STRATEGIES TO REDUCE MONITORING COSTS ON SOLAR SITES

2023 EDITION

phase
pollinator habitat aligned with solar energy

Strategies to Reduce Monitoring Costs

This guidance document presents a series of strategies that can be used to help reduce the cost of monitoring. Approaches to cost reduction can vary depending on the management and sampling objectives, monitoring approach, and resources used. Approaches and specific implementation strategies covered in this document include:

Strategies	Organizing Samples	Adapting Sampling Approaches	Reduced Sampling
Specific approaches	• Stratification • Two-stage cluster sampling	• Balancing sampling over time • Using permanent plots • Using multiple assessment tiers	• Key areas focus • Representative sampling • Revise sampling objectives
How it Reduces Costs	Focusing sampling efforts based on selected characteristics maximizes efficient use of budget.	Decreasing or adjusting sampling efforts over a longer period may reduce per effort costs.	Focusing sampling on key or representative areas reduces sampling effort.

1. Organizing Samples for Cost Effectiveness

Choosing a sampling strategy, or organizing samples, can help reduce costs associated with monitoring depending on specific goals and objectives of the site and organization. Aside from simple random sampling, other sampling strategies that may reduce costs include (A) stratified sampling and (B) two-stage cluster sampling.

A. Stratified Sampling

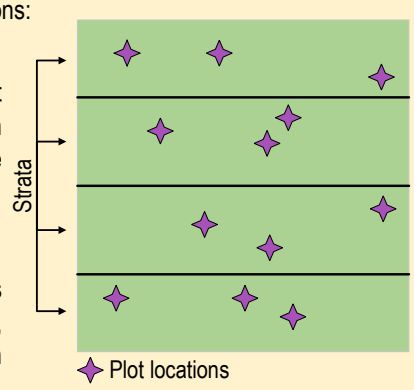
Stratification entails dividing your solar site into groups with like characteristics in order to test differences between the groups. In practice, an area of interested would be divided into strata based on predetermined characteristics, and an equal number of samples would be collected in each stratum. Stratification is most useful when differences between strata are considerable. You might consider stratification for one of two reasons:

To test differences in management

When comparing two or more management approaches, your area of interest will be split into strata based on management approach. Vegetation parameters can be compared between these strata. This will require more plots than simply characterizing the site as a whole.

To test differences between significantly different vegetation

Stratifying by different vegetation types can reduce the number of plots required by reducing the variability from plot to plot in each stratum. However, if the variability between vegetation types is not sufficiently high, then stratification risks requiring more samples than simple random sampling.

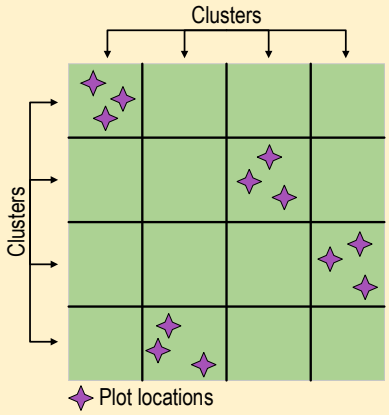


B. *Two-Stage Clustering*

Two-stage cluster samples can reduce the cost of sampling by reducing travel time between plots. A two-stage cluster sample allows you to take a handful of samples in a location before moving on to the next cluster of samples. However, it comes at a cost of precision. You can overcome the loss in precision by taking more total samples than you would in a simple random sample. It is better to add more clusters than to add more plots per cluster to reduce uncertainty in the sample parameter estimates.

To construct a two-stage cluster sample, first decide how you will divide your area of interest site into primary sampling units (i.e., clusters). Ideally, all clusters should be approximately the same size. If the sampling units must be different sizes, you must randomly select clusters with probability proportional to their size. To analyze the data, you will need to know the area of each cluster.

After establishing cluster division, randomly select a subset of the clusters, and randomly or systematically distribute plots within the cluster. The same number of plots should be assessed in each cluster. Keep track of which cluster each plot belongs to for data analysis. How to construct a confidence interval for a two-stage cluster sample is described in Calculation Worksheet: Construct a confidence interval.



2. Adapting Sampling Approaches

Sampling approaches can be adapted in different ways to reduce their overall cost. Some strategies of adaptation that can be employed including (A) balancing sampling over time, (B) using permanent plots, and (C) utilizing multiple different assessment tiers.

A. *Balancing sampling over time*

All plots do not need to be collected in the same year. If you have more plots than you can sample given annual resources, consider splitting up data collection over multiple years. This can allow you to characterize a larger area with your budget. If you will be adding new areas to your area of interest over time, consider decreasing the frequency of monitoring at sites that are more established and less likely to require adaptive management.

B. *Using permanent plots*

If using permanent plots to detect changes in vegetation conditions (i.e., trend), fewer samples are typically required due to the correlation between plots from year to year. Depending on your objectives, you may be able to decrease monitoring intensity in subsequent years if you are only trying to detect changes from year to year.

C. *Using multiple assessment tiers*

Consider pairing intensive Tier 3 monitoring with less intensive Tier 1 or 2 monitoring and/or qualitative monitoring like photopoints to support management decisions without adding high cost. Remember however that a large proportion of the cost of any monitoring project is the time required to get to a point, so this strategy may be best suited for organizations who have non-biologists frequently visiting sites that can collect Tier 1 or 2 assessment data, rather than having biologists take less data once at a plot.

3. Reducing Costs Through Reduced Sampling

Depending on an organization's goals and objectives related to monitoring, a number of different reduced sampling measures can be used to reduce overall cost of monitoring activities. Before employing any of these strategies, be sure to understand the benefits and drawbacks of each. Further, some of these reduction strategies may not be eligible if monitoring is associated with Agreements such as the Monarch CCAA.

A. *Key areas*

If resources do not permit distributing samples across the entire area of interest, you can instead identify 'key areas' within your solar site to sample. Key areas are locations that are either of high importance or indicative of the habitat as a whole. While you cannot make generalizations from key areas to your entire solar site, it is not unreasonable to make management decisions based on what you find within key areas. When using the key areas strategy, it is recommended to also include qualitative methods outside of the key areas, like photopoints, to ensure that the key areas continue to be representative of the habitat as a whole.

B. *Representative sampling*

Representative plots can be used to characterize smaller sites when desired. The data collector will review the site, often by spending a brief time walking the site, before identifying a plot that is representative of the vegetation as a whole. One to three plots is typically sufficient to characterize sites using representative samples. Representative plots should not be used for larger areas (where it is more difficult to establish what is "representative"). Data from representative plots should never be pooled with data from randomly selected plots.

C. *Revise sampling objectives (for less precision or statistical power)*

If none of the other strategies described here allows you to collect the number of plots required to meet your sampling objectives, you will need to revise your sampling objectives or drop sampling objectives. Look across all sampling objectives to identify the objective that is associated with the highest number of plots required. You may decrease confidence level, increase the probability of a missed change error, or increase the minimum detectable change or confidence interval width. Carefully consider why you selected those levels in the first place and how relaxing them will impact your ability to interpret the data. Also consider if there are other ways of getting the same information--through photopoints, qualitative descriptions, or other ways--to replace or support this sampling objective.

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