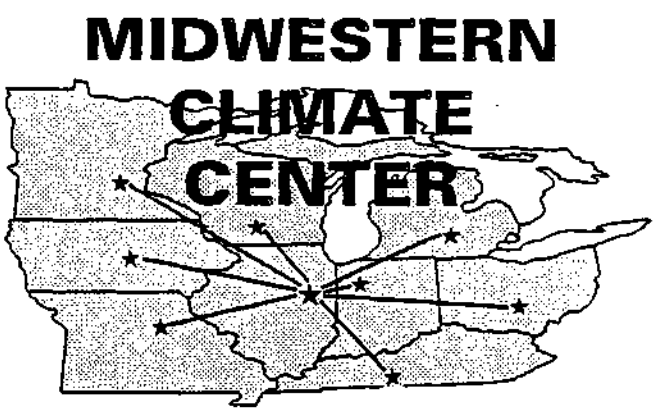
SWS Miscellaneous Publication 136

Mean 1961–1990 Temperature and Precipitation over the Upper Midwest

by

Wayne M. Wendland (IL), Kenneth E. Kunkel, Glen Conner (KY), Wayne L. Decker (MO), Harry Hillaker (IA), Pant Naber-Knox (WI), Fred V. Nurnberger (MI), Jeffrey Rogers (OH), Kenneth Scheeringa (IN), & James Zandlo (MN)



Research Report 92-01
January 1992

Midwestern Climate Center
Office of Applied Climatology
Illinois State Water Survey
2204 Griffith Drive
Champaign, Illinois 61820-7495
(217) 244-8226

Mean 1961-1990 Temperature and Precipitation over the Upper Midwest

by

Wayne M. Wendland (IL), Kenneth E. Kunkel,
Glen Conner (KY), Wayne L. Decker (MO),
Harry Hillaker (IA), Pam Naber-Knox (WI),
Fred V. Nurnberger (MI), Jeffrey Rogers (OH),
Kenneth Scheeringa (IN), & James Zandlo (MN)

Midwestern Climate Center
Research Report 92-01

Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495

January 1992

K. E. Kunkel is Director of the Midwestern Climate Center. Remaining authors are the State Climatologists of the states within the region of the Center.

printed on recycled paper

Introduction

Several years ago, mean charts of temperature and precipitation were prepared for the upper Midwest by the North Central Regional Climate Center, based on 1951-1980 data (Wendland et al., 1985). Since the World Meteorological Organization and the U.S. National Weather Service (NWS) recommend updating 30-year averages each decade for the construction of climatic mean (normal) values, the following analyses are presented for 1961-1990 data for the nine states included in the region of the Midwestern Climate Center.

The data used for the analysis are observations from NWS Offices and Forecast Offices, as well as NWS Cooperative sites, acquired from the Midwest Climate Information System, located at the Illinois State Water Survey, Champaign. Data density varied upwards from about 60 stations per state.

ANALYSIS

Mean maximum and minimum temperatures are presented for the mid-season months: January, April, July and October. Data were plotted to tenths of a Fahrenheit degree and analyzed at 2°F intervals. They are also labeled in degrees Celsius.

Some smoothing of raw temperature data was required due to differences in the time of the daily observation. NWS Cooperative stations record the highest and lowest temperature, precipitation and snowfall from the 24 hrs prior to time of observation, and snow depth at the time of observation once each day. Experience shows that monthly mean temperatures composed of once-per-day observations made near the time of minimum temperature (early morning) will tend to underestimate the midnight-to-midnight means by as much as 5°F (Karl et al., 1986), whereas those taken near the time of maximum temperature (afternoon) will overestimate midnight-to-midnight means by a like amount. Therefore 2 sites within, say, 20 miles of each other, may exhibit mean monthly temperature differences of a few degrees, but in fact only reflect means composed of observations from different times.

Because of the importance of the distribution of precipitation throughout the year, these analyses are presented for all months (water equivalent), plus mean annual and annual snowfall. Data density was essentially equivalent to that of temperature. Data were plotted to hundredths of an inch, and isohyets were drawn for each 0.4 inch (also labeled in millimeters) on the monthly precipitation charts, every 2 inches for annual precipitation, and every 4 inches for annual snowfall, except in Indiana and Upper and Lower Michigan where the interval is expanded to accommodate the relatively high lake-effect precipitation.

Precipitation, too, required some smoothing due to continuing changes in capture efficiency of any given raingage as a function of wind conditions, and if on a slope, whether the wind direction exposed the gage to an upslope or downslope, etc. That being said, features with scale sizes less than perhaps 30 miles should not be interpreted from these charts.

Lake-effect precipitation

Lake-effect precipitation often exhibits gradients of 10 inches or more per storm over distances of only a few miles, especially near the eastern and southern margins of Lake Michigan, and southern shores of Lake Superior. Generally lake-effect precipitation diminishes with increasing downstream distance from the lakes.

The principle area of Indiana affected by lake-effect precipitation lies to the south of U.S. Hwy 6 (about 5 mi south of Lake Michigan) and north of the Kankakee River (about 25 mi south of the lake), from the Illinois state line to Indiana State Road 15 (some 50 mi east of the lake).

Lake-effect precipitation can also have an appreciable influence in Indiana further inland. Lake-effect precipitation has been frequently noted near Logansport and Kokomo, and occasionally Lafayette (80 mi south of the lake). Northeastern Indiana counties as far south as Fort Wayne are also influenced, although in a minor way. Though precipitation amounts in these secondary areas are less than those closer to Lake Michigan, satellite imagery clearly shows this long distance moisture trajectory.

Lake-effect precipitation in lower Michigan is greatest in the southwestern and western part of the state, generally to the west of U.S. Route 131. The lake-effect snow is enhanced by the higher terrain to the north (from south of Cadillac northeastward to just south of Alpena). How this increase is partitioned between lake-effect and topographic effect, however, is not known. To a much less degree the Lake Huron shoreline receives lake-enhanced snowfall when storm systems pass to the south and circulation is inland from the lake. These zones are much narrower and realize less of an increase.

In Upper Michigan, lake-effect snow also plays a significant role, with near-shore locations measuring several times more snow that a score or so miles further inland. Topographic relief also plays a strong role in modifying lake-effect precipitation over the Keweenaw Peninsula. Lake-effect snow does not generally reach the Michigan-Wisconsin border.

Climatic "normals"

It is appropriate at this point to comment on the term, climatic "normals," which are simply 30-year means. One should not infer that the "normal" precipication or temperature value is the most likely value for a given location and time. For example, in autumn, mean 30-yr temperatures decline regularly from day to day, suggesting a gradual cooling, but is actually an artifact of the statistical treatment of the data. Obviously, a cooling trend is the signature of autumn, but it is the result of increasing frequencies of cooler air from Canada and decreasing frequencies of air from the south, resembling a step-function, rather than a gradual day-to-day transition from warmer temperatures to cooler. Again, 30-year normals are simply 30-year means.

One should also note that "normals" are not constant over time. Although the magnitude and orientation of temperature and precipitation gradients remain much the same as those shown in 1951-1980 data (Wendland et al., 1986), there are areas which exhibit substantial change in the magnitudes of the "normals," even though the data for this atlas retain 20 years of those used in the earlier publication.

Temperature magnitudes change only little from 1951-1980 to the present presentation. It is primarily in precipitation where differences are noted, and primarily in the central portion of the Upper Midwest, although other smaller regions exhibit substantial changes as well. The precipitation changes are virtually all increases from the earlier data. This appears to be primarily because the rather dry 1950s were replaced with data from the rather wet 1980s in the new "normals."

ACKNOWLEDGEMENTS

We acknowledge comments offered by Donald Baker, John Baker, David Ruschy, Mark Seeley, Richard Skaggs and Greg Spoden, associates of the Minnesota State Climatologist; and the quality charts, prepared by John Brother of the Water Survey.

REFERENCES

Karl, T. R., C. N. Williams, Jr., P. J. Young & W. M. Wendland, 1986: A model to estimate the time of observation bias associated with monthly mean maximum, minimum and mean temperatures for United States locations. J. Clim. Appl. Meteor. 25:145-160.

Wendland, W.M., J.L. Vogel & S.A. Changnon, Jr., 1985: Mean 1951-1980 temperature and precipitation for the North Central Region. NCRCC Paper No. 7. Illinois State Water Survey, Champaign. 30 p.

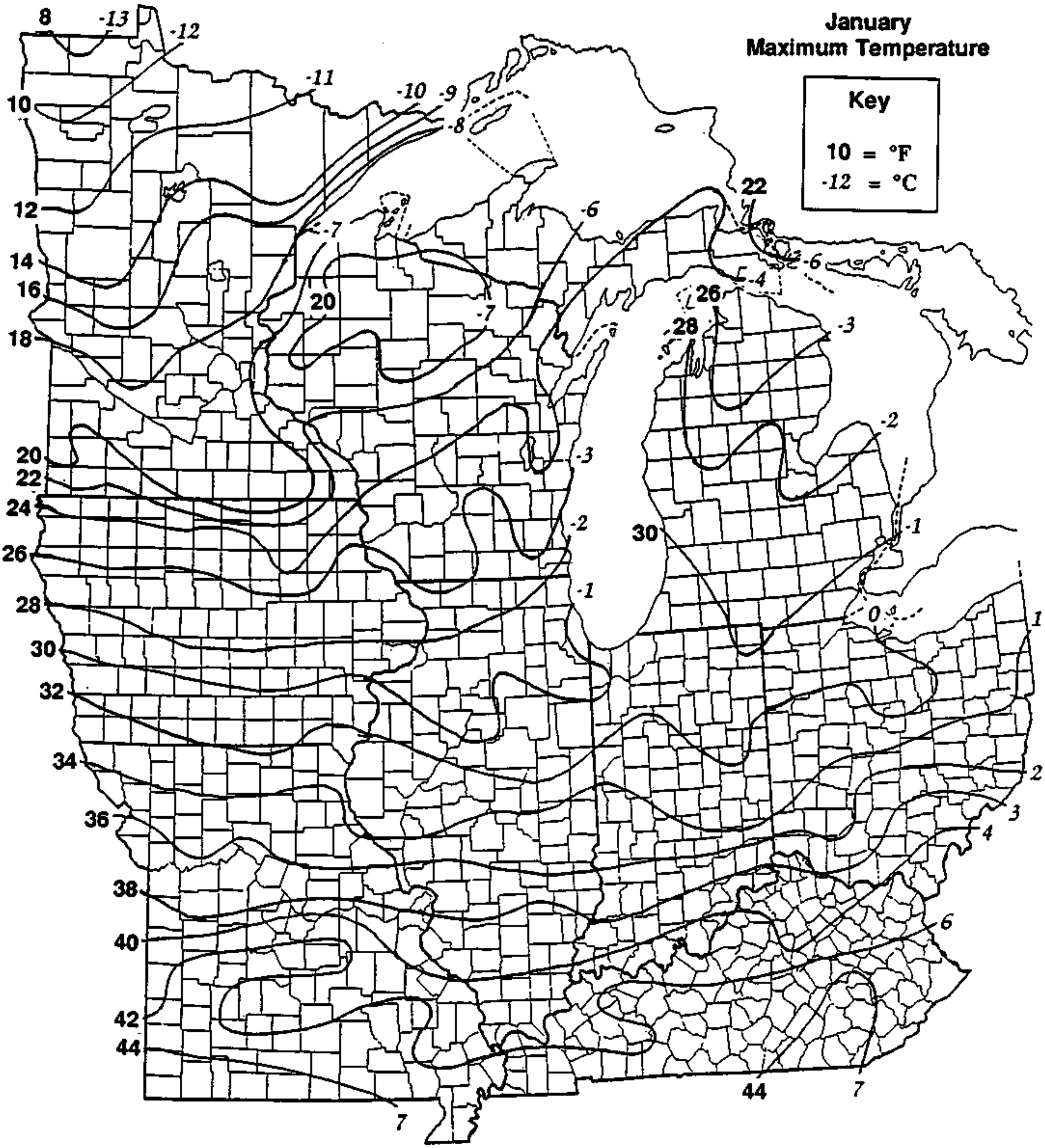


Fig. 1. Mean January Maximum Temperature (1961-1990)

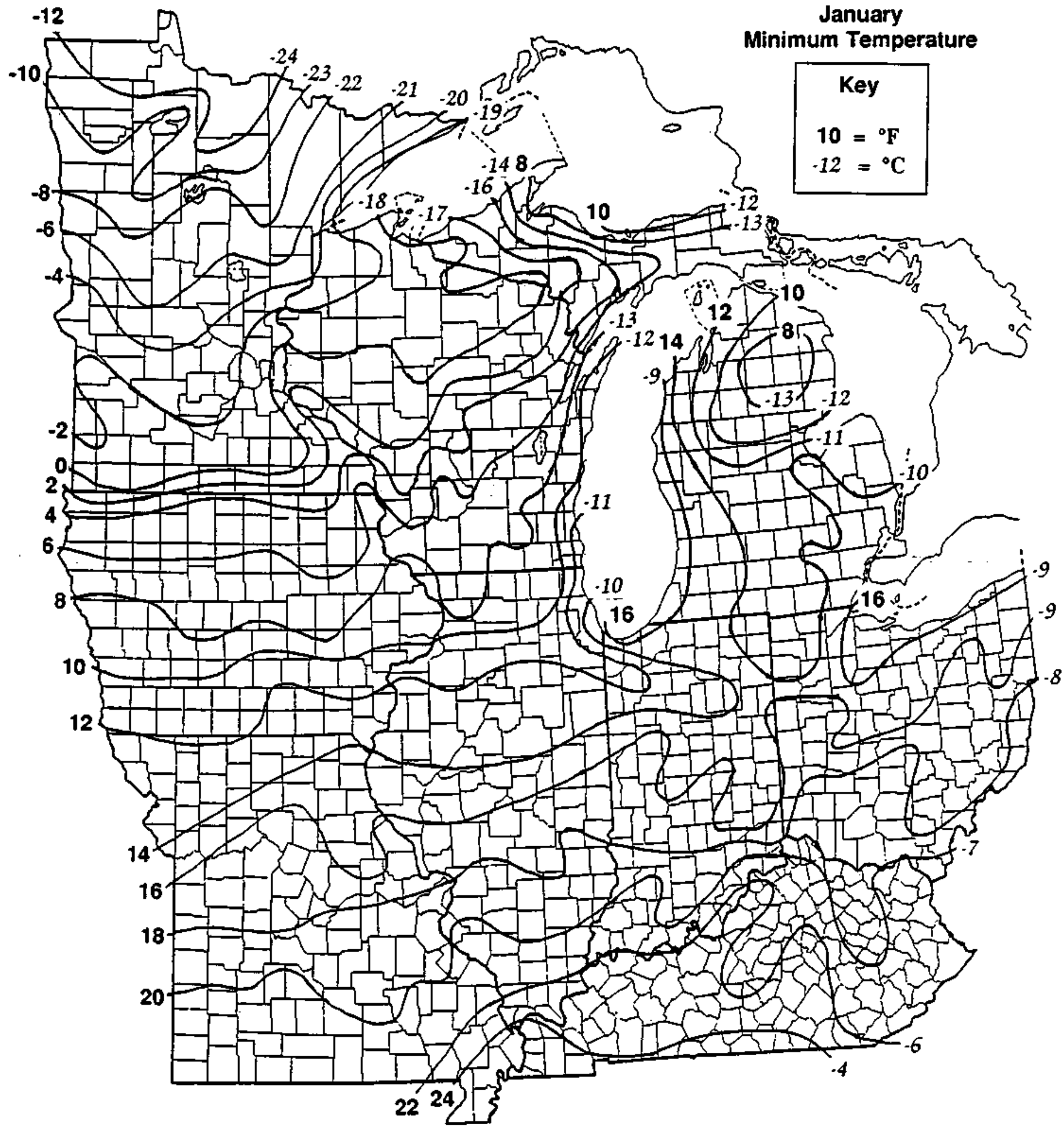


Fig. 2. Mean January Minimum Temperature (1961-1990)

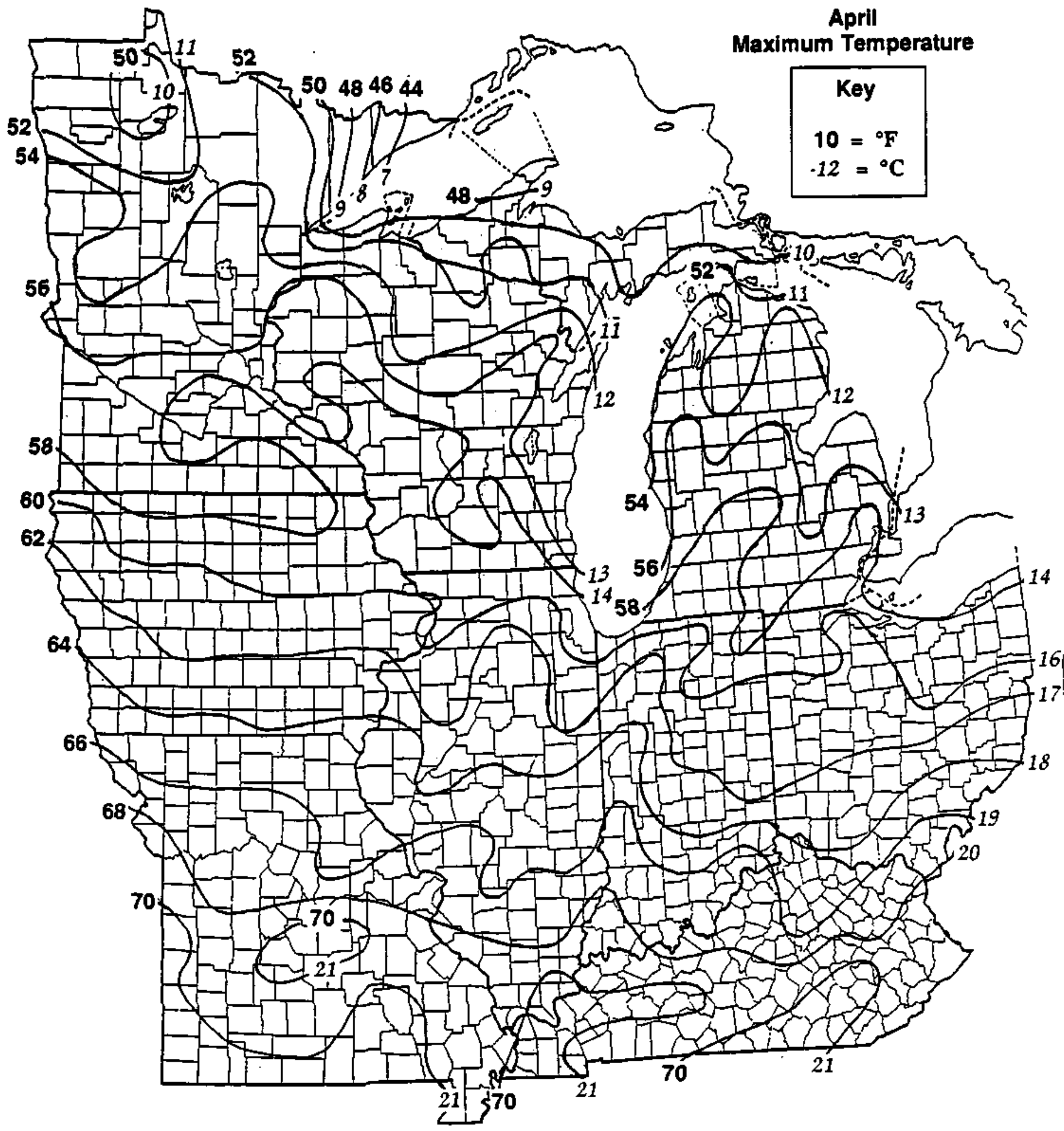


Fig. 3. Mean April Maximum Temperature (1961-1990)

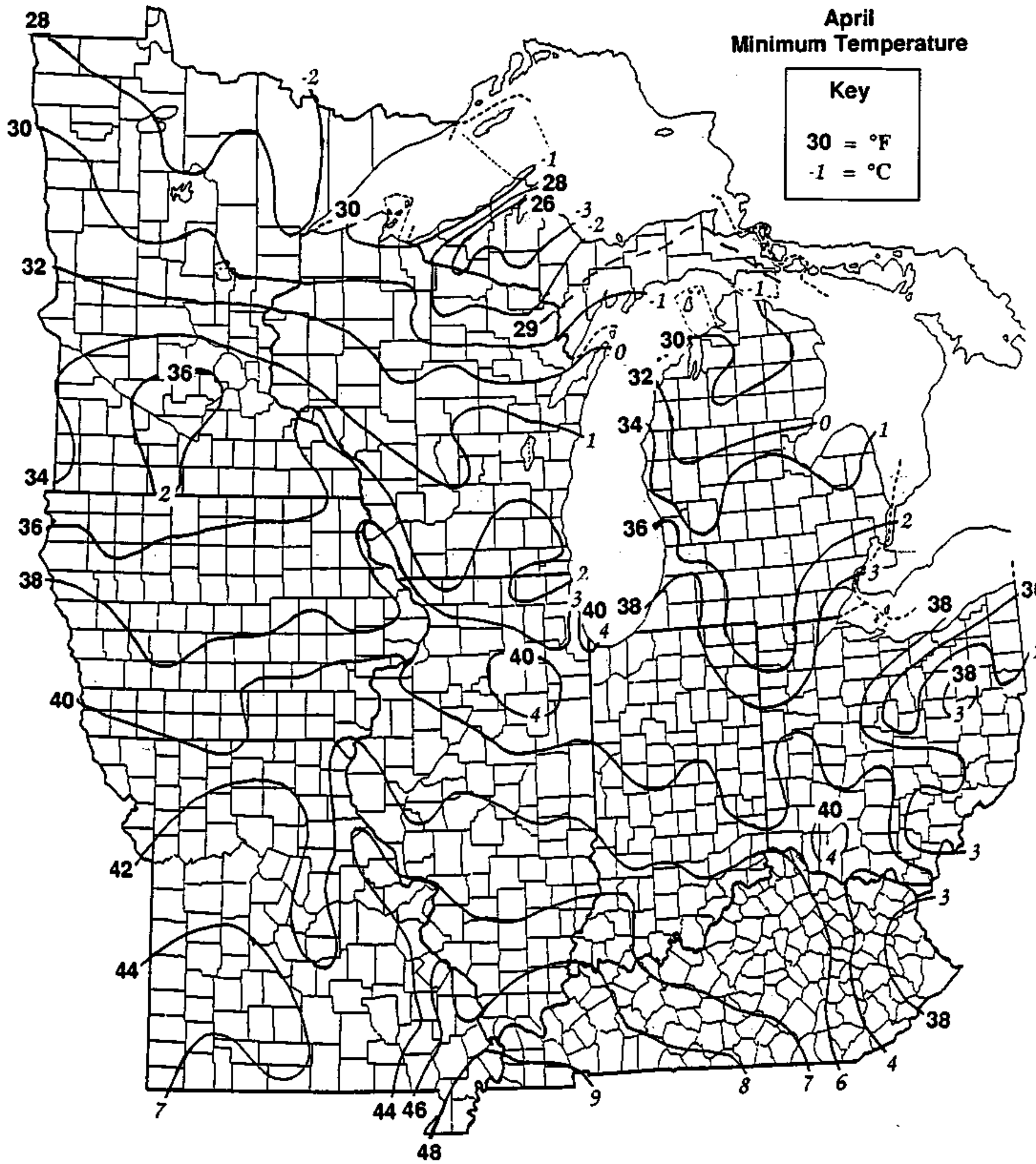


Fig. 4. Mean April Minimum Temperature (1961-1990)

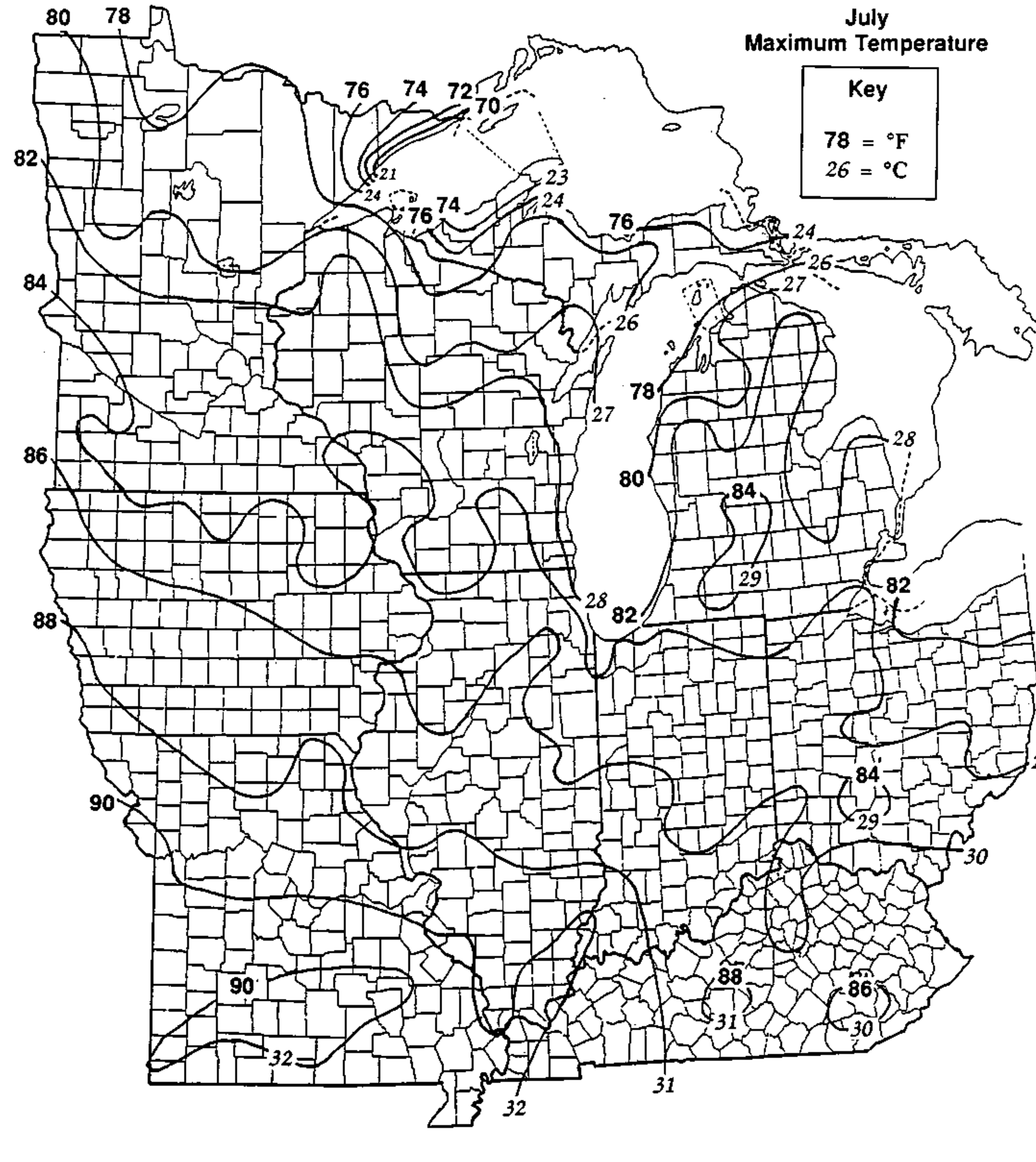


Fig. 5. Mean July Maximum Temperature (1961-1990)

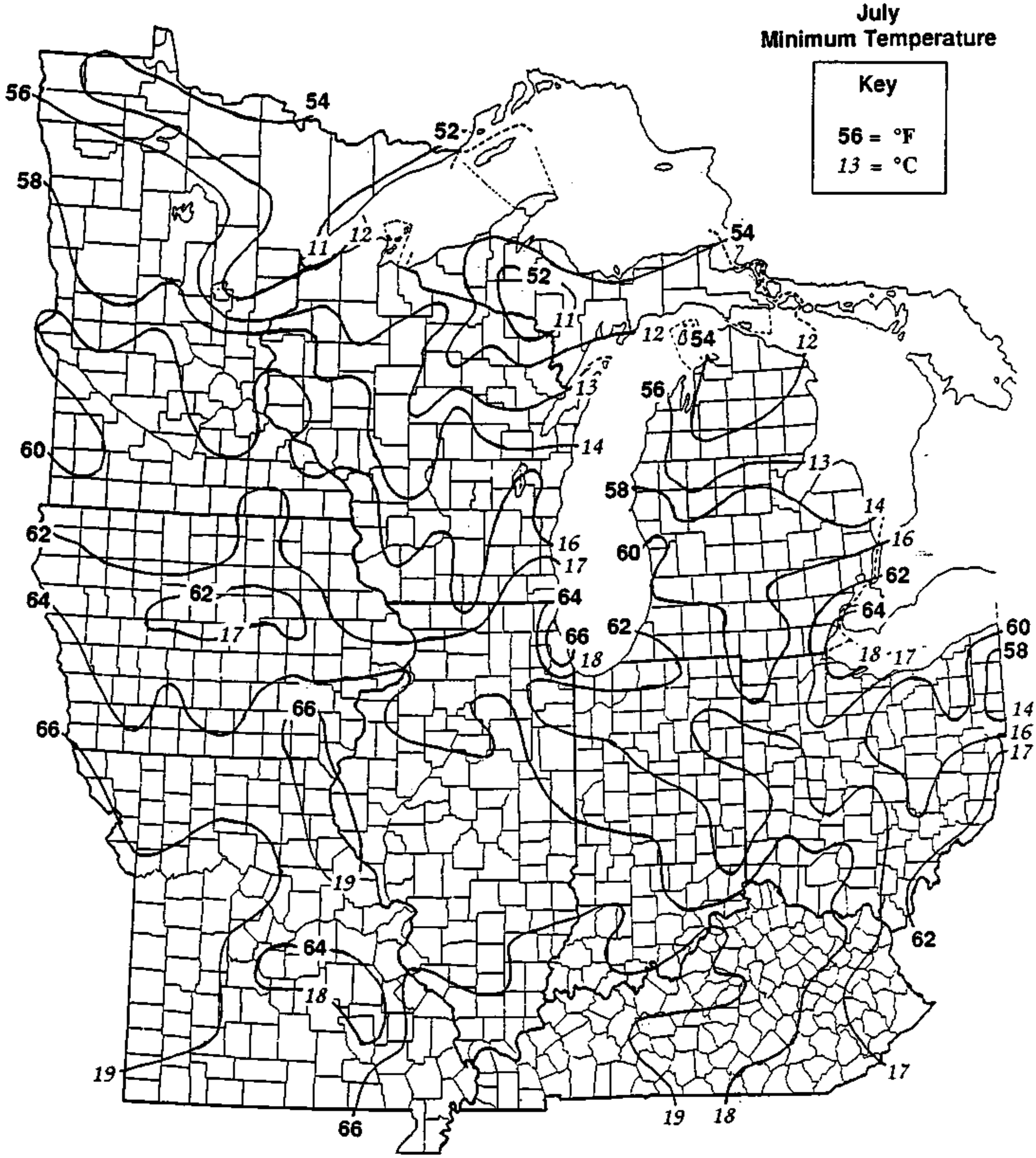


Fig. 6. Mean July Minimum Temperature (1961-1990)

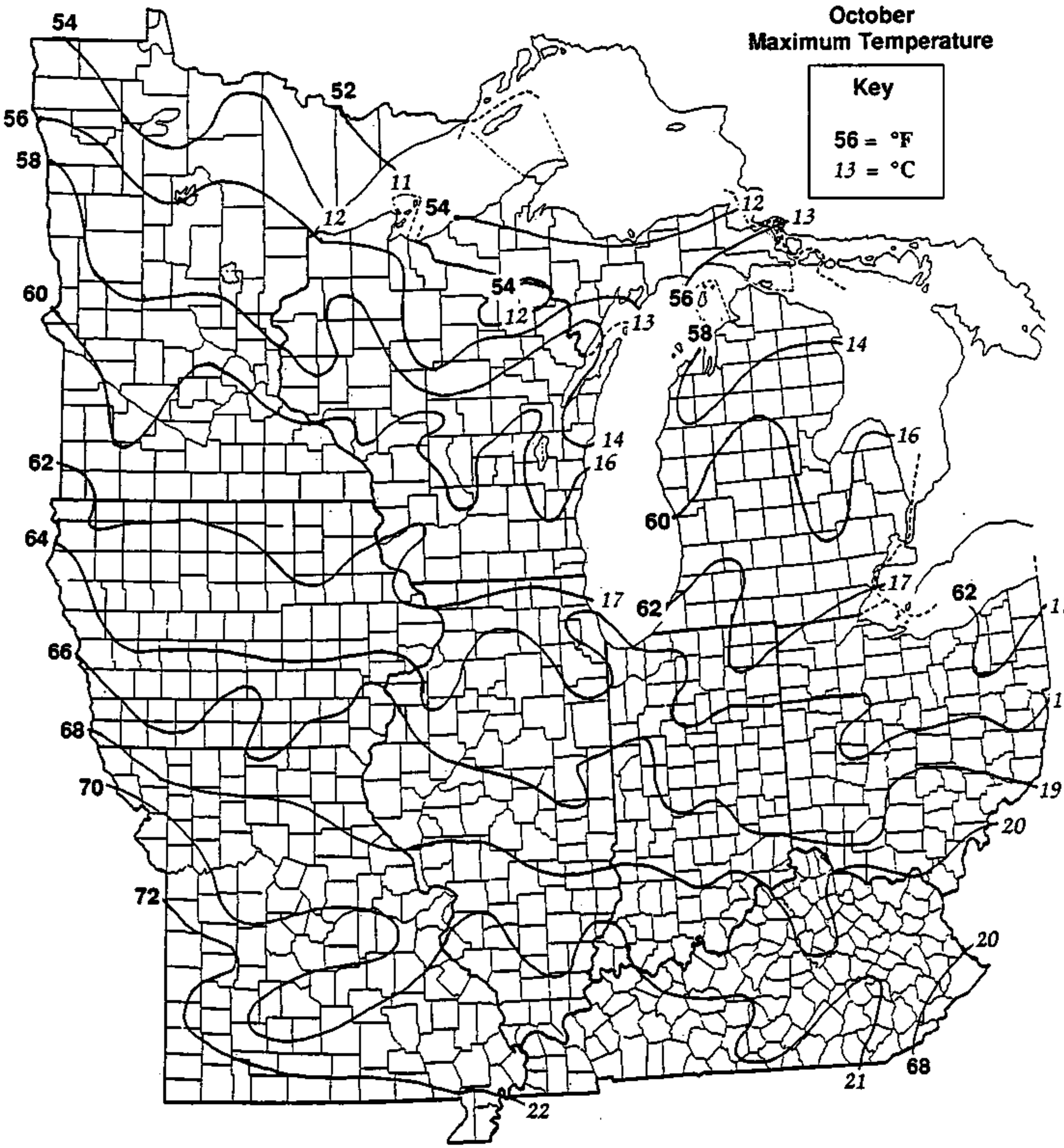


Fig. 7. Mean October Maximum Temperature (1961-1990)

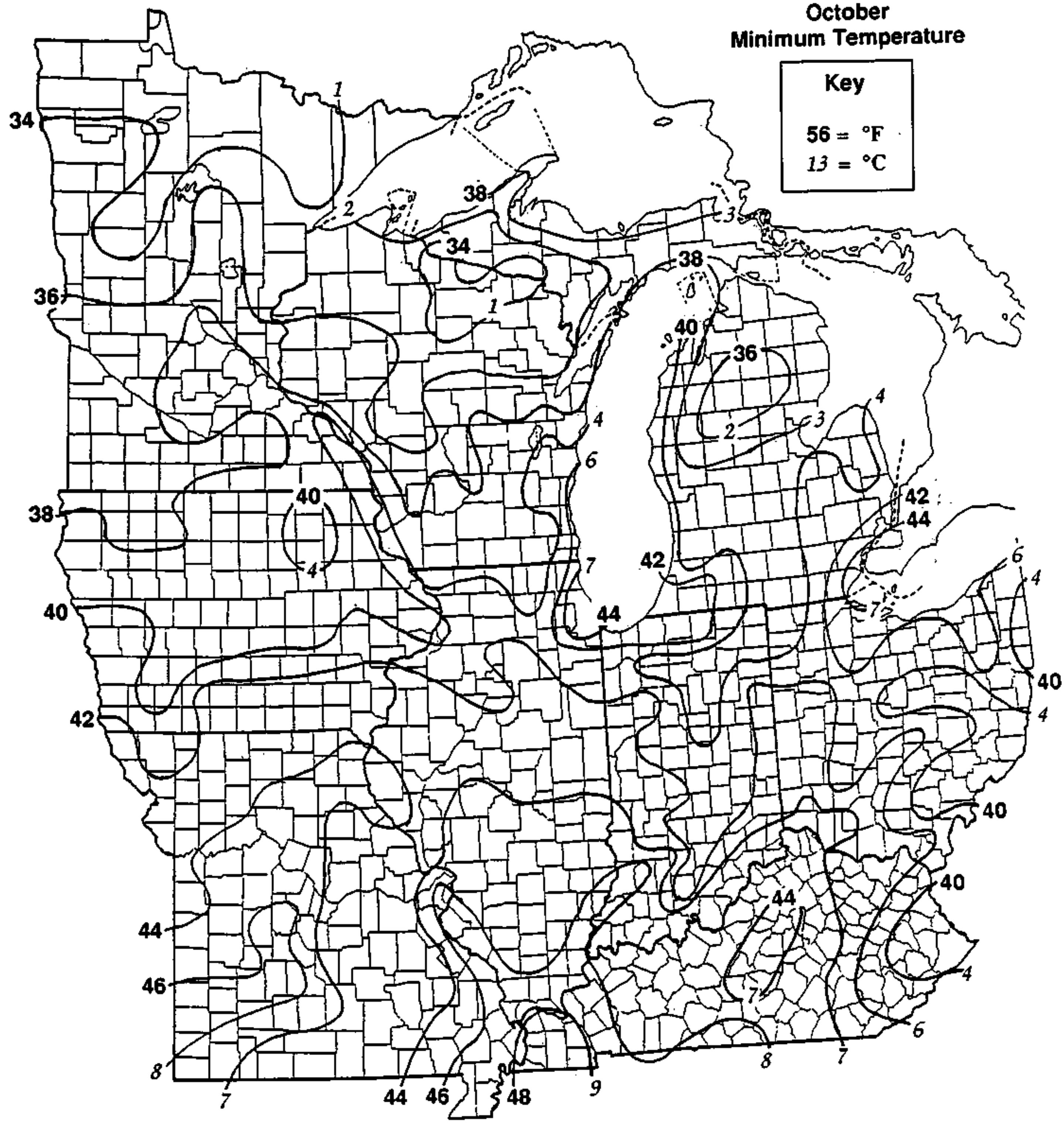


Fig. 8. Mean October Minimum Temperature (1961-1990)

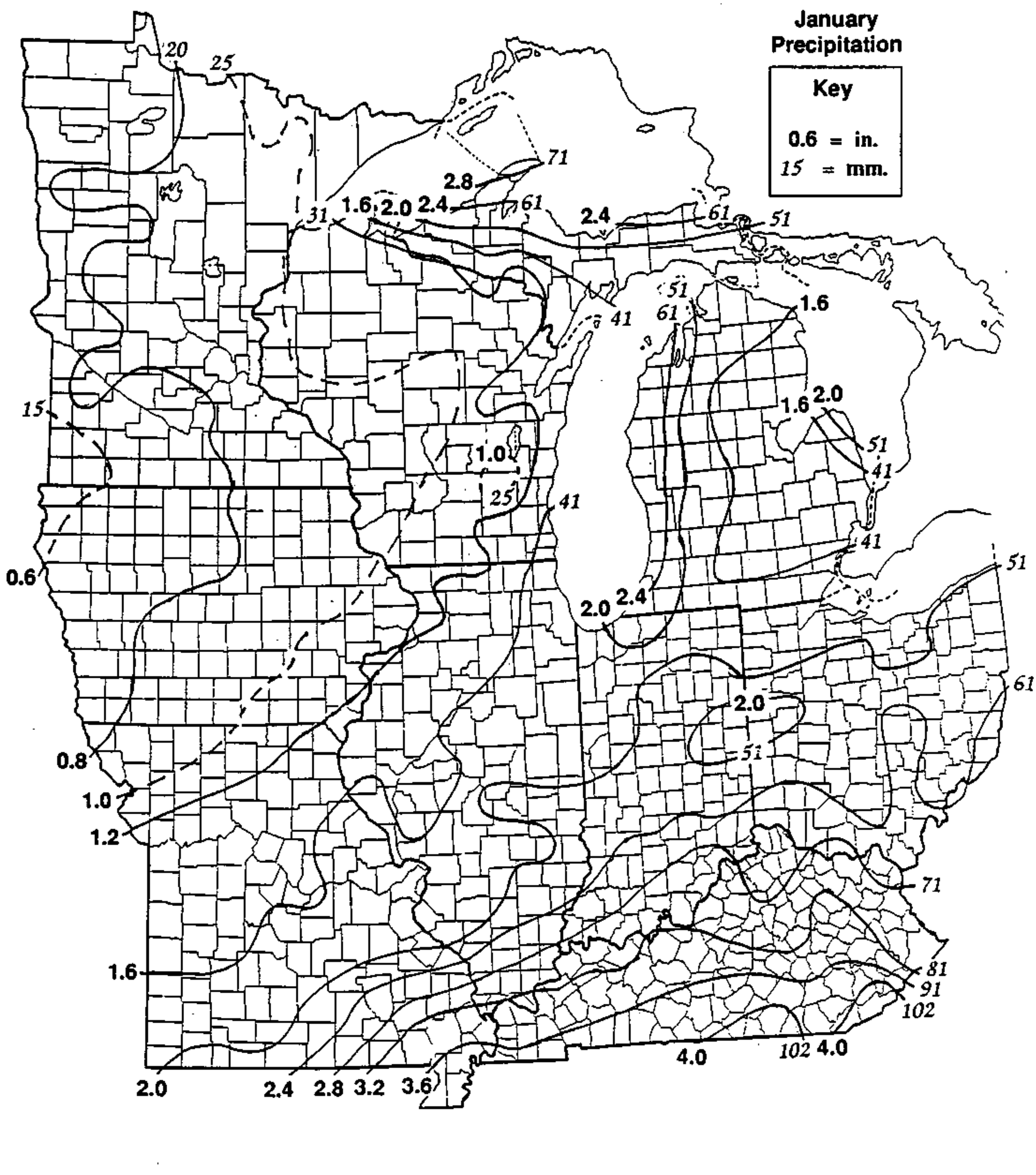


Fig 9. Mean January Precipitation (1961-1990)

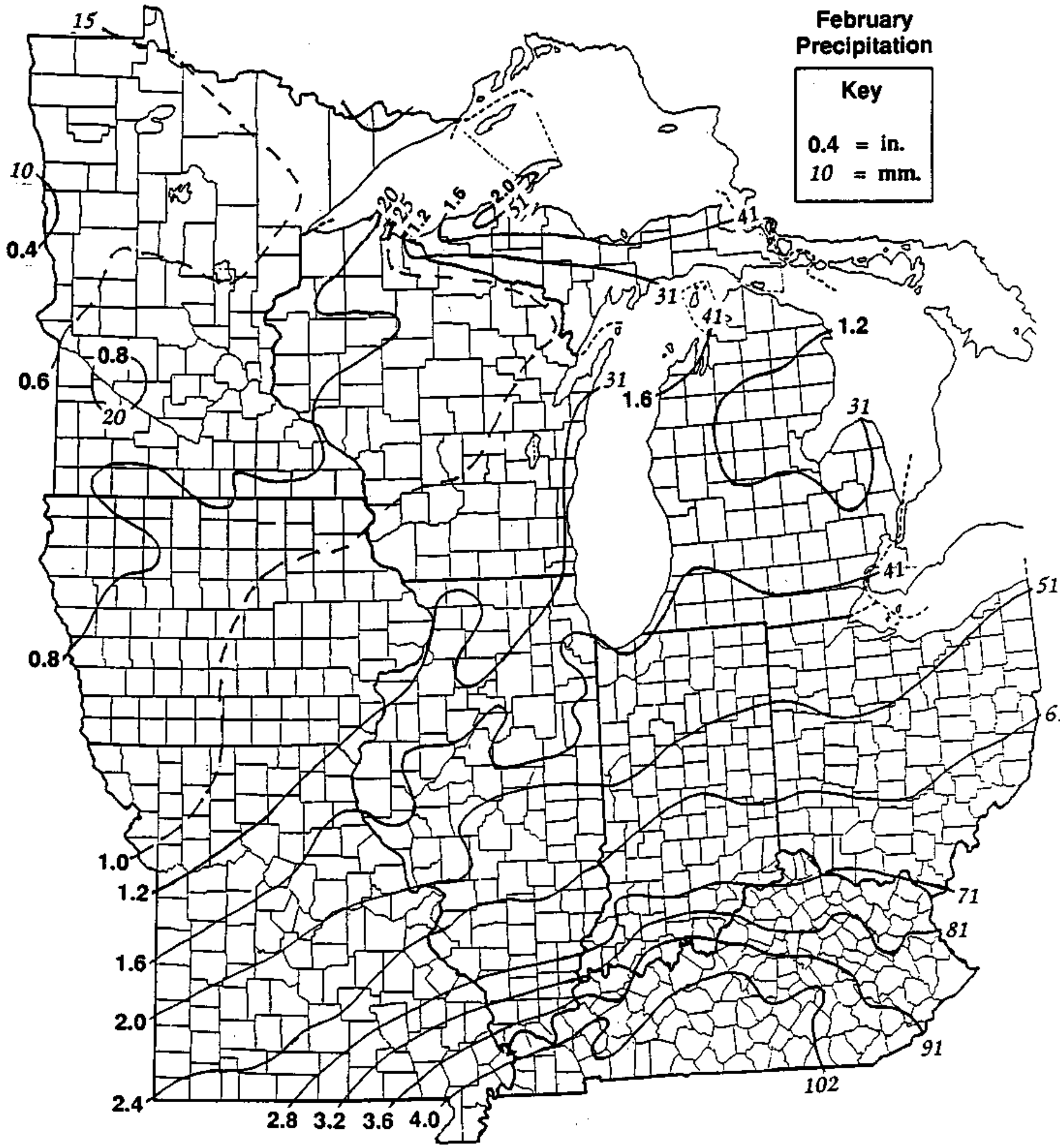


Fig 10. Mean February Precipitation (1961-1990)

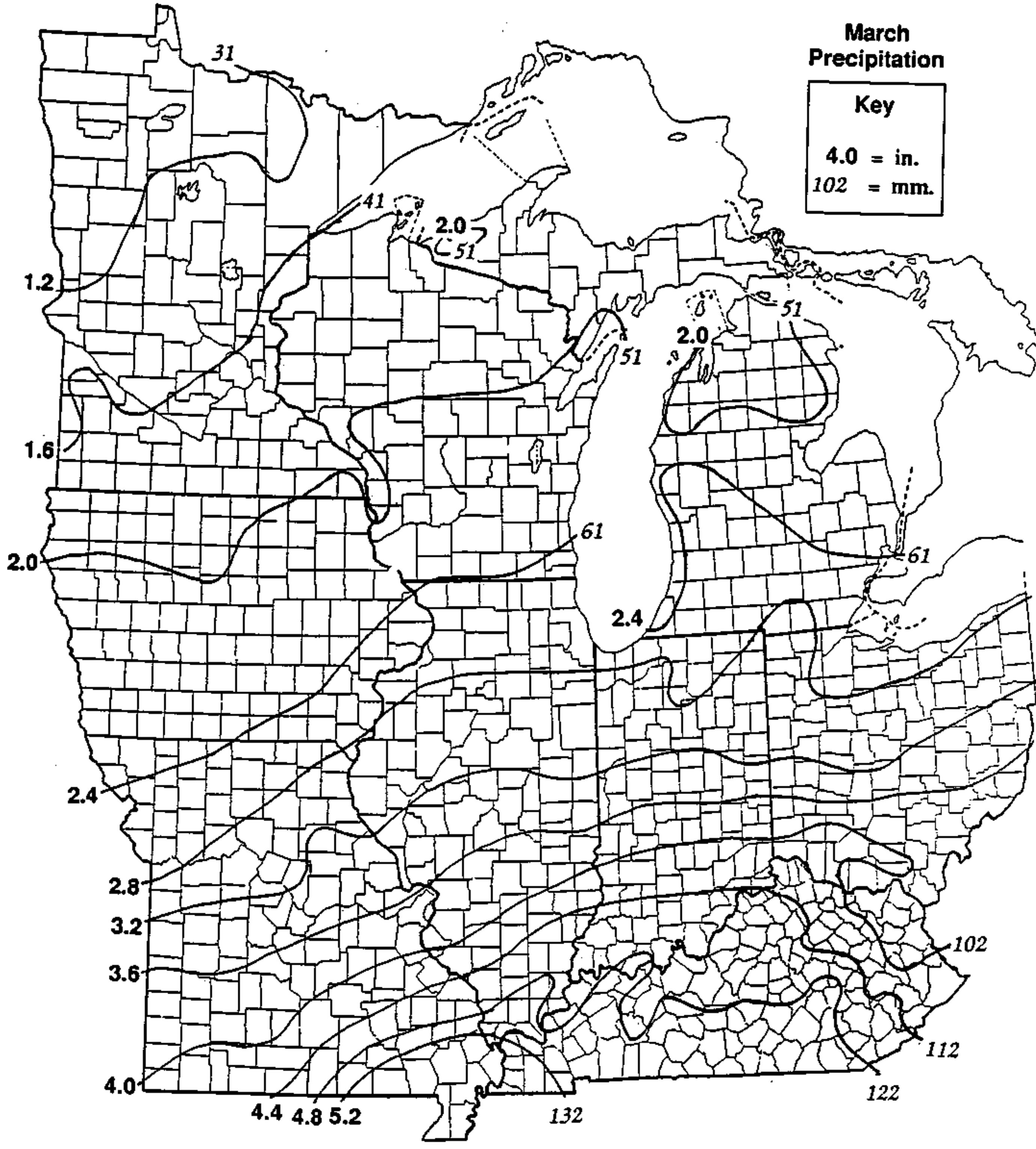


Fig 11. Mean March Precipitation (1961-1990)

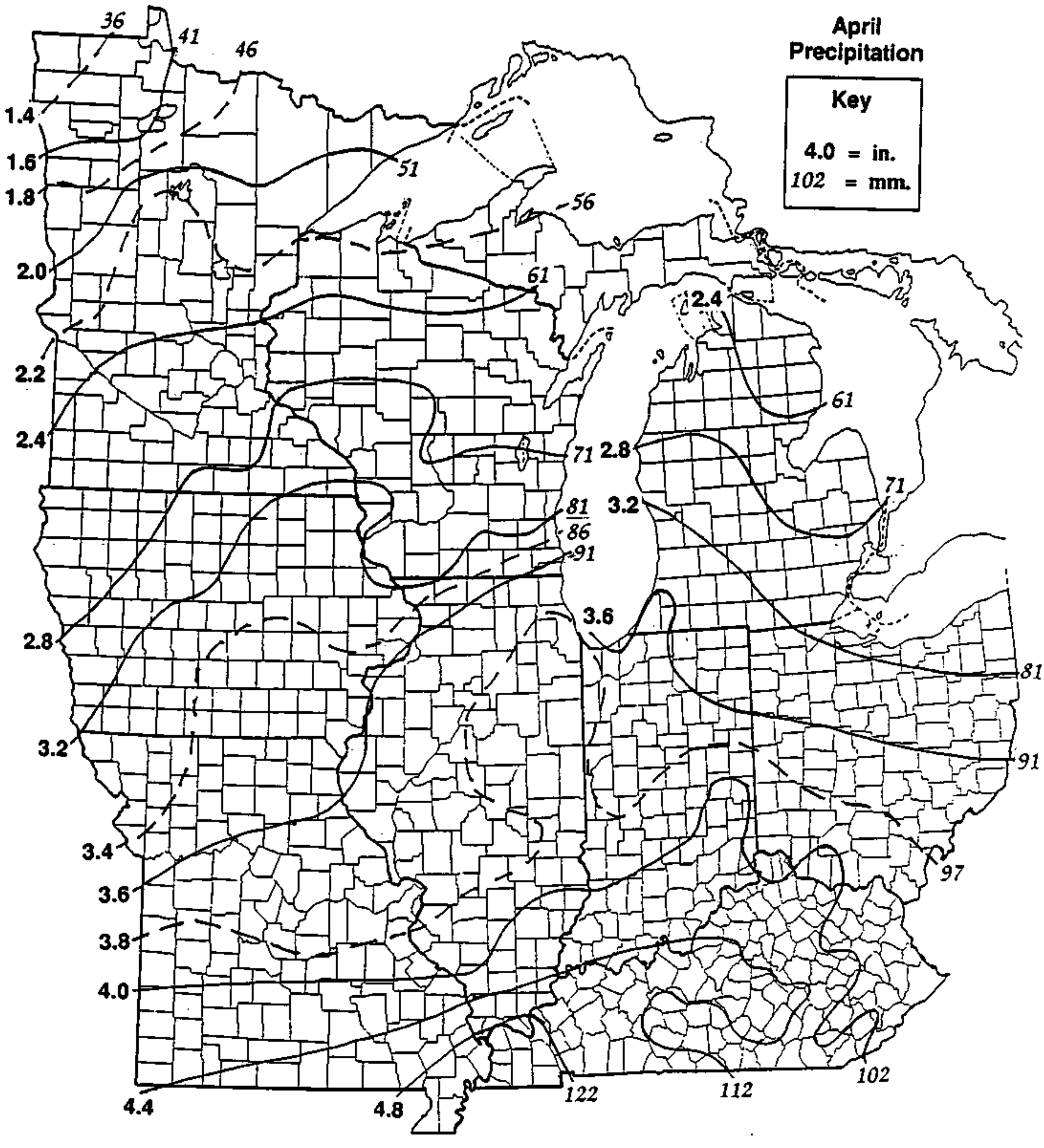


Fig 12. Mean April Precipitation (1961-1990)

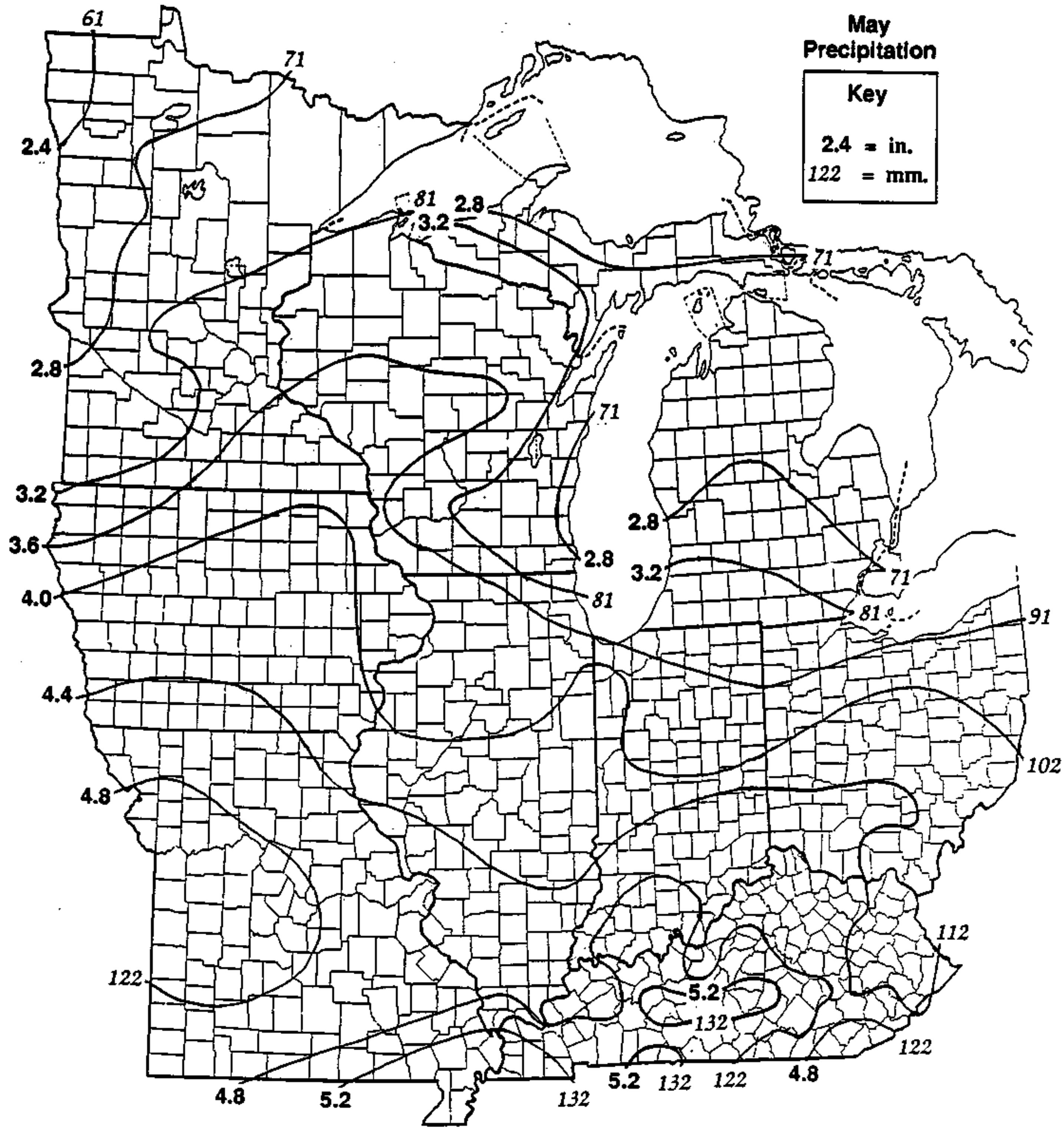


Fig 13. Mean May Precipitation (1961-1990)

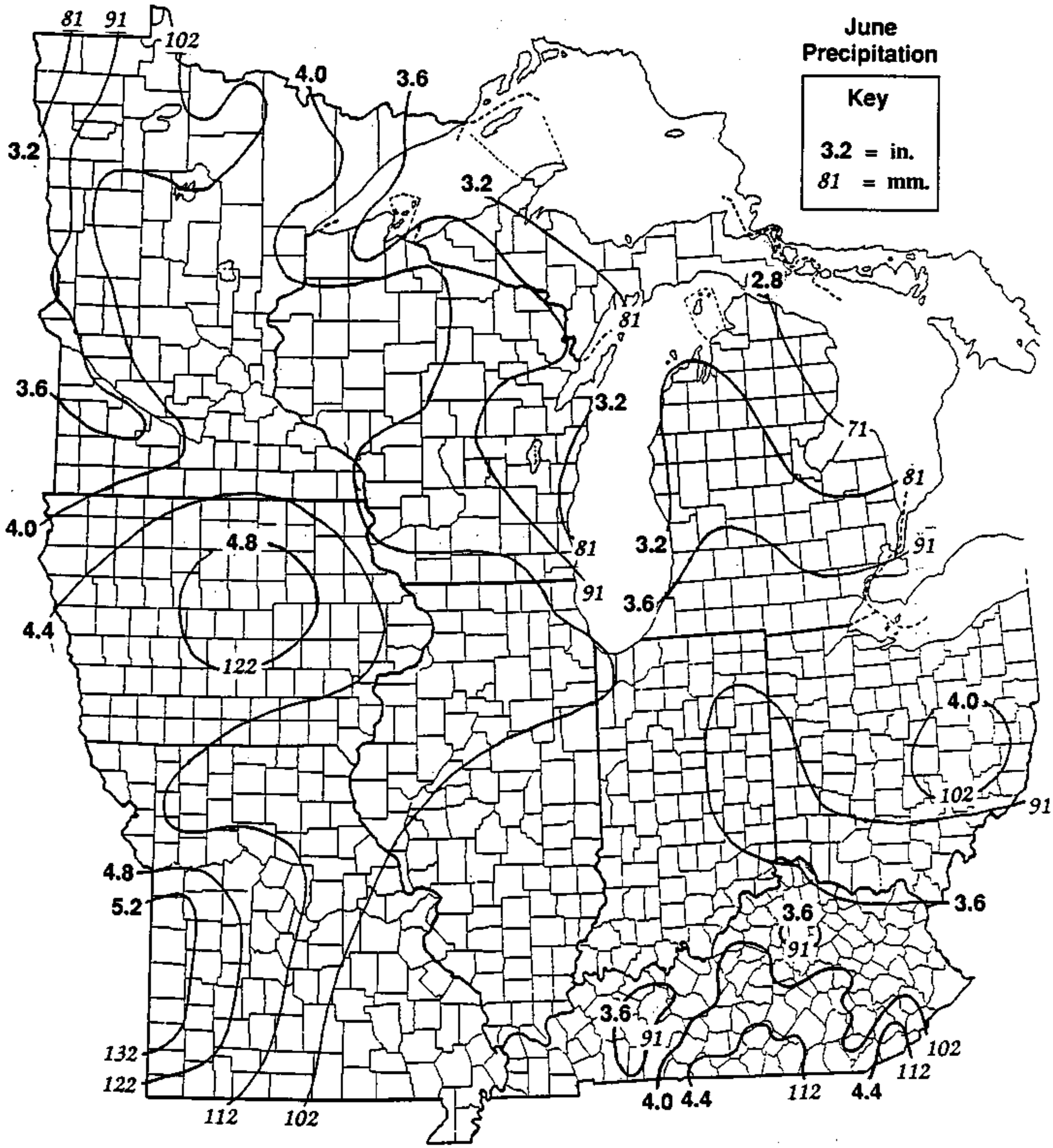


Fig 14. Mean June Precipitation (1961-1990)

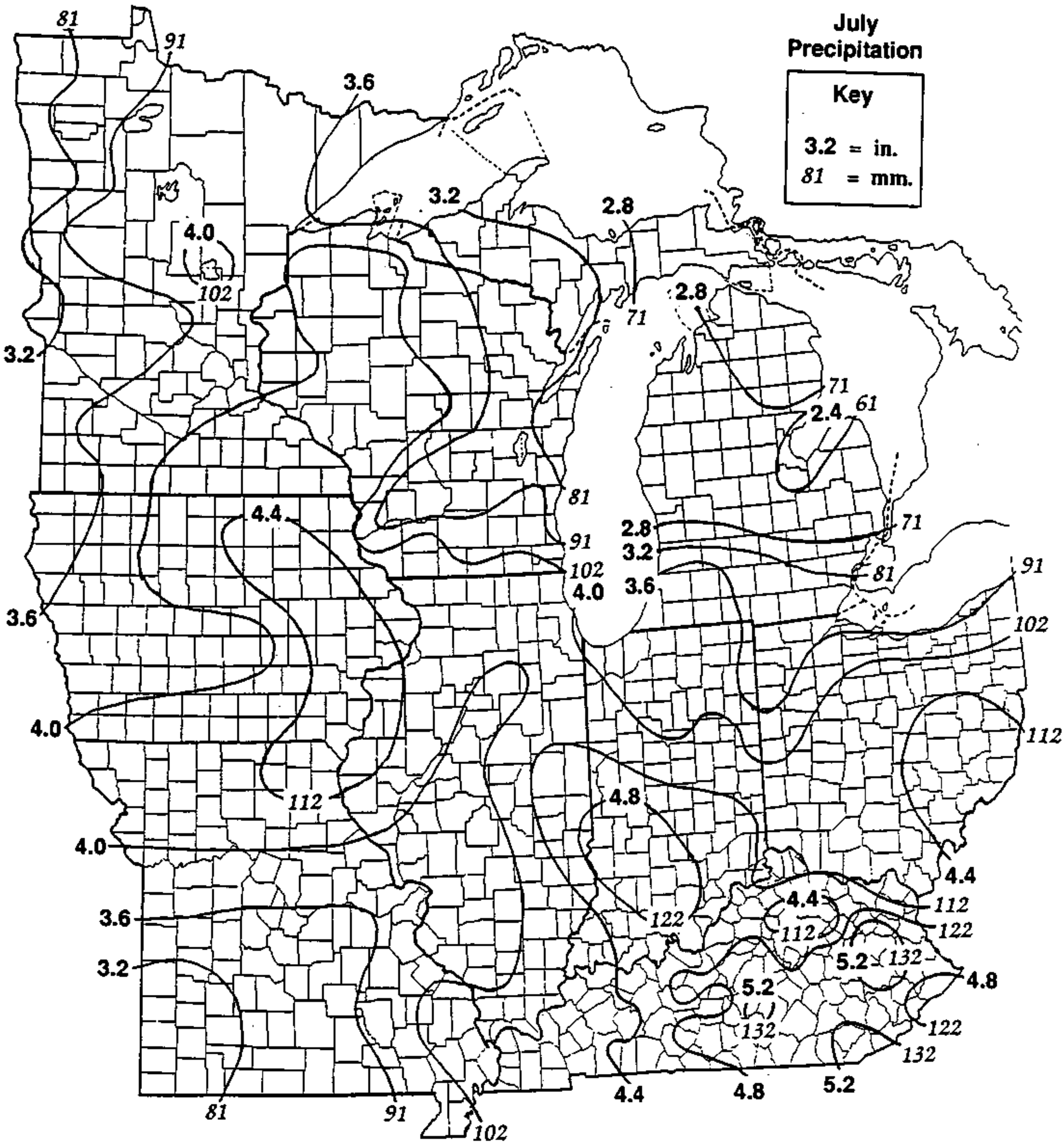


Fig 15. Mean July Precipitation (1961-1990)

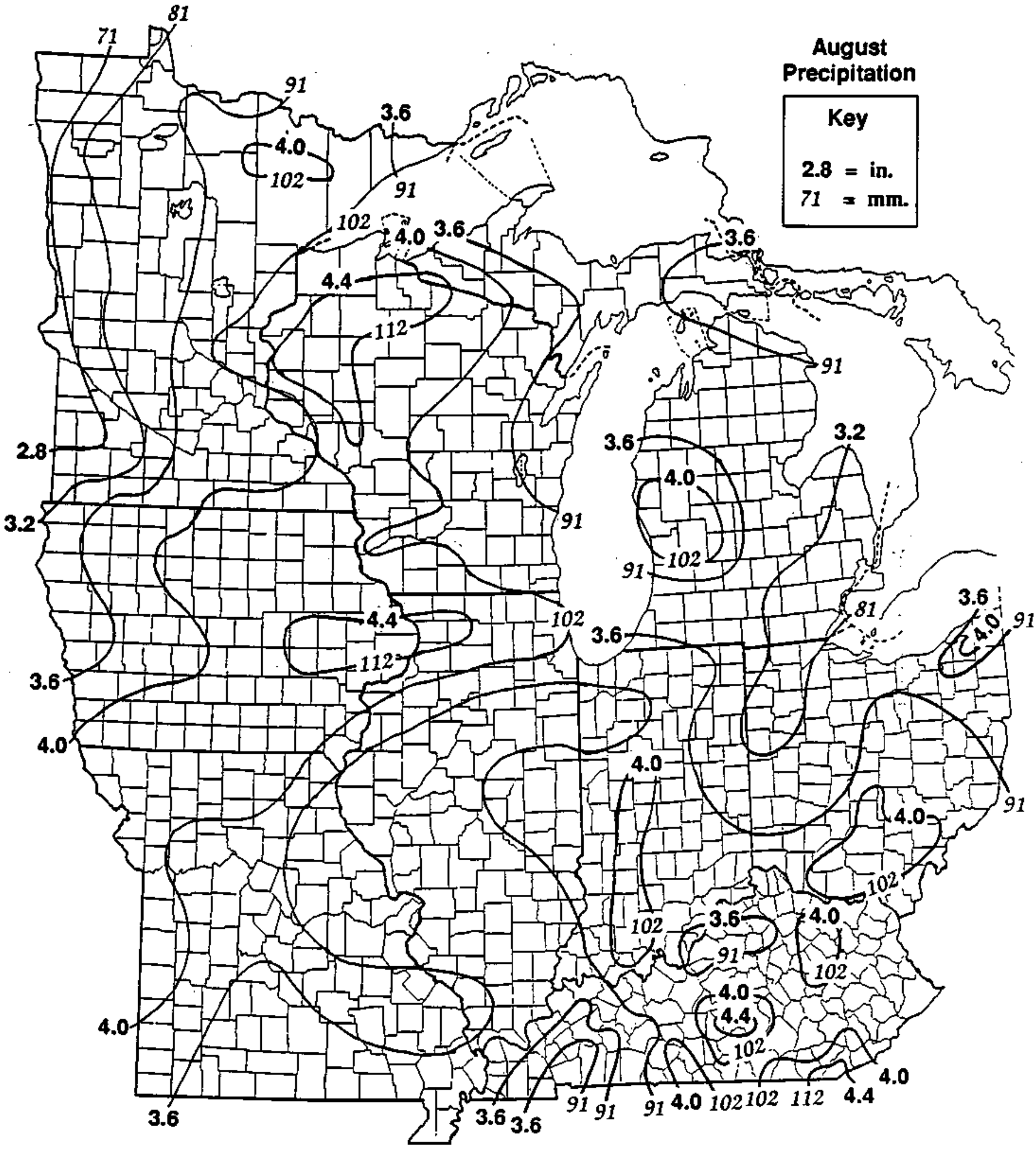


Fig 16. Mean August Precipitation (1961-1990)

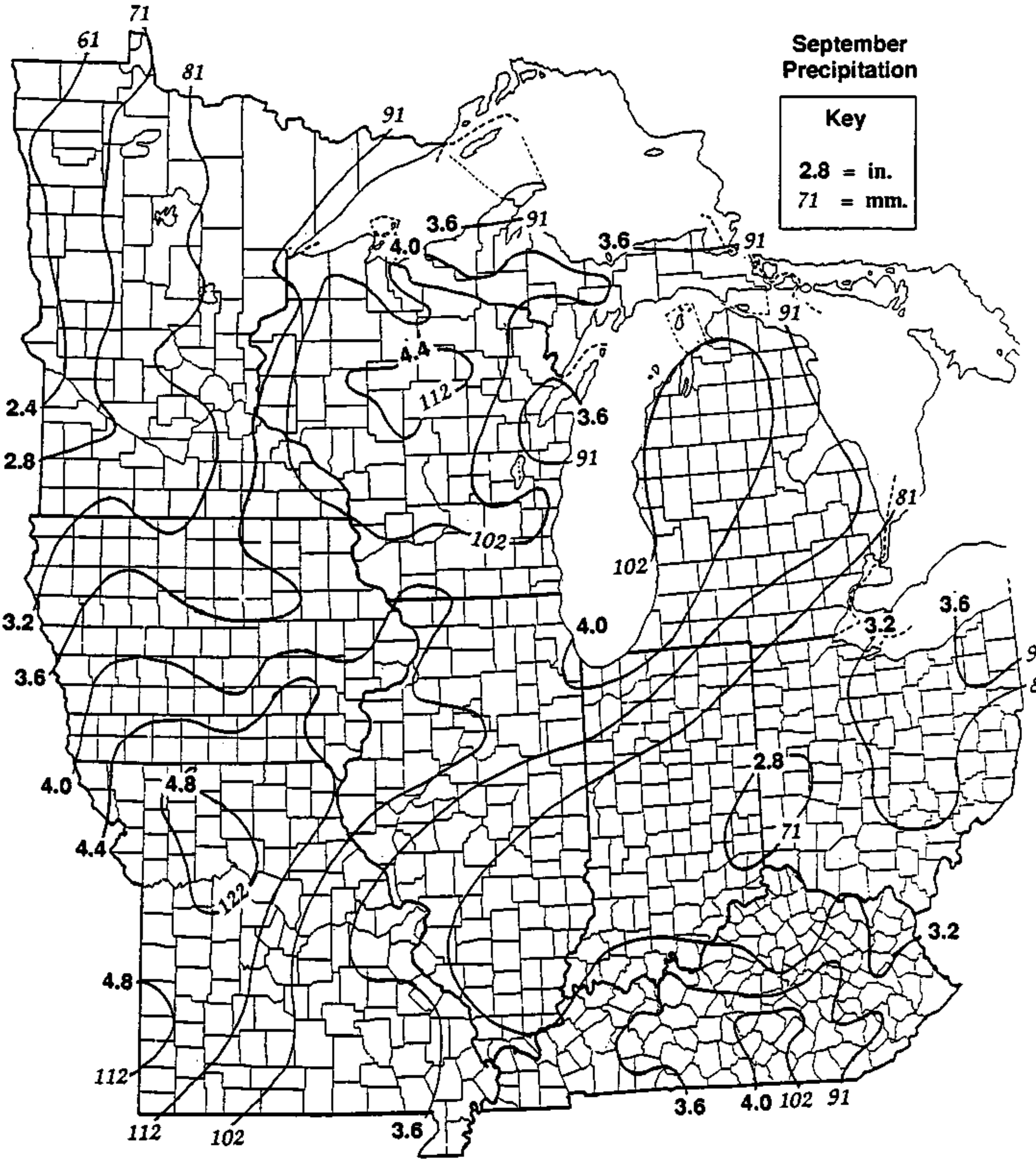


Fig 17. Mean September Precipitation (1961-1990)

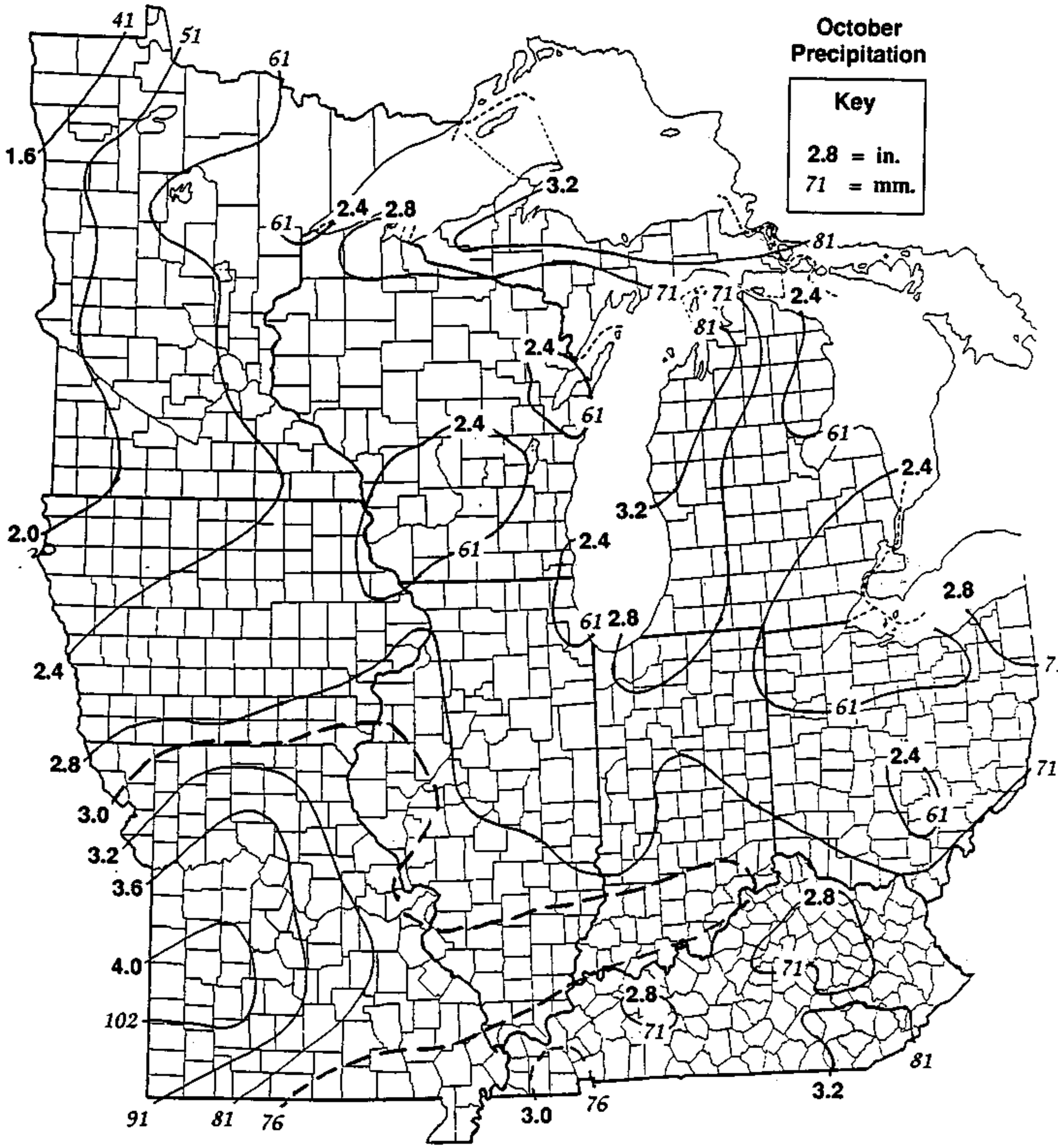


Fig 18. Mean October Precipitation (1961-1990)

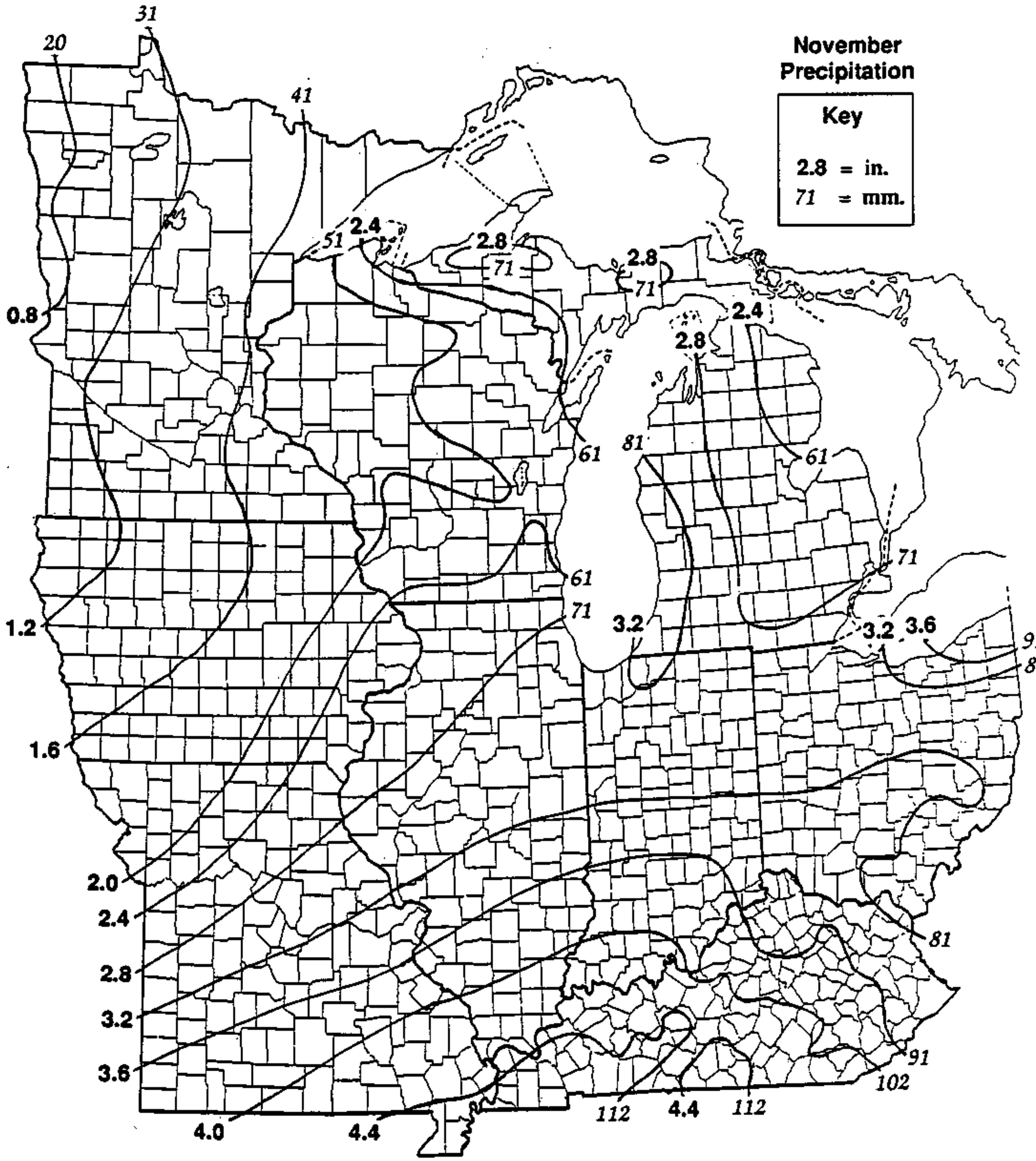


Fig 19. Mean November Precipitation (1961-1990)

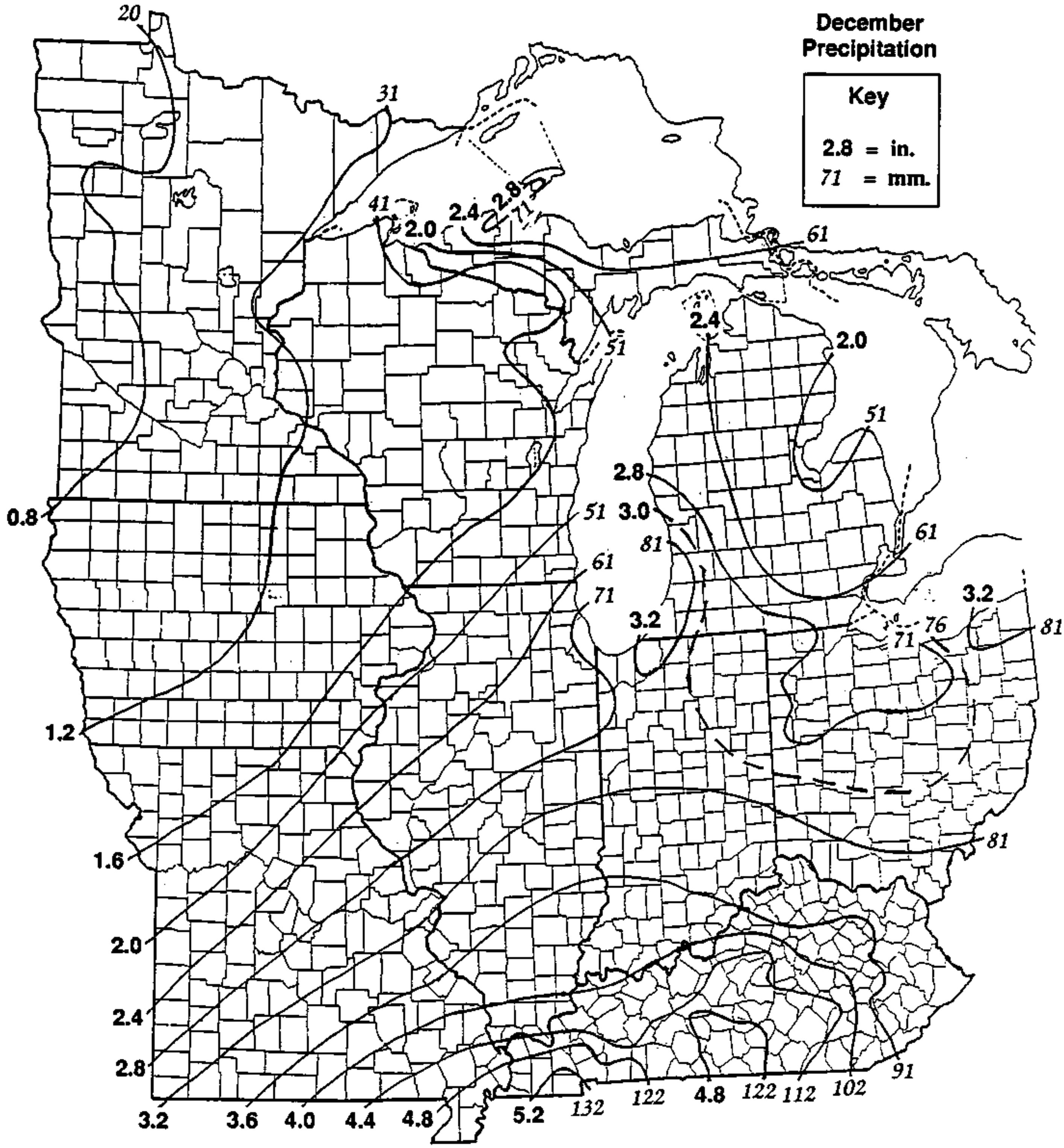


Fig 20. Mean December Precipitation (1961-1990)

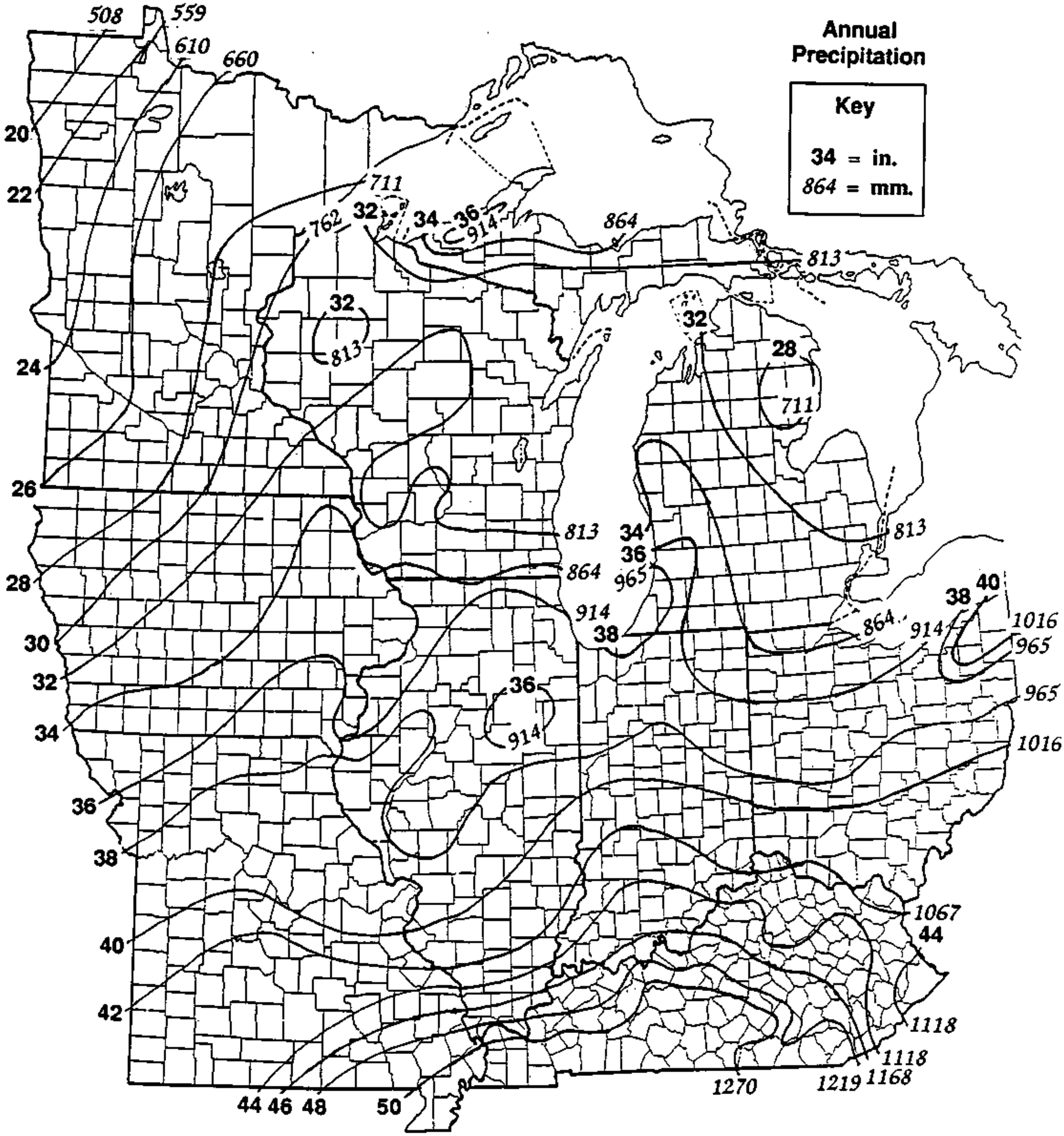


Fig 21. Mean Annual Precipitation (1961-1990)

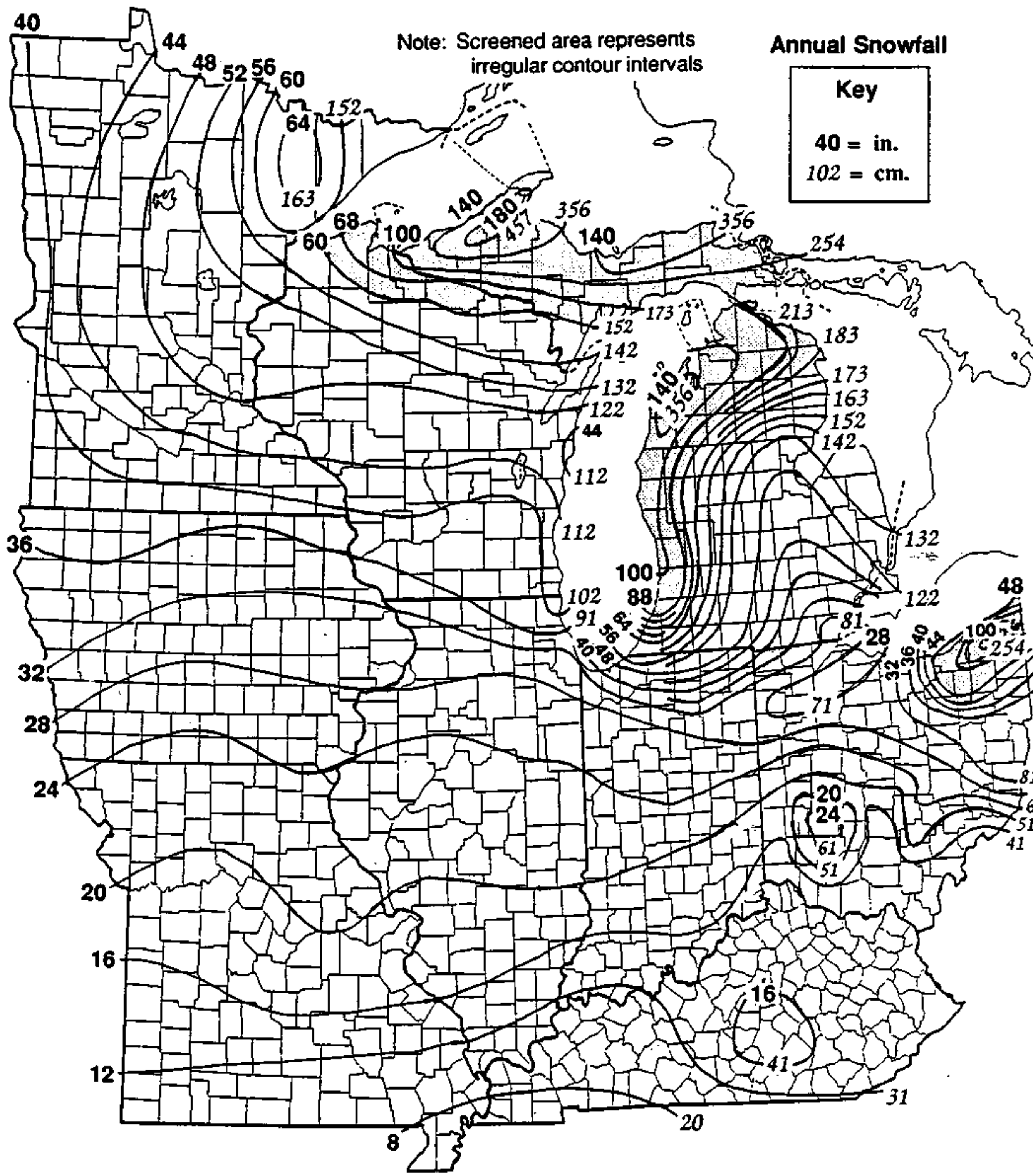


Fig 22. Mean Annual Snowfall (1961-1990)