

**Overview:** An ecosystem is simulated over a period of 72 months. In this ecosystem, grain grows or dies depending on the temperature and precipitation (generated randomly given a specific month). Deer population depends on the amount of grain. Human hunter-gatherers in the area depends on both grain growth and deer populations.

1. My own-choice quantity is hunter-gatherers (don't ask why there are hunter-gatherers in 2017-2022). These technologically primitive humans depend on wild grain growth and deer populations in order to grow. When there are plenty of grain and deer to eat, many come to live and eat in the area (+2). If there is either sufficient grain or a decent deer population, some more will come (+1). Low grain growth and deer populations will cause some to leave (-1), and a horrible month where there is no grain or deer will make many relocate to better areas (-2). The hunter-gatherers are very nomadic, and rarely will their population be stable in this area. Winter and early spring months are a challenge for them to survive, and until grain and deer populations recover from winter, no hunter-gatherers will be in the area.

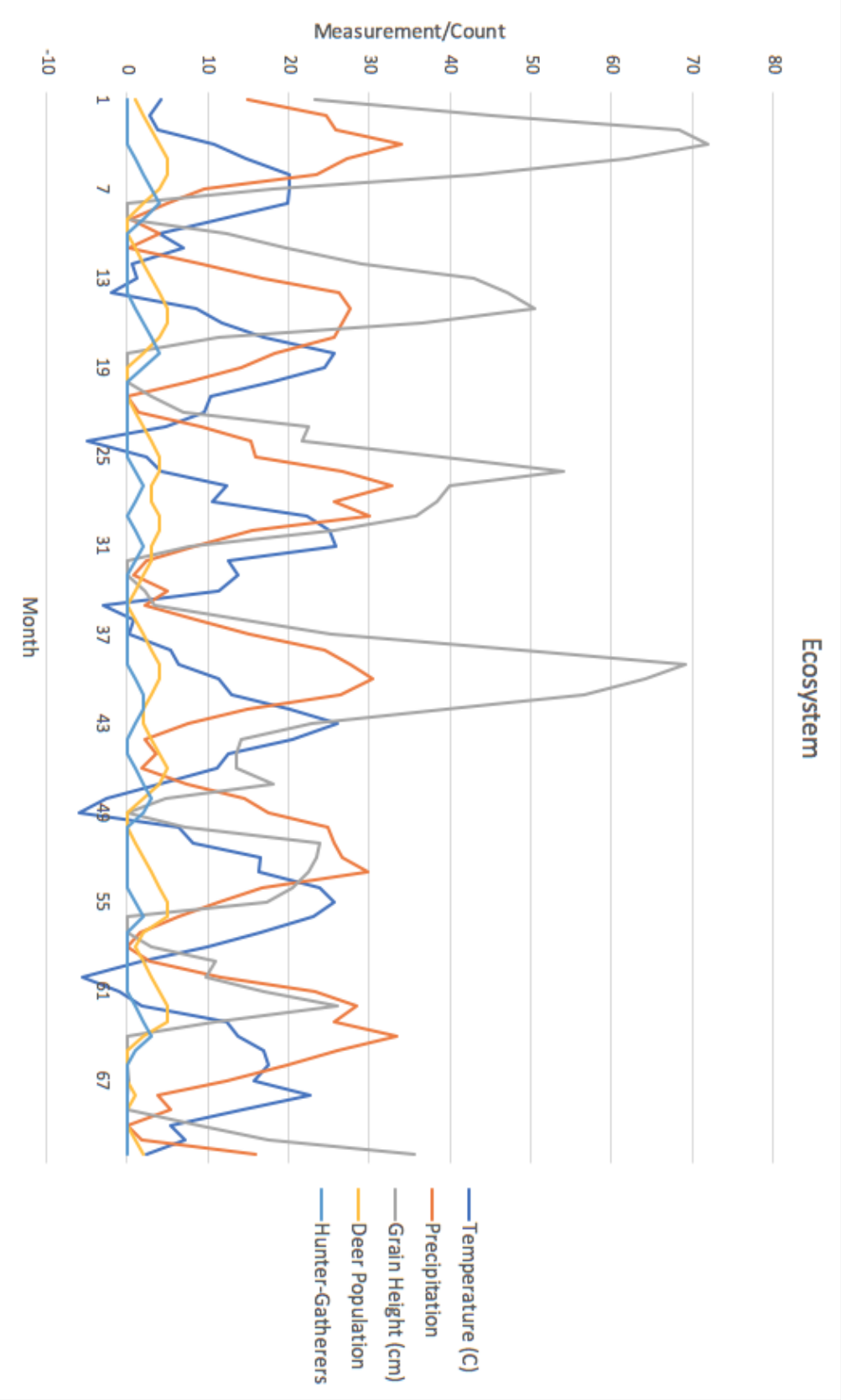
2.

Year	Month	Temperature (C)	Precipitation	Grain Height (cm)	Deer Population	Hunter-Gatherers
2017	0	4.15	15	23.32	1	0
2017	1	2.74	24.61	45.14	2	0
2017	2	3.88	25.84	68.37	3	0
2017	3	10.81	33.98	71.91	4	0
2017	4	14.65	27.21	61.99	5	1
2017	5	20.06	23.55	43.58	5	2
2017	6	20.15	9.5	18.19	4	3
2017	7	19.89	4.92	0	2	4
2017	8	11.45	0.42	0	0	2
2017	9	4	3.97	12.38	0	0

2017	10	6.88	0.27	19.63	1	0
2017	11	0.66	9.11	28.94	2	0
2018	0	1.18	16.62	43	3	0
2018	1	-2	26.24	47.07	4	0
2018	2	8.64	27.54	50.54	5	1
2018	3	11.78	26.69	36.56	5	2
2018	4	16.91	25.71	11.33	4	3
2018	5	25.59	18.37	0	2	4
2018	6	24.49	14.09	0	0	2
2018	7	17.82	7.63	0	0	0
2018	8	10.37	0	3	0	0
2018	9	9.52	1.43	6.9	1	0
2018	10	4.77	9.07	22.37	2	0
2018	11	-4.97	15.27	21.68	3	0
2019	0	2.37	15.91	38.99	4	0
2019	1	4.19	26.73	54.11	4	1
2019	2	12.43	32.86	39.92	3	2
2019	3	10.45	25.71	38.29	3	1
2019	4	22.27	29.95	35.76	4	0
2019	5	25.11	15.45	25.6	4	1
2019	6	25.94	8.27	7.82	3	2
2019	7	12.49	2.42	0	3	1
2019	8	13.71	0.78	0	2	0
2019	9	11.4	4.98	2.14	1	0

2019	10	-2.87	2.24	3.46	0	0
2019	11	0.86	8.55	14.25	1	0
2020	0	0.25	15.15	25.18	2	0
2020	1	5.28	24.42	48.7	3	0
2020	2	6.39	27.56	69.11	4	0
2020	3	11.31	30.32	64.27	4	1
2020	4	12.9	26.46	56.6	3	2
2020	5	20.11	14.89	39.46	2	2
2020	6	26.14	7.54	22.95	2	1
2020	7	20.56	2.25	14.07	3	0
2020	8	12.59	3.69	13.58	4	0
2020	9	11.08	1.73	13.6	5	1
2020	10	4.02	7.45	18.13	4	2
2020	11	-2.47	14.5	4.84	2	3
2021	0	-5.99	17.42	0	0	2
2021	1	6.38	24.81	7.25	0	0
2021	2	8.07	25.63	23.82	1	0
2021	3	16.52	26.71	23.41	2	0
2021	4	16.22	29.84	22.42	3	0
2021	5	23.82	16.73	20.52	4	0
2021	6	25.64	11.43	17.34	5	1
2021	7	23.06	6.31	0	5	2
2021	8	16.56	1.67	0	2	0
2021	9	9.9	0	2.93	1	0

2021	10	1.87	2.86	10.98	2	0
2021	11	-5.63	11.61	9.78	3	0
2022	0	-1.02	23.25	16.81	4	0
2022	1	1.82	28.42	26.04	5	1
2022	2	12.4	25.58	10.9	5	2
2022	3	13.68	33.45	0	2	3
2022	4	16.87	26.14	0	0	1
2022	5	17.56	19.91	0	0	0
2022	6	15.75	12.32	0.31	0	0
2022	7	22.67	3.88	0	1	0
2022	8	14.23	5.38	0	0	0
2022	9	5.44	0	9.05	0	0
2022	10	7.17	1.83	17.48	1	0
2022	11	2.39	15.98	35.52	2	0



#### 4. Patterns and reasons:

- Temperature is randomized, but is pretty consistently seasonal year-to-year. So the temperature rises steadily and peaks around midyear. It then begins to drop steadily, often going negative Celsius around the end and beginning of the years. Precipitation has a very similar pattern to temperature, except that it trails a little bit behind: precipitation steadily rises and peaks around the first quarter of each year, and then dips to the single digits by the 3rd quarter of each year. These patterns make sense, as they're based on sine/cosine waves with minor randomized tweaks.
- Grain height is affected by every other factor in the ecosystem, but precipitation and temperature are the largest two factors that affect the growth and amount of grain availability, with precipitation being the biggest factor significantly. This can be seen in the graph, as peak grain heights correlate strongly with peak precipitation. Deer and hunter-gatherers also reduce grain height as both groups consume more and more grain as their population grows, however this by far has less of an effect than how precipitation and temperature affect grain height, mostly due to the fact that deer and hunter-gatherer populations are never really big enough to be a significant factor, and they themselves are hugely affecting one another as well and keeping each other in check.
- Deer population flourish when there is plenty of grain to eat. This can be seen in the graph, as when grain height grows and peaks, so does deer population. Unfortunately, when the deer population gets bigger, hunter-gatherers are quick to come into the ecosystem to hunt them: we see that around each deer population peak, the number of hunter-gatherers also starts growing. This, combined with the seasons of drought and grain height loss is devastating to the deer population. We see that they get decimated consistently (except during 2019) around the 3rd quarter of each year due to the number of hunter-gatherers (which peak at this point) and sudden lack of grain to eat (which also significantly drops at this time).
- The hunter-gatherers come when grain and deer population are plentiful, and leave when they are not. They are more influenced by the deer population than the grain height, as they come to the ecosystem rapidly when deer population peaks. Unfortunately, their presence also leads to their decline. The more hunter-gatherers there are, the quicker the deer population also declines. When the deer population gets decimated due to hunting and low grain height, the hunter-gatherers quickly leave as well. Being herbivores, the hunter-gatherers also consume grain, but given their low numbers and appearance, grain height is not affected too much by them. No hunter-gatherers are usually seen in late fall to winter, as there are no deers to hunt around this time. They only come to the

ecosystem around late spring and summer when deer populations are sufficiently good.