NOMAD SAMPLING: AN ANALYTIC STUDY OF ALTERNATIVE DESIGN STRATEGIES

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1. INTRODUCTION

Nomads in many developing countries represent a valuable but largely untapped human resource which when brought into the economic mainstream can contribute significantly to progress. Drawing on this resource, however, requires additional knowledge obtained about these peoples through sample surveys. Problems in designing such surveys are often great and have provided the author with the impetus to produce this research (Kalsbeek and Cross, 1982).

The problem addressed in this paper is one of deciding how one might best sample nomadic households and organize the collection of data from selected households. Although other options exist, we only consider sampling of nomads through those waterpoints where they must periodically receive water for their animals and themselves during the dry seasons of the year. Such was the approach followed in a recent demographic survey in Somalia (Central Statistical Department, 1981).

Two design strategies suggested by the United Nations (1977) and considered for the Somalia survey are compared in this paper. The extended-period model is an approach in which interviewers are placed at each selected waterpoint and households arriving to water their animals for the first time during the period of enumeration are included in the study. The single-day model, on the other hand, is one in which an interviewer attempts to enumerate all nomadic households who appear at a selected waterpoint on one day of the enumeration period that has been randomly assigned to the waterpoint. Subject to some simplifying assumptions and circumstances similar to those encountered in the Somalia survey, we conclude from a numerical example presented that the estimate of the total number of nomadic households (N) obtained through the single-day model is less preferred than the extended-period model.

2. NOMADIC HOUSEHOLDS

Two types of nomads are generally recognized. Pure nomads are those who depend entirely on their animals for livelihood and who, as a result of this dependence, move periodically about in search of water and pasture, thereby having no permanent residence. Semi-nomads are similar to pure nomads except that they also engage in agriculture during part of the year when crops can be grown. However, during the dry season both types of nomads herd their animals in search of water and grazing lands and are therefore referred to collectively in our discussion as nomads.

A nomadic household (the adjective "nomadic" is dropped hereafter) typically consists of a nuclear family, including in some instances members of the husband's family (Lewis, 1961). During the dry season these households may split with the men and older boys taking part of the herd in search of more remote grazing while the women and younger children remain with the rest of the herd closer to a "home" waterpoint.

Virtually all households maintain herds of animals of varying composition. The types of animals most frequently seen are cattle, camels, sheep and goats (the latter two types treated jointly as sheep/goats since the one type is rarely seen without the other). Herds made up of all different combinations of these three types of animals may be observed. Because of the differing lengths of time required for watering (i.e., cattle about every two days, sheep/goats every four days, and camels every 12 days), the frequency of appearance at waterpoints by the household may vary as well (Dahl and Hjort, 1976). Watering intervals, which are religiously maintained by most households, are dependent on the watering interval of what we call the predominating animal, which in any herd is the animal type with the shortest watering interval. The symbol I_i is used to denote the watering interval for the i-th household in the population ($i = 1,2,\ldots,N$).

Sampling nomadic populations through waterpoints is also complicated by several aspects of their lifestyle. One is their mobility which may cause them to be associated with multiple waterpoints during data collection. This creates a multiplicity problem which can be remedied by uniquely linking each household to a single waterpoint or by accounting for the multiple selection opportunities during analysis. Nomadic migration in or out of the area covered by the survey may also contribute to problems in establishing the target population for the study. The problems caused by the households' mobility may be further complicated by differential grazing patterns in the nomadic herds. Dahl and Hjort (1976) have reported that cattle and sheep/goats with shorter watering intervals tend to graze close to a single waterpoint during dry periods, whereas camel herds because of their ability to go without water for longer intervals tend to move about more and may water at several waterpoints. For longer periods of data collection this means that the likelihood of selecting households with camels only may be increased somewhat by the fact that they could be selected through several waterpoints. If, however, the period of data collection is shortened (ideally to 12 days) and data collection is scheduled so that appearance of multiple waterpoints is unlikely, then the multiplicity problem is eliminated.

A second aspect of the nomadic lifestyle which may cause problems is their splitting up (as described earlier) during the dry seasons when they would be studied. The split household problem may not be as severe if all persons eligible for the survey remain together during this period. Such was the case in the Somalia survey where women aged 15-49 years were studied.

The varying composition of nomadic herds presents a third problem since for most sampling approaches the probability of selection for the i-th household will vary inversely with

I_i. If left unaccounted for during analysis, the varying selection probabilities due to I_i will bias estimates when the household's watering interval is in any way related to the study's subject matter.

Finally, sample coverage will be incomplete if a list of all existing waterpoints cannot be constructed. The largest waterpoints or those run by the government are usually easiest to identify. Smaller wells or natural watering areas (e.g., by ponds and streams) are more difficult to list completely. Further bias in estimates may results if nomads in the listed waterpoints differ from those using unlisted waterpoints.

3. TWO ALTERNATIVE DESIGNS

Suppose that the object of the survey is to estimate N, the total number of nomadic households, and that there exist M waterpoints in the population, from which m are to be chosen by simple random sampling (without replacement). To simplify matters somewhat it is assumed that interviewing at waterpoints occurs over a period of 12 days, although what follows can be adapted to a longer period as long as its length were a multiple of 12. Assuming that watering intervals in individual households do not vary, we can define for each household an integral value, $E_i = 12/I_i$, which is the number of times during the interviewing period that the household must water its herd.

The two design alternatives investigated are now briefly described.

Extended-Period Model:

In the so-called extended-period model one or more interviewers are set up at each sample waterpoint for the full 12 days. They are instructed to screen all households which appear during that period but to interview only those households which are watering for the first time during that period. This has the effect of eliminating multiple changes of entry into the study for households, as long as all eligible respondents are together in split households and the grazing pattern of their herd is such that they would appear at only one waterpoint during interviewing. While eliminating the multiplicity problem, this alternative has the disadvantage of turning away households that are eligible for the study except that they have previously watered during the interviewing period.

Single-Day Model:

The second design alternative, called the single-day model, calls for one or more interviewers to be stationed at each sample waterpoints as before, but for only one day (randomly chosen from the 12 days of interviewing). All households watering during the designated day of interviewing are included in the study. Information to determine E_i for each sample household is gathered and incorporated into the estimator of N. This alternative therefore has the advantage of accepting all eligibles (during selected days) but the disadvantage of having to deal with multiplicity in analysis. This approach also requires that more waterpoints be chosen to achieve the same household sample size as the extended period approach.

4. ESTIMATORS AND VARIANCES

Before turning to the matter of estimation under the two design options, a few additional comments are needed. First, let us define the indicator random variable,

$$\lambda_{ijk}^{(h)} = \begin{cases} 1 & \text{if the h-th watering episode during interviewing for the i-th household occurs at the j-th waterpoint on the k-th day of interviewing} \\ 0 & \text{if otherwise,} \end{cases}$$

with

$h = 1, 2, \ldots, E_i$ (episode)
$i = 1, 2, \ldots, N$ (household)
$j = 1, 2, \ldots, M$ (waterpoint)
$k = 1, 2, \ldots, 12$ (one-day time period);

and the associated probability,

$$\pi_{ijk}^{(h)} = \Pr[\lambda_{ijk}^{(h)} = 1].$$

Note also that

$$N = \sum_i^N \sum_j^M \sum_k^{12} \lambda_{ijk}^{(1)} = \sum_i^N \sum_j^M \sum_k^{12} \lambda_{ijk}^{(+)}/E_i = \sum_j^M \tau_j, \quad (1)$$

where $\lambda_{ijk}^{(+)} = \sum_h^{E_i} \lambda_{ijk}^{(h)}$ and τ_j is the total number of different households who water at the j-th waterpoint during the interviewing period.

Before turning to the matter of estimation, we note that variances of estimators will be formulated by considering the following four stochastic sources, listed in sequence of their occurrence:

Source	Due to
1	Choice of the waterpoint at which the household will water
2	Choice of which day the household will appear at the chosen waterpoint
3	Without-replacement simple random sampling at each sample waterpoint
4	Random designation of one day for interviewing at each waterpoint (single-day model only)

Since various sequences of statistical expectations and variances are needed to derive these variances, let us define a few additional

terms to help streamline our notation.
If $E_u(.)$ and $Var_u(.)$, respectively, refer to expectation and variance considering the u-th source (u = 1,2,3,4) conditioned on any prior sources, then let $E_{u,v}(.) = E_u E_{u+1} \cdots E_v(.)$ for $1 \leq u \leq v \leq 4$ and let $V_u(.)$ be the conditional variance for the u-th source around expectations for other sources; e.g., $V_2(.) = E_1 Var_2 E_3 E_4(.)$ when all four sources are considered in the single-day model. Similar notation is followed in defining covariances.

Extended-Period Model:

When the extended-period design is followed, an unbiased estimator of N will be

$$\hat{N}_e = \frac{M}{m} \sum_j^m \tau_j \tag{2}$$

where τ_j can be determined by counting the number of households first watering at the waterpoint during the 12 day period.

The variance of $\hat{N}_e$ is generally determined as $Var(\hat{N}_e) = \sum_u^3 V_u(\hat{N}_e)$. Since $E_3(\hat{N}_e) = N$, $V_1(\hat{N}_e) = V_2(\hat{N}_e) = 0$ and $Var(\hat{N}_e) = V_3(\hat{N}_e)$. Now $V_3(\hat{N}_e) = E_1E_2Var_3(\hat{N}_e)$ requires that we first note from basic sampling theory (Cochran, 1977) that

$$Var_3(\hat{N}_e) = \frac{M^2(M-m)}{m\ (M-1)} \sigma_\tau^2 , \tag{3}$$

where $\sigma_\tau^2 = \sum_j^M (\tau_j - \mu_\tau)^2/M$ and $\mu_\tau = \sum_j^M \tau_j/M = N/M$.

Since M and m are constants in Eq. (3) we must next obtain

$$E_{1,2}(\sigma_\tau^2) = \sum_j^M E_{1,2}(\tau_j^2)/M - \mu_\tau^2 \tag{4}$$

Now since $\tau_j = \sum_i^N \sum_k^{12} \lambda_{ijk}^{(1)}$,

$$E_{1,2}\ (\tau_j^2) = \sum_i^N \sum_k^{12} \pi_{ijk}^{(1)} + \sum_{i \neq i'}^N \sum^N \sum_k^{12} \pi_{ijk}^{(1)}\pi_{i'jk}^{(1)}$$

$$+ \sum_{i \neq i'}^N \sum^N \sum_{k \neq k'}^{12} \sum^{12} \pi_{ijk}^{(1)}\pi_{i'jk'}^{(1)} \tag{5}$$

if one is willing to assume that the watering practices of households are mutually uncorrelated. Finally, we note that in general

$$\pi_{ijk}^{(1)} = \begin{cases} \pi_{ij}^{(1)}/I_i & \text{if } k = 1, 2, \ldots, I_i \\ 0 & \text{if otherwise} \end{cases}$$

so that $\sum_k^{12} \pi_{ijk}^{(1)} = \pi_{ij}^{(1)}$, where $\pi_{ij}^{(1)}$ is the probability that the i-th household will first water at the j-th waterpoint. Assuming that for all households $\pi_{ij}^{(1)} = \pi_j^{(1)}$ (i.e., that the probability of first watering at the j-th waterpoint is the same for all households), we have

$$Var(\hat{N}_e) = \frac{MN(M-m)}{m(M-1)} [(\mu_\tau R_1 + 1) - (R_1 + 1)/M], \tag{7}$$

where $R_1 = \sum_j^M (\pi_j^{(1)} - \bar{\pi}_1)^2/\bar{\pi}_1^2 M$ and $\bar{\pi}_1 = \sum_j^M \pi_j^{(1)}/M$.

When M is large, the following is approximately true:

$$Var(\hat{N}_e) = \frac{MN(M-m)}{m(M-1)} [\mu_\tau R_1 + 1]. \tag{8}$$

Single-Day Model:

Turning now to analysis under the single-day design alternative, we could use the unbiased estimator,

$$\hat{N}_s = \frac{12M}{m} \sum_j^m t_j \tag{9}$$

to estimate N, where $t_j = \sum_i^N \lambda_{ijk_j}^{(+)}/E_i$ is the weighted sum of households appearing at the j-th waterpoint on the randomly chosen day for interviewing (designated by k_j which can equal any value between 1 and 12). Note that $\hat{N}_s$ is a function of E_i which reflects the households' chances of selection determined by the frequency of watering during data collection.

The variance of $\hat{N}_s$ is obtained as the sum of components attributable to all four of the stochastic sources listed earlier, i.e., $Var(\hat{N}_s) = \sum^4 V_u(\hat{N}_s)$.. Now, as before, $V_1(\hat{N}_s) = V_2(\hat{N}_s) = 0$ since $E_{3,4}(\hat{N}_s) = N$ which is constant over sources 1 and 2. That leaves us to obtain $V_4(\hat{N}_s)$ because $V_3(\hat{N}_s) = Var(\hat{N}_e)$ since $E_4(t_j) = \tau_j/12$ and thus $E_4(\hat{N}_s) = 12\ M\ E_4(t_j)/m = \hat{N}_e$. We also note that $Var(\hat{N}_s) \geq Var(\hat{N}_e)$ if the waterpoint sample sizes for both models are equal (i.e., $m_e = m_s = m$) since $V_4(\hat{N}_s) \geq 0$. To obtain $V_4(\hat{N}_s)$ we begin by noting that

$$E_3 Var_4(\hat{N}_s) = \frac{144M^2}{m^2} E_3 \sum_j^m [Var_4\{\sum_i^N \lambda_{ijkj}^{(+)}/E_i\}]$$

$$= \frac{144M}{m} \sum_j^M Var_4\{\sum_i^M \lambda_{ijk_j}^{(+)}/E_i\} \tag{10}$$

Now since $\lambda_{ijk_j}^{(+)^2} = \lambda_{ijk_j}^{(+)}$ and

$$E_4(\lambda_{ijk_j}^{(+)}) = \begin{cases} I_i^{-1} & \text{if the i-th household waters at the j-th waterpoint during interviewing} \\ 0 & \text{if otherwise,} \end{cases}$$

we have

$$Var_4(\lambda_{ijk_j}^{(+)}) = \begin{cases} I_i^{-1}\ (I - I_i^{-1}) & \text{if the household waters at the j-th waterpoint during interviewing.} \\ 0 & \text{if otherwise.} \end{cases}$$

Similarly, we note that $I_i I_{i'} Cov_4(\lambda_{ijk_j}^{(+)}, \lambda_{i'jk_j}^{(+)})$ (1) equals $12\ Min(I_i, I_{i'}) - 1$ if both i-th and i'-th households water at j-th waterpoint during interviewing and

$$\frac{|\ell_i - \ell_{i'}|}{Min(I_i, I_{i'})} = Q,$$

(2) equals -1 if both i-th and i'-th households water at j-th waterpoint during interviewing and

$$\frac{|\ell_i - \ell_{i'}|}{Min(I_i, I_{i'})} \neq Q,$$

and (3) equals 0 if otherwise; where ℓ_i is the day during interviewing when water is first sought by the i-th household at its waterpoint and Q is an integer which takes on the value 0 or $Max(I_i, I_{i'})/Min(I_i, I_{i'}) - 1$.

At this point we have

$$E_3 Var_4(\hat{N}_s) = \frac{M}{m}[N(\bar{I} - 1) + 2 \sum_j^N \sum_{i<i'}^N \sum^N I_i I_{i'} Cov_4(\lambda_{ijk_j}, \lambda_{i'jk_j})], \quad (11)$$

where $\bar{I} = \sum_i^N I/N$, but we must still determine (for all j) how many of the $\binom{N}{2}$ combinations with i < i' that yield different values of $I_i I_{i'} Cov_4(\lambda_{ijk_j}^{(+)}, \lambda_{i'jk_j}^{(+)})$. This relatively straightforward but rather laborious process, plus taking expectation over sources 1 and 2, leads us to

$$V_4(\hat{N}_s) = \frac{MN}{m}[\Psi_2 + 3\Psi_4 + 11\Psi_{12}) + \mu_\tau(R_1 + 1)\{11 + 22(\Psi_2\Psi_4 + \Psi_2\Psi_{12} + \Psi_4\Psi_{12})\}], \quad (12)$$

where Ψ_2, Ψ_4, and Ψ_{12} are, respectively, the proportion of households in the population that have cattle, sheep/goats, and camels as the predominating animal. Finally, we have

$$Var(\hat{N}_s) = \frac{MN}{m}[(\frac{M-m}{M-1})(\mu_\tau R_1 + 1) + (\Psi_2 + 3\Psi_4 + 11\Psi_{12}) + \mu_\tau(R_1 + 1)\{11 + 22(\Psi_2\Psi_4 + \Psi_2\Psi_{12} + \Psi_4\Psi_{12})\}]. \quad (13)$$

5. DATA COLLECTION COSTS

Let us now turn to the cost of data collection associated with the two design models. The presumption in each model is that interviewing is done in person at each selected waterpoint by specially trained interviewing teams. Each of r teams, consisting of a supervisor, a driver (to transport interviewers to and from assigned waterpoints in a van) and exactly t interviewers, is assigned to a sector which (on average) contains q geographically contiguous to sample waterpoints. The size of t and each team is determined by the size of the vehicles used for transporting interviewers. In the Somalia survey, for example t=4 since land-rovers were used. To simply matters, we assume that the same number (ℓ) of interviewers would be needed at each waterpoint to handle the flow of interviews. We also let w denote the number of waterpoints at which the data collection model will allow an interviewer to be stationed during the 12 day interviewing period. Thus $q = wt/\ell$ and the total number of sample waterpoints can be determined as $m = rq = rwt/\ell$.

Data collection costs are computed exclusively in person-days of wages paid to members of the interviewing teams for whom salaries of all members is assumed equal. Computing costs in this way of course ignores the relatively small percentage of expenses for supplies and transportation, although the latter expenses might be considered in specifying drivers and interviewers to collect equal salaries (drivers are usually paid less). Because comparative costs of the two models is the major focus of our study, we assume that these expenses are similar, though clearly transportation expenses would probably be greater for the single-day model where more travel among selected waterpoints will be necessary.

Extended-Period Model:

The assumed time-line for the period of data collection under the extended-period model is given below:

Inter-viewer Training	Delivery to Water-points	Interviewing at Waterpoints	Pick-up from Water-points
T_o	T_*	12	T_*

time (in days)⟶

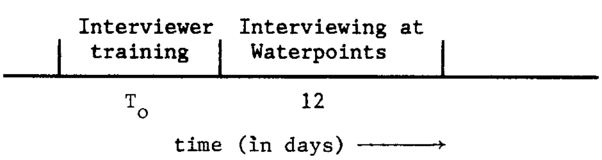
Data collection begins with a period of T_o days in which all interviewers are trained for the survey. After training each interviewer is transported to his or her assigned waterpoint. The delivery operation takes T_* days after which interviewing following the extended-period model described earlier begins and continues for a period of 12 days in each waterpoint. At the end of interviewing, T_* days are once again required to pick up the interviewers and return them to the home-base.

The total number of person-days of salary during data collection can be easily determined by adding together the collective time spent on each of the activities identified in the figure above. Since training involves all but the driver, the total number of person-days paid will be $r(t + 1)T_o$. Both pick-up and delivery involve the entire team in each sector and thus each would require $r(t + 2)T_*$ person-days, while interviewing (also involving all team members, albeit idle for the driver) would require $12r(t + 2)$ person-days of effort. Thus, the total cost in person-days of salary would be

$$T_e = r[(t + 2)(T_o + 2T_* + 12) - T_o]. \qquad (14)$$

Single-Day Model

For the second model, where interviewing in each section is done randomly selected days during the interviewing period, the time-line is as we see in the second figure:



Time designated for transport to and from waterpoints is subsumed within the period of data collection. Following the same logic as above with the extended-period model, the total number of person-days of salary paid is just,

$$T_s = r[(t + 2)(T_o + 12) - T_o]. \qquad (15)$$

6. COMPARISON AND DISCUSSION

To compare the feasibility of the extended-period and single-day models we prespecify that the same number of person-days of salary be available under each model; i.e., that $T_e = T_s = T*$. We next determine respective values for r under each model. Values of r (and thus m) will not be the same for the two models because of different cost formulations in Eqs. (14) and (15) resulting from variations in the data collection procedures. Values of t are assumed to be equal under the two models since teams should be transported by land-rover in either case. The number of interviewers needed per waterpoint (ℓ) would also be the same under either model since interviewers would be equally busy with interviewing at the busiest time under either model. Measures of m determined under either model, combined with other relevant parameters (e.g., $M, \mu_T, R_1, \Psi_2, \Psi_4$, and Ψ_{12}) are then applied to compare the variances under the two models. The compared variances thus enable us to establish which model, given the assumed parameters, yields the greatest precision per dollar spent on interviewing. Parameters determined for the Somalia survey are used for a numerical example.

Given the above constraints, we have from earlier definitions as well as from Eqs. (14) and (15) the ratio of the total number of sample waterpoints under the two models as

$$\frac{m_s}{m_e} = \frac{r_s w_s}{r_e w_e} = \frac{w_s}{w_e}\left[1 + \frac{2T_*(t+2)}{(t+2)(T_o+12) - T_o}\right] \qquad (16)$$

The variance ratio of the two models can be obtained from Eqs. (8) and (13) as

$$\Phi = \frac{\mathrm{Var}(\hat{N}_e)}{\mathrm{Var}(\hat{N}_s)}$$

$$= \left[\frac{m_s}{m_e}\right] \frac{\left(\frac{M-m_e}{M-1}\right)(\mu_T R_1 + 1)}{Q* + (\Psi_2+3\Psi_4+11\Psi_{12})+\mu_\tau(R_1+1)\{11+22(\Psi_2\Psi_4+\Psi_2\Psi_{12}+\Psi_4\Psi_{12})\}} \qquad (17)$$

where

$$Q* = \left(\frac{M-m_s}{M-1}\right)(\mu_T R_1 + 1). \qquad (18)$$

Values of R_1 (measuring the relative variation in the probabilities, $\pi_j^{(1)}$, choosing the j-th waterpoint for the first watering of animals during the interviewing period) may be obtained by the following line of reasoning. Suppose it is reasonable to expect for all households that $\pi_j^{(1)} = 1/\rho M$ for ρM ($\rho \leq 1$) waterpoints and $\pi_j^{(1)} = 0$ for all other waterpoints. Under these circumstances $R_1 = (1 - \rho)/\rho$ which for various values of ρ would be:

ρ	R_1
0.001	999
0.005	199
0.010	99
0.100	9

This setting presumes that each household is somewhat selective in its choice of watering spots but that it is nondiscriminatory among those waterpoints it would consider. Findings by Dyson-Hudson and Irons (1972) and Lewis (1961) that nomadic movement is not random but follows certain predictable migratory patterns would tend to sustain this assumed behavior.

As a simple illustration of how this format for comparison might be applied, we consider an illustration based on the Somalia survey. To do so the following parameter values are needed:

T_* = 2000 person-days of salary available;
T_o = 5 days for training;
t = 4 interviewers in each team;
T_* = 4 days each for dropping interviewers off at waterpoints and then picking them up after interviewing is completed;
ℓ = 2 interviewers needed at each waterpoint;
M = 1100 total waterpoints estimated to be in the country;
μ_T = 300 nomadic households per waterpoint;
R_1 = 10 and 100 assuming that Somalia nomads follow somewhat regular migratory patterns;
Ψ_2 = 0.08, Ψ_4 = 0.86, and Ψ_{12} = 0.06 using Somalia data from the Barao district (see Somalia Ministry of Planning, 1978);
w_e = 1 waterpoint at which an interviewer can work during data collection in the extended-period model; and
w_s = 4 waterpoints at which an interviewer can work during data collection in the single-day model.

Using Eq. (17) and the above parameters we obtain the following:

Value of	Assuming Above Parameters with Example 1: $R_1 = 10$	Example 2: $R_1 = 100$
m_e	28	28
m_s	165	165
Φ	0.365	0.396

We see from these two values of Φ that, despite the larger number of waterpoints affordable under the single-day model, the extended-period yields greater precision for fixed cost. This finding is attributable to the larger number of interviewing days under the latter model, and to the perhaps naive assumptions we make concerning the interrelationship of watering behavior. Different assumptions might have led to values of Φ that are closer to unity. For example, altering the N x M matrix of first watering probabilities linking household and waterpoints might create a clustering effect which would have made it more advantageous to select more waterpoints with fewer interviewing days at each waterpoint. Our current work is pointed in that direction.

Some practical issues might also influence our choice between the two models. For one, the single-day model would be more physically demanding on the interviewers than the extended-period model since more travel would be required during the interviewing period. Each team member must visit multiple waterpoints during the 12 day period under the single-day model (e.g., four visits for the Somalia illustration), wile only one visit per team member is required in the extended-period model. Another practical problem with the single-day model is that randomly chosen interview days within each sector may not be "optimum" in the sense of feasibility for the team's travel itinerary. For example, widely scattered waterpoints requiring visits on consecutive days may require an itinerary which is impossible to follow. Finally, screening for the first watering in the extended-period model implies a suboptimal use of interviewer time since as the period of interviewing progresses the percent of first-watering households will diminish causing a larger percentage of potentially useful households to be screened out of th study.

To summarize, then, our research presents some evidence in retrospect that the extended-period model may have been a more cost-effective strategy than the single-day model in surveying Somali nomads. Much, however, remains to be learned about the general feasibility of the two design options, by considering other nomadic populations and by applying more realistic assumptions to this interesting design problem.

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