# Passenger Pigeon/Allee effect

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## Allee Effect

Figure 1:

What happens if density dependence goes the other way? What if an decrease in density changes vital rates to produce an *decrease* in the population growth rate $r$?

Imagine a very social species, like prairie dogs. If the density is high, they can warn each other about predators. If the density is low, the predation rate might go up, resulting in higher $d$. This is a positive feedback, and can result in, well, you should simulate it for yourself! But remember, positive feedbacks generally result in unstable or non-regulated systems!

This effect – whereby population growth rate may **decrease** when population size decreases – is called an **Allee effect**, named after ecologist Warder Clyde Allee (1885-1955). Allee specialized in social behavior and aggregations, and recognized the benefits of social aggregations to individual fitness.

Interestingly, Allee's interest in cooperation and the benefits of social aggregations spilled over into his life in other ways. He was an anti-war activist!

One of the most famous examples of a possible Allee effect involves the passenger pigeon (*Ectopistes migratorius*).

The passenger pigeon was one of the most abundant birds in North America. Some estimate that the total species abundance may have been over three *billion*!

Aldo Leopold once said,


Figure 2:

Figure 3:

> "Men still live who, in their youth, remember pigeons; trees still live who, in their youth, were shaken by a living wind. But a few decades hence only the oldest oaks will remember, and at long last only the hills will know." â€"Aldo Leopold, â€œOn a Monument to the Pigeon", 1947

What happened to the passenger pigeon? Well, first of all pigeons were hunted on a massive scale using wasteful methods.

Secondly, hardwood forests were cleared on a massive scale, reducing habitat.

But what do passenger pigeons have to do with the Allee effect? Well, they were an *extremely* gregarious species. Once their numbers dwindled (due to hunting and clearcutting) their social systems broke down, and they could no longer effectively reproduce or avoid predators.

## In-class exercise: Allee effect

In this exercise we will explore the implications of **positive density dependence** on vital rates.

1. In InsightMaker, load up the logistic model with vital rates – that is, where $b$ and $d$ are each modeled density-dependent. It should look something like this (or if you don't already have this, load it from here):
2. Now add a new [Variable] called *Allee threshold*. Set this variable equal to 200.
3. As for the other parameters, set them as follows:

- Initial abundance: 201 (just above the Allee threshold)
- Density dependence on birth rate: 0.004
- Density dependence on survival: 0.001
- Max birth rate: 0.8
- Min mortality: 0.3

Figure 4:

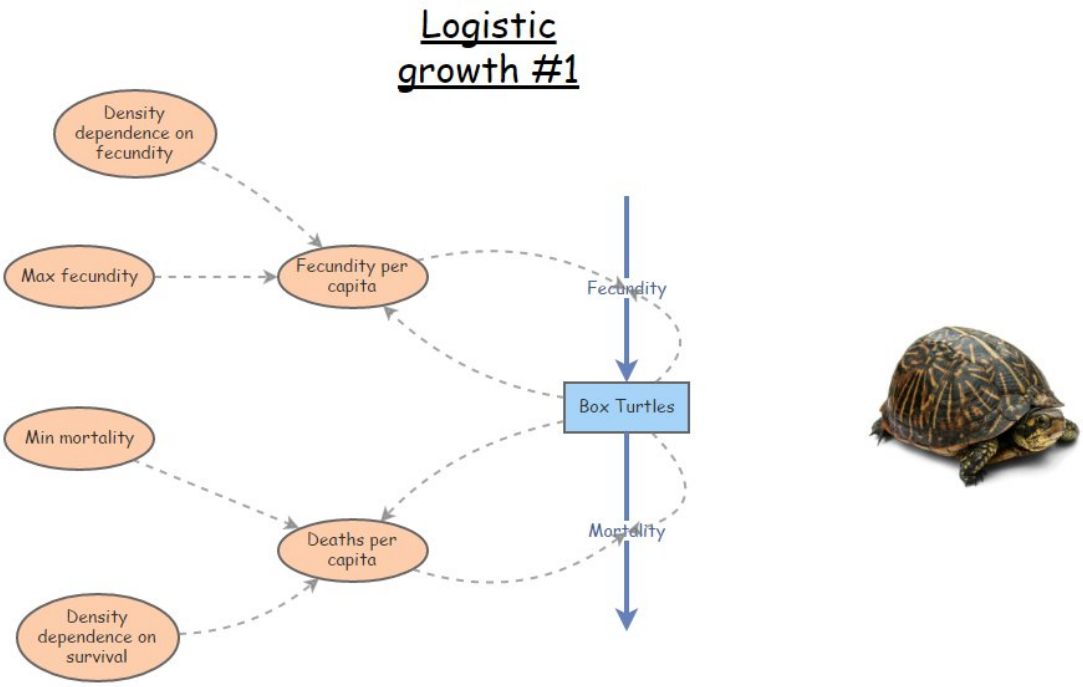
Logistic
growth #1
Density dependence on fecundity
Max fecundity
Fecundity per capita
Fecundity
Box Turtles
Min mortality
Deaths per capita
Mortality
Density dependence on survival

Figure 5:

4. Now let's use a *Conditional (IF-THEN-ELSE) statement* to specify an Allee effect. The population experiences maximum growth rate at the Allee threshold. If the population is above the Allee threshold, the population exhibits (stabilizing) negative density dependence. If the population is below the Allee threshold, then the population experiences positive density dependence- whereby individuals in smaller populations have *lower* overall fitness.

To do this, define your *Births per Capita* using the following syntax:

```
If [Pigeons]<[Allee threshold] Then
  [Max fecundity]-[Density dependence on fecundity]*([Allee threshold]-[Pigeons])
Else
  [Max fecundity]-[Density dependence on fecundity]*([Pigeons]-[Allee threshold])
End If
```

Similarly, define your *Deaths per capita* using the following syntax:

```
If [Pigeons]<[Allee threshold] Then
  [Min mortality]+[Density dependence on survival]*([Allee threshold]-[Pigeons])
Else
  [Min mortality]+[Density dependence on survival]*([Pigeons]-[Allee threshold])
End If
```

5. If we are running out of time in class (which we probably will be!), load the model (and clone it!) using this link!

Now you can try to answer the following questions:

**Q**: What is the carrying capacity (K) for this population?

**Q**: Carrying capacity (K) represents one equilibrium point in this model. Try to find another equilibrium point- that is, a point where the population neither grows nor declines.

**Q**: is this equilibrium a *stable equilibrium* or an *unstable equilibrium*?

**Q**: if you plot birth and death rates as a function of density in this model, can you identify the two equilibria?

**Q:** Why do Allee effects generally spell bad news for wildlife conservation and management?

And just for fun, here is an article about the passenger pigeon and its possible "de-extinction"

**Q:** Do you support bringing back the passenger pigeon? Why or why not??

–go to next lecture–