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Do Additional Designations of Wilderness Result in Increases in Recreation Use?

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Designation of public lands as wilderness continues to be a contentious issue. With about 45 million acres designated as wilderness in the lower 48 states, the question of whether designation of additional wilderness would result in increased recreation use has been raised. We address this issue using a fixed-effects regression model for wilderness use at national forests and national parks throughout the United States. We find the acreage variable is statistically significant in predicting visitor use at both agencies land. It appears that additional designations of wilderness will provide recreation benefits.

Keywords fixed-effects regression, Forest Service, National Park Service, recreation, time series, wilderness

Nearly all issues with wilderness have been and continue to be controversial. It took nearly 8 years and 56 different bills to pass the Wilderness Act of 1964 (Dana and Fairfax 1980). The debate over designation of additional acreage has also been quite controversial, as the USDA Forest Service Roadless Area Review and Evaluation (RARE) demonstrated. While the Wilderness Act lists numerous reasons for protection of areas, opportunities for primitive and unconfined recreation are often a key element (Hendee et al. 1990). Unfortunately, there are often diametrically opposed opinions on whether designation of additional acreage will result in a net increase in recreational use of the National Wilderness Preservation System (NWPS) lands. At one end of the spectrum is the view that designation results in a "neon sign" effect, drawing attention and thousands of new users to newly designated areas (McCool 1985). At the other end is the view that it is possible that addition of new areas simply shifts use between old and new areas, resulting in no net increase (Godfrey and Christy 1992).

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TABLE 1 U.S. Forest Service and National Park Service Acreage and Recreation Visitor Days (RVDs)

Year	Region	USFS Acres	USFS RVDs	NPS Acres	NPS RVDs
1970	Northeast	804 828	1 171 500		
1975	Northeast	888 247	1 205 200	131 880	19 076
1980	Northeast	941 540	1 421 300	133 243	28 043
1985	Northeast	1 167 003	1 352 920	133 243	32 313
1990	Northeast	1 300 010	1 821 800	133 243	37 489
1993	Northeast	1 300 010	1 837 800	133 243	40 690
1970	Southeast	29 425	15 300		
1975	Southeast	197 898	169 900	79 579	99 238
1980	Southeast	220 636	422 600	1 435 258	89 101
1985	Southeast	573 861	527 850	1 444 098	73 570
1990	Southeast	683 777	519 783	1 459 108	81 278
1993	Southeast	708 457	507 716	1 459 108	106 661
1970	Rocky Mtn.	7 130 468	1 054 500		
1975	Rocky Mtn.	8 448 654	1 635 900	96 420	282
1980	Rocky Mtn.	14 392 495	3 751 460	693 152	15 801
1985	Rocky Mtn.	16 869 257	4 917 400	693 152	13 065
1990	Rocky Mtn.	17 551 951	5 136 700	693 152	11 631
1993	Rocky Mtn.	18 005 426	5 959 575	693 152	14 966
1975	Pacific Coast	5 337 125	2 404 700		
1975	Pacific Coast	5 679 241	3 454 000	107 442	53 307
1980	Pacific Coast	6 589 833	3 484 000	849 604	46 684
1985	Pacific Coast	9 380 766	4 156 000	2 264 184	298 826
1990	Pacific Coast	9 390 766	4 091 538	3 942 322	428 504
1993	Pacific Coast	9 706 816	3 723 782	3 942 322	525 625

To date there has been little statistical testing on a broad regional scale of the hypothesis that designation of additional wilderness acreage has no net effect on wilderness recreation use. In part this is due to lack of historic data. McCool (1985) tested the hypothesis for one wilderness area near Missoula, MT. Because this is a single area test, it is difficult to assess Godfrey and Christy's view that use would shift from old areas to the new area, resulting in no net increase in overall use. These competing views have significant implications to debates over additional designation of additional wilderness in states like Montana and Utah. If designation of additional areas results in a net increase in use, then states may benefit from increased tourism dollars from additional tourism.

Because the Wilderness Act was passed just 33 years ago, there have been too few years of time-series data to test this relationship. While pooling across regions can partially compensate for this, only recently have statistical packages become available that offer aggregate panel data models allowing estimation of fixed-effect type models (Greene 1990). The purpose of this article is to test the hypothesis that there is a statistically significant increase in regional wilderness recreation use when additional acres are designated. This test is performed for acreage administered by the U.S. Forest Service and National Park Service, as these are the only agencies with consistently collected data for Wilderness Areas.[1] By pooling all acreage in a region, we can test whether or not there is a net increase in use.

Table 1 provides an overview of acreage and recreation visitor days (RVDs) by U.S. Census region for selected years for both the U.S. Forest Service and National Park Service. While there is a general upward trend in all data series, it is not uniform, and visitation may well be driven as much by rapidly increasing population and income levels as by wilderness acreage.

Methods

To test whether visitation is sensitive or not to increases in wilderness acreage, a fixed-effects regression model was estimated. The basic form of the regression model had visitor use as the dependent variable and demographic variables, a price proxy, and wilderness acreage as the explanatory variables. This specification follows the reduced form modeling framework of Hof and Kaiser (1983), such that the dependent variable is consumption of recreation and acreage is included as public agency supply.

Econometric Model Specification

To take full advantage of the available data and to allow for testing whether additions in acreage have any net effect on overall wilderness visitation, it was advantageous to pool the time-series data over the four U.S. Census regions. The time-series nature of the data and the pooling of time series and cross section raise several econometric issues. As with all time-series data, the possibility of autocorrelation is a serious issue. Autocorrelation implies a serial correlation of error terms or that a disturbance or perturbation in one period does have an effect on future periods. Such a correlation violates one of the assumptions of ordinary least squares (OLS) regression. While the regression coefficients themselves are unbiased and consistent, their variances are biased, making significance tests misleading (Kmenta 1986, 311). Preliminary OLS analysis with these data resulted in Durbin–Watson statistics strongly suggesting autocorrelation. As part of the statistical analysis, correction was made for first-order serial correlation using a first-order autoregressive correction. This procedure incorporates the residual from the past observation into the regression model for the current observation. Equation (1) provides the AR(1) corrected equation that is estimated:

$$(\mathrm{RVD/POP})_{it} = \alpha + \beta X_{it} + (\rho \varepsilon_{it-1} + \eta_{it}) \tag{1}$$

where $(\mathrm{RVD/POP})_{it}$ recreation visitor days per capita in region i occurring in years t; α and β are intercept and slope coefficients, respectively, to be estimated; X is a vector of explanatory variables; and ρ is the first-order serial correlation coefficient, which is multiplied by the previous periods error term (ε_{it-1}) and then added to the unconditional error, η_{it}.

When pooling cross-section and time-series data, it is useful to take advantage of the fact that the data are really several blocks of related data. To increase the variation in the wilderness acres variable it is desirable to pool data across regions. However, visitation in 1990 from the Pacific Coast may be different than visitation in 1990 from the East Coast due to unobserved factors not included as variables in the regression. With our use of four U.S. Census regions, we essentially have four panels or groups of data. Running simple OLS regression does not take advantage of the fact that blocks of the observations are related. There are two approaches to incorporating the panel nature of these data into the estimation: (a) random effects, and (b) fixed effects. As Greene (1990, 485–486) notes, when the analyst has a census or 100% of the population data, the fixed-effects model is likely to be more appropriate. In particular, we might expect each region to have a parametric shift in the regression function that relates to factors specific to that region. These show up as region-specific constants. The fixed-effects regression model in Limdep (Greene 1995) use a t-statistic on the regional constants and a likelihood ratio and F-test to see if these region specific constants improve the overall regression fit as compared to a single constant as would be estimated with OLS. A further advantage of the fixed-effects model is that it avoids the assumption of the random effects model, which assumes the individual effects are uncorrelated with the other regressor (Greene 1990, 495).

Incorporating fixed-effects constant terms into the AR(1) corrected model in Eq. (1) yields Eq. (2):

$$\ln(\mathrm{RVD/POP})_{it} = \alpha \mathrm{D}_i + \beta X_{it} + (\rho \varepsilon_{it-1} + \eta_{it}) \tag{2}$$

where D_i are the regional constants reflecting the fixed effects.

The full empirical specification of the model is:

$$\begin{aligned}\ln(\mathrm{RVD/POP})_{it} = {} & \alpha D_i + \beta_1(\ln \mathrm{INCOME}_{it}) + \beta_2(\ln \mathrm{PGAS}_t) + \beta_3 \mathrm{UNEMP}_{it} \\ & + \beta_4 \mathrm{TREND}_t + \beta_5(\ln \mathrm{AGE}_{it}) + \beta_6(\ln \mathrm{ACRES}_{it}) \\ & + (\rho \varepsilon_{it-1} + \eta_{it})\end{aligned} \tag{3}$$

where INCOME_{it} is disposable per capita income in region i in year t, PGAS_t is the inflation indexed price of gasoline in year t, UNEMP_{it} is the unemployment rate in region i in year t, TREND_t is a trend variable to reflect any systematic factors varying over time that are not accounted for by the other independent variables, AGE_{it} is percent of population in region i in year t in prime wilderness using years 18–44 (this age was chosen as being old enough to drive and physically fit), and ACRES_{it} is agency acreage of designated wilderness in region i in year t.

Hypothesis Tests

The main hypothesis tested was whether or not there is a statistically significant increase in visitation associated with additional acreage designation. This was tested by whether the t-statistic on ACRES was statistically different from zero, that is,

$$\mathrm{H}_0\colon \beta_6 = 0 \quad \text{vs.} \quad \mathrm{H}_a\colon \beta_6 > 0. \tag{4}$$

While it would be expected that $\beta_6 > 0$, it would also be expected that additional acres of wilderness would result in a less than proportional increase in visitation, that is, diminishing marginal increases in visitation with each additional acre. Therefore, the change in visitation with a 1% change in acreage (i.e., acreage elasticity) should be less than 1%. Given the double-log functional form, the coefficient on acres can be interpreted as an elasticity. We would expect the elasticity would be less than 1 ($0 < \beta_6 < 1$).

Data Sources

Dependent Variable: $(RVD/POP)_{it}$

To calculate visits per capita, data were needed on visits and population. Data on recreation visitor days (RVDs) from 1965 to 1993 were obtained from the Intermountain Research Station of the USDA Forest Service. These data are admittedly of varying quality, as only 13% are based on systematic counts such as permits or counters (McClaran and Cole 1993). This was one reason to take as the unit of observation RVDs of all wilderness areas in a given U.S. Census region. This aggregation will net out much of the year-to-year variability in use arising from unusual weather or inconsistencies in administrative estimates. Cole (1996) also suggested that aggregating areas will improve the reliability of the visitation data. Thus the trend relationships will be more evident in such aggregate data. Data on National Park Service Wilderness visits were also obtained from the Intermountain Research Station. This agency's data were originally collected as overnight visits and then converted to visitor days by Cole using average length of stay. Then day use was added to this figure (see Cole 1996 for more details). The National Park Service (NPS) visitation day may be more reliable as the NPS more closely regulates overnight backcountry use through a mandatory permit system at most larger parks. In addition, the more limited access points and backcountry patrols for the national parks make it easier to monitor visitor use levels.

Population is perhaps one of the most common and important determinants of total consumption for nearly any product. We collected state population statistics from the U.S. Census and the *Statistical Abstract of the United States* (U.S. Bureau of the Census 1966–1995).

Since it is unlikely that population would simply have a linear additive effect on visitation, irrespective of other factors, visits were divided by U.S. Census region population to yield visits per capita. This is a common formulation for many recreation demand models such as the zonal travel cost model (Hellerstein 1995; Loomis and Walsh 1997). In addition, making population a part of the dependent variable eliminates the multicolinearity between acres and population as independent variables. Finally, the natural log of visits per capita was used to estimate a nonlinear relationship between visits per capita and the independent variables.

Independent Variables

Per Capita Income

A commonly investigated determinant of recreation behavior is disposable per capita income (Hof and Kaiser 1983). This is a measure of the ability of households to incur the travel cost to visit wilderness areas as well as purchase the appropriate equipment.

To allow for comparability across years, income was deflated and put into real terms (in 1992 dollars). The natural log of income is used to allow for a nonlinear effect of changes in income on quantity of visitation. Per capita personal disposable income data are found in *State Personal Income 1929–1993* (U.S. Bureau of Economic Analysis 1995).

Unemployment Rate

This variable was included to test for the possibility that the performance of the overall economy and specifically labor market conditions might influence wilderness use. In particular, since wilderness trips are relatively inexpensive but quite time intensive, it may be hypothesized that the opportunity costs of such trips are lower when the unemployment rate is high. That is, with high unemployment rate, many people are without jobs, and wages tend to be lower. This would make the travel and on-site time cost of wilderness visits less. In addition, with high unemployment rate people may substitute wilderness visits for more expensive forms of outdoor recreation such as staying at resorts. The possibility of a positive relationship between unemployment rate and wilderness use will be tested by the *t*-statistic on this variable. The unemployment rate by state is also found in the *Statistical Abstract of the United States* (U.S. Bureau of the Census 1966–1995).

Real Price of Gasoline

This variable is a proxy for the direct price of wilderness recreation. Due to the fact that federal agencies did not charge for entrance to wilderness areas, the majority of the cost is travel to the wilderness area. Since data are not available on the average travel distances for all wilderness areas in the United States, real price of gasoline was used as a proxy price to capture changes in the relative cost of visiting wilderness areas over the 30-year period of data. This is similar in spirit to Hof and Kaiser's participation price index.

Age

Hendee et al. (1990) suggested that the aging of the population may be having an influence on wilderness use trends. However, research by English and Cordell (1985) suggests that recreation participation rates among all age cohorts have risen steadily since 1960. Data were assembled on percentage of the population in the 18–44 years age category to test if the percentage of this prime age wilderness use group had any influence on visitation.

Acreage

Acres of wilderness is the measure of agency supply and is the policy variable of interest for the hypothesis. If acreage is statistically significant, it would allow estimating future visitor days with different wilderness designation scenarios. To allow for a nonlinear effect, the natural log of acres was used. Since the dependent variable is log of visits per capita, the coefficient can be interpreted as an elasticity. To test whether this elasticity is less than 1, the 90% confidence interval around it was constructed using 1.645 times the coefficient's standard error. Data on acreage came from the U.S. Forest Service and National Park Service.

Trend

There are many other demographic and preference influences that may have influenced recreation use of wilderness areas over the past 30 years. Unfortunately, it is difficult to get annual data on variables such as ethnicity of the population and education. These variables are collected at the state level only each decade during the U.S. Census. While wilderness users tend to have above-average levels of education (Hendee et al. 1990), they also tend to be nonminorities (National Park Service 1986, 21). The trend in the United States and particularly in populous states like California is toward increasing percentages of the population being minority. Given the lack of consistent data on demographic variables such as ethnicity, a trend variable is used to capture all of these influences. The trend variable was represented by a linear series, 1, 2, 3, . . . , 30.

Regional Influences

The fixed-effects regression model estimates a separate constant for each of the regions. These regional dummy variables are intended to reflect the unquantified influences that vary across the regions. Region is indexed as i in the regression models that follow. If these regional constants are significantly different from zero (using a standard t-test) and contribute significantly to model fit (using a likelihood ratio test and F-test), this suggests each region has specific factors that are different from each other but that they vary in a systematic way.

Statistical Results

For both the U.S. Forest Service (USFS) and NPS, the analysis started with a full specification including all of the candidate independent variables just listed. Variables that were consistently insignificant, such as real price of gasoline, were dropped from the final model, since retention of insignificant variables increases the variance of the regression.

The D_i or regional constants reflecting the fixed effects are $i = 1, 2, 3, 4$, reflecting northeastern, southeastern, Rocky Mountain (sometimes called intermountain), and Pacific Coast (California, Oregon, and Washington) regions. Detailed statistical results are presented in Table 2. Estimation of separate models with slight differences in variable specification of the NPS and USFS equations is consistent with results of Chow tests (Kmenta 1986), which rejected coefficient equality for the two agencies' wilderness areas at the .01 level. As shown in Table 2, the multiple regression results of RVDs of wilderness areas administered by the USFS are quite satisfactory. Log of acres, unemployment rate, and trend are significant at the .01 level, while log of disposable per capita income is significant at the .014 level. When the full model was run, age and price of gasoline were consistently insignificant and

TABLE 2 Results of Fixed-Effects Autoregressive Model for U.S. Forest Service Wilderness

Variable	Coefficient	t-Ratio	Probability	Mean of X
Log of acres	0.899 82	13.747	0.000 00	14.54
Log of income	1.769 6	2.499	0.014 09	9.569
Unemployment rate	0.075 31	3.490	0.000 72	6.470
Trend	−0.029 87	− 2.943	0.004 04	1981

Estimated fixed effects

Region	Sample size	Coefficient	t-Ratio
1	25	31.727 62	2.19
2	25	32.184 03	2.27
3	25	32.409 01	2.23
4	25	31.927 77	2.21

Adjusted $R^2 = .9$ $F = 625.36$ $p = .713$.

were dropped to avoid reductions in efficiency in estimation from retaining insignificant variables. The adjusted R^2 is quite high at .9, and the very large F-statistic is significant at the .01 level. Each of the region fixed-effect constants is significant at the .05 level. While these constants may look only marginally different, the reader should recall that log of RVDs per capita is the dependent variable, and hence even changes in the first decimal have a marked effect on the retransformed estimate of total RVDS.

As shown in Table 3, the full fixed effect model with X variables and the group (region) effects outperforms the classic multiple regression model (number 3, X variables only) according to the likelihood ratio test chi-square statistic of 23.739 and the F-test of 8.216, both of which are significant at the .01 level.

Table 4 presents the results of the fixed-effects analysis for wilderness areas administered by the National Park Service. Here, just log of acres, log of disposable per capita income, and trend are statistically significant at conventional levels. The adjusted R^2 of .77, while lower than the U.S. Forest Service regression, is still quite

TABLE 3 Test Statistics for Alternative Models of U.S. Forest Service Wilderness

	Hypothesis Tests						
	Likelihood ratio test			*F*-tests			
Model	Chi-squared	df	Prob. value	*F*	Num.	Denom.	Prob. value
(2) vs. (1)	192.290	3	.000 00	186.904	3	95	.000 00
(3) vs. (1)	364.586	4	.000 00	886.244	4	95	.000 00
(4) vs. (1)	388.324	7	.000 00	625.355	7	93	.000 00
(4) vs. (2)	196.034	4	.000 00	140.341	4	93	.000 00
(4) vs. (3)	23.739	3	.000 03	8.216	3	93	.000 07

Note. Model designations: (1) constant term only; (2) group effects only; (3) X variables only; (4) X and group effects.

TABLE 4 Results of Fixed-Effects Autoregressive Model for National Park Service Wilderness

Variable	Coefficient	*t*-Ratio	Probability	Mean of *X*
Log of acres	0.570 74	3.840	0.00	13.26
Log of income	−5.877 9	−2.497	0.01	9.622
Trend	0.124 74	2.970	0.00	1984

Estimated fixed effects

Region	Sample size	Coefficient	*t*-ratio	Probability
1	18	−198.774 00	3.18	0.00
2	18	−199.461 14	3.19	0.00
3	23	−199.696 02	3.20	0.00
4	22	−196.861 88	3.18	0.00

Adjusted $R^2 = .77$ $F = 46.96$ $p = .499.$

TABLE 5 Test Statistics for the Classical Model Versus Fixed Effects of National Park Service Wilderness Area

	Hypothesis tests						
	Likelihood ratio test			*F*-tests			
Model	Chi-squared	d.f.	Prob. value	*F*	Num	Denom.	Prob. value
(2) vs. (1)	60.847	3	.000 00	28.735	3	76	.000 00
(3) vs. (1)	98.727	3	.000 00	61.171	3	77	.000 00
(4) vs. (1)	127.192	6	.000 00	46.965	6	75	.000 00
(4) vs. (2)	66.345	3	.000 00	31.287	3	75	.000 00
(4) vs. (3)	28.465	3	.000 00	10.387	3	75	.000 01

Note. Model designations: (1) constant term only; (2) group effects only; (3) *X* variables only; (4) *X* and group effects.

good. The *F*-statistic indicates the overall regression is significant at the .01 level. Each of the region fixed-effect constants is significant at the .01 level.

As shown in Table 5, the full fixed-effect model with *X* variables and group (region) effects outperforms the classic multiple regression model (number 3, *X* variables only) according to the likelihood ratio test chi-square statistic of 28.465 and *F*-test of 10.387, both of which are significant at the .01 level.

Results of Hypotheses Tests

The regression results in Tables 2 and 4 for the Forest Service and National Park Service, respectively, suggest we reject the null hypothesis that wilderness acreage has no net effect on visitation. The *t*-statistics on wilderness acreage are 13.747 and 3.84 for the Forest Service and National Park Service, respectively. These are clearly significant at well beyond the .01 level. Thus, there appears to be a net increase in overall regional wilderness recreation use with additional designations.

In terms of the second hypothesis regarding the elasticity of visitation with respect to acreage being less than 1; results from Table 2 suggest we reject the null hypothesis for the Forest Service. The 90% confidence interval on the elasticity ranges from .79 to 1.0. The upper 95% confidence interval (CI) is 1.03. This suggests for the Forest Service that the relationship between acreage and visitation may be proportional. For the National Park Service, we reject the null hypothesis of the elasticity of acreage with respect to visitation being equal to 1. The 90% confidence interval is from .32 to .81. The 95% CI has an upper bound of .86. Thus for the National Park Service, the relationship of visitation to additional acreage appears to be less than proportional.

Conclusions and Qualifications

For both the National Park Service and Forest Service wilderness areas, adding new acreage did result in a statistically significant increase in visitor use in each of four regions of the United States. The National Park Service elasticity of .57 was significantly less than 1, while the Forest Service elasticity of .89 had a confidence interval that included 1. Thus for the National Park Service there appears to be diminishing marginal effect of adding more wilderness, while for the Forest Service this does not appear to be the case.

These conclusions must be considered tentative due to data quality concerns. In particular, the Forest Service visitation data are not very reliable, as slightly more than 10% are based on systematic counts or visitor permit data. Nonetheless, a statistically significant effect of additional acres on visitation was also obtained with the National Park Service data. These data are believed to be of much higher quality due to being largely based on mandatory overnight backcountry permits and more carefully monitored visitor use levels. However, given the heated political debate over designation of additional wilderness in most western states, it would seem that all four federal wilderness agencies would want to collect more defensible visitor use statistics. Such data is not only important for addressing the wilderness allocation issue, but is essential for good management of existing wilderness areas. Without estimates of current visitation to which to correlate with recreation impacts, it is difficult to decide by how much use must be reduced to maintain acceptable social and biological impacts.

Nonetheless, the implications of this analysis for assessment of potential wilderness areas suggest that there does appear to be a recreational demand for additional wilderness. States like Montana and Utah, which are debating how much wilderness to recommend, should be cognizant that additional designations appear to result in a net increase in visitor use. As such, there may be gains in tourism spending in areas adjacent to these new wilderness areas, without corresponding reductions at existing areas. If better visitation data were available on individual areas, it may be possible to construct detailed models of the underlying processes generating the net increase in visitation. In particular, the net increase in visitation may arise for several reasons:

1. Newly designated areas are closer to populations centers not currently served by existing wilderness areas, such that previous nonusers are visiting wilderness for the first time.
2. Newly designated areas are resulting in existing users making additional wilderness visits.

If (2) is the case, it suggests a definite upper limit on how much longer one might see use increasing with additional designations, unless newly designated areas have complementary seasons of use (e.g., spring or fall) as compared to existing areas (e.g., summer). However, reason (1) may be an explanation for continued near-term increases in visitor use with designation, if, as suggested by one reviewer, the debate over the wilderness designation process itself may highlight areas of federal land the public was previously unaware of. This is partly the essence of the neon sign syndrome pointed out by McCool. However, wilderness designation may act more like a trademark, assuring a minimum level of quality, than like a neon sign. Wilderness designation may telegraph to potential users three important pieces of information. First, that the area is relatively pristine and provides outstanding opportunities for primitive recreation. Second, the recreation user will encounter few incompatible uses such as off-road vehicles, mountain bikes, clear-cuts, etc. Third, the area will be managed to provide solitude. Perhaps visitors do "read the labels." However, to uncover the underlying behavioral processes will require more than just better visitor counts; we will need to engage in structured interviews or administer questionnaires to wilderness visitors. This is an important area for future collaboration between academic researchers and the agency personnel on the ground.

Note

1. The Bureau of Land Management and the U.S. Fish and Wildlife Service do not collect or maintain adequate visitation data for their areas, making analysis of factors affecting their wilderness visitation virtually impossible.

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