Resource Inventory Notes

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A DISTRIBUTION-FREE METHOD FOR INTERVAL ESTIMATION AND SAMPLE SIZE DETERMINATION

by

Gary W. Fowler and Dale Hauke[1/]

ABSTRACT: A distribution-free method for interval estimation and sample size determination based on Tchebysheff's Inequality is presented and compared with the normal-based confidence interval methods currently used in natural resource sampling. The distribution-free method appears to be superior to the normal-based methods.

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INTRODUCTION

Sampling natural resource populations frequently involves estimating the mean of some population random variable or characteristic of interest with a sample mean (a point estimate). The goodness (reliability, precision, or accuracy) of this estimate is most commonly determined by making a confidence statement based on the calculation of a confidence interval (an interval estimate). For example, one might state with 95% confidence that the true population mean is within the interval $[\bar{x} - d, \bar{x} + d]$, where $\bar{x}$ is the sample mean, d is the confidence interval half-width, 95% is the confidence coefficient, and $\bar{x} - d$ and $\bar{x} + d$ are the confidence limits.

The confidence statement is based on the assumption that the population random variable is normally distributed, and the confidence coefficient is correct only when this assumption is met. Random variables associated with natural resource populations are seldom normally distributed and, at best, are only approximately normal. If the random variable is not normal, the confidence coefficient of the confidence statement is unknown and not equal to the confidence coefficient under normality. The actual value of the confidence

1/ The authors are, respectively, Associate Professor of Biometrics and Graduate Research Assistant, School of Natural Resources, The University of Michigan, Ann Arbor, Michigan, 48109.

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coefficient depends on the distribution of the random variable and the number of observations in the sample.[2] Therefore, when sampling natural resource populations, a distribution-free method for interval estimation is desirable.

The objectives of this paper are to (1) review the confidence interval and sample size determination methods currently used in natural resource sampling and (2) present a distribution-free interval estimation and sample size determination method based on Tchebysheff's Inequality (Hogg and Craig 1965).

All methods are compared by sampling a 23.4 acre stand of eastern white pine (Pinus strobus) located within the Ottawa National Forest in Michigan's Upper Peninsula. This population was divided into 234 mutually exclusive 0.1 acre square plots with diameter at breast height (DBH) measured on all 8 inch and larger white pine trees in each plot. This stand consisted of 1060 trees, and the average basal area per acre was 87.24 sq. ft. The sampling unit is the 0.1 acre plot, and the characteristic of interest associated with each plot is basal area per acre (X_i). The population mean and standard deviation for all sampling units are μ = 87.24 sq. ft. and σ = 50.24 sq. ft., respectively. To facilitate comparison of all methods, a random sample of size n = 20 plots was drawn without replacement from the population of 234 plots (Table 1).

Table 1. Observations and sample statistics for the sample of 20 plots from the forest population of 234 plots.

OBSERVATION NO. (i)	X_i	OBSERVATION NO. (i)	X_i	OBSERVATION NO. (i)	X_i	OBSERVATION NO. (i)	X_i
1	73.66	6	94.60	11	68.73	16	112.62
2	148.76	7	58.61	12	21.82	17	100.75
3	184.69	8	140.20	13	67.92	18	60.08
4	147.00	9	70.87	14	171.69	19	147.16
5	56.64	10	93.61	15	182.77	20	35.37

sample size: n = 20
mean: $\bar{x}$ = 101.88
standard deviation: s = 49.51
standard error: $s_{\bar{x}}$ = 10.61

2/ The Central Limit Theorem (Hogg and Craig 1965) shows that the distribution of the sample mean approaches the normal distribution as sample size increases. The sample size required for an adequate approximation of normality is usually unknown and depends on the actual population distribution, which is also usually unknown. Most samplers probably do not even know how good of a normal approximation they want.

PROCEDURES BASED ON NORMALITY

Normal-based procedures for confidence intervals and sample size determinations related to the mean of a population have been used in natural resource sampling when the variance of the population is either assumed known or unknown. We will examine these procedures for simple random sampling without replacement from a finite population.

Variance Assumed Known

The $(1 - \alpha)\%$[3] confidence interval for the population mean μ is

(1) $\bar{x} \pm d$ or $\bar{x} \pm Z_{\alpha/2}\sigma_{\bar{x}}$

where α = level of significance
d = confidence interval half-width
$Z_{\alpha/2}$ = critical value of the standard normal distribution for an upper-tail probability of $\alpha/2$
$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}}$ = population standard error of the mean
n = sample size
N = population size
$(1 - \alpha)\%$ = level of confidence or confidence coefficient

For a confidence interval calculated from a specific sample, the sampler is $(1 - \alpha)\%$ confident that the calculated confidence interval $[\bar{x} - Z_{\alpha/2}\sigma_{\bar{x}}, \bar{x} + Z_{\alpha/2}\sigma_{\bar{x}}]$ includes the population mean μ. This means that $(1 - \alpha)\%$ of all confidence intervals calculated in the long run will include μ, while $\alpha\%$ will not include μ. The sampler is willing to accept an error $\alpha\%$ of the time.

The formula for sample size determination can be derived from equation (1) by solving for n and is

(2) $$n = \frac{A^2}{1 + \frac{A^2 - 1}{N}}$$

where $A = Z_{\alpha/2}\sigma/d$
N = population size
σ = population standard deviation
d = desired confidence interval half-width

Equations (1) and (2) are used in natural resource applications by replacing $\sigma_{\bar{x}}$ and σ by the sample standard error $s_{\bar{x}}$ and the sample standard deviation s, respectively. These substitutions cause the results from both equations to be approximate. Given the sample of 20 plots from the forest population and $\alpha = 0.05$, the approximate 95% confidence interval for μ is [81.08, 122.68]. The approximate desired sample size to yield $d = 10$ at $\alpha = 0.05$ is $n = 67$.

Variance Assumed Unknown

The $(1 - \alpha)\%$ confidence interval for the population mean μ is

(3) $\bar{x} \pm d$ or $\bar{x} \pm t_{\alpha/2, n-1} s_{\bar{x}}$

where $t_{\alpha/2, n-1}$ = critical value of student's t - distribution for an upper-tail probability of $\alpha/2$ and $n - 1$ degrees of freedom

$$s_{\bar{x}} = \frac{s}{\sqrt{n}} \sqrt{\frac{N - n}{N}}$$ = sample standard error of the mean

The formula for sample size determination can be derived from equation (3) by solving for n* and is

(4) $$n^* = \frac{Q^2}{1 + \frac{Q^2}{N}}$$

where $Q = t_{\alpha/2, n-1} s/d$

s = sample standard deviation
n = sample size
N = population size
d = desired confidence interval half-width

An iterative procedure must be used to solve for the desired sample size n*. A preliminary sample of size n_1 is selected from the population, and s is calculated. Equation (4) is first solved for n* by initializing $n - 1$ at $n_1 - 1$ for the degrees of freedom associated with the critical t- value. If $n^* > n_1$, the degrees of freedom in the critical t- value are increased interatively from $n_1 - 1$, and n* is recalculated and compared with n at each iteration. When $n^* \approx n$, the procedure terminates. s from the preliminary sample is used throughout this sample size determination procedure.

Given the sample of 20 plots from the forest population and $\alpha = 0.05$, the 95% confidence interval for μ is [79.67, 124.09]. The approximate desired sample size to yield d = 10 at $\alpha = 0.05$ is n* = 68.

GENERAL

For our sample size of n = 20, the two methods give similar results for the 95% confidence intervals and desired sample sizes. This should be expected because the t-distribution approaches the Z distribution as the number of degrees of freedom increase. Remember that both procedures assume that the underlying distribution is normal, and the confidence coefficient is correct only under normality.

3/ $(1 - \alpha)\%$ and $(1 - 1/k^2)\%$ should be $100(1 - \alpha)\%$ and $100(1 - 1/k^2)\%$, respectively The 100 has been left off for simplicity.

The two formulas for sample size can be modified by replacing the standard deviation with the coefficient of variation and d with the percentage that d is of the mean.

An investigation of the literature related to natural resource sampling shows there is no evidence indicating superiority of either normal-based procedure.

ERROR BOUND METHOD

The $(1 - \alpha)\%$ confidence coefficient for the normal based procedures just discussed is correct only when the characteristic of interest is normally distributed. If the distribution of the characteristic of interest is not normal and normal-based procedures are used, the actual confidence coefficient of a $(1 - \alpha)\%$ confidence interval will almost always be smaller than $(1 - \alpha)\%$, with the unknown difference depending on how far the distribution deviates from normality. In other words, the sampler might make a 95% confidence statement about the population mean μ, but due to the non-normality of the distribution the actual unknown confidence coefficient might be 80%. Since most natural resource populations are not normal, it would seem that a confidence statement that applies given any distribution would be desirable.

A distribution-free method for calculating interval estimates and determining optimal sample sizes can be developed using Tchebysheff's Theorem (Hogg and Craig 1965, Mendenhall et al. 1971). The method will be developed for simple random sampling without replacement from a finite population.

The $(1 - 1/k^2)\%$ [3/] error bound for the population mean μ can be derived from Tchebysheff's Inequality and is

(5) $\bar{x} \pm d$ or $\bar{x} \pm k\sigma_{\bar{x}}$

where d is the error bound half-width, $k > 0$, and $\sigma_{\bar{x}}$ is the population standard error of the mean. For an error bound calculated from a specific sample, the sampler is at least $(1 - 1/k^2)\%$ confident that the error bound $[\bar{x} - k\sigma_{\bar{x}}, \bar{x} + k\sigma_{\bar{x}}]$ will include the population mean μ, regardless of the distribution of the characteristic of interest. In other words, a confidence statement can be constructed that gives a lower bound on the confidence coefficient no matter what shape the underlying distribution takes on.

The constant k is usually set at 2, which yields a 75% error bound, $\bar{x} \pm 2\sigma_{\bar{x}}$. The lowest the confidence coefficient can be is 75%. Most distributions would yield a confidence coefficient between 80% and 90%. The 75% error bound has a confidence coefficient equal to approximately 95% when the population distribution is normal because $Z_{.025} = 1.96$ in equation (1) is very close to 2.

The formula for sample size determination can be obtained from equation (5) by solving for n and is

$$(6)\quad n = \frac{B^2}{1 + \frac{B^2}{N}}$$

where $B = k\sigma/d$ ($k = 2$ for the 75% error bound)
d = desired error bound half-width
σ = population standard deviation

$s_{\bar{x}}$ and s are usually substituted for $\sigma_{\bar{x}}$ and σ in equations (5) and (6), respectively, because the population variance is almost always unknown. If the sample size is greater than 10, the effect of these substitutions on the error bound coefficient is negligible.

Given the sample of 20 plots from the forest population, the 75% error bound for μ is [80.66, 123.10]. The desired sample size to yield $d = 10$ for a 75% error bound is $n = 69$. These results are very close to the results obtained for the two normal based procedures (Table 2).

Table 2. Comparison of interval estimates and desired sample sizes for the error bound and two normal-based methods.

METHOD	C.I.	n
95% C.I. with σ^2 known	[81.08, 122.68]	67
95% C.I. with σ^2 unknown	[79.67, 124.09]	68
75% E.B.	[80.66, 123.10]	69

Notice that all three interval estimates include the population mean $\mu = 87.24$.

If the population being sampled has a normal distribution, the 75% error bound has a confidence coefficient of exactly 95.45%. The distribution of basal area/acre for the forest population of 234 plots is not too different from normality as the skewness coefficient γ_1 and kurtosis coefficient γ_2 of the distribution are 0.213 and -0.608, respectively. This population was sampled 3000 times with a sample size of $n = 20$ using Monte Carlo simulation procedures. The confidence coefficient associated with this population was estimated to be 93.2% by determining the percentage of the 3000 error bounds that included the population mean μ.

CONCLUSIONS

We propose that natural resource samplers should use the error bound method for calculating interval estimates and determining desired sample size unless the population distribution is known to be normal or sample sizes are very large. This method puts a lower bound on the confidence coefficient regardless of the population distribution while at the same time says that the confidence coefficient is known to be equal to some specific value if the distribution is normal. If the normal-based methods are used, the confidence coefficient is correct only for a normal distribution, and if the distribution is not normal, the actual confidence coefficient is unknown.

The error bound method should be used as follows to calculate an interval estimate:

(1) Select a value of k to yield the desired lower bound $(1 - 1/k^2)\%$ to be used for the interval estimate. For the forestry example, $k = 2$ yielded a lower bound of 75%.

(2) Set $Z_{\alpha/2} = k$, and find the probability α associated with $Z_{\alpha/2}$ in the standard normal table. Given the probability α, the confidence coefficient $(1 - \alpha)\%$ related to a normal distribution can be determined. For the forestry example, $Z_{\alpha/2} = k = 2$ yields a normal-based confidence coefficient of 95.45%.

(3) Take a sample of size n from the population and calculate the $(1 - 1/k^2)\%$ error bound using the formula $\bar{x} \pm ks_{\bar{x}}$. For the forestry example, the 75% error bound is [80.66, 123.10]. The sampler is at least 75% confident that this interval estimate includes μ. If the distribution of basal area/acre were normal, the sampler would be 95.45% confident that the interval inlcudes μ.

The sample size necessary to yield a $(1 - 1/k^2)\%$ error bound half-width no larger than d should be determined as follows:

(1) Estimate the population standard deviation by (a) taking a preliminary sample from the population of interest, (b) using past data from a previous sample from the same or a similar population, or (c) calculating a crude estimate using the formula $s \approx R/4$ where R is an estimate of the range of the random variable. If possible, a small preliminary sample is best. For the forestry example, a sample of 20 plots was used as the preliminary sample.

(2) Determine a value for the desired error bound half-width d. This value can be determined by experience or by setting d equal to a certain percentage of the mean obtained from the preliminary sample $(d = P \cdot \bar{x})$. For the forestry example, it was decided

that d = 10 sq. ft. by experience. If d were set equal to 10% of the sample mean from the preliminary sample of 20 plots, d = .10 (101.88) = 10.19 sq. ft.

(3) Calculate the desired sample size using the formula $n = B^2/(1+B^2/N)$. For the forestry example, n = 69 rounded to the nearest integer. The sampler would then take a simple random sample of 69 plots. The 20 plots in the preliminary sample may or may not be included in the final sample, depending on the survey objectives.

If the sampler did not have an estimate of the population standard deviation, the crude formula $s \approx R/4$ should be used. For the forestry example, the range of the population of 234 plots for basal area/acre is R = 230.35 sq. ft., which yields $s \approx 57.59$ and n = 85 rounded to the nearest integer. This estimate of s should be used only if nothing else is available.

The guidelines just developed to calculate an interval estimate and to determine the desired sample size based on the error bound method can be combined to form a two-stage procedure for interval estimation. Stage 1 consists of taking the preliminary sample, determining the desired error bound half-width, and calculating the sample size necessary to yield the desired error bound half-width. Stage 2 consists of taking the sample of size n determined in Stage 1 and calculating the error bound.

For simple random sampling with replacement, equation (6) reduces to $n = B^2$. The formula for n can be modified by replacing the standard deviation with the coefficient of variation and d with the percentage that d is of the mean. The error bound approach can be developed for sampling designs other than simple random sampling (Mendenhall et al. 1971).

Sample size determination has been examined in this paper strictly from the statistical viewpoint. In natural resource sampling, sample size will frequently be constrained by fixed budgets, time and personnel available, and whether sampling is destructive or not. Even though the sample size determined using the error bound method may not be feasible due to one or more of the above constraints, it gives the sampler a first estimate as to sample size. Once the constrained sample size is determined and taken in the field, the accuracy of the sample mean (a point estimate) in estimating the population mean can be obtained by calculating the error bound (an interval estimate) with a lower bound on the confidence coefficient.

LITERATURE CITED

Hogg, R.V. and A.T. Craig. 1965. Introduction to Mathematical Statistics. The Macmillan Co., New York. 383 p.

Mendenhall, W., L. Ott, and R.L. Schaefer. 1971. Elementary Survey Sampling. Wadsworth Publishing Co., Inc., Belmont, California. 247 p.

Converting Outside Bark to Inside Bark Diameters

by

Froylan Castaneda[2/]

ABSTRACT: Grosenbaugh's bark Option 1, which assumes constant dib/dob-ratio, is recommended for estimating upper stem diameter inside bark from diameter outside bark measurements of Appalachian hardwood species, unless specific studies indicate other relations should be used.

Several studies have been reported concerning bark thickness of Appalachian hardwoods (1,2,3,9). Such studies confirm relationships as described by Meyer (7), Mesavage (6), and Pemberton (8), in that the relation of bark thickness at breast height to upper stem bark thickness varies among species.

The relation may also vary for the same species in different geographical locations. Using Grosenbaugh's bark options (5), Boehmer and Rennie (1), in Tennessee, found Option 3 to be the best estimator for yellow-poplar (*Liriodendron tilipifera L.*). Contrary to this, Wiant and Koch (9), in northern West Virginia, determined that Option 1 was the best estimator for that yellow-poplar, although Option 2 was nearly as good; DeMoss(3) reported Option 2 was best in another northern West Virginia study. Those results indicate that more study is needed concerning these relationships.

The options, as presented by Grosenbaugh (5), are:

(1) Dib = Dob (Dbhib/Dbh)

(2) Dib = Dob (1.0 - (1.0 - Dbhib/Dbh) (1.0 / (2.0 - Dob/Dbh)))

(3) Dib = Dob (Dbhib/Dbh) (9.0 / (10.0 - Dob/ Dbh))

where: Dib = upper stem diameter inside bark
Dob = diameter outside bark at that point
Dbh = diameter at breast height (4.5 ft.)
Dbhib = Dbh inside bark

Reasoning and assumptions of these options were given by Mesavage (6).

PROCEDURE: Data for this study were collected at the West Virginia University Forest, near Morgantown, as part of a weight study. Species investigated include black cherry (*Prunus serotina Ehrh.*), black birch (*Betula lenta* L.), cucumbertree (*Magnolia acuminata* L.), bigtooth aspen (*Populus grandidentata* Michx.) and red maple (*Acer rubrum* L.). Sample trees were selected within a range of 2 to 16 inches at dbh. Diameter outside bark was measured with a D-tape to the nearest 0.1 inch at dbh and at 4-foot intervals to a 4-inch top. Double-bark thickness was determined as the sum of two readings taken at right angles at the same heights. Bark thickness was measured to the nearest 0.05 inch. Number of trees and number of readings appear in Table 1.

2/ The author was a graduate student in the Division of Forestry, West Virginia University, Morgantown. He is now a PhD student in the College of Forestry, Wildlife and Range Sciences at the University of Idaho, Moscow, Idado, 83843

Actual dib readings and the estimates provided by the bark options were compared using Freese's (4) chi-square test of accuracy. This test computed error limits to a specified deviation unless a 1 in 20 chance occurred. The option which registered the lowest error limit for a given species was considered the best estimator.

RESULTS and DISCUSSIONS: Option 1 provided the best estimate for all five species. This indicates that the ratio of inside bark to outside bark at dbh tends to remain constant at any point along the stem for these species.

TABLE 1. Error Limits For Upper Stem Diameters, Inside Bark, For The Bark Options (95% Level).

Species	Percent Error Limit (%) Option 1	Option 2	Option 3	Number of Measurements
Black cherry	2.10*	3.32	7.12	255
Black birch	1.39*	2.93	4.78	23
Cucumbertree	1.13*	1.56	6.27	48
Bigtooth aspen	1.64*	3.29	6.11	40
Red maple	2.66*	3.90	7.26	213

* Indicates option which provided best estimates.

A summary of several similar studies is shown in Table 2, indicating the variation in results obtained. Option 1 proved best in a majority of these tests, and that option is recommended in cases where no previous studies indicate another option is more appropriate for a given species.

ERRATUM: The data presented in the November 1976 issue of Resource Inventory Notes (BLM-2) in the article, A test of the statistical validity of a 3P and point sampling design, should be interpreted to indicate that double sampling using the mean-of-ratios estimator may be appropriate if number of logs are estimated for in-trees at all point samples and per-acre volumes are determined on a randomly selected subsample of points. When the subsample is selected by the 3P method, no assumptions concerning linearity, intercept value, or standard deviations are necessary. ...Harry V. Wiant, Jr., Division of Forestry, West Virginia University, Morgantown.

ERRATUM: Computations on page 2 of the January, 1979 (BLM-17) article Variable Radius Plot and 3P Timber Sampling, included an error. Variable plot standard error (E plot) should equal 9.17.

In addition on page 4, variable plot stand error (E plot) should read variable plot standard error (E plot).

TABLE 2: Summary Of Upper Stem Inside Diameter Estimators For Some Appalachian Hardwoods (95%).

Source	Species	Percent Error Limit (%) Option 1	Option 2	Option 3	Number of Measurments
Colannino (2)	White oak	6.5	9.8	5.0*	228
	Chestnut oak	7.6	12.3	5.2*	240
DeMoss (3)	Yellow-poplar	5.4	3.8*	11.2	198
	Hickory	4.3	3.6*	10.0	142
Scheetz[3/]	Northern red oak	2.7*	5.0	7.1	206
	Black oak	3.4*	5.8	5.8	203
	Scarlet oak	2.9*	5.9	6.6	202
Wiant and Koch (9)	Yellow-poplar	4.5*	4.6	8.5	519
	Red maple	2.0*	3.1	5.3	105
	Northern red oak	2.7*	6.8	7.9	319
	Black oak	3.6*	3.9	9.1	81
	Scarlet oak	2.9*	3.3	7.3	84
					No. of Trees
Boehmer and Rennie (1)	Cherrybark oak	5.2	7.4	4.6*	19
	Sweetgum	8.4	10.7	4.9*	51
	Southern red oak	4.3*	6.0	6.9	40
	Yellow-poplar	5.1*	7.2	5.3	21
	White oak	4.9*	6.7	5.3**	45

[3/]West Virginia University, thesis in process.
* Indicates option which provided best estimates.
** Option 3, modified with least square analysis, provided a better estimate than Option 1.

LITERATURE CITED

1. Boehmer, W. D. and J. C. Rennie. 1976. Predicting bark thickness for some hardwoods in West Tennessee. Wood Sci. 8:209-212.

2. Colannino, A. 1976. Weight equations for white oak and chestnut oak. Thesis. West Virginia University Division of Forestry Library. 74 pp.

3. DeMoss, C. J. 1976. Weights of yellow-poplar and hickory in Northern West Virginia. West Virginia University Division of Forestry Library. 61 pp.

4. Freese, F. 1960. Testing accuracy. For. Sci. 6:139-145.

5. Grosenbaugh, L. R. 1964. STX-FORTRAN-4 program for estimates of tree populations from 3-P sample-trees-measurements. U.S.D.A. For. Serv.

Res. Paper PSW-13.

6. Mesavage, C. 1969. Converting dendrometer estimates of outside-bark stem dimensions to wood diameters on major southern pines. U.S.D.A. For. Serv. Res. Note SO-93.

7. Meyer, H. A. 1946. Bark volume determination in trees. J. For. 44:1067-70.

8. Pemberton, J. E. 1924. The relation of bark to diameter and volume in redwood. J. For. 22:44-48.

9. Wiant, H. V., Jr. and C. B. Koch. 1974. Predicting diameters inside bark from outside bark measurements of some Appalachian hardwoods. J. For. 72:775.

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Res. Note PNW-318 "The Reliability of Determining Age of Red Alder by Ring Counts"

Res. Bulletin PNW-75 "Forest Area and Timber Resources of the San Joaquin Area, Calif."

All from Pacific N.W. Forest and Range Exp. Station, P.O. Box 3141, Portland, OR 97208

"Sampling Overwintering Spruce Budworm Populations in Heavily Attached Stands": in Bi-Monthly Research Notes, Vol. 3_ (5): 29-30. Sept.-Oct. 1978 available from Information Services, Department of Fisheries and the Environment, Ottawa, Ontario, KIA OE7, Canada

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"How to Identify and Control the Walnut Catepillar" and Res. Note NC-236 "Availability of Forest and Associated Land Resources in Illinois." From North Central Forest Exp. Station, 1992 Folwell Avenue, St. Paul, MN 55108

Resource Bulletin SO-67 "Mississippi Forests Trends and Outlooks" from Southern Forest Exp. Sta., Room T-10210, U.S. Postal Services BLDG., 701 Loyola Avenue, New Orleans, LA 70113

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Bulletin A-73 "Estimation of Range Use with Grazed-Class Photo Guides" from Coop. Extension Service, University of Arizona, Tucson, AZ 85721

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Sea Grant Publication 76-10 "Know your Mud, Sand and Water; A Practical Guide to Coastal Development." from Sea Grant Program, University of North Carolina, Raleigh, NC 27607 $1.25 outside of state

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NASA Tech. Report. "Discrimination of Rock Classes and Alteration Products in South Western Saudi Arabia with Computer Enhanced Landsat Data" by Blodget, Gunther and Podwysocki, U.S. Department of Commerce, NTIS, 5285 Port Royal Road, Springfield, VA 22161. Price $4.50.

NASA SP-360 "Educators Guide for Mission to Earth: Landsat Views The World" by Tindal. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $2.50

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Meetings

Variable Probability Sampling-Variable Plot and 3P. March 12-16, 1979. Registration for both courses $135. Contact Conference Assistant, c/o Business Office, School of Forestry, Oregon State University, Corvallis, OR 97331

Satellite Hydrology - will be the topic for the Fifth Annual William T. Pecora Memorial Symposium to be held June 11-15, 1979, in Souix Falls, S.D.. For details contact Donald R. Wiesnet, NOAA/NESS, S-33, Washington, D.C. 20233

Workshop on Remote Sensing Field Research - June 25-26 at Purdue University. Scene characterization, spectral data acquisition and calibration, data analysis and instrumentation systems will be covered.

Machine Processing of Remotely Sensed Data - A symposium, June 27-29, 1979 at Purdue University. Emphasis will be on Research Results in:

1. Digital representation and understanding of remotely sensed scenes.
2. Utilization of digitally processed earth resource data.
3. Extraction of information primarily from digital remotely sensed earth resource data.

For information on any of these meetings contact Purdue University, Laboratory for Applications of Remote Sensing, West Lafayette, IN 47907

Sampling on Successive Occasions - A workshop sponsored by Department of Forest and Wood Sciences, Colorado State University, S.A.F. Inventory Working Group and IUFRO S4.02-03 will be held July 17-20, 1979. The workshop is designed for resource managers and researchers engaged in sampling projects such as national and state timber surveys, multi-resource inventories, timber inventories on industry-owned lands, etc. A knowledge of basic sampling technique is assumed. The course will be limited to 40 people and will cover expected values, probability sampling, best linear unbiased estimates, independent estimates, remeasurement, sampling with partial replacement, optimum sample sized and sampling on more than two occasions. The fee is $250. Contact Office of Conferences and Institutes, Residential Conference Center, Colorado State University, Fort Collins, Colorado 80523

1979 Forest Inventory Workshop. This workshop is designed to appeal to land managers, inventory specialists, practitioners, data analysts and biometricians. This national meeting is sponsored by the SAF Inventory and Biometrics Working Groups, IUFRO Subject Groups S4.02 and S6.02 and by Colorado State University. Over 84 papers will deal with such subjects as Multi-Resource Inventories, Biometrics, Inventory Projection and Growth, Inventories on Successive Occasions, Sampling Techniques, Sampling Aspects of Aerial Photography, Computer Uses in Resource Inventories, Tropical Inventories, Biomass Measurement, Biomass Inventory, Metric Conversion Strategies, Product Estimation and a series of Contributed papers. Registration fee will be about $75. The dates are July 23-26 1979, at Colorado State University. For details contact Office of Conference and Institues, Residential Conference Center, Colorado State University, Fort Collins, Colorado 80523.

Forest Photogrammetry - A short course will cover use of Aerial Photos in Type Mapping, Measurments, Flight Planning etc. The dates are August 27-31, 1979 at V.P.I. The fee will be $22. For details contact Adult Register, Donaldson Brown Center for Continuing Education, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. Phone (703) 961-5182.

Coming in 1980! Arid Land Resource Inventory - workshop sponsored by the Mexican Forest Service and the Society of American Forester's Inventory Working Group. Dates are November 30-December 6, 1980 and the place La Paz, Mexico. Watch the Notes for further details and plan to attend.

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Wanted! Lead articles, current literature and meeting announcements for publishing in the "Notes". If announcing a meeting, please allow at least a four month lag time.

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