STRATIFICATION IN DOUBLE SAMPLING -- "THE EASY WAY
OUT MAY SOMETIMES BE THE BEST WAY"

by

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Double sampling with aerial photo and ground plots is commonly used for timber
inventories. Most of these inventories have several parameters of interest.
Take, for example, the estimation of forest area in a large land area such as
a state. A typical inventory of a state might include several thousand aerial
photo plots with a subsample of several hundred ground plots.

Assume that we have 80,000 photo plots with 500 to be selected for ground
examination. We might do the following:

(1) Stratify the 80,000 photo plots into two categories -- forest
and nonforest.

(2) Select some plots at random from each category for ground examination.

The ground classification may differ from the photo classification because of
changes which have occurred since the date the photos were taken. Also, there
is a possibility of error because of misclassification by the photo interpreters.

We might arrive at these results:
64,526 photo plots classified as forest
15,474 photo plots classified as nonforest

If proportional allocation of ground plots is used, we may have:
103 ground plots selected at random from the 64,526 plots classified as
forest; ground examination reveals that 386 are actually forest and 17 are
nonforest.

97 ground plots selected at random from the 15,474 plots classified as
nonforest; ground examination reveals that 87 are actually nonforest and
10 are forest.

Our estimate of forest area at the time of ground examination (assuming that
the state has 20,580,000 acres of land area) is

\[ FA = \frac{N_f}{N_p} \]

where \( A = \) land area
\( N_f = \) primary sample size (photo plots) in stratum i

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\[ N = IN_i \]

\[ P_i = \text{estimated proportion of forest area in stratum } i \]

\[ FA = 20,580,000 \left\{ \left( \frac{64,528}{80,000} \right) \left( \frac{386}{403} \right) + \left( \frac{15,474}{80,000} \right) \left( \frac{10}{95} \right) \right\} = 16,309,000 \text{ acres} \]

with variance

\[ S_{FA}^2 = \frac{A^2}{N(N-1)} \left\{ \frac{N_i(N_i-1)}{n_i(n_i-1)} \frac{(P_i - \bar{P})^2}{n_i} \right\} + \frac{N_i(P_i - \bar{P})^2}{n_i} \]

where \( P = \frac{\sum N_i P_i}{N} \)

\( s_i \) = secondary sample size (ground plots) in stratum \( i \)

\[ S_{FA} = 209,000 \]

This is a common procedure and the results are typical of many such statewide inventories. Many photo plots were used, but they are relatively cheap in relation to ground plots. Sometimes, however, there is a way to make the photo interpretation task even easier (and cheaper) and at the same time improve the precision of estimated forest area.

Most of the photo plots were probably easy to classify. The ones which took the most time on the part of the photo interpreters (and consequently were the most expensive to handle) were the ones which were doubtful. You've seen it before: An interpreter looks at a photo plot, is unsure how to classify it and after looking at it some more he asks advice of other interpreters. Finally, after spending much more time on this than the "easy" ones, it's put into one class or the other.

Let's try an alternative. Let's create a third class which represents all the photo plots which are difficult to classify. Don't spend time on any plot which is doubtful; just put it in this class.

Applying this to the same problem given above, we may have the following results:

- 64,101 photo plots classified as forest
- 15,104 photo plots classified as nonforest
- 795 photo plots not classified as either
Again, using proportional allocation, we have:

431 ground plots selected at random from the 64,101 plots classified as forest; ground examination reveals that 396 are actually forest and 3 are nonforest.

94 ground plots selected at random from the 15,104 plots classified as nonforest; ground examination reveals that 93 are actually nonforest and 1 is forest.

5 ground plots selected at random from the 795 photo plots classified as doubtful; ground examination reveals that 2 are actually forest and 3 are nonforest.

\[
PA = \frac{28,580,000}{64,101} \cdot \left(\frac{396}{80,000}\right) + \frac{15,104}{80,000} \cdot \frac{1}{94} + \frac{795}{80,000} \cdot \frac{2}{3}
\]

\[
= 16,408,000 \text{ acres}
\]

Thus, by taking the "easy way out," we have realized a reduction in the standard error of the estimate from 209,000 to 116,000. We were able to do this by absorbing most of the photo interpretation error into one class which represents a small segment of the population. At the same time we have reduced photo interpretation costs.
FORESTRY

0008-2 "Forest Inventory - Iran - The Caspian Forest Inventory" and 0008-3 "The Zagros Forest Inventory" by James C. Space. Requests for copies should be directed to: Forest Service, USDA, James C. Space, Computer Systems Applications Staff, P.O. Box 2417, Washington, D.C. 20013.


"Economic Analysis - Phase II - Washington Forest Productivity Study" from State of Washington, Dept. of Natural Resources, Olympia, WA 98504.

677-334 "Timber Sale Contracts" is available from Cooperative Extension Service, University of Nebraska, Lincoln, NE 68583.

Forest Inventory - Volume I, second edition "Statistics of Forest Inventory and Information from Aerial Photographs" and Volume II "Collection of Data in the Field and Related Sources of Info, Fundamentals of ZDP and Methodological Components for Inventory Planning" by Loutsch, Zohrer and Hailer available from BLV Verlagsgesellschaft MBH, D-8 Munchen 40, Lotharstrasse 29, P.O. Box 40 03 20, Fed. Rep. of Germany. The prices are DM 150 and DM 195 respectively.

RANGE and WILDLIFE

G75-205 "Estimating Hay in Stock Pens"
and
EC 76-131 "Nebraska Handbook of Range Management" from USDA Extension Service, University of Nebraska, Institute of Agriculture and Natural Resources, Lincoln, NE 68583.


RECREATION

WRRT Bulletin 27: "An Unobtrusive Measure of the Recreational Value of a Lake" may be purchased from Water Resources Research Institute, 205 Samford Hall, Auburn University, Auburn, AL 36830. The price is $2.00.


WATERSHED and 2013

Brochure "The Detection and Mapping of Subterranean Water Bearing Channels" from Missouri Water Resources Research Center, 424 Clark, University of Missouri, Columbia, MO 65201.


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Cir. 476 "Soil Classification in Hawaii" from: Cooperative Extension Service, University of Hawaii, Honolulu, HI 96822.

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Remote Sensing


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"Specifications et Recommandations Concernant Quelques Instruments Métroiques de Mesure Dans Le Secteur Forestier Canadien".


"Resources for Teaching Remote Sensing" by L. Swyn-Wittgenstein. - are all available from Forest Management Institute, Canadian Forestry Service, Ottawa, Ontario, K1A 0W2 Canada.

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General

Res. Note NE-236 "RIDGE - A Computer Program for Calculating Ridge Regression Estimates"

and


Coop. Ext. Pub. 1917 "Use Value Assessment ....... Everything You Wanted to Know About It, but Were Afraid to Ask Your Assessor" from Louisiana Cooperative Extension Service, Kipp Hall, Baton Rouge, LA 70803.

Cir. 232 "Simplified Programming as a Farm Management Tool" from Agricultural Exp. Station, Auburn University, Auburn, AL 36830.


"Richtwerte für die Freiraumplanung" may be obtained from Dr. N.C. M. Prodan, 78 Freiburg, Wallstr. 22, West Germany.

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Meeting


The course is for those land resource managers who have not had or who need a refresher on such topics as: obtaining aerial photography, small format camera systems, preparing and viewing aerial photos stereoscopically, determining scale, distances, heights, slopes, and area, making simple maps, and interpreting vegetation and landform. Cost $100.

Contact Dr. Joseph J. Ulliman, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, Idaho 83843.

The Laboratory for Applications of Remote Sensing (LARS) is sponsoring a series of short courses on Remote Sensing Technology and Applications. The four day courses are held monthly March through June.
Also a course on "Advanced Topics in the Analysis of Remote Sensing Data" will be held April 10-14, 1978. For either course contact the Continuing Education Business Office, Room 110, Stewart Center, Purdue University, West Lafayette, IN 47907.

Get this on your calendars!

A workshop entitled "Implementing Computer Systems in the Field" is being co-sponsored by the SAP's Systems Analysis Working Group and Iowa State University. The workshop will be held in the Schuman Continuing Education Building on the Iowa State University Campus in Ames, Iowa on April 27-28, 1978. The registration fee of $65.00 includes lunch on April 27 and 28, dinner April 27, shuttle service between the Schuman Building and major hotels and motels, and workshop proceedings.

For further information contact David W. Countryman, Dept. of Forestry, 251 Bessey Hall, Ames, IA 50011 or phone (515) 294-1166.

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