Compiled by:
Resources Evaluation Techniques Program
USDA Forest Service
Rocky Mountain Forest and Range Experiment Station
240 West Prospect Street
Fort Collins, Colorado 80526

Resources Evaluation Newsletter

• Classification • Remote Sensing • Inventory • Analysis •

Distribution list maintained by:
Division of Resource Inventory Systems
USDI Bureau of Land Management (D-460)
Building 50, Denver Federal Center
Denver, Colorado 80225

REN 9 July 1981

Technical Article 1

TESTING FOR NORMALITY

by
Gary W. Fowler[1]

ABSTRACT

Various descriptive and statistical methods for examining the assumption of a normal distribution are presented and applied to a random sample from a population with a known normal distribution. The problem of which methods to use is discussed.

INTRODUCTION

To make inferences about populations, the natural resource sampler uses a variety of statistical procedures that assume the underlying random variable(s) is normally distributed. The sampler should find out how closely this assumption is met before he uses such procedures.

The objectives of this paper are to (1) present various descriptive and statistical methods used in testing for normality, (2) apply these methods to a random sample from a population with a known normal distribution, and (3) discuss the problem of which methods to use.

THE DATA SET

Fifty observations were randomly selected from a population having a normal distribution with mean $\mu = 50$ and variance $\sigma^2 = 100$ using a computer-based normal distribution generator (table 1). The sample mean $\bar{x}$ and variance s^2 for this sample are 49.63 and 136.3441, respectively. Standardized values $(Z_i = (x_i - \bar{x})/s)$ were calculated for these 50 observations and ordered from smallest to largest (table 2). These results will be used in applying the methods presented below.

Table 1: Fifty observations from a N(50, 100) distribution.

i	x_i	i	x_i	i	x_i	i	x_i	i	x_i
1	39.42	11	68.75	21	49.93	31	59.37	41	34.13
2	60.38	12	48.81	22	48.73	32	57.23	42	45.25
3	55.93	13	52.57	23	56.73	33	38.05	43	63.96
4	51.46	14	52.43	24	43.61	34	46.35	44	45.90
5	30.80	15	34.49	25	40.14	35	58.78	45	69.15
6	36.32	16	42.37	26	50.80	36	52.27	46	47.31
7	67.97	17	53.34	27	43.09	37	43.84	47	60.70
8	52.21	18	45.36	28	63.25	38	32.10	48	40.64
9	58.69	19	24.10	29	49.12	39	69.34	49	27.37
10	37.77	20	41.30	30	51.30	40	65.67	50	73.16

Table 2. Ordered standardized values Z_i for the example with n=50 observations.

i	Z_i	i	Z_i	i	Z_i	i	Z_i	i	Z_i
1	-2.19	11	-0.81	21	-0.28	31	0.23	41	0.92
2	-1.91	12	-0.77	22	-0.20	32	0.24	42	0.95
3	-1.61	13	-0.71	23	-0.08	33	0.25	43	1.17
4	-1.50	14	-0.62	24	-0.07	34	0.32	44	1.23
5	-1.33	15	-0.56	25	-0.04	35	0.54	45	1.37
6	-1.30	16	-0.52	26	0.03	36	0.61	46	1.57
7	-1.14	17	-0.50	27	0.10	37	0.65	47	1.64
8	-0.02	18	-0.38	28	0.14	38	0.77	48	1.67
9	-0.99	19	-0.37	29	0.16	39	0.78	49	1.69
10	-0.87	20	-0.32	30	0.22	40	0.83	50	2.01

[1]Professor of Biometrics, School of Natural Resources, The University of Michigan, Ann Arbor, MI 48109.

DESCRIPTIVE METHODS

Descriptive methods for testing normality include (1) the histogram plot, (2) comparison of observed sample and expected normal probabilities, (3) the normal plot, and (4) examination of skewness and kurtosis coefficients.

The Histogram Plot

A histogram plot shows the frequencies associated with various classes of Z_i. The 50 Z_i's from our example (table 2) were grouped into 6 successive classes of unit width (fig. 1). The sampler should be aware that the shape of the histogram plot can be affected by the choice of class width, and that kurtosis is not as clearly shown as skewness.

Comparison of Observed Sample and Expected Normal Probabilities

Observed probabilities calculated from the empirical standardized distribution based on the sample data ($F_n(Z)$) can be compared with expected probabilities of the standard normal distribution ($F_o(Z)$). $P(|Z| \leq Z^*)$ was compared for $F_o(Z)$ and $F_n(Z)$ for various values of Z^* (table 3). Z^* is an upper critical value of $F_o(Z)$. For example, the probability that Z is between -1 and +1 is 0.682 and 0.680 for $F_o(Z)$ and $F_n(Z)$, respectively.

Table 3. $P(|Z| \leq Z^*)$ for $F_o(Z)$ and $F_n(Z)$ for various values of Z^*.

Z^*	$P(\|Z\| \leq Z^*)$	
	$F_o(Z)$	$F_n(Z)$
0.5	0.383	0.360
1.0	0.682	0.680
1.5	0.866	0.840
2.0	0.955	0.960
2.5	0.982	1.000
3.0	0.998	1.000

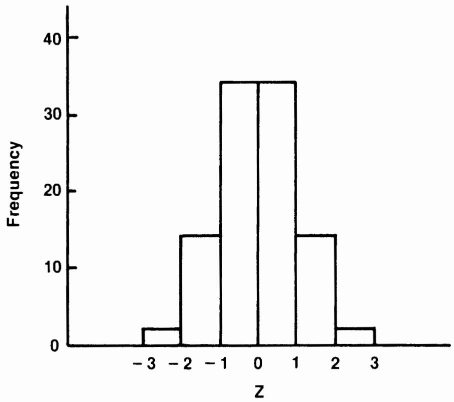

Figure 1.--Histogram plot of the standardized values Z_i for the example with n-50 observations.

The Normal Plot

A normal plot (Daniel and Wood 1971) of the standardized sample values is obtained by ordering the standardized values Z_i from smallest to largest, and plotting these ordered values (d_i) on a vertical ordinary arithmetic scale against the cumulative percentages $P_i = [(i - 1/2)/n]100$ ($i = 1, \ldots, n$) on a horizontal normal probability scale. The standard normal distribution is represented by a straight line on such a graph, and the sample standardized values based on observations from a normal distribution should not deviate too drastically from this line. The 50 points (d_i, P_i, $i = 1, \ldots, 50$) from our example show little deviation from the standard normal line (fig. 2). The d_i's are the Z_i's from table 2. The cumulative distribution function of the sample Z_i's for various values of Z (e.g., -4, -3, ..., 4) could be plotted instead of the points (d_i, P_i) in figure 2 (Neter and Wasserman 1974).

Examination of Skewness and Kurtosis Coefficients

The sample skewness ($\hat{\gamma}_1$) and kurtosis ($\hat{\gamma}_2$) coefficients (Snedecor and Cochran 1968) for our example are:

$$\hat{\gamma}_1 = [\sum_{i=1}^{50} (x_i - \bar{x})^3/50]/s^3 = 0.034$$

and

$$\hat{\gamma}_2 = [\sum_{i=1}^{50} (x_i - \bar{x})^4/50]/s^4 - 3 = -0.501$$

where $s = \sqrt{\sum_{i=1}^{50} (x_i - \bar{x})^2/50}$. γ_1 and γ_2 are both zero for a normal distribution. The absolute values of $\hat{\gamma}_1$ and $\hat{\gamma}_2$ should be less than 1 if the assumption of normality is not drastically violated. The larger the sample size the closer these values should be to zero.

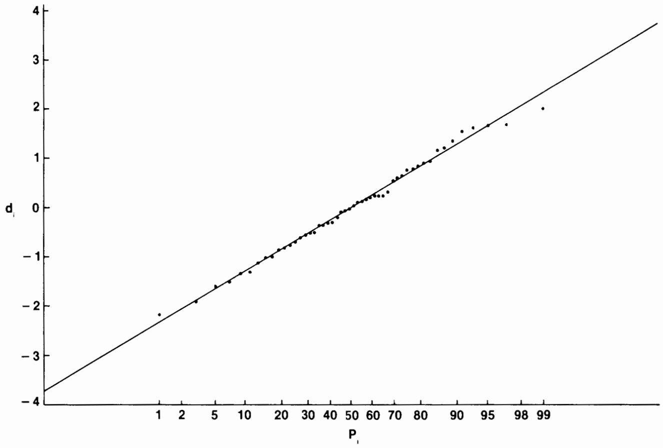

Figure 2.--Normal plot of the ordered standardized values from the sample of 50 observations. d_i is the ith ordered standardized value, and $P_i=((i-1/2)/n)100$.

STATISTICAL METHODS

Statistical methods used in testing for normality include testing for skewness and kurtosis under normality and the following goodness-of-fit tests: (1) χ^2 test, (2) Kolmogorov test, (3) Lilliefors test, and (4) Shapiro-Wilk test.

Testing for Skewness and Kurtosis Under Normality

To test for skewness under normality (Snedecor and Cochran 1968), the null hypothesis $H_o{:}\gamma_1 = 0$ is tested against the alternative hypothesis $H_1{:}\gamma_1 \neq 0$. For our example, $\gamma_1 = 0.034$ is compared to the lower (-0.534) and upper (0.543) critical values of γ_1 under H_o for $\alpha = 0.10$. To test for kurtosis under normality (Snedecor and Cochran 1968), $H_o{:}\gamma_2 = 0$ is tested against $H_1{:}\gamma_2 \neq 0$. For our example, $\gamma_2 = -0.501$ is compared to the lower (-0.85) and upper (0.99) critical values of the distribution of γ_2 under H_o for $\alpha = 0.10$. H_o is accepted in each case. Critical values for both of these tests can be found in Pearson and Hartley (1954) and Snedecor and Cochran (1968).

The χ^2 Test

The χ^2 test for normality tests $H_o{:}F(X)$ is normal against $H_1{:}F(X)$ is not normal. Since μ and σ^2 are usually unknown, they must be estimated from sample data. For our example with $n = 50$, $\bar{x} = 49.63$ and $s^2 = 136.3441$. Using a standard normal table (Conover 1980), J successive finite intervals of Z are created such that the probability of Z being in any interval is 1/J. For example, if J = 10, the first interval is $(-\infty, -1.28)$ with $P(-\infty{<}Z{\leq}-1.28) = 0.10$. The observed frequencies O_i for the ith interval (i=1, ..., J) are determined by the number of the n standardized sample values Z_i falling into each interval of Z. The expected frequencies $E_i = (1/J)n$ based on the standard normal distribution are compared with the O_i's.

For our example, J was chosen as 10 so that the standardized normal scale Z could be subdivided into 10 successive finite intervals with $E_i = (1/J)n = 5$ for each interval. J should be chosen so that no E_i is less than 5 in order to obtain an adequate χ^2 approximation. The O_i's, determined with the use of table 2, show, in general, relatively little variation from the E_i's (table 4).

Table 4. Observed (O_i) and expected (E_i) frequencies for the example with n=50 observations.

i	1	2	3	4	5	6	7	8	9	10
O_i	6	4	5	6	4	8	1	6	4	6
E_i	5	5	5	5	5	5	5	5	5	5

The test for our example is

$$\chi^2_7 = \sum_{i=1}^{10} (O_i - E_i)^2/E_i = 6.4.$$

Note that we lose a total of 3 degrees of freedom because both μ and σ^2 were estimated from sample data. Since $\chi^2_7 = 6.4$ is considerably less than the critical value $\chi^2_{0.95,7} = 14.067$, we accept H_o (P   0.50). If μ and σ^2 were not estimated from sample data, we would lose only 1 degree of freedom in the χ^2 statistic.

The Kolmogorov Test

The Kolmogorov test (Kolmogorov 1933, Conover 1980) for normality tests $H_o{:}F(X)$ is normal against $H_1{:}F(X)$ is not normal. It assumes the parameters μ and σ^2 are known and not estimated from sample data. If the parameters are estimated, the test is conservative. The test statistic is

$$D_n = \text{Max.}\left|F_o(X) - F_n(X)\right|$$

where D_n is the largest absolute vertical difference between the hypothesized normal cumulative distribution function $F_o(X)$ and the empirical cumulative distribution function $F_n(X)$. $F_o(X)$ is constructed with the aid of standard normal probabilities and the standard normal transformation $Z = (X - \mu)/\sigma$. $F_n(X)$ is constructed by ordering the sample values x_i from smallest to largest and plotting the ith ordered value versus $F_n(X) = i/n$. The easiest way to obtain D_n is to graph the two c.d.f.'s.

For our example, assuming μ and σ^2 known and equal to 50 and 100, respectively, $D_{50} = 0.071$ at $x_i = 43.84$ (fig. 3) is considerably less than the two-sided critical value $D_{.05,50} = 0.192$ (table A14, Conover 1980), so we accept H_o ($P > 0.20$). A

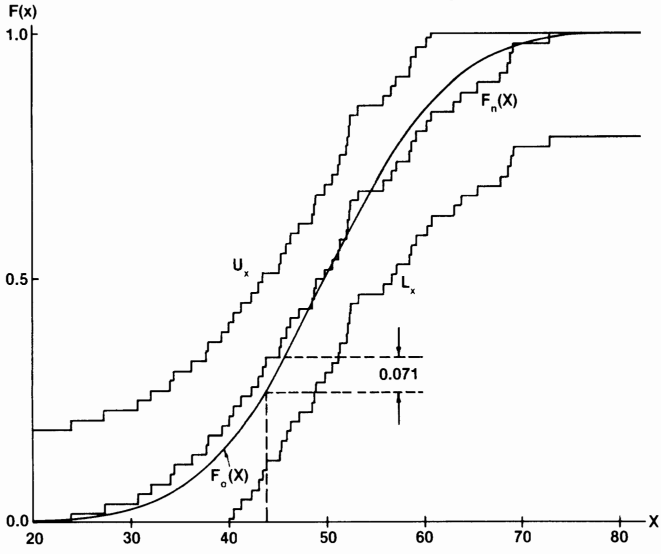

Figure 3.--$F_o(X)$, $F_n(X)$, and D_n for the example with n = 50 observations. U_X and L_X are the upper and lower bounds of the 95% confidence band for F(X).

95% confidence band for $F(X)$ is $F_n(X) \pm D_{.05,50}$ and contains $F_o(X)$ completely within its boundaries (fig. 3), indicating strong agreement between $F_o(X)$ and $F(X)$, the unknown population c.d.f. from which $F_n(X)$ is obtained (Conover 1980).

The Lilliefors Test

The Lilliefors test (Lilliefors 1967, Conover 1980) is a modification of the Kolmogorov test for testing normality when μ and σ^2 are estimated from sample data. The critical values of the test statistic are not exact but have been accurately estimated using computer simulation procedures. H_o:F(X) is normal is tested against H_1:F(X) is not normal using the test statistic

$$L_n = \text{Max.}\left|F_o(Z) - F_n(Z)\right|$$

L_n is similar to the Kolmogorov test statistic D_n except that the standard normal distribution $F_o(Z)$ is compared with the empirical standardized distribution $F_n(Z)$ based on $\bar{x}$ and s^2 from the sample data. L_n is the largest vertical difference between $F_o(Z)$ and $F_n(Z)$. $F_o(Z)$ is constructed with the aid of standard normal probabilities. $F_n(Z)$ is constructed by ordering the sample standardized values Z_i from smallest to largest and plotting the ith ordered value versus $F_n(Z) = i/n$.

For our example, with $\bar{x} = 49.63$ and $s^2 = 136.3441$, $L_{50} = 0.061$ at $Z_i = 0.25$ (fig. 4) is considerably less than the critical value $L_{.05,50} = 0.125$ (table A15, Conover 1980), so we accept H_o ($P > 0.20$).

The Shapiro-Wilk Test

The Shapiro-Wilk test for normality (Shapiro and Wilk 1965, 1968, Conover 1980) tests H_o:F(X) is normal versus H_1:F(X) is not normal using the test statistic

$$W = \frac{1}{D}\left[\sum_{i=1}^{k} a_i\left(y^{(n-i+1)} - y^{(i)}\right)\right]^2$$

where $D = \sum_{i=1}^{n}(x_i - \bar{x})^2$, $k \approx n/2$, $a_1, a_2, \ldots, a_k$ are coefficients from table A17 (Conover 1980), and $y^{(1)}, y^{(2)}, \ldots y^{(n)}$ are the ordered values (from smallest to largest) of $x_1, x_2, \ldots, x_n$. For our example, $W = 0.9786$ is considerably larger than $W_{0.05} = 0.947$ (table A18, Conover 1980), so we accept H_o ($P \approx 0.66$, table A19, Conover 1980). Notice that the rejection region for this test is in the lower tail of the distribution of W. This test is sometimes called the W test.

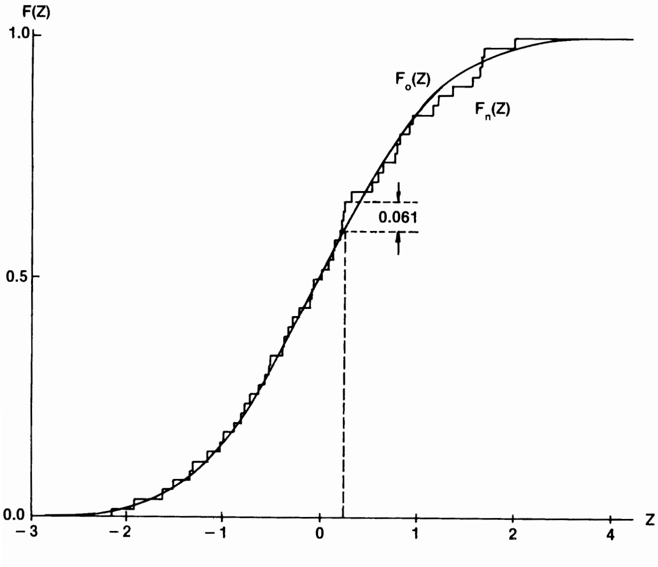

Figure 4.--$F_o(Z)$, $F_n(Z)$, and L_n for the example with n = 50 observations.

DISCUSSION

All descriptive and statistical procedures indicate that the sample of 50 observations comes from a population with a distribution not too different from the normal distribution. This should be the case since the sample was from a normal distribution!

It is not feasible for the natural resource sampler to use all of the procedures covered in this paper to test for normality. The descriptive procedures are subjective at best, only useful in detecting large departures from normality, and of limited use for small sample sizes. I consider the normal plot and the skewness and kurtosis coefficients to be the best descriptive procedures because they are somewhat more objective and probably give a clearer picture of closeness to normality. I consider the Lilliefors and Shapiro-Wilk tests to be the best statistical procedures because they are probably the most powerful procedures when m and s^2 must be estimated from sample data. When μ and σ^2 are known, the Kolmogorov test is also a powerful procedure. A combination of one or two descriptive procedures and one or two statistical procedures seems optimal.

The sampler must, of course, make the final decision as to which methods to use in a given situation. Whichever methods are used, the sampler will never be able to say that the unknown distribution is normal. However, he or she will be able to say that the normal distribution does not seem to be an unreasonable approximation to the true unknown distribution and, hence, justify the use of normal-based statistical procedures.

LITERATURE CITED

Conover, W. J. 1980. Practical nonparametric statistics. John Wiley and Sons, Inc. New York.

Daniel, C., and F. S. Wood. 1971. Fitting equations to data. John Wiley and Sons, Inc. New York.

Kolmogorov, A. N. 1933. Sulla determinazione empirica di una legge di distribuzione. Geornale dell' Instituto Italiano degli Attuari 4:83-91.

Lilliefors, H. W. 1967. On the Kolmogorov-Smirnov test for normality with mean and variance unknown. Journal of the American Statistical Association 62:399-402.

Neter, J., and W. Wasserman. 1974. Applied linear statistical models. Richard D. Irwin, Inc., Homewood, Ill.

Pearson, E. S., and H. O. Hartley. 1954. Biometrika tables for statisticians. Vol. I. The University Press, Cambridge, England.

Shapiro, S. S., and M. B. Wilk. 1965. An analysis of variance test for normality (complete samples). Biometrika 52:591-611.

Shapiro, S. S., and M. B. Wilk. 1968. Approximations for the null distribution of the W statistic. Technometrics 10:861-866.

Snedecor, G. W., and W. G. Cochran. 1968. Statistical methods. The Iowa State University Press, Ames, Iowa.

* * * * *

Technical Article 2

CONSIDERATIONS IN USING METRIC MEASUREMENTS UNITS FOR TIMBER INVENTORIES

by
Wallace J. Greentree[1] and Vernon J. LaBau[2]

ABSTRACT

Crews used metric units of measurement in a timber inventory. Measuring equipment calibrated in metric units was purchased and used in place of similar equipment calibrated in U. S. standard units. The steel retractable 15-m tape was used for all distance measurements made from the center of the plot. The 30-m reinforced fiberglass tape was used for measuring distances between plots, and for measuring the BAF sample and tree heights, a narrow-scale metric Spiegel Relaskop was used. A photo scale-protractor was used for distance measurements in metric units on aerial photographs ranging in scales from 1:20,000 to 1:28,000.

Several metric measurements of trees yielded numbers familiar to timber cruisers who were experienced in using U. S. standard units. For example, a metric 9BAF gave essentially the same tree count as a U. S. standard 40BAF. Likewise, a 5-m (16.3-foot) log length is close to the standard 16.4-foot log. For log grading and cull estimation, a 1.25-m bolt approximates 4 feet. Cubic volume measurements were based on a 10-cm top in place of 4 inches, and a sawlog top was 15 cm instead of 6 inches. A 30-cm stump height approximates 1 foot.

Crews measured d.b.h. at the metric standard point of 1.3 m and at the U. S. standard 4.5 feet (1.37 m). A paired analysis of the two points showed a significant difference, prompting development of a prediction equation for calculating wood volume at 1.37 m when measurement is made at 1.3 m. Use of 5-cm classes with even integers simplifies keeping track of site trees and growth sample trees. Crews used a minimum diameter of 10 cm (3.94 inches) for tallying growing stock trees. Distance between points on a 10-point cluster plot was 25 m. One acre was converted to .4 h and fixed plot size to 1/740 h with a plot radius of 2.07 m.

INTRODUCTION

Metric measurements during the summer of 1979 were used for a multiresource inventory project in Grand County, Colorado, by personnel from the Resource Evaluation Techniques (RET) Research and Development Program[3], the Renewable Resource Evaluation Unit (RREU) Ogden, Utah, and the Colorado State Forest Service. During the two year effort, about 60 people from the three units were exposed to metric measurements. This paper is a report on the timber portion of the inventory only. The decision to change to metric was made in order to work with a universal system of measurements. It was hoped that a basis for recommending metric measurements in nationwide inventories would result from this experience. The paper points out some of the problem areas of changing to metric measurement in timber inventories.

METHODS AND DISCUSSION

All timber-related measurements required by the Intermountain RREU Handbook were changed to metric measurement units and metric tools were purchased or developed for making these measurements.

Metric Equipment

Equipment calibrated in metric units was used in much the same manner as equipment calibrated in U. S. standard units. The steel 15-m tape mounted on retractable spools with a nail attached to the end of the tape enabled one person to make all distance measurements on both the variable plots and fixed-plots. The 30-m tape and the 50-m tape were used for measuring long distances between plots. Field experience indicated that a distance of about 30 m is a maximum workable distance for

[1]Forestry Technician, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo., in cooperation with Colorado State University.

[2]Research Forester, Pacific Northwest Forest and Range Experiment Station, Anchorage, Alaska.

[3]USDA Forest Service, Rocky Mountain Forest and Range Experiment Station Fort Collins, Colo.

line-of-sight measurements in moderately dense understory conditions. Use of the 50-m tape in open country required fewer set-ups between plots. Both of the longer tapes are made from reinforced fiberglass. A ruler graduated to 1/20 cm was used to measure increment core length for 10-year radial growth measurements. A 2-m steel retractable tape for measuring seedling height worked well.

For measuring the basal area factor (BAF) and tree heights, we chose the narrow-scale metric Spiegel Relaskop[4]. This instrument is slope-correctable and has three, easy-to-use height scales (20, 25 and 30 m). This model does not have a directly readable, 9 BAF ($9 m^2$ per h) sample target; however, a very good approximation was possible.

Borderline trees could be accurately called "in" or "out" with the help of limiting distance tables. Metric prisms could have been used for the BAF sample, but the convenience and accuracy of sampling borderline trees on a slope is improved using the Relaskop. The slope correction is built into the Relaskop whereas, the prism must be used in conjunction with a separate instrument, such as a metric clinometer.

The wide-scale metric Spiegel Relaskop could also be used. It contains a directly readable 9-BAF sampling target and is slope correctable. For heights, it has nine, even number tangent bar scales that are usable at distances ranging from 4 m to 20 m from the tree.

A limiting distance factor was calculated for the 9 BAF (table 1), and a table of limiting distances was developed for use in the field to determine if borderline trees are in or out of the variable sample plot.

A metric aerial photo scale-protractor aid was not available from commercial sources, so one was developed. The aid contains 17 photo scales ranging from 1:20,000 to 1:28,000 at intervals of 500. Photo distances are measured in units of meters and decameters for any of the 17 scales. The aid includes a 0-360 degree compass rose for measuring photo azimuth.

Measurement Changes

Metric tree measurements of BAF and log volume factors were compatible to U. S. standard measurements. A metric BAF of $9 m^2$ of basal area per h is equivalent to a U. S. standard BAF of 39.2 square feet per acre. Using a metric 9 BAF, the sample tree count per point remained essentially the same as for the U. S. standard 40 BAF, which had been the inventory standard for the Rocky Mountain area. The two BAF's should not be used interchangeably though, because the resultant basal area would be biased by about 2%.

Traditionally, logs in the United States are measured in lengths of 16.3 or 32.6 feet to accommodate 16-foot lumber. A 5-m log is 16.4 feet long, a minimal difference from the 16.3-foot standard. Likewise, in the United States logs are evaluated in 4-foot panel lengths for log grading and cull estimation. Thus, a 1.25-m length. Cubic meter volumes were measured to a 10-cm (3.9-inch) top approximating the 4-inch top, and sawlog volumes to a 15-cm (5.9-inch) top for the standard 6 inch top. All volume measurements started from a 30-cm (11.8-inch) stump, essentially a 1-foot stump.

Another concern involved making the estimation more acceptable to traditional users of field information by recording a special board-foot cull variable. This allowed a "squaring out" of defect in rotten or damaged trees so that a conversion from cubic meters to board feet may be made when needed.

Forest measurements such as tree diameter, diameter classes, minimum diameter of growing stock trees, and plot design are measured using different bases in the metric and U. S. standard; thus, conversions of these measurements had to be related to the differences in measurement procedure between the two systems. U. S. foresters measure trees at 4.5 feet (1.37 m) above the ground. The international standard (except in New Zealand) is 1.3 m, 2.8 inches below the U. S. d.b.h. point. In order to evaluate the possible effects of this change on the application of existing volume table formulae, diameter measurements were taken at both points (1.3- and 1.37-m). A paired diameter analysis test of this data showed a significant difference. From this data, a prediction equation has been developed for deriving U. S. volume at 4.5 feet when d.b.h. is measured at the metric standard of 1.3 m.

It appeared that grouping tree diameter classes into cm groups would be simple because 5 cm closely approximates 2 inches. However, a closer look presented problems. For instance, the 10-inch diameter class (9.0 through 10.99 inches) converts to 22.86 through 27.91 cm--awkward numbers to work with. Likewise, a 5-cm diameter class centered on multiples of 5-cm (e.g. 25-cm diameter class ranging from 22.50 cm through 27.49 cm) would be confusing to workers in the field. Therefore, 5-cm classes based on integer endpoints were used: the 27.5-cm class ranges from 25 cm to 30 cm.

If the U. S. standard minimum diameter of 5-inches is used, with 5-cm diameter classes, the first class is unbalanced with those following. Therefore, we changed the lower metric diameter limit to 10 cm (3.94 inches). In some instances, where utilization is intense, considerations should be given to measuring diameter down to 2.5 cm (1 inch).

---

[4]The use of trade and company names is for the benefit of the reader. Such use does not constitute an official endorsement or approval of any service or product by the U. S. Department of Agriculture to the exclusion of others that may be suitable.

Table 1. Prism strengths, Basal Area Factors, (BAF) and corresponding limiting distance factors for point sampling

Prism strength		Basal area factor		Limiting distance factor
(K)[3]	(Θ)[4]	(M)[1]	(F)[2]	(LDF)[5]
Diopter	Minutes	m^2/h	Square feet per acre	M/cm d.b.h.
1	34.378	0.250	1.089	1.000
2	68.756	1.000	4.356	0.500
3	103.113	2.249	9.797	0.333
4	137.485	3.998	17.416	0.250
5	171.850	6.246	27.208	0.200
6	206.204	[6]8.992	39.170	0.167
7	240.544	12.235	53.297	0.143
8	274.869	15.974	69.584	0.125
9	309.188	20.209	88.032	0.111
10	343.491	24.938	108.632	0.100

1/From Table 93 - (Wilson and Robbins, 1969)

2/Square feet per acre = 4.3561 X M

3/$K = 2\sqrt{M} = 2\sqrt{BAF}$

4/Θ = critical angle = [Arctan $\sqrt{-M/M-100}$] [2(180)(60)/Π] where the value of the first bracket is its radian measure.

5/$LDF = \sqrt{1/4\ m} = \sqrt{1/4\ BAF}$

6/Rounded the 8.992 to 9.0 for the Grand County study.

A 10-point cluster plot design, similar to that used by RREU's throughout the United States, was used by RET field crews for the 1978 field work. A choice was made to use a 20-m (65.6 feet) distance between the points. Experience by RREU suggests that in the Western United States, one chain (66 feet) does not allow enough independence between the cluster points, resulting in some trees being measured more than once in the cluster. Although no volume bias exists here, within cluster variance estimates are affected. Therefore, the decision was made to establish the points 25 m (82 feet) apart. The same 10-point cluster design was used successfully by the Colorado State Forest Service personnel for the 1979 field work. The RET field crews used a ricochet method for establishing 10 points within a homogeneous vegetation polygon in 1979. The problem of independence between plots did not occur using the ricochet because distances between points varied from 35-m to 160-m.

In practice, it may be worth considering sampling metric variable areas that are easily expanded, such as half hectare areas when using the 10-point cluster plot. A 10-point sample on a 22-m equidistant interpoint grid would approximate .5h using a metric 9 BAF angle gauge sample. It is important to remember that area sample size and intrapoint independence changes with change in BAF.

Plot size was assigned an area of .4 h to coincide with current RREU plots based on 1 acre. Fixed area reproduction plots (1/300-acre) were reassigned an area of 1/170 h, using the same plot radius (6.8 feet) measured as 2.07 m. From a field operation standpoint, the 2.07-m plot radius was easy to work with.

When using straight conversions, care must be taken in applying blowup factors so that accurate estimates will be maintained. For example, one computer program modification that had to be made was related to use of straight area conversions for fixed plots, while reducing the minimum volume tree size tallied from 5 inches to 10 cm (3.94 inches). The 2.07-m radius had been used by RREU's because that was the limiting distance of a 5-inch tree. Stocking computations were made using different formulae for the fixed and variable plots, but the formulae came into coincidence relative to 5-inch trees.

Table 2. Metric equipment per crew, used for Grand County survey, with costs based on 1981 prices from major forestry suppliers.

Equipment	Uses	Cost with Relaskop	Cost without Relaskop
Spiegel Relaskop (narrow scale)	Basal area Slope corrections Slope percent Tree heights	$600.00	—
Prism (BAF #9)	Basal area	—	$20.00
Clinometer (15 and 20 meter scales)	Tree heights Slope percent	— —	44.00
50-meter tape (fiberglass)	Distance to plots Plot distances	25.00	25.00
30-meter tape (non-metallic)	Plot distances	49.00	49.00
15-meter logger's tape (steel)	Fixed plot radius Distance from trees	30.00	30.00
7½-meter diameter tape (steel)	D.b.h.	45.00	45.00
15-cm scale (6 inches) (transparent plastic)	10-year annual growth	.50	.50
Photo scale-protractor (transparent plastic)	Aerial photo azimuth, distances and plot size	2.00	2.00
TOTALS		$751.50	$215.50

In changing the definition of minimum volume growing stock trees to 10 cm, but holding to a 2.07-m radius plot, it was necessary to reduce the stocking equations for the seedlings and saplings (under 10 cm) proportional to the relationship of the two plot areas. This had no effect on volume, because the volumes were related only to variable plot tally. In making a true metric conversion the better approach would be to change the smaller fixed plot size.

Cost of Changing to Metric Measurements

Direct costs for this study were in converting the timber manual, purchasing metric equipment, and computer software programs. The cost of rewriting the timber manual using metric measurement units was about $2,000. Metric equipment costs will vary according to type of equipment purchased. For example, the cost of equipment for one crew using a Relaskop, 50-m, 30-m, and 15-m tapes, and diameter tape would be about $700 based on 1981 prices (Table 2). The costs with the relaskop replaced by a prism and clinometer would be about $200. If one is planning to change to metric tools, the costs may be deferred to equipment replacement.

The USDA Forest Service Rocky Mountain Forest and Range Experiment Station staff developed a metric computer routine for converting volume and area tables via the FINSYS (LaBau and Brink 1979). The conversion was done for the 1980 National Timber Assessment with very little effort or cost. The program is currently being maintained by the RET Program at the Rocky Mountain Station, Fort Collins, Colorado as part of the FINSYS (Barnard 1978) Table/Output Subsystem. An input system to convert metric to U. S. Standard for internal processing could easily be added to FINSYS.

Programs using conversions to either number system will run less efficiently than those written with complete metric units throughout. However, it will probably be some time before metric measurement units will be accepted in place of board and cubic feet volume figures. Some conversions between the two systems will likely have to be maintained for some time in any compilation program.

Indirect costs would be associated with remeasurement of permanent plots in the forest survey system. An example is how the tally is affected by changing the point of measuring d.b.h. Some trees that are observed with an angle gauge as nontally trees will be observed as tally trees if the point of tree measurement is lowered 7-cm. These trees might erroneously be recorded by field recorders as ongrowth trees. Likewise, forked trees forking between 1.3 and 1.37 m will create problems. Where two trees were recorded using the 1.37-m (4.5-foot) measurement points, only one tree would be recorded using the 1.3-m measurement point.

Remeasurement problems of this sort require a double accounting system be set up for at least one remeasurement cycle and that field crews be alerted to record these situations in an accountable manner. Also, conversions to either system might be desirable within the compilation program for one remeasurement cycle. It may be that some historic remeasurement situations may require use of such conversions for more than one cycle.

Obviously, the use of double accounting in the field and of conversions in computer programs is troublesome and adds to inventory costs, but our experience in Grand County using double accounting of d.b.h. measurements and of special variables to measure board foot information indicated that such problems were not very hard to overcome.

Another indirect cost is that of training people who have always used the U. S. Standard system and now want to use the metric system. This cost is nominal, and both permanent staff and seasonal personnel employed both summers quickly learned to use the metric system.

SUMMARY

Our experience in Grand County showed that the change to metric units of measurement can be done quickly and inexpensively and can provide easy-to-work-with numbers based on the powers of ten.

LITERATURE CITED

Barnard, Joseph E. 1978. FINSYS--A tool for the processing of integrated resource inventory data. p. 332-335. In Proc. Workshop on Integrated Inventories of Renewable Natural Resources. USDA Forest Service General Technical Report RM-55.

LaBau, V. J. and G. E. Brink. 1979. Use of FINSYS in developing and accessing the timber and wildlife data bases for the 1980 assessment. p. 449-505. In Proc. Workshop on Forest Resource Inventories. Vol. 1. Colorado State University, Fort Collins.

* * * * *

THE NATIONAL RESOURCE ANALYSIS TECHNIQUES PROJECT

The March 1981 issue of this newsletter reported on the status of the National Resource Inventory Techniques Project. The National Resource Analysis Techniques Project is another one of the four companion projects within the Resource Evaluation Techniques (RET) Research and Development Program, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. The mission of the National Analysis Project is to develop new and improved techniques for national, regional, and state analyses of all forest and rangeland renewable resources as a basis for renewable resource assessments, appraisals, resource program development and delivery, and land management planning. The Project Leader is Thomas W. Hoekstra.

The National Analysis Project, chartered in July 1979, has five assigned problem areas. These include: integrated resource analysis; timber supply analysis; range supply/demand analysis; wildlife and fish assessment analyses; and information needs assessments. Activities of the project have centered on synthesizing the state-of-the-art and defining the research needs for the five problem areas. The central focus of the project research is on integrated resource analysis research for land and resource management planning. A problem analysis submitted for approval defines research needed to support multilevel, integrated resource planning assessments. In addition, a paper on multidisciplinary (ecological, economic, social) integrated resource analysis techniques has been written and will be published as one of a series of state-of-the-art papers as a General Technical Report, Rocky Mountain Forest and Range Experiment Station. The publication date for the series is expected to be late 1981.

The project is cooperating with other research projects within the Forest Service in defining the research needs related to timber supply analysis techniques. A problem analysis and state-of-the-art paper on timber supply techniques has also been written for the series mentioned above. The approach to this problem is from the perspective of the integrated analysis, hence joint resource production output/joint resource production costs are of interest, rather than functional resource outputs and costs.

Range analysis techniques, including consideration of forage production and AUM production, demands for red meat, and derived demands for forage, are part of another National Analysis Project problem area. This research effort is also a part of the integrated analysis. State-of-the-art papers on ecological and economic aspects of production analysis techniques have been written for the publication series. A problem analysis is being completed on research needed to improve the demand analysis techniques used in resource planning.

Wildlife and fish assessments include a wide array of analysis techniques, and two major areas have been examined. A multiagency effort to define research needs for ecological analysis techniques has been completed. Copies of this statement of research needs have been circulated to technical reviewers and interested individuals. Contact Tom Hoekstra for additional copies. Another in the series of state-of-the-art papers will cover ecological analysis techniques for consideration of wildlife and fish in land and resource management planning. The second major area has examined the state-of-the-art and research needs for use and improvement of techniques related to defining wildlife values.

The National Analysis Project had lead responsibility for defining information needed to support future RPA Assessments. A final report submitted to the Forest Service RPA Staff in Washington has completed the Project's task. The report will provide a basis for future assessment teams and researchers to define integrated assessment analyses and related information needs.

The Project is also conducting a multiagency assessment of wildlife and fish information needs. This effort is addressing the need to define information which is common to both state and federal agencies. Representatives of state fish and wildlife agencies, Bureau of Land Management, Fish and Wildlife Service, Forest Service, and Soil Conservation Service are involved in this study.

Anyone wishing to obtain more information on the activities of the National Resource Analysis Techniques Project should contact Thomas W. Hoekstra, Project Leader, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, Colorado 80526.

* * * * *

INTERAGENCY WILDLIFE GROUP (IWG) ACTIVITIES

In keeping with Forest Service policy to review and evaluate research programs at least once every 5 years, the Resources Evaluation Techniques (RET) Research and Development Program, which was initiated in June 1976, is now undergoing review. The review and approval process for chartering new research and development projects and preparing research work unit descriptions is to be completed by October 1, 1981.

The IWG has prepared the following position statement which describes six research, development, and application efforts that the IWG agrees are essential to meet interagency concerns and needs for wildlife and fish assessments/appraisals.

Interagency Wildlife Group Position Statement

The Interagency Wildlife Group recommends the following research, development, and application efforts within the RET Program and related project activities within the Rocky Mountain Forest and Range Experiment Station to meet interagency needs for national assessments/appraisals of wildlife and fish resources, in the following sequence:

1. Continuation of development of the Interagency Information Needs Assessment for wildlife and fish resources.

2. Development of new and improved analytical techniques to integrate resources (timber, range, wildlife and fish, water, etc.) and ecological, economic, and social considerations of these resources to meet interagency needs for national assessments/appraisals of wildlife and fish and other resources.

3. Development of an ecosystem classification system that meets interagency needs for national assessments/appraisals of wildlife and fish resources. This process will include evaluation and incorporation of appropriate aspects of existing classification systems.

4. Development of optimum inventory techniques for measuring wildlife and fish resource and other ecosystem resource variables (data elements) in the following order of priority:

   a. Those identified by the Wildlife and Fish Interagency Information Needs Assessment.

   b. Those specified by procedures developed by the above (2) integrated analysis efforts.

5. Coordinate development of wildlife and fish data bases and information management systems which will meet agency needs for national, regional, and local assessments/appraisals.

6. Development of a formalized organizational approach for transferring technology on wildlife fish resource assessments/appraisals, developed by the Resources Evaluation Techniques Program, to the appropriate operational units within other agencies.

The six points comprising the position statement are consistent with the multiresource and multidisciplinary approach of integrated resource analysis for national, regional, and local assessments supported by the IWG.

* * * * *

METRIC REPORTER

The Metric Reporter is the primary publication of the American National Metric Council (ANMC). The Council is a private, non profit organization dedicated to planning and coordinating voluntary metric conversion in the various sectors of the U. S. economy. It's main tasks are: to prepare and coordinate industry conversion plans; to keep subscribers and others informed of U. S. metric developments; to prepare the United States for conversion through education and information programs; and, to act as a representative of the private sector in formulating a coordinated industry-government approach to metrication. The Metric Reporter, published 25 times a year, provides the latest information on metric developments in business, industry, government, education, and consumer affairs. Subscription rates are $50 for one year, $90 for two years, and $120 for three years. To subscribe, or for further information, contact American National Metric Council, 1625 Massachusetts Ave., N. W., Washington, D. C. 20036.

* * * * *

RESOURCE INVENTORIES FOR MONITORING CHANGE AND TRENDS

The Society of American Foresters Inventory Working Group and Oregon State University will be sponsoring a National or International workshop on "Resource Inventories for Monitoring Change and Trends" to be held at Corvallis, Oregon, August 8-12, 1983. Ideas for format, scope and content are sought as well as for additional sponsors.

Please send your ideas by September 1, 1981 to:

Dr. John F. Bell
School of Forestry
Oregon State University
Corvallis, OR 97330
Phone (503) 754-4036; FTS 425-4036

* * * * *

CURRENT LITERATURE

Please order directly from sources given in ( ). In case of journal articles, contact your local library for availability.

GENERAL

Nelson, Brad B., and Raymond E. Arndt. 1980. Eastern states endangered plants. 109 p. (USDI BLM, Eastern States Office, 350 South Pickett St., Alexandria, VA 22304).

Goldsmith, F. B. 1980. An evaluation of a forest resource: A study from Nova Scotia. Journal of Environmental Management 10(1):83-100.

Sassaman, R. W. 1981. Threshold of concern: A technique for evaluating environmental impacts and amenity values. Journal of Forestry 79(2):84-86.

ANALYSIS

Buhyoff, Gregory J., Harold M. Rauscher, R. Bruce Hull IV, and Kevin Killeen. 1980. Microcomputer - resident comprehensive statistical analysis. Behavior Research Methods and Instrumentation 12(5):551-553.

Farmer, R. E. 1980. Relationship of leaf area and dry weight to height and volume in a young plantation of northern red oak. Tree Planter's Notes. 31(3)16-17.

Miller, R. E. 1980. Analyzing forest fertilization: Study evaluates costs, benefits. Forest Industries. 106(10):60-62.

Smeck, Neil E. et al. 1980. Computerized processing and storage of soil descriptions and characterization data. Soil Science Society of America Journal. 44(3):649-652.

Dobie, J. 1980. Lumber yields from sweepy lodgepole pine. Forestry Chronicle. 56(2):66-67.

Schwarzbart, G. 1980. Information transfer methods which facilitate use-ability of simulation models. California Air Environmental. 7(3):8-9.

Schwarzbart, Gideon. 1979. Recent advances and trends in the design and implementation of management information systems. In Proceedings of International Symposium IUFRO Sub. Gp. 6.03. Information systems and terminology. [May 15-18 1979, Hamburg, Germany], p. 87-93.

DeMars, C. J. 1980. Managing tree mortality location data with a desk-top minicomputer. In Proceedings of Remote Sensing for Natural Resources, an International View of Problems, Promises and Accomplishments. [September 10-14, 1979, Moscow, Idaho], p. 69-77.

Robertson, J. L., R. M. Russell, and N. E. Savin. 1980. POLO: A user's guide to Probit Or LOgit analysis. USDA Forest Service Gen. Tech. Report PSW-38, 15 p. (The above 3 publications are available from Publications Distribution, USDA Forest Service, PSW F&RES, P. O. Box 245, Berkeley, CA 97401).

Leak, William B. 1980. Rapid economic analysis of northern hardwood stand improvement options. USDA Forest Service Res. Note NE-296. 6 p. (Publications Distribution, USDA Forest Service, NEFES, 370 Reed Road, Broomall, PA 19008).

Nelson, Dayton D., Richard O. Mahan, and C. Thomas King. 1980. LANDFORM: Land analysis and display for mining. Mining Congr. J. (July 1980): 49-51.

INVENTORY

Lund, H. Gyde, Miguel Caballero, R. H. Hamre, Richard S. Driscoll, and William Bonner. (Tech. Coordinators) 1981. Arid land resource inventories: Developing cost efficient methods. Proceedings of the workshop. USDA Forest Service Gen. Tech. Report WO-28. 620 p. (Publications Distribution, USDA Forest Service, P. O. Box 2417, Washington, D. C. 20013).

Boyne, H. S., and D. A. Ellerbruch. 1980. Active microwave water equivalence measurements of snowpack; microwave remote sensing of snowpack properties. NASA Conference Publication 2153. p. 119-129.

Wiant, Harry V., and Dan E. Wingerd. 1981. Biomass factors for point sampling in Appalachian hardwoods. Journal of Forestry 79(1):21, 29.

Galgowski, C. G., and W. R. Wright. 1980. A variable-depth ground-water sampler. Soil Science Society of America Journal. 44(5): 1120-1121.

Loijens, H. S. 1980. Determination of soil-water content from terrestrial gamma radiation measurements. Water Resources Research. 16(3):563-573.

Render, Barry, and Larry Samuel. 1980. Guide for conducting a market basket survey. Research Study No. 36. 19 p. (Division of Business and Economic Research, University of New Orleans, New Orleans, LA 70122).

Grassia, A. 1980. Estimating bark thickness in natural stands of eucalyptus. Australian Journal of Ecology. 5:411-417.

Wilbur, S. R. 1980. Estimating the size and trend of the California condor population, 1965-1978. California Fish and Game. 66(1):40-48.

Bonner, F. T. 1980. Rapid measurement of the moisture content of large seeds. Tree Planters' Notes. 31(3):9-10.

Middleton, L. J. 1980. Computerized inventory systems for forest fire equipment and personnel. Forestry Chronicle. 56(1):11-12.

Beschta, R. L. 1980. Modifying automated pumping samplers for use in small mountain streams. Water Resource Bulletin 16(1): 137-138.

Simmons, C. S. 1979. Scaling of field-measured soil-water properties. p. 75-174. (Division of Agricultural Sciences, University of California, Berkeley, California).

1979. An aid to land use planning. The New Zealand land inventory. 38 p. (The Dept. of Lands and Survey Head Office, Private Bag, Wellington, New Zealand.)

Grosenbaugh, L. R. 1981. Measuring trees that lean, fork, crook, or sweep. Journal of Forestry 79(2):89-92.

Laflin, Bonny D. 1980. Inventory and classification of streams in the Rough River and Nolin River drainages. Bulletin No. 65. October. 91 p. (Dept. of Fish and Wildlife Resources, Frankfort, KY.)

King, G. S., and F. W. Holmes. 1979. Tree evaluation. L-178. 7 p. (Cooperative Extension Service, U. S. Dept. of Agr., University of Massachusetts, Amherst, Massachusetts 01003.)

Miller, Gerald A. 1980. Soil information related to nonpoint pollution. PM-901C August. (Cooperative Extension Service, Iowa State University, Ames, Iowa 50011.)

Coder, K. D., and P. H. Wray. 1980. Key for trees of Iowa. PM-970. Sept. (Cooperative Extension Service, Iowa State University, Ames, Iowa 50011.)

Hoa, N. T. 1981. A new method allowing the measurement of rapid variations of the water content in sandy porous media. Water Resources Research. 17(1):41-49.

Janardan, Konanur G., and D. J. Schaeffer. 1981. Method for estimating the number of identifiable organic pollutants in the aquatic environment. Water Resources Research. 17(1):243-250.

Eis, S., and D. Craigdallie. 1980. Gulf islands of British Columbia - a landscape analysis. BC-X-216, 39 p. (Pacific Forest Research Centre, 506 West Burnside Road, Victoria, B. C. V82 1M5.)

Ferber, R., P. Sheatsley, A. Turner, and J. Waksberg. 1980. What is a survey? 25 p. (American Statistical Assoc., 806 Fifteenth St., N.W., Washington, D. C. 20005.)

Swanson, R. H. 1970. Sampling for direct transpiration estimates. Journal of Hydrology (N.Z.) 9(2):72-77.

Seidel, K. W. 1980. A guide for comparing height growth of advance reproduction and planted seedlings. USDA Forest Service Res. Note PNW-360. 6 p. (Publication Distribution, Pacific Northwest Forest and Range Exp. Station, 809 NE 6th Ave., Box 3141, Portland, OR 97208).

Fight, Roger D. 1980. Planners guide for estimating cost per user-day of proposed recreational facilities. USDA Forest Service Res. Note PNW-110. 10 p. (Publication Distribution, Pacific Northwest Forest and Range Exp. Station, 809 NE 6th Ave., Box 3141, Portland, OR 97208).

Zamora, Benjamin A. 1981. An approach to plot sampling for canopy volume in shrub communities. Journal of Range Management. 34(2): 155-157.

Manning, G. H. (Editor) 1980. Forest management outputs: Who needs them and why? Proceedings of a workshop held Oct. 1, 1979 at Jasper Park Lodge, Alberta. Canadian Forestry Service Report BC-X-206. 38 p. (Pacific Forest Research Centre, 506 W. Burnside Rd., Victoria, B.C. V8Z 1M5.)

Eis, S., and D. Craigdallie. 1980. Shore and landscape analysis of the western section of the capital regional district of British Columbia. Canadian Forestry Service Report BC-X-208. 43 p. (Pacific Forest Research Centre, 506 W. Burnside Rd., Victoria, B. C. V8Z 1M5.)

Brown, Ray W., and J. M. Collins. 1980. A screen-caged thermocouple psychrometer and calibration chamber for measurement of plant and soil water potential. Agronomy Journal. 72:851-854.

Felt, Dorothy G. 1980. Forest area and timber resource statistics for the Beartooth Working Circle, Montana, 1977. USDA Forest Service Resource Bulletin INT-24, 22 p.

Rothermel, R. C., and J. E. Deeming. 1980. Measuring and interpreting fire behavior for correlation with fire effects. USDA Forest Service Gen. Tech. Report INT-93. 4 p.

Hann, David W. 1980. Development and evaluation of an even- and uneven-aged ponderosa pine/ Arizona fescue stand simulator. USDA Forest Service Research Paper INT-267. (The above 3 are available from USDA Forest Service, Intermountain Forest and Range Exp. Station, 507 25th St., Ogden, UT 84401.)

Zavitkovski, J. 1981. Small plots with unplanted plot border can distort data in biomass production studies. Canadian Journal of Forest Research 11(11): 9-12.

DeGraff, J. V., E. P. Olson, T. Collins, and A. Godfrey. 1980. R-4 Inventory of geological hazards. G-R-80-1. 23 p. (USDA Forest Service - Federal Office Bldg., 324 25th St., Ogden, UT 84401.)

Zeide, Boris. 1981. Method of mound dating. Forest Science 27(1):39-41.

Oderwald, Richard G. 1981. Comparison of point and plot sampling basal area estimators. Forest Science 27(1):42-48.

Mitchell, B. R., and B. B. Bare. 1981. A separable goal programming approach to optimizing multivariate sampling designs for forest inventory. Forest Science 27(1):147-162.

Flewelling, James W. 1981. Compatible estimates of basal area and basal area growth from remeasured point samples. Forest Science 27(1):191-203.

Bevins, Collin D., and Peter J. Roussopoulos. 1980. National fuels inventory library. p. 146-150. In Proceedings sixth conference on fire and forest meteorology [Seattle, Wash., Apr. 22-24, 19801, 304 p. Society of American Foresters, Washington, D. C.

Troendle, Charles A., and Charles F. Leaf. 1980. Hydrology, Chapter III. p. 111-173. In An approach to water resources evaluation of non-point silvicultural sources (a procedural handbook). EPA 60018-80-012, Environmental Research Laboratory, Athens, GA.

Haas, Glenn E., B. L. Driver, and Perry J. Brown. 1980. Measuring wilderness recreation experiences. p. 20-40. In Proceedings of wilderness psychology conference [Durham, N. H., August 14-15]. New England Center for Continuing Education, Durham, NH. 219 p.

Sackett, Stephen S. 1980. An instrument for rapid, accurate, determination of fuel moisture content. p. 17-18. USDA Forest Service Fire Management Notes, Vol. 41(2). Spring 1980.

REMOTE SENSING

Rango, Albert. 1980. Operational applications of satellite snow cover observations. Water Resources Bulletin. 16(6):1066-1073.

Collins, S. H. 1980. Stereoscopic depth perception. Photogrammetric Engineering and Remote Sensing. 47(1):45-52.

Roberts, Arthur, and Peter Hiscocks. 1980. A computer based camera control system. Photogrammetric Engineering and Remote Sensing. 47(1):53-57.

Mitchell, John K. 1980. The pitfalls and temptations of aerial mapping. Photogrammetric Engineering and Remote Sensing. 47(1):59-61.

Stephens, P. R., D. L. Hicks, and N. A. Trustrum. 1980. Aerial photographic techniques for soil conservation research. Photogrammetric Engineering and Remote Sensing. 47(1):79-87.

Thomas, I. L., R. Howorth, A. Eggers, and A. D. Fowler. 1980. Textural enhancement of a circular geological feature. Photogrammetric Engineering and Remote Sensing. 47(1):89-91.

Hodgson, R. M., F. M. Cady, and D. Pairman. 1981. A solid-state airborne sensing system for remote sensing. Photogrammetric Engineering and Remote Sensing 47(2):177-182.

Stow, Douglas A., and John E. Estes. 1981. Landsat and digital terrain data for county-level resource management. Photogrammetric Engineering and Remote Sensing. 47(2):215-222.

Price, John C. 1981. The contribution of thermal data in Landsat multispectral classification. Photogrammetric Engineering and Remote Sensing. 47(2):229-236.

Imanaga, M., M. Kitamura, and R. Hosaka. 1980. Method evaluating the the results of grown sugi (Crytomeria japonica) forest on aerial photographs. p. 3-8. Text in Japanese, summary in English. (Prof. Dr. M. Imanaga, Yamagata University, Faculty of Agriculture, 997 Tsuruoka-shi, Wakabamach: 1-23, Japan).

Kirby, C. L. 1980. A camera and interpretation system for assessment of forest regeneration. Information Report NOR-X-221, March 1980. 8 p. (Northern Forest Research Centre, Canadian Forestry Service, Environment Canada, 5320 122 Street, Edmonton, Canada T6H 3S5).

Sonderman, David L. 1980. Using terrestrial stereo photography to interpret changes in tree quality characteristics. USDA Forest Service Research Note NE-298, 8 p. (Northeastern Forest Experiment Station, 370 Reed Road, Broomall, PA 19008.)

Hathout, S. 1981. Heat loss detection from residential areas of Winnipeg City by using air-borne IR line scanning system. Journal of Environmental Management 12(2):149-156.

Allison, Ray, and Karl M. Hegg. 1981. A low-cost X/Y stereocarrier. USDA Forest Service Field Engineering Notes 13(2):1-3.

Stow, D. A., and J. E. Estes. 1981. Landsat and digital terrain data for county-level resource management. Photogrammetric Engineering and Remote Sensing. 47(2):215-222.

Myers, B. J., and M. L. Benson. 1981. Rainforest species on large-scale color photos. Photogrammetric Engineering and Remote Sensing. 47(4):505-513.

CLASSIFICATION

Bergeron, R., J. M. Levasseur, and J. M. Mondoux. 1979. Wildlife interpretation keys for the James Bay Territory ecological classification, p. 145-152. In Applications of ecological (biophysical) land classification in Canada. Canada Committee on Ecological (Biophysical) Land Classification. Ecol. Land Classif. Ser., No. 7, Lands Directorate, Environ. Can., Ottawa. 396 p.

CCELC, 1980. Land/wildlife integration. Ecological Land Classification Series No. 11. Lands Directorate, Environment Canada, Ottawa. 160 p.

Dyrness, C. T., and D. F. Grigal. 1979. Vegetation-soil relationships along a spruce forest transect in interior Alaska. Canadian Journal of Botany. 27(23):2644-2656.

Eedy, W., K. Schiefer, J. Rowsell, and R. McCoy. 1979. Application of ecological (biophysical) land classification in the environmental assessment process. Examples from various types of resource developments across Canada. p. 221-237. In Applications of ecological (biophysical) land classification in Canada. Can. Comm. on Ecol. (Biophys.) Land Classif., Ecol. Land Classif. Ser., No. 7, Lands Directorate, Environ. Can., Ottawa. 396 p.

Franklin, J. F. 1980. Ecological site classification activities in Oregon and Washington. Forestry Chronicle. 56(2):68-70.

Graham, Russell T., and Jonalea R. Tonn. 1980. Case study: growth and development of forest stands in the Northern Rocky Mountains. USDA Forest Service Res. Pap. INT-255, 24 p. (Publication Distribution, Intermountain Forest and Range Experiment Station, 507 25th St., Ogden, UT 84401.)

Maser, Chris, J. M. Geist, D. M. Concannon, R. Anderson, and B. Lovell. 1979. Wildlife habitats in managed rangelands--the Great Basin of southeastern Oregon: geomorphic and edaphic habitats. USDA Forest Service, Gen. Tech. Report PNW-99. 84 p. (Publication Distribution, Pacific Northwest Forest and Range Experiment Station, 809 NE 6th Ave., Box 3141, Portland, OR 97208.)

Perret, N. G. 1969. Land capability classification for wildlife. The Canada Land Inventory, Rept. 7, Lands Directorate, Environment Canada, Ottawa. 30 p.

Platts, W. S. 1980. A plea for fishery habitat classification. Fisheries, Vol. 5, No. 1:2-6.

Sather, J. H. 1976. Proceedings of the national wetland classification and inventory workshop, July 20-23, 1975, Univ. of Maryland, College Park, Maryland. 248 p. (Office of Biological Services, Fish and Wildlife Service, USDI, Washington, D. C.)

Seel, K. E. 1978. Wildlife data and ecological land classification: A resolvable problem, p. 1-2. In Canada Committee on Ecological Land Classification, Newsletter No. 4, Lands Directorate, Environment Canada. Ottawa. 8 p.

Subcomm. on Biophys. Land Classif. 1969. Guidelines for biophysical land classification (comp. by D. S. Lacate). Can. For. Serv., Dept. of Fisheries and Forestry, Publ. No. 1264. 61 p.

Taylor, D. 1978. Wildlife in ecological land classification studies. p. 3-5. In Canada Committee on Ecological Land Classification, Newsletter No. 4, Lands Directorate, Environment Canada, Ottawa. 8 p.

U. S. Dept. of the Interior. 1978. Classification, inventory and analysis of fish and wildlife habitat. Proc. of a national symposium, Phoenix, Arizona, January 24-27, 1977 (A. Marmelstein, general chairman). Sponsored by the Office of Biological Services, Fish and Wildlife Service, U. S. Dept. of the Interior, Washington, D. C. FWS/OBS-78/76. 604 p.

* * * * *

MEETINGS, WORKSHOPS, AND SYMPOSIA

August 2-5, 1981. Soil Conservation Society of America 36th Annual Meeting (Spokane, Washington). Theme: Land, people and policy - The western connection. Contact: SCSA, 7515 Northeast Ankeny Rd., Ankeny, IA 50021.

August 9-14, 1981. In-Place Resource Inventories: Principles and Practices--A National Workshop. (Orono, Maine). $60. Sponsored by the Renewable Natural Resources Foundation, the Society of American Foresters, Society for Range Management, American Society of Photogrammetry, Wildlife Society, and in cooperation with the Forest Industries of Maine, University of Maine, the USDA Forest Service, and USDI Bureau of Land Management. Contact: John Benoit, Conferences and Institutes Division, University of Maine, 128 College Ave., Orono, ME 04473. Phone (207) 581-2626.

August 10-14, 1981. Silviculture Summer Fieldweek (F8108). (University of B. C. Research Forest, Maple Ridge, B. C., Canada). Sponsored by Forestry Off-Campus Programs. Contact: Forestry Off-Campus Programs, Room 72, 2357 Main Mall, The University of British Columbia, Vancouver, B. C. V6T 1W5 Canada. Phone: (604) 228-6108 or 228-6821.

August 17-20, 1981. Institute of Mathematical Statistics, Annual Meeting, (Vail, Colorado). Contact: M. Fox, Executive Secretary, Dept. of Statistics and Probability, Michigan State University, East Lansing, MI 48824.

August 31-September 4, 1981. Second Australasian LANDSAT Conference. Contact: LANDSAT 81, P. O. Box 783, Canberra City, ACT 2601, Australia. Phone (062) 47-5335.

September 8-11, 1981. Down to Earth Management: 7th Canadian Symposium on Remote Sensing. Contact: Mr. D. Pearson, Registration, Box 1106, Winnipeg, Manitoba, Canada R3C 2X4.

September 17-19, 1981. California Riparian Systems - A statewide conference on their ecology, conservation and productive management. Contact: Dr. Richard Warner, Field Studies Center, P. O. Box 402, Davis, CA 95616.

September 27-30, 1981. Increasing Forest Productivity. SAF National Convention. (Orlando, Florida). Contact: Edward F. Robie, SAF, 5400 Grosvenor Lane, Washington, D. C. 20014. Phone (301) 897-8720.

October 5-8, 1981. Symposium and Workshop on Dutch Elm Disease. (Manitoba, Canada). Contact: E. S. Kondo, Great Lakes Forest Research Centre, Canadian Forestry Service, P. O. Box 490, Sault Ste. Marie, Ontario, Canada P6A 5M7. Telephone (705) 949-9461.

October 13-24, 1981. International Geologic Correlation Programme (IGCP) Workshop on Remote Sensing and Mineral Exploration. (Nairobi, Kenya). Contact: W. D. Carter, U. S. Geological Survey, National Center, Mail Stop 730, Reston, VA 22092.

October 18-21, 1981. Remote Sensing: An Input to Geographic Information Systems in the 1980s. Pecora VII Symposium. (Sioux Falls, SD). Contact: Dr. B. F. Richardson, Dept. of Geography, Carroll College, Waukesha, WI 53186. Phone (414) 547-1211, Ext. 144.

October 26-30, 1981. Applications of Remote Sensing in Geology/Hydrology. Contact: Branch of Applications, EROS Data Center, Sioux Falls, SD 57198. Phone (605) 594-6114.

October 28-30, 1981. A symposium on the acquisition and utilization of aquatic habitat inventory information. Organized by the Western Division, American Fisheries Society. Contact: Neil B. Armantrout, P. O. Box 2965, Portland, OR 97208. Phone (503) 231-6870; FTS 429-6870.

November 16-20, 1981. Advanced Geological Workshop. Contact: Branch of Applications, EROS Data Center, Sioux Falls, SD 57198. Phone (605) 594-6114.

November 30-December 11, 1981. International Statistical Institute, 43rd Biennial Session, (includes meetings of Bernoulli Society for Mathematical Statistics and Probability, International Association for Statistical Computing and International Association of Survey Statisticians), Buenos Aires, Argentina. Contact: ISI Permanent Office, 428 Prinses Beatrixlaan, 2270 AZ Voorburg, Netherlands.

February 15-18, 1982. The Third Symposium on Environmental Concerns in Rights-of-Way Management. Call for papers. (San Diego, California). Contact: Allen F. Crabtree, Environmental Enforcement Division, Michigan Dept. of Natural Resources, Mason Building, 6th Floor, Lansing MI 48909. Phone (517) 373-3503.

* * * * *

WANTED--Materials for the Newsletter--feature articles, news items, current literature, and meeting notices. All articles received are to be grammatically and technically correct. Send your material to Resources Evaluation Newsletter, Rocky Mountain Forest and Range Exp. Stn., 240 West Prospect Street, Fort Collins, CO 80526. Phone: (303) 221-4390, ext. 202 or FTS 323-1202.

* * * * *

☆ U.S. GOVERNMENT PRINTING OFFICE: 1981 — 780-294/395 Region No. 8

We are required to update the REN distribution list annually. If you wish to be removed from the distribution list, or if your address needs correcting, please contact:

USDI Bureau of Land Management, D-460
Bldg. 50, Denver Federal Center
Denver, CO 80225
USA

Be sure to include your old distribution label or copy the code numbers found in the upper right hand corner of the label.

* * * * *

Some views expressed in this Newsletter may not necessarily reflect the position of all of the sponsoring agencies.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DENVER FEDERAL CENTER
BUILDING 50
DENVER, COLORADO 80225

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
U. S. DEPARTMENT OF THE INTERIOR
Int 415

U.S.MAIL

TIMOTHY G. GREGOIRE 01 006923
YALE UNIVERSITY-SCHOOL OF FORE
MARSH HALL
360 PROSPECT STREET
NEW HAVEN CT 06511