

Visualizing Water Quality Sampling-Events in Florida

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ABSTRACT:

Water quality sampling in Florida is acknowledged to be spatially and temporally variable. The rotational monitoring program that was created to capture data within the state's thousands of miles of coastline and streams, and millions of acres of lakes, reservoirs, and ponds may be partly responsible for inducing the variability as an artifact. Florida's new dissolved-oxygen-standard methodology will require more data to calculate a percent saturation. This additional data requirement's impact can be seen when the new methodology is applied retrospectively to the historical collection. To understand how, where, and when the methodological change could alter the environmental quality narrative of state waters requires addressing induced bias from prior sampling events and behaviors. Here stream and coastal water quality data is explored through several modalities to maximize understanding and communication of the spatiotemporal relationships. Previous methodology and expected-retrospective calculations outside the regulatory framework are found to be significantly different, but dependent on the spatiotemporal perspective. Data visualization is leveraged to demonstrate these differences, their potential impacts on environmental narratives, and to direct further review and analysis.

1. INTRODUCTION

Florida contains thousands of miles of freshwater streams and coast, and millions of acres of lakes, ponds, and reservoirs for which the state is responsible. This represents approximately 13.6 ft. of streams and 4,575 sq. ft. of lakes per Floridian (USEPA, 2000 and U.S. Census, 2015). Additionally, sharing these resources are 269 endemic species of 4,368 known species in the Sunshine State (Bruce, 2002). This biological bounty ranks Florida 4th in the nation for endemism and 7th for biodiversity. Despite their growing wealth of environmental data, not every water body can be sampled every year within this water rich and biodiverse state.

1.1 Sampling in Florida

Due to practical time and manpower constraints sampling in Florida is completed on a 5 group and cycle rotation program. Groups are constituted from a collection of basins from across the state, such that no quadrant of the state receives more assessment focus in a cycle than another. Cycles contain two significant regulatory components: a planning period of 10 years and a verified period of 7.5 years. Basins have stable boundaries and are internally comprised of regulatory assessment units: the Water Body IDentification unit (WBID). Containing none or more stations, WBIDs subdivide basins as contiguous spatial extents. Station data within WBIDs are aggregated to the assessment unit for application in regulatory assessment. In streams and coastal areas dissolved oxygen (DO) is reported as a calculated daily average. Stations do not move in space, but their use may vary throughout time – with locations commissioned or decommissioned for a bevy of reasons. WBIDs, however, may move within the boundaries of the basins. WBID boundaries and water body type too can be refined by the Florida Department of Environmental Protection (FDEP) to more accurately define water bodies for regulatory assessment purposes. In this way stations may change WBID designation without moving. Within the WBID refinement and group-cycle processes, sampling must also be applied by FDEP to maximize both human and environmental protection. Approaching the resulting system through the lens of a

water quality standard methodology change, Dissolved Oxygen (DO) to Dissolved Oxygen Saturation Percent (DOSat%), allows for a brief view of the impact sampling efforts can have on environmental quality narratives.

1.2 A New Standard

As part of ongoing and dedicated work by the local, state, and federal agencies, advocacy groups, and citizen scientists that shape the policy applied in Florida, a new DO assessment methodology and standard was developed for the state: DOSat%. This new standard recognizes ecosystem factors that can contribute to changes in the potential maximum DO within a given sample. These were determined, by FDEP, to primarily include temperature, barometric pressure, and conductivity or salinity. As these factors vary in response to change in the environment, so too does DO. How this standard is applied to assess for water quality impairment varies between water body types- in both collection frequency and perspective. For example, DOSat% in marine waters is viewed from daily, weekly, and monthly perspectives whereas streams are viewed at the daily step (FDEP, 2015). This study focuses on the daily perspective that is common to both the streams and coastal sampling.

The state of Florida is currently changing from the single DO standard to the more complex measure. This move, the value of which this study does not seek to address, will change the environmental quality portrayal, or narrative, and will create a greater data requirement on future sampling. Identifying how, where, and when the change in data requirements will impact the story being told can be accomplished by applying the new methodology to the historical collection. The extension of the criteria back through time and outside of the assessment units and regulatory time framework can offer a meaningful narrative for all parties to consider. Additionally, how this story differs from those within relevant spatial and temporal regulatory perspectives is important to the ongoing policy conversation. Analyzing the influence sampling event behavior differences between DO and DOSAT% will begin to tease apart how the narrative may or may

Group	Basin	Coastal DO and pDOSAT Sampling Event Days											
		PoR			1975			1980			2001		
		DO	pDOSAT	%	DO	pDOSAT	%	DO	pDOSAT	%	DO	pDOSAT	%
1	Everglades West Coast	275	275	100.00%	275	275	100.00%	275	275	100.00%	12	12	100.00%
	Ochlockonee - St. Marks	2437	2437	100.00%	2437	2437	100.00%	2437	2437	100.00%	1752	1752	100.00%
	Suwannee	9730	9728	99.98%	9730	9728	99.98%	9730	9728	99.98%	7463	7461	99.97%
	Tampa Bay	3572	3571	99.97%	3572	3571	99.97%	3572	3571	99.97%	2309	2309	100.00%
2	Apalachicola - Chipola	2758	2758	100.00%	2758	2758	100.00%	2758	2758	100.00%	2758	2758	100.00%
	Charlotte Harbor	14	14	100.00%	14	14	100.00%	14	14	100.00%	14	14	100.00%
	Lower St. Johns	1207	1194	98.92%	961	950	98.86%	947	942	99.47%	942	937	99.47%
	St. Lucie - Loxahatchee	273	273	100.00%	273	273	100.00%	273	273	100.00%	261	261	100.00%
3	Caloosahatchee	721	720	99.86%	721	720	99.86%	709	708	99.86%	127	127	100.00%
	Choctawhatchee - St. Andrew	2719	2026	74.51%	2719	2026	74.51%	2719	2026	74.51%	2719	2026	74.51%
	Lake Worth Lagoon - Palm Beach Coast	114	114	100.00%	114	114	100.00%	114	114	100.00%	114	114	100.00%
	Sarasota Bay - Peace - Myakka	24	24	100.00%	24	24	100.00%	24	24	100.00%	24	24	100.00%
4	Nassau - St. Marys	326	326	100.00%	326	326	100.00%	326	326	100.00%	326	326	100.00%
	Pensacola	496	494	99.60%	496	494	99.60%	496	494	99.60%	496	494	99.60%
	Southeast Coast - Biscayne Bay	1171	1053	89.92%	1043	995	95.40%	950	950	100.00%	944	944	100.00%
5	Everglades	21	21	100.00%	21	21	100.00%	21	21	100.00%	21	21	100.00%
	Florida Keys	59	59	100.00%	59	59	100.00%	59	59	100.00%	59	59	100.00%
	Indian River Lagoon	946	937	99.05%	946	937	99.05%	946	937	99.05%	946	937	99.05%
	Perdido	114	114	100.00%	114	114	100.00%	114	114	100.00%	114	114	100.00%
	Springs Coast	1	1	100.00%	1	1	100.00%	1	1	100.00%	1	1	100.00%
	Upper East Coast	705	705	100.00%	705	705	100.00%	705	705	100.00%	705	705	100.00%
All	Statewide	27683	26844	96.97%	27309	26542	97.19%	27190	26477	97.38%	22107	21396	96.78%

Table 1. Coastal Sampling History. pDOSAT is represented here as n and % of DO.

not have changed. This study focuses on this aspect of the process, potential pitfalls, and how to best generally communicate the influence of sampling–event behaviors to a varied audience.

In the U.S., questions about environmental quality are approached from multiple levels and backgrounds via regulators, scientists, citizen activists, industry, etc. Included in the pursuit of best available approaches is the inherent problem of addressing access and consensus building within a broad audience and the additional issue of avoiding perception and environmental memory ratchets (Pitcher, 2001 and Kahn, 2002). As suggested by Host (2000), how much can visualization assist broader audiences to access information while addressing shifting perceptions in the face of shifting standards? This study leverages the opportunity created in the Florida water quality standard shift to address these questions and assertions.

2. DATA & METHODS

Data was delivered via MS-Access, manipulated and analyzed in MS-Excel, and visualized in R and ESRI ArcGIS. The GoogleVis package from the CRAN library was used to visualize data with R.

2.1 Data

The primary coastal and stream environmental quality data was retrieved from the Florida Integrated Water Quality Assessment Report, which is a product of that state's Impaired Waters Rule (IWR). Each cycle and any additional site specific sampling events within that cycle are included in an updated "Run". Each Run is a snapshot of the WBIDs, new data, and all data preceding which is packaged into an MS-Access database. The file is publicly

available from the FDEP website and reflects their total sampling efforts to date.

The most recent IWR Run, number 49, was chosen. Due to the dynamic nature of WBIDs, their discussion and inclusion here is for reference only. The WBID delineation is set by Run 49 and does not reflect past permutations; station and basin data received primary focus. This places the study findings outside meaningful regulatory spatial framework. Annual reporting was complete up to and including 2012, thus the data in this study ranges from 1905–2012. Additional and incomplete data for 2013 and 2014 that exist in the IWR was not included. For the purposes of this study, sampling is viewed as a continuous record.

2.1.1 MS-Excel Station data from the IWR Run 49 MS-Access database was exported and compiled to the station level for each of the two water body types: streams and coastal areas. Identifiers included were: WBID, group, basin, and the presence of a sampling for the constituent parameters: DO, DOSat%, conductivity, salinity, and temperature. Barometric pressure, while included in the equation, is treated as constant by FDEP and is not reported. To study potential sampling bias, water quality results were converted to a nominal identifier for presence or absence of sampling per each parameter and station. These were then composited to daily sampling events, as per the regulatory perspective, although per station (FDEP, 2015). The potential to perform a DOSat% calculation (pDOSAT) was identified in the same way, per station

Group	Basin	Stream DO and pDOSAT Sampling Event Days											
		Period of Record (PoR)			1975			1980			2001		
		DO	pDOSAT	%	DO	pDOSAT	%	DO	pDOSAT	%	DO	pDOSAT	%
1	Everglades West Coast	887	873	98.42%	866	854	98.61%	801	789	98.50%	16	16	100.00%
	Lake Okeechobee	2133	2075	97.28%	2094	2036	97.23%	2090	2032	97.22%	2053	1997	97.27%
	Ochlockonee - St. Marks	1035	775	74.88%	771	771	100.00%	771	771	100.00%	771	771	100.00%
	Ocklawaha	1880	1851	98.46%	1238	1234	99.68%	921	920	99.89%	787	787	100.00%
	Suwannee	3131	3043	97.19%	2640	2614	99.02%	2640	2614	99.02%	2579	2554	99.03%
	Tampa Bay	1869	1770	94.70%	1670	1612	96.53%	1300	1244	95.69%	312	312	100.00%
2	Apalachicola - Chipola	1592	1481	93.03%	463	463	100.00%	460	460	100.00%	460	460	100.00%
	Charlotte Harbor	62	59	95.16%	45	42	93.33%	38	36	94.74%	-	-	-
	Lower St. Johns	5198	5168	99.42%	5198	5168	99.42%	5198	5168	99.42%	5198	5168	99.42%
	Middle St. Johns	242	238	98.35%	242	238	98.35%	242	238	98.35%	130	130	100.00%
	St. Lucie - Loxahatchee	2133	2123	99.53%	2114	2104	99.53%	2001	1993	99.60%	105	105	100.00%
	Tampa Bay Tributaries	4867	4721	97.00%	4306	4222	98.05%	3397	3336	98.20%	1020	1016	99.61%
3	Caloosahatchee	2416	2373	98.22%	2356	2315	98.26%	1381	1368	99.06%	423	422	99.76%
	Choctawhatchee - St. Andrew	257	254	98.83%	142	140	98.59%	140	140	100.00%	140	140	100.00%
	Lake Worth Lagoon - Palm Beach Coast	2679	2499	93.28%	2456	2380	96.91%	2202	2201	99.95%	336	336	100.00%
	Sarasota Bay - Peace - Myakka	2946	2888	98.03%	2654	2600	97.97%	2211	2172	98.24%	371	371	100.00%
	Upper St. Johns	139	139	100.00%	139	139	100.00%	139	139	100.00%	139	139	100.00%
4	Fisheating Creek	1112	1107	99.55%	1045	1040	99.52%	964	960	99.59%	889	885	99.55%
	Kissimmee River	6640	6582	99.13%	6103	6048	99.10%	5020	4978	99.16%	1754	1751	99.83%
	Nassau - St. Marys	1050	1010	96.19%	954	922	96.65%	827	799	96.61%	527	527	100.00%
	Pensacola	2628	2364	89.95%	903	888	98.34%	899	885	98.44%	899	885	98.44%
	Southeast Coast - Biscayne Bay	3863	3191	82.60%	3103	2775	89.43%	2405	2368	98.46%	1160	1159	99.91%
	Withlacoochee	473	472	99.79%	416	415	99.76%	416	415	99.76%	416	415	99.76%
5	Everglades	6452	6402	99.23%	6431	6391	99.38%	6164	6148	99.74%	2090	2087	99.86%
	Indian River Lagoon	221	219	99.10%	171	170	99.42%	85	85	100.00%	4	4	100.00%
	Perdido	515	491	95.34%	355	354	99.72%	355	354	99.72%	352	351	99.72%
	Springs Coast	112	109	97.32%	112	109	97.32%	112	109	97.32%	83	82	98.80%
	Upper East Coast	583	582	99.83%	555	554	99.82%	487	487	100.00%	394	394	100.00%
All	Statewide	57115	54859	96.05%	49542	48598	98.09%	43666	43209	98.95%	23408	23264	99.38%

Table 2. Stream Sampling History. pDOSAT is represented here as n and % of DO.

daily, and included. The pDOSAT data was combined with the IWR data and summarized to daily station-sampling-events per basin for DO and pDOSAT. The data was then viewed from varying temporal perspectives.

2.2 Methods

2.2.1 Descriptive Analysis Using MS-Excel (2013), a descriptive table comparing daily station sampling events for pDOSAT and DO per basin, per year was created (Tables 1, 2). This study focuses on four time intervals which: the Period of Record (PoR), the early years of Clean Water Act implementation (1975-2012), renewal impacts (1980-2012), and the adoption of the Florida Impaired Waters Rule program (2001-2012).

2.2.2 Chi Square The basin and group aggregated coastal waters and streams DO and pDOSAT data was analyzed across the time periods of note, via Chi Square test for Independence. (Tables 3, 4) All analysis was conducted in MS-Excel.

2.2.3 R Coastal and stream daily sampling data sets, including the above parameters and the calculated pDOSAT, were loaded into R (i386 3.1.2). Data was converted into a dataframe and date fields were converted from MS-Excel format to R format. Using the GoogleVis package (0.5.6), coastal and stream data for the entire record were visualized into two motion charts: stream and coastal.

2.2.4 GIS The data loaded into R in 2.2.3 was also imported into ESRI ArcGIS using the Excel to Table tool. The table's coordinate data was displayed and projected onto a WBID layer from FDEP. The result was converted to a shapefile, and "Time" was enabled which allows for use of the Time Slider.

3. RESULTS

3.1 Descriptive Analysis

The descriptive analysis revealed a greater agreement between DO and pDOSAT stream sampling events in more recent years. Within the entire period of record, there is a considerable 25% spread which tightens to a 3% spread in the 2001-2012 or IWR adoption period. (Table 2). Coastal data, with the exception of the recent sampling events in the Choctawatchee-St. Andrew basin, follow the same pattern as stream data in closing the spread between DO and pDOSAT sampling events. Here the spread moves from 11% to 1% across temporal scales (Table 1).

Coastal DO & pDOSAT Sampling Events				
Comparisons	Period of Record	1975-2012	1980-2012	2001-2012
All Basins	2.446×10^{-42}	4.742×10^{-28}	1.348×10^{-27}	1.350×10^{-27}
Sub Totals	1.095×10^{-29}	2.002×10^{-28}	3.133×10^{-28}	8.948×10^{-34}
Group 1	0.999	0.999	0.999	0.999
Group 2	0.987	0.989	0.999	0.999
Group 3	4.715×10^{-38}	4.715×10^{-38}	4.715×10^{-38}	4.719×10^{-38}
Group 4	0.003	0.330	0.996	0.996
Group 5	0.999	0.999	0.999	0.999

Table 3. Coastal DO & pDOSAT Chi Square test for Independence. Test was conducted at various spatial and temporal scales.

Stream DO & pDOSAT Sampling Events				
Comparisons	Period of Record	1975-2012	1980-2012	2001-2012
All Basins	2.8×10^{-38}	0.009	0.999	1
Sub Totals	9.887×10^{-24}	1.05×10^{-4}	0.219	0.865
Group 1	7.825×10^{-15}	0.541	0.485	0.88
Group 2	0.028	0.832	0.916	0.996
Group 3	0.007	0.381	0.937	0.999
Group 4	3.917×10^{-30}	7.49×10^{-7}	0.834	0.999
Group 5	0.794	0.987	0.998	0.999

Table 4. Stream DO & pDOSAT Chi Square test for Independence. Test was conducted at various spatial and temporal scales.

3.2 Chi Square

Analysis of the period of record for both streams and coastal waters reveals significant difference between DO sampling and pDOSAT. The significance of the component groups and temporal scales, however, is more complex (Table 3, 4). Where possible due to data constraints imposed by analytical methods, further analysis of the constituent basins does not reveal a significant difference between the data sets (Table5, 6).

3.3 Motion Charts

When pDOSAT and DO are visualized in the multivariate space of the motion chart discrepancies in spatial and temporal sampling event distribution are identifiable (Figures 1). Localized sampling event phenomenon, such as legacies of specific campaigns, can also be identified.

3.4 Animated Maps

Similar to the motion charts, discrepancies were visible when size and color of sampling-days represented combinations of pDOSAT and DO. This was seen somewhat in the static maps, but was more prominent in the animated map of the coastal sampling. The variability and frequency of coastal and stream sampling was more

apparent within the spatiotemporal space provided by the map (Figure 2, 3).

Coastal DO & pDOSAT		
Time	Basin	χ^2
1975-2012	Apalachicola - Chipola	1.00
1980-2012	Apalachicola - Chipola	1.00
2001-2012	Apalachicola - Chipola	1.00
PoR	Apalachicola - Chipola	1.00
1975-2012	Caloosahatchee	1.00
1980-2012	Caloosahatchee	1.00
2001-2012	Caloosahatchee	1.00
PoR	Caloosahatchee	1.00
1975-2012	Everglades West Coast	1.00
PoR	Everglades West Coast	1.00
1975-2012	Lake Worth Lagoon - Palm Beach Coast	1.00
1980-2012	Lake Worth Lagoon - Palm Beach Coast	1.00
2001-2012	Lake Worth Lagoon - Palm Beach Coast	1.00
PoR	Lake Worth Lagoon - Palm Beach Coast	1.00
2001-2012	Lower St. Johns	1.00
1975-2012	Southeast Coast - Biscayne Bay	0.89
1980-2012	Suwannee	1.00
2001-2012	Suwannee	1.00
PoR	Suwannee	1.00
1975-2012	Tampa Bay	1.00
1980-2012	Tampa Bay	1.00
2001-2012	Tampa Bay	1.00
PoR	Tampa Bay	1.00

Table 5. Coastal DO & pDOSAT basin level analysis. Chi square test for independence was applied to those basins that could support the test to illustrate scalar differences.

4. DISCUSSION & CONCLUSION

Loaning from Pitcher's (2001) description of well-known environment and resource perception ratchets in fisheries and Kahn's (2002) work on environmental amnesia we can recognize there are potential traps inherent in handling environmental data. These traps can begin to be avoided by understanding the progression of environmental quality at varying scales through time. Similarly, accessing the interconnected behaviors of environmental quality parameters is important to understanding their progression. This is reflected in the mathematical underpinnings of the DOSat% standard which recognizes the influence of temperature, salinity, and conductivity upon the potential for DO within a sample. These parameters are often themselves a proxy for the influence of a host of constituents. Thus, in addition to the complexities within the study system, those

imposed by sampling can have an additional influence. In both short term sampling cycles and over the entire period of record there appears to be a sampling influence asserted.

Stream DO & pDOSAT		
Time	Basin	χ^2
1975-2012	Caloosahatchee	1.0000
1980-2012	Caloosahatchee	1.0000
PoR	Caloosahatchee	1.0000
1975-2012	Charlotte Harbor	0.9801
1980-2012	Charlotte Harbor	0.9811
1975-2012	Fisheating Creek	1.0000
1980-2012	Fisheating Creek	0.9990
2001-2012	Fisheating Creek	0.9990
PoR	Fisheating Creek	1.0000
1975-2012	Kissimmee River	1.0000
1980-2012	Kissimmee River	1.0000
2001-2012	St. Lucie - Loxahatchee	1.0000
1975-2012	Tampa Bay	0.8574
PoR	Withlacoochee	1.0000

Table 6. Stream DO & pDOSAT basin level analysis. Chi square test for independence was applied to those basins that could support the test to illustrate scalar differences.

4.1 Statistical Analysis

As is seen in the descriptive statistics, in keeping with Odum's ratchet, sampling behavior at the state and basin level may not always align (Pitcher, 2001). For example, over the period of record, 96% and 97% of all DO and pDOSAT sample events agree in streams and coastal bodies respectively; however there is great variability of sample event agreement at the basin level within the same period. This is also played out in the Chi square analysis at the state, intergroup, intragroup, and basin scales (Tables 3, 4, 5, 6). These results highlight the impact of upscaling and aggregating practices, across space and time. Further analysis of the specific drivers behind this pattern is needed, specifically reviewing for spatiotemporal sensitivity.

It is important to note that this study focuses on two of the four types of water bodies identified in the IWR Run 49. The variations in basin spatial extent, in addition to basin makeup, may account for the order of magnitude variation between sampling. Viewing the sampling behavior of all water bodies within a basin would aid in further overcoming perception traps. This is also true when reviewing sampling results, due to the connectivity between these systems. This study's analysis recognizes and applies the regulatory use of daily averages. How this process may affect the ability to identify significant but temporal phenomena and whether data currently exist to support such analysis requires additional work at more fine spatial and temporal scales.

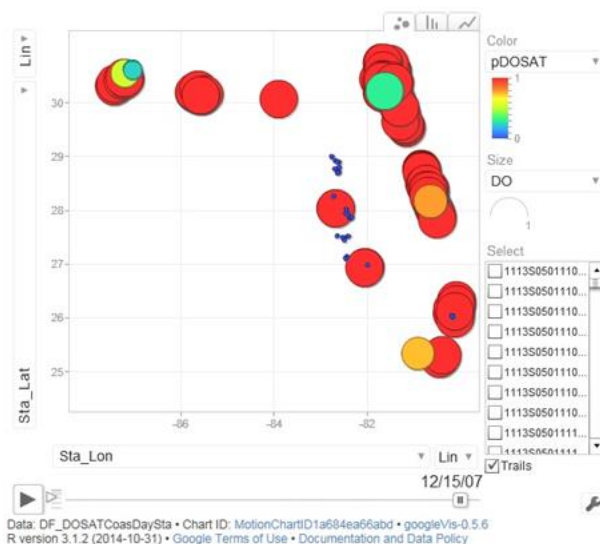


Figure 1. Coastal DO and pDOSAT motion chart.

4.2 Visualization

As noted in Host et al (2000) and Silberbauer (2009) there is both a need for quick and broadly accessible data communication of complex issues surrounding environmental quality information. Both of those studies and this one recognize the limitations in visual inspection to determine significance. Similarly, there exists a possibility of drawing spurious conclusions from visual inspection that should be confirmed statistically. Countering these concerns, is the ability of visualization to assimilate large amounts of data over long periods in an accessible manner.

As in Figures 1-3 Florida's entire record of daily coastal DOSat% constituent parameters, and pDOSAT were visualized in two different programs. Stream data was also visualized in this manner; stream visualization images were not included for the sake of

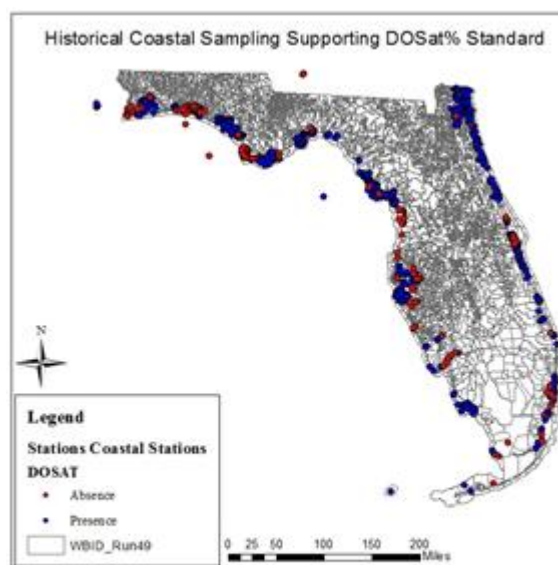


Figure 2. Coastal DO and pDOSAT historical record map.

brevity. Figure 1 demonstrates the behaviors identified in the five variable space that motion charts provide. Depicted is December 15, 2007 with large red circles signaling recent DO findings that coincide with pDOSAT. The smaller blue dots identify a recent sampling that does not include DO and does not meet the requirements for pDOSAT. A drawback to this visualization process is the “hang time” of the circles which the program interprets as integer data for smoothing purposes. In both stream and coastal motion charts changes in sampling frequency, latitude, longitude, spatial extent, and constituency are apparent through time. Areas with less data are easily recognizable in some combinations- as in the above which shows a momentary gap in the Suwannee basin. The change in the relationship between DO and pDOSAT is noticeable when viewed in this manner. Other phenomenon are apparent, such as abrupt lack of sampling during major weather events.

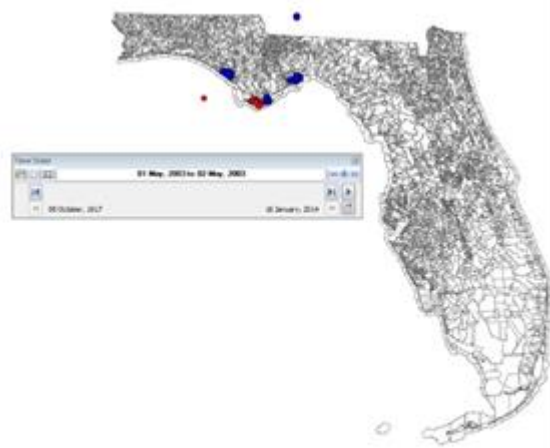


Figure 3. Coastal DO and pDOSAT animated map.

GIS data visualization shown in Figure 2 displays the entire record of Florida’s coastal sampling, statically stacked. Here larger red circles also identify points where pDOSAT was supported and DO reported. Likewise, smaller blue circles are points where neither DO was reported nor pDOSAT supported. This creates a 4 variable representation (latitude, longitude, pDOSAT, DO) or 5 if including spatial relationships. Figure 3 animates that map, providing the additional variable of time. The data seen in place over their respective WBIDs adds an additional variable. With this visualization tool some patterns are identifiable and noticeable prior to statistical review. This arrangement of geospatial data is also ripe for conversion for spatial statistical analysis which may yield further insight into sampling behavior and the possibility for sample bias.

As tools for communicating data behavior, both motion charts and animated maps provided unexpectedly supportive views of statistically identified trends. The inclusion of the entire record of Florida’s sampling for pDOSAT constituents and DO creates a compelling look at the progression of stream and coastal water quality sample-events throughout the last approximately 90 years. Further research and work on combining these data visualizations into a robust suite of communication and consensus building tools should be conducted in addition to the work already completed (Host, 2000; Boyer, 2000; and Halls 2003). Regulatory

perspectives on applicability to ongoing discussions should be explored.

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