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What Is This Thing Called Growth?

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WHAT IS THIS THING called "growth"? We foresters are constantly thinking in terms of growth. We use growth data to evaluate a forest property. We use them to determine how much we can cut. We use them to weigh the results of a type of cutting.

In using growth data, we juggle them around in different ways to find the answers we need. Sometimes, when we have data that don't quite fit our needs, we come up with results that may confuse others. And sometimes we even confuse ourselves.

Our problem is to present growth data in a way that is not misleading. Here is one approach to the problem.

TERMINOLOGY

First, we should adopt and define a set of terms for the components of growth. The basic elements are accretion, mortality, and ingrowth. These definitions are suggested:

<u>Accretion</u> is growth on the initial trees. These are all trees that were measured at the beginning of the period. Accretion includes the growth on trees that were cut during the period. However, accretion on trees that have died is ignored.

<u>Mortality</u> is the volume of initial trees that have died during the period.

<u>Ingrowth</u> consists of the volume, at the end of the period, of those trees that grew into the lowest inventoried diameter class during the period.

Net growth, production, and volume increase are derived from these elements.

<u>Net growth</u> is accretion minus mortality.

<u>Production</u> is the sum of net growth and ingrowth. In any one diameter class, it is the change in volume during the period. Production is a measure of the growth on an area as compared to the growth of the initial trees.

<u>Volume increase</u> is the sum of accretion and ingrowth. In any one diameter class, it is the change in volume, plus mortality, during the period.

These are all measures of volume growth, and they can be expressed as percentages. <u>Average annual diameter increment</u>, on the other hand, is a linear measure. It is usually expressed in hundredths of inches.

Accretion and production are terms that are used by Bourgenot (<u>1</u>) to describe growth. He says:

> It must be realized that ingrowth does not depend upon the minimum diameter limit adopted by the inventory. If you were to fix that limit at zero, ingrowth would include those seedlings that were produced during the inventory period. Thus, you can easily see that it is the stand that ac-

cretes in volume; the area, which nourishes it, produces.

Volume increase, a term coined by H. Arthur Meyer (2), is a special function of structure in balanced, uneven-aged forests. On such forests, it can be determined directly from a stand table and the average diameter increment.

APPLICATION

After a set of growth terms is adopted, the next step is to decide which terms are needed. The purpose of the growth study gives the clue.

Many foresters want to know how much timber they can cut during a period. Production gives the best estimate. With stable conditions, if the production is cut, the area will produce as much volume during the next period.

But do not forget ingrowth. It may be a large part of production. And it may vary from one period to another. If this were to happen, it would be difficult to keep up the level of production.

Some foresters want to weigh the results of a type of cutting. They know that one type of cutting may yield more than another. Or it may make more efficient use of the growing stock. In general, accretion is the best measure of the immediate results of a treatment. It tells how the treatment affected the growth of the initial trees in the stand.

Since the volume of one large dead tree may equal or exceed the growth on several acres, net growth figures for a small area could be meaningless. For larger areas, where mortality averages out, net growth is better. After some types of cutting there may still be a large amount of mortality. In these cases, mortality data are desirable.

To compare the behavior of diameter classes (or groups), use average annual diameter increment. This is better than using accretion rates. Except in even-aged stands, accretion rates will decrease as diameter increases.

EXAMPLE

A sample presentation of growth data may be helpful. Table 1 contains the basic data for an uneven-aged stand of northern hardwoods for the 15-year period after partial cutting. These data are from 100 percent continuous inventories. They are in gross square feet of basal area per acre. The treated area was $12\frac{1}{2}$ acres; the check, $2\frac{1}{2}$ acres.

Table 2 contains the growth data for the same stand. The table tells how much can be cut. The forester assumes that if he cuts the production of each diameter group, he will have a similar stand 15 years later. (He can, of course, adjust for other cutting cycles.) Uneven-aged stands can be brought into a balanced structure by cutting more or less of the production (or volume increase) in each diameter class. H. A. Meyer (2) has discussed this subject thoroughly.

The data also show that the treated stand benefited from the partial cutting. It accreted 24 square feet of

Table 1.--Stocking of northern hardwoods for 15-year period after partial cutting

Item	Treated stand					Check stand				
	D.b.h. group (in inches)				Total	D.b.h. group (in inches)				Total
	5-10	11-15	16-20	21+		5-10	11-15	16-20	21+	
NUMBER OF TREES										
Initial	69	37	25	8	139	105	31	18	7	161
After cutting	52	28	15	4	99	--	--	--	--	—
Final	64	30	19	5	118	97	35	21	7	160
BASAL AREA, IN SQUARE FEET										
Initial	20	33	43	27	123	30	29	30	21	110
Percent cut	25	24	42	56	37	--	--	--	--	--
After cutting	15	25	25	12	77	--	--	--	--	--
Final	18	28	33	15	94	28	31	36	20	115

Table 2.--Growth behavior of northern hardwoods for 15-year period after partial cutting

Item	Treated stand					Check stand				
	D.b.h. group (in inches)				Total	D.b.h. group (in inches)				Total
	5-10	11-15	16-20	21+		5-10	11-15	16-20	21+	
HUNDREDTHS OF INCHES										
Average annual diameter increment	0.12	0.13	0.11	0.09	0.12	0.06	0.10	0.10	0.09	0.08
SQUARE FEET OF BASAL AREA PER ACRE										
Accretion	8.6	8.4	5.4	1.6	24.0	7.9	6.9	5.7	2.1	22.6
Annual accretion rate	—	—	—	—	2.1	—	—	—	—	1.4
Mortality	1.3	2.0	3.3	4.1	10.7	3.4	2.9	7.1	7.2	20.6
Net growth	7.3	6.4	2.1	-2.5	13.3	4.5	4.0	-1.4	-5.1	2.0
Ingrowth	—	—	—	—	3.7	—	—	—	—	2.7
Production	2.7	3.5	7.3	3.5	17.0	-2.7	1.4	6.3	- .3	4.7
Volume increase	4.0	5.5	10.6	7.6	27.7	.7	4.3	13.4	6.9	25.3

basal area per acre on 77 square feet of growing stock. The check stand accreted 23 square feet on 110. The average annual accretion rate for the treated stand was 2.1 percent; for the check stand, 1.4 percent. Despite the gap in growing-stock levels, the treated stand accreted almost as much volume in trees 16 inches d.b.h. and larger as the check stand.

The smaller diameter groups on the treated stand had a much higher diameter increment than those on the check stand. Average annual diameter increment was parabolic, reaching its peak in the 11- to 15-inch class.

The treated stand lost 11 square feet of basal area per acre in dead trees. The check stand lost 21.

Thus, by using accretion, accretion rate, average annual diameter increment and, in this case, mortality, the forester can evaluate the partial cutting.

This approach to the problem of presenting growth data is best suited for irregular and uneven-aged stands. But on even-aged stands that are just reaching merchantable size, separate rates for accretion and ingrowth should be shown. This would reduce some of the fantastic "growth percents" we read about.

Under some methods of growth estimation, all the growth components cannot be separated. The forester must balance the data he needs against what he can get.

LITERATURE CITED

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