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Alisa D. Golodetz; David R. Foster

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History and Importance of Land Use and Protection in the North Quabbin Region of Massachusetts (USA)

ALISA D. GOLODETZ* AND DAVID R. FOSTER†

Harvard Forest, Harvard University, Petersham, MA 01366, U.S.A.

Abstract: *Evaluating the consequences and future of land protection requires broad temporal and spatial perspectives of ecological and cultural factors. We assessed the development of a system of protected areas comprising 37% of central Massachusetts in terms of changing rates and means of land protection. We compared protected areas to the surrounding matrix in terms of physical, biological, and historical features and used these results to raise issues concerning future planning. The rate, purpose, and means of land protection in the North Quabbin Region (168,312 ha) have been dynamic as a result of changes in cultural values and transformation of the landscape from predominantly agriculture to forest. Protected lands are managed by 25 federal and state agencies, private groups, and municipal departments and commissions and are physically and biologically typical of the regional landscape which results from (1) participation of diverse organizations with varied agendas; (2) predominance of large government acquisitions driven by landscape-scale criteria; and (3) absence of coordination among groups. The large area, relative homogeneity and largely undeveloped status of the North Quabbin Region suggest conservation goals distinct from those in the fragmented and extensively developed neighboring areas of the Connecticut River Valley and Cape Cod and Islands Region. Large tracts of forests, wetlands, and lakes in the North Quabbin Region provide (1) habitat for species requiring extensive, intact areas; (2) the opportunity to maintain broad-scale ecological processes; (3) connections to regional conservation areas; and (4) recreation. To realize the area's potential, a comprehensive plan must be based on a broad-scale perspective and historical understanding of the landscape.*

Historia e importancia del uso y protección de suelo en la región North Quabbin de Massachusetts (E.U.A.)

Resumen: *La evaluación de consecuencias y futuro de la protección de suelos requiere de amplias perspectivas espaciales y temporales de factores ecológicos y culturales. Evaluamos el desarrollo de un sistema de áreas protegidas que abarca el 37% del centro de Massachusetts en términos de cambios en las tasas y medios de protección de suelo. Comparamos las áreas protegidas con la matriz circundante en términos de sus características físicas, biológicas e históricas e utilizamos los resultados para hacer consideraciones de respecto a planeación futura. La tasa, el propósito y los medios de protección de suelo en la región North Quabbin (168,312 ha) han sido dinámicos como consecuencia de cambios de valores culturales y transformación del paisaje de predominantemente agrícola a forestal. Las áreas protegidas son manejadas por 25 agencias federales y estatales, grupos privados, departamentos y comisiones municipales; física y biológicamente son típicas del paisaje regional que resulta de (1) la participación de organizaciones diversas con agendas variadas; (2) predominancia de grandes adquisiciones gubernamentales motivadas por criterios a escala de paisaje y (3) falta de coordinación entre grupos. La extensión de la región North Quabbin, su relativa homogeneidad y estatus poco desarrollados sugieren metas de conservación distintas a las de áreas vecinas, fragmentadas y extensamente desarrolladas, del valle del Río Connecticut y las regiones Cape Cod e Islands. Los extensos bosques, humedales y lagos en la región North Quabbin proporcionan (1) hábitat para especies que requieren áreas extensas e intactas, (2) la oportunidad de mantener procesos ecológicos en amplia escala, (3)*

*Current address: RR1, Box 570, Sharon, VT 05065, U.S.A.

†Address correspondence to David R. Foster, email drfoster@fas.harvard.edu
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conexiones con áreas de conservación regionales y (4) recreación. Para que el potencial del área sea realidad se debe utilizar un plan general basado en una perspectiva escalar amplia y en el entendimiento de la historia del paisaje.

Introduction

Human activities are a major factor controlling the structure, composition, and dynamics of natural communities and need to be considered explicitly in conservation assessments and plans (Peterken 1993). For example, in southern New England, during the 350 years since European settlement, the landscape has been transformed as the forested region was widely cleared for agriculture and subsequently reforested by floristically and structurally distinct second-growth stands (Foster 1995). Determining the conservation value and management of species, communities, and landscapes in this region requires consideration of the temporal and spatial patterns of both cultural and ecological factors (Birks et al. 1988; Dunwiddie 1990; Motzkin et al. 1996; Hunter et al. 1988).

One land-use practice that will continue to exert an imprint on natural landscapes is the protection of lands from development through various legislative or legal restrictions. Systems of protected federal, state, municipal, and private lands establish constraints on certain activity and provide the opportunity for broad-scale conservation planning. Consequently, land protection is an integral part of land-use history that must be considered for an understanding of modern landscapes and the anticipation of future ones.

We examine the historical patterns of land protection in central New England in relation to underlying ecological and cultural factors. We include an assessment of the current biological and physical attributes of protected versus non-protected lands and use this information to identify issues relevant in evaluating potential future strategies. We explore questions concerning land protection that may be generally applicable to many conservation systems:

- What is the history of conservation activities and land protection?
- What types of organizations, purposes, and methods have been involved?
- What is the spatial pattern of protected lands with regard to physical, biological, and human features of the landscape?
- What are the local and regional conservation values of these areas?
- How does this historical perspective guide considerations of future planning and land protection?

The North Quabbin Region (NQR) of central Massachusetts is well suited for this study (Foster & Foster

1994). Formal land protection dates to the early twentieth century and has involved diverse public agencies and private groups. The NQR is historically, physically, and culturally representative of upland regions of the northeastern United States, includes some of the greatest concentration of protected lands in New England, and is a key element of regional conservation planning due to the proximity of major metropolitan areas (Noss 1992). The low intensity of development in the NQR provides the opportunity for broad-scale conservation planning (Ahern 1990) in anticipation of impending future growth.

Study Area and Methods

The NQR includes portions of 19 towns in three counties in the central, upland region of Massachusetts (Fig. 1; Franklin County Commission 1991; Department of Environmental Management 1993) and is delineated by township lines to the east and south, the New Hampshire border to the north, and the Connecticut River Valley to the west. The NQR includes three-quarters of the 9,600-ha Quabbin Reservoir (Fig. 2) and totals 168,312 ha at elevations ranging from 75 to 487 m a.s.l. The uplands of granite, schist, and gneiss are topographically rough with southward trending valleys (Motts & O'Brien 1981). Well-drained, sandy-loam till soils predominate, but sandy and gravelly soils are common on glacial outwash and alluvial deposits (Mott & Fuller 1967). The climate is humid continental and temperatures average 9°C, rainfall 56 cm yr⁻¹, and snowfall 165 cm⁻¹ (Taylor & Holtz 1985). The population is approximately 60,000 with densities ranging from 5 to 133 persons per km² (U.S. Dept. of Commerce 1991).

By the mid-nineteenth century, European settlers had cleared much of this forested region for agriculture. Farmland was abandoned between 1850 and 1900 as the rural population migrated into urban industrial areas and to the Midwest (Raup 1966). Old-field forests dominated by white pine (*Pinus strobus*) were extensively logged by the 1920s and second growth hardwoods—white pine-hemlock forests now cover 81% of the landscape (Foster 1993).

We define protected land as areas where legal, political, or institutional mechanisms prevent commercial and residential development indefinitely. These mechanisms include ownership of or restrictions on land by a federal or state agency, municipal conservation commission or

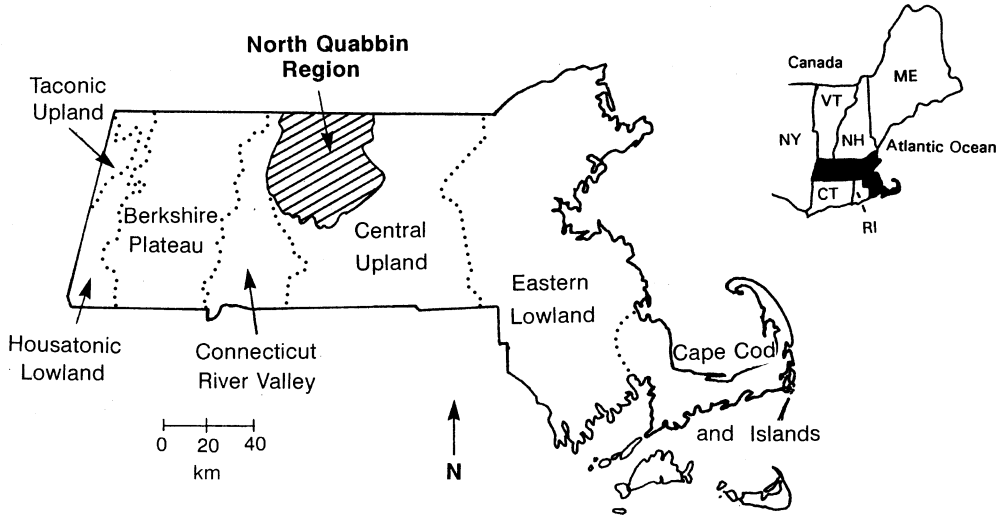


Figure 1. Location of the North Quabbin Region study area in north-central Massachusetts in relation to the state's physiographic regions and the northeastern U.S. (adapted from Motts & O'Brien 1981).

water authority, private land trust, or private research institution committed to land conservation.

Boundaries of protected tracts were delineated on U.S. Geological Survey (USGS) topographic maps (1:25,000) from landowner or municipal property maps.

Township boundaries came from USGS maps. All boundaries were digitized in vector format into a Geographic Information System (GIS) in reference to the Universal Transverse Mercator (UTM) coordinate system, converted to the Massachusetts State Plane coordinate system, and

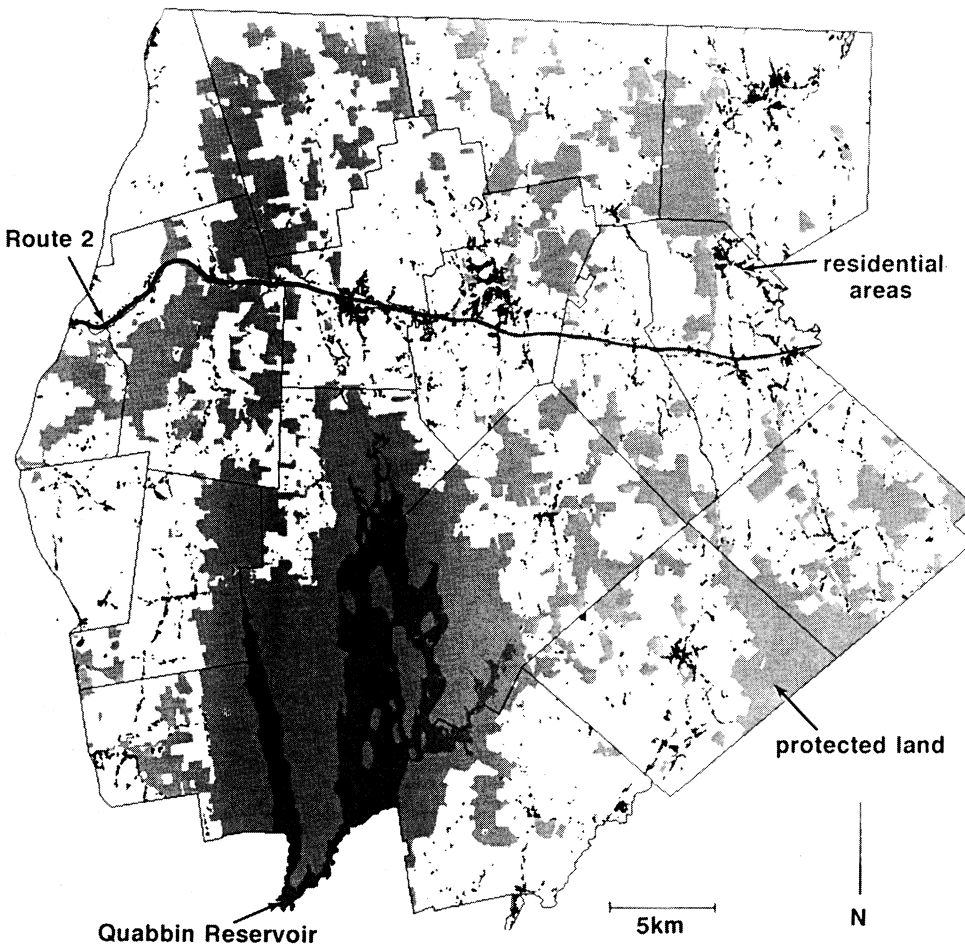


Figure 2. The North Quabbin Region study area showing protected lands (light gray), residential areas (black), the Quabbin Reservoir (dark gray), township boundaries, and Route 2, the main east-west highway.

then transferred into raster format (resolution = 60 m) for analysis using IDRISI (Eastman 1993). Three GIS overlays were created by coding each parcel by current owner and decade and means of acquisition. We were unable to establish acquisition dates for 6% of the area.

Overlays were also developed for past and current land-use, elevation, and rare species occurrences. Permanently forested sites (primary forest *sensu* Peterken 1993) may differ substantially in composition from similar sites that have been cleared and then naturally reforested (secondary forest *sensu* Peterken 1993; Peterken & Game 1984; Hermy 1990; Foster 1993; Motzkin et al. 1995). To assess the relative abundance of primary versus secondary forest, we used maps of forest distribution in 1830, near the peak of agricultural clearance (Massachusetts State Archives, unpublished data). Elevation (1-m accuracy) derived from digital elevation models was used to produce overlays of slope and aspect. Land-use and cover maps interpreted from 1985 aerial photographs (University of Massachusetts, unpublished data) were recoded for forest, non-forested wetlands, waterbodies, open areas, agriculture, residential, and other developed land. The Massachusetts Natural Heritage and Endangered Species Program supplied the location, name, and status of state-listed rare species.

Overlays were analyzed in IDRISI to produce summary and distributional statistics and to identify patterns of physical, biological, and cultural features in protected and unprotected areas.

Results

Acquisition History

Protected land in the NQR is owned by five state agencies (52,723 ha), six private organizations (4145 ha), the U.S. Army Corps of Engineers (2603 ha), four municipal water departments (1837 ha), and nine town Conservation Commissions (652 ha) (more detailed information on protected lands in the NQR is available from DRF). Land acquisition rates and means by these groups has varied over time.

Between 1900 and June 1993, 239 parcels totaling 61,960 ha were acquired for protection in four periods: 1900-1929, 1930-1949, 1950-1979, and 1980-1993 (Fig. 3). From 1900-1929, 1122 ha were acquired by state agencies and private organizations in small, isolated parcels across the central NQR and at the slowest rate of land protection (Fig. 3). More than half of current protected land (34,329 ha) was acquired by state and federal agencies in the 1930s (28,220 ha) and 1940s (6,016 ha) (Fig. 3), including the Quabbin Reservation. Land acquisitions declined between 1950-1979 and included small purchases by private groups and municipal agencies contiguous with existing protected areas (Fig.

3). From 1980-1993 acquisitions increased with 6030 ha located in small parcels adjacent to existing protected areas (Fig. 3).

Overall most acquisitions have been public agency purchases (37,863 ha) and most donations (336 ha) have gone to private organizations. Conservation and Agricultural Preservation Restrictions (Commonwealth of Massachusetts 1992) have protected 1282 ha of land since 1970, of which 58% is held by state agencies, 37% by private organizations, and 5% by municipal agencies.

Physical and Biological Characteristics

Currently 61,960 ha (37%) of the NQR are protected in individual parcels ranging from 1.3 to 27,635 ha and

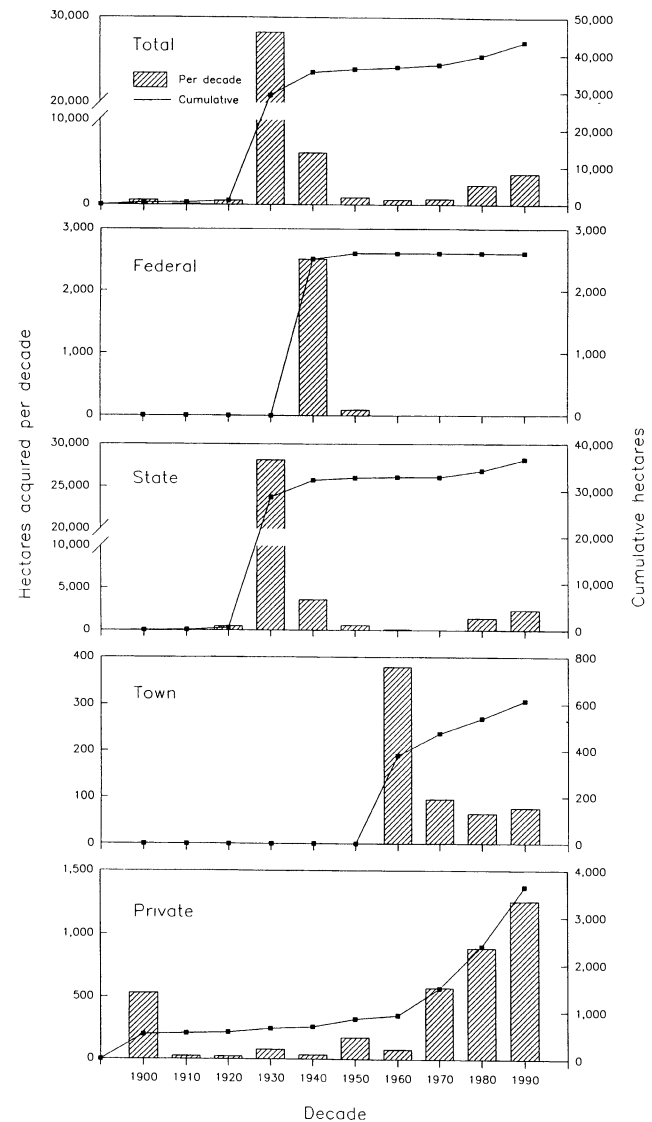


Figure 3. Temporal patterns of land protection in the North Quabbin Region by major ownership categories (note different scales). Data for 1990 extend through June 1993.

contiguous areas from 1.4 to 31,976 ha. The modern land cover of continuous forest interrupted by small openings contrasts with the 1830 landscape of scattered woodlots in an open agricultural matrix (Fig. 4). Protected and non-protected lands are similar in forest cover (81%), open land (1–2%), and wetlands (2–3%; Table 1). There is more water on protected land (14% ver-

sus 2%), as a result of the Quabbin Reservoir, and protected lands have no residential or developed areas in contrast to 7% on non-protected lands. Agricultural land is an important focus of wildlife management but is under-represented on protected areas (1% versus 7%), despite the use of Agricultural Preservation Restrictions.

Topographically, protected and non-protected lands are essentially identical in the average and distribution of elevation, slope, and aspect (Table 1). Primary forest comprises 23% of the NQR and is equally represented in protected (21%) and non-protected (26%) areas (Fig. 4). Of the 121 documented occurrences of state-listed rare species in the study area, 67% are on protected lands, including 18 of 21 species considered endangered (Table 2). Species represented are mostly vertebrates (67%) and vascular plants (26%).

Demographics

Human density in the NQR is inversely related to land protection on a township level (Fig. 5). Population shows a modern increase starting around 1980 and projected into the twenty-first century (Fig. 6). Rural and industrial towns show strongly contrasting trends. Rural towns grew rapidly to a peak population in the early-nineteenth century, decreased as agriculture declined, and increased in the last decade. Industrial towns expanded in the Industrial Revolution and continue to grow.

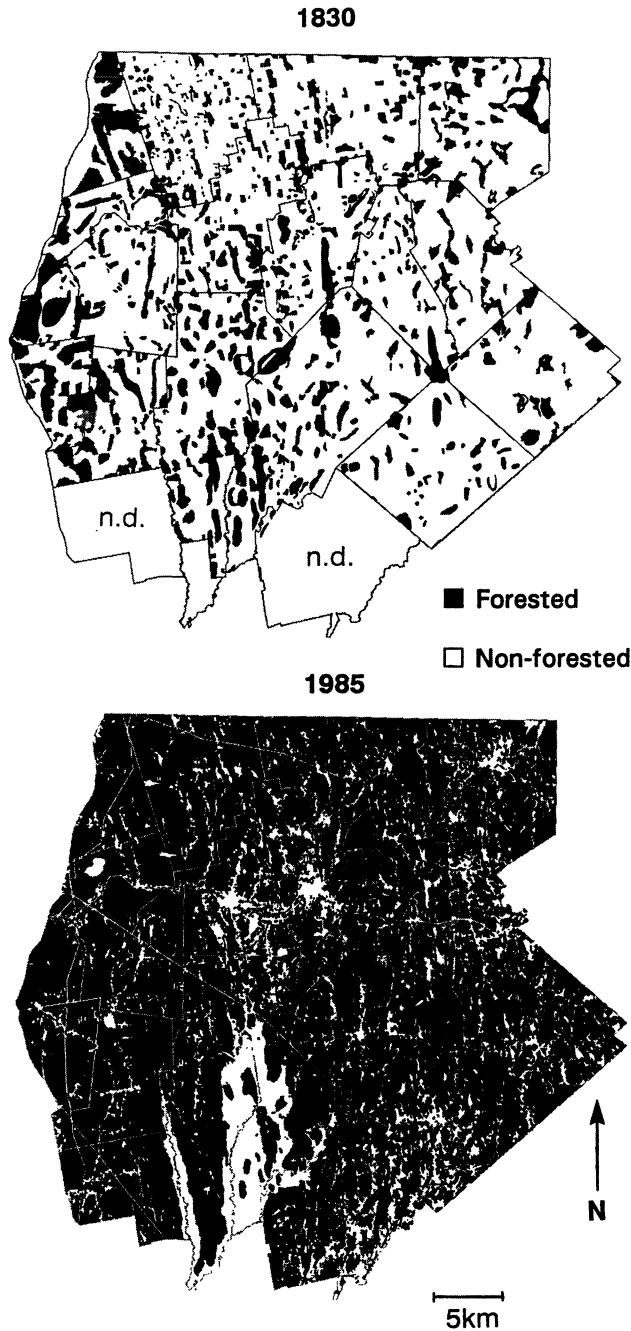


Figure 4. The distribution of forest cover at the approximate height of agriculture activity (1830) and in the modern landscape (1985) in the North Quabbin Region.

Table 1. Land-use and physical characteristics of protected versus non-protected lands in the North Quabbin Region.

	Study area	Protected lands	Non-protected lands
Land use (% of total ha)	forest	81	81
	open	1	1
	wetland	2	3
	water	6	14
	agriculture	5	1
	residential	3	0
Elevation (m)	developed	1	0
	minimum	75	79
	maximum	487	487
	average	270	268
	SD	57	13
Slope (°)	SD	57	13
	minimum	0	0
	maximum	37	37
	average	3	3
	SD	4	2
Aspect (% total ha)	N	5	5
	NE	7	9
	E	14	16
	SE	9	9
	S	8	7
	SW	11	9
	W	18	18
	NW	8	8

Table 2. Number of occurrences of rare species on protected and non-protected land in the North Quabbin Region.

	Number of occurrences	Study area	Protected land	Non-protected land
	Total	121	82	39
Species type	Vertebrates	82	56	26
	Invertebrates	7	6	1
	Vascular Plants	32	20	12
Statewide status	Endangered	21	18	3
	Threatened	13	5	8
	Special Concern	72	48	24
	Watch List	15	11	4

Discussion

Historical Patterns and Motivations for Land Protection

The NQR and its sociocultural context are dynamic (e.g., Foster 1993). European settlers transformed the forested landscape into a patchwork of agricultural fields and small woodlots (Fig. 4). Widespread farm abandonment began in the mid-nineteenth century and the forests that naturally re-established have been logged since the late-nineteenth century. Aggrading forests, in which growth exceeds harvest, cover most of the modern landscape (Fig. 4). Striking transformations in composition have ac-

companied these historical changes in forest cover (Foster et al. 1992; Foster 1995).

During the twentieth century, land protection has become a major land-use practice that will continue to affect the natural landscape. The focus and rate of land protection have been dynamic due to the shifting participation and agendas of numerous agencies and organizations (Fig. 3). In turn, each group's purpose and means of land protection were influenced by changing ecological, economic, and political factors. Diminishing forest resources in the nineteenth century encouraged forest conservation (Emerson 1846) and resulted in the protection of scattered forest tracts between 1900 and 1929 by state forest agencies and the Harvard Forest, a research and educational institute of Harvard University (Fig. 3). National conservation priorities shifted in the 1930s when a large labor force and low land prices enabled government purchase of extensive areas for public works projects (Koppes 1988). In the NQR federal flood control projects and the state's Quabbin Reservoir and Ware River Watershed (total 34,000 ha) were established between 1930 and 1949, imposing a framework of protected land (Fig. 3). Concurrently, private conservation groups broadened their scope to include north-central Massachusetts.

Land protection after 1950 increasingly involved local landowners. Increases in land and timber prices accompanied the postwar prosperity of the 1950s and land protection consequently slowed through the 1970s (Fig.

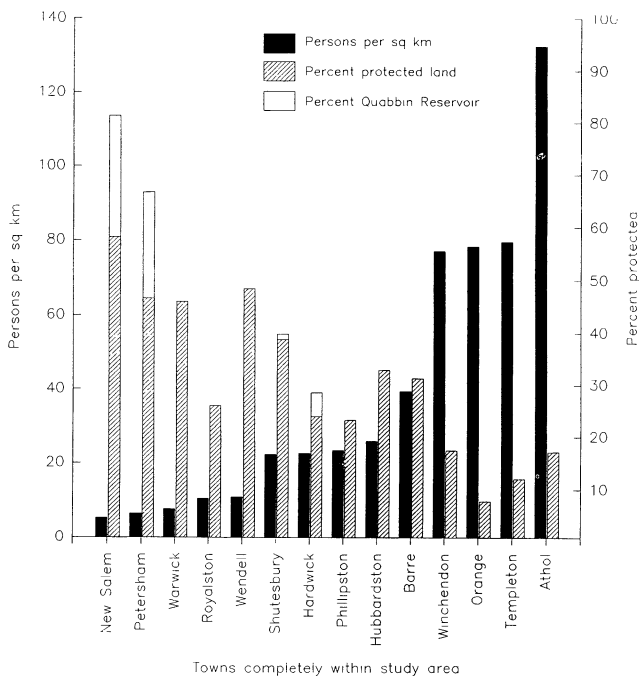


Figure 5. The relationship between population density and protected land in the North Quabbin Region. The surface area of water of the Quabbin Reservoir in each township is included in the total for protected land and is indicated separately.

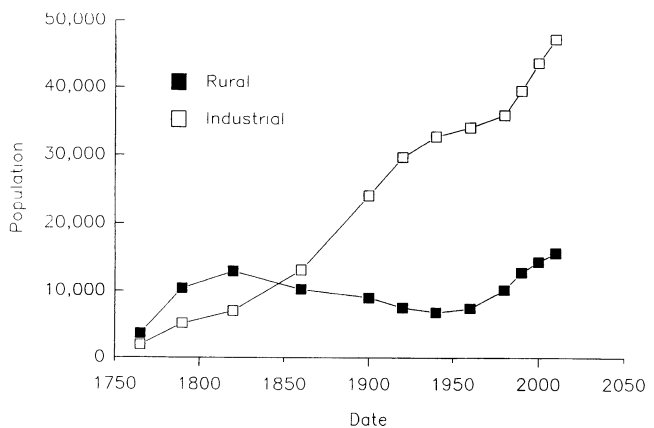


Figure 6. Population trends in the North Quabbin Region from 1765 to 2010. Data is included for all townships that are entirely or nearly entirely included within the boundaries of the study area. Townships are broken down into industrial (Athol, Barre, Erving, Orange, Templeton, Winchendon) and rural (Hardwick, Hubbardston, New Salem, Pelham, Petersham, Royalston, Shutesbury, Warwick, Wendell) based on population density and economic base. Data are from the U.S. Census and population projections are from MISER (1994).

3; cf. Koppes 1988). Growth in outdoor recreation broadened the focus of land protection to include public access (Cordell et al. 1989) and motivated land protection by the state Department of Fisheries and Wildlife and municipal Conservation Commissions. The growth of preservationist sentiment has increased the rate of land protection since 1980 and grassroots efforts have grown in importance with increased donations and new protection techniques, such as Conservation and Agricultural Preservation Restrictions (Fig. 3).

Characteristics of the Protected Areas

Remarkably, and of significance for conservation planning, the protected lands in the NQR are physically and biologically characteristic of the entire region (Tables 1-2). The main ecological difference between protected and non-protected land is the somewhat greater occurrence of rare species on protected lands (Table 2). Although this difference may be real, it may also result from a concentration of research activity on protected areas (P. Swain and H. Woolsey, personal communication).

The similarity between protected and non-protected lands in the NQR contrasts with many systems of protected lands, which are often dominated by either unique or low value land (Cordell et al. 1989), and is a direct outcome of low regional diversity and the area's specific preservation history, notably: (1) participation of diverse organizations with varied agendas; (2) predominance of large government acquisitions guided by broad-scale physiographic criteria; and (3) absence of coordination among groups.

Varying agendas for land protection through time have prevented a single conservation goal from dominating the NQR and have resulted in the preservation of diverse terrestrial and aquatic ecosystems. As numerous groups operated independently, haphazard acquisitions protected a variety of habitats and physiographic features in a range of parcel sizes (Table 1; Fig. 2). Large state and federal purchases contributed greatly to the protection of a representative sample of the landscape as these acquisitions were based on broad-scale physiographic characteristics that were essentially independent of economic or ecological value. In the case of the Quabbin Reservation, township-wide areas, which were regionally typical by virtue of their size, were protected at one time.

Value of the Protected Lands

The current value and future potential of protected lands in the NQR contrasts with preserved areas in developed parts of Massachusetts. In the Connecticut River Valley to the west and Cape Cod and Islands Region to the east, high species and habitat diversity along with intense development pressures and high land

prices have motivated the preservation of rarity in scattered, small areas (Dunwiddie 1990; Greenbaum & O'Donnell 1987). In contrast, the NQR comprises ecosystems typical of New England uplands with moderate diversity, low productivity, and modest numbers of uncommon species and communities (Kimball & Brown 1995). Low land prices and development pressures have enabled the protection of a large (37%), representative part of this landscape in sizable tracts (Fig. 2). Thus, although the value of the protected lands in the Valley and Coast includes uniqueness, a major potential of the NQR lies in the preservation of large typical landscapes.

Values of the NQR include (1) mosaics of wetland, water, and forest that can support species requiring extensive, diverse habitat; (2) opportunity to protect broad-scale ecological processes and systems; (3) connections to regional conservation areas; and (4) recreation. Forest and water are major resources of the NQR, which has one of the highest percentages of forest cover in Massachusetts (Fig. 1; More 1985). Extensive forests and the large Quabbin Reservoir present unique ecological benefits missing in developed areas of southern New England (Greenbaum & O'Donnell 1987), including habitat for forest interior species and species requiring large waterbodies. For example, the NQR has been important in the establishment of uncommon or new wildlife species, such as Bald Eagle (*Haliaeetus leucocephalus*), Turkey (*Melagris gallopavo*), and coyote (*Canis latrans*) and the range expansion of species previously restricted by deforestation, such as fisher (*Martes pennanti*), and moose (*Alces*), (P. Lyons, personal communication; DeGraaf & Rudis 1983). Protection of extensive forest areas also provide the potential to manage for large stands of old-growth forest (Hubley 1994) and broad-scale ecosystem processes (Noss 1992).

The NQR is an important component of regional conservation strategies. Through the participation of federal, state, and private groups, three corridors of protected land are being established across the NQR with linkages to western and eastern Massachusetts (Department of Environmental Management 1993; Phelps 1992; Ahern 1990; Bergman et al. 1990). On a broader scale the NQR connects with the developing Silvio O. Conte National Fish and Wildlife Refuge, which extends north and south along the Connecticut River Watershed (Silvio O. Conte National Fish and Wildlife Refuge Act 1991) and could be linked through protected land in New Hampshire or Vermont with the Northern Forest Lands of northern New England and New York (Harper et al. 1990; Kellett 1993). Incorporating the NQR protected lands into these plans will increase the conservation value and ecological integrity of all areas (Noss 1992).

Within densely populated southern New England, the NQR is a rural, forested enclave between the developed Connecticut River Valley to the west and south, the sprawling suburbs of Boston to the east, and the urban-

ized seaboard stretching from Boston to New York and beyond (Foster & Foster 1994). The NQR is accessible within 3 hours to urban populations exceeding 10 million people and thus has the potential to address ecological and human values. Recreation is an important component of local economies (Greenbaum & O'Donnell 1987) and a vital source of grassroots support for ongoing preservation activity (Conuel 1994).

Future Conservation Opportunities

Just as historical land use dramatically changed the New England landscape (Fig. 4), so has land protection permanently altered the NQR. Thirty-seven percent of the NQR has been restricted from specific uses. As the human population and development pressures increase in this region (Fig. 6), the protected land will become increasingly differentiated from the surrounding matrix. Although the haphazard historical approach to land protection has produced unique and important conservation opportunities, enhanced development and the real threat of landscape fragmentation and parcelization (D. Kittredge, in preparation) suggests that a comprehensive vision and conservation plan for the NQR is now needed.

Our temporal and spatial review of cultural, biological, and physical characteristics of the NQR suggests that this vision should focus on protection of intact, typical portions of the landscape in large tracts. The disaggregated pattern of protected land, however, makes it highly vulnerable to fragmentation and perforation (D. Kittredge, in review). To enhance values associated with large, continuous tracts, such as optimal habitat for certain Neotropical migrant birds, future acquisitions may need to be strategically located to increase the size of contiguous protected areas.

The diversity of land owners in the NQR brings both opportunity and complexity to land management. Contrasting agendas among 25 groups, combined with the dominant ownership of a few federal and state agencies, makes it difficult to develop a region-wide management plan. Nevertheless, the large amount of protected land, the inclusion of most landscape features within the protected landscape, and the diversity of parcel sizes allow for a range of management activities to occur from the protection of rarity to the maintenance of landscape-scale processes. Increased collaboration and exchange of information among groups is necessary if a comprehensive management strategy is to be developed.

The vision for the NQR must consider explicitly the relationship between the protected and non-protected landscapes. Unlike many regions where protected areas, non-protected areas, and developed areas are geographically separate, these three landscapes are integrated in the NQR (Fig. 2). This pattern constrains certain objectives (e.g., isolated wilderness areas) and creates the potential that development may threaten the integrity of

protected areas. The pattern also means that a balance of economic and conservation goals can be achieved. To do so, local involvement in landscape-level planning is critical. Examining local issues and controls such as zoning, the effect of protected land's tax-exempt status on municipal revenues, and economic development potential will contribute to the success of an integrated landscape that meets a variety of needs.

Conclusion

A representative cross-section of the NQR landscape has been protected in tracts comprising 37% of the area. An examination of the first 93 years of land protection reveals a unique and important conservation opportunity to protect large, typical portions of the landscape. Nevertheless, many years of land protection without coordination or a broad-scale plan has created threats. As development pressures increase, the opportunities for this area will only be fully realized with a clearly established vision, coordination among landowners, involvement of local residents, and participation of planners at the local, state, and regional levels. Planning and coordination must occur soon before land available for acquisition decreases and management problems increase. Although utilizing a broad temporal and spatial perspective of cultural and ecological factors provides useful information for turning the unplanned NQR into a more deliberate conservation system, such a perspective is applicable to and will be equally useful for any protected lands whether they are large or small, well established or just beginning.

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