USGS-NPS VEGETATION MAPPING PROGRAM

Classification of the Vegetation of Isle Royale National Park

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The Nature Conservancy
Midwest Regional Office
1313 Fifth St SE, Suite 314
Minneapolis, MN 55414

The Nature Conservancy
International Headquarters
4245 North Fairfax Drive
Arlington, VA 22203

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INTRODUCTION

The U.S. Geological Survey and National Park Service formed a partnership in 1994 to map National Parks in the United States using The Nature Conservancy's U.S. National Vegetation Classification, a standard for reporting vegetation information among federal agencies (FGDC 1997, Grossman *et al.* 1998). The goal of the projects are, among others, to provide baseline ecological data to the resource managers in the park, to put this data in a regional and national context, and to provide opportunities for future inventory, monitoring, and research activities. Each park has a vegetation team that follows standardized field sampling and vegetation classification standards to document the various vegetation types found in a given park, and conduct accuracy assessments of the aerial photo interpretations provided by the mapping team (Grossman *et al.* 1994). The final products consist of a vegetation map, descriptions of each vegetation type, a key to each type, and all related metadata files (original field forms, plot data, accuracy assessment points). This report presents the work conducted at Isle Royale National Park in northern Michigan between 1996 and 1999.

BACKGROUND

The vegetation classification used in this report, the U.S. National Vegetation Classification (USNVC), has been developed by The Nature Conservancy, in partnership with the network of Natural Heritage Programs. Additional support has come from federal agencies and the Ecological Society of America. A first edition of the classification has recently been released that provides a thorough introduction to the classification, its structure, and the list of vegetation units found across the United States, as of April 1997 (Grossman *et al.* 1998, Anderson *et al.* 1998). Refinements to the classification occur in the process of application, leading to ongoing proposed revisions that are reviewed both locally and nationally.

Not all vegetation types are equally mappable at a certain scale. Coordination between the aerial photo team and the ground team is needed to resolve the best way to map the types, whether directly at the association level, at higher classification levels, such as the alliance or formation, or as a mosaic or complex. Thus not all types described in this report are necessarily mapped directly.

STUDY AREA

Isle Royale National Park, in the northwestern portion of Lake Superior, is an archipelago of islands with a northeast/southwest orientation. The archipelago includes one large island (Isle Royale) about 45 miles long and 9 miles wide, and this large island is surrounded by about 400 small islands. The park is located about 60 miles northwest of Michigan's Keweenaw Peninsula, about 22 miles east of Grand Portage, Minnesota, and about 35 miles southeast of Thunder Bay, Ontario. The total size of the park (land and water) is 571,790 acres or 893 square miles, of which 133,782 acres (23.4%, 209 square miles) is land, and the rest is open water of Lake Superior and inland lakes and ponds. The park boundaries extend about 4.5 miles out into Lake Superior from the archipelago.

Isle Royale National Park was authorized on March 3, 1931; it was formally established in 1940, and officially dedicated in 1946. Most of the park's land area (98%) was designated as a Wilderness area in October 1976, and later additions increased the total Wilderness to 99% of the park. The park was designated an International Biosphere Reserve in 1980.

The climate is mid-continental, with a mean annual temperature of 3.4 ^{o}C, extremes of 32 and -34^{o}C and a mean annual precipitation of 77 cm per yr. (Hansen *et al.* 1973). The landscape is rugged terrain, consisting of Precambrian basalts, sandstones, and conglomerates (conglomerates outcrop mainly in the southwest portion of the island). Due to the steep SE dip of the interbedded layers of igneous and sedimentary rocks that form the Lake Superior basin, the bedrock layers form a series of parallel ridges and valleys oriented southwest to northeast. The southeastern slopes of these ridges have a moderate slope, and the northwestern slopes are often very steep hogbacks.

Prolonged erosion and glacial scouring during the Pleistocene have produced the current surficial geology features, which include sandy loam tills, lacustrine, and localized outwash deposits of sand and gravel. Much of the island is covered by thin soils. These were formed from till, talus, and other glacial deposits. Successive stages of post-glacial lake levels are marked by ancient beaches and wave-cut terraces on the rocky coastal ridges (Hansen *et al.* 1973).

The topography of the area is a complex pattern of low ridges and valleys, with a maximum relief of 244 m (792 ft) at Mount Desor (Hansen *et al.* 1973), but more typically is 20 to 40 m. All of Isle Royale National Park falls in one ecological land unit at the subsection level, the Isle Royale subsection (212Ib of Keys *et al.* 1995).

The park has a long history of human use, beginning with prehistoric copper mining by Native Americans, with charcoal evidence in aboriginal mining pits near McCargoe Cove yielding a radiocarbon age of about 1,500 B.C. (Huber 1983). Archaeological studies have indicated that Native American activity peaked during the period from A.D. 800 to 1600, possibly including copper mining as late as 1500. During the 1800's small Ojibway groups remained on the island hunting, fishing, and tapping sugar maples, and a few still worked the mines (Shelton 1997).

During the 1800's and early 1900's European immigrants came to Isle Royale for commercial fishing, copper mining, and logging, and later for recreation at several tourist resorts and private cottages. The first European immigrant settlements were built as fishing stations by the Northwest Fur Company in the late 1830's. Immigrant copper mining was active in the 1840's through the early 1890's. Both Native American and European immigrant mining operations probably used fires to clear land for prospecting (Shelton 1997, Cole *et al.* 1997). Most of the logging on the island was done to support mining and for firewood. Two commercial lumber operations were established, one at Windigo in the 1890's and a second at Siskiwit Bay in the 1930's. Both ended with major losses to the lumber companies. At Windigo, white cedar and pine were cut along Washington Creek, and the logs were floated into Washington Harbor, where they were held by boom chains. But a big storm caused the creek to flood and break the log barrier, and the harvest was lost to Lake Superior. At Siskiwit Bay a paper company was logging spruce and fir from its holdings in the swamps at the head of the Bay; in July 1936 a fire started near a lumber camp joined two other fires, and eventually burned about 20% of the island (Shelton 1997). Almost the entire large island, and many of the smaller islands were disturbed by logging, mining operations, or fires prior to park establishment in 1940.

Prior to settlement and logging, which began around 1843 and ended in 1940, (cutting much of the park forests in the process), the vegetation consisted of hardwood forests (sugar maple, yellow birch) at the southwest end of the island, and boreal mixed and conifer forests at the northeast end (Cole *et al.* 1997). Periodic fires both before and after settlement favored the aspen-birch forests, as well as the fire-dependent pines on ridges. Windstorms, spruce-budworm disease, herbivory by moose, and beaver

activity are other disturbance factors acting in the park (Hansen *et al.* 1973, Cole *et al.* 1997). The impact of browsing by large populations of moose is significantly changing current successional patterns and altering future forest composition (Cole *et al.* 1997).

METHODS

Planning

In general, the field methods used for developing the classification and conducting the accuracy assessment followed the methodology outlined by the USGS-NPS Vegetation Mapping Program (Grossman *et al.* 1994). An overview of the entire methodology is presented as it was applied at Isle Royale.

Isle Royale is a large-sized park (100-2500 km^2) based on land area (541 km^2 land area, and 2313 km^2 including open water); however, environmentally it is not all that complex, the entire unit falling in one ecological subsection (Isle Royale 212Ib of Keys et al 1995). Thus, although a gradsect sampling approach is recommended based on the park's size, it was not used at Isle Royale. Plots and accuracy assessment points were distributed as equitably as possibly throughout the park, as long as they were reasonably accessible from trails or from lakeshore areas accessible by motorboat or canoe. Access to some areas of the park was difficult because there are large tracts with no trails and no easy access from the shore. The more remote areas were sampled by bushwacking off trail, but there are fewer samples from the more remote portions of the park (e.g. Siskiwit Swamp to Lily Lake and Red Oak Ridge, and Minong Ridge midway between Windigo and North Desor Campground).

A preliminary list of vegetation associations and alliances from Faber-Langendoen *et al.* (1996, Midwest portion of USNVC) was generated for the park in January of 1997. A total of 67 community types were listed. In addition recent publications on vegetation types in northwestern Ontario were consulted (Sims *et al.* 1989, Harris *et al.* 1996).

Reconnaissance and Verification

The classification was developed based on observations during a reconnaissance trip in fall of 1996 by combined teams of aerial photo interpreters and ecologists. This reconnaissance trip clarified both the nature of the classification units and their aerial photo signatures. A minimum mapping unit of 0.5 ha guided decisions about how to treat various units as complexes or mosaics. Based on the reconnaissance trip, the aerial photo team attempted to identify all of the different aerial photo signatures that might correspond to the vegetation types. By the spring of 1997, mapping protocols were sufficiently stabilized to permit the aerial photo team to begin delineating polygons throughout the park. The full set of airphoto overlays for the park were delivered to the field team in mid-July 1997, and they were then used to locate polygons for plot sampling.

Plot sampling

Plot sampling was limited to an average of 3 plots per type. More samples were allocated to less well understood types and fewer to better understood associations. The plots were to be equitably spread across the park as much as possible, within access constraints described above. A total of 187 plots were sampled as part of this project in 1997.

The size of most plots was 20 x 20 m; there were 3 10 x 10 m plots used for cliff communities. Plots were placed subjectively so as to be most representative of the stand of vegetation. The

vegetation was visually divided into strata, and height and cover abundance of each strata were estimated. All the species of each stratum were listed (including mosses and lichens) and percent cover estimated using the cover scale provided by TNC (see example in Grossman *et al.* 1998). Additional species within the vegetation unit or polygon that occurred outside of sampled plots (generally within 2 m of the plot border) were listed separately. Species that were not identifiable in the field were collected for later identification. In addition to floristic information, the following environmental information was recorded on field forms: surficial geology, hydrologic (flooding) regime, soil drainage regime, soil texture, slope, aspect, topographic position, and evidence of disturbance. Universal Transverse Mercator (UTM) coordinates of each plot were recorded using a GPS unit, along with other locational information. The vegetation profile in cross-section was usually sketched by hand to represent the location and setting of the plot. A provisional vegetation type was assigned to the plot. All but 6 plots were permanently marked with 2 ft long angle iron stakes; the exceptions were mainly aquatic habitats with water deeper than the height of the installed stake. Plot sampling was conducted by Will MacKinnon, Carol Reschke, Mark Romanski, and Sherry Martine from June 4, 1997 to September 23, 1997.

Accuracy Assessment

Following the plot sampling, the plot data were analyzed, and the classification refined. Ecologists and air photo interpreters met in late April 1998 to review the refined classification and refine photosignatures to match the revised classification. The final product was a list of 52 associations.

Once polygon photosignatures were reviewed and updated by the aerial photo interpretation team, an accuracy assessment was conducted. The number of polygons visited per type depended on how common the type was, from 24 polygons for widespread types to 2 for rare types. Points were stratified to be equitably distributed across the island. The target number of polygons to be sampled for each community was split into two groups, one for a team working the northeast half of the park (east team), and one for the team working the southwest half of the park (west team).

The surveyors on the east team were Janet Marr and Lynn Repola, with occasional assistance from Mark Romanski. The west team consisted of Carol Reschke and Jon Kazmierski, with occasional assistance from Emmet Judziewicz and Alicia Giatas. Park Service staff including natural resource management staff, rangers, and maintenance staff frequently provided boat rides to and from shoreline access points. From there all access was either on foot or by canoe and portage. Some field work was completed in day trips from base camps at Davidson Island (east end) or Windigo Ranger Station (west end), and the rest was completed during two to seven day backpacking and/or canoe trips.

Field teams were sent out with a preliminary vegetation key and a set of aerial photos and overlays on which vegetation polygons had completely delineated. Team members selected polygons for sampling, and used maps and GPS units to locate polygons. Teams recorded locational information, briefly described the vegetation, noting canopy structure, dominant species by strata, and environmental features, including topographic position, slope, and aspect. Adjacent vegetation types were often noted. Rationale for the classification type chosen and comments on problems with the classification were also recorded. A total of 551 accuracy assessment points were surveyed in 1998, and almost all of these were in different polygons than the 187 plots sampled in 1997.

Data Analysis

Isle Royale plot data (187 plots) and accuracy assessment data (551 AAP's) were entered into the PLOTS database developed by The Nature Conservancy (TNC 1997). Species were assigned standardized codes and names based on the PLANTS database developed by National Resources Conservation Service (NRCS) in cooperation with the Biota of North America Program (BONAP). For the vegetation analysis, the plot data were analyzed by PC-ORD Multivariate Analysis package (McCune and Mefford 1997). The data were analyzed in a series of runs, partitioning the data into successively smaller sets based on groupings determined in the larger data sets, until sufficient resolution was achieved. Multivariate analyses were done using UPGMA or group average cluster analysis (Lance and Williams 1967; Wishart 1978, 1969), Bray-Curtis ordination (Beals 1984, McCune and Beals 1993), Nonmetric multidimensional scaling or NMS ordination (Mather 1976) starting with the axis coordinates from the Bray-Curtis ordination, and Detrended Correspondence Analysis or DCA (Hill and Gauch 1980). These were then reviewed and assessed for perceived environmental gradients (e.g. moisture gradients, geology, soil texture and depth, etc.).

These groups were compared with the USNVC (Faber-Langendoen *et al.* 1996, Grossman *et al.* 1998), as well as to northwestern Ontario types (Sims *et al.* 1989, Harris *et al.* 1996). Care was taken not to over-emphasize local variations found at Isle Royale compared to more extensive information compiled at the state or regional level. Nevertheless, several types in the USNVC were revised based on these analyses. Plot summaries were produced for each type using species composition data and environmental data from both plot and accuracy assessment point data sets.

RESULTS

Community types

A total of 52 community types were described in the course of the survey. An additional 5 variants were recognized because they contained structural or floristic patterns somewhat different from other stands in the type. A total of 187 plots were collected to describe these types more carefully and to verify their compositional characteristics. The vegetation survey turned up at least one new plant species for the park and the eastern United States, *Prosartes (Disporum) trachycarpa* (Judziewicz *et al.* 1997).

Ordination of all 187 plots and 400 taxa revealed three large groups, upland forests and woodlands, upland open bedrock vegetation, and wetlands. The wetlands were separable into two subgroups, the open shrub/herb dominated group and the more forested swamps. Within the upland open bedrock group, individual types could be distinguished fairly well within the overall dataset. These types show a pattern from very open bedrock types, such as the Great Lakes basalt (conglomerate) bedrock lakeshore (#51) or the Great Lakes basalt/diabase cliff (#52), that share little in common with more forested types, to those that overlap in composition with these forests, such as the Boreal rocky shrubland (#29), the Spruce-fir basalt bedrock glade (#62), and particularly the Canada yew mixed shrubland (#35). Somewhat surprisingly, the more open herbaceous wetland group, such as the Northern Water Lily aquatic wetland (#50) appear clustered near types in the open bedrock group, such as the bedrock lakeshore (#51). This may reflect the somewhat lower diversity found in both types, as well as the compression of the diversity of types into 2 axes. The third axis clearly separates the two groups.

Within the wetlands group, the forested swamp types showed discernable clusters on the overall ordination. The drier forested swamps, such as the White cedar-black ash swamp (#18) and the Black ash-mixed hardwood swamp (#26) were more similar to upland types than were the more saturated and peaty swamps, such as the white cedar-(mixed conifer)/alder swamp (#7), the Black spruce/labrador tea poor swamp (#25) and the Northern tamarack rich swamp (#65).

The more shrub and herbaceous dominated wetland subgroup was ordinated separately from the swamp subgroup to further clarify patterns of those types. The first axis orders the stands from more open water types, such as the Water horsetail-spikerush marsh (#47), through emergent marsh and meadow types, such as the Midwest mixed emergent deep marsh (#46) and the Bluejoint eastern meadow (#40), to fen and swamp peatland types, such as the Boreal calcareous seepage fen (#44) and the Sweet gale shrub fen (#37). The Black spruce/labrador tea poor swamp type (#25), included for comparative purposes, clearly separates from these shrub/herb types, but is most similar to the Northern sedge poor fen (#25), the White cedar/sweet gale scrub fen (#60), and an outlier stand of the Northern sedge wet meadow type (#41).

Forested uplands were also ordinated separately from the complete dataset. The primary axis separates dry, woodland types, such as the Boreal pine rocky woodland (#63) and Spruce-fir basalt bedrock glade (#62) from more mesic forest types, such as the Maple-yellow birch northern hardwoods forest (#9) and the White cedar-yellow birch forest (#16). The second axis separates the more island-influenced and cooler microclimate types (e.g. Mountain ash-mountain maple forest, #13; Balsam fir/Canada yew-devil's club forest, #2, which is a variant of the spruce-fir/feathermoss forest, #1; Balsam fir/Canada-yew woodland, #22, a variant of the Canada yew mixed shrubland, #35) from deeper soil, warmer spruce-fir-aspen (#23) and aspen-birch types (#8, 54.2, 54.6). Dominating the central portions of the ordination is the more closed spruce-fir-aspen forest type (#55) as well as the more open spruce-fir-aspen open forest (#23). The latter type, thought to be induced primarily by heavy moose grazing, appears to separate somewhat from the former, but compositional similarity is still quite high.

Ecological Groups

The types can be organized from an ecological perspective using ecological groups (Table 2). These groups bring together types that share ecological processes. The 14 ecological groups present at Isle Royale include 4 wetland groups and 10 upland groups. The Lake Superior shorelines add interesting and unusual features to this boreal system.

Linkage of Mapping Units to Classification Units

Results of the linkage between mapping units and classification units are still under review, and will be discussed in the mapping report.

DISCUSSION

Field survey methods were somewhat hampered by the logistic difficulties of moving around the island; nevertheless a very comprehensive survey of the vegetation of Isle Royale was feasible because of the linkage of classification and mapping. The mapping effort encouraged sampling of vegetation in a fairly systematic way across the island for two reasons. First, the distribution of each vegetation type across the entire park could be determined from aerial photo interpretation, and plots and accuracy assessment points could be spread accordingly. Second, any vegetation stand that had

distinct vegetational signatures was recorded by the aerial photo team and subsequently visited by the ground team, thereby ensuring that all variability visible on the photos was assessed.

Some types were very difficult to resolve. The open forest or woodland phase (#23) of the spruce-fir-aspen type (#55) contained some structural and floristic differences from the more closed or forested phase. Ultimately the decision was made to keep these as one type, and allow the two phases to remain as separate mapping units. This should lead to more stable vegetation typing, as a more open stand may close over in a relatively short period of time, depending on moose grazing pressures.

Wetland types were often small and difficult to distinguish on aerial photos. Mapping them required the use of map units called complexes or mosaics, particularly in the herbaceous wetland group. It was possible to recognize many of the forested swamp types.

New and unusual types recorded on the island include the White cedar-sweet gale scrub fen (#60), the Boreal calcareous seepage fen (#44), and the Sweet gale shrub fen (#37). The Twig rush wet meadow (#48) is also unusual. The Lake Superior Shoreline contains a number of high quality occurrences of bedrock types, including the Great Lakes basalt (conglomerate) bedrock lakeshore (#51) and the Great Lakes basalt/diabase cobble-gravel lakeshore (#33, 39). The cold climate of Isle Royale is reflected in the species-poor and more boreal spruce-fir/feathermoss forest type (#1), which is not found in the U.S. south of Isle Royale, nor immediately north on the somewhat warmer north shore of Lake Superior. Several island types or variants, such as those found on Passage Island, including the Canada yew mixed shrubland (#35), its variant, the Balsam fir/Canada yew woodland (#22), and the Balsam fir/Canada yew-devil's club forest (#2), a variant of the Spruce-fir/feathermoss type (#1), require more extensive investigation throughout the Lake Superior islands to assess their relative distinctiveness from their main types.

At least 6 new types were described as a result of the survey work on the Island. These are as follows: the Canada yew mixed shrubland (#35) and its variant, the Balsam fir/Canada yew woodland (#22), Yellow birch-(spruce) forest (#74), White spruce rocky woodland (#19, which bears some resemblance to Boreal pine rocky woodland, #63), the Great Lakes boreal talus woodland (#28), the Thimbleberry shrubland (#32), and the White cedar-sweet gale scrub fen (#60). Other types, as mentioned above, such as the Common juniper rocky krummholz (#31), have important variants found on the island, such as described by the White cedar-balsam fir/leatherleaf/black crowberry krummholz type (#34) found in association with the Common juniper rocky krummholz (#31)near the open rocky shorelines. See also Judziewicz (1997) for more information on the vegetation of Passage Island.

A number of types are currently ranked globally rare (G1-G3). These include the White cedar - yellow birch forest (G2Q) and the Boreal calcareous seepage fen (G2Q), both of which have uncertain ranks because of range-wide vegetation classification issues. Other types may well be rare, based on a preliminary review of their ranks. These include the Balsam fir-Canada yew woodland, the Common juniper rocky krummholz, the Great Lakes basalt/diabase cliff, and the Great Lakes basalt (conglomerate) bedrock lakeshore. The bedrock shorelines have been described elsewhere in Michigan by Reschke (1985) and Albert *et al.* (1994, 1995, 1997). Further review of the rarity of these types is needed, especially by ecological specialists in Ontario.

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Table 1. List of community types (plant associations) for Isle Royale. The Community Number is used throughout as the project number for the type. The Community Common Name is the global common name for the type, except where an asterisk occurs, which indicates the name is that of a variant of the main type (the type itself is indicated by the global code given in the last column), or a +, which indicates that the type is an alliance, complex or mosaic. The Physiognomic Type identifies the structural category that the type fits into at the subclass level of the USNVC (Grossman *et al.* 1998). The Upland/Wetland category indicates whether the type falls into the wetland category as defined by Cowardin *et al.*(1985). The Global Rank refers to the level of rarity of the type, ranging from G1 (very rare) to G5 (very common) (See Grossman *et al.* 1998 for more details). GW indicates a weedy, or exotic type, and a 'Q' after the rank means the type is taxonomically questionable, which may affect the rank. Global ranks for many types found at Isle Royale had not been determined, as indicated by a G? The last column provides the Global Elcode, a unique identifier for each plant association in the USNVC. Global ranks and codes are not applied to variants, alliances, complexes and mosaics.

Community Number	Community Common Name	Physiognomic Type	Upland/ Wetland	Global rank	Global code
01	Spruce - fir / feathermoss forest	Evergreen forest	Upland	G?	2509
02	Balsam fir / Canada yew - devil's club forest*	Evergreen forest	Upland	-	2509 variant
03	White pine - aspen - birch forest	Mixed evergreen – deciduous forest	Upland	G4?	2479
04	White cedar - boreal conifer mesic forest	Evergreen forest	Upland	G4	2449
05	Black spruce / feathermoss forest	Evergreen forest	Upland	G5	2447
06	Jack pine - black spruce / feathermoss forest	Evergreen forest	Upland	G5	2448
07	White cedar - (mixed conifer) / alder swamp	Evergreen forest	Wetland	G4	2456
08	Aspen - birch - red maple forest	Deciduous forest	Upland	G5	2467
09	Maple - yellow birch - northern hardwoods forest	Deciduous forest	Upland	G3G4	2457
10	Red oak - sugar maple forest	Deciduous forest	Upland	G?	2461
12	Great Lakes boreal cliff forest	Deciduous forest	Upland	G?	5251
13	Mountain ash - mountain maple forest	Deciduous forest	Upland	G?	5253
14	Aspen - balsam poplar lowland forest	Deciduous forest	Upland	G5	5036
16	White cedar - yellow birch forest	Mixed evergreen – deciduous forest	Upland	G2Q	2450
18	White cedar - black ash swamp	Mixed evergreen – deciduous forest	Wetland	G?	5165
19	White spruce woodland	Evergreen woodland	Upland	G?	5196
22	Balsam fir / Canada yew woodland*	Evergreen woodland	Upland	-	5254 variant

23	Spruce - fir – aspen open forest*	Mixed evergreen – deciduous woodland (sometimes deciduous)	Upland	-	2475 variant
25	Black spruce / Labrador tea poor swamp	Evergreen woodland	Wetland	G5	2454
26	Black ash – mixed hardwood swamp	Deciduous woodland or forest	Wetland	G4	2105
27	Red maple – ash - birch swamp forest	Deciduous woodland	Wetland	G4	2071
28	Great Lakes boreal talus woodland	Mixed evergreen – deciduous woodland	Upland	G?	5252
29	Boreal rocky shrubland	Deciduous shrubland	Upland	G?	5197
31	Common juniper rocky krummholz	Evergreen dwarf-shrubland or shrubland	Upland	G3G4	5065
32	Thimbleberry shrubland	Deciduous shrubland	Upland	G?	5248
33	Great Lakes basalt/diabase cobble-gravel lakeshore, shrub zone*	Deciduous dwarf-shrubland (zone in sparse veg. type)	Upland	-	5250 variant
34	White cedar – balsam fir / leatherleaf / black crowberry krummholz*	Evergreen shrubland	Upland	-	5065 variant
35	Canada yew mixed shrubland	Mixed evergreen - deciduous shrubland	Upland	G?	5254
36	Speckled alder swamp	Deciduous shrubland	Wetland	G5?	2381
37	Sweet gale shrub fen	Deciduous dwarf-shrubland	Wetland	G?	5141
38	Poverty grass barrens	Perennial graminoid vegetation	Upland	G?	5157
39	Great Lakes basalt/diabase cobble-gravel lakeshore	Boulder, cobble, gravel, or talus sparse vegetation	Upland	G?	5250
40	Bluejoint eastern meadow	Perennial graminoid vegetation	Wetland	G?	5174
41	Northern sedge wet meadow	Perennial graminoid vegetation	Wetland	G4G5Q	2257
42	Northern poor fen	Perennial graminoid vegetation	Wetland	G3G4	2265
44	Boreal calcareous seepage fen	Perennial graminoid vegetation	Wetland	G2Q	2496
45	Great Lakes shoreline bulrush – cattail marsh	Perennial graminoid vegetation	Wetland	G4?	5112
46	Midwest mixed emergent deep marsh	Perennial graminoid vegetation	Wetland	G4G5	2229
47	Water horsetail - spikerush marsh	Perennial graminoid vegetation	Wetland	G4	5258
48	Twig rush wet meadow	Perennial graminoid vegetation	Wetland	G3G5	5103
49	Midwest pondweed submerged aquatic wetland	Hydromorphic rooted vegetation	Wetland	G5Q	2282
50	Northern water lily aquatic wetland	Hydromorphic rooted vegetation	Wetland	G5	2562

51	Great Lakes basalt (conglomerate) bedrock lakeshore	Lichen vegetation	Upland	G?	5215
52	Great Lakes basalt/diabase cliff	Consolidated rock sparse vegetation	Upland	G?	5191
53	Paper birch / bush honeysuckle - fir forest	Deciduous forest	Upland	G4?	2463
54	Aspen – birch alliance+	Deciduous forest	Upland	-	Alliance
54a	Aspen – birch / boreal conifer forest	Deciduous forest	Upland	G5	2466
54b	Aspen - birch / sugar maple - mixed hardwoods forest	Deciduous forest	Upland	G5	2468
55	Spruce - fir - aspen forest	Mixed evergreen – deciduous forest	Upland	G5	2475
56	Spruce – fir and sugar maple – yellow birch mosaic+	Mosaic forest: evergreen/deciduous	Upland	-	Mosaic
58	Sedge meadow complex	Perennial graminoid vegetation	Wetland	-	Complex
59	Sedge / Sphagnum meadow complex+	Perennial graminoid vegetation	Wetland	-	Complex
60	White cedar - sweet gale scrub fen	Mixed evergreen - deciduous shrubland	Wetland	G?	5193
62	Spruce – fir basalt bedrock glade	Evergreen woodland	Upland	G?	5214
63	Boreal pine rocky woodland	Mixed evergreen - deciduous woodland	Upland	G?	2463
65	Northern tamarack rich swamp	Deciduous (needle-leaved) forest	Wetland	G4	2471
66	Black spruce / alder rich swamp	Evergreen forest/woodland	Wetland	G5	2452
67	Leatherleaf - sweet gale shore fen	Mixed evergreen - deciduous dwarf-shrubland	Wetland	G?	5228
70	Leatherleaf bog	Evergreen dwarf-shrubland	Wetland	G5	2498
72	Timothy - (bluejoint) seminatural meadow	Perennial graminoid vegetation	Upland	GW	5249
74	Yellow birch - (spruce) forest	Deciduous forest	Upland	G?	5245

Table 2. List of community types for Isle Royale based on ecological groups. The Community Number is used throughout as the project number for the type. The Community Common Name is the global common name for the type, except where an asterisk occurs, which indicates the name is that of a variant of the main type (the type itself is indicated by the global code given in the last column). The ecological groups are modified slightly from Faber-Langendoen (1999).

Community Number	Ecological Group Name Community Common Name	Global code
	Northern Shrub/Graminoid Fens and Bogs	
44	Boreal calcareous seepage fen	2496
70	Leatherleaf bog	2498
67	Leatherleaf - sweet gale shore fen	5228
42	Northern poor fen	2265
37	Sweet gale shrub fen	5141
60	White cedar - sweet gale scrub fen	5193
	Rooted/Floating Aquatic Marshes	
49	Midwest pondweed submerged aquatic wetland	2282
50	Northern water lily aquatic wetland	2562
	Wet Meadows/Marshes	
40	Bluejoint eastern meadow	5174
45	Great Lakes shoreline bulrush – cattail marsh	5112
46	Midwest mixed emergent deep marsh	2229
41	Northern sedge wet meadow	2257
48	Twig rush wet meadow	5103
47	Water horsetail - spikerush marsh	5258
	Northern Conifer and Hardwood Forest and Shrub Swamps	
26	Black ash – mixed hardwood swamp	2105
66	Black spruce / alder rich swamp	2452
25	Black spruce / Labrador tea poor swamp	2454
65	Northern tamarack rich swamp	2471
27	Red maple – ash – birch swamp forest	2071
36	Speckled alder swamp	2381
07	White cedar - (mixed conifer) / alder swamp	2456
18	White cedar – black ash swamp	5165
	Great Lakes Rocky Shores	
39	Great Lakes basalt/diabase cobble-gravel lakeshore	5250
33	Great Lakes basalt/diabase cobble-gravel lakeshore, shrub zone*	5250 variant
51	Great Lakes basalt (conglomerate) bedrock lakeshore	5215
	Rock Barrens	
29	Boreal rocky shrubland	5197
31	Common juniper rocky krummholz	5065
38	Poverty grass barrens	5157
62	Spruce – fir basalt bedrock glade	5214
34	White cedar – balsam fir / leatherleaf / black crowberry krummholz*	5065 variant
	Cliffs and Talus	
52	Great Lakes basalt/diabase cliff	5191
12	Great Lakes boreal cliff forest	5251
28	Great Lakes boreal talus woodland	5252
	Northern Dry Conifer-(Hardwood) Forests and Woodlands	
63	Boreal pine rocky woodland	2463
06	Jack pine - black spruce / feathermoss forest	2448
03	White pine - aspen - birch forest	2479
	Northern Mesic Conifer-(Hardwood) Forests	
04	White cedar - boreal conifer mesic forest	2449
16	White cedar - yellow birch forest	2450

	Northern Spruce – Fir –(Hardwood) Forests	
02	Balsam fir / Canada yew – devil's club forest*	2509 variant
22	Balsam fir / Canada yew woodland*	5254 variant
05	Black spruce / feathermoss forest	2447
01	Spruce - fir / feathermoss forest	2509
55	Spruce - fir – aspen forest	2475
23	Spruce - fir – aspen open forest*	2475 variant
19	White spruce woodland	5196
	Boreal Hardwood Forests and Woodlands	
14	Aspen – balsam poplar lowland forest	5036
08	Aspen – birch – red maple forest	2467
54a	Aspen – birch / boreal conifer forest	2466
54b	Aspen – birch / sugar maple – mixed hardwoods forest	2468
53	Paper birch / bush honeysuckle – fir forest	2463
	Northern Hardwood Forests and Woodlands	
09	Maple – yellow birch - northern hardwoods forest	2457
13	Mountain ash - mountain maple forest	5253
10	Red oak – sugar maple forest	2461
74	Yellow birch - (spruce) forest	5245
	Northern Shrublands	
35	Canada yew mixed shrubland	5254
32	Thimbleberry shrubland	5248
	Semi-natural Meadows	
72	Timothy - (bluejoint) seminatural meadow	5249

CLASSIFICATION OF ISLE ROYALE NATIONAL PARK

I. Forest
I.A Evergreen Forest
I.A.8 Temperate or subpolar needle-leaved evergreen forest
I.A.8.N.c Conical-crowned temperate or subpolar needle-leaved evergreen forest
PICEA MARIANA FOREST ALLIANCE
Picea mariana / Pleurozium schreberi Forest
Pinus banksiana – Picea mariana / Vaccinium spp. / Pleurozium schreberi Forest

THUJA OCCIDENTALIS FOREST ALLIANCE
Thuja occidentalis /Abies balsamea – Acer spicatum Forest

PICEA GLAUCA - ABIES BALSAMEA FOREST ALLIANCE
Picea glauca – Abies balsamea / Pleurozium schreberi Forest

I.A.8.N.g Saturated temperate or subpolar needle-leaved evergreen forest
PICEA MARIANA SATURATED FOREST ALLIANCE
Picea mariana / Alnus incana / Sphagnum spp. Forest
Picea mariana / Ledum groenlandicum / Sphagnum spp. Forest

THUJA OCCIDENTALIS SATURATED FOREST ALLIANCE
Thuja occidentalis - (Picea mariana, Abies balsamea) / Alnus incana Forest

I.B Deciduous forest
I.B.2 Cold-deciduous forest
I.B.2.N.a Lowland or submontane cold-deciduous forest
QUERCUS RUBRA – ACER SACCHARUM – (QUERCUS ALBA) FOREST ALLIANCE
Quercus rubra - Acer saccharum Forest

ACER SACCHARUM – BETUAL ALLEGHANIENSIS - (FAGUS GRANDIFOLIA) FOREST ALLIANCE
Acer saccharum - Betula alleghaniensis - (Tilia americana) Forest
Betula alleghaniensis - (Acer saccharum, Picea glauca) Forest

I.B.2.N.b Montane or boreal cold-deciduous forest
BETULA PAPYRIFERA FOREST ALLIANCE
Betula papyrifera / Diervilla lonicera - (Abies balsamea) Forest

POPULUS TREMULOIDES – BETULA PAPYRIFERA FOREST ALLIANCE
Populus tremuloides - Betula papyrifera / (Abies balsamea, Picea glauca) Forest
Populus tremuloides - Betula papyrifera - (Acer rubrum, Populus grandidentata) Forest
Populus tremuloides - Betula papyrifera / Acer saccharum - Mixed Hardwoods Forest

I.B.2.N.d Temporarily flooded cold-deciduous forest
POPULUS TREMULOIDES TEMPORARILY FLOODED FOREST ALLIANCE
Populus tremuloides - Populus balsamifera - Mixed Hardwoods Lowland Forest

I.B.2.N.g Saturated cold-deciduous forest
FRAXINUS NIGRA – ACER RUBRUM SATURATED FOREST ALLIANCE
Fraxinus nigra - Mixed Hardwoods-Conifers / Cornus sericea / Carex spp. Forest
Acer rubrum - Fraxinus spp. - Betula papyrifera / Cornus canadensis Forest

LARIX LARICINA SATURATED FOREST ALLIANCE
Larix laricina / Alnus incana Forest

I.C Mixed evergreen-deciduous forest
I.C.3 Mixed needle-leaved evergreen – cold-deciduous forest
I.C.3.N.a Mixed needle-leaved evergreen – cold-deciduous forest
THUJA OCCIDENTALIS – BETULA ALLEGHANIENSIS FOREST ALLIANCE
Thuja occidentalis - Betula alleghaniensis Forest

PINUS STROBUS – (PINUS RESINOSA) – POPULUS TREMULOIDES FOREST ALLIANCE
Pinus strobus - Populus tremuloides / Corylus cornuta Forest

PICEA GLAUCA – ABIES BALSAMEA – POPULUS SPP. FOREST ALLIANCE
Picea glauca - Abies balsamea - Populus tremuloides / Mixed Herbs Forest

I.C.3.N.d Saturated mixed needle-leaved evergreen – cold-deciduous forest
THUJA OCCIDENTALIS – ACER RUBRUM SATURATED FOREST ALLIANCE
Thuja occidentalis - Fraxinus nigra Forest

II Woodland
II.A Evergreen woodland
II.A.4 Temperate or subpolar needle-leaved evergreen woodland
II.A.4.N.b Conical-crowned temperate or subpolar needle-leaved evergeen woodland
PINUS (BANKSIANA, RESINOSA) WOODLAND ALLIANCE
Pinus banksiana - (Picea mariana, Pinus strobus) / Vaccinium spp. Rocky Woodland

PICEA GLAUCA WOODLAND ALLIANCE
Picea glauca - (Betula papyrifera) / Danthonia spicata Woodland
Picea glauca - Abies balsamea Basalt (Conglomerate) Woodland

II.C Mixed evergreen – deciduous woodland
II.C.3 Mixed needle-leaved evergreen – cold-deciduous woodland
II.C.3.N.a Mixed needle-leaved evergreen – cold-deciduous woodland
PICEA GLAUCA – BETULA PAPYRIFERA WOODLAND ALLIANCE
Betula papyrifera - Picea glauca / Acer spicatum - Alnus viridis / Polypodium vulgare Talus Woodland [Provisional]

III Shrubland
III.A Evergreen shrubland
III.A.3 Needle-leaved evergreen shrubland
III.A.3.N.a Needle-leaved evergreen shrubland
JUNIPERUS COMMUNIS SHRUBLAND ALLIANCE
Juniperus communis - (Quercus rubra) / Juniperus horizontalis - Arctostaphylos uva-ursi Shrubland

III.B Deciduous shrubland
III.B.2 Cold-deciduous shrubland
III.B.2.N.a Temperate cold-deciduous shrubland
ACER SPICATUM SHRUBLAND ALLIANCE
Acer spicatum - Thuja occidentalis - Betula papyrifera / Taxus canadensis cliff forested scrub [Provisional]
Sorbus decora - Acer spicatum / Dryopteris carthusiana Forested Scrub [Provisional]

CORYLUS CONRUTA – AMELANCHIER SPP. SHRUBLAND ALLIANCE
Corylus cornuta - Amelanchier spp. - Prunus virginiana Rocky Shrubland

III.B.2.N.b Subalpine or subpolar cold-deciduous shrubland
RUBUS PARVIFLORUS SHRUBLAND ALLIANCE
Rubus parviflorus Shrubland

III.B.2.N.e Seasonally flooded cold-deciduous shrubland
ALNUS INCANA SEASONALLY FLOODED SHRUBLAND ALLIANCE
Alnus incana Swamp Shrubland [Provisional]

III.B.2.N.g Saturated cold-deciduous shrubland
PENTAPHYLLOIDES FLORIBUNDA - MYRICA GALE - (CAREX LASIOCARPA) SATURATED SHRUBLAND ALLIANCE
Myrica gale Fen Shrubland
Thuja occidentalis - (Myrica gale) / Eriophorum alpinum / Drepanocladus spp. Shrubland

III.C Mixed evergreen – deciduous shrubland
III.C.2 Mixed evergreen – cold-deciduous shrubland
III.C.2.N.a Mixed evergreen – cold-deciduous shrubland
TAXUS CANADENSIS – MIXED DECIDUOUS SHRUBLAND ALLIANCE
Taxus canadensis - Viburnum edule - Cornus sericea - Alnus viride - Oplopanax horridus Shrubland [Provisional]

IV Dwarf-shrubland
IV.A Evergreen dwarf-shrubland
IV.A.1 Needle-leaved or microphyllous evergreen dwarf-shrubland
IV.A.1.N.g Saturated needle-leaved or microphyllous evergreen dwarf-shrubland
CHAMAEDAPHNE CALYCULATA SATURATED DWARF-SHRUBLAND ALLIANCE
Chamaedaphne calyculata - Ledum groenlandicum - Kalmia polifolia Bog Dwarf-shrubland
Chamaedaphne calyculata - Myrica gale / Carex lasiocarpa Dwarf-shrubland

V Herbaceous vegetation
V.A Perennial graminoid vegetation
V.A.5 Temperate or subpolar grassland
V.A.5.N.a Tall sod temperate grassland
PHLEUM PRATENSE HERBACEOUS ALLIANCE
Phleum pratense - (Calamagrostis canadensis) Seminatural Herbaceous Vegetation

V.A.5.N.c Medium-tall sod temperate or subpolar grassland
DANTHONIA SPICATA HERBACEOUS ALLIANCE
Danthonia spicata - Poa compressa Granite Herbaceous Vegetation

V.A.5.N.k Seasonally flooded temperate or subpolar grassland
CALAMAGROSTIS CANADENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE
Calamagrostis canadensis Eastern Herbaceous Vegetation [Provisional]

CAREX (ROSTRATA, UTRICULATA) SEASONALLY FLOODED HERBACEOUS ALLIANCE
Carex rostrata - Carex lacustris - (Carex vesicaria) Herbaceous Vegetation

CLADIUM MARISCOIDES SEASONALLY FLOODED HERBACEOUS ALLIANCE
Cladium mariscoides - Carex cryptolepis - Rhynchospora alba - Juncus canadensis Herbaceous Vegetation

V.A.5.N.l Semipermanently flooded temperate or subpolar grassland
TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCIRPUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
Typha spp. - Scirpus spp. - Mixed Herbs Great Lakes Shore Herbaceous Vegetation
Typha spp. - Scirpus acutus - Mixed Herbs Midwest Herbaceous Vegetation

V.A.5.N.m Saturated temperate or subpolar grassland
CAREX OLIGOSPERMA - CAREX LASIOCARPA SATURATED HERBACEOUS ALLIANCE
Carex lasiocarpa - Carex oligosperma / Sphagnum spp. Herbaceous Vegetation

CAREX LASIOCARPA SATURATED HERBACEOUS ALLIANCE

Carex lasiocarpa - Scirpus cespitosus - Rhynchospora capillacea / Andromeda glaucophylla Herbaceous Vegetation

V.B Perennial forb vegetation
V.B.2 Temperate or subpolar perennial forb vegetation
V.B.2.N.e Semipermanently flooded temperate perennial forb vegetation
EQUISETUM FLUVIATILE SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
Equisetum fluviatile - (Eleocharis smallii) Herbaceous Vegetation

V.C Hydromorphic rooted vegetation
V.C.2 Temperate or subpoloar hydromorphic rooted vegetation
V.C.2.N.a Permanently flooded temperate or subpolar hydromorphic rooted vegetatiton
POTAMOGETON SPP. - CERATOPHYLLUM SPP. - ELODEA SPP. PERMANENTLY FLOODED HERBACEOUS ALLIANCE
Potamogeton spp. - Ceratophyllum spp. Midwest Herbaceous Vegetation

NUPHAR LUTEA - NYMPHAEA ODORATA PERMANENTLY FLOODED HERBACEOUS ALLIANCE
Nymphaea odorata - Nuphar lutea (ssp. pumila, variegata) Herbaceous Vegetation

VII Sparse vegetation
VII.A Consolidated rock sparse vegetation
VII.A.1 Sparsely vegetated cliffs
VII.A.1.N.a Cliffs with sparse vascular vegetation
OPEN BLUFF/CLIFF SPARSE VEGETATION
Basalt/Diabase Great Lakes Cliff Sparse Vegetation

VII.A.2 Sparsely vegetated pavement
VII.A.2.N.a Pavement with sparse vascular vegetation
OPEN PAVEMENT SPARSE VEGETATION
Great Lakes Basalt (Conglomerate) Bedrock Lakeshore Sparse Vegetation

VII.B Boulder, gravel, cobble, or talus sparse vegetation
VII.B.2 Sparsely vegetated rock flats
VII.B.2.N.b Cobble/gravel beaches and shores
COBBLE/GRALVE SHORE SPARSE VEGETATION
Basalt/Diabase Cobble-Gravel Great Lakes Shore Sparse Vegetation

APPENDIX: INFORMATION IN VEGETATION DESCRIPTIONS

GLOBAL NAME
Association name based on Latin names of dominant or characteristic plant species. The association (or plant association) is the finest level of the classification system. It is the level at which community inventory and conservation action are aimed.

COMMON NAME
Association common name; same as the GNAME, but with common names instead of scientific names for the species.

SYNONYM
A unique name by which the community may be more easily recognized or described.

PHYSIOGNOMIC CLASS
The second level of National Vegetation Classification System, which is a vegetation structural classification, adapted from UNESCO 1973 and Driscoll et al. 1984. This level is based on the structure of the vegetation. This is determined by the height and relative percentage of cover of the dominant life-forms: tree, shrub, dwarf-shrub, herbaceous and nonvascular.

PHYSIOGNOMIC SUBCLASS
The third level of National Vegetation Classification System. This level is determined by the predominant leaf phenology of classes defined by a tree, shrub or dwarf-shrub stratum, the persistence and growth form of herbaceous and nonvascular vegetation, and particle size of the substrate for sparse vegetation (e.g., consolidated rocks, gravel/cobble).

PHYSIOGNOMIC GROUP
The fourth level of National Vegetation Classification System. The group generally represents a grouping of vegetation units based on leaf characters, such as broad-leaf, needle-leaf, microphyllous, and xeromorphic. These units are identified and named with broadly defined macroclimatic types to provide a structural-geographic orientation, but the ecological climate terms do not define the groups *per se*.

PHYSIOGNOMIC SUBGROUP
The fifth level of National Vegetation Classification System represents a distinction between natural vegetation, including natural, semi-natural and some modified vegetation, and cultural vegetation (planted/cultivated).

FORMATION
The sixth level of National Vegetation Classification System; represents a grouping of community types that share a definite physiognomy or structure and broadly defined environmental factors, such as elevation and hydrologic regime.

ALLIANCE: Level of National Vegetation Classification System reflecting a physiognomically uniform group of plant associations sharing one or more diagnostic species (dominant, differential, indicator, or character), which (generally) are found in the uppermost stratum of the vegetation.

CLASSIFICATION CONFIDENCE LEVEL: the degree of confidence associated with the classification of the Element. This confidence is based on the quality and type of data used in the analysis as well as the extent to which the entire (or potential) range of the Element was considered
1 = STRONG
Classification based on recent field data. Information is based on Element Occurrences or other data based on occurrences that can be relocated. Classification considers information collected across the entire range or potential range of the Element. Classification may be based on quantitative or qualitative data

2 MODERATE
Classification is based on data that is of questionable quality, limited numbers of sample points, or data from a limited range.

3 WEAK
Classification is based on secondary or anecdotal information. Or a new type for which data have only been collected at a very small number of sites.

USFWS WETLAND SYSTEM:
USFWS Wetland Classification System, if applicable. (Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* United States Fish and Wildlife Service. Washington, DC.).

RANGE:
Globally
Description of the association's present range, including states of occurrence
XXXXX National Park
Description of where the community is found in the Park or environs.

ENVIRONMENTAL DESCRIPTION
Globally
Most important environmental determinants of the biological composition or structure of this association and/or its subtypes.
XXXXX National Park
Important environmental determinants of the biological composition or structure of this association within the Park or environs (if known).

MOST ABUNDANT SPECIES
Globally
Stratum Species
Most abundant species by stratum
XXXXX National Park
Stratum Species
Most abundant species by stratum, based on data and observations in the Park and environs.

DIAGNOSTIC SPECIES
Globally
Latin names of plant species not necessarily most abundant, but which are characteristic or diagnostic of the association when taken singly or in combination with other species.
XXXXX National Park
Characteristic species for the association in the Park and environs.

VEGETATION DESCRIPTION
Globally
Additional comments on vegetation attributes of the association including species richness, diversity, physiognomic structure, spatial distribution of vegetation, strata height, dominant life-forms, coverage of unvegetated substrate, and additional compositional comments.
XXXXX National Park
Vegetation description for the association as it is found in the Park and environs.

OTHER NOTEWORTHY SPECIES
High ranked species, animals, endemics, disjuncts, and exotics that are found within occurrences of this association.

CONSERVATION RANK
Global Element rank which characterizes the relative rarity or endangerment of the association world-wide.

RANK JUSTIFICATION
Reason for assigning the Global Element Rank, such as number of occurrences, number of hectares, total area reduction from original, threats, degradation, etc.

DATABASECODE
Element Code from the National Community Database.

COMMENTS
Globally
Any other comments about this association not covered in the fields above such as landscape relationships, inclusion communities, etc.
XXXXX National Park
Any other comments about this association specific to the Park, including notes about possible problems in photointerpretation.

REFERENCES
Sources of information used to define or describe the association.