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# CO-OPERATIVE FOREST STUDY *of the* GRAYS HARBOR AREA (WASHINGTON)

A "Critical Unit" Study Suggestive of  
Co-operation Under the Principle of  
the Clarke-McNary Act To Establish  
Efficient And Permanent Protection  
of Forest Regions

PUBLISHED BY  
WESTERN FORESTRY AND CONSERVATION  
ASSOCIATION

WITH THE ASSISTANCE OF  
CHARLES LATHROP PACK

PORTLAND, OREGON  
1929

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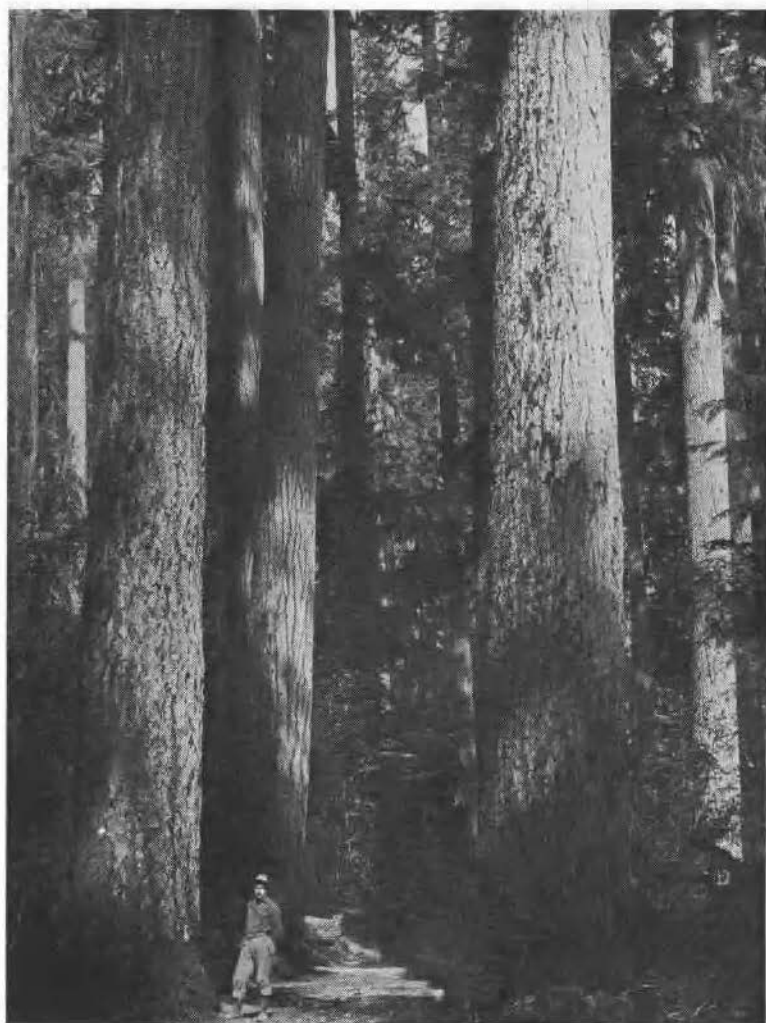
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TYPICAL GRAYS HARBOR VIRGIN TIMBER



## INTRODUCTION

The co-operative survey of Grays Harbor county, Washington, summarized herein, is an experiment unique in American forest history although only a logical development of the co-operative principle which Congress declared by the Clarke-McNary Act to be the basis of the nation's forest policy. As an illustrative experiment it has proved of interest to many forest states.

Early in 1928, Charles Lathrop Pack, president of the American Tree Association, contributed funds for use by the Western Forestry and Conservation Association for research into forest fire problems in the Pacific Northwest, where public and private co-operation in forest protection has been highly developed.

Three questions immediately suggested themselves:

"Is there any better way for a forest-dependent community to meet its forest problems intelligently, before any get beyond solution, than by having all of them studied co-operatively by the authorities most competent to judge the situation and best able to take corrective steps?"

"Since in most cases corrective steps involve several agencies—state, county, land-owner, public, and perhaps the Government—is not their effective harmony tested and strengthened by the very experiment of co-operative study?"

"If with inherent differences of interest and pride of prestige, these several agencies nevertheless agree fairly well on the needs of a corrective program, must not it be assumed that this demands the support of the entire community?"

On such considerations, the Grays Harbor region was selected as illustrative of conditions in some part duplicated throughout forest states. The services of eleven agencies were enlisted; none claiming leadership, each reserving independence of opinion; all seeking, however, to perfect a complete picture. They were:

Aberdeen and Hoquiam Chambers of Commerce.  
State Supervisor of Forestry.  
U. S. Forest Service; District 6.  
Washington Forest Fire Association.  
Pacific Northwest Forest Experiment Station; U. S. Forest Service.  
U. S. Weather Bureau.  
U. S. Office of Forest Pathology.  
Federal Forest Taxation Inquiry.  
West Coast Lumbermen's Association.  
Western Forestry and Conservation Association.

### Fire Prevention a Paramount Object

The greatest forestry requirement of any region is dependable continued fire prevention, giving nature's processes of recovery a chance, also safeguarding needed artificial steps, such as selection cutting or planting, not warranted if the investment is to be destroyed by fire.

To assure this requires co-operation by all concerned—land-owner, public agencies and community. To enlist and co-ordinate their joint effort requires showing each what is necessary in method and cost, the promise of return if they succeed, what they sacrifice if they fail. Which means, for any region: reliable appraisal of its forest-growing capacity, steps required to utilize this, and the dangers of processes to the contrary. Carrying costs, including taxation as well as those of conservative lumbering and fire prevention, demand intelligent appraisal and sharing. The possibility of making them pay requires knowledge of forest habits, reproduction and growth rate; expectable uses and return from the product.

The ability of forest industry to carry its share of such costs until repaid is crucial. Directly connected is the ability of public timber, if there is such nearby, to supply a source of manufacturing earnings to bridge the gap while cutover private lands recover and re-supply operating material. Interlocked throughout is technical detail of logging and protective methods that will sustain and safeguard continuous yield.

### Grays Harbor Region Illustrative

The Grays Harbor region presents all the above problems. None in the United States, in recent years at least, has contributed more to the nation's interior and export lumber supply. Washington is well-known to be the state with the greatest present lumber production. Nearly a third of this is in Grays Harbor county alone. The assessed value of its lumber and wood-working plants is nearly \$8,000,000; its yearly forest industrial payroll nearly \$27,000,000; its banking resources (including building and loan) amount to over \$25,000,000.

On this great forest industry have been built, not ephemeral "lumber camps," but modern cities; Hoquiam, Aberdeen, Montesano and others; with sky-scrapers, up-to-date transportation and electrical development, model school systems, dock and harbor improvements, perfect highways and every other attribute of America's best civilization. Whether we consider losses locally sustained, or losses to state and nation, it will be a tragedy if such a group of communities does not endure.

The fact must be faced, however, that these are *forest* communities, with comparatively small fishing and agricultural resources behind them. Also that, of Grays Harbor county's water and land area of 1,196,000 acres nearly 1,000,000 acres are forest, or cutover lands largely in various stages of reforestation, but today a burden rather than a convertible asset. The assessor's books show only eight billion feet of privately-owned mature timber remaining. The annual cut, enforced by the pyramiding of costs on the industry, which it is now trying to keep up to carry its overhead, is nearly a billion and a half feet—at that rate having less than six years to go.

This is not entirely true. Some operators will snuff out quickly; some, with larger resources, have indefinite life. The Quinault Indian Reservation adds an available supply of nearly four billion feet. On the north, state grant lands and the

Olympic National Forest afford a much larger reserve, but unless allocated by Government and state to Grays Harbor operators, this will probably be competed for by others. It is possible that logs may be brought in from greater distances; Oregon already sends up rafts. As straight lumbering diminishes, more refined wood utilization will doubtless increase, so a lesser supply will maintain an equal industry. But it is clear that only sincere concerted effort will enable this important industrial region to bridge the gap between its virgin timber supply from *any* source and adequate new crops to support its economic fabric.

It is necessary under such circumstances to know what new crops are dependable, how they can be augmented by better management, how fast they grow, what protective measures they demand. The land owner must have this information to decide whether he can chance the effort and risk, or had better abandon his land to become no-man's-land; untaxable, a fire menace, a public burden. The public must have it to know what its own part must be in solving the problem through care with fire and fair tax treatment. Officials controlling the disposal of state and federal timber must have it to determine their responsibility for supplying material when most needed to carry through; far greater than their narrower responsibility for quick or sustained returns from the land they control. Fire prevention agencies need it, for fire enters the picture above almost all else, not only as a destroyer, but also as a tool of the forester, determining restocking of the land. Hence all should work together in any such survey, and remedial steps following; contributing their specialized expertness, harmonizing their needs, acquiring mutual confidence, building co-operative machinery for applying the lessons learned.

### **The Sharing of the Work**

No dispute arose as to the responsibility each agency assumed.

A basic survey of the region's productive condition and possibilities was previously made by the research department of the Western Forestry and Conservation Association, financed by several prominent lumber and logging companies: Weyerhaeuser Timber Company, Clemons Logging Company, Polson Logging Company, Schafer Bros. Logging Company, North-Western Lumber Company, Simpson Logging Company, and Donovan-Corkery Logging Company. Instructions were to ignore any individual interests whatever; to appraise the situation as a whole exactly as might be done by an entirely public survey. This report emphasized the necessity of a co-operative solution of the threatening situation disclosed, featuring the commanding position of public timber management to enforce local reciprocity.

A weakness was lack of "fog-belt" silvicultural knowledge. The Grays Harbor region is a phenomenal pulp-wood (spruce and hemlock) producer. Too little was positively known of growth-rate of these species in this optimum of theirs, or of conditions which assure their prompt re-seeding and establishment. This suggested further



study both by silvicultural researchers and by fire experts whose specialty is involved because there is controversy as to whether logging slash in this region should be annually burned or not. So the "Grays Harbor Survey" took the greater part of Mr. Pack's contribution (the remainder going toward the printing of this report) to employ a "fog-belt" silvicultural expert, J. L. Alexander, formerly employed on such work by the Province of British Columbia and later on the faculty of the University of Washington. Synopsis of his report follows in due place.

The Pacific Northwest Forest Experiment Station contributed the acuteness of R. E. McArdle in devising a system of analyzing fire reports that shows likelihood of weakness in prevailing systems and suggests to all protective agencies ways of utilizing such reports and of making them more consistent. Mr. L. A. Isaac represented the Station in silvicultural suggestions.

The Weather Bureau contributed an analysis of its fire weather work in the Grays Harbor region, showing the need of further system and perfection.

The U. S. Office of Forest Pathology went into the question of slash decay, with its relation to protection problems.

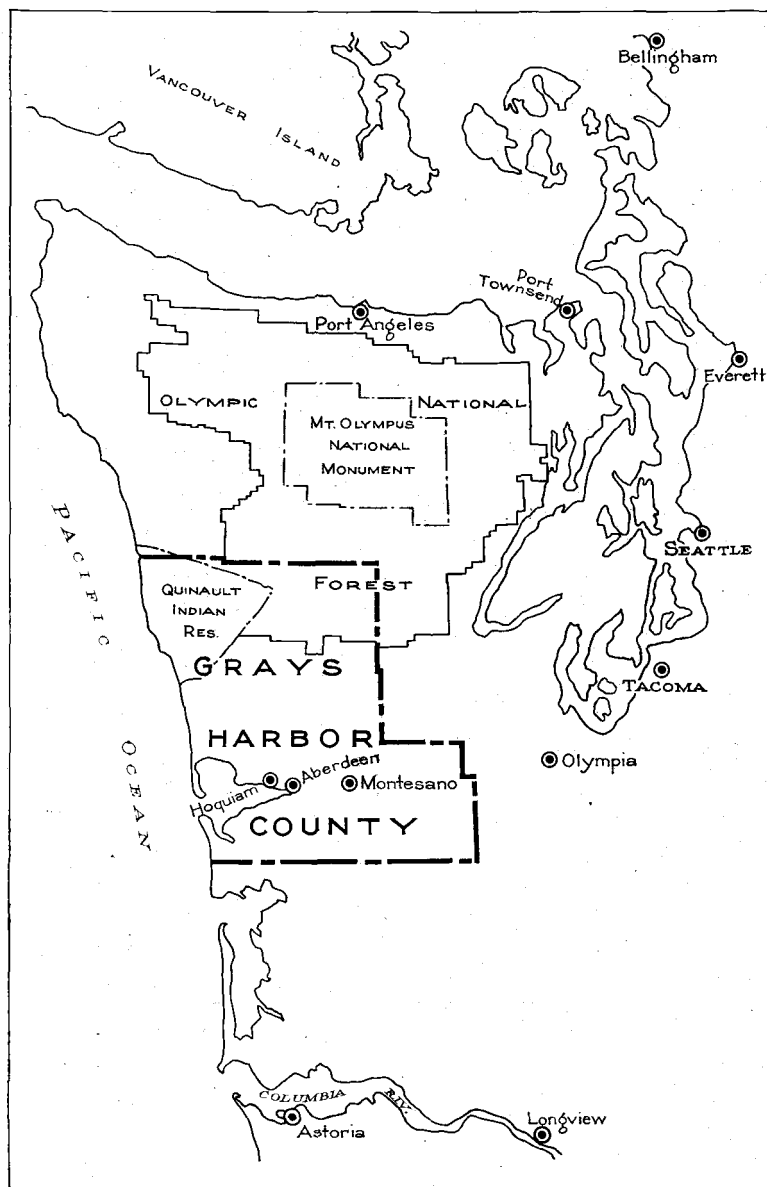
The foregoing material was placed in the hands of the three private, state and federal authorities—State Supervisor of Forestry, Chief Fire Warden of the Washington Forest Fire Association, and the Forest Service inspector of Clarke-McNary Act co-operation—who have the actual job of correlating their respective expenditures and activities to protect the forest growth of the region. With any assistance afforded by all the studies, they were asked to go over the ground and seek, as they found their system adequate or lacking, to make it a model under conditions confronted.

The Forest Taxation Inquiry, under Dr. Fred R. Fairchild, gave the Grays Harbor region its most detailed work, synopsized herein. It is reasonable to suppose that this tremendously valuable study, in connection with the others, may help give the State of Washington impetus and confidence to follow other Pacific Coast states in forest tax reform that will enable private owners to carry on.

The U. S. District Forester then considered the entire showing, together with the Grays Harbor demand for Olympic National Forest timber, and presents his view; questioning the present assurance of any reciprocal private ownership program to warrant National Forest departure from its own sustained yield calculations, also emphasizing the equal responsibility of State and Indian timber authorities.

To some extent the several viewpoints differ as to remedial steps. It should be borne in mind that the survey did not purpose to present an immediate administrative agreement, which may take further study, conference, or legislation. It was a co-operative investigation to develop ascertainable facts, to suggest further necessary considerations, and to place squarely upon all concerned the responsibility of following up to a dependable solution of the forest protection problem.

Only illustrative excerpts from the several reports are presented herein. The great mass of detail, tables and graphs is held available for technical consultation.



## THE REGIONAL COMMUNITY ANGLE

F. W. MATHIAS, *Hoquiam Chamber of Commerce.*

Forest exploitation, destruction, or preservation affect communities differently as they have built economic fabrics upon their forest resources. These must be appraised aside from continuing productive capacity, of interest to the nation's consumers of wood products. There is a vast difference between the subsidence of ephemeral "lumber camps" and the future of regions that have built up large populations and civic and industrial fabrics dependent upon continuing forest industry. Such facts must be put before forest owners, county authorities, and state legislators, so they may appraise their several responsibilities with respect to fire prevention, tax reform, etc. In the "Grays Harbor Survey" this analysis of community interest was delegated largely to the regional Chambers of Commerce. An immense amount of pertinent data was thus compiled by all of them, which for the purpose of this illustrative digest is confined to a synopsis of material from all, put in shortest form by F. W. Mathias of the Hoquiam Chamber, although he speaks also for other similar civic bodies who participated in the compilation. He says, in part:

In the dim past, the Indian used our great forests by making his dugout from a cedar log. Early settlers found the timber stand a hindrance, and cut and burned to clear a way for homestead, pasture and garden. Then the logger came, and saw-mill operator turned the great trees into lumber and by-products, resulting in the industries that have made Grays Harbor the largest lumber shipping port in the United States.

A summary of our present wood-working industry shows:

52 lumber and shingle mills  
7 mill working plants  
1 wood fibre  
1 piano parts and airplane stock  
3 door factories  
1 garage door factory  
1 wood pulp plant  
2 veneer companies  
1 wood articles  
1 tubs and pails  
1 spars

8 hr. lumber capacity—approximately  
5,000,000 f. b. m.

8 hr. employment—5510

71

31 logging companies—8 hr. capacity—over 6,000,000 feet—

Employees ..... 4640

Total Employees ..... 10,150

The assessor's value of lumber and wood-working plants for taxation purposes in Grays Harbor county is \$7,437,386.

The Department of Commerce figures for 1927 show 130 manufacturing establishments in Grays Harbor county, of all kinds, with an average of 10,937 wage earners. Wages are \$26,570,000, and product value \$57,221,000.

The Port of Grays Harbor has a property value of \$1,044,000, and has expended two and a quarter million dollars in improvements. \$1,175,000 of this has been for dredging the inner harbor.

The Federal Government has expended \$4,350,000 in the construction of jetties, bar dredging, and installation of navigation aids.

In 1924 the Port of Grays Harbor won the name of the "Port of the Billionth Foot," being the first recorded port to have shipped a billion feet of lumber in any one year.

In a 20-year period, 11,377 vessels, with a net tonnage of 11,775,000 tons, have carried cargo of 12,780,000,000 feet. Eight years' rail shipments have averaged annually approximately 400,000,000 feet.

In 1928 this port shipped 31.39% of all Washington forest products reported by the Pacific Lumber Inspection Bureau.

An interesting development in Grays Harbor is the water shipment of panels, doors, and box shooks, from nothing in 1921 to 6700 tons in 1928.

There are, at present, 35 public and private docks, with an area of 200 acres of wharves, and 20,000 lineal feet of berthage.

Another Grays Harbor development is the construction and improvement of an airport at the Port of Grays Harbor, with a ten-plane hangar and additions being made as business warrants.

Naturally the great lumber industry has built prosperous cities and communities, and a review of population figures shows the county census for 1910, 35,570; 1920, 44,745; 1928, 58,000.

Seventy-five per cent of our population is native born.

Actual school attendance in 1928 was 7,673. The total assessed valuation of Grays Harbor county in 1928 was \$37,847,000.

Another basic industry of Grays Harbor is salmon and clam fisheries. Approximately \$1,000,000 is invested in seafood canneries and equipment, with an average of 1,062 fishermen engaged as trollers, and operators of other gear: 97 gas boats, supplying four salmon canneries. The maximum annual pack of salmon and clams on Grays Harbor represent a product with a value of one million dollars.

Banking resources of Grays Harbor county in 1928 were \$18,400,000; building and loan approximately \$7,000,000; or a total of over \$25,000,000.

In 1928 there were 1892 business firms in Grays Harbor County, from abstractors to auto dealers, from banks to bakeries, churches to contractors, dairies to dry goods, engineers to express company, finance companies to foundries, garages to grocers, ice to insurance, jewelry to junk, laundries to locksmiths, machine shops to markets, natatoriums to nurses, oil to osteopaths, paint to plumbers, radio to restaurants, schools to stage lines, tailors to theaters, undertakers to upholsterers, veterinarians to vegetables, and washing machines to water companies.

Grays Harbor county is not self-supporting agriculturally. This situation is probably due to the high wages paid in logging camps and other local industries.

Grays Harbor county has an area of 1,196,000 acres. 956,000 acres are *logged-off lands*; approximately 22,000 acres are improved. In 1921 the Federal government listed 1,600 farms, with buildings, valued at \$1,700,000. In 1925 the Federal report shows 1,279 farms, with a value of \$2,500,000.

Grays Harbor agricultural products have an annual value of approximately \$2,000,000. Listed in order of importance are dairy products, poultry, berries, vegetables, sheep, and bees.

Early settlers believed chickens and sheep could not be raised in western Grays Harbor county. Present development proves to the contrary. Eggs from this district sell at a premium on the New York market.

Transportation facilities are excellent, served by many steamship lines and three trans-continental railroads, the latter operating 147 miles of main line; private logging railroads totalling 217 miles; 105 miles of state highway—50 miles (Olympic Highway) paved; 450 miles of county roads, and over 400 county bridges.

The mineral wealth of Grays Harbor county is not known. Large deposits of clay exist, and the Government furnished information on manganese in Bulletin No. 725. Rich copper claims have been located. Other minerals are reported to exist in commercial quantities.

Development of the recreational and scenic resources of Grays Harbor county and the Olympic Peninsula will mean much to the future welfare of the community. Present investments in beach and mountain resorts total half a million dollars, and development is just beginning.

Grays Harbor county is well served with rivers and tributaries. Few sections in the county are not crossed by a running stream. Only three small streams in the county have been developed for hydro-electric power, and these only to the extent of 500 horsepower. All other electric power furnished is being generated from sawdust and "hogged fuel"; Public utility: 23,000 H. P.; Private: 1,200 H. P. Conservative estimate of development possible in the county and tributary streams totals 81,000 continuous horsepower.

The county assessor's figures show 8,119,514,000 feet of standing old growth merchantable timber in Grays Harbor county. There are 3,718,724,000 feet of old growth merchantable timber in the Quinault Indian Reservation; a total of 11,838,298,000 feet in the county.

The timber stand in the Olympic National Forest directly tributary to this district, consisting of first-growth fir, spruce, cedar and hemlock, amounts approximately to 22,000,000,000 feet.\*

With an average yearly cut of approximately a billion and a half feet of lumber, the question naturally arises: "How long will Grays Harbor sawmills continue to operate at the present capacity?"

It is evident that 1927 represents the peak of Grays Harbor lumber production. With proper reforestation and a sustained annual cut from the Olympic National Forest a billion feet a year should be available.

With privately-owned timber, the present production can probably be maintained. No move should be considered to encourage more sawmills. The need is for more by-product plants, as door factories, veneer plants, etc. Wood distillation and the use of forest products as tan-bark and pulp-wood will be developed when economically feasible.

A vital factor that should receive earnest consideration is the closer use of material now wasted; present logging operations, according to Forest Service observation, leave approximately twenty cords of wood of pulp size or better to the acre.

As nature abhors a vacuum, so does she abhor a bare spot in Grays Harbor and adjacent counties, where with proper fire protection, adequate but just taxation, a practical reforestation policy, and a proper allocation of public timber land, wood-working industries should go on forever.

\*EDITOR'S NOTE—It is not conceded by everyone that more than 15 billion feet of this is unquestionably "tributary."

## STABILITY IN FOREST INDUSTRY COMMUNITIES

By W. B. GREELEY, *Secretary-Manager*

West Coast Lumbermen's Association

(formerly Chief Forester for the United States)

Where communities have been given a new lease of life through reforestation, and a re-shaping of their wood-using industries as the character of the raw material changed, this has not been accidental. It results from organized effort and earnest co-operation by the people of the community with forest owners and forest-using industries.

Where forest-built communities have taken this road, usually the first notable development has been the creation of *community security* for the growing of timber. Its first requirement is reduction of forest fires to a point where land owners generally feel warranted in investing real money in carrying and reforesting their holdings. But community security is needed no less in protecting the timber grower from taxation beyond what the business of reforestation can economically bear.

A second development common in forest communities, as they pass from virgin timber to second growth, is diversification in the industries which use wood. Thus we commonly see the manufacture of lumber supplemented by the manufacture of pulp and paper, by the manufacture of boxes and other containers, by the production of fibre or insulating materials, by mill-work, veneer, furniture plants, and a great variety of refabricated products. This means additional manufacturing plants, the employment of more labor in working and finishing the products fabricated, more payrolls, and the creation of more wealth out of the same volume of raw material.

Depletion of virgin timber in Grays Harbor county, and the extent of the industrial and community developments which her forests have created, make it urgent that every possible impetus be given to renewal of timber supply and its more complete utilization through diversified forest industries. Here is a county about twice the size of the State of Rhode Island, in which progressive men within two generations have built from the products of the primeval forest cities, roads, schools, ports and transportation facilities as good for the needs of its inhabitants as any in America. Instead of temporary logging camps and sawmill towns, these lumbermen have created permanent cities into which have come thousands of American families. The future of these communities rests largely upon what is done to perpetuate their supply of timber.

Grays Harbor county has many natural advantages in charting its future development along the general lines indicated. Among them is the proximity of large state and federal forest holdings, whose management can undoubtedly be relied upon to support efforts of the community in working towards a stable basis of forest production.

The county contains nearly a million acres of timber land, most of which will probably render the greatest economic service in regrowing timber. The rate of forest growth in the "fog belt" is rapid, exceeding that which can be obtained in at least most of the forested sections of the United States. The major portion of this land will restock itself with a valuable second crop if fire is kept out, as thousands of acres in the county already reforested by this natural process testify.

Grays Harbor county already has diversified forest-using industries. They represent a wide range of products. In some instances, like airplane members, their products have as high a unit value as any manufactured from wood in the entire United States. The establishment of pulp and paper industry forecasts important economic development in store for this form of wood utilization, given assured future by the large supply of pulpwood now available.

Grays Harbor county produces all valuable timber species characteristic of the northern Pacific Coast. Its industries have already developed markets for a great variety of their products, including specialized markets available for such woods as Sitka Spruce and Western Red Cedar. These markets will constantly expand.

A distinct economic trend in the Pacific Northwest is toward remanufacture of lumber at the source, or fabrication of the log at the source, into such products as veneer and plywood, automobile body parts, doors and millwork, factory cuttings for a great variety of products and the like, as well as utilization of waste material for pulp, fibre products and distillates. This trend in the Northwest is recognizing the economies resulting from concentrating wood manufactures and their refinement at the source of supply. The factory is moving to the raw material. This trend will work definitely to the advantage of localities like Grays Harbor which have available or in prospect large quantities of timber requisite to meet the special needs of diversified industries.

The value of such developments to the community cannot be over-stressed. A log exported over the dock to a foreign port brings a return to the timber land owner, the logger and the transportation company. But once slung over the ship's side, it is no longer an asset to the community. The same log if cut into lumber supplies a sawmill payroll. If a portion of it is reworked in a local wood-using plant, a third industrial payroll is maintained. The more processes of manufacture, the greater the number of payrolls, and correspondingly greater is the wealth created out of raw material before it leaves the country.

This is the vision of complete wood use within the county itself that we would wish for Grays Harbor. It is this sort of vision that is needed to create the soundest economic basis for reforestation and to bring local public opinion solidly behind the perpetuation of forest resources.

It is certain that wood-using industries of this community will inevitably adjust themselves to a scale determined by the volume of timber available. The economic life of Grays Harbor, in so far as it depends upon forest resources, will necessarily be scaled down to the actual volume of raw material to be had. The vital question is—how large or how small will that volume be?

Federal and state holdings available to Grays Harbor can undoubtedly be relied upon for a substantial, permanent yield of timber. But it would be disastrous to the interests of the community to rely wholly upon them. The million or so acres of forest land in private ownership should contribute their share. It is of utmost importance to the future of the county to insure the productiveness of these privately-owned forests. In the long run, the maintenance of wood-using industries on an adequate scale depends upon them.

This brings us back to the importance of community security for timber growing—in fire protection, in taxation, and in local public sentiment. The most important part of the undertaking is to focus the active interest of the people of Grays Harbor upon the necessity for a continuous supply of timber in days to come, and upon practical ways and means whereby aggressive public opinion can aid in bringing this about.



TYPICAL "FOG-BELT" REPRODUCTION, CALLED CLASS 7 IN TEXT AND TABLES.



## PRODUCTIVE CAPACITY

The research department of the Western Forestry and Conservation Association mapped all private forest lands in the county by ten classifications of their character and condition and calculated their possible production for 70 years. (Table, Page 17).

Adding Classes 1 to 3 shows that only 27.6 per cent of the private forest land still bears merchantable and taxable timber. Classes 4 to 7, mostly early-logged lands, adequately restocked with new crops varying in age from those just starting to those nearly ready for re-harvest, amount to 25.4 per cent. Classes 8 and 9, comprising both recently logged and burned lands and lands with well-advanced but scrappy reforestation, comprise 30.4 per cent, concerning much of which foresters' opinion as to the period required for fairly satisfactory restocking varies from 5 to 20 years. Probably 10 to 15 years hence is an optimistic average from which to figure the start of most of this crop. Class 10, comprising 16.6 per cent, includes potential agricultural lands, developed or not developed, of which half seems as likely to stay in forest use as to grow other crops and, in reforestation, averages as do the other classes described.

All of these lands were also classified by "site," as foresters call it, as to high, medium or low forest-growing capacity. The following fir-hemlock yield tables for these sites were computed separately, applying the Scribner Decimal C rule to trees 12 inches or more in diameter, D. B. H., used to an 8-inch top. Pulpwood can be cut at younger and smaller sizes, but volume in cords may be reckoned at 90 cubic feet to the cord.

DOUGLAS FIR AND HEMLOCK YIELD TABLE (Per Acre)

AGE Years	HIGH SITE Lands west of Wynoochee-Satsop divide and of Chehalis-North River divide. (Except some gravel and swamp.)		MEDIUM HIGH SITE Chehalis drainage east of Montesano, and Satsop drainage, except gravelly soils.		LOW SITE Gravel soil northeast corner county.	
	<i>Cubic Ft.</i>	<i>Ft. Bd. Measure</i>	<i>Cubic Ft.</i>	<i>Ft. Bd. Measure</i>	<i>Cubic Ft.</i>	<i>Ft. Bd. Measure</i>
40	7,000	17,000	6,700	16,000	5,000	11,500
45	8,500	23,000	7,900	22,000	5,800	16,000
50	9,400	35,000	9,000	30,000	6,500	21,000
55	10,500	42,000	9,900	37,000	7,100	26,000
60	11,400	50,000	10,800	44,000	7,800	30,000
65	12,000	57,000	11,500	50,000	8,000	33,000
70	12,800	63,000	12,300	55,000	8,300	35,000

NOTE—In applying such a table to particular areas, suitable deduction must be made for various "fail" factors in restocking and utilization.

As a general-purpose age for predicting future yields, 55 years is quite generally approved and was used in applying the above site tables separately to the several area classifications. For anyone who may wish to make rougher, averaged calculations,

following is a brief combined fir-hemlock-spruce table giving only three crop ages and averaging the entire county as to "site." It discloses an expectable average acreage yield, when second crops reach 55 years old, of about 35,000 feet of small saw timber, or 100 cords of pulpwood, per acre. In applying either table, some allowance must be made for fire loss or other reduction of reasonably full stocking at time of harvest.

AVERAGE YIELD TABLE—GRAYS HARBOR COUNTY

*Douglas Fir, Hemlock and Spruce*

<i>Height Average</i>				
<i>Dominant</i>	<i>Volume in</i>	<i>Volume in</i>	<i>Volume in</i>	
<i>Trees in</i>	<i>Cubic Feet</i>	<i>Feet B. M.</i>	<i>Cords</i>	
<i>Age</i>	<i>Feet</i>	<i>Per Acre</i>	<i>Per Acre</i>	<i>Per Acre</i>
40	75	6,500	13,000	65
55	99	9,500	35,000	100
70	115	11,500	50,000	125

With these preliminary explanations, it will be easy to interpret the following classification table which, re-arranged and synopsised (there are a dozen more specific tables and maps in the original "Western Forestry" report), shows (a) the land classifications, (b) their percentages of the whole private area, and (c) the expectable yield of each new crop area-class in the next 70 years, *as each arrives at merchantability age*, added to Classes 1, 2 and 3, which already offer between 53,000 to 40,000 feet per acre.

PRODUCTION TABLE FOR THE NEXT 70 YEARS

<i>Class</i>	<i>Acres</i>	<i>Per cent</i>	<i>Yield in M Feet*</i>
1. Virgin Timber .....	207,920	25.1	11,000,000
2. Tie and pole timber (60-80 years) .....	5,280	0.6	211,200
3. Mixed-age timber (largely pulpwood) .....	15,790	1.9	631,600
4. 40 to 60 year second growth .....	43,430	5.2	1,520,000
5. 20 to 40 year second growth .....	22,040	2.7	771,400
6. 10 to 20 year second growth .....	44,260	5.4	1,550,000
7. 1 to 10 year second growth .....	100,130	12.1	3,500,000
8. 10 to 20 year second growth, land only 20 to 50% stocked ..	44,100	5.3	1,540,000
9. Recently cut or burned; will probably be restocked in 10 to 20 years .....	208,400	25.1	6,252,000
10. Potential agricultural land, probably half remaining in forest ..	138,073	16.6	2,416,000
Total .....	829,423	100.0	29,392,200

\*Easily convertible to pulpwood cords.

### Possible Earnings

Admitting that future stumpage values can only be guessed, if we step them up merely theoretically, by way of illustration, from \$2 today to \$12.50 in the year 2000 A. D., we find that by then these Grays Harbor county lands may earn, merely as stumpage value, the sum of \$140,000,000, an average of \$2,000,000 a year.

If we estimate land and harvest taxes at 25 per cent of total forest revenue; county and state will have received \$500,000 a year, averaged, in taxes. In addition



THE OLD AND THE NEW. STUMP OF OLD GRAYS HARBOR LOGGING WITH REPRODUCTION NOW ESTABLISHED. CLASS 8 IN TEXT AND TABLES.

to this there are in the county 189,920 acres of Indian lands that will in the 70-year period yield at least 6,000,000,000 feet, B. M., and 154,908 acres national forest land that will yield in the same period at least 3,000,000,000 feet. When the latter is sold, the county gets 25% of the gross receipts, which should amount at least to \$200,000 a year averaged throughout the period. So the average annual tax and equivalent revenue would about equal present annual taxes collected from timber lands.

Protection costs will hardly average over 5 cents an acre, annually, being \$41,471.

Net community profits thus roughly indicated are without reckoning a probable \$20 per thousand (or pulpwood equivalent), to be put in circulation for labor and other harvesting costs, and brought in by sale of the product. If production could be held to average a billion feet a year, approximately, (perhaps optimistic) this means twenty million dollars a year more.

### Public Timber Required

The above possibilities do not include National Forest, State or Indian lands, except as they produce a tax equivalent. But they emphasize the responsibility of public timber for bridging the gap between old and new private crops which will quite soon become serious and, with comparatively little young growth merchantable earlier, continue until about 35 years hence, when, if given a chance, large areas will be yielding again. This future gap of perhaps 20 years is the region's greatest threat—unless it is bridged.

Theoretically again, a co-operative program could be something like this:

Until 1935, assume private timber to be cut as follows: Class 1, 150,000 acres, or 8 billion feet; Class 2, 3000 acres or 120 million feet; Class 3, 5000 acres or 150 million feet; Class 4, 4000 acres or 150 million feet; totalling 182,000 acres or 8,420,000,000 feet. With 5000 acres of national forest and 6000 acres of Indian timber; totalling 330,000,000 feet of public timber; altogether providing, private and public,  $1\frac{1}{4}$  billion feet a year.

The next decade, 1936 to 1945; private timber furnishing: Class 1, 58,000 acres; Class 2, 2000 acres; Class 3, 10,000 acres; Class 4, 30,000 acres; totalling 4 billion feet; with 40,000 acres of National Forest timber 60,000 acres of Indian timber, and 40,000 acres of state timber; together adding 5 billion feet, and making 900,000,000 feet a year for the decade.

From 1946 to 1955, private production will fall to its minimum. Classes 1, 2 and 3 are exhausted. Class 4 promises only 10,000 acres; Class 5 comes in heavily with 14,000 acres; Class 10 promises 10,000 acres—a total yield of 1,200,000,000 feet. To keep up production, the Olympic National Forest must then be ready to supply its maximum help, 5 billion feet for the decade; Indian timber can drop to

1,500,000,000 feet, but state timber, like federal, must reach its maximum contribution, 1,300,000,000 feet. Total is 9 billion feet for this decade; again 900 million annually.

From 1956 to 1965, private production rises again, through the merchantability of new growth; classes 5, 6, 7 and 10 to 90,000 acres or 3 billion feet. Therefore, public timber contribution can fall back to 3 billion feet of national forest timber, 1 billion feet of Indian timber, and 2 billion feet of state timber; totalling 9 billion feet for the decade and keeping regional production again up to 900,000,000 feet a year.

From 1966 to 1975, private classes 6, 7 and 10, together with balance left in classes 4 and 5, bring to merchantability 90,000 acres or 3 billion feet. To keep up the industry on a sustained basis, national forest timber must supply 3 billion feet as before; Indian timber 1 billion as before; and state timber 2 billion. This decade again averages 900,000,000 feet a year.

From 1976 to 1985, private classes 8, 9 and 11 increase heavily, producing a cut of 5,500,000,000 feet a year. National forest aid can drop sharply to 1,500,000,000 feet; state lands to 500,000,000 feet; Indian lands to 1,500,000,000 feet. But the total is again close to a billion feet a year. And from then on it maintains nearly that sustained production in perpetuity—with good fire luck and if all join in some such program with reciprocal obligation assured, and keep the land productive accordingly, which is admittedly theoretical and only suggestive of a way the agencies concerned might attack the problem. Here are quotations from the original "Western Forestry" report:

### **Team Work Imperative**

The actual condition confronted is that the virgin timber proportion now remaining is a storage area, not a producing one, and the cut-over proportion is not producing in a manner to keep up the requirement. The accident of differing periodical logging activity, and of fire setback, gives a large area capable of another yield 40 years hence and onward, but only a small area capable of a yield to bridge the gap after the virgin timber is exhausted.

This gap of some 20 years threatens to destroy the region. Unless it can be bridged, industry, institutions and taxation may all break down. Since under such circumstances protection of the growing crop can hardly be financed, locally at least, recovery becomes doubtful. Cut-out owners will have no means or inducement to carry their land over a non-earning period. The community will be likely to find itself with the land instead of with revenue with which to protect it. Remaining operators may be faced with added fire and tax burden, so incline to speed up the finish rather than to prolong it.

There is little theory in the above. It is inexorable logic from the certainty of the gap shown by the condition of the land. As obviously it can be met in only one way, if at all; by so utilizing all the tributary timber of the region, public and private—and there is barely enough—so as to sustain the industrial and other institutions as going concerns to bridge the gap. Apparently this is possible if production is not

speeded up, if public policies and resources are systematically contributory, and if in return private lands are kept productive to meet the end of the old timber.

It sums up that appraisal of all possibilities, in both old and new timber, indicates that team work alone will save the region. Systematic pooling of all private and public resources in timber and cutover land would about carry the present cut for 10 years, then drop to a 900,000,000 cut forever.

This can be accomplished by letting the private cut down gradually, through throwing in public timber, so its low point is reached 20 or 30 years hence; then gradually withdrawing the public supply as the private new crop increases. It also maintains present utilization standards, equipment and markets for the longest possible time, with new ones suitable for small timber developed gradually, instead of requiring the region to convert from one to the other suddenly.

The necessity of such a conversion must be faced and is not serious, economically, if gradual. All forest regions experience it—Maine, the Atlantic pine region, the Gulf states. Obsolescence of equipment and method, and the development of new, keep pace with changing utilization and market opportunities for a new class of timber. The only exceptions to this are regions, of which the Lake states afford some example, where there is an absolute gap but no bridge.

### Practicability of Co-operation

It is clear enough that if regional production is to be maintained there must be (a) some such concerted cutting program to dovetail possible supplies together, and that (b) if there is to be anything like certainty and maximum result, the cutover land must be kept productive. The first requirement might possibly work out more or less through economic forces, provided it did not also depend on the second. To assure the latter requires responsibility by someone for keeping and protecting the reforestation land and for the use of the crop when it can be used. Either this must be made a possibility for private owners, or some public agency must take over the job and its costs, finding means for this without taxing the land. It will hardly be accomplished by letting the land revert piecemeal for delinquent taxes. Neither state nor federal acquisition seems at all dependable at this time, even if it were acceptable to the county.

The owner with a long operating life is likely to look favorably on such a project, the more he studies it, especially as concerns his land which offers the shortest carry. The owner with a short operating life has no such chance, except as there is promise of disposal to somebody with a better chance. In either case, the long-carry land is at a disadvantage, therefore likely to receive poor treatment unless some inducement is offered for treating it as part of an entire project. Putting together the long-carry land and the early-harvest land in short-life owners' hands, we have a large part of the area presenting a serious problem. It is in danger of reverting to a sort of no-man's-land, neither growing timber nor paying taxes, while threatening the rest with fire. The early-harvest part is a very real community asset, representing values that should not be lost.

If a way can be found to join all interests concerned, it is certainly desirable. It can be done in theory in more than one way, each depending on co-operation by public agencies, such as, perhaps:

1. A holding company might be organized to include the chief owners covenanting to keep and protect all their cutover land and in return being sold (or promised it shall be withheld from competition) sufficient public timber to enable all members

to stay in the game, bridge the gap, and carry their cutover land till it yields again. It would be allocated as needed; in the near future, at least, most heavily to the cut-out owners to whom this plan offers the greatest advantage.

2. Somewhat similarly, guarantee of public timber to tide over could be made to either established or new-coming operators who will take over the cutover lands of those short-life operators who do not care to continue under the first plan.

3. Either plan might be made to include the feature of exchange so the governmental area takes over part of the cutover land in return for timber.

In some such way, although this cannot be specified without adjustment of views, the region as a whole could be protected. Owners willing to keep their lands productive could be assured against being stranded in their lumber operations by sale of public timber to competitors offering no such public service. In return, obviously, the government must insist on assurance that such service will be performed to keep up the yield of the entire region. Otherwise, it would hardly abandon its competitive principle of selling, or risk either over-cutting or under-cutting its own timber, or refuse to let its timber go to the north or east if legitimate demand appears there.

## THE DISTRICT FORESTER'S VIEW

Following the foregoing economic suggestion, the U. S. District Forester, Mr. C. M. Granger, presents a somewhat differing view, predicated upon federal responsibility for treating its National Forests as independent units and questioning the present assurance of community or private ownership dependability to guarantee reciprocity should the Government undertake to undercut now and overcut in the future in order to sustain the community's production. The issue is clearly the possibility of reaching a practical and dependable agreement.

### National Forest Timber

C. M. GRANGER, *U. S. District Forester.*

The National Forest timber on the Queets, Quinault and Humptulips may be said to be directly tributary to Grays Harbor because these drainages lie almost at Grays Harbor's doorstep. The Bogachiel, Hoh, Wynooche and Satsop are somewhat less directly tributary, but reasonably so.

The total stand of National Forest timber on these watersheds is roughly estimated to be slightly over fifteen billion feet. Detailed cruises are not available, but a rough calculation shows a possible annual cut on a sustained-yield basis of around 190 million feet.

The Forest Service believes that the stability of Grays Harbor communities in their dependence on the timber industry can be best helped by the National Forest timber if that timber is sold strictly on a sustained-yield basis. There is not sufficient assurance of sustained productivity of private lands to permit pooling the National Forest timber in a gap-bridging program. It might be possible to work out a plan of joint management of National Forest units with immediately adjacent private units, but that would depend on stability of private management and some changes in legislation governing National Forest sales. Furthermore, it would have to be determined on the basis of what is the best public policy.

It would be very desirable for joint plans of management to be considered between the state and federal Forest Service where large timber holdings of the two adjoin. Perhaps the same thing could be done in connection with Indian reservation timber. In any event, it is very desirable that a permanent policy for the management of state and Indian timber be developed.

The Forest Service policy for National Forest timber on the watersheds above enumerated is as follows:

1. To handle it on a sustained-yield basis.
2. To withhold from sale the timber on the Bogachiel, Hoh and Queets until the common carrier railroad is constructed from Grays Harbor to at least the Hoh River, and until closer utilization of all material, especially pulpwood species, is possible than under present logging conditions. In other words, this timber will be held until economic conditions are right for its disposal.
3. To make an immediate sale in the working circle consisting of the combined Humptulips, Satsop and Wynooche drainages on a sustained-yield basis of 40 million feet a year. This sale is made for the purpose of enabling mills in the Grays Harbor



district which are on the verge of running out of timber to bid on this unit. We believe that feeding this National Forest timber into the supply at this time on a sustained-yield basis is the most effective way to make National Forest timber help Grays Harbor begin gradually reducing its annual production to a figure which can be permanently sustained.

4. To make the timber on the Quinault available for sale when reached in the orderly development of logging on that drainage, conditioned also on better utilization and on a sustained-yield basis.



FIFTEEN YEARS AFTER LOGGING; GRAYS HARBOR COUNTY. CLASS 6 IN TEXT AND TABLES.

## REFORESTATION INFLUENCES AND YIELD

If forest owners and public are to consider growing, protection and taxation of forests in an intelligent businesslike way, they must know what the land may be expected to do in repayment. Facts concerning reforestation processes and growth-rate on typical Douglas fir and pine lands have been quite fully established, but, except in British Columbia, comparatively little study has been given the "fog-belt" timber type in extreme western Grays Harbor county. To complete the survey in this particular, Professor J. L. Alexander, University of Washington Forest School, who did most of the British Columbia work, was engaged. The cost was mostly met by Mr. Charles Lathrop Pack, with assistance by the State Supervisor of Forestry and the Washington Forest Fire Association.

A portion of Professor Alexander's report follows. His findings as to growth and yield differ little from previous estimates, but add technical information about reseedling and survival of seedlings of particular value to those desiring to appraise processes and results.

### Regeneration and Yield—"Fog Belt"—Grays Harbor County

J. L. ALEXANDER

Evidence to date indicates stored seed cannot be depended upon to restock areas satisfactorily. Previous acceptance of the "stored seed" theory has been an economic misfortune. Seed blown over cut-over areas is the important source of reproduction.

If there is abundant seed, reproduction cannot be prevented in Grays Harbor county, irrespective of the severity or reoccurrence of fires. Where the seed supply is insufficient, cut-over areas cannot be expected to regenerate rapidly although they will in time.

Sitka Spruce, Hemlock and Cedar are more abundant seeders than Douglas Fir. On one area where a fire burned into standing timber, 94% of seedlings were Sitka Spruce and 6% Douglas Fir, yet Sitka Spruce formed less than 1% of the virgin stand. There had been a heavy Spruce seed crop and a failure in Douglas Fir. On another area where Cedar formed 80% of the virgin stand, Spruce is predominating in the reproduction due to a group of large-crowned Spruce within seeding distance.

There has not been a good seed crop for Douglas Fir since 1923. Douglas Fir may be expected to produce two good seed crops every decade. Hemlock, Cedar and Spruce are more prolific and their period between heavy seed crops less than for Douglas Fir.

### Seed Dissemination

There is not sufficient information to determine precisely how far blocks of seed trees may be expected to seed up areas, but indications are that one-quarter mile in the direction of the prevailing winds (east and west) is about the limit for *rapid* natural seeding.

TABLE SHOWING NUMBER OF SPRUCE SEEDLINGS PER ACRE FOUND EIGHT YEARS AFTER LOGGING AT VARIOUS DISTANCES FROM SEED TREES

Distance from Seed Trees in 66' chains.	
0-5	No data
5-10	8080
10-15	3100
15-20	1000
20-25	240
25-30	160
30-35	100
35-40	60
40-45	0
45-50	0
50-55	0
55-60	20

TABLE SHOWING THE NUMBER OF SEEDLINGS FOUND AT VARIOUS DISTANCES FROM GREEN TIMBER. AVERAGES BASED ON ALL AREAS EXAMINED.

Distance from Seed Trees in 66' chains	Number of Seedlings per Acre		
	<i>Hemlock</i>	<i>Spruce</i>	<i>Cedar</i>
0-5	3630	not sufficient data	1800
5-10	2544	4300	810
10-15	1098	1280	240
15-20	580	500	200
20-25	368	110	150
25-30	125	53	20
30-35	14	34	0
35-40	0	20	0
40-45	0	0	0

The above tables indicate the relative importance of stored and windblown seed. They indicate that beyond 20 chains from seed trees the restocking of cut-over areas will be slow.\*

\*EDITOR'S NOTE—This conclusion disregards strong east winds and forest fire drafts that spread fewer seeds great distances when they coincide with good seed crop.

### Seed Survival

Controlled seed dissemination studies show that emergence of seed from cones may extend over a long period. Examinations of duff during summer indicated that seed found had recently fallen. In the spring of 1924, following the heavy seed crop of 1923, thousands of Douglas Fir with only the primary leaves were found in the virgin forests. They all died during the summer.

However, where logging takes place in fall, or in winter following a heavy seed crop, some reproduction may be expected from the seeds of the previous fall. Rodent population multiplies very rapidly after logging and in years of poor seed crops loss from rodents is great. In years of poor seed crops a large percentage of cones are damaged by insects also.

The studies indicate that windblown seed is the important factor in restocking cut-over areas and there must be lots of seed for *rapid* reforestation.

### Seed Germination

Favorable seed bed is an important factor in natural reproduction. One area within 10 chains of green timber was burned over in 1920 and reburned in 1922. An average of 100 Douglas Fir, 50 Cedar, 850 Hemlock and 175 Spruce was found. Most of the Hemlock and Spruce had established on rotten logs. On one log, 13 feet long and 1.5 feet wide, with a surface area of 19.5 square feet, 5 Spruce and 11 Hemlock were found. Rotten wood was moist 1 inch below the surface, whereas mineral soil was too dry to support seedling growth for a depth of over 3 inches. There were about 30 times as many seedlings per unit area on this log as under average conditions throughout the area. Most of the Hemlock and Cedar was found on decayed logs.

Another area logged in 1923, and burned that spring, had dense covering of fern. Eight Sitka Spruce, 24 Hemlock and 5 Cedar were found on a partially decayed log which was 40 inches in diameter and 27 feet in length. The Spruce were 4 years old, 13 inches in height, and the roots had a vertical penetration into the log of 15 inches and a lateral spread of 21 inches. The roots penetrated the rotten wood along the margin of checks where the moisture was most favorable, and had grown for four years without contact with the mineral soil. Moisture could be squeezed from the wood at one-half inch from the surface.

On an area where sufficient vegetation had not established to afford shade from direct sunlight, 91% of the Hemlock and 76% of the Cedar were in the shade of logs, and most of the remaining seedlings were found amid rotting wood which seemed to retain more moisture than the soil.

TABLE SHOWING EFFECT OF SEED BED ON NUMBER  
OF SEEDLINGS GERMINATING\*

	<i>Fir</i>	<i>Cedar</i>	<i>Hemlock</i>	<i>Spruce</i>
Bare Mineral Soil .....	64....	30....	0....	0
No Shade Spring Burn.....	37....	54....	0....	0
25% " " " .....	176....	620....	11....	29
50% " " " .....	150....	1198....	48....	77
75% " " " .....	110....	2600....	185....	107
Southern Aspect, Bracken .....	0....	5....	8....	8
Level Aspect, Bracken .....	58....	159....	40....	44
Northern Aspect, Bracken .....	12....	144....	99....	38
Total .....	607....	4810....	391....	313

Above table shows the relative number of seedlings where the same amount of seed for each series of tests for each species was broadcast sown in the early spring. 22,000 Douglas Fir, 67,000 Cedar and an undetermined amount of Hemlock and Spruce seed were used in the experiment.

\*NOTE—Some of these half dozen seedling tables include studies of fog-belt conditions outside Grays Harbor county.

TABLE SHOWING THE PERCENTAGE OF THE TOTAL NUMBER OF SEEDLINGS WHICH GERMINATED UNDER VARIOUS CONDITIONS

	<i>Fir</i>	<i>Cedar</i>	<i>Hemlock</i>	<i>Spruce</i>
Bare Mineral Soil .....	10.5	0.6	0.	0.
No Shade Spring Burn .....	6.1	1.1	0.	3.2
25% " " " .....	29.0	12.9	2.8	9.3
50% " " " .....	24.7	24.9	12.3	24.6
75% " " " .....	18.1	54.1	47.3	34.2
Southern Aspect Bracken .....	0.	0.1	2.1	2.5
Level " " .....	9.6	3.3	10.2	14.1
Northern " " .....	2.0	3.0	25.3	12.1
Total .....	100.0	100.0	100.0	100.0

Above table indicates that shade is required for favorable germination of all species. Douglas Fir germinated best on fresh burn with 25% shade, although the difference between 25% shade and 50% shade may not be significant. Cedar is more adapted to fresh burns without shade than Hemlock or Spruce. Hemlock shows marked preference for shaded areas and northern aspects. Shade is beneficial largely through its effect on the moisture condition of the seed bed. The most favorable natural condition would occur after fire when shade from established vegetation would more than counteract its competition for moisture.

Examination of a recently burned-over area in the mixed Douglas Fir-Cedar-Hemlock Type showed the following seed bed conditions:—

	<i>Sq. Ft. Per Acre</i>
Humus layer surface burned .....	37% .....
Mineral Soil unshaded .....	22% .....
Mixed humus and mineral soil .....	13% .....
Cull logs and pieces of wood in contact with ground .....	13% .....
Humus layer surface unburned .....	8% .....
Mineral soil shaded by logs .....	5% .....
Humus layer shaded by logs .....	1% .....
Stumps .....	1% .....
Total .....	100%

All conditions of seed bed were available in sufficient area for satisfactory germination if abundant seed were available.

### Seedling Survival

Examination of northern and southern aspects showed a larger number of seedlings on the northern aspect. Effects of exposure are best indicated by studies made previously by the writer.

#### SEEDLINGS PER ACRE

<i>Species</i>	<i>Northern Aspect</i>		<i>Southern Aspect</i>	
	<i>No.</i>	<i>% by species</i>	<i>No.</i>	<i>% by species</i>
Douglas Fir .....	1347	30	501	77
Hemlock .....	2553	58	124	19
Cedar .....	515	12	25	4
White Pine .....	13	trace	—	—
Totals .....	4428	100	650	100

Studies above show reproduction found nine years after a burn, under conditions where *aspect* was the only marked difference in the areas examined. Difference in reproduction found on various aspects is due to difference in temperatures.

Southern aspects and level areas present a more serious problem than areas with northern aspects. Areas with southern aspects may be expected to restock slowly even though near seed supply.

TABLE SHOWING PERCENTAGE OF SEEDLINGS WHICH LIVED THROUGH FIRST SUMMER

Surface	% of Seedlings			
	Fir	Hemlock	Cedar	Spruce
Bare Mineral Soil . . . . .	58	0	37	0
No-Shade Spring Burn . . . . .	51	0	30	0
25% " " " . . . . .	60	27	64	38
50% " " " . . . . .	81	27	86	48
75% " " " . . . . .	62	40	92	60
Southern Aspect Bracken Cover . . . . .	0	0	0	0
Level Bracken Cover . . . . .	74	5	30	2
Northern Aspect Bracken Cover . . . . .	67	62	57	34

The above data indicate that conditions which exist the first year after a slash fire are not favorable for establishment of seedlings in regions with little precipitation during summer months. The most favorable conditions for Douglas Fir was a burned area with 50% shade. Hemlock, Cedar and Spruce survived in largest quantities under 75% shade.

Competition of lesser vegetation on level areas somewhat offsets the beneficial shade for the shallow-rooted species. Cedar withstands severe conditions on exposed areas better than Hemlock or Spruce. Studies indicate that Hemlock and Spruce require some cover. As vegetation establishes after logging, conditions improve for establishment of seedlings until vegetation reaches density where competition for moisture more than offsets shading effect. The most favorable condition occurs from one to two years after logging or burning; then conditions become less favorable until lesser vegetation begins to thin out and light bracken becomes dominant. At this stage, conditions for establishment of seedlings begin to improve. Studies indicate it is not practical, even provided plenty of seed is available, to determine if areas will or will not restock naturally until several years after the area is logged.

TABLE SHOWING CAUSES OF DEATH OF DOUGLAS FIR FIRST YEAR AFTER GERMINATION

DOUGLAS FIR MORTALITY

	% of Total Seedlings Killed				% of seedlings which died from all causes
	High Soil Temp.	Drought	Insects	Not Identified	
Bare Mineral Soil . . . . .	78	15	7	0	42
No-Shade Spring Burn . . . . .	86	14	0	0	49
25% " " " . . . . .	64	21	8	7	40
50% " " " . . . . .	17	53	30	0	19
75% " " " . . . . .	9	72	14	5	38
Southern Aspect Bracken Cover . . . . .	—	—	—	—	—
Level " " " . . . . .	73	7	13	7	26
Northern " " " . . . . .	0	100	0	0	33

The preceding table shows the high percentage of seedlings on exposed sites killed through the soil becoming sufficiently hot to cause lesions on the stems. Although



AERIAL PHOTO BY LAGE VON WERNSTEDT. BACKGROUND, AGRICULTURAL VALLEY (CHEHALIS); MIDDLEGROUND, RECENT LOGGING; FOREGROUND, REFORESTATION ON LOGGED LAND ESCAPING FIRE. GRAYS HARBOR COUNTY.

(COURTESY FOREST SERVICE)

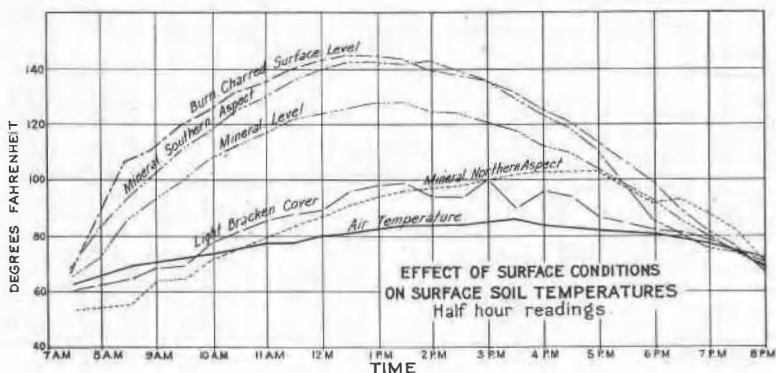


AERIAL PHOTO BY LAGE VON WERNSTEDT. BACKGROUND, FRESH LOGGING. FOREGROUND, REFORESTATION ON LOGGED LAND ESCAPING FIRE. GRAYS HARBOR COUNTY.

(COURTESY FOREST SERVICE)



moisture determinations were not made, it was apparent that the seedlings killed by drought were not able to absorb sufficient moisture through their roots to offset the amount transpired through the leaves, although the roots were established in soil with a sufficient moisture content to support the seedlings if the transpiration was less rapid. The 30% loss under 50% shade was due to some unidentified insects which destroyed the leaves.



The above chart based on half-hourly readings indicates the effect of various conditions on the temperature of the soil at its surface. Temperatures above 130° Fahrenheit are critical for seedlings. Although average temperature for a given site might be above the critical temperature, those seedlings that were protected through the surface not being uniform would survive. Highest soil temperatures occurred after prolonged dry spells on clear, calm days.\*

These studies explain why the major percentage of reproduction establishing on exposed sites is found in the shade of logs; also indicates that in seed spotting, or setting out seedlings, advantage should be taken of natural cover where they will receive greatest protection from the sun.

### Yield

#### LOCAL YIELD TABLE WESTERN HEMLOCK—GRAYS HARBOR COUNTY

(Alexander's table. Checks closely with table on page 16,  
built on different utilization standards.)

Age	Average Diameter Breast-High	Total Height, Feet	Basal Area Sq. Ft.	Total No. of Trees per Acre	Total Volume per Acre, Cu. Ft.	Volume of Trees over 7" in D.B. H. to 5" Top, Cu. Ft.	Present Utilized Volume of Trees 14" and over, D. B. H., Board Feet
40	8.6	79	197	489	7,275	4,530	4,995
60	12.4	108	212	253	10,275	9,202	28,680
80	15.2	126	224	178	12,292	11,550	42,975
100	17.4	140	232	141	13,845	13,102	52,575
120	18.6	148	237	126	14,700	13,980	59,175
140	19.7	155	241	114	15,465	14,775	63,150
160	20.5	160	243	106	16,050	15,360	66,675

\*EDITOR'S NOTE—Alexander's surface temperature curves, showing nearly 150° Fahrenheit on black-ash burns, are extremely significant and go far to explain non-survival of seedlings.

Examination of representative second-growth stands throughout the region indicated that hemlock averages 140 feet in height at 100 years of age. Average basal areas are 75% of those given in a Hemlock normal yield table previously prepared for the B. C. Forest Service. Corrections were made for density of stocking. The above table gives the yield which may be expected over large well-stocked areas. There are some areas which will produce more than the above table indicates and others which will produce less.

Spruce will yield approximately the same volume as Hemlock and, although the diameter of the Spruce will be greater than Hemlock, there will be less trees per acre. A 30-year-old stand could be thinned for pulp and the remainder carried to a longer rotation for saw material. The yield could be greatly increased by thinning on account of the rapid response of Hemlock and Spruce when relieved from competition.

### Management

It is good economics to practice more intensive forestry and produce full crops from forest soil rather than half crops. Cost of regeneration may be greater, but fire protection will be less difficult, and quality of the final crop superior.

Fundamentally logging practice should aim—

- (1) To secure the most efficient production
- (2) To have a well-balanced program for capital expenditures for equipment, engineering, etc.
- (3) To gain the best results in conditions arising from the logging operation proper, as effecting reforestation and protection from fire, insect and fungi.

The first objective is obtained through harvesting the stands which are not earning, yet which will yield a profit, and leaving for future operations those of negative value.

The second objective is more difficult to schedule. It is difficult to determine to what extent modifications of methods and principles of logging, sanctioned by costs, can be made in order to secure better protection and regrowth on the cut-over areas and protection to future operating costs and timber values.

The third objective is gained through closer utilization, better protection, logging by compartments so as to insure an abundant seed supply and by creating favorable seed-bed conditions.

For a long period the logging operation was considered and, with exceptions, is still considered, by operators the sole operation connected with the business of using the forest, and under certain conditions of land tenure, high fire and insect risk, exorbitant taxation it may reasonably be considered so.

Success or failure of natural regeneration depends on logging practice. In reforesting by natural means the following must be considered:—

- (1) There must be a seed supply and favorable conditions for establishment and growth.
- (2) Seed must come from trees left on or adjacent to the cut-over areas. Stored seed is not an important factor.
- (3) The ultimate means of reducing fire risk is through the establishment of a cover of trees. With few exceptions, areas which have not reforested naturally have not been, and apparently cannot be, protected from fire for a long period.

Individual seed trees of Spruce, Hemlock, Cedar and Douglas Fir have not proven satisfactory on moister sites due to loss from windthrow and interference with logging. Douglas Fir on drier sites, such as tops of knolls, have deep root systems and will stand up better than those on the moister sites where the root system is invariably shallow. It is not advisable to leave individual or small groups of seed trees. It is desirable to retain blocks of virgin timber for fire protection and seeding purposes along main-line railways or other locations where they can be economically logged at a future time. Blocks should be at least twelve hundred feet in width to justify future exploitation. Larger belts would reduce the loss from windthrow and afford better breaks for fire protection as it is only under very extreme conditions that fire will travel in green timber. These blocks should be left for at least five years, or until cut-over areas have been stocked with seedlings.

One operator splits up his units and retains during summer a belt of unlogged timber between the cut-over area and the new logging. These fire breaks are logged during the winter. If belts of timber were left until cut-over areas had restocked, they would solve the silvicultural problem. On many areas it is advisable to adopt a "setting" selection system, logging only those stands which will yield profit, leaving the rest until economic conditions justify exploitation.

With high-powered heavy steam machinery, logs are usually yarded for longer distances than with gas machinery, and the duff on the forest floor is sufficiently mixed with the mineral soil to form a favorable seed-bed. With increasing use of light gasoline donkeys for cold-decking, "settings" are smaller and less forest floor and vegetation is disturbed, and the seed-bed is less favorable than where the heavier machinery is used. This may be offset by more trees of seed-bearing size being left.

SUMMARY OF ALL AREAS EXAMINED THAT HAD BEEN LOGGED  
FOR AN AVERAGE OF EIGHT YEARS

<i>Seedlings per Acre</i>	<i>Unburned</i>	<i>Burned</i>
1000+	46%	42%
500+	66%	63%

If 1000 seedlings per acre at eight years after logging is considered necessary for satisfactory stocking, less than half the fog-belt cut-over areas meet this requirement. If 500 seedlings per acre are accepted as standard, two-thirds of the areas are satisfactorily stocked and one-third unsatisfactorily stocked\*. Difference in percentages found are not of sufficient magnitude to indicate that more reproduction occurs on unburned areas than on burned areas. However, the summary shows that present logging methods do not result in satisfactory conditions.

Where the duff and lesser vegetation covers the ground with little mixing of the duff and mineral soil, burning of the surface layer improves the seed-bed, provided the burn is sufficiently hot to reduce the duff to a thin layer. Beneficial effect on the seed-bed may be offset by destruction of the residual stand left after logging. Where there is no advanced reproduction and no part of the area is further than one-quarter mile from seed trees, burning of the logged-over areas appears to be beneficial, particularly where a thick layer of undecayed debris covers the ground. Broadcast burns in the past, however, have usually been detrimental because not confined to areas of fresh slash. A broadcast burn is not insurance against another fire, as little material over three inches in diameter is usually consumed. Fire will burn over an area two or more times during a season. The second fire over the same area, but three weeks later, was so intense last year that it could not be controlled at a graded highway. This fire was more difficult to control in slash areas that had been burned over two years previously

\*EDITOR'S NOTE—"Western Forestry" assumes 700 to the acre satisfactory if well-distributed.

than it was in unburned slash, because of it being impossible to backfire at night the areas that had been burned. In afternoons the fire was so intense it was impossible to hold on lines where backfiring had not been done.

Instead of general broadcast burning, better results would be achieved by more intensive burning along railway grades, around bridges and camps, and along lines which would break the areas up into compartments. Broadcast burning as has been conducted in the past, without sufficient preparation to keep the fires confined within the area of fresh slash, has done more harm than good.

Burning of slash, except where duff is deep and lesser vegetation covers the ground too completely for reproduction to establish, is not a silvicultural problem. If slash is to be reduced by burning it should be burned as soon after logging as possible, while the area is within seeding distance from the margin of the unlogged timber. It makes little difference to reproduction whether slash is burned in spring, summer or fall. Light burn does not consume sufficient debris to make control of future fires possible and summer burn, which is best, will go out of control. Spring burning is dangerous on account of hold-over fires. Fall burning leaves slash from the winter logging through the hazardous summer season. Whether to burn, or not to burn, depends on the individual requirements of operators.

Closer utilization of small logs will materially assist in solving the fire problem and assist natural reforestation. There is left on each acre, after logging, ten to twenty thousand board feet of small material which might be used for various purposes if economic conditions justified its removal. High-value products such as Cedar poles, ties and piling are frequently yarded with horses or flexible machinery before the main stand is felled. Logging small material after saw logs have been yarded may often cost more than the market price. Some type of barker and chipper, mounted on railway trucks in the woods and used to reduce the small material to chips for pulp may be the means of salvaging a large quantity of the small logs now wasted.

Natural reproduction should be the general aim, but artificial regeneration has a place in the practice of "Forestry in the Fog Belt" as follows:

- (1) In restocking areas that will not regenerate naturally and rapidly.
- (2) In increasing amount of desirable species in mixtures, particularly Spruce.

Experiments in broadcast seeding with Douglas Fir have generally shown unsatisfactory results. Little seeding has been done with Hemlock and Spruce. There are about ten times as many seeds in a pound of these species as in the same weight of Douglas Fir. The seeds, being smaller, have better chance of escaping rodents. Seed-spotting would be more successful and cheaper than broadcast sowing. Planting seedlings produced in a nursery is at present preferred to direct seeding and could be done at an estimated cost of \$10.00 per acre.

### Summary

- (1) At least one-third of *recently* cut-over areas are left in a denuded condition.
- (2) Operators are now interested in inter-relationship between logging practice, protection methods, engineering program and reforestation methods.
- (3) It is necessary to make provision for a seed supply if natural regeneration is to be satisfactory. Breaking up of areas by leaving blocks of timber is the best method and also assists in protection from fire.\*

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\*EDITOR'S NOTE—This challenges Forest Service practice in government timber sales.

- (4) Slash disposal is largely a fire protection rather than a silvicultural problem.
- (5) The ultimate means of reducing the fire hazard is through the establishment of tree-cover. Full crops will reduce the carrying charges through reduction of fire hazard, and will produce more and better material, will cost less to log, and will pay better returns on the investment than partial crops.
- (6) All areas will restock naturally if given protection and sufficient time.



TYPICAL 35- TO 40-YEAR OLYMPIC PENINSULAR SECOND-GROWTH; NEARLY READY TO LOG AGAIN. REFERRED TO IN TEXT AND TABLES AS CLASS 5.

## REPRODUCTION IN THE FOG BELT

LEO A. ISAAC, *Pacific Northwest Forest Experiment Station*

Here are presented the observations of a federal research forester, not entirely in accord with some other observers, yet counseling about the same remedial measures. This statement is not intended as a thorough picture of the whole reforestation situation, but as Mr. Isaac says, is based on what he saw in a portion of the county in a limited time and on only a small amount of detail work in this particular county.

As transition takes place from the Douglas fir type to the fog belt type, fir persists on the ridges, while flats and creek bottoms run heavy to hemlock and cedar with a light mixture of Sitka spruce. As we approach the fog belt proper, percentage of Douglas fir decreases and percentage of spruce increases, especially on moist ground. Along the coast are extensive flats where the soil is apparently sour and sterile. These flats are covered with lodgepole or very slow-growing hemlock and cedar. Cedar is characteristically spike-topped. Elsewhere are pure stands of young hemlock, or of young cedar, spruce and fir, where other species might be expected to grow or were present in the old stand. This condition apparently comes about as a result of the occurrence of heavy seed crop of one of the species immediately following fire or cutting operations.

Where we made the most detailed study of conditions, we examined areas cut since 1919. We found reproduction that varied from dense stands to a complete blank on areas cut or burned at different dates. In most instances where reproduction was found, the area was not burned or else cutting records indicated that there was standing green timber within a quarter mile of the area for a seeding season or more following the slash fire. Similar to our findings in other parts of the region, little or no reproduction was found coming in since 1924.

In general I was impressed with the vastness of the cut-over areas and their lack of reproduction and remoteness from an ample source of seed. There are miles of cut-over land with scarcely a green tree in sight, and from general inspection my estimate would be that not more than 25% of the area that I actually saw had a stand of reproduction of 700 or more to the acre. The principal cover on this land is bracken, salal and blackberry. Much of this land has been burned repeatedly, but we were surprised to find large single burns and even unburned areas upon which there was little or no reproduction. This we could attribute only to the retreating of the cutting edge of green timber to a point beyond normal seeding distance before the occurrence of a good seed crop. In general we found very little reproduction coming in since 1924 and from what local information we could secure there has apparently been very little seed of any species produced since that time. On the trip we noticed some 1928 cones on the cedar but little or none on spruce, hemlock and Douglas fir.

### Probable Rate of Restocking

Reproduction will come in even on these vast fern-covered areas, but the rate at which it comes in will be controlled by density of competing vegetation and available seed supply. I would estimate that such broad treeless stretches as may be found in the vicinity of Greenwood and Nisson on the upper Wishkah and Hoquiam Rivers may require upwards of 25 years to fully restock, assuming that fires are kept out. These areas have a cover of bracken and already have or are developing an under cover of

salal and blackberry, or a cover of the taller brush that will shade out the bracken in time. Most of this area is so far from green timber and has so few living trees that little seed will be available until scattered reproduction now on the ground reaches seeding age, and by that time competing vegetation will have become so dense that restocking will be slow.

### Comments on Future Management

The cut-over area in general is exceptionally good timber-growing land. To protect from fire surrounding settlements and that portion of the area which is restocking, it will be necessary to protect the entire area. To avoid protecting a vast acreage of idle land over a long period, it will probably be necessary to plant the larger areas that are now nearly devoid of reproduction, or at least to plant belts through these areas that will in time furnish firebreaks and seed for intervening spaces.

It is probably not economically possible so to handle logging of the remaining timber land that all of it will restock without planting or seeding, but it should be possible to secure a much higher percentage of natural restocking than is now being obtained.

From loss of seed trees on Government sales areas, both when left in small blocks or as single seed trees, and from appearance of scenic strips along highways and small clumps of timber left elsewhere, it is evident that the small block of seed trees or single-seed-tree system will result in considerable loss. Some loss may be avoided where it is possible to leave seed trees along ridge tops or other exposed places where trees are naturally windfirm, but such windfirm spots are so uncommon in the Fog Belt that it seems necessary to adopt some other method of getting land restocked. Direct seeding, while never pronounced a success in other parts of the United States, may offer possibilities in this humid climate, especially with the tiny seeds of cedar, hemlock and Sitka spruce. It should be tested out.

The following suggestions should aid in securing better restocking:

1. Use every precaution to leave unburned areas cut during the latter part of a good seed year and the year following. Burning not only destroys the seed in the soil but kills occasional young hemlock, cedar or spruce that exists under the old stand and escapes logging operations.
2. Where it is felt that slash must be burned for protection purposes, avoid burning when area is so dry that all humus will be burned out of the soil.
3. During years when no seed is produced, delay logging on occasional blocks of timber until intervening lands are seeded up. Block of timber should be large enough to furnish a good firebreak for the logging operation and be reasonably windfirm. Distance out from green timber that effective seeding may be expected is not definitely known, but the writer would place it between a quarter and a half mile, depending on the position of the stand and local winds in this region.

As a whole, cut-over areas of Grays Harbor county are not restocking satisfactorily. Intensive fire protection *may*, for a period, keep fire out of most of this highly inflammable region, but no type of protection will keep fire out indefinitely. The best fire guard obtainable, on the job day and night, is young growth. The sooner logging is so conducted as to secure better natural restocking and the now vast cut-over areas are broken up by broad belts of young growth, the sooner the great burden of fire protection will be reduced and reforestation become a reality.

## FOREST PROTECTION

As the introduction relates, the research agencies' studies of protection and reforestation angles were turned over to executive protection agencies. Mr. McArdle's complete report tabulates and graphs in every detail the whole history of hazard and protection results as shown by official records. Only an illustrative fraction of his graphic findings and conclusions can be offered as illustrative of how such research can afford an immensely practical guide to protective systems in any region. Taken in connection with the comment of protection officials, appearing later, it demonstrates the importance of more systematic reporting and use of reports.

The reader should realize that few of the many tables and graphs are included or discussed in this illustrative digest. He covered the whole field of fire causes, seasonal distribution and cover-type distribution in this way.

### **ANALYSIS OF FOREST FIRE REPORTS FOR GRAYS HARBOR COUNTY, WASHINGTON (National Forest and Indian Lands Excluded) FROM 1922 to 1927.**

RICHARD E. MCARDLE, *Pacific Northwest Forest Experiment Station*

This report summarizes results from analysis of reports on forest fires in Grays Harbor county, for six years, 1922 to 1927, inclusive. The purpose is to furnish a reliable basis upon which to base a fire protection plan for Grays Harbor county. It is hoped that these data will verify facts heretofore suspected but unproven; that they will suggest new angles of approach to this difficult problem, and stimulate enthusiasm in development of a practical and scientifically sound plan for improved control of forest fires.

These results are, in effect, the crystallized experience of several years of fire suppression work in Grays Harbor county. They are based almost entirely on fire wardens' reports of individual fires. In other words, actual experience of a period of years with several hundred fires has been boiled down so that the entire situation may be evaluated with but small study. Insofar as fire wardens' reports are correct, these analyses are correct.

It cannot be stressed too strongly that considerable study must be made of these summaries if full benefit is to be derived. Much work was necessary to arrange the experience record of the past half-dozen years in a way to make the record of value. Such work can be done by anyone trained in careful handling of statistics. But real analysis of these figures is yet to be done, requiring thoughtful consideration of these summaries of the past few years by those skilled in forest protective work and knowing how to apply lessons indicated by such an experience record. A few conclusions are drawn from these summaries to illustrate how the data may be used, but many other facts of vital importance can and should be digested from these basic figures.

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This report is a digest of a much longer report. The tables and charts given here were selected chiefly for illustrative purposes to show how analysis was made. The real value of the analysis is in the complete set of tables and charts, only a portion of which is included in this digest.



### Scope of the Study

These analyses are based on individual fire reports for six years, 1922 to 1927 inclusive. A total of 361 reports was used. In addition were available 20 reports that could not be used because of incompleteness. Six of the 381 fires, though very near, were not within established boundaries of Grays Harbor county; these fires were included by the State Supervisor of Forestry in the Grays Harbor county reports and therefore are included in this analysis. Locations of 379 fires are shown on transparent map sheets.

These analyses show only *when* fires occurred, *where* they occurred, and to what *cause* each was attributed. It was hoped that it would be possible to complete a second phase of the study, namely, an analysis of the physical factors, (weather conditions, fuel inflammability, etc.) affecting fire behavior. This would yield information on some fundamental principles governing fire behavior and show the exact combination of factors which result in extremely dangerous conditions. Lack of time and data prevent such an analysis now.\*

Insufficient data were available to include cost of suppression and amount of damage in these analyses. It is difficult to eliminate entirely the effect of possible variation in fire suppressive measures. Acreage burned over is here taken as a principal criterion of hazard, even though this basis admittedly is unsatisfactory because it fails to include any evaluation of protective measures. Such criticism is applicable only to individual fires where acreage of one fire is compared to that of another. The criticism does not apply to these analyses because these figures are averages of many fires, for wide variety of conditions and throughout a term of years. Discrepancies due to varying efficiency in fire suppression are certain to be smoothed out. These analyses show what may be expected when the protective force is performing as efficiently as it can under existing conditions. In this sense, fire suppression efficiency is constant, for presumably the protective force always does its very best. As soon as more complete data is obtained on fire behavior in relation to various physical factors, and as soon as better weather records and fuel inflammability records are kept, it will be simple to make an analysis of fire records that will furnish an exceedingly accurate measure of fire detection and suppression efficiency.

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\*Evidently should be done.

## Cause of Fires

TABLE 1.—DISTRIBUTION OF FIRES BY NUMBER AND AREA BURNED ACCORDING TO CAUSE. GRAYS HARBOR COUNTY, WASHINGTON, 1922-1927.

YEAR	LUMBERING				RAILROADS		CAMPERS		SMOKERS		SLASH BURNING	
	Donkey		Other		No.	Acres	No.	Acres	No.	Acres	No.	Acres
	No.	Acres	No.	Acres								
1922	10	11,045	3	2,915	5	1,346	5	345	5	1,074	4	5,040
1923	7	1,346	3	104	10	282	4	3	5	1,092	8	4,535
1924	9	4,620	6	14,130	5	93	17	1,278	4	760	13	3,333
1925	4	642	3	2,100	8	1,907	7	10	10	2,384	12	5,571
1926	2	2,966	9	3,665	1	0	19	1,202	10	401	8	579
1927	1	1	.....	.....	3	23	.....	.....	5	1,220	.....	.....
Total	33	20,620	24	22,914	32	3,651	52	2,838	39	6,931	45	19,058

YEAR	BERRY PICKERS		INCENDIARY		LIGHTNING		MISCELLANEOUS		TOTAL		IN-COMplete
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	
1922	5	971	5	2,816	.....	.....	21	8,815	63	34,367	4
1923	5	212	6	982	2	14	14	727	64	9,297	3
1924	2	20	5	1,091	.....	.....	24	13,987	85	39,312	1
1925	10	128	.....	.....	.....	.....	15	2,302	69	15,044	2
1926	3	280	1	30	.....	.....	9	886	62	10,009	2
1927	2	6	1	15	1	0	5	118	18	1,383	8
Total	27	1,617	18	4,934	3	14	88	26,835	361	109,412	20

Table 1 gives yearly totals for each cause\* of number of fires and acreage burned over. Expressed in percentages of total number of fires and total acreage burned during these six years, average relative importance of various causes of fires is as follows:

## ACCORDING TO NUMBER OF FIRES

Miscellaneous and unknown	24.4
Campers	14.5
Slash Burning	12.5
Smokers	10.8
Lumbering (Donkey)	9.1
Railroads	8.9
Berry Pickers	7.5
Lumbering (other)	6.6
Incendiary	4.9
Lightning	0.8

## ACCORDING TO ACREAGE BURNED

Miscellaneous and unknown	24.6
Lumbering (other)	20.9
Lumbering (Donkey)	18.8
Slash Burning	17.5
Smokers	6.3
Incendiary	4.5
Railroads	3.3
Campers	2.6
Berry Pickers	1.5
Lightning	0.0

\*"Unknown" causes are included with "Miscellaneous," and constitute at least 50 per cent of the total fires listed as due to "Miscellaneous" causes.

### Seasonal Distribution of Fires by Causes

It is important to know yearly totals of fires attributed to various causative agencies. It is equally necessary to know, for any given cause, distribution or occurrence of fires throughout the year. This information for individual years from 1922 to 1927 is summarized in Table 2. Table 3 is Table 2 converted to a percentage basis. Table 4 likewise is a percentage expression of Table 2, but based on unit periods instead of causes.

TABLE 2.—PERIODIC DISTRIBUTION OF FIRES BY CAUSES, YEARS 1922 TO 1927 COMBINED. GRAYS HARBOR COUNTY, WASHINGTON.

PERIOD	LUMBERING				LIGHTNING		CAMPERS		SMOKERS		BERRY PICKERS	
	Donkey		Other		No.	Acres	No.	Acres	No.	Acres	No.	Acres
	No.	Acres	No.	Acres								
Jan. to Apr.						1	30					
Apr. 1-15												
Apr. 16-30	1	160										
May 1-15	1	1							2	1,590		
May 16-31	5	12,010	4	3,225			1	320	3	1,260		
June 1-15	2	160	2	280	1	0	4	271				
June 16-30	9	3,291	10	5,446	1	4	6	647	1	20	3	35
July 1-15	4	1,420	2	2,640			16	775	12	980	2	10
July 16-31	5	601	3	8,883			6	40	10	1,906	14	1,453
Aug. 1-15	5	2,967	2	440			13	695	7	295	8	119
Aug. 16-31					1	10	1	0	3	760		
Sept. 1-15	1	10	1	2,000			3	60	1	120		
Sept. 16-30							1	0				
Oct. to Dec.												
Total	33	20,620	24	22,914	3	14	52	2,838	39	6,931	27	1,617

PERIOD	SLASH BURNING		RAILROADS		INCENDIARY		MISCELLANEOUS		TOTAL		INCOMPLETE
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.
Jan. to Apr. ....					1	30			2	60	
Apr. 1-15 .....							3	690	3	690	
Apr. 16-30 .....	3	950			1	200			5	1,310	
May 1-15 .....	1	400	1	800			1	1,660	6	4,451	
May 16-31 .....	7	2,225			3	551	4	11	27	19,602	
June 1-15 .....	2	6	3	120	1	0	8	3,976	23	4,813	
June 16-30 .....	4	6,250	5	383	1	2	11	1,221	51	17,299	
July 1-15 .....	4	171	7	2,059	3	1,911	15	12,797	65	22,763	
July 16-31 .....	9	2,743	6	243	3	1,205	20	4,207	76	21,281	
Aug. 1-15 .....	5	663	6	26			10	1,435	56	6,640	
Aug. 16-31 .....	3	3,920	3	20	3	75	5	263	19	5,048	
Sept. 1-15 .....	3	580	1	0	1	40	5	181	16	2,991	
Sept. 16-30 .....	4	1,150			1	920	6	394	12	2,464	
Oct. to Dec. ....											
Total .....	45	19,058	32	3,651	18	4,934	88	26,835	361	109,412	20

TABLE 3.—PERIODIC DISTRIBUTION OF FIRES BY CAUSES, AVERAGE OF YEARS  
1922 TO 1927, EXPRESSED AS PER CENT OF TOTAL FOR EACH CAUSE.  
GRAYS HARBOR COUNTY, WASHINGTON.

[illegible][illegible]

TABLE 4.—PERIODIC DISTRIBUTION OF FIRES BY CAUSES, AVERAGE OF YEARS 1922 TO 1927, EXPRESSED AS PERCENTAGE OF TOTAL BY PERIODS. GRAYS HARBOR COUNTY, WASHINGTON.

PERIOD	LUMBERING				LIGHTNING		CAMPERS		SMOKERS		BERRY PICKERS	
	Donkey		Other		No.	Acres	No.	Acres	No.	Acres	No.	Acres
	No.	Acres	No.	Acres								
P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
Jan.-Apr.							50.0	50.0				
Apr. 1-15.												
Apr. 16-30.	20.0	12.2										
May 1-15.	16.7	0.0							33.4	35.7		
May 16-31.	18.5	61.3	14.8	16.6			3.8	1.6	11.1	6.4		
June 1-15.	8.7	3.3	8.7	5.9	4.3	0.0	17.4	5.6				
June 16-30.	17.7	19.0	19.6	31.5	2.0	0.0	11.7	3.7	2.0	0.1	5.9	0.2
July 1-15.	6.2	6.2	3.1	11.6			24.6	3.4	18.5	4.3	3.1	0.0
July 16-31.	6.6	2.8	3.9	41.6			7.9	0.2	13.2	8.8	18.5	6.7
Aug. 1-15.	8.9	44.7	3.6	6.6			23.2	10.5	12.6	4.4	14.3	1.8
Aug. 16-31.					5.3	0.2	5.3	0.0	15.8	15.0		
Sept. 1-15.	6.3	0.3	6.3	66.9			18.7	2.0	6.2	4.0		
Sept. 16-30.							8.3	0.0				
Oct. to Dec.												
Total.	9.1	18.8	6.6	20.9	0.8	0.0	14.5	2.6	10.8	6.3	7.5	1.5

PERIOD	SLASH BURNING		RAILROADS		INCENDIARY		MISCELLANEOUS		TOTAL	
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres
Jan.-Apr.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
Apr. 1-15					50.0	50.0			100.0	100.0
Apr. 16-30	60.0	72.5			20.0	15.3			100.0	100.0
May 1-15	16.7	9.0	16.6	18.0			16.6	37.3	100.0	100.0
May 16-31	25.9	11.3			11.1	2.8	14.8	0.0	100.0	100.0
June 1-15	8.7	0.0	13.1	2.5	4.3	0.0	34.8	82.7	100.0	100.0
June 16-30	7.8	36.2	9.7	2.2	2.0	0.0	21.6	7.1	100.0	100.0
July 1-15	6.2	0.7	10.7	9.1	4.6	8.4	23.0	56.3	100.0	100.0
July 16-31	11.9	12.9	7.9	1.4	3.9	5.6	26.2	20.0	100.0	100.0
Aug. 1-15	8.9	10.0	10.7	0.4			17.8	21.6	100.0	100.0
Aug. 16-31	15.8	77.7	15.8	0.4	15.8	1.5	26.2	5.2	100.0	100.0
Sept. 1-15	18.7	19.5	6.3	6.0	6.3	1.3	31.2	6.0	100.0	100.0
Sept. 16-30	33.4	46.7			8.3	37.3	50.0	16.0	100.0	100.0
Oct. to Dec.										
Total	12.5	17.5	8.9	3.3	4.9	4.5	24.4	24.6	100.0	100.0

One purpose of these analyses is to provide a normal or average with which individual years may be compared. Tables 2, 3 and 4 represent such average. Comparison of total number and area of fires (all causes combined) in Table 2 with corresponding figures for individual years shows striking similarity in seasonal distribution of fires and area burned over. Data in Table 2 show two pronounced peaks, one in late spring (May) and another in late summer (July). Individual years exhibit the same characteristics, although maxima vary with each year. For example, in 1922 the first peak occurs in late May; in 1923 it is in June; in 1924 in late May and early June; in 1925 in May; in 1926 in April, and in 1927 there is no early maximum. Agencies responsible for these "peak loads" can be determined, but exact reason for yearly fluctuation in maxima can only be conjectured until analysis is made of weather and fuel conditions. Need for weather and fuel inflammability data already has been stressed.

Table 3 will be understood more easily if placed in graphic form such as Figure 11, which is an example of charts prepared to picture conditions tabulated in Table 3. For example, 58.3 per cent of all burned-over area attributed to sparks from donkey engines occurs, on an average, in late May and represents 61.3 per cent of all area burned during that period. (See Tables 3 and 4). Lumbering fires and slash burning\* fires together are responsible for almost 75 per cent of all area burned before June 1, and over 17 per cent of total acreage for the entire year. Early spring fires set by *sparks from donkey engines* alone are responsible for more than 11 per cent of total acreage burned yearly from all causes. (Early spring fires due to other causes in connection with lumbering—heated blocks, blasting fuse, etc.—represent about 3 per cent of total acreage burned yearly). Significance of this is clear: if only early spring fires caused by sparks from donkey engines are eliminated, over one-tenth of total area burned per year (from all causes) will be eliminated.\*

A few additional suggestions can be made concerning analysis of Table 3. Berry Pickers' fires are on an average most prevalent, and do most damage, during late July (90 per cent of area, due to this cause, is burned from July 16 to 31). Strangely enough, campers' fires and, to some extent, smokers' fires, appear usually to decrease during this period. It may be that fires occurring at this time normally are attributed to Berry Pickers on general principles. Phenological records for Grays Harbor county in 1927, however, show that ripening of blackberries in this region corresponds exactly with the sudden increase in Berry Pickers' fires. It seems logical to believe that detection and suppression measures aimed at reduction of Berry Pickers' fires should be strengthened or more strategically employed as blackberries begin to ripen and may be reduced after about three weeks. It is realized that Berry Pickers' fires are a source of danger and if not promptly attended to may cause serious loss, but it appears that this cause may very easily be over-stressed and its relative importance overlooked. Except lightning, Berry Pickers apparently are least serious of all the causative agencies (See totals in Table 4).

Figure 11† (all causes of fires combined) is of interest because it indicates the periodic severity of the fire season, and probable occurrence of peak loads. The June 1 to 15 period, between early and late peak loads, illustrates that these tables and charts

\*Slash burning fires are said to be only those slash fires which escaped control when burning under permit.

†As will be shown later, most of these early logging fires are in cut-over areas and it is probable that fires thus started accidentally are allowed to burn in order partially to eliminate slash hazard.

EDITOR'S NOTE—All figures referred to in this chapter bear their number in the much fuller series not reproduced herein in full.

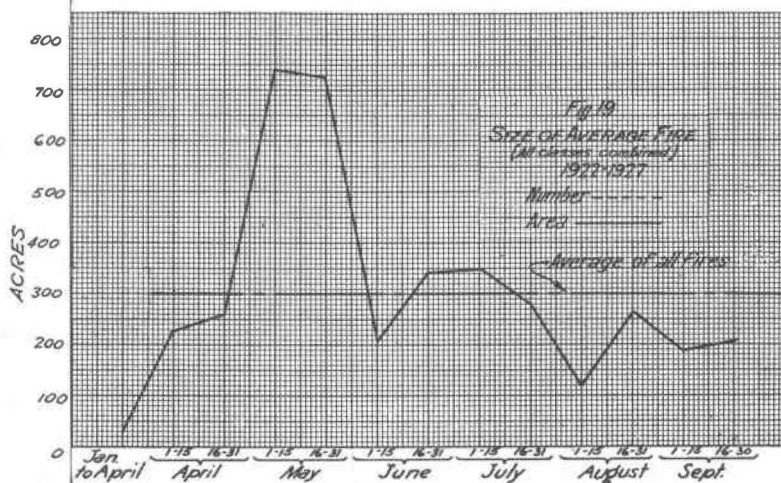
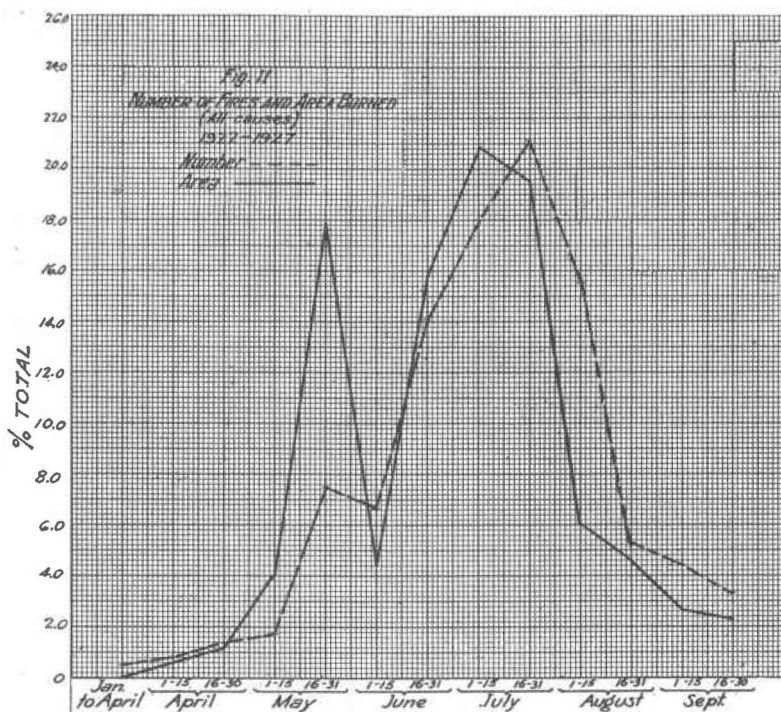


TABLE 5.—PERIODIC DISTRIBUTION OF FIRES BY COVER TYPE, YEARS 1922 TO 1927  
COMBINED. GRAYS HARBOR COUNTY, WASHINGTON.

PERIOD	MER- CHANTABLE		SECOND GROWTH		BRUSH		OLD BURN		CUTOVER		TOTAL		IN- COM- PLETE
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	
Jan. to Apr.							2	60			2	60	
Apr. 1-15..							2	390	1	300	3	690	
Apr. 16-30.		20			1	200	2	490	2	600	5	1,310	
May 1-15..							2	210	4	4,241	6	4,451	
May 16-31.		820			1	660	9	3,940	17	14,182	27	19,602	
June 1-15..	4	505			2	63	7	754	10	3,491	23	4,813	
June 16-30.	4	965			2	103	13	1,159	32	15,072	51	17,299	
July 1-15..	2	516		80	4	176	33	8,422	26	13,569	65	22,763	
July 16-31.	8	4,606	1	460	4	70	33	5,203	30	10,942	76	21,281	
Aug. 1-15..	2	126	1	11	4	46	32	2,308	17	4,149	56	6,640	
Aug. 16-31.	1	50			1	40	8	1,480	9	3,478	19	5,048	
Sept. 1-15.		160	1	80	1	10	6	191	8	2,550	16	2,991	
Sept. 16-30	1	52		10	1	10	4	1,082	6	1,310	12	2,464	
Oct. to Dec.													
Total...	22	7,820	3	641	21	1,378	153	25,689	162	73,884	361	109,412	20

TABLE 6.—PERIODIC DISTRIBUTION OF FIRES ACCORDING TO COVER TYPE, AVERAGE OF YEARS 1922 TO 1927, EXPRESSED AS PERCENTAGE OF TOTAL FOR EACH TYPE. GRAYS HARBOR COUNTY, WASHINGTON.

[illegible]



will furnish valuable information only if they are studied. It will be seen in this figure (and in Table 3) that total number of fires is about the same in late May (7.5 per cent) as in early June (6.4 per cent) but total area burned suddenly decreases from 18 per cent to slightly over 4 per cent within a period of about two weeks. Furthermore, as will be shown later, burned area in the Brush, Cut-over and Old Burn types likewise drops during the same period. Burned area in the Brush type drops from 48 to 5 per cent; from 15 to 3 per cent in Old Burn type; and from 19 to 5 per cent in Cut-over type. Phenological records for Grays Harbor county indicate that bracken fern reaches full growth during this period and succulent cover thus established may account in large part for marked decrease in fire hazard.

### Seasonal Distribution of Fires by Cover Types

Causes of fires may be left for a moment and attention turned to seasonal occurrence of fires according to cover type of burned areas. In the fire reports these types are listed as Merchantable Timber, Second-growth timber, Brush, Cut-over, and Old Burns\*. Data for six years are summarized in Table 5. In Table 6 data of Table 5 are converted to percentage basis, each cover type being treated as a unit. Figures 13 and 16 are examples of charts made to picture the situation as recorded in Table 6.

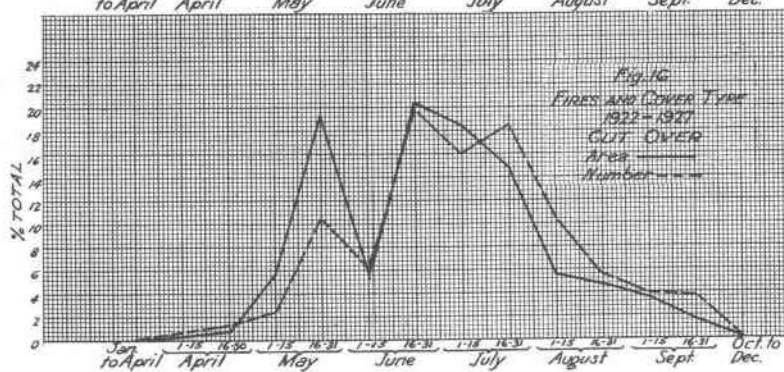
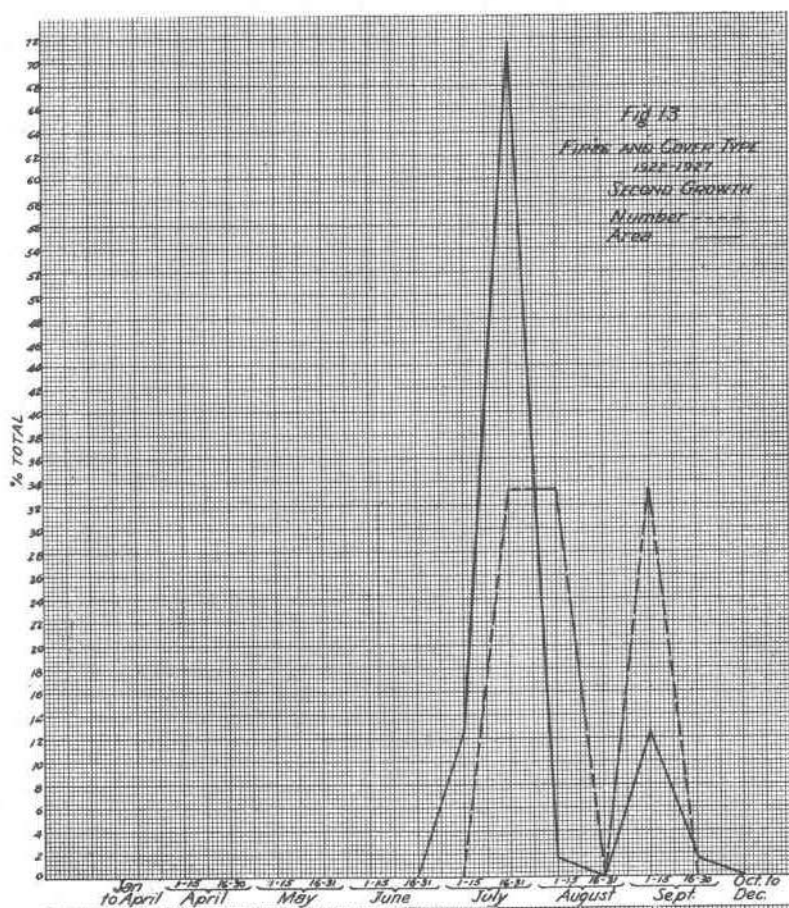
It will be noticed for any unit in these tables that area burned does not necessarily correspond exactly with number of fires. For example, in May, 1922, there were eight fires, two of which started in the Old Burn type and six in the Cut-over type. Brush and Merchantable timber types show no fires, but some area burned during this period. Apparent discrepancy is because one or several of these fires burned in more than one cover type. This prevents obtaining data on average size of fire in each type, but in no other way reduces value of the figures since these data are meant to show only total area burned in each type.

From these tables and charts, it appears that greatest proportion of total burned area in timbered types usually occurs during late July with relatively small acreage burned during spring and fall. But in non-timbered types,—Cut-over, Old Burn and Brush,—the danger period is distributed over a longer period, beginning in April, rising to a minor peak in May, falling during early June, and rising to a second and larger peak in July, finally to decline gradually through August and September. In short, the "fire season" is considerably longer on non-timbered areas than on forested areas.

All illustrates that demands upon the protective force are not of constant character, but are relatively light at certain periods and heavy at others. It is apparent also that time of occurrence of "peak loads" varies from year to year and those dates may roughly be predicted from an experience record such as these analyses. Unless the protective force can be maintained on a basis sufficient to cope with maximum demand, it is of extreme importance to know *precisely* when the protective force must at all cost be increased. As has been indicated, this can be done approximately on the basis of experience, but it is dubious if this prediction is accurate enough to further improve the detection and suppression system. The experience record must be augmented with accurate knowledge of fuel inflammability and all other physical factors which bear upon formation of "peak loads." Until this is done, the protective force is bound to be striking more in the dark than in the light.

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\*Figures for the Old Burn type are given here exactly as recorded in fire warden's reports. This is true of other cover types; no changes have been made in type classification.



### Causes of Fires in Relation to Cover Type

Localization of fires due to each cause is important. Table 7 shows how fires attributed to each cause are distributed in relation to cover type.

TABLE 7.—DISTRIBUTION OF FIRES IN EACH COVER TYPE ACCORDING TO CAUSE, YEARS 1922 TO 1927 COMBINED. GRAYS HARBOR COUNTY, WASHINGTON.

CAUSE	MER- CHANT- ABLE		SECOND GROWTH		BRUSH		OLD BURN		CUT- OVER		TOTAL	
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres
Lumbering (donkey)...	6	447			1	161	2	2,865	24	17,147	33	20,620
Lumbering (other)....	1	3,035		140			1	16	22	19,723	24	22,914
Lightning.....	2	10							1	4	3	14
Campers.....	2	0	2	60	4	163	36	2,077	8	538	52	2,838
Smokers.....	1	490			2	4	25	3,833	11	2,604	39	6,931
Berry Pickers.....				20	1	2	16	1,262	10	333	27	1,617
Slash Burning.....	1	1,140			4	153	22	2,925	18	14,840	45	19,058
Railroads.....	1	116					15	133	16	3,402	32	3,651
Incendiary.....	1	85		80	2	701	8	3,902	7	166	18	34,934
Misc. and Unknown...	7	2,497	1	341	7	194	28	8,676	45	15,127	88	26,835
	22	7,820	3	641	21	1,378	153	25,689	162	73,884	361	109,412

In Table 7 it can be seen, for example, that about three-fourths of Berry Pickers' and Campers' fires are in the Old Burn type. This information, coupled with that of periodic distribution of fires by causes (See Table 3), indicates where and when to guard against these classes of fires. As another illustration, over 40 per cent of merchantable timber annually burned is due to lumbering. According to Table 6, about one-fourth of this loss occurs before June 1. If early spring fires in lumbering operations can be attended to more promptly, there should be reduction in area of merchantable timber burned over. The second most important cause of merchantable timber destruction is, according to Table 7, slash fires which escape control. Table 3 indicates that over half of the area attributed to this cause is burned before June 15.

Table 7 also indicates that about half the total burned area of cut-over land may be attributed to lumbering operations alone, nearly one-fourth to escaped slash fires, and the rest due to all other causes.

According to Table 7, if incendiary fires would be detected promptly, then look to the Brush type of cover.

### Size of Average Fire

If charts for individual causes of fires (See examples, Figure 11), are examined critically, it will be noticed that in practically every chart is striking similarity in relationship between number of fires and area burned. For example, in Figure 16 (all causes combined) the number of fires for spring months is less than proportionate area burned. Whereas in late summer and fall, this situation is exactly reversed. In other words, the average spring fire is larger than the average fall fire. There are *more* fires in summer and fall than there are in spring, but their area proportionately is smaller. Since insufficient information is available on the physical factors which

control fire behavior, it is impossible to state that these data indicate greater difficulty of fire control in spring than in late summer and fall. It may be that fires in spring are considered to be of small importance, are allowed to burn and suddenly become large fires; or, it may be that the protective force is organized too late to catch these fires. Practically all of these early fires are in the Old Burn and Cut-over types (Table 6).

TABLE 8.—SIZE OF AVERAGE FIRE (ALL CAUSES COMBINED)  
BY 15-DAY PERIODS. AVERAGE FOR YEARS 1922  
TO 1927. GRAYS HARBOR COUNTY, WASHINGTON.

<i>Period</i>	<i>Size of average fire Acres</i>
January to April .....	30
April 1-15 .....	230
16-30 .....	262
May 1-15 .....	742
16-31 .....	725
June 1-15 .....	209
16-30 .....	339
July 1-15 .....	350
16-31 .....	280
August 1-15 .....	119
16-31 .....	266
September 1-15 .....	187
16-30 .....	205
October to December .....	0
Average, all periods .....	303

Table 8 and Figure 4 show average sizes of fires (all causes combined) according to 15-day periods. They support the suggestion already made that the average spring fire is larger than the average fall fire.

### Relative Hazards of Cover Types

The fire hazard of an area is a composite expression which takes into account a great many individual factors, such as presence of causative agencies, topography, climate, type of cover, fuel inflammability, etc. Only approximate expression can be given for relative hazards of various cover types, because information necessary for complete classification is lacking. Approximate hazard or danger of each cover type can be based on Table 6. Thus, according to per cent of total area burned, different types stand in about this order:

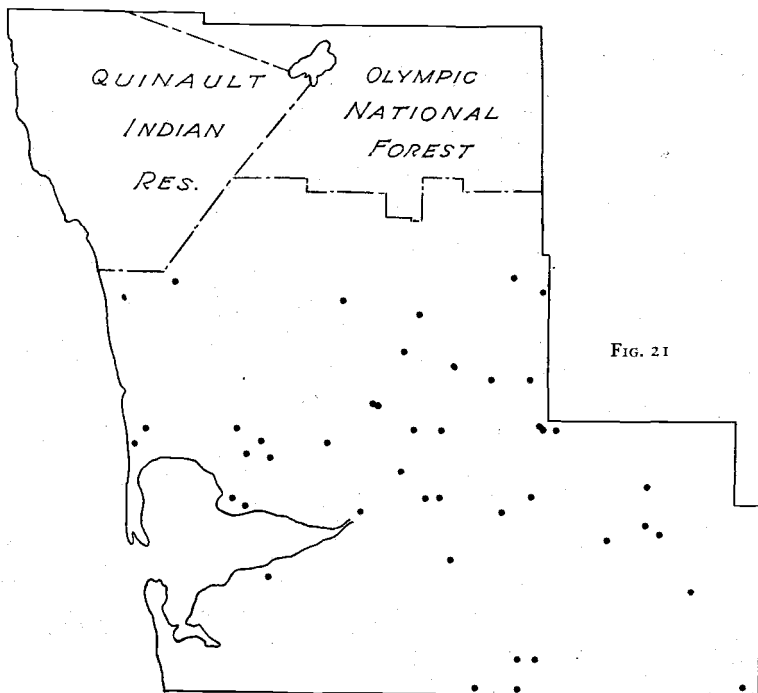
Second growth .....	0.6
Brush .....	1.2
Merchantable timber .....	7.1
Old Burn .....	23.5
Cut-over .....	67.6

These figures are averages of a great many individual areas and can scarcely be applied to single areas. More precise relationship could be had by comparing area burned in each type with total area of the type. Thus, a small area of second growth, if burned, might, when compared to total area of second growth, indicate different relationship than that just stated. In absence of figures for total area of each type, this makeshift analysis must suffice. It does indicate, under present standards of protection, in about what order different cover types stand.

### Location of Fires

Causes of fires and time of their occurrence have been described; locations of these fires will next be discussed.

Fire reports were sorted according to cause of fire and all fires attributed to a single cause were treated as a unit.\* A sheet of transparent paper was laid over a regulation map of the county and county outlines traced. According to location, Smokers' fires, for instance, were platted on one of these sheets; Berry Pickers' fires were platted on another sheet, and so on for every class of fire. Locations of fires due to any given cause were thus separated from all other fires.



Example of transparencies showing every class of fires for five years, used by being laid over map of county. These are smokers' fires.

When these transparent sheets are superimposed on cover type maps of the same size, as, for example, Fig. 6, it becomes apparent if any relationship exists between cause of fire and location.† Practically every fire attributed to smokers is near a road or railroad. This indicates need for regular patrol system if this class of fires is to be detected promptly.

Berry Pickers' fires run in a wide swath across the center of the county from east to west. None of them are far removed from a road. They evidently are not in

\*379 fires were used; the locations of two fires were not given.

†Only one of these location maps is shown in this published report, namely, Smokers' fires (Fig. 21) which will show the type of map prepared.

steep country because they fall almost entirely in areas classified by "Western Forestry" as being agricultural, or near-agricultural.

Railroad fires apparently are caused chiefly by logging locomotives, and appear to be mostly in "fern patches" and other cut-over and poorly restocking areas. These fires are largely grouped in rather definite localities. For instance, it might be well to check up on railroad equipment of companies operating in T. 20 N., R. 7 W.

Incendiary fires, with few exceptions, appear to be near roads and railroads, and chiefly in land that might be classed as agricultural. They are scattered across the center of the county in an east and west direction.

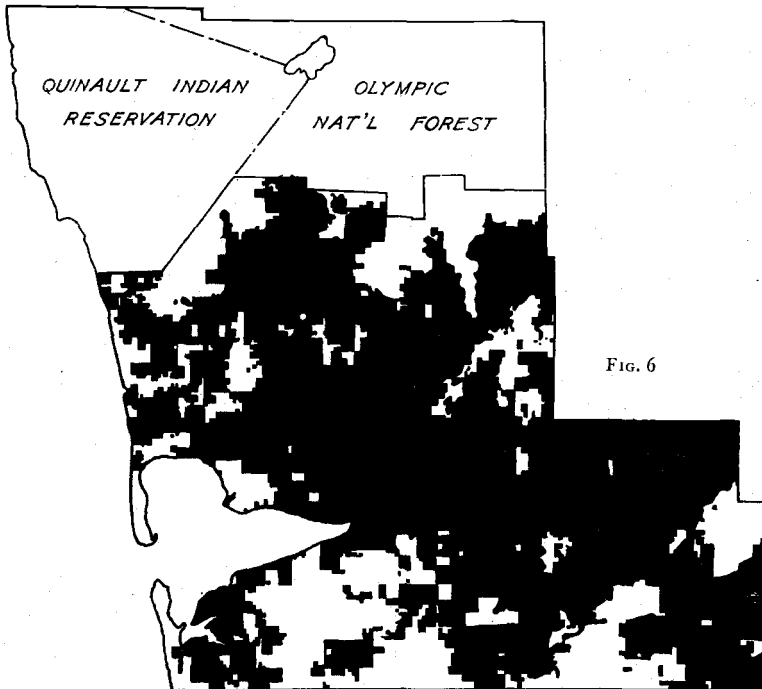


FIG. 6

### GRAYS HARBOR COUNTY WASHINGTON

■ Black is cut-over land

Miscellaneous and unknown fires are scattered throughout the county, but concentrated in or near river bottoms and along roads. This is especially true of fires attributed to unknown causes. Few such occur in virgin timber.

Campers' fires are almost entirely near roads and occur chiefly in the western part of the county. It appears these fires usually are on level or slightly rolling land that might be classed as agricultural.

Slash fires which escape from control are nearly all along roads and correspond closely to areas classed as agricultural lands. This fact suggests that this class of fires may be due chiefly to ranchers' clearing land. These fires are mostly in the center of the county and northward.

Figure 6 is example of maps prepared for this study. Road and railroad maps were also prepared from Kroll's 1925 map. Locations of railroads were obtained from the county assessor's office. Some railroads shown undoubtedly have been removed, but roadbeds are still in existence. Other abandoned railroad grades are known to exist, but could not be located from the assessor's maps. Locations of all railroads and abandoned railroad grades should be obtained from logging companies, as these trails offer convenient means of access to areas otherwise difficult to reach. The map of the area cut over from 1882 to 1927 (Fig. 6) is based on maps of the county assessor. Areas logged in 1927 are included. It is unfortunate no maps are known which show cover types (Old Burn, etc.) as prescribed on the fire-report form.

Finally, it is well to state that no attempt is made to draw definite conclusions other than random observations already discussed. The real meat of this analysis is presented in tables and charts. This report is merely to point out salient results and to suggest ways by which the fire situation may be pictured, with aid of such tables and figures, in any forest region.

## WEATHER INFLUENCES

Herein are quoted only excerpts from the Weather Bureau's very detailed study by G. W. Alexander, covering the region by districts as these differ, containing a mass of tables and charts available to the several protective agencies. That fire hazard due to weather conditions can be expected to reach distinct early spring and late summer peaks, with a much safer period in June, is strikingly confirmed by the similar peaks in actual fire records, given elsewhere in this report. Yet they do not quite coincide, probably for three reasons: (a) natural lagging of the early spring fire record until after the dryness peak has been passed, (b) natural increase of summer fire causes before the summer dry peak arrives, and (c) the distortion from normal that two or three bad fire years may produce in an averaged several years' fire record. The great value that may lie in further study to determine these relationships is apparent.

Of major importance as affecting the climate of this region is its location just to the south of the usual track for the eastward passage of the centers of cyclonic activity (barometric "LOWS") moving from the north Pacific across the continent during the fall, winter and spring months, which location is also near, but somewhat to the north, of the center of impingement on the coast of the semi-permanent Pacific "HIGH." Topographically of major importance is the general rise in elevation to the eastward, most marked in the northeastern section where the Olympic Mountains quite abruptly rise to a height of several thousand feet. These mountains, and certain of the ranges of the Willapa Hills in the southwestern section, which lie transversely to the direction of the rain-bringing winds, affect in some manner, while the breaks in the coastal barriers afforded by the numerous rivers and by the two inlets of the sea (Gray's Harbor and Willapa Bay), which afford unobstructed ingress to moisture laden winds from off the ocean, affect in another, the local reactions to the general conditions which affect the weather, in a manner which will be noted in the discussion of the several elements.

It will be noted that Clearwater, nearest the coast, and where winds from south to northwest, inclusive, are from off the sea, has the fewest extraordinarily hot days. There they are to be expected, apparently, in only one June or July, in four, one August in ten, and one September in twenty. Aberdeen, somewhat removed from the immediate coast, and to some extent sheltered from certain sea breezes, but subject to winds from off Gray's Harbor, has a greater number, but less than one per month in July and August; while the two inland stations have about three times as many for the season, and may expect between two and three such days during the normal July or August.

Wynooche Oxbow, at the head of a valley open to the rain-bearing south-westerlies, with a sharp rise in elevation occurring just to the north, is in a particularly favorable location for heavy precipitation, as the air currents must rise and cool over or just beyond it. The computed annual normal, 140.55 inches, would indicate that this is one of, if not the wettest spot in the continental United States at which records are made. Greater amounts would be recorded at higher elevations on the Olympic slopes, could observers be obtained at the proper points.

A most important characteristic, common to all stations, is the comparatively small amount of mid-summer precipitation, July having the smallest amount, with



the actual dryest period comprising the latter half of that month and the first half of August. This has an important bearing on the inflammability of forest materials and the fire protection problems.

Of great importance, from the protective viewpoint, is the probability of very light, or no rains, in any month. It will be noted that very light rains are most probable in July and August, and that they may be expected in the other four months with a probability varying from 15 to 25 per cent.

As affecting the fire hazard the effectiveness of any amount of precipitation depends more largely on its distribution throughout the period than on its actual quantity. That is, moderate rains, at frequent intervals are better than infrequent but heavier downpours. This distribution throughout the six months of the fire season, for the four stations, is shown graphically and in tabular form.

While it may seem paradoxical to speak of such a thing as drought over a section so well watered normally, nevertheless rainless periods of considerable length, up to 60 days or more, are not infrequent. The duration and frequency of such dry periods are of the greatest importance in estimating the possible degree of fire hazard that may be expected. A tabulation of the "Dry Day Groups" at the three stations whose records are most suitable has been made, the percentage of probability of occurrence, by groups of varying length, from 5 days up to the greatest number, has been computed, and curves produced for each month.

Since local observations have been made in Grays Harbor county, every occurrence of low humidity at North Head has been attended by similar humidity, usually much lower, and easterly winds even to the northern boundary of the county. Hence tabulation of the frequency of low humidities at North Head should give a close approximation of the frequency of "seed carrying east winds" over that county.

During 35 years such winds have occurred in 23 Septembers and 23 Octobers. There have been but four years (1893, 1909, 1917, 1922) during which no such winds occurred in either of these two months. The average duration of such winds is 1.78 days in September and 2.39 days in October.

In Grays Harbor county the frequency of such winds should vary somewhat, but not greatly, from the figures above. The intensity and duration of winds, however, will vary largely within the county, being greater in the river valleys and near the immediate coast, and somewhat less on the lee (western, in this case) slopes of the higher and more abrupt mountains. Their relative dryness will, as a rule, be greater in those regions where, on account of topography, precipitation is greatest, because, in descending from the higher interior to sea level the air is compressed and heated, and its capacity for water vapor increased.

Our graphic presentation of data showing dates and duration of humidity abnormalities allows of the most ready comparison between the different sections of the county and between the county and the balance of western Washington.

The differences in the probabilities of the occurrence of low humidity over the different sections of the county seem to be well expressed by the actual occurrences in 1928, that is, at Clearwater 14 days, at Sutico 24, at Satsop 41, and at Camp Five 41.

Clearwater and Sutico represent the coastal and near-coastal sections. There northerly winds cause low humidity, but for comparatively short periods. During the prevalence of northerly winds and high temperatures over the interior of Washington, which is a not infrequent midsummer condition, such northerly winds are

usually of small velocity. The high temperatures over the interior set up local convection, cause a lessening of the density of the air, which results in the formation of a trough of low pressure. This induces moist, westerly winds, from off the Pacific. The cooling effect of these winds is greatest near the coast, and becomes progressively less towards the interior. Where openings in the coast line afford free ingress the effective penetration is greater, conversely, where any barrier is interposed, as a transverse range of hills of even moderate elevation, the effects are negligible to the leeward. This fact accounts for lesser number of days of low humidity, and lesser number of hours of duration on such days as do occur.

Northeast and east winds, however, cause low humidities to the very coast line, with minimum percentages nearest the coast. Such winds are more frequent in April and September than during the balance of the season.

Certain inferences may be drawn from data available. Low humidities caused by east winds may be expected in the county with greatest frequency in April and September and least in July. The records show that such humidities may be expected in about two Aprils in five and one September in two. These occurrences are not regular, there is no rhythmic or cyclic tendency observable, they may occur over several consecutive years, and there may be as many consecutive years without them. Low humidities and east winds noted as occurring in October have in general but little bearing on fire hazard. Due to the lower temperatures and the abundance of precipitation, humidities that attend east winds, while distinctly sub-normal, are not as a rule sufficiently low to cause marked change in general conditions.

Combination of probabilities seem to indicate that the chances for inception and spread of fires in April are good, especially over non-forested areas. Within and under green timber temperatures are lower, insolation and force of wind are less, and desiccation is not so rapid. Few Aprils, however, pass without sufficient precipitation to allow of control or suppression of any fire that may be started, so to that extent danger is minimized. During the month it seems that principal damage to be expected is that to reproduction, particularly in its earlier stages.

During May and June, precipitation is progressively less in amount, but with progress of growing season newer and more succulent growth is increasingly abundant. Moderate temperatures are the rule. The probability for extremely low humidity and desiccating east winds, over the entire county, is less than in April. Over coastal sections, moderately low humidity, from 39% to 30%, may be expected at infrequent intervals, about equally in each of the two months. Over the interior of the county, especially south and southwest of the Olympics, such percentages should occur more frequently, with an average of approximately six such days in each month.

Rainfall expectancy lessens during July and reaches minimum during the latter portion of that month and the first decade of August. Annual vegetation reaches maturity, and becomes less succulent. Ripe berries invite the presence of the picker; tourists and campers are most numerous. Soil moisture, near the surface, is at a minimum. Probability of extended periods without rain increases. While few days with excessively low humidity (below 25%) should occur, those with percentages between 26 and 39 have maximum expectancy in July and August—about seven or eight such days in the normal month—over the interior of the county. Temperatures are higher over a greater portion of the day than earlier or later in the season; hence humidities tend to become low at an earlier hour and remain so longer.

There is a period wherein cumulative effects of light precipitation, high temperatures, and occasional subnormal humidity will reach maximum. At such a

time, fire hazard over the interior of the county will be greatest, and, in general, should be fairly comparable with hazard over the major portion of the interior of western Washington. Along the immediate coast, effects will be less pronounced, as precipitation frequency is greater, and days and hours of low humidity are curtailed by sea breezes induced on days of high temperature over the interior. But under proper pressure distribution, and after long dry periods such as that of 1928, high hazard may exist even to the very shore line. The duration of this period of maximum hazard is generally dependent on beginning of the fall rains. It may be ended early in August; should be, in fact, in the average August; but there are possibilities that it may continue into September.

Despite the fact that this is known as the "Fog Belt" (and for a large portion of the interior of the county this term is something of a misnomer) the actual facts disclosed by records available force the conclusion that, save in exceptionally wet seasons, possibility of periods of high fire hazard cannot be safely discounted. The county has fire history. Combination of abundance of material quickly reactive to changes in atmospheric moisture content and low humidities that do occur, plus tendency for fairly high winds that exist so near the coast, may at times set the stage for fires as difficult to control as those in any other portion of the Douglas Fir region.

September's rainfall is usually sufficient to put an end to the fire season. The probabilities for occasional dry periods and low humidity with east winds in this month have been shown. The extent of effects of desiccating east winds will depend largely on their duration and on immediately preceding precipitation. Combined effects of all weather norms for the month tend to reduce normal fire hazard for September well below that for the July-August period.

Taking into consideration all weather elements that affect inflammability of materials, it appears that, if expressed graphically, the curve of relative fire hazard should show three peaks; a minor one during the first two decades of April, a major peak culminating sometime during the first fifteen days of August, ascending rather gently but declining sharply, and a second minor peak, abrupt on both faces, sometime during September. In "good" years the two, or either of the two minor peaks may not occur at all, and that of the mid-summer may be barely evident. But in this the county again but resembles the rest of the Fir region.

Precipitation, temperatures and average humidity are usually such in March and October as to preclude any marked rise in the fire hazard. Occasionally low humidities may occur, but for short periods only, and only the lightest of materials should be affected. The probability of damaging fires is very slight.

## SLASH DECAY FROM THE PROTECTION VIEWPOINT

H. G. LACHMUND, *U. S. Office of Forest Pathology*

(SYNOPSISIZED)

Here is a brief digest of the forest pathologist's contribution to the Grays Harbor survey, which, like the other studies, is supported by tables, and analyses thereof, which cannot be presented here in full, but are available for use by the protective agencies.

Work done in Grays Harbor county was part of an extensive survey constituting the initial step in a detailed study in the Douglas Fir region to determine the bearing of rate of decay in the problem of slash disposal.

Since the question of slash burning is of greatest doubt in the coast fog belt, the study was centered in this region. It was concentrated in Grays Harbor county so that data would be available for use in the Grays Harbor co-operative survey. Twenty-seven areas were examined in this county; 11 in the coast fog belt hemlock-cedar-spruce type, three in mixtures of Douglas Fir in this type, 11 in the somewhat more inland moist Douglas Fir type, one in spruce and one in cedar.

Most important decays in slash in this section may be roughly separated into two categories—"wet rots" and "dry rots." The term wet rot here refers to decays causing a soggy disintegration of wood. Dry rots cause a crumbly disintegration.

Dry rots absorb and hold water during wet weather. If fully exposed to sun and air for a sufficient period, they dry out to charcoal-like consistency.

Wet rots are fundamentally wet, the wood being turned to a soggy, mucilaginous mass, very slow to dry. Exposure to dry weather, unless exceedingly prolonged, results generally in establishment of a dry outer layer only, while the interior remains soggy.

Over seventy per cent of the decay is of dry rot type. Wet rots may make up as much as thirty to forty per cent of decay on unburned areas, however. This is important in connection with fire hazard, since it makes the material on unburned areas fundamentally of wetter consistency than on burned slashings.

On unburned areas, debris of needles and twigs is almost entirely rotted in two or three years—mainly by soil fungi. Most sapwood is rotten in four to six years. The rotten material absorbs water during rains. A considerable proportion of the decay is of wet rot types.

Rank growth of brush springs up rapidly and retards drying. It forms a closed canopy over most slash in the hemlock-spruce-cedar type in five to eight years and in ten years in Douglas Fir type. The rotten wood and debris become and stay increasingly wet, and, as the canopy increases in density, finally remain more or less continuously water-soaked.

On burned areas, most fine debris, part of duff, and some of bark and wood of the large material, is consumed by fire, but a large proportion of slash volume and a portion of duff and litter remain. Ten to thirty per cent of bark is burned off larger material. Most of the rest of the bark is dried out and loosened to a greater or less extent by fire. This has a tendency to hasten inception of decay in thick-barked material where the bark otherwise remains tight for a time. It has the effect of

accelerating the decay in Douglas Fir heartwood considerably. In general, however, decay is decidedly slower. It is primarily of dry rot types. Establishment of brush is retarded five years or more. Its place is taken by brake-fern (or bracken), fire-weed, and other annuals which form flashy fuel. During these years in which the area is largely devoid of brush, slash is practically fully exposed to sun and air, and during dry weather decay dries out to the consistency of tinder.

Apparently, after three or four years, due to factors enumerated above, relative receptivity to establishment of fire conditions becomes greater than on unburned areas and increases rapidly in the next five or six years. After brush has become established and finally begins to close in on burned areas, conditions become more closely similar to those on unburned areas and the differences decrease.

Probable difficulty of control in event of fire must be decidedly *greater at first* on unburned than on burned slashings. It must, however, be rapidly reduced with increasing wetness of unburned slash and apparently should fall *below* that on burned areas in five or six years.

## PROTECTION AGENCIES' VIEWS

Except for individual systems maintained by one or two large forest owners, independently complying with the compulsory patrol laws of Washington; fire prevention and control in Grays Harbor county has for years been the co-operative project typical of the Pacific Coast where it has reached its highest development. Forest owners maintain co-operative organization, assessing themselves pro rata to meet the season's costs, while the state, and the federal government under the Clarke-McNary law, contribute also and exercise supervision to protect their interests. Owners who fail to respond find the cost each year charged against them by the state, which collects it, through the county taxing machinery, as taxes are collected, although it is not strictly a tax. The work is directed mainly by the Washington Forest Fire Association, but inspected and checked by the State Supervisor of Forestry (who absolutely directs its police authority) and a Forest Service inspector representing government co-operation.

To these three officials were referred the findings of the several research agencies. They also went over the ground together in a joint administrative survey of their own. Their synopsis comment follows, with a brief description of the present system agreed upon as reasonably efficient, although not beyond improvement as the future permits.

This may seem a disappointing result of the entire survey in that it does not, although in a sense an aim of the whole study, present a clear-cut, detailed recommendation of what should constitute an adequate protective system for Grays Harbor county and, by inference, for much of the Douglas Fir region. It may be by some said it should do this by a set-up of requirements, comprising what seem to be the majority views, in a straight one-two-three-four fashion, such as:

1. Protection of reforestation lands; which being open and quickly dried, also under-regarded by the community; have a spring and fall hazard beyond that of other lands; demands substantial lengthening at each end of the season of protective effort. What does this entail upon owners, state and government? How equitably shared?

2. There must be brought home to lumbermen, by argument and by penalty, their responsibility and their interest in handling fire that threatens reproduction, especially in spring and fall. How? Who is responsible for doing it?

3. There must be a more difficult, determined attack on the indifference of settlers and forest visitors who over-estimate the spurious safety of the "fog-belt" region, who realize neither the importance or possibilities of cut-over lands; who are, in a word, not "fire-conscious." This also by argument and by penalty that outlaws the fire-brand. Whose job is this?



TEN- TO TWELVE-YEAR ALDER FURNITURE WOOD, ALREADY FOUR TO SIX INCHES DIAMETER.  
MARKETABLE IN TEN YEARS MORE.

4. Protective agencies must never rest on their oars, but must admit being behind the ideal and further develop their detective system, their study of every technique for every regional type involved, and in this particular region improve their trail system which is good in some parts of the county but poor in others, especially in the south of the county.

5. Slash disposal policy needs systematizing as between the several forest types, demanding different treatment as protection and restocking are balanced. And where slash is burned, should it not be by forest officers trained and experienced in this dangerous work, and with every control precaution required, rather than by ordering loggers to set fires to comply with a slash-burning statute?

6. Is legislation adequate, correct or enforceable; as suitable for the region—slash disposal or snag-falling, for example? If so, good,—if not, whose duty is its improvement? Same as to appropriations; private, state or federal.

7. Same as to tax reform; a state duty, but requiring united community presentation in order to demonstrate its necessities to meet the requirements of dependable forest protection.

8. To sum up, no complacency; but aroused and correlated responsibility for doing better.

On the other hand, it is clear enough that paper plans are not dependable under the constantly-changing conditions of a region of such heavy exploitation risk, public indifference risk, uncertain climatic influences, and uncertain financial support; also that the three allied protective agencies cannot commit themselves to any local program that they cannot carry through without discrimination against their responsibilities elsewhere. This is one of the constructive results of the survey, indicating the necessity of its extension to all other areas covered by the same group of protective agencies, to reach a balance. The joint comment of the three protective agencies under these limitations is as follows:

## FOREST FIRE CONDITIONS IN GRAYS HARBOR COUNTY

GEORGE C. JOY, *State Supervisor of Forestry*

C. S. COWAN, *Chief Fire Warden, Washington Forest Fire Association*

E. H. MACDANIELS, *United States Forest Service*

Forest protection in the State of Washington is but twenty-five years old. When the fire prevention movement started, about 1902, its principal aim was protection of the standing timber areas. The logged-off land area had not assumed any considerable proportions, and that its future was something which would largely solve itself was, in the main, the viewpoint of forest executives as well as of land owner and general public.

Later, forest officers were educated to think ahead; to segregate mentally those areas whose immediate value lay in growing of future timber crops, and to give such areas stricter supervision and added protection.



It is our opinion that the greatest menace to the second crop lies not so much in danger of fire as in lack of a source of seed supply, if natural reproduction is sought. To gain this end, arrangements might be made with operating companies to leave certain logging units along main line railroads. The county assessor must then arrange to take into consideration risk to the logger, for such blocks are not wind-firm, are subject to fire, and have initial investment in railroad that will not be realized until such timber is finally taken out, which means delayed return on the investment. Valuation should therefore be set at a figure that will offer inducement to the operator, for state and county are the gainers by such procedure no less than the lumberman. If this procedure could be put into effect, Grays Harbor county is well assured of a second crop.

### **Area of Second Growth**

The several surveys and views differ somewhat, but certainly indicate that a majority of the lands will restock.

Considering the comparative youth of the second-growth protection movement, this is a fairly satisfactory condition, for which nature itself must take a large portion of credit. Protection of this area of second-growth is now a matter for public and protective organizations.

### **Fire Prevention in Logging Operations**

During late years far-sighted operators have spent considerable time, energy, thought and money trying to meet fire danger, with increasing success.

Conditions are still far from perfect, but as fire which threatens cut-over land, also threatens equipment, logs and other physical property, strenuous efforts are being made to prevent fire occurrence, if only for personal and present-day reasons.

Fire-fighting equipment of the most modern kind is now a standard requirement of most logging operators, as well as state and federal regulation. In spite of this, large areas are still visited annually by fire.

### **Timber Loss**

Lumbering is charged by statistics with 44.5 per cent of all timber loss. This is more apparent than real, for timber killed in logging fires is in the vast majority of cases logged as soon as possible. Lightning is responsible for 9 per cent; smokers, slash burning, railroads and incendiary responsible for 4.5 per cent. Other major cause of timber loss is "miscellaneous and unknown causes," responsible for 32 per cent. It is difficult to investigate the miscellaneous column to recommend a cure, for we find such causes as explosion of an automobile, a still catching fire and other odd causes.

Protection of merchantable timber from lumbering fires is, therefore, at least half the battle and, as stated, the actual loss from this cause is more apparent than real and the actual loss is, therefore, not quite possible to determine.

### **Analysis of Fire Reports**

Much time was devoted to study of McArdle's splendid compilation of data pertaining to occurrence of fires in Grays Harbor county during 1922-1927.

In this study, knowledge of local customs and fire conditions, as governed by ground cover and meteorological conditions, is essential if true facts are to be brought out. The picture brought out by McArdle's report must be subjected to application of knowledge as to local customs.

"Cause" column shows May responsible for 9% of the season's fires, and June for 22%. Acreage burned during these months is reversed, as May shows acreage of 31.7% for the season, while June is 17.1%, or approximately half.

Lumbering is charged, during these months, with a relatively high proportion of the acreage burned over, although the "cause" column shows that for the six-year period about 25% of all fires are chargeable to this cause.

While it is the belief of the authors that this percentage should be reduced, yet the following facts stand out sharply:

1. Logging is in itself a hazard, due to the fact that among the "sub-causes" are listed the following:

- (a) Friction of wire rope on standing and down trees.
- (b) Rope friction on block sheaves.
- (c) Sparks from locomotive or donkey engines.
- (d) Men smoking in the woods.
- (e) Hot scalings from brake shoes.
- (f) Carbonaceous matter thrown out when sanding oil-burning locomotives.
- (g) Fire set from burning fuse.
- (h) Frozen blocks and many other causes.

In addition to this it must be remembered that so long as logging continues, the operation itself must always be at the point of greatest danger, i. e., in unburned slash.

This slash must be burned sooner or later, if hazard is to be removed and general practice among protective forces no less than among loggers is to burn the full acreage of unburned slash, fearing it should catch fire accidentally.

This practice is the result of long experience. It has been proved to be almost impossible to completely extinguish fire in fresh slash, with resultant risk of "hang-over" fires breaking out if this is attempted. Because of the system of reporting, however, the full acreage burned is charged to this cause, showing an undue percentage of acreage covered, because the *origin* of the fire was *accidental*.

In view of the tendency to burn slash somewhat earlier in the year than has hitherto been the case, it apparently makes little difference when the slash is burned for the FIRST time. Such a burn creates a large measure of protection, as shown further in this report.

July, August and September are responsible for 41.0%, 23.5% and 21.5% respectively of causes. The acreage figures, however, show July as responsible for 37.5% of acreage, while August shows sharp reduction to 8.7%, and September to 5%. This is largely due to weather conditions, mainly moist westerly winds and more moderate humidities, dew-fall, etc.

### Deletion of Fire Causes from Analysis

It is felt that, as the purpose of this report is to find cause and effect, slash fires are not material to this study. Cure for such fires is largely in the hands of competent authorities, for such fires can be prevented by:

- (a) Refusal of permits to burn.
- (b) Better knowledge of how and when such slash burning should be done.

Slash fire which escapes control is an "accidental" fire, vide the reports; irrespective of the fact that the area to which the fire spreads may merely be beyond the limits of the permit issued, but for which a further permit was to be applied for. Further, a closer co-operation between the operators, land-clearers and forest protective agencies, and, through these agencies, with the Weather Bureau, have led very largely to sharp decrease in acreage covered by this class of fire in recent years.

It is further the thought of the authors that the scope of this report should cover accidental and incendiary fires, as being beyond their absolute control and therefore an "effect" for which a cure should be sought. "Miscellaneous causes" of fire is too ambiguous a title, and gives nothing upon which a solution could be advanced. For these reasons, acreages and numbers of fires attributed to the above two causes do not come within the scope of this analysis.

### **Old Burn Type**

Custom of state and private forest protective agencies has been to include in this category all lands which have been burned over, irrespective of whether such areas were logged or not. In this regard, Mr. McArdle's analyses may lead to some doubtful conclusions for which our own reports, which he was obliged to use, are entirely responsible. A revision of our warden's reporting system is indicated.

### **Analysis of McArdle's Report**

Study of figures for the period shows that while lumbering is responsible for 25.5% of the causes, it is responsible for 69.5% of the area covered. Referring now to the "monthly" presentations, it is found that during the earlier part of the fire season, lumbering is proportionately responsible for 75% of the acreage covered by fire.

This is not because of carelessness with fire early in the season, but largely because experience has shown the lumberman that when an area of fresh slash catches on fire accidentally, it is the wisest course deliberately to burn the full area. This is dealt with in detail earlier in our report. Fires are prevalent in the early part of the fire season, due to the fact that lower humidities are more likely to occur, and do occur, during these months, particularly during May. Further, the previous year's vegetation is dead and dry, acting as kindling to the chance spark. Later in the year, green vegetation offers fire resistance.

Comparison of causes, month by month, shows constantly decreasing proportion of fires chargeable to lumbering as the year draws on.

The tendency of the present-day operator is to close down for from four to six weeks during the fire season. Logging, however, has progressed to the point that most operators are adversely influenced by snow and frost conditions during mid-winter months, necessitating further shut-down. These shut-downs are serious in the economic life of the state, for labor is thrown out of work, camps disorganized and overhead mounts steadily upward.

The tendency therefore must, in the future, be towards continuous summer logging, with shut-downs only on those days when dangerous fire weather is predicted. Most camps are now equipped with hygro-thermographs, which record relative humidity, and such camps fully realize the value of the information so obtained. The Weather Bureau fire weather service also keeps in telegraphic touch with logging operators, and issues warnings where necessary. Still, fires occur in logging camps.

It is true that ground-cover exposed to lumbering fires is of the most inflammable type, and consequently gets out of control more rapidly than any other type, but, because of this, it is in order to investigate even more closely what the cure should be.

Study of the "cause" charts brings out that campers, berry-pickers and smokers, in proportion to the number of "causes," are responsible for a comparatively small percentage of the acreage covered. This gives rise to the thought that:

- (a) Quicker control of fire is obtained by fire protective agencies than in case of areas covered by "lumbering" fires.
- (b) The area in which these fires originate offer greater ease of control.

It appears that both reasons have effect upon keeping down acreage covered by these causes, but the second reason appears to carry most weight.

To further study this question still, reference is made to "incendiary" fires. These are, as a rule, set to gain rapid spread, and generally set at a time when weather conditions are at their worst. Areas so set on fire are usually areas of agricultural and semi-agricultural land over which some return, in the form of grazing, is looked for. Such areas are nearly always logged-off lands which have been burned at least once.

That such fires are held to such a low acreage, when conditions governing origin of such fires are taken into consideration, can only mean that fires gather headway comparatively slowly, and, further, that such areas offer less resistance to the fire crew and have less fuel on the ground, than other area types. Slash burning, in the majority of areas, therefore, appears to be a partial solution.

This premise is borne out also by the fact that railroad fires, which largely start on burned-over land, burn over an acreage in inverse proportion to cause.

Campers' fires are, or should be, classed on a different basis from other causes. In this case, acreage burned comes as a result, as a rule, of fire left unattended or unextinguished. Here is a somewhat different start from the fire which comes as a result of a spark, and the fire which comes from a live flame. But camp fires in virgin timber are a negligible quantity, as compared with camp fires adjacent to burned-off and brush lands. It would appear that this situation was being handled fairly well.

It will be noted that the peak of fire-occurrence, both as to number of fires and acreage covered, is reached by July, and falls off sharply during August and September.

Prevailing westerly winds of August and September, as outlined in George W. Alexander's Meteorological Report for Grays Harbor, have apparently a marked effect upon fire conditions. It is to be noted that while the fire-cause figure for August is 57% of the July figure, yet the acreage burned over during August is but 23% of the July figure.

The part that weather conditions play is thus illustrated.

Incendiary fires show marked proportionate increase during September, both in cause and acreage covered.

### Conclusions

It is apparent that lumbering offers the greatest field of study in searching for methods to decrease fire losses. The "cause" chart shows constantly decreasing number of such fires proportionately from May to August, with slight rise in September.

This rise is due to greater prevalence of low humidity, and stronger winds during September than in preceding months. Cure for such fire occurrence is largely in the hands of lumber operators. It will be granted that risk of fire is inherent to the operation of logging, but the fact that this is known, should cause operators to look carefully over the fire situation. Every help should be offered lumber operators. It is suggested that lack of men skilled in the handling of forest fires is reflected in results.

There is growing sentiment on the part of lumbermen to create camp fire wardens. Wise choice of such men, on whom will rest responsibility for fire control, may completely alter the situation. A further point is that lumbermen are leaning

more and more upon advice of protective organizations. This also is having good results.

Co-operation of the federal government in helping to protect logged-off lands, and thus to insure reproduction of the forest crop, has helped tremendously in perfecting the organizations charged with such protection, and has allowed for development of a force which covers such logged-off areas, instead of devoting all time, men and money to the protection of standing timber.

All other classes of fires appear to be dealt with fairly effectively, although more expenditure, study, and co-operation by lumbermen and public are essential to the perfection sought.

### The Present System

At Satsop is a supervising field warden, an assistant warden and a clerk; also a local meteorological station with hygro-thermograph, checking sling psychrometer and rain gauge. Telegraphic weather reports are exchanged every day with the U. S. Weather Bureau at Seattle and forecasts passed on to local wardens throughout the country. Here also is kept fire-fighting truck, portable pumps, hose and tools.

Distributed throughout the county are sixteen patrolmen with automobiles, three foot patrolmen and three extras; 27 patrolmen for the county. A Mason county patrolman also covers some Grays Harbor territory. Extra help is hired as needed. Average area covered by regular patrolmen is 30,000 acres. In addition one lumber company keeps two regular patrolmen and another company keeps one. The men are put on as the season demands, from April until in full force June 1, and kept until fall rains.

There are five lookout stations; three belonging to the co-operative system and two in the Quinault Indian reservation, all co-operating. Telephone connection is being steadily extended as necessary to keep the entire force in communication as any shifts are made.

Grays Harbor has the most logging, most slashings, and the largest area of hazardous cut-over land of any county in the state. In 1929, an unusually bad and long fire year, it had 57 fires; lumbering causing 6, railroads 3, camp fires 6, smokers 9, berry-pickers 1, brush-burners 3, lightning 5, incendiaries 11, miscellaneous 13. Of these 57 fires, 37 were from one-fourth acre to 10 acres in size, nine from 10 to 100 acres, 11 over 100 acres. Acreage burned over was 4,261, an average of 75 acres per fire, practically all on logged-off lands. It is about .7 of one per cent of such lands and .05 of one per cent of the county area—not a bad record for an extra bad fire year with relative humidity several times down to 19 or 20 even in the "fog belt."

But no theorizing on past conditions covers the continual shift of logging operations to new areas; a kaleidoscopic change that must be met by practical administrative judgment, experience and observation; made possible by a dependable *system*, rather than by studies continually behind the conditions confronted. A dependable system assuring this permanently is the constructive essential.

## SLASH DISPOSAL

A question the experts left answered undecidedly is the exemption of logging slash in the "fog belt" spruce-hemlock-cedar mixture from the prompt broadcast burning practice which is standard in typical Douglas Fir regions. In the former fire fails to penetrate deeply into the heavy accumulation of damp material, which consequently still carries fire when its surface dries again. Reforestation was proved quicker without burning and, being comparatively unflammable, is, when well established, the earliest and best reducer of hazard to the minimum. On the other hand is the possibility of fire, despite every effort, during the period of fresh slash and inadequate reforestation and under a weather condition making control impossible.

But majority opinion favors clearly enough a recognition of both arguments; represented by slash-burning in the typical Douglas Fir type of the interior, *no burning at all* in the typical "fog-belt" strip, and individual operation policy in the transition zone, there determined mostly as these types are differentiated by ridges and low-lands. Further study is indicated to clarify these distinctions as applying to individual areas.



BURNED SLASH, LEAVING UNUTILIZABLE WOOD TO CARRY ANOTHER FIRE.

## TAXATION

Federal Forest Taxation Inquiry. FRED R. FAIRCHILD.

Perhaps the most painstaking, extremely detailed and suggestive feature of the Grays Harbor co-operative survey was that handled by the federal Forest Taxation Inquiry. Certainly not on the Pacific Coast, if ever in the United States, has there been any more searching analysis of any taxation unit's governmental expenditures and obligations, its procedure in meeting these, or indication of its inevitable future based on its sources of revenue. The material is far too full to be printed in this digest, although available to any who desire to study it. Following is a list of the tables compiled, up to the latest reliable figures, available during the field study in 1928, of which only an illustrative few are herein reproduced, together with a few illustrative quotations from the report, which analyzes every table similarly and in fuller detail. The moral is evident enough—that forest resources and their perpetuation measure community welfare, and that such studies should be made everywhere in forest regions. Observe that forests pay most of the community taxes; consequently if they cease to be able to do so, the whole system will break down.

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SOURCE OF REVENUE OF GRAYS HARBOR COUNTY AND ALL SUBORDINATE  
TAXING DISTRICTS EXCEPT CITIES AND TOWNS

Source	Dollars	Percentage of Total
General Property Taxes .....	1,765,204.22	74.02
License Taxes .....	14,270.80	0.60
Special Assessments .....	27,449.70	1.15
Fines, Forfeits and Escheats .....	17,765.40	0.75
Subventions and Grants from State .....	316,733.62	13.28
Teachers' Retirement Assessments .....	2,256.00	0.10
Interest on Bank Balances .....	15,551.58	0.65
Earnings of General Departments .....	95,967.15	4.02
Port District Earnings .....	129,465.25	5.43
Total .....	2,384,663.72	100.00

PROPERTY TAXES, BY PROPERTY CLASSES, LEVIED ON REAL ESTATE FOR 1926

Grays Harbor County.

Property Class	General Property Tax
Forest not in other use—	
Corporation owned .....	\$ 688,354.87
Individual owned—	
Resident .....	62,298.39
Non-resident .....	61,848.50
Total individual owned .....	\$ 124,146.89
Total forest not in other use .....	\$ 812,501.76
Forest partly in other use .....	6,440.96
Resort .....	1,534.14
Farm .....	83,038.19
Residential .....	1,918.81
Business—	
Sawmill .....	21,063.25
Public utilities .....	130,534.08
Tideland .....	63,226.32
All other .....	2,420.07
Total business .....	\$ 217,243.72
Total .....	\$1,122,677.58



ASSESSED AREA AND VALUE OF RURAL REAL ESTATE<sup>1</sup> FROM TAX BOOKS OF 1926  
Grays Harbor County

PROPERTY CLASS	IMPROVED		UNIMPROVED		TIMBER				TOTAL	
	Area <sup>2</sup> (Acres)	Value	Area <sup>2</sup> (Acres)	Value	Area <sup>2</sup> (Acres)	Value			Area <sup>2</sup> (Acres)	Value <sup>3</sup>
						Land	Timber	Total		
Forest not in other use:										
Corporation owned.....	83	\$1,250	293,515	\$739,555	246,316	\$703,983	\$8,851,750	\$9,555,733	539,914 <sup>4</sup>	\$10,296,538
Individual owned:										
Resident.....	11	120	80,092	304,418	26,679	90,620	540,624	631,244	106,782	935,782
Non-resident.....	40	80	53,010	156,536	20,571	68,869	704,080	772,949	73,621	929,565
Total individual owned..	51	200	133,102	460,954	47,250	159,489	1,244,704	1,404,193	180,403	1,865,347
Total forest not in other use	134	1,450	426,617	1,200,509	293,566	863,472	10,096,454	10,959,926	720,317	12,161,885
Forest partly in other use....	72	1,585	6,268	33,875	137	610	645	1,255	6,477	36,715
Resort.....	8	320	1,174	8,070	628	2,550	4,825	7,375	1,810	15,765
Farm.....	20,115	562,955	52,908	302,018	3,518	13,630	23,250	36,880	76,541 <sup>4</sup>	901,853
Residential.....	103	5,155	316	4,612	0	0	0	0	419	9,767
Business:										
Sawmill.....	76	3,095	1,118	10,305	0	0	0	0	1,194	13,400
Public utilities.....	45	205	1,440	5,795	3,642	11,345	179,390	190,735	5,127	196,735
Tideland.....	0	0	0	0	0	0	0	0	0	0
All other.....	177	7,155	349	5,380	0	0	0	0	526	12,535
Total business.....	298	10,455	2,907	21,480	3,642	11,345	179,390	190,735	6,847	222,670
Total.....	20,730	\$581,920	490,190	\$1,570,564	301,491	\$891,607	\$10,304,564	\$11,196,171	812,411	\$13,348,655

<sup>1</sup>By rural real estate is meant all real estate outside of cities, villages, and platted subdivisions.

<sup>2</sup>Does not include small tracts for which no area is given on the tax roll.

<sup>3</sup>Does not include tideland value or other unclassified properties.

<sup>4</sup>Excludes areas not distributed on the acreage tax books among columns 1, 3 and 5. These undistributed areas are included in Table 5, column 1.

Source of data: Columns 1 to 7 inclusive: Acreage tax books for 1926.

TAX DELINQUENCY OF RURAL REAL ESTATE MEASURED BY AREA AND PER CENT  
DELINQUENT AS OF DECEMBER 31, 1927<sup>1</sup>

## Grays Harbor County

Property class	Taxes paid (acres)	Taxes delinquent (acres)	Total (acres)	Ratio of delinquent to total (per cent)
	(1)	(2)	(3)	(4)
Forest not in other use:				
Corporation owned.....	530,752	9,282	540,034	1.72
Individual owned:				
Resident.....	78,125	28,657	106,782	26.84
Non-resident.....	58,318	15,303	73,621	20.79
Total individual owned.....	136,443	43,960	180,403	24.37
Total forest not in other use.....	667,195	53,242	720,437	7.39
Forest partly in other use.....	5,684	793	6,477	12.24
Resort.....	1,426	384	1,810	21.22
Farm.....	64,723	11,897	76,620	15.53
Residential.....	365	54	419	12.89
Business:				
Sawmill.....	1,149	45	1,194	3.77
Public utilities.....	5,098	29	5,127	.57
Tideland.....	0	0	0	0.00
All other.....	518	8	526	1.52
Total business.....	6,765	82	6,847	1.20
Total.....	746,158	66,452	812,610	8.18

PURPOSE OF GOVERNMENTAL COST PAYMENTS OF GRAYS HARBOR COUNTY  
AND ALL SUBORDINATE TAXING DISTRICTS EXCEPT CITIES AND TOWNS

Purpose	Dollars	Percentage of Total
General Government .....	192,537.52	8.75
Protection to Person and Property .....	63,957.24	2.91
Development and Conservation of Natural Resources .....	15,117.87	0.69
Conservation of Health and Sanitation .....	8,866.32	0.40
Highways .....	348,333.17	15.83
Charities, Hospitals and Corrections .....	132,048.54	6.00
Education .....	1,033,116.19	46.96
Port District Payments .....	216,183.84	9.83
Interest Payments .....	159,609.10	7.25
Miscellaneous .....	30,291.97	1.38
Total .....	2,200,061.76	100.00
Less Warrants Cancelled .....	1,604.34	
Total Governmental Cost Payments.....	2,198,457.42	

<sup>1</sup>Delinquent with respect to taxes (exclusive of fire patrol and weed district taxes) levied for 1926 and prior years on the date the books were closed at the end of 1927, approximately December 31 of that year. Includes all real estate outside of cities, villages, and platted subdivisions except tidelands for which there is no recorded area.

Sources of data: Columns 1-3: Acreage tax books for 1926. Column 4: Column 2 divided by column 1, and multiplied by 100.

### Quotations from Report

Of 810,000 acres of rural real estate on the tax roll in 1926, 540,000 was forest land owned by corporations. Individual owners have title to over 180,000 acres of forest, about 74,000 acres belonging to those not resident of the county. Farms included only 76,000 acres, and resorts 1,800 acres. The 6,500 acres of "forest partly in other use" represents land which cannot be clearly classified as forest, farm or resort.

The bulk of assessed value of rural real estate represents the value of corporation property, the most of it (\$10,300,000) being classified as "forest." Individual owners of forest land are assessed at \$1,900,000 while farms are valued at about \$1,200,000. The bulk of improvement value is on business property (\$660,000), farms ranking second with about \$290,000.

Forest land was called on to pay more than half of the tax—about \$800,000 out of about \$1,100,000. Business property is second with about \$220,000, and farm property third with about \$83,000. Corporation-owned forest land, together with business property, most of which also owned by corporations, was taxed nearly \$900,000 in 1926. Taxes of the 1926 levy on rural real estate reported delinquent amounted to nearly \$46,000. Forest property, with a levy of over \$800,000, was delinquent to the amount of \$24,000; farms with a levy of \$83,000 to the amount of \$11,000; and business to the amount of \$9,000 on a levy of nearly \$220,000.

Another table presents percentage relationships. Thus, 89 per cent of the area is in the "forest not in other use" class, and only nine per cent in "farm," and .2 per cent in "resort." Corporations own more than half the land; their holdings in the property class "forest not in other use" amounts to 66 per cent of the area, on which they are required to pay 61 per cent of the taxes. Public utilities are called on for 12 per cent of the taxes and farms seven per cent. "Forest not in other use," owned by residents of the county, accounts for 28 per cent of the delinquency in the 1926 roll. Farm property comes next, with 25 per cent; forests owned by non-resident individuals is third, with 14 per cent; and corporation-owned forests not in other use is fourth with 12 per cent. Business is required to pay only 19 per cent of rural taxes, because most business properties of the region are located in cities and villages.

Most rural acreage in improved land is naturally in farms, amounting to 20,000 acres, with an assessed value of \$560,000. Farms also include 53,000 acres of unimproved land value at \$300,000 out of a total of 490,000 acres of such land valued at \$1,570,000. Most timberland is, of course, in the "forest not in other use" property class. Only 3,500 acres of timberland valued at \$36,800 is in farm ownership out of a total strictly forest area of 300,000 acres valued at over \$11,000,000. Corporations in the property class of "forest not in use" own most of the timberland—250,000 acres out of 300,000. Land under timber is valued at nearly \$900,000, \$700,000 of which is in corporate ownership. Timber in the county is assessed at \$10,300,000, of which corporations own over \$8,800,000. Corporations also hold the majority of unimproved land—290,000 acres out of 490,000. Individually-owned "forest not in other use" amounts to 133,000 acres of unimproved land, valued at \$460,000, and 47,000 acres of timberland, valued at \$1,400,000.

Average assessed value of improved land in farms is \$27.99 per acre. Average value per acre of unimproved land in the property class "forest not in other use," being the bulk of the cut-over land, is \$2.75; that owned by individuals resident in the county is somewhat higher than the average, being \$3.66. Unimproved land in

"farms," "resort," and "forest partly in other use" is all valued at about \$5.50 per acre. Land under timber in the "forest not in other use" property class is valued at \$2.94 per acre, somewhat higher than cut-over land. However, average value per acre of land under timber in the "farm" property class is materially lower than that of unimproved land in farms, being \$3.87 as against \$5.71. Timber in the property class "forest not in other use" containing most and probably the best timber, averages \$34.39 per acre. Timber in other property classes is assessed very much lower, ranging from \$4.70 to \$7.69 per acre.

Of the area of rural real estate which was delinquent at the end of 1927 for the taxes of 1926 and previous years; over 66,000 acres or about eight per cent of the area are on the rural tax roll. Most of this delinquent land, or 53,000 acres, is "forest not in other use." However, on basis of total taxable area in each property class, farm property has a proportionately greater delinquent area than forest property; 16 per cent as against seven per cent. Low ratio of forest land delinquency is attributable to preponderance of corporation-owned forests; as only 1.7 per cent of this class is delinquent, though 27 per cent of the forest land owned by individuals resident of the county and 21 per cent of that belonging to non-resident individuals is delinquent.

Over \$115,000 in taxes levied against rural real estate in 1926 and previous years had not been collected by the end of 1927. Of this \$73,000 was due from property classified as "forests not in other use," the greatest part being due from individually-owned property, corporations being in arrears for only \$19,000. Farm and tideland properties are second and third respectively in delinquency with \$22,000 and \$10,500 in back taxes outstanding. Nearly half the total taxes delinquent are of the 1926 levy (\$45,500).

It will be noted that total revenue of the county and all its subordinate taxing districts except cities and towns was \$2,384,664 during 1927. Of this amount, \$1,765,204 were derived from general property taxes. Thus general property tax provides practically the three-quarters of the total revenue. Next to general property tax, subventions and grants from the state of Washington provide the most important source of revenue; revenue from this source constituting more than an eighth of the total. Since most funds received from the state are collected as general property tax paid on property within the county is the original source of much more than three-quarters of the total revenue of the county and its subordinate taxing districts except cities and towns, this statement would be equally true if the cities and towns were included.

If we deduct from the auditor's total receipts all receipts from sale of bonds, all refund receipts, and all receipts paid out during the year as refund payments, the balance will represent combined revenue of state, county, and subordinate taxing districts which passes through the county treasury. In this calculation, city and state taxes and special assessments are included. Almost nine-tenths of this total revenue is derived from taxes and special assessments.

Cost of government for Grays Harbor county and all minor taxing districts except cities and towns was \$2,198,457 in 1927. The school system of the county, including school districts in the cities, cost \$1,033,116 plus absorbing nearly half of the total cost of government. Highway construction and maintenance is the next most costly governmental function. The fact should not be overlooked that cost of construction and maintenance of city streets by the cities themselves is not included in the figure here given for highway costs. Thus limited, highways were responsible for less than a sixth of all costs, and only slightly more than a third the cost of education. Education and highways, together, account for nearly two-thirds of all costs. In

addition, almost quarter of all governmental cost payments are distributed quite evenly between the Port of Grays Harbor, general government costs, and interest payments. Out of every hundred dollars paid out as governmental cost payments, \$7.25 was paid as interest on debt obligations.

### **Public Debt**

The combined bonded debt of Grays Harbor county and all subordinate taxing districts, except cities and towns, amounted to \$2,689,410 on January 1, 1927. The bulk of this debt is distributed somewhat evenly between county, school districts, and port district. On December 31, 1927, the total bonded debt was \$2,563,910. During 1927, therefore, the total bonded debt was reduced \$125,500. The only bonds issued during the year were issued by school districts; and the only taxing districts showing an increase in bonded debt were the school districts, whose debt increased from \$935,410 to \$976,910.

The warrant debt of the county and all of its subordinate taxing districts except cities and towns amounted to \$445,149, on January 1, 1927. Of this total, \$305,058 is represented by outstanding school warrants. On December 31, 1927, the warrant debt stood at \$364,298.

On January 1, 1927, the net debt of the county and all of its taxing districts except cities and towns was \$2,657,899.

## CONCLUSIONS

1. A generally-supported system that assures continuing fire prevention, reasonably safe-guarding forest crops until they are cut, is the first essential of forest production. Upon it rests the safety of any public or private investment in carrying forest lands or in improving their condition. With such a system assured, but seldom otherwise, the technique of forest protection itself, and of production methods as well, will continue to develop toward the perfection both now lack as a rule.

2. To find means of guaranteeing forest owners and public such a dependable protective system, with financial and other responsibility equitably assumed by all beneficiaries—owner, community, state and nation, is the primary forest problem. It will hardly be solved permanently until in each differing region each beneficiary has the facts on which to base its participation. To illustrate this has been the object of this co-operative study.

3. It has developed far more information than can be presented without going into technical detail beyond the interest or appreciation of either layman or technician without especial Grays Harbor interest. Consequently, a compromise synopsis is presented, not only by merely digesting the several and somewhat different viewpoints now presented, and by reminding all concerned that much further detail of results is available to those interested, but also by pointing out that final conclusions from this or similar studies elsewhere require following up by those primarily concerned. This study does not represent an administrative agreement, but is the preliminary survey.

4. It shows an important productive region in danger of distress in a not distant future and in need of an immediate co-operative program of defense. It shows responsibility divided between forest owners, not all doing their maximum to keep their lands fire-guarded and productive; between community, county and state populations doing even less through fire consciousness and tax justice to warrant forest owners in going the limit to improve the situation; and between National Forest, State and Indian land authorities remaining uncommitted as to what they are willing to do, although largely in command of the situation, because apparently unagreed among themselves or unready each to initiate any independent position until every other element joins in presenting a co-operative proposal to be met.

5. In this economic connection the survey gives the present views of such agencies as have made their views public, clearly leaving a similar responsibility with those which have not. Therefore it suggests further co-operation to bring about sincere joint attempt to solve a joint problem. The early suggestion of the Western Forestry and Conservation Association for a merger of interests and purpose appears not entirely in line with the present attitude of the Forest Service policy concerning Olympic National Forest timber disposal, but neither has any definite assurance from

other interests involved to support its position. The obvious moral is further conference, authentically backed by all agencies concerned, which this study seems to prove an unavoidable responsibility upon each.

6. The study appears to show essential facts as to economic, forest-protective, and forest-growing necessities; both as far as they are agreed upon and as they demand further joint study to reconcile disagreements; thus presenting to all the program of further study and conference.

7. It proves the high possibility of the region to meet its necessities, provided there is sincere co-operation to do so; because, although there appear some difficulties of forest regeneration to be solved (the solution is fairly well agreed upon and indicated by the forestry experts), its natural forest productivity is very high.

8. The study collects the somewhat differing, but in the main corroborative, views of experts upon fire prevention, taxation, reforestation, weather influence, forest diseases, etc., from which forest owner, public agency or community can estimate promise and risk, also charts a general course representing their interest and responsibility.

9. The conclusion is that here is a region of phenomenal forest productive capacity; badly treated by every community element dependent upon it; of immense importance to community, state and nation; capable of redemption if all responsible elements unite; with the essential scientific and economic information either provided by this co-operative study or suggested for completion. Which ends, as it began, mainly as information on which to base a dependable fire prevention system to warrant all other steps.

10. In any other region the factors might differ, but a similar co-operative study is indicated, in line with the Clarke-McNary law, the co-operative policy of the nation established by Congress, which will succeed in the measure it is sincerely put into practice to solve forest problems of regions and nation through such co-operation.

11. Specifically, the majority technical conclusions of the study include strengthening of protection against fire, the importance of tax reform, and that large-scale logging by the clean-cutting practice recognized as correct practice in the West-Cascade region is not leaving enough adjacent seed supply. Also that scattered wind-exposed seed-trees are useless; consequently that good practice is leaving fairly large blocks here and there until a good seed year and favorable winds have reseeded contiguous areas. When re-growth will be exceptionally rapid. But the fire problem is not solved. It demands a far higher joint consciousness.

12. Economically, the situation calls for a co-operation, unique in American forest history, of all private, state and federal forest ownerships involved, and their joint influence on tax legislation, etc., to bring about an early jointly-supported program, not only to use public timber tributary to Grays Harbor intelligently to

bridge the gap between the virgin timber private supply and the possible second-growth private supply; keeping the entire region up to its highest total yield, but quite as much to demonstrate to state, community, and private forest owners their own interest, promise, and responsibility in taking advantage of the possibilities which lie in their own hands to profit by the opportunities afforded by this region of great productive capacity.

13. All of the foregoing is to be considered by no means only as applying to this illustrative Grays Harbor area, but rather as suggestive of extension to other areas in the same state, to bring about a correct balance in the minds of all concerned therein—private, state and federal—and as well to every forest region in the United States, beginning first with its most critical areas, and extending therefrom, until the whole story is told, and each agency is perforce obligated by facts and the publicity thereof to meet its benefit and its responsibility in joint solution of forest problems, among which dependable fire prevention is paramount.

NOTE: Although the purpose of this entire report is to present the several views without bias, demonstrating the value of such co-operative study; nevertheless the presentation of apparently majority conclusions as above, as well as introductions of the co-operators' contributions, and unfortunately the abridgment of much valuable material to meet space consistency; all proved to be an editorial charge upon someone. It seemed by the majority to be placed upon the Western Forestry and Conservation Association, but E. T. Allen assumes entire responsibility for any errors.