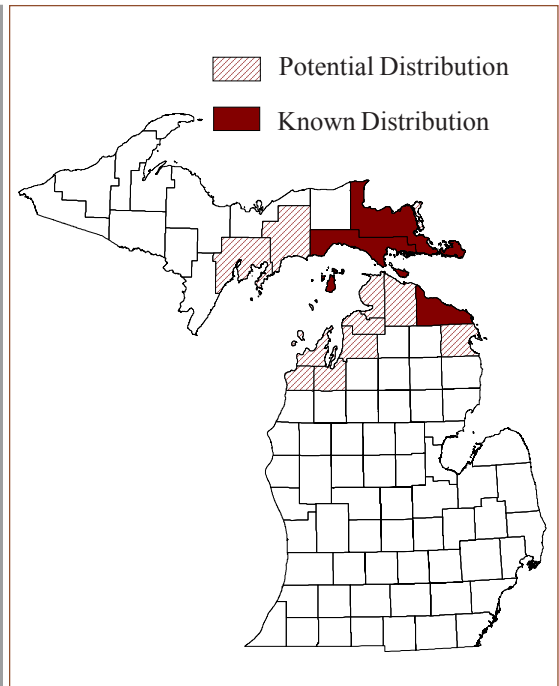




Photo by Joshua G. Cohen



Global and State Rank: G2G3/S3

Overview: Limestone cobble shore is characterized by less than 5 percent cover of herbs, shrubs, or small trees growing between limestone or dolomite (dolostone) cobbles along the Great Lakes shore. Vegetation is typically sparse, both because cobbles cover most of the surface and because storm waves prevent the development of a diverse, persistent plant community. There has been little formal discussion of this plant community, although it is recognized by NatureServe (Faber-Langendoen 2001, NatureServe 2006).

Common Name: Great Lakes Limestone Cobble Shore.

Range: Limestone cobble shore is a biologically distinct geological feature associated with Silurian, Ordovician, and Devonian limestone and dolomite bedrock occurring along the Niagaran Escarpment and Cuesta of the Laurentian Great Lakes. Cobble shores are most extensive along the north shore of Lake Michigan, Lake Huron, and Georgian Bay, from the Door Peninsula in northern Wisconsin to the Bruce Peninsula of Ontario, and then farther east along the Lake Ontario shoreline into New York State (Albert et al. 1997, Judziewicz 2001). Cobble shores are also common on many of the

northern islands of all three of these large water bodies. Most of the cobbles were part of Silurian, Ordovician, and Devonian limestone reefs that formed in the shallow seas of the Michigan Basin. The cobble shores often occur as an alternating pattern of limestone pavement interspersed with cobble and gravel (Albert et al. 1997). New York recognizes a similar community, described as stable cobbles imbedded in clay or sand along the Great Lakes shoreline (Reschke 1990, Edinger et al. 2002).

Rank Justification: There has been little sampling of limestone cobble shore, but it occurs scattered along the shorelines of Lakes Michigan, Huron, Erie, and Ontario, as well as southern Georgian Bay, in the states of Wisconsin, Michigan, and New York, and in the province of Ontario. There may also be localized areas on the Erie Islands of Ohio.

Landscape and Abiotic Context: The bedrock of the Niagaran Cuesta is Silurian-age limestone formed from marine reefs that were common in shallow portions of the Michigan Basin (Dorr and Eschman 1970, Ehlers 1973, Reed and Daniels 1987). Much of the limestone along the Niagaran Escarpment has been converted through geological processes to dolomite (also called dolostone), a magnesium-rich form of limestone. The Niagaran formation typically dips gently (average 1%



slope) toward the south into the Michigan Basin. Cobble shore is also formed from Ordovician-age limestone on northern Drummond Island, and from Devonian-age limestone in Presque Isle and Alpena counties in Lower Michigan. Being formed from marine organisms, these rocks are rich in calcium carbonates. Limestone cobble shores also form from limestone-rich glacial till; storm waves remove the finer sediments, leaving a layer of surface cobbles underlain by carbonate-rich loam- or clay-rich sediments.

Limestone cobble shores are located within Sub-sections VII.6.3, VIII.1.1, and VIII.1.3 of the Regional Landscape Ecosystems as delineated by Albert (1995), where proximity to the Great Lakes results in moderated climate and high precipitation. The substrate is neutral to slightly alkaline (pH 6.7 to 8.0) and there is little soil development along the shore due to ice scour and storm wave erosion. Thin soils resulting from storm waves and ice scour result in scattered vegetation dominated by a mix of herbs, shrubs, and shrub-sized trees. Cobble beach often occurs interspersed with limestone bedrock lakeshore and adjacent to Great Lakes marsh, coastal fen, limestone bedrock glade, boreal forest, alvar, and wooded dune and swale complexes (Kost et al. 2007).



Photos by Joshua G. Cohen

Limestone cobble shore transitioning to Great Lakes marsh (left) and to limestone bedrock lakeshore (right). The size of the cobbles and both the depth and texture of underlying sediments vary greatly and can affect both the diversity and the stability of the plant community. While most of the beach surface consists of cobbles of varying size, the underlying parent material is either limestone bedrock or fine-textured till. Between the cobbles is rock, mineral soil, or organic soil. Soil texture is typically heavy clay or loam, but in some

areas these fine-textured soils are overlain with a thin veneer of sand. Organic sediments accumulate to 5 or more cm in protected inner portions of the shore. Regardless of the soil texture, pH is mildly to moderately alkaline (7.4 to 8.4). Deep accumulations of large cobble tend to be quite dry and support little vegetation. In contrast, shallow accumulations of small gravel and cobbles, especially when mixed with a moist sandy or loamy substrate, tend to support denser and more diverse plant cover.



Photo by Joshua G. Cohen

Shallow accumulations of small cobble (above) with moist sandy or loamy substrate support dense, diverse, and relatively stable plant cover, while deep accumulations (below) are often unvegetated due to dry conditions and lack of soil development.



Photo by Joshua G. Cohen

Natural Processes: Cobble beaches form in a dynamic environment of storm wind and waves. Storm waves regularly disturb the beaches, reconfiguring the substrate and removing fine sediments. During the winter, shoreline ice freezes to the bottom sediments



and is plucked loose during storms, further eroding and modifying the lake bottom. Wave action results in the removal of finer clay, silt, and sand particles from fine-textured tills, resulting in the formation of a cobble layer (lag) underlain by finer till. Angular cobbles also form when weathering releases rock fragments from the underlying bedrock; on some bedrock beaches the observer can see the entire sequence of recently eroded, angular rocks to rocks rounded by years of wave action. Limestone and dolomite are also readily dissolved by rain water, and many limestone cobbles on the shoreline contain large numbers of small solution cavities. But resistance to dissolution is variable, with much less sign of dissolution on limestone rocks that contains abundant sand, silt, or clay impurities derived from the terrestrial environment adjacent to the ancient shallow seas.



Photo by Michael A. Kost

Limestone cobble storm beach backing expansive limestone bedrock lakeshore on the Garden Peninsula.

Intense winter storms can result in the formation of storm beaches, in which cobble-sized rocks are piled upon each other. Storm beaches can accumulate cobbles up to several meters or more in depth. In addition, long-term, cyclic fluctuations of Great Lakes water levels significantly influence vegetation patterns of limestone cobble shore, with vegetation becoming well established during low-water periods and the loss of most species during high-water periods.

Vegetation Description: Among the frequently encountered plants occurring within limestone cobble shore are bird's-eye primula (*Primula mistassinica*), harebell (*Campanula rotundifolia*), calamint (*Calamintha arkansana*), bog lobelia (*Lobelia*

kalmii), silverweed (*Potentilla anserina*), grass-of-Parnassus (*Parnassia glauca*), false asphodel (*Tofieldia glutinosa*), tickle-grass (*Agrostis hyemalis*), sedges (*Carex viridula*, *C. eburnea*, and *C. crawii*), rushes (*Juncus balticus* and *J. dudleyi*), gold-seeded spike rush (*Eleocharis elliptica*), beak-rush (*Rhynchospora capillacea*), fringed gentian (*Gentianopsis procera*), Indian paintbrush (*Castilleja coccinea*), Ohio goldenrod (*Solidago ohioensis*), and balsam poplar (*Populus balsamifera*). Surveys of the cobble beach have been few, but many of the species listed above are common plants of the calcium-rich shoreline of the northern Great Lakes.



Photo by Joshua G. Cohen

Vegetation of limestone cobble shores is characterized by sparse herbaceous cover, scattered shrubs, and infrequent stunted trees, all confined to areas between cobble where soil accumulation can occur.

Characteristic Plants: Other characteristic species include common boneset (*Eupatorium perfoliatum*), white camas (*Zigadenus glaucus*), small skullcap (*Scutellaria parvula*), purple gerardia (*Agalinis purpurea*), upland white goldenrod (*Solidago ptarmicoides*), variegated scouring rush (*Equisetum variegatum*), spike-rushes (*Eleocharis quinquefolia* and *E. rostellata*), grass-leaved goldenrod (*Euthamia graminifolia*), slender bog arrow-grass (*Triglochin palustris*), Kalm's St. John's-wort (*Hypericum kalmianum*), and small yellow lady's-slipper (*Cypripedium calceolus* var. *parviflorum*). On the New York shoreline of Lake Ontario, characteristic species include Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), dogbane (*Apocynum androsaemifolium*), deer-tongue grass (*Panicum clandestinum*), grass-leaved goldenrod, beggar-ticks (*Bidens frondosa*), silverweed (*Potentilla anserina*),



and bluejoint grass (*Calamagrostis canadensis*) (Reschke 1990). Many of the species characteristic of either nearby bedrock shore or shore fen can be found growing scattered along the cobble beach, including many rare plant species.

Zonation: The cobble beach gradually grades from open, unvegetated cobbles close to the water, to a more-vegetated herbaceous zone closer to the forested upland. Growing among the herbs are often shrub-sized balsam poplar, paper birch (*Betula papyrifera*), tamarack (*Larix laricina*), and northern white-cedar (*Thuja occidentalis*). Recurring high-water does not allow these trees to reach maturity, but just inland of the open cobble shore is typically a dense thicket of upland trees and shrubs, including balsam poplar, tamarack, northern white-cedar, paper birch, trembling aspen (*Populus tremuloides*), and white spruce (*Picea glauca*), along with soapberry (*Shepherdia canadensis*), speckled alder (*Alnus rugosa*), and shrubby cinquefoil (*Potentilla fruticosa*).

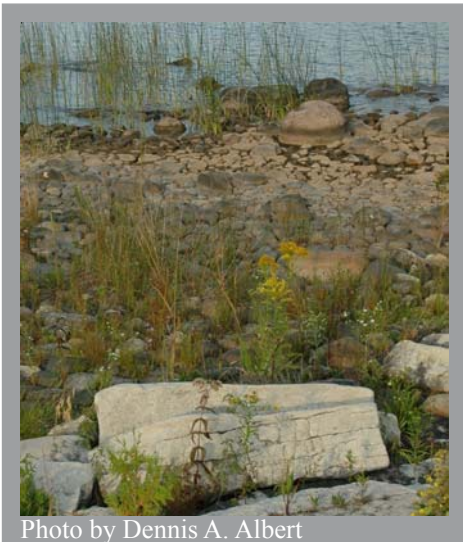


Photo by Dennis A. Albert

Vegetative zones often include unvegetated cobbles adjacent to the water and an herbaceous zone closer to the upland margin.

Associated Species: Limestone cobble shore supports many of the same species found on limestone bedrock lakeshore and alvar, as well as species of shore fen and sand and gravel beach.

Invasive Plants: Non-native herbs occurring within limestone cobble shore are ox-eye daisy (*Chrysanthemum leucanthemum*), lawn prunella (*Prunella vulgaris*), common mullein (*Verbascum thapsus*), Canada bluegrass (*Poa compressa*), and

non-native mustards such as dog mustard (*Erucastrum gallicum*) and wall rocket (*Diplotaxis muralis*).

Michigan Indicator Species: bird's-eye primula (*Primula mistassinica*), harebell (*Campanula rotundifolia*), calamint (*Calamintha arkansana*), bog lobelia (*Lobelia kalmii*), silverweed (*Potentilla anserina*), grass-of-Parnassus (*Parnassia glauca*), false asphodel (*Tofieldia glutinosa*), tickle-grass (*Agrostis hyemalis*), sedge (*Carex viridula*), rush (*Juncus balticus*), fringed gentian (*Gentianopsis procera*), Ohio goldenrod (*Solidago ohioensis*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), northern white-cedar (*Thuja occidentalis*).

Other Noteworthy Species: The high-energy environment of the cobble shore appears to provide little stable habitat for terrestrial insects, but the sediments and rock surfaces are extremely rich in aquatic invertebrates. Limestone cobble shores share many species with cold, fast-flowing streams, including midges (*Chironomidae*), stoneflies (*Perlidae*), and mayflies (*Ephemeroptera*). Spring migrations of warblers feed heavily on the midges that settle in the northern white-cedar that ring the shoreline.

Special Animals: Species associated with limestone cobble beach in Michigan include piping plover (*Charadrius melodus*, state and federally endangered), common tern (*Sterna hirundo*, state threatened), and Caspian tern (*Sterna caspia*, state threatened). These species forage and nest on cobble beach. Numerous rare land snails are associated with cobble beach: tawny glass snail (*Euconulus alderi*, state special concern), *Catinella exile* (state special concern), Lambda snaggletooth snail (*Gastrocopta holzingeri*, state special concern), gravel pyrg (*Pyrgulopsis letsoni*, state special concern), tapered vertigo (*Vertigo elatior*, state special concern), and *Vallonia albula* (state special concern). Rare reptiles that utilize cobble beach include Blanding's turtle (*Emys blandingii*, state special concern) and eastern massasauga (*Sistrurus catenatus catenatus*, state special concern). One rare insect is associated with cobble beach, the aweme borer (*Papaipema aweme*, state special concern).

Special Plants: Many of the rare plants found on the limestone cobble shore are more common on either adjacent bedrock, sand and gravel beach, or coastal fen,



but occupy appropriate niches within the cobble-beach environment. These include dwarf lake iris (*Iris lacustris*, state threatened), butterwort (*Pinguicula vulgaris*, state special concern), bulrush sedge (*Carex scirpoidea*, state threatened), beauty sedge (*C. concinna*, state special concern), Richardson's sedge (*C. richardsonii*, state special concern), tuberous Indian plantain (*Cacalia plantaginea*, state special concern), Houghton's goldenrod (*Solidago houghtonii*, state threatened), scabrous black sedge (*Carex atratiformis* (state threatened), climbing fumitory (*Adlumia fungosa*, state special concern), black crowberry (*Empetrum nigrum*, state threatened), Lake Huron tansy (*Tanacetum huronense*, state threatened), veiny meadow-rue (*Thalictrum venulosum* var. *confine*, state special concern), and small skullcap (*Scutellaria parvula*, state threatened).

Conservation and Biodiversity Management: A principal threat to limestone cobble beach is off-road vehicle use, which can result in the introduction or spread of invasive, non-native plant species. The extremely dynamic energy of this environment makes it less easily damaged than many other natural communities, but nesting birds remain vulnerable to off-road vehicles and pets, primarily dogs.



Photo by Joshua G. Cohen

Off-road-vehicle damage to limestone cobble shore backed by boreal forest.

Research Needs: Additional sampling is needed to adequately characterize the flora, as well as the fauna. The floras of limestone cobble shores formed over limestone bedrock should be compared to those on clay or loam to determine if they are different enough to warrant separation as two types. How long term

fluctuations of Great Lakes water levels impacts the successional dynamics of limestone cobble shore warrants study.



Photo by Bradford S. Slaughter

Extensive limestone cobble shore along northern Lake Michigan during a low water year (2006). The impact of long term water level fluctuations on the vegetation dynamics of cobble shore merits study.

Similar Communities: In Michigan, similar natural communities include limestone bedrock lakeshore, volcanic cobble shore, sand and gravel beach, coastal fen, and Great Lakes marsh (Albert et al. 1997). Limestone cobble shore is classified by NatureServe (Faber-Langendoen 2001, NatureServe 2006) as "Great Lakes Limestone Cobble - Gravel Shore", based largely on data collected from Michigan sites. This shore type is commonly found along the northern Great Lakes shores in the United States and Canada, ranging from Wisconsin in the west to Ontario and New York in the east (Reschke 1990, Lee et al. 1998, Edinger et al. 2002, Epstein et al. 2002). Wisconsin calls the natural community "Great Lakes cobble beach (alkaline subtype)" (Epstein et al. 2002). The natural community often occurs interspersed with either coastal fen, which has less cobbles exposed at the surface, or limestone bedrock lakeshore, which consists largely of exposed bedrock along the shore. Vermont has a similar plant community, Lake Shale or Cobble Beach, which does not appear to share many species with Michigan (Thompson 1996).

Related Abstracts: Dwarf lake iris, Houghton's goldenrod, Richardson's sedge, tuberous Indian plantain, piping plover, common, Caspian terns, limestone bedrock lakeshore, limestone bedrock glade, and sand and gravel beach.



Other Classifications:**The Nature Conservancy National Vegetation**

Classification: (Faber-Langendoen 2001, NatureServe 2006): CODE; ALLIANCE; ASSOCIATION; COMMON NAME.

VII.B.2.N.b; Limestone Cobble - Gravel Great Lakes Shore Sparse Vegetation; Great Lakes Limestone Cobble - Gravel Shore; Cobble/Gravel Shore Sparsely Vegetated Alliance

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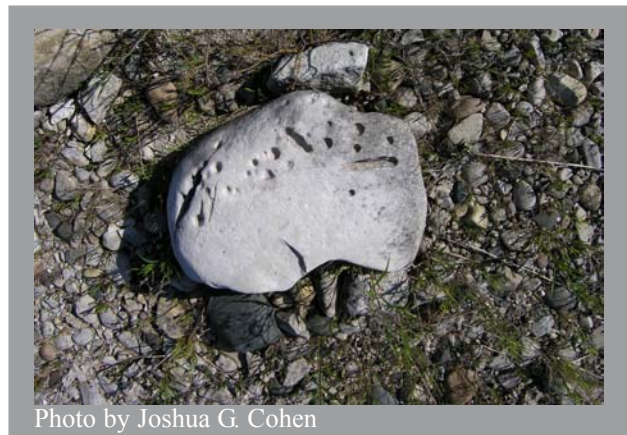
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Solution depression on limestone cobble, Bois Blanc Island.

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