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Land Survey of the Town of Durham, New Hampshire

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DURHAM, N. H.

SUMMARY

For this survey the town of Durham, N. H., was separated into blocks with definite boundaries, and strips run back and forth across each block until it was mapped. Each strip was mapped by a paced line, zig-zag enough to include all important points in the strip. This method proved accurate to within 2 chains, and practicable. It is recommended for this type of survey.

The town was found to be about equally divided into hay (30%), pasture (31%), and woodland (34%). The remaining (5%) is swampland.

Of the hayland, about 1100 acres, or 24%, is cared for and producing well, while the other 3500 acres is going wild. Some of this wild land does not produce enough to pay for cutting it.

Nearly 1300 acres, or 27%, of the pasture, which amounts to 73% of the open class of pasture, is well grassed, but the rest of the open, and all of the other, pasture, except for small areas of little consequence, is largely covered with non-forage vegetation.

Of the woodland 40% is pine, 53% hardwoods and 7% gray birch.

The annual production of the hayland is about 2110 tons, and the pasture is estimated to be capable of supporting 606 cows. The total estimate of the timber in the town is 12,777,000 board feet of lumber and 2685 cords of hardwood.

Only 188 acres of the 5267 acres of woodland would cut good quality pine, and 80 of that is reserved.

About 1650 acres of hardwoods would have been pine if cut properly.

While little land in the town is actually idle, very little has been sufficiently cared for to preserve its productivity, so that some is too poor to pay for cutting the hay, and all hayland and pasture, is reduced in value.

Two thousand acres of this unproductive land resulted from wasteful lumbering.

There are 173 farms, totalling 13,660 acres, or 89%, of the town. This does not include the land of the University of New Hampshire. Of the 123 farms over 25 acres in extent, 26% are under 50 acres, 32½% have between 50 and 100, and the other 41½% exceed 100 acres. The largest has 428. Eight farms have been abandoned recently.

The typical farm has about 30 acres of hayland, 30 of pasture without tree growth, and 40 of woodland. Only 5 acres of the hayland and 7½ of the pasture are improved.

LAND SURVEY OF THE TOWN OF DURHAM, NEW HAMPSHIRE*

Most New Hampshire towns do not appreciate the extent of the poorly utilized land within their borders. A farm is abandoned, and perhaps a neighbor cuts the hay but he does not keep the fields producing well, and they become hardly worth cutting. A woodlot is cut clean, and no young growth comes up. Junipers and briers make it poor pasture—practically waste land. The value of the land goes down, and the taxes on the rest must go up to replace what this land had been paying.

A logical first step in providing for the reclamation of these lands is to survey the town and find out where they are, and their total acreage. At the same time a map showing fences, buildings, the use of each lot, an estimate of the timber, hayland and pasture production of the town, a map on which the property lines may be shown, and the other facts which can be secured in a survey, all help to take the guesswork out of administrative problems.

In some cases property lines are not known to the owners, nor described clearly in the deeds. A property map of the town should be made while the older men, who know many of the lines, are still living. This condition exists generally over the state. The old deeds describe lines simply by giving the names of the adjoining owners, or by landmarks which have disappeared. Hence the lines are forgotten.

The town of Durham was selected and surveyed to show what can be done, to give representative figures for this part of the state, and to help select the most suitable surveying procedure for similar work elsewhere.

This report should be supplemented by a soil survey, and finally by a plan of specific recommendations for the utilization of the lands of the town.

HOW THE SURVEY WAS MADE

The methods used in making any survey depend on the purposes for which it is undertaken. In this case the need was for a fairly accurate and detailed map of the town. As the time and appropriation were limited, the quickest and cheapest way of making such a map was the most expedient.

Fortunately, the Dover quadrangle of the United States Geological Survey gives a topographic map of Durham. A copy of this map, enlarged to the scale of eight inches to the mile, made an excellent base map for the survey. Even enlarged to eight times its normal size this proved to be surprisingly accurate. Only a few minor points were changed in the finished map after careful checking.

*This thesis has been submitted to the University of New Hampshire in partial fulfillment of the requirements for the degree of Master of Science in Forestry.

A transit, plane table or staffhead compass and chain survey would have been too expensive, and was unnecessary with this base map to work from. Pacing seemed the only method of measuring distances which fitted into the plan. By checking frequently to key points, the map was found accurate to within two chains (132') and seldom more than one chain (66 feet) in error. Any errors of more than one chain were distributed so that the resulting error between points near to each other was slight.

The base map was laid off into blocks bounded by roads, brooks or other clearly defined lines. These blocks were mapped in the order which would give the most accurate results. Starting at a central point the blocks were surveyed outward to the edge of the town in one direction until a fan-shaped section was completed. Then, starting again at the center, another sector was mapped. Within a sector, the blocks were taken in the order which gave most opportunity to check points on one block against those on another. The order was changed in the field to fit the circumstances.

The general plan within a block was to start from a known point on the base map near one corner of the block, and map a strip down one side of it, an eighth of a mile wide, then run one back beside that one, a third beside the second, and so on until the block was mapped. The "strips" were laid out entirely in the field, by pacing a zig-zag line planned so that it came near all points such as wall corners, type lines, brook intersections, buildings, etc., which were to be mapped. Running from side to side of the strip was avoided except to insure careful location of these points. When running a strip back beside one already mapped, some shots were made to points already located to check the accuracy, for there are bound to be errors in pacing, and frequent checking makes it easier to locate them.

This plan is well adapted to mapping solid blocks, especially as it is flexible enough to allow for rearrangement to fit circumstances. Where there were large fields, the lines could be run farther apart, but in a section where the lots were small, the lines were closer.

In the end, a block on the map would be found to contain several major points to which the other important points were connected. If these could be accurately located, either because there was no appreciable error or because the errors balanced, no more field work was necessary, and the rest of the map could be built around them. Otherwise, a line had to be run connecting these major points and locating them definitely. Once in a while an error made it necessary also to locate lesser points, but usually the strips run in surveying were so interwoven that it was not difficult to correct errors.

A hand compass was used for direction, as any other instrument would have been cumbersome, much slower and more expensive.

The finished map was a mass of fine lines, small lots and small printing, or the details could not have been shown. As a wall map it would have been awkward to read, so it was made up in sections representing a square mile each (eight inches square), drawn on 8½ x 11 paper, and put in a loose-leaf notebook. In this form, special farms could be referred to more easily, and if more than one sheet were needed the

others could be taken out and placed beside it. The only thing which this map did not give was a picture of the whole town at once, and this was accomplished by the smaller scale map which is reprinted as Figure 2. In this town the map sheets were drawn with the index point at the bench mark opposite the Durham railroad station. Lines were drawn north, south, east, and west from this point in checkerboard fashion to form the edges of the sheets. It would be better to base them on latitude and longitude in another survey.

A quarter of one sheet of the map was drawn to scale and is shown in Fig. 1. While this sheet is not colored, and is only a small area, it illustrates the scale and the type of map made.

This map is accurate enough for all general purposes, and copies of individual farms made from it can be used to calculate acreage, show the layout of the farms, and the location of fences. On it a record can be kept of which fields were cultivated, what was grown, and what was cut from the woodlots, for example. Other uses would suggest themselves.

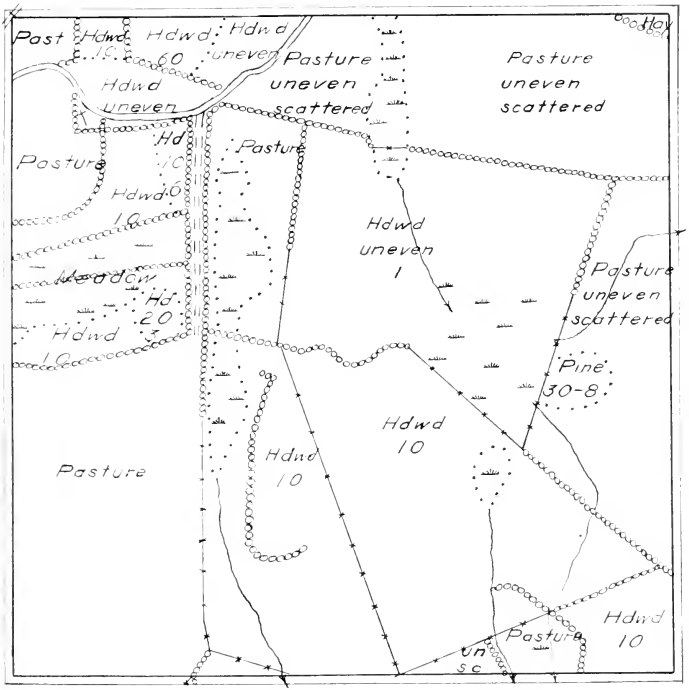


FIG. 1. Section of Map of Durham

The acreage of each lot was computed from its size on the finished map, and the total acreage for each class of cover was calculated. These figures are recorded in Table 3.

The estimate of the timber in the town is merely an approximation. Estimates of individual woodlots were not attempted, and, as only 5% of the trees were measured, approximate results are all that could be expected. There was no table for the board foot volume of bushy, old field pine, so these had to be disregarded. There is little timber in them, so this is not much loss. The trees measured were in quarter acre plots taken at random since no regular strips were run to space them on. The lots themselves were so small and variable that accuracy would have meant a long task, and since the estimate was a side-issue of the survey, approximate results were acceptable. Selecting the plots at random and measuring a low per cent. of the trees is not as haphazard as it appears, for lots with the same density and age were fairly uniform, and the stand was separately computed for each age and density class.

The volume of each tree measured was found for white pine from the Massachusetts Mill Tally volume table, and for hardwoods from the Red Maple cordwood table of the Harvard Forest.* Adding the volumes of the trees recorded gave the volume for the plot or quarter acre. When this had been done for all plots, they were grouped by age and density classes, and the average for each was found. This gave the average stand per quarter acre. Multiplying by four, then, gave the stand per acre. The acreage was taken from Table 3 and multiplied by this figure to get the total stand of this class in the town. The totals of the classes give the total stand of the town. The totals by classes make up Table 4.

The method in the field, then, was to select one block on the base map with definite boundaries, and survey it by pacing with a hand compass. Lines were paced passing all points which it was necessary to locate accurately such as boundaries of lots, houses, brooks, fences, etc. At the same time a note was made on each lot on the map classifying it as described below. If the lot had merchantable timber on it, quarter-acre sample plots were taken covering five per cent. of the area (one plot for every five acres), and recorded under the same class name.

Definitions of Classes of Land

In classifying the lots, six major types were recognized—hayland, pasture, swamp and open water, hardwoods, gray birch and white pine.

Hayland included all areas suitable for cutting hay, cultivation, or higher uses, as orchards and houses. There were no subdivisions in this type.

Pasture covered all areas which would not cut hay and were less than half covered by trees. This type was subdivided into open pasture, devoid of trees, and wooded pasture. Some of the wooded pasture was practically open, but had some tree growth on it. The open pasture was not subdivided, but the wooded division was separated into smaller classes by the age and density of the pine present.

*Hawley & Hawes, "Manual of Forestry," John Wiley & Sons, 1918.

The swamp and open water type took all lands too wet to grow anything but bunch grass and alder. This was not subdivided.

All lands more than half covered with hardwood growth other than gray birch were classed as hardwoods, subdivisions being made on the basis of age of the stand and the density of white pine.

The gray birch type followed the same rule, claiming all lands more than half gray birch, and subdivided by age and the density of pine.

Similarly, the pine type took all lands predominantly pine with age and density subclasses.

In dividing these classes by age, ten-year classes were used. That is, areas with trees between 0 and 15 years old were classed as 10 years. Accurate measurement of ages was confined to counting the whorls of pines.

The density classes were not as standard. Lots were grouped in five classes; those having pine: "scattered," 1 10, 3 10, 6 10 or 8 10 covered. An area called hardwoods 10-3 10 for example, would be covered, for the most part, with 10-year-old hardwoods, but 3 10 with 10-year-old pine. Pasture unevenly scattered would be practically open pasture, with a few old and a few young pines here and there.

In making the notes in tables and on the map it was necessary to use abbreviations, and the following were adopted:

Hay: Hayland
Past: Pastureland
Hd or Hdwd: Hardwoods
WP or Pine: White Pine
GB: Gray Birch
10, 20 etc.: Age (10, 20 yrs. etc.)
Sc: Scattered (density)
1, 3, 6 or 8: Density (1 10, 3 10, 6 10 or 8 10)

Swamp land was shown by the standard symbol of a clump of grass. An area marked GB 20-1 means a 20-year-old stand of gray birch, 1 10 pine. WP 40-8 means a 40-year-old pine lot, 8 10 density. In a few cases it was necessary to go farther, as in a stand labelled Hd. 40-WP 10-1, which would represent a hardwood stand 40 years old, with 1 10 of the ground shaded by 10-year-old pine. In a table this would be simplified and placed in the Hd 40-1 class.

RESULTS OF THE SURVEY

Durham is in Strafford County, in the southeastern part of New Hampshire. It is about five miles south of the city of Dover, and borders on the towns of Lee, Madbury and Newmarket with Great Bay to the east. The Dover branch of the Boston and Maine Railroad passes through, running northeast and southwest.

The bed rock of the town is of three types. A wide belt of eruptive rock formation takes in most of the town and is a part of an interrupted belt which follows the coast through neighboring towns. The coastal formation is quartzite, while a strip down the Lee line is composed of slaty schists. The soil has been altered by glacial action both

by deposits, including Beech Hill, a drumlin, and by the fact that as the glacier receded the sea flooded the town to an elevation of about 200 feet for a short time, distributing clays and sands from the glacial wash in layers. Subsequent erosion has cut these layers until now the soil is mostly clayey in the hollows and sandy loam on the knolls. Two potholes, of which Spruce Hole is one, were formed by glacial deposits around a slowly melting mass of ice.

The only hill of any size is Beech Hill, rising to about 245′ above sea level. The rest of the town is rolling, and level enough so that brooks rarely run noticeably, and there are swamps three-quarters of a mile long.

Two rivers, the Oyster and the Lamprey, drain the northern and southwestern sections of town respectively. The Piscassic River crosses the Newmarket line into Durham, but flows into the Lamprey almost immediately. It was interesting to find that a branch of Longmarsh Creek flows from the Lamprey at Moat Island into the Oyster River. The southeastern section, south of the Oyster River and east of the Newmarket Road, is characterized by low hills and shallow hollows, the hills with shallow soil and some ledge outcroppings, the hollows usually swampy. This is not true of the land bordering the bay, which is well drained, and makes the best fields of the town. A few farms have been built in the interior, but only to be abandoned. It is here that most of the wasteland occurs.

Except for the University and the stores dependent on it, Durham is almost entirely a farming community. There are several summer camps and houses on the Bay shore.

Description of the Types of Land Used

Hayland. The town is about equally divided into hayland (30%), pasture (31%), and woodland (34%), with swamp covering the remaining 5%. Of these, the hayland is by far the most valuable. Disregarding the 500 acres used for residences, cultivation, etc., which need more thorough investigation, there are about 600 acres of well cared for hayland. About half of this is in the four square miles in the northwest corner of town, and almost all the rest along the bay. The other 3500 acres of hayland are allowed to produce what they will without special cultural treatment.

TABLE 1—ACREAGE OF TOWN OF DURHAM BY PRINCIPAL LAND USES

	Acres	Per Cent. of Total
Hay	4,609	30
Pasture	4,777¾	31¼
Hardwoods	2,854¾	18½
Gray Birch	335¾	2¼
Pine	2,077	13½
Swamp and Water	670¼	4½
	15,324½	100

The better type will average two tons to the acre, and sometimes return as much as five, but the semi-wild fields will cut only about ¼

of a ton on the average. Five acres of this poorer hayland will pasture a cow, which puts it in the class with the open pastureland for this use. From these figures the production of better class haylands in the town is estimated at 1237 tons, while about 872½ tons grow on the poorer lands. This gives a total production of 2109½ tons for the town. (See Table 2). The lands with a low yield at present are nearly all capable of producing their two tons per acre if brought under treatment, and this is the urgent problem in land utilization at present.

The grasses on the treated lands are largely cultivated, although on the higher well drained fields witch-grass soon crowds out the sown grasses. Timothy and red top are the favorites, with red and alsike clovers (and some alfalfa) next in importance. Other wild grasses besides witch-grass are also present, but less common, and most of them contribute little forage.

TABLE 2.—CLASSIFICATION AND YIELD FOR HAYLAND AND PASTURE TYPES

	Acreage	Per cent. of total	Yield	
			hay (tons)	pasturing capacity (cows)
Hayland				
Residence, etc.	500	11	.....	.....
Treated	618½	13	1,237	.....
Semi-wild	3,490½	76	872½	†698
Total	4,609	100	2,109½	.....
Pasture				
Well grassed	1,281	27	.....	256
Poor	3,497	73	.....	350
Total	4,778	100	.....	606

On the semi-wild lands timothy and red top, though present, are subordinate and clover is uncommon. The higher lands are apt to be about half and half Kentucky bluegrass and sweet vernal and witch-grass with some poverty grass, especially on the sandy soils. The lower lands have more of the escaped tame grasses; witch-grass has been partly replaced by foxtail, while sweet vernal is still a dominant species. In the swales, rough unpalatable grasses are found, with sedges and a mixture of the other species already named subordinate to them. The grasses present depend on the character of the soil, which varies greatly because of uneven wearing of post-glacial stratified deposits.

Pastureland. Pastureland is the catch-all type. Anything too rough or bushy for hay and with too few trees for woodland has been classified as pasture. Naturally, there is quite a variety in the individual areas. To simplify this, the pasturelands may be classified much like the haylands, placing the open pasture, well grassed and usually suitable for improvement, in the better class, and throwing all the poorer, partially grown-up pasture into the lower group. Another classification on the basis of the tree growth will be described later.

†Semi-wild hayland would pasture 698 cows or produce 872½ tons of hay.

The better type of pastureland is relatively free from juniper and similar plants, but not suitable for mowing. It may be too rocky, or be too steep and broken by erosion. These lands are as good for pasture as the poorer haylands.

Below this there is the land which is so largely covered with ledges, juniper and other bushes, loose rocks, brush and trees that the grass is crowded and sparse. Such lands are of little value as pasture, but no attempt is made to improve them.

About 27% of the pasturelands, and 73% of that which has no tree growth, is of the better type. This amounts to 1281 acres, while the other 463 acres of the "open" pasture class, and most of the "wooded" land are poor. Five acres of the better pasture will support a cow for the summer, while the capacity of the poorer lands varies with the density of the grass. If half the land is covered with grass, 10 acres will support a cow, which is about the average.

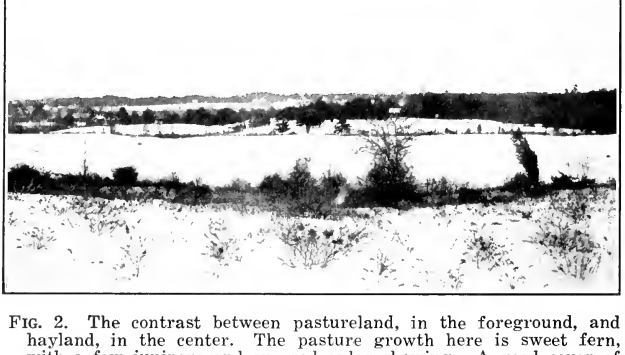


FIG. 2. The contrast between pastureland, in the foreground, and hayland, in the center. The pasture growth here is sweet fern, with a few junipers and one red cedar showing. A good cover of grass grows underneath.

The grasses on pastureland are practically the same as are found on the wild haylands. On the uplands bluegrass, sweet vernal and witchgrass predominate, while on the lowlands and meadows these are supported by or subordinate to foxtail, sedges, and non-palatable, coarser species. A scattering of timothy and red top escaped from nearby fields is rather common. Many other lesser species of wild grasses are more or less frequently found both on the pasture and the haylands.

Most of the pasture type has at least scattered pines, with perhaps some cherry, gray birch, elm or other hardwoods. The most characteristic plants are juniper, sweet fern and red cedar. Raspberry and blackberry bushes are common on some cutover land, and meadowsweet and hardhack are apt to be scattered throughout. When pines are present, they are bushy, weeviled, big-limbed and useless for lumber, but are good seed trees, and windfirm.

Such areas are usually extensive, sometimes exceeding 100 acres in a block, while the better type of pasture is apt to be in small lots, often near farm buildings.

Woodland. The woodlands of the town fall conveniently into three subtypes: pure white pine, pure gray birch and mixed hardwoods. Of course, a "pure" pine stand would have other species present, but more than half of the surface of the ground would be covered with pine. Since the trees were seldom so thick that all the ground was covered, considerably more than half the trees, and usually practically all, were pines. Gray birch is commonly associated with young pine stands, but it is intolerant, and only a few are found in mature pine. Red oak and both sugar and red maples are the most common hardwoods, with elm, hickory, black birch and beech frequent, and all of the other hardwoods scattered. Of the softwoods, hemlock is the most common, with red pine the only other timber producing softwood. Pitch pine and red cedar are not unusual, but are of little value except for cedar posts. Pure or nearly pure stands of pitch pine occur in a few places.

The pine type is found under a wide variety of conditions but prefers the higher, well drained slopes. Commonly it is in small lots, but sometimes, where cutting has not been too clean, areas of fifty acres or more are found. Of the merchantable stands, the better ones are reserved, as the groves along the bay and the College Woods. Most of the rest was inconvenient to cut. The pine lands raised for timber are usually cut as soon as they can be sold, at about 40 years, when they yield only the poorest lumber. Only 188 acres have reached the 50-year class or better, and at least 80 of that is reserved.

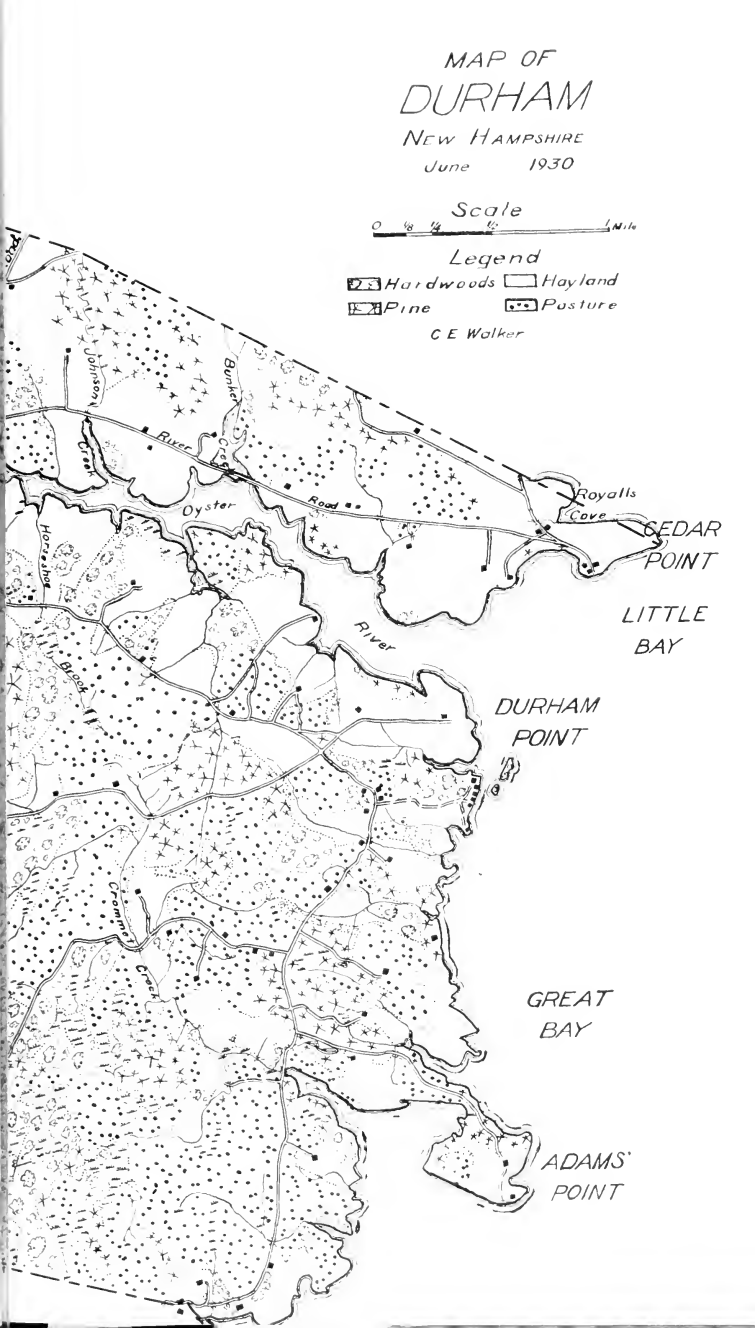
The fact that the pine stands are largely pure increases the damage done by insect pests and fungous diseases. The worst of these are the pine weevil, *Pissodes strobi*, and the blister rust, *Cronartium ribicola*. The weevil is responsible for the dead leaders common in all young stands of pine, especially in the open. The damage from blister rust is well known.

Gray birch, which is a minor type, results from the prolificacy of birch in seeding in distant areas, such as cutover devoid of tree growth, and burns. There is usually an understory of pine, which often is thick enough to dominate the birch as it grows older. A few other species may intermingle but are only scattered.

The mixed hardwood type is the most extensive at present because in many instances pine was cut clean and hardwoods seeded in, usually with a few pines. At least 1650 acres, and possibly twice that, were mismanaged in this way. In wet hollows with clay soils, and in woodlots where hardwood has been grown for fuel for the farm, hardwoods have dominated all along. On the swamp lands which are wooded, red maple and elm are most common, usually raised on hummocks above the surface of the water. A few pines and more hemlocks are apt to be present, and a scattering of other hardwoods.

On the uplands, almost any combination of species is possible. Red and sugar maple, red and white oak, gray and black birch, beech and white pine are the most common, with hickory, hemlock, blue beech, white ash, basswood, black cherry, trembling and large toothed aspen,

Beech Hill
Reservoir
Turnpike
Road
Mast
River
Oyster
Mill Road
Spruce Hole
LEE
BAM BR
PACKER'S FALLS
Lamprey
River
Pawtuckaway
Mountains
Madbury Rd
Spruce Hill
Green
Longmarsh Rd
Meadow
Folletts Br
NEWMARKET
Piscassic
DUR
R


MAP OF
DURHAM
NEW HAMPSHIRE
June 1930
Scale
0 1/8 1/4 1/2 1 Mile
Legend
Hardwoods
Hayland
Pine
Pasture
C E Walker
Johnson
Creek
Bunker
Creek
Great
Oyster
River
Road
Royalls
Cove
CEDAR
POINT
LITTLE
BAY
Horsehide
Brook
River
DURHAM
POINT
Crommet
Creek
GREAT
BAY
ADAMS'
POINT

frequent and paper birch, hop hornbeam and lesser species scattered in occasionally.

Few hardwood stands grow to more than 25-30 years of age, as they are then about the right size to cut for cordwood. Any older stands are probably cut selectively, as wood is needed.

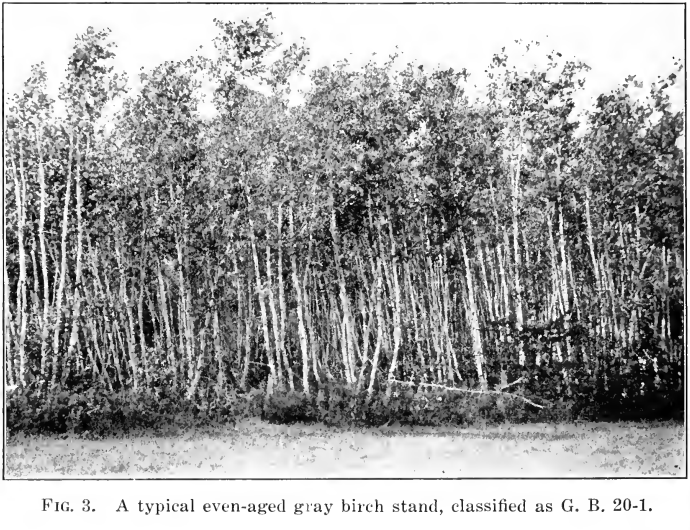


FIG. 3. A typical even-aged gray birch stand, classified as G. B. 20-1.

While there are few pure stands of any species of hardwoods, except gray birch, the important insects and fungi are not particular, and attack several species alike. The gypsy moth, *Porthetria dispar*, is the worst offender, choosing cherry, oak, maple and birch as its favorites, but accepting even softwoods, though the young larvae cannot eat softwood needles. Ash and hickory are the only hardwoods not damaged.

The rots, which do the most damage of the fungi, also disregard species. *Fomes igniarius*, which forms the common shelf fungi on oaks, maples, poplar, birch, beech, hickory, willow and others, causes the common brown heart rot which is the most widespread disease of hardwoods.

Swamp. The swamp type, covering only about one square mile altogether, is the last one to discuss. Setting aside the few ponds, the swamps were either covered with bunch grass and perhaps an occasional elm, or with alder. The grass swamps may often be pastured, as the bottoms are clay and bog holes are not reported. There is so much other land available that this is only incidental. The alder swamps are of no value at present. Salt marshes along the bay and tidewaters of the Oyster River are covered with grass suitable for

second class pasture but not for mowing, as it is washed flat. The swamps are now almost all waste land.

Meadows used for pasture, swamps with hardwood growth on them and other partly flooded areas which are being used are classified as though the water were not there. The water is shown on such areas on the map by the symbol representing a bunch of grass, with the same coloring and wording as for dry land.

Tabulated Results

The figures for which the survey was made are presented in a series of tables and diagrams and used as a basis for the discussion. The basic table is No. 3, in which the total area occupied by lands of each type is shown with subdivisions. The acreage of each class of woodland is recorded and cross-totaled for each age to show the acreage of the types and of each density class, as well as the grand total for the age. In the same way the totals along the bottom of the table show the total acreage for each type while those along the side show the totals for each age. The sum of these gives the total acreage of the town. Other figures, as the amount of merchantable timber, may be obtained by adding subtotals in this table.

All other tables are directly or indirectly based on this one. Table 1, for instance, merely records the totals found at the bottom of Table 3, with percentage figures included to make them more easy to compare.

Table 4 was compiled as described previously to show the amount of timber per acre and also the total for the whole town for each class. This is given in board feet for pine and cords for hardwoods. Where there were hardwood saw logs they were recorded in the table as board feet of hardwoods. Totals of hardwood, pasture and pine types are given, with subtotals by age classes. There are some irregularities in the table—there is a figure for pine lumber in the hardwood 50-year class, for instance, even though this is classed as a purely hardwood stand. In classes with only a few acres the plots were too few to get good averages. These irregularities should tend to balance each other so that the total estimate would not be affected appreciably.

Table 2 classifies the hayland and pasture roughly according to their productivity and estimates the annual yield for each type.

The age class distribution diagram (Fig. 3) shows the acreage of the three types of woodland for each age. The number of acres is shown by the horizontal distance, and the age by the vertical. The figure in each block gives the acreage for that type and age. Evidently, pine lots over 45 years old, and hardwoods over 30, are unusual. Below these ages, assuming that most of the gray birch will be replaced by pine, there is about an equal acreage in each of the age classes for both pine and hardwoods; that is, there is about as much 10-year as there is 20-year, etc. This would mean that as soon as one class becomes merchantable and is cut, it would be replaced by an equal area of the class below. This is called a "normal" stand. However, some hardwood lands and some pasture will grow up into pine lands, so that this balance is not as even as it looks.

TABLE 3—ACREAGE OF TOWN OF DURHAM BY DETAILED LAND USES

	Hay	Pasture	Hardw'd	Gray Birch	Pine	Water & Swamp	Sub-totals	Totals
Open	4,609	1,744¼	....	....	....	670¼		7,023½
Planted	....	73½	....	22¾	....	....		96¼
10-yr. class								
No pine	....	....	318	127	....	....	445	
Pine scatt'd	....	152	200	23	....	....	375	
1/10	....	143½	527½	92½	....	....	763½	
3/10	....	45	44½	11½	....	....	101	
6/10	....	....	....	....	109	....	109	
8/10	....	....	....	....	7½	....	7½	
Total 10-yr.		340½	1,090	254	116½			1,801
20-yr. class								
No pine	....	....	170	6	....	....	176	
Pine scatt'd	....	26	57	3	....	....	86	
1/10	....	162½	745¾	15	....	....	923¼	
3/10	....	287	75¾	30	....	....	392¾	
6/10	....	....	....	....	412½	....	412½	
8/10	....	....	....	....	43½	....	43½	
Total 20-yr.		475½	1,048½	54	456			2,034
30-yr. class								
No pine	....	....	61½	....	....	....	61½	
Pine 1/10	....	....	72½	5	....	....	77½	
3/10	....	88½	27	....	....	....	115½	
6/10	....	....	....	....	321½	....	321½	
8/10	....	....	....	....	94	....	94	
Total 30-yr.		88½	161	5	415½			670
40-yr. class								
No pine	....	....	26	....	....	....	26	
Pine scatt'd	....	22	16½	....	....	....	38½	
1/10	....	43½	48½	....	....	....	92	
3/10	....	130½	10	....	....	....	140½	
6/10	....	....	....	....	316	....	316	
8/10	....	....	....	....	154	....	154	
Total 40-yr.		196	101		470			767
50-yr. class								
No pine	....	....	6¾	....	....	....	6¾	
Pine 6/10	....	....	....	....	50½	....	50½	
8/10	....	....	....	....	25½	....	25½	
Total 50-yr.			6¾		76			82¾
60-yr. class								
No pine	....	....	7	....	....	....	7	
Pine 1/10	....	....	½	....	....	....	½	
3/10	....	....	....	....	6½	....	6½	
6/10	....	....	....	....	34½	....	34½	
8/10	....	....	....	....	3½	....	3½	
Total 60-yr.			7½		44½			52
70-yr., pine 8/10	....	....	....	....	6½	....		6½
100-yr., pine 8/10	....	....	....	....	61	....		61
Uneven aged								
No pine	....	....	185½	....	....	....	185½	
Pine scatt'd	....	924½	....	....	....	....	924½	
1/10	....	686	209	....	....	....	895	
3/10	....	249	45½	....	....	....	294½	
6/10	....	....	....	....	431	....	431	
Total uneven		1,859½	440		431			2,730½
Totals	4,609	4,777¾	2,859¾	335¾	2,077	670¼		15,324½

TABLE 4.—ESTIMATE OF THE TIMBER IN THE TOWN OF DURHAM

	Stand per acre			Total stand		
	bd. ft. hdwd.	bd. ft. pine	cordwood cds.	bd. ft. hdwd.	bd. ft. pine	cordwood cds.
HARDWOODS						
Hdwd. 30	....	.....	4.75	.....	.....	292
Pine 1 10	....	1,045	5.12	.....	81,000	39.75
3 10	....	580	.9	.....	15,660	24.15
Total 30					96,660	355.90
Hdwd. 40	67	.....	11.1	1,742	.....	289
Pine sc.	....	200	4.	.....	3,300	66
1 10	....	812	2.95	.....	39,400	143
3 10	....	1,000	2.5	.....	10,000	25
Total 40				1,742	52,700	523
Hdwd. 50	....	220	9.6	.....	1,485	65
Hdwd. 60	....	.....	16.	.....	.....	110
Pine 1 10	200	680	11.15	100	340	5.57
Total 60				100	340	115.57
Hdwd. uneven	....	.....	2.96	.....	.....	549
Pine 1 10	97	463	1.65	20,275	96,750	344
3 10	....	932	2.33	.....	42,400	106.2
Total uneven				20,275	139,150	999.2
Total hdwds.				22,117	290,335	2,058.67
PASTURE						
Pasture 40-1 10	....	2,040	.05	.....	88,750	2
-3 10	....	5,200	1.31	.....	679,000	178
Total 40					767,750	180
Past. unev. -3 10	....	630	.20	.....	156,000	4.5
Total pasture				0	923,750	184.5
WHITE PINE						
Pine 30-8 10	....	3,956	.29	.....	370,800	27.6
40-6 10	....	6,775	.31	.....	2,138,000	98
8 10	....	15,300	.20	.....	2,360,000	31.7
Total 40					4,498,000	129.7
Pine 50-6 10	....	16,045	.64	.....	810,000	32.4
8 10	....	21,320	....	.....	544,000	.....
Total 50					1,354,000	32.4
Pine 60-3 10	....	6,950	3.4	.....	452,000	22
6 10	....	25,600	2.7	.....	883,000	93.4
8 10	....	30,460	....	.....	169,000	.....
Total 60					1,504,000	115.4
Pine 70-8 10	....	36,060	....	.....	234,000	.....
Pine 100-8 10	....	41,000	....	.....	2,500,000	.....
Pine un. -6 10....		2,510	.32	.....	1,080,000	137
Total pine				0	11,540,800	442.1
TOTALS				22,117	12,754,885	2,685.27

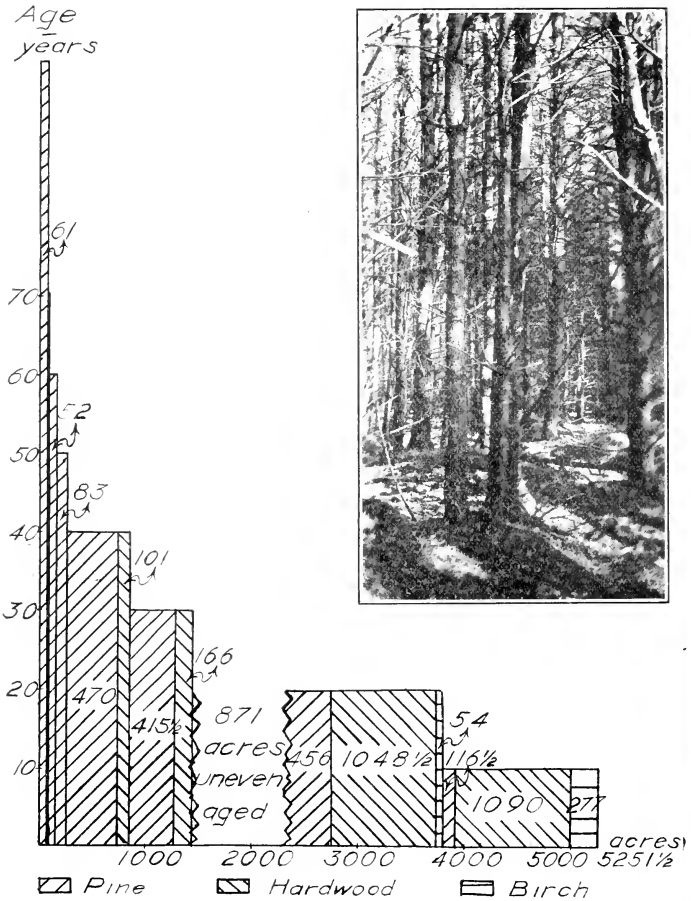


FIG. 4. Distribution of age classes. (Insert) An unusually good stand of pine in the northwest corner of town—classified as pine 50-8.

In all probability the acreage of pine will increase in the next ten to twenty years, mostly from the pastures which grow up. However, the timber on these lots is scrubby so that the estimate will not be much higher because of that. On the other hand, hardwood lots with an undergrowth of pine may become pine land later on, producing good timber which will raise the estimate. If stands were allowed to grow older before they were cut, the estimate would likewise be increased.

The Idle Land Problem

One question which a survey of this kind might answer is, what is the best use for these different types of land? This would require a knowledge of what can be sold as well as what can be produced. Knowing about how much can be grown on an acre of each type of land, the producing power is a matter of calculating, but when it comes to figuring what can be sold, the problem is much more complicated. The best this survey can do is to present the situation, and leave it to another study to complete the work.

For this reason, too, nothing can be said in this report concerning land uses which depend more on the market than on the amount of land available. Cultivated land, residence (both year round and summer only), poultry and other intensive land uses are in this class.

The uses which this report can briefly consider, those which depend primarily on the amount of land suitable for each, are pasturage, both of dairy cattle and sheep, hay for wintering all stock, and growing timber, either pine for lumber or hardwoods for fuel.

About 500 acres in the town are under relatively intensive management. The remaining 4100 acres of the hayland and all the pasture and woodlands are turned over to this last list of uses.

What haylands and pastures are not required by the stock in town tend to become idle, and eventually waste land. Those which are used but not improved from time to time become run out, and very much reduced in value. The amount of idle land can be approximated by determining how much the lands of the town exceed the needs of the stock. Figures from this survey are for the town as a whole, and not individual farms. Figures for an average farm can be estimated later.

The town assessment figures show 521 cattle, 132 horses, and 708 sheep for 1930. Experience has shown that a cow or horse will need about three tons of hay, and that, in addition, the cow will need to be pastured. A sheep will require one-seventh as much as a cow.

With this as a basis, it would take 1563 tons of hay for the cows, 396 for the horses, and 303 for the sheep—a total of 2262 tons. If the better hayland produces two tons to the acre, as it should easily do, that part which is not cultivated will produce 1237 tons of hay. This would leave 1025 tons to be produced by the poorer haylands.

A reasonable figure for the producing power of these semi-wild fields would be one-fourth of a ton to the acre. It would take 4100 acres to produce 1025 tons at this rate. As there are only 3490 available, some hay would have to be imported from neighboring towns. This is, in fact, the case.

Five acres of the better pasture will support one cow, while 10 would be required, on the average, for the scrub pasture type. At 5 acres to cow, 256 cows could be fed from the well grassed pasture, leaving 265 for the juniper lands. Reserving 2650 acres of juniper and sweet fern, then, for these cattle, there will be 847 left for the 708 sheep, each of which should graze 1 3/7 acres. Evidently, some of the woodland is grazed, but not to capacity.

The area in woodland is all producing something which can be marketed, so none of this can be classed as waste land. Very little of it is cared for with an aim toward producing good quality timber. The essential in prevention of waste land here is to make provision for a second crop when logging. 2000 acres of the poorest pasture is a strong reminder of this. While fire has caused comparatively little loss to the woodlands of the town, its prevention is always a major problem.

Roughly, then, it seems that there is a small idle land problem in the town, but a correspondingly large problem of reclaiming the run out lands insofar as they are needed to support the stock in town. This is especially true of those lands so badly run out that they are idle because the crop doesn't pay for the cutting.

The extent of reclamation depends on the sale for the products—hay, etc., and, indirectly, of milk, meat, etc. This is a subject for further investigation.

Number and Size of the Farms in the Town

Although the survey was conducted for the town as a whole, rather than for each farm in the town, the property lines were drawn in on

TABLE 5.—NUMBER AND SIZE OF FARMS

Farms	Farms all in Durham			Farms partly out of Durham			Total		
	No. of farms	Size of avg.	Acreage	No. of farms	Size of avg.	Acreage	No. of farms	Size of avg.	Acreage
0-25 acres	28	13	364½	22	11	246	50	12	610½
25-50	30	38	920	8	35	281	32	37½	1,201
50-100	40	72	2,157	10	70	702	40	71½	2,859
Over 100	45	180	5,079	6	152	913½	51	176	8,992½
Total	127	97½	11,520½	46	47	7,142½	173	79	13,663
Non-agricultural lands									211½
University of New Hampshire									1,130½
Ownership doubtful									75½
Rivers, etc.									244
Total acreage of town									15,324½

the map in order that some facts about the individual farms could be compiled.

It was found that there were 173 owners of farm property in the town, holding an aggregate of 13,633 acres, or 89% of the town lands. The rest of the town's acreage is divided into residence, 211½ acres; holdings of the University of New Hampshire, 1130½ acres; and 75½ acres of doubtful ownership. The rivers, with 244 acres, bring the total up to 15,324½.

Table 5 was arranged to show this distribution of acreage, with the number and size of the farms in the town. The farms have been classified into those under 25 acres, between 25 and 50, 50 and 100, and over 100, and the number, average size, and total acreage of the farms in each class is the main part of the table. In finding the size of the average farm, whole farms only should be used, so those which spread over the town line had to be separated out. For this reason Table 5 shows three sets of figures: Those for farms wholly in Durham; partly in Durham, and the sum of the two. The average farm, then, has 97½ acres. Some of the "farms" which enter into this average are so small, that they cannot be farmed as a unit. If only those in the 25-50 class and over are averaged, there would be about 113 acres per farm.

Applying the results of the survey for the town as a whole, the "average" farm would have about 30 acres of hayland, 30 of pasture, and 40 of woodland. Only 5 acres of hayland and 7½ of pasture would be improved and the rest allowed to produce whatever it would without treatment.

The largest area under one management in the town is the 1130½ acres belonging to the University of New Hampshire. The largest privately owned farm is Stone House Farm, with 428 acres along the bay in the southeast section of the town.

There are eight farms in the town which have been abandoned fairly recently. Three of these are in the 0-25 acre class, one in the 25-50, 2 in the 50-100, and 3 in the 100 and over. Most of these resulted from failure of the heirs to carry on farming when the owner died. Some of these lands are rented out for pasture or hay.

Additional data for any particular farm may be obtained from the map. Brown-print maps showing property lines in the town have also been made.

PLAN FOR EXTENSION OF THE SURVEY

The conclusions reached in this survey are only generally applicable to other towns and in order to obtain similar facts for them it would be necessary to survey each town. To provide for this, the plan in this town was somewhat experimental, with the purpose of selecting what appeared to be the best methods for this type of work.

Cost of Present Survey

One man spent 538 hours in the field mapping and estimating the town at the rate of 28.4 acres per hour. The office work, making up the map, and tabulating the data, exclusive of time spent in preparing this report, took 450 hours, or 34 acres per hour. For each hour spent on

the survey, then, either in the office or in the field work, 16 acres of land were completed. At ten dollars a day for the surveyor's wages, the cost per acre would be slightly under 7c. For this town of 15,324 acres the cost at this rate would be $1,063.50. In addition, photographing the topographic sheet for use as the base map cost $26.50, which would make the total cost $1090.

The map of Durham was made by as accurate a method as pacing with a hand compass would allow. With this as a standard, a much simpler method was tried out on a sample square mile and tested for accuracy, cost and practicability.

This other plan was the true strip method. Strips were run north and south an eighth of a mile apart until one square mile was completed. All crossings of type lines, fences, etc., were recorded and as much of the land on either side as could be seen. After the strips were run, any lines not completed were drawn in where it seemed most likely that they would go. From a comparison of the same section, mapped in the different ways, it seemed that if accuracy in detail is an object of the survey the strip method will not give it, but it will give a fairly accurate general map. By running tie strips across the main strips and extra lines where details are hazy the accuracy could be increased, but then it approaches the original method.

The cost of this strip method is a big argument in its favor. The sample square mile was mapped at the rate of 35 acres per hour as compared to 16 for the first method. In a larger survey, 35 acres could not be done in an hour, as obvious errors would be found which would have to be checked. Also, another survey would not take as much time as this one in the first method were used, because of experience gained. The strip method was tested after the surveyor had already become familiar with the country.

If a general map, approximate data, and the omission of some details will serve, and cheapness is an important factor, the strip system will be acceptable. If, on the other hand, any use is to be made of individual lots which would require the map to be fairly accurate, such as filling in property lines or acreage figures for special areas, and the map is to be of permanent value, it is worth while to spend more and use a more accurate method. A combination of the two might be best in some cases, but a compromise gives neither accuracy nor cheapness, and it is difficult to do any more than a strip method without mapping the details, which amounts to the first plan.

The estimate in either case would be equally accurate.

As to the base map, the photographic enlargement is expensive, but accurate, while raising the scale by hand takes time and is a little less accurate. An accurate base map is advisable even for an approximately accurate finished map, and the rougher the method of filling in details the more necessary it is to have accurately located points to tie to, which is the purpose of a base map.

On the whole, it seems worth while to go to the extra expense to have a dependable map, useful for all ordinary work, rather than one valuable only for general reference. In many cases the main reason for making a map will probably be the location of property lines. If this

is done, the more accurate methods are necessary, both as to base map and field work.

In the absence of an accurate topographic map a plane table survey of the roads would be necessary.

The financing of such a survey can easily be arranged if the towns think the results worth while.

To those who are accustomed to surveying done by a crew of six men or so, using either a transit or a staff head compass for direction and a tape or chain for distance, these methods seem haphazard. They are. If property lines are to be run out and corners set on the ground, an error of 20 feet in location is very important. If, on the other hand, the aim is to draw a map on a scale such as was used in Durham, where a pen line is ten feet wide and an error of less than 20 feet is hard to see, such accurate work is unnecessary and rather extravagant. Such a crew could map the outside lines of a property for a minimum of fifty cents an acre, while the pacer can make the outside lines, and the interior as well, for 7c. The more accurate methods should be used where lines are to be established. The transit is out of place in most woods work, for it requires too much axe work and is too slow. The compass, either on a staff or tripod, is commonly used with a chain or tape in extensive cruising where long strips are run and only the ends located on known base lines. This method is applicable where rough topography and large tracts make pacing errors large, although even here a two man crew does about what one man could do alone, pacing, and, while the land along the strip run is mapped more accurately, that between strips is often sketched in later. This can be corrected only by increasing the cost. This type has the decided advantage of not requiring labor as skilled as the paced survey, to obtain the same degree of accuracy. The compass and tape, or plane table and tape are excellent for making base maps where these are necessary, although pacing to a traverse board, if done carefully, is faster, much less expensive and nearly as accurate, from a mapping standpoint.*

Certainly pacing has much in its favor for mapping the small, irregularly shaped lots common in farming communities of southern New Hampshire when compared to the more cumbersome, slower, more expensive, though more accurate, methods commonly used by surveyors.

*A base map made in this way for about 5000 acres in the town of Fremont, N. H., closed within 2 chains (132 feet) wherever checked against itself—an error which is insignificant when distributed over the whole area.