From:	Aayushi Dhebar
То:	parkboard
Subject:	Research to Share
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Hello,

Our names are Aayushi Dhebar, James Froelich, and Kennady Nguyen. We are students from Bellevue College who are working on a civic engagement project as part of our Chemistry class. We are writing to you to introduce ourselves and let you know that we would love to share our research and data with the Board regarding the results of our research. The project is to test the effect of the density of trees in an area to the area's CO2 level and if having more trees would reduce the CO2 level in order to have safer air conditions. Thank you for reading this email, and we look forward to discussing our results with you.

Sincerely,

Aayushi Dhebar, James Froelich, and Kennady Nguyen

RESEARCH PRESENTATION

Aayushi Dhebar, James Froelich, Kennady Nguyen 1 December 2020

RESEARCH QUESTION- SMART

What effect, if any, do the forested parks have on the CO2 levels and temperatures in Bellevue, comparing the shopping center in Bellevue downtown and **Robinswood park near Bellevue College?** *Measured 1-2 times a week over a 4week period.

RESEARCH QUESTION-SMART

Specific: The research question specifically says that the research will be focused on the CO2 regarding the effect of forested parks.

Measurable: CO2 and temperature can be measured by a CO2 monitor, and will be collected 1-2 times per week.

Achievable: It is achievable because the locations are accessible to the group members for data collection.

Realistic: "What effect, if any" is realistic because it is possible that the forested area has little to no effect on CO2 levels

Temporal: The data will be collected over a specified 4-week period

RATIONALE

- Increasing the amount/density of trees is one of the easiest way to improve air quality
- Trees help reduce CO₂ and temperatures through photosynthesis, as well as reducing PM2.5 by the leaves collecting particulates.
- We wanted to explore the differences between the small park vs. less forested areas
- The knowledge gap from the scientific paper, Air Quality Effects of Urban Trees and Parks, came from the sampling locations and size. The research had only measured very large parks and urban areas, but there was not as much data for a smaller scale, which is what our data will do.



HYPOTHESIS

If the Robinswood park is more densely forested than the shopping centers in Bellevue, then the park will have lower CO2 levels and temperatures.

Independent Variable: density of trees in an area

Dependent Variable: CO2 levels and temperatures

According to Air Quality Effects of Urban Trees and Parks, when an area has more trees, its air quality is improved. From this, it can be inferred that more trees would lead to lower CO2 levels, which is one of the contributors to poor air quality.

METHODOLOGY

- Time of Day : Around 12 pm +- half an hour and around 6 pm +half an hour
- Sample Frequency: twice a day, 1 to 2 times a week, 6 trials at an interval of 5 minutes.
- Each trial recorded CO2 levels in ppm and temperature in °F. General weather conditions were recorded.
- Overall Collection Time Period: 4 weeks
- Equipment: CO2 monitor to collect temperature and CO2, Camera to take pictures of the location and equipment, vehicle to get to locations, power inverter DC to AC for CO2 monitor to work in vehicle.

Location A (Bellevue Downtown Shopping Center): Construction site across the street, busy roads and small, bare/full trees, lots of pedestrians walking around

Location B (Robinswood Park): Full of trees/plants, minimal cars passing through, minimal amount of pedestrians





THE TRANSECT

Both locations were chosen for their similar distance to the 405/190 (~700-800 M) but are clearly different in tree coverage.

Our locations are separated by 4,997 meters (or ~3.1 miles)

We used Google Earth for the satellite images of each location and to measure the distance

METHODOLOGY

For each day, we found the average of the 6 trials using excel.

Now having one value for the CO2 levels and Temperature for each day, we were able to graph 4 time series comparing the values of each location.

Each value would have a different uncertainty, which could be calculated by finding the standard deviation for each set of trials, but Excel only allows for one uncertainty for each graph. We instead found the Std. Dev. for one set of trials and used it as an estimate of the precision of the CO2 monitor for each time series.

Location A			_	
		2		
CO2 Level (PPIVI)		Location A	Location b	
6 Nov	6-Nov	435	#N/A	
0-1100	9-Nov	#N/A	393.5	
400	13-Nov	429.166667	#N/A	
489	14-Nov	#N/A	409.3333333	
421	16-Nov	414	397	
421	19-Nov	405.833333	381.3333333	
493	23-Nov	421.5	388.6666667	
155	24-Nov	474.166667	#N/A	
390	25-Nov	#N/A	444.3333333	
202				
393	Std dev	4.28174419	3.265986324	
424				

RESULTS

Robinswood park trail

Robinswood Park Playground

VS

Robinswood Community Park Tennis Center

Robinswood

Robinswood Park Dog Corrale

ROBINSWOOD PARK

DOWNTOWN BELLEVUE

RESULTS: RAW DATA

12pm-12:30		6pm-6:30													
Location A		Location A		Location A		Location A		Location B		Location B		Location B		Location B	
CO2 Level (PPM)	Temp (F)														
2-Nov		6-Nov		18-Nov		19-Nov		8-Nov		9-Nov		18-Nov		19-Nov	
427	65.7	489	45	440	49.3	411	46.3	414	43.1	379	44.9	428	47.6	379	42.8
428	64.7	421	43.3	438	49.1	409	44.9	403	42	375	44.3	419	47.2	372	41.9
438	59	493	43.2	437	48.7	405	44.8	399	42.8	379	44.3	427	48	381	41.7
438	58.9	390	41.4	432	48.7	402	43.1	409	42.7	385	43.5	423	48.1	379	41.1
425	59.6	393	41.3	438	49.9	403	43.2	395	43.3	420	42.8	418	46.9	390	42.9
411	61.6	424	41.8	436	49.3	405	44	384	45.4	423	41.5	416	46.6	387	41.2
13-Nov				23-Nov				14-Nov				23-Nov			
381	48.2	436	44.6	401	50.8	410	47.3	382	47.2	414	44.2	382	47.6	407	45.2
361	47.7	433	43.7	404	50.9	423	48.2	381	45.9	411	43.4	396	48.1	373	44.7
379	47.8	428	43.7	398	49.4	422	48.3	378	46.3	409	42.3	405	48.8	372	43.8
375	48.3	430	44.4	405	49.2	417	47.7	387	46.5	412	42.6	419	48.1	375	43.7
357	50.8	425	43.6	387	48.7	430	49.5	388	47.1	406	41.9	405	48.3	401	43.5
370	47.4	423	43.5	399	49.2	427	49.2	381	47.9	404	41.8	419	47.9	404	45.8
16-Nov				24-Nov				16-Nov				25-Nov			
431	45.9	423	44.5	441	47.6	460	46.7	409	44.3	399	39.9	422	46.2	450	45.6
425	47.1	412	43.9	439	49.3	464	46.5	407	44.2	402	40.2	421	45.8	446	44.2
415	47	410	44.4	442	48.2	495	46.8	403	43.9	397	40	420	47.1	442	44.4
417	47.8	414	44.3	429	47.9	461	46.2	405	44.1	398	39.8	422	46.3	438	44.3
414	47	414	44.7	433	48.3	470	45.8	404	44	392	37.9	426	45.2	446	45.7
399	46.8	411	44	432	48.2	495	48.2	401	43.6	394	38.2	437	46.1	444	45.6

The park (green) has consistently lower CO2 Levels



The park (green) has consistently lower temperatures



The park (greens) has consistently similar CO2 levels throughout the day. The shopping center consistently had higher CO2 levers by end-of-day

RESULTS

If the Robinswood park is more densely forested than the shopping centers in Bellevue, then the park will have lower CO2 levels and temperatures.

Hypothesis correct: YES 🗸

- We clearly see a correlation between an increase in trees and a decrease in CO2 levels and temperature.
- This is assuming other independent variables we were unable to track had little effect. (Traffic patterns, wind directions, etc.)

DISCUSSION

- Changes/errors made throughout collection:
 - Instead of collecting data from one location once a day we began collecting from both locations (A & B) one after the other, during the same day at two different times
- Significance, trends, relationships, and/or new knowledge
 - The data showed poor correlation between CO2 and temperature, when it should have showed high correlation, as have previous studies. This different result was most likely due to the days data was collected, in which the season was changing, resulting in large temperature variations with relatively little change in CO2.
- Knowledge gaps
 - There was no great discovery here, but we showed a small group of amateurs with basic equipment could produce valuable information for their community.

DISCUSSION

- How results have changed field of study
 - We showed that hypotheses from much large studies could be applied on a much smaller scale and the data still proved the hypothesis.
- Future research
 - Future research would ideally take place in a stagnant season, where temperature stayed relatively even for each location, so that researchers could truly measure the effects of a forested area.
- Article 2: Elevated atmospheric CO2 concentration and temperature across an urban-rural transect paper
 - The researchers in the Baltimore transect study found "the urban site ranged from 448–537 ppm." Our average values ~430 ppm (downtown) and ~402 ppm (park) are a little lower than their value but are very close. They also stated CO2 "significantly increased on average by 66 ppm from the rural to the urban site." Our increase is much lower at about 28 ppm, which make sense as our two location were much closer.

ARTICLE 3

The table to the right is from a research study titled, *Effects of Forests on Amounts of CO2:Case Study of Kastamonu and Ilgaz Mountain National Parks* which took place in Turkey. It details the amount of CO2 in a city center and forest during the winter which is closely related to our research. The difference is that in our study, the tree coverage was far less than that of a National Park, therefore, our levels, were around 20-30 ppm and the study's levels, ranged from 330-930 ppm. Though on a smaller scale, the results were essentially the same, in that the CO2 levels were much higher in the city center, than the forest. Table 1. Measurement results.

Measurement time		Forest	City Center	Kuzeykent		
Summer		Max	203	512	265	
	Day	Min	121	325	198	
		Mean	148	398	230	
	Night	Max	271	439	358	
		Min	199	358	236	
		Mean	229	401	297	
Winter	Day	Max	450	720	456	
		Min	330	517	415	
		Mean	391	621	438	
	Night	Max	502	918	514	
		Min	357	552	427	
		Mean	422	758	473	

ARTICLES

- <u>https://www.nrpa.org/uploadedFiles/nrpa.org/Publications_and_Research/Research/Papers/Nowak-Heisler-Research-Paper.pdf#:~:text=Trees%20and%20vegetation%20in%20parks%20can%20help%20reduce,and%20building%20energy%20use%20in%20and%20near%20parks
 </u>
- George et al atm CO2 urban rural transect.pdf: 3313C012 CHEM&161 General Chemistry I (instructure.com)
- https://d1wqtxts1xzle7.cloudfront.net/42608731/Effects_of_Forests_on_Amounts_of_C02_Cas20160212-2091wh2gfu.pdf?1455275399=&response-contentdisposition=inline%3B+filename%3DEFFECTS_OF_FORESTS_ON_THE_AMOUNT_OF_C02.pdf&Expires=1606785152&Signature=KlbP30 xDjU2Smmm3Cu~Vu16-0d~ISHEQUr8P3IsDo58WeayaZ6~QE5gcQ18vafWjSyi8oPsRgwHUPBVh06FzY-~cDWnK2f0Gn8oiZmjElckavo5VWuHQU~-QVIWI3LWZ8VrAKHtReAmo4Fu473ArHzYv2xL~~WISVt9IJRMyscIEAOInns6dgzMWJnzThtbQRNDfGc095nX80NBrE4EbmEgHPr6GPnnftHVvvT9zDQcNsDYKUi5k9EQmKwms7GapusmXgjZxs-OZICSH5d3~GTJfR~PoNEp~VPvQEiuLnmGiKHf-08gWYjFGDQ2Ibpu4ULDJdzMuXDDqyP0Vq7QKg__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA