Ecological Sampling Design

Overview of designs

Objective

- Describe some commonly used sampling designs

Take Home:
1) a poor design can lead to poor data
2) the mean and variance calculations (i.e., estimate and confidence intervals) depend upon the sampling design

An Eight Step Approach to Design

1. Define Study Objectives/Hypotheses

2. Specify Assumptions and Constraints (e.g., setting limits on study scope as the study area boundary)

3. Specify parameters to be estimated (the fewer the better- no need to measure everything!)

4. Identify Sources of Variance in Laboratory and Field

An Eight Step Approach to Design

5. Identify Limits on Acceptability or how good to we need to be? (data precision [90% confidence intervals ± 20% of estimate], power)

6. Determine Data Collection Process (included in **protocol**)

7. Develop Most Efficient Design- work toward unbiased estimate with high precision or certainty (included in **protocol**)

8. Evaluate Ability to Achieve Objectives (e.g., pilot study, power analysis, adequacy of sample size)

Criteria for Choosing a Sampling Design

- Objectives of study
- Cost-effectiveness of alternative designs
- Patterns of ecological or environmental response and variability
  - Spatial and temporal considerations
- Practical considerations (site access, level of public use/security)

Methods for Selecting Study Sites or Sampling Locations

- Haphazard
- Judgment sampling
- Probabilistic sampling

Haphazard Sampling

- Sites and times selected without scientific rational (any sites will work)
- May work if units are homogeneous
- Potential for bias
  - Units selected for convenience
  - Variability does often change over populations or sub-populations
  - Example: Powell River mussel survey

Judgment Sampling

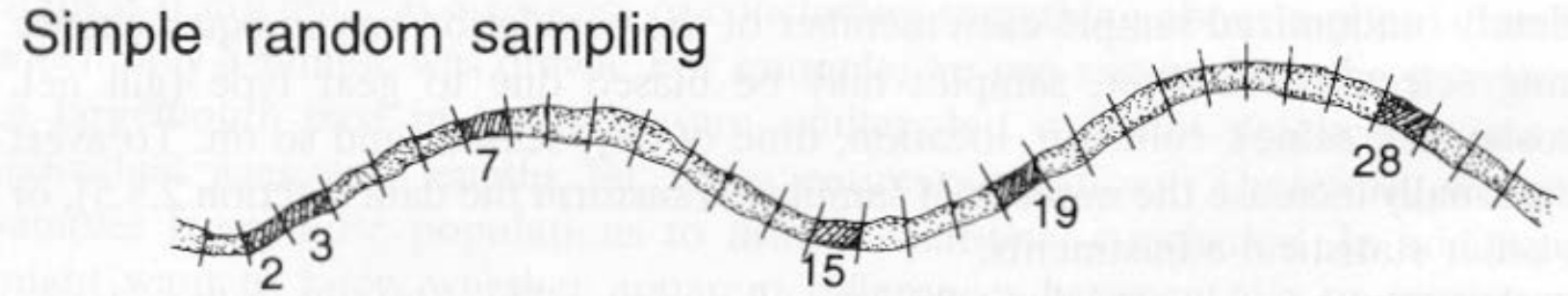
- Subjective selection of sites by an individual, therefore a potential for bias exists
- May be useful if all the units are visible and one can select a “representative” sample
- Requires extensive knowledge of problem and sampling area
- May result in good estimate with unknown variance - atypical members cannot be used to make inference about a population
- May be useful for finding unique attributes
- Very useful in pilot studies

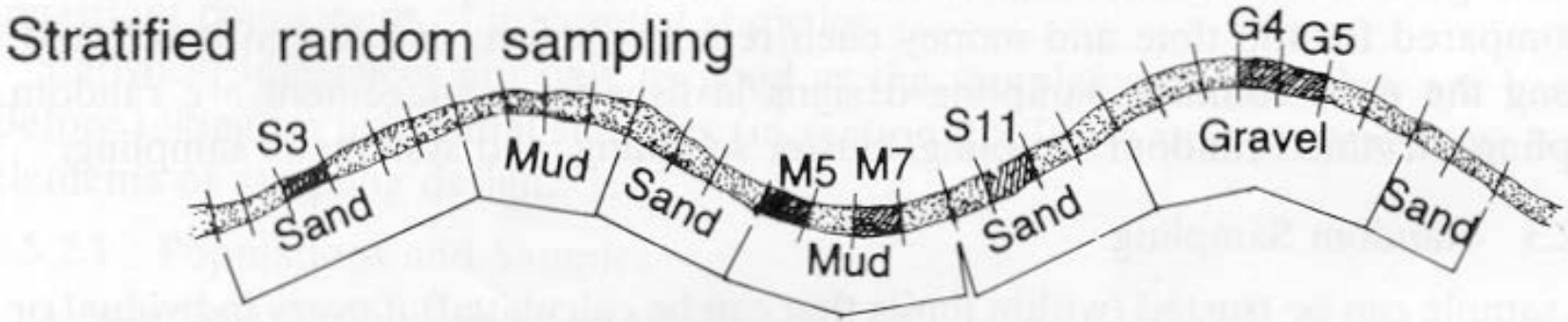
Probabilistic Sampling

- Useful when bias and variance are issues
- Useful when populations are heterogeneous
- Can be adapted to complex situations
- May result in unrealistic sampling schemes
  - sites which are inaccessible
  - streams on maps but don't exist
- Variance estimates may be complex
- Often require prior information for good design

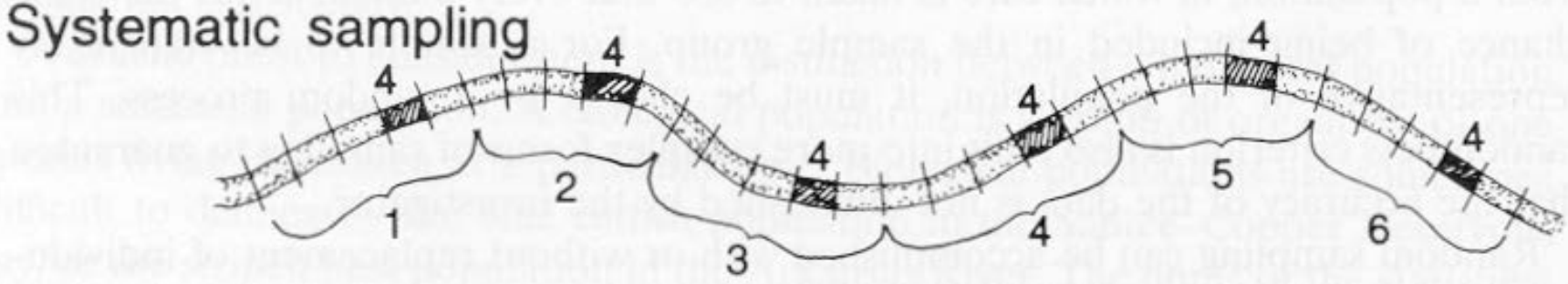
(Some) Probabilistic Sampling Methods

- Simple random sampling
- Stratified random sampling
- Systematic sampling





These techniques can be applied to selecting study sites in a stream



Random sampling required the use of a random number table.

These techniques also can be used to locate spots where actual sampling takes place within a study site.

But first, how are study site boundaries determined?

Study Site Delineation

- "The reach should include an entire meander (i.e., two bends) if possible. The length should be at least 20 times the bankfull width of the channel. …this length will include a range of features sufficient to accurately characterize the stream."
  - Harrelson et al. 1994. Stream Channel Reference Sites

Study Site Delineation (continued)

- "…the reach length is determined by multiplying the mean wetted channel width by 20. The width is multiplied by 20 because, in meandering streams, 20 times the channel width typically encompasses at least on complete meander wavelength. This ensures that all habitat types are represented in the reach"
  - Fitzpatrick et al. 1998. Revised Methods for Characterizing Stream Habitat in the NAWQA Program. USGS.

Study Site Delineation (continued)

In addition-

- “the reach should include at least two examples each of two types of GCU’s. Only those GCU’s that are greater than 50 percent of the channel width are considered”

And

- Minimum and maximum reach lengths for wadeable streams are 150 and 300 m, respectively

- Fitzpatrick et al. 1998. Revised Methods for Characterizing Stream Habitat in the NAWQA Program. USGS.

Study Site Delineation (continued)

- Sites were approximately 35 – 40 mean (wetted) stream widths (MSW)in length
- Began and ended sites at the downstream end of riffles, if present.
- The mean stream width was based on 15 – 20 measurements of wetted stream width from throughout the station.

  - Simonson, T.D. et al. 1994. Quantifying fish habitat in streams: Transect spacing, sample size, and a proposed framework. N.A. Journal of Fisheries Management 14:607-615.

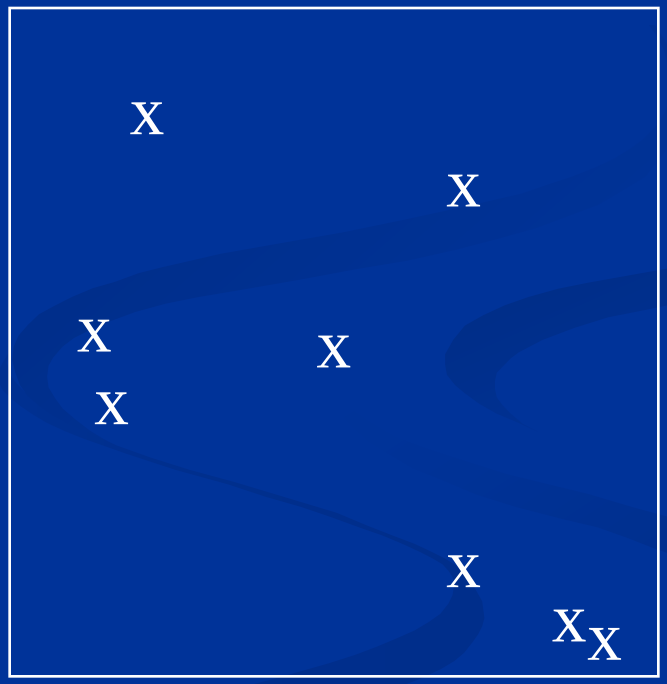
Sampling Within a Study Site

- Now that a study site has been delineated, where do you take observations (“samples”).

Simple Random Sampling

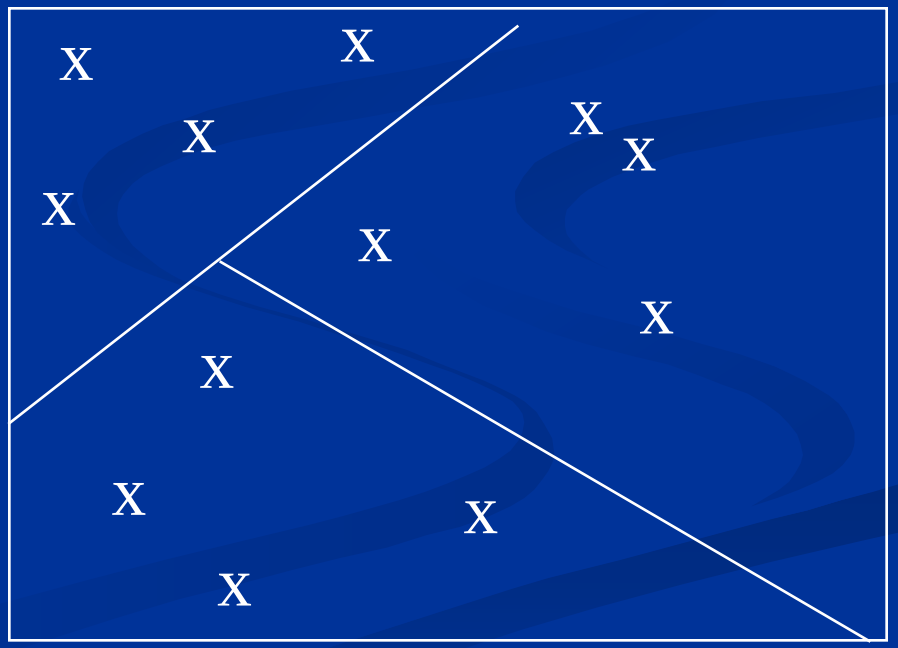
- Simple design
- Requires homogeneous population
- Other designs are better when there are trends or groups

Simple random sampling



Stratified Random Sampling

- Used when heterogeneous population can be broken into parts
- Example: 3 different habitat types



Systematic Sampling

- Useful for estimating trends in time or patterns in space
- Provide good spatial coverage
- Randomness from selection of starting point

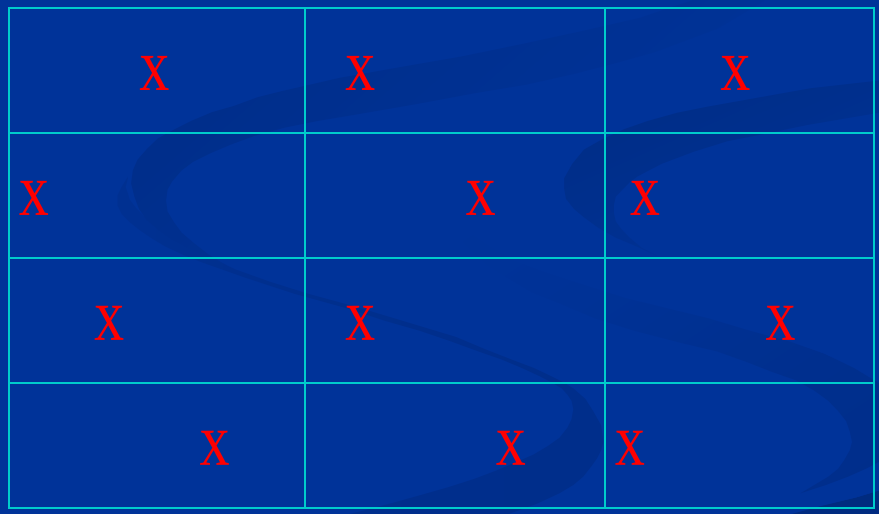
- Systematic sampling

X	X	X
X	X	X
X	X	X
X	X	X

Systematic Sampling

- Can be combined with random sampling

Random sampling within blocks



Systematic Transect Number & Spacing

- Recommend measuring habitat variables along ~20 transects, spaced 2 MSWs apart, over a site 35 – 40 MSWs (non-random start)
  - Simonson et al. (1994)

- 11 transects spaced 2 MSW apart with start at ~ one-half of the MSW upstream or downstream of GCU boundary
  - Fitzpatrick et al. (1998)

Specialized Methods for Ecological Sampling

- Strip transect (Quadrat sampling) –we will use in bank condition sampling
- Line transect sampling –we will use for measuring velocities and depths
- Line intercept sampling –we will use in estimating instream cover

References

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- Seber, G.A.F. 1982 The estimation of animal abundance. MacMillan Publishing Co. New York
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- Thompson S.K. 2002. Sampling. John Wiley and Sons, New York