Uneven-aged Management I.

Lecture 9 (5/1/2017)

Definitions:

- <u>Uneven-aged stand:</u> 3< age classes at all times (ideally, all age-classes are present up to a maximum);
- <u>Uneven-aged management</u>: the process of making decisions to best achieve ownership objectives while maintaining an uneven-aged structure

Advantages of uneven-aged management

- Constant forest cover (good for erosion control);
- Frequent incomes from the stand;
- Provides a specific type of wildlife or plant habitat (diverse tree sizes, multilayered canopy);
- An uneven-aged stand is never clearcut (aesthetically pleasing);
- Low investment requirements because it relies on natural regeneration;
- If shade-tolerant species are in the mix of desired species composition, uneven-aged management is the best tool to maintain that mix.

Disadvantages of uneven-aged management

- Does not work well with shade-intolerant species (e.g., most pines, Douglas fir, aspen, black cherry), etc..;
- Many wildlife species prefer openings, early successional or mature forest patches;
- Requires more detailed info about the stand;
- Complexity: difficult to achieve and maintain;
- More frequent entries and lighter harvests mean (1) higher logging costs per unit wood removed, (2) more damage to residual stand, and (3) more compaction, rutting (i.e., more site degradation);
- High-grading is often practiced in the name of uneven-aged management.

The key decisions in uneven-aged management

- Target diameter-class distribution decision;
- The cutting cycle decision;
- Individual tree harvesting decision.

We will assume that an uneven-aged stand already exists and we will not discuss how to convert an even-aged stand to an uneven-aged stand.

The target diameter-class distribution

- The Q factor: determines the relative balance between smaller and larger trees:

$$Q = \frac{n(d)}{n(d+1)}$$

- The stand basal area (BA): must be low enough to ensure adequate regeneration, yet high enough to maximize the use of the site.
- Maximum diameter (d_{max}): specifies the size at which trees become mature and their future growth would not financially justify to keep them any longer.

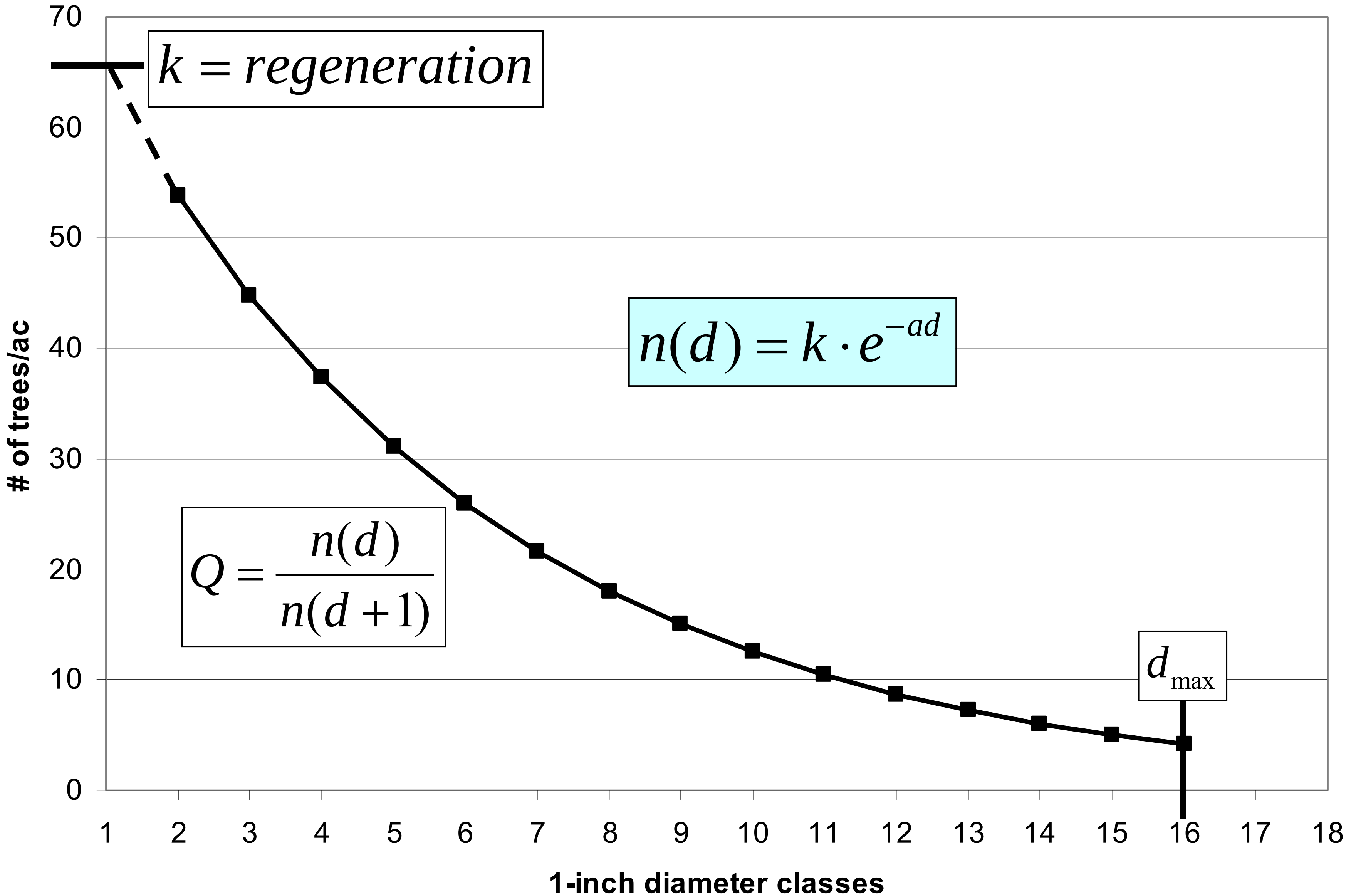
The cutting cycle

- Short cutting cycles:
  - frequent harvests with too little volume,
  - higher average harvesting costs,
  - density can be kept close to optimal for growth and regeneration.
- Long cutting cycles:
  - The stand will deviate far from the target diameter-class distribution,
  - Too sparse at the beginning of the cutting cycle and too dense at the end of it.

The individual tree harvesting decision

- Individual trees must be selected to be cut in diameter-classes with surplus stocking;
- Undesirable trees should be removed first: those that have defects, insect or disease problems, and undesirable species;
- Trees with the least potential to increase in quality sawlog value should go next.

The “Ideal” Diameter-class Distribution



The Negative Exponential Diameter-class Distribution

A proof that $n(d) = k \cdot e^{-ad}$ provides a constant Q:

$$Q = \frac{n(d)}{n(d+1)} = \frac{k \cdot e^{-ad}}{k \cdot e^{-a(d+1)}}$$

Now, use the fact that: $\frac{e^a}{e^b} = e^{(a-b)}$

$$Q = \frac{n(d)}{n(d+1)} = \frac{k \cdot e^{-ad}}{k \cdot e^{-a(d+1)}} = e^{(-ad+ad+a)} = \underline{e^a}$$

The Negative Exponential Diameter-class Distribution (cont.)

$$Q = e^{a} \Longrightarrow a = \ln(Q)$$

- "a" is like the <u>slope</u> of the diameter-class distribution function;
- "k" is the <u>intercept</u>. Proof:

$$n(0) = k \cdot e^{-ad} = k \cdot e^{-a0} = k \cdot e^{0} = \underline{k}$$

- Parameter *k* is a measure of the amount of regeneration that is needed at any point in time in order to maintain the diameter-class distribution.

- Example #1: Calculating *Q* from *a*.

  Determine the *Q* factor for the following diameter-class distribution function: $n(d) = 65 \cdot e^{-0.1823d}$

  Answer: $Q = e^{a} = e^{0.1823} = \underline{1.2}$

- Example #2: Calculating *a* from *Q*.

  What value of the *a* parameter gives a negative exponential diameter-class distribution function with a *Q*=1.3?

  Answer: $a = \ln(Q) = \ln(1.3) = \underline{0.26236}$

Determining the parameters of the negative exponential function

- Example #1: From *Q* and *n(1)*.

Determine the specific form of the negative exponential function with a Q factor of 1.1 and 180 trees in the 1-inch diameter-class (*n(1)* = 180)

Answer:

$$a = \ln(Q) = \ln(1.1) = 0.09531$$

$$\downarrow$$

$$n(1) = k \cdot e^{-0.09531 \cdot (1)} = 180 \rightarrow k = 180 \cdot e^{0.09531} = 180 \cdot 1.1 = \underline{198}$$

The specific form then is: $n(d) = 198 \cdot e^{-0.09531 \cdot (d)}$

Determining the parameters of the negative exponential function (cont.)

- <u>Example #2</u>: From two points.

  Determine the specific form of the negative exponential function that gives 80 trees in the 3-inch diameter-class (*n(3)* = 80) and 45 trees in the 6-inch diameter-class (*n(6)* = 45) .

  <u>Answer:</u>

$$\left.\begin{aligned} n(3) &= 80 = k \cdot e^{-3a} \\ n(6) &= 45 = k \cdot e^{-6a} \end{aligned}\right\} \rightarrow \frac{80}{45} = e^{3a} \longrightarrow a = \frac{\ln(80/45)}{3} = \underline{0.1918}$$

$$\frac{80}{45} = e^{a^3} = Q^3$$

$$\downarrow$$

$$Q = \sqrt[3]{80/45} = 1.21$$

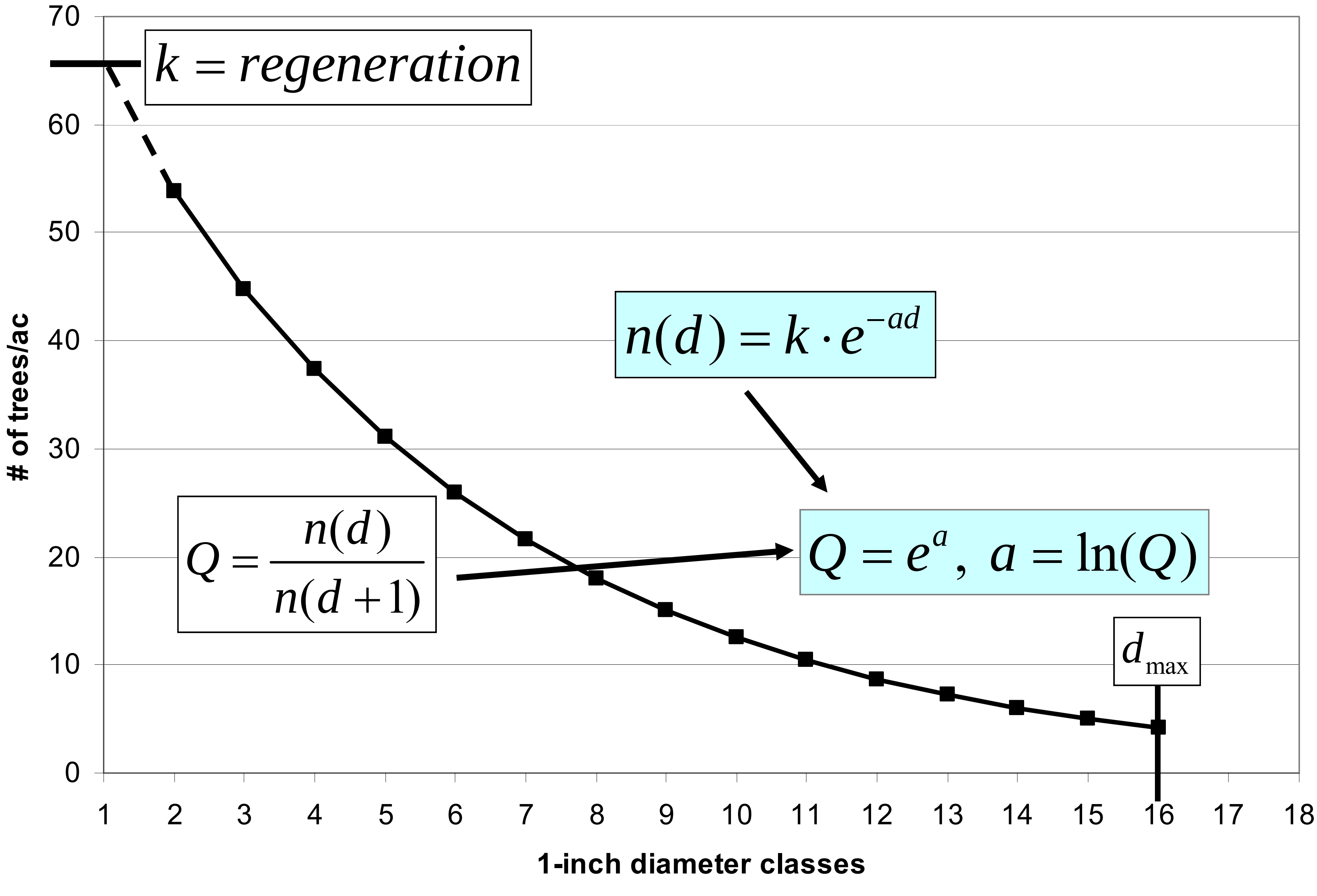
$$Q = e^{a} = e^{0.1918} = \underline{1.21}$$

$$k = 80 \cdot e^{3 \cdot 0.1918} = \underline{142.22}$$

The specific form then is:

$$n(d) = 142.22 \cdot e^{-0.1918(d)}$$

Summary: The negative exponential function



Review of the negative exponential function

- Constant Q;
- Two parameters: *a* (slope), *k* (intercept or regen needed);
- You need *a* and *k* to identify the specific form of the function;
- You can calculate a and k from Q and one point on the curve or from two points on the curve.

Selecting a Q-factor

- We need *a* (slope), *k* (intercept or regeneration), and d_{max}.
- <u>Step 1</u>: Select d_{max};
- <u>Step 2</u>: Select *Q* (which, in turn, defines *a*);
- <u>Step 3</u>: Select *k* (equivalent to selecting a target basal area).

Selecting a Q-factor (cont.)

- The basal area decision is driven by the need to acquire adequate regeneration while maximizing the utilization of the site.
- The selection of k is a silvicultural decision;
- The selection of d_{max} and Q are management decisions.

Regeneration

- The relationship between stand basal area and the amount of regeneration in the stand:
  - Negative slope, and
  - The function is 0 at or above basal areas of 80-90 ft^2.
  - E.g., it can look like this:

$$k = d(0) = 300 \cdot e^{-0.03 \cdot BA}$$