DEPARTMENT OF ENVIRONMENTAL PROTECTION
Progress Report Form

Exhibit A

DEP Agreement No.:	**AT008**		
Grantee Name:	University of South Florida		
Grantee Address:	4202 E. Fowler Ave., SVC 1039, Tampa, FL 33620-5800		
Grantee's Grant Manager:	Dr. Shawn Landry	**Telephone No.:**	813-974-4590
Reporting Period:	6/1/2023 – 6/30/2023		
Project Number and Title:	AT008: Water quality enhancement and accountability as listed in Line Item 1640 2022-23 GAA: Water Quality Analysis Pilot Study for the SEACAR Program		

Task 1A: Data Collection and Exploration

Progress for this reporting period:
Task 1A was completed and invoiced as part of the 10/1/2022-12/31/2022 Progress Report..

Task 1B: Spatial Interpolation
Task 1B was completed and invoiced as part of the Invoice 2 (1/1/2023 – 5/31/2023) Report.

After providing deliverables, additional work was done in response to a request by the SEACAR team. We standardized the legend/color ramp for the final interpolated maps and modified the naming convention for interpolated map files. A request was also made to display the sample location points within the online map.

File naming conventions were changed to the following:
Managed Area (abbreviation) – Parameter (abbreviation) – units – Year – Season

Example: BBAP_Turb_ntu_2021_Spring.tif

Managed Area	Abbreviation
Big Bend Seagrasses Aquatic Preserve	BBSAP
Biscayne Bay Aquatic Preserve	BBAP
Estero Bay Aquatic Preserve	EBAP
Gasparilla Sound-Charlotte Harbor Aquatic Preserve	GSCHAP
Guana Tolomato Matanzas National Estuarine Research Reserve	GTMNERR

ParameterName	Abbreviation	Units
Dissolved Oxygen	DO	mgl
Salinity	Sal	ppt
Secchi Depth	Secchi	m
Total Nitrogen	TN	mgl
Turbidity	Turb	ntu

The color ramps were standardized after examining the descriptive statistics for the original data and then choosing a representative interpolated map which would include the range of values within the data from the 0-10th percentile to the 90-100th percentile. The following shows the representative interpolated maps used for standardizing the color ramps for each Managed Area – Parameter combination.

Managed Area	Parameter	min	max	v1	v9	v10	Reference Seasor	Filename	Directory
Charlotte Harbor	Dissolved Oxygen	0.01	18.3	3.64	11.16	18.30	2007_Summer	GSCHAP_DO_mgl_2007_Summer.tif	output_raster\Charlotte Harbor
Charlotte Harbor	Salinity	0	51.5	13.90	45.28	51.50	2021_Fall	GSCHAP_Sal_ppt_2021_Fall.tif	output_raster\Charlotte Harbor
Charlotte Harbor	Secchi Depth	0.1	6	0.43	3.87	15.32	2020_Spring	GSCHAP_Secchi_m_2020_Spring.tif	output_raster\Charlotte Harbor
Charlotte Harbor	Total Nitrogen	0	5.525	0.18	1.58	5.53	2016_Summer	GSCHAP_TN_mgl_2016_Summer.tif	output_raster\Charlotte Harbor
Charlotte Harbor	Turbidity	0.07	24	0.92	8.25	24.00	2015_Spring	GSCHAP_Turb_ntu_2015_Spring.tif	output_raster\Charlotte Harbor
Estero Bay	Dissolved Oxygen	0	15.1	3.67	10.09	15.10	2012_Fall	EBAP_DO_mgl_2012_Fall.tif	output_raster\Estero Bay
Estero Bay	Salinity	0	46.9	22.48	44.06	46.90	2018_Spring	EBAP_Sal_ppt_2018_Spring.tif	output_raster\Estero Bay
Estero Bay	Secchi Depth	0.15	2.9	0.35	2.00	2.90	2005_Fall	EBAP_Secchi_m_2005_Fall.tif	output_raster\Estero Bay
Estero Bay	Total Nitrogen	0.00019	5.1	0.16	1.40	5.10	2005_Winter	EBAP_TN_mgl_2005_Winter.tif	output_raster\Estero Bay
Estero Bay	Turbidity	0	25	1.82	16.36	25.00	2020_Spring	EBAP_Turb_ntu_2020_Spring.tif	output_raster\Estero Bay
Big Bend	Dissolved Oxygen	0	20.4	4.30	11.32	20.40	2015_Winter	BBSAP_DO_mgl_2015_Winter.tif	output_raster\Big Bend
Big Bend	Salinity	0	40.6	7.49	45.33	50.06	2013_Summer	BBSAP_Sal_ppt_2013_Summer.tif	output_raster\Big Bend
Big Bend	Secchi Depth	0	21.34	0.46	4.12	21.34	2011_Summer	BBSAP_Secchi_m_2011_Summer.tif	output_raster\Big Bend
Big Bend	Total Nitrogen	0.00008	6.36	0.18	1.62	6.36	2009_Spring	BBSAP_TN_mgl_2009_Spring.tif	output_raster\Big Bend
Big Bend	Turbidity	0	25	2.09	18.84	25.00	2004_Spring	BBSAP_Turb_ntu_2004_Spring.tif	output_raster\Big Bend
Biscayne Bay	Dissolved Oxygen	0	21.89	3.13	12.33	21.89	2022_Winter	BBAP_DO_mgl_2022_Winter.tif	output_raster\Biscayne Bay
Biscayne Bay	Salinity	0	48.9	8.53	44.41	48.90	2019_Summer	BBAP_Sal_ppt_2019_Summer.tif	output_raster\Biscayne Bay
Biscayne Bay	Secchi Depth	0.1524	4.3	0.53	3.50	10.55	2019_Fall	BBAP_Secchi_m_2019_Fall.tif	output_raster\Biscayne Bay
Biscayne Bay	Total Nitrogen	0.00014	4.248	0.11	1.01	7.68	2019_Spring	BBAP_TN_mgl_2019_Spring.tif	output_raster\Biscayne Bay
Biscayne Bay	Turbidity	0	25	1.02	9.17	25.00	2019_Fall	BBAP_Turb_ntu_2019_Fall.tif	output_raster\Biscayne Bay
GTM Reserve	Dissolved Oxygen	0	21.89	3.13	12.33	21.89	2009_Spring	GTMNERR_DO_mgl_2009_Spring.tif	output_raster\GTM Reserve
GTM Reserve	Salinity	0	48.9	8.53	44.41	48.90	2009_Fall	GTMNERR_Sal_ppt_2009_Fall.tif	output_raster\GTM Reserve
GTM Reserve	Secchi Depth	0.1524	4.3	0.36	2.00	2.20	2005_Summer	GTMNERR_Secchi_m_2005_Summer.tif	output_raster\GTM Reserve
GTM Reserve	Total Nitrogen	0.00014	4.248	0.11	1.01	4.25	2021_Summer	GTMNERR_TN_mgl_2021_Summer.tif	output_raster\GTM Reserve
GTM Reserve	Turbidity	0	25	1.78	16.02	50.00	2003_Winter	GTMNERR_Turb_ntu_2003_Winter.tif	output_raster\GTM Reserve

All changes were implemented on the maps in the Box folder: SEACAR_WQ_Analysis_Pilot\Deliverables Task 1b\Interpolated_Maps2 (main folder link for read access is https://usf.box.com/s/kip9rxg6q0g2hlqszccksyzmcr16rhxt).

Changes were also included in the updated online map: https://dev.gis.waterinstitute.usf.edu/maps/SEACAR-OEAT-WQ/

Corresponding Map Service Names (for users to view in ArcGIS or other tools) are as follows:

- https://dev.gis2.waterinstitute.usf.edu/arcgis/rest/services/Maps/SEACAR_OEAT_Standard_Error_Prediction/MapServer
- https://dev.gis2.waterinstitute.usf.edu/arcgis/rest/services/Maps/SEACAR_OEAT_Interpolated_Maps/MapServer

Task 1C: Spatial Analysis of Uncertainty

Progress for this reporting period:

During Task 1b, the decision was made to use Regression Kriging for all study areas with different combinations of covariates. Standard error of prediction maps (raster) are used to quantify the uncertainty of the interpolation. Regression Kriging utilizes covariate layers, and the final models included the following covariate layers:

- Guana Tolomato Matanzas National Estuarine Research Reserve (GTM): Regression Kriging (covariates: LDI)
- Biscayne Bay Aquatic Preserve: Regression Kriging (covariates: bathymetry+LDI+popden)
- Estero Bay Aquatic Preserve: Regression Kriging (covariates: bathymetry+LDI+popden)
- Big Bend Seagrasses Aquatic Preserve: Regression Kriging (covariates: bathymetry+LDI)

- Gasparilla Sound-Charlotte Harbor Aquatic Preserve: Regression Kriging (covariates: bathymetry+LDI+popden+water_flow_dry)

During the June 7, 2023 project meeting, the University presented the Kernel Density (density of sample site locations) and Aggregated Standard Error maps based on WQ data from 2015 to 2019. It was decided that both maps were useful for making decisions about monitoring gaps. The Kernel Density maps showed where there were high and low densities of existing monitoring locations. The Standard Error maps showed where there was high and low error in the interpolated maps. The project team realized that it is possible to have a high density of sampling locations but also a high error in the interpolated maps. Conversely, it is possible to have a very low density of sampling points but a also a very low error in the interpolated maps. The project team made several decisions related to the Gap analysis methods.

First, it was decided that the combination of the Kernel Density (Density) and Standard Error (SE) results would be used to determine the Gap Analysis decisions. Each of the maps was categorized into "high" and "low" areas based on the distribution of values within each of the maps. Area with values at or below the 25th percentile would be labelled as "low" and areas at or above the 75th percentile would be reclassified as "high" within each of the maps. Then the reclassified kernel density maps and standard error maps are overlaid to identify gaps and redundancies. The following table outlines the methods and decisions.

Table 1. Matrix for Gap Analysis Implications

Density map areas	**SE map areas**	**Potential Implication**	**Task 1c Deliverable**
High	High	Natural variation, potentially seasonal issue, or might be unexplained variation	Display seasonal maps for SEACAR team to consider explanation
High	Low	Potential redundancy where there is low error but a high density of points	Identify specific sampling points within these areas
Low	Low	Low error despite the low density of points. No change needed / low priority	Reference only
Low	High	There is a high error that might be due to the low density of points. Potential need for more stations	Identify areas on the map

Areas reclassified as high density and low standard error of prediction are considered as redundant areas. Unique sampling points from 2015 to 2019 located in the redundant areas are labelled as redundant points. Areas reclassified as low density and high standard error of predictions are considered as gaps. Both redundant areas and gaps are displayed in maps available in the Box folder: SEACAR_WQ_Analysis_Pilot\Deliverables Task 1c\Gap_analysis\KDE_SE_overlay\maps (https://usf.box.com/s/w4kgzbtzalhopgs80je2she8uai2ga8l).

Second, it was decided that the Kernel Density and Standard Error maps for each Managed Area – Season – Parameter combination, and the All Season combined Parameter maps would be presented in the page layout outline below to facilitate exploration. The maps would either be in a GitHub online page or with MS Word or other format. For each Managed Area, the All Season maps would be together, and then Parameter maps for individual seasons would be together following the layout shown below:

All-season maps

All Season DO KD	TN KD	Secchi KD	Turb KD	Sal KD
All Season DO SE	TN SE	Secchi SE	Turb SE	Sal SE

The visualization of all-season maps can be found: https://github.com/FloridaSEACAR/SEACAR_WQ_Pilot/blob/main/Gap_Analysis/Gap_Analysis_Part1.md (due to large number of figures, the loading of the webpage may take a few seconds)

Maps of the gaps and redundancy areas are provided in a PowerPoint file called Maps.pptx and jpg files within the Maps folder of Box (Deliverables Task 1c\Gap_analysis\KDE_SE_overlay\maps): https://usf.box.com/s/w4kgzbtzalhopgs80je2she8uai2ga8l

Seasonal maps

Spring DO KD	Summer DO KD	Fall DO KD	Winter DO KD
Spring DO SE	Summer DO SE	Fall DO SE	Winter DO SE

Spring TN KD	…	…	…
Spring TN SE	…	…	…

Spring Turb KD	…	…	…
Spring Turb SE	…	…	…

Spring Secchi KD	…	…	…
Spring Secchi SE	…	…	…

Spring Sal KD	…	…	…
Spring Sal SE	…	…	…

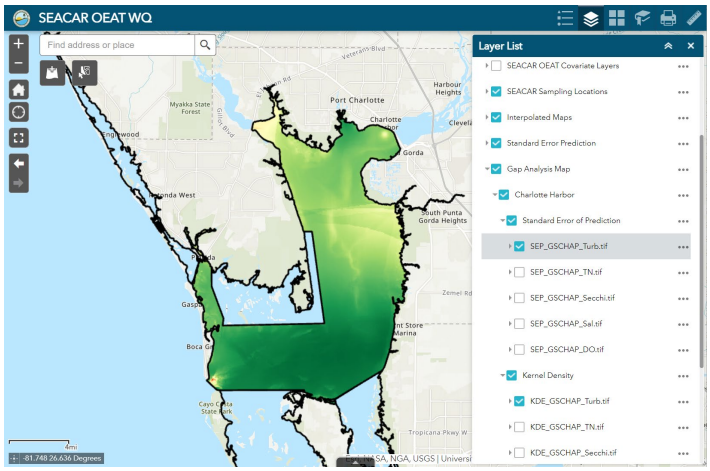
The visualization of seasonal maps can be found: https://github.com/FloridaSEACAR/SEACAR_WQ_Pilot/blob/main/Gap_Analysis/Gap_Analysis_Part2.md (due to large number of figures, the loading of the webpage may take a few seconds)

Identify any delays or problems encountered:
NA

Deliverables

Important for users of the Box Drive app: Box has a limitation that prevents opening files that are buried deep within subdirectors and therefore the file path plus filename is longer than 259 characters. Box Drive users might need to download local copies in order to open some files. This limitation does not apply to Box access within a browser.

1. Copy of bubble and/or raster maps showing SE and residual of the interpolated water quality maps; All project related maps, including pilot thematic, bubble, raster and final interpolation maps, used for review with the DEP staff will be made available via an ArcGIS server similar to other map services used for SEACAR (e.g., https://data.florida-seacar.org/maps/locations/indicators/);
    a. The aggregated All-season Kernel Density and Standard Error of Prediction maps are available within the online map application at https://dev.gis.waterinstitute.usf.edu/maps/SEACAR-OEAT-WQ/



    b. The same All-season maps, as well as the individual season Kernel Density and Standard Error of Prediction maps are available as TIF files on Box (Deliverables Task 1c\Gap_analysis\KDE_SEP_TIF_All and Deliverables Task 1c\Gap_analysis\KDE_SEP_TIF_Season (https://usf.box.com/s/r3g3bw1iq429w13utacm0w5bkowzk0rm).

    c. The final Gap Analysis maps are included in the "Gap and Redundant Areas Map" section of the online mapping application: https://dev.gis.waterinstitute.usf.edu/maps/SEACAR-OEAT-WQ/

    d. The original raster data (in geotiff format) of the individual standard error of prediction maps created during Task 1b are available for download from Box (Deliverables Task 1b\Interpolated_Maps2\GIS_data): https://usf.app.box.com/s/sf8cuoa9nyohapuj9xmfkghw3ib7e7cg/folder/212604238113

GIS_data > standard_error_prediction

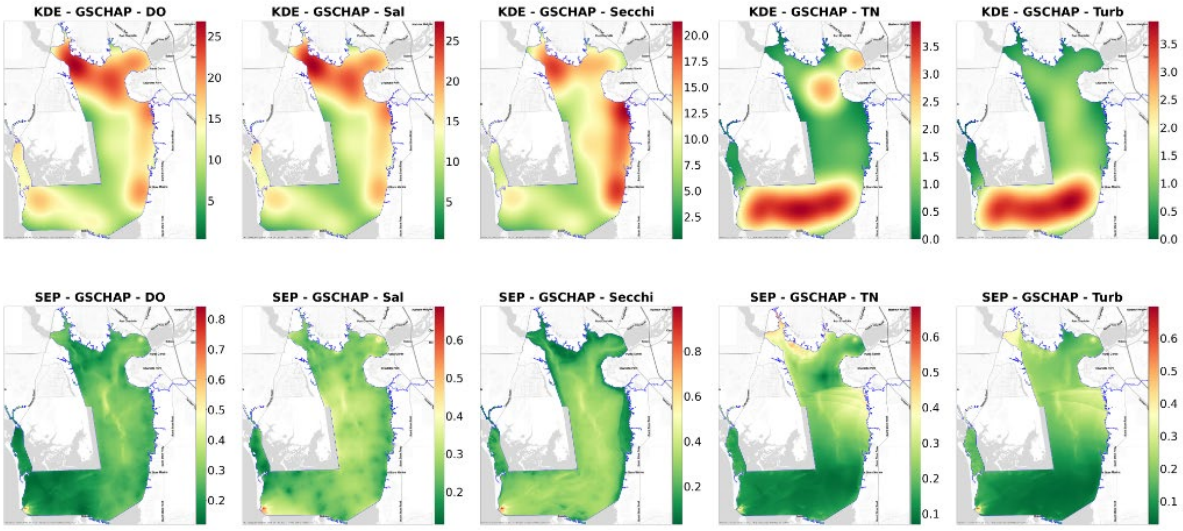
NAME	UPDATED ↓	SIZE
GTM Reserve	Jun 14, 2023 by Yi Qiang	723 Files
Estero Bay	Jun 14, 2023 by Yi Qiang	585 Files
Charlotte Harbor	Jun 14, 2023 by Yi Qiang	1,110 Files
Biscayne Bay	Jun 14, 2023 by Yi Qiang	881 Files
Big Bend	Jun 14, 2023 by Yi Qiang	1,200 Files

e. The aggregated All-season maps of kernel density and standard error of prediction are available within GitHub and displayed in the layout requested during the June 6, 2023 meeting: https://github.com/FloridaSEACAR/SEACAR_WQ_Pilot/blob/main/Gap_Analysis/Gap_Analysis_Part1.md (due to large number of figures, the loading of the webpage may take a few seconds)

The figure below is an example of Charlotte Harbor

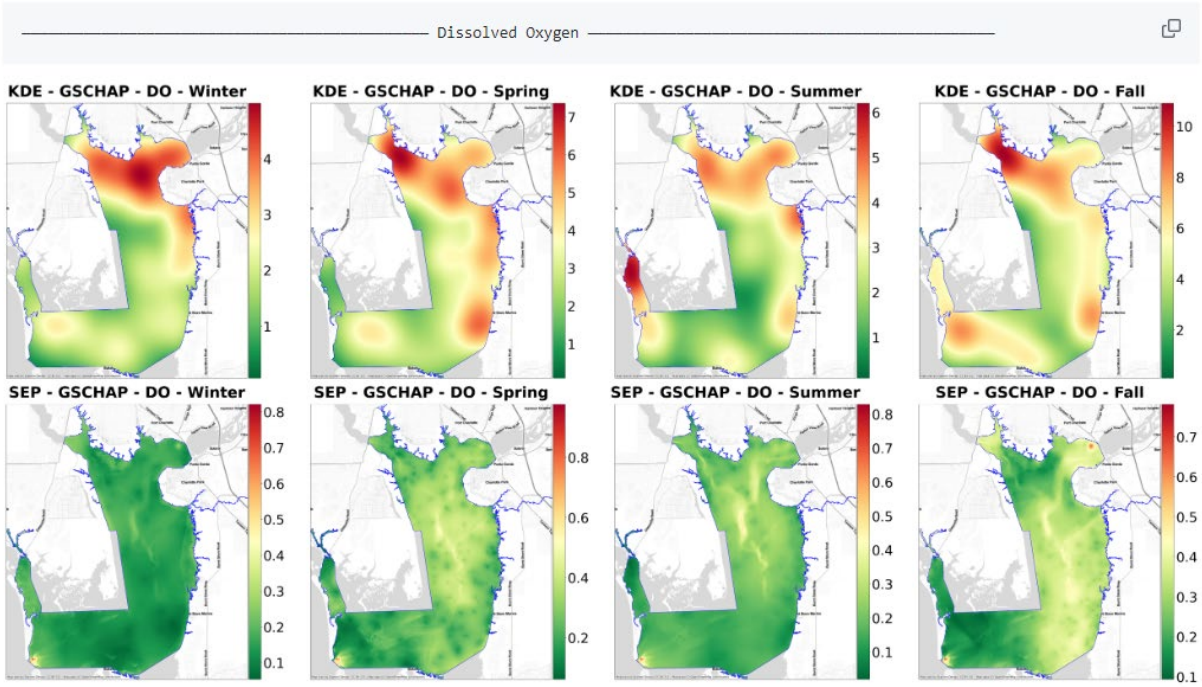
5.1 Charlotte Harbor

```
GapAnalysis.plot_pairs(kde_sep_files, 'Gasparilla Sound-Charlotte Harbor Aquatic Preserve', boundary, 80, 20)
```

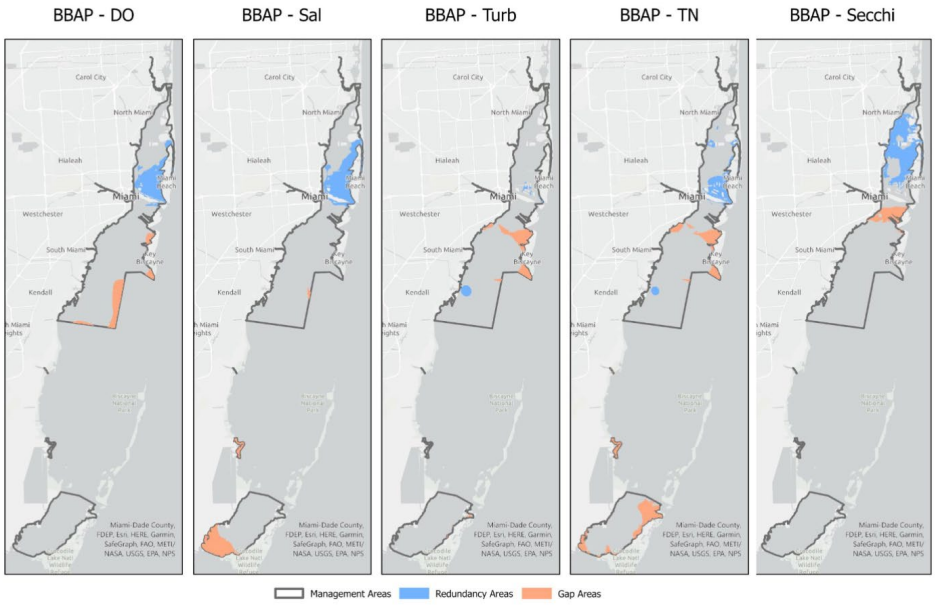


f. Seasonal maps of kernel density and standard error of prediction are also available within GitHub in the requested layout: https://github.com/FloridaSEACAR/SEACAR_WQ_Pilot/blob/main/Gap_Analysis/Gap_Analysis_Part2.md (due to large number of figures, the loading of the webpage may take a few seconds)

The figure below is an example of Charlotte Harbor



2. List of identified areas where additional monitoring sites are needed to improve model accuracy (gaps);
    a. The maps of gaps and redundant areas are shown in the Maps.pptx PowerPoint file and the jpg files within the Box folder (Deliverables Task 1c\Gap_analysis\KDE_SE_overlay\maps): https://usf.box.com/s/w4kgzbtzalhopgs80je2she8uai2ga8l
    b. The same maps are available in the online mapping application within the section called "Gap and Redundant Areas Map" as mentioned above.
    c. The figure below is an example of Biscayne Bay



3. List of identified redundant monitoring sites, with corresponding latitude/longitude coordinates, that can be potentially removed or relocated without affecting water quality interpolation (redundancies).
    a. All unique sample locations each parameter were exported from the June 6, 2023 SEACAR Discrete and Continuous WQ export. Sampling locations were only included if data for the parameter had been collected/reported for the station since 2015. Separate shapefiles were created for each parameter and added to GIS. Shapefiles are included in the Box folder: Deliverables Task 1c\Gap_analysis\KDE_SEP_overlay\Points\Result (https://usf.box.com/s/w4kgzbtzalhopgs80je2she8uai2ga8l).

    b. The unique sample locations and the Gap Analysis results (exported from the shapefiles above) are in the Box folder Deliverables Task 1c\Unique Sample Locations (https://usf.box.com/s/n6cxxzk8b976sfjwkuiv1w7to3dzvy45). The excel file called SampleLocations_GapAnalysis.xlsx was created as an export of all shapefiles, with each parameter on a separate worksheet. Columns that were added based on the Matrix for Gap Analysis Implications (Table 1 above) include: SEP and KDE for the All-season High/Low determination; Implication shows the Gap analysis implication; Solution indicates specific points that are potentially redundant (Identify points), or points within areas that might require more sample locations (Identify areas). A screenshot of the excel file is shown here:

ManagedArea	ParameterNa	ProgramID	ProgramName	Type	ProgramLocation	Lat	Long	SEP	KDE	Implication	Solution
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	4058	City of Miami Beach Water M	Discrete	25	25.7943	-80.1553	Low	High	Potential redundancy	Identify points
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	5002	Florida STORET / WIN	Discrete	WIN_21FLDADE_LR01	25.84486031	-80.1738506	Low	High	Potential redundancy	Identify points
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	103	EPA STOrage and RETrieval I	Discrete	21FLDADE_WQX-BB47	25.3367944	-80.3200766	Low	Low	No change needed / low priority	
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	5026	North Biscayne Bay Seagrass	Discrete	WQ05	25.808136	-80.140808	Low	High	Potential redundancy	Identify points
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	4058	City of Miami Beach Water M	Discrete	18	25.8075	-80.1251	Low	High	Potential redundancy	Identify points
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	5002	Florida STORET / WIN	Discrete	STORET_21FLDADE_B	25.3367944	-80.3200766	Low	Low	No change needed / low priority	
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	4058	City of Miami Beach Water M	Discrete	21	25.7933	-80.1629	Low	High	Potential redundancy	Identify points
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	5002	Florida STORET / WIN	Discrete	STORET_21FLDADE_B	25.6299983	-80.25	Median	Median		
Biscayne Bay Aquatic Preserve	Dissolved Oxygen	103	EPA STOrage and RETrieval I	Discrete	21FLDADE_WQX-LR01	25.84486031	-80.1738506	Median	Median		

    c. The monitoring location points are also included for reference within the "Gap and Redundant Areas Map" section of the online mapping application: https://dev.gis.waterinstitute.usf.edu/maps/SEACAR-OEAT-WQ/

4. Copies of invoice and proof of payment for monthly IT server costs. Time sheets are not required as the USF staff are salaried.
    a. IT Billing for June 2023 charge of $398.36 is documented within the document Invoice 3 IT Billing Documentation.pdf: https://usf.box.com/s/s0lcb9nvh8xmuv1fah9hwn3try80neat.

Task 1D: Creation of Scheduled Interpolation Map

Progress for this reporting period:

There were two primary purposes of this task:

1. **Automated Map Generation**: To develop an automated and scheduled tool to create interpolation maps of water quality data for the Managed Areas included within this pilot project. The automated tool would be able to produce new interpolated maps on a regular basis as data becomes available.

2. **Extract Interpolated WQ Data for SAV and Oysters**: To enable an initial exploration of the relationship between water quality and SAV and oyster habitat conditions, data from the interpolated maps will be extracted based on the sample locations and dates of SEACAR SAV and oyster habitat data.

Automated Map Generation

The goal of the automated map generation was to add automation and publication to the scripts developed during Task 1b of the project. The Task 1b scripts were designed to loop through each Managed Area – Parameter – Year – Season and generate the appropriate interpolation map and associated standard error map. The conceptual process for the automated map generation is as follows:

1. Discrete/Continuous WQ data is exported from the SEACAR database on a regular basis.
    a. The format for the data used by the map generation process differs slightly from the exports designed for SEACAR analysis in several ways, including: data are already filtered based on the SEACAR "include" column, only the required fields/columns included, lat/long values are added, and only the designated Managed Areas and Parameters are included.
2. Based on the date of the SEACAR export, a new "control" file is generated that specifies each Managed Area – Year – Season combination that can be run through the automation process. The Managed Area – Year – Season combination is based on the end date of the seasons determined for each Managed Area.
    a. Due to lack of a "better" method, the Managed Area – Year – Season combination is based on the assumption that there is a 6 month lag before data for a specific season is available. The 6 month lag is based only on the experience of the University with SEACAR data updates, Water Atlas data updates and familiarity with WIN timelines.
    b. For example, let's say SEACAR data were exported July 6, 2023. Based on the 6 month lag, we would assume that there is sufficient data/points to generate maps for any season ending before January 6, 2023 (approximately). Since the fall season ends Dec 20th for GSCHAP and Dec 24th for EBAP, the control file would record Fall 2022 as a possible season to generate maps for those two Managed Areas. However, Fall of 2022 could not be generated for the remaining Managed Areas since fall doesn't end until Jan 14th for BBSAP, Feb 7th for BBAP, and Feb 10th for GTMNERR.

MANAGED AREA	SEASON	START	END
BBSAP	spring	18-Feb	13-Jun
BBSAP	summer	14-Jun	30-Aug
BBSAP	fall	31-Aug	14-Jan
BBSAP	winter	15-Jan	17-Feb
BBAP	spring	2-Mar	31-May
BBAP	summer	1-Jun	26-Aug
BBAP	fall	27-Aug	7-Feb
BBAP	winter	8-Feb	1-Mar
EBAP	spring	27-Feb	6-Jun
EBAP	summer	7-Jun	26-Aug
EBAP	fall	27-Aug	24-Dec
EBAP	winter	25-Dec	26-Feb
GSCHAP	spring	28-Feb	5-Jun

GSCHAP	summer	6-Jun	16-Aug
GSCHAP	fall	17-Aug	20-Dec
GSCHAP	winter	21-Dec	27-Feb
GTMNERR	spring	23-Feb	23-Jun
GTMNERR	summer	24-Jun	20-Aug
GTMNERR	fall	21-Aug	10-Feb
GTMNERR	winter	11-Feb	22-Feb

3. A scheduled computer process would trigger the automation routine to run.
4. The automation runs the slightly modified scripts from Task 1b. The scripts import the SEACAR export data and run processes to convert to a format for python. The MA-Year-Season control file tells the process to select data for one parameter at a time, generate points, and run the appropriate Regression Kriging using the covariates specified during Task 1b (see above).
5. Once the map TIF files are generated, another process assigns the legend color to match the previous interpolated maps for each specific Managed Area – Parameter combination.
6. The final interpolated TIF files and associated Standard Error files are transferred to an ArcGIS Map Server.
7. The maps are inserted into the map service, within the appropriate Managed Area / Parameter table of contents shown in the online map.
8. Once the map service is updated, the online map automatically displays the latest addition(s).

Extract Interpolated WQ Data for SAV and Oysters

On June 2, 2023, the SEACAR Team provided clarification of their desires for the products of this portion of the task.

> Our goal with the "extraction" of parameter values for the SEACAR SAV and Oyster habitat monitoring events is to generate contemporaneous estimates of water quality parameter values for each habitat monitoring date/location (which together define a monitoring "event"). The process looks something like this:
>
> 1. Identify the unique SAV and Oyster habitat monitoring locations (i.e., lat/long points) in each of the pilot managed areas (i.e., GTMNERR/GRMAP/PCAP, BBSAP, LBAP, CHGSAP, CZAP, PISAP, MPAP, EBAP) and the years/pre-defined seasons into which they fall.
> 2. Use the interpolation models corresponding to each of the managed area/season/year combinations from step 1 to estimate the T, S, SD, TN, DO values and uncertainties for each SEACAR SAV and Oyster habitat monitoring location point(s) that had a monitoring event in the relevant managed area/season/year.
> 3. Compile a data file of the SEACAR SAV and Oyster habitat monitoring events for each managed area/season/year/location and the corresponding parameter estimates and uncertainties for each point location. Alternatively, the parameter estimates and uncertainties can be added as new columns to existing SEACAR DDI export files for Oyster and SAV indicators, if that is easier for the USF team.

The University outlined the conceptual process for the "extraction" during the June 7th meeting.

Unique Sample Date and Location Files

Unique Sample Date and Location information are exported from the SEACAR database from the latest SAV and Oyster export files. Unique Sample Date and Location files contain the fields: AreaID, ManagedAreaName, SampleDate, ProgramID, LocationID, ProgramLocationID, Latitude_DD and Logitude_DD.

- SEACAR_WQ_Analysis_Pilot\Deliverables Task 1d\OysterSampleDateLocation\OEAT_OYSTER_Export_ SampleDateLocation.csv
- SEACAR_WQ_Analysis_Pilot\Deliverables Task 1d\SAVSampleDateLocation\OEAT_SAV_Export_ SampleDateLocation.csv

The key fields required to join interpolated values to the exported SAV and Oyster data include: AreaID, SampleDate, ProgramID, and LocationID. These fields, at a minimum, must be retained in the final dataset. For reference, the same folders contain a list of unique sample dates within each file: OEAT_OYSTER_Export_UniqueSampleDates.xlsx and OEAT_SAV_Export_UniqueSampleDates.xlsx

Conceptual Process for a single season

A conceptual process is summarized below. However, the actual process was programmed within python. This process uses Estero Bay as the example.

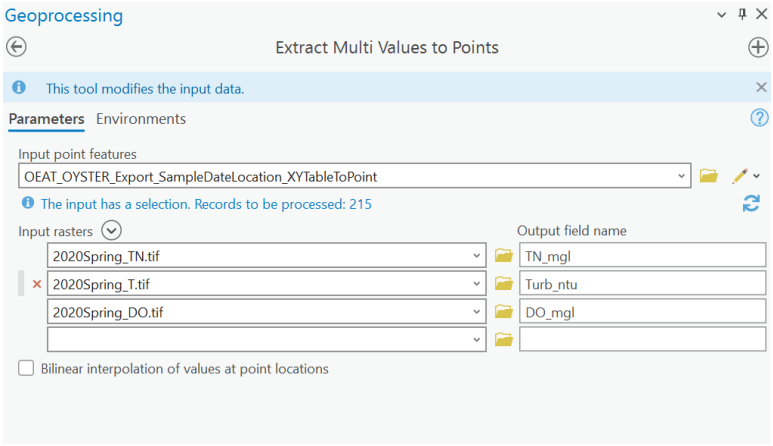
1. SampleDateLocation.csv files are converted to points

2. Season is assigned to each sample date based on season begin/end date rules.

	OBJECTID *	Shape *	AreaID	ManagedAreaName	SampleDate	ProgramID	LocationID	ProgramLocationID	Latitude_DD	Longitude_DD	Season
49	161	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919736	ReefElev-158	26.395315	-81.866863	2020 Spring
50	162	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919737	ReefElev-159	26.395324	-81.866849	2020 Spring
51	163	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919738	ReefElev-16	26.394986	-81.86623	2020 Spring
52	164	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919739	ReefElev-160	26.395331	-81.866836	2020 Spring
53	165	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919740	ReefElev-161	26.395335	-81.866826	2020 Spring
54	166	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919741	ReefElev-162	26.395323	-81.866848	2020 Spring
55	167	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919742	ReefElev-163	26.395324	-81.866863	2020 Spring
56	168	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919743	ReefElev-164	26.395306	-81.866865	2020 Spring
57	169	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919744	ReefElev-165	26.395287	-81.866844	2020 Spring
58	170	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919745	ReefElev-166	26.395267	-81.866838	2020 Spring
59	171	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919746	ReefElev-167	26.395253	-81.866827	2020 Spring
60	172	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919747	ReefElev-168	26.395238	-81.866831	2020 Spring

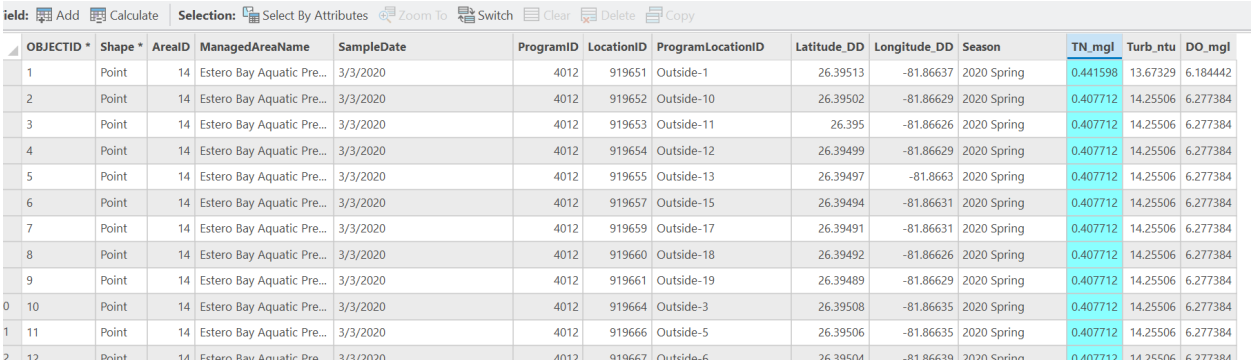
3. A season is selected from the SampleDateLocation points (e.g., 2020 Spring)

4. The process "Extract Multi Values to Points" is used to extract the values from the appropriate TIF file. Output field names for each parameter use the naming convention defined for the project. Possible parameters (for the pilot project) include: DO_mgl, Sal_ppt, Secchi_m, TN_mgl, and Turb_ntu.



5. The "Extract Multi Values to Points" process runs against both the Interpolated Maps (IV) as well as the associated Standard Error of Prediction (SE) maps. The final field names include the parameter abbreviation and the "iv" or "se" suffix: DO_mgl_iv, DO_mgl_se, Sal_ppt_iv, Sal_ppt_se, Secchi_m_iv, Secchi_m_se, TN_mgl_iv, TN_mgl_se, Turb_ntu_iv, Turb_ntu_se.

6. Result would look something like this if done within ArcGIS



OBJECTID *	Shape *	AreaID	ManagedAreaName	SampleDate	ProgramID	LocationID	ProgramLocationID	Latitude_DD	Longitude_DD	Season	TN_mgl	Turb_ntu	DO_mgl
1	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919651	Outside-1	26.39513	-81.86637	2020 Spring	0.441598	13.67329	6.184442
2	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919652	Outside-10	26.39502	-81.86629	2020 Spring	0.407712	14.25506	6.277384
3	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919653	Outside-11	26.395	-81.86626	2020 Spring	0.407712	14.25506	6.277384
4	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919654	Outside-12	26.39499	-81.86629	2020 Spring	0.407712	14.25506	6.277384
5	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919655	Outside-13	26.39497	-81.8663	2020 Spring	0.407712	14.25506	6.277384
6	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919657	Outside-15	26.39494	-81.86631	2020 Spring	0.407712	14.25506	6.277384
7	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919659	Outside-17	26.39491	-81.86631	2020 Spring	0.407712	14.25506	6.277384
8	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919660	Outside-18	26.39492	-81.86626	2020 Spring	0.407712	14.25506	6.277384
9	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919661	Outside-19	26.39489	-81.86629	2020 Spring	0.407712	14.25506	6.277384
10	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919664	Outside-3	26.39508	-81.86635	2020 Spring	0.407712	14.25506	6.277384
11	Point	14	Estero Bay Aquatic Pre...	3/3/2020	4012	919666	Outside-5	26.39506	-81.86635	2020 Spring	0.407712	14.25506	6.277384

7. Important issues to note:
    a. Depending on the availability of WQ data for a specific year/season, some parameters will not have an interpolated map

Results

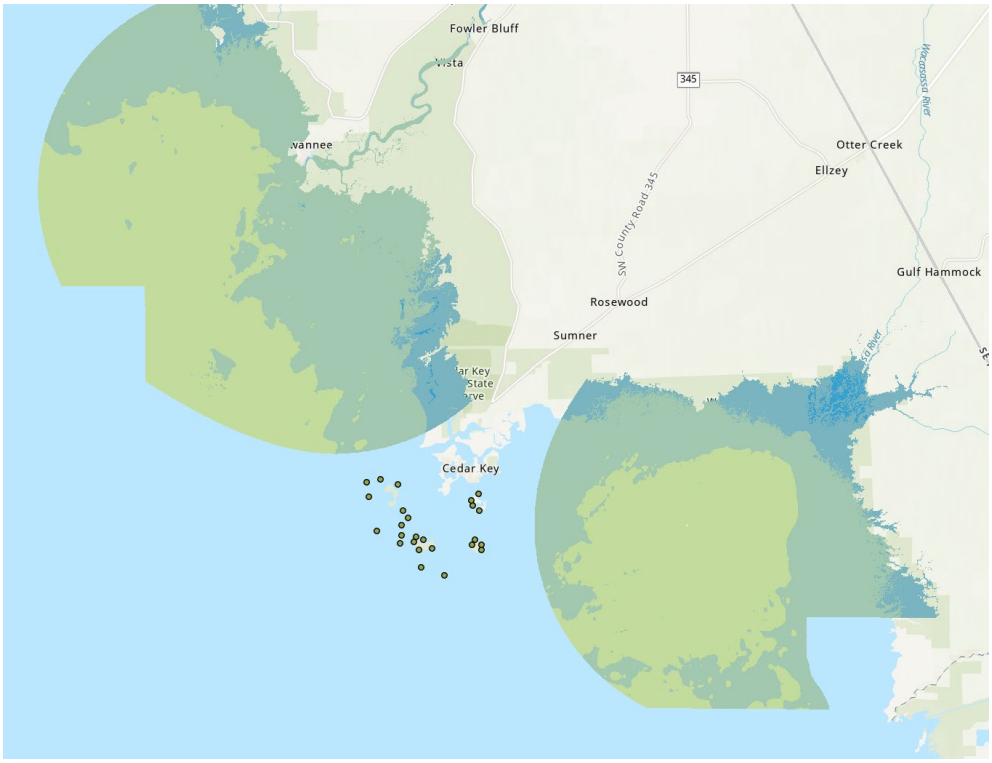
The process described above was implemented by developing a python/Arcpy script. The script loops through each Managed Area - Year – Season combination available within the SAV and Oyster results and extracts all available Managed Area – Parameter – Year Season values at those specific points. The process also extracts the corresponding standard error values from the associated maps so that the final results would include the parameter values and uncertainty estimate. The final output is a csv file that can be joined to the SAV or Oyster data exports for the purpose of analysis.

A copy of final data are in the Box folder SEACAR_WQ_Analysis_Pilot\Deliverables Task 1d\SAV and Oyster Data Extraction (https://usf.box.com/s/3cmf7thpr4wn67r5i47vjfnff8wszp3y).

- The final parameter extraction for the SAV and Oyster data was performed based on the June 5, 2023 SEACAR export data. A copy of these exports are included in the same box folder: All_Oyster_Parameters-2023-Jun-05.zip, and All_SAV_Parameters-2023-Jun-05.zip.
- Based on the June 5th data, all unique combinations of Managed Area (and AreaID), SampleDate, ProgramID, ProgramLocationID (and LocationID), and Latitude_DD/Longitude_DD were extracted. In other words, all of the unique sampling locations for which any SAV or Oyster data were available. The files are OEAT_OYSTER_Export_SampleDateLocation.csv and OEAT_SAV_Export_SampleDateLocation.csv. For references, a summary of the number of unique sample locations for each sampledate are included in the files OEAT_OYSTER_Export_UniqueSampleDates.xlsx and OEAT_SAV_Export_UniqueSampleDates.xlsx.
- **The extraction process produced one file for SAV and one for Oyster, named SAV_IV_SE_Extraction_Output.csv and OYSTER_IV_SE_Extraction_Output.csv**. Each of these files includes the columns/fields: AreaID; ManagedAreaName; SampleDate; ProgramID; LocationID; ProgramLocationID; Latitude_DD; Longitude_DD; season; DO_mgl_iv; DO_mgl_se; Sal_ppt_iv; Sal_ppt_se; Secchi_m_iv; Secchi_m_se; TN_mgl_iv; TN_mgl_se; Turb_ntu_iv; Turb_ntu_se.
- Important: The extracted parameter values from these files can be joined to the June 5, 2023 SEACAR export data using a minimum of these columns: AreaID, SampleDate, ProgramID and LocationID. ManagedAreaName and ProgramLocationID are included but are not truly "unique identifiers."
- A screenshot of one of the final files is shown here:

	AreaID	ManagedAreaName	SampleDate	ProgramID	LocationID	ProgramLoc	Latitude_DD	Longitude_DD	season	DO_mgl_iv	DO_mgl_se	Sal_ppt_iv	Sal_ppt_se	Secchi_m_iv	Secchi_m_se	TN_mgl_iv	TN_mgl_se	Turb_ntu_iv	Turb_ntu_se
535	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005948	STCH01	29.675	-83.44167	spring	6.45823	0.851462	30.772	2.0905499	-9999	-9999	-9999	-9999	1.73859	0.830805
536	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005949	STCH02	29.675	-83.475	spring	6.52597	0.945122	30.3838	2.8478701	-9999	-9999	-9999	-9999	1.60906	1.0591
537	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005950	STCH03	29.6675	-83.4669	spring	6.7670102	0.968679	30.767	2.53585	-9999	-9999	-9999	-9999	1.40982	0.949567
538	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005951	STCH04	29.65833	-83.425	spring	6.6651101	0.838781	31.1491	1.67895	-9999	-9999	-9999	-9999	1.51588	0.687257
539	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005952	STCH05	29.64167	-83.40833	spring	6.4555001	0.878201	30.5302	2.5393901	1.43995	1.27338	1.30136	0.401332	1.69627	0.933749
540	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005953	STCH06	29.6414	-83.4146	spring	6.5710702	0.883979	30.7231	2.3875999	1.63068	1.43216	1.31619	0.399789	1.5587699	0.880513
541	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005954	STCH07	29.6444	-83.4257	spring	6.5701098	0.858376	30.8891	2.0821199	1.6234601	1.50166	1.35371	0.415604	1.56926	0.802836
542	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005955	STCH08	29.64167	-83.44167	spring	6.8102798	0.924528	30.9736	2.1570699	1.88133	1.72654	1.57932	0.432405	1.46495	0.829724
543	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005956	STCH09	29.63453	-83.42518	spring	6.52842	0.870233	30.6013	2.44857	1.38967	1.19444	1.52997	0.411915	1.7136101	0.896205
544	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005957	STCH10	29.625	-83.425	spring	6.6071601	0.880874	30.4985	2.75192	1.44226	1.0910701	1.55391	0.375614	1.6740201	0.937119
545	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005958	STCH11	29.6129	-83.4237	spring	6.5852799	0.851965	30.2226	3.1384599	1.30525	0.872796	1.57527	0.344372	1.82987	0.995972
546	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005959	STCH12	29.60833	-83.40833	spring	6.43997	0.792394	29.8691	3.4289999	1.03825	0.646795	1.55803	0.336669	2.15166	1.05417
547	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005960	STCH13	29.60046	-83.41712	spring	6.4897299	0.794443	29.7527	3.6040499	1.04441	0.627038	1.60281	0.333731	2.1766	1.06701
548	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005961	STCH14	29.59167	-83.425	spring	6.4718199	0.802739	29.5458	3.8789101	1.0736099	0.621892	1.44712	0.322556	2.18941	1.09412
549	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005962	STCH15	29.5916	-83.4386	spring	6.5878301	0.873043	29.6728	3.8485999	1.26886	0.775946	1.49494	0.325459	1.99621	1.11265
550	5	Big Bend Seagrasses	6/1/2002 0:00	560	1005963	STCH16	29.5824	-83.4252	spring	6.48071	0.804842	29.1642	4.2583799	1.01352	0.558713	1.46368	0.320706	2.36902	1.1461

- Interpolated map values are not available for all parameters for every Managed Area – SampleDate – location combination. Two cases exist within the data:
    - NULL values for a parameter (e.g., secchi_m_iv): The NULL values will exist when an interpolated map for that specific Managed Area – Parameter – Season could not be generated due to insufficient data.
    - -9999 values for a parameter: The -9999 values will exist when an interpolated map was/is available but the interpolation did not react the specific Lat/Long location of the SAV/Oyster data. For example, the Cedar Key area did not have interpolated DO, Sal or Turb values for summer of 2020, as shown in the map below:

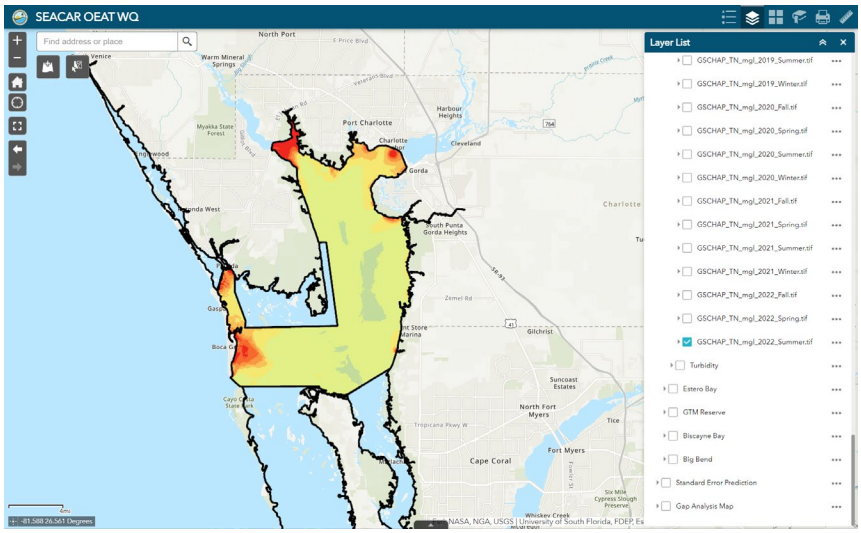


Identify any delays or problems encountered:
NA

Deliverables

Important for users of the Box Drive app: Box has a limitation that prevents opening files that are buried deep within subdirectors and therefore the file path plus filename is longer than 259 characters. Box Drive users might need to download local copies in order to open some files. This limitation does not apply to Box access within a browser.

1. Copy of interpolation maps; All project related maps, including pilot thematic, bubble, raster and final interpolation maps, used for review with the DEP staff will be made available via an ArcGIS server similar to other map services used for SEACAR (e.g., https://data.florida-seacar.org/maps/locations/indicators/);
    a. The last step in the automation process described above is to insert the new maps into an ArcGIS Server Map Service which is then immediately visible from the same online map where the rest of the project deliverables are displayed: https://dev.gis.waterinstitute.usf.edu/maps/SEACAR-OEAT-WQ/. The two layer groups are called Interpolated Maps and Standard Error of Prediction. The example below shows a Summer 2022 map for TN that was generated by the process. This map had not been produced during Task 1b because data for Summer 2022 did not exist within the data used for that task. The data export from June 6, 2023 was used for the automation task and resulted in the generation of additional maps since 2020 (depending on the Managed Area).



b. A copy of all automation and extraction python scripts and associated files are available within the Box folder (Deliverables Task 1d\ArcGIS_project\): https://usf.box.com/s/csrykvcwbetfqvdhz71ctzsnboknurnu. It is recommended that a user wants to run the scripts should download the entire ArcGIS_Project folder.

i. Automation Scripts: These are located within the "interpolation_wq" folder of the Box folder (ArcGIS_project\python_automation_resources\python_files\). The "readme.txt" files within this folder includes a detailed description of steps, and explanatory comments are included within the individual python files (i.e., *.py files).

ii. Oyster and SAV data extrapolation scripts: These are located within the "oyster_sav" folder of the Box folder (ArcGIS_project\python_automation_resources\python_files\). The "readme.txt" files within this folder includes a detailed description of steps, and explanatory comments are included within the individual python files (i.e., *.py files).

2. Copy of extracted interpolated result data made available via the USF/SEACAR Box Drive;

a. See above for additional details. The final extracted values from the interpolated maps are available within the Box folder SEACAR_WQ_Analysis_Pilot\Deliverables Task 1d\SAV and Oyster Data Extraction (https://usf.box.com/s/3cmf7thpr4wn67r5i47vjfnff8wszp3y).

b. The extraction process produced one file for SAV and one for Oyster, named SAV_IV_SE_Extraction_Output.csv and OYSTER_IV_SE_Extraction_Output.csv.

i. Each of these files includes the columns/fields: AreaID; ManagedAreaName; SampleDate; ProgramID; LocationID; ProgramLocationID; Latitude_DD; Longitude_DD; season; DO_mgl_iv; DO_mgl_se; Sal_ppt_iv; Sal_ppt_se; Secchi_m_iv; Secchi_m_se; TN_mgl_iv; TN_mgl_se; Turb_ntu_iv; Turb_ntu_se.

ii. Important: The extracted parameter values from these files can be joined to the June 5, 2023 SEACAR export data using a minimum of these columns: AreaID, SampleDate, ProgramID and LocationID. ManagedAreaName and ProgramLocationID are included but are not truly "unique identifiers."

3. Copies of invoice and proof of payment for monthly IT server costs; Time sheets are not required as the USF staff are salaried.
   a. IT Billing for June 2023 charge of $398.36 is documented within the document Invoice 3 IT Billing Documentation.pdf: https://usf.box.com/s/s0lcb9nvh8xmuv1fah9hwn3try80neat.

This report is submitted in accordance with the reporting requirements of DEP Agreement No. AT008 and accurately reflects the activities associated with the project.

Shawn Landry	6/28/2023
Signature of Grantee's Grant Manager	Date