HSU Greenhouse Plants in Relation to Countries Around the World

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<u>Abstract</u>

To help visualize which geological regions the Dennis K. Walker Greenhouse represents more than others, and to determine which plant adaptations evolved in relation to convergent evolution, this geospatial analysis was conducted. Data was collected from the Dennis K. Walker Greenhouse at Humboldt State University by recording the name (common and scientific), room location, and region of origin. Utilizing ArcMap, data was mapped to both the greenhouse and to the world using appropriate data sets. The analysis was split into two stages: analyzing the countries and states (Stage 1) and interpreting and mapping the greenhouse and its rooms (Stage 2). After lengthy analysis, results displayed the most represented regions in the entire Greenhouse including Central America, Eastern South America, and Southern Africa. Furthermore, the most represented country in the each of the rooms are displayed. Overall, this project provides knowledge of where plants originate from and which room they are classified into the Dennis K. Walker Greenhouse. With this knowledge, a better understanding on how convergent evolution has affected the adaptations of these plants on different continents or countries is gained.

Introduction

The world is made up of numerous diversified vegetation regions, ranging from tropical forests to arid deserts. Since vegetation regions around the world could be alike or parallel, the plants present in them would be subjected to similar environmental variables. These variables can lead to something called convergent evolution, or the process of unrelated species evolving similar adaptations. The Dennis K. Walker Greenhouse located at Humboldt State University has a collection of plants from around the world (Figure 1). Its 11,500 square feet of space contains over 1,000 different species of plants, and is the largest collection in the CSU system. It is

separated into six rooms that simulate different vegetative regions: temperate, tropical, desert, fern, aquatic, and subtropic.

The goal of this project is to help visualize which geological region the Dennis K. Walker Greenhouse represents to a greater extent than others. Knowing this would allow students who visit the greenhouse to better discern what adaptations the plants from each region have evolved while providing a better look at convergent evolution. The analysis will be separated into two stages: one where the greenhouse and its rooms are interpreted and mapped, and the other where the countries and states are analyzed. For each plant, we will try to be as precise as possible with their origin, and we expect to see some that will have a broad geographic range that expands beyond a single state/country. In those instances, each state/country in it's range will be counted as an origin area for a single plant.



Figure 1. The Dennis K. Walker Greenhouse in relation to Humboldt County.

Methods

Data was collected from the Dennis K. Walker Greenhouse at Humboldt State University by recording the name (common and scientific), room location, and region of origin. The data will then be mapped to both the greenhouse, as well as a world map. We will be using the following external datasets: <u>HSU Campus Map (For Greenhouse)</u>, <u>World Map with</u> <u>Administrative Boundaries</u>. These datasets are in the WGS 1984 geographic coordinate system. The analysis was split into two parts: analyzing the countries and states (Stage 1) and interpreting and mapping the greenhouse and its rooms (Stage 2).

For stage 1, the data from the Greenhouse was then used to gather a count of each county represented. Regions (e.g. tropics) and ranges (e.g. Japan - Taiwan) were also converted into this country count, and each room was recorded separately. For each room, this count was joined to our world map shapefile and exported to a new shapefile to permanently join. These new layers were then each projected to Eckert IV due to its equal-area properties and our desire for proper representation with minimal distortion. To display the counts, the symbology was changed to graduated colors according to the Count field. To account for the whole greenhouse, the counts were added together and added to the map using the same method for the rooms.

For stage 2, the final counts for the greenhouse were sorted by most occurring and represented according to the greenhouse room. The HSU campus map was used to export the greenhouse, and the rooms themselves were geo-processed from the <u>greenhouse layout</u>. After digitizing the pertinent rooms, the most occurring countries were added to the attribute table. This field was used to represent the symbology and ties in most occurring.

Results

_____The results show that many regions of the earth are represented in each room of the Greenhouse. In the Aquatic Room, the countries most represented are in North America and Eastern South America (Figure 2). The Desert Room most represents countries in North America, Central America, and Southern Africa (Figure 3). The Fern Room, similar to the Aquatic Room, most represents countries in North America and Eastern South America (Figure 4). The Subtropical Dome most represents countries in Eastern South America and Australia

(Figure 5). The most represented countries in the Temperate Room are in Central America, Asia, and South Africa (Figure 6). The Tropical Room most represented countries in Central America, Eastern South America, and parts of Asia (Figure 7). The countries represented the most in the entire Greenhouse were in Central America, Eastern South America, and South Africa (Figure 8). The most represented country in each room of the Greenhouse is also given (Figure 9).



Figure 2. The most represented countries of the Aquatic room of the Dennis K. Walker Greenhouse.



Figure 3. The most represented countries of the Desert room of the Dennis K. Walker Greenhouse.



Figure 4. The most represented countries of the Fern room of the Dennis K. Walker Greenhouse.



Figure 5. The most represented countries of the Subtropical Dome of the Dennis K. Walker Greenhouse.



Figure 6. The most represented countries of the Temperate room of the Dennis K. Walker Greenhouse.



Figure 7. The most represented countries of the Tropical room of the Dennis K. Walker Greenhouse.



Figure 8. The most represented countries of the Dennis K. Walker Greenhouse.



Figure 9. The Dennis K. Walker Greenhouse, and the most represented county for each room.

Discussion and Conclusion

The purpose of this study was to learn which regions of the world are most represented in the Dennis K. Walker Greenhouse. The results show that there is a wide distribution of the countries that are represented in the Dennis K. Walker Greenhouse. Each room in the Greenhouse represents certain regions more than others based on the criteria, such as tropical and aquatic. It is intriguing to know which regions you can find the most of a certain type of plant located. This study also shows evidence of convergent evolution, as many of these species have similar characteristics even though they are continents apart.

A few recommendations for the Greenhouse were noted as we went through this project. One is that the Greenhouse should make the names more specific and detailed for each plant in every room. Also, access to the Greenhouse shouldn't be so limited as it was difficult to find time to go in and collect data. Lastly, when listing the regions where the plant is located, it should be more specific. For example, some of the plants only said East Africa, or Pantropical, or Old Tropics. These regions were not very helpful and we had to conduct some research to find the specific countries within those regions.

In conclusion, this study allowed us to determine which regions of the world are the most represented on our campus' greenhouse. It is interesting to know where these plants came from and which room they are classified into. With this knowledge, we have a better understanding of how convergent evolution has affected the adaptations of these plants on different continents. We can only hope that our project will allow students or visitors have a greater experience when they visit the greenhouse.

Acknowledgements

We would like to give our thanks to the Dennis K. Walker Greenhouse manager, Brianne Lee, for giving us access into each of the greenhouse rooms.

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<u>Appendix</u>

Table 1. How many times each country w	vas represented for	r each room,	as well as	s the gree	nhouse
	itself.				

Country	Aquatic	Desert	Fern	Subtropical	Temperate	Tropical	All
Afghanistan	3	0	2	1	10	0	16
Åland	4	0	2	0	5	0	11
Albania	4	0	2	0	7	0	13
Algeria	3	2	0	0	3	0	8
American Samoa	1	0	9	5	1	1	17
Andorra	4	0	2	0	5	0	11
Angola	2	2	3	1	1	0	9
Anguilla	3	2	2	4	3	1	15
Antarctica	0	0	0	0	0	0	0
Antigua and Barbuda	3	2	2	4	3	1	15
Argentina	5	6	7	8	8	2	36
Armenia	3	0	2	1	8	0	14
Aruba	3	2	2	4	3	1	15
Australia	3	0	14	10	9	3	39
Austria	4	0	2	0	5	0	11
Azerbaijan	3	0	2	1	8	0	14
Bahamas	3	2	2	4	3	1	15
Bahrain	3	0	2	1	8	0	14
Bangladesh	3	0	2	3	11	0	19
Barbados	3	2	2	4	3	1	15
Belarus	4	0	2	0	5	0	11
Belgium	4	0	2	0	5	0	11
Belize	4	5	6	5	7	4	31
Benin	2	2	4	2	1	0	11
Bermuda	5	0	2	0	4	0	11
Bhutan	3	0	2	3	11	0	19
Bolivia	5	4	9	7	8	2	35
Bonaire, Saint Eustatius and Saba	3	2	2	4	3	1	15
Bosnia and Herzegovina	4	0	2	0	7	0	13
Botswana	2	1	0	1	1	1	6
Brazil	9	7	9	11	9	7	52
British Virgin Islands	3	2	2	4	3	1	15
Brunei	4	1	9	5	13	6	38
Bulgaria	4	0	2	0	6	0	12
Burkina Faso	2	2	4	2	1	0	11
Burundi	2	2	4	1	2	0	11

Cambodia	4	1	9	5	12	6	37
Cameroon	2	1	3	1	1	0	8
Canada	7	0	2	0	3	0	12
Cape Verde	2	2	4	2	1	0	11
Cayman Islands	3	2	2	4	3	1	15
Central African Republic	2	1	3	1	1	0	8
Chad	2	1	3	1	1	0	8
Chile	5	1	9	7	8	2	32
China	5	1	6	2	14	6	34
Colombia	6	1	9	7	9	6	38
Comoros	2	2	0	1	1	0	6
Cook Islands	1	0	9	3	1	1	15
Costa Rica	4	5	7	5	7	4	32
Côte d'Ivoire	2	2	4	2	1	0	11
Croatia	4	1	2	0	7	0	14
Cuba	3	2	2	4	3	1	15
Curaçao	3	2	2	4	3	1	15
Cyprus	3	0	2	1	9	0	15
Czech Republic	4	0	2	0	5	0	11
Democratic Republic of the Congo	2	1	3	1	1	0	8
Denmark	4	0	2	0	5	0	11
Djibouti	2	3	0	1	1	0	7
Dominica	3	2	2	4	3	1	15
Dominican Republic	3	2	2	4	3	1	15
East Timor	4	1	9	5	13	5	37
Ecuador	5	2	9	7	9	3	35
Egypt	3	2	0	0	3	0	8
El Salvador	4	5	6	5	7	4	31
Equatorial Guinea	2	1	3	1	1	0	8
Eritrea	2	3	0	1	1	0	7
Estonia	4	0	2	0	5	0	11
Ethiopia	2	3	3	2	1	0	11
Falkland Islands	5	0	7	6	4	2	24
Faroe Islands	4	0	2	0	5	0	11
Fiji	1	0	7	4	1	0	13
Finland	4	0	2	0	5	0	11
France	4	1	2	0	6	0	13
French Guiana	6	1	9	6	4	4	30
French Polynesia	1	0	9	4	1	1	16

Gabon	2	1	3	1	1	0	8
Gambia	2	2	4	2	1	0	11
Georgia	3	0	2	1	8	0	14
Germany	4	0	2	0	5	0	11
Ghana	2	2	4	2	1	0	11
Gibraltar	4	0	2	0	6	0	12
Greece	4	1	2	0	7	0	14
Greenland	5	0	2	0	3	0	10
Grenada	3	2	2	4	3	1	15
Guadeloupe	3	2	2	4	3	1	15
Guam	1	0	6	2	1	0	10
Guatemala	4	5	6	5	7	6	33
Guernsey	4	0	2	0	5	0	11
Guinea	2	2	4	2	1	0	11
Guinea-Bissau	2	2	4	2	1	0	11
Guyana	6	1	9	7	4	4	31
Haiti	3	2	2	4	3	1	15
Honduras	4	5	6	5	8	5	33
Hong Kong	4	0	2	2	7	0	15
Hungary	4	0	2	0	5	0	11
Iceland	4	0	2	0	5	0	11
India	5	2	7	6	15	3	38
Indonesia	4	1	9	6	13	7	40
Iran	3	0	2	1	10	0	16
Iraq	3	0	2	1	8	0	14
Ireland	4	0	2	0	5	0	11
Isle of Man	4	0	2	0	5	0	11
Israel	3	1	2	1	9	0	16
Italy	4	1	2	0	6	0	13
Jamaica	3	2	2	4	3	1	15
Japan	4	0	4	2	8	4	22
Jersey	4	0	2	0	5	0	11
Jordan	3	0	2	1	8	0	14
Kazakhstan	3	0	2	1	7	0	13
Kenya	2	3	3	1	2	2	13
Kiribati	1	0	6	4	1	0	12
Kuwait	3	0	2	1	8	0	14
Kyrgyzstan	3	0	2	1	7	0	13
Laos	4	1	9	5	12	5	36

Latvia	4	0	2	0	5	0	11
Lebanon	3	1	2	1	9	0	16
Lesotho	2	2	0	1	2	1	8
Liberia	2	2	4	2	1	1	12
Libya	3	2	0	0	3	0	8
Liechtenstein	4	0	2	0	5	0	11
Lithuania	4	0	2	0	5	0	11
Luxembourg	4	0	2	0	5	0	11
Macao	4	0	2	2	7	0	15
Macedonia	4	0	2	0	6	0	12
Madagascar	2	15	0	1	5	1	24
Malawi	2	3	3	1	2	1	12
Malaysia	4	1	11	7	14	7	44
Maldives	3	0	2	1	10	0	16
Mali	2	2	4	2	1	0	11
Malta	4	0	2	0	7	0	13
Marshall Islands	1	0	6	4	1	0	12
Martinique	3	2	2	4	3	1	15
Mauritania	2	2	1	2	1	0	8
Mauritius	2	2	0	1	1	0	6
Mayotte	2	2	0	1	1	0	6
Mexico	4	28	8	5	23	6	74
Micronesia	1	0	6	4	1	0	12
Moldova	4	0	2	0	5	0	11
Monaco	4	0	2	0	6	0	12
Mongolia	4	0	2	2	7	0	15
Montenegro	4	0	2	0	7	0	13
Montserrat	3	2	2	4	3	1	15
Morocco	3	2	0	0	3	0	8
Mozambique	2	3	3	2	3	1	14
Myanmar	4	1	9	7	12	5	38
Namibia	2	3	0	1	2	0	8
Nauru	1	0	6	2	1	0	10
Nepal	3	0	2	4	12	0	21
Netherlands	4	0	2	0	5	0	11
New Caledonia	1	0	8	4	1	0	14
New Zealand	2	0	4	4	6	0	16
Nicaragua	4	5	6	5	8	4	32
Niger	2	2	4	2	1	0	11

Nigeria	2	2	4	2	1	0	11
Niue	1	0	9	3	1	1	15
Norfolk Island	1	0	0	1	1	0	3
North Korea	4	0	3	2	7	0	16
Northern Mariana Islands	1	0	6	4	1	0	12
Norway	4	0	2	0	5	0	11
Oman	3	2	2	1	8	0	16
Pakistan	3	0	2	1	11	0	17
Palau	1	0	6	4	1	0	12
Palestina	3	0	2	1	9	0	15
Panama	4	5	7	5	7	4	32
Papua New Guinea	1	0	9	5	5	2	22
Paraguay	5	0	7	7	4	2	25
Peru	6	4	9	7	6	3	35
Philippines	4	1	9	6	13	5	38
Pitcairn Islands	1	0	9	3	1	1	15
Poland	4	0	2	0	5	0	11
Portugal	4	1	2	0	5	0	12
Puerto Rico	3	2	2	4	3	1	15
Qatar	3	0	2	1	8	0	14
Republic of Congo	2	1	3	1	1	0	8
Reunion	2	2	0	1	1	0	6
Romania	4	0	2	0	5	0	11
Russia	4	0	2	0	5	0	11
Rwanda	2	2	4	1	2	0	11
Saint Barthélemy	3	2	2	4	3	1	15
Saint Helena	2	2	4	2	1	0	11
Saint Kitts and Nevis	3	2	2	4	3	1	15
Saint Lucia	3	2	2	4	3	1	15
Saint Pierre and Miquelon	5	0	2	0	3	0	10
Saint Vincent and the Grenadines	3	2	2	4	3	1	15
Samoa	1	0	9	5	1	1	17
San Marino	4	0	2	0	5	0	11
Sao Tome and Principe	2	1	3	1	1	0	8
Saudi Arabia	3	2	2	2	8	0	17
Senegal	2	2	4	2	1	0	11
Serbia	4	0	2	0	6	0	12
Seychelles	2	2	0	1	1	0	6
Sierra Leone	2	2	4	2	1	2	13

Singapore	4	1	9	5	13	6	38
Sint Maarten	3	2	2	4	3	1	15
Slovakia	4	0	2	0	5	0	11
Slovenia	4	0	2	0	6	0	12
Solomon Islands	1	0	6	4	3	0	14
Somalia	2	3	3	1	1	0	10
South Africa	2	28	0	5	13	1	49
South Korea	4	0	3	2	7	1	17
South Sudan	2	0	4	1	1	0	8
Spain	4	1	2	0	7	0	14
Sri Lanka	5	1	3	3	12	1	25
Sudan	3	1	3	0	2	0	9
Suriname	6	1	9	7	4	4	31
Svalbard and Jan Mayen	4	0	2	0	5	0	11
Swaziland	2	2	0	0	3	1	8
Sweden	4	0	2	0	5	0	11
Switzerland	4	0	2	0	5	0	11
Syria	3	1	2	1	9	0	16
Taiwan	4	0	4	5	8	2	23
Tajikistan	3	0	2	1	7	0	13
Tanzania	2	4	3	1	2	2	14
Thailand	4	1	9	6	12	6	38
Тодо	2	2	4	2	1	0	11
Tokelau	1	0	9	3	1	1	15
Tonga	1	0	9	5	1	1	17
Trinidad and Tobago	3	2	2	4	3	1	15
Tunisia	3	2	0	0	3	0	8
Turkey	3	1	2	1	9	0	16
Turkmenistan	3	0	2	1	7	0	13
Turks and Caicos Islands	3	2	2	4	2	1	14
Tuvalu	1	0	9	3	1	1	15
Uganda	2	2	3	1	2	0	10
Ukraine	4	0	2	0	5	0	11
United Arab Emirates	3	0	2	1	8	0	14
United Kingdom	4	0	2	0	5	0	11
United States	9	10	10	3	9	0	41
Uruguay	5	0	7	7	4	2	25
Uzbekistan	3	0	2	1	7	0	13
Vanuatu	1	0	6	4	3	0	14

Vatican City	4	0	2	0	5	0	11
Venezuela	7	1	9	7	5	6	35
Vietnam	4	1	9	5	12	6	37
Virgin Islands, U.S.	3	2	2	4	3	1	15
Wallis and Futuna	1	0	9	3	1	1	15
Western Sahara	3	3	0	1	2	0	9
Yemen	3	3	2	2	8	0	18
Zambia	2	3	3	1	1	1	11
Zimbabwe	2	5	0	2	2	0	11

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