

South Florida/Caribbean Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure WT08

QA/QC of Newly Imported HOBO® Data Files into Aquarius— Version 2.2

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Purpose

The water temperature data used to be stored in a Microsoft Access database. In 2018, the program shifted water temperature data storage to Aquarius Time-Series, a NPS-wide continuous water quality database. The software platform was updated from Aquarius v3.10 to Aquarius NG v2020.1, and later upgraded to v2022.1. The [DOI Aquarius Sharepoint](#) site contains additional resources to facilitate learning how to use the application. This SOP describes how data uploaded into Aquarius are checked for errors and verified. This SOP also describes the documentation of any data gaps in Aquarius. Data that are free of errors are marked “Approved” and given a grade of “Good” which allows it to be visible through the Aquarius web data portal on IRMA (<https://irma.nps.gov/aqwebportal/>).

This SOP is for users who already have access to Aquatic Informatics’ Aquarius v2022.1. If you do not have access, contact the SFCN Data Manager and/or Dean Tucker (dean_tucker@nps.gov), the Natural Resource Specialist in the Water Resource Division.

Requirements

Login and access to Aquatic Informatics Aquarius NG v2022.1 (or “Aquarius” for short)

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #
4/15/2020	Lee Richter	Data are now uploaded to Aquarius Time-Series database	MS Access database no longer used	2.0
10/26/20	Lee Richter	1) Added Tutorials for Aquarius NG section 2) Updated procedures to run QA/QC on dataset using updated software platform Aquarius NG v2020.1	Aquarius v3.1 updated to Aquarius NG v2020.1.	2.1
9/27/22	Lee Richter	Changes due to update to Aquarius v2022.1	Aquarius updated to v2022.1	2.2

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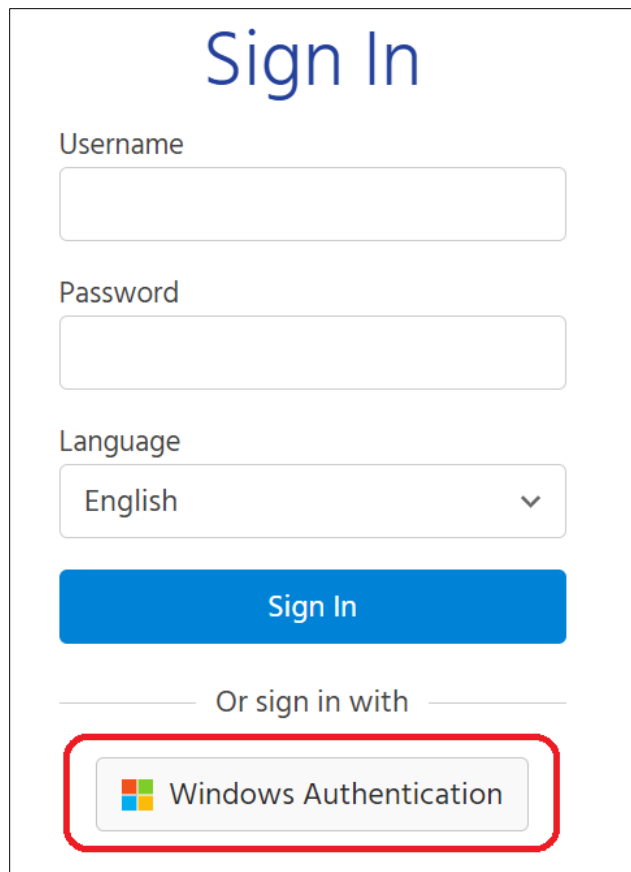
Procedures

Tutorials for Aquarius NG

Tutorials for Aquarius (documents and videos) are available on the NPS Aquarius Sharepoint site: <https://doimspp.sharepoint.com/sites/nps-nrss-wrd/data/Pages/AquariusNG.aspx>. Any user who plans to enter or edit SFCN water temperature data in Aquarius should familiarize themselves with these resources. They cover Aquarius operations in far more detail than this SOP and may be used as an additional reference. Specifically for this SOP, users should first review the following documents and/or associated videos: “03_Data_Visualization_Correction.docx” and “05_Approval_Levels.docx”.

Applying a Grade to Newly Appended Dataset

1. These steps occur immediately after *.csv files are uploaded to the Aquarius database in SOP WT12: *Importing data to Aquarius Database—Version 1.2* (SFCN 2025a). Navigate to the Aquarius v2022.1 Springboard in your web browser: <http://aquarius.nps.gov/AQUARIUS/>.
2. Click the Windows Authentication button at the bottom of the window to sign in (Figure 1). You do not need a username or password, but you must be connected to an NPS server (or using Ivanti Secure Access Client) in order to sign in. If you are unable to sign in, contact Dean Tucker (Dean_Tucker@nps.gov) and ask to reinstate your license. At the time of this writing, licenses for editing water quality data in Aquarius v2022.1 are limited and must be turned on/off to meet the demands across the entire NPS.



Sign In

Username

Password

Language

English

Sign In

Or sign in with

Windows Authentication

Figure 1. A screenshot of the sign in window. To sign in, the user must click the Windows Authentication button while connected to an NPS server (or using Ivanti Secure Access Client).

3. Once in the Springboard, search for the site with the data you wish to upload. Typing a few letters into the search panel at the left of the screen will bring up options (Figure 2).

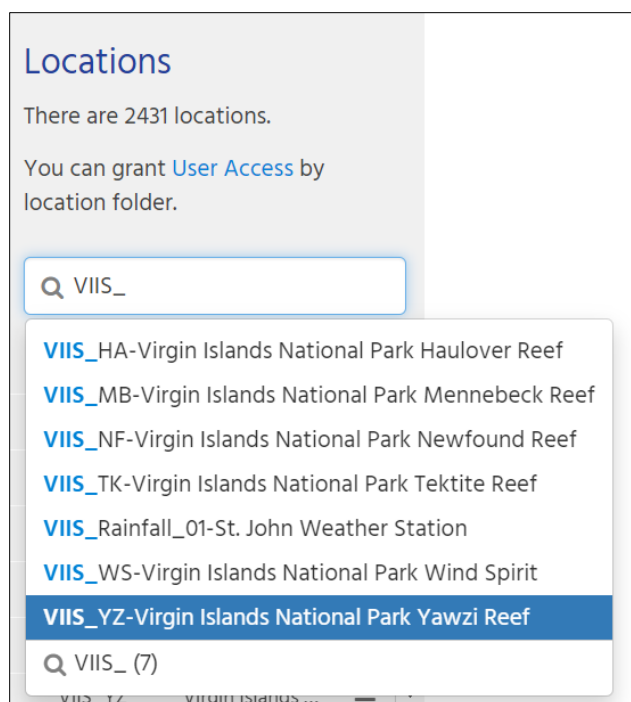


Figure 2. A screenshot of the search panel within Springboard to navigate a water temperature monitoring site. In the above example, typing “VIIS” brings up all water quality datasets associated with that park.

4. Once the temperature monitoring site is selected from the search panel, two datasets corresponding to each logger should populate the main panel in the screen. Click the check box next to the first logger at the site. Once a box is checked next to a dataset, some of the icons at the top of the screen change color and become selectable (Figure 3).

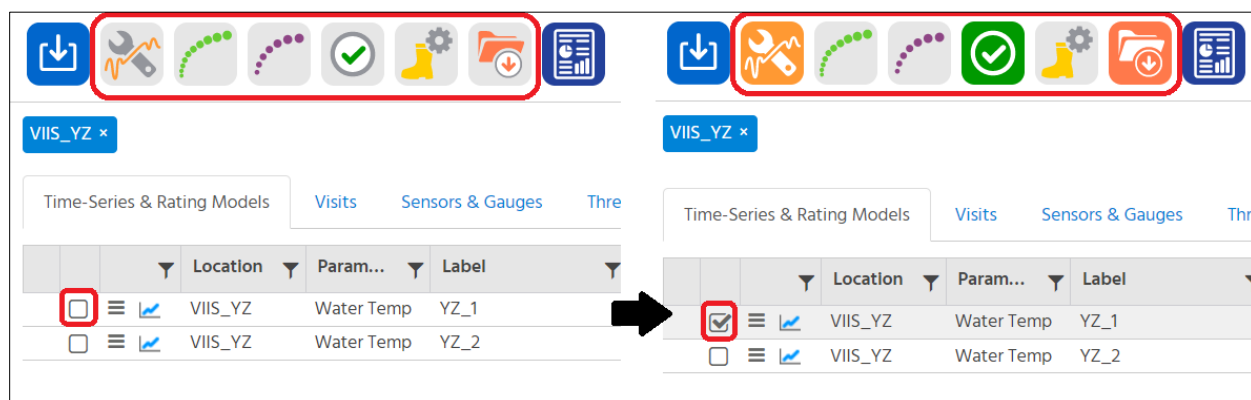


Figure 3. Two screenshots of the Aquarius Springboard. The icons at the top of the screen change color and become selectable when a box is checked next to a dataset.

5. With a box checked next to one of the datasets, click the orange icon at the top left of the screen to open the Data Review Tool (Figure 4).

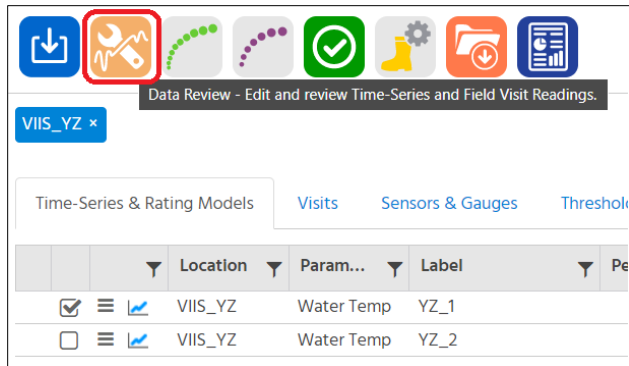


Figure 4. A screenshot of the Aquarius Springboard. With a box next to one of the datasets checked, select the orange Data Review icon at the top of the screen.

6. The Data Review Tool will open in a separate tab and is comprised of a few parts (Figure 5):
 - a. Focus chart: This is the primary user interface showing a portion of the dataset. You can zoom and select different portions within this chart using the toolbar immediately above the chart.
 - b. Overview chart: This is located below the focus chart and shows the entire dataset range. The portion of the dataset that appears in the Focus Chart above is highlighted in blue (Figure 5).
 - c. Metadata Legend: This appears in between the Focus and Overview charts and shows you the approval and grade levels of various portions of the data. For newly appended data, the approval is set to “Working” (red) and grade is set to “-1- Unspecified” (grey) by default.



Figure 5. Screenshot showing the Data Review tool. The Focus Chart is the primary user interface. Below this is the Overview Chart showing the full dataset range. The portion of the Overview Chart highlighted in blue is the data that appears in the above Focus Chart. The Metadata Legend, between the two charts, shows the approval and grade settings for various portions of the dataset.

7. In the Metadata Legend, hover over the red Approval bar (“Working”) or grey Grade bar (“-1 - Unspecified”) and double-click to select the newly appended dataset for that range. Selected data will appear highlighted in yellow (Figure 6). It is also possible to manually select data using the Selection Tool . However, the Selection Tool is more useful when selecting a much smaller data range with the Focus Chart zoomed in.



Figure 6. Screenshot showing the Data Review tool. Newly appended data has been selected (highlighted in yellow) by double-clicking the red Approval bar or grey Grade bar in the Metadata Legend.

8. With the data selected, select the Edit panel from the pane of tabs at the very right-hand side of the screen (Figure 7). If desired, you can refine the selection of data within the Edit panel by manually entering the start and end dates/times.

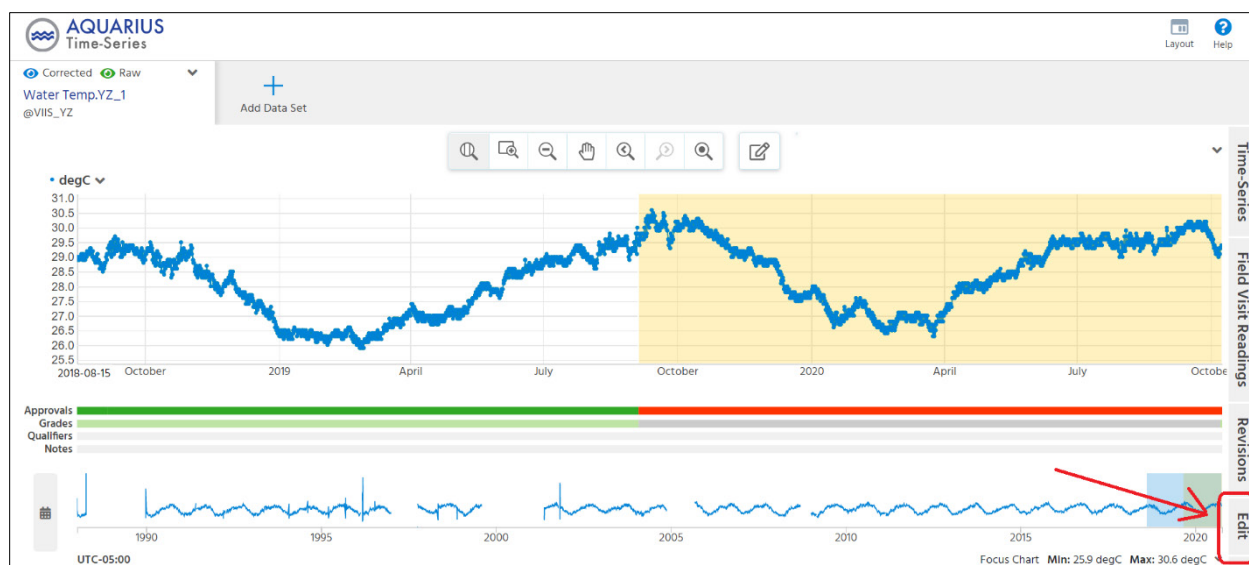


Figure 7. Screenshot showing the Data Review tool. Select the Edit panel from the pane of tabs at the right-hand side of the screen.

9. In the Edit panel, select “Grade” from the drop-down list labeled “Choose a type to apply to your selection”. Then, if the data appears as it should without any errors, select “31-Good” from the drop-down list labeled “Grade” (Figure 8). Click the “Apply” button.



Figure 8. Screenshot showing the Data Review tool with the Edit panel open. Select “Grade” from the drop-down list labeled “Choose a type to apply to your selection”. Apply a grade of “31-Good” by selecting it from the drop-down list labeled “Grade” that appears.

10. After the new grade is applied, the changes will have to be saved by clicking the green Save button that appears at the top right of the screen (Figure 9). Notice that the Grade bar in the Metadata Legend has turned from grey to light green.



Figure 9. Screenshot showing the Data Review tool with the Edit panel open. After a new grade is applied to the portion of the dataset, the change will need to be saved by clicking the green Save button that appears at the top right of the screen.

11. You may exit the Data Review tool by closing the tab. Back in the Aquarius Springboard tab, complete the previous steps for the second logger located at the site. Then, proceed to the next section to assign the approval rating for the newly appended data.

Applying an Approval Rating to Newly Appended Dataset

1. In the Aquarius Springboard tab, check the box next to the dataset you want to apply an approval rating to. Then, click the green Approval Levels icon at the top of the screen (Figure 10).

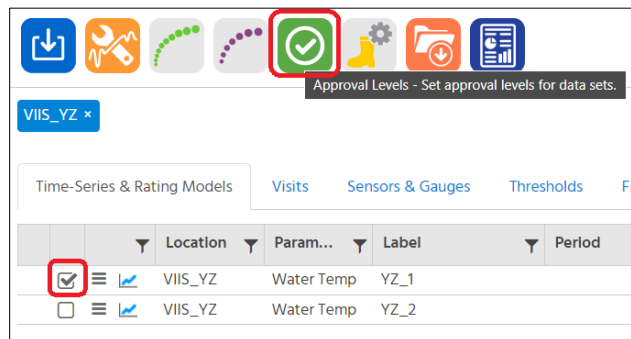


Figure 10. A screenshot of the Aquarius Springboard. With a box next to one of the datasets checked, click the green Approval Levels icon at the top of the screen.

2. In the Approval Levels window, click the “Choose Date” button in order to manually enter the beginning and ending timestamp for the dataset. Previously approved data is green and unapproved data is red. Note that once a timeframe is approved, that portion of the dataset

becomes “locked”, which means the alterations cannot be made in the Data Review panel, unless the approval rating is reset to “working” or “in review” (Figure 11).

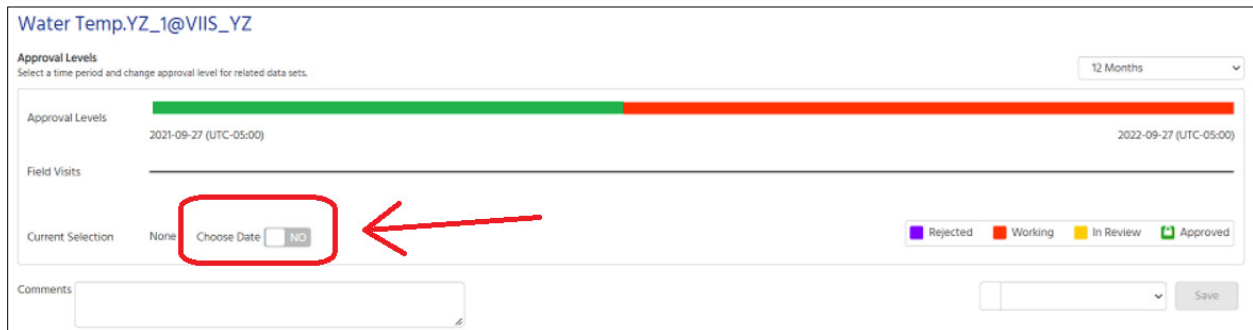


Figure 11. A screenshot of the Approval Levels tab. Select “Choose Date” to manually enter the beginning and end of the dataset awaiting approval.

3. Manually enter the start date, start time, end date, and end time in the window that expands. Once entered, select the drop down at the bottom right and select “Approved”. Then click Save to apply the “Approved” rating to that portion of the dataset (Figure 12). Note that you may have the Data Review Tool tab and the Approval Levels tab for the same dataset open simultaneously.

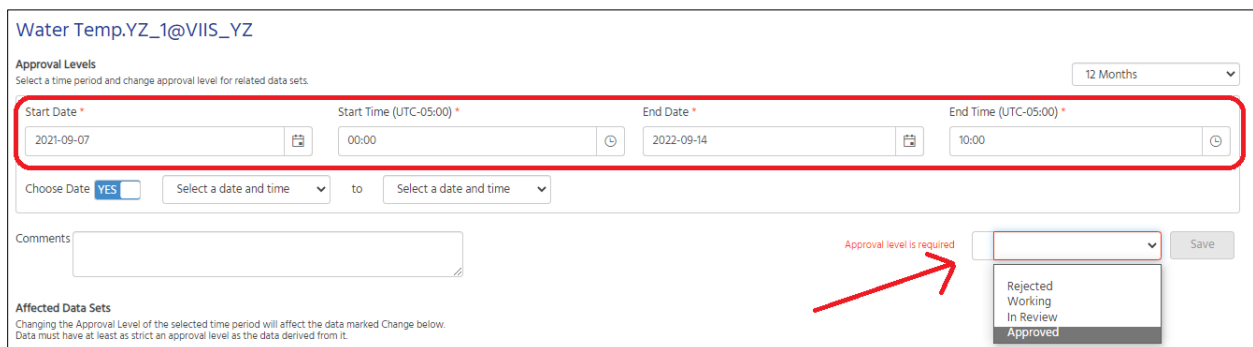


Figure 12. A screenshot of the Approval Levels tab. Enter the start and end timestamps for the dataset awaiting approval. Select Approved from the drop-down list and click Save to apply the approval rating to the dataset.

4. Once saved, the red bar should turn from red (“Working”) to green (“Approved”). A note of “Approval changed to Approved by USERNAME” is automatically added in the comments section. Exit the Approval Levels tab and return to main Aquarius Springboard.
5. In the Aquarius Springboard, re-open the Data Review Tool for the dataset with the updated grade and approval ratings. You will notice the Approval and Grade bars in the Metadata Legend have been updated to green. The data is also now locked for editing. It may not be edited unless the Approval rating is changed back to “Working” (Figure 13).

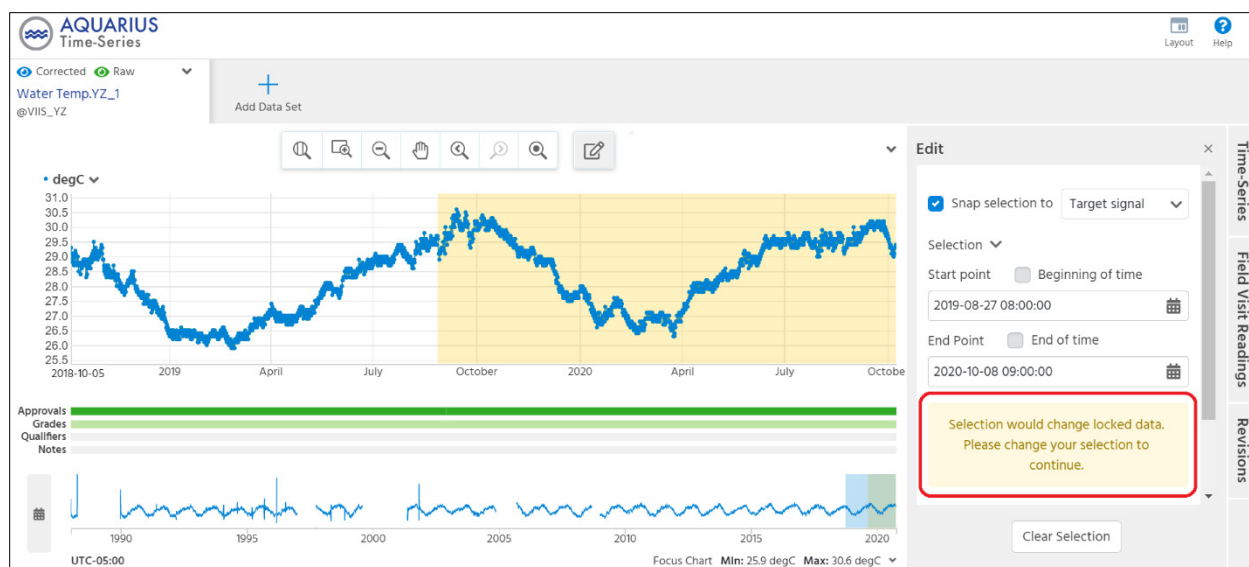


Figure 13. A screenshot of the Data Review Tool. After data has been approved, the Approval bar in the Metadata Legend changes from red to green. Approved data cannot be edited.

Detecting and Marking Errors in the Water Temperature Dataset

1. There will be occasions where erroneous data may appear in the dataset. Errors are generally typified by spikes or gaps in the dataset that are outside the typical seasonal and daily temperature patterns. While abrupt changes in water temperature are possible (e.g. upwelling events in Dry Tortugas), any sudden change in temperature will be investigated for possible error. Possible common errors to look for include:
 - a. A logger was collecting air temperature readings prior to deployment or after retrieval
 - b. A shuttle that was not launched prior to logger download can cause the date and time stamp of the data to be completely wrong
 - c. A faulty logger (inherent software, firmware, or battery issue) can cause data gaps or wild, clearly false fluctuations in temperature (e.g. below 0°C to above 100°C)
 - d. Gaps from datasets that were not uploaded or verified correctly
2. In the event that erroneous data exists, the erroneous sections of the data will need to have the Grade set to “-2- Unusable” and Approval set to “Rejected”. The example below shows how a logger had a gap, followed by questionable readings over the course of two days (Figure 14). This pattern is typical for when a logger is launched in an office setting with a delay before deployment, causing the logger to read air temperatures before actually being secured underwater.

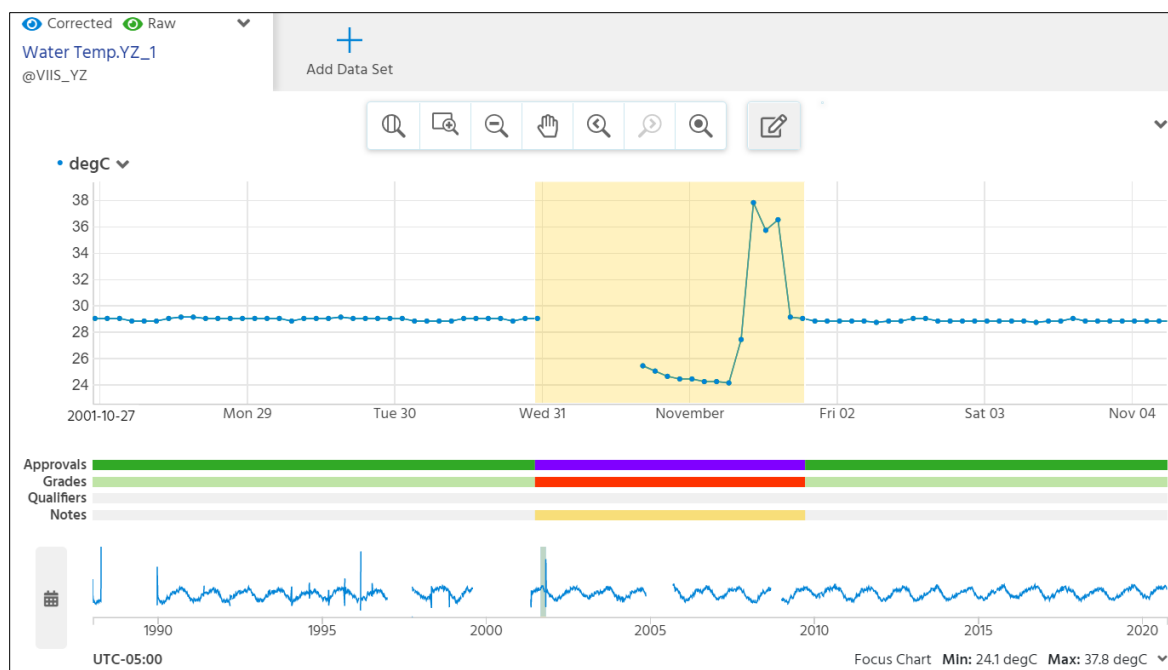


Figure 14. A screenshot of the Data Review Tool. The gap and erroneous portion of data has been marked with an Approval rating of “Rejected” (purple) and a Grade of “-2- Unusable” (red).

3. A note will accompany all portions of the dataset that are rejected, including all gaps and erroneous data. With the erroneous data selected in the Data Review Tool, open the Edit panel from the pane at the right-hand side of the screen. Select “Note” in the drop-down list labeled “Choose a type to apply to your selection”. Then write a note that describes the cause (if known) of the erroneous data. Click “Apply” when finished (Figure 15). The Notes bar in the Metadata Legend will turn yellow if a note exists for that portion of the dataset.

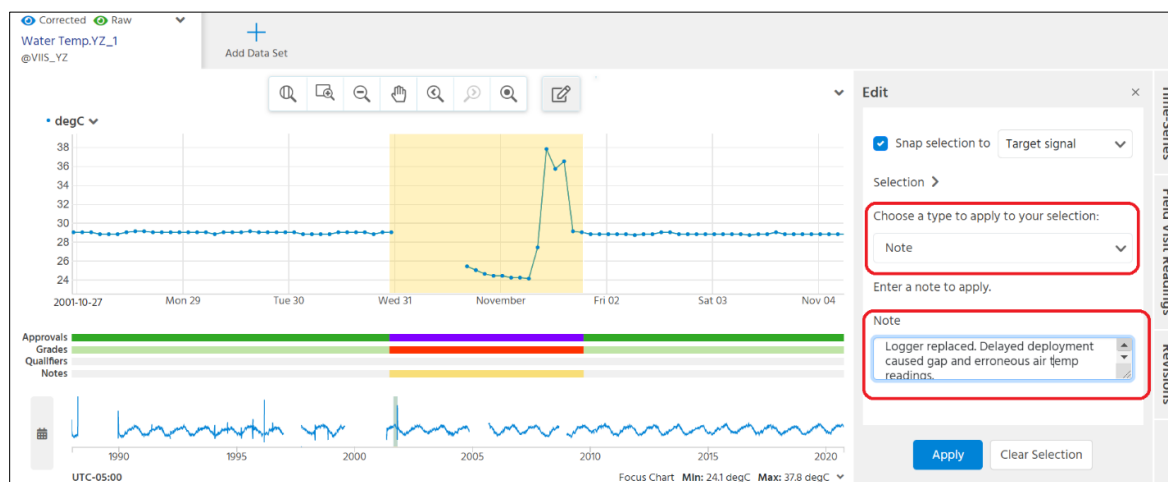


Figure 15. A screenshot of the Data Review Tool and Edit pane. Select “Note” from the drop-down list labeled “Choose a type to apply to your selection”. Type a note that explains cause (if known) of the gap or erroneous data. In the Metadata Legend, the Notes bar will turn yellow when a note exists for that portion of the dataset.

Detecting and Marking Gaps in the Dataset

1. There are circumstances where data gaps occur in the dataset. In Aquarius, a data “gap” is considered any period of time greater than the logging interval of two hours where no data are present. Small gaps (less than 12 hours) can happen when new loggers are deployed (delayed launch until midnight of the following day) or if a logger has to be removed from the water for download. Larger gaps (more than 12 hours) likely indicate a technical issue with the dataset that needs to be documented.
2. In the Data Review Tool, select the Time-Series tab from the pane at the right-hand side of the screen. Once open, check the box in the panel labeled “Only show gaps”. This brings up a list of all gaps in the dataset for that site (Figure 16).

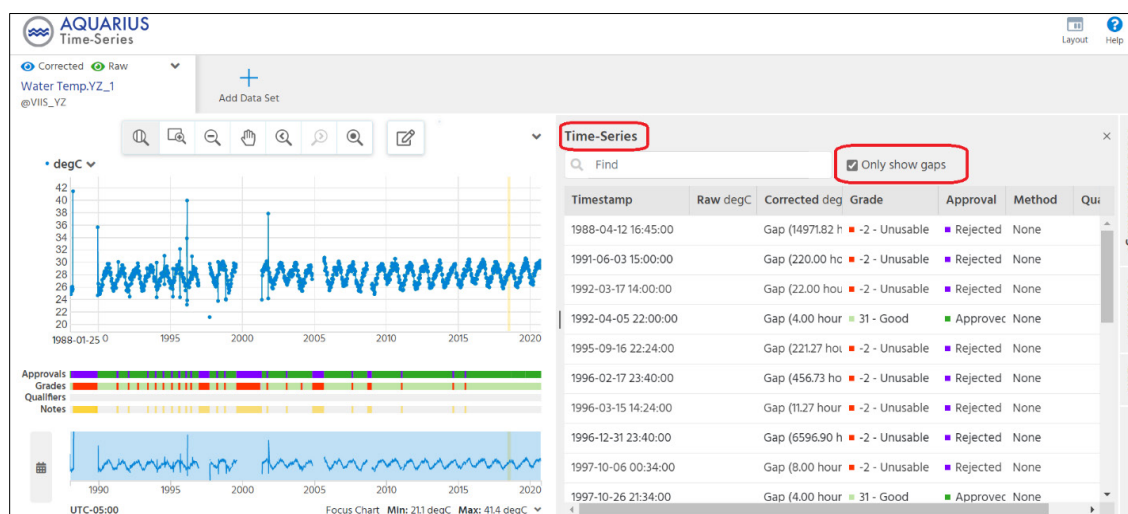


Figure 16. A screenshot of the Data Review Tool and Time-Series pane. Checking the “Only show gaps” box will populate the table with all gaps in the dataset. Click on a row in the table to select a particular data gap.

Comparing Co-located Temperature Loggers at a Site

1. The data from the co-located loggers at a site should mirror each other. In the Aquarius Springboard, select the checkboxes next to both datasets of the co-located loggers at a site (Figure 17). Click the Data Review Tool to view the datasets simultaneously.

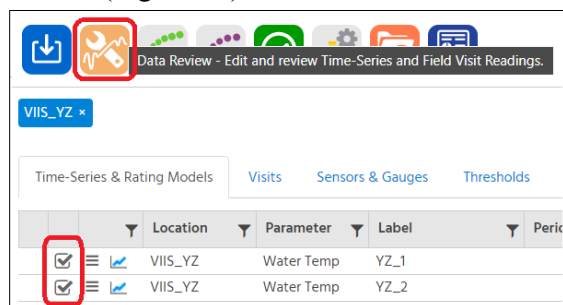


Figure 17. A screenshot of the Aquarius Springboard. Select the boxes next to both co-located loggers at a site to compare them in the Data Review Tool.

2. In the Data Review Tool, the data from logger 1 is in blue and the data from logger 2 is in red. This gives a quick visual comparison of the two loggers to see if there are any large, noticeable disparities (Figure 18).



Figure 18. A screenshot of the Data Review Tool with data from two loggers plotted on the same chart. Logger 1 is in blue and logger 2 is in red. This comparison is good for detecting any large disparities between co-located loggers.

3. The Data Review Tool gives a good visual comparison of the two loggers and detection of any large disparities. However, any differences between the loggers of greater than 0.3°C will be investigated and is done more efficiently by comparing the individual values through an R-script.
 - a. Open the R script ‘Logger_Comparison.R’ in R Studio from the following folder:
X:\Files\Vital_Signs\Coral_Reef_Water_Temperature\analysis\Logger_Comparison.
 - b. Update the temp.directory to a folder that has a full set of downloaded CSV files from Aquarius. See *SOP WT09 Reports, Graphing and Web Page Data—Version 2.1* (SFCN 2025) for a companion script that downloads the full period of record for each logger.
 - c. Run the script.
 - i. The script starts by loading all the CSV files for sensor 1 into one data frame and the CSV files for sensor 2 into a second. Readings with “Unacceptable” approval and grade ratings are removed.
 - ii. Then the round_date function within the lubridate package is used to round timestamps to the nearest five minutes to accommodate for slight time discrepancies between loggers.

- iii. Everything is then merged together on a key that is comprised of the Park, Site, and rounded timestamp. This ensures that co-located sensors with the same timestamp are in adjacent columns.
 - iv. The script then calculates the absolute value of the temperature difference between co-located sensor and reformats the data frame to improve readability and to only show discrepancies that are $> 0.3^{\circ}\text{C}$.
 - v. As a final step, the scrip exports a CSV file named YYYYMMDD_flagged_temp_differences.csv with any readings that need to be investigated.
- d. Review the output from the script (e.g. 20200714_flagged_temp_differences.csv), and when readings are determined to be erroneous (e.g., $> 3^{\circ}\text{C}$ for an extended time period), adjust the Grade to “-2- Unusable” and Approval set to “Rejected” within Aquarius.

Reviewing Approved Data in the Public Aquarius Web Data Portal

1. Once the data for both loggers have been appended with grade and approval set, check the online Aquarius web data portal on IRMA to make sure it appears correctly. This can be found at the following address: <https://irma.nps.gov/aqwebportal/>
2. Use the map to find the location you want view. Select the site (Figure 19).

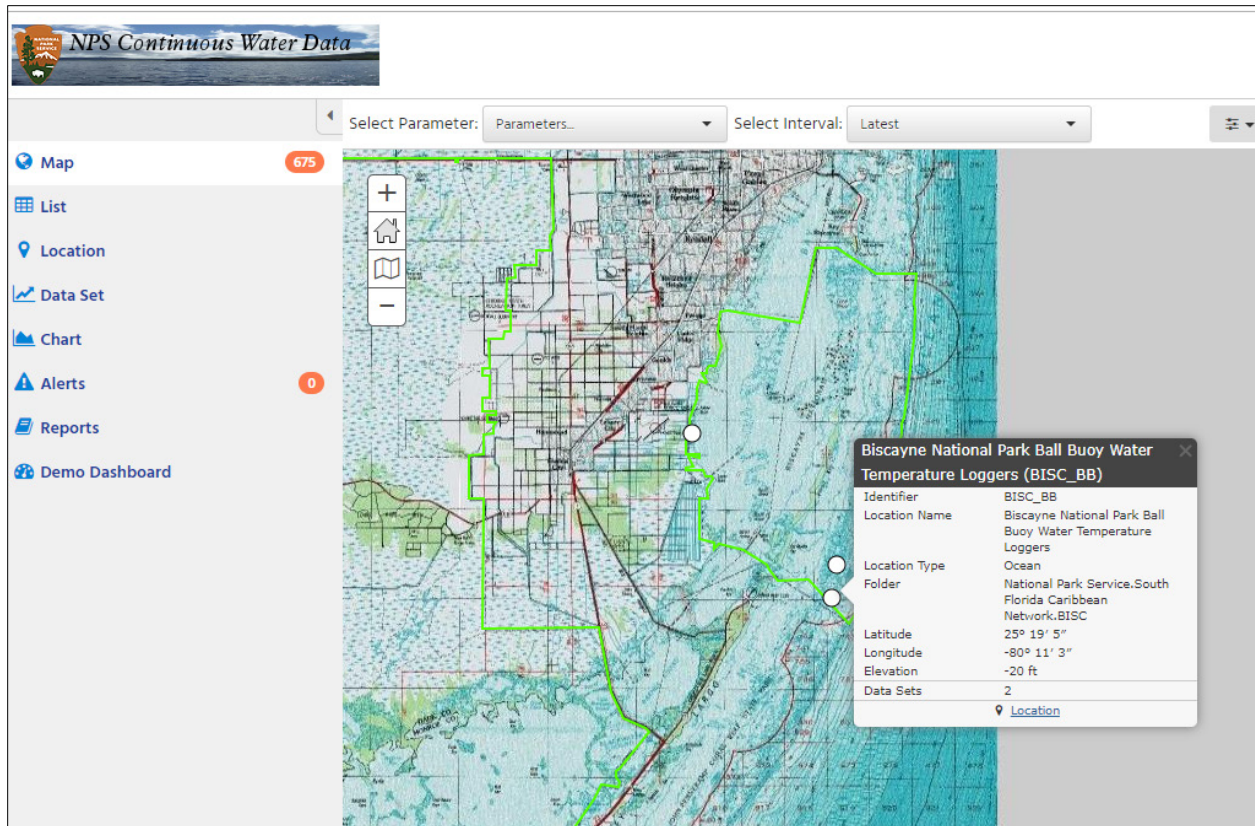


Figure 19. A screenshot showing the Aquarius Web Portal in Map View.

- From the menu at the left side of the screen, select “Data Set”. On the main screen, look at the “End of Record” and “Last Updated” sections on the screen. The “End of Record” time stamp should be when the logger was last downloaded, i.e. the end of the dataset. The “Last Updated” timestamp should be when the online portion of the Aquarius database was last updated (Figure 20). Please note that there may be a delay between when you complete your edits in Springboard and when they show up on the web data portal. An automatic service on the Aquarius server attempts to synchronize the web portal database every 5 minutes, but sometimes IT updates prevent this from occurring. If the updated data do not appear within 24 hours, please reach out to the SFCN Data Manager or directly to Dean Tucker (dean_tucker@nps.gov).

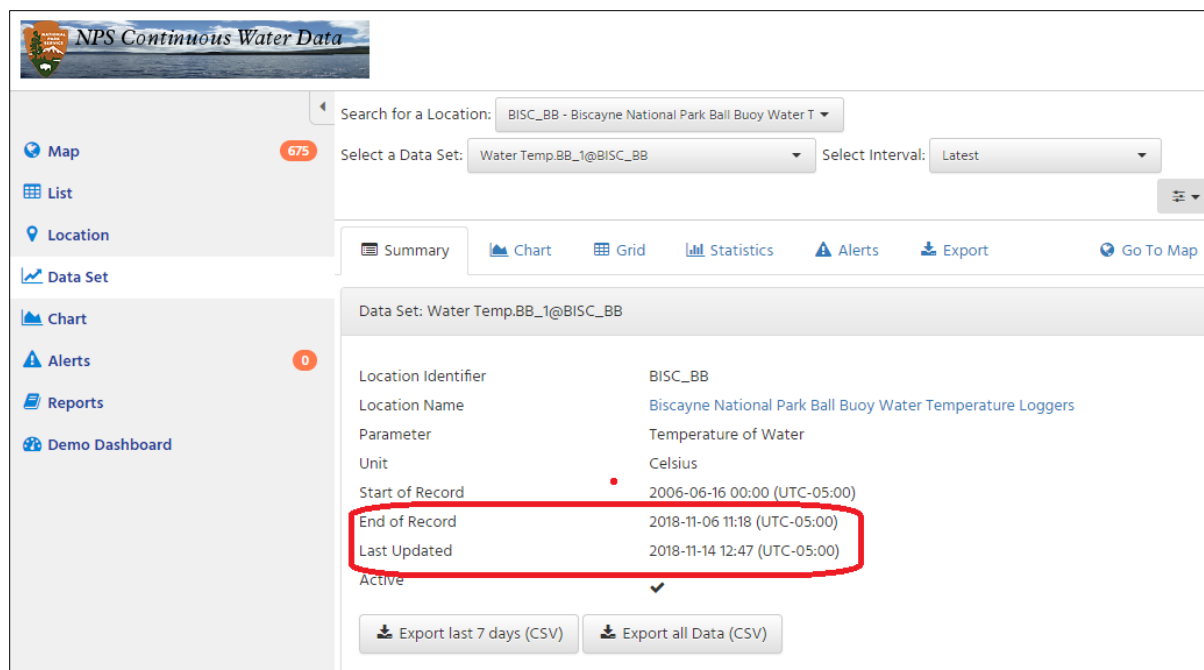


Figure 20. A screenshot showing the Aquarius Web Portal in Data Set View. The Summary tab is selected with the End of Record and Last Updated information highlighted.

4. From the same window, you can also select the Chart view to see the whole dataset in graphical form (Figure 21):

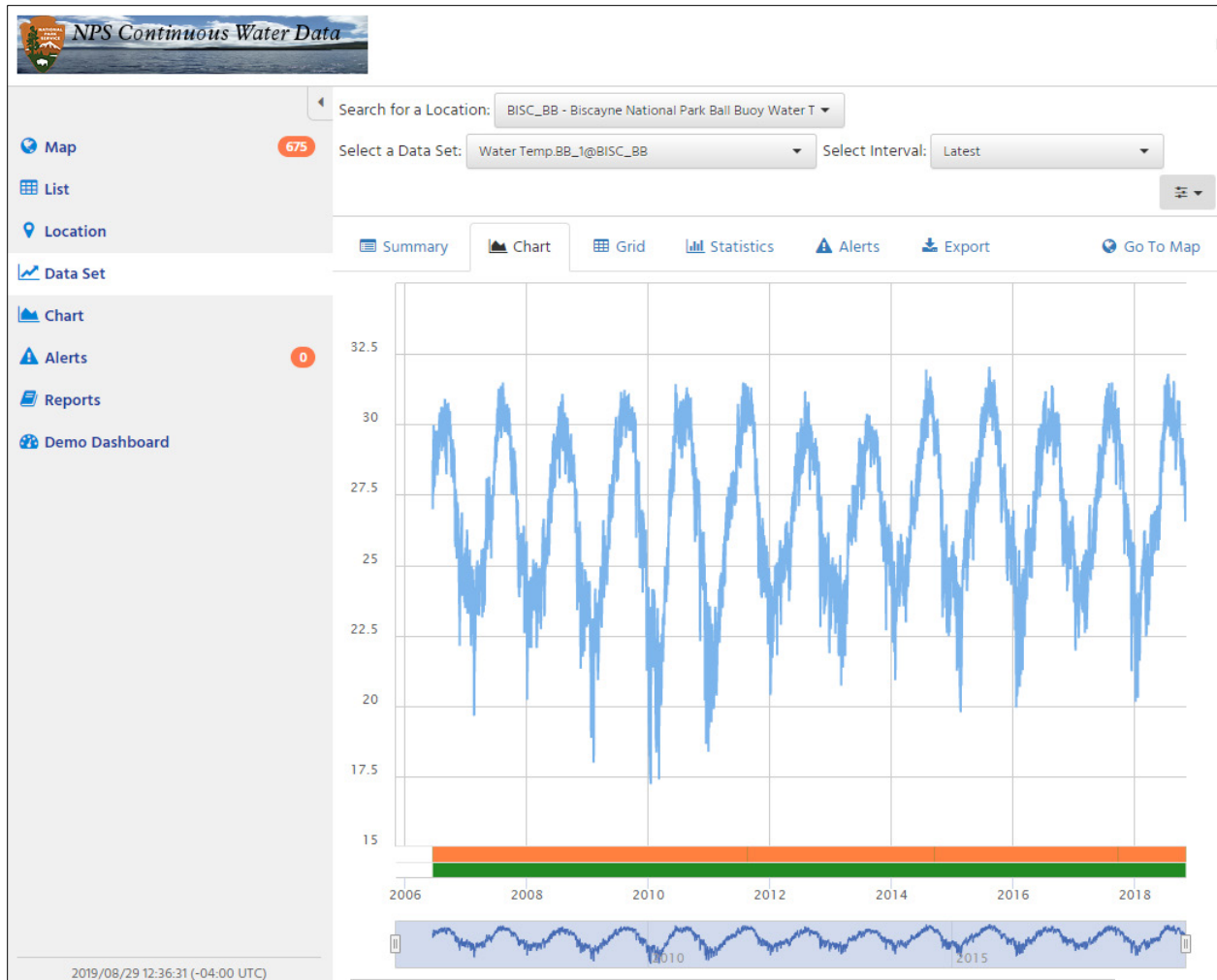


Figure 21. A screenshot showing the Aquarius Web Portal in Data Set View. The Chart tab is selected showing a graphical representation for the specified dataset.

5. Once the data have been successfully uploaded into Aquarius, the *.csv and *.hobo files should be downloaded following the procedures set forth in SOP WT09 (SFCN 2025), then stored on the server in the “Archive” subfolder found in the appropriate site folder:

X:\Files\Vital_Signs\Coral_Reef_Water_Temperature\data\sites

Literature Cited

- South Florida/Caribbean Network (SFCN). 2025a. Importing data to Aquarius database—Version 1.2. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—WT12. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: irma.nps.gov/DataStore/Reference/Profile/2307752 (last accessed January 2025).
- South Florida/Caribbean Network (SFCN). 2025b. Reports, graphing, and web page data—Version 2.1. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—WT09. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2307754> (last accessed January 2025).