Exploring the Decline in Bees and Flower Density in England

Computational Practices: Visualisation and Sensing

Samia Tirike

Table of Contents

ABSTRACT

For this data visualisation project, I will explore flower and bee density and further look into the decline in both bees and flowers. The reduction in flowers can impact the number of bees found in nature. Flowers are essential as they help attract pollen to plants that need to produce seeds and insects like bees which feed off pollen and nectar to create food for themselves. Bees moving from one flower to another make them the most essential natural pollinators.

For my end project, I have created a series of informative posters that displays various graphs showing the decline in flowers and bees over the years and a more visual bubble chart showing the different flower species in England. I decided to create an informative poster instead of other mediums, such as a website, because posters can be placed in different locations, e.g. a park, to target audiences interested in nature and biodiversity. It engages the viewer more visually and is simpler to digest since it's easier to communicate a message physically. Posters are also easier to understand since they are accessible, allowing viewers of all literacy skills to understand.

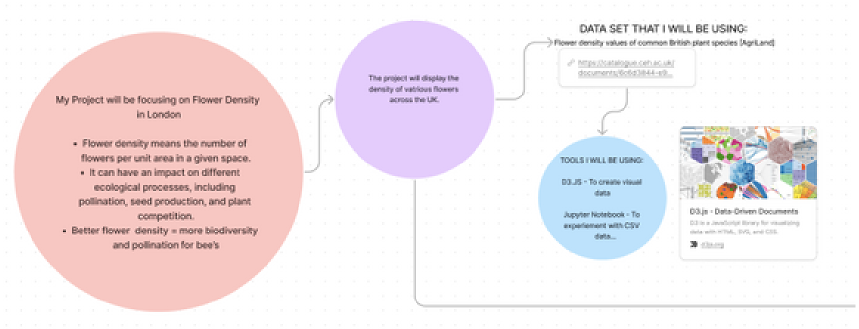
Data: The data I will use from this project is from the UK Pollinator Scheme, which records the number of flower-visiting species such as bees and flowers. They collect data using pan traps to monitor insect populations. The UK Pollinator is an ideal data source because they are the first to generate systematic data on the abundance of insects.

Motivation: With the visualisations, I intend to show the varying species of flowers and the storytelling of the decline of flowers and bees and link them to the biodiversity of plants in England as well as various graphs, e.g., bubble charts and bar charts. I want to create an informative, accessible, and creative way of showing information.

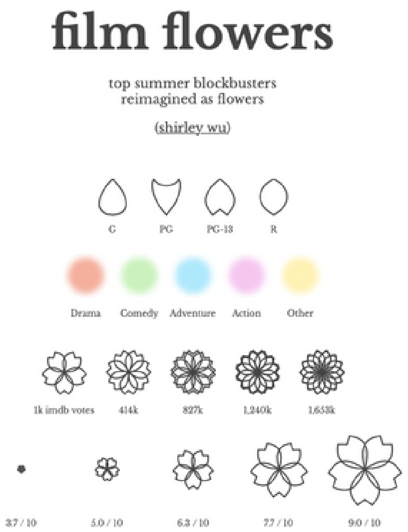
Audience: The project audience is interested in nature, specifically biodiversity, pollination and global warming, since the decline of bees and flowers is a by-product.

Context: The viewers will engage with the poster in areas like a park or community hubs like universities where the posters can be raised in discussions and create awareness around biodiversity and the decline in species.

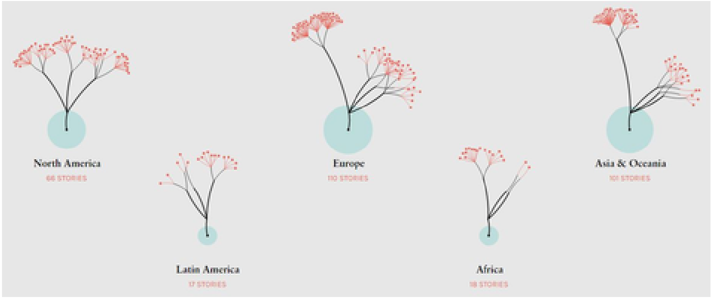
Research/Inspirations



Figma planning



Film Flowers



Federica Fragapane

To plan, I started on Figma, writing down elements I wanted to display in my project and what software I would use, e.g. D3.JS. I used Figma to gather my ideas on what data to look at. From there, I decided to find datasets where I could look at species of flowers within an area. I found UK POMS, which focuses on flowers and bees' pollination. This data set is reliable because it was conducted in a controlled scientific investigation using pan traps. Using websites that rely on community databases isn't reliable because it can be invalid information about the flower and its location. So, sticking to research that is conducted relatively was the ideal method.

My main inspiration for the project is Film Flowers project by Shirley Wu. She incorporates data about IMDB ratings and films and generates flowers from them. I like her use of creating different kinds of flowers from data. Another inspiration is Federica Fragapane, an information designer who creates informative pieces on current climates. Fragapane's work is precise and displays storytelling on problems faced worldwide. Fragapane's work displayed shows key workers coming from a migrant background contribution to COVID-19.

I take both artists as inspiration because they both incorporate data in a creative and informative way. I also admire that they don't use traditional graphs, yet the data storytelling is evident.

Data

```
In [11]: spreadsheet1 = pd.read_csv('TFUdata.csv')[:60]

In [12]: spreadsheet1
Out[12]:
```

	sample_id	country	location_code	location_name	X1km_square	date	year	pan_trap_station	occurrence_id	taxon_group	taxon_source	English_nam
0	3054144	England	76	near West Itchenor	SU7800	16/06/2017	2017	1	6003146	flowering plant	Ranunculus repens	Creepin Buttercu
1	3054249	England	76	near West Itchenor	SU7800	16/06/2017	2017	2	6003401	flowering plant	Ranunculus repens	Creepin Buttercu
2	3054249	England	76	near West Itchenor	SU7800	16/06/2017	2017	2	6003402	flowering plant	Stellaria graminea	Lesse Stitchwo
3	3054249	England	76	near West Itchenor	SU7800	16/06/2017	2017	2	6003403	flowering plant	Lotus pedunculatus	Greater Bird's foot-trefo
4	3054249	England	76	near West Itchenor	SU7800	16/06/2017	2017	2	6003404	flowering plant	Vicia sativa	Commo Vetc
5	3054249	England	76	near West Itchenor	SU7800	16/06/2017	2017	2	6003405	flowering plant	Oenanthe crocata	Hemloc Wate dropwo
6	3054547	England	76	near West Itchenor	SU7800	16/06/2017	2017	3	6003994	flowering plant	Ranunculus repens	Creepin Buttercu

Figure 1. Data for flowers

Using the UK Pollinating Monitoring Scheme, I found a data set that focused on monitoring the number of flowers found using 1km pan traps. The dataset mentions flowers within 2 meters of each pan trap sampling area. The first dataset I sorted was only on flower density. It had information on location names, the years, English names, types of flowers, pan trap stations, and their density. Using this data, I removed unnecessary data that didn't align with my storytelling, such as sample id and sorted the flower density integers from lowest to highest. I focused on this dataset in 2017 because I found out that you can display all of the data in a datasheet instead of a limited maximum. Using this data, I looked at the flower density in 2017 and the species—this data I used to develop later on in my developments.

```
In [33]:
data1 = pd.read_csv('datafinal.csv',encoding='latin1')

In [34]: data1
[34]:
```

	sample_id	country	location_code	location_name	X1km_square	sample_projection	land_cover	date	year	sample_media	digitised_by	recorder_type
0	3054602	England	76	near West Itchenor	SU7800	OSGB	agricultural	16/06/2017	2017	0.0	147199	I am confident in identifying the commonly-occ...
1	3054606	England	76	near West Itchenor	SU7800	OSGB	agricultural	16/06/2017	2017	0.0	147199	I am confident in identifying the commonly-occ...
2	3070263	England	96	LLanrothal	SO4718	OSGB	agricultural	21/06/2017	2017	0.0	147199	I am confident in identifying the commonly-occ...
												I am confident

```
In [37]: data2 = data1.drop(["sample_id", "location_code", "location_name", "X1km_square", "sample_projection", "land_cover"

In [38]: data2
Out[38]:
```

	country	year	floral_unit_count	bumblebees	honeybees	solitary_bees
0	England	2017	24	3	2	0
1	England	2017	7	0	0	1
2	England	2017	85	1	0	1
3	England	2017	15	0	0	1
4	England	2017	80	2	0	0
5	England	2017	43	0	0	0
6	England	2017	11	1	0	1
7	England	2017	8	0	0	0

```
In [125]: data3
Out[125]:
```

	country	year	floral_unit_count	bumblebees	honeybees	solitary_bees
0	England	2017	24	3	2	0
1	England	2017	7	0	0	1
2	England	2017	85	1	0	1
3	England	2017	15	0	0	1
4	England	2017	80	2	0	0
5	England	2017	43	0	0	0
6	England	2017	11	1	0	1
7	England	2017	8	0	0	0
11	England	2017	28	0	0	0
12	England	2017	29	0	0	0
13	England	2017	7	0	0	0

```
In [127]:
data3['bees_total'] = data3['bumblebees'] + data3['honeybees'] + data3[]

In [128]: data3
Out[128]:
```

	country	year	floral_unit_count	bumblebees	honeybees	solitary_bees	bees_total
0	England	2017	24	3	2	0	5
1	England	2017	7	0	0	1	0
2	England	2017	85	1	0	1	1
3	England	2017	15	0	0	1	0
4	England	2017	80	2	0	0	2
5	England	2017	43	0	0	0	0
6	England	2017	11	1	0	1	1
7	England	2017	8	0	0	0	0
11	England	2017	28	0	0	0	0
12	England	2017	29	0	0	0	0
13	England	2017	7	0	0	0	0

Figure 2. Data for flowers and bee total

To look further at the data, I decided to look at the floral units and bee population over the years. First, I dropped all the columns that could aren't necessary. Then, I combined three columns, bumblebees, honeybees and solitary bees, and called it bees_total. Doing this helped me connect all my data needed to look at all the bee species instead of just looking at one. Lastly, I grabbed all my data, including the years 2017-2020; bees total and the floral_unit_count. Getting this data allows me to look at the biodiversity of beesands the total count of flowers within an athree-yearr time frame.

Development& Design

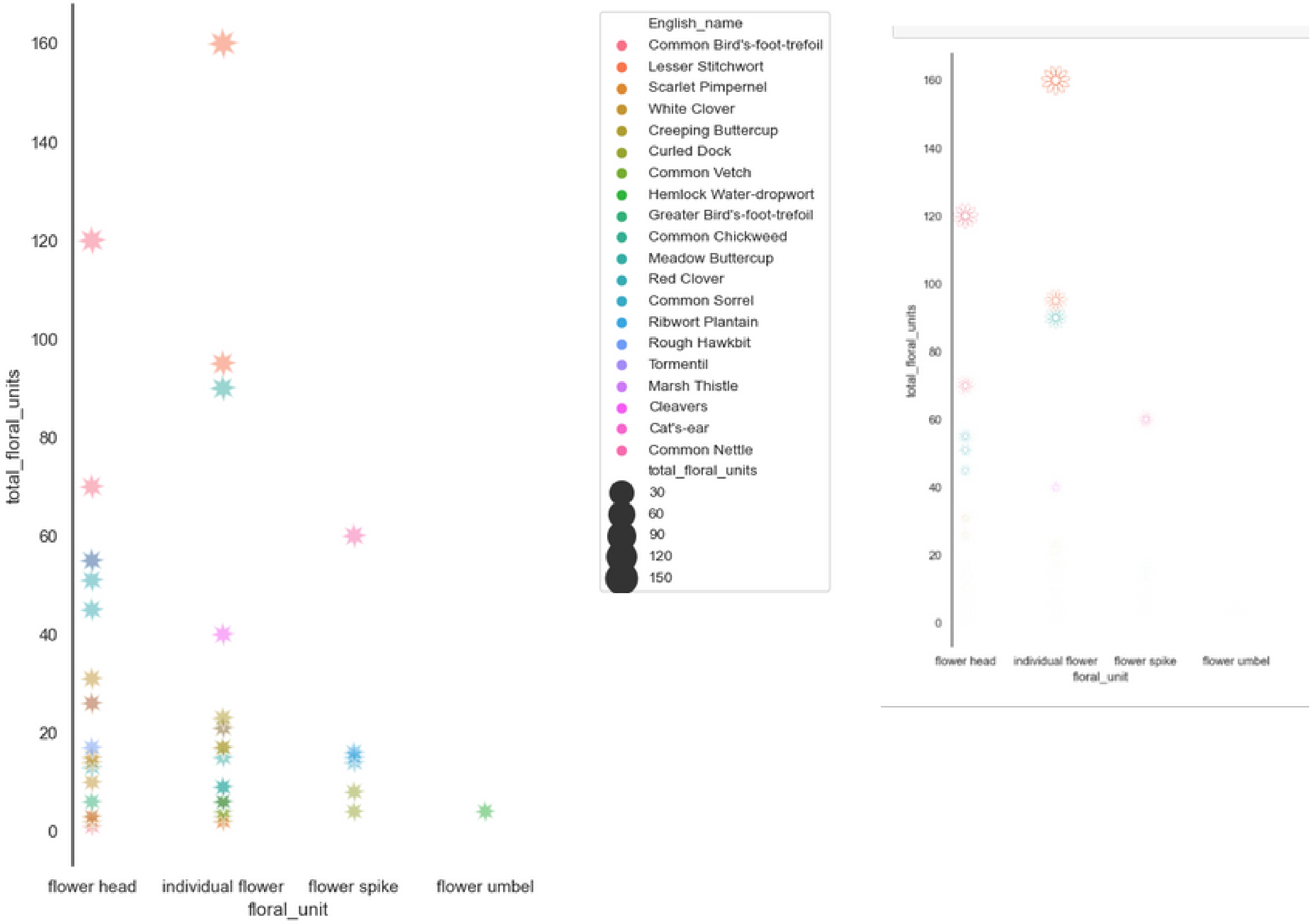
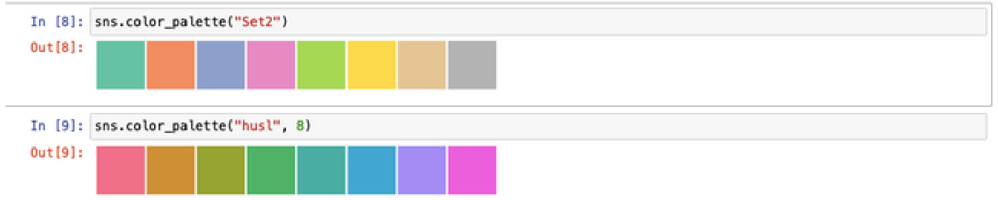


Figure 3. Data for flowers

To visualise the data, I wanted a graph that would clearly show the density of the flowers. I used the seaborn's scatter to display the data and changed the marker to a "flower" shape, but I don't think it shows the density correctly. However, I like that I could change the colours based on flower species.   I also tried implementing SVG flowers so that it looks visually better but it made the plots less visible when smaller, which reduces accessibility. Therefore, users would struggle to infer the data's story.



For the plot colours design, I wanted the plots to be bright and vibrant similar to flowers so I decided to use Seaborn's set colour palettes.

Figure 4. Colour Pallettes

Figure 5. D3JS work

Then, I decided to try out D3.JS and create my version of the Film Flowers made by Shirley Wu, but I found using D3.JS hard for first-time use, so I decided to stick to Python's modules like seaborn and circlifly. I found data binding to the SVGs challenging, even with the console log. However, the use of SVG helped me later on in the final project to make distinctive flowers using D3JS with my bubble chart..

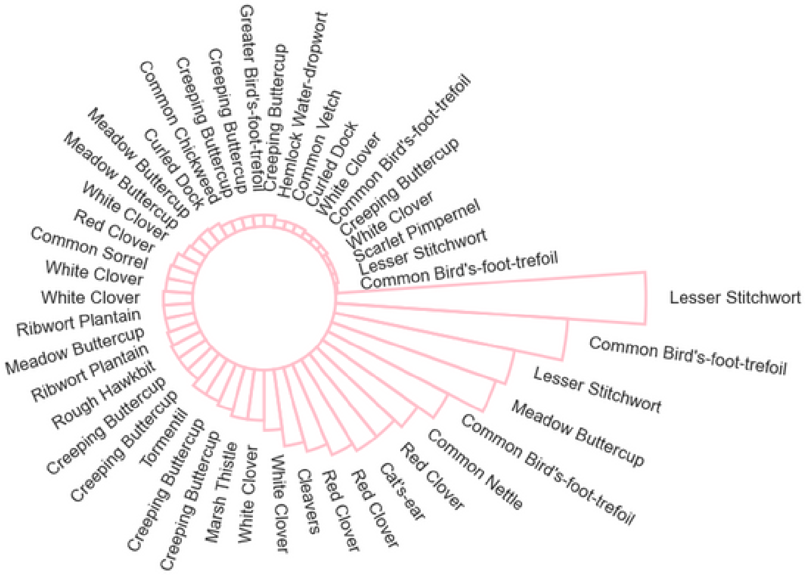


Figure 6. Radial Bar Chart

I started branching outside of scatter graphs because I wanted creative flexibility. The information shown is the total floral units and standard English names for those species. I started with a radial bar chart because it resembles a flower. To further improve the visualisation, I could have a colour code depending on the type of flower and make the bars look more like petals.

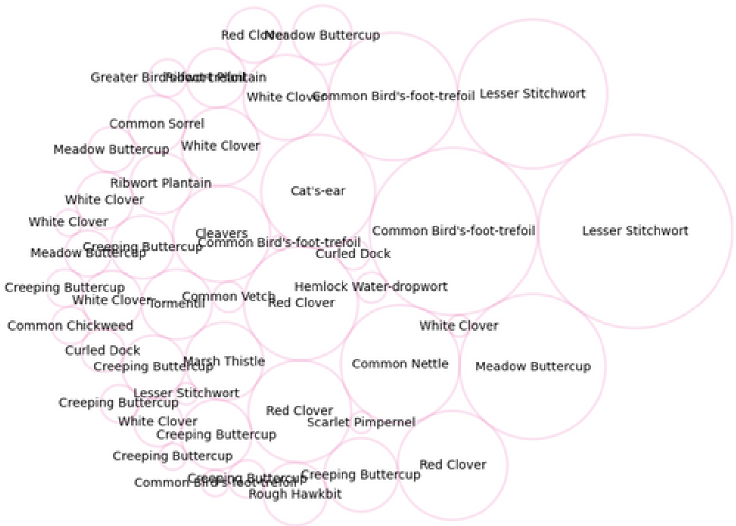


Figure 7. Bubble Chart w/Names

I tested showing data using a clumped bubble chart. I made the chart using Circlify, a Python module, to create bubble charts. Visually, it shows the flower density. I also like how it has a hierarchical structure, which can be compared to other species of flowers. The only downside is the labelling since I couldn't fit the English names of flowers inside the circle, so the label seems cramped.,

Bigger circles = A higher density.

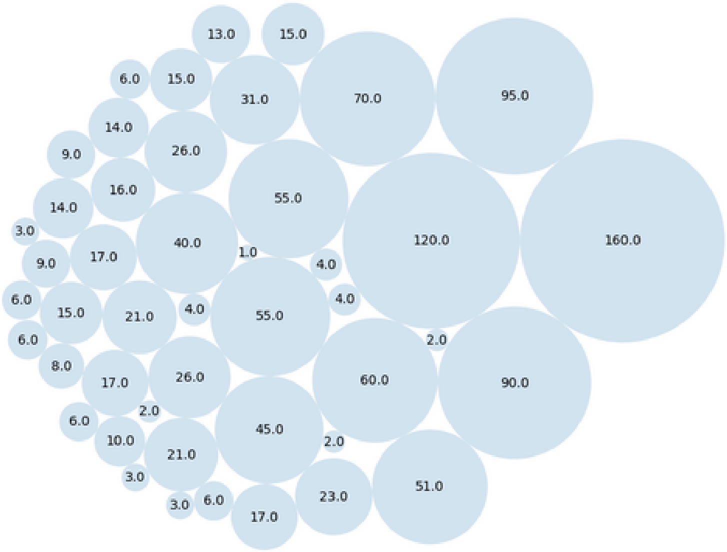


Figure 8. Bubble Chart w/Floral Units

Lastly, to see if the labelling problem would change, I swapped the label from an English name to "Total_Floral_Units", which helped solve my problem. But now it doesn't show any identification for the flowers themselves which is what I will further improve in my portfolio.

To further improve the bubble chart, I added visually appealing features to understand the data better. I used my original bubble chart as a template. I made this enhanced bubble chart which is now identified by the flower type: flower head, individual flower, flower spike and flower umbel. This gives insight into what flower types were found in the data and the flower density. I used specific SVG to decipher which English flower to make the graph even more straightforward. I made this through D3.JS, which allowed me to customise different SVG paths in petal shape and size. I tried to incorporate data into the flowers, but it didn't work out since I found it too complex and challenging to put the data into distinct petals. My initial idea was to bind data into the flowers and alter them into different kinds of flowers. To solve my problem, I just manually created the flowers one by one and changed the shapes of the flowers. Even though the flowers don't have data bound to them, they still show great visualisation and display what flowers are found in the graph.

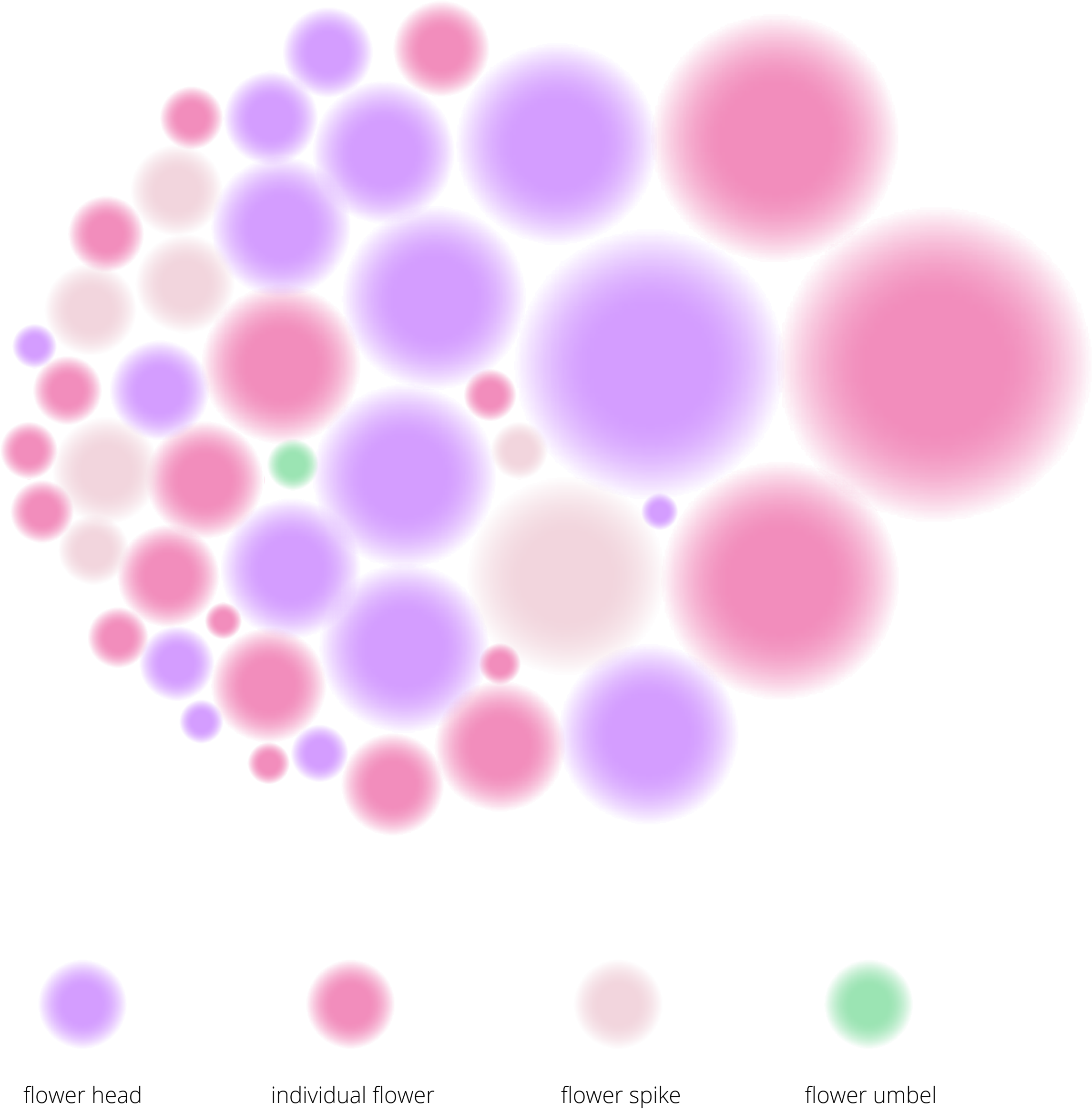
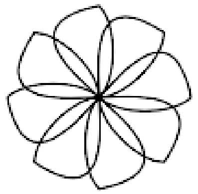
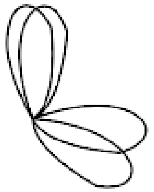
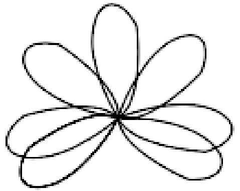
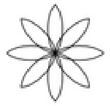


Figure 9.Visually appealing bubble chart









```
html`

  <body>
    <!--Common Bird's-foot-trefoil-->
    <svg id =width="200" height="200">
      <g transform="translate(100, 100)">
      <g fill="none" stroke="black">
        <path d='M 0,0 C -10,-10 -10,-40 0,-50 C 10,-40 10,-10 0,0' fill="none" />
        <use xlink:href="#petal" transform="rotate(45)" />
        <use xlink:href="#petal" transform="rotate(90)" />
        <use xlink:href="#petal" transform="rotate(135)" />
        <use xlink:href="#petal" transform="rotate(180)" />
        <use xlink:href="#petal" transform="rotate(225)" />
        <use xlink:href="#petal" transform="rotate(270)" />
        <use xlink:href="#petal" transform="rotate(315)" />
      </g>
      <path id="petal" d='M 0,0 C -10,-10 -10,-40 0,-50 C 10,-40 10,-10 0,0' fill="none" />
    </svg>
  </body>
</html>
`
```

Figure 10. D3JS Flowers

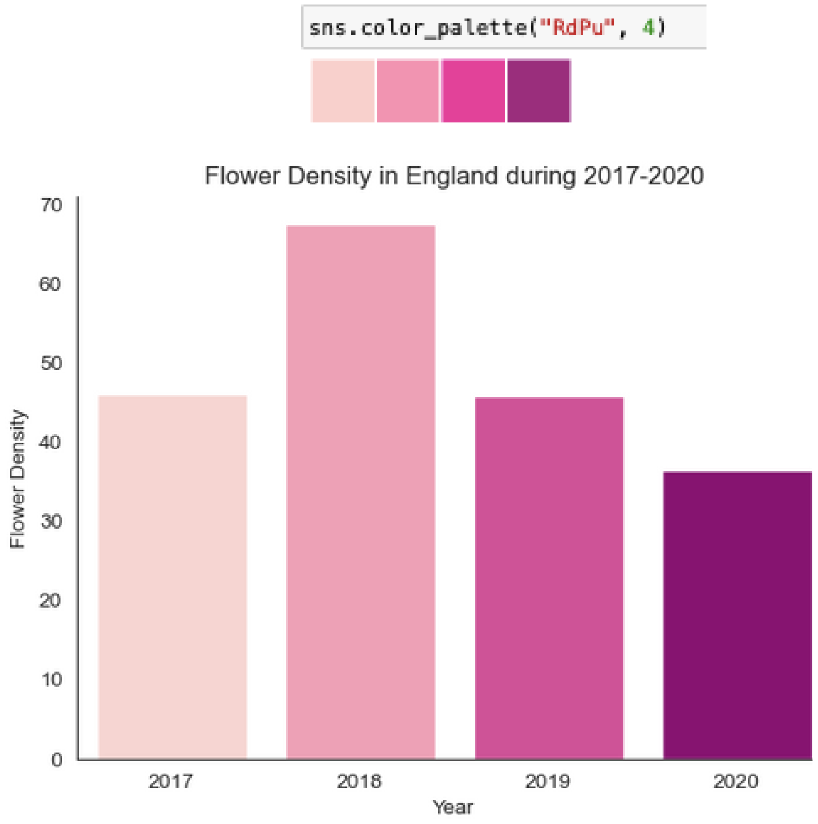


Figure 11. Bar Chart for Flowers

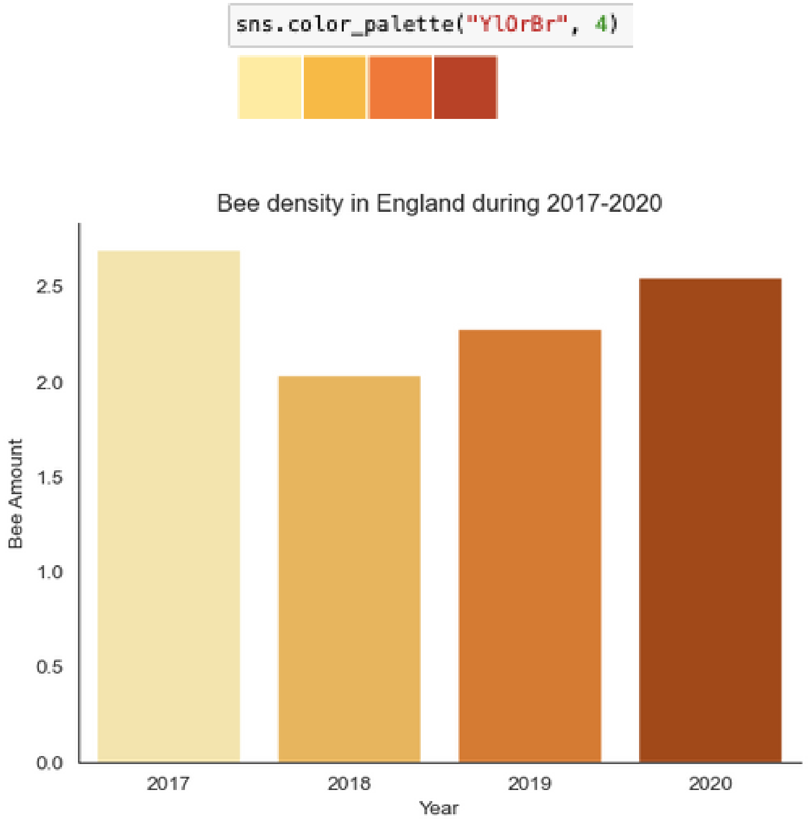


Figure 12. Bar Chart for Bees

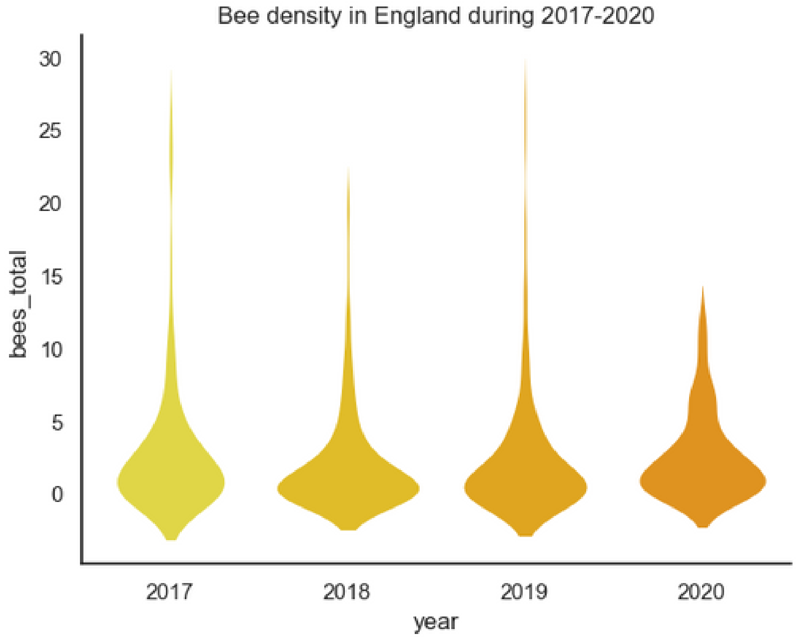


Figure 13. Violin plot for Bees

To develop my story further, I looked into the contrast between the flower and bee density in 2017 - 2020. Looking at data over time can tell a story of the decline in bees and flower density in England, reflecting the current state of biodiversity. Looking at the Flower density decline, as shown, it also affects the bee population. Both graphs show fluctuating flower densities and bee populations from 2018 to 2019, but they still contrast the fall of the bees and flowers. I also tried using a violin plot because it shows the distribution of the bee population over the years. The data using the violin plots is more apparent because the violin plots get smaller by approximately 13 bees recorded every 10 minutes from 2017 to 2020, showing the decline. Still, it is more visually complex for a poster and is not a common way to interpret data. The colour palettes I used for my graphs are similar to what I'm trying to represent. For example, for flower density, I show the fall of flowers using a colour scheme that is common in flowers, and as it gets darker, it's closer to the present day and the future of biodiversity getting darker and insignificant. The same goes for the bee population and finding a colour scheme that connotates to bees, honey and honeycombs and getting closer to the present day and darker over time. Visualising the data can show how the data can change within the span of only three years.

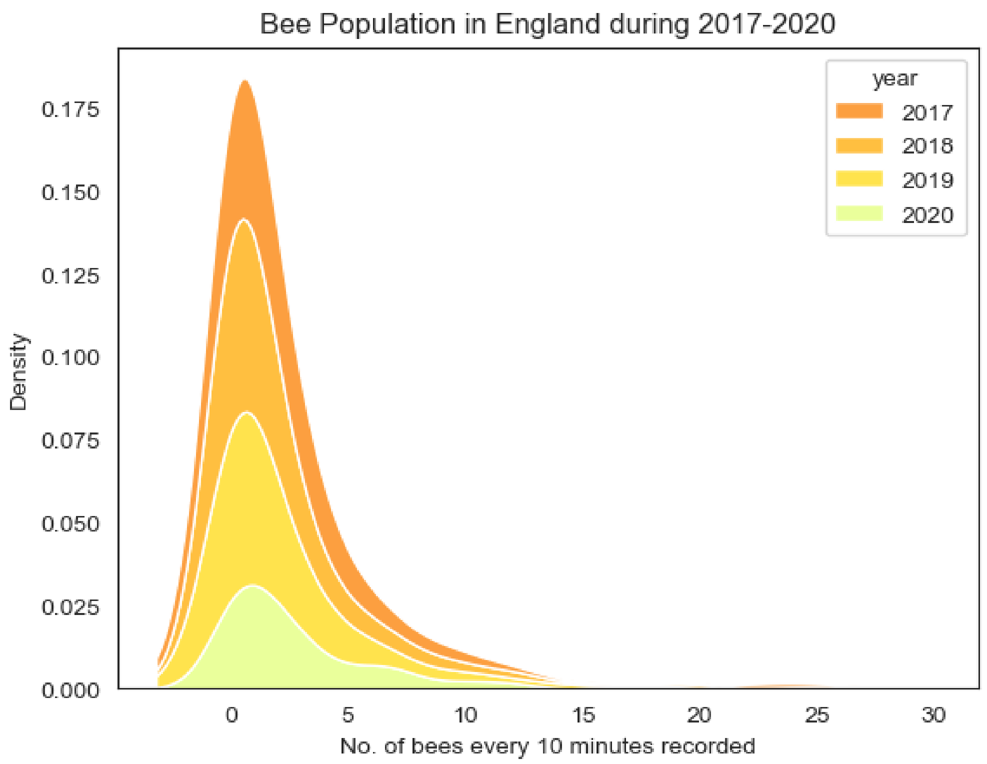


Figure 14. KDE plot for Bees

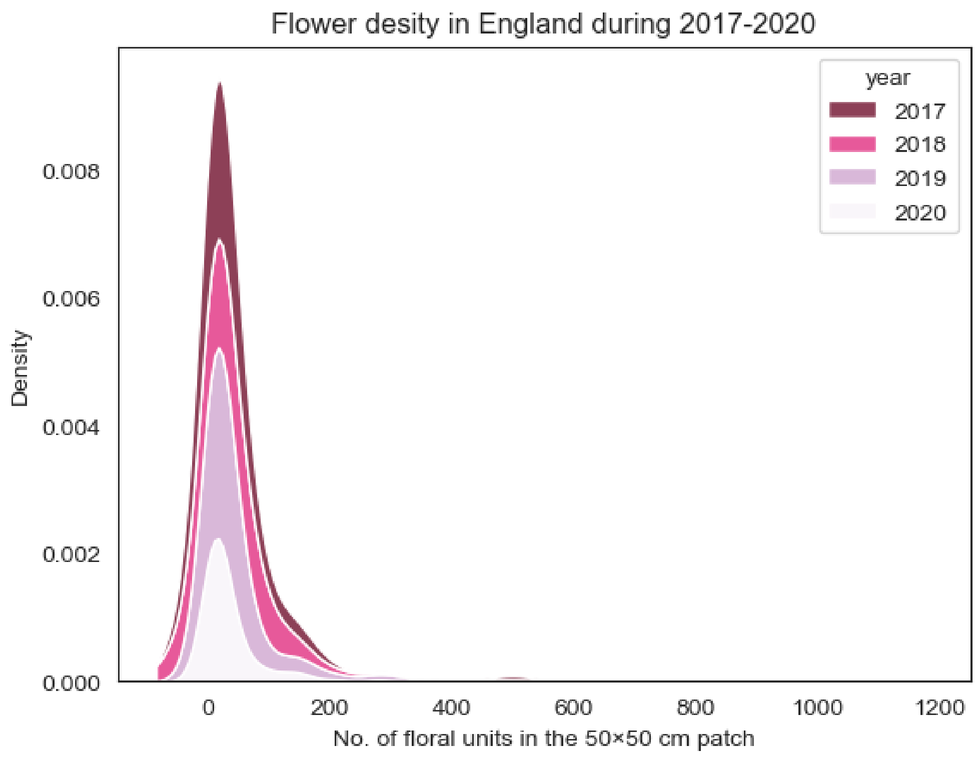


Figure 15. KDE plot for Flowers

To further explore the visualisation of the graphs, I used a KDE plot which visualises the distribution of a variable from a dataset. It highlights the trends and patterns in the distribution of flowers and bees across the three-year time gap. It can show the peaks and patterns of density amount in the data allowing to show contrasts, which helps the data to be easier to interpret.

For example, the bee population graph shows that 2017 was the highest number of bees, with 0.175 density. The range is approximately 0 to 15 bees recorded every 10 minutes. From 2017 to 2020, the plot's width and height decreases, illustrating a decline in bees.

With the flower density, they show the no. of floral units recorded in a 50x50cm patch. The graph shows that the most concentrated area stays under 200 floral units recorded, with its highest density being 0.009. The width of the curves stays about the same, but the height of the thickness becomes smaller, showing the decline of flowers recorded from 2017 to 2020.

Linking the two graphs together, they both convey that from years 2017 to 2020 that the number of both bees and flowers decline over time, showing the reason for the lack of pollination from bees and biodiversity loss in nature.

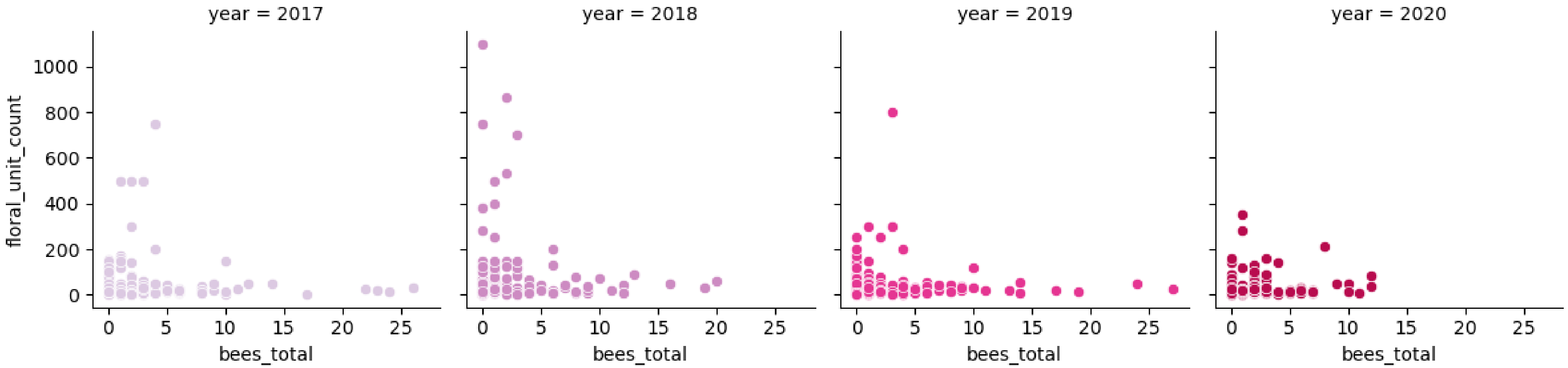
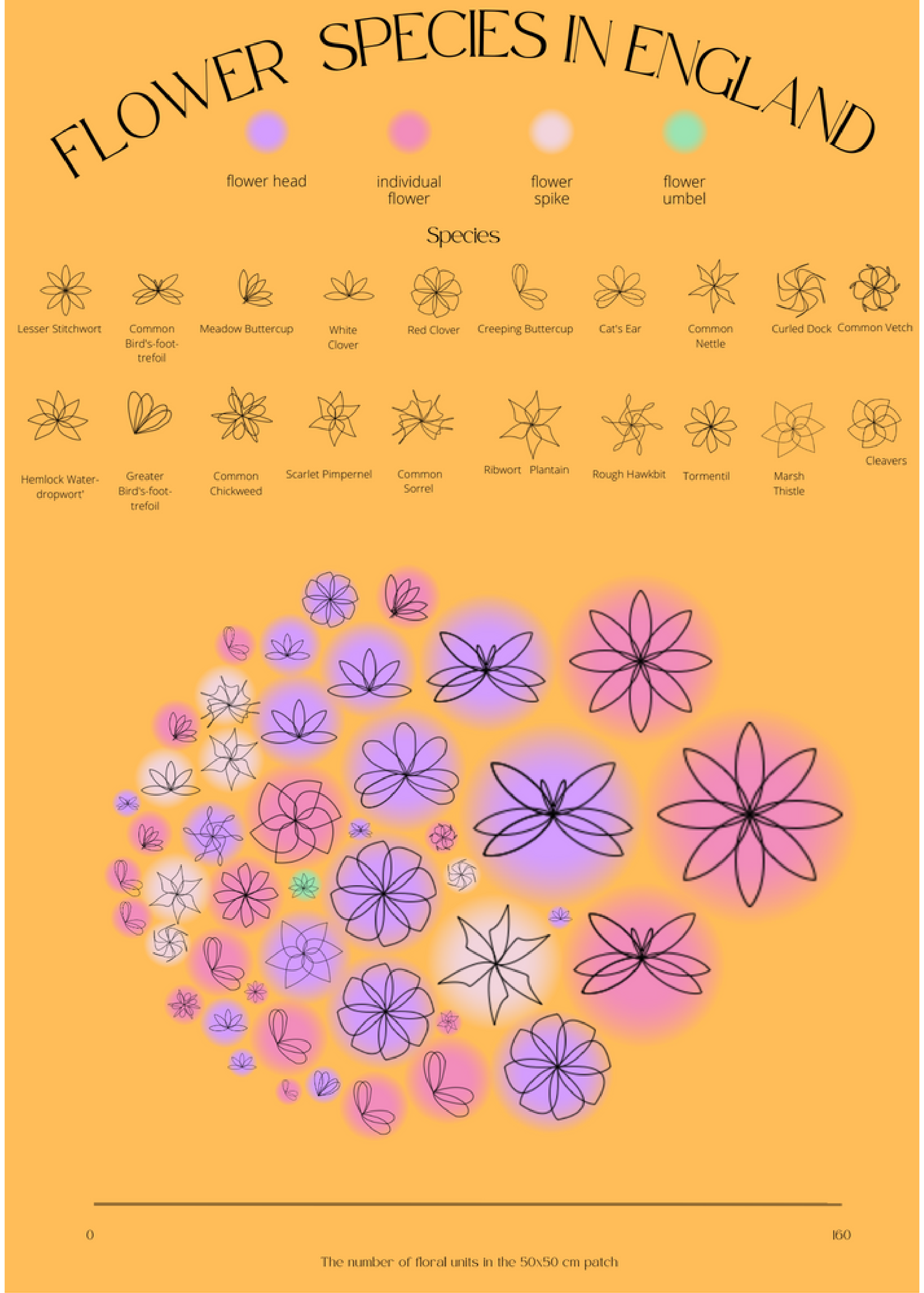
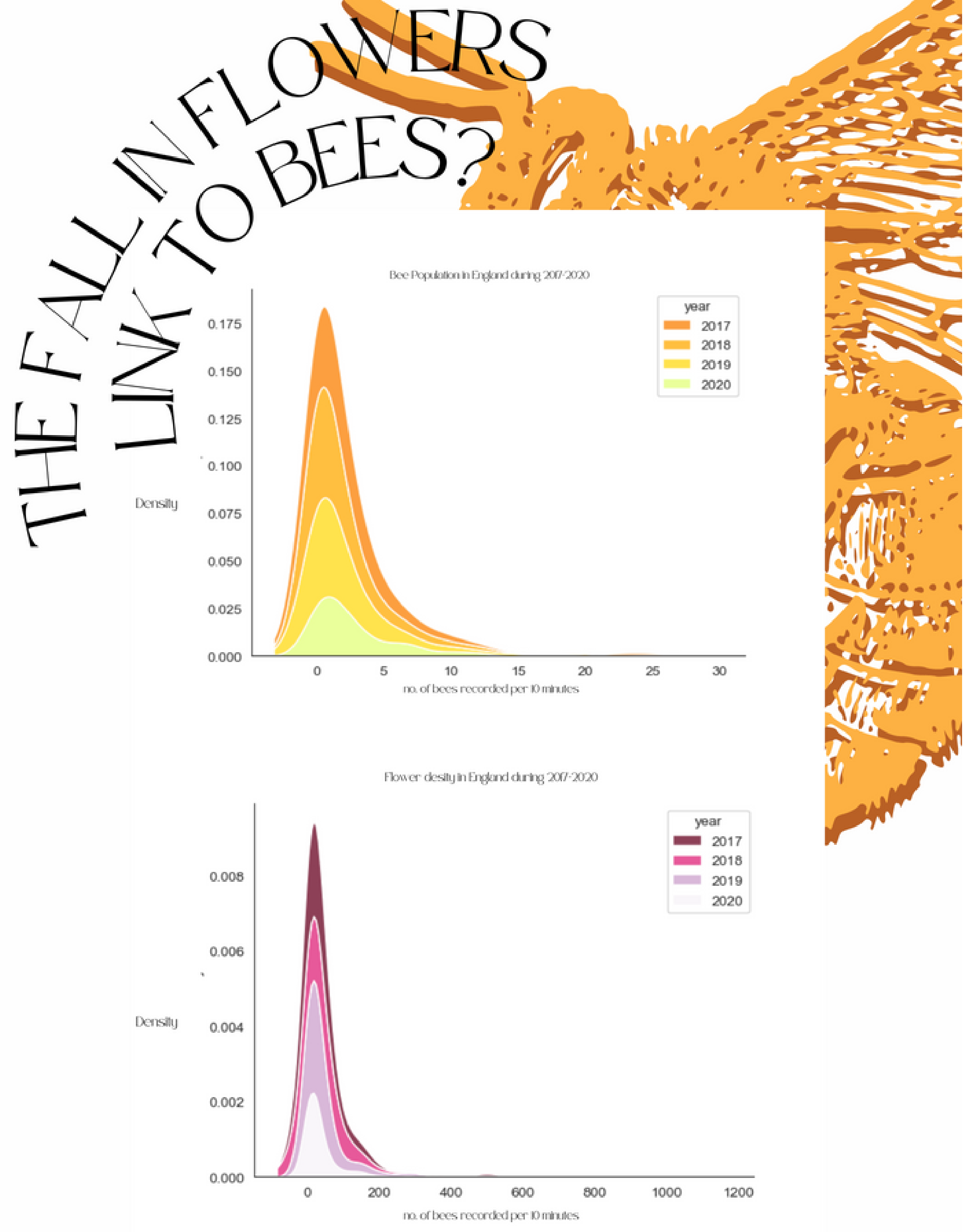


Figure 16. Facet plot for the flowers count and bee recorded every 10 minute

Then, I created a facet plot, a graph that splits the data into subsets. This is great for my project because I can break the dataset into years and show a better contrast between flowers and bees' decline. I used the floral unit count and bee total on the axis and split the datasets based on years. This allowed me to depict the fall of the bee and flower populations in the most straightforward way possible. I also used a colour palette that replicates the colours of flowers to show that as it gets darker, the closer it is to the present day, it can also signify the future of the bee population of bees and the density of flowers getting darker and insignificant in nature. The only issue with the graph is that I couldn't change the x and y label, so I resolved it later by adding it through Canva.

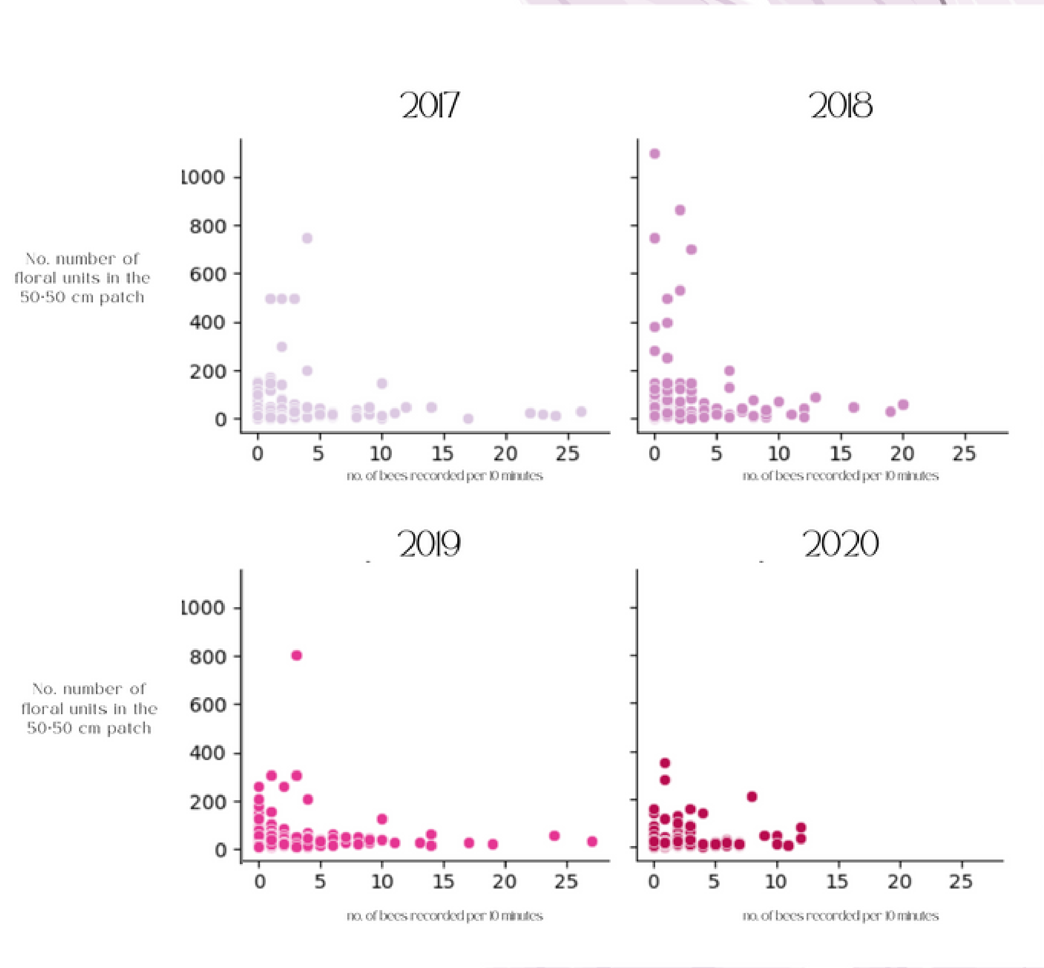
Final Projects





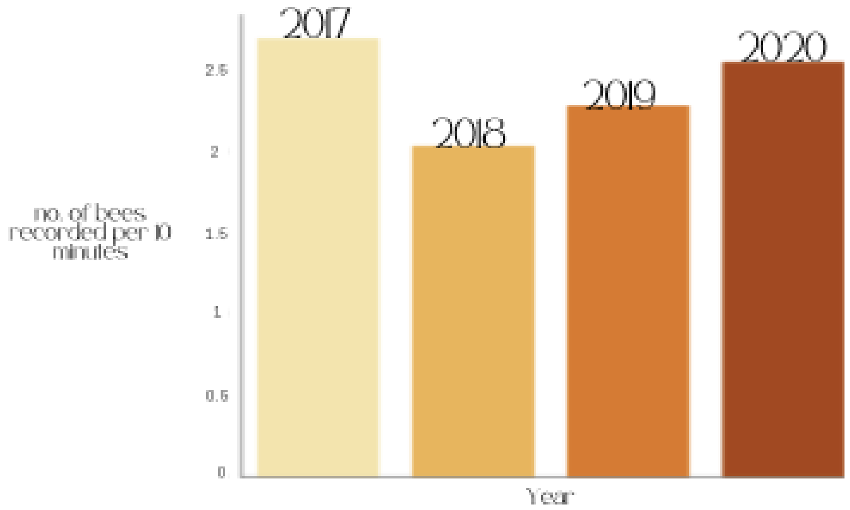
Pollination is vital for creating a healthy ecosystem. Studies have shown that the decline in flowers contributes to the fall in all species of bees. Flowers are essential because they help attract pollen to plants to create seeds and allow bees to make food. Flowers can also impact climate change. The changes in environmental temperatures and timing can disrupt flowers from blooming, causing it difficult for bees to find flowers and pollinate. The graphs show flower and bee patterns from 2017 to 2020, showing the flower decline (Thomann et al., 2013).

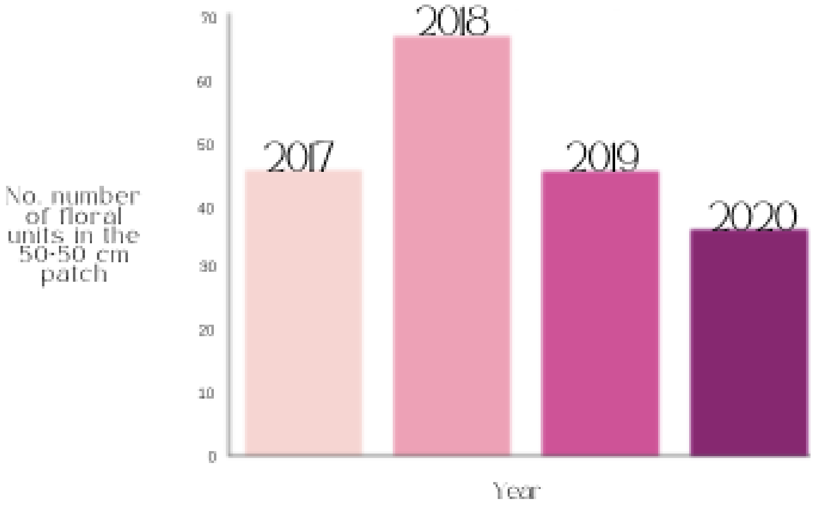
FLOWERS & BEES DENSITY OVER THE YEARS



Over the 3-year time frame (2017 to 2020), the decrease in flowers and bees is shown using this graph. Climate change is a significant factor because it creates abnormalities in the environment, causing the flowers to be unable to bloom. The change in climates is dangerous because it causes biodiversity harm. If not fixed, climate change will increase if biodiversity, like flowers and bees, is not protected (Goulson et al., 2015).

FLOWERS & BEE DENSITY DURING 2017-2020





For the outcome, I printed my posters on A3 and placed them around CCI. If I had more time, I would place it at local parks to target my local audience. When printing, I discovered the sizing and placement of text, so I had to enlarge the text and place the objects accordingly. To give further information, I added a little paragraph on the bottom explaining flowers, bees and climate change.

POSTERS IN FULLSCREEN (LINK)

CHALLENGES:

- One of my first challenges was finding a way to display all the data., I needed help with the notebook, only showing a few. I resolved this by implementing code that would display all the data.
- Another problem was filtering my data, e.g. country and specific species. I resolved this by dropping irrelevant data and combining columns like bees to see the bee's total.
- Lastly, another problem I had was visualising the data. I realised later on that specific graphs didn't work as well with m data, so I decided to use charts that focused on density and amount to show the data as clearly as possible.

TO IMPROVE FURTHER:

- To implement further, I could have looked at my data on a larger scale, e.g. the United Kingdom. The graphs could make the data more reliable and give a more straightforward and bigger image of my argument about the decline in flowers.
- So that the posts are more widespread, I could add a QR code which allows you to find more information and share the research with others.
- Lastly, I could make a physical visualisation which can be made using Arduino and shows the decline in flowers. The numerous LEDs can show different species of flowers and the shade of these LED light show different density levels.

References

Goulson, D., Nicholls, E., Botías, C. and Rotheray, E.L., 2015. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. Science, 347(6229), p.1255957.

Thomann, M., Imbert, E., Devaux, C. and Cheptou, P.O., 2013. Flowering plants under global pollinator decline. Trends in plant science, 18(7), pp.353-359.

UK Pollinator Monitoring Scheme (2022). Flower-insect timed count data from the UK Pollinator Monitoring Scheme, 2017-2020 version 2. NERC EDS Environmental Information Data Centre. (Dataset). https://doi.org/10.5285/13aed7ac-334f-4bb7-b476-4f1c3da45a13

UK Pollinator Monitoring Scheme (2022). Pan-trap survey data from the UK Pollinator Monitoring Scheme, 2017-2020 version 2. NERC EDS Environmental Information Data Centre. (Dataset). https://doi.org/10.5285/2c43ba3c-d821-442c-989b-754451d72091