easily read, the differentiation may in part be explained by these expectations instead of actual performance.

Jurors who used more of the group's scarce resource, their common time together, were perceived by respondents to be the jurors desired if they were on trial. This finding suggests that whatever the criteria used by the groups to regulate the contributions of their members, these criteria were broadly held. The differential distribution of speaking time was achieved without serious violation of developing group norms. Further, face to face experience, in contrast with occupational stereotypes, tended to smooth post-meeting choices into a gradient parallel to both activity rates and status. These findings and others reported constitute a preliminary clarification of the small group process within the deliberation.

While our data do little to illuminate *how* differentiation arises, the status gradients emerge clearly in as brief a time as the one or two hour discussions under study. Though careful study will be required to determine the degree to which one may generalize from status in the larger social system to a particular interaction context, the demonstration of the continuity of status in the present case should be noted in any theory directed to the description of the process of status affirmation and maintenance.

WATER-WITCHING IN THE UNITED STATES *

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A WIDELY used method of locating well sites is variously known as "water-witching," "water-divining," or "dowsing." [1] This practice would be of interest if only because of widespread adherence to it among the U. S. rural population. But it piques one's curiosity by the additional fact that it is considered an outcast by orthodox science.[2] In studying water-witching, we concentrated on the question of why this unorthodoxy persists within a culture that prides itself on its scientific and technological advancement.

In essence water-witching consists in an effort to locate underground water by interpreting the motion of a divining rod. The divining rod may be a forked twig or V-shaped branch. The operator or diviner grasps one arm of the V in each hand so that the apex points upward and forward. He then paces back and forth over a plot of land until the rod rotates in his hands and the apex points downward. This action of the rod is translated: "Dig here and you will find water." In some hands the rod is more responsive and provides information concerning depth, quality and amount of water.

This study reports on two objectives: (1) to estimate the number of diviners practicing in the United States, (2) to ascertain the conditions favorable to water-witching. In particular, we were interested in the relationship of water-witching to problems of obtaining water. Preliminary investigation enabled us to formulate three separate views of why witching persists, and each view specified a different relationship between witching and water problems:

* This paper forms part of a larger project on water-witching. The data were collected during the academic year 1955–56. The project was supported in part by a grant from the Hodgson Fund of the Psychology Department at Harvard University. Additional funds were supplied by the Laboratory of Social Relations of Harvard University. The principal investigators were Evon Z. Vogt and Ray Hyman and their research associates were Elizabeth G. Cohen and Peggy Golde.

[1] Historical background and bibliographies can be found in W. F. Barrett and T. Besterman, *The Divining Rod*, London: Methuen, 1926; and E. Z. Vogt, "Water-Witching: An Interpretation of a Ritual Pattern in a Rural American Community," *The Scientific Monthly*, 75 (September, 1952), pp. 175–186.

[2] See, e.g., J. W. Gregory, "Water Divining," in The Smithsonian Institution's *Annual Report for 1928*, Washington, D. C.: U.S.G.P.O., 1929, pp. 325–348; T. N. Riddick, "Dowsing," *Proceedings of the American Philosophical Society*, 96 (October, 1952), pp. 526–534; L. Don Leet, review of Kenneth Roberts' *The Seventh Sense*, in *American Scientist*, 41 (October, 1953), pp. 652–656.

1. The extent of water-witching might be unrelated to underground water conditions except insofar as there must be some wells being developed to have the practice at all. The view that witching is merely a superstitious survival from the past,[3] for example, might lead to the prediction that the probability of a given well-site's being witched is independent of current groundwater conditions.

2. The extent of water-witching might be positively related to the ease and certainty of finding water. If water can be found almost anywhere at a uniform depth, the water-witch might easily gain a reputation for success since he can never be wrong. According to this view, witching persists because consumers fail to realize that they could be just as successful without it.

3. The extent of water-witching might be negatively related to the ease and certainty of finding water. According to this view, witching is employed as a last resort because of unfavorable natural conditions and lack of scientific information. This relationship would also be postulated by those who look upon witching as analogous to magic and ritual in non-literate cultures.[4] This analogy would view witching as a kind of ritual that functions to relieve anxiety over the outcome of an attempt to cope with an uncertain environment.

This paper describes the findings from responses to questionnaires sent to a stratified sample of county agricultural extension agents. The responses were combined with information from censuses and published statistics and then subjected to various statistical analyses.[5]

PROCEDURES

The Pilot Study. To pretest the questionnaire and to help in designing our investigation, we sent questionnaires to a random sample of 80 agricultural extension agents. The 44 returns received were used to revise the questionnaire,[6] estimate sample size and develop an effective principle of stratification. The sampling plan was derived, in part, from the results of this pilot study.[7]

Sampling Plan. The sampling unit was the United States county, and the target population was that of the continental United States. Since the sample included only those counties having an agricultural extension agent, however, the actual population consisted of 3,017 counties having a total of 137,161,000 people or about 91 per cent of the total United States population. The excluded portions, for the most part, were either entirely urban or unpopulated.

The counties were stratified according to two principles. All counties with 50 per cent or more of their population classified as urban in the 1950 census were placed in the "urban" stratum; all other counties were classified as "rural." "Rural" counties were further stratified on the basis of their location in one of ten groundwater regions.[8] From each of the resulting eleven strata, a random sample of counties, giving each county an equal chance of being selected, was chosen so that the sample from a stratum was of a size roughly proportional to the number of counties in that stratum. Table 1 gives a brief description of the groundwater conditions in each of the rural strata. It also reports the number of individuals and counties as well as the sample size from each stratum.

In February, 1956 each agent in the sample was sent a questionnaire along with a covering letter explaining the purpose of our investigation. Informants were told that a diviner or dowser was defined by us as one who: "(1) uses or has used a forked stick, wire or pendulum to locate underground water, and (2) as a result of his

[3] Vogt, *op. cit.*

[4] Vogt, *op. cit.*

[5] Such questions as "Does it work?" and "What makes the rod move?" as well as the historical background and folklore are dealt with in E. Z. Vogt and R. Hyman, *Water-Witching U.S.A.*, (In preparation).

[6] A copy of the complete questionnaire is reproduced in Vogt and Hyman, *op. cit.*

[7] In addition to questionnaire data, other sources of information were the 1950 census; U. S. Department of Agriculture, *Climate and Man*, Washington, D. C.: U.S.G.P.O., 1941.

[8] Harold E. Thomas, *The Physical and Economic Foundation of Natural Resources, III: Ground-Water Regions of the United States—Their Storage Facilities*, Washington, D. C.: Interior and Insular Affairs Committee, House of Representatives, 1952. Because the boundaries of groundwater regions do not always coincide with those of counties, counties that fell into two groundwater regions were arbitrarily classified as belonging to just one of these regions. We used topographical and drainage features to guide us in this classification.

TABLE 1. POPULATION, NUMBER OF COUNTIES, SAMPLE COUNTIES, AND GROUNDWATER CONDITIONS BY STRATA

Stratum	Groundwater Conditions *	Population (in thousands)	Number of Counties	Number of Counties in Sample	Number of Responding Counties
Urban		85,246	629	52	43
Rural (groundwater regions)					
Western mountain ranges	Great rain catchers but do not store groundwater in great quantity, or for long	1,618	89	20	16
Arid basins	Great receivers and storers of water, far ahead of all other regions in groundwater development	1,815	64	19	16
Columbia lava plateau	Imperfectly known	608	41	10	10
Great plains	Prevailing water deficiency under existing development	790	110	20	16
Unglaciated central	Aquifers of rather low productivity, general inadequacy of water supplies	10,783	575	99	69
Glaciated central	Water problems less serious than in some other regions	11,745	595	100	68
Colorado plateau	Lack of adequate water supplies even for grazing	378	31	10	4
Coastal plains	Most abundantly endowed of all regions in U. S.	12,905	554	100	65
Unglaciated Appalachian	Water problems are less serious than in some other regions	9,030	280	50	34
Glaciated Appalachian	Relatively abundant supplies of good quality water	2,242	47	20	17
Total		137,161	3,017	500	358

* Source: Thomas, *op. cit.*

activity a well has been dug or drilled on the site he indicated."

Approximately six weeks after the initial questionnaire was sent, a duplicate questionnaire with a new letter was sent to those agents who had not yet responded.

All counties in the sample from which we had not heard by June, 1956 were classified as non-respondents. We restratified non-respondents and drew a random subsample from each of three new strata. We then made an effort to reach the 23 agents in our non-response subsample or suitable alternates, such as well-drillers or newspaper editors. The returns from this non-respondent subsample were used to estimate the extent, if any, of non-respondent bias and to correct estimates based upon the sample of original respondents.

RESULTS

Estimation of the Number of Diviners. The last column of Table 1 lists the number of useable responses received from each stratum. Table 2 gives the estimates made of the number of diviners from these returns,[9] and the number of diviners per 100,000 population to facilitate comparisons among the strata.

The data, after being corrected for possible non-respondent bias, yield an estimate of the number of diviners between 20,000 and 31,000.[10] To guard against the possibility that the agents might have consistently over- or under-reported the number of diviners, we arbitrarily widened this 95-per cent confidence interval. Thus, we conclude that there are between 15,000 and 35,000 diviners practicing today in this country with the best single guess being about 25,000.

[9] The procedure for making the estimates is described as Method II in William G. Cochran, *Sampling Techniques*, New York: Wiley, 1953, Ch. 11.

[10] Our procedure is adapted from Walter A. Hendricks, *Mathematics of Sampling*, Blacksburg: Virginia Agricultural Experiment Station, 1948, pp. 29–32.

TABLE 2. DIVINERS BY STRATUM

Stratum	Estimated Number of Diviners	Number* of Diviners per 100,000
Urban	6,538	7.7
Rural (groundwater regions)	18,341	35.3
Glaciated Appalachian	437	19.5
Unglaciated Appalachian	2,684	29.7
Coastal plain	2,769	21.5
Glaciated central	5,232	44.6
Unglaciated central	5,175	48.0
Great plains	474	60 0
Colorado plateau	209	55.4
Columbia lava plateau	608	70.1
Arid basins	440	24.2
Western mountain ranges	495	30.6
Total	24,879	18.1

* The numbers of diviners per 100,000 are probably slightly overestimated because the denominators of the ratios are based on the 1950 census figures.

Sources of Variation in Concentration of Diviners. Counties vary greatly in concentration of diviners, the range in our sample being from 0 to 643 diviners per 100,000 population.[11] As Table 2 indicates, one obvious source of this variation is due to the relatively low concentration of diviners in urban counties.

Table 2 also suggests another source of variation—groundwater region. The figures in Table 2, however, are based on *individuals* in our population. Because the *county* is our basic sampling unit, we should consider our results in terms of variation among counties.

Variations Among Groundwater Regions. Using the county as the unit, we computed the median number of diviners per 100,000 population for each rural groundwater region. The regions were then ranked according to their median concentration of diviners from lowest to highest. The variation among the groundwater regions in concentration of diviners is significant at the .01 level by the median test.

But these regions vary in other ways, of course, as well as in the number of diviners per 100,000 population. The correlations between the rankings of the regions on diviner concentration with their ranking on other variables are listed in Table 3. In general, the picture given by these correlations is that those groundwater regions having a high concentration of diviners tend to have counties with low population, low population density, low precipitation, a high number of new wells drilled or dug each year, and a high problem score for drilled wells.[12]

Variation Within Regions. We now examine variations among the counties within regions instead of among regions. Intercorrelations among several variables within each region were computed. These intercorrela-

TABLE 3. RANK CORRELATIONS BETWEEN DIVINER RATE AND OTHER VARIABLES *

Population density	—.82†
Population	—.85†
Per cent urban	—.40
Population increase	—.18
Number of new wells	—.60
Per cent dry holes	.47
Per cent wells drilled	.16
Depth of drilled wells	.16
Range of depth	.44
Problem score of dug wells	.12
Problem score of drilled wells	.71†
Adequacy of information	.12
Annual precipitation	—.77†
January precipitation	—.82†
July precipitation	—.77†

* The correlations are between the rank order of the strata on diviner rate and their rank order on other variables. Only 9 ground water regions are included in these rankings. The Colorado Plateau is omitted from these calculations because our sample contains only four counties in that region.

† Significant at the .05 level. Throughout this paper we use significance levels as convenient cut-off points rather than as actual tests of inference.

[11] In addition to number of diviners per 100,000 persons, we also tried another index of witching activity, the proportion of wells witched. This latter index proved less satisfactory because many agents found it difficult and several refused to make such an estimate. Since the average correlation of this index (when available) with number of diviners per 100,000 persons was .88 within regions, and since the reliability of both indices is very likely less than 1.00, we concluded that the two indices are equivalent. This follows from the well-known theorem that even if two variables are perfectly correlated, the observed correlation cannot exceed the geometric mean of the reliabilities of the two measures.

[12] Each county was given a composite problem score on the basis of how the agent rated the importance of each of these problems on a three-point scale: may get a dry hole, may cost a great deal, may have to drill to a great depth, may get too little water, may get poor quality water, may not be able to find water where wanted. A separate score was obtained for hand dug wells and for drilled wells.

tions were then averaged across regions.[13] In this way we obtain a covariation pattern independent of variations among regions. Only the four largest strata had sufficient numbers of counties to be employed in this procedure. Accordingly, the intercorrelations among variables within each of these regions (Unglaciated Central, Glaciated Central, Coastal Plain, and Unglaciated Appalachian) were obtained and averaged so that variations among regions were eliminated.

Although the resulting correlations suggest a pattern similar to those in Table 3, they do not directly indicate, for example, if the correlations with problem score and inadequacy of groundwater information would exist if the counties are equated for number of new wells and population density. To equate counties for population variables we resorted to statistical rather than empirical controls because of the small number of counties in the sample. The procedure was to use factor analysis to partial out unwanted variation. Omitting the variables in Table 3 that did not correlate with key variables or that were not adequately represented in all counties, we factor analyzed the intercorrelations among the 12 remaining variables by Thurstone's centroid method.[14]

Table 4 lists the three independent factors extracted as well as the correlations of each variable with these factors. The first two factors have been rotated to partial out the effects of population variables; the third factor is not discussed because we believe that it is a sampling artifact.

The first factor tells the obvious story that urbanized areas tend to have few diviners. Keeping in mind that the second factor is independent of groundwater regions as well as of the other two factors, we can interpret it as follows: If counties are equated in terms of groundwater conditions, population, size, number of new wells per annum, and precipitation, then those counties with a high concentration of diviners will also tend to be high on the following variables: population decrease,[15] per cent dry holes, range in depth of drilled wells, inadequacy of groundwater information, and problem score for drilled wells.

[13] The actual procedure was as follows. Within a region, each variable was dichotomized at the median for that stratum. Then all the possible 2 x 2 contingency tables among the variables were constructed; these tables were added across regions. Tetrachoric r was computed from each pooled table by using the tables provided by M. D. Davidoff and H. W. Goheen, "A Table for the Rapid Determination of the Tetrachoric Correlation Coefficient," *Psychometrika*, 18 (June, 1953), pp. 115–121.

[14] Because of the small number of variables we estimated the communalities by equation 15. See L. L. Thurstone, *Multiple-Factor Analysis*, Chicago: University of Chicago Press, 1947, p. 300.

DISCUSSION

The validity of almost all our findings depends upon the adequacy of our respondents as observers. Preliminary investigations convinced us that the county agricultural extension agent was the best single person to use as a source of information. His training and duties tend to make him sensitive to the ways in which people in his community solve their water problems. The fact that he is the best available informant, however, does not guarantee the adequacy of the information received from him. Our impression was that most agents made an effort to supply us with adequate data, and the information they supplied, while lacking in many ways, was sufficiently reliable for our purposes.

Despite the limitations imposed upon our data, certain themes emerged in such bold relief that we have little doubt about their validity. Concerning the two objectives

TABLE 4. FACTOR LOADINGS OF KEY VARIABLES

Variables	Factors 1	2	3
1. Number of diviners per 100,000	—.23	.60	.19
2. Population density	.72	—.26	.31
3. Population	.92	—.16	—.07
4. Per cent urban	.80	—.13	—.26
5. Population increase	.61	—.44	.18
6. January precipitation	.06	—.13	.50
7. July precipitation	.09	—.28	.28
8. Number of new wells	.49	.04	—.15
9. Per cent dry holes	.00	.55	.39
10. Range of depth	.00	.30	—.24
11. Groundwater information	.08	—.38	—.19
12. Problem score of drilled wells	.06	.75	.23

[15] The variable "Population increase" is the percentage increment in population for a county from 1940 to 1950 as given in the 1950 census.

mentioned in our introduction,[16] we can state that the number of diviners practicing in this country is much larger than we had anticipated; that the distribution is widespread, being practiced in every state in the country; and that this practice is most likely to occur under conditions of difficulty in procuring and maintaining a steady and adequate supply of water.

Difficulty of finding water, however, is not the only factor accounting for variations in amount of water-witching. Even holding number of wells and population constant, there are many exceptions to this relationship. A few counties with severe water problems have no diviners, and a few counties with no water problems have many diviners.

Despite these exceptions, the probability is high that witching will be found in those rural areas where underground water is a problem. Witching seems to persist where the water supply is attended by anxiety and uncertainty. It is a way of coping with nature in a situation wherein the outcome is important but uncertain. Our findings are consistent with the view that witching is a ritual that functions to reduce anxiety in a manner similar to that of magic in nonliterate societies.

The value of this analogy, however, can be overemphasized and may, indeed, hinder an understanding of the factors underlying the use of witching. The hasty labeling of the practice as "magic" or "ritual" may blind us to some of the rational or quasi-rational aspects involved in its persistence, especially when the phenomenon is considered from the standpoint of the consumer.

Although some actually view it as a supernatural phenomenon, we believe the majority of people who employ witching look upon it as a technique that operates on principles consistent with physical science. Respondents report that most diviners do not have specific theories about why witching seems to work. But if an explanation is elicited from the diviner, it is most frequently in terms of some form of physical attraction between the rod and the underground water.[17]

Not only do many people see water-witching as a phenomenon consistent with physical science, but some are probably unaware that it is viewed as unorthodoxy. A great deal of ambiguity exists about water-witching in the ruralite's sources of information. Most newspapers and farm journals take a neutral stand in articles on water-witching. County agricultural extension agents are divided on the issue of the efficacy of water-witching. Of the 38 per cent we were able to classify according to their attitudes on witching, 56 per cent experssed outright disbelief in the validity of the practice, 20 per cent expressed belief in its efficacy, and 24 per cent said that they were open-minded on the subject.

The alternatives available to a man about to drill a well can be crudely categorized as drilling in a convenient spot, seeking expert advice, or calling in a diviner. Only 38 per cent of the respondents in our sample feel that groundwater information is "adequate" for their entire county and, even where such information is available, it still allows for a "zone of uncertainty" as to best site. This suggests that in many communities the available alternatives are reduced to just two: drilling in a convenient spot or consulting a diviner. It is in just these situations where information is inadequate that water-witching tends to flourish.

Finally, the fact that the cost of the diviner's services is negligible relative to the ultimate cost of developing an adequate water supply helps to explain why consumers make out a rational case for employing water-witching.[18] As one Nebraska agent put it, "Farmers drilling an irrigation well feel that the $5 to $25 fee is so small compared to the $3,000 to $15,000 investment that they do it even though they aren't sold on it." Or to put the same idea in the words of a respondent from Iowa, "Not too many have faith in witching, but use it in the absence of any other method of locating water."

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[16] For the results of a third objective see E. Z. Vogt and Peggy Golde, "Some Aspects of the Folklore of Water-Witching in the United States," *Journal of American Folklore*, (in press) 1958.

[17] Vogt and Golde, *op. cit.*

[18] A typical fee seems to be about $25, and $50 is usually considered high. In some extraordinary situations, fees up to $3,000 have been reported. More frequently, however, the diviner performs his work for nothing. Over 60 per cent of the counties in our sample report that their diviners are noncommercial.