RECREATIONAL USE OF THOMAS HILL RESERVOIR AND ADJOINING LANDS

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Abstract: An estimate of the total recreational use of the Thomas Hill Wildlife Area (1,778 ha reservoir and 2,424 ha of adjoining lands) in northern Missouri was made from 1 July 1972 to 30 June 1974. Recreational activity was determined by interviewing departing recreationists utilizing the non-uniform probability sampling technique. There were an estimated 219,700 recreational trips totaling 1,398,900 hours during the 2-year study. Twenty-two recreational activities were measured. Seven recreational uses; sight-seeing, boating, fishing, camping, swimming, picnicking, and hunting accounted for over 99% of all the trips and hours. Sight-seeing made up 25%, boating 21%, angling 20%, camping 16%, and swimming 9% of the total trips. However in hours, camping made up 42%, boating 22%, angling 21%, and swimming 6% of the total. There were 63 trips per water surface ha and approximtely 45 trips per land surface ha. Anglers caught an estimated 172,100 fish during the study. A catch rate of 0.6 fish per hour provided a harvest of 97 fish per ha. White crappie (*Pomoxis annularis*) (87%) dominated the catch. Deer, rabbits, squirrels, predators, quail, and ducks were harvested. Harvest rates varied from 0.1 per hour for predators to 0.7 per hour for squirrels. Local residents made up 48% of all visitors while 78% came from within a 120-km radius. Recreationists came from 56 Missouri counties and from out-of-state. About 48% of all visitors held some type of Department license; many who did not were too young or too old to need a fishing license. The Thomas Hill Wildlife Area increased available public recreational opportunity in this region of the state and was important to North Central Missourians.

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Thomas Hill Reservoir, which provides cooling water for a steam power plant, was the first large reservoir built in the prairie portion of northern Missouri. It has provided fishing and other forms of aquatic recreation. In addition, the surrounding lands, which are owned by the Associated Electric Cooperative, were leased to the Missouri Department of Conservation for wildlife management. These lands provide a variety of recreational opportunities. To assess the value of these resources to the public and the Department, an estimate of the total recreational use was made from 1 July 1972 to 30 June 1974.

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MATERIALS AND METHODS

The Thomas Hill Wildlife Area is located in the North Missouri glacial and loessial physiographic region (Fig. 1). Land uses include row crop farming, small grain farming, grazing, and soft coal strip-mining. The general topography is gently rolling hills of low relief with timbered draws and streams. The average annual rainfall is 890 to 1,016 mm.

Thomas Hill Reservoir, a 1,778-ha impoundment in Macon and Randolph Counties, was completed in 1965 by the Associated Electric Cooperative in a coal strip-mine area on the Middle Fork of the Chariton River. Maximum and mean depths are 10.7 m and 4 m, respectively. Orientation of the main axis of the reservoir with prevailing southwesterly winds and shallow average depth, combined with wave action, often cause Thomas Hill Reservoir to have quite turbid water conditions. Further descriptive information about this reservoir is given by Hanson (1973).

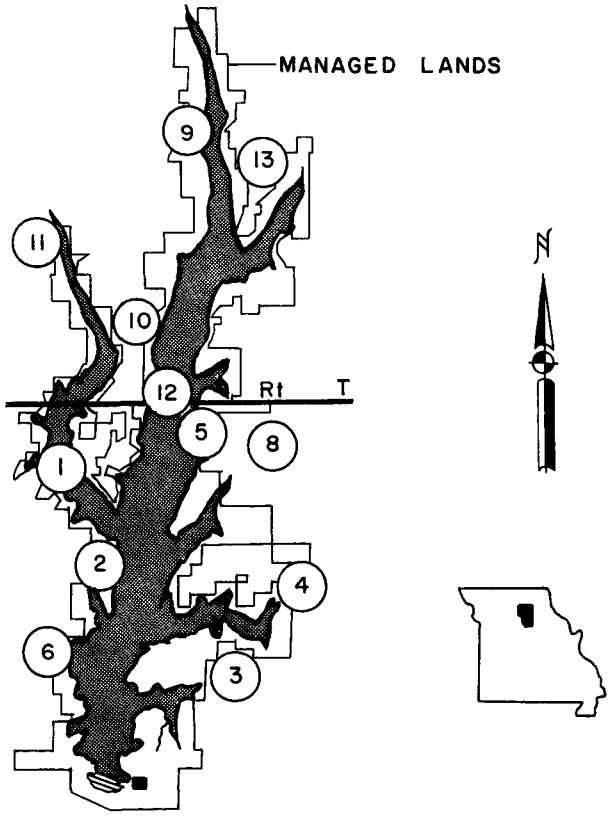

Fig. 1. Recreational use census stations and managed land boundaries at Thomas Hill Wildlife Area, Missouri.

The Missouri Department of Conservation manages, by lease agreement, the fish and wildlife resources of the reservoir and about 2,424 ha of surrounding company-owned lands (Fig. 1). There is good access to the reservoir and to the managed lands via the many roads incorporated into the wildlife area. The Department developed an additional access area for the warm-water arm (Station 3) and built a boat launching ramp there and at Station 5. Developments also include building primitive campgrounds, stocking fish, establishing a limited wildlife refuge area, providing boat launching facilities, and providing trash disposal. Management practices which benefited wildlife more directly included permitting farmers to plant row crops on shares, grazing to maintain beneficial plant succession, direct food and cover planting, lake shoreline planting, emergent aquatic vegetation planting, and wind-break plantings.

Commercial accommodations near the Thomas Hill Wildlife Area include 2 private campgrounds with boat rental and sundry-item sales and services. Stores are located at College Mound approximately 6.4 km east of the lake, at Caseyville approximately 0.8 km west of the lake, and in nearby towns such as Macon, Maberly, and Huntsville. In addition, a marine sales and service business is located on Highway T which crosses the lake.

Recreational use of the Thomas Hill Wildlife Area was estimated by utilizing non-uniform probability sampling from 1 July 1972 to 30 June 1974. Recreational activity was determined at various access sites by interviewing departing users. The methods of sampling and extrapolation were modified from those outlined by Fleener (1972).

Stations (access sites) to be sampled were selected on the basis of known use patterns and assigned a probability for sampling. For example, if an access site was heavily used it was scheduled to be sampled more frequently than an access site that was infrequently used. Sampling frequencies were changed when usage of a particular access site changed. Probabilities were changed seasonally for most stations. For example, the fall hunting season resulted in increased use of some sites as angling and boating dropped at others. Changing sampling frequencies greatly improved the accuracy of estimated total recreational use.

All stations were considered when schedules were made for sampling. However, all stations were not necessarily sampled during winter because of the very low probable use rating assigned for that quarter. A job-trained clerk interviewed departing recreationists during 8-hour segments of randomly selected days. Activities included angling, set-lining, hunting, trapping, hiking, group activity, environmental education, sight-seeing, photography, camping, picnicking, swimming, boating, water skiing, and frogging. Hunting was further categorized into types. Weekday and weekend information was recorded separately, but later combined for total figures. Holidays were considered as weekend days. The 8-hour day segments (0600-1400; 1400-2200; 2200-0600) were selected on the basis of probable use. Initial night censusing revealed very few users. Therefore, this segment of the 24-hour day was assigned a low probability rating and was sampled infrequently. Information was combined seasonally: Summer (July-September), Fall (October-December), Winter (January-March), and Spring (April-June). Total interview time for the 2-year study was 2,496 hours or approximately 14% of the total time.

Field data were transferred to punch cards and the information was extrapolated to estimated figures using an inflation factor as follows:

$$\frac{1}{\text{Sampling probability x}}$$

$$\frac{\text{Total recreational persons leaving area}}{\text{Total persons interviewed}}$$

The standard deviation was computed for each measured use. Confidence intervals were computed by multiplying the standard deviation times 100 divided by the estimated number of trips or hours. Confidence intervals computed at the 67% level of probability were considered adequate for the type of sampling done in this study.

RESULTS

Trips and hours

An estimated 219,700 recreational trips (1 person per day participating in a given activity equals 1 trip) totaling 1,398,900 hours were estimated to have been made to the Thomas Hill Wildlife Area from 1 July 1972 to 30 June 1974 (Table 1). These trips were grouped into 5 major categories: fishing, hunting, minor time activities (activities in which short trips were likely), major time activities, and miscellaneous activities. Twenty-two different recreational activities were measured during the study.

Seven recreational uses were predominant during 1972-1973: sight-seeing (27%), boating (19%), fishing (17%), camping (16%), swimming (11%), picnicking (8%), and hunting (1%) accounted for 99.6% of all trips. These same activities also accounted for 99.8% of all the estimated recreational hours: camping (43%), boating (22%), fishing (19%) swimming (7%), picnicking (7%), sightseeing (3%), and hunting less than 1%.

Table 1. Estimates of recreational use for Thomas Hill Reservoir and adjoining lands from 1 July 1972 to 30 June 1974. Confidence interval at 67 percent level of probability expressed as percentage of the estimate.

	Total Trips				*Total Hours*			
	1972-1973		1973-1974		1972-1973		1973-1974	
Activity	*Number*	*Confidence Interval*	*Number*	*Confidence Interval*	*Number*	*Confidence Interval*	*Number*	*Confidence Interval*
Fishing								
Angling	29,523	4.8	13,597	11.3	201,520	17.0	84,430	29.0
Set line	242	19.1			1,616	57.3		
Subtotal	29,765	4.7	13,597	11.3	203,136	16.8	84,430	29.0
Hunting								
Deer, gun	111	16.8	498	52.8	382	58.8	9,712	64.6
Deer, bow	398	79.5	130	55.4	1,450	76.8	337	61.7
Rabbit	1,295	88.2	126	100.0	1,295	88.2	754	100.0
Squirrel			135	83.7			325	86.2
Predator	210	26.8	59	81.0	544	48.8	250	89.6
Quail	30	36.0	117	65.8	51	65.7	351	65.5
Duck	182	24.2	92	60.9	696	39.7	711	59.6
Subtotal	2,226	53.3	1,157	29.2	4,418	37.5	12,440	51.1
Minor Time								
Sight-seeing	45,343	5.2	10,322	22.9	27,425	22.9	6,255	32.3
Photography			42	*100.0*			4	*100.0*
Loafing			245	74.3			409	71.9
Environmental ed.	163	70.6	371	100.0	244	70.7	115	100.0
Organized group	16	116.3			1,139	117.6		
Off-road vehicle			59	100.0			645	100.0
Subtotal	45,522	5.1	11,039	21.8	28,808	15.0	7,428	28.7
Major Time								
Boating	33,227	6.6	13,910	51.4	234,034	20.4	79,558	55.5
Water skiing			147	100.0			368	100.0
Camping	27,450	6.1	6,728	35.4	456,951	22.6	135,305	36.3
Picnicking	13,154	7.7	970	62.2	71,255	34.3	2,130	58.8
Swimming	19,099	11.2	1,376	55.8	74,727	29.3	3,293	53.0
Subtotal	92,930	3.5	23,131	32.9	836,967	14.1	220,654	29.9
Miscellaneous								
Frogging	388	98.2			561	88.2		
Trapping			17	100.0			17	100.0
Subtotal	388	98.2	17	100.0	561	88.2	17	100.0
Totals	170,831	2.6	48,941	17.2	1,073,890	11.5	324,969	21.8

Again in 1973-1974, the above recreational activities were predominant. However, there were some significant shifts in which ones accounted for the most trips and hours. For instance, sight-seeing dropped from first place in number of trips to third place. Boating was first in 1973-1974 (28% of the trips). The other activities (percentage of all trips) in descending order the second year were: fishing (28%), sight-seeing (21%), camping (14%), swimming (3%), hunting (2%), and picnicking (2%). These 7 recreational uses accounted for 98.2% of all the trips between 1 July 1973 and 30 June 1974.

The most significant difference in the recreation hours between the 2 years was in fishing. The percentage of hours of boating and camping remained about the same; 22-25% and 42-43%, for the 2 years, respectively. These three activities accounted for about 80-90% of the hours expended by recreationists at the Thomas Hill Wildlife Area both years. Angling accounted for 17% of all recreational trips to the Thomas Hill Wildlife Area in 1972-1973, and 28% of the total trips in 1973-1974.

The number of hunting trips during the second year decreased from those of the previous year, but the hours hunted increased about threefold. The number of trips by rabbit hunters had the greatest influence upon the decrease during the second year. The increase in hours expended by hunters during 1973-1974 was mostly due to deer hunting.

Quail hunting increased some in 1973-1974 while duck hunting dropped. Squirrel hunting was only recorded during the second year.

Sight-seeing represented 27% and 21% of all trips, respectively, during the 2 years of study, but it provided only 3% and 8%, respectively, of the total hours. Conversely, camping provided 16% and 14% of the trips, but it provided 43% and 42%, respectively, of the total hours. Thus, camping was the largest activity in hours by a considerable amount.

Off-road vehicular activity included all terrain vehicles and trail cycles. Environmental educational activities included bird watching and nature study. Loafing included recreationists who responded as such when interviewed.

Average trip lengths for the various recreational activities varied, but overall averages were nearly the same (Table 2). Trip lengths for organized groups and deer (gun) hunting the first year were longer because 1 large group stayed a long time and inflated this figure accordingly. Some deer hunters camped the second year, thus increasing their trip lengths.

Table 2. Average trip length for the various types of recreational use on Thomas Hill Reservoir and adjoining lands, 1 July 1972 to June 30, 1974.

Activity	*Trip Length (Hours)* 1972 - 1973	1973 - 1974
Angling	6.8	6.2
Set-line fishing	6.7	---
Deer, gun hunting	3.4	19.5
Deer, bow hunting	3.6	2.6
Rabbit hunting	1.0	6.0
Squirrel hunting	---	2.4
Predator hunting	2.6	4.2
Quail hunting	1.7	3.0
Duck hunting	3.8	7.7
Environmental education	1.5	0.3
Sight-seeing	0.6	0.6
Photography	---	0.1
Loafing	---	1.7
Off-road vehicle	---	10.9
Organized group	71.2	---
Camping	16.6	20.1
Picknicking	5.4	2.2
Swimming	3.9	2.4
Boating	7.0	5.7
Water skiing	---	2.5
Frogging	1.4	---
Trapping	---	1.0
Average	6.3	6.6

About 67% of all the recreational trips were recorded during the summer months and 71% of the hours were also recorded in the summer. Boating, camping, and fishing trips and hours were much lower in the fall than in the spring and summer. There was little winter activity in these recreational pursuits. The increase in camping trips and hours during the winter of 1973-1974 was due to anglers camping in self-contained, facility

equipped campers at the warm-water arm (Station 3). About 8% of all angling trips occurred in winter, and all were at the warm-water arm. The greatest number of winter sight-seeing trips were also made to the warm-water arm to observe this unusual area and the fishery.

Hunting trips were mainly recorded in the fall since most of the open hunting seasons occur then. Predator hunters were contacted during the winter, but no rabbit hunting (the only other open season during the winter) was recorded.

Harvest

Anglers caught an estimated 172,100 fish during the study. An overall catch rate of 0.6 fish per hour provided a total harvest of 97 fish per ha during the study. Catch rates and harvest were much better the first year (Table 3). White crappie (87%) dominated the catch with channel catfish (*Ictalurus punctatus*) (10%) second. Largemouth bass (*Micropterus salmoides*) made up only 3% of the total catch. Harvest rates for wildlife species were also computed (Table 4).

Table 3. The total estimated numbers of fish caught, estimated hours fished, catch rates, and yield (numbers) per ha from Thomas Hill Reservoir from 1 July 1972 to 30 June 1974.

Species	*Numbers caught* 1972 - 1973	*Numbers caught* 1973 - 1974
White crappie	127,450	21,616
Channel catfish	6,699	10,230
Largemouth bass	2,011	750
Bullhead (*Ictalurus* sp.)	1,222	46
Carp (*Cyprinus carpio*)	878	324
Bluegill (*Lepomis macrochirus*)	133	---
Green sunfish (*L. cyanellus*)	---	616
Northern pike (*Esox lucius*)	12	81
Totals	138,405	33,663
Fish/hour	0.68	0.40
Hours fished	203,136	84,430
Hours/hectare	120.3	50.2
Fish/hectare	82.0	20.0

User characteristics

There were 2,063 individuals interviewed during this study, or about 1% of the people visiting the area. Local recreationists from Macon and Randolph counties accounted for 48% of all those interviewed. The common border shared by these counties approximately bisects the Thomas Hill Wildlife Area between north and south. Metropolitan recreationists from Kansas City, St. Louis, St. Joseph, and Springfield made up 9%. Out-of-state users made up only 3%.

Recreationists came from 56 (49%) of Missouri's 114 counties. Seventy-eight percent of the recreationists intervivewed came from 35 counties all or part of which lay within a 120-km radius of the Thomas Hill Wildlife Area (Fig. 2); 48% came from within a 40-km radius (Table 5). Nineteen percent came from the 82-126-km radius which included the cities of Boonville, Brookfield, Columbia, Kirskville, Mexico, and most of Jefferson City.

Table 4. Rates of harvest for fish and wildlife game from Thomas Hill Reservoir and adjoining lands from 1 July 1972 to 30 June 1974.

Categories	Total Harvest		Total Hours		Rate (No./Hour)	
	1972-73	1973-74	1972-73	1973-74	1972-73	1973-74
Fish	138,405	33,663	203,136	84,430	0.68	0.40
Deer, gun	0	119	382	9,712	0.00	0.10
Deer, bow	0	0	1,450	337	0.00	0.00
Rabbit	0	378	1,295	754	0.00	0.50
Squirrel	0	229	0	325	0.00	0.70
Predator	0	22	544	250	0.00	0.10
Quail	12	67	51	351	0.24	0.19
Duck	164	94	696	711	0.24	0.13

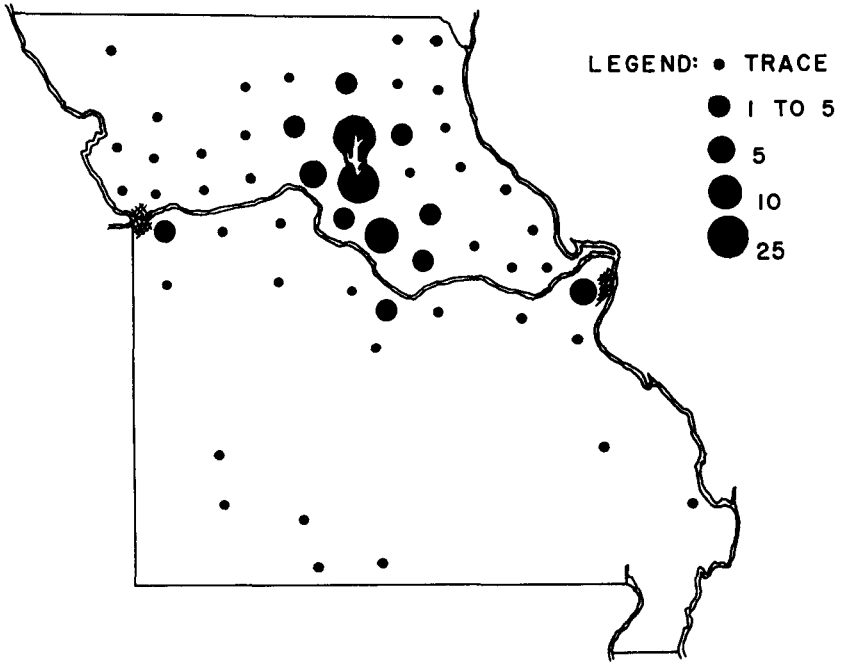

Fig. 2. Origin by percent of Missouri recreationists interviewed at Thomas Hill Wildlife Area, Missouri.

Table 5. Numbers of recreationists interviewed, categorized by miles driven to Thomas Hill Reservoir and adjoining lands from 1 July 1972 to 30 June 1974.

Miles Driven	1972-1973		1973-1974		*Total*	*%*
	No.	*%*	*No.*	*%*		
1-25	632	45	354	54	986	48
26-50	162	12	66	10	228	11
51-75	271	19	111	17	382	19
76-100	114	8	45	7	159	7
101-125	31	2	10	2	41	2
126-150	63	4	21	3	84	4
151 +	139	10	44	7	183	9
p	1,412		651		2,063	10

Passenger cars, either alone or pulling some type of trailer, pickups, and panel trucks made up 95% of all vehicular traffic (Table 6). Other modes of transportation included horses, team and wagon, bicycles, and hikers.

Table 6. Estimated numbers of vehicles of each type used by recreationists visiting Thomas Hill Reservoir and adjoining lands from 1 July 1972 to 30 June 1974.

Vehicle Type	*Year*		*Total*	*Percent*
	1972-73	1973-74		
Passenger car	27,287	7,091	34,378	54
With boat trailer	8,475	5,135	13,610	21
With house trailer	298	85	383	1
With camper	704	538	1,242	2
Subtotal	36,764	12,849	49,613	77
Pickup or panel	9,622	2,678	11,700	18
Camper bus	475	35	510	1
Motorcycle	1,389	215	1,604	2
Other	812	0	812	1
Undetermined	65	0	65	*T
Grand total	48,527	15,777	64,304	100

*T = trace or less than 1%

Information on the type of Department of Conservation license held, or not held, by recreationists visiting the Thomas Hill Wildlife Area was obtained for a spring and summer quarter in 1974 (Table 7). Approximately 48% had some type of hunting or fishing license. We did observe, however, that many of those who did not have a license were too young to need a fishing license (age 14 or under).

DISCUSSION

The Thomas Hill Wildlife Area increased the availability of public recreational opportunities in this region of the state. Hunting, particularly in connection with strip-mined lands, and fishing (Middle Fork of Chariton River before impoundment) were

Table 7. Types and numbers of Department of Conservation licenses held by persons interviewed while they visited Thomas Hill Reservoir and adjoining lands from 1 April 1974 to 30 September 1974.

Type of license	*Spring (Apr-Jun)*	*Summer (Jul-Sep)*	*Total*	*Percent*
Fishing	112	77	189	20.0
Hunting	4	20	24	2.5
Combination	102	105	207	22.0
Non-res. fishing	0	0	2	0.2
Non-res. hunting	0	0	0	0.0
Free (over 70)	11	17	28	3.0
No license	198	296	494	52.3
No response	0	0	0	0.0
Totals	427	517	944	100.0

known to have taken place before the lake was built, but most of the land and water was in private ownership. Recreational use in the area was unknown. At the time of dam closure, there were approximately 24 lakes with a minimum of 646 total ha, 17 river access sites, and 31 wildlife areas with a total of 18,100 ha managed by the Department of Conservation within a 120-km radius of the Thomas Hill Wildlife Area. Recreational use on these sites was not determined.

Recreational use of the Thomas Hill Wildlife Area was originally scheduled to be measured from 1 July 1972 to 30 June 1973. Because of unusually wet weather from September through April of 1972-1973 the census was continued for an additional year. Since this was the first attempt to measure total recreational use of a large reservoir area, it was necessary to get an estimate during a more normal year. The 2 estimates were substantially different. The specific reasons for these differences are a matter of speculation, but weather, water turbidity, and changes in the operation and management of the area were some of the most obvious factors influencing recreational use.

Some of the decline in recreational activities during the second year; principally in the amount of boating, picnicking, duck hunting, and camping may have been related to several necessary changes in the operation of the area by the Department of Conservation. For example, the lake area north of Highway T was made into a waterfowl refuge in 1974 which put the best waterfowl hunting area off-limits to duck hunters and doubtless lowered the amount of hunting and the kill in 1974. Several camping and other access areas were closed to control extensive littering and litter disposal problems. Also, the concessionaire, located at Station 5, did not renew his contract so these services were not available the second year.

The reservoir was much more turbid in 1973-1974 than during 1972-1973 which undoubtedly inhibited angler success, thus limiting this activity. This response by fishermen to turbid water conditions was documented there during a previous creel census study (Hanson 1973). What influence the increased turbidity had, if any, upon the other forms of recreation remain a matter of speculation. Data from studies on Lake of the Ozarks indicated that pleasure boating decreased and increased with more or less turbid water conditions with a correlation at the 1% level on the Niangua Arm and at the 5% level on the Osage Arm (Hanson 1975).

Confidence limits were wide on some hunting activities because of short seasons (2 weeks for deer) which made the probability of encountering a successful hunter rather small, or on other species because of a poor, lengthy season. The resulting small sample size resulted in wider confidence limits.

It was somewhat surprising that there was so much sight-seeing; however, Thomas Hill Reservoir was only 13-km west of U. S. Highway 63, and many travelers drove over merely to look around. On one occasion, I saw a bus loaded with school children stop at Station 5 for only 10 min. This amounted to 30 trips, but very little total time. Trip lengths for sight-seeing averaged slightly more than 0.5 hours while that for camping averaged 16.6 hours. Wallace and Olson (1969) found in New Hampshire a similar ratio of sight-seeing on a 21-km section of the Androscoggin River.

The average number of trips for each of the 12 stations sampled was 14, 236. However, some stations received far more use than others, and, of course, the use varied according to the season. For example, an access site might be used more during duck season but little used during the main fishing season. During 1972-1973, stations 2, 3, and 5 were much more heavily used than stations 10, 11, and 13 which were the least used. There were 46.2 water oriented trips per surface ha and 36.3 per land surface ha. How much unaccounted recreation was provided by the lake is unknown.

Comparative recreational use data for other Missouri reservoirs is not available since this study is the first one conducted. Actually, the Thomas Hill Wildlife Area Use Study is unique. The literature contains little total recreational information on similar-type areas. Most published recreational use studies have been for rivers, or for large tracts of land containing waters of various kinds on which water-oriented recreation was minor.

Two other Missouri use studies have been conducted. Fleener (1972) censused the recreational use of 92 km of stream (243.4 ha) and an accompanying 30-m lateral strip of land. At the Thomas Hill Wildlife Area the 4,202 ha of land and water were within a block approximately 13-km long and 3-km wide. Direct comparisons may not be valid but Fleener (1972) estimated about 1,038 hours per ha for fishing. At Thomas Hill Reservoir there was an estimated 120 hours of fishing per ha or roughly 1/10 of that in Fleener's study. James and Harper (1965) reported on a study of 8,086 ha of lakes, ponds, and 241-km of river at Ocala National Forest (Florida) that water-oriented activities, including fishing, averaged about 494 hours per ha. However in that national forest, swimming accounted for over one-fourth of the total because of the excellent natural springs. At Thomas Hill Reservoir swimming accounted for only 7.0% of all hours spent.

Fleener (1975) found on Pool 21 of the Mississippi River (2,565 ha water; 3,449 ha Corps of Engineers owned land) that of an estimated 1,084,000 hours of recreational use, about 133, 725 hours, or 12% was fishing. This was about 178 hours per ha total use, or about 52 hours of fishing per ha for a 1-year period which was very similar to the total use the first year at the Thomas Hill Wildlife Area. The increase in recreational use in this region of the state after construction and management of the Thomas Hill Wildlife Area is not known. However, it attracted a substantial number of users. A reservoir which offers more opportunity for group activities than land without water can be expected to markedly increase recreational activity in its locale. Thomas Hill Reservoir undoubtedly functioned in this manner.

Christensen and Yoesting (1973) found that group affiliation and attitudes toward leisure and expansion of recreational facilities were important to the level of participation in outdoor recreation. During the second year at Thomas Hill Wildlife Area, facilities were actually diminished (out of necessity) and, importantly, corresponding use patterns changed and attendance declined. Some of the groups were known to attend the area almost weekly in the first year of this study. But when "their" spot was fenced off or closed down, they lost interest and quit coming or came less often. When established groups could not recreate (and litter) in their accustomed manner at their regular place, the experience became less satisfying and, consequently, attendance dropped.

One important implication of this is that use patterns at newly developed or acquired wildlife areas may be influenced beforehand by careful planning of access and location of facilities.

Total recreational use of the Thomas Hill Wildlife Area was surprisingly heavy considering its rural setting. It was also helpful to find that most of the recreationists came from within a radius of 120 km. I can only conclude that this is a very important recreational facility to north central Missourians.

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