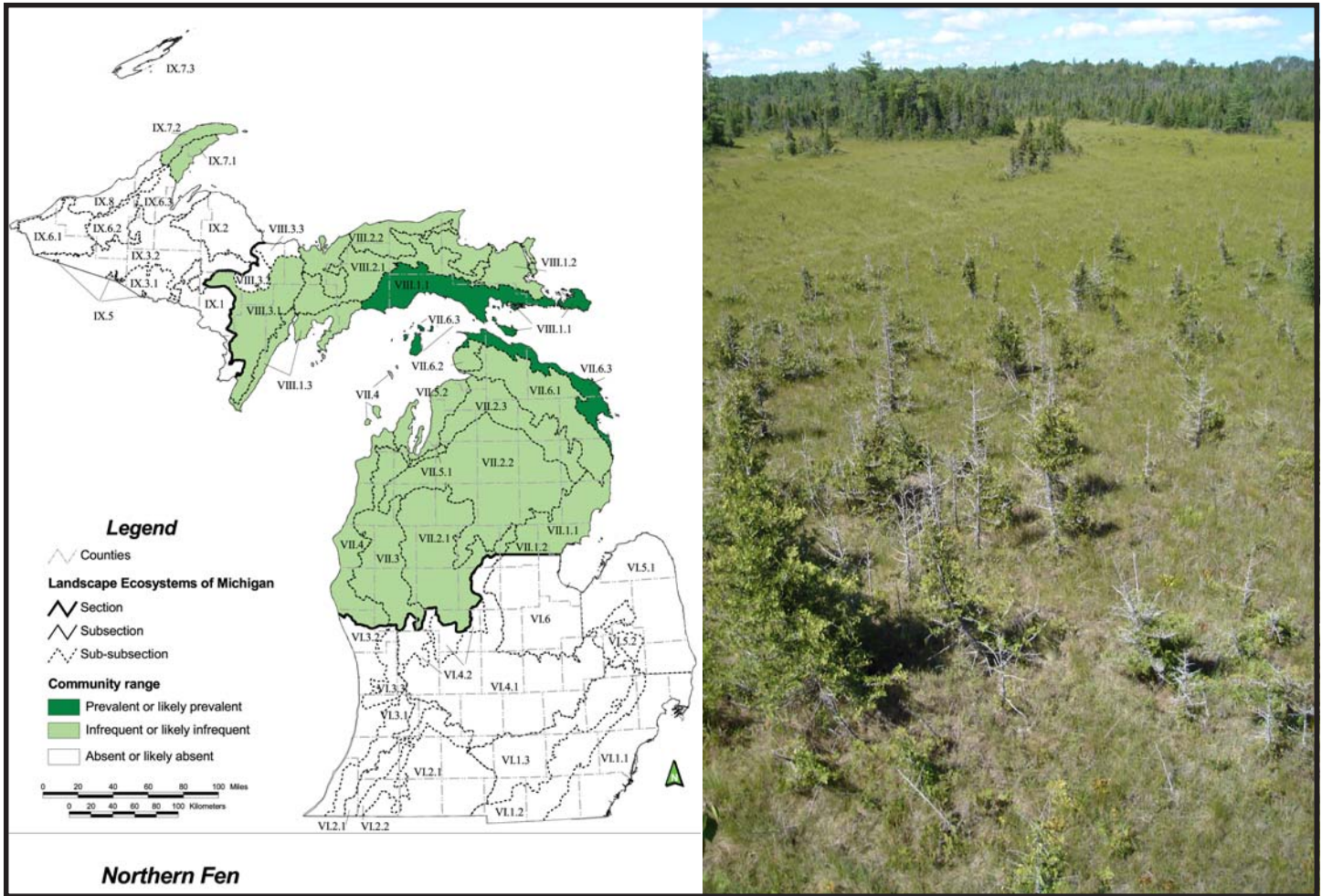


# Distribution Maps of Michigan's Natural Communities



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Cover photo of Stevenson's Fen, a northern fen from Presque Isle County and the Presque Isle Subsection of Albert's (1995) Regional Landscape Ecosystems of Michigan (Photo by Joshua G. Cohen).

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## INTRODUCTION

The Michigan Natural Features Inventory (MNFI) natural community classification recognizes 76 different natural communities native to Michigan (Kost et al. 2007). A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs across the landscape under similar environmental conditions. Natural communities are predominantly structured by natural processes rather than modern anthropogenic disturbances. Understanding the distribution of natural communities across Michigan's landscapes is essential for the conservation of Michigan's biodiversity. Protecting and managing representative natural communities is critical to biodiversity conservation, since native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over the millennia (Kost et al. 2007). This report provides distribution maps for each of the 76 natural communities by ecological Sub-subsection (Albert 1995) and by county and is intended to complement MNFI's natural community classification (Kost et al. 2007). The report also briefly discusses the methods employed to generate the distribution maps and suggests some of their potential conservation applications.

## METHODS

Distribution maps for each natural community were derived based on a combination of sources from state-wide and regional surveys, literature review, and expert assessment. Specific sources critical to the production of these maps included the Michigan circa 1800 vegetation map (Comer et al. 1995a), Regional Landscape Ecosystems of Michigan (Albert 1995), Landtype Associations of Northern Lower Michigan (Corner and Albert 1999a-f), Geology of Michigan (Dorr and Eschman 1970), Quaternary Geology of Michigan (Farrand and Bell 1982), Bedrock Geology of Michigan (Reed and Daniels 1987), Michigan Flora (Voss 1972, 1985, 1996), and MNFI's Biotics database (MNFI 2010). The circa 1800 vegetation map provides a hypothesis of the historical distribution of native vegetation across Michigan and was helpful in developing distribution maps for communities that today have limited distributions within Michigan, such as many of the prairie and savanna types. Maps of current distribution of natural communities were developed from interpretation of the ecological factors that influence natural community distributions in Michigan, including climate, bedrock geology, landforms, soils, and natural disturbances, from the collective field experience of the authors, and from data of natural community occurrences. Spatial records documenting the locations (occurrences) of high-quality natural communities are available within MNFI's Biotics database. This database is especially useful for determining the distribution of natural communities that are rare to critically imperiled, since survey efforts have focused on this subset of Michigan's natural communities. For those natural communities for which specific plants are strong indicators, plant distribution maps (Voss 1972, Voss 1985, Voss 1996, Reznicek et al. 2004, USDA 2008) were reviewed to corroborate natural community distribution maps. Occurrences of rare species that are known to be characteristic of specific natural communities were also utilized.

Within each Sub-subsection and county, natural community distribution was assigned to one of three categories: prevalent or likely prevalent, infrequent or likely infrequent, and absent or likely absent. The category of "prevalent or likely prevalent" is used to signify that a community was or remains common within an area. The category of "infrequent or likely infrequent" is used to signify that a community was or remains uncommon within an area. "Absent or likely absent" is used to indicate that a community is unlikely to occur and/or unlikely occurred historically within an area. For most communities, the assigned categories apply to both current and historical distributions. However, for those communities (e.g., prairies and savannas) that have been significantly reduced or eliminated from the landscape due to anthropogenic disturbance, these categories apply to historic distribution, and this caveat is noted on the individual distribution maps.

## RESULTS

Distribution maps for each of the 76 natural communities by ecological Sub-subsection (Albert 1995) and by county are included within Appendix 1 (Sub-subsection maps) and Appendix 2 (county maps). The natural community distribution maps are also available as GIS shapefiles upon request.

## DISCUSSION

These distribution maps are intended to be used as “hypotheses to be tested” by scientists conducting vegetation surveys or sampling. It is our hope that this report will be a dynamic document, continually being improved and updated following future vegetation surveys by resource professionals and academics.

The distribution maps presented in this report can serve as the starting point for assessing regional survey needs (i.e., inventory gaps) and targeting systematic surveys for specific natural communities within Michigan (e.g., by Sub-subsection or county). Only a handful of Michigan’s natural communities have been systematically surveyed across the state; these include open dunes (Chapman et al. 1985, Reese et al. 1986), Great Lakes marsh (Albert et al. 1987, 1988, 1989), wooded dune and swale complex (Comer and Albert 1993), alvar (Albert et al. 1997a and 1997b), limestone, sandstone, granite, and volcanic bedrock lakeshores (Albert et al. 1997a and 1997b), limestone, sandstone, granite, and volcanic lakeshore cliffs (Albert et al. 1997a and 1997b), and lakeplain wet-mesic prairie and lakeplain wet prairie (Comer et al. 1995a). The development of natural community distribution maps allows conservation agencies and resource managers to evaluate regional restoration and management needs based on historic and current natural community distributions. In addition, these maps will facilitate regional “coarse filter” planning efforts to identify the critical lands necessary for conserving the diversity of native plants and animals that represent Michigan’s natural heritage. Currently, the Department of Natural Resources is engaged in a biodiversity conservation planning process. One of the primary goals of this process is to establish a network of representative natural communities that contribute to functioning ecosystems across the state (Michigan Department of Natural Resources 2007). Distribution maps of natural communities can help facilitate this process by providing the framework for where this network of representative natural communities can potentially occur.

## REFERENCES

- Albert, D.A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: A working map and classification. USDA, Forest Service, North Central Forest Experiment Station, St. Paul, MN. 250 pp.
- Albert, D.A. 1999. Natural community abstract for open dunes. Michigan Natural Features Inventory, Lansing, MI. 7 pp.
- Albert, D.A. 2001a. Natural community abstract for Great Lakes marsh. Michigan Natural Features Inventory. Lansing, MI. 11 pp.
- Albert, D.A. 2001b. Natural community abstract for inland salt marsh. Michigan Natural Features Inventory, Lansing, MI. 3 pp.
- Albert, D.A. 2004. Between Land and Lake: Michigan’s Great Lake Coastal Wetlands. MSUE bulletin E2902, Michigan Natural Features Inventory, Lansing, MI.
- Albert, D.A. 2006a. Borne of the Wind: An Introduction to the Ecology of Michigan Sand Dunes. University of Michigan Press, Ann Arbor, MI. 63 pp.
- Albert, D.A. 2006b. Natural community abstract for alvar. Michigan Natural Features Inventory, Lansing, MI. 8 pp.
- Albert, D.A. 2006c. Natural community abstract for limestone bedrock glade. Michigan Natural Features Inventory, Lansing, MI. 7 pp.
- Albert, D.A. 2007a. Natural community abstract for granite bedrock lakeshore. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Albert, D.A. 2007b. Natural community abstract for interdunal wetland. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Albert, D.A. 2007c. Natural community abstract for limestone cobble shore. Michigan Natural Features Inventory, Lansing, MI. 5 pp.
- Albert, D.A. 2007d. Natural community abstract for sand and gravel beach. Michigan Natural Features Inventory, Lansing, MI. 7 pp.

- Albert, D.A. 2009a. Natural community abstract for sandstone lakeshore cliff. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Albert, D.A. 2009b. Natural community abstract for volcanic bedrock glade. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Albert, D.A. 2009c. Natural community abstract for volcanic bedrock lakeshore. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Albert, D.A., and P.J. Comer. 1999. Natural community abstract for wooded dune and swale complex. Natural Features Inventory, Lansing, MI. 8 pp.
- Albert, D.A., and M.A. Kost. 1998a. Natural community abstract for lakeplain wet prairie. Michigan Natural Features Inventory, Lansing, MI. 5 pp.
- Albert, D.A., and M.A. Kost. 1998b. Natural community abstract for lakeplain wet-mesic prairie. Michigan Natural Features Inventory, Lansing, MI. 5 pp.
- Albert, D.A., P.J. Comer, R.A. Corner, D.L. Cuthrell, M.R. Penskar, and M.L. Rabe. 1995. Bedrock shoreline survey of the Niagaran Escarpment in Michigan's Upper Peninsula: Mackinac County to Delta County. Report to Michigan Department of Natural Resources, Land and Water Management Division. Michigan Natural Features Inventory, Lansing, MI. Report Number 1995-02. 51 pp. + 10 color plates.
- Albert, D.A., P.J. Comer, D.L. Cuthrell, D.A. Hyde, W.A. MacKinnon, M.R. Penskar, and M.L. Rabe. 1997a. The Great Lakes Bedrock Lakeshores of Michigan. Michigan Natural Features Inventory, Lansing, MI. Report Number 1997-01. 218 pp.
- Albert, D.A., P.J. Comer, D.L. Cuthrell, D.A. Hyde, W.A. MacKinnon, M.R. Penskar, and M.L. Rabe. 1997b. Great Lakes Bedrock Shores of Michigan. Michigan Natural Features Inventory, Lansing, MI. Report Number 1997-02. 58 pp.
- Albert, D.A., D.L. Cuthrell, D.A. Hyde, J.T. Legge, M.R. Penskar, and M.L. Rabe. 1996. Sampling and management of lakeplain prairies in southern Lower Michigan. Michigan Natural Features Inventory. 93 pp.
- Albert, D.A., S.R. Denton, and B.V. Barnes. 1986. Regional landscape ecosystems of Michigan. University of Michigan, School of Natural Resources, Ann Arbor, MI. 32 pp. & map.
- Albert, D.A., G. Reese, S.R. Crispin, L.A. Wilsmann, and S.J. Ouwinga. 1987. A Survey of Great Lakes Marshes in Michigan's Upper Peninsula. MNFI report for Land and Water Management Division of Michigan DNR, Coastal Zone Management Program (CZM Contract 9C-10). 73 pp.
- Albert, D.A., G. Reese, S.R. Crispin, M.R. Penskar, L.A. Wilsmann, and S.J. Ouwinga. 1988. A Survey of Great Lakes Marshes in the Southern Half of Michigan's Lower Peninsula. MNFI report for Land and Water Management Division of Michigan DNR, Coastal Zone Management Program (CZM Contract 10C-3). 116 pp.
- Albert, D.A., G. Reese, M.R. Penskar, L.A. Wilsmann, and S.J. Ouwinga. 1989. A Survey of Great Lakes Marshes in the Northern Half of Michigan's Lower Peninsula and throughout Michigan's Upper Peninsula. MNFI report for Land and Water Management Division of Michigan DNR, Coastal Zone Management Program (CZM Contract 10C-3). 124 pp.
- Albert, D.A., D.A. Wilcox, J.W. Ingram, and T.A. Thompson. 2005. Hydrogeomorphic classification for Great Lakes coastal wetlands. *Journal of Great Lakes Research*. 31 (Supplement1): 129-146.
- Amon, J.P., C.A. Thompson, Q.J. Carpenter, and J. Mines. 2002. Temperate zone fens of the glaciated Midwestern USA. *Wetlands* 22(2): 301-317.
- Anderson, R.C., and M.L. Bowles. 1999. Deep-soil savannas and barrens of the Midwestern United States. Pp. 155- 170 in R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds., Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge University Press, Cambridge, UK.
- Baker, M.E., and B.V. Barnes. 1998. Landscape ecosystem diversity of river floodplains in northwestern Lower Michigan, U.S.A. *Canadian Journal of Forestry Research* 28: 1405-1418.
- Barnes, B.V. 1976. Succession in deciduous swamp communities of southeastern Michigan, formerly dominated by American elm. *Canadian Journal of Botany* 54: 19-24.
- Barnes, B.V. 1989. Old-growth forests of the Northern Lakes States: A landscape ecosystem perspective. *Natural Areas Journal* 9(1): 45-57.

- Barnes, B.V., and W.H. Wagner, Jr. 1981. Michigan trees: A guide to the trees of Michigan and the Great Lakes region. University of Michigan Press, Ann Arbor, MI. 383 pp.
- Bedford, B.L., and K.S. Godwin. 2003. Fens of the United States: Distribution, characteristics, and scientific connection versus legal isolation. *Wetlands* 23(3): 608-629.
- Benninghoff, W.S., and A.I. Gebben. 1960. Phytosociological studies of some beech-maple stands in Michigan's Lower Peninsula. *Papers of the Michigan Academy of Science, Arts, and Letters* 45: 83-91.
- Black, T.J. 1997. Evaporite karst of northern Lower Michigan. *Carbonates and Evaporites* 12(1): 81-83.
- Bornhorst, T.J., and W.I. Rose. 1994. Self-guided geological field trip to the Keweenaw Peninsula, Michigan. *Proceedings of the Institute on Lake Superior Geology*. Volume 40, Part 2. 185 pp.
- Brewer, L.G., T.W. Hodler, and H.A. Raup. 1984. Presettlement vegetation of southwestern Michigan. *Michigan Botanist* 23: 153-156.
- Brewer, L.G., H.A. Raup, and T.W. Hodler. 1984. Presettlement vegetation of southwest Michigan (map). Western Michigan University, Department of Geology, Kalamazoo, MI.
- Brewer, R. 1966. Vegetation of two bogs in southwestern Michigan. *Michigan Botanist* 5: 36-46.
- Brewer, R., and S. Kitler. 1989. Tree distribution in southwestern Michigan bur oak openings. *Michigan Botanist* 28: 73-79.
- Brewer, R., and P.J. Merritt. 1978. Windthrow and tree replacement in a climax beech-maple forest. *Oikos* 30: 149-152.
- Brodowicz, W.W. 1989. Report on the coastal plain flora of the Great Lakes Region. Michigan Natural Features Inventory, Lansing, MI.
- Brubaker, L.B. 1975. Postglacial forest patterns associated with till and outwash in northcentral Upper Michigan. *Quaternary Research* 5: 499-527.
- Buckler, W.R. 1979. Dune Type Inventory and Barrier Dune Classification Study of Michigan's Lake Michigan Shore. Report of Investigation 23. Geological Survey Division, MI Department of Natural Resources. 32 pp.
- Burns, G.P. 1906. Bog studies. *Field studies in botany*. University Bulletin, n.s., 7(14): 3-13. University of Michigan, Ann Arbor, MI.
- Byer, M.D. 1960. An analysis of pattern and interspecific association along a soil moisture gradient on the jack pine plains of northern Lower Michigan. M.S. thesis, Michigan State University, East Lansing, MI. 232 pp.
- Cain, S.A. 1935. Studies on virgin hardwood forest: III. Warren's Woods, a beech-maple climax forest in Berrien County, Michigan. *Ecology* 16(3): 500-513.
- Catling, P.M., and V.R. Brownell. 1995. A review of the alvars of the Great Lakes region: Distribution, floristic composition, biogeography and protection. *Canadian Field-Naturalist* 109(2): 143-171.
- Catling, P.M., and V.R. Brownell. 1999. Alvars of the Great Lakes Region. Pp. 375-391 in R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds., Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge University Press, Cambridge, UK.
- Chapman, K.A. 1984. An ecological investigation of native grassland in Southern Lower Michigan. M.A. thesis, Western Michigan University, Kalamazoo, MI. 235 pp.
- Chapman, K.A., and R. Brewer. 2008. Prairie and savanna in southern Lower Michigan: History, classification, ecology. *Michigan Botanist* 47: 1-48.
- Chapman, K.A., S.R. Crispin, L.A. Wilsman, and S.J. Ouwinga. 1985. Natural Area Inventory of Designated Sand Dune Areas in Michigan. Report to the Michigan Department of Natural Resources, Land Resource Programs Division. Michigan Natural Features Inventory, Lansing MI. Report Number 1985-04. 46 pp.
- Chapman, K.A., V.L. Dunevitz, and H.T. Kuhn. 1985. Vegetation and chemical analysis of a salt marsh in Clinton County, Michigan. *Michigan Botanist* 24: 135-144.
- Chapman, K.A., M.A. White, and M.R. Huffman. 1989. Draft: Oak barrens stewardship abstract. Midwest Heritage Task Force, The Nature Conservancy. Minneapolis, MN.

- Chapman, K.A., M.A. White, M.R. Huffman, and D. Faber-Langendoen. 1995. Ecology and stewardship guidelines for oak barrens landscapes in the upper Midwest. Pp. 1-29 *in* F. Stearns and K. Holland, eds., *Proceedings of the Midwest Oak Savanna Conference, 1993*. U.S. Environmental Protection Agency, Internet Publications. Available: <http://www.epa.gov/glnpo/oak/oak93/chapman.html> (Accessed: September 21, 2000).
- Cleland, D.T., J.B. Hart, G.E. Host, K.S. Pregitzer, and C.W. Ramm. 1994. Field guide to the ecological classification and inventory system of the Huron-Manistee National Forest. USDA Forest Service, North Central Forest Experiment Station.
- Cleland, D.T., T.R. Crow, S.C. Saunders, D.I. Dickmann, A.L. Maclean, J.K. Jordan, R.L. Watson, A.M. Sloan, and K.D. Brososke. 2004. Characterizing historical and modern fire regimes in Michigan (USA): A landscape ecosystem approach. *Landscape Ecology* 19: 311-325.
- Coburn, H., D. Dean, and G.M. Grant. 1933. An ecological study of Bryant's Bog, Cheboygan County, Michigan. *Papers of the Michigan Academy of Science, Arts, and Letters* 17: 57-65.
- Cohen, J.G. 2000a. Natural community abstract for mesic northern forest. Natural Features Inventory, Lansing, MI. 7 pp.
- Cohen, J.G. 2000b. Natural community abstract for oak-pine barrens. Natural Features Inventory, Lansing, MI. 6 pp.
- Cohen, J.G. 2001a. Natural community abstract for lakeplain oak openings. Natural Features Inventory, Lansing, MI. 9 pp.
- Cohen, J.G. 2001b. Natural community abstract for oak barrens. Natural Features Inventory, Lansing, MI. 9 pp.
- Cohen, J.G. 2002a. Natural community abstract for dry-mesic northern forest. Natural Features Inventory, Lansing, MI. 11 pp.
- Cohen, J.G. 2002b. Natural community abstract for dry northern forest. Michigan Natural Features Inventory, Lansing, MI. 11 pp.
- Cohen, J.G. 2004a. Natural community abstract for bur oak plains. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Cohen, J.G. 2004b. Natural community abstract for mesic southern forest. Natural Features Inventory, Lansing, MI. 11 pp.
- Cohen, J.G. 2004c. Natural community abstract for oak openings. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Cohen, J.G. 2005a. Natural community abstract for muskeg. Michigan Natural Features Inventory, Lansing, MI. 20 pp.
- Cohen, J.G. 2005b. Natural community abstract for poor conifer swamp. Michigan Natural Features Inventory, Lansing, MI. 856 pp.
- Cohen, J.G. 2007. Natural community abstract for boreal forest. Michigan Natural Features Inventory, Lansing, MI. 22 pp.
- Cohen, J.G., and M.A. Kost. 2007a. Natural community abstract for bog. Michigan Natural Features Inventory, Lansing, MI. 19 pp.
- Cohen, J.G., and M.A. Kost. 2007b. Natural community abstract for intermittent wetland. Michigan Natural Features Inventory, Lansing, MI. 11 pp.
- Cohen, J.G., and M.A. Kost. 2007c. Natural community abstract for northern fen. Michigan Natural Features Inventory, Lansing, MI. 16 pp.
- Cohen, J.G., and M.A. Kost. 2007d. Natural community abstract for northern shrub thicket. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Cohen, J.G., and M.A. Kost. 2007e. Natural community abstract for northern wet meadow. Michigan Natural Features Inventory, Lansing, MI. 8 pp.
- Cohen, J.G., and M.A. Kost. 2007f. Natural community abstract for poor fen. Michigan Natural Features Inventory, Lansing, MI. 15 pp.
- Cohen, J.G., B.S. Slaughter, and M.A. Kost. 2008. Natural Community Surveys of Potential Ecological Reference Areas on State Forest Lands. Michigan Natural Features Inventory, Lansing, MI. Report Number 2008-04. 272 pp.

- Cohen, J.G. 2009. Natural Community Surveys of Potential Landscape Units. Michigan Natural Features Inventory, Lansing, MI. Report Number 2009-14. 14 pp.
- Cohen, J.G., B.S. Slaughter, and M.A. Kost. 2009. Natural Community Surveys and Stewardship Prioritization of Potential Ecological Reference Areas on State Forest Lands. Version 1.0. Michigan Natural Features Inventory, Lansing, MI. Report Number 2009-21. 526 pp.
- Collins, R.A. 1958. Old-growth red pine in Lower Michigan. M.A. thesis, University of Michigan, Ann Arbor, MI. 106 pp.
- Comer, P.J. 1996. Natural community abstract for pine barrens. Michigan Natural Features Inventory, Lansing, MI. 3 pp.
- Comer, P.J., and D.A. Albert. 1991. A Survey of Wooded Dune and Swale Complexes in the Northern Lower and Eastern Upper Peninsulas of Michigan. A report by the Michigan Natural Features Inventory to the Coastal Management Program, Michigan Department of Natural Resources. 99 pp.
- Comer, P.J., and D.A. Albert. 1993. A Survey of Wooded Dune and Swale Complexes in Michigan. Report to Michigan Department of Natural Resources, Land and Water Management Division, Coastal Zone Management Program. 159 pp.
- Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Comer, and D.W. Schuen. 1995a. Michigan's presettlement vegetation, as interpreted from the General Land Office surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. 76 pp.
- Comer, P.J., D.L. Cuthrell, D.A. Albert, and M.R. Penskar. 1997. Natural community abstract for limestone bedrock lakeshore. Michigan Natural Features Inventory, Lansing, MI. 3 pp.
- Comer, P.J., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, VA. 75 pp.
- Comer, P.J., W.A. MacKinnon, M.L. Rabe, D.L. Cuthrell, M.R. Penskar, and D.A. Albert. 1995b. A survey of lakeplain prairie in Michigan. Michigan Natural Features Inventory, Lansing, MI. 232 pp.
- Cook, W.C. 1914. The brine and salt deposits of Michigan. Mich. Geol. and Biol. Survey Publ. 15, Geo. Series 12. 188 pp.
- Cooper, W.S. 1913. The climax forest of Isle Royale, Lake Superior, and its development. Botanical Gazette 55: 1-44, 115-140, 189-235.
- Corner, R.A., and D.A. Albert. 1999a. Landtype Associations of the Arenac Subsection: Subsection VII.1. Prepared for the Northern Lower Michigan Ecosystem Management Project. Michigan Natural Features Inventory, Lansing, MI. Report Number 1999-02. 69 pp. + maps.
- Corner, R.A., and D.A. Albert. 1999b. Landtype Associations of the High Plains: Subsection VII.2. Prepared for the Northern Lower Michigan Ecosystem Management Project. Michigan Natural Features Inventory, Lansing, MI. Report Number 1999-03. 177 pp. + maps.
- Corner, R.A., and D.A. Albert. 1999c. Landtype Associations of the Leelanau and Grand Traverse Peninsula: Subsection VII.5. Prepared for the Northern Lower Michigan Ecosystem Management Project. Michigan Natural Features Inventory, Lansing, MI. Report Number 1999-06. 47 pp. + maps.
- Corner, R.A., and D.A. Albert. 1999d. Landtype Associations of the Manistee Subsection: Subsection VII.4. Prepared for the Northern Lower Michigan Ecosystem Management Project. Michigan Natural Features Inventory, Lansing, MI. Report Number 1999-05. 84 pp. + maps.
- Corner, R.A., and D.A. Albert. 1999e. Landtype Associations of the Newaygo Outwash Plain: Subsection VII.3. Prepared for the Northern Lower Michigan Ecosystem Management Project. Michigan Natural Features Inventory, Lansing, MI. Report Number 1999-04. 76 pp. + maps.
- Corner, R.A., and D.A. Albert. 1999f. Landtype Associations of the Presque Isle Subsection: Subsection VII.6. Prepared for the Northern Lower Michigan Ecosystem Management Project. Michigan Natural Features Inventory, Lansing, MI. Report Number 1999-07. 137 pp. + maps.
- Cowles, H.C. 1899. The ecological relations of the vegetation on the sand dunes of Lake Michigan. Botanical Gazette 27: 95-391.
- Crow, H.A. 1969. An ecological analysis of a southern Michigan bog. Michigan Botanist 8: 11-27.
- Curtis, J.T. 1959. Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI. 657 pp.

- Darlington, H.T. 1940. Some vegetational aspects of Beaver Island, Lake Michigan. *Papers of the Michigan Academy of Science, Arts, and Letters* 25: 31-37.
- Dean, D., and H. Coburn. 1927. An ecological study of Linne Bog, Cheboygan County, Michigan with special reference to *Nemopanthus mucranata* (L.) Trelease. *Papers of the Michigan Academy of Science, Arts, and Letters* 8: 87-96.
- Denton, S.R., and B.V. Barnes. 1987. Tree species distributions related to climatic patterns in Michigan. *Canadian Journal of Forest Research* 17: 613-629.
- Dodge, S.L., and J.R. Harman. 1985. Soil, subsoil and forest composition in south-central MI, USA. *Physical Geography* 6(1): 85-101.
- Donnelly, G.T., and P.G. Murphy. 1987. Warren Woods as forest primeval: a comparison of forest composition with presettlement beech-sugar maple forests of Berrien County, Michigan. *Michigan Botanist* 26: 17-26.
- Dorr, J.A., Jr., and D.F. Eschman. 1970. *Geology of Michigan*. University of Michigan Press, Ann Arbor, MI. 470 pp.
- Ehlers, G.M. 1973. Stratigraphy of the Niagaran Series of the Northern Peninsula of Michigan. *Museum of Paleontology, Papers on Paleontology*, No. 3. University of Michigan, Ann Arbor, MI. 200 pp.
- Faber-Langendoen, D. 1993. A proposed classification for savannas in the Midwest. Background paper for the Midwest Oak Savanna Conference, 1993. 18 pp.
- Faber-Langendoen, D., ed. 1999. International classification of ecological communities: Terrestrial vegetation of the midwestern United States. The Nature Conservancy, Midwest Conservation Science Department, Minneapolis, MN.
- Faber-Langendoen, D., ed. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix (705 pp.).
- Farrand, W.R., and D.L. Bell. 1982. Quaternary Geology of Michigan (map). Michigan Department of Natural Resources Geological Survey.
- Fisher, J.H. 1994. Pre-European settlement forest of northern Lower Michigan: The role of landform in determining composition across the landscape. M.S. thesis, Michigan State University, East Lansing, MI. 101 pp.
- Fitzgerald, S., and R.E. Bailey. 1975. Vegetational characteristics of a circum-neutral bog, Barney's Lake, Beaver Island, Michigan. *Michigan Academician* 7(4): 477-488.
- Frelich, L.E. 1995. Old forests in the Lake States today and before European settlement. *Natural Areas Journal* 15(2): 157-167.
- Frelich, L.E., and C.G. Lorimer. 1991. Natural disturbance regimes in hemlock-hardwood forests of the Upper Great Lakes region. *Ecological Monographs* 61(2): 145-164.
- Frelich, L.E., and P.B. Reich. 1996. Old-growth in the Great Lakes Region. Pp. 144-160 in M.B. Davis, ed., Eastern Old-Growth Forests: Prospects for Rediscovery and Recovery. Island Press, Washington, DC. 383 pp.
- Futyma, R.P., and N.G. Miller. 1986. Stratigraphy and genesis of the Lake Sixteen peatland, northern Michigan. *Canadian Journal of Botany* 64: 3008-3019.
- Gates, F.C. 1942. The bogs of northern Lower Michigan. *Ecological Monographs* 12(3): 213-254.
- Gignac, L.D., L.A. Halsey, and D.H. Vitt. 2000. A bioclimatic model for the distribution of sphagnum-dominated peatlands in North America under present climatic conditions. *Journal of Biogeography* 27(5): 1139-1151.
- Given, D.R., and J.H. Soper. 1981. The arctic-alpine element of the vascular flora at Lake Superior. *National Museums of Canada, Publication in Botany* 10: 1-70.
- Gleason, H.A. 1924. The structure of the maple-beech association in northern Michigan. *Papers of the Michigan Academy of Sciences, Arts, and Letters* 4: 285-296.
- Goforth, R.R., D.M. Stagliano, Y.M. Lee, J.G. Cohen, and M.R. Penskar. 2002. Biodiversity analysis of selected riparian ecosystems within a fragmented landscape. Michigan Natural Features Inventory. Lansing, MI. 126 pp.
- Graham, S.A. 1941. Climax forests of the Upper Peninsula of Michigan. *Ecology* 22(4): 355-362.
- Halsey, L.A., and D.H. Vitt. 2000. Sphagnum-dominated peatlands in North America since the last glacial maximum: Their occurrence and extent. *Bryologist* 103(2): 334-352.

- Harman, J.R., and J. Plough. 1986. Asymmetric distribution of coniferous trees on northern Lake Michigan Islands. *East Lakes Geographer* 21: 24-33
- Hauser, R.S. 1953. An ecological analysis of the isolated prairies of Newaygo County Michigan. Ph.D. diss. Michigan State College, East Lansing, MI. 168 pp.
- Hayes, B.N. 1964. An ecological study of wet prairie on Harsons Island, Michigan. *Michigan Botanist* 3: 71-82.
- Heinselman, M.L. 1965. String bogs and other patterned organic terrain near Seney, Upper Michigan. *Ecology* 46: 185-188.
- Hix, D., B.V. Barnes, A.N. Lynch, and J.A. Witter. 1987. Relationship between spruce budworm damage and site factors in spruce-fir-dominated ecosystems of western Upper Michigan. *Forest Ecology and Management* 21: 129-140.
- Hodler, T.W., R. Brewer, L.G. Brewer and H.A. Raup. 1981. Presettlement vegetation of Kalamazoo County (map). Department of Geography, Western Michigan University, Kalamazoo MI.
- Hover, W. 1990. The importance of cedar in Michigan's forest history. Pp.3-7 in D.O. Lantagne, ed., *Workshop Proceedings of Northern White Cedar in Michigan*. Sault Ste. Marie, MI. Michigan State University Agricultural Experimental Station 1991: Report #512.
- Jones, C.L., and R.O. Kapp. 1972. Relationship of Bay County Michigan presettlement forest patterns to Indian cultures. *Michigan Academician* 5: 17-28.
- Jones, J.J., and W. Zicker. 1955. A spruce-fir stand in the northern peninsula of Michigan. *Ecology* 36(2): 345.
- Judziewicz, E.J. 2001. Flora and vegetation of the Grand Traverse Islands (Lake Michigan), Wisconsin and Michigan. *Michigan Botanist* 30(4): 81-208.
- Kenoyer, L.A. 1930. Ecological notes on Kalamazoo County, Michigan, based on the original land survey. *Papers of the Michigan Academy of Science, Arts, and Letters* 11: 211-217.
- Kenoyer, L.A. 1934. Forest distribution in southwestern Michigan as interpreted from the original land survey (1826-32). *Papers of the Michigan Academy of Science, Arts, and Letters* 19: 107-111.
- Kenoyer, L.A. 1940. Plant associations in Barry, Calhoun, and Branch Counties, Michigan, as interpreted from the original survey. *Papers of the Michigan Academy of Science, Arts, and Letters* 25: 75-77.
- Kittredge, J., and A.K. Chittenden. 1929. Oak forests of Northern Michigan. Agricultural Experiment Station, Michigan State College. *Michigan Experimental Special Bulletin No. 190*: 3-47.
- Knopp, P.D. 1999. Landscape ecosystems of the Maumee Lake Plain, southeastern Lower Michigan: Interrelationships of physiography, soil, and vegetation. M.S. thesis, University of Michigan, Ann Arbor, MI. 100 pp.
- Kost, M.A. 2000. Natural community abstract for coastal plain marsh. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Kost, M.A. 2001a. Natural community abstract for relict conifer swamp. Michigan Natural Features Inventory, Lansing, MI. 6 pp.
- Kost, M.A. 2001b. Natural community abstract for southern wet meadow. Natural Features Inventory, Lansing, MI. 6 pp.
- Kost, M.A. 2001c. Potential Indicators for assessing biological integrity of forested, depressional wetlands in southern Michigan. Michigan Natural Features Inventory, Lansing, MI. 69 pp. Available: [http://www.dnr.state.mi.us/wildlife/Heritage/Mnfi/pubs/ibi\\_final.pdf](http://www.dnr.state.mi.us/wildlife/Heritage/Mnfi/pubs/ibi_final.pdf).
- Kost, M.A. 2002. Natural community abstract for rich conifer swamp. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Kost, M.A. 2004a. Natural community abstract for dry sand prairie prairie. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Kost, M.A. 2004b. Natural community abstract for mesic prairie. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Kost, M.A., and M.R. Penskar. 2000. Natural community abstract for coastal plain marsh. Michigan Natural Features Inventory, Lansing, MI. 5 pp.
- Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory, Lansing, MI. Report Number 2007-21. 314 pp.



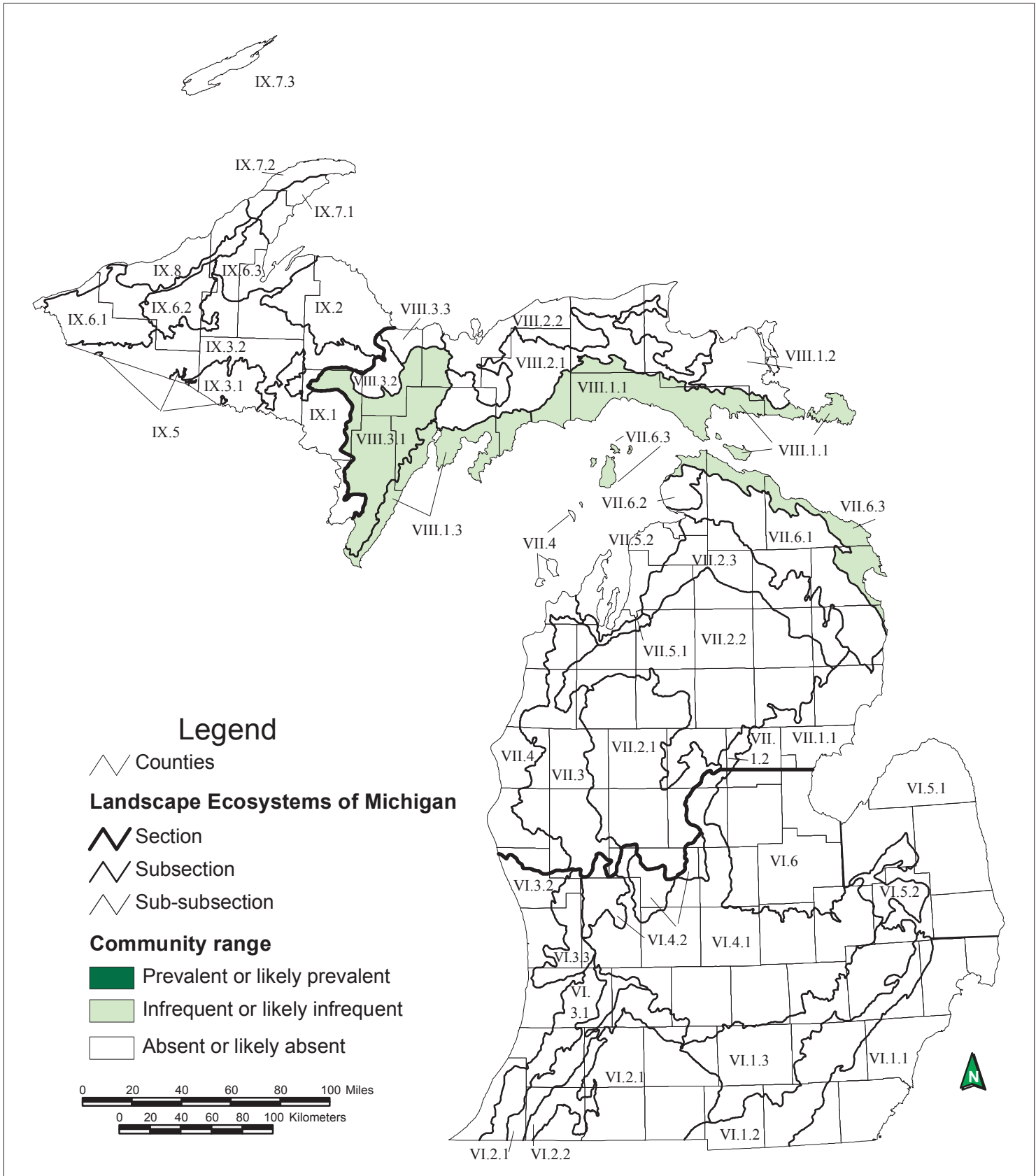
- Kost, M.A., and B.S. Slaughter. 2009a. Natural community abstract for mesic sand prairie. Michigan Natural Features Inventory, Lansing, MI. 9 pp.
- Kost, M.A., and B.S. Slaughter. 2009b. Natural community abstract for wet-mesic sand prairie. Michigan Natural Features Inventory, Lansing, MI. 8 pp.
- Kudray, G.M., and M.R. Gale. 1997. Relationships between groundwater characteristics, vegetation, and peatland type in the Hiawatha National Forest, Michigan. Pp. 89-96 in C.C. Trettin, M.F. Jurgensen, D.F. Grigal, M.R. Gale, and J.K. Jeglum, eds., Northern Forested Wetlands: Ecology and Management. CRC Press, Boca Raton, FL. 486 pp.
- LaBerge, G.L. 1994. Geology of the Lake Superior region. Geoscience Press, Phoenix, AZ. 313 pp.
- Lawson, D.W., U. Matthes-Sears, and P.E. Kelly. 1999. The cliff ecosystems of the Niagara Escarpment. Pp. 362-374 in R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds., Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge University Press, Cambridge, UK. 480 pp.
- Leahy, M.J., and K.S. Pregitzer. 2003. A comparison of presettlement and present-day forests in northeastern Lower Michigan. *American Midland Naturalist* 149: 71-89.
- Lee, J.G. 2007. Natural community abstract for dry-mesic southern forest. Michigan Natural Features Inventory, Lansing, MI. 19 pp.
- Lee, Y.M., L.J. Scrimger, D.A. Albert, M.R. Penskar, P.J. Comer, and D.L. Cuthrell. 1998. Alvars of Michigan. Michigan Natural Features Inventory, Lansing, MI. 30 pp.
- Lichter, J. 1998. Primary succession and forest development on coastal Lake Michigan sand dunes. *Ecological Monographs* 68(4): 487-510.
- Livingston, B.E. 1905. The relation of soils to natural vegetation in Roscommon and Crawford Counties, Michigan. *Botanical Gazette* 39: 22-41.
- Lohrentz, M., and L. Mattei. 1995. Newaygo prairie-barrens ecosystem site conservation plan. 59 pp.
- Mackey, S.D., and D.L. Liebenthal. 2005. Mapping changes in Great Lakes nearshore substrate distributions. *Journal of Great Lakes Research* 32 (Supplement 1): 75-89.
- Madsen, B.J. 1987. Interaction of vegetation and physical processes in patterned peatlands: A comparison of two sites in Upper Michigan. Unpublished Ph.D. diss., University of Michigan, Ann Arbor, MI. 84 pp. + charts.
- Maycock, P.F. 1961. The spruce-fir forests of the Keweenaw Peninsula, Northern Michigan. *Ecology* 42(2): 357-365.
- Maycock, P.F., and J.T. Curtis. 1960. The phytosociology of boreal conifers – Hardwood forests of the Great Lakes Region. *Ecological Monographs* 30: 1-35.
- McAtee, W.L. 1920. Notes on the jack pine plains of Michigan. *Bulletin of the Torrey Botanical Club* 47: 187-190.
- Michigan Department of Natural Resources. 1989. Atlas of Critical Dunes. Land and Water Management Division, Michigan Department of Natural Resources, Lansing, MI. 72 pp.
- Michigan Department of Natural Resources. 2001a. IFMAP/GAP Lower Peninsula Land Cover (produced as part of the IFMAP natural resources decision support system). Michigan Department of Natural Resources, Lansing, MI. Digital dataset and report.
- Michigan Department of Natural Resources. 2001b. IFMAP/GAP Upper Peninsula Land Cover (produced as part of the IFMAP natural resources decision support system). Michigan Department of Natural Resources, Lansing, MI. Digital dataset and report.
- Michigan Department of Natural Resources. 2007. Biodiversity Conservation Planning Process. Michigan Department of Natural Resources, Lansing, MI. 34 pp.
- Michigan Karst Conservancy. [http://www.caves.org/conservancy/mkc/michigan\\_karst\\_conservancy.htm](http://www.caves.org/conservancy/mkc/michigan_karst_conservancy.htm).
- Michigan Natural Features Inventory (MNFI). 2008. Biotics database. Michigan Natural Features Inventory, Lansing, MI.
- Minc, L.D. 1995. Seasonal hydrology and species relationships in Lower Michigan's lakeplain prairies. An analysis and report submitted to Michigan Natural Features Inventory. 89 pp.

- Minc, L.D. 1997. Great Lakes Coastal Wetlands: An Overview of Abiotic Factors Affecting their Distribution, Form, and Species Composition. A Report in 3 Parts Submitted to Michigan Natural Features Inventory, December, 1997. Funded by EPA Great Lakes National Program Office (Federal Grant GL9 95810-02), through The Nature Conservancy's Great Lakes Program Office. 307 pp.
- Minc, L.D., and D.A. Albert. 1990. Oak-dominated communities of Southern Lower Michigan: Floristic and abiotic comparisons. Michigan Natural Features Inventory, Lansing, MI. (Unpublished manuscript.) 103 pp.
- Minc, L.D., and D.A. Albert. 1998. Great Lakes Coastal Wetlands: Abiotic and Floristic Characterization. Michigan Natural Features Inventory. 36 pp.
- MIRIS. 1978. MIRIS Landcover 1978. Michigan Department of Natural Resources, Lansing, MI. Digital dataset.
- Moore, J.B., M.S. Hagan, and L.P. Bruederle. 1993. Comparison of three prairie fens in southern Michigan. Report to MNFI. Biology Dept., University of Michigan, Flint, MI. 42 pp.
- NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [Web application]. Version 6.1. NatureServe, Arlington, VA. Available: <http://www.natureserve.org/explorer>. (Accessed: January 12, 2007.)
- Nicoll, R.S. 1966. Development of karst features of the Silurian of the Northern Peninsula of Michigan and the Devonian of Indiana. Bloomington Indiana Grotto Newsletter 6(3): 23 pp.
- Nuzzo, V. 1986. Extent and status of Midwest oak savanna: Presettlement and 1985. Natural Areas Journal 6(2): 6-36.
- Olson, J.S. 1958. Lake Michigan dune development. 2. Plants as agents and tools in geomorphology. Journal of Geology 66: 345-351.
- Osvold, H. 1935. A bog at Hartford, Michigan. Ecology 16(3): 520-528.
- Parker, G.R., and G. Schneider. 1974. Structure and edaphic factors of an alder swamp in northern Michigan. Canadian Journal of Forest Research 4: 499-508.
- Penskar, M.R., D.A. Hyde, J.A. Olson, M.A. Kost, P.J. Higman, J.J. Paskus, R.L. Boehm, and M.T. Fashoway. 2001. Biological Inventory for Conservation of Great Lakes Islands: Year 2000 Progress Report. Report for Michigan Coastal Management Program. Land and Water Management Division, Michigan Department of Environmental Quality. Michigan Natural Features Inventory, Lansing, MI. Report Number 2000-15. 110 pp.
- Penskar, M.R., Y.M. Lee, M.A. Kost, D.A. Hyde, J.J. Paskus, D.L. Cuthrell, and H.D. Enander. Biological Inventory for Conservation of Great Lakes Islands: 2002 Inventory and Final Report. Report for Michigan Coastal Management Program. Environmental Science and Services Division. Michigan Natural Features Inventory, Lansing, MI. Report Number 2002-27. 42 pp. and appendices.
- Potzger, J.E. 1941. The vegetation of Mackinac Island, Michigan: An ecological survey. American Midland Naturalist 25(2): 298-323.
- Poulson, T.L., and W.J. Platt. 1996. Replacement patterns of beech and sugar maple in Warren Woods, Michigan. Ecology 77(4): 1234-1253.
- Pregitzer, K.S. 1981. Relationships among physiography, soils and vegetation of the McCormick experimental forest, Upper Michigan. Ph.D. diss., University of Michigan, Ann Arbor, MI. 205 pp.
- Pregitzer, K.S. 1990. The ecology of northern white-cedar. Pp. 8-14 in D.O. Lantagne, ed., Workshop Proceedings of Northern White Cedar in Michigan. Sault Ste. Marie, MI. Michigan State University Agricultural Experimental Station 1991: Report #512.
- Price, J.R., and M.A. Velbel. 2000. Weathering of the Eaton Sandstone (Pennsylvanian), Grand Ledge, Michigan: Geochemical mass-balance and implications for reservoir properties beneath unconformities. Journal of Sedimentary Research 70(5): 1118-1128.
- Quarterman, E., M.P. Burbank, and D.J. Shure. 1993. Rock Outcrop Communities: Limestone, Sandstone, and Granite. Pp 35-86 in W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds., Biodiversity of the Southeastern United States: Upland Terrestrial Communities. John Wiley and Sons, New York, NY.
- Quick, B.E. 1924. A comparative study of the distribution of the climax association in southern Michigan. Papers of the Michigan Academy of Sciences, Arts, and Letters 3: 211-245.

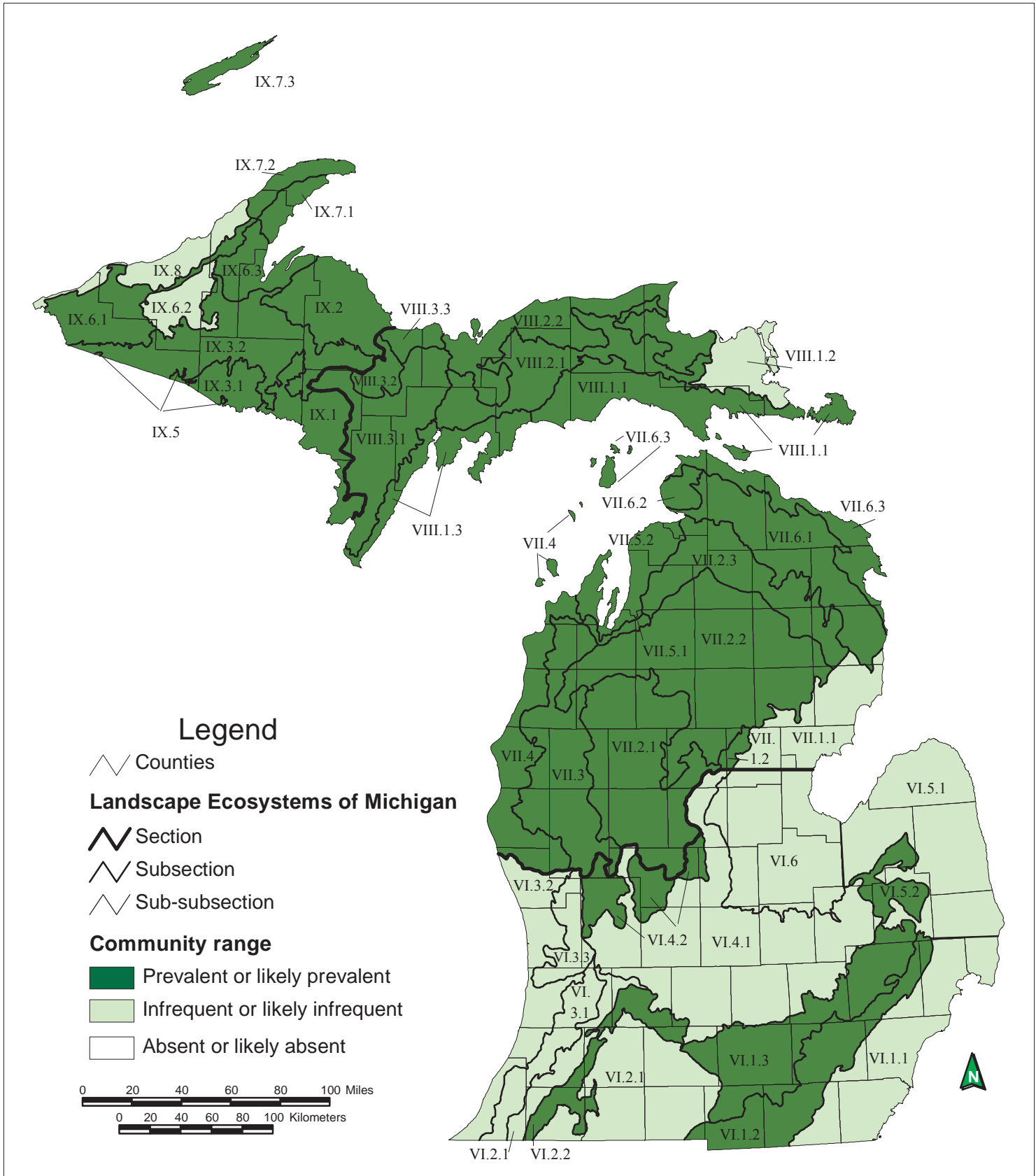
- Reed, R.C., and J. Daniels. 1987. Bedrock Geology of Northern Michigan. State of Michigan Department of Natural Resources. Map: 1: 500,000.
- Reese, G.A., D.A. Albert, S.R. Crispin, L.A. Wilsmann, and S.J. Ouwinga. 1986. Final Report on a Natural Areas Inventory of Michigan's Designated Sand Dune Areas. Report to the Michigan Department of Natural Resources, Land Resource Programs Division. Michigan Natural Features Inventory, Lansing, MI. Report Number 1986-04. 67 pp.
- Reschke, C. 1985. Vegetation of the conglomerate rock shoreline of the Keweenaw Peninsula, northern Michigan. M.S. thesis. University of Wisconsin, Madison, WI. 118 pp.
- Reschke, C., R. Reid, J. Jones, T. Feeney, and H. Potter. 1999. Conserving Great Lakes alvar: final technical report of the International Alvar Conservation Initiative. The Nature Conservancy, Chicago, IL. 241 pp.
- Reuter, D.D. 1986. Sedge meadows of the upper Midwest: A stewardship summary. *Natural Areas Journal* 6(4): 27-34.
- Reznicek, A.A. 1994. The disjunct coastal plain flora in the Great Lakes Region. *Biological Conservation* 68:203-215.
- Reznicek, A.A., E.G. Voss, and R.A. Simpson. 2004. *Online Atlas of Michigan Plants*. Edition 1. University of Michigan. Available: <http://herbarium.lsa.umich.edu/website/michflora/index.html>. (Accessed: December 18, 2008.)
- Rutkowski, D.R., and R. Stottlemeyer. 1993. Composition, biomass, and nutrient distribution in mature northern hardwood and boreal forest stands, Michigan. *American Midland Naturalist* 130(1): 13-30.
- Scharrer, E.M. 1972. Relict prairie flora of southwestern Michigan. Pp. 9-12 in J.H. Zimmerman, ed., *Proceedings of the Second Midwest Prairie Conference*, Madison, WI. 242 pp.
- Schwintzer, C.R. 1978a. Nutrient and water levels in a small Michigan bog with high tree mortality. *American Midland Naturalist* 100(2): 441-451.
- Schwintzer, C.R. 1978b. Vegetation and nutrient status of northern Michigan fens. *Canadian Journal of Botany* 56: 3044-3051.
- Schwintzer, C.R. 1979. Vegetation changes following a water level rise and tree mortality in a Michigan bog. *Michigan Botanist* 18: 91-98.
- Schwintzer, C.R. 1981. Vegetation and nutrient status of northern Michigan bogs and conifer swamps with a comparison to fens. *Canadian Journal of Botany* 59: 842-853.
- Schwintzer, C.R., and T.J. Tomberlin. 1982. Chemical and physical characteristics of shallow ground waters in northern Michigan bogs, swamps, and fens. *American Journal of Botany* 69(8): 1231-1239.
- Schwintzer, C.R., and G. Williams. 1974. Vegetation changes in a small Michigan bog from 1917 to 1972. *American Midland Naturalist* 92(2): 447-459.
- Simard, A.J., and R.W. Blank. 1982. Fire history of a Michigan jack pine forest. *Michigan Academician* 15: 59-71.
- Simpson, T.B., P.E. Stuart, and B.V. Barnes. 1990. Landscape ecosystems and cover types of the reserve area and adjacent lands of the Huron Mountain Club. *Occasional papers of the Huron Mountain Wildlife Foundation* 4: 128.
- Slavick, A.D., and R.A. Janke. 1987. The vascular flora of Isle Royale National Park. *Michigan Botanist* 26: 91-134.
- Slaughter, B.S. 2009. Natural community abstract for southern hardwood swamp. Michigan Natural Features Inventory, Lansing, MI. 14 pp.
- Slaughter, B.S., J.G. Cohen, and M.A. Kost. 2007. Natural community abstract for hardwood-conifer swamp. Michigan Natural Features Inventory, Lansing, MI. 19 pp.
- Slaughter, B.S., B.S. Walters, and E.H. Schools. 2007. A natural features inventory of Newaygo County, Michigan. Report No. 2007-01. Michigan Natural Features Inventory, Lansing, MI. 55 pp.
- Spieles, J.B., P.J. Comer, D.A. Albert, and M.A. Kost. 1999. Natural community abstract for prairie fen. Michigan Natural Features Inventory, Lansing, MI. 4 pp.
- Spies, T.A., and B.V. Barnes. 1985. A multifactor ecological classification of the northern hardwood and conifer ecosystems of Sylvania Recreation Area, Upper Peninsula, Michigan. *Canadian Journal of Forest Research* 15: 949-960.

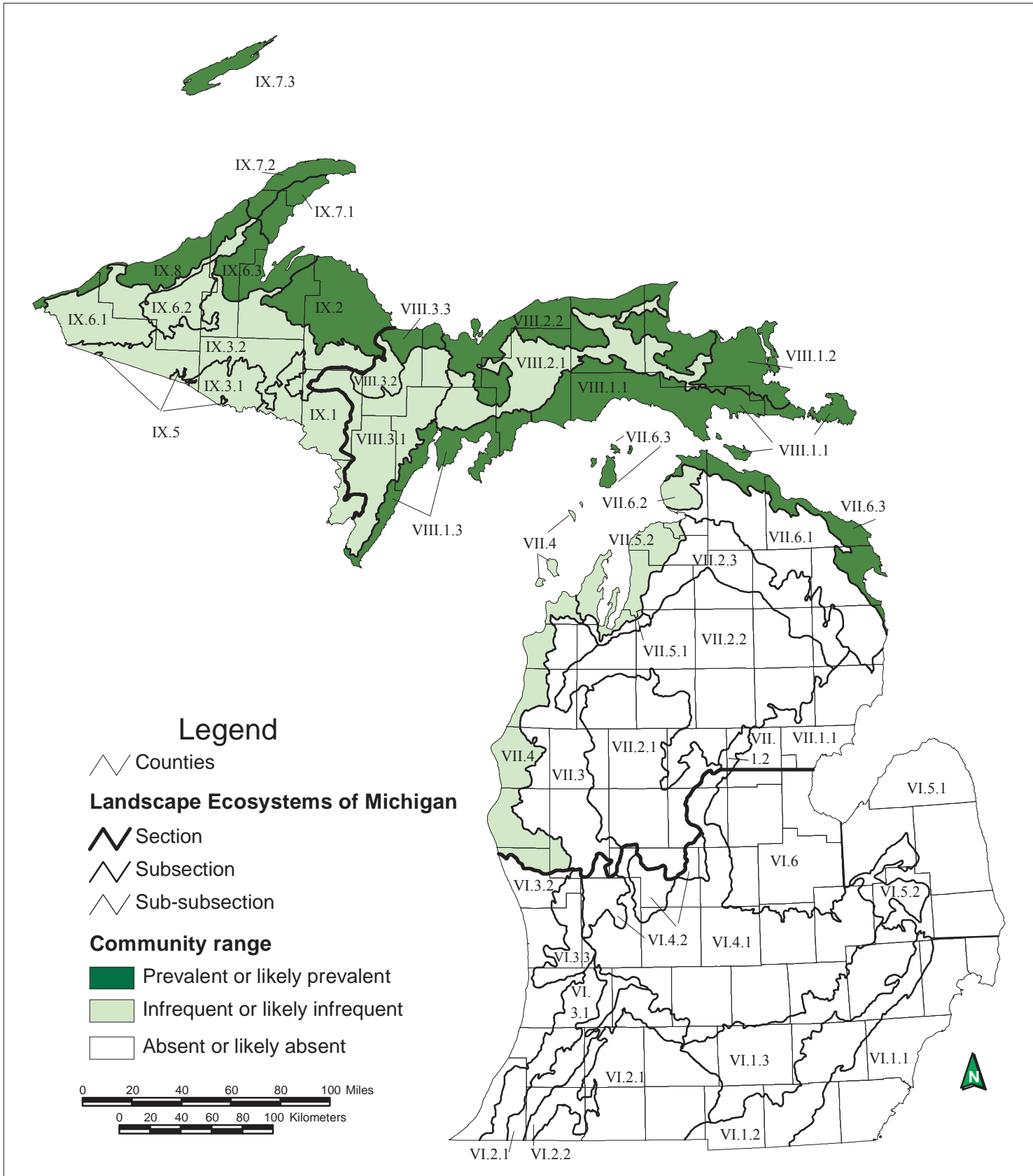
- Tepley, A.J., J.G. Cohen, and L. Huberty. 2004. Natural community abstract for southern floodplain forest. Natural Features Inventory, Lansing, MI. 14 pp.
- Thompson, P.W. 1968. A wet prairie community in Ann Arbor, Michigan. *Michigan Academician* 2: 87-94.
- Thompson, P.W. 1970. The preservation of prairie stands in Michigan. Pp. 13-14 in J.H. Zimmerman, ed., *Proceedings of the Second Midwest Prairie Conference*, Madison, WI. 242 pp.
- Thompson, P.W. 1975. The floristic composition of prairie stands in southern Michigan. Pp. 317-331 in M.K. Wali, ed., *Prairie: A multiple view*. University of North Dakota, Grand Fork, ND.
- Thompson, P.W. 1983. Composition of prairie stands in southern Michigan and adjoining areas. Pp. 105-111 in R. Brewer, ed., *Proceedings of the Eighth North American Prairie Conference*. Western Michigan University, Kalamazoo, MI.
- Thompson, P.W. 1985. An old-growth white pine stand in the Huron Mountains, Upper Michigan. *Michigan Botanist* 24: 164-168.
- Transeau, E.N. 1935. The prairie peninsula. *Ecology* 16:423-437.
- USDA, NRCS. 2008. The PLANTS Database Available: <http://plants.usda.gov> (Accessed: 12 December 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
- Van Deelen, T.R., K.S. Pregitzer, and J.B. Haufler. 1996. A comparison of presettlement and present-day forests in two northern Michigan deer yards. *American Midland Naturalist* 135:181-194.
- Veatch, J.O. 1927. The dry prairies of Michigan. *Papers of the Michigan Academy of Science, Arts, and Letters* 8: 269-278.
- Verme, L.J. 1965. Swamp conifer deeryards in northern Michigan: their ecology and management. *Journal of Forestry* 63: 523-529.
- Vitt, D.H., H. Crum, and J.A. Snider. 1975. The vertical zonation of sphagnum species in hummock-hollow complexes in northern Michigan. *Michigan Botanist* 14(4): 190-200.
- Voss, E.G. 1972. Michigan Flora. Part I: Gymnosperms and Monocots. *Bulletin of the Cranbrook Institute of Science* 55. Bloomfield Hills, MI. 488 pp.
- Voss, E.G. 1985. Michigan Flora. Part II: Dicots (Saururaceae- Cornaceae). *Bulletin of the Cranbrook Institute of Science* 59 and University of Michigan Herbarium. Ann Arbor, MI. 724 pp.
- Voss, E.G. 1996. Michigan Flora. Part III: Dicots (Pyrolaceae- Compositae). *Bulletin of the Cranbrook Institute of Science* 61 and University of Michigan Herbarium. Ann Arbor, MI. 622 pp.
- Warners, D.P. 1993. Species diversity in southern Michigan sedge meadows. Unpublished report to The Nature Conservancy, Michigan Chapter, East Lansing, MI. 35 pp.
- Warners, D.P. 1997. Plant diversity in sedge meadows: Effects of groundwater and fire. Ph.D. diss., University of Michigan, Ann Arbor, MI. 231 pp.
- Wenger, J.D. 1975. The vegetation of a white-cedar swamp in southwestern Michigan. *Michigan Botanist* 14: 124-130.
- Whitney, G.G. 1986. Relation of Michigan's presettlement pine forests to substrate and disturbance history. *Ecology* 67: 1548-1559.
- Whitney, G.G. 1987. An ecological history of the Great Lakes Forest of Michigan. *Journal of Ecology* 75: 667-684.
- Will-Wolf, S., and F. Stearns. 1999. Dry soil oak savanna in the Great Lakes region. Pp. 135-154 in R.C. Anderson, J.S. Fralish, and J.M. Baskin, eds., *Savannas, Barrens, and Rock Outcrop Plant Communities of North America*. Cambridge University Press, Cambridge, UK.
- Wing, L.W. 1937. Evidences of ancient oak openings in southern Michigan. *Ecology* 18: 170-171.
- Woods, K.D. 1979. Reciprocal replacement and the maintenance of codominance in a beech maple forest. *Oikos* 33: 31-39.
- Zhang, Q., K.S. Pregitzer, and D.D. Reed. 2000. Historical changes in the forests of the Luce District of the Upper Peninsula of Michigan. *American Midland Naturalist* 143:94-110.
- Zimmerman, D.A. 1956. The jack pine association in the lower peninsula of Michigan: Its structure and composition. Ph.D. Diss., University of Michigan, Ann Arbor, MI. 278 pp.

**Appendix 1**  
**Natural Community Distribution Maps by**  
**Ecological Sub-subsection**



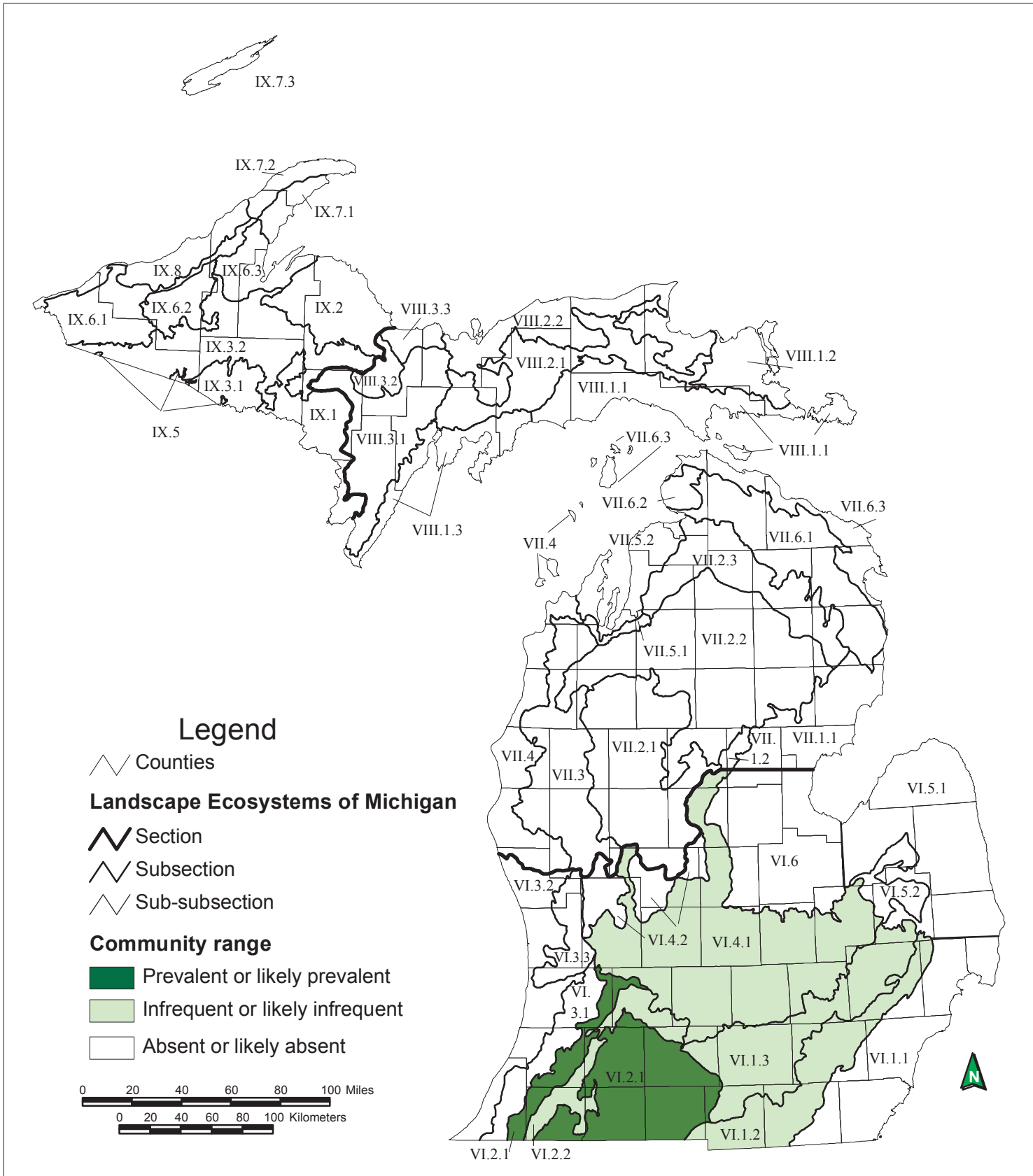
## Alvar



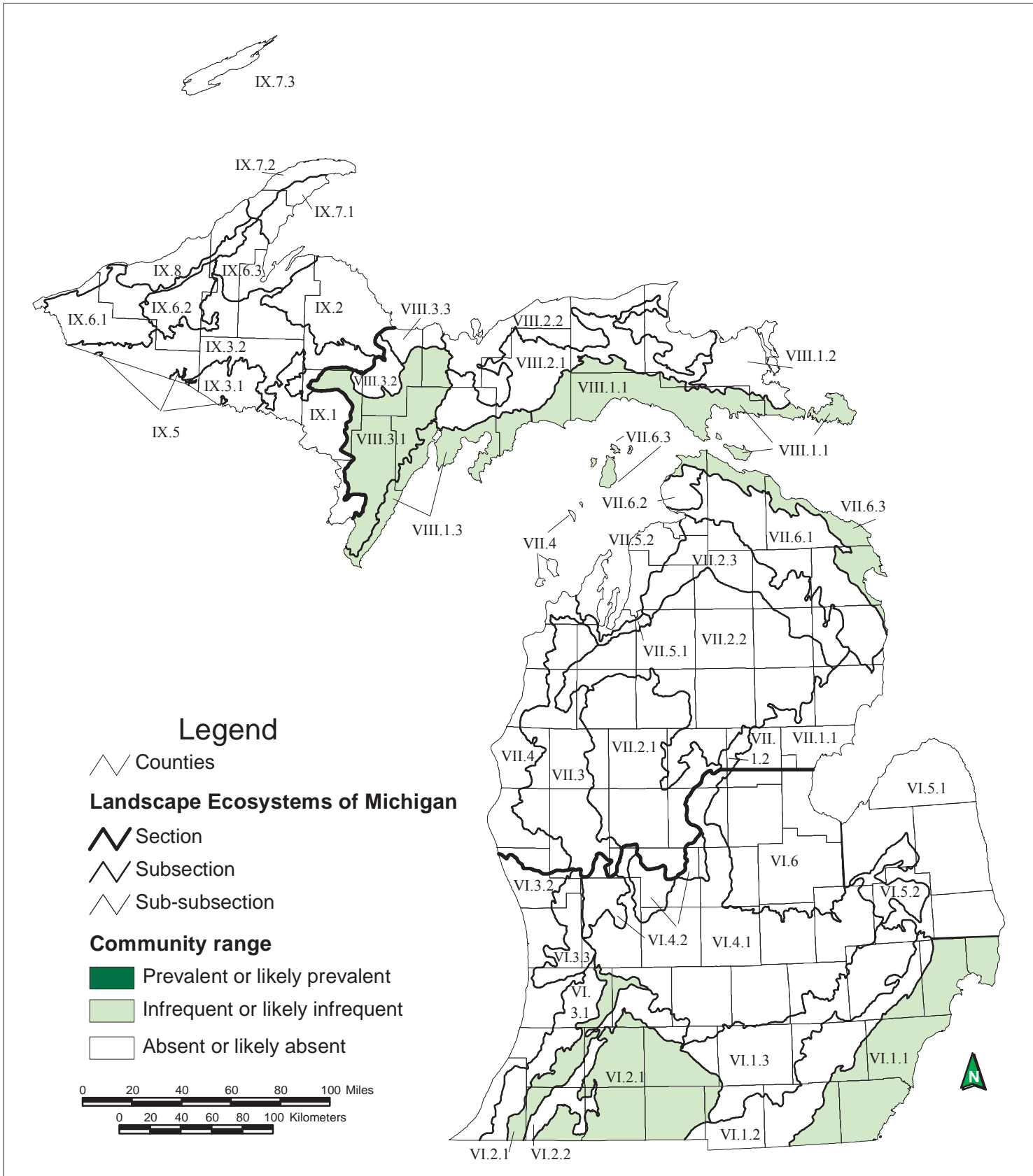


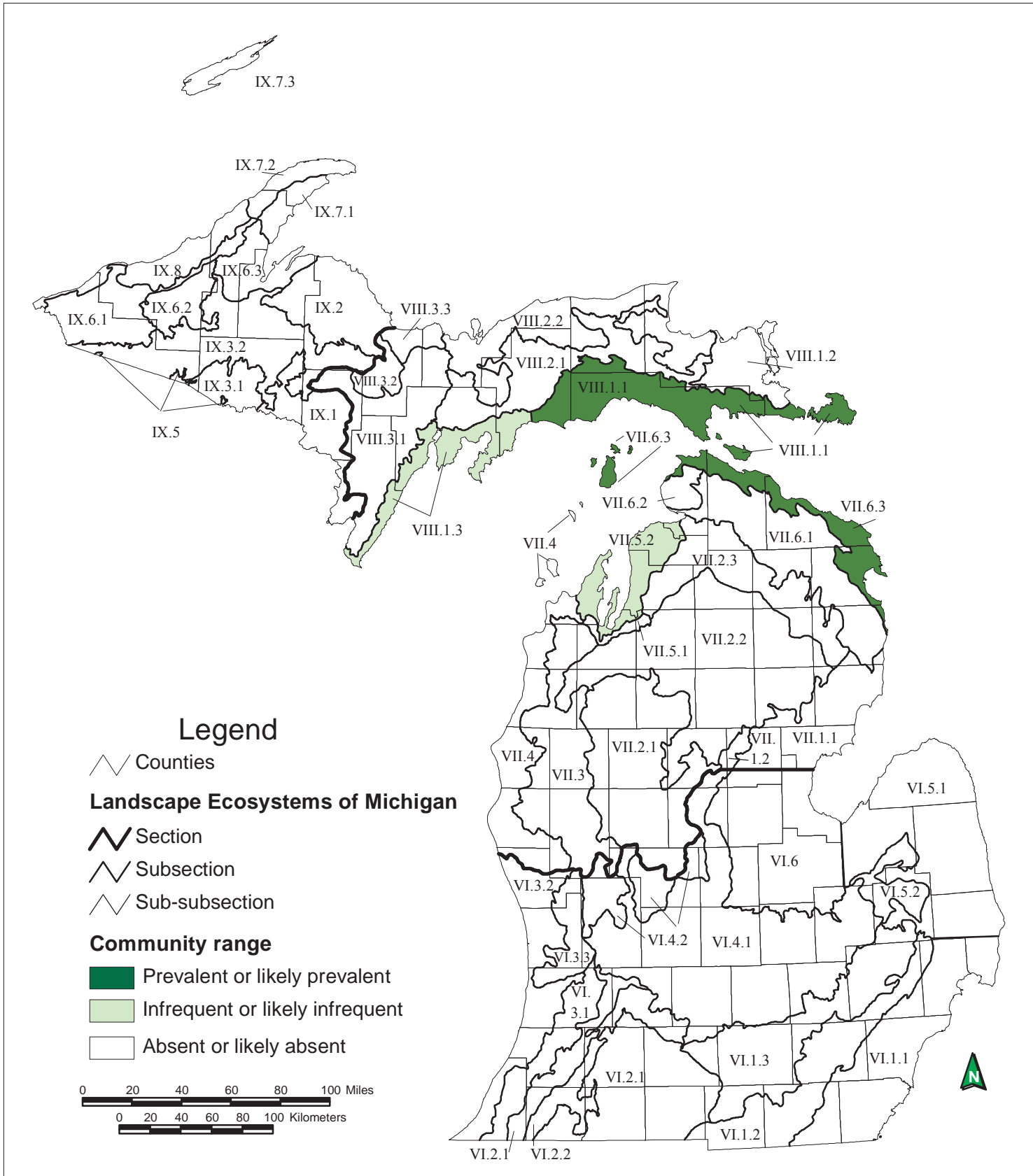
## Boreal Forest



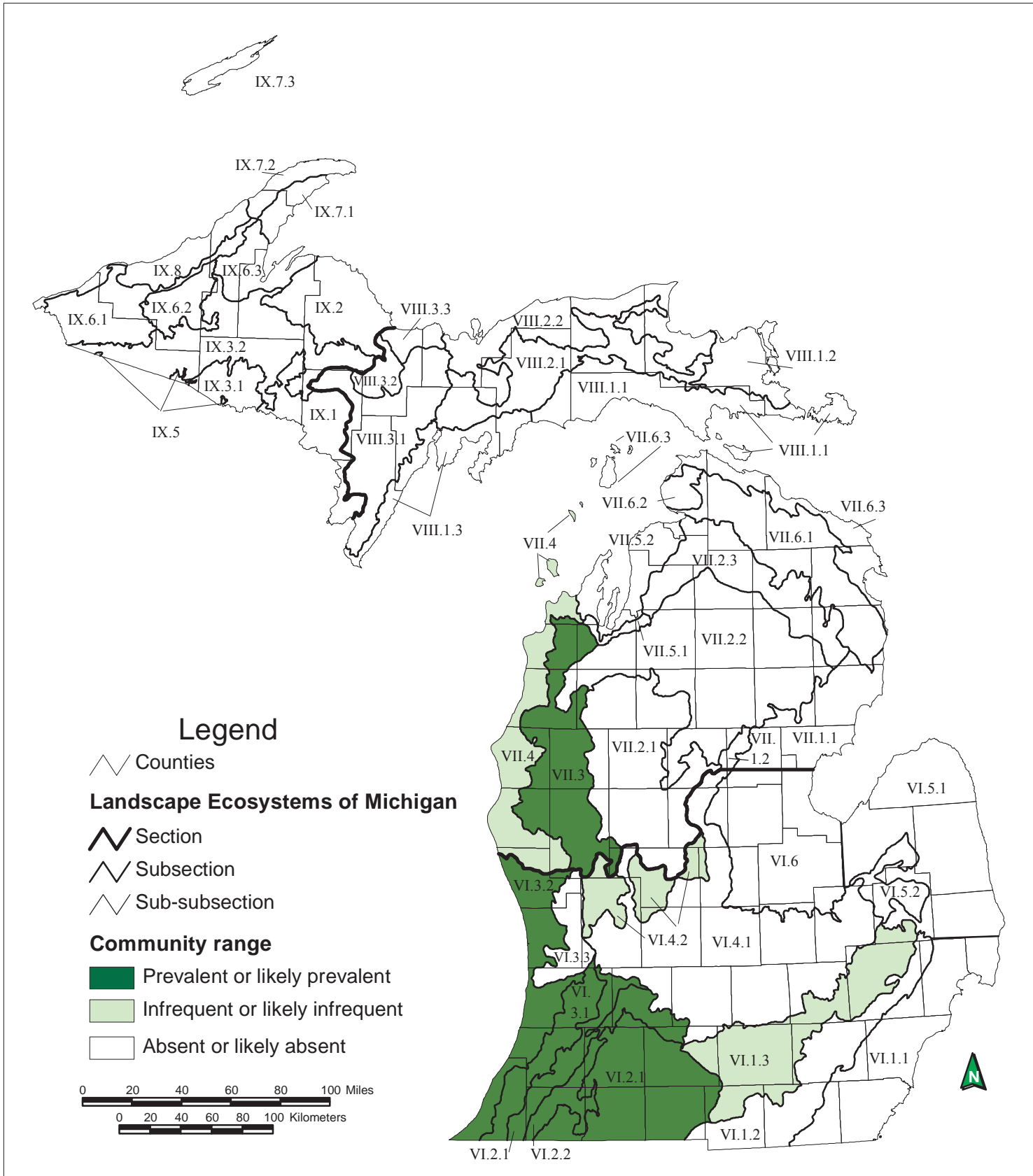


## Bur Oak Plains

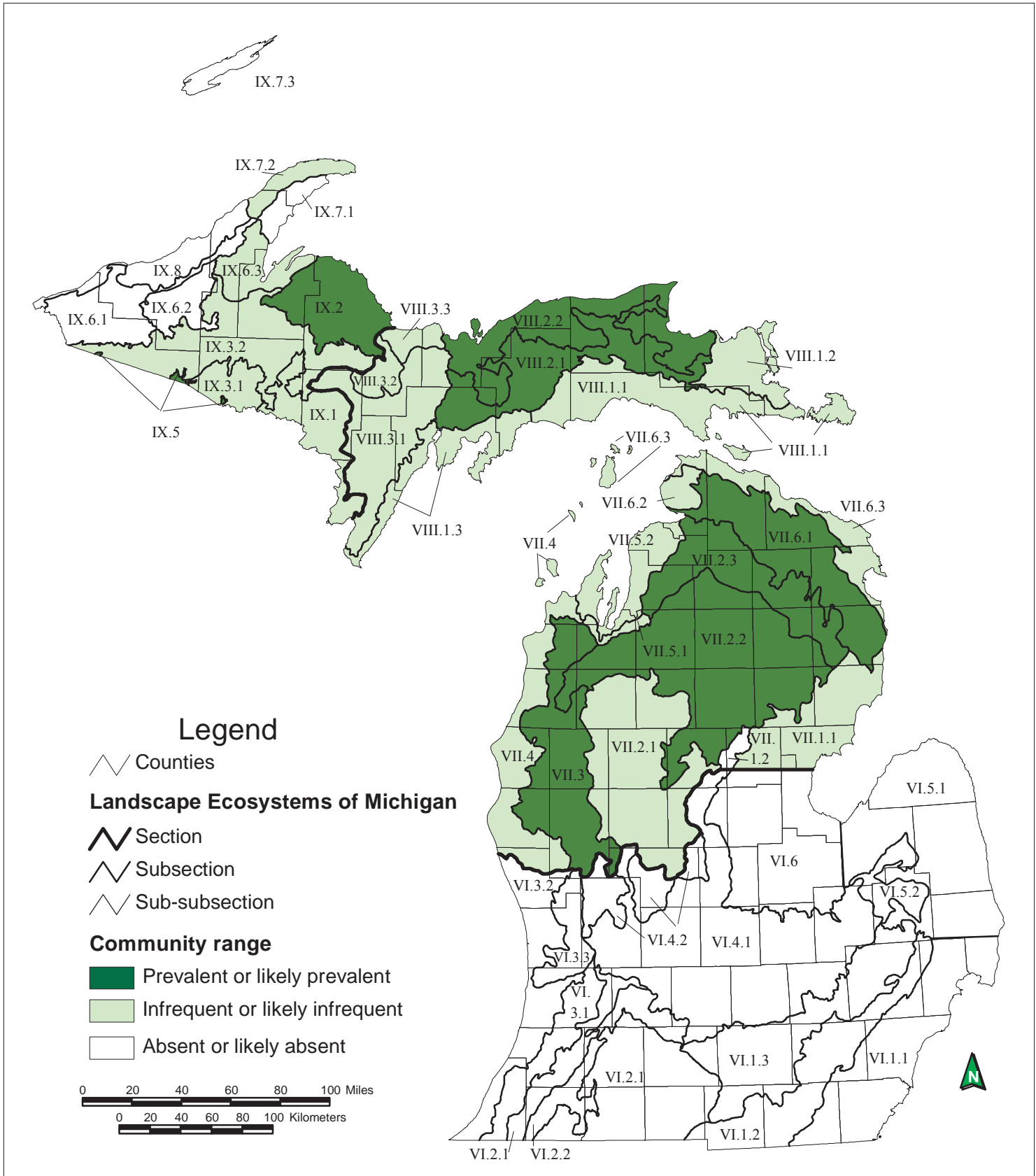




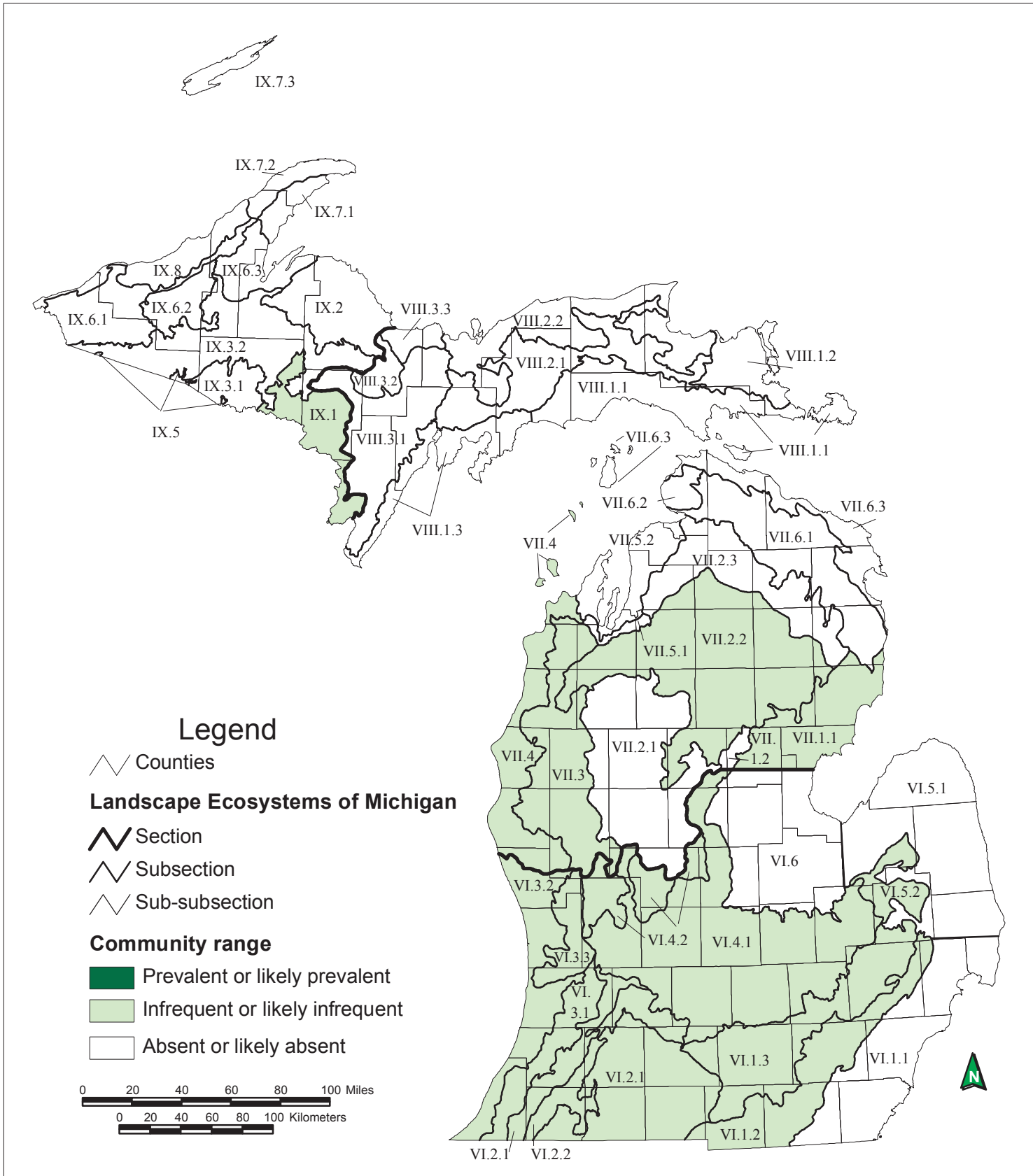
## Coastal Fen



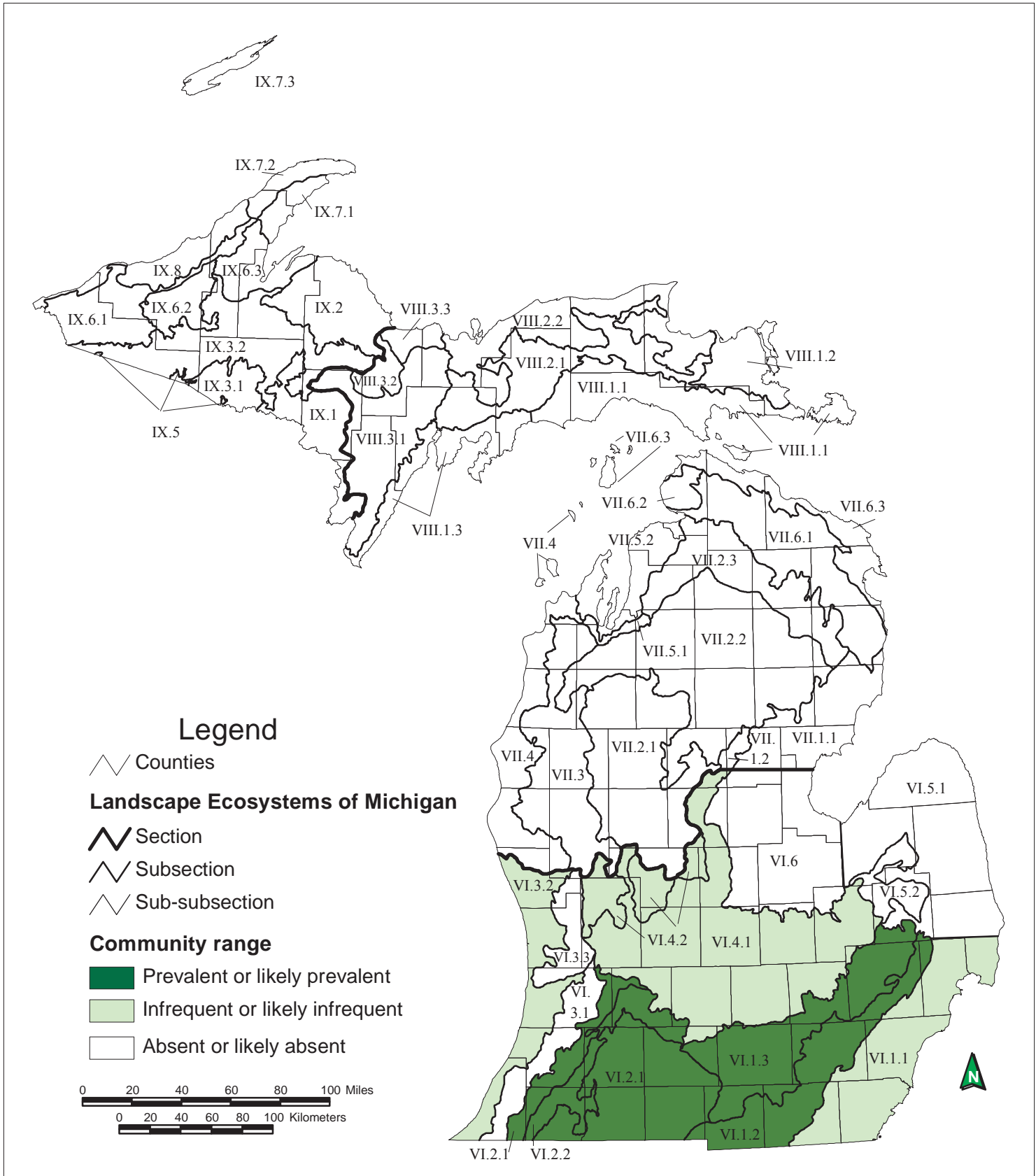
## Coastal Plain Marsh



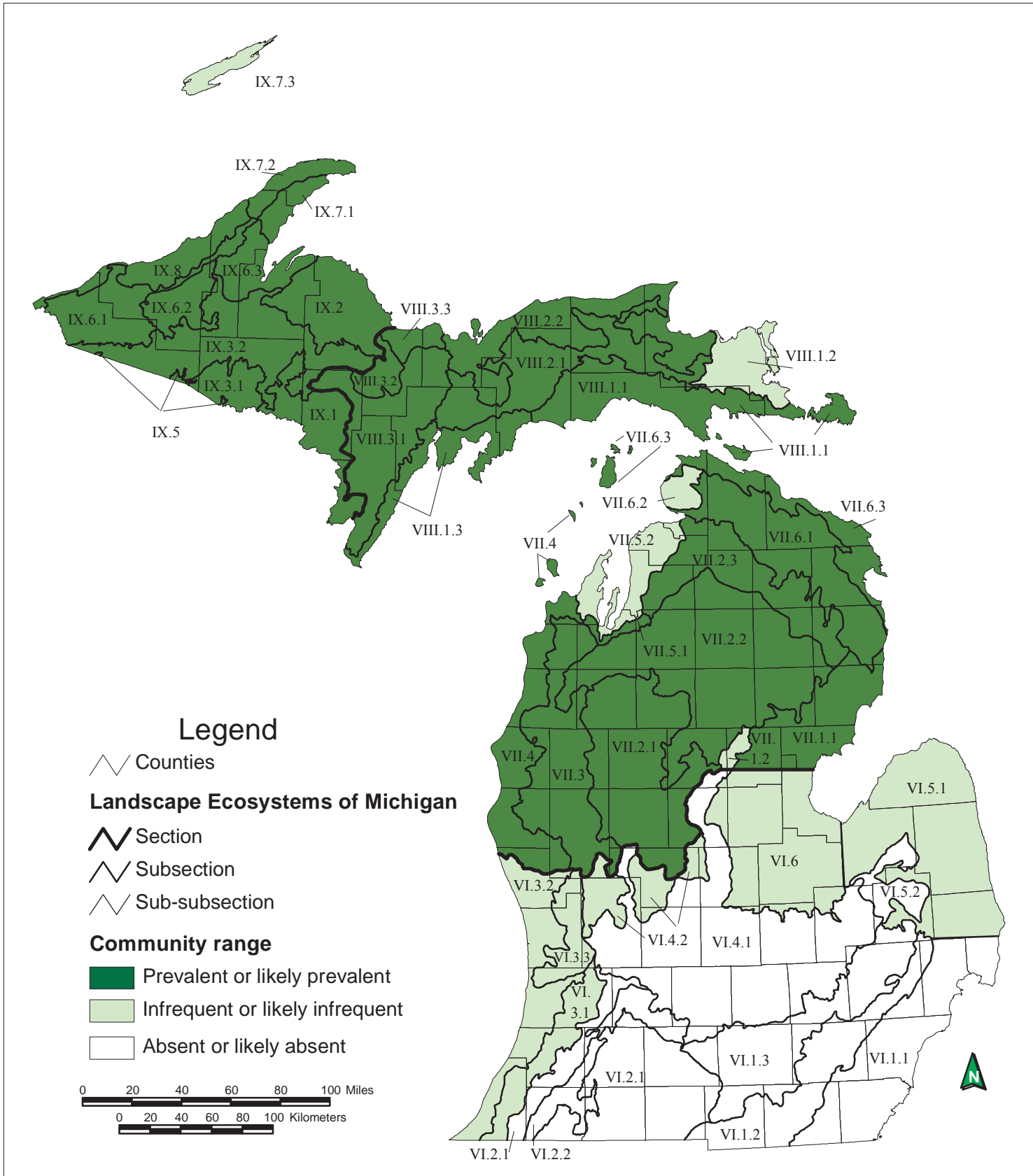
## Dry Northern Forest



## Dry Sand Prairie

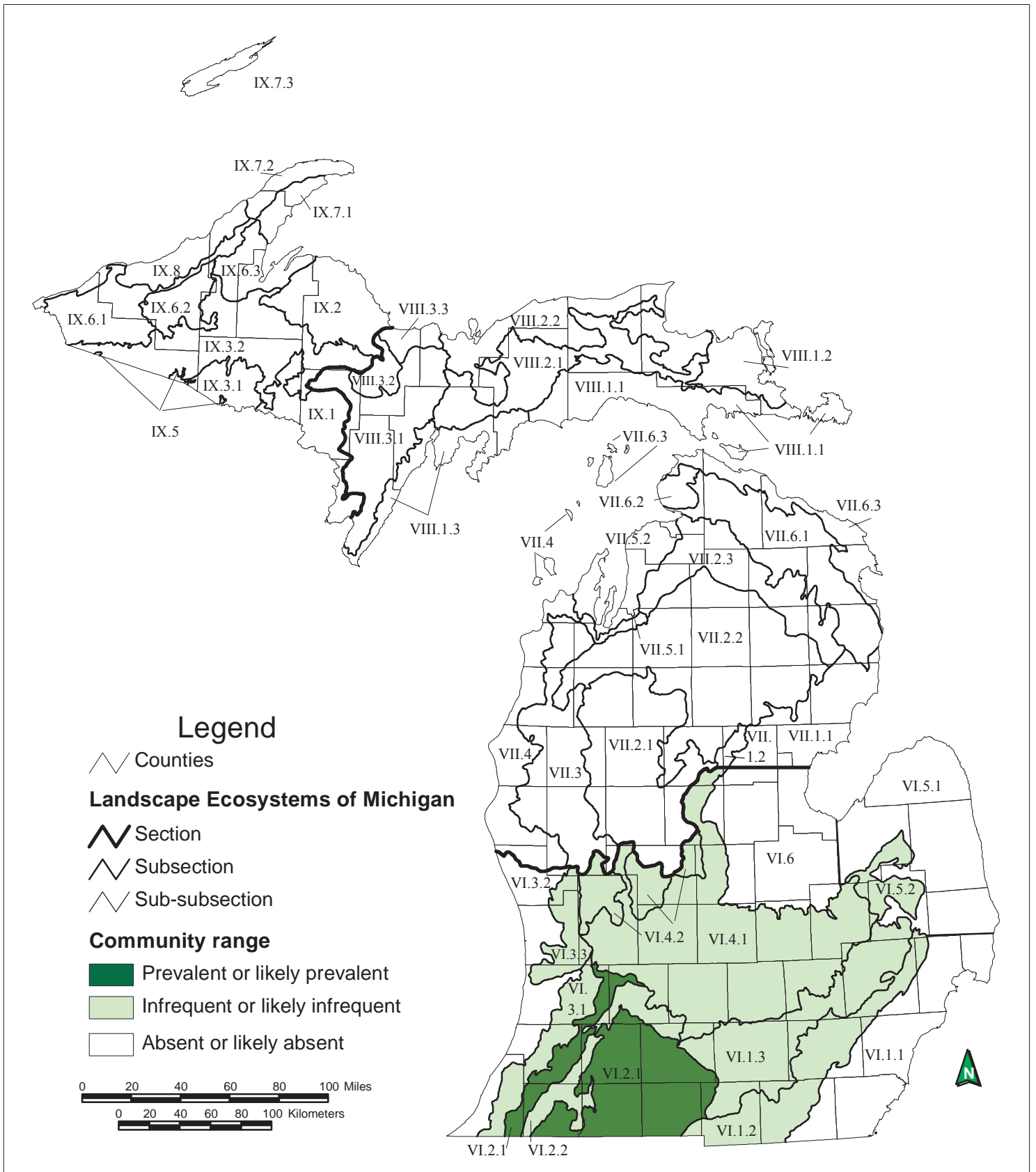


## Dry Southern Forest

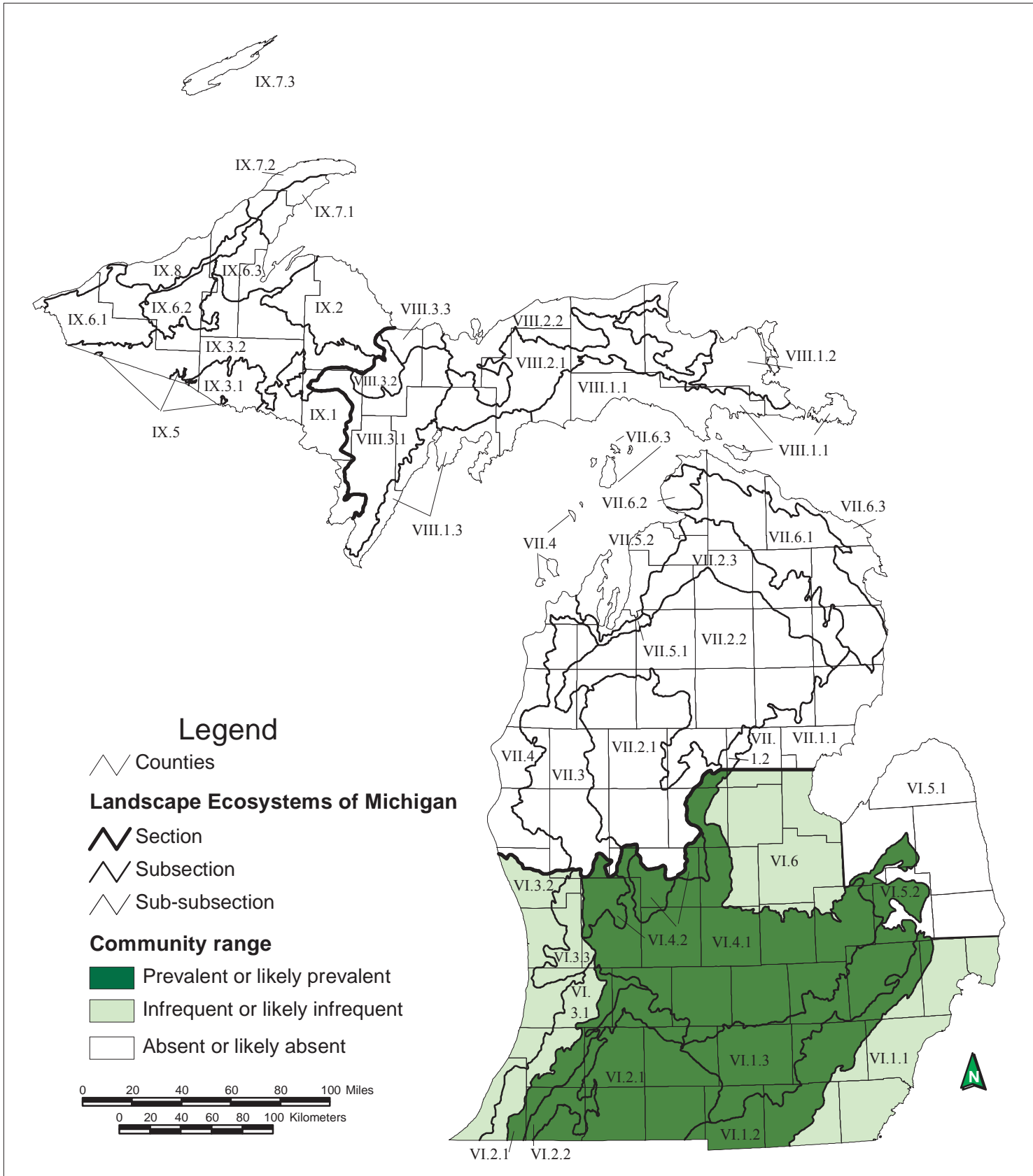


## Dry-mesic Northern Forest

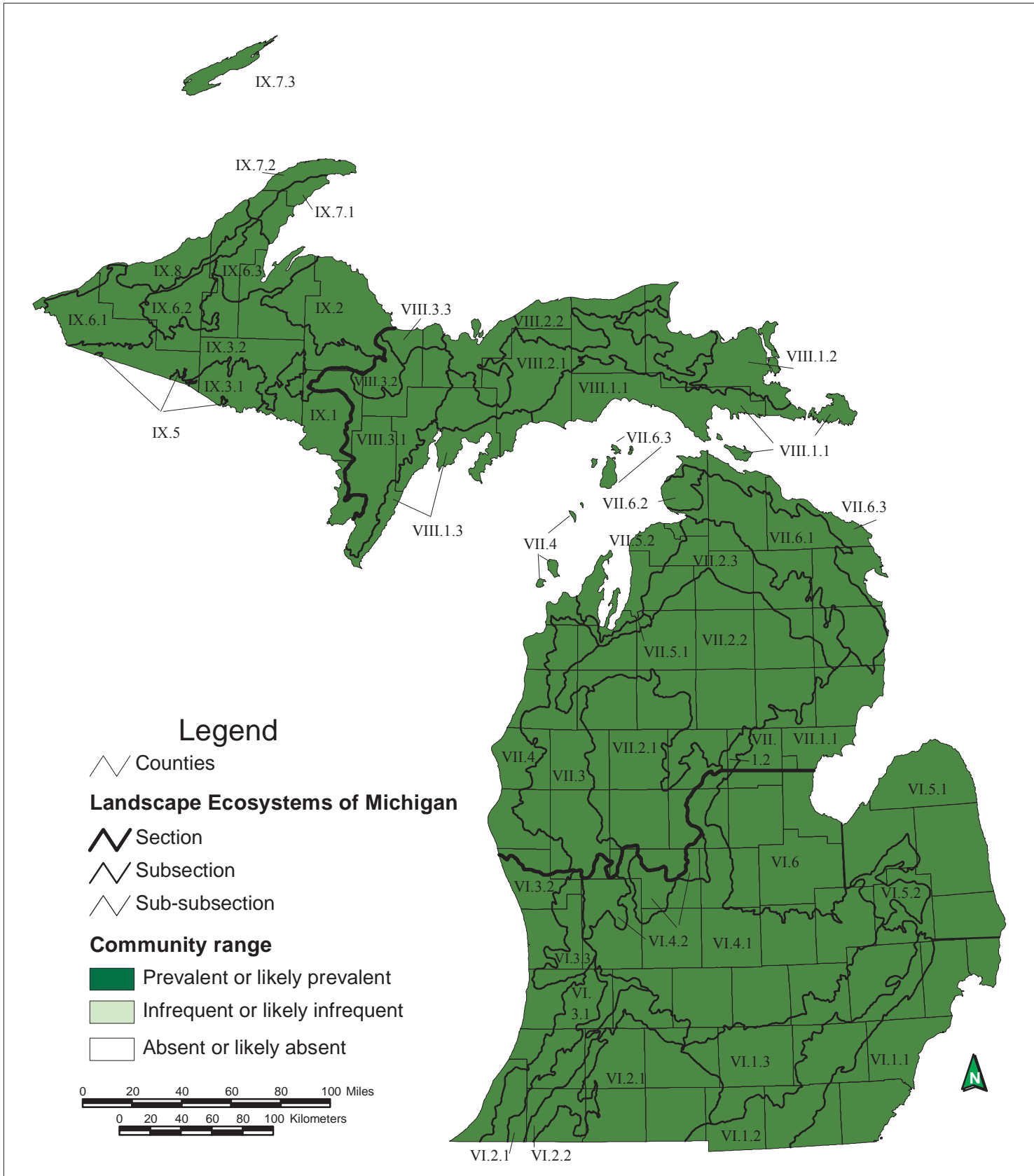




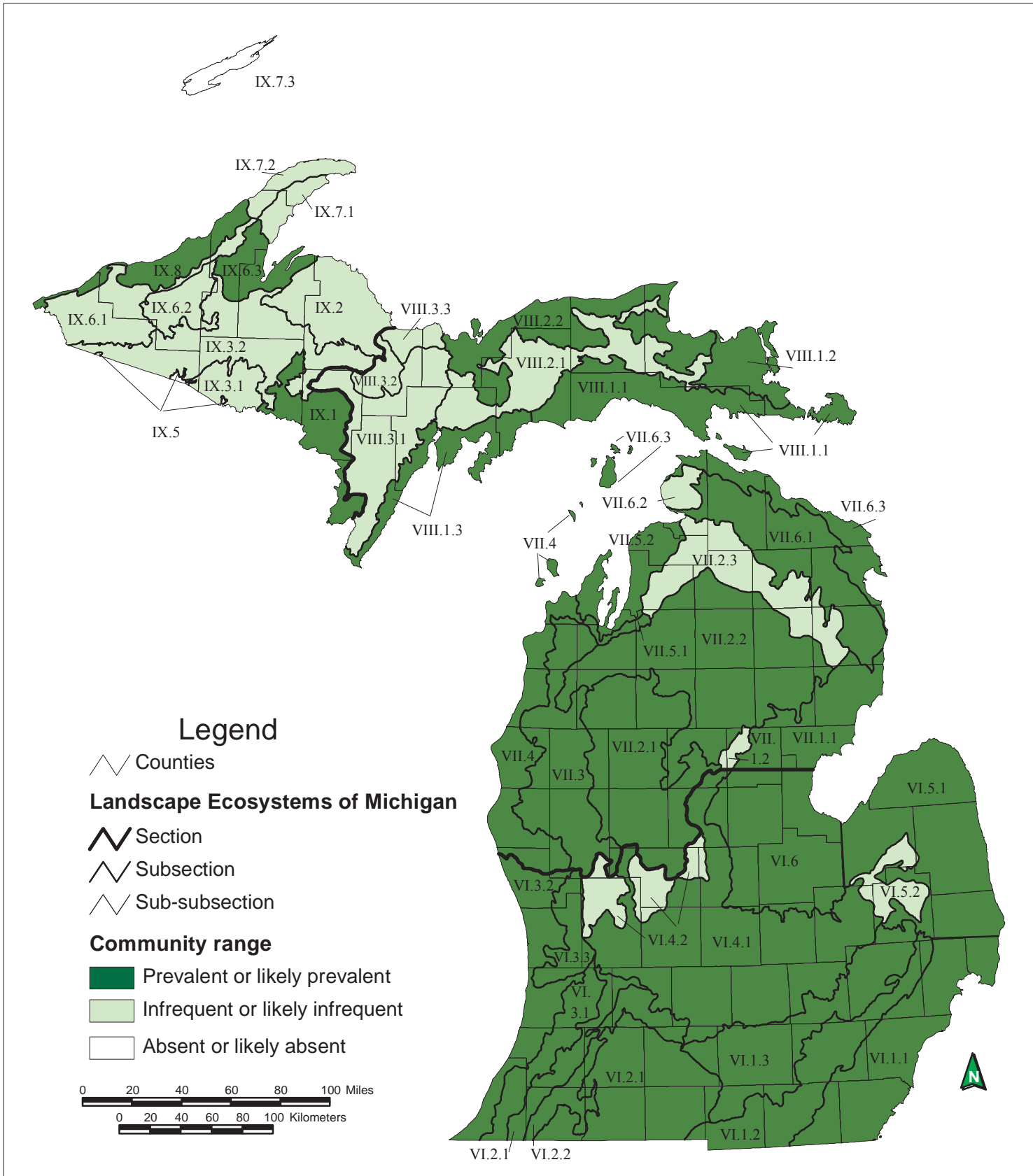
## Dry-mesic Prairie



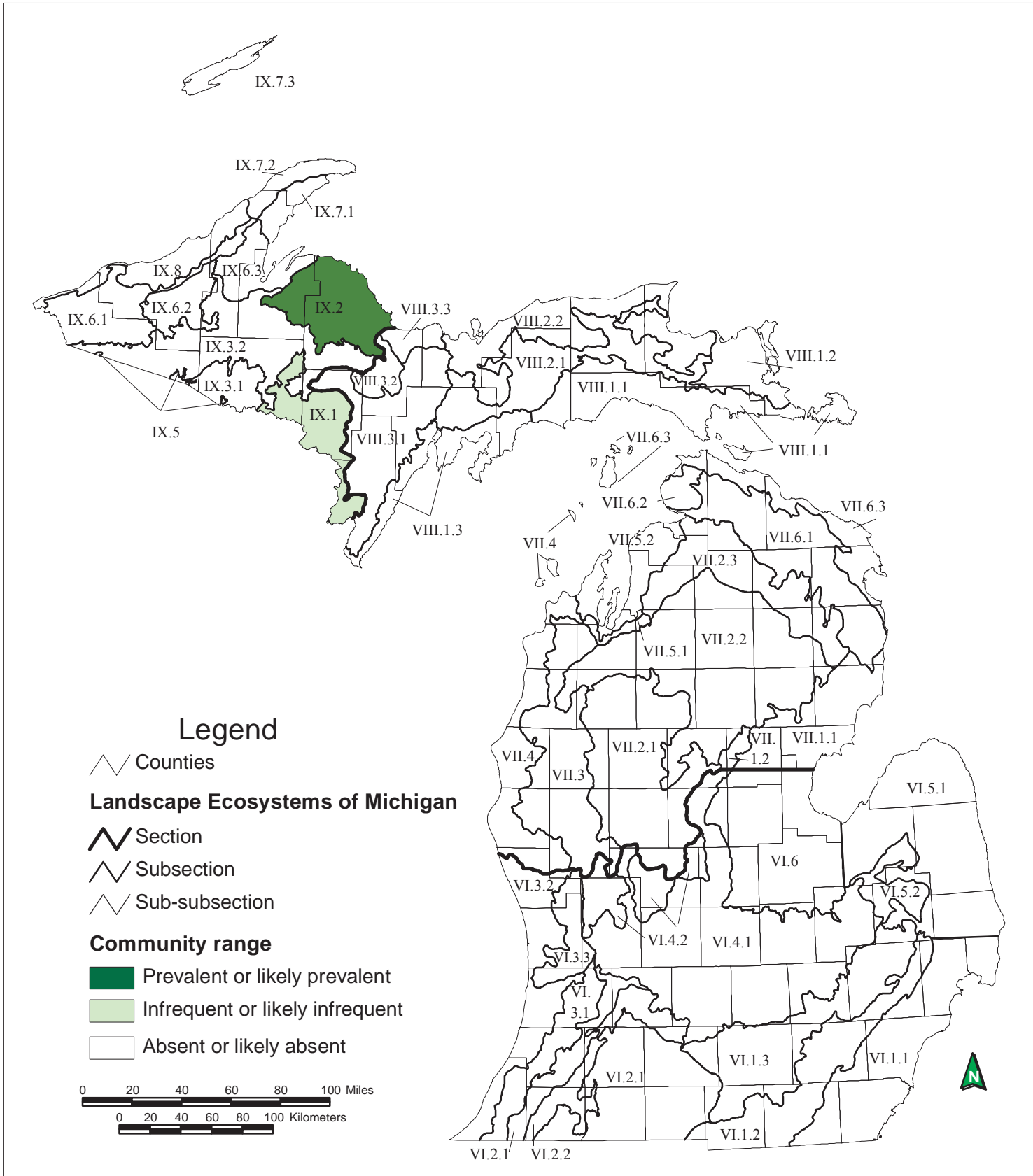
## Dry-mesic Southern Forest



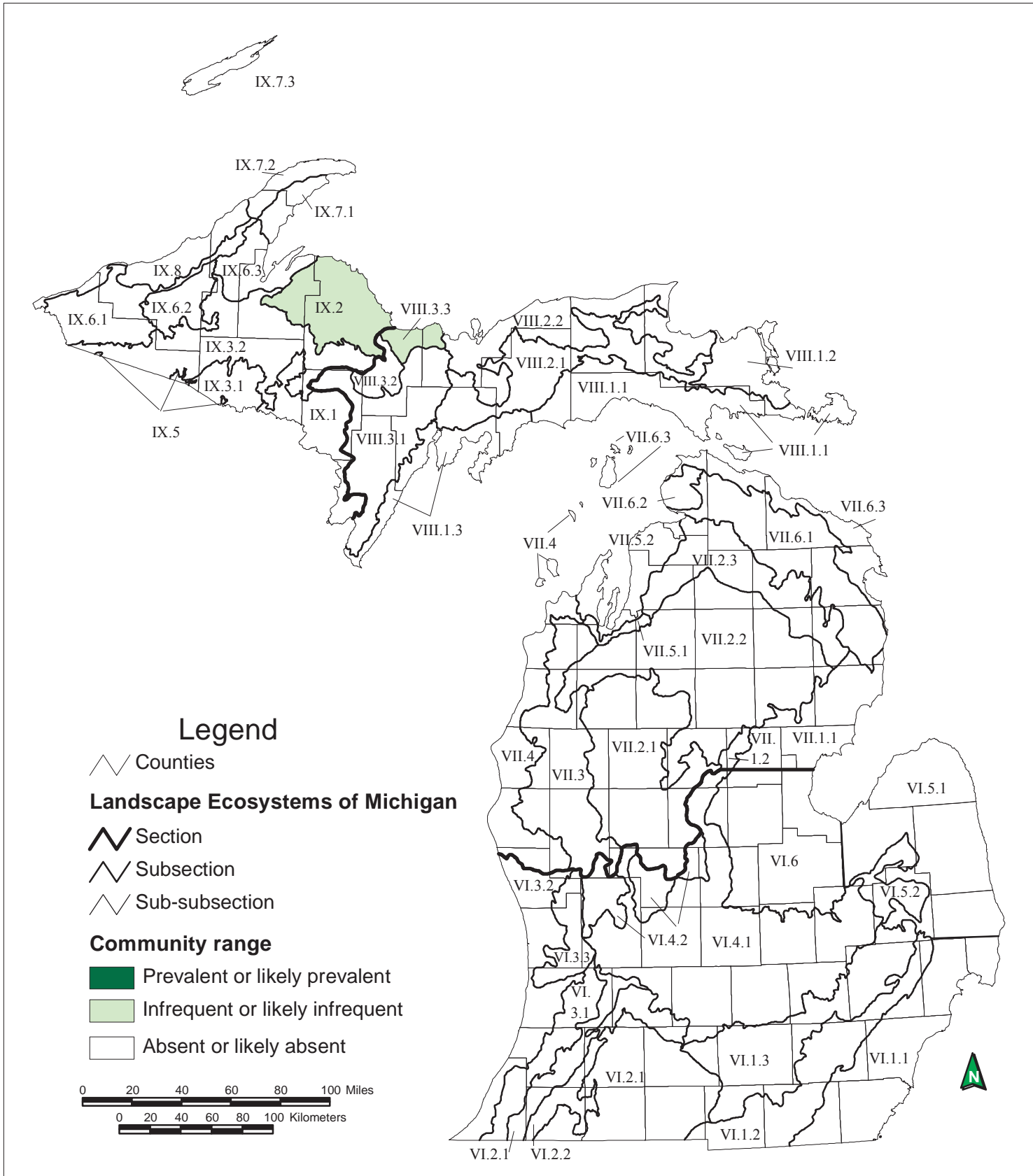
## Emergent Marsh



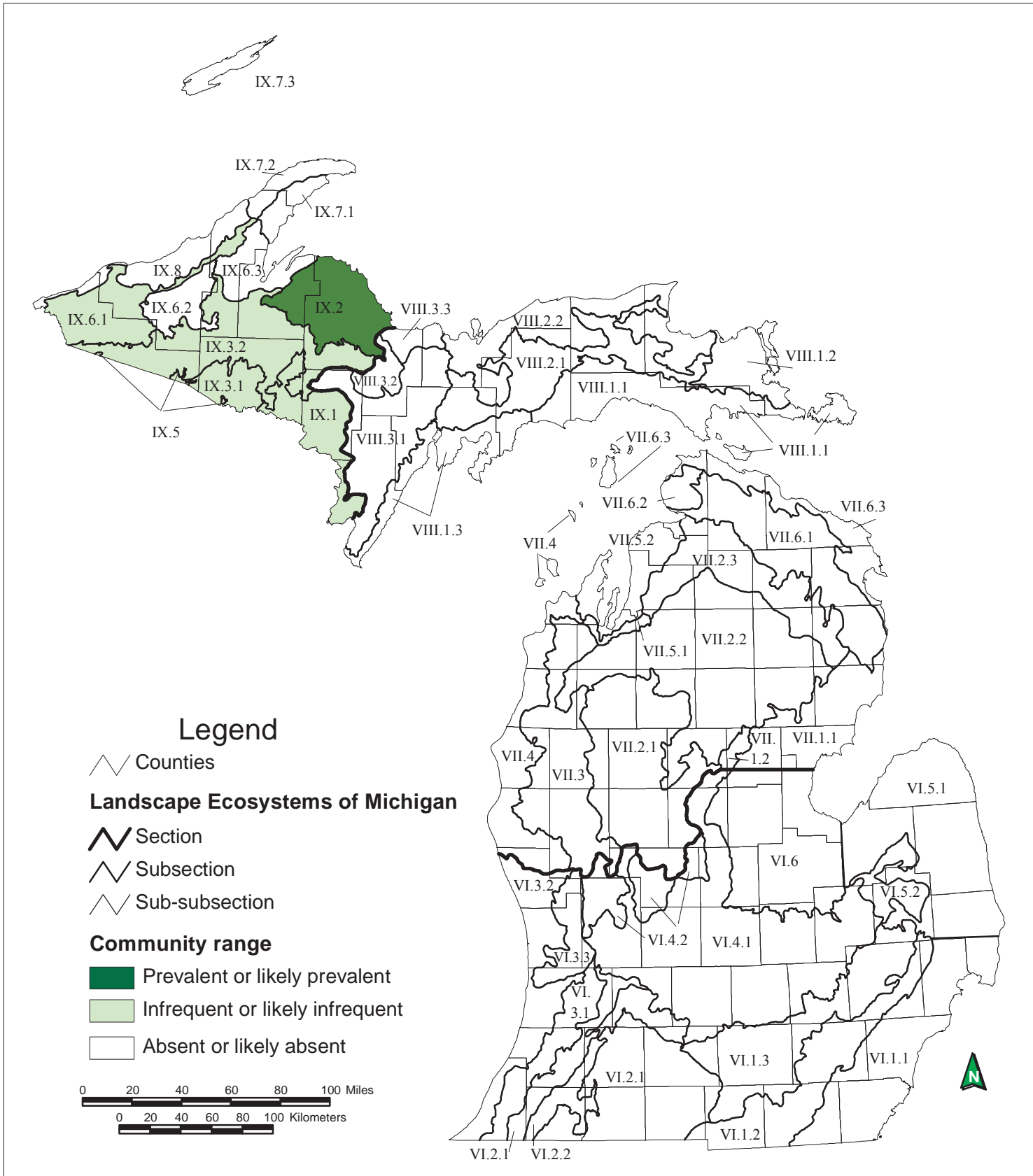
## Floodplain Forest



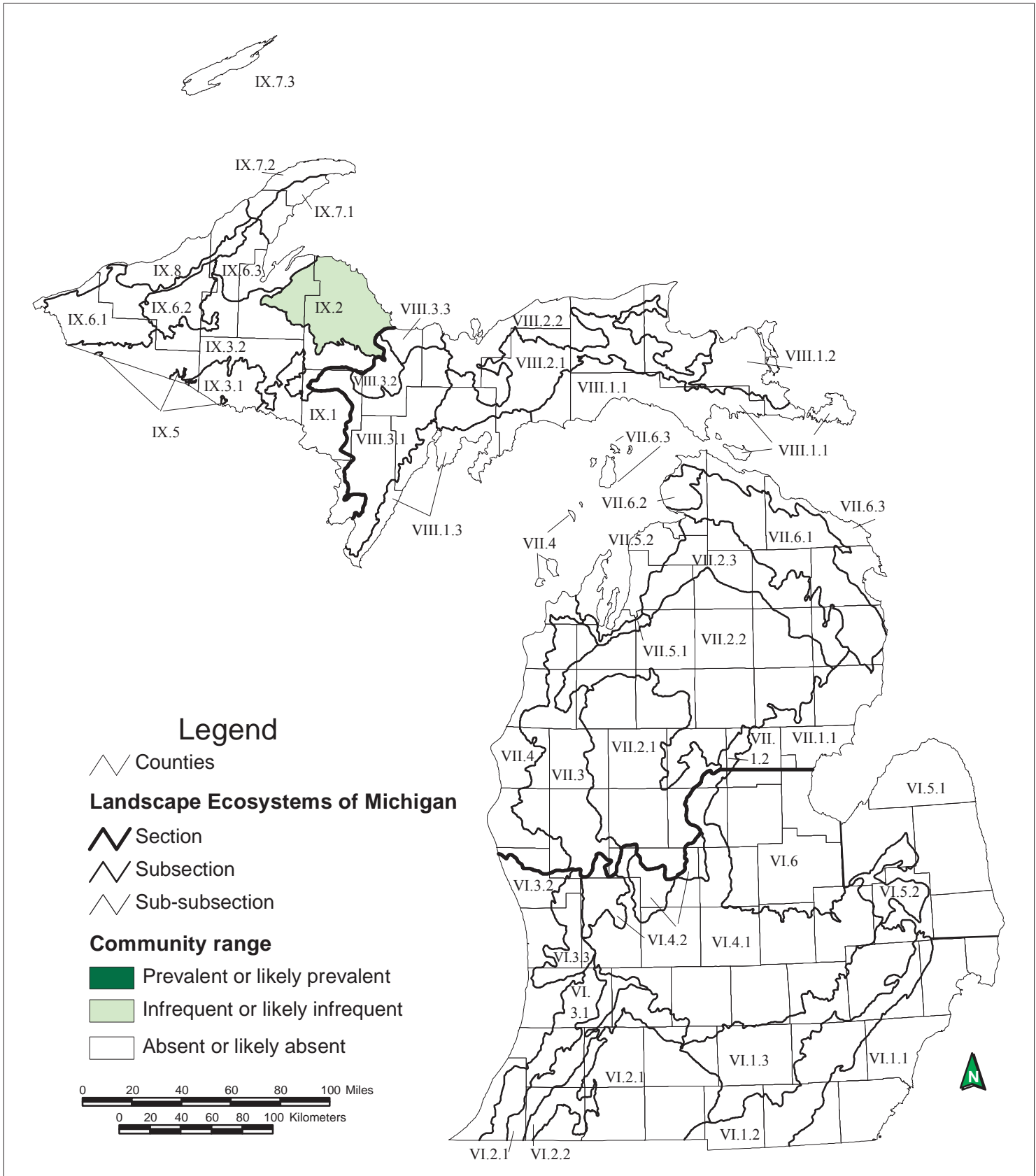
## Granite Bedrock Glade



## Granite Bedrock Lakeshore

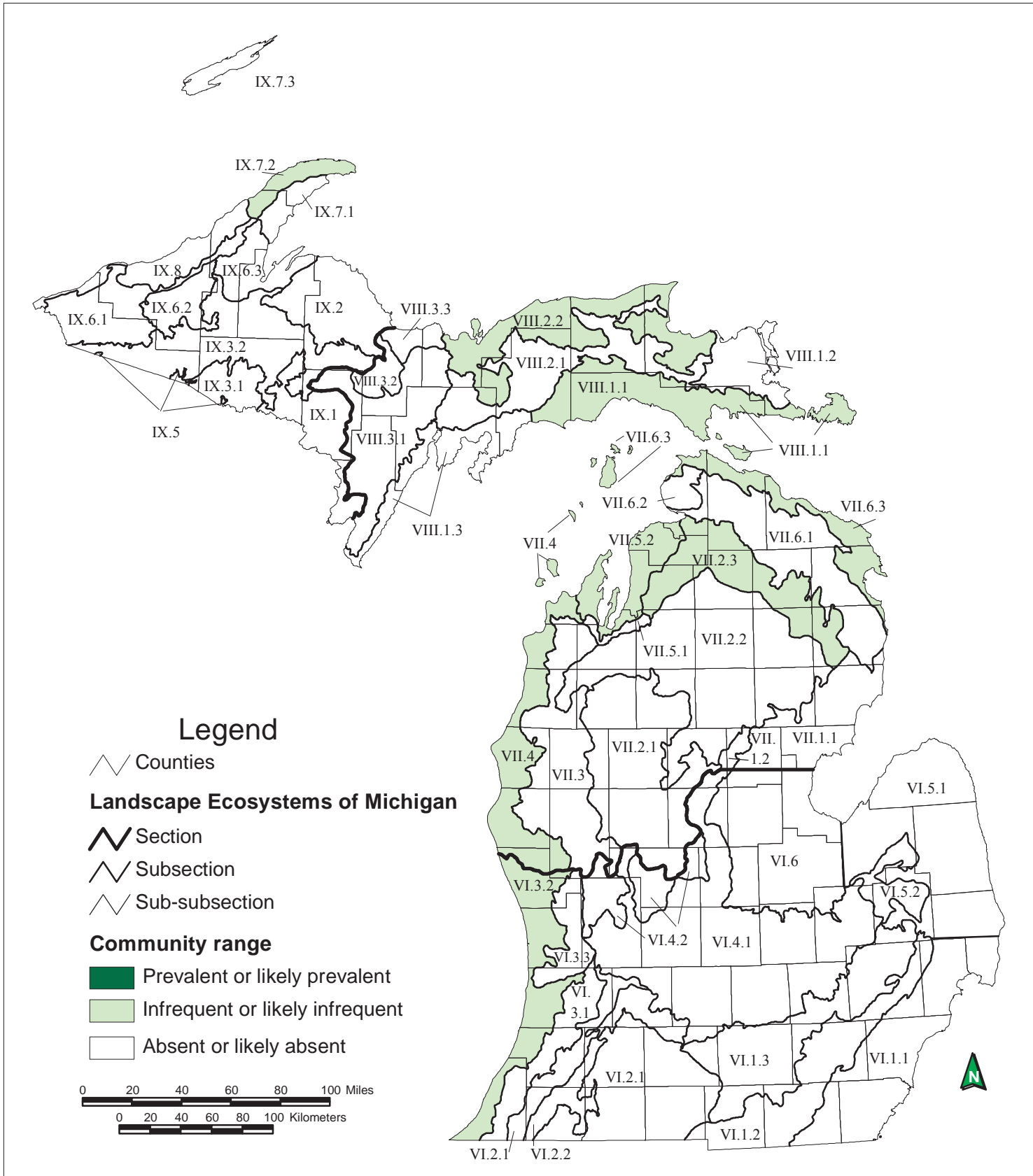


## Granite Cliff

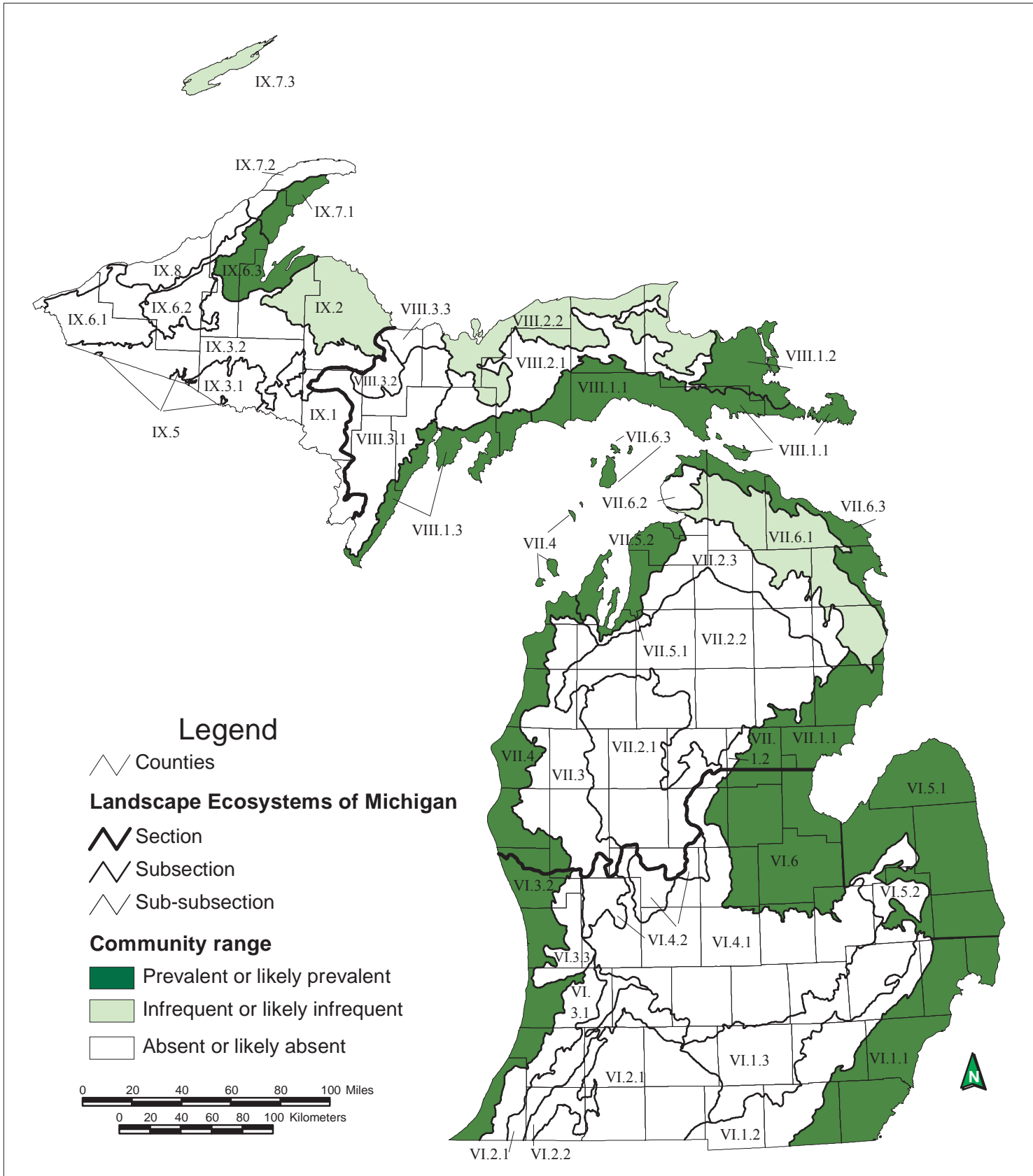


## Granite Lakeshore Cliff

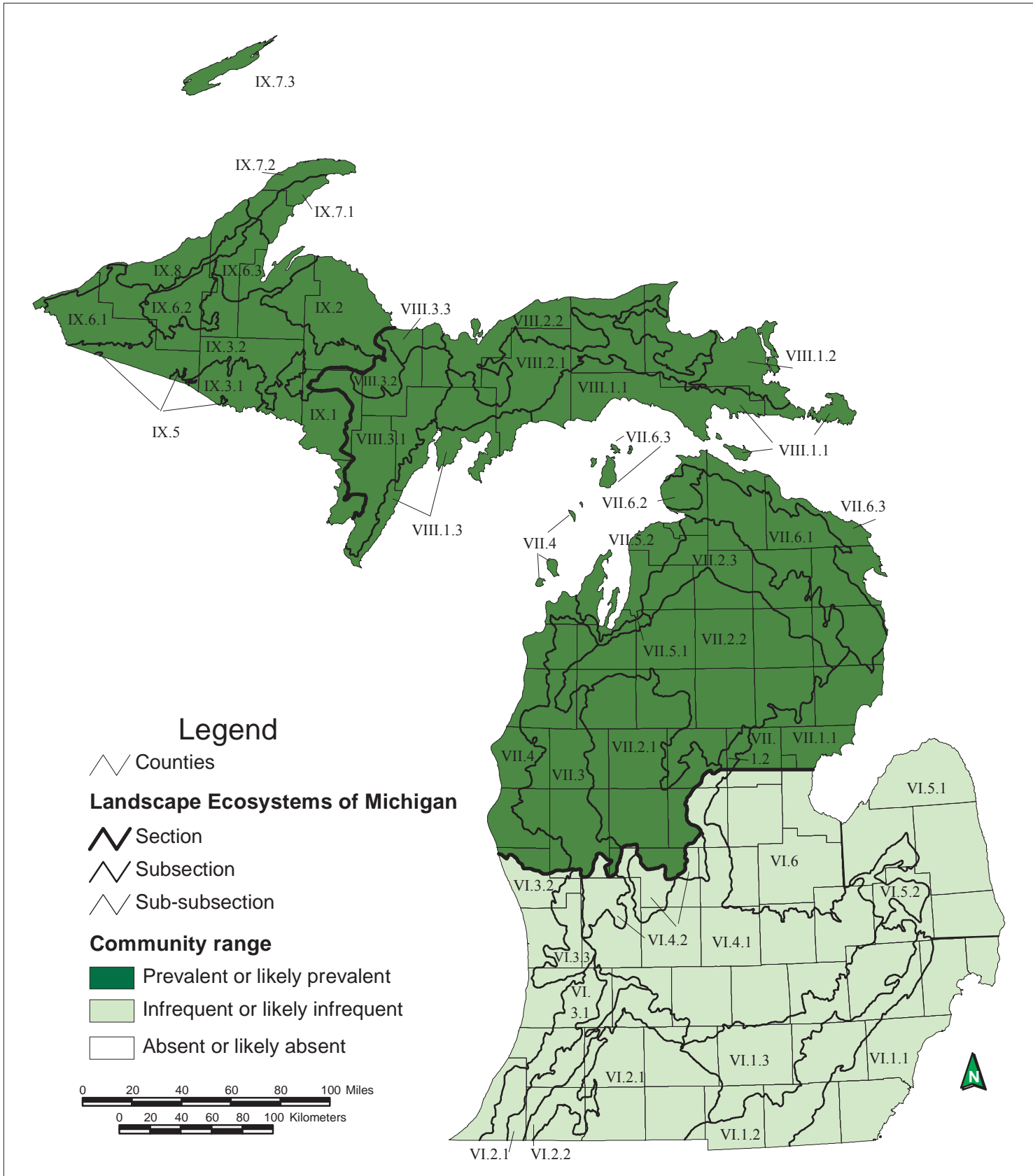




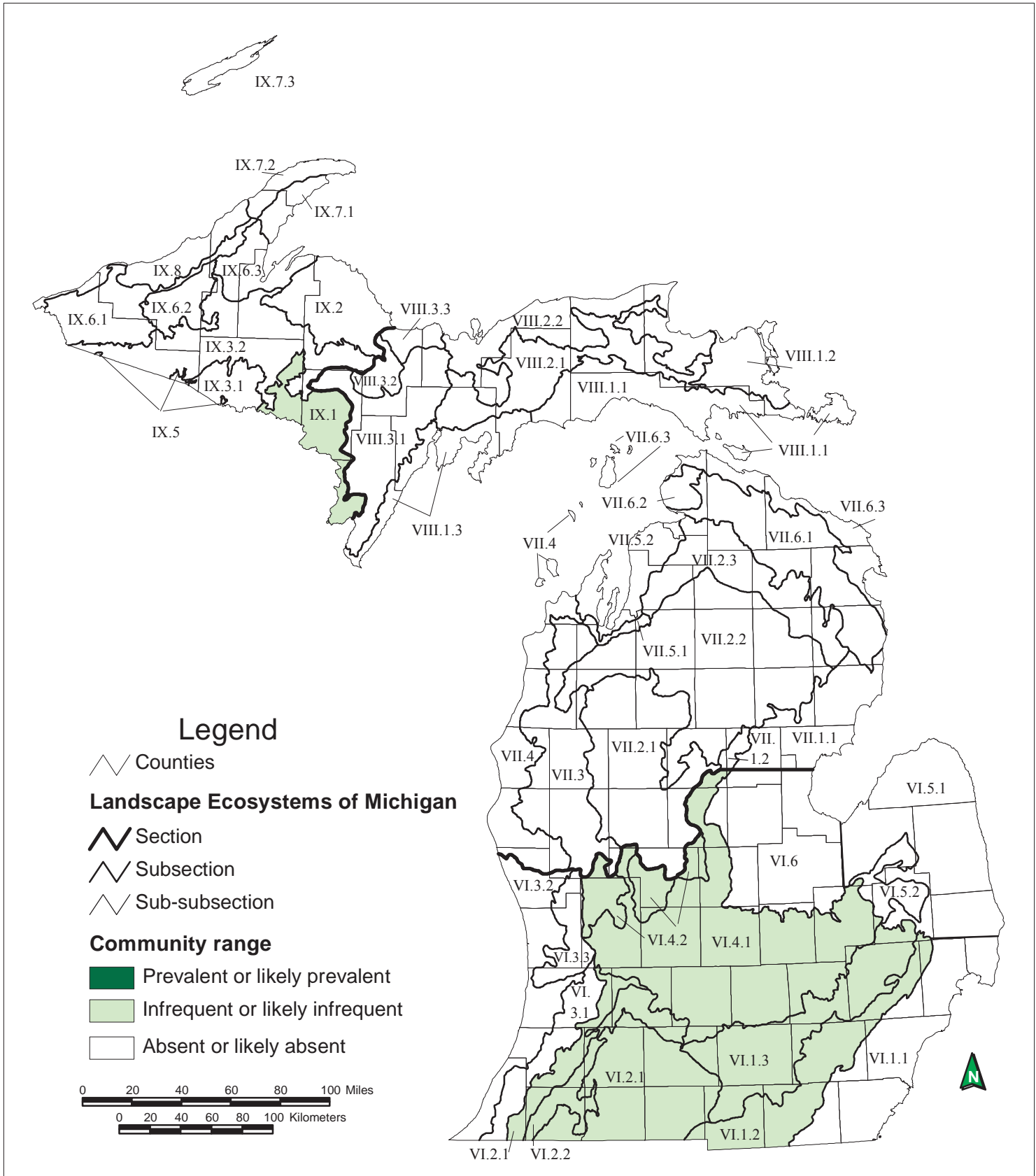
## Great Lakes Barrens



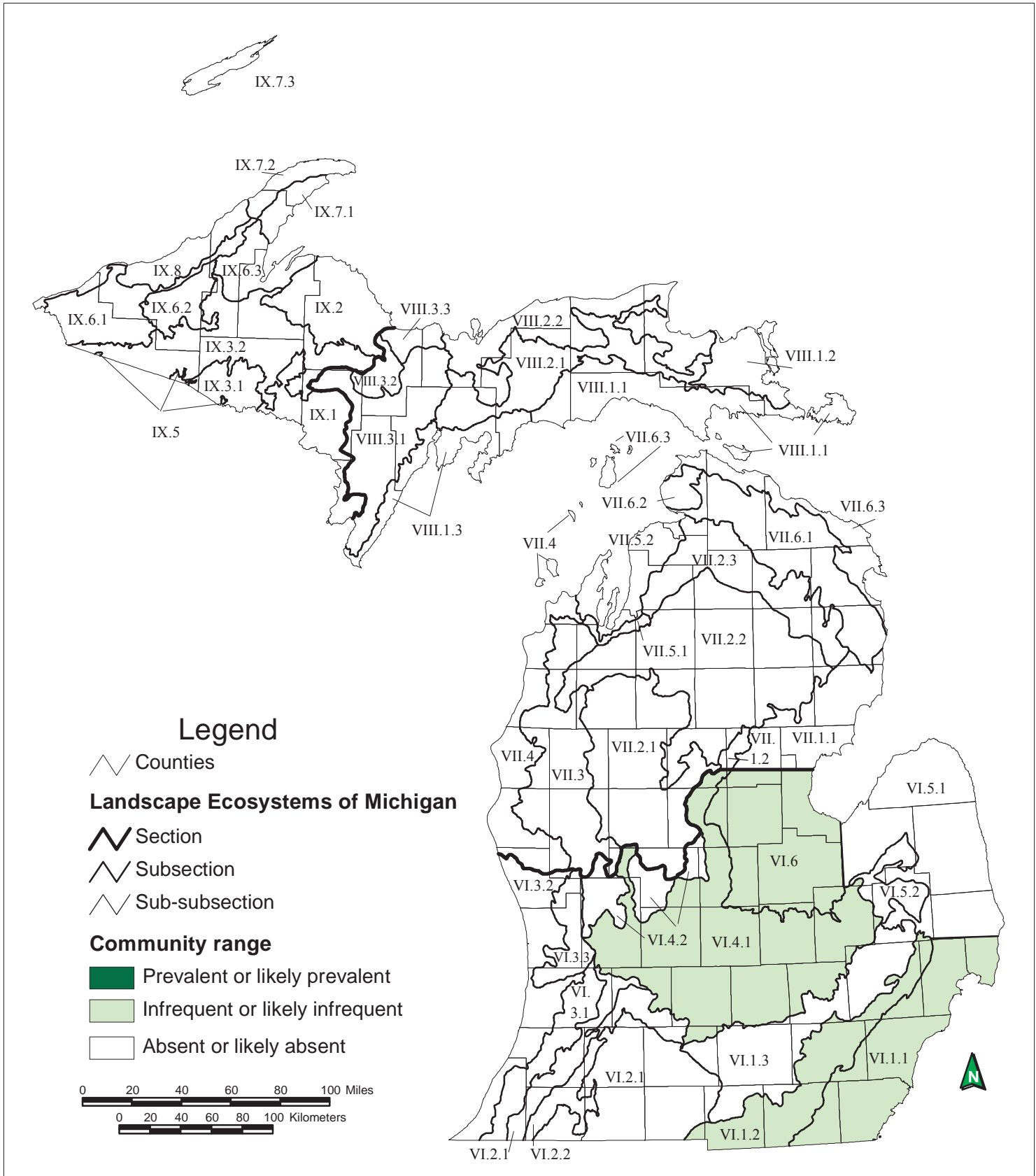
## Great Lakes Marsh



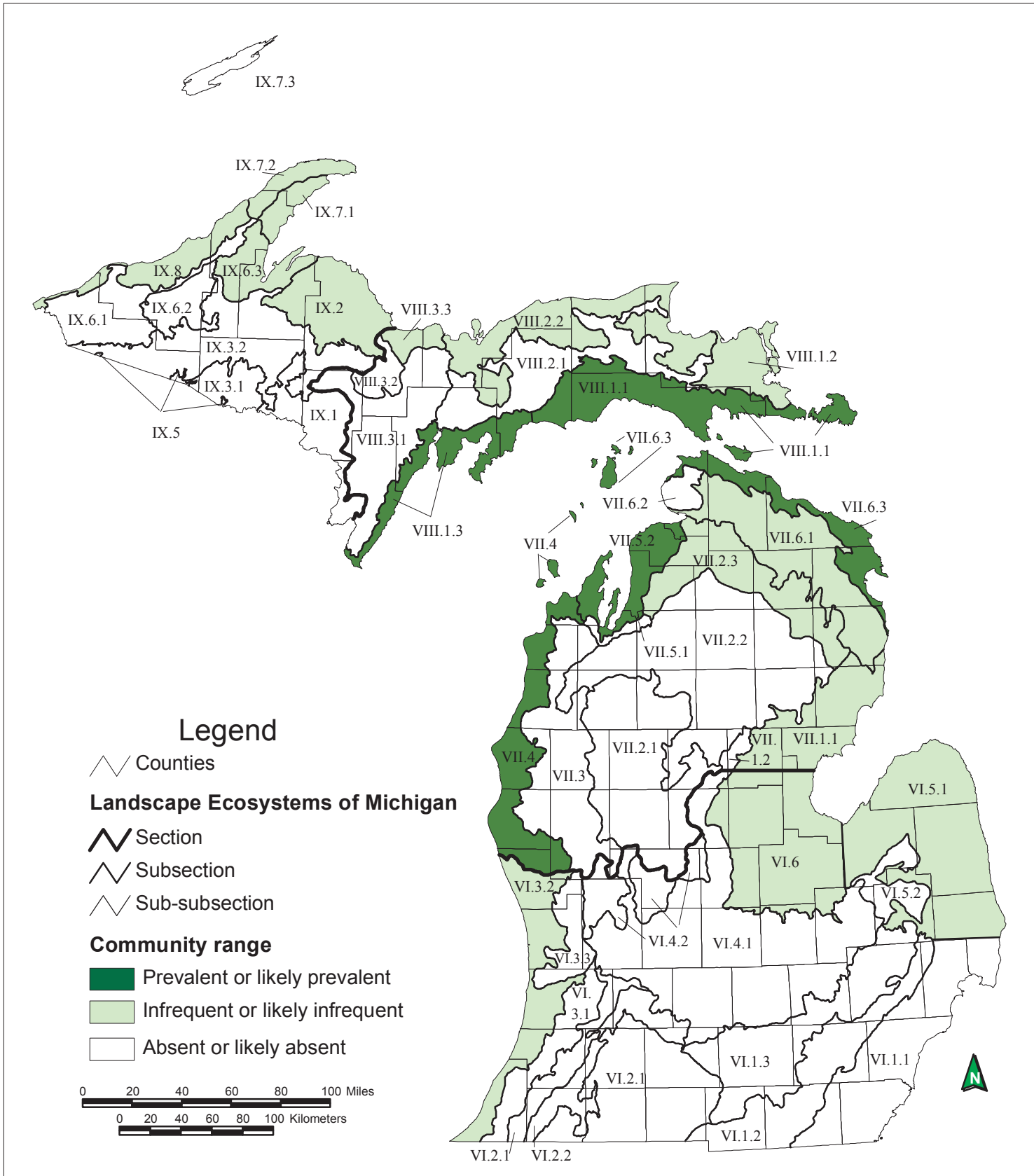
## Hardwood-conifer Swamp



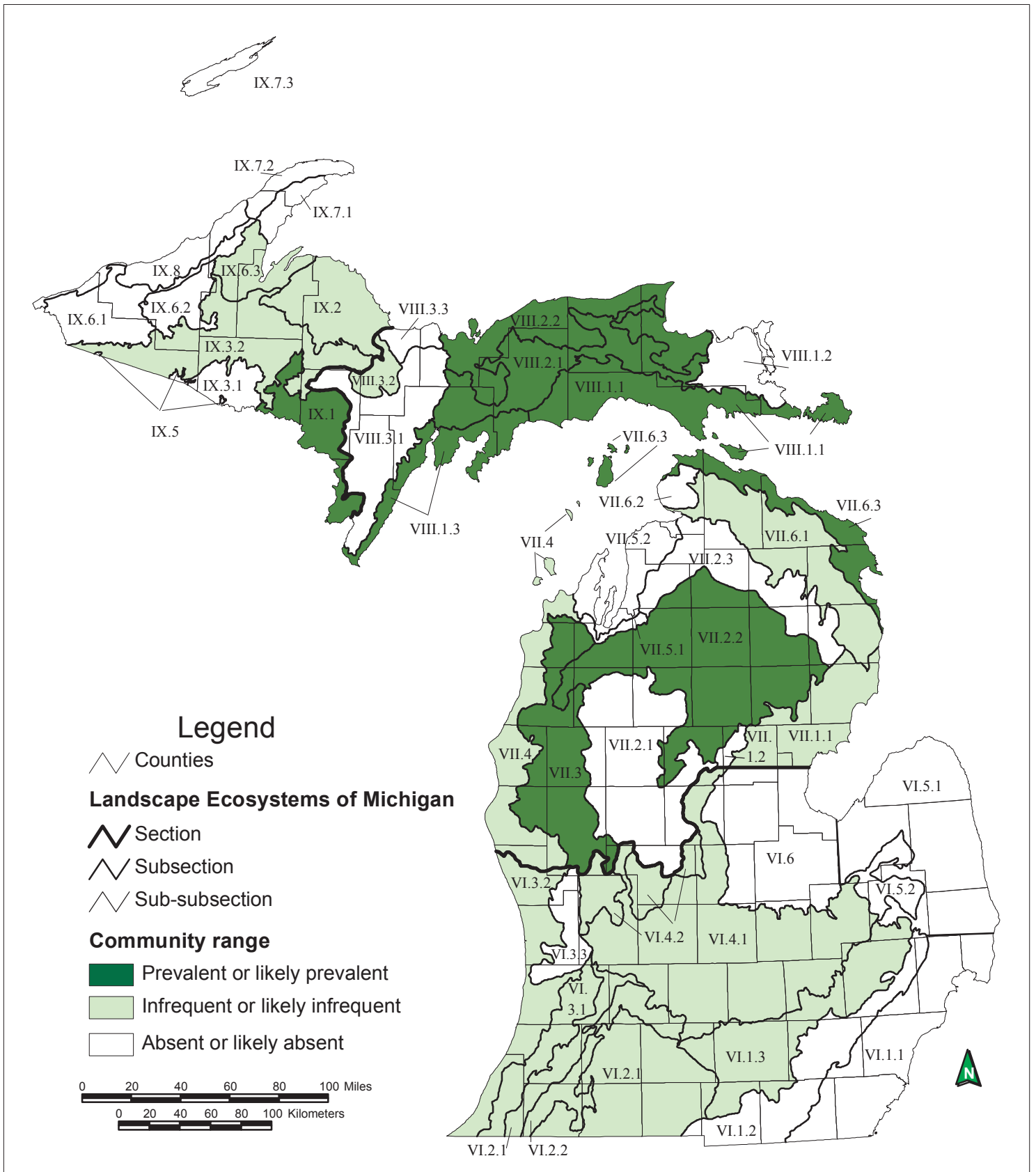
## Hillside Prairie



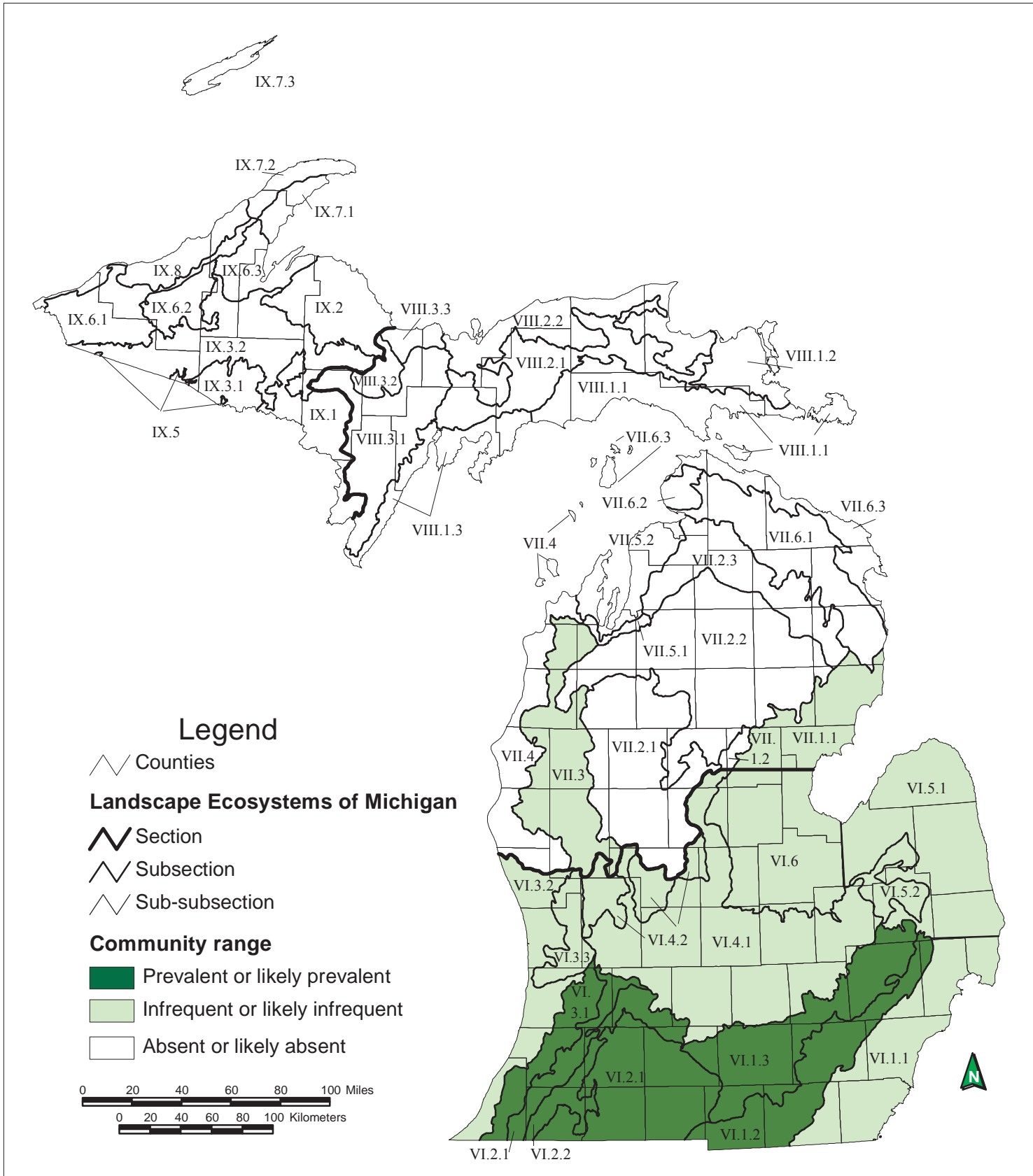
## Inland Salt Marsh



## Interdunal Wetland

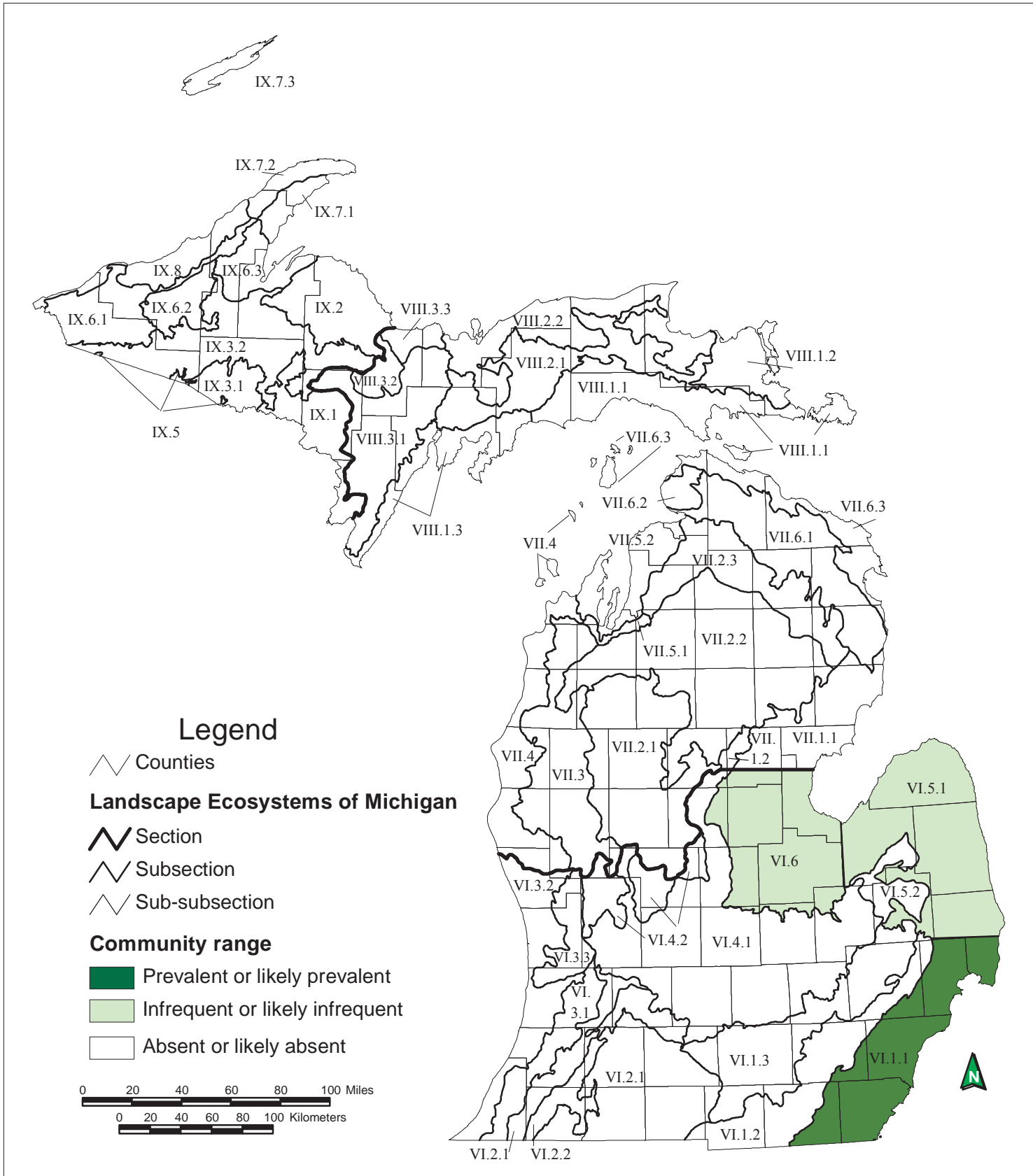


## Intermittent Wetland

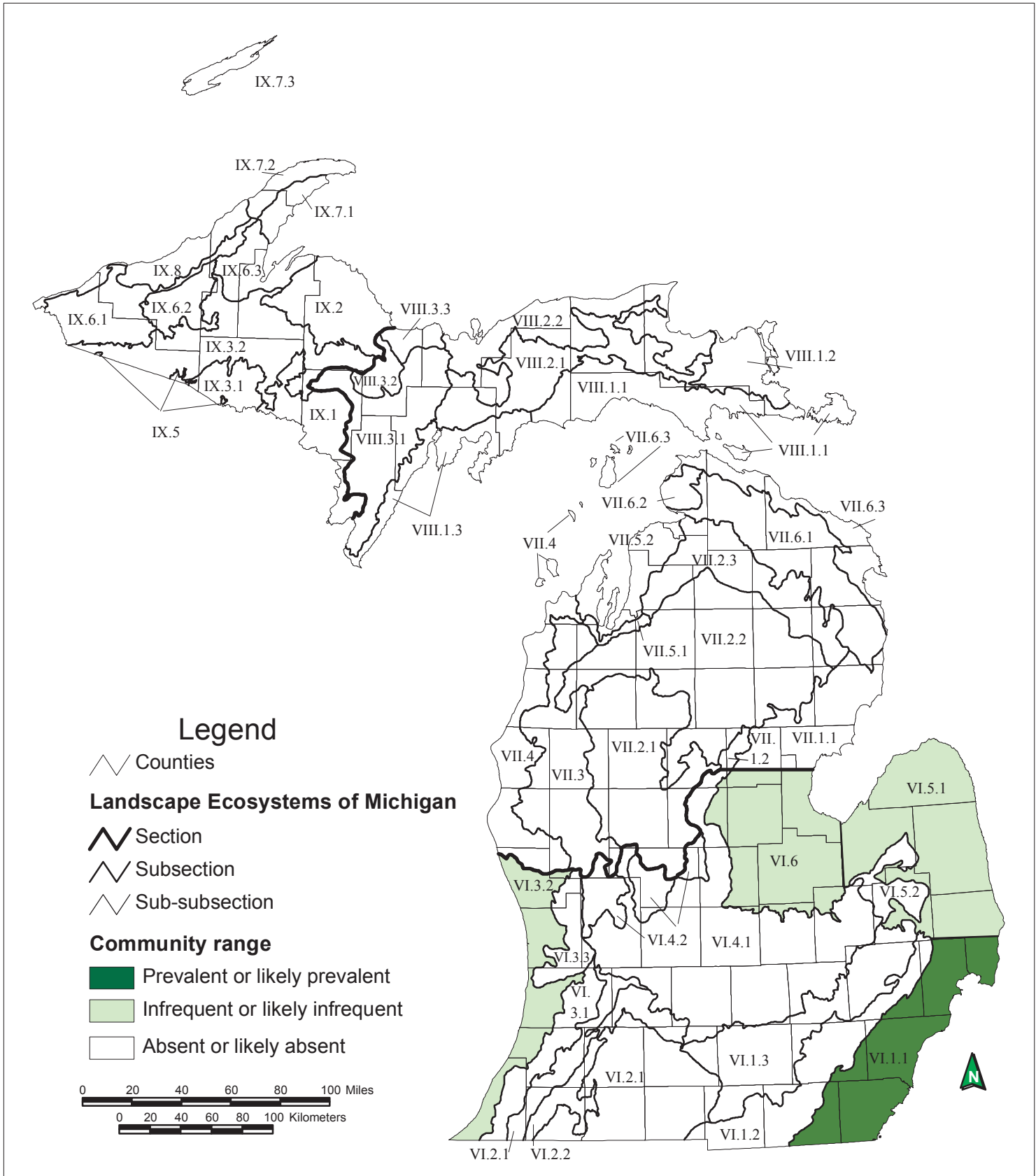


## Inundated Shrub Swamp

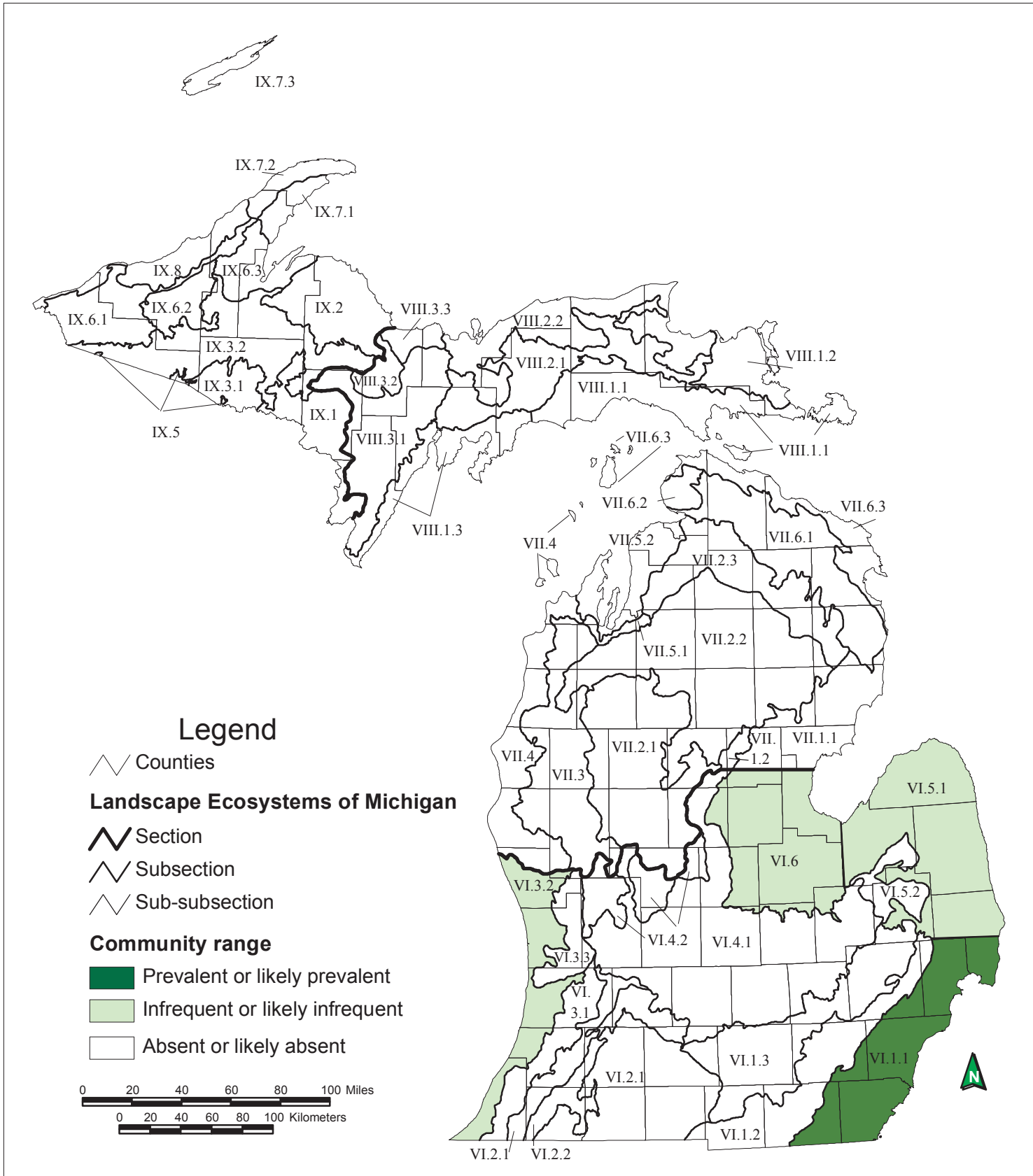




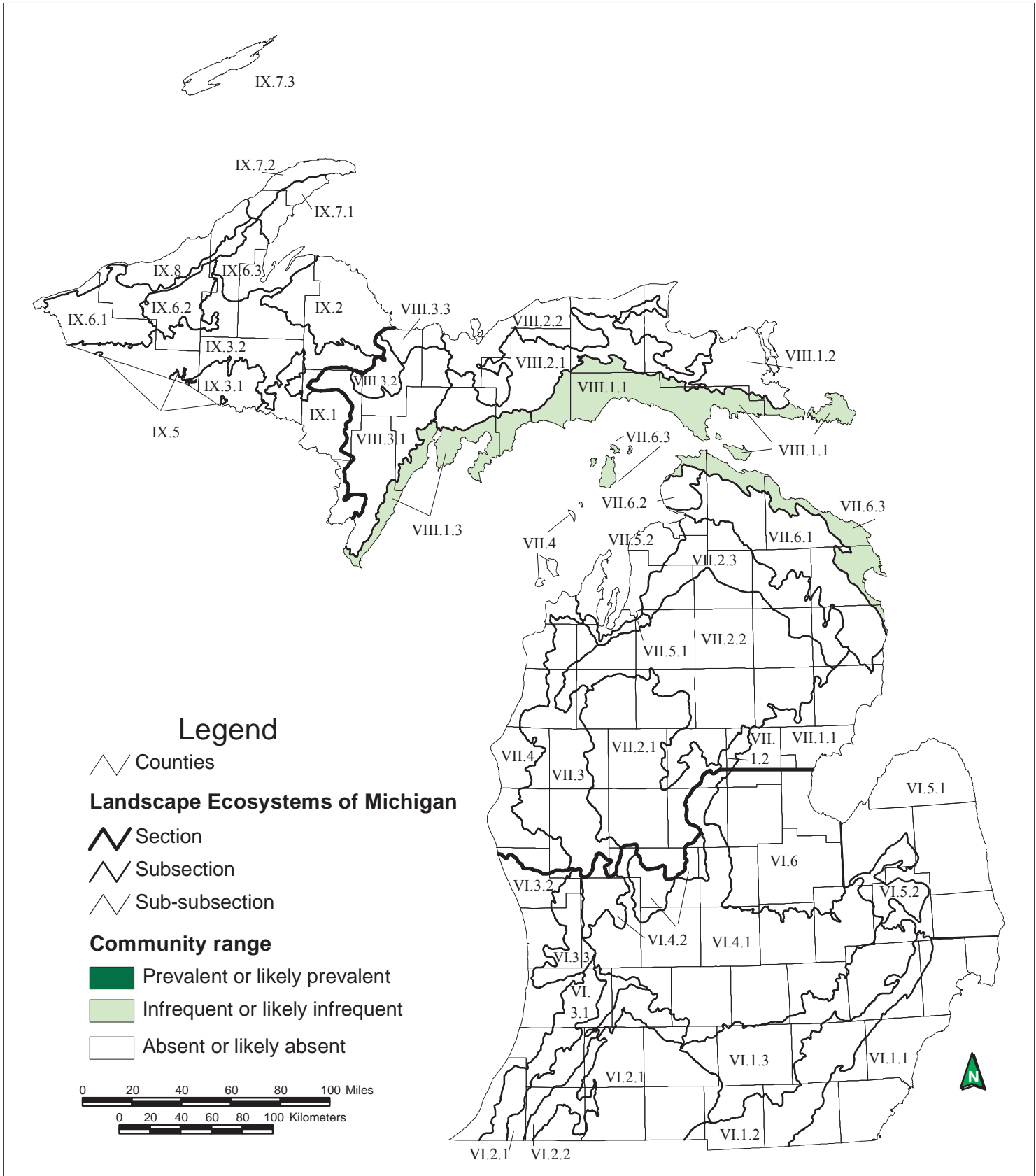
## Lakeplain Oak Openings



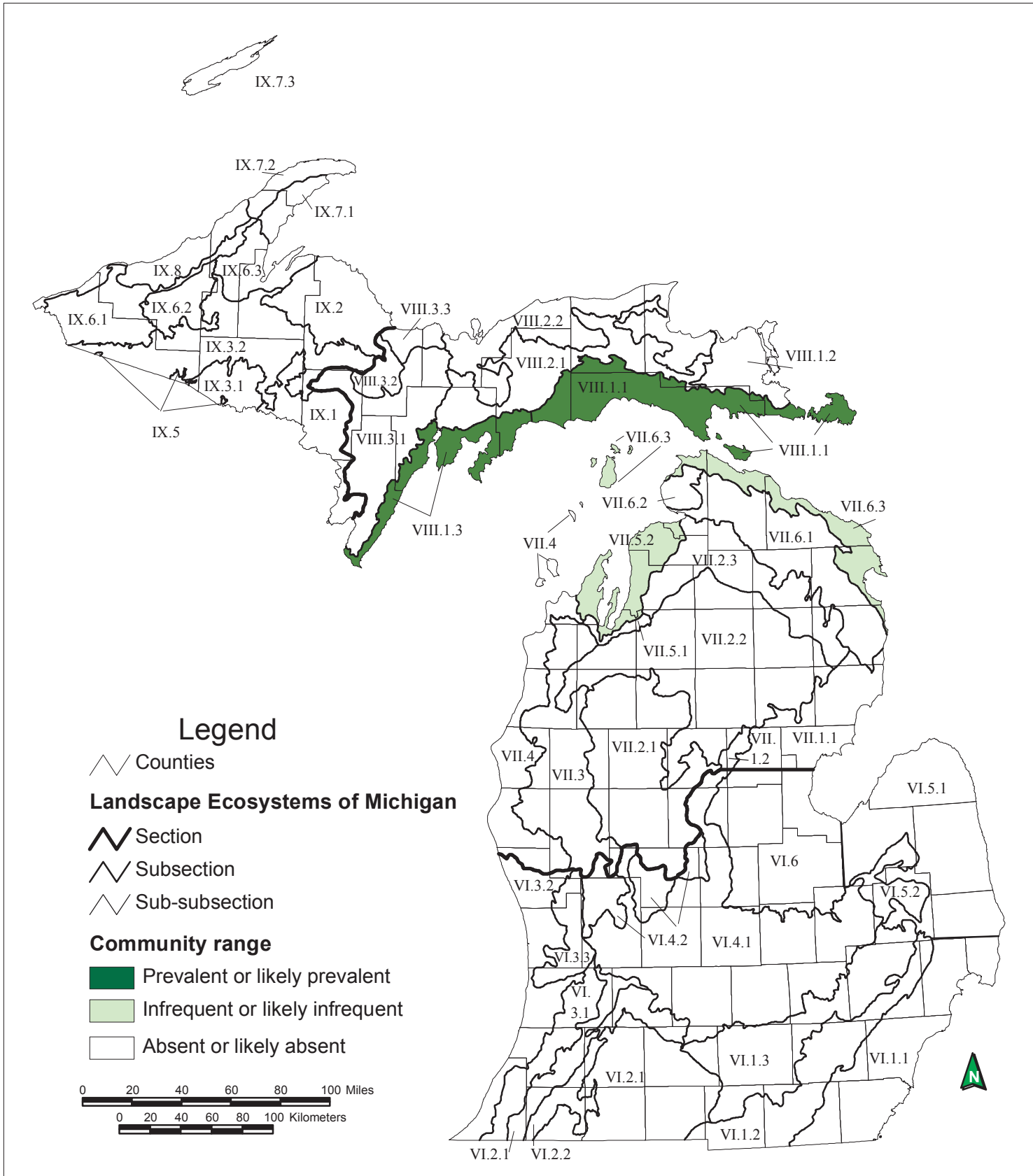
## Lakeplain Wet Prairie



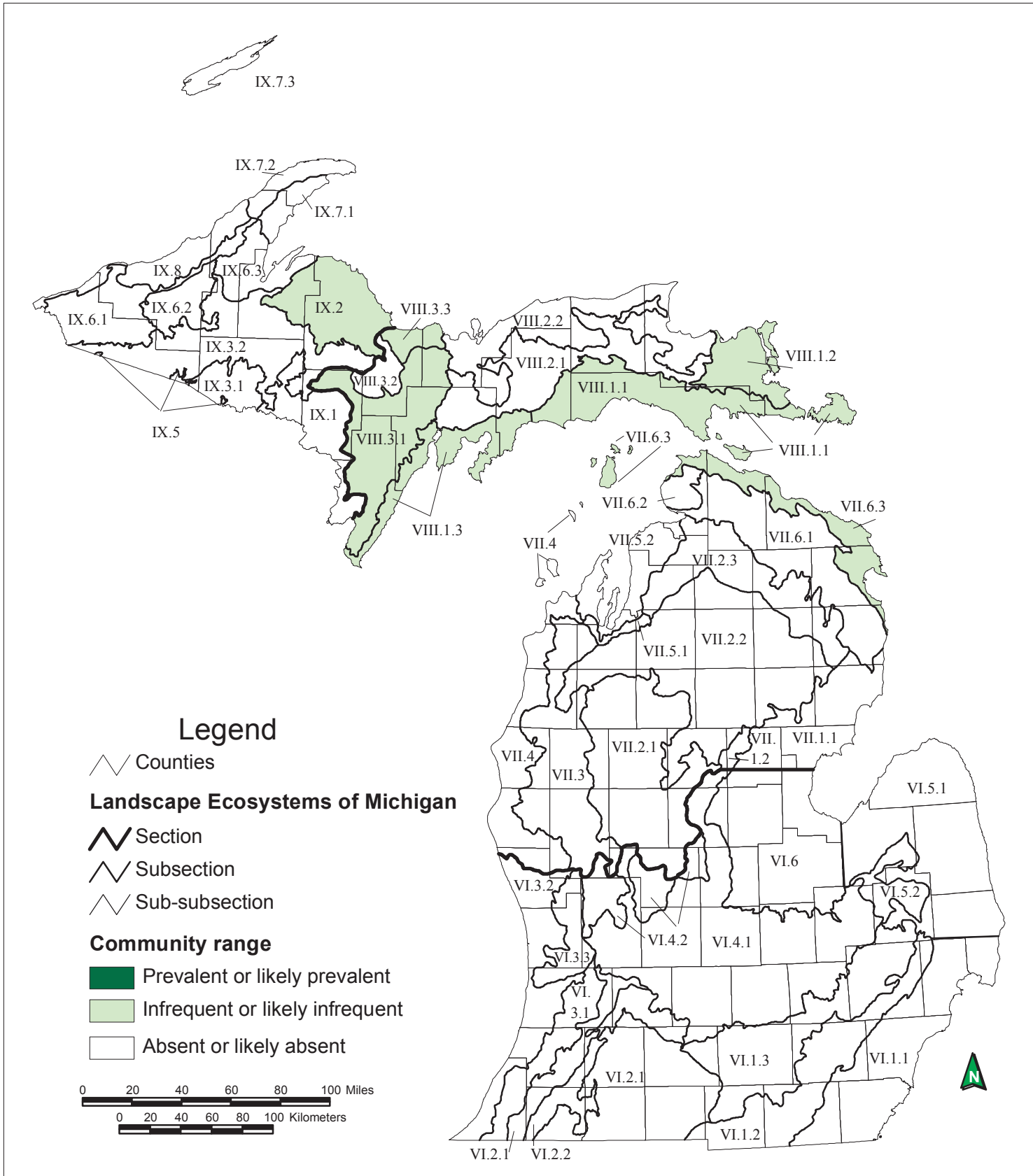
## Lakeplain Wet-mesic Prairie



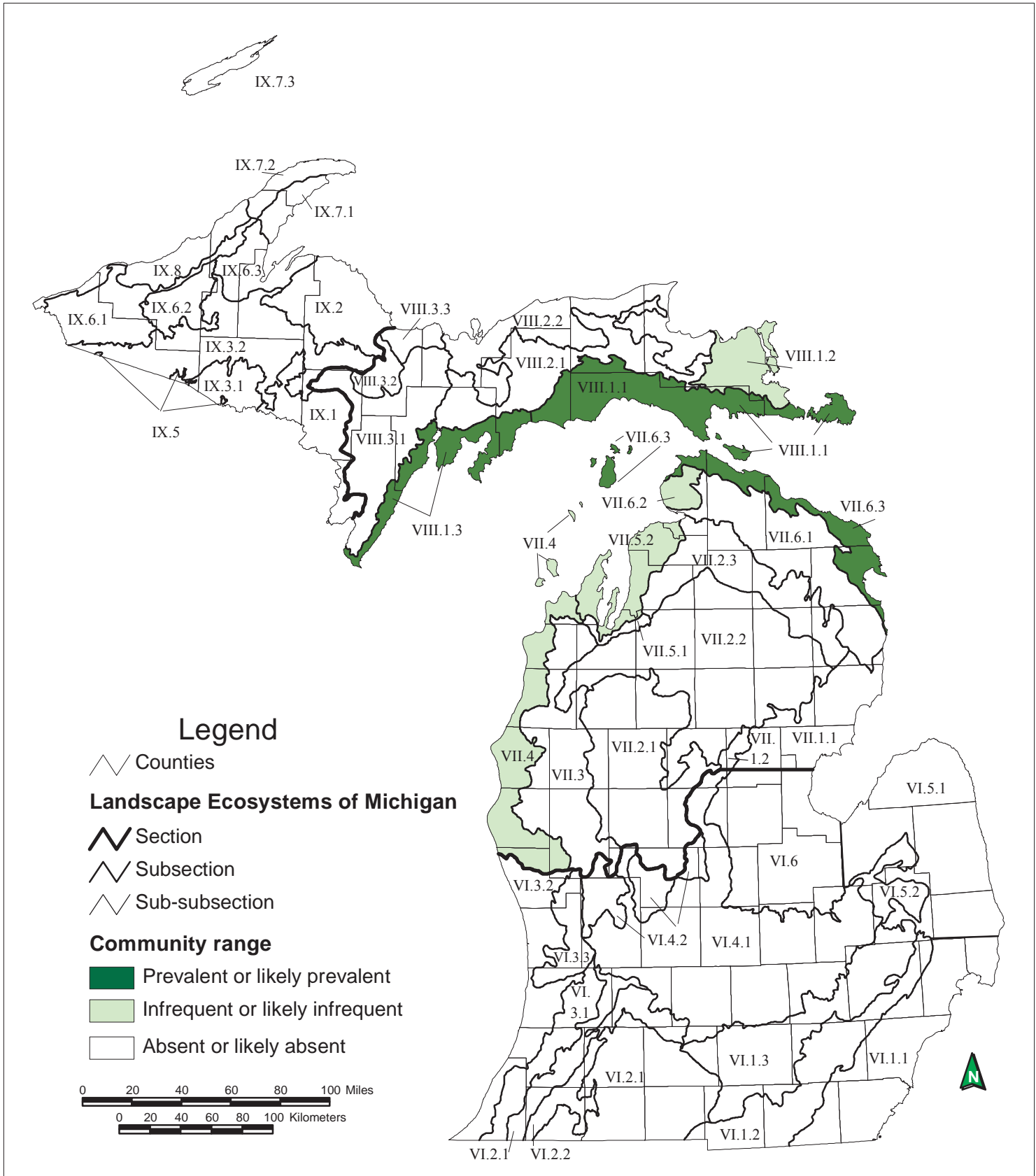
## Limestone Bedrock Glade



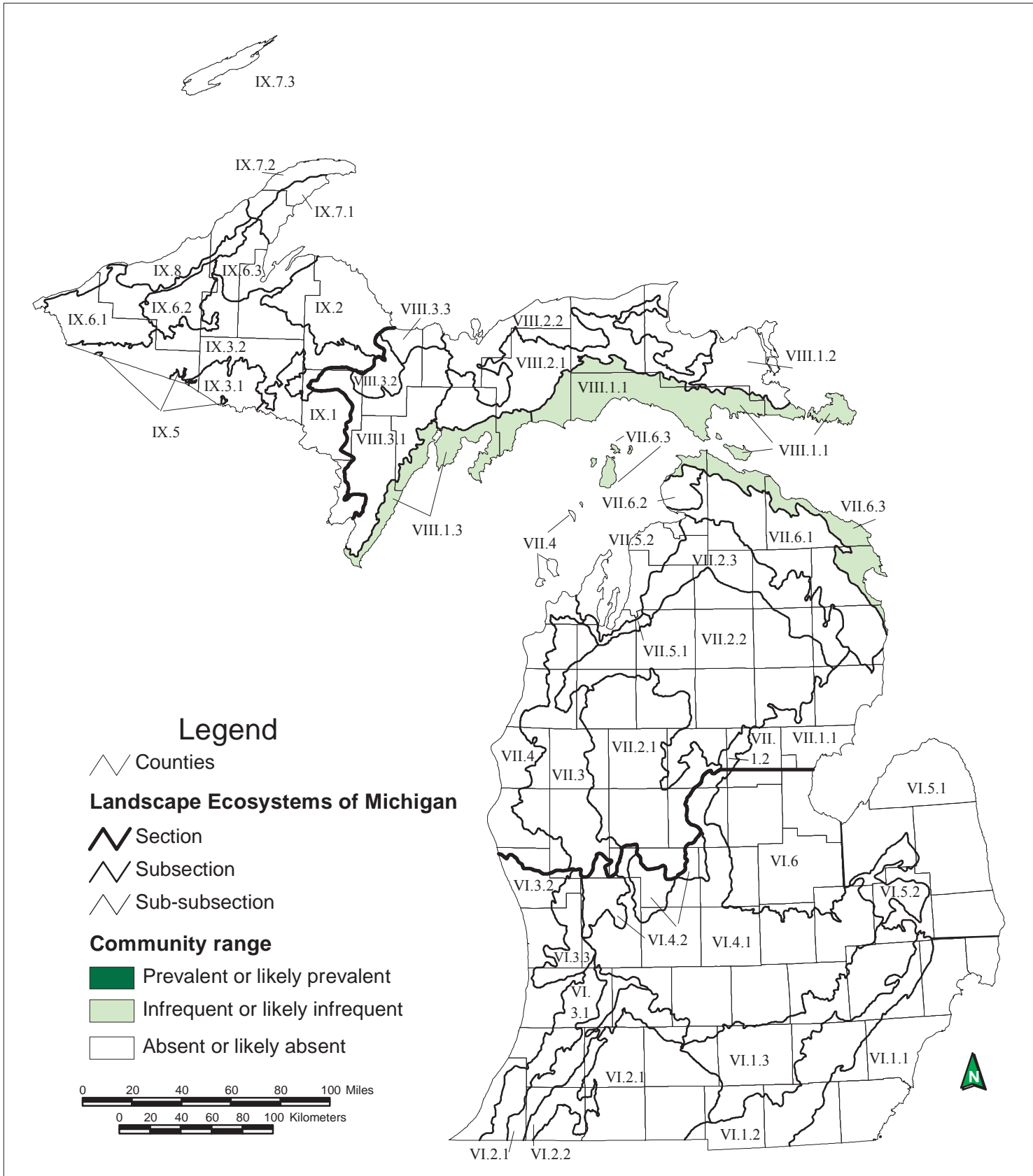
## Limestone Bedrock Lakeshore



## Limestone Cliff



## Limestone Cobble Shore



### Legend

Counties

### Landscape Ecosystems of Michigan

Section

Subsection

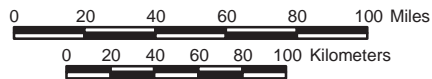
Sub-subsection

### Community range

Prevalent or likely prevalent

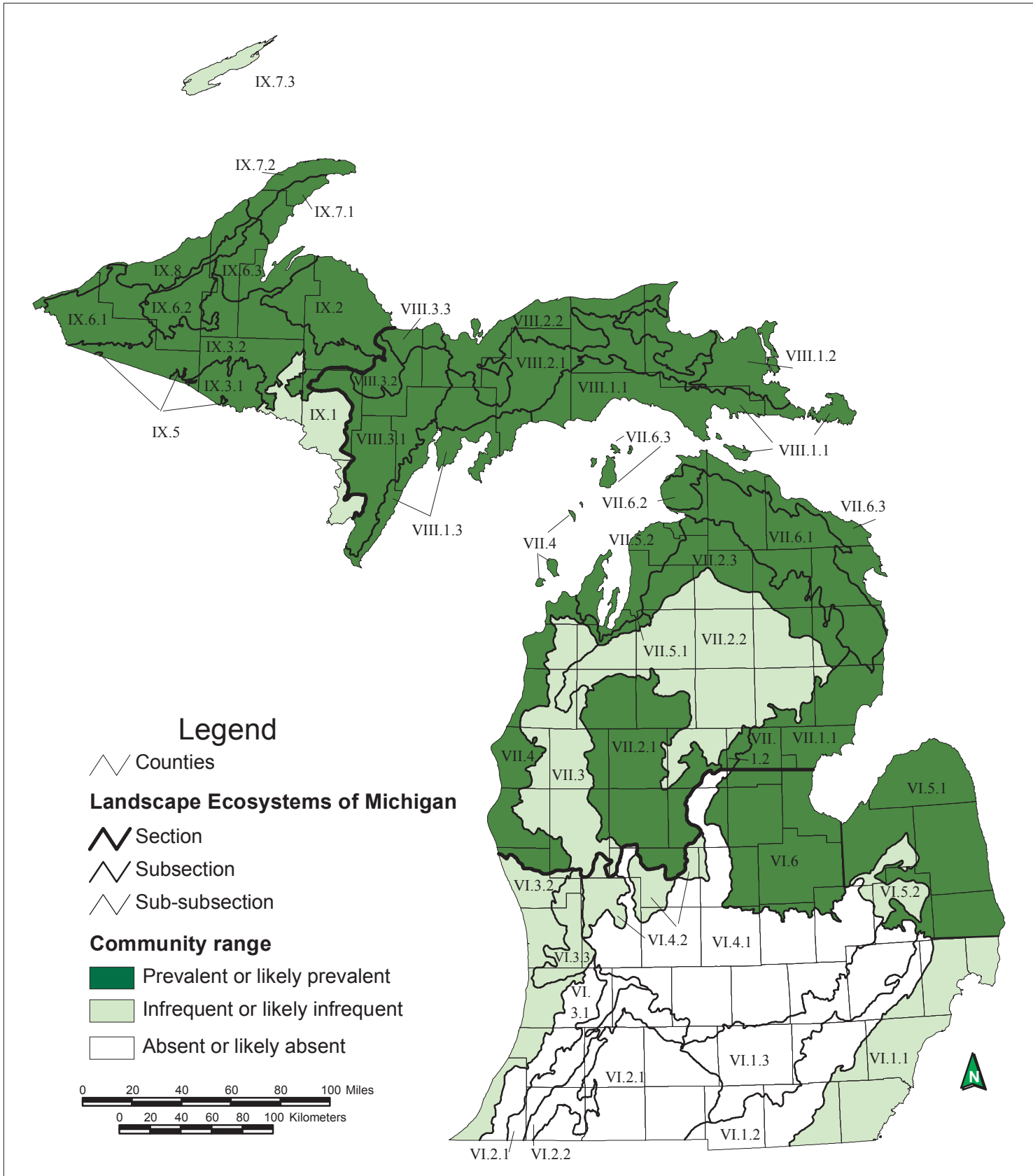
Infrequent or likely infrequent

Absent or likely absent

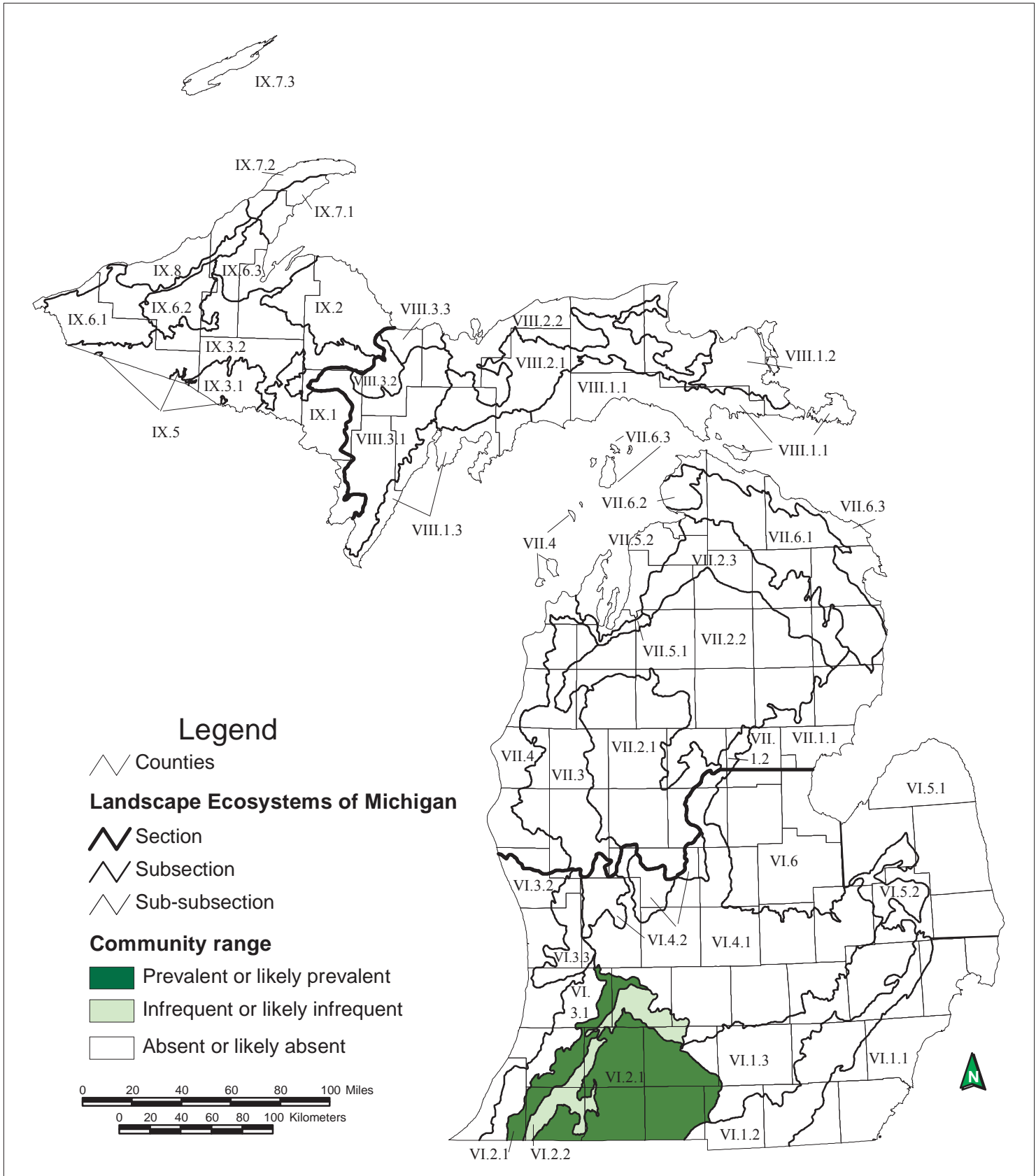


## Limestone Lakeshore Cliff

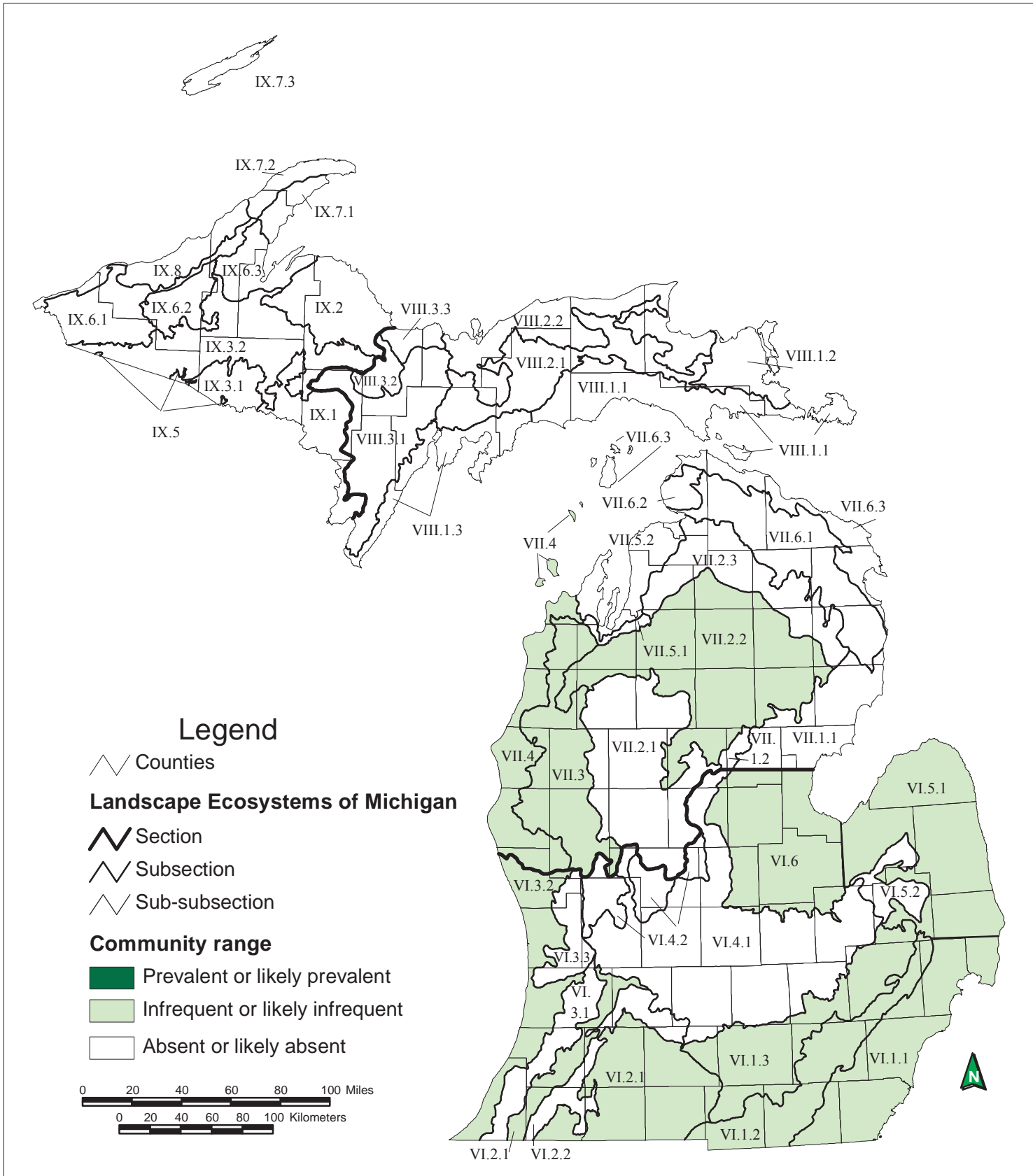




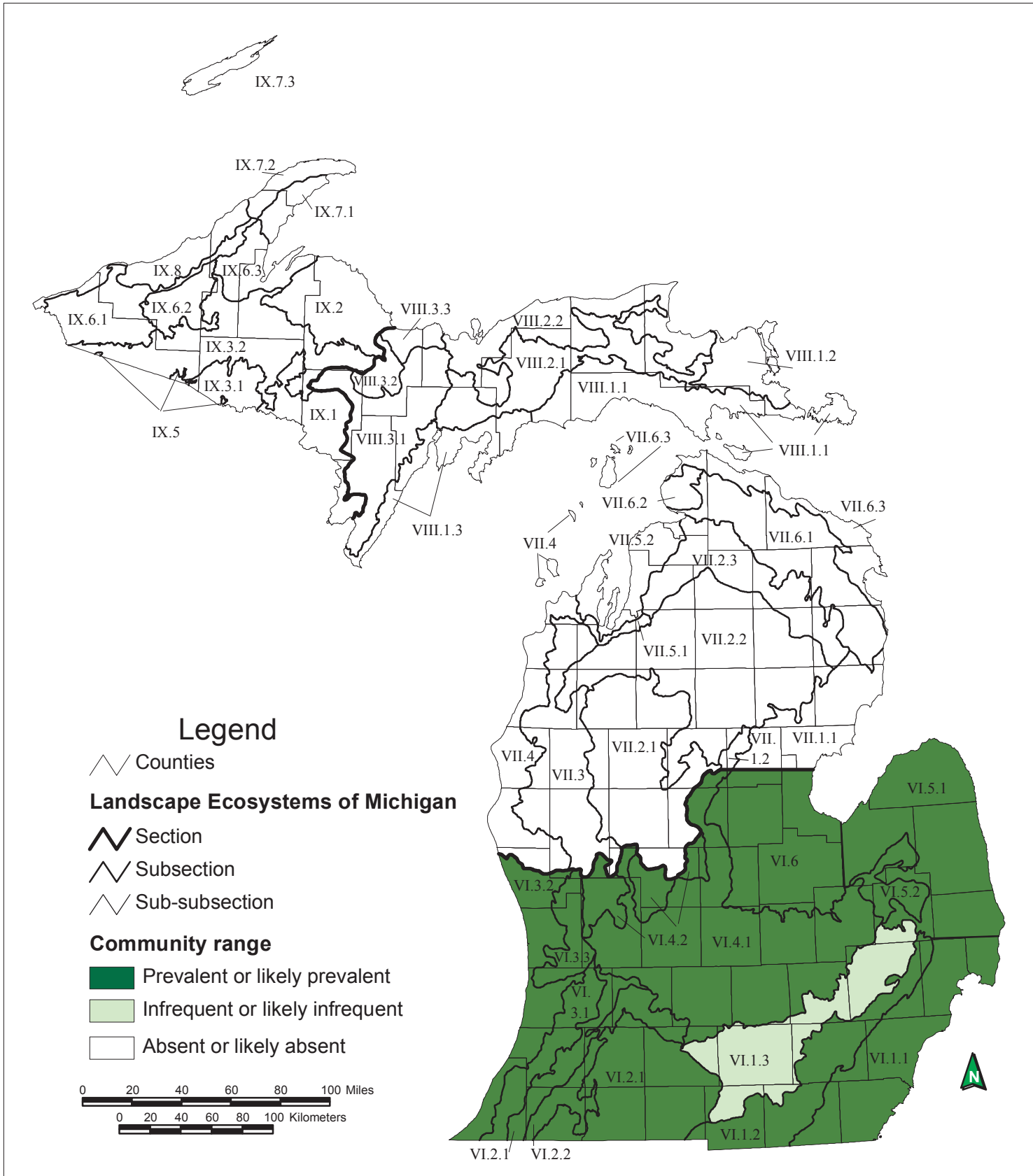
## Mesic Northern Forest



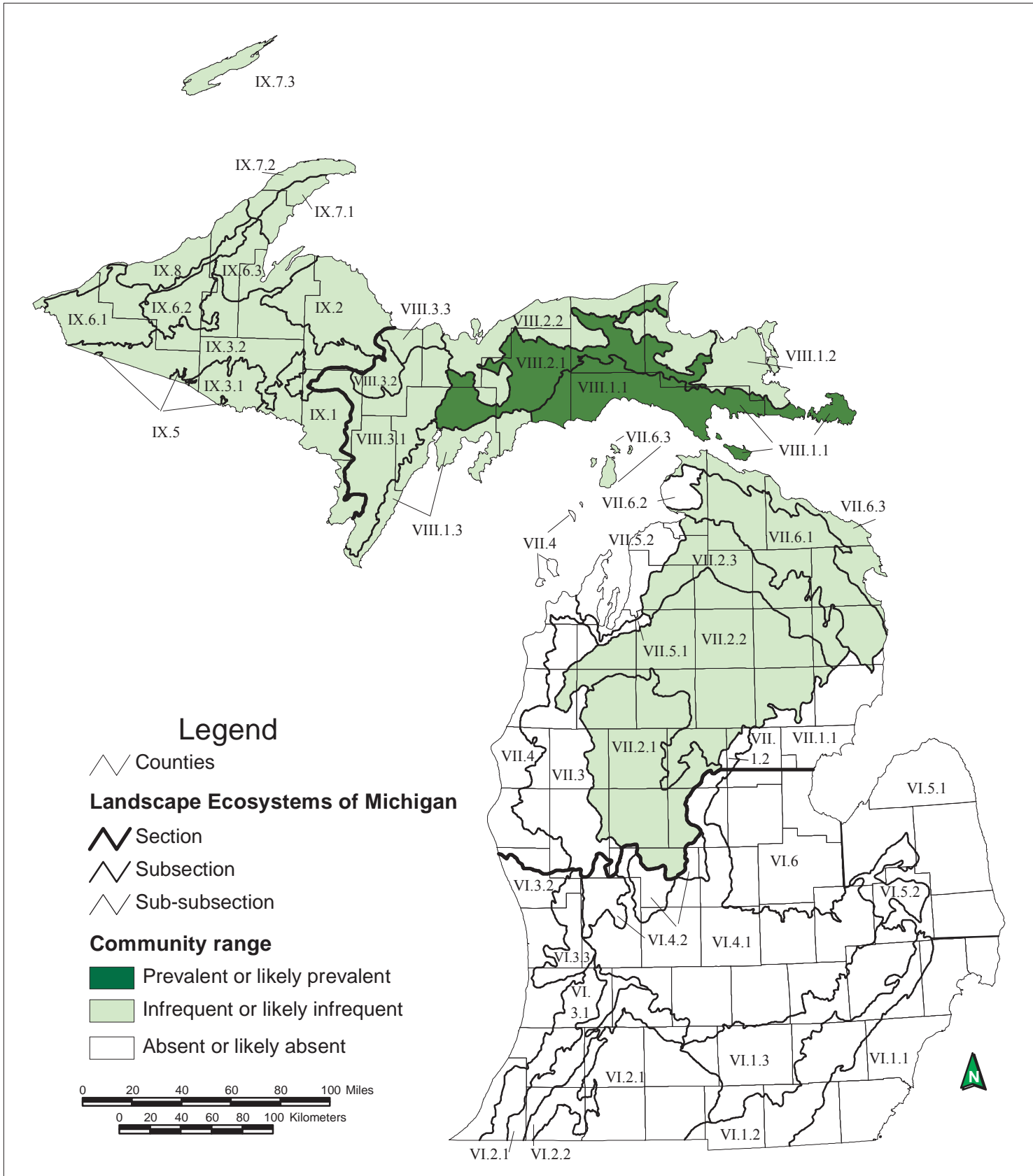
## Mesic Prairie



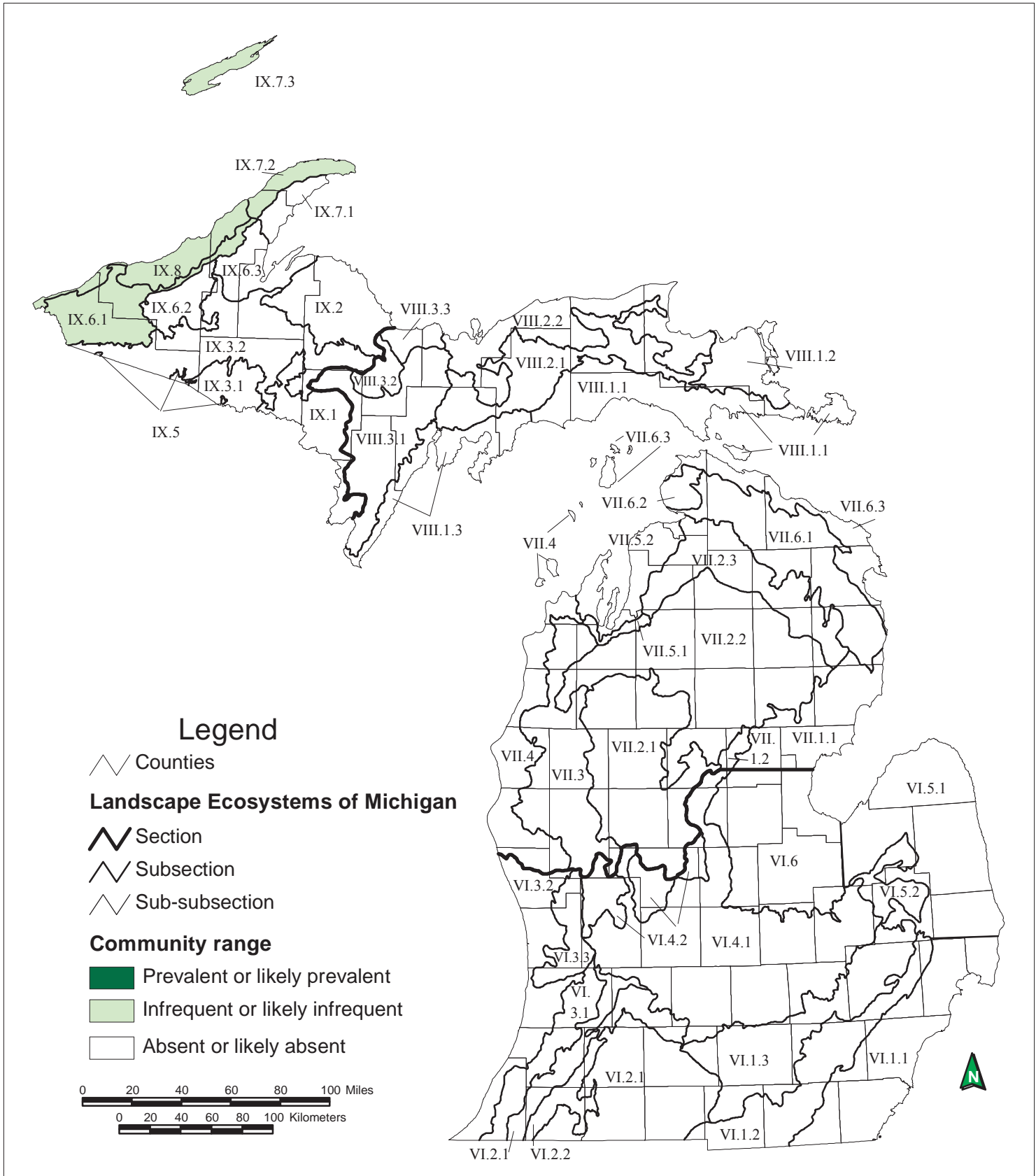
## Mesic Sand Prairie



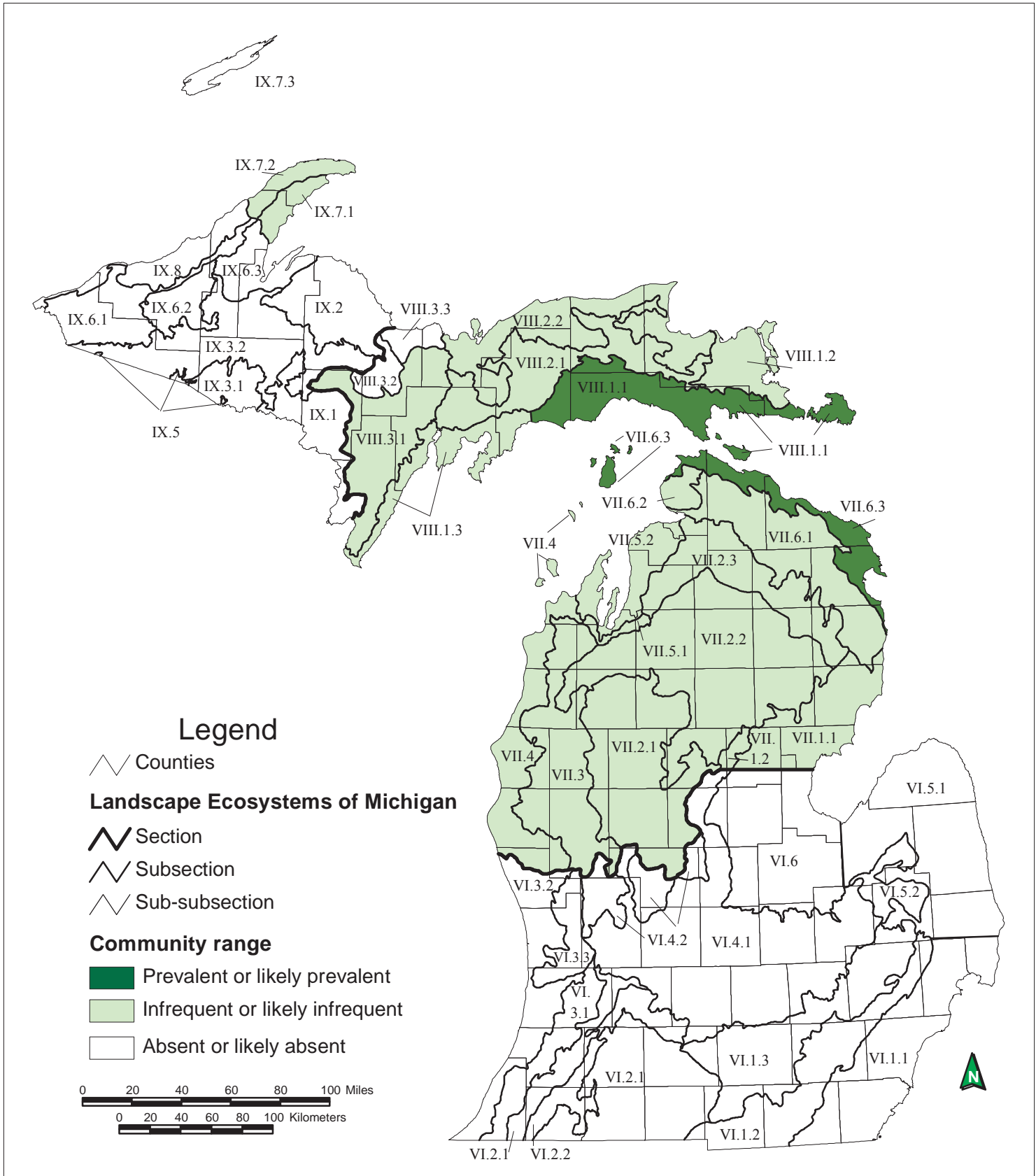
## Mesic Southern Forest



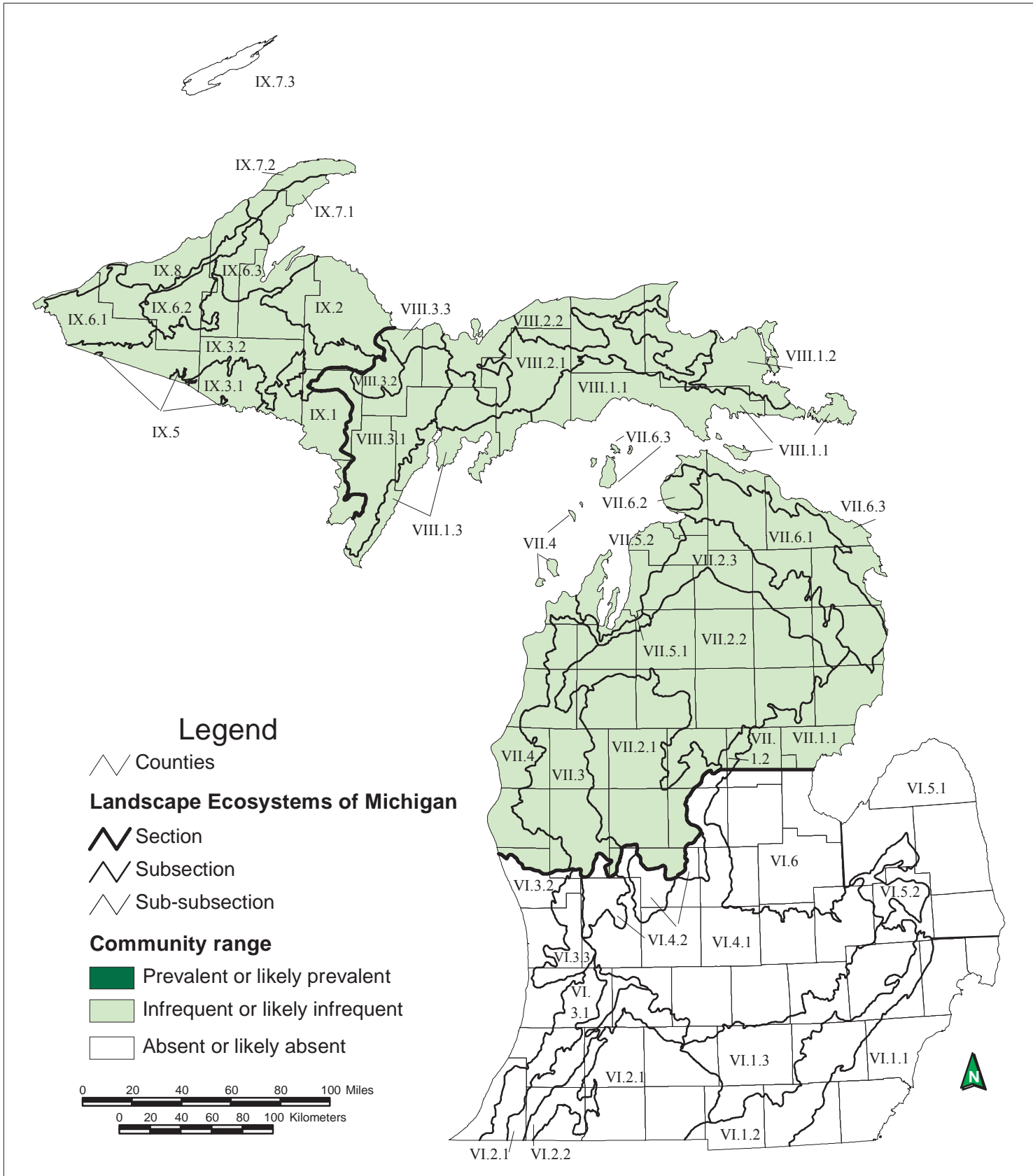
## Muskeg



## Northern Bald

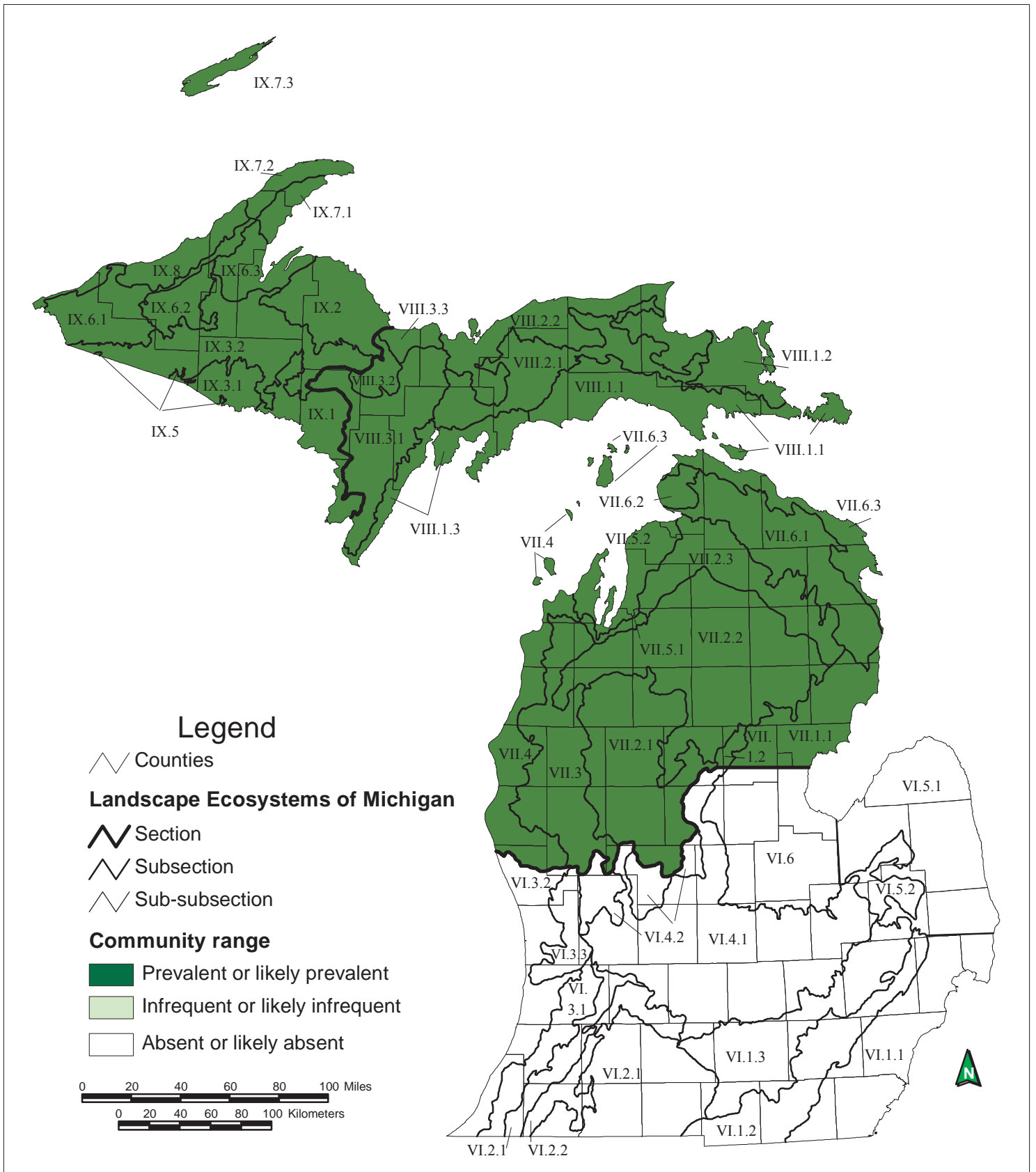


## Northern Fen

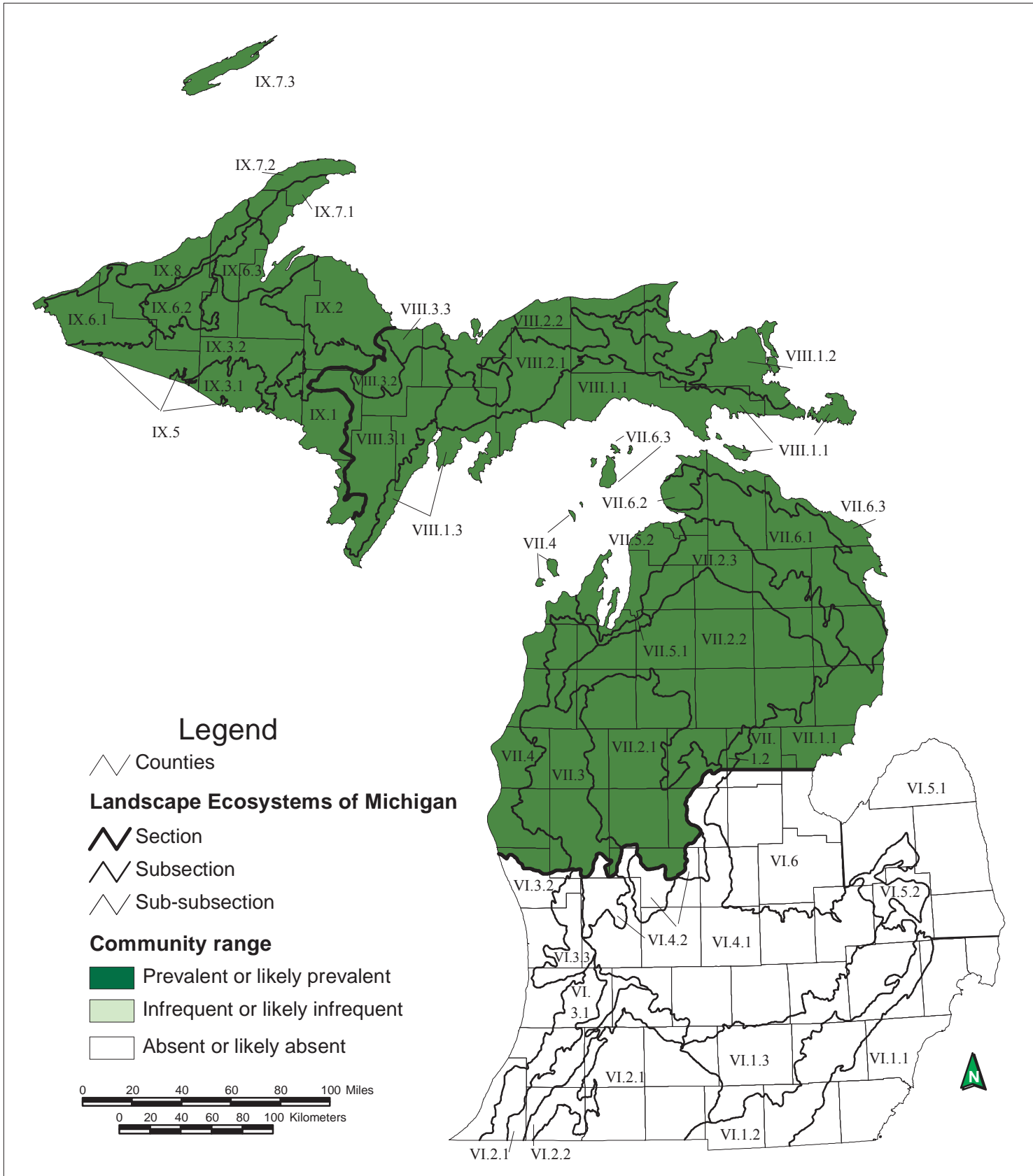


## Northern Hardwood Swamp

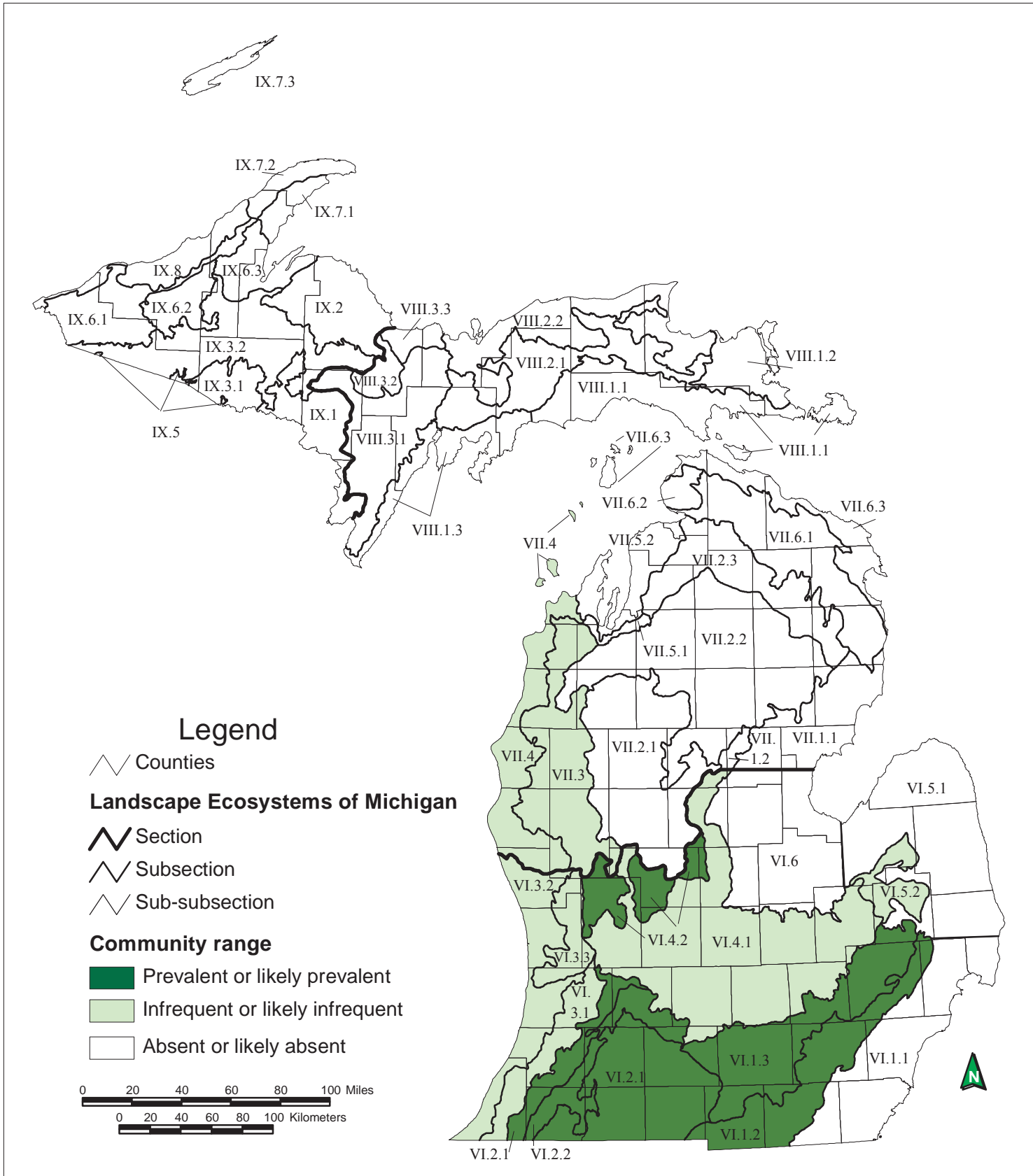




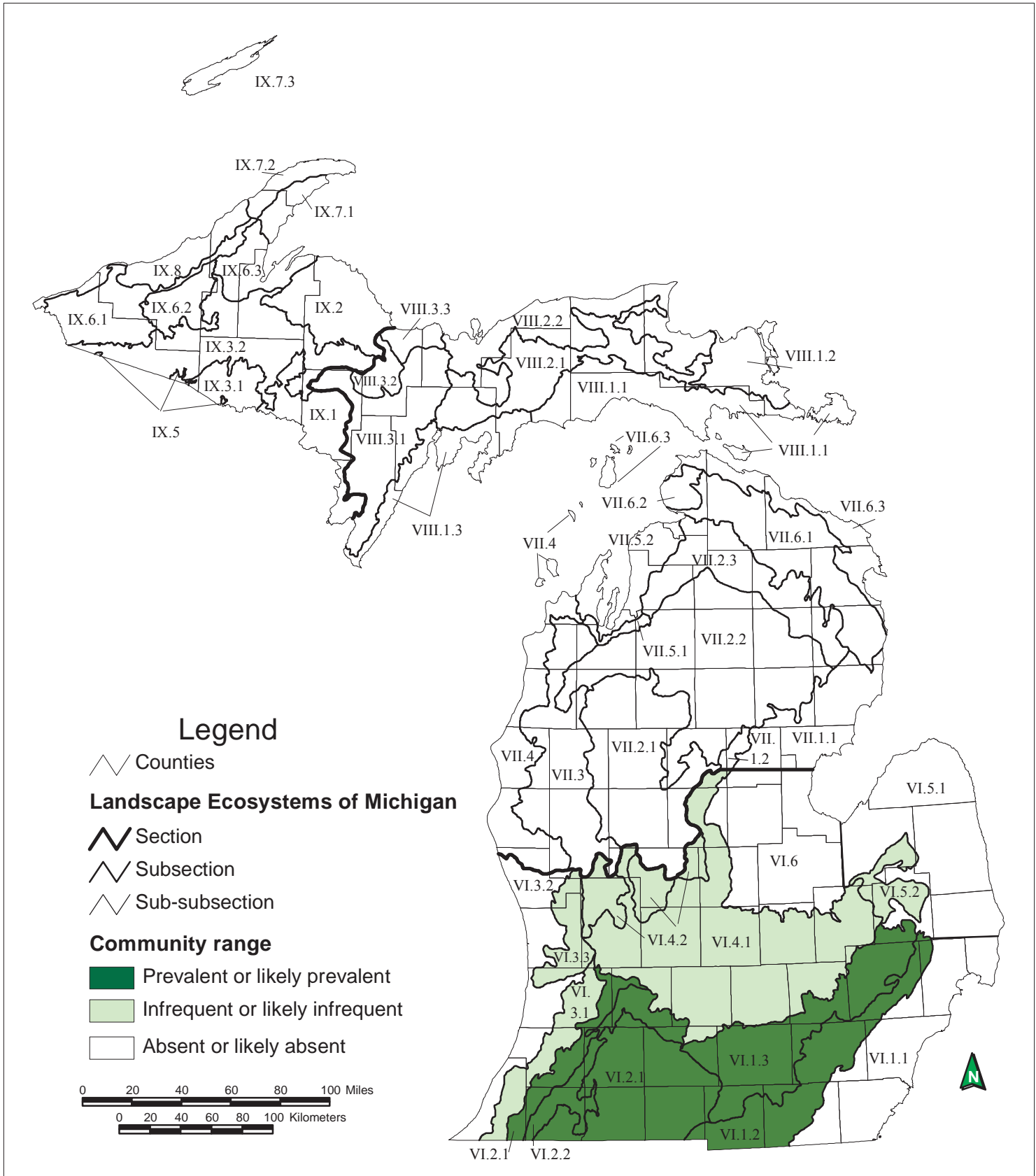
## Northern Shrub Thicket



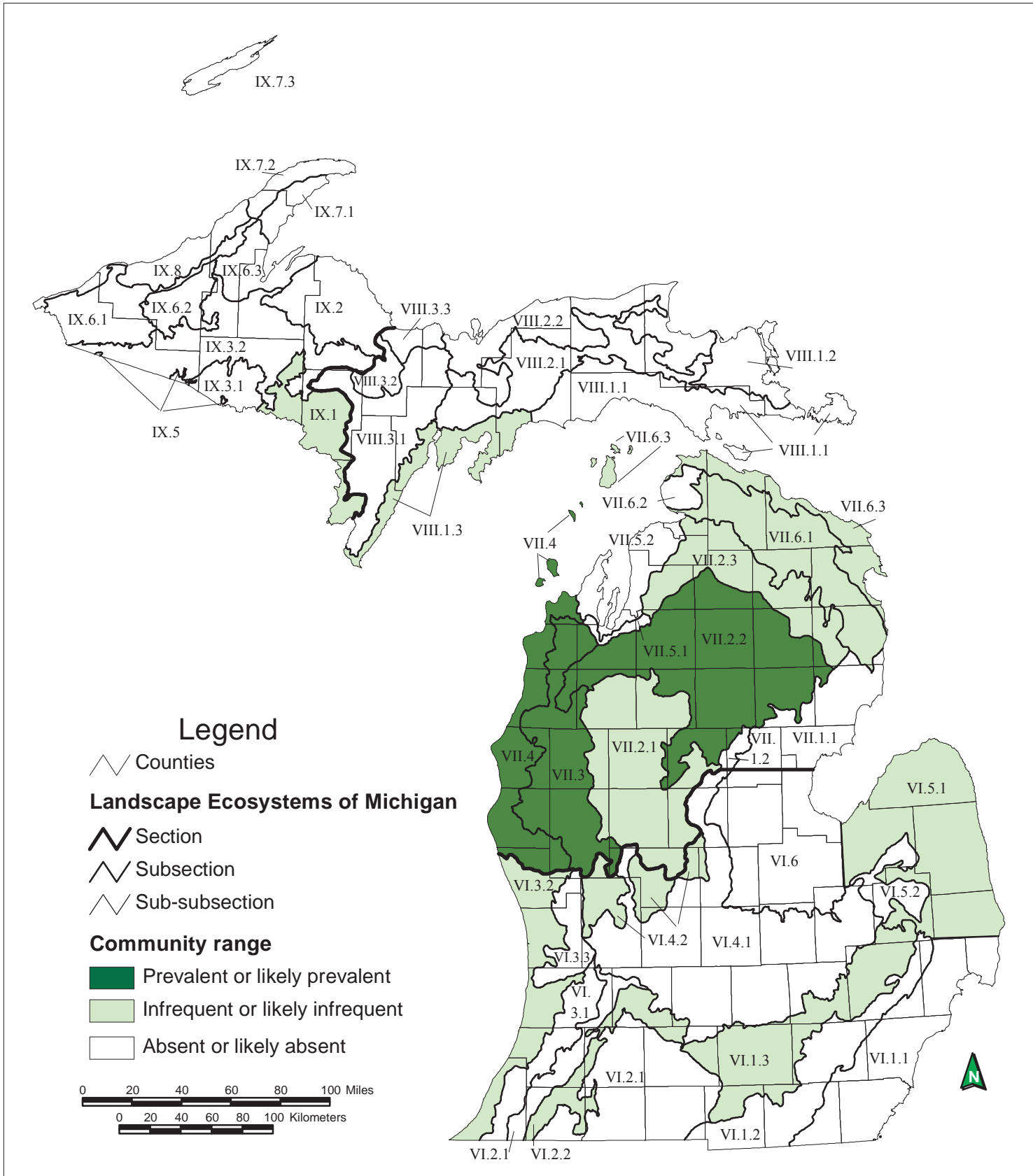
## Northern Wet Meadow



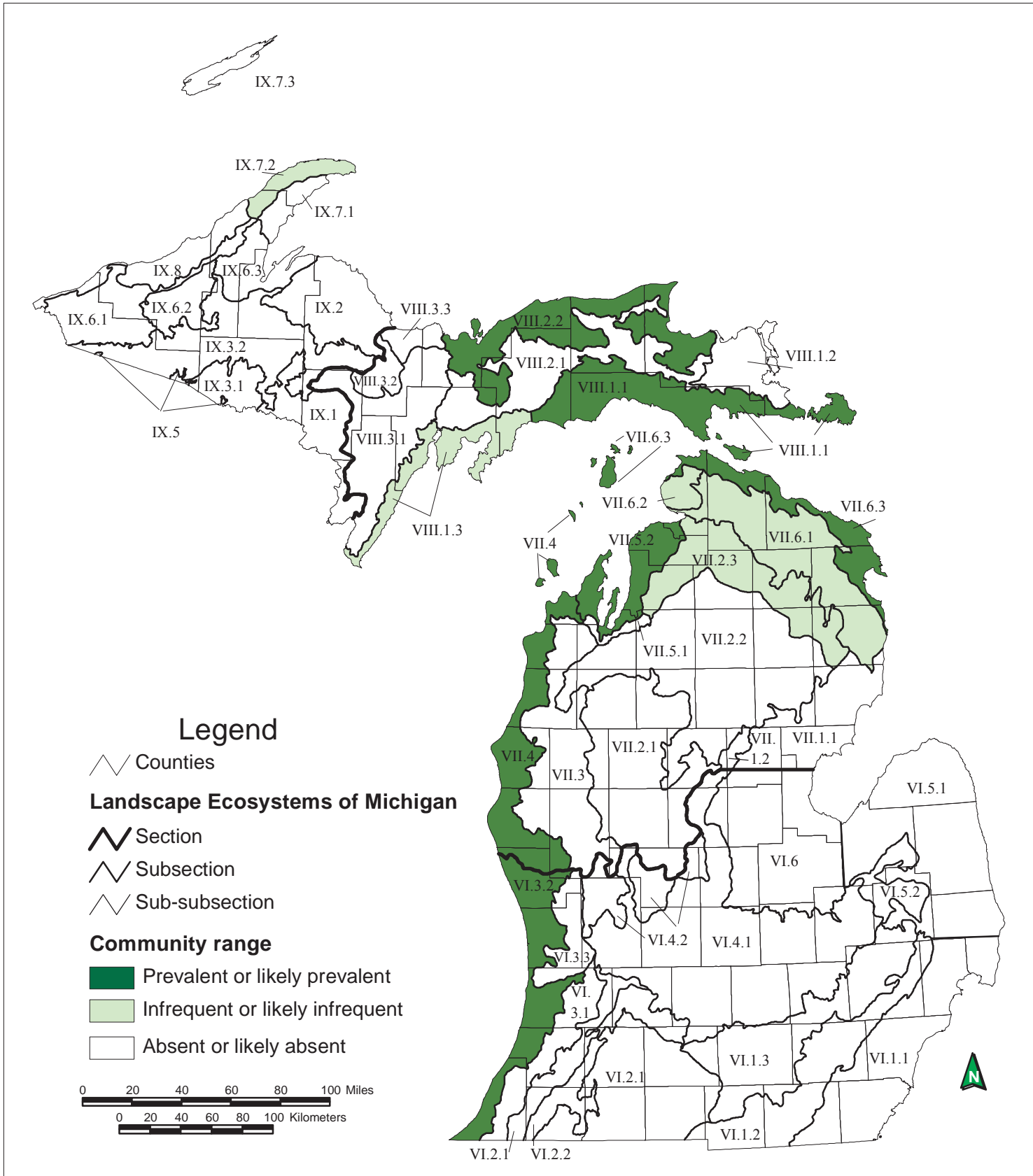
## Oak Barrens

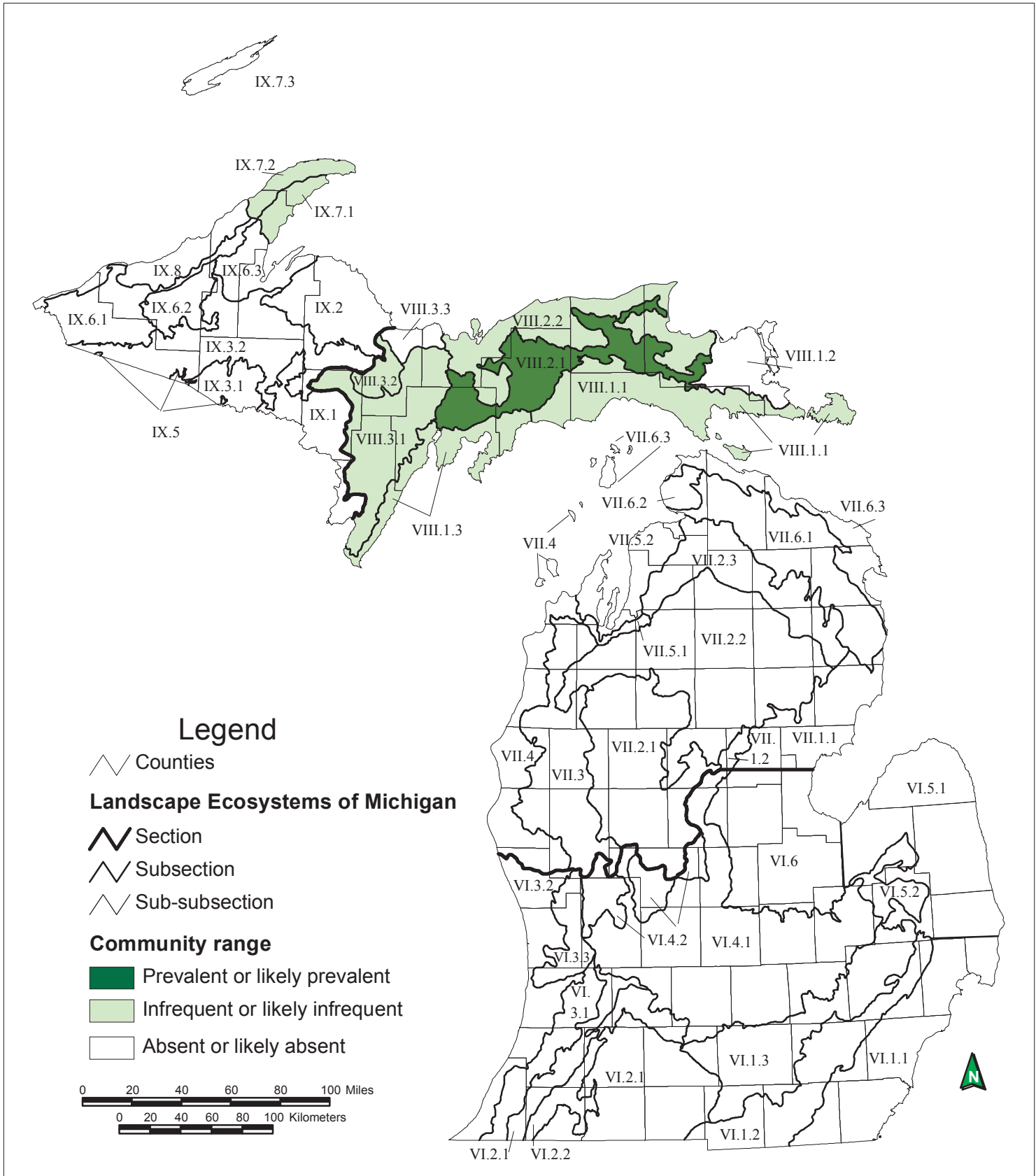


## Oak Openings

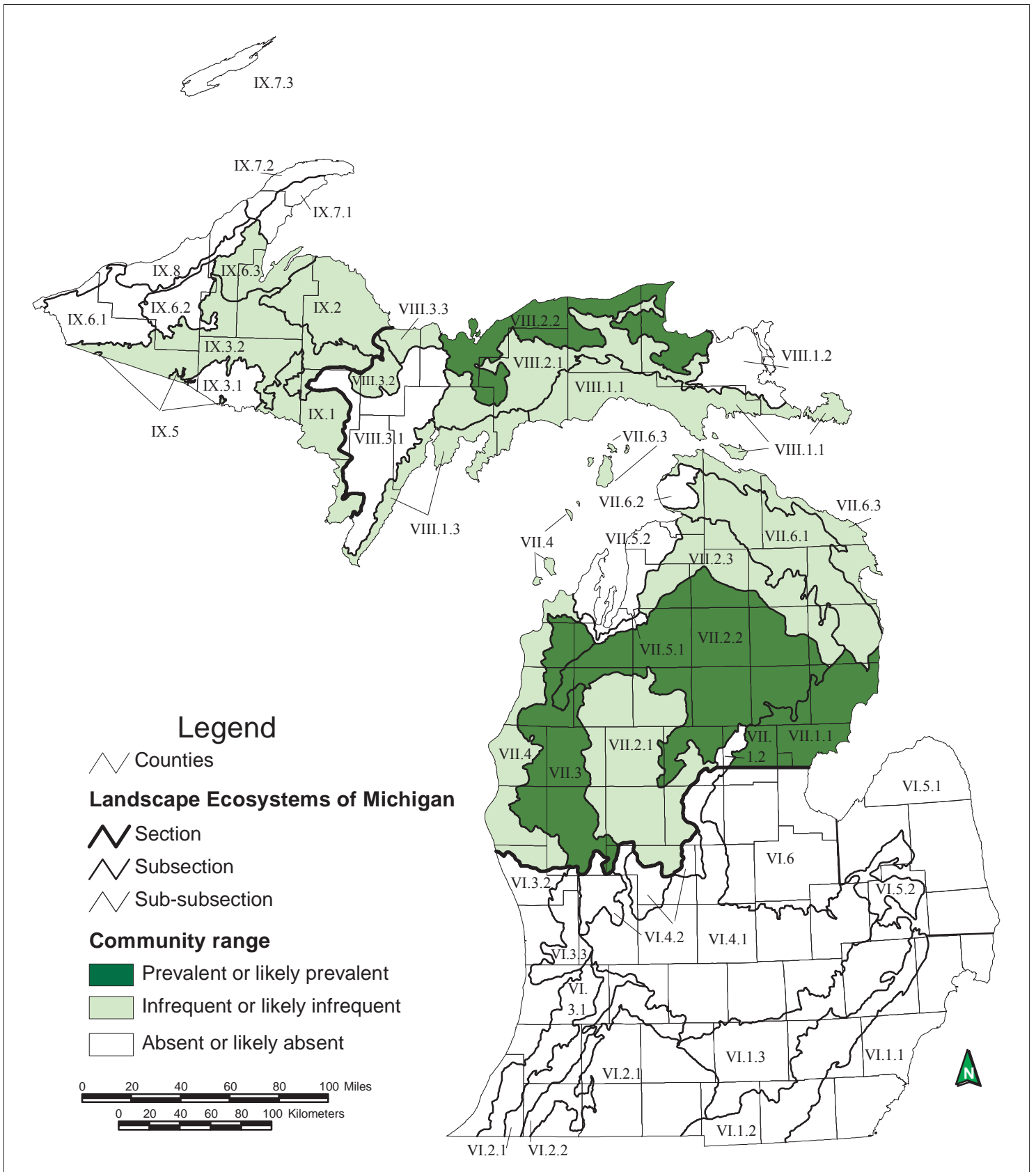


## Oak-pine Barrens



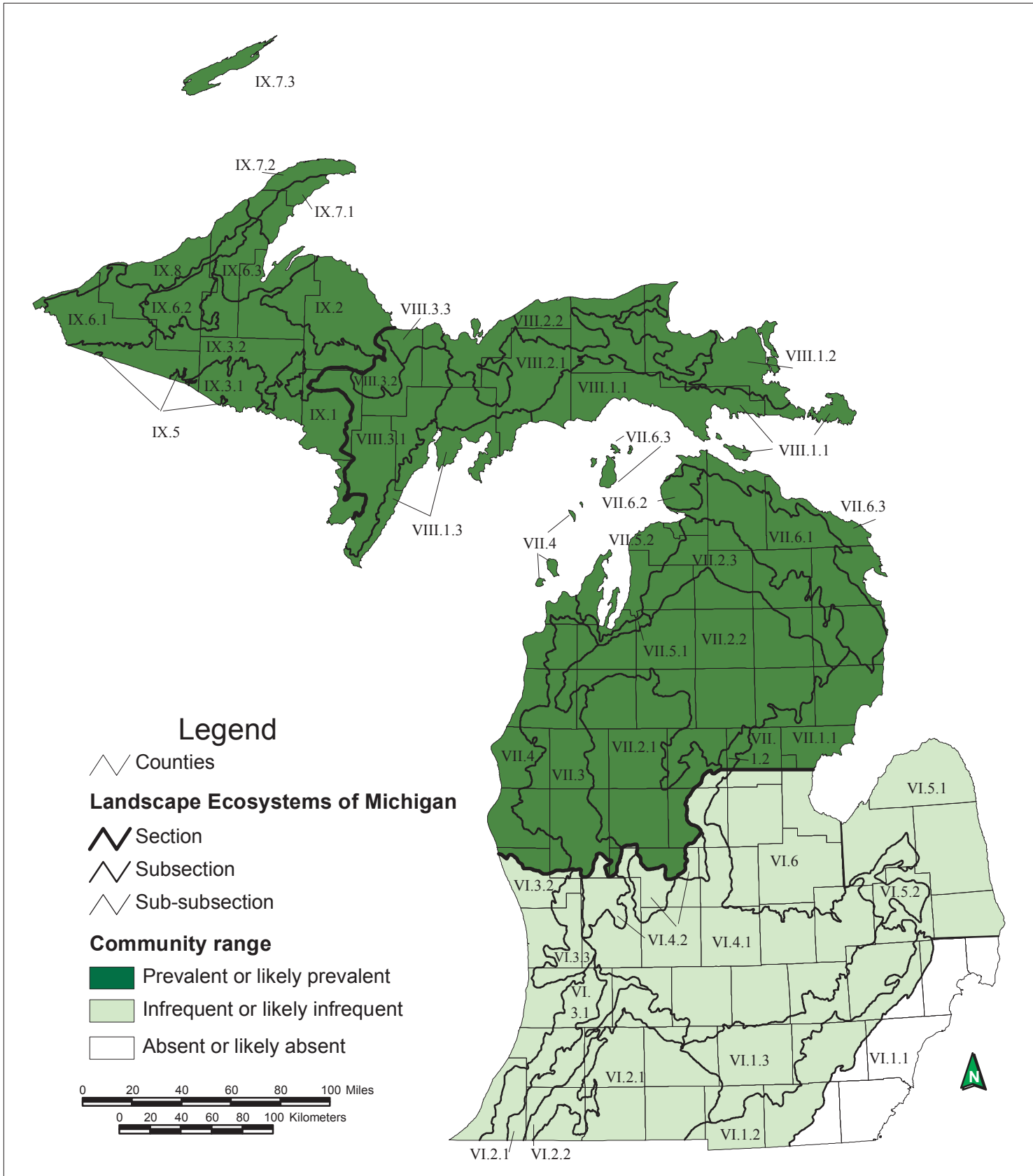


## Patterned Fen

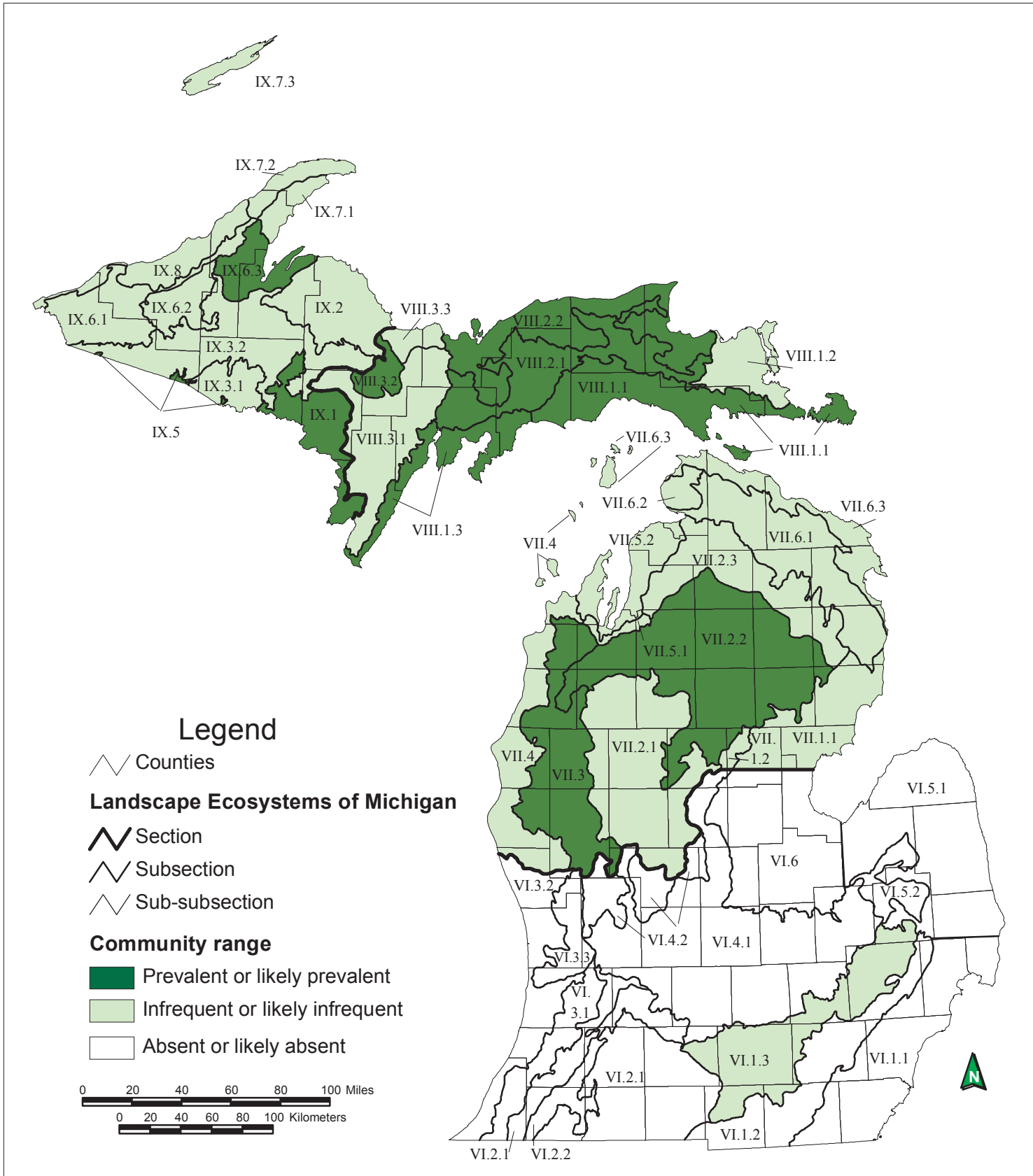


## Pine Barrens



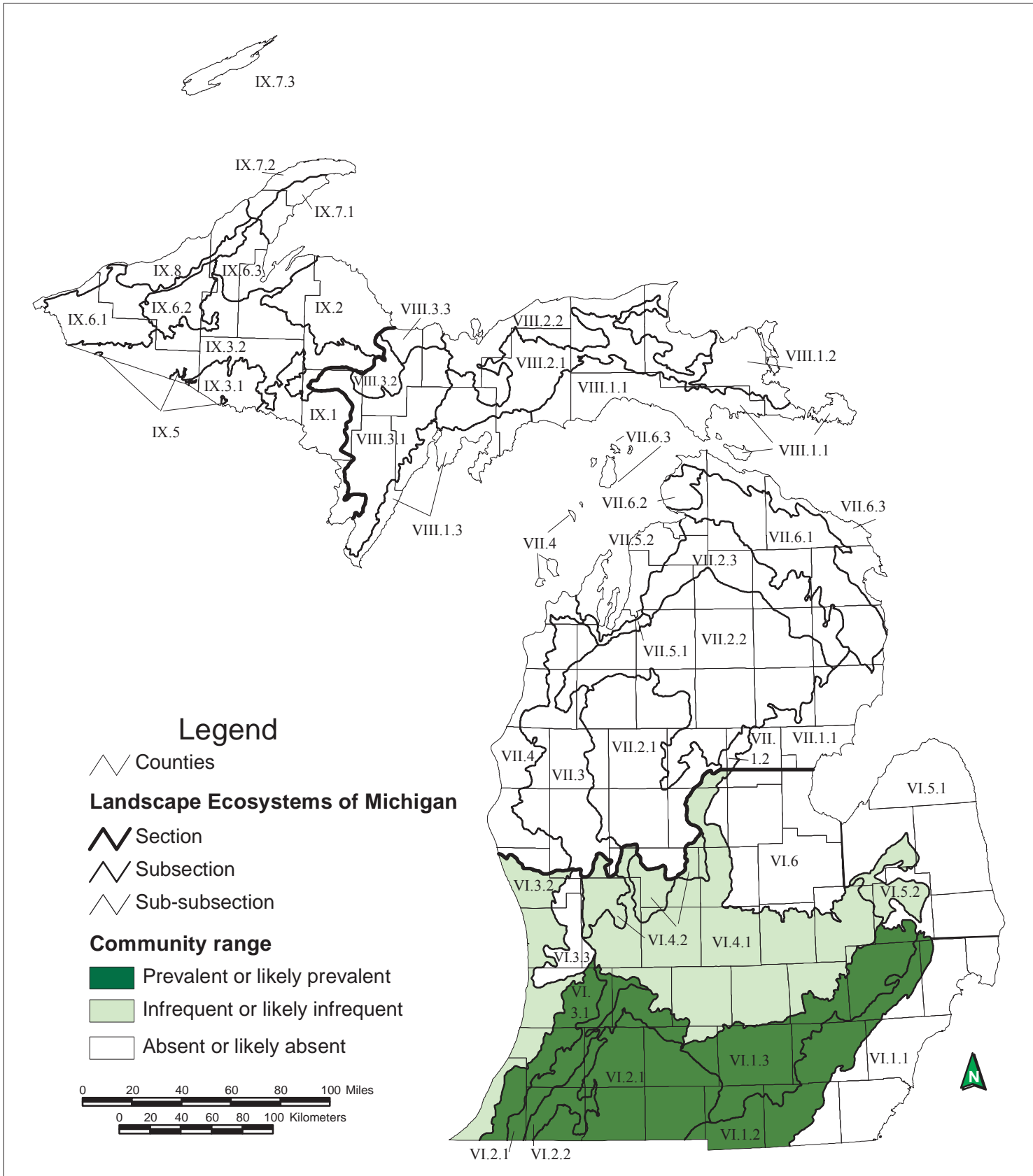


## Poor Conifer Swamp

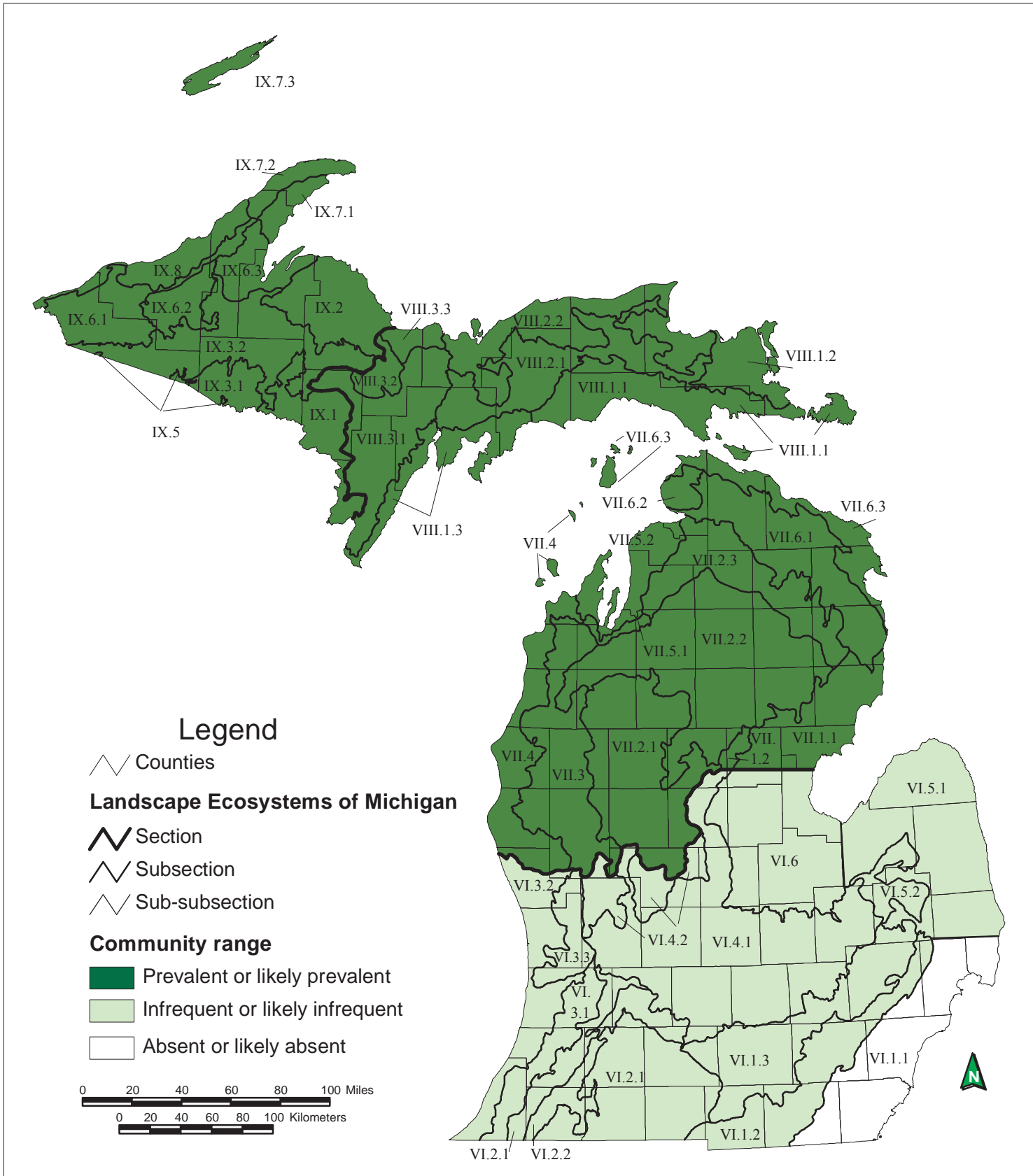


## Poor Fen

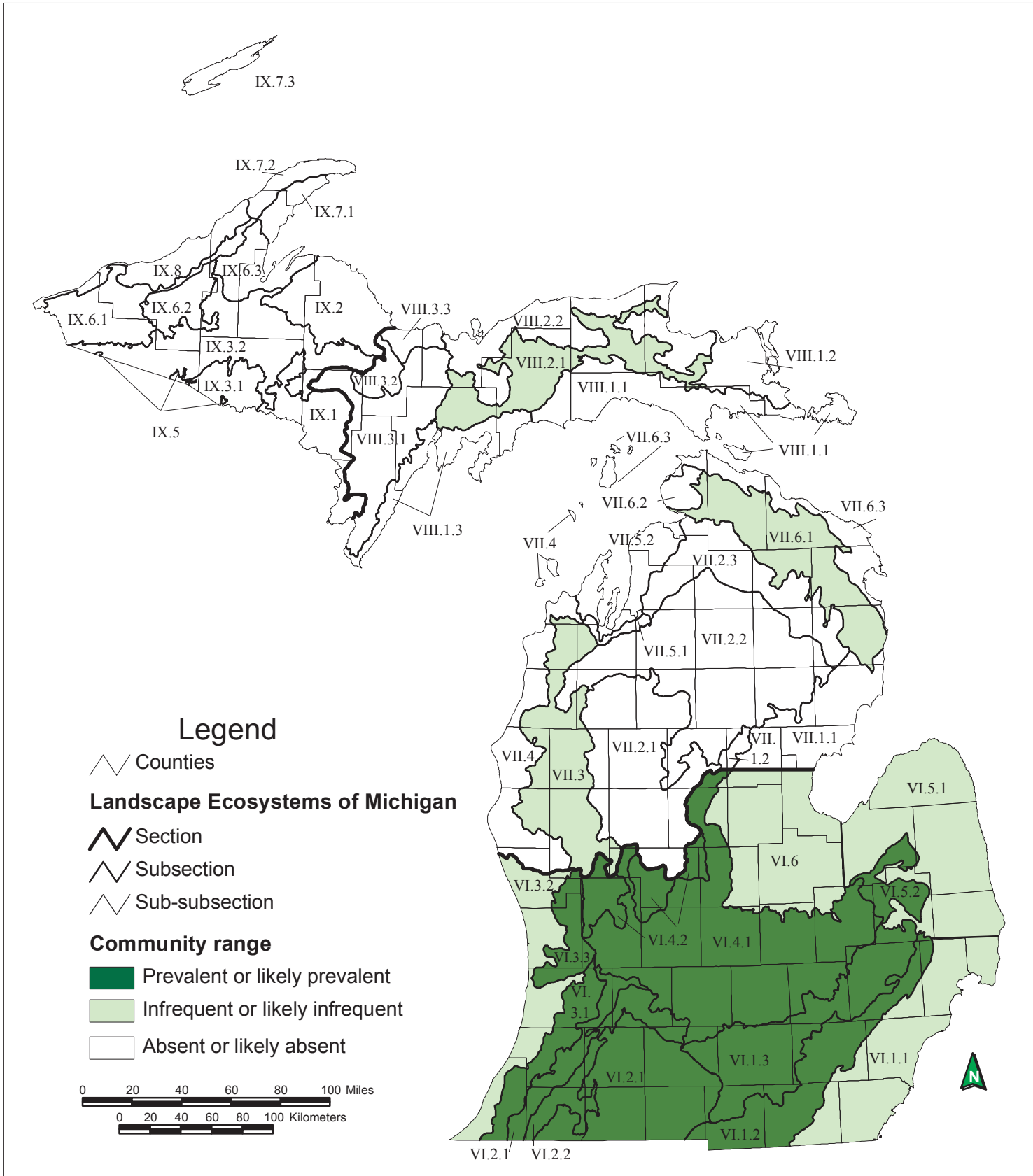




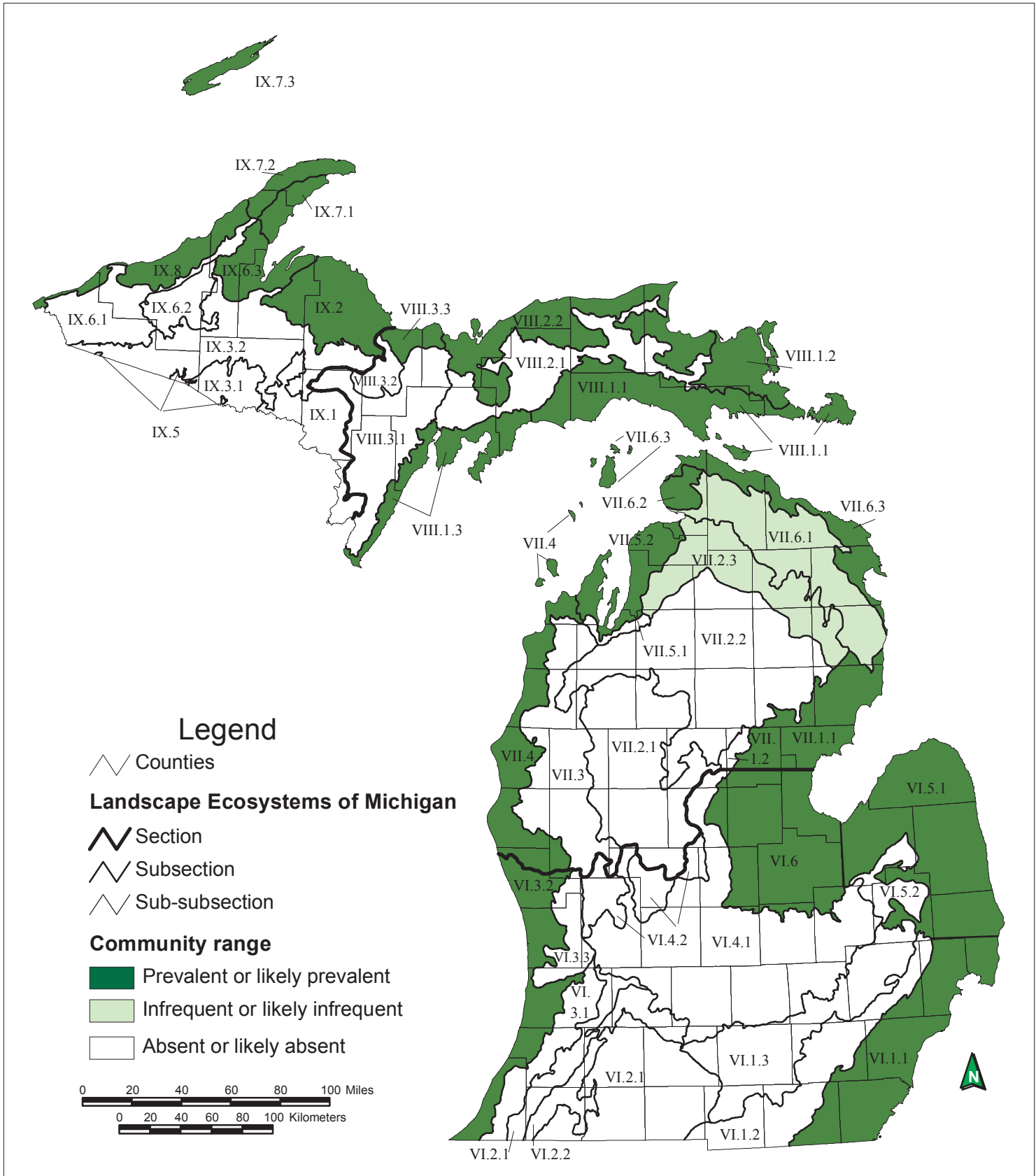
## Prairie Fen



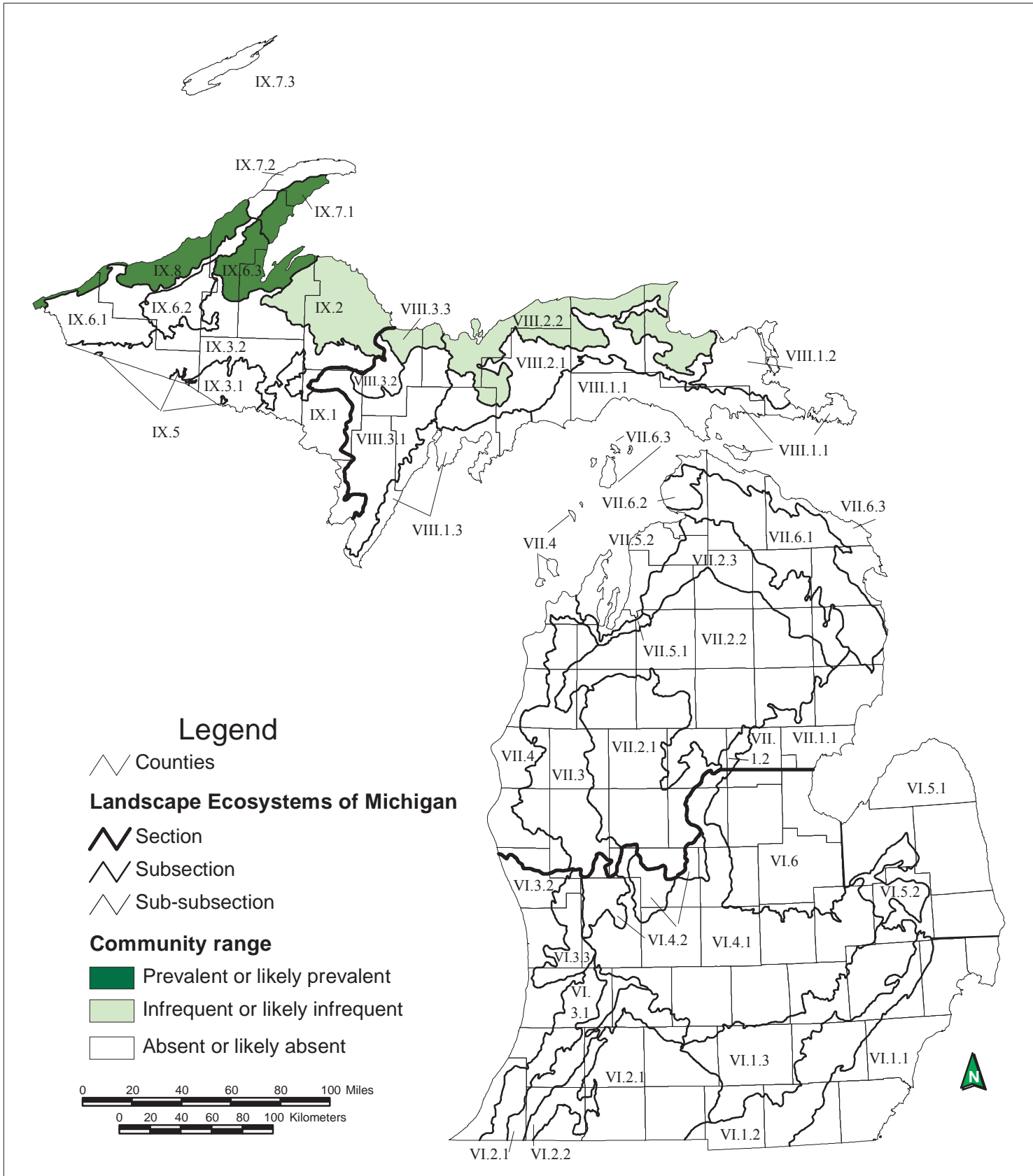
## Rich Conifer Swamp



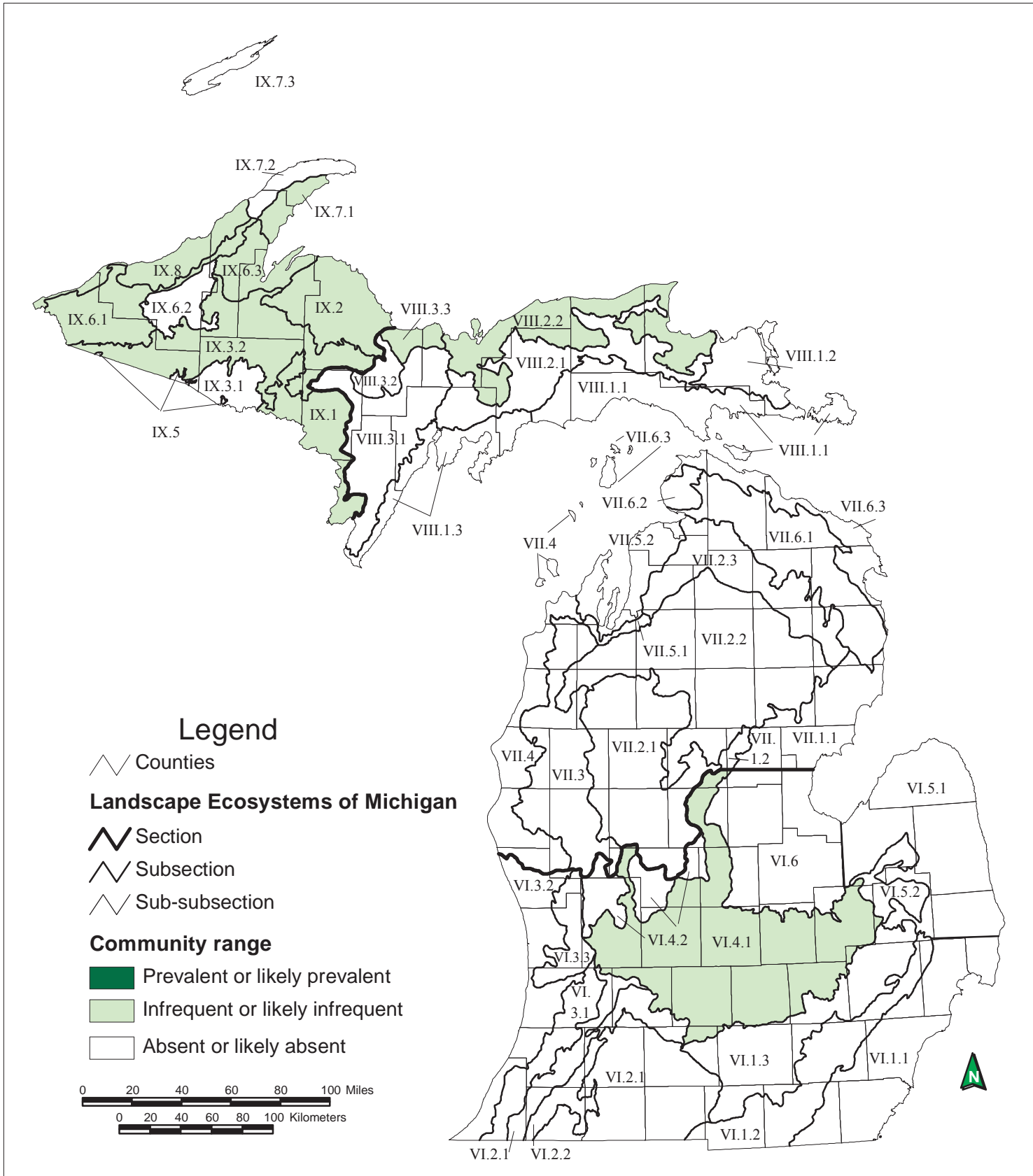
## Rich Tamarack Swamp



## Sand and Gravel Beach

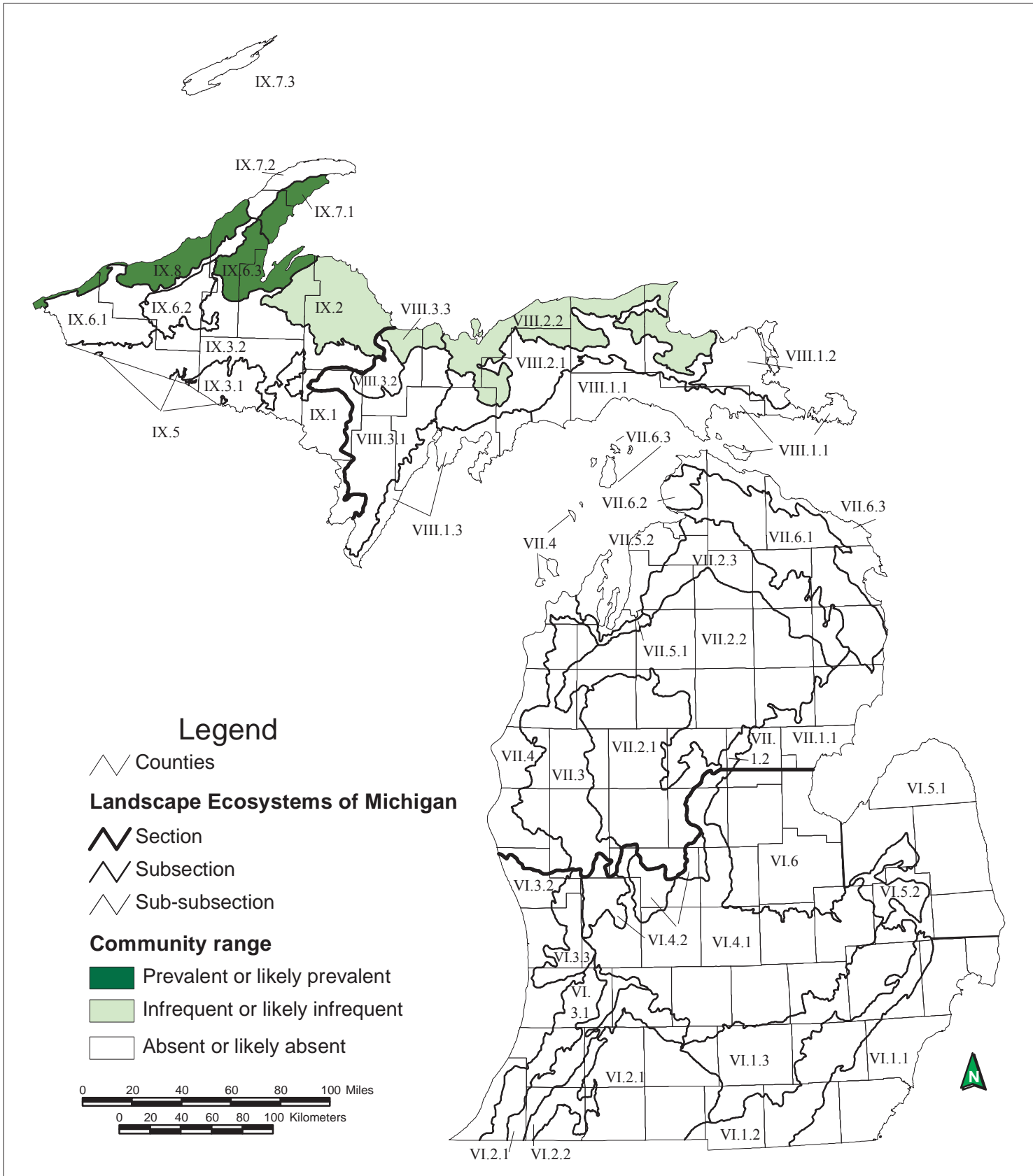


## Sandstone Bedrock Lakeshore

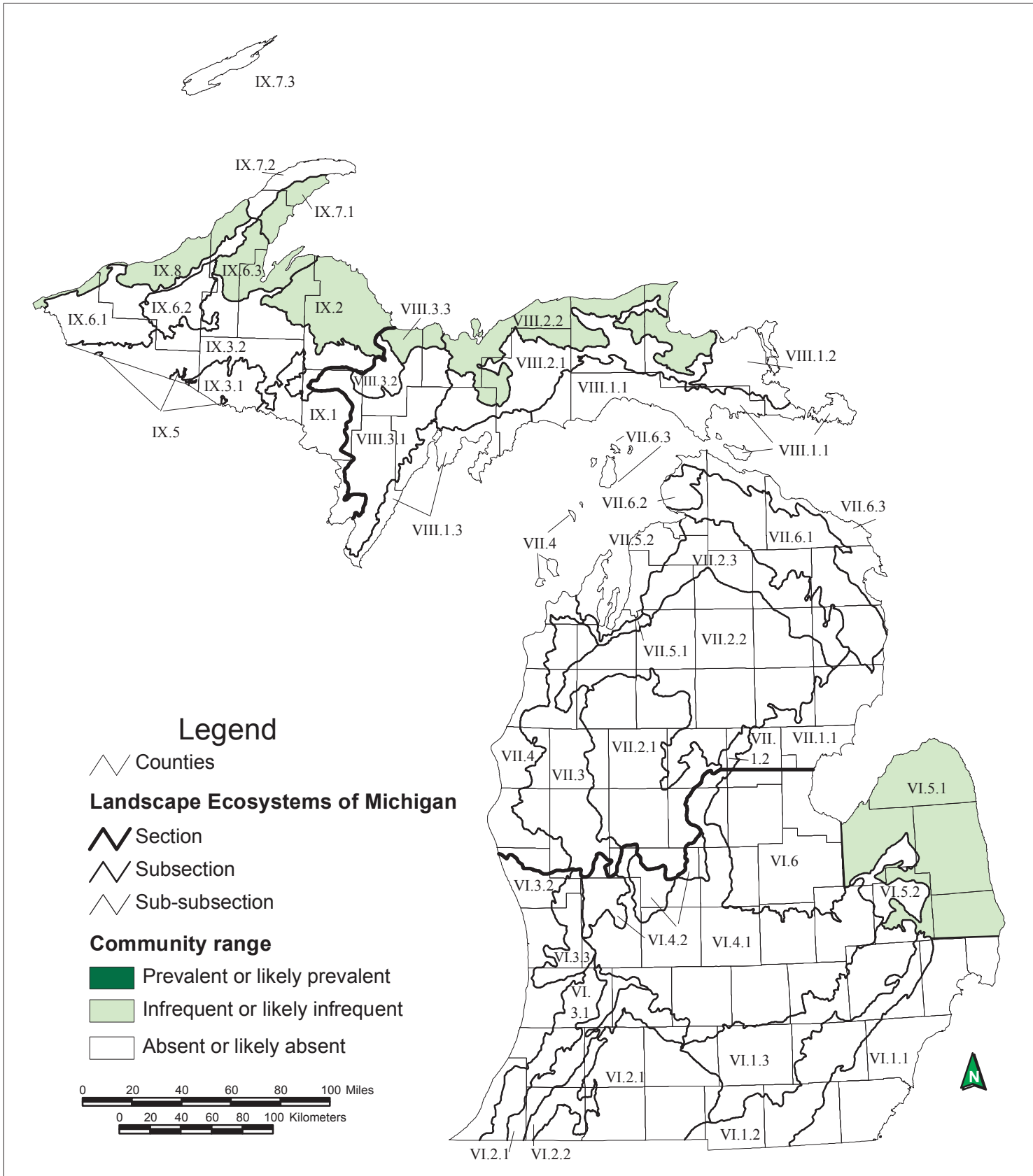


## Sandstone Cliff

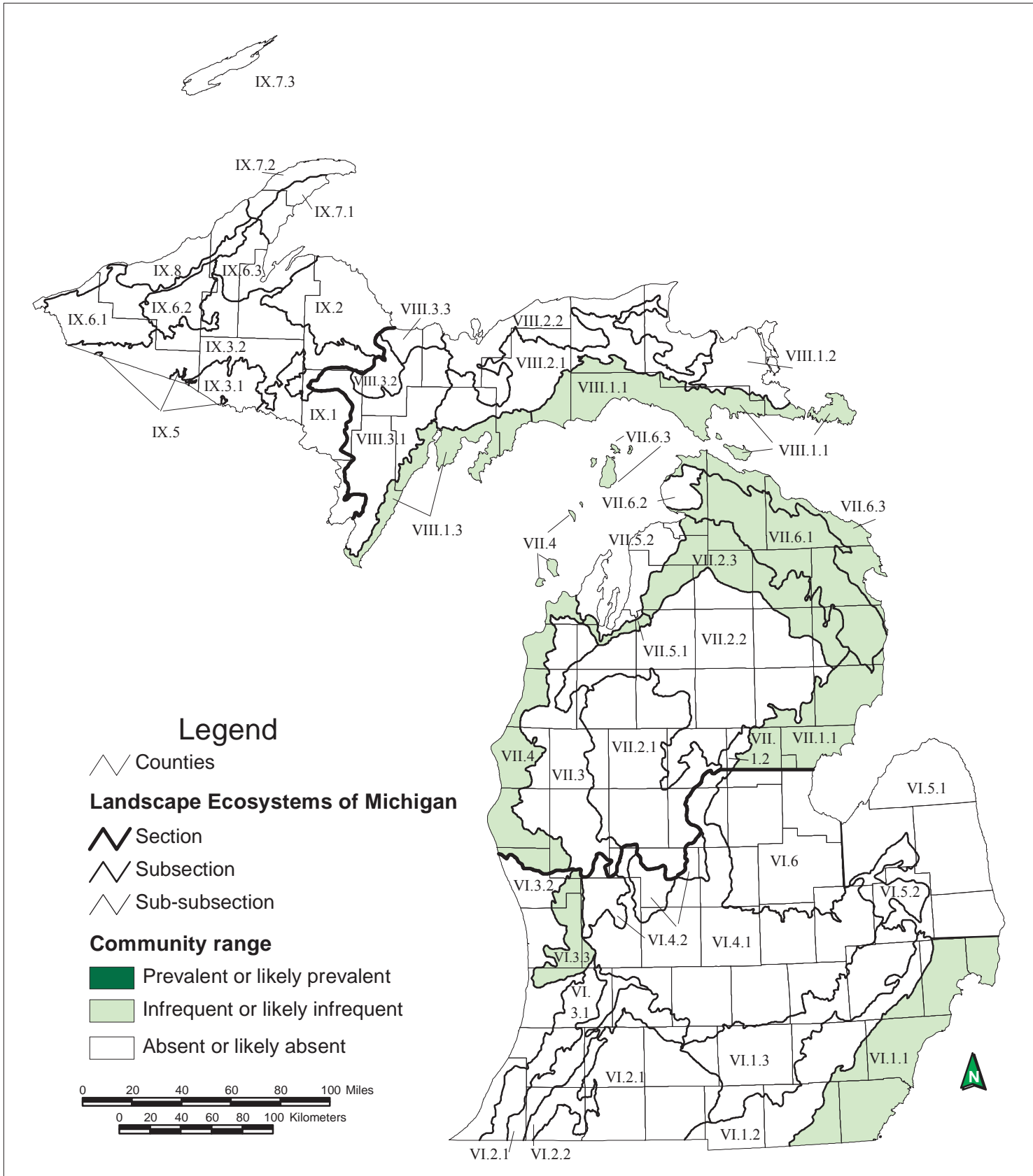




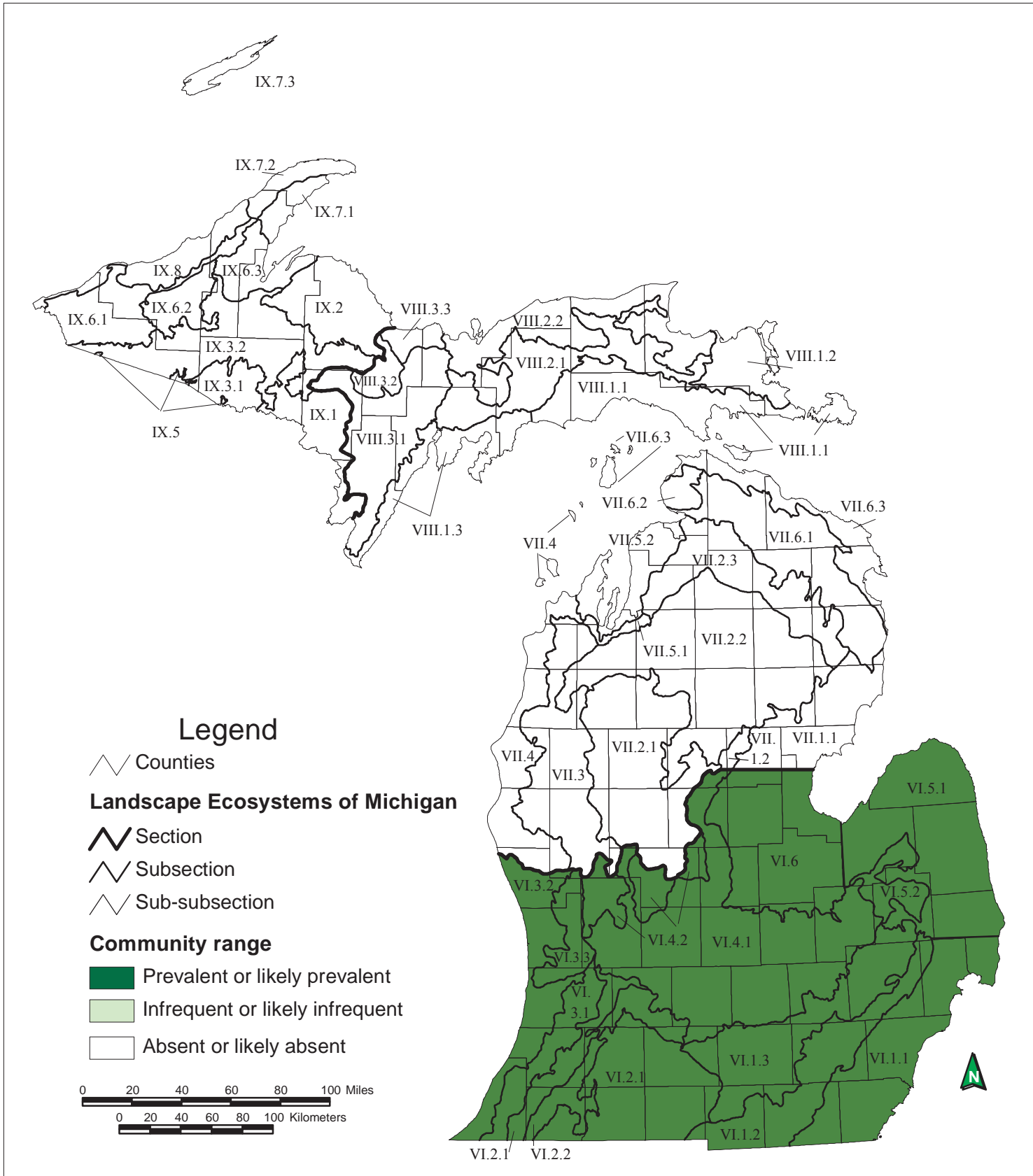
## Sandstone Cobble Shore



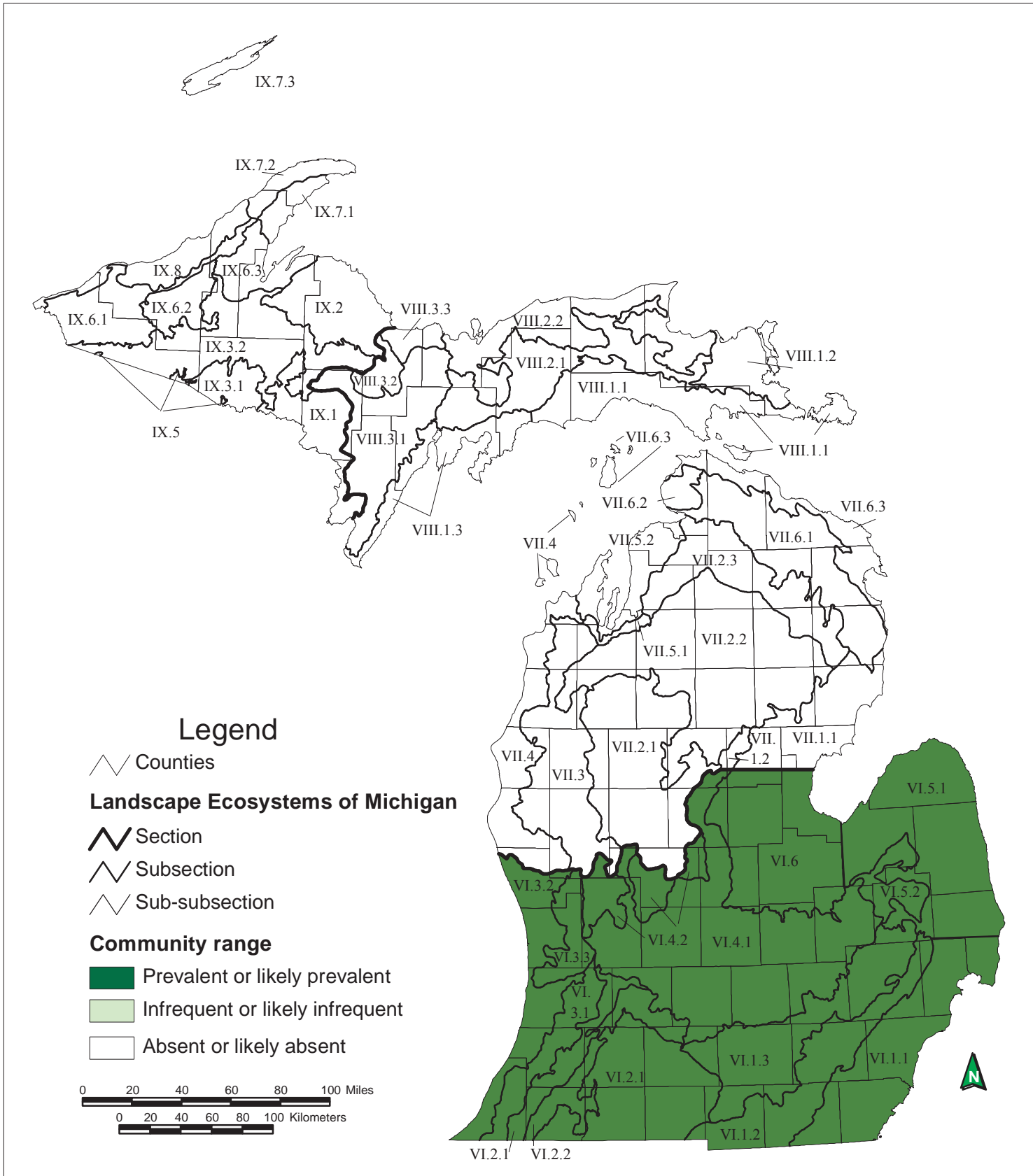
## Sandstone Lakeshore Cliff



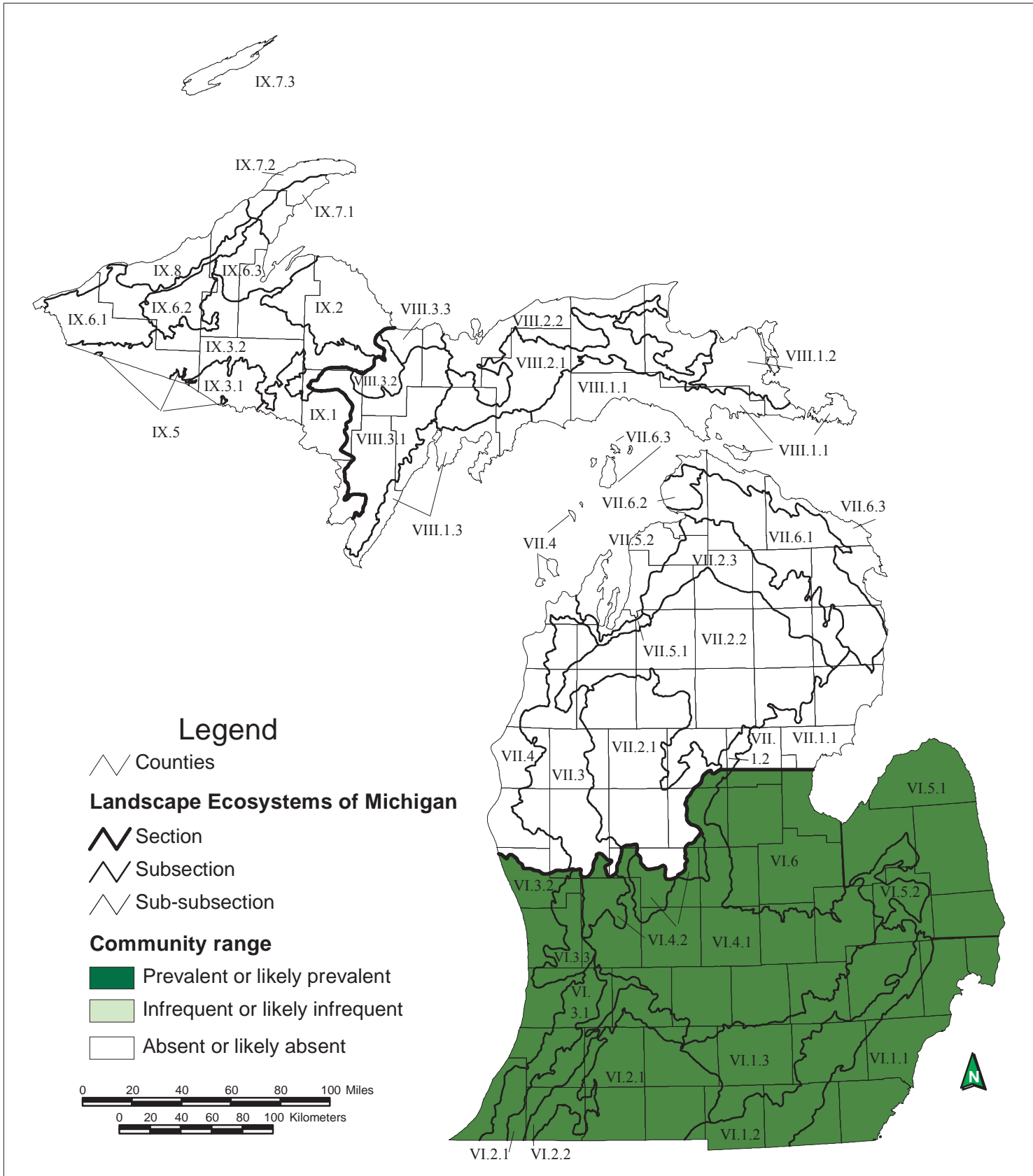
## Sinkhole



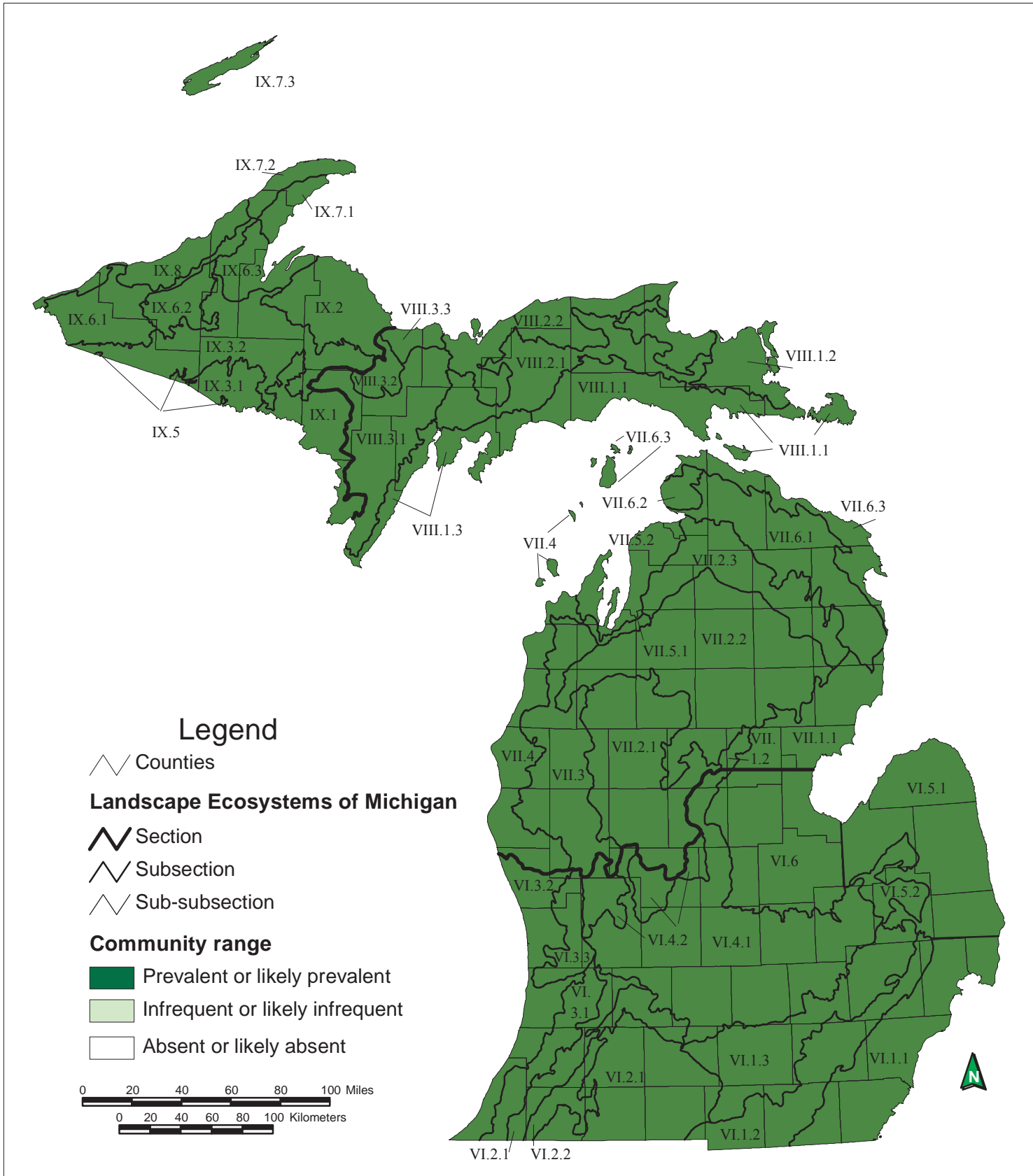
## Southern Hardwood Swamp



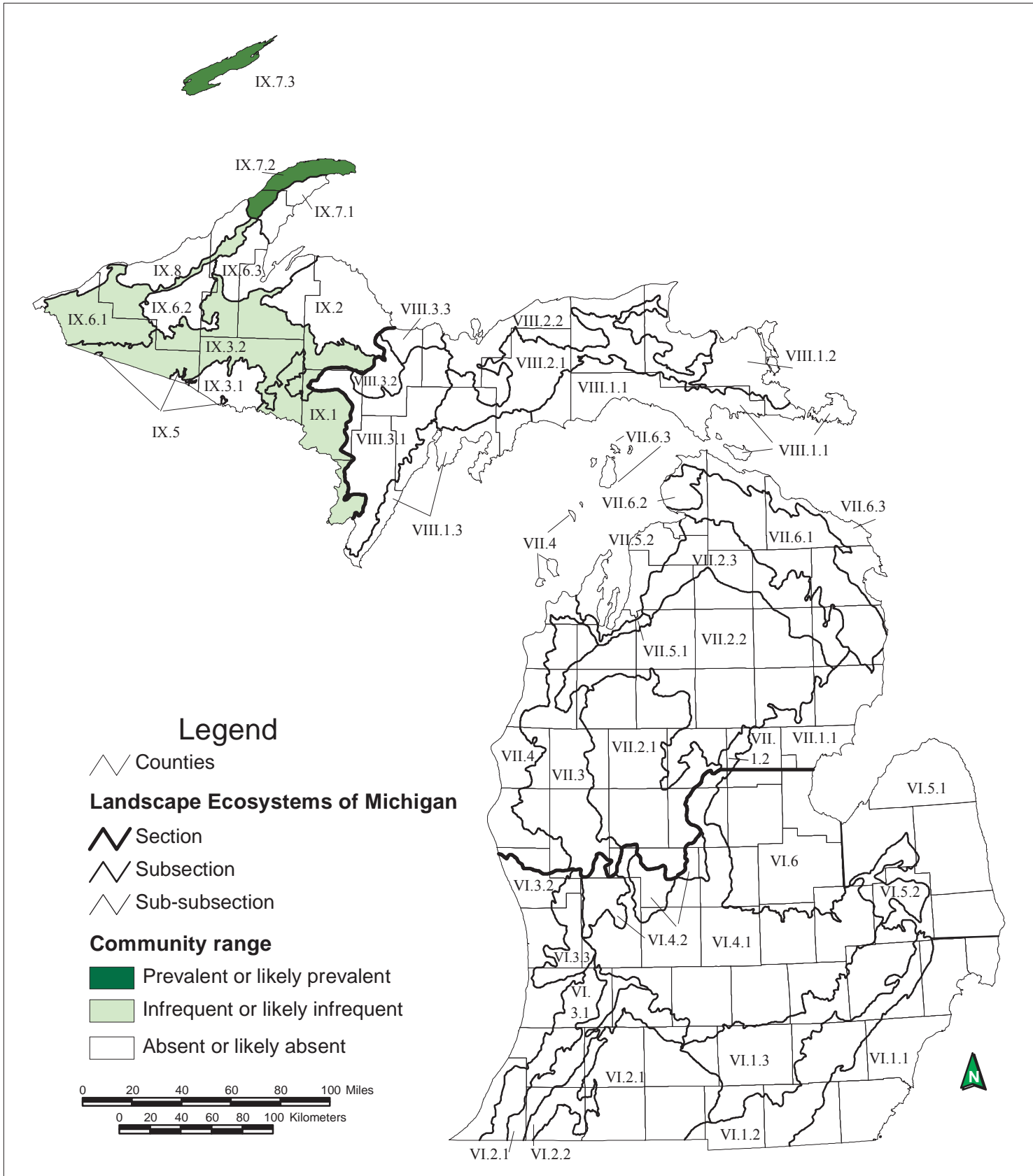
## Southern Shrub-Carr



## Southern Wet Meadow

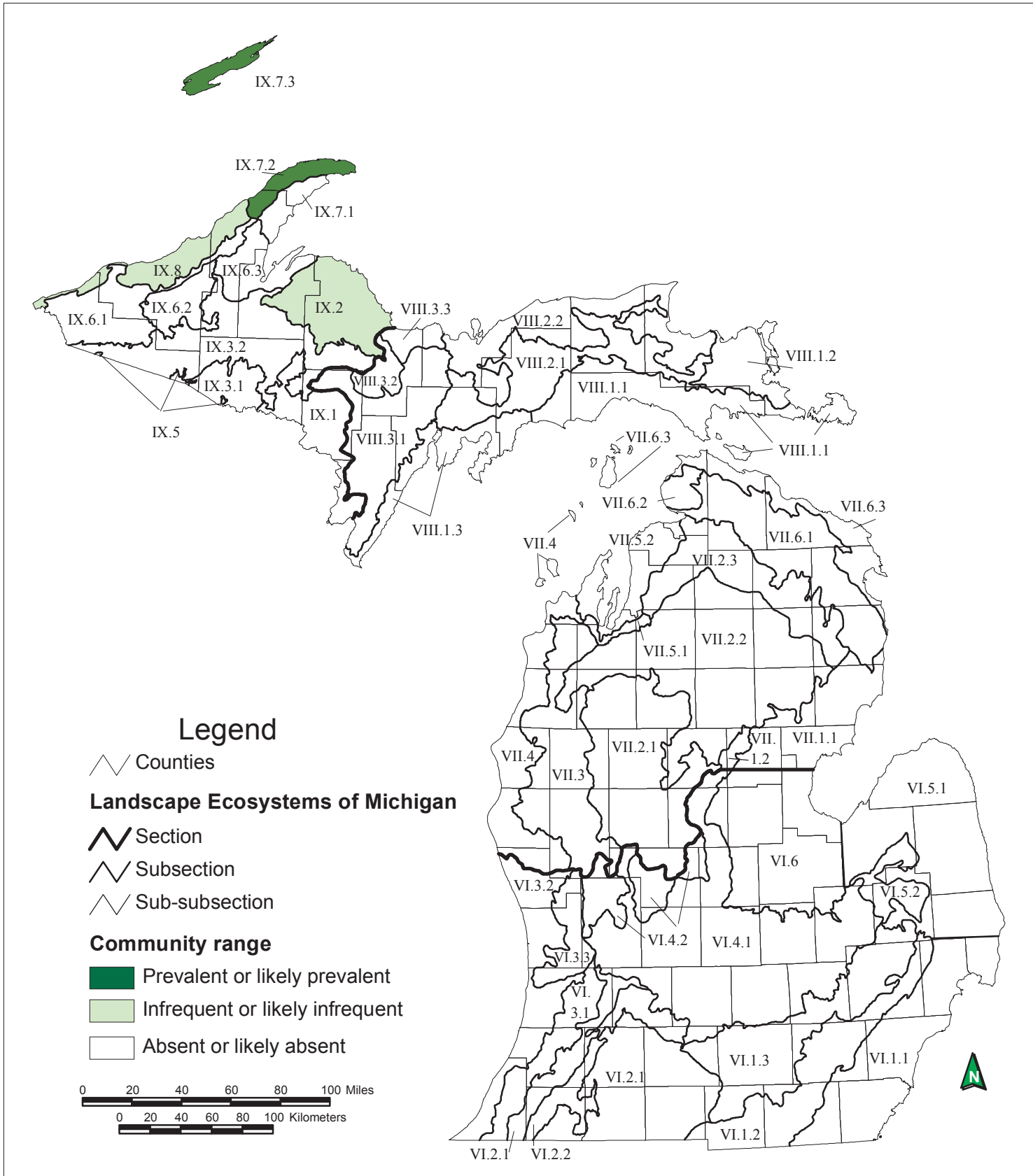


## Submergent Marsh

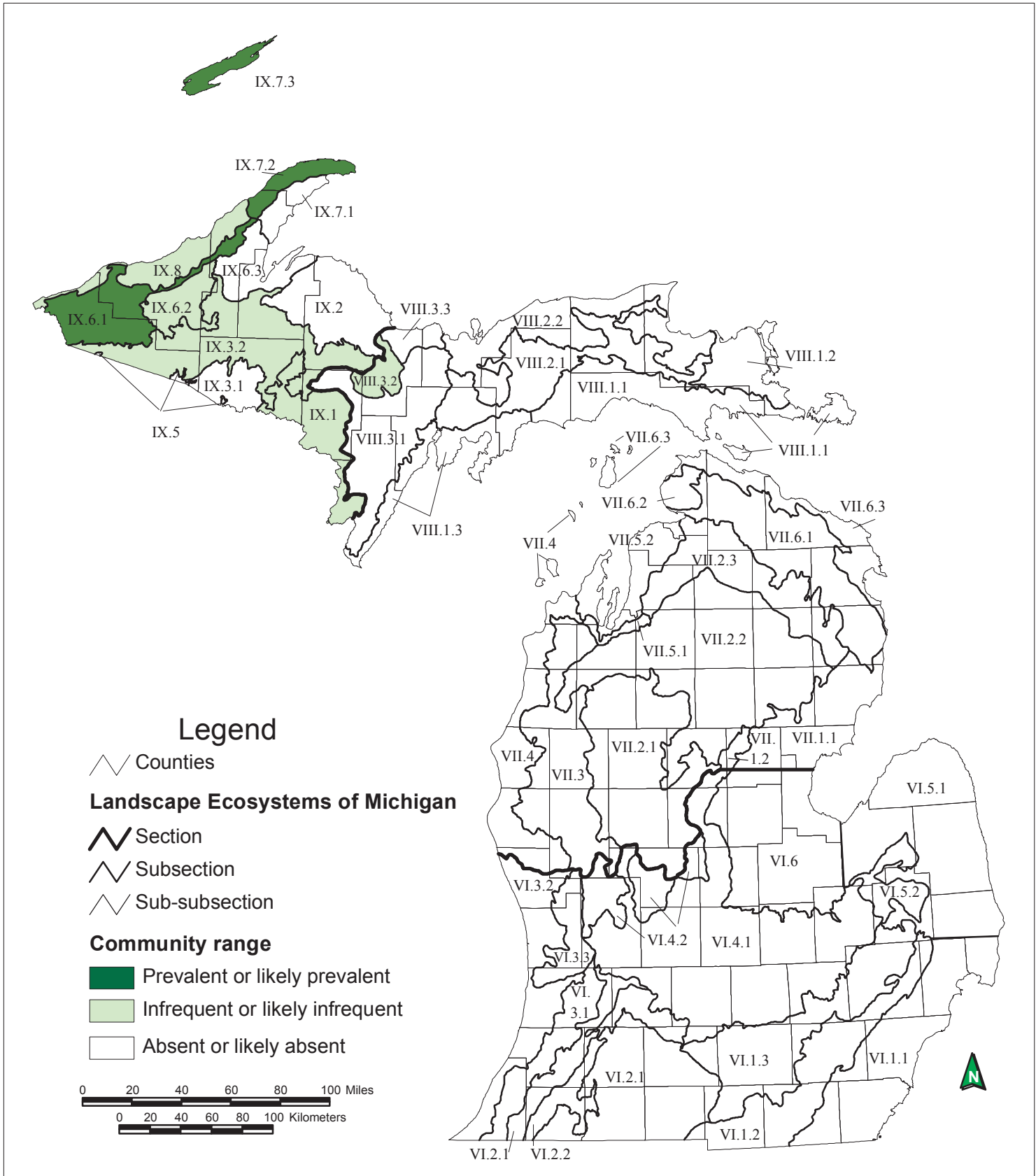


## Volcanic Bedrock Glade

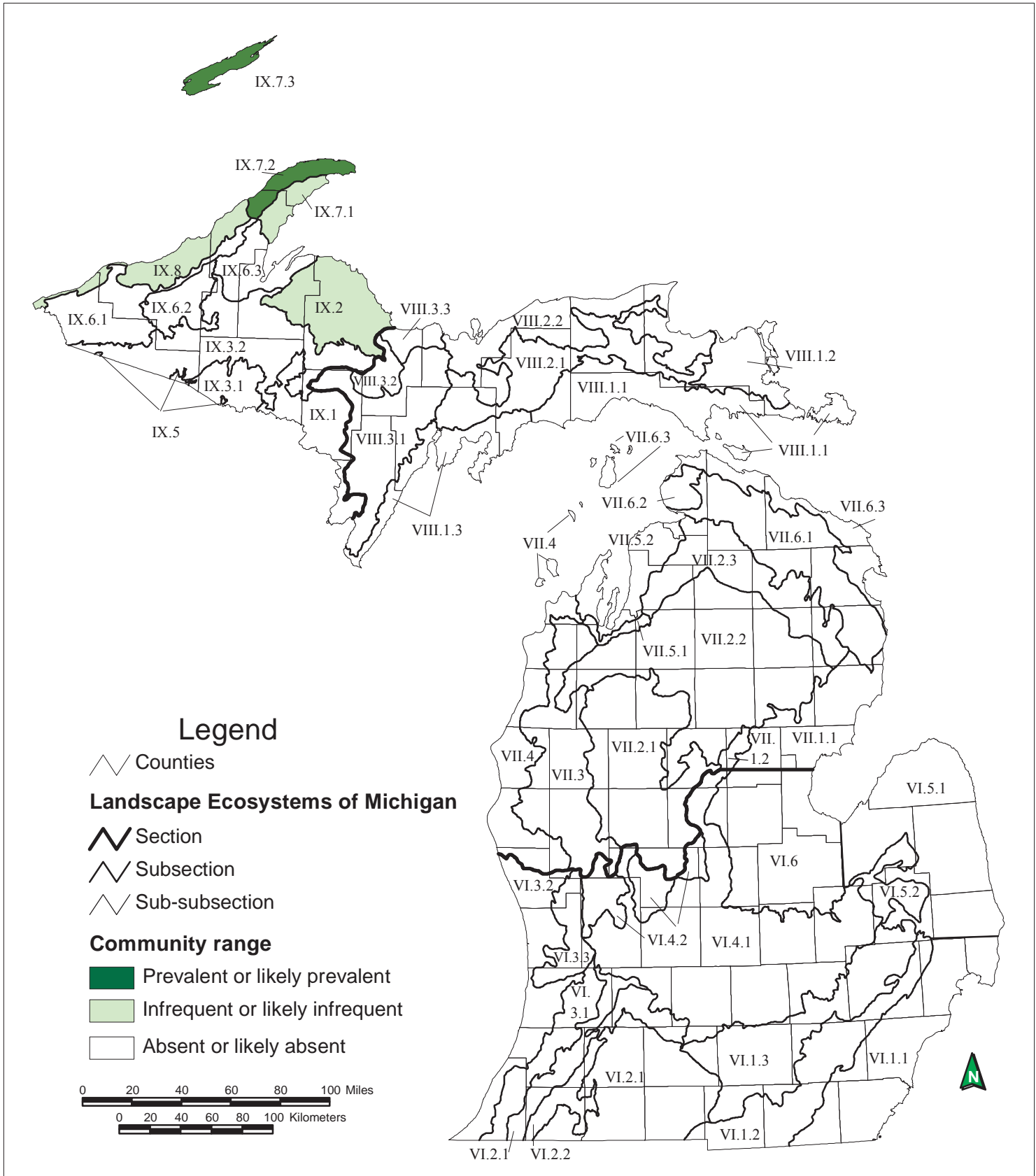




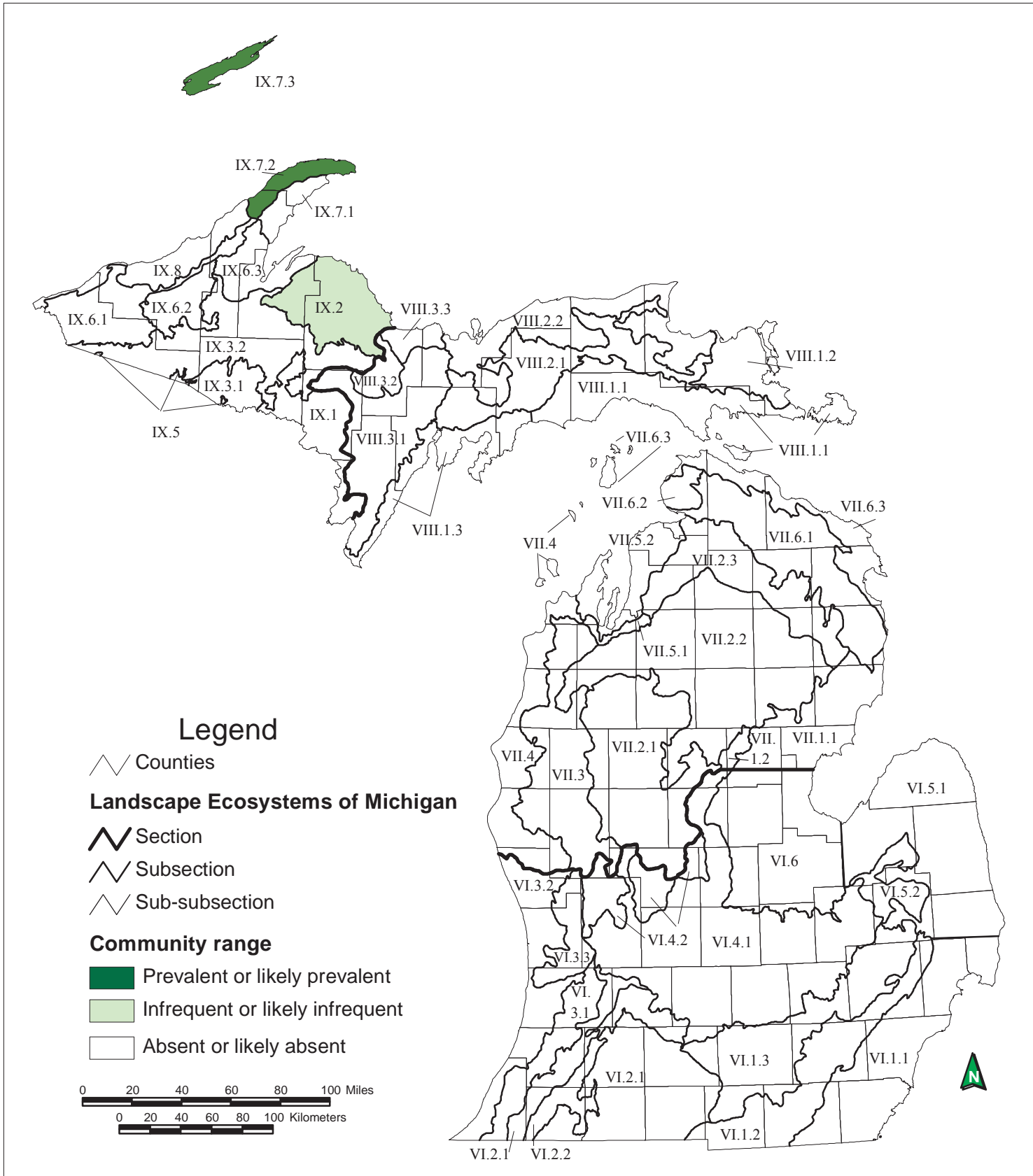
## Volcanic Bedrock Lakeshore



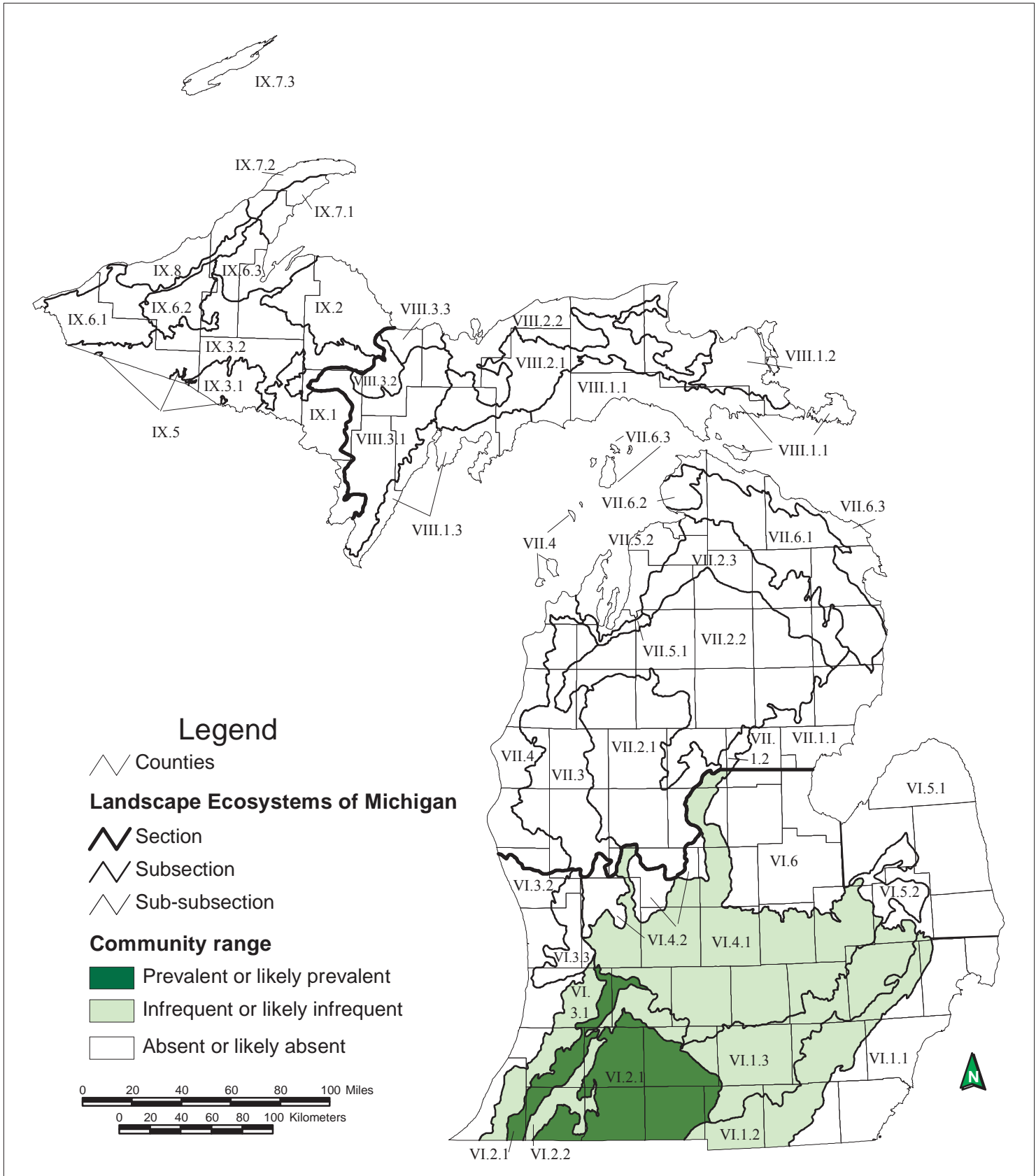
## Volcanic Cliff



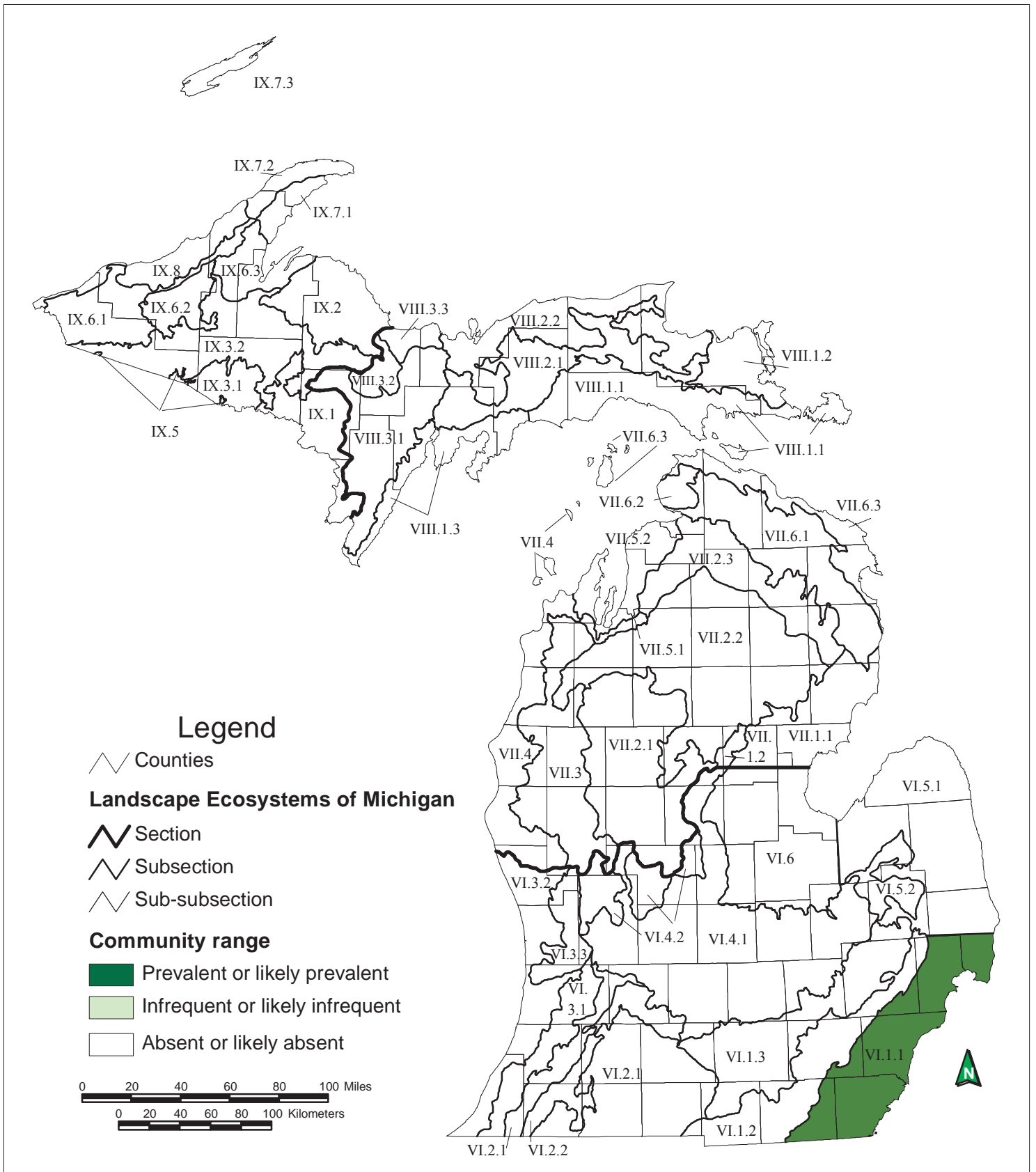
## Volcanic Cobble Shore



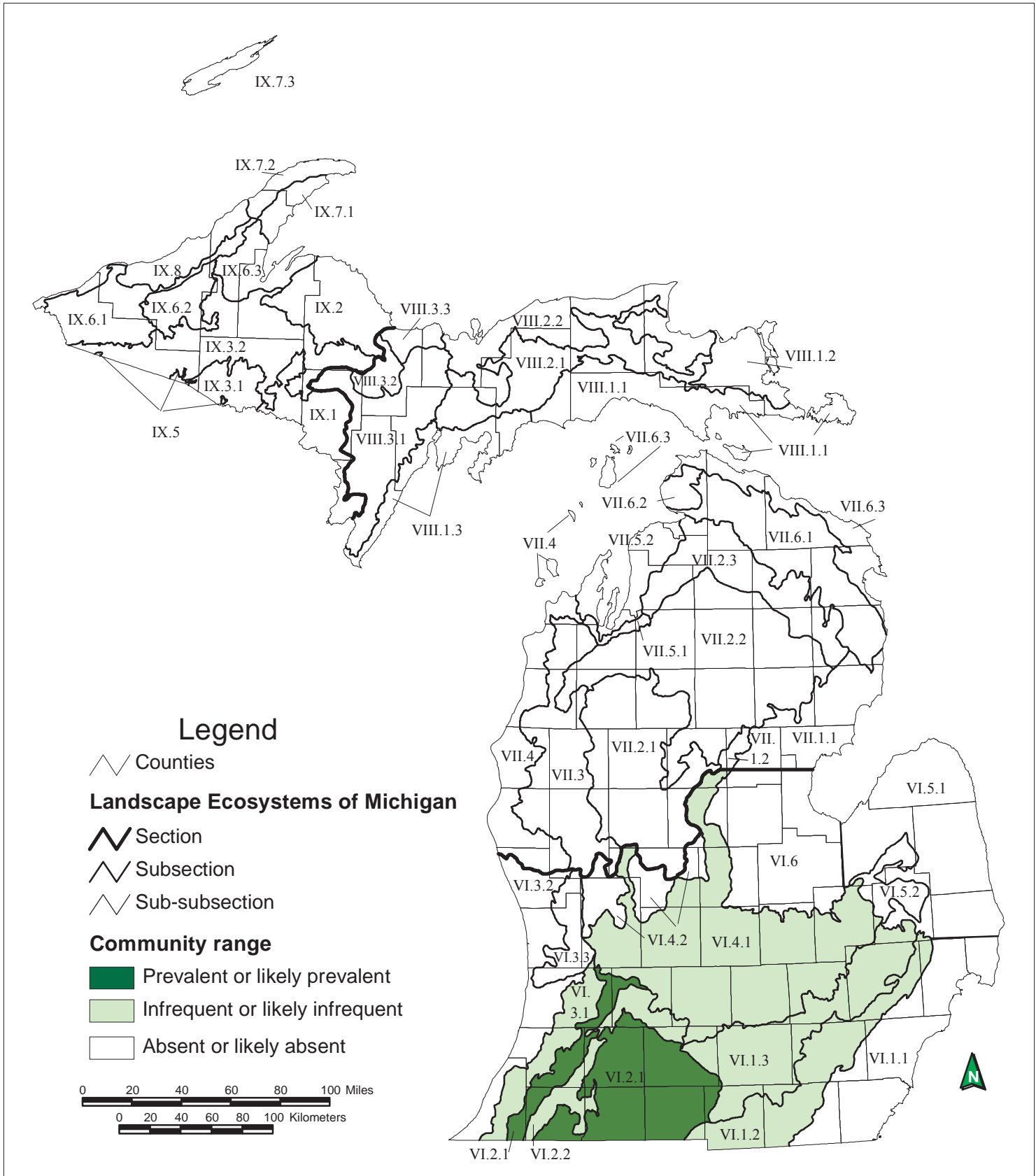
## Volcanic Lakeshore Cliff



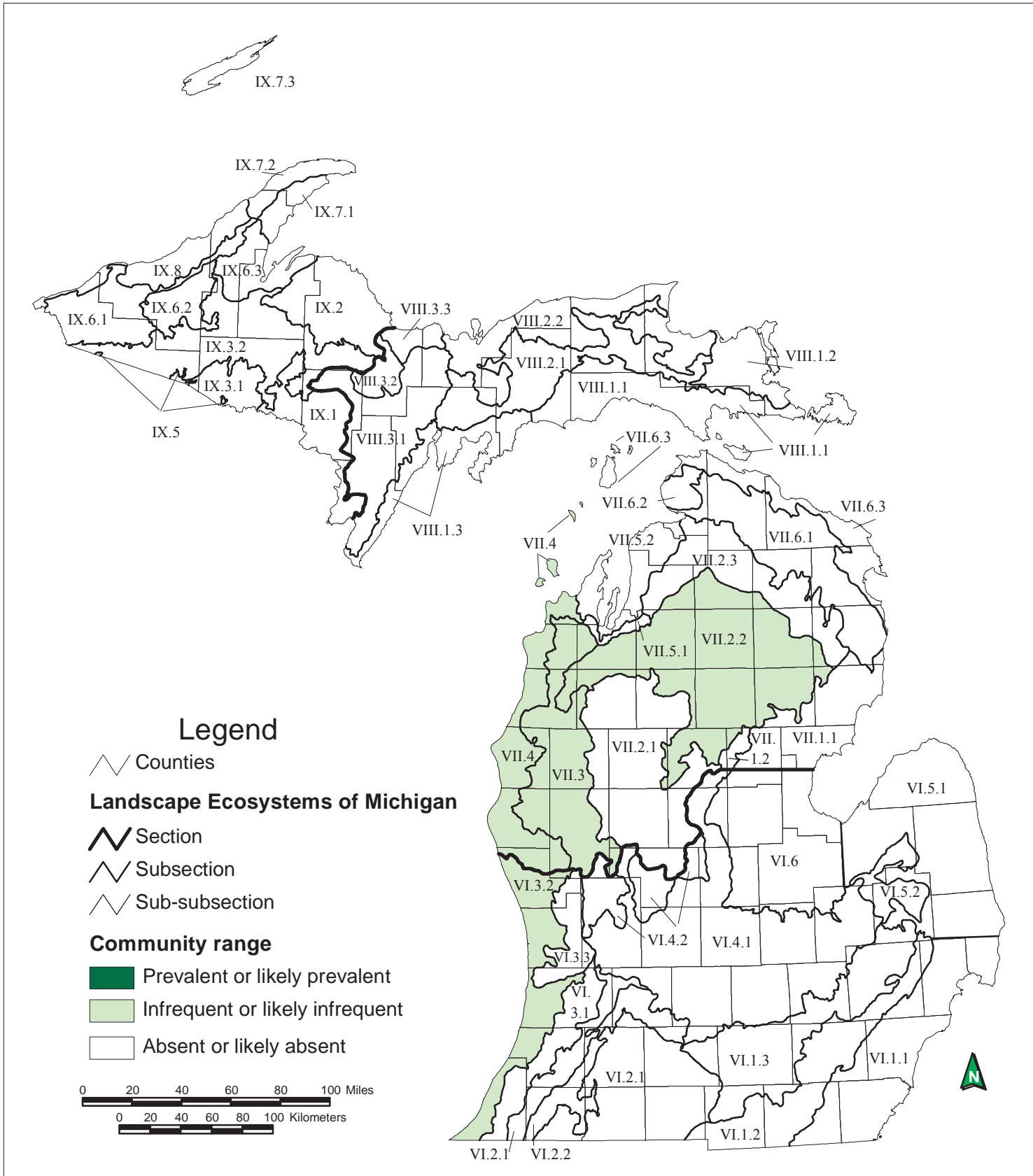
## Wet Prairie



## Wet-mesic Flatwoods

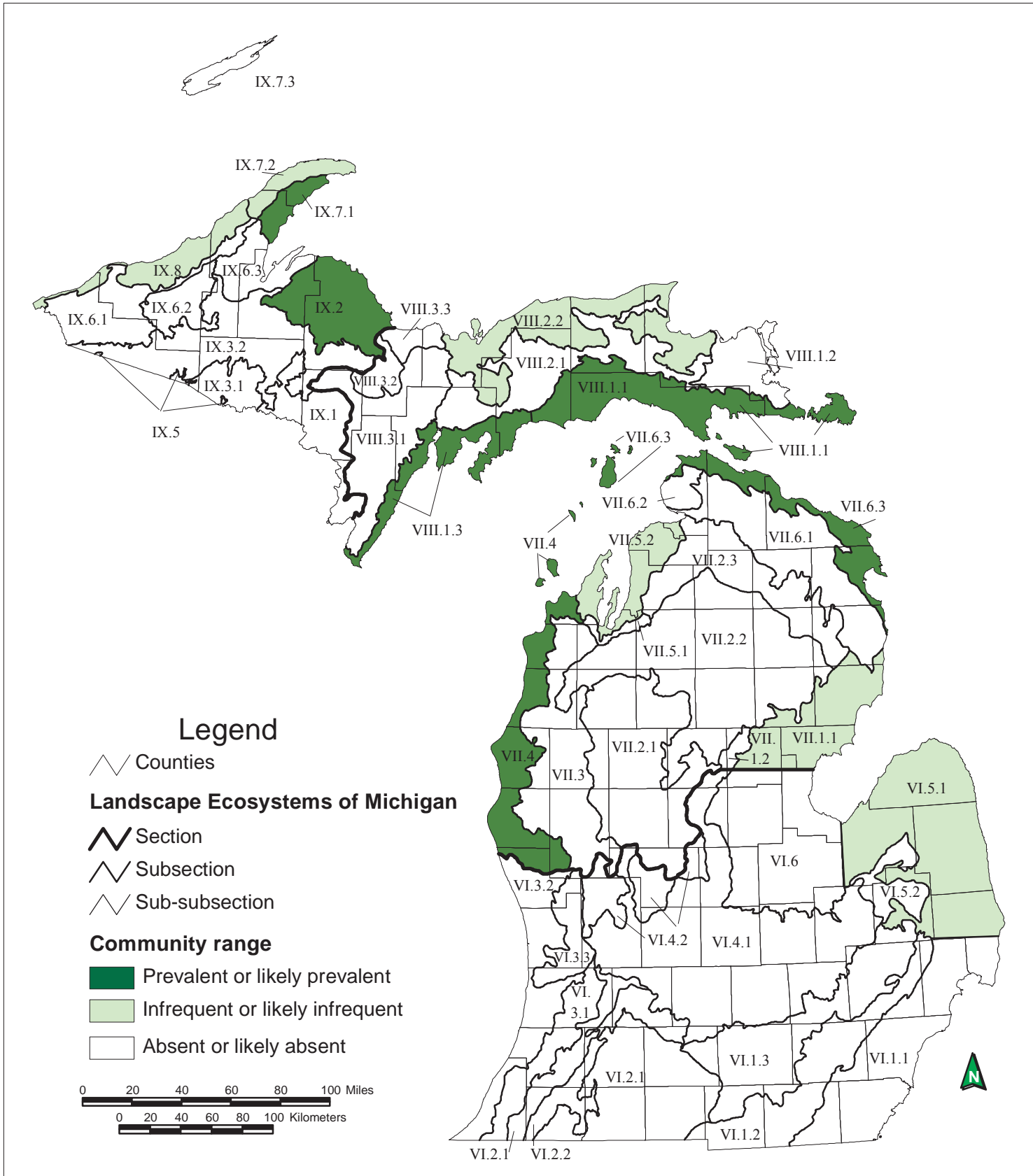


## Wet-mesic Prairie



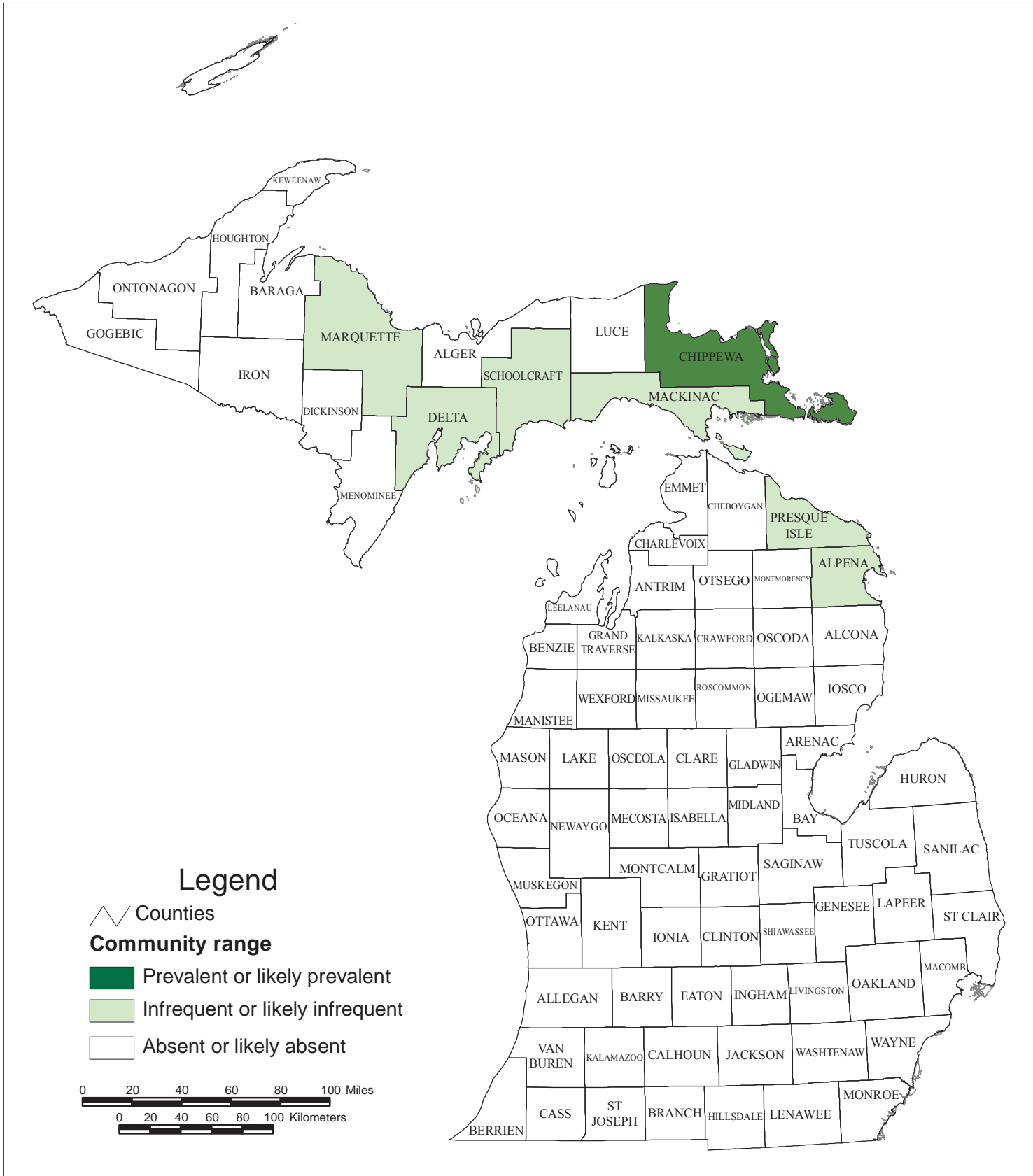
## Wet-mesic Sand Prairie

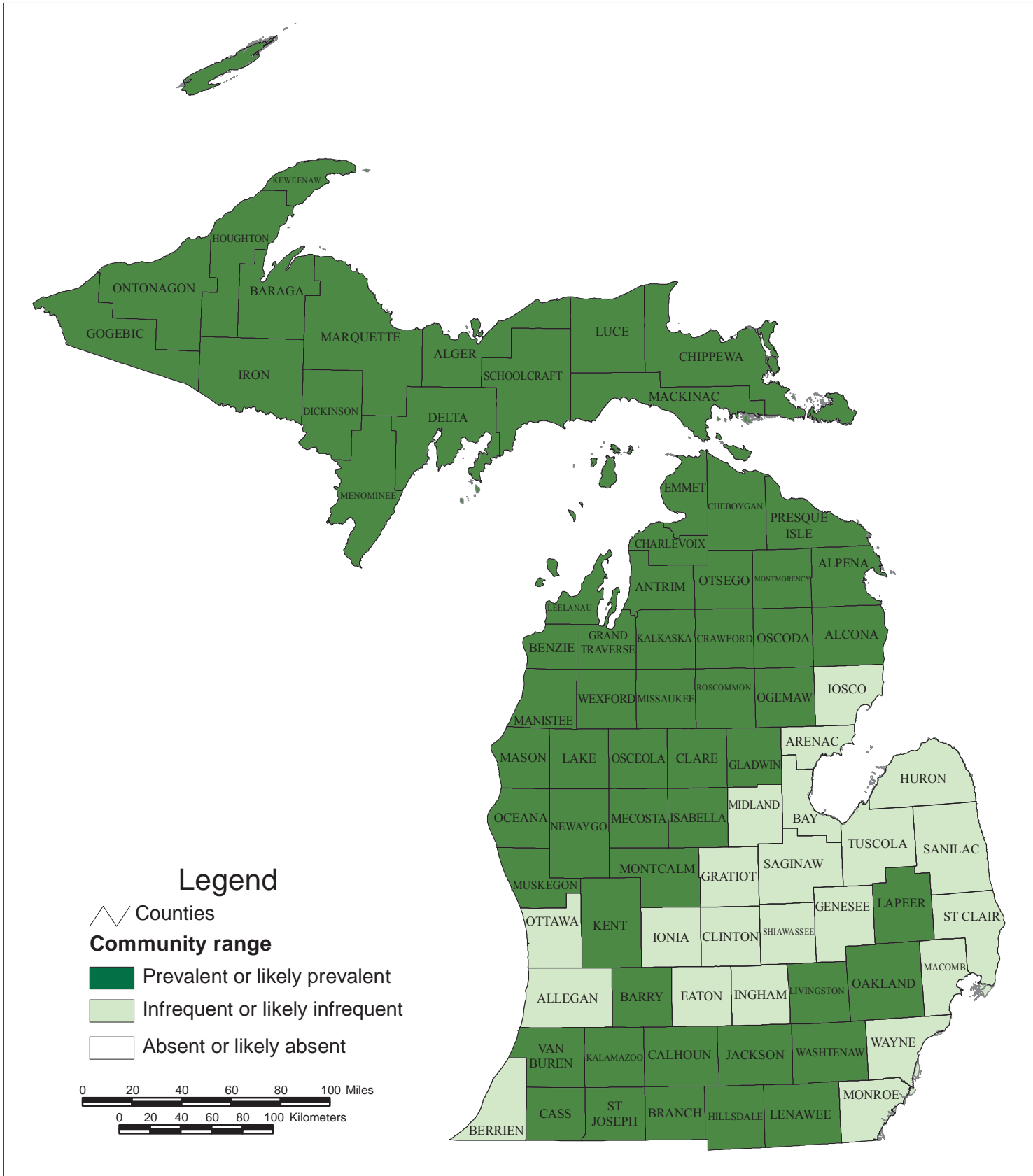


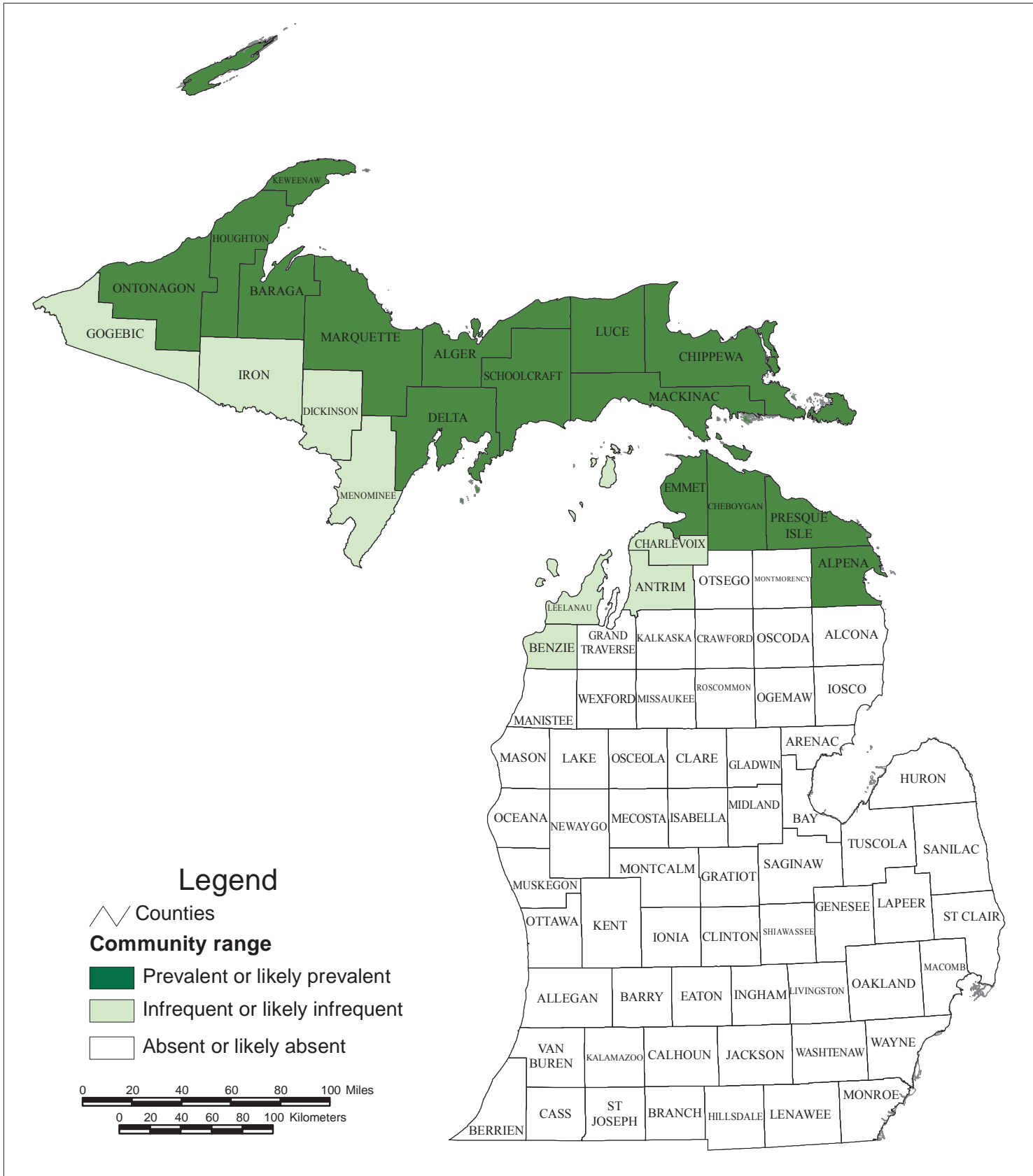


## Wooded Dune and Swale Complex

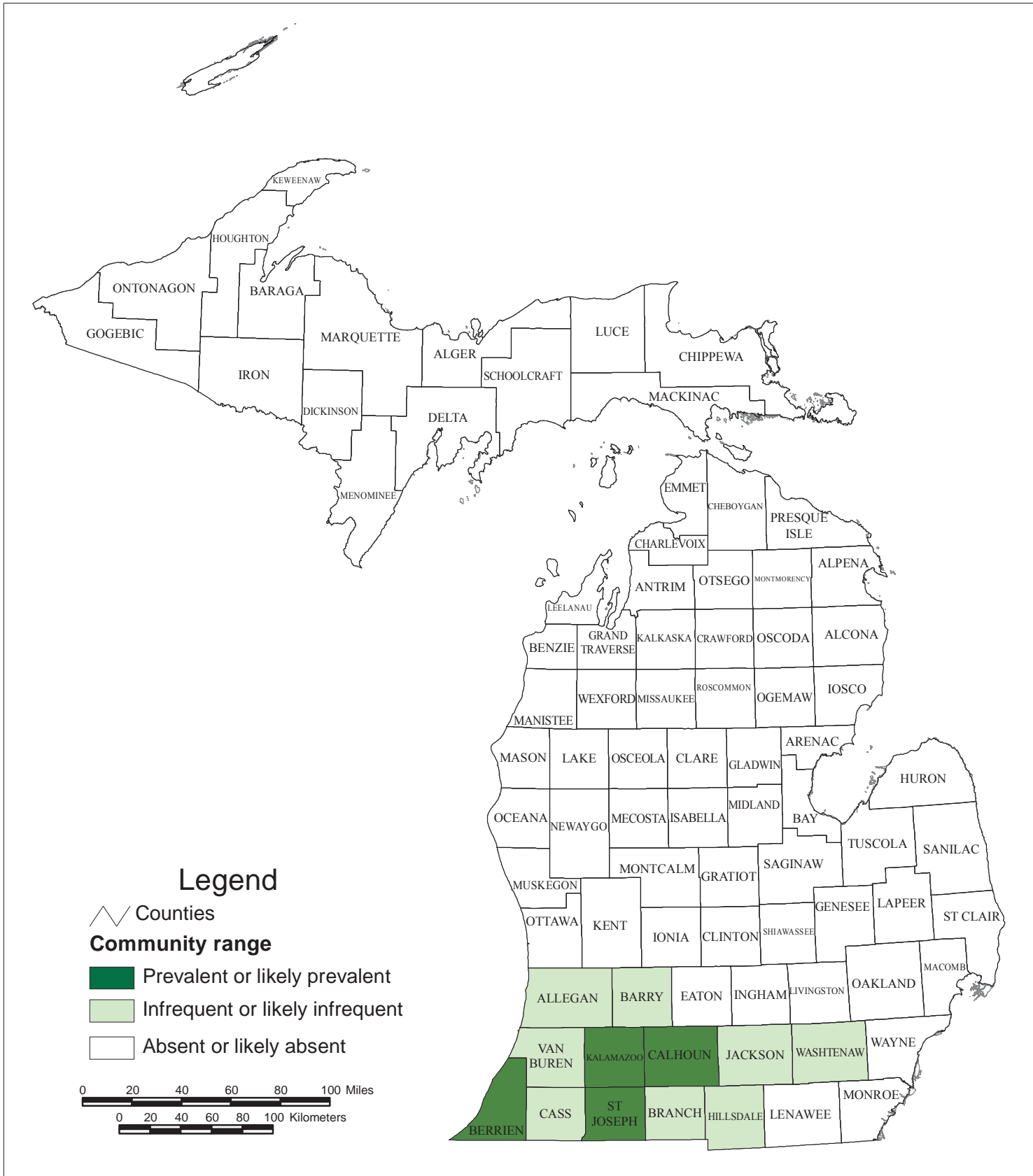
**Appendix 2**  
**Natural Community Distribution Maps by**  
**County**



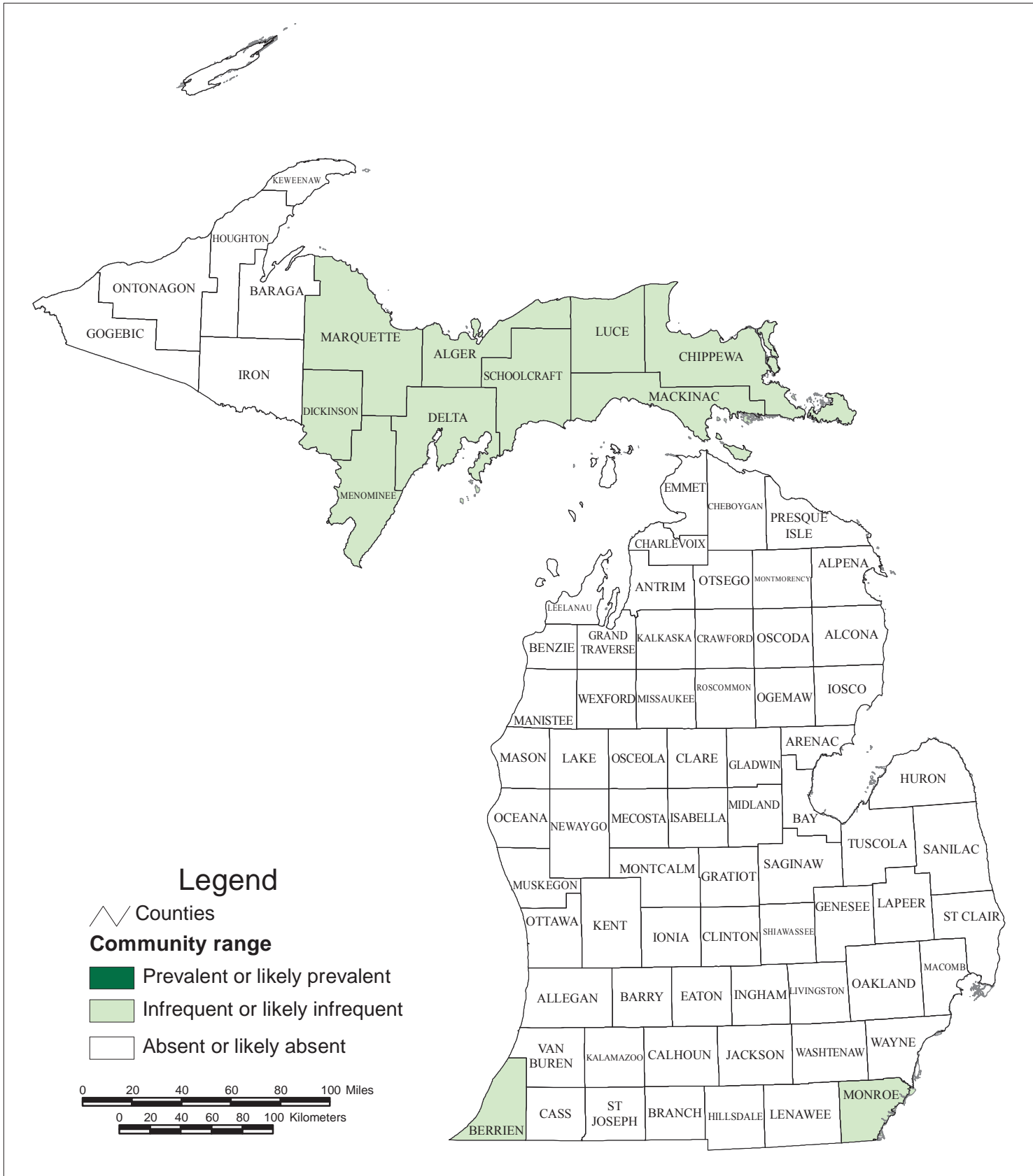




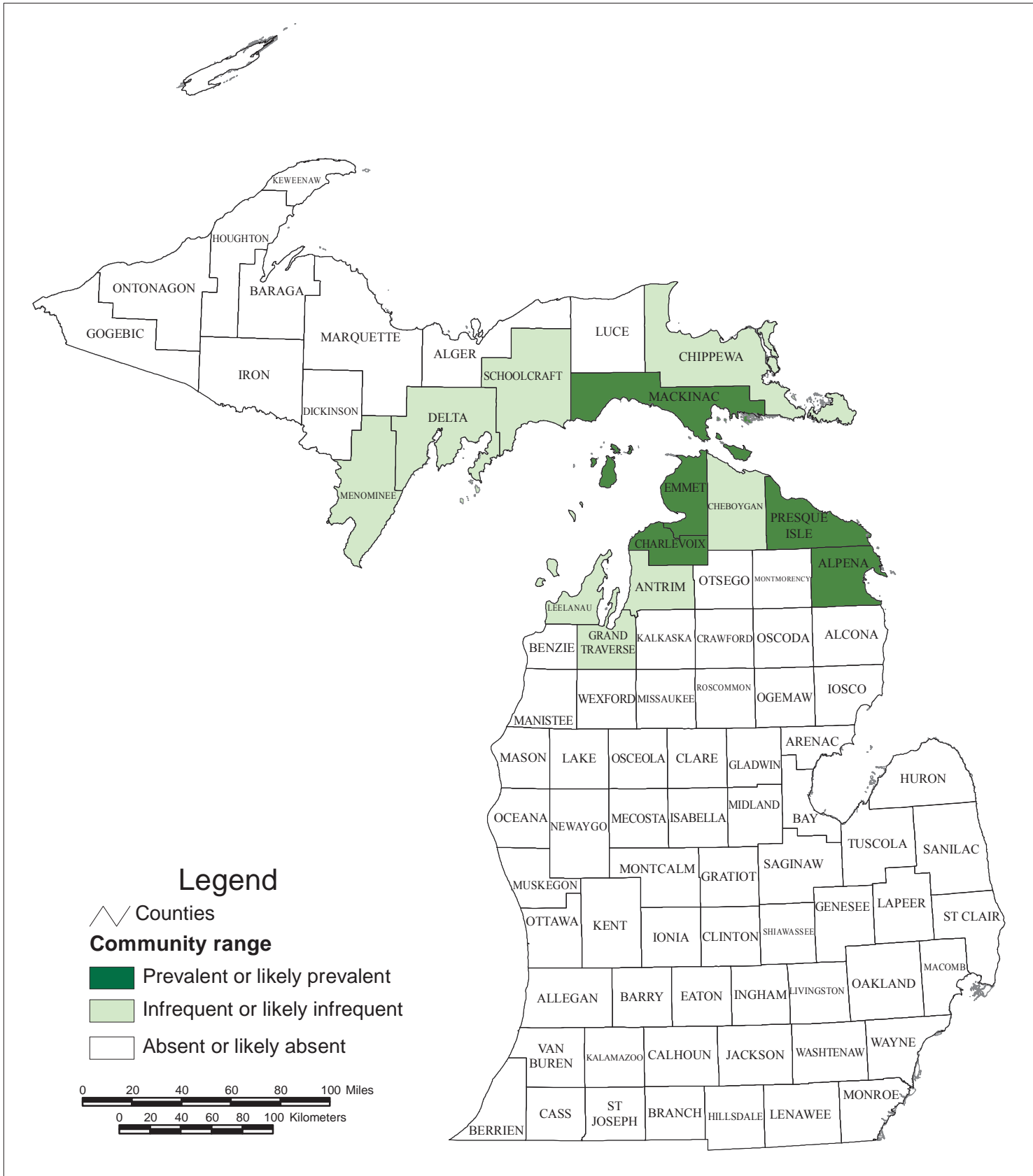
## Boreal Forest



## Bur Oak Plains

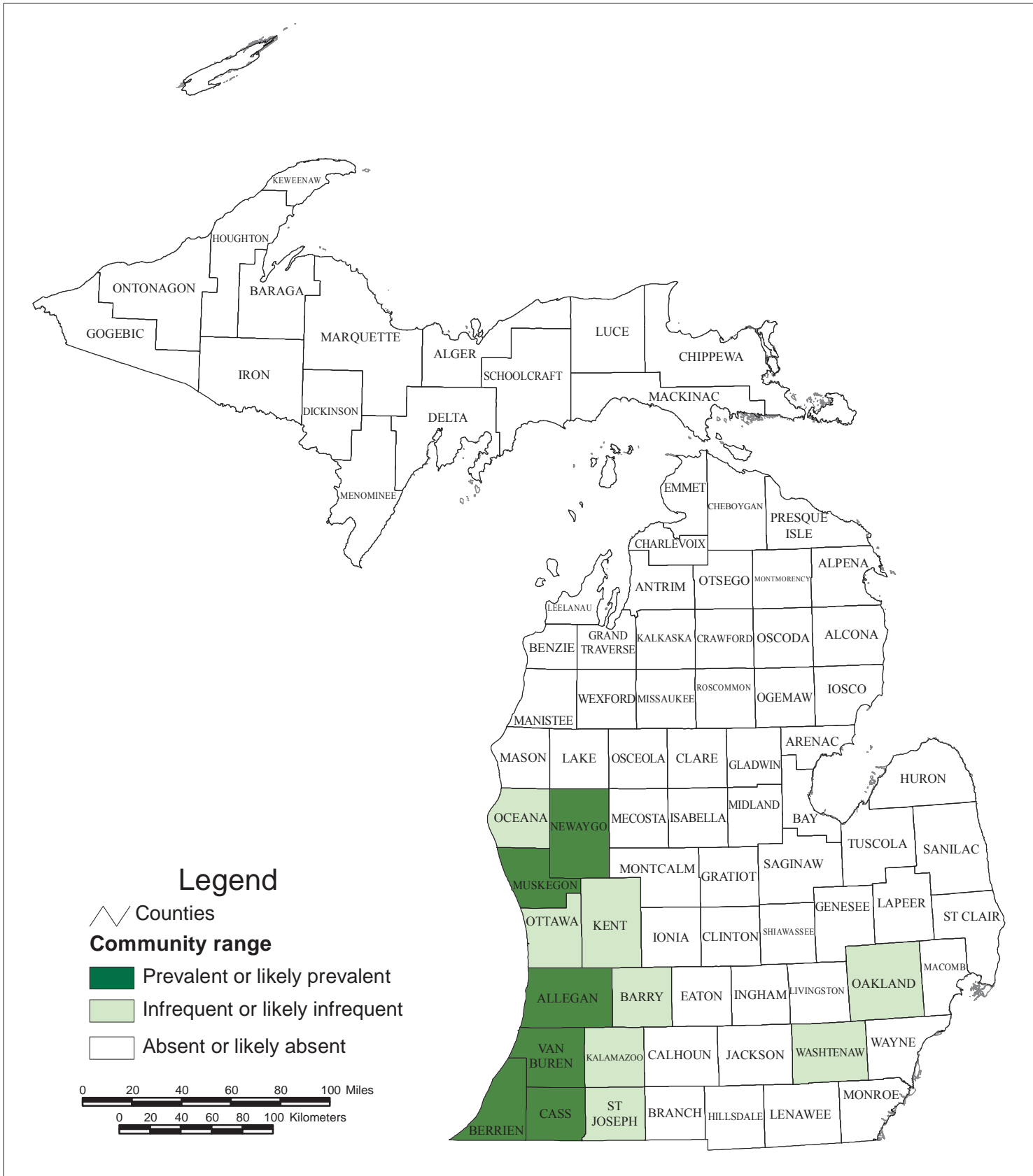


## Cave

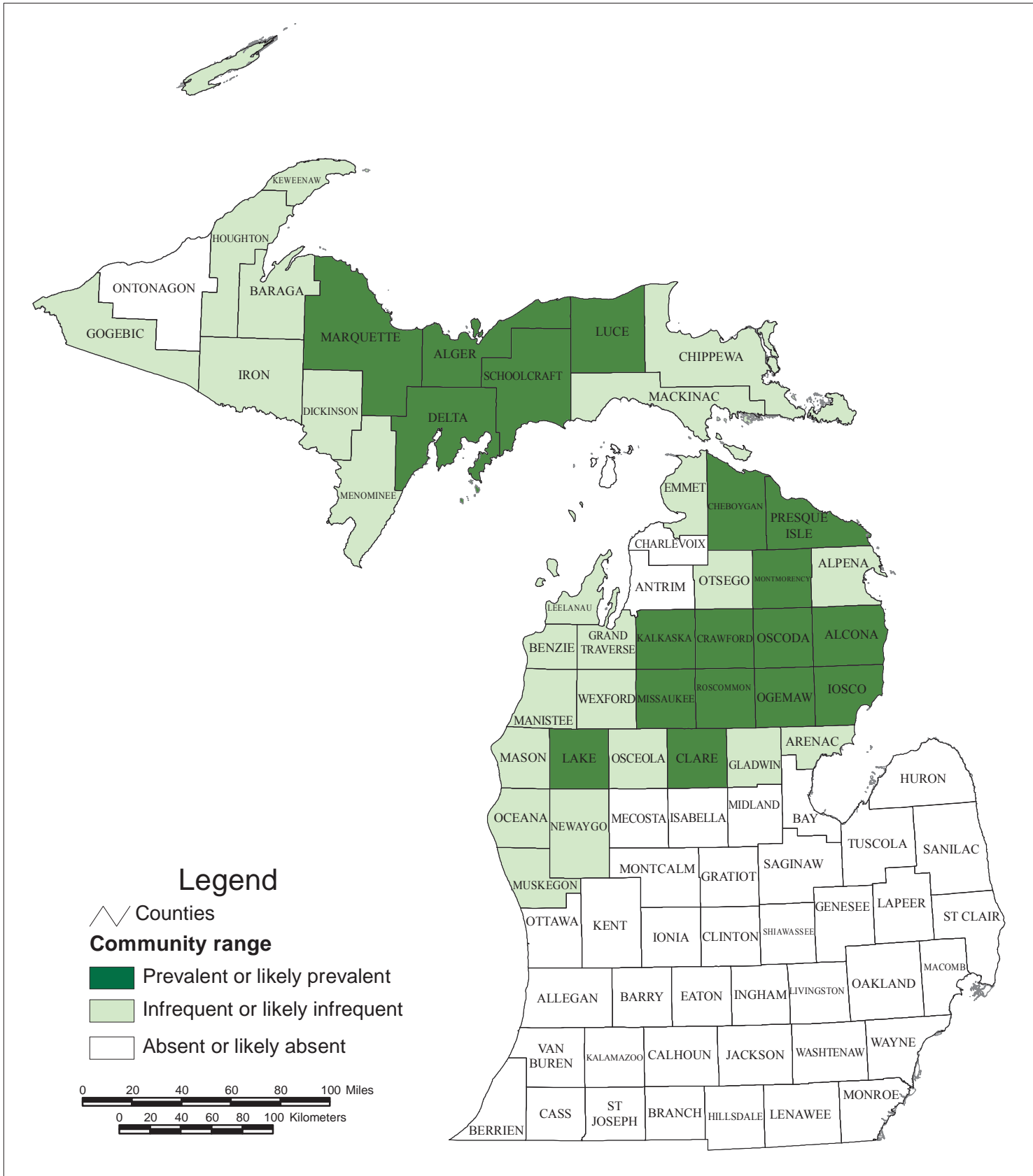


## Coastal Fen

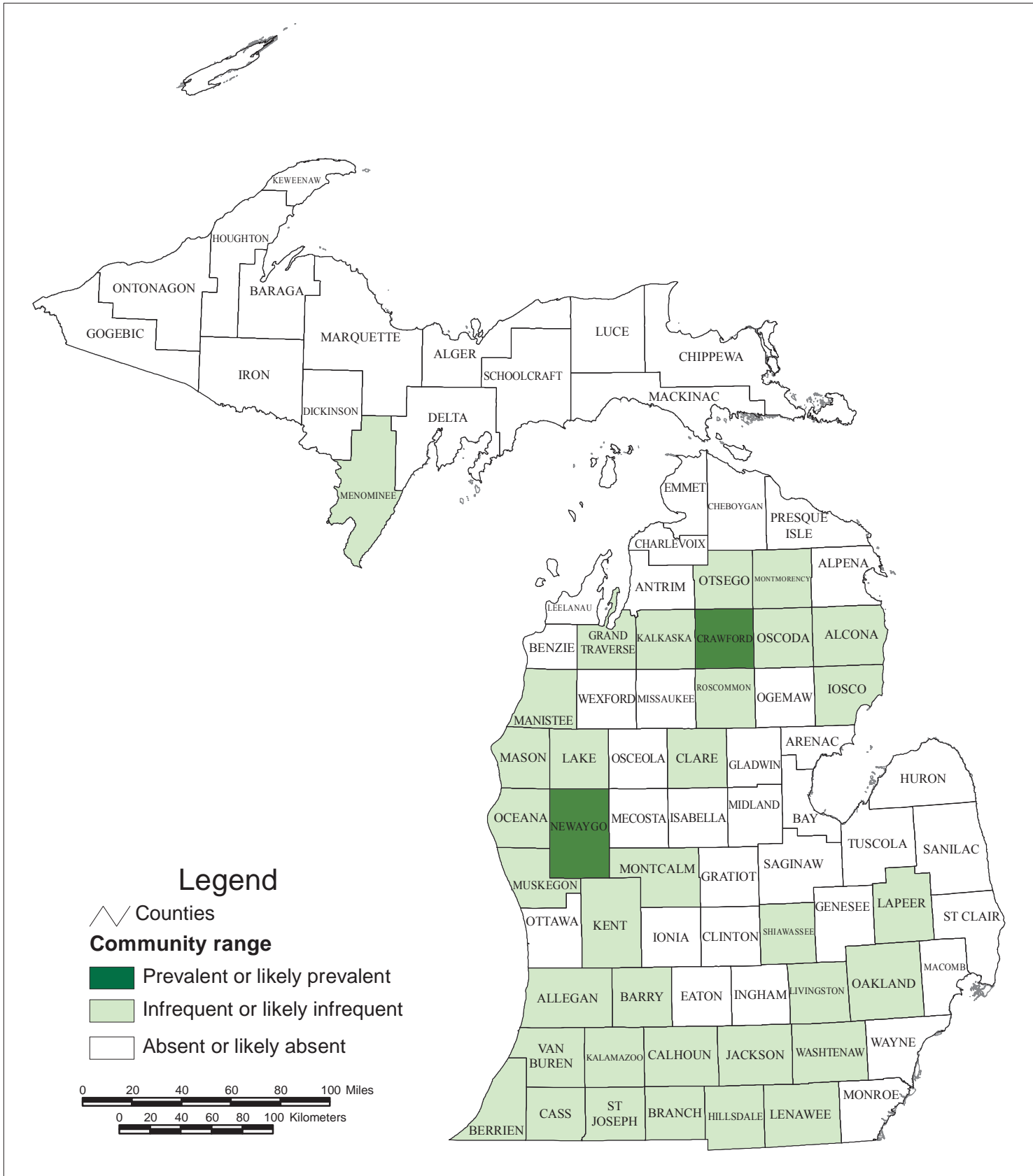




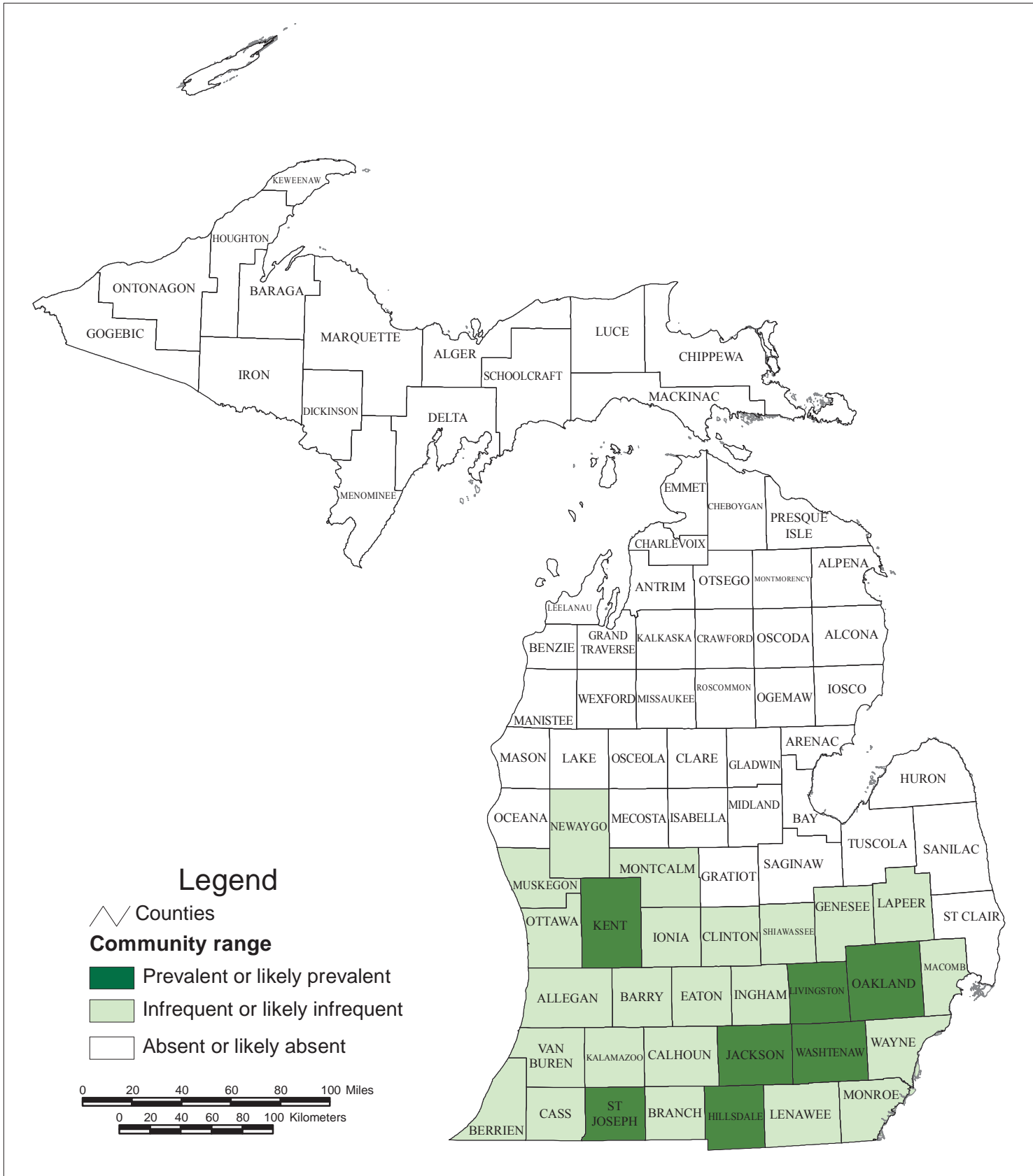
## Coastal Plain Marsh



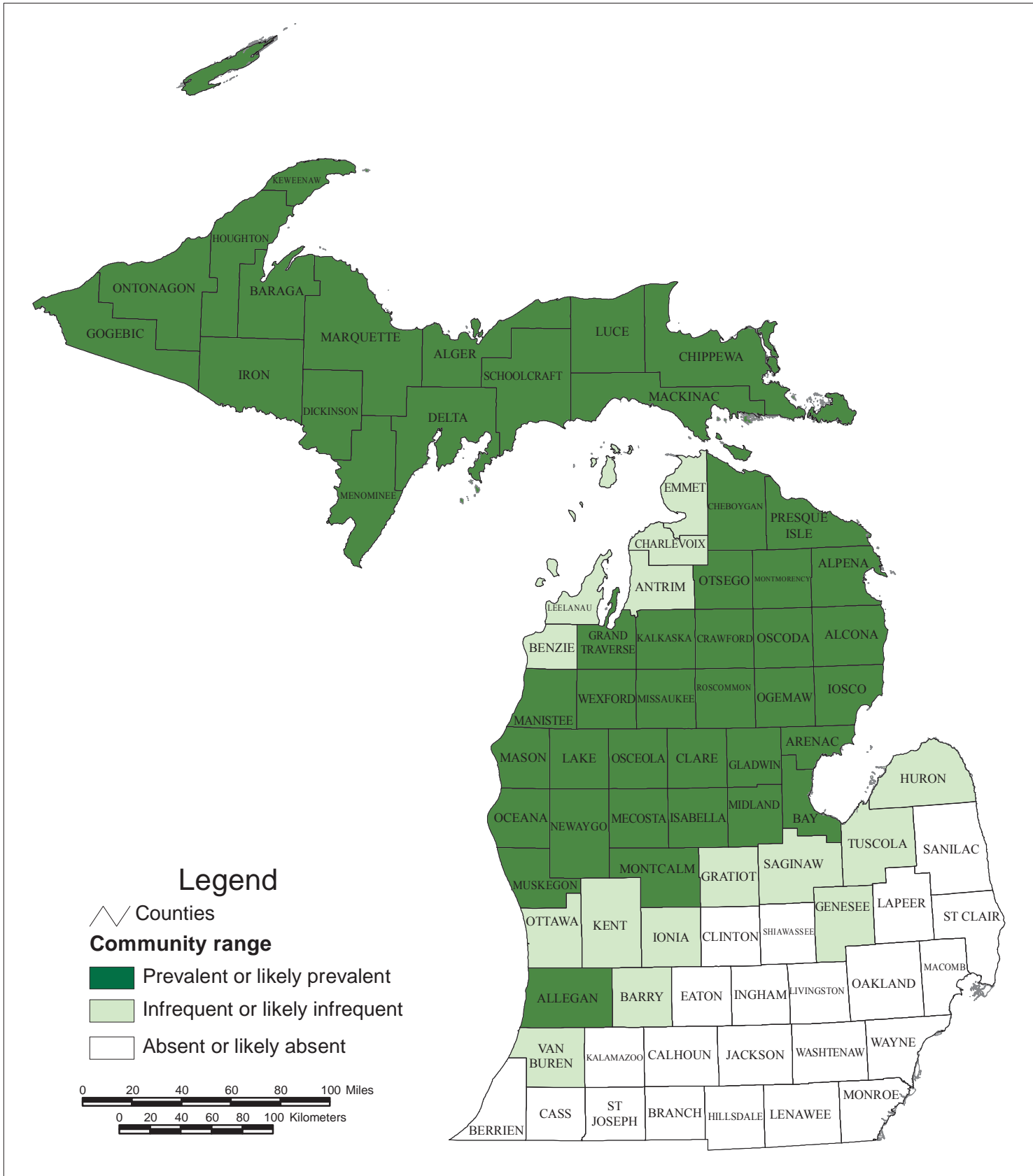
## Dry Northern Forest



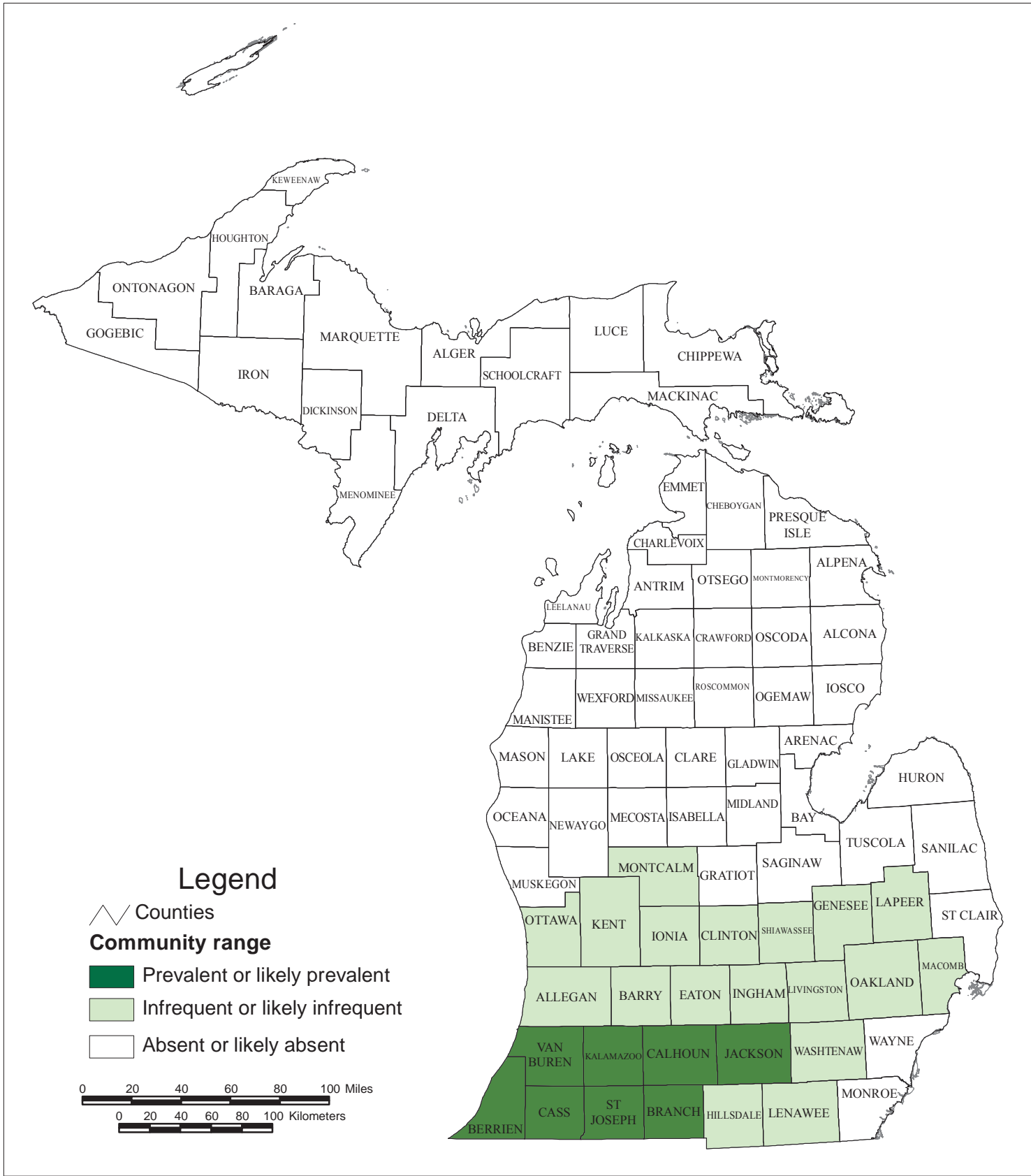
## Dry Sand Prairie



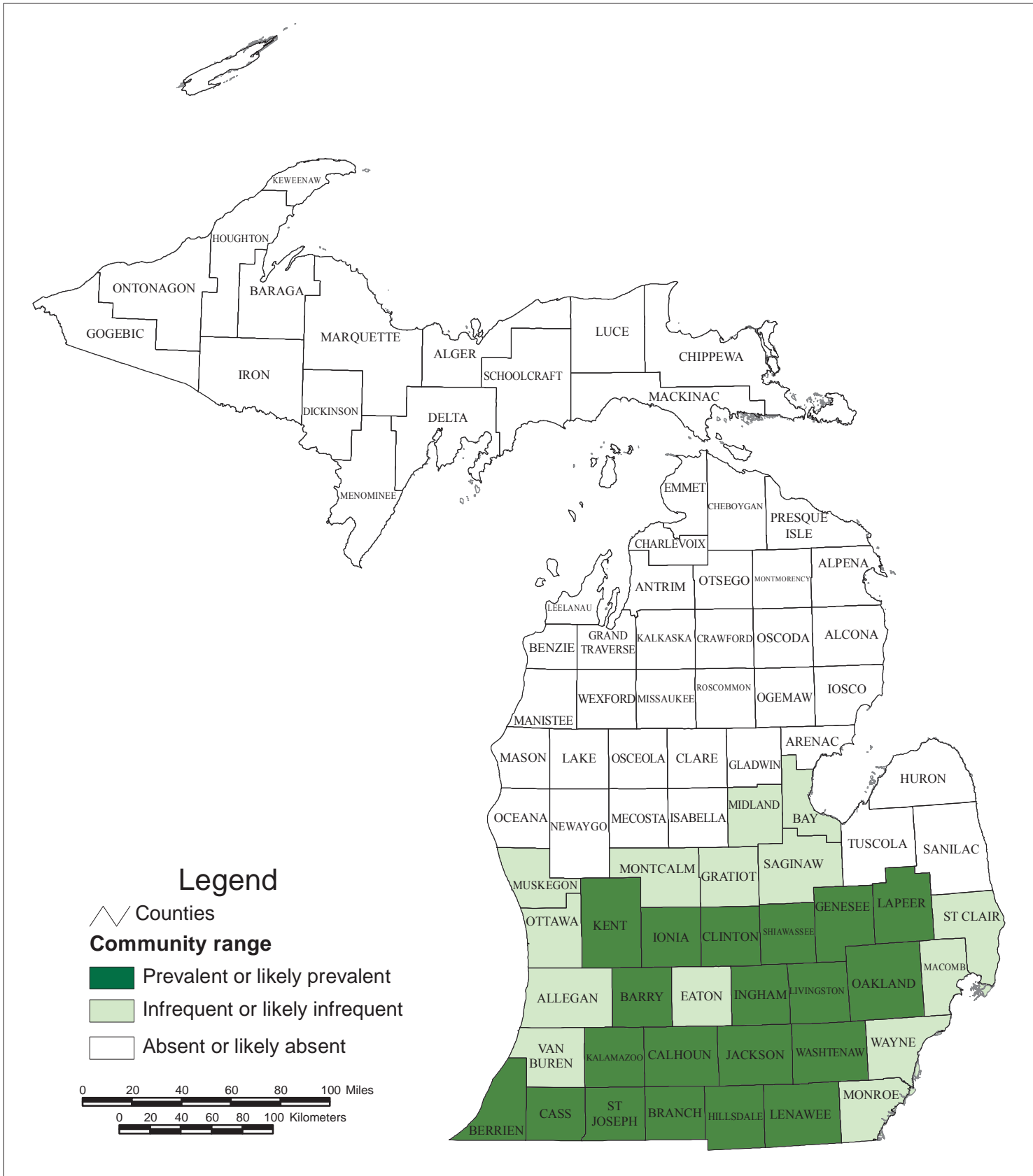
## Dry Southern Forest



## Dry-mesic Northern Forest



## Dry-mesic Prairie

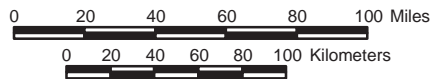


### Legend

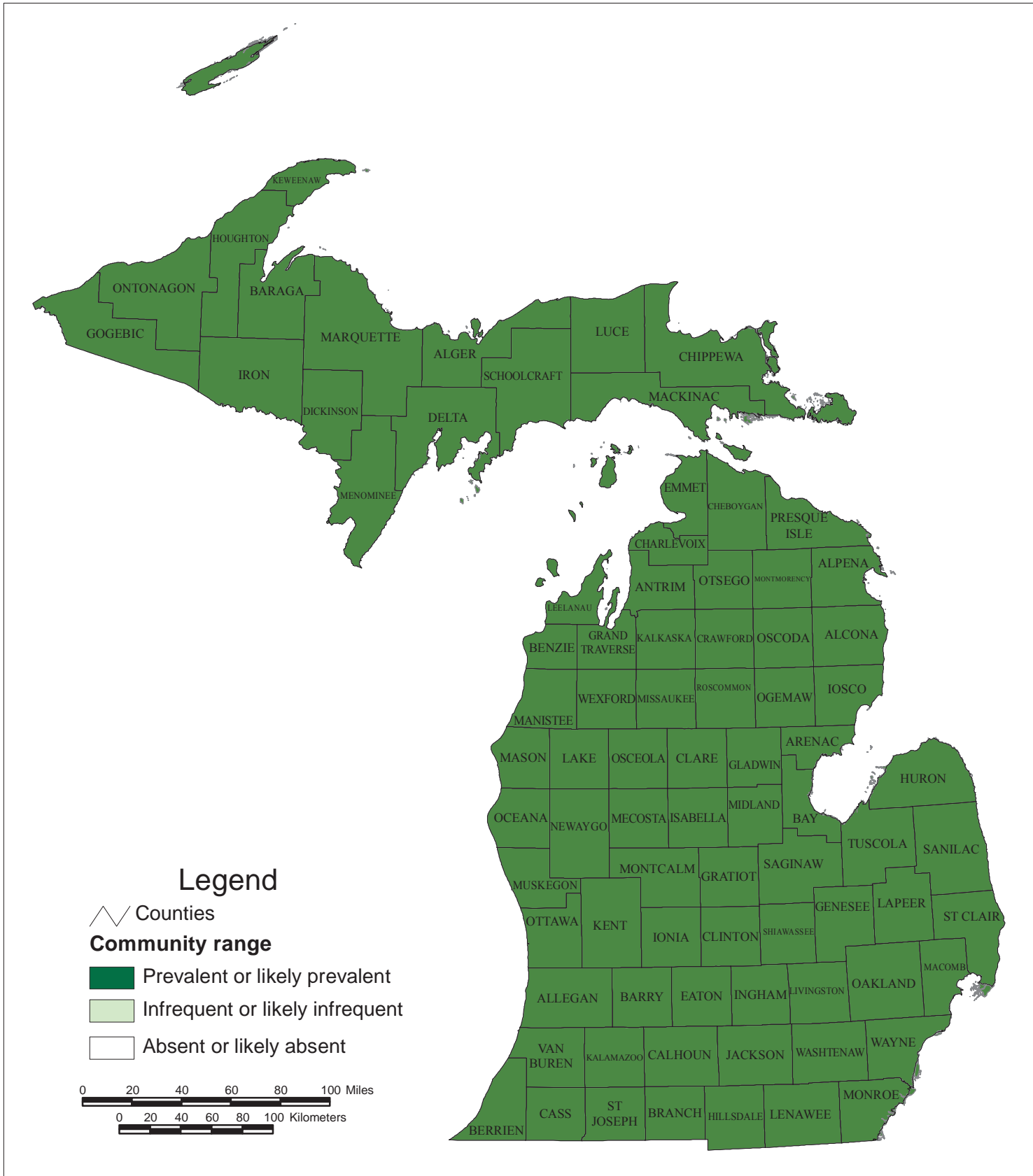
Counties

#### Community range

- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent



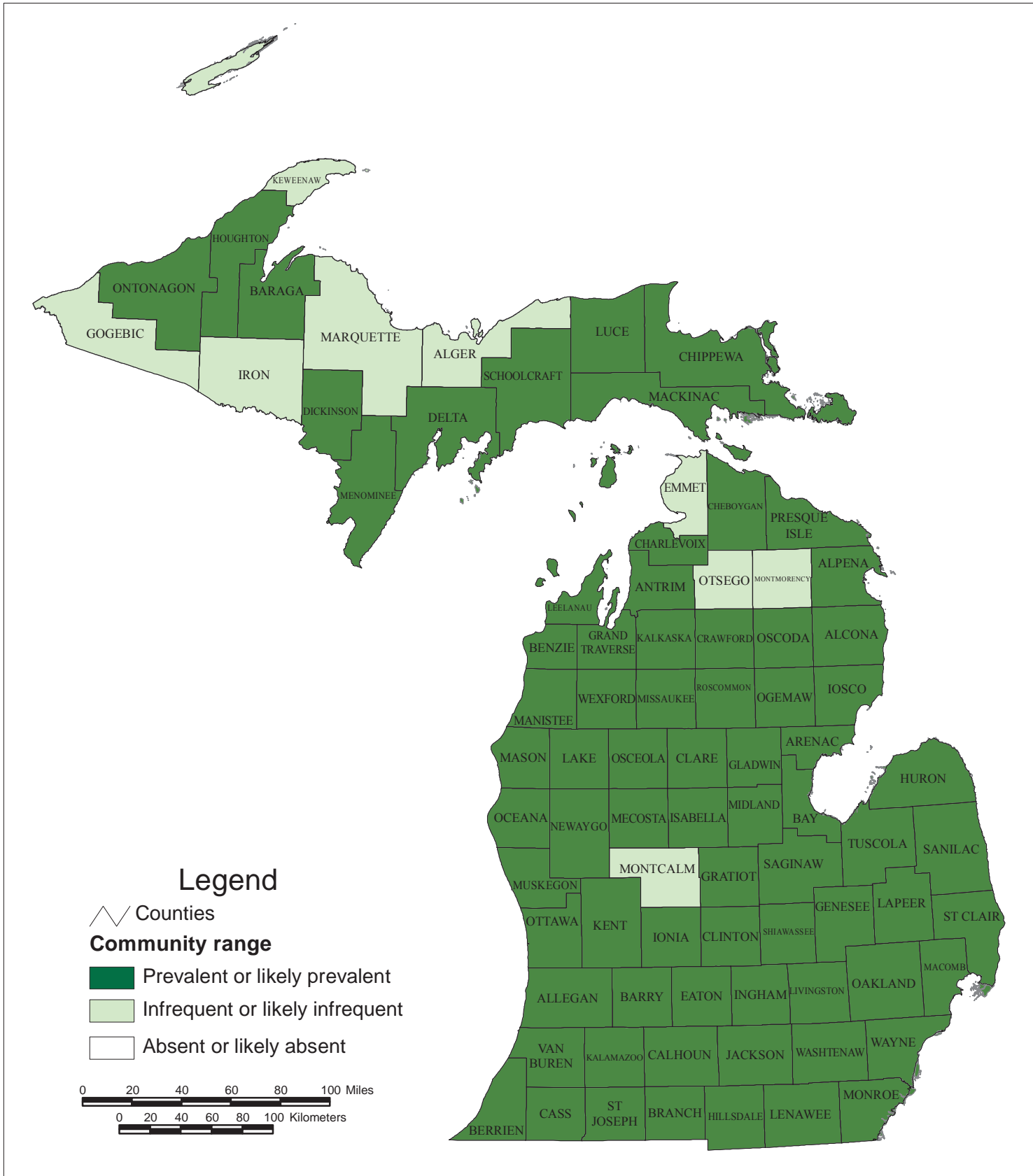
## Dry-mesic Southern Forest



## Emergent Marsh

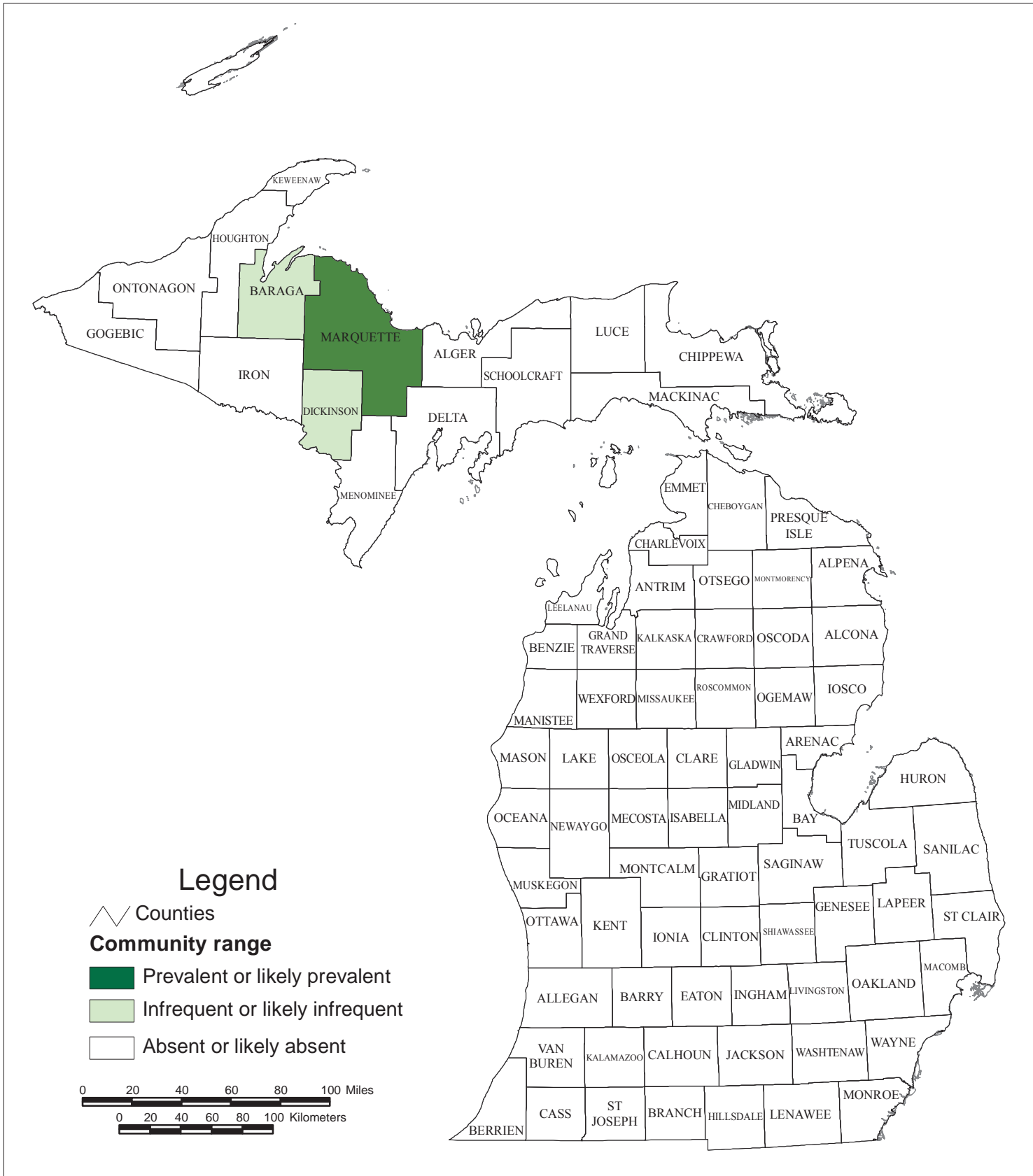




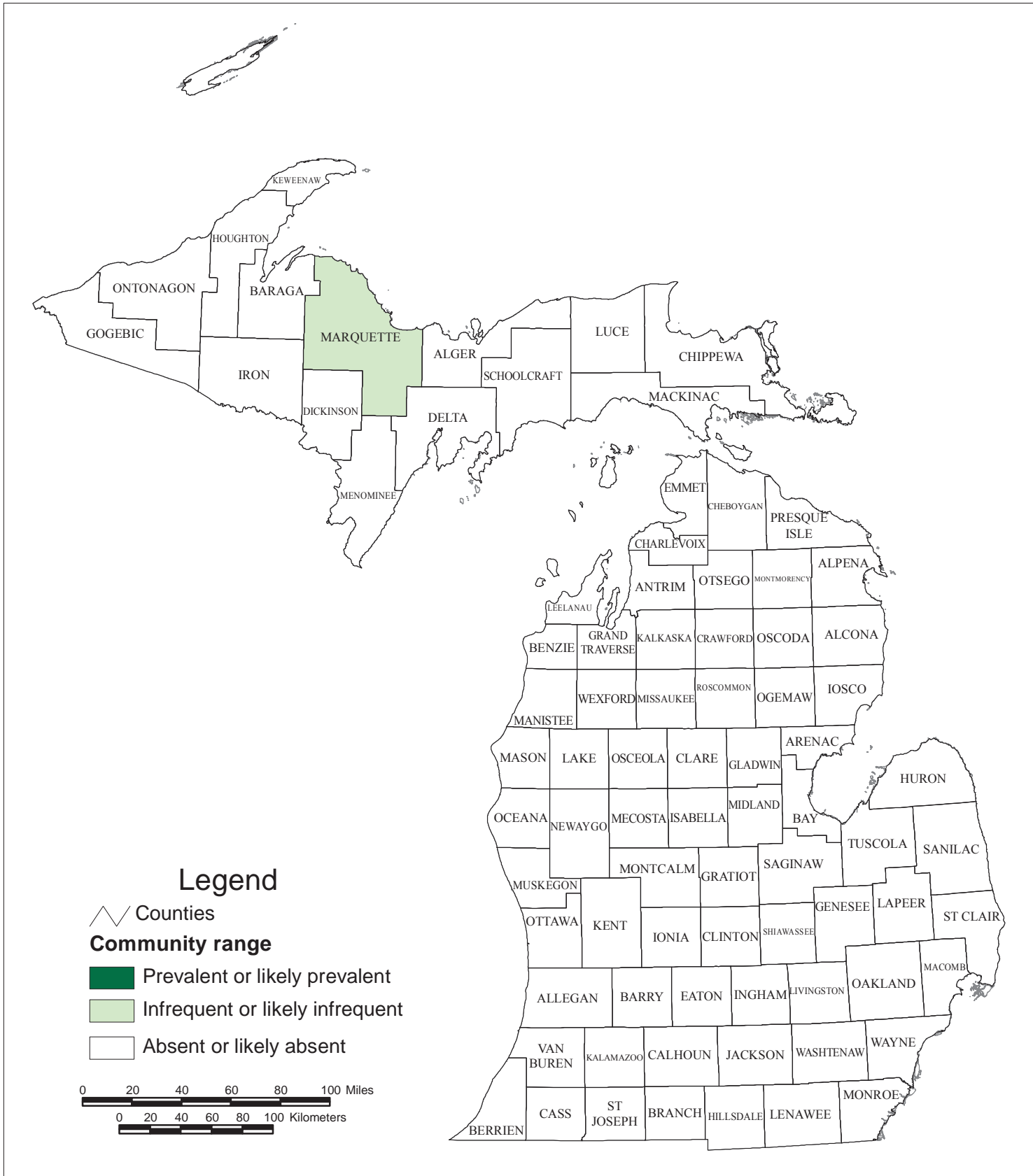


## Floodplain Forest

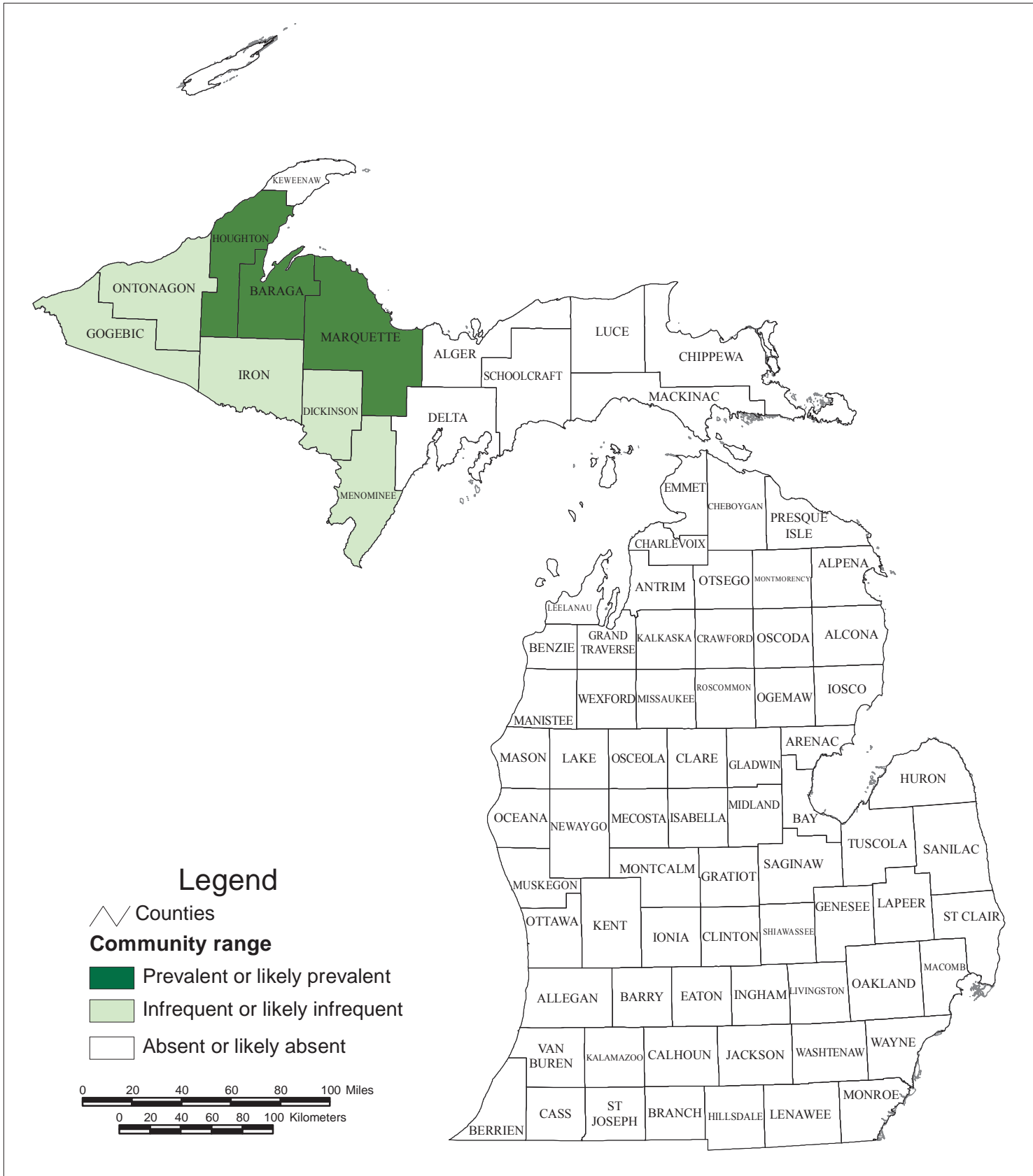


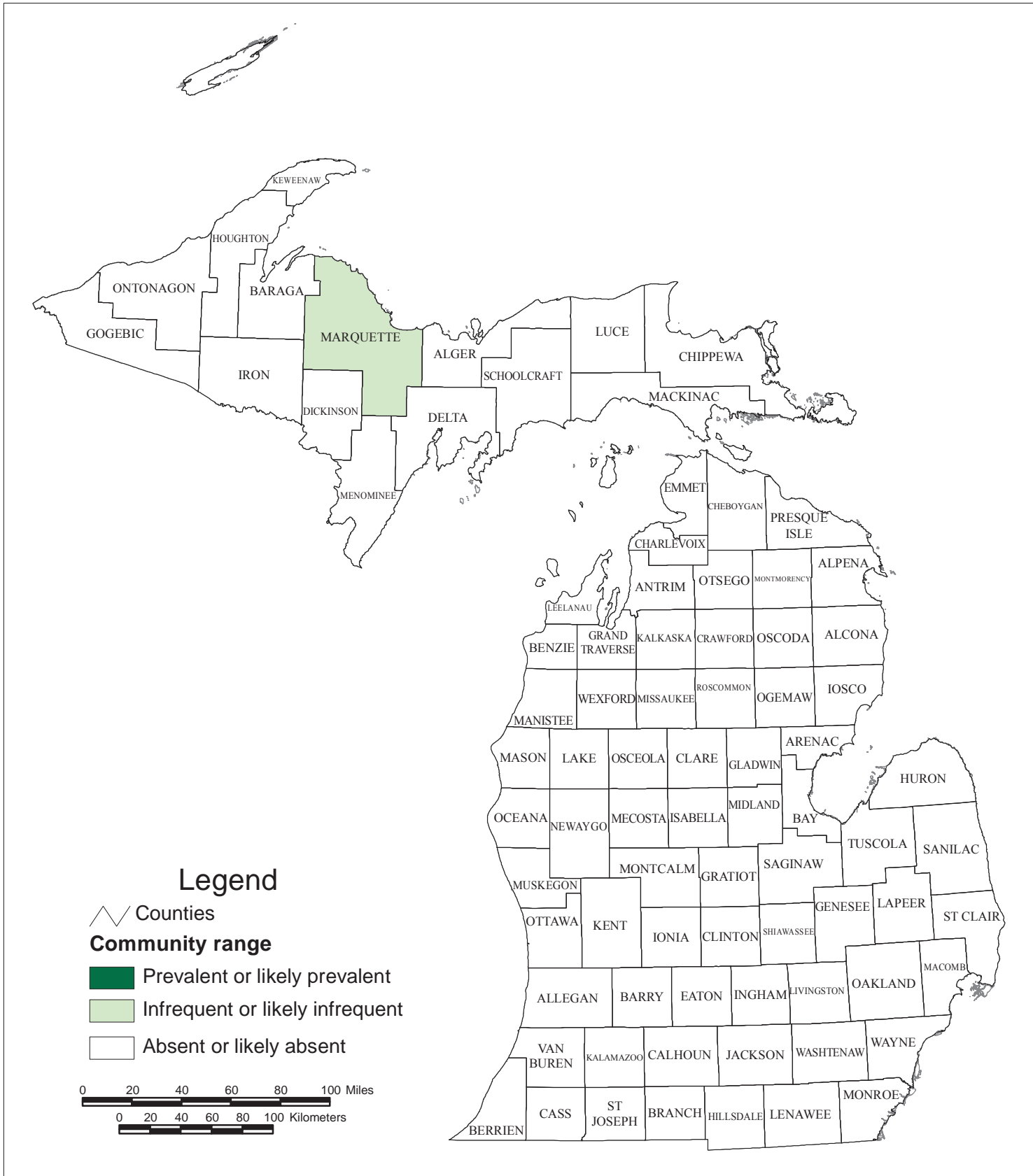


## Granite Bedrock Glade

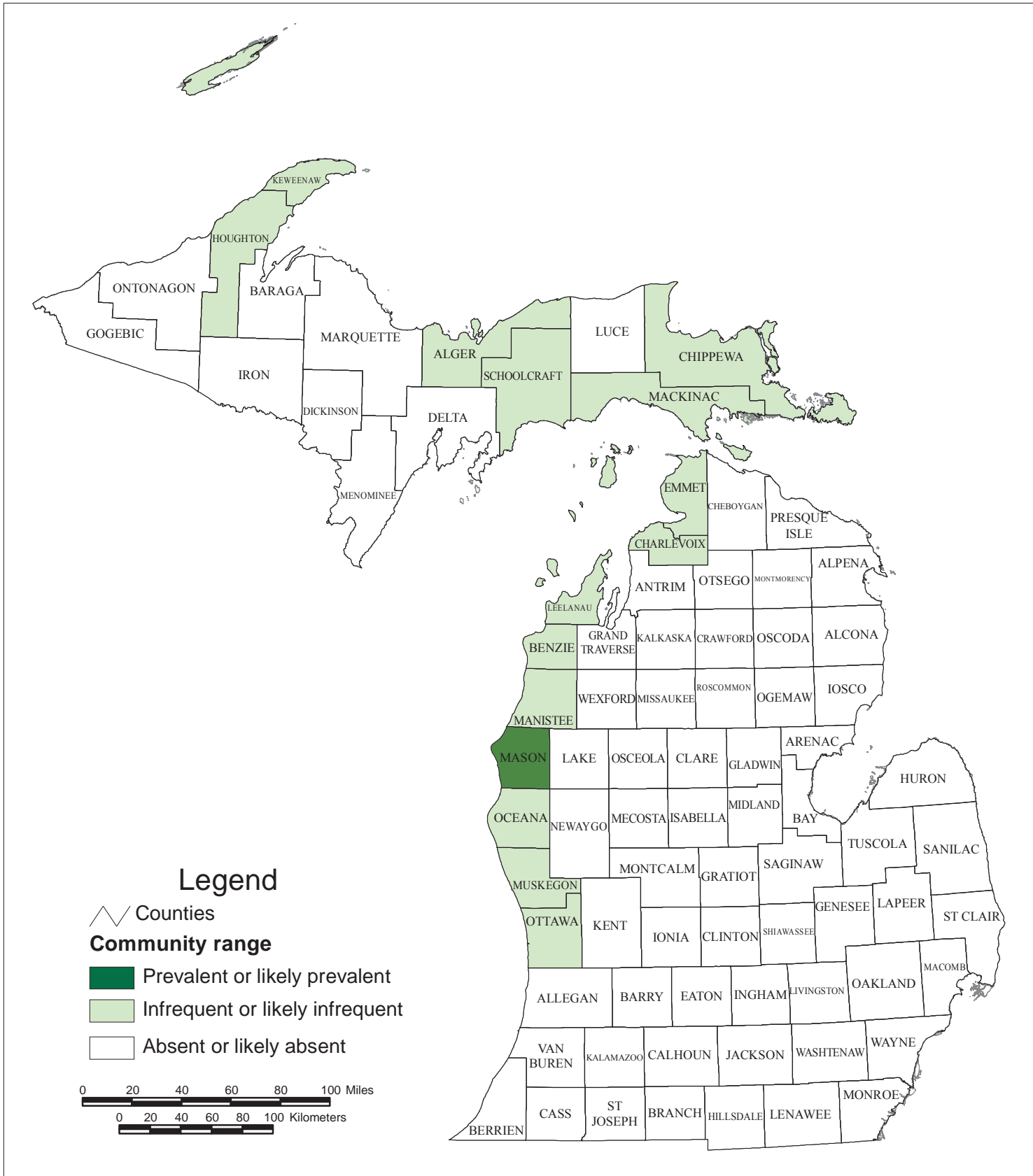


## Granite Bedrock Lakeshore

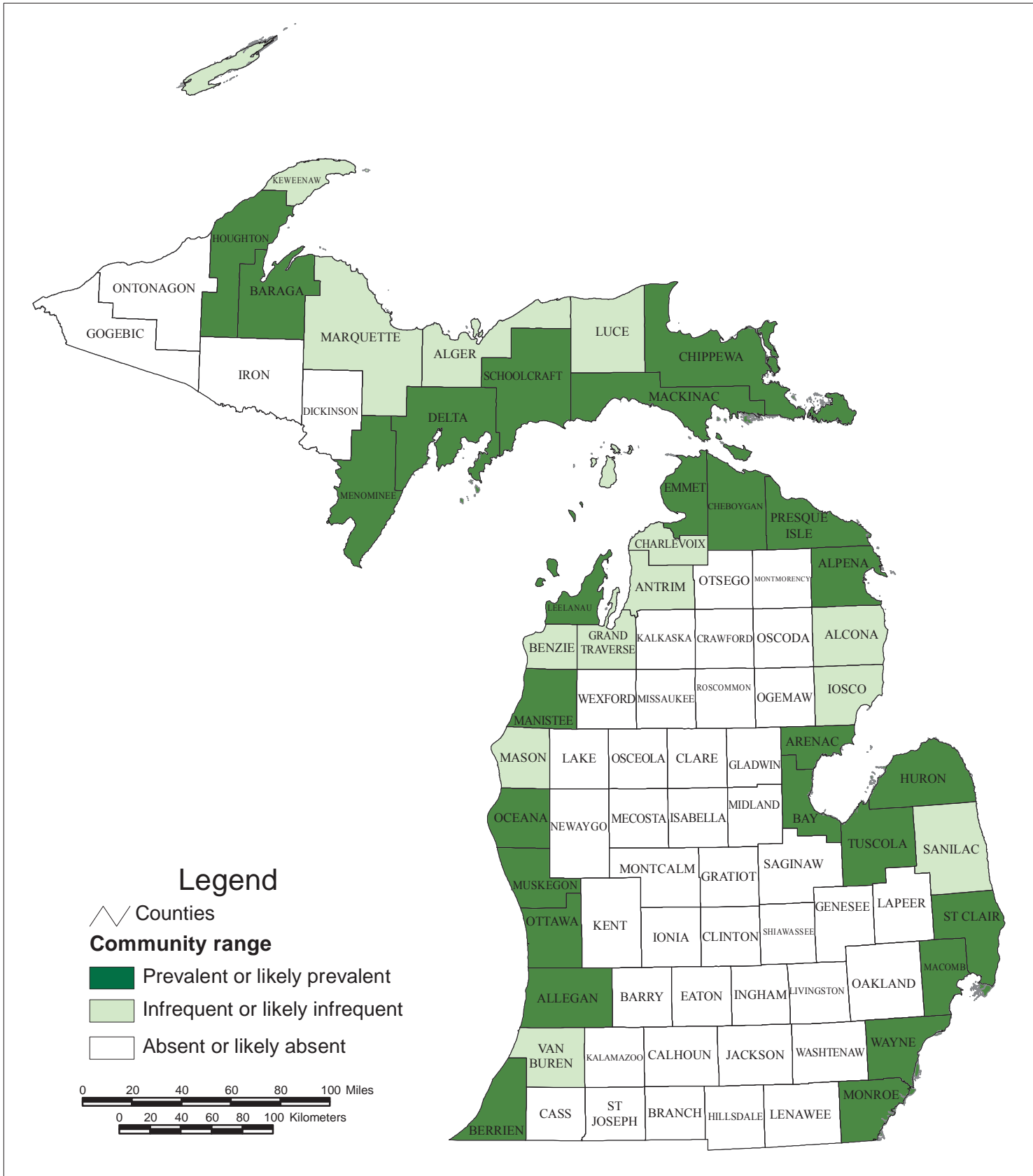




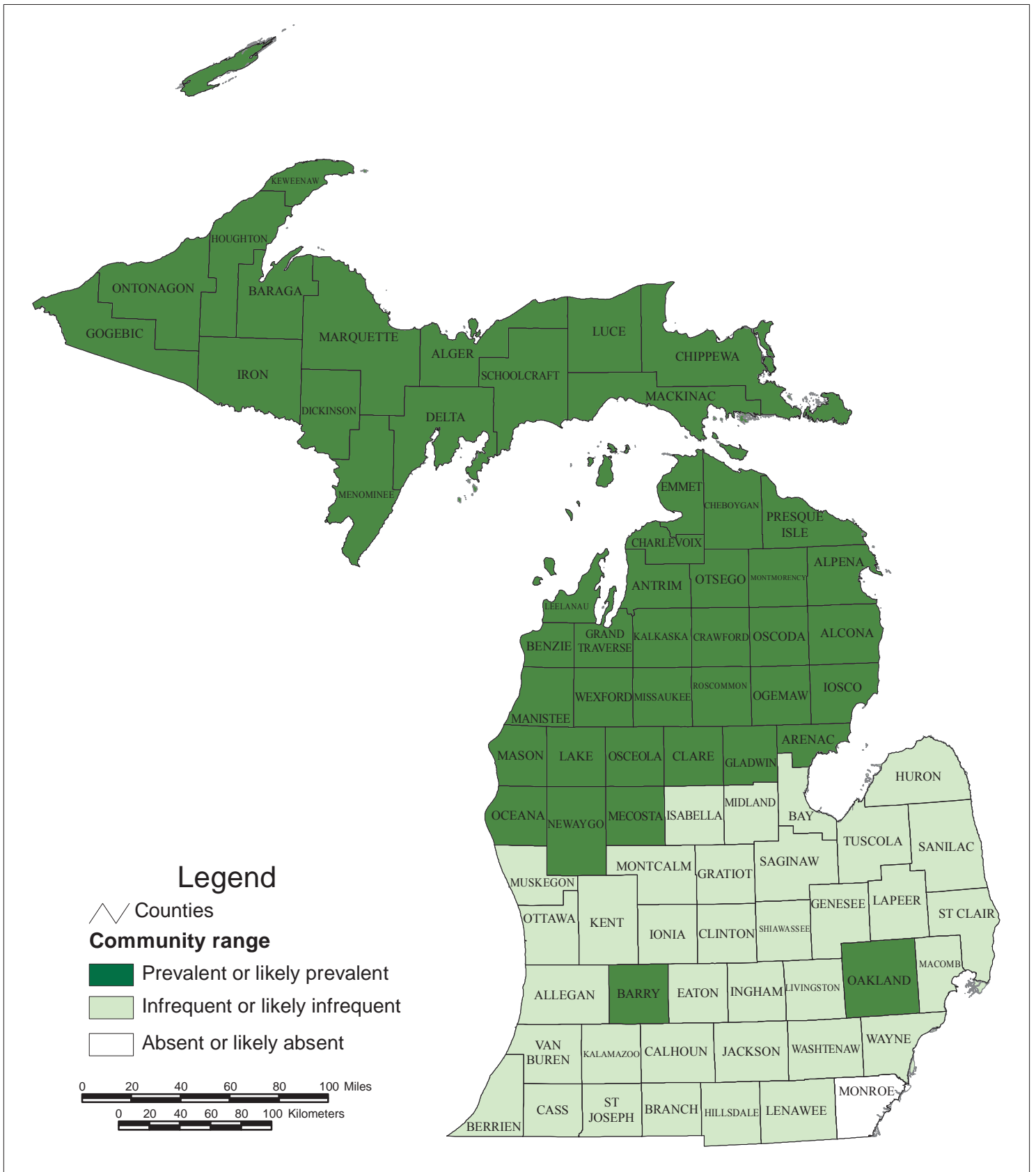
## Granite Lakeshore Cliff



## Great Lakes Barrens

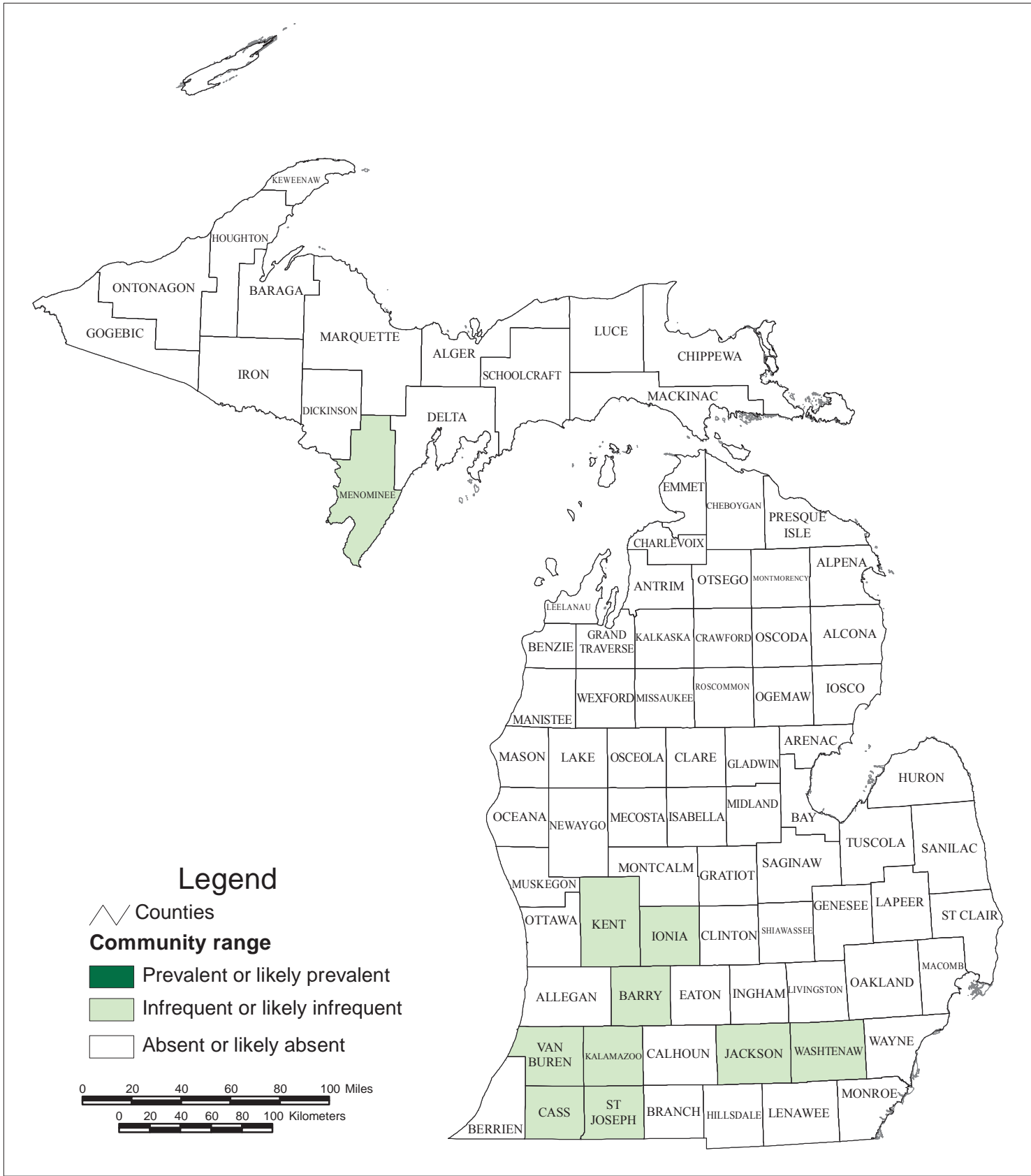


## Great Lakes Marsh

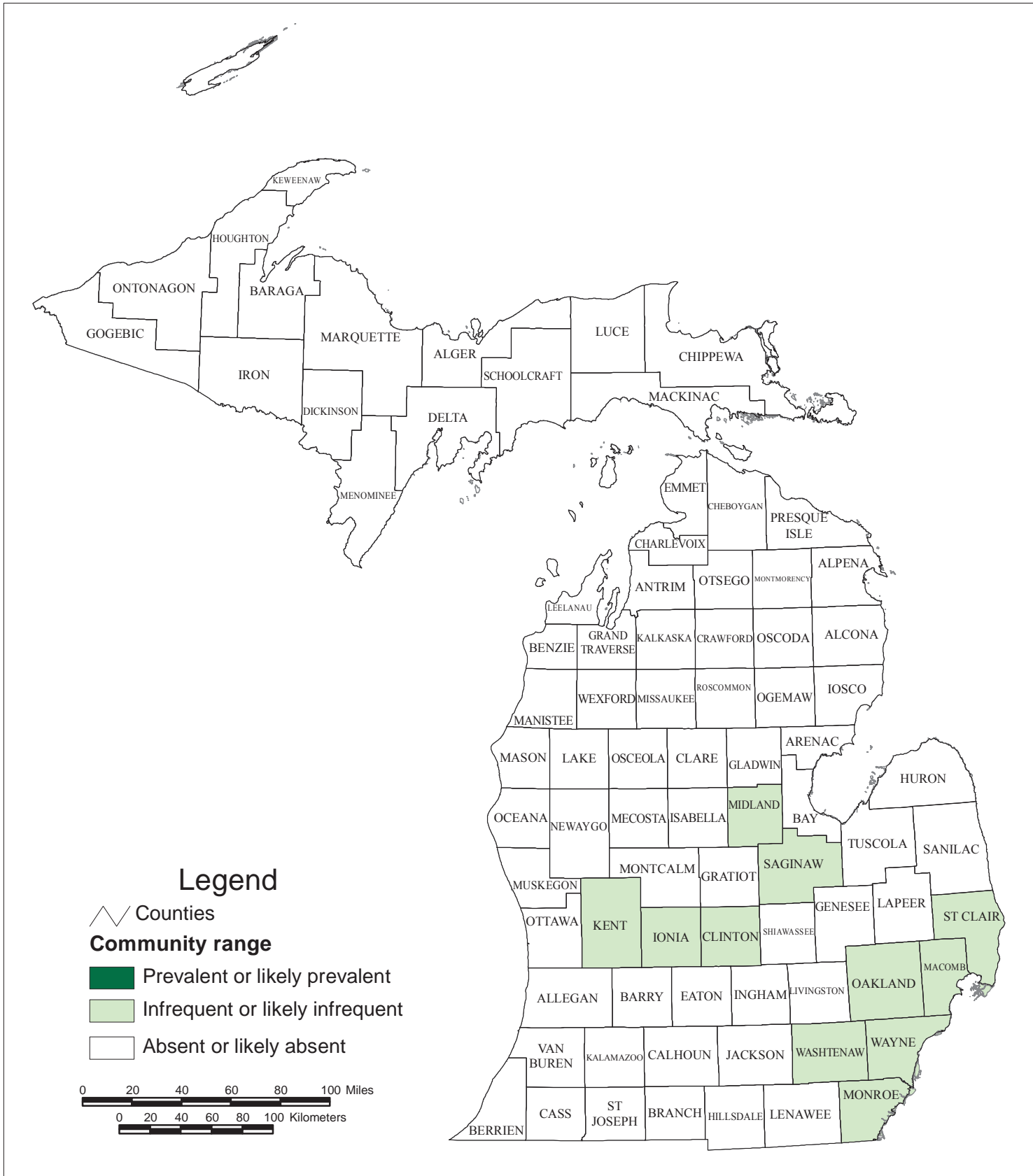


## Hardwood-conifer Swamp

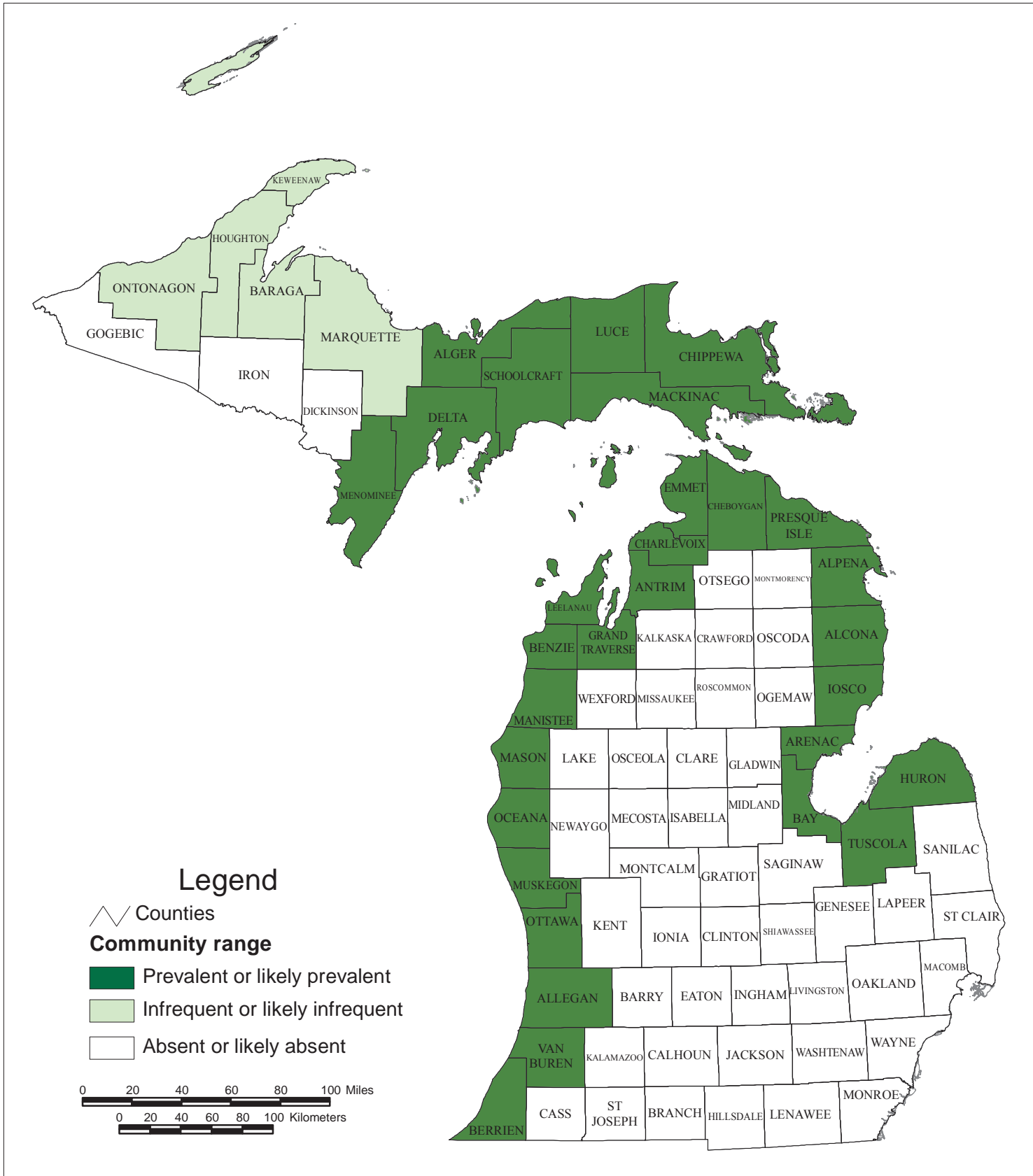




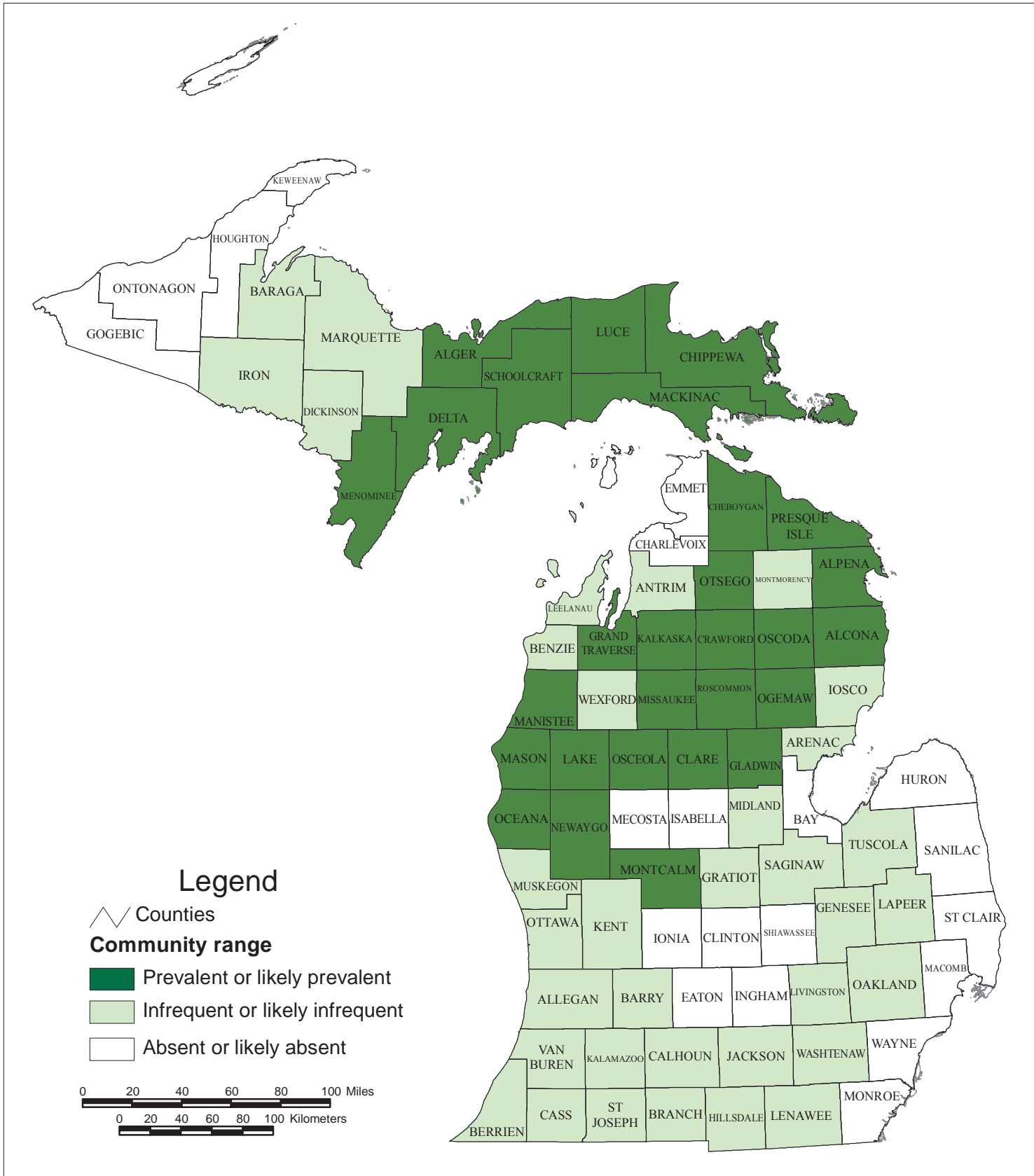
## Hillside Prairie



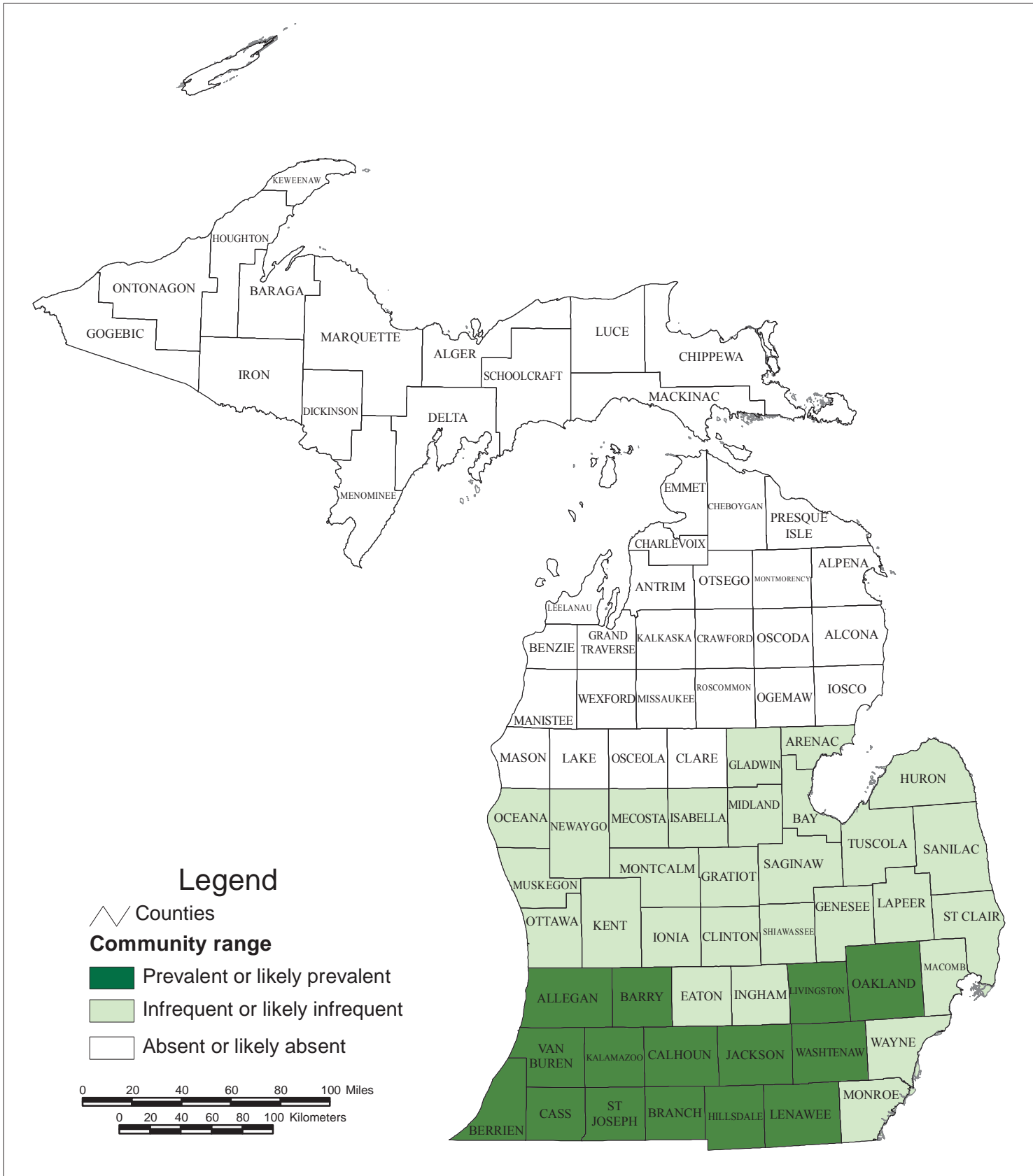
## Inland Salt Marsh



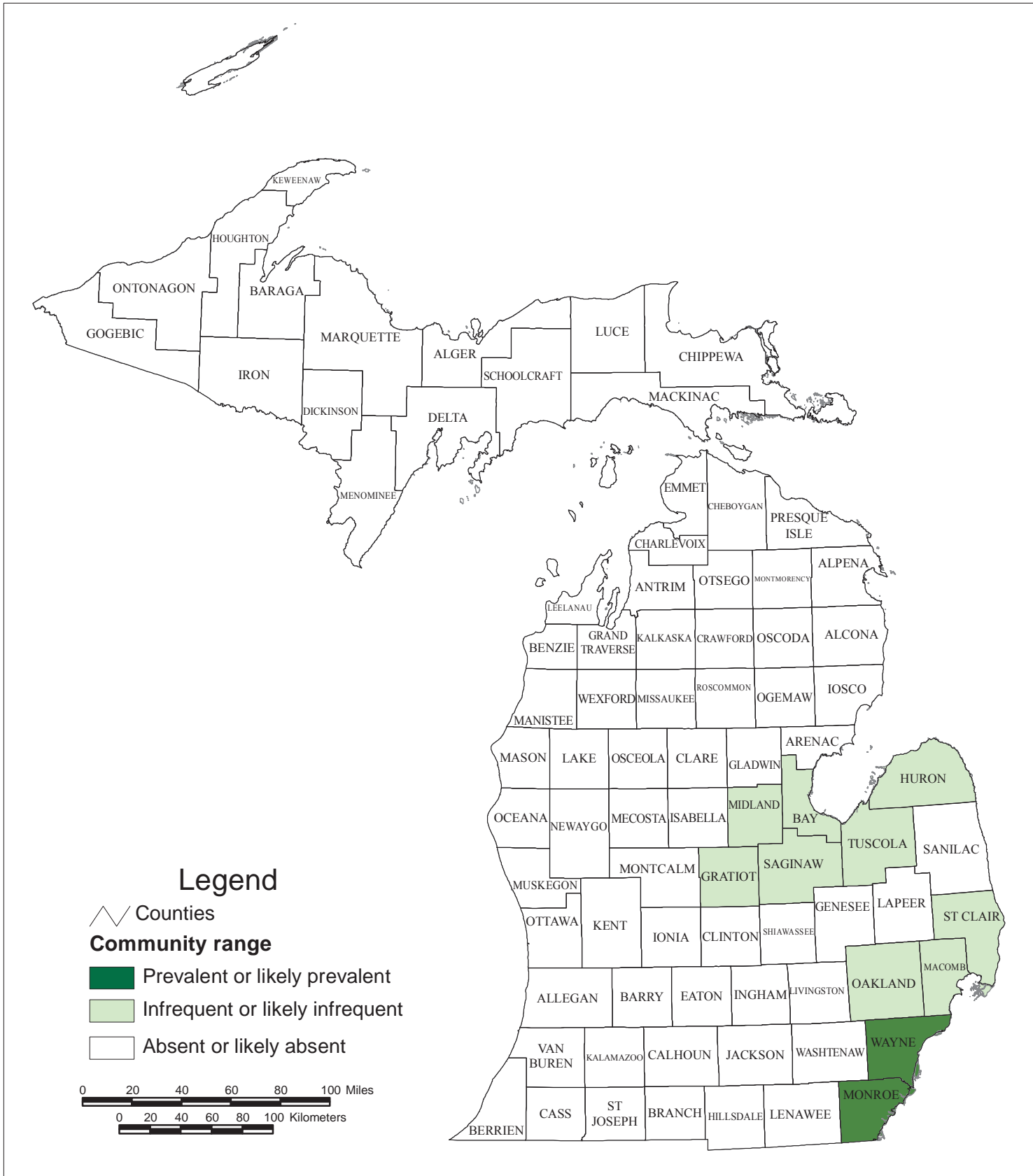
## Interdunal Wetland



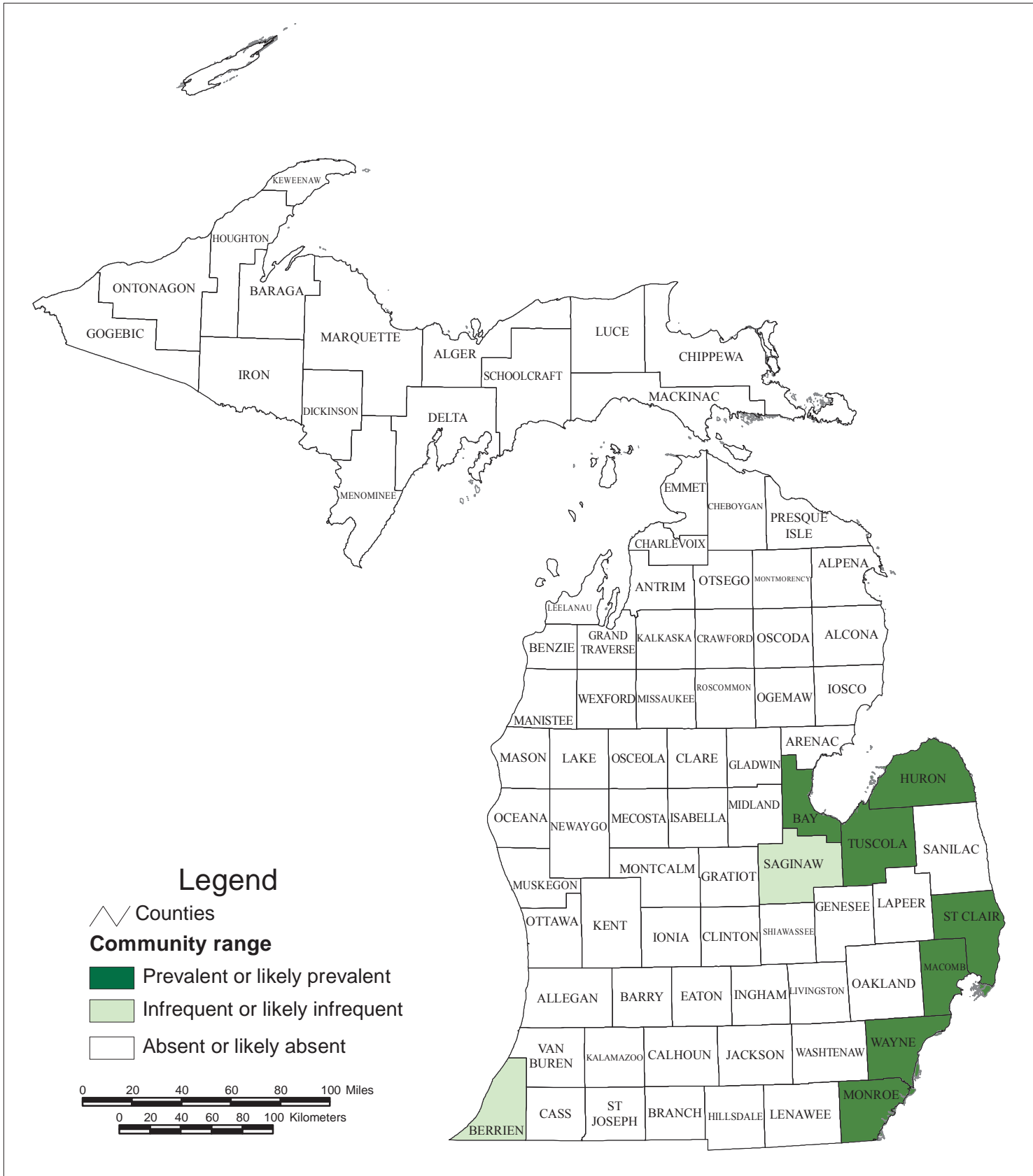
## Intermittent Wetland



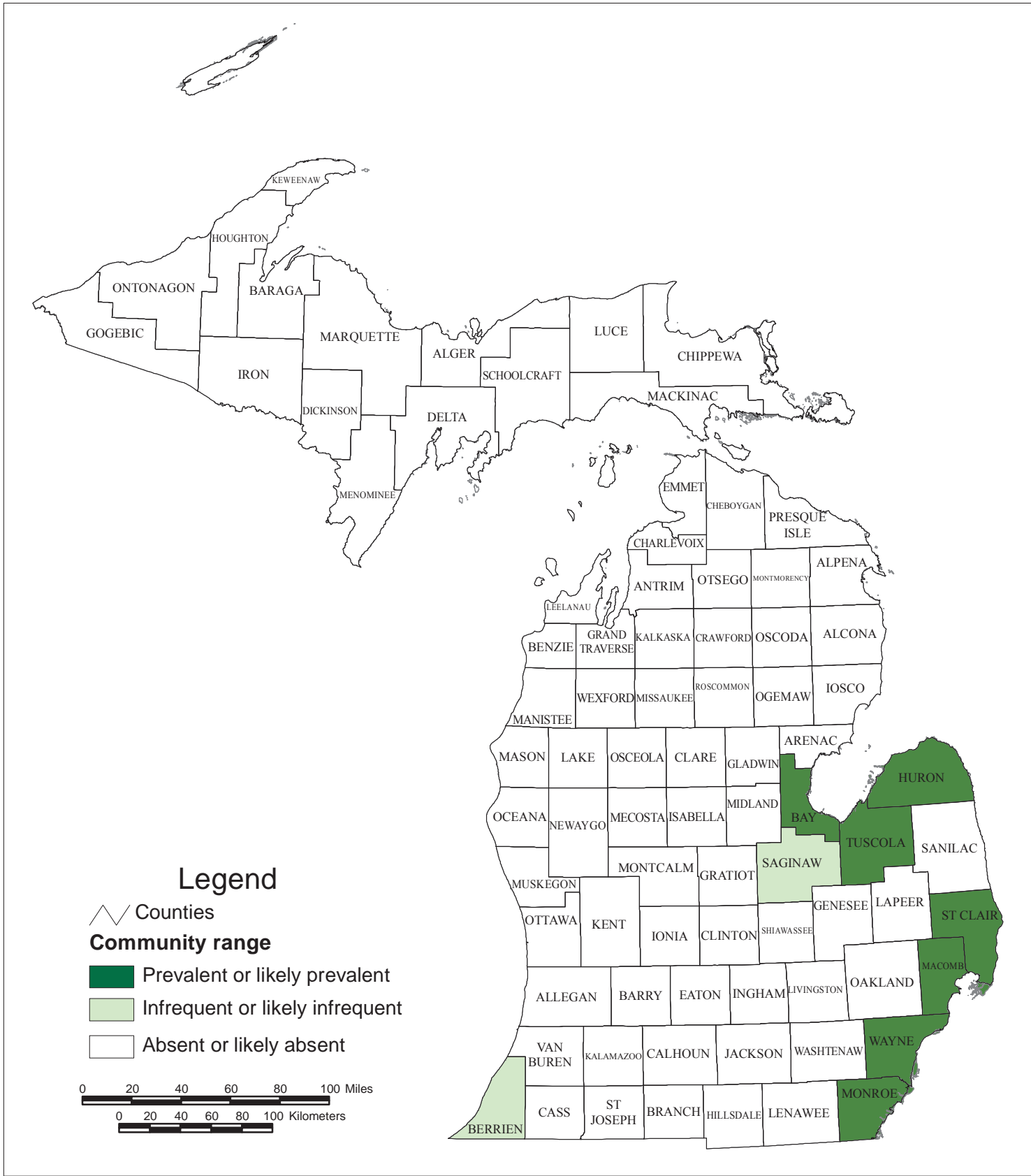
## Inundated Shrub Swamp



## Lakeplain Oak Openings

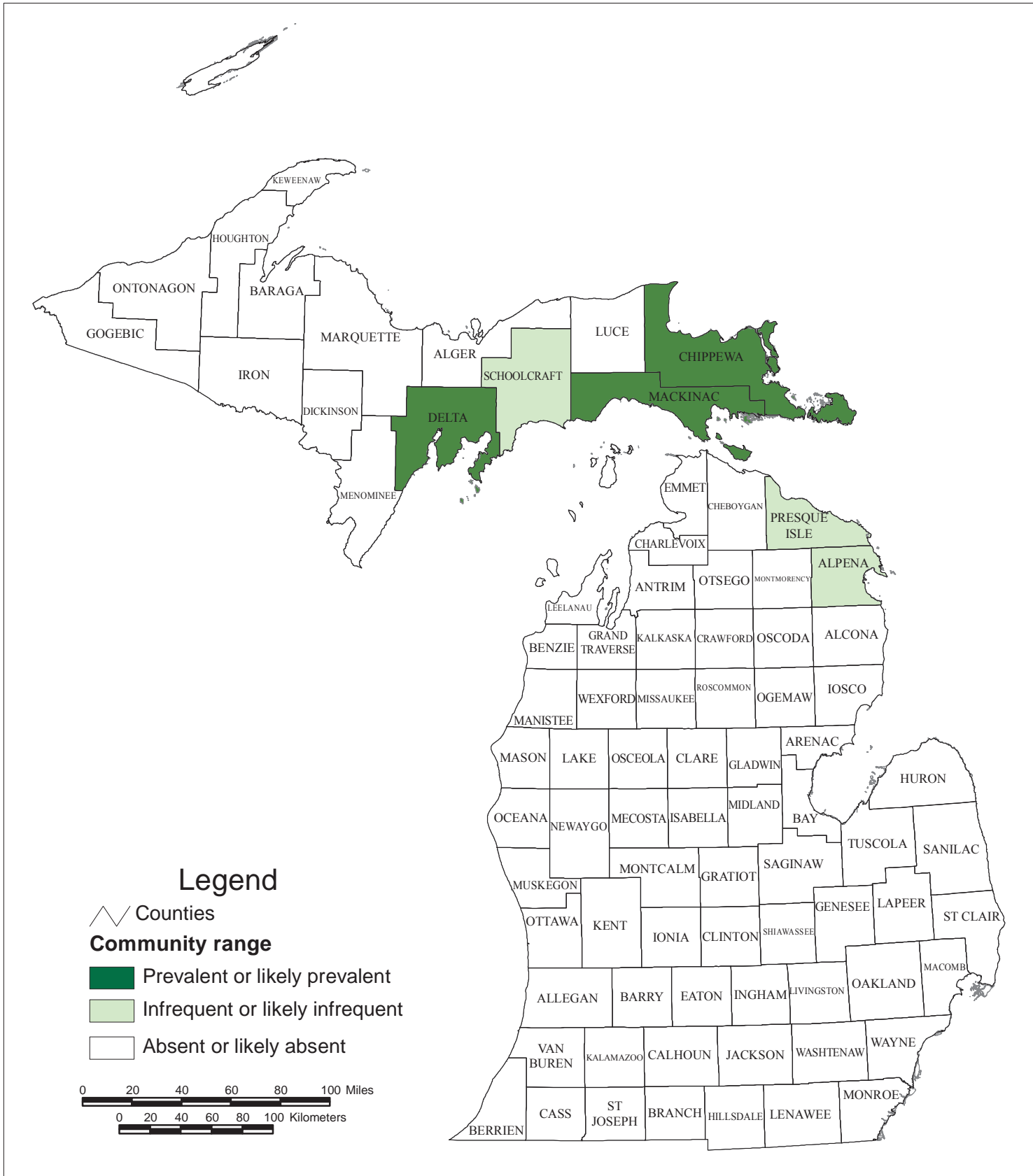


## Lakeplain Wet Prairie

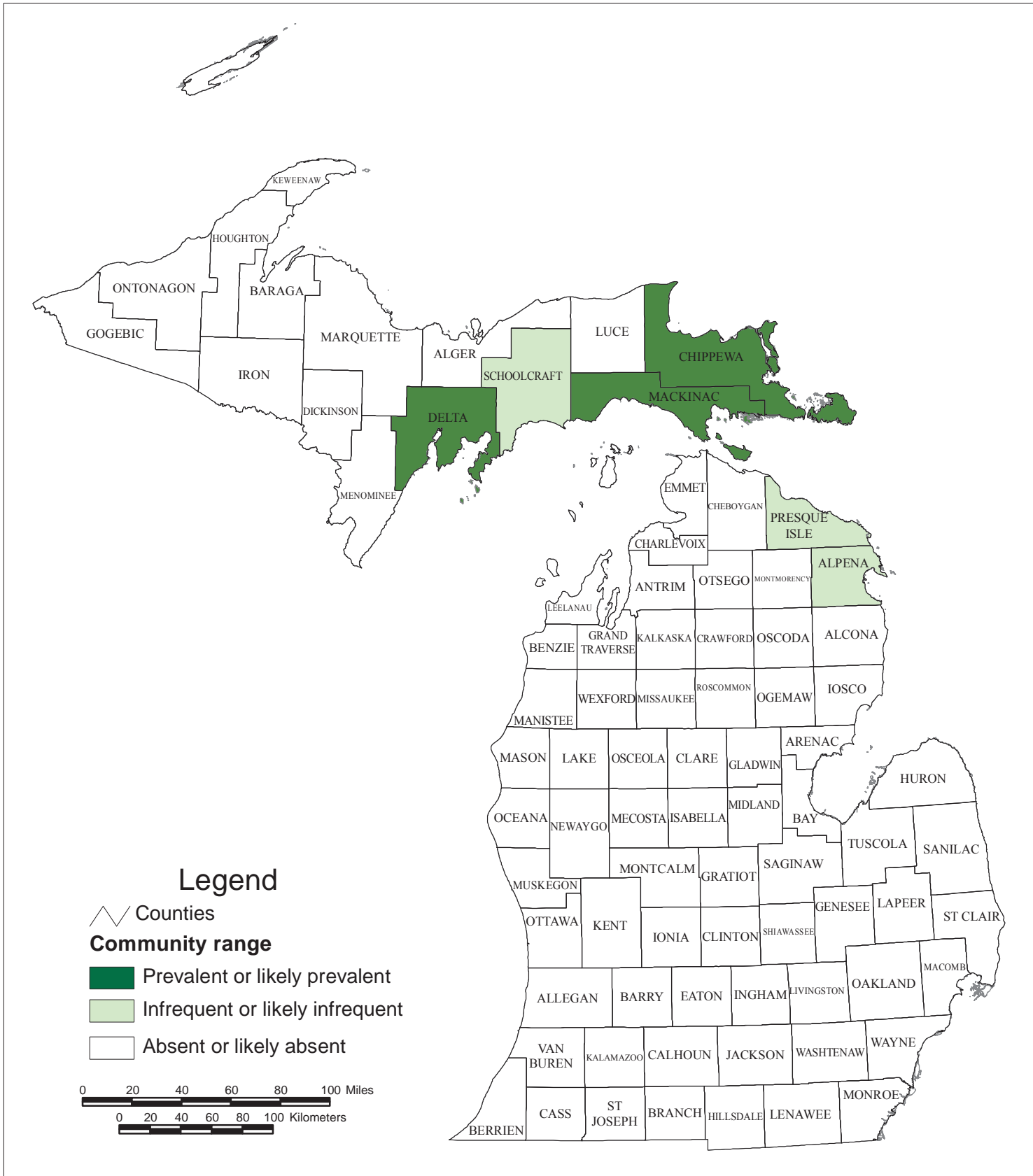


## Lakeplain Wet-mesic Prairie

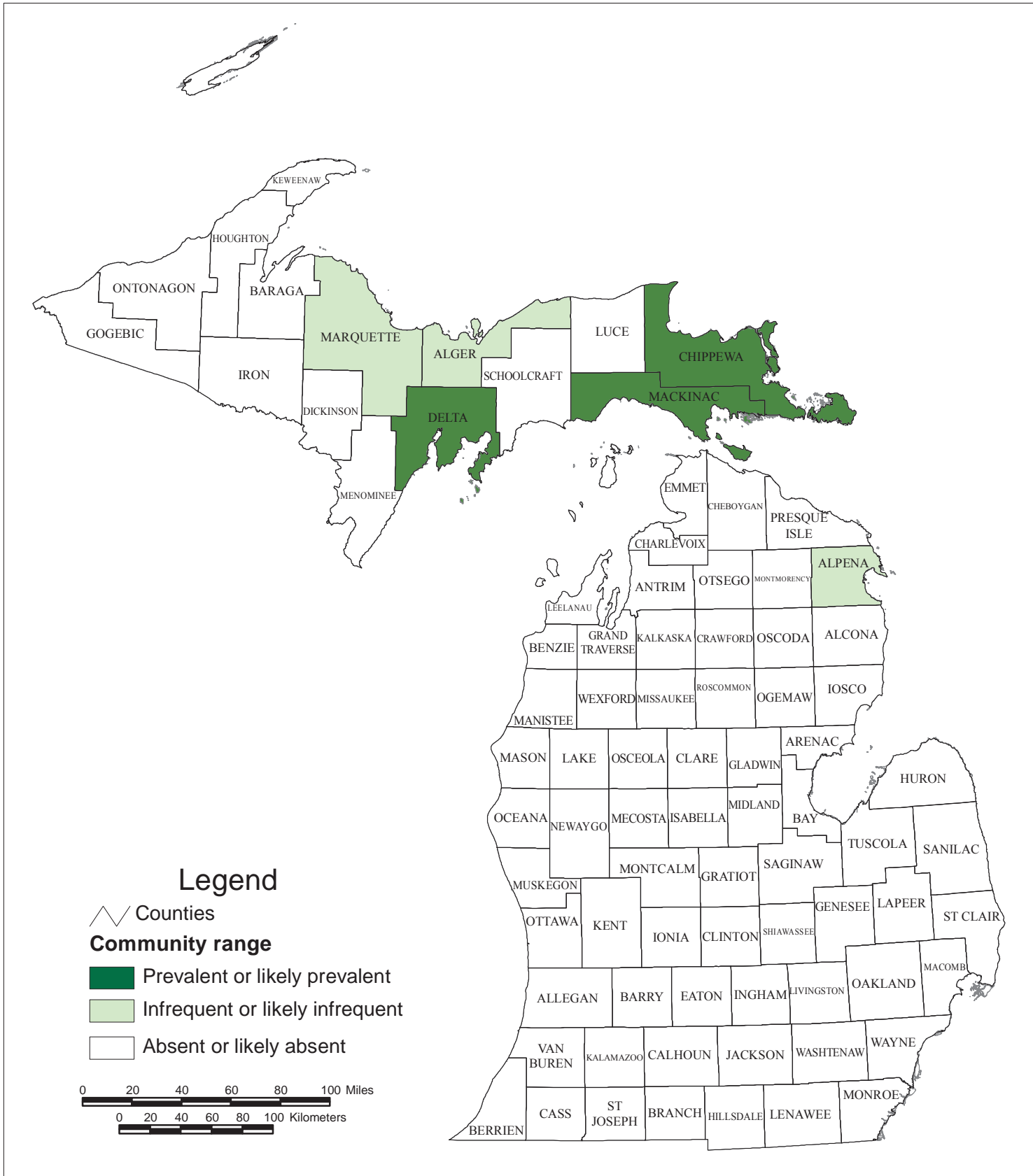




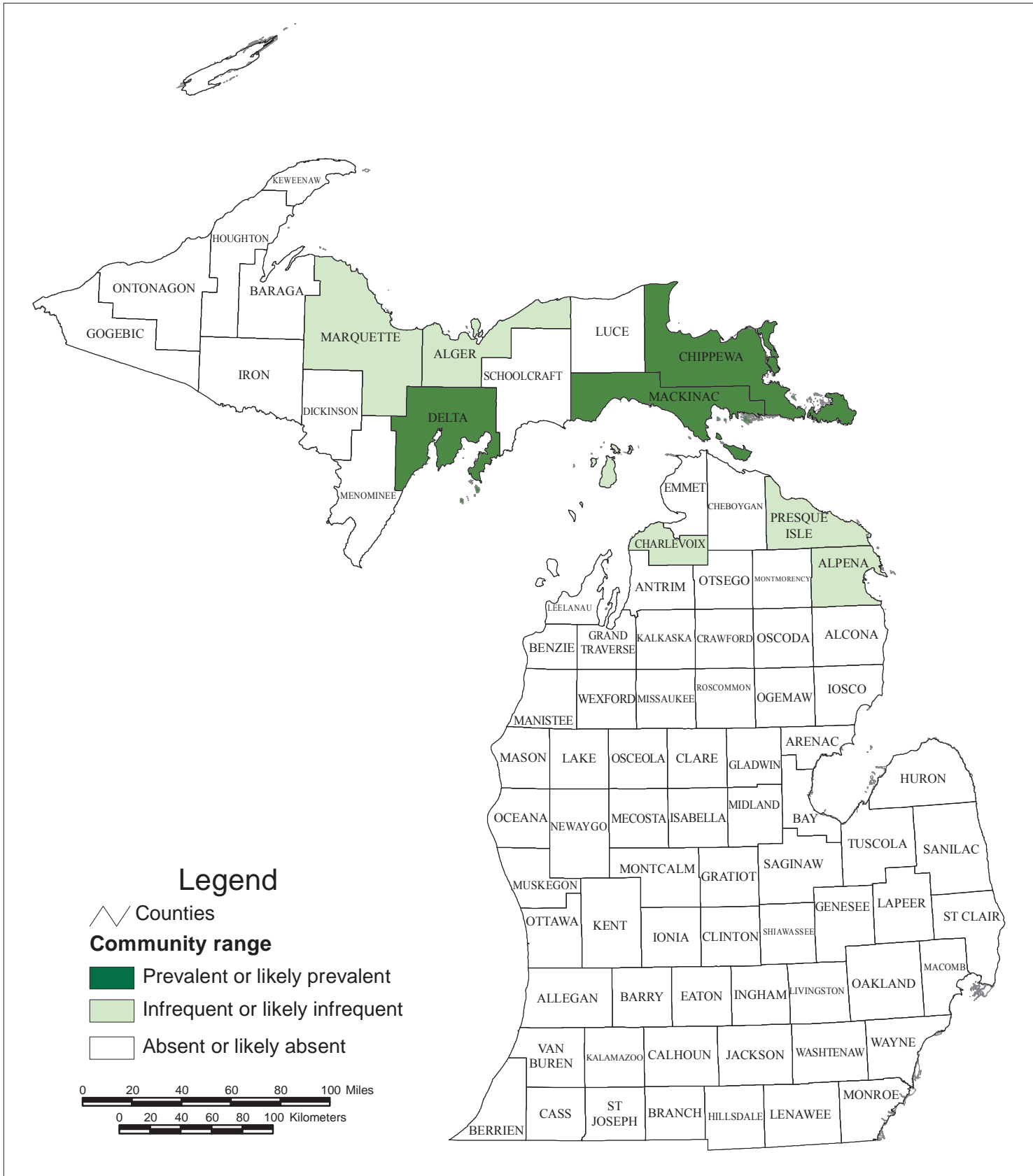
## Limestone Bedrock Glade



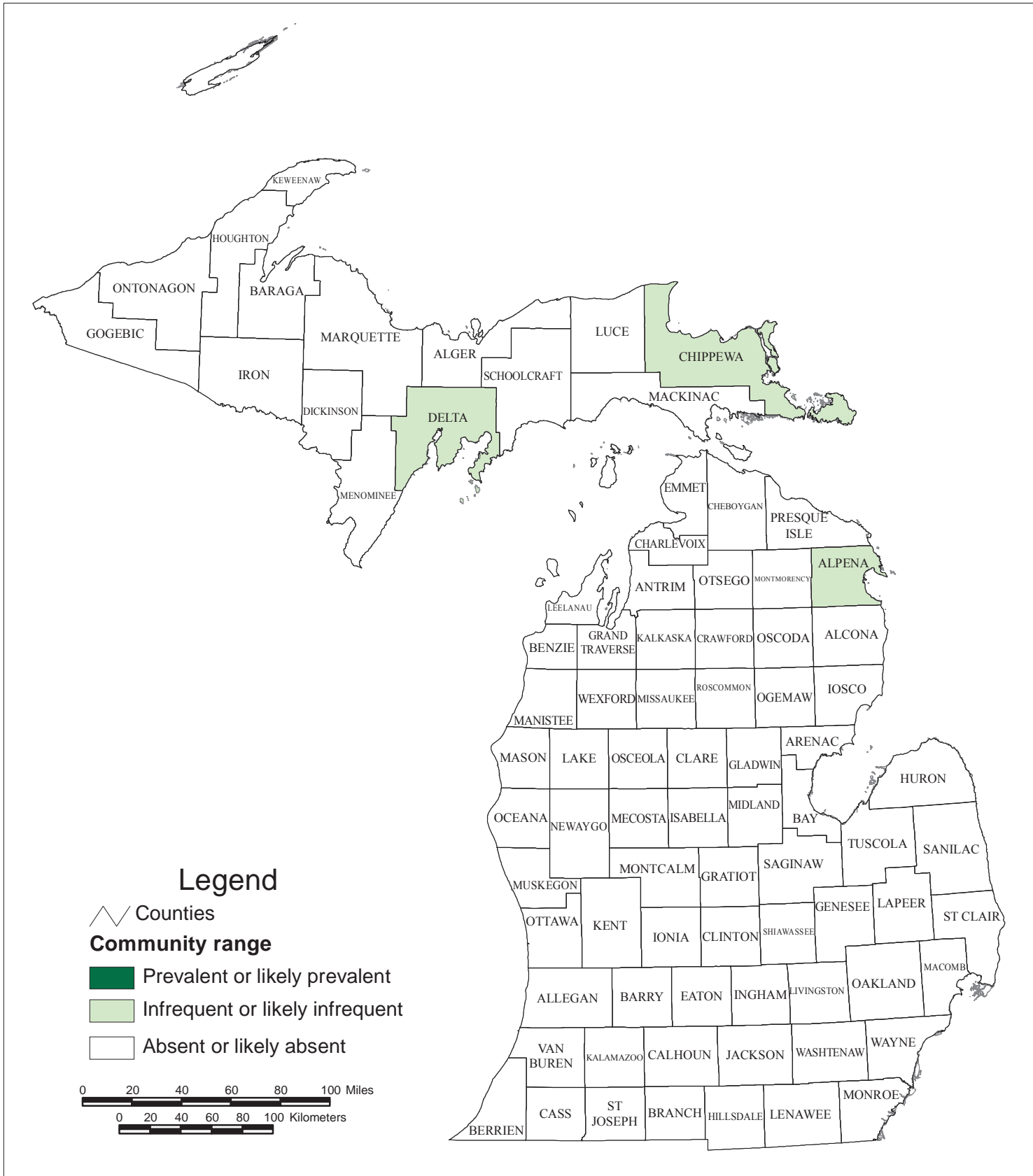
## Limestone Bedrock Lakeshore



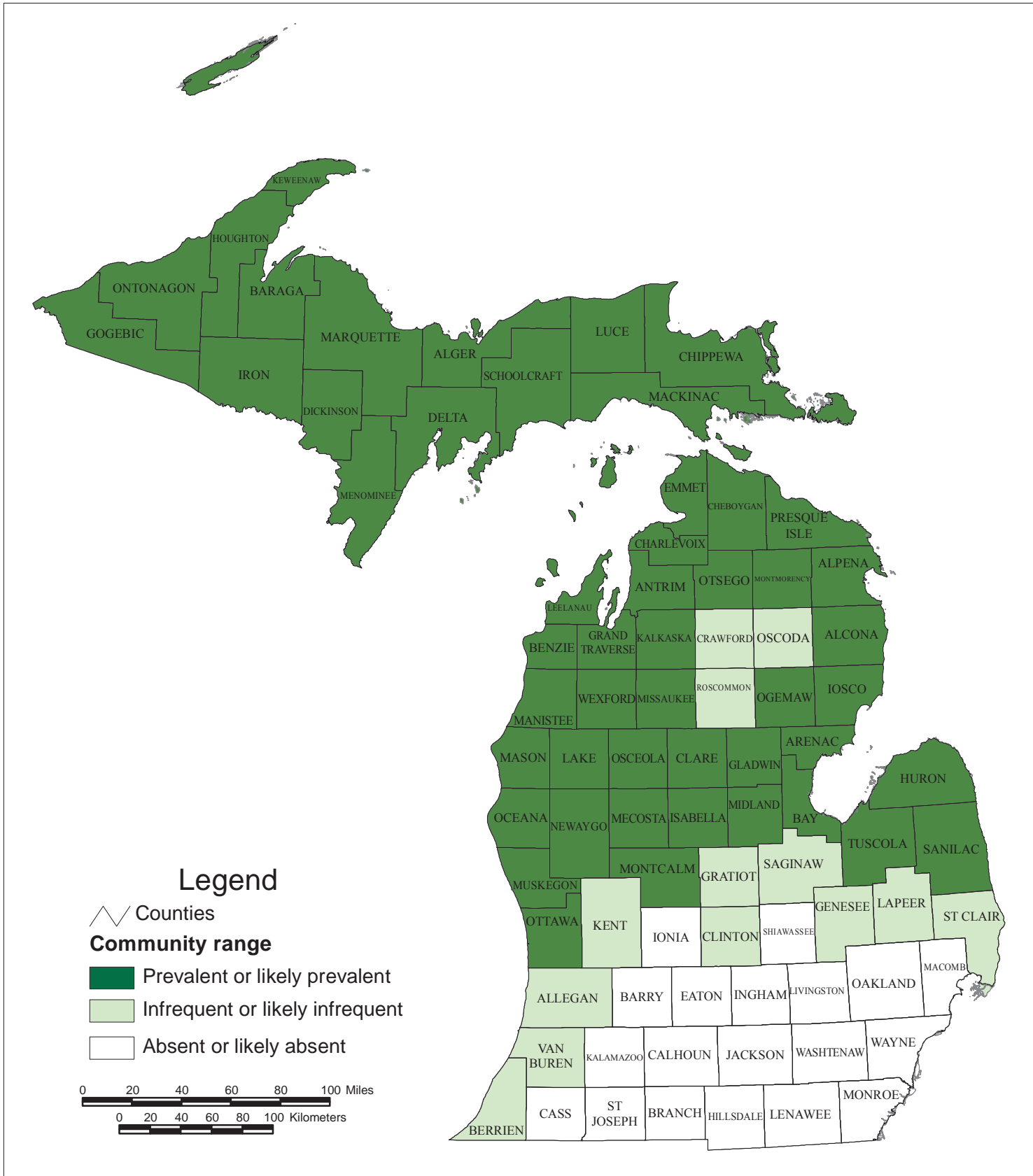
## Limestone Cliff



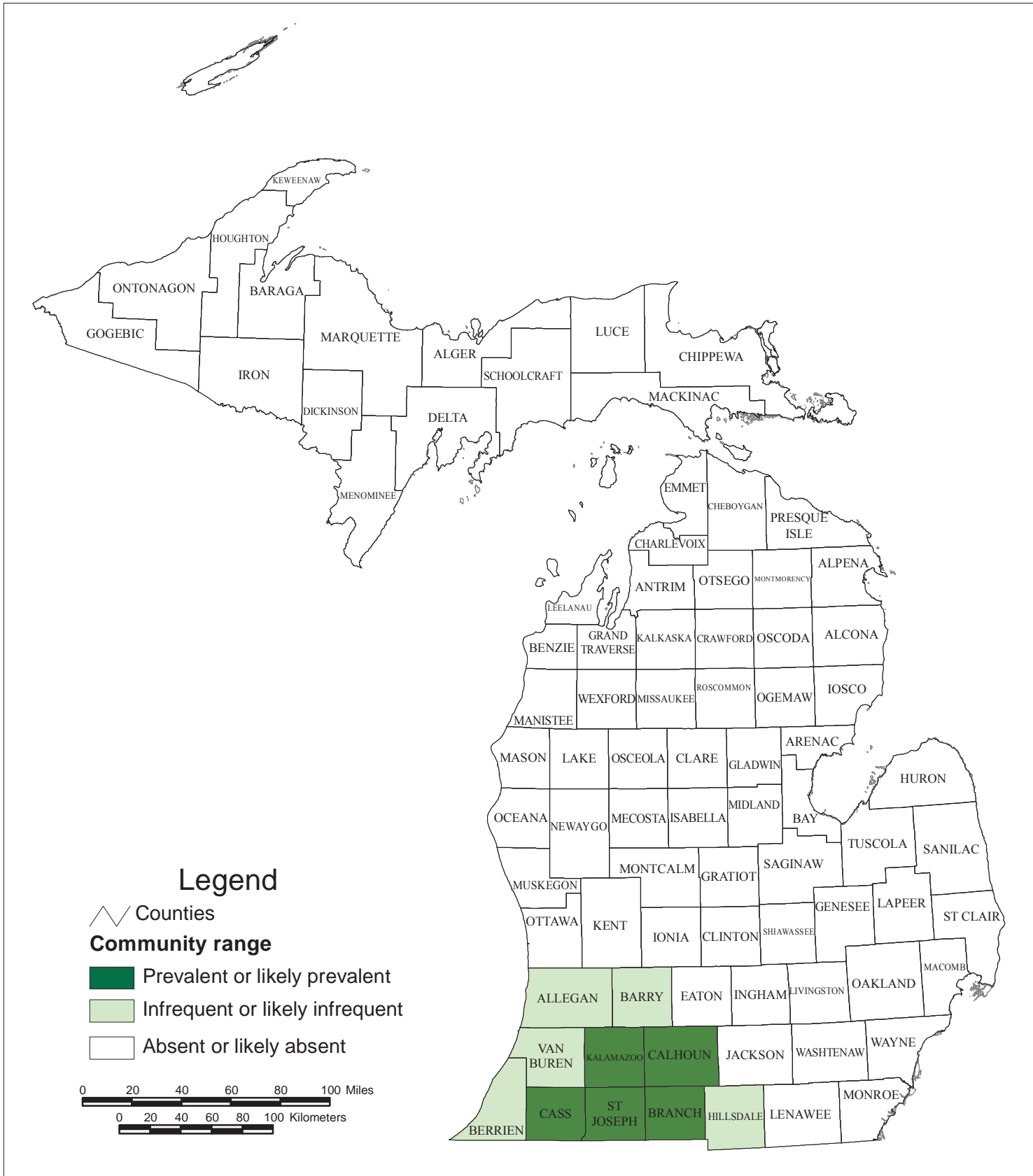
## Limestone Cobble Shore



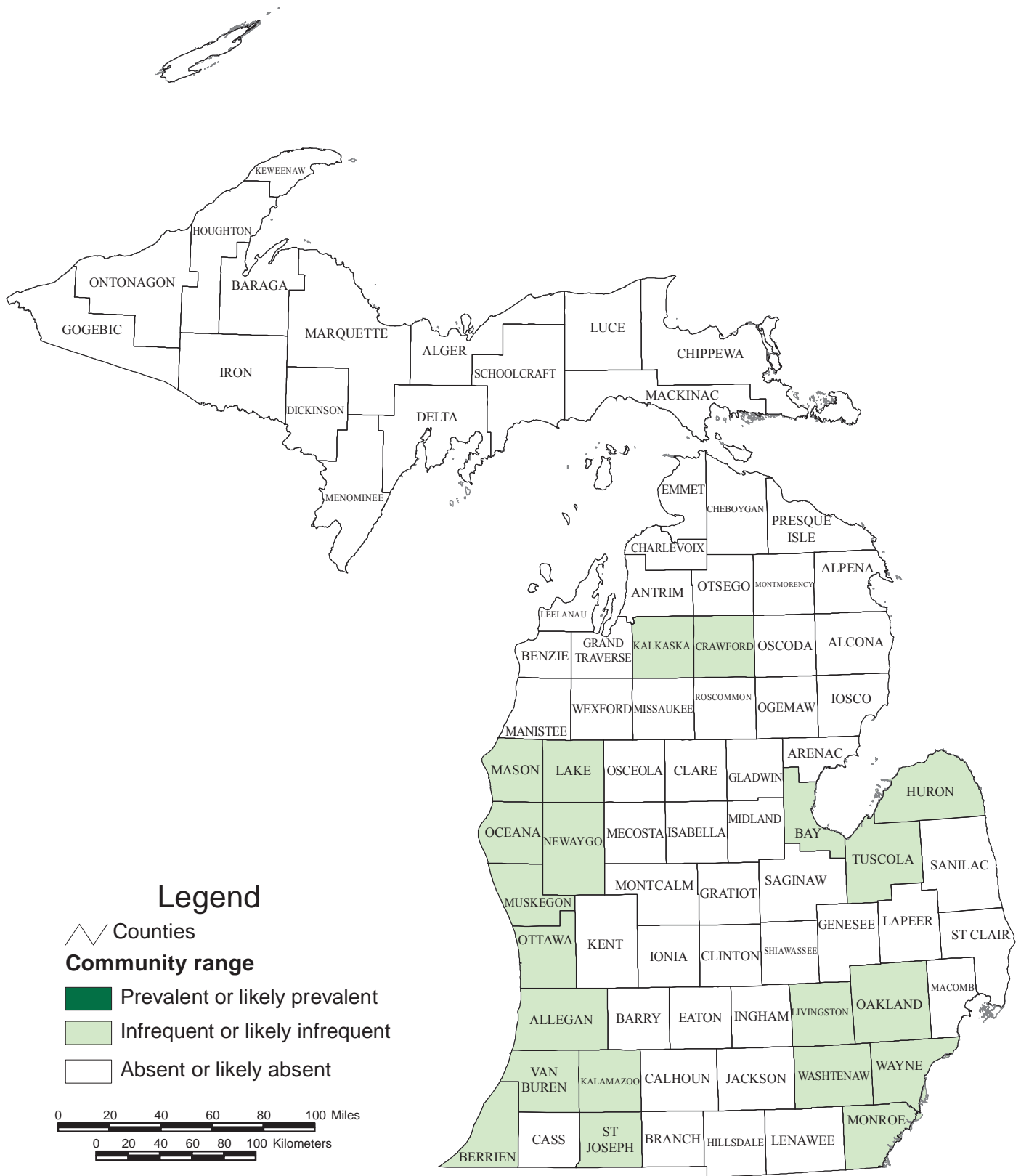
## Limestone Lakeshore Cliff



## Mesic Northern Forest

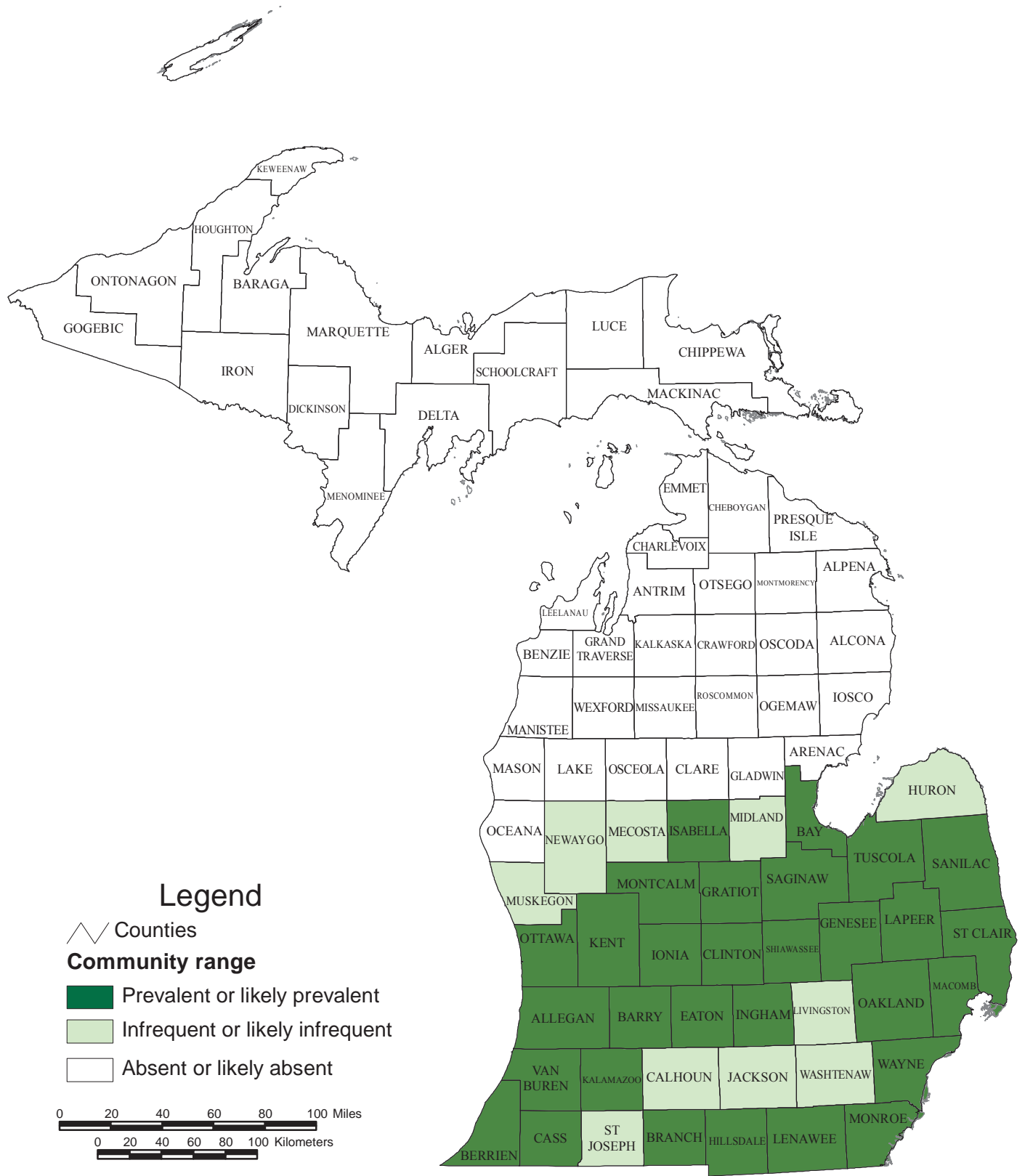


## Mesic Prairie

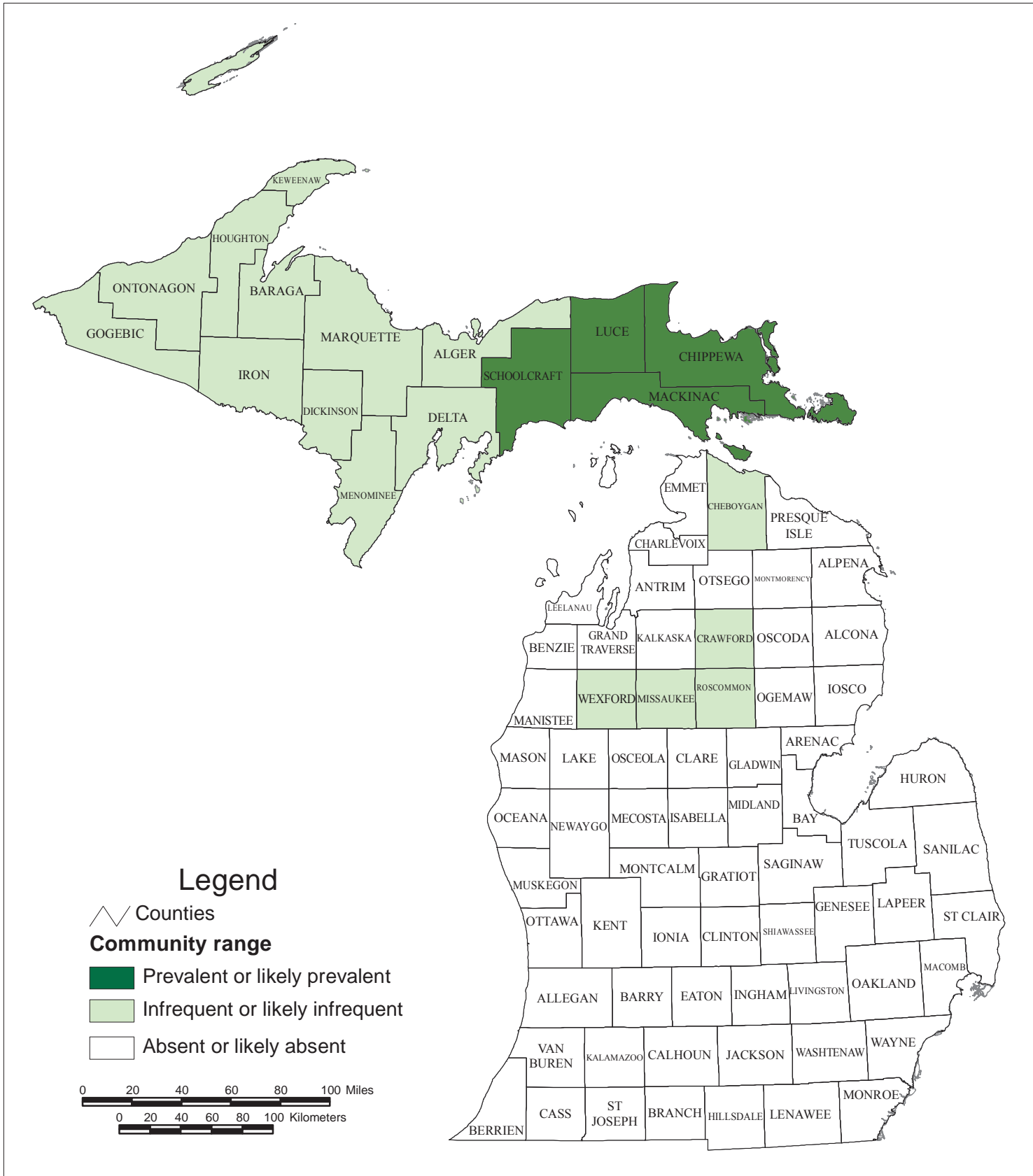


## Mesic Sand Prairie

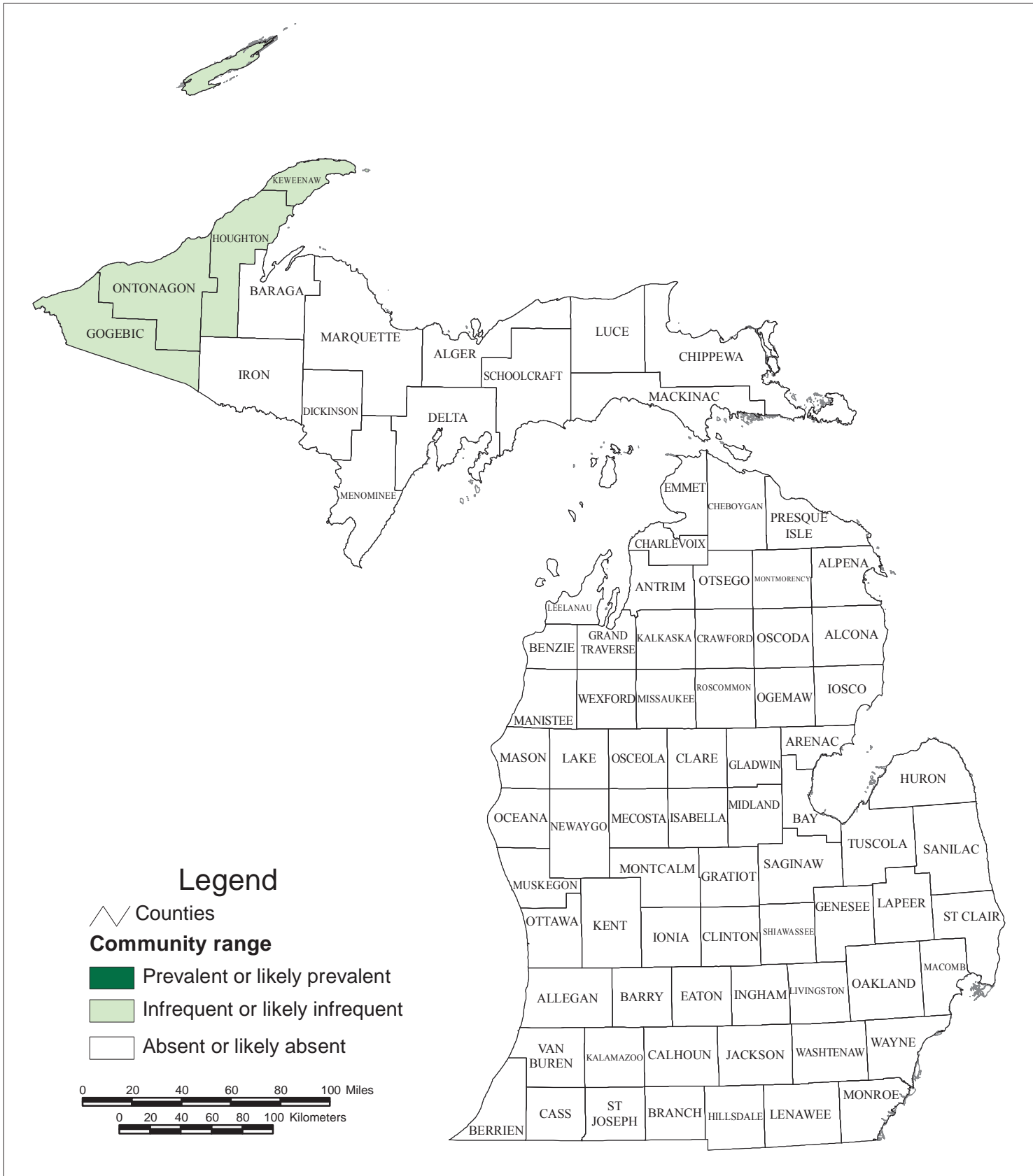




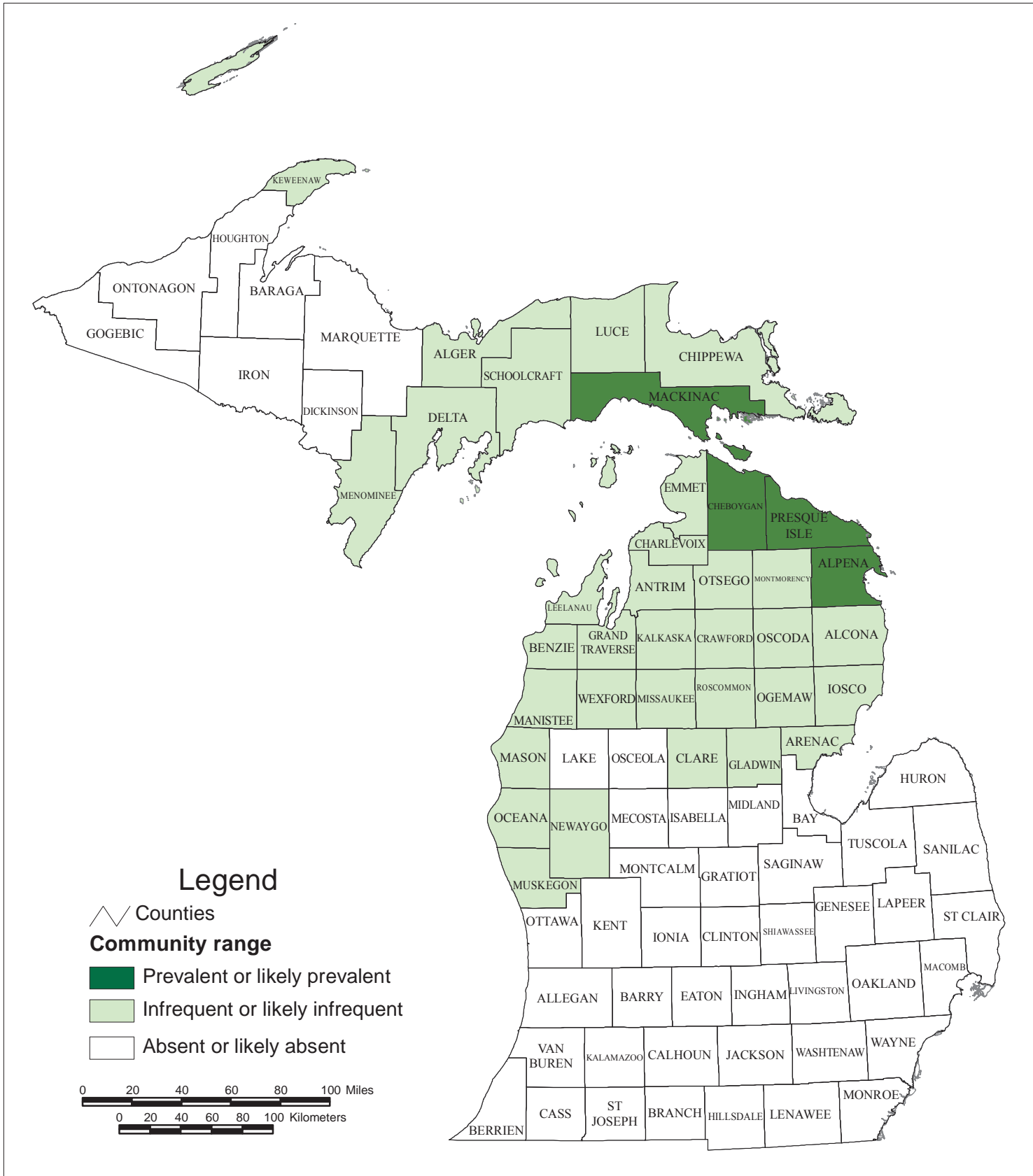
### Mesic Southern Forest

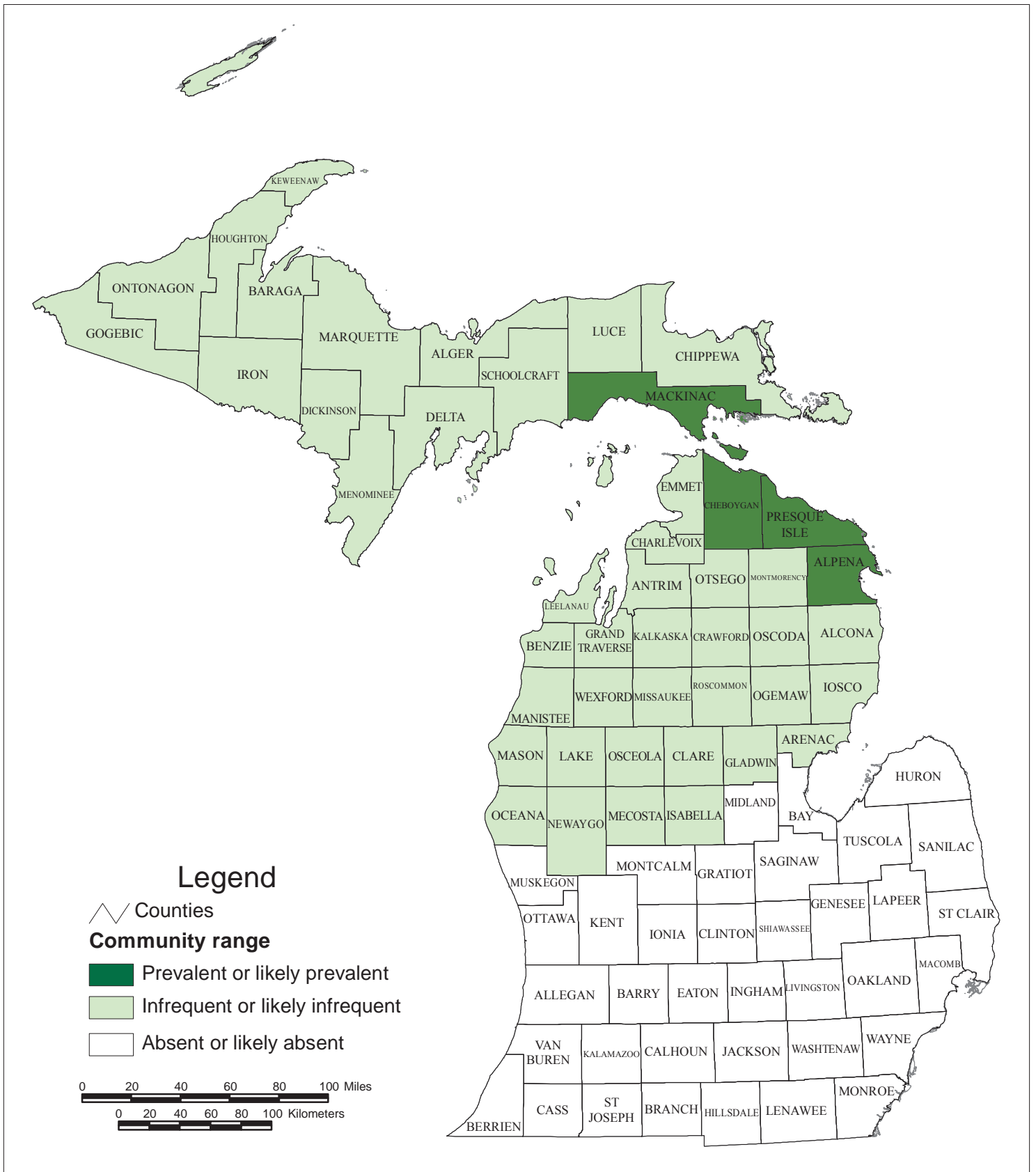


## Muskeg



## Northern Bald



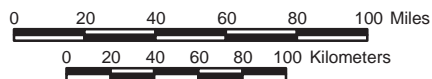


### Legend

Counties

#### Community range

- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent

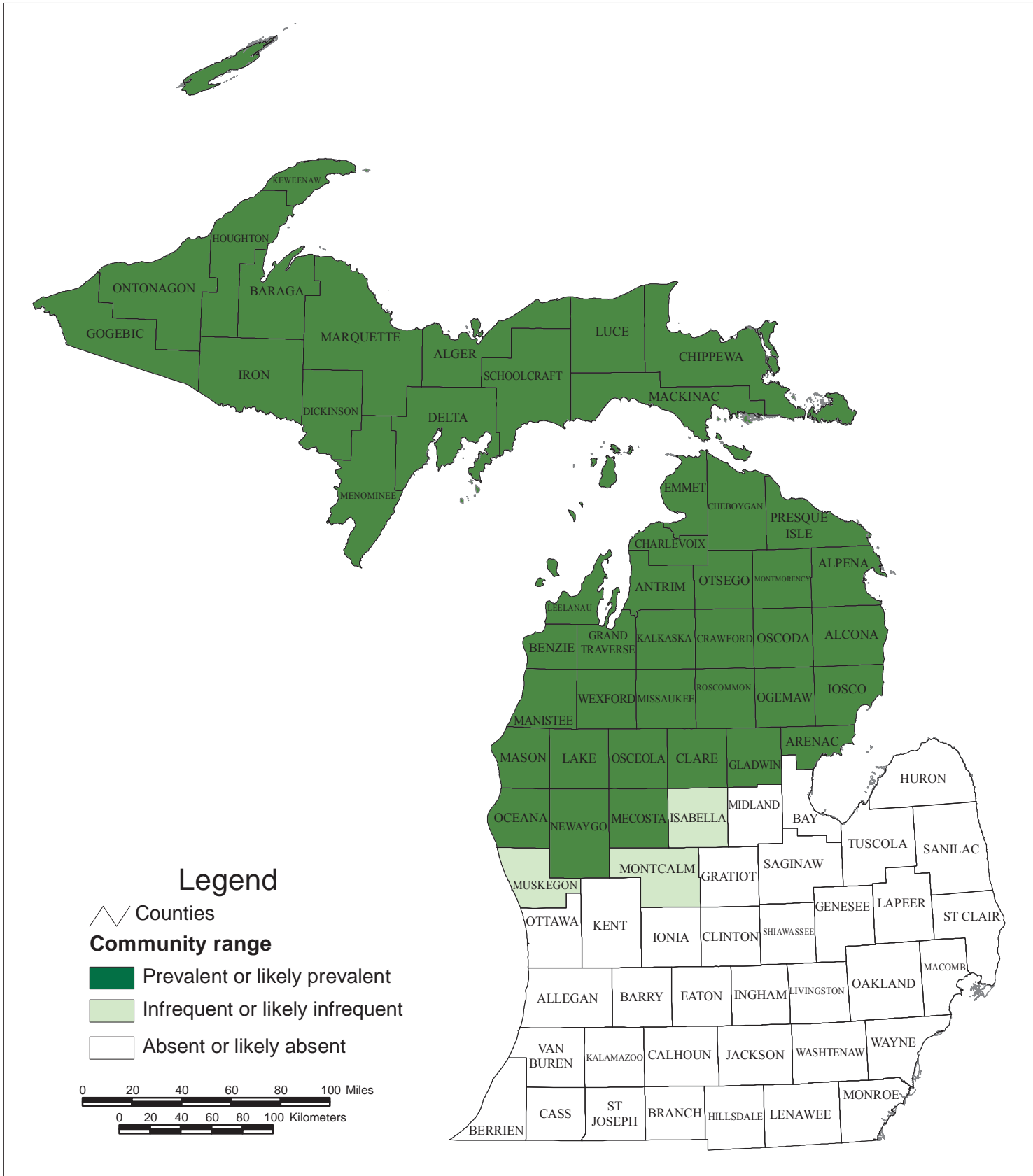


## Northern Hardwood Swamp

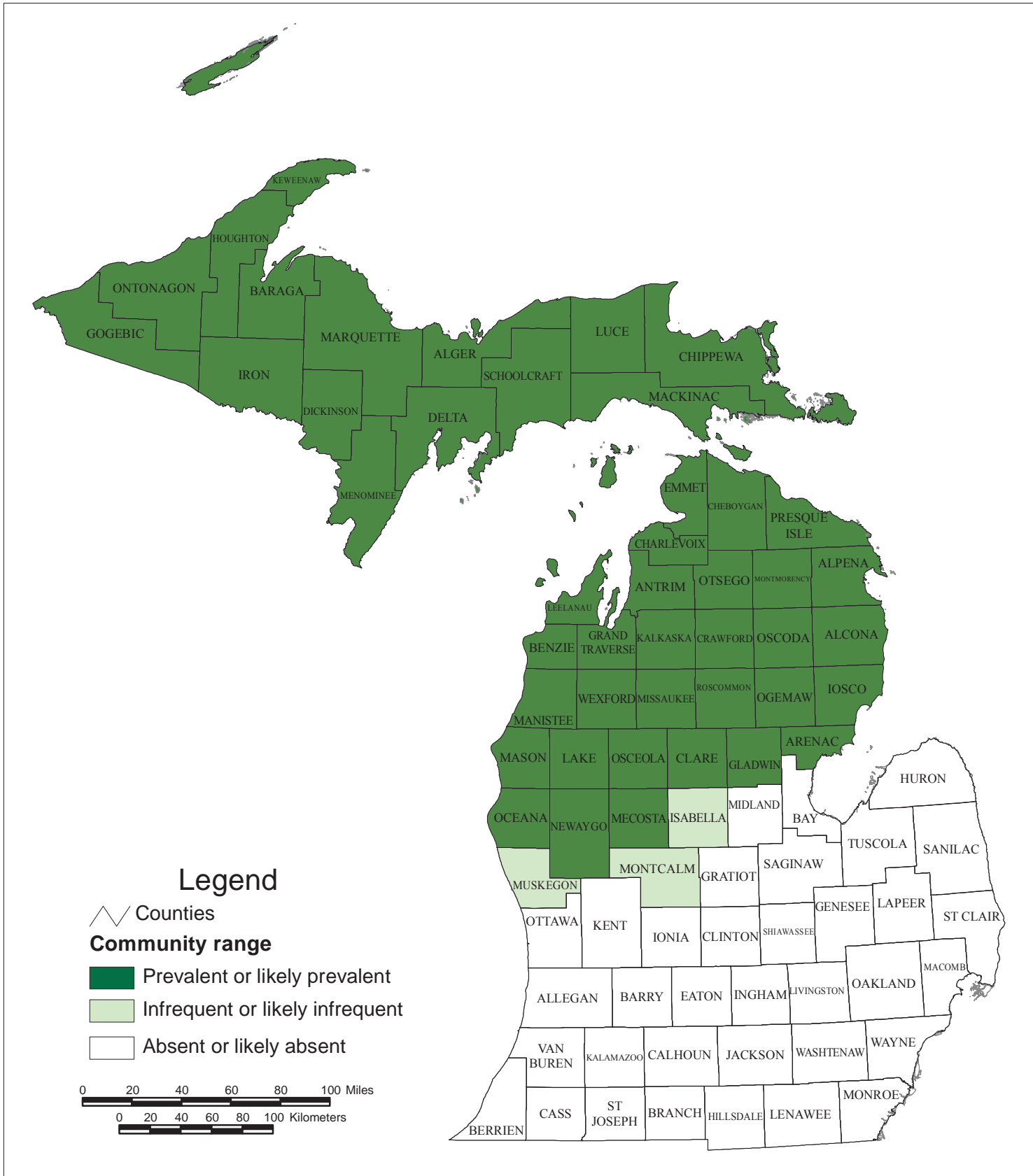


Albert, D.A., J.G. Cohen, M.A. Kost, B.S. Slaughter, and H.D. Enander. 2008. Distribution Maps of Michigan's Natural Communities. Michigan Natural Features Inventory, Report No. 2008-01, Lansing, MI. 166 pp.

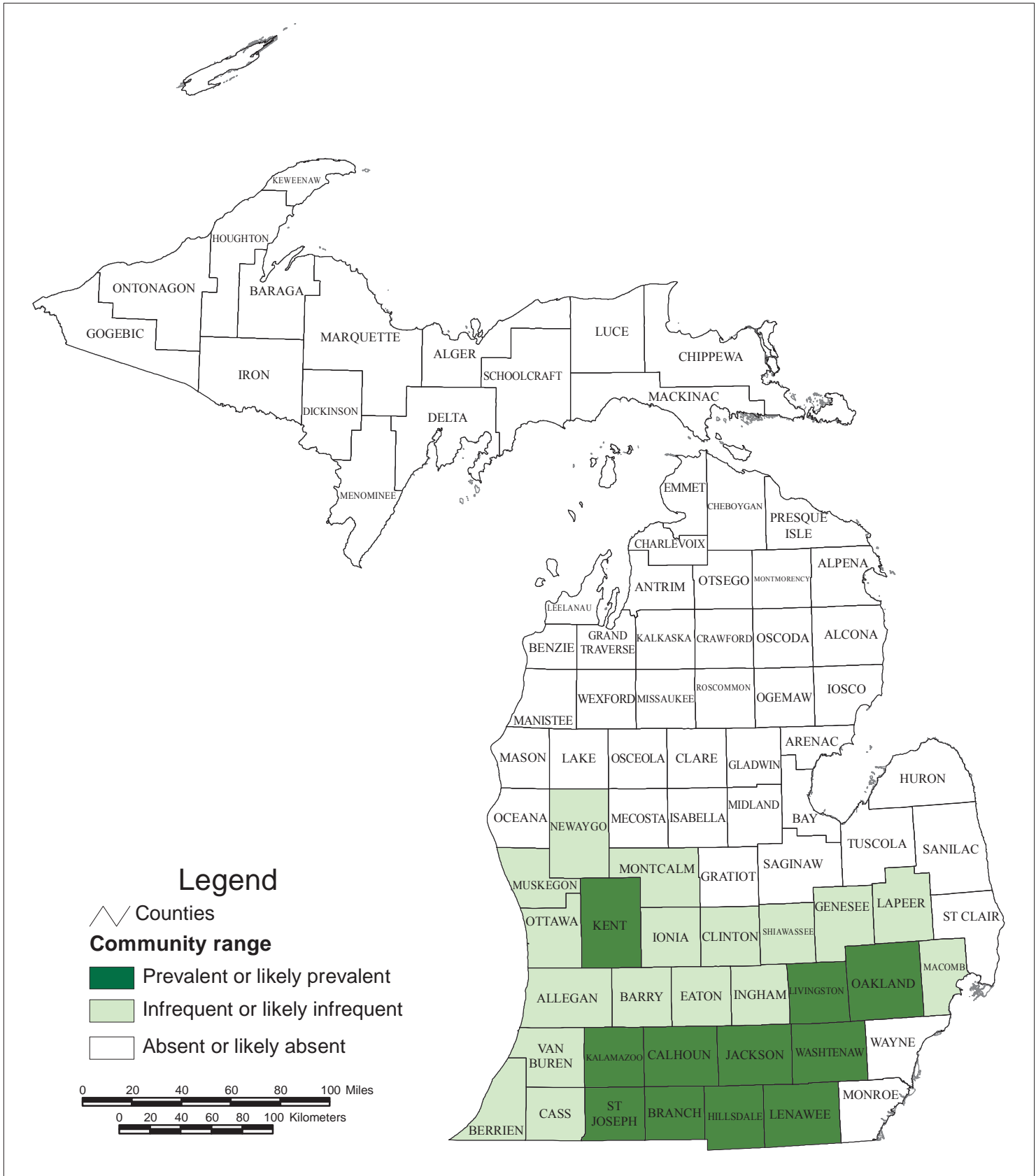
*MSU is an affirmative-action, equal-opportunity employer.*



## Northern Shrub Thicket

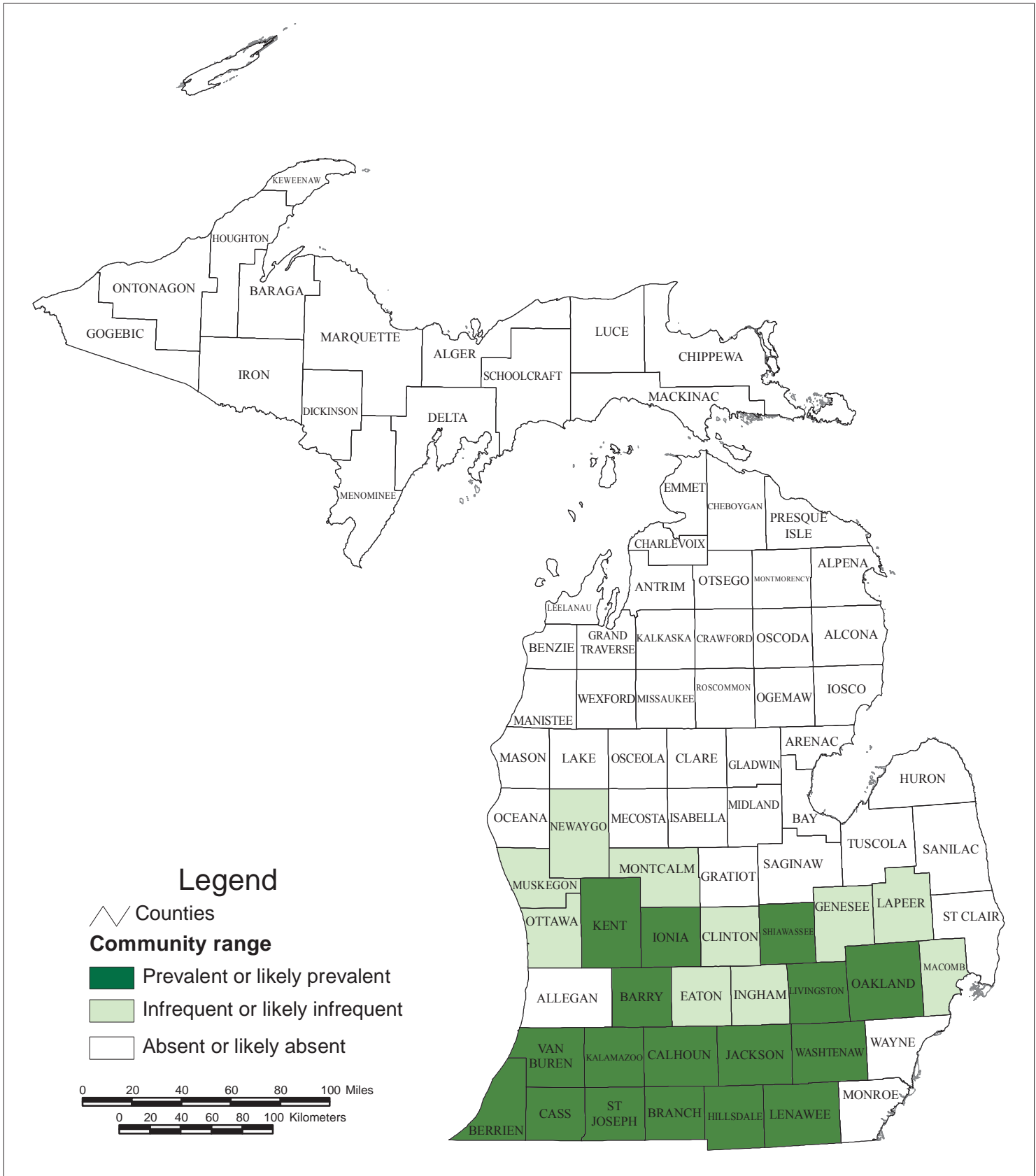


## Northern Wet Meadow



## Oak Barrens



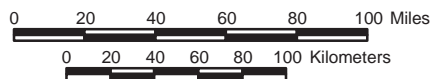


### Legend

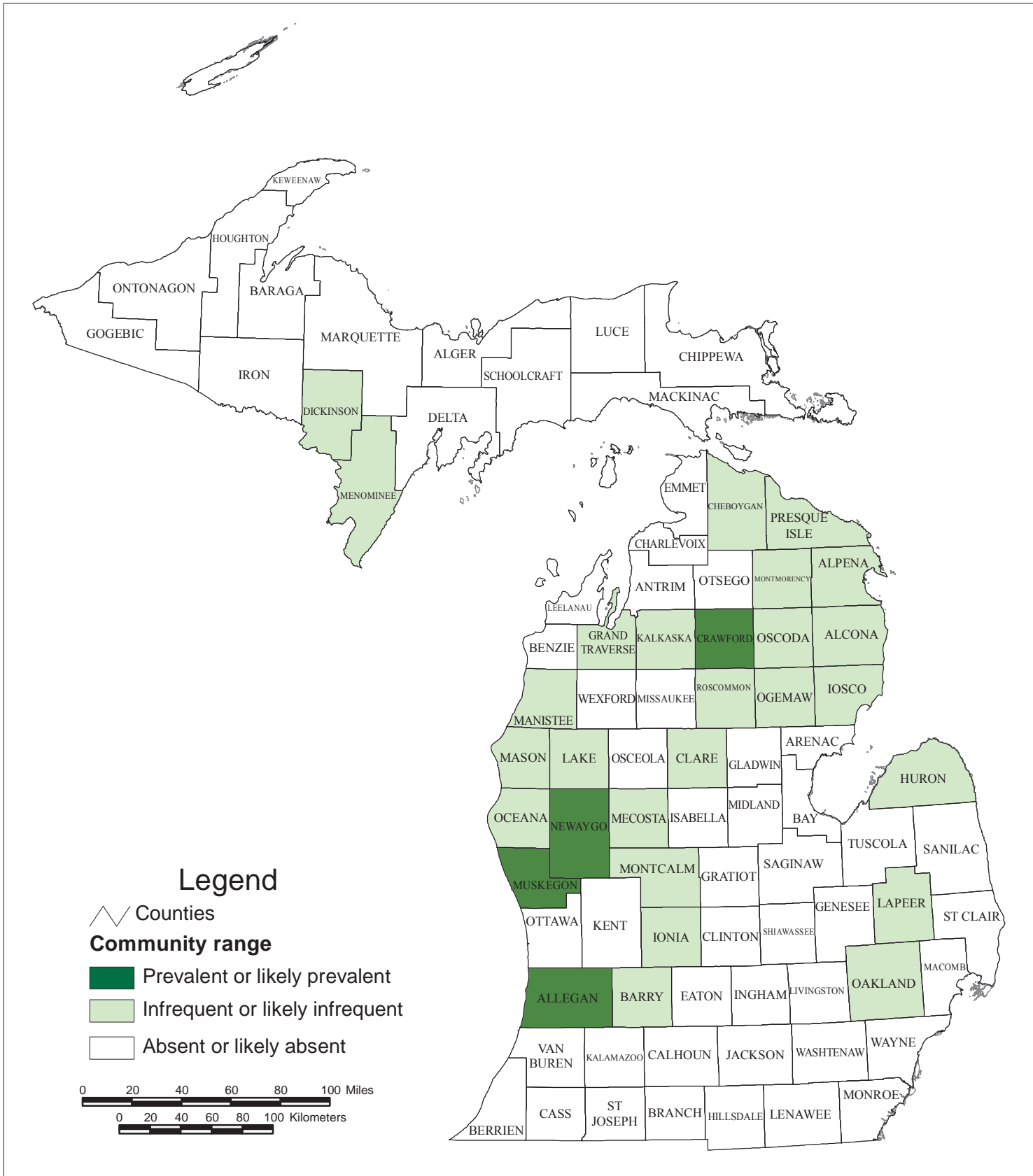
Counties

#### Community range

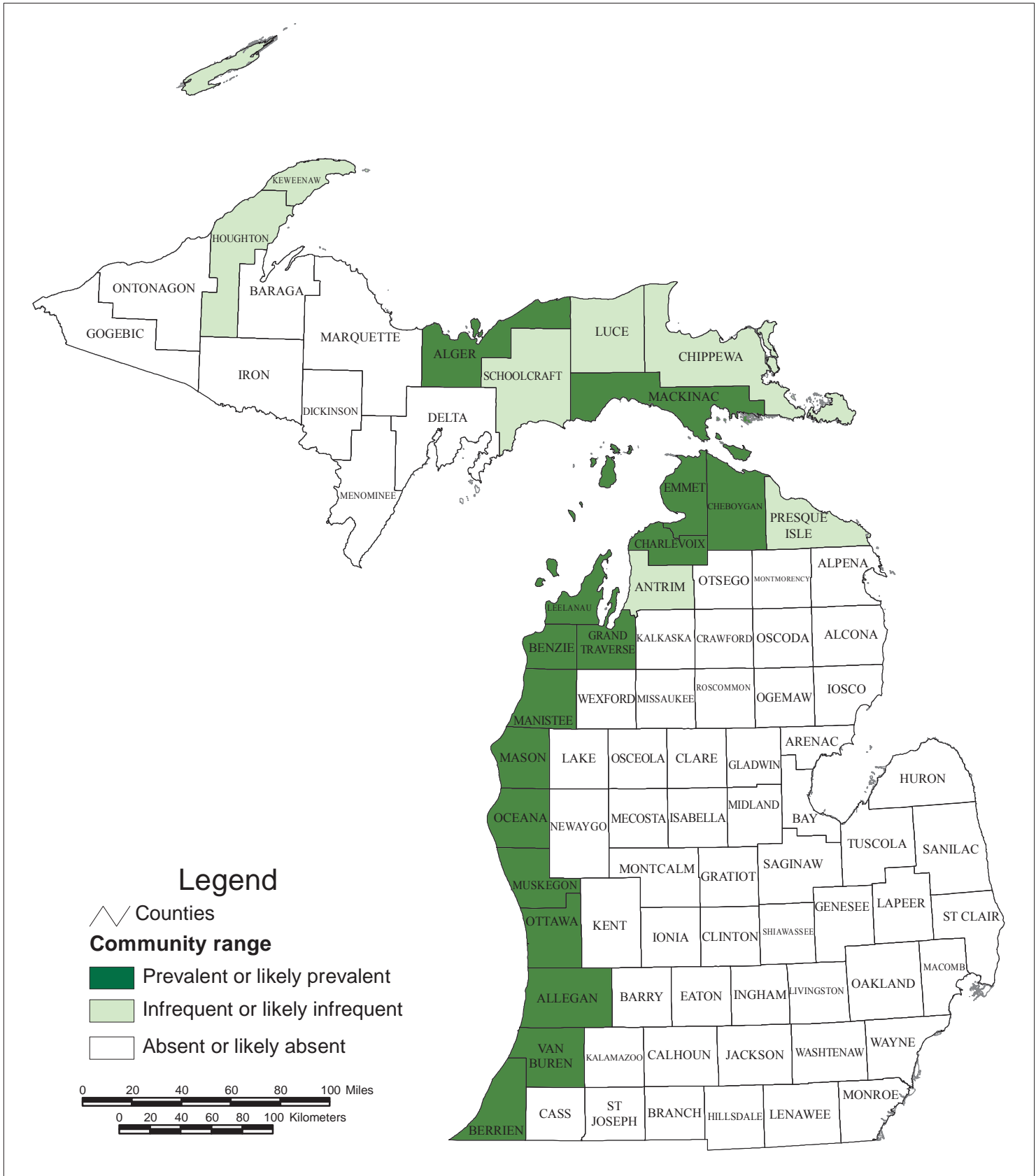
- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent



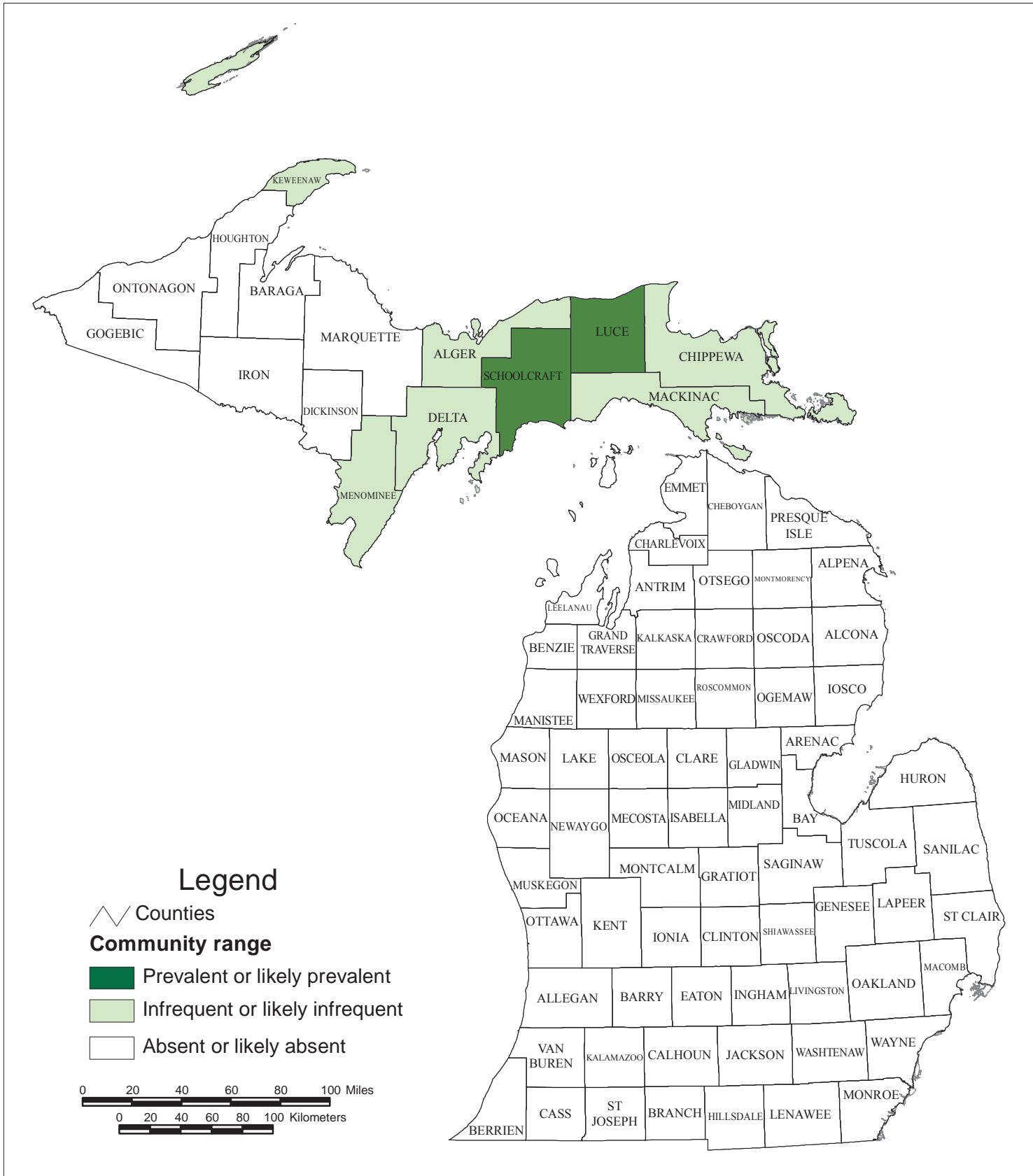
## Oak Openings



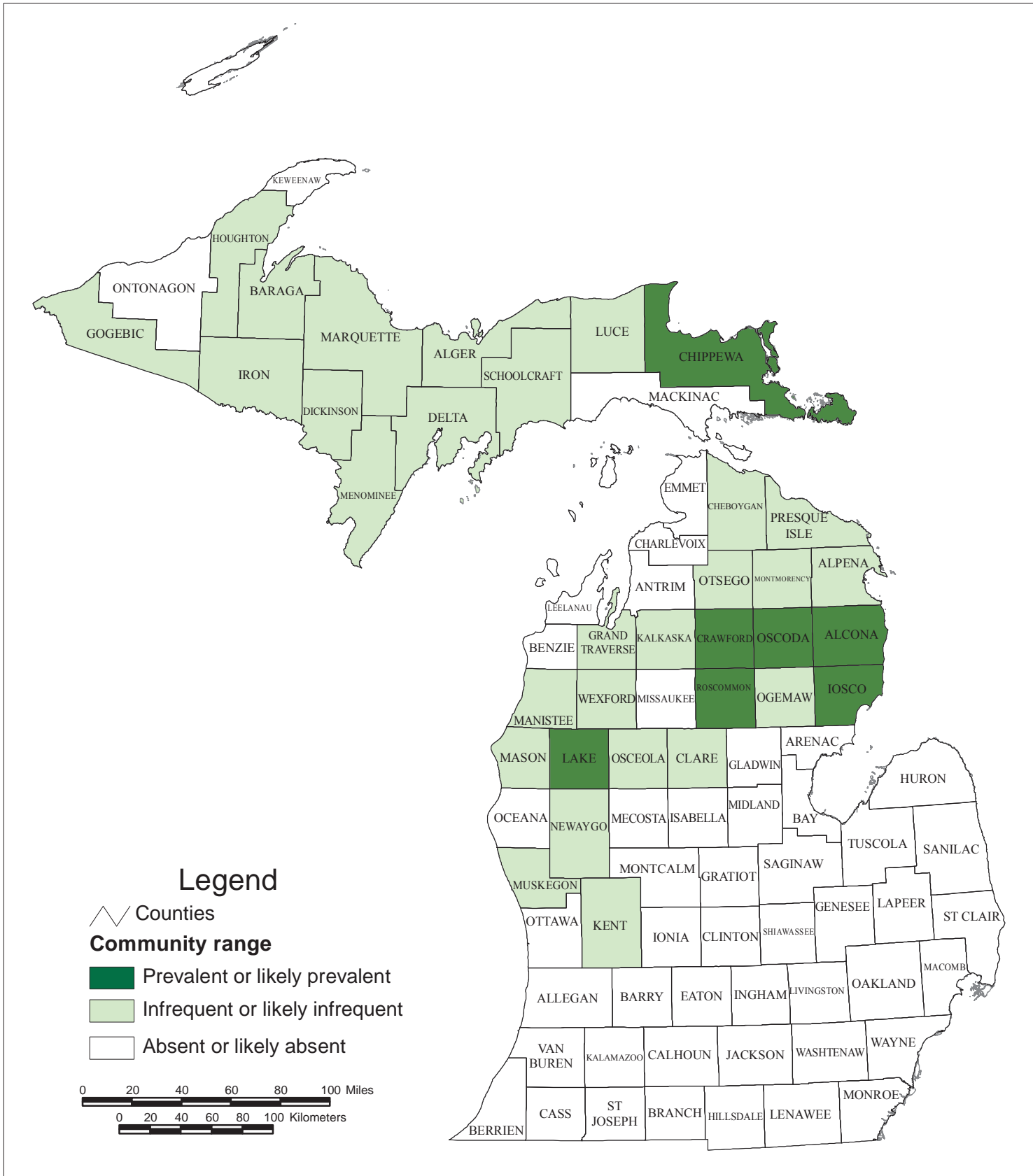
## Oak-pine Barrens



## Open Dunes



## Patterned Fen

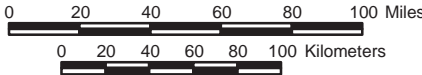


**Legend**

Counties

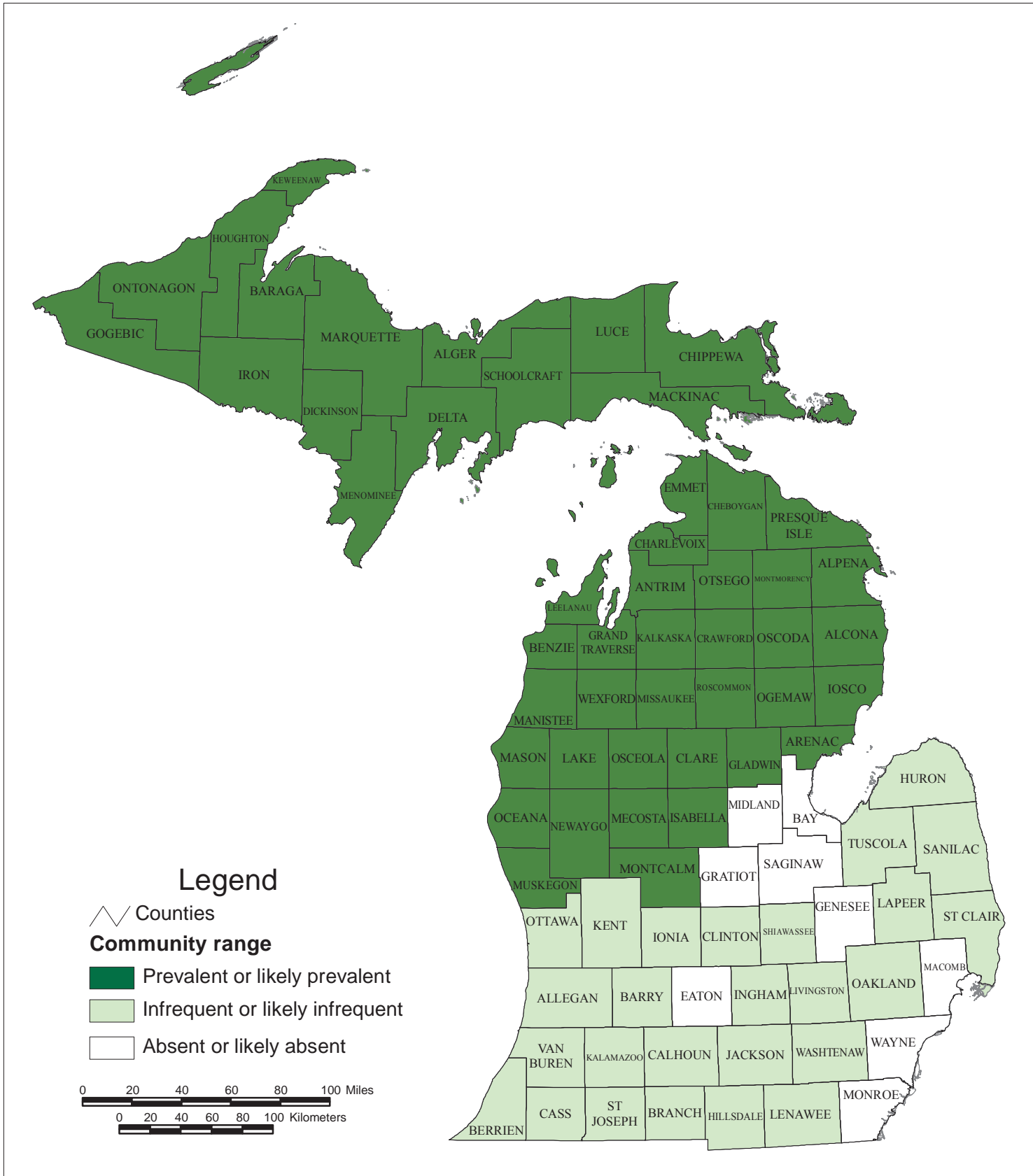
**Community range**

- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent

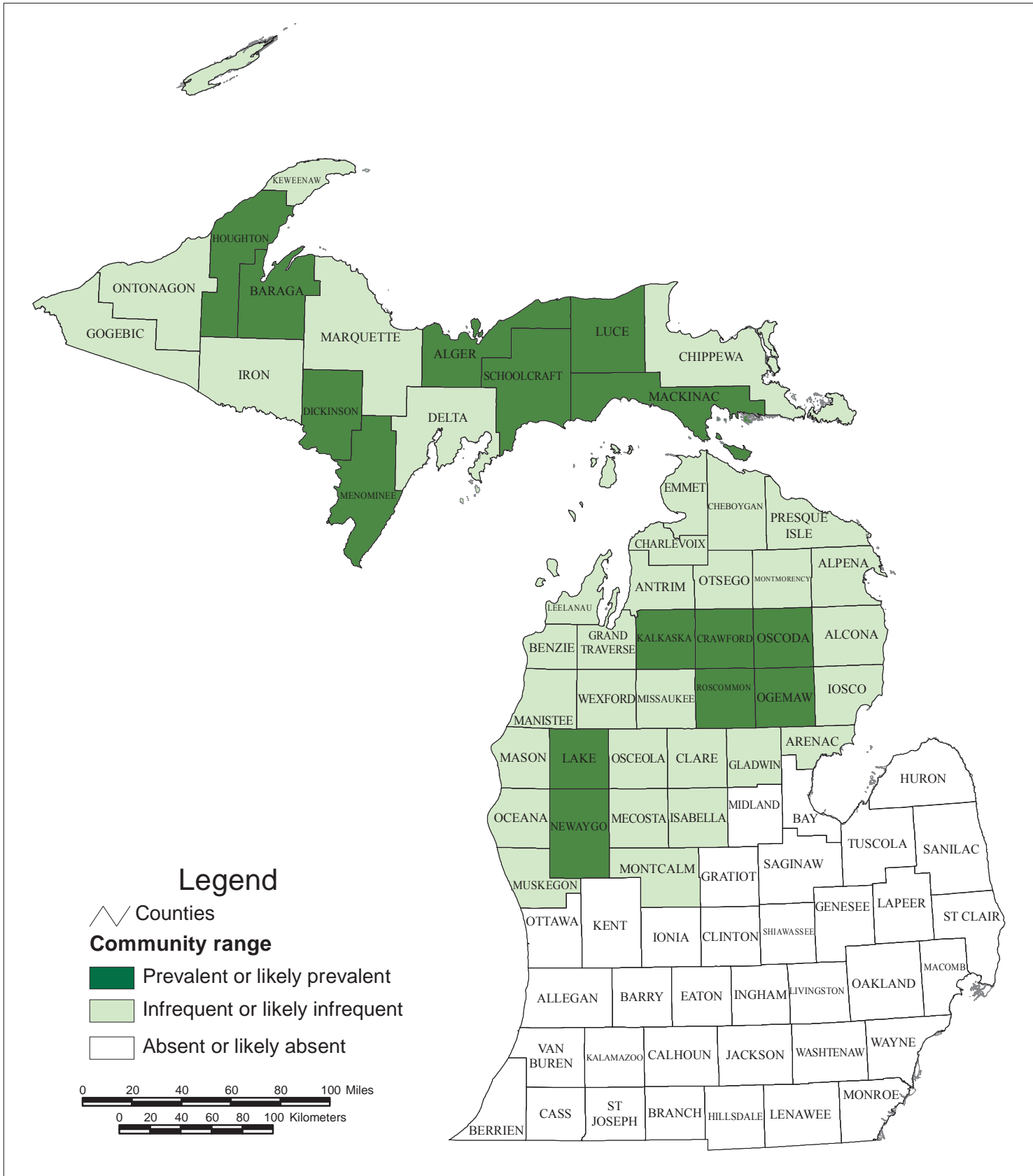


**Pine Barrens**





## Poor Conifer Swamp

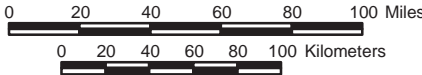


**Legend**

Counties

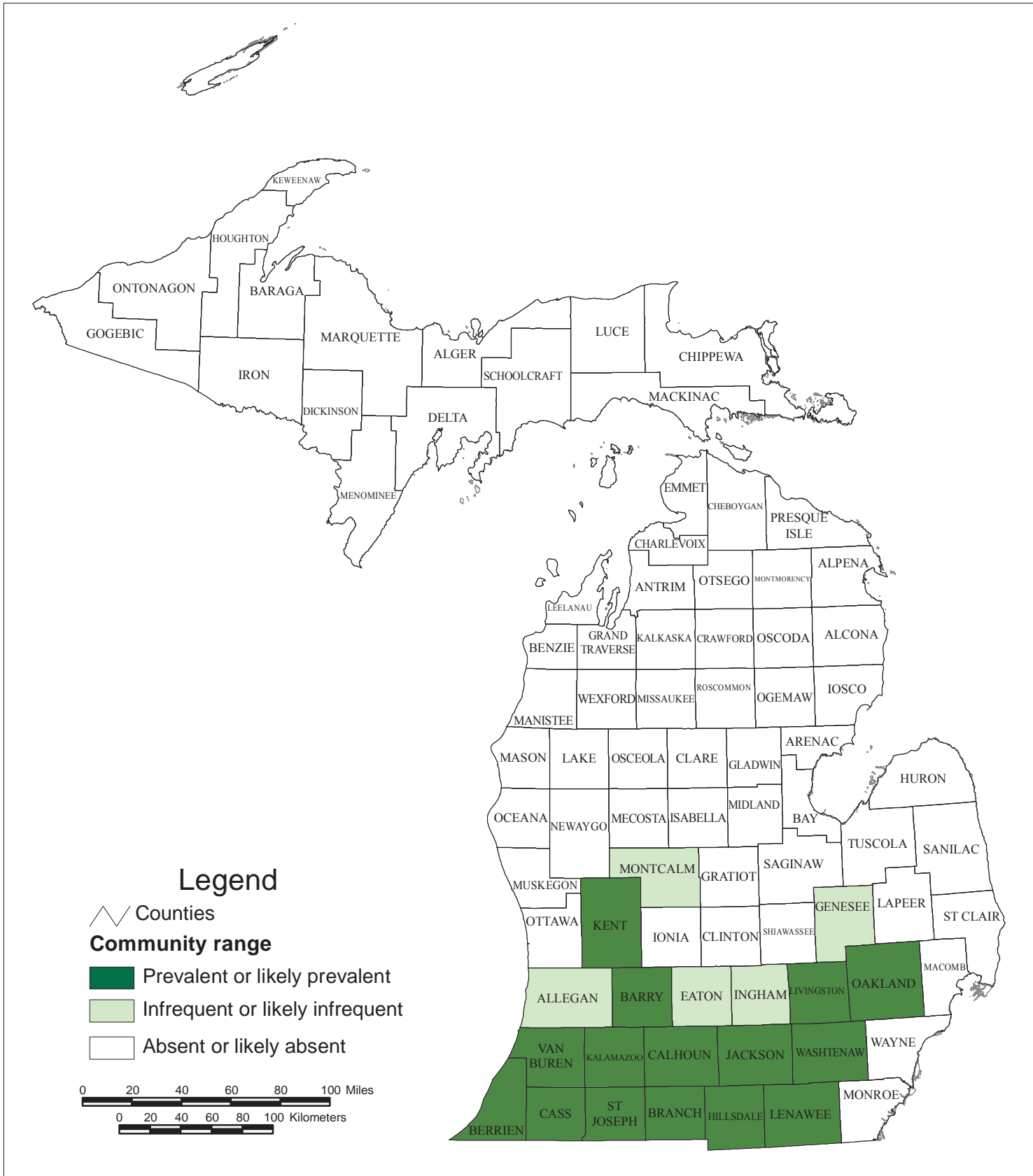
**Community range**

- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent



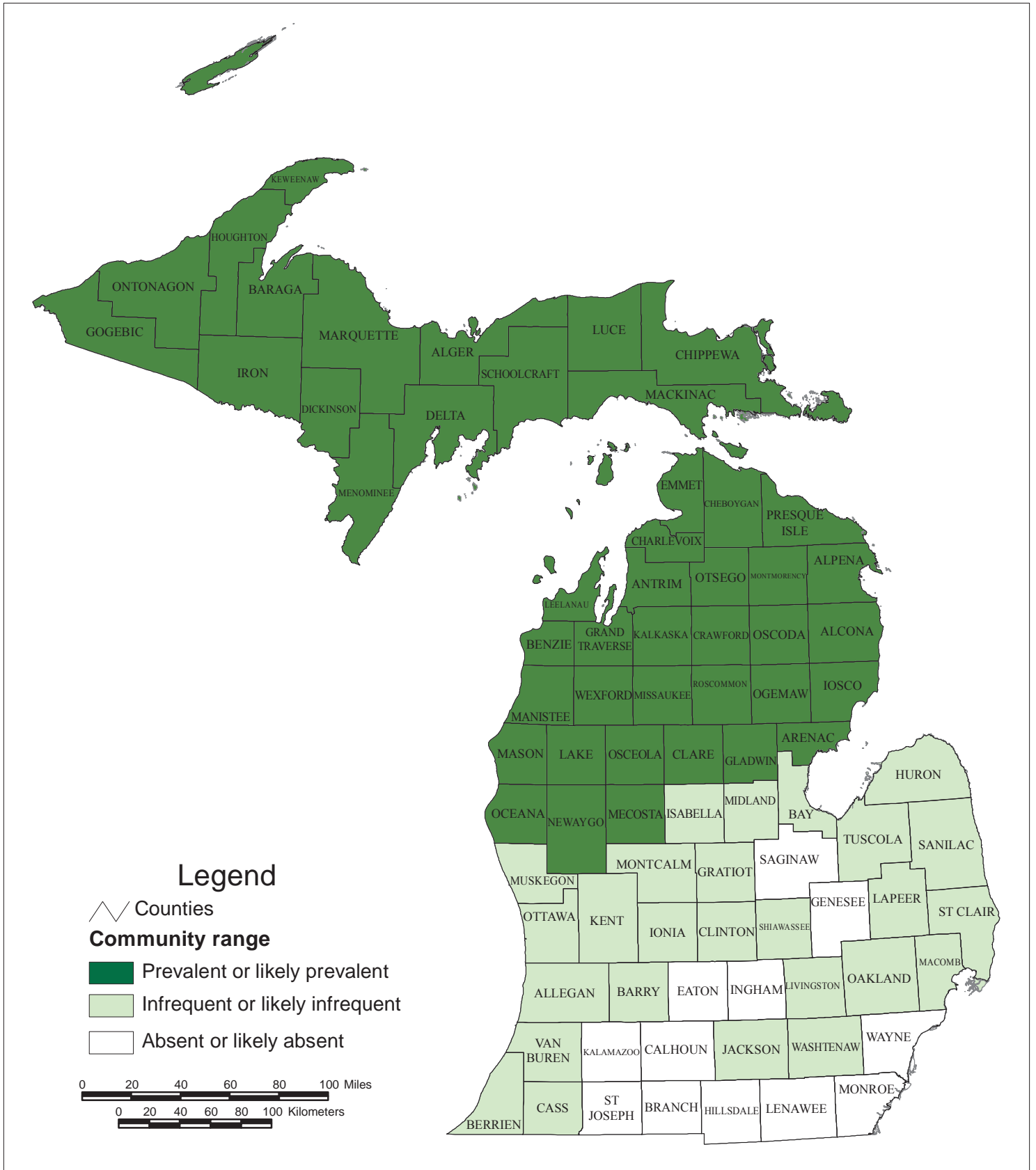
**Poor Fen**



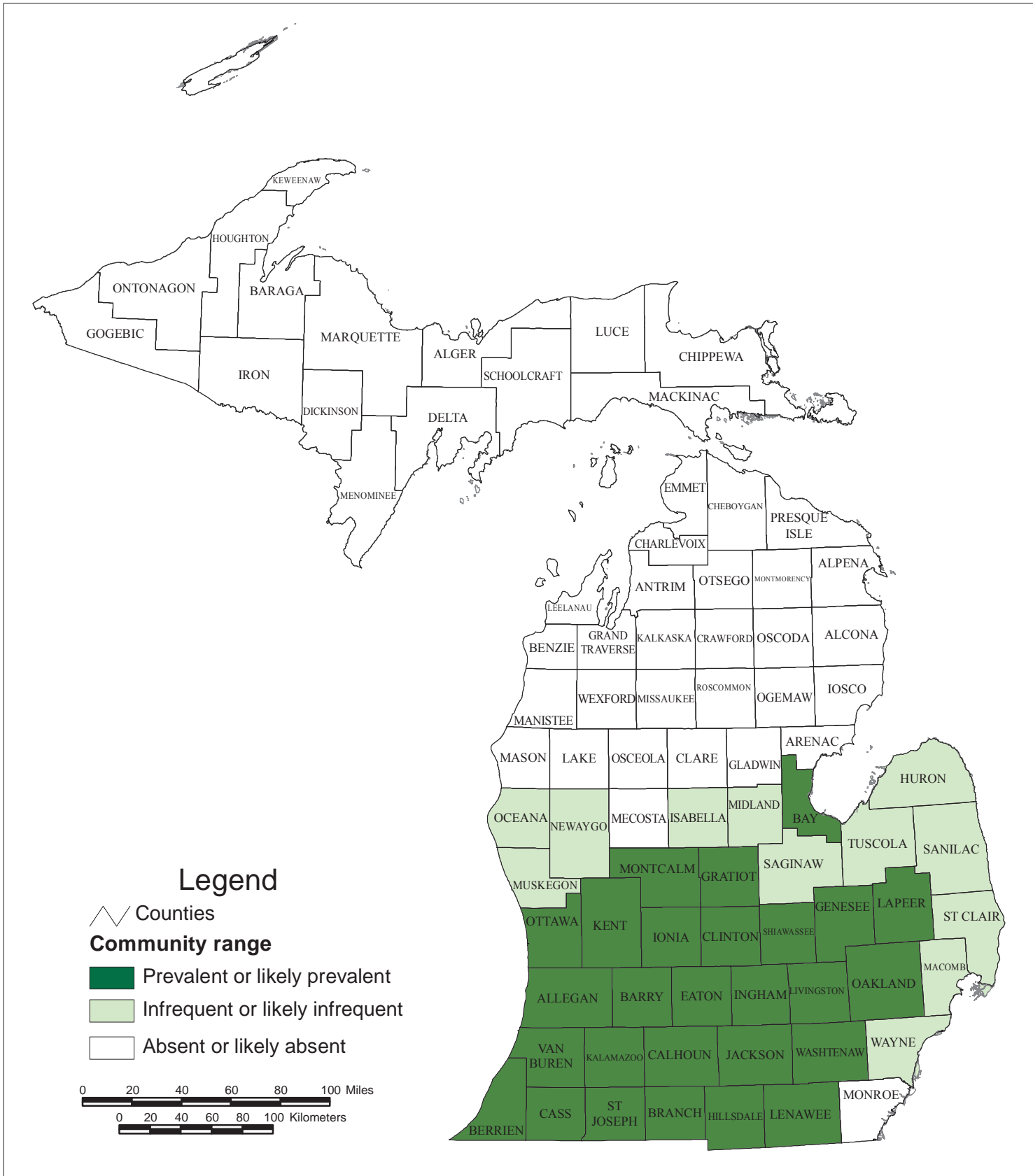


## Prairie Fen

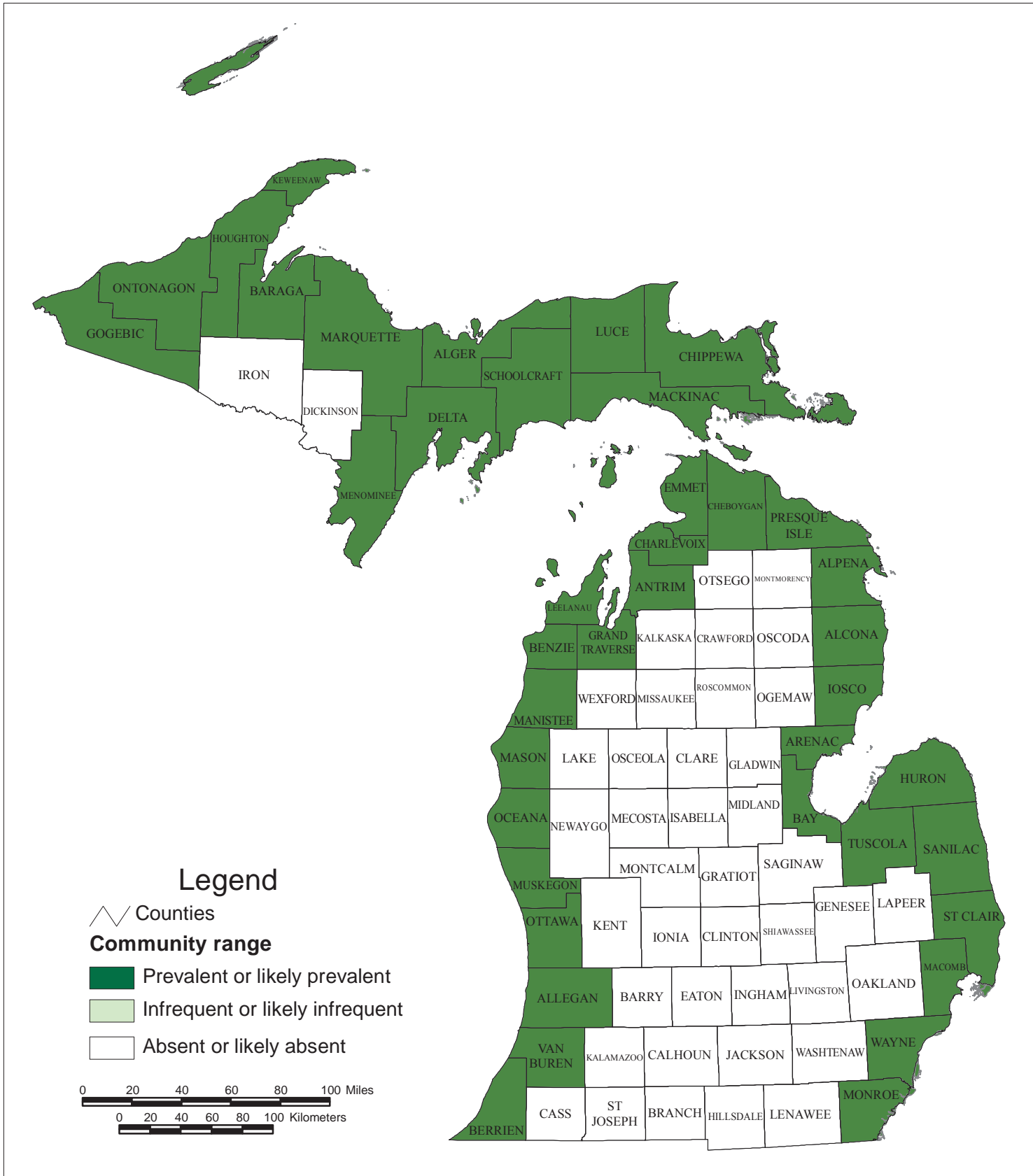




## Rich Conifer Swamp



## Rich Tamarack Swamp

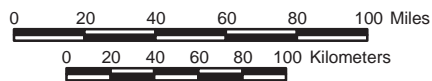


### Legend

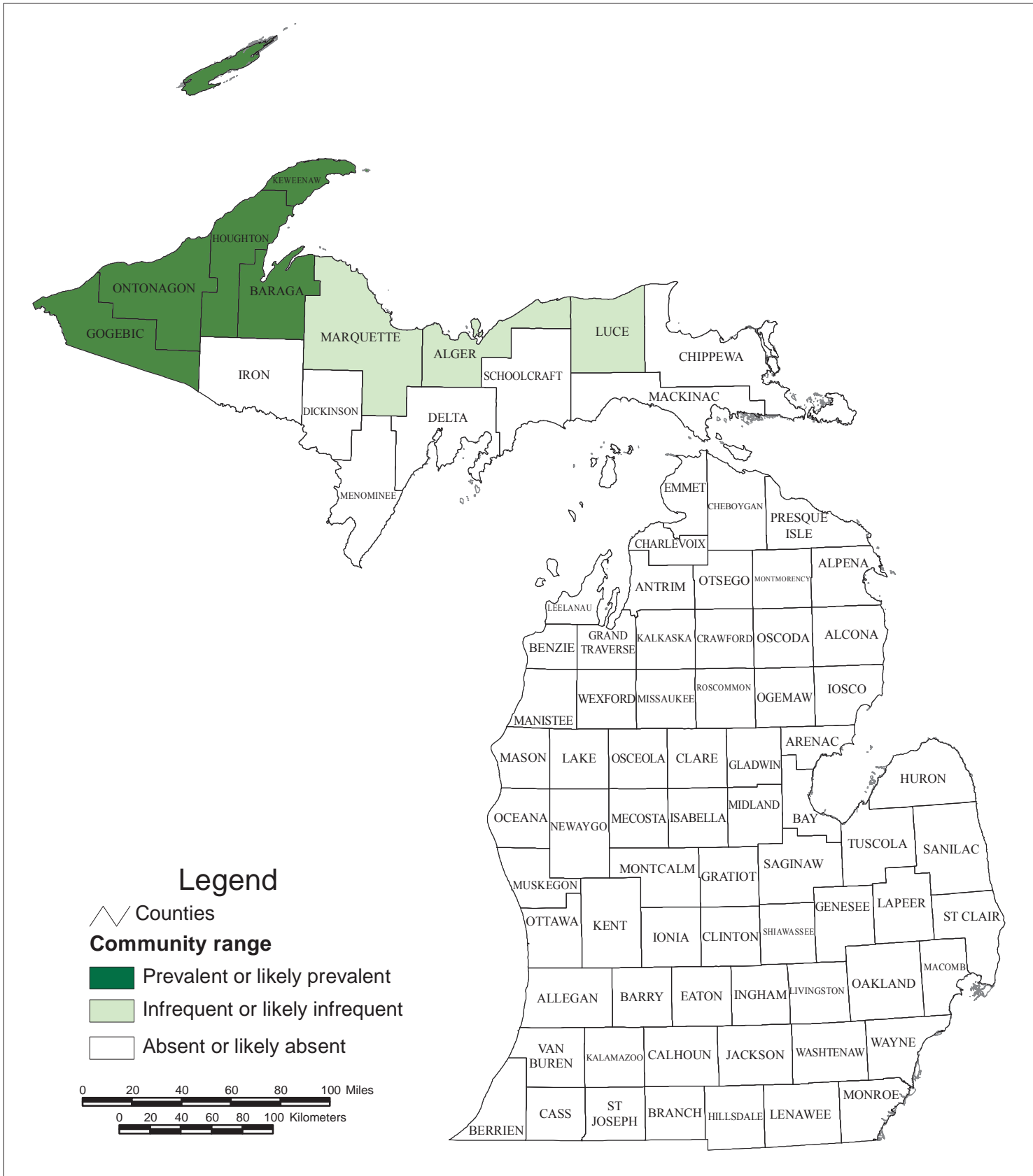
Counties

### Community range

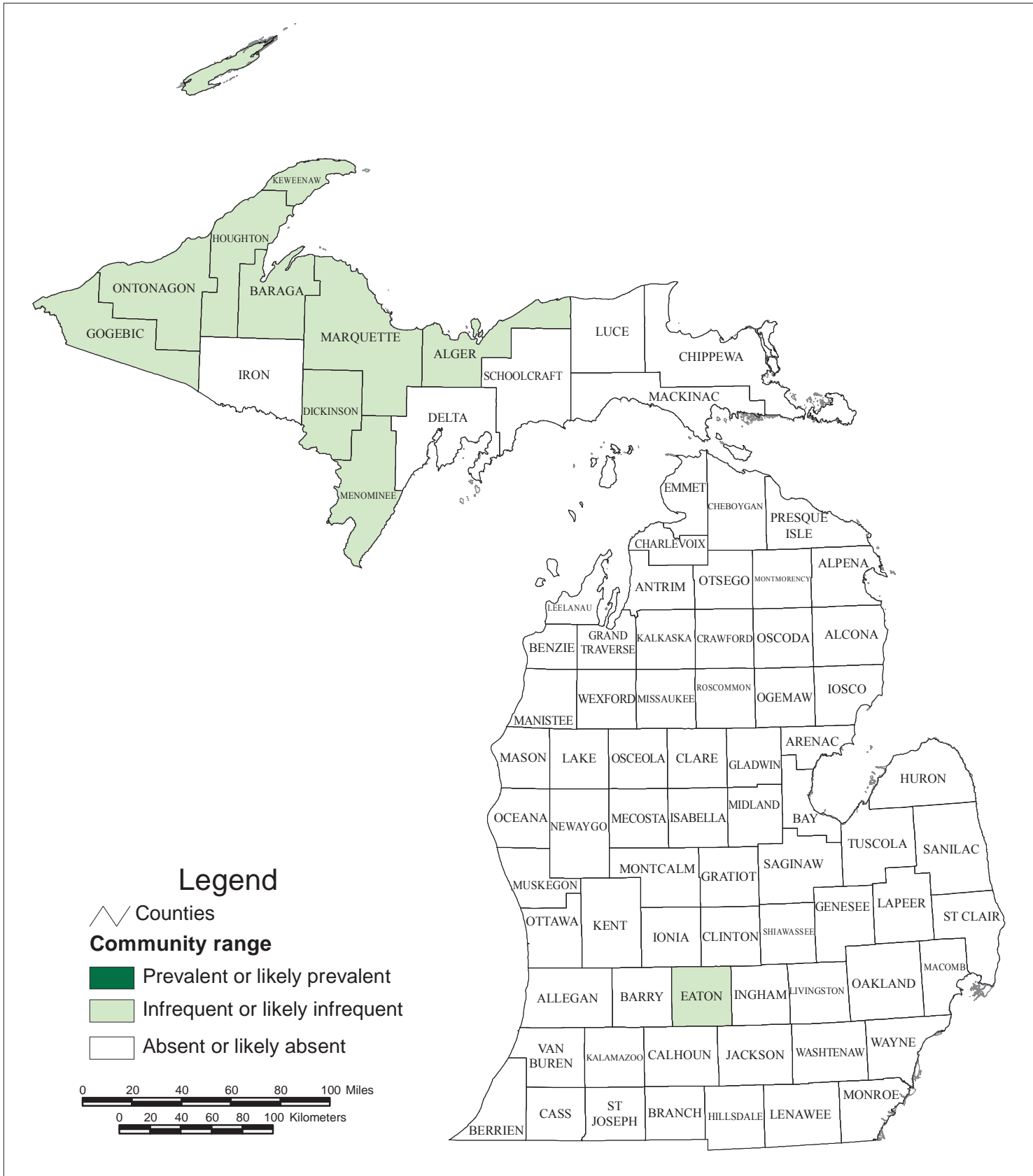
- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent



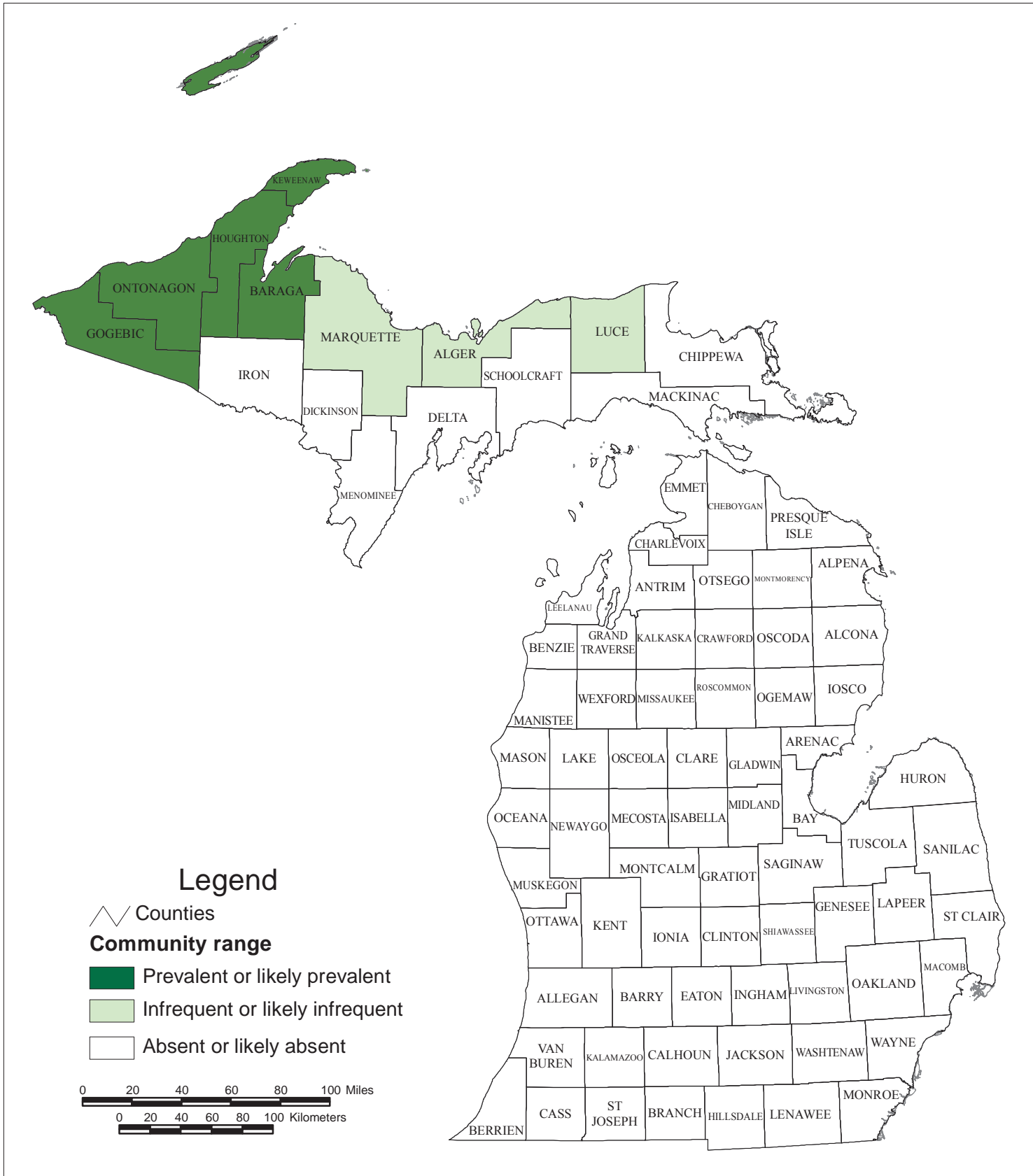
## Sand and Gravel Beach



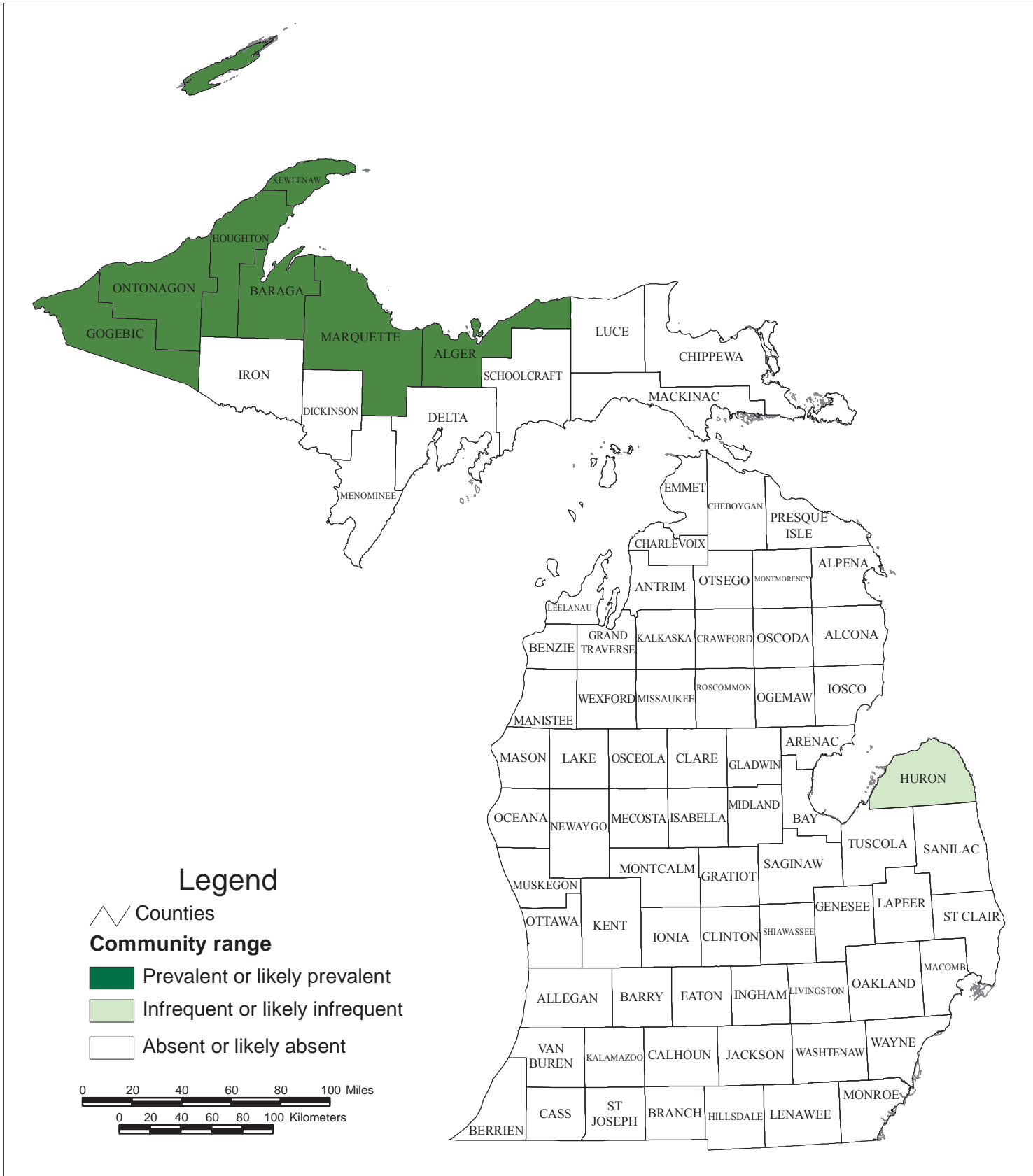
## Sandstone Bedrock Lakeshore



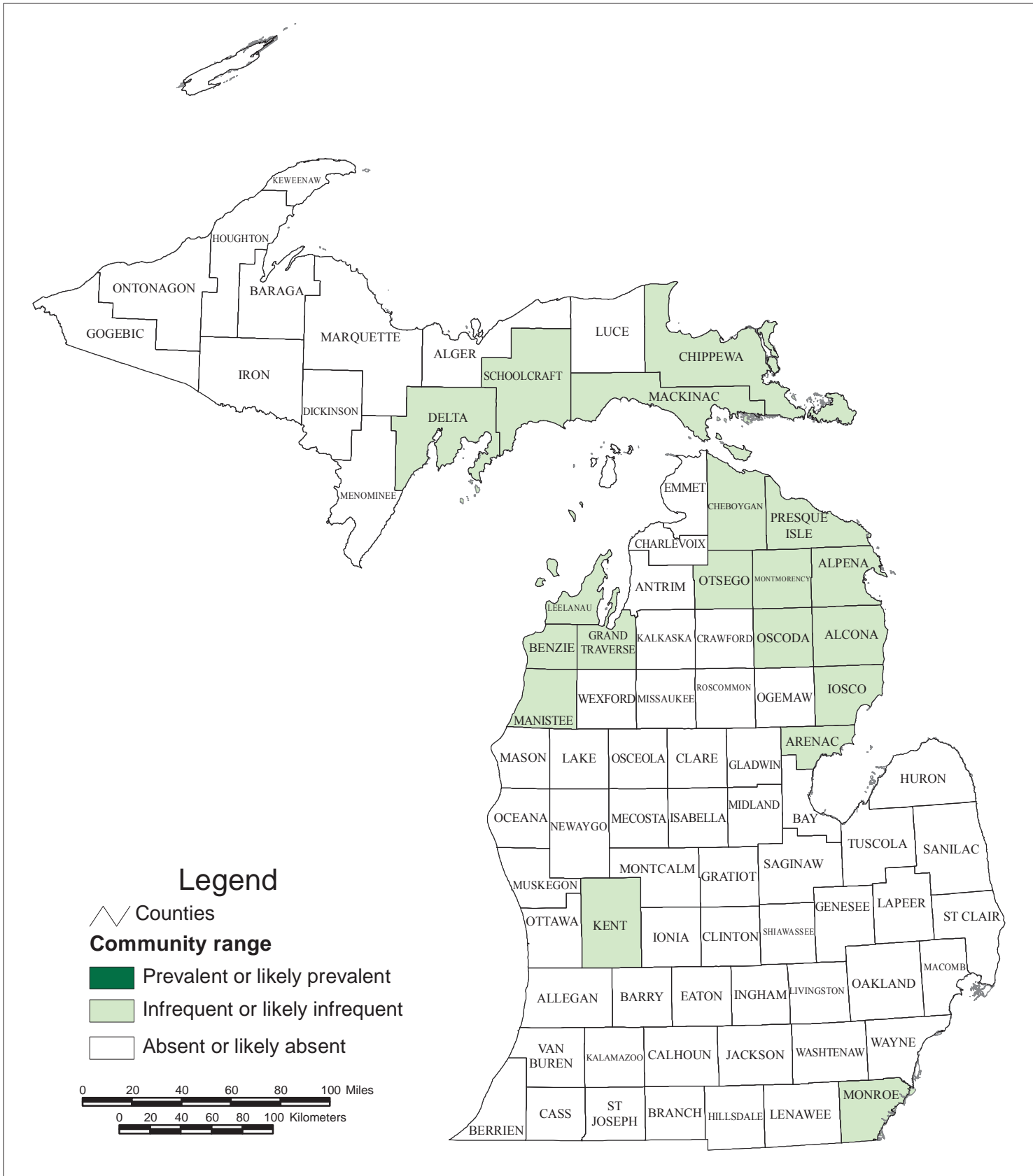
## Sandstone Cliff



## Sandstone Cobble Shore

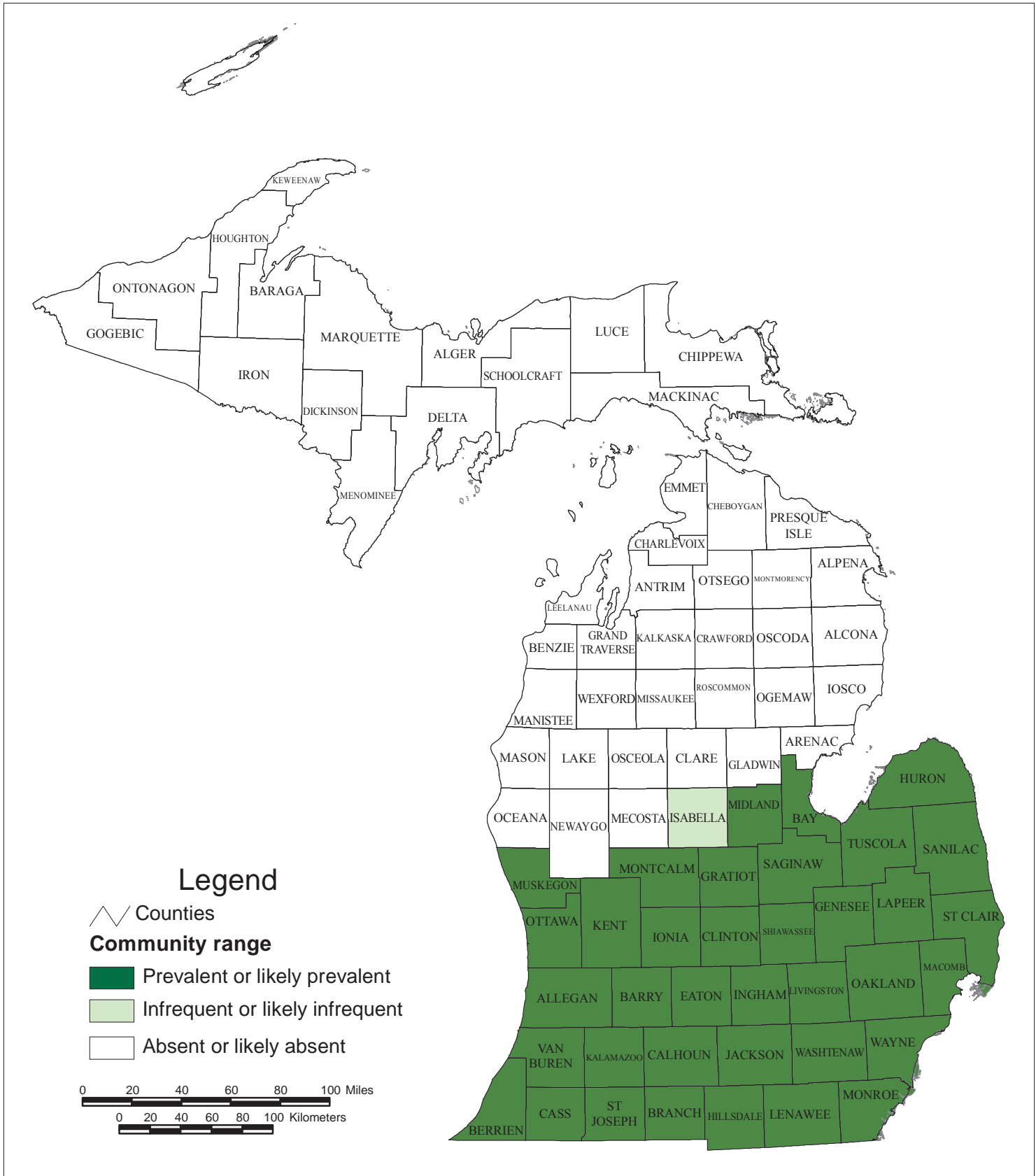


## Sandstone Lakeshore Cliff

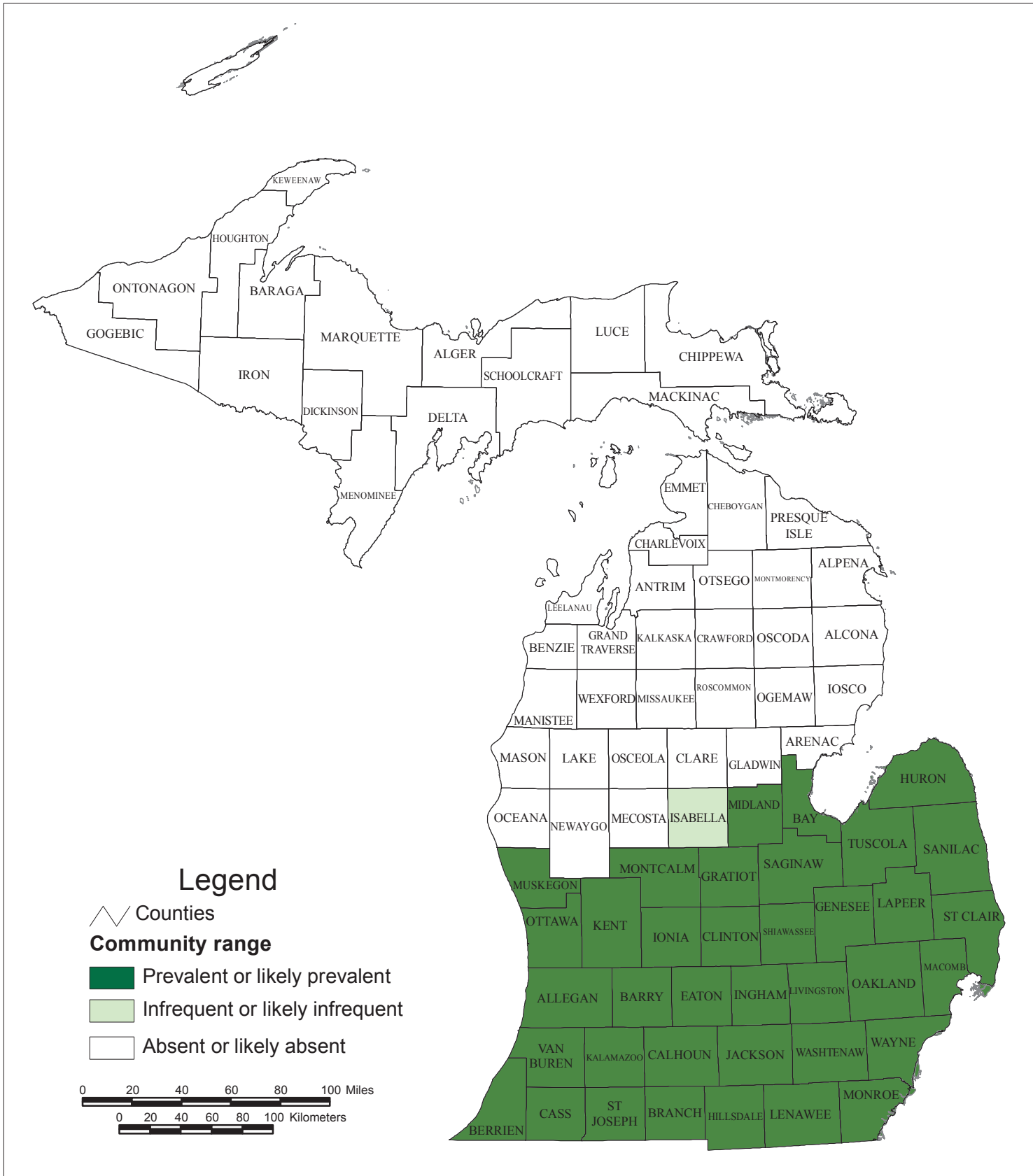


## Sinkhole



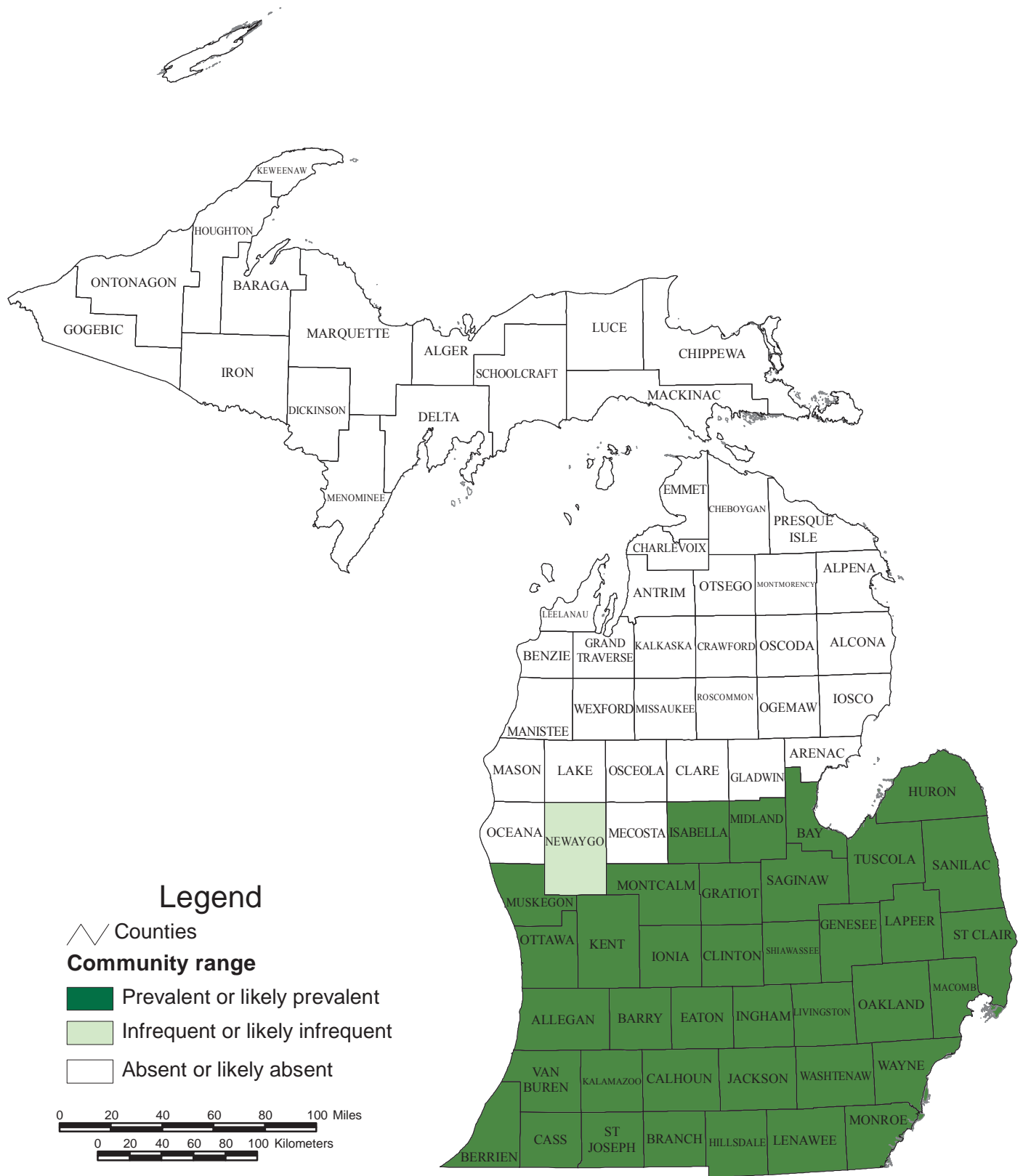


## Southern Hardwood Swamp



## Southern Shrub-Carr



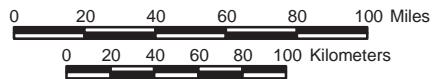


### Legend

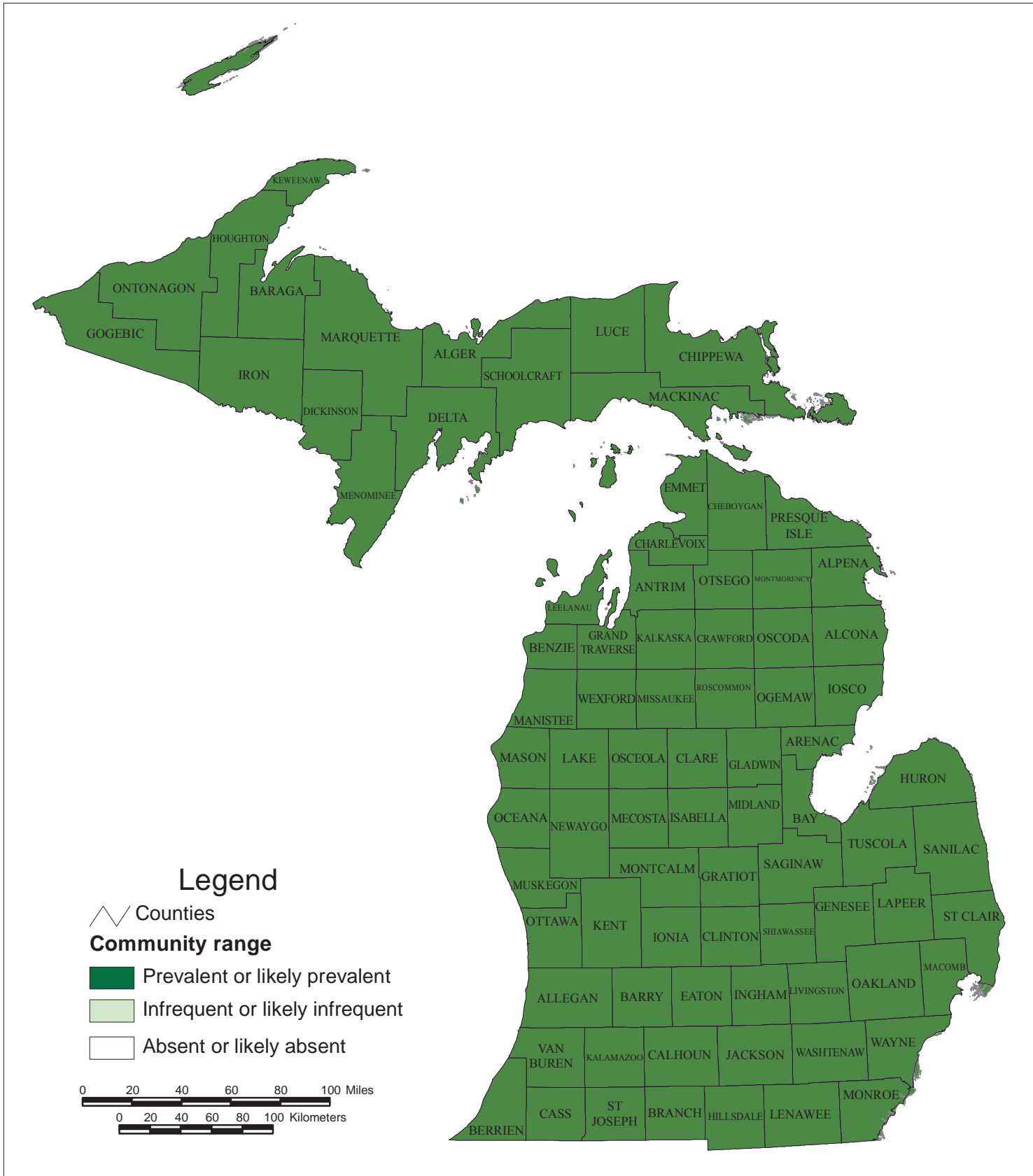
▭ Counties

#### Community range

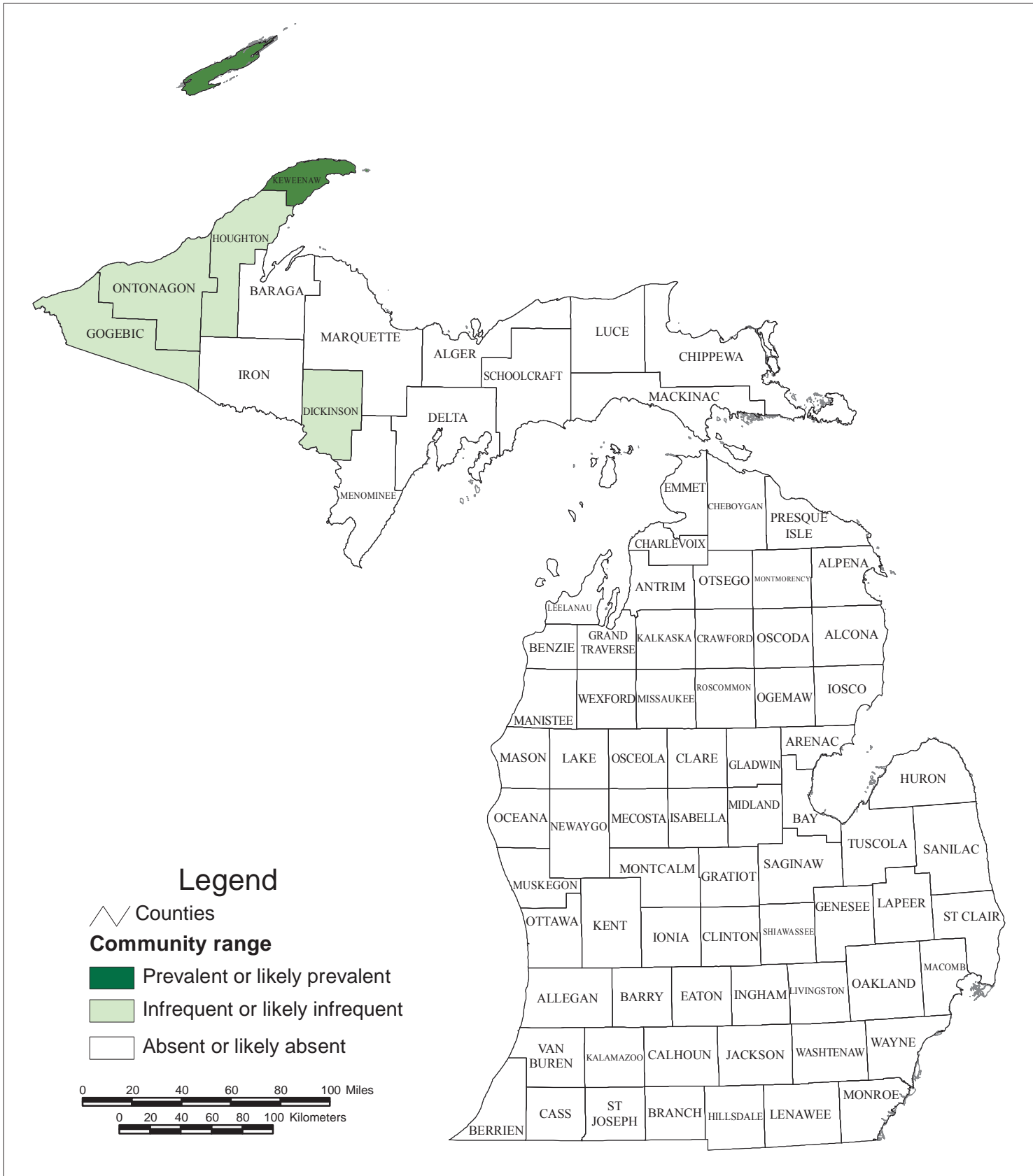
- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent



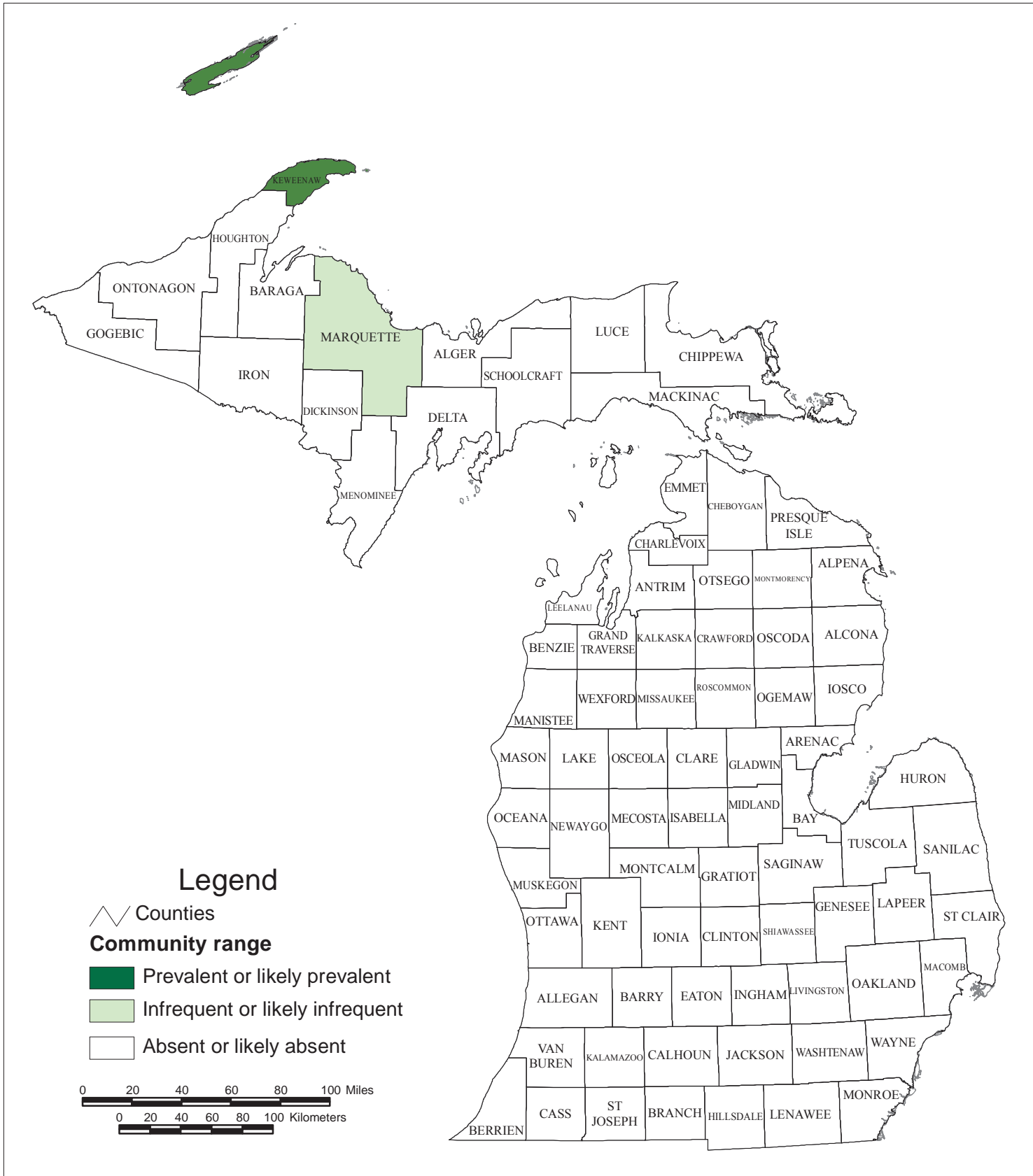
## Southern Wet Meadow



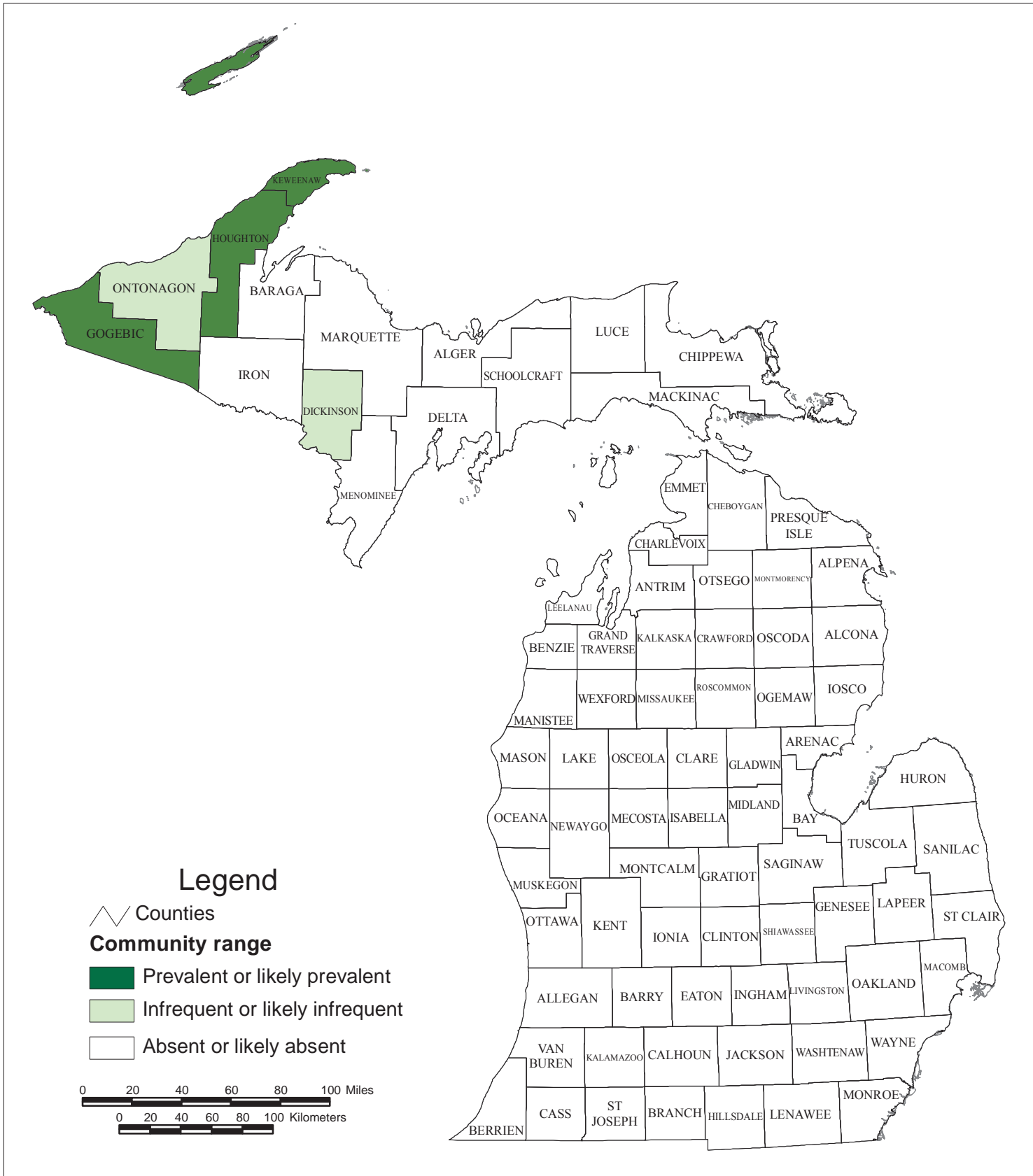
## Submergent Marsh



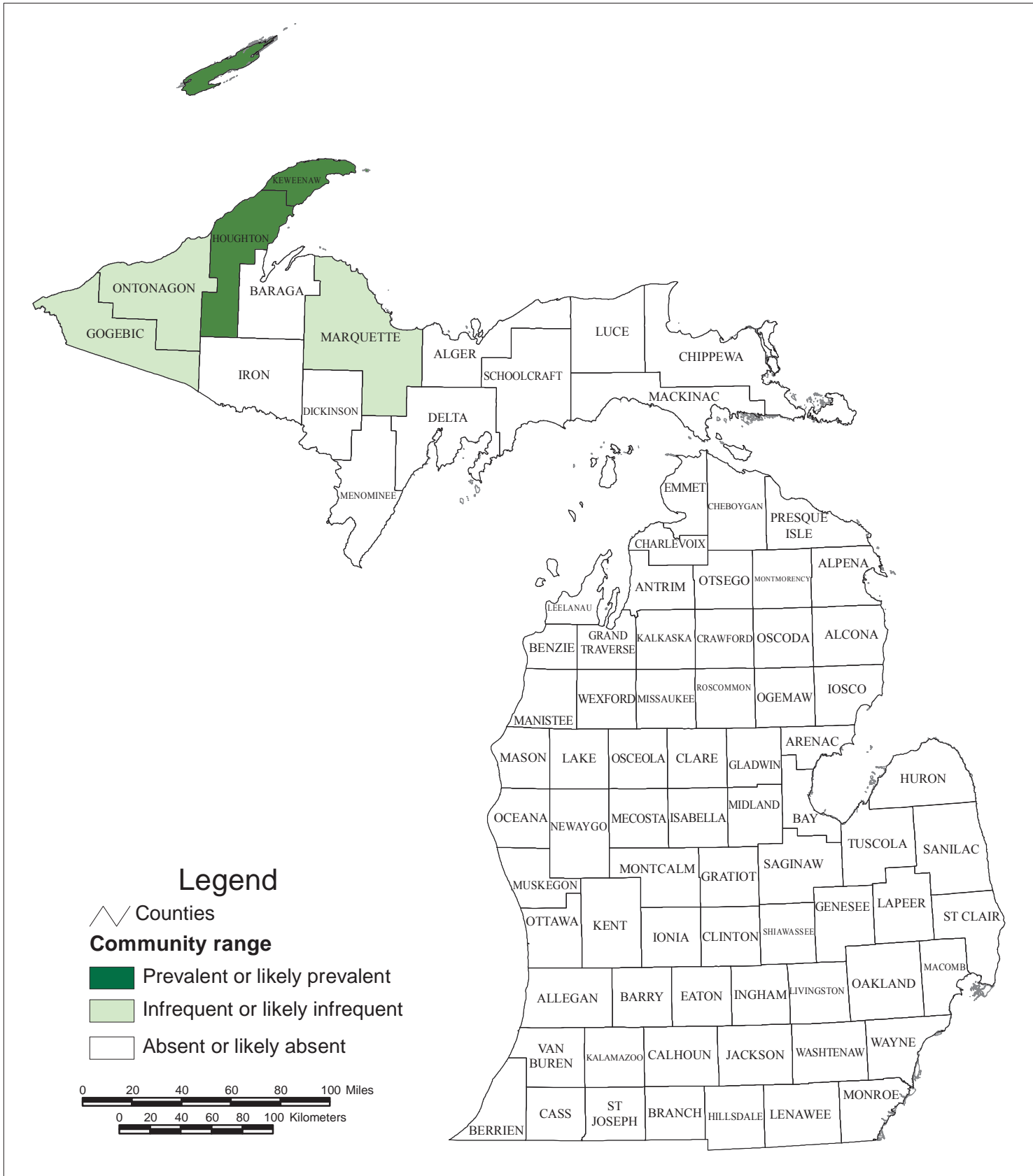
## Volcanic Bedrock Glade



## Volcanic Bedrock Lakeshore

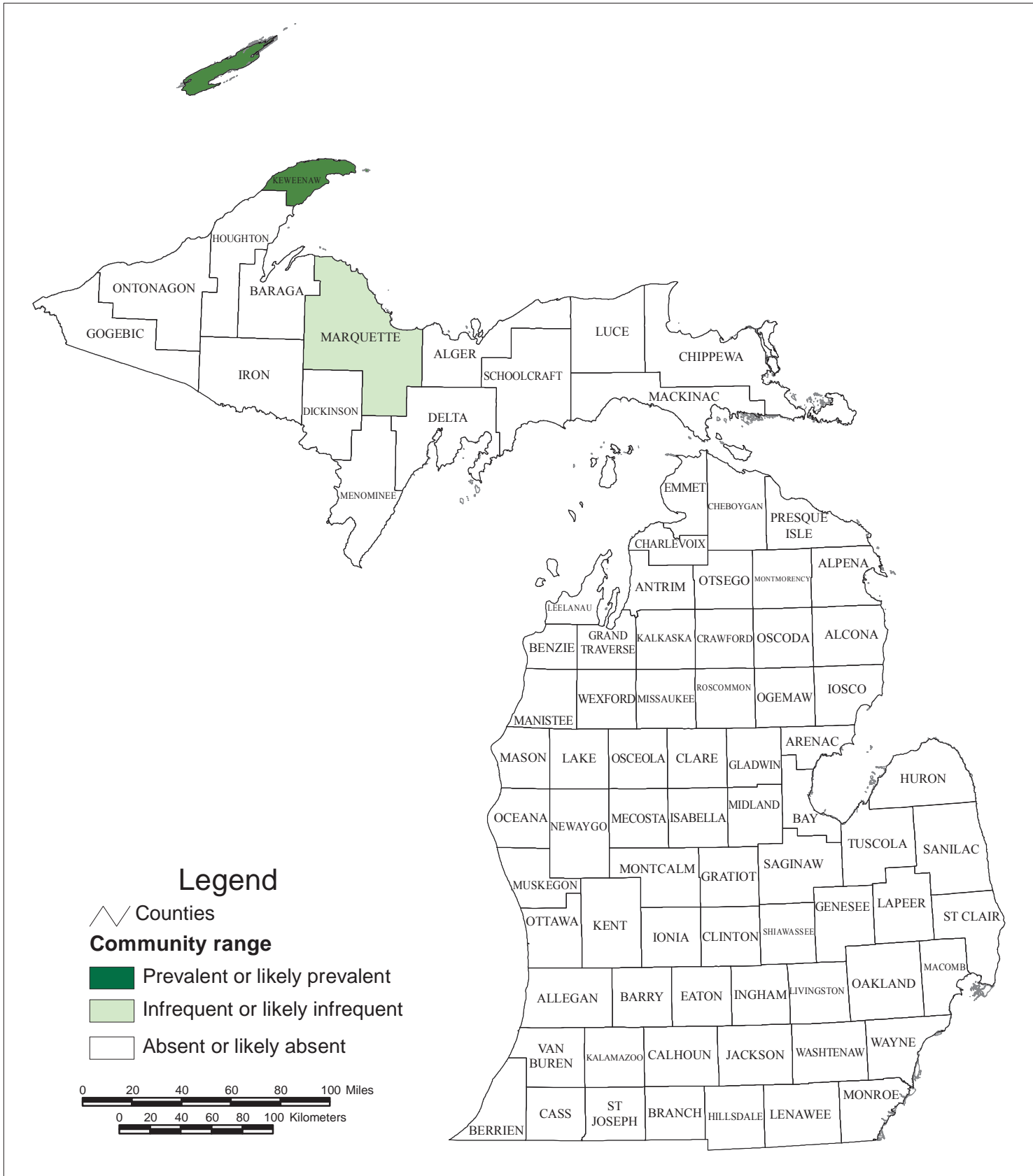


## Volcanic Cliff

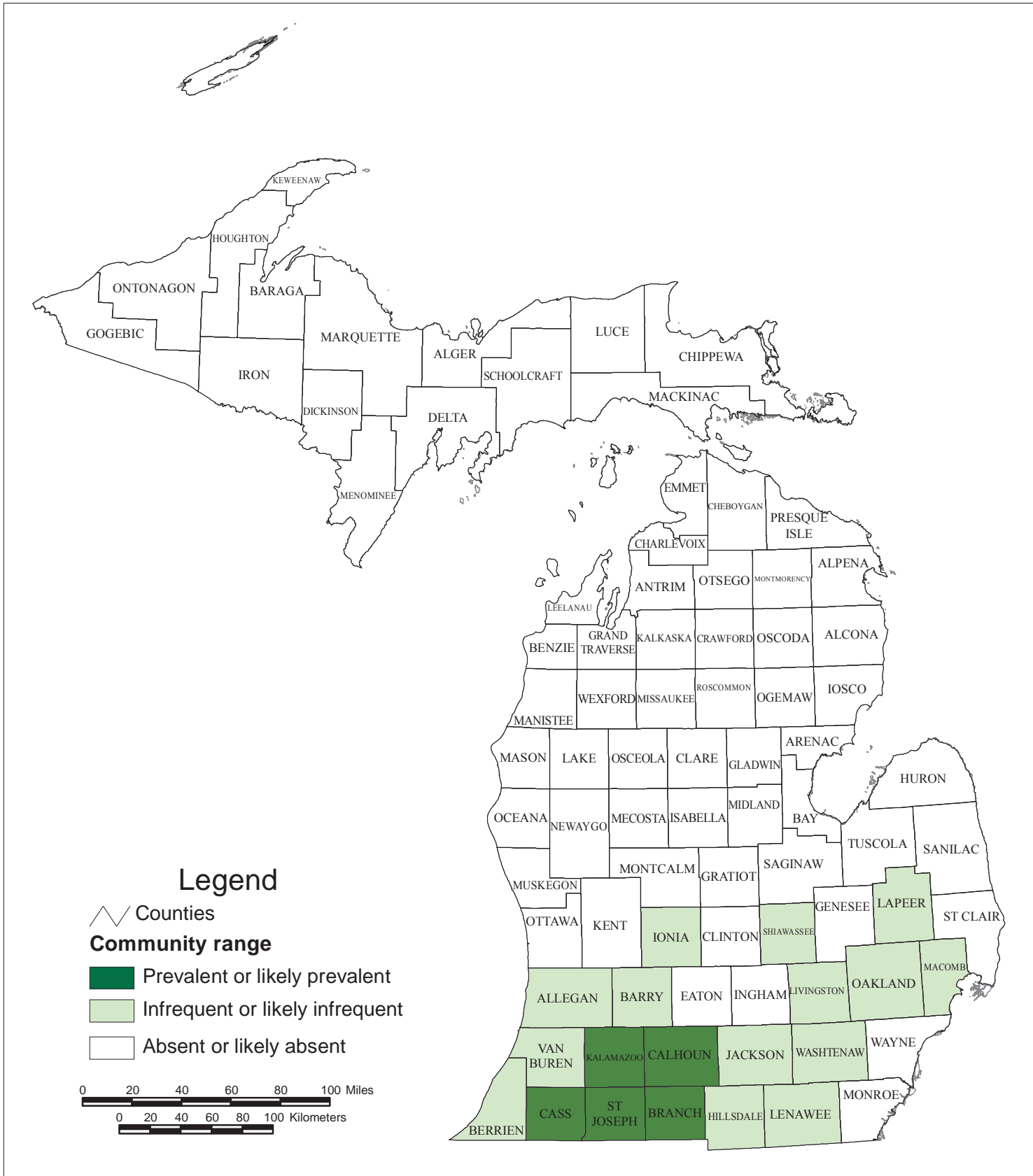


## Volcanic Cobble Shore

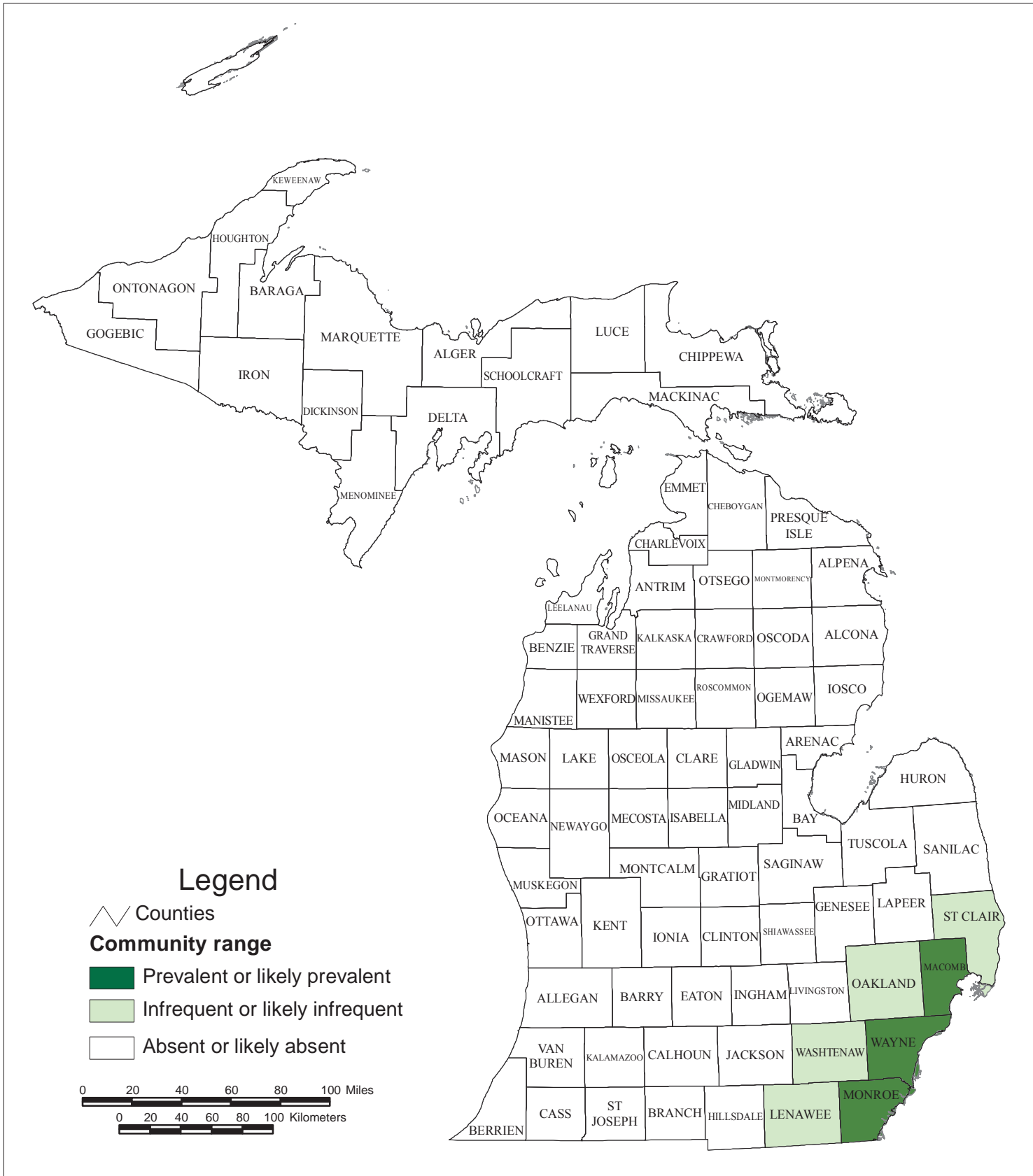




## Volcanic Lakeshore Cliff

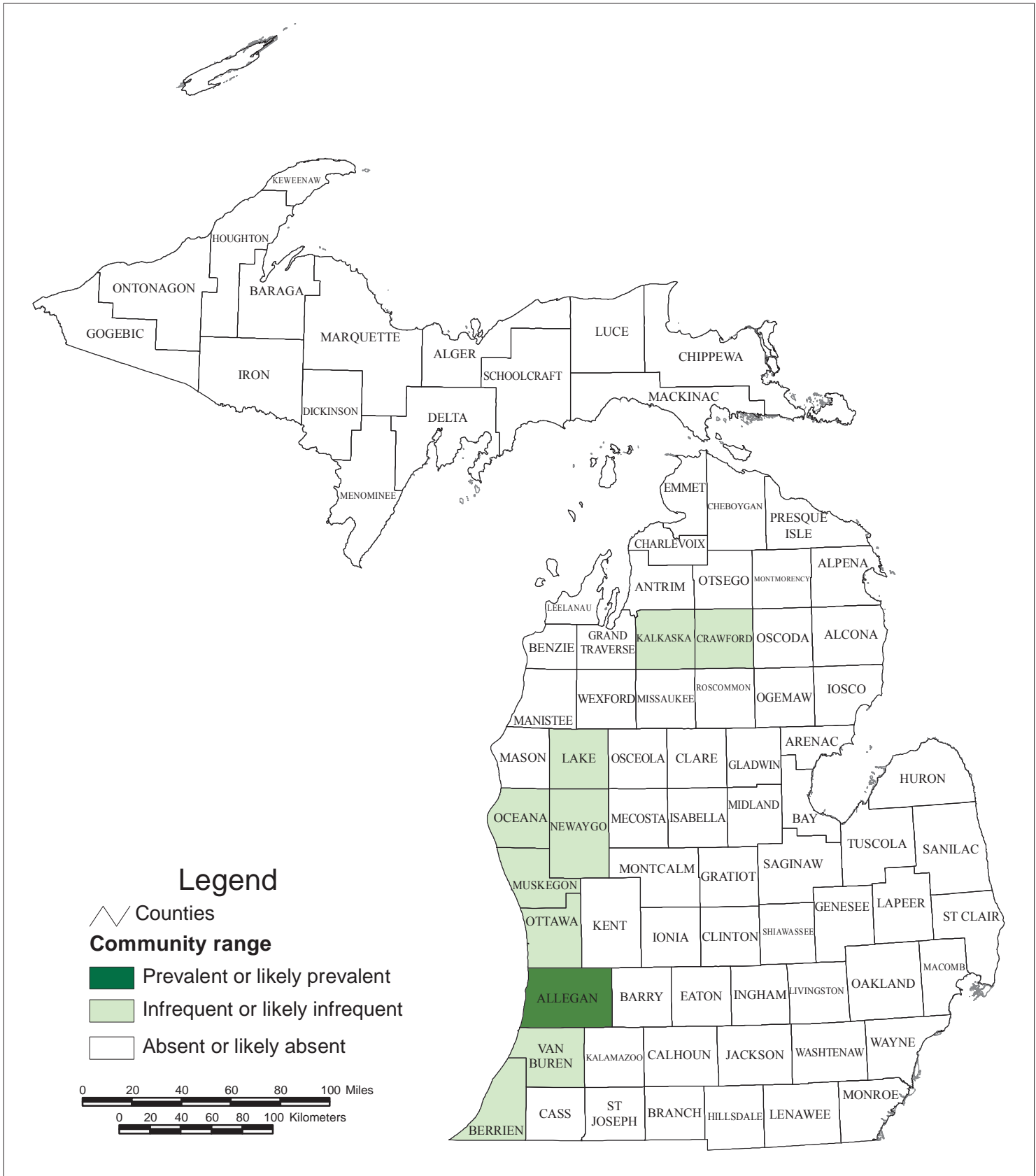


## Wet Prairie

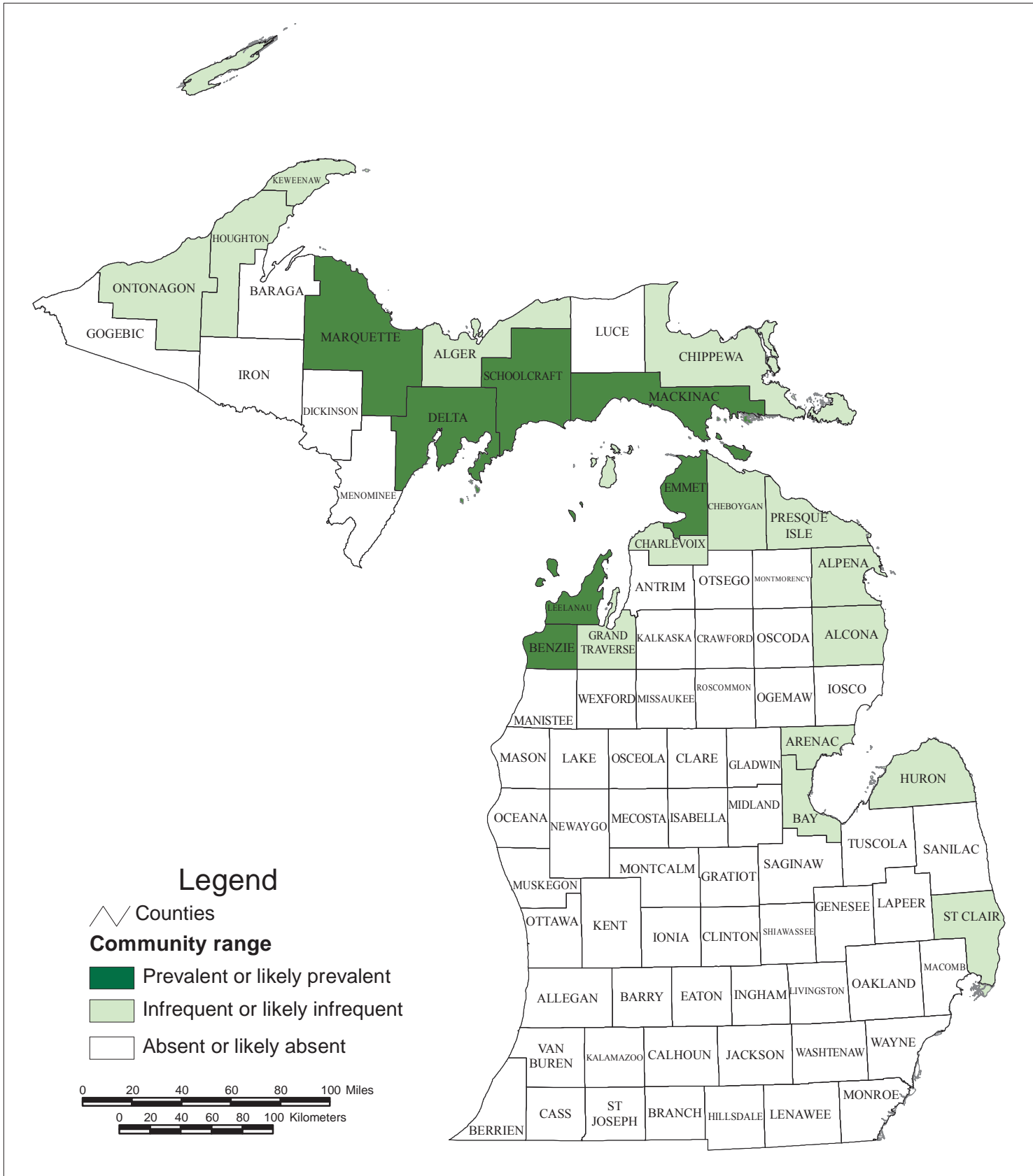


## Wet-mesic Flatwoods





## Wet-mesic Sand Prairie

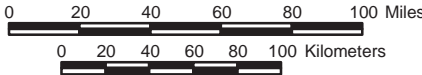


**Legend**

Counties

**Community range**

- Prevalent or likely prevalent
- Infrequent or likely infrequent
- Absent or likely absent



**Wooded Dune and Swale Complex**

