U.S. National Vegetation Classification: Advancing the Description and Management of the Nation's Ecosystems

A Data-Driven Method for Assembling Map Classes from Vegetation Associations in WA State National Parks

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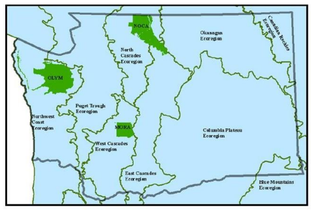
Background

The large national parks of Washington State are large, rugged, and ecologically complicated; exhaustive field mapping of plant communities would be prohibitively expensive. Therefore, our plant community maps rely on modeling to extend field data across remote areas. We model with predictor layers derived (in-house) from satellite data, air photos, lidar, and climate data.

Figure 1. Location of Mount Rainier (MORA), North Cascades (NOCA), and Olympic (OLYM) National Parks with respect to Washington State ecoregions

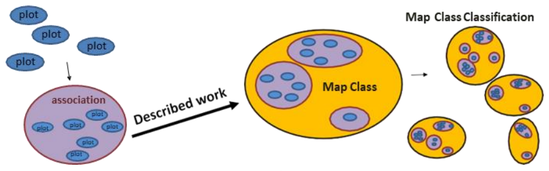


Training data were collected at more than 6000 field plots representing 294 distinct vegetation associations—far too many to map. National Park Service methods suggest mapping at higher levels of the vegetation hierarchy, such as alliances or even groups (Natureserve 2010). Based on this approach, we initially lumped associations into 40 alliance and group level map classes.

Unfortunately, this hierarchical lumping did not produce well distinguished map classes. On average, the map class an association was assigned to received just 0.5% more model votes than its second best fit. Floristics were also not well separated: associations were only 3.6% more similar to their assigned class than to their second best fit.

Accurate modeled maps require map classes to be distinguishable on the ground *and* in predictor data. We worked to group associations in a way that maximized the separability of map classes in mapping while maintain field identification (floristic separation) and structure from the United States National Vegetation Classification (USNVC).

Methods



We used a data-driven approach to refine the map classification. Confusion between map classes is realized on the ground, so we based our analysis of confusion on the characteristics of our 6000+ training plots rather than simple association summaries. We optimized the classification to minimize confusion in the field (floristic similarity between map classes) and confusion in the modeling process (which depresses mapability and thus map accuracy).

We define **modeling confusion** as the percent difference in 'model votes' for random forests models between each pair of associations.

We define **floristic similarity** as the Euclidian distance between each plot and the floristic centroid of each association.

For both floristic similarity and modeling confusion, we aimed to **maximize** the plot-level margin of victory (model votes or distance in the assigned class compared to next best fit). Summarized plot-level margin of victory scores were used to assess the consequences of each assignment on classification-wide floristic similarity and model confusion.

Analyses used R (3.3.2, 'vegclust' package), MS Excel, and ArcGIS (10.3)

Our classification is based on user-expected plant community concepts (often alliances). We seeded map classes with these distinct associations, then grew each class in a stepwise fashion to create the classification. After each assignment, the geometric mean of plot-level margin of victories was re-calculated across all associations and map classes.

Map Classification

M01 Deciduous Floodplain and Swamp Forest
***Acer macrophyllum/Oxalis oregana* Forest**
***Alnus rubra/Oxalis oregana* Forest**
***Alnus rubra/Athyrium filix-femina–Lysichiton americanus* Forest**
***Alnus rubra/Elymus glaucus* Forest**
***Alnus rubra/Oplopanax horridus–Rubus spectabilis* Forest**
***Alnus rubra/Rubus spectabilis/Carex obnupta–Lysichiton americanus* Woodland**
***Alnus rubra/Rubus spectabilis* Forest**
***Alnus rubra/Stachys chamissonis–Tolmiea menziesii* Forest**
***Populus balsamifera/Cornus sericea* Forest**
***Populus balsamifera–Alnus rubra/Carex obnupta* Forest**
Populus balsamifera–Alnus rubra/Rubus spectabilis Forest
***Populus balsamifera–Picea sitchensis–(Acer macrophyllum)/Oxalis oregana* Forest**

M19 Debris Apron Deciduous Forest
Acer macrophyllum–(Pseudotsuga menziesii)/Symphoricarpos albus–(Cornus nuttallii)/Pteridium aquilinum Forest
Acer macrophyllum/Maianthemum stellatum Forest
Acer macrophyllum/Rubus parviflorus–(Cornus sericea)/(Maianthemum racemosa)-Forest

M20C Coastal Bluff Deciduous Forest
***Alnus rubra/Polystichum munitum* Forest**
***Picea sitchensis–(Alnus rubra)/Rubus spectabilis/Polystichum munitum* Forest**

M20I Upland Deciduous Forest
Acer macrophyllum–(Pseudotsuga menziesii)/Polystichum munitum Forest
***Acer macrophyllum/Polystichum munitum–Tolmiea menziesii* Forest**
***Acer macrophyllum/Rubus spectabilis* Forest**
***Alnus rubra/Acer circinatum/Claytonia sibirica* Forest**
Populus balsamifera–Acer macrophyllum/Acer circinatum/Polystichum munitum Forest
Populus tremuloides/Cornus nuttallii Forest

M82 Ruderal Meadow
Agrostis (capillaris, stolonifera) Herbaceous Vegetation

M27C Sitka Spruce–Western Hemlock Hypermaritime Forest
***Picea sitchensis/Gaultheria shallon* Forest**
***Picea sitchensis/Maianthemum dilatatum* Forest**
***Picea sitchensis/Rubus spectabilis/Carex obnupta–Lysichiton americanus* Forest**
***Picea sitchensis–Tsuga heterophylla/Polystichum munitum* Forest**
***Tsuga heterophylla–(Abies amabilis)/Gaultheria shallon/Blechnum spicant* Forest**
***Tsuga heterophylla/Gaultheria shallon/Polystichum munitum–Blechnum spicant* Forest**
***Tsuga heterophylla–Thuja plicata–(Abies amabilis)/Gaultheria shallon/Blechnum spicant* Forest**

M45 Western Hemlock–Western Red Cedar Hypermaritime Forest
Picea sitchensis/Vaccinium ovatum Forest
Thuja plicata–Tsuga heterophylla/Vaccinium ovatum Forest
***Tsuga heterophylla–Thuja plicata/Gaultheria shallon/Lysichiton americanus* Forest**

M27I Sitka Spruce–Western Hemlock Forest
***Picea sitchensis–Tsuga heterophylla/Polystichum munitum–Oxalis oregana* Forest**
***Pseudotsuga menziesii–(Alnus rubra–Tsuga heterophylla)/Rubus spectabilis* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Polystichum munitum–Oxalis oregana* Forest**
***Tsuga heterophylla/Polystichum munitum–Oxalis oregana* Forest**
***Tsuga heterophylla/Vaccinium alaskaense/Oxalis oregana* Forest**
***Tsuga heterophylla–Pseudotsuga menziesii/Vaccinium alaskaense/Oxalis oregana* Forest**

M44 Wet Western Hemlock–Douglas-fir Forest
Abies amabilis/Rubus spectabilis–Vaccinium alaskaense Forest
Thuja plicata–Tsuga heterophylla–(Picea engelmannii)/Oplopanax horridus Forest
***Tsuga heterophylla/Polystichum munitum–Blechnum spicant* Forest**
***Tsuga heterophylla–(Pseudotsuga menziesii)/Tiarella trifoliata–Gymnocarpium dryopteris* Forest**
***Tsuga heterophylla–(Pseudotsuga menziesii)/Vaccinium alaskaense/Polystichum munitum* Forest**
***Tsuga heterophylla–(Pseudotsuga menziesii–Thuja plicata)/Oplopanax horridus/Polystichum munitum* Forest**
***Tsuga heterophylla–(Pseudotsuga menziesii–Thuja plicata)/Polystichum munitum–Athyrium filix-femina* Forest**
***Tsuga heterophylla–(Thuja plicata–Alnus rubra)/Lysichiton americanus–Athyrium filix-femina* Forest**
***Tsuga heterophylla–Abies amabilis/Blechnum spicant–Tiarella trifoliata–Polystichum munitum* Forest**
***Tsuga heterophylla–Abies amabilis/Oxalis oregana–Blechnum spicant* Forest**

M42 Mesic Western Hemlock–Douglas-fir Forest
Abies lasiocarpa–Pseudotsuga menziesii/Mahonia nervosa Forest
Pseudotsuga menziesii–(Thuja plicata–Abies grandis)/Vaccinium membranaceum Forest
***Pseudotsuga menziesii–Tsuga heterophylla/Achlys triphylla* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/(Acer circinatum)/Polystichum munitum* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Gaultheria shallon–Vaccinium parvifolium* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Gaultheria shallon/Polystichum munitum* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Gaultheria shallon–Mahonia nervosa* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Mahonia nervosa* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Mahonia nervosa–Polystichum munitum* Forest**
Pseudotsuga menziesii–Tsuga heterophylla/Paxistima myrsinites/Linnaea borealis Forest
***Pseudotsuga menziesii–Tsuga heterophylla/Rhododendron macrophyllum* Forest**
***Pseudotsuga menziesii–Tsuga heterophylla/Vaccinium alaskaense/Xerophyllum tenax* Forest**
***Tsuga heterophylla–(Pseudotsuga menziesii)/Vaccinium alaskaense–Mahonia nervosa–(Gaultheria shallon)* Forest**
***Tsuga heterophylla–Pseudotsuga menziesii/Mahonia nervosa–Chimaphila menziesii* Forest**

M66 Herbaceous Bald Vegetation
Arctostaphylos (nevadensis, uva–ursi)–Pseudoroegneria spicata Dwarf-Shrubland
Arctostaphylos (nevadensis, uva–ursi)–Paxistima myrsinites Dwarf-Shrubland
Arctostaphylos columbiana Shrubland
Arctostaphylos uva–ursi–Fragaria virginiana–(Festuca roemeri) Dwarf-Shrubland
Danthonia intermedia–Racomitrium canescens Herbaceous Vegetation
***Festuca roemeri–Cerastium arvense–Koeleria macrantha* Herbaceous Vegetation**
Koeleria macrantha–(Agrostis pallens) Herbaceous Vegetation
Lewisia columbiana–(Juncus parryi) Lithomorphic Vegetation
Luina hypoleuca Lithomorphic Vegetation
Polygonum minimum–Racomitrium elongatum Lithomorphic Vegetation
Pseudoroegneria spicata/Selaginella wallacei Herbaceous Vegetation
Racomitrium canescens–(Penstemon davidsonii) Herbaceous Vegetation

M43W Pacific Madrone–Douglas-Fir Forest
***Pseudotsuga menziesii/Gaultheria shallon–Holodiscus discolor* Forest**
***Pseudotsuga menziesii/Gaultheria shallon–Mahonia nervosa/Polystichum munitum* Forest**
Pseudotsuga menziesii/Gaultheria shallon–Vaccinium parvifolium Forest
***Pseudotsuga menziesii/Holodiscus discolor–Rosa gymnocarpa/Festuca occidentalis* Forest**
Pseudotsuga menziesii/Mahonia nervosa/Achlys triphylla Forest
Pseudotsuga menziesii–Tsuga heterophylla/Gaultheria shallon–Holodiscus discolor Forest

M43E Dry Western Hemlock–Douglas-fir Forest
Betula papyrifera–(Thuja plicata)/Acer circinatum/Mahonia nervosa Forest
Pseudotsuga menziesii–(Abies grandis)/Acer circinatum/Paxistima myrsinites Forest
Pseudotsuga menziesii–(Tsuga heterophylla)/Acer circinatum–Paxistima myrsinites Forest
***Pseudotsuga menziesii/Acer circinatum/Mahonia nervosa* Forest**
Pseudotsuga menziesii/Holodiscus discolor/Calamagrostis rubescens Forest

M33 Douglas Fir–Subalpine Fir Woodland
***Abies lasiocarpa–(Pseudotsuga menziesii)/Vaccinium membranaceum/Calamagrostis rubescens* Forest**
Pseudotsuga menziesii/Paxistima myrsinites–Spiraea betulifolia Woodland
***Pseudotsuga menziesii/Vaccinium membranaceum* Forest**

M35 Lodgepole Pine–Douglas-Fir Forest
Pinus contorta/Paxistima myrsinites/Calamagrostis rubescens Forest
***Pinus contorta/Vaccinium membranaceum* Woodland**
***Pinus contorta–Pseudotsuga menziesii/Gaultheria shallon* Forest**
***Pseudotsuga menziesii–(Pinus contorta)/Arctostaphylos uva–ursi/Racomitrium canescens* Woodland**
Pseudotsuga menziesii–Pinus contorta/Arctostaphylos nevadensis Woodland

M36 Ponderosa Pine–Douglas-Fir Forest
Pseudotsuga menziesii–(Pinus ponderosa)/Symphoricarpos albus Forest
Pseudotsuga menziesii–Pinus ponderosa/Arctostaphylos nevadensis Woodland
Pseudotsuga menziesii–Pinus ponderosa/Calamagrostis rubescens Forest

M07 Warm Silver Fir–Western Hemlock Forest
Abies amabilis–(Pseudotsuga menziesii)/Achlys triphylla–Tiarella trifoliata Forest
***Abies amabilis–Pseudotsuga menziesii/Achlys triphylla* Forest**
***Abies amabilis–Tsuga heterophylla/Oplopanax horridus* Forest**
Abies amabilis–Tsuga heterophylla/Oxypolis Forest
Abies amabilis–Tsuga heterophylla/Rubus pedatus–Tiarella trifoliata Forest
***Tsuga heterophylla–(Pseudotsuga menziesii)/Vaccinium alaskaense/Cornus unalaschkensis* Forest**
Tsuga heterophylla–Abies amabilis–(Pseudotsuga menziesii)/Vaccinium alaskaense Forest
***Tsuga heterophylla–Abies amabilis–(Thuja plicata)/Vaccinium alaskaense/Blechnum spicant* Forest**
***Tsuga heterophylla–Abies amabilis/Vaccinium alaskaense/Rubus pedatus* Forest**
***Tsuga heterophylla–Abies amabilis/Vaccinium alaskaense/Tiarella trifoliata* Forest**
***Tsuga heterophylla–Abies amabilis–Pseudotsuga menziesii/Gaultheria shallon* Forest**
***Tsuga heterophylla–Abies amabilis–Pseudotsuga menziesii/Mahonia nervosa* Forest**

M46A Mountain Hemlock–Silver Fir Forest
***Abies amabilis–(Pseudotsuga menziesii–Abies procera)/Vaccinium membranaceum/Xerophyllum tenax* Forest**
***Abies amabilis–(Tsuga heterophylla)/Vaccinium membranaceum–Vaccinium alaskaense* Forest**
***Abies amabilis/Menziesia ferruginea* Forest**
***Abies amabilis–Tsuga mertensiana/Menziesia ferruginea* Forest**
***Abies amabilis–Tsuga mertensiana/Streptopus lanceolatus* Forest**
***Tsuga mertensiana–Abies amabilis/Vaccinium alaskaense/Rubus pedatus* Forest**

M46B Silver Fir–Mountain Hemlock Forest
***Abies amabilis–(Tsuga heterophylla)/Vaccinium membranaceum* Forest**
***Abies amabilis/Rhododendron albiflorum* Forest**
***Abies amabilis/Vaccinium membranaceum/Rubus lasiococcus* Forest**
***Abies amabilis–Tsuga mertensiana/Vaccinium membranaceum/Rubus lasiococcus* Forest**
***Tsuga mertensiana–Abies amabilis/Rhododendron albiflorum* Forest**

M06 Mesic Subalpine Forest and Woodland
***Abies lasiocarpa–(Abies amabilis)/Vaccinium membranaceum/Valeriana sitchensis* Forest**
Abies lasiocarpa–(Abies amabilis)/Vaccinium membranaceum/Xerophyllum tenax Forest
***Abies lasiocarpa–(Picea engelmannii)/Rhododendron albiflorum* Forest**
***Abies lasiocarpa/Rhododendron albiflorum/Rubus lasiococcus* Forest**
***Abies lasiocarpa/Vaccinium membranaceum/Lupinus arcticus* Woodland**
***Abies lasiocarpa/Valeriana sitchensis* Forest**
Abies lasiocarpa/Veratrum viride Woodland
Cupressus nootkatensis/Valeriana sitchensis Forest

M47 Subalpine Mixed Woodland and Shrubland
***Abies lasiocarpa/Vaccinium deliciosum* Woodland**
***Tsuga mertensiana/Phyllodoce empetriformis–Vaccinium deliciosum* Woodland**
***Tsuga mertensiana–Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* Forest**
***Tsuga mertensiana–Abies lasiocarpa/Vaccinium deliciosum–Phyllodoce empetriformis* Woodland**

M17E Whitebark Pine-Subalpine Fir Woodland
***Abies lasiocarpa–(Tsuga mertensiana)/Festuca viridula* Woodland**
Abies lasiocarpa/Vaccinium scoparium/Valeriana sitchensis Woodland
***Pinus albicaulis–(Abies lasiocarpa)/Vaccinium scoparium–Luzula glabrata* Woodland**
***Pinus albicaulis/Calamagrostis rubescens* Woodland**
Pinus albicaulis/Festuca viridula Woodland
***Pinus albicaulis/Juniperus communis* Woodland**

M17W Dry Subalpine Forest and Woodland
Abies lasiocarpa–(Pinus contorta)/Juniperus communis–Lomatium martindalei Woodland
***Abies lasiocarpa–(Pinus contorta)/Lupinus arcticus* Woodland**
Abies lasiocarpa/Erythronium montanum Forest
Abies lasiocarpa/Polemonium pulcherrimum–Pedicularis racemosa Woodland

M24 Subalpine Larch-Subalpine Fir Woodland
***Abies lasiocarpa–Picea engelmannii/Vaccinium scoparium* Woodland**
Larix lyallii/Cassiope mertensiana–Luetkea pectinata Woodland
***Larix lyallii/Vaccinium scoparium/Luzula glabrata* Woodland**
***Larix lyallii/Vaccinium deliciosum* Woodland**

M15 Krummholz
Abies lasiocarpa Krummholz Shrubland
Arctostaphylos (nevadensis, uva–ursi)–Juniperus communis Dwarf-shrubland
Pinus albicaulis Krummholz Shrubland
***Tsuga mertensiana* Krummholz Shrubland**

M50 Vine Maple Talus Shrubland
(Pseudotsuga menziesii)/Acer circinatum–(Holodiscus discolor) Woodland
Abies lasiocarpa–(Pseudotsuga menziesii)/Acer circinatum Talus Woodland
Cupressus nootkatensis–(Acer circinatum–Alnus viridis)/(Paxistima myrsinites) Shrubland
Populus tremuloides Shrubland

M51 Dry Tall Shrubland
Ceanothus velutinus–(Spiraea betulifolia)/Calamagrostis rubescens Shrubland
Prunus emarginata–Amelanchier alnifolia–Ceanothus velutinus/(Maianthemum racemosa–Thalictrum occidentalis) Shrubland
Salix spp.–Acer glabrum–(Sorbus scopulina)/Paxistima myrsinites Shrubland

M18 Low Elevation Deciduous Tall Shrubland
***Acer circinatum–(Alnus viridis–Cornus sericea)/(Pteridium aquilinum)* Shrubland**
***Acer circinatum/Athyrium filix-femina–Tolmiea menziesii* Shrubland**
Acer spp.–(Corylus cornuta)/Paxistima myrsinites Shrubland

M21 High Elevation Deciduous and Mixed Tall Shrubland
***Alnus viridis/Pteridium aquilinum–Athyrium filix-femina* Shrubland**
***Alnus viridis–Oplopanax horridus* Shrubland**
***Alnus viridis–Rubus spectabilis/(Athyrium filix-femina)* Shrubland**
***Alnus viridis–Sambucus racemosa/(Thalictrum occidentalis)* Shrubland**
Cupressus nootkatensis–Alnus viridis–(Oplopanax horridus)/(Erythronium montanum) Shrubland
***Rubus spectabilis–Ribes bracteosum–(Oplopanax horridus)* Shrubland**
Salix sitchensis–Alnus viridis/(Chamerion angustifolium–Heracleum maximum) Shrubland

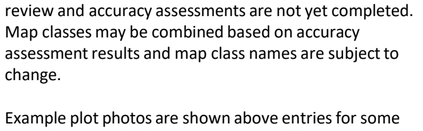
M61 Mesic Tall Forbs
***Heracleum maximum–(Thalictrum occidentale–Saussurea americana)* Herbaceous Vegetation**
***Rubus parviflorus/Pteridium aquilinum–Chamerion angustifolium* Shrubland**
Symphoricarpos albus–Malus fusca Shrubland

M52 Mixed Forb and Graminoid Herbaceous Meadow
***Antennaria lanata* Herbaceous Vegetation**
Danthonia intermedia Herbaceous Vegetation
***Festuca viridula–Lupinus arcticus* Herbaceous Vegetation**
Juncus parryi–(Polygonum bistortoides) Herbaceous Vegetation

M62 Olympic Mountain Aster Herbaceous Meadow
Eucephalus paucicapitatus Herbaceous Vegetation

M67E Green Fescue–Cascade Aster Dry Herbaceous Meadow
Festuca viridula–(Phlox diffusa–Arenaria capillaris) Herbaceous Vegetation
***Festuca viridula–Eucephalus ledophyllus* Herbaceous Vegetation**
Paxistima myrsinites–Phlox diffusa Dwarf–Shrubland
Vaccinium deliciosum–Festuca viridula Dwarf-Shrubland

M67W Roemer's Fescue Dry Herbaceous Meadow
Dasiphora fruticosa–(Phlox diffusa) Dwarf-Shrubland
Festuca roemeri–(Phlox diffusa–Arenaria capillaris) Herbaceous Vegetation
Juniperus communis–(Phlox diffusa) Dwarf-Shrubland
Juniperus communis Shrubland
Phlox diffusa–(Lomatium martindalei–Carex phaeocephala) Herbaceous Vegetation
Saxifraga bronchialis Lithomorphic Vegetation



M86 Showy Sedge–Sitka Valarian Mesic Subalpine Meadow
***Carex spectabilis–(Lupinus arcticus–Polygonum bistortoides* Herbaceous Vegetation**
Spiraea splendens/Cirsium spectabile–(Polygonum bistortoides) Shrubland
***Valeriana sitchensis–Carex spectabilis* Herbaceous Vegetation**
***Valeriana sitchensis–Ligusticum grayi* Herbaceous Vegetation**
***Valeriana sitchensis–Veratrum viride* Herbaceous Vegetation**

M85 High Elevation Dry Shrubland
Sorbus sitchensis/Phyllodoce empetriformis–Vaccinium deliciosum Shrubland
Vaccinium spp./Xerophyllum tenax Shrubland
Vaccinium membranaceum–(Sorbus sitchensis–Paxistima myrsinites) Shrubland
Vaccinium membranaceum/Calamagrostis rubescens Shrubland
Vaccinium scoparium Dwarf-Shrubland

M74S Subalpine Mountain Heather Dwarf-Shrubland
***Arctostaphylos uva–ursi–(Dasiphora fruticosa)* Dwarf-Shrubland**
***Phyllodoce empetriformis–(Vaccinium deliciosum)–Lupinus arcticus* Dwarf-Shrubland**
***Phyllodoce empetriformis–Vaccinium deliciosum–(Cassiope mertensiana) Subalpine* Dwarf-Shrubland**

M74A Alpine Mountain Heather Dwarf-Shrubland
***Carex nigricans–(Luetkea pectinata)* Herbaceous Vegetation**
***Cassiope mertensiana–Phyllodoce empetriformis* Alpine Dwarf-Shrubland**
***Empetrum nigrum–Lupinus sellulus* Dwarf-Shrubland**
***Phyllodoce glandulliflora–(Cassiope mertensiana)* Dwarf-Shrubland**

M73 Sparsely Vegetated Talus and Fellfield
Artemisia ludoviciana–Lomatium martindalei Herbaceous Vegetation
***Athyrium americanum–Cryptogramma acrostichoides* Lithomorphic Vegetation**
Chamerion latifolium–Oxyria digyna–(Valeriana sitchensis) Lithomorphic Vegetation
Elmera racemosa–(Senecio neowebsteri) Lithomorphic Vegetation
Eriogonum pyrolifolium–Polygonum davisiae Lithomorphic Vegetation
Phlox diffusa–Lupinus sellulus–(Pedicularis contorta) Herbaceous Vegetation

M63 Sparsely Vegetated Alpine Herbaceous Vegetation
Luetkea pectinata–Carex spectabilis Lithomorphic Vegetation
***Saxifraga tolmiei–(Luzula piperi–Carex nigricans)* Lithomorphic Vegetation**

M39H Lowland Wet Meadow
Carex aquatilis–(Menyanthes trifoliata–Equisetum spp.*)* Herbaceous Vegetation*

M39S Lowland Wet Shrubland
***Cornus sericea* Shrubland**
Salix sitchensis–Spiraea douglasii/Carex aquatilis–Lysichiton americanus Shrubland*

M58 High Elevation Wet Meadow
Carex (nigricans, spectabilis)–Caltha leptosepala–(Leptarrhena pyrolifolia) Herbaceous Vegetation
Carex nigricans–(Kalmia microphylla–Vaccinium deliciosum) Herbaceous Vegetation*
Carex nigricans–Carex lenticularis–(Calamagrostis canadensis) Herbaceous Vegetation
***Carex spectabilis–Carex nigricans–(Potentilla flabellifolia)* Herbaceous Vegetation**
Salix commutata/(Valeriana sitchensis–Senecio triangularis) Shrubland
***Salix commutata* Shrubland**
Trichophorum caespitosum Herbaceous Vegetation

M81 Coastal Bog
(Thuja plicata)/(Ledum groenlandicum)/Carex obnupta–(Sphagnum spp.*)* Bog*
***Thuja plicata–Tsuga heterophylla/Lysichiton americanus/Sphagnum spp. Woodland**

*Represents multiple associations that were lumped prior to map classification, mostly because of low plot numbers in component associations.

The central chart represents the resultant crosswalk between mapping associations and map classes. This crosswalk balances user expectation, floristic similarity and model separability. Final modeling, map class prevalence review and accuracy assessments are not yet completed. Map classes may be combined based on accuracy assessment results and map class names are subject to change.

Example plot photos are shown above entries for some map classes. Each photo represents a different component association. Bolded mapping associations are already part of the USNVC, all others are preliminary or provisional and stem from extensive field work and ongoing classification efforts (Crawford et. al. 2009).

Results

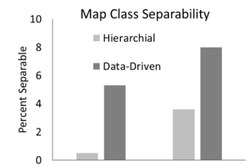


Figure 2. Comparison of map class separability by classification method. Our percent separability metrics are the geometric mean of the margin of victory across all associations and map classes.

We ended up with 44 separable, vegetated map classes, listed in the central chart with their component mapping associations. This classification represents a significant increase in the two metrics of mapability that we worked to maximize. The map class an association was assigned to received 5.3% more model votes than its second best fit, a more than 10 fold improvement over modeling based on NVC hierarchy. Floristic separability also improved markedly: floristics were 8.0% more similar to their assigned class than to their second best fit (up from 3.6%).

Our revised classification also highlights and maintains the key ecological communities that local ecologists and NPS staff expect in these maps. To reflect these expert opinions and expectations, our final classification is a compromise between a pure data-driven agglomeration process and previous methods based on manual assignment based on user expectations and local ecology alone.

We retained parts of the hierarchical classification that were important to managers, in some cases despite an alternative that increased both measures of separability. For example, we retained the alpine heather map class (M74S) as distinct from the alpine sparsely vegetated map class (M63) because of requests from NPS staff.

These three large national parks cover four ecoregions (Figure 1) and span steep elevation (0 – 14,411 feet) and climate gradients (66 – 660 cm annual rainfall). Despite these differences, the parks have similar montane and subalpine forests and National Park Service Inventory and Monitoring efforts are organized at the network scale (North Coast and Cascades Network). We created a consistent map class classification, where all map classes are defined similarly at all parks. Two thirds of the map classes are common enough to be mapped at more than two parks, while one third are unique to just one park (e.g. hypermaritime map classes at Olympic National Park). If a map class was not represented by enough plots to effectively map at a particular park, it was lumped with the next most similar type. This lumping is not expected to have a significant effect on the final maps as it affects under 1% of field plots.

Conclusions

We created a classification that maximizes separability without sacrificing user experience. Our data-driven approach maintained well-supported NVC hierarchical groupings, increased achievable map accuracy and increased consistency of map class field identification. Our extensive field dataset allowed us to ask the data which associations were most confused. To meet user needs, we seeded map classes with the robust categories (endmembers) that were important to map users, and manually maintained a consistent crosswalk between parks, except where data were insufficient.

Our work showed the benefit of specifically testing and maximizing separability. We suggest that these techniques can help USNVC Hierarchy-based vegetation mapping efforts using modeling or photo-interpretation meet desired accuracy targets by specifically prioritizing separability in the mapping process. Our compromise was toward map classes which do not adhere strictly to USNVC hierarchy but we believe the gains in accuracy and field utility will be valued by the map users.

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