

Earthquakes In and Near the Northeastern United States, 1638–1998

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About This Map

This map shows the regional pattern of earthquake distribution in and near the northeastern United States. It was prepared for a general, nontechnical audience. Accordingly, you should not use it to assess earthquake hazard in small areas or at individual locations. Such hazard assessments are best performed by specialists who use information that is more specific and extensive than could be shown on this map. The map does not show known explosions, mine collapses, sonic booms, or violent bursts caused by the expansion of frozen ground, all of which can be mistaken for earthquakes.

Earthquakes occur on geologic faults. However, in nearly all parts of the northeastern U.S., we do not yet know how to tell which fault caused an individual earthquake. Geologic maps show faults that are exposed at the Earth's surface, and maps like this one show the locations of earthquakes, but there is no reliable map of "earthquake faults" for the northeastern U.S.

The most common way to measure the size of an earthquake is to measure its magnitude. There are many different magnitude scales, or ways to measure magnitude. The frequently cited "Richter scale" was the first of these magnitude scales, although the name is too often applied indiscriminately. Each scale was designed to match the Richter scale, and also to be best for a particular region of North America, or for a particular scientific purpose. Use of different scales can give slightly different values for the magnitude of the same earthquake. Differences of several tenths of a magnitude unit are common. Therefore, your favorite earthquake might be shown here with a magnitude slightly different from what you have seen reported elsewhere.

The location of the earthquake's focus is uncertain, typically by several kilometers (miles) or more. Uncertainties are larger where seismographs (instruments that record earthquakes or shaking) are far apart, and for earthquakes that occurred before the development of seismographs. In fact, the latitudes and longitudes of some older earthquakes were so uncertain that they were rounded off to the nearest tenth or half a degree of longitude and latitude, or even to the nearest whole degree. The result is that some of these earthquakes with uncertain locations appear to line up along east-west or north-south lines. The map shows some earthquakes in Massachusetts and New Hampshire north of Boston. Nonetheless, despite the uncertain earthquake locations, the map shows that most parts of the map area have had earthquakes since European settlers arrived there. The descriptions of "notable earthquakes" indicate that all parts of the map area have been shaken by earthquakes.

Different areas were settled at different times, and these differences also affect the geographic distribution of known earthquakes. This is particularly true of earthquakes that occurred before the establishment of a network of seismographs throughout the northeastern U.S. during the 1970's. If an earthquake was too old, too small, or too remote to be recorded by a seismograph, we are likely to know about it only if it was felt or caused damage, and if it was reported in newspapers, diaries, or other written records. This may be the reason why earthquakes that are known from 1638 to 1937 are most numerous in long-settled coastal areas, whereas earthquakes since 1975 are more evenly distributed across the northeastern U.S., including in inland areas.



Old woodcut illustration showing contemporary account of damage to towns northeast of Boston, Massachusetts, during a magnitude 4.7 earthquake that occurred in 1744. Shaking was strongest about 20 kilometers (12 miles) northeast of the center of present-day Boston. (Reproduction of woodcut courtesy of the Rare Books Division, New York Public Library, Astor, Lenox, and Tilden Foundations.)



Old woodcut illustration showing contemporary account of damage to Boston, Massachusetts, during the Cape Ann earthquake of November 16, 1755. Shaking was strongest northeast of Boston. The magnitude 6.0 quake caused considerable damage in Boston, knocking down or damaging as many as 1,800 chimneys and collapsing brick walls of several buildings. (Reproduction of woodcut courtesy of the Trustees of the Boston Public Library.)

Or solemn Warning to the World; by the tremendous EARTHQUAKE which happen'd on Tuesday Morning the 18th of November 1755, between four and five o'Clock.

See! how poor Wretches from their Beds Afrightedly arise, And to their clatt'ring Windows run, With Horror in their Eyes!

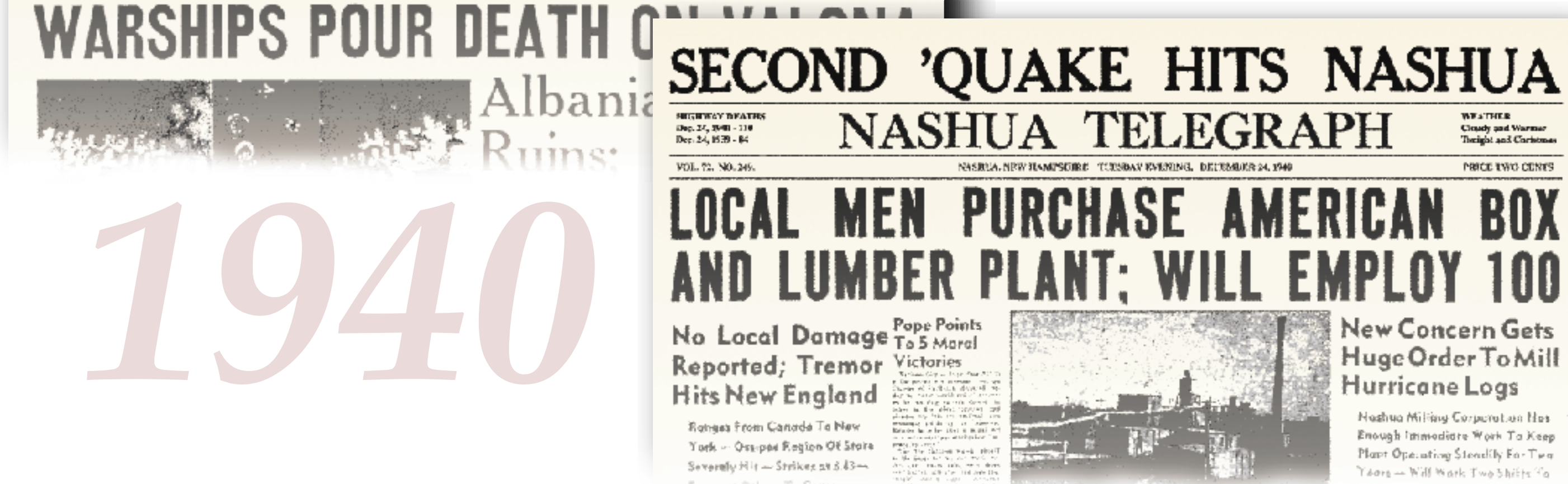
Buildings leap up, the Joins give Way, The crumbling Chimney groans; The loos'ned Bricks tost from on high Come thund'ring on the Stones.

The Birds flew flutt'ring through the Air, The Cows and Oxen low'd; And the Stone-Fence the Country round, Lies scatt'rd o'er the Road.

(Left) Descriptive verse from an old broadside poster that described the Cape Ann earthquake of 1755. (Reproduction made possible through the courtesy of the Trustees of the Boston Public Library.)



(Left and Below) Newspaper headlines and banner. (Reprinted with permission of the Nashua Telegraph, Nashua, New Hampshire; all rights reserved.)



(Right) Newspaper headlines and banner. (Reprinted with permission of the Springfield Union News and Sunday Republican, Springfield, Massachusetts; all rights reserved.)



Earthquake Causes Much Alarm, Some Damage in Big Area

Quake Evidently Breaks Water Mains in City

Automatic Indicators Show Some Ruptures in System After Shock

Dog Here Suffers After Quake

'Earthquake Baby' Born at Weson

Quake Center 235 Miles From Boston

Pope Prays for Victims

New Concern Gets Huge Order To Mill Hurricane Logs



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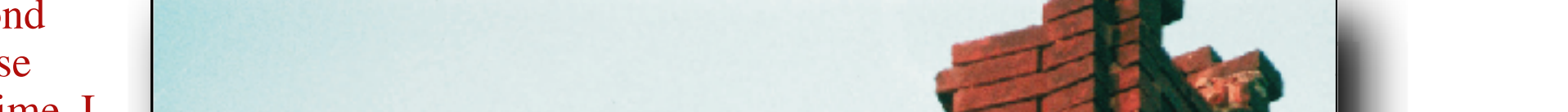
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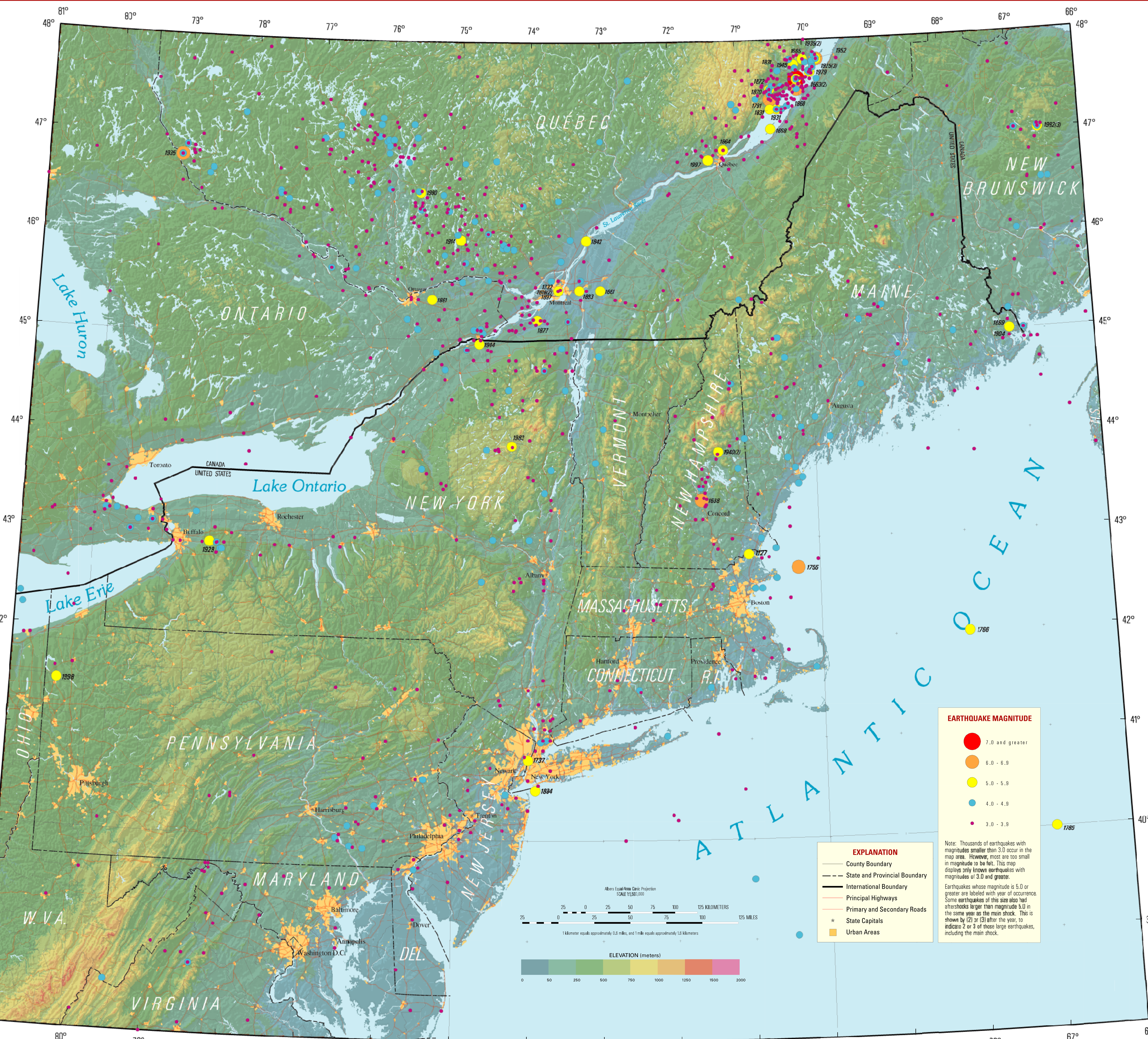
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Notable Earthquakes

Although some of the notable earthquakes shown on the map were centered in Canada, all were large enough to cause damage or be felt strongly in the United States. For selected notable earthquakes, the years, magnitudes, and map symbols appear below, to the left of a short description of the earthquake's effects.

Times shown are local standard time. In scientific publications, earthquake times are given in Universal Coordinated Time (UTC), which uses a 24-hour clock. UTC also uses Greenwich Mean Time, which is five hours ahead of the Eastern Standard Time zone of North America. Thus, seismologists would give the time and day of the 1928 earthquake as UTC 02:19 on March 1.

- June 11, 1638, 2 p.m.**
Central New Hampshire: The location and damage levels are very uncertain because settlements were sparse and reports were few. Shaking was felt strongly along the St. Lawrence River in Canada and in Boston, widely but less strongly across southern New England, and on ships near the coast. Aftershocks were felt for 20 days in eastern Massachusetts.
- Feb. 5, 1663, 5:30 p.m.**
Charlevoix, Quebec: The largest earthquake known in the northeastern U.S. and nearby parts of Canada occurred in this seismically active area, about 100 km (60 mi) northwest of northern Maine. Shaking was reported to have lasted about 2 minutes and caused landslides and sand boils. Six hundred km (375 mi) away in eastern Massachusetts, chimneys fell, plaster fell from shelves, and many people ran into the streets. The largest aftershocks of the next three days were felt in Boston. Aftershocks were felt in Quebec for more than 7 months.
- Nov. 9, 1727, 10:40 p.m.**
Newbury, Massachusetts: At Newbury in northeasternmost Massachusetts, many stone walls and nearly all chimney tops fell. Springs were altered. New trees became more numerous and others less so, and sand blows were reported. It was difficult to walk. Shaking was felt from southern Maine to Philadelphia, and on ships at sea. Aftershocks lasted several years.
- Dec. 18, 1737, 10:45 p.m.**
New York City: Bell ring, and several chimneys fell. The earthquake was felt in Boston, Philadelphia, and northern Delaware.
- June 14, 1744, 10:15 a.m.**
Southern Cape Ann, Massachusetts, approximately 20 km (12 mi) northeast of Boston along the coast: Bricks were shaken down, and many persons were alarmed. Shaking was reported from southern Maine to New York City.
- Nov. 18, 1755, 4:12 a.m.**
Cape Ann, Massachusetts: At Boston, about 55 km (34 mi) southwest of Cape Ann, effects were strongest on inflated and near the wharves. About 100 chimneys were thrown down, and as many as 1,500 others were damaged. Walls of several brick buildings fell. Some fences fell throughout the countryside. Springs opened or stopped. In eastern Massachusetts, ground cracks formed, some emitted sand and water. Aftershocks were reported. Shaking was felt from Nova Scotia to Maryland, and from New York State to a ship 320 km (200 mi) at sea. Those aboard the ship thought it had run aground.
- Oct. 22, 1869, 6 a.m.**
Easternmost Maine: In central and coastal New Brunswick, a rumbling noise preceded about 20 seconds of shaking, during which people ran outside, walls cracked, and chimneys fell. Similar reports were scattered across southern New Brunswick and eastern Maine. Because reports of this earthquake were few, the location is uncertain, but the geographic distribution of reports of shaking closely resembles that of the better-reported earthquake in 1904. For that reason we plotted the 1869 earthquake at the 1904 location. Shaking was felt throughout most of New England, Nova Scotia, and New Brunswick, and in Quebec, City and Montreal on the St. Lawrence River. One forelock and several aftershocks were reported.
- Aug. 10, 1884, 2:07 p.m.**
New York City: Chimneys and bricks fell and walls and plaster cracked in Connecticut, northern New Jersey, southern New York, and eastern Pennsylvania. The earthquake was felt from southern Maine to central Virginia, and westward to northeastern Ohio. Three strong shocks occurred: the second was the strongest. Slight aftershocks occurred on Aug. 11.
- Mar. 21, 1904, 1:04 a.m.**
Easternmost Maine: Chimneys fell in and near two towns in Maine and one in New Brunswick. Shaking was felt throughout most of New England, Nova Scotia, New Brunswick, Prince Edward Island, and southeastern Quebec. One forelock was reported and more than 14 aftershocks were reported over the next two and a half days.
- Feb. 28, 1925, 9:19 p.m.**
Charlevoix, Quebec: This large earthquake caused damage in the same area that was impacted by the larger shock of 1663. The 1925 earthquake, and many smaller ones since then, demonstrate that the area remains seismically active.
- Aug. 12, 1928, 6:45 p.m.**
Attica, New York: Most damage was in or just east of this western New York State city. Two hundred and fifty chimneys fell, several brick buildings were damaged, a railroad embankment cracked, nearly all monuments toppled in a cemetery, several wells went dry, and one well cracked. Shaking was felt from New Hampshire to Michigan and from Maryland to northern Ontario.
- Dec. 20, 1940, 2:27 a.m.**
Ossipee, New Hampshire: In east-central New Hampshire, old houses and chimneys were the most commonly affected. Chimneys fell or were damaged, walls cracked, plaster fell, water pipes and furniture broke, and four cemetery monuments moved. The timber foundation of one old house shifted. Well water was muddied and crusty snow eroded. Lesser damage occurred in nearby parts of Maine, Massachusetts, New York, and Vermont. Shaking was felt throughout New England and most of New York State, and in adjacent parts of New Jersey, Pennsylvania, and Canada. Some of the damage was caused by a second earthquake of similar size and location four days later. Aftershocks were felt for several months.
- Sept. 4, 1944, 11:39 p.m.**
Cornwall, Pennsylvania: New York: At Massena in northeastern New York State and across the St. Lawrence River in Cornwall, Ontario, nearly all chimneys were thrown down or damaged, and foundations, plumbing, and masonry were damaged severely. Surrounding towns as far away as 80 km (50 mi) reported lesser chimney damage and many water wells went dry. Damage in Massena and Cornwall was estimated at two million 1944 dollars (approximately 20 million 2008 dollars). Shaking was felt from Maine to Indiana and from Maryland to central Ontario and central Quebec.
- Jan. 9, 1962, 8:53 a.m.**
Miramichi, New Brunswick: Damage was very slight, because the area where the earthquake occurred was sparsely populated to begin with. Cracks formed in streets, chimneys, foundations, sidewalks, plaster, and drywall in towns as far away as 100 km (60 mi) or so. Shaking was felt from Prince Edward Island in the east to Ottawa in the west, throughout New England, and as far south as New York City. Within three days, two aftershocks larger than magnitude 5 caused additional damage. Hundreds of smaller aftershocks continued for at least half a year, including one of magnitude 4.6 on March 31 and another of magnitude 4.6 on June 16.
- Oct. 7, 1983, 5:19 a.m.**
Goodnow, New York: The sparsely settled area in the Adirondack Mountains received only slight damage. One chimney collapsed and others cracked, 20 tombstones moved, plaster cracked slightly, and several landslides were reported. Shaking was felt from southern Maine to easternmost Michigan, and from northern New Jersey to southern Ontario and southwestern Quebec. The felt area was almost the same as for the more damaging 1929 Attica earthquake.
- Sept. 25, 1998, 2:52 p.m.**
Pymatuning Reservoir, Pennsylvania: The area in northwestern Pennsylvania where the earthquake was centered is mostly rural with many small towns. The shaking and an explosion-like noise drove many people outdoors. One person was thrown down and injured. A factory lost power when its transformer was damaged. Some chimneys cracked or lost bricks and a few fell. Some walls and windows cracked. Plaster fell. In an empty elementary school, ceiling tiles fell and windows broke. Many items fell from shelves in homes and stores. More than 100 residential water wells lost water and many of them had to be deepened. Shaking was felt in western New York State and Pennsylvania, northeastern Ohio, eastern Michigan, and southwestern Ontario. Several small aftershocks occurred.

Sources of Information

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Technical Notes for Seismologists

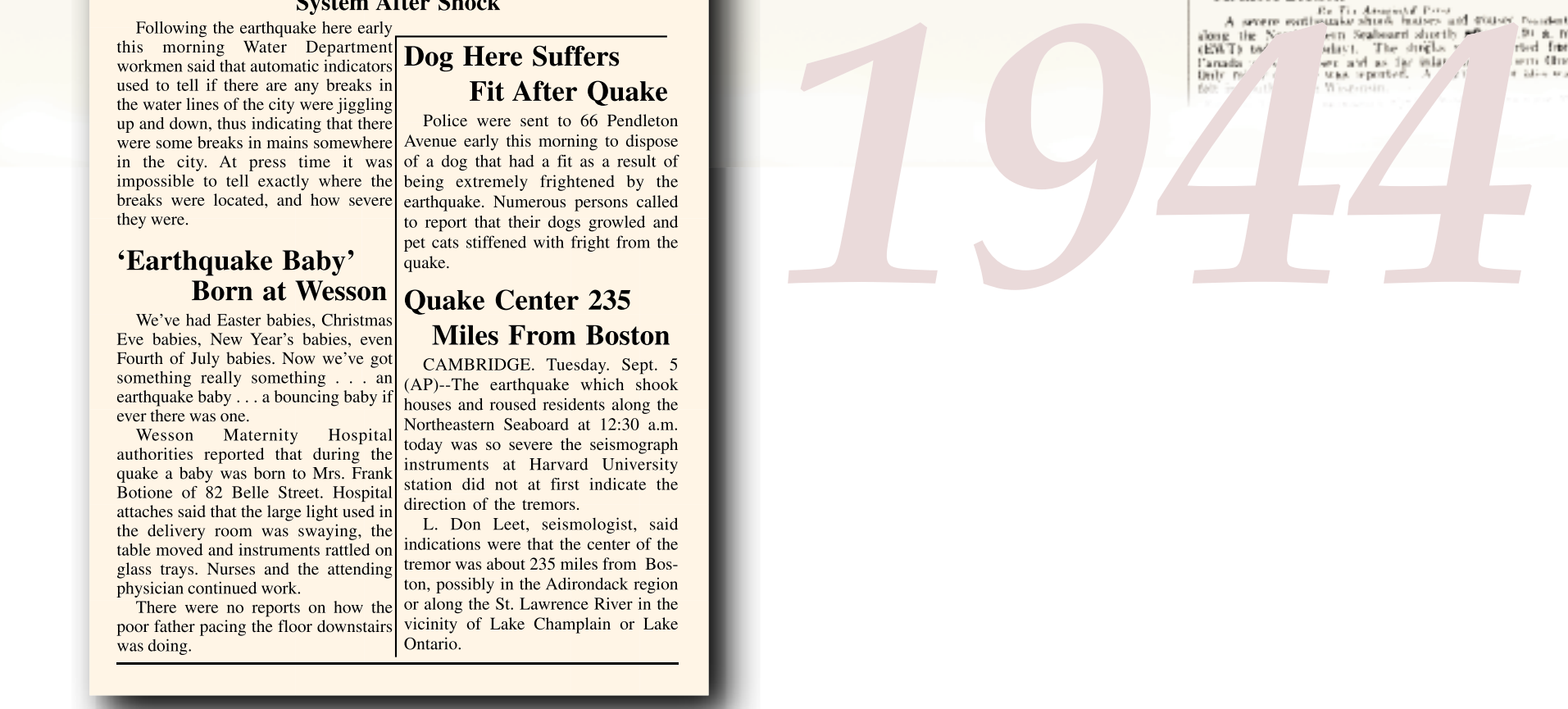
The catalog of earthquakes shown here was designed to show the general public the regional distribution of seismicity, and to provide seismologists with an outreach and teaching tool. Limited resources required use of existing earthquake catalogs. Selected seismologists generously corrected many errors in the catalog entries for earthquakes and areas that they had studied. However, the catalog of earthquakes shown here may still contain duplicates, omissions, events that were not earthquakes, incomplete data, and other errors. The map was prepared for a nontechnical audience. Therefore, for maximum impact it should show a State's or Province's earthquakes in a manner consistent with how they are shown by the local source to which the citizens of the State or Province turn for earthquake information. Accordingly, the earthquake subdivisions for each State and Canada were assembled in consultation with the State and Canadian geological surveys (details are in Wheeler, 2000, USGS Open-File Report 00-016, 6 p., available for downloading at URL: <http://www.ncei.noaa.gov/products/earthquake/00-016.pdf>). For that part of the map area that shows earthquakes listed in the catalog that was used to prepare the 1995 Canadian national hazard maps, for New England, the map shows earthquakes from the Northeastern U.S. Seismic Network and New England Seismic Network catalogs. For other States, the map shows earthquakes from various mixes of established regional catalogs and earthquake lists maintained by State geological surveys. Thus, magnitude scales, compilation methodology, and other factors vary across the map area. However, the overall pattern of epicenters and magnitudes shown on the map is approximately the same as that shown on a test map using the catalogs compiled for the 1995 Canadian and 1997 U.S. national hazard maps. The final map shows 1,069 earthquakes of magnitude 3.0 or larger that occurred from 1638 through 1998.

Acknowledgments

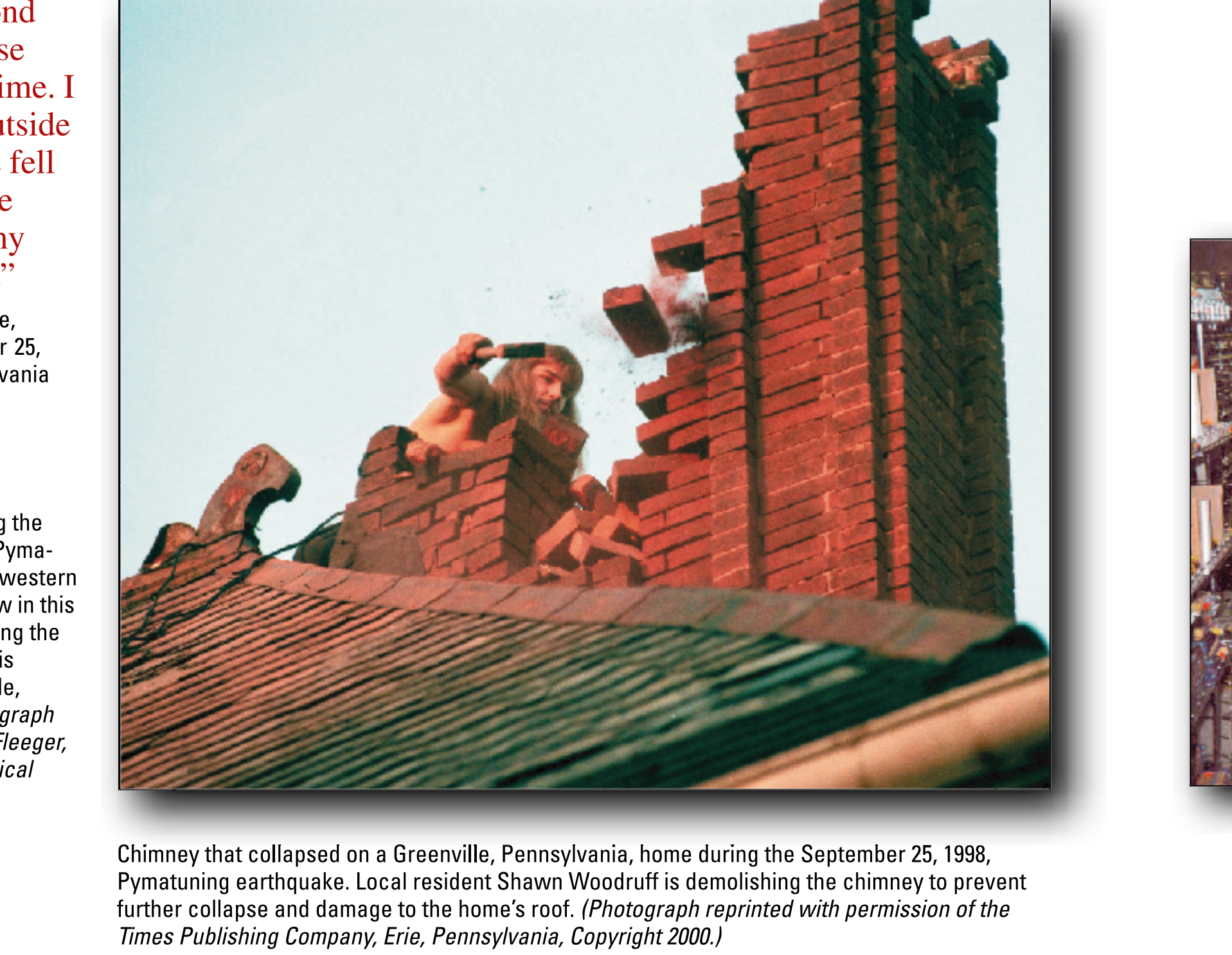
The map and parts of the earthquake descriptions and catalog were improved by suggestions and data from John Adams, Shelton Alexander, John Ambruster, Stefanie Baxter, Martin Chapman, Edward Cranwick, Pamela Derra, James Dewey, Charles Doli, Daniel Donbrovski, Jr., Janet Drysdale, John Ebel, Roger Fall, Robert Finkbeiner, Edward Frantz, Stephen Haskins, Michael Hansen, Klaus Jacob, Alan Karls, Won-Young Kim, John Lahr, Charles Langston, Nancy McHose, Stuart Nissenkov, Gary Nissen, James Reger, Damon Salzer, Charles Schumberger, Leonardo Seber, and Naif Toksoz. Newspaper headlines were provided by Kathleen Langone, earthquake historian.

1944

Shaded relief base created from U.S. Geological Survey Digital Elevation Model (DEM) with a 30-meter resolution. Altitude values are shown in meters. Contour interval is 20 m. 30° 30' N and 80° 30' W, central meridian 27° 30' W. Latitude of projection is 39° 10' N.



Water-logged field near Greenville, Pennsylvania, caused by a rise in the water table immediately following the September 25, 1998, Pymatuning earthquake in western Pennsylvania. The water-logged soil made parts of the field inaccessible to the farmer working the land. (Photograph courtesy of Gary M. Flegler, Pennsylvania Geological Survey.)



Chimney that collapsed on a Greenville, Pennsylvania, home during the September 25, 1998, Pymatuning earthquake. Local resident Shawn Woodruff is demolishing the chimney to prevent further collapse and damage to the home's roof. (Photograph furnished with permission of the Times Publishing Company, Erie, Pennsylvania, Copyright 2000.)



Groceries knocked off the shelves at the Golden Dawn Supermarket in Jamestown, Pennsylvania, during the September 25, 1998, Pymatuning earthquake. The magnitude 5.2 earthquake was felt over an area of 200,000 square kilometers (77,230 square miles), as far west as Illinois and Wisconsin, as far south as Kentucky and Virginia, as far east as New Jersey, Connecticut, and Washington, D.C., and as far north as southern Ontario, Canada. (Photographs courtesy of Regis Shawkey of the Golden Dawn Supermarket.)