the Northeast Shelf Ecosystem

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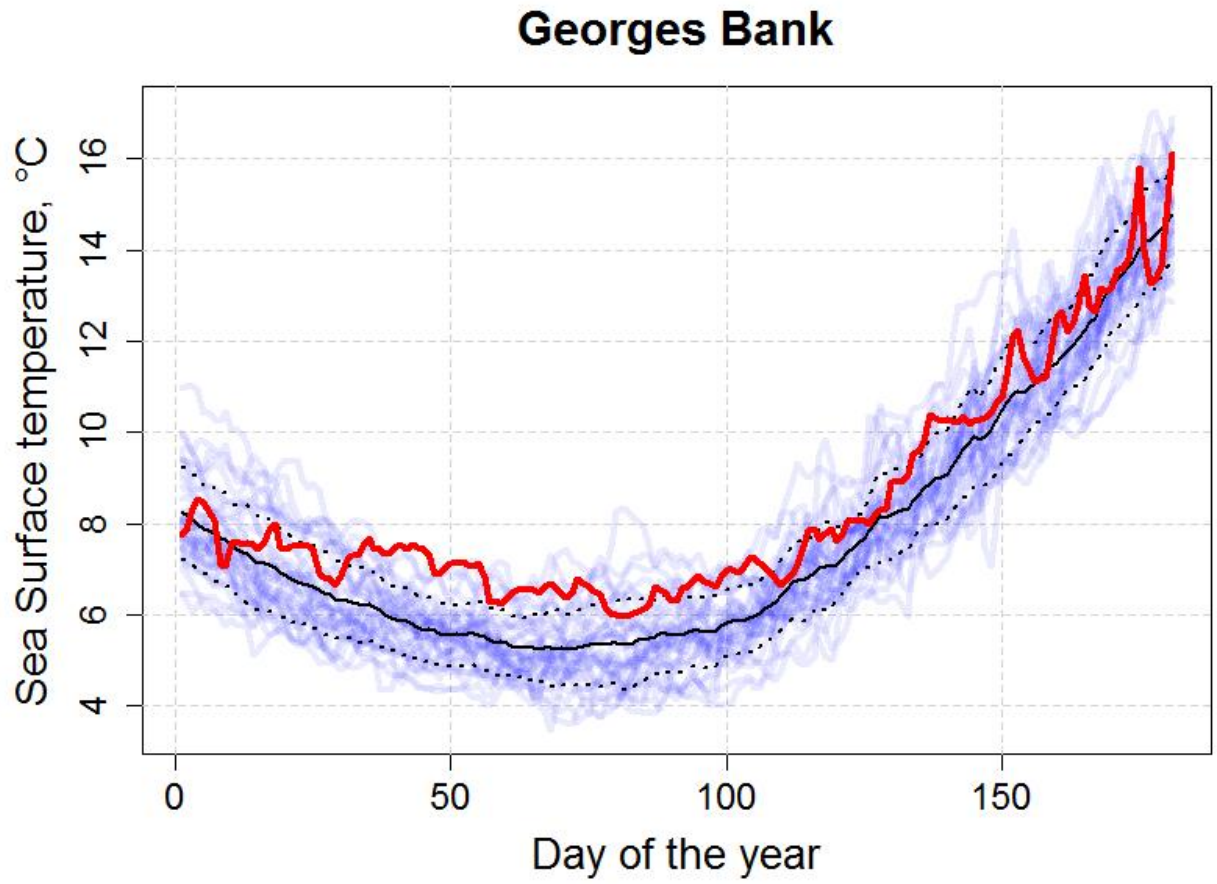
Fall 2018 Update

Summary of Conditions of the Northeast Shelf Ecosystem

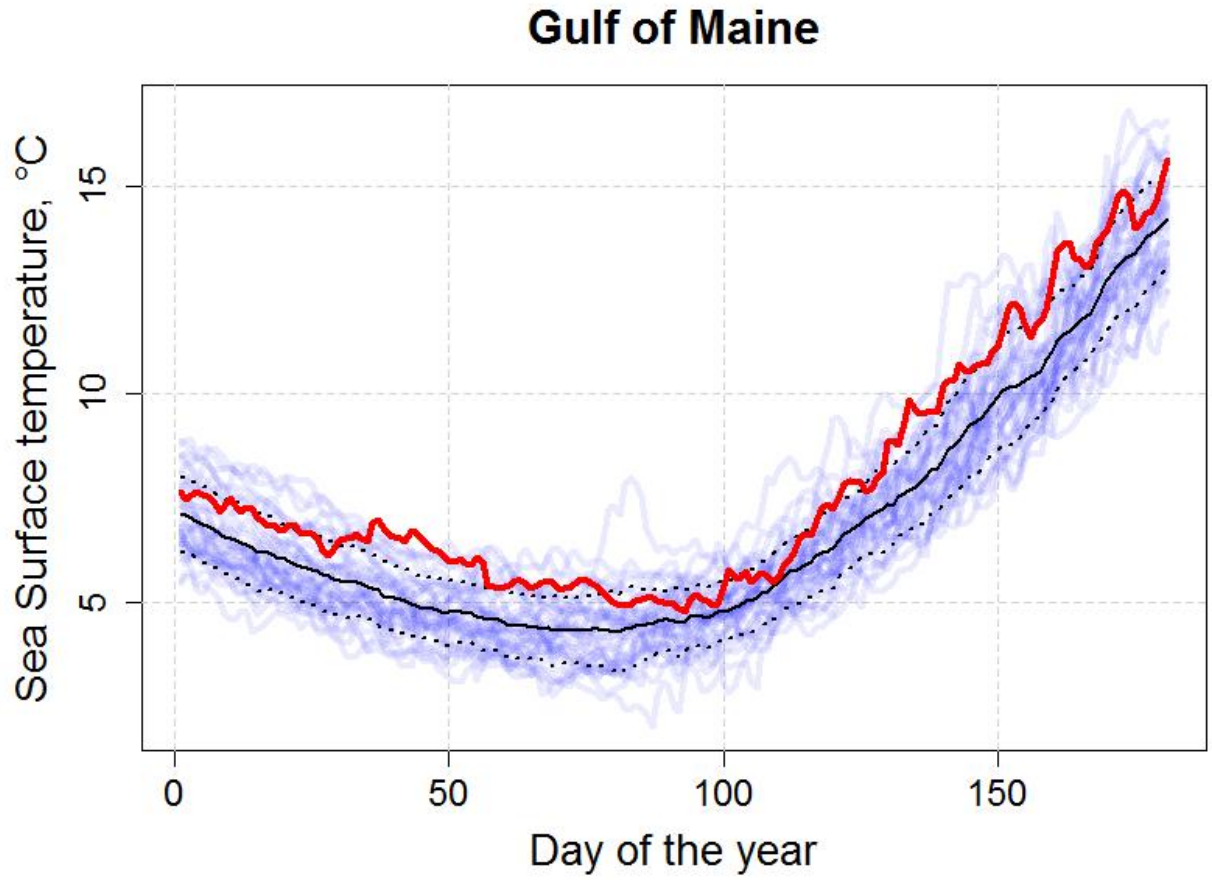
- Sea surface temperature in the Northeast Shelf Ecosystem during the first half of 2018 continued to moderate compared to the record high temperatures that occurred in 2012; however, temperatures remain above the long-term mean based on both contemporary satellite remote-sensing data and ship-board measurements.
- The spring bloom in the Gulf of Maine and Georges Bank areas comprised lower than average chlorophyll concentrations in 2018.
- Spring temperature conditions have delayed the spring thermal transition dates for 2018 compared to recent years.
- The distribution of fish and invertebrate species sampled by the NEFSC bottom trawl survey has changed; utilizing data through the spring 2018 survey, most distribution metrics indicate a shift in species distribution to the northeast and into deeper water.

Daily Sea Surface Temperature for the First Half of the Year

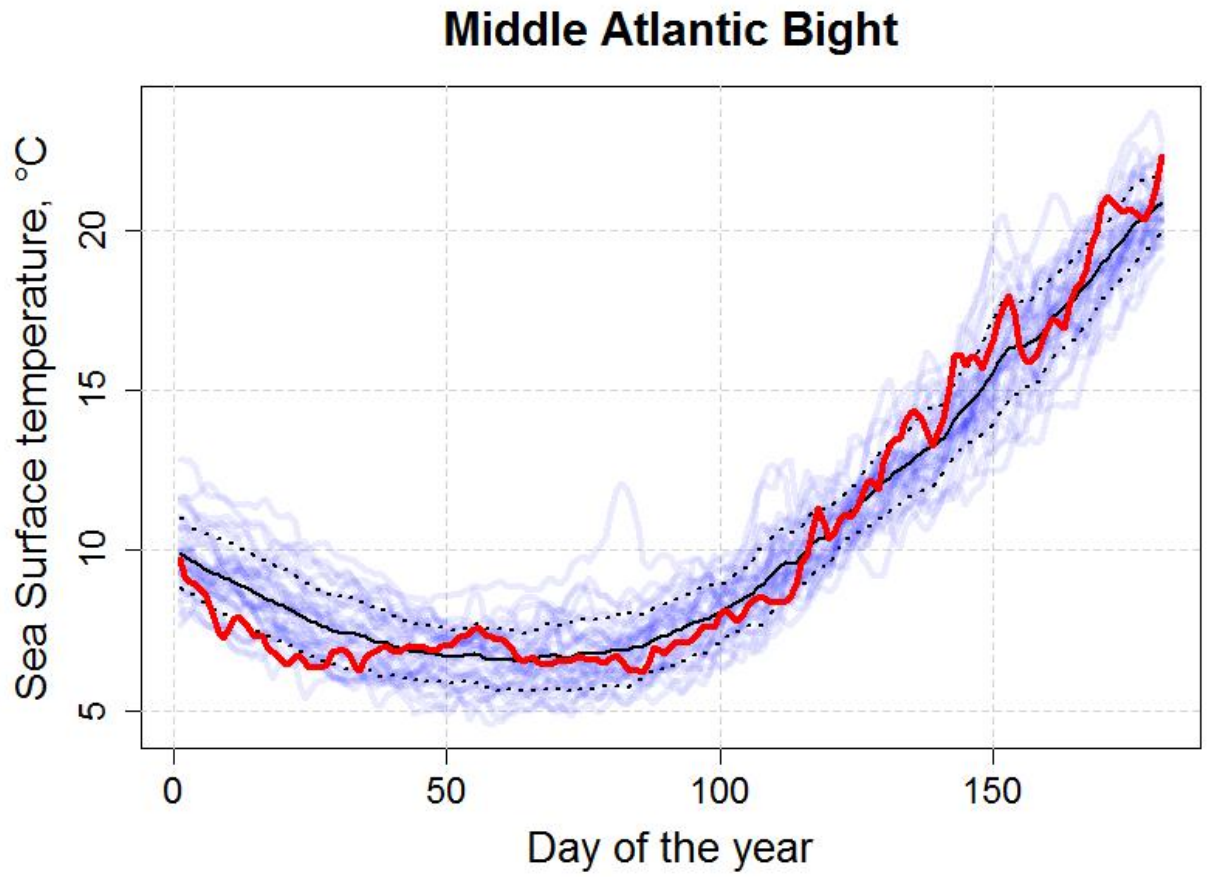
Daily sea surface temperatures tended to be at or above average conditions during the first half of 2018. The largest departures from average conditions can be seen in the data for the Scotian Shelf ecoregion (see graph). In these plots, the current year temperatures are shown as a red line with all previous years in the dataset, starting in 1982, shown as transparent blue lines; the black line is the time series mean and the dotted lines mark plus/minus one standard deviation. Early in the year, temperatures were approximately 3°C above the mean in the Scotian Shelf area before returning to level of a degree or so above the mean by mid-year. In contrast, temperatures approximated the mean through most of the first half of the year in the Middle Atlantic Bight and tended to be approximately one standard deviation above the mean in both the Gulf of Maine and Georges Bank.



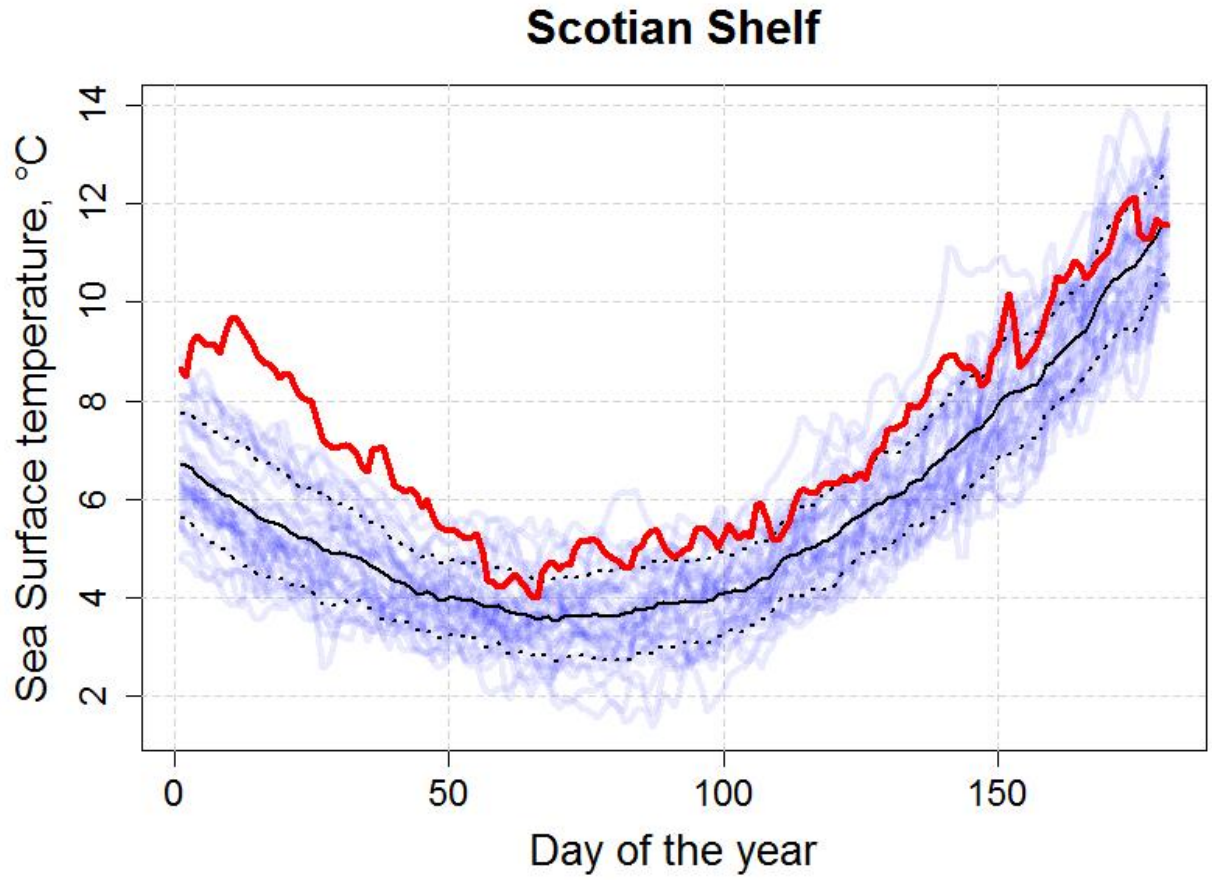
Daily sea surface temperatures on Georges Bank during the first half of 2018



Daily sea surface temperatures in the Gulf of Maine during the first half of 2018



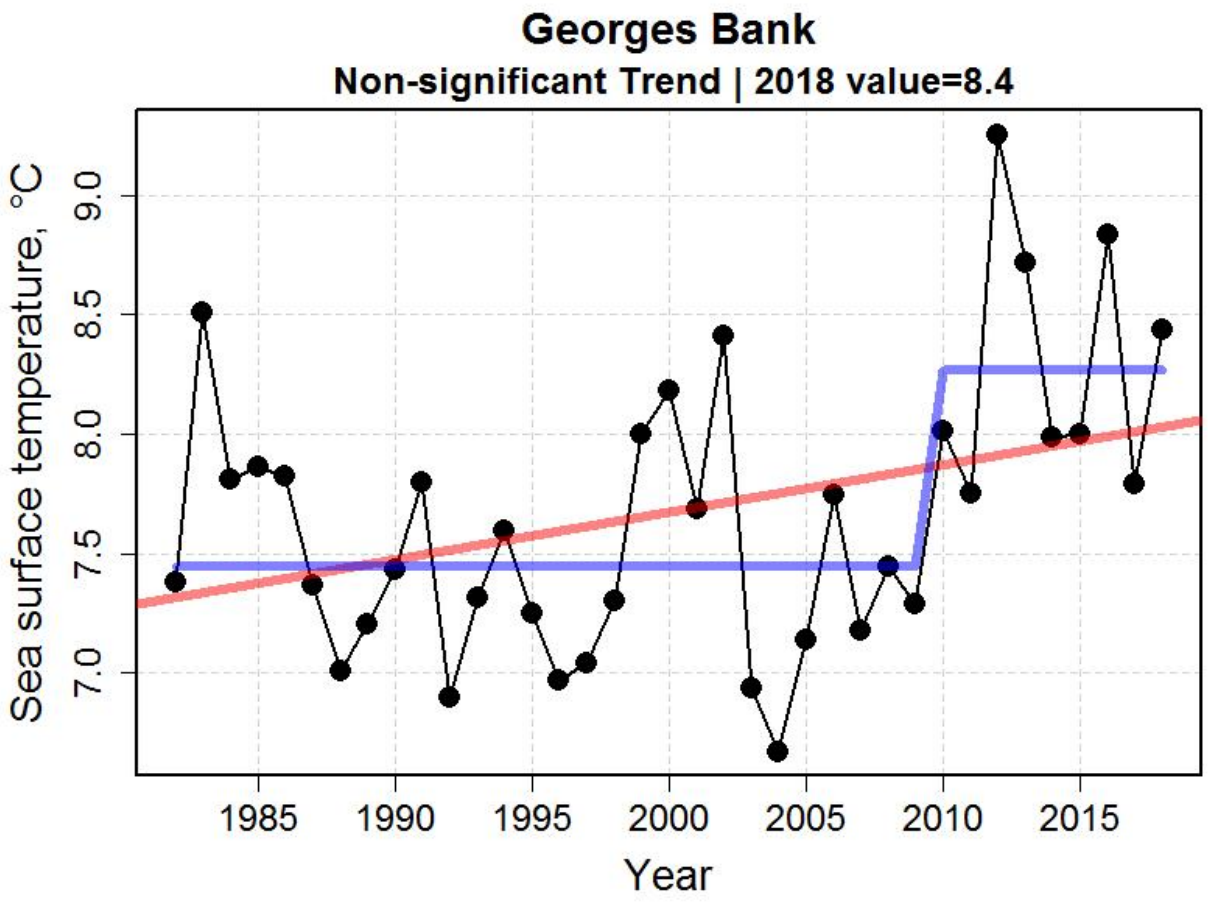
Daily sea surface temperatures in the Middle Atlantic Bight during the first half of 2018



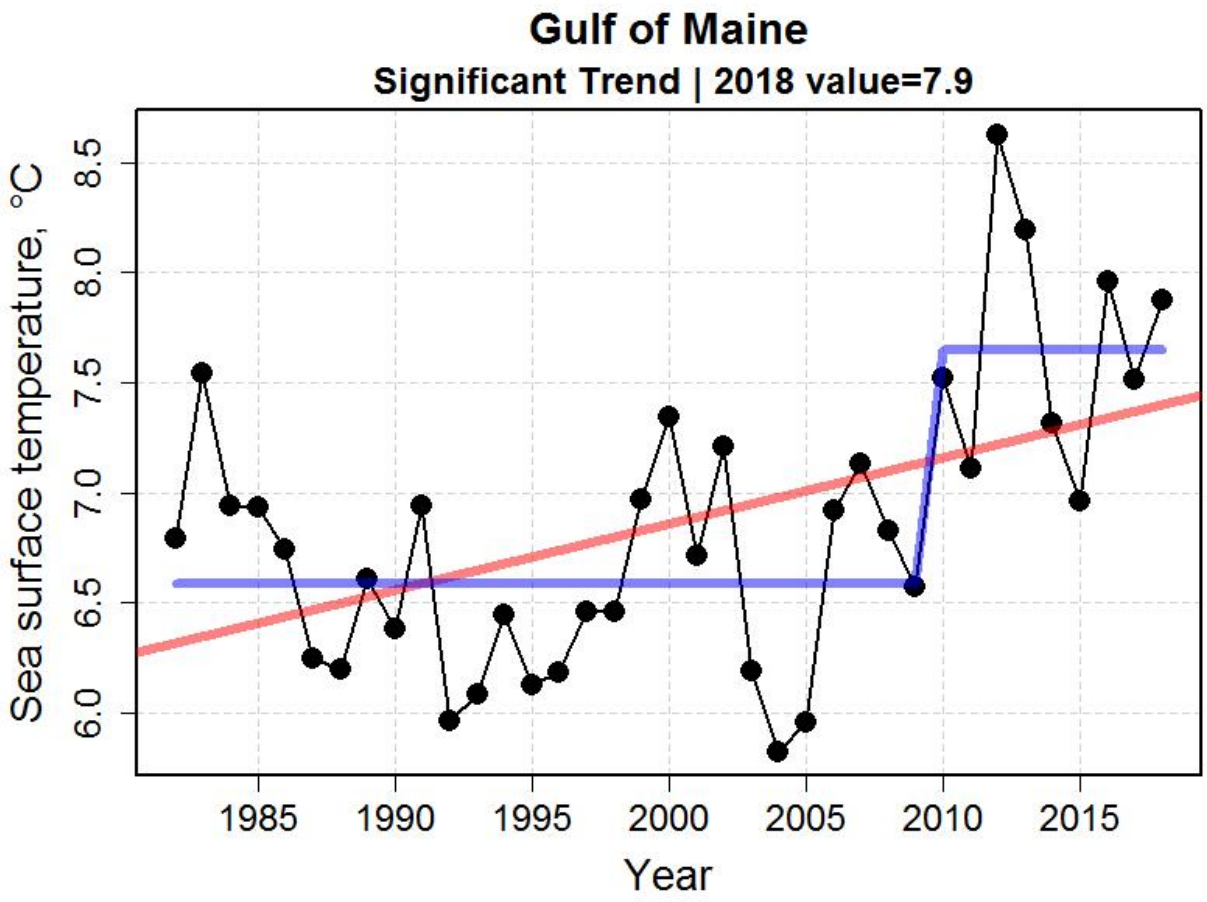
Daily sea surface temperatures on the Scotian Shelf during the first half of 2018

Sea Surface Temperature for the First Half of the Year

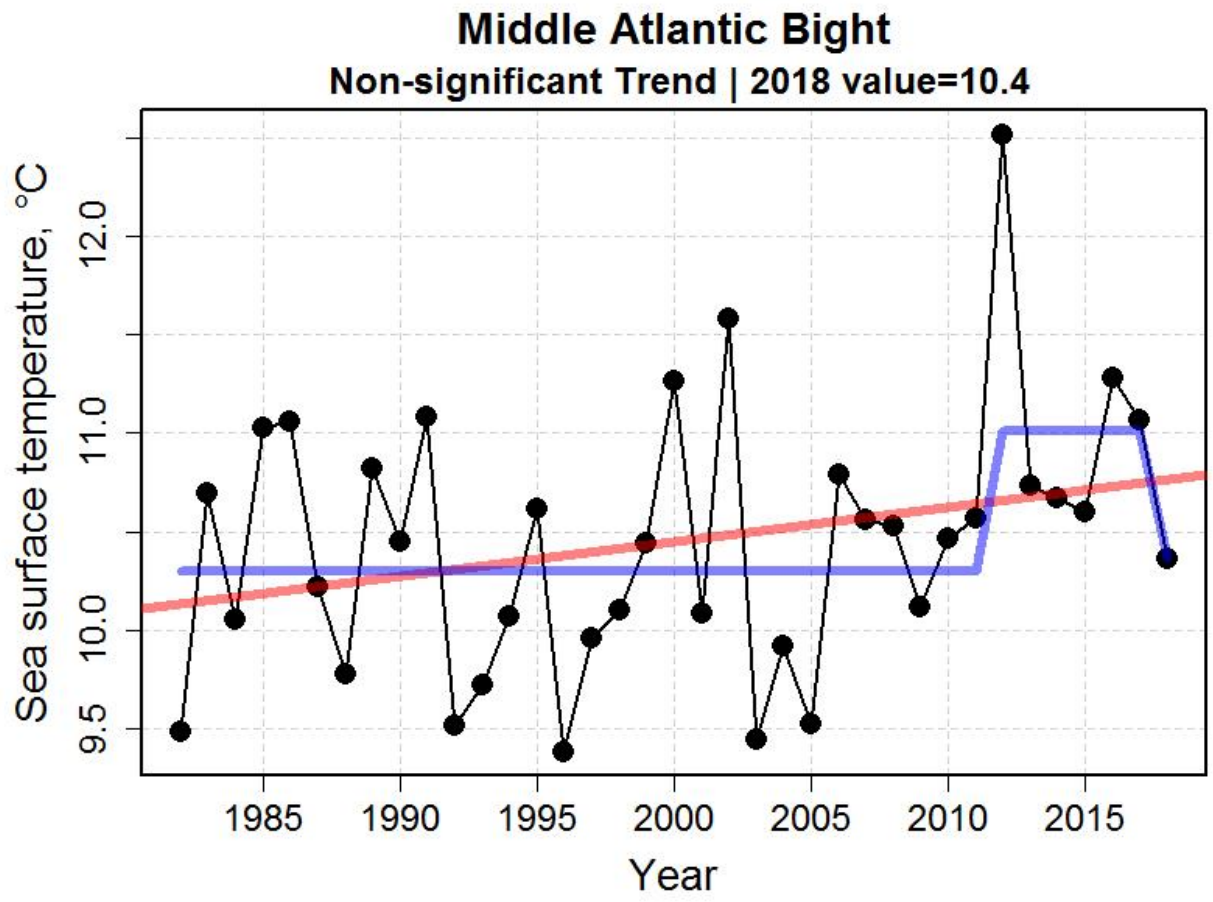
The OISTT sea surface temperature data is based on satellite measurements and provides high spatial and temporal resolution depictions of temperature trends. The SST conditions for the first half of 2018 were generally at above average levels in all ecoregions, however, noting that thermal conditions have moderated since the record high temperatures recorded in 2012. The Gulf of Maine SST time series appears to have two features associated with it, a suggestion of a significant long-term trend and an abrupt change within the last decade (see graph). These time series plots contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue. Though the linear trend in the other ecoregions appear to indicate increasing temperature, none of them appears to be significant. However, all areas provide an indication of an abrupt change in temperature in the last decade.



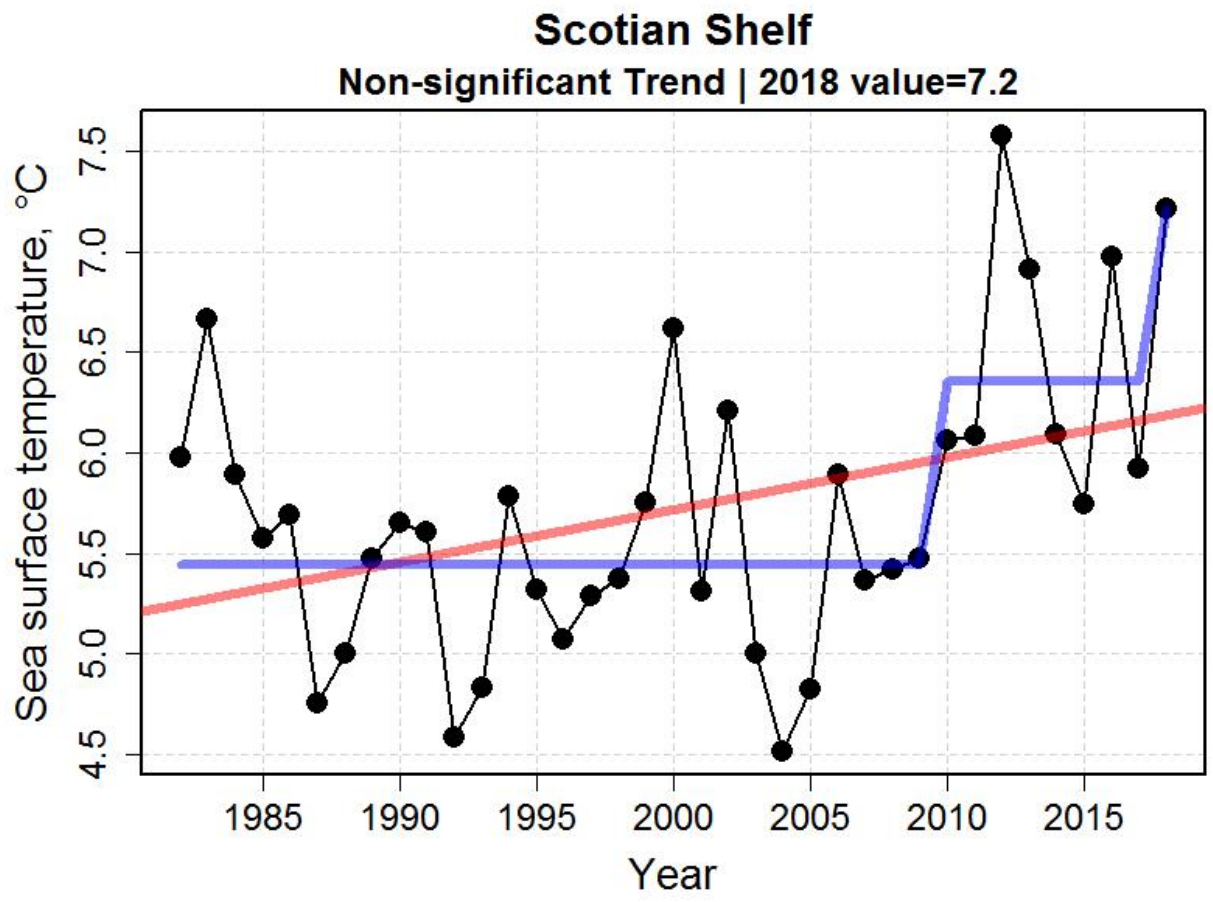
Sea surface temperature time series for Georges Bank during the first half of 2018



Sea surface temperature time series for the Gulf of Maine during the first half of 2018



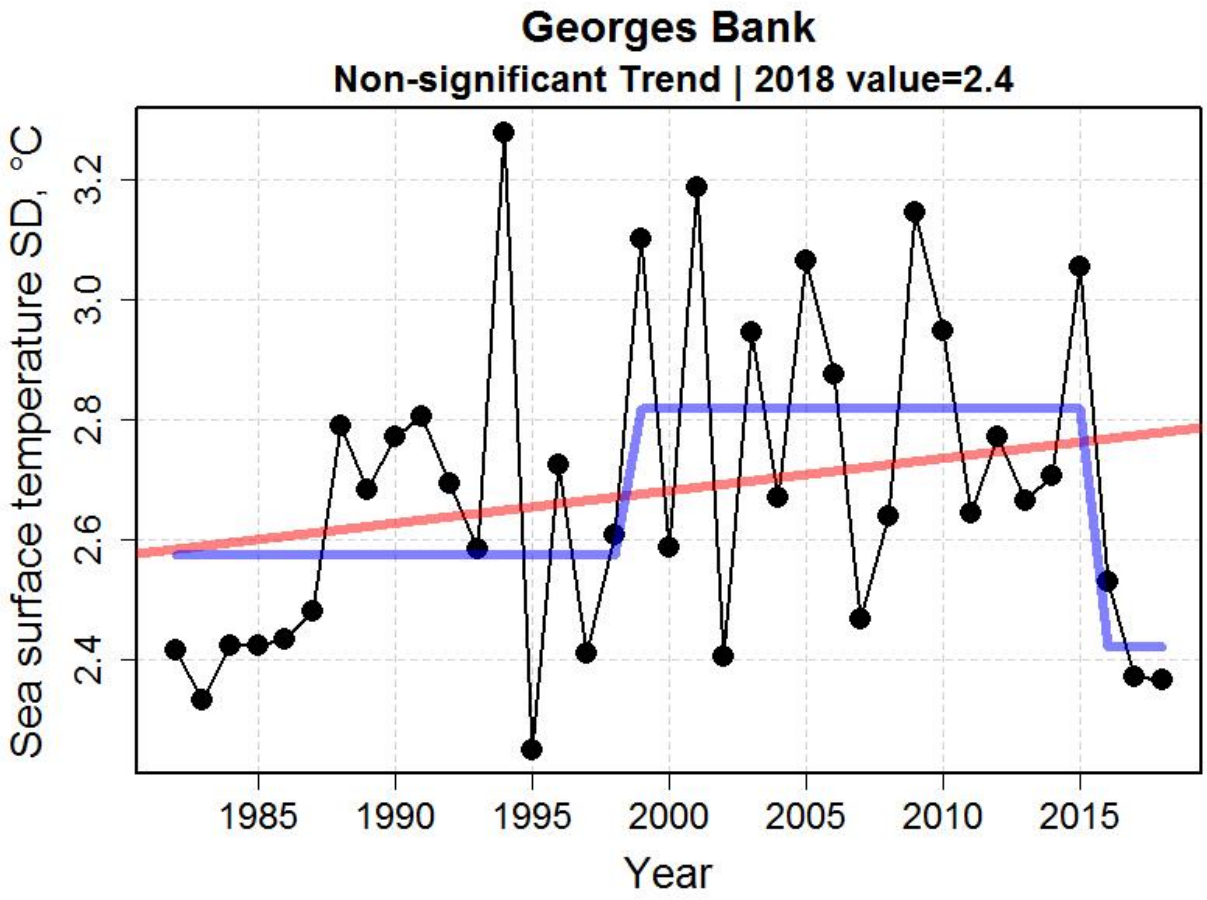
Sea surface temperature time series for the Middle Atlantic Bight during the first half of 2018



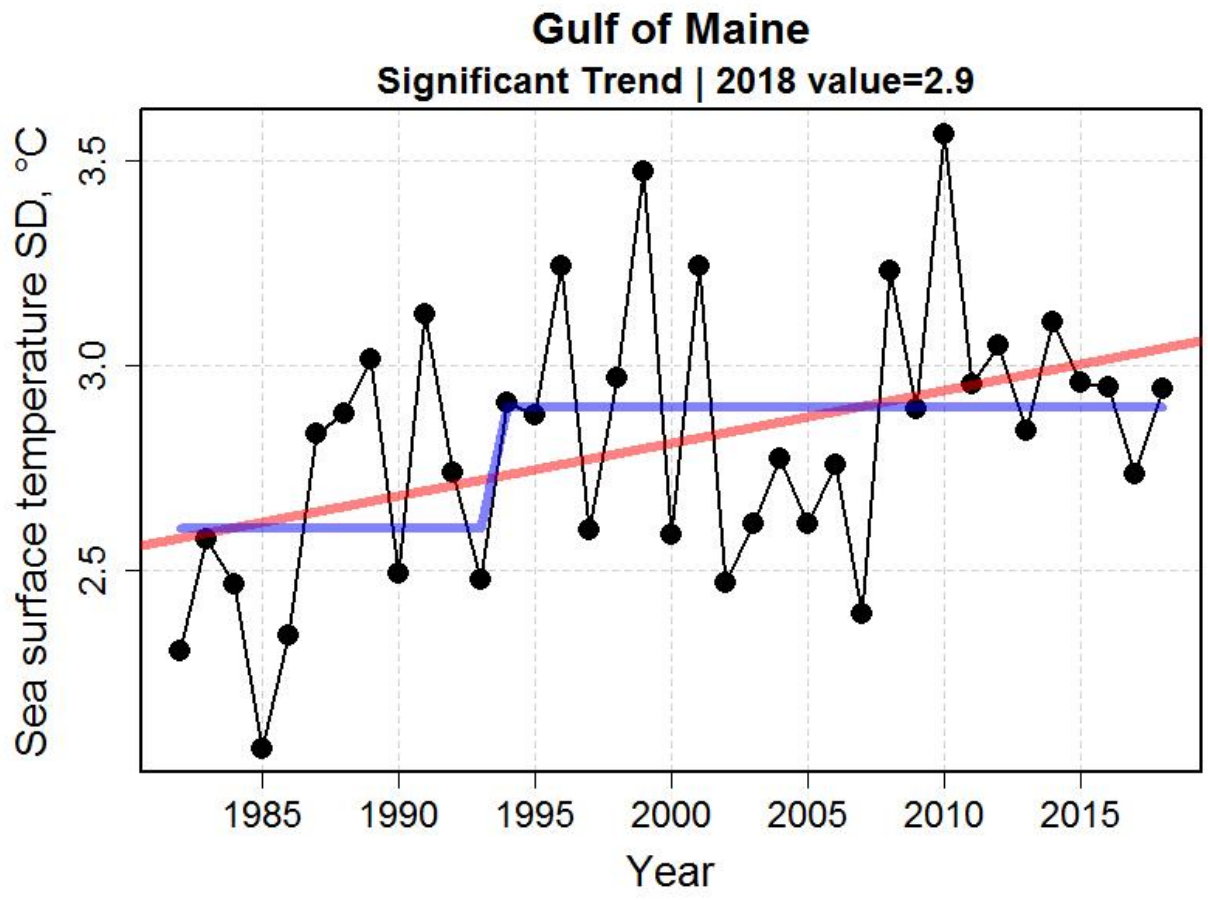
Sea surface temperature time series for the Scotian Shelf during the first half of 2018

Variability in Sea Surface Temperature for the First Half of the Year

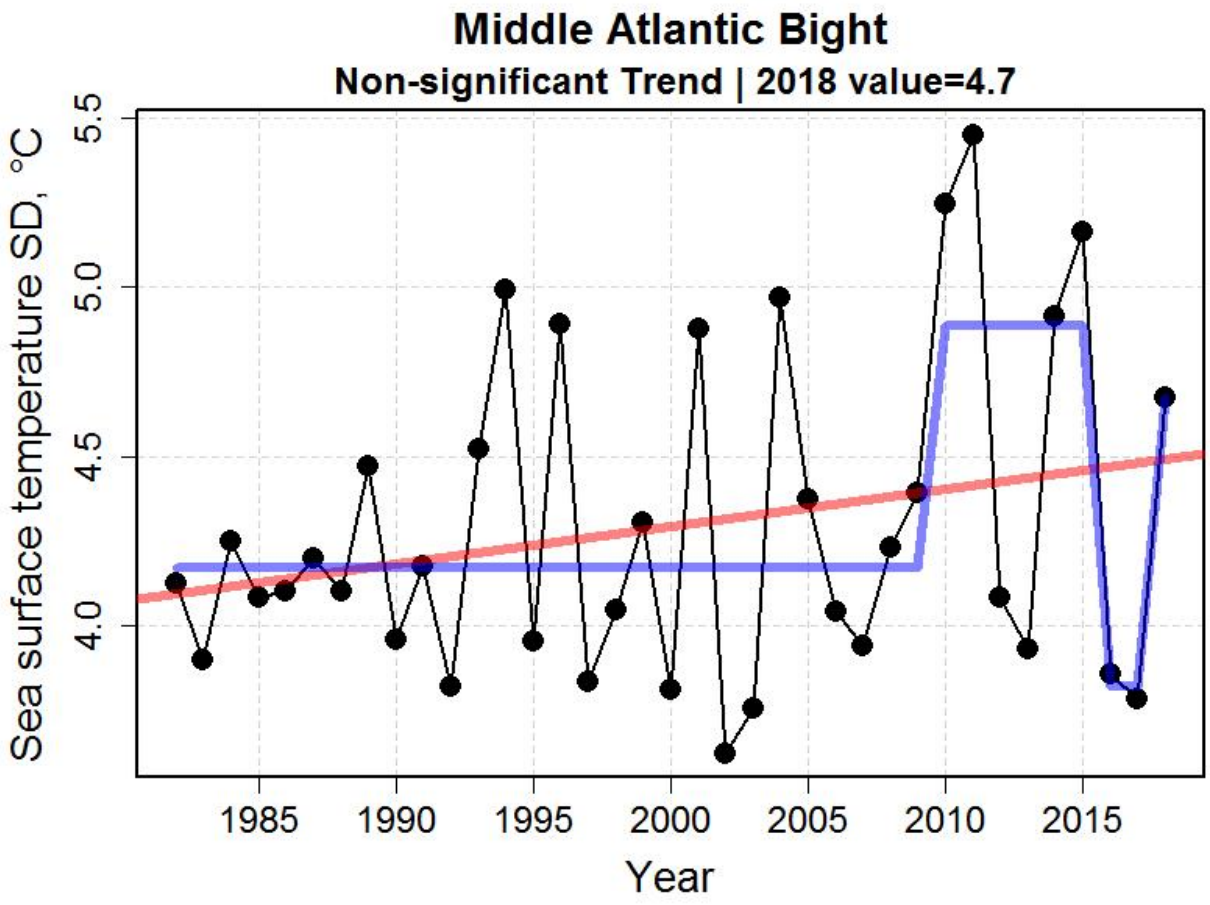
The OISTT sea surface temperature data is based on satellite measurements and provides high spatial and temporal resolution depictions of temperature trends. The variability in sea surface temperature conditions for the first half of year has been increasing in all ecoregions (see graphs). These time series plots contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue. The increasing trends in variability appear to be significant in the Gulf of Maine and Scotian Shelf areas but non-significant in the other areas. There were no clear-cut patterns in any change points in variability between areas.



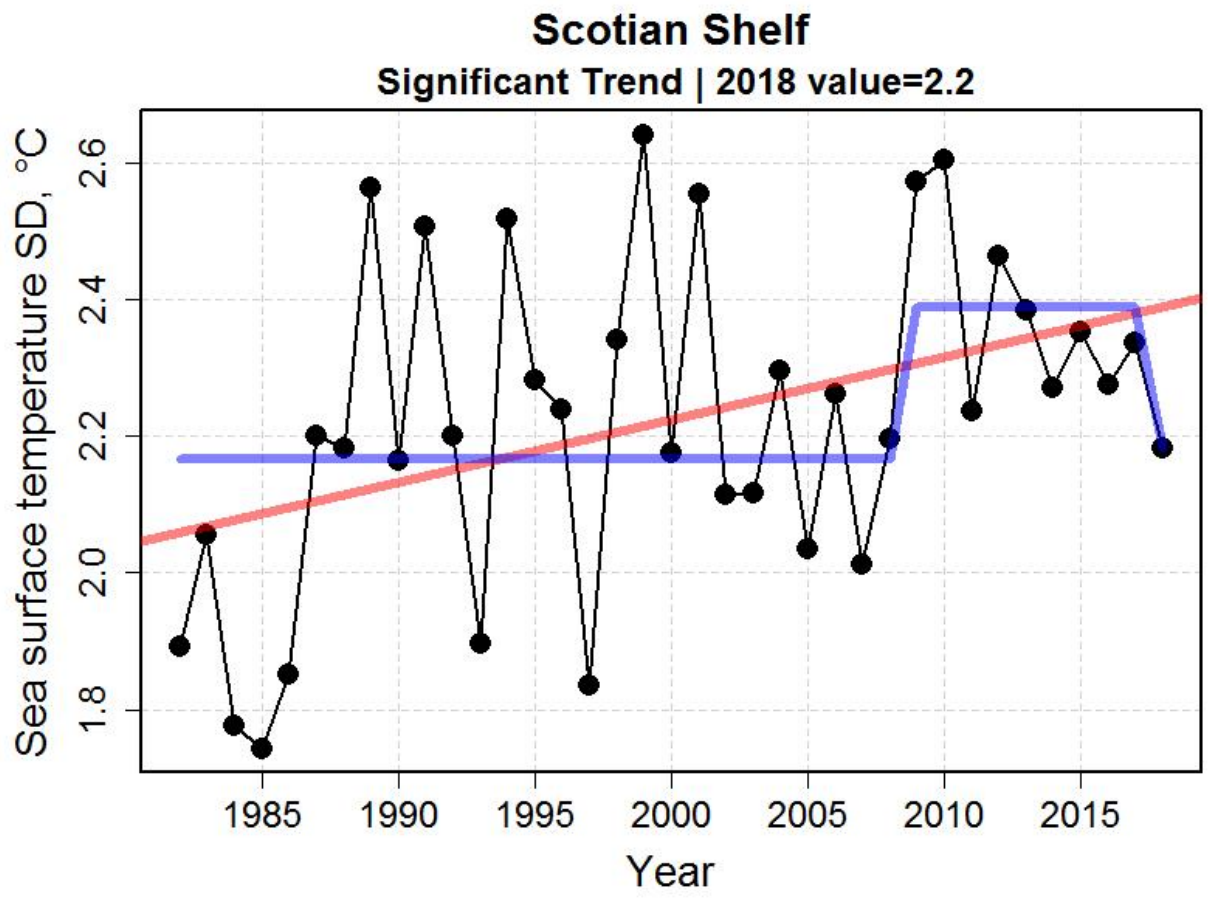
Sea surface temperature variability for Georges Bank during the first half of 2018



Sea surface temperature variability for the Gulf of Maine during the first half of 2018



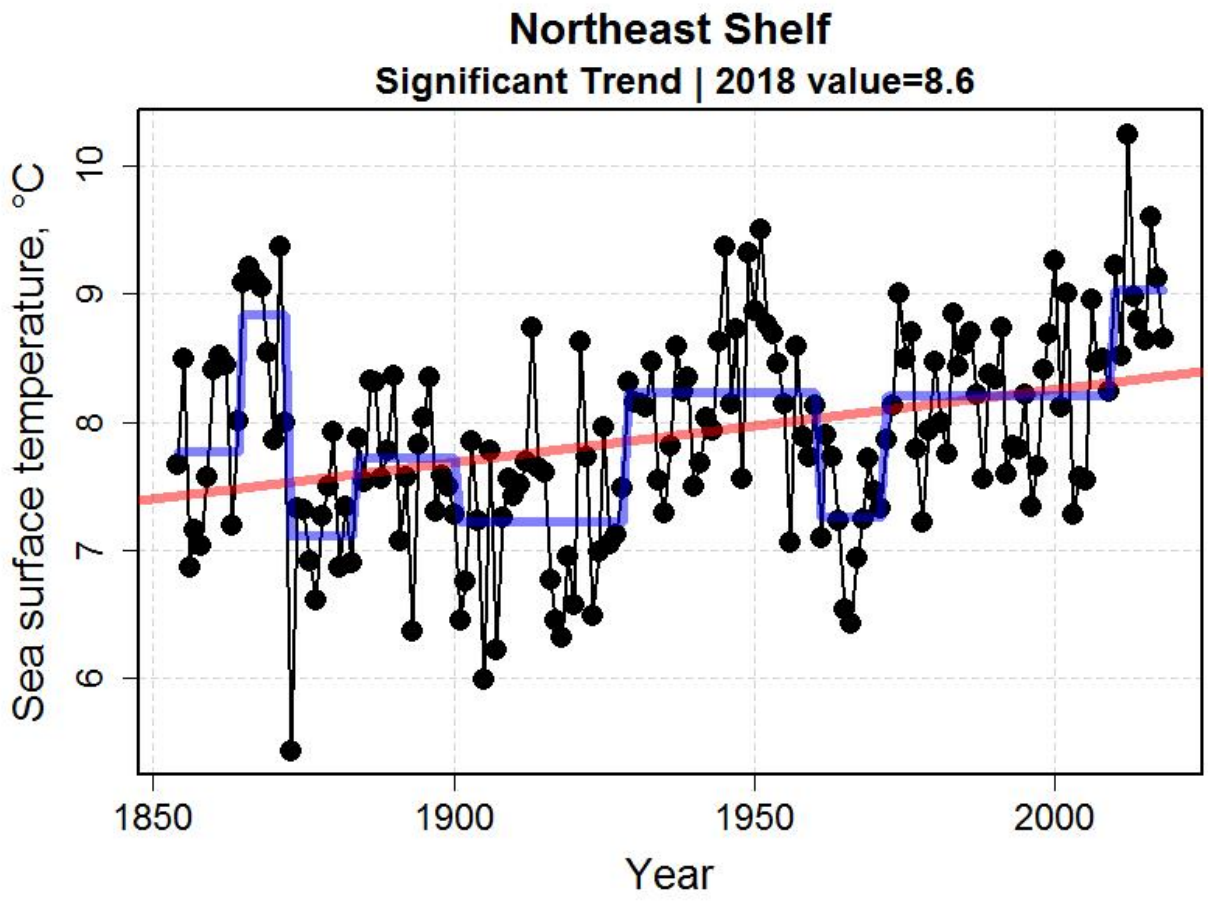
Sea surface temperature variability for the Middle Atlantic Bight during the first half of 2018



Sea surface temperature variability for the Scotian Shelf during the first half of 2018

Long-term Sea Surface Temperature for the First Half of the Year

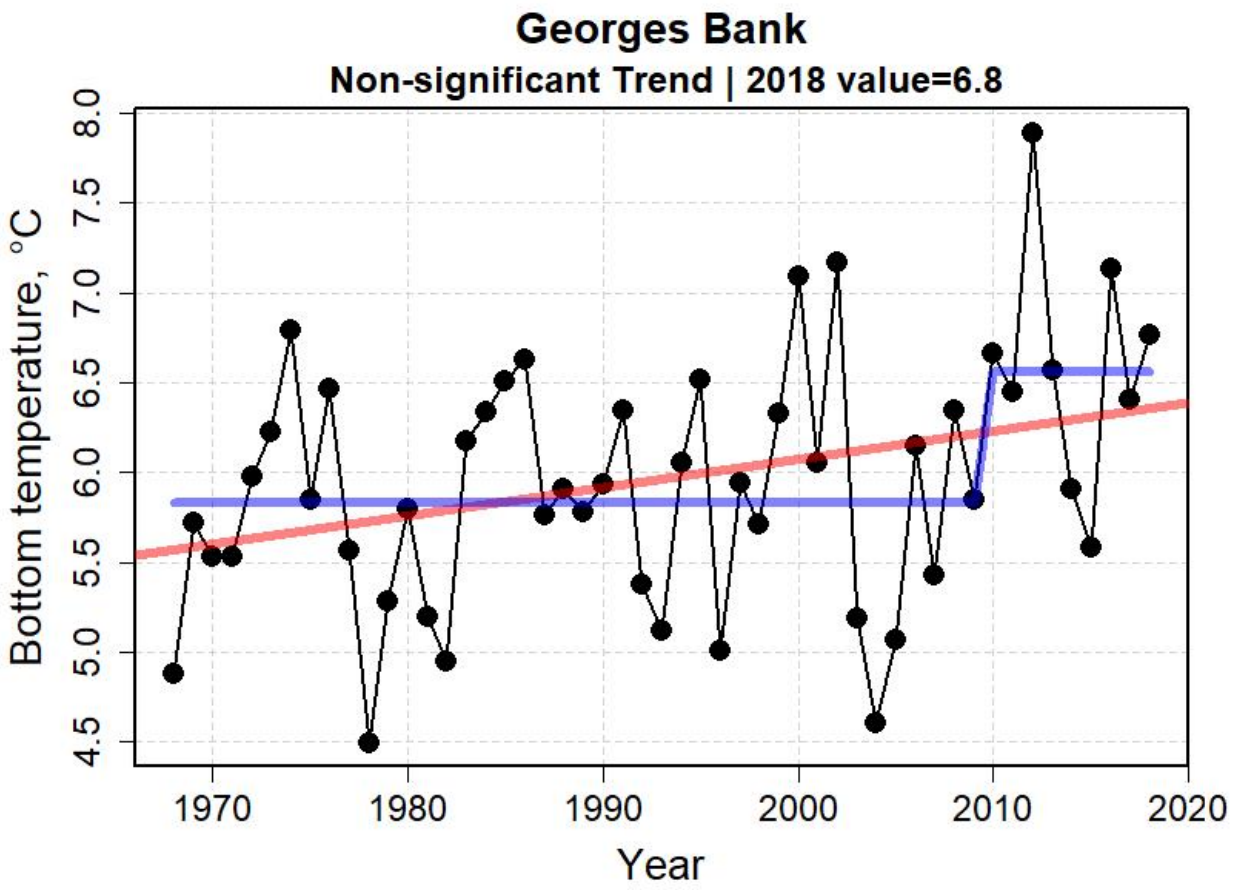
The ERSST temperature time series provides a low resolution depiction of sea surface temperature on the Northeast Shelf since the 1850s and is based on historical shipboard measures and augmented with other data in recent years. The SST conditions for the first half of 2018 were above average and generally match the sea surface temperatures seen during the warm period of the late 1940s and early 1950s (see graph). These time series plots contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue.



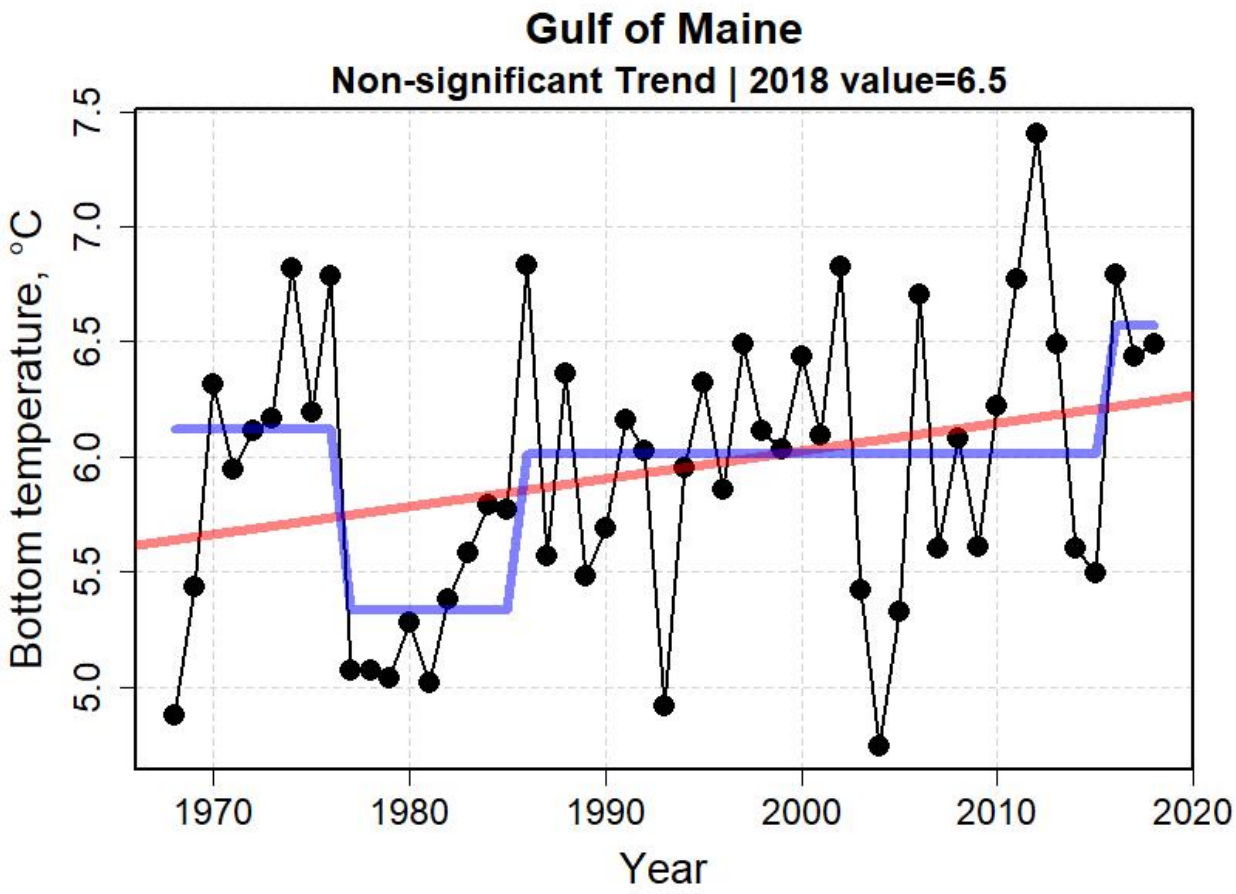
Long-term sea surface temperature for the first half of 2018

Bottom Temperature for the First Half of the Year

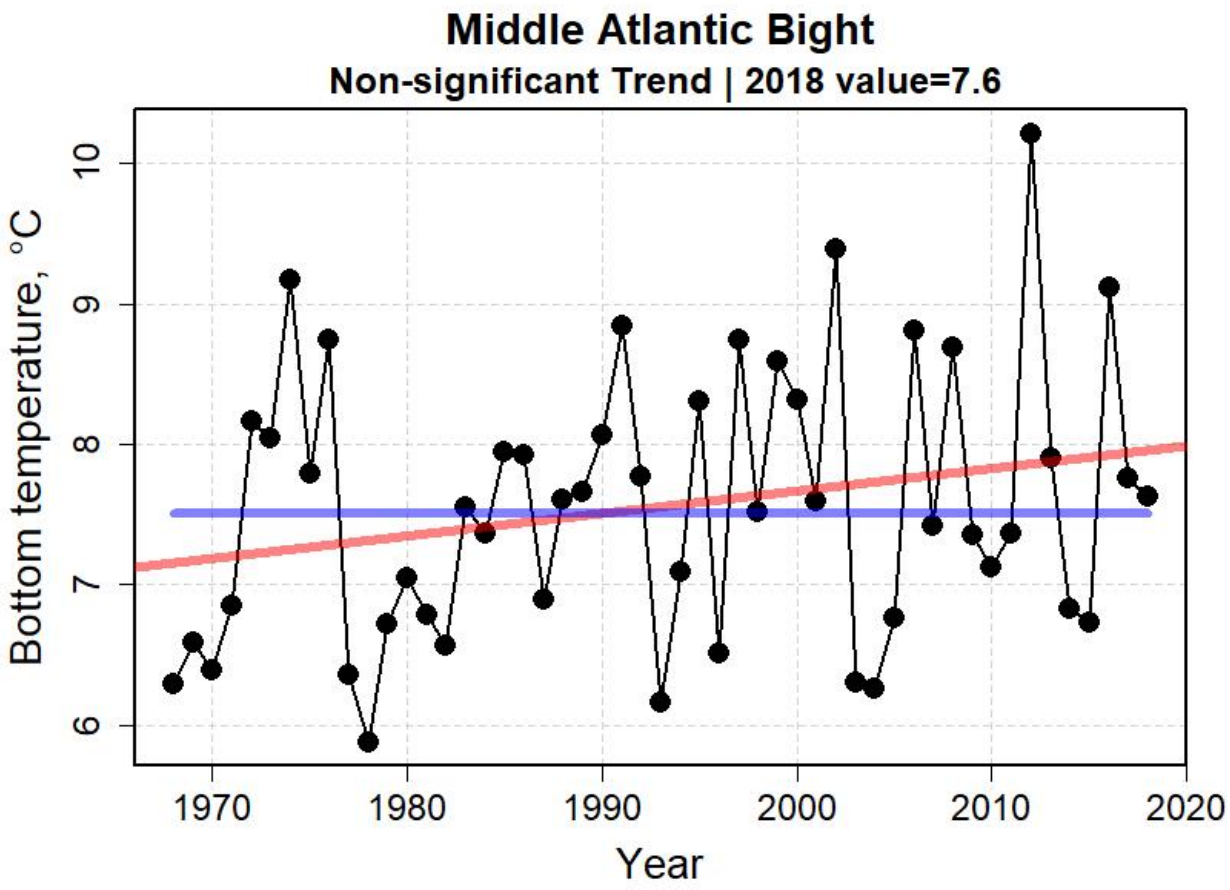
The thermal conditions at the bottom of the water column are extremely important in defining the habitats for the majority of resource species. Unlike sea surface temperatures that can be measured synoptically with satellite telemetry, bottom temperatures must be measured directly from ship surveys and other means. Thus, we often have incomplete spatial and temporal sample coverage to describe bottom temperature conditions. Recently, scientists at the NEFSC developed an interpolation approach that provides a more accurate depiction of bottom temperatures. The temperature conditions for the first half of year has been increasing in all ecoregions (see graphs). These time series plots contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue. The increasing trend in bottom temperatures appear to be significant in the Scotian Shelf only. There were no suggestions of any change points in temperature in the Middle Atlantic Bight; however, there were change points in the Scotian Shelf and Georges Bank areas around 2010.



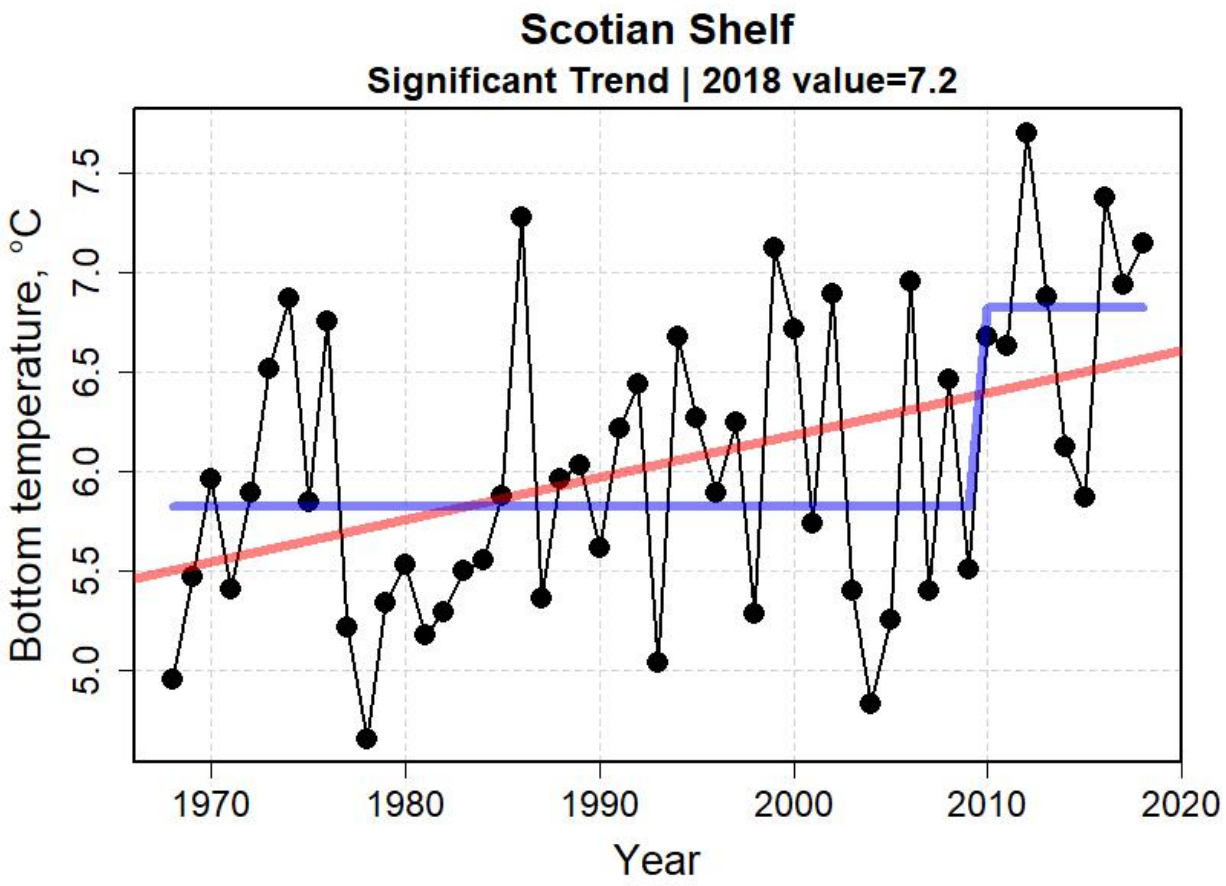
Bottom temperatures for the first half of 2018 on Georges Bank



Bottom temperatures for the first half of 2018 in the Gulf of Maine



Bottom temperatures for the first half of 2018 in the Middle Atlantic Bight



Bottom temperatures for the first half of 2018 on the Scotian Shelf

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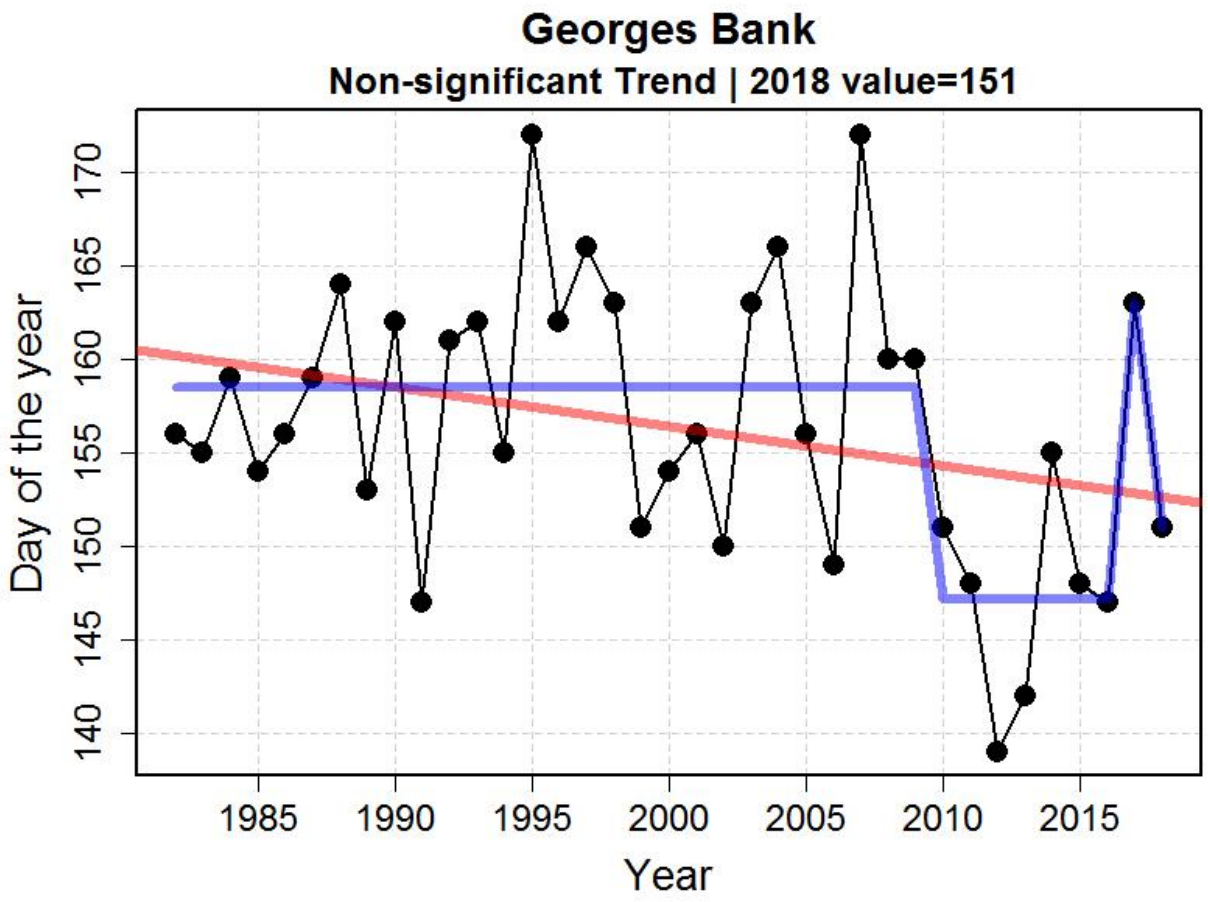
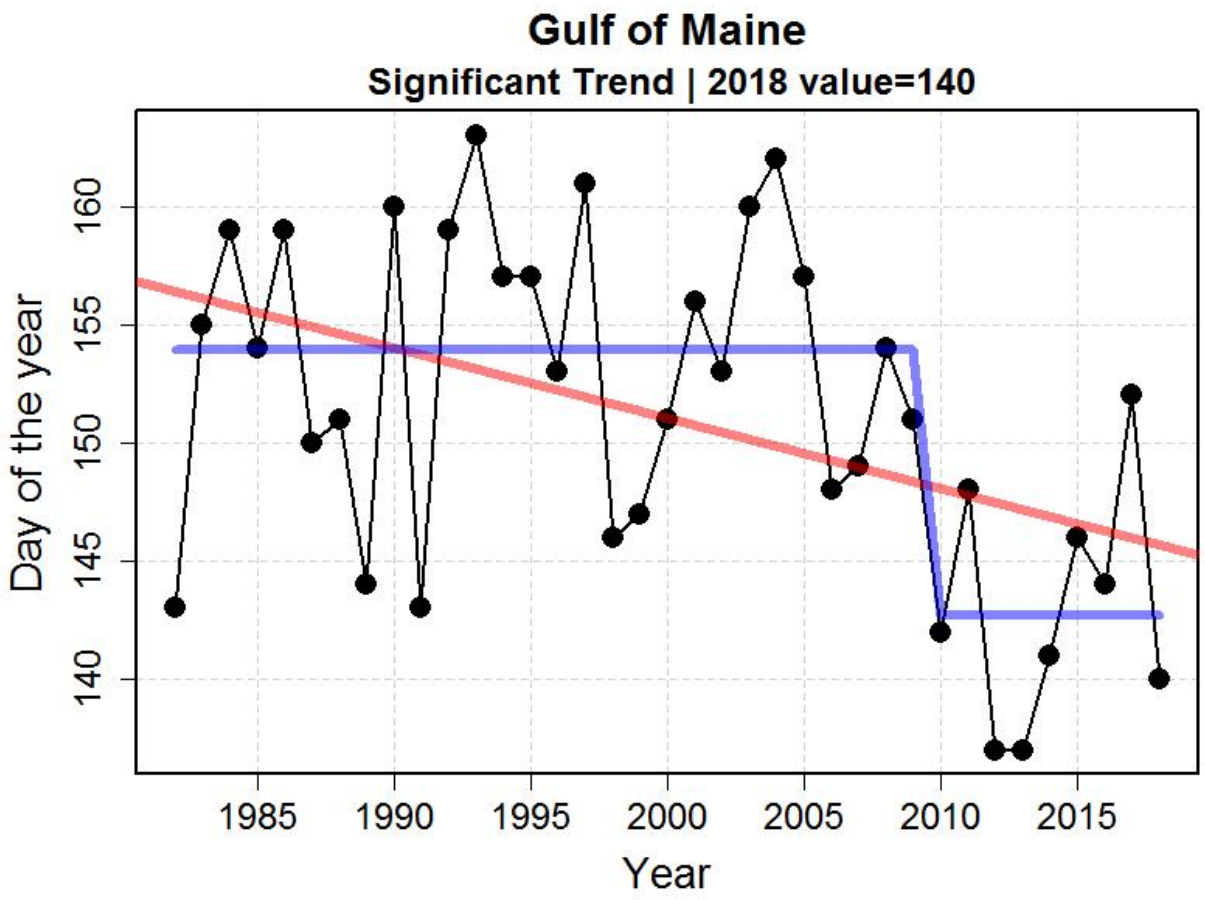
Spring Thermal Transition Day of the Year

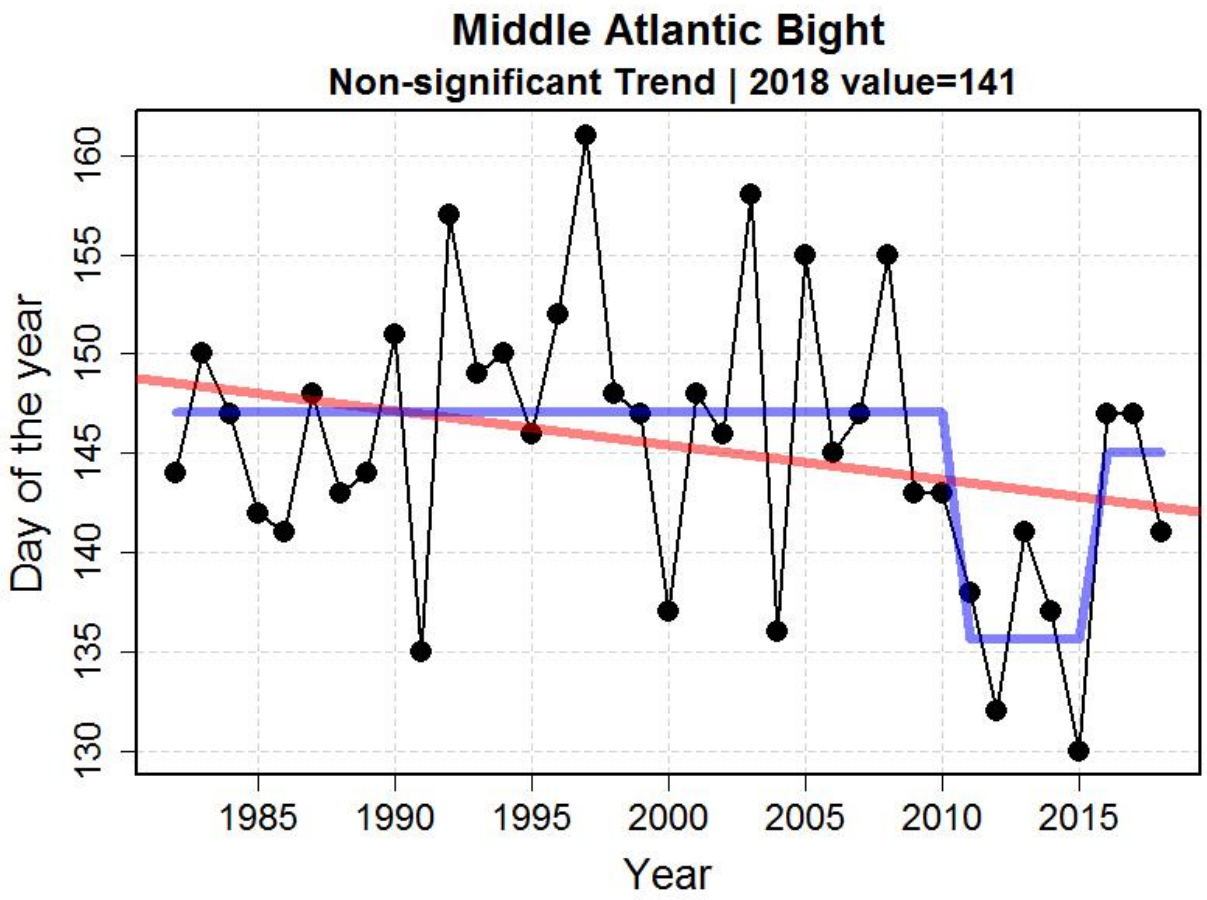
Phenology is the climate influence on the timing between plant and animal production cycles. Many marine organisms time their reproductive cycles to best utilize seasonal phytoplankton blooms, like the spring bloom, and in turn, temperature plays a role in the development of the spring bloom. One measure to characterize the change in the timing of thermal forcing is the date of arrival of a spring transition temperature, which will vary by region and is meant to mark the average temperature between winter and summer. The date of arrival of the spring thermal transition temperature has been relatively constant since 1982 to approximately 2010 for the Northeast Shelf ecoregions (see graphs). These time series plots contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue. The trend in transition day appears significant in the Gulf of Maine and Scotian Shelf. In all areas, there is an indication of a change point around 2010 where spring transition date advanced approximately two weeks.



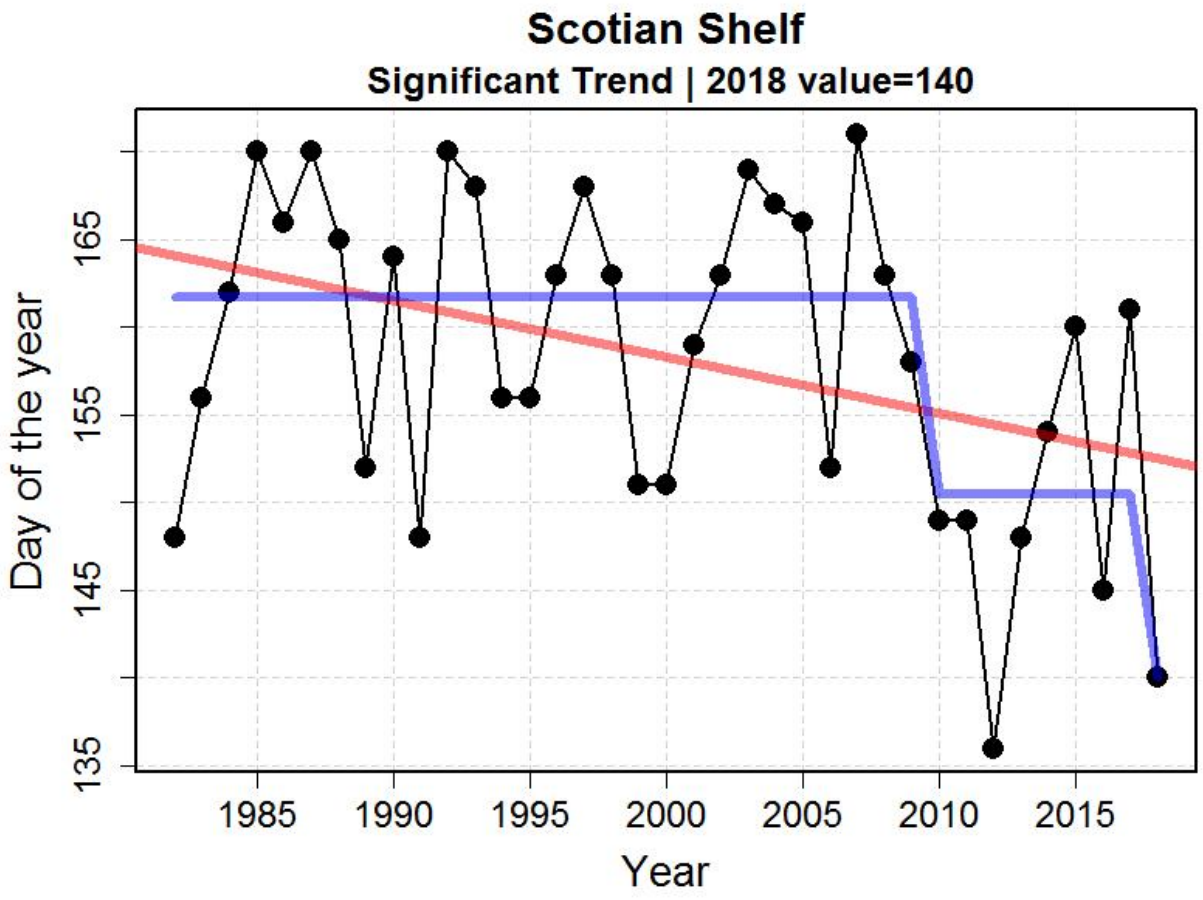
Spring thermal transition day of the year for Georges Bank



Spring thermal transition day of the year for the Gulf of Maine



Spring thermal transition day of the year for the Middle Atlantic Bight



Spring thermal transition day of the year for the Scotian Shelf

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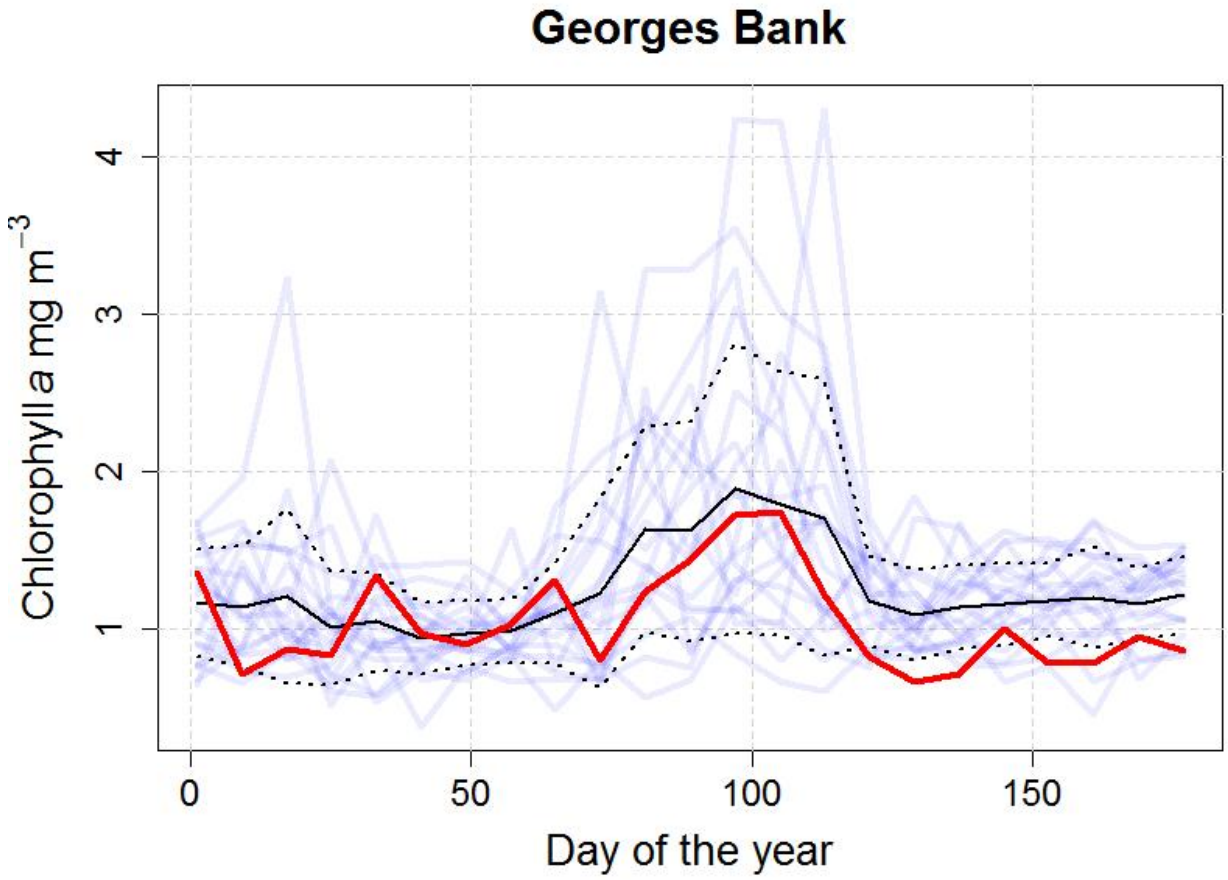
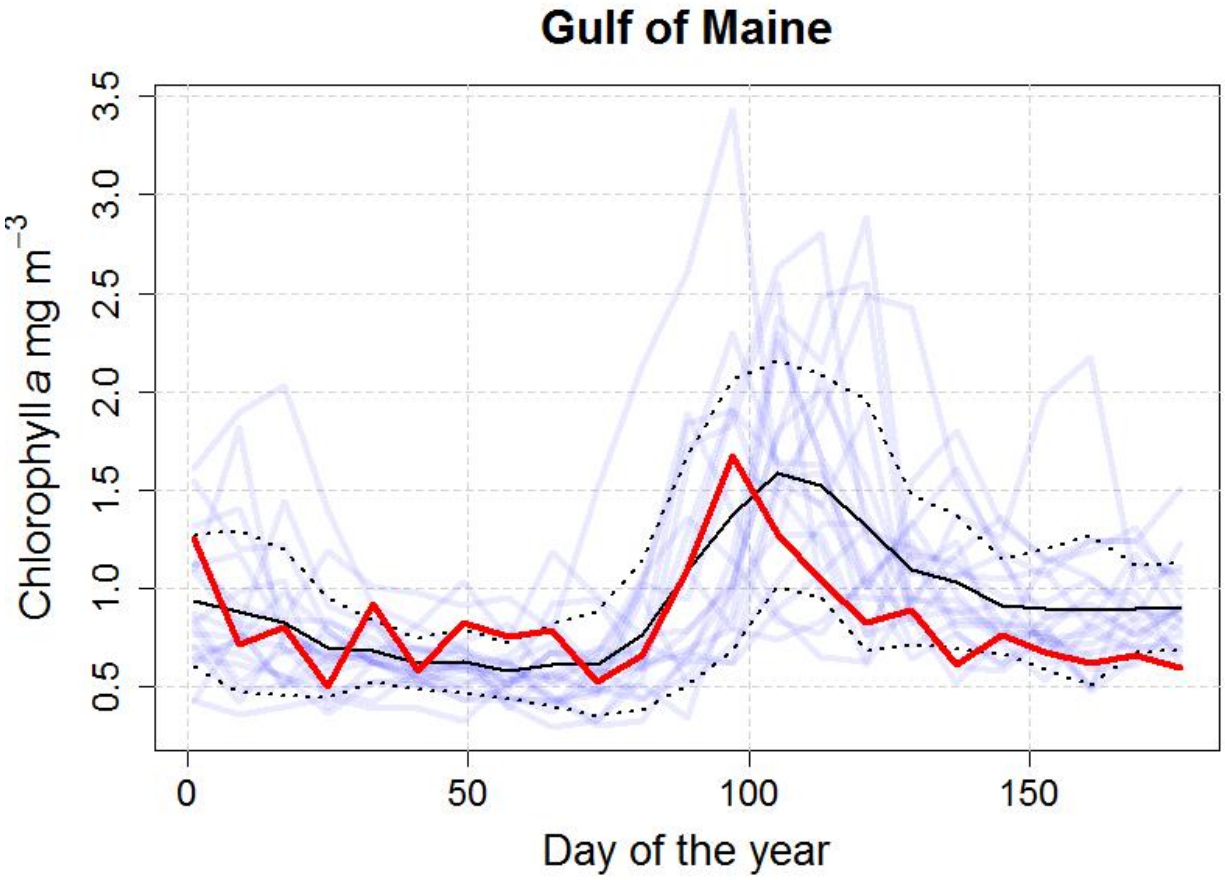
Weekly (8-day time step) Chlorophyll Concentration for the First Half Year

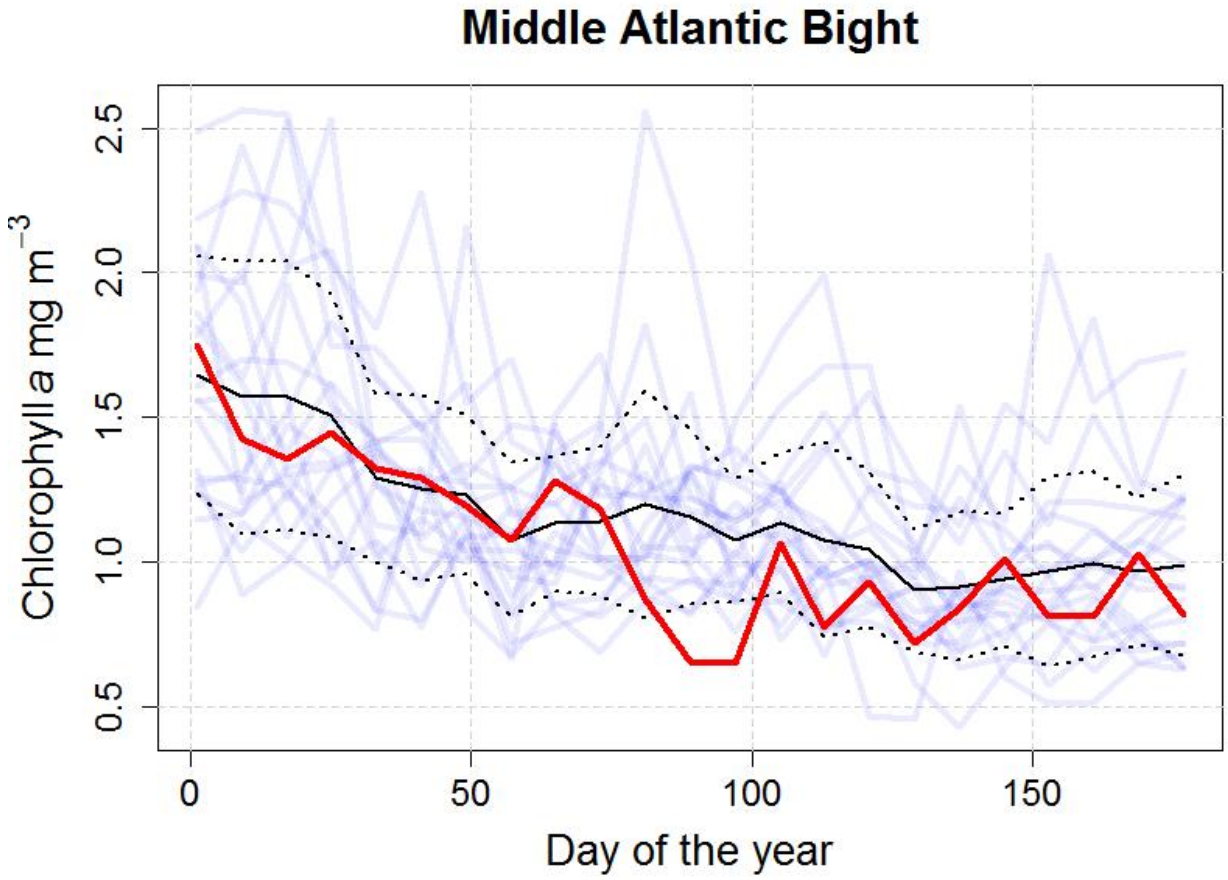
Chlorophyll concentration tended to be at or below average conditions during the first half of 2018. In areas that typically have a spring bloom, such as Georges Bank, chlorophyll concentration was below the long-term mean through the bloom period (see graph). In these plots, the current year chlorophyll concentrations are shown as a red line with all previous years in the dataset, starting in 1998, shown as transparent blue lines; the black line is the time series mean and the dotted lines mark plus/minus one standard deviation. In the Gulf of Maine, also an area that tends to have a spring bloom, chlorophyll concentration was above average for one week, but well below average for most of the bloom period.



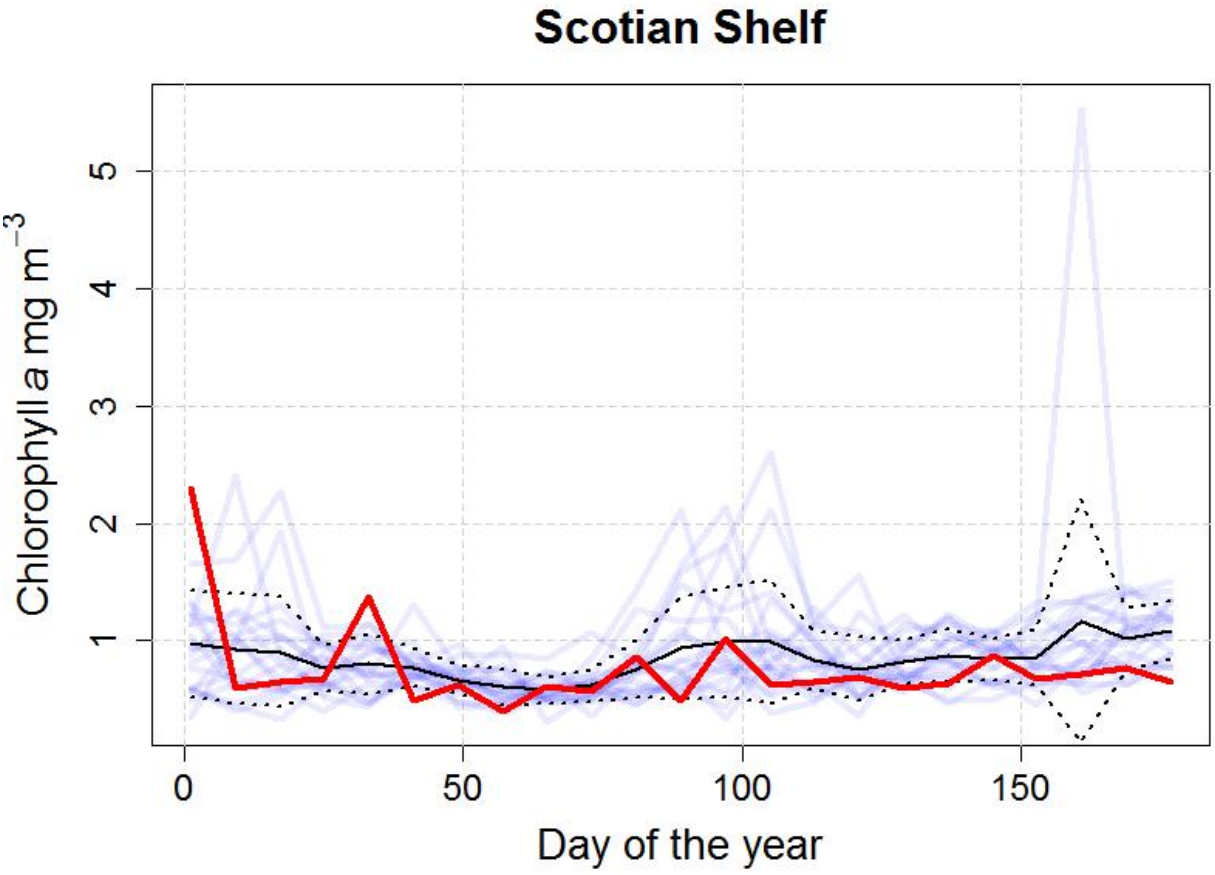
Weekly chlorophyll concentration for the first half of 2018 on Georges Bank



Weekly chlorophyll concentration for the first half of 2018 in the Gulf of Maine



Weekly chlorophyll concentration for the first half of 2018 in the Middle Atlantic Bight



Weekly chlorophyll concentration for the first half of 2018 on the Scotian Shelf

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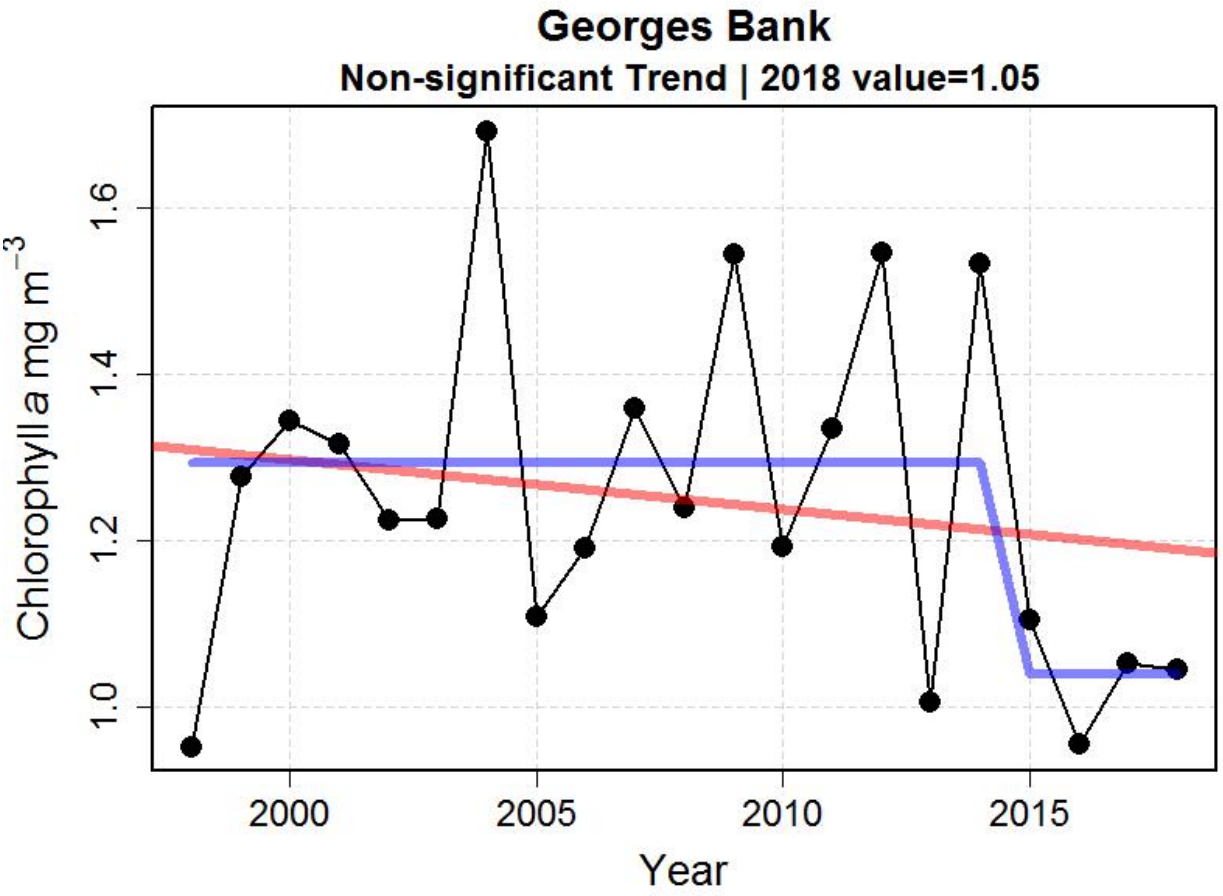
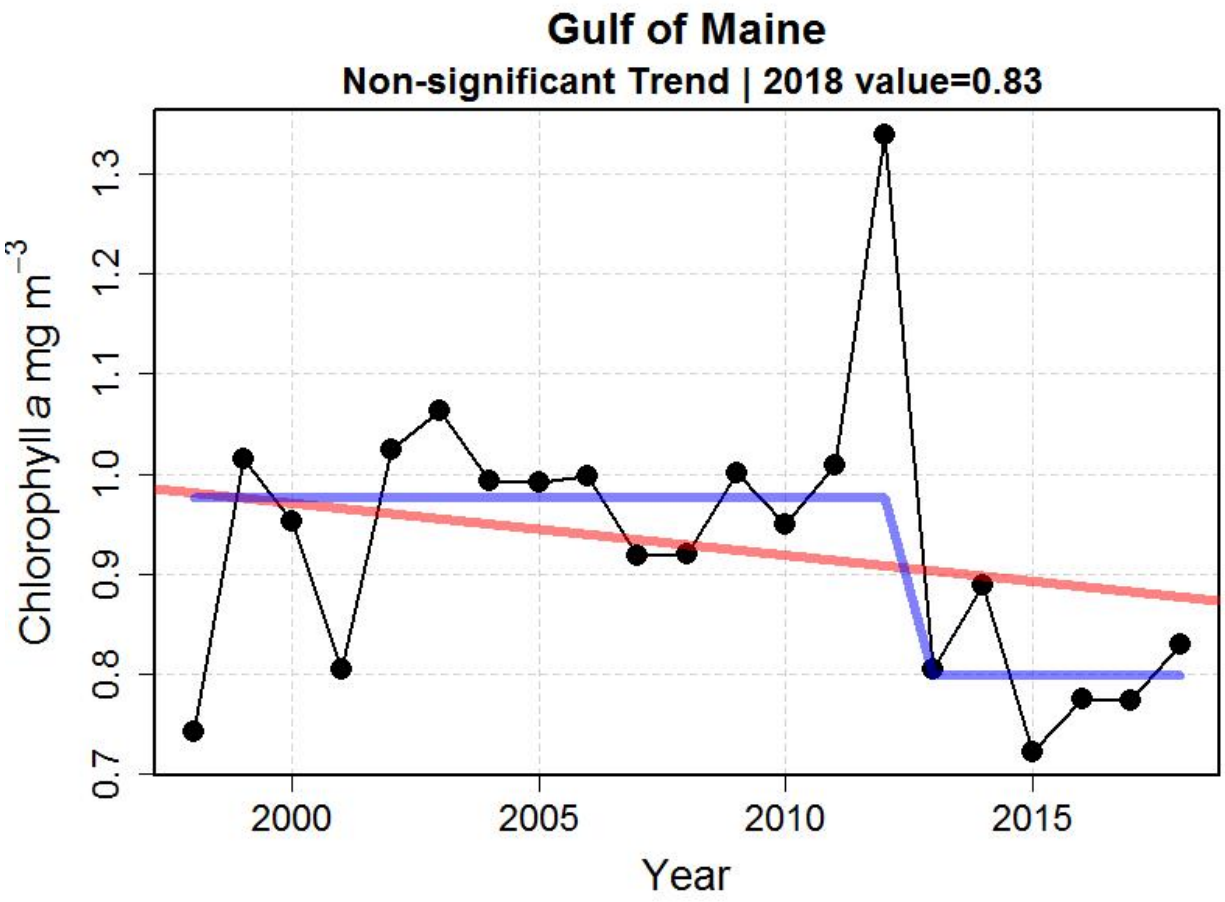
Chlorophyll Concentration for the First Half Year

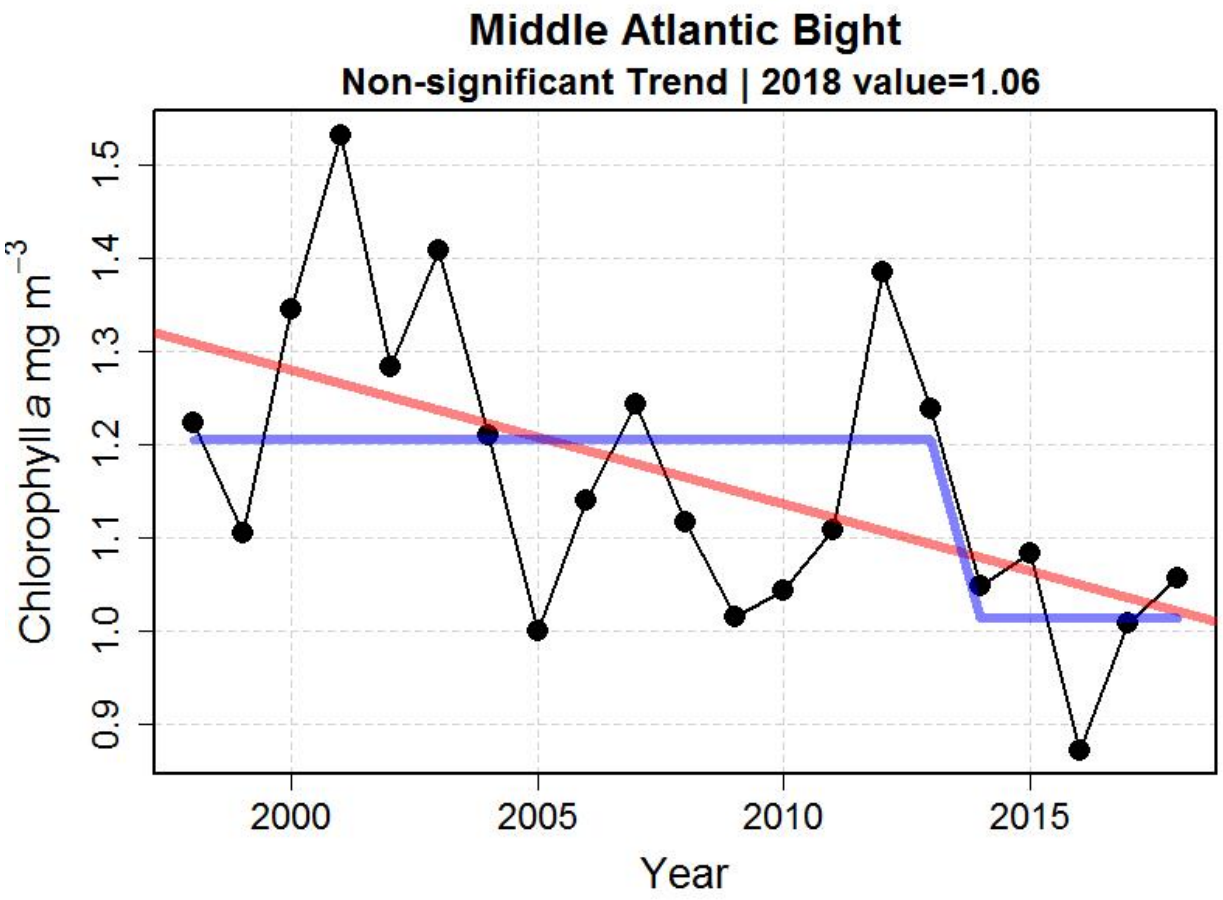
Chlorophyll concentration appears to have decreased in recent years in all areas of the ecosystem. The most dramatic decline appears to have occurred in the Middle Atlantic Bight, however, this trend, as in the other ecoregions, is non-significant (see graph). These time series plots contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue. It is noteworthy that a change point in chlorophyll concentration has been identified in all areas within the last decade or so.



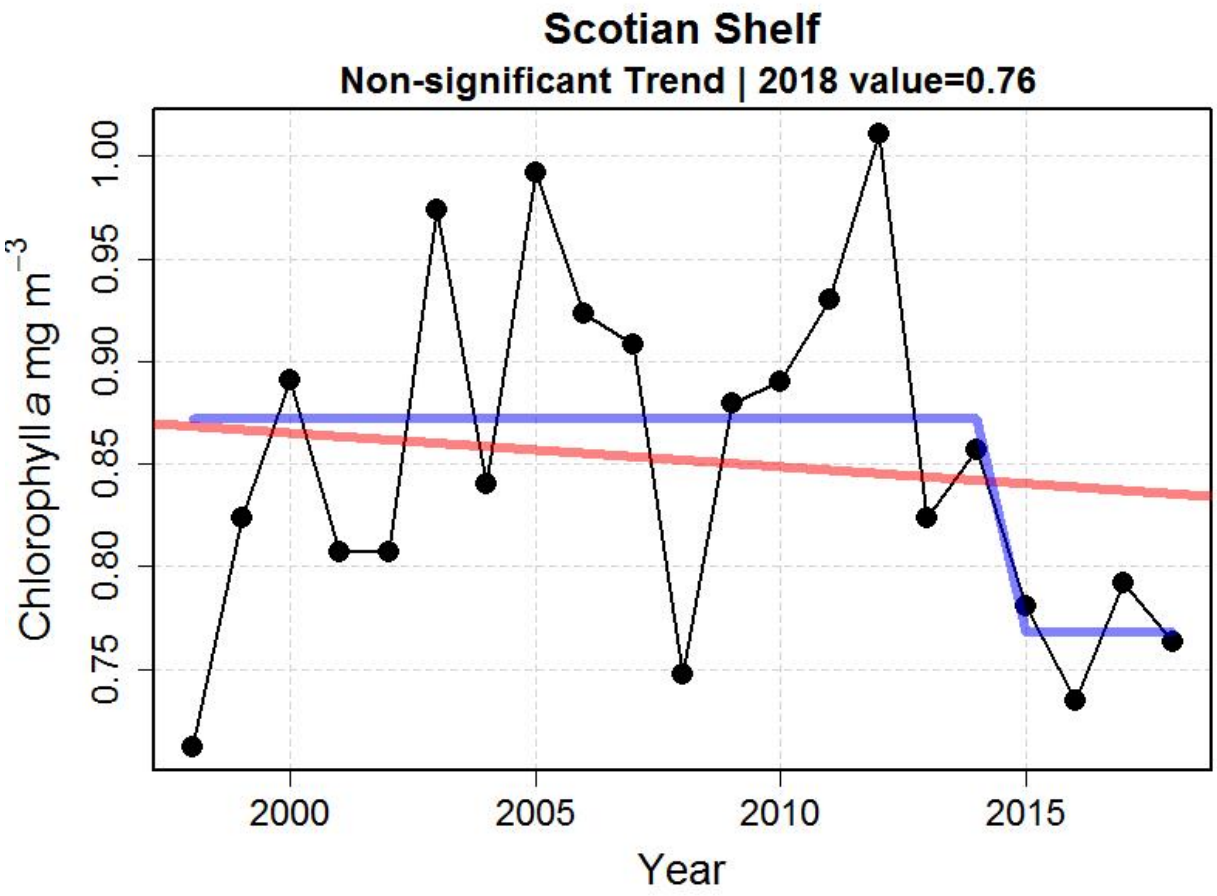
Chlorophyll concentration for the first half of 2018 on Georges Bank



Chlorophyll concentration for the first half of 2018 in the Gulf of Maine



Chlorophyll concentration for the first half of 2018 in the Middle Atlantic Bight



Chlorophyll concentration for the first half of 2018 on the Scotian Shelf

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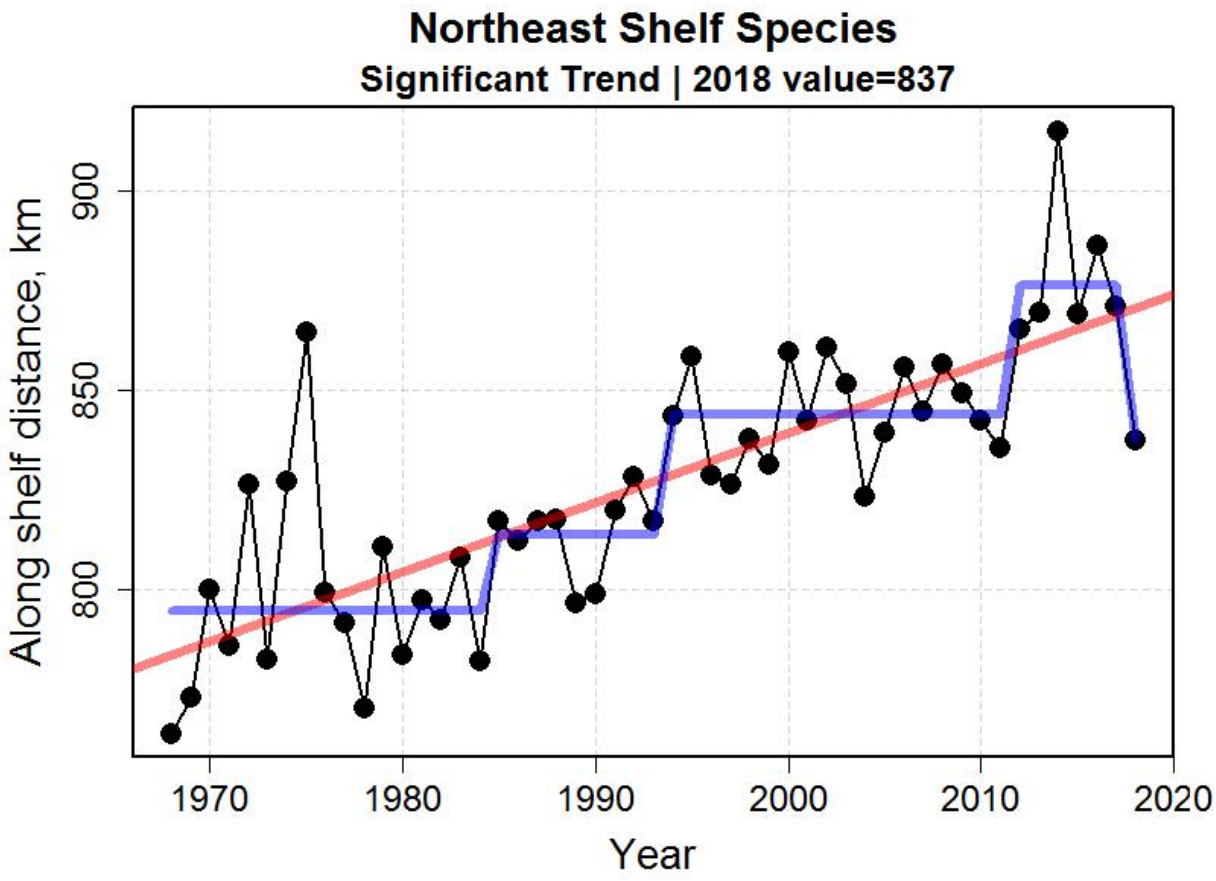
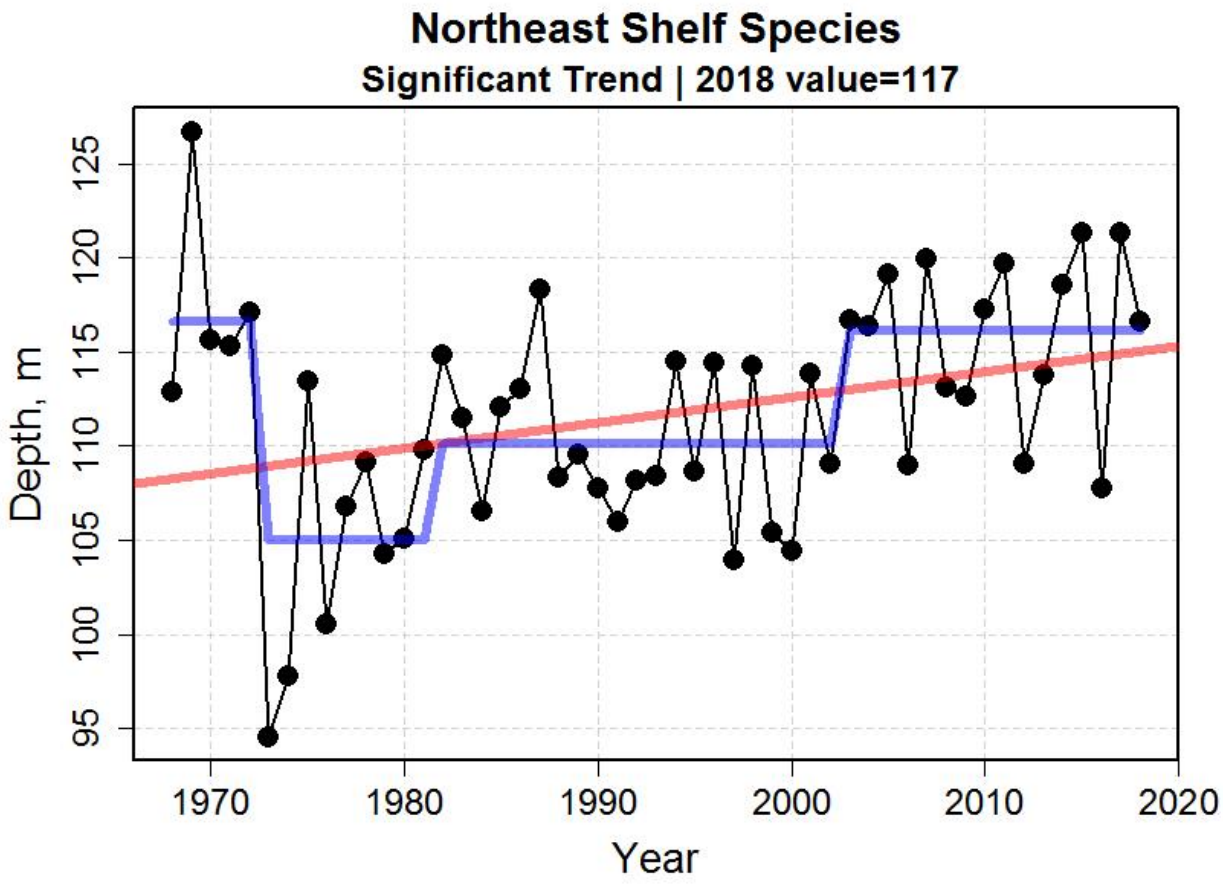
Trends in Species Distribution Metrics for the First Half Year

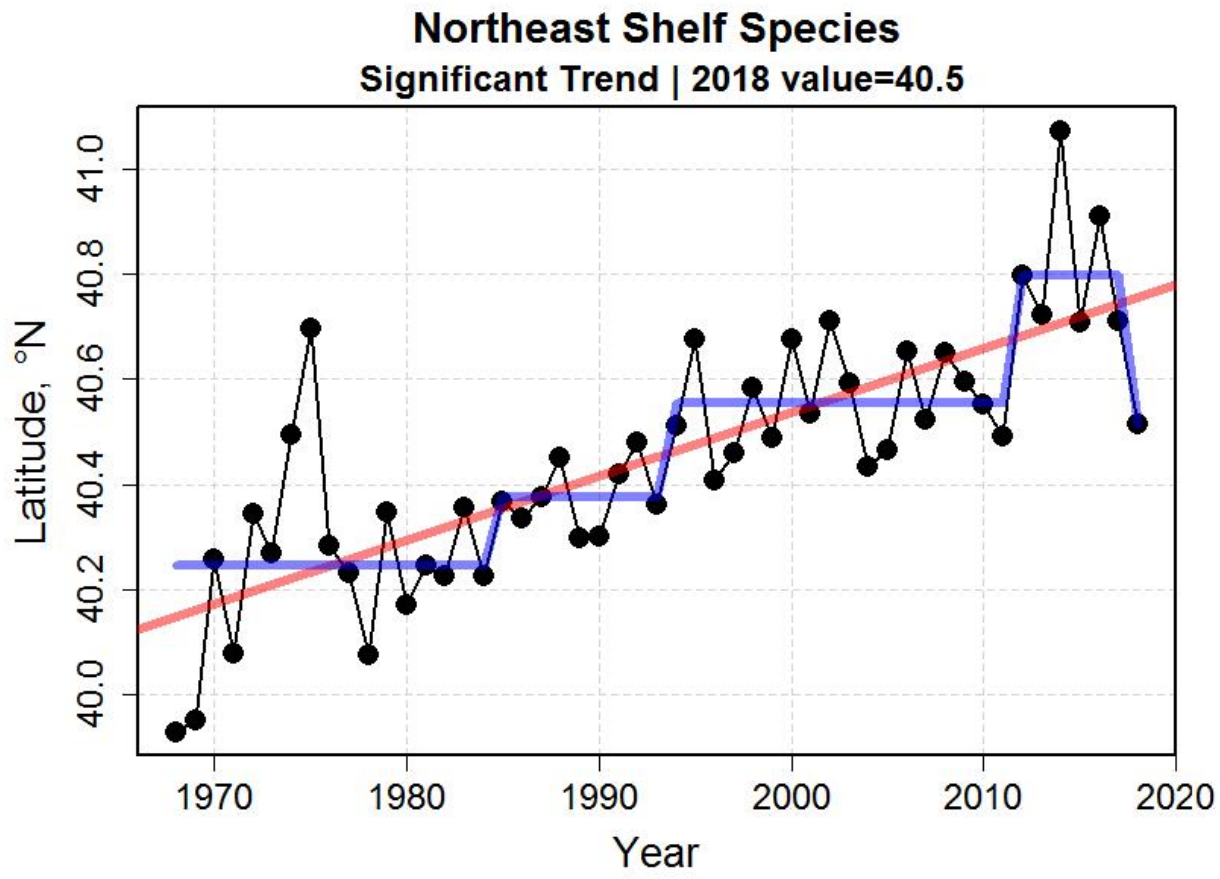
The species of the Northeast Shelf ecosystem have shown changes in distribution over recent decades. Individual species have shifted distribution due to a number of reasons and these shifts can be characterized with metrics including the center of gravity of: 1) along shelf position in the ecosystem along an axis oriented from the southwest to the northeast; 2) the depth of occurrence; 3) latitude; 4) longitude; and, 5) distance to the coastline. The mean of these metrics for 48 of the more abundant Northeast Shelf species are shown in time series plots that contain the linear trend shown in red with an indication of the significance of the trend in the title and a change point indicator shown in blue. All these metrics have increased significantly with the exception of distance to the coast (see graphs), indicating a continuing shift of species distribution to the northeast and into deeper water.



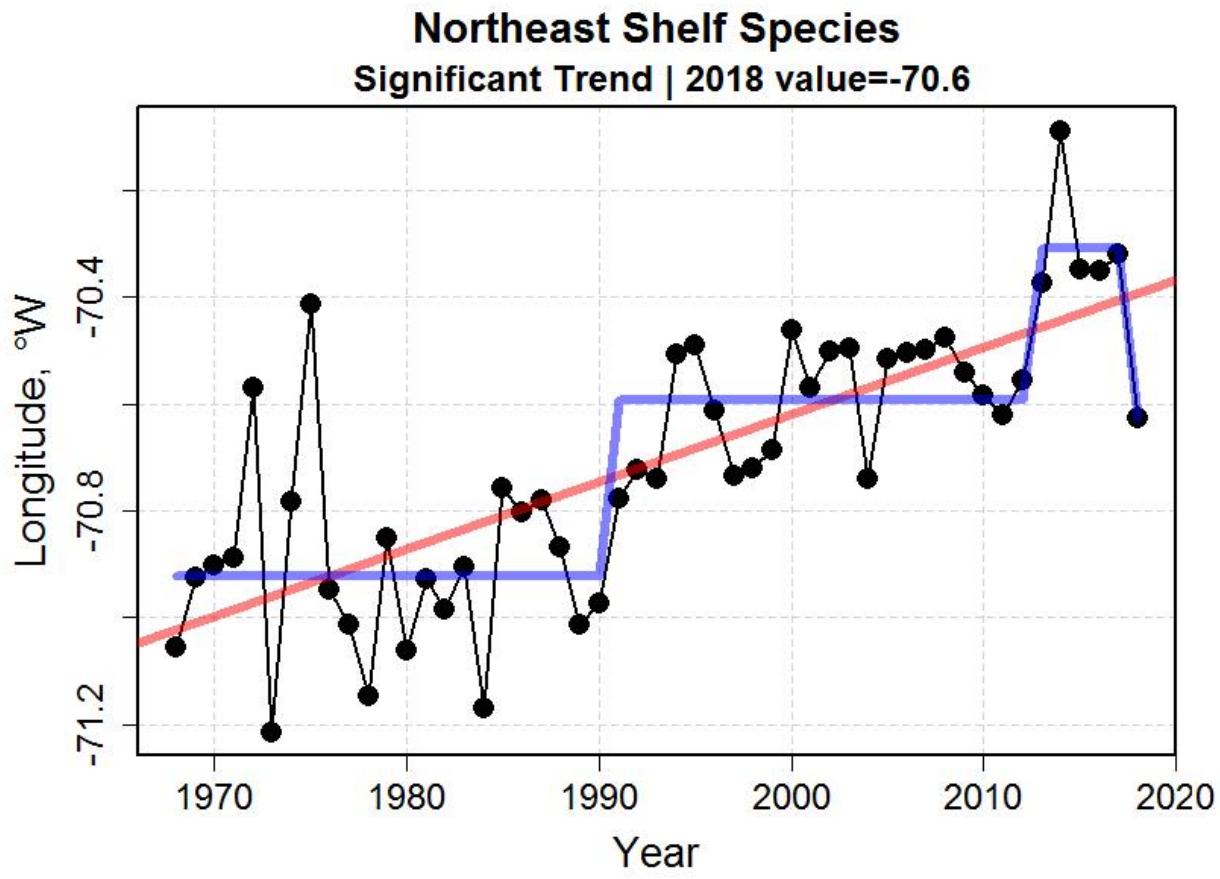
Along-shelf species distribution trends for the first half of 2018



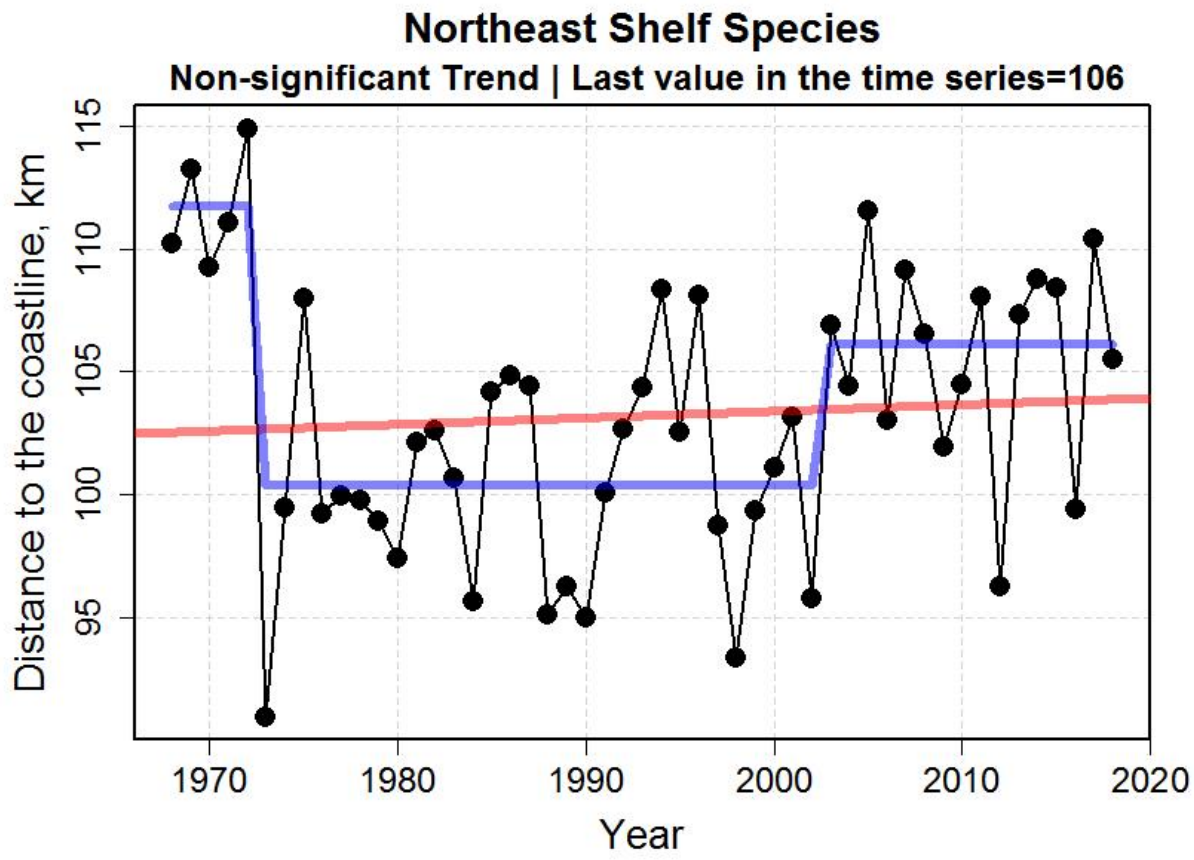
Species distribution trends by depth for the first half of 2018



Species distribution trends by latitude for the first half of 2018



Species distribution trends by longitude for the first half of 2018



Species distribution trends by distance from coastline for the first half of 2018