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Recreational Use of Water Supply Reservoirs

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13. ABSTRACT (Maximum 200 words) This report surveys recreational use of water supply reservoirs, provides guidance for recreational activities, and discusses the effects of recreation on water quality. Although state policies vary, recreation on water supply reservoirs and watersheds is permitted in most states. Policies are most restricted in northeastern states. Factors influencing recreational access policies include public health concerns and demands, reservoir characteristics, water management, history, and economics. The average cost for maintaining the recreational area is $350,000. Studies concerning the impact of recreational activities on water quality were reviewed. In general, recreation appears to have only minor, localized impacts on water quality. Increased bacterial levels as well as nutrient loading are found near swimming and camping areas. Boating and hiking activities may increase suspended solids concentrations in waters. Contaminants released by outboard motors appear to have little effect on water quality. Practices to reduce impacts on water quality include adequate sanitary facilities, public education and enforcement, and zoning restrictions near water supply intakes.

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RECREATIONAL USE OF WATER SUPPLY RESERVOIRS

prepared for

The State of Rhode Island

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

EXECUTIVE SUMMARY

This report provides information to assist Rhode Island water resource planners in the development of a recreational access policy for water supply reservoirs. The study presents the results of a survey of recreational use at water supply reservoirs the United States and discusses factors responsible for existing polices. Also provided is guidance for planning recreational programs at water supply reservoirs, and a literature review concerning the effects of recreation on lake and reservoir water quality. A survey of recreation activities and management practices at U.S. Army Corps of Engineers reservoirs is also included.

A number of previous studies concerning recreation at water supply reservoirs in the United States were reviewed. The most comprehensive study (Baumann, 1969) found that some form of recreation was permitted on about two-thirds of the water supply reservoirs in the United States.

In order to assess current state policies concerning the recreational use of water supply reservoirs a survey of state water resource agencies was conducted. Results of the survey indicate that recreation is allowed to some extent on water supply reservoirs and watersheds in virtually all states. However, the extent that recreation is permitted varies greatly among states, and among reservoirs within states. In many midwestern, southern, and western states there is virtually unrestricted access to water supply reservoirs and watersheds. A full range of body contact and non-contact activities occur on most reservoirs within these states. In a second group of states recreational access is somewhat restricted, especially on smaller privately owned reservoirs. Larger reservoirs in these states, however, may offer a wide range of recreational opportunities, including in many cases, swimming and boating. In a third group of states, policies are highly restrictive. Swimming and boating are often not allowed and in many cases, reservoir watersheds are closed to most recreational activities.

Overall, swimming generally occurs on reservoirs in about 50 % of the states surveyed. Fishing from shore generally occurs on reservoirs in about 70 % of the states. Hiking and picnicking were the most frequent watershed activities and generally occur on reservoirs in about 80 % of the states.

About half the states surveyed have formal policies or regulations in place governing the recreational use of water supply reservoirs and/or watersheds. States without formal policies or regulations tend to be those with few water supply reservoirs, or those which allow unrestricted use.

Various factors can influence the development of recreational access policies at water supply reservoirs. Public health concerns are probably the most important reasons for not permitting recreation to occur on water supply reservoirs. Other significant factors include reservoir characteristics (size, type, ownership), economic considerations, historical factors, water manager concerns, and public demand.

General information to aid in planning for recreation at water supply reservoirs is provided in this report. Topics discussed included the provision and management of recreational facilities, visitor management, economic cost-benefit analysis, and recreational carrying capacity.

Information concerning current recreational access policies and management practices at U.S. Army Corps of Engineers water supply reservoirs was obtained from a survey of 24 reservoirs located throughout the country. A wide range of recreational activities are permitted at virtually all Corps reservoirs surveyed. Body contact activities (swimming and water skiing) were allowed at most reservoirs. Few restrictions on boating were in place. Facilities provided at most Corps reservoirs include picnic areas, boat ramps, campgrounds, hiking trials, and swimming beaches. All Corps facilities provide basic services such as general maintenance, trash collection, lawn mowing, and security patrols. Lifeguards were generally not provided.

Cost estimates for managing and maintaining recreational facilities were available from 15 Corps reservoirs. Expenditures ranged from $14,000 to $ 1.5 million per year, with average and median values of $350,000, and $200,000, respectively. Costs per visitor per year ranged from about $0.01 to $0.70, with average and median values of about $ 0.24. Most reservoirs (ca. 80 %) charged some sort of user fee to help defray management and maintenance costs. At ten reservoirs where user fees were charged, fees defrayed from 10 % to 50 % of costs (mean = 22 %).

A literature review concerning the impact of recreational activities on lake and reservoir water quality was accomplished. Virtually all studies have found that recreational activities have no significant effect on the overall microbial water quality of lakes or reservoirs. Elevated bacterial levels, however, have frequently been noted in the vicinity of swimming areas, marinas, and near campsites or cottages. Given adequate spatial separation between these sites and water supply intakes, recreational activities should have no adverse impact on raw water quality.

Recreational activities have the potential to add nutrients to lake ecosystems via direct discharge of human wastes, leaching from near-shore sanitary facilities, runoff of nutrient rich sediments from disturbed areas, and nutrient release from resuspended bottom sediments. The sensitivity of reservoirs to nutrient loading should be evaluated on a case by case basis to determine the permissible levels of recreational activities.

Recreational activities have the potential to elevate suspended solids concentrations in lake waters. Bottom sediments can be resuspended by motorboats. On-shore activities such as shore fishing and hiking can disturb soils and vegetation and cause increased transport of sediments into reservoirs.

Outboard motors can release contaminants such as nonvolatile oils (lubricating oils), volatile oils (gasoline), phenols, and lead. These discharges probably do not normally have a significant impact on reservoir water quality.

Modern water treatment systems are very efficient in removing suspended solids and microbial contaminants. In situations where full treatment systems (i.e. filtration, coagulation, disinfection)are available and properly managed it is highly unlikely that recreational activities would have any adverse impact on finished water quality. In situations where only disinfection is practiced it is possible that recreation could cause slight increases in suspended solid levels in finished water supplies. In reservoirs with extremely good water quality it is conceivable that recreational impacts could trigger the need for filtration under the forthcoming EPA filtration rule.

Management practices to minimize recreation impacts on reservoir water quality included proper sanitary facilities, an active public education and enforcement program, placement of restricted use zones around water supply intakes, zoning ordinances, speed limits to minimize resuspension of bottom sediment, and proper siting of shore-based facilities to minimize potential soil erosion.

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INTRODUCTION

STUDY AUTHORITY

This study was conducted by the New England Division of the U.S. Army Corps of Engineers at the request of the Rhode Island State Planning Office. Authority for the study is contained in Section 22 of the 1974 Flood Control Act (Public Law 93-251) as amended ("Planning Assistance to States") which authorizes cooperation with the states in preparation of plans for the development, utilization, and conservation of water and related resources.

STUDY PURPOSE AND SCOPE

Long-standing policies in Rhode Island strictly prohibit recreation activities on most of the state's public water supply reservoirs. These reservoirs are a potentially valuable recreational resource, however, and the implications of instituting less restrictive policies are under review by the state Office of Statewide Planning. This report provides information to assist Rhode Island water resource planners in the development of a prudent recreational access policy for water supply reservoirs. The study presents the results of a survey of recreation use policies at water supply reservoirs in the United States, and a discussion of factors that influence recreational access. Guidance for planning recreational programs at water supply reservoirs and a literature review concerning the effects of recreation on lake and reservoir water quality is provided. A survey of recreation activities and management practices at U.S. Army Corps of Engineers reservoirs is also included.

RECREATIONAL USE OF WATER SUPPLY RESERVOIRS IN THE UNITED STATES

This section provides a summary of recreational access policies at water supply reservoirs in the United States. A brief synopsis of previous studies and the results of a survey conducted to determine current polices are included.

PREVIOUS STUDIES

A number of previous studies have examined the recreational use of water supply reservoirs in the United States. The most comprehensive nationwide study was conducted by Baumann (1969). This study reviewed previous reports and obtained information on management practices from several hundred water supply managers throughout the United States. Information was also obtained from state health department offices, and from public opinion surveys conducted in selected communities.

Some form of recreation was permitted on about two-thirds of the surveyed water supply reservoirs. Non-contact activities (i.e. fishing and boating) were more frequently permitted than water contact activities such as swimming and water-skiing. Significant regional differences in recreational access at water supply reservoirs were evident. Recreational opportunities were most restricted in the northeastern and far western United States. Water contact activities were rarely allowed on reservoirs in northeastern or far western states, but were permitted on about 50 percent of those elsewhere in the country. Recreational use of water supply reservoirs was also related to reservoir size, and was much more likely to be permitted at larger reservoirs.

Stone and Friedland (1972) conducted a nationwide survey of state public health department policies and found that 39 of 48 states permitted some form of recreation on one or more water supply reservoirs. Fifteen states allowed body contact recreation such as swimming.

Dissmeyer and Swank (1976) conducted a comprehensive survey of management practices in southeastern United States water supply watersheds. The study found that various recreational activities were allowed on most watersheds. Hunting and fishing was permitted in most cases, while camping, boating, and swimming were allowed on about half the watersheds. Recreational activities generally occurred much less frequently on small (less than 5 square mile), and more heavily forested watersheds. Smaller watersheds were more likely to be owned by municipalities, and thus more easily subject to restrictive land use policies.

The Council of Environmental Quality (CEQ, 1975) published a handbook designed to promote the recreational use of water supply reservoirs in the Northeastern United States. The study presented a historical overview of the issue, described existing policies in the United States, and provided detailed planning guidelines for increasing recreational use. Policies and practices in six northeastern states (Connecticut, Massachusetts, New Jersey, New York, Rhode Island, and Pennsylvania) were reviewed.

CURRENT POLICIES AND PRACTICES

Survey Methodology

In order to assess current state policies concerning the recreational use of water supply reservoirs a phone survey of state water resource agencies was conducted in March of 1989. Initial contacts were provided by a directory prepared by the Association of State Drinking Water Administrators (1989). All forty eight states in the continental U.S. were contacted, and appropriate officials from 42 states were interviewed. A questionnaire was prepared to structure the interview, and is presented at the end of the report. Although the limited scope of this study precluded a detailed survey of practices at individual reservoirs, several reservoir managers or local water authority officials were also interviewed.

General Policies and Practices

Results of the survey indicate that recreation is allowed to some extent on water supply reservoirs and watersheds in virtually all states (see Figure 1). The level of recreation permitted varies greatly however, among states, and among reservoirs within states.

In many midwestern, southern, and western states there is virtually unrestricted access to water supply reservoirs and watersheds. A full range of body contact and non contact activities occur on most reservoirs within these states.

In a second group of states recreational access is often somewhat restricted, especially on smaller privately owned reservoirs. Larger reservoirs in these states, however, may offer a wide range of recreational opportunities, including in many cases, swimming and boating.

In a third group of states, policies are highly restrictive. Swimming and boating are often not allowed and in many cases, reservoir watersheds are closed to most recreational activities. States with the most restrictive policies include, Washington, Delaware, Rhode Island, Connecticut, and North Carolina.

As noted in previous studies (Baumann, 1969; CEQ, 1975), policies concerning the recreational use of water supply reservoirs are more conservative in New England than in most other regions of the country. Swimming and boating are typically not allowed, and watershed activities are frequently severely restricted. Current practices in each of the six New England states are summarized in Exhibit 1 .

About 50 % of the officials interviewed indicated that state policies concerning recreation on water supply reservoirs have changed little in recent years. The remainder were equally divided as to whether policies have become more restrictive or more favorable towards recreational use. In several states (New Mexico, West Virginia, North Dakota), policies have become more favorable towards recreation in order to promote tourism. In California, where contact recreation on terminal reservoirs is not permitted by state statute, public pressures led to an exemption of this rule for San Diego's reservoirs. In Georgia, there is interest in liberalizing policies towards recreation so that recreational benefits can be included in proposals to build new reservoirs. Policies in a few states (i.e. Pennsylvania, Indiana, Oklahoma) have become somewhat more conservative because of water quality concerns.

EXHIBIT 1: RECREATION ACCESS POLICIES IN NEW ENGLAND STATES

Connecticut: Recreational use of water supply reservoirs or watersheds is rarely allowed. Swimming, and boating (with gasoline motors) is prohibited on all reservoirs. Fishing from shore is occasionally permitted. Boating (non power or electric) and boat fishing is rarely permitted. Although hiking is occasionally allowed, all other watershed activities are rarely permitted. Under state statute local authorities must apply to the Commissioner of Health Services for permission to allow recreational activities. Water companies are empowered to charge user fees, and typically charge day use fees for fishing permits.

Maine: Recreational policies in Maine are the most liberal of the New England States. Swimming and boating are often allowed, as are most watershed activities. State regulations require a 500 foot protection zone around water supply intakes. Local authorities may petition the State Legislature for enactment of reservoir specific restrictions.

Massachusetts: Swimming is not permitted in Massachusetts water supply reservoirs. Boating is infrequently permitted, and reservoir lands are typically closed to most other recreational activities. State regulations prohibit recreational use of water supply reservoir unless permitted by the Department of Public Health.

New Hampshire: Swimming is not permitted on New Hampshire reservoirs. Boating and fishing occasionally occur. Hiking and other watershed activities almost always occur, but are often not sanctioned. Two-thirds of local water supply authorities have enacted regulations governing recreational use of water supply reservoirs and watersheds. In many instances local regulations are adopted by the state. State adoption of local regulations occurs frequently when watershed boundaries cross local jurisdictional lines. State adoption of regulations is not required, however, and may not occur in situations where a water supply watershed is situated entirely within a single town. The state can empower local officials to enforce state-adopted regulations. State policies seek to minimize recreation on reservoirs to the maximum possible extent.

Rhode Island: Swimming is not permitted in water supply reservoirs. Boating and fishing occur rarely, and only in reservoirs where it is not possible to impose more stringent restrictions. Hiking and other watershed activities are not permitted, but occasionally occur. State statute prohibits discharge of contaminants into water supply reservoirs and watersheds, but with the exception of bathing, does not expressly restrict recreational activities. Although expressed state policy is to allow recreation on reservoirs (if the public water supply is not jeopardized), in practice the recreational use of reservoirs and watersheds in the state is severely restricted. State policy requires that all costs incurred to develop and maintain recreational facilities must not be borne by the primary water users.

Vermont: State statute totally prohibits recreational use of water supply reservoirs and watersheds.

PREVALENCE OF SPECIFIC RECREATIONAL ACTIVITIES

Survey respondents were asked to indicate how frequently various recreational activities occur on water supply reservoirs and watersheds within their state. Frequency was estimated on a "1" to "4" scale ranging from rarely (or not at all) to always (or nearly always). Results are summarized in Figure 2.

Swimming usually or always occurred on reservoirs in about 50 % of the states surveyed. These include mainly western, midwestern, and southern states. Swimming occurs rarely or not at all on reservoirs in about one-third of the states. No swimming is allowed on water supply reservoirs in Washington, Vermont, Rhode Island, North Carolina, Nevada, Delaware, Massachusetts, and Connecticut.

The occurrence and frequency of boating with gasoline powered engines closely parallels swimming. Policies towards non-powered (i.e. row boats, canoes) are somewhat less restrictive than those for gasoline engines.

Fishing from shore usually or always occurred on reservoirs in about 70 % of the states. Shore fishing occurs somewhat more frequently than fishing from boats.

Hiking and picnicking are the most frequent watershed activities allowed, and usually or always occurred on reservoirs in about 80 % of the states. These activities occur rarely or not at all on reservoirs in only a few states (i.e. Washington, Delaware, Rhode Island, Connecticut, and North Carolina).

Other watershed activities such as hunting, camping and use of Off the Road Vehicles (ORV's) are more restricted. ORV's are allowed rarely or not at all on watersheds in about 50 % of the surveyed states.

STATE LAWS AND REGULATIONS

About half the states surveyed have formal policies or regulations in place which govern the recreational use of water supply reservoirs and/or watersheds. States without formal policies or regulations tend to be those with few water supply reservoirs, or those which allow unrestricted use.

A number of states have laws requiring local authorities to file a detailed water quality protection plan for water supply reservoirs. These plans include rules concerning recreational access that must conform to state regulations or policy. Frequently these plans reviewed by

agencies such as the Water Supply Division of the State Health Department or State Department of Environmental Resources.

In other states local authorities must file for a permit to allow specific activities on water supply reservoirs and watersheds. In states where no regulations govern the recreational use of water supply reservoirs, regulation is left to local communities or water authorities. In some instances local authorities are encouraged to follow non binding state guidelines.

A synopsis of laws and regulations pertaining to the recreational use of water supply reservoirs is provided for selected states in Exhibit 2.

EXHIBIT 2: SYNOPSIS OF STATE LAWS AND REGULATIONS

California: Recreational use of water supply reservoirs is prohibited by state statute unless authorized by a permit. Permits may be granted for terminal reservoirs with full treatment and secondary reservoirs. With the exception of San Diego County, no body contact recreation is allowed on terminal reservoirs. Public agencies operating reservoirs are allowed to charge user fees to the cover the cost of providing sanitary facilities and other incidental costs.

Colorado: No state regulations are in place to govern water supply reservoir use. Formal State Health Department policies recommend 1) no body contact recreation, 2) no motorized boats, 3) provision of adequate sanitary facilities, restricted access, and enforcement, 4) monitoring of raw water quality.

Connecticut: Under state statute local authorities must apply to the Commissioner of Health Services for permission to allow fishing and other recreational activities. Water companies are empowered to charge user fees.

Georgia: Regulations are in preparation which would require local authorities to submit a water quality management plan for approval by the Sate Dept. of Natural Resources. The plan would address recreation use of the reservoir and the maintenance of a vegetated buffer strip around reservoirs. Local governments would be empowered to adopt more stringent regulations to protect water supply reservoirs. Existing regulations prohibit recreation, but waivers are frequently given.

Louisiana: Regulations allow the State Health Officer to prohibit recreation if a health hazard is deemed to exist. In all cases recreation is prohibited within 100 feet of the water supply intake point.

Maine: State regulations require a 500 foot protection zone around water supply intakes. Local authorities may petition the State Legislature for enactment of reservoir specific regulations

Massachusetts: Regulations prohibit recreational use of water supply reservoirs unless permitted by the Department of Public Health.

New Hampshire: Approximately two-thirds of local water supply authorities have watershed protection regulations which have been adopted by the state. Local regulations are typically adopted at the state level when watershed boundaries cross local jurisdictional lines. State adoption of regulations is not required, however, and may not occur in situations where a water supply watershed is situated entirely within a single town. The state can empower local officials to enforce state-adopted regulations. State policies seek to minimize recreation on reservoirs to the maximum possible extent.

New Mexico: Local authorities develop regulations. State has general rules for watershed protection, but no specific regulations concerning recreation.

New York: State public health law requires local authorities to develop an approved water quality protection plan that includes a discussion of recreational use policy. No activities are permitted within 1000 feet of water supply intakes.

North Carolina: Local authorities must apply to the State Health Department for a permit to allow recreational activities. No recreational activities are permitted within 50 yards of water supply intakes.

Oklahoma: No state statutes governing recreation on water water supply reservoirs or watersheds. All reservoirs are Corps or BLM facilities and managed under Oklahoma Division of State Parks rules and regulations.

Pennsylvania: State regulations prohibit recreational use of water supply reservoirs unless full treatment is available. State policy opposes use of gas engines, and promotes enforcement of local restrictions.

Rhode Island: State statute prohibits discharge of contaminants into water supply reservoirs and watersheds, but with the exception of bathing, does not expressly restrict recreational activities. State policy is to allow recreation on reservoirs, if the public water supply is not jeopardized. In practice, recreational use of reservoirs and watersheds in the state is severely restricted. State policy requires that all costs incurred to develop and maintain recreational facilities must not be borne by the primary water users.

Vermont: State statute prohibits recreational use of water supply reservoirs and watersheds.

Virginia: The state health department sets policies which are enforced by local authorities. Use of gasoline engines is restricted in vicinity of water supply intakes.

Washington: State regulations strictly prohibit recreational use of water supply reservoirs and watersheds.

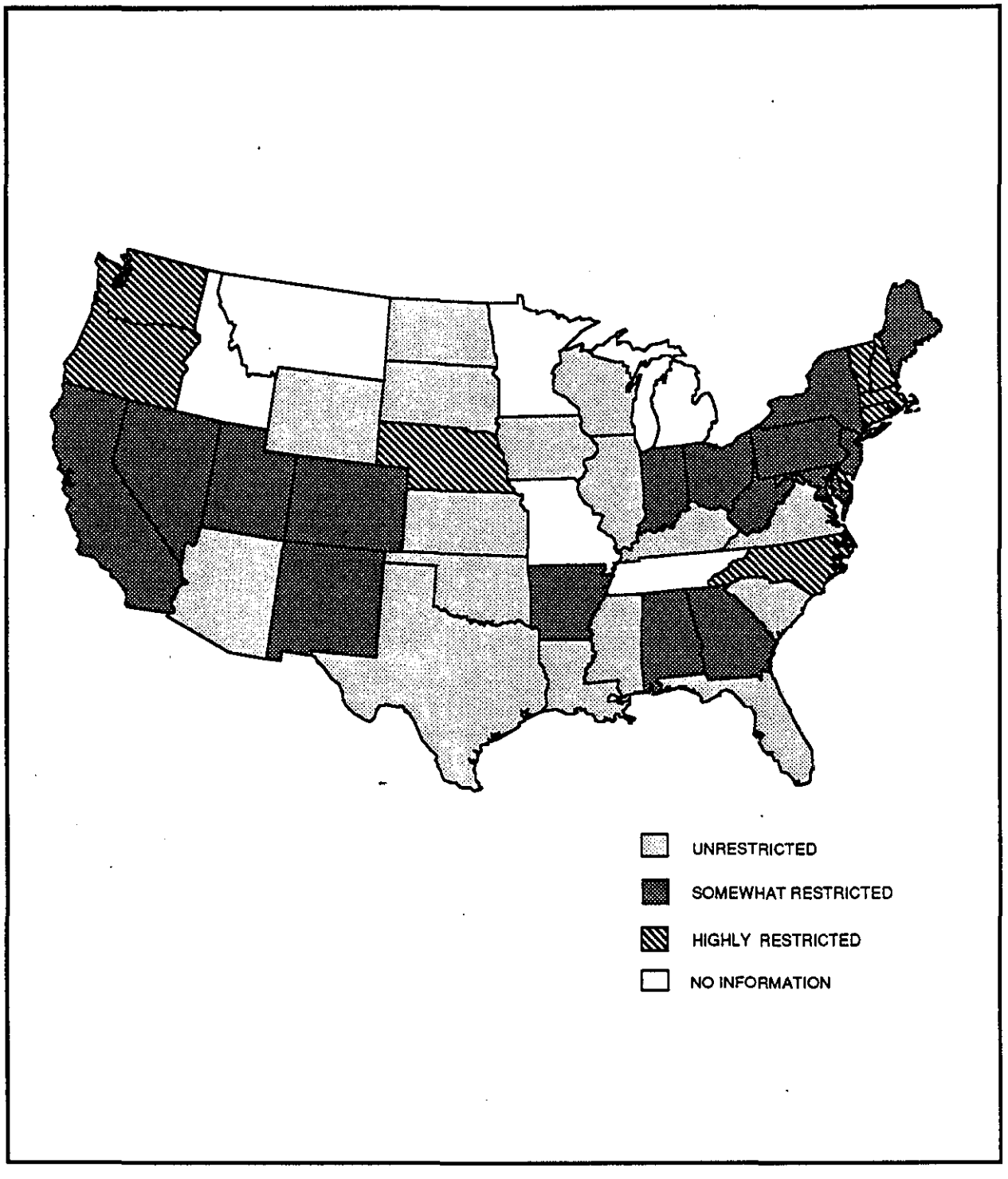
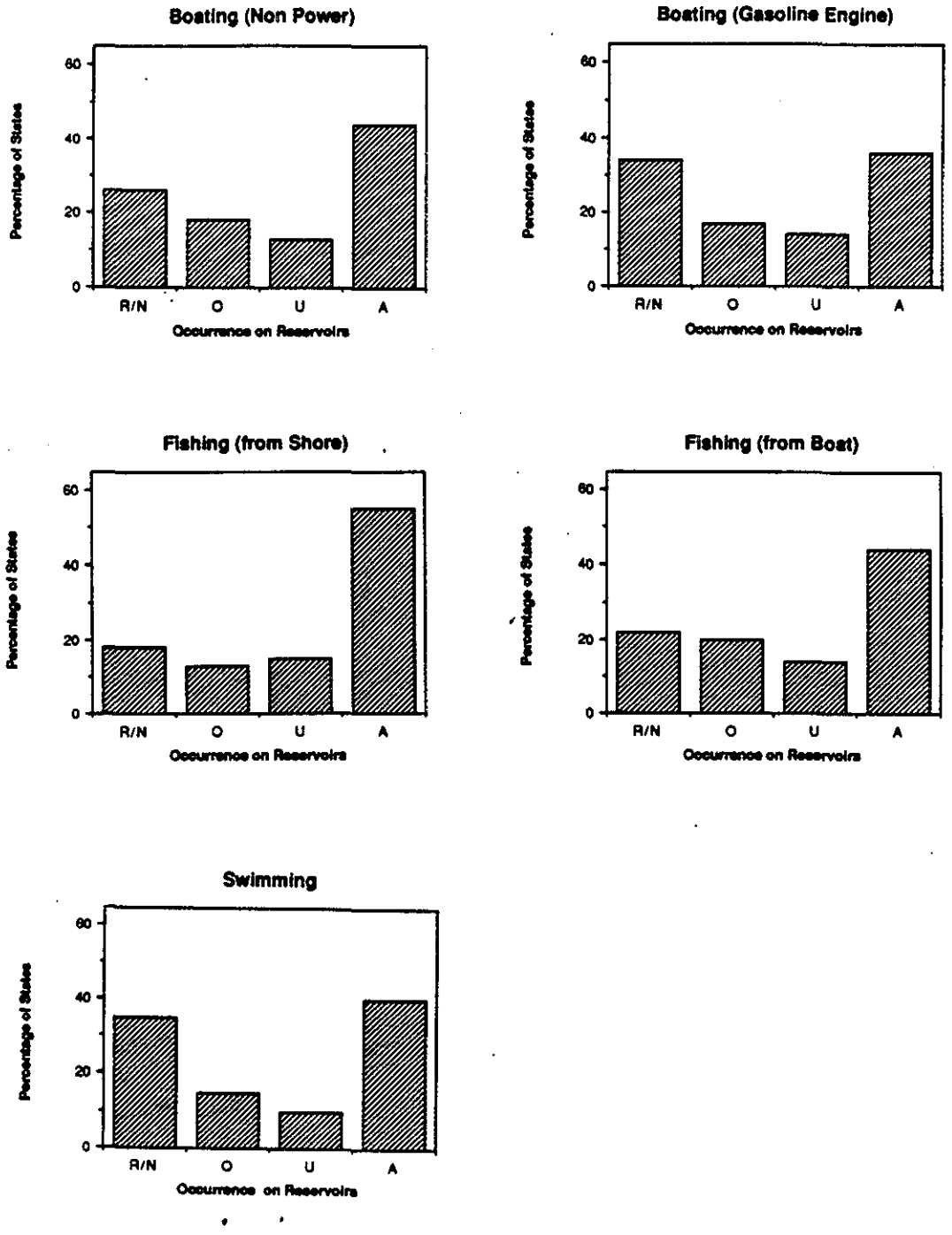


FIGURE 1

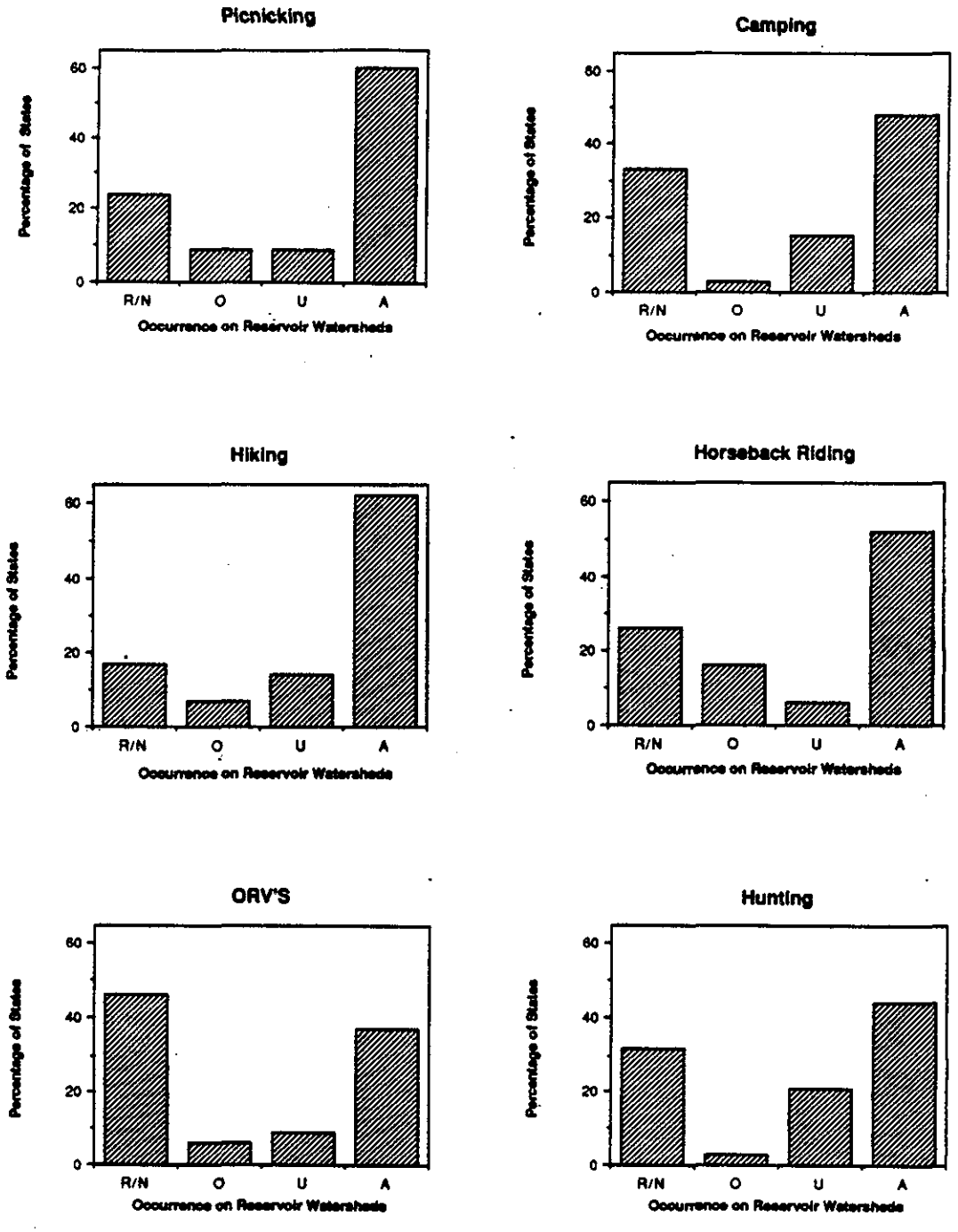
General Recreational Access Policies at Water Supply Reservoirs



R/N rarely or never, O occasionally, U usually, A always or nearly always

FIGURE 2a

Prevalence of recreational activities on water supply reservoirs in the United States



R/N rarely or never, O occasionally, U usually, A always or nearly always

FIGURE 2b

Prevalence of recreational activities on water supply reservoirs in the United States

FACTORS INFLUENCING RECREATIONAL ACCESS POLICIES AT WATER SUPPLY RESERVOIRS

This section provides a discussion of factors which influence state and local policies concerning the recreational use of water supply reservoirs. Information is drawn from both the literature and the nationwide survey of state water supply managers conducted for this study.

PUBLIC HEALTH AND WATER QUALITY CONCERNS

Public health concerns are often cited as the the primary reason for not permitting recreation on water supply reservoirs (CEQ, 1975). In this study, for states where restrictions on recreation are in place, virtually all respondents indicted that health related water quality concerns were the primary motivating factor. Concerns over other water quality impacts (i.e. sedimentation and eutrophication) were also frequently raised in states with restrictions. The impacts of recreation on water quality will be discussed in detail in a latter section.

WATER MANAGER ATTITUDES AND MANAGEMENT CONCERNS

Irrespective of state policies, attitudes of water managers can present a serious barrier to the recreational use of water supply reservoirs. A recent survey in Massachusetts found that water managers held highly conservative views towards recreation use (Klar and Ghirin, 1983). Approximately 75 % favored allowing little or no recreation on reservoirs. Fewer than 50 % favored any specific activity (Table 1). Most Massachusetts water managers felt that recreation could have adverse effects on water quality, and were unaware or unconvinced by evidence to the contrary in the technical literature.

Table 1: Massachusetts water managers attitudes towards recreation on water supply reservoirs (from Klar and Ghirin, 1983).

Activity	% Favoring Activity
Fishing from Shore	48
Hunting	43
Canoeing	42
Sailing	42
Snowmobiling	29
Camping	27
Swimming	21
Fishing from Motorboats	13
Motorboating	10

Various other management issues are also frequently cited as arguments against allowing increased public use of water supply reservoirs (Baumann, 1969; Bergey 1979; Imhoffer, 1989). These include:

- vandalism
- littering
- management costs (who pays)
- soil erosion
- forest fires
- legal liability issues

In some instances the optimal management of reservoirs for water supply may clearly conflict with recreational use. Proscribed use of copper sulfate to control algae causing taste and odor problems, for example, might not be feasible (or at least be very controversial) in a reservoir with an active recreational fishery (Imhoffer, 1987). Managers of some systems (e.g. the New York City Reservoir System) are reluctant to allow increased recreation, in part, because they wish to maintain the freedom to manage reservoir water levels without concern for impacts on recreational users.

HISTORICAL FACTORS

As discussed in detail by Baumann (1969) and CEQ (1975) regional differences in recreational use policy have a strong historical basis. Restrictive laws and policies in the Northeastern United States date from the 1800's when watershed protection was the primary measure available to insure drinking water quality. Although all supplies in the Northeast are now disinfected, and many are filtered, highly restrictive source protection policies have remained in place.

RESERVOIR SIZE, TYPE, AND OWNERSHIP

Policies concerning the recreational use of water supply reservoirs can vary greatly from reservoir to reservoir within states. Baumann (1969) and others have noted that restrictions are more likely to be in place on relatively small reservoirs. In the current study, several state officials noted that recreational access is much more restricted on small, privately owned, reservoirs relative to large state or Federal facilities. Recreation probably tends to be more restricted on small reservoir for several reasons. Most large state and Federal reservoirs were built as multipurpose reservoirs, and from the outset, were intended for recreational use. In contrast, many small reservoirs were built solely for water supply and were historically closed to recreation. The watersheds of small reservoirs are also more likely to be completely under control of water authorities, and thus more liable to the implementation of restrictive policies. Lastly, water quality concerns are less acute in large reservoirs where long retention times and high dilution volumes render water quality impacts associated with moderate amounts of recreation insignificant.

Recreational access policies also vary with the type of reservoir. Policies tend to be more restrictive on terminal reservoirs (reservoirs from which water is drawn for treatment) than in secondary (collection) reservoirs. In California, for example, contact recreation is permitted at secondary reservoirs, but generally prohibited on terminal reservoirs. Recreational use of distribution reservoirs (reservoirs from which water is drawn for distribution to consumers without further treatment) does not occur in the United States.

At terminal reservoirs the type of water treatment available can influence recreational use policy. Recreation is likely to be especially restricted on reservoirs that rely on source protection, rather than full treatment (i.e coagulation, filtration, and disinfection), to provide high finished water quality.

Recommended recreational use of a reservoir also depends on adequacy and reliability of existing water treatment facilities (Alford and Binkley, 1977; CEQ, 1975). Suggested guidelines for permissible activities at water supply reservoirs are provided in Table 2a and 2b. In general, larger collection reservoirs can safely support more intensive recreational use than small terminal reservoirs. Swimming is not recommended on terminal reservoirs or small collection reservoirs unless the water treatment regime includes filtration.

Ownership of the water supply reservoir also can influence the extent of recreation that is permitted. Recreation is less likely to be restricted in situations where the water authority owns or controls easements on only a portion of the water supply reservoir or watershed.

GENERAL SITE SUITABILITY

Some sites, especially small reservoirs built solely for water supply, may be poorly suited for recreational use. The reservoirs may be located in remote areas with poor public access. Reservoirs may lack suitable sites for recreational facilities such as beaches and boat ramps. Under normal operations some reservoirs may experience wide water level fluctuations that limit development of potential recreational sites. Reservoir watersheds may have rugged topography and erosion prone soils that limit development of hiking trails. Swimming may be prohibited in reservoirs with numerous submerged tress and irregular bottoms because of safety concerns.

In some instances restricted recreational access to water supply watersheds has been advocated in order to preserve valuable undeveloped wildlife habitat (Imhoffer et al., 1987; Bergey, 1979). This argument has been forwarded at Massachusetts' Quabbin Reservoir, which is perhaps the largest undeveloped "semi-wilderness" area in southern New England (MDC, 1988).

Table 2a: Suggested guidelines for recreational activities at terminal reservoirs. from Alford and Binkley, 1977

Terminal Reservoir Size	Plain Chlorination	Free Residual Chlorination	Filtration and Free Residual Chlorination	Activated Carbon or Other Advanced Process
Small: Residence Time <30 Days			Fishing, boating (no motor)	Fishing, boating (no motor), sailboating, swimming
	Informal land-based recreation: hiking, picnicking, game sports, hunting, bicycling	Informal land-based recreation: hiking, picnicking, game sports, hunting, bicycling	Informal land-based recreation: hiking, picnicking, game sports, hunting, bicycling, golf	Informal land-based recreation: hiking picnicking, game sports, hunting, bicycling, golf
	Informal land-based winter recreation: cross-country skiing, snowshoeing, ice skating (on reservoir) snowmobiling (no access to shore)	Informal land-based winter recreation: cross-country skiing, snowshoeing, ice skating (on reservoir) snowmobiling (controlled access to shore)	Informal land-based winter recreation: cross-country skiing, snowshoeing, ice skating, snowmobiling ice fishing	Informal land-based winter recreation: cross country skiing, snowshoeing, ice skating, snowmobiling ice fishing
Large: Residence Time >30 Days		Fishing (from shore) sailboating, swimming	Fishing, boating (no motor), sailboating, swimming	Fishing, boating (small motor),
	Informal land-based recreation: hiking, picnicking, team sports, hunting	Informal land-based recreation: hiking, picnicking, game sports, hunting, bicycling	Informal land-based recreation: hiking, picnicking, game sports,riding, hunting, bicycling, camping, golf	Informal land-based recreation: hiking, picnicking, game sports, riding, hunting, bicycling, camping, golf
	Informal land-based winter recreation: cross-country skiing, snowshoeing, ice skating (semiartificial rink) snowmobiling (no access to shore)	Informal land-based winter recreation: cross country skiing, snowshoeing, ice skating (on reservoir), snowmobiling, ice fishing (controlled access to shore)	Informal land-based winter recreation: cross country skiing, snowshoeing, ice skating (on reservoir), snowmobiling, ice fishing	Informal land-based winter recreation: cross country skiing, snowshoeing, ice skating (on reservoir), snowmobiling, ice fishing

Table 2b: Suggested guidelines for recreational activities at collection reservoirs.

from Alford and Binkley, 1977

Collection Reservoir Size	Plain Chlorination	Free Residual Chlorination	Filtration and Free Residual Chlorination	Activated Carbon or Other Advanced Process
Small <5 mi^2		Fishing,boating (no motor), sailboating	Fishing,boating (small motor), sailboating	Fishing,boating (small motor), sailboating
	Informal land-based recreation: hiking, picnicking, bicycling, game sports, hunting, golf	Informal land-based recreation: hiking, picnicking, bicycling, golf, game sports, hunting, riding	Informal land-based recreation: hiking, picnicking, bicycling, camping, game sports,hunting,riding,golf	Informal land-based recreation: hiking, picnicking, bicycling, camping, game sports,hunting,riding,golf
	Informal winter land-based recreation: cross-country skiing, snowshoeing, ice skating (semiartificial rink) snowmobiling (no access to shore)	Informal winter land-based recreation: cross-country skiing, snowshoeing, ice skating (semiartificial rink) snowmobiling (controlled access to shore)	Informal winter land-based recreation: cross-country skiing, snowshoeing,ice skating semiartificial rink) snowmobiling	Informal winter land-based recreation: cross-country skiing,. snowshoeing,ice skating (semiartificial rink) snowmobiling
Large >5 mi^2		Fishing,boating(small motor) sailboating, swimming	Fishing, boating(any size motor), swimming	Fishing, boating (any size motor),sailboating, swimming
	Informal land-based recreation: hiking, picnicking, bicycling, golf, game sports, hunting,riding	Informal land-based recreation: hiking, picnicking, bicycling,camping,game sports, hunting,riding,golf	Informal land-based recreation: hiking, picnicking bicycling,camping, game sports, hunting,riding,golf	Informal land-based recreation: hiking, picnicking, bicycling, camping,game sports,hunting,riding,golf
	Informal land-based winter recreation: cross-country skiing, snowshoeing,ice skating (semiartificial rink) snowmobiling (no access to shore)	Informal land-based winter recreation: cross-country skiing,snowshoeing,ice skating (semiartificial rink) snowmobiling (no access to shore)	Informal land-based winter recreation: cross-country skiing,snowshoeing,snow mobiling, ice skating (semi-artificial rink)	Informal land-based winter recreation: cross-country skiing,snowshoeing,snow mobiling, ice skating (semi-artificial rink)

ECONOMIC CONSIDERATIONS

Economic factors can influence recreational access to water supply reservoirs. A major argument against allowing recreation has centered on the cost of providing and maintaining recreational facilities. Many water mangers hold that water consumers should not bear the excess costs of providing recreation at reservoirs, especially those built primarily for water supply. In some states (e.g. California and Rhode Island) state law requires that the excess costs of recreation not be borne by utility customers. It should be recognized that highly restrictive policies also incur management costs. Reservoirs in urbanized areas must be patrolled and/or fenced to curtail illicit use. In many instances resources for enforcement are limited, and "restrictions" are openly flaunted.

Conversely, the economic benefits of recreation have been cited as justification for increased recreational use of reservoirs. In this study, officials in several states (West Virginia, North Dakota, New Mexico) indicated that interest in increasing tourism revenues had resulted in a liberalized attitude towards recreation on reservoirs. Georgia is in the process of liberalizing policies towards recreation so that recreational benefits can be used to justify new water supply reservoirs.

In some instances strong pressures are exerted by developers to open up reservoir lands to recreation. Some utilities have sold valuable portions of their watershed holdings to finance capital improvements (Imhoffer, 1987).

DEMAND FOR RECREATIONAL FACILITIES

Decisions to permit increased recreational use of water supply reservoirs should consider whether there is a genuine demand for recreational opportunities that cannot be satisfied at alternative sites (Alford and Binkley, 1977). In remote areas with little demand, or areas with numerous developed or undeveloped lakes , there may be little justification for developing unused water supply reservoirs.

In this study state officials indicated that public pressure to relax restrictions on reservoir recreation exists in about 25 % of the states surveyed. Public pressures exist mainly in states with fairly restrictive policies (e.g. Washington, New Hampshire, Maryland). Pressures to relax restrictions are greatest on large reservoirs situated close to urban centers (e.g. Manchester, New Hampshire; Denver, Colorado; the New York City Reservoir system; the Patuxent Reservoir in Washington). In some instances public pressures have resulted in major policy changes. Public pressure was instrumental in changing California State law to allow body contact recreation on terminal reservoirs in San Diego County.

WATER INDUSTRY TRADE ORGANIZATION POLICIES

Attitudes of reservoir mangers and policy makers are undoubtedly strongly influenced by policies adopted by national or regional water industry trade organizations. In the United States the most influential water industry organization is the American Water Works Association. The AWWA has historically supported only limited recreational access to water supply reservoirs. The most recent AWWA policy statement (AWWA, 1987) concerning recreational access is included at the end of this report. Principle findings and recommendations include:

- "Public water supply reservoirs should not be used for recreation if other surface waters are available. Body-contact sports such as swimming, should not be allowed in reservoirs designed, financed, and built solely for public water supply. Distribution reservoirs from which water is supplied directly to the public require the strictest controls and under no condition should be used for recreation."

- "It should be the vested responsibility of water utilities to determine the use of their reservoirs." Decisions concerning recreation should be based on local and state laws and regulations, technical information, and on an assessment of public need for additional recreational opportunities.

- It should be recognized that recreational use of reservoirs may result in added costs that may either increase water costs for the consumer or be borne by the recreational user.

In New England, the New England Water Works Association (NEWWA) has adopted a staunchly conservative policy opposing recreational use of water supply reservoir and watersheds. This policy statement is included at the end of this report.

ENVIRONMENTAL PROTECTION AGENCY GUIDELINES AND REGULATIONS

The Environmental Protection Agency is the lead federal agency responsible for regulating drinking water quality under the Safe Drinking Water Act. Although the EPA has no specific regulations concerning the utilization of water supply reservoirs and watersheds for recreation, the agency is in favor of maintaining and enhancing water quality through source protection. In the northeastern United States (Region 1) the agency is strongly in favor of limiting recreation on water supply reservoirs and watersheds. The agency opposes water contact activities (i.e. swimming) on all reservoirs, and opposed liberalization of recreation policies at Massachusetts' Quabbin Reservoir.

Under the proposed Safe Drinking Water Act "filtration rule" all utilities will be required to filter surface water supplies unless stringent water quality criteria are met (see 40 CFR 141 and 142). Those systems not using filtration would be required to submit a "Watershed Control

Program" and conduct periodic sanitary surveys to insure source protection. EPA guidelines indicate that Watershed Control Programs and sanitary surveys should include an evaluation of the impact of recreational activities on water quality (EPA, 1989).

Officials in most states indicate that the proposed EPA "filtration rule" would have little impact on recreational use policies. Typically, regulations in these states already require full treatment of surface water supplies. Officials in some states where filtration is not required suggested that the rule would remove incentives for source protection, and result in more liberal policies towards recreation. Conversely, in some reservoirs without filtration and with very good raw water quality (e.g. Quabbin Reservoir in Massachusetts), the rule might place added emphasis on source protection in order to avoid the filtration requirement (see Long and Stukenberg, 1988).

PUBLIC OPINION

Some water authority officials have argued that recreational use of water supply reservoirs is inappropriate because it is undesirable to utility customers. This argument has been advanced in particular to justify restrictions on water contact activities (i.e. "The public doesn't want people swimming in their drinking water").

Few studies, however, have gauged public opinion concerning the recreational use of water supply reservoirs. Baumann (1969) found that over 80 % of people surveyed in Texas, Kansas, and Illinois favored allowing all types of recreational activities on water supply reservoirs. Public opinion was much more conservative in Massachusetts, however, where only about 12 % of respondents favored recreation. Baumann suggested that public opinion in Massachusetts was a reflection of the conservative approach favored by local water managers and public health officials.

In a more recent study Bumgardner et al. (1980) found that most Massachusetts residents favor at least moderate use of water supply reservoirs for recreational purposes. The majority of respondents favored allowing a wide variety of activities (Table 3). Use of ORV's (snowmobiles and motorcycles), hunting, and some water contact activities (swimming, motor boating, and water skiing) were the only activities not favored by a majority of respondents. Visitors to Massachusetts Quabbin Reservoir were more supportive of recreation on reservoirs than the general population. Among respondents objecting to recreational use of water supply reservoirs, water quality was usually the key concern.

Table 3: Public attitudes towards recreational use of water supply reservoirs in Massachusetts(adapted from Bumgardner et al., 1980).

Activity	Percentage of Respondents Favoring Activity on Water Supply Reservoirs	
	State-wide	Quabbin Reservoir Visitors
Photography	95.1	98.5
Nature Study	94.7	98.1
Sight-seeing	92.7	95.2
Hiking	90.5	95.3
Bicycling	88.4	89.1
Cross-Country Skiing	84.2	78.3
Horseback Riding	70.6	66.4
Fishing From Shore	69.1	-
Fishing From Boats	50.8	74.5
Ice Fishing	68.1	74.6
Sailing	60.1	69.7
Camping	60.0	61.3
Canoeing	59.5	76.9
Snowmobiling	47.6	33.1
Hunting	36.7	26.9
Swimming	30.1	48.8
Motorboating	16.0	28.5
Water Skiing	12.7	20.6

Napier et al. (1986) found that long term residents in the vicinity of a heavily used multipurpose reservoir in Ohio generally had a favorable opinion of recreational use of the reservoir. Among various uses (flood control, water supply, and fish and wildlife habitat) however, recreation was least favored. Local residents expressed concerns over litter, trespassing, crime, noise, increased demands on public services, and other problems associated with recreational use of the reservoir.

RECREATION PLANNING AND MANAGEMENT AT WATER SUPPLY RESERVOIRS

In instances where recreation is allowed at water supply reservoirs a detailed management program should be in place to protect water quality, optimize recreational opportunities, and insure public safety. This section provides general information to aid in the development of such a program. More detailed information concerning some aspects of recreational planning at water supply reservoirs can be found in CEQ (1975) and Alford and Binkley (1977). Information concerning recreation management at U.S. Army Corps of Engineers reservoirs is presented in a latter section.

PROVISION AND MAINTENANCE OF RECREATIONAL FACILITIES

Facilities required to support recreational activities at water supply reservoirs include parking lots, boat docks, boat ramps, moorings, campsites, picnic areas, and hiking trails. The selection of the optimal location for these facilities is a key facet of recreational planning. Careful site selection can minimize safety hazards, conflicts between various recreational activities, and environmental impacts. General guidelines concerning the design and proper placement of campsites, swimming beaches, boat ramps, and other support facilities are provided by CEQ (1975), Hendee et al., (1978), U.S. Dept. of Interior (1980), Fogg (1981), Green et al. (1981), Douglas (1982), and Marion and Merriam (1985).

Swimming areas should be located at sites with a gently sloped, sandy or gravelly substrate. Because of safety concerns, obstacles such as large rocks and logs should be absent from the area or removed. Areas with submerged weed beds should be avoided. Where possible, swimming areas should be situated in well flushed locations to minimize the potential buildup of high bacterial counts. No swimming should be allowed in the vicinity of water supply intakes.

Marinas and boat ramps should be placed in areas where flushing will minimize the potential buildup of contaminants. Where possible, sites with submerged weed beds, soft bottoms, or sensitive shorelines should be avoided.

Soil characteristics and topography are key to the selection of suitable locations for campsites, picnic areas, hiking trails and other shore-based facilities. In general, sites with steep slopes and shallow soils with low organic content should be avoided. Potential for shoreline erosion can be minimized by selecting sites with bedrock outcrops or cobble at the shoreline, and by avoiding steeply sloped banks.

VISITOR MANAGEMENT

Recreation planning at water supply reservoirs should include the preparation of a detailed visitor management plan. At a minimum the plan should establish reservoir rules and

regulations, provide for visitor education, and outline enforcement procedures. In some instances measures to control visitor numbers may also be included. A well prepared and implemented plan can reduce potential recreational impacts on water quality and other natural resources, reduce maintenance costs, enhance user safety, and alleviate potential conflicts between recreational activities.

An important aspect of a visitor management plan is public education. Pamphlets should be prepared to acquaint the public with reservoirs rules and regulations (e.g. WSSC, 1989). Efforts to explain the rationale and benefits associated with use restrictions are likely to increase public acceptance and compliance. Restricted areas should be clearly demarcated with signs and/or buoys. Adequate resources must be allocated to enforcement.

Zoning can be instituted to reduce conflicts between various activities, improve public safety, and protect environmental resources. Jaakson (1971) provided a thorough discussion of the concept and defined three primary "activity zones" in lakes. These are a shoreline, an open water, and a wildlife zone.

The shoreline zone extends about 200-300 feet from shore (or to the five foot depth contour). Boating is limited in this zone to avoid conflicts with activities such as swimming, and to minimize adverse environmental impacts.

The open water activity zone consists of the remainder of a lake beyond the shoreline zone. In large lakes with complex morphology, this zone could be further subdivided to reduce conflicts between various sorts of open water activities (i.e. water skiing, power boating, sail boating).

The wildlife activity zone is designed to protect a portion of the lake ecosystem from adverse recreational impacts. This zone would include a portion of the littoral zone and adjacent shoreline habitat. Jaakson proposed limiting recreational activities in this zone to sedentary or slow moving pursuits such as canoeing, fishing, and nature observation.

In some instances it is desirable to limit the number of people using a recreational facility. User density can be controlled by various sorts of rationing techniques. These include systems which limit entry based on reservations, lotteries (chance), queuing (first-come, first-serve), and user fees. Rationing can be employed to limit reservoir use on either a daily or seasonal basis. Hendee et al. (1978) provide a discussion of the relative merits and problems associated with various rationing techniques in wilderness situations. Much of their discussion, however, is applicable to other recreational settings.

ECONOMIC ISSUES

Planning for recreation at water supply reservoirs should include a detailed analysis of the economic costs and benefits of the proposed facilities.

Useful guidelines for estimating recreational benefits are provided by Woods and Banerji (1981), the U.S. Army Corps of Engineers (1983), and Behan et al. (1985). Benefits are typically calculated as a function of the number of potential user visits (demand) and anticipated expenditures per visit. Benefits accrue directly to the reservoir facility via user fees and indirectly via increased tax revenues resulting in increased economic activity in the surrounding community.

Cost estimates for the provision and maintenance of recreational facilities can be obtained from the literature (e.g. CEQ, 1975; Alford and Binkley, 1977) and from operational records at other multipurpose water supply reservoirs. Expenditures for facilities, staff salaries, and operation and maintenance expenses must be considered. Potential increased water treatment costs resulting from recreational impacts on water quality must also be considered, but in most instances are not likely to be significant.

Economic models incorporating cost/benefit information can be used to determine if recreation activities are economically justified and to select the mix of activities that would generate the greatest net economic benefits. A study conducted by Klar et al. (1983) for Massachusetts Quabbin Reservoir provides a useful model for evaluating recreation options at water supply reservoirs.

RECREATIONAL CARRYING CAPACITY

Management plans should consider the potential recreational carrying capacity (RCC) of water supply reservoirs. RCC is defined as the level of recreational use an area can sustain before an unacceptable decline in the quality of the recreational experience or natural resources occurs (Pigram, 1983).

RCC has several components, including "physical", "ecological", and "social" carrying capacity. Physical carrying capacity is concerned with the maximum number of people (or boats, activities) that can be accommodated by a recreational resource. The concept is generally regarded to encompass absolute space requirements (i.e. the minimum space required for swimmers on a beach), safety related concerns (i.e. the number of boats that can safely operate on a lake), and the availability of support facilities (e.g. parking lots, boat ramps, restrooms).

Social carrying capacity is concerned with the impact of user density on the "quality" of the recreational experience and is likely to be the key limiting factor in most recreational settings.

It has been defined as:

> "... the maximum level of recreational use in terms of numbers of activities, above which there is a decline in the quality of the recreational experience from the point of view of the recreation participant." (Pigram, 1983)

Social carrying capacity is evaluated in terms of user satisfaction, "perceived crowding", or norms which define the appropriate number of encounters in a particular recreational setting (see Shelby and Heberlein, 1986).

Ecological carrying capacity is concerned with the impact of recreational activities on natural resources. The concept involves issues related to both the sustainable use of recreational resources and human perceptions of resource quality. Contemporary definitions include:

> "The level of use of a recreation resource beyond which irreversible deterioration takes place or degradation of the physical environment makes the resource no longer suitable or attractive for that recreational use." (U.S. Army Corps of Engineers, 1980)

> "... the maximum level of recreational use in terms of numbers and activities that can be accommodated by an area or an ecosystem before an unacceptable or irreversible decline in ecosystem values occurs." (Pigram, 1983)

Ecological carrying capacity is exceeded when a recreational resource is stressed to the extent that preexisting environmental conditions cannot be maintained by natural processes, or when the resource is no longer perceived to be acceptable by users.

The recreational carrying capacity concept and methods for assessing RCC have been described in detail by Shelby and Heberlein (1986) and U.S. Army Corps of Engineers (1980, 1989).

CASE STUDIES

Triadelphia and T.H. Duckett Reservoirs
Patuxent River Watershed
Maryland

The Triadelphia Reservoir is a collection reservoir located on the Patuxent River. The reservoir has a water surface area of about 800 acres, a 50,000 acre watershed, and a storage capacity of 7 billion gallons. The T.H. Duckett Reservoir is a terminal reservoir located on the Patuxent, about 13 miles downstream of the Triadelphia Reservoir. The reservoir has a surface area of 810 acres, a 84,500 square mile watershed, and a storage capacity of 6.4 billion acres. Water withdrawn from the T.H. Duckett reservoir under goes full treatment, including coagulation, filtration, and chlorination. WSSD owns 1,930 acres of perimeter property around the Triadelphia Reservoir and 2,193 acres around the T.H. Duckett Reservoir. Both reservoirs are managed by the Maryland Washington Suburban Sanitary District (WSSD).

Although the reservoirs were built as single purpose water supply reservoir, limited recreational activities are allowed. These include:

- Fishing from designated portions of the shoreline and from boats

- Boating (canoes, kayaks, inflatable craft, sailboats, and other craft). No gasoline engines are permitted, and minimum sizes are established to minimize accidental body contact with reservoir waters. There are seven boat launch areas and 550 seasonal moorings

- Picnicking are seven designated areas

- Horseback riding along 13 miles of trails at the T.H. Duckett Reservoir

- Shotgun hunting and Bow Hunting at selected areas of the Triadelphia reservoir

- A 5 acre Azalea garden at the Triadelphia reservoir

- Team sports at five ball fields

Swimming is not permitted at either reservoir. No hiking trails or camping facilities are provided.

Recreational use amounted to 500,000 visitor days in 1986. All activities require a watershed use permit. Day use fees are $2.50 per day or 25.00 for a seasonal pass. User fees offset about 75 % of the recreational management costs.

Public pressures are being exerted to liberalize recreation use policies to allow swimming and hiking.

No water quality problems have been noted. Some erosion problems and loss of vegetation has occurred at shoreline fishing areas. Vandalism, littering, and fires were also of concern.

The WSSD has produced an excellent series of information pamphlets and leaflets for public education, as well as a detailed handbook on watershed regulations .

Rend Lake
Illinois

Rend Lake is a 18,900 acre multipurpose terminal reservoir managed by the Corps of Engineers for water supply, flood control, and recreation. Water withdrawn from the reservoir undergoes full treatment and supplies about 300,000 people in southern Illinois.

A full range of recreational activities are allowed on the reservoir and reservoir watershed (including swimming, boating with gas motors, fishing, water-skiing, hiking, hunting, camping, picnicking, horseback riding). No ORV's are permitted.

Facilities provided include hiking trails, boat ramps (23) picnic areas, a marina, two beaches, 5 major campgrounds, a golf course, tennis courts, sports fields, a visitor center, and handicapped access recreation areas. A portion of the reservoir is managed as a wildlife refuge. Special services include a handicapped hunter deer hunting program.

Approximately 2.1 to 2.2 million persons visit the facility each year. Recreation related operation expenses are about 1.5 million dollars per year. User fees (shelter reservations fees) offset the recreational costs to only a minor extent. The facility employes 14 persons during the off season and 30 during the peak recreation season (plus contract workers).

Vandalism and substance abuse are the most serious management problems at the facility.

Quabbin Reservoir
Massachusetts

The Quabbin Reservoir of central Massachusetts is the principal water supply source for 2.5 million people in the Boston metropolitan area. The reservoir was built as a sole purpose collection reservoir in the 1930's. Water from Quabbin is piped into a terminal reservoir (the Wachusett Reservoir) and disinfected prior to distribution. From the onset, source protection was allocated a primary role in preserving drinking water quality.

The Quabbin watershed consists of 25,000 acres of surface waters, 56,000 acres of lands controlled by a regional water authority (the Metropolitan District Commission), and 36,000 acres of land owned by the public or other governmental units. MDC holdings include Quabbin Park (a 3,100 acre park adjacent to the southern end of the reservoir) and the 45,000 acre "Quabbin Reservation".

Limited recreational opportunities are provided at both Quabbin Park and Quabbin Reservation (MDC, 1988), and overall about 40,000 acres of MDC lands are open to the public.

Activities allowed at the Park include hiking and nature study, sight-seeing, picnicking at several areas, bicycling on paved roads, and fishing along a river flowing into the reservoir Restrooms and an visitor center with interpretive displays have been provided. Approximately 600,000 persons visits are made to the park each year.

Boat and shore fishing is allowed on the Reservation. Boat access is provided from three boat launch areas. Shoreline fishing is allowed in designated areas covering about one-half the shoreline. Outboard motors (20 hp limit) and rowboats are allowed, but canoes and sailboats are prohibited. Boat landings are only allowed at the boat launch areas. Fees are charged for parking and boat rentals. Approximately 60,000 person visits per year occur at the boat fishing access sites, and an unknown number of people use shore fishing areas. Hiking is allowed on unrestricted areas of the reservation and bicycling is allowed on paved roads. Hunting, camping, cross country skiing, and horseback riding are prohibited. Recreational use is restricted in a portion of the reservation protected as a nature preserve.

A recent management plan for the Quabbin Reservoir documented various problems associated with recreational use. These included:

- sanitary problems (although the Reservation and Park receive about 700,000 visitors annually, restrooms are located at only five sites)

- litter along the reservoir shoreline and roadsides

- forest fires (3 fires in 1986-1987)

- unauthorized boat beaching

- illegal camping and swimming

- removal of archeological artifacts

- deer poaching

Operation of the public access program at the reservoir costs approximately one million dollars per year. This includes $ 250,000 to manage the fishing program and $70,000 to maintain the Visitor Center at Quabbin Park. Fees from the fishing program generate approximately $ 160,000 in revenues per year. Management of the recreational program requires 12 people during the off season, and about 25 persons during the summer (including maintenance workers).

RECREATION POLICIES AND MANAGEMENT AT CORPS RESERVOIRS

This section provides information concerning current recreational access policies and management practices at U.S. Army Corps of Engineers multipurpose water supply reservoirs. Results of a survey of policies at 24 Corps reservoirs located throughout the country are discussed. A list of Corps reservoirs surveyed are presented in Table 4. The questionnaire used is presented at the end of the report.

Table 4: List of Corps Reservoirs Surveyed in this study

Reservoir	State	Reservoir Size (acre feet)	Visitors/Year (1000's)
Lake Okeechobee	FL	*	11000
Saka Kawea Lake	ND	368,000	
Lake Sonoma	CA	381,000	2200
Lavon Lake	TX	275,600	2500
Lake Mendocino	CA	122,500	1500
Lake Traverse	MN	106,000	358
Dierks Lake	AK	96,800	350
Degray Lake	AK	31,800	
Rend Lake	IL	18,900	
B. Everett Jordan	NC	13,500	1750
Mosquito Creek Lake	OH	11,800	10000
Falls Lake	NC	11,500	2300
Littleville Lake	MA	9,400	100
Green River Lake	KT	8,000	600
Clinton Lake	KS	7,000	1000
Melvern Lake	KS	6,930	
Hillsdale Lake	MI	4,580	
Lost Creek Lake	OR	3,430	500
W. Kerr Dam and Res.	NC	1,500	1500
Deleware Lake	OH	1,300	90
Blue Marsh Lake	PA	1,150	1500
Jenings Randolph Lake	WV	952	125
Beltzville Lake	PA	940	800
Paint Creek Lake	OH	435	900

GENERAL RULES AND REGULATIONS

Rules and regulations governing the public use of Corps multipurpose reservoirs (and other civil works projects) are provided in 36 CFR (part 327). The regulations allow boating on reservoirs in accordance with site specific restrictions and applicable Federal, state, and local laws. Swimming is permitted at one's own risk, except in restricted areas. Water skiing, picnicking, hunting, fishing, and trapping are permitted, except in prohibited areas. Camping is permitted only at designated sites.

RECREATIONAL ACTIVITIES AT CORPS WATER SUPPLY RESERVOIRS

A wide range of recreational activities were permitted at virtually all the reservoirs surveyed (Table 5). Body contact activities (swimming and water skiing) were allowed at all but two reservoirs. Swimming and water-skiing were prohibited at one reservoir (Lake Okeechobee, Florida) because of dangers posed by alligators. Body contact activities were banned at Littleville Lake (a secondary reservoir in Massachusetts) in deference to the local water utility.

There were few restrictions on boating at the surveyed Corps reservoirs. Gasoline powered engines were allowed on all reservoirs. A minimum size restriction (12') and 10 hp limit was imposed at Littleville Lake, Massachusetts.

Off road recreational vehicles (ORV's) were prohibited at nearly all reservoirs because of concerns over soil erosion, damage to vegetation, and/or noise. Where permitted, use of ORV's was restricted to designated areas or trails.

Hunting was allowed on most reservoir watersheds, but in many cases was restricted to relatively remote areas because of safety concerns.

Camping was allowed in designated areas only, and was prohibited at reservoirs lacking developed campgrounds.

Table 5: Occurrence of recreational activities at Corps multipurpose water supply reservoirs.

Activity	Frequency (%)
Water Contact	
Swimming	92
Boating	96
Fishing (Boat)	96
Water-Skiing	88
Watershed	
Hiking	100
Bicycling	96
Hunting	96
Fishing (Shore)	96
Picnicking	96
Camping	75
Horseback Riding	71
Team Sports	54
ORV's	13

Approximately 80 percent of reservoir managers indicated that policies regarding recreation on reservoirs had stayed about the same in recent years. The remainder indicated that policies towards recreation had become more liberal.

At most reservoirs (ca. 70 %) there was public pressure to provide increased recreational opportunities. Typically there were demands for increased facilities (i.e. boat ramps, marinas, campgrounds) to relieve overcrowding. Sportsman's groups were lobbying for increased hunting opportunities at several reservoirs.

FACILITIES AND SERVICES PROVIDED

Most of the 24 Corps multipurpose water supply reservoirs surveyed offer a wide range of recreational opportunities. All provide basic facilities required to accommodate public use (i.e. parking lots, restrooms, and drinking water). Virtually all provide picnic areas. Most provide boat ramps, and many have boat docks or marinas. Larger reservoirs typically have multiple access points for boaters. Campgrounds, hiking trials, and swimming beaches are

also provided at most locations. Athletic fields are provided at about one-third of the reservoirs. Other facilities present at some reservoirs include showers, playgrounds, handicapped access areas, golf courses, and tennis courts.

All Corps facilities require basic services such as general maintenance, trash collection, lawn mowing, and security patrols. In some instances services are provided wholly or in part by state authorities. Trash collection and lawn mowing is usually under contract. Security patrols by Corps personnel are frequently augmented under agreements with local or state law enforcement agencies. Although many Corps reservoirs have instituted water safety educational programs, under regulations swimming is at ones own risk, and no lifeguards are provided. In instances where recreational facilities are managed by states, however, lifeguards are typically provided. Most Corps reservoirs offer food service concessions under contract.

Table 6: Facilities and services provided at Corps multipurpose water supply reservoirs

Facility or Service	% Occurrence
Facilities	
Parking Areas	100
Restrooms/Drinking Water	100
Picnic Area	96
Fishing Access (boat ramps)	92
Visitor Center	83
Campground	75
Hiking Trail	75
Dock/Marina	71
Interpretative Exhibit	43
Athletic Field	33
Services	
Trash Collection	100
Security Patrols	100
Food Concessions	83
Lifeguards	21

STAFFING

A variety of individuals are required to operate Corps multipurpose reservoirs. These include reservoir managers, park rangers, security officers, clerical workers, and maintenance workers. At most reservoirs Corps personnel are augmented by contract workers and/or state

and local personnel. Workers responsible for maintaining grounds and trash collection are frequently on contract. Security officers are frequently provided under agreements with state or local police agencies. Food concessions are always under contract and staffed by private sector workers. Life guards, when present, are always provided by state or local governments.

The numbers of persons employed at Corps reservoirs surveyed in this study varied widely. Average "off" and "peak" season reservoir staffs were 8 and 18 persons, respectively. Estimates of additional personnel required solely to manage and maintain recreational facilities ranged from 2 to 45 persons (mean = 10). There was no clear relationship between staff levels and reservoir size. Although most reservoirs with less than 500 thousand visitors per year had relatively small staffs, overall staff levels were poorly correlated with visitor numbers. Staff levels appear to be primarily a function of the extent that services are provided by contract workers, or by other agencies.

MANAGEMENT PROBLEMS

Problems resulting from the recreational use of Corps reservoirs are summarized in Table 7. Littering, vandalism, and substance abuse were of principal concern. Other frequently occurring problems were overcrowding and public safety. Minor erosion problems caused by recreation were perceived at about 40 % of the reservoirs. Minor water quality problems attributable to recreation occurred at three reservoirs. Accidental fires were of concern mostly at midwestern and western reservoirs.

Table 7: Management problems perceived by Corps reservoir managers.

Problem	Perceived Severity of Problem		
	Minor	Moderate	Severe
	(number of respondents)		
Littering	12	7	1
Vandalism	11	7	1
Drug/Alcohol Abuse	4	9	2
Congestion 3	6	1	
Water or Public Safety	7	3	
Erosion/Sedimentation	9		
Fire	7		
Water Quality	3		

Measures have been taken at many reservoirs to minimize or alleviate problems caused by recreation. These include:

- Education programs to reduce water safety concerns
- Relocation of trails to reduce erosion problems
- Alcohol bans
- Public education programs to reduce littering.
- Active security patrols to reduce vandalism and littering.
- Construction of additional facilities (e.g. boat ramps, parking lots) to reduce overcrowding.

MANAGEMENT COSTS AND USER FEES

Cost estimates for managing and maintaining recreational facilities were available from 15 Corps reservoirs. Costs ranged from $14,000 to $ 1.5 million per year, with average and median values of $350,000, and $200,000, respectively. Costs per visitor per year ranged from about $0.01 to $0.70, with average and median values of about $ 0.24. Costs per visitor were poorly correlated with the total numbers of visitors.

About 80 % of reservoirs charged some sort of user fee to help defray management and maintenance costs. User fees were charged at all campgrounds. Fees were also frequently charged to reserve day-use picnic areas or picnic shelters. Entrance fees were charged at several reservoirs managed jointly with state agencies. Only one reservoir managed solely by the Corps charged a day use entrance fee. Boating and fishing permit fees where charged at a reservoir managed jointly with state park authorities. At ten reservoirs where user fees were charged fees defrayed from 10 % to 50 % of costs (mean = 22 %).

Potential sources of contamination include:

- improper discharge of human waste in reservoirs from shore or boats
- direct release of waste into reservoir waters by swimmers
- release from bottom sediments disturbed by boats or swimmers
- seepage via waste water effluent from sanitary facilities
- surface runoff from upland locations contaminated by wastes

A number of studies have attempted to evaluate the effect of recreation on reservoir (or lake) microbial water quality. Three principal types of investigations have been conducted (Peavy and Matney, 1977):

- studies comparing water quality in closed vs open reservoirs
- studies comparing water quality between areas within reservoirs with different levels of use (i.e. swimming and non-swimming areas)
- studies comparing water quality during periods of high vs low recreational use

Most studies have monitored total or fecal coliform levels as indicators of fecal contamination. Few studies have have utilized less ambiguous indicators such as fecal streptococci, or attempted to quantify the actual occurrence of pathogenic organisms.

Virtually all studies have found that recreational activities have no significant effect on the overall microbial water quality of lakes or reservoirs (see Rhode Island State Planning Program, 1974; Peavy and Matney, 1977; Binkley, 1979; Johnson, 1975; Carswell, et al. 1969). Recreational use however, can result in localized, near-shore degradation of water quality (see below). With adequate spatial separation between water supply intakes and recreational sites, these localized impacts should have no significant effect on the quality of raw waters drawn from reservoirs. Microbial water quality impacts of specific activities are discussed below.

Elevated bacterial levels have frequently been noted in the vicinity of swimming areas (e.g. Wagenet and Lawrence, 1974; Dietrich and Mulamootil, 1974). Elevated levels probably occur because people shed considerable numbers of bacteria while swimming (Hanes et al., 1982) and may resuspend bacterial rich bottom sediments (Seyfried, et al., 1985).

In a study of Thunderbird Lake (Oklahoma) rapid build up and die-offs of fecal coliforms were noted at swimming areas and were closely correlated with user density (see Peavy and Matney, 1977). Levels were generally low, however, even in heavily used areas, and were very

NUTRIENTS AND EUTROPHICATION

From a water supply standpoint nutrient loading of reservoirs is of concern principally because it can enhance algal productivity. Increased algal productivity in water supply reservoirs can be undesirable for a number of reasons (Hayes and Greene, 1984):

- potential clogging of filters by algae and coalition of treatment additives by algal breakdown products

- potential reduction in reservoir oxygen levels and subsequent increases in Fe, Mn, and ammonia levels

- potential increased taste and odor problems caused by certain algae

- potential increased concentrations of carcinogenic trihalomethanes resulting from the chlorination of algal breakdown products

Recreational activities can result in increased nutrient loading of lakes and reservoirs via a number of pathways. These include:

- the direct discharge of wastes (i.e. human excrement and urine, soaps, phosphorous rich oils, garbage) into reservoir waters

- groundwater seepage of effluent from sanitary facilities

- release of nutrients from bottom sediments disturbed by boating and other activities.

- runoff of nutrient rich sediments from sites disturbed by human activities.

No studies have determined nutrient loading rates into reservoirs resulting from sanitary waste discharges from boaters or other recreationists. Potential loading rates, which assume that all nutrients from waste discharges eventually enter reservoir waters, are on the order of 2-3 grams total phosphorus and 8-9 grams total nitrogen per user per day (Bniska, 1985; Klar et al., 1983). Actual loading rates are likely to be somewhat less, and would depend on the efficiency of waste collection and treatment systems.

Nutrients can leach from near-shore sanitary facilities into lake or reservoir waters. Total phosphorus levels in remote Minnesota recreational lakes were significantly higher near primitive campsites than at adjacent control locations (King and Mace, 1974). Effluent from shallow pit toilets, detergents, and outboard motor fuel were considered likely sources of phosphorus. Other studies have clearly documented nutrient loading via effluent from lakeshore septic systems (see Chen, 1988). Along lakeshores, groundwater transport of nutrients from septic systems is most likely to occur at sites with large cracks in soils, heavy rainfall, step slopes, and/or an impermeable soil layer.

Turbulence from outboard motors can resuspended bottom sediments and may impact internal nutrient cycling within lakes and reservoirs. Field studies by Yousef et al. (1980) found that mixing by motorboats in two shallow, muddy bottomed, Florida lakes caused short term increases in phosphorus levels in lake waters. Short term increases in chlorophyll a concentration (a measure of algal productivity) also occurred, but could be attributable to resuspension of benthic algae. In general, phosphorus released from suspended sediments by boating is probably either taken up by algae or bacteria or (under aerobic conditions) precipitates out of the water with ferric hydroxide.

Exhausts from outboard motors contain nitrogen and phosphorous but are unlikely to be a significant nutrient source in lake and reservoir ecosystems (Hallock and Falter, 1987).

Recreational activities on reservoir watersheds can disturb vegetation and soils, and lead to increased erosion of nutrient rich sediments. Potential impacts are probably greatest in small, heavily used reservoirs with watersheds with thin soils, and steep slopes. Dickman and Dorais (1977) found strong evidence that erosion of phosphorus (apatite) rich soils caused by human trampling resulted in the eutrophication of a small (11.6 ha) Canadian lake.

Various models (see Reckhow, 1979; Reckhow and Simpson, 1980; Barstad and Karasov, 1987) have been developed to predict the sensitivity of lakes and reservoirs to eutrophication. Although the use of these models is constrained by the lack of accurate information concerning nutrient loading rates associated with recreational activities, they may still be of some value in predicting recreational impacts. Klar et al. (1983), for example, used simple models developed by Vollenweider to evaluate the sensitivity of the Quabbin Reservoir in Massachusetts to increased nutrient loading from recreation or other activities. This technique, and algal bioassay studies, suggested that the reservoir may be sensitive to increased nutrient loading.

In summary, recreational activities have the potential to add nutrients to lake ecosystems in a number of ways. Although information concerning actual loading rates attributable to recreation is generally lacking, it seems likely that nutrient leaching from near-shore sanitary facilities, runoff of nutrient rich sediments from disturbed areas, and nutrient release from resuspended bottom sediments are of principal concern. The sensitivity of reservoirs to nutrient loading should be evaluated on a case by case basis to determine the permissible levels

of recreational activities. Factors such as watershed characteristics, reservoir morphology (depth), reservoir trophic status, reservoir soils should be included in the analysis.

SUSPENDED SEDIMENTS

Various recreational activities have the potential to elevate suspended solids concentrations in lake waters. Bottom sediments can be resuspended by motorboats (e.g. Wright, 1982; Gucinski, 1982) and presumably to some extent even by less intense activities such as swimming. The amount of sediments resuspended by boating will depend primarily on the type of boat and boat velocity, grain size of bottom sediments, and water depth (Garrad and Hey, 1987). The amount of material suspended is likely to be greatest in shallow waters with muddy, unvegetated bottoms. The occurrence of prolonged water quality impacts would depend on the frequency and intensity of boating, and the settling rate of suspended material.

Boat wakes can cause shore erosion, and could conceivably increase the ambient suspended solid concentration in near-shore waters (Liddle and Scorgie, 1980). Shore erosion resulting from boat traffic is most likely to be a problem in waterways with narrow channels, sharp bends, or areas with steep, poorly vegetated banks (Miller et al., 1987).

On-shore activities such as bank fishing, boat launching, hiking, and camping can disturb soils and vegetation (e.g. Marion and Smith, 1975; Dickamn and Dorias, 1987; Murphy and Pearce, 1987), and are likely to result in increased transport of sediments into lakes, streams and reservoirs.

OTHER CONTAMINANTS

Two-stroke outboard motors release a variety of contaminants into lake waters through engine exhausts and, in older (pre 1972) models, through crankcase drainage. Principal contaminants released into waters by exhausts are nonvolatile oils (lubricating oils), volatile oils (gasoline), phenols, and lead. Montz et al. (1982) found that the major water soluble hydrocarbons found in exhausts are monocyclic benzene derivatives.

Older motors without crankcase recycling discharged on average, 10 - 20 % of fuel into lake waters. Typical inputs of gasoline, lubricating oil, and other petrochemicals via spillage by boaters have not been quantified.

Few studies have investigated the affects of contaminants released by boating on lake water quality. Various anecdotal reports have have noted that contaminates discharged from outboard motors can form visible surface slicks. Studies by English et al. (1963) noted increased levels of hydrocarbons in a small pond and lake as cumulative fuel consumption increased over a summer. Longterm experimental studies of boating impacts on small (0.5

acre) ponds with high use levels, however, noted no significant water quality impacts (Boating Industry Associates, 1975). Byrd and Perona (1980) noted a correlation between the number of boats launched and lead concentrations in water from the boat dock area of a large (1420 ha) California lake. Lead concentrations in the main body of the lake, however, was not significantly affected by boating.

In marine waters, Gschwend (see Montz et al., 1982) noted higher concentrations of volatile organic compounds (benzenes) from Vineyard Sound (Massachusetts) immediately after summer weekends in which recreational activity were greatest. Voudrais and Smith (1986) noted elevated concentrations of petrochemicals in bottom sediments from estuarine marinas.

Minor fuel spills are likely to occur but should have no adverse impact on finished water quality. Spills would be rapidly dissipated by dilution and evaporation. Furthermore, gasoline floats, and intakes at nearly all reservoirs are located below the surface (Imhoffer, 1987).

Several recent studies in Great Britain have quantified the amount of angling litter (fishing line, lead sinkers, and hooks) deposited by fisherman (Bell, et al. 1985; Forbes 1986; Cryer et al., 1987; Edwards and Cryer 1987). Estimated loss rates for sinkers range from 2-3 to 4-7 per visit. Dissolution of lead sinkers is likely to be very slow (cf. Cryer et al. 1987) and very unlikely to adversely impact reservoir water quality.

IMPACTS ON FINISHED WATER QUALITY

Modern water treatment systems are very efficient in removing suspended solids and microbial contaminants (CEQ, 1975). In situations where full treatment systems (i.e. coagulation, filtration, disinfection) are available and properly managed it is highly unlikely that recreational activities would have any adverse impact on finished water quality.

In situations where only disinfection is practiced (about 20 percent of surface water supply systems in the U.S., EPA, 1987), the impacts of recreation are more problematic. It is possible that slight increases in suspended solid levels could occur in finished water supplies as a result recreation. In some reservoirs it is conceivable that recreational impacts on raw water quality could trigger the need for filtration under the forthcoming EPA filtration rule. In systems without filtration, recreation could increase the risk of Giardia transmission. If recreation resulted in higher turbidity levels, more stringent disinfection measures might be required in order to insure that viral and bacteria levels in finished water meet acceptable standards.

MANAGEMENT PRACTICES TO MINIMIZE WATER QUALITY IMPACTS

A variety of steps can be taken to minimize the impacts of recreation on reservoir water quality. Of primary importance is the provision of proper sanitary facilities to collect and dispose of human wastes. Provision of these facilities is critical to reducing improper discharges along lakeshores by swimmers, campers, fisherman, and other recreationists. Facilities should be properly designed, situated, and maintained to encourage use, and minimize the drainage of effluent into lakes. Depending on level of use, the sensitivity of a lake to nutrient loading, and economic considerations, facilities can range from simple pit privies to toilets with elaborate septic systems. In instances where reservoirs are sensitive to nutrient loading, the use of pump-out vault toilets is advisable.

Measures must also be in place to minimize waste discharges from boats. If larger craft are permitted, facilities for offloading wastes from on-board holding tanks should be provided. Holding tanks can be sealed to insure against illegal discharges.

In addition to provision of facilities, an active public education and enforcement program can reduce illicit waste discharges

Where possible, swimming areas, marinas, and boat ramps should be situated in well flushed locations to minimize the potential buildup of contaminants.

Restricted use zones should be placed around water supply intakes to minimize potential contamination of the raw water supply.

Resuspension of bottom sediments by boating can be minimized by zoning ordinances which limit boat velocities and/or access in sensitive areas (i.e. shallow, sheltered embayments with soft bottoms). Experimental studies can be used to establish threshold velocities at which which very little resuspension of bottom sediment occurs (Garrad and Hey, 1987).

Locations of campsites, picnic areas, hiking trails, and other shore-based facilities should be selected to minimize potential soil erosion and sedimentation. Activities with a high potential to cause erosion such as ORV use and horseback riding should be banned or only allowed in upland areas where potential water quality impacts are minimal. In general, sites with steep slopes and shallow soils with low organic content should be avoided. Potential for shoreline erosion can be minimized by selecting sites with bedrock outcrops or cobble at the shoreline, and by avoiding steeply sloped banks. The Universal Soil Loss Equation can be used to evaluate the suitability of sites for recreational facilities (Kuss and Morgan, 1986). This

technique predicts the susceptibility of a site to disturbance by integrating information concerning soil characteristics, tree canopy types, canopy densities, ground cover types, topographical factors (i.e. slope and aspect), and rainfall.

Near-shore sites damaged by recreational activities and prone to erosion should be stabilized and revegetated. Low cost innovative bio-engineering techniques can be applied to stabilize slopes (see Allen, 1978; Gray and Leiser, 1982; and Schiechtl, 1980). Information concerning the selection of plant material for use in riparian (near shore) habitats is provided by Hightshoe (1978), EPA (1976), and Whitlow et al. (1979).

The water quality in multipurpose water supply reservoirs should be periodically monitored for bacterial contamination and turbidity. Bacterial counts should be taken at the water supply intake and selected locations with potential contamination problems (i.e. beaches, marinas, shore fishing areas). Beaches should be closed to swimming if unacceptable counts are noted. The 30 day concentration of enterococci in recreational freshwaters should not exceed 33 organisms per 100 ml (U.S. EPA, 1986). Periodic sanitary surveys should be conducted to detect sanitary violations. Persistent problems sites should be dealt with by stepped up enforcement, provision of additional sanitary facilities, or curtailment of recreational access.

FINDINGS

The information contained in this report provides Rhode Island policy makers with a summary of current recreational use policies at water supply reservoirs in the United States. Results indicate that policies vary widely between states, with those in New England, including Rhode Island, among the most restrictive in the country.

The widespread occurrence of recreational activities on many water supply reservoirs without apparent significant adverse water quality impacts suggests that highly restrictive access policies may not be required to insure adequate drinking water quality. At a minimum, in states where highly restrictive policies are in effect, consideration should be given to relaxing regulations against passive forms of recreation such as hiking, picnicking, and shore fishing. Given a favorable institutional climate, adequate water treatment facilities and water quality monitoring, sufficient public demand for recreational opportunities, and good planning, there appears to be no fundamental barrier to the prudent use of many water supply reservoirs for selected recreational activities.

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QUESTIONNAIRES

QUESTIONNAIRE USED IN STATEWIDE SURVEY
(adapted from Johnson, 1987)

1. Are you familiar with issues concerning the recreational use of water supply reservoirs in your area ? ___ yes ___ no

2. Does your state have a policy concerning the recreational use of public drinking water supply reservoirs and/or watersheds

___ yes ___ no ___ don't know

If "yes", is this policy:

___ formal (written).....request copy of policy if written
___ informal (unwritten)

3. In general, is recreation allowed on water supply reservoirs ?

__ yes __ no

Types of recreational activities allowed on reservoirs:

Please estimate how frequently the following activities are allowed on water supply reservoirs in your area:

rarely (R); occasionally (O), usually (U), almost always (A)

___ swimming
___ water-skiing
___ fishing (from shore)
___ fishing (from boat)
___ ice fishing
___ sailing
___ boating (gas motor)
___ boating (electric motor)
___ canoeing/rowing
___ ice skating

4. In general is recreation allowed within water supply reservoir watersheds? __ yes __ no

Please estimate how frequently the following activities are allowed on water supply reservoirs in your area:

rarely (R); occasionally (O), usually (U), almost always (A)

___ hiking
___ bicycling
___ fishing (from shore)
___ hunting
___ horseback riding
___ picnicking
___ camping
___ ORV's
___ X-country skiing

5. Why do you feel that activities are restricted?

(rank in order of importance 1 to 5)

Reservoirs

___ water quality (health)
___ water quality (sediments /nutrients)

Watersheds

___ water quality (health)
___ water quality (sediments /nutrients)

___ historical attitudes
___ management problems
___ management costs

___ historical attitudes
___ management problems
___ management costs

6. Who usually bears the primary costs of allowing recreation to occur on water supply reservoirs or watersheds in your area ?

____ users (user fees)
____ local community
____ utilities
____ others

7. What sorts of regulations govern the use of water supply reservoirs for recreation in your area? (i.e. state health department regs., local laws)

8. What governmental agencies are involved in setting policy and regulating recreation on water supply reservoirs in your area?

Which organization has the primary role ?

9. What sorts of conflicts, if any, exist between these agencies ?

10. Is there public pressure in your area to use water supply reservoirs to a greater extent for recreation? (if yes, what sorts of groups are involved, ie. local governments, local residents, sportsmans groups).

11. In general, how have policies allowing recreation on water supply reservoirs changed in your area in the last 15 years ?

____ more liberal (i.e. more recreation)
____ more conservative (i.e. less recreation)
____ about the same

Why have these changes occurred ?

12. Will the new regulations under the E.P.A. filtration rule affect the way reservoirs are managed for recreation in your area ?
___ yes ___ no

13. Do you know of any studies that were conducted on this subject?

QUESTIONNAIRE USED IN SURVEY OF CORPS RESERVOIRS
(adapted from Johnson, 1987).

1. Approximate size of reservoir (acres):_____

   Approximate volume of water supplied for drinking water:_____

2. Type of reservoir managed: _____ Storage
   _____ Primary
   _____ Secondary
   _____ Distribution or Terminal

3. Treatment provided to reservoir water supplies prior to final distribution (after water leaves the reservoir):

__ Disinfection (type)	__ Filtration (type)	__ Flocculation
__ Chlorination	__ Sand	__ pH regulation
__ Ozonization	__ Activated Carbon	__ Settling
__ Other Disinfection	__ Other Filtration	

4. Is recreation allowed in/on the waterbody? __ yes __ no

   If yes, types of recreational activities allowed:

   __ swimming
   __ fishing (from boat)
   __ boating (gas motor)
   __ boating (electric motor)
   __ canoeing/rowing
   __ sailing
   __ ice fishing
   __ ice skating
   __ waterskiing
   __ other (specify):_____
   _____

5. Is recreation allowed within the reservoir watershed?

   If yes, types of recreational activities allowed:

   __ hiking
   __ bicycling
   __ fishing (from shore)
   __ hunting
   __ picnicking
   __ camping
   __ ORV's
   __ X-country skiing
   __ horseback riding
   __ team sports
   __ other (specify):_____
   _____

6. What recreational activities, if any, are restricted or prohibited?

7. Does your agency have restrictions on the number of recreation participants within reservoir and watershed areas?

___ Yes ___ No

If yes, how are the restrictions enforced?

__ permit system
__ parking or facility limitations (patrons turned away when areas are full)
__ other method (specify): _____

8. Does your agency charge entrance or user fees? (Y or N) __

9. Problems resulting from public access and recreational use and the severity of the problem:

PROBLEM:	SEVERITY OF PROBLEM:		
__ littering	__ severe	__ moderate	__ minor
__ vandalism	__ severe	__ moderate	__ minor
__ erosion/ sedimentation	__ severe	__ moderate	__ minor
__ public safety	__ severe	__ moderate	__ minor
__ traffic congestion	__ severe	__ moderate	__ minor
__ drug/alcohol abuse	__ severe	__ moderate	__ minor
__ water safety	__ severe	__ moderate	__ minor
__ fire danger	__ severe	__ moderate	__ minor
__ degrading of water quality	__ severe	__ moderate	__ minor

10. If the water quality has declined, what are the water quality parameters affected:

PARAMETERS		SEVERITY OF PROBLEM	
__ bacterial counts	__ severe	__ moderate	__ minor
__ turbidity/suspended solids	__ severe	__ moderate	__ minor
__ organic compounds	__ severe	__ moderate	__ minor
(i.e. oil, hydrocarbons)	__ severe	__ moderate	__ minor
__ minerals	__ severe	__ moderate	__ minor
__ sodium levels	__ severe	__ moderate	__ minor
__ other:_____	__ severe	__ moderate	__ minor
_____	__ severe	__ moderate	__ minor
_____	__ severe	__ moderate	__ minor

12. What sort of regulations govern the use of water supply reservoirs for recreation in your area? (i.e. Corps regs, state health dept. regs, local laws)

13. Is there public pressure in your area to use water supply reservoirs to a greater extent for recreation? (if yes, what groups are involved, i.e. local gov'ts, local residents, sportman's groups).

14. Have policies regarding recreation on water supply reservoirs changed in your area in the last 15 years?

___ more liberal
___ more conservative
___ about the same

Why have these changes, if any occurred?

___ new regulations
___ changes in AWWA policies
___ increased public demand for water based recreation
___ management problems (water quality, vandalism, etc.)
___ other

15. Do you know of any studies that were conducted on this subject?

16. What facilities are provided to accomodate recreation?

__ marked/maintained trails
__ fishing accesses(ramps)
__ interpretative exhibits
__ sport fields
__ visitor center
__ picnic areas
__ dock/marina
__ beach area
__ campground
__ other:_____

17. What services are provided to accomodate receation?

__ visitor parking
__ restrooms
__ lifeguards
__ food service
__ trash collection
__ drinking water
__ first aid
__ security patrols

__ other: _____

18. How many persons are on staff?

_____ off-season _____ on-season

19. How many person are required to manage/maintain recreational facilities?

20. How much does it cost per year to manage/maintain recreational facilities?

21. To what extent do user fees offset management/ maintenance costs?

22. Approximate number of visitors per year: _____

POLICY STATEMENTS

AWWA POLICY STATEMENT

Adopted by the AWWA Board of Directors June 13, 1971, and revised January 25, 1987.

The American Water Works Association (AWWA) supports the principle that water of highest quality should be used as the source of supply for public water systems. Because each water utility is responsible for its product, determination of the type and extent of recreational use of impounding reservoirs should be vested in the water utility.

Water utilities of the United States and Canada have consistently and reliably provided high-quality drinking water to many generations of consumers. In order to continue this outstanding record, each water utility must continue to recognize its responsibility to deliver a safe and appealing product to its consumers. A growing demand for use of reservoirs for recreational purposes, however, may make this responsibility more difficult to carry out in the future.

It should be recognized that uncontrolled recreational use of domestic water supply reservoirs may result in degradation of water quality and conflicts with management practices needed to control water quality. Reservoir management practices in the provision of a water supply for domestic use are often not compatible with those for recreational use of reservoirs. For example, uncontrolled recreational use of reservoirs can result in deteriorated water quality that increases the potential for waterborne disease to occur. In addition, the use of chemicals to control nuisance organisms and plants in reservoirs may conflict with recreational activities such as fishing. Considerations such as these should be carefully evaluated prior to allowing recreation on domestic water supply reservoirs.

It should be the vested responsibility of water utilities to determine the use of their reservoirs. The decision concerning recreation should be based on state or provincial and local laws and regulations; on information provided by AWWA, the U.S. Environmental Protection Agency, and other organizations that conduct research and present technical reports; and on an assessment of the public need for the fuller utilization of water resources.

Research on the effects of recreation on water quality should be expanded. Recreational users of water supply reservoirs must receive close supervision. The impact of swimming, boating, and fish enhancement programs requires close monitoring. In all cases, water from reservoirs used for recreation must be treated, with the degree of treatment to be determined according to state or provincial and local utility laws, regulations, and policies. The public must recognize that recreational use of reservoirs may result in added capital and operating costs that may either increase the charges for water or be borne by the recreational user.

Public water supply reservoirs should not be used for recreation if other surface waters are available. Body-contact sports, such as swimming, should not be allowed in reservoirs designed, financed and built solely for public water supply. For the purpose of this policy statement, reservoir means an impoundment reservoir subsequent to which water receives treatment before consumption. Distribution reservoirs from which water is supplied directly to the public require the strictest of controls and under no condition should be used for recreation.

NEWWA POLICY STATEMENT

Proceedings

REPORT OF COMMITTEE ON RECREATIONAL USE OF WATER SUPPLY RESERVOIRS

September 1979

To the New England Water Works Association:

In accordance with your August, 1978 directive for a review of the Association's current policy on recreation, the 45 Committee has reviewed and updated this policy as last published in the March, 1974 Journal of NEWWA.

Although a number of wording changes were suggested by members of the committee, the basic format and intent of the policy remains unchanged, i.e., recreational use of water supply reservoirs is inimical to the basic function of furnishing a sale and palatable water supply to the system customers and should be prohibited.

Based on this review, the 45 Committee recommends adoption to the following revised resolution, policy statements and recommendations concerning recreational use of public water supplies.

I. Resolution Concerning Recreational Use of Water Supplies

WHEREAS:

During the past decade there has been a tremendous increase in the demand for water based outdoor recreation, and

Public water supplies are often cited as prime areas for the development of recreation interests and facilities, and

The proponents of recreational use of water supplies usually based their arguments on the excellent health record and quality of the finished water and not on the raw water which varies with the degree of human activity, and

WHEREAS:

The absence of water-borne disease in a community is not a viable reason for the relaxation of measures which protect a water supply or watershed, and

Public health records indicate that water-borne diseased are no longer on the decline in the United States, and

There have been past experience of gross pollution of supplies where recreational use of water supplies was allowed, and

WHEREAS:

Northeastern water purveyors are not faced with extreme water shortages and thus are not forced, as their western counterparts are, to accept the concept of multiple use of watershed reservoirs, and

Public water supply reservoirs are known to comprise only a small percentage of the total surface water area in the Northeast, and

The State and Federal Governments are spending billions of dollars per year to build sewage treatment facilities to make available many more heretofore polluted surface waters such as rivers, lakes, and streams available for recreation, and

WHEREAS:

Water Treatment facilities and the individuals who operate and maintain these facilities are not infallible, and

The legal and moral responsibility of providing a safe, high quality drinking water rests with the local water supply agency and water supply manager.

NOW, THEREFORE, BE IT RESOLVED:

That the New England Water Works Association opposes legislation or local administrative action which will permit or require the opening of domestic water supply reservoirs and adjacent lands to recreational use.

AND BE IT FURTHER RESOLVED:

That the New England Water Works Association registers its approval of the policy to maintain the control of domestic water supply reservoirs in the hand of the State Health Agency and the local Water Purveyor.

II. Committee Recommendations

1. STATE LAWS AND REGULATIONS REGARDING THE CONTROL OF WATER SUPPLIES.

The Committee recommends that all laws and regulations regarding the control of public water supplies should be specific directives and should avoid discretionary clauses.

2. PROPOSALS FOR RELAXATION OF RESTRICTIONS

The Committee recommends that all proposals for the relaxation of measures which protect a water supply or watershed should be vigorously opposed by the local water supply agency and public health agencies involved. Such proposals should be submitted to the State Health Agency for a review of the sanitary implications, and only when the report of the State Health Agency if favorable should such proposals then be reviewed by the local water supply manager who should have complete and final authority to attach such limitations to the proposal as he/she deems necessary to prevent interference with his/her moral and legal obligation to produce a safe and palatable water supply for public consumption. Only when the local water supply manager or water supply agency is overruled by a higher authority should the matter of recreational use restrictions be decided by a public hearing or referendum.

III. Reservoir Classification and Policies

Reservoirs may be classified as follows:

1. DISTRIBUTION RESERVOIRS - Reservoirs within the area served, delivering finished water (water ready for consumption) to the distribution system.

Policy - Recreational use of "distribution Reservoirs" and adjacent marginal land is inimical to the basic function of furnishing a safe, palatable water supply to the system's customers and safe practice requires prohibition of all activity in and about such reservoirs.

2. SUPPLY RESERVOIRS - Areas providing end storage of water prior to treatment and delivery of finished water to the distribution system.

Policy - In general terms, recreation use of supply reservoirs is inimical to the basic function of furnishing a safe and palatable water supply to the system's customers and should be prohibited to the greatest extent possible.

3. WATERSHED RESERVOIRS - Reservoirs providing storage of water at various points on the watershed to provide or supplement the main water supply.

Policy - Recreational use of watershed reservoirs should be subject to the control of the State Health Agency and to such other limitations as the local water supply manager considers necessary for preventing interference with his moral and legal obligation to produce a safe and palatable water supply.

Respectfully submitted,

David Kittredge, P.E., Chairman
Richard A. Currier
Francis D. Faucher
Robert P. Grady
Peter C. Karalekas, Jr.
Stephen W. Leavenworth
John G. Lizzi
William H. Mahoney