MONT 105N – Analyzing Environmental Data
A modeling example
Class, January 28, 2019

Consider the following situation:

- A park service wants to maintain a stock of rainbow trout in a (relatively small) lake as a resource for recreational fishermen.
- The lake manager knows that for a long period, the number of trout caught every week has been 50 and that the total population of the lake has been 600 adult trout.
- The trout population in the lake has been maintained by buying adult trout from a commercial hatchery and introducing them in the lake on a regular basis (restocking).
- Orders of new trout for restocking take exactly *five weeks* to arrive from the hatchery to the lake (a *delivery delay*).
- Now suppose that at some point the demand for fishing increases and there will be 55 fish caught every week.
- In order to plan for the restocking under the new situation (and provide some flexibility in case the demand changes again in other ways), the manager decides to institute the following system:

  1. Each week, she will compute the *average* of the numbers of fish caught in the *five previous weeks*. She calls this the *perceived need for restocking*.
  2. Having too many fish in the lake makes the fishing too easy (the fishermen want a challenge, after all!). But having too few fish makes the fishing too difficult. The ideal number is for the total number of fish in the lake to be $12\times$ the number of fish that will be taken. This the *desired number* of fish she aims to maintain.
  3. Each week the manager decides to do a count of the actual number of the fish in the lake and finds the difference between the desired number from point 2 above and the actual number; she calls the difference the *discrepancy*.
  4. While it would certainly be possible to try to order enough new fish to make up the demand plus the discrepancy each week, she decides it's probably better (partly because of the delivery delay) to try to "spread out" making up the discrepancy over several weeks–say *three weeks*. This might also change in the future, so she thinks of this as an adjustable parameter. In other words, the order of fish from the hatchery will be

     $$\text{(fish caught in previous week)} + \text{(discrepancy)}/3$$

     to start. Note that not trying to make up the full discrepancy immediately means that the manager is building in a *response delay*. Also, note that in some extreme situations it could be true that the discrepancy was very negative and the formula above could yield a negative number. How should the manager handle that??

We want to try to model this situation to understand what will happen over a period of about 2 years – i.e. 100 weeks.