Tools for effective science communication

Interpreting your data

Dylan Taillie & Caroline Donovan CMC Introduction to Data Interpretation Workshop January 30, 2018



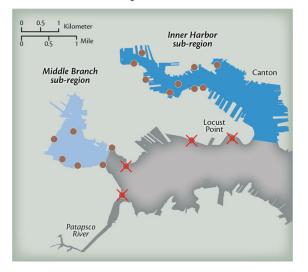
Interpretation

• Evaluating and analyzing your data in order to communicate it in a meaningful way with your selected audience

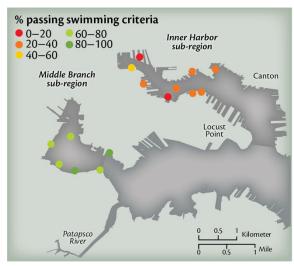
Data

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1	Branch	B	C Station Description	Count	Count Included for Geometric Mean	Geometric Mean	Maximum	Count At or Below Frequent Full Body Contact Recreation (104 MPN/100 ml)
2	Middle	BML-03	Hanover St. Drawbridge	11	11	38	50,000	7
3	Middle	BML-04	Baltimore Rowing Center	10	10	26	80,000	8
4	Middle	BML-05	Middle Branch Moorings	11	11	23	8,000	8
5	Middle	BML-06	Westport	10	10	35	50,000	7
6	Middle	BML-07	Middle Branch Channel	10	10	56	50,000	6
7	Middle	BML-08	Insulator Drive	10	10	14	5,000	8
8	Northwest	BML-12	Hull Street (Tide Point)	13	13	295	43,000	4
9	Northwest	BML-13	Channel between Domino Sugar and	13	13	348	23,000	4
10	Northwest	BML-14	General Ship Repair	13	13	485	130,000	2
11	Northwest	BML-15	Pierside Drive (Harborview)	13	12	806	80.000	3
12	Northwest	BML-16	Rusty Scupper	12	12	108	13,000	5
13	Northwest	BML-17	Power Plant	13	13	2,507	1,600,000	1
14	Northwest	BML-18	Broadway Pier (Fells Point)	13	13	371	80,000	5
15	Northwest	BML-19	North Shore Condo's	13	13	258	70,000	3
16	Northwest	BML-20	Domino Sugar	13	13	284	17,000	4
17	Patapsco	BML-02	Harbor Hospital (fmr. Vietnam Vet)	10	10	56	3,000	6
18	Patapsco	BML-09	Ferry Bar Park	11	11	14	3,000	9
19	Patapsco	BML-11	Fort McHenry Wetlands	10	10	24	2,300	7
20	Patapsco	BML-10	South Locust Point Marine Terminal	11	11	6	430	10

Interpretation



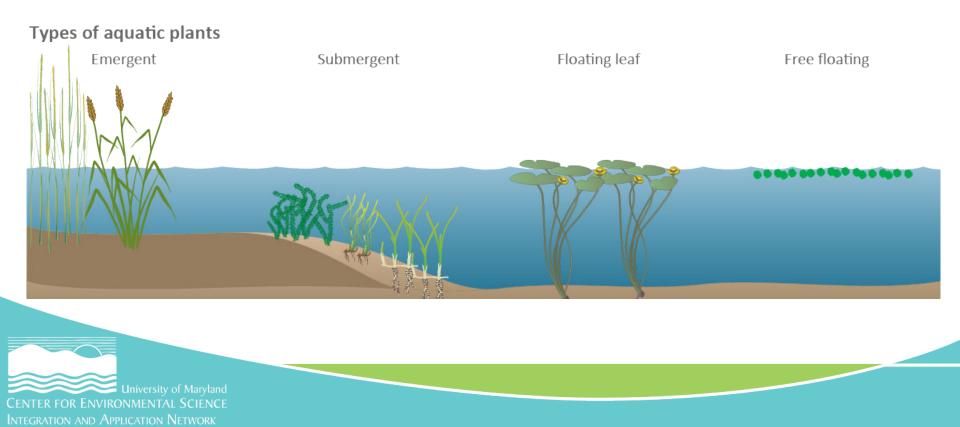
Synthesis





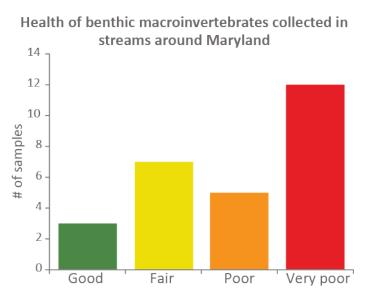
Kinds of data

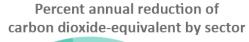
- Nominal
 - Non-numerical
 - Qualitative

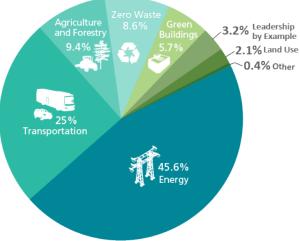


Kinds of data

- Ordinal
 - Numerical
 - Quantitative





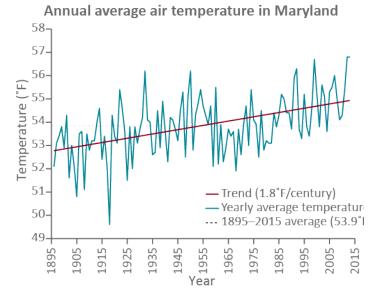


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Kinds of data

- Interval
 - Basic WQ data
 - Distance between numbers

- Ratio
 - Similar to interval
 - Absolute zero

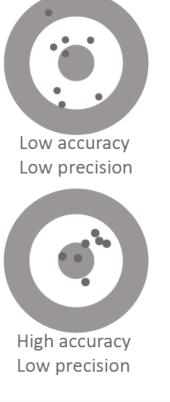


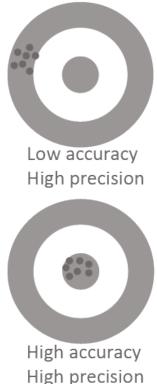
Sampling Location	Dissolved Oxygen (mg/L)
Choptank River	6.0
Elizabeth River	4.0
James River	6.3
Lower Bay	7.1
Lower Eastern Shore	6.3
Lower Western Shore	5.5
Mid Bay	4.2
Patapsco River	3.9
Patuxent River	4.2
Potomac River	5.7
Rappahannock River	6.1
Upper Bay	6.3
Upper Eastern Shore	6.9
Upper Western Shore	7.5
York River	5.4

CENTER FOR ENVIRONMENTAL SCIENCE INTEGRATION AND APPLICATION NETWORK

Precision vs Accuracy

- Accuracy is how close a measurement is to a real value
- Precision is when repeated measurements closely match each other







Precision vs Accuracy

- Accuracy is how close a measurement is to a real value
- Precision is when repeated measurements closely match each other

WQ Parameter	Equipment	Precision	Accuracy	Range
Dissolved oxygen	LaMotte 5860	0.2 mg/L		0 – 10+ mg/L
Dissolved oxygen	Ex. LaMotte 1761	0.01 mg/L	± 2% FS	0 – 20 mg/L
Nitrate-nitrogen	Hach NI-14 1416100	0.01 mg/L		0 – 1 mg/L;
		(0 – 1 mg/L);		1 – 10 mg/L
		0.1 mg/L		
		(1 – 10 mg/L)		
Nitrate-nitrogen	LaMotte 3110	0.25, 0.5, 1, 2, 4, 6, 8,		
		10 mg/L		
Nitrate-nitrogen	LaMotte 3354	0, 1, 2, 4, 6, 8, 10, 15		0 – 10 mg/L
		mg/L		



Activity - Cleaning your data in excel

- Cleaning is required before you interpret your data
- What does cleaning my data mean?
 - Formatting your spreadsheet so it's consistent
 - Flagging unusual or duplicate data





Excel activity – step 1

- Are there headers with units associated with the data values?
- Do the rows and columns have the right widths and heights to view all the data or is that even needed?
- Are there any missing data that are in another spreadsheet or on another tab that need to be incorporated here?



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Should you add more tabs so that the data is organized by indicator? Or by surface vs bottom measurements? Or something else? How are you going to address data values that are not numbers?

CENTER FOR ENVIRONMENTAL SCIENCE NTEGRATION AND APPLICATION NETWORK

Excel activity – step 2

- How are the data organized? By date or sampling station? Which way is the best way to look at and interpret the data?
- Are there any duplicate entries? Why? Do you delete them altogether or save them "just in case"? How do you organize and structure your files to do this?
- Are there any unusual data? You can sort the data from high to low and determine if any values are outside the expected range. This could be due to typing errors, instrument error, or they could be genuine outliers



The column headers are bolded and each label makes sense and has appropriate units

Extra decimal point

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Is this the correct sampling date? Check original fieldsheets or verify with field staff/volunteer monitor.

This row is duplicated. Do you delete it or keep it and flag it?



Excel activity – step 3

- Are there any cells that need to be changed from numbers to text or vice versa so that Excel can read them correctly?
- How are your latitude and longitude written? Is it in a format that works for you or for someone who will be doing GIS mapping?



This spreadsheet has been cleaned and simplified. Only columns pertaining to dissolved oxygen were kept. The tab is labelled appropriately. The columns have been sorted first by date, then by station.

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~		Get Extern	al Data	reserves 1972	Connections	S	ort & Filter	1 - 040	Dat	a Tools	100.500
	5	2 .	• (*	fa:							
Å	A	В	С	D	E	F	G	Н	1	1	K
t	Site	Latitude	Longitude	Date	Depth (ft)	Salinity (psu)	Temperature (deg C)	O2 (mg/l)	O ₂ Saturation (% sat)	O ₂ (Wnklr)	
2	E10	40.843460	-73,764060	1/10/2011	3	26.42	1.35	11.73	99.7	11.74	
3	E11		-73.765620	1/10/2011	3	26.22	0.55	11.96	99.4	13.07	
i.	E14	40.800480	-73.864330	1/10/2011	4	23.87	2.60	11.02	95.1	11.43	
5	E15	40.762900	-73.849110	1/10/2011	3	25.01	1.21	11.58	97.2	11.87	
6	E4	40.782300	-73.921120	1/10/2011	3	20.86	2.71	11.41	96.8	11.98	
7	E6	40.785840	-73.861200	1/10/2011	3	25.09	2.31	11.08	95.7	11.57	
8	E7	40.802800	-73.819960	1/10/2011	3	25.47	2.07	11.24	96.7	11.40	
9	E8	40.801560	-73.780740	1/10/2011	3	26.25	1.83	11.45	98.5	11.91	
10	FLC1	40.761980	-73.836660	1/10/2011	3	24.47	1.05	10.90	90.7	11.23	
11	FLC2	40.765100	-73.843100	1/10/2011	4	24.39	0.79	11.44	94.5	11.97	
12	LN1	40.779840	-73.701040	1/11/2011	3	26.25	0.51	11.98	99.5	12.47	
13	E10	40.843420	-73.764580	2/7/2011	3	26.56	0.49	14.08	117.0	16.09	
14	E11	40.790720	-73.765880	2/7/2011	3	25.82	0.82	13.44	112.2	15.75	
15	E14		-73.864960	2/7/2011	3	24.57	1.26	12.08	101.1	14.98	
16	E15	40.763080	-73.849270	2/7/2011	3	24.29	1.80	13.34	113.1	15.54	
17	E4	40.781900	-73.922040	2/7/2011	3	23.40	1.70	11.56	97.2	13.80	
	E6	40.786340	-73.861580	2/7/2011	3	24.00	1.60	13.59	114.4	14.90	
	E7		-73.819840	2/7/2011	3	24.84	1.18	13.23	110.9	14.51	
	E8		-73.781000	2/7/2011	3	25.67	0.91	13.68	114.4	14.88	
	FB1		-73.853280	2/7/2011	3	24.29	1.82	13.25	112.2	16.04	
22			-73.853280	2/7/2011	3	24.29	1.82	13.25	112.2	16.04	
23			-73.836760	2/7/2011	3	24.14	1.53	11.14	93.7	14.68	
24			-73.842840	2/7/2011	3	23.93	2.15	12.59	107.6	15.90	
	BR5		-73.871500	5/16/2011	3	22.09	12.38	6.95	74.7	9.46	
	E10		-73.765230	5/16/2011	3	23.99	12.07	8.70	94.1	9.19	
27	E11		-73.766140	5/16/2011	3	23.30	12.18	7.71	83.2	8.67	
	_		-73.864650	5/16/2011	3	22.99	12.23	7.64	82.4	8.37	
	E15		-73.849400	5/16/2011	3	22.04	13.05	7.19	78.4	8.08	
	E4		-73.922770	5/16/2011	3	22.56	12.28	7.12	76.6	7.96	
	E6		-73.861140	5/16/2011	3	22.23	12.52	7.08	76.5	7.78	
	E7		-73.820050	5/16/2011	3	23.59	11.92	7.86	84.4	8.64	
33	E8	40.801310	-73.781740		3	23.24	12.00	7.43	79.8	8.26	

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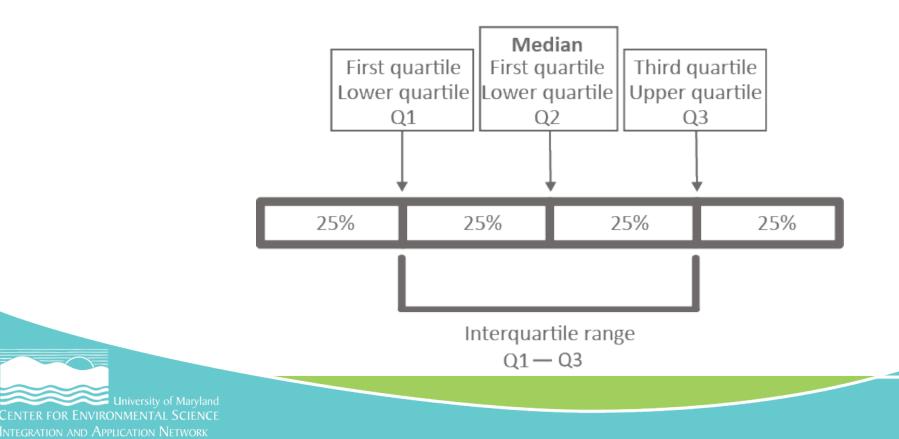
- What are descriptive statistics?
 - Tools to provide basic summarized information about your data
 - Mean, median and mode

Sample site	Caddisfly (count)	Mayfly (count)	Stonefly (count)	Clams (count)	Aquatic worms (count)	Crayfish (count)	% Sensitive to Pollution
A1	2	3	1	15	2	4	22
A2	1	1	1	5	7	11	12
GP1	0	0	0	13	16	9	0
GP2	4	7	4	8	12	3	40
GP3	4	5	2	12	10	9	33
D1	6	6	9	11	7	4	49
B11	0	1	2	8	9	12	1
mean	2.4	3.3	2.7	10.3	9.0	7.4	22.4%
median	2	3	2	11	9	9	22%
mode	0	1	1	8	7	4	N/A

Range

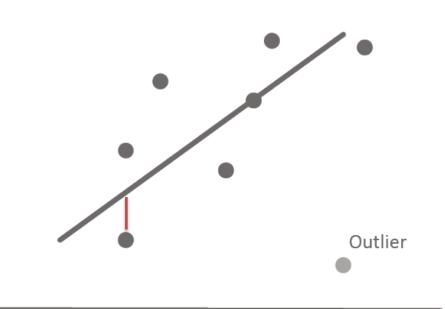
The total spread of all values in a dataset

Median and Quartiles



γ

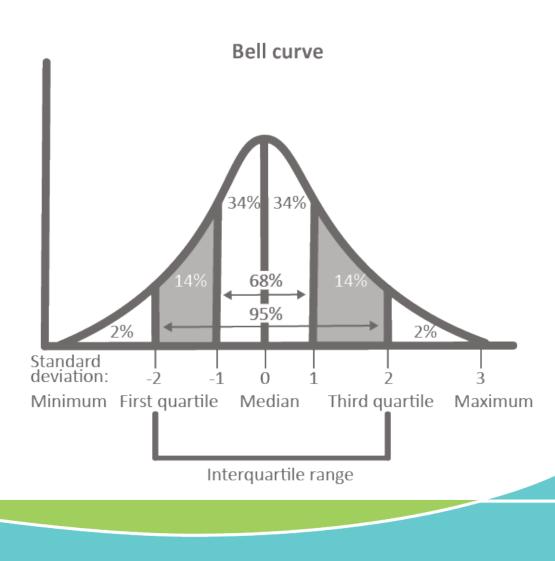
- Outliers
 - Data values that fall outside the general distribution of the data
- Standard deviation
 - Distance from mean
 - Variability
- Standard error
 - Type of SD
 - Depends on sample size



Х

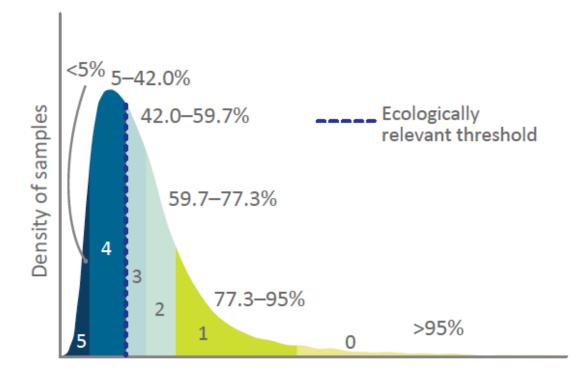


- Bell curves
 - Normal distribution
 - 95% of data within 2
 SD



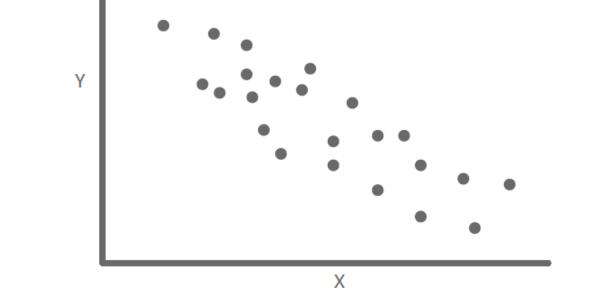
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• Non-normal distribution



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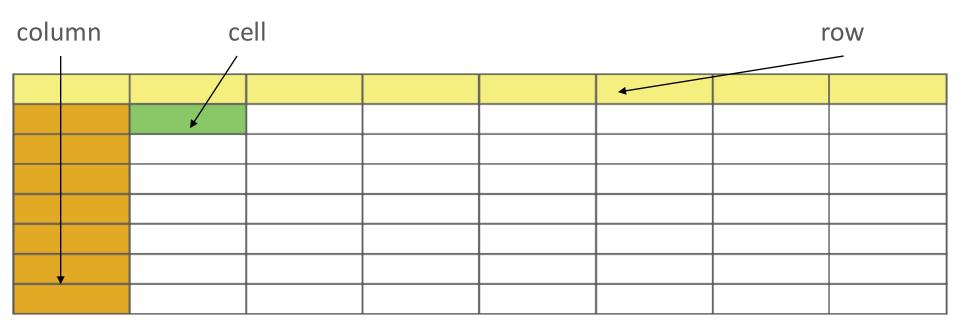
- Correlation
 - Two variables related
 - Temperature & DO





Displaying data

- Data in tables why use a table?
- Parts of a table



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Formatting a table for your audience

EXAMPLE 3: BASIC TABLE WITH SCIENCE COMMUNICATION PRINCIPLES EMBEDDED

Sample site	Caddisfly	Mayfly	Stonefly	Clams	Aquatic worms	Crayfish	% Sensitive to Pollution
		AMARE	- Martin		\sim	- All m	
Anacostia 1	2	3	1	15	2	4	22
Anacostia 2	1	1	1	5	7	11	12
Gunpowder 1	0	0	0	13	16	9	0
Gunpowder 2	4	7	4	8	12	3	40
Gunpowder 3	4	5	2	12	10	9	33
Davis Branch 1	6	6	9	11	7	4	49
Big Elk 11	0	1	2	8	9	12	1



Data in graphs

- Graphing data is the easiest way to visualize your data
- Help you too:
 - See relationships between different measurements in the data
 - Identify outliers
 - Visualize and identify trends



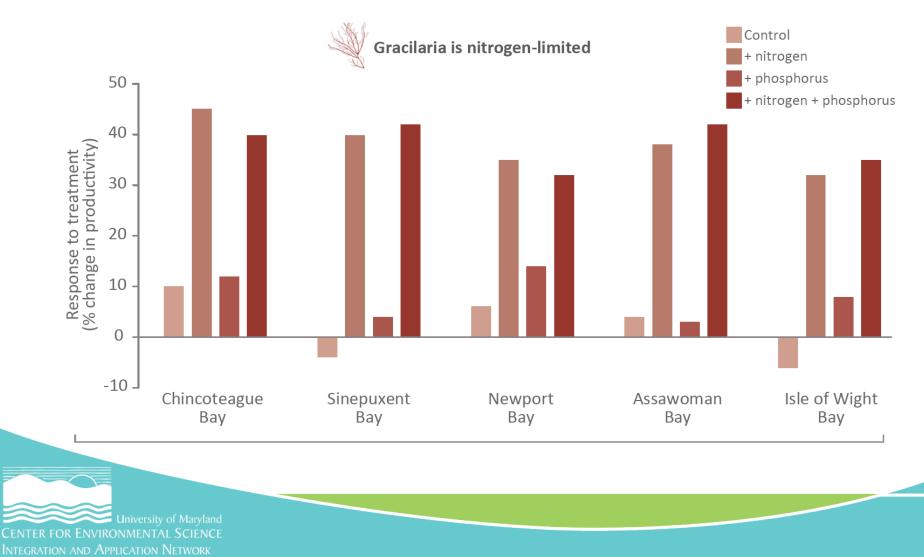
Types of graphs

- Bar graph
- Line graph
- Pie graph
- Comparison bar graph



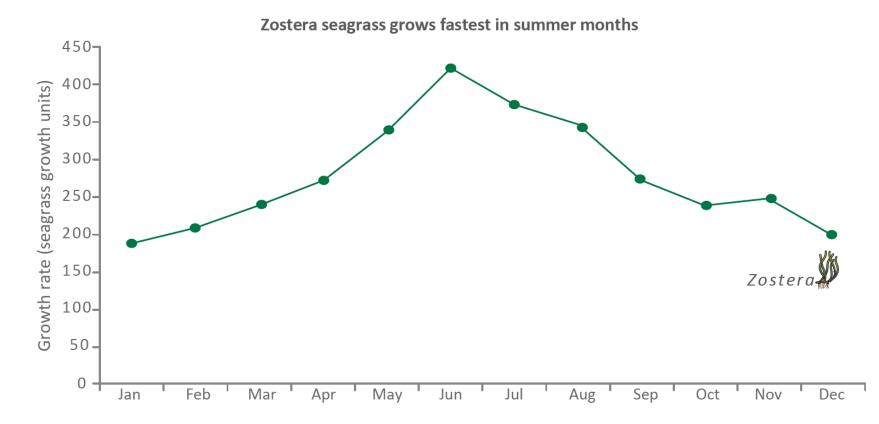
Choosing a graph and formatting – bar graph

EXAMPLE 2: AFTER FORMATTING, BAR GRAPH



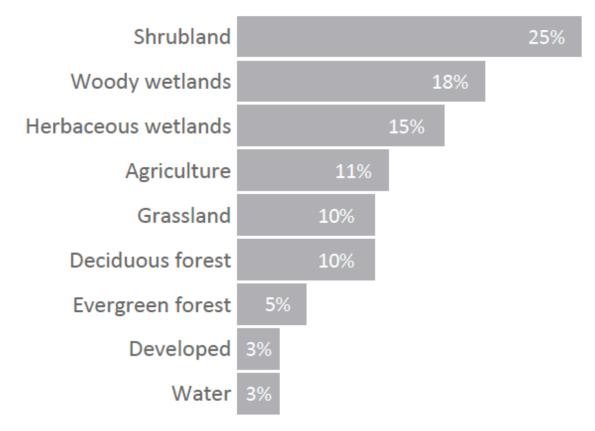
Choosing a graph and formatting – line graph

EXAMPLE 4: AFTER FORMATTING, LINE GRAPH



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Choosing a graph and formatting – pie graph

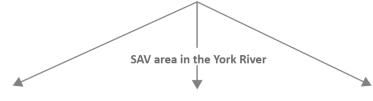


Land use by area



		Bed de	ensity		
Sample site and year	0-10%	10-40%	40-70%	70-100%	Total
York tidal fresh 2005	7	16	21	81	125
York oligohaline 2005	1	10	8	34	53
York total 2005	8	50	29	115	178
York tidal fresh 2010	2	22	13	73	110
York oligohaline 2010	0	28	32	143	203
York total 2010	2	50	45	216	313
York tidal fresh 2015	37	14	16	167	234
York oligohaline 2015	15	135	44	188	367
York total 2015	72	149	60	355	601

Submerged aquatic vegetation (SAV) area (hectares) in the York River





Tidal Oligo- Total Tidal Oligo- Total Tidal Oligo- Total

fresh haline 2005 fresh haline 2010 fresh haline 2015

■0-10% ■10-40% ■40-70% ■70-100% ■Total

2015 2015

2010 2010

2005 2005







— 0-10% **—** 10-40% **—** 40-70% **—** 70-100%

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Data in figures

- Help readers visually connect information
- Connect numbers from graphs to general patterns and trends or show information on a geographic scale

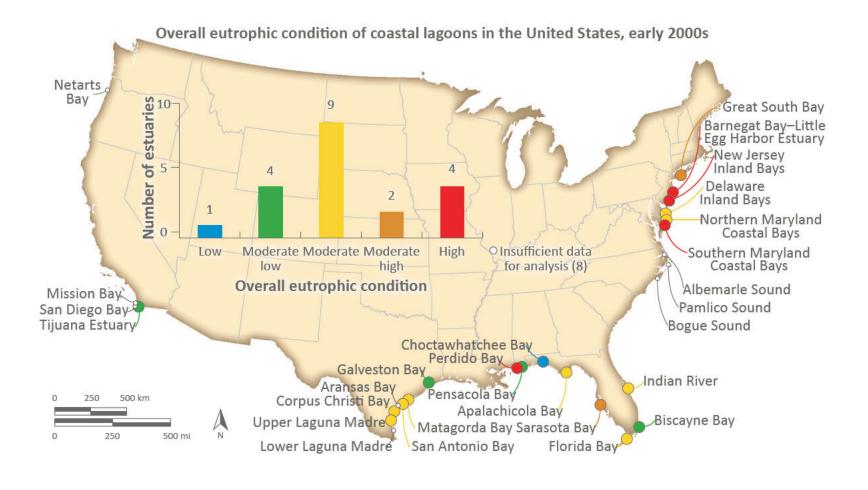


Data in figures

- Parts of a figure
 - Maps
 - Graphs
 - Photos
 - Text
 - Caption
 - Title



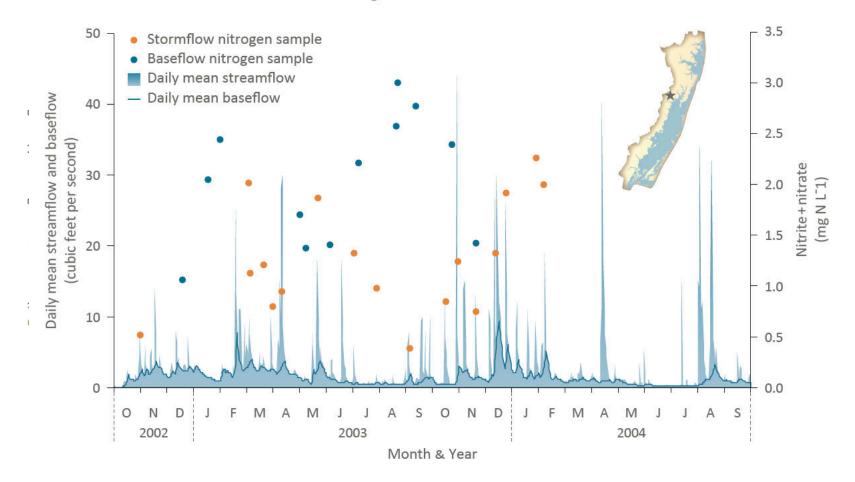
Figure example



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Figure example

Flow rate & nitrogen concentrations in Bassett Creek



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Summary

- Start small, let the data lead you
 - What kind of data are you collecting?
 - What is the best way to organize your data?
 - What is the best graph for your data?
 - Will a figure help explain your data?
- Thanks for joining us and let Caroline and I know if you have any questions!



Now go back and choose the best display type for your parameter!

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