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TECHNICAL
REPORT
67-34-ES

SEASONAL CHANGE REVEALED BY TIME-LAPSE PHOTOGRAPHY

by Roland J. Frodigh • Earth Sciences Division • March, 1967

UNITED STATES ARMY NATICK LABORATORIES
Natick, Massachusetts 01760

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U.S. Army Materiel Command
U.S. ARMY NATICK LABORATORIES
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FOREWORD

Most land areas of the world are affected by seasonal changes in climate — changes which often significantly alter the appearance and characteristics of the natural landscape. Such changes have military implications since they affect camouflage, opportunities for cover and concealment, and logistic requirements for specialized types of equipment.

This report analyzes seasonal contrasts in a mid-latitude region of the northeastern United States, an environment in which seasonal changes are pronounced. The intent is to show, from the viewpoint of the ground observer, how time-lapse photography may be used to describe contrasting surface conditions associated with each season and to identify their normal periods of occurrence. It is a fresh approach to environmental analysis in that it combines photographic, cartographic, and narrative descriptions of areas where seasonal changes in climate induce changes in such factors as vegetation color and density, visibility, trafficability and drainage.

The research on which this report is based was authorized and supported under the In-House Laboratory Independent Research (ILIR) program of the Natick Laboratories.

L. W. TRUEBLOOD
Chief
Earth Sciences Division

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ABSTRACT

This report demonstrates the application of time-lapse photographic techniques to a study of seasonal changes in coloration and appearance at sixteen locations in New England. The sites used to illustrate the method were selected for their representativeness of the four major physiographic regions: coastal lowland, uplands, interior lowlands, and mountains. Individual landscapes were photographed in color during each season, recording the identical field-of-view from the same spot locations. The photography is supplemented by topographic, vegetation, and climatic maps, graphs, site data, and narrative descriptions.

Factors pertaining to camouflage problems are documented photographically to illustrate significant changes in vegetation color. The combination of maximum visibility and minimum canopy coverage during periods of vegetation dormancy in forested areas is contrasted with greatly reduced visibility and nearly complete canopy coverage during the growing season. Trafficability problems in off-road areas are strikingly evident in scenes depicting winter snow accumulation and seasonal flooding in spring.

SEASONAL CHANGE
REVEALED BY TIME-LAPSE PHOTOGRAPHY

1. INTRODUCTION

In a mid-latitude region such as the northeastern United States, seasonal changes in the natural environment are pronounced. These changes are not only of scientific but also of military interest since they may have an impact on tactics, e.g., camouflage and opportunities for cover and concealment, and on logistics, e.g., the requirements for specialized types of equipment. This report documents the changes that occur in a typical environment of this kind by means of time-lapse photography, extending over a three-year period. Although the work accomplished demonstrates the usefulness of time-lapse photographic techniques in a specific regional study, New England seasonality, it is reasonable to assume that it also has wide application in analyzing seasonal change in other regions.

Photography, except in the specialized field of aerial photography, has played a comparatively minor role in geographic research. It could to advantage play a greater role, for, as Frederick Moncrieff of the University of Michigan has stated, "Rocket launchings, crystal formations, mechanical failures, plant growth, nuclear explosions, and thousands of other phenomena are captured on film as part of the scientific process." (1). To this list of applications should be added "natural environments." This report directs attention to the potential of the camera as a research tool for such studies.

2. INITIAL PROCEDURES IN IMPLEMENTING THE TIME-LAPSE CONCEPT

The Natick Laboratories in Massachusetts are well situated as a base from which to conduct a regional study of New England seasonality. Central location within a few hours drive of all parts of the region makes visits to even the most remote areas possible on a timely basis.

Forty-one landscapes were selected for analysis in this study, each depicting a terrain-vegetation association typical of one of the four major physiographic subdivisions: the coastal lowlands, the uplands, the mountains, and the interior lowlands (Fig. 1). Landscapes were recorded from the same site at different seasons, repeating the identical field-of-view, in order to show the full range of seasonal variation. Four-season coverage was recorded at all sites, with a fifth seasonal phase photographed during the early spring at 26 locations within 100 miles of the Natick Laboratories. This additional phase was included to portray that part of the year when vegetation is dormant and snow-cover is absent. All landscapes were recorded in color, with the early spring, summer, and winter periods also photographed in black and white. Full color, four-season reproduction of sixteen of the forty-one landscapes are included in this report, with the early spring period shown for twelve sites and the late spring shown for four.*

3. FIELD EQUIPMENT

The following equipment was used in the field for recording photographic, meteorological, and visibility information:

16mm Bell & Howell, Model 70 KRM, motion picture camera, with 25mm and 17mm lenses

35mm Kardon camera, with 50mm lens

4 x 5 inch Speed Graphic Camera with 127mm lens

**The original color and black and white photography as described in this technical report is available at these Laboratories.*

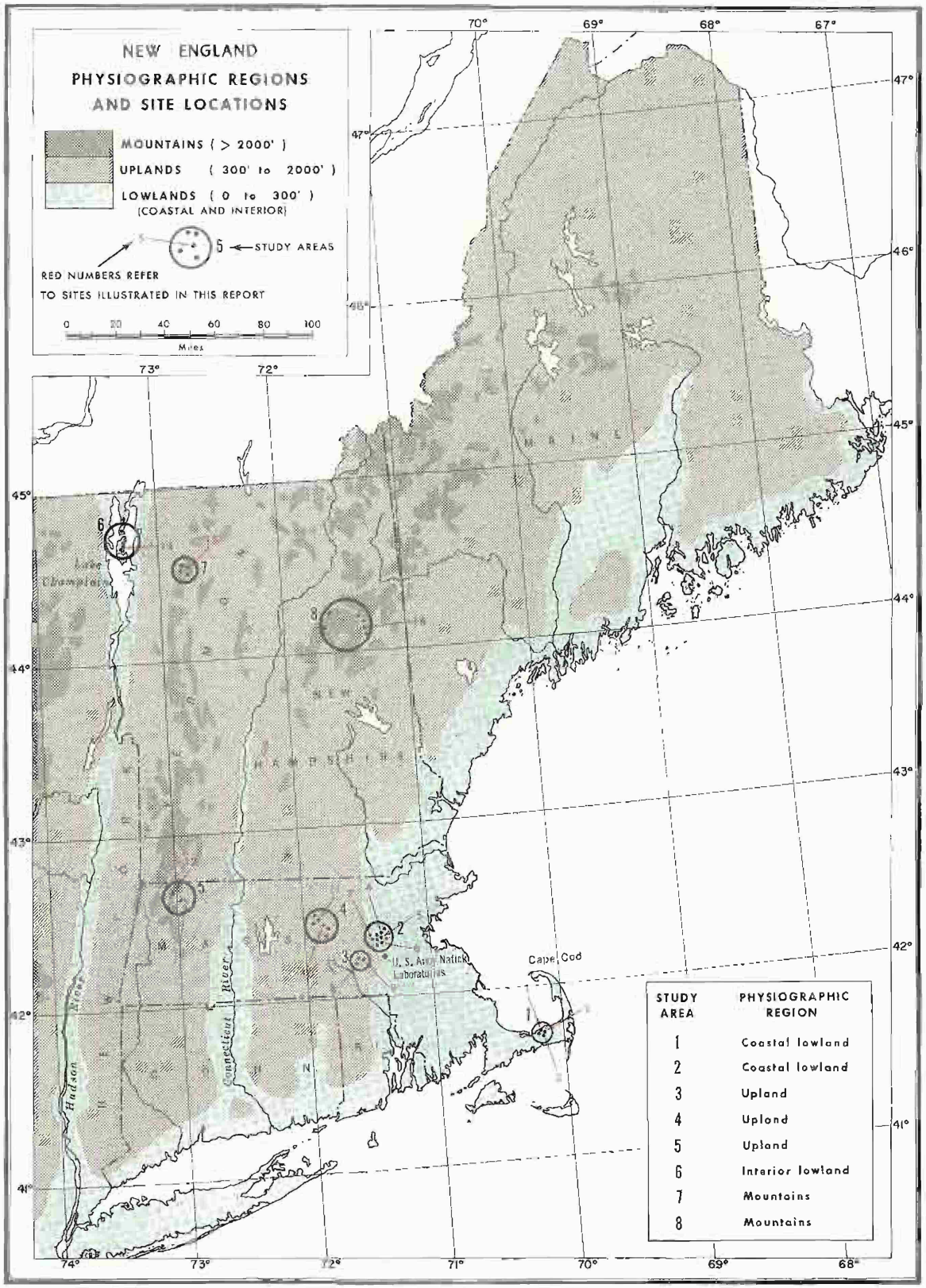

NEW ENGLAND
PHYSIOGRAPHIC REGIONS
AND SITE LOCATIONS
MOUNTAINS (> 2000')
UPLANDS (300' to 2000')
LOWLANDS (0 to 300')
(COASTAL AND INTERIOR)
5 ←STUDY AREAS
RED NUMBERS REFER
TO SITES ILLUSTRATED IN THIS REPORT
0 20 40 60 80 100
Miles
70° 69° 68° 67°
47° 46° 45° 44° 43° 42° 41°
73° 72° 71° 70° 69° 68° 74°
MAINE
NEW HAMPSHIRE
Lake Champlain
Hudson River
Connecticut River
U. S. Army Natick Laboratories
Cape Cod
STUDY AREA
PHYSIOGRAPHIC REGION
1 Coastal lowland
2 Coastal lowland
3 Upland
4 Upland
5 Upland
6 Interior lowland
7 Mountains
8 Mountains

Fig. 1

Weston exposure meter
Tripod
Film: 16mm and 35mm Kodachrome II (ASA 25)
4 x 5 inch black and white panchromatic, Kodak Superpan Press (ASA 250)
Hand anemometer
Sling psychrometer
Magnetic compass
Secchi disk (30cm, flat white)
Topographic maps

The three cameras listed were selected to give complete photographic coverage. Maximum realism was recorded by the 16mm motion picture camera, particularly in scenes where the action of wind or water was apparent. This equipment was also used for photographing random occurrences of meteorological phenomena such as thunderstorms, blizzards, and coastal gales. The 35mm camera, one of two still cameras used, provided color transparencies for projection and for color reproduction. The 4 x 5 inch camera was used to expose black and white film, providing negatives for printing enlargements and for offset reproduction. The sling psychrometer was used for recording dry and wet bulb temperatures; the hand anemometer for wind speeds. Wind direction and camera azimuth were determined with the magnetic compass. Visibility measurements were made in forested areas with a Secchi disk (3), a target 30 centimeters in diameter, painted flat white.

4. FIELD TECHNIQUES

When the point from which to photograph a particular landscape had been selected, the tripod was firmly set to provide a rigid camera base. Nearly all pictures were taken in bright sunlight during the high-sun period of the day (1000 to 1500 hours), in order to insure daylight color temperatures closely equivalent to the color balance of the film. All exposures were calculated from reflected light readings.

Motion picture coverage was recorded in most cases through a 17mm wide angle lens. Ten feet of film was exposed for each sequence at sound speed (24 frames/second). Generally, an additional ten feet of film was shot at one stop above and one stop below the aperture indicated by the meter, providing three exposures from which to select the one most closely approximating natural coloration. A film "clip" (two or three frames) cut from footage exposed on the first visit to each site was used as a reference guide for aligning the camera on subsequent visits, assuring smooth transition of time-lapse sequences in the edited film. The 35mm camera was used in a similar manner. Correct exposure indicated by the meter was "bracketed" and additional shots made to include the best possible exposure. One of the rejected transparencies served as a guide in framing the identical scene on repeat visits. A small hand viewer was found helpful for viewing both the 16mm film clip and the 35mm slide when adjusting the cameras for proper framing. Effects of fogging on internal lens elements were noticeable on some winter exposures, a problem which was overcome by acclimatizing the camera for longer periods before use. Of the three cameras used, the 4 x 5 inch equipment proved to be best suited for precise time-lapse registration. With a contact print made from the negative exposed on the first visit, the author framed each seasonal exposure on the ground-glass back of the camera, matching the two images. A medium yellow filter was normally used with this camera.

Photographic coverage in color on 35mm and 16mm film was recorded at each site for each season. Landscapes were not photographed in black and white during the late spring and early fall because differences between these seasons and the summer period are largely differences in color, and therefore can not be illustrated to any significant degree in monochrome photography.

Extensive field notes were taken at each site, including information for locating the camera position on return visits. Spot locations were identified by stakes, cairns, or individual rocks. When such objects were hidden under deep snow, it was relatively easy to "zero in" on the exact spot by referring to the black and white contact print, adjusting the camera position until the relative position of objects on the 4 x 5 inch ground-glass surface matched those on the 4 x 5 inch print. In selecting lowland sites, care was taken to avoid camera positions which are subject to seasonal flooding.

5. SEASONAL DEFINITIONS

In this report seasons are defined according to landscape appearance, a criterion not necessarily coincident with calendar seasons. For example, a landscape photographed on Cape Cod on 1 October, although after the autumnal equinox (21 September), would be recorded as a summer scene because summer appearances prevail. Conversely, a landscape photographed on 15 September in the White Mountains of New Hampshire would be designated as a fall scene. Thus the term season as used here is a definition based on visual identification. Length of seasons and periods of occurrence within four sub-regions are shown in Figure 2.

a. Early Spring Landscapes photographed during this season are actually representative of that part of the year when vegetation is dormant and snow-cover is absent, a period which extends from the end of early fall to the beginning of late spring. Major differences between early spring and late fall are found in contrasting ground surface conditions. Tall grass, erect in the late fall, becames matted and bent by winter snows, and low water levels of late fall contrast with the high water of early spring (Plate 4).

b. Late Spring Everywhere in New England, late spring begins well after the vernal equinox (21 March). It is a period of new vegetative growth, terminating between late May and mid-June when full leaf growth is attained. Coastal locations experience a seasonal lag of two to three weeks compared with interior areas.

c. Summer The summer season extends from late May through early October, varying from 12 to 16 weeks in length, and is identified as the period when vegetation is green and in full leaf.

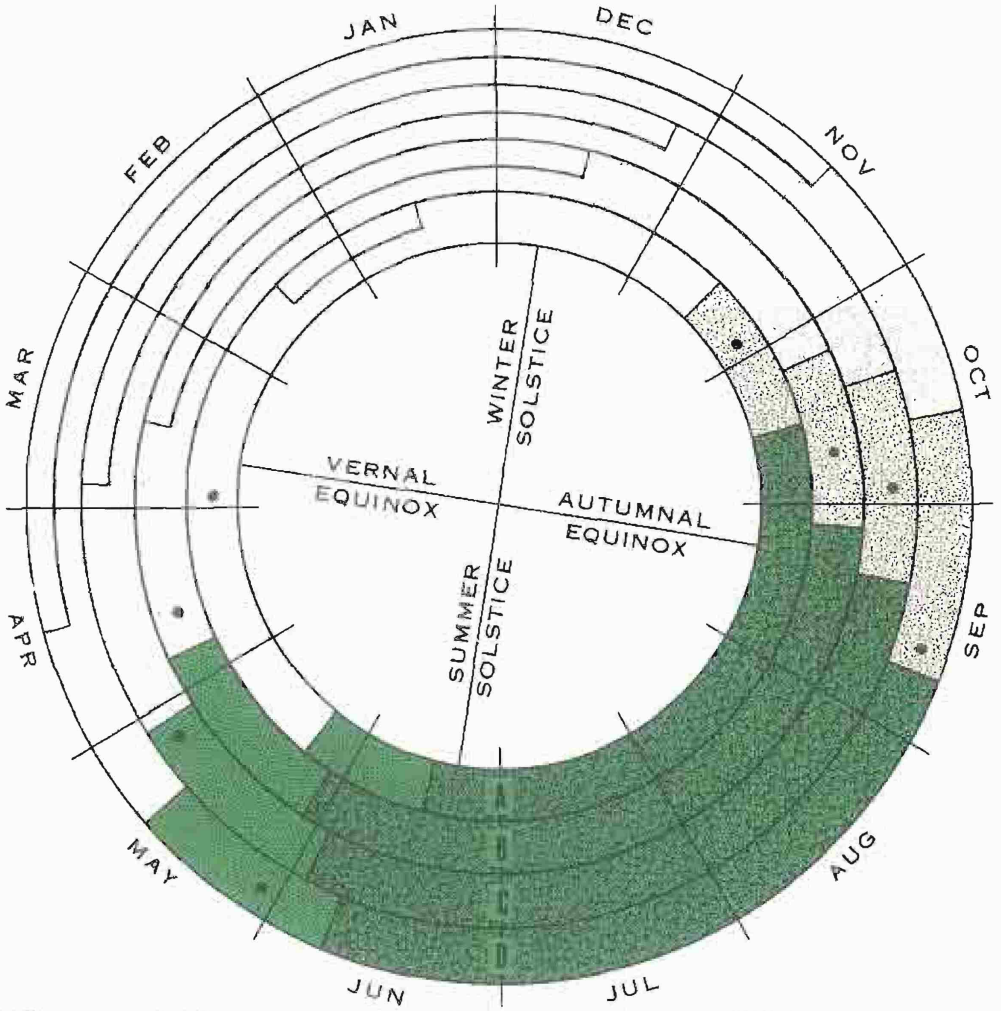
d. Early Fall Coloration changes in deciduous vegetation mark the beginning of fall. This season comes first to the mountains and last to coastal areas, where ocean waters have a moderating influence on the climate. The early fall period lasts from four to six weeks and ends when nearly all leaves have fallen.

e. Late Fall This part of the fall, like the early spring, represents a period when vegetation is dormant and snow-cover is absent, but unlike the early spring, water levels normally are low, and tall grass, as yet unaffected by winter snows, provides some cover.

f. Winter In this study, winter is treated as the period between late fall and early spring when there is snow-cover on the ground. The average length of the winter season varies from one month or less on Cape Cod and the offshore islands, to more than four months in northern and interior New England.

6. REGIONAL GEOGRAPHY

Time-lapse photographic sequences of seasonal landscape contrasts, however revealing, become more informative when supported by information of a type designed to describe such related geographic factors as seasonal distributions of temperature and precipitation, period of occurrence and length of seasons, duration of snow-cover, and provide information relative to terrain, hydrography, vegetation and visibility. The following sections on climate, topography, and vegetation present descriptive regional geographic information closely related to the study of seasonality.

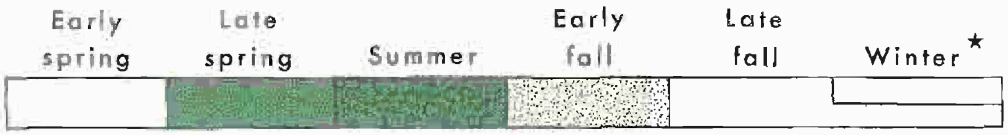


A. COASTAL LOWLAND (near-shore) - Plates 1–3

B. COASTAL LOWLAND (inland) - Plates 4–7

C. UPLAND - Plates 8–13

D. MOUNTAINS - Plates 15 & 16



• Mean dates of last killing frost in the spring and first killing frost in the fall.

★ Mean number of weeks with snow-cover is indicated by length of the white bands. Snow-cover is normally continuous during the colder months in northern sections and in the mountains, and is normally intermittent along the coast and in southern areas.

Mean duration and period of occurrence of seasons in four New England sub-regions.

Fig. 2

a. **CLIMATE** Although no part of New England lies more than 175 miles from the Atlantic Ocean, its climate is predominantly continental, under the influence of prevailing westerly wind flow. Cold air masses of polar origin, and moist tropical air masses from the south meet over the North American continent, creating cyclonic storms which in their normal west to east movement significantly affect New England weather. The influence of the ocean is felt when moisture-laden air is carried onshore by counterclockwise circulation around "lows" passing over or close to New England, a condition which spawns blizzards (Northeasters) during the winter months. The coastal snow accumulation illustrated in Plates 1, 2 and 3 was the result of a winter storm of this type.

(1) **Temperature** Wide differences in temperature from place to place and from season to season in New England are attributed to the six degree latitudinal range of the region, moderate differences in altitude, and the proximity of the Atlantic Ocean (4). These differences are reflected in the duration and period of occurrence of each season, and in the duration of snow-cover shown in Figure 2. Also illustrated in this figure is the seasonal "lag" experienced along the coast, where the summer period occurs almost entirely after the high-sun period of the summer solstice (21 June). Figures 4 through 7, mean daily minimum and maximum temperatures for January and July, show regional distributions as well as diurnal variations of temperature during periods representative of summer and winter extremes.

(2) **Precipitation** A relatively even distribution of precipitation throughout the year characterizes all New England. Mean annual precipitation varies from approximately 30 inches in the Champlain Valley (Fig. 15, Plate 14), to more than 50 inches in the mountains (Fig. 15, Plates 15 and 16). Brooks (5)writes: "The heavy storms of winter, the storms and showers of spring, the summer thunderstorms and occasional general storms, and the autumn rains of tropical or mid-latitude origin provide a fairly uniform seasonal distribution for all New England. There is, however, a distinct summer maximum and winter minimum well into the interior and a winter maximum and summer minimum on the coast. The summer maximum is due to the strong development of summer showers in the interior, and the winter maximum to the frequency with which storms affect the coasts. In the belt between the coast and interior, the rainfall is nearly the same in all months." Annual snowfall varies from less than 30 inches on Cape Cod to more than 100 inches in highland areas, and the average annual duration of snow-cover varies from less than 30 to more than 120 days. Snow-cover during the colder months is normally continuous in the mountains and in the interior north, whereas warm spells in southern and coastal areas result in an intermittent snow-cover.

Periods of drought are not uncommon to New England, and when annual rainfall drops several inches below the annual average for two or three consecutive years, water shortages become acute. Prolonged dry periods also create serious fire hazards, alter landscape coloration, and reduce water levels, particularly during the late summer and fall as illustrated in Plate 4. Dominant brown coloration of the fall scene attests to the effects of prolonged drought, accentuated by normal seasonal color transformation in deciduous vegetation. Conversely, flood control dams have been constructed by the Corps of Engineers along many rivers to control and absorb the impact of unusual run-off, often associated with heavy spring or late winter rainfall and snow-melt above still frozen ground. Normal early spring flooding is clearly evident in Plate 4. The lakelike appearance of such inundated lowlands is contrasted with the turbulent flow of upland and mountain streams. In the late summer and early fall, hurricanes sometimes cause heavy

precipitation as well as abnormally high tides along the coast. Coastal gale conditions, resulting from such a hurricane passing east of New England, have been recorded for this study on motion picture film.

b. **TOPOGRAPHY** The surface geology of New England has been analyzed by numerous authorities. One of the most descriptive explanations advanced for the complex patterns of landforms that have evolved is that given by Wright (6), the following excerpt from which summarizes the principal causative forces underlying the New England scene as we know it today. "Much of New England is a country of ancient, worn-down mountains, a land of extremely complex rock structure. The ceaseless forces of erosion have etched out a pattern of valleys below the general levels to which the mountains were reduced far back in geological times, and the complexity of relief reflects the complexity of the underlying rocks. The invasions and retreats of the continental ice sheets did much to accentuate the diversified quality of the surface. The ice scraped the earth and carried away pieces of rock from countless hillsides; it dropped its load in moraines, damming streams and impounding the waters in lakes and ponds. It turned rivers aside from their older channels. It scattered boulders and gravel far and wide. Its melting waters gathered along the ice fronts in lakes, now vanished. On the floors of these lakes, sand and mud were laid down, and these deposits today form little plains, often terraced by post-glacial streams." Landscapes recorded for this report illustrate the diversity of the New England topography. Slow-flowing, low-gradient rivers meandering along broad floodplains (Plate 4), contrast with high gradient mountain and upland streams (Plates 13, 15 and 16), draining narrow steep-walled valleys. Precipitous, rocky slopes are contrasted with wide lowland valleys.

c. **VEGETATION** About three-quarters of the land surface of New England is forested. Mixed stands of coniferous and deciduous trees characterize much of the countryside, but pure stands of conifers predominate in some places. Changes in the appearance of the mantle of deciduous trees, as described in Chapter 5 (Seasonal Definitions), were key factors in determining normal seasonal durations for this study (Fig. 2). Only the winter season is determined by landscape characteristics other than vegetation.

A detailed study of the natural forests of New England has been published by the Committee on Silviculture, New England Section, Society of American Foresters (7). The delineation of forest zones on the Vegetation Map (Fig. 3) and the following zone descriptions are based on this work.

Zone 1 Spruce-Fir-Northern Hardwoods This is the only forest zone in New England where softwoods (conifers) may outnumber the hardwoods. Within the zone are the extensive coniferous forests of northern New England, with southerly extensions along the Maine coast, along the Green Mountains of Vermont into the Berkshires of Massachusetts, and along the White Mountains of New Hampshire. In general, spruce-fir stands occur on high slopes, ridges, and in swampy areas. The northern hardwoods of Zone 1 are subdivided into two groups. Beech, sugar maple, and yellow birch are dominant on lower slopes and well-drained flats. Paper birch, aspen, and red maple grow on higher slopes and poorly drained areas near streams and lakes. Plates 15 and 16 illustrate the spruce-fir-northern hardwood association in the Green and White Mountains. Conifers are shown in mixture with hardwoods, but occur as pure stands only in relatively small patches and along ridges. It is evident from these photographs that forests in the southern extensions of Zone 1 are dominated by hardwoods.

Zone 2 Northern Hardwoods - Hemlock - White Pine Beech, sugar maple and yellow birch are the dominant hardwoods of Zone 2. Less abundant, but widespread throughout the

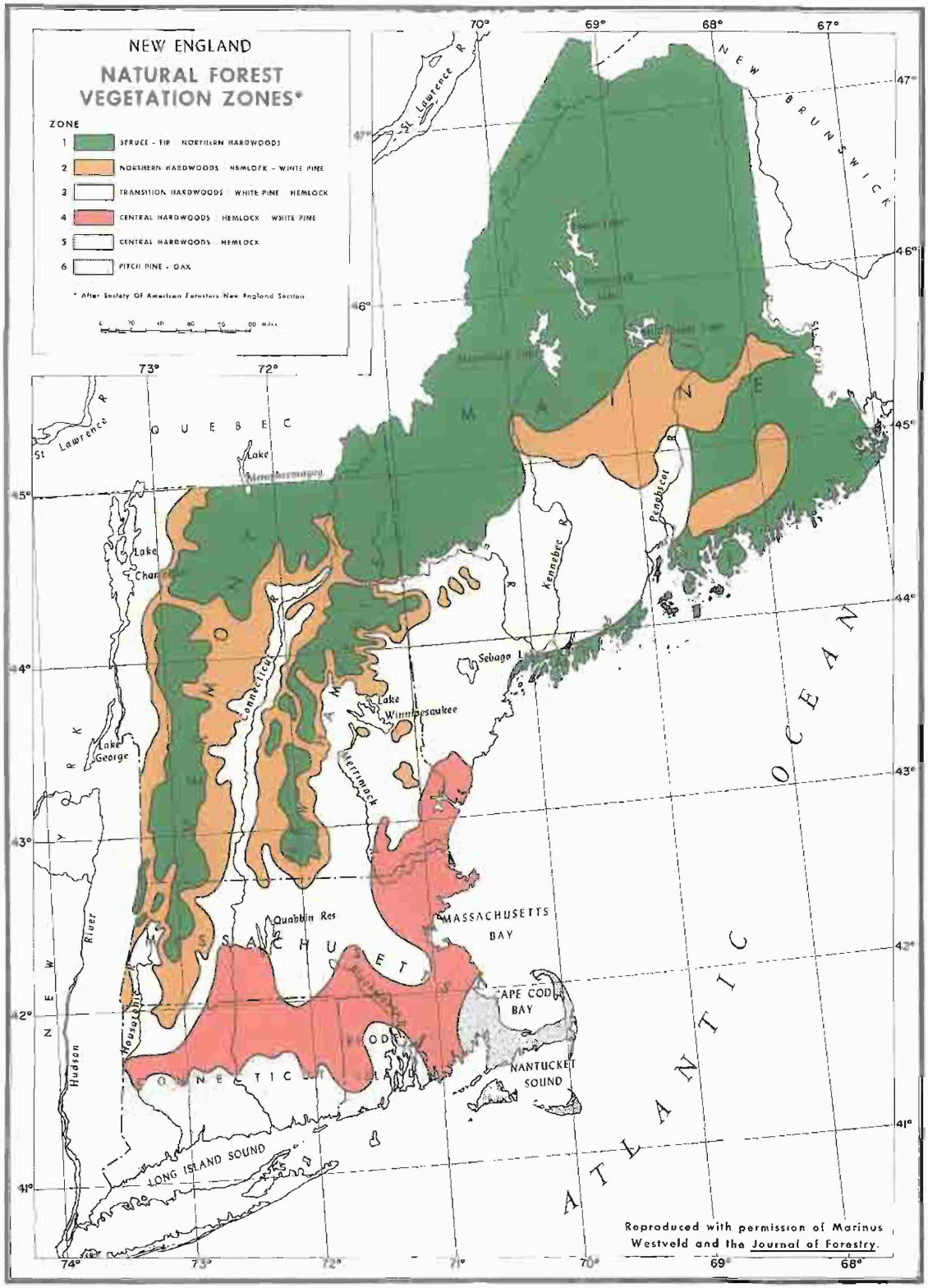

NEW ENGLAND
NATURAL FOREST VEGETATION ZONES*
ZONE
1 SPRUCE - FIR - NORTHERN HARDWOODS
2 NORTHERN HARDWOODS - HEMLOCK - WHITE PINE
3 TRANSITION HARDWOODS - WHITE PINE - HEMLOCK
4 CENTRAL HARDWOODS - HEMLOCK - WHITE PINE
5 CENTRAL HARDWOODS - HEMLOCK
6 PITCH PINE - OAK
* After Society Of American Foresters New England Section
St Lawrence R.
QUEBEC
NEW BRUNSWICK
MAINE
Lake Memphremagog
Lake Champlain
Connecticut R.
Kennebec R.
Penobscot R.
Sebago L.
Lake Winnipesaukee
Merrimack R.
Lake George
Quabbin Res.
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
Housatonic River
Hudson River
LONG ISLAND SOUND
ATLANTIC OCEAN
Reproduced with permission of Marinus Westveld and the Journal of Forestry.

Fig. 3

zone are white ash, black cherry, sweet birch, paper birch, northern red oak, American elm, and basswood. Occurring in mixture with the hardwoods are hemlock, white pine and some spruce and balsam fir. A scattering of oaks in addition to red oak is confined to the southern margin of the zone.

Zone 3 Transition Hardwoods-White Pine-Hemlock Here, the northern hardwoods and the central hardwoods overlap, constituting a zone in which the majority of New England hardwoods are represented. In certain areas, northern and southern species grow together in the same stand, whereas in other areas patches of northern species alternate with patches of southern species, forming a mosaic pattern.

Zone 4 Central Hardwoods-Hemlock-White Pine Dominant hardwoods of Zone 4 are black, red, and white oaks, and shagbark and bitternut hickories. Also present are red maple, chestnut oak, and black birch. White pine is abundant on sandy sites but may be entirely lacking over large areas. The boundary between Zones 3 and 4 is indistinct, since the northern hardwoods of Zone 3 give way to the central hardwoods of Zone 4 through a wide transitional area within which the hardwoods of both zones are about equally represented.

Zone 5 Central Hardwoods-Hemlock Oaks and hickories are the dominant hardwoods, but some sugar maple, beech and yellow poplar are present on lower slopes and along valley bottoms. Xerophytic species such as the black, scarlet, chestnut, and bear oaks grow on thin and drier soils. Hemlock is the key conifer in this zone with eastern red cedar associated with abandoned fields.

Zone 6 Pitch Pine-Oak The pitch pine-oak region of southeastern Massachusetts is the least extensive of New England's forest zones. It also has the least number of species. Pitch pine and oak grow in separate stands, as shown in Plates 1 and 2, as well as in pine-oak mixtures with small pine stands (Plate 3). Pitch pine is dominant on drier soils within the zone.

7. COLOR PLATES

In this section, four-season, full-color reproductions are included for 16 New England landscapes (Fig. 1). Opposite each color plate is a page designed to supplement the photography with location information, description of the area, meteorological data recorded at the time each landscape was photographed, visibility data, and notes pertaining to seasonal features having particular military significance. The average duration of each season is shown on a bar graph, and a topographic map depicts the area planimetrically, with the photographed field-of-view indicated in color.

Natural coloration is closely matched in the Kodachrome transparencies from which these four-color lithographic plates were made. However, in printing the plates there has been some loss in accurately reproducing the coloring in the original photography. A comparison of the plates with the transparencies shows that seasonal color contrasts as represented in the lithographs are not exaggerated, but in general are more subdued than in nature.

LOCATION: Dennis, Massachusetts (Cape Cod). Lat. 41°44′40″ N. Long. 70°11′10″ W. Elevation: 17 feet above mean sea level. Physiographic classification: Coastal lowland, glacial terminal moraine. Local relief: 40 feet on moraine, 20 feet on coastal plain. Lake level: 20 feet above mean sea level. Vegetation: Pitch Pine-Oak. Camera azimuth: 150°.

AREA DESCRIPTION: Scargo Hill, a dominant feature of the terminal moraine, is viewed from the north shore of Scargo Lake, a fresh water pond on the mile-wide coastal plain. Contrasting with the relatively low relief of the plain, Scargo Hill rises steeply (34% grade) from the lake shore. Morainal hills are densely forested in pitch pine and scrub oak (see detailed vegetation and visibility data for Plate 2). Seasonal variations in ground conditions affecting vehicular mobility are less significant here than in many areas of New England because of the high porosity of glacial sands and gravels. Rainfall rapidly filters through this material to the water table, a source of potable water, generally within a few feet of the surface. There is little surface runoff and fresh-water streams are almost non-existent. Unpaved roads are generally passable at all seasons, except during brief periods with snow-cover (Fig. 2).

EARLY SPRING

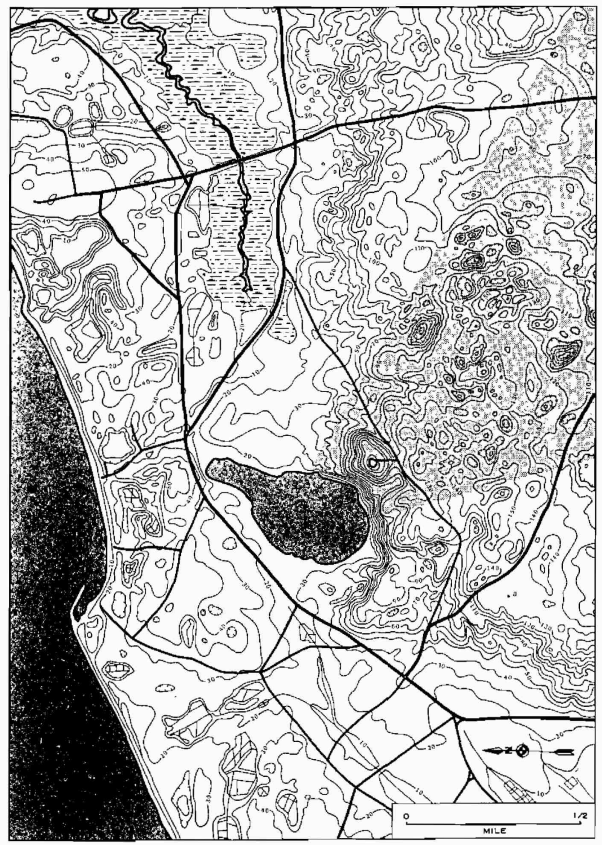
J F M A M J J A S O N D

Date: 4 May 1964 Hour: 1500
Temp: 65° Dewpoint: 34°
Relative humidity: 32%
Wind: Southwest, 12 mph
Sky cover: None
Mean visibility (oak forest): 250 feet
Notes: Best cover in pine stands. Eroded gully clearly evident on Scargo Hill.

SUMMER

J F M A M J J A S O N D

Date: 18 Sep 1964 Hour: 1445
Temp: 74° Dewpoint: 60°
Relative humidity: 62%
Wind: Southwest, 5 mph
Sky cover: 1/10 fractocumulus
Mean visibility (oak forest): 75 feet
Notes: Pine and oak forests provide excellent cover. Erosion scar on Scargo Hill concealed by oak canopy.



EARLY FALL

J F M A M J J A S O N D

Date: 2 Nov 1964 Hour: 1345
Temp: 50° Dewpoint: 42°
Relative humidity: 74%
Wind: Northeast, 8 mph
Sky cover: 1/10 cumulus, 8/10 thin cirrus and cirrostratus.
Notes: Dry oak leaf litter on forest floor noisy under foot.

WINTER

J F M A M J J A S O N D

Date: 17 Jan 1964 Hour: 1430
Temp: 37° Dewpoint: —
Relative humidity: —
Wind: Northwest, 5 mph
Sky cover: None
Snow-cover: 10 inches
Notes: Lake surface solidly frozen. Best cover in pine stands.

Plate 1

Plate 2

LOCATION: Dennis, Massachusetts (Cape Cod). Lat. 41°44′21″ N. Long. 70°10′51″ W. Elevation: 165 feet above mean sea level. Physiographic classification: Coastal lowland, glacial terminal moraine (wave built short features). Local relief: 40 feet on moraine; 20 feet on coastal plain. Vegetation: Pitch Pine-Oak. Camera azimuth: 345°. Tidal range: 10 feet.

AREA DESCRIPTION: View is from tower on summit of Scargo Hill, shown on Plate 1. Hills average 100 feet above sea level and have a dense cover of scrub oak and pine, mixed, and in pure stands. Trees average 4½″ in diameter and 20 feet in height, and spacing between trees averages 7 feet. Crowns are interlaced forming a solid canopy during the full leaf period (early June through late October). A narrow belt of sand dunes (10 to 20 feet high) borders the bay shore, breached by salt water creeks and marshes which extend inland on the coastal plain and parallel the coast near the base of the morainal hills. These drainage features represent natural barriers to surface travel. Scargo Lake, shown here, is one of many fresh-water lakes and ponds which occupy numerous depressions (kettles) in the glacial topography. Typically, such water bodies are not associated with stream drainage systems, but reflect a perennial source of ground water.

EARLY SPRING

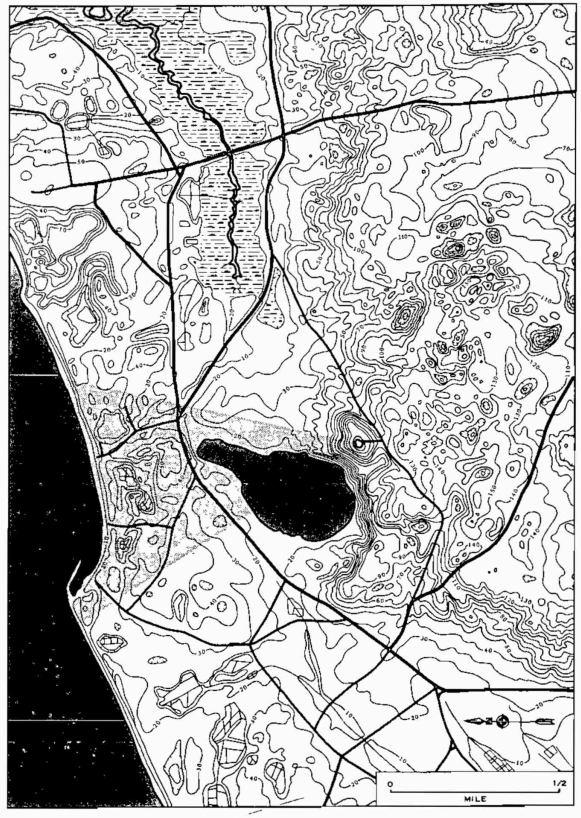
J F M A M J J A S O N D

Date: 4 May 1964 Hour: 1430
Temp: 65° Dewpoint: 28°
Relative humidity: 25%
Wind: Southwest, 8 mph
Sky cover: None
Mean visibility (oak forest): 250 feet
Notes: Compare dormant vegetation with spring scene, Plate 15, taken 9 days later in Mts., 190 miles north of Cape Cod.

SUMMER

J F M A M J J A S O N D

Date: 18 Sep 1964 Hour: 1300
Temp: 75° Dewpoint: 61°
Relative humidity: 62%
Wind: Southwest, 5 mph
Sky cover: None, moderate haze
Mean visibility (oak forest): 75 feet
Notes: Pine and oak forests provide excellent cover.



EARLY FALL

J F M A M J J A S O N D

Date: 2 Nov 1964 Hour: 1310
Temp: 50° Dewpoint: 42°
Relative humidity: 74%
Wind: Northeast, 10 mph
Sky cover: 2/10 cumulus, 1/10 cirrostratus.
Notes: Many oak leaves remain on trees well into the late fall and early winter.

WINTER

J F M A M J J A S O N D

Date: 17 Jan 1964 Hour: 1300
Temp: 37° Dewpoint: —
Relative humidity: —
Wind: Northwest, 10 mph
Sky cover: None
Snow-cover: 10 inches
Notes: Snow windrows appear on lake ice.

LOCATION: Dennis, Massachusetts (Cape Cod). Lat. 41°44′21″ N. Long. 70°10′51″ W. Elevation: 165 feet above mean sea level. Physiographic classification: Glacial terminal moraine, and pitted outwash plain. Local relief: 40 feet on moraine, 20 feet on outwash plain. Vegetation: Pitch Pine-Oak. Camera azimuth: 155°.

AREA DESCRIPTION: Viewed from the same site as Plate 2 (approximately 180° difference in azimuth), the morainal hills slope gradually to the south, merging with a pitted outwash plain (also of glacial origin), terminating at the wave-built beaches on Nantucket Sound, six miles south of Scargo Hill. Dominant vegetation on the moraine and outwash plain is scrub oak and pine (see detailed vegetation data for Plate 2). At lower levels, and in protected valleys, trees are larger in all respects than those exposed to coastal winds on ridges and exposed slopes. In forested areas low branches and underbrush impede foot travel, but offer good cover. Fresh water ponds are numerous and occupy many depressions (kettles). The forest vegetation, tidal rivers, and to a lesser extent the irregular terrain, limit vehicular traffic to established roads.

EARLY SPRING

J F M A M J J A S O N D

Date: 4 May 1964 Hour: 1510
Temp: 64° Dewpoint: 36°
Relative humidity: 35%
Wind: Southwest, 8 mph
Sky cover: None
Mean visibility (oak forest): 250 feet

SUMMER

J F M A M J J A S O N D

Date: 18 Sep 1964 Hour: 1415
Temp: 75° Dewpoint: 61°
Relative humidity: 62%
Wind: Southwest, 4 mph
Sky cover: None, moderate haze
Mean visibility (oak forest): 75 feet
Notes: Pines and oaks coalesce to form a solid canopy.

EARLY FALL

J F M A M J J A S O N D

Date: 2 Nov 1964 Hour: 1320
Temp: 50° Dewpoint: 42°
Relative humidity: 74%
Wind: Northeast, 10 mph
Sky cover: 2/10 cumulus, 1/10 cirrostratus.
Notes: Dead oak leaves on trees provide some cover after the beginning of the dormant period.

WINTER

J F M A M J J A S O N D

Date: 17 Jan 1964 Hour: 1330
Temp: 37° Dewpoint: —
Relative humidity: —
Wind: Northwest, 10 mph
Sky cover: None
Snow depth: 10 inches
Notes: Normally snow-cover is intermittent through the winter.

Plate 3

Plate 4

LOCATION: Wayland, Massachusetts. Lat. 42°23′50″ N. Long. 71°21′53″ W. Elevation: 120 feet above mean sea level. Physiographic classification: Sudbury River floodplain, coastal lowland. Local relief: 100 feet. River gradient: 6″/mile. Vegetation: Central Hardwoods-Hemlock-White Pine. Camera azimuth: 295°.

AREA DESCRIPTION: The Sudbury River is typical of many meandering, low gradient streams draining the coastal lowland belt of eastern Massachusetts. For ten miles in the area photographed, the flat Sudbury River floodplain averages six-tenths of a mile in width, varying from 250 feet to slightly more than one mile. Average stream width is approximately 175 feet. Vegetation on the valley floor consists of marsh grass, duckweed and other hydrophytic plants. Higher ground and hills are wooded, with red maple and oak at lower elevations interspersed with white pine. Oak, maple, ash, and spotty stands of white pine are dominant at higher levels. River water is not potable because of industrial pollution. Relatively small increases in water level (12 to 18 inches) cause widespread inundation. From mid-May to mid-October, wooded areas provide excellent cover from aerial surveillance.

EARLY SPRING

J F M A M J J A S O N D

Date: 1 Apr 1964 Hour: 1515
Temp: 42° Dewpoint: 13°
Relative humidity: 30%
Wind: Northwest, 15 mph
Sky cover: 2/10 cumulus
Notes: Normal early spring inundation. Normal stream channel difficult to identify. Current noticeable only in narrows.

SUMMER

J F M A M J J A S O N D

Date: 9 Aug 1963 Hour: 1430
Temp: 85° Dewpoint: 62°
Relative humidity: 47%
Wind: Southwest, 3 mph
Sky cover: None
Notes: Drought conditions extending into fall period. Normal low water during summer and fall. Slight current. Cover afforded by marsh grass (2-3 feet high). Algae form on the river.

EARLY FALL

J F M A M J J A S O N D

Date: 16 Oct 1963 Hour: 1445
Temp: 77° Dewpoint: 43°
Relative humidity: 30%
Wind: West, 5 mph
Sky cover: 1/10 cirrus
Notes: Drought conditions. Serious fire hazard. Cover on floodplain provided by marsh grass.

WINTER

J F M A M J J A S O N D

Date: 8 Jan 1964 Hour: 1440
Temp: 38° Dewpoint: 19°
Relative humidity: 46%
Wind: Northwest, 2 mph
Sky cover: 2/10 cirrus
Snow depth: 6 inches
Notes: River surface is completely ice covered. Floodplain is easily traversed on foot. Best cover is in white pine stands.

LOCATION: Wayland, Massachusetts. Lat. 42°21′47″ N. Long. 71°22′25″ W. Elevation: 120 feet above mean sea level. Physiographic classification: Sudbury River floodplain, coastal lowland. Local relief: 100 feet. River gradient: 6″/mile. Vegetation: Central Hardwoods-Hemlock-White Pine. Camera azimuth: 155°.

AREA DESCRIPTION: Normal seasonal variations in the water level of low gradient rivers of the coastal lowland are illustrated in this landscape as well as in the preceding one. The Sudbury River, meandering sluggishly along its broad, marshy floodplain, contrasts with clear, rapidly flowing streams of the upland and mountains (Plates 10, 13, and 16). Whereas land routes closely parallel mountain and upland streams (Plates 10, 13, and 16), swamp bordered lowland rivers represent obstacles to travel, and highways are ordinarily located away from them, on higher ground, except where they bridge such streams. Tidal streams along the coast, and fresh water rivers like the Sudbury, are similar in appearance and pose similar problems in respect to military operations. During the ice-free period of the year, the muddy bottom and banks are obstacles to both vehicles and personnel attempting to ford the river.

EARLY SPRING

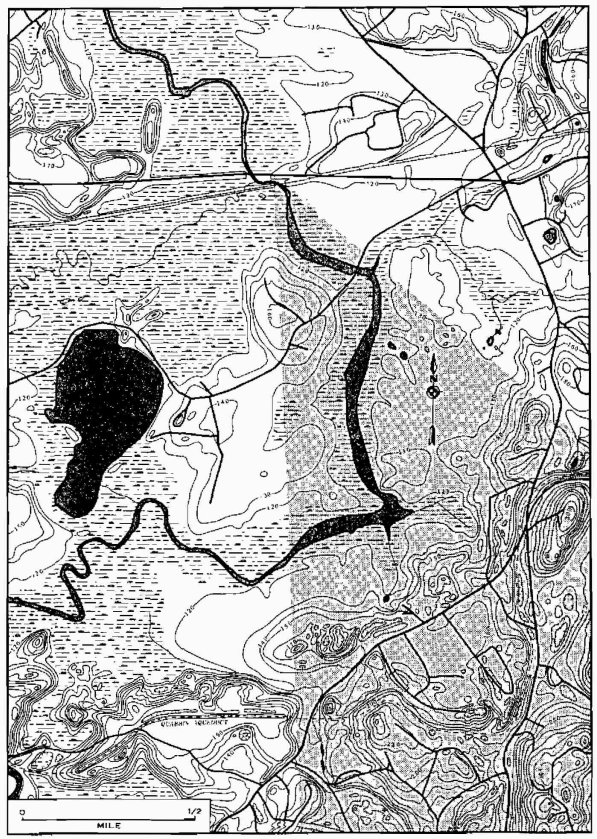
J F M A M J J A S O N D

Date: 10 Apr 1964 Hour: 1530
Temp: 62° Dewpoint: 32°
Relative humidity: 33%
Wind: West, 5 mph
Sky cover: 5/10 cumulus
Notes: Period of maximum high water, associated with spring rains and snow melt.

SUMMER

J F M A M J J A S O N D

Date: 16 Aug 1963 Hour: 1330
Temp: 75° Dewpoint: 52°
Relative humidity: 45%
Wind: Northwest, 3 mph
Sky cover: 1/10 cumulus
Notes: Low water period extending into fall.



EARLY FALL

J F M A M J J A S O N D

Date: 12 Oct 1964 Hour: 1500
Temp: 65° Dewpoint: 31°
Relative humidity: 28%
Wind: West, 10 mph
Sky cover: None
Notes: Normal low water conditions.

WINTER

J F M A M J J A S O N D

Date: 16 Jan 1964 Hour: 1515
Temp: 34° Dewpoint: —
Relative humidity: —
Wind: West-northwest, 4 mph
Sky cover: None
Snow depth: 6 inches
Notes: Water level rises during the winter season.

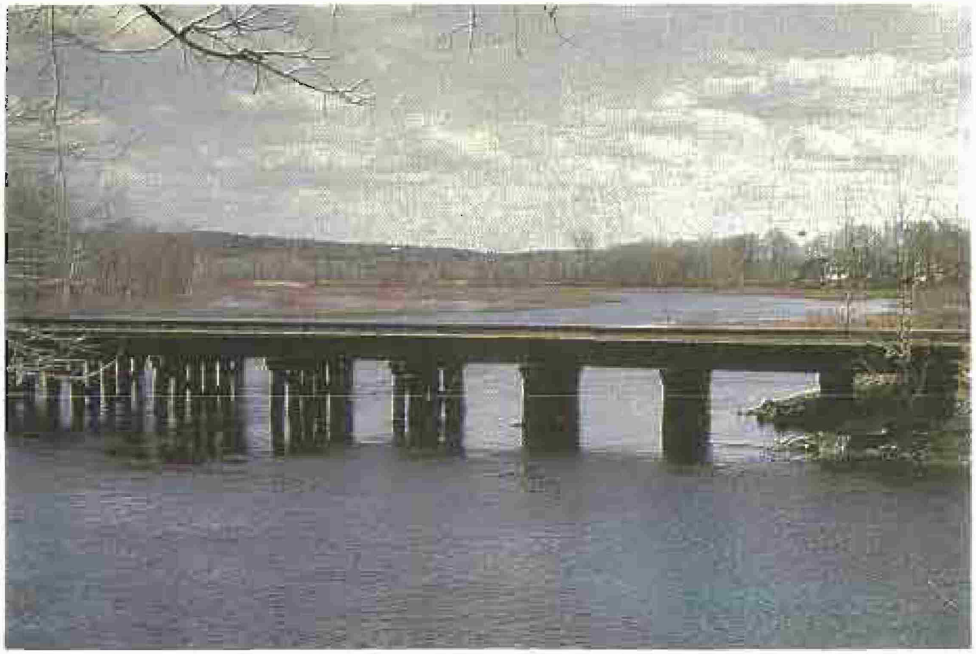


Plate 5

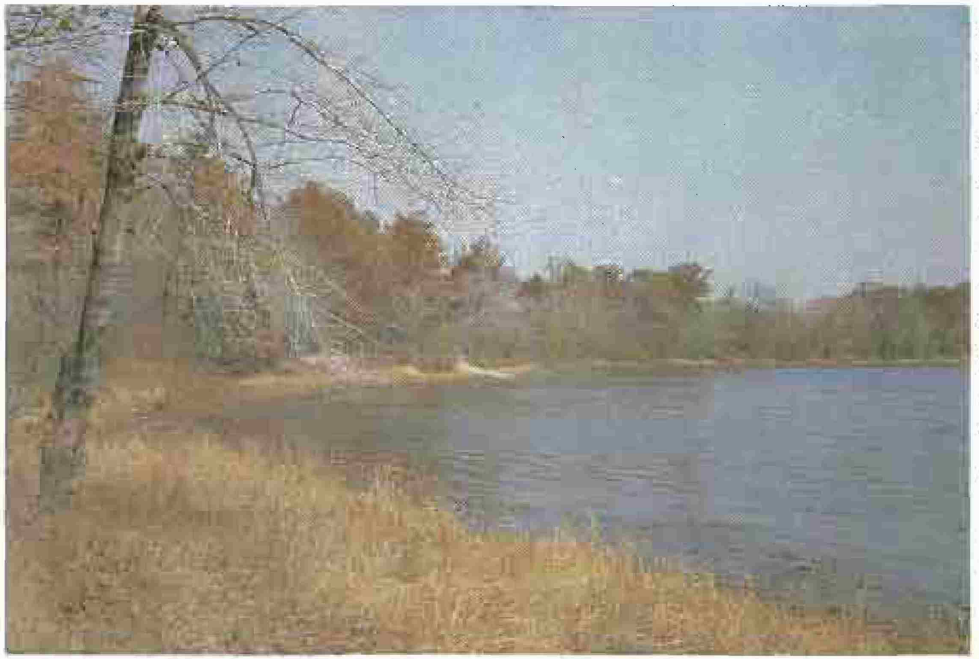


Plate 6

LOCATION: Wayland, Massachusetts. Lat. 42°21′17″ N. Long. 71°23′12″ W. Elevation: 115 feet above mean sea level. Physiographic classification: Sudbury River floodplain, coastal lowland. Local relief: 50 feet. Stream gradient: 6″/mile. Vegetation: Central Hardwoods-Hemlock-White Pine. Camera azimuth: 120°.

AREA DESCRIPTION: Heard Pond is one of several water bodies located along the flat, marshy floodplain of the Sudbury River. During dry periods, such ponds are isolated from the main stream, but at times of high water (late winter and early spring) they lose their identity in seasonal flooding which drastically alters normal floodplain hydrography. On the map below, the 120 foot contour line closely approximates the mean high water level. Heard Pond is bordered by marshland, both forested and unforested. The wooded area shown is depicted in more detail in Plate 7, a location 200 yards from this site. During the summer the shallow, muddy lake sustains a dense growth of aquatic plants. The road, which for some distance (see map) follows the lake shore line, is raised two to three feet above the average level of the adjacent land, and is subject to inundation only during periods of extreme flooding.

EARLY SPRING

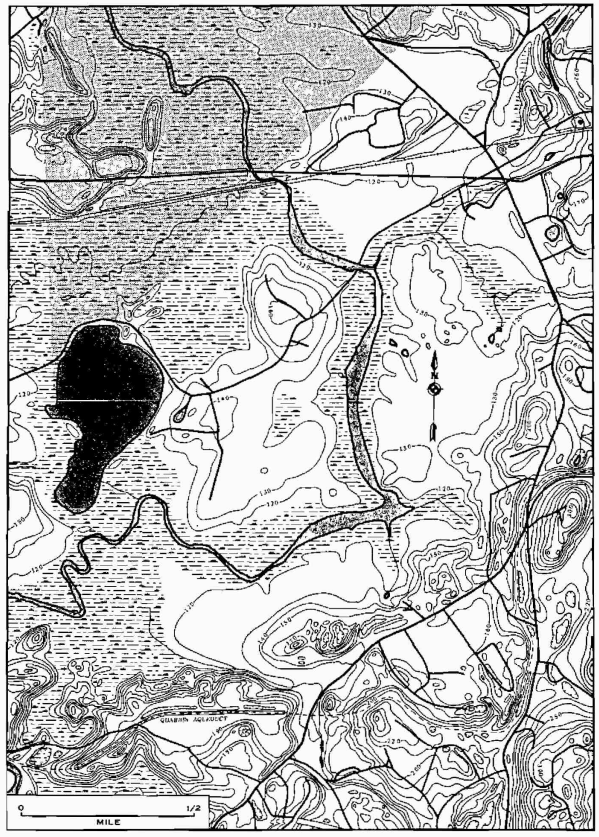
J F M A M J J A S O N D

Date: 10 Apr 1964 Hour: 1345
Temp: 62° Dewpoint: 32°
Relative humidity: 55%
Wind: West, 5 mph
Sky cover: 1/10 cumulus
Notes: High water period, corresponding to rise in the Sudbury River level.

SUMMER

J F M A M J J A S O N D

Date: 16 Aug 1963 Hour: 1200
Temp: 74° Dewpoint: 54°
Relative humidity: 50%
Wind: Northwest, 2 mph
Sky cover: 5/10 cumulus
Notes: Low water period continuing through the fall season.



EARLY FALL

J F M A M J J A S O N D

Date: 17 Oct 1963 Hour: 1200
Temp: 65° Dewpoint: 47°
Relative humidity: 53%
Wind: East-southeast, 8 mph
Sky cover: None
Notes: Low water, drought conditions prevalent.

WINTER

J F M A M J J A S O N D

Date: 16 Jan 1964 Hour: 1430
Temp: 35° Dewpoint: —
Relative humidity: —
Wind: West, 4 mph
Sky cover: None
Snow depth: 6 to 8 inches
Notes: Pond is solidly frozen, one foot thick.

LOCATION: Wayland, Massachusetts. Lat. 42°21′20″ N. Long. 71°23′12″ W. Elevation: 116 feet above mean sea level. Physiographic classification: Sudbury River floodplain, coastal lowland. Local relief: 10 feet. Vegetation: Central Hardwoods-Hemlock-White Pine. Camera azimuth: 050°.

AREA DESCRIPTION: The low woodland depicted is shown on the USGS Topographic map as forested marshland. Wet lowland soils support tree growth of red maple, swamp oak, alder, ash and elm, with an understory of saplings, catbrier thickets, spicebush, high bush blueberries, and ferns. Trees grow in clumps and average 10 inches in diameter and 65 feet in height. Average spacing between clumps is 20 feet. Thorny catbrier thickets are widespread and make foot travel difficult in all seasons. During the summer, there are marked contrasts in the local microclimate. Jungle-like conditions prevail in low forested areas, where oppressive humidity frequently combines with other disagreeable environmental factors: thorny plants, myriad water-filled depressions, muddy soils and mosquito infestation. Such conditions contrast with the more hospitable environment of adjacent high-land, where problems of mobility and human comfort are fewer, and less severe. In the late summer and fall, marshland tends to dry up and standing water persists only in well established drainage channels.

EARLY SPRING

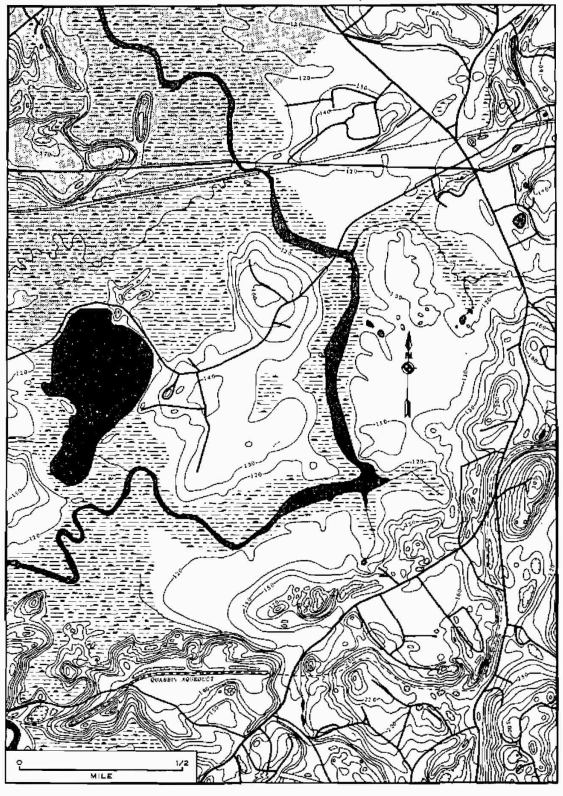
J F M A M J J A S O N D

Date: 8 May 1964 Hour: 1445
Temp: 81° Dewpoint: 51°
Relative humidity: 36%
Wind: Southwest, 4 mph
Sky cover: 10/10 thin stratus
Mean visibility: 160 feet
Notes: High water level. Extensive areas of floodplain under water.

SUMMER

J F M A M J J A S O N D

Date: 27 Aug 1964 Hour: 1300
Temp: 75° Dewpoint: 52°
Relative humidity: 45%
Wind: West, 3 mph
Sky cover: 1/10 cumulus, 1/10 cirrus.
Mean visibility: 40 feet
Notes: Low water period.



EARLY FALL

J F M A M J J A S O N D

Date: 12 Oct 1964 Hour: 1130
Temp: 60° Dewpoint: 32°
Relative humidity: 35%
Wind: West, 6 mph
Sky cover: 1/10 cumulus
Notes: Low ground is relatively dry. Little standing water.

WINTER

J F M A M J J A S O N D

Date: 9 Dec 1964 Hour: 1335
Temp: 29° Dewpoint: —
Relative humidity: —
Wind: Northeast, 5 mph
Sky cover: 10/10 nimbostratus
Snow depth: 3 inches
Notes: Intermittent snow showers.

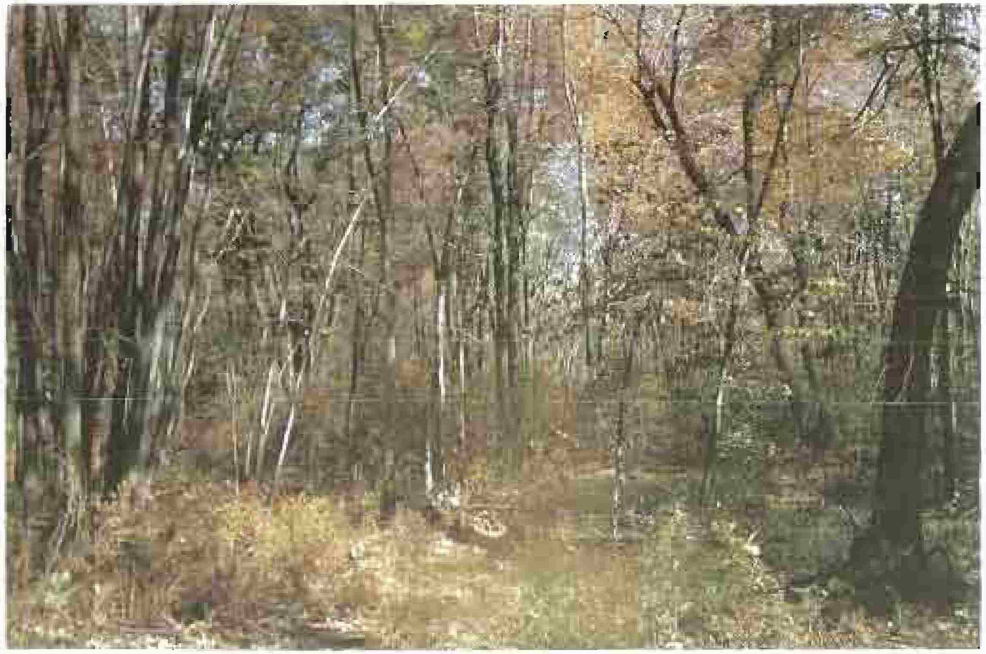


Plate 7

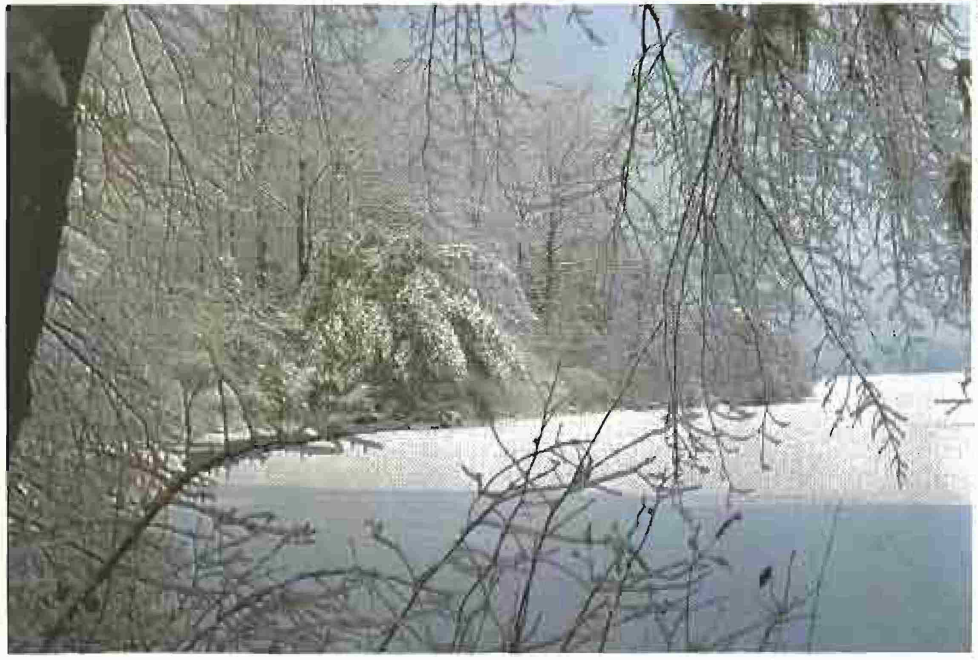


Plate 8

LOCATION: Hopkinton, Massachusetts (Whitehall Reservoir). Lat. 42°14′14″ N. Long. 71°34′58″ W. Elevation: 335 feet above mean sea level. Physiographic classification: Eastern Upland. Local relief: 170 feet. Vegetation: Transition Hardwoods-White Pine-Hemlock. Camera azimuth: 40°.

AREA DESCRIPTION: Typical of the shore line of many New England lakes, natural vegetation grows close to the water's edge, and branches overhang the water in many places. Trees are closely spaced, and undergrowth is dense, offering good cover, particularly near the shore where sunlight encourages thick undergrowth. See detailed vegetation data for Plate 9, an area on the eastern shore of Whitehall Reservoir with similar vegetation. Much of the lake is shallow, providing an environment ideally suited for the growth of aquatic plants. So thick is this vegetation in many areas that boat movement is restricted and swimming would be difficult. Severe glaze (9), 0.50″ thick, illustrated here occurs in southern New England on an average of once in three years. Icing as pictured persisted for one week because of continuous sub-freezing temperatures and an absence of high winds.

EARLY SPRING

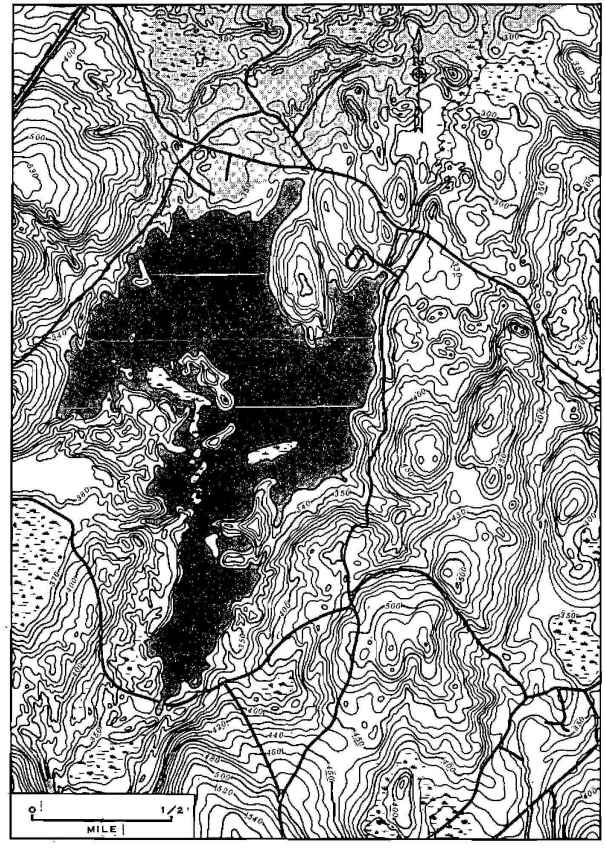
J F M A M J J A S O N D

Date: 6 Apr 1964 Hour: 1045
Temp: 51° Dewpoint: 28°
Relative humidity: 41%
Wind: South, 7 mph
Sky cover: 9/10 thin cirrus

SUMMER

J F M A M J J A S O N D

Date: 19 Sep 1963 Hour: 1220
Temp: 77° Dewpoint: 58°
Relative humidity: 53%
Wind: North, 3 mph
Sky cover: 3/10 cumulus



EARLY FALL

J F M A M J J A S O N D

Date: 11 Oct 1963 Hour: 1250
Temp: 71° Dewpoint: 46°
Relative humidity: 42%
Wind: Southwest, 5 mph
Sky cover: 2/10 thin cirrus
Notes: Drought conditions, woodland is very dry.

WINTER

J F M A M J J A S O N D

Date: 9 Dec 1964 Hour: 1130
Temp: 30° Dewpoint: —
Relative humidity: —
Wind: West, 4 mph
Sky cover: 4/10 cumulus
Snow depth: 4 to 6 inches
Notes: Vegetation coated with ice from ice storm of 4 Dec.

LOCATION: Hopkinton, Massachusetts. Lat. 42°13′58″. Long. 71°33′57″ W. Elevation: 342 feet above mean sea level. Physiographic classification: Eastern Upland. Local relief: 170 feet. Vegetation: Transition Hardwoods-White Pine-Hemlock. Camera azimuth: 135°.

AREA DESCRIPTION: Mixed deciduous forest; maple, oak, gray birch, with scattered white pine, mostly small, 6 to 10 feet high. Trees average 8 inches in diameter and 45 feet in height. Average spacing between trees is 11 feet. Undergrowth consists primarily of saplings. Terrain is typical of the New England Upland, irregular and mantled with glacial debris. Large boulders, 6 to 10 feet long are common features of the upland. Smaller rocks in some areas are less abundant, many having been moved more than a century ago for use in building stone fences when much of the land was cleared for agricultural use. Such fences are frequently encountered in this and other Massachusetts woodlands, providing good cover for personnel, but standing as obstacles to cross-country vehicular traffic. Woodland swamps are common to the area and are found in relatively small depressions as well as in association with stream drainage systems. The areal extent of swampland and the depth of standing water vary significantly between wet and dry periods.

EARLY SPRING

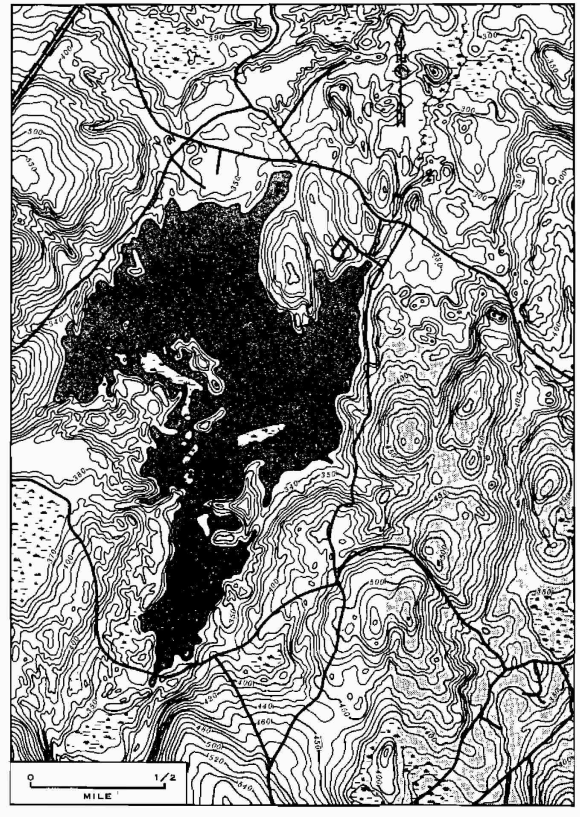
J F M A M J J A S O N D

Date: 6 Apr 1964 Hour: 1130
Temp: 52° Dewpoint: 25°
Relative humidity: 35%
Wind: South-southwest, 4 mph
Sky cover: 6/10 thin cirrus
Mean visibility: 185 feet
Notes: Previous years leaf litter (when dry) creates a noisy surface for personnel on foot.

SUMMER

J F M A M J J A S O N D

Date: 19 Sep 1963 Hour: 1340
Temp: 79° Dewpoint: 59°
Relative humidity: 50%
Wind: North, 3 mph
Sky cover: 4/10 cumulus
Mean visibility: 125 feet



EARLY FALL

J F M A M J J A S O N D

Date: 11 Oct 1963 Hour: 1340
Temp: 70° Dewpoint: 47°
Relative humidity: 44%
Wind: Southwest, 5 mph
Sky cover: 3/10 cirrus
Notes: Approximately half the leaves have fallen. Dry leaf litter is noisy underfoot.

WINTER

J F M A M J J A S O N D

Date: 9 Dec 1964 Hour: 1320
Temp: 30° Dewpoint: —
Relative humidity: —
Wind: West, 4 mph
Sky cover: 4/10 cumulus
Snow depth: 4 to 6 inches
Notes: Vegetation is coated with ice from storm of 4 Dec.

Plate 9

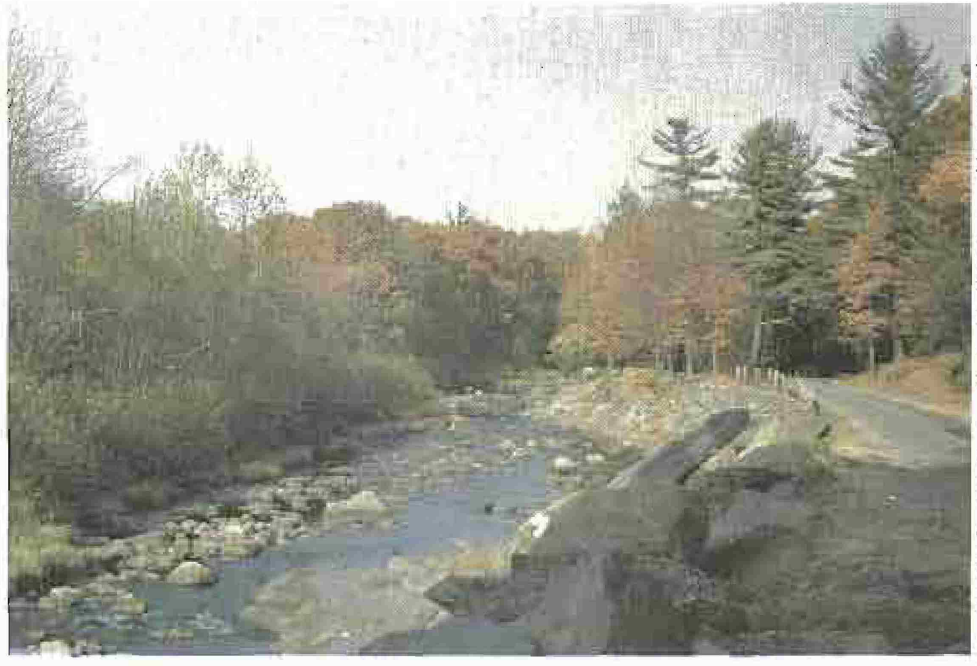


Plate 10

LOCATION: West Boylston, Massachusetts, Quinapoxet River. Lat. 42°23′09″ N. Long. 71°48′34″ W. Elevation: 430 feet above mean sea level. Physiographic classification: Eastern Upland. Local relief: 300 feet. Vegetation: Transition Hardwoods-White Pine-Hemlock. Stream gradient: 80 feet/mile. Camera azimuth: 047°.

AREA DESCRIPTION: Typical of upland streams, the Quinapoxet River has reached a stage in its evolution where soil, gravel, and small rocks have been transported downstream, leaving a river bed paved with glacial boulders. Highly resistant to further hydraulic action, except during periods of unusual runoff, such accumulated material, in association with vegetation, limits further erosion. Stream flow, although rapid, is clear, with little material in suspension. Large rocks on right are fill used in road construction. Forest consists of transition hardwoods with some white pine and hemlock. Oaks are dominant in this area and are 10 to 12 inches in diameter and 60 feet in height. Below mature oaks are closely spaced oak saplings, 2 to 5 inches in diameter and 20 feet in height. Windfalls are numerous and thick laurel growth (an evergreen shrub, 6 to 7 feet high) restricts visibility and provides good cover at all seasons.

EARLY SPRING

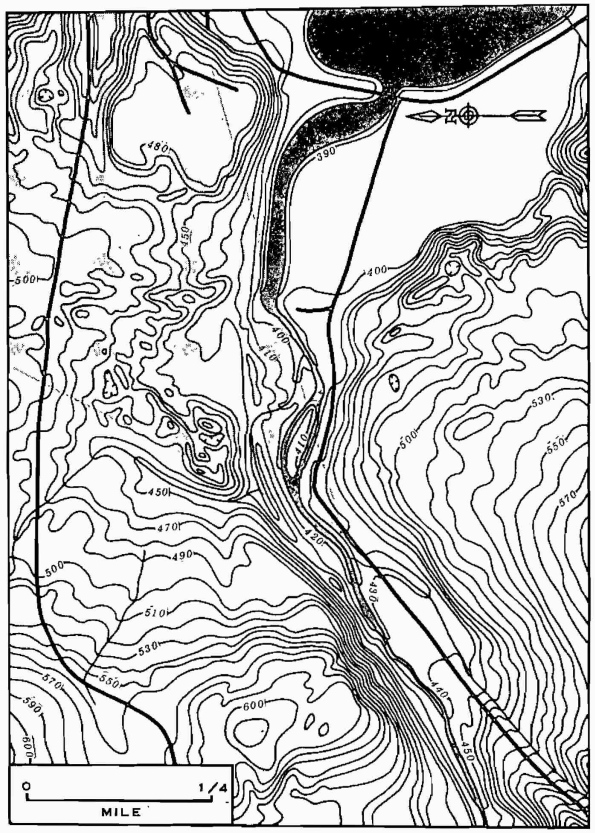
J F M A M J J A S O N D

Date: 13 Apr 1964 Hour: 1500
Temp: 61° Dewpoint: 44°
Relative humidity: 53%
Wind: West, 4 mph
Sky cover: 6/10 cumulus, 1/10 cirrocumulus, 1/10 stratocumulus

SUMMER

J F M A M J J A S O N D

Date: 19 Sep 1963 Hour: 1630
Temp: 80° Dewpoint: 62°
Relative humidity: 55%
Wind: North, 3 mph
Sky cover: 3/10 stratocumulus



EARLY FALL

J F M A M J J A S O N D

Date: 11 Oct 1963 Hour: 1600
Temp: 71° Dewpoint: 44°
Relative humidity: 38%
Wind: Calm
Sky cover: 1/10 cirrus
Notes: Light haze.

WINTER

J F M A M J J A S O N D

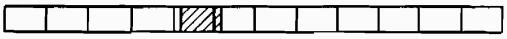
Date: 18 Feb. 1964 Hour: 1330
Temp: 38° Dewpoint: 19°
Relative humidity: 46%
Wind: East, 4 mph
Sky cover: None
Snow depth: 12 to 14 inches

LOCATION: Princeton, Massachusetts (State Highway 62). Lat. 42°26′58″ N. Long. 71°51′15″ W. Elevation: 810 feet above mean sea level. Physiographic classification: Eastern Upland. Local relief: 250 feet. Vegetation: Transition Hardwoods-White Pine-Hemlock. Camera azimuth: 290°.

AREA DESCRIPTION: This road scene is representative of tree lined highways throughout New England. Here, maples averaging 12 inches in diameter and 60 feet in height form a canopy which provides good cover from aerial detection, particularly during the full-leaf period (mid-May through mid-October at this site). In many areas, trees along such roads are more closely spaced, larger, and offer better cover than those in adjacent woodlands. Growing along public right-of-ways, they receive care and protection, and because of their location, are less susceptible to fire damage. Relatively unbroken stretches of roadway with arboreal cover vary up to several miles in length. A location map is not included for this site because tree-bordered roads, hard surfaced and gravel, are common to the region as a whole, and although tree species differ from place to place, their military implications are similar.

LATE SPRING

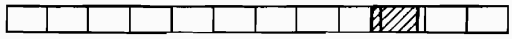
J F M A M J J A S O N D



Date: 21 May 1964 Hour: 1230
Temp: 60° Dewpoint: 29°
Relative humidity: 31%
Wind: West-northwest, 4 mph
Sky cover: 2/10 thin cirrus

EARLY FALL

J F M A M J J A S O N D



Date: 14 Oct 1963 Hour: 1330
Temp: 67° Dewpoint: 40°
Relative humidity: 38%
Wind: Southwest, 5 mph
Sky cover: None

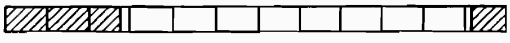
SUMMER

J F M A M J J A S O N D

Date: 28 Aug 1963 Hour: 1130
Temp: 74° Dewpoint: 50°
Relative humidity: 44%
Wind: Calm
Sky cover: None

WINTER

J F M A M J J A S O N D



Date: 20 Mar 1964 Hour: 1130
Temp: 41° Dewpoint: 19°
Relative humidity: 41%
Wind: West, 5 mph
Sky cover: None
Snow depth: 3 to 4 inches

Plate 11

Plate 12

LOCATION: Florida, Massachusetts (Whitcomb Summit). Lat. 42°41′21″ N. Long. 73°01′14″ W. Elevation: 2150 feet above mean sea level. Physiographic classification: Western Upland. Local relief: 1500 feet. Vegetation: Spruce-Fir-Northern Hardwoods. Average stream gradient: 100 feet/mile. Camera azimuth: 095°.

AREA DESCRIPTION: View eastward across the Deerfield Valley and Western Upland of Massachusetts from a location in the Berkshires, a southerly extension of the Green Mountains of Vermont. Forests also represent an extension of vegetation types characteristic of the Green Mountains. Spruce is the dominant conifer, mixed with northern hardwoods, and also occurring in small stands. The relatively flat skyline or peneplane (almost a plane) is distinctive of the New England Upland. The deceptively level horizon contrasts sharply with steep-walled valleys, such as the Deerfield "Canyon" which has an average relief of 1500 feet in this area, and has slopes in excess of 75%. Even the steepest slopes are heavily wooded, offering good personnel cover. Vehicular traffic is largely restricted to established roadways, particularly in valleys where precipitous slopes and roadside drainage ditches restrict off-the-road movement.

EARLY SPRING

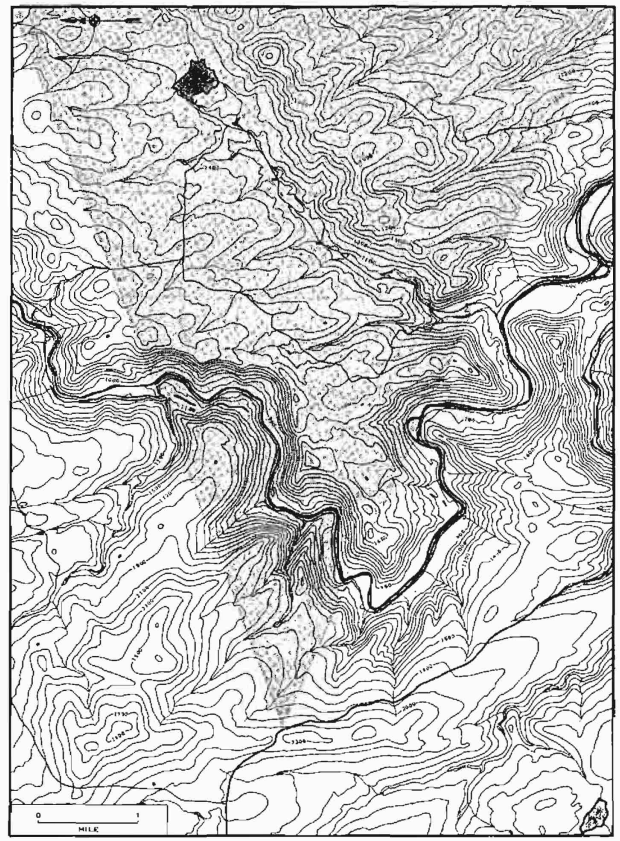
J F M A M J J A S O N D

Date: 1 May 1964 Hour: 1410
Temp: 63° Dewpoint: 34°
Relative humidity: 34%
Wind: East, 10 mph
Sky cover: 1/10 cirrus and cirrocumulus.

SUMMER

J F M A M J J A S O N D

Date: 28 Aug 1964 Hour: 1245
Temp: 77° Dewpoint: 50°
Relative humidity: 39%
Wind: Southeast, 8 mph
Sky cover: 2/10 cirrus



EARLY FALL

J F M A M J J A S O N D

Date: 1 Oct 1964 Hour: 1245
Temp: 53° Dewpoint: 39°
Relative humidity: 59%
Wind: East, 4 mph
Sky cover: 1/10 cumulus

WINTER

J F M A M J J A S O N D

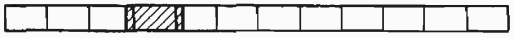
Date: 27 Feb 1964 Hour: 1330
Temp: 25° Dewpoint: —
Relative humidity: —
Wind: West, 15 mph
Sky cover: 5/10 cumulus
Snow depth: 18 to 36 inches

LOCATION: Savoy, Massachusetts (State Highway No. 2). Lat. 42°38′29″ N. Long. 72°57′32″ W. Elevation: 830 feet above mean sea level. Physiographic classification: Western Upland (Cold River Valley). Local relief: 1100 feet. Vegetation: Northern Hardwoods-Hemlock-White Pine. Stream gradient: 80 feet/mile. Camera azimuth: 272°.

AREA DESCRIPTION: The Cold River, a tributary of the Deerfield, is part of the stream complex draining the eastern slopes of the Berkshires. The source of this river lies five miles west of the site photographed, near the north-south divide from which the photographs on Plate 12 were taken. The region is densely forested in northern hardwoods, with white pine, hemlock, and some spruce. This deeply eroded upland valley, like the mountain valleys shown in Plates 15 and 16, is highly restrictive in respect to vehicular mobility. Highway and river occupy the narrow valley floor, with steep slopes severely limiting off-the-road travel. Forests offer good cover for personnel, but travel on foot is impeded by rocky terrain, windfalls, and thick undergrowth.

EARLY SPRING

J F M A M J J A S O N D

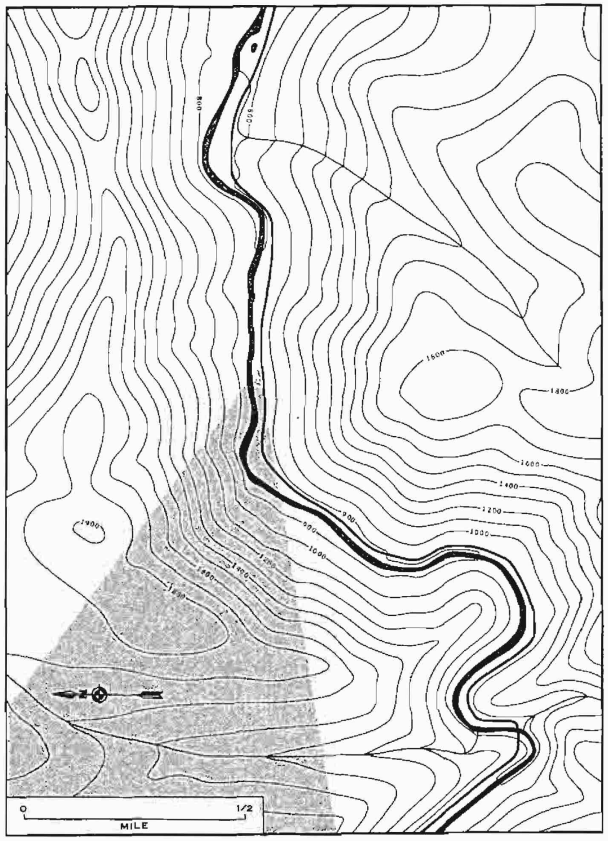


Date: 1 May 1964 Hour: 1500
Temp: 66° Dewpoint: 36°
Relative humidity: 33%
Wind: East, 4 mph
Sky cover: 1/10 cirrus, 1/10 cirrocumulus
Water temp: 55°

SUMMER

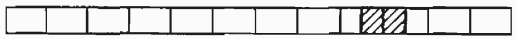
J F M A M J J A S O N D

Date: 28 Aug 1964 Hour: 1430
Temp: 73° Dewpoint: 55°
Relative humidity: 53%
Wind: East, 3 mph
Sky cover: 3/10 thin cirrus
Water temp: 74°



EARLY FALL

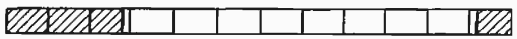
J F M A M J J A S O N D



Date: 21 Oct 1963 Hour: 1300
Temp: 77° Dewpoint: 55°
Relative humidity: 48%
Wind: Calm
Sky cover: None, moderate haze
Water temp: 56°
Notes: Drought conditions. Severe fire hazard.

WINTER

J F M A M J J A S O N D



Date: 27 Feb 1964 Hour: 1230
Temp: 25° Dewpoint: —
Relative humidity: —
Wind: West, 6 mph
Sky cover: 6/10 cumulus
Snow depth: 18 to 36 inches

Plate 13

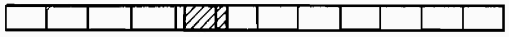
Plate 14

LOCATION: Grand Isle, Vermont, Lake Champlain Islands. Lat. 44°40′53″ N. Long. 73°18′18″ W. Elevation: 212 feet above mean sea level. Physiographic classification: Interior Lowland. Local relief: 100 feet. Vegetation: Transition Hardwoods-White Pine-Hemlock. Lake level: 95 feet. Camera azimuth: 140°.

AREA DESCRIPTION: Lake Champlain is 107 miles long and varies from 2 to 14 miles in width. The long, narrow, Champlain Valley (Fig. 1) has a milder climate than other parts of northern New England, and, lying in the rain shadows of the Adirondack and Green Mountains, receives less precipitation than any other section of the six-state area (Fig. 15). The lake has a moderating influence on the local climate and southerly winds frequently flow unobstructed up the Hudson Valley, providing the region with a frost-free season averaging more than one month longer than in the adjacent highlands (Fig. 14). Most land in the valley, including the large islands, have been cleared for farming. Tree growth is spotty, providing limited cover along roads, along the lake shore, and in isolated wooded patches. Capabilities for cross-country mobility are good, with wooden rail fences representing the major obstacles to off-the-road movement.

LATE SPRING

J F M A M J J A S O N D

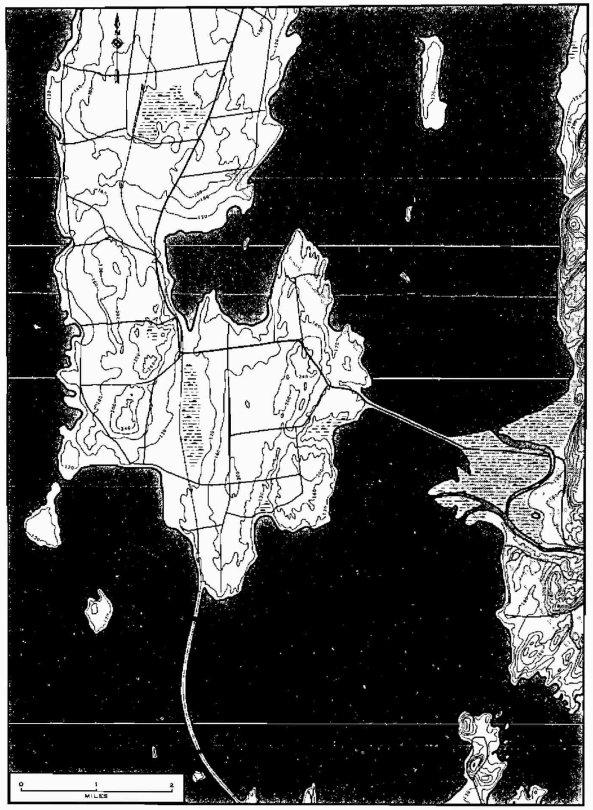


Date: 12 May 1964 Hour: 1300
Temp: 64° Dewpoint: 48°
Relative humidity: 56%
Wind: Northeast, 6 mph
Sky cover: 1/10 cirrus

SUMMER

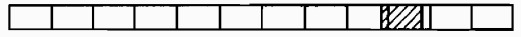
J F M A M J J A S O N D

Date: 4 Sep 1963 Hour: 1530
Temp: 64° Dewpoint: 41°
Relative humidity: 43%
Wind: North-northwest, 16 mph
Sky cover: 1/10 fractocumulus, stratocumulus over mountains.



EARLY FALL

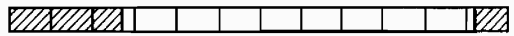
J F M A M J J A S O N D



Date: 7 Oct 1964 Hour: 1200
Temp: 42° Dewpoint: 21°
Relative humidity: 43%
Wind: North, 6 mph
Sky cover: 3/10 cumulus

WINTER

J F M A M J J A S O N D



Date: 11 Feb 1964 Hour: 1500
Temp: 22° Dewpoint: —
Relative humidity: —
Wind: South-southwest, 10 mph
Sky cover: 1/10 cumulus
Snow depth: 2 to 4 inches

LOCATION: Smugglers Notch, Vermont, Mount Mansfield State Forest (Highway 108). Lat. 44°31′57″ N. Long. 72°47′07″ W. Elevation: 1640 feet above mean sea level. Physiographic classification: Green Mountains. Local relief: 2000 feet. Vegetation: Spruce-Fir-Northern Hardwoods. Road gradient: 480 feet/mile. Camera azimuth: 350°.

AREA DESCRIPTION: This area is part of the Green Mountain chain, extending 160 miles from Massachusetts to Quebec. The site is located 20 miles east of the Champlain lowland (Plate 14), and one mile south of Smugglers Notch, a narrow mountain pass. During the winter season the Notch Road (State Highway 108) is snowbound, and may be traversed by tracked vehicles only. The Green Mountains are densely wooded, except for nearly vertical rock cliffs and barren ridges. Sugar maple and beech are dominant among the deciduous vegetation, mixed with spruce at higher levels. Spruce stands cover many summits and ridges. Vehicular traffic is restricted to existing roadways because of steep slopes and dense vegetation. Trees provide some cover at all seasons, with maximum cover available between mid-May and early October. Windfalls are abundant at all levels.

LATE SPRING

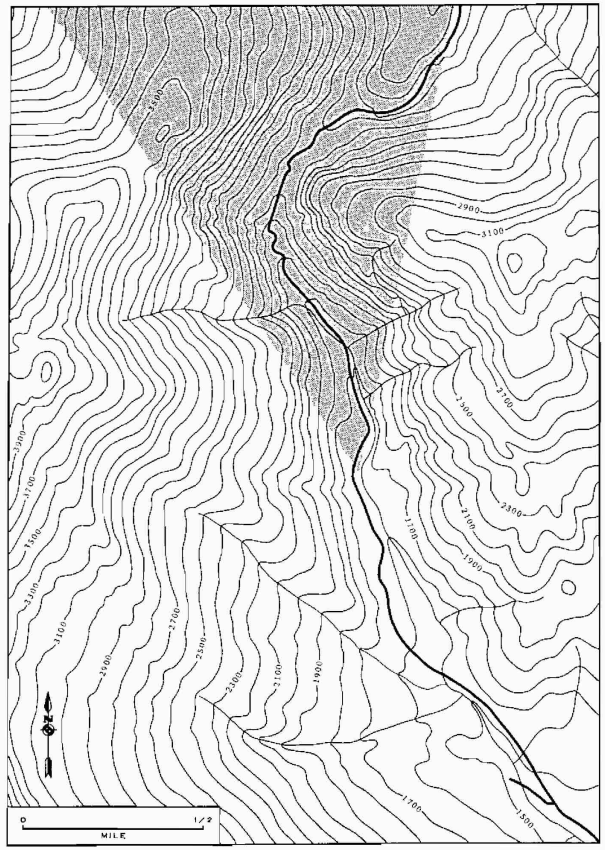
J F M A M J J A S O N D

Date: 13 May 1964 Hour: 0945
Temp: 67° Dewpoint: 45°
Relative humidity: 46%
Wind: West, 8 mph
Sky cover: 7/10 cumulus and stratocumulus
Notes: Moderate haze.

SUMMER

J F M A M J J A S O N D

Date: 5 Sep 1963 Hour: 1030
Temp: 52° Dewpoint: 40°
Relative humidity: 63%
Wind: South, 5 mph
Sky cover: 2/10 cumulus and stratocumulus.



EARLY FALL

J F M A M J J A S O N D

Date: 2 Oct 1963 Hour: 1010
Temp: 65° Dewpoint: 49°
Relative humidity: 57%
Wind: South, 10 mph
Sky cover: None

WINTER

J F M A M J J A S O N D

Date: 12 Feb 1964 Hour: 1115
Temp: 32° Dewpoint: —
Relative humidity: —
Wind: South, 4 mph
Sky cover: None
Snow depth: 18 to 36 inches

Plate 15

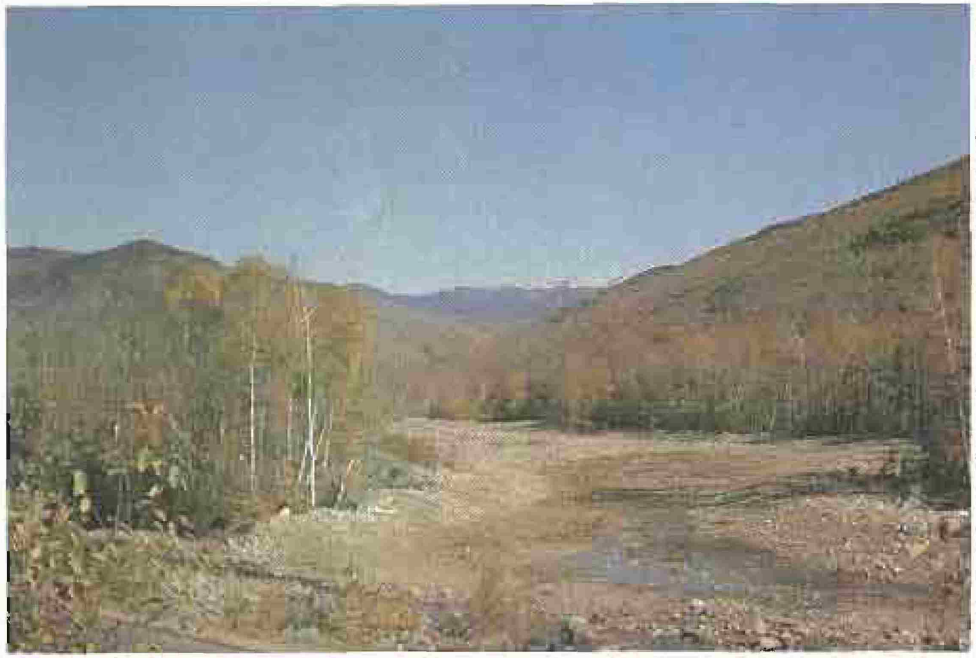


Plate 16

LOCATION: Crawford Notch, Harts Location, New Hampshire (U.S. Highway 302). Lat. 44°08′15″ N. Long. 71°21′45″ W. Elevation: 1085 feet above mean sea level. Physiographic classification: White Mountains. Local relief: 1900 feet. Vegetation: Spruce-Fir-Northern Hardwoods. Stream gradient: 130 feet/mile. Camera azimuth: 012°.

AREA DESCRIPTION: View in Crawford Notch, showing the confluence of the Dry River (right), and the Saco River (left foreground). The site is seven miles below the headwaters of the Saco, a major stream draining the White Mountains, south of Mt. Washington. Here there are 5 vegetation zones, altitudinally spaced (10). Below 2500 feet is the deciduous hardwood forest, a zone having the greatest seasonal color and visibility contrasts. Between 2500 and 3200 feet is the mixed deciduous and coniferous forest (beech and spruce dominant). The coniferous forest (Balsam fir and spruce) grows between 3200 and 4000 feet. From 4000 feet to timberline (approximately 4800 feet) is found the scrub coniferous forest. The arctic plant zone above timberline consists of arctic grasses, sedges, lichens, dwarf shrubs and stunted trees. Windfalls are abundant at all levels below the scrub coniferous forest.

LATE SPRING

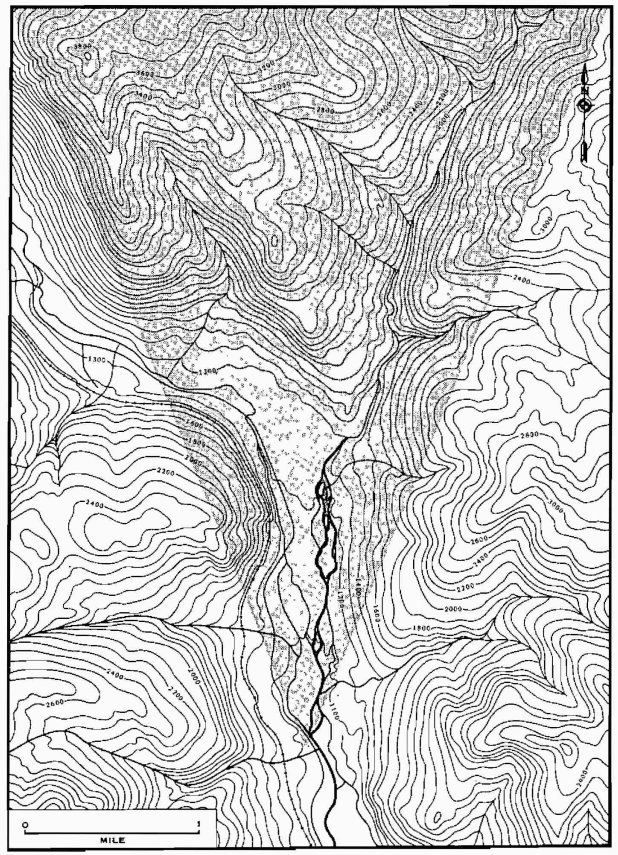
J F M A M J J A S O N D

Date: 16 May 1964 Hour: 1115
Temp: 69° Dewpoint: 41°
Relative humidity: 36%
Wind: West, 3 mph
Sky cover: 1/10 cirrus, 1/10 stratocumulus.

SUMMER

J F M A M J J A S O N D

Date: 3 Sep 1964 Hour: 1200
Temp: 66° Dewpoint: 46°
Relative humidity: 49%
Wind: Northwest, 8 mph
Sky cover: 1/10 altocumulus, cumulus over mountains.



EARLY FALL

J F M A M J J A S O N D

Date: 5 Oct 1963 Hour: 1030
Temp: 55° Dewpoint: 24°
Relative humidity: 30%
Wind: North, 5 mph
Sky cover: None

WINTER

J F M A M J J A S O N D

Date: 13 Mar 1964 Hour: 1215
Temp: 33° Dewpoint: —
Relative humidity: —
Wind: West, 12 mph
Sky cover: 2/10 cumulus
Snow depth: 24 inches

8. CONCLUSIONS

The potential for quantitative analysis inherent in vertical aerial photography is lacking in horizontal surface photography. This should not detract, however, from the value of the latter as a useful tool in environmental research. Photography recorded from the viewpoint of the ground observer complements aerial coverage, and contributes to a more comprehensive regional analysis.

Photographic time-lapse sequences of New England landscapes reveal that the magnitude of seasonal change is not fully realized, even by residents around whom such changes repeatedly take place, year after year. This would undoubtedly be true wherever the transition from one season to the next is gradual.

Methods described in this paper could be applied to a wide range of geographic regions, among which the tropical savanna is suggested as an example. The seasonal regime of the savanna, unlike that of New England, is controlled by great differences in precipitation, with only a relatively slight annual temperature range. A wet season, marked by predominant green coloration, mud, widespread inundation, swollen streams, and clouds of insects, contrasts with desert-like conditions prevalent during the dry season, a period marked by flint-hard ground, dried-up stream beds, extensive brown grasslands, frequent fires, and dust storms. The military implications here are strikingly apparent. Application of time-lapse photographic techniques would reveal much about such a region, illustrating drastic changes which occur almost overnight.

Photographic information, when complemented by cartographic and narrative descriptions, provides the equipment designer, the tactician, the logistician, and other users with a comprehensive picture of factors relating to seasonality in areas where the normal march of seasons effect significant changes within the natural environment.

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4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

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13. ABSTRACT

This report demonstrates the application of time-lapse photographic techniques to a study of seasonal changes in coloration and appearance at sixteen locations in New England. The sites used to illustrate the method were selected for their representativeness of the four major physiographic regions: coastal lowland, uplands, interior lowlands, and mountains. Individual landscapes were photographed in color during each season, recording the identical field-of-view from the same spot locations. The photography is supplemented by topographic, vegetation, and climatic maps, graphs, site data, and narrative descriptions.

Factors pertaining to camouflage problems are documented photographically to illustrate significant changes in vegetation color. The combination of maximum visibility and minimum canopy coverage during periods of vegetation dormancy in forested areas is contrasted with greatly reduced visibility and nearly complete canopy coverage during the growing season. Trafficability problems in off-road areas are strikingly evident in scenes depicting winter snow accumulation and seasonal flooding in spring.

DD FORM 1 JAN 64 1473

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Analysis	8					
Seasonal variations	8,9		6			
Climate	9		6			
Environment	9		7			
New England	9		9			
Photography	10					
Time-lapse	0					
Camouflage	4					
Armed Forces operations	4					
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Color			7			
Visibility			7			
Trafficability			7			
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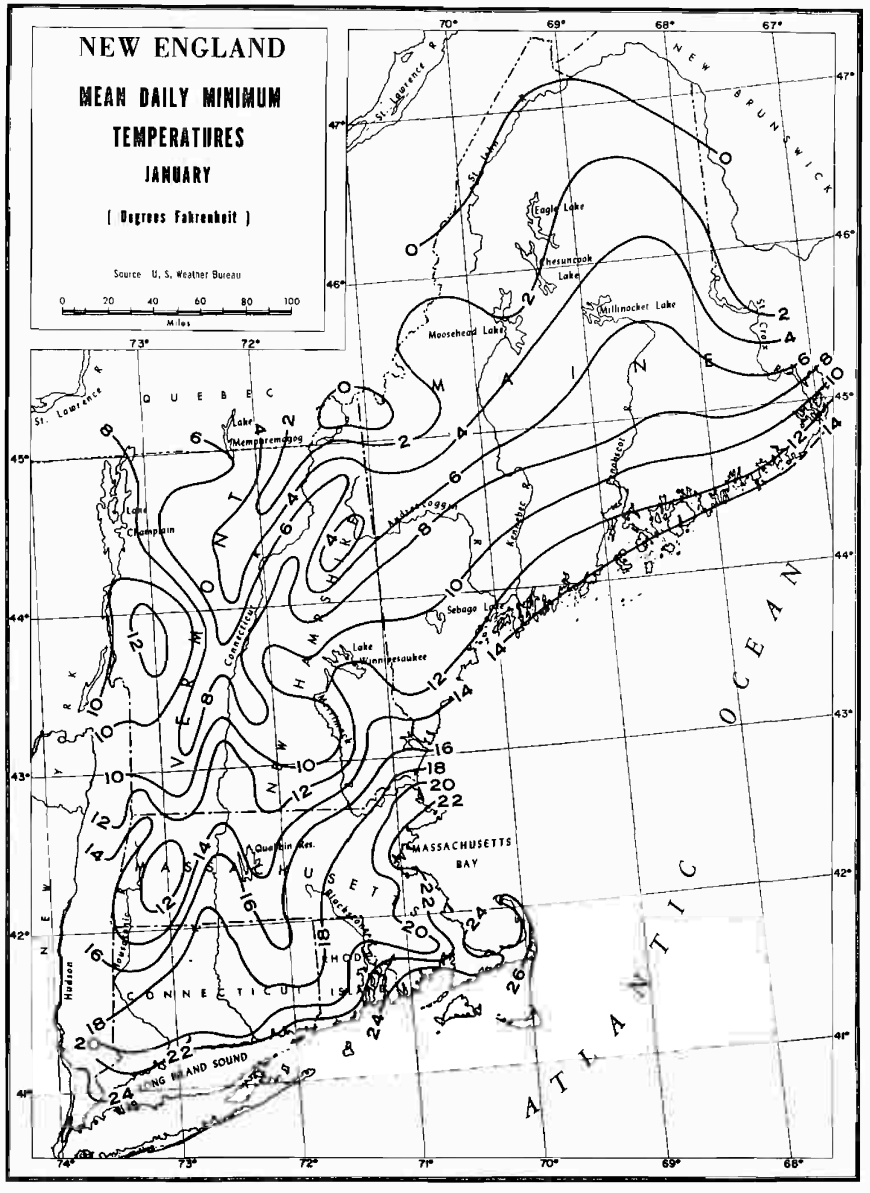
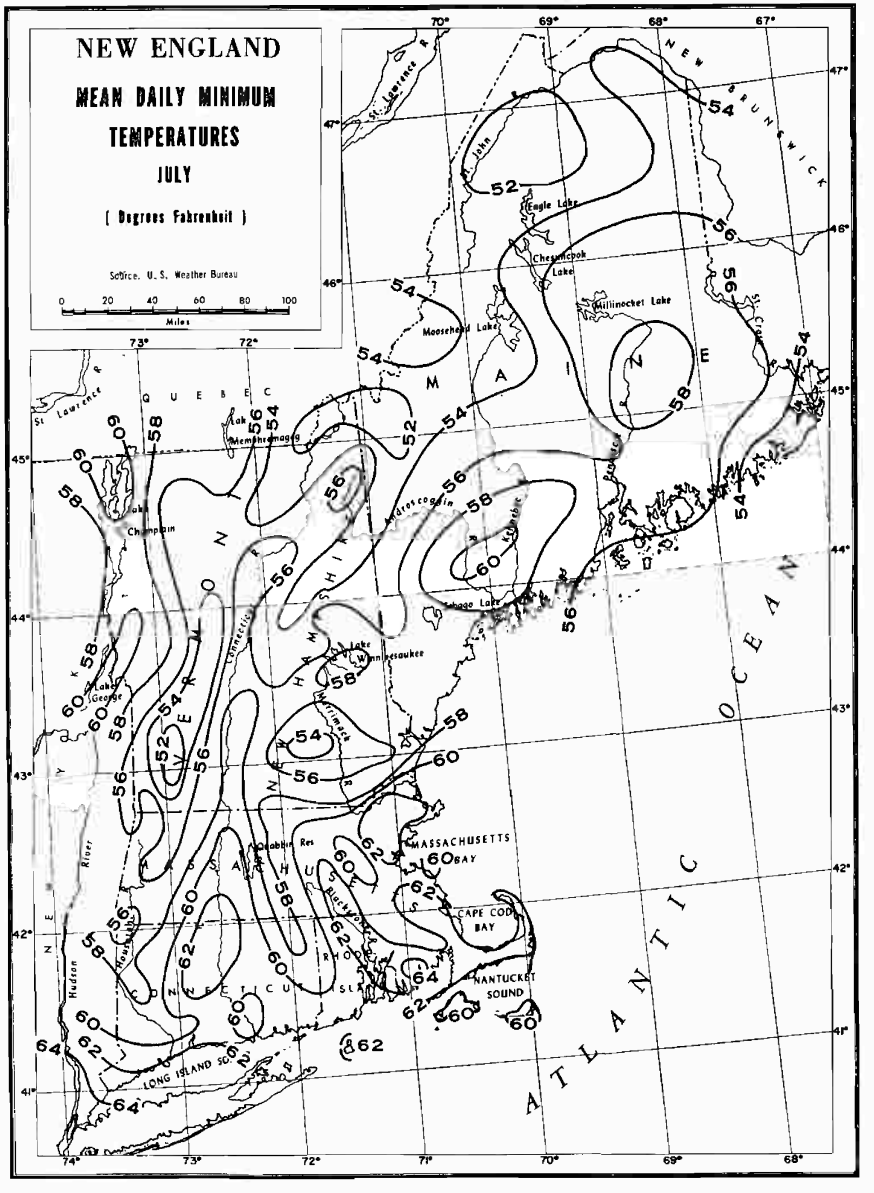

NEW ENGLAND
MEAN DAILY MINIMUM
TEMPERATURES
JANUARY
(Degrees Fahrenheit)
Source U. S. Weather Bureau
0 20 40 60 80 100
Miles
QUEBEC
NEW BRUNSWICK
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
ATLANTIC OCEAN
MASSACHUSETTS BAY
LONG ISLAND SOUND
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Lake Winnipesaukee
Sebago Lake
Quabbin Res.
St. Lawrence R.
Connecticut R.
Androscoggin R.
Kennebec R.
Merrimack R.
Hudson R.

Fig. 4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TEMPERATURES
JULY
(Degrees Fahrenheit)
Source U. S. Weather Bureau
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Miles
QUEBEC
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VERMONT
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MASSACHUSETTS
CONNECTICUT
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ATLANTIC OCEAN
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Lake George
Lake Winnipesaukee
Sebago Lake
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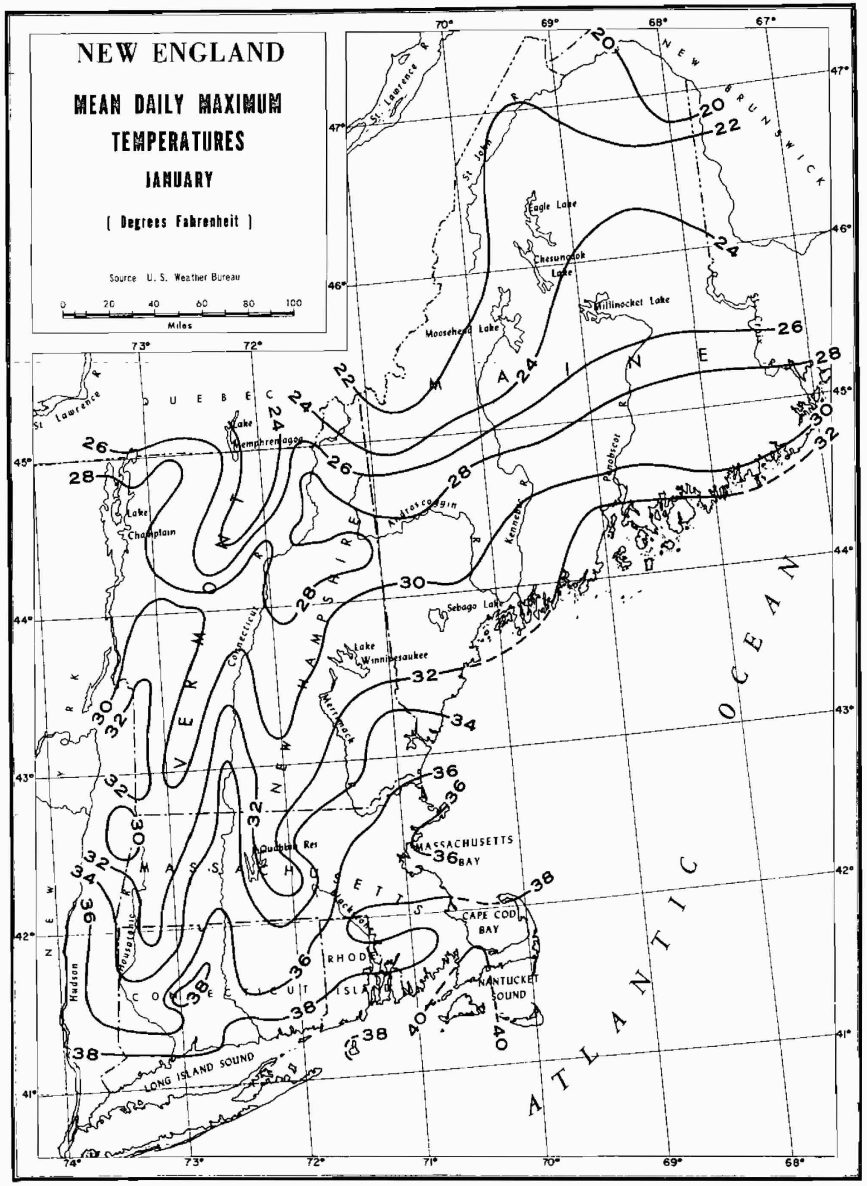
Fig. 5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TEMPERATURES
JANUARY
[Degrees Fahrenheit]
Source U. S. Weather Bureau
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Miles
ATLANTIC OCEAN
QUEBEC
MAINE
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NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
NEW YORK
NEW BRUNSWICK
St. Lawrence R.
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Lake Memphremagog
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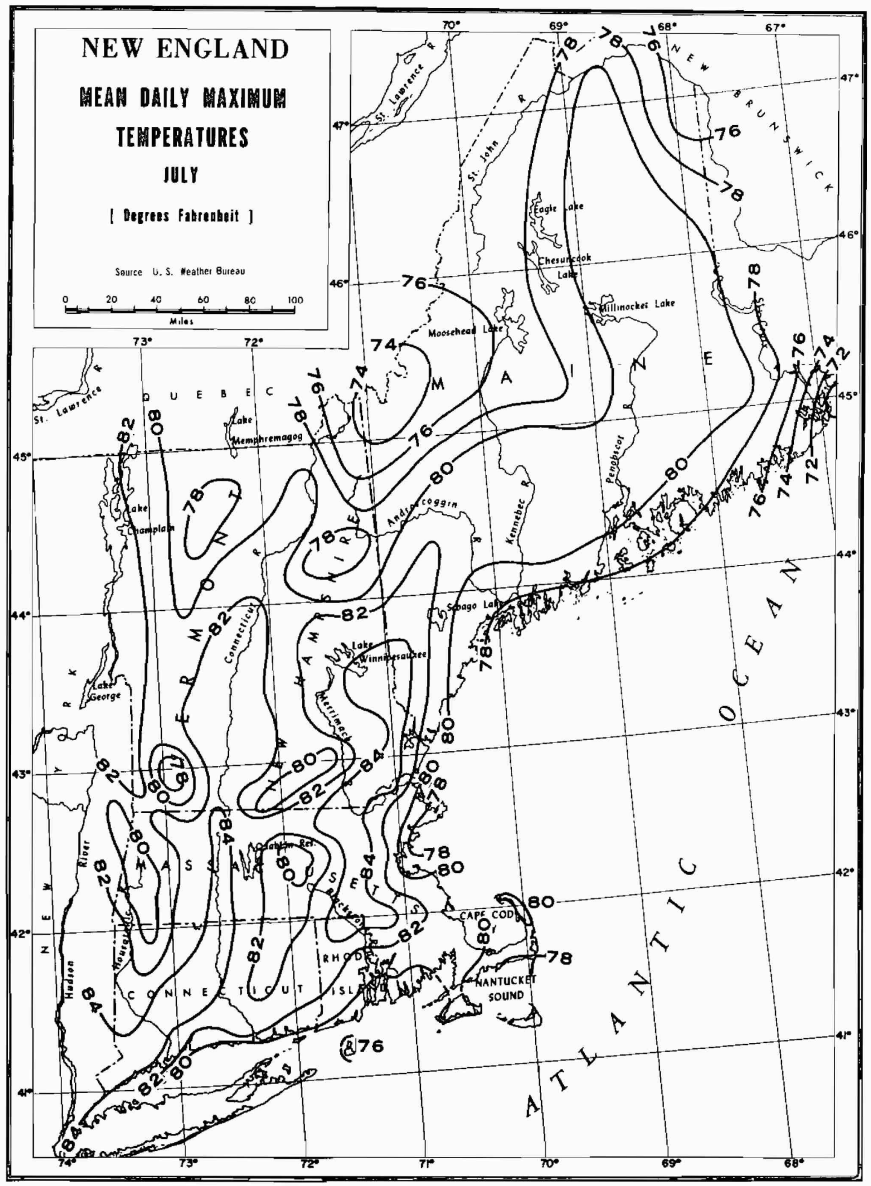
Sebago Lake
Moosehead Lake
Eagle Lake
Chesuncook Lake
Millinocket Lake
Androscoggin R.
Kennebec R.
Penobscot R.
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Hudson R.
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND

Fig. 6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MEAN DAILY MAXIMUM
TEMPERATURES
JULY
[Degrees Fahrenheit]
Source U. S. Weather Bureau
0 20 40 60 80 100
Miles
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QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
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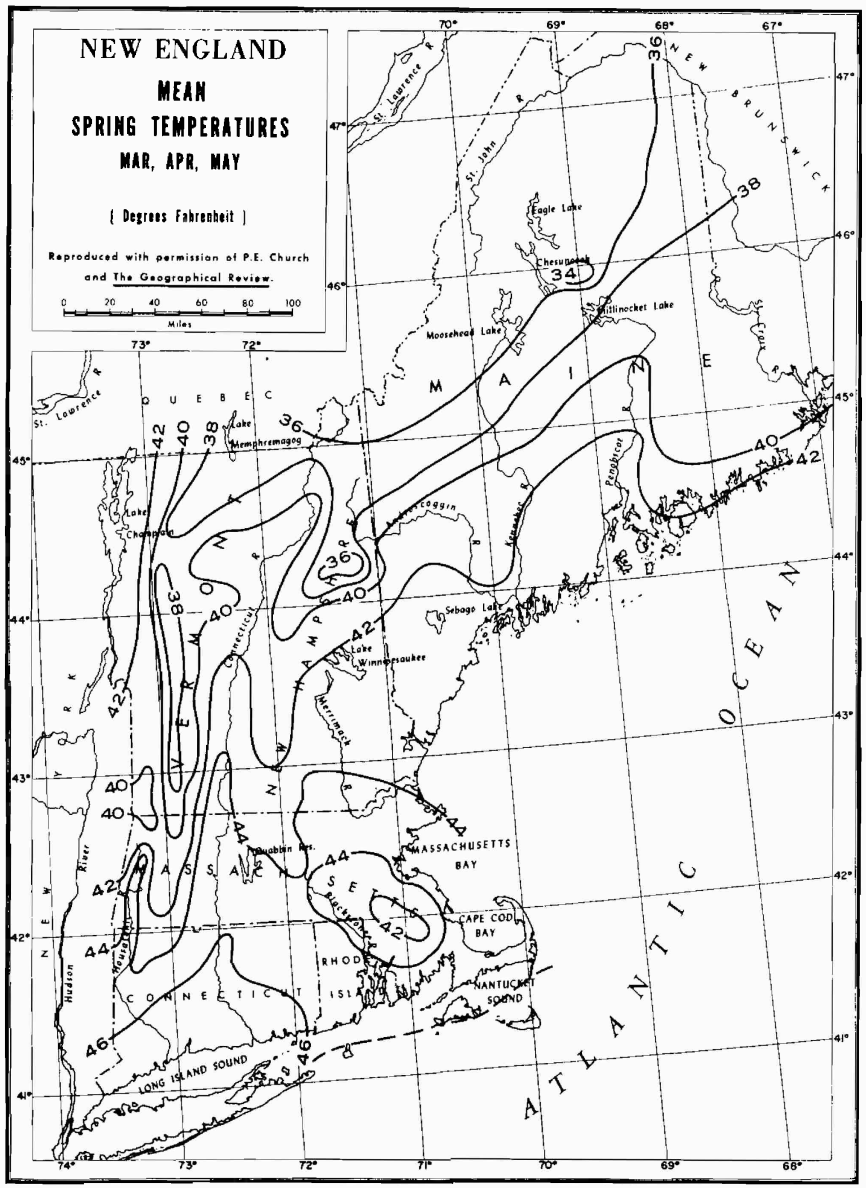
Kennebec R.
Penobscot R.
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Hudson R.
CAPE COD BAY
NANTUCKET SOUND

Fig. 7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Miles
ATLANTIC OCEAN
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND

Fig. 8

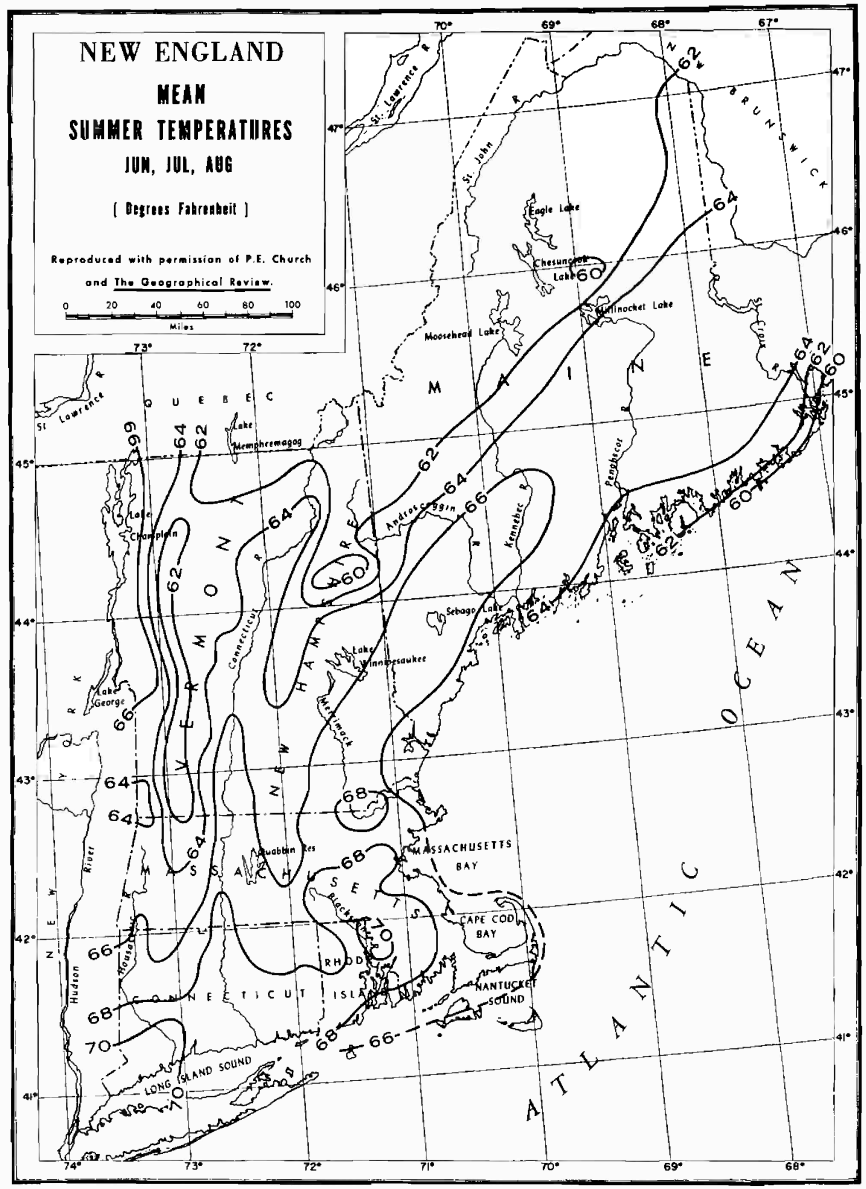
NEW ENGLAND
MEAN
SUMMER TEMPERATURES
JUN, JUL, AUG
(Degrees Fahrenheit)
Reproduced with permission of P.E. Church
and The Geographical Review.
0 20 40 60 80 100
Miles
ATLANTIC OCEAN
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND

Fig. 9

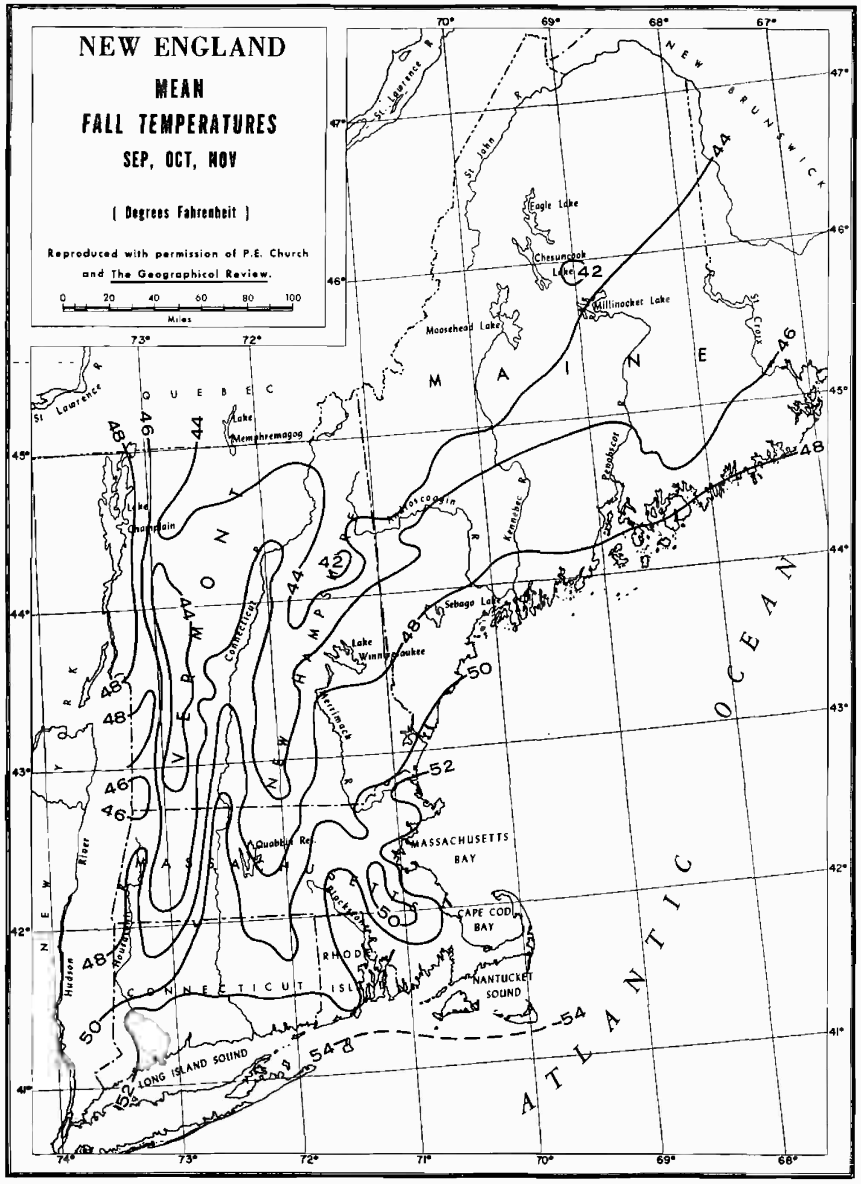
NEW ENGLAND
MEAN
FALL TEMPERATURES
SEP, OCT, NOV
(Degrees Fahrenheit)
Reproduced with permission of P.E. Church and The Geographical Review.
0 20 40 60 80 100
Miles
ATLANTIC OCEAN
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
CONNECTICUT
RHODE ISLAND
QUEBEC
NEW BRUNSWICK
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Lake Winnipesaukee
Sebago Lake
Lake George
St Lawrence R.
St John R.
St Croix R.
Penobscot R.
Kennebec R.
Androscoggin R.
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Hudson R.
Mohawk R.
Blackstone R.
42
44
46
48
50
52
54

Fig. 10

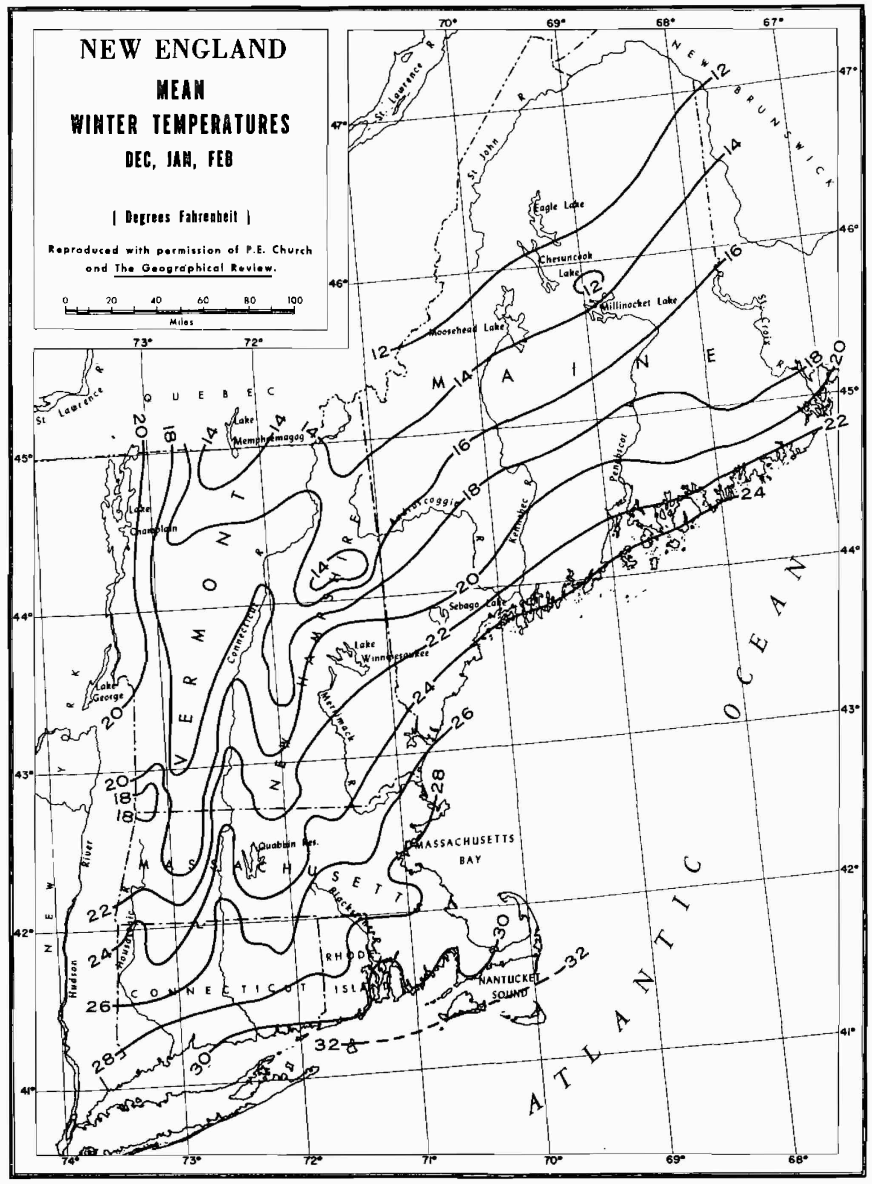
NEW ENGLAND
MEAN
WINTER TEMPERATURES
DEC, JAN, FEB
(Degrees Fahrenheit)
Reproduced with permission of P.E. Church and The Geographical Review.
0 20 40 60 80 100
Miles
ATLANTIC OCEAN
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
CONNECTICUT
RHODE ISLAND
QUEBEC
NEW BRUNSWICK
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Lake Winnipesaukee
Sebago Lake
Lake George
St Lawrence R.
St John R.
St Croix R.
Penobscot R.
Kennebec R.
Androscoggin R.
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Hudson R.
Mohawk R.
Blackstone R.
12
14
16
18
20
22
24
26
28
30
32

Fig. 11

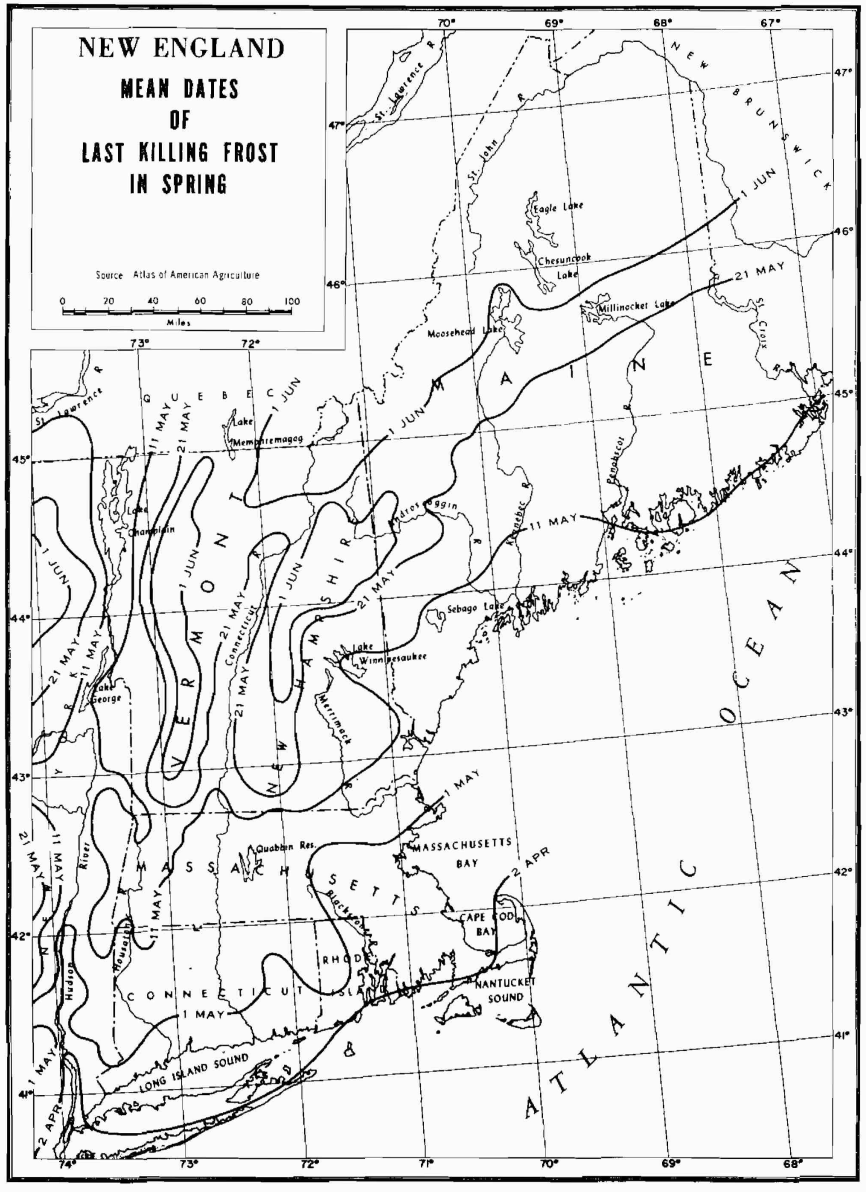
NEW ENGLAND
MEAN DATES
OF
LAST KILLING FROST
IN SPRING
Source Atlas of American Agriculture
0 20 40 60 80 100
Miles
1 JUN
21 MAY
11 MAY
1 MAY
21 APR
2 APR
11 APR
1 APR
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Lake George
Lake Winnipesaukee
Sebago Lake
Quabbin Res.
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
ATLANTIC OCEAN
QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW YORK
NEW BRUNSWICK
St. Lawrence R.
St. John R.
Androscoggin R.
Kennebec R.
Penobscot R.
Connecticut R.
Merrimack R.
Hudson R.
Housatonic R.

Fig. 12

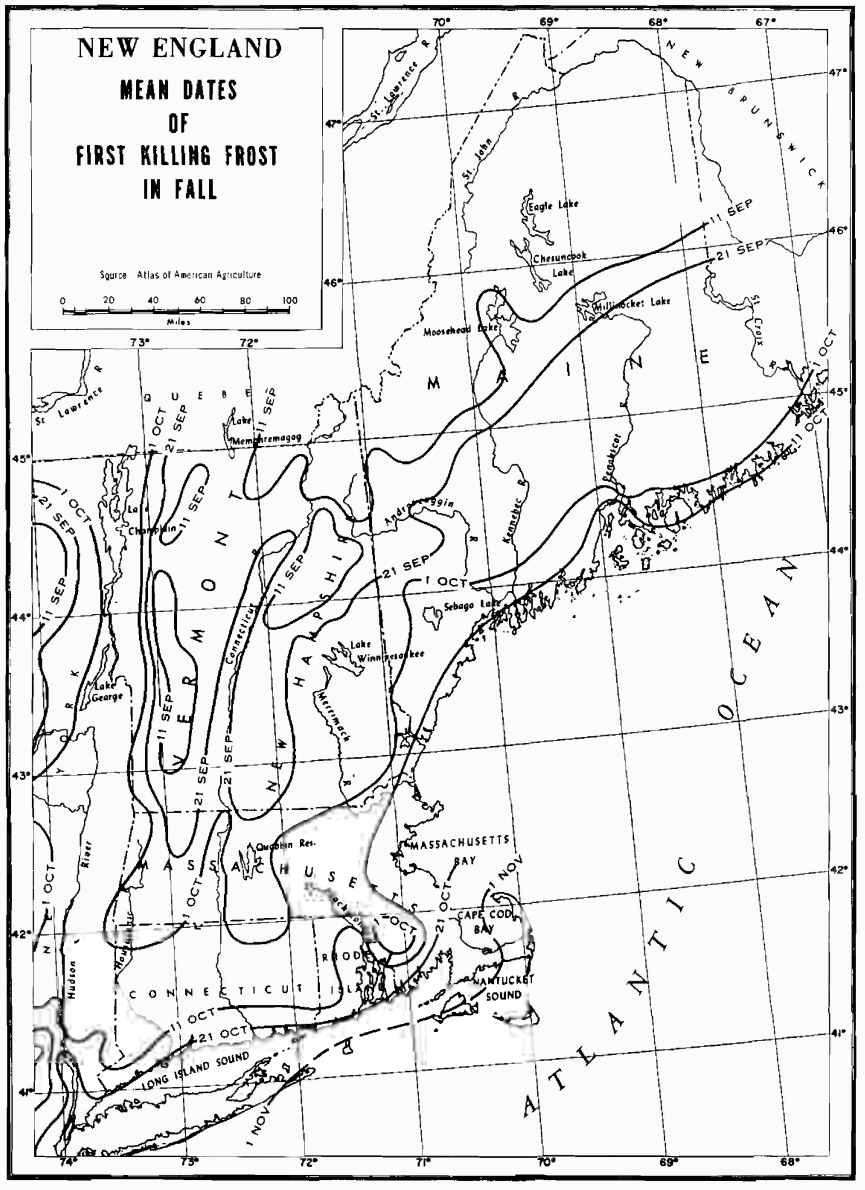
NEW ENGLAND
MEAN DATES
OF
FIRST KILLING FROST
IN FALL
Source Atlas of American Agriculture
0 20 40 60 80 100
Miles
1 OCT
21 SEP
11 SEP
1 SEP
11 OCT
21 OCT
1 NOV
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Lake George
Lake Winnipesaukee
Sebago Lake
Quabbin Res.
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
ATLANTIC OCEAN
QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW YORK
NEW BRUNSWICK
St. Lawrence R.
St. John R.
Androscoggin R.
Kennebec R.
Penobscot R.
Connecticut R.
Merrimack R.
Hudson R.
Housatonic R.

Fig. 13

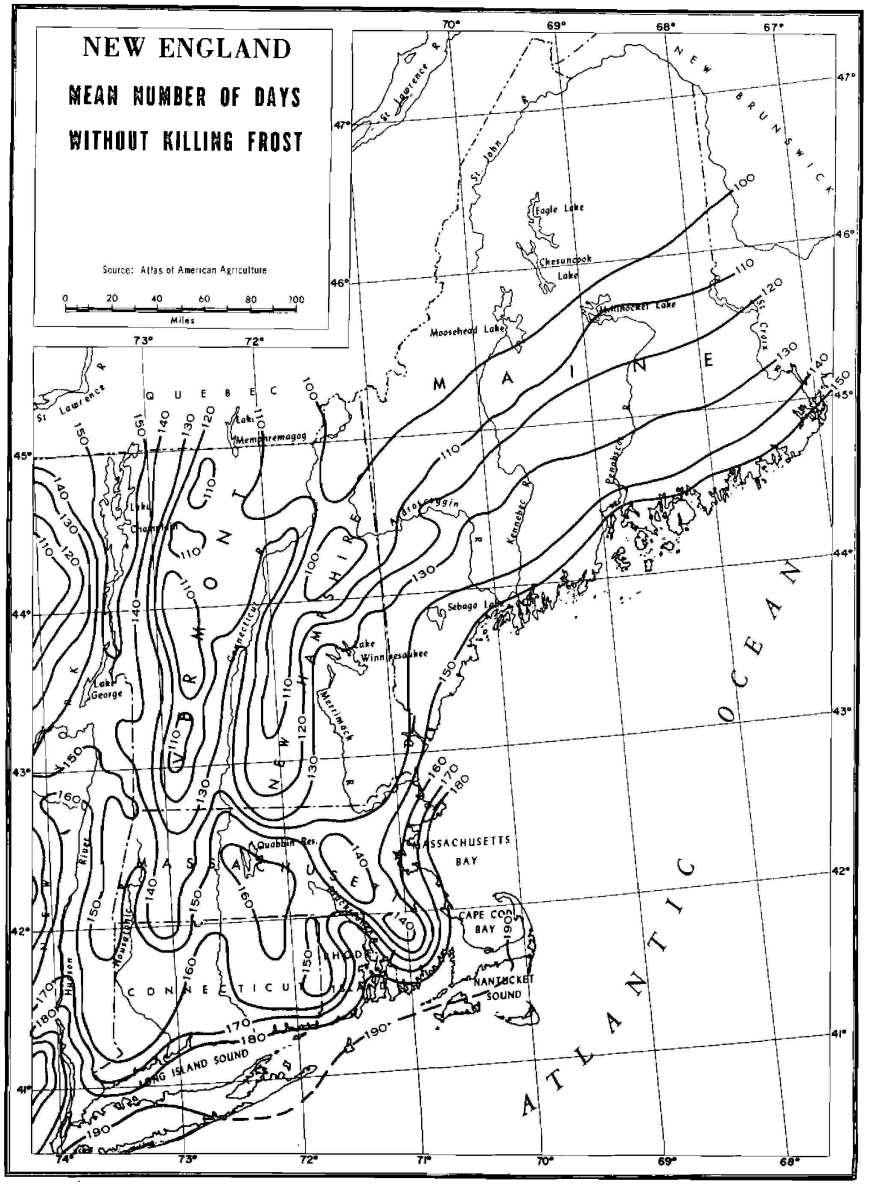
NEW ENGLAND
MEAN NUMBER OF DAYS
WITHOUT KILLING FROST
Source: Atlas of American Agriculture
0 20 40 60 80 100
Miles
QUEBEC
MAINE
NEW HAMPSHIRE
VERMONT
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
ATLANTIC OCEAN
St. Lawrence R.
St. John R.
NEW BRUNSWICK
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Androscoggin R.
Kennebec R.
Penobscot R.
Sebago Lake
Lake Winnipesaukee
Lake George
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Thames R.
Hudson R.
Delaware R.
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
MASSACHUSETTS BAY

Fig. 14

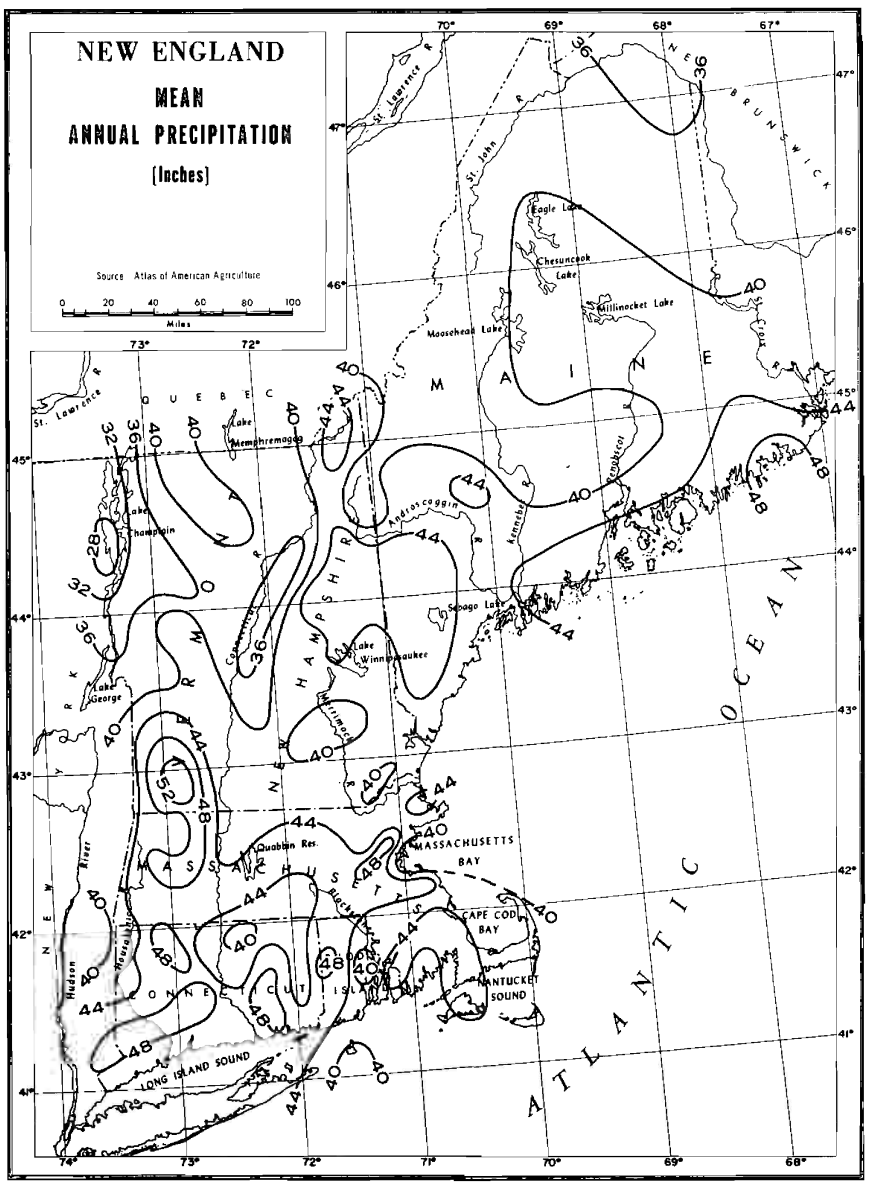
NEW ENGLAND
MEAN
ANNUAL PRECIPITATION
(Inches)
Source: Atlas of American Agriculture
0 20 40 60 80 100
Miles
QUEBEC
MAINE
NEW HAMPSHIRE
VERMONT
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
ATLANTIC OCEAN
St. Lawrence R.
St. John R.
NEW BRUNSWICK
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Androscoggin R.
Kennebec R.
Penobscot R.
Sebago Lake
Lake Winnipesaukee
Lake George
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Thames R.
Hudson R.
Delaware R.
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
MASSACHUSETTS BAY

Fig. 15

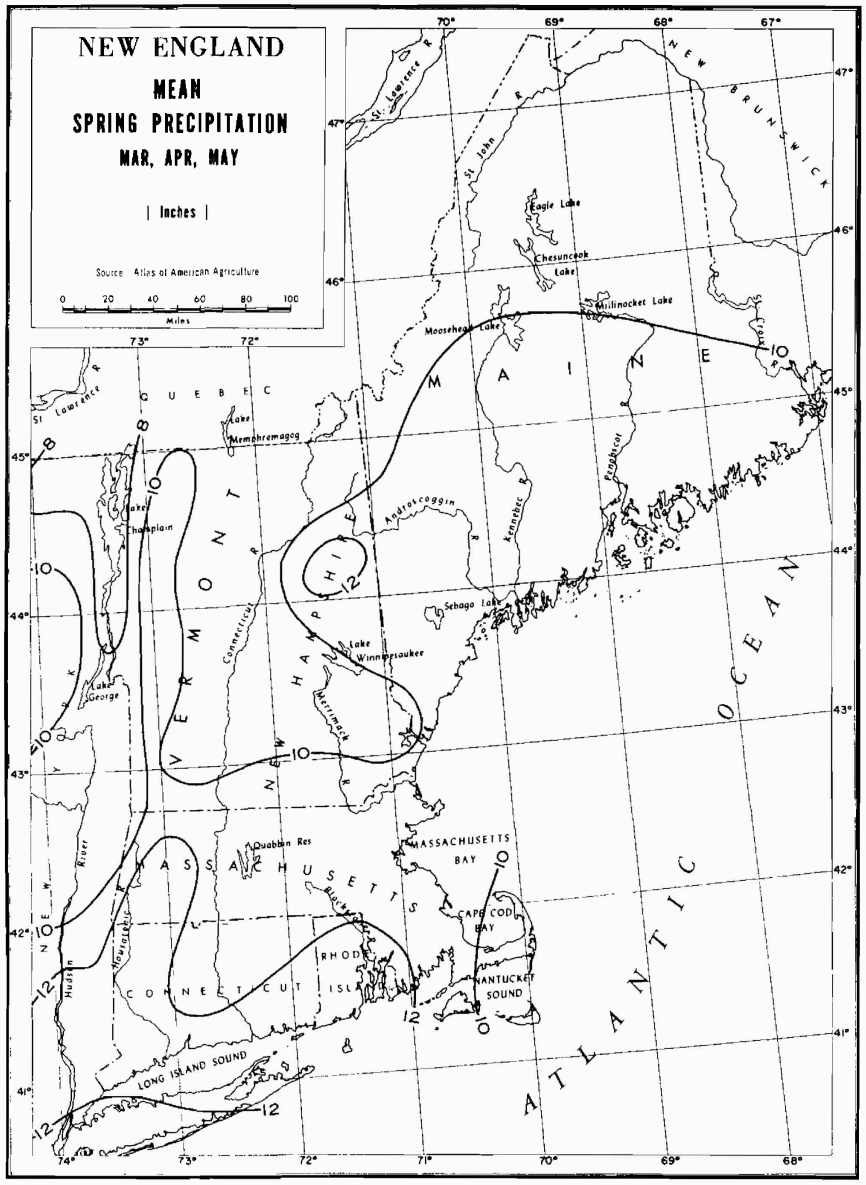
NEW ENGLAND
MEAN
SPRING PRECIPITATION
MAR, APR, MAY
(Inches)
Source Atlas of American Agriculture
0 20 40 60 80 100
Miles
QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
St Lawrence R
NEW BRUNSWICK
St John R
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Androscoggin R
Kennebec R
Penobscot R
Connecticut R
Sebago Lake
Lake Winnipesaukee
Lake George
Merrimack R
Quabbin Res
Hudson R
Housatonic R
Blackstone R
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
70° 69° 68° 67°
47° 46° 45° 44° 43° 42° 41°
73° 72° 71° 70° 69° 68°
74° 73° 72° 71° 70° 69° 68°
8 10 12

Fig. 16

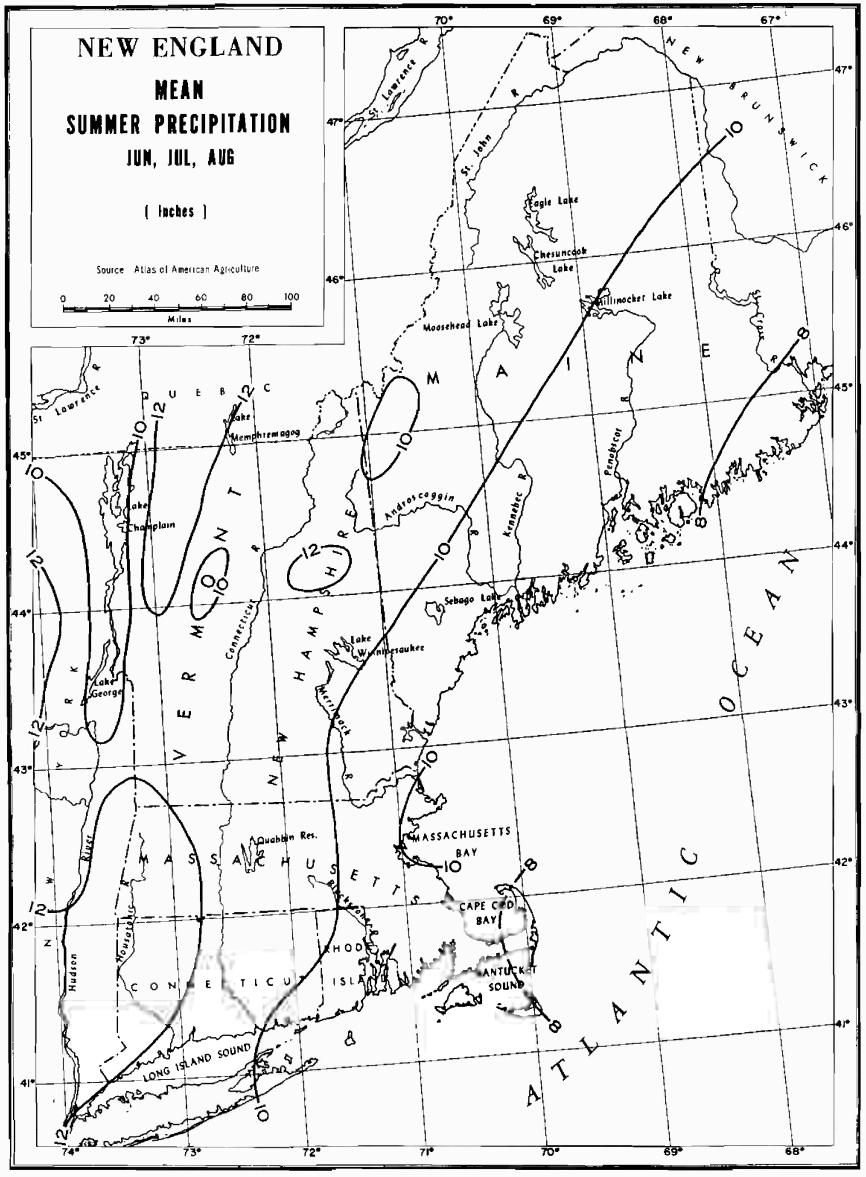
NEW ENGLAND
MEAN
SUMMER PRECIPITATION
JUN, JUL, AUG
(Inches)
Source Atlas of American Agriculture
0 20 40 60 80 100
Miles
QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
St Lawrence R
NEW BRUNSWICK
St John R
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Androscoggin R
Kennebec R
Penobscot R
Connecticut R
Sebago Lake
Lake Winnipesaukee
Lake George
Merrimack R
Quabbin Res.
Hudson R
Housatonic R
Blackstone R
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
70° 69° 68° 67°
47° 46° 45° 44° 43° 42° 41°
73° 72° 71° 70° 69° 68°
74° 73° 72° 71° 70° 69° 68°
8 10 12

Fig. 17

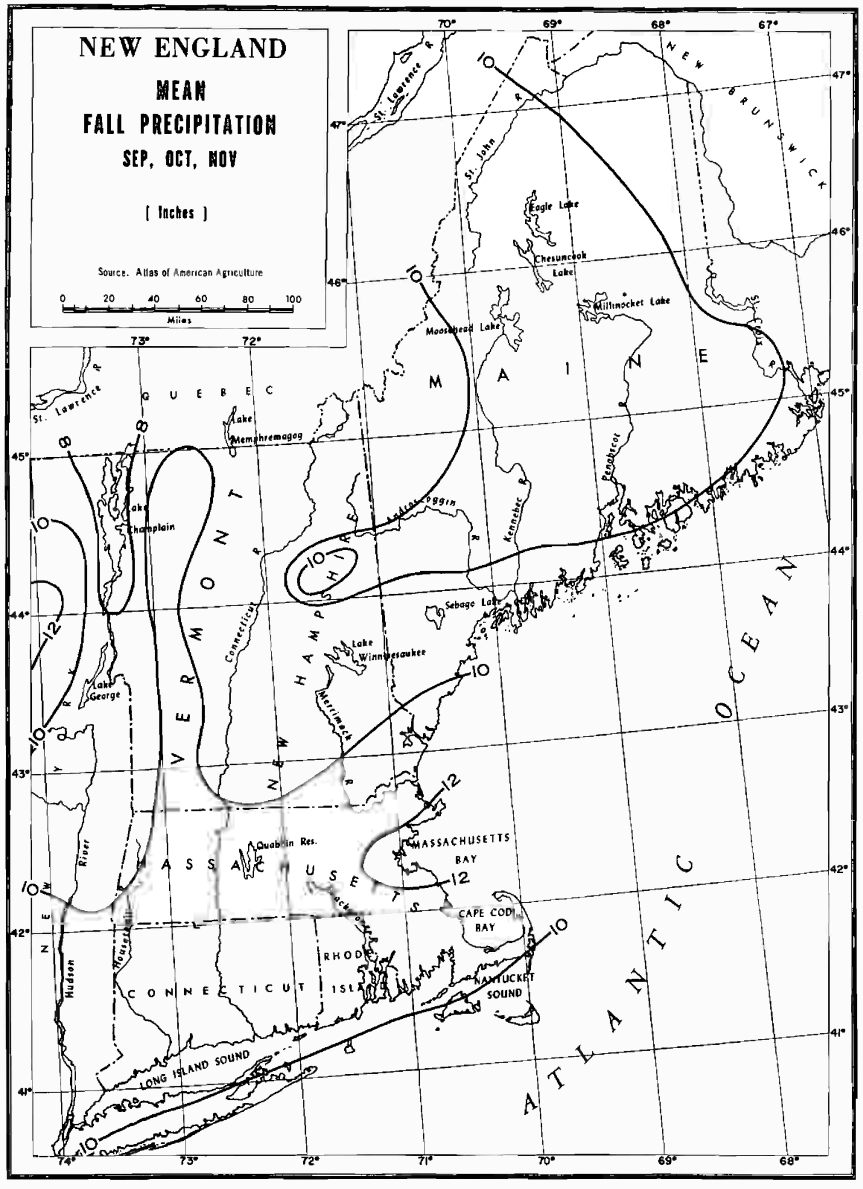
NEW ENGLAND
MEAN
FALL PRECIPITATION
SEP, OCT, NOV
[Inches]
Source. Atlas of American Agriculture
0 20 40 60 80 100
Miles
QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
St. Lawrence R.
St. John R.
NEW BRUNSWICK
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Androscoggin R.
Kennebec R.
Penobscot R.
Sebago Lake
Lake Winnipesaukee
Lake George
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Hudson R.
Mohawk R.
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
70° 69° 68° 67°
47° 46° 45° 44° 43° 42° 41°
74° 73° 72° 71° 70° 69° 68°
6 8 10 12 H

Fig. 18

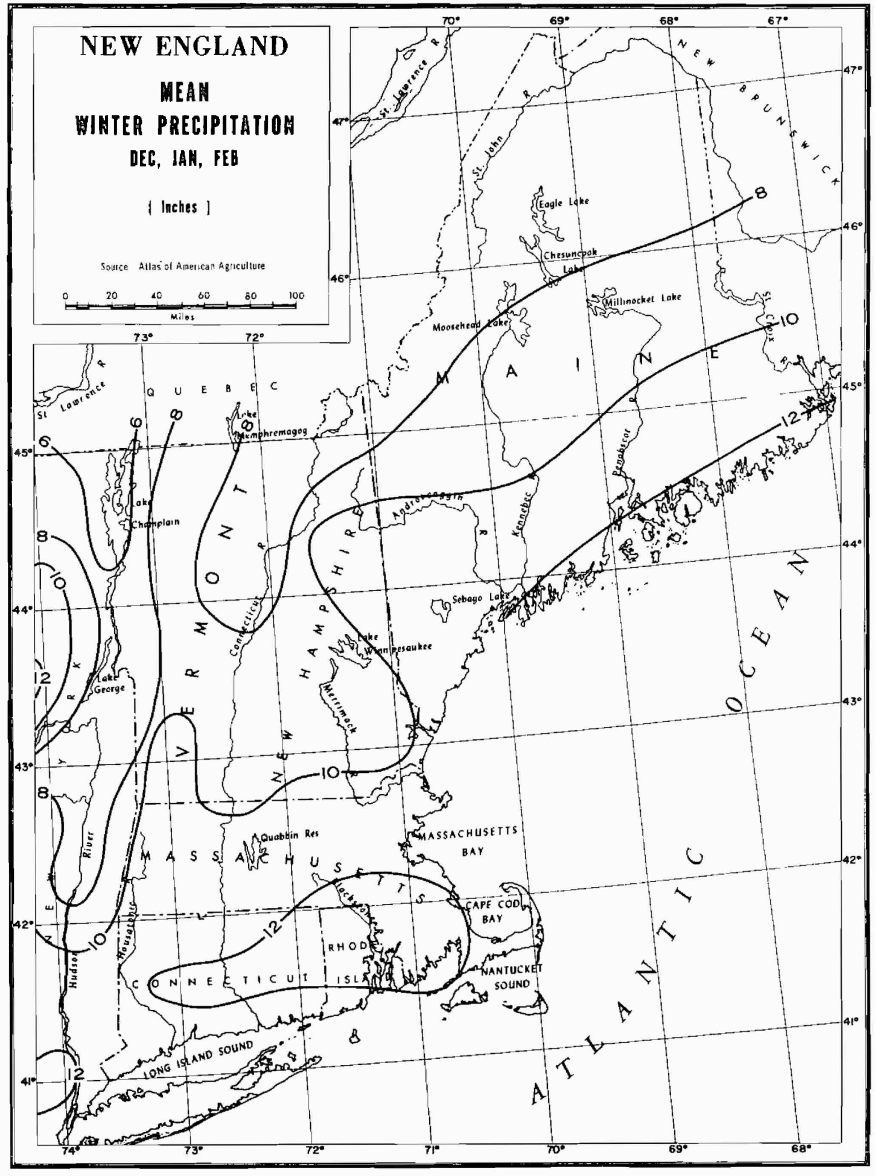
NEW ENGLAND
MEAN
WINTER PRECIPITATION
DEC, JAN, FEB
[Inches]
Source Atlas of American Agriculture
0 20 40 60 80 100
Miles
QUEBEC
MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
St. Lawrence R.
St. John R.
NEW BRUNSWICK
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
Lake Memphremagog
Lake Champlain
Androscoggin R.
Kennebec R.
Penobscot R.
Sebago Lake
Lake Winnipesaukee
Lake George
Connecticut R.
Merrimack R.
Quabbin Res.
Housatonic R.
Hudson R.
Mohawk R.
MASSACHUSETTS BAY
CAPE COD BAY
NANTUCKET SOUND
LONG ISLAND SOUND
70° 69° 68° 67°
47° 46° 45° 44° 43° 42° 41°
74° 73° 72° 71° 70° 69° 68°
6 8 10 12

Fig. 19


NEW ENGLAND
MEAN CONSECUTIVE WEEKS
WITH 2 INCHES OR MORE
SNOW COVER
Reproduced with permission of Robert G. Stone and the Transactions of The American Geophysical Union.
0 20 40 60 80 100
Miles
ATLANTIC OCEAN
QUEBEC
MAINE
NEW HAMPSHIRE
VERMONT
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW YORK
NEW BRUNSWICK
St. Lawrence R.
St. John R.
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
St. Croix R.
Lake Memphremagog
Lake Champlain
Kennebec R.
Androscoggin R.
Sebago Lake
Lake Winnipesaukee
Connecticut R.
Merrimack R.
Lake George
Quabbin Res.
Housatonic R.
Hudson R.
CAPE COD BAY
MASSACHUSETTS BAY
NANTUCKET SOUND
LONG ISLAND SOUND

Fig. 20

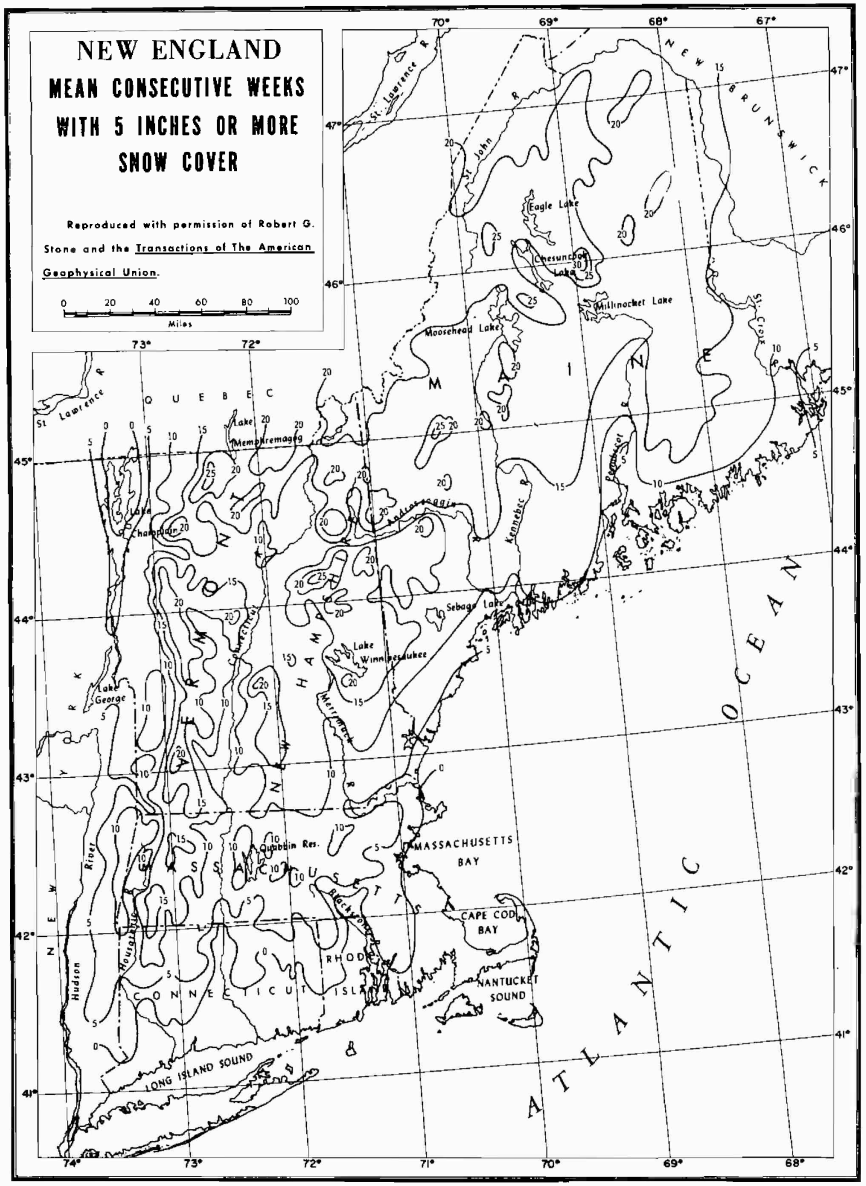
NEW ENGLAND
MEAN CONSECUTIVE WEEKS
WITH 5 INCHES OR MORE
SNOW COVER
Reproduced with permission of Robert G. Stone and the Transactions of The American Geophysical Union.
0 20 40 60 80 100
Miles
ATLANTIC OCEAN
QUEBEC
MAINE
NEW HAMPSHIRE
VERMONT
MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
NEW YORK
NEW BRUNSWICK
St. Lawrence R.
St. John R.
Eagle Lake
Chesuncook Lake
Millinocket Lake
Moosehead Lake
St. Croix R.
Lake Memphremagog
Lake Champlain
Kennebec R.
Androscoggin R.
Sebago Lake
Lake Winnipesaukee
Connecticut R.
Merrimack R.
Lake George
Quabbin Res.
Housatonic R.
Hudson R.
CAPE COD BAY
MASSACHUSETTS BAY
NANTUCKET SOUND
LONG ISLAND SOUND

Fig. 21

Fig. 22

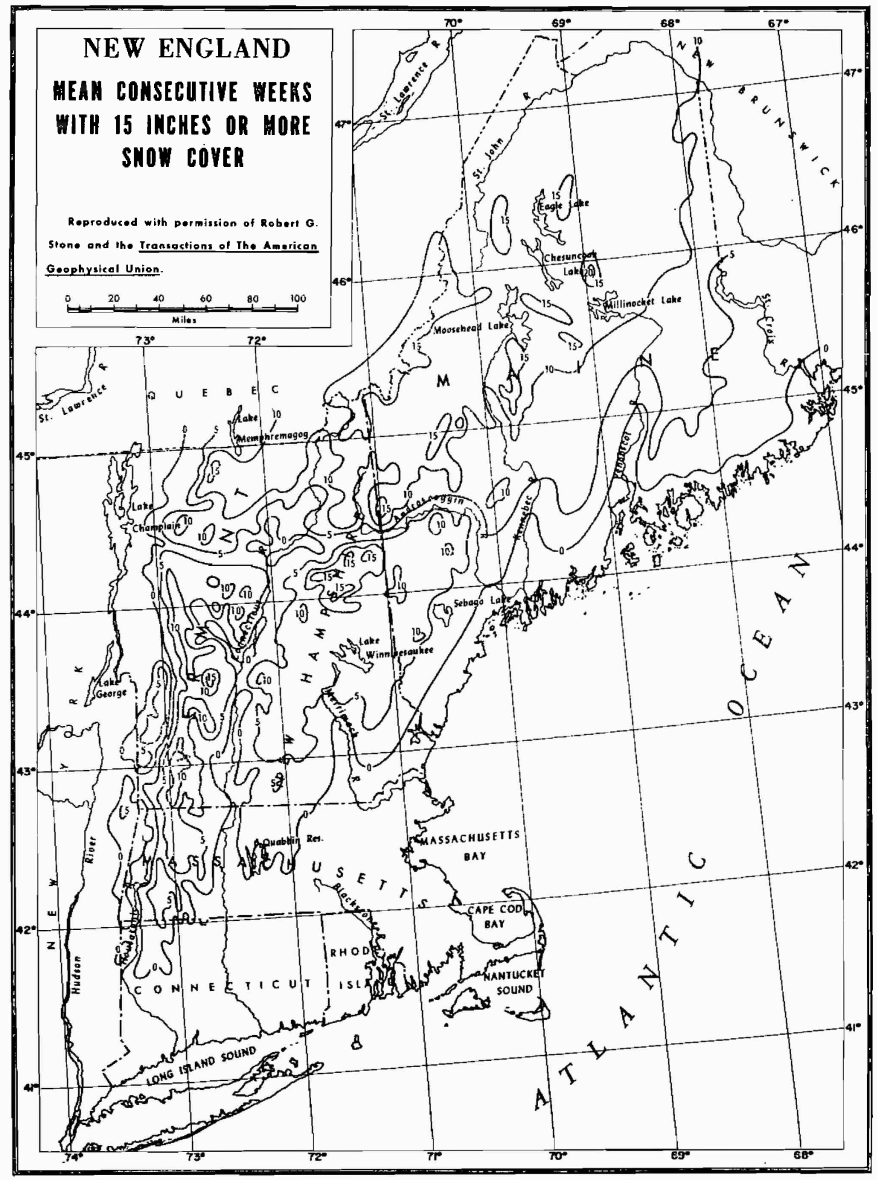

Fig. 23

AFPS/OGDEN, UTAH/67-907