TIMBER SURVEYS

The first timber survey of record was made in 1905 by Fred G. Plummer, a Forest Service civil engineer, who took his transit to the woods of Calaveras County and estimated the volume of Big Trees in the North Grove. 99 of the giant sequoias were measured individually.

During July, 1907, the Chief wrote to all Forest Supervisors and requested each to make estimates of the timber on their Forests, by species. They were given until the end of year to submit their reports.

On March 14, 1908, Wm. T. Cox wrote to each Supervisor and said in part:

"In view of the fact that the time to prepare the estimates was so short and that a great many of the Forests had but recently been placed under administration, the estimates were exceptionally good and many of them complete in detail. The reports have been received by the Forester and tabulated. The results show the extreme importance of this work and of its continuance.

"In their replies many of the Forest Officers intimated that a revised and much more accurate estimate would be made for the following year, when more attention and time could be given to the work. It seems therefore advisable to request new and if possible, more detailed estimates to be submitted to the Forester not later than February 1, 1909."

"These estimates were to include:

1. The total amount of all sawlog timber.
2. The total amount of merchantable cordwood, in cords.
3. Total estimates by species.
4. The estimates should be based only on the area of National Forest after deducting alienations of state lands, private holdings, and railroad land grants.
5. Separate estimates by State and "It will be a great aid if the estimates are tabulated by watersheds or other natural divisions."

To all this Cox added:

"The work to advantage be divided into Ranger Districts. Each Ranger should, with your assistance and supervision, be able to make a very accurate estimate of the timber in his territory. If not already experienced, please see that your Rangers are instructed in timber estimating either by yourself or some other Forest Officer competent to do so. The Rangers should be taught to estimate either by the strip surveys or by sample areas, or by both, as conditions on your Forest may indicate. The time which you can spare from your regular duties, and the Ranger's need of

> assistance and instruction will, to a great extent, determine the attention you should give the field work."

Cox's parting shot was,

> "I need not emphasize the importance of making as accurate an estimate as possible, since you realize that it is basic to all farsighted management of the timber resources on your Forest."

How these estimates were made will never be known, but at least the results were pleasing to the Forester. These early Forest Officers were used to taking orders from Headquarters and doing the job the best way possible.

The tabulation of timber in District 5 by Forest totaled almost 104 billion board feet of timber and almost 29 million cords of wood. These amounts were used by the Chief's Office to develop the "Limitation of Annual Cut" for each National Forest.

Since that time when the first District estimates were made, many other tabulations have been developed. Over the years many changes in base lands have occurred along with changes in survey methods. Changes in merchantability of areas and species have played a large part to change total estimates. Land acquisition of timberlands has also influenced the resource totals. The effect of logging and mortality is also reflected in the totals. There is some consistency in estimates between 1908 and 1946 with a high of 124 billion board feet in 1913, and a low of 100 billion by forest survey in 1946.

From 1953 through 1972, a 20-year period, the total inventory for the Region reduced less than 3 billion board feet (1953—163 billion and 1972 – 160.3 billion). During this same 20-year period the harvest from timber sales was 32 billion board feet, or an average annual reduction 1.6 billion, which is nearly equal to the annual growth for the same period. Again, over the same period, the annual allowable cut has risen from 1.205 billion to 1.975 billion. Increases in net growth and utilization of intermediate cuttings account for most of the increases in the annual cut. The increases in allowable cuts are predicated on accomplishing precommercial thinnings on schedule and further increases in cutting rates can be made as existing non-stocked lands (old brushfields) are reforested and added to the growing stock inventory.

During the period the National Forests have been under management by the Forest Service (1905-1973), the total harvest of timber from them has been 43.5 billion board feet.

Louis Margolin joined the Staff in San Francisco in 1909, shortly after the District Office was formed, and took charge of timber reconnaissance. About this time the Chief's Office was putting pressure on not only needed volume estimates, but also for reliable growth information. Margolin took a look at what was available and found nearly complete lack of reliable volume tables and practically nothing usable for estimating growth. On April 28, 1909 he wrote District Forester Olmstead:

> "Volume and growth tables are the first prerequisites for any intelligent system of forest management, and are the bases for working plans. Parties making the new Reconnaissance working plans are usually not in a position to make volume and growth studies. To be of the greatest value, the construction of volume tables should precede the working plan, so that the estimates may be checked.
>
> "Since there is no one in the District available to estimate timber by the ocular method, all of our valuation surveys will have to be worked up by means of volume table work. Furthermore, if we had good volume tables, it would not be difficult for a man to become proficient in the ocular method of estimating.
>
> "I would suggest, therefore, that as much measurement work as possible should be inaugurated in District 5 as soon as funds and men are available for this work."

At the same time (1909) a four-page "Outline for Working Plans on National Forests" was provided by the Chief's Office.

After exchanges of correspondence with the Chief's Office, a three-man crew was organized and a cruise made for the Cow Creek Block on the Stanislaus. Shirley Allen, a recent graduate from Ames School of Forestry in charge of the party, and students from the University of California, Gerald D. Kennedy and Fredrick F. Thomas made up the crew. Allen received $40 per month and the crew members $25 per month. Their appointments as Forest Agents had to be cleared with the Secretary's Office in Washington D.C. Thus, in 1909 timber surveys (reconnaissance) on a project basis, out of the San Francisco Office, was launched in District 5 National Forests.

Timber reconnaissance party, near Hyampom, Trinity National Forest, 1910. Left to right: Frank Nottage, E. V. Jotter, Howard Curry, and Oscar M. Evans. Two of the men have tree calipers for measuring tree diameters.

Timber reconnaissance party and camp, Pasture Gulch, Trinity National Forest, 1911

An interesting sidelight to the volume table discussion resulted in part for abandonment of the Branch of Products. When Margolin wrote Olmstead on April 28, 1909, Margolin was unaware that volume tables did exist for yellow pine in Circular 127 prepared by E.. A. Ziegler for Scribner Decimal C, and was adaptable to California, as was another table for Sugar Pine. These were found later in the Branch of Products and not listed by Margolin in the Office of Silviculture. Olmstead's letter to the Chief dated May 17, 1909 contained the following:

> "Your letter of May 10 and Mr. Ziegler's memorandum again bring out the incongruity of dividing the measurements work among two separate offices. The Office of Silviculture is practically the only office which uses volume and growth tables. There is no reason why, therefore, this office should not keep all tree tables. The office (Branch) of Products will then simply compute the data as requested by the Office (of Silviculture) and immediately turn over the constructed tables to the Office of Silviculture which will, in turn, keep the Supervisors and Rangers supplied with the latest up-to-date tables. Would it not be possible to arrange matters so that the responsibility for volume and growth tables will not be divided between two offices?"

E. E. Carter's letter dated May 26, 1909 in reply to Olmsted said in part:

> "You will probably soon receive a letter directing that the Office of Products in your District is to be discontinued, and the work, including the file of tables, put in the Office of Silviculture. This will promptly clear up any question of conflict between offices as they now exist; and the responsibility for knowing what tables are in the

District Offices and for the use of them to the best advantage will rest squarely on the Office of Silviculture."

On April 25, 1910, an outline covering 8 pages "For Reconnaissance Working Plans for National Forests, District 5" was issued. It stated all details for doing timber reconnaissance work and essentially was the first timber surveys handbook for the District. No author is indicated, but it was probably written by Margolin.

A report to the Chief dated 7/6/10 showed accomplishments to date:

"The following is a table showing the area covered by the reconnaissance within the Forests of District No. 5 during the fiscal years 1906-1909, and during the year 1909-1910, together with the acreage covered and the amount estimated both in MBM and Cords:

	Area	Amount	
Years	Acres	M.B.M	Cords
1906-1909	191,274	867,716	54,930
1909-1910	203,290	938,216	0
Total	394,464	1,805,932	54,930

The exact accuracy of this table cannot be guaranteed since the Supervisors found it very hard to draw the line between reconnaissance work and rough estimates."

On March 11, 1911, Swift Berry provided the interesting information to the District Forester as follows:

"Detailed reconnaissance work in this District prior to the Spring of 1910, may be summarized as follows: Sequoia approximately 2,000 acres Pratt (1906); Sierra 8,700 acres Eldridge (1906); Trinity (Hoopa Valley) 57,000 acres (Eldridge (1908); Plumas 35,000 acres Hall (1908). During the season of 1910 a total of 308,967 acres were covered at an average cost of $0.031 per acre. This work took place on the following Forests: California, Inyo, Klamath, Modoc, Mono, Plumas, Shasta, Stanislaus, Tahoe, and Trinity."

For the 1911 season, 48 men @ $50 per month and expenses were to work on twelve northern Forests. Most of the men would be recruited from Forest Schools and would participate in fire fighting as needed. All recommendations for employment were to be made by the Office of Silviculture, but the field work was the responsibility of the Forest Supervisor.

During the 1911 field season, Forest Expert William C. Hodge (apparently attached to the District Forester's Office) made a study of the "Results of Reconnaissance Checking" and made some valuable criticisms and suggestions, among them was a proposal to add a hypsometer to the cruising stick used for determining tree heights. Just prior, Schenck

had introduced the Biltmore stick. Hodges' proposal for a hypsometer was eventually adopted. Hodges' report, dated October 11, 2011, covered 34 pages. It pointed out many differences in cruising methods and offered solutions to many of them. He indicated the necessity of relying on instruments because of the inexperienced character of the men employed and the absolutely necessary of frequent checking of measurements. He also analyzed the courses of careless work in taking measurements and pointed out means of overdoing carelessness by making the work easier, *i.e.,* simplifying instruments and forms.

Oscar Evans using the Biltmore stick hypsometer to estimate tree height in 16-foot logs to an 8-inch merchantable top, the Eldorado Project, 1923.

The report was sent to all Forests and the subject was discussed at the January, 1912, Forest Supervisors' Meeting. Woodbury led the discussion and several changes in

procedures were agreed upon to make the work more accurate. The need for periodic check cruising was emphasized. The net result of the meeting was more attention by Supervisors for increased accuracy and more efficient and experienced crews doing the work.

In the Office of Silviculture, Woodbury, Swift Berry, Hodge, and Margolin collaborated on a better type-mapping procedure and defined timber types to better meet California conditions.

In 1913, the Chief's Office issued the standard "Instructions for Reconnaissance Surveys and Maps" (no copy found in files), and on June 1, 1914, District Forester Coert De Bois approved a District 5 supplement to these instructions entitled, "Manual of Intensive Reconnaissance", authored by Margolin. This was a 123-page (typed) document with RO standard volume tables for various species and the areas attached.

On July 195, 1915, Woodbury requested the field to review a set of instructions for small sales which would be incorporated with a new Manual of Intensive Reconnaissance in 1916. This called attention to the fact that a higher percentage of the area should be cruised on small areas. The minimum was set at 10 percent. The standard for large areas was a minimum of 5 percent with 10 percent as a maximum.

In 1915, W. H. Gallaher was made the new head of this activity after the death of Margolin while traveling between timber survey camps on the Dinkey Creek District of the Sierra Forest. The files indicate that to September, 1915, District 5 had completed 2,721,107 acres of intensive and 4,591, 212 acres of extensive timber reconnaissance. Nearly all of the intensive and a large portion of the extensive work had been accomplished during Margolin's tenure.

Map Making in Connection With Timber Surveys

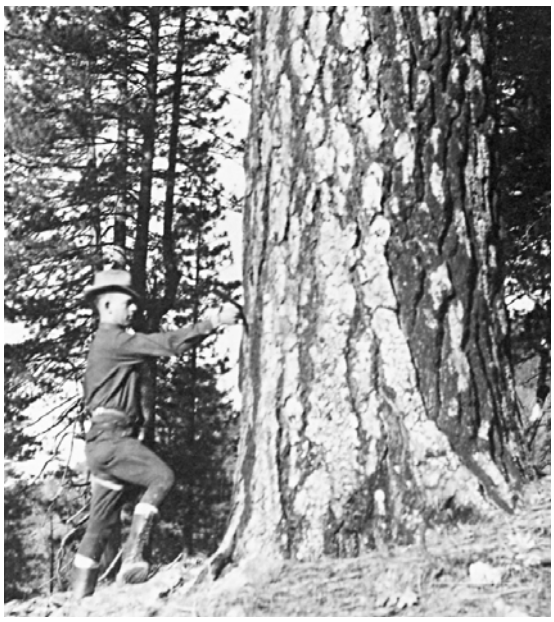
[Buck quoted the process described in R. W. Ayers, "A History of Timber Management in the California National Forests, 1850 to 1937", 1947, copy on file in the Regional Office, which is not repeated here.]

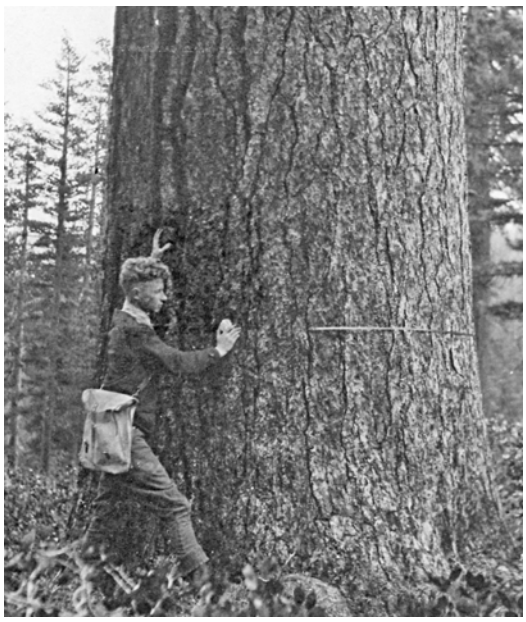
Timber Surveys

On June 15, 1916, the term (reconnaissance) was changed to "Timber Surveys"

Oscar M. Evans headed up the District 5 timber survey project in 1918, and remained in this position until he retired in 1945. Oscar had been active on the Trinity on timber survey work for a number of years prior to that time. During the 27 years that Evans was in charge of Timber Surveys the general methods for cruising remained nearly the same. Essentially it was strips of arbitrary, systematic arrangement across each 40 acres of varying percentage. Most often it was a 5, 10, or 20 percent cruise. At the same time

data were provided for topographic maps. The strips provided the best arrangement for mapping.





Measuring DBH on a ponderosa pine with a Biltmore Stick, Prather Creek, 1935 (left), and with a diameter tape on a sugar pine, 1923 (right). Both photos from the Eldorado National Forest.

Typical timber survey camp of the 1930's and 1940's. Eldorado National Forest, 1937.

Under Evan's administration of timber surveys the methods were standardized into a system that could be used satisfactorily by inexperienced cruisers and mappers. Under

his direction the surveys were projected out of the San Francisco office according to need for the timber sale business, land acquisition program and for timber management plans.

Chaining on a slope with Abney and 2 ½ chain topographic trailer tape, Prather Creek cruise, Eldorado National Forest, 1935.

Ayers indicates that Evans produced a timber survey manual dated 1932. This could not be found (1973). His two manuals, 1935 and 1936, were published as bound books. The letter of transmittal with the 1936 edition signed by Evans and approved by Woodbury said in part:

> "It is hoped that the Manual will contribute to some measure to the making of closer estimates of standing timber and to the preparation of better topographic maps. Surely, if our Forests are the be put under adequate and successful management, the administration have, at the very beginning, complete and accurate acre-by-acre information which includes topographic, type, and soil maps of ample scale, records of the forest composition and quality of the trees, amount of young growth, and thoroughly reliable timber estimates."

Both of Evans' Manuals had the following as an Introduction:

> "The object of Timber Surveys is to obtain an inventory of the timber resources of the National Forests for purposes of management, sale, protection, or exchange, and incidentally to further the development and correlation of other uses, as, for example, recreation, grazing, stand improvement, or blister rust control. To practically all cases the object is not only to make maps, get an estimate of the volume of merchantable timber and a record of the young growth, but also to obtain the data necessary for the intelligent management and use of the National Forests, for the

proper silvicultural treatments of stands and for determining what areas need planting. To manage forests successfully their resources and topography must be known in detail.

"The following instructions give the method of Timber Surveys to be followed in the California Region, and apply especially to the pine section. They supplement: (1) 'Instructions for Making Timber Surveys in the National Forest' (Washington, 1925); (2) the 'Specification for Horizontal and Vertical Control of the Board of Surveys and Maps', issued January 11, 1921, and revised April 13, 1926; and (3) the 'National Forest Manual'. While this Manual is based on the conduct of intensive project, 5 percent to 20 percent cruises, by standard crews, its principles should be applied to the intensive examination of small sale areas and to extensive work – two strips or less per section. These instructions supercede al previously issued and deviations from them should be made only with the written consent of the Regional Office."

This Dodge screen-side was the survey crew's transportation from camp to work and back each day. Many a Cal forestry major rode this "cage" in the 1930's.

Evans spent almost all of his career with the Service improving the system, defending the methods, training people in its application, and in earlier years acting as chief of party on many projects, and supervising an enlarged survey program in later years.

With the exception of the first "modern" Timber Management for the Meadow Valley Working Circle (based on 1910 estimates and approved in 1924), all of the plans were to be developed in the next 30 years were, at least in part, based on Evans' cruises.

During this period billions of board feet of timber were sold with Evans' cruises as the basis for the estimates. In order to use these timber survey estimates, additional field data were collected on sample cruises, to determine cut and leave percentages and to determine standing tree log grades for appraisal purposes. For larger areas the cruises were excellent and were exceedingly valuable to the timber sale program.

Evans prepared a summary of intensive timber surveys in 1944 that excluded the early extensive cruises and was confined primarily to the pine region of the northern portion of the Region. No projects were listed for the southern Forests or that portion of northern California that is now the Six Rivers National Forest. Generally the high elevation true fir stands were not cruised. The summary shows 3,158,217 acres of Government land and 100,751 acres of intermingled private land cruised and mapped up to that time. In addition, Evans' cruise work included many land exchange timber estimates that were not included in the above tabulation.

Mapping Procedures Questioned

Ever since timber surveys began it had been a requirement that maps of each project be prepared and copies sent to the Washington Office. Some time later timber type and topographic maps were required. This mapping work apparently started about 1916.

The Office of Silviculture provided the field data area field sketch maps. The Drafting Section in the District Engineers Office was responsible for inking and finalizing the maps, including coloring the types. These maps were on a 4-inch scale. Several copies of bared colored maps were required for 40 to 50,000 acres annually.

In 1921 the colored maps were to be provided on 2-inch scale and the number of colored maps reduced in number to save expense and the impacting on Drafting. Colored maps were considered essential for timber management plan. The 4-inch scale maps would continue in use for general Forest management work, but would not be colored. The net result was that six hand-colored maps of each project would be needed o provide a copy for the Washington Office, the San Francisco Office, and the Supervisor. Three additional copies would be required if and when a timber management plan was prepared.

In 1922 the preparation of topographic maps on areas already covered by U. S. Geographic Surveys, which had been active since 1890, was being questioned by the Washington Office. John Preston felt that the expense of collecting data and making maps should be better spent in getting better cruises. Woodbury, Evans, and Bonner (District 5 Engineer) were all in agreement that good maps were essential to the conduct of Service business, and that the USGS maps did not provide the essential detail and that

they were, in many cases, grossly inaccurate. Evans made a time study and found that 25 percent more cruise line could be run without mapping.

The argument ended with District Forester Redington transmitted a 5-year timber survey plan to the Chief on January 23, 1923 and said:

> "In connection with the timber survey work outlined about, it is planned to use existing maps wherever they furnish the necessary details and have been prepared with a satisfactory degree of accuracy. Topographic maps will be prepared by the timber survey party covering areas of rough topography and areas of timber for which no satisfactory topographic map is available. Maps of this character are necessarily primarily in connection with timber appraisals work and secondarily to assist the operators in preparing working plans and an aid in general administration. In connection with extensive timber surveys as a basis for management plans, where no timber cutting is anticipated for a number of years, if there are no satisfactory maps available, drainage maps only will as a rule be prepared."

Carter agreed with this solution to the mapping problem and also informed the District that "The approval of (by the Chief) specific projects (timber surveys) has been dropped. He also informed the District that allotments for timber survey work would remain at $10,000 annually for the next three fiscal years. (This level of financing for the District had been in effect for several years.)

The First Aerial Photos

An article in "The Military Engineer" appeared in 1927 that outlined a procedure for the use of aerial photographs for making topographic maps. In July, 1929, T. R. Littlefield, then chief of Maps and Surveys, negotiated a small contract with Fairchild to furnish aerial photos of a small area in the Nelson Creek drainage, Shasta National Forest. Copies of these photos were made available to forest management. It was also planned to have the Army photograph some other area for forest management. The files did not disclose the results of a ground check to be made of these photos.

It was about 10 years before anything more was done with aerial photos in timber survey work.

Comparison of the Sample Plot and Strip Method of Cruising

The files on this subject are not complete, but apparently Woodbury asked Evans to make a comparison check of plot cruising and strip cruising. This was done during the 1935 field season on 40 acres on the Stanislaus project. Evans detailed his results of the comparison on February 13, 1936. A ten percent 2-strip cruise was compared to four one-acre sample plots laid out in the center of each 10-acre parcel. The result was 19.8 percent less volume on the sample plots than on the strip cruise and even a wider

discrepancy in the species volumes. Oscar concluded the sample plot method was, "No damn good". Woodbury replied to Evans:

> "It does not seem to me that the check which you made furnishes a very thorough and reliable basis for judging the comparative value of the strip cruising method and the sample plot method. I suggest you take about a quarter-section next season, cruise it 100 percent by the strip system, and then cruise 16 acres in quarter-acre plots, evenly spaced. You will then have a basis for comparing the 10 percent plot system with any combination of the strip system. By taking the smaller plots, you will get a better distribution of these plots over the area and should get better results. It would be well to keep a comparative cost record showing the costs of both systems.
>
> It is my understanding that unless a large number of small plots are taken and unless the work is very accurately done, the plot method does not show up to good advantage. If the work is accurately done, I understand that this system has given excellent results when applied to large areas."

Woodbury was being rather patient with Oscar, but Oscar "drug in his feet" on doing anything. Notes on the file copy show that Dunston discussed the job with Lee Thomas, then a cruising party chief, in 1937. The work was never done, even though Oscar agreed he could do the work in 1938.

In the meantime, Austin Hasel had been busy on sample plot cruising methods. His first paper on the subject, June, 1937, "Analysis of Sample Methods for Volume Determination in a Ponderosa Pine Forest", detailed results of research at Black's Mountain. His analysis showed that random sampling could be done to a given standard of sampling error. A second paper on the same subject, received in the Division on April 3, 1937, suggested a way to utilize the information and was titled "Arrangement of Cruise Plots to Permit a Valid Estimate of Sampling Error".

Evans had received the draft copy of the June, 1937, paper a year earlier and said:

> "There is no doubt but there is a great need for information on this subject and that a 100 percent cruise furnishes excellent basic data for an article. I found the paper very difficult reading, with many dull, complex, involved sentences and altogether too technical to be of readable interest to a forester …
>
> "Hasel compares and contrasts in several places the plot vs. the strip method of estimating timber. At one time he seems to argue for the plot system and at another for the strip system. No matter what conclusion he arrives at, I am thoroughly convinced that to get all the information we are supposed to get on timber surveys, namely: (1) volume per forty, (2) a good representation of the species, (3) outline of forest types, (4) topographic maps, (5) reproduction, *etc.*, that is to give the examiner a complete picture of a forty, the strip system is far the better of the two, especially when we are using a two-man party as we are doing now in Timber Surveys. The

> plot system may give as correct a volume, but for all the other information it seems to me the strip method is better."

At the same time Mr. Kneipp (W.O.) was promoting sample plot methods of cruising on land acquisition projects. Both Evans and John Berry were busy in January, 1937, justifying strip cruising as being practiced in R-5. Evans wrote to the Division of Land on January 28, 1937, and made his pitch for strip cruising and provided the "clincher" in his last paragraph:

> "But why not leave it optional as to whether the strip or plot method is always to be used? The decision can depend upon the value of the stand, the accuracy desired and the likes and dislikes of the 'chief of party'".

Berry directed his remarks to the Regional Forester. As usual, John used rational arguments and was highly in favor of refinements that would give better cruising results, or that could be applied to show the approximate accuracy of the results obtained. He felt plot sampling had merit, but that the method would first have to be tested. Berry felt strongly that "The predetermination of the number of sample plots necessary by the method of varying accuracy suggested in Mr. Kneipp's letter would naturally lead to a purely random plot selection with a loss of dependability of type and topographic maps and other data essential to the appraiser."

A rather curious note appears in the files dated July 2, 1937:

> "Kotok's memorandum of July 2, 1937, under designation 'R-Cal, Publications A. A. Hasel, Arrangement of Cruise Plots, *etc*., and analysis of Sampling Methods, *etc*.' with preliminary mimeographed manuscripts by Hasel were sent to Evans for comment on July 23, 1937.
>
> November 27, 1937, Mr. Evans says these papers were lost in the Field."
>
> C.V.D.W.
> (Division Chief Clerk)

During the decades of the 1930's aerial photos had been used on mapping projects and some experimental work done in using them for type mapping. The Region had begun to realize that the use of aerial photos for resource management could pay big dividends. A meeting was held of all Divisions, including the Experiment Station on December 16, 1938, to appraise their future usefulness to the Region, make plans for future work, and to seek a means to finance the program.

By this time a planimetric map, by use of aerial photos, had been made of the Southern Redwood Purchase Unit and topographic maps of portions of the Stanislaus, Shasta, Klamath, Trinity, and Lassen Forests had been made. Fire Control had some experience with photos for fighting fires. Range Management had made range surveys. Wieslander had done type mapping using photographs obtained from the Soil Conservation Service of an area near Placerville. On the Redwood project, John Berry

had shown that “different types of timber could be distinguished and were projected on pictures in the office, and then checked on the ground”. All Division representatives were enthusiastic about the future of aerial photos in their work.

The result of the meeting was the Region should expand the use of aerial photos and decided on a standard scale for all pictures at 1:20,000. The affected Divisions would provide funds from project allotments to expand the Regional program of planimetric mapping and provide photos for resource work. Timber Management was represented at the meeting by Dunston, Berry, and Evans.

Under date of March 24, 1939, R. C. Wilson, Research Forester, sent a paper to the Division entitled, “Hypothetical Case for a Timber Cruise Controlled by Aerial Photograph”. The method proposed was based on having an aerial photo topographic map available and a photo delineation of the forest types. The cruise lines would be determined to give an adequate sample of each of the types and cruise lines confined to the timber type only. A test of the method was to be made on the Foresthill Divide in 1940. The Division files are completely silent on the test cruise of the Wilson proposal. It is interesting to note that R-2 had standardized their timber surveys in 1941 on a method essentially the same as outlined by Wilson which he refers to in his paper.

During the early war years of 1941-42, the timber survey project was not well financed. Funds were very limited even though there were several high-priority jobs needing attention to meet the needs for timber sales, management plans, and land exchanges. The 1943 project was planned so as to utilize Civilian Public Service personnel (Conscientious Objectors) and supplemented with a small amount of survey funds. The primary cruise effort was to come from C. P. S. camps centered at Coleville, Placerville and Northfork. Ten men from each camp were to be trained to do the cruising work. A crew of the Lassen was added later. In general their work checked reasonably well. There were of course many more problems to be dealt with than with free men hired under normal circumstances. Needless to say, Evans was “slightly” bitter after the first season experience. He had been unable to get what he considered adequate production. This experience must have expedited Evans’ plans for retirement. He continued with C. P. S. crews the season of 1944, with no better results, and retired on June 30, 1945.

Harold Coons assumed the Regional timber survey responsibilities with Marc Edwards who had joined the staff in 1944 as an assistant. By the end of 1944 much of the Region had aerial photography, and training meetings had developed many people with expertise in the use of photos. Planimetric maps were being turned out for large areas of the National Forests.

For the 1946 season the timber survey methods were modified to use aerial photo techniques and new planimetric base maps. Hal Coons briefly stated the three important changes in timber surveys in a memorandum to Personnel Management, dated March 19, 1946:

1. Aerial photographs will be used to locate stands of timber, to determine densities and stand structure and to layout the sampling systems. Plot centers, section corners and other features will be located on the photos. This will require that both men will have to be reasonably skilled at aerial photo interpretation, or at least capable of being trained.
2. Valuation and growth information will be collected along with strictly inventory data. Previously, valuation data were collected by a separate survey, and growth data by still another.
3. Sample plots will be used for sampling instead of the continuous strip as in the past. Only between plots will the compassman function as such. Once on the plot, the two men work as a team in measuring and recording tree diameters, heights, log grades, young growth, site classification, *etc*. In some instances, where the timber stand is open, they may work individually, each taking measurements on the trees in a portion of the plot. In other cases, where the stand is dense, one man will obtain tree heights, Dunning's tree classes and "cut or leave", while the other obtains diameters and log grades.

In May, 1946, Coons represented the Region at Harvard Forest, Petersham, Massachusetts on aerial photo interpretation and timber survey techniques to integrate the National Forest Survey Project with Regional timber survey projects. It was a joint effort with Forest Service Research and National Forest Administration. All Experiment Stations and Regions sent representatives.

With this new method of cruising, the design of the cruise to achieve the levels of accuracy desired, the arrangement of sample plots, size and shape of plots, method of tallying, summarizing data and display of the data, all became issues to be standardized. Additional research was needed on some of these phases. The publication issued in October, 1939, titled "Timber Cruising" by James W. Girard and Suren R. Gevorkiantz became the "bible" for much of the work. Evans' Timber Survey Manual was also a standard reference for layout of survey control, chaining and measuring trees, even though strip cruising was little used in the conventional manner as described in Evans' Manual.

Coons left the Regional Office in 1948, and Marc Edmonds took over timber surveys. Most of Edmond's time was spent in developing inventory data for north coast working circles on the Mendocino, Trinity, Klamath and Six Rivers. Much of the area had never been cruised, but did have estimates from old reconnaissance type surveys. Much of this country was still undeveloped and surveys had to be made on foot with pack animals. Edmond's notes in the "Project Report" for the Lower Trinity Working Circle illustrate some of the difficulties encountered as late as 1951:

> "Field work started June 1 and ended September 15, 1951. (Edmonds chief of party and 4 men from U. C. and Iowa State.) Base camp was at Salyer Ranger Station in two house-trailers and a cook tent. The crew arrived June 18 and 21. The base camp was used to July 8 and on weekends and fires thereafter. Part of this Working Circle was hard to get into. The two riding-pack mules kept at Salyer Ranger Station were

used to pack supplies to camps on trails. Bedding and food were backpacked into camps where it was impossible to take mules. Mules were hauled to trail heads by Ranger District assistants. All packing was done by the survey party. A ten-day pack trip schedule of work was used advantageously several times. Fires kept the crew busy from August 15 to 26,when District Ranger Hotelling released them to finish the job before they returned to school." Fourteen pack camps were used during the season. The work was planned to sample 1/10 of 1 percent. This was secured by running strips across the unit at 4-mile intervals, taking 1/5 acre samples at 6-chain intervals. 489 plots were taken, and 47 one-acre permanent sample plots were established.

"The old survey in this Working Circle was largely fraudulent. The deputy surveyors worked along the pioneer pack trails setting corners that could be conveniently reached. Fragmentary surveys made by local surveyors have a distorted pattern which is very confusing. T4N, R5E, and T5N, R5E, are office survey jobs. No authentic interior corners have ever been found. Rough surveys have been carried in from the nearest known corners in adjoining townships to locate the homesteads and timber patents."

The 1951 season project covered 151,000 acres of which 123,000 acres was classed as productive forest land. The project cost was $5,129.

On May 1, 1952 Edmonds submitted the Management Plan for the Lower Trinity Working Circle that was approved in March, 1953 by Wm. F. Fischer, Forest Supervisor, and B. H. Payne, Assistant Regional Forester. During the balance of Edmund's career he continued this same kind of work, year after year until his retirement in 1961. Frank Oyung followed Edmunds and has been responsible for Timber Inventory Methods and Procedures.

The files do not document exactly when the transition of timber surveys from a Regional project basis to when the work became a responsibility of each National Forest. It is known to have been a gradual transition. The trend toward local cruising on Forests for timber sales began in the Sierra Nevada during the 1940s. By the time the timber sale business in the north coast portion of the Region began to build up in the middle 1950's, cruising needs for timber sales were being done by timber sale personnel on all Ranger Districts.

Variable Plot Cruising and 3P Cruising

In 1960,W. R. Howden introduced variable plot cruising in a paper dated March, 1960. This method was said to be particularly useful for patch cutting of old-growth Doublas-fir and white fir timber sales. Also it was recommended for reconnaissance cruises to obtain "rough" estimates of timber volumes. The wedge prism was the recommended instrument for the tree tally. His opening paragraphs partially explain the

reasons why the variable plots cruising method is an improvement in accuracy because a higher percentage of the larger trees is sampled:

> " The variable plot method cruising versus the fixed plot method. Before we can take off into the stratosphere we need a launching platform – a point of reference. It also seems to me that the relatively new subject of prism cruising should be first introduced by comparing it with a method with which we are all familiar – the fixed plot method.
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> "For years mensuration texts have instructed students in sampling procedures whereby all trees occurring on strips of constant width, or plots of constant dimension, were counted, measured, and recorded. Division by acres of tally converted this information to a per acre basis. The per-acre figure was then multiplied by the number of acres in the tract to obtain an estimated total volume. In forest stands where trees of widely varying diameters were intermingled, foresters soon recognized that more time was being spent on small trees than on larger trees containing the greatest values. Also, greater sampling accuracy was being obtained for the less important portions of the stand than for the more important size classes. Recognition of these facts led to a modification in cruise design in which two or more plot sizes were employed. As an example, recording seedlings and saplings on plots of 1/1000 acres, poles on 1/25 acres, small sawlogs on 1/5 acres, and larger sawtimber on 2/5 acres. This modification more closely apportioned cruising effort to information values. The variation in plot radius succeeds in applying a much higher percentage of cruise to the larger, more important trees."

This same principle of cruising is now applied to lump sum sales of second-growth timber. Variable plot cruising (prism cruising) as initially described by Howden is still in use in some locations for old-growth timber cruising for sales where patch cutting is the prescribed silvicultural treatment.

The 3P sampling techniques (sampling with probability proportional to prediction) was initially developed by Lew Grosenbaugh . 3P sampling for regular old-growth timber sales was analyzed where pines are a major component of the stand to be cut, and trees are large with high values. Because of problems with log grading and estimating tree volume (d.b.h.), Will Charter and Frank Oyung recommended against the use of 3P cruising methods for old-growth pine. Their arguments are contained in a memorandum to the files dated June 4, 1968.