CyANWeb User's Guide

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Contents

Introduction

The Cyanobacteria Assessment Network (CyAN) is a multi-agency (National Aeronautics and Space Administration [NASA], US Geological Survey [USGS], National Oceanic and Atmospheric Administration [NOAA], US Environmental Protection Agency [EPA]) project, and its mission supports the environmental management and public use of US lakes and reservoirs by providing a capability of detecting and quantifying algal blooms using satellite data records and disseminating this information through CyAN, a mobile application developed and hosted by EPA.

The app provides water quality managers and public health officials with a user-friendly tool that reduces the complexities associated with accessing satellite data to allow fast, efficient, initial assessments across lakes and reservoirs. Data from the European Space Agency (ESA) Copernicus Sentinel-3 satellites Ocean and Land Colour Instruments (OLCI) are used in near real-time to make initial water quality assessments and quickly alert managers to potential problems and emerging threats related to cyanobacteria.

The CyAN mobile app (Schaeffer et al., 2018) was publicly released in July 2019 and, to date, is well received by users, gaining a 4.4/5 star rating on Google Play with 1000+ installs; however, CyAN is an app that runs only on Android devices. Being Android-only is a common complaint. People wanted to run CyAN on their iPhones in the field and on desktops/laptops/tablets in their offices. This project is an effort to reach a much wider user community with a valuable tool for monitoring Harmful Algal Bloom (HAB) indicators in waterbodies across the contiguous (conterminous) United States.

The initial goal of this project is to replicate the functional capabilities of the CyAN Android app in a browser-based application. Further, by using modern software technology and tools, design the web interface to be responsive – meaning that it's designed to operate in most web browsers, on most operating systems, and on most devices (desktop, laptop, tablet, phone). A successful implementation of CyANWeb would eventually obviate the requirement of maintaining a separate Android application and supporting infrastructure and provide a clearer, simpler path to maintenance and enhancement of its functionality.

Finally, this version contains a substantive enhancement. In addition to the point location monitoring data, CyANWeb now provides historic cyanobacteria detection data for fresh waterbodies in the contiguous United States. The waterbodies available include those that have a surface area greater than 1 square kilometer, a USGS Geographic Names Information System (GNIS) name, and are either a lake, pond, or reservoir. Associating the data with the waterbody geometry provides a full histogram distribution for satellite observations within the entire waterbody with the exception of near-shore areas, allowing that information to be served through the CyANWeb application.

Target Audience:

The target audience of CyANWeb includes state and local water quality managers and public health officials needing assistance to make faster and better-informed management decisions to mitigate cyanobacterial algal blooms. Additionally, the intended audience includes EPA Regions and researchers and others in academia and non-governmental organizations who may be interested in detecting and quantifying cyanobacterial blooms as well as monitoring them over time.

Further members of the target audience include current CyAN app users looking for a desktop/laptop/tablet alternative to the Android app. CyANWeb is a different interface to the same HAB data provided to the Android app. CyANWeb is meant to provide the same functionality as the Android app. However, this version has been enhanced to permit both point location monitoring and waterbody-wide monitoring, as well as provide availability for bulk data download.

CyANWeb is a browser-based interface that has been tested and targeted for desktop/laptop browsers. It is certainly possible to use smaller devices to access the web interface (e.g., smart phones and tablets). This document's screenshot images show how the CyANWeb interface looks on desktop/laptop browsers. Content in screenshots will appear differently on smaller device browsers but have the same functionality. Supported browsers include Chrome, Firefox, Opera, and Safari. Issues have been identified with Edge (some versions may work, others not), and there is no plan to support Internet Explorer.

CyANWeb is available to any user. If needed, refer to the EPA CyAN webpage and its linked content for further information about the CyAN project: https://www.epa.gov/water-research/cyanobacteria-assessment-network-mobile-application-cyan-app

Understanding the Data

The CyAN system reports cyanobacteria concentrations. The data products as delivered by USGS/NASA are CI_cyano and include chlorophyll-*a* and phycocyanin in the response of the OLCI satellite sensors (Coffer et al., 2020, Mishra et al., 2019, Lunetta et al., 2015). Refer to the references for algorithms used for the detection of cyanobacteria.

Be aware that OLCI weekly/daily data are separately-handled data products on the CyAN app/website. Daily data are a snapshot of cyanobacteria at the time of detection; weekly data are a composite of daily maximums collected over a 7-day period.

- The weekly data represent waterbody composite maximum cyanobacteria concentrations derived from two to three satellite overpasses per week (Sundays through Saturdays) at each detectable waterbody.

- Weekly data are served by default. Daily data can be selected and viewed. Weekly data are typically available by the following Monday for the previous week. Daily data are uploaded daily, meaning yesterday's data are available today.

- What is a "discernable" waterbody? What is the minimum sized lake? The OLCI data resolution is 300 meters. Is that resolvable? Yes, but a valid cyanobacteria response should be from a 3x3 raster matrix, meaning the waterbody should be at least 900x900 meters for the center pixel to be considered valid. Currently, 2,370 waterbodies across CONUS are resolvable.

Temporal Aspects

The cyanobacteria concentration data reported in the CyAN Android app and the CyAN website are derived from ESA's OLCI instruments on the Sentinel 3a and 3b satellites (S3A, S3B) and are delivered in two temporal classifications: weekly and daily data. Daily data prior to July 2020 were derived from the single S3A and have limited spatial coverage across CONUS. In late July 2020, the S3B satellite data stream came online and, because of their separate orbital tracks, the spatial coverage of CONUS became much more extensive.

Daily data are simply a snapshot of the cyanobacteria response and are derived from merged S3A and S3B data streams.

Weekly data are a composite of maximum cyanobacteria response from a week-long collection of daily satellite overpasses (Sunday through Saturday). In general, S3A and S3B merged data streams (post July 2020) will have between 2 and 4 observational cyanobacteria responses at each CONUS waterbody location. The maximum cyan response detected within the weekly time span is the value reported at each location.

Spatial Aspects:

Data are delivered from NASA to the EPA in TIFF-formatted raster image files (gridded images). Each image is composed of 4 million grid cells (pixels). Each grid cell represents a 300x300 meter area. Each image is masked for land (and for oceans near the coasts) leaving waterbodies exposed. A waterbody pixel having a cyanobacteria response as detect by the OLCI instruments on ESA's satellites is reported by CyAN. To get CONUS spatial extent, a collection of 37 raster images (tiles) is produced (Figure 36). It is

important to note that a reported cyanobacteria value is not representative of an entire waterbody; rather it's the cyanobacteria response of the pixel where your location resides.
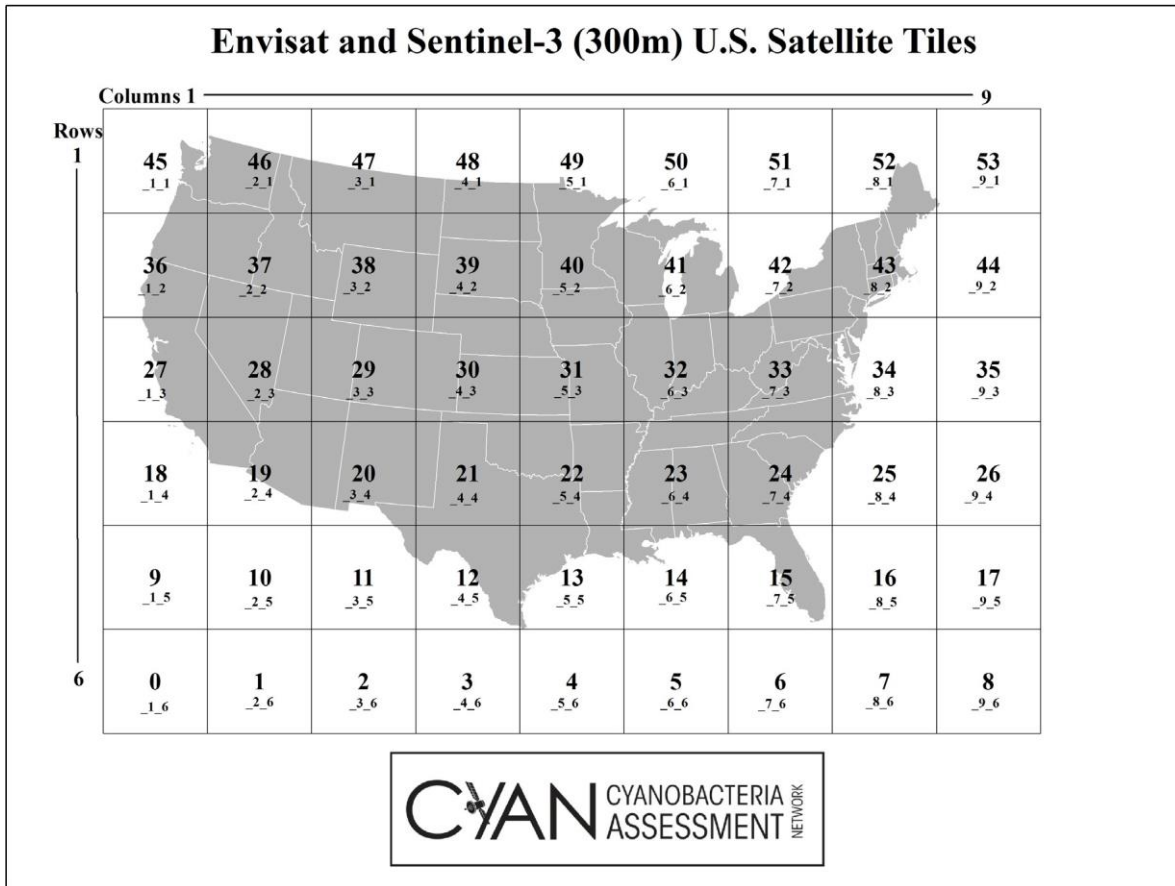

Figure 36 – How CyAN divides the satellite images into smaller files

Data for 37 of 54 tiles in Figure 36 are accessible via the CyANWeb app. Data for any non-CONUS tiles are not processed. For example, all tiles in row 6 and all tiles in column 9 are absent from CyAN. Each tile is a geo-referenced TIFF formatted raster file containing 2000x2000 = 4,000,000 cells. Each pixel cell represents a 300x300 meter area.

Opening Screen Message; Data Issues

The opening screen says:

> This experimental web application provides provisional satellite derived measures of cyanobacteria, which may contain errors and should be considered a research tool. Users should refer to the app help menu for more details. The focus of this application is to provide cyanobacteria measures for larger lakes and reservoirs within the contiguous (conterminous) United States. Data products are 7-day maximum cyanobacteria measures updated weekly and, beginning late July 2020, daily snapshots of cyanobacteria measures updated every day.

Possible data issues include:

- Near-shore response: mixed land/water pixels may be reading land vegetation and/or shallow water bottom foliage. It is not possible to discount reported concentration entirely, as a response may be valid due to wind action on a bloom resulting in shoreline accumulation. Data values reported should be considered in context of the local conditions near and within the waterbody. Data reported should be validated in situ.

- Estuaries: data have not been validated for brine/salt water.

- Rivers: large flowing waterways are not masked and can have a cyanobacteria response that is not validated.

- Ice: ice-covered waterbodies have high reflectance that read as a cyanobacteria response to the sensors. This issue has been resolved with delivery of OLCI data v3 (what CyANWeb now serves to the interface).

- Unmasked land: this issue has also been resolved with the delivery of OLCI data v3.

- Dry/ephemeral waterbodies: invalid cyanobacteria response is evident. Resolved in OLCI data v3. These areas now masked.

- A resolvable waterbody is considered to have, at minimum, a 3x3 raster cell matrix size (900x900m), with the center pixel being considered valid. Smaller or irregularly shaped waterbodies (i.e., those not having the minimum 900x900m size) may be evident in the data, and their cyanobacteria responses are suspect and open to interpretation. See "Near-shore response" above.

Data Interpretation – What could go wrong?

The CyAN/CyANWeb system shows cyanobacteria concentration data when and where the satellite data detects it. What we cannot store, or show, is non-detect events. Why is this important and how can this affect interpretation of the data we serve? How may the information displayed in the interface be misleading? Consider some scenarios:

Scenario A – I have a marker in my waterbody, and it is now, for example, red, indicating a very high level of cyanobacteria concentration. Conversely, the marker is categorized in the green, indicating no appreciable HAB level.

Initial Conclusion: My waterbody is currently in a high HAB condition. Conversely, my waterbody is not worthy of immediate concern.

Analysis: Either conclusion may be true, but be cognizant of dates associated with the marker symbology. The last satellite detection level may not represent current conditions. The last detection event may have been yesterday, last week, last month, or even years ago. Dates of detection are evident on dialog details at the marker symbols on the basemaps or in the list of My Locations.

Scenario B – I have a currently high cyanobacteria concentration detection level reading at my waterbody marker.

Initial Conclusion: The waterbody is toxic and should be avoided.

Analysis: CyANWeb says absolutely nothing about bloom toxicity. The data are only indicative of the need for toxicity sampling and testing. Cyanobacteria come in many forms; some produce toxins and some do not. The only way to tell if toxins are present is by water sampling and laboratory testing.

Scenario C – I have a marker in a waterbody that indicates a cyanobacteria level of concern (example 1).

Initial Conclusion: The waterbody is unfit for recreation (swimming, fishing, etc.) or other human usage of the water derived from the waterbody.

Analysis: Water conditions at a single monitoring marker are not necessarily indicative of the state of water conditions throughout the waterbody. A marker indicates the satellite detected cyanobacteria concentration within a 300x300 meter pixel location within the waterbody. If your waterbody is small (< 900x900 meters), then the marker may indicate the HAB state of the waterbody. If the waterbody is larger, more markers distributed throughout the waterbody are warranted to determine its cyanobacteria state. Cyanobacteria blooms (HABs) are not static, and not uniform in distribution within the bloom area.

Scenario D – I have a marker in a waterbody that indicates a cyanobacteria level of concern (example 2).

Initial Conclusion: The waterbody is unfit for recreation (drinking, swimming, fishing) or other human usage of the water derived from the waterbody.

Analysis: What is the shape of the waterbody you've marked for monitoring? How close to the shoreline have you placed you monitoring marker? What is the depth of water in your marked waterbody?

Cyanobacteria satellite detection may be fooled by:

- shallow waters (< 6 ft depth in clear water, even less in murky water) where non-cyanobacteria bottom vegetation is being detected, and

- the edge effect of shoreline vegetation, so called mixed pixel readings.

A "valid" cyanobacteria value is considered to be free of mixed pixel readings and in "deep" water. Your waterbody cyanobacteria cell value should be the center pixel value in a 3x3 raster image (imagery is delivered in 300x300m raster cells) meaning your waterbody should be at least 900x900 meters for the center pixel value to be considered "valid." However, you should not ignore cyanobacteria readings if your waterbody does not meet the 900x900m size due to shape of the waterbody or water depth. Use whatever cyanobacteria readings are provided as a guide to determine the need for in situ sampling and testing. The user should know the morphology of their waterbody of interest and use CyAN data accordingly.

Scenario E – The time series plots of cyanobacteria concentrations on location charts and blooming charts (from the Compare Location tab) show a continuous increase (or decrease) through time.

Initial Conclusion: My waterbody is getting worse (or better) for HAB incidence over time.

Analysis: Although the x-axis of the plots (the bottom axis) is linear (meaning time increments on this axis are equal), the data points on them representing cyanobacteria concentrations are, in all probability, not available for all time intervals. Plot points appear continuous through time because data points are line-connected. However, detections events are rarely evenly continuous through time. Cloud cover occlusion to the satellite sensors may prevent HAB detection at regular intervals. This might best be illustrated when comparing locations; data records may be longer or shorter than the compared location(s) and have different data points before, after, and/or within the timespan of the plot. Therefore, a user recognizing that CyANWeb interpolates missing data points can perform further analysis regarding various environmental factors that might increase or decrease the likelihood of cyanobacteria growth at specific missing times and interpret the time series plots accordingly.

Navigating the CyANWeb Interface

Conceptually, the web interface is simple to use. Using the basemap, zoom to a freshwater waterbody (principally larger lakes and reservoirs) within the contiguous (conterminous) United States (CONUS) and tap or mouse-click the location to create a pin marker. If the marker location has any history of cyanobacteria detected by the OLCI sensors on the Sentinel satellites, the marker color will reflect the most recent cyanobacteria category status. Further capabilities of the web interface will provide access to plots and charts of the location's cyanobacteria history and the satellite data maps (imagery) of the location.

Login to the web site
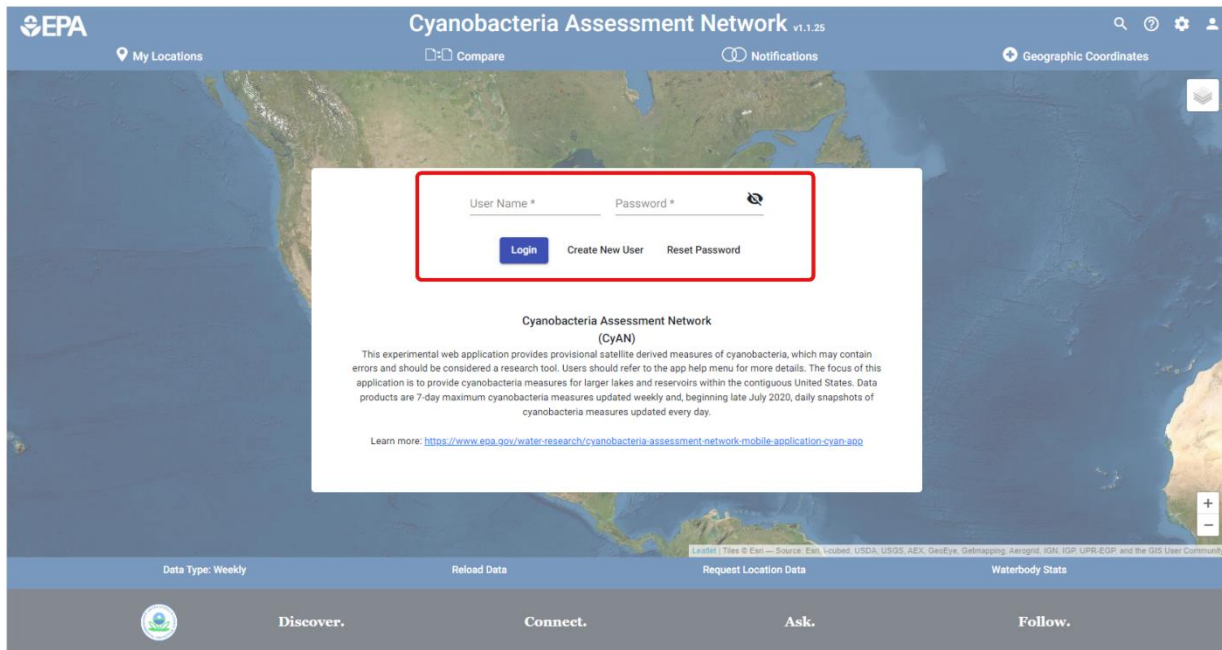
Figure 1 - CyANWeb interface, login

If you've already registered as a user, simply enter your account name and password to proceed and gain access to the web interface via the *Login* button. Otherwise, select *Create New User.*

If you've forgotten your account password, select *Reset Password* and follow the instructions in the email you'll receive. The email will be sent to the email account you used to register your CyANWeb user account.
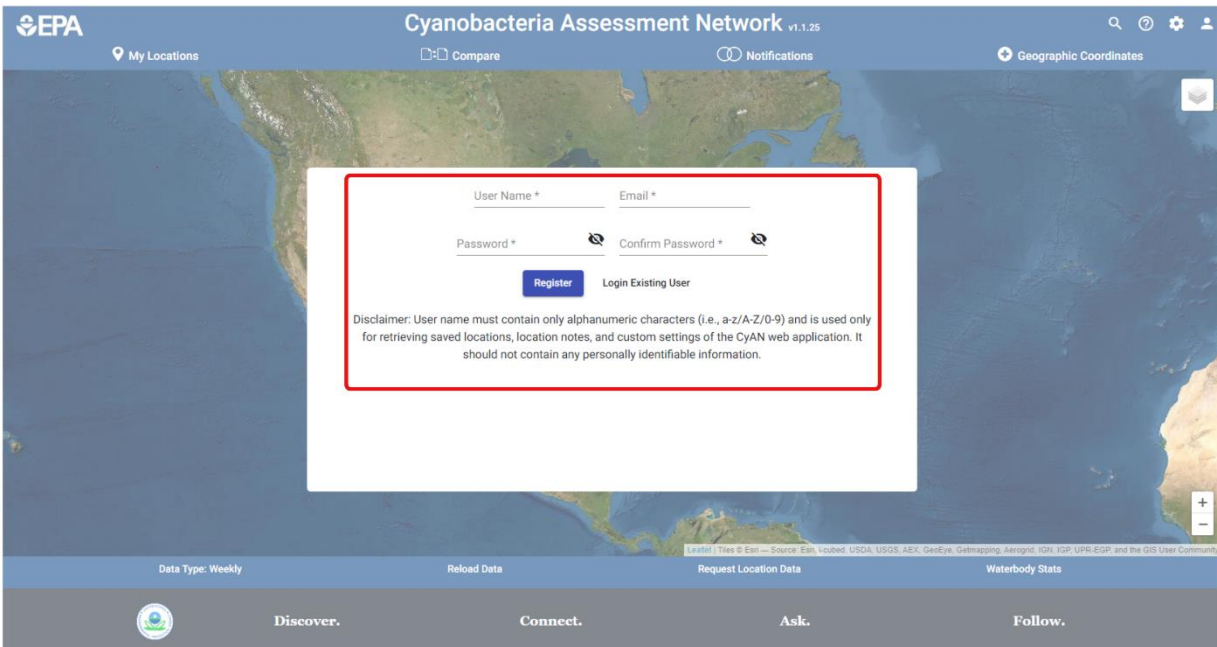
Create New User

Figure 2 - CyANWeb, create user account

To register a new user account, enter a *User Name*, an *Email* account you want to use, a *Password* and password confirmation. Then select *Register*. You will then be able to log in to the web interface with that information. Note the caution about using personally identifiable information for your account. CyANWeb accounts are used only for storing your marker locations and user-configurable settings of the interface.
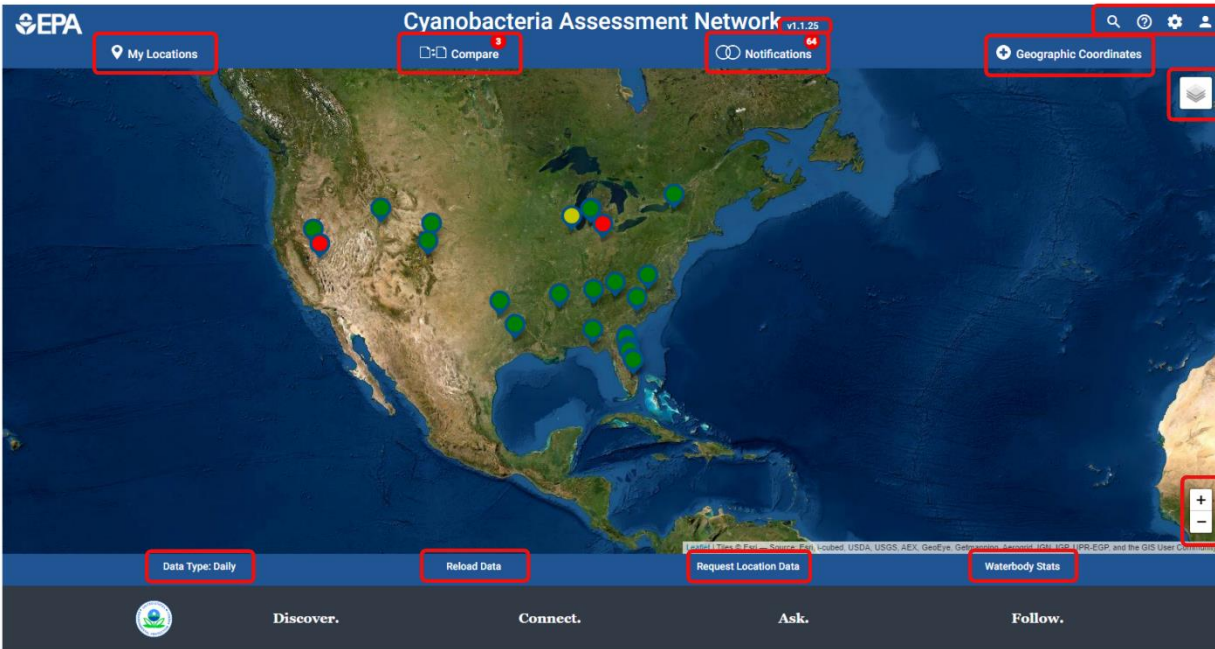
CyAN - Home screen navigation

Figure 3 - CyANWeb home screen interface, user controls and information

Table 1 –Controls and their function
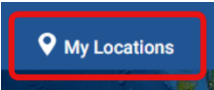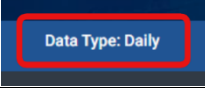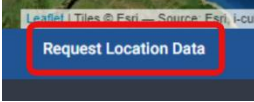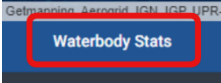
Along the top of the screen	
	Informational – tells the user the version number of the web interface. Please identify the version should you seek assistance or report issues.
	From left to right, these icons represent location search function, online help (access to this document), the user settings configuration dialog, and user account control.
Second line along top of the screen	
	Provides access to the list of your marked locations. Selection of a location from the list provides access to detailed history of cyanobacteria for the location, downloadable images, and plots.
	Provides access to the website's compare locations data features. Compare provides access to features to assess differences between locations you've selected.
	View informative messages about new data availability and upcoming system maintenance/security issues that may impact data services.
	Place map markers through geographic coordinate input.
Right side of the screen	
	View locations and data. Note: the zoom function can also be controlled by mouse-wheel adjustment or screen double-tap and/or finger-pinch on haptic devices.

Table 1 –Controls and their function

	Choose the basemap to display via this control (Imagery, Street, orTopographic).
Along the bottom of the screen	
	View markers and data for either daily or weekly cyanobacteria data.
	Refresh the data and imagery for your markers. For the web interface, this is necessary only if new data are loaded to our system while the interface is in use. Otherwise, data including imagery are updated every time a user logs into the system.
	Receive recent weekly or monthly cyanobacteria data for one or more user-specified locations.
	View data associated with an entire waterbody of interest instead of single point locations.
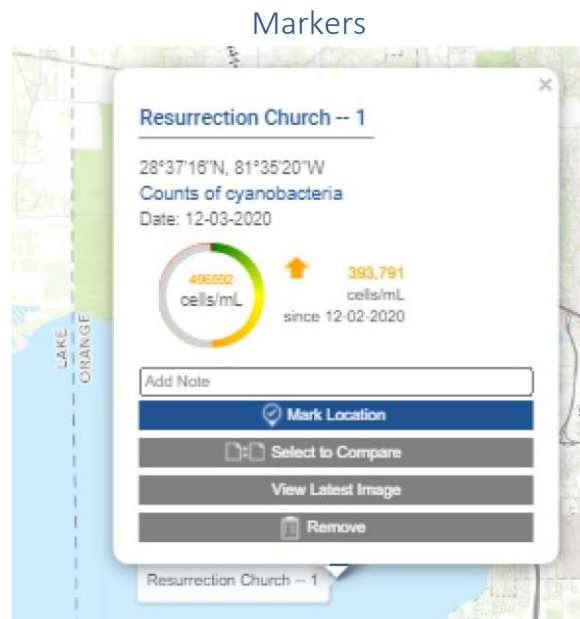
Markers

Figure 4- Marker pin dialog, detail

Adding a marker to a discernable waterbody on the map, either by mouse-click or tapping (haptic devices), gives you a dialog:

- The location's Google Map name (editable). If you want to name the location differently, select the Google Map name and type in your choice. If no cyanobacteria response has been detected, the dialog reports "Unknown Location, Counts of cyanobacteria=0".

- Shows the coordinates of the location.

- Shows the latest (or only) cyanobacteria concentration at the location (value inside circle

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symbol), but only If the location has a history of cyanobacteria response. The value displayed may be from the most current data or it may be from a previous date. If no data exist for the location, the circle displays "0 cells/mL" inside it.

- Shows an up/down arrow, value and date indicating a change in concentration. If no data exist for the location, the arrow points down, and no date or value information is provided.

- A type-in textbox for any user notes for the specific location.

- Options to *Check Location*, *Select to Compare*, *View Latest Image* or *Remove.*

Markers – adding to the basemap dialog details:

- *Check Location* changes the look of the pin marker on the basemap. Selecting this results in closure of the dialog and the pin marker being changed from one having a plain circle to one having a circle with a checkmark inside. The dialog may also be dismissed by selecting the *x* symbol in the top-right corner of the dialog, or by clicking elsewhere on the basemap. Dismissal of the dialog in these instances results in a pin marker being present on the basemap without a checkmark symbol. The user has the option to list only checked pin marker locations or all locations with pin markers in the *My Locations* list; other than filtering out unchecked locations, there is no functional difference between checked and unchecked pin markers.

- *Select to Compare* adds the location to the list of locations you want to view side-by-side. Select two or more locations to use this aspect of the app.

- *View Latest Image* provides a mechanism to view the location's latest tile imagery regardless of detectable cyanobacteria levels at the location. Click the *x* in the upper right to return to the Marker's dialog details.

- *Remove* deletes the pin marker from the basemap, thereby closing its Marker dialog details.

Markers – adding to the basemap – coordinate entry
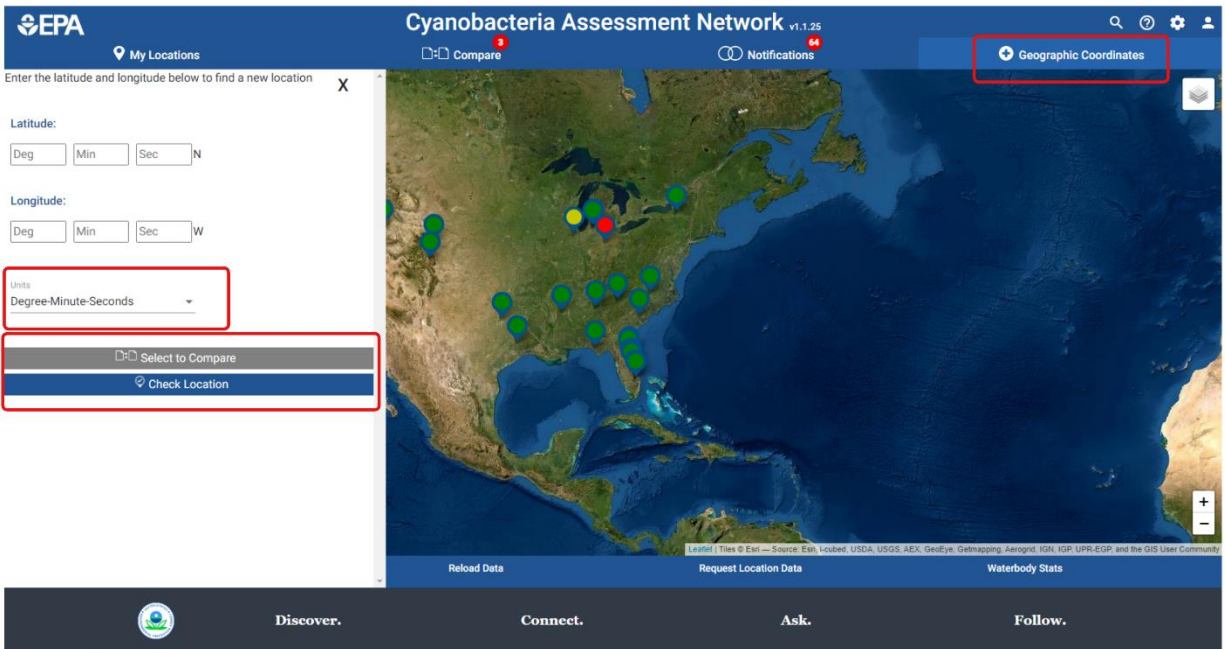
Figure 5 - Geographic coordinate entry, resulting dialog on the left

Figure 6 - Coordinate entry dialog, detail

Precise pin marker locations may be added to the basemap with coordinate entry. Degree-Minute-Second latitude and longitude values are the default. Select *Units* → *Decimal Degrees* if preferred. After numerical coordinate entry, select the *Check Location* button to add a pin marker including the check mark to the basemap. Use the *Select to Compare* button to add both the pin marker to the basemap and the location to the *Compare* list of markers. The coordinate entry dialog can be dismissed using the *x* symbol in the upper- right corner, and no pin marker is dropped.

Markers – user configuration settings

Figure 7 - User configuration controls dialog accessible from the main page gear icon

- Select the gear icon to access the marker color dialog. The colors used by pin marker symbology and text are binned into four categories of cyanobacteria concentration: low, medium, high, and very high. The default values for these categories are set to World Health Organization limits (*World Health Organization 1999 Guidelines)*.
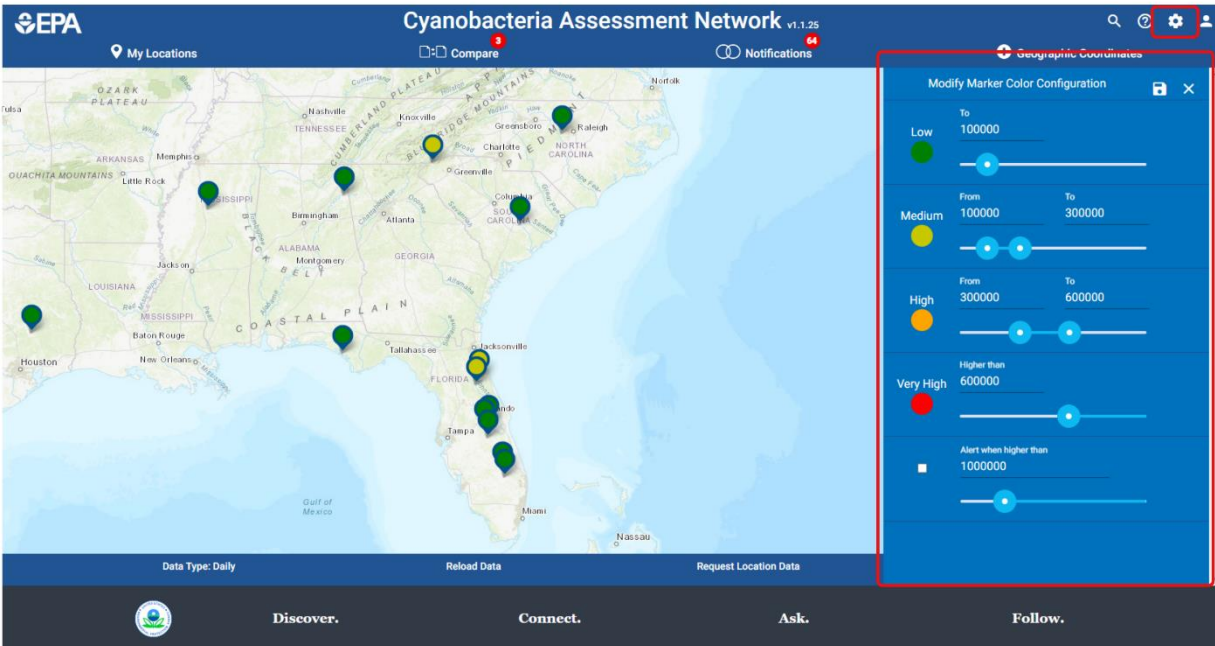
- If you or your organization use different values, you can select the color categories by adjusting the sliders to your preferred values. When the slider does not have the sensitivity required for an exact number, hold the cursor over the number and use the up-down arrows for fine adjustment, or select the numerical value and type in your preferred setting.

- You can also set an *Alert* value that puts a symbol next to markers (within the *My Locations* list of pin markers) that have a current cyanobacteria concentration exceeding the value you set. Select the checkbox and adjust the slider to use this feature.

- Save any adjustments you make to your login account by selecting the diskette symbol at the top of the dialog. This action will also close the dialog box. Failure to save preferred settings results in reversion to default values the next time you log in to the interface. The dialog can be dismissed by selecting the *x* symbol in the upper-right corner of the dialog, but no further changes would be saved.

Markers – selecting existing map pins

Hovering the mouse over a marker already placed on the map displays the location name and the date of the most recent cyanobacteria detection. Selecting the existing marker opens the pin marker dialog and allows you to select the *View Latest Image* button to view the latest tile image for the location regardless of the location's current cyanobacteria status, which is a useful method to check the area around the marker for cyanobacteria detections that may not be evident at the marker pin itself. Zoom the image via the map zoom control, mouse wheel, and/or finger-pinch on haptic devices. Zooming slowly and deliberately is recommended to ensure the system can respond as requested.

You can also perform any actions the marker dialog allows; rename the location, add notes, select the location for comparison, remove the marker, and depending on marker check/uncheck status, to either mark or unmark the location. Note that *Uncheck Location* and *Check Location* merely change the check/uncheck location status; neither button removes the marker from the map. As stated before, per the user's choice, the list can show only checked pin marker locations in the *My Locations* list or all pin marker locations; otherwise, there is no functional difference between checked and unchecked pin markers.

My Locations tab
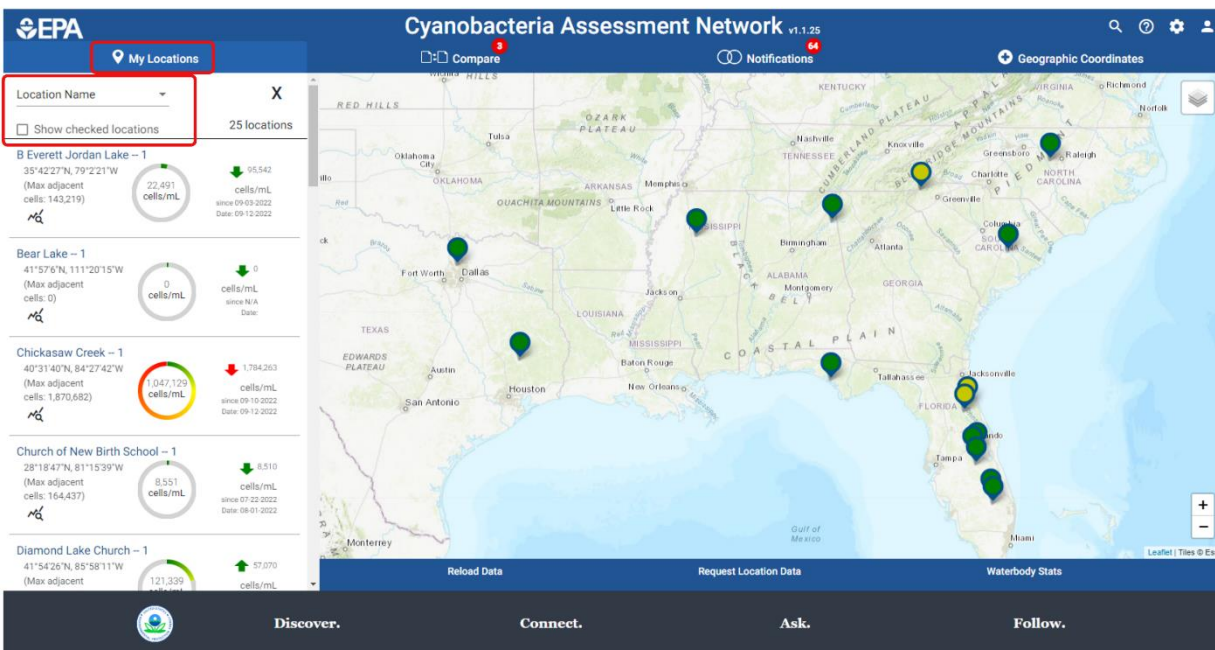
Figure 8 - My Locations tab, list of marked locations

Select the *My Locations* tab to view a list of pin marker locations you've added to the basemap. The list is sortable by location name (the default) or cyanobacteria cell count. You can also filter out locations that are not check marked. The list shows:

- Location name, location latitude/longitude, max areal cyanobacteria cell count value about the location (*Max adjacent cells*), color coded symbol and cyanobacteria value (circle symbol with numerical value centered), and a color-coded directional symbol and value representing the change in cyanobacteria concentration since last reading (note the dates provided). Also, note that the basemap shown to the right of the list is interactive; pin markers can be added/removed using the map in this view and zoom/pan is enabled. Note

that *Max adjacent cells* is a useful feature to check the immediately adjacent area around the marker for cyanobacteria detections that may not be evident at the current marker pin itself.

- Locations that exceed designated cyanobacteria values. The threshold is set using the menu slider *Alert when higher than* shown on the bottom right of Figure 7, accessed by clicking the main page gear icon). The alert symbol in *My Locations* is a red circle with a centered *!* [exclamation mark]).

- Select a single location list entry to access the location's related imagery and plotted data. The location's *Overview* screen is then displayed.

Otherwise, dismiss the location list by selecting the *x* in the top-right corner of the dialog to return to the full basemap home screen.

<div align="center">My Locations → Overview tab</div>
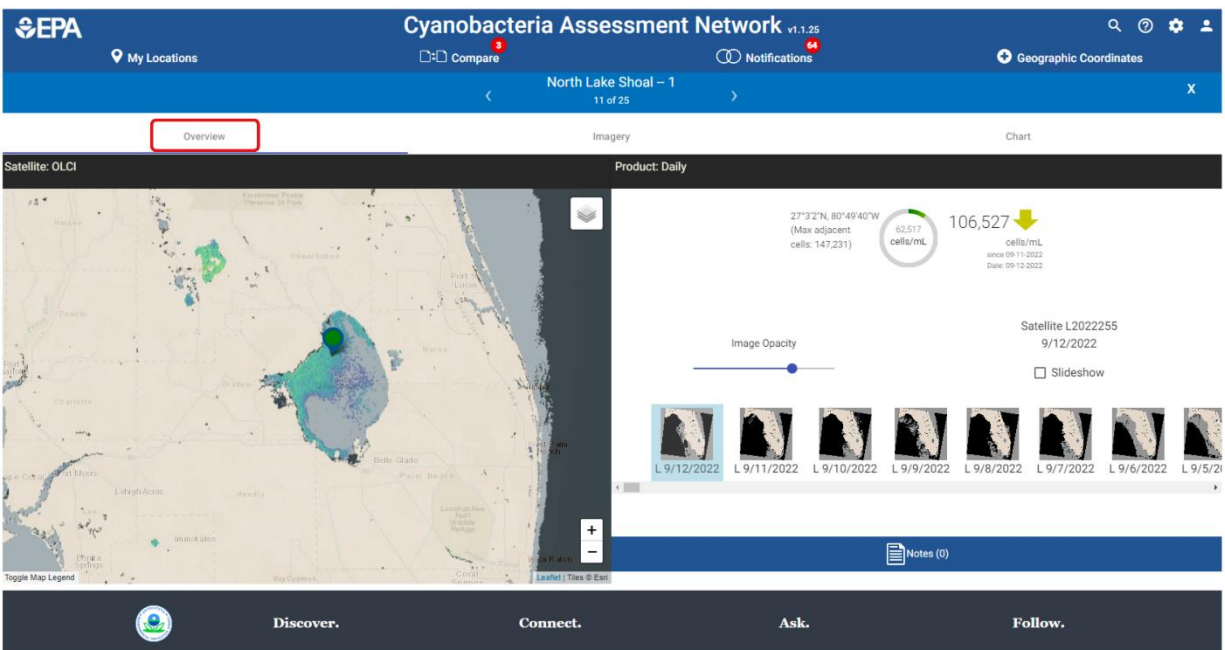
<div align="center">*Figure 9 - Location list Overview screen*</div>

The Overview screen is composed of five major sections:

- The light blue bar across the top specifying the location name and *x* tab dismissal button. The location name sits between two controls (< and >) that allow cycling through locations you have marked without having to return to the location list. Note that the map and control sections (described below) are synched with the currently-selected location.

- A white bar with selectable tabs (*Overview, Imagery, Chart*).

- A black bar specifying the data source satellite platform (*OLCI*) and the data product being shown (*Daily* or *Weekly*).

- A map section (lower-left) showing latest cyanobacteria tile image for the location and location pin marker. The map is pan/zoom enabled but pin markers cannot be manipulated here. To view an image legend, select the *Toggle Map Legend* button in the lower left of the map area.

- A control section to the right of the map. This section contains:

  o Information and symbology for the location (latitude, longitude, max adjacent cells, direction of change in concentration between cyanobacteria detection dates).

  o The cyanobacteria data layer name (e.g., Satellite L20210592021065, for a weekly max composite image) and date.

  o An opacity slider that adjusts the visibility of the cyanobacteria data layer overlaying the map. This slider can be controlled via mouse or by finger on haptic devices.

  o A *Slideshow* checkbox that, when selected, sequentially overlays all the available cyanobacteria data layer images for the location on the map. Uncheck the checkbox to pause between images.

  o A scrollable list of thumbnail cyanobacteria data layer images available for the location; this is a date-sorted list of images that have a cyanobacteria response at the location. Select a thumbnail to overlay that image on the map and show cyanobacteria information for the date the image represents.

  o A blue colored *Notes* button that allows adding or editing any user supplied notes for the specific location.
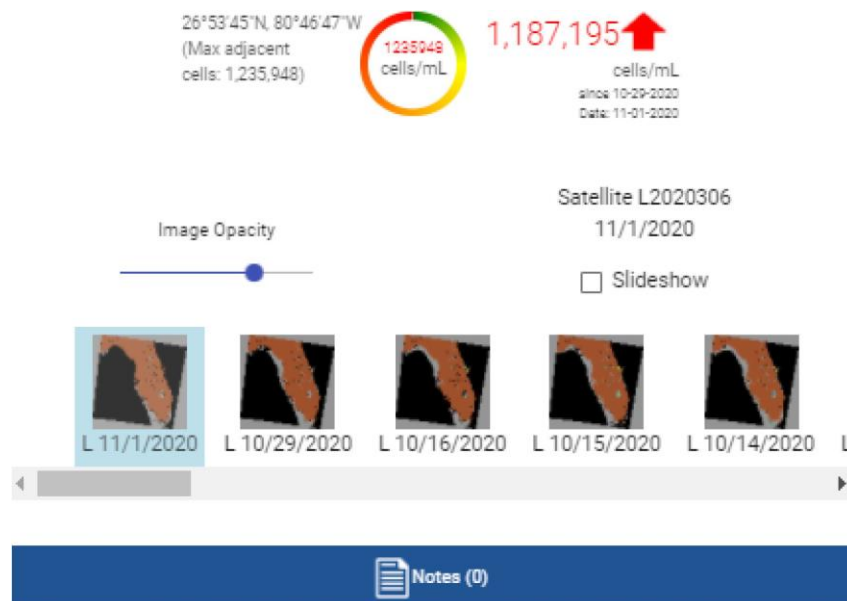
Figure 10 - User control section of Overview pane, detail

My Locations → Imagery tab
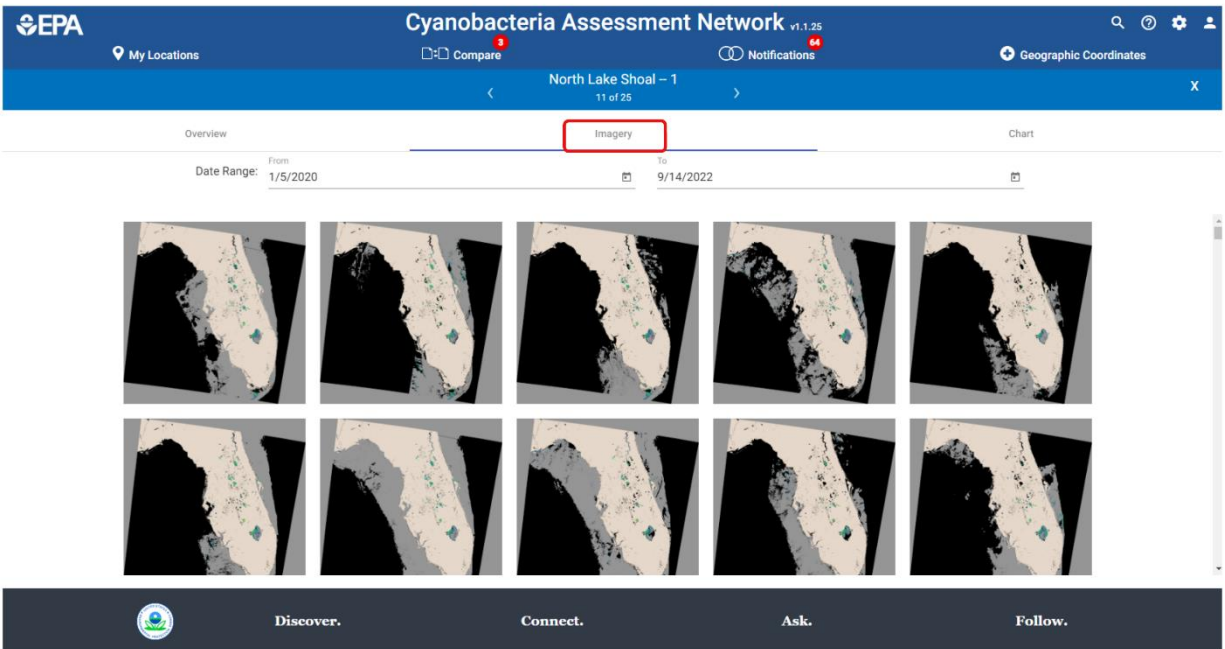
Figure 11 - Location list Imagery screen

The Imagery screen contains:

- A thumbnail list of data images for the location; the most recent image is at the top left, earliest at the bottom right.

- Date range inputs to narrow or expand the list of viewable images.

Location controls (< and >) to scroll through your list of locations and to access their imagery. Select the desired image to download and save to your device. Note that images are geo-referenced TIFF-formatted raster images in Web Mercator projection.
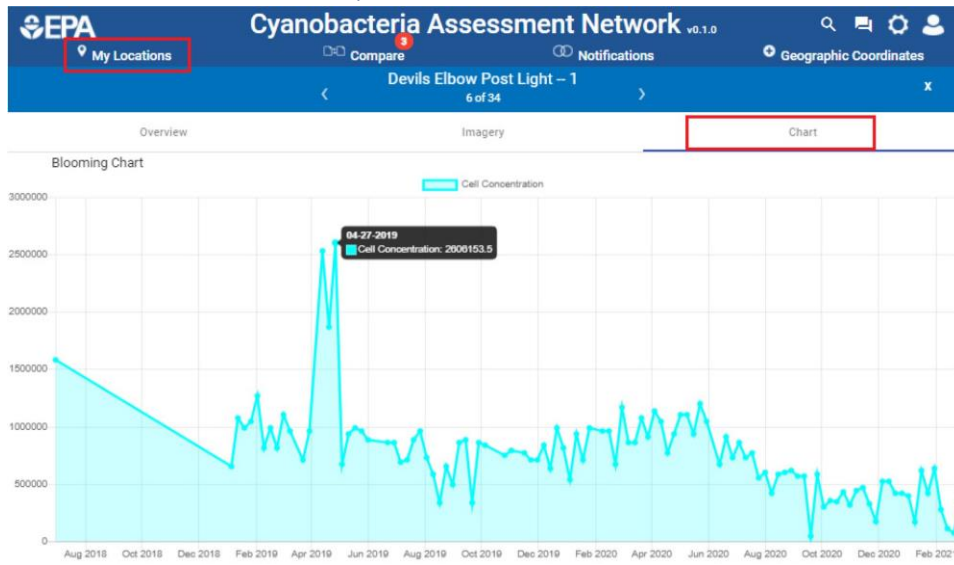
Figure 12 - Chart tab view under My Locations

The Chart tab contains:

- A time-series plot (the entire stored online record of cyanobacteria level at the location, currently 2020 to the present) of cyanobacteria levels.

Note: the plot appears continuous through time but likely is not; any non-detects (i.e., below detection level) and missing detects (e.g., clouds) are not stored/shown. Selection of data points within the plot will show a date and cyanobacteria value for that point.

- Location controls (< and >) to scroll through your list of locations.

- The *x* in the top- right corner to dismiss the location details screens (*Overview, Imagery*, and *Chart*) and return to the full basemap home screen.

Compare tab
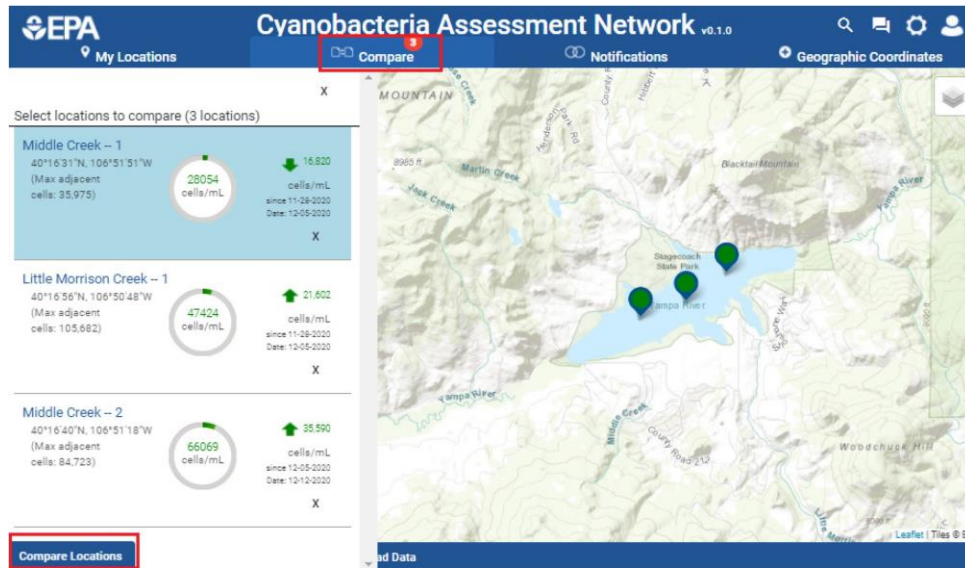
Figure 13 - Compare locations, list of locations selected to compare

Much like the *My Location* tab, the *Compare* tab shows a list of locations. These locations have been user-selected from the Home screen location marker dialog via *Select to Compare*. (See Figure 4, Marker pin dialog, detail.) The location data shown (location name, coordinates, max adjacent, cyanobacteria value, and direction of change in cyanobacteria value/date) are data for the most recent dates available.

Tap *x* next to a location (lower left of each location's row) to remove a location from the compare list. Note: removal from the compare list does not change the pin marker or remove it from the basemap; it also has no effect on the presence of the location in *My Locations*. If a location was removed from the compare list in error, go to the location's marker on the Home screen map, click on it, and select *Select to Compare*.

Use the lower-left *Compare Locations* button to proceed, or *x* in the upper-right of the list to exit and return to the full basemap home screen.

Compare → Statistics tab
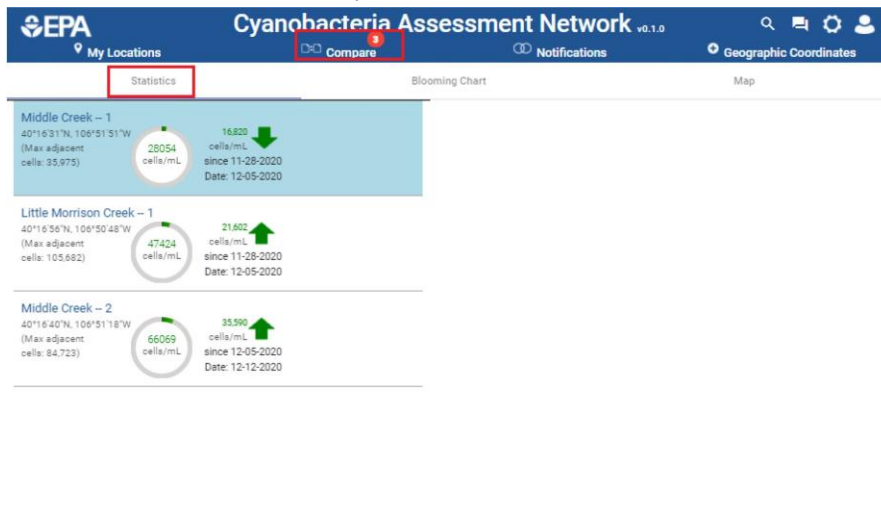
Figure 14 Compare locations, statistics

The *Statistics* tab repeats the information shown in the *Compare* tab. If necessary, use the scroll bar to view the entire list of information about all locations present when the *Compare* button was selected.

Compare → Blooming Chart tab
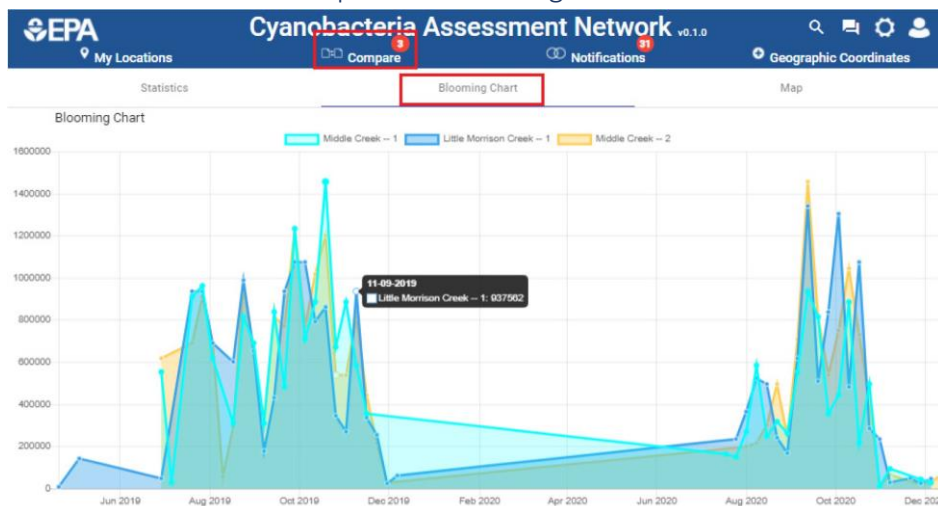
Figure 15 -- Compare locations, blooming chart

Select the *Blooming Chart* tab to see a plot of the cyanobacteria response for all the locations present when the *Compare* button was selected. The chart shows the location's cyanobacteria response through time. Missing and below detection responses for the locations are not shown. Individual location cyanobacteria level traces may be toggled off/on by selecting the location names in the plot title. The plot will adjust to the remaining locations selected for comparison. Hover the mouse over data points in the plot to show cyanobacteria level values and date of detection.

Compare → Map tab
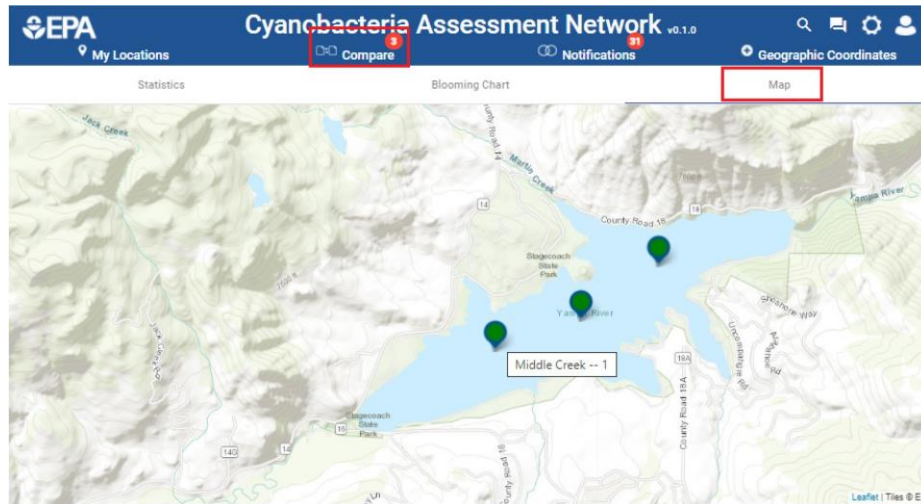
Figure 16 – Compare locations, map tab

The map shows the geographic locations you've chosen to compare. You cannot add/remove markers from the map or access location imagery from here. You can still pan/zoom and change the basemap.

Notifications tab
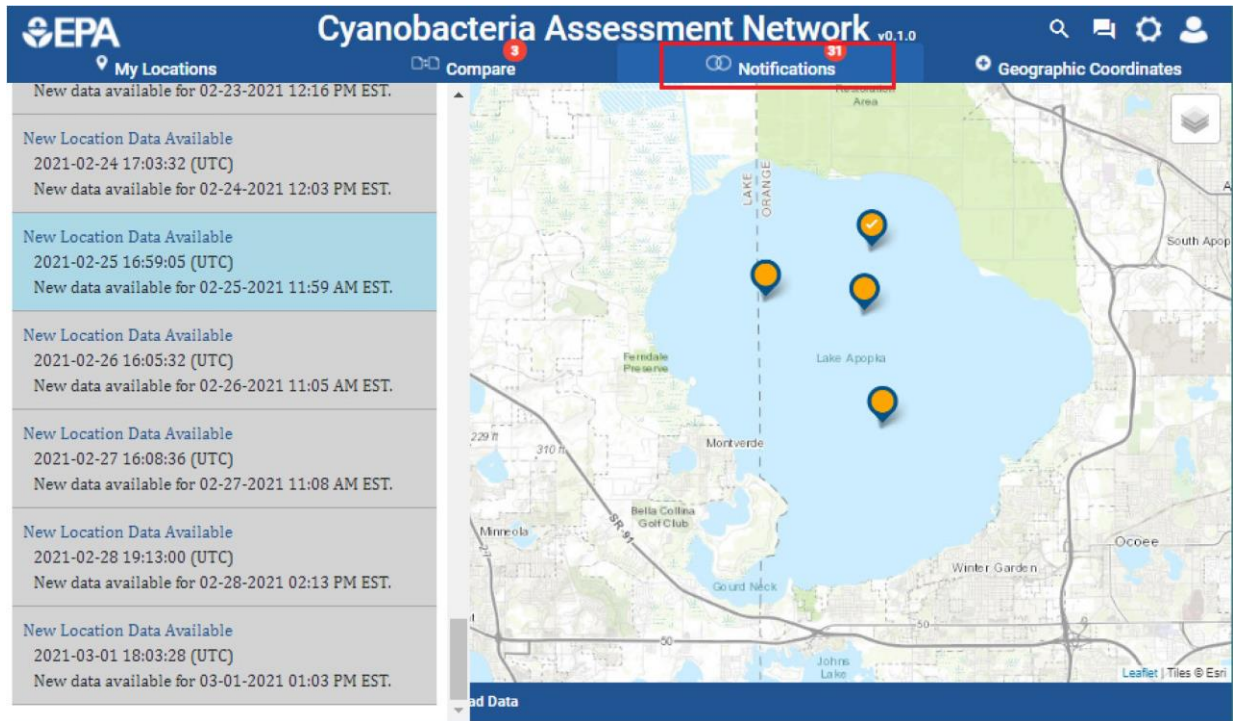
Figure 17 - Notifications tab

Notifications shows a list of messages sent to the community to alert users of new data availability, system outages, app version upgrades, issues with data access or other topics of interest that impact the viability of the system. You can manage the contents and length of this list. The "Clear" button will delete all listed notifications; the "Only show unread notifications" checkbox will filter out read notifications from view but will not remove them.

Request Location Data

Via the Request Location Data control button on the bottom bar on the Home Screen, the user is given the opportunity to obtain a customized cyanobacteria data set via email. Figure 18 shows the interface with instructions on how to provide one or more locations by their geographical coordinates (in decimal format within CONUS) and the desired type of data collected (daily or weekly are the only valid choices). The user is presented with an example (template) CSV file to download and to enter these user-desired specifications. Alternatively, the user can create a CSV file with three column headings in row 1: latitude, longitude, and type. If the user wants to receive both daily and weekly data for a particular location, do not enter "both" in the datatype (type) column; instead enter the same latitude and longitude on a new row, and change the datatype (type) column entry to the other choice.
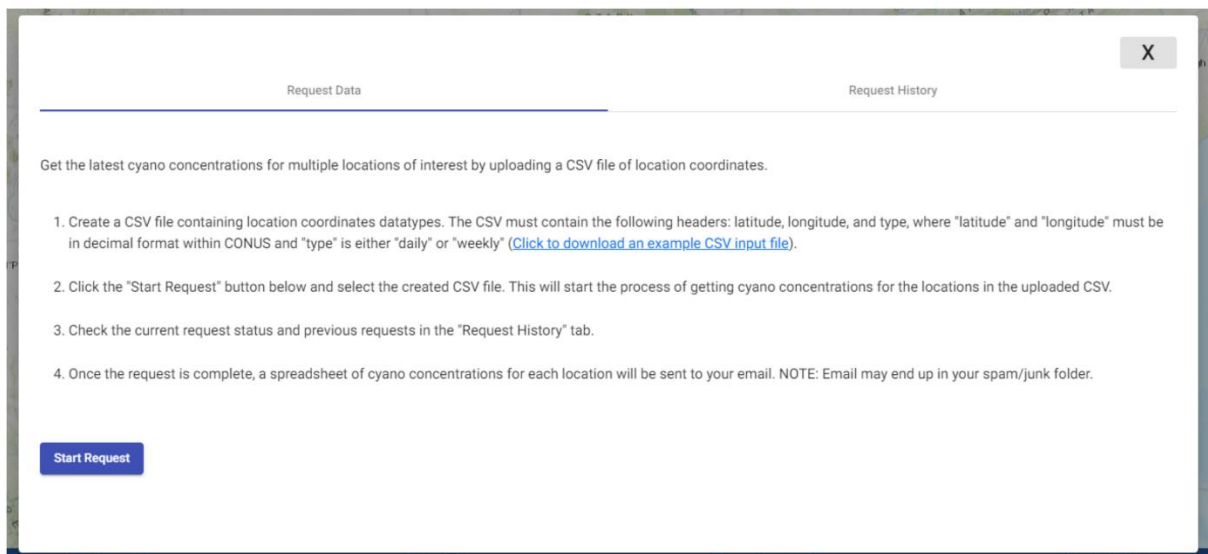
Figure 18 – Request location data

Using this interface under the "Run" tab, the user uploads the customized CSV file by clicking the "Upload" button. The user locates the file to upload in a typical file selection interface and selects it (e.g., using Windows, the user clicks "Open" when the appropriate file is selected).

The CyANWeb system will send an email with a CSV attachment to the user's email address associated with the user's Username. This email is typically sent immediately, but the user's receipt of the email and attachment may be slowed down depending on Internet traffic and spam filters.

In case the user has forgotten which email address is associated with the CyANWeb user account, this email address is displayed each time the user logs in to CyANWeb in the upper right corner of the opening pop-up. The email address is also displayed via the User Profile control at the upper right of the screen, in the upper right corner of a similar pop-up, when the user is provided with a choice of either continuing to use CyANWeb or logging out (Figure 19).

Figure 19 – User account email address

On the Request Location Data interface, the user can track all current and past runs using the "Jobs" tab, which provides a list of each job the user has run and its status.

Waterbody Information

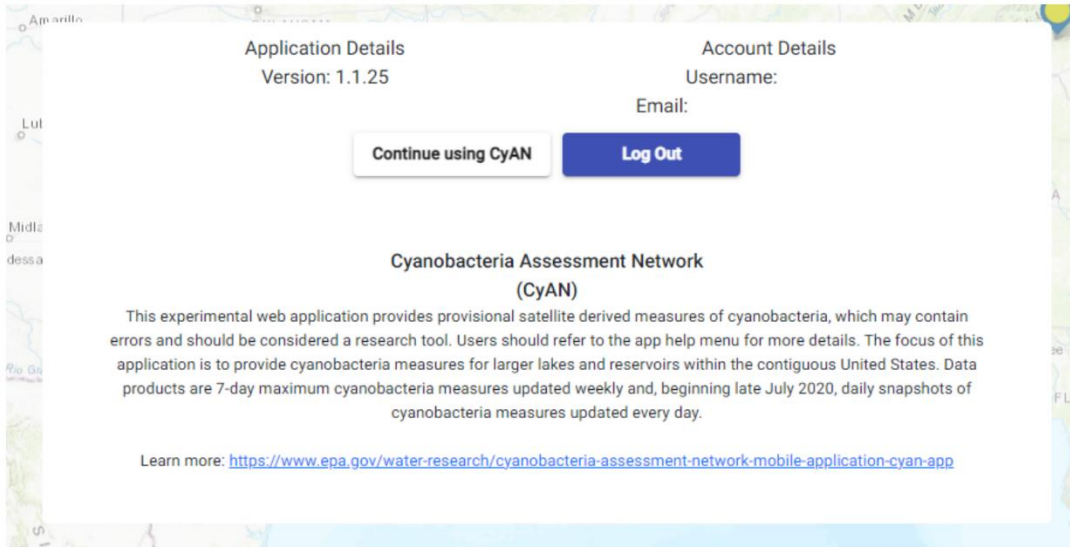In addition to the point location monitoring data, CyANWeb also provides historic cyanobacteria detection data for fresh waterbodies in the contiguous United States. The data are derived from the same satellite raster images used for location cell concentration values. The raw raster images are clipped using waterbody geometries from the National Hydrology Dataset Plus High Resolution (NHDPlus HR: https://www.usgs.gov/core-science-systems/ngp/national-hydrography/nhdplus-high-resolution) dataset. The waterbodies available include those that have a surface area greater than 1 square kilometer, have a USGS Geographic Names Information System (GNIS) name, and are either a lake, pond, or reservoir. Clipping the raster to the waterbody geometry provides a full histogram distribution for the entire waterbody, allowing that information to be served through the CyANWeb application.
Disclaimer: The NHD HR dataset may not contain a fully comprehensive collection of waterbodies in the contiguous United States, with some larger waterbodies not being given a GNIS name or having a name which does not correspond to the waterbody's common name.

There are two ways to access waterbody statistics data on CyAN Web:
1. From the *My Locations* panel, a location that falls within one of the available waterbodies will display an icon (below) that is a link to launch the waterbody statistics for that waterbody.
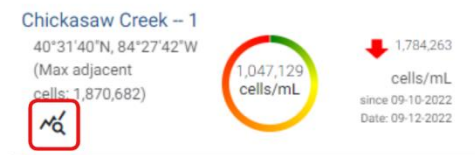
Figure 20 – Example My Locations panel showing waterbody statistics icon

After clicking that link, you can now see the waterbody statistics panel interface. Note that the name of the associated waterbody is displayed, but your single point location name is not.
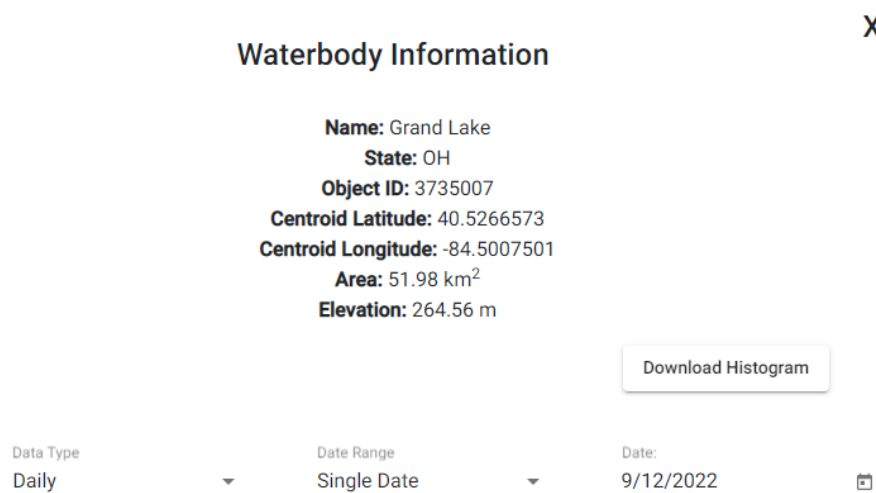
Figure 21 – Example waterbody information screen
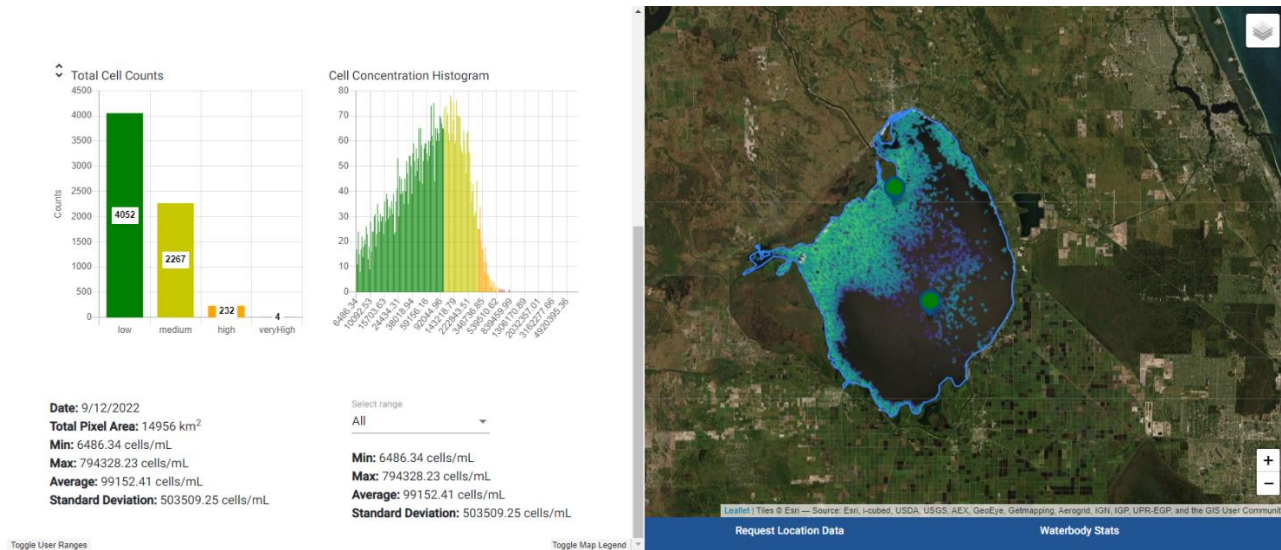
Figure 22 – Example waterbody data graphs and map imagery

2. Alternatively, from the main map, access the waterbody search feature by clicking on the *Waterbody Stats* button on the bottom right side under the map.
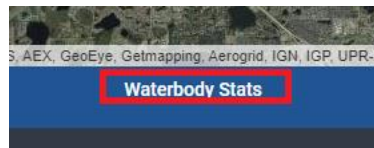
Figure 23 – Waterbody Stats button on the main map

a. From the waterbody search panel, search for your waterbody by either name or geospatial coordinates (as decimal degrees). **Note:** you may convert locational coordinates from degree-minute-seconds to decimal degrees using the *Geographic Coordinates* button in the upper right of the screen above the main map. Enter your known coordinates in the applicable fields and then toggle the view to Decimal Degrees. Use the newly presented decimal degrees information in the *Waterbody Stats* tool.

Waterbody Search   Waterbody Reports   X

Waterbody Search

Search for an available waterbody by name or coordinates. Disclaimer:
name searches and waterbody boundaries come from the USGS NHD
HR geospatial dataset.

Search for waterbody by:
Name ▼

Enter a waterbody name to search

Search

Figure 24 – Waterbody search tab

    b. Upon selecting a waterbody from the search results, or by clicking a location's waterbody icon in the *My Locations* panel, the waterbody statistics panel interface will be visible.

3. The waterbody statistics panel has three input fields:
    a. Data Type: the user specifies either the daily satellite imagery or weekly max composite imagery.
    b. Available Dates: lists all the dates that have been processed and are available for viewing; select the single date or latest date of interest (depending on date range desired).
    c. Date Range: provides the option of viewing the data for a single day, the past 7 days from the selected date, or the past 30 days from the selected date.

4. After populating all three of the fields, you will see the side map load the satellite imagery for that selected date or for the first date in the selected range. There is a waterbody legend for the satellite imagery map in the lower right corner of the *Waterbody Information* panel that you may toggle on or off. The ranges displayed on this map legend are attached to the OLCI satellite raster raw data and are not user editable.
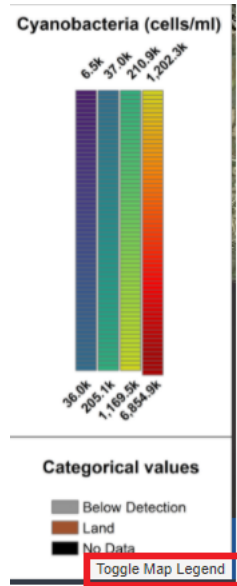
Figure 25 – Waterbody information panel map legend and its toggle button

5. If you selected 7-day or 30-day history, click the checkbox next to "Start slideshow" to see satellite imagery for each of the other dates in your selected range. Click the checkbox next to "Slideshow started" to pause the progression. You can select "Start slideshow" again to resume the slideshow from where you paused.

6. You will also see two graphs displayed lower down in the waterbody statistics panel. These graphs are updated as the slideshow progresses through the 7-day or 30-day history (if selected).

   a. Regardless of date range, the graph on the left will show a vertical bar chart of the distribution by concentration range, using the user's current cell concentration range definitions.

      i. See the current user range definitions by clicking the toggle button at the very bottom of the panel. Select the toggle again to minimize the range details. **Note:** it is recommended that you do not toggle on both the Toggle User Ranges and Toggle Map Legend at the same time, as one display will be on top of the other.
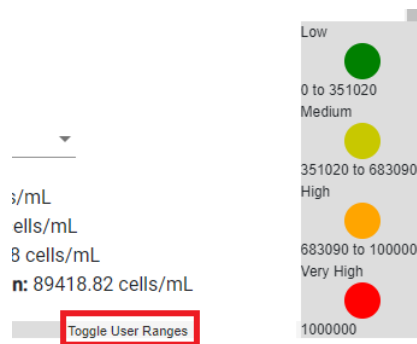
Figure 26 – Example waterbody information panel user range legend and its toggle button

      ii. See the section Markers – user configuration settings within this User's Guide to update ranges from the latest settings. Ensure you click the "Save" button at the top of the configuration settings panel if you want to retain your changes for your next CyANWeb session.

b. Only in the case of a single date being viewed, you can view additional graphs by clicking on the control next to the left graph title. Options are a vertical bar chart for Total Cell Counts and pie charts for Percentage of Detected Area and Percentage of Total Area.
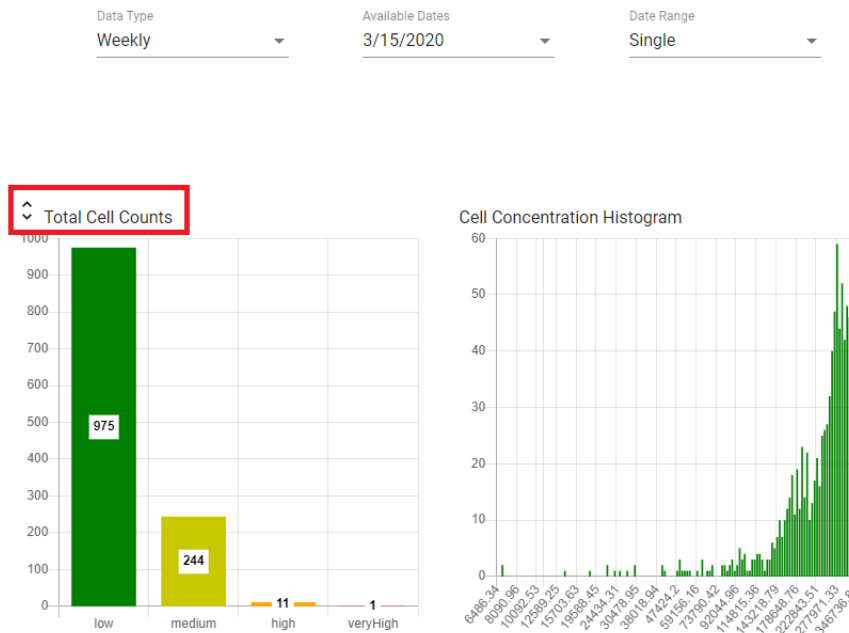
Figure 27 – Example waterbody single date range button to view additional graphs

c. Only in the case of a single date being viewed, the graph on the right is the complete histogram distribution of detected cell concentration pixels for the waterbody on the selected date.

d. If the 7- or 30-day histories were selected, you can view two graphs: the left graph will show a stacked bar chart, while the right will be a line graph showing you the changes in those cell count ranges over the selected date range.
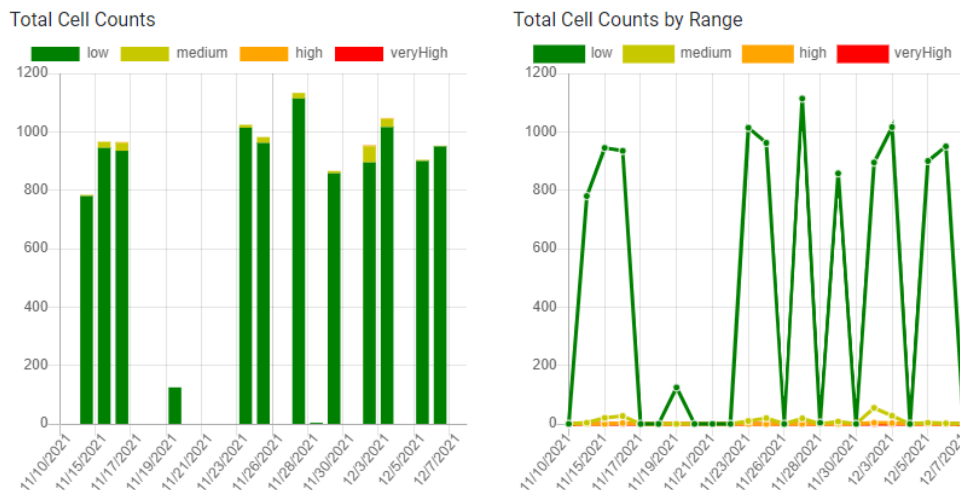
Figure 28 – Example waterbody multiple date range graphs

e. Metrics for the selected date range are shown below the graphs, including minimum detection, maximum detection, average, and standard deviation.

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Date: 12/6/2021
Total Pixel Area: 1774 km²
Min: 6486.34 cells/mL
Max: 409260.66 cells/mL
Average: 993273.38 cells/mL
Standard Deviation: 1570987.34 cells/mL

Select range
Low

Min: 6486.34 cells/mL
Max: 346736.85 cells/mL
Average: 86148.08 cells/mL
Standard Deviation: 89418.82 cells/mL

Figure 29 – Example waterbody information panel metrics

7. The user can download all waterbody histogram data from the waterbody information panel by clicking on the *Download histogram* button. **Note:** the user may need to use a laptop or workstation to implement this action if your phone or tablet cannot receive downloaded files.

Waterbody Information

Name: Lake Kissimmee
State: FL
Object ID: 3612440
Centroid Latitude: 27.91068246
**Centroid Longitude:** -81.266949
Area: 127 km²

Download histogram

Available Dates
12/7/2021

Date Range
30 Day History

Figure 30 – Download waterbody histogram data

    a.   All values in the downloaded csv file correspond to occurrence counts by Digital Number (DN) values, pixel values ranging from 0 to 255, and their corresponding cell concentration values.

    b.   The equation to convert DN to a cell concentration can be found in the References section of this User's Guide.

Waterbody Reports

Another option for obtaining waterbody statistics is to generate a waterbody report, using the *Waterbody Report* feature accessed from the *Waterbody Stats* panel (i.e., the user must use the *Waterbody Stats* button instead of the *My Locations* button). Reports contain a regional summary of the waterbodies specified, or waterbodies falling within a selected geopolitical boundary (such as a county), as well as a collection of graphs, tables, and metrics to provide a wholistic overview of the set of waterbodies.

1. Using the *Waterbody Stats* button, go to the default *Waterbody Search* tab on the panel. Select the *Waterbody Reports* tab. At the "Generate report using" field, select County, User Locations, or Tribe as the starting point to identify your waterbody(ies) of interest.
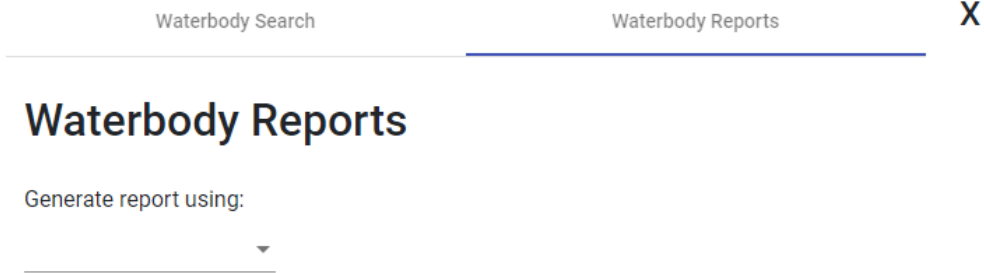
Waterbody Search   Waterbody Reports   **X**

Waterbody Reports

Generate report using:

▼

Figure 31 – Waterbody Reports tab

a. If County is selected, choose the specific state and then the specific county from the dropdown lists.
b. If User Locations is selected, the list of user locations from *My Locations* is displayed.
    i. If a user location in *My Locations* is associated with a waterbody of sufficient size and other required characteristics, the name of the waterbody will appear next to the location name.
    ii. You can select multiple location/waterbody combinations for a single report or run the report one waterbody at a time by repeating these steps.
c. If Tribe is selected, select a name from the dropdown list.
2. Select a date, and then press the *Generate Report* button.
a. The date you select should be your primary date of interest.
b. For some data presentations in the resulting report, this date will be the last date for a 30-day history.
c. For other data presentations, this date will determine the last month for a 13-month history.

Select a date:
9/17/2021 📅

Generate Report
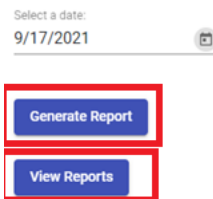
View Reports

Figure 32 – Waterbody Reports Generate Report and View Reports buttons

3. Once you have generated the report (which may take some time to process, depending in part on the number of waterbodies involved and the amount of data per waterbody), press the *View Reports* button for a list of your generated reports.

List of ▮▮▮▮ generated reports   **X**

Report	Status	Report ID	Received	Finished	Report Date	Object IDs	Tribes	Counties	Range (low)	Range (medium)	Range (high)	Download Report
1	SUCCESS	247c0cf1-3bad-4fb8-85d8-5ee6092f1c	2021-12-17 13:19:03	2021-12-17 13:19:20	11/26/20212271721				351020	683090	1000000	⬇

Figure 33 – Example list of user-generated reports

a. Reports will receive a sequential number, a status (e.g., SUCCESS) report ID, and various metadata associated with the report.

b. You can download your new report or your historical 30-day reports; each report download is a PDF file with the report ID as the file name, and you can rename the PDF file once you have downloaded it. **Note:** the user may need to use a laptop or workstation to implement this action if your phone or tablet cannot receive downloaded files.
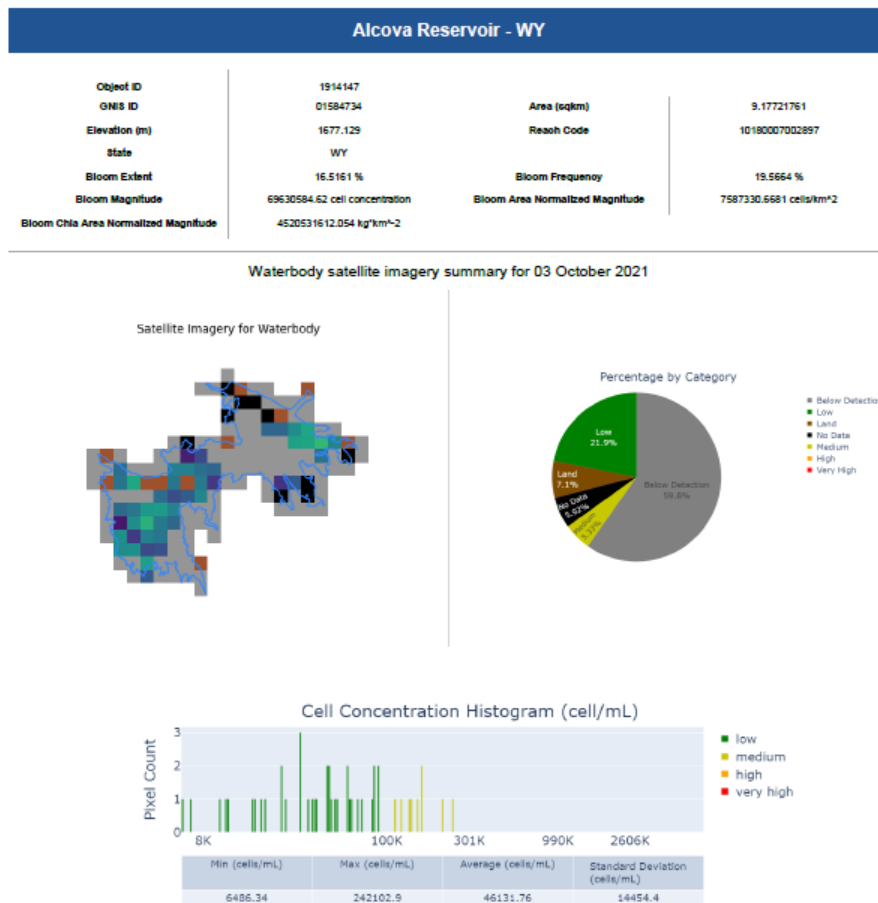

Figure 34 – Example report cover.

Figure 35 – Example report waterbody entry

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Usage Tips

Saving Your Work

Any location markers you place are automatically saved to your user account. Any marker color configurations and location alert level settings that you choose or notes that you add (e.g., to a pin marker or to a site listed on the My Locations Overview tab) must be saved if they are to be preserved for the next time you access your account. To save, select the diskette symbol at the top of the user configuration dialog.

Data Latency Issues

Data latency may be significant if you've placed a lot of markers (~60), or if your locations have a significantly long history of cyanobacteria response. We now host multiple years of weekly data online (since Jan 2019). Some US waterbodies (e.g., Apopka in Florida, Grand in Ohio) seem perpetually polluted with HABs, and it takes some time to retrieve 100+ data records for these types of locations. Please be patient with the interface.

Display Issues

There are myriad screen resolutions and aspect ratios utilized on desktop/laptop systems. We cannot custom code for all possibilities. The best user experience for desktop-based browsers is to maximize the browser window; even then you may encounter styling issues with overlapping visual components that make it difficult to access the individual controls. Try adjusting the zoom level in the browser to minimize overlap but still maintain the ability to read the displayed information easily. Your browser control/configuration menu (browser settings) will provide access to zoom levels; in Firefox and Chrome, shortcut keys for zoom-out and zoom-in are, respectively, "Ctrl–", and "Ctrl+".

Access Issues

If you get logged off for user inactivity, log back in. You should not have to revisit the password page to access CyANWeb again if the browser session you are using is still active. However, it is possible that you lost any unsaved configurations or notes if the system logged you off (see *Saving Your Work* above). It is recommended that you confirm whether your new settings are in place before you close the current browser setting.

Getting Help

For assistance in using the application, to report issues or leave comments, email **CyAN@epa.gov**

FAQ

Q – I selected a location at my waterbody of interest that had no cyanobacteria data—what are some easy ways to look nearby for more likely locations?

A – There are two ways to locate potential cyanobacteria data nearby. See the *My Locations* → *Overview* tab to locate nearby locations with cyanobacteria detections using the cyanobacteria detection color coding displayed on the location's map. Also, see your location's "Max adjacent cells" value on the *Compare* → *Statistics* tab to determine whether there are higher values nearby. See also **Q -** What does "(Max:…)" indicate when comparing locations? below.

Q - How are unchecked location pins useful?

A - Having unchecked locations is useful to differentiate between your priority locations and your non-priority locations by keeping your non-priority locations unchecked and then controlling whether they appear or not in the "My Location" list using the "show checked locations" checkbox. This checkbox controls a filter and does not remove the unchecked location pins from the map or the locations themselves from your saved locations.

Q - The pin location I selected is an "Unknown Location."

A - If you mark a location that has no satellite data in the current archive, the CyAN app will return "Unknown Location" and no count information. This is typical in areas extremely close to shore, waterbodies smaller than can be resolved by the satellite, or if you place a pin marker on land.

Q - Why are my data reloading slowly?

A - Reloading data will be dependent on: (1) the speed of your wireless/internet service connection, (2) the number of markers you use, and (3) the number of satellite data records hosted on the servers.

Q - What does "(Max:…)" indicate when comparing locations?

A - The Max value is an attempt to provide a small aerial view of the cyanobacteria conditions around the location raster cell. Max is the largest cyanobacteria value in a 900mx900m raster cell matrix around the location.

Q - What is OLCI?

A - OLCI (Ocean and Land Colour Instrument) is a collection of sensing instruments on the European Space Agency's (ESA's) Sentinel-3 satellites that are used to detect cyanobacteria in waterbodies. Each Sentinel-3 satellite tile is a geo-referenced TIFF formatted raster file containing 2000x2000 = 4,000,000 raster cells. Each pixel cell represents a 300x300 meter area.

Q - When I switch from OLCI-Daily to OLCI-Weekly or vice versa, why do my pins change color?

A - OLCI weekly/daily data are separate data products that the CyAN web interface is capable of handling. Daily data are a snapshot of cyanobacteria at the time of detection; weekly data are a composite of daily maxima during a seven day time period.

Disclaimer Statements

This report has been reviewed by the ORD/CEMM/EPD Quality Assurance Manager and it has been determined to be consistent with EPA Category B quality assurance requirements.

The information generated in this report was performed under CEMM Quality Assurance Project Plan (QAPP) "Cyanobacteria Assessment Network" J-WECD-0031501-QP-1-5, effective date 1/28/2022. There are no significant deviations from the approved QAPP and data quality and limitations of usability of this research is discussed in sections titled "Understanding the Data" and "Data Interpretations – What could go wrong?".

Although the software has been subjected to rigorous review, the USEPA reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USEPA or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the USEPA nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

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