Table 3.1 Selecting a sampling strategy for estimating population size. Throughout this table, the term 'quadrat' is used for the sampling unit

Strategy	Principle	Applications	Advantages	Limitations and disadvantages
Simple random sampling without replacement (SRS)	Quadrats selected at random. Each quadrat in study area has equal probability of being in sample	Best for relatively uniformly distributed organisms	Simplicity	Relatively poor for patchily distributed organisms. High risk of unconscious bias in selecting random points, when using imprecise navigation
Systematic sampling (SystS)	Quadrats selected on a regular grid or line	As for SRS, to which it is roughly equivalent in most cases	Very simple. Sample covers whole study area, and is resistant to bias in selecting locations	May fail if there is periodicity in distribution of organism. Disliked by statisticians
Stratified random sampling (StrRS)	Study region divided into strata of known size, chosen so that variation between strata is maximized, and variation within strata is minimized	Patchily distributed organisms, where patchiness is predictable from mappable environmental characteristics	If patchiness is predictable, estimate is considerably more precise than that produced by SRS or SystS	Slightly more complex than SRS. Areas of strata must be known. Does not help with unpredictable patchiness
Cluster sampling (CS)	Primary points located at random. Cluster of quadrats located in fixed conformation around these. Cluster designed so that variability within it is maximized	Useful if cost of locating random quadrats is high compared with cost of sampling quadrats. Can help with unpredictable patchiness	Less chance of unconscious bias in quadrat location than SRS. Often produces better precision for same effort than SRS	If number of primary points is too small (< 10), confidence limits may be wide. Open to the error of treating each quadrat as an independent unit
Adaptive sampling (AS)	Initial quadrats selected at random. If population density above a threshold, neighbouring quadrats sampled too	Patchily distributed organisms, where locations of patches cannot be predicted before sampling	Major gains in precision possible relative to SRS	Highly complex, and performance in real situations not fully understood. Potential gains dependent on quadrat size and threshold rule used

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Table 3.1 *contd*

Strategy	Principle	Applications	Advantages	Limitations and disadvantages
Two-stage sampling (2Stg)	Initial sample selected using SRS. From each unit selected , a sample of subunits is taken, also by SRS	Useful if enumerating the population of an entire primary unit is not feasible. Size of primary unit usually not under investigator's control (e.g. trees, ponds)	Major gains in precision possible if primary units selected with probability depending on size	Size of all primary units in the population must then be known
Ratio estimation (REst)	Sample selected using SRS. Auxiliary variable x recorded in addition to population size. Ratio of y to x used to form estimate	Auxiliary variable usually some feature of environment that is easily measurable, and to which population size is roughly proportional	If population size y is nearly proportional to auxiliary variable, major gains in precision relative to SRS	Mean value of auxiliary variable over total study area must be known. Small problem with bias
Double sampling for stratification (DStrRS)	Proportion of study area falling into strata determined from sample selected using SRS. Population size determined from a subsample from each stratum	As for StrRS, but possible even if stratum areas cannot be determined in advance	As for StrRS	Only helpful if allocating samples into strata is easier than measuring population size itself
Double sampling for ratio estimation (DREst)	Initial sample taken using SRS. Auxiliary variable measured on this sample. Subsample taken from which population size is recorded too. Then proceed as for REst	As for REst, but can be used if auxiliary variable overall mean is unknown. Can also be used to calibrate or ground-truth survey methods	As for REst	Only helpful if it is cheaper and easier to estimate auxiliary variable than population size, and if there is a sufficiently strong relationship between auxiliary and population size

Simple random sampling

As its name suggests, this is the simplest possible sampling design, and one with which almost all biologists are familiar. It is rarely the case, however, that simple random sampling is the best design for a given problem. In a simple

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