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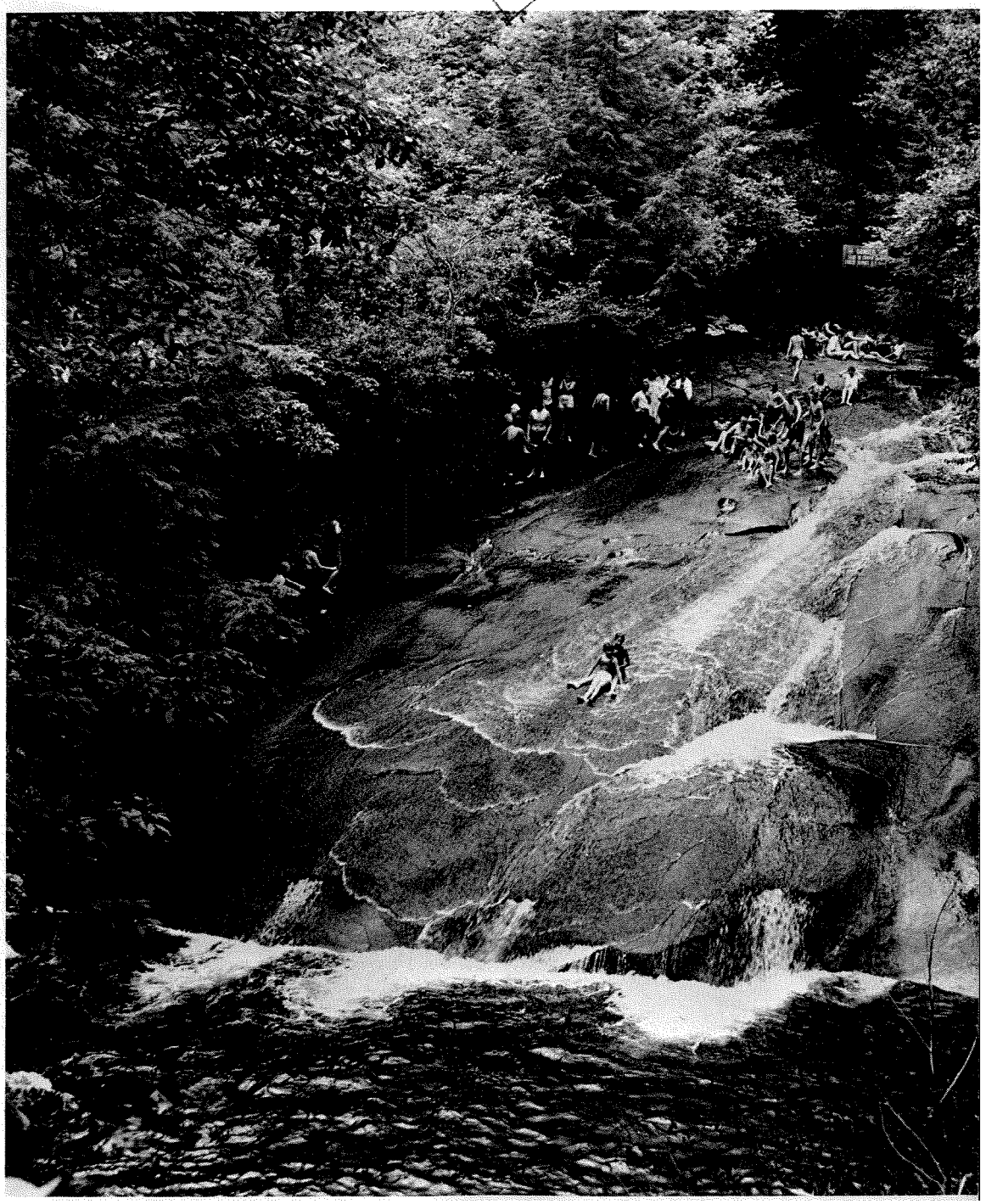

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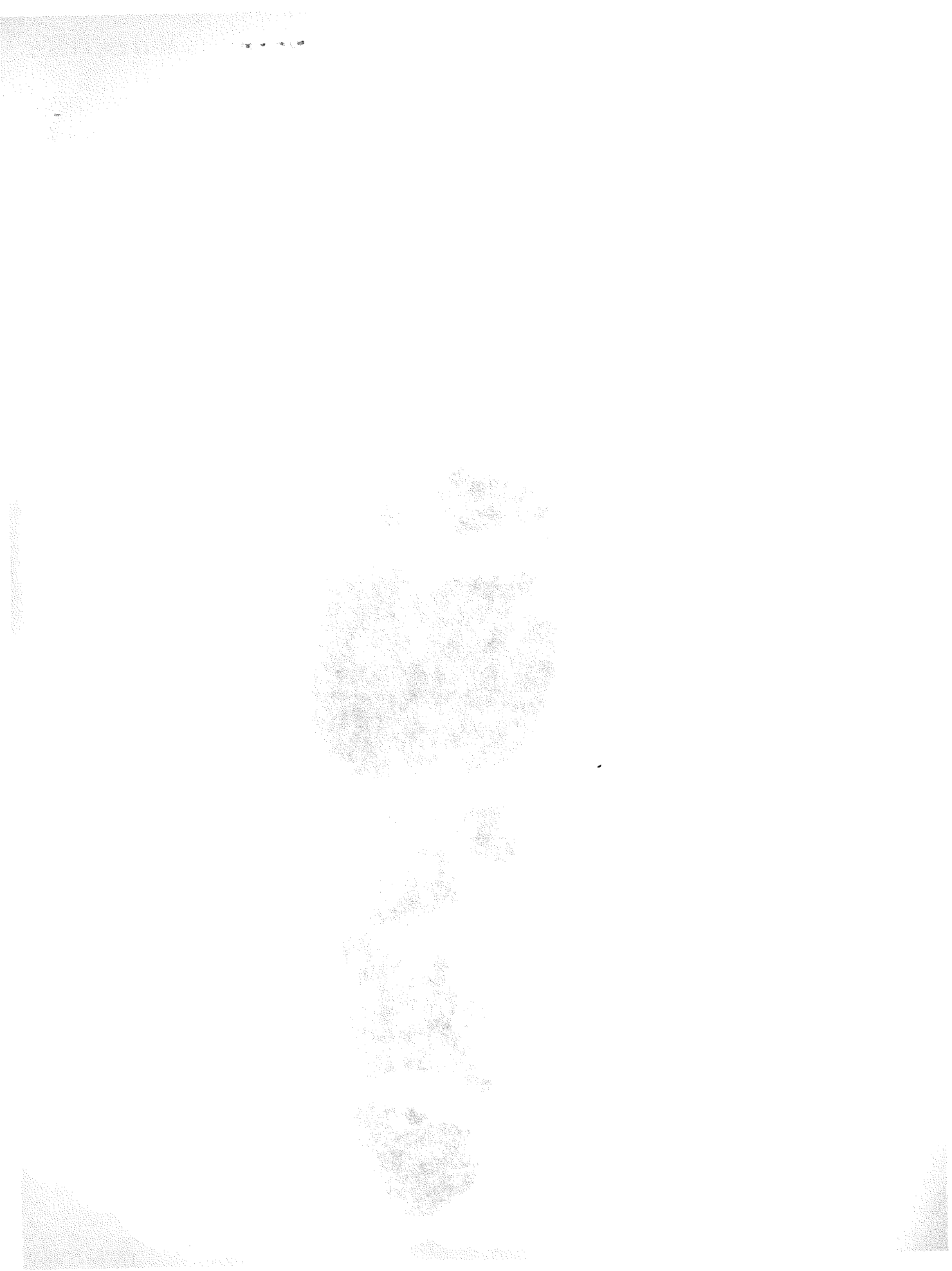


Instructions for Using Traffic Counters to Estimate Recreation Visits and Use

by
GEORGE A. JAMES AND
THOMAS H. RIPLEY-j

INTRODUCTION

Every manager of a recreation site needs three essential statistics: man-hours of use, number of visits, and peak loads. Man-hours of use are a good gauge of site wear and tear and service requirements. Visits reflect the number of impressions gained by people and hence provide an index to public approval or dissatisfaction, depending upon site condition. Peak load data are the basis of plans for capacity or overload crowds.

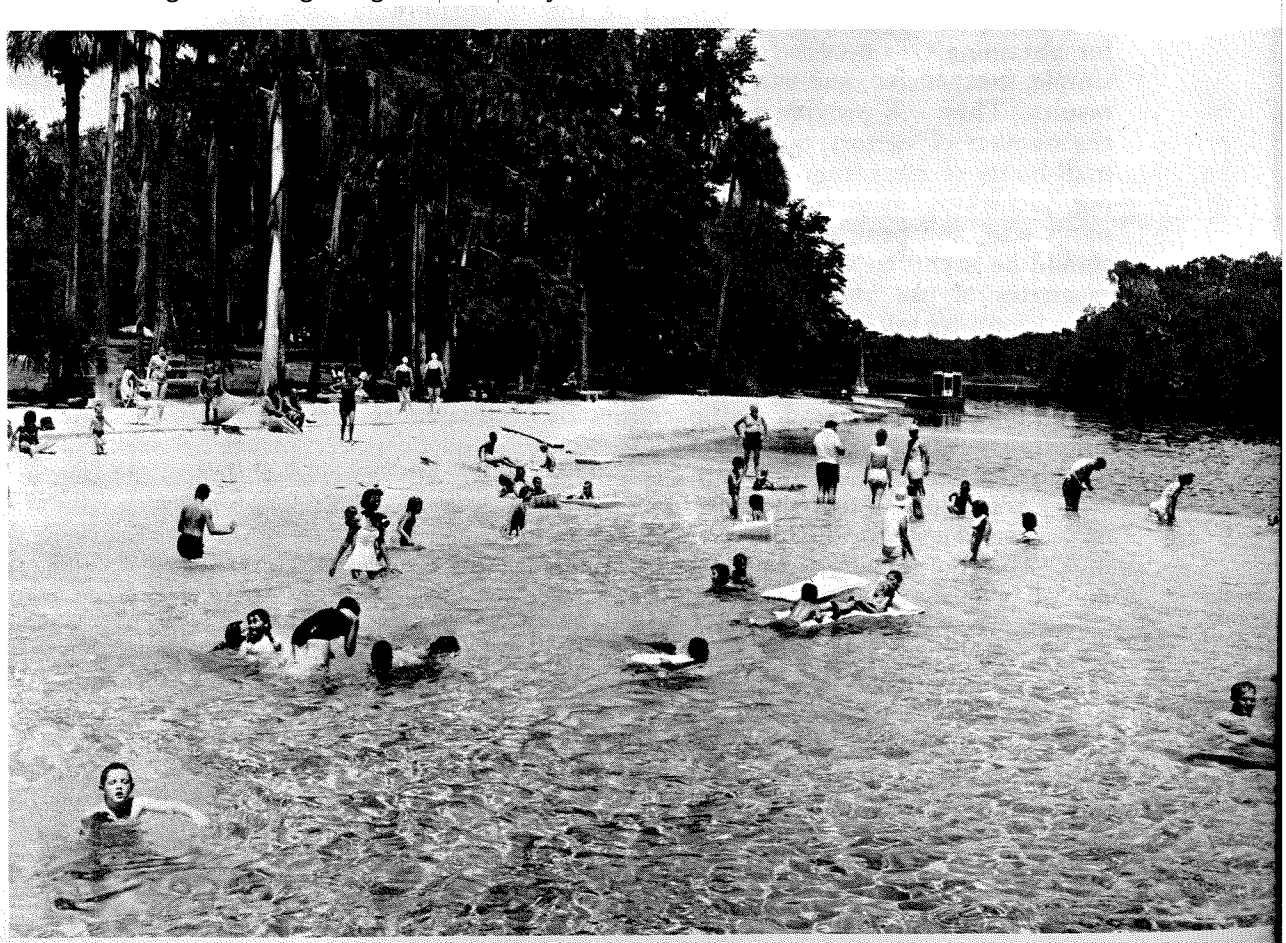
Techniques described in the following pages for obtaining this necessary information are simple, inexpensive, and can produce reliable results. They will provide good estimates of the number of visitors; total and component man-hours of recreation uses such as camping, picnicking, swimming, boating; average party size; and peak use loads. The method should be useful to all public agencies where estimates of use and visits on unattended recreation sites are needed.

To obtain the estimates, we develop a ratio between the desired statistic (visits, total recreation use, etc.) and traffic counts by simultaneously measuring both. This is called double sampling. Pneumatic traffic counters, either recording or nonrecording, are placed on site entrances to tally total vehicle crossings. The counters are read daily. The number of people visiting the area and the use levels on recreational facilities are determined hourly during a 12-hour period on a few randomly selected "sampling days" during the season. On days when someone is not on the site counting people and recording what they do, the traffic counters alone provide the basis for use estimates. The data are then analyzed, and estimates are calculated showing visits and use for each site for the current season. The tables and charts prepared from this sampling effort can be used to provide estimates during the next several years from vehicle counts only, provided there are no major changes in the sites.

The method was evolved from two studies. The first was an informal sampling conducted in 1961 on two National Forest recreation sites in the southern Appalachians. This brief test determined what attributes could best be measured, sampling procedures, size of sample, and relations to traffic counter readings, etc. Findings revealed a strong relationship between pneumatic traffic counts and the amount of use the areas received.

As a result of early success, a second and comprehensive study was planned and conducted June 30-September 3, 1962. This was a cooperative venture between National Forest Administration and Southeastern Forest Experiment Station. Thirteen recreation sites were involved: 11 in the Southern Region, and 2 in the Northeastern Region. Results were highly successful and have resulted in sampling and analytical procedures with wide application.

These are the cars that brought the swimmers, Alexander Springs, Florida National Forest. Pnenmatio traffic counters were able to predict swimming use seasom long with a high degree of accuracy.



PRELIMINARY STEPS

1. The first step is to choose the period of year for which estimates are desired. Information will probably be needed for the entire year on some recreation sites. In most cases it will be necessary to divide the year into at least two parts: high-use and off-season. Each must be sampled independently because use estimates for a specific period are generally accurate only for that period. It is recommended that most forests in the southern and southeastern states divide the sampling year into high-use (June 1 through Labor Day) and off-season (remainder of year) periods. Florida and other deep south forests might classify the high-use sampling period from May 15 through Labor Day. Other combinations are possible and should be considered.
2. Each period chosen should be sampled by a minimum of 10 randomly selected 12-hour satnpling days. Half the sampling days must be selected from all possible weekends and holidays, and half from *all possible* weekdays included in the sampling season. It is necessary that all samples be selected in a random manner. A sampling schedule must be prepared for each site in advance of study installation.
3. Prior to study installation, traffic counters must be installed at each entrance of the site to be sampled. Counters need not, however, be placed on exits in areas having l-way traffic only. Two counters installed at each site entrance provide good insurance in case one of the counters fails to work. Two counters are recommended for single-entrance sites where use is heavy. Care must be exercised in selecting roads on which counters are installed. Placement of counters is covered in detail under *"Traffic Counters"* in a later section of this booklet.

SAMPLING DETAILS

1. All estimates are based on the traffic-count record, so it is imperative that accurate records be obtained. During the seasonal sampling period all traffic counters must be read every 24 hours. Meters must be read every day at the same time between 6:00 a.m. and 10:00 a.m., preferably as near 10:00 a.m. as possible. Record actual daily axle counts,[1] not meter readings, on Form 1 (see Appendix). A limited number of "missed" readings, though undesirable, will not invalidate the entire axle-count record. The following example shows how to enter axle counts on Form 1 if one or more days are missed :

Date	*Actual axle count*	
June S	1,416	
June 9	Missed	
June 10	Missed	
June 11	3,790	(total for 3 days)
June 12	980	

2. On each of the ten 12-hour sampling days which have been randomly selected, observer should begin making observations at 10:00 a.m. All information to cotnplete Form 2 (see Appendix) should he collected. On most recreation sites, one observer will be able to collect the necessary information. Some sites will probably require two observers during periods of heavy recreation use. Summary instructions for sampling and recording data on Form 2 are shown below:

1O:OO a.m.-Read traffic counter(s) and insert observation at top, opposite 10:00 a.m. Example: if there are three counters reading 00287, 12006, and 22943, record each reading.

10:00-10:30 a.m.-Begin at site entrance and subsample for exactly 30 minutes, counting all people entering the area regardless of tnode of travel. Record opposite 10:00 a.m. at top of "Visits" column. In areas having more than one entrance, it will be necessary to determine starting entrance in a random manner. This is done by writing numbers, corresponding to numbers of entrances, on single pieces of paper, placing them in a container and drawing a single number. As an example: number 2 is drawn for an area having three en-

[1] *Axle* count as used throughout this manual means two counter registers per passenger vehicle, one per 2-wheel boat trailer, and so forth.

trances. Consequently, the 10:00 a.m. sampling begins at entrance number 2, with 11:00 a.m. sampling at entrance 3, 12:00 noon sampling at entrance 1, and continuing in sequence throughout the day. The same random selection of starting entrance and subsequent procedure must be followed for each 12-hour sampling day of the season.

10: 30-l 1: 00 a.m.-Circulate the area and determine (as of 10:30 a.m.) the number of people and parties (camping and picnicking) associated with each major use in the area. A party may consist of one or more persons. Record these totals in appropriate "Component use" columns opposite 10:30 a.m. These must be viewed as instantaneous estimates.

11:00-11:30 a.m.-Return to the single entrance, or go to the next entrance in sequence in multi-entrance sites, and determine visits for exactly 30 minutes. Record as before opposite 11:OO a.m. under "Visits."

11: 30-12 : 00 noon.-Repeat procedures followed between 10: 30-1 1: 00 a.m., tallying total people and parties as before.

Repeat these steps throughout the day until 1O:OO p.m. Read traffic counters at 1O:OO a.m. the following morning and record opposite "lO:OO a.m. next day."

Form 2 data sheets should be summarized and checked for arithmetic error as soon as possible and any pertinent remarks concerning irregularities should be noted. This completes the work at the actual recreation site. The remaining summarization and analysis can best be accomplished by headquarters staff.

OFFICE COMPUTATIONS (FORM 2)

Total all counter readings in axle crossings for all entrances from 10:00 a.m. on sampling day to 1O:OO a.m. on following day. Record 24-hour total under item A at bottom of form.

Add up the "Visits" column. Multiply this total by 2 to convert the 30-minute readings to an hourly basis. Next multiply by number of entrances involved. Example: If there were 3 entrances, each total should be multiplied by 3. Enter these expanded 12-hour values under item B. Note that sampling does not provide an estimate of visitors between 1O:OO p.m. and 10:00 a.m. the following morning. Visits during night (after 10:00 p.m.) are generally few and have little bearing on site management. Man-hours of use and number of parties for each 12-hour period should be totaled. Enter these values under "Totals" at bottom of form. A 24-hour value for use and parties must be determined. For most uses, the 12-hour daytime tally gives an accurate estimate, because few people swim, fish, or picnic at night. Camping is the exception and the only significant overnight use on most recreation sites; consequently, it must be figured on a night-time basis also. Two assumptions are made with regard to campers: if they are in the area with tents up at 6:00 p.m., they will remain overnight; and most children and many adults retire sometime between the hours of 6:00 p.m. and 10:00 p.m. Accordingly, the largest number of campers and parties counted between the hours of 6:00 p.m. and 10:00 p.m. is multiplied by 12 to account for camping man-hours between 10:00 p.m. and 10:00 a.m. the following morning. These values are added to the 12-hour daytime use to estimate 24-hour values. Record 24-hour camping use and camping parties at the bottom of the form under (C).

Determine mean *party* size for camping and picnicking by dividing use by number of parties associated with that use.

Example: Total 24-hour camping use is 500 hours; total number of camping parties is 125. Divide 500 by 12.5 to obtain the average camping party size, namely, 4 persons.

Double check entries, expansions, and totals on Forms 1 and 2. The data are now ready to be examined by multiple regression analysis. To be most efficient this should be done using ADP (Automatic Data Processing) procedures for several areas, say 10 or more at a time.

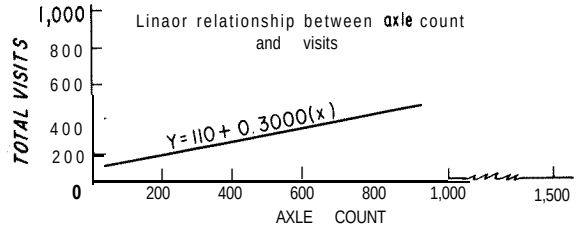
Punch data on ADP cards, or record on ADP magnetic tapes. Insert F values on parameter cards to instruct machine to reject x variables which in final equations are not significant at desired levels of probability. A probability level of 90 percent or higher is recommended. Consult appropriate statistical text for this step.

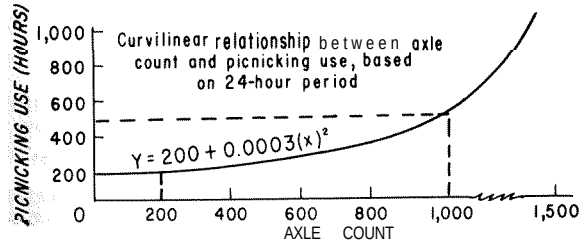
Run multiple regression analysis computations on ADP computer.

Analyze ADP computations. Compute predicting equations and error terms for each significant variable.

PREPARATION OF PREDICTING TABLES AND CHARTS

Two independent variables are examined in this analysis: axle counts (x) and axle counts squared (x") . Estimates involving solely the x variable will produce a straight line relationship between x and y (variate). Estimates containing the x^2 variable will show a curved relationship between x and y. Examples of the two types of situations are shown below:





Linear relationships, such as shown above, remain constant over the entire range of values. In such cases it is necessary to obtain a record of total seasonal axle counts only during the next several years to predict visits or use.

Curvilinear relationships, such as shown above, do not remain constant over the range of values. It can be readily seen from the above relationshin that 24-hour axle counts are necessary to produce reliable estimates. Example: consider a S-day continuous period during which 200 axle counts are recorded each day. If the counter is read only once during the period, 1,000 axle crossings are recorded. The above curve (and the table prepared from this curve) shows slightly less than 500 picnicking hours during the S-day period. A daily reading of 200 axle crossings, however, shows 200 hours of picnicking use daily, or a total of 1,000 hours during the period.

Situations where the x^2 variable alone best expresses the relationship between x and y can be expected to occur frequently. Of the 71 predicting equations resulting from the 1962 study, 46 percent involved the x^2 variate. The predicting equations for each site will generally contain some involving the x variate only, and others containing the x^2 variate only. On only 2 of the 13 recreation sites sampled during 1962 were all site variables best predicted by the x variate only.

Ninety-seven percent of the regressions resulting from the 1962 study were either simple linear or simple curvilinear, i.e., involving either the x or x^2 variates alone, not in combination. Less than 3 percent of the regressions were multiple curvilinear, involving x and x^2 in combination.

With these facts in mind, we are now ready to prepare predicting tables and charts. Procedures for constructing the sheets summarizing season-long visits and use estimates for each site, such as shown in table 1 (Appendix). are as follows:

1. Use appropriate formula for each variable to be predicted, plus seasonal record of daily axle counts. Plug axle count (x) or x^2 into formula. For linear relationships use axle counts directly from Form 1. For curvilinear relationships use axle counts squared. x^2.

Example of linear relationship

Basic formula is Y= (a) times (number of days in season) + (b) times (total axle count from Form 1) .

Actual formula is $Y=88$ (66 days) + 1.7189 (35,000 axle crossings)
= 5,808 + 60,162
= 65,970 units (visits or hours).

Example *of* curvilinear *relationship*

Basic formula is Y=(a) times (number of days in season) + (b) times (Σx_i^2). To obtain (Σx_i^2) it is necessary to square each 24-hour axle count from Form 1 and add the squared values.

Actual formula is $Y=7$ (66 days) + 0.0003 (Σx_i^2) or $7(66)$ + 0.0003 (5,000,000)
= 462 + 1,500
= 1,962 units (visits or hours).

2. Compute sampling error for each predicting equation. Consult basic statistical text for calculation of standard errors and sampling errors. Note that the season-long summary tables thus prepared apply only for the season and site sampled.

It may be disappointing to find that reliable predicting equations are not always produced for all desired variables. Due to certain site characteristics, or weak basic data, it will occasionally be found that neither x nor x^2 accurately predicts some site uses. However, good estimates generally will result for most component uses. In some cases where they do not, it may be possible to obtain close approximations by simply subtracting predicted values of other variables from *total* use.

The next step is the preparation of RECREATION VISITS AND USE ESTIMATES tables for each site (table 2, Appendix).

PROCEDURE

1) Insert various values of axle crossings into appropriate formulae. Some values will be x, others x^2. Prepare table similar to table 2 (Appendix) for each area, as follows:

Example of linear relationship

Basic formula is $Y = a + b(x)$

Actual formula is $Y = 608 + 1.7638(x)$

Insert values of axle crossings into above formula as follows:

$Y = 608 + 1.7638(100) = 784$
$Y = 608 + 1.7638(200) = 961$
$Y = 608 + 1.7638(300) = 1137$
$Y = 608 + 1.7638(400) = 1314$

etc., until complete table is constructed.

Example of *curvilinear relationship*

Basic formula is $Y = a + b(x)^2$

Actual formula is $Y = 188 + 0.0003\ (x)^2$

Insert squared values of axle count into formula as follows:

$Y = 188 + 0.0003\ (100)^2 = 191$
$Y = 188 + 0.0003(200)^2 = 200$
$Y = 188 + 0.0003(300)^2 = 215$
$Y = 188 + 0.0003(400)^2 = 236$

etc., until complete table is constructed.

Note that the x values used in preparing the tables should not be greater than the maximum, nor less than the minimum, *actual* axle crossings shown on Form 1 for any area. These tables can be used to estimate future recreation visits and use only during the season for which sampling was done, i.e., either during high use or off season.

Two major steps have been accomplished up to this point: Estimates of visits and use for each sampled site have been computed (table 1); and tables showing the relationships between axle crossings and the y variables (uses and visits) have been prepared as shown in table 2. The use of table 1 has already been discussed. RECREATION VISITS AND USE ESTIMATES based on axle crossing counts (table 2) are applicable during the next several-year period. It is expected that the relationships between axle counts and associated visits and uses will remain fairly constant for the next S-year period. It is necessary only to obtain an accurate record of 24-hour axle counts to obtain reliable estimates. These relationships will remain constant, however, only if no major change in recreational facilities is made on the respective site. Examples of major change would be the construction of swimming pool or boat ramp where neither of these facilities existed previously. Increasing the number of picnic tables or family camping units is not expected to invalidate estimates.

SAMPLING PRECISION

The recommended sampling intensity of 10 sampling days per site is expected to yield error terms no larger than plus or minus 25 percent of the estimated variable at the 67-percent level of probability. Many error terms will be considerably less than 2.5 percent (see table 1, Appendix). A few may occasionally be less accurate, depending on such things as site characteristics, accuracy of measurements, etc.

Example: If an equation estimates 100,000 hours of camping use, and sampling error is ± 25 percent, then the true value will lie somewhere between 75,000 and 125,000 hours two out of three times.

If error terms consistently less than 2.5 percent are desired, a sharp increase in number of 12-hour sampling days will be necessary.

OTHER INDEPENDENT VARIABLES

Several independent variables were assessed in the two sampling studies. These included weather, period of week (weekday vs. weekend and holiday), 12-hour axle count, 24-hour axle count, and the squared expressions of these last two variables. Multiple regression analysis performed on all dependent variables (visits, total, and component uses) revealed that only two of the independent variables, 24-hour axle count and 24-hour axle count squared, were good predictors. The other independent variables proved to be poor estimators. Because they accounted for only a small proportion of total variation. they were dropped.

STRATIFICATION OF RECREATION SITES

Multiple regression analyses were performed to determine whether recreation sites having similar recreational facilities could be combined and one set of predicting equations applied to several sites. It was found that the predicting equations could be used only for the site from which the sample was obtained, and that stratification was not possible. This does not mean, however, that certain areas cannot eventually be grouped. It means only that the widely scattered sites studied in 1962 (no two sites on any one National Forest) did not lend themselves to stratification. Site variation was apparently too great to permit combining areas. Similar areas on a single National Forest or Ranger District might, however, lend themselves to site stratification. If so, sampling requirements could be reduced.

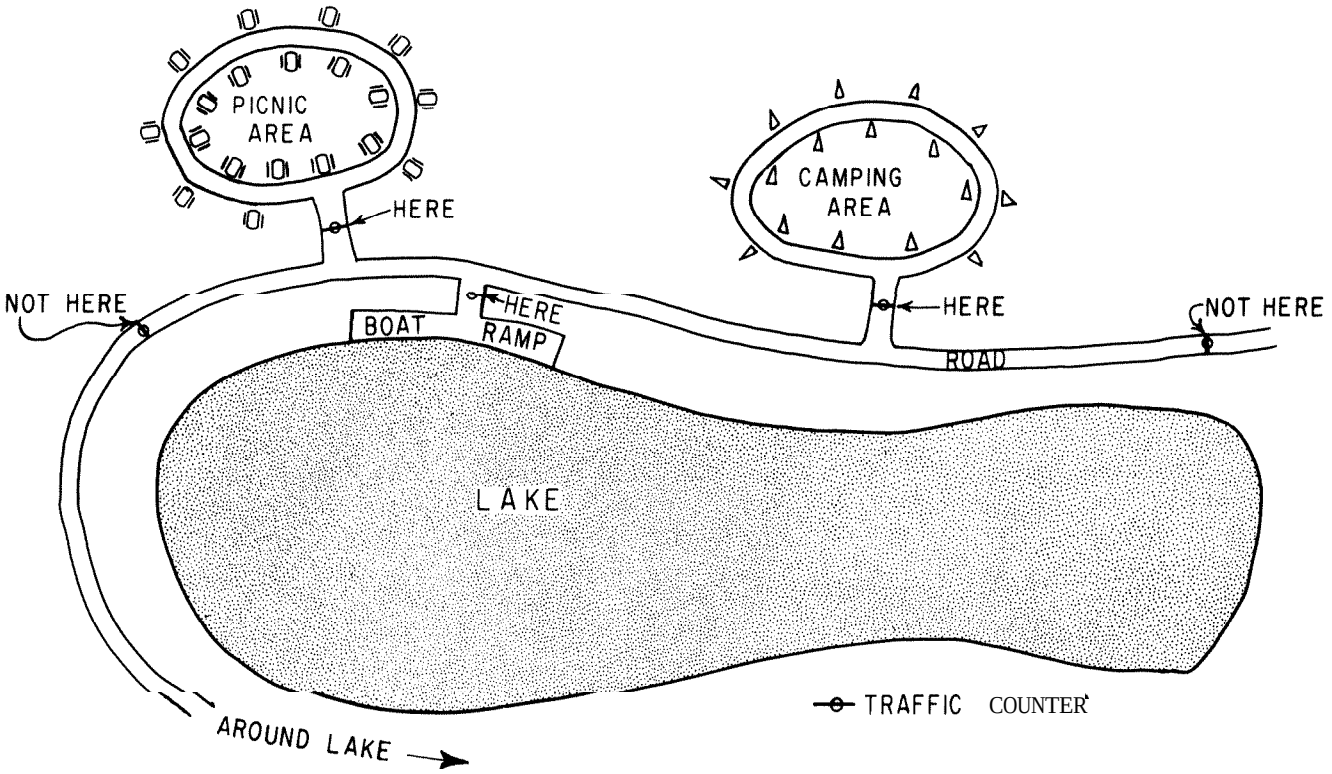
TRAFFIC COUNTERS

Shortly prior to study installation, install traffic counters at the entrance to each study site. Counters should be installed on roads leading directly to the recreation site, not on roads leading past the site to other destinations. An example of correct and incorrect placement is shown in the accompanying sketch.

Traffic counters in subsequent years must be kept in the same location as during the first sampling year. A change in counter location will change the relationship between axle count and the y variate, and result in estimates that are inaccurate.

An extra counter and spare counter batteries should be carried in the recreation vehicle, or furnished the concessionaire where applicable, so that faulty counters may be repaired each morning.

The use of self-recording counters should be considered. These machines provide a continuous record of axle crossings and peak use, and need to be serviced only periodically. Because most sites will require a 24-hour axle-count record, self-recording counters might pay for themselves during a single season.



APPENDIX

Form 1

Record of daily axle counts (June 1 through Labor Day)

Region _____ Forest _____ District _____ Site _____

Date	Axle count	Date	Axle count	Date	Axle count
June 1		July 1		Aug. 1	
June 2		July 2		Aug. 2	
June 3		July 3		Aug. 3	
June 4		July 4		Aug. 4	
June 5		July 5		Aug. 5	
June 6		July 6		Aug. 6	
June 7		July 7		Aug. 7	
June 8		July 8		Aug. 8	
June 9		July 9		Aug. 9	
June 10		July 10		Aug. 10	
June 11		July 11		Aug. 11	
June 12		July 12		Aug. 12	
June 13		July 13		Aug. 13	
June 14		July 14		Aug. 14	
June 15		July 15		Aug. 15	
June 16		July 16		Aug. 16	
June 17		July 17		Aug. 17	
June 18		July 18		Aug. 18	
June 19		July 19		Aug. 19	
June 20		July 20		Aug. 20	
June 21		July 21		Aug. 21	
June 22		July 22		Aug. 22	
June 23		July 23		Aug. 23	
June 24		July 24		Aug. 24	
June 25		July 25		Aug. 25	
June 26		July 26		Aug. 26	
June 27		July 27		Aug. 27	
June 28		July 28		Aug. 28	
June 29		July 29		Aug. 29	
June 30		July 30		Aug. 30	
		July 31		Aug. 31	
				Sept. 1	
				Sept. 2	
				Sept. 3	

Form 2

Daily summary of axle count and recreation use

Region _____ Forest _____ District _____

Site _____ Observer _____ Date _____

Time	Counter readings: Entrance 1	Entrance 2	Entrance 3	Entrance 4	Visits (as tallied for 30 minutes each hour)	Component uses: Camping People	Camping Parties	Picnicking People	Picnicking Parties	Swimming People	Boating and/or Fishing People	Misc. People	Total People
10:00 AM	00287	12006	22943										
10:30													
11:00 AM													
11:30													
12:00 Noon													
12:30													
1:00 PM													
1:30													
2:00 PM													
2:30													
3:00 PM													
3:30													
4:00 PM													
4:30													
5:00 PM													
5:30													
6:00 PM													
6:30													
7:00 PM													
7:30													
8:00 PM													
8:30													
9:00 PM													
9:30													
10:00 PM													
10:00 AM (Next day)													
Totals													

DO NOT WRITE IN SHADED BLOCKS

(A) Total 24-hour axle count . . . . . _____

(B) Total visits, 10:00 AM to 10:00 PM . . . . . _____

(C) Component uses

Camping -- Man-hours, 24-hour period . . . . . _____
Number of parties, 24-hour period . . . . _____
Mean size of party . . . . . _____

Picnicking - Man-hours, 12-hour period . . . . . _____
Number of parties, 12-hour period . . . . _____
Mean party size . . . . . _____

Swimming - Man-hours, 12-hour period . . . . . _____

Boating and/ or Fishing - Man-hours, 12-hour period . . . . . _____

Miscellaneous - Man-hours, 12-hour period . . . . . _____

TOTAL USE (24-hour period) . . . . . _____

Table 1. --Visits and use estimates

Site: Alexander Springs Forest: Florida Region: 8

Period beginning: 10:00 AM June 30, 1962 Ending: 10:00 AM September 4, 1962

Variable	Estimate	Accuracy 1/
		Percent
Total visits (number)	62,877	± 3.0
Camping use (hours)	470,768	i-11.0
Average camping party size (number)	3.7	± 8.0
Picnicking use (hours)	24,892	± 9.0
Average picnicking party size (number)	4.5	±11.0
Swimming use (hours)	71,535	± 4.0
Boating-fishing use (hours)	7,842	± 8.0
Total use (hours)	613,118	± 8.0

1/ True value lies between the plus percentage and minus percentage shown, at the 67-percent level of probability.

Table 2. --Axle counts (24-hour) and associated recreation visits and use estimates

(June 1 through Labor Day)

Region _____ Forest _____ District _____ Site _____

Axle crossings (x)	Total visits	Picnicking use	Swimming use	Total use
	$= -59 + 0.6349\ (x_1)$	$= 188 + 0.0003\ (x)^2$	$= 56 + 0.0003\ (x)^2$	$= 608 + 1.7638\ (x_1)$
Number	Number	Hours	Hours	Hours
100	4	191	59	784
150	36	195	63	873
200	68	200	68	961
250	100	207	75	1,049
300	131	215	83	1,137
350	163	225	93	1,225
400	195	236	104	1,314
450	227	249	117	1,402
500	258	263	131	1,490
550	290	279	147	1,578
600	322	296	164	1,666
650	354	315	183	1,754
700	385	335	203	1,843
750	417	357	225	1,931
800	449	380	248	2,019
850	481	405	273	2,107
900	512	431	299	2,195
950	544	459	327	2,284
1,000	576	488	356	2,372
1,100	640	551	419	2,548
1,200	704	620	488	2,724
1,300	766	695	563	2,901
1,400	830	776	644	3,077
1,500	893	863	731	3,254
1,600	957	956	824	3,430
1,700	1,020	1,055	923	3,606
1,800	1,084	1,160	1,028	3,783
1,900	1,147	1,271	1,139	3,959
2,000	1,211	1,388	1,256	4,136
2,100	1,274	1,511	1,379	4,312
2,200	1,338	1,640	1,508	4,488
2,300	1,401	1,775	1,643	4,665
2,400	1,465	1,916	1,784	4,841
2,500	1,528	2,063	1,931	5,018