

US EPA ARCHIVE DOCUMENT

Stevens, D. L., Jr. and A. R. Olsen (2004). "Spatially-balanced sampling of natural resources." *Journal of American Statistical Association* 99(465): 262-278.

The spatial distribution of a natural resource is an important consideration in designing an efficient survey or monitoring program for the resource. Generally, sample sites that are spatially balanced, that is, more or less evenly dispersed over the extent of the resource, are more efficient than simple random sampling. We review a unified strategy for selecting spatially balanced probability samples of natural resources. The technique is based on creating a function that maps two-dimensional space into one-dimensional space, thereby defining an ordered spatial address. We use a restricted randomization to randomly order the addresses, so that systematic sampling along the randomly ordered linear structure results in a spatially well-balanced random sample. Variable inclusion probability, proportional to an arbitrary positive ancillary variable, is easily accommodated. The basic technique selects points in a two-dimensional continuum, but is also applicable to sampling finite populations or one-dimensional continua embedded in two-dimensional space. An extension of the basic technique gives a way to order the sample points so that any set of consecutively numbered points is in itself a spatially well-balanced sample. This latter property is extremely useful in adjusting the sample for the frame imperfections common in environmental sampling.