

## Drawing Flow Diagrams (taken from Otto & Day)

1. Draw a separate circle to represent each variable in your model.
2. Use a solid arrow to indicate when a process removes an amount of the variable (arrow exits circle) or contributes an amount to the variable (arrow enters circle).
3. Use an arrow that comes from nowhere but that enters a circle to indicate when there is an external source for one of the variables (e.g., mice from another field).
4. Use an arrow that comes from a circle but goes to nowhere (or to a skull) to indicate when a variable exits the system (e.g., by death or emigration).
5. Use an arrow that starts at one circle and goes to another circle to indicate when one type can become converted into another type (e.g., a susceptible individual catches the flu).
6. Use a dashed arrow to indicate when a variable influences the flow into another circle but does not represent a decline in the variable from which the arrow begins (e.g., a carrier of the flu does not lose the flu by passing it on).
7. Include an arrow that exits and returns to the same circle ("a returning arrow") whenever a variable can generate more of itself (e.g., by new births). A returning arrow can represent changes due to births only, or can describe the net change following both births and deaths.
8. Write down the total flow along each arrow, specifying how this flow depends on the variable from which the arrow comes and on any interacting variables. If the flow across an arrow represents a conversion from one type to another (e.g., from number of prey to number of predators), there may be a conversion factor (e.g., one prey might represent only  $\epsilon = 1/100$  of the resources needed to produce one predator). Write this factor as "times  $\epsilon$ " at the end of the arrow.
9. For discrete-time models, decide on an ordering for the various events that occur during each time step and put a prime after the variable to indicate its state "after the first event," a double prime after the variable to indicate its state "after the second event," etc.
10. Check to make certain that your variables are linked together in the way that you want.
11. Check to make sure that each arrow has a flow rate written by it.
12. Check to see if there are any variables that are completely unconnected to the rest of the diagram.
13. Check to see if there are any parameters in your model that do not appear on the flow diagram.
14. For a discrete-time model, check that there is never more than 100% of a variable leaving a circle.