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Recreation Use of Upper Pemigewasset and Swift River Drainages, New Hampshire

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Abstract

In-stream recreation use of the upper Pemigewasset and Swift River Drainages was estimated by a technique based on modified, stratified sampling. Results are reported by category of stream segment, season, day of week, time of day, and activity. "Weekend and holiday" use exceeded weekday use during spring and fall, but weekdays had the heaviest use during the summer. Recreation use was much greater in summer than in spring or fall. Feeder streams had the heaviest recreation use during summer weekdays, but the main stems had the most use during summer "weekends and holidays" and during both periods of the week in the other seasons. Use was heaviest in early afternoon. Swimming/wading was the most popular activity during summer, followed by passive leisure. Both feeders and main stem had the heaviest use per mile of stream during the summer.

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Introduction

Reliable information on recreation stream use is recognized as a requisite for effective management and planning on the White Mountain National Forest. Since the Northeastern Forest Experiment Station had developed an observational technique for estimating stream use in the White River Drainage in Vermont during 1987 (Glass et al. 1992), Station scientists were asked to assist the White Mountain National Forest with similar estimates of recreational use in the upper Pemigewasset (essentially from the confluence of Baker River upstream) and Swift River Drainages (Fig. 1). The USDI Fish and Wildlife Service and New Hampshire Fish and Game Department also desired data on stream use and contributed useful insights and information.

The Pemigewasset and Swift River Drainages are of special interest because they are components of multimillion dollar state and Federal efforts to reestablish viable populations of sea-run Atlantic salmon (*Salmo salar*) in New England (USDI Fish and Wildl. Serv. 1989). Information on water-based recreation use is needed to determine if current and potential water use may conflict with the salmon restoration effort. There is particular concern that heavy human use may disturb salmon in holding pools.

The study area includes 736 square miles and 340 miles of stream. For this study, the upper Pemigewasset includes that portion of the river drainage from a point one-quarter mile downstream from the confluence of Baker River in Plymouth, New Hampshire, to its headwaters. The Drainage includes 622 square miles. The entire Swift River Drainage from its confluence with the Saco River in Conway, New Hampshire, to its headwaters includes 114 square miles. Total miles of stream refers to miles sampled (upstream to the point where the average width was 5 feet).

The two Drainages contained areas of federally designated wilderness, but much of the area is readily accessible by automobile. The Drainages are within easy driving distance from the northern portion of the Northeast megapolis; for example, portions of the study area are only a 2-1/2-hour drive from Boston. The main stem of the Swift River parallels the Kancamagus Highway, a well-known and heavily used tourist route. The upper Pemegewasset also parallels major road systems, including Interstate 93. Tourism is an important component of the economy of the region. From July 1991 to June 1992, it is estimated that the White Mountain travel region, which includes the study area, hosted 7.3 million visitor days with direct expenditures of $330 million (Okrant et al. 1993). National Forest facilities provide considerable opportunities for recreationists.

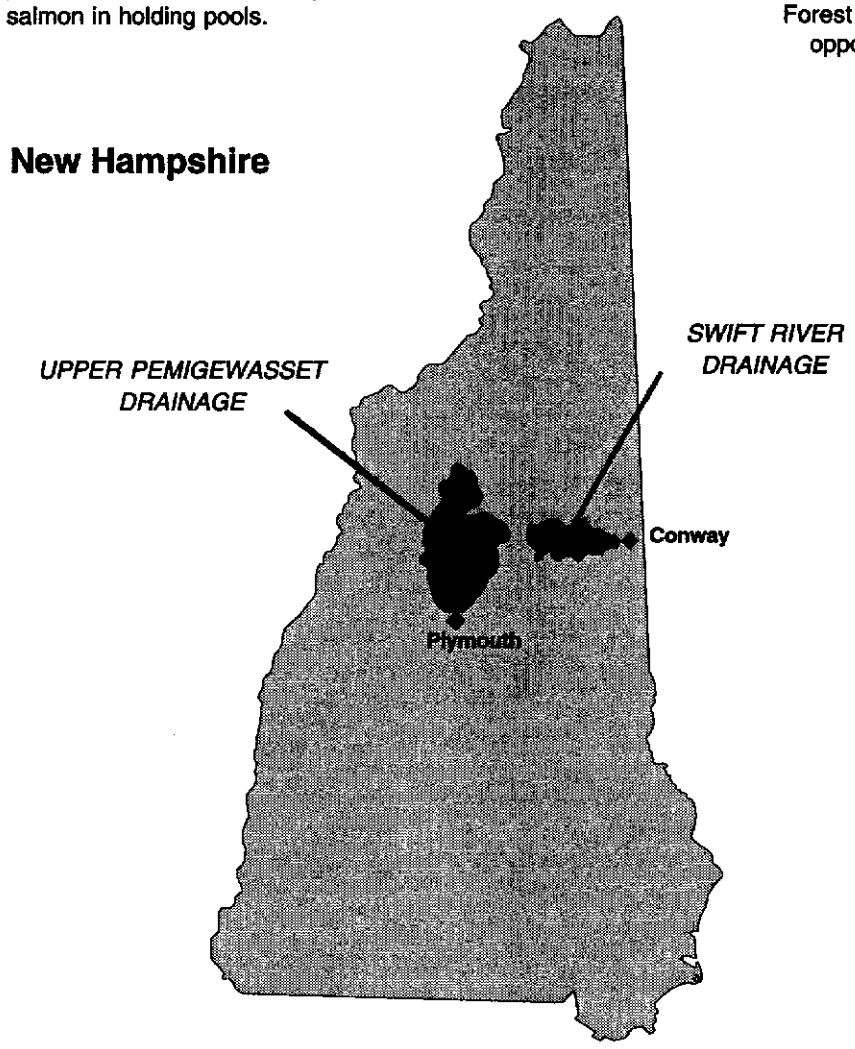

Figure 1.—Swift and Upper Pemigewasset River Drainages, New Hampshire.

Methods

Using the same techniques employed in the White River study (see appendix in Glass et al. 1991 [1992] for detailed discussion of the methods used), an observational study of the upper Pemigewasset and Swift River Drainages was undertaken in 1989 from May 15 to October 9. Tabulations were made of the number of people using the stream proper (individuals actually involved in recreation activities in the water surface or on islands, rocks, or bridges over the water surface) by use category.

All of the streams of both river systems were placed into one of four categories: main stem, major tributaries, minor tributaries, and feeder streams. The upper reaches of streams were included in the study only to the point where the average width was 5 feet. These points were marked on topographical maps and distances later determined by planimetry. Long streams were subdivided into segments to avoid bias that would be caused by certain reaches being sampled consistently later in the day because they are located near the midpoints of the sampling run. As a result, the main stem of the Swift River was treated as one segment, but the upper Pemigewassett was divided into three segments. No major tributary was identified for the Swift River; the upper Pemigewasset had four (Mad River, East Branch, Hancock Branch, and Baker River.) In all, 339.8 miles of stream were sampled—50.8 miles on the main stems, 98.5 miles of the Pemigewasset tributaries and branches, and 190.5 miles of feeders in the two systems.

Stream segments also were categorized by expected level of recreation use and convenience in making observations. Since the sample observations were undertaken by one person working a 40-hour week, the strategy was to maximize the efficiency of the observations by favoring areas with expected high-intensity use or easy access. Nonetheless, we took an adequate sample of the more remote areas with expectations of lighter use to ensure that they were covered. Stream segments were stratified on the basis of accessibility, that is, easy (segments that could be observed from a vehicle), hard (segments for which walking was necessary), and moderate (observations made by a combination of walking and riding). Each stratum was given a probability of selection and a sample drawn (Table 1).

Stream segments were identified on maps and a subjective evaluation was made of their likely intensity of use and accessibility. Weights were determined for various combinations of use and accessibility to reflect the "cost" and "use" relevant to optimal sampling probabilities for six strata. All candidate segments were sampled via computer; a random number generator was used so that the probability that a candidate from a particular stratum was selected was proportional to the strata weight. Table 1 includes definitions, weights, and other characteristics of the strata.

Field observations of recreation use were made on all Saturdays, Sundays, and holidays. Workdays were sampled randomly so that there were five observation days per week, including weekends and holidays. Starting time for each day was selected randomly from three overlapping, 8-hour observation periods: (1) 6 a.m. to 2 p.m., (2) 8 a.m. to 4 p.m., (3) noon to 8 p.m. The probability of selection was 0.2 for the observation runs beginning at 6 a.m. and 0.4 for the other two periods.

A stream-use data collection sheet (Fig. 2) and instructions were prepared in which the date, starting and finishing times, observations of recreation use, and other information were tabulated. A continuation sheet was developed for cases in which heavy recreation use required more than one page for tabulation. The collected stream-use data were tabulated and analyzed by Northeastern Station scientists.

Results

In-stream, daily recreation use by activity type was estimated for each category of stream segment, i.e., main stem, tributaries, and feeder streams, and by season of the year:

Table 1.—Strata characteristics of stream segments

Strata	Access	Use	Weight	Selection probability	Miles of stream	
					Swift	Pemigesasset
1	Easy	High	40	.546928	19.7	52.7
2	Easy	Moderate	20	.250675	-	50.4
3	Moderate	Moderate-High	10	.125338	2.8	18.5
4	Easy	Low	4	.044877	-	85.8
5	Moderate	Low	2	.022415	24.8	65.0
6	Hard	Low-Moderate	1	.009767	2.8	17.3
				Total	50.1	289.7

STREAM USE DATA SHEET

Date: _____
Stream: _____
Segment of stream: _____
Begin point: _____
Begin time: _____
End point: _____
End time: _____
Observation time: _____

Observer: _____
Mode of transportation: _____
Distance traveled:
Road miles: _____
Stream miles: _____
Weather conditions:
Rain _____ Cloudy _____
Snow _____ Clear _____
Fog _____
Air temperature: _____

Time of observation	Activity	Number of participants	Comments

Figure 2.—Stream use data sheet used in study.

spring (May 15 to June 30), summer (July 1 to August 31), and fall (September 1 to October 9). By measure of total daily recreation use for the entire system, "weekend and holiday" use exceeded weekday use during the spring and fall (Table 2). For the entire system, estimated weekday recreation use per day was 12,942 person-hours, but the standard error was high (10,959). Weekend person-hours of use were less than one-half of weekday estimates, but the standard error was much lower. Feeder streams had the greatest daily use during weekdays in summer, but the main stems had higher estimates for weekends. Daily recreation use dropped off sharply during the fall, particularly in the feeder streams. Use also was lower in spring than in summer.

Except for spring weekdays, recreation use was heaviest during the early afternoon (Table 3). During spring weekdays, use was heaviest during the evening. With the exception of summer "weekends and holidays," recreation use was lightest before 9 a.m. Afternoon use far exceeded morning use regardless of season or day of the week.

Participation by type of activity varied substantially by season of the year and day of the week (Table 4). Passive recreation, which included activities such as standing, sitting, or sunbathing had the highest use during the spring and fall on both weekdays and "holidays and weekends." During summer, swimming/wading had the highest use followed by passive recreation. Daily person-hours devoted to swimming/wading was estimated at 11,008, with a standard error of 9,879. Fishing had the greatest use during summer weekends and holidays and dropped sharply in the fall. While there were notable exceptions, for example, swimming/wading and passive recreation during summer, "holidays and weekend days" tended to have higher use estimates than weekdays. In some cases, high standard errors added to the difficulty in interpreting the results.

Total recreation activity for the upper Pemigewasset and Swift River Drainages was estimated at 743,700 person-hours during the study period (Table 5). Nearly 90 percent of this activity occurred during the summer, which also had more days included than either of the other two seasons. Average daily use for all activities was 10,781 person-hours during the summer, 868 in spring, and 885 in the fall. Swimming/wading was the predominant use (73.5 percent of the total). Passive recreation was the second most prolific activity, followed by fishing. Use estimates were highest during the summer for most activities; photography and painting was an exception, with the greatest number of person-hours occurring in the fall.

The intensity of recreation stream use can be expressed more meaningfully in person-hours of use per mile of stream (Table 6). For the season total, feeder streams had greatest use during the summer, but the main stem had more use in spring and fall. Tributaries had the least amount of use on a per-mile basis. When reduced to a daily basis, use was greatest on feeders during the summer followed by the main stem for the same season. Both feeders and tributaries had sparse use per mile during spring and fall. Combined, the two river drainages had slightly less than 32 person-hours per mile of daily recreation use during the peak summer period. During spring and fall, total recreational use for the system was less than three person-hours per day. The main stem averaged about 12 person-hours of recreation use daily per mile during spring and fall.

Table 2.—Estimated daily recreation stream use of upper Pemigewasset and Swift River Drainages by stream category, day of week, and season, 1989

Day of week	Recreation use	Stream segment			
		Main stem	Tributaries	Feeders	Entire system
			SPRING		
Weekdays	Person-hours (no.)	519	40	59	618
	Standard error	210	24	47	217
	Observation runs	26	20	30	76
Weekends and holidays	Person-hours (no.)	751	194	574	1,519
	Standard error	176	26	204	271
	Observation runs	11	20	29	60
			SUMMER		
Weekdays	Person-hours (no.)	1,110	580	11,202	12,942
	Standard error	227	107	10,956	10,959
	Observation runs	68	38	80	186
Weekends and holidays	Person-hours (no.)	2,927	953	2,007	5,887
	Standard error	757	99	989	1,250
	Observation runs	49	32	57	138
			FALL		
Weekdays	Person-hours (no.)	261	1	0	262
	Standard error	127	1	0	127
	Observation runs	36	19	58	113
Weekends and holidays	Person-hours (no.)	1,301	337	138	1,776
	Standard error	348	127	100	384
	Observation runs	28	26	48	102

Table 3.—Estimated daily stream recreation use of upper Pemigewasset and Swift River Drainages by time of day, day of week, and season, 1989

Day of week	Early morning (6 to 9 a.m.)		Midmorning (9 a.m. to noon)		Early afternoon (Noon to 4 p.m.)		Evening (4 to 8 p.m.)		All day	
	Person-hours	Standard error	Person-hours	Standard error	Person-hours	Standard error	Person-hours	Standard error	Person-hours	Standard error
	Number		*Number*		*Number*		*Number*		*Number*	
					SPRING					
Weekdays	0	0	55	50	163	57	400	203	618	217
Weekends and holidays	70	70	191	30	1,175	254	83	56	1,519	271
					SUMMER					
Weekdays	128	40	259	119	12,184	10,958	371	96	12,942	10,959
Weekends and holidays	649	406	343	68	3,243	735	1,606	932	5,887	1,250
					FALL					
Weekdays	0	0	65	62	197	111	0	0	262	127
Weekends and holidays	12	3	336	138	1,255	358	173	0	1,776	384

Table 4.—Estimated daily stream recreation use of upper Pemigewasset and Swift River Drainages by activity, day of week, and season, 1989

Day of week	No. person-hours devoted to:							
	Fishing	Swimming/ wading	Tubing	Boating	Photography/ painting	Active leisure[a]	Passive leisure[b]	Other[c]
				SPRING				
Weekdays	43 (15)[d]	221 (90)	16 (12)	3 (3)	3 (3)	12 (9)	302 (129)	18 (14)
Weekends and holidays	248 (25)	319 (103)	28 (12)	97 (64)	223 (219)	78 (25)	433 (103)	93 (70)
				SUMMER				
Weekdays	158 (29)	11,008 (9,879)	47 (21)	24 (11)	1 (1)	12 (7)	1,620(1083)	72 (34)
Weekends and holidays	1,209 (408)	2,767 (996)	115 (39)	67 (29)	1 (1)	20 (20)	1,345 (398)	363 (83)
				FALL				
Weekdays	9 (5)	24 (24)	0 (0)	0 (0)	165 (110)	0 (0)	64 (42)	0 (0)
Weekends and holidays	89 (18)	559 (312)	24 (4)	63 (18)	180 (122)	11 (10)	687 (119)	163 (100)

[a] Includes walking and playing.
[b] Standing, sitting, and sunbathing.
[c] Any activity not classified in the preceding groups.
[d] Standard error in parentheses.

Table 5.—Estimated stream recreation use of upper Pemigewasset and Swift River Drainages during the day by activity and season, 1989

Season	No. person-hours devoted to:								
	Fishing	Swimming/ wading	Tubing	Boating	Photography/ painting	Active leisure	Passive leisure	Other	Total
Spring	4,700	11,700	900	1,400	3,000	1,400	15,900	1,800	40,800
Summer	29,800	525,900	4,200	2,300	100	900	95,200	10,000	668,400
Fall	1,600	9,100	400	900	7,600	200	12,200	2,500	34,500
Total	36,100	546,700	5,500	4,600	10,700	2,500	123,300	14,300	743,700

Table 6.—Estimated stream recreation use of upper Pemigewasset and Swift River Drainages per mile of stream category and season, 1989

Season	Main stem		Tributaries		Feeders		Entire system	
	Season	Day	Season	Day	Season	Day	Season	Day
	Person-hours (no.)							
Spring	540	11.5	39	0.8	50	1.0	120	2.6
Summer	2,076	33.5	437	7.0	2,729	44.0	1,167	31.7
Fall	538	12.0	52	1.1	11	0.2	102	2.2

Discussion

High standard errors for some estimates are a matter of concern. An estimate of 11,202 person-hours of use with a standard error of 10,956 hours based on 80 segment visits, as was the case for summer weekend use of feeders, suggests that the high estimate is the result of several observations on segments with a high concentration of people, with little activity during the other observations and few observations in the stratum. Thus, the impact of several high observations is exacerbated when the segments were from strata with relatively low probabilities of selection. The fact that unbiased estimators are used for the estimates and errors means that, in the long run, several excessively large estimates will be balanced by more smaller estimates.

Indeed, there are several feeder streams such as Sabbaday Brook (falls and picnic area) that are readily accessible and have attributes that attract large numbers of people, many of whom are likely to engage in water-related activities. At the other extreme is the estimate of zero for fall weekend use of feeders with a standard error of zero, based on 58 segment visits. All 58 observations were zero, so the best estimate of the error is zero even though it is unlikely that use was exactly zero for the category. Data collected for these estimates have been used as efficiently as possible, so without incorporating exogeneous information, there is no way to improve upon the estimates given. It should be noted that most of the estimates have smaller standard errors than those cited in the text.

By comparison to the White River Drainage in Vermont, the upper Pemigewasset and Swift River Drainages appear to be heavily used for water recreation. Although the sampling season for the latter was shorter, total use was estimated at 743,700 person-hours compared to 205,000 person-hours for the White River Drainage. However, the latter contained 221.1 miles of stream that were sampled compared to 339.8 miles for the upper Pemigewasset and Swift River Drainages. A better comparison can be made by examining the results in terms of average daily use per mile of stream. By this measure, the daily summer recreation use of the entire White River system was 3.6 person-hours compared to 31.7 person-hours per mile of stream for the New Hampshire systems. The upper Pemigewasset and Swift River Drainages also had greater use in the spring (2.6 to 1.5 person-hours) and fall (2.2 to 1.8), but these estimates involve different seasonal definitions and times of day. The White River study began on April 11 and ended on October 25 and observations were made from one-half hour before sunrise until one-half hour after sunset.

Due to the sampling period, certain recreation activities are likely to be underestimated. For example, fishing was not the major use during the May 15 to June 30 period, but may have been the primary use earlier in the season. Trout species, for which the two drainages offer the most opportunities, often are fished heavily earlier in the spring. Other water activities such as canoeing and kayaking also have considerable participation during high water periods in the spring. By contrast, swimming, the major summer use, is likely to have minor participation during the cold-water spring flows.

The relatively heavy use of the main stems of the Pemigewasset and Swift Rivers suggest possible conflicts among recreationists. For example, swimming/wading may be compatible with activities such as passive recreation, but this may not be the case for an activity like fishing. While daily water recreation use of 33.5 person-hours per mile of main stem may not seem excessive, people are unlikely to be distributed evenly by time or space. Areas with certain attributes are likely to experience concentrations of use, particularly during the most favored times and weather conditions.

Little is known about the impacts of stress on salmon from human recreation use. Salmon holding pools often have characteristics that also are desirable for swimming, and salmon are likely to be present during periods of the heavy human use (July and August). As a result, there is the possibility of serious conflicts. Additional information is needed on how salmon respond to human activities in water with respect to survival and subsequent spawning.

Data on use in feeder streams suggest that there may be a limited number of streams that have heavy use, especially during the summer, and many others that have sparse use. Since these smaller streams have less capacity for most uses, recreation conflicts are possible. For example, more than a single angler could seriously diminish the quality of a recreation outing on a stretch of feeder stream, but a large pool in the main stem might accommodate several anglers at one time. However, the tolerance for crowding in relation to the quality of a recreation experience varies among individuals. Yet, there are 3.8 times as many miles of feeder streams as main stem, so there is greater opportunity to pursue activities where humans are not concentrated. Environmental damage caused by heavy human use of small streams is another concern that should be monitored at critical locations.

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