



Module 2: Environmental Sampling

2.4 Systematic Sampling



Systematic Sampling

- ◆ Systematic sampling involves selecting sample units according to a specified pattern in time or space
- ◆ This ensures that the entire population is evenly covered.
- ◆ For this reason, it is intuitively appealing and often used in environmental sampling



One-Dimensional Procedure

- ◆ One-dimensional systematic sampling is useful for sampling in time or along a line such as a river or stream
- ◆ Calculate $k=N/n$ as the spacing interval. Round k to nearest integer.
- ◆ Pick a starting position at random and sample it
- ◆ Select the second sample point k distance from it, the third k distance from the second, and so on until n samples have been defined

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One-Dimensional Procedure

- ◆ Notes:
 - Often the last distance does not exactly equal k
 - View the linear population as circular so that, when the end is reached, you circle back to the beginning and continue

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One-Dimensional Procedure

◆ Example:

- Population = the days in July (N=31)
- Sample 6 days in the month
- $k=31/6 = 5.17 = 5$
- Randomly pick a number between 1 and 31 = 17
- Sample days 17, 22, 27, 1, 6, 11
 - [Note: day 1 was calculated by $27+5=32-31=1$]
- Sort into order for reporting purposes:
1, 6, 11, 17, 22, 27



Two-Dimensional Procedure

- ◆ Two-dimensional systematic sampling is useful for sampling the land surface.
- ◆ Split the population into n equal areas
- ◆ The areas could be squares, rectangles, triangles, or any other shape
- ◆ Pick a point in each area to sample. Points can be:
 - middle of each area
 - Randomly chosen once and then sample that same point in each area
 - Randomly choose a different point in each area



Data Analysis

- The simplest way to analyze the data is to treat it as though it was collected using simple random sampling. This probably overestimates the standard error but that is better than underestimating it.
- Another way to analyze the data is to arbitrarily stratify into groupings of equal numbers of points and analyze using methods for stratified samples.
- The best way is to analyze using methods for spatial data (Chapter 9).

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Systematic Sampling

- If the population has natural cycles or trends, and the periodicity of the sampling coincides with the cycle, then the sample will be biased.
 - For example, temperature cycles based on 24 hour periods (as well as 365 day periods)
 - If $k=12$ hours, then samples will always be taken at the same times each day
 - If temperature affects the measurement, then the full range of temperature will not be experienced and the samples will be biased.

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Systematic Sampling

- ◆ Advantages
 - Easy to do
 - Intuitively appealing
- ◆ Disadvantages
 - Simple analysis overestimates the standard error
 - Cycles or patterns in the population may create problems