TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

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PROCEDURE TO DETERMINE AMOUNT OF ACCESS ROAD MILEAGE AND ACRES COVERED BY COUNTY AND MLRA

The attached material provides a procedure to determine amount of access road mileage and acres covered by County and MLRA. The results using this procedure will be useful in identifying realistic figures for County Resource Inventory figures.

The procedure was developed by Jerry D. Owens, Soil Conservationist, at Ukiah and submitted and approved as a Employee Suggestion.

BRIEF SUMMARY OF SUGGESTION

The stratified sampling technique is, in effect, a simple means of estimating the amount of roadway on a given land surface area. Each Major Land Resource Area (MLRA) in a county represents a strata that is sampled exclusive of the others. In this way, the variability of land use patterns between MLRA's is accounted for, providing a more reliable estimate.

This method will utilize randomly selected Primary Sample Units (PSU) as sample points. Sample size (ie: number of observations) and hence man hours involved would be determined by the level of precision desired by the decision maker.

DETAILED EXPLANATION

Present Method:

There is no recommended method at present which will give a reliable estimate within desired parameters. The lack of a systematic approach utilized by all ffices involved with National Resource Inventory (NRI) road inventories produces data of wide variability.

Proposal:

It is proposed that a stratified sampling technique be utilized that will produce data of desired error and precision. This method will utilize PSU's as they exist on aerial photographs as sampling points. The number of observations to be taken can be determined by a simple equation (see "Method"). The value obtained from this equation is a function of 1) varience of preliminary observations, 2) the desired level of precision and error, and 3) time and budgetary constraints. In cases of extreme wide variability, statistic values may indicate an impractical number of observations. In this case good judgement on the part of the decision maker should prevail. A minimum of ten observations per sample is recommended in all cases.

Once the required number of observations has been completed, the values are then extrapolated to reflect the extimated acreage of private rural roads in each MLRA. See attachment for an example of the stratified sampling technique.

Advantages:

The advantages of this method are:

1) A simple, systematic approach that is consistant between all offices, thereby increasing the degree of reliability of data submitted between counties.
2) The use of the PSU as a sample point provides an easily located point. Other vital information (MLRA, proximity to federal land, etc.) is readily available in PSU worksheets. This reduces the "paper shuffling" and thereby man-hours involved.

Disadvantages and Mitigation:

The disadvantage of this method is:

1) the wide variability between observations within a strata may require an impractical sample size to attain desired precision. Good judgement can prevail in this case without severly diminishing precision.

Method:

Road Inventory Utilizing Stratified Sampling Technique

I. Public Roads
   1. Sources of information on state maintained roads.
      a.) Contact state highway departments.
   2. Sources for information on county roads and railroads.
      a.) Contact the county public works office.
   3. Sources for information on federal roads.
      a.) Contact USFS, BLM, etc.

II. Private Rural Roads
   1. Pull the PSU data worksheet and determine those PSU's in existance in 1977 NRI.
      a.) List PSU's by number by MLRA. Do not include those on federal land.
      b.) Randomly choose a minimum of ten PSU's from each MLRA.
      c.) With a rectangular plot that is equivalent to 500 acres on a 1:24000 scale, sample each PSU by aligning the plot adjacent to the PSU in a predetermined fashion.
      d.) Keep data for each MLRA separate from others.
   2. Determine adequate sample size for each MLRA by use of the following equation:

$$n = \frac{t^2 \, s\bar{x}^2}{e^2}$$

Where: n = number of observations
t = value derived from t table
$s\bar{x}^2$ = varience
e = error = (desired % error)($\bar{x}$)

This step is repeated for each MLRA being sampled.

1.) List randomly selected PSU's by number.

2.) Placing the rectangular plot in a predetermined fashion on the aerial photo, measure the length of roadway within the plot.

MLRA 1

PSU	Inches	Inches Squared			
040401	4	16	A.	Enter No. of samples	10
070801	5	25	B.	Enter total of inches	49
100701	4	16	C.	Divide B by A	4.9
100901	4	16	D.	Enter sum of inches squared	247
130601	6	36	E.	Square B	2401
130801	5	25	F.	Divide E by A	240.1
090401	6	36	G.	Subtract F from D	6.9
021101	5	25	H.	Divide G by A minus 1 (A-1)	0.7667
041001	6	36		$S\bar{x}^2 = 0.7667$	
050801	4	16		t at 9 degrees of freedom and 80% level of probability = 1.383	
	49	247			

$$n = \frac{(t)^2 (S\bar{x}^2)}{(e)^2} = \frac{(1.383)^2 (0.7667)}{\left[(0.1)(4.9)\right]^2} = 6.1 = 7 \text{ observations needed.}$$

3.) Since 10 samples have already been taken and the results indicate only 7 are needed, no further samples need be taken.

Therefore: (4.9) (2000 ft/5280 ft/mi) (2.5 ac/mi) (10000ac/500 ac) = 92.8 acres of private rural road in MLRA 1

4.) Now repeat the procedure for MLRA 2.

MLRA 2

PSU	Inches	Inches Squared			
130602	7	49	A.	Enter No. of samples	10
090802	12	144	B.	Enter total of inches	66
010802	4	16	C.	Divide B by A	6.6
022002	6	36	D.	Enter sum of inches squared	496
100902	4	16	E.	Square B	4356
130802	10	100	F.	Divide E by A	435.6
120402	5	25	G.	Subtract F from D	60.4
063802	5	25	H.	Divide G by A minus 1 (A-1)	6.71
053602	6	36		$S\bar{x}^2 = 6.71$	
102702	7	49		t at 9 degrees of freedom and 80% level of probability = 1.383	

$$n = \frac{(t)^2 \; (S\bar{x}^2)}{(e)^2} = \frac{(1.383)^2 \; (6.71)}{\left[(0.1)\;(6.6)\right]^2} = 29.46 = 30 \text{ observations needed}$$

5.) Since 10 samples have already been taken and the results indicate an additional 30-10 = 20 samples need still be taken, proceed with the sampling process and extrapolate the results as in MLRA 1.

EMPLOYEE SUGGESTION (Continued)

Detailed Explanation (Continued):

3. Selection of sample and sampling procedure.
   a.) The ten observations taken from each MLRA to determine adequate sample size may be retained for further use.
   b.) Randomly select the appropriate number of samples (PSU's) for each MLRA.
   c.) Pull aerial photos that correspond with the PSU's selected.
   d.) Sample as before.
   e.) Determine $\bar{x}$ for each MLRA and expand data to reflect the estimated acreage.
   f.) Add totals for federal and non-federal as directed.

Note:

1.) A decision on the desired error and precision must be made to determine t and e in equation I.

    Example: 15% error with 90% precision is desired after 10 observations
    $e = (0.15)\ (\bar{x})$
    $t = 1.833$ (from table)

2.) Care must be taken to avoid including state, federal, and county roads in sample. Refer to the appropriate topographic quad map if there is any doubt.
3.) Measure dirt and gravel roads separately but count as one observation.
4.) The use of an electronic planimeter is highly recommended.
5.) MLRA's with large urban acreages may exhibit wide variability.

Example of Stratified Sampling Technique:

Suppose we have a county with a total surface area of 50,000 acres. There are two MLRA's within this area. MLRA 1 has a total surface area of 10,000 acres. MLRA 2 has a total surface area of 40,000 acres. The dirt roads in the county average 20 feet in width which equals 2.5 acres/mile. Determine total surface area (acres) of road in each MLRA with 10% error and 80% precision. A 500 acre plot is used. Aerial photos are 1:24000 scale.

Table C

Critical Values of *t*

For any given df, the table shows the values of *t* corresponding to various levels of probability. Obtained *t* is significant at a given level if its absolute value is equal to or *greater than* the value shown in the table.

80% Probability

	Level of significance for one-tailed test					
	.10	.05	.025	.01	.005	.0005
	Level of significance for two-tailed test					
df	.20	.10	.05	.02	.01	.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291