

## Using Probability, Nonprobability, and Certainty Samples

Note: This guidance is designed to ensure that GAO policies on evidence and generally accepted government auditing standards are met. The guidance conforms to the generally accepted principles and practices of the appropriate disciplines. Statements that particular actions “should” be taken are practices that are expected to be followed, unless there are good reasons for not doing so. Before deviating from a practice expressed as a “should” statement, staff members must consult with an appropriate staff member in Applied Research and Methods (ARM) or a team specialist and must document the consultation.

Abstract: This document identifies key considerations when choosing between probability, nonprobability, and certainty sampling, and provides definitions and features of each of these samples. Some limitations of each method are discussed, as well as the types of conclusions that can be drawn from each type.

Probability or nonprobability sampling approaches may be appropriate when it is not feasible to gather or analyze information for the entire population. A sample for which information is gathered or analyzed for the entire population is referred to as a certainty sample (or a 100 percent sample, or census). GAO uses each of these methods, and their approaches and roles are very different. The engagement objectives are the starting point in establishing which approach should be used. Each type of sampling is briefly discussed below. The use of sampling in financial audits differs somewhat from its use in performance audits or evaluations. For more information on financial audits, see the Financial Audit Manual on the Financial Management and Assurance team’s Web site<sup>1</sup> and GAO’s Yellow Book.

A statistician (from ARM’s Center for Design, Methods, and Analysis, or from the team) should be involved whenever sampling is considered. If a probability sample is proposed, a statistician can help design sampling strategies that are efficient and defensible. If a nonprobability sample is proposed, an ARM statistician or methodologist can help explore whether a probability sample might be a feasible alternative, depending on the engagement objectives.

### Probability Sampling

In a probability sample (sometimes referred to as a statistical or random sample), each unit in the population has a known, non-zero probability of being selected. The results of a probability sample can usually be generalized

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<sup>1</sup>U.S. General Accounting Office, Financial Audit Manual, PCIE/GAO FAM 2008 (Washington, D.C.).

to the population from which the sample was taken. The sampling error of these population estimates can be quantified, and confidence intervals designed to (nearly always) include the true but unknown population values can be constructed.

If the objective is to report characteristics about a population, such as the percent of an agency's officials who received certain training, or the total dollar value of transactions in error in an agency's system, then a probability sample may be appropriate. For more information, see Designing Evaluations on the ARM Web site under Evaluation.<sup>2</sup> For more guidance, including reporting language examples, see "Reporting Results from Probability Samples" on ARM's Web site.

### **Nonprobability Sampling**

In a nonprobability sample, some units in the population have no chance, or an unknown chance, of being selected. In nonprobability sampling, a sample is selected based on knowledge of the population's characteristics or from a subset of a population.<sup>3</sup> Selecting locations to visit and identifying officials to interview are a part of many GAO engagements, and these choices are usually made using a nonprobability sampling approach, but they can be selected randomly, particularly if it is important to avoid the appearance of selection bias. In either approach, the sample is not designed to produce estimates of the entire population.<sup>4</sup>

A nonprobability sample may be appropriate to provide illustrative examples, to establish vulnerability to fraud, or to provide some information on a specific group within a population. For example, selecting a small number of airports out of the more than 400 throughout the country, or choosing several states out of the 50. However, the major limitation of a nonprobability sample is that the results cannot be used to make inferences about a population. A nonprobability sample, therefore, should not be used if the engagement objectives are to generalize about the population from which the sample is taken.

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<sup>2</sup>U.S. General Accounting Office, Designing Evaluations, GAO/PEMD-10.1.4 (Washington, D.C.: May 1991).

<sup>3</sup> For example, a sample may be selected from a part of the entire population that is easily accessible or for which data is available.

<sup>4</sup> A nonprobability sample is always a nongeneralizable sample, and some probability samples are not designed to produce reliable population estimates and are also referred to as "nongeneralizable". In this document, the term "nonprobability sample" also refers to nongeneralizable samples that may have been selected randomly. For more information, see the ARM guidance, "Selecting a Sample of Nongeneralizable Cases for Review in GAO Engagements".

Depending on a job's objectives, teams may be able to turn what looks like an opportunity to use a nonprobability sample into a probability sample. For example, a team may wish to collect data from cases in several different geographic areas by selecting a nonprobability sample of cases from each of these areas. As an alternative to this nonprobability approach, the team could group the entire population into several geographic areas and select cases randomly (i.e., probability sampling) from each geographic area. Depending on resources available, this approach could allow the team to produce population estimates that are sufficiently reliable to meet the engagement's objectives. Teams should consult with a statistician to explore whether a probability sampling approach may be an appropriate alternative to a nonprobability sample.

In some cases, it is neither feasible nor desirable to use probability sampling. The team generally then determines the desired sampling approach with advice from senior management and specialists. Suppose, for example, that the team is examining compliance with administrative procedures across the field offices of a specific program and is attempting to select from a small group of field offices of particular interest to the requesters.<sup>5</sup> If it is expected that the size of the field office will be closely associated with compliance, then the team may consider selecting field offices of different sizes from this small group. An approach like this may be an efficient way of suggesting which size of field office is compliant, even though the sample is not a probability sample

When describing a nonprobability sample in the methodology section of a GAO product, qualifying language should be considered. For example:

“We also conducted telephone interviews with a nonprobability sample of 25 projects. While the results of our telephone discussions cannot be projected nationwide, they represent a mix of stewardship contracting projects by virtue of their geographic diversity; the stewardship contracting authorities being used; and project status, objectives, and activities.”

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<sup>5</sup> For more information on this, please refer to the ARM guidance paper, “Guidance: Handling requester's suggestions for locations or items to test”

## Certainty Sampling

In some situations it makes sense to include the entire population in the sample. This type of sample may be referred to as a certainty sample, a 100 percent sample, or a census. Typical factors that influence a decision to do a certainty sample include:

- The population is small enough that, given the available resources and timeframes of the engagement, a certainty sample is possible.
- Sufficient resources are available to collect and analyse data for the entire population.
- The cost and time to obtain and analyze data for the entire population is minimal (for example, relevant population data is accessible in a machine-readable form).
- Population characteristics with very high precision are required.

When a certainty sample is appropriate, one of the major advantages is that there are no sampling errors. Consequently, if the population is small and if the team is considering a sampling approach, they might also consider whether a certainty sample is feasible.<sup>6</sup> A common example of a certainty sample in GAO engagements is a survey of all 50 states.

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<sup>6</sup> Additional considerations for reporting certainty sample information based on small population sizes is contained in the ARM guidance paper “Reporting Results Based on Small Data Sets.”