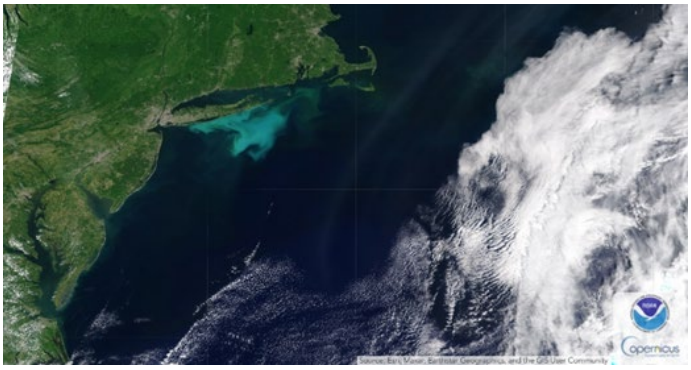
Tutorial: Ocean Color & Water Quality

Comparing Chlorophyll and monitored coastal water conditions using ArcGIS Pro (desktop). **Tutorial requires the *spatial analysis tool* or *image analysis tool***



Chlorophyll-a is a widely used proxy for phytoplankton biomass and an indicator for changes in phytoplankton production. As an essential source of energy in the marine environment, the extent and availability of phytoplankton biomass can be highly influential for fisheries production. Changes in phytoplankton biomass are predominantly affected by changes in nutrient availability, through either natural (e.g., turbulent ocean mixing) or anthropogenic (e.g., agricultural runoff) processes.

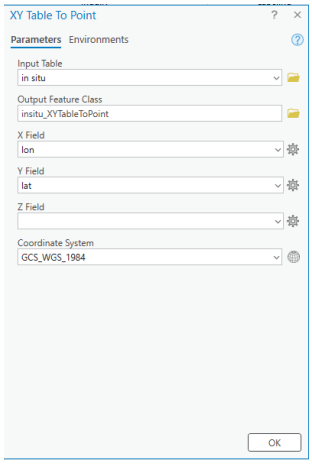
Research Question:
How does chlorophyll-*a* concentrations across Long Island sound spatially vary during the summer bloom. Does increased nutrient loading in the western section derive a larger bloom?

DOWNLOAD DATA

1. Download the exercise remote sensing dataset(**LIS_WQ_exercise_1_June2022.nc**). The dataset contains a monthly composite of water quality parameters (chlor_a, cdom, doc, spm) retrieved from OLCI over June 2022.
2. Download the exercise *in-situ* dataset (**CTDEEP_BOL_insitu_exercise_1.csv**). This csv file contains Chl-a measurements collected by CT-DEEP during their WQJUN22 cruise from the mainstem of LIS as well as Chl-a data collected by the Tzortziou Bio-Optics group from the Great South Bay and Peconic Bay in June 2022.
3. Download the LIS_subregions shapefile (all files contained in the **LIS_subregions** folder). The shapefile contains three geometries that partition the Long Island Sound into three subregions, the Eastern LIS, Central LIS and Western LIS (which includes the Narrows and West LIS). These subregions are based on the Save the Sound reporting regions.

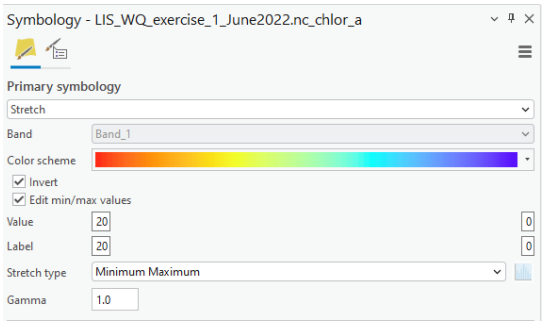
CREATE MAP (*ArcGIS Pro Version 3.4.x*)

1. Open ArcGIS and start a new blank project
    a. Select **Start without a template** and then under **Insert** in the top ribbon menu bar, click **New Map**
2. Add satellite data (NetCDF file)
    a. Under **Map**, use the dropdown menu under **Add Data** in the top ribbon menu bar and click **Multidimensional Raster Layer**
    b. Navigate to the .nc file path by clicking on the folder icon to fill the Input File, Mosaic Dataset or Image Service box
    c. In the Select Variables dialog, check the box for "**chlor_a**" and click **OK**
    d. Right-click the .csv table in the Contents pane, choose **Properties**, **General** then change **NAME** to **chl_olci**
3. Add *insitu* data table (.csv file)
    a. Under **Map**, use the dropdown menu under **Add Data**, navigate to the .csv file, then double-click to add the table.
    b. Right-click the .csv table in the Contents pane, choose **Properties**, **General** then change **NAME** to **chl_insitu**
    c. Right-click **chl_insitu** in the Contents pane and select **Create Points From Table** then **XY Table to Point**, set X Field to **lon**, Y Field to **lat**, and make sure the appropriate Coordinate System is set (WGS 1984)



DATA PROCESSING

1. Format Ocean Color satellite dataset
    a. Right-click the **chl_olci** layer in the Contents pane and click on **Symbology** (Multipart color scheme)
    b. Check the box to **Edit min/max** and **Invert** then set the "value" to 20 and 0
2. Format *in-situ* dataset
    a. Right-click the **chl_insitu** layer in the Contents pane and click on **Symbology**
    b. In the Symbology panel, choose **Graduated Colors** as the symbology type. (Multipart color scheme)
    c. Set the Field to **chl** (or your chlorophyll column).

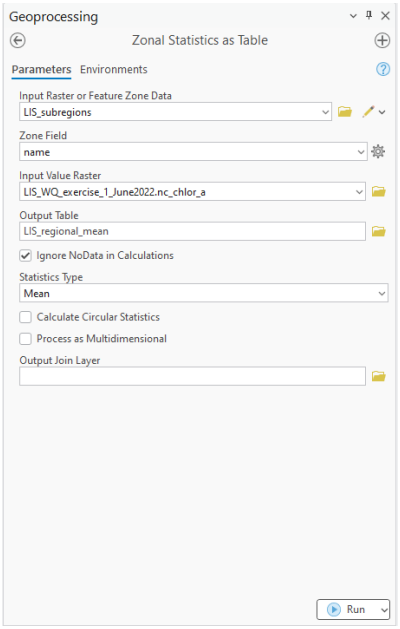


d. Set the Classification Method to **Equal Interval**, and change to 20 **Classes**
e. Manually adjust the classification range (min/max) to 0 and 20 to match the satellite data color scale.

3. Add Long Island Sound subregions shapefile
    a. Under **Map**, use the dropdown menu under **Add Data.** Navigate to the folder containing the **shapefile (LIS_subregions/LIS_subregions.shp)**, select it and click **OK**.

Optional (requires *spatial analysis tool* or *image analysis tool*)

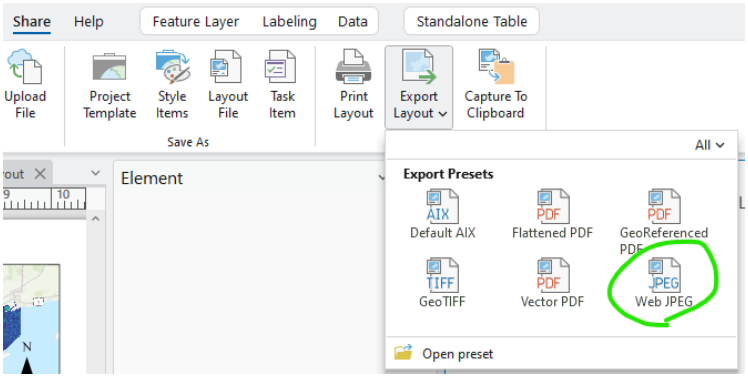
4. Compute Subregion statistics
    a. Navigate to the **Analysis** tab in the top ribbon menu bar, click **Tools** and select **Geoprocessing pane**.
    b. In the search box type **Zonal Statistics as a table** and select it from the list
    c. In the **Zonal Statistics as a Table** tool:
        i. For the **Input Raster / Feature Zone Data** select the **LIS_subregions** layer
        ii. Set **Zone Field** to **name**
        iii. For **Input Value Raster** select the **chl_olci** layer
        iv. Set the name and location for the **Output Table** to be saved (~/**LIS_regional_mean**)
        v. Select **MEAN** in the **Statistics type** (make sure “ignore NoData in Calculation" is checked)
        vi. Click **Run**



Output figure

1. Under **Insert**, click **New Layout** in the top ribbon menu bar and select the **Landscape Letter 8.5” x 11”**
2. Then from the drop-down menu under **Map Frame**, click on the Chlorophyll Map
3. Visually tailor the map
    a. Move the map and stretch the map extent in the layout window
    b. Insert a title, north arrow, scale bar, legend, and other desired features
    c. Change the layer names, color symbology, and point symbol if desired
4. On the menu ribbon select **Text** and then insert a **Straight Text**. For proper data reference type in “**Sentinel-3 OLCI data courtesy of Copernicus Program (modified by NOAA CoastWatch)**

5. Under **Share**, click **Export Layout** in the top ribbon menu bar and select **Web JPEG** to export map image (save image as ***FirstName***).



Send map to **coastwatch.info@noaa.gov** with a subject of "**CWTRAINING**" -- case sensitive)