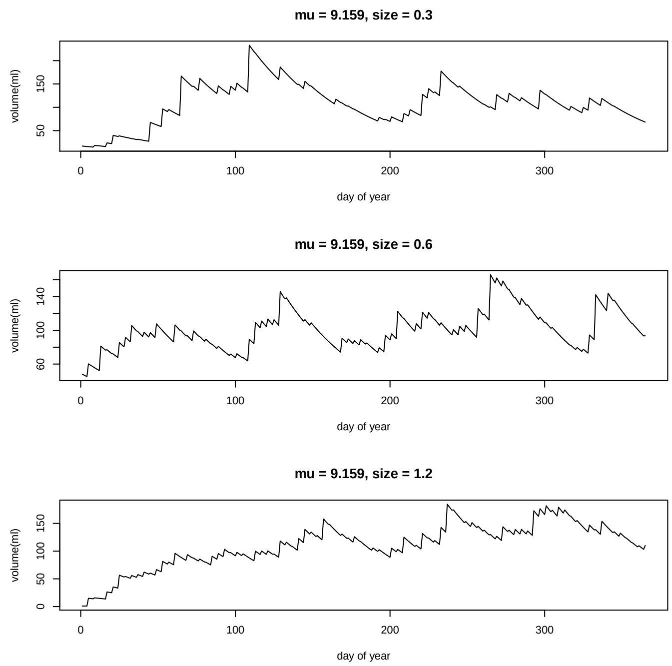

Figure 1: Variation in water level within one year. The parameter estimates represent the observed for Costa Rica, with various values of k. (i.e. parameter values corresponding to the center column in the table that Diane sent)

Hello everyone,

Diane's idea of fitting rainfall to a statistical distribution, and manipulating the parameters of that distribution, really caught my imagination. I started to sketch out how I picture it working, and ended up with the following simulation in R. I thought the results might be interesting, so I'll describe what I did.

First, I imagined that, since Diane had simulated 92 values, that she had intended them to be evenly spaced at 4 day intervals over an entire year. I see from the mailing list that in fact we are considering a 60 day experiment, but I think that, for the sake of just exploring the idea in a simulation, the duration isn't too important.

In my simulations, I used the same range of parameters that Diane suggested in her email. I simulated 92 values from the negative binomial distribution and assigned each to a "water day" (at 4 day intervals) in a random sequence. I also imagined that the bromeliads dry out every day, losing 2 percent of their volume daily (this is probably too high?). The bromeliads are visited every fourth day by a perfectly responsible graduate student, who measures the quantity of water and adds the amount prescribed by the distribution (which may be 0). On unwatered days the bromeliads continue to dry.

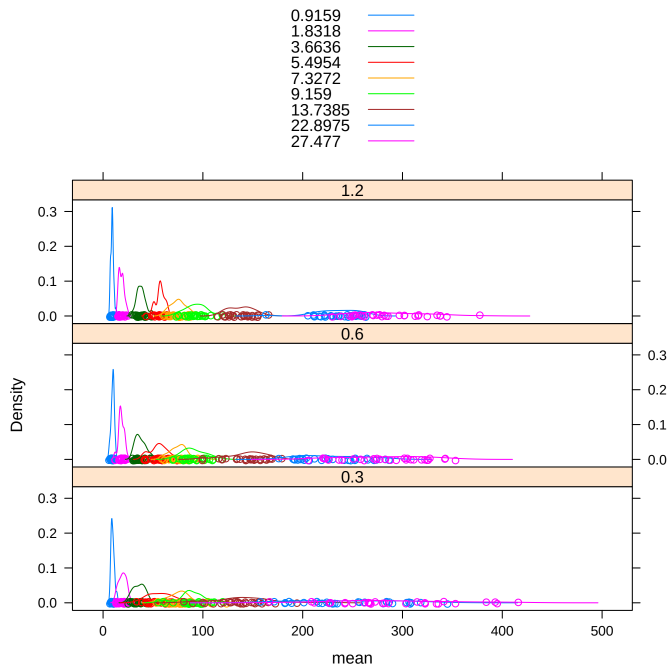

Figure 2: Mean annual variation in water content for 30 bromeliads in each combination of parameter values. Within each panel, the different colours represent different values of mu (see key). the different panels are different values of k.

The spiky lines here show how the water level in three bromeliads might change in this kind of scenario. Its a really rudimentary simulation: bromeliads start from empty, and have no maximum size.

I think we were discussing collecting some aggregate data on water levels, such as average water content. In these simulations, our dutiful grad student measures the water just before adding more. So, our data on mean water content represents the low point before each spike.

We can calculate the mean water content of a bromeliad under all the pairs of parameters that Diane suggested (Figure 2). Each density curve represents 30 bromeliads. It seems like, even with very large sample sizes, there can be large variation within treatments when mu is large.

I was also interested by Regis and Ignacio's comments about the *sequence* of water additions. Again focusing on mean water content, I made a graph of mean water volume as a function of total water volume (Fig 3)

I completely agree that there may be important biological consequences to the timing of rainfall (e.g. how much water is present during the breeding window of a certain population). However, I thought it was interesting to see that there can be quite a lot of variation in something as basic as mean annual water content, just based on how much time the bromeliad spent drying out.

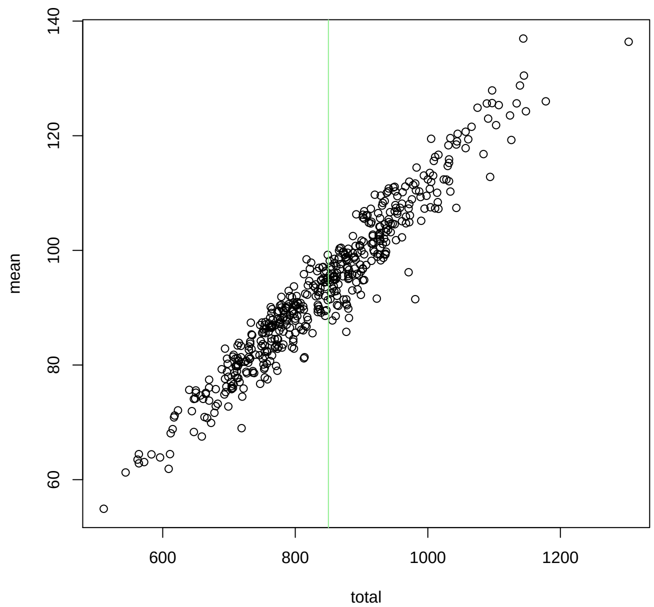

Figure 3: 500 simulations of the relationship between the total amount of rain that falls in a year, and the average water content of the bromeliad. Because each simulation is drawn at random, they vary in their total water content (x axis). Within a given total rainfall amount (e.g. green line), variation in mean bromeliad capacity is entirely due to how much time the bromeliad spends drying out – which may vary, depending on how many low-precipitation days happened to occur consecutively. parameters are constant for all simulations: mu = 9.159, k=0.6

Perhaps we are actually trying to vary too much. Varying the number of rainy days, as well as the amount of rainy days, is already quite a lot. Maybe we should try to hold the sequence in which they occur relatively constant. Here's one possibility:

- first simulate all the rain amounts: all the replicates, in all the parameter combinations we intend to use
- within each of these simulated "yearly rainfalls", score each rainy day with a percentile
- calculate the mean amount of rain on each calendar day for the last ten years, and transform these into percentiles too
- map the simulated rain onto calendar dates, using the observed percentiles as a guide.

What I'm trying to imagine is a way to put the rainiest days and the driest days in the same order within all treatments. So, on the "rainiest day", one bromeliad might get 70ml, while another only gets 30ml – but both cases it is the maximum rain they will get in the entire experiment, and they get it on the same day. Mapping this sequence onto natural rainfall might not be necessary (for many sites, the natural variation probably looks pretty random!) – but having some standard among all replicates and treatments seems like a good idea.

I haven't done much playing with drying rate to see what effect that has on any of these patterns. I thought I would see what everyone thinks before getting too carried away. Thoughts?