United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research Paper NE-658

Estimates of Recreation Use in the White River Drainage, Vermont

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Abstract

An observation technique that incorporates modified, stratified sampling was used to estimate in-stream recreation use in the White River Drainage in Vermont. Results were reported by season (spring, summer, and fall); day of week ("weekends and holidays" and "weekdays"); time of day (early morning, midmorning, early afternoon, and evening); kind of activity (fishing, boating, floating, swimming, and other); and portion of stream (main stem, tributaries, and feeders). Summer had the highest use followed by spring and fall. Except in fall, weekends and holidays received substantially more recreation use than weekdays. Midmorning and early afternoon had the greatest use. Fishing was the predominant use in the spring, while swimming was the single most popular activity in summer. The main stem received the greatest use followed by tributaries and feeders.

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Manuscript received for publication 17 June 1991

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February 1992

Introduction

Reliable information on the kinds and intensity of stream recreation use in the Northeast is needed by resource management agencies at both the state and Federal level. As a result, the Green Mountain National Forest, USDI Fish and Wildlife Service, and Vermont Fish and Wildlife Department joined the Northeastern Forest Experiment Station in a study of recreation use in the White River Drainage, Vermont (Fig. 1). Specifically, an observation method was used to estimate recreation use on the White River and its tributaries.

The White River Drainage has special interest because it is a principal component of a multimillion dollar state and federal effort[1] to reestablish a viable population of sea-run Atlantic salmon (*Salmo salar*) in the Connecticut River Drainage. The initial return of sea-run salmon has been observed in the White River since 1986, so baseline information on recreation use was sought to help determine possible impacts if a salmon sport fishery is established. Also, there is concern that heavy human use may disturb salmon in holding pools.

Apart from restoration of Atlantic salmon, reliable estimates of recreation use on the White River are needed for several other purposes. Both state and Federal agencies desire information on human use patterns to identify sites to be considered for public acquisition. Further, budget allocations by public agencies are being increasingly influenced by the level of human use. Previous studies on the White River have been limited in scope. In 1979, Manning conducted a study of four Vermont rivers, including the White, that focused on the relationship of anglers to other recreationists. The results, based on personal interviews, indicated that anglers, the most frequent recreationists, experienced the highest level of conflict with other recreational users.

Elsewhere, recreation use has been estimated successfully by the use of mail questionnaires or personal interviews (Cushwa and McGinnes 1963; Echelberger and Moeller 1977), but such techniques are not readily adaptable to the conditions that exist on the White River. Approaches that combine interviews and observation (James et al. 1971; Rawhouser et al, 1989) have been effective in some situations but, again, were not readily adaptable to our White River study.

The use of secondary variables such as traffic counts also have been successful (James 1971; James and Rich 1966), but the easy accessibility of much of the White River Drainage and its location along multipurpose transportation corridors made this technique inappropriate for our study.

Finally, observation techniques used to estimate recreation use and participant behavior have proven successful in certain situations. Instantaneous count sampling has been effective for estimating person-days of recreational activity on small areas (Echelberger and Moeller 1973; Schreuder et al. 1975; Tyre and Siderelis 1979). However, this approach does not lend itself to a study area with the characteristics of the White River Drainage. Observation also has been used successfully to quantify recreational activity and behavior of recreationists (Heberlein and Dunwiddie 1979).

We decided to record stream use through direct observation from a distance for several reasons. First, distant observation is less costly and less of an infringement on users than approaches requiring personal contact. Second, the characteristics of the White River Drainage are such that use can be observed conveniently whereas personal contact with some users (e.g., tubers and kayakers) is likely to be difficult. The effective use of mail questionnaires to the general population was hampered by the fact that there is a large population with relatively easy access to the Drainage but only a small proportion of the population uses the resource for recreation. Third, Federal agencies must obtain Office of Management and Budget approval to use personal-contact survey instruments, a time-consuming procedure that can result in critical delays in monitoring changes in stream use. Finally, this study was designed to estimate recreation use for varying time periods, and, therefore, differs from other observation studies that have concentrated on estimates of numbers of users at specific points in time. And our study was designed to estimate recreation use for the entire system of the White River (main stem, tributaries, and feeders) while previous work concentrated on the main stem.

[1]A cooperative agreement between state and Federal agencies to reestablish the Atlantic salmon in the Connecticut River Basin was established in 1967. The Connecticut River Atlantic Salmon Commission was formed in 1984.

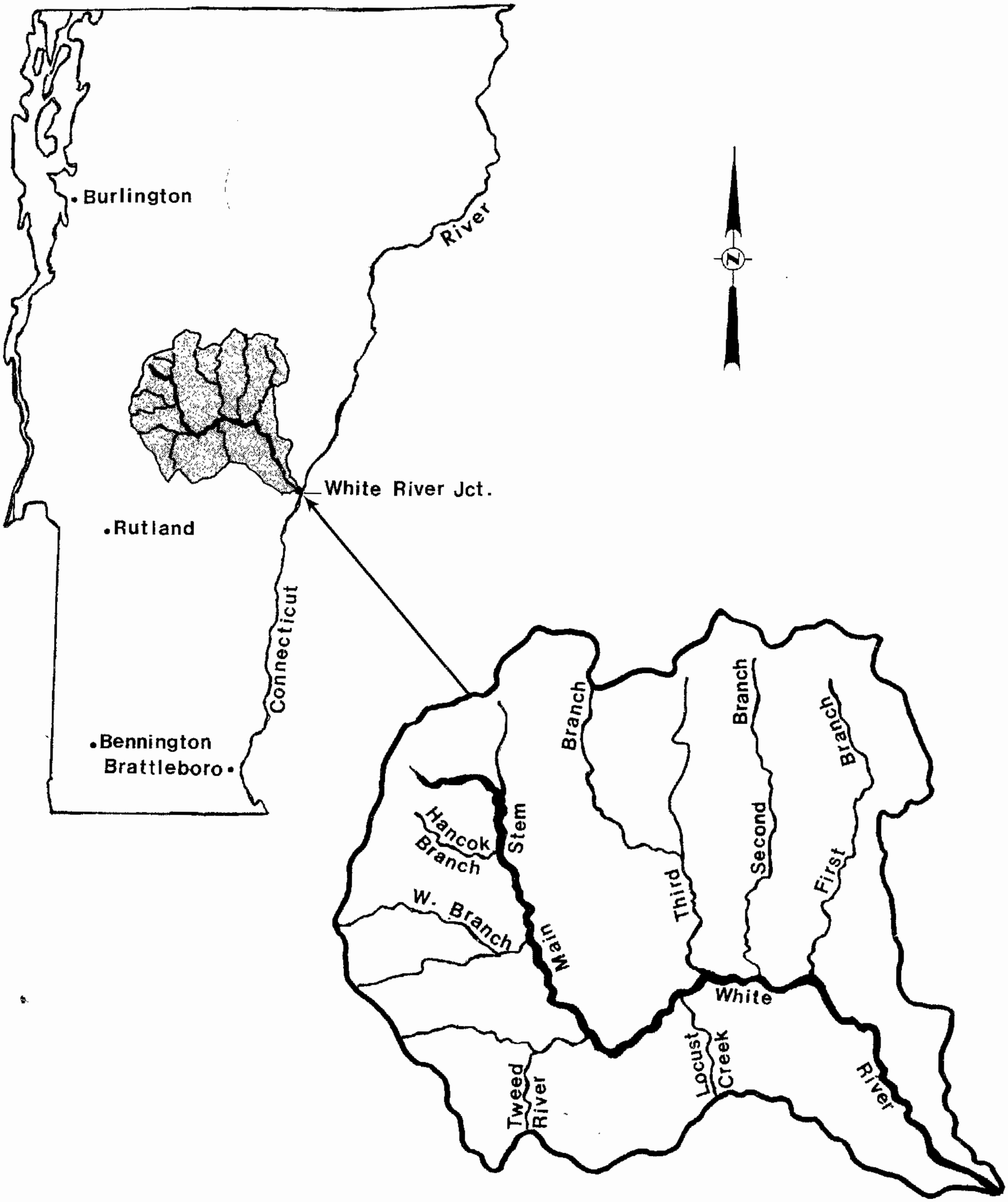

Figure 1.—White River Drainage in Vermont.

Methods

The White River Drainage is a complex network of rivers and streams encompassing a 710-square-mile area. A list of streams in this area was provided by the Vermont Department of Fish and Wildlife. A stratified sampling technique was used to estimate stream-corridor recreation use within the White River Drainage from April 11 to October 25 during the 1987 Vermont trout fishing season. We included any such activity that occurred one-half hour before sunrise to one-half hour after sunset. Streams were visited and segmented by natural boundaries such as tributaries, or to a 5-foot minimum width.

The field observation was designed to accommodate one person working 5 days a week, 8 hours a day. The work schedule was designed to include every weekend day and holiday; the remaining days in the week were selected at random to fill the week's work schedule. To accommodate the full range of times during any day, three work shifts were designated: the early shift was an 8-hour period beginning one-half hour before sunrise; the late shift was an 8-hour period ending one-half hour after sunset; and the middle shift was from 8 a.m. to 4 p.m. The work shift for any day was assigned at random, as described in the Appendix, to complete the work schedule for the season.

Longer stretches of streams were divided into segments using boundaries that could be identified easily in the field. The order in which the segments were to be observed was randomly selected as described in the Appendix, and provided prior to the field work. This scheme allowed the field crew to visit as many stream segments as possible during a work shift. The observer, in recording the required information on a visit to a given segment (see data sheet, Figure 2) was instructed to proceed along the stream segment and record all individuals engaged in a stream recreation activity and the time the activity was observed. Any activity that was recreational in nature and took place on the stream or directly adjacent to it was recorded. To better facilitate reporting and attain higher confidence in results, recreational activities were divided into five categories: fishing, boating, floating, swimming, and "other" (see footnote, Table 3).

Results

Recreation use by activity type was estimated for each category of stream segment—main stem, tributaries, and feeder streams. In total daily recreation use for the entire White River system, weekends and holidays were the busiest during the spring and summer seasons (Table 1). Estimated use was 2,401 person-hours per day during summer weekends and holidays compared to 874 person-hours for weekdays. By contrast, daily use was estimated at 873 person-hours for fall weekdays but only 274 person-hours for weekends and holidays. Further, the main stem received the most use during the spring and summer. The tributaries were used more heavily in the fall than in spring. Viewing of fall foliage (even when limited to viewing from bridges, rocks, or islands), was a major seasonal use, especially on the tributaries. Feeder streams had the least use during each of the seasons. It should be noted that standard errors are relatively high in all cases, so a more detailed breakdown of recreational activities, as they vary with day of the week and season of the year, would not provide reliable results.

The middle of the day (midmorning and early afternoon) generally was the most popular time of recreation use (Table 2). A notable exception was during summer weekends and holidays when the evening period received more use than midmorning but not as much as early afternoon. The latter had the highest use (1,352 person-hours per day) of any time period for any season. In all cases except fall weekends and holidays, the early morning received the least use. Again, relatively high standard errors discouraged a more detailed examination of use estimates by kinds of recreation.

Participation in various kinds of recreation varied considerably by season of the year and day of the week (Table 3). In person-hours of participation, fishing was most popular in the spring but ranked third in popularity during summer. Most fishing occurred on weekends and holidays. As with most recreational activities, fishing declined substantially during the fall. Boating occurred most frequently during the spring, primarily on weekends and holidays. Floating and swimming were almost exclusively summer activities, though there was limited participation in the spring. The catchall "other" category showed substantial use in the fall, much of this related to foliage viewers who clambered over rocks or viewed from bridges and other spots within the stream banks.

Total recreation use for the entire White River system reached nearly 205,000 person-hours during 1987 (Table 4). For many managerial purposes, especially those dealing with the threat of potential use conflicts, the upper levels of the confidence interval may provide more meaningful insights. At 90 percent probability, it is estimated that total recreation use over the entire season did not exceed 208,350 person-hours. Considering the miles of stream involved, the upper level at 90 percent probability amounts to 555 person-hours per mile of stream for the entire season.

On a seasional basis, summer had the heaviest use but also included a larger number of days than spring or fall. Fishing and swimming were the most popular activities, though "other" (which includes a number of specific activities) was the largest category. This category included a large proportion of passive activities such as sunbathing and laying on rocks during the summer. During spring, fishing was the major on-stream recreation use in the drainage. In summer, swimming was the leading activity, followed by fishing and boating. While fishing was the leading individual activity during the autumn, the "other" category had the highest use.

Table 1.—Estimates of daily on-stream recreation use in White River Drainage by season of year, day of week, and stream segment, 1987

Season	Day of week	Statistical measures	Stream category: Main stem	Tributaries	Feeders	Entire system
Spring	Weekdays	Person-hours of use (no.)	148	59	0	207
		Standard error	35	35	0	50
		Observational runs (no.)	52	20	12	84
	Weekends and holidays	Person-hours of use (no.)	806	381	282	1,469
		Standard error	243	149	225	363
		Observational runs (no.)	30	16	11	57
Summer	Weekdays	Person-hours of use (no.)	460	405	9	874
		Standard error	90	103	9	137
		Observational runs (no.)	86	55	36	177
	Weekends and holidays	Person-hours of use (no.)	1,456	720	224	2,401
		Standard error	209	212	143	330
		Observational runs (no.)	82	42	23	147
Fall	Weekdays	Person-hours of use (no.)	148	695	29	873
		Standard error	19	230	29	232
		Observational runs (no.)	37	28	18	83
	Weekends and holidays	Person-hours of use (no.)	136	138	0	274
		Standard error	39	66	0	76
		Observational runs (no.)	30	21	19	70

Table 2.—Estimated daily on-stream recreation use by time of day, day of week, and season of year for White River Drainage, 1987

Season	Day of week	Early morning: Person hours	Early morning: Standard error	Midmorning: Person hours	Midmorning: Standard error	Early afternoon: Person hours	Early afternoon: Standard error	Evening: Person hours	Evening: Standard error	All day: Person hours	All day: Standard error
		Number		*Number*		*Number*		*Number*		*Number*	
Spring	Weekdays	29	20	41	13	101	40	36	19	207	50
	Weekends and holidays	32	16	753	330	486	124	198	84	1,469	363
Summer	Weekdays	47	24	246	80	451	103	130	36	874	137
	Weekends and holidays	122	86	343	70	1,352	243	584	193	2,401	330
Fall	Weekdays	79	21	312	178	373	141	109	44	873	232
	Weekends and holidays	43	18	101	48	116	56	14	9	274	76

Table 3.—Estimated daily on-stream recreation use by kind of activity, day of week, and season of year for White River Drainage, 1987

		Person hours (no.)						Standard error of total
Season	Day of week	Fishing[a]	Boating[b]	Floating[c]	Swimming[d]	Other[e]	Total	
Spring	Weekdays	161	5	0	15	27	207	50
	Weekends and holidays	838	258	4	20	349	1,469	363
Summer	Weekdays	167	14	49	249	396	874	137
	Weekends and holidays	469	72	294	727	838	2,401	330
Fall	Weekdays	37	0	0	0	836	873	232
	Weekends and holidays	50	14	0	0	210	274	76

[a]Includes fishing from boat.
[b]Includes canoeing and kayaking.
[c]Includes inner tubes and rafts.
[d]Includes swimming and wading.
[e]Includes a wide range of recreational activities that occurred on the stream corridor, e.g., on rocks and islands surrounded by water, bridges over the water, and in the water. Activities included sunbathing, picnicking, photography, viewing scenery, sitting on rocks, and other stream uses. While these are an important component of recreational use in total, they represent a small share of overall use individually and tend to be passive in nature, i.e., unlikely sources of conflict.

Table 4.—Estimated on-stream recreation use by kind of activity and season of year for White River Drainage, 1987

	Person hours (no.)						Standard error of total
Season	Fishing	Boating	Floating	Swimming	Other	Total	
Spring	14,874	3,231	50	687	4,996	23,838	1,286
Summer	29,240	3,580	14,060	44,641	59,795	151,316	2,293
Fall	1,819	210	0	0	27,391	29,420	1,285
All seasons	45,933	7,021	14,110	45,328	92,182	204,574	2,926

Table 5.—Estimated on-stream recreation use per mile of stream by segment category and season of year for White River Drainage, 1987

	Person hours (no.)							
	Main stem		Tributaries		Feeders		Entire system	
Season	Season	Day	Season	Day	Season	Day	Season	Day
Spring	324.4	7.72	42.6	1.01	18.5	0.44	63.5	1.51
Summer	1,986.7	17.74	378.3	3.34	46.6	0.42	403.1	3.60
Fall	145.8	3.31	149.2	3.39	4.6	0.10	78.4	1.78
Survey period	2,456.93	12.41	570.2	2.88	69.6	0.19	544.9	2.75

When estimates of recreation use estimates are reduced to a per-mile basis, the preponderance of use and potential for conflicts within the main stem is more apparent (Table 5). For example, recreation use in the main stem during the summer season approached 2,000 person-hours per mile, slightly less than 18 person-hours per mile of stream per day. Estimates of use per mile were substantially lower for tributaries than for the main stem except during the fall. Estimated daily use on feeder streams was less than 0.5 person-hour per mile for each season.

Discussion

Despite the large standard errors, the observation technique used in this study is a feasible means of estimating recreation use. Data collected during the 1987 field season was sufficient to provide baseline information on levels of use and indicate the potential for conflict among recreationists. Relatively light use in feeder streams and major tributaries does not assure an absence of conflict—these stream categories are smaller and individuals might be more easily disturbed by the activities of others. Even in the main stem during the summer season, daily recreation use was less than 18 person-hours per mile. However, use patterns were highly irregular such that conflicts might be serious during peak periods in locations that attract diverse groups, e.g., fishermen vs. floaters.

Since recreation use is heaviest and most diverse in summer, this is the time that conflicts would be most likely. For instance, swimming occurs primarily in the summer and in the main stem, where most boating, floating, and sunning also occur. Undoubtedly, not all of these activities are totally compatible when pursued at the same place and at the same time. However, total recreation use, even in the main stem, has yet to reach the level where several activities cannot occur simultaneously so long as participants do not demand specific locations at the same time.

The White River study was designed to determine if the kind and extent of current recreation use could result in conflicts. With regard to the main stem, where the level of recreation is sufficient to raise concern, a more detailed follow-up observation study should be implemented. Also, the level of human use of specific salmon holding pools was not estimated, but the results indicate moderately high use of the main stem, where most salmon holding pools are located. And salmon are found in these pools mostly during July and August, which coincides with the heaviest overall human use. As part of a habitat survey of the White River Drainage by the USDI Fish and Wildlife Service, in conjunction with the Atlantic salmon restoration program, potential salmon holding pools are being identified. When this process is completed, the observation technique used in this study can be modified so that the amount and timing of human use can be estimated for specific locations. There is still some uncertainty regarding the likely impact of various kinds of recreation on salmon behavior; no information is available on the ability of salmon to adjust to periodic disturbances.

With regard to the acquisition of additional access points to the White River by public agencies, the main stem appears to have the greatest need. Procurement decisions must take into account site-specific river attributes that are required to satisfy public wants, but current levels do suggest that demand exists. While there is posting against trespass for all stream categories, the relatively light recreation use along feeders and main tributaries, considered with their greater numbers of miles, suggests that current alternative public access may be sufficient for these segments. However, access and parking is more likely to become a problem (if it isn't already) along the more heavily used but shorter main stem.

Date: ____________________
Stream: ____________________
Segment of stream: ____________
Begin point: ________________
End point: __________________
Begin time: _________________
End time: __________________
Observation time: ___________
Weather conditions:
Rain _____ Cloudy _____
Snow _____ Clear _____
Fog _____
Air temperature ______(F)

Observer: __________________
Mode of transportations: ________
Distance travelled:
Road miles: ________
Stream miles: _______
Water conditions:
Clear _____ Muddy _____
Frozen over _____
Water level:
Flooded _____ Low _____
High _____ Dry _____
Normal _____

Time of observation	Activity	Number of participants	Landmark (record time of reaching even if no activities are occurring)	Comments

Figure 2.—Stream use data sheet.

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Appendix

Sampling Design

The White River Drainage of Vermont was segmented into sampling units prior to the field-observation season using the criteria that length of each segment be short enough so that an observer could survey its entire length in 4 hours or less, and that the boundaries of an individual segment could be designated clearly. Ninety-four segments were identified and classified by type of stream (main stem, tributary, or feeder stream) and mode by which they would be surveyed (riding, walking, or both). The seven occupied cells in Table 6 are referenced as "stream type-access" categories and serve to classify all stream segments. The time (to the nearest hour) for an observation run for a segment in each access class was estimated before the actual field work.

The strategy for sampling was to establish probabilities of selection in proportion to anticipated use and inversely proportional to anticipated cost. Using the "estimated average observation time" to represent cost, anticipated use (which was established in consultation with the staff of the resource management agencies) per unit length of stream and the total length of stream in each type-access category, probabilities for choosing segments of a given access category were computed. It is prudent to have probabilities sufficiently large to assure at least two observations in each category, so minimums were imposed and new probabilities computed. The final probabilities used in selecting a type-access category are shown in Table 7. A type-access category was selected using the probabilities, then one of the segments within that category was chosen with equal probability. The values of the probabilities of selection affect the optimum utilization of sampling resources, but, as will become clear, the values are not an issue in the validity of the estimates of recreation use. A computer program using the probabilities of selection in Table 2 was used to generate a list of segments to be sampled; this list was supplied to the field crew before the field season. Segments to be visited were taken in sequence from the list.

The segment itself is an incomplete sample-unit specification since the day of the week and the work shift in which the sampling is to be done also must be selected. (Formally, all possible segments and all possible times of sampling would be the sampling universe, but it is not useful to use this formalization here for reasons that will become clear.) All weekend days and holidays were scheduled for observation, but the probability that a particular workday in the week would be chosen is 1/n where there are n workdays in the week. It was assumed that recreation use during the morning work shift was about one-half that in the two later shifts, so the morning, midday, and evening shifts were selected with probabilities .2, .4, and .4, respectively, for all days. Prior to the field seasons, a computer program was written to select weekdays to be worked and the shift time to be worked for all days for the entire trout fishing season.

If the object of this study was to estimate some characteristic of the stream system that could be expressed as a total for all possible visits of some variable, the population parameter in question could be estimated using an unbiased estimator, as the probability that any visit occurs in the sample can be calculated (see Kendall and Stuart 1966, Chapter 39). However, this approach is not relevant because the purpose of the study is to evaluate person-hours of recreation. This parameter was not observed directly and cannot be expressed as the sum of the observations that were measured on visits to the stream segments. However, the probability sampling described in the last section can be expected to provide cost-effective estimates of recreation use.

The method of estimation that was used can best be explained by an example. Suppose we are interested in determining a given recreation use (e.g., fishing) for a specific period during a workday (e.g., 9 a.m. to noon) during a given season and for a particular stem type-access category (major tributaries accessible by car). If the convention is adopted that the segment "belongs" to the 9 to 12 time slot only if most of the observer's time was spent in that slot (regardless of the shift the observer was working), then it is possible to list all samples that might contribute information (including that no fishing occurred) about the "fishing use" that we wish to estimate. We also make the assumption that the use is constant during the period in question, that is, the 9 to 12 period and the sampling visits are short enough that the visit provides a "snapshot" of the entire use on the segment from 9 to 12. If this is the case, then $z = x/d$ can be used to measure the number of persons fishing per unit length of stream at the time of day on a workday, where d is the length of the segment and x is the number of persons observed fishing. Now, let D_i be the total length of all streams in the study that contribute to the cell, t_j the length of time interval (3 h), n_{ij} the number of contributing visits, and z_{ij} be the average number of (fishing) users, per unit stream length, over n_{ij} visits. Then

$$S_{ij} = D_i t_j z_{ij}$$

is an estimate of the person-hours of fishing during the time period j (9 to 12) in stream type-access i. This type of estimate can be summed over other stream type-access categories to obtain use by stream type (main stem, say) and/or summed over other times of day to obtain daily totals. Thus, all the estimates of recreational use that are required can be determined.

What makes this method work and why aren't the sampling probabilities specifically used? First, the sampling probability for the work shift does not come into play since we have assumed that the use at a particular time and place would be the same regardless of what shift the observer was working, and because of the assumption that any observation on a particular segment in the 9 to 12 time period would have yielded the same information. This assumption of "uniformity of use" on a segment during any time period also is what justifies the calculation of z_{ij}, the average person per unit length of stream, for a particular period and stream type-access category, and its conversion to person-hours of use, S_{ij}. If the observer saw 10 anglers on a 2-mile stream between 9 and 12, the estimate of (10/2)3 = 15 angler-hours per mile of stream holds whether 10 stayed the entire 3 hours or 30 took turns so that there were 10 on the segment at any time.

The reason that probabilities of selection for a segment do not come into play in the example is that fishing use was calculated for a particular type-access category, and all segments within this category have an equal probability of being selected. The z_{ij} in the formula are averages of random variables (users per mile) with standard errors that may be estimated within a type-access category. The fact that the stream length and the length of the time interval, t_j, are known values (i.e., not random variables) makes S_{ij} a random variable measuring use for the segment, and the mean and standard errors of the z_{ij} provide the desired unbiased estimate and error estimate of use under the assumptions stated. Although the type-access categories were sampled with different probabilities, they were sampled independently so that estimates and standard errors for combinations of these categories are easily computed. The only difficulty is that the t_j change with the season when they represent times after sunrise and before sunset. The solution was to use average time over each day in any season.

In summary, the stratified sampling probabilities were fabricated to make the field work cost-efficient in terms of the standard errors of the results. The usual stratified estimation methods could not be used since the population parameters of interest could not be expressed as sums of variables that were directly measured on a segment. Assumptions are specified that underly the estimation method used to obtain person-hours spent in various types of recreation activity in the study area at various times.

Table 6.—Number of stream segments, estimated observation time, and anticipated use by stream type-access category

Stream category	Ride		Walk		Ride and walk		Anticipated relative use
	No. of segments	Expected observation time	No. of segments	Expected observation time	No. of segments	Expected observation time	
		Hours		*Hours*		*Hours*	
Main stem	4	1	0	--	2	3	100
Tributaries	5	2	0	--	11	4	50
Feeders	8	1	26	4	38	3	1

Table 7.—Probabilities of segment selection by stream type-access category and assessibility

Stream category	Ride		Walk		Ride and walk	
	Probability of selection	Miles of stream	Probability of selection	Miles of stream	Probability of selection	Miles of stream
		Number		*Number*		*Number*
Main stem	.426	29.6	--	--	.088	13.9
Tributaries	.133	46.9	--	--	.147	102.1
Feeders	.060	27.7	.086	50.1	.060	105.1

Glass, Ronald J.; Walton, Gerald; Echelberger, Herbert E. 1991. **Estimates of recreational stream use in the White River drainage, Vermont.** Res. Pap. NE-658. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 10 p.

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ODC 907.2 (743)

Keywords: Stratified sampling, resource management

☆ U.S. GOVERNMENT PRINTING OFFICE: 1991—648-139/40,007

Headquarters of the Northeastern Forest Experiment Station is in Radnor, Pennsylvania. Field laboratories are maintained at:

Amherst, Massachusetts, in cooperation with the University of Massachusetts

Burlington, Vermont, in cooperation with the University of Vermont

Delaware, Ohio

Durham, New Hampshire, in cooperation with the University of New Hampshire

Hamden, Connecticut, in cooperation with Yale University

Morgantown, West Virginia, in cooperation with West Virginia University

Orono, Maine, in cooperation with the University of Maine

Parsons, West Virginia

Princeton, West Virginia

Syracuse, New York, in cooperation with the State University of New York, College of Environmental Sciences and Forestry at Syracuse University

University Park, Pennsylvania, in cooperation with The Pennsylvania State University

Warren, Pennsylvania

"Caring for the Land and Serving People Through Research"