Rookery Bay National Estuarine Research Reserve (RKBNERR)
NERR Nutrient Metadata
January – December 2022
Latest update: June 01, 2022

Note: This is a provisional metadata document; it has not been authenticated as of its download date. Contents of this document are subject to change throughout the QAQC process and it should not be considered a final record of data documentation until that process is complete. Contact the CDMO (cdmosupport@baruch.sc.edu) or reserve with any additional questions.

I. Data Set and Research Descriptors

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2) Research objectives:

The System-wide Monitoring Program water quality initiative began at the RKBNERR in 1996. Currently, there are four primary SWMP stations and one secondary SWMP station that are in estuaries affected by watersheds demonstrating different patterns of land use. Their placement addresses priority resource management issues that are identified in the Reserve's management plan. Specifically, the data from these stations provide valuable information concerning the effects of land-use activities on the quantity, quality, and timing of freshwater inflow into the reserve. Each bay studied exhibits a pattern of altered freshwater inflow.

a) Monthly Grab Sampling Program: The principal objective of the monthly grab sampling is to determine spatial and temporal differences in water quality between sites representing different land-use patterns.

b) Diel Sampling Program: The principal objective of the diel sampling is to quantify temporal variability over a lunar tidal cycle and to determine the impact of tidal water exchange within Henderson Creek (a source of freshwater into the Rookery Bay proper waterbody).

3) Research methods:

a) Monthly Grab Sampling Program

Monthly grab samples were collected at all four primary SWMP water quality stations: Henderson Creek, Middle Blackwater River, Faka Union Bay, and Fakahatchee Bay. Beginning in October 2012, grab samples were also collected at Pumpkin Bay which was designated a Secondary SWMP Station by the CDMO in October of 2016. Duplicate grab samples were taken every month at each of the water quality stations following the National Estuarine Research Reserve System Nutrient and Chlorophyll Monitoring Program and Database Design SOP v1.8. Slack low tide was generally not considered for the grab sampling events due to the travel time between sites and the time constraints with the contracted laboratory. Rainfall conditions prior to grab sampling were generally not considered due to constraints with the contracted laboratory.

Sample bottles were pre-cleaned by the contracted laboratory following their Quality Assurance Management Plan (available by request). The bottle kits for each station were labeled with a unique sample identification number and chain of custody sheets were completed for tracking the samples during laboratory analysis and in the laboratory database. Tubing for the water sampling device (peristaltic pump), carboys (for deionized water), and filter holders were pre-cleaned using a Florida Department of Environmental Protection (FLDEP) decontamination procedure (FLDEP SOP FC1000/DEP-QAA-01/001) which involved: cleaning with phosphate-free soap, rinsing three times with tap water, soaking from 4 - 24 hours in a 10% hydrochloric acid bath, rinsing three times with deionized water, and drying for 24 hours. One to two days prior to field sampling, the filter holders were assembled with in-line filters (0.7 µm glass microfiber filters and 0.45 µm membrane filters).

At each water quality station, grab samples for dissolved nutrients were collected 0.5 meter below the surface (near surface grab) using a peristaltic pump. A filter holder attached to the peristaltic

pump tubing was used to filter for dissolved nutrients in the field. Nitrile gloves were worn through the entire process of sample collection and filtering. Unfiltered parameters included chlorophyll *a*, phaeophytin *a*, total phosphorous (TP), total Kjeldahl nitrogen (TKN), and total suspended solids (TSS). Filtered parameters included ammonium (NH4), nitrite + nitrate (NO23), nitrite (NO2), and orthophosphate (PO4). Chlorophyll *a*/ phaeophytin *a* and TSS sample bottles were rinsed three times with the sample water then filled to the shoulder, capped, and immediately stored in a cooler with ice. The nitrite/ orthophosphate bottle was rinsed three times with filtered water and then filled with the filtrate, capped, and immediately stored in a cooler with ice. The sample bottles for ammonia, nitrite + nitrate, total Kjeldhal nitrogen, and total phosphorus contained sulfuric acid for preservation and therefore were not rinsed before adding the sample. All sample bottles were made of translucent high-density polyethylene (HDPE) with the exception of the chlorophyll *a*/ phaeophytin *a* bottle which was an opaque amber HDPE bottle. To avoid cross contamination, the peristaltic pump tubing was rinsed thoroughly with deionized water after each sampling and then rinsed thoroughly with sample water before sampling at each new station. New gloves and filters were used at each site. Additionally, an equipment blank using deionized water was performed at the end of each sampling event following all the same procedures. Samples were shipped overnight to the FLDEP lab in Tallahassee, FL.

Starting in January 2018, additional Chlorophyll *a* grab samples were collected at each site, using the same collection methods, in a different opaque amber HDPE bottles to compare the fluorometric and spectrophotometer method of analysis. The FLDEP lab reported the results for comparison purposes and the fluorometric data are available by request. The method comparisons were concluded July 2020 and the original spectrophotometer method was continued.

At each site physical/chemical water quality parameters were measured at the same depth as the nutrient samples were collected. A YSI EXO1 datasonde with handheld display were used to record the measurements. Recorded parameters included salinity (ppt), specific conductivity (mS/cm), temperature (°C), dissolved oxygen (% and mg/L), pH, and turbidity (NTU). Equipment calibration was done according to NERRS SWMP EXO SOP v2.2 and FLDEP SOP 001/01.

b) Diel Sampling Program

Monthly diel samples were collected at the depth of the water quality datasonde (0.25 meters above the bottom) every 2.5 hours over a lunar day (24hr:48 min) using an ISCO refrigerated auto-sampler (model 6712FR). The sampler was stationed approximately 100 meters from the Lower Henderson water quality site, on the RKBNERR Shell Island Road dock. Prior to sampling, the polyethylene bottles used in the auto-sampler were washed following the same FLDEP decontamination procedure as described above in the grab sampling methods. A day before the sampling was to begin, the ISCO auto-sampler was set up and programmed. The siphon hose was rinsed with 900 ml ambient water prior to programming the auto-sampler. Sample bottles for the laboratory analysis were pre-cleaned by the contracted laboratory following their Quality Assurance Management Plan (available by request). Bottle kits for each sample interval (11) were labeled with a unique sample identification number and chain of custody sheets were completed for tracking the samples during laboratory analysis and in the laboratory database.

Sample filtration: Nitrile gloves were worn during sample processing. At Rookery Bay's laboratory, each polyethylene bottle containing 1000 ml of sample water was shaken to homogenize the sample. A peristaltic pump with a filter holder attached to the sampling tube was used to filter for dissolved nutrients. For dissolved phosphorus and nitrite, HDPE sample bottles were filled with the filtrate, capped, and immediately stored in a cooler with ice. For ammonium and nitrite + nitrate, the HDPE sample bottles contained sulfuric acid for preservation and therefore were not rinsed before adding the filtrate, capped, and immediately stored in a cooler with ice. New filters were used for each sample. For the chlorophyll *a* samples, HDPE amber

sample bottles were filled with at least 500 ml of unfiltered sample, capped, and immediately stored in a cooler with ice. Samples were shipped overnight to the FLDEP lab in Tallahassee, FL.

c) All Samples

Samples are placed on ice immediately after collection and kept on ice while shipped overnight to the to the FLDEP lab in Tallahassee, FL. Once at the lab, they are inventoried and placed in the appropriate refrigerator/freezer. Refrigerators range from 0 to 6.0˚C and freezers from -30.0 to -5.0˚C.

4) Site location and character:

The RKBNERR spans approximately 110,000 acres (445.2 km^2) of public lands on Florida's Gulf coast south of Naples. Approximately 5 percent (6,000 acres) are uplands and 95 percent (104,000 acres) are submerged lands. Within the submerged lands, 68, 000 acres are open water and 36,000 acres are mangroves. The Reserve covers approximately 40 percent of the Collier County coastline, from Gordon Pass in Naples southward to the northwestern boundary of Everglades National Park. Major habitats of the Reserve include extensive pristine subtropical mangrove-forested wetlands, undeveloped barrier islands, and some of the last remaining intact tropical hardwood hammocks and coastal scrub habitats in southwest Florida. The coastal ecosystem within the Reserve has national and international significance as the western edge of the Everglades ecosystem, yet it is located adjacent to one of the fastest developing coastal areas in the United States. DEP has designated all tidally connected waters within the boundaries of the Reserve as Class II and Outstanding Florida Waters (OFW).

Natural drainage patterns within Collier County have been significantly altered by the construction of canal systems designed to lower annual peak water levels during the wet season to prevent flooding. Such canals include the Henderson Creek Canal, Lely Canal, Faka Union Canal, and borrow canals used for constructing U.S. 41 (Tamiami Trail), State Road 951 (Collier Boulevard), and County Road 92. A combination of fixed weirs and gates control canal flow, preventing excessive freshwater drainage and saltwater encroachment. The primary basins that feed the Rookery Bay Reserve watershed are Lely (SFWMD No. 6), Henderson Creek, and Picayune Strand. These basins are sub-units of SFWMD.

The climate for southwest Florida is classified as Tropical Rainy. The average annual rainfall is approximately 54 inches (137 cm) per year, with the wet season extending from the end of May through the beginning of October. The average annual air temperature in the Reserve as recorded at the RKBNERR SWMP weather station was 24.8°C (76.6°F) for 2020. Seasonal variation in temperature within the Reserve follows that of rainfall with a summer period of high temperatures between May and October and a cooler period extending from December through March. Southwestern Florida lies in the seasonal tropical weather belt that channels hurricanes toward or along the coast. One of the most common extreme weather impacts to the Reserve area is from tropical cyclones such as tropical depressions, tropical storms, and hurricanes. On average, Naples is affected once every 2.67 years by tropical cyclones, every 6.68 years by hurricanes, and every 10.5 years by major hurricanes. The last major hurricane that affected this area was Hurricane Irma on September 10, 2017, which made landfall on Marco Island with sustained winds of 115 mph.

Station Descriptions:

<u>Lower Henderson Creek (rkblhwq):</u>

Lat/Long (Decimal Degrees): 26.02749 N, -81.73361 W

The Lower Henderson Creek station is affixed to a piling with a manatee caution sign located approximately 100 meters across the Reserve's Shell Island Road boat dock. The monitoring site is approximately 5 km downstream of a four-lane highway (SR 951) that crosses Henderson Creek. The creek is 5.8 km long (mainstream linear dimension), has an average mid-channel depth of approximately 2 meters at MHW, and an average width of 239 meters. At the sampling site, the depth is 2 meters at MHW and the width is 600 meters. Tides at Lower Henderson Creek are mixed and range from 0.23 m to 1.50 m (average 0.84 m). Salinity at this site ranged from 11.6 to 36.4 ppt during 2022. Creek bottom habitats are predominantly fine sand and there is no bottom vegetation. The dominant marsh vegetation near the sampling site is red mangrove. The dominant natural vegetation of the watershed is hydric pine and cypress.

The Lower Henderson Creek station receives most of its freshwater from a canal system that drains a watershed area with approximately 55% developed versus natural landscape. Land-use in the developed area is divided equally between residential and agricultural activities. Residential areas include developments with septic systems. A weir controls most of the freshwater flowing into Henderson Creek. The amount of water released from this weir can sometimes mask natural tidal salinity patterns. The historic Henderson Creek watershed was approximately 50% under State ownership and much of this protected area had intact cypress sloughs and other wetland vegetation. Canals and water use for agriculture and human consumption have altered the hydroperiod of this watershed. Consequently, the Henderson creek watershed may receive non-point source pollution runoff from a variety of sources.

Middle Blackwater River (rkbmbwq):

Lat/Long (Decimal Degrees): 25.9343 N, -81.5946 W

The Middle Blackwater River station is affixed to navigational marker 17 within the river channel. The average depth at this marker is approximately 2 meters at MHW. The tidal range for the station varies between 0.05 and 1.90 meters (average 0.95 m). Salinity at this site ranged from 2.1 to 38.1 ppt during 2022. Salinities fluctuate with the tides and watershed rainfall. The substrate within the channel is a mixture of sand and silt with oyster shell with some organic matter mixed in. Mature red mangrove forests dominate the banks of the river.

The Middle Blackwater River station has a watershed that is 75% natural landscape. Agriculture dominates the land-use activities within the developed area of the watershed, but residential development of the watershed has been increasing. Upstream influences consist of the Collier-Seminole State Park boat basin and upstream agricultural fields adjacent to Blackwater River's main feeder canal (SR 41 canal). Nonpoint source pollution from agricultural operations and golf courses may affect this site. In addition, canals and roads built during the 1960's (Picayune Strand, formerly Southern Golden Gate Estates) may have caused significant disruptions to overland sheet-flow reducing the amounts of freshwater flowing to this estuary. Despite these alterations, the salinity fluctuations of this site suggest that seasonal fluctuations in salinity are more closely correlated to watershed rainfall patterns than salinities of estuaries with water control structures, such as Henderson Creek. Based on modeling of historic flow-way patterns, the watershed draining into Blackwater River has been significantly reduced possibly resulting in higher than historical salinity values.

Faka Union Bay (rkbfuwq):

Lat/Long (Decimal Degrees): 25.9005 N, -81.5159 W

The Faka Union Bay station is located at the mouth of the Faka Union Canal on a manatee speed zone sign next to the main channel. The average depth at this site is approximately 2 meters at MHW. The tidal range for Faka Union Bay varies between 0.06 and 1.68 meters (average 0.79 m). Salinity at this site ranged from 0.3 to 37.5 ppt during 2022. Salinities fluctuate daily with tides, seasonal rainfall,

and management of upstream water control structures. The substrate within the channel is a mixture of sand and silt with some organic matter. Mature red mangrove forests and spoil islands dominate the banks of the canal.

The Faka Union Bay station is located immediately downstream of Port of the Isles community and the failed housing development and current PSRP. Four canals constructed for the original project converge into one canal (Faka Union Canal) which drains into Faka Union Bay. Consequently, this station represents the most extreme state of altered freshwater inflow of the four monitoring sites in the Ten Thousand Islands. Faka Union Bay experiences lower than historical salinity values and extreme fluctuations in salinity during the wet season.

Fakahatchee Bay (rkbfbwq):

Lat/Long (Decimal Degrees): 25.8922 N, -81.4770 W

The Fakahatchee Bay station is located at the mouth of two rivers, Fakahatchee River and East River, secured to a 6-inch PVC pipe hydro-jetted into the substrate. The average depth at MHW is approximately 1.5 meters. The tide range varies between 0.00 and 1.84 meters (average 0.80 m). Salinity at the station ranged from 3.3 to 37.8 ppt during 2022. Salinities fluctuate daily with the tides and seasonal rainfall. The substrate within the channel is a mixture of sand, silt and some organic matter. Mature red mangrove forests dominate the banks of the rivers.

The Fakahatchee Bay station is the least disturbed system relative to the other sites in the Ten Thousand Islands. The Fakahatchee Bay watershed is primarily under Preserve status and has been relatively undisturbed by the hydrologic alteration of the Southern Golden Gate Estates canal system. Upstream there are minimal influences from the Picayune Strand State Forest with non-point source pollutants possible from the culverts under I-75 and US 41. Fakahatchee Strand State Preserve and Big Cypress National Park manage the headwaters of Fakahatchee Bay. Because Fakahatchee Bay's watershed is considered the least altered, the water quality data collected from this station serves as a reference for assessing the effectiveness of the PSRP.

Pumpkin Bay (rkbpbwq):

Lat/Long (Decimal Degrees): 25.9141 N, -81.5404 W

The Pumpkin Bay station is located at the mouth of the Pumpkin River secured to a 6-inch PVC pipe hydro-jetted into the substrate. The tide range for Pumpkin Bay varies between 0.00 and 1.64 meters (average 0.64 m). Salinity at this site ranged from 10.1 to 38.2 ppt during 2022. The bottom habitat is predominantly fine sand and there is no bottom vegetation. Mature red mangrove forests dominate the Pumpkin River and the bay. Upland land use is minimal with the main influences being US 41 and the Picayune Strand canal system, which has diverted freshwater to Faka Union Bay. Like Blackwater River, the modeling of historic flow-way patterns, show the watershed draining into Pumpkin Bay has been significantly reduced resulting in higher than historical salinity values.

Station Code	SWMP Status	Station Name	Location	Active Dates	Reason Decommissioned	Notes
rkbfbnut	Primary	Fakahatchee Bay	25.8922 -81.477	01/01/2002 – current	NA	NA
rkbfunut	Primary	Faka Union Bay	25.9005 -81.5159	01/01/2002 – current	NA	NA

rkblhnut	Primary	Lower Henderson Creek	26.0257 -81.7332	01/01/2001 – current	NA	NA
rkbmbnut	Primary	Middle Blackwater River	25.9343 -81.5946	01/01/2000 – current	NA	NA
rkbpbnut	Secondary	Pumpkin Bay	25.9141 -81.5404	07/06/2016 – current	NA	NA

5) Coded variable definitions:

Station Codes:
rkblhnut = Rookery Bay Lower Henderson nutrients (monthly grabs and diel sampling)
rkbmbnut = Rookery Bay Middle Blackwater nutrients (monthly grabs)
rkbfunut = Rookery Bay Faka Union nutrients (monthly grabs)
rkbfbnut = Rookery Bay Fakahatchee Bay nutrients (monthly grabs)
rkbpbnut = Rookery Bay Pumpkin Bay nutrients (monthly grabs, Secondary SWMP station)

Monitoring Codes:
monthly grab sample program = 1
monthly diel sample program = 2

Replicate grab samples were denoted as 1 for the first sample and 2 for the second sample at each station in the "*Rep*" column. Since 1 diel sample was collected every 2.5 hrs., the replicate number was always denoted as 1 in the "*Rep*" column.

6) Data collection period:

The RKBNERR monthly grab sampling began in January 2002 at all the primary SWMP sampling stations. Grab sampling began in October 2012 at the Secondary SWMP station, rkbpbnut. Diel sampling began at the Lower Henderson Creek site in February 2002. Start times and end times have been modified to report in Eastern Standard Time (EST).

Monthly Grab Sampling Collection Period: January – December 2022

Station Code	Date Time Stamp (rep 1)	Date Time Stamp (rep 2)
rkblhnut	01/11/2022 13:21	01/11/2022 13:37
rkblhnut	02/09/2022 12:59	02/09/2022 13:05
rkblhnut	03/09/2022 07:30	03/09/2022 07:36
rkblhnut	04/12/2022 07:05	04/12/2022 07:10
rkblhnut	05/10/2022 07:14	05/10/2022 07:19
rkblhnut	06/07/2022 06:50	06/07/2022 06:55
rkblhnut	07/06/2022 05:56	07/06/2022 06:01
rkblhnut	08/02/2022 10:24	08/02/2022 10:28
rkblhnut	09/14/2022 10:29	09/14/2022 10:34
rkblhnut	10/18/2022 11:06	10/18/2022 11:10
rkblhnut	11/01/2022 11:19	11/01/2022 11:23
rkblhnut	12/14/2022 13:19	12/14/2022 13:23

rkbmbnut	01/11/2022 11:11	01/11/2022 11:16
rkbmbnut	02/09/2022 10:59	02/09/2022 11:06
rkbmbnut	03/09/2022 09:19	03/09/2022 09:24
rkbmbnut	04/12/2022 11:32	04/12/2022 11:38
rkbmbnut	05/10/2022 08:59	05/10/2022 09:04
rkbmbnut	06/08/2022 08:50	06/08/2022 08:55
rkbmbnut	07/06/2022 07:36	07/06/2022 07:40
rkbmbnut	08/02/2022 06:31	08/02/2022 06:35
rkbmbnut	09/14/2022 06:49	09/14/2022 06:54
rkbmbnut	10/18/2022 06:57	10/18/2022 07:02
rkbmbnut	11/01/2022 07:09	11/01/2022 07:09
rkbmbnut	12/14/2022 08:43	12/14/2022 08:48
rkbfunut	01/11/2022 08:53	01/11/2022 08:58
rkbfunut	02/09/2022 08:59	02/09/2022 09:05
rkbfunut	03/09/2022 10:45	03/09/2022 10:50
rkbfunut	04/12/2022 10:03	04/12/2022 10:09
rkbfunut	05/10/2022 10:28	05/10/2022 10:33
rkbfunut	06/08/2022 10:05	06/08/2022 10:20
rkbfunut	07/06/2022 08:55	07/06/2022 08:58
rkbfunut	08/02/2022 08:07	08/02/2022 08:11
rkbfunut	09/14/2022 07:55	09/14/2022 08:02
rkbfunut	10/18/2022 08:44	10/18/2022 08:48
rkbfunut	11/01/2022 08:30	11/01/2022 08:34
rkbfunut	12/14/2022 11:06	12/14/2022 11:10
rkbfbnut	01/11/2022 09:24	01/11/2022 09:31
rkbfbnut	02/09/2022 09:29	02/09/2022 09:33
rkbfbnut	03/09/2022 11:21	03/09/2022 11:26
rkbfbnut	04/12/2022 09:29	04/12/2022 09:36
rkbfbnut	05/10/2022 11:00	05/10/2022 11:02
rkbfbnut	06/08/2022 10:52	06/08/2022 10:57
rkbfbnut	07/06/2022 09:24	07/06/2022 09:27
rkbfbnut	08/02/2022 07:40	08/02/2022 07:44
rkbfbnut	09/14/2022 08:26	09/14/2022 08:31
rkbfbnut	10/18/2022 08:17	10/18/2022 08:22
rkbfbnut	11/01/2022 08:59	11/01/2022 09:04
rkbfbnut	12/14/2022 10:23	12/14/2022 10:28
rkbpbnut	01/11/2022 10:22	01/11/2022 10:28
rkbpbnut	02/09/2022 10:10	02/09/2022 10:16
rkbpbnut	03/09/2022 10:09	03/09/2022 10:12
rkbpbnut	04/12/2022 10:39	04/12/2022 10:45

rkbpbnut	05/10/2022 09:53	05/10/2022 09:58
rkbpbnut	06/08/2022 09:45	06/08/2022 09:50
rkbpbnut	07/06/2022 08:18	07/06/2022 08:21
rkbpbnut	08/02/2022 07:12	08/02/2022 07:16
rkbpbnut	09/14/2022 07:29	09/14/2022 07:35
rkbpbnut	10/18/2022 07:47	10/18/2022 07:52
rkbpbnut	11/01/2022 07:54	11/01/2022 07:59
rkbpbnut	12/14/2022 09:34	12/14/2022 09:38

Monthly Diel Sampling Collection Period: January – December 2022

Station Code	Date Time stamp (begin)	Date Time stamp (end)
rkblhnut	01/04/2022 08:30	01/05/2022 09:30
rkblhnut	02/15/2022 06:30	02/16/2022 07:30
rkblhnut	03/01/2022 06:30	03/02/2022 07:30
rkblhnut	04/19/2022 09:30	04/20/2022 10:30
rkblhnut	05/17/2022 08:30	05/18/2022 09:30
rkblhnut	06/14/2022 07:30	06/15/2022 08:30
rkblhnut	07/19/2022 00:00	07/20/2022 01:00
rkblhnut	08/16/2022 23:30	08/18/2022 00:30
rkblhnut	09/20/2022 04:00	09/21/2022 05:00
rkblhnut	10/19/2022 03:00	10/20/2022 04:00
rkblhnut	11/08/2022 07:00	11/09/2022 08:00
rkblhnut	12/06/2022 06:00	12/07/2022 07:00

7) Associated researchers and projects:

Both water quality and nutrient data generated by RKBNERR have been used by the USACOE, USFWS, SFWMD and Florida DEP to analyze restoration targets established for the PSRP, which is a portion of the CERP.

In 2021, Florida DEP started using water quality and nutrient data to create an internal departmental data analysis dash board to analyze the duration of hypoxia, trends and comparisons relating to dissolved oxygen (DO) and other analytes available for the continuous monitoring stations, change and patterns at those stations, including how the stations may relate to external factors. Florida DEP is also using SWMP data for the Statewide Ecosystem Assessment of Coastal and Aquatic Resources (SEACAR) project. The project will provide status and trends reporting through web-based access to data and assessments and a tiered reporting format for a variety of audiences.

Other significant water quality research and monitoring initiatives within the RKBNERR include regular monitoring by Florida Department of Environmental Protection's Division of Environmental Assessment and Restoration (https://floridadep.gov/DEAR) water quality assessment program, oyster reef/benthic crab survey (1999 – 2008), long-term fisheries survey (July 1998 - June 2013 and October 2015 - present), shark demographics survey (May 2000 - present) and shorebird mortality MST water quality study (July 2021 – present). The fisheries data are obtained through monthly trawls in the bays corresponding with the SWMP water quality sites to document the population dynamics in a variety of fish species, as well as commercially important invertebrates such as stone crabs, blue

crabs and pink shrimp. Shark demographic data are also collected monthly from the reference bays downstream of the PSRP through long-line and gillnet 'tag, measure and release' surveys. Benthic crabs were collected from oyster reefs using Hester-Dendy collection substrates at the four SWMP water quality stations. In October 2021, NOAA submitted the paper "Canals reroute freshwater to the Ten Thousand Islands, Florida USA: Too much freshwater vs not enough and how much does it matter to estuarine fish?", to *Estuaries and Coasts*.

The water quality and nutrient data are also used by visiting investigators/ researchers to support the research conducted within the Reserve.

As part of the SWMP long-term monitoring program, RKBNERR also monitors 15-minute meteorological and water quality data which may be correlated with this nutrient/pigment dataset. These data are available at www.nerrsdata.org.

8) Distribution:

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:
NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: www.nerrsdata.org; *accessed* 12 October 2021.

NERR nutrient data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in comma separated version format.

II. Physical Structure Descriptors

9) Entry verification:

The analytical results (electronic files) were provided monthly from the contracted laboratory to Julie Drevenkar, SWMP Manager. Upon receiving the results, the SWMP Manager reviewed the data for errors. The SWMP Manager was responsible for compilation and QA/QC of the final data set according to chapter 10 of the Centralized Data Management Office (CDMO) NERR SWMP Data Management Manual v 6.7. The data reported from the lab were in the required units making it unnecessary to convert the data prior to entering it into Microsoft Excel.

Nutrient data are entered into a Microsoft Excel worksheet and processed using the NutrientQAQC Excel macro. The NutrientQAQC macro sets up the data worksheet, metadata worksheets, and MDL worksheet; adds chosen parameters and facilitates data entry; allows the user to set the number of significant figures to be reported for each parameter and rounds using banker's rounding rules; allows

the user to input MDL values and then automatically flags/codes measured values below MDL and inserts the MDL; calculates parameters chosen by the user and automatically flags/codes for component values below MDL, negative calculated values, and missing data; allows the user to apply QAQC flags and codes to the data; produces summary statistics; graphs selected parameters for review; and exports the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO's authoritative online database.

10) Parameter titles and variable names by category:

Required NOAA NERRS System-wide Monitoring Program nutrient parameters are denoted by an asterisk "*".

Data Category	Parameter	Variable Name	Units of Measure
Phosphorus			
	Orthophosphate, Filtered*	PO4F	mg/L as P
	Total Phosphorus	TP	mg/L as P
Nitrogen			
	Nitrite + Nitrate, Filtered*	NO23F	mg/L as N
	Nitrite, Filtered*	NO2F	mg/L as N
	Nitrate, Filtered*	NO3F	mg/L as N
	Ammonium, Filtered*	NH4F	mg/L as N
	Total Kjeldahl Nitrogen	TKN	mg/L as N
	Total Organic Nitrogen	TON	mg/L as N
Plant Pigments			
	Chlorophyll *a* *	CHLA_N	µg/L
	Phaeophytin	PHEA	µg/L
Other Lab Parameters			
	Total Suspended Solids	TSS	mg/L
Field Parameters			
	Water Temperature	WTEM_N	degrees Celsius
	Specific Conductance	SCON_N	mS/cm
	Salinity	SALT_N	ppt
	Dissolved Oxygen	DO_N	mg/L
	Dissolved Oxygen Saturation	DO_S_N	percent
	pH	PH_N	standard units
	Turbidity	TURB_N	NTU/FNU

Notes:

1. Time is coded based on a 2400 clock and is referenced to Standard Time.
2. Reserves have the option of measuring either NO2 and NO3 or they may substitute NO23 for individual analyses if they can show that NO2 is a minor component relative to NO3.

11) Measured or calculated laboratory parameters:

a) Parameters measured directly

Phosphorus species:	PO4F, TP
Nitrogen species:	NH4F, NO2F, NO23F, TKN
Plant Pigments:	CHLA_N, PHEA
Other:	TSS

b) Calculated parameters

NO3	(NO23F*Df) – (NO2F*Df)
	Df = Dilution factor
DIN	NO23F + NH4F
TON	TKN – NH4F
TN	TKN + NO23F

12) Limits of detection:

Method Detection Limits (MDL), the lowest concentration of a parameter that an analytical procedure can reliably detect, were established by the Florida Department of Environmental Protection (FLDEP) Laboratory. MDLs were determined using the U.S. Environmental Protection Agency MDL procedure found in Title 40 Code of Federal Regulations Part 136 (40 CFR 136, Appendix B, revision 2.0). Once the MDL was established using this method, verification was done prior to use. Verification included analyzing a known standard at 2-3 times the calculated MDL. Additionally, various checks and balances were used to ensure suitability of the MDL. Every quarter the labs employed verification checks on all MDLs. If the verification checks met the lab's acceptance criteria, then the MDL remained unchanged. The MDL for all parameters were determined by the FLDEP Laboratory.

FLDEP laboratory MDL determination:

The FLDEP Laboratory defines the MDL as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from the method blank result. MDLs are determined using the method specified in the Federal Register, 40 CFR Part136 Appendix B Revision 2, using LCSs prepared near the estimated detection limit as surrogates to estimate methodological noise for actual method blanks to directly measure methodological noise. If none of the method blanks give numerical results for an individual analyte, method blanks are not required for the determination of the MDL. Where the possibility exists for significant systematic bias from sample preparation and handling or from the analytical determinative step (typically inorganic analyses), bias is taken into account when calculating detection limits. Published MDLs may be set higher than experimentally determined MDLs to (1) avoid observed positive interferences from matrix effects or common reagent contaminants or (2) for reporting convenience (i.e., to group common compounds with similar but slightly different experimentally determined MDLs). MDLs are determined in a suitable analyte-free matrix when possible. For certain analytes and matrices, no suitable, analyte-free matrix may be available. In those cases, MDLs are determined in the absence of any matrix, but in the presence of all preparatory reagents carried through the full preparatory and determinative steps. LOD verification procedures may be found in SOP LB-031, *Limit of Detection Verification*. (From page 42 of FLDEP Laboratory Quality Manual 2023 located at: Florida DEP Laboratory Quality Manual (state.fl.us))

2022 MDLs

Monthly MDL Changes: Due to the need for sample dilution by the lab for the sample to be analyzed, chlorophyll *a*, pheaphytin *a*, nitrite+nitrate, and TSS MDLs may be elevated. Some values are flagged as below sensor limits <-4> [SBL] while the value reported is higher than the normal MDL. A table of these instances are below.

Parameter	Start Date	End Date	Nominal (Base) MDL	MDL Range	Date Revisited	SOP Name
PO4F	04/02/2021	08/10/2021	0.004	0.004	04/01/2021	NU-070-1.21
PO4F	08/11/2022	12/31/2022	0.004	0.004	08/04/2022	NU-070-1.22
TP	12/27/2021	12/31/2022	0.002	0.002	12/27/2021	NU-082-1.16
NH4F	03/10/2021	10/09/2022	0.002	0.002	03/09/2021	NU-104-1.2
NH4F	10/10/2022	12/31/2022	0.002	0.002	08/31/2022	NU-104-1.3
NO23F	12/27/2021	12/31/2022	0.004	0.004	12/20/2021	NU-066-1.24
TKN	12/30/2020	01/31/2021	0.080 to 4.0	0.080	12/30/2020	NU-092-1.11
TKN	02/01/2022	12/31/2022	0.080 to 4.0	0.080	01/27/2022	NU-092-1.12
CHLA_N	02/15/2021	02/15/2022	0.82	0.82	02/15/2021	BB-029-2.8
CHLA_N	02/16/2022	12/31/2022	0.82	0.82 - 9.60	02/16/2022	BB-029-2.9
PHEA	02/15/2021	02/15/2022	0.90	0.90	02/15/2021	BB-029-2.8
PHEA	02/16/2022	12/31/2022	0.90	0.90 - 10.00	02/16/2022	BB-029-2.9
TSS	01/04/2021	01/25/2022	2.0 or 3.0*	2.0	01/04/2021	NU-051-3.24
TSS	01/26/2022	10/02/2022	2.0 or 3.0*	2.0	11/23/2021	NU-051-3.25
TSS	10/03/2022	12/31/2022	2.0 or 3.0*	2.0 - 3.0	10/03/2022	NU-051-3.26

*MDL for Total Suspended Solids is 3.0 mg/L when conductivity is > 15,000 µmhos/cm.

FLDEP MDLs for the chlorophyll suite of components may change by station and month based on the need to dilute samples during processing. The base MDL listed in the FLDEP SOP is based on the maximum filtration volume and minimum extract volume and will therefore be the lowest MDL. This MDL was last verified by the FLDEP laboratory 2/16/2022 (as presented in version BB-029-2.9 of the FLDEP SOP for *Spectrophotometric Determination of Corrected and Uncorrected Chlorophyll a and Phaeophytin*, available here: https://fldeploc.dep.state.fl.us/sop/sop3.asp?sect=BIOLOGY&cat=CHLOROPHYLL-BOD-SEDIMENT+GRAIN+SIZE&A1=Submit).

The sample MDL is calculated based on the number of times a sample must be diluted. For example, if a CHL_A sample must be diluted to twice its volume, the base MDL of 0.55 ug/L is multiplied by a dilution factor of two (0.55 ug/L x 2) thus resulting in an MDL of 1.10 ug/L. For samples that fall below the MDL and their MDL is greater than the base MDL, individual sample MDLs are listed in the table below. These data have been flagged and coded as -4 SBL in the dataset.

13) Laboratory methods:

Chemical and biological analysis was performed by Florida Department of Environmental Protection Laboratory. FLDEP SOP hold times are as follows:

NH4F, Ammonia	Cool, ≤6 °C, H2SO4 to pH<2	28 days

NO2F, Nitrite	Cool, ≤6 °C	48 hours
NO23F, Nitrate-Nitrite	Cool, ≤6 °C, H2SO4 to pH<2	28 days
TP, Total Phosphorous	Cool, ≤6 °C, H2SO4 to pH<2	28 days
TKN, Total Kjeldahl Nitrogen	Cool, ≤6 °C, H2SO4 to pH<2	28 days
TON, Total Organic Nitrogen	Cool, ≤6 °C, H2SO4 to pH<2	28 days
PO4F, Orthophosphate	Cool, to ≤6 °C	Filter w/in 15 minutes; Analyze w/in 48 hours
TSS, Total Suspended Solids	Cool, to ≤6 °C	7 days

*Note that FDEP lab hold times INCLUDE time spent in transport and held at the laboratory.

a) Parameter: PO4F

FDEP SOP: PO4_NU_070-1.21, PO4_NU-070-1.22
Reference Method: EPA 365.1 Revision 2.0
Method Reference: U.S. Environmental Protection Agency (EPA), 1993. Determination of Phosphorus by Semi-Automated Colorimetry, EPA Method 365.1 Revision 2.0. Cincinnati, OH and Bran+Lubbe method G-146-95 Rev. 3.
Method Description: Ammonium molybdate and antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an antimony-phosphomolybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid. The color is proportional to the phosphorus concentration and is measured with a rapid flow autoanalyzer.
Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field, stored in ice and shipped. Samples stored in the laboratory at 4 ºC and are analyzed within 28 days of collection.

b) Parameter: TP

FDEP SOP: TP_NU-082-1.15, TP_NU-082-1.16
Reference Method: EPA 365.1 Revision 2.0
Method Reference U.S. Environmental Protection Agency (EPA), 1993. Determination of Phosphorus by Semi-Automated Colorimetry, EPA Method 365.1 Revision 2.0. Cincinnati, OH.
Method Description: Ammonium molybdate and antimony potassium tartrate react in an acidmedium with dilute solutions of phosphorus to form an antimony-phosphomolybdate complex. All the phosphorus present in the sample regardless of forms is measured by the persulfate digestion procedure.
Preservation Method: Samples were preserved with H_2SO_4 to a pH ≤ 2, stored on ice and shipped. Samples stored in the laboratory at 4 ºC and are analyzed within 28 days of collection.

c) Parameter: NH4F

There was a change in instrumentation used to analyze ammonia. Prior to 02/15/2021 an OI Analytical Gas Diffusion Segmented Flow Analyzer was used. That instrument was phased out and the newer Seal Bran+Luebbe AA3 Gas Diffusion Segmented Flow Analyzer is now being used. The method remains unchanged.

FDEP SOP: NH4_NU-104-1.2, NH4_NU-104-1.3
Reference Method: EPA 350.1 Revision. 2.0 (no distillation)

Method Reference: U.S. Environmental Protection Agency (EPA), 1993, Determination of Ammonia Nitrogen by Semi-Automated Colorimetry, EPA Method 350.1 Revision 2.0. Cincinnati, OH and OI Analytical Method 327152 utilizing gas diffusion.
Method Description: Alkaline phenol and hypochlorite react with ammonia to form indophenol blue that is proportional to the ammonia concentration. The blue color formed is intensified with sodium nitroprusside. The color's absorbance is directly proportional to analyte concentration and is measured with a rapid flow autoanalyzer.
Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field and preserved with H2SO4 to a pH ≤ 2, stored in ice and shipped. Samples are analyzed within 28 days of collection.

NOTE: This method measures total ammonia, NH3 is considered negligible.

d) Parameter: NO2F

FDEP SOP: Nitrite NO2_NU-087-1.14
Reference Method: EPA 353.2 Revision 2.0
Method Reference: This method is based upon EPA method 353.2, Rev. 2.0 (1993) and Seal Analytical AQ2 method EPA-137-A Rev.1.
Method Description: The diazonium compound, formed by diazotation of sulfanilamide by nitrite in water under acid conditions, is coupled with N-(1-naphthyl)-ethylenediamine dihydrochloride (NED) to produce a reddish-purple azo dye, which is measured colorimetrically at a wavelength of 520 nm.
Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field and preserved with H2SO4 to a pH ≤ 2, stored in ice, shipped, and analyzed within 48 hours.

e) Parameter: NO23F

FDEP SOP: Nitrate_Nitrite_NU-066-1.24
Reference Method: EPA 353.2 Revision 2.0
Method Reference: U.S. Environmental Protection Agency (EPA), 1993. Nitrogen, Nitrate-Nitrite (Colorimetric, Automated, Cadmium Reduction), EPA Method 353.2 Revision 2.0. Cincinnati, OH and Seal Analytical AQ2 method EPA-137-A Rev. 1.
Method Description: A filtered sample is passed through a column containing granulated copper-cadmium to reduce nitrate to nitrite. The nitrite (that was originally present plus reduced nitrate) is determined by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye, which is measured colorimetrically with a rapid flow autoanalyzer.
Preservation Method: Samples are filtered through 0.7 µm glass microfiber filters and 0.45 µm membrane filters in the field and preserved with H2SO4 to a pH ≤ 2, stored in ice and shipped. Samples are analyzed within 28 days of collection.

f) Parameter: TKN

FDEP SOP: TKN_NU-092-1.12
Reference Method: EPA 351.2 Revision 2.0
Method Reference: U.S. Environmental Protection Agency (EPA), 1993. Determination of Total Kjeldahl nitrogen by Semi-Automated Colorimetry, EPA Method 351.2 Revision 2.0. Cincinnati, OH and AQ2 method No: EPA-111-A Rev.4.
Method Description: The sample is heated in the presence of sulfuric acid, H2SO4 for two- and one-half hours. The residue is cooled, diluted to 25 mL and analyzed for ammonia. This digested sample may also be used for phosphorus determination. Total Kjeldahl nitrogen is the sum of free-ammonia and organic nitrogen compounds which are converted to ammonium sulfate

(NH4)2SO4, under the conditions of digestion described. Organic Kjeldahl nitrogen is the difference obtained by subtracting the free ammonia value from the total Kjeldahl nitrogen value. Reduced volume versions of this method that use the same reagents and molar ratios are acceptable provided they meet the quality control and performance requirements stated in the method.
Preservation Method: Samples were preserved with H_2SO_4 and stored at 4 ºC until analysis.

g) Parameter: TSS

FDEP SOP: TSS_NU-051-3.24, TSS_NU-051-3.25, TSS_NU-051-3.26
Reference Method: Standard Methods 2540 D-97
Method Description: A well-mixed sample is filtered through a pre-weighed glass fiber filter. The filter and any residue are then dried to a constant weight at 103-105 ºC. The filter is cooled in a desiccator, weighed and the result used to compute the TSS of the sample.
Preservation Method: Samples are collected as whole water samples, stored in ice and shipped. Samples are stored at 4°C in the laboratory and filtration is performed within 48 hours of collection.

h) Parameter: CHLA and PHEA

FDEP SOP: Spectrophotometric CHLA and PHEA BB-029-2.8, Spectrophotometric CHLA and PHEA BB-029-2.9
Reference Method: SM 10200 H and EPA 446.0 Revision 1.2
Method Reference APHA (American Public Health Association), 2001. Standard Methods for the Examination of Water and Wastewater, (SM 10200H). 20th Edition, Baltimore, Maryland: United Book Press, Inc. and U.S. Environmental Protection Agency (EPA), 1993. In Vitro Determination of Chlorophylls a, b, c1+c2 and Pheopigments in Marine and Freshwater Algae by Visible Spectrophotometry, EPA Method 446.0 Revision 1.2. Cincinnati, OH.
Method Description: An extractive spectrophotometric technique was used to determine chlorophyll *a* concentration. Samples were filtered immediately at the laboratory. Filters were placed in a tissue grinder with 2-3 ml of 90% aqueous acetone. Extracts steeped for at least 2 hours at 4 °C in the dark. Extracts were analyzed using a UV/VIS Spectrophotometer.
Preservation Method: Samples are collected as whole water samples in a dark sampling bottle and stored at 4 ºC and filtered at the lab upon arrival.

14) Field and Laboratory QAQC programs:

The FDEP laboratory has an established quality control program for monitoring the performance of test methods. The laboratory QA/QC procedures for the State of Florida Department of Environmental Protection Bureau of Laboratories FDOH Certification Number E31780 are as prescribed in the Quality Manual (https://floridadep.gov/dear/florida-dep-laboratory/content/dep-laboratory-quality-assurance-manual-and-sops) and test SOPs.

a) Precision

i. **Field variability** - In the field each month, two successive grab samples are collected at each site. Replicate (N=2) samples are collected using a pole sampler lowered to the approximate depth of the data sonde probes in closed position and then opened to draw water from the specified depth. One field blank is included in each monthly collection.

ii. **Laboratory variability** - Method blanks and duplicate samples are run with every sample batch. A batch of samples consists of 20 or fewer samples (with the exception of microbiology) that are prepared and/or analyzed in a single run. Microbiology samples are

batched by day, so that all samples received and processed on a given day are in the same prep and analysis batch. Saline matrices are batched separately where the test is impacted by high conductivity samples.

Replicate analyses are used to evaluate precision (with the exception of microbiology). Precision is expressed by the relative percent difference (RPD) to compare duplicate samples/spikes A and B and is based on the formula:

$$RPD\ (\%) = |A-B|/(A+B) \times 200$$

Precision may be determined from duplicate authentic samples, from duplicate Laboratory Control Samples (LCS), or from matrix spike duplicates. Where RPDs are calculated based on matrix spike duplicates, A and B represent the raw results of the spiked sample (spike plus the background). Microbiology precision is evaluated according to Standard Methods 9020, in which the precision criteria (calculated by multiplying the mean range of the last fifteen points by 3.27) is compared to the log value range between duplicates.

iii. Inter-organizational splits – None

b) Accuracy

i. Sample spikes – Sample spikes are performed with each sample batch. The acceptance limits for sample or spike duplicates is a RPD of less than 20% if both results are above the PQL. Laboratory fortified blanks are run with each sample batch, acceptance limits for recovery are 85-115%.

ii. Standard Reference Material Analysis – Check standards are included in each batch and at the beginning and end of each run. Check standard acceptance limits for recovery are 85-115%.

iii. Cross Calibration Exercises – FDEP laboratory Chemistry and Microbiology sections participated in two rounds of performance testing (PT) in 2022. The first round was in the spring and the second in the fall. The studies are performed by many labs around the nation to and are required to maintain the lab's TNI certification. Additionally, the laboratory participated in two voluntary PT studies administered by United States Geological Survey (USGS) for Trace Metals and Nutrients in the spring and fall.

15) QAQC flag definitions:

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by an F_). QAQC flags are applied to the nutrient data during secondary QAQC to indicate data that are out of sensor range low (-4), rejected due to QAQC checks (-3), missing (-2), optional and were not collected (-1), suspect (1), and that have been corrected (5). All remaining data are flagged as having passed initial QAQC checks (0) when the data are uploaded and assimilated into the CDMO ODIS as provisional plus data. The historical data flag (4) is used to indicate data that were submitted to the CDMO prior to the initiation of secondary QAQC flags and codes (and the use of the automated primary QAQC system for WQ and MET data). This flag is only present in historical data that are exported from the CDMO ODIS.

-4	Outside Low Sensor Range
-3	Data Rejected due to QAQC
-2	Missing Data
-1	Optional SWMP Supported Parameter

0	Data Passed Initial QAQC Checks
1	Suspect Data
4	Historical Data: Pre-Auto QAQC
5	Corrected Data

16) QAQC code definitions:

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the sample or sample collection, sensor errors document common sensor or parameter specific problems, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point. However, a record flag column (F_Record) in the nutrient data allows multiple comment codes to be applied to the entire data record.

General errors

GCM	Calculated value could not be determined due to missing data
GCR	Calculated value could not be determined due to rejected data
GDM	Data missing or sample never collected
GQD	Data rejected due to QA/QC checks
GQS	Data suspect due to QA/QC checks
GSM	See metadata

Sensor errors

SBL	Value below minimum limit of method detection
SCB	Calculated value could not be determined due to a below MDL component
SCC	Calculation with this component resulted in a negative value
SNV	Calculated value is negative
SRD	Replicate values differ substantially
SUL	Value above upper limit of method detection

Parameter comments

CAB	Algal bloom
CDR	Sample diluted and rerun
CHB	Sample held beyond specified holding time
CIP	Ice present in sample vicinity
CIF	Flotsam present in sample vicinity
CLE	Sample collected later/earlier than scheduled
CRE	Significant rain event
CSM	See metadata
CUS	Lab analysis from unpreserved sample

Record comments

CAB	Algal bloom
CHB	Sample held beyond specified holding time
CIP	Ice present in sample vicinity
CIF	Flotsam present in sample vicinity
CLE	Sample collected later/earlier than scheduled
CRE	Significant rain event
CSM	See metadata
CUS	Lab analysis from unpreserved sample

Cloud cover

CCL	clear (0-10%)

CSP	scattered to partly cloudy (10-50%)
CPB	partly to broken (50-90%)
COC	overcast (>90%)
CFY	foggy
CHY	hazy
CCC	cloud (no percentage)

Precipitation

PNP	none
PDR	drizzle
PLR	light rain
PHR	heavy rain
PSQ	squally
PFQ	frozen precipitation (sleet/snow/freezing rain)
PSR	mixed rain and snow

Tide stage

TSE	ebb tide
TSF	flood tide
TSH	high tide
TSL	low tide

Wave height

WH0	0 to <0.1 meters
WH1	0.1 to 0.3 meters
WH2	0.3 to 0.6 meters
WH3	0.6 to > 1.0 meters
WH4	1.0 to 1.3 meters
WH5	1.3 or greater meters

Wind direction

N	from the north
NNE	from the north northeast
NE	from the northeast
ENE	from the east northeast
E	from the east
ESE	from the east southeast
SE	from the southeast
SSE	from the south southeast
S	from the south
SSW	from the south southwest
SW	from the southwest
WSW	from the west southwest
W	from the west
WNW	from the west northwest
NW	from the northwest
NNW	from the north northwest

Wind speed

WS0	0 to 1 knot
WS1	> 1 to 10 knots
WS2	> 10 to 20 knots
WS3	> 20 to 30 knots
WS4	> 30 to 40 knots
WS5	> 40 knots

17) Other remarks/notes:

Data may be missing due to problems with sample collection or processing. Laboratories in the NERRS System submit data that are censored at a lower detection rate limit, called the Method Detection Limit or MDL. MDLs for specific parameters are listed in the Laboratory Methods and Detection Limits Section (Section II, Part 12) of this document. Concentrations that are less than this limit are censored with the use of a QAQC flag and code, and the reported value is the method detection limit itself rather than a measured value. For example, if the measured concentration of NO23F was 0.0005 mg/l as N (MDL=0.0008), the reported value would be 0.0008 and would be flagged as out of sensor range low (-4) and coded SBL. In addition, if any of the components used to calculate a variable are below the MDL, the calculated variable is removed and flagged/coded -4 SCB. If a calculated value is negative, it is rejected, and all measured components are marked suspect. If additional information on MDL's or missing, suspect, or rejected data is needed, contact the Research Coordinator at the reserve submitting the data.

Note: The way below MDL values are handled in the NERRS SWMP dataset was changed in November of 2011. Previously, below MDL data from 2007-2010 were also flagged/coded, but either reported as the measured value or a blank cell. Any 2007-2011 nutrient/pigment data downloaded from the CDMO prior to November of 2011 will reflect this difference.

Sample hold times for 2022: Samples are held at 4°C by the FDEP Laboratory. NERRS SOP allows nutrient samples to be held for up to 24 hours at 4°C or 28 days at 4°C with acidification, plus up to 5 days for collecting, processing, and shipping samples. Samples held beyond that time period are flagged suspect and coded CHB. The dates recorded in the table below are the longest hold date that the FLDEP Laboratory analyzed each parameter.

Sample Date	Program Type	Date Analyzed				
		PO4F	NH4	NO2	NO23	CHLA_N
01/04/2022 - 01/05/2022	Diel	01/06/2022	01/13/2022	01/06/2022	01/10/2022	01/11/2022
01/11/2022	Grab	01/12/2022	01/21/2022	01/12/2022	01/14/2022	01/14/2022
02/09/2022	Grab	02/10/2022	02/18/2022	02/10/2022	02/21/2022	02/16/2022
02/15/2022 - 02/16/2022	Diel	02/16/2022	02/25/2022	02/17/2022	02/25/2022	02/24/2022
03/01/2022 - 03/02/2022	Diel	03/03/2022	03/04/2022	03/03/2022	03/16/2022	03/10/2022
03/09/2022	Grab	03/10/2022	03/15/2022	03/10/2022	03/18/2022	03/16/2022
04/12/2022	Grab	04/13/2022	04/28/2022	04/13/2022	04/14/2022	04/14/2022
04/19/2022 - 04/20/2022	Diel	04/21/2022	04/28/2022	04/21/2022	04/22/2022	04/26/2022
05/10/2022	Grab	05/11/2022	05/18/2022	05/11/2022	05/16/2022	05/18/2022
05/17/2022 - 05/18/2022	Diel	05/19/2022	06/09/2022	05/19/2022	05/20/2022	05/26/2022
06/07/2022	Grab	06/09/2022	06/21/2022	06/09/2022	06/21/2022	06/22/2022
06/14/2022 - 06/15/2022	Diel	06/16/2022	06/22/2022	06/16/2022	06/27/2022	06/27/2022
07/06/2022	Grab	07/07/2022	07/08/2022	07/08/2022	07/11/2022	07/14/2022
07/19/2022 - 07/20/2022	Diel	07/21/2022	07/27/2022	07/21/2022	07/26/2022	07/25/2022
08/02/2022	Grab	08/03/2022	08/09/2022	08/03/2022	08/09/2022	08/09/2022
08/17/2022 - 08/18/2022	Diel	08/19/2022	09/06/2022	08/19/2022	08/24/2022	08/29/2022
09/14/2022	Grab	09/15/2022	09/22/2022	09/15/2022	09/21/2022	10/03/2022
09/20/2022 - 09/21/2022	Diel	09/22/2022	10/06/2022	09/22/2022	09/28/2022	10/10/2022
10/18/2022	Grab	10/19/2022	11/03/2022	10/19/2022	10/26/2022	10/24/2022
10/19/2022 - 10/20/2022	Diel	10/21/2022	11/03/2022	10/21/2022	11/01/2022	10/28/2022
11/01/2022	Grab	11/02/2022	11/08/2022	11/02/2022	11/07/2022	11/03/2022
11/08/2022 - 11/09/2022	Diel	11/10/2022	11/17/2022	11/10/2022	11/18/2022	11/15/2022
12/14/2022	Grab	12/15/2022	12/21/2022	12/15/2022	01/06/2023	12/20/2022
12/06/2022 - 12/07/2022	Diel	12/08/2022	12/21/2022	12/08/2022	12/12/2022	12/16/2022

Monthly QAQC Code explanations:

January

All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

For the diel samples 01/04/2022 08:30 and 01/04/2022 11:00, PO4 and NO2 were Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the samples were within the CDMO's hold time criteria.

For the diel sample 01/04/2022 08:30, CHLA and PHEA were Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the sample was within the CDMO's hold time criteria.

The Total Suspended Solids (TSS) grab sample for rkblhnut taken at 01/11/2022 13:37 was A-qualified, "Value reported is the mean of two or more determinations."

February
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

For the diel sample on 02/15/2022 11:30 the sample was not collected due to malfunctioning ISCO equipment.

March
The Total Phosphorus (TP) grab sample for rkbfunut taken at 03/09/2022 10:45 was J- qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

April
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

Grab samples for rkbfunut on 04/12/2022 10:03 was J- qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

May
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

June
Diel sample 06/14/2022 15:00 was rejected and Y-qualified, "The laboratory analysis was from an unpreserved or improperly preserved sample. The data may not be accurate.", by the lab due to the temperature of the bottle at arrival to the lab was out of compliance.

Diel samples from 06/14/2022 17:30 through 06/15/2022 08:30 were not collected due to a power outage at the ISCO equipment.

July
The following Nitrite (NO2) grab samples were J- qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

rkblhnut	7/6/2022 5:56
rkbmbnut	7/6/2022 7:36
rkbmbnut	7/6/2022 7:40
rkbfunut	7/6/2022 8:55
rkbfunut	7/6/2022 8:58

The Chlorophyll *a* (CHLA) grab sample for rkbpbnut taken at 07/06/2022 08:21 was A-qualified, "Value reported is the mean of two or more determinations."

The Nitrite (NO2) diel sample for rkblhnut taken at 07/19/2022 00:00 was J- qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

August
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The Total Suspended Solids (TSS) grab samples for rkblhnut taken on 08/02/2022 at 10:24 and 10:28 were J- qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

Diel sample from 08/16/2022 23:30 through 08/17/2022 07:00 were not collected due to an ISCO equipment malfunction.

For the diel sample 08/17/2022 09:30, NO2 was Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the sample was within the CDMO's hold time criteria.

For the diel sample 08/17/2022 12:00, PO4 and NO2 were Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the sample was within the CDMO's hold time criteria.

September
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

For the 09/20/2022 14:00 diel sample, the PO4 sample was Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the sample was within the CDMO's hold time criteria.

October
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The Nitrite (NO2) diel sample for rkbfbnut taken at 10/18/2022 08:17 was J- qualified, "Estimated value and/or the analysis did not meet established quality control criteria."

For the 10/19/2022 10:30 diel sample, the PO4, NO2, CHLA and PHEA were Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the samples were within the CDMO's hold time criteria.

For the 10/19/2022 13:00 diel sample, the PO4 and NO2 were Q-qualified, "sample held beyond normal holding time" by the lab due to the "sample expired upon receipt", but the samples were within the CDMO's hold time criteria.

For the 10/19/2022 15:30 diel sample, the NO2 was Q-qualified, "sample held beyond normal holding time", by the lab due to the "sample expired upon receipt", but the sample was within the CDMO's hold time criteria

November
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

Diel sample from 11/08/2022 19:30 was not collected due to an ISCO equipment malfunction.

December
All Ammonia grab samples were flagged suspect due to an elevated reading for the equipment blank sample.

The 12/14/2022 10:28 grab sample for rkbfbnut was O-qualified for CHLA and PHEA, "Sampled, but analysis lost or not performed.", by the lab due to the "Sample was lost during centrifuging due to broken cap."

The 12/06/2022 diel samples from 16:00 through 23:30 were rejected and Y-qualified, "The laboratory analysis was from an unpreserved or improperly preserved sample. The data may not be accurate.", by the lab due to the temperature of the bottle at arrival to the lab was out of compliance.

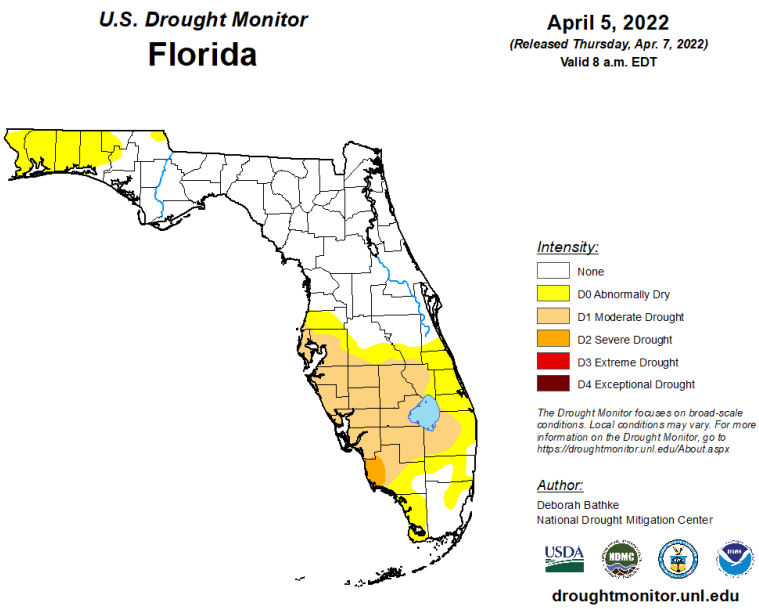
2021-2022 weather conditions based on SFWMD Big Cypress Basin (BCB) Hydrologic Reports:

December 2021: A warm and dry weather pattern remained in place over the Basin during December. The month was exceptionally dry with only six (6) of the last thirty-one (31) Decembers being drier than this year. Even with the extremely dry conditions, most surface and groundwater levels are at or above normal. Even with the very dry December, the rainfall total for the year was very close to average. The 2021 Basin rainfall was 54.1 inches which is 96% of average. June was the wettest month with 11.1 inches and December was the driest with 0.4 inches. The basin-wide monthly average **was 0.41 inches (23% of normal)**, which was not even a quarter of the 1.76 inches typically collected. Based on collected gauge and radar data, the rainfall distribution across the Basin was very uniform with most areas receiving totals very close to the 0.4 inch average.

January and February: January and February continued the below average rainfall trend. December through February rainfall totals are approximately 48% of average. Given the below average rainfall, it is not surprising that most of Collier are in abnormally dry conditions according to the US Drought Monitor (yellow color to right). The seasonal drought look does indicate that further drought development for Florida is likely as the peak of the dry season approaches. Drier than normal conditions are expected to continue given the La Nina remains present in the Pacific Ocean.
January:
As measured by twenty-three (23) reporting stations, the basin-wide January monthly average was **1.4 inches (68% of normal)**, which is below the average 2.1 inches typically collected.

February:
As measured by twenty-three (23) reporting stations, the basin-wide February monthly average was **0.89 inches (51% of normal)**, which is below the average 1.73 inches typically collected.

March: The below normal rainfall trend continued in March. Most of the Basin has not received meaningful rainfall since early November 2021. A couple of very isolated areas (<5 sq mi) in northern Golden Gate Main basin and Fakahatchee have higher than normal totals from one or two strong thunderstorms. Overall though, the December—March rainfall totals are well below average at 45% of normal with about a 4 inch deficit. Given the well below average rainfall and above average temperatures, the US Drought Monitor (right) now show severe drought conditions for western portions of the Basin.



The weather pattern in March was once again mostly hot and dry which continues the pattern from the first half of the 2021/22 dry season. The basin-wide monthly average was **0.74 inches (43% of normal)**, which is below the average 1.79 inches typically collected.

April: Late April's rainfall finally reversed the almost 6 month below average rainfall trend. While the majority of April was extremely dry, the last 3 days of the month brought significant wet-season like rainfall to the Basin. It may have felt and looked like the beginning of wet season, however the above average rainfall was a result of a stalled weather system over the region and not daily sea-breeze thunderstorms. April's rainfall of about 200% of normal was impressive, however it was not enough to completely erase the 2022 rainfall deficit but did shrink to only about half an inch. The weather pattern in April was once again mostly hot and dry, except for the very end of the month which provided some much needed temporary relief from the long dry period. The basin-wide monthly average was **4.46 inches (200% of normal)**, which is well above the average 2.24 inches typically collected.

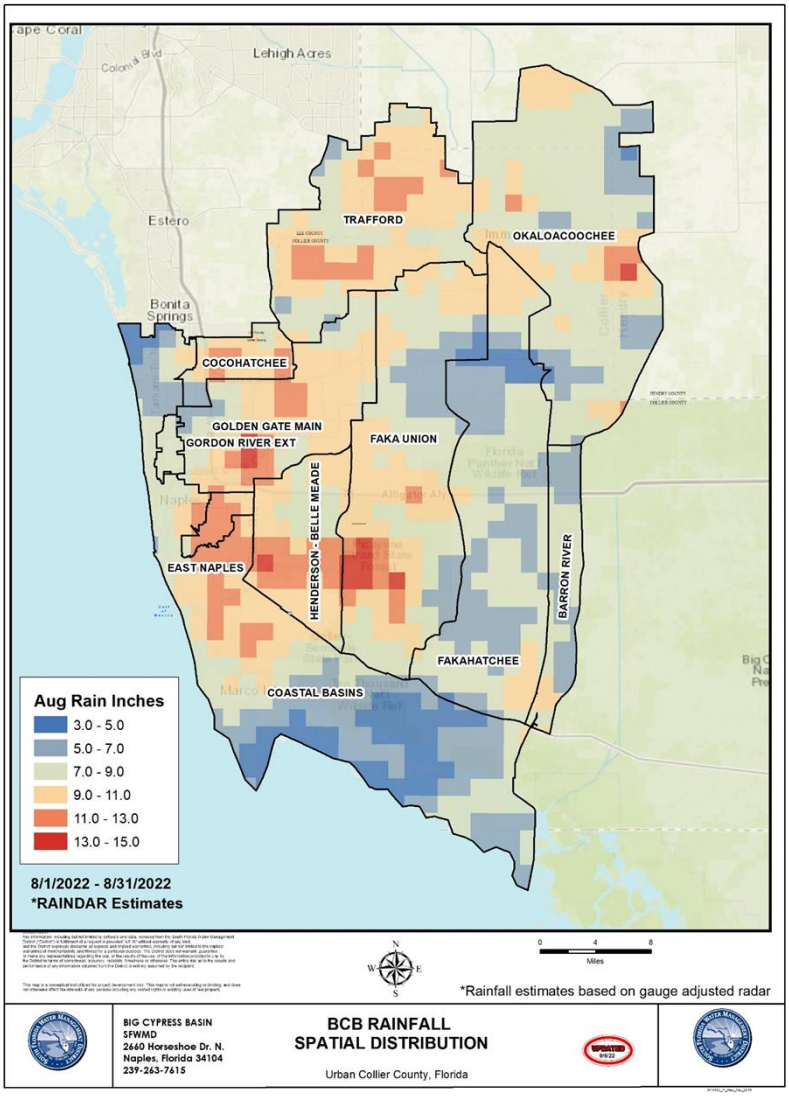
May: May started with widespread beneficial rainfall which helped to alleviate the dry conditions that prevailed through the early portions of the year. The official wet season began on May 12th, approximately 2 weeks earlier than normal, which pushed the region's rainfall above average for May. As May ended, the 2022 rainfall deficit was eliminated, and the Basin started accruing about an inch surplus. The basin-wide May monthly average was 5.2 inches (131% of normal), which is above the average 3.98 inches typically collected.

June: As June began, eyes turned to the tropics at what later became Tropical Storm Alex approached the southwest coast of Florida. While rainfall totals were quite high from the storm, 6" - 8" areal average, the region still had ample room to accept the rainfall. Southern regions of the Basin received the highest totals with local maximum of around 13" in about 24 hours and average rainfall for the event everywhere else was close to six inches. As the system recovered from the event, the western regions of South Florida remained the focus for rainfall. No major rainfall events occurred but there was almost no break from the daily heavy thunderstorm activity. Totals for June were approximately 132% of normal. The basin-wide June monthly average was 13.41 inches (131% of normal), which is above the average 10.23 inches typically collected.

July: While the tropics remained quiet during July, the daily thunderstorm activity remained focused on the western side of the peninsula for the majority of the month. As the month ended, ample

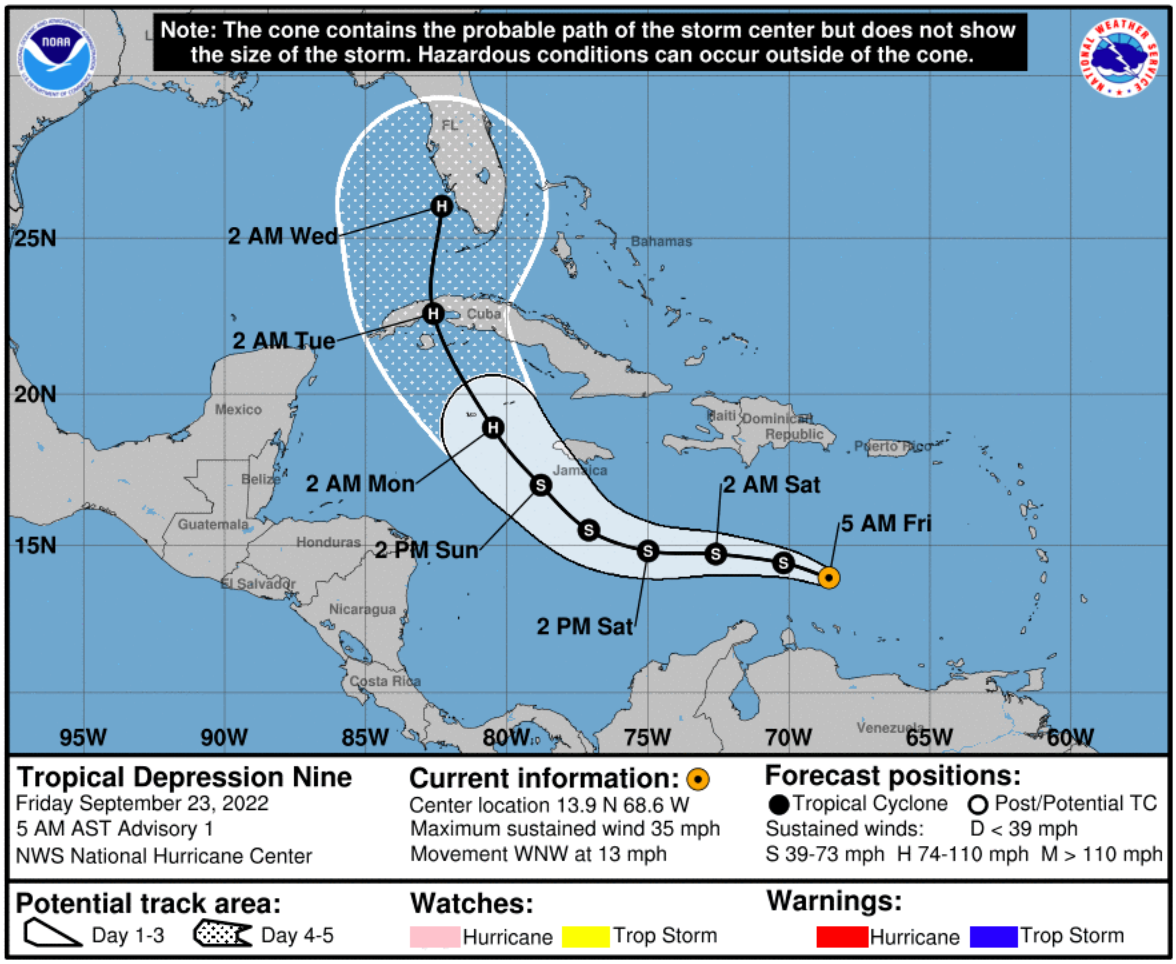
Saharan dust helped to limit the daily rainfall totals for the last week of the month, but total July rainfall still ended above normal. The basin-wide July monthly average was 9.3 inches (106% of normal), which is above the average 8.8 inches typically collected.

August: Rainfall map for the month of August 2022.

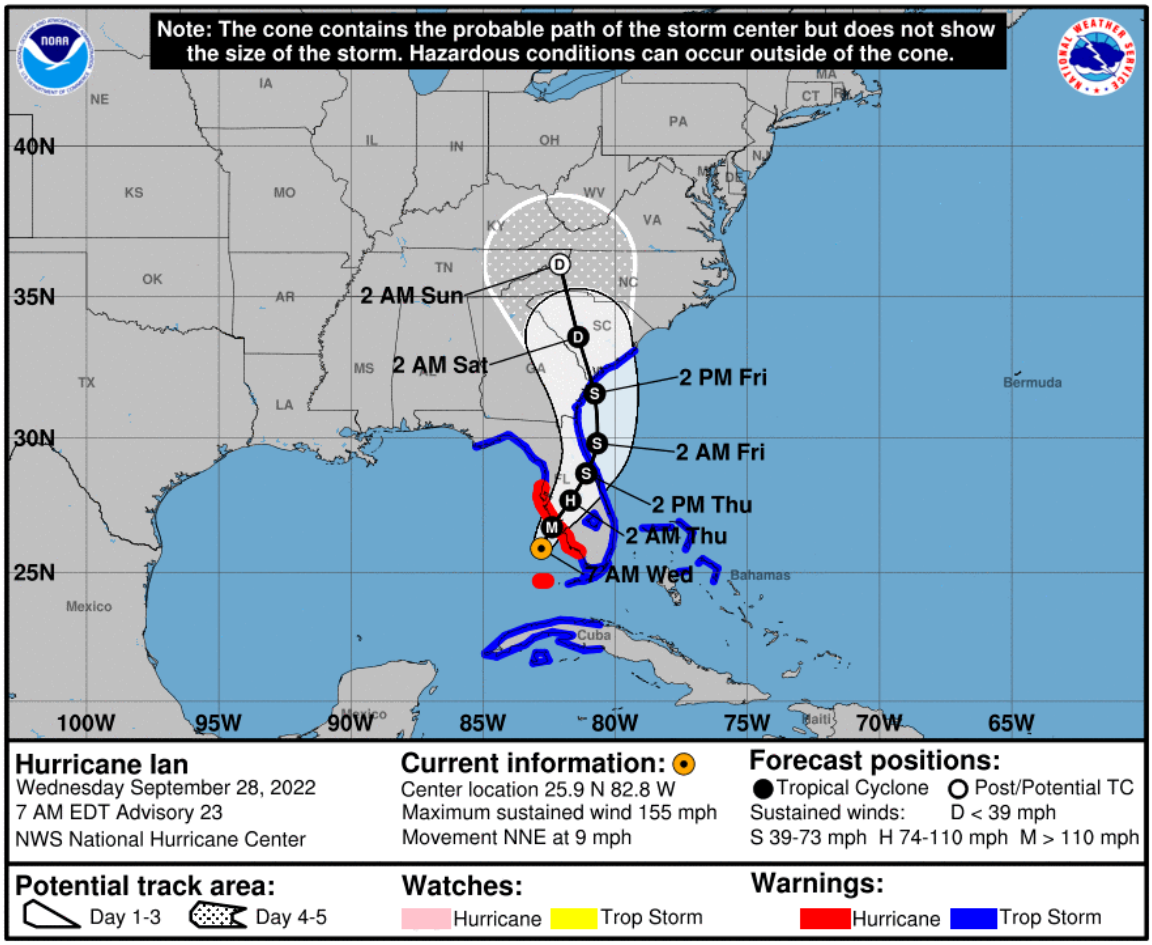


September:

Hurricane Ian NOAA overview: By the early morning hours of September 23rd, the tropical wave was located just to the northwest of the ABC Islands and atmospheric conditions became more conducive for development. The system was officially designated as Tropical Depression Nine by the National Hurricane Center as of the 5am advisory on September 23rd, and the first advisory on what would eventually become Hurricane Ian was fresh off of the press.



Radar and reconnaissance aircraft investigating the storm during the early morning of September 28th indicated that the eyewall replacement cycle of Ian had come to completion and that the system had resumed strengthening. In fact, aircraft reconnaissance investigating the storm during the early morning hours experienced several turbulence and graupel in the eyewall. Maximum winds increased from 120 mph at the 2am intermediate advisory to 155 mph at the 7am advisory, a jump in intensity of 35mph in a time period of 5 hours. Ian had now become a very intense Category 4 hurricane on the Saffir-Simpson Hurricane Wind Scale as it approached the coastline of Southwest Florida. The forward motion of the storm also began to slow on its approach to the Florida coast. Lightning sensor arrays indicated significant lightning in the eyewall of Ian during this time period, indicative of powerful updrafts within the eyewall that allowed for ice crystals to form in the tall convective towers of the storm. Water levels and wind speeds along the Southwest Florida coast steadily increased during the morning as the center of the storm and the eyewall inched closer to the coast.

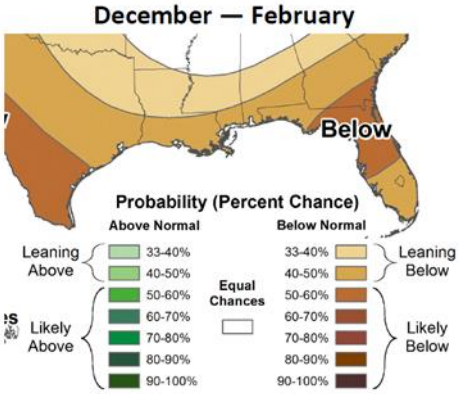


By 305pm EDT on September 28th, the National Hurricane Center announced that radar imagery indicated that the eye of Ian made landfall along the southwestern coast of Florida near Cayo Costa. Data from an Air Force Reserve reconnaissance aircraft indicated that Ian's maximum sustained winds at landfall were estimated to be near 150 mph (240 km/h) with an estimated minimum central pressure of 940 mb (27.75 inches). As the system moved onshore across Southwest Florida, significant impacts were experienced across much of the area. These impacts will be covered in detail in various tabs ahead, examining the storm surge, flooding, tornado, and wind impacts that were observed across southern Florida.

Collier County Storm Impact:
Significant to major storm surge flooding covered almost all of Collier County south/west of Tamiami Trail/US 41 from Everglades City to the Lee County line. Major storm surge flooding occurred within a mile of the coast, both at the beachfront as well as the intracoastal waterways. Farther inland, there was significant to major storm surge flooding south and west of Naples Municipal Airport along the Gordon River and Rock Creek, as well as along the Cocohatchee River and Palm River areas. Wind gusts of 100- 110 mph were measured at about 100-150 feet above ground level over western Collier County, with peak near-surface wind gusts likely in the 80-90 mph range. Wind damage was mainly confined to trees/fences/screens, with minor wind damage to vulnerable structures. Estimated highest number of customers without power was 201,095 as of 3 PM on September 29th. Reported damage estimates for the entire county are $2.2 billion. Of that, $1.7 billion is to residential properties and $492 million to commercial. A total of 33 buildings were destroyed, with 3,515 residential and commercial buildings suffering major damage. Breakdown of

damage amount by City/area: unincorporated Collier $948 million, city of Naples $989 million, Marco Island $256 million, Everglades City $7.1 million.
October: After the passage of Hurricane Ian in late September, this year's wet season came to a rapid close on September 29th. October ushered in welcome drier and cooler weather into the region. Rainfall totals for October finally broke the above average rainfall trend the Basin has been experiencing since late April.

Looking ahead at the upcoming dry season, a third year of La Nina conditions are expected to continue in the Pacific Ocean. Those conditions typically setup a warmer and drier than normal winter for Florida, as the area has experienced in the last few years. The NWS CPC has issued guidance indicating above average chances for drier and warmer than normal conditions to persist throughout the region until April 2023.

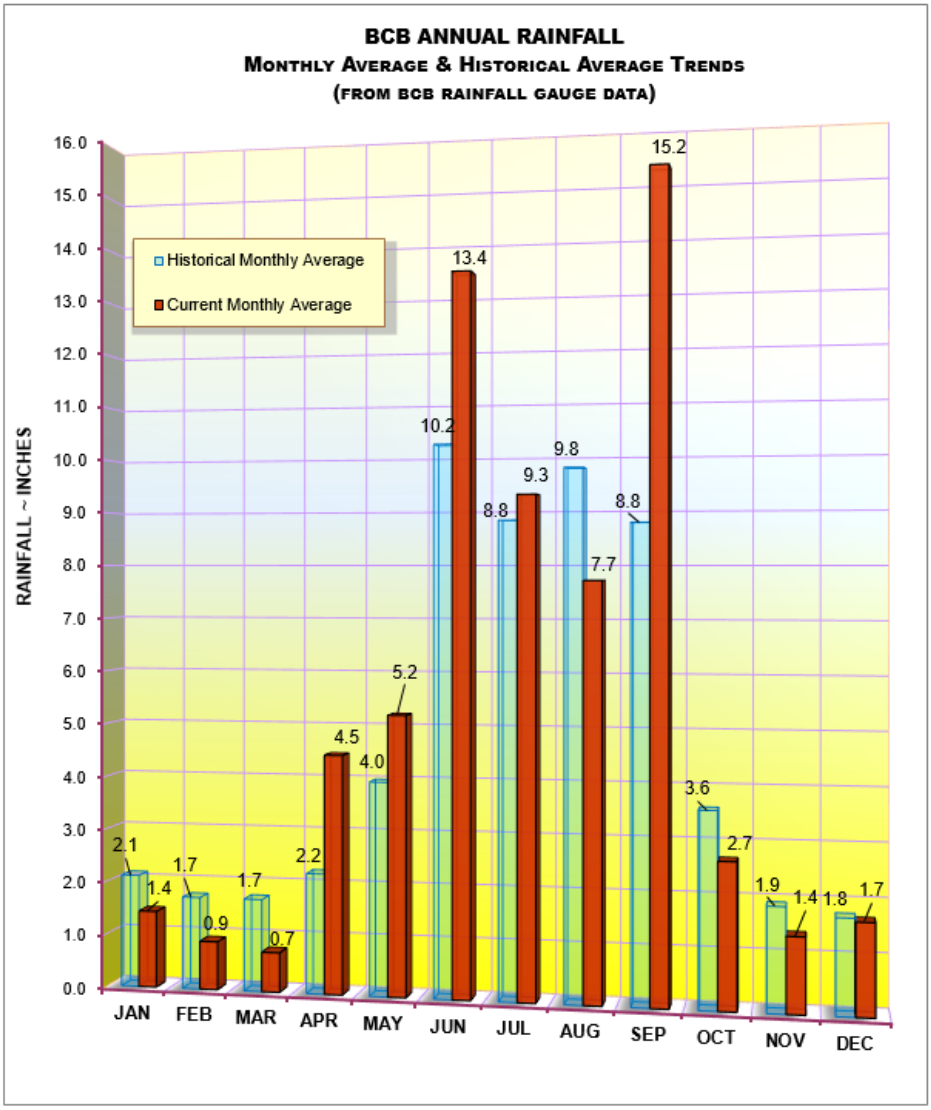


The basin-wide October monthly average was 2.7 inches (74% of normal), which is below the average 3.6 inches typically collected.

November: La Nina conditions continued in the Pacific Ocean which contributed to the drier than average weather throughout the month. November 30th marked the end of hurricane season with 14 named storms and weather for the month was typical. Rainfall for November fell slightly below average and the cumulative rainfall for the year remained above the annual average. The basin-wide November monthly average was 1.4 inches (74% of normal), which is below the average 1.9 inches typically collected.

December: The month of December for the Big Cypress Basin continued with warm and dry conditions apart from the last week which ushered in a strong cold front. The cold front was the result of an arctic blast which brought in near freezing conditions to the Basin which triggered the unusual weather warning of "falling iguanas." Even with a rainfall deficit for December, the 2022 cumulative rainfall for the Basin was above average at 63.9 inches which is 113% above average. The basin-wide December monthly average was 1.7 inches which is 94% of normal, which is below the average 1.8 inches typically collected.

2022 Summary: September was the wettest month with 15.2 inches, and March was the driest with 0.7 inches. 2022 brought with it 14 named tropical storms six of which were hurricanes and two were major hurricanes. Three of these storms (Alex, Ian, & Nicole) impacted South Florida which contributed to 2022 being the 4th wettest year since 1990. La Nina conditions in the Pacific Ocean continue to have an impact on Florida's climate by continuing to bring warmer and drier than normal weather. The current predictions anticipate that La Nina will transition to average conditions in February or March (Spring) of 2023.



2022 BCB GAUGE RAINFALL MONTHLY AVERAGES

Acknowledgement: The data included with this document were collected by the staff of the Florida Department of Environmental Protection at the Rookery Bay National Estuarine Research Reserve with funding through NOAA's Estuarine Research Division. Any products derived from these data should clearly acknowledge this source (please use the attached logos). This recognition is important for ensuring that this long-term monitoring program continues to receive the necessary political and financial support.