Center for Science & International Affairs

MANAGING THE GREENWEALTH
THE FORESTS OF QUABBIN

Charles H.W. Foster
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October 1994

Environment and Natural Resources Program

JOHN F. KENNEDY SCHOOL OF GOVERNMENT

Harvard University

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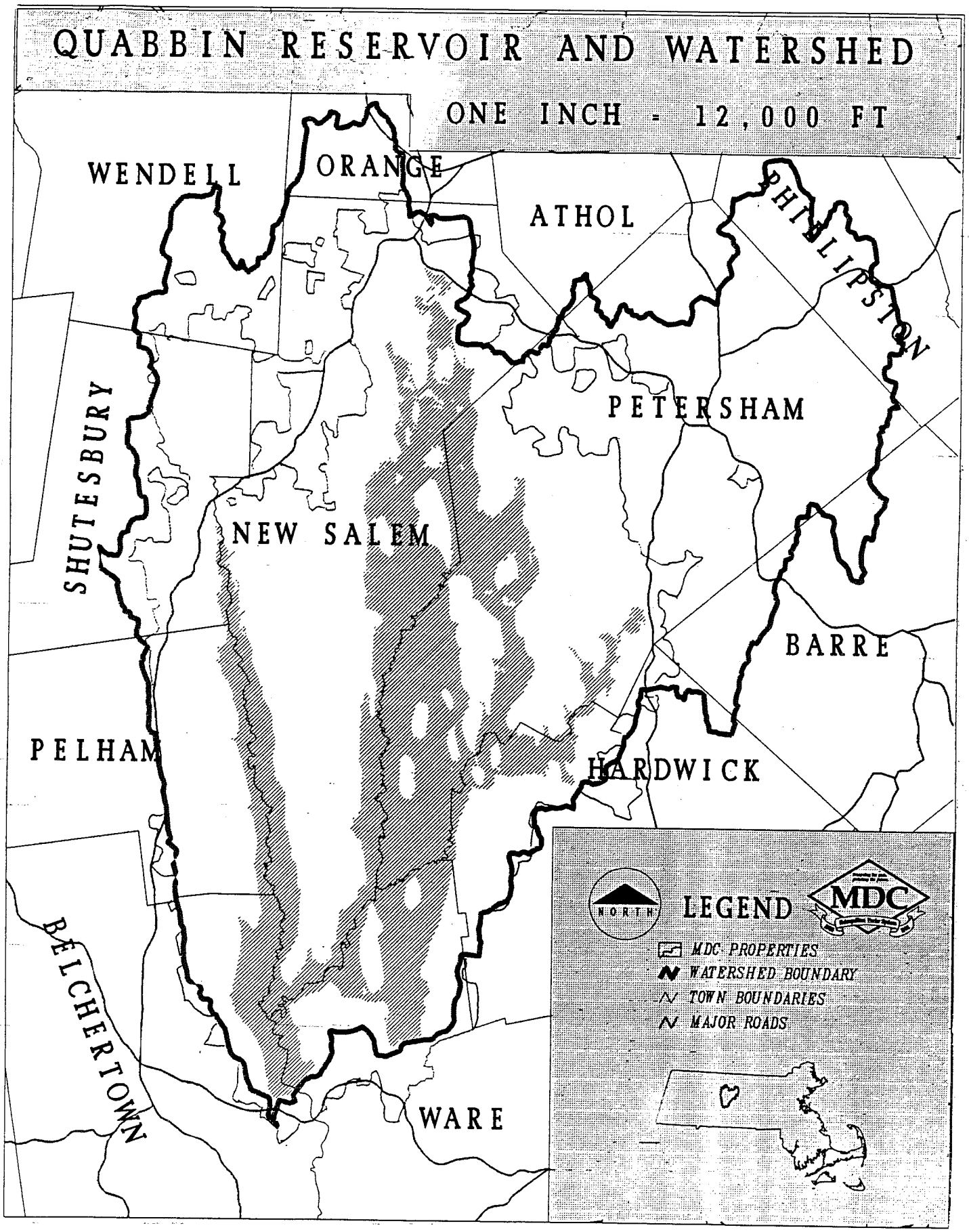
QUABBIN RESERVOIR AND WATERSHED
ONE INCH - 12,000 FT
WENDELL
ORANGE
ATHOL
PHILLIPSTON
SHUTESBURY
PETERSHAM
NEW SALEM
BARRE
PELHAM
HARDWICK
BELCHERTOWN
WARE
NORTH
LEGEND
MDC
MDC PROPERTIES
WATERSHED BOUNDARY
TOWN BOUNDARIES
MAJOR ROADS

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Map courtesy of Metropolitan District Commission

PREFACE

During the fall of 1993, students from Harvard University and neighboring institutions undertook a review of selected land management policies and practices at Quabbin, Boston's main water supply reservoir located in central Massachusetts. The inquiry was conducted through *Topics in Environmental Policy* (ENR 522), a graduate level course at the John F. Kennedy School of Government offered jointly by *Dr. Charles H.W. Foster*, an environment and natural resources faculty member and former Massachusetts secretary of environmental affairs, and *Dr. David R. Foster*, director of the Harvard Forest in Petersham (MA) and a member of the Harvard faculty in biology.

Enrolled in the course were twenty-two students (see Appendix A), many of them at the mid-career level. A remarkable range of interests, experiences, disciplines, and geographic diversity was represented. Since none had prior exposure to Quabbin, the policy analysis could be conducted with entirely fresh eyes.

The course consisted of an introductory module on environmental forestry, a weekend field trip to Quabbin, a series of visits from guest experts (Appendix B), special sessions and exercises designed to advance consensus, and student papers examining specific aspects of policy and practice (see Appendix C). The analysis to follow attempts to capture the best of the ideas and observations and to provide the managing agency with practical suggestions for improving its operations at Quabbin.

None of the above would have been possible without the full encouragement and cooperation of the Division of Watershed Management of the Metropolitan District Commission (MDC), the managers of Quabbin. Advance copies of a draft land management plan were made available to us. MDC field personel provided a personalized tour of the area. We were visited by virtually every agency principal, from the superintendent of the Quabbin Section to the commissioner of the entire MDC, who described with both substance and candor the issues at hand. Time was spent freely with students as they prepared their individual reports.

The coordinator of the project, *Robert W. O'Connor*, the MDC's director of natural resources, is deserving of special commendation. Any criticisms contained in the report, either expressed or implied, must be tempered by our admiration - even astonishment - at the willingness of the MDC's professional personnel to entertain and tolerate such a searching examination of their roles and responsibilities. To Bob O'Connor and the others, we extend our most heartfelt thanks for a remarkable educational experience.

Charles H.W. Foster
Cambridge, Massachusetts

David R. Foster
Petersham, Massachusetts

INTRODUCTION

Quabbin Reservoir, world-renowned as a pure source of drinking water for the Boston metropolitan area's 2.4 million residents, occupies nearly 25,000 acres of the former Swift River valley in central Massachusetts. Once the domain of Chief Nama-Qabin of the Nipmuck Indians, then for a century and a half the site of four settled Massachusetts towns, the 120,000 acre Quabbin watershed has since reverted to largely wildland status. Where stream valleys once existed, the reservoir now tongues its way into the upland. Farms have been abandoned; entire cemeteries moved; and buildings and structures taken down. Only foundations are left to mark the homes of the five hundred families who occupied the land at the peak of settlement. But with the passage of time and under careful protection, the forest has resurged to become what one foreign visitor termed a veritable "greenwealth."

The creation of Quabbin represented a remarkable feat of physical engineering during the 1930s, but also an unprecedented experiment in social engineering. Western Massachusetts residents were required to give up their communities to ensure a secure water supply for eastern Massachusetts. Despite the passage of time, the memories of what once was still intrude upon the prospect of what can be.

But rather than a self-contained island of land and water resources, Quabbin is part of an interconnected water supply system providing consumers with over 100 billion gallons of drinking water annually. Not one but three main surface water sources make up this sixty mile chain of custody: the 120,000 Quabbin Reservoir watershed, the 62,000 acre Ware River watershed, and the 75,000 acre Wachusett Reservoir watershed. Interconnected by 25 miles of pipeline, the upland sources converge on the fifty year old Hultman Aqueduct in Clinton for the eventual journey to the metropolitan service area. Untreated except for disinfection, fluoridation, and corrosion control chemicals, Boston's supply is one of only three major metropolitan water sources in the country that remain unfiltered.

The 1986 amendments to the Safe Drinking Water Act (SDWA) threaten this distinction. Under the Environmental Protection Agency (EPA) surface water treatment rule, promulgated in 1989, sources must now meet eight specific drinking water standards in order to be eligible for a waiver of the filtration requirement. The Metropolitan Water Resources Authority (MWRA), whose 2.4 million ratepayers fully fund the MDC's watershed operations, faces a dilemma here, because its western sources (Quabbin and Ware River) meet the standards comfortably, but its Wachusett watershed does not.

Consequently, a dual track scenario was negotiated in June of 1993 with the Massachusetts Department of Environmental Protection (DEP), EPA's surrogate for the SDWA provisions. A waiver was granted for the three Connecticut valley communities (Wilbraham, Chicopee, and the South Hadley Fire District) served directly by Quabbin. The remainder of the system was granted a deferral until June of 1998 pending efforts to control contamination at the source. Passage of the Massachusetts Watershed Protection Act of 1992, with its authorizations for the acquisition of critical land parcels and the establishment of protective buffer zones, had much to do with this decision. If watershed protection does not work, the alternative will be a filtration plant built below Wachusett Reservoir at an estimated cost of $447-538 million to be functional by the year 2001.

The specter of a mandated filtration of the Boston water supply system raises two important policy questions. The first is the continued acceptability of even the modest activities that now occur on watershed lands. More stringent user controls, some argue, might provide the grounds for a waiver of the expensive filtration requirement. The second question accepts the inevitability of a filtered supply. Given a higher level of treatment, could additional uses be entertained and, if so, would these then lead to heightened threats from development and more intensive recreational activities? In Quabbin's case, the question seems moot as long as the reservoir continues to serve as the direct source of supply for three area communities. With Chicopee signing a new ten year agreement to stay on the Quabbin system, local use of the Quabbin, at least in the short term, is assured.

Overshadowed by the more than 400 billion gallons stored in Quabbin, the

equivalent of some 300 million gallons a day in safe yield, is a reservoir of another sort, the 65,000 acres of watershed land owned or controlled by Commonwealth agencies. These contain major storehouses of materials, uses, and values, both present and prospective. The management of these watershed resources presents the MDC with a dilemma. Although the lands have long been viewed as simply adjuncts to the production and protection of water, their future has begun to assume a life of its own.

For purposes of this report, we will refer to the lands located within the perimeter of Routes 9, 202, 122, 32, and 32A (the area formally designated by Chapter 737, Acts of 1972) as the *Quabbin Reservation*. The MDC holdings external to these boundaries are termed *North Quabbin*. The public use area adjacent to Winsor Dam and largely below the watershed is called *Quabbin Park*.

As the pages to follow will detail, little policy guidance has been provided to Quabbin's land managers in the past. The statutes and federal regulations understandably concentrate on the agency's water supply functions and responsibilities. Chapter 737, Acts of 1972, the closest equivalent to a land management organic act, is contradictory in places and quite dated. Chapter 372, Acts of 1984, directs the division of watershed management to periodically prepare watershed management plans. The advisory apparatus authorized by that statute, the *Quabbin Watershed Advisory Committee*, seems limited in its contributions and incomplete in its outreach.

However, under these general authorities, or simply at its own volition, the MDC has generated or encouraged a profusion of special reports and plans. Among those reviewed have been the forest and wildlife plan for the Quabbin watershed (Spencer and Lyons, 1986), the recreation and public access policy and plan for the Quabbin and Ware River watersheds (MDC, 1988), the natural resource management review panel summary (MDC, 1989), the Quabbin forest regeneration study (Kyker-Snowman, 1989), the interpretation and visitor services plan for Quabbin Reservoir (Krantz, 1989), the Quabbin Reservation white-tailed deer impact management plan (MDC, 1991), the watershed protection plan for the MDC/MWRA water supply sources (MWRA/MDC, 1992), the interdisciplinary ecological review of the Quabbin ecosystem (Mather, 1992),

and the draft Quabbin watershed land management plan (MDC, 1993).

Confronted with the task of reviewing this daunting set of policy materials, the Harvard group elected an unusual approach. From these reports and the advice of some twenty visiting experts, 171 specific policy questions were identified. Then, utilizing a Delphi self-survey process, the group settled on several issues where concensus on priorities appeared most evident. These are reflected in the topical sections of the report. The report also includes ideas from student reports as well as those of the authors.

Thus, we begin this report with a look at the forest, the most dominant resource at Quabbin next to water. From there we will examine recreational uses, present and prospective. That discussion will lead inevitably to how Quabbin is perceived by the general public. We will close with a look at the role science can play in the management of this remarkable area and the intriguing potential of a formal biosphere reserve designation.

The concluding recommendations are designed to build upon the MDC's unusual freedom to interpret and even formulate its own land management policies. They encourage the agency to be proactive, not simply reactive, and to use its flexibility to the maximum in order to incorporate the new scientific understandings and management initiatives modern circumstances now seem to warrant. And we end with five practical steps the MDC can take to advance these recommendations to the point of implementation.

Before proceeding down this path, one other set of observations should be made. Despite all of its factual reality, Quabbin serves not just as an arena for competing interests but also as a battleground for social order. Values rather than technical or scientific certainty will ultimately determine resource management policies. In that regard, Quabbin mirrors much of past conservation history. However, in the new paradigm, *ecosystem management*, which visualizes human and natural resources occurring synergistically within geographic limits set by natural systems, there is encouraging evidence of a potential merger of competing philosophies. Quabbin could be an important way-station to that end.

FORESTRY AT QUABBIN

Quabbin's approximately 50,000 acres of managed forest are quite extraordinary. They reflect not only the endemic capacity of much of the area to grow quality trees, but more than three decades of skillful and thoughtful husbandry on the part of the MDC. The Quabbin forest is mostly hardwood. It is actually three distinct forests organized managerially into 94 different compartments. There are 2,700 acres of coniferous plantation remaining from the earlier days of water supply management; 19,000 acres of regrowth since the great hurricane of 1938; and 28,000 acres of forest that came in during the early 1900s following the removal of the open field white pine. The plantations and post-1938 forests are nearing 60 years of age; the turn-of-the-century forest is now more than 90 years old. In conventional forestry terms, the latter is reaching rotation age.

So natural is the forest in appearance, one is hard-pressed to remember the extent of past human influences. Yet, portions of the oak forest still reflect the use of fire by pre-colonial hunters and gatherers. Forest stands surrounded by stone walls provide mute testimony to the fields and pastures abandoned from agriculture in the mid-1800s. And on ridgetops and in swamps and ponds, the remnants of blowdowns and subsequent log salvage operations can still be seen today. While Quabbin's forests are magnificently wild, they are not primeval.

Forestry has been practiced professionally at Quabbin since the early 1950s. The first formal management plan was prepared in 1961. Growth and condition are monitored regularly through a series of fifth-acre Continuous Forest Inventory (CFI) plots installed in 1960 and remeasured every five years. Enough timber is already on the stump to build houses for a community of 150,000. An additional 1,000 house-equivalents grow each year. 35,000 acres of silvicultural improvements have been accomplished since 1960, and an additional 1,500 acres are due to be treated each year for the balance of this century.

Silviculture is practiced to achieve three principal forestry objectives: 1) open up

stands so that regeneration can be established; 2) release young growth to constitute the new forest; and 3) enhance species diversity given individual site characteristics. While commercial harvesting is used as the means to these ends, yielding some $200,000 in revenues each year, it is not the primary objective of forest management at Quabbin. The MDC has concluded that "watershed protection will be served best by a forest where the majority of acreage is diverse in age, species, and vertical structure; is actively accumulating biomass; and is continuously reproducing." In short, Quabbin's foresters have taken on the challenging task of replicating through management many of the characteristics of the primeval forest.

Two issues have arisen to disturb this otherwise tranquil, sylvan scenario. An irruption of white-tailed deer, symptomatic of the protected and productive new habitat, has seriously impacted the capacity of the forest to regenerate. The second issue has been the assertion that the real land management objective at Quabbin should be the creation of a "new" old-growth, not a managed forest. Letting the forest develop naturally has been advanced as the most desirable policy to pursue.

When deer populations began to reach 60 animals per square mile (six times the level a continuous and normally regenerating forest can be expected to support), the MDC set about to correct the imbalance. In accord with the 1991 Quabbin Reservation White-tailed Deer Impact Management Plan, a first-ever public hunt took place that fall on a 9,000 acre portion of the Quabbin Reservation. Two subsequent hunts were held in 1992 and 1993. Although vigorously protested by animal rights groups and those committed to maintaining an inviolate wildlife sanctuary at Quabbin, more than 1,700 animals were removed to achieve at least a 50% reduction in population. Increases in forest regeneration have begun to be documented.

The debate over an old-growth forest future for Quabbin is more profound. It is rooted in the growing scarcity of old-growth forest - approximately 185,000 acres in the eastern United States, only two established reserves in New England (one each in Maine and New Hampshire), and some 20-30 scattered, individual sites in Massachusetts constituting barely one-hundredth of one percent of the state's total forest area. An old-growth future for Quabbin would be a significant remedial step and one seemingly

compatible with the primacy of the MDC's own water mission.

The countervailing arguments are several-fold. First, there is scientific evidence that forests of considerable age can "leak" nutrients, thereby producing adverse water quality effects. Keeping nutrients bound up in vigorous, thrifty forests tends to forestall that problem. The second old-growth effect is biological. Organisms adapted to deep woods conditions are likely to replace the current species diversity. A third concern is the possible impact of large natural disturbances within old-growth, such as hurricanes and fires, on water quality. However, any civil, intellectual discourse on old-growth invariably becomes clouded by the issue of management vs non-management.

Although there will and should be vigorous debate over what constitutes naturalness, our view is that Quabbin's forests must be regenerated and restructured to near-natural conditions before the issue of old-growth can really be addressed. The proposed ten year forest management plan seems to be a useful step to that end. By 2004, with forest regeneration development much improved, and the major biotic influence (deer) under control, there would be every reason to reexamine an old-growth future for Quabbin. At that time, a decision between further intervention to improve age distribution and species diversity, or a hands-off approach, would be more appropriate. In preparation for that eventuality, two important steps should be taken.

First, the MDC should begin deliberately accumulating an old-growth forest reserve. Rather than abandoning forestry entirely, it should build the reserve incrementally through management actions. The 10,000 acres already recommended for special management restrictions are a good start. As other stands are successfully regenerated and reconstructed, they should be added to the reserve. If this practice is followed, an appreciable portion of the Quabbin Reservation will have been placed in the reserve category by the end of the sixty year period targeted in the MDC management plan.

Second, in the treatments to be applied, we would like to see the MDC pioneer what might be called a "new silviculture." Ensuring ecosystem integrity should be emphasized. A landscape-scale rather than a stand perspective should be utilized. In many instances, non-harvest silvicultural techniques may be the most appropriate to

apply. In addition to enlarging the Commonwealth's future old-growth forest reserves, the MDC would be breaking ground for the kind of environmentally-sensitive forestry the state's quarter-million non-industrial forest landowners would find especially appealing.

With that in mind, we would urge the initiation of a special program of forestry services, such as the MDC is beginning at Wachusett Reservoir, for the nearly 35,000 acres of privately-owned land within the Quabbin watershed, 80% of which is in forest cover. Much like the professional services often supplied at no cost to landowners by forest products companies, the MDC could make available a service forester to encourage excellence in forestry practices within the entire watershed. At the same time, the MDC should intensify the management of its own 7,500 acres lying outside the highway-bounded Quabbin Reservation. These tracts could become the nuclei for a new system of public/private "Quabbin legacy forests" where joint management would be encouraged under special cooperative agreements. MDC timber sales would thereupon become magnet markets available to be shared with the smaller private ownerships. The MDC presence would also help upgrade standards for operations within the entire Quabbin region.

The long-term goal should be the creation of an environmentally-sound, interdependent, forest management system outside of the core Quabbin Reservation that would stabilize and even expand local employment and the economy under a concept of enduring resource sustainability. In pursuing such a goal, the MDC would be well-advised to seek the help of the Soil Conservation Service's new community assistance unit and consider advancing the creation of a special USDA Resource, Conservation, and Development District for the Quabbin region.

RECREATION AT QUABBIN

At least 700,000 person-visits are believed to occur at Quabbin each year. The bulk (600,000) are at Quabbin Park, a 3,100 acre peninsula lying adjacent to the reservoir between Goodnough Dike and Winsor Dam. The area offers lookouts, picnic tables, hiking, bicycling, and nature study. The Visitor Center within the Park provides visitor information, interpretive displays, programs, and lectures. An additional 60,000 person-visits occur at Quabbin's three boat launching areas located strategically around the perimeter. They are provided only to facilitate reservoir fishing, an authorized use since 1951. The remainder of the estimated visitation occurs sporadically and is difficult to estimate accurately. Quabbin's network of paved and gravel roads, a reminder of its settled past, offers some 250 miles of informal hiking access via more than forty controlled gates. Bicycling is allowed at only four gates and is restricted to paved roads only.

The wildlife experience should not be underestimated. Eagle, beaver (lodges, dams, cut sticks), coyote, deer, and other wildlife are relatively easy to see. The quiet and vastness of the place, especially the panoramas from shore, are remarkable qualities. The natural experience is accentuated by the presence of more than 400 former homesteads, historical, and archeological sites which pay tribute to the extensive human influence in past years. Former residents and their families, and groups from educational institutions, are accorded special visitation privileges. Because some 90% of current use is believed to be local, public use impacts Quabbin less intensively.

In 1983, an independent study (Klar et al., 1983) examined the recreational potential at Quabbin and concluded that more use could be allowed without compromising the water quality objectives. However, the tightening of drinking water requirements since 1983 may necessitate a reexamination of this premise. The study found that revised policies would help mitigate current inconsistencies (e.g., boating restricted to fishing, hiking but not cross-country skiing) as well as utilize underdeveloped resources. However, increased recreation would require added development and

management costs on the part of the MDC.

A comprehensive plan for public use was mandated by the provisions of Chapter 372, Acts of 1984, a measure that also established an eleven member Quabbin Watershed Advisory Committee (QWAC). After three years of work, twenty-five committee and subcommittee meetings, and five public hearings attended by more than 600 people, a formal recreation and public access policy and plan was endorsed by QWAC effective January 1, 1989. At the heart of the plan was a master policy statement containing ten criteria for determining the appropriateness of a proposed recreational activity. Except for those specifically authorized by regulation or statute, recreational uses were to be permitted only if they did not degrade water supply, apparent wilderness character, natural resources, or historic and prehistoric sites. The net effect has been to define recreation as a low intensity use.

The widely-held belief in the zero-sum relationship between Quabbin's natural resources and recreational opportunities - namely, that the needs of one can be met only at the expense of the other - may well be misplaced. We are convinced that important opportunities are being neglected and that a strong case can be made for creative management of the people who now and could delight in Quabbin that is fully consistent with water quality objectives. We predicate this view on the emerging stature of the resources at Quabbin in at least state and regional terms, and the need for the MDC's mission to be broadened beyond simply water to a multi-objective, recreation-conservation, management framework. We respectfully disagree with the assertion in the draft land management plan that the MDC's mandate is properly much narrower than that of most public land managing agencies. We believe that pressure by the media and the public will eventually cause the MDC or some other agency to manage Quabbin in accord with a revised and broadened legal mandate, much as occurred earlier with the opening of Quabbin Reservoir to fishing. In anticipation of that reality, we suggest the pursuit of two modest but promising new recreational initiatives - ecotourism and trail use - and the endorsement of partnership approaches to achieve these and other conservation and recreational objectives at minimal cost to the agency.

Ecotourism

Among promising, untapped opportunities for recreation at Quabbin, nature tourism (ecotourism) must stand near the top of the list. A special kind of organized travel designed to experience nature without harming the natural resource base, ecotourism can generate substantial revenues for resource protection and also stimulate the local economy. At its best, it offers a model of sustainable resource use and helps create a balance between the competing demands of economic development and conservation. Although the concept is increasingly popular in the developing world, it is yet to catch on in the United States.

A successful ecotourism program deliberately limits the number of visitors and the activities in which they are engaged, giving priority to education, interpretation, and research. Each site visited must reflect three kinds of carrying capacities: the *ecological* capacity to absorb visitors; the *aesthetic* capacity to provide a quality experience; and the *social* capacity of the surrounding communities to accomodate the needs of travelers without harm to local cultural or economic stability.

Quabbin's potential as a resource for nature tourism seems to be exceptional. The reservation stands apart from other New England forests in several ways. It is one of the largest continuous forests in the region with an unusual mixture of size, water, and forest. It has a diverse array of plant and animal life and, as host to 35 identified natural heritage sites, provides habitat for several rare and endangered species. It is located within easy reach of several major metropolitan areas. And it has an interesting and significant human history and many accessible historic sites.

Moreover, ecotourism promises to be a recreational activity fully compatible with the MDC's own long-term goals for Quabbin. The reservation's function as a water supply source requires an unusually conservative approach to protection and use. Nature-oriented activities are those that are the least likely to threaten water quality, because they require minimal developed facilities. Nature constituencies also have the potential to countervail more detrimental interest group activities. The needed visitor services could contribute modestly to the economy of local communities, thereby adding further potential constituents. And the fees generated from this special activity would not

only meet expected costs, but support a range of research and educational activities at Quabbin without further burdening the metropolitan water rate payer.

Several studies have shown that water suppliers may have cause for concern with human visitation, especially through the introduction of parasites and viruses into reservoirs (e.g., Giardia and Cryptosporidium). Prior studies have also documented that the majority of visitors to certain sections of Quabbin probably do not use sanitary facilities. These factors point out the potential benefit of a carefully supervised ecotourism program. As organized groups apply for educational programs, on-site supervision (by MDC staff or trained subcontractors) and special sanitary arrangements could be required. A model for this type of program already exists at the Seattle (WA) water supply watershed where visitors must be accompanied by interpretive staff.

In addition, emphasis could be placed on visitors gaining research experience at Quabbin, through programs such as Earthwatch, where on-site supervision and research benefits would be present. The MDC has already successfully hosted an Earthwatch group in studying the Quabbin beaver population. By marketing such research experiences, Quabbin could be differentiated from the more traditional ecotourism experiences offered in isolated, rare, or spectacular settings. This type of program could help meld local and regional interests and increase local stewardship for Quabbin.

The data on present nature use at Quabbin is primarily anecdotal. However, the 1988 survey of visitors (Klar, 1988) did underscore the special nature and seasonality of much of the current tourism - eagle watching in January, fishing and general outdoor use in spring and summer, and foliage viewing in the fall. Origin and destination analyses indicated a largely untapped visitation potential from eastern Massachusetts and other portions of southern New England, to say nothing of travelers from the remainder of the United States and abroad (especially Canada). Among visitors to Quabbin Park surveyed in 1988, fully two-thirds stated that more nature programs were needed. Commercial travel companies occasionally include Quabbin on the itineraries. During fall foliage season, for example, one agency alone generated as many as 1,200 visitors to Quabbin Park. In addition, the MDC staff offers regular educational and school programs within watershed and water-using local communities. Approximately 50,000 people visit the

Quabbin Visitor Center each year.

Any policies for developing ecotourism should be predicated upon two fundamental strategies: the creation of a new public identity for Quabbin as a unique protected area; and the encouragement of low impact uses in the facilitation and expansion of nature-oriented activities and education.

Within these constraints, the first step should be to conduct long-term research on visitors and visitation; the impact of recreation on water quality, wildlife, and the forest; and the ecological, aesthetic, and social carrying capacities of Quabbin. Investigators at the University of Massachusetts' Hotel, Restaurant, and Travel Administration could be helpful here. Alternately, the national Ecotourism Society, based in Vermont, could be contacted for assistance.

Second, to provide a focal point for the exploration of ecotourism, the MDC should establish a special advisory committee composed of selected recreation users, leaders of natural history tours, local business representatives, environmental educators, and at least one member of QWAC. Among the committee's assignments would be the development of program criteria and standards compatible with the MDC's management at Quabbin, the identification of candidate areas for visitation, the evaluation of program costs and potential user fees, and the design of exhibits, signs, and interpretive materials. The advisory committee should also explore potential connections between ecotourism and research via such established programs as Earthwatch expeditions. Citizen volunteers, working directly with field scientists, can help lay a firm knowledge base for ecotourism and enlist the power of citizen participation and support in Quabbin's management.

Trails

Development of an active trail program also seems illustrative of the low impact, new constituencies visualized for Quabbin. Doing so at Quabbin Park and North Quabbin, areas mostly removed from the watershed, would ease concerns over watershed protection and enable the Quabbin Reservation to be the focal point for ecotourism. The existing network of former town ways, maintenance routes, and logging roads is already

attracting thousands of users annually. The challenge would be to build a formal system of trails that would include established entry points, parking, and trail heads. The trails should be usable for a mix of hiking, cross-country skiing, and biking. A more formal trail system would help reduce illegal activities and minimize their impact on the environment. Encouraging trail use would also help build a recognizable constituency for Quabbin. As public needs are met, credibility and trust in the MDC would be enhanced. Given an enlarged set of stakeholders, a broader list of concerns could be addressed; conflicts can be identified earlier; and the final results are apt to be more creative. In short, good public involvement invariably fosters improved agency decision-making and policy implementation.

With respect to the trails themselves, they should be of varying lengths to accomodate different levels of user competence. To provide system flexibility, they should be completely interconnected both within and without Quabbin. No one segment should exceed 10 miles in length. Where possible, trails should run with the grain of the watershed in order to keep stream crossings to a minimum. Because of possible water supply impacts, the objective of the trails program should be to provide a meaningful experience but limit the time users actually spend in the reservation.

Overuse of a Quabbin trails system can be avoided by having good inter-connections with trails outside of the reservation to accomodate long-distance trail users. In central Massachusetts and New England, the external environment for a regional trails program seems especially promising. The Rivers, Trails, and Conservation Assistance Program of the National Park Service, already active in trails and greenway planning within central New England, would be available to help design a trail program. The Massachusetts Department of Environmental Management, overseer of the state's 2,500 mile public and private trail system, has a full-time trails coordinator for central Massachusetts and an active Adopt-a-Trail program. The Appalachian Mountain Club's Worcester and Berkshire Chapters include more than three thousand members. Trail groups convene annually in a New England Trails Conference (the 1994 meeting was hosted by the Worcester chapter of the Appalachian Mountain Club). The Boston-based AMC, one of the oldest recreational and conservation organizations in the country, has

decades of experience in designing, building, managing, and maintaining trail systems that would be available to MDC land managers upon request. Two special circumstances make the creation of a Quabbin trails system both timely and appropriate.

First, volunteer groups have already designed and built parallel north-south, long distance trails through central New England: the Metacomet-Monadnock Trail, which originates in Granby (CT) and terminates at Mt. Monadnock (NH), and the Mid-State Trail extending from the Douglas State Forest on the Massachusetts-Rhode Island line to Mt. Watatic in southern New Hampshire. An east-west trail through Quabbin would be a challenging prospect and the first of its kind in Massachusetts. It could be designed to intersect with the proposed Mohican Trail extending into New York state. A second prospect is the comprehensive open space program being advanced by the Mt. Grace Land Conservation Trust and others for the North Quabbin region. It is one of five federally-approved Forest Legacy Areas in the Commonwealth. The project visualizes a 50 mile protected corridor, involving both public and private cooperators, extending from Quabbin to the New Hampshire border. The inclusion of a trail system would be entirely consistent with this important project.

Dedicated Funds

We believe that recreation and ecotourism can and should be entirely self-sustaining activities supported by dedicated funds. With the assistance of its advisory committee, the MDC should begin by considering ways to more firmly establish Quabbin's identity as a premier wildlands area. As one example, we favor the issuance of an attractive series of stamps featuring resources encountered at Quabbin. These would be collectors' items. Patterned after the duck stamp, each would be the result of an advertised design competition. Much like lottery tickets and hunting and fishing licenses, stamps could be sold by franchisers at a surcharge, thereby providing modest local sources of revenue. The base cost would be fully tax-deductible.

As a starter, the stamp should be used simply to build an identifiable, state-wide, wildlands constituency for Quabbin and to generate revenues for its education and research programs. Over time, however, the MDC should consider making the stamp

multi-functional. For example, evidence of purchase could make a visitor eligible to receive a discount at facilities where fees are charged. The stamp could eventually serve as a required sticker for any means of transportation engaged in activities at Quabbin.

A special funds depository would be desirable. The MDC's existing Watershed Management Fund, which derives revenues from hydroelectric power generation, recreational fees, and wood products harvested from watershed lands, is one such possibility; but the funds generated simply reduce the contribution from the MWRA and do not increase actual expenditures. Alternately, the MDC's established Metropolitan Parks Trust Fund and Metropolitan Parks Expense Fund, or the Massachusetts Environmental Trust, which are not subject to appropriation, should be looked into as potential depositories. A legislatively-established Quabbin Ecotourism Fund, which would spell out the proposed purposes and uses, might be the best route of all to take.

Partnerships

Inherent in all of the above is the concept of working partnerships between the MDC and user groups. By partnerships, we mean more than mere consultation. True partnerships involve an actual sharing of management responsibilities and decisions within the framework of a cooperative agreement. From a legal standpoint, they are work contracts. Such arrangements can seem threatening to an agency's autonomy, expensive to carry out, and beyond its official mandate. They can be resisted in the belief that cooperators will lack longevity, prove to be unreliable, and open up the agency to liability claims. But of all the potential impediments to partnerships, lack of trust in the good faith of each of the participants is the one that usually impedes effective collaboration.

Yet, despite these potential obstacles, there is much the MDC could gain from selected partnership arrangements. Critical work could be accomplished. Mutual understandings could be built. And common ground would be created with vocal and politically-effective advocacy groups. But since the MDC may have initial operational misgivings about formal partnerships, we suggest increasing the use of volunteers first in accord with the recommendations of the 1988 Recreation and Public Access Plan. The

agreement between the MDC and the Friends of Quabbin to help operate the Quabbin Visitor Center should be used as a model.

Trail development and maintenance is one potential cooperative venture where the public/private experience has been overwhelmingly positive. Arrangements range from the popular, informal, "Adopt-a-Trail" programs of the Massachusetts Department of Environmental Management to the ten-year-old agreement between the private Appalachian Trail Conference and the National Park Service to actually manage the entire 2,000 mile Appalachian National Scenic Trail. Development of a trail system at Quabbin would be a prime candidate for partnership consideration.

Similarly, the MDC should consider partnerships with non-profit conservation organizations to help develop nature-oriented programs, including ecotourism. The precedent has already been set with local organizations like Friends of Quabbin, the Swift River Valley Historical Society, the Hitchcock Center in Amherst, and the Valley Educational Cooperative. Supplemental arrangements could be explored with private conservation organizations (e.g., the Massachusetts and Rhode Island Audubon Societies) who regularly offer natural history travel opportunities to their members. The idea of educational and interpretive partnerships is fully consistent with the MDC's 1989 Interpretation and Visitor Services Plan.

A third area of prospective partnership activity involves land protection. Under the provisions of the Massachusetts Watershed Protection Act of 1992, some 1,450 acres are to be added to Quabbin before the turn of the century. Where possible, the protection sought should be secured through partnerships with affected landowners using conservation restrictions rather than fee acquisition. The MDC has already secured such agreements on over 750 acres on its watersheds in the past five years. This gives landowners a direct stake in protecting the watershed, encourages good land stewardship, and eases the historic resentment toward the intervention of eastern water interests.

For the remainder of the watershed not likely to be in state ownership, the MDC should enter into partnerships of another type. We suggest a close working arrangement with local land trusts to identify parcels, craft protective covenants, and have the land

trusts ultimately acquire and monitor conservation restrictions on the public's behalf. The current MDC watershed protection easement and/or the provisions of the general Watershed Lands Preservation Restriction Act (Chapter 275, Acts of 1989) could be used as models within these portions of the Quabbin drainage.

PUBLIC PERCEPTIONS OF QUABBIN

What might be termed the Quabbin region embraces the jurisdictions of twelve Massachusetts municipalities with a total population (1990) of approximately 50,000. Portions of the Quabbin drainage fall within each. The largest town (Petersham) covers 68 square miles; the smallest (Phillipston) 24 square miles. Athol, Ware, Belchertown, and Orange have more than 2,000 individual households each; half of the towns have less than 500. General fund revenues for the region, derived principally from property taxes, approximate $50 million annually. Despite their modest dimensions, the Quabbin towns are of considerable antiquity, dating back to a land grant made by the General Court in 1736 to the veterans of King Philip's War. Like many New England towns, governance is by locally-elected selectmen whose actions are validated by the citizenry at annual town meetings.

Outside of its hydrologic connection with the Swift River drainage and Quabbin Reservoir, the twelve town area has no well-defined sense of region. It is tugged south-eastward toward Worcester, southward toward Springfield, westward toward the five college community centered in Amherst, and northward to the Orange-Athol urban complex. It is divided among three county jurisdictions (Hampshire, Hamden, and Worcester). It falls between the cracks of two regional planning agencies (e.g., Belchertown, Pelham, and Ware are affiliated with the Pioneer Valley Commission in Springfield; the remainder of the towns with the Central Massachusetts Commission in Worcester). Militantly independent though they are likely to remain, the Quabbin towns could profit from more of a common identity. The galvanizing force, we believe, should be a joint effort to protect the integrity of the Quabbin watershed.

A good way to begin is found in the provisions of Chapter 36, Acts of 1992, the so-called Watershed Protection Act (Cohen bill). The measure calls for a draconian set of actions by the MDC to protect the quality of its major water sources, including Quabbin. The act prohibits the discharge of pollutants within 200' of a tributary or water surface and restricts certain uses and activities up to 400' from such areas. The MDC has

promulgated draft regulations to implement these provisions and has already held one set of local meetings to alert affected local officials and property owners. Absent a tradition of community outreach, a veritable firestorm of protest has resulted. The MDC's timetable is to move ahead first on the Wachusett watershed where only a small proportion of the drainage is in public ownership, and tackle Quabbin in subsequent years. Rather than simply advancing its own regulations, we would urge the MDC to use the occasion to develop a standing constituency relationship with its twelve Quabbin communities.

The first step should be to expand the provisions of the existing watershed protection plan (MDC/MWRA, March 1991) by making it a community-based, action program. In recognition of the human dimensions involved, both social and political, the prescribed region should be the twelve towns in their entirety, not just the portions that lie within the Quabbin drainage. Under the technical assistance provisions of the Watershed Protection Act of 1992, the MDC is already empowered to provide professional services. In preparation for completing this task and implementing the Watershed Protection Act, the MDC has created a new environmental planning unit consisting of six planners. The MDC needs to utilize this unit to initiate the direct involvement of the towns and enable them to become engaged individually and collectively in the effort.

Thus, the second step should be the encouragement of a representative mechanism to take direct responsibility for planning and programmatic actions. Echoing successful experience elsewhere (e.g., Wachusett Reservoir, King County, WA), we recommend the formation of a 15 member interlocal *Quabbin Forum* consisting of a designee of each of the twelve towns plus three members selected at large by the MDC (possibly from the three jurisdictions supplied with water directly from Quabbin). The Forum would have the option of serving simply as an advisory body, or taking direct responsibility for the preparation and implementation of a watershed protection program.

Third, the program could be developed centrally by the Forum, or undertaken on a town by town basis with coordination supplied by the Forum. At the least, the MDC should assign liaison staff to the program, operating out of Quabbin rather than Boston,

and it should make support resources available much as it does for the Water Supply Citizens Advisory Committee (WSCAC) and the Wachusett Task Force, possibly in the form of a master contract for consultant services or a series of grants made to the Forum and/or its constituent communities.

We are keen on the Forum for a number of reasons. It would provide the recognizable community outreach mechanism that has been needed for so long. It would materially advance watershed protection through a program of shared responsibility. It would begin to build an informed and supportive local constituency and, in so doing, temper the MDC's reputation as an autocratic governmental agency operating at a distance from Quabbin. And once the watershed protective program was underway, the Forum could take the lead in shaping other important initiatives - among them an improved public understanding of the functions, values, and benefits contributed by Quabbin; a review of the current benefits and costs and the distribution of equity; and the development of a compatible set of growth and development objectives for the region. This might warrant a formal memorandum of agreement with the Pioneer Valley and Central Massachusetts regional planning agencies, patterned perhaps on the transjurisdictional arrangements for aquifer protection and transportation in other portions of the state, that would give the Quabbin region access to regular planning services.

The Public Face of Quabbin

Commendably, the current land management plan for Quabbin contains a specific endorsement of the desirability of public participation. From the agency's viewpoint, four objectives are to be realized: 1) an improved understanding by the public of the technical aspects of management, including the generation of additional program ideas; 2) an enlarged understanding by the MDC of public issues and concerns; 3) the development of an understanding of the purposes and goals of the MDC by the public; and 4) the development of a support base to assist in smooth implementation of the selected program.

Along such lines, the MDC has utilized a number of approaches to public

participation ranging from ad hoc task forces, public presentations, workshops, panel discussions, and hearings to the statutory, eleven member, Quabbin Watershed Advisory Committee (QWAC). But the MDC seems to suffer from the two classic characteristics of policy-makers that hinder the efficacy of citizen participation. The first is a lack of agreement heretofore within the agency on the specific goals of public participation. A second is the policy-makers' belief in the primacy of their agency's mission versus the opinions of the citizenry in representing the public interest.

Intended or not, Quabbin is beginning to attract serious public attention. A review of the data base, Nexis, for the past decade revealed more than two hundred story entries. Celebrated events such as drought or deer commanded the most attention, echoing the conventional wisdom that news is something that tends to be "new and now." The most influential pieces appeared in the larger metropolitan media markets of Springfield and Boston, but the sizable number of local stories validated the role of small newspapers in serving as escape valves for the affected citizenry. Still to weigh in at Quabbin have been the broadcast media: network radio and television, and the proliferating cable industry. With the future in mind, several practical realities need to guide any Quabbin media strategy.

First, agency managers need to be aware of the kinds of stories that attract conventional media attention. The issue needs to be acute and dramatic and, in the case of television, vividly visual. Having people directly impacted heightens a story's appeal. Evidence of controversy usually helps, because it provides an opportunity to present a juxtaposition of opinions. If the conflict is just beginning to unfold, the story is likely to have continuing appeal. Where the issue remains largely unaddressed by those responsible, the reader or viewer may be inveigled into taking remedial action, an occasion that generates additional opportunities for media coverage.

Second, the agency manager needs to be aware of the typical hierarchy of what actually gets covered and run. The "new and now" stories obviously receive priority attention, particularly if they can be fitted into the short bites of information that characterize media coverage today. An issue that has already been covered by one medium (a newspaper) is often validated for the next (television). The sizable

investments required for independent discovery make media executives receptive to story ideas presented by others (e.g., wire services, even non-profit organizations). Budgetary realities affect coverage, too. If the subject is close at hand and readily filmed, for example, it is more likely to be a candidate for television.

These observations prompt us to urge the MDC to develop a formal, media strategy, and to consider creating a modest media service center operating out of the Visitor Center at Quabbin. Although the MDC's Visitor Center staff currently perform both educational and media contact roles, the importance of media coordination merits even more focus. At least one person, initially on a consulting basis but ultimately on staff, should be charged with developing effective media contacts. A factual data base should be compiled and a library of film footage created. Story ideas on Quabbin resources or activities should be made available in multi-media form. We visualize the center as being both responsive and pro-active. Over time, it should acquire the capability to produce short features of its own to place in selected media markets.

Along with coverage of the day-to-day water supply activities, the strategy should emphasize four additional themes. The first would be *Quabbin as a regional resource*, an important wildland base for Massachusetts and New England. The second would be *Quabbin as a resource reserve*, a storehouse of invaluable biotic and genetic material. A third would be *Quabbin as a demonstration area*, a place where resource managers are learning how to improve and expand natural land uses and values. The final theme should be *Quabbin as an example of ecosystem management in practice*. As the world struggles to manage its resources on more of a holistic basis, examples close to home become especially relevant. This is a story just waiting to be told.

SCIENCE AT QUABBIN

In its use of science to inform and guide management, the MDC's land management plan is quite remarkable. The documentation is impressive, the data presented informative and persuasive, and the treatment highly supportive of the assertion that science can be employed usefully in giving the decision-maker a rich palette of choices for his policy canvas. Yet, we found the MDC to be somewhat ambivalent about the role science should play in its affairs and the manner in which scientists should actually become involved in the work of the agency. This led us to consult several outsiders, not about Quabbin itself, but about what kind of science is applicable within the broader public sphere, and how science can be utilized effectively within an institutional framework.

We were warned, first, that scientists speak as much from values as they do from truth. For example, values can materially affect which problems they select for analysis. Among the scientists themselves, there will often be a need to distinguish as clearly between conflicts in values as uncertainty over facts. Second, we were reminded that scientists perform multiple roles in society - as wise technical arbiters, potential contractors, and representatives of important political constituencies. Although they attempt to apply a measure of discipline to their representations, their reactions are invariably human ones.

Third, scientists are likely to make their best contributions from within their own fields, areas where the questions fall on familiar ground. But even there, the goal should be simply to identify and illuminate policy choices, for rarely is science able to provide definitive and authoritarian answers. What disciplinary competence contributes is perspective - the ability to examine problems, as it were, with lenses of different focal lengths.

Fourth, we were reminded that science operates best when it is relatively unconstrained - as one observer put it, "knowledge mushrooms in undefined pastures." Yet, a plane of relevance is usually needed to guide individual projects, and a measure

of intervention can ensure that the contours of the research are consistent with the goals of the sponsoring institution.

This leads to the final observation - the inherent tension between science and democracy. The public is often simply unwilling to accept assertions of fact at face value. Viewpoints can be reconciled only if the scientific results are both technically valid and politically feasible.

In examining the present and proposed uses of science at Quabbin, we were troubled by three factors: 1) the need for a substantial measure of interdisciplinarity; 2) the seeming neglect of holistic ("large") science in favor of small scale research and fact gathering; and 3) the absence of a recognized institutional home for Quabbin studies.

With regard to interdisciplinarity, it is well-known that scientists are often prisoners of their own professional training. Yet, interdisciplinarity itself can often be shallow and superficial. Much of this may be due to the second factor, the absence of a larger conceptual framework within which the various disciplines can come together and exercise, as it were, a measure of self-discipline. Were there to be the equivalent of a systems approach to the problems at Quabbin, the functional niches for individual scientists, and the opportunities for fruitful collaboration, would become more readily apparent. The third shortcoming of the present land management plan then becomes obvious. There is presently no institutional device to encourage the exercise of interdisciplinarity within such a holistic framework.

Put directly, there has been limited science funded by the MDC to date. When the MDC does initiate scientific projects, they are most often indirect or secondary (e.g., a collection of relevant literature by a graduate student), or highly focussed, reactionary, or piecemeal (e.g., beaver impacts on water quality). Exceptions are the two basin studies conducted by the US Geological Survey in the Dickey Brook, West Branch (Swift River), and East Branch (Fever Brook) drainages that were funded by the MDC. There has been little attempt to "mine" or synthesize existing data, to relate or coordinate diverse studies, or to develop research initiatives with real continuity. Fundamental attributes of the system (e.g., landscape-level forest patterns, terrestrial-aquatic linkages, Quabbin limnology) have never been studied. And the surrounding academic and state agency

strengths have not been fully utilized. In our opinion, the MDC will never have the ability to orchestrate the needed long-term, on-going, and comprehensive research if it remains totally dependent on the initiatives and good graces of the researchers arriving at its door with their own funding.

Quabbin Institute

Our suggested solution is the creation of what we are calling the *Quabbin Institute*, an entity set up specifically to encourage and coordinate the various technical and scientific investigations at Quabbin. The Institute should embrace the full range of both the natural and the social sciences. Rather than being set apart, it should be an arena where scientists and agency managers are regularly and mutually engaged. Indeed, the very structure of the institution should be the product of such deliberations, not simply imposed from the outside and on high.

In our minds, the Institute should have a full-time director (possibly a scientist on leave from a recognized institution) functioning as the chief scientist for Quabbin. It should be provided an office and a small support staff (probably at the Visitor Center at Quabbin) but, otherwise, function largely as a research facilitating institution. To increase the likelihood of access to outside funds, it should enjoy legal status as a 501(c)(3) organization.

The Institute's first charge should be to develop a common conceptual framework for the land and water resources at Quabbin, using such realities as watershed boundaries, natural systems, and entire landscapes as the initial bounding attributes, but reaching well beyond these purely physiographic and biotic factors to reflect the prevailing economic, social, and political systems as well. The second set of responsibilities would be to define the inquiries needed - the disciplines required, the relative priorities of the studies, the most useful products, and the most promising investigators - and to determine how these inquiries might best be accomplished. A particular priority would be that already listed as the key project in the Quabbin Land Management Plan - to evaluate the information already collected using one or more of

the analytical models currently available. The final activity would be to promote, guide, coordinate, support, and evaluate the investigations carried out at Quabbin, and to encourage prompt use of the findings by agency policy makers and others.

As we visualize it, the Quabbin Institute would be a different kind of institution. It would perform the functions of a conventional research center, such as the convening and coordination of area scientists, provide outreach to national laboratories and other groups, and sponsor research. Like the rest of the Quabbin operations, its core budget would derive from an annual reimbursement made by the MWRA. But the Institute should also have a goal of augmenting its budget through grants and other funding mechanisms. It should develop special competence in underutilized areas such as risk analysis. We would also like to see the Institute pioneer the use of consensus building techniques to help understand the causes of disagreement, build consensus on the technical aspects of management decisions, and devise ways to reach policy agreement in the presence of substantial technical uncertainty. It should also develop change models responsive to the "typologies of surprise" encountered in dynamic planning environments.

We would also urge an imaginative use of techniques to bridge the current chasm between science, management, and society. For example, an annual meeting might be held at the Visitor Center, in conjunction with the proposed Quabbin Forum, to provide a public setting for research reports and agency management plans, as well as an occasion for unfettered observations, reactions, and suggestions from the affected public. The MDC's watershed workshop and research symposium formats could be used as models. A quarterly newsletter from the Visitor Center or the Institute could provide a supplemental channel of information and a device for gradually building an informed and supportive Quabbin constituency. And, looking ahead, we would urge the MDC, acting perhaps through the proposed Quabbin Institute, to begin exploring the formal designation of Quabbin as an international biosphere reserve under the charter of UNESCO.

BIOSPHERE RESERVES

Projects of the United Nations Educational, Scientific, and Cultural Organization (UNESCO)'s Program on Man and the Biosphere (MAB), biosphere reserves had their origins in the international conference on the rational use and conservation of the biosphere held in Paris in September of 1968. In summarizing the conference, Interior Assistant Secretary Stanley E. Cain urged the 250 delegates to replace the historic, independent, and uncoordinated use of resources with a set of well-planned, integrated, multi-disciplinary activities. U.S. leadership would be assured when President Nixon and General Secretary Brezhnev, at the U.S./U.S.S.R.summit held in Moscow in June of 1974, issued a joint communique pledging their best efforts to establish biosphere reserves and conduct related scientific research in their respective countries.

More than 100 nations have since become party to the MAB program. Nearly 300 biosphere reserves have been established in some 70 different countries, 46 in the U.S. alone. Candidate areas are first proposed to national committees established by member nations (e.g., U.S. MAB in the Department of State), then recommended for formal designation as international biosphere reserves by the MAB International Coordinating Council and the Director-General of UNESCO. Although certification provides no formal program support or protective sanctions, international designation does set the stage for broad-scale cooperative action using all available sources of authority and funds.

Biosphere reserves are unique because they provide for a balanced program of conservation, use, and development. They are predicated upon the premise that human and natural systems, rather than being antithetical, have an inherent interdependency. Thus, the typical reserve has a fully protected *core*. This is surrounded by a *buffer* area within which non-destructive uses can occur. An outer, *transition* zone is where traditional uses, growth, and even development are encouraged. The reserve may take the form of zones arrayed in concentric circles, or may embrace a number of non-contiguous areas occurring in a cluster.

The core of a reserve must be strictly protected, and the buffer area fully regulated. Because of such requirements, these elements invariably demand an established, administrative agency. The transition area, however, is more loosely constructed. It typically involves a range of independent jurisdictions and ownerships, both public and private. The emphasis here is on outreach and cooperative arangements such that sustainable resource development can occur in ways that are fully consonant with the objectives of the reserve.

There are no formal size requirements for a biosphere reserve. In the Northeast, they range from the 7,000 acre Hubbard Brook Forest in New Hampshire to the 10 million acre Champlain-Adirondack Reserve in New York and Vermont (the only two biosphere reserves in New England). However, each must represent one or more of fourteen priorities initially identified for research attention by the international secretariat, most of which have either an ecosystem or a geographic focus. More recently, the nature and scale of resource-related human issues has caused other areas of research interest to be added. During the 1990s, MAB national committees will be encouraged to consider four new topics: 1) ecosystem functioning under different intensities of human impact; 2) the management and restoration of human-impacted resources; 3) human investments and resource use; and 4) human response to environmental stress.

Quabbin Biosphere Reserve

With these particulars as a backdrop, we have concluded that the designation of Quabbin as a biosphere reserve would be singularly appropriate. Its size is at a scale presently under-represented in the eastern U.S. reserve system. Of the fourteen classic priorities of research interest, eight can be found at Quabbin - temperate ecological effects, lake and riverine ecological effects, island ecosystems, natural areas, major engineering works, interactions between environmental transformations and human populations, perceptions of environmental quality, and the effects of environmental pollution. A liberal definition of the biosphere reserve area to include the urbanizing portions of the mid-Connecticut valley and central Massachusetts would embrace virtually all of the human-related research areas. More importantly, bioreserve

designation would provide a common framework within which water, forests, recreation, conservation, public perception, and science could come together.

The three primary criteria for selection seem well met at Quabbin. The area of *conservation concern* is represented by the MDC's on-going actions to protect the entire watershed and to encourage ecosystem integrity and biological diversity. *Logistic concern* is satisfied by the presence of the MDC's watershed management staff and facilities, its outright ownership of more than 60% of the watershed, and the ready access it enjoys to eight nearby research universities, including the University of Massachusetts. The potential also exists to address matters of *development concern*. The prospective reserve falls within twelve local jurisdictions, many dating back to the early days of the colonies. The history of prior land use speaks to literally centuries of human-nature relations within the region. Further, under provisions of the Massachusetts Watershed Protection Act of 1992, the MDC is now empowered to intervene directly to ensure environmentally-responsible development in the watershed communities.

Turning to the actual dimensions of a Quabbin biosphere reserve, the three zone configuration of the typical biosphere reserve would seem to be readily applicable. For example, the *core area* would naturally include the approximately 9,000 acres of water surface and affected shoreline currently closed to boating and fishing, and the 10,000 acres set aside as areas with special management restrictions, including the 3,500 acres of islands. A suitable *buffer area* might encompass the 100,000 acres of remaining land within the watershed. The *transition area* should include the lands, public and private, which are directly adjacent to the Quabbin watershed, including the proposed North Quabbin Legacy Forest area.

But in light of the extraordinary attributes of Quabbin in both human and natural terms, we would propose adding a fourth zone - an *area of influence*. This would purposely have soft (elastic) boundaries fitted to the particular problem at hand. A number of illustrations can be cited. Water supply functions already interlink the proposed reserve with forty-four Boston and three Springfield area communities which derive the bulk of their drinking water from Quabbin. The effects of atmospheric

deposition on the forests and waters of Quabbin involve airsheds extending halfway across the United States. Quabbin lands have the potential to serve as the keystone of a regional system of protected open space and recreational corridors throughout much of central New England. The restoration of a resident wolf pack, the return of anadromous fish like Atlantic salmon, or the recovery of threatened avian species all involve home ranges extending well beyond the limits of Quabbin.

So, too, will the human dimensions of Quabbin take the reserve in many different directions. Beyond the essential human needs provided by drinking water, "soft" recreational activities, such as hunting, fishing, hiking, day use, and nature study, promise to draw from an expansive area of contribution. Compatible economic activities, such as ecotourism, forestry, or other forms of sustainable resource use and development, while locally based, will impact ever extending markets. And properly-placed commercial, residential, and second home development promise to expand the ranks of those with a special sense of place for the Quabbin region.

Realistically speaking, what is the likelihood of a biosphere reserve at Quabbin? We regard the designation prospects as promising, but the nomination in some doubt unless several policy changes take place. Perhaps the most important are changes to the goals to be pursued at Quabbin, and changes to the MDC's legal mission, actual or perceived, to serve as the area's manager.

A reading of history (e.g., Nesson, 1983) makes it clear that the purpose of land-takings in the Swift River watershed was for the purpose of adding to, extending, and further developing additional sources of water supply for the metropolitan water system (Chapter 375, Acts of 1926). A special three member water supply commission was created and $60 million in bonds authorized. When the work was completed in 1939, the facilities were turned over to the MDC for maintenance and operation. Thus, there is substantial justification for the MDC's stated position that the primary purpose of Quabbin is "the delivery of sufficient quantities of pure water to present and future generations of water users of the system", and that secondary values "will be encouraged and enhanced where they do not impair the primary mandate".

Chapter 372, Acts of 1984, the organic act for the MDC's Division of Watershed

Management, enlarges the historic pure water mission by requiring the agency to "utilize and conserve such water and other natural resources in order to protect, preserve, and enhance the environment of the Commonwealth and to assure the availability of pure water for future generations."

Section 105 of the organic act, by making the division explicitly subject to the provisions of Chapter 737, Acts of 1972, incorporates the additional objectives at Quabbin of "maintaining wilderness character, natural ecology, balanced wildlife habitat, and maintaining and conserving forests in a healthful state of ecological balance consistent with reservoir and watershed purposes."

And as a unit of the MDC itself, the division cannot ignore the commission's stated mission to "preserve the region's unique landscape by acquiring and protecting parklands, river corridors and coastal areas; reclaiming and restoring abused and neglected sites; and setting aside areas of great scenic beauty as reservations for the refreshment, recreation, and health of the region's residents."

Thus, one can only conclude that a more expansive view of the MDC's mission at Quabbin is more a matter of interpretation than one of statutory insufficiency. Within the constraints of its water supply responsibilities, the agency could simply elect a larger vision, actively explore a leadership role in the emerging field of ecosystem management, and entertain a modest and prudent measure of increased public involvement.

GETTING FROM HERE TO THERE

The findings and recommendations set forth above represent a challenging set of ambitions. They can only be advanced through deliberate action. We suggest five specific steps for the MDC to take to accomplish these objectives in the foreseeable future.

First, the current draft land management plan needs to be modified as necessary and then promulgated without further delay. Perfection notwithstanding, it is time to move on. Some members of the Harvard group found troubling the absence of an official validating mechanism - say, legislative endorsement of the plan - but review and approval by the Metropolitan District Commission should be able to provide most of the necessary checks and balances. This does suggest the desirability of having at least one associate commissioner in the future drawn from the watershed communities, a provision that the governor should consider seriously in the next cycle of appointments.

Second, the MDC should move promptly to improve its outreach to Quabbin area communities by convening an open meeting and providing the opportunity to have the suggested interlocal Quabbin Forum come into being. An early fall open house at the Visitor Center, similar to that held by the MDC this spring, could be the setting for a combined community and public report session, an outing for area families, and the precursor of actions by town officials in the early fall to create a formal advisory organization.

Third, special working groups of user representatives, constituted perhaps under the auspices of the Quabbin Watershed Advisory Committee, should begin examining the feasibility of the ecotourism and trails initiatives identified in this report. Alternately, the MDC could engage special consultants to develop an option document for each subject.

Fourth, the advancement of scientific studies at Quabbin merits immediate attention. As examples, the MDC should commence the search for an individual of stature who could serve at least part-time as chief scientist. One or more working conferences of concerned scientists should be convened at area institutions like the University of Massachusetts or the Harvard Forest. This could build on the 1992

University of Massachusetts graduate seminar which focused on Quabbin science and research. Two particular subjects should be part of that agenda: 1) the scope and nature of the interdisciplinary studies needed at Quabbin; and 2) the institutional, organizational, and financial commitments necessary to advance that work.

Finally, the MDC should examine seriously the use of the biosphere reserve designation to serve as the structural context for its entire program at Quabbin. The US MAB directorate should be contacted for information. MDC specialists should arrange to visit each of the existing eastern US biosphere reserves. If the prospects appeared promising, a special advisory group might be constituted and convened to help develop the particulars of a formal submission. Designation could be timed to coincide with the sixtieth anniversary of Quabbin, an occasion where managers, neighbors, users, and the public could collectively celebrate the creation of this remarkable reservation.

Yet we should close on a note of caution for, despite all of their accomplishments, Quabbin's forest managers are not without their share of detractors. A report of this sort, which is intended to set forth additional policy options, could readily be misconstrued and even misused. For the record, we find no fault with the past and present emphasis upon water supply. Indeed, there is much to commend. Our purposes are simply to identify the values present beyond those associated directly with the MDC's water mission, and to underscore the opportunities to practice ecosystem management more generally at Quabbin. If these actions are taken, we are convinced that the stage will be set to elevate the management of Quabbin to new heights and to achieve a measure of the added prominence its land, water, and other natural resources so richly deserve.

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SELECTED REFERENCES

Austin, Patricia et al. Annually since 1990. Water quality reports: Quabbin Reservoir and Ware River watersheds. Metropolitan District Commission. Boston.

Batchelder, Gail and Virginia Irvine. 1992. Impacts of acid deposition on watersheds of the Quabbin Reservoir. Publication No. 166, Massachusetts Water Resources Research Center. Amherst.

Bridges, C.H. and L.S. Hambly. 1971. A summary of 18 years of salmonid management at Quabbin Reservoir, Massachusetts. Reservoir Fisheries and Limnology Special Publication No. 8.

Carlton, M.M. 1990. Literature review: water quality implications of converting forested watersheds to principally herbaceous cover - implications to the Quabbin watershed. Metropolitan District Commission. Boston.

Colburn, Elizabeth A. and Robie Hubley (eds.). 1990. Watershed decisions: the case for watershed protection in Massachusetts. Massachusetts Audubon Society. Lincoln, MA.

Conuel, Thomas 1993. Quabbin: the accidental wilderness. Massachusetts Audubon Society. Lincoln. MA.

Dizard, Jan E. 1991. Going wild: constructions of nature and the debate over environmental policy at the Quabbin. Little Three Conference. Wesleyan University. Middletown, CT.

Ecotourism Society. 1993. Ecotourism guidelines for nature tour operators. North Bennington, VT.

Foster, David R. 1993. Land-use history and four hundred years of vegetation change in New England (draft). Harvard Forest. Petersham, MA.

_____. 1992. Land use history and forest transformations in central New England. In S. Pickett and M. McDonnell (eds), Human impacts on the environment. Springer-Verlag. New York.

_____ and E.R. Boose. 1992. Patterns of forest damage resulting from catastrophic wind in central New England. *Journal of Ecology* 80: 79-98.

Friends of Quabbin. 1990. Quabbin facts and figures.

_____. August 1991. Letters from Quabbin: The Springfield Union, April 14, 1938 - July 19, 1938.

Gilbert, Vernon C. November 1989. The Southern Appalachian Man and the Biosphere Program: a chronology. SAMAB Cooperative. Gatlinburg, TN.

Golodetz, Alisa D. February 1993. Historical patterns of land protection in north-central Massachusetts: the emergence of a greenway. Hampshire College. Amherst, MA.

_____ and David R. Foster, 1994. The North Quabbin conservation region: history, ecology, and development of protected land in central New England (draft). Harvard Forest. Petersham, MA.

Greene, J. R. Summer 1986. "The creation of Quabbin Reservoir." *Massachusetts Wildlife* 36(3): pp. 21-26.

_____. 1989. An atlas of the Quabbin valley and Ware River diversion. The Transcript Press. Athol, MA.

_____. December 1989. The day four Quabbin towns died. The Transcript Press. Athol, MA.

_____. 1992. A bibliography of Quabbin valley history. The Transcript Press. Athol, MA.

Healy, William M. May 31, 1989. Summary of U.S. Forest Service wildlife research on the Quabbin Reservation. Prepared for the MDC Natural Resources Review Panel.

_____; Brooks, R.T; and P. J. Lyons. 1987. "Deer and forests on Boston's municipal watershed after 50 years as a wildlife sanctuary." In proceedings Deer, forestry, and agriculture: interactions and strategies for management. Allegheny Section, Society of American Foresters. Warren, PA.

Hunt, F.M. 1961. Forest resources on Metropolitan District Commission lands surrounding Quabbin Reservoir. Master's thesis. University of Massachusetts. Amherst.

Jones, W.R. 1951. The deer herd of Prescott Peninsula, Quabbin Reservation, and its ecology. Master's thesis. University of Massachusetts. Amherst.

Keller, Richard L. 1987. Acidification and fish harvest trends at Quabbin reservoir. Massachusetts Division of Fisheries and Wildlife. Westboro.

Klar, Lawrence R., Jr. 1988. Recreation services and management practices at Quabbin Reservation: a survey of visitors. Metropolitan District Commission. Boston. and A. Ghirin. 1983. Recreation at drinking water reservoirs in Massachusetts: a survey of water managers. *Water Resources Bulletin* 19: 477-81.

Krantz, Heidi. 1989. Interpretation and visitor services plan for Quabbin Reservoir. Cooperating Association for New England Parks, Inc. Boston.

Kroll, J.C.; Goodrum, W.D.; and P.J. Behrman. 1986. "Twenty-seven years of over-browsing: implications to white-tailed deer management on wilderness areas." In Wilderness and Natural Areas in the Eastern United States: a Management Challenge, Kulhavy, D.L. and R.N. Conner (eds).

Kyker-Snowman, T. 1989. 1989 Quabbin forest regeneration study. Submitted September 7, 1989.

Leahy, Christopher. December 1990. The Quabbin deer population: a policy analysis. Massachusetts Audubon Society. Lincoln.

Leonard, Wendy C. et al. December 1984. Hydrogeology and processes of acid neutralization in Cadwell Creek watershed, Quabbin Reservation, Massachusetts. Publication No. 148, Massachusetts Water Resources Research Center. Amherst.

Lyons, P.J. and P. Rezendes. 1988 The ecology of eastern coyotes on Quabbin Reservation (unpublished). Friends of Quabbin.

Massachusetts Audubon Society. 1993. Correspondence between Gerard Bertrand and Professors David B. Kittredge, Jr. and Todd K. Fuller, University of Massachusetts.

_____. 1993 and 1994. Correspondence between Robie Hubley and Joseph McGinn, Metropolitan District Commission.

Massachusetts Department of Environmental Management, Bureau of Forest Development. 1993. Forest legacy need assessment for Massachusetts. Boston.

Massachusetts Superior Court. 1991. Court decision on special deer hunt. Boston.

Mather, Martha E. Fall 1992. The Quabbin ecosystem: an interdisciplinary ecological review (final report). University of Massachusetts. Amherst.

Metropolitan District Commission, Division of Watershed Management. 1993. MDC land management plan: Quabbin watershed (draft).

_____. 1991. Quabbin Reservation white-tailed deer impact management plan. Submitted July 1, 1991. Also Technical Appendix submitted July 1, 1991.

_____. 1989. Deer browse impacts on MDC Quabbin watershed lands: answers to commonly asked questions. Submitted October 25, 1989.

_____. 1989. Natural resource management review panel summary. Submitted May 26, 1989.

_____. 1988. Quabbin and Ware River watersheds: recreation and public access policy and plan.

Metropolitan Water Resources Authority. 1990. Long range water supply program: briefing and recommendations to the board of directors.

_____ and Metropolitan District Commission. June 1992. Watershed protection plan for the MDC/MWRA water supply sources: executive summary. Prepared with the assistance of Rizzo Associates, Inc. Natick, MA.

Nesson, Fern L. 1983. Great waters: a history of Boston's water supply. University Press of New England. Hanover, NH.

O'Connor, Robert W. 1982. Recreation use of drinking water reservoir watersheds.

_____. undated. Recreation and public access at Quabbin Reservoir: conflict in a commons. MDC (unpublished).

Ottenheimer, Daniel G. December 1992. Hurricane susceptibility and water quality at Quabbin Forest, Massachusetts. Master's thesis, SUNY (Syracuse).

Parkhurst, James A. and Robert W. O'Connor. 1992. The Quabbin Reservation white-tailed deer impact management plan:a case history. *Proceedings* Eastern Wildlife Damage Control Conference 5: pp. 173-81.

Scudder, J.H. 1949. A preliminary study of forest succession in central New England. Master's thesis. Harvard University, Cambridge.

Spencer, B. A. and P.J. Lyons. 1986. A ten year forest and wildlife plan for the Quabbin watershed. MDC (unpublished).

US Department of State, Man and Biosphere Program. June 1987. A practical guide to MAB. Washington, D.C.

Wallace, Floyd Associates. 1989. Watershed forest management plan: a technical review. Submitted April 1989.

Appendix A

HARVARD UNIVERSITY
JOHN F. KENNEDY SCHOOL OF GOVERNMENT

TOPICS IN ENVIRONMENTAL POLICY (ENR 522)

Course Participants

Boyd, Beverly (California) is an international relations/environmental studies graduate of the University of Southern California. She has worked for the city of Los Angeles and EPA in pollution prevention implementation, including direct experience with public/private partnerships under EPA's Design for the Environment Program. Ms. Boyd is enrolled in the Kennedy School's master's in public policy program.

Dawson, Christopher (Vermont) received his BS in political science from the United States Air Force Academy. He is currently enrolled in the Kennedy School's master's in public policy program. Mr. Dawson has spent two summers in Washington (DC) working for the Pentagon and the House Armed Services Committee on military budgeting and program authorization. He has also conducted analyses of foreign and defense policy in Southwest Asia.

Ferenz, Michele (Switzerland), a linguist, free lance writer, and former print and broadcast journalist, is a graduate of Brown University in political science. She has traveled extensively in Italy and conducted independent research on many facets of Italian media, politics, and public life. Ms. Ferenz is currently a candidate for a master's degree in public policy with a concentration in natural resource management.

Field, Patrick (Massachusetts), a graduate of Carleton College (MN), expects to receive his master's of city planning degree from MIT in June, 1994. In his most recent professional assignment, Mr. Field served as project planner for the Massachusetts Division of Capital Planning & Operations specializing in energy efficiency and savings. His private consulting work has included a marketing overview of the $27 billion US seafood industry.

Gostenhofer, Karen (Massachusetts). A prospective master's degree recipient in landscape architecture at Harvard, Ms. Gostenhofer brings to the group ten years' experience as a commercial graphics artist/illustrator in the advertising field as well as within the environmental consulting industry. She has a special interest in issues of conservation and stewardship.

Gulick, Susan (Washington), a mid-career master's in public administration candidate, graduated from the University of California (Santa Barbara)'s environmental studies program. Ms. Gulick served for six years as an environmental analyst for the Washington House Committee on Environmental Affairs, negotiating and drafting hazardous waste, land use, and water quality laws. She came to the Kennedy School from her present position as Waste Reduction and Recycling Manager for King County's Solid Waste Division.

Hess, James (Washington, D.C.) is currently completing his master's in public policy. Before coming to the Kennedy School, he served as Legislative Director for U.S. Representative Sam Gejdenson (D-CT), where he was the Congressman's principal advisor on environment, energy, agriculture, and transportation issues. He also served as a Professional Staff Member for the House Committee on Interior and Insular Affairs.

Knowlton, Thomas (Pennsylvania), a history graduate of Trinity College, has acquired extensive knowledge and experience in all areas of publishing. Mr. Knowlton served as promotion manager for Inc. Magazine, as director of marketing for CFO Magazine and, just prior to enrolling in the mid-career master's in public administration program at the Kennedy School, as director of publications for Earthwatch.

Lipman, Steven (California), recipient of BA and MA degrees in history from Berkeley and Pennsylvania, respectively, and a PhD candidate at the University of Pennsylvania, is enrolled in the Kennedy School's mid-career master's in public administration program. A senior government and public policy professional for the past seventeen years, Mr. Lipman has helped develop innovative approaches to solid waste, household hazardous waste, and water reclamation. He is currently focusing on ways to link urban economic development and environmental policy.

Long, Jonathan (North Carolina) is in the second year of the Kennedy School's master's in public policy program concentrating in environment and natural resources policy. Following graduation from the College of William and Mary with a degree in public policy, Mr. Long worked for the White Mountain Apache Tribe in Arizona on issues of endangered species, integrated resources planning, and environmental protection. He is continuing that work at Harvard by examining the merits of using habitat management for plants and wildlife as a policy tool.

Maguire, Derek (New Jersey) is a senior in Harvard University's undergraduate arts and sciences program. He is currently pursuing a BA in environmental science and public policy with special interests in deforestation and sustainable development. Mr. Maguire has worked for the Quality Assurance Unit and US Formulations Group 1 of American Cyanamid's Agricultural Research Division to develop a control release mechanism for the application of certain pesticides.

Martin, Lisa (New York) is enrolled in the Kennedy School's master's in public policy program concentrating in environmental and natural resource policy. Her prior exposure to industrial and labor relations at Cornell has given her valuable quantitative, statistical, and analytical skills. During the summer of 1993, Ms. Martin worked as a program assistant for the Fire Management Program of the Department of the Interior. She plans to eventually pursue a career in environmental law.

Natarajan, Kottayam (Washington), a candidate for the master's of public policy degree, graduated from Whitman College with a concentration in economics and French literature. As an international banker with First Interstate Bank, and in his current research position with the Harvard Institute for International Development, Mr. Natarajan has experienced the banking aspects of international trade, finance, and foreign exchange markets. He has also helped design an international workshop to promote sustainable development and the economic evaluation of the environmental impacts of policies and projects.

Petricone, Stephen (Connecticut), a licensed pilot and currently a master's in public policy candidate, graduated from Yale University's American studies program. A former executive assistant to U.S. Representative Ron Wyden (D-OR), he has also served as press assistant to the League of Conservation Voters and as opposition research director and campaign scheduler for the Moffett for Congress committee in Connecticut. Mr. Petricone was recently engaged by the World Wildlife Fund to study the land-use changes and deforestation likely in Mexico if trade in citrus is liberalized.

Rosen, Sydney (Minnesota) is enrolled in the Kennedy School's master's in public administration program. A history graduate of Harvard College, she has extensive program management experience in the developing world. Prior to her present graduate work, Ms. Rosen founded and then directed the work of an international volunteer organization, WorldTeach, Incorporated.

Shearer, Neal (Arizona), trained in social sciences at Illinois State University, is on educational leave from the city of Scottsdale (AZ) to add a mid-career master's degree in public administration to his prior credentials as a graduate of the Kennedy School's Program for Senior Executives in State and Local Government. Mr. Shearer's sixteen years of public management experience are reflected in his current position as Scottsdale's Government Relations Director. He has been actively involved in the passage of Arizona legislation involving water, solid waste, economic development, public safety, and other urban issues.

Stoll, Ira (Massachusetts) is a senior at Harvard College concentrating in American history. He is president of the Harvard Crimson and has a special interest in environmental journalism. Active in hiking and skiing in New England, Mr. Stoll planned and built a cross-country ski trail in Worcester's Green Hill Park as an Eagle Scout service project.

Taliento, Lynn (New Hampshire) is an American studies graduate of Yale University and a candidate for the master's in public policy degree at Harvard. Proficient in Czech and Italian, Ms. Taliento has planned and conducted conferences for women in politics in Central and East Europe and conducted economic and legal analyses for the Ministry of the Economy in Prague. She also has legislative experience with US Congressman Ron Wyden (D-OR) and the House Committee on Small Business' Subcommittee on Regulation.

Verma, Monish (India) is currently enrolled in the Fletcher School of Law and Diplomacy at Tufts University. Educated at Washington University (St. Louis) in physics, system science, and mathematics, he is earning a second master's degree with emphasis upon international environmental policy and resource management. Mr. Verma is currently a consultant for Oxfam America researching carbon storage/sequestration models appropriate for tropical rainforests in Bolivia, Ecuador, and Peru and fitted to the qualitative needs of indigenous groups in such areas.

Wagner, Cheryl (Maine) holds a bachelor's degree in public administration from the University of Maine. For five years she coordinated interdisciplinary teams commissioning artwork for capital construction projects at state agencies in Maine and Colorado. This June, Ms. Wagner will complete a master's degree in Landscape Architecture from the Harvard Graduate School of Design.

Warren, David (New Jersey) is a graduate of Brown University and a former lecturer in American literature and civilization at the Sorbonne and Lumiere Universities in France. He has served most recently as an operations analyst/consultant for the World Bank specializing in human resources development. Mr. Warren 's master's in public policy degree this June will reflect his interests in political and economic development and international trade and finance.

Wenham, Sean (Massachusetts) is a senior at Harvard College concentrating on environmental science and public policy. A serious background in scuba diving first made him aware of the impacts of people and industry on the natural environment. Mr. Wenham hopes to enter the business community and help build there a new sense of environmental consciousness and responsibility.

Appendix B

TOPICS IN ENVIRONMENTAL POLICY (ENR 522)

Multi-Objective Resources Planning and Management: The Case of Quabbin

SCHEDULE

Introduction to Forestry

Sep. 21	Course introduction	Charles Foster
Sep. 23	History, uses, and values of forests	Charles Foster
Sep. 28	Ecology of forests	David Foster
Sep. 30	Forests and land use	David Foster
Oct. 5	Forest management principles	Charles Foster
Oct. 7	Forests and water	Charles Foster
Oct. 12	Forests and wildlife	Charles Foster
Oct. 14	Forest management strategies	Charles Foster
Oct. 16-17	Field trip: Quabbin Reservation Consensus session I	C. and D. Foster

Introduction to the Quabbin Reservation

Oct. 19	Establishment and history Clifton R. Read Supervisor of Interpretive Services Metropolitan District Commission	
Oct. 21	Water supply and distribution Dr. Michael S. Connor Director of Environmental Quality Massachusetts Water Resources Authority	

Oct. 26	Aquatic resources and fisheries Dr. Martha Mather University of Massachusetts	
Oct. 28	Wildlife resources Paul J. Lyons Natural Resource Specialist Metropolitan District Commission	
Nov. 2	Research and modeling (Harvard Forest panel)) Dr. David R. Foster Dr. Richard D. Boone Dr. Thomas Spies	
Nov. 4	Human dimensions Dr. Robert Muth University of Massachusetts	
Nov. 9	The Quabbin primeval Robie Hubley Senior Policy Specialist Massachusetts Audubon Society	
Nov. 16	Decision-making M. Ilyas Bhatti Commissioner Metropolitan District Commission	
Nov. 18	Consensus session II	C. and D. Foster

Multi-Objective Resource Management at the Quabbin

Nov. 23	The policy parameters	Class discussion
	Robert O'Connor, Director of Natural Resources William E. Pula, Superintendent, Quabbin Section Metropolitan District Commission	(advisors)

Nov. 30	The planning parameters	Class discussion
	Julia O'Brien, Director of Planning, MDC Sarah Peskin, Chief of Planning, NPS	(advisors)
Dec. 7	Values: present and future	Class discussion
	Dr. Peter Dunwiddie, Plant Ecologist Massachusetts Audubon Society	(advisor)
Dec. 9	Economic yields and values	Class discussion
	Dr. David B. Kittredge, Jr., Extension Forester University of Massachusetts	(advisor)
Dec. 14	Open space and recreation	Class discussion
	Wesley Ward, Deputy Director, Trustees of Reservations Keith Ross, Mt. Grace Land Conservation Trust	(advisors)
Dec. 16	Public expectations	Class discussion
	Dr. Jan Dizard, Amherst College State Senator Robert Wetmore	(advisors)
Dec. 21	Consensus session III	C. and D. Foster

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Appendix C

STUDENT PAPERS

Boyd, Beverly. How likely is required filtration?: probabilities for Boston's water supply.

Dawson, Christopher. Establishing a system of trails at Quabbin Reservoir: a study of hiking, cross-country skiing, and mountain biking.

Ferenz, Michele. The broadcast media and environmental coverage: lessons for Quabbin.

Field, Patrick. Public participation and the Metropolitan District Commission's Division of Watershed Management.

Gostenhofer, Karen. The Massachusetts Metropolitan District Commission: "new silviculture" (a graphic).

Gulick, Susan. Improving relations between MDC, the local watershed communities, and the public: lessons from a case study of solid waste management in King County, Washington.

Hess, James. Watershed lands acquisition program: conservation restrictions and a new partnership for the 1990s.

Knowlton, Thomas. The Quabbin Reservoir, old-growth ecosystem or water supply, is there room for growth?: an analysis of the potential for old-growth forest at Quabbin.

Lipman, Steven. Meeting of the waters: managing the Quabbin watershed and the interests of Boston's water users in a representative democracy.

Long, Jonathan. Missing the forest for the trees: the role of language and vision at the Quabbin.

Maguire, Derek. Quabbin economics, management, and distribution of equity: controversy at the hands of conflicting benefits and costs.

Martin, Lisa. The Metropolitan District Commission and its mandate.

Natarajan, Kottayam, Jr. Watershed management or wilderness area management?: a cost benefit analysis of values at the Quabbin Reservoir.

Petricone, Stephen. Untapped potentials: improving Quabbin's recreational resources and environmental quality through permit and partnership programs.

Rosen, Sydney. Policies for developing nature tourism at Quabbin Reservation.

Shearer, Neal. Public involvement and the use of advisory groups: issues and opportunities for the Quabbin watershed area.

Stoll, Ira. Press coverage of Quabbin: water, water everywhere.

Taliento, Lynn. Sports vs. science: citizen participation in the Quabbin planning process.

Verma, Monish. Science at Quabbin.

Wagner, Cheryl. More than just water: proceedings of a discussion between Harvard University faculty members on the perspectives of landscape architecture in planning and design at Quabbin Reservoir.

Warren, David. Promoting environmentally compatible economic development in the Quabbin watershed through intra- and extra-regional cooperation: the biosphere reserve approach.

Wenham, Sean. Introducing wolves into Quabbin: a solution to problems due to deer overpopulation.