
CLASSIFICATION AND DESCRIPTION OF WORLD FORMATION TYPES

PART II. DESCRIPTION OF WORLD FORMATIONS (v 2.0)

*Hierarchy Revisions Working Group
(Federal Geographic Data Committee)*

2012

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This document is being developed for the U.S. National Vegetation Classification, the International Vegetation Classification, and other national and international vegetation classifications.

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EXECUTIVE SUMMARY

A vegetation-ecologic classification approach has been developed in which a combination of vegetation attributes (physiognomy, structure, and floristics) and their response to ecological and biogeographic factors are used as the basis for classifying vegetation types (Faber-Langendoen et al. 2012). This approach can help support international, national and subnational classification efforts. Support for many aspects of the development of classification was provided by the U.S. National Vegetation Classification (USNVC) partnership, in conjunction with development of the International Vegetation Classification (IVC) (FGDC 2008, Faber-Langendoen et al. 2009, Jennings et al. 2009). The classification structure was largely developed by the Hierarchy Revisions Working Group (HRWG), which contained members from across the Americas. The group was authorized by the U.S. Federal Geographic Data Committee (FGDC) to develop a revised vegetation classification, global in scope, to replace the earlier versions of the structure that guided the USNVC and IVC, which relied on the UNESCO (1973) global classification (see FGDC 1997, Grossman et al. 1998). In this document, we summarize the development of the upper formation levels.

We first describe the history of the Hierarchy Revisions Working Group and discuss the three main parameters that guide the classification – it focuses on vegetated parts of the globe, on existing vegetation, and includes (but distinguishes) both cultural and natural vegetation, for which parallel hierarchies are provided.

For natural (including semi-natural) vegetation, we define three main physiognomic levels: Formation Class, Formation Subclass, and Formation and describe each of the types for all three levels. For cultural vegetation, we define and describe four main physiognomic levels: Cultural Class, Cultural Subclass, Cultural Formation, and Cultural Subformation. We use a fourth physiognomic level for cultural vegetation because the floristic / biogeographic patterns used for natural vegetation at the fourth level are not nearly as relevant for cultural vegetation. We provide guidance for developing formation type description and nomenclature.

The upper levels were not developed in a strictly top down manner. Rather, members of the HRWG had access to draft mid and lower level units (from Division to association) for the U.S. and parts of Canada and Latin America. A comprehensive master spreadsheet of draft units for these units was organized under the upper levels, and was used to critique the overall “naturalness” of the formation units. The HRWG reevaluated formation concepts where formations introduced undesirable splits in lower units that were otherwise ecologically and floristically similar. Our goal was to make splits between upper level types that had good ecological and vegetation support for them. Still, inevitably, given the multi-dimensional and continuous gradients affecting vegetation, some criteria for upper levels require splitting otherwise closely related floristic and physiognomic types (e.g., open woodland from grassland, floodplain forest from upland forest).

Part I of the report provides an introduction to the overall classification, focusing on the upper formation levels. Part II provides a description for each type, following a standardized template format.

In Part I, appendices provide important information on members of the working group, a draft set of formation types at all three levels, growth forms used to describe the types, and comparisons with other formation level classifications. One appendix provides a key to Level 1. The final appendix introduces

examples of the Division level, the level immediately below formation. A comprehensive set of Divisions for all formations is a key next step in the process of establishing an ecological vegetation classification framework.

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1. Forest to Open Woodland (C01)

OVERVIEW

Database Code: 1 (C01)

Scientific Name: Mesomorphic Tree Vegetation Class

Common Name (Translated Scientific Name): Mesomorphic Tree Vegetation Class

Colloquial Name: Forest to Open Woodland

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 1.A. Tropical Forest (S17)
- 1.B. Temperate & Boreal Forest (S15)

Type Concept Sentence: Tropical, temperate and boreal forests, woodlands and tree savannas characterized by broadly mesomorphic (including scleromorphic) tree growth forms (including *broad-leaved*, *needle-leaved*, *sclerophyllous*, *palm*, *bamboo trees*, and *tree ferns*), typically with at least 10% cover, irregular horizontal spacing of vegetation structure, and spanning humid to seasonally dry tropical to boreal and subalpine climates and wet to dry substrate conditions. Includes native forests, as well as managed, and some plantation forests where human management is infrequent.

Type Concept: *Trees* with broadly mesomorphic (including scleromorphic) growth forms (including *broad-leaved*, *needle-leaved*, *sclerophyllous*, *palm*, and *bamboo trees*, and *tree ferns*) characterize this type. Vegetation structure typically has irregular horizontal spacing. The mesomorphic tree canopy is typically greater than 10% cover and often exceeds 5 m in height, and often has both a mature (overstory) and regeneration layer. Climates range from humid tropical to boreal and subalpine, with fairly moderate moisture and temperature conditions. Substrate moisture conditions vary from dry to wet. Vegetation includes tropical, temperate, and boreal forests and woodlands.

Classification Comments [optional]: Plantations, ruderal and native forest and woodland stands are typically placed in this class. Many plantation forests can be placed here rather than in 7. Agricultural & Developed Vegetation Class (C07) despite having a canopy layer that may be very regular (spaced in planted rows), if the tree regeneration, shrub and ground layers develop spontaneously with irregular horizontal spacing, similar to native forests (i.e., regular human intervention does not occur for these layers). However, where plantations have highly regular horizontal structure, with regular human intervention in all layers (e.g., through cutting, spraying, ground-layer mowing), they may better be placed in 7. Agricultural & Developed Vegetation Class (C07).

Similarly, tree-dominated vegetation that has a natural, irregular horizontal spacing in the tree layer, but highly regular shrub or herb layers because of human intervention, should be placed in 7. Agricultural & Developed Vegetation Class (C07). For example, shade coffee, cacao, and other woody agricultural crops grown under native (or exotic) tree species and in which all non-treed strata layers are subject to regular human intervention should be placed in that class.

Included in this class are low-statured trees that overtop other growth forms. These include tree sapling and seedling stands with trees <2 m, where the tree growth form is at least 10% cover and overtops other growth forms. These also include subarctic woodlands, krummholz, and coastal dwarf-tree woodlands that are <2 m but are single-stemmed, with definite crowns. Where trees share the same strata as grasslands and shrublands (e.g., tallgrass brush prairie of 1-3 m, with trees <2 m), the vegetation is placed in the shrub- and herb-dominated classes.

Tree cover ranges from 10-100%, and thus is inclusive of what are called forests, woodlands, and tree savannas. The class limit of 10% tree cover (for mesomorphic tree growth forms) follows that of FAO's Global Forest Resources Assessment 2000 (FAO 2001). As with FAO, we include most tree plantations, but exclude stands of trees planted primarily for agricultural production (such as fruit tree plantations) and agroforestry, as well as those in developed lands, such as cities and roadsides. However, unlike FAO, we do not include what FAO calls "temporarily unstocked areas" (such as clearcuts, burnt areas) unless the tree growth form is actually present at 10% cover (even if in seedling or sapling form) and exceeds the height of other growth forms. Distinctions between plantation forests and native forests typically are made lower in the NVC hierarchy based on finer-scale structural and floristic differences.

Other classifications may limit forests and woodland to a narrower range of tree cover. For examples, forests and woodlands are defined as 25-100% cover, and the tree savannas with 10-25% cover were included under broadly defined grassland and shrubland classes (Driscoll et al. 1984, FGDC 1997, Grossman et al. 1998, Minnesota DNR 2005). UNESCO (1973) required that there also be a strong herbaceous layer (>50% graminoid cover). Still, a variety of definitions of tree savanna have been published, from the 10-25% cover noted above, to 10-30% cover in Nelson (2005), 10-40% in UNESCO (1973), and 10-50% cover in Curtis (1959). However, apart from tree savannas, there are many other forest and woodland types and regions where the degree of canopy closure plays less of a role in defining types, e.g., forested swamps and bogs, longleaf pine woodlands (Peet 2006), eastern pine barrens, and subarctic woodlands.

Blue oak, Engelmann oak, and other woodlands in California Mediterranean woodlands are typically between 10 and 60% cover, and California state ecologists place these in the Forest & Woodland (Barbour et al. 2007). Thus, given the variety of situations, we have chosen a more inclusive definition of forest and woodland, and rely on lower levels of the hierarchy to make distinctions based on a combination of biogeography, ecology, and floristics. For example, in the context of the eastern Great Plains tallgrass prairie-forest border, it is common to recognize oak savannas, based on open tree cover levels (e.g., 5-30% tree cover in Nelson 2005), as separate from oak woodlands (30-80% cover) and oak forests (80-100% cover). Savannas may be distinguished from forests or woodlands. These structural distinctions often correspond to lower-level units of the NVC hierarchy (e.g., group, alliance, association).

Similar NVC Types:

- 2. Shrubland & Grassland (C02): When grasses and shrubs dominate the ground layer and tree cover is near but greater than 10% cover, or clumped, or overtopped by grasses and shrubs, there may be cases where assignment to this class is preferable. Short mesomorphic trees that do not overtop shrubs and herbs are placed in this class.
- 3. Desert & Semi-Desert (C03): Occasionally xeromorphic trees may be sufficiently dense to form woodland stands (e.g., saguaro, Joshua tree, microphyllous-leaved mesquite woodlands, tropical thorn woodlands). The dominance of xeromorphic growth forms places these stands in the Desert & Semi-Desert class rather than Forest to Open Woodland.
- 7. Agricultural & Developed Vegetation (C07): Forests found in urban parks and lawns may have an irregular horizontal spacing but a highly regular or mowed understory and are placed in this developed vegetation class. Or forests, such as orchards, typically have either a very regularly spaced tree canopy (often pruned or trained) and/or plowed or regularly manipulated ground layer (e.g., tree-shaded shrub or herb crops).

Diagnostic Characteristics: Mesomorphic tree growth forms (*broad-leaved*, *needle-leaved*, and *sclerophyllous trees*, *palms*, *bamboo trees*, and *tree ferns*) have >10% canopy cover, a spontaneous, irregular horizontal canopy spacing, and overtop other growth forms.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Growth Forms: Stands are dominated by mesomorphic trees, including *broad-leaved deciduous* (including mostly deciduous, winter-deciduous, facultatively-deciduous), *broad-leaved evergreen* (including mostly evergreen), *needle-leaved* (deciduous and evergreen), *sclerophyllous trees*, *palms*, *bamboo trees*, and *tree ferns*. Tree growth forms generally have a single main stem and more-or-less definite crowns, and may be as low as 2 m (scrub trees) (e.g., tropical cloud elfin forest, mesquite woodland). Where growth forms are not easily defined, woody plants equal to or greater than 5 m at maturity are considered trees (FGDC 2008).

Structure: Typical stands have one or more of the tree growth forms exceeding 5 m in height, and the canopy has irregular horizontal tree stem spacing, with a minimum of 10% canopy cover. A tree regeneration layer is often present, along with various associated growth forms (shrubs, herbs, nonvasculars). Stands of trees where the tree growth form is short <5 m in height, but overtopping shrub and herb growth forms, also are placed in this class.

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: [There is a need to bring in some climatic classification categories, such as Koeppen or Holdridge, or both. These could be used to broadly summarize ranges of temperature and precipitation that correspond to mesomorphic growth forms. A good summary of Koeppen is at: <http://www.meteorologyclimate.com/koppenclassification.htm>. Koeppen seems among the best globally since it is based on the global distribution of natural vegetation. However, the Trewartha climate classification scheme may be more in line with what we are thinking of for North America (it is a modification of Koeppen based on the notion of warm-temperate versus cold-temperate. <http://www.travel-university.org/general/geography/climatology/trewartha3.html>. Also helpful may be: "A Dichotomous Flowchart Key to the Trewartha Climatic Classification System." Journal of Geography 75(4):222-226. April 1976. Here's a good link to global Koeppen climate charts: http://en.wikipedia.org/wiki/Koeppen_climate_classification.]

Soil/substrate/hydrology: Dry to wet soils, including those found in swamp forests and mangroves.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]: Given the various criteria for tree canopy cover to define forests and woodlands [see Classification Comments], we strongly recommend that inventory and mapping programs document the tree canopy cover (e.g., 10-25%, 25-50%, 50-75%, 75-100%) as a descriptor of pixels, points, plots or polygons. Adding these descriptors does not imply that each level of canopy cover closure is its own type! Rather, users may choose how to use this information for their particular needs.

Mapping based on the 10% tree cover rule: Satellite-based remote sensing imagery may not permit distinctions at the 10% tree cover level; 25% may be more feasible. Aerial photography does permit a 10% tree cover distinction. Dwarf-trees <2 m may not be distinguishable on imagery from low shrubs and herbs. Thus, low krummholz vegetation may be indistinguishable from shrub

tundra.

Distinguishing 7. Agricultural & Developed Vegetation Class (C07) from 1. Forest to Open Woodland Class (C01) may be difficult when those classes have an overstory of native trees (e.g., shade-grown coffee stands).

DISTRIBUTION

Geographic Range: Climate zones? Bailey (1989) Domains: Dry, Humid Tropical, Humid Temperate Domain, Subarctic Division of Polar Domain, and Mountain Divisions of Dry Domain. Less common in other divisions of Polar or Dry domains.

Nations [incomplete except for CA and US]: AU, CA, CL, CN, ES, FR, GB, IT, JP, NZ, PR, RU, SE, TR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Forest (FAO 2001) [Approximately equivalent. Xeromorphic scrub woodlands are probably included here, but otherwise the concepts are very similar.]

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: Hierarchy Revisions Working Group

Acknowledgments:

Version Date: 16 Jul 2012

1.A. Tropical Forest (S17)

OVERVIEW

Database Code: 1.A (S17)

Scientific Name: Tropical Forest Subclass

Common Name (Translated Scientific Name): Tropical Forest Subclass

Colloquial Name: Tropical Forest

Hierarchy Level: Subclass

Placement in Hierarchy: 1. Forest to Open Woodland (C01)

Lower Level Hierarchy Units:

- 1.A.1. Tropical Seasonally Dry Forest (F003)
- 1.A.2. Tropical Lowland Humid Forest (F020)
- 1.A.3. Tropical Montane Humid Forest (F004)
- 1.A.4. Tropical Flooded & Swamp Forest (F029)
- 1.A.5. Mangrove (F006)

Type Concept Sentence: Tropical forests found at lowland and montane elevations including tropical dry forests, and lowland to montane humid forests (tropical rainforests) and tropical forested wetlands, where hard frosts occur less than once every few years.

Type Concept: Tropical Forest varies from dry to humid forests from sea level to montane elevations and includes forested wetlands. Tropical dry forest (sometimes called tropical seasonally dry forest) range in canopy types, including evergreen, semi-evergreen (needle-leaved or broad-leaved), or largely or wholly deciduous. Tree growth forms predominate and may be species-rich, with micro- to mesophyll leaves, but succulent species may be present. It occurs in humid dry tropical climates with a pronounced dry season, during which some or all of the trees may lose their leaves, or leaves may be moderately small and evergreen sclerophyllous. Canopy heights decrease and canopy coverage tends to decrease as the climate dries until the forests are reduced to open, short-statured (5-15 m) woodlands.

Tropical humid forests (including moist and wet forests) occur in the humid tropics where rainfall varies from abundant and well-distributed throughout the year to somewhat seasonal. Tree growth forms predominate, are tall, often of numerous species, some with buttressed bases, often smooth bark, and evergreen meso- to macrophyll leaves. Also present may be tree ferns, large woody climbers or lianas, and both vascular and nonvascular epiphytes, often of greater diversity than the ground layer. Heights may exceed 30 m. Tropical forested wetlands include swamps and mangroves, where soils are seasonally or permanently saturated to inundated by freshwater or saltwater, with hydrophytic plants and, in the case of mangrove, distinctive hydromorphic growth forms adapted to saline conditions.

Classification Comments [optional]: Review of tropical monsoon forests is needed, as they can vary from dry to moist.

Similar NVC Types:

- 1.B. Temperate & Boreal Forest (S15): Broad-leaved evergreen trees may be common in warm temperate forests, comparable to tropical dry forests (i.e., evergreen leaves are typically small), but deciduousness is caused by frost, and types are found where a hard frost occurs annually.
- 2.A. Tropical Grassland, Savanna & Shrubland (S01): Where tree cover exceeds 10%, stands are typically placed in the Tropical Forest (S17), including "grassy woodlands."
- 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06): Thorn woodlands, with xeromorphic characteristics (a-phyllous or very small-leaved trees, with succulents), are placed in this subclass, and rainfall is more typically between 25 and 100 cm.
- 7.A. Woody Agricultural Vegetation (S22): Tropical Forest (S17) long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar to Woody Agricultural Vegetation (S22) in their early stages of development, especially if planted in rows and the understory is strongly manipulated.

Diagnostic Characteristics: Tropical Forest is dominated by broad-leaved, often megaphyll, evergreen trees, broad-leaved drought-deciduous or semi-deciduous trees, or small-leaved (micro- to mesophyll evergreen trees). Evergreen needle-leaved trees may occur in association with these other growth forms. Climates are consistently warm (seasonal daily temperatures with minimal variation), and annual rainfall is typically >100 cm.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical dry forest (sometimes called tropical seasonally dry forest) range in canopy types, including evergreen, semi-evergreen (needle-leaved or broad-leaved), or largely or wholly deciduous. Tree growth forms predominate, with micro- to mesophyll leaves, but succulent species may be present. They occur in humid dry tropical climates with a pronounced dry season, during which some or all of the trees may lose their leaves, or leaves may be moderately small and evergreen sclerophyllous. Canopy heights decrease and canopy coverage tends to decrease as the climate dries until the forests are reduced to open, short-statured (5-15 m) woodlands (Whittaker 1975).

Tropical humid forests (including moist and wet forests) occur in the humid tropics where rainfall varies from abundant and well-distributed throughout the year to somewhat seasonal. Tree growth forms predominate, are tall, often of numerous species, some with buttressed bases, often smooth bark, and evergreen meso- to macrophyll leaves. Also present may be tree ferns, large woody climbers or lianas, and both vascular and nonvascular epiphytes, often of greater diversity than the ground layer. Heights may exceed 30 m (Whittaker 1975).

Tropical forested wetlands include swamps and mangroves, with hydrophytic plants and, in the case of mangrove, distinctive hydromorphic growth forms adapted to saline conditions.

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

Climate: In general, the tropical humid forest has a fairly consistent average annual temperature, ranging from 26-27 degrees C, and a more variable daily temperature, with changes up to 5 degrees C. In the tropical dry forest, average annual temperatures range between 20 and 30 degrees C, and daily temperatures change from between 26 to 28 degrees C. Frost is essentially absent from the tropical forest (Holdridge 1967). Rainfall ranges from 100 to 450 cm (400-180 inches), with the rainfall becoming increasingly more seasonal in tropical dry climates, where the dry season may extend for 4-7 months (Holzman 2008).

Soil/substrate/hydrology: Soils in humid regions are often highly weathered ancient soils with high acidity and low nutrient and organic matter content; however, many tropical forests occur on rich volcanic or limestone soils. The major soil orders in the U.S. system include Oxisols, Ultisols, Inceptisols, and Entisols (Soil Survey Staff 1999) [see Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems]. Younger and richer soils are found in alluvial habitats or in areas influenced by ashes from volcanic activity (Holzman 2008).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Tropical Forest is concentrated around the equator with tropical moist forest most common between 0 and 10 degrees N and S latitude, and tropical dry forest between 10 and 23 degrees N and S, with latitudinal limits shaped by frost and drought. Tropical Forest is found in three major regions: South and Central America; Africa (west, central and interior) and Madagascar; and the Indo-Asian Pacific (India, Southeast Asia, Indonesia, New Guinea, Pacific Islands, and northeastern Australia).

Nations [incomplete except for CA and US]: PR, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Tropical Forest (Holzman 2008)

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fulst, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and E. Helmer

Acknowledgments:

Version Date: 12 Jul 2012

1. Forest to Open Woodland

1.A. Tropical Forest

1.A.1. Tropical Seasonally Dry Forest (F003)**OVERVIEW****Database Code:** 1.A.1 (F003)**Scientific Name:** Tropical Seasonally Dry Forest Formation**Common Name (Translated Scientific Name):** Tropical Seasonally Dry Forest Formation**Colloquial Name:** Tropical Seasonally Dry Forest**Hierarchy Level:** Formation**Placement in Hierarchy:** 1.A. Tropical Forest (S17)**Lower Level Hierarchy Units [incomplete]:**

- 1.A.1.Ea. Caribbean Dry Forest (D099)
- 1.A.1.Fe. Malagasy Dry Deciduous & Evergreen Forest & Woodland (D150)
- 1.A.1.Ff. Eastern African Dry Semi-Deciduous Forest (D154)
- 1.A.1.Fg. Albany Subtropical Thicket (D155)
- 1.A.1.Fh. Southern African Dry Tropical Forest (D156)
- 1.A.1.Oc. Polynesian Dry Forest (D072)
- 1.A.1.Od. Eastern Melanesian Dry Forest (D073)

Type Concept Sentence: Tropical Seasonally Dry Forest is dominated by both broad-leaved drought-deciduous, semi-deciduous, and small-leaved or sclerophyllous evergreen trees where rainfall is lower, often associated with more strongly seasonal, tropical climates, rainshadows, or drying winds, and continental scales, the largest areas occur between 10 and 23 degrees N and S latitude.

Type Concept: Tropical Seasonally Dry Forest, including most monsoon forests, occurs in extensive areas near the equator around the globe between 10 and 23 degrees N and S latitude, though it can also be found near windward coasts and on the leeward sides of mountains or islands. These forests are dominated by broad-leaved drought-deciduous trees or, more rarely, small-leaved (micro- to mesophyll) evergreen trees or broad-leaved (meso- to macrophyll) sclerophyllous-leaved trees. Evergreen needle-leaved trees may occur in association with these other growth forms. It is a medium to high forest varying on average from 15 to 25 m tall, typically with several structural levels as complex upper canopy, several subcanopy levels of treelets and shrubs, woody vines, and an irregular low herbaceous plant stratum. Canopy heights decrease and canopy coverage tends to decrease as the climate dries until the forests are reduced to open, short-statured (5-15 m) woodlands (more rarely shorter). Included are semi-evergreen, partially sclerophyllous, semi-deciduous and deciduous, mostly dense to semi-dense forests adapted for a distinct period of seasonal winter drought, resulting in 4 to 7 months of drought (rainfall 60 mm or less), during which some or all of the trees lose their leaves. Annual rainfall ranges from 100 to 200 cm. The considerable diversity of dry tropical forest types are related to the topographic, hydric and edaphic variations as well as with the floristic composition and different biogeography.

Classification Comments [optional]: Mooney et al. (1995) suggest that tropical seasonally dry forest may be defined as forest occurring in tropical regions characterized by pronounced seasonality in rainfall distribution, resulting in several months of drought. The forests that develop under such climatic conditions share a broadly similar structure and physiognomy; they mainly occur on oligotrophic, reddish soils (Oxisols, Ultisols), but may also occur on mesotrophic soils. Beyond that, they note that these shared characteristics are difficult to define with precision. They may either be deciduous or evergreen, though typically small-leaved, and either open- or closed-canopy. There are sclerophyllous evergreen broad-leaved (mesophyllous- to macrophyllous-leaved) Tropical Seasonally Dry Forest in the Brazilian-Bolivian Cerrado.

Many authors include thorn woodlands as part of a broadly defined "tropical dry forest" or "seasonally dry tropical forest" (SDTF). For example, Pennington et al. (2006) use a wide interpretation of SDTF in the Neotropics, including formations as diverse as tall forest on moister sites to cactus scrub on the driest, but they exclude the Chaco of Argentina, Paraguay and Bolivia because it receives frost. See also Oliveira-Filho et al. (2006), who include caatingas and carrascos within their broad definition of SDTF, but exclude cerrados and chaco. Here we treat 3.A.1 Tropical Thorn Woodland Formation (F039) as a separate xeromorphic growth form-based formation that includes, in the Neotropics, caatingas, carrascos, cerrados, and chaco).

Tropical monsoon forests are sometimes grouped with 1.A.2 Tropical Lowland Humid Forest Formation (F020) as "tropical moist forest," but being deciduous with pronounced drought periods, they are better included with 1.A.1 Tropical Seasonally Dry Forest Formation (F003) (Whitmore 1998). Further review of the range of variation in tropical monsoon forests is needed, to clarify the transition to Tropical Lowland Humid Forest.

Similar NVC Types:

- 1.A.2. Tropical Lowland Humid Forest (F020): As seasonality increases, the abundance of drought-deciduous trees increases and semi-evergreen rainforests more closely resemble Tropical Seasonally Dry Forest (F013). Tropical monsoon forests are sometimes grouped with Tropical Lowland Humid Forest as "tropical moist forest" (Whitmore 1998), but they are here included with Tropical Seasonally Dry Forest.

- 1.B.1. Warm Temperate Forest (F018): Broad-leaved evergreen trees may be common in this formation, comparable to Tropical Seasonally Dry Forest (i.e., evergreen leaves are typically small), but deciduousness is caused by frost, and types are found north or south of 23 degrees N and S latitude.
- 3.A.1. Tropical Thorn Woodland (F039): Thorn woodlands, with xeromorphic characteristics (a-phyllous or very small-leaved trees, with succulents) are placed in this xeromorphic woodland formation (F039). Rainfall is between 25 and 100 cm. Tropical Seasonally Dry Forest grades to Tropical Thorn Woodland in areas with lower annual rainfall and increasing period of seasonal drought (in xeric warm bioclimates), while the trees and shrubs become fully deciduous and with a considerable increase of distinct xeromorphic adaptations such as thorns, succulency and clearly microphyllous species that instead are scarce or absent in Tropical Seasonally Dry Forest.
- 7.A.2. Intensive Forestry Plantation & Agroforestry Crop (F043): Tropical Seasonally Dry Forest (F003) long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.

Diagnostic Characteristics: Tropical Seasonally Dry Forest is dominated by broad-leaved drought-deciduous trees or, more rarely, small-leaved (micro- to mesophyll) evergreen trees or broad-leaved (meso- to macrophyll) sclerophyllous-leaved trees. Thorn forest and scrub are excluded. Evergreen needle-leaved trees may occur in association with these other growth forms. Climates are consistently warm (seasonal daily temperatures with minimal variation), and annual rainfall is strongly seasonal, but average annual rainfall is typically >100 cm.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical Seasonally Dry Forest is dominated by broad-leaved drought-deciduous trees or, more rarely, small-leaved (micro- to mesophyll) evergreen trees or broad-leaved (meso- to macrophyll) sclerophyllous-leaved trees (Lugo et al. 2006). Evergreen needle-leaved trees may occur in association with these other growth forms. It is a medium to high forest varying on average from 15 to 25 m tall, typically with several structural levels as complex upper canopy, several subcanopy levels of treelets and shrubs, woody vines, and an irregular low herbaceous plant stratum. Canopy heights decrease and canopy coverage tends to decrease as the climate dries until the forests are reduced to open, short-statured (5-15 m) woodlands (more rarely shorter). Included are semi-evergreen, partially sclerophyllous, semi-deciduous and deciduous, mostly dense to semi-dense forest (Whittaker 1975).

In the Neotropics the lower forest level is often dominated by colonies of clumping terrestrial bromeliads. Overall, there is a predominance in the canopy of medium-sized leaves (mesophyllous) that fall partially or almost completely in the dry season. Tall arborescent cacti can be frequent in dry semi-deciduous forest of the Neotropics and physiognomically similar arborescent succulent euphorbias in the Paleotropics. In western Brazil, eastern Bolivia and Paraguay, this formation includes large stands of medium-low and partially sclerophyllous semi-evergreen forests or "cerrado," with characteristic adaptations to drought and fire, such as very corky bark on twisted trunks and xylopodiums.

Floristics [optional]: In the Neotropics, more characteristic families that predominate in the dry forests are mainly Fabaceae, Anacardiaceae, Bombacaceae, Bignoniaceae and Apocynaceae. The Cerrado dry sclerophyllous forest flora is highly diverse with important families being Vochysiaceae, Fabaceae, Caryocariaceae, Malpighiaceae, Dilleniaceae, Sapindaceae, Erythroxylaceae and Bignoniaceae.

[This information will be moved to divisions and macrogroup descriptions when these are available.]

Chiquitano Dry Forest, Brazil, Bolivia, Paraguay (trees): *Acosmium cardenasii*, *Amburana cearensis*, *Anadenanthera colubrina*, *Aspidosperma cylindrocarpon*, *Astronium urundeuva*, *Caesalpinia pluviosa*, *Ceiba speciosa*, *Cedrela fissilis*, *Cereus tacuaralensis*, *Combretum leprosum*, *Copaifera langsdorfii*, *Cordia alliodora*, *Enterolobium contortisiliquum*, *Eriotheca roseorum*, *Gallesia integrifolia*, *Guibourtia chodatiana*, *Hymenaea courbaril*, *Machaerium scleroxylon*, *Maclura tinctoria*, *Piptadenia viridiflora*, *Platymiscium ulei*, *Pseudobombax marginatum*, *Schinopsis brasiliensis*, *Sweetia fruticosa*, *Tabebuia impetiginosa*, *Tabebuia serratifolia*.

Cerrado Sclerophyllous Semi-evergreen Forest, Brazil, Bolivia, Paraguay: *Agonandra brasiliensis*, *Allagoptera leucocalyx*, *Astronium fraxinifolium*, *Bowdichia virgilioides*, *Bromelia villosa*, *Brosimum gaudichaudii*, *Byrsonima coccolobifolia*, *Callisthene fasciculata*, *Caryocar brasiliensis*, *Curatella americana*, *Cydistax antisiphylitica*, *Dypteris alata*, *Dyptichandra aurantiaca*, *Erythroxylum daphnites*, *Erythroxylum suberosum*, *Guettarda viburnoides*, *Himatanthus obovatus*, *Jacaranda cuspidifolia*, *Kielmeyera coriacea*, *Lafoensia pacari*, *Luehea paniculata*, *Machaerium acutifolium*, *Magonia pubescens*, *Plathymenia reticulata*, *Platydictyon elegans*, *Pseudobombax longiflorum*, *Qualea grandiflora*, *Qualea multiflora*, *Qualea parviflora*, *Rhamnidium elaeocarpum*, *Stryphnodendron obovatum*, *Tabebuia aurea*, *Terminalia argentea*, *Vatairea macrocarpa*, *Vochysia rufa*, *Xylopia aromatica*, *Zamia boliviana*.

Peruvian and Ecuadorian Dry Forest (trees): *Albizia guachapele*, *Alseis eggersii*, *Aspidosperma ulei*, *Caesalpinia paipai*, *Capparis petiolaris*, *Cavanillesia platanifolia*, *Cedrela odorata*, *Centrolobium ochroxylon*, *Cochlospermum vitifolium*, *Cynometra bauhiniaefolia*, *Erythrina velutina*, *Eriotheca ruizii*, *Machaerium millei*, *Myroxylon peruiferum*, *Ocotea cernua*, *Pradosia nutans*, *Pseudobombax millei*,

Tabebuia chrysantha, *Terminalia valverdae*, *Triplaris cummingiana*, *Vitex gigantea*, *Zizyphus thyrsoiflora*.

Mesoamerican Dry Forest: *Anacardium excelsum*, *Andira inermis*, *Astronium graveolens*, *Bernoullia flammea*, *Brosimum alicastrum*, *Bursera arborea*, *Bursera simaruba*, *Calycophyllum candidissimum*, *Cedrela mexicana*, *Ceiba pentandra*, *Celtis monoica*, *Cochlospermum vitifolium*, *Cordia alliodora*, *Dalbergia granadillo*, *Enterolobium cyclocarpum*, *Hura polyandra*, *Hymenaea courbaril*, *Lonchocarpus lanceolatus*, *Luehea candida*, *Lysiloma acapulcensis*, *Piptadenia constricta*, *Platymiscium dimorphandrum*, *Poeppigia procera*, *Pterocarpus acapulcensis*, *Plumeria rubra*, *Roseodendron donnell-smithii*, *Sideroxylon capiri*, *Spondias mombin*, *Spondias purpurea*, *Sterculia apetala*, *Swietenia humilis*, *Tabebuia chrysantha*, *Tabebuia palmeri*.

ENVIRONMENT

Environmental Description [optional]:

Climate: Tropical Seasonally Dry Forest occurs in areas where the air subsides near the tropics of Cancer and Capricorn and the Intertropical Convergence Zone (ICZ) migrate north and south seasonally, producing the alternate pattern of rainfall and dryness. The average drought season varies in length from 3 to 6 months and is generally coincident with the annual lowest temperatures. Annual rainfall ranges from 100 to 200 cm (Whitmore 1998), or where the rainfall is less than 160 cm/year, with a period of at least 5 to 6 months receiving less than 10 cm, during which some or all of the trees lose their leaves (Pennington et al. 2006). The climate is warm tropical pluviseasonal, subhumid to humid.

Soil/substrate/hydrology: The substrate often includes large areas of highly weathered reddish soils with high iron and aluminum content and low mineral nutrients content, as well as frequent development of laterization process. The main soil orders in the U.S. system associated with Tropical Seasonally Dry Forest are Oxisols, Ultisols and Alfisols (Soil Survey Staff 1999) [see Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems]. More rarely, they occur on mesotrophic soils. This type also occurs on limestone substrates in the Caribbean and Mesoamerica (Lugo et al. 2006).

In most areas, Tropical Seasonally Dry Forest supports seasonal regimes of fire, both natural or adaptative and characteristically human-induced, that can cause frequent pyrogenic secondary savannized or woodland physiognomies. Fires, in conjunction with climate, are likely to partially explain the distribution of Tropical Seasonally Dry Forest (Bond et al. 2005).

Tropical Seasonally Dry Forest tends to occur at lower elevations. However, in South America, large more-or-less isolated pockets occur in several valleys of the eastern slopes of the Andes, particularly in southern Peru and Bolivia, where they can reach altitudes up to approximately 1200 m.

DISCUSSION

Discussion [optional]: Miles et al. (2006) estimated that 1,048,700 square km of Tropical Seasonally Dry Forest remain, distributed throughout the three tropical regions. More than half of the forest area (54.2%) is located within South America; the remaining area being almost equally divided between northern South America - Central America, Africa and Eurasia, with a relatively small proportion (3.8%) occurring within Australasia and Southeast Asia. Their definition of "forest" is restricted to areas with 40% tree cover or greater. The 40% value corresponds to the FAO Global Forest Resources Assessment definition of closed forest. The estimate by Miles et al. (2006) may be an overestimate, according to Sánchez-Azofeifa and Portillo-Quintero (2011), as they may have included dry shrubland and woodlands in their estimates.

Animals [optional]: In Tropical Seasonally Dry Forest, termites are typically one of the animal groups that are most important in the function and ecosystem dynamics, particularly in recycling of organic matter, also representing one of the largest biomasses of invertebrate animals that exist in any other environment (Holzman 2008).

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Tropical Seasonally Dry Forest is concentrated near the equator, primarily between 10 and 23 degrees N and S latitude. It is found in three major regions: South and Central America; Africa (west, central and interior) and Madagascar; and the Indo-Asian Pacific (India, Southeast Asia, Indonesia, New Guinea, Pacific Islands, and northeastern Australia).

In the Neotropics, this formation occupies large areas in central South America, mainly in eastern Bolivia, central and western Brazil and eastern Paraguay. Also, in the Neotropics, these forests extend across northern South America (Venezuela) and in western Mesoamerica (Mexico to Panama), with minor extensions in western Ecuador and Peru.

In the Paleotropics, Tropical Seasonally Dry Forest potentially occupies large areas in Africa (Sudano-Zambezian and Madagascan regions), India and Southeast Asia (Indochinese region), northeastern Australia, and the Pacific Islands, but generally has been extensively degraded by human activity to semi-open woodlands and arboreal savannas.

Nations [incomplete except for CA and US]: PR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: High

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Seasonally Dry Tropical Forests (Mooney et al. 1995)
- = Tropical Dry Forest (Miles et al. 2006)
- = Tropical Seasonal Forest (Holzman 2008)
- ? Tropical broadleaf woodland: biome-type 8 (Whittaker 1975)
- = Tropical seasonal forest: biome-type 2 (Whittaker 1975)

Full Citation:

- Bond, W. J., F. I. Woodward, and G. F. Midgley. 2005. The global distribution of ecosystems in a world without fire. *New Phytologist* 165:525-538.
- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: G. Navarro, D. Faber-Langendoen and E. Helmer

Acknowledgments:

Version Date: 12 Jul 2012

1. Forest to Open Woodland

1.A. Tropical Forest

1.A.2. Tropical Lowland Humid Forest (F020)

OVERVIEW

Database Code: 1.A.2 (F020)

Scientific Name: Tropical Lowland Humid Forest Formation

Common Name (Translated Scientific Name): Tropical Lowland Humid Forest Formation

Colloquial Name: Tropical Lowland Humid Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.A. Tropical Forest (S17)

Lower Level Hierarchy Units [incomplete]:

- 1.A.2.Ec. Caribbean & Central American Lowland Rainforest (D091)
- 1.A.2.Fd. Guineo-Congolian Evergreen & Semi-Evergreen Rainforest (D147)
- 1.A.2.Fe. Malagasy Evergreen & Semi-Evergreen Forest (D148)
- 1.A.2.Ff. Eastern & Southern African Lowland Evergreen & Semi-Evergreen Forest (D149)
- 1.A.2.Oa. Polynesian Lowland Rainforest (D066)
- 1.A.2.Ob. Eastern Melanesian Lowland Rainforest (D067)

Type Concept Sentence: Tropical Lowland Humid Forest is dominated by broad-leaved evergreen trees, often with multiple complex strata and growth forms in lowland to submontane or premontane elevations with aseasonal to moderately seasonal rainfall and warm temperatures.

Type Concept: Tropical Lowland Humid Forest occurs in the humid tropics, often within 10 degrees of the equator, where rainfall is abundant and well-distributed throughout most or much of the year, including both wet evergreen and more moist semi-evergreen forest. Elevations range from lowland to submontane or premontane, with ranges from sea level to between (500) 1000 and 1700 m depending on location. Soils are often ancient and deeply weathered, reddish and yellow clays or sands, or more recent soils found on volcanic, colluvial and alluvial deposits. Tree growth forms predominate, are tall, of numerous species, some with buttressed bases, often smooth bark, and with evergreen meso- to macrophyll leaves. Also present may be tree ferns, large woody climbers or lianas, and both vascular and nonvascular epiphytes, often of greater diversity than the ground layer. Heights often exceed 30 m. Evergreenness varies from completely evergreen to semi-evergreen seasonal forests, in which around 25% of the main canopy may be regularly deciduous. The vegetation is often species-rich, often lacking dominants, with the majority of the tree species of very low abundance.

Classification Comments [optional]: Heath forests are a striking variant within this formation, as described by Richards (1996) and Whitmore (1998). They occur on podsolized soils developed from siliceous sand, either coastal alluvium or weathered sandstones. Although typically found in a rainforest climate and retaining basic growth forms characteristic of 1.A.2 Tropical Lowland Humid Forest Formation (F020), the nutrient-poor, acidic conditions produce a strikingly distinct physiognomy. Here are found dense, often pole-sized trees, a stronger predominance of microphylls over mesophylls, with some sclerophylls, and woody climbers that are more often slender. The most extensive heath forests are found in the upper reaches of the Rio Negro and Rio Orinoco of South America, also in Guyana (wallaba forests of *Eperua falcata*), coastal forests of southeastern Madagascar, Gabon, Cameroon and Ivory Coast, and in Kalimantan, Sarawak and Brunei in Borneo (referred to as kerangas), and parts of Malaya (Whitmore 1998).

Tropical montane forests may resemble heath forests to some degree (Whitmore 1998).

Tropical monsoon forests are sometimes grouped with Tropical Lowland Humid Forest as "tropical moist forest" (Whitmore 1998), but by and large, they are included with 1.A.1 Tropical Seasonally Dry Forest Formation (F003). Further review is needed of the transition between monsoon forests and humid forests or rainforests.

Similar NVC Types:

- 1.A.1. Tropical Seasonally Dry Forest (F003): As climate becomes more seasonal, increasing numbers of deciduous trees are found. Stands are placed in Tropical Seasonally Dry Forest when >25% cover of trees are deciduous during a dry period, or where small-leaved (micro- to mesophyll) trees dominate. These forests also share some characteristics with the heath forest variant of Tropical Lowland Humid Forest.

- 1.A.3. Tropical Montane Humid Forest (F004): Montane rainforests at highest elevations are considerably smaller and heavily covered with bryophytes, but lower elevation montane forests (towards 1000 m) share similarities with Tropical Lowland Humid Forest.
- 1.A.4. Tropical Flooded & Swamp Forest (F029): Soils are typically saturated to flooded, but many of the growth forms are shared with Tropical Lowland Humid Forest.

Diagnostic Characteristics: Tropical Lowland Humid Forest is dominated by meso- to megaphyll, broad-leaved evergreen trees (up to 25% deciduous trees), with a complex multi-layer structure, often exceeding 30 m in height. Climates are consistently warm (seasonal daily temperatures with minimal variation), and annual rainfall is relatively aseasonal and typically >100 cm, with any given month rarely less than 60 mm.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical Lowland Humid Forest is a dense, multi-layered forest, with broad-leaved evergreen trees that can exceed 45 m in height. The tree layer is minimally divided into a top stratum with giant emergent trees, over a main stratum between 25 and 35 m tall, under which a stratum of shorter trees between 10 and 25 m occurs. Ground vegetation may be sparse, commonly with small trees (treelets). Herbs may be patchy. Individual trees may be deciduous or semi-deciduous, but overall comprise less than 25% of the main stratum. Evergreenness varies from completely evergreen, to evergreen seasonal forests (which is mainly evergreen but individual trees may lose their leaves) and semi-evergreen seasonal forest (in which up to around 25% of the main canopy may be deciduous) (Richards 1996). Whitmore (1998) notes the following features: buttresses are common, cauliflory and ramiflory are occasional to common, pinnate leaves are frequent, leaf blades of mesophyll size predominate, big woody climbers, mostly free-hanging are frequent to abundant and sometimes also bole climbers, shade and sun epiphytes are occasional to frequent; bryophytes are rare (Table 1). These characteristics are lost as forests become drier or as elevation increases.

Table 1. Characters used to distinguish Tropical Lowland Humid Forest from Tropical Montane Humid Forest (after Whitmore (1998), Table 2.2).

Formation Criteria	Tropical Lowland Humid Forest	Tropical Montane Humid Forest
Canopy height	25-45 m	1.5-33 m
Emergent trees	Characteristic, to 60 (80) m tall	Often to usually absent, to 37 m tall
Pinnate leaves	Frequent	Rare to very rare
Principle leaf size class of woody plants [define terms]	Mesophyll	Mesophyll or microphyll
Buttresses	Usually frequent and large	Uncommon, small or absent
Cauliflory	Frequent	Rare to absent
Big woody climbers	Abundant	Usually none
Bole climbers	Often abundant	Very few, frequent to abundant
Vascular epiphytes	Frequent	Frequent to abundant
Nonvascular epiphytes	Occasional	Occasional to abundant

Floristics [optional]: Tropical Lowland Humid Forests are species-rich, often lacking dominants, and two-thirds or more of the upper-canopy trees are of species individually of very low abundance. This formation is the most species-rich, in terms of plants and many animal groups, of all formations.

ENVIRONMENT

Environmental Description [optional]:

Climate: Tropical Lowland Humid Forest (including semi-evergreen rainforest) occurs in aseasonal, humid climates where water stress is low to absent, with no regular annual dry season (Whitmore 1998). In general, a tropical rainforest climate can be defined as one with monthly mean temperatures of at least 18 degrees C throughout the year, and an annual rainfall of at least 170 cm (and usually above 200 cm) and either no dry season or a short one of fewer than four consecutive months with less than 10 cm (Richards 1996, Whitmore 1998).

African rainforests are primarily semi-evergreen (where deciduous trees may comprise up to 25% of the main canopy), as are Australian rainforests, and various parts of other regional rainforest blocks (Whitmore 1998).

Soil/substrate/hydrology: These forests generally occur from sea level to approximately 1200 m elevation, but the boundary between lowland and montane forests occurs at different elevations depending on the "Massenerhebung effect" (Collins 1990, Richards 1996). This is a phenomenon whereby large mountains and the central parts of large ranges are warmer at given elevations

than small mountains and outlying spurs. Thus Collins (1990) mapped the boundaries in the Caribbean, Central America, Madagascar, Australia and Southeast Asia at 910 m, whereas in West Africa the boundary was set at 1200 m, in New Guinea at 1400 m and in South America at 1800 m.

Soils are often ancient and deeply weathered, with little organic darkening of the topsoil and with bright reddish or yellowish colors throughout the subsoil. Few of the original rock minerals remain in the upper horizon. Organic content may vary. Soils are often clay-like, but weathered sands also occur. Other more recent soils include those found on recent volcanic deposits, colluvial and alluvial soils (Richards 1996).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Tropical Lowland Humid Forest is concentrated around the equator, between the Tropic of Cancer (23 degrees N latitude) and Tropic of Capricorn (23 degrees S latitude). It is found in three major regions: South and Central America; Africa (west, central and interior) and Madagascar; and the Indo-Asian Pacific (India, Southeast Asia, Indonesia, New Guinea, Pacific Islands, and northeastern Australia). In the U.S., it is found in Hawaii and in several territories, including Puerto Rico and many of its Pacific island territories.

Nations [incomplete except for CA and US]: PR, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Lowland tropical rain forest: biome-type 1 (Whittaker 1975)
- = Tropical Rain Forest (Richards 1996)
- > Tropical heath forest (Whitmore 1998) [Heath forests occur on podsolized soils developed from siliceous sand, either coastal alluvium or weathered sandstones. The nutrient-poor, acidic conditions produce a strikingly different physiognomy of dense, often pole-sized trees, stronger predominance of microphylls over mesophylls, with some sclerophylly. Woody climbers are more often slender.]
- > Tropical lowland evergreen rain forest (Whitmore 1998) [Whitmore separates out tropical semi-evergreen rainforest, which is here combined at the formation level.]
- > Tropical semi-evergreen rain forest (Whitmore 1998) [Whitmore separates out tropical lowland evergreen rainforest, which is here combined at the formation level.]

Full Citation:

- Collins, M. 1990. The Last Rain Forests: A World Conservation Atlas. Oxford University Press, New York.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Richards, P. W. 1996. The Tropical Rain Forest: An Ecological Study. Second edition. Cambridge University Press, Cambridge, UK. 600 pp.
- Whitmore, T. C. 1998. An introduction to tropical rain forests. Second edition. Oxford University Press, Oxford.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Nov 2011

1. Forest to Open Woodland

1.A. Tropical Forest

1.A.3. Tropical Montane Humid Forest (F004)

OVERVIEW

Database Code: 1.A.3 (F004)

Scientific Name: Tropical Montane Humid Forest Formation

Common Name (Translated Scientific Name): Tropical Montane Humid Forest Formation

Colloquial Name: Tropical Montane Humid Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.A. Tropical Forest (S17)

Lower Level Hierarchy Units [incomplete]:

- 1.A.3.Ec. Caribbean & Central American Montane & Cloud Forest (D090)
- 1.A.3.Fd. Afromontane Dry Forest (D151)
- 1.A.3.Fe. Afromontane Mesic Forest (D152)
- 1.A.3.Ff. Afromontane Moist Forest (D153)
- 1.A.3.Oa. Polynesian Montane & Cloud Forest (D068)
- 1.A.3.Ob. Eastern Melanesian Montane & Cloud Forest (D069)

Type Concept Sentence: Tropical Montane Humid Forest is dominated by broad-leaved evergreen trees, with increasingly small leaves and stems, often gnarly, with dense crowns as elevations increase. These forests are generally found within 23 degrees N and S latitude of the equator between 1000 and 3500 m in elevation.

Type Concept: Tropical Montane Humid Forest is dominated by broad-leaved evergreen trees, with increasingly small leaves and stems, often gnarly, with dense crowns as elevations increase. They are generally found within 23 degrees N and S latitude of the equator, between (500) 1000 and 3500 m in elevation. Lower elevations contain a transition to 1.A.2 Tropical Lowland Humid Forest Formation (F020). At the highest elevations, the trees may be less than 10 m tall (sometimes referred to as elfin woodland and scrub), and covered in bryophytes, ferns, and other epiphytic plants. Evergreenness varies from completely evergreen to semi-evergreen seasonal forests, in which around 25% of the main canopy may be regularly deciduous. Climates are more often cool, but without frost, with seasonal daily temperatures with minimal variation. Annual rainfall is relatively aseasonal and typically >100 cm, with any given month rarely receiving less than 60 mm.

Classification Comments [optional]: The proportion of precipitation that is from clouds is a defining factor, but is difficult to assess.

Tropical Montane Humid Forests resemble heath forests to some degree (Whitmore 1998), with their wet climate, but smaller stems and leaves.

Similar NVC Types:

- 1.A.2. Tropical Lowland Humid Forest (F020): These rainforests are typically much taller, with multiple strata and growth forms, but as elevations increase (up to 1000 m), a transition occurs to lower elevation Tropical Montane Humid Forest.

Diagnostic Characteristics: Tropical Montane Humid Forest is dominated by micro- to mesophyll, broad-leaved evergreen trees (up to 25% deciduous trees), with a simple or two-layer structure, ranging from 5 to 30 m in height. Climates are more often cool, but without frost, with seasonal daily temperatures with minimal variation. Annual rainfall is relatively aseasonal and typically >100 cm, with any given month rarely receiving less than 60 mm. The proportion of precipitation that is from clouds is a defining factor, but is difficult to assess. Better defining characteristics are the amounts of epiphytes and ferns and where the epiphytes occur as well as canopy structure.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical Montane Humid Forest is dominated by broad-leaved evergreen trees, with increasingly small leaves and stems, often gnarly, with dense crowns as elevations increase. Lower elevations represent a transition from 1.A.2 Tropical Lowland Humid Forest Formation (F020) [see Table 1 below]. At the highest elevations, the trees may be less than 10 m tall (sometimes referred to as elfin woodland), and covered in bryophytes, ferns, and other epiphytic plants. Peat may form, sometimes with sphagnum mosses (*Sphagnum* spp.). These in turn may be replaced by a kind of "tropical subalpine forest" with very tiny leaves (nanophylls), as found in New Guinea and the Andes (Whitmore 1998). Treeline is typically reached between 3500 and 4000 m, where the vegetation transitions to "tropical high montane grassland and shrubland" (tropical "alpine" vegetation).

Table 1. Characters used to distinguish Tropical Lowland Humid Forest from the two types of Tropical Montane Humid Forest (after Whitmore (1998), Table 2.2, based primarily on Southeast Asian forests).

Formation Criteria	Tropical Lowland Humid Forest	Tropical Montane Humid Forest
Canopy height	25-45 m	1.5-33 m
Emergent trees	Characteristic, to 60 (80) m tall	Often to usually absent, to 37 m tall
Pinnate leaves	Frequent	Rare to very rare
Principle leaf size class of woody plants [define terms]	Mesophyll	Mesophyll or microphyll
Buttresses	Usually frequent and large	Uncommon, small or absent
Cauliflory	Frequent	Rare to absent
Big woody climbers	Abundant	Usually none
Bole climbers	Often abundant	Very few, frequent to abundant
Vascular epiphytes	Frequent	Frequent to abundant
Nonvascular epiphytes	Occasional	Occasional to abundant

Floristics [optional]: In the Neotropics, important predominant families and genera in the montane rainforests are Cunoniaceae (*Weinmannia*), Symplocaceae (*Symplocos*), Podocarpaceae (*Podocarpus*, *Prumnopitys*), Araliaceae (*Oreopanax*, *Schefflera*), Clethraceae (*Clethra*), Ericaceae (many genera), Cyatheaceae (*Cyathea*, *Diksonia*, *Nephelea*), Aquifoliaceae (*Ilex*), Lauraceae (*Persea*, *Nectandra*), and Rosaceae (*Polylepis*, *Hesperomeles*, *Prunus*).

ENVIRONMENT

Environmental Description [optional]:

Climate: Climates are more often cool, but without frost, with seasonal daily temperatures with minimal variation. Annual rainfall is relatively aseasonal and typically >100 cm, with any given month rarely receiving less than 60 mm. The proportion of precipitation that is from clouds is a defining factor, though this is difficult to know in the field. Better defining characteristics are the amounts of epiphytes and ferns and where the epiphytes occur as well as canopy structure.

Soil/substrate/hydrology: Tropical Montane Humid Forest is found between elevations of 1000 to 3500 m, with the treeline typically reached between 3500 and 4000 m. But the boundary between lowland and montane forests occurs at different elevations depending on the "Massenerhebung effect" (Collins 1990, Richards 1996). This is a phenomenon whereby large mountains and the central parts of large ranges are warmer at given elevations than small mountains and outlying spurs. Thus Collins (1990) mapped the boundaries in the Caribbean, Central America, Madagascar, Australia and Southeast Asia at 910 m, whereas in West Africa the boundary was set at 1200 m, in New Guinea at 1400 m and in South America at 1800 m.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Tropical Montane Humid Forest is generally found around the globe within 23 degrees N and S latitude of the equator, typically between 1000 and 3500 m in elevation. It is found extensively in Central and South America, especially the Andes and parts of the Caribbean, and is uncommon in Africa (Cameroon and the eastern fringe of the Congo basin) and many mountain regions throughout the Indo-Malayan region.

Nations [incomplete except for CA and US]: PR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: High

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Elfinwoods: biome-type 7 (Whittaker 1975)
- = Tropical montane rain forests (Whitmore 1998) [Whitmore (Table 2.2) discusses the range of variation between lower and upper montane rainforests.]

Full Citation:

- Collins, M. 1990. The Last Rain Forests: A World Conservation Atlas. Oxford University Press, New York.

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Richards, P. W. 1996. The Tropical Rain Forest: An Ecological Study. Second edition. Cambridge University Press, Cambridge, UK. 600 pp.
- Whitmore, T. C. 1998. An introduction to tropical rain forests. Second edition. Oxford University Press, Oxford.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, E. Helmer and J. Sawyer

Acknowledgments:

Version Date: 16 Nov 2011

1. Forest to Open Woodland

1.A. Tropical Forest

1.A.4. Tropical Flooded & Swamp Forest (F029)

OVERVIEW

Database Code: 1.A.4 (F029)

Scientific Name: Tropical Flooded & Swamp Forest Formation

Common Name (Translated Scientific Name): Tropical Flooded & Swamp Forest Formation

Colloquial Name: Tropical Flooded & Swamp Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.A. Tropical Forest (S17)

Lower Level Hierarchy Units [incomplete]:

- 1.A.4.Ea. Neotropical Flooded & Swamp Forest (D002)
- 1.A.4.Ed. Caribbean & Central American Flooded & Swamp Forest (D093)
- 1.A.4.Fe. Eastern African Swamp Forest (D157)
- 1.A.4.Ff. Southern African Swamp Forest (D158)
- 1.A.4.Fg. Guineo-Congolian Swamp Forest (D159)
- 1.A.4.Fh. Sahelian Swamp Forest (D160)
- 1.A.4.Ob. Polynesian Flooded & Swamp Forest (D003)
- 1.A.4.Oc. Eastern Melanesian Flooded & Swamp Forest (D070)

Type Concept Sentence: Tropical Flooded & Swamp Forest is a forested or wooded wetland and peatland found in margins of freshwater lakes, alluvial plains, rivers and depressions around the globe.

Type Concept: Tropical Flooded & Swamp Forest is a forested or wooded wetland and peatland. Structural characteristics that recur in flooded forests are presence of monospecific stands such as palm swamp, even-canopied forests, and sharp vegetation zonation. It is common to find that trees in flooded tropical forests develop sclerophylly (firm, thickened leaves) due to poor nutrition or water limitations, or gas exchange structures such as pneumatophores, lenticels, knees, aerial roots, swelling of base of trees, surface or aerial roots in order to overcome poor soil aeration, or support structures, e.g., plank buttresses and stilt roots to provide stability in muddy or steep conditions. Tree heights can vary greatly, from 1 to 50 m. Tropical swamp forests can be divided into freshwater swamp or floodplain forest (along rivers and lakes) and peat swamp forest (formed behind natural floodplain levees), where peat layers may be well in excess of 1 m thick. The floodplain forests are found along rivers, streams and lakes. They have a dynamic water table, with seasonal flooding inundating the vegetation for short (<7 days) to long (>1 month) periods, leading to an influx of sediment and mineral enrichment during high water periods.

Floristic composition, diversity and structure of these forests can vary considerably depending on the characteristics of the flood. Thus, it is possible to differentiate, at least in the Neotropics, turbid white-water flooded forests versus limpid black- and clear-water flooded forests (Irmiler 1977, Prance 1979, Kubitzki 1989). The ecological differences among these types of floodwater regimes relate primarily to the significant amount of suspended sediment and dissolved calcium (white water), compared to the low sediment load and low concentration of calcium in black and clear waters. Also, the blackwaters typically contain significant amounts of humic acid substances in colloidal suspension. In addition, another important cause of ecological variation in these forests is related to the type of flooding, mainly flooded regime (inundation by waters flowing from the overflow of rivers and relatively fast drainage) versus stagnant waters that accumulate in large shallow topographic depressions and that are only slowly removed by evaporation (ponded regime).

Classification Comments [optional]: Forests may vary from deciduous to evergreen. Further review is needed of the degree of variation in evergreen versus deciduous-leaved trees between floodplains and swamps in tropical dry versus moist-wet climates.

Similar NVC Types:

- 1.A.2. Tropical Lowland Humid Forest (F020): Overall dominant growth forms are similar, but forest structure is more complex in Tropical Lowland Humid Forest, and the soils are not saturated or inundated. Tree palms and lianas are more common.
- 1.A.5. Mangrove (F006): As concentrations of salts decline, Mangrove (F006) may grade into Tropical Flooded & Swamp Forest.

Diagnostic Characteristics: This formation is dominated by mesophyll, broad-leaved, evergreen trees, with soils saturated to flooded for all or parts of the year, varying from peat to mineral soil textures. Climates are consistently warm (seasonal daily temperatures with minimal variation).

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical Flooded & Swamp Forest is a forested or wooded wetland and peatland. Structural characteristics that recur in flooded forests are presence of monospecific stands such as palm swamp, even-canopied forests, and sharp vegetation zonation. It is common to find that trees in flooded tropical forests develop sclerophylly (firm, thickened leaf) due to poor nutrition or water limitations, or gas exchange structures such as pneumatophores, lenticels, knees, aerial roots, swelling of base of trees, surface or aerial roots in order to overcome poor soil aeration, or support structures, e.g., plank buttresses and stilt roots to provide stability in muddy or steep conditions. Tree heights can vary greatly, from 1 to 50 m.

Based on the type of dominant species, swamp forests can be conveniently divided into two types: forests dominated by broad-leaved evergreen hardwood species and those dominated by palms. Dominance by palms becomes stronger with increasing hydroperiod or soil moisture conditions. Species richness generally decreases with increasing hydroperiod. One formation that covers large areas in western Amazonia and in the Orinoco River basin is the often monodominant "aguajales" or *Mauritia flexuosa* stands. These palm swamps may be regularly affected by riverine floods, but they mostly occur farther from current river channels, the water-logged condition then being maintained by a combination of high precipitation and poor drainage in depressional terrain. Other palm-associated (*Raphia*, *Manicaria*) swamps are typical of the coastal regions of Central America and northern South America along estuarine channels, sometimes in mixed stands with a few mangrove species.

Floristics [optional]: In white-water flooded forests of the Neotropics, floristic composition is fairly homogeneous and similar among different countries. Families and genera that predominate are Moraceae (*Brosimum*, *Maquira*, *Batocarpus*, *Helicostylis*, *Pseudolmedia*, *Ficus*), Sapotaceae (*Pouteria*, *Manilkara*), Lecythidaceae (*Eschweilera*, *Gustavia*, *Couroupita*), Bombacaceae (*Ceiba*, *Ochroma*, *Pachira*), Fabaceae (*Dypterix*, *Mora*, *Andira*, *Erythrina*, *Pterocarpus*, *Pithecellobium*, *Albizia*, *Swartzia*), Euphorbiaceae (*Hura*, *Hevea*), and Annonaceae (*Xylopia*). In contrast, the floristic composition of black- and clear-water flooded neotropical forests is by far more diverse and regionally differentiated (Kubitzki 1989), with several endemic restricted taxa; important families and genera are Myristicaceae (*Virola*), Fabaceae (*Acosmium*, *Sclerolobium*, *Cynometra*, *Aldina*, *Crudia*, *Macrolobium*, *Parkia*, *Campsiandra*, *Pentaclethra*, *Tachigali*), Lecythidaceae (*Lecythis*, *Eschweilera*, *Couratari*), Chrysobalanaceae (*Licania*, *Couepia*), Vochysiaceae (*Qualea*, *Erisma*), and Arecaceae (*Mauritia*, *Mauritiella*, *Astrocaryum*, *Bactris*, *Leopoldinia*).

ENVIRONMENT

Environmental Description [optional]: *Soil/substrate/hydrology:* Tropical swamp forests can be divided into freshwater swamp or floodplain forest (along rivers and lakes) and peat swamp forest (formed behind natural floodplain levees), where peat layers may be well in excess of 1 m thick (Whitmore 1984). The floodplain forests are found along rivers, streams and lakes. They have a dynamic water table, with seasonal flooding inundating the vegetation for short (<7 days) to long (>1 month) periods, leading to an influx of sediment and mineral enrichment during high water periods. Information about underlying soils is scarce.

Many floodplain swamp forests are potentially peat-accumulating, but, although studies on this subject exist in Southeast Asia, they have apparently never been published for the Amazon basin (Whitmore 1998). Swamps and other types of wetlands in the Neotropics have been described in terms of their vegetation composition, structure, and geomorphology, but studies have failed to deal with peat formation or detailed descriptions of the underlying soils. There is evidence that at least the *Mauritia* swamps frequently accumulate peat of some kind.

The lowland tropical peat swamps are formed from layers of woody debris too waterlogged to fully decompose. Slowly deposited over thousands of years, the carbon-rich peat strata have been known to reach a thickness of up to 20 m. In Indonesia the ombrogenous peatlands are mostly formed on the inward edge of the mangroves. They are usually dome-shaped and several meters thick overlying the mangrove mineral soil; the whole sequence taking several thousand years. Periods with rising sea levels promote the formation of very deep peat layers up to 20 m thickness with the alluvial soil far below present sea levels. Peat domes younger than 3000 years do have the alluvial soil at about present mean sea level.

The initial rate of vegetation growth and peat build-up is rapid, as the alluvial mangrove soils are nutrient-rich. As the peat accumulates, it builds up above the level of the nutrients in the alluvial soils that are accessible for the plant roots. In that case the mineral supply to the vegetation depends on the minerals in the rainwater and available nutrients of the decaying vegetation in the surface layer. As the swamp ages and the peat layer thickens, nutrients become increasingly scarce, the tree growth and litter

production are reduced, and growth of the whole formation slows down.

Besides its association with mangroves, the lowland Neotropical peatlands are associated with palm swamps and open herbaceous marshes, the latter apparently are relatively nutrient-rich, since surface runoff water easily reaches all parts of the swamps. Furthermore, the layer of organic material is usually thin enough for the roots of the plants to have direct contact with the underlying mineral soil. In the case of palm swamps, they may be regularly affected by riverine floods, but for most of their extent they occur farther from current river channels, the water-logged condition then being maintained by a combination of high precipitation and poor drainage, which makes them ombrogenous types of peatlands.

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Flooded forest systems are a regular feature of the low-lying coastal areas in the West Indies, southern Mexico, Central America, and northern South America. In South America, the greatest extent of flooded forest occurs in Amazonia, and in the basins of other important rivers, such as the Orinoco and the Atrato, but the most complex mosaics of wetlands, savannas, and flooded forests are maybe those of the Beni in Bolivia and the Brazilian Pantanal, on very extensive flat basins subject to a strong seasonality in the precipitation. Some of the extensive floodplains of South America include treed and shrub swamps that are located off the direct influence of the main-river channels, usually occupying past, silted-up river arms or depressed areas with inflows product of runoff and seepage or only sporadic, extreme river floods.

Nations [incomplete except for CA and US]: PR, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- > Freshwater swamp forest (Whitmore 1998) [Whitmore divides the Tropical Swamp & Flooded Forest into two formations based on peat or mineral soils.]
- > Peat swamp forest (Whitmore 1998) [Whitmore divides the Tropical Swamp & Flooded Forest into two formations based on peat or mineral soils.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: C. Josse and G. Navarro

Acknowledgments:

Version Date: 16 Nov 2011

1. Forest to Open Woodland

1.A. Tropical Forest

1.A.5. Mangrove (F006)

OVERVIEW

Database Code: 1.A.5 (F006)

Scientific Name: Mangrove Formation

Common Name (Translated Scientific Name): Mangrove Formation

Colloquial Name: Mangrove

Hierarchy Level: Formation

Placement in Hierarchy: 1.A. Tropical Forest (S17)

Lower Level Hierarchy Units [incomplete]:

- 1.A.5.Ua. Atlantic & Caribbean & East Pacific Mangrove (D004)
- 1.A.5.Wb. Indo-West Pacific Mangrove (D071)

Type Concept Sentence: Mangroves are dominated by broad-leaved evergreen trees, with complex aerial root systems, found in estuarine and coastal marine habitats that form a typically narrow fringe along the coasts of tropical latitudes worldwide.

Type Concept: Mangroves (mangal, mangle) are tidal, estuarine and coastal marine forested wetlands that occur along the (sheltered) coasts of tropical latitudes worldwide. Their adaptations to cope with seawater include methods of salt secretion, exclusion and accumulation. Physiognomically, they vary in size from dwarf-shrubs to tall trees. They are commonly found on the intertidal mudflats along the shores of estuaries, usually in the region between the salt marshes and seagrass beds. Where tidal amplitude is relatively low, they form narrow bands along the coastal plains, and rarely penetrate inland more than several kilometers along rivers. Where tidal amplitude is greater, mangroves extend farther inland along river courses forming extensive stands in the major river deltas. Mangrove cays occur also within the lagoon complex of barrier reefs. In general, mangroves fall within two categories: mangroves of oceanic islands and inland mangroves. The latter type needs to adapt to a pronounced variation in salinity due to the variations in freshwater carried from the interior streams, whereas the former type has a salinity gradient driven by the rate of evaporation in the shallow ponds and mudflats and the rainfall on site, especially in the case of small to very small islands.

Classification Comments [optional]:

Similar NVC Types:

- 1.A.4. Tropical Flooded & Swamp Forest (F029): As concentrations of salts decline, Mangrove (F006) may grade into this formation.
- 2.B.7. Salt Marsh (F035): Dwarf mangroves may grade into tropical salt marshes.

Diagnostic Characteristics: Broad-leaved evergreen trees, with complex aerial root systems (including aerial "stilt" roots and pneumatophores), found in tropical estuarine and coastal marine habitats.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Physiognomically, mangroves vary in size from shrubby dwarf-trees to tall trees, with mesophyll, evergreen leaves. They have a complex set of aerial roots. Roots may diverge from the tree as much as 2 m above ground and penetrate the soil away from the main stem. Secondary roots may branch off, creating a "stilt root" structure. They also may contain pneumatophores, root extensions growing up above the water surface, emerging 30 cm or more above the muddy surface. Their adaptations to cope with seawater include methods of salt secretion, exclusion and accumulation.

Floristics [optional]: There are more than 50 mangrove species worldwide in 20 genera, belonging to 16 families. Thus they are taxonomically diverse. But two families, the Avicenniaceae and the Rhizophoraceae, contain 25 of the species.

Mangrove species are diverse where annual temperature is high and temperature amplitude is small. Low temperature reduces the tree size, leaf-area index and species composition of the flora as well as the complexity of vegetation. Rainfall, as well as temperature, has a significant influence on the distribution and zonation of mangrove species. Regions with low rainfall have mangrove systems that are poor and scattered with stunted trees.

Three species occur in Florida, and there are four primary mangrove species in Central America: *Rhizophora mangle* (Rhizophoraceae); *Avicennia germinans* (Avicenniaceae); and *Laguncularia racemosa* and *Conocarpus erectus* (Combretaceae). Several other mangrove species occur on the Pacific Coast of Central America, and in general, diversity tends to increase towards equatorial regions, however, the most diverse mangroves occur in Southeast Asia, India and Malaysia.

ENVIRONMENT

Environmental Description [optional]: *Soil/substrate/hydrology:* Mangroves (mangal, mangle) are tidal, estuarine forested wetlands that occur along the (sheltered) coasts of tropical latitudes of the Earth. They are commonly found on the intertidal mudflats along the shores of estuaries, usually in the region between the salt marshes and seagrass beds. Where tidal amplitude is relatively low, they form narrow bands along the coastal plains, and rarely penetrate inland more than several kilometers along rivers. Where tidal amplitude is greater, mangroves extend farther inland along river courses forming extensive stands in the major river deltas. Mangrove cays occur also within the lagoon complex of barrier reefs (Stoddart et al. 1982). In general, mangroves fall within two categories: mangroves of oceanic islands and inland mangroves. The latter need to adapt to a pronounced variation in salinity due to the variations in freshwater carried from the interior streams, while the former owe the salinity gradient to the rate of evaporation in the shallow ponds and mudflats and the rainfall on site, especially in the case of small to very small islands.

Gilmore and Snedaker (1993) described five distinct types of mangrove forests based on water level, wave energy, and pore water salinity: (1) mangrove fringe forests, (2) overwash mangrove islands, (3) riverine mangrove forests, (4) basin mangrove forests, and (5) dwarf mangrove forests. Dwarf forests are most commonly observed in south Florida, around the vicinity of the Everglades, but occur in all portions of the range where physical conditions are suboptimal, especially in drier transitional areas.

Rainfall plays an important role in distribution and species composition because rainfall regulates salt concentrations in soils and plants, as well as providing a source of freshwater for the mangroves. This is an important factor when propagules begin to take root and when mature individuals bloom and fruit. If high rainfall occurs over a short period and other months of the year are prone to drought, the conditions can be considered unfavorable for the growth and distribution of mangroves.

Mangroves provide habitats for commercially important crustaceans; are important nursery grounds for juvenile fish; filter and trap pollutants and sediments from land runoff thus maintaining estuarine water quality; provide barriers and buffer zones to stabilize shorelines and prevent coastal erosion; and are also a major producer of organic material. Mangroves protect the coast against erosion, but monsoons and storms cause large waves and winds to erode the coast, destroying many mangrove areas. Sea level rise, together with monsoons or hurricanes and storms, accelerates the speed of mangrove coastal erosion.

Mangroves cannot tolerate frost, especially in the seedling stage, but mangroves are also regulated by sea temperatures, rarely occurring outside the range delimited by the winter position of the 20-degree C isotherm (Hogarth 2007). It is not entirely clear why mangroves are limited to the tropics. Given their pan-tropical distribution and the wide availability of muddy, saline habitats in temperate regions, there would seem to be many suitable opportunities to spread into these latitudes. Hogarth (2007) suggests that perhaps the combination of being a tree, tolerating salt, and coping with waterlogging creates a metabolic cost that is difficult to sustain in lower temperatures and shorter day lengths.

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Mangroves occur along the (sheltered) coasts of tropical latitudes of the Earth, typically between the equator and 23 degrees N and S, but mangroves occur considerably southward in southeastern Australia. Mangrove distribution appears to be limited by both frost and sea temperatures, rarely occurring outside the range delimited by the winter position of the 20-degree C isotherm (Hogarth 2007). They are estimated to cover 18 million ha (Spalding et al. 1997, in Hogarth 2007).

Nations [incomplete except for CA and US]: PR, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Mangrove vegetation (mangal) (Richards 1996)

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: C. Josse

Acknowledgments:

Version Date: 16 Nov 2011

1. Forest to Open Woodland

1.B. Temperate & Boreal Forest (S15)**OVERVIEW****Database Code:** 1.B (S15)**Scientific Name:** Temperate & Boreal Forest Subclass**Common Name (Translated Scientific Name):** Temperate & Boreal Forest Subclass**Colloquial Name:** Temperate & Boreal Forest**Hierarchy Level:** Subclass**Placement in Hierarchy:** 1. Forest to Open Woodland (C01)**Lower Level Hierarchy Units:**

- 1.B.1. Warm Temperate Forest (F018)
- 1.B.2. Cool Temperate Forest (F008)
- 1.B.3. Temperate Flooded & Swamp Forest (F026)
- 1.B.4. Boreal Forest (F001)
- 1.B.5. Boreal Flooded & Swamp Forest (F036)

Type Concept Sentence: Temperate & Boreal Forest is typically dominated by broad-leaved deciduous and needle-leaved trees, with some broad-leaved evergreens in warmer regions, and a climate that varies from warm temperate with only rare frosts to very cold subarctic conditions. It is found across the globe, in the mid-latitudes, typically between 25 and 60-70 degrees N and S latitude, including boreal, cool temperate, warm temperate/Mediterranean forests.

Type Concept: Temperate & Boreal Forest is typically dominated by broad-leaved deciduous and needle-leaved trees, with some broad-leaved evergreens in warmer regions. It is found across the globe typically between 25 and 60-70 degrees N and S latitude, but is far more abundant in the Northern Hemisphere than the Southern Hemisphere. The climate varies from warm temperate with only rare frosts and snow to cold subarctic conditions. The gradation from warm temperate (including Mediterranean) to boreal vegetation is often subtle and occurs across broad regions, so they are treated together as one subclass (Table 1).

Temperate & Boreal Forest includes temperate rainforest, temperate deciduous forest, and temperate evergreen forest. These forests are dominated by broad-leaved or needle-leaved growth forms. Trees typically range in height from 10 to 30 m, but rainforest trees may attain great height, exceeding 50 m. Temperate broad-leaved deciduous and needle-leaved forests grow in cool temperate climates, with summer rainfall and cold winters (during which the broad-leaved trees lose their leaves), extending to the treeline of temperate regions, where they resemble boreal forests. Temperate broad-leaved evergreen forests, often mixed with broad-leaved deciduous and needle-leaved trees, occur in warm-temperate climates, with either mild winters and moist, warm summers, or winter-rain winters and dry, warm summers (Mediterranean).

Boreal forest contains primarily needle-leaved evergreen trees, with or without boreal broad-leaved deciduous trees. Structure varies from tall, closed-canopy (but rarely exceeding 15 m) to open, low (<5 m) subarctic and boreal subalpine woodlands at treeline. Nonvascular mosses and lichens may predominate in the ground layer. Winters are very cold and vary from arid to moist. Temperate high montane forest may resemble boreal forest. Tree species diversity is very low.

Table 1. Comparison of Boreal, Cool Temperate and Warm Temperate Formations (adapted from Kuennecke 2008).

Criterion	BOREAL FOREST (upland and wetland)	COOL TEMPERATE FOREST (upland and wetland)	WARM TEMPERATE FOREST (upland and wetland)
Dominant growth forms	Needle-leaved (usually evergreen) conifer, often strongly conical-shaped, and simple, broad-leaved, small mesophyll deciduous hardwoods.	Broad-leaved deciduous or evergreen needle-leaved conifer, alone or in mixes, variable leaf and crown shapes, and leaf sizes typically mesophyll with a seasonal green understory of herbs. The tall-shrub layer is variable, and is often broad-leaved deciduous, but the short-shrub layer may be heath. The moss layer is often sparse, but more dominant in cold, rainy and/or high montane needle-leaved evergreen stands.	Broad-leaved evergreen trees, microphyll to small mesophyll leaves, sometimes dwarfed stems, sclerophyllous or small-leaved trees (e.g., eucalypts, sclerophyllous oaks); or various combinations of broad-leaved deciduous, broad-leaved evergreen or evergreen needle-leaved conifer trees.
Location	Northern Hemisphere south of the arctic treeline.	Middle latitudes of North America, western and far-eastern Eurasia, and an isolated small area in the middle latitude of South America.	Mediterranean Basin and Mediterranean and warm temperate regions in North America (California, Southeast Coastal Plain), Chile, South Africa, Australia, India and Southeast Asia.
Climate type	Cold snow climates, with extended cold winters and short mild summers, frozen soils in winter.	Humid temperate climates with distinctive spring, summer, autumn, and cool to cold winter seasons, with freezing temperatures.	Mild (mostly frost-free) winter, temperate humid spring, hot-dry summer, and mild, often dry autumn seasons. Rainy season in winter and dry summers (Mediterranean).
Temperature	Lengthy periods of freezing temperatures with the coldest month isotherm -3°C , with the growing season generally averaging less than 100 days, occasionally interrupted by nights of below-freezing temperatures.	Freezing temperatures usually of moderate duration, although of frequent occurrence during winter months. Potential growing season generally from 100 to 200 days and confined to late spring and summer when freezing temperatures are infrequent or absent.	Freezing temperatures of short duration but generally occurring every year during winter months. Potential growing season more than 200 days with less than an average of 150 days a year subject to temperatures below 0°C or chilling fog.
Precipitation controls	Seasonal shift of polar front.	Summer convectional storms, Atlantic hurricanes, Asian monsoons.	Stationary high-pressure cells in summer.
Precipitation (annual)	38-50 cm (15-20 inches)	75-125 cm (30-50 inches).	25 to 100 cm (10-40 inches) (Mediterranean).
Dominant Soil-Forming Process	Podzolization	Podzolization.	Severe weathering.
Major Soil Orders (Soil Survey Staff 1999)	Gelisols, some Spodosols in south.	Alfisols and Ultisols, some Spodosols in north.	Various, Ultisols and Alfisols common.
Soil characteristics	Sandy ash-colored A horizon; accumulation of minerals in B horizon; generally low in natural fertility.	Gray forest soils with accumulated silicate clay minerals in B horizon; some (Alfisols) with relatively high natural fertility; more leached soils in southern areas (Ultisols) due to higher precipitation levels.	Naturally productive soils, some regions worn by thousands of years of human use.
Biogeographic History	Recent-post Pleistocene migration of plants and animals.	Recent-post Pleistocene to ancient Tertiary origins.	Recent to more ancient, some regions influenced by thousands of years of human use.

Classification Comments [optional]: Warm temperate forests are defined here to include both the classic Mediterranean forests and the more humid warm temperate forests. Both share increasing levels of broad-leaved evergreen trees, including sclerophyllous-leaved trees, as well as evergreen shrubs and herbs, as compared to other temperate forests. Walter (1985) recognizes two warm-temperate biomes, the "Zonobiome of the Winter-Rain Region with an Arid-Humid Climate and Sclerophyllic Woodlands" (Zone IV) and the "Zonobiome of the Warm-Temperate Humid Climate" (Zone V), distinct from the cool-temperate biome "Zonobiome of the Temperate-Nemoral Climate" (Zone VI) and the boreal biome "Zonobiome of the Cold-Temperate Boreal

Climate" (Zone VIII). Schultz (1995) also recognizes the two warm-temperate regions, which he refers to as: "Mediterranean-Type subtropics" (with world distribution shown in Figure 129) and "Humid subtropics" (with world distribution shown in Figure 171).

Similar NVC Types:

- 1.A. Tropical Forest (S17): There is a strong dominance by broad-leaved evergreen trees, and deciduousness is caused by drought rather than forest composition.
- 2.B. Temperate & Boreal Grassland & Shrubland (S18): Tree cover is <10%.
- 7.A. Woody Agricultural Vegetation (S22): Long-rotation plantations or woody restoration plantings of Temperate & Boreal Forest (S15) with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development to Woody Agricultural Vegetation (S22), especially if planted in rows and the understory is strongly manipulated.

Diagnostic Characteristics: Temperate & Boreal Forest is typically dominated by broad-leaved deciduous and needle-leaved trees, with some broad-leaved evergreens in warmer regions. Climate varies from warm temperate with only rare frosts and snow to cold subarctic conditions. It is found across the globe typically between 25 and 60-70 degrees N and S latitude.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Temperate forests include temperate rainforest, temperate deciduous forest, and temperate evergreen forest. They are dominated by broad-leaved or needle-leaved growth forms. Trees typically range in height from 10-30 m, but rainforest trees may attain great height, exceeding 50 m. Temperate broad-leaved deciduous and needle-leaved forests grow in cool temperate continental climates, with summer rainfall and cold winters, during which the broad-leaved trees lose their leaves, extending to high montane regions, where they resemble boreal forests. Temperate broad-leaved evergreen forests, often mixed with broad-leaved deciduous and needle-leaved trees, occur in warm-temperate climates, with either mild winters and moist, warm summers, or winter-rain winters and dry, warm summers (Mediterranean). Tree species diversity is low in temperate forests (Whittaker 1975).

Boreal forest contains primarily needle-leaved evergreen trees, with or without boreal broad-leaved deciduous trees. Structure varies from tall, closed canopy (but rarely exceeding 30 m) to open, low (<5 m) subarctic woodlands. Nonvascular mosses and lichens may predominate in the ground layer. Winters are very cold and vary from arid to moist. Temperate high montane forest may resemble boreal forest (Whittaker 1975).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: Soil orders in Table 1 are described using the U.S. soil orders (Soil Survey Staff 1999). See Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Temperate forests range from the giant forests of the Pacific Coast of North America, or the Australian temperate rainforests, to New Zealand and Chile, to montane forests in various locations. Temperate forests occur across much of the United States and southern Canada, in limited parts of Mesoamerica, western Europe, Mediterranean regions, Southeast Asia, southern Australia, and limited parts of Chile. Boreal forests occur in the northern regions of North America and Eurasia. A few isolated areas may occur in the Southern Hemisphere.

Nations [incomplete except for CA and US]: AU, CA, CL, CN, ES, FR, GB, IT, JP, NZ, RU, SE, TR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: High

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Temperate Forest Biomes (Kuennecke 2008) [Kuennecke includes boreal, cool temperate, and warm temperate (Mediterranean) formations as part his "temperate forest biomes" concept.]
- = Temperate and boreal woodlands & scrub (Mucina 1997) [Mucina created this type as an organizational category for Braun-Blanquet classes and did not define it as a formal type.]
- > Temperate broadleaved forests and scrub (Rodwell et al. 2002) [European cool and warm temperate forests are included in the subclass, including floodplain forests, but boreal forests are excluded.]

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
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- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 12 Jul 2012

1. Forest to Open Woodland

1.B. Temperate & Boreal Forest

1.B.1. Warm Temperate Forest (F018)

OVERVIEW

Database Code: 1.B.1 (F018)

Scientific Name: Warm Temperate Forest Formation

Common Name (Translated Scientific Name): Warm Temperate Forest Formation

Colloquial Name: Warm Temperate Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.B. Temperate & Boreal Forest (S15)

Lower Level Hierarchy Units [incomplete]:

- 1.B.1.Fe. Southern African Warm Temperate Evergreen Forest (D161)
- 1.B.1.Na. Southeastern North American Warm Temperate Forest (D006)
- 1.B.1.Nc. Californian Warm Temperate Forest (D007)
- 1.B.1.Nd. Madrean & Southwest Great Plains Warm Temperate Woodland & Scrub (D060)

Type Concept Sentence: Warm Temperate Forest is dominated by broad-leaved evergreen trees, sometimes with dwarfed stems and small, sclerophyllous leaves (in Mediterranean climates); or various combinations of broad-leaved deciduous, broad-leaved evergreen and needle-leaved evergreen conifer trees. Winters are mild (mostly frost-free), and may be the rainiest season, springs are temperate humid, summers are hot-dry, and autumn is often dry.

Type Concept: Warm Temperate Forest is found in North America (Mediterranean Basin and Mediterranean of California, the warm, dry interior of Great Basin and Madrean regions and warm-temperate regions of the Southeast Coastal Plain), Chile, South Africa, Australia, India and Southeast Asia. The climate is mild (mostly frost-free) winter, temperate humid spring, hot-dry summer, and mild, often dry autumn seasons. The rainy season occurs in winter (most evident in "Mediterranean climates"), and summers are dry. The vegetation varies from (a) dominance by broad-leaved evergreen trees, sometimes with dwarfed stems, and microphyll to small mesophyll leaves, with varying levels of sclerophylly (Mediterranean) to (b) various combinations of broad-leaved deciduous, broad-leaved evergreen or needle-leaved evergreen conifer trees. Natural disturbances include wind and fire.

Classification Comments [optional]: The warm-temperate Mediterranean regions around the world typically contain both the classic Mediterranean scrub (2.B.1. Mediterranean Scrub & Grassland Formation (F038)), and the forests and woodlands included here. Cool- and warm-temperate forests may be difficult to distinguish, but cool-temperate forests are more strongly dominated by broad-leaved deciduous trees, and broad-leaved evergreen trees are essentially absent. Braun (1950) includes at least parts of these warm-temperate forests in her "Deciduous Forest Formation" (the "Southeastern Evergreen Forest Region"), but briefly notes a "Subtropical Broad-leaved Evergreen Forest" that includes central Florida southward.

Various ecoregional treatments recognize the distinct vegetation and climate of the warm-temperate region, e.g., Brown et al. (1998) separates cool-temperate from warm-temperate vegetation. Walter (1985) recognizes two warm-temperate biomes, the

"Zonobiome of the Winter-Rain Region with an Arid-Humid Climate and Sclerophyllic Woodlands" (Zone IV) and the "Zonobiome of the Warm-Temperate Humid Climate" (Zone V), distinct from the cool-temperate biome "Zonobiome of the Temperate-Nemoral Climate" (Zone VI) and the boreal biome "Zonobiome of the Cold-Temperate Boreal Climate" (Zone VIII). Similarly, Schultz (1995) recognizes the two warm temperate regions, which he refers to as: "Mediterranean-Type subtropics" (with world distribution shown in Figure 129) and "Humid subtropics" (with world distribution shown in Figure 171). We prefer the term warm temperate to subtropics. Schultz states that "apart from the driest sites and those with lowest nutrient contents, all the regions of the Mediterranean-Type subtropics were originally covered by forests of mostly evergreen sclerophyllous species of trees" and in the European Mediterranean region, these were mostly evergreen oak, such as *Quercus ilex*. Today, many of these regions are more typically dominated by sclerophyllous shrub formations, as described in 2.B.1 Mediterranean Scrub & Grassland Formation (F038).

Similar NVC Types:

- 1.A.1. Tropical Seasonally Dry Forest (F003): Broad-leaved evergreen trees may be common in Warm Temperate Forest (F018), comparable to Tropical Seasonally Dry Forest (F003) (i.e., evergreen leaves are typically small), but deciduousness in Warm Temperate Forest is caused by frost, and types are found north or south of 23 degrees N and S latitude.
- 1.B.2. Cool Temperate Forest (F008): More strongly dominated by broad-leaved deciduous trees; broad-leaved evergreen trees essentially absent. Frost regularly occurs, with snow common in the northern parts of the regions.
- 1.B.3. Temperate Flooded & Swamp Forest (F026): Warm Temperate Forest (F018) typically contains well-drained soils and lacks any aquatic vegetation, peat or muck layer.
- 2.B.1. Mediterranean Scrub & Grassland (F038): The vegetation is more commonly scrub-shrub, typically sclerophyllous, or with open (sometimes annual-dominated) grasslands and forb meadows. Combinations of dwarf scrubby trees <2 m tall with low shrubs may grade into Warm Temperate Forest.
- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): Open woodlands or tree savannas, with grassy or shrubby understories, and with trees 10% cover or more, are placed in Warm Temperate Forest (F018), but may have strong floristic similarities to grasslands.

Diagnostic Characteristics: Broad-leaved evergreen trees, sometimes with dwarfed stems, microphyll to small mesophyll leaves, sclerophyllous (Mediterranean); or various combinations of broad-leaved deciduous, broad-leaved evergreen or needle-leaved evergreen conifer trees. Mild (mostly frost-free) winter, temperate humid spring, hot-dry summer, and mild, often dry autumn seasons. Rainy season in winter and dry summers (Mediterranean).

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: Freezing temperatures of short duration are expected, generally occurring every year during winter months. The potential growing season is more than 200 days with less than an average of 150 days a year subject to temperatures below 0 degrees C or chilling fog (Brown et al. 1998). Spring is temperate, summers are hot-dry, and autumns are mild and often dry. Rainy season in winter is most strong in Mediterranean climates. Average annual precipitation varies from 25 to 100 cm (10-40 inches).

Soil/substrate/hydrology: Soils are often strongly weathered. Soils are various, with Ultisols and Alfisols most common, and productive, but in some regions the soils are worn by thousands of years of human use (Soil Survey Staff 1999) [see Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems].

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Warm Temperate Forest is found in the Mediterranean Basin and Mediterranean and warm temperate regions in North America (California, Southeast Coastal Plain), Chile, South Africa, Australia, India and Southeast Asia.

Nations [incomplete except for CA and US]: US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Warm Temperate Forest and Woodland (Brown et al. 1998)

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- Braun, E. L. 1950. Deciduous forests of eastern North America. Hafner Press, New York. 596 pp.
- Brown, D. E., F. Reichenbacher, and S. E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press, Salt Lake City. 141 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Schultz, J. 1995. The ecozones of the world. Springer-Verlag, New York.
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Second edition. USDA Natural Resources Conservation Service, Washington, DC.
- Walter, H. 1985. Vegetation of the Earth and Ecological Systems of the Geo-Biosphere. Third edition. Springer-Verlag, New York.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 12 Jul 2012

1. Forest to Open Woodland

1.B. Temperate & Boreal Forest

1.B.2. Cool Temperate Forest (F008)

OVERVIEW

Database Code: 1.B.2 (F008)

Scientific Name: Cool Temperate Forest Formation

Common Name (Translated Scientific Name): Cool Temperate Forest Formation

Colloquial Name: Cool Temperate Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.B. Temperate & Boreal Forest (S15)

Lower Level Hierarchy Units [incomplete]:

- 1.B.2.Na. Eastern North American Cool Temperate Forest (D008)
- 1.B.2.Nb. Rocky Mountain Cool Temperate Forest (D194)
- 1.B.2.Nc. Western North American Cool Temperate Woodland & Scrub (D010)
- 1.B.2.Nd. Vancouverian Cool Temperate Forest (D192)

Type Concept Sentence: Cool Temperate Forest includes temperate deciduous forest, temperate needle-leaved forest, and temperate rainforest, dominated by broad-leaved or needle-leaved tree growth forms.

Type Concept: Cool Temperate Forest includes temperate deciduous forest, temperate needle-leaved forest, and temperate rainforest. These forests are dominated by broad-leaved or needle-leaved tree growth forms. Rainforest trees may attain great heights; trees easily exceed 50 m, but these forests more typically range from 10 to 30 m in height. They are found in oceanic temperate to cool temperate continental climates, with summer rainfall and cold winters (during which the broad-leaved trees lose their leaves), extending to treeline, where they resemble boreal forests.

The formation is most prominent in the Northern Hemisphere, where it occurs in four major, formation expressions in (1) western and central Europe, (2) eastern Asia, including Korea and Japan, (3) eastern North America, and (4) western North America. It occurs as small formation expressions in the Southern Hemisphere, including southern South America (Chile and Argentina), southern Australia, and New Zealand. This formation is associated with cooler continental and oceanic temperate climates (Koeppen Dca, Dcb, and Do, and in Europe, Cfb). There is an approximately 6-month growing season. The 50 to 150 cm (20-60 inches) of precipitation is distributed evenly throughout the year. The non-growing season is due to temperature-induced drought during the cold winters.

Forest structure is usually complex, commonly consisting of five strata: (1) a tree stratum, 15-35 m (60-100 feet) tall, dominated by broad-leaved deciduous and/or needle-leaved evergreen species, often with a substratum of small trees (5-15 m tall); (2) a small-tree and tall-sapling layer (between 2-5 m); (3) a short-shrub layer (<2 m); (4) an herb layer of perennial forbs, including an ecological group with species that bloom primarily in early spring (in deciduous broadleaf-dominated examples); and (5) a ground

layer of lichens, clubmosses, and true mosses. Lichens and mosses also grow on the trunks of trees. Natural disturbances include wind and fire.

Classification Comments [optional]: This formation includes a range of conifer and broad-leaved hardwood growth forms. The formation is sometimes restricted to "temperate broadleaf forest regions," but even there, pure conifer stands can occur, e.g., in temperate eastern North America, there are pure conifer stands of *Tsuga canadensis* and *Pinus strobus*. Inclusion of western North American conifer forests in this cool-temperate formation rather than the boreal forest follows that of Brandt (2009) and others. Warm-temperate and cool-temperate forest formations are very similar, but differences are driven by broad climatic patterns. Overlap with boreal forests in the western montane region also presents conceptual challenges.

Various ecoregional treatments recognize the distinct vegetation and climate of the cool-temperate region, e.g., Brown et al. (1998) separates cool-temperate from warm-temperate vegetation. Walter (1985) recognizes the cool-temperate biome "Zonobiome of the Temperate-Nemoral Climate" (Zone VI) distinct from two warm-temperate biomes, the "Zonobiome of the Winter-Rain Region with an Arid-Humid Climate and Sclerophyllic Woodlands" (Zone IV) and the "Zonobiome of the Warm-Temperate Humid Climate" (Zone V), and from the boreal biome "Zonobiome of the Cold-temperate Boreal Climate" (Zone VIII).

Our approach treats the subalpine forests of the Rocky Mountain region as part of 1.B.2 Cool Temperate Forest Formation (F008), rather than as part of 1.B.4 Boreal Forest Formation (F001), such as done by Whittaker (1975) and Brown et al. (1998). Our decision is in line with a more biogeographic approach for divisions, and corresponds to that of Rivas-Martinez et al. (1999b), but is debatable from a structural and climatic perspective. As Chris Lea (pers. comm. 2012) notes, one could retain lowland and lower montane western coniferous forests in Cool Temperate, but move high montane and subalpine to the Boreal formation, to which they also have strong floristic and environmental similarities (this would require a name change of the latter to something like "Boreal & High Montane" or "Boreal & Subalpine" formation). This would have minimal impact on lower level units, requiring only a transfer of two current western North America groups (G020 and G025) to F001, under a new (western North American) division of F001 and eastern North America group G024 (requires a new macrogroup and division, but the description of these would be identical with the existing group description). The only major new description for Forests and Woodlands would be a new division description for "Western North America High Montane & Subalpine Forest," within formation F001. These forests, fairly simply, contain quaking aspen and lodgepole pine on up through the Engelmann spruce-fir types. Ponderosa pine, Douglas-fir, "mixed conifers" (white fir, etc.) (in the Sierra Nevada) represent the upper limits of 1.B.3 Temperate Flooded & Swamp Forest Formation (F026). The Shrubland & Grassland class needs no formation-level adjustments, but some lower level adjustments might be needed for consistency. We will continue to review this issue as we compare our work with that of Eurasian treatments of boreal and cool temperate (nemoral) forests.

Similar NVC Types:

- 1.B.1. Warm Temperate Forest (F018): has increasing prominence of evergreen broad-leaved trees, and shrubs, and evergreen herb ground layer. Snow virtually absent, frost is relatively rare.
- 1.B.3. Temperate Flooded & Swamp Forest (F026): Cool Temperate Forest (F008) typically contains well-drained soils and lacks any aquatic vegetation, peat or muck layer.
- 1.B.4. Boreal Forest (F001): has greatly simplified set of growth forms, primarily more conical-shaped spruce, fir and larch, and simple-leaved boreal hardwoods of *Betula* spp. and *Populus* spp. Moss layer often very prominent. Persistence of snow typically greater than 5 months of the year. Frost possible in almost any season. These conditions also closely describe North American subalpine and high montane forests, but those are treated here with Cool Temperate Forest because of the floristic, biogeographic and ecological similarities with lower elevation forests. But see Brown et al. (1998) who recognize a "Boreal and Subalpine Forest & Woodland" type.
- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): Open woodlands or tree savannas, with grassy or shrubby understories, and with trees 10% cover or more, are placed in Cool Temperate Forest (F008), but may have strong floristic similarities to grasslands.
- 7.A.2. Intensive Forestry Plantation & Agroforestry Crop (F043): Long-rotation plantations or woody restoration plantings of Cool Temperate Forest (F008) with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.

Diagnostic Characteristics: This formation contains pure or mixed stands of broad-leaved deciduous or needle-leaved evergreen tree growth forms, with a seasonal green understory of herbs. The tall-shrub layer is variable, and is often broad-leaved deciduous, but the short-shrub layer may be heath. The moss layer is often sparse, but more dominant in cold, rainy and/or high montane needle-leaved evergreen stands. Snow may be on the ground between <1 to 6 months of the year (8 months in high montane temperate examples?).

Rationale for Nominal Species or Physiognomic Features [optional]: The term "Cool Temperate" covers the range of physiognomic variability (and genera) that correlate with these climatic conditions. In the scientific name, the term "Cool Temperate" could be replaced by a more descriptive physiognomic set of terms.

VEGETATION

Physiognomy and Structure [optional]: There are commonly five strata: (1) a tree stratum, 15-35 m (60-100 feet) tall, dominated by broad-leaved deciduous and/or needle-leaved evergreen forest, often with a substratum of small trees (5-15 m tall); (2) a small-tree and tall-sapling layer (between 2-5 m); (3) a short-shrub layer (<2 m); (4) an herb layer of perennial forbs, including an ecological group that bloom primarily in early spring (in deciduous broadleaf-dominated examples); and (5) a ground layer of lichens, clubmosses, and true mosses. Lichens and mosses also grow on the trunks of trees. Woody vines (lianas) are not common (Woodward 1997). In western North America, structure is more variable, reflecting the range of ecological sites, from high mountains and valleys, to coastal rainforests with a variety of mesoclimates. Structural variability ranges from short-statured conifers, with a sparse understory and heavy duff layer, to the tallest and largest trees in the world in moist to wet climates, with shrub, herb and moss growth forms prominent (Whittaker 1975).

Floristics [optional]: Many of the genera, previously part of an Arcto-Tertiary Geoflora, are common to all three of the disjunct Northern Hemisphere broadleaf expressions of this biome. Included among these genera are *Quercus* (oak), *Acer* (maple), *Fagus* (beech), *Castanea* (chestnut), *Carya* (hickory), *Ulmus* (elm), *Tilia* (basswood or linden), *Juglans* (walnut), and *Liquidambar* (sweetgum) (Woodward 1997). Different species of these genera occur on each continent. In the Southern Hemisphere different sets of genera and species are found. Western North America contains a much reduced set of hardwood genera and expanded conifer diversity (*Abies*, *Picea*, *Pinus*, *Pseudotsuga*, *Thuja*, *Tsuga*). Transitions to the boreal forests are also apparent.

The temperate regions of the Southern Hemisphere differ from their northern counterparts. Distinctions between warm temperate and cool temperate are much contracted, e.g., in parts of the evergreen southern beech *Nothofagus* forests (South America, Australia and New Zealand).

ENVIRONMENT

Environmental Description [optional]:

Climate: This formation is associated with cooler continental and oceanic temperate climates (Koeppen Dca, Dcb, and Do, and in Europe, Cfb). There is a growing season of approximately 100 to 200 day, confined to late spring and summer when freezing temperatures are infrequent or absent. The 50 to 150 cm (20-60 inches) of precipitation are distributed evenly throughout the year. The non-growing season is due to temperature-induced drought during the cold winters.

Soil/substrate/hydrology: Soils are sometimes referred to as "gray forest soils," where silicate clay minerals accumulate in the B horizon. Some soils (Alfisols) have relatively high natural fertility; others are more leached, due to higher precipitation levels (Ultisols) and more common in the warmer parts of the region. Other orders in the U.S. system include Spodosols in the more northern regions and Inceptisols (Soil Survey Staff 1999) [see Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems].

DISCUSSION

Discussion [optional]: This formation is most prominent in the Northern Hemisphere, where it occurs in four major, disjunct expressions in (1) western and central Europe, (2) eastern Asia, including Korea and Japan, (3) eastern North America, and (4) western North America. In Europe, a species-poor forest reflects widespread extinctions during the Pleistocene. Oaks, beeches, and elms dominate. Most of the forest was cleared for agriculture, with remnants surviving only in some royal hunting preserves. In China, this formation is known as much from the fossil record as from the current scattered extant examples; intensive agriculture has caused this region to be cleared of natural vegetation for at least 4000 years. Japan has a largely cultural or semi-natural forest, but in the mountains of Korea the forest is more-or-less intact and fall foliage is reminiscent of New England. Many of the forests of eastern North America are second-growth, but they preserve the world's greatest diversity of cool temperate flora and fauna. This is especially true of the unglaciated Appalachian Plateau of eastern Kentucky, Tennessee, western North Carolina and Virginia. The Great Smoky Mountains have been designated a world biosphere reserve to help protect the rich assortment of species (Woodward 1997). In western North America, the cool temperate forest takes on a strong conifer dominance, and the range of high mountains, valleys, and coastal rainforests provide an immense variety of mesoclimates, physiognomic variability and genera.

[Standard discussion might include influence of natural processes such as fire, insect and other disease outbreaks, slope failure in mountainous regions, etc. All result in matrix of fine to broad scales depending upon climate and processes.]

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation is most prominent in the Northern Hemisphere, where it occurs in four major, disjunct expressions in (1) western and central Europe, (2) eastern Asia, including Korea and Japan, (3) eastern North America, and (4) western North America. Cool temperate forests may occur as minor components of southern and montane New Zealand and in Australia, especially Tasmania. Cool temperate forests also occur in Chile.

Nations [incomplete except for CA and US]: AU, CA, CL, CN, ES, FR, GB, IT, JP, NZ, RU, SE, TR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:**CONFIDENCE LEVEL****Confidence Level:**

Confidence Level Comments [optional]: Inclusion of western North American conifer forests in this temperate formation (rather a broadly defined boreal and temperate conifer forest) follows that of Brandt (2009). However, some authors expand the boreal formation to include the subalpine or high montane forests within the temperate zone (e.g., Whittaker (1975) - the "subarctic-subalpine needle-leaved forests; Brown et al. (1998) - Boreal and Subalpine Forest & Woodland). Within North America, this creates challenges for placement of *Picea rubens* (red spruce) forests in the northern temperate region, which are partly subalpine or high montane, but are most common at lower elevations. We follow a more floristic, biogeographic and ecological approach in treating the subalpine forests with their lower elevation counterparts at the formation level. But we recognize that high montane and subalpine forests are also similar to boreal forests in regard to some aspects of climate, species diversity patterns, and floristic similarity (at least at the genus level). Warm temperate and cool temperate forest formations are very similar, but differences are driven by increasing presence of broad-leaved evergreen trees and shrubs, and evergreen herb layer that corresponds with broad climatic patterns. Overlap with boreal forests in the western montane region also presents conceptual challenges.

CITATIONS**Synonymy:**

- > Cool Temperate Forest (Brown et al. 1998) [Brown et al. place the subalpine forests of the montane regions in their "Boreal and Subalpine Forest and Woodland" type.]
- < Taiga or Subarctic - Subalpine needle-leaved forests (biome-type 6) (Whittaker 1975) [Whittaker combines the subalpine forests of the temperate region with boreal forests.]
- > Temperate deciduous forests (biome-type 4) (Whittaker 1975)
- > Temperate evergreen (needle-leaved) forest (biome-type 5) (Whittaker 1975) [Whittaker includes both temperate evergreen broadleaf and temperate evergreen needle-leaved forest in this biome-type, but notes the distinction between the two in Plate 4.]
- > Temperate rain forests (biome-type 3) (Whittaker 1975)

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- Brandt, J. P. 2009. The extent of the North American boreal zone. *Environmental Review* 17:101-161.
- Brown, D. E., F. Reichenbacher, and S. E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press, Salt Lake City. 141 pp.
- Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Lea, Chris. Personal communication. Ecologist, formerly with National Park Service, USGS / NPS Vegetation Mapping Program, Denver, CO.
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Second edition. USDA Natural Resources Conservation Service, Washington, DC.
- Walter, H. 1985. Vegetation of the Earth and Ecological Systems of the Geo-Biosphere. Third edition. Springer-Verlag, New York.
- *Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.
- Woodward, S. L. 1997. The Virtual Geography Department Project and the Department of Geography, Radford University. [http://www.radford.edu/~swoodwar/CLASSES/GEOG235/biomes/main.html]

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012) after R.H. Whittaker (1975)

Author of Description: D. Faber-Langendoen

Acknowledgments: Todd Keeler-Wolf, Ken Baldwin, Chris Lea

Version Date: 12 Jul 2012

-
- 1. Forest to Open Woodland
 - 1.B. Temperate & Boreal Forest
-

1.B.3. Temperate Flooded & Swamp Forest (F026)

OVERVIEW

Database Code: 1.B.3 (F026)

Scientific Name: Temperate Flooded & Swamp Forest Formation

Common Name (Translated Scientific Name): Temperate Flooded & Swamp Forest Formation

Colloquial Name: Temperate Flooded & Swamp Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.B. Temperate & Boreal Forest (S15)

Lower Level Hierarchy Units [incomplete]:

- 1.B.3.Fe. Fynbos Riparian Thicket (D162)
- 1.B.3.Ff. Southern African Riparian Phreatophyte Vegetation (D163)
- 1.B.3.Na. Eastern North American Flooded & Swamp Forest (D011)
- 1.B.3.Nb. Southeastern North American Flooded & Swamp Forest (D062)
- 1.B.3.Nc. Rocky Mountain & Great Basin Flooded & Swamp Forest (D195)
- 1.B.3.Nd. Southwest North American Flooded & Swamp Forest (D013)
- 1.B.3.Ng. Vancouverian Flooded & Swamp Forest (D193)

Type Concept Sentence: Temperate Flooded & Swamp Forest is a tree-dominated wetland influenced by minerotrophic groundwater, either on mineral or organic (peat) soil, found in mid-latitudes of the globe.

Type Concept: Temperate Flooded & Swamp Forest is a forested wetland and peatland. It is defined as a tree-dominated wetland in temperate climates that is influenced by minerotrophic groundwater, either on mineral or organic (peat) soils. The vegetation is dominated by broad-leaved or needle-leaved trees, generally over 10% cover, and either a wood-rich peat, more common in depressions, or a mineral soil on floodplains. In swamp forests, the water table is often below the major portion of the ground surface, and the dominant ground surface is at the hummock ground surface, that is, 20 cm or more above the average summer groundwater level. It is the aerated (or partly aerated) zone of substrates above the water that is available for root growth of trees and/or tall shrubs. Flooded forests (sometimes called riverine or riparian swamps) have a more dynamic water table, with seasonal flooding inundating the vegetation for short (<7 days) to long (>1 month) periods. They are found along rivers, streams and lakes. They are subject to dramatic water fluctuations, seasonal flooding, and an influx of sediment and mineral enrichment during high water periods. Peat accumulation is usually shallow (less than 40 cm). The nutrient regime in swamps is highly variable, ranging from base-rich conditions with pH above 7.0, to base-poor conditions where pH can be in the range of 4.5 or lower.

Classification Comments [optional]: No distinction is made between warm- versus cool-temperate floodplain and swamp forests, because they do not have the same degree of change from broad-leaved evergreen to broad-leaved deciduous trees observed in uplands. Separation of temperate wetland from upland forests requires consideration of soils, vegetation and hydrology. At the wettest extremes, these forests are either continuously flooded and aquatic vegetation growth forms may be dominant, or saturated and a peat layer may form. There are also practical user benefits and ecological benefits to distinguishing wetland forests from upland forests at the formation level.

Similar NVC Types:

- 1.B.1. Warm Temperate Forest (F018): These typically contain well-drained soils, and lack any aquatic vegetation, peat or muck layer.
- 1.B.2. Cool Temperate Forest (F008): These typically contain well-drained soils, and lack any aquatic vegetation, peat or muck layer.
- 1.B.5. Boreal Flooded & Swamp Forest (F036): Temperate Flooded & Swamp Forest (F026) less often contains a sphagnum peat layer and is more commonly dominated by hardwood species.
- 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013): Tall-shrub swamps share many structural and habitat similarities to hardwood tree swamps, especially during the tree regeneration stage.

Diagnostic Characteristics: Temperate Flooded & Swamp Forest is defined as a tree-dominated wetland in a temperate climate that is influenced by minerotrophic groundwater, either on mineral or organic soils. The vegetation is dominated by broad-leaved or needle-leaved trees, generally over 10% cover, and either a wood-rich peat or a mineral soil on floodplains.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Temperate Flooded & Swamp Forest is a forested wetland and peatland. These swamps are defined as tree-dominated wetlands that are influenced by minerotrophic groundwater, either on mineral or organic soils. The vegetation is dominated by either broad-leaved or needle-leaved trees generally over 10% cover, and either a wood-rich peat or a mineral soil on floodplains (National Wetlands Working Group 1997).

There are three general physiognomic variants of forested swamps: coniferous swamps, broad-leaved deciduous (hardwood) swamps, and broad-leaved evergreen (hardwood) swamps. Mixtures of the above can also be described. Shading of the understory tends to favor shade-tolerant species. In cool-temperate regions, generally hardwood swamps occur in somewhat richer conditions, giving way to shrub swamps and marshes in somewhat wetter locations. Coniferous swamps occur across a wider range of trophic levels from rich to poor (National Wetlands Working Group 1997).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: *Soil/substrate/hydrology:* In swamp forests, the water table is often below the major portion of the ground surface, and the dominant ground surface is at the hummock ground surface, that is, 20 cm or more above the average summer groundwater level. It is the aerated (or partly aerated) zone of substrates above the water that is available for root growth of trees. These temperate swamps are not as wet as marshes, fens and the open bogs. The drier treed swamps grade into upland forest on mineral soil, and the wettest treed swamps grade into scrubby treed fen, which is wetter with less tree canopy cover. Scrubby tree fens may grade into tall-shrub swamps, but they are somewhat drier and have at least 10% tree canopy cover (National Wetlands Working Group 1997).

Flooded forests (sometimes called riverine or riparian swamps) have a more dynamic water table, with seasonal flooding inundating the vegetation for short (<7 days) to long (>1 month) periods. They are found along rivers, streams and lakes. They are subject to dramatic water fluctuations, seasonal flooding, and an influx of sediment and mineral enrichment during high water periods. Peat accumulation is usually shallow, often less than 40 cm, but depths of 1 m can exist (National Wetlands Working Group 1997).

The temperate flooded and swamp forest occurs on mineral soils as well as on peat. In the cool temperate regions, the texture of underlying mineral soils is variable, ranging from clays to sands, and they frequently are Gleysols. On sands, iron-rich ortsteins or fragipans are often present, acting as impermeable layers which impede water drainage. Swamps on mineral soils tend to accumulate peat by the paludification process. When organic soils develop, they are Histosols (U.S. system) or Mesisols or Humisols (Canadian system) that are rich in woody peat, at least in the surface layers [see Brady and Weil (2002) for a comparison of U.S. soil orders with Canadian and FAO systems]. Swamps on peat have developed either by a basin-filling process or by paludification of previously drier mineral soils. In the basin-filling process, the previous ecosystem was a marsh or fen, whereas in paludification the swamp has developed over an older, dry upland forest on mineral soil (National Wetlands Working Group 1997).

The nutrient regime in swamps is highly variable, ranging from base-rich conditions with pH above 7.0, to base-poor conditions where pH can be in the range of 4.5 or lower. Temperate swamp forms may be recognized based on the base-rich/pH gradient, i.e., calcareous rich (eutrophic), intermediate (mesotrophic), and poor (oligotrophic) (National Wetlands Working Group 1997).

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: These forested wetlands are widely distributed throughout the mid-latitudes around the globe.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- > Cold Temperate Swamp & Riparian Forest (Brown et al. 1998) [Cool- and warm-temperate forested wetlands are distinguished, based on climate.]
- >> Swamp (National Wetlands Working Group 1997) [This type includes tree swamps with >30% cover, boreal and temperate swamps, and both tree and tall-shrub (>1 m) swamps.]
- > Warm Temperate Swamp & Riparian Forest (Brown et al. 1998) [Cool- and warm-temperate forested wetlands are distinguished, based on climate.]

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- Brown, D. E., F. Reichenbacher, and S. E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press, Salt Lake City. 141 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments:

Version Date: 12 Jul 2012

1. Forest to Open Woodland

1.B. Temperate & Boreal Forest

1.B.4. Boreal Forest (F001)

OVERVIEW

Database Code: 1.B.4 (F001)

Scientific Name: Boreal Forest Formation

Common Name (Translated Scientific Name): Boreal Forest Formation

Colloquial Name: Boreal Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.B. Temperate & Boreal Forest (S15)

Lower Level Hierarchy Units [incomplete]:

- 1.B.4.Na. North American Boreal Forest (D014)

Type Concept Sentence: Boreal Forest (or taiga) is dominated by needle-leaved (usually evergreen, conical-shaped) conifers, and broad-leaved deciduous hardwoods that cover the northern regions of North America and Eurasia, with extended cold winters and short mild summers.

Type Concept: Boreal Forest (or taiga) extends across the northern regions of North America and Eurasia, with extended cold winters and short mild summers. It is bounded on the north by tundra and on the south by either the northern limit of temperate lowland and subalpine forests or grasslands (steppes). A number of ecological factors, including topography, climate and edaphic conditions, control Boreal Forest distribution. It is dominated by needle-leaved (usually evergreen, conical-shaped) conifers, and broad-leaved deciduous hardwoods. Lichens and mosses often dominate the ground layer. The structure of Boreal Forest varies from closed forest to lichen woodland and forest-tundra. Closed forests dominate the southern boreal zone; lichen woodlands dominate the northern regions; and isolated forest-tundra patches occur in the tundra zone near or just above treeline. Boreal forests are disturbance-based, with fires the primary disturbance.

Classification Comments [optional]: The Braun-Blanquet approach generally recognizes the *Vaccinio-Piceetea* class of vegetation as synonymous with Eurasian and North American boreal and sub-boreal coniferous forests, including both upland boreal forests and forested swamps (Peinado et al. 1998, Spribille and Chytrý 2002, Kolbek et al. 2003); however, Rivas-Martinez et al. (1999b) separated the North American boreal forest into a separate class, distinct from both European boreal forests and western temperate forests.

Various ecoregional treatments recognize the distinct vegetation and climate of the boreal region, compared to the temperate region. Brown et al. (1998) separates arctic-boreal from both cool-temperate and warm-temperate vegetation. Walter (1985) recognizes the boreal biome "Zonobiome of the Cold-temperate Boreal Climate" (Zone VIII), distinct from the cool-temperate biome "Zonobiome of the Temperate-Nemoral Climate" (Zone VI) and two warm-temperate biomes, the "Zonobiome of the Winter-Rain Region with an Arid-Humid Climate and Sclerophyllic Woodlands" (Zone IV) and the "Zonobiome of the Warm-Temperate Humid Climate" (Zone V).

Some authors extend the North American boreal forest southward into the southern Rocky Mountains and/or Appalachian Mountains (e.g., Whittaker 1975, Brown et al. 1998, Kuennecke 2008), primarily because of the spruce-fir zones that occur in those ranges. But the more temperate climate, increasingly diverse conifer and hardwood growth forms, biogeographic patterns and distinctive species suggest that they can satisfactorily be placed in a temperate formation, where they extend up to the treeline in the subalpine regions [see also Rivas-Martinez et al. (1999b)]. However, biogeographic comparisons across larger regions, including biome or formation scales, and which can be done at the genus level and above (e.g., McLaughlin 2007), suggest a greater similarity of high-elevation Engelmann spruce-fir in the Rocky Mountains with that of the boreal. But similarities are less strong in the eastern deciduous region, where red spruce-fir forests share more species with the eastern temperate region. Chris Lea (pers. comm. 2012) notes that there are a number of subdominant species common to North American high montane/subalpine forests, North American boreal forests, and Eurasian boreal forests (a number of *Vaccinium* spp., *Linnaea borealis*, *Carex aquatilis*, *Carex utriculata*, etc.), and at least one dominant tree species (*Populus tremuloides*) that are common to North American high montane/subalpine and North American boreal forests. Additionally, many fauna species (lynx, pine marten, pine grosbeak, golden-crowned kinglet, crossbills, etc.) show similar species distribution patterns. But many of these species also have considerable overlap in the temperate zone. We will continue to review this issue with North American and Eurasian colleagues.

Similar NVC Types:

- 1.B.2. Cool Temperate Forest (F008):
- 1.B.5. Boreal Flooded & Swamp Forest (F036):
- 7.A.2. Intensive Forestry Plantation & Agroforestry Crop (F043): Long-rotation plantations or woody restoration plantings of Boreal Forest (F001) with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.

Diagnostic Characteristics: Boreal Forest is dominated by needle-leaved (usually evergreen, conical-shaped) conifers, and broad-leaved deciduous hardwoods, with extended cold winters and short mild summers. Canopy structure rarely exceeds 15 m, and may be as low as 2 m in subarctic conditions. Lichens and mosses frequently dominate the ground layer.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Boreal Forest is dominated by needle-leaved (usually evergreen, conical-shaped) conifers, and broad-leaved deciduous hardwoods. Lichens and mosses often dominate the ground layer. The structure of Boreal Forest varies from closed forest to lichen woodland and forest-tundra. Closed forests dominate the southern boreal zone; lichen woodlands dominate the northern regions; and isolated forest-tundra patches occur in the tundra zone near or just above treeline (Elliott-Fisk 2000). Boreal forests are a disturbance-based forest, with fires and insect outbreaks as primary disturbances.

Floristics [optional]: Tree species diversity is very low. Evergreen spruce (*Picea*), fir (*Abies*), and deciduous larch (*Larix*) are common, distinctive genera, as are broad-leaved deciduous aspen (*Populus*) and birch (*Betula*) (Whittaker 1975).

ENVIRONMENT

Environmental Description [optional]: According to Brandt (2009), the boreal zone's northern boundary in both North America and Eurasia is generally the southern limit of the tundra; its southern boundary generally coincides with the northern limit of temperate forests, or grasslands (steppes).

Climate: There are lengthy periods of freezing temperatures with the coldest month isotherm of -3 degrees C, and the growing season generally averaging less than 100 days, occasionally interrupted by nights of below-freezing temperatures. Snow may be present for extended periods (7-10 months) and soils are frozen in winter. Annual precipitation is 38-50 cm (15-20 inches). In North America, the northern boundary of the forest corresponds to the July isotherm of 13 degrees C, with departures due to montane or maritime influences (Elliott-Fisk 2000). The southern boundary in central and eastern Canada corresponds approximately with the 18-degree C July isotherm, but in the west the forest border shifts to slightly cooler regions with higher precipitation (Elliott-Fisk 2000). These broad-scale climatic factors are modified by local and regional topography, climates and soils.

Brandt (2009, Table 2) characterizes the limits of boreal forests based on their dominance by "cold-tolerant" trees species, i.e., tolerant of temperatures of -80 degrees C or lower (primarily within *Abies*, *Larix*, *Picea*, or *Pinus* but also *Populus* and *Betula*). Temperate forests are characterized by "cold-intolerant" species, i.e., they require temperatures above -45 degrees C to survive. A number of temperate species have "intermediate cold-tolerance," common to the cool-temperate forest. Regions of the landscape where both species co-occur is sometimes referred to as the "hemiboreal subzone," that is, the northern parts of the cool-temperate zone where cold-intolerant tree species, cold-tolerant tree species, and species with intermediate cold-tolerance co-occur, and with the cold-tolerant species contributing substantially to the forest cover. Brandt's information provides the cold-tolerance limits of these species, but equally valuable in understanding the temperate versus boreal distinction would be the warm-tolerance limits. E.g., in North America, *Picea mariana* appears to be less warm-tolerant than *Pinus banksiana*, but both have the same cold-tolerance.

Soil/substrate/hydrology: Most boreal soils were subject to extensive glaciations (excluding parts of the Yukon Territory, the Northwest Territories, and Alaska). Soils are moderately poorly- to excessively-drained. They are the result of podzolization, which is a consequence of low temperatures and excess precipitation above that of evapotranspiration. Soils often contain a sandy ash-colored A horizon, with an accumulation of iron and aluminum with organic matter in the B horizon. Soils are generally of low fertility, as nutrients are also removed from the upper horizons. With the low temperatures, organic matter decomposes slowly, resulting in acidic soil conditions and low nitrogen and mineral levels (Elliott-Fisk 2000, Kuennecke 2008). Permafrost is absent or typically occurs <100 cm below the surface in the boreal forest zone. Spodosols are most common; Inceptisols, Histosols, and Entisols occasional (Soil Survey Staff 1999) [see Brady and Weil (2002) for a comparison of U.S. soil orders with Canadian and FAO systems].

DISCUSSION

Discussion [optional]: Ecologically, the boreal landscape is relatively young. For example, in North America, as recently as 21,400 calendar years ago at the peak of the Wisconsin, the entire boreal zone was covered with ice, excluding parts of the Yukon Territory, the Northwest Territories, and Alaska. With the melting of the glaciers over the next 15,000-16,000 years, the current tree species migrated northward from refugia south of the ice margin (Brandt 2009).

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Boreal Forest is found in North America from Greenland to Newfoundland and across northern Canada into Alaska, and in Eurasia, throughout most of Scandinavia and Russia, and parts of China, Kazakhstan, and Mongolia (Brandt 2009). It is absent from the Southern Hemisphere.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = *Linnaeo americanae-Piceetea marianae* (Rivas-Martínez et al. 1999b) [The concept of boreal forest as applied within North America closely corresponds to the concept here. The authors also appear to be the first in the Braun-Blanquet tradition to recognize a distinct North American Boreal Forest class.]
- < *Vaccinio-Piceetea* (Peinado et al. 1998) [The authors discuss the full diagnostic floristic composition of boreal forests across the Northern Hemisphere, then focus on North America. They extend the boreal forest further south (into the temperate-montane and cool-temperate regions of western and eastern North America) than the concept provided here.]
- < Boreal Forest Biome (Kuennecke 2008) [The author provides a general introduction to the entire boreal forest, but in North America extends the concept into the Southern Rockies and Appalachian Mountains.]
- = Taiga and Boreal Forest (Elliott-Fisk 2000) [The treatment is restricted to North America.]
- < Taiga or Subarctic - Subalpine needle-leaved forests (biome-type 6) (Whittaker 1975) [Whittaker combines the subalpine forests of the temperate region with boreal forests.]

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- Brandt, J. P. 2009. The extent of the North American boreal zone. *Environmental Review* 17:101-161.
- Brown, D. E., F. Reichenbacher, and S. E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press, Salt Lake City. 141 pp.
- Elliott-Fisk, D. L. 2000. The taiga and boreal forest. Pages 41-73 in: M. G. Barbour and W. D. Billings, editors. *North American terrestrial vegetation*. Second edition. Cambridge University Press, New York.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
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- Whittaker, R. H. 1975. *Communities and ecosystems*. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments: Ken Baldwin, Chris Lea

Version Date: 12 Jul 2012

1. Forest to Open Woodland
1.B. Temperate & Boreal Forest

1.B.5. Boreal Flooded & Swamp Forest (F036)

OVERVIEW

Database Code: 1.B.5 (F036)

Scientific Name: Boreal Flooded & Swamp Forest Formation

Common Name (Translated Scientific Name): Boreal Flooded & Swamp Forest Formation

Colloquial Name: Boreal Flooded & Swamp Forest

Hierarchy Level: Formation

Placement in Hierarchy: 1.B. Temperate & Boreal Forest (S15)

Lower Level Hierarchy Units [incomplete]:

- 1.B.5.Na. North American Boreal Flooded & Swamp Forest (D016)

Type Concept Sentence: Boreal Flooded & Swamp Forest is a tree-dominated wetland influenced by minerotrophic groundwater (rarely ombrotrophic), either on mineral or organic (peat) soil, found in northern, high latitudes of North America and Eurasia, with extended cold winters and short mild summers.

Type Concept: Boreal Flooded & Swamp Forest is a forested wetland and peatland. These swamps are defined as a tree-dominated wetlands in a boreal climate that are influenced by minerotrophic groundwater, either on mineral or organic (peat) soils; less commonly, they occur in transitional floodplain habitats. The vegetation is dominated by tall woody, mostly needle-leaved trees generally over 10% cover, and the wood-rich (less commonly sphagnum-rich) peat laid down by this vegetation. The water table is below the major portion of the ground surface, and the dominant ground surface is at the hummock ground surface, that is, 20 cm or more above the average summer groundwater level. It is the aerated (or partly aerated) zone of substrates above the water that is available for root growth of trees and/or tall shrubs. The nutrient regime in swamps is highly variable, ranging from base-rich conditions with pH above 7.0 (very rare), to base-poor conditions where pH can be in the range of 4.5 or lower. Various swamp forms may be recognized, based on the base-rich/pH gradient, i.e., calcareous-rich (eutrophic), intermediate (mesotrophic), and poor (oligotrophic to ombrotrophic).

Classification Comments [optional]: Subarctic and arctic (polar) flooded and swamp forests, including willow swamps (though these may not exceed 2 m), belong in this formation. Forested bogs and fens (>10% canopy) are also included here.

Similar NVC Types:

- 1.B.3. Temperate Flooded & Swamp Forest (F026): These forests less often contain a sphagnum peat layer and are more commonly dominated by hardwood species.
- 1.B.4. Boreal Forest (F001): These typically contain better-drained soils, lack any aquatic vegetation or muck layer, and, if a peat layer is present, is shallow (<40 cm).
- 2.B.5. Temperate & Boreal Bog & Fen (F016): Boreal Flooded & Swamp Forest (F036) includes forested bogs with >10% cover, along with poor swamps.

Diagnostic Characteristics: Boreal Flooded & Swamp Forest is defined as a tree-dominated wetland in a boreal climate that is influenced by minerotrophic groundwater, either on mineral or organic (peat) soils; less commonly, they occur in transitional floodplain habitats. The vegetation is dominated by needle-leaved trees generally over 10% cover, and the wood-rich (less commonly sphagnum-rich) peat laid down by this vegetation.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Boreal Flooded & Swamp Forest is a forested or wooded wetland and peatland. These swamps are defined as tree-dominated wetlands that are influenced by minerotrophic groundwater, either on mineral or organic soils. The vegetation is dominated by mostly needle-leaved trees generally over 10% cover, and the wood-rich peat laid down by this vegetation; less commonly, they occur in transitional floodplain habitats (National Wetlands Working Group 1997).

There are two general physiognomic variants of boreal swamps: coniferous (needle-leaved) swamps and hardwood (broad-leaved deciduous) swamps. Mixtures of the above can also be described. The understory contains shade-tolerant forest species. Generally in boreal regions, deciduous hardwoods occur in somewhat richer conditions, the deciduous swamp being in drier wetland locations. Coniferous swamps occur across a wider range of trophic levels from rich to poor (National Wetlands Working Group 1997).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: *Soil/substrate/hydrology:* The water table is below the major portion of the ground surface, and the dominant ground surface is at the hummock ground surface, that is, 20 cm or more above the average summer groundwater level. It is the aerated (or partly aerated) zone of substrates above the water that is available for root growth of trees and/or tall shrubs. Boreal swamps are not as wet as marshes, fens and the open bogs. The drier treed swamps grade into upland forest on mineral soil, and the wettest treed swamps include tree fen, which is wetter with less tree canopy cover. Tree bogs can

form on raised bogs, where the sphagnum mat may be relatively dry (National Wetlands Working Group 1997).

Boreal Flooded & Swamp Forest occurs on mineral soils as well as on peat. In the boreal region, the texture of underlying mineral soils is variable, ranging from clays to sands, and they frequently are Gleysols. On sands, iron-rich ortsteins or fragipans are often present, acting as impermeable layers which impede water drainage. Swamps on mineral soils tend to accumulate peat by the paludification process. When organic soils develop, they are Histosols (U.S. system) or Mesisols or Humisols (Canadian system) that are rich in woody peat, at least in the surface layers [see Brady and Weil 2002 for comparison of U.S. soil orders with Canadian and FAO systems]. Swamps on peat have developed by a basin-filling process or by paludification of previously drier mineral soils. In the basin-filling process, the previous ecosystem was a marsh or open fen, whereas in paludification, the swamp has developed over an older, dry upland forest on mineral soil (National Wetlands Working Group 1997).

The nutrient regime in swamps is highly variable, ranging from base-rich conditions with pH above 7.0, to base-poor conditions where pH can be in the range of 4.5 or lower. Swamp forms may be recognized based on the base-rich/pH gradient, i.e., calcareous-rich (eutrophic), intermediate (mesotrophic), and poor (oligotrophic to ombrotrophic) (National Wetlands Working Group 1997).

There are two general physiognomic variants of Boreal Swamp & Flooded Forest: coniferous (needle-leaved) swamps and hardwood (broad-leaved deciduous) swamps. Mixtures of the above can also be described. The understory contains shade-tolerant forest species. Generally in boreal regions, deciduous hardwood swamps occur in somewhat richer conditions, giving way to shrub swamps and marshes as conditions get wetter. Coniferous swamps occur across a wider range of trophic levels from rich to poor (National Wetlands Working Group 1997).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Boreal Flooded & Swamp Forest is found in North America, from Greenland to Newfoundland and across northern Canada into Alaska, and in Eurasia throughout most of Scandinavia and Russia, and parts of China, Kazakhstan, and Mongolia (Brandt 2009). It is absent from the Southern Hemisphere.

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Boreal Swamp and Riparian Forest (Brown et al. 1998)

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- Brandt, J. P. 2009. The extent of the North American boreal zone. *Environmental Review* 17:101-161.
- Brown, D. E., F. Reichenbacher, and S. E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press, Salt Lake City. 141 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments: Ken Baldwin

Version Date: 12 Jul 2012

2. Shrubland & Grassland (C02)

OVERVIEW

Database Code: 2 (C02)

Scientific Name: Mesomorphic Shrub & Herb Vegetation Class

Common Name (Translated Scientific Name): Mesomorphic Shrub & Herb Vegetation Class

Colloquial Name: Shrubland & Grassland

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 2.A. Tropical Grassland, Savanna & Shrubland (S01)
- 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Type Concept Sentence: Grasslands, shrublands, open tree savannas, marshes, bogs and fens dominated by broadly mesomorphic (including scleromorphic) shrub and herb growth forms (including *broad-leaved*, *needle-leaved*, and *sclerophyllous shrubs*, and *forb* and *graminoid herbs*) with an irregular horizontal canopy structure, mesomorphic trees typically <10% cover, tropical to boreal and subalpine climates, and wet to dry substrate conditions.

Type Concept: Shrubs and herbs with broadly mesomorphic (including scleromorphic) growth forms (including *broad-leaved*, *needle-leaved*, and *sclerophyllous shrubs*, some types of *rosette shrubs*, and *forb* and *graminoid herbs*) dominate this type. Vegetation structure is typically moderately open to closed canopy, with irregular horizontal canopy spacing and variable height, but typically less than 5 m. Mesomorphic trees have <10% cover and mesomorphic shrub and herb growth forms have the majority of cover compared to xeromorphic or cryomorphic growth forms. Climates range from tropical humid to (seasonal) dry to boreal and subalpine, with fairly moderate moisture and temperature conditions. Substrate moisture conditions vary from dry to wet. Vegetation includes upland grasslands, shrublands, open tree savannas, wetland emergent marshes, bogs and fens.

Classification Comments [optional]: This class includes both non-treed grasslands and shrublands, and open tree savannas, where tree canopy cover is typically <10%. Tree savannas, defined by a strong graminoid layer (>50% in UNESCO 1973) and some level of open tree cover (10-25% cover in UNESCO (1973), 10-30% cover in Nelson (2005), 10-50% cover in Curtis (1959)), often closely resemble open upland grasslands and shrublands, especially in grassland regions. Thus, in this particular realm of vegetation, the open tree canopy, in combination with the ground layer, helps define savanna vegetation, distinct from forests or woodlands (e.g., Nelson 2005). But in many other regions and vegetation types, the role of canopy closure varies, e.g., forested swamps and bogs, longleaf pine woodlands (Peet 2006), subarctic woodlands, etc. Here we place tree savannas with woodland and forest.

Croplands with a spontaneous ground layer of "weeds," where the annual rotation of crops prevents a persistent ground layer of herbs, are treated under 7. Agricultural & Developed Vegetation Class (C07). If agricultural practices are abandoned, these sites may succeed to more persistent "ruderal" grasslands and shrublands (and forests) and would be placed in this class.

Blue oak, Engelmann oak, and other woodlands in California Mediterranean climate are typically between 10 and 60% cover, and California state ecologists place these as part of Forest & Woodland (Barbour et al. 2007). By contrast, many Midwestern states in the tallgrass prairie region have recognized oak savannas, based on open tree cover levels (e.g., 5-30% tree cover in Nelson 2005), as separate from oak woodlands (30-80%) and oak forests (80-100% cover). These savannas are often most similar to grasslands, and are sometimes placed with them at higher levels (Minnesota DNR 2005). Here we recommend the oak savanna distinction to be made closer to the 10% limit (e.g., 2-15%), and treat more closed tree canopy stands with Forest & Woodland. Note that UNESCO (1973), which includes many detailed structural criteria in the classification, recognizes both the very open savannas (tree cover <10%) and the more closed savanna (10-40%) separate from each other and from woodland (>40%) and closed forest. These distinctions may well be important at lower levels of the NVC hierarchy (e.g., Group, Alliance, Association).

Where grasses and shrubs overtop low trees ("brush prairie"), the stands are placed here in Shrubland & Grassland. These situations may often occur in grassland or cool semi-desert regions (e.g., North American Great Plains or Great Basin). Also challenging are some scrub trees, such as juniper (*Juniperus* spp.) or mesquite (*Prosopis* spp.), which can form shrublike stands, and are typically <5 m tall at maturity in parts of their range. Where forms are not easily defined, woody plants equal to or greater than 5 m at maturity are considered trees (FGDC 2008). In the U.S., there are shrubby junipers (*Juniperus communis*, *Juniperus pinchotii*) that should be treated as shrubs. But pygmy conifers can potentially make 5 m and are treated as trees (*Pinus edulis*, *Juniperus scopulorum*, *Juniperus monosperma*, *Juniperus occidentalis*, *Juniperus osteosperma*).

There is a group of ephemerals that are generally mesomorphic, which can, under optimal rainfall conditions, grow on sand, including desert sands and pavement. They are adapted to deserts through their seed characteristics. Typically they do not occupy extensive deep shifting sands, only margins of sandsheets, and more stable sands. They rely on seedbanks that may persist for decades in the sand and germinate under optimal winter or summer episodes of heavy rains. These are treated here as part of the mesomorphic shrub and herb class. Examples of psammophytic species include some sand verbenas (*Abronia* spp.), and several Asteraceae (e.g., *Dicoria canescens*, *Palafoxia* spp., etc.).

Similar NVC Types:

- 3. Desert & Semi-Desert (C03): Desert grassland growth forms currently are not distinguished from temperate (mesomorphic) grasslands, and, where these grasslands lack xeromorphic shrubs, there may be no growth forms that provide xeromorphic criteria. In addition, the transition from dry temperate grassland to cool or warm semi-desert may be challenging, and rely more on floristics than growth forms. Desert grasslands lacking many xeromorphic associates in the sense of those in the Southwest U.S. (NM, TX or AZ) may be considered monsoonal and, thus, could be considered mesomorphic grasslands. Further review is needed.
- 4. Polar & High Montane Scrub & Grassland (C04): Distinguishing cryomorphic vegetation from mesomorphic can be a challenge in both arctic and alpine regions. Here we allow mesomorphic extensions into the cryomorphic climatic zone to be retained in the mesomorphic class (e.g., boreal mesomorphic tall willow shrublands along arctic drainageways are excluded from Cryomorphic Vegetation), whereas prostrate or dwarf willow species are treated as part of the cryomorphic class.
- 6. Rock Vegetation (C06): Sparsely vegetated sand dunes are similar to this class, but the vascular species present are typically mesomorphic, with adaptations to rooting in sand (psammophytic); crustose lichens and ferns are typically absent. Unstable scree may also contain scattered mesomorphic herbs and little to no nonvascular vegetation, but for now are retained in this class.
- 7. Agricultural & Developed Vegetation (C07): Agricultural grasslands in this class may be regularly mowed, hayed or grazed, and have an atypical "cut" structure periodically throughout the season, and may be dominated by exotic grasses. Developed grasslands in this class have a very regularly, often very low, cropped structure, because of regular cutting or mowing (even weekly during the growing season).

Diagnostic Characteristics: Shrubs and herbs at least 10% cover, mesomorphic trees <10% cover, and the majority of cover is comprised of mesomorphic shrub (*broad-leaved*, *needle-leaved*, *sclerophyllous*, and *rosette shrubs*) and herb (*forbs* and *graminoids*) growth forms compared to xeromorphic or cryomorphic shrub and herb growth forms. The vegetation structure has irregular horizontal canopy spacing.

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

Growth Forms: Stands are dominated by any broadly mesomorphic (including scleromorphic) herb or shrub growth form, with or without a layer of nonvascular growth form (i.e., lichen, moss). Mesomorphic shrubs include *broad-leaved*, *needle-leaved*, *sclerophyllous*, and *palm shrubs*. Semi-shrubs are typically absent. Mesomorphic herbs include *forbs* (including *flowering forbs*, *ferns*, and *succulent forbs*) and *graminoids*. These herbaceous growth forms are not exclusive to the mesomorphic class, and more work is needed to assess whether additional herbaceous growth form types should be recognized that may be distinctive for this class.

Structure: Stands have irregular shrub or herb horizontal stem spacing, typically with a moderately open to closed shrub or herb layer. There is <10% mesomorphic tree cover, and the majority of shrub and/or herb growth forms are mesomorphic, typically exceeding 10% cover (but may be as low as 1-10% cover). Nonvascular and dwarf-shrub growth forms may vary from 0 to 100%, and tree seedlings or saplings may be present at any level of cover if they are below the predominant heights of the shrubs and herbs. At maturity, dominant shrubs and herbs are typically >0.3 m (sometimes over 5-10 m).

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

Climate: Shrublands and grasslands occur in the following Trewartha Climatic zones:

Aw = Tropical wet-dry

Am = Tropical wet-dry ("monsoon")

BS = Semiarid [BSh, hot semiarid]

BW = Arid Specifically BW_h (hot Subtropical High desert)

BW_n (or B_n) Climates (cool coastal deserts) "*n*" for *nebel* = fog

Cs = Subtropical dry summer "*Mediterranean*"

Do = Oceanic "*Marine West Coast*"

BS = Semiarid (BS_k, cool semiarid)

Dc = Continental

Soil/substrate/hydrology: Dry to wet soils, including dry rocky outcrops to marshes, bogs and fens.

DISCUSSION

Discussion [optional]: Sand dune, including psammophytic, vegetation is placed here in mesomorphic, even though there are some resemblances to Lithomorphic Vegetation. Kudryashov (2010) describes the characteristics of "psammophyte" (i.e., plants that thrive in shifting sands, primarily in deserts, and which have a number of adaptations that enable them to exist on wind-blown sands).

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Climate zones? Bailey (1989) Domains: Most common in Steppe Divisions of the Dry Domain, but also Subarctic Divisions of Polar Domain. Less common in other divisions of Polar or Dry domains, and uncommon in Humid Tropical, Humid Temperate Domain, but common in semi-humid Tropical domains (savannas).

Nations [incomplete except for CA and US]: AR, AU, BR, CA, CG, CL, CN, ES, ET, FR, GR, IL, IT, KE, LS, MA, MN, MR, MX, MZ, NA, PR, RU, SN, SO, TN, TZ, US, UY, ZA

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Grassland Biomes (Woodward 2008) [Approximately equivalent. Although only grasslands are mentioned in the name, shrublands are considered as part of the concept.]
- > Range Land (Anderson et al. 1976) [The authors exclude wet grasslands and shrublands, treating them as part of their "Wetlands" category.]

Full Citation:

- Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. USDI, Geological Survey Professional Paper No. 964. Washington, DC. 26 pp.
- Bailey, R. G. 1989. Explanatory supplement to ecoregions map of the continents. Environmental Conservation 16:307-309 with separate map at 1:30,000,000. USDA Forest Service, Washington, DC.
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- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Kudryashov, V. 2010. The Great Soviet Encyclopedia. Third edition (1970-1979). The Gale Group, Inc.
- Minnesota DNR [Minnesota Department of Natural Resources]. 2005b. Field guide to the native plant communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands provinces. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. Minnesota Department of Natural Resources, St. Paul.
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- Peet, R. K. 2006. Ecological classification of longleaf pine woodlands. Pages 51-94 in: S. Jose, E. Jokela and D. Miller, editors. Longleaf pine ecosystems: Ecology, management, and restoration. Springer, NY. [http://www.bio.unc.edu/faculty/peet/pubs/LongLeaf.pdf]
- UNESCO [United Nations Educational, Scientific and Cultural Organization]. 1973. International classification and mapping of vegetation. Series 6, Ecology and Conservation. United Nations Educational, Scientific, and Cultural Organization. Paris. 93 pp.
- Woodward, S. 2008. Grassland Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: Hierarchy Revisions Working Group

Acknowledgments:

Version Date: 16 Jul 2012

2. Shrubland & Grassland

2.A. Tropical Grassland, Savanna & Shrubland (S01)

OVERVIEW

Database Code: 2.A (S01)

Scientific Name: Tropical Grassland, Savanna & Shrubland Subclass

Common Name (Translated Scientific Name): Tropical Grassland, Savanna & Shrubland Subclass

Colloquial Name: Tropical Grassland, Savanna & Shrubland

Hierarchy Level: Subclass

Placement in Hierarchy: 2. Shrubland & Grassland (C02)

Lower Level Hierarchy Units:

- 2.A.1. Tropical Lowland Grassland, Savanna & Shrubland (F019)
- 2.A.2. Tropical Montane Grassland & Shrubland (F017)
- 2.A.3. Tropical Scrub & Herb Coastal Vegetation (F024)
- 2.A.4. Tropical Bog & Fen (F002)
- 2.A.5. Tropical Freshwater Marsh, Wet Meadow & Shrubland (F030)

Type Concept Sentence: Tropical Grassland, Savanna & Shrubland is dominated by mesomorphic grasses and shrubs, with or without scattered trees (but trees typically <10% cover), ranging from tropical coastal and inland lowland and montane grasslands and shrublands, to bogs, fens, and marshes. Stands are found in warm tropical continental climates, typically from the equator to about 23 degrees N and S latitude, with low or pronounced rainfall seasonality, with either one or two short dry seasons, or one long dry season, but frost virtually absent.

Type Concept: Tropical Grassland, Savanna & Shrubland is dominated by grasses and shrubs, with or without scattered trees. Some occur in climates too dry for forest; others depend on soil conditions or fire, or both, rather than climate. The structure is a single, major grass or shrub stratum, or a mix of the two, with trees typically less than 10% cover, rarely with bare ground.

Classification Comments [optional]: Inclusion of wetland and uplands makes this class somewhat heterogeneous, but all types share a mesomorphic, shrub and herb vegetation.

Similar NVC Types:

- 1.A. Tropical Forest (S17): Where tree cover exceeds 10%, stands are typically placed in Tropical Forest (S17), including "grassy woodlands."
- 2.B. Temperate & Boreal Grassland & Shrubland (S18): Tropical Grassland, Savanna & Shrubland (S18) growth forms have a phenology driven by rain and drought, but not frost.

Diagnostic Characteristics: Tropical Grassland, Savanna & Shrubland is dominated by grasses and shrubs, with or without scattered trees. Some occur in climates too dry for forest; others depend on soil conditions or fire, or both, rather than climate, but frost is typically absent throughout the growing season. The structure is a single, major grass or shrub stratum, or a mix of the two, exceeding 10% cover, rarely with bare ground (Whittaker 1975).

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical Grassland, Savanna & Shrubland is dominated by grasses and shrubs, with or without scattered trees (but tree cover <10%). Some occur in climates too dry for forest; others depend on soil conditions or fire, or both, rather than climate. The structure is a single, major grass or shrub stratum, or a mix of the two, exceeding 10-20% cover, rarely with bare ground (Whittaker 1975).

The range of variation in upland formations corresponds to Lowland versus Montane versus Coastal patterns of variation. A sketch of the range of variation for the wetlands within the subclass is provided in Table 1.

Table 1. Major wetland types used to guide formation distinctions within the tropical region. Types and definitions are adapted from the National Wetlands Working Group (1997) and Mackenzie and Moran (2004), but need further review for tropical summaries.

• Wetland Type	• Definition	• Environmental features	• Growth forms	• Mitsch & Gosselink (2000) type
• Tropical Bog & Fen	• Bogs are shrubby, nutrient-poor peatlands with distinctive communities of ericaceous shrubs and hummock-forming <i>Sphagnum</i> species, sometimes with sedges, adapted to high acid and oxygen-poor soil conditions. Trees >2 m have <10% cover (rarely, raised bogs may contain some forested stands). Vegetation of bogs and poor fen often overlap and are sometimes treated together as "acid peatland."	• +/- ombrotrophic • pH <4.5 • >40 cm fibric/mesic peat.	• Stunted (<2 m tall) needle-leaved tree, stunted broad-leaved tree, low shrub, dwarf-shrub (ericaceous), sphagnum.	• Peatland
•	• Fens are peatlands where groundwater inflow maintains	• Groundwater-fed • pH >4.5 (approximate	• Low shrub (often non-ericaceous,	• Peatland

	relatively moderate to high mineral content within the rooting zone. Sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses (often with sphagnum). Ranges from poor fen to rich fen. Poor fens overlap with bogs and are sometimes treated as "acid peatland" separate from "alkaline peatland."	ranges include poor fen 4.5-5.5, medium or intermediate fen 5.5-6.5, rich fen 6.5-7.5 and extremely rich fen >7.5). • >40 cm fibric/mesic peat.	but evergreen), sedge (often fine), grass, reed, and brown moss, often with sphagnum.	
• Tropical Freshwater Marsh, Wet Meadow & Shrubland	• A marsh-wet meadow is a shallowly flooded or saturated wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes and wet meadows, with early season high water tables and some flooding dropping through the growing (or dry) season, and exposure of the substrate or drying of the profile possible in late (or high of dry) season or drought years. Shrub wetlands (shrub carrs) occupy similar sites to wet meadows.	• Mineral soils or well-humified peat. Protracted shallow flooding (0.1 to 2.0 m) or prolonged soil profile saturation.	• Grass, sedge (often coarse), forb, low shrub, tall shrub.	• Freshwater marshes • Tidal freshwater marshes • riparian ecosystem (wetland, herb/shrub)
• Salt Marsh (tropical?)	• Saltwater marshes are intertidal to supratidal ecosystems that are flooded diurnally (or less), sometimes with freshwater inputs, and has communities dominated by salt-tolerant emergent graminoids and succulents.	• Intertidal and supratidal zones, semi-diurnal to diurnal, flooding by brackish or saltwater [<i>n.b. inland non-tidal saline wet meadows may also be placed here</i>].	• Grass, sedge, forb, halophytic (succulent) forb, halophytic shrub.	• Tidal salt marshes
• Wetlands Treated Elsewhere				
• Flooded & Swamp Forests (I.A.4, I.B.3, I.B.5)	• A swamp forest is a tree-dominated mineral or peat wetland, on sites with a flowing/flooded or fluctuating semipermanent, near- or at-surface water table. A flooded forest occurs on sites where flooding varies from temporary (<7 days) to semipermanent (>180 days).	• Mineral soils or well-humified peat, temporary to semipermanent flooding (0.1 to 2 m deep), rarely saline	• Broad-leaved tree, needle-leaved tree, tall shrub, forb, graminoid, hydromorphic herb (rarely), trees >10% cover.	• Freshwater swamps • Riparian ecosystems (wetland, tree)
• Mangrove (I.A.5)	• Mangroves occur in the intertidal and brackish backwater of estuarine areas in tropical regions.	• Intertidal and supratidal zones, semi-diurnal to diurnal, flooding by brackish or saltwater.	• Mangrove, halophytic shrub, halophytic (succulent) forb, graminoids.	• Mangrove swamps
• Aquatic Vegetation (5.A, 5.B)	• Aquatic wetlands are shallow waters dominated by rooted, submerged and floating aquatic plants. They are associated with permanent still or slow-moving waters, such as shallow potholes, ponds, rivers and lakes or in oceans. Aquatic plants may occur in mineral or in well-humified sedimentary peat.	• +/- Permanent deep flooding (0.5-2 m), or deep water lakes and oceans.	• Hydromorphic (aquatic) herb, emergents <10% cover.	• --

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: Stands are found in warm tropical continental climates, with low or pronounced rainfall seasonality, with either one or two short dry seasons, or one long dry season, but in all cases frost virtually absent.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This subclass is found widely throughout lowland and montane upland and wetland habitats of the tropical latitudes, from the equator to about 23 degrees N and S.

Nations [incomplete except for CA and US]: AU, BR, CG, ET, KE, MR, MZ, NA, PR, SN, SO, TZ, US, ZA

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: High

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- > Tropical Savanna Biome (Woodward 2008) [Woodward includes upland lowland and montane grassland, but does not describe wetland types.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fulst, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.
- Woodward, S. 2008. Grassland Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Nov 2011

2. Shrubland & Grassland

2.A. Tropical Grassland, Savanna & Shrubland

2.A.1. Tropical Lowland Grassland, Savanna & Shrubland (F019)

OVERVIEW

Database Code: 2.A.1 (F019)

Scientific Name: Tropical Lowland Grassland, Savanna & Shrubland Formation

Common Name (Translated Scientific Name): Tropical Lowland Grassland, Savanna & Shrubland Formation

Colloquial Name: Tropical Lowland Grassland, Savanna & Shrubland

Hierarchy Level: Formation

Placement in Hierarchy: 2.A. Tropical Grassland, Savanna & Shrubland (S01)

Lower Level Hierarchy Units [incomplete]:

- 2.A.1.Ea. Caribbean & Central American Lowland Shrubland, Grassland & Savanna (D094)
- 2.A.1.Eb. Amazonian Shrubland & Savanna (D124)
- 2.A.1.Ec. Guyanan Shrubland & Savanna (D125)
- 2.A.1.Ed. Parana Brazilian Shrubland & Savanna (D126)
- 2.A.1.Ee. Chacoan Shrubland & Savanna (D127)
- 2.A.1.Ff. West-Central African Mesic Woodland & Savanna (D128)
- 2.A.1.Fg. Eastern & Southern African Dry Savanna & Woodland (D129)
- 2.A.1.Fh. Mopane Savanna (D130)
- 2.A.1.Fi. Sudano-Sahelian Dry Savanna (D131)
- 2.A.1.Fn. Miombo & Associated Broadleaf Savanna (D164)

- 2.A.1.Fo. Eastern African Moist Woodland & Savanna (D165)
- 2.A.1.Fp. Malagasy Dry Forest & Scrubland (D166)
- 2.A.1.Fq. Malagasy Subhumid Woodland & Savanna (D167)
- 2.A.1.Ij. Indo-Malayan Mesic Savanna & Grassland (D132)
- 2.A.1.Lk. Australian Tropical Savanna (D133)
- 2.A.1.Ol. Polynesian Lowland Shrubland, Grassland & Savanna (D074)
- 2.A.1.Om. Eastern Melanesian Lowland Shrubland, Grassland & Savanna (D075)

Type Concept Sentence: Tropical Lowland Grassland, Savanna & Shrubland is characterized by a ground layer with a more-or-less continuous grass or graminoid layer, or mixed forb layer which may have up to 80-90% shrub cover and/or typically less than to 10% tree cover. Shrubs are predominantly broad-leaved evergreen and deciduous, but sclerophyllous growth forms are also included. Stands are found in warm tropical continental climates, with low or pronounced rainfall seasonality, with either one or two short dry seasons, or one long dry season.

Type Concept: Tropical Lowland Grassland, Savanna & Shrubland is characterized by shrubs and herbs with mesomorphic growth forms (including *broad-leaved*, *small-leaved*, *sclerophyllous*, and *palm shrubs*, and *forb* and *graminoid herbs*). Annual precipitation is seasonal to monsoonal and varies from 50-150 (200) cm. In the driest climates, the herbaceous cover is annual and/or sparse. Vegetation structure varies from open grasslands, with very few woody growth forms to closed-canopy shrubland. Spatially patchy vegetation structure is typical for this type, especially the savannas with clumped or irregular horizontal canopy spacing and variable height, but typically overall structure is less than 5 m. Neotropical and paleotropical savannas are included here as well as lowland shrublands occurring commonly amid a tropical forest due to edaphic limitations, such as the Amazonian *caatingas*. Savannas represent the vast majority of the area covered by this type and they are characterized by a layer of perennial herbaceous plants, mainly C4 grasses and sedges, and C3 forbs, with varying degrees of shrubs, and with trees typically less than 10% cover.

Classification Comments [optional]: "Savanna" refers to a type of vegetation where grasses form a complete ground cover but there may also be an upperstory of scattered trees, shrubs, or palms. The word *savanna* comes from a Carib word for a treeless plain covered with grass (i.e., a grassland). The Spanish adopted the term when they colonized the West Indies, and they introduced it to other western languages. Today, among vegetation scientists, the meaning has changed only slightly: "savanna" refers to a type of vegetation where grasses form a complete ground cover; an upperstory of scattered trees, shrubs, or palms is usual (thus tropical grasslands, with or without scattered trees are referred to as savannas). The term is mostly reserved to describe tropical vegetation, and the popular image of tropical savanna comes from the African part of the biome, where vast grasslands dotted with umbrella-shaped deciduous trees and thorny shrubs are inhabited by herds of large grazing animals. Not all savannas are like this, however.

The term savanna has also been applied to vegetation of similar structure in temperate zones, but there the term grassland or prairie is used for non-treed grasslands, and savanna is only used when scattered trees are present (between 10 and 30%); these stands are placed in 1. Forest to Open Woodland Class (C01). Some scientists use the term *savanna landscape* to describe a group of interrelated grassland, gallery or riparian forest, swamps, and/or marsh vegetation.

Savannas in tropical Asia are most likely "derived" and not natural savannas. This means that they are the result of human activities such as logging, burning, and the grazing of livestock, any or all of which altered tropical dry (or deciduous) forests that once grew in the area. Since they are not considered natural, the tropical savannas of India and Southeast Asia are not described in this book (Woodward 2008).

The Caribbean pine savannas like other treed savannas, should be placed according to the percentage coverage of the tree layer. Where grasses and shrubs overtop low trees ("brush prairie"), the stands are placed here in Shrubland & Grassland. In the tropics, the separation between the lowland shrubland and grassland and warm semi-desert thorn woodland/shrubland should be guided by the presence of succulents, small-leaved and thorny shrubs and trees, and other xeromorphic growth forms, characteristic of the latter.

Savannas that flood seasonally are common in the tropics, especially in South America (the Llanos, Beni and Pantanal). The extensive hydrologic network combined with topographic complexities and precipitation gradients cause a complex spatial mosaic of upland and seasonally flooded types that might be challenging to classify, with waterlogged soils grading into drained soils within very short distances.

This type may extend to nearly treeline (3000 m elevation), covering the lower montane region. See description for 2.A.2. Tropical Montane Grassland & Shrubland Formation (F017).

Similar NVC Types:

- 2.A.3. Tropical Scrub & Herb Coastal Vegetation (F024): Further review is needed to describe differences between Tropical Lowland Grassland, Savanna & Shrubland (F019) and coastal vegetation (F024).

- 4.A.1. Tropical High Montane Scrub & Grassland (F022): This type is often treated broadly to include both tropical montane and high montane vegetation, i.e., all vegetation near or above the tropical treeline (e.g., Quinn 2008).
- 7.B.2. Pasture - Hay Field & Crop (F045): Tropical Lowland Grassland, Savanna & Shrubland (F019) may overlap in composition with pasture grasslands, particularly in grassland regions. And in regions where a pastoral tradition has existed from 100s to 1000s of years, recognition of native versus agricultural grasslands may be challenging.

Diagnostic Characteristics: Shrubs and herbs at least 10% cover, mesomorphic trees <10% cover, and the majority of cover is comprised of mesomorphic shrub (*broad-leaved*, *sclerophyllous*, and *rosette shrubs*) and herb (*forbs* and *graminoids*) growth forms compared to xeromorphic or cryomorphic shrub and herb growth forms. The vegetation structure has irregular horizontal canopy spacing.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Stands are dominated by any mesomorphic herb or shrub growth form, with or without a layer of nonvascular growth form (i.e., lichen, moss). Mesomorphic shrubs include *broad-leaved*, *sclerophyllous*, and *palm shrubs*. Semi-shrubs are typically absent. Mesomorphic herbs include forbs (including *flowering forbs* and *ferns*) and graminoids. "Savanna" refers to a type of vegetation where grasses form a complete ground cover; an upperstory of scattered trees, shrubs, or palms is usual. Stands vary widely from regular shrub or herb horizontal stem spacing to irregular, typically with a moderately open shrub layer. There is <10% mesomorphic tree cover, and the majority of shrub and/or herb growth forms are mesomorphic, typically exceeding 10% cover (but may be as low as 1-10% cover). Nonvascular and dwarf-shrub growth forms may vary from 0 to 10%, and tree seedlings or saplings may be present at any level of cover, if they are below the predominant heights of the shrubs and herbs. At maturity, dominant shrubs and herbs are typically >0.3 m (sometimes over 5-10 m).

The typical grasses are bunch grasses, some 2-4 m high. The blades are tough and contain many silica bodies. Savanna grasses use the C4 photosynthetic pathway. In addition to grasses, the herb layer of tropical savannas is often rich in sedges and forbs. Trees of the savannas, with the exception of the huge *Adansonia digitata* (baobab), are rarely taller than 12 m. Most are only 2-6 m tall. A thick bark often defends savanna trees against fire. Many can sprout from their roots, another survival tactic in the face of frequent burning. In Africa, where grazing by large mammals is a major factor, many woody plants are armed with thorns. These same trees and shrubs are apt to have tiny leaves and very deep taproots. Other growth forms commonly found in tropical savannas include subshrubs and annual forbs and grasses, all well-adapted to strongly seasonal environments. The subshrub dies down at the end of one rainy season and produces new woody stems at the beginning of the next. Two flowering seasons are usual in the Tropical Savanna Biome. Some plants bloom at the very beginning of the rainy season even before their leaves have fully developed. Other species bloom in the middle of the rainy season or towards its end. Scientists recognize different types of savanna according to the spacing and frequency of trees or other woody plants (Woodward 2008).

Floristics [optional]: The typical grasses are bunch grasses, some 2-4 m high. In addition to grasses, the herb layer of tropical savannas is often rich in sedges and forbs. Many of the forbs are members of the pea or legume family (Woodward 2008).

ENVIRONMENT

Environmental Description [optional]:

Climate: This formation occurs typically within an annual precipitation range of 100-150 cm though lower and upper extremes are around 40 and 200 cm, respectively. The rainfall is seasonal, with either a short (1-3 months) dry season or a long one (5-7 months). The wet season can be interrupted by a short period of drought that may last for 1 to 3 weeks. As distance from the equator increases, different types of savanna may form distinct zones, a pattern that results from the longer and longer dry seasons experienced, and the less and less total annual precipitation received, the closer an area is to the permanent high pressure cells centered near 30 degrees latitude in both hemispheres (Woodward 2008). Mean annual temperature is around 22-25 degrees C, but can reach 6 degrees C in winter in the edges of the tropical distribution range (i.e., southern limit of Cerrado in Brazil, eastern southern Africa), with very occasional frosts.

Tropical savannas occur in areas with distinct annual rhythms based upon alternating wet and dry seasons. Abundant precipitation during the rainy season makes this a type of tropical humid climate known as the Tropical Wet and Dry Climate (Aw in the Koeppen climate classification system), or often simply the Tropical Savanna Climate. The rains come during the high sun period, when the Intertropical Convergence Zone (ITCZ) is positioned nearby. The ITCZ is the place where the trade winds of the Northern and Southern hemispheres meet and force the air to rise and generate rainfall. Its position shifts during the year as the vertical rays of the sun migrate between the Tropic of Cancer and the Tropic of Capricorn. The low sun season, when the vertical rays strike in the opposite hemisphere, is the dry season. There may be 3-4 months when little or no precipitation falls. Total precipitation within the biome varies from 1000-1500 mm (40-60 inches) to as little as 500 mm (20 inches) a year (Woodward 2008). The tropical nature of the climate is apparent in the year-round warm temperatures, with frost being an unknown or extremely rare event. The temperature difference between the warmest month (usually at the end of the dry season) and the coolest month (during low sun) is only 2.8-5.5 degrees C (5-10 degrees F). The difference between daytime and nighttime temperatures is often greater (Woodward 2008). Even though a close correlation exists between tropical savannas and the Tropical Wet and Dry Climate, climate does not

seem to be the main reason most savannas are found where they are. Repeated burning, low-nutrient soils, iron-rich hardpans close to the surface, and the impacts of large grazing and browsing mammals are also factors in the presence and maintenance of many of the world's tropical grasslands (Woodward 2008).

Soil/substrate/hydrology: Tropical savanna usually develops on nutrient-deficient, acidic soils with aluminum toxicity and pronounced alteration of wet and dry conditions (Woodward 2008).

Soils Comments [optional]: Soil formation: Soils in humid tropical climates are exposed to high rates of leaching, the dissolving and washing down into the soil column of any soluble compound. The typical soil-forming process is one of laterization. The amount of leaching that has occurred is related to the age of the land surface. The tropical savannas of Brazil and western Africa lie on very ancient surfaces (exposed continental shields) that for millions of years have been affected by high temperatures and relatively high amounts of rainfall. The bedrock has been deeply weathered, and most soluble compounds, including even silica compounds, have been removed. Since plant matter decays rapidly in constant warm, moist conditions, essentially no humus is available to help bind soluble bases (key plant nutrients) even temporarily. Left behind is a soft residue high in iron oxides and aluminum oxides and lacking most plant nutrients. The high amount of iron in the soils gives them a bright red or yellow color. Concentrations of aluminum can be high enough that the soil is mined as an ore (the ore of aluminum metal is called bauxite). In parts of the Brazilian Highlands, aluminum concentrations are so high as to be toxic to many plants. Native trees and shrubs have special adaptations to withstand these challenging conditions (Woodward 2008).

Soils developed on ancient surfaces composed of granitic rocks tend to be quite acidic (average pH = 4.9), further reducing the ability of the soil to hold nutrient bases. Another problem for plant life is the repeated wetting and drying of the iron-rich soils that can turn them into a brick-hard layer known as laterite. This hardpan prevents root penetration and halts the percolation of water during the rainy season, creating waterlogged soils or even temporary pools of standing water. The existence of laterite can be one reason for the lack of trees in some tropical savanna areas (Woodward 2008).

In some parts of the tropics, weathering and leaching have been neither so prolonged nor extreme. In well-drained areas and regions where the crystalline bedrock is not as old or has been more recently exposed than described above, soil-forming processes more like those of temperate regions (podzolization) are able to take place. Over much of eastern and southern Africa, for example, the savanna soils are less acidic (pH = 6.2) and somewhat more fertile than on the more ancient shield surfaces (Woodward 2008). On base-rich bedrock such as basalt or limestone, soils develop that are high in essential plant nutrients such as calcium and magnesium (both are bases). They typically have a high clay content that makes them swell during the wet season and shrink and crack during the dry season. Such soils have relatively high natural fertility and tend to be associated with grass savannas (Woodward 2008).

Soil types: The typical, iron- and aluminum-rich, low-nutrient soils of the ancient plateaus of Africa and South America are classified in the U.S. Soil Taxonomy (Soil Survey Staff 1999) as Oxisols. "Oxi" refers to the oxides of those two elements that are so concentrated by tropical soil-forming processes. Similar soils are also found in the Tropical Rainforest Biome. In other classifications, they are known as Latosols or lateritic soils (Woodward 2008). Where drainage is better or younger crystalline rock forms the parent material of the soils, the soils are Ultisols according to the U.S. Soil Taxonomy. "Ulti" means ultimate or last: the last of the nutrients have been removed by leaching (Woodward 2008). The more fertile soils developed on basalt or limestone and still containing abundant plant nutrients are among the Vertisols of the U.S. Soil Taxonomy (Soil Survey Staff 1999). "Vert" means turn. The swelling and shrinking of the clay mixes or turns the soil so that no true horizons can form. In other soil classification systems, they are more vividly named "black cracking soils" (Woodward 2008).

DISCUSSION

Discussion [optional]:

Animals [optional]: There can be no single description for animal life in the world's various tropical savannas. The popular view of savanna life comes from the game parks of eastern and southern Africa, where herds of large hoofed mammals, including *Equus* spp. (zebras), *Connochaetes taurinus* (wildebeest), *Hippotragus equines* (antelope) in delightful variety, as well as the great *Loxodonta africanus* (elephant), *Diceros bicornis* and *Ceratotherium* spp. (rhinoceroses), and *Giraffa* spp. (giraffes), dominate the scene. They truly represent one of the spectacles of nature, but they are not typical of savannas anywhere else. In most savannas small mammals, including rodents, rabbits, and hares, are more characteristic. In Australia, small marsupials resemble rodents and hares (Woodward 2008). Small mammals are usually nocturnal and seldom seen. Many seek refuge below ground during the warmest parts of the day: they are fossorial. Burrows also provide protection from the grass fires that are frequent at the end of the dry season for those that cannot run away from the flames. The small mammals tend to be omnivores, consuming green leaves, fruits, seeds, roots, and tubers, but also insects and other invertebrates. A considerable number focus almost exclusively on invertebrates, such as the extremely abundant termites and ants. Larger predators consume reptiles, birds, and rodents. Only Africa has a large number of both feline and canine carnivores that regularly hunt large mammals (Woodward 2008).

Scavengers play important roles in recycling animal matter. *Aegypius tracheliotus*, *Cathartes burrovianus*, *Gyps africanus*, *Torgos*

tracheliotus, and *Trigonoceps occipitalis* (vultures) are conspicuous components of the scavenger community in tropical savannas (Woodward 2008). On all three continents with natural savannas, mammals share the land with large, flightless birds known as ratites. *Struthio camelus* (ostrich) inhabit African savannas, *Dromaius novaehollandiae* (emu) occur in Australia, and *Rhea americana* (rhea) live in the South American grasslands. Other birds, possessing the ability to fly, are both abundant and diverse throughout the tropical savannas. An impressive number of larger predators and scavengers such as hawks and vultures are typical, as are smaller songbirds, many of which are seed-eaters. Both South America and Australia boast large numbers of fruit-eating parrots (Woodward 2008).

Reptiles are also abundant and diverse in tropical savannas. Vipers, pit vipers, and boas; *Ptenopus garralus* (geckos) and skinks; and *Geochelone* spp. and *Kinixys* spp. (tortoises) are characteristic in all. Chameleons occur in Africa, *Iguana iguana* (iguana) in South America (Woodward 2008). Frogs, tree frogs, and toads live in areas where open water is available all year or at least during every rainy season. Like the small mammals, most amphibians are active only at night, and some only during the wet season (Woodward 2008).

Probably the most important animal in the savanna ecosystem is a tiny invertebrate that is largely unseen, but occurs by the millions: *Macrotermes* spp. (termites). Although termites are visible only during the short period when winged individuals fly forth to form new colonies, the structures some species build above ground (mounds or termitaria) are conspicuous elements of all savannas (Woodward 2008).

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: This formation type is found in northern South America, western and southwestern Amazon Basin, Guiana Shield, Brazilian Shield, Western Africa (Guinea-Congolia/Sudania regional transition zone), sub-Sahel (Sudanian regional center), the Central African Plateau (Guinea-Congolia/Zambezia regional transition zone and the Zambezian regional center), and Eastern Africa (Somali-Masai regional center of endemism), northern Australia and Indomalaysia. They are typically located poleward of the Tropical Rainforest and Tropical Dry Forest biomes and form a transition between those forests and the deserts of the subtropics. The boundary between forest and savanna is often abrupt.

Nations [incomplete except for CA and US]: AU, BR, CG, ET, KE, MR, MZ, NA, SN, SO, TZ, US, ZA

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Tropical Savanna Biome (Woodward 2008)

Full Citation:

- Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Second edition. USDA Natural Resources Conservation Service, Washington, DC.
- *Woodward, S. 2008. Grassland Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012) after S. Woodward (2008)

Author of Description: C. Josse and D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Nov 2011

2. Shrubland & Grassland

2.A. Tropical Grassland, Savanna & Shrubland

2.A.2. Tropical Montane Grassland & Shrubland (F017)

OVERVIEW

Database Code: 2.A.2 (F017)

Scientific Name: Tropical Montane Grassland & Shrubland Formation

Common Name (Translated Scientific Name): Tropical Montane Grassland & Shrubland Formation

Colloquial Name: Tropical Montane Grassland & Shrubland

Hierarchy Level: Formation

Placement in Hierarchy: 2.A. Tropical Grassland, Savanna & Shrubland (S01)

Lower Level Hierarchy Units [incomplete]:

- 2.A.2.Ea. Tropical Andes Shrubland & Grassland (D134)
- 2.A.2.Eb. Caribbean & Central American Montane Shrubland & Grassland (D135)
- 2.A.2.Ec. Guyanan Montane Shrubland & Grassland (D136)
- 2.A.2.Ed. Parana Brazilian Montane Shrubland & Savanna (D137)
- 2.A.2.Fe. African Montane Grassland & Shrubland (D138)
- 2.A.2.Fj. Malagasy Montane Thicket & Sclerophyllous Shrubland (D168)
- 2.A.2.If. Indo-Malayan Montane Meadow (D139)
- 2.A.2.Lg. New Guinea Montane Meadow (D140)
- 2.A.2.Oh. Polynesian Montane Shrubland, Grassland & Savanna (D076)
- 2.A.2.Oi. Eastern Melanesian Montane Shrubland, Grassland & Savanna (D077)

Type Concept Sentence: Tropical Montane Grassland & Shrubland is dominated by shrubs and herbs with mesomorphic growth forms (predominantly tussock grasses, large rosette plants, shrubs with evergreen coriaceous and sclerophyllous - *ericoid* leaves, and cushion plants).

Type Concept: Tropical Montane Grassland & Shrubland is dominated by shrubs and herbs with mesomorphic growth forms (predominantly tussock grasses, large rosette plants, shrubs with evergreen coriaceous and sclerophyllous - *ericoid* leaves, and cushion plants). Vegetation structure varies from grasslands, with few short woody growth forms to a closed canopy of shrubs usually not taller than 1-2 m high. Spatially, patchy vegetation structure is typical due to both substrate heterogeneity and human influence characterized by periodic burning and grazing. The majority of the area covered by this vegetation corresponds to types that occur on tropical mountains above the limit of continuous, closed-canopy forest or forestline and below the sub-nival elevations, from 3000 to 4500 m (i.e., *páramo* and *puna*). Annual precipitation varies with the site and aspect of the location, from 50 to 300 cm, and seasonality is related to the rainfall rather than to temperature. The main difference between this formation and its temperate counterpart is the diurnal fluctuation of temperature, which can be of 20 degrees C or more in tropical high mountains (i.e., Andes, Africa), with no growth limiting season. Shrub and herbaceous vegetation of smaller tropical ranges (i.e., Central America, Southeast Asia and New Guinea) and on the summits of mountains of the Guyana Shield and the Brazilian *planaltos* (plateaus) are included here because they occur above the forest line (about 1600 m in the latter).

Classification Comments [optional]: In terms of overall physiognomy, this formation is closely related to 4.A.1 Tropical High Montane Scrub & Grassland Formation (F022) that has been placed within 4. Polar & High Montane Scrub & Grassland Class (C04), and many authors would place all of the vegetation described here in that formation (e.g., Quinn 2008). The main reason for this split is that in the Tropics, the true cryomorphic vegetation grows above 4300 m elevation up to the permanent snowline, with mean annual temperatures <3 degrees C, and soils have cryomorphic features (such as cryoturbation). Physiognomic distinctions are mostly based on the ground cover of the formation, which is continuous as compared to the low, semi-open coverage of the tropical cryomorphic formations.

Still, as defined here, 2.A.2 Tropical Montane Grassland & Shrubland Formation (F017) often is found at elevations above 3000 m, which means that 2.A.1. Tropical Lowland Grassland, Savanna & Shrubland Formation (F019) extends up to 3000 m. This may be problematic with respect to the use of Montane versus Lowland as used for descriptions of tropical forests. This formation is near to sometimes above treeline, but many will associate montane with a mid-elevation forest zone, including lower and upper montane forests.

Do we need savanna in the name of the formation, if we are at or near treeline?

Similar NVC Types:

- 4.A.1. Tropical High Montane Scrub & Grassland (F022): Many authors would place what is described in Tropical Montane Shrubland, Grassland & Savanna with this formation (e.g., Quinn 2008).

Diagnostic Characteristics: Herbaceous perennials (forbs and grasses) and small woody shrubs are predominant, with small rosette and large caulirosette plants with arborescent habit also present. The overall structure is semi-open to almost 100% coverage. The vegetation structure has irregular horizontal canopy spacing, except for the vast expanses of grassland communities in some locations.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT**Environmental Description [optional]:**

Climate: This formation occurs above the treeline of tropical mountains; the elevation range varies depending on the location, but it is the correlation between elevation and a decrease in temperature that, in natural conditions, generates the replacement of forested vegetation with grasslands and shrublands. There are other factors, such as the effect of recent glaciation periods, and anthropogenic disturbance as well. The variability in elevation range goes together with a great variation in climate among locations, but in general, the mean annual temperature for this type should be between 3 and 12 degrees C, with lower locations reaching a maximum of 18 degrees C average annual temperature, the greatest fluctuation in temperature occurring daily rather than seasonally. Due to the mountain setting, precipitation is highly variable as well, not only in the annual amount but its distribution, with some locales having a marked dry season and others more humid throughout the year.

Soil/substrate/hydrology: Given the volcanic origin of several tropical mountains, they have volcanic ash soils, with very high organic content and a high water-retention capacity. Other uplifts have formed metamorphic, sandstone or limestone ranges, with soils varying from shallow to deep, highly humic and forming clayish peat, in locations with permanently high moisture.

DISCUSSION**Discussion [optional]:****Animals [optional]:****Mapping Issues [optional]:****DISTRIBUTION**

Geographic Range: Tropical Montane Grassland & Shrubland occurs in the tropical mountain regions of Central and South America, Africa, Malaysia, including New Guinea, Hawaii, lower ranges in the Caribbean, and Brazil.

Nations [incomplete except for CA and US]: US

USFS Ecoregions (2005) [optional]:

Omerik Ecoregions [optional]:

CONFIDENCE LEVEL**Confidence Level:****Confidence Level Comments [optional]:****CITATIONS****Synonymy:**

- < Tropical Alpine Biome (Quinn 2008) [Quinn includes both the tropical montane and tropical high montane scrub band grassland in her type.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: C. Josse

Acknowledgments:

Version Date: 12 Jul 2012

2. Shrubland & Grassland

2.A. Tropical Grassland, Savanna & Shrubland

2.A.3. Tropical Scrub & Herb Coastal Vegetation (F024)

OVERVIEW

Database Code: 2.A.3 (F024)

Scientific Name: Tropical Scrub & Herb Coastal Vegetation Formation

Common Name (Translated Scientific Name): Tropical Scrub & Herb Coastal Vegetation Formation

Colloquial Name: Tropical Scrub & Herb Coastal Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 2.A. Tropical Grassland, Savanna & Shrubland (S01)

Lower Level Hierarchy Units [incomplete]:

- 2.A.3.Ed. Neotropical Coastal Scrub (D095)

- 2.A.3.Ob. Polynesian Scrub & Herb Coastal Vegetation (D078)
- 2.A.3.Oc. Eastern Melanesian Scrub & Herb Coastal Vegetation (D079)

Type Concept Sentence: Tropical Scrub & Herb Coastal Vegetation is found in tropical coastal habitats, including beaches, bluffs and dunes, where wind and water are major drivers of the vegetation, from the equator to 23 degrees N and S latitude, and is dominated by prostrate perennials on the beach and foredune, and graminoids and scrub on backdunes and bluffs.

Type Concept: Tropical Scrub & Herb Coastal Vegetation includes upland habitats found along the coast, including beaches, bluffs and dunes, where wind, water, and salinity are major drivers of the vegetation. They extend from the equator to 23 degrees N and S latitude, and occur along both coastal saline waters and large freshwater lakes. Beaches include the strip of sand or gravel that extends from the mean tideline to the top of the foredune (frontal foredune). The dune extends further inland wherever the sandy/gravelly site conditions restrict tree growth (<10% cover). Unconsolidated bluffs (but not marine rock cliffs) are more stable, relatively vertical habitats. The vegetation often has morphological (psammophytic) adaptations to these habitats, including prostrate herbaceous perennial growth forms, with mesomorphic leaves, neither succulent nor sclerophyllous, less commonly with annual herbs, and increasingly with perennial grasses and shrubs on the stabilized backdunes. The tropical coastal vegetation tends to have prostrate or low perennial grasses on the beach and foredune and have woody species (favored by the long growing season) on the backdunes. In drier tropical climates, there may be a shift to xeromorphic desert species.

Classification Comments [optional]: This formation is only weakly defined by growth forms. It may be a more appropriate division-level distinction, but it does provide a convenient grouping of very similar divisions across the globe; thus it may be a formation, based on global scale coastal ecological processes and justified by a bottom-up perspective. See discussion under 2.B.4. Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005).

There are windswept inland dunes that can appear similar to coastal environments. They may have established on more ancient coastal shorelines. Review is needed to determine whether the vegetation fits here or in 2.A.1. Tropical Lowland Grassland, Savanna & Shrubland Formation (F019).

In temperate coastal habitats, large perennial grasses are found, with a diversity of forbs, and with higher wind and wave energy. A zone of ephemerals (such as *Cakile*, *Atriplex*, and *Salsola*) is perhaps more common (Barbour 1992).

Similar NVC Types:

- 2.A.1. Tropical Lowland Grassland, Savanna & Shrubland (F019):
- 2.B.4. Temperate & Boreal Scrub & Herb Coastal Vegetation (F005): The strength of the tropical versus temperate distinction may be weak in these coastal habits, but annual or ephemeral herbs may be more common in temperate beaches.

Diagnostic Characteristics: The vegetation often has morphological (psammophytic) adaptations to these habitats, including prostrate herbaceous perennial growth forms, with mesomorphic leaves, neither succulent nor sclerophyllous, less commonly with annual herbs, and increasingly with perennial grasses and shrubs on the stabilized backdunes. The backdune may have more typical mesomorphic or xeromorphic scrub and herb vegetation.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: The vegetation often has morphological (psammophytic) adaptations to the beach, dune and bluff habitats, including prostrate herbaceous perennial growth forms, with mesomorphic leaves, neither succulent nor sclerophyllous, less commonly with annual herbs, and increasingly with perennial grasses and shrubs on the stabilized backdunes. The tropical coastal vegetation tends to have prostrate or low perennial grasses on the beach and foredune and woody species (favored by the long growing season) on the backdunes. In drier tropical climates, there may be a shift to xeromorphic desert species (Barbour 1992).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: Tropical Scrub & Herb Coastal Vegetation includes upland habitats found along the coast, including beaches, bluffs and dunes, where wind, water, and salinity are major drivers of the vegetation. Beaches include the strip of sand or gravel that extends from the mean tideline to the top of the foredune (frontal foredune). The dune extends further inland wherever the sandy/gravelly site conditions restrict tree growth (<10% cover). Unconsolidated bluffs (but not marine rock cliffs) are more stable, relatively vertical habitats (Barbour 1992).

Beach sand is typically enriched with nutrients and organic matter from the sea or lake. The permeability of the sandy substrate permits drainage and leaching, with a tendency towards arid systems. Proximity to the sea or lake induces permanently high air humidity and reduces climatic extremes. Sea-level changes constantly rework the substrate (Seeliger 1992). Winds are a constant influence.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation is found in tropical coastal habitats, including beaches, bluffs and dunes, from the equator to 23 degrees N and S latitude.

Nations [incomplete except for CA and US]: PR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Low

Confidence Level Comments [optional]: The beach and foredune part of the concept is most distinctive. Backdune grasslands and shrublands appear very similar to inland grasslands and shrublands, but floristically the vegetation of the foredune and backdune may be rather comparable.

CITATIONS

Synonymy:

- > Coastal foredunes of southern Brazil (Seeliger 1992) [The author uses the vegetation type as a name for a chapter in a book on Latin American coastal plant communities. Beaches are not described.]
- = The Dune Plant Community (Seeliger 1992) [The author uses the vegetation type as a name for a section in a book on Latin American coastal plant communities. Beaches and dunes are included.]

Full Citation:

- Barbour, M. G. 1992. Life at the leading edge: The beach plant syndrome. Pages 291-307 in: U. Seeliger, editor. Coastal Plant Communities of Latin America. Academic Press, Inc., New York.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Seeliger, U. 1992. Coastal foredunes of southern Brazil: Physiography, habitats and vegetation. Pages 367-381 in: U. Seeliger, editor. Coastal Plant Communities of Latin America. Academic Press, Inc., New York.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Nov 2011

2. Shrubland & Grassland

2.A. Tropical Grassland, Savanna & Shrubland

2.A.4. Tropical Bog & Fen (F002)

OVERVIEW

Database Code: 2.A.4 (F002)

Scientific Name: Tropical Bog & Fen Formation

Common Name (Translated Scientific Name): Tropical Bog & Fen Formation

Colloquial Name: Tropical Bog & Fen

Hierarchy Level: Formation

Placement in Hierarchy: 2.A. Tropical Grassland, Savanna & Shrubland (S01)

Lower Level Hierarchy Units [incomplete]:

- 2.A.4.Oa. Polynesian Bog & Fen (D017)
- 2.A.4.Oc. Eastern Melanesian Bog & Fen (D080)

Type Concept Sentence: Tropical Bog & Fen is found where peat-accumulating conditions occur in the cold, wet mountain highlands and in various floodplains of the lowlands, where trees are excluded. They are dominated by sedges, heath and moss peat.

Type Concept: In tropical regions of the world, peat-accumulating conditions occur in the cold, wet mountain highlands and in most of the floodplains of the lowlands, where peatlands have a fluctuating water table, with groundwater and surface water movements being common. "True" tropical bogs and fens, however, with sedge or moss peat are relatively rare. Tropical bogs occur in high, rainy regions, on flat to gently sloping, water-soaked ground with nearly impervious clay beneath peat of depths varying from <0.1 to >3 m. They are covered by a mixed vegetation of sedges and grasses, with scattered or clumped growth of dwarfed trees or shrubs.

Classification Comments [optional]: Tropical peat swamps, where tree cover exceeds 10%, are treated under 1.A.4. Tropical Flooded & Swamp Forest Formation (F029).

Similar NVC Types:

- 2.A.5. Tropical Freshwater Marsh, Wet Meadow & Shrubland (F030):

Diagnostic Characteristics: Tropical Bog & Fen is found where peat-accumulating conditions occur in the cold, wet mountain highlands and in various floodplains of the lowlands, where trees are excluded. They are dominated by sedges, heath and moss peat.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: "True" tropical bogs and fens, with sedge or moss peat, are relatively rare. Tropical bogs are covered by a mixed vegetation of sedges and grasses, with scattered or clumped growth of dwarfed trees or shrubs. Given the lack of information on tropical bogs and fens worldwide, a summary is provided from Hawai'i (Mueller-Dombois and Fosberg 1998).

The vegetation of most of the Hawaiian bogs may be a continuous or discontinuous dwarf-scrub interspersed with a matrix of hummocky sedges, usually with scattered emergent shrubs 1 or 2 m tall, or rarely, a bed of *Sphagnum* and grass with scattered shrubs and large ferns. Peatmoss (*Sphagnum* spp.) occurs in only a few Hawaiian bogs. Thus, peat is from sedges and grasses, with inclusions of woody peat. Most bogs are found as openings in rainforest, often next to cloud forests (Mueller-Dombois and Fosberg 1998).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: In tropical regions of the world, peat-accumulating conditions occur in the cold, wet highlands of the Andes and in the floodplains of the lowlands, where peatlands have a fluctuating water table, with groundwater and surface water movements being common, and trees are excluded. "True" tropical bogs and fens, however, with sedge or moss peat are relatively rare. Tropical bogs occur in high, rainy regions, on flat to gently sloping, water-soaked ground with nearly impervious clay beneath peat of depths varying from <0.1 to >3 m. Given the lack of information on tropical bogs and fens worldwide, a summary is provided from Hawai'i (Mueller-Dombois and Fosberg 1998).

Most Hawaiian bogs are on relatively flat ground underlain by more-or-less impervious clay in areas of high rainfall, usually exceeding 250 cm per year. They range in size from less than 1000 square m to over 5 ha. Organic overlays may vary from less than 10 cm ("protobogs" or "clay bogs") to those with less than 50 (40?) cm ("semi-bogs") to those with over 50 (40?) cm organic overlays ("true bogs"). The depth of the overlay is a function of age (some bogs originated over 11,000 years ago), temperature (with cooler locations having slower decomposition and greater peat depths) and anaerobic conditions (Mueller-Dombois and Fosberg 1998).

Two kinds of Hawaiian bogs can be distinguished: ombrogenous (fed by rainwater) and soligenous (fed by both rain- and groundwater). The first type can occur in areas of high rainfall, exceeding 12 m per year, so that the soil need not even be impervious for the bog to form. The second term, "soligenous bog" (or fen), is more appropriate for most Hawaiian bogs (Mueller-Dombois and Fosberg 1998).

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Tropical Bog & Fen is found where peat-accumulating conditions occur in the cold, wet mountain highlands and in various floodplains of the lowlands, where trees are excluded. In the U.S., the type is found in Hawaii.

Nations [incomplete except for CA and US]: US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- > Peatlands (Mitsch and Gosselink 2000) [Bogs and fens are treated together, but tropical and temperate bogs are not separated. Forested bogs are included.]
- > Peatlands (Roth 2009) [Bogs and fens are treated together, but tropical and temperate bogs are not separated. Forested bogs are included.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- Mueller-Dombois, D., and F. R. Fosberg. 1998. Vegetation of the tropical Pacific islands. Springer-Verlag, New York. 733 pp.
- Roth, R. A. 2009. Freshwater Aquatic Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and C. Josse

Acknowledgments:

Version Date: 16 Nov 2011

2. Shrubland & Grassland

2.A. Tropical Grassland, Savanna & Shrubland

2.A.5. Tropical Freshwater Marsh, Wet Meadow & Shrubland (F030)

OVERVIEW

Database Code: 2.A.5 (F030)

Scientific Name: Tropical Freshwater Marsh, Wet Meadow & Shrubland Formation

Common Name (Translated Scientific Name): Tropical Freshwater Marsh, Wet Meadow & Shrubland Formation

Colloquial Name: Tropical Freshwater Marsh, Wet Meadow & Shrubland

Hierarchy Level: Formation

Placement in Hierarchy: 2.A. Tropical Grassland, Savanna & Shrubland (S01)

Lower Level Hierarchy Units [incomplete]:

- 2.A.5.Ea. Neotropical Freshwater Marsh, Wet Meadow & Shrubland (D018)
- 2.A.5.Fc. Tropical Herbaceous Swamp & Aquatic Vegetation (D169)
- 2.A.5.Fd. Southern African Phreatophyte Vegetation (D170)
- 2.A.5.Fe. Western African Phreatophyte Vegetation (D171)
- 2.A.5.Ob. Polynesian & Eastern Melanesian Freshwater Marsh (D019)

Type Concept Sentence: Tropical Freshwater Marsh, Wet Meadow & Shrubland includes freshwater wet meadows, shallow and deep emergent marshes, with the upper limits of salinity at 0.5 ppt, above which it is considered saltwater. The vegetation comprises evergreen emergent aquatic macrophytes, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes, floating-leaved and submergent species, and nonvascular plants such as brown mosses, liverworts, and macroscopic algae. It is found widely throughout wetland habitats of the tropical latitudes, from the equator to about 23 degrees N and S.

Type Concept: Tropical Freshwater Marsh, Wet Meadow & Shrubland includes wet meadows, shallow and deep emergent marshes. These wetlands have shallow water and levels that usually fluctuate daily, seasonally or annually due to tides (freshwater tidal), flooding, evapotranspiration, groundwater recharge, or seepage losses, with the upper limits of salinity at 0.5 ppt, above which it is considered saltwater. The vegetation comprises evergreen emergent aquatic macrophytes, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes, floating-leaved and submergent species, and nonvascular plants such as brown mosses, liverworts, and macroscopic algae. Vegetation is usually arranged in distinct zones of parallel or concentric patterns in response to gradients of water depth, frequency of drawdown, water chemistry or disturbance. Saline or brackish non-tidal marshes are included here. Seasonal drawdowns may expose mudflats which are revegetated by pioneering herb and grass species. The vegetation of seasonal marshes is dynamic. It shifts spatially with water levels and changes in composition over a short time, whereas the vegetation of semipermanent marshes usually is more stable, represented by stands of reeds which may persist for many years in the absence of severe drought.

Classification Comments [optional]: Further review is needed of the similarities and differences between temperate and tropical freshwater marshes.

Similar NVC Types:

- 2.A.4. Tropical Bog & Fen (F002): Tropical Freshwater Marsh, Wet Meadow & Shrubland (F030) more typically contains muck soils and lacks the heath and moss layers found in this bog and fen formation (F002).
- 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013):

Diagnostic Characteristics: The vegetation comprises evergreen emergent aquatic macrophytes, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes, floating-leaved and submergent species, and nonvascular plants such as brown mosses, liverworts, and macroscopic algae, with tree cover less than 10%, with the upper limits of salinity at 0.5 ppt, above which it is considered saltwater, and where freezing temperate are rare to absent.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical Freshwater Marsh, Wet Meadow & Shrubland vegetation predominantly comprises evergreen emergent aquatic macrophytes, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes, floating-leaved and submergent species, and nonvascular plants such as brown mosses, liverworts, and macroscopic algae. There is a greater proportion of evergreen herbaceous plants in this tropic type, as compared to the temperate type. Vegetation is usually arranged in distinct zones of parallel or concentric patterns in response to gradients of water depth, frequency of drawdown, water chemistry or disturbance. Seasonal drawdowns may expose mudflats which are revegetated by pioneering herb and grass species.

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: These wetlands have shallow water and levels that usually fluctuate daily, seasonally or annually due to tides (freshwater tidal), flooding, evapotranspiration, groundwater recharge, or seepage losses, with the upper limits of salinity at 0.5 ppt, above which it is considered saltwater. Seasonal drawdowns may occur.

The occurrence of large savanna extensions in flat land (Orinoco basin and Beni savannas), as well as of numerous lakes in the Amazon basin, create some unique tropical geomorphological settings that in the seasonal savannas are occupied by permanent marshes dominated by herbs such as *Cyperus giganteus* and *Thalia geniculata*, and seasonally inundated savannas that are dominated by grasses (*Hymenachne amplexicaulis*, *Panicum mertensii*, *Paspalum fasciculatum*). The vegetation surrounding the Amazonian lakes varies from flooded forest to dense aquatic vegetation formations, and the freshwater marshes belong to the more stable conditions in this gradient created by the river's dynamics.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation is found widely throughout wetland habitats of the tropical latitudes, from the equator to about 23 degrees N and S.

Nations [incomplete except for CA and US]: PR, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- > Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, and inland saline marshes are included here too, and both emergent and aquatic vegetation.]
- > Nontidal Freshwater Marshes (Roth 2009) [It is not clear whether non-tidal salt marshes are included here. Both tropical and temperate marshes are treated together.]
- > Tidal Freshwater Marshes (Roth 2009) [Both tropical and temperate marshes are treated together.]
- > Tidal Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, and both emergent and aquatic vegetation.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.
- Roth, R. A. 2009. Freshwater Aquatic Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: C. Josse and D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments:

Version Date: 16 Nov 2011

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland (S18)

OVERVIEW

Database Code: 2.B (S18)

Scientific Name: Temperate & Boreal Grassland & Shrubland Subclass

Common Name (Translated Scientific Name): Temperate & Boreal Grassland & Shrubland Subclass

Colloquial Name: Temperate & Boreal Grassland & Shrubland

Hierarchy Level: Subclass

Placement in Hierarchy: 2. Shrubland & Grassland (C02)

Lower Level Hierarchy Units:

- 2.B.1. Mediterranean Scrub & Grassland (F038)
- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012)
- 2.B.3. Boreal Grassland, Meadow & Shrubland (F028)
- 2.B.4. Temperate & Boreal Scrub & Herb Coastal Vegetation (F005)
- 2.B.5. Temperate & Boreal Bog & Fen (F016)
- 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013)
- 2.B.7. Salt Marsh (F035)

Type Concept Sentence: Temperate & Boreal Grassland & Shrubland is dominated by mesomorphic grasses and shrubs, with or without scattered trees (and trees typically <10% cover), ranging from temperate coastal and inland lowland and montane grasslands and shrublands, to bogs, fens, and marshes, with a strongly seasonal climate, with at least some frost to extended cold seasons.

Type Concept: Temperate & Boreal Grassland & Shrubland occurs in areas of moderately dry to wet, continental, coastal and Mediterranean climates, and is most abundant in North America, Eurasia (the steppes), South America, and parts of Southern Africa and Australia. The vegetation varies from grasslands of open to dense bunch or sod grasses, often with scattered shrubs or trees, to low (<2 m) open to dense shrublands and sclerophyllous or soft chaparral scrub, and trees absent to scattered (<10% cover), and sedge meadows and marshes. Xeromorphic growth forms are largely absent; the surface layer has a thin to thick litter and duff layer, posed in contrast to desert grassland and scrub, where the surface layer may be bare, or contain a biological crust. Structure is a single, major grass or shrub stratum, or a mix of the two, typically exceeding 10-20% cover. This is ecologically a very heterogeneous subclass as there are a number of drivers that can preclude establishment of forest vegetation in these climates; including climatic characteristics, water regime (droughty to wet habitats), and fire and flooding disturbances.

Classification Comments [optional]: Desert grasslands are treated in 3. Desert & Semi-Desert Class (C03) based on the typical presence or abundance of xerophytic woody growth forms, or perhaps presence/abundance of ephemerals plants. Review of herbaceous growth forms is needed to determine if there are forms that more clearly distinguish desert grasslands from temperate grasslands.

Inclusion of wetlands and uplands makes this subclass somewhat heterogeneous, but all types share a primarily mesomorphic set of shrub and herb growth forms, and the various upland and wetland distinctions are deferred until the formation level. Still, it is tempting to consider separating out the vegetation of emergent wetlands from that of "uplands."

Similar NVC Types:

- 1.B. Temperate & Boreal Forest (S15): Temperate & Boreal Grassland & Shrubland (S18) tree cover is <10%.
- 2.A. Tropical Grassland, Savanna & Shrubland (S01):
- 3.B. Cool Semi-Desert Scrub & Grassland (S11): Temperate & Boreal Grassland & Shrubland (S18) typically lacks the microphyllous leaved shrubs, more open and short grasses, and dry soils of cool semi-desert formation (S11), but dry grasslands, such as shortgrass prairies in North America, may have many similarities to cool semi-deserts.
- 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04): Temperate & Boreal Grassland & Shrubland (S18) contains many rocky river and lake shoreline types.

Diagnostic Characteristics: Temperate & Boreal Grassland & Shrubland is dominated by mesomorphic grasses or grasses and shrubs, with or without scattered trees (and trees typically <10% cover), ranging from temperate coastal and inland lowland and montane grasslands and shrublands, to bogs, fens, and marshes, with a strongly seasonal climate, with at least some frost and with extended strong cold seasons.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: The vegetation varies from grasslands of open to dense bunch or sod grasses, often with scattered shrubs, to low (<2 m) open to dense shrublands and sclerophyllous or soft chaparral and drought-deciduous scrub.

Xeromorphic growth forms are largely absent, and the surface layer contains a thin to thick litter and duff layer in contrast to desert grassland and scrub, where the surface layer may be bare or contain a biological crust. Structure is a single, major grass or shrub stratum, or a mix of the two, with mesomorphic tree cover <10-20%, rarely with bare ground (Whittaker 1975).

The range of variation in upland formations corresponds to Mediterranean, Temperate, Boreal, and Coastal climatic gradients. A sketch of the range of variation for the wetlands within the subclass is provided in Table 1.

Table 1. Major wetland types used to guide formation distinctions within the temperate and boreal region. Types and definitions are adapted from the National Wetlands Working Group (1997) and Mackenzie and Moran (2004).

Wetland Type	Definition	Environmental features	Growth forms	Mitsch & Gosselink (2000) type
Temperate & Boreal Bog & Fen	Bogs are shrubby, nutrient-poor peatlands with distinctive communities of ericaceous shrubs and hummock-forming <i>Sphagnum</i> species, sometimes with sedges, adapted to high acid and oxygen-poor soil conditions. Trees >2 m have <10% cover (rarely, raised bogs may contain some forested stands). The vegetation of bogs and poor fens overlap, and are sometimes treated together as "acid peatland."	+/- ombrotrophic pH <4.5 >40 cm fibric/mesic peat.	Stunted (<2 m tall) needle-leaved tree, low shrub, dwarf-shrub (ericaceous), sphagnum.	Peatland
	Fens are peatlands where groundwater inflow maintains relatively moderate to high mineral content within the rooting zone. Sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses (often mixed with <i>Sphagnum</i>). A gradient from poor fen to rich fen is often described. Poor fens overlap with bogs and are sometimes treated as "acid peatland" separate from "alkaline peatland."	Groundwater-fed pH >4.5 (approximate ranges include poor fen 4.5-5.5, medium or intermediate fen 5.5-6.5, rich fen 6.5-7.5 and extremely rich fen >7.5). >40 cm fibric/mesic peat.	Low shrub (often non-ericaceous), sedge (often fine), grass, reed, and brown moss, often mixed with sphagnum.	Peatland
Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	A marsh-wet meadow is a shallowly flooded or saturated wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes and wet meadows, with early season high water tables and some flooding dropping through the growing (or dry) season, and exposure of the substrate or drying of the profile possible in late (or high of dry) season or drought years. Shrub wetlands (shrub carrs) occupy similar sites to wet meadows.	Mineral soils or well-humified peat. Protracted shallow flooding (0.1 to 2.0 m) or prolonged soil profile saturation.	Grass, sedge (often coarse), forb, low shrub, tall shrub.	Freshwater marshes Tidal freshwater marshes riparian ecosystem (wetland, herb/shrub)
Salt Marsh (temperate and tropical?)	Saltwater marshes are intertidal to supratidal ecosystems that are flooded diurnally (or less), sometimes with freshwater inputs, and have communities	Intertidal and supratidal zones, semi-diurnal to diurnal, flooding by brackish or saltwater [<i>n.b. inland</i>	Grass, sedge, forb, halophytic (succulent) forb, halophytic shrub.	Tidal salt marshes

	dominated by salt-tolerant emergent graminoids and succulents.	<i>non-tidal saline wet meadows may also be placed here]</i>		
Wetlands Treated Elsewhere				
Flooded & Swamp Forests (I.A.4, I.B.3, I.B.5)	A swamp forest is a tree-dominated mineral or peat wetland, on sites with a flowing/flooded or fluctuating semipermanent, near-surface water table. A flooded forest occurs on sites where flooding varies from temporary (<7 days) to semipermanent (>180 days).	Mineral soils or well-humified peat, temporary to semipermanent flooding (0.1 to 2 m deep), rarely saline.	Broad-leaved tree, needle-leaved tree, tall shrub, forb, graminoid, hydromorphic herb (rarely), trees >10% cover.	Freshwater swamps Riparian ecosystems (wetland, tree)
Mangrove (I.A.5)	Mangroves occur in the intertidal and brackish backwater of estuarine areas in tropical regions.	Intertidal and supratidal zones, semi-diurnal to diurnal, flooding by brackish or saltwater.	Mangrove, halophytic shrub, halophytic (succulent) forb, graminoids.	Mangrove swamps
Aquatic Vegetation (5.A., 5.B)	Aquatic wetlands are shallow waters dominated by rooted, submerged and floating aquatic plants. They are associated with permanent still or slow-moving waters, such as shallow potholes, ponds, rivers and lakes or in oceans. Aquatic plants may occur in mineral or in well-humified sedimentary peat.	+/-Permanent deep flooding (0.5-2 m), or deep water lakes and oceans.	Hydromorphic (aquatic) herb, emergents <10% cover.	

Floristics [optional]:**ENVIRONMENT**

Environmental Description [optional]: The vegetation occurs in areas of moderately dry to wet, continental, coastal and Mediterranean climates (moderately dry, warm temperate, maritime climates with little or no summer rain). This is ecologically a very heterogeneous subclass as there are a number of drivers that can preclude establishment of forest vegetation in these climates, including climatic characteristics, water regime (droughty to wet habitats), and fire and flooding disturbances. See Table 1 above.

DISCUSSION**Discussion [optional]:****Animals [optional]:****Mapping Issues [optional]:****DISTRIBUTION**

Geographic Range: This subclass occurs in the middle latitudes (25 to 60-70 degrees N and S latitude) of both hemispheres, and is most abundant in North America, Eurasia (the steppes), South America, and parts of Southern Africa and Australia. Specific latitudes depend upon the continent on which they are located.

Nations [incomplete except for CA and US]: AR, AU, BR, CA, CL, CN, ES, FR, GR, IL, IT, LS, MA, MN, MX, RU, TN, US, UY, ZA

USFS Ecoregions (2005) [optional]:**Omerik Ecoregions [optional]:****CONFIDENCE LEVEL****Confidence Level:** High

Confidence Level Comments [optional]: Inclusion of wetland and uplands (as well as climatic drivers and disturbance drivers) makes this subclass somewhat heterogeneous.

CITATIONS**Synonymy:**

- > Temperate Grassland Biome (Woodward 2008) [Woodward treats the upland part of this subclass only.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- MacKenzie, W. H., and J. R. Moran. 2004. Wetlands of British Columbia: A guide to identification. Land Management Handbook No. 52. Research Branch, British Columbia Ministry of Forests and Lands, Victoria, BC. 287 pp.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.
- Woodward, S. 2008. Grassland Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.1. Mediterranean Scrub & Grassland (F038)

OVERVIEW

Database Code: 2.B.1 (F038)

Scientific Name: Mediterranean Scrub & Grassland Formation

Common Name (Translated Scientific Name): Mediterranean Scrub & Grassland Formation

Colloquial Name: Mediterranean Scrub & Grassland

Hierarchy Level: Formation

Placement in Hierarchy: 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Lower Level Hierarchy Units [incomplete]:

- 2.B.1.Ef. Chilean Mediterranean Scrub (D106)
- 2.B.1.Fd. South African Cape Mediterranean Scrub (D107)
- 2.B.1.Le. Australian Mediterranean Scrub (D108)
- 2.B.1.Na. California Scrub (D020)
- 2.B.1.Nb. California Grassland & Meadow (D021)
- 2.B.1.Pb. Mediterranean Basin Dry Grassland (D104)
- 2.B.1.Pc. Mediterranean Basin Scrub (D103)
- 2.B.1.Pd. Mediterranean Basin Montane Grassland & Scrub (D105)

Type Concept Sentence: Mediterranean Scrub & Grassland includes the sclerophyllous scrub that develops in Mediterranean climates found in the Mediterranean Basin, lowland California in the United States, west-central Chile, the western Cape Province of South Africa, and southwestern and southern Australia. It also includes Mediterranean grasslands, "wildflower fields" and prairies from California.

Type Concept: Mediterranean Scrub & Grassland includes the sclerophyllous scrub and herbaceous vegetation, which develop in Mediterranean climates (moderately dry, warm temperate, maritime climates with little or no summer rain). It occurs in the Mediterranean Basin, southwestern California in the United States, west-central Chile, the western Cape Province of South Africa, and southwestern and southern Australia. Sclerophyll-leaved growth forms prevail, but facultatively drought-deciduous "soft chaparral" forms may also occur. Mixed annual and perennial grasslands and non-grass "forblands" may also occur, with only scattered scrub. Size and coverage of the shrubs range from low subshrubs (<1 m) to arborescent (2 to 5 m tall) with a closed canopy, to below 1 m and quite open, in response to moisture and other factors. Fire may be a common to infrequent natural process. Dominant plants are affected by frequent fires. Sclerophyll woodlands and forest are excluded [see 1.B.1 Warm Temperate Forest Formation (F018)]. Grasslands are a mix of annual and perennial growth forms.

Classification Comments [optional]: Each region of Mediterranean scrub has developed unique names for the type, including in California, *chaparral* and *coastal scrub*; in Chile, *matorral* and *espinal*; in Spain, *tomillares*; in France or French-speaking countries, *maquis* or *garrigue*; in Greece, *phrygana*; in Israel, *bath'a* or *goresh*; in South Africa, *fynbos* and *strandveld*; and in Australia, *kwongan* and *mallee* (Kuennecke 2008).

Mediterranean grassland and meadow are included in this formation. In California, they are separated from Mediterranean scrub at the division level (2.B.1.Na. California Grassland & Meadow Division (D021)), and the vegetation includes the Central Valley and foothill herbaceous vegetation with more pronounced summer drought. These drier Mediterranean California grasslands resemble

desert grasslands. However, they have even less rain in the growing season than many desert grasslands. Although other Mediterranean regions of the world do have many annual species, California is the only region that has extensive annual-dominated herbaceous vegetation (T. Keeler-Wolf pers. obs. 2011).

California "coastal prairies," including diagnostics such as *Festuca rubra*, *Festuca idahoensis*, *Danthonia californica*, etc., are placed in 2.B.2 Temperate Grassland, Meadow & Shrubland Formation (F012) (2.B.2.Na Southern Vancouverian Lowland Grassland & Shrubland Macrogroup (M050)).

Placement of montane (oro-) Mediterranean vegetation needs further review. In California, the growth forms of this vegetation are common to other, primarily cool-temperate vegetation, with which it is placed (2.B.2 Temperate Grassland, Meadow & Shrubland Formation (F012)). In Europe, "Oromediterranean grasslands and scrub" is treated as a separate formation from either "Temperate grasslands, heaths and fringe vegetation" or "Mediterranean garrigue, maquis, matorral, tomillar and phrygna" vegetation (Rodwell et al. 2002). Perhaps the "oro-Mediterranean" distinction in Europe includes a "warm temperate montane grassland and scrub" not found in other continents? Such a distinction could be made at the division level, if the flora of the montane Mediterranean vegetation was largely distinct from the lowland coastal Mediterranean vegetation.

Similar NVC Types:

- 1.B.1. Warm Temperate Forest (F018): The vegetation contains tree growth forms with >10% cover. Combinations of dwarf scrubby trees <2 m with low shrubs may grade into Warm Temperate Forest.
- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): The vegetation tends to produce highest biomass in the warm to hot summers and become dormant in the winter cool or cold periods. Above-ground portions of perennial grasses dry and wither, or annuals set seed and die by late fall.

Diagnostic Characteristics: Sclerophyll-leaved shrub growth forms prevail, but soft chaparral and drought-deciduous forms may also occur. Size and coverage of the shrubs range from arborescent (2 to 5 m tall) with a closed canopy, to below 1 m and quite open. Mixed annual and perennial grasslands may also occur, with only scattered scrub. The vegetation tends to produce highest biomass in the cool rainy winter and becomes dormant in the summer drought. Above-ground portions of perennial grasses dry and wither, or annuals set seed and die by mid-spring to early summer. The type is restricted to the Mediterranean Basin, southwestern California in the United States, west-central Chile, the western Cape Province of South Africa, and southwestern and southern Australia.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Shrubs have adaptations to drought, nutrient-poor soils and fire. Broad-leaved evergreen, sclerophyllous shrubs dominate the vegetation of areas with higher and more predictable winter rainfall, while facultatively-deciduous shrubs, or perennial or annual herbs dominate where precipitation is lowest and less predictable. There is a complex variation of growth forms from woody sclerophyll to woody drought-deciduous shrubs and from perennial bunch grasses to perennial geophytes (bulbs, corms, etc. especially common in South Africa), and to ephemeral annual herbs depending upon the interactions of rainfall, soil texture, and type and intensity of natural processes such as fire, browsing/grazing, and bioturbation. Generally, sclerophylls occur where winter rain is adequate and predictable and soils are well-drained. Facultatively-deciduous scrub occurs in areas with drier or more unpredictable rainfall patterns and often occur on finer-textured soils than sclerophyll scrub. Perennial herbaceous vegetation such as bunch grasses occur in areas with relatively high precipitation, while annual herbs (forbs), dominate episodically following favorable winter rainfall events, but may be largely stored as seedbanks in the soil in low rainfall years. The vegetation tends to produce highest biomass in the cool rainy winter and becomes dormant in the summer drought. Above-ground portions of perennial grasses dry and wither, or annuals set seed and die by mid-spring to early summer. Small numbers of summer annuals also occur (mostly Asteraceae tribe Madiaceae in California) which take advantage of lingering deep soil moisture by having evolved long taproots.

Floristics [optional]: Many species that are components of the California grasslands have evolved "bet-hedging" strategies similar to desert ephemeral annuals where reproductive plasticity influences which genotypes of individuals of a given species will predominate in a given year. In most years except for the very driest, there will be some individuals flowering and setting seed. Although other Mediterranean regions of the world do have many annual species, California is the only region that has extensive annual-dominated herbaceous vegetation (T. Keeler-Wolf pers. obs. 2011). They tend to form a gradient from the driest semi-desert winter rainfall settings of the South Coast Ranges and western Mojave Desert where composition is almost entirely annual forbs (mostly Asteraceae, Boraginaceae, Hydrophyllaceae, Polemoniaceae, Scrophulariaceae, Papaveraceae, without Poaceae), to a more mixed assortment of annual and perennial grasses and broadleaf herbs in areas with relatively higher and more predictable winter rain.

ENVIRONMENT

Environmental Description [optional]:

Climate: The Mediterranean climate is characterized by dry summers and mild, humid, sometimes rainy winters. Annual precipitation averages 25-100 cm. Freezing temperatures are relatively rare. Wherever mountains and predominant wind directions

cause orographic effects (for example the rainfall increases on the windward side), annual precipitation at the higher elevations may be sufficient to support a change from scrub to woodland or forest (and these would be placed in 1.B.1 Warm Temperate Forest Formation (F018)). With increasing latitude, rainfall totals and length of the rainy season also increase, causing a comparable shift to woodland or forest (Kuennecke 2008). Many Mediterranean climate areas have been "invaded" by exotic annual grasses and other species which have tended to modify natural disturbance patterns such as fire (Keeley 2001).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: This formation occurs in the Mediterranean Basin, and in the Mediterranean climate regions of southwestern California in the United States, west-central Chile, the western Cape Province of South Africa, and southwestern and southern Australia, at latitudes between 31 and 46 degrees N in the Northern Hemisphere and between 28 and 42 degrees S in the Southern Hemisphere. These areas form on the western or southern margins of continents where warm-season high pressure tends to settle offshore driving all precipitation to the north or south of the adjacent shore areas.

Nations [incomplete except for CA and US]: AU, CL, ES, FR, GR, IL, IT, MA, MX, TN, US, ZA

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- > Chaparral-like Shrublands (Dallman 1998)
- > Coastal Scrub (Dallman 1998)
- = Mediterranean Woodland & Scrub Biome (Kuennecke 2008) [Approximately equivalent. Despite including woodland in the name, the author emphasizes that the concept of this type is primarily that of the scrub.]

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: T. Keeler-Wolf

Acknowledgments:

Version Date: 17 Nov 2011

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.2. Temperate Grassland, Meadow & Shrubland (F012)

OVERVIEW

Database Code: 2.B.2 (F012)

Scientific Name: Temperate Grassland, Meadow & Shrubland Formation

Common Name (Translated Scientific Name): Temperate Grassland, Meadow & Shrubland Formation

Colloquial Name: Temperate Grassland, Meadow & Shrubland

Hierarchy Level: Formation

Placement in Hierarchy: 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Lower Level Hierarchy Units [incomplete]:

- 2.B.2.Ek. Pampas Grassland & Shrubland (D141)
- 2.B.2.El. Southern Andean Shrubland & Grassland (D142)
- 2.B.2.Fm. Southern African Montane Grassland (D143)
- 2.B.2.Li. Australian Grassland & Shrubland (D112)
- 2.B.2.Lj. New Zealand Grassland & Shrubland (D113)
- 2.B.2.Na. Western North American Grassland & Shrubland (D022)
- 2.B.2.Nb. Great Plains Grassland & Shrubland (D023)
- 2.B.2.Nc. Eastern North American Grassland, Meadow & Shrubland (D024)
- 2.B.2.Nd. Western North American Interior Sclerophyllous Chaparral Shrubland (D061)
- 2.B.2.Ne. Southeastern North American Grassland & Shrubland (D102)
- 2.B.2.Pf. European Grassland & Heath (D109)
- 2.B.2.Pg. Western Eurasian Grassland & Shrubland (D110)
- 2.B.2.Ph. Eastern Eurasian Grassland & Shrubland (D111)

Type Concept Sentence: Temperate Grassland, Meadow & Shrubland is dominated by perennial grasses, forbs and shrubs typical of moderately dry to moist habitats, and is found in the mid-latitude regions of all continents (23 to 55 degrees N and S), varying from large open grassland landscapes to droughty hillside meadows in forested landscapes.

Type Concept: Temperate Grassland, Meadow & Shrubland is dominated by mesomorphic perennial grasses and forbs, and is found in the mid-latitude regions across the globe. It is associated with a moist to semi-arid climate and geographically occurs between temperate forests and deserts. The present plant assemblages were strongly affected by Pleistocene glaciations, though regions close to the equator may have retained vegetation back to the Tertiary.

Grasslands are a predominant type in this formation and each continent has its own popular name for its part of this formation. In North America, it is the prairie; in Eurasia, the steppe. South Americans usually refer to pampas and South Africans to the veld. The plants (and animals) of the North American and Eurasian sections of the biome are closely related, but have been impacted differently by Pleistocene and post-Pleistocene climate changes, human occupation and use, wildfires, and grazing pressures from both wild and domesticated large mammals. The origins of South America's pampas and southern Africa's veld are still poorly understood. Fire may be implicated, as it is a necessary management tool today in preventing the encroachment of woody plants.

In addition to the larger geographic areas of grasslands and associated shrublands, scattered grassland, shrub and forb vegetation within temperate forest formations are included.

Although mesomorphic perennial grasses and shrubs are the most common growth forms in this formation, a large number of other herbaceous plants, primarily perennial forbs, are also found. Trees are not major components of the vegetation, except as a scattered layer (typically <10% cover).

Classification Comments [optional]:

Similar NVC Types:

- 1.B.1. Warm Temperate Forest (F018): Open woodlands or tree savannas, with grassy or shrubby understories, and with trees 10% cover or more, are placed here, but may have strong floristic similarities to grasslands.
- 1.B.2. Cool Temperate Forest (F008): Open woodlands or tree savannas, with grassy or shrubby understories, and with trees 10% cover or more, are placed here, but may have strong floristic similarities to grasslands.
- 2.B.1. Mediterranean Scrub & Grassland (F038): The vegetation tends to produce highest biomass in the cool winters, and become dormant in the summer hot periods. Above-ground portions of perennial grasses dry and wither, or annuals set seed and die by late spring.
- 2.B.3. Boreal Grassland, Meadow & Shrubland (F028): Temperate Grassland, Meadow & Shrubland (F012) is currently separated based on geography and climate from boreal grassland (F028), but more specific vegetation criteria are needed.
- 2.B.4. Temperate & Boreal Scrub & Herb Coastal Vegetation (F005): Temperate Grassland, Meadow & Shrubland (F012) has similarities to coastal vegetation, especially between coastal and inland dunes in terms of growth forms and even wind-driven processes.
- 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013): Temperate Grassland, Meadow & Shrubland (F012) transition, such as wet-mesic or moist grasslands and prairies, may be very similar to freshwater marshes and wet meadows (F013).
- 3.B.1. Cool Semi-Desert Scrub & Grassland (F033): Typically with small leaved, xerophytic shrubs (e.g., sage) and more open bare ground, sometimes with biological crust.
- 7.B.2. Pasture - Hay Field & Crop (F045): Temperate Grassland, Meadow & Shrubland (F012) may overlap in composition with pasture grasslands (F045), particularly in grassland regions. And in regions where a pastoral tradition has existed from 100s to 1000s of years, recognition of native versus agricultural grasslands may be challenging.

Diagnostic Characteristics: Mesomorphic perennial grasses and shrubs are the most common growth forms in this formation, with a variable amount of perennial forbs. Trees are scattered to largely absent (typically <10% cover). Stands are found in the mid-latitude regions of all continents, typically associated with semi-arid climates or stressful sites in moist climates in the mid latitudes (23 to 55 degrees N and S).

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Mesomorphic perennial grasses and shrubs are the most common growth forms in this formation, with a variable amount of perennial forbs. Trees are scattered to largely absent (typically <10% cover). Grasses and forbs grow to different heights at maturity. Furthermore, some grasses and most forbs are erect, while others are recumbent, creeping along the ground. Thus a distinct layering of plant foliage occurs in some temperate grasslands. Forbs and grasses may grow and bloom at different times during the growing season, so temperate grasslands may have recognizable color phases, or aspects, depending upon what plants are blooming. This is especially evident in the east European steppes. Grasses and perennial forbs are well-suited to withstand cold seasons and tolerate grazing and fire because of the position of their renewal buds near the ground surface. The plants are generally able to regenerate from these buds after seasonal die-downs, burns, or cropping by grazing animals (Woodward 2008). Among the grasses, both sod-forming and bunch grasses are prominent throughout, but bunch grasses become a much more frequent component of the vegetation in the drier short-grass regions.

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: Gradation in precipitation amounts occurs in most regional expressions of the biome and is mirrored in the zonation pattern of the vegetation and animal life in each. In some instances, such as in North America, longitudinal zones dominate and replace each other in an east-west direction across the mid-continent. In other areas, latitudinal zonation is prominent and plant and animal communities change in a north-south direction. Still other natural grasslands are a consequence of rainshadows on the lee sides of major mountain ranges or of high elevation, as is the case in southern Africa (Woodward 2008).

Climate: Temperate grasslands have developed in regions having a semi-arid climate (mostly BSk in the Koeppen climate classification). Mid-latitude semi-arid climate regions receive 25-75 cm (10-20 inches) of precipitation a year. In some areas (most notably the mid-continental prairie of North America and the East European steppes of Eurasia), a significant amount falls as snow during the winter months, such that snowmelt contributes importantly to soil moisture in early spring. The interior position of grasslands on the large North American and Eurasian continents results in the wide annual range in temperatures, a temperature

pattern that is considered typical for the biome. Winters see temperatures well below freezing, whereas summers can be scorchingly hot. Such a temperature pattern is described by climatologists as continental. Similar temperature conditions often occur in humid forested regions at the same latitudes (Woodward 2008).

North American and Eurasian grasslands owe their existence to their positions in the middle of large continents, where precipitation is reduced and temperature extremes are pronounced. The South American grasslands lie in the rainshadow east of the Andes Mountains. In Africa, elevation is a factor. According to latitude alone, these African grasslands are subtropical, but the elevated surface at the southern end of the African Plateau creates regional temperature patterns similar to middle latitude conditions (Woodward 2008).

In all regions of the formation, gradual changes in climate occur across great distances. In Eurasia, the variation occurs in a north-south direction. The wetter (subhumid) northern regions of the Temperate Grassland borders the Cool Temperate Forest and Boreal Forest formations, and the drier (arid) southern margins grade into the Desert formations. In the Americas, the gradation from subhumid to arid runs in an east-west direction, with precipitation becoming progressively less the farther west one goes. In all areas a change in vegetation coincides with the change in total precipitation. Wetter areas contain taller grass species and usually a greater variety of plants and animals than do the shorter grass areas in the driest parts of the biome (Woodward 2008).

Soil/substrate/hydrology: The soils beneath prairies, steppes, pampas, and highveld are among the most fertile on Earth. Once the technology was available to break through the thick sod, many grasslands were converted to agriculture. Wheat and corn replaced native grasses, and the temperate grasslands became the breadbaskets of their respective countries (Woodward 2008).

Soils Comments [optional]: *Formation of Temperate Grassland soils:* The underground portion of the grass plant is equally, if not more, important to the functioning of the ecosystem and formation of soil. Grasses develop a dense, intricate system of fine roots that not only acts to hold the plant in place but absorbs water and nutrients from the soil and stores some of the carbohydrates that the plant manufactures during photosynthesis for later use. In fact, more living plant matter (biomass) exists below ground in the temperate grasslands than above. Roots continually grow, die, and decay and thus contribute organic matter in the form of humus to the soil. The fine roots create a crumbly texture to the soil that allows water and air to penetrate to depths up to 3.5 m (12 feet) in the wetter parts of the biome, further enhancing the soil environment for plant growth. Those soluble compounds (e.g., calcium carbonate and magnesium carbonate) that might be leached to depth after rainstorms or snowmelt can be returned to the root zone during dry periods by capillary action along the tiny tunnels left by dead roots. The carbonates precipitate out near the top of the subsoil (B-horizon) when the soil moisture evaporates. The concentration of carbonates in this manner is the main feature of the soil-forming process known as calcification, which is characteristic of semi-arid and arid climate regions. The carbonate-rich layer forms closer to the surface the drier the climatic conditions (Woodward 2008).

Soil types: Grassland soils of temperate regions are classified in U.S. Soil Taxonomy as Mollisols. The prefix "moll" means soft and describes the friable or crumbly texture of these soils that persists even when the top layers dry out. (Other parts of the world and the United Nations Food and Agriculture Organization use other names. In Canada they are called chernozemic soils; in Russia they are chernozems.) Mollisols are brown in color due to the abundance of humus in both the topsoil and subsoil (A and B horizons). Color varies from dark brown and even black to chestnut brown and light brown as climate changes from subhumid to dry and grasses change from tall with deep roots to short with shallow roots. For the darkest of all, the truly black soils, the Russian name *Chernozem* (meaning black soil) is used, even in the United States. Chernozems have especially deep A and B horizons (each up to 1 m [3 feet] deep), both of which are dark with humus and humic acid stains. They have formed where semi-arid regions receive the most precipitation and where the parent material is a fine, windblown material known as loess. Loess originated as tiny particles on the newly exposed bare ground at the edge of continental glaciers when ice sheets retreated at the end of the Pleistocene ice age. Winds coming off the ice picked the dust-like material up and carried it to more humid, vegetated regions, where it accumulated. Thick deposits of loess occur in the Central Lowlands of North America, across much of semi-arid Eurasia, and in Uruguay and eastern parts of Argentina. Loess is often rich in carbonates. The soils developed upon it are among the most fertile in the world, and today they produce much of the world's wheat and corn (both of which are domesticated grasses) (Woodward 2008).

DISCUSSION

Discussion [optional]:

Animals [optional]: The herbivorous mammals of the temperate grasslands generally can be placed in one of two groups: fast-running ungulates that move in either small or large herds or burrowing rodents that live in colonies. It appears to be an advantage in an open habitat to have many sets of ears and eyes alert to danger. The largest predators, at least in North America and Eurasia, were wolves, but they have largely been exterminated. The smaller predators surviving today include members of the dog, cat, and weasel families (Woodward 2008). Animal diversity is relatively low, especially in comparison to the animals of some tropical grasslands. Large mammals are generally rare or already extinct. Different species are found in each part of the biome (Woodward 2008).

Birds in the grasslands are by necessity ground-nesters and some are good runners. Partridge- or grouse-like birds are common.

Reptiles are represented by both snakes and lizards, but neither group is especially diverse. Amphibians are primarily the tail-less forms, the frogs and toads, and are associated with ponds and streams (Woodward 2008). By far the most important herbivores are insects. Grasshoppers are especially abundant (Woodward 2008).

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Temperate grasslands and shrublands occur in the middle latitudes (25-55 degrees latitude) of both hemispheres. Specific latitudes depend upon the continent on which they are located. The largest areas of this formation are found in the Northern Hemisphere on the North American and Eurasian continents. Smaller but still major segments of the formation are found in the Southern Hemisphere in South America and southern Africa (Woodward 2008).

Nations [incomplete except for CA and US]: AR, BR, CA, CL, CN, LS, MN, MX, RU, US, UY, ZA

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level:

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Temperate Grassland (Woodward 2008) [Despite the name, shrublands found within the grassland regions are included in Woodward's concept.]

Full Citation:

- Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- *Woodward, S. 2008. Grassland Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012) after S. Woodward (2008)

Author of Description: D. Faber-Langendoen and J. Messick

Acknowledgments:

Version Date: 17 Nov 2011

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.3. Boreal Grassland, Meadow & Shrubland (F028)

OVERVIEW

Database Code: 2.B.3 (F028)

Scientific Name: Boreal Grassland, Meadow & Shrubland Formation

Common Name (Translated Scientific Name): Boreal Grassland, Meadow & Shrubland Formation

Colloquial Name: Boreal Grassland, Meadow & Shrubland

Hierarchy Level: Formation

Placement in Hierarchy: 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Lower Level Hierarchy Units [incomplete]:

- 2.B.3.Na. North American Boreal Grassland, Meadow & Shrubland (D025)
- 2.B.3.Pb. Eurasian Boreal Grassland, Meadow & Shrubland (D114)

Type Concept Sentence: Boreal Grassland, Meadow & Shrubland is dominated by mesomorphic perennial grasses, forbs and shrubs, and is found in the northern mid-latitude (boreal) regions of North America and Eurasia, between 55 and 70 degrees N, with extended cold winters and short mild summers.

Type Concept: Boreal Grassland, Meadow & Shrubland is dominated by mesomorphic perennial grasses, forbs and shrubs, and is found in the northern mid-latitude (boreal) regions of North America and Eurasia. It is associated with cold semi-arid to moist climates, with extended cold winters and short mild summers, and geographically occurs mixed with boreal forests and wetlands. The climate generally favors establishment of forest vegetation; thus, the absence of forest vegetation is a result of local conditions related to water regime, soil parameters or disturbance regimes. The present assemblages of plants and animals date to after the Pleistocene, following glaciation, when modern climates were established. Wildfires and grazing also play a role in some of these grasslands.

Along with the mesomorphic perennial grasses, shrubs, and forbs, mosses and lichens can also play an important role. Boreal tree growth forms are not major components of the vegetation, except as a scattered layer (typically <10%). In disturbance situations, Boreal Grassland, Meadow & Shrubland can grade to Boreal Forest and may not be clearly separated from it floristically.

Classification Comments [optional]: Clarification of the growth forms, distribution and extent, and ecological processes that control boreal shrublands and grasslands is needed. Examples of vegetation from western boreal include: (1) *Betula nana* and/or *Salix glauca* shrublands and *Festuca altaica* grasslands in cold air-influenced valleys and high-elevation areas below the alpine; (2) *Elymus trachycaulus* grassland or *Amelanchier alnifolia* / *Leymus innovatus* / *Arctostaphylos uva-ursi* scrub on warm aspects, often on coarse-textured materials; and (3) Post-fire disturbance vegetation that can be dominated by willows and may exclude tree regeneration.

Similar NVC Types:

- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): This type is currently separated based on geography and climate.

Diagnostic Characteristics: Mesomorphic perennial grasses and shrubs are the most common growth forms in this formation, with a variable amount of perennial forbs. Trees are scattered to minimally present (typically <10% cover) in the northern mid-latitude regions of North America and Eurasia, extending from cool temperate regions into the boreal region between 55 and 70 degrees N latitude.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]: There are no common floristic elements at this level.

ENVIRONMENT

Environmental Description [optional]:

Climate: There are lengthy periods of freezing temperatures with the coldest month isotherm of -3 degrees C, and the growing season generally averaging less than 100 days, occasionally interrupted by nights of below-freezing temperatures. Snow may be present for extended periods (7-10 months) and soils are frozen in winter. Annual precipitation is 38-50 cm (15-20 inches). The northern and southern boundary of these boreal grasslands may be similar to that of boreal forest, but the reasons for the presence of grassland and shrubland rather than forest typically reflects water regime, soil characteristics, disturbance regime, and local climate that prevent tree growth.

DISCUSSION

Discussion [optional]: This is a heterogeneous formation as it unites all treeless vegetation of different origins and ecological drivers within a certain climate that favors the tree vegetation.

Animals [optional]:

Mapping Issues [optional]: This is a useful formation from a mapping perspective, as it can be well-distinguished from forests on many remote sensing materials.

DISTRIBUTION

Geographic Range: This formation is found in the northern mid-latitude regions of North America and Eurasia, extending through much of the boreal region between 55 and 70 degrees N latitude.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Low

Confidence Level Comments [optional]: Clarification of the growth forms and extent of boreal shrublands and grasslands is needed. The low level of confidence is also related to the heterogeneous nature of ecological drivers and therefore vegetation. Due to this reason, the low confidence level can be increased by collecting more data.

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, S. Ponomarenko and D. Meidinger

Acknowledgments:

Version Date: 17 Nov 2011

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.4. Temperate & Boreal Scrub & Herb Coastal Vegetation (F005)**OVERVIEW****Database Code:** 2.B.4 (F005)**Scientific Name:** Temperate & Boreal Scrub & Herb Coastal Vegetation Formation**Common Name (Translated Scientific Name):** Temperate & Boreal Scrub & Herb Coastal Vegetation Formation**Colloquial Name:** Temperate & Boreal Scrub & Herb Coastal Vegetation**Hierarchy Level:** Formation**Placement in Hierarchy:** 2.B. Temperate & Boreal Grassland & Shrubland (S18)**Lower Level Hierarchy Units [incomplete]:**

- 2.B.4.Na. Eastern North American Dune & Coastal Grassland & Shrubland (D026)
- 2.B.4.Nb. Pacific North American Coast Scrub & Herb Vegetation (D027)
- 2.B.4.Nd. Arctic Coast Scrub & Herb Vegetation (D146)
- 2.B.4.Pe. Atlantic & Mediterranean Europe Coastal Scrub & Herb Vegetation [Honckenyo-Elymetea arenarii, Ammophiletea] (D190)
- 2.B.4.Pf. Atlantic & Mediterranean Europe Beach Strand Vegetation [Cakiletea maritima] (D191)

Type Concept Sentence: Temperate & Boreal Scrub & Herb Coastal Vegetation is found in temperate coastal habitats, including beaches, bluffs and dunes, where wind and water are major drivers of the vegetation, across the mid latitudes from 23 to 60-70 degrees N and S latitude, dominated by prostrate perennials on the beach and foredune, and graminoids and scrub on backdunes and bluffs.

Type Concept: Temperate & Boreal Scrub & Herb Coastal Vegetation includes upland habitats found along the coast, including beaches, bluffs and dunes, where wind, water, and salinity are major drivers of the vegetation. It extends across the mid latitudes from 23 to 60-70 degrees N and S, and occurs along both coastal saline waters and large freshwater lakes. Beaches include the strip of sand or gravel that extends from the mean tideline to the top of the foredune (frontal foredune). The dune extends further inland wherever the sandy/gravelly site conditions restrict tree growth (<10% cover). Unconsolidated bluffs (but not marine rock cliffs) are more stable, relatively vertical habitats. The vegetation often has morphological (psammophytic) adaptations to these habitats, including prostrate herbaceous annual growth forms, with mesomorphic leaves, neither succulent nor sclerophyllous, less commonly with perennial herbs, and increasingly with perennial grasses and shrubs on the stabilized backdunes. Temperate coastal habitats tend to have large perennial grasses, with a diversity of forbs, and have higher wind and wave energy. A zone of ephemerals (such as *Cakile*, *Atriplex*, and *Salsola*) is perhaps more common (Barbour 1992).

Classification Comments [optional]: This formation is only weakly defined by growth forms. It may be a more appropriate division-level distinction, but it does provide a convenient grouping of very similar divisions across the globe; thus it may be a formation, based on global scale coastal ecological processes and justified by a bottom-up perspective [see Table 1].

Table 1. Grassland and Shrubland Formations and Divisions of the Northern Hemisphere (Southern Hemisphere not shown).

2.B.2 Temperate Grassland, Meadow, Shrubland & Savanna		
	D022	2.B.2.Na Western North American Grassland & Shrubland
	D023	2.B.2.Nb Great Plains Grassland & Shrubland
	D024	2.B.2.Nc Eastern North American Grassland, Meadow & Shrubland
	D061	2.B.2.Nd Western North American Interior Sclerophyllous Chaparral Shrubland
	D102	2.B.2.Ne Southeastern North American Grassland & Shrubland
	D109	2.B.2.Pf European Grassland & Heath
	D110	2.B.2.Pg Western Eurasian Grassland & Shrubland
	D111	2.B.2.Ph Eastern Eurasian Grassland & Shrubland
2.B.3 Boreal Grassland, Meadow & Shrubland		
	D025	2.B.3.Na North American Boreal Grassland, Meadow & Shrubland
	D114	2.B.3.Pb Eurasian Boreal Grassland, Meadow & Shrubland
2.B.4 Temperate & Boreal Scrub & Herb Coastal Vegetation		
	D026	2.B.4.Na Eastern North American Dune & Coastal Grassland & Shrubland

D027	2.B.4.Nb Pacific North American Coast Scrub & Herb Vegetation
D028	2.B.4.Nc Eastern North American Atlantic Rim Beach Strand Vegetation
D146	2.B.4.Nd Arctic Coast Scrub & Herb Vegetation [not temperate.boreal]?
D190	Atlantic & Mediterranean Europe Coastal Scrub & Herb Vegetation [Honckenyo-Elymetea arenarii, Ammophiletea]
D191	Atlantic & Mediterranean Europe Beach Stand Vegetation [Cakiletea maritima]

There are windswept inland dunes that can appear similar to coastal environments. They may have established on more ancient coastal shorelines. Review is needed to determine whether the vegetation fits here or in 2.B.2. Temperate Grassland, Meadow & Shrubland Formation (F012).

The tropical coastal vegetation tends to have prostrate or low perennial grasses on the beach and foredune and have woody species (favored by the long growing season) on the backdunes. In drier temperate climates, there may be a shift to xeromorphic cool desert species.

Similar NVC Types:

- 2.A.3. Tropical Scrub & Herb Coastal Vegetation (F024): The strength of the tropical versus temperate distinction may be weak in these coastal habits, but perennial herbs may be more common in tropical beaches.
- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): There are similarities between coastal and inland dunes in terms of growth forms and even wind-driven processes.

Diagnostic Characteristics: The vegetation often has morphological (psammophytic) adaptations to these habitats, including prostrate herbaceous perennial growth forms, with mesomorphic leaves, neither succulent nor sclerophyllous, less commonly with annual herbs, and increasingly with perennial grasses and shrubs on the stabilized backdunes. The backdune may have more typical mesomorphic or xeromorphic scrub and herb vegetation.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: The vegetation often has morphological (psammophytic) adaptations to the beach, dune and bluff habitats, including prostrate herbaceous annual growth forms, with mesomorphic leaves, neither succulent nor sclerophyllous, less commonly with annual herbs, and increasingly with perennial grasses and shrubs on the stabilized backdunes. The temperate coastal vegetation tends to have prostrate or low perennial grasses on the beach and foredune and woody species (favored by the long growing season) on the backdunes. In drier climates, there may be a shift to xeromorphic cool desert species (Barbour 1992).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: This formation includes upland habitats found along the coast, including beaches, bluffs and dunes, where wind, water, and salinity are major drivers of the vegetation. Beaches include the strip of sand or gravel that extends from the mean tideline to the top of the foredune (frontal foredune). The dune extends further inland wherever the sandy/gravelly site conditions restrict tree growth (<10% cover). Unconsolidated bluffs (but not marine rock cliffs) are more stable, relatively vertical habitats (Barbour 1992).

Beach sand is typically enriched with nutrients and organic matter from the sea or lake. The permeability of the sandy substrate permits drainage and leaching, with a tendency towards arid systems. Proximity to the sea or lake induces permanently high air humidity and reduces climatic extremes. Sea-level changes constantly rework the substrate (Seeliger 1992). Winds are a constant influence.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation is found in temperate coastal habitats, including beaches, bluffs and dunes, across the mid-latitudes from 23 to 60-70 degrees N and S latitude.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL**Confidence Level:** Low

Confidence Level Comments [optional]: The beach and foredune part of the concept is most distinctive. Backdune grasslands and shrublands appear very similar to inland grasslands and shrublands, but floristically the vegetation of the foredune and backdune may be rather comparable.

CITATIONS**Synonymy:**

- = The Dune Plant Community (Seeliger 1992) [The author uses the vegetation type as a name for a section in a book on Latin American coastal plant communities. Beaches and dunes are included.]

Full Citation:

- Barbour, M. G. 1992. Life at the leading edge: The beach plant syndrome. Pages 291-307 in: U. Seeliger, editor. Coastal Plant Communities of Latin America. Academic Press, Inc., New York.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Seeliger, U. 1992. Coastal foredunes of southern Brazil: Physiography, habitats and vegetation. Pages 367-381 in: U. Seeliger, editor. Coastal Plant Communities of Latin America. Academic Press, Inc., New York.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.5. Temperate & Boreal Bog & Fen (F016)

OVERVIEW

Database Code: 2.B.5 (F016)

Scientific Name: Temperate & Boreal Bog & Fen Formation

Common Name (Translated Scientific Name): Temperate & Boreal Bog & Fen Formation

Colloquial Name: Temperate & Boreal Bog & Fen

Hierarchy Level: Formation

Placement in Hierarchy: 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Lower Level Hierarchy Units [incomplete]:

- 2.B.5.Na. North American Bog & Fen (D029)

Type Concept Sentence: Temperate & Boreal Bog & Fen includes temperate bogs and fens dominated by *Sphagnum* or brown mosses with ericaceous shrubs, graminoids and low scrub tree growth forms, across the mid-latitudes of the Northern Hemisphere from 23 to 70 degrees N, but is much less common in the southern mid-latitudes.

Type Concept: Temperate & Boreal Bog & Fen includes temperate and boreal bogs and fens dominated by *Sphagnum* or brown mosses with ericaceous shrubs, graminoids and low scrub tree growth forms (<2 m). The driest bogs, especially in permafrost terrain, may be covered in dwarf-shrubs and lichens. The bog surface, which is raised or level with the surrounding terrain, is virtually unaffected by runoff waters or groundwaters from the surrounding mineral soils. Precipitation, fog and snowmelt are the primary water sources and, thus, all bogs are ombrogenous.

A temperate and boreal fen is a peatland with a fluctuating water table. The waters in fens are rich in dissolved minerals and, therefore, are minerotrophic. Groundwater and surface water movement is a common characteristic of fens. Surface flow may be directed through channels, pools, and other open waterbodies that can form characteristic surface patterns. The dominant materials are moderately decomposed sedge and brown moss peats of variable thickness. The vegetation on fens is closely related to the depth of the water table and the chemistry of the water present. The composition of vegetation may also reflect regional geographic variations. In general, graminoid vegetation and some bryophytes dominate wetter fens where the water table is above the surface. Shrubs are prominent in drier fens where the water table is lower. Trees appear on the driest fen sites where microtopographic features such as moss hummocks provide habitats as much as 20 cm above the water table.

Classification Comments [optional]: Subarctic and arctic (polar) bogs and fens belong in this formation.

Similar NVC Types:

- 1.B.5. Boreal Flooded & Swamp Forest (F036): This type includes forested bogs with >10% cover along with poor swamps.

- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): Upland transitions to wet-mesic or moist grasslands, such as wet-mesic prairies, can be hard to place.
- 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013): Fens and marshes can be similar, especially when fen peat mats are inundated (as with "shore fens").

Diagnostic Characteristics: This peatland type is dominated by *Sphagnum* spp. or brown mosses, with ericaceous shrubs, graminoids and low scrub tree growth forms (<2 m). The driest bogs, especially in permafrost terrain, may be covered in dwarf-shrubs and lichens. Bogs contain raised or level sphagnum peat surfaces that are ombrotrophic or weakly minerotrophic, whereas fens are groundwater-driven, moderately to strongly minerotrophic.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: This peatland type is dominated by *Sphagnum* spp. or brown mosses, with ericaceous shrubs, graminoids and low scrub tree growth forms (<2 m). The driest bogs, especially in permafrost terrain, may be covered in dwarf-shrubs and lichens. The vegetation on fens is closely related to the depth of the water table and the chemistry of the water present. The composition of vegetation may also reflect regional geographic variations. In general, graminoid vegetation and some bryophytes dominate wetter fens where the water table is above the surface. Shrubs are prominent in drier fens where the water table is lower. Trees appear on the driest fen sites where microtopographic features such as moss hummocks provide habitats as much as 20 cm above the water table. Sites in fens with waters extremely low in dissolved minerals are poor fens and have *Sphagnum* mosses and ericaceous shrubs. Poor fens are sometimes placed with bogs as "acid peatlands." Fens with slightly higher concentrations of dissolved minerals are moderately rich fens and are dominated by sedges and brown mosses (such as *Drepanocladus* sp.). The moderate to extremely rich fens are sometimes collectively called "alkaline peatlands" or "rich peatlands" (National Wetlands Working Group 1997).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: The bog surface, which is raised or level with the surrounding terrain, is virtually unaffected by runoff waters or groundwater from the surrounding mineral soils. Generally the water table is at or slightly below the bog surface. As the bog surface is raised, so is the bog water table relative to the elevation of the water table at the edges of the bog. Precipitation, fog and snowmelt are the primary water sources and, thus, all bogs are ombrogenous. Given that precipitation does not contain dissolved minerals and is mildly acidic, the surface bog waters are consequently low in dissolved minerals and acidic. Bog water acidity, usually between pH 4.0 and 4.8 (Gorham and Janssens 1992), is enhanced due to the organic acids that form during decomposition of the peat and the acids present within *Sphagnum* leaves (National Wetlands Working Group 1997). The soils are mainly Fibrisols, Mesisols and Organic Cryosols (permafrost soils) in the Canadian soil classification system (National Wetlands Working Group 1997) [see Brady and Weil (2002) for comparison of Canadian soil orders with U.S. and FAO systems].

Fens are peatlands with a fluctuating water table. The waters in fens are rich in dissolved minerals and, therefore, are minerotrophic. Groundwater and surface water movement is a common characteristic of fens. Surface flow may be directed through channels, pools, and other open waterbodies that can form characteristic surface patterns. The dominant materials are moderately decomposed sedge and brown moss peats of variable thickness. The soils are mainly Mesisols, Humisols and Organic Cryosols (National Wetlands Working Group 1997).

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation is found across the mid-latitudes of the Northern Hemisphere from 23 to 70 degrees N, but is much less common in the southern mid-latitudes.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: High

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- > Bog Wetland Class (National Wetlands Working Group 1997) [The class includes treed bogs (10-25%), but is otherwise synonymous with the bog part of this formation.]

- > Fen Wetland Class (National Wetlands Working Group 1997) [The class is synonymous with the fen part of this formation. Trees are typically <10% cover.]
- > Peatlands (Mitsch and Gosselink 2000) [Bogs and fens are treated together, but tropical and temperate bogs are not separated. Forested bogs are included.]
- > Peatlands (Roth 2009) [Bogs and fens are treated together, but tropical and temperate bogs are not separated. Forested bogs are included.]

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.
- Roth, R. A. 2009. Freshwater Aquatic Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments:

Version Date: 11 Jul 2012

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013)

OVERVIEW

Database Code: 2.B.6 (F013)

Scientific Name: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Formation

Common Name (Translated Scientific Name): Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Formation

Colloquial Name: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland

Hierarchy Level: Formation

Placement in Hierarchy: 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Lower Level Hierarchy Units [incomplete]:

- 2.B.6.Fd. Temperate Herbaceous Swamp & Aquatic Vegetation (D172)
- 2.B.6.Na. Eastern North American Freshwater Wet Meadow, Riparian & Marsh (D030)
- 2.B.6.Nb. Western North American Freshwater Shrubland, Wet Meadow & Marsh (D031)
- 2.B.6.Nc. Southwestern North American Warm Desert Freshwater Marsh (D032)

Type Concept Sentence: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland includes wet riparian and swamp shrublands, wet meadows, wet prairies, and shallow and deep emergent marshes. The vegetation is comprised of seasonal green emergent, hydrophytic shrubs and herbs with at least 10% cover, on mucky, inundated or saturated soils across the mid-latitudes of the Northern and Southern hemispheres from 23 to 70 degrees.

Type Concept: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland includes wet riparian and swamp shrublands, wet meadows, wet prairies, and shallow and deep emergent marshes on mucky, inundated or saturated soils across the mid-latitudes of the Northern and Southern hemispheres from 23 to 70 degrees. These wetlands have shallow water, with levels that usually fluctuate daily, seasonally or annually due to tides (freshwater tidal), flooding, evapotranspiration, groundwater recharge, or seepage losses. The vegetation is comprised of seasonal green emergent hydrophytic woody and herbaceous macrophytes with at least 10% cover, including graminoids such as rushes, reeds, grasses and sedges, other herbaceous species such as broad-leaved emergent forbs, and short to tall shrubs (primarily broad-leaved deciduous but some broad-leaved evergreen in warm-temperate regions). Associated with these plants are floating-leaved and submergent species, and nonvascular plants such as brown mosses, liverworts, and macroscopic algae. The vegetation is usually arranged in distinct zones of parallel or concentric patterns in response to gradients of water depth, frequency of drawdown, water chemistry or disturbance. Saline or brackish non-tidal marshes are excluded. Seasonal drawdowns may expose mudflats which are vegetated by pioneering herb and grass species. Plant communities of seasonal marshes are dynamic. They shift spatially with water levels, and change in composition over a short time, whereas communities of semipermanent marshes usually are more stable, represented by stands of reeds which may persist for many years in the absence of severe drought.

Classification Comments [optional]: Inland salt marshes are currently excluded here and placed with salt marsh. Freshwater tidal marshes are placed here. Further review is needed of the similarities and differences between temperate and tropical freshwater marshes. Subarctic and arctic (polar) marshes belong in this formation.

Similar NVC Types:

- 1.B.3. Temperate Flooded & Swamp Forest (F026): Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013) contains tall-shrub swamps that share many structural and habitat similarities to hardwood tree swamps (F026), especially during the tree regeneration stage.
- 2.A.5. Tropical Freshwater Marsh, Wet Meadow & Shrubland (F030): Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013) is more strongly affected by cold climatic conditions, but vegetation criteria that distinguish these two formations need to be described.
- 2.B.5. Temperate & Boreal Bog & Fen (F016): Fens and marshes can be similar, especially when fen peat mats are inundated (as with "shore fens").
- 2.B.7. Salt Marsh (F035): Inland salt marshes are non-tidal, but saline (or haline) and may resemble some brackish freshwater marshes.

Diagnostic Characteristics: The vegetation is comprised of seasonal green emergent hydrophytic macrophytes, chiefly graminoids such as rushes, reeds, grasses and sedges, other herbaceous species such as broad-leaved emergent forbs, and short to tall, primarily broad-leaved deciduous shrubs (some broad-leaved evergreen shrubs in warm-temperate climates), across the mid-latitudes of the Northern and Southern hemispheres from 23 to 70 degrees.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland vegetation predominantly comprises summer green emergent hydrophytic macrophytes, with at least 10% cover, including graminoids such as rushes, reeds, grasses and sedges, other herbaceous species such as broad-leaved emergent forbs, and short to tall shrubs (primarily broad-leaved deciduous, but some broad-leaved evergreen in warm-temperate regions). Associated with these plants are floating-leaved and submergent species, and nonvascular plants such as brown mosses, liverworts, and macroscopic algae. Vegetation is usually arranged in distinct zones of parallel or concentric patterns in response to gradients of water depth, frequency of drawdown, water chemistry or disturbance (National Wetlands Working Group 1997).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: A temperate freshwater marsh is a wetland that has shallow water and levels that usually fluctuate daily, seasonally or annually due to tides (freshwater tidal), flooding, evapotranspiration, groundwater recharge, or seepage losses. Marshes may experience water level drawdowns which will result in portions drying up and exposing the sediments. Marshes receive their water from the surrounding catchment as surface runoff, stream inflow, precipitation, storm surges, groundwater discharge, longshore currents and tidal action. Marshes dependent upon surface runoff usually retain less permanent water than sites supplied by groundwater. The water table usually remains at or below the soil surface, but soil water remains within the rooting zone for most of the growing season, except in years of extreme drought. In semi-arid regions, some basin marshes may remain dry for several consecutive years, and consequently may assume some characteristics of terrestrial ecosystems until water levels are restored by above-average precipitation and runoff (National Wetlands Working Group 1997).

A marsh is a minerotrophic and usually eutrophic wetland. Nutrients are derived from the substrate through periodic aeration. High nutrient levels give rise to the characteristic high productivity of vascular plants and high decomposition rates of the plant material at the end of the growing season. Such high rates of decomposition give rise to marshes producing significant quantities of gases such as methane and carbon dioxide. Freshwater marshes are usually circumneutral to highly alkaline owing to the presence of dissolved minerals such as calcium, potassium carbonate, or potassium bicarbonate.

Soils and substrates encountered in marsh wetlands typically range from mineral soils such as Humic and Rego Gleysols to organic soils such as Humisols and Mesisols in the Canadian soil classification system [see Brady and Weil (2002) for comparison of Canadian soil orders with U.S. and FAO systems]. Normally, marsh sediment is a mixture of unconsolidated organic and inorganic material. Clumps, hummocks, or tussocks of live and dead herbaceous vegetation may exist in standing water. Those marshes that are seasonally dry or exposed to high energy currents usually accumulate little organic matter, in contrast to hydrologically more stable and permanently saturated marshes. In the latter case, such as in lakeshore or delta marshes, Humisols develop; this organic material can accumulate but seldom is more than 40 to 50 cm deep. Under persistent conditions of stable water, sedges and aquatic mosses create floating mats of vegetation. This is characteristic of marsh stages transitional to rich fens (National Wetlands Working Group 1997).

Marshes occur in many geomorphological settings which include low-lying areas adjacent to rivers, lakes, the sea, and any other position on the land surface where groundwater may discharge. In northern regions, marshes are common in nutrient-rich sites

associated with rivers either in the floodplains or at their mouth on alluvial fans and deltas (National Wetlands Working Group 1997).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: This formation is found on mucky, inundated or saturated soils across the mid-latitudes of the Northern and Southern hemispheres from 23 to 70 degrees.

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- < Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together.]
- < Nontidal Freshwater Marshes (Roth 2009) [It is not clear whether nontidal salt marshes are included here. Both tropical and temperate marshes are treated together.]
- < Tidal Freshwater Marshes (Roth 2009) [Both tropical and temperate marshes are treated together.]
- < Tidal Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together.]

Full Citation:

- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.
- Roth, R. A. 2009. Freshwater Aquatic Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments:

Version Date: 11 Jul 2012

2. Shrubland & Grassland

2.B. Temperate & Boreal Grassland & Shrubland

2.B.7. Salt Marsh (F035)

OVERVIEW

Database Code: 2.B.7 (F035)

Scientific Name: Salt Marsh Formation

Common Name (Translated Scientific Name): Salt Marsh Formation

Colloquial Name: Salt Marsh

Hierarchy Level: Formation

Placement in Hierarchy: 2.B. Temperate & Boreal Grassland & Shrubland (S18)

Lower Level Hierarchy Units [incomplete]:

- 2.B.7.Fg. Temperate Coastal Salt Marsh (D173)
- 2.B.7.Fh. Tropical Coastal Salt Marsh (D174)
- 2.B.7.Fi. Eastern African Salt Pan (D175)
- 2.B.7.Fj. Southern African Salt Pan (D176)
- 2.B.7.Na. North American Eastern Interior Brackish Marsh (D033)
- 2.B.7.Nb. Temperate & Boreal Atlantic Coastal Salt Marsh (D034)

- 2.B.7.Nc. Temperate & Boreal Pacific Coastal Salt Marsh (D035)
- 2.B.7.Nd. North American Western Interior Brackish Marsh (D036)
- 2.B.7.Nk. Arctic Coastal Salt Marsh (D187)
- 2.B.7.Ue. Tropical Atlantic Coastal Salt Marsh (D037)
- 2.B.7.Wf. Tropical Indo-Pacific Coastal Salt Marsh (D038)

Type Concept Sentence: Salt Marsh is a wetland that has shallow water and levels that usually fluctuate due primarily to tides along the coast or changes in water depth in depressions. Coastal salt marshes are primarily intertidal; that is, they are found in areas at least occasionally inundated by high tide but not flooded during low tide, including estuaries, lagoons, and the lee side of barrier islands. The vegetation is comprised of emergent shrubs and herbs with at least 10% cover, especially saline or halophytic species. They occur at all latitudes around the globe, but are concentrated in the temperate mid-latitudes (23-70 degrees N and S).

Type Concept: Salt Marsh is a wetland that has shallow water and levels that usually fluctuate due primarily to tides along the coast or changes in water depth in depressions. Coastal salt marshes are primarily intertidal; that is, they are found in areas at least occasionally inundated by high tide but not flooded during low tide, including estuaries, lagoons, and the lee side of barrier islands. The vegetation is comprised of emergent aquatic macrophytes, especially saline or halophytic species, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes, floating-leaved and submergent species (aquatic vegetation), and macroscopic algae. The vegetation is usually arranged in distinct zones of parallel patterns in response to gradients of tidal flooding frequency and duration, water chemistry or disturbance, sometimes described simply as "high marsh" (limits of high tide) and "low marsh" (intertidal marsh). Salt marshes have gradients that include barren salt flats at the tidal edge, rushes, and then halophytic herbs and grasses at the outer edge. Daily drawdowns may expose mudflats which contain a sparse mix of pioneering herb and grass species. Salt marsh chemistry is dominated by salinity. Salinity levels vary depending on a complex of factors, including frequency of inundation, rainfall, soil texture, freshwater influence, fossil salt deposits, and other factors. The lower limits of salinity are defined as at least 0.5 ppt, below which it is considered freshwater.

Classification Comments [optional]: Further review is needed of the similarities and differences between temperate and tropical salt marsh, as well as subarctic and arctic (polar) salt marshes, all of which are placed in this formation. From an overall physiognomic and ecological perspective, maintaining a single salt marsh formation is desirable, but it does not fit as neatly within the climatic enveloped species by the subclass (temperate and boreal). This issue is further complicated by inland tropical and temperate salt marshes, which may more closely track climate; this may favor the option of separating salt marsh into two formations (temperate and boreal versus tropical). Two alternatives are possible: one is to create a single subclass within Class 2 to separate out salt marshes; the other is to split salt marsh into temperate & boreal (and arctic?) versus tropical formations. Although they represent a small fraction of the overall salt marsh area, there are extensive tropical salt marshes, often found in association with mangroves; the mangroves occupy the lower, regularly tidally-inundated part of the intertidal zone and salt marsh the upper zone above the mangroves. Australia has more than one million hectares of salt marsh and sparsely vegetated high level tidal flat, with a large proportion of this being tropical. More information on potentially distinct floristics and growth forms of tropical salt marshes is needed. If tropical salt marsh floristics are largely distinct from temperate and boreal salt marshes, and if they more closely overlap with mangrove floristics, then a separate tropical salt marsh formation would better describe the three-way relationships.

Similar NVC Types:

- 1.A.5. Mangrove (F006): Some mangrove formations may be mixed with salt marshes, but by and large they are physiognomically quite distinct.
- 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (F013): Salt Marsh (F035) contains inland salt marshes that are non-tidal and saline (or haline) and may resemble some brackish freshwater marshes (F013).

Diagnostic Characteristics: Salt Marsh is a wetland that has shallow water and levels that usually fluctuate due primarily to tides along the coast or changes in water depth in depressions. Coastal tidal salt marshes are found in areas at least occasionally inundated by high tide but not flooded during low tide. The vegetation is comprised of emergent aquatic macrophytes with at least 10% cover, especially saline or halophytic species, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes. They occur at all latitudes around the globe, but are concentrated in the temperate mid-latitudes (23-70 degrees N and S).

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Salt Marsh vegetation predominantly comprises emergent aquatic macrophytes with at least 10% cover, especially saline or halophytic species, chiefly graminoids such as rushes, reeds, grasses and sedges, and shrubs and other herbaceous species such as broad-leaved emergent macrophytes. Floating-leaved and submergent species (aquatic vegetation) and macroscopic algae are present at varying levels of abundance.

In tidal salt marshes, the vegetation is usually arranged in distinct zones of parallel patterns in response to gradients of tidal flooding frequency and duration, water chemistry or disturbance, sometimes described simply as "high marsh" (limits of high tide) and "low marsh" (intertidal marsh). These salt marshes have gradients that include barren salt flats at the tidal edge, rushes, and then

halophytic herbs and grasses at the outer edge. Daily drawdowns may expose mudflats which contain a sparse mix of pioneering herb and grass species.

Saline or brackish non-tidal marshes also have gradients but with fewer zones that include barren salt flats in the centre of the marsh, rushes, and then halophytic herbs and grasses at the outer edge. Seasonal drawdowns may expose mudflats which are revegetated by pioneering herb and grass species.

Although the bulk of salt marshes are temperate to polar, there are tropical salt marshes, often found in association with mangroves; the mangroves occupy the lower, regularly tidally-inundated part of the intertidal zone and salt marsh the upper zone above the mangroves. Australia has more than one million hectares of salt marsh and sparsely vegetated high level tidal flat, with the greater proportion of this being tropical. Tropical salt marshes are species-poor, and species richness increases with more temperate conditions; for example in Australia, the richest salt marsh floras are found in Tasmania and Victoria.

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#) A salt marsh is a wetland that has shallow water and levels that usually fluctuate due primarily to tides or drawdowns in seasonal saline basins. Coastal salt marshes are primarily intertidal; that is, they are found in areas at least occasionally inundated by high tide but not flooded during low tide, including estuaries, lagoons, and the lee side of barrier islands. Salt marshes form wherever the accumulation of sediments is equal to or exceeds the rate of land subsidence and where there is adequate protection from high energy waves and storms. Salt marshes are located in estuaries or lower stream reaches, and behind baymouth bars or other sheltered sites. Sediments can either be formed from reworked marine sediments on marine-dominated coastlines and those that were formed in deltaic areas where the main source of mineral sediment is riverine.

Salt marsh chemistry is dominated by salinity. Salinity levels vary depending on a complex of factors, including frequency of inundation, rainfall, soil texture, freshwater influence, fossil salt deposits, and other factors. The lower limits of salinity are defined as at least 0.5 ppt, below which it is considered freshwater, though the oligohaline category (0.5-5 ppt) can be considered transitional freshwater [see Cowardin et al. (1979) for salinity scale]. The concentration of most elements needed for plant growth also varies depending on these factors. A number of studies have shown that salt marshes are especially nitrogen limited. The water in non-tidal saline marshes is high in dissolved salts because water losses through evaporation concentrate sulphates and chlorides of sodium and magnesium. In highly saline non-tidal marshes, vegetation development is severely hampered because salt concentrations are so high as to become toxic to plants (National Wetlands Working Group 1997).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Salt marshes occur at all latitudes around the globe, but are concentrated in the temperate mid-latitudes (23-70 degrees N and S).

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#) Resolution of the role of climate on salt marshes is needed.

CITATIONS

Synonymy:

- = Salt Marshes (Woodward 2008)
- > Tidal Salt Marshes (Mitsch and Gosselink 2000) [Non-tidal inland salt marshes are treated under Freshwater Marsh.]

Full Citation:

- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. USDI Fish & Wildlife Service, Office of Biological Services, Washington, DC. 103 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.

- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.
- Woodward, S. 2008. Grassland Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments:

Version Date: 11 Jul 2012

3. Desert & Semi-Desert (C03)

OVERVIEW

Database Code: 3 (C03)

Scientific Name: Xeromorphic Woodland, Scrub & Herb Vegetation Class

Common Name (Translated Scientific Name): Xeromorphic Woodland, Scrub & Herb Vegetation Class

Colloquial Name: Desert & Semi-Desert

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06)
- 3.B. Cool Semi-Desert Scrub & Grassland (S11)

Type Concept Sentence: Cool and warm semi-deserts dominated by xeromorphic growth forms, including *succulent* (e.g., cacti, euphorbias) and *small-leaved shrubs* and *trees*, desert grasses and other xeromorphic growth forms, with an irregular horizontal canopy spacing that is often open to very sparse.

Type Concept: Succulents, small-leaved shrubs and trees, desert grasses and other xeromorphic growth forms are dominant or characteristic in this type. Vegetation often has open and irregular horizontal canopy spacing, typically <5 m tall. Mesomorphic trees have less than 10% cover, and xeromorphic growth forms (including *succulent trees* and *shrubs* (e.g., cacti, euphorbias)) and *small-leaved shrubs* and *trees*, have the majority of cover compared to mesomorphic or cryomorphic growth forms. The herb cover varies from open to absent, with various growth forms, including ephemerals and *succulent forbs*. Climates include warm (tropical) to cool (temperate) arid to desert, with regular drought periods. Substrates are dry to moist, sometimes strongly haline-alkaline, or rarely, temporarily wet (e.g., desert washes). Vegetation includes cool and warm semi-deserts.

Classification Comments [optional]: In desert regions, the vegetation may be very sparse (at or below 1%). Some judgment is required to ensure how to sample and classify vegetation in stands where there is <1% vascular plant cover in parts, but not all, of the stand. That is, some deserts may have only patchy non-vegetated areas, whereas others may have extensive non-vegetated areas. More work is needed to define xeromorphic herbaceous growth forms, such as ephemerals, that may appear under rare high-precipitation years.

Semi-desert grasslands may be hard to identify in this class when woody plants are absent or uncommon, because there are no herbaceous growth forms currently recognized that are diagnostic for the xeromorphic class. Desert grasses may be xerophytic but not clearly xeromorphic. However, in many cases they will have strong floristic similarity to open desert shrublands and, if degraded, may be dominated by desert shrubs. More work is needed to determine if such growth forms can be specified (e.g., desert-blooming ephemerals).

Similar NVC Types:

- 2. Shrubland & Grassland (C02): Desert grasslands typically include xeromorphic shrubs and trees, which place them in the Xeromorphic class. Environmental drivers and stressors can cause desert grasslands to cross thresholds into desert scrub. They may also cause dry mesomorphic grasslands with small-leaved shrubs to appear similar to xeromorphic grasslands (e.g., shortgrass prairie in the North American Great Plains).
- 4. Polar & High Montane Scrub & Grassland (C04): In montane deserts, there may be a transition from cool semi-desert to alpine that may be difficult to distinguish.
- 6. Rock Vegetation (C06): In some desert habitats, the vegetation will be limited to growing on or near rocks that can hold some moisture; and therefore it may qualify as lithomorphic vegetation.

Diagnostic Characteristics: Xeromorphic tree (*succulent tree*, *small-leaved tree*) or shrub (*succulent shrub*, *small-leaved shrub*) growth forms have the majority of the cover compared to mesomorphic and cryomorphic shrub and herb growth forms, and mesomorphic trees have <10% cover. The vegetation has irregular horizontal canopy spacing.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Growth Forms: Stands are dominated by xeromorphic growth forms (*succulent tree*, *small-leaved tree*, *succulent shrub*, *small-leaved shrub*, some types of *rosette shrub*) and various associated herb growth forms. Drought-deciduous, including facultatively drought-deciduous, trees may be present. Other characteristics include opportunistic leaf-flush (e.g., ocotillo), high incidence of

energy allocation to protective structures such as spines, and allocation to heat- or moisture-loss structures. The various herb growth forms currently recognized in FGDC (2008) are not exclusive to the xeromorphic class, and more work is needed to assess whether additional herbaceous growth form types should be recognized that may be distinctive for this class. For example, Crassulacean Acid Metabolism (CAM) physiology is common in desert plants, especially among succulents.

In addition some desert vegetation has biological crust, comprised of soil particles, cyanobacteria, algae, microfungi, lichens, and bryophytes. The crusts do not develop under a closed canopy of vascular plants. They do occur in all climates following disturbance of that cover. However, the most conspicuous development of crusts occurs in hot, cool, and cold semi-arid and arid areas where plants are widely spaced.

Structure: Stands are very open and have irregular shrub or herb horizontal stem spacing, often with prominent non-vegetated surfaces. Xeromorphic trees are present, occasionally moderately dense (10-60%). There is <10% cover of mesomorphic trees, and xeromorphic tree, shrub and/or herb growth forms have the majority of cover compared to mesomorphic or cryomorphic shrubs or herbs. Cover varies from sparse to moderately closed (1% to >50% cover). Nonvascular and dwarf-shrub growth forms may vary from 0 to 100%. At maturity, xeromorphic trees typically are >2 m, tall shrubs typically >0.3 m, and herbs are of any height, but mostly >0.3 m. A biological crust layer may also be present.

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

Climate: [Use climate type categories from e.g., Koeppen or Holdridge (e.g., BWh in parts of the Sonoran Desert, W, H). In temperate climates, the growing season is typically very dry, and in tropical climates, droughts are persistent, and rain is minimal.]

Soil/substrate/hydrology: Soils may be thin, rocky, saline/haline (salt pannes, playas).

DISCUSSION

[Discussion \[optional\]:](#) There is very sparse desert vegetation that, because so few species are present, may only be classifiable into Group and Macrogroup levels and higher. This may also occur in other ecological settings.

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Climate zones? Desert divisions in Bailey's (1989) Dry Domain.

Nations [incomplete except for CA and US]: AR, AU, BO, BR, CA, CL, CO, EC, MX, PE, PY, US, VE

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level:

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Desert Biomes (Quinn 2009)

Full Citation:

- Bailey, R. G. 1989. Explanatory supplement to ecoregions map of the continents. Environmental Conservation 16:307-309 with separate map at 1:30,000,000. USDA Forest Service, Washington, DC.
- Belnap, J., and O. L. Lange, editors. 2003. Biological soil crusts: Structure, function, and management. Second edition. Springer-Verlag, Berlin.
- FGDC [Federal Geographic Data Committee]. 2008. National Vegetation Classification Standard (Version 2.0). FGDC Document Number FGDC-STD-005-2008. Vegetation Subcommittee, Federal Geographic Data Committee, Reston, VA. 126 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2009. Desert Biomes. Greenwood Press, Westport, CT.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: Hierarchy Revisions Working Group

Acknowledgments:

Version Date: 17 Jul 2012

3. Desert & Semi-Desert

3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06)**OVERVIEW****Database Code:** 3.A (S06)**Scientific Name:** Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass**Common Name (Translated Scientific Name):** Warm Desert & Semi-Desert Woodland, Scrub & Grassland Subclass**Colloquial Name:** Warm Desert & Semi-Desert Woodland, Scrub & Grassland**Hierarchy Level:** Subclass**Placement in Hierarchy:** 3. Desert & Semi-Desert (C03)**Lower Level Hierarchy Units:**

- 3.A.1. Tropical Thorn Woodland (F039)
- 3.A.2. Warm Desert & Semi-Desert Scrub & Grassland (F015)

Type Concept Sentence: Warm Desert & Semi-Desert Woodland, Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates, uncommon near the equator to increasingly common between 15 and 35 degrees N and S latitude.**Type Concept:** Warm Desert & Semi-Desert Woodland, Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates. Vegetation is dominated by xeromorphic growth forms, and varies from open to closed woodlands, open shrub-scrub to complexes of succulents, thornscrub, and microphyllous-leaved subshrubs, often less than 2 m tall, though scattered tall succulents may occur. Ephemeral (therophytic) herbaceous growth forms may also be present within semi-desert woodlands. Desert grasslands often occur in transitional zones, typically containing a sparse layer of xeromorphic shrubs and open ground layer. Included are very open deserts where vegetation is very sparse, and where the ground layer is sandy, stony desert pavements, salt crust (bare rock, often with nonvascular mats is placed in lithomorphic vegetation).**Classification Comments [optional]:** This subclass includes the low desert-like tropical thornwoods, which can form a transition to 1.A.1. Tropical Seasonally Dry Forest Formation (F003). In the Neotropics, Brazilian caatinga includes both Tropical Seasonally Dry Forests and extensive Tropical Thorn Woodland and scrub. This subclass also occurs in the Neotropics in the Guajira (Colombia, Venezuela), Gran Chaco (Bolivia, Argentina, Paraguay), Low Dry Inter-Andean Valleys (Bolivia, Argentina) and Pacific semi-deserts of west-southern Ecuador and northwestern Perú (Tumbes).**Similar NVC Types:**

- 1.A. Tropical Forest (S17): Tropical Forest (S17) in drier climates may have small-leaved sclerophyllous evergreen trees or deciduous trees that can be similar to trees found in thorn woodland in warm deserts. Thorn woodlands are sometimes included as part of Tropical Forest.
- 6.C. Desert & Semi-Desert Rock Vegetation (S03): Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06) contains >10% vascular plant cover.

Diagnostic Characteristics: Vegetation is dominated by xeromorphic growth forms, and varies from open to closed woodlands, open shrub-scrub to complexes of succulents, thornscrub, and microphyllous-leaved subshrubs, often less than 2 m tall, though scattered tall succulents may occur. Ephemeral (therophytic) herbaceous growth forms may also be present.**Rationale for Nominal Species or Physiognomic Features [optional]:****VEGETATION****Physiognomy and Structure [optional]:** Vegetation is dominated by xeromorphic growth forms, and varies from open to closed woodlands, open shrub-scrub to complexes of succulents, thornscrub, and microphyllous-leaved subshrubs, often less than 2 m tall, though scattered tall succulents may occur. Ephemeral (therophytic) herbaceous growth forms may also be present within semi-desert woodlands. Desert grasslands often occur in transitional zones, typically containing a sparse layer of xeromorphic shrubs and open ground layer. Included are very open deserts where vegetation is very sparse, and where the ground layer is sandy, stony desert pavements, salt crust (bare rock, often with nonvascular mats is placed in lithomorphic vegetation) (Whittaker 1975).**Floristics [optional]:****ENVIRONMENT****Environmental Description [optional]:***Climate:* Warm semi-desert woodlands, scrub and grasslands occur in dry warm-temperate, subtropical and tropical climates.**DISCUSSION****Discussion [optional]:****Animals [optional]:****Mapping Issues [optional]:****DISTRIBUTION****Geographic Range:** Warm Desert & Semi-Desert Woodland, Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates, is uncommon near the equator to increasingly common between 15 and 35 degrees N and S latitude.**Nations [incomplete except for CA and US]:** AR, AU, BO, BR, CL, CO, EC, MX, PE, PY, US, VE

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- > Warm Deserts (Quinn 2009) [The author does not include thorn woodlands.]
- = Warm semidesert scrub: biome-type 17 (Whittaker 1975) [The author does not include thorn woodlands.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2009. Desert Biomes. Greenwood Press, Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and G. Navarro

Acknowledgments:

Version Date: 12 Jul 2012

3. Desert & Semi-Desert

3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland

3.A.1. Tropical Thorn Woodland (F039)

OVERVIEW

Database Code: 3.A.1 (F039)

Scientific Name: Tropical Thorn Woodland Formation

Common Name (Translated Scientific Name): Tropical Thorn Woodland Formation

Colloquial Name: Tropical Thorn Woodland

Hierarchy Level: Formation

Placement in Hierarchy: 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Tropical Thorn Woodland includes warm semi-arid or arid deciduous woodlands and low forests with xeromorphic adaptations found in Tropical, Mediterranean and Temperate xeric and desertic bioclimates around the globe, uncommon near the equator to increasingly common between 15 and 35 degrees N and S latitude.

Type Concept: Tropical Thorn Woodland includes warm semi-arid or arid deciduous woodlands and low forests with several xeromorphic adaptations such as microphyllous and/or resinous leaves, thorns, brachyblasts, pachycaul treelets and diverse shrubby and arborescent Cactaceae. The woodland canopy varies from open to closed. The low structural layer of this woodland/forest is frequently largely dominated by dense colonies of thorny terrestrial bromeliads. In the open ground, and intermixed with the woodlands, occur stands of ephemeral herbaceous vegetation that develop in the rainy season. The drought season is always strong, with 6-10 climatic and ecologically dry months per year.

Classification Comments [optional]: Many authors include Tropical Thorn Woodland as part of a broadly defined "Tropical Seasonally Dry Forest" or "seasonally dry tropical forest" (SDTF). For example, Pennington et al. (2006) use a wide interpretation of SDTF in the Neotropics, including formations as diverse as tall forest on moister sites to cactus scrub on the driest, but they exclude the Chaco of Argentina, Paraguay and Bolivia because it receives frost. See also Oliveira-Filho et al. (2006), who include caatinga and carrascos within their broad definition of SDTF, but exclude cerrados and chaco. Here, we create a separate formation for Tropical Thorn Woodlands, in which we unite the xeromorphic parts of the caatinga, carrascos, cerrados, and chaco, separate from a more narrowly defined 1.A.1. Tropical Seasonally Dry Forest Formation (F003) that lacks xeromorphic growth forms.

Distribution of this type needs review. It may be most common in tropical climates, but may extend into warm-temperate regions, such as northern Mexico and southwestern United States. By our definition, a certain amount of frost can also occur.

Similar NVC Types:

- 1.A.1. Tropical Seasonally Dry Forest (F003):
- 3.A.2. Warm Desert & Semi-Desert Scrub & Grassland (F015):

Diagnostic Characteristics: Tropical Thorn Woodland includes warm semi-arid or arid deciduous woodlands and low forests with several xeromorphic adaptations such as microphyllous and/or resinous leaves, thorns, brachyblasts, pachycaul treelets and diverse shrubby and arborescent Cactaceae.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: The canopy is 8 to 15 m tall, open to dense, and dominated by low deciduous trees, arboreal cacti and high shrubs with xeromorphic adaptations. Very characteristic large colonies of thorny terrestrial clumping bromeliads, diverse thorn microphyllous scrubs and xeromorphic herbs and vines are frequently found in the understory.

Floristics [optional]: Floristic characteristics vary across the Neotropics (Navarro and Maldonado 2002, Navarro 2004, Navarro et al. 2006).

Gran Chaco: *Aspidosperma quebracho-blanco* (Apocynaceae), *Bulnesia foliosa*, *Caesalpinia argentina*, *Caesalpinia paraguariensis*, *Caesalpinia stuckertii*, *Acacia praecox*, *Acacia emilioana*, *Mimosa castanoclada*, *Mimosa detinens* (Fabaceae), *Schinopsis quebracho-colorado* (Anacardiaceae), *Stetsonia coryne*, *Cereus dayamii* (Cactaceae), *Ruprechtia triflora* (Polygonaceae), *Capparis retusa*, *Capparis salicifolia*, *Capparis tweediana* (Capparaceae), *Celtis chichape* (Ulmaceae), *Ceiba insignis* (Bombacaceae), *Maytenus spinosus* (Celastraceae), etc.

Dry Inter-Andean Valleys Bolivia-Argentina: *Schinopsis haenkeana*, *Loxopterygium grisebachii* (Anacardiaceae), *Pseudobombax andicola* (Bombacaceae), *Espostoa guentheri*, *Browningia caineana*, *Neoraimondia herzogiana* (Cactaceae), *Bougainvillea stipitata*, *Bougainvillea berberidifolia*, *Ruprechtia apetala* (Nyctaginaceae), etc.

Xeromorphic Woodland Brazilian Caatinga: *Acacia bahiensis*, *Auxemma glazioviana*, *Caesalpinia bracteosa*, *Caesalpinia gardneriana*, *Caesalpinia microphylla*, *Caesalpinia pyramidalis*, *Capparis jacobinae*, *Capparis yco*, *Caryocar coriaceum*, *Commiphora leptophloeos*, *Cordia dardanoi*, *Loxopterygium gardneri*, *Maytenus caatingarum*, *Melocactus zehntneri*, *Opuntia inamoena*, *Pilosocereus catingicola*, *Pilosocereus gounellei*, *Spondias tuberosa*, *Tacinga funalis*.

Tumbesian Southwestern Ecuador and Northwestern Perú: *Armatocereus cartwrightianus*, *Bursera graveolens*, *Caesalpinia corymbosa*, *Capparis angulata*, *Capparis mollis*, *Ceiba trichistandra*, *Cereus diffusus*, *Cordia lutea*, *Cryptocarpus pyriformis*, *Eriotheca ruizii*, *Erythrina velutina*, *Geoffroea spinosa*, *Hylocereus polyrhizus*, *Jacquinia sprucei*, *Loxopterygium huasango*, *Mimosa acantholoba*, *Pilosocereus tweedianus*, *Scutia pauciflora*, *Sideroxylon obtusifolium*, *Ziziphus piurensis*, *Ziziphus thyrsoflora*.

Colombian and Venezuelan Guajira: *Bursera simaruba*, *Consolea macracantha*, *Gerascanthus gerascanthoides*, *Opuntia dillenii*, *Stenocereus hystrix*.

ENVIRONMENT

Environmental Description [optional]:

Climate: Tropical Thorn Woodland occurs in Tropical, Mediterranean and Temperate xeric and desertic bioclimate categories of the global bioclimatic classification of Rivas-Martínez and Rivas-Saenz (1996-2009), with dry, semi-arid and arid ombrotypes.

Soil/substrate/hydrology: The soils are well- to somewhat well-drained, non-floodable and xeric, frequently on old alluvial plains and glacia.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: The largest area of this formation in the Neotropics is the Gran Chaco ecoregion in southern Bolivia, northern Argentina and northwestern Paraguay. Other important areas include the dry Inter-Andean Valley ecoregion of the southern Bolivian Andes and northwestern Argentina; the Caatinga ecoregion in Brazil and the Colombian-Venezuelan Guajira. Minor areas also occur in southwestern Pacific coastal Ecuador and adjacent northwestern Perú (Tumbesian ecoregion). In extratropical areas of South America, this formation occurs in semi-deserts and deserts of central Chile and in central-west Argentina (xeric Patagonia, Argentinian Monte). Elsewhere these woodlands may be expected in Africa and parts of the Indo-Malaysian tropics.

Nations [incomplete except for CA and US]: AR, BO, BR, CL, CO, EC, MX?, PE, PY, US?, VE

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Tropical thorn scrub or thornwood: biome-type 9 (Whittaker 1975)

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Navarro, G. 2004. Mapa de Vegetación del Parque Nacional y Area Natural de Manejo Integrado "KAA-IYA" del Gran Chaco. CABI- WCS- USAID. Editorial FAN. Santa Cruz de la Sierra. 42 pp. + 1 mapa.
- Navarro, G., J. A. Molina, and L. Perez de Molas. 2006. Classification of the forests of the Northern Paraguayan Chaco. *Phytocoenologia* 36(4).
- Navarro, G., and M. Maldonado. 2002. Geografía Ecológica de Bolivia: Vegetación y Ambientes Acuáticos. Editorial Centro de Ecología Simón I. Patiño. Cochabamba, Bolivia. 719 pp.
- Oliveira-Filho, A. T., J. A. Jarenkow, and M. G. Nogueira Rodal. 2006. Floristic relationships of seasonally dry forests of eastern South America based on tree species distribution patterns. Pages 159-192 in: R. T. Pennington, G. P. Lewis, and J. A. Ratter, editors. Neotropical savannas and seasonally dry forests: Plant diversity, biogeography and conservation. CRC Press, Boca Raton, FL.
- Pennington, R. T., G. P. Lewis, and J. A. Ratter. 2006. An overview of the plant diversity, biogeography and conservation of neotropical savannas and seasonally dry forests. Pages 1-29 in: R. T. Pennington, G. P. Lewis, and J. A. Ratter, editors. Neotropical savannas and seasonally dry forests: Plant diversity, biogeography and conservation. CRC Press, Boca Raton, FL.
- Rivas-Martinez, S., and S. Rivas-Saenz. 1996-2009. Worldwide Bioclimatic Classification System. Phytosociological Research Center, Spain. [<http://www.globalbioclimatics.org>]
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: G. Navarro and D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

3. Desert & Semi-Desert

3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland (F015)

OVERVIEW

Database Code: 3.A.2 (F015)

Scientific Name: Warm Desert & Semi-Desert Scrub & Grassland Formation

Common Name (Translated Scientific Name): Warm Desert & Semi-Desert Scrub & Grassland Formation

Colloquial Name: Warm Desert & Semi-Desert Scrub & Grassland

Hierarchy Level: Formation

Placement in Hierarchy: 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06)

Lower Level Hierarchy Units [incomplete]:

- 3.A.2.Eb. Neotropical Semi-Desert (D101)
- 3.A.2.Fc. Succulent Karoo (D177)
- 3.A.2.Fd. Madagascar Xeric Scrub & Grassland (D178)
- 3.A.2.Fe. Eastern African Xeric Scrub (D179)
- 3.A.2.Ff. North Sahel Semi-Desert Scrub & Grassland (D180)
- 3.A.2.Fg. Sahara Warm Desert Scrub & Grassland (D181)
- 3.A.2.Fh. Nama Karoo Semi-Desert Scrub & Grassland (D182)
- 3.A.2.Fi. Namib-Gariep Desert (D183)
- 3.A.2.Fj. Saharan Desert (D184)
- 3.A.2.Na. North American Warm Desert Scrub & Grassland (D039)

Type Concept Sentence: Warm Desert & Semi-Desert Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates, is uncommon near the equator to increasingly common between 15 and 35 degrees N and S latitude.

Type Concept: Warm Desert & Semi-Desert Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates. Vegetation is dominated by xeromorphic growth forms, and varies from shrub-scrub to complexes of succulents, thornscrub, and microphyllous-leaved subshrubs, often less than 2 m tall, though scattered tall succulents may occur. Ephemeral (therophytic) herbaceous growth forms may also be present. Desert grasslands often occur in transitional zones, typically containing a sparse layer

of xeromorphic shrubs and an open ground layer. Included are very open deserts where vegetation is very sparse, and where the ground layer is sandy, stony desert pavements, salt crust (bare rock, often with nonvascular mats is placed in lithomorphic vegetation). Australian semi-deserts are most unlike other semi-deserts; succulents are lacking and spiny tussock grasses (spinifex, *Triodia*) are major plants.

[Classification Comments \[optional\]:](#)

Similar NVC Types:

- 3.A.1. Tropical Thorn Woodland (F039):
- 6.C.1. Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation (F025): Warm Desert & Semi-Desert Scrub & Grassland (F015) has >10% vascular plant cover.
- 6.C.2. Cool Semi-Desert Cliff, Scree & Other Rock Vegetation (F032): Warm Desert & Semi-Desert Scrub & Grassland (F015) contains many succulents of Cactaceae and Euphorbiaceae, with spiny growth forms, and typically >10% vascular plant cover.

Diagnostic Characteristics: Vegetation is dominated by xeromorphic growth forms, and varies from open shrub-scrub to complexes of succulents, thornscrub, and microphyllous-leaved subshrubs, often less than 2 m tall, though scattered tall succulents may occur. Ephemeral (therophytic) herbaceous growth forms may also be present.

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

Physiognomy and Structure [optional]: Vegetation is dominated by xeromorphic growth forms, and varies from open shrub-scrub to complexes of succulents, thornscrub, and microphyllous-leaved subshrubs, often less than 2 m tall, though scattered tall succulents may occur. Ephemeral (therophytic) herbaceous growth forms may also be present. Desert grasslands often occur in transitional zones, typically containing a sparse layer of xeromorphic shrubs and an open ground layer. Included are very open deserts where vegetation is very sparse, and where the ground layer is sandy, stony desert pavements, salt crust (bare rock, often with nonvascular mats is placed in lithomorphic vegetation). Australian semi-deserts, having evolved in long isolation, are most unlike other semi-deserts on other continents; succulents are lacking and spiny tussock grasses (spinifex, *Triodia*) are major plants (Whittaker 1975).

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

Climate: Warm Desert & Semi-Desert Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates. Mean summer temperatures are 29.5 to 35 degrees C, and mean winter temperatures 7 to 15.5 degrees C. Annual precipitation is 0 to 25 cm, as rain only (Quinn 2009). **Soil/substrate/hydrology:** Calcification, salinization, Aridisols, azonal, salt pans, rocky, sandy, with little humus (Quinn 2009).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Warm Desert & Semi-Desert Scrub & Grassland occurs in dry warm-temperate, subtropical and tropical climates, uncommon near the equator to increasingly common between 15 and 35 degrees N and S latitude. In North America, it is found in the Mojave, Sonoran, and Chihuahuan regions, and southward into México; in South America from Argentina and Chile to Bolivia and Peru, then scattered parts of Venezuela and Colombia; great areas of the semi-desert surround the Sahara in northern Africa and extend through the Arabian Peninsula to Iran and the Thar Desert of India. More limited areas with distinctive semi-desert occur in parts of the arid areas in East Africa (Somali-Chalbi) and Southwest Africa (Kalahari and Karoo). Australian semi-deserts are a quite distinctive form (Whittaker 1975).

Nations [incomplete except for CA and US]: AR, AU, BO, CO, EC, MX, PE, PY, US, VE

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Warm Deserts (Quinn 2009)
- = Warm semidesert scrub: biome-type 17 (Whittaker 1975)

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2009. Desert Biomes. Greenwood Press, Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and G. Navarro

Acknowledgments:

Version Date: 12 Jul 2012

3. Desert & Semi-Desert

3.B. Cool Semi-Desert Scrub & Grassland (S11)

OVERVIEW

Database Code: 3.B (S11)

Scientific Name: Cool Semi-Desert Scrub & Grassland Subclass

Common Name (Translated Scientific Name): Cool Semi-Desert Scrub & Grassland Subclass

Colloquial Name: Cool Semi-Desert Scrub & Grassland

Hierarchy Level: Subclass

Placement in Hierarchy: 3. Desert & Semi-Desert (C03)

Lower Level Hierarchy Units:

- 3.B.1. Cool Semi-Desert Scrub & Grassland (F033)

Type Concept Sentence: Cool Semi-Desert Scrub & Grassland occurs in dry, cool-temperate climates, at mid-latitudes (35 to 50 degrees N), typically in the interior of continents.

Type Concept: Cool Semi-Desert Scrub & Grassland occurs in dry, cool-temperate climates. Vegetation is dominated by microphyllous-leaved xeromorphic shrubs. Structure consists of typically low shrubs or graminoids and varies from open grassland and shrub-steppe to shrubland. Vegetation not as much limited by substrates as by drought and fires.

Classification Comments [optional]: The gradation in growth forms between 2.B Temperate & Boreal Grassland & Shrubland Subclass (S18) and 3.B Cool Semi-Desert Scrub & Grassland Subclass (S11) makes delimiting the concept a challenge. For example, in North America, microphyllous sagebrush shrubs may be common in parts of the western Great Plains, comparable to sagebrush types in the Great Basin.

Also montane cool semi-desert, in which the temperatures are more strongly hot/cold, may resemble cryomorphic vegetation. For example, the Salar de Uyuni in southwestern Bolivia is the world's largest salt flat at 10,582 square kilometers (4086 square miles), near the crest of the Andes, at 3656 m (11,995 feet) elevation, and contains both xeromorphic and cryomorphic characteristics (C. Josse pers. comm. 2011).

Similar NVC Types:

- 2.B. Temperate & Boreal Grassland & Shrubland (S18): Cool Semi-Desert Scrub & Grassland (S11) typically has small-leaved, xerophytic shrubs (e.g., sage) and more open bare ground, sometimes with biological crust.
- 6.C. Desert & Semi-Desert Rock Vegetation (S03): Cool Semi-Desert Scrub & Grassland (S11) typically contains >10% vascular cover.

Diagnostic Characteristics: Vegetation is dominated by microphyllous-leaved xeromorphic shrubs. Structure consists of typically low shrubs or graminoids and varies from open grassland and shrub-steppe to shrubland.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: The vegetation is dominated by microphyllous-leaved xeromorphic shrubs. Structure consists of typically low shrubs or graminoids and varies from open grassland and shrub-steppe to shrubland. Vegetation not as much limited by substrates as by drought and fires (Whittaker 1975).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: Cool Semi-Desert Scrub & Grassland occurs in dry, cool-temperate climates, typically in the interior of continents (Quinn 2009).

DISCUSSION

Discussion [optional]:

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: This type occupies extensive landscapes of the Great Basin of the western United States, central Asia and Iran, in South America (Patagonia and the Andes) and parts of Australia (Whittaker 1975).

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Cold Deserts (Quinn 2009)
- = Cool-temperate semidesert scrub: biome-type 18 (Whittaker 1975)

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Josse, Carmen. Personal communication. Senior Ecologist, Latin America. NatureServe, Arlington, VA.
- Quinn, J. A. 2009. Desert Biomes. Greenwood Press, Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

3. Desert & Semi-Desert

3.B. Cool Semi-Desert Scrub & Grassland

3.B.1. Cool Semi-Desert Scrub & Grassland (F033)

OVERVIEW

Database Code: 3.B.1 (F033)

Scientific Name: Cool Semi-Desert Scrub & Grassland Formation

Common Name (Translated Scientific Name): Cool Semi-Desert Scrub & Grassland Formation

Colloquial Name: Cool Semi-Desert Scrub & Grassland

Hierarchy Level: Formation

Placement in Hierarchy: 3.B. Cool Semi-Desert Scrub & Grassland (S11)

Lower Level Hierarchy Units [incomplete]:

- 3.B.1.Eb. Patagonian Grassland & Shrubland (D144)
- 3.B.1.Ec. Andean Semi-Desert (D145)
- 3.B.1.Ed. Patagonian Cool Semi-Desert Scrub & Grassland (D117)
- 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland (D040)
- 3.B.1.Pf. Eastern Eurasian Cool Semi-Desert Scrub & Grassland (D115)
- 3.B.1.Pg. Western Eurasian Cool Semi-Desert Scrub & Grassland (D116)

Type Concept Sentence: Cool Semi-Desert Scrub & Grassland occurs in dry, cool-temperate climates, at mid-latitudes (35 to 50 degrees N), typically in the interior of continents.

Type Concept: Cool Semi-Desert Scrub & Grassland occurs in dry, cool-temperate climates. Vegetation is dominated by microphyllous-leaved xeromorphic shrubs. Structure consists of typically low shrubs or graminoids and varies from open grassland and shrub-steppe to shrubland. Vegetation not as much limited by substrates as by drought and fires.

Classification Comments [optional]: The gradation in growth forms between 2.B Temperate & Boreal Grassland & Shrubland Subclass (S18) and 3.B Cool Semi-Desert Scrub & Grassland Subclass (S11) makes delimiting the concept a challenge. For example, in North America, microphyllous sagebrush shrubs may be common in parts of the western Great Plains, comparable to sagebrush types in the Great Basin.

Also montane cool semi-desert, in which the temperatures are more strongly hot/cold, may resemble cryomorphic vegetation. For example, the Salar de Uyuni in southwestern Bolivia is the world's largest salt flat at 10,582 square kilometers (4086 square miles), near the crest of the Andes, at 3656 m (11,995 feet) elevation, and contains both xeromorphic and cryomorphic characteristics (C. Josse pers. comm. 2011).

Similar NVC Types:

- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): Cool Semi-Desert Scrub & Grassland (F033) typically has small-leaved, xerophytic shrubs (e.g., sage) and more open bare ground, sometimes with biological crust.
- 4.A.1. Tropical High Montane Scrub & Grassland (F022): Cool Semi-Desert Scrub & Grassland (F033) at high altitudes in the tropics, may be cool or rather hot/cold deserts that share some characteristics of cryomorphic vegetation of the tropical high montane grasslands (F022) because of the freezing temperatures.
- 6.C.1. Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation (F025):
- 6.C.2. Cool Semi-Desert Cliff, Scree & Other Rock Vegetation (F032):

Diagnostic Characteristics: Vegetation is dominated by microphyllous-leaved xeromorphic shrubs. Structure consists of typically low shrubs or graminoids and varies from open grassland and shrub-steppe to shrubland.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: The vegetation is dominated by microphyllous-leaved xeromorphic shrubs. Structure consists of typically low shrubs or graminoids and varies from open grassland and shrub-steppe to shrubland. Vegetation not as much limited by substrates as by drought and fires (Whittaker 1975).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: This type occurs in dry, cool-temperate climates, typically in the interior of continents (Quinn 2009).

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation occupies extensive landscapes of the Great Basin of the western United States, central Asia and Iran, in South America (Patagonia and the Andes) and parts of Australia (Whittaker 1975).

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Cold Deserts (Quinn 2009)
- = Cool-temperate semidesert scrub: biome-type 18 (Whittaker 1975)

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Josse, Carmen. Personal communication. Senior Ecologist, Latin America. NatureServe, Arlington, VA.
- Quinn, J. A. 2009. Desert Biomes. Greenwood Press, Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

4. Polar & High Montane Scrub & Grassland (C04)

OVERVIEW

Database Code: 4 (C04)

Scientific Name: Cryomorphic Scrub & Herb Vegetation Class

Common Name (Translated Scientific Name): Cryomorphic Scrub & Herb Vegetation Class

Colloquial Name: Polar & High Montane Scrub & Grassland

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 4.A. Tropical High Montane Scrub & Grassland (S16)
- 4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation (S12)

Type Concept Sentence: Tundra, alpine and tropical high montane habitats dominated by cryomorphic growth forms (including *dwarf-shrubs*, associated *herbs*, *lichens* and *mosses*), with low height and open to closed canopy.

Type Concept: Shrubs and herbs with cryomorphic growth forms are dominant, including *dwarf-shrub*, *caulirrosulate* (páramo) or associated herbs. Nonvascular lichen and moss growth forms may also be dominant. The vegetation structure has irregular, horizontal spacing, is of low height, often much less than 1 m tall. Mesomorphic trees have <10% cover, and cryomorphic shrubs and herbs have the majority of cover compared to mesomorphic or xeromorphic growth forms. Climates include tropical high montane (alpine to nival) to polar tundra, with stands located above continuous forest line in altitude or latitude, and regular cold and/or freezing temperatures. Substrates are dry to wet, with varying degrees and depths of permafrost or cryic soils. Vegetation includes tundra, alpine, and tropical high montane types, such as páramo and puna.

Classification Comments [optional]: Our criteria would place a stand with 1% or more cover of cryomorphic shrubs and herbs, and 99% cover of nonvascular lichen and moss in this class, if stands are on non-lithomorphic substrates (e.g., lichen tundra, typically foliose and fruticose lichens) (Viéreck et al. 1992).

Review is needed on the placement of páramo and puna in South America. Currently all páramo and puna are placed here, but there may be justification for restricting application of this class in that region to only include the more strongly cryomorphic high montane forms of puna and páramos (e.g., in Venezuela there are stands dominated by cryomorphic growth forms but lack the typical grass cover). This is because lower elevation páramo and moist puna have mesomorphic grasses covering the ground (often exceeding 80% cover), whereas cryomorphic shrubs and herbs, although present and conspicuous, may be less than 20% cover. These lower elevation stands also lack any cryoturbation. By these criteria we would place these lower elevation stands in the mesomorphic Shrubland & Grassland, and the "Tropical Montane Grassland & Shrubland" formation. On the other hand, we don't yet have a working set of "cryomorphic herbs" versus "mesomorphic herb" growth forms so it is hard to know how to weight the presence of these mesomorphic herbs against the cryomorphic shrubs. Consistent placement of the subalpine and alpine zones across tropical, temperate and boreal regions is needed.

Similar NVC Types:

- 2. Shrubland & Grassland (C02): Distinguishing cryomorphic vegetation from mesomorphic vegetation can be a challenge in both arctic and alpine regions. Here we allow mesomorphic extensions into the cryomorphic climatic zone to be retained in the mesomorphic class (e.g., boreal mesomorphic tall willow shrublands along arctic drainages, or, the tropics, lower elevation expressions of high montane páramo and puna in South America).
- 3. Desert & Semi-Desert (C03): In high montane deserts, the xeromorphic desert growth forms will transition to cryomorphic growth forms. Review is needed to see where issues may arise between temperate alpine and dry deserts or tropical high montane puna and high deserts.
- 6. Rock Vegetation (C06): In some alpine or tundra habitats, the vegetation will be limited to growing on or near rocks; and therefore may qualify as lithomorphic vegetation. The only practical solution may be to apply the arbitrary >1% cover of total vascular flowering vegetation to place it in Cryomorphic Vegetation.

Diagnostic Characteristics: Cryomorphic shrub, herb, and nonvascular growth forms (including *dwarf-shrubs*, paramoid or associated *herbs*, *lichens*, *mosses*) have the majority of cover compared to mesomorphic or xeromorphic shrub and herb growth forms, and mesomorphic trees <10% cover. The vegetation structure is irregular horizontally, and of low height, often much less than 1 m tall.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Growth Forms: Stands are dominated by cryomorphic growth forms, such as *dwarf-shrub*, *caulirrosulate* (páramo) and various associated herb growth forms (*forb*, *graminoid*), along with nonvascular *lichen* and *moss* growth forms. The various herb growth forms are not exclusive to the cryomorphic class, and more work is needed to assess whether herbaceous growth form types should be recognized that may be distinctive for this class (e.g., creeping or matted herb growth forms). In addition, lichens in this class may more commonly be foliose or fruticose (e.g., reindeer lichens), at least in Arctic tundra, and found on mineral soils (Billings 2000).

Structure: Stands have open to closed irregular shrub or herb stem spacing; often a single low complex stratum, sometimes with prominent non-vegetated surfaces. There is less than 10% mesomorphic tree cover, and typically >10% shrub or herb cover (but sparse open cover between 1% and 10% may occur), and with a majority of that cover being cryomorphic shrub and/or herb growth

form, as compared to mesomorphic or xeromorphic shrub and/or herb cover. Nonvascular growth forms may vary from 0 to 100%. At maturity, shrubs are typically less than 0.3 m, but occasionally as tall as 1 m, and herbs are typically less than 0.5 m.

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

Climate: Use climate categories, such as from Holdridge or Koeppen. Growing season is either very short, and snow cover may persist for most of the year, or growth greatly restricted by freezing to near-freezing temperatures. Edf: cold continental climate without dry season.

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Climate zones? Bailey (1989) Domains: Polar Domain, especially Tundra divisions, but also highest elevations in other domains.

Nations [incomplete except for CA and US]: AR, BO, CA, CL, CO, EC, PE, US, VE

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level:

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Arctic and Alpine Biomes (Quinn 2008)

Full Citation:

- Bailey, R. G. 1989. Explanatory supplement to ecoregions map of the continents. Environmental Conservation 16:307-309 with separate map at 1:30,000,000. USDA Forest Service, Washington, DC.
- Billings, W. D. 2000. Alpine vegetation of North America. Pages 537-572 in: M. G. Barbour and W. D. Billings, editors. North American terrestrial vegetation. Second edition. Cambridge University Press, New York. 434 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Viereck, L. A., C. T. Dyrness, A. R. Batten, and K. J. Wenzlick. 1992. The Alaska vegetation classification. General Technical Report PNW-GTR286. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 278 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: Hierarchy Revisions Working Group

Acknowledgments:

Version Date: 17 Jul 2012

4. Polar & High Montane Scrub & Grassland

4.A. Tropical High Montane Scrub & Grassland (S16)

OVERVIEW

Database Code: 4.A (S16)

Scientific Name: Tropical High Montane Scrub & Grassland Subclass

Common Name (Translated Scientific Name): Tropical High Montane Scrub & Grassland Subclass

Colloquial Name: Tropical High Montane Scrub & Grassland

Hierarchy Level: Subclass

Placement in Hierarchy: 4. Polar & High Montane Scrub & Grassland (C04)

Lower Level Hierarchy Units:

- 4.A.1. Tropical High Montane Scrub & Grassland (F022)

Type Concept Sentence: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and small-leaved low woody shrubs or small sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. It occurs in all tropical high mountains worldwide, where it occupies the sub-nival elevations.

Type Concept: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and woody shrubs or small-leaved low sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. It occurs in all tropical high mountains worldwide, where it occupies the sub-nival altitudinal belt. The predominant growth forms are rosulate plants with deep taproots and several plants with densely caespitose root systems and or creeping prostrate habit. The canopy cover varies from very low to open or semi-open. Species have, in general, adapted to sliding or movement of the substrate due to the diurnal alternation of freezing and melting, which is a typical phenomenon of the high tropical mountains. Soils have marked cryogenic phenomena, mainly contraction and expansion, gelifluction and freeze fracture (gelifraction).

Classification Comments [optional]: The páramo and the dry and moist puna are included in this subclass, because they have primarily mesomorphic adaptations, and because the soils are not subject to cryogenic processes. These vegetation types are treated with 2.A.2 Tropical Montane Grassland & Shrubland Formation (F017). Nonetheless, although the páramo and the dry and moist puna are not subject to cryogenic soil processes, they are subject to varying levels of freezing. Perhaps the term "cryomorphic" places too great a restriction on the concept of "tropical alpine" vegetation.

Also challenging to place consistently in this class is the South American xerophytic vegetation and the Altiplano central-south of Bolivia-Argentina-Chile, because the cryomorphic definition is very similar to xeromorphic; that is to say, they share ecological processes and have similar structures (growth forms) to each other. The vegetation is not Cool Semi-Desert, but is a hot/cold semi-desert, while at the same time is hardly affected by edaphic processes of cryoturbation and geliturbation expected of the cryomorphic class. We find again the diurnal rhythm of ice/thaw of the tropical mountains, but it is marked in these high dry southern areas with very high daily solar temperatures and very low nocturnal temperatures. Where to place these ecosystems? For example, in the Great Salt Flats of Uyuni (Salar de Uyuni) to 3800 m of altitude, during the day temperatures can rise to 20 degrees C and at night to -20 degrees C. This is an extreme case related to the immense salt flats, but the lands that surround them repeat almost the same features listed above, although with smaller thermal amplitudes (C. Josse pers. comm. 2011). So high-elevation semi-deserts share some characteristics with the tropical high montane vegetation.

Similar NVC Types:

Diagnostic Characteristics: Herbaceous perennials and small woody, small-leaved prostrate sub-shrubs, with a predominance of tap-roots and creeping or densely caespitose root systems.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and woody shrubs or small-leaved low sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. The predominant growth forms are rosulate plants with deep taproots and several plants with densely caespitose root systems and or creeping prostrate habit. The canopy cover varies from very low to open or semi-open. It occurs in all tropical high mountains worldwide, where it occupies the sub-nival altitudinal belt. Species have, in general, adapted to sliding or movement of the substrate due to the diurnal alternation of freezing and melting, which is a typical phenomenon of the high tropical mountains.

Floristics [optional]: In the central Andes, the vegetation is strongly characterized and differentiated by species of the following genera, several of them endemic to the high Andes: *Nototriche* (Malvaceae); *Pycnophyllum* (Caryophyllaceae); *Anthochloa*, *Deyeuxia*, *Dielsiochloa*, *Festuca*, and *Stipa* (Poaceae); *Englerocharis*, *Menonvillea*, *Parodiodoxa*, and *Weberbaueria* (Brassicaceae); *Stangea* and *Valeriana* (Valerianaceae); *Chaetanthera*, *Oriastrum*, *Senecio*, *Werneria* (Asteraceae); *Azorella* (Apiaceae); *Urbania* (Verbenaceae).

ENVIRONMENT

Environmental Description [optional]:

Climate: Diurnal and nonseasonal energy pattern, with seasonal moisture regime consisting of a rainy summer and a dry winter that is a typical pattern of high tropical mountains, in contrast to non-tropical high mountains (temperate, boreal, Mediterranean) where there is a seasonal energy regime and where the rainfall has not matched up with the warmest time of year.

In the Andes, this formation is generally above 4500 m altitude.

Soil/substrate/hydrology: Soils have alterations in structure and texture due to deformation caused by freezing processes (contraction and dilatation) with diurnal periodicity of freezing and thawing. The substrates are mostly fine- to medium-textured, stony on the surface (loose stony pavement), with a muddy matrix that is saturated with meltwater and freezes daily. In tropical mountains, surface layers that freeze may overlie unfrozen subsurface layers. An important effect of frost-heaving is the upward movement of stones in soils and unconsolidated deposits that is more rapid and pervasive in wetter soils with a sparse vegetation cover. The process associated with frost can also cause upward or downward displacement of soil material in mass that can result in

slope cryoplanation terraces at several scales. These soils are located in the highest areas of tropical mountains above 4500 m altitude.

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: This subclass occurs in tropical high montane regions of South America, eastern Africa and New Guinea. Further review is needed to determine whether it occurs in Central America, Malaysia, and tropical oceanic islands. In the Neotropics, this type occupies the highest elevations of the tropical Andes, above 4500-4600 m altitude, from Venezuela to Argentina, and is well-represented in the central Andes of Bolivia and Perú.

Nations [incomplete except for CA and US]: AR, BO, CL, CO, EC, PE, US, VE

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- < Alpine semi-desert: biome-type 19 (Whittaker 1975) [The author does not separate out tropical from temperate.]
- < Tropical Alpine Biome (Quinn 2008) [Quinn includes both the tropical montane and tropical high montane scrub band grassland in her type.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Josse, Carmen. Personal communication. Senior Ecologist, Latin America. NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: G. Navarro and D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

4. Polar & High Montane Scrub & Grassland

4.A. Tropical High Montane Scrub & Grassland

4.A.1. Tropical High Montane Scrub & Grassland (F022)

OVERVIEW

Database Code: 4.A.1 (F022)

Scientific Name: Tropical High Montane Scrub & Grassland Formation

Common Name (Translated Scientific Name): Tropical High Montane Scrub & Grassland Formation

Colloquial Name: Tropical High Montane Scrub & Grassland

Hierarchy Level: Formation

Placement in Hierarchy: 4.A. Tropical High Montane Scrub & Grassland (S16)

Lower Level Hierarchy Units [incomplete]:

- 4.A.1.Ea. Central American & Caribbean High Montane Scrub & Grassland (D041)
- 4.A.1.Eb. Andean High Montane Scrub & Grassland (D118)
- 4.A.1.Fc. Madagascar Alpine Scrub, Forb Meadow & Grassland (D119)
- 4.A.1.Od. Polynesian High Montane Scrub & Grassland (D082)
- 4.A.1.Oe. Eastern Melanesian High Montane Scrub & Grassland (D083)

Type Concept Sentence: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and small-leaved low woody shrubs or small sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. They occur in all tropical high mountains, where they occupy the sub-nival altitudinal belt, generally above 4500 m altitude in the Andes.

Type Concept: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and woody shrubs or small-leaved low sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. They occur in all tropical high mountains, where they occupy the sub-nival altitudinal belt, generally above 4500 m altitude in the Andes. Species have, in general, adapted to sliding or movement of the substrate due to the diurnal alternation of freezing and melting, which is a typical phenomenon of the high tropical mountains. Soils have marked cryogenic phenomena, mainly contraction and expansion, gelifluction and freeze fracture (gelifraction). The predominant growth forms are rosulate plants with deep taproots and several plants with densely caespitose root systems and or creeping prostrate habit. The canopy cover varies from very low to open or semi-open.

Classification Comments [optional]: The páramo and the dry and moist puna cannot be included in this formation, because they have primarily mesomorphic adaptations, and because the soils are not subject to cryogenic processes. These vegetation types are treated with 2.A.2 Tropical Montane Grassland & Shrubland Formation (F017). Nonetheless, although the páramo and the dry and moist puna are not subject to cryogenic soil processes, they are subject to varying levels of freezing. Perhaps the term "cryomorphic" places too great a restriction on the concept of "tropical alpine" vegetation.

Also challenging to place consistently in this class is the South American xerophytic vegetation and the Altiplano central-south of Bolivia-Argentina-Chile, because the cryomorphic definition is very similar to xeromorphic; that is to say, they share ecological processes and have similar structures (growth forms) to each other. The vegetation is not Cool Semi-Desert, but is a hot/cold semi-desert, while at the same time is hardly affected by edaphic processes of cryoturbation and geliturbation expected of the cryomorphic class. We find again the diurnal rhythm of ice/thaw of the tropical mountains, but it is marked in these high dry southern areas with very high daily solar temperatures and very low nocturnal temperatures. Where to place these ecosystems? For example, in the Great Salt Flats of Uyuni (Salar de Uyuni) to 3800 m of altitude, during the day temperatures can rise to 20 degrees C and at night to -20 degrees C. This is an extreme case related to the immense salt flats, but the lands that surround them repeat almost the same features listed above, although with smaller thermal amplitudes (C. Josse pers. comm. 2011). So high-elevation semi-deserts share some characteristics with the tropical high montane vegetation.

Similar NVC Types:

- 2.A.1. Tropical Lowland Grassland, Savanna & Shrubland (F019):
- 2.A.2. Tropical Montane Grassland & Shrubland (F017): This formation contains high montane vegetation that is at or near treeline in the tropics, but is not subject to regular freezing or affected by cryogenic soil processes. In the Neotropics we place páramo and puna in this formation because they predominantly do not have cryogenic soils or experience frost.
- 3.B.1. Cool Semi-Desert Scrub & Grassland (F033): At high altitudes in the tropics, these cool or rather hot/cold deserts share some characteristics of cryomorphic vegetation because of the freezing temperatures.
- 4.B.1. Temperate & Boreal Alpine Vegetation (F037): This formation lacks constant freezing temperate and cryomorphic soils.

Diagnostic Characteristics: Herbaceous perennials and small woody, small-leaved prostrate sub-shrubs, with a predominance of tap-roots and creeping or densely caespitose root systems.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and woody shrubs or small-leaved low sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. The predominant growth forms are rosulate plants with deep taproots and several plants with densely caespitose root systems and or creeping prostrate habit. The canopy cover varies from very low to open or semi-open. It occurs in all tropical high mountains worldwide, where it occupies the sub-nival altitudinal belt. Species have, in general, adapted to sliding or movement of the substrate due to the diurnal alternation of freezing and melting, which is a typical phenomenon of the high tropical mountains.

Floristics [optional]: In the central Andes, the communities are strongly characterized and differentiated by species of the following genera, several of them endemic to the high Andes: *Nototriche* (Malvaceae); *Pycnophyllum* (Caryophyllaceae); *Anthochloa*, *Deyeuxia*, *Dielsiochloa*, *Festuca*, and *Stipa* (Poaceae); *Englerocharis*, *Menonvillea*, *Parodiodoxa*, and *Weberbaueria* (Brassicaceae); *Stangea* and *Valeriana* (Valerianaceae); *Chaetanthera*, *Oriastrum*, *Senecio*, *Werneria* (Asteraceae); *Azorella* (Apiaceae); *Urbania* (Verbenaceae).

ENVIRONMENT

Environmental Description [optional]:

Climate: Diurnal and nonseasonal energy pattern, with seasonal moisture regime consisting of a rainy summer and a dry winter that is a typical pattern of high tropical mountains, in contrast to non-tropical high mountains (temperate, boreal, Mediterranean) where there is a seasonal energy regime and where the rainfall has not matched up with the warmest time of year.

In the Andes, this formation is generally above 4500 m altitude.

Soil/substrate/hydrology: Soils have alterations in structure and texture due to deformation caused by freezing processes (contraction and dilatation) with diurnal periodicity of freezing and thawing. The substrates are mostly fine- to medium-textured,

stony on the surface (loose stony pavement), with a muddy matrix that is saturated with meltwater and freezes daily. In tropical mountains, surface layers that freeze may overlie unfrozen subsurface layers. An important effect of frost-heaving is the upward movement of stones in soils and unconsolidated deposits that is more rapid and pervasive in wetter soils with a sparse vegetation cover. The process associated with frost can also cause upward or downward displacement of soil material in mass that can result in slope cryoplanation terraces at several scales. These soils are located in the highest areas of tropical mountains above 4500 m altitude.

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Tropical High Montane Scrub & Grassland is dominated by herbaceous perennials and small-leaved low woody shrubs or small sub-woody species in high tropical mountains, where freezing and cryogenic processes occur. It occurs in all tropical high mountains worldwide, where it occupies the sub-nival altitudinal belt.

Nations [incomplete except for CA and US]: AR, BO, CL, CO, EC, PE, US, VE

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]: Review of the distinction between 2.A.2 Tropical Montane Grassland & Shrubland Formation (F017) and 4.A.1 Tropical High Montane Scrub & Grassland Formation (F022) around the globe is needed.

CITATIONS

Synonymy:

- < Alpine semi-desert: biome-type 19 (Whittaker 1975) [The author does not separate out tropical from temperate.]
- < Tropical Alpine Biome (Quinn 2008) [Quinn includes both the tropical montane and tropical high montane scrub band grassland in her type.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fuels, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Josse, Carmen. Personal communication. Senior Ecologist, Latin America. NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: G. Navarro, C. Josse and D. Faber-Langendoen

Acknowledgments:

Version Date: 17 Nov 2011

4. Polar & High Montane Scrub & Grassland

4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation (S12)

OVERVIEW

Database Code: 4.B (S12)

Scientific Name: Temperate, Boreal & Polar Alpine - Tundra Vegetation Subclass

Common Name (Translated Scientific Name): Temperate, Boreal & Polar Alpine - Tundra Vegetation Subclass

Colloquial Name: Temperate, Boreal & Polar Alpine - Tundra Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 4. Polar & High Montane Scrub & Grassland (C04)

Lower Level Hierarchy Units:

- 4.B.1. Temperate & Boreal Alpine Vegetation (F037)
- 4.B.2. Polar Tundra Vegetation (F031)

Type Concept Sentence: Alpine dwarf-shrublands, forb meadows, and grasslands occurring above treeline in temperate and boreal regions around the globe, predominantly in North America and Eurasia, with more isolated occurrences in the Southern Hemisphere. Polar tundra is dominated by dwarf-shrubs, cushion shrubs, sedges and grasses, mosses and lichens, and is found in the high

latitudes north of 60 degrees N in the Arctic region and south of 50 degrees S in the Antarctic region, in permafrost soils that range from dry to seasonally saturated.

Type Concept: Temperate, Boreal & Polar Alpine - Tundra Vegetation occurs above treeline in temperate and boreal regions, predominantly in North America and Eurasia, with more isolated occurrences in the Southern Hemisphere. Creeping, matted and low upright dwarf-shrubs may occur, along with alpine grasses and forbs. The ground layer density varies from densely vegetated to open, rocky, rubbly, or frost-sorted habitats, and includes fell-field, boulderfield, tundra, heath and meadow. Bryophyte and lichen cover also varies considerably. Treeline varies depending on latitudinal shifts in climate, moisture, and type of mountain range, including its size and degree of isolation, so varies, for example, from 1650 m in the Andean steppe of Argentina to 3300-3600 m in the Himalayas, Southern Rocky Mountains and Californian Sierra Nevada to 2300 m in the Lesotho Plateau of South Africa.

Classification Comments [optional]: This type excludes very sparse alpine semi-desert vegetation, where the alpine regions grade into high-elevation deserts. Soils show cryogenic features. Krummholz is included with subalpine forests. Scree and talus are placed in 6.D.2 Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation (F007). Fellfields, which are placed here, have a mix of nonvascular and vascular plants that may overlap with 6.D.2. Snowbank vegetation, which can be seasonally saturated, with wetland-like conditions, is tentatively included here.

Placement of alpine vegetation in arctic and subarctic regions is under review. In those regions, the vegetation is beyond the latitudinal limits of trees. If alpine vegetation exists in those regions, then the subclass should include Arctic or Subarctic in the name.

The High Arctic is often bare not because it is "rock" but because of the climate (cold and wind) and cryomorphic processes, hence it fits here. The vegetation may be similar to High Arctic 6.D.2 Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation (F007). In true polar deserts, even cryptogams are sparse, and total cover is 0-3% (Quinn 2008).

We include "wet tundra" (tundra on saturated, somewhat peaty soils) with dry to mesic tundra. Arctic wet meadows and marshes are treated with temperate and boreal wet meadows and marshes under 2.B.6 Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Formation (F013).

Similar NVC Types:

- 6.D. Polar & High Montane Rock Vegetation (S05): Polar deserts and semi-deserts are mostly bare rock, primarily dominated by lichens and mosses with widely scattered herbs, but may contain tundra vegetation.

Diagnostic Characteristics: Alpine dwarf-shrublands, forb meadows and grasslands occurring above treeline in temperate and boreal regions. Vegetation is dominated by graminoids, low creeping or matted dwarf-shrubs, and perennial forbs, often in cushion or rosette form. Polar tundra growth forms are varied and often with complex patterns of dominance by dwarf-shrubs, sedges and grasses, mosses and lichens. In many tundra areas, the deep layers of the soil are permanently frozen, and only the surface layer is thawed and becomes biologically active during the summer.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Alpine vegetation includes creeping and matted dwarf-shrubs, and occasional trees may occur, along with alpine grasses and forbs, including cushion forms of dwarf-shrubs and forbs. The ground layer varies from densely vegetated to open, rocky, rubbly or frost-sorted habitats (Whittaker 1975, Quinn 2008). Polar tundra exists on the treeless arctic plains; the vegetation growth forms are varied and often with complex patterns of dominance by dwarf-shrubs, sedges and grasses, mosses and lichens (Whittaker 1975). The Low Arctic region typically contains continuous vegetation cover (80-100%), except in rocky places, and contains the typical mix of dwarf-shrubs, sedges and grasses, mosses and lichens. Tundra also occurs in the High Arctic, and plants are primarily lichens and mosses with scattered herbs. It may resemble polar semi-desert or desert on rock substrates (6.D.2 Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation (F007), in part), but in true polar rocky deserts, even cryptogams are sparse, and total cover is 0-3% (Quinn 2008).

Floristics [optional]: Alpine tundra of most Eurasian and North American mountains is similar to that of the Arctic but with a richer flora (Quinn 2008).

ENVIRONMENT

Environmental Description [optional]: Alpine vegetation occurs above treeline. Treeline varies depending on latitude and the "mountain mass" (i.e., large mountain masses retain more heat and tend to have higher treeline elevations, whereas smaller and more isolated mountain masses tend to have lower treeline elevations). In addition to elevation, exposure to wind is a key factor in the type of vegetation: in snowy regions, it impacts on the depth and duration of snow cover and, hence, protection of the vegetation, length of growing season, and soil moisture conditions.

Climate: For alpine vegetation, the "tundra" climate of high altitudes does not necessarily correspond to that of high latitudes (i.e., Arctic tundra). Although both regions have low mean annual temperature and short growing seasons, and experience a seasonal change in sun angle (high in the summer, low in the winter), the light regimes are quite different. Alpine regions never experience 24

hours of day or night; day length varies with latitude. And although permafrost occurs on high mountains, it does not produce the kinds of landforms found in the Arctic because few flat sites are available. Conversely, avalanches and rockslides are common in alpine regions, but do not occur in the Arctic (Quinn 2008). Some alpine can have very deep snow (several meters), whereas the Arctic generally has low snow cover.

Temperatures in the Arctic and Antarctic vary with the season, which has periods of 24-hour light (summer) and dark (winter). The number of days with those extremes varies with latitude, ranging from one day at the Arctic and Antarctic circles (66½ degrees N and S latitude) to six months at the poles. Temperatures vary both with latitude and degree of continentality. Mean temperatures of the warmest summer months vary considerably but generally average between 4.5 and 13 degrees C. In the winter, they average from -20 to -30 degrees C. Annual precipitation, which often falls as snow, is typically less than 25 cm, but some localities may have as much as 50 cm.

Soil/substrate/hydrology: Most alpine soils are regularly disturbed by freezing, erosion and downslope slides, and contain a mix of rocks and fine particles (Quinn 2008). Three major types of soils occur in the alpine regions: (1) Poorly-developed rocky or stony soils (or Entisols) are sometimes called Lithosols when formed on bare rock of slopes and ridges and Regosols when formed on unconsolidated rock-like talus, scree, or rubble (soil orders from Soil Survey Staff (1999)) [see Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems]. Both types are shallow, dry and azonal (talus and scree are in 6.D.2 Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation (F007) but shallow, poorly-developed soils can occur here). (2) Alpine turf and meadow soils (or Inceptisols) are up to 75 cm deep and exhibit distinct horizons; and (3) bog soils (Histosols) are found in depressions or where seepage saturates the ground to a depth of 1 m or more (Quinn 2008).

In many polar tundra areas, the deep layers of the soil are permanently frozen (permafrost), and only the surface layer is thawed and becomes biologically active during the summer (Whittaker 1975). Soils may be dry to seasonally saturated. Permafrost is ground that is permanently frozen, and is widespread in the Arctic, covering large parts of Canada and Russia. It is discontinuous in the boreal forest region to the south. It can extend down more than 600 m, depending on mean annual temperature, type of soil and rock, proximity to the ocean and topography. In the summer, only the soil surface may thaw, up to 20-60 cm. On slopes, the thawed soil may begin to move, a process called solifluction (Quinn 2008). Permafrost also creates specific landscape features collectively called patterned ground, forming circles, polygons, nets, hummocks, steps or stripes (Quinn 2008).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Temperate, Boreal & Polar Alpine - Tundra Vegetation occurs above treeline in temperate and boreal regions around the globe, predominantly in North America and Eurasia, with more isolated occurrences in the Southern Hemisphere. Polar tundra is dominated by complex patterns of dominance by dwarf-shrubs, sedges and grasses, mosses and lichens, and is found in the high latitudes north of 60 degrees N in the Arctic region and south of 50 degrees S in the Antarctic region, where climatic conditions exclude tree and tall-shrub growth forms.

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level:

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- >< Alpine grassland: biome-type 15 (Whittaker 1975)
- >< Alpine shrubland: biome-type 14 (Whittaker 1975)
- < Arctic and Antarctic Tundra (Quinn 2008) [The author includes both lithomorphic and cryomorphic vegetation in the Polar High Arctic semi-desert description as well as wet tundras.]
- = Low Arctic Tundra (Bliss 2000) [Bliss includes both dry and wet tundra in his description.]
- = Mid-latitude Alpine Tundra (Quinn 2008) [Approximately equivalent. Quinn includes alpine scree and talus in her concept.]

Full Citation:

- Bliss, L. C. 2000. Arctic Tundra and Polar Desert Biome. Pages 1-40 in: M. G. Barbour and W. D. Billings, editors. North American Terrestrial Vegetation, second edition. Cambridge University Press, New York.
- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Second edition. USDA Natural Resources Conservation Service, Washington, DC.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments: Chris Lea

Version Date: 12 Jul 2012

4. Polar & High Montane Scrub & Grassland

4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation

4.B.1. Temperate & Boreal Alpine Vegetation (F037)

OVERVIEW

Database Code: 4.B.1 (F037)

Scientific Name: Temperate & Boreal Alpine Vegetation Formation

Common Name (Translated Scientific Name): Temperate & Boreal Alpine Vegetation Formation

Colloquial Name: Temperate & Boreal Alpine Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation (S12)

Lower Level Hierarchy Units [incomplete]:

- 4.B.1.Le. Australian Alpine Vegetation (D122)
- 4.B.1.Lf. New Zealand Alpine Vegetation (D123)
- 4.B.1.Na. Eastern North American Alpine Vegetation (D042)
- 4.B.1.Nb. Western North American Alpine Vegetation (D043)
- 4.B.1.Pc. European Alpine Vegetation (D120)
- 4.B.1.Pd. Central Asian Alpine Vegetation (D121)

Type Concept Sentence: Alpine dwarf-shrublands, forb meadows and grasslands occurring above treeline in temperate and boreal regions around the globe, predominantly in North America and Eurasia, with more isolated occurrences in the Southern Hemisphere.

Type Concept: Alpine dwarf-shrublands, forb meadows and grasslands occurring above treeline in temperate and boreal regions, predominantly in North America and Eurasia, with more isolated occurrences in the Southern Hemisphere. Creeping, matted and low upright dwarf-shrubs may occur, along with alpine grasses and forbs. The ground layer density varies from densely vegetated to open, rocky, rubbly, or frost-sorted habitats, and includes fell-field, boulderfield, tundra, heath and meadow. Bryophyte and lichen cover also varies considerably. Treeline varies depending on latitudinal shifts in climate, moisture and type of mountain range, including its size and degree of isolation, so varies, for example, from 1650 m in the Andean steppe of Argentina to 3300-3600 m in the Himalayas, Southern Rocky Mountains and Californian Sierra Nevada to 2300 m in the Lesotho Plateau of South Africa.

Classification Comments [optional]: Excludes very sparse alpine semi-desert vegetation, where the alpine regions grade into high-elevation deserts. Soils show cryogenic features. Krummholz is included with subalpine forests. Scree and talus are placed in 6.D.2 Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation (F007). Fellfields, which are placed here, have a mix of nonvascular and vascular plants that may overlap with 6.D.2.

Placement of alpine vegetation in arctic and subarctic regions is under review. In those regions, the vegetation is beyond the latitudinal limits of trees. If alpine vegetation exists in those regions, then the subclass should include Arctic or Subarctic in the name.

The growth form distinctions between alpine vegetation and polar tundra need further review.

Similar NVC Types:

- 4.A.1. Tropical High Montane Scrub & Grassland (F022):
- 4.B.2. Polar Tundra Vegetation (F031): Occurs latitudinally beyond the treeline, though may extend southward into mountains of the subarctic (subpolar) woodland regions.

Diagnostic Characteristics: Alpine dwarf-shrublands, forb meadows and grasslands occurring above treeline in temperate and boreal regions. Vegetation is dominated by graminoids, low creeping or matted dwarf-shrubs, and perennial forbs, often in cushion or rosette form.

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#) Creeping and matted dwarf-shrubs and occasional trees may occur, along with alpine grasses and forbs, including cushion forms of dwarf-shrubs and forbs. The ground layer varies from densely vegetated to open, rocky, rubby or frost-sorted habitats (Whittaker 1975, Billings 2000, Quinn 2008). An extended list of alpine growth forms is provided by Billings (2000, Table 14.3).

[Floristics \[optional\]:](#) Alpine tundra of most Eurasian and North American mountains is similar to that of the Arctic but with a richer flora (Quinn 2008).

ENVIRONMENT

[Environmental Description \[optional\]:](#) Treeline varies depending on latitude and the "mountain mass" (i.e., large mountain masses retain more heat and tend to have higher treeline elevations, whereas smaller and more isolated mountain masses tend to have lower treeline elevations). In addition to elevation, exposure to wind is a key factor in the type of vegetation: in snowy regions, it impacts on the depth and duration of snow cover and, hence, protection of the vegetation, length of growing season, and soil moisture conditions.

Climate: The "tundra" climate of high altitudes does not necessarily correspond to that of high latitudes (i.e., Arctic tundra). Although both regions have low mean annual temperature and short growing seasons, and experience a seasonal change in sun angle (high in the summer, low in the winter), the light regimes are quite different. Alpine regions never experience 24 hours of day or night; day length varies with latitude. And although permafrost occurs on high mountains, it does not produce the kinds of landforms found in the Arctic because few flat sites are available. Conversely, avalanches and rockslides are common in alpine regions, but do not occur in the Arctic (Billings 2000, Quinn 2008). Some alpine can have very deep snow (several meters), whereas the Arctic generally has low snow cover.

Soil/substrate/hydrology: Most alpine soils are regularly disturbed by freezing, erosion and downslope slides, and contain a mix of rocks and fine particles (Quinn 2008). Three major types of soils occur in the alpine regions: (1) Poorly-developed rocky or stony soils (or Entisols) are sometimes called Lithosols when formed on bare rock of slopes and ridges and Regosols when formed on unconsolidated rock-like talus, scree, or rubble (soil orders from Soil Survey Staff (1999)) [see Brady and Weil (2002) for comparison of U.S. soil orders with Canadian and FAO systems]. Both types are shallow, dry and azonal (talus and scree are in 6.D.2 Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation (F007) but shallow, poorly-developed soils can occur here). (2) Alpine turf and meadow soils (or Inceptisols) are up to 75 cm deep and exhibit distinct horizons; and (3) bog soils (Histosols) are found in depressions or where seepage saturates the ground to a depth of 1 m or more (Billings 2000, Quinn 2008).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Temperate & Boreal Alpine Vegetation occurs above treeline in temperate and boreal regions around the globe, predominantly in North America and Eurasia, with more isolated occurrences in the Southern Hemisphere.

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: High

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- >< Alpine grassland: biome-type 15 (Whittaker 1975)
- >< Alpine shrubland: biome-type 14 (Whittaker 1975)
- = Mid-latitude Alpine Tundra (Quinn 2008) [Approximately equivalent. Quinn includes alpine scree and talus in her concept.]

Full Citation:

- Billings, W. D. 2000. Alpine vegetation of North America. Pages 537-572 in: M. G. Barbour and W. D. Billings, editors. North American terrestrial vegetation. Second edition. Cambridge University Press, New York. 434 pp.
- Brady, N. C., and R. R. Weil. 2002. The nature and properties of soils. Thirteenth edition. Prentice Hall, Upper Saddle River, NJ.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II

(Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Second edition. USDA Natural Resources Conservation Service, Washington, DC.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments: Chris Lea

Version Date: 12 Jul 2012

4. Polar & High Montane Scrub & Grassland

4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation

4.B.2. Polar Tundra Vegetation (F031)

OVERVIEW

Database Code: 4.B.2 (F031)

Scientific Name: Polar Tundra Vegetation Formation

Common Name (Translated Scientific Name): Polar Tundra Vegetation Formation

Colloquial Name: Polar Tundra Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation (S12)

Lower Level Hierarchy Units [incomplete]:

- 4.B.2.Xa. Arctic Tundra (D044)

Type Concept Sentence: Upland or dry polar tundra is dominated by dwarf-shrubs, sedges and grasses, mosses and lichens, and is found in the high latitudes north of 60 degrees N in the Arctic region and south of 50 degrees S in the Antarctic region, in permafrost soils that range from dry to seasonally saturated.

Type Concept: Upland or dry tundra exists at the high latitudes north of 60 degrees N in the Arctic region and south of 50 degrees S in the Antarctic region. The vegetation growth forms are varied and often with complex patterns of dominance by dwarf-shrubs, sedges and grasses, mosses and lichens, and creeping or matted herbs. In many tundra areas, the deep layers of the soil are permanently frozen, and only the surface layer is thawed and becomes biologically active during the summer. The Low Arctic region typically contains continuous vegetation cover (80-100%), except in rocky places, and contains the typical mix of dwarf-shrubs, sedges and grasses, mosses and lichens. Tundra also occurs in the High Arctic, and plants are primarily lichens and mosses with scattered herbs. The High Arctic has fine soil material, and can be wet and strongly influenced by cryoturbation, with more sparse vegetation.

Classification Comments [optional]: Plants are primarily lichens and mosses with scattered herbs (Quinn 2008). We include "wet tundra" (tundra on saturated, somewhat peaty soils) with dry to mesic tundra. Arctic wet meadows and marshes are treated with temperate and boreal wet meadows and marshes under 2.B.6 Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Formation (F013).

Similar NVC Types:

- 4.B.1. Temperate & Boreal Alpine Vegetation (F037): Polar vegetation may extend southward into the subarctic mountain regions.
- 6.D.2. Polar & Alpine Cliff, Scree & Other Rock Vegetation (F007): Polar deserts and semi-deserts, are mostly bare rock, primarily dominated by lichens and mosses with widely scattered herbs, but may contain tundra vegetation.

Diagnostic Characteristics: The vegetation growth forms are varied and often with complex patterns of dominance by dwarf-shrubs, low sedges and grasses, mosses and lichens, and creeping or matted herbs. Soil conditions are dry to seasonally saturated, with deep layers of the soil permanently frozen, with only the surface layer thawing in summer and becoming biologically active.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Upland or dry polar tundra is found in the high latitudes north of 60 degrees N in the Arctic region and south of 50 degrees S in the Antarctic region. The vegetation growth forms are varied and often with complex patterns of dominance by dwarf-shrubs, sedges and grasses, mosses and lichens. The Low Arctic region typically contains continuous vegetation cover (80-100%), except in rocky places, and contains the typical mix of dwarf-shrubs, sedges and grasses, mosses and lichens. Plants in the High Arctic tundra are primarily lichens and mosses with scattered herbs. The High Arctic has fine soil material, and can be wet and strongly influenced by cryoturbation, with more sparse vegetation. Wetter tundra includes low sedge- and moss-dominated types. It is called "graminoid-moss tundra" by Bliss (2000), who describes it as containing species of *Carex* and *Eriophorum*, along with an abundance of bryophytes, but few lichens.

Floristics [optional]:

ENVIRONMENT**Environmental Description [optional]:**

Climate: Temperatures in the Arctic and Antarctic vary with the season, which has periods of 24-hour light (summer) and dark (winter). The number of days with those extremes varies with latitude, ranging from one day at the Arctic and Antarctic circles (66½ degrees N and S latitude) to six months at the poles. Temperatures vary both with latitude and degree of continentality. Mean temperatures of the warmest summer months vary considerably but generally average between 4.5 and 13 degrees C. In the winter, they average from -20 to -30 degrees C. Precipitation, which often falls as snow, is typically less than 25 cm, but some localities may have as much as 50 cm.

Soil/substrate/hydrology: In many tundra areas, the deep layers of the soil are permanently frozen (permafrost), and only the surface layer is thawed and becomes biologically active during the summer (Whittaker 1975). Soils may be dry to seasonally saturated. Permafrost is ground that is permanently frozen, and is widespread in the Arctic, covering large parts of Canada and Russia. It is discontinuous in the boreal forest region to the south. It can extend down more than 600 m, depending on mean annual temperature, type of soil and rock, proximity to the ocean and topography. In the summer, only the soil surface may thaw, up to 20-60 cm. On slopes, the thawed soil may begin to move, a process called solifluction (Quinn 2008). Permafrost also creates specific landscape features collectively called patterned ground, forming circles, polygons, nets, hummocks, steps or stripes (Quinn 2008).

DISCUSSION**Discussion [optional]:****Animals [optional]:****Mapping Issues [optional]:****DISTRIBUTION**

Geographic Range: Upland or dry polar tundra is found in the high latitudes north of 60 degrees N in the Arctic region and south of 50 degrees S in the Antarctic region.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:**Omernik Ecoregions [optional]:****CONFIDENCE LEVEL**

Confidence Level: High

Confidence Level Comments [optional]:**CITATIONS****Synonymy:**

- < Arctic and Antarctic Tundra (Quinn 2008) [Polar (High Arctic) deserts (which fall under lithomorphic vegetation) are included in the authors concept.]
- < Low Arctic Tundra (Bliss 2000) [Bliss includes dry and wet tundra in his overall concept, but the tall-shrub tundra, low-shrub tundra, dwarf-shrub heath tundra, and cottongrass-dwarf-shrub heath tundra are all dry tundra and fit here.]

Full Citation:

- Bliss, L. C. 2000. Arctic Tundra and Polar Desert Biome. Pages 1-40 in: M. G. Barbour and W. D. Billings, editors. North American Terrestrial Vegetation, second edition. Cambridge University Press, New York.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fuels, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Quinn, J. A. 2008. Arctic and Alpine Biomes. Greenwood Press. Westport, CT.
- Whittaker, R. H. 1975. Communities and ecosystems. Second edition. Macmillan Publishing Co., New York. 387 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and S. Ponomarenko

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation (C05)

OVERVIEW

Database Code: 5 (C05)

Scientific Name: Hydromorphic Vegetation Class

Common Name (Translated Scientific Name): Hydromorphic Vegetation Class

Colloquial Name: Aquatic Vegetation

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 5.A. Saltwater Aquatic Vegetation (S09)
- 5.B. Freshwater Aquatic Vegetation (S13)

Type Concept Sentence: Open freshwater and saltwater wetlands dominated by aquatic vegetation, either rooted with leaves rising up to or near the surface, or floating freely on the water surface. Stands typically have surface water, generally up to 2 m in depth, along ocean, lake, pond, and river margins in non-tidal, tidal and intertidal habitats.

Type Concept: Hydromorphic growth forms dominate, including rooting and floating *aquatic herbs* and *alga*, in freshwater and saltwater wetland and open-water environments. Vegetation structure has irregular horizontal canopy spacing, and shoreline edges are shaped by natural processes. Emergent growth forms typically have <10% cover, and hydromorphic vegetation is at least 1% cover. Climates are various, often less determinative than presence of open surface water conditions, which are typically found along ocean, lake, pond, and river margins in (semi-)permanently flooded non-tidal, tidal and intertidal habitats.

Classification Comments [optional]: Open-water submerged and floating *aquatic herb* and *alga* wetland vegetation is included here if found in shallow aquatic habitats, usually, but not limited to, less than 2 m depth (e.g., along lakeshores and rivershores) and less than 8 ha in size (i.e., ponds), where active wave-forming or bedrock shoreline features are lacking (following the U.S. wetland classification criteria of Cowardin et al. 1979). Other deeper or larger aquatic habitats, such as lakes, rivers, estuaries and oceans, are included in the non-vegetated aquatic class, where the vegetation layer is no longer a controlling layer in the system. Submerged tidal aquatic vegetation has been mapped where cover is <10% (Orth et al. 2010).

Similar NVC Types: Non-vegetated category: lakes and rivers may overlap with this class, but typically are >2 m deep and larger than 8 ha, and lakeshores are shaped by wave-forming processes.

- 7. Agricultural & Developed Vegetation (C07): These cultural wetlands may have a vegetation structure that is regularly managed (e.g., rice paddies), the water levels may be regularly manipulated, or the shores of the wetland may be highly modified by concrete, berms, etc.

Diagnostic Characteristics: Hydromorphic growth forms dominate, including rooting and floating *aquatic herbs* and *alga*. Emergent growth forms have <10% cover, and hydromorphic vegetation is at least 1% cover. Vegetation structure has irregular horizontal canopy spacing, and shoreline edges are shaped by natural processes.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Growth Forms: Stands have hydromorphic growth forms, including rooted and floating *aquatic herbs* and *alga*, with various other growth forms.

Structure: Stands typically have surface water, up to 2 m in depth, and have *aquatic herbs* either rooted with leaves rising up to or near the surface, or floating freely on the water surface, or *alga*. The vegetation cover varies from very open to closed, with irregular horizontal canopy spacing. Emergent growth forms have <10% cover, and hydromorphic vegetation is at least 10% cover. The height of the vegetation is a function of the water depth along the ocean, lake, river, or in the pond, but practically, only vegetation within 2 m of the water surface is included in this type.

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: Found in any climate where water regimes are sufficient to support rooted or floating vegetation.

Soil/substrate/hydrology: This type includes shallow aquatic habitats, typically less than 2 m depth (e.g., along ocean, lake and river shores) and less than 8 ha in size (i.e., ponds), where active wave-forming or bedrock shorelines features are lacking (Cowardin 1985). Other deeper or larger aquatic habitats, such as lakes, rivers, estuaries and oceans, are included in the non-vegetated Aquatic class, where the vegetation layer is no longer a controlling layer in the system.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]: Submerged tidal aquatic vegetation has been mapped where cover is <10% (Orth et al. 2010).

DISTRIBUTION

Geographic Range: Climate zones? Bailey (1989) Domains:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- < Coastal Mudflats and Brackish Waters (Rodwell et al. 2002)
- < Freshwater Aquatic Vegetation (Rodwell et al. 2002)

Full Citation:

- Bailey, R. G. 1989. Explanatory supplement to ecoregions map of the continents. Environmental Conservation 16:307-309 with separate map at 1:30,000,000. USDA Forest Service, Washington, DC.
- Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. USDI Fish & Wildlife Service, Office of Biological Services, Washington, DC. 103 pp.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Orth, R. J., D. J. Wilcox, J. R. Whiting, L. S. Nagey, A. L. Owens, and A. K. Keene. 2010. VIMS Special Scientific Report Number 152. 2009 Distribution of Submerged Aquatic Vegetation in Chesapeake and Coastal Bays. Final report to EPA. Grant No. CB97377401-0. Virginia Institute of Marine Sciences. [<http://www.vims.edu/bio/sav/sav09> <<http://web.vims.edu/bio/sav/sav09/?svr=www>>]
- Rodwell, J. S., J. H. J. Schaminee, L. Mucian, S. Pignatti, J. Dring, and D. Moss. 2002. The diversity of European vegetation. An overview of phytosociological alliances and their relationships to EUNIS habitats. Wageningen, NL. EC-LNV. Report EC-LNV nr. 2002/054.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: Hierarchy Revisions Working Group

Acknowledgments:

Version Date: 17 Jul 2012

5. Aquatic Vegetation

5.A. Saltwater Aquatic Vegetation (S09)

OVERVIEW

Database Code: 5.A (S09)

Scientific Name: Saltwater Aquatic Vegetation Subclass

Common Name (Translated Scientific Name): Saltwater Aquatic Vegetation Subclass

Colloquial Name: Saltwater Aquatic Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 5. Aquatic Vegetation (C05)

Lower Level Hierarchy Units:

- 5.A.1. Floating & Suspended Macroalgae Saltwater Vegetation (F052)
- 5.A.2. Benthic Macroalgae Saltwater Vegetation (F053)
- 5.A.3. Benthic Aquatic Vascular Saltwater Vegetation (F054)
- 5.A.4. Benthic Lichen Saltwater Vegetation (F055)

Type Concept Sentence: Saltwater Aquatic Vegetation occurs in shallow to deep saline habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, occurring around the globe from the equator to the polar regions.

Type Concept: Saltwater Aquatic Vegetation wetlands are distinct wetlands transitional along the coast between the intertidal salt marshes or other intertidal areas, and permanent, deep water oceans. More rarely they occur in inland saline habitats. The lower limits of salinity are set at 0.5 ppt, below which it is considered freshwater. Submerged or floating-aquatic plants usually dominate the vegetation, with less than 10% of the surface water area occluded by standing emergent or woody plants. Macroalga may be common. Open surface water at a range of depths is present for all or most of the year.

Classification Comments [optional]:

Similar NVC Types:

- 5.B. Freshwater Aquatic Vegetation (S13):

Diagnostic Characteristics: Saltwater Aquatic Vegetation occurs in shallow to deep water habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, with the lower limits of salinity set at 0.5 ppt, below which it is considered freshwater. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows or intertidal periods. This vegetation occurs around the globe from the equator to polar regions in saltwater habitats.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Submerged or floating-aquatic plants and/or macroalgae usually dominate the vegetation, with less than 10% of the surface water area occluded by standing emergent or woody plants. Macroalga may be common. Open surface water at a range of depths is present for all or most of the year.

Floristics [optional]: Stands may be dominated by submerged vascular plant species, submerged macroalgae species, or both. More rarely, floating plant species may be important.

With respect to submerged vascular plants (seagrasses), typical dominant genera in temperate regions include *Zostera*, *Ruppia*, *Cymodocea*, *Posidonia*, *Halodule*, *Phyllospadix*, *Amphibolis*, and *Thallasodendron*. Dominant genera in temperate regions include *Thalassia*, *Cymodocea*, *Posidonia*, *Halophila*, *Halodule*, *Syringodium*, *Ruppia*, *Enhalus*, and *Thallasodendron* (Short et al. 2007). Vascular species diversity (species richness and species evenness) generally is very low, compared to that found in other formations, with monospecific to several-species stands often the norm. In general, tropical regions support higher vascular species diversity than do temperate regions, and the Indo-Pacific regions support higher vascular species diversity than does the Atlantic Ocean and Mediterranean Sea regions (Short et al. 2007).

Macroalgae floristics are less well known, both in cases in which macroalgae are components of seagrass-dominated stands or where macroalgae themselves dominate. Common growth forms and species include green algae (*Chlorophyta*) (e.g., *Ulva lactuca*), brown algae (Heterokontophyta) (e.g., *Macrocystis*, *Laminaria*, *Sargassum*), red algae (*Rhodophyta*), and cyanobacteria (*Cyanophyta*).

ENVIRONMENT

Environmental Description [optional]: Saltwater Aquatic Vegetation occurs in deeper waters of wetlands or in shallow open-water habitats that are transitional along the coast between the intertidal salt marshes or other intertidal areas, and permanent, deep-water oceans. Water levels may be influenced by intertidal periods. More rarely, they occur as floating vegetation in shallow zones of deep oceans or in inland saline habitats with permanent water. The lower limits of salinity for this formation are set at 0.5 ppt, below which aquatic vegetation is considered freshwater.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Saltwater Aquatic Vegetation occurs in both shallow to moderately deep saltwater benthic habitats and in floating habitats around the globe from the equator to the polar regions.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- >< Shallow Water Wetland Class (National Wetlands Working Group 1997) [The authors include both saltwater aquatic and freshwater aquatic vegetation in their concept and restrict the type to wetland aquatic vegetation, whereas the concept used here could extend to deeper water habitats.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.
- Short, F., T. Carruthers, W. Dennison, and M. Waycott. 2007. Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology* 350:3-20.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, C. Lea, K. Goodin

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation
5.A. Saltwater Aquatic Vegetation

5.A.1. Floating & Suspended Macroalgae Saltwater Vegetation (F052)

OVERVIEW

Database Code: 5.A.1 (F052)

Scientific Name: Floating & Suspended Macroalgae Saltwater Vegetation Formation

Common Name (Translated Scientific Name): Floating & Suspended Macroalgae Saltwater Vegetation Formation

Colloquial Name: Floating & Suspended Macroalgae Saltwater Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 5.A. Saltwater Aquatic Vegetation (S09)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Floating & Suspended Macroalgae Saltwater Vegetation includes areas dominated by macroalgae that are floating on the surface or are suspended freely in the water column, i.e., macroalgae that are not rooted or attached to the bottom. Examples include *Gracilaria* Rafts, Kelp Rafts, Rockweed Rafts, *Sargassum* Rafts, and *Ulva* Rafts.

Type Concept:

Classification Comments [optional]: There are no known marine, floating or suspended vascular plant species. Vascular vegetation that is floating on the surface, but rooted in the substrate is included in 5.A.3 Benthic Aquatic Vascular Saltwater Vegetation Formation (F054).

Similar NVC Types:

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Biotic Subclass: Floating/Suspended Macroalgae (FGDC 2012)

Full Citation:

- *FGDC [Federal Geographic Data Committee]. 2012. Coastal and Marine Ecological Classification Standard Version 4.0 (January 2012). FGDC Document Number XX. Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 246 pp. plus appendices.

Primary Concept Source: Federal Geographic Data Committee (2012)

Author of Description: K. Goodin and D. Faber-Langendoen

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation
5.A. Saltwater Aquatic Vegetation

5.A.2. Benthic Macroalgae Saltwater Vegetation (F053)

OVERVIEW

Database Code: 5.A.2 (F053)

Scientific Name: Benthic Macroalgae Saltwater Vegetation Formation

Common Name (Translated Scientific Name): Benthic Macroalgae Saltwater Vegetation Formation

Colloquial Name: Benthic Macroalgae Saltwater Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 5.A. Saltwater Aquatic Vegetation (S09)

Lower Level Hierarchy Units [incomplete]:

- 5.A.2.Wb. Temperate Intertidal Shore (D047)
- 5.A.2.Xg. Tropical Intertidal Marine Aquatic Vegetation (D098)

Type Concept Sentence: The vegetation includes subtidal or intertidal bottoms and other areas dominated by attached macroalgae, including kelp, intertidal fucoids, and calcareous algae, which are usually submersed within or extend to the surface of the water column, though they may be exposed during low tides.

Type Concept: Benthic Macroalgae Saltwater Vegetation includes subtidal or intertidal bottoms and any other areas characterized by a dominant cover of attached macroalgae, which are usually submersed within or extend to the surface of the water column. They may be exposed during low tides. The aquatic beds dominated by macroalgae include kelp, intertidal fucoids, and calcareous algae. Macroalgal communities can exist at all depths within the photic zone, on diverse substrates, and across a range of energy and water chemistry regimes. Many macroalgal types and communities have low temporal persistence and can bloom and die-back within short periods. This aspect of macroalgae can be reflected with a temporal persistence modifier.

While many researchers organize macroalgae based on their pigmentation, the Coastal and Marine Ecological Classification Standard (CMECS) (FGDC 2012) takes a growth morphology approach to defining benthic algal biotic groups. This decision was driven by the fact that macroalgal assemblages often include a variety of co-existing algal species, making delineations of individual species difficult. This approach also captures the influence that the algal growth structure has in shaping the local environment, by providing shelter, shade, and detrital material to an area, which is important to associated fauna. Thus CMECS distinguishes sheet group, filamentous group, coarsely branched group, thick leathery group, jointed calcareous group, and crustose group.

Classification Comments [optional]: Free-floating macroalgae are included under 5.A.1 Floating & Suspended Macroalgae Saltwater Vegetation Formation (F052). Macroalgal communities (typically coralline/crustose algae) that build substrate in a reef setting are categorized separately as Reef Biota and not included here.

Similar NVC Types:

- 5.A.3. Benthic Aquatic Vascular Saltwater Vegetation (F054):
- 5.A.4. Benthic Lichen Saltwater Vegetation (F055):

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Biotic Subclass: Benthic Macroalgae (FGDC 2012)

Full Citation:

- *FGDC [Federal Geographic Data Committee]. 2012. Coastal and Marine Ecological Classification Standard Version 4.0 (January 2012). FGDC Document Number XX. Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 246 pp. plus appendices.

Primary Concept Source: Federal Geographic Data Committee (2012)

Author of Description: K. Goodin and D. Faber-Langendoen

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation

5.A. Saltwater Aquatic Vegetation

5.A.3. Benthic Aquatic Vascular Saltwater Vegetation (F054)

OVERVIEW

Database Code: 5.A.3 (F054)

Scientific Name: Benthic Aquatic Vascular Saltwater Vegetation Formation

Common Name (Translated Scientific Name): Benthic Aquatic Vascular Saltwater Vegetation Formation

Colloquial Name: Benthic Aquatic Vascular Saltwater Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 5.A. Saltwater Aquatic Vegetation (S09)

Lower Level Hierarchy Units [incomplete]:

- 5.A.3.We. Temperate Seagrass Aquatic Vegetation (D064)
- 5.A.3.Wf. Temperate Coastal Intertidal & Inland Saline Aquatic Vegetation (D065)
- 5.A.3.Xd. Tropical Seagrass Aquatic Vegetation (D063)

Type Concept Sentence: The vegetation includes subtidal or intertidal bottoms of rooted vascular vegetation beds commonly dominated by any number of seagrass or eelgrass species, including species of *Cymodocea*, *Halodule*, *Thalassia*, *Halophila*, *Vallisneria*, *Ruppia*, *Phyllospadix*, and *Zostera*, and which are usually submersed in the water column or floating on the surface, or exposed during low tides.

Type Concept: Benthic Aquatic Vascular Saltwater Vegetation includes subtidal or intertidal bottoms and any other areas characterized by a dominant cover of rooted vascular plants which are usually submersed in the water column or floating on the surface. They may be exposed during low tides. The vascular vegetation beds are commonly dominated by any number of seagrass or eelgrass species, including species of *Cymodocea*, *Halodule*, *Thalassia*, *Halophila*, *Vallisneria*, *Ruppia*, *Phyllospadix*, and *Zostera*. Seagrass beds may occur in true marine salinities, and they may extend into the lower salinity zones of estuaries. Seagrass beds are complex structural habitats that provide refuge and foraging opportunities for abundant and diverse faunal communities in shallow waters. Seagrass beds require a specific set of ecological conditions for success, and they are generally perceived as areas of high environmental quality.

Classification Comments [optional]: Non-rooted floating vascular is not known to occur in marine environments, and free-floating macroalgae are included under 5.A.1 Floating & Suspended Macroalgae Saltwater Vegetation Formation (F052).

Similar NVC Types:

- 5.A.2. Benthic Macroalgae Saltwater Vegetation (F053):
- 5.A.4. Benthic Lichen Saltwater Vegetation (F055):
- 5.B.1. Tropical Freshwater Aquatic Vegetation (F056):
- 5.B.2. Temperate & Boreal Freshwater Aquatic Vegetation (F057):

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level:

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Biotic Subclass: Aquatic Vascular Vegetation (FGDC 2012)

Full Citation:

- *FGDC [Federal Geographic Data Committee]. 2012. Coastal and Marine Ecological Classification Standard Version 4.0 (January 2012). FGDC Document Number XX. Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 246 pp. plus appendices.

Primary Concept Source: Federal Geographic Data Committee (2012)

Author of Description: K. Goodin and D. Faber-Langendoen

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation

5.A. Saltwater Aquatic Vegetation

5.A.4. Benthic Lichen Saltwater Vegetation (F055)

OVERVIEW

Database Code: 5.A.4 (F055)

Scientific Name: Benthic Lichen Saltwater Vegetation Formation

Common Name (Translated Scientific Name): Benthic Lichen Saltwater Vegetation Formation

Colloquial Name: Benthic Lichen Saltwater Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 5.A. Saltwater Aquatic Vegetation (S09)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Saltwater tidal areas dominated by submerged or emergent lichens on the surface of the substrate, occurring in two major zones - the intertidal (or Littoral) Lichen Zone, and the Supratidal (or Supralittoral) Lichen Zone.

Type Concept: Saltwater tidal areas dominated by submerged or emergent lichens that form patches or visible patterns on the surface of the substrate. Lichens are generally recognized as a symbiotic association with a fungus and an alga (or cyanobacterium) living together and forming patches or a visible pattern on the surface of the substrate. Lichens occur in relatively recognizable zones based on, among other factors, the extent to which they are submerged or flooded. The two major zones are the Intertidal (or Littoral) Lichen Zone, dominated by patches of lichens that are regularly submerged by marine tides, and the Supratidal (or Supralittoral) Lichen Zone, which are rarely submerged, but are regularly wetted by splash and sea spray, often in rocky habitats.

Classification Comments [optional]: Fletcher (1973) describes Marine Lichen types. Lichen zones are described by Fletcher (1973), Gilbert and Giavarini (1997), and Hawksworth (2000). Although some mosses have been reported in tidal salt marshes, they have not been reported as dominant (Garbary et al. 2008). Thus, at this time, benthic communities dominated by mosses are only recognized in freshwater tidal situations.

Similar NVC Types:

- 5.A.2. Benthic Macroalgae Saltwater Vegetation (F053):
- 5.A.3. Benthic Aquatic Vascular Saltwater Vegetation (F054):

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Biotic Subclass: Marine Lichens (FGDC 2012)

Full Citation:

- *FGDC [Federal Geographic Data Committee]. 2012. Coastal and Marine Ecological Classification Standard Version 4.0 (January 2012). FGDC Document Number XX. Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 246 pp. plus appendices.
- Fletcher, A. 1973. The ecology of marine (supra littoral) lichens on some rocky shores of Anglesey. *Lichenologist* 5:401-422.
- Garbary, A., A. Miller, R. Scrosati, K. Kim, and W. Schofield. 2008. Distribution and salinity tolerance of intertidal mosses from Nova Scotian salt marshes. *The Bryologist* 111(2):282-291.
- Gilbert, O. L., and V. J. Giavarini. 1997. The lichen vegetation of acid watercourses in England. *Lichenologist* 29:347-367.
- Hawksworth, D. L. 2000. Freshwater and marine lichen-forming fungi. Pages 1-7 in: K. D. Hyde, W. H. Ho, and S. B. Pointing, editors. *Aquatic Mycology Across the Millennium*. Fungal Diversity 5: 1-7.

Primary Concept Source: Federal Geographic Data Committee (2012)

Author of Description: K. Goodin and D. Faber-Langendoen

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation

5.B. Freshwater Aquatic Vegetation (S13)

OVERVIEW

Database Code: 5.B (S13)

Scientific Name: Freshwater Aquatic Vegetation Subclass

Common Name (Translated Scientific Name): Freshwater Aquatic Vegetation Subclass

Colloquial Name: Freshwater Aquatic Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 5. Aquatic Vegetation (C05)

Lower Level Hierarchy Units:

- 5.B.1. Tropical Freshwater Aquatic Vegetation (F056)
- 5.B.2. Temperate & Boreal Freshwater Aquatic Vegetation (F057)

Type Concept Sentence: Freshwater Aquatic Vegetation occurs in shallow to deep freshwater habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, occurring around the globe from the equator to the polar regions.

Type Concept: Freshwater Aquatic Vegetation occurs in shallow to deep water habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, occurring around the globe from the equator to the polar regions. The upper limits of salinity are set at 0.5 ppt, above which it is considered saltwater. They are transitional between those wetlands that are saturated or seasonally wet (i.e., bog, fen, marsh or swamp) and permanent, deep waterbodies (i.e., lakes). Submerged or floating-aquatic plants usually dominate the vegetation. Open surface water up to 2 m deep is present for all or most of the year. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows or intertidal periods.

[Classification Comments \[optional\]:](#) The concept of this subclass extends to deeper water habitats (i.e., deeper than 2 m in lakes) and to riverine bottoms, but in practice, freshwater aquatic classifications may supersede this one from a user standpoint [see Formation Class discussion]. That is, it may be desirable to first assign a lake or river type to the aquatic system, and secondarily note the NVC vegetation type present. Vegetation found in many urban and agricultural ponds may be very similar to natural freshwater

aquatic vegetation, because agricultural and urban ponds typically manipulate the physical setting, not the vegetation itself. There are distinct cultural aquatic vegetation types, but these should be limited to situations in which the vegetation itself is manipulated for horticultural (e.g., aquatic gardens) or agricultural (e.g., water chestnuts grown in impoundments, rice paddies) that are parallel with terrestrial cultural vegetation. However, many agricultural ponds may actively prevent vegetation from forming. For practical applications of classification and mapping of freshwater aquatic vegetation, the agricultural and urban ponds may be initially placed within the 7. Agricultural & Developed Vegetation Class (C07), and, where evidence is gathered to show they have a natural composition, they may be reclassified.

Similar NVC Types:

- 5.A. Saltwater Aquatic Vegetation (S09):
- 7.C. Herbaceous & Woody Developed Vegetation (S21):
- 7.D. Agricultural & Developed Aquatic Vegetation (S24):

Diagnostic Characteristics: Freshwater Aquatic Vegetation occurs in shallow to deep water habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, with the upper limits of salinity set at 0.5 ppt, above which it is considered saltwater. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows or intertidal periods. Freshwater Aquatic Vegetation occurs around the globe from the equator to the polar regions in freshwater habitats.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Submerged or floating-aquatic plants usually dominate the vegetation, with less than 10% of the surface water area covered by standing emergent or woody plants. Open surface water up to 2 m or more deep is present for all or most of the year (National Wetlands Working Group 1997).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: Freshwater Aquatic Vegetation is subject to aquatic processes typical of upper limnetic or infralittoral lake zones, such as nutrient and gaseous exchange, oxidation and decomposition. Ionic composition of waters varies widely. The upper limits of salinity for Freshwater Aquatic Vegetation are set at 0.5 ppt, above which the vegetation is considered 5.A Saltwater Aquatic Vegetation Subclass (S09). Dissolved minerals, acid-base balances, and nutrient levels are influenced by the hydrology, underlying geological materials, nutrient fluxes and plant communities. Freshwater Aquatic Vegetation is usually situated on substrates of limnic peat, mixed limnic organic-mineral material, and marl in stable-water regimes. Little sediment accumulation occurs in high-energy shallow waters such as tidal regimes, rivers or large lakes. In semi-arid regions, shallow waters dry up intermittently, often leaving evaporite alkaline salt deposits. Except in highly saline or acidic waters, these deposits provide a substrate for rooted submerged and floating macrophytes, algae and aquatic mosses (National Wetlands Working Group 1997).

Freshwater Aquatic Vegetation is found in shallow water that usually has standing or flowing water less than 2 m deep in mid-summer. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts or low flows. Shallow-water vegetation may also occupy bays and margins of profundal zones of lakes (National Wetlands Working Group 1997).

Freshwater Aquatic Vegetation occurs in ponds, pools, shallow lakes, oxbows, sloughs, natural and artificial impoundments, or channels. Boundaries are determined by water-eroded shorelines, beaches or landward margins of mudflats, recent limnic deposits, floating mats, emergents or hydrophytic trees or shrubs. Bordering mats of rooted emergent vegetation, including inundated trees, may occupy up to 10% of the shallow-water area. Shallow waters are found in all hydrogeomorphic settings, but are usually associated with lacustrine, fluvial, stream, river and permafrost systems (National Wetlands Working Group 1997).

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Freshwater Aquatic Vegetation occurs in shallow to deep freshwater habitats around the globe from the equator to the polar regions.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- >> Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, and inland saline marshes are included here too, as are emergent and aquatic vegetation.]
- >> Shallow Water Wetland Class (National Wetlands Working Group 1997) [The authors include both saltwater aquatic and freshwater aquatic vegetation in their concept and restrict the type to wetland aquatic vegetation, whereas the concept used here could extend to deeper water habitats.]
- >> Tidal Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, as are emergent and aquatic vegetation.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fuels, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997)

Acknowledgments:

Version Date: 12 Jul 2012

5. Aquatic Vegetation

5.B. Freshwater Aquatic Vegetation

5.B.1. Tropical Freshwater Aquatic Vegetation (F056)

OVERVIEW

Database Code: 5.B.1 (F056)

Scientific Name: Tropical Freshwater Aquatic Vegetation Formation

Common Name (Translated Scientific Name): Tropical Freshwater Aquatic Vegetation Formation

Colloquial Name: Tropical Freshwater Aquatic Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 5.B. Freshwater Aquatic Vegetation (S13)

Lower Level Hierarchy Units [incomplete]:

- 5.B.1.Ed. Neotropical Freshwater Aquatic Vegetation (D097)
- 5.B.1.Ob. Polynesian & Eastern Melanesian Freshwater Aquatic Vegetation (D084)
- 5.B.1.Oc. Eastern Melanesian Freshwater Aquatic Vegetation (D085)

Type Concept Sentence: Tropical Freshwater Aquatic Vegetation occurs in shallow to deep freshwater habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, occurring around the globe within the tropical regions (roughly, between 30 degrees North and 30 degrees South in latitude).

Type Concept:

Classification Comments [optional]: The concept of this subclass extends to deeper water habitats (i.e., deeper than 2 m in lakes) and to riverine bottoms, but in practice, freshwater aquatic classifications may supersede this one from a user standpoint [see Formation Class discussion]. That is, it may be desirable to first assign a lake or river type to the aquatic system, and secondarily note the NVC vegetation type present. Vegetation found in many urban and agricultural ponds may be very similar to natural freshwater aquatic vegetation, because agricultural and urban ponds typically manipulate the physical setting, not the vegetation itself. There are distinct cultural aquatic vegetation types, but these should be limited to situations in which the vegetation itself is manipulated for horticultural (e.g., aquatic gardens) or agricultural (e.g., water chestnuts grown in impoundments, rice paddies) that are parallel with terrestrial cultural vegetation. However, many agricultural ponds may actively prevent vegetation from forming. For practical applications of classification and mapping of freshwater aquatic vegetation, the agricultural and urban ponds may be initially placed within the 7. Agricultural & Developed Vegetation Class (C07), and, where evidence is gathered to show they have a natural composition, they may be reclassified.

Similar NVC Types:

- 5.A.3. Benthic Aquatic Vascular Saltwater Vegetation (F054):
- 5.B.2. Temperate & Boreal Freshwater Aquatic Vegetation (F057):
- 7.D.1. Agricultural Aquatic Vegetation (F047): Although in some cases there may be difficulty distinguishing natural ponds (F056) from agricultural ponds (F047), in the large majority of cases, they are distinct in ecological setting, edges, and in composition.

- 7.D.2. Developed Aquatic Vegetation (F048): Although in some cases there may be difficulty distinguishing natural (F056) from urban ponds (F048), in the large majority of cases, they are distinct in ecological setting, edges, and in composition.

Diagnostic Characteristics: Tropical Freshwater Aquatic Vegetation occurs in shallow to deep water habitats where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, with the upper limits of salinity set at 0.5 ppt, above which it is considered saltwater. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows or intertidal periods. Tropical Freshwater Aquatic Vegetation occurs around the globe within the tropical regions (roughly, between 30 degrees North and 30 degrees South in latitude). Vegetation is more typically present throughout the year, or changes in response to factors other than temperature.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]: Submerged or floating-aquatic plants usually dominate the vegetation, with less than 10% of the surface water area covered by standing emergent or woody plants. Above-sediment or floating biomass remains relatively constant in abundance throughout the year, or fluctuates in response to factors other than temperature change (e.g., water levels or suspended sediment). Open surface water up to 2 m or more deep is present for all or most of the year (National Wetlands Working Group 1997).

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: Tropical Freshwater Aquatic Vegetation is subject to aquatic processes typical of upper limnetic or infralittoral lake zones, such as nutrient and gaseous exchange, oxidation and decomposition. Ionic composition of waters varies widely. The upper limits of salinity for Tropical Freshwater Aquatic Vegetation are set at 0.5 ppt. Dissolved minerals, acid-base balances, and nutrient levels are influenced by the hydrology, underlying geological materials, nutrient fluxes and plant communities. Tropical Freshwater Aquatic Vegetation usually is situated on substrates of limnic organic or mineral material, or marl in stable-water regimes. Little sediment accumulation occurs in high-energy shallow waters such as tidal regimes, rivers or large lakes. In semi-arid regions, shallow waters dry up intermittently, often leaving evaporite alkaline salt deposits. Except in highly saline or acidic waters, these deposits provide a substrate for rooted submerged and floating macrophytes, algae and aquatic mosses (National Wetlands Working Group 1997).

Tropical Freshwater Aquatic Vegetation is found in shallow water that usually has standing or flowing water less than 2 m deep in mid-summer. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts or low flows. Shallow-water vegetation may also occupy bays and margins of profundal zones of lakes (National Wetlands Working Group 1997).

Tropical Freshwater Aquatic Vegetation occurs in ponds, pools, shallow lakes, oxbows, sloughs, natural and artificial impoundments, canals, or stream and river channels, including freshwater portions of estuaries. Boundaries are determined by water-eroded shorelines, beaches or landward margins of mudflats, recent limnic deposits, floating mats, emergents or hydrophytic trees or shrubs. Bordering mats of rooted emergent vegetation, including inundated trees, may occupy up to 10% of the shallow water area. Shallow waters are found in all hydrogeomorphic settings, but are usually associated with lacustrine, fluvial, stream, river and permafrost systems (National Wetlands Working Group 1997).

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Tropical Freshwater Aquatic Vegetation occurs in shallow to deep freshwater habitats around the globe within the tropical regions (roughly, between 30 degrees N and 30 degrees S latitude).

Nations [incomplete except for CA and US]: US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- >> Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, and inland saline marshes are included here too, as are emergent and aquatic vegetation.]

- >< Shallow Water Wetland Class (National Wetlands Working Group 1997) [The authors include both saltwater aquatic and freshwater aquatic vegetation in their concept and restrict the type to wetland aquatic vegetation, whereas the concept used here could extend to deeper water habitats.]
- >< Tidal Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, as are emergent and aquatic vegetation.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997), modified C. Lea

Acknowledgments:

Version Date: 13 Jul 2012

5. Aquatic Vegetation

5.B. Freshwater Aquatic Vegetation

5.B.2. Temperate & Boreal Freshwater Aquatic Vegetation (F057)

OVERVIEW

Database Code: 5.B.2 (F057)

Scientific Name: Temperate & Boreal Freshwater Aquatic Vegetation Formation

Common Name (Translated Scientific Name): Temperate & Boreal Freshwater Aquatic Vegetation Formation

Colloquial Name: Temperate & Boreal Freshwater Aquatic Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 5.B. Freshwater Aquatic Vegetation (S13)

Lower Level Hierarchy Units [incomplete]:

- 5.B.2.Na. North American Freshwater Aquatic Vegetation (D049)

Type Concept Sentence: Temperate & Boreal Freshwater Aquatic Vegetation occurs in shallow to deep freshwater habitats (e.g., lakes, ponds, canals, streams, rivers, and freshwater portions of estuaries) where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, occurring around the globe in both hemispheres, from the tropics north and south to the polar regions.

Type Concept:

Classification Comments [optional]: The concept of this formation extends to deeper water habitats (i.e., deeper than 2 m in lakes) and to riverine bottoms, but in practice, freshwater aquatic classifications may supersede this one from a user standpoint [see Formation Class discussion]. That is, it may be desirable to first assign a lake or river type to the aquatic system, and secondarily note the NVC vegetation type present. Vegetation found in many urban and agricultural ponds may be very similar to natural freshwater aquatic vegetation, because agricultural and urban ponds typically manipulate the physical setting, not the vegetation itself. There are distinct cultural aquatic vegetation types, but these should be limited to situations in which the vegetation itself is manipulated for horticultural (e.g., aquatic gardens) or agricultural (e.g., water chestnuts grown in impoundments, rice paddies) that are parallel with terrestrial cultural vegetation. However, many agricultural ponds may actively prevent vegetation from forming. For practical applications of classification and mapping of freshwater aquatic vegetation, the agricultural and urban ponds may be initially placed within the 7. Agricultural & Developed Vegetation Class (C07), and, where evidence is gathered to show they have a natural composition, they may be reclassified.

Similar NVC Types:

- 5.A.3. Benthic Aquatic Vascular Saltwater Vegetation (F054):
- 5.B.1. Tropical Freshwater Aquatic Vegetation (F056):
- 7.D.1. Agricultural Aquatic Vegetation (F047): Although in some cases there may be difficulty distinguishing natural (F057) from agricultural ponds (F047), in the large majority of cases, they are distinct in ecological setting, edges, and in composition.
- 7.D.2. Developed Aquatic Vegetation (F048): Although in some cases there may be difficulty distinguishing natural (F057) from urban ponds (F048), in the large majority of cases, they are distinct in ecological setting, edges, and in composition.

Diagnostic Characteristics: Temperate & Boreal Freshwater Aquatic Vegetation occurs in shallow to deep water habitats (e.g., lakes, ponds, canals, streams, rivers, and freshwater portions of estuaries) where emergent vegetation is <10% cover, and submerged or floating-aquatic plants have >1% cover, with the upper limits of salinity set at 0.5 ppt, above which it is considered saltwater. Water

levels are seasonally stable, permanently flooded, or intermittently exposed during droughts, low flows or intertidal periods. Temperate & Boreal Freshwater Aquatic Vegetation occurs around the globe in both hemispheres, from the tropics north and south to the polar regions. Vegetation may only be seasonally present, and absent during colder months.

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#) Submerged or floating-aquatic plants usually dominate the vegetation, with less than 10% of the surface water area covered by standing emergent or woody plants. In cold season, rooted vegetation (submerged and floating-leaved) usually dies back to sediment, and floating plants may largely disappear. Above sediment biomass may persist longer or throughout the year in warmer parts of the range. Open surface water up to 2 m or more deep is present for all or most of the year (National Wetlands Working Group 1997).

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#) Temperate & Boreal Freshwater Aquatic Vegetation is subject to aquatic processes typical of upper limnetic or infra-littoral lake zones, such as nutrient and gaseous exchange, oxidation and decomposition. Ionic composition of waters varies widely. The upper limits of salinity for Temperate & Boreal Freshwater Aquatic Vegetation are set at 0.5 ppt. Dissolved minerals, acid-base balances, and nutrient levels are influenced by the hydrology, underlying geological materials, nutrient fluxes and plant communities. Temperate & Boreal Freshwater Aquatic Vegetation is usually situated on substrates of limnic organic or mineral material, or on marl in stable-water regimes. Little sediment accumulation occurs in high-energy shallow waters such as tidal regimes, rivers or large lakes. In semi-arid regions, shallow waters dry up intermittently, often leaving evaporite alkaline salt deposits. Except in highly saline or acidic waters, these deposits provide a substrate for rooted submerged and floating macrophytes, algae and aquatic mosses (National Wetlands Working Group 1997).

Temperate & Boreal Freshwater Aquatic Vegetation is found in shallow water that usually has standing or flowing water less than 2 m deep in mid-summer. Water levels are seasonally stable, permanently flooded, or intermittently exposed during droughts or low flows. Shallow-water vegetation may also occupy bays and margins of profundal zones of lakes (National Wetlands Working Group 1997).

Temperate & Boreal Freshwater Aquatic Vegetation occurs in ponds, pools, shallow lakes, oxbows, sloughs, natural and artificial impoundments, canals, or stream and river channels, including freshwater portions of estuaries. Boundaries are determined by water-eroded shorelines, beaches or landward margins of mudflats, recent limnic deposits, floating mats, emergents or hydrophytic trees or shrubs. Bordering mats of rooted emergent vegetation, including inundated trees, may occupy up to 10% of the shallow-water area. Shallow waters are found in all hydrogeomorphic settings, but are usually associated with lacustrine, fluvial, stream, river and permafrost systems (National Wetlands Working Group 1997).

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

[Geographic Range:](#) Temperate & Boreal Freshwater Aquatic Vegetation occurs in shallow to deep freshwater habitats around the globe in both hemispheres, from the tropics north and south to the polar regions.

[Nations \[incomplete except for CA and US\]:](#) CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

[Confidence Level:](#) Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

[Synonymy:](#)

- >> Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, and inland saline marshes are included here too, as are emergent and aquatic vegetation.]
- >> Shallow Water Wetland Class (National Wetlands Working Group 1997) [The authors include both saltwater aquatic and freshwater aquatic vegetation in their concept and restrict the type to wetland aquatic vegetation, whereas the concept used here could extend to deeper water habitats.]
- >> Tidal Freshwater Marshes (Mitsch and Gosselink 2000) [Both tropical and temperate marshes are treated together, as are emergent and aquatic vegetation.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. Third edition. John Wiley & Sons, Inc., New York. 920 pp.
- National Wetlands Working Group. 1997. Wetlands of Canada. C. D. A. Rubec, editor. Ecological Land Classification Series No. 24. Environment Canada, Ottawa, and Polyscience Publications, Inc., Montreal. 452 pp.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, after National Wetlands Working Group (1997), modified C. Lea

Acknowledgments:

Version Date: 12 Jul 2012

6. Rock Vegetation (C06)

OVERVIEW

Database Code: 6 (C06)

Scientific Name: Lithomorphic Vegetation Class

Common Name (Translated Scientific Name): Lithomorphic Vegetation Class

Colloquial Name: Rock Vegetation

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 6.A. Tropical Rock Vegetation (S02)
- 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04)
- 6.C. Desert & Semi-Desert Rock Vegetation (S03)
- 6.D. Polar & High Montane Rock Vegetation (S05)

Type Concept Sentence: Tropical, temperate, boreal, and polar habitats are characterized or dominated by plant growth forms, such as *lichen*, *bryophyte*, *alga*, or *fern*, that have structural adaptations for living on stable rock surfaces or on unstable rocky substrates, such as cliffs, talus, scree, pavement, cobble, lava or boulderfields.

Type Concept: Nonvascular plants, especially *bryophyte*, *lichen*, *alga* or *fern* (including clubmosses and other vascular spore-bearing plants) growth forms are present, but are constrained by rock or other hard substrates, such as cliff, talus, scree, cobble, lava, and rock flats. Vascular growth form structure is largely determined by the rock fissures, etc., and is typically less than 10% cover, with irregular horizontal spacing. Climates are various, often less determinative than presence of open rock surface. Substrates are typically dry to moist, but occasionally wet (e.g., seepage cliffs) and typically lack soil development of any kind. Stands typically contain crustose lichen and/or sparse vascular vegetation.

Classification Comments [optional]: This class is defined by primarily nonvascular, often crustose lichen, ferns or very sparse other vascular vegetation that is controlled by the rocky substrate. The substrate can be classed as either stable (large boulders, outcrops, monoliths, etc.) or unstable (colluvium such as scree, talus or dense, alluvial cobble). Stable substrates prevent vascular plant roots from penetrating. Species adapted to such substrates have no roots and occupy the surface of the substrates, such as nonvasculars (lichens, mosses, liverworts), or are largely prevented from growing on the substrate, except in localized fissures or cracks. Whenever the vegetation is able to establish sufficient cover on the rocky surface (typically >10% cover), the growth forms of the vegetation determine the class. Vascular spore-bearing plants (ferns and others) are included in this class. Spikemoss (*Selaginella*) regularly adheres to cliff and outcrops, as do many species of ferns such as *Polypodium*, *Cheilanthes*, *Pellaea*, etc.

Lithology may be consolidated or unconsolidated, but the conditions of the substrate preclude development of soil and either strongly impede the penetration of roots or require specialized adaptations of roots to support the plant species. Lithomorphic Vegetation may be similar to desert or polar types where climate *per se* limits the overall plant growth, and substrate limitations are secondary.

Open sand dunes are excluded from this class in general as open sand dunes are an extreme condition of other classes (i.e., mesomorphic, xeromorphic), where the constant movement of sand (ablation, deposition, etc.) is at too extreme a pace for even the typical adaptations of psammophytic plants, such as creeping stolons, rhizomes, etc., to keep up.

Larson et al. (2000b) characterize cliffs as having a "high, steep, or overhanging face of rock," whereas rock outcrop is a "portion of bedrock protruding through the soil." Lava flows and colluvial deposits would lay over the soil. They include both consolidated and unconsolidated cliffs in their definition, including sand, gravel or loess, as well as rock cliffs. Here we restrict it to rock (or at least very rocklike) materials. Apart from suggesting that to qualify as a cliff it need be "high enough that falling off will kill you," they suggest that even 3 m of height is sufficient to create suitable cliff habitat.

Defining this class to include sparse vascular vegetation stands that are limited in their cover because of substrate is an issue. For example, scree vegetation could be considered very similar to psammophytic (dune and other sandy) vegetation and be treated as an extreme form of mesomorphic vegetation (mostly or all in 2. Shrubland & Grassland Class (C02)). Scree is usually dominated by sparse vascular plants, has considerable soil development for vascular plant establishment, but has unstable substrate on which nonvascular vegetation cannot become well-established (C. Lea pers. comm. 2011). However, whereas dunes can have vegetation that greatly exceeds 10% cover, this is less common on scree; by-and-large, the vascular vegetation remains sparse, and nonvascular vegetation is typical. Talus is generally stable enough that it has significant nonvascular vegetation, whereas screen may be unstable and less commonly contains a strong nonvascular component (though further review of this distinction is needed). Thus talus fits in this Lithomorphic Vegetation Class based on the nonvascular vegetation criteria, and scree fits in this class because of the sparse vascular vegetation, perhaps in combination with nonvascular vegetation.

Further review may suggest that this class can be improved by distinguishing (probably at the subclass level), the less "rocklike" vegetation (including vegetation on scree, badlands, pavement) from the true lithomorphic (solid rock) vegetation (C. Lea pers. comm. 2012). Scree and other loose rocky substrates (volcanic cinders) typically have enough soil development to support a dominant layer of disturbance-adapted, facultative mesomorphic shrubs and/or herbs (e.g., in the U.S., *Ribes* spp., *Prunus virginiana*, and other forest, woodland, or shrubland shrubs in the central Rockies), and true lithomorphs (saxicolous lichens) are quite sparse, if present at all. Although the surface may be "rocky," the driving ecological factor is the availability of soil in quantity under the relatively shallow rock armoring and the absence of large, stable substrates for true lithomorphs (saxicolous lichens) to establish. Cobbles along rivers and streams may also not typically support lithomorphic growth forms, and may best be treated as sometimes sparse flooded types within mesomorphic formations. Badlands (hard clays) and desert pavements also tend to support facultative vascular species, as opposed to lithomorphs or lithophiles, and could be considered for the xeromorphic class. Given this narrower definition of lithomorphic, a requirement for <10% vascular cover and nonvascular cover greater than vascular cover for the more narrowly defined lithomorphic vegetation may be more appropriate, to separate them from sparse or occasionally sparse types (scree, volcanic cinders) in which vascular layers are clearly dominant and lithomorphic nonvascular is insignificant (C. Lea pers. comm. 2012).

Similar NVC Types:

- 2. Shrubland & Grassland (C02): In moist climates, cliff, talus, scree and rock outcrops can contain inclusions of mesomorphic vegetation, but the lithomorphic substrate limits their cover. Where mesomorphic cover is >10 % of total vascular vegetation (excluding ferns and allies), the vegetation is placed in this class.
- 3. Desert & Semi-Desert (C03): Dry habitats with sparse vegetation on rocky surfaces. When xeromorphic plants have >10% cover on rocky substrates, or, if < 10%, are the dominant growth present, stands are classified as xeromorphic vegetation.
- 4. Polar & High Montane Scrub & Grassland (C04): In either extreme alpine habitats or in polar deserts, the vegetation will be limited to growing on rocks and become so sparse as to qualify as lithomorphic vegetation. But where the vegetation typically has >10% cover of total vascular vegetation (excluding ferns and allies), and is dominated by cryomorphic growth forms, it belongs in this class. This class also includes stands in polar regions where the vascular vegetation has extensive moss or fruticose or foliose lichen (but not crustose lichen) and is on mineral soil (i.e., lichen tundra vegetation).

Diagnostic Characteristics: Lithomorphic growth forms dominate, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, *alga*, *ferns* (non-woody, including clubmosses, etc.), and crevice-dwelling (rupicolous) vascular plants. Vascular vegetation is <10% cover. Vegetation structure may be patchy across the rocky surfaces.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Growth Forms: Stands have varying levels of nonvascular growth forms (including *bryophyte*, *lichen*, *alga*), and vascular *ferns*, and vascular flowering vegetation is typically sparse to absent. Foliose and crustose (saxicolous) lichens may be particularly diagnostic. Vascular plants may have a variety of adaptations that allow them to thrive in these rocky habitats (sometimes referred to as rupicolous species).

Structure: The structure is very open to closed, with irregular spacing of nonvascular and fern vegetation, which can vary from absent (but then vascular plants are at least sparsely present up to 10%) to continuous. Vascular plant cover is patchy, confined to crevices in the substrate. Height of the nonvascular or fern species is typically <0.3 m; other growth forms are highly variable in height, as they may include creeping or matted to tall erect herbs, shrubs, and trees.

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: Found on bare rock and in rock crevices of cliffs, scree, talus, lava, pavement, other rock outcrops, and cobble-gravel habitat, with soils typically absent. Most often in non-desert or non-polar climates where substrate features override mesomorphic vegetation. Habitat with flat bedrock, but with thin soil layers, typically excluded.

Soil/substrate/hydrology: Organic soil component usually lacking, substrate either consolidated rock, or cobble, gravel, or stone with or without regular movement.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]: Rocky vegetation can be difficult to map because of the small size of individual units, or difficulty in discerning vegetation, or a combination of the two. Vertical cliff faces are also difficult to characterize and map. Fine-scale classification of nonvascular vegetation is not generally well-developed.

DISTRIBUTION

Geographic Range: Azonal areas found in regions from tropical to polar zones. Bailey (1989) Domains:

Nations [incomplete except for CA and US]: AU, CA, CL, US, ZA

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]: More work is needed to determine how to define rock vegetation separate from other sparsely vegetated habitats where rocky substrates are dominant, and lichen vegetation is absent. Placement of rocky river and lake shoreline habitats needs review.

CITATIONS

Synonymy:

- = Cliff, Bluffs and Rock Outcrops (Wardle 1991) [Wardle's concept is applied to New Zealand.]

Full Citation:

- Bailey, R. G. 1989. Explanatory supplement to ecoregions map of the continents. Environmental Conservation 16:307-309 with separate map at 1:30,000,000. USDA Forest Service, Washington, DC.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Larson, D. W., U. Matthes, and P. E. Kelly. 2000b. Cliff ecology: Patterns and processes in cliff ecosystems. Cambridge University Press, Cambridge, MA.
- Lea, Chris. Personal communication. Ecologist, formerly with National Park Service, USGS / NPS Vegetation Mapping Program, Denver, CO.
- Wardle, P. 1991. Vegetation of New Zealand. Reprinted in 2002. The Blackburn Press, Caldwell, NJ.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: Hierarchy Revisions Working Group

Acknowledgments:

Version Date: 17 Jul 2012

6. Rock Vegetation

6.A. Tropical Rock Vegetation (S02)

OVERVIEW

Database Code: 6.A (S02)

Scientific Name: Tropical Rock Vegetation Subclass

Common Name (Translated Scientific Name): Tropical Rock Vegetation Subclass

Colloquial Name: Tropical Rock Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 6. Rock Vegetation (C06)

Lower Level Hierarchy Units:

- 6.A.1. Tropical Cliff, Scree & Other Rock Vegetation (F011)

Type Concept Sentence: Tropical rock habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) at low elevations from approximately 23 degrees N to 23 degrees S latitude (typically frost-free) from the equator characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates. A sparse cover of various vascular growth forms, including woody plants, may be present.

Type Concept: Tropical Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in the tropical regional around the globe. Stands typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Vascular and nonvascular plant cover, especially *bryophytes*, *lichens*, *algae*, or *ferns*, is <1%; vascular plant cover, including bromeliad growth forms, largely determined by the rock fissures and typically >>10%, with irregular horizontal spacing. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating, and their presence is largely determined by the rock fissures. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence. Vascular woody growth forms of either evergreen broad-leaved or drought-deciduous woody plants, including lianas, may be present. Tropical climates, where daily temperate changes are greater than the seasonal changes, are various and often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. We suggest that cliff and slope sites with hardpacked sedimentary rocks and clays be included in this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are dominant and lichen vegetation is absent. For example, many rocky river and lake shoreline types may be placed in 2.A.3. Tropical Scrub & Herb Coastal Vegetation Formation (F024) where vegetation is patchy but may exceed 10%.

Currently all vascular plant cover is treated together. But cover of *ferns* (non-woody, including clubmosses, etc.), *bromeliads*, and crevice-dwelling (rupicolous) vascular plants may need to be considered separately from other vascular cover when deciding on cover thresholds for this class.

Further review may suggest that this subclass can be improved by distinguishing the less "rocklike" vegetation (including vegetation on scree, badlands, pavement) from the true lithomorphic (solid rock) vegetation (C. Lea pers. comm. 2012).

Similar NVC Types:

- 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04): Warm-temperate cliffs contain subtropical-like cliff features.

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, and *alga*, with cover >1%; vascular vegetation (including clubmosses, etc.), *bromeliads*, and crevice-dwelling (rupicolous) vascular plants is typically <10% cover. Vascular cover may include either evergreen broad-leaved or drought-deciduous trees and shrubs or evergreen herbs. Vegetation structure may be patchy across the rocky surfaces.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Tropical Rock Vegetation is found in localized areas throughout the tropical latitudes, where frost is essentially absent, approximately from 23 degrees N to S around the equator.

Nations [incomplete except for CA and US]: US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

- Lea, Chris. Personal communication. Ecologist, formerly with National Park Service, USGS / NPS Vegetation Mapping Program, Denver, CO.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 17 Nov 2011

6. Rock Vegetation

6.A. Tropical Rock Vegetation

6.A.1. Tropical Cliff, Scree & Other Rock Vegetation (F011)

OVERVIEW

Database Code: 6.A.1 (F011)

Scientific Name: Tropical Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Tropical Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Tropical Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.A. Tropical Rock Vegetation (S02)

Lower Level Hierarchy Units [incomplete]:

- 6.A.1.Fc. African Tropical Cliff, Scree, Rock & Dune Vegetation (D185)
- 6.A.1.Oa. Polynesian Cliff, Scree & Rock Vegetation (D086)
- 6.A.1.Ob. Eastern Melanesian Cliff, Scree & Rock Vegetation (D087)

Type Concept Sentence: Tropical rock habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) at low elevations from approximately 23 degrees N to 23 degrees S latitude (typically frost-free) from the equator characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates. A sparse cover of various vascular growth forms, including woody plants, may be present.

Type Concept: Tropical Cliff, Scree & Other Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in the tropical regional around the globe. Stands typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Vascular and nonvascular plant cover, especially *bryophytes*, *lichens*, *algae*, or *ferns*, is <1%; vascular plant cover, including bromeliad growth forms, largely determined by the rock fissures and typically >>10%, with irregular horizontal spacing. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating, and their presence is largely determined by the rock fissures. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence. Vascular woody growth forms of either evergreen broad-leaved or drought-deciduous woody plants, including lianas, may be present. Tropical climates, where daily temperate changes are greater than the seasonal changes, are various and often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. We suggest that cliff and slope sites with hardpacked sedimentary rocks and clays be included in this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are dominant and lichen vegetation is absent. For example, many rocky river and lake shoreline types may be placed in 2.A.3. Tropical Scrub & Herb Coastal Vegetation Formation (F024) where vegetation is patchy but may exceed 10%.

Currently all vascular plant cover is treated together. But cover of *ferns* (non-woody, including clubmosses, etc.), *bromeliads*, and crevice-dwelling (rupicolous) vascular plants may need to be considered separately from other vascular cover when deciding on cover thresholds for this class.

Similar NVC Types:

- 6.B.2. Temperate & Boreal Cliff, Scree & Other Rock Vegetation (F034): Warm-temperate cliffs contain subtropical-like cliff features.

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, and *alga*, with cover >1%; vascular vegetation (including clubmosses, etc.), *bromeliads*, and crevice-dwelling (rupicolous) vascular plants is typically <10% cover. Vascular cover may include either evergreen broad-leaved or drought-deciduous trees and shrubs or evergreen herbs. Vegetation structure may be patchy across the rocky surfaces.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Tropical Cliff, Scree & Other Rock Vegetation is found in localized areas throughout the tropical latitudes from 23 degrees N to S around the equator.

Nations [incomplete except for CA and US]: US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 12 Jul 2012

6. Rock Vegetation

6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04)

OVERVIEW

Database Code: 6.B (S04)

Scientific Name: Mediterranean, Temperate & Boreal Rock Vegetation Subclass

Common Name (Translated Scientific Name): Mediterranean, Temperate & Boreal Rock Vegetation Subclass

Colloquial Name: Mediterranean, Temperate & Boreal Rock Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 6. Rock Vegetation (C06)

Lower Level Hierarchy Units:

- 6.B.1. Mediterranean Cliff, Scree & Other Rock Vegetation (F014)
- 6.B.2. Temperate & Boreal Cliff, Scree & Other Rock Vegetation (F034)

Type Concept Sentence: Rocky habitats (such as cliffs, talus, scree, pavement, cobbles, recent lava flows, or large rock outcrops) characterized by temperate, including Mediterranean, and boreal lithomorphic and lithophilic plant species (including saxicolous lichens, bryophytes, algae, and/or ferns and other pteridophytes), tree forms less than 10% cover, very sparse and often irregular horizontal spacing in the vascular plant layers, and a very open canopy structure; woody growth forms, when present, include cold-deciduous broad-leaved and needle-leaved trees and shrubs.

Vegetation found on temperate and boreal rocky habitats (such as cliffs, talus, recent lava flows, or rock outcrops) at low to moderate elevations at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe that are characterized by nonvascular plant growth forms that have structural adaptations for living on these habitats.

Type Concept: Mediterranean, Temperate & Boreal Rock Vegetation is found on rocky habitats (such as cliffs, talus, recent lava flows, or rock outcrops) where the median particle size is >10 cm in diameter in the Mediterranean, temperate and boreal regions around the globe. Stands typically contain a covering of saxicolous foliose and/or crustose lichens growing directly on rock surfaces and/or sparse covering of vascular plants growing in soil pockets. Vascular and nonvascular plant cover is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing, and is typically exceeded by nonvascular cover, especially lichens, bryophytes, and/or algae. On stable rock surfaces (e.g., outcrops), vascular plant roots are prevented from penetrating most of the substrate,

and their presence is largely determined by the rock fissures, where minimal soil development and more moisture occurs. On less stable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence and depth to soil under the boulders. A sparse cover of vascular mesomorphic growth forms, including evergreen needle-leaved or cold-deciduous broad-leaved woody plants, may be present. Herbs are often seasonally green. Low-elevation temperate and boreal climates are various, often less determinative than presence of open rock surfaces. Substrates are typically very dry to moist, but occasionally wet and typically lack soil development of any kind. The climate is cool and warm temperate, Mediterranean, and to boreal, and even subarctic, where frosts occur regularly (except in part of the Mediterranean region), snow is not permanent, and there are strong daily and seasonal temperature changes.

Classification Comments [optional]: There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. We tentatively include cliff and slope sites with hardpacked sedimentary rocks and clays (badlands) within this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are dominant and lichen vegetation is absent, such as scree or volcanic cinders. For example, many rocky river and lake shoreline types may be placed in 2.B.4 Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005) where vegetation is patchy but may exceed 10%.

Further review may suggest that this subclass can be improved by distinguishing the less "rocklike" vegetation (including vegetation on scree, badlands, pavement) from the true lithomorph (solid rock) vegetation (C. Lea pers. comm. 2012). Scree and other loose rocky substrates (volcanic cinders) typically have enough soil development to support a dominant layer of disturbance-adapted, facultative mesomorphic shrubs and/or herbs (e.g., in the U.S., *Ribes* spp., *Prunus virginiana*, and other forest, woodland, or shrubland shrubs in the central Rockies), and true lithomorphs (saxicolous lichens) are quite sparse, if present at all. Although the surface may be "rocky," the driving ecological factor is the availability of soil in quantity under the relatively shallow rock armoring and the absence of large, stable substrates for true lithomorphs (saxicolous lichens) to establish. Cobbles along rivers and streams may also not typically support lithomorph growth forms, and may best be treated as sometimes sparse flooded types within mesomorphic formations. Badlands (hard clays) and desert pavements also tend to support facultative vascular species, as opposed to lithomorphs or lithophiles, and could be considered for the xeromorph class. Given this narrower definition of lithomorph, a requirement for <10% vascular cover and nonvascular cover greater than vascular cover would be more appropriate for distinguishing the "true" lithomorph types, and separate out sparse or occasionally sparse types (scree, volcanic cinders) in which vascular layers are clearly dominant and lithomorph nonvascular is insignificant (C. Lea pers. comm. 2012).

Similar NVC Types:

- 2.B. Temperate & Boreal Grassland & Shrubland (S18): Many rocky river and lake shoreline types are placed in 2.B.4 Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005) where vegetation may be patchy but can exceed 10%.
- 6.A. Tropical Rock Vegetation (S02): Subtropical cliffs may resemble warm-temperate cliffs.
- 6.C. Desert & Semi-Desert Rock Vegetation (S03):
- 6.D. Polar & High Montane Rock Vegetation (S05):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorph or lithophilic plant species, including *lichens* (especially foliose and crustose *lichens*), *bryophytes*, *algae*, and rupicolous vascular plants, often with a strong component of *ferns* and other pteridophytes. Vascular vegetation is typically <10% cover, and may include either evergreen needle-leaved or cold-deciduous broad-leaved trees or shrubs. Vegetation structure may be patchy across the rocky surfaces.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]: This vegetation occurs on large-particle, relatively stable temperate and boreal rocky habitats (such as cliffs, talus, recent lava flows, or rock outcrops) at low to moderate elevations at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe that are characterized by nonvascular plant growth forms that have structural adaptations for living on these habitats.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Mediterranean, Temperate & Boreal Rock Vegetation is found in localized areas throughout the mid-latitudes from 23 to 60-70 degrees N or S around the globe.

Nations [incomplete except for CA and US]: AU, CA, CL, US, ZA

USFS Ecoregions (2005) [optional]:

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

- = Cliff, bluffs and rock outcrops (Wardle 1991) [Wardle's concept is applied to New Zealand.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Lea, Chris. Personal communication. Ecologist, formerly with National Park Service, USGS / NPS Vegetation Mapping Program, Denver, CO.
- Wardle, P. 1991. Vegetation of New Zealand. Reprinted in 2002. The Blackburn Press, Caldwell, NJ.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 12 Jul 2012

6. Rock Vegetation

6.B. Mediterranean, Temperate & Boreal Rock Vegetation

6.B.1. Mediterranean Cliff, Scree & Other Rock Vegetation (F014)

OVERVIEW

Database Code: 6.B.1 (F014)

Scientific Name: Mediterranean Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Mediterranean Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Mediterranean Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04)

Lower Level Hierarchy Units [incomplete]:

- 6.B.1.Na. Mediterranean California Cliff, Scree & Rock Vegetation (D050)

Type Concept Sentence: Mediterranean vegetation found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or large rock outcrops, such as boulderfields) at low elevations at mid-latitudes around the globe characterized by nonvascular plant lithomorphic growth forms and lithophilic plant species that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates. A sparse cover of vascular mesomorphic growth forms, including needle-leaved and sclerophyllous-leaved woody plants, may be present.

Type Concept: Mediterranean Cliff, Scree & Other Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in the Mediterranean regions of the world. Stands typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Vascular and nonvascular plant cover, especially of *bryophytes*, *lichens*, *algae*, or *ferns*, is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating, and their presence is largely determined by the rock fissures. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence. A sparse cover of vascular mesomorphic growth forms, including needle-leaved and evergreen or deciduous broad-leaved woody plants, may be present. The low-elevation Mediterranean climates are often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: The term scree is used broadly to include talus. Perhaps talus is preferable for lower-elevation habitats, whereas scree is the preferred term for Polar and High Montane habitats?

There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

More work is needed to separate rock vegetation from very sparsely vegetated habitats dominated by rocky substrates where lichen vegetation is absent. Placement of rocky river and lake shoreline types needs review. In addition, review is needed to determine

how distinctive 6.B.1 Mediterranean Cliff, Scree & Other Rock Vegetation Formation (F014) is from 6.B.2 Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation (F034).

Similar NVC Types:

- 6.B.2. Temperate & Boreal Cliff, Scree & Other Rock Vegetation (F034):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, and *alga* and rupicolous vascular plants, often with a strong component of *ferns* and other pteridophytes. Vascular vegetation is typically <10% cover, and may include either needle-leaved or broad-leaved (sometimes sclerophyllous) evergreen trees and shrubs. Vegetation structure is patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Mediterranean Cliff, Scree & Other Rock Vegetation is found in the Mediterranean Basin and in Mediterranean climate regions in North America (California), Chile, South Africa, and Australia.

Nations [incomplete except for CA and US]: AU, CL, US, ZA

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- = Cliff, bluffs and rock outcrops (Wardle 1991) [Wardle's concept is applied to New Zealand.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Wardle, P. 1991. Vegetation of New Zealand. Reprinted in 2002. The Blackburn Press, Caldwell, NJ.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 12 Jul 2012

6. Rock Vegetation

6.B. Mediterranean, Temperate & Boreal Rock Vegetation

6.B.2. Temperate & Boreal Cliff, Scree & Other Rock Vegetation (F034)

OVERVIEW

Database Code: 6.B.2 (F034)

Scientific Name: Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Temperate & Boreal Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04)

Lower Level Hierarchy Units [incomplete]:

- 6.B.2.Fb. African Temperate Cliff, Scree, Rock & Dune Vegetation (D186)

- 6.B.2.Na. Eastern North American Temperate Cliff, Scree & Rock Vegetation (D051)
- 6.B.2.Nb. Western North American Temperate Cliff, Scree & Rock Vegetation (D052)
- 6.B.2.Nc. Great Plains Cliff, Scree & Rock Vegetation (D053)

Type Concept Sentence: Vegetation in temperate and boreal habitats found in rocky or rocklike habitats (such as cliffs, talus, scree, pavement, cobbles, lava, boulderfields, or badlands) at low elevations at mid-latitudes around the globe characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates. A sparse cover of vascular mesomorphic growth forms, including needle-leaved and cold-deciduous broad-leaved woody plants, may be present.

Type Concept: Temperate & Boreal Cliff, Scree & Other Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or large rock outcrops, such as boulderfields) in the temperate and boreal regions around the globe. Stands typically contain a covering of saxicolous foliose and/or crustose lichens growing directly on rock surfaces, and/or sparse covering of vascular plants growing in soil pockets. Vascular and nonvascular plant cover is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing, and is typically exceeded by nonvascular cover, especially lichens, bryophytes, and/or algae. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating most of the substrate, and their presence is largely determined by the rock fissures, where minimal soil development and more moisture occurs. On less stable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence, and depth to soil under the boulders. The vascular woody growth forms are a mix of evergreen needle-leaved or cold-deciduous broad-leaved trees and shrubs. The low-elevation climates are temperate or boreal (excluding Mediterranean ones), where there are strong daily temperate changes and even greater seasonal variations. These climates, though, are often less determinative than presence of open rock surfaces. Substrates are typically very dry to moist, but occasionally wet, and typically lack soil development of any kind.

Classification Comments [optional]: We suggest that cliff and slope sites with hardpacked sedimentary rocks and clays (badlands) be included in this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are dominant and lichen vegetation is absent. For example, many rocky river and lake shoreline types may be placed in 2.B.4 Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005) where vegetation is patchy but may exceed 10%.

The term scree is used broadly to include talus. Perhaps talus is preferable for lower-elevation habitats, whereas scree is the preferred term for Polar and High Montane habitats. Colloquially, in the western U.S., and as used here, scree generally refers to smaller-particle, looser, rock debris, and is often mixed with soil, whereas talus generally refers to larger, more stable particles, with little surface soil. Scree may be somewhat more abundant in high montane settings (perhaps because of more pronounced freeze-thaw cycles and weathering of rock), but both can be found at all elevations and latitudes.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

More work is needed to separate rock vegetation from very sparsely vegetated habitats dominated by rocky substrates where lichen vegetation is absent. Placement of rocky river and lake shoreline types needs review. In addition, review is needed to determine how distinctive 6.B.1 Mediterranean Cliff, Scree & Other Rock Vegetation Formation (F014) is from 6.B.2 Temperate & Boreal Cliff, Scree & Other Rock Vegetation Formation (F034).

Similar NVC Types:

- 6.A.1. Tropical Cliff, Scree & Other Rock Vegetation (F011): Warm-temperate cliffs within the temperate & boreal cliff formation (F034) contain subtropical-like cliff features similar to tropical cliffs (F011).
- 6.B.1. Mediterranean Cliff, Scree & Other Rock Vegetation (F014):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, and *alga*, and lithophilic or rupicolous vascular plants, often with a strong component of *ferns* and other pteridophytes. Vascular vegetation is typically <10% cover, and may include either evergreen needle-leaved or cold-deciduous broad-leaved trees or shrubs. Vegetation structure may be patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Temperate & Boreal Cliff, Scree & Other Rock Vegetation is found in localized low elevations throughout the temperate and boreal climates (excluding Mediterranean climates) of the mid-latitudes from 23 to 60-70 degrees N or S.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- < Cliff, bluffs and rock outcrops (Wardle 1991) [Wardle's concept is applied through New Zealand, including both alpine and temperate regions.]

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fulst, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Wardle, P. 1991. Vegetation of New Zealand. Reprinted in 2002. The Blackburn Press, Caldwell, NJ.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 12 Jul 2012

6. Rock Vegetation

6.C. Desert & Semi-Desert Rock Vegetation (S03)

OVERVIEW

Database Code: 6.C (S03)

Scientific Name: Desert & Semi-Desert Rock Vegetation Subclass

Common Name (Translated Scientific Name): Desert & Semi-Desert Rock Vegetation Subclass

Colloquial Name: Desert & Semi-Desert Rock Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 6. Rock Vegetation (C06)

Lower Level Hierarchy Units:

- 6.C.1. Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation (F025)
- 6.C.2. Cool Semi-Desert Cliff, Scree & Other Rock Vegetation (F032)

Type Concept Sentence: Desert & Semi-Desert Rock Vegetation at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces (cliff, rock outcrops) or in unstable rocky substrates (talus, scree, cobbles, lava, or boulderfields). A sparse cover of xeromorphic growth forms, including woody plants, may be present.

Type Concept: Desert & Semi-Desert Rock Vegetation is found on rocky or rocklike habitats (such as cliffs, rock outcrops, talus, scree, pavement, cobbles, lava, or boulderfields) in the desert and semi-desert regions around the globe. Stands typically contain a covering of saxicolous foliose and/or crustose lichens and/or sparse covering of vascular plants. Vascular and nonvascular plant cover is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing, and is typically exceeded by nonvascular cover, especially lichens, bryophytes, and/or algae. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating most of the substrate, and their presence is largely determined by the rock fissures, where minimal soil development and more moisture occurs. On less stable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence and depth to soil under the boulders. A sparse cover of vascular xeromorphic growth forms may be present. Desert and semi-desert climates, where annual precipitation is typically <25 cm, may include snow in the winter. These climates are often less determinative than presence of open rock surfaces. Substrates are typically very dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: Overlaps with more-vegetated cool and warm semi-desert vegetation. There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. We tentatively include cliff and slope sites with hardpacked sedimentary rocks and clays (badlands) be included in this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are

dominant and lichen vegetation is absent, such as scree or volcanic cinders. For example, many rocky river and lake shoreline types in desert regions may be placed in 2.B.4 Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005) where vegetation is patchy but may exceed 10%.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

Further review may suggest that this subclass can be improved by distinguishing the less "rocklike" vegetation (including vegetation on scree, badlands, pavement) from the true lithomorphic (solid rock) vegetation (C. Lea pers. comm. 2012). Scree and other loose rocky substrates (volcanic cinders) typically have enough soil development to support a dominant layer of disturbance-adapted, facultative mesomorphic shrubs and/or herbs (e.g., in the U.S., *Ribes* spp., *Prunus virginiana*, and other forest, woodland, or shrubland shrubs in the central Rockies), and true lithomorphs (saxicolous lichens) are quite sparse, if present at all. Although the surface may be "rocky," the driving ecological factor is the availability of soil in quantity under the relatively shallow rock armoring and the absence of large, stable substrates for true lithomorphs (saxicolous lichens) to establish. Cobbles along rivers and streams may also not typically support lithomorphic growth forms, and may best be treated as sometimes sparse flooded types within mesomorphic formations. Badlands (hard clays) and desert pavements also tend to support facultative vascular species, as opposed to lithomorphs or lithophiles, and could be considered for the xeromorphic class. Given this narrower definition of lithomorphic, a requirement for <10% vascular cover and nonvascular cover greater than vascular cover would be more appropriate, to accommodate sparse or occasionally sparse types (scree, volcanic cinders) in which vascular layers are clearly dominant and lithomorphic nonvascular is insignificant (C. Lea pers. comm. 2012).

Similar NVC Types:

- 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland (S06):
- 3.B. Cool Semi-Desert Scrub & Grassland (S11):
- 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic or lithophilic plant species, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, and *alga* at least 1% cover, and vascular vegetation is typically <10% cover. Vascular plant growth forms include a mix of evergreen needle-leaved or xerophytic broad-leaved trees and shrubs. Vegetation structure may be patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Desert & Semi-Desert Rock Vegetation is found in semi-desert or desert climates at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe, where annual precipitation is typically less than 25 cm, with snow possible in winter in cool climates.

Nations [incomplete except for CA and US]: CA?, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

- Lea, Chris. Personal communication. Ecologist, formerly with National Park Service, USGS / NPS Vegetation Mapping Program, Denver, CO.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 06 Jul 2012

6. Rock Vegetation

6.C. Desert & Semi-Desert Rock Vegetation

6.C.1. Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation (F025)

OVERVIEW

Database Code: 6.C.1 (F025)

Scientific Name: Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.C. Desert & Semi-Desert Rock Vegetation (S03)

Lower Level Hierarchy Units [incomplete]:

- 6.C.1.Na. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (D054)

Type Concept Sentence: Warm desert and semi-desert vegetation on rock habitats are found at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces (cliff, rock outcrops) or in unstable rocky substrates (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields). A sparse cover of xeromorphic growth forms, including woody plants, may be present.

Type Concept: Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation is found on rocky or rocklike habitats (such as cliffs, rock outcrops, talus, scree, pavement, cobbles, lava, or boulderfields) in warm desert and semi-desert regions around the globe. The climate is warm, where annual precipitation is typically less than 25 cm. Substrates are typically dry and typically lack soil development of any kind. Vascular and nonvascular plant cover is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing, and is typically exceeded by nonvascular cover, especially lichens, bryophytes, and/or algae. The vegetation is constrained by rock or other hard substrates, such as cliff, talus, scree, cobble, lava, and rock flats. Vascular growth form structure is largely determined by rock fissures or ledges, where minimal soil development and more moisture occur. The vascular growth forms include evergreen needle-leaved or xeromorphic trees, shrubs, and herbs.

Classification Comments [optional]: There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. We tentatively include cliff and slope sites with hardpacked sedimentary rocks and clays (badlands) in this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are dominant, and lichen vegetation is absent. For example, many rocky river and lake shoreline types may be placed in 2.B.4 Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005) where vegetation is patchy but may exceed 10%.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

Similar NVC Types:

- 3.A.2. Warm Desert & Semi-Desert Scrub & Grassland (F015):
- 3.B.1. Cool Semi-Desert Scrub & Grassland (F033):
- 6.C.2. Cool Semi-Desert Cliff, Scree & Other Rock Vegetation (F032):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte*, *alga*, and *fern* (non-woody, including clubmosses, etc.), and crevice-dwelling (rupicolous) vascular plants, with cover $\geq 1\%$. Vascular vegetation is typically <10% cover, and may include a mix of evergreen needle-leaved or xeromorphic scrub, and succulents. Vegetation structure may be patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION[Discussion \[optional\]:](#)[Animals \[optional\]:](#)[Mapping Issues \[optional\]:](#)**DISTRIBUTION**

Geographic Range: This formation is found in localized areas throughout the warm desert and semi-desert climates at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe, where rainfall is typically less than 25 cm/year.

Nations [incomplete except for CA and US]: US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]: More work is needed to determine how to define rock vegetation separate from other sparsely vegetated habitats where rocky substrates are dominant, and lichen vegetation is absent.

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 16 Jul 2012

6. Rock Vegetation

6.C. Desert & Semi-Desert Rock Vegetation

6.C.2. Cool Semi-Desert Cliff, Scree & Other Rock Vegetation (F032)

OVERVIEW

Database Code: 6.C.2 (F032)

Scientific Name: Cool Semi-Desert Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Cool Semi-Desert Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Cool Semi-Desert Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.C. Desert & Semi-Desert Rock Vegetation (S03)

Lower Level Hierarchy Units [incomplete]:

- 6.C.2.Na. North American Cool Semi-Desert Cliff, Scree & Rock Vegetation (D055)

Type Concept Sentence: Cool Semi-Desert Cliff, Scree & Other Rock Vegetation is found on rock habitats at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces (cliff, rock outcrops) or in unstable rocky substrates (such as cliffs, rock outcrops, talus, scree, pavement, cobbles, lava, or boulderfields). A sparse cover of xeromorphic growth forms, including woody plants, may be present.

Type Concept: Cool Semi-Desert Cliff, Scree & Other Rock Vegetation is found on rocky or rocklike habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in cool semi-desert regions around the globe. Stands typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Vascular and nonvascular plant cover is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing, and is typically exceeded by nonvascular cover, especially lichens, bryophytes, and/or algae. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating the surface, and their presence is largely determined by the rock fissures or ledges, where minimal soil development and more moisture occur. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence and depth to soil under the boulders. A sparse cover of vascular xeromorphic growth forms, including evergreen or facultatively-deciduous broad-leaved woody plants, may be present. Desert and semi-desert climates, where rainfall is often <25 cm, may include snow in the winter. Climates are often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. We suggest that cliff and slope sites with hardpacked sedimentary rocks and clays (badlands) be included in this class. More work is needed to clarify the distinctions between rock vegetation and other sparsely vegetated habitats where rocky substrates are dominant and lichen vegetation is absent. For example, many rocky river and lake shoreline types may be placed in 2.B.4. Temperate & Boreal Scrub & Herb Coastal Vegetation Formation (F005) where vegetation is patchy but may exceed 10%.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

Similar NVC Types:

- 3.A.2. Warm Desert & Semi-Desert Scrub & Grassland (F015):
- 3.B.1. Cool Semi-Desert Scrub & Grassland (F033):
- 6.C.1. Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation (F025):

Diagnostic Characteristics: Lithomorphic nonvascular growth forms dominate, including *lichen* (especially foliose and crustose *lichens*), *bryophyte* and *alga* with cover $\geq 1\%$, and vascular vegetation is typically $< 10\%$ cover. Vascular growth forms may include a mix of evergreen needle-leaved or xeromorphic scrub. Vegetation structure may be patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: This formation is found in localized areas throughout the cool desert and semi-desert climates at mid-latitudes from 23 degrees to 60 or 70 degrees N or S latitude around the globe, where rainfall is less than 25 cm/year.

Nations [incomplete except for CA and US]: CA?, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 16 Jul 2012

6. Rock Vegetation

6.D. Polar & High Montane Rock Vegetation (S05)

OVERVIEW

Database Code: 6.D (S05)

Scientific Name: Polar & High Montane Rock Vegetation Subclass

Common Name (Translated Scientific Name): Polar & High Montane Rock Vegetation Subclass

Colloquial Name: Polar & High Montane Rock Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 6. Rock Vegetation (C06)

Lower Level Hierarchy Units:

- 6.D.1. Tropical High Montane Cliff, Scree & Other Rock Vegetation (F010)
- 6.D.2. Polar & Alpine Cliff, Scree & Other Rock Vegetation (F007)

Type Concept Sentence: Polar vegetation found on rock habitats beyond 60 degrees N or 70 degrees S latitude around the globe and at high elevations in the boreal, temperate and tropical regions characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields). A sparse cover of cryomorphic and other woody growth forms may be present.

Type Concept: Polar & High Montane Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in the polar and high montane (alpine) regions around the globe. Stands occur at polar and at high montane, subalpine, alpine and nival elevations at boreal, temperate, and tropical latitudes that typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Nonvascular plant cover, especially *bryophytes*, *lichens*, and *algae*, is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating, and their presence is largely determined by the rock fissures. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence. The sparse vascular woody growth forms are a mix of cryomorphic scrub and herb. The cold climates extend from polar to tropical latitudes with many months of snow, but climate is often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: This vegetation type grades into 4. Polar & High Montane Scrub & Grassland Class (C04) at high latitudes, and into more-vegetated 3. Desert & Semi-Desert Class (C03) at lower latitudes. This type lacks or has a very thin (<10 cm) soil layer. There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. The very open, rocky non-vegetated habitats of polar regions at high elevation lacking <1% plant cover may be difficult to distinguish from this class.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

Further review may suggest that this subclass can be improved by distinguishing the less "rocklike" vegetation (including vegetation on scree, badlands, pavement) from the true lithomorphic (solid rock) vegetation (C. Lea pers. comm. 2012). Scree and other loose rocky substrates (volcanic cinders) typically have enough soil development to support a dominant layer of disturbance-adapted, facultative mesomorphic shrubs and/or herbs (e.g., in the U.S., *Ribes* spp., *Prunus virginiana*, and other forest, woodland, or shrubland shrubs in the central Rockies), and true lithomorphs (saxicolous lichens) are quite sparse, if present at all. Although the surface may be "rocky," the driving ecological factor is the availability of soil in quantity under the relatively shallow rock armoring and the absence of large, stable substrates for true lithomorphs (saxicolous lichens) to establish. Cobbles along rivers and streams may also not typically support lithomorphic growth forms, and may best be treated as sometimes sparse flooded types within mesomorphic formations. Badlands (hard clays) and desert pavements also tend to support facultative vascular species, as opposed to lithomorphs or lithophiles, and could be considered for the xeromorphic class. Given this narrower definition of lithomorphic, a requirement for <10% vascular cover and nonvascular cover greater than vascular cover would be more appropriate for distinguishing the "true" lithomorphic types, and separate out the sparse or occasionally sparse types (scree, volcanic cinders) in which vascular layers are clearly dominant and lithomorphic nonvascular is insignificant (C. Lea pers. comm. 2012).

Similar NVC Types:

- 4.B. Temperate, Boreal & Polar Alpine - Tundra Vegetation (S12):
- 6.B. Mediterranean, Temperate & Boreal Rock Vegetation (S04):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte* and *alga*. *Ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants may be present. Vascular vegetation is typically <10% cover, and may include a mix of cryomorphic scrub and herb. Vegetation structure may be patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Polar & High Montane Rock Vegetation is found in polar, boreal and temperate regions, and tropical latitudes at high montane, subalpine, alpine and nival habitats, with many months of snow in polar and temperate alpine regions, and constant freezing temperatures in tropical regions.

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Lea, Chris. Personal communication. Ecologist, formerly with National Park Service, USGS / NPS Vegetation Mapping Program, Denver, CO.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 17 Nov 2011

6. Rock Vegetation

6.D. Polar & High Montane Rock Vegetation

6.D.1. Tropical High Montane Cliff, Scree & Other Rock Vegetation (F010)

OVERVIEW

Database Code: 6.D.1 (F010)

Scientific Name: Tropical High Montane Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Tropical High Montane Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Tropical High Montane Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.D. Polar & High Montane Rock Vegetation (S05)

Lower Level Hierarchy Units [incomplete]:

- 6.D.1.Ea. Andean High Montane Cliff, Scree & Rock Vegetation (D056)
- 6.D.1.Ob. Pacific Island High Montane Cliff, Scree & Rock Vegetation (D088)
- 6.D.1.Oc. Eastern Melanesian High Montane Cliff, Scree & Rock Vegetation (D089)

Type Concept Sentence: Tropical vegetation found on rocky habitats at high elevations from 23 degrees N to 23 degrees S latitude around the equator characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields). A sparse cover of vascular growth forms, including woody plants of various tropical growth forms, may be present.

Type Concept: Tropical High Montane Cliff, Scree & Other Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in the tropical high montane regions around the globe. Stands are found in high montane, subalpine, alpine and nival elevations at tropical latitudes that typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Nonvascular plant cover, especially of *bryophytes*, *lichens*, and *algae*, is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating, and their presence is largely determined by the rock fissures. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence. The cold climate at the higher elevations includes nightly freezing temperatures and snow, but climate is often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind. The sparse vascular woody growth forms are a mix of cryomorphic scrub.

Classification Comments [optional]: There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. The very open habitats of 4.A.1 Tropical High Montane Scrub & Grassland Formation (F022)

may be difficult to distinguish from this class. Low cover of vascular vegetation (<10%) provides an arbitrary cutoff, but further review is needed.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

Similar NVC Types:

- 4.A.1. Tropical High Montane Scrub & Grassland (F022): This formation lacks constant freezing temperate and cryomorphic soils.
- 6.D.2. Polar & Alpine Cliff, Scree & Other Rock Vegetation (F007):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte* and *alga*. *Ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants may be common. Vascular vegetation is typically <10% cover, and may include a mix of tropical mesomorphic growth forms. Vegetation structure may be patchy across the rocky surfaces.

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range: Tropical High Montane Cliff, Scree & Other Rock Vegetation is found in tropical high montane (alpine) habitats, with constant freezing temperatures.

Nations [incomplete except for CA and US]: US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 16 Jul 2012

6. Rock Vegetation

6.D. Polar & High Montane Rock Vegetation

6.D.2. Polar & Alpine Cliff, Scree & Other Rock Vegetation (F007)

OVERVIEW

Database Code: 6.D.2 (F007)

Scientific Name: Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation

Common Name (Translated Scientific Name): Polar & Alpine Cliff, Scree & Other Rock Vegetation Formation

Colloquial Name: Polar & Alpine Cliff, Scree & Other Rock Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 6.D. Polar & High Montane Rock Vegetation (S05)

Lower Level Hierarchy Units [incomplete]:

- 6.D.2.Nb. North American Alpine Cliff, Scree & Rock Vegetation (D058)
- 6.D.2.Xa. Arctic & Boreal Cliff, Scree & Rock Vegetation (D057)

Type Concept Sentence: Polar and alpine vegetation found on rock habitats beyond 60 degrees N or 70 degrees S latitude around the globe and at high-elevation boreal and temperate regions characterized by nonvascular plant growth forms that have structural adaptations for living on stable rock surfaces or in unstable rocky substrates (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields). A sparse cover of vascular, cryomorphic plants may be present.

Type Concept: Polar & Alpine Montane Cliff, Scree & Other Rock Vegetation is found on rocky habitats (such as cliffs, talus, scree, pavement, cobbles, lava, or boulderfields) in the polar and temperate and boreal high montane (alpine) regions of the world. Stands occur at polar and at high montane, subalpine, alpine and nival elevations at boreal and temperate latitudes, and typically contain a covering of crustose lichens and/or sparse covering of vascular plants. Nonvascular plant cover, especially *bryophytes*, *lichens*, and *algae*, is >1%; vascular plant cover is typically <10%, with irregular horizontal spacing. Stable rock surfaces (e.g., outcrops) prevent vascular plant roots from penetrating, and their presence is largely determined by the rock fissures. On unstable rocky surfaces (e.g., talus), the presence of vascular plants is largely determined by a degree of permanence. The sparse vascular woody growth forms are a mix of cryomorphic scrub. The cold climate extends from polar to temperate latitudes with many months of snow, but climate is often less determinative than presence of open rock surfaces. Substrates are typically dry to moist, but occasionally wet and typically lack soil development of any kind.

Classification Comments [optional]: This vegetation grades into more-vegetated 4. Polar & High Montane Scrub & Grassland Class (C04) at high latitudes and into more-vegetated 3. Desert & Semi-Desert Class (C03) and 6.D.1. Tropical High Montane Cliff, Scree & Other Rock Vegetation Formation (F010) at low latitudes. There is little information that has been comprehensively evaluated across the globe, making it difficult to describe the type concept. The very open, rocky non-vegetated habitats of polar regions at high elevation lacking <1% plant cover may be difficult to distinguish from this vegetation. Low cover of vascular plant cover (<10%) provides an arbitrary cutoff, but further review is needed.

Currently, vascular plant cover includes *ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants. Consideration could be given to excluding these from the vascular species cover estimates.

Similar NVC Types:

- 4.B.2. Polar Tundra Vegetation (F031): Polar & Alpine Cliff, Scree & Other Rock Vegetation (F007) includes polar deserts and semi-deserts, which are mostly bare rock, primarily dominated by lichens and mosses with widely scattered herbs, but patches of polar tundra (F031) may occur.
- 6.D.1. Tropical High Montane Cliff, Scree & Other Rock Vegetation (F010):

Diagnostic Characteristics: Rocky or rocklike substrates dominated by lithomorphic growth forms, including *lichen* (especially foliose and crustose *lichens*), *bryophyte* and *alga*. *Ferns* (non-woody, including clubmosses, etc.) and crevice-dwelling (rupicolous) vascular plants may be common. Vascular vegetation is typically <10% cover, and may include a mix of cryomorphic scrub. Vegetation structure may be patchy.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Polar & Alpine Montane Cliff, Scree & Other Rock Vegetation is found in localized areas throughout polar, boreal and temperate latitudes at high montane to nival elevations around the globe.

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:**Full Citation:**

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen and J. Sawyer

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation (C07)

OVERVIEW

Database Code: 7 (C07)

Scientific Name: Anthromorphic Vegetation Class

Common Name (Translated Scientific Name): Anthromorphic Vegetation Class

Colloquial Name: Agricultural & Developed Vegetation

Hierarchy Level: Class

Lower Level Hierarchy Units:

- 7.A. Woody Agricultural Vegetation (S22)
- 7.B. Herbaceous Agricultural Vegetation (S23)
- 7.C. Herbaceous & Woody Developed Vegetation (S21)
- 7.D. Agricultural & Developed Aquatic Vegetation (S24)

Type Concept Sentence: Vegetation of agricultural lands, including row crops, intensive pastures, orchards, vineyards, plowed or harvested fallow fields, rice paddies, and farm ponds, and vegetation of developed lands, including urban, suburban and rural cities and villages, typically lawns, parks, horticultural gardens, golf courses, and urban ponds.

Type Concept: The vegetation is broadly characterized as agricultural and developed vegetation. Agricultural vegetation includes a wide variety of growth forms, often with distinctive cultural forms (e.g., orchards, vineyards, row crops, rice paddies) or structure (linear spacing, regular mowing, plowing), often to facilitate harvesting. "Agro-mesomorphic" tree, shrub, and herb growth forms are most typical. Structure is often very regular, with open to closed horizontal spacing. There is typically regular human management, such as plowing, mowing, or pruning that determines the structure and growth forms that are present. Climates vary, but this type is typically absent from polar or arid climates, where agricultural growth forms cannot grow and practices are not feasible, unless substantial irrigated water is provided (e.g., northern Africa and the Middle East). Substrates are dry to wet, including aquatic.

Developed vegetation is the vegetation of urban, suburban and rural cities and villages, typically lawns, parks, gardens, and urban ponds. A wide variety of growth forms dominate, but low, regularly mowed mesomorphic graminoid (lawn) growth forms often predominate, with or without tree cover. Growth forms may be atypical of the climate or substrate because of human activities that allow them to persist (winter protection, watering, etc.). The vegetation varies from highly regular to irregular horizontal spacing. There may be frequent, repeated disturbances, typically mowing, clipping, herbiciding, and watering. Climates are various, but this type is typically absent from polar or dry climates. Substrates are dry to wet, including urban aquatic ponds.

Classification Comments [optional]: Although this is a somewhat "bulky" class in terms of structural variation (including tree, shrub and herbaceous stands), they largely intergrade based on human manipulation, and the subclasses jointly cross ecological gradients. Thus, ecologically, it appears most helpful to group them initially into a single class. It is important to conceptually separate this class of planted and cultivated vegetation (such as intensive short-rotation pine plantations) from natural/semi-natural vegetation (such as successional and natural pine communities, or restoration pine plantings or long-rotation pine plantations where the understory is largely controlled by natural processes) because of the distinctive growth forms, species, ecology, biogeographic patterns (or lack thereof) and degree of human manipulation, and this is best done by explicitly accounting for this distinctive vegetation in this class.

If mesomorphic tree growth forms are >10% in canopy and at least of minor importance in the regeneration layer, stands may better fit 1. Forest to Open Woodland Class (C01), whereas, if the forests may have an irregular tree canopy but a highly regular or mowed understory, such as in urban parks and lawns, they better fit with developed vegetation.

Agricultural orchards have a very regularly spaced tree canopy (often pruned or trained), with a plowed, mowed, or hayed ground layer.

Urban and agricultural ponds typically have a highly managed growth form composition, regulated water levels, and hardened, human-created shorelines.

Separation of agricultural and developed vegetation based on anthropogenic processes from vegetation formed under natural processes is parallel to that proposed in soil taxonomy, where the need for separation of soils altered by humans over centuries has been proposed (Bryant and Galbraith 2003). Several national soil systems, such as that for China (Zi-tong et al. 2003), and international systems, such as FAO (1988, in Di Gregorio 2005), already recognize a new soil order - Anthrosols, and Bryant and Galbraith (2003) suggest that the U.S. system should do the same.

Similar NVC Types:

- 1. Forest to Open Woodland (C01): Where mesomorphic tree growth forms are >10% in canopy, and are irregular in structure in the understory (i.e., natural processes occur for tree saplings, seedlings, herbs and shrubs), stands may better fit here (e.g., tree plantations where the ground layer is not managed or eliminated).
- 2. Shrubland & Grassland (C02): Where mesomorphic shrub and herb growth forms are irregular in structure (i.e., natural processes occur for tree seedlings, herbs and shrubs), stands may better fit here (e.g., pastures where non-intensive grazing of livestock on native or introduced grasslands).
- 5. Aquatic Vegetation (C05): Farm and urban ponds that are not regularly managed may contain a native set of growth forms and species that place them in this class.

Diagnostic Characteristics: Agricultural vegetation often has a very regularly horizontally spaced tree, shrub or herb canopy, with the ground layer subject to annual plowing, planting, pruning, haying, sometimes coupled with flooding (e.g., rice paddies). Developed vegetation may have a regular or irregularly spaced canopy layer, but always has a highly regular ground layer, typically caused by annual, often frequent, mowing or clipping, or essentially absent and replaced by pavement.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Growth Forms: Agricultural stands are dominated by tree, shrub and herb growth forms, sometimes with distinctive cultural forms (vineyards, orchard trees, rice paddies). No growth forms *per se* have been described that are specific to agricultural vegetation. Developed stands are dominated by a wide variety of growth forms, but herb and shrub growth forms are often most characteristic, used to create lawns and gardens, with annuals, bulbs, or perennial rooted plants. FGDC (2008) does not provide guidance on cultural growth forms.

Structure: Agricultural vegetation structure is very open to closed, typically with very regular horizontal spacing and regularly manipulated heights; with some or all of the plant parts being harvested, often on an annual or more frequent basis. A tree sapling or seedling layer is typically absent under the canopy (e.g., vineyards, orchards). Vegetation typically has >10% cover, but completely bare or flooded surfaces are possible for short durations (e.g., plowed fields, rice paddies). Developed vegetation is typically closed, with regular or irregular horizontal spacing and height, often closely mown on a regular basis (resulting in uniform, short heights (<0.1 m), or the vegetation pattern is irregular, but highly regulated (e.g., flower gardens). Vegetation cover typically is >10%, but completely bare surfaces are possible for short durations.

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

Climate: Found in all climatic domains, most common in non-arid climates.

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range: Climate zones? Bailey (1989) Domains:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level:

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

- < Agricultural Land (Anderson et al. 1976)

- >> Cultivated Aquatic or Regularly Flooded Areas (Di Gregorio 2003) [This type is restricted to only wetland vegetation, but includes both agricultural and developed vegetation.]
- >> Cultivated and Managed Terrestrial Areas (Di Gregorio 2003) [This type is restricted to only upland vegetation, but includes both agricultural and developed vegetation.]
- >> Urban or Built-up Land (17. Other Urban or Build Up Land) (Anderson et al. 1976) [Anderson includes both non-vegetated and vegetated urban lands in this class, but subclass 17 covers the more extensive developed vegetation types.]

Full Citation:

- Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. USDI, Geological Survey Professional Paper No. 964. Washington, DC. 26 pp.
- Bailey, R. G. 1989. Explanatory supplement to ecoregions map of the continents. Environmental Conservation 16:307-309 with separate map at 1:30,000,000. USDA Forest Service, Washington, DC.
- Bryant, R. B., and J. M. Galbraith. 2003. Incorporating anthropogenic processes in soil classification. Pages 57-66 in: H. Eswaran, T. Rice, R. Ahrens, and B. A. Steward. Soil classification: A global desk reference. CRC Press, New York.
- Di Gregorio, A. 2005. Land Cover Classification System (LCCS), version 2: Classification concepts and user manual. FAO Environment and Natural Resources Service Series, No.8 - FAO Rome 2005.
- FAO [Food and Agriculture Organization]. 1988. FAO-UNESCO Soil Map of the World. Revised Legend. FAO/UNESCO/ISRIC World Soil Resources Reports. No. 60. Reprinted in 1990.
- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.
- Zi-tong, G., G. Ghang, and Z. Chen. 2003. Development of soil classification in China. Pages 101-126 in: H. Eswaran, T. Rice, R. Ahrens, and B. A. Steward. Soil classification: A global desk reference. CRC Press, New York.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen, G. Fults, and T. Keeler-Wolf

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.A. Woody Agricultural Vegetation (S22)

OVERVIEW

Database Code: 7.A (S22)

Scientific Name: Woody Agricultural Vegetation Subclass

Common Name (Translated Scientific Name): Woody Agricultural Vegetation Subclass

Colloquial Name: Woody Agricultural Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 7. Agricultural & Developed Vegetation (C07)

Lower Level Hierarchy Units:

- 7.A.1. Woody Horticultural Crop (F042)
- 7.A.2. Intensive Forestry Plantation & Agroforestry Crop (F043)
- 7.A.3. Woody Wetland Horticultural Crop (F049)

Type Concept Sentence: Agricultural crops dominated by shrub and tree vegetation, including orchards, vineyards, woody berry crops, intensive (often short-rotation) forest plantations, various agroforestry woody crops, and woody wetland crops, such as cranberries.

Type Concept:

Classification Comments [optional]:

Similar NVC Types:

- 1.A. Tropical Forest (S17): Long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.
- 1.B. Temperate & Boreal Forest (S15): Long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.
- 7.B. Herbaceous Agricultural Vegetation (S23):
- 7.C. Herbaceous & Woody Developed Vegetation (S21):
- 7.D. Agricultural & Developed Aquatic Vegetation (S24): Some urban ponds with woody vegetation may be similar to 7.A.

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.A. Woody Agricultural Vegetation

7.A.1. Woody Horticultural Crop (F042)

OVERVIEW

Database Code: 7.A.1 (F042)

Scientific Name: Woody Horticultural Crop Formation

Common Name (Translated Scientific Name): Woody Horticultural Crop Formation

Colloquial Name: Woody Horticultural Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.A. Woody Agricultural Vegetation (S22)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural crops dominated by shrub and tree vegetation, including orchards, vineyards, and woody berry crops.

Type Concept:

Classification Comments [optional]:

Similar NVC Types:

- 7.A.2. Intensive Forestry Plantation & Agroforestry Crop (F043):

Diagnostic Characteristics: Typically found as row crops, often in monocultures.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.A. Woody Agricultural Vegetation

7.A.2. Intensive Forestry Plantation & Agroforestry Crop (F043)

OVERVIEW

Database Code: 7.A.2 (F043)

Scientific Name: Intensive Forestry Plantation & Agroforestry Crop Formation

Common Name (Translated Scientific Name): Intensive Forestry Plantation & Agroforestry Crop Formation

Colloquial Name: Intensive Forestry Plantation & Agroforestry Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.A. Woody Agricultural Vegetation (S22)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural crops dominated by intensive (often short-rotation) forest plantations and various agroforestry woody crops.

Type Concept:

[Classification Comments \[optional\]:](#) Long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer are placed in 1.A Tropical Forest Subclass (S17) or 1.B. Temperate & Boreal Forest Subclass (S15) as the vegetation structure and composition may be largely native or naturalized. But in their early stages of development, especially if planted in rows and the understory is strongly manipulated, they may better fit within this class.

Similar NVC Types:

- 1.A.1. Tropical Seasonally Dry Forest (F003): Long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.
- 1.B.2. Cool Temperate Forest (F008): Long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.
- 1.B.4. Boreal Forest (F001): Long-rotation plantations or woody restoration plantings with an irregular structure and a largely spontaneous ground layer may initially be similar in their early stages of development, especially if planted in rows and the understory is strongly manipulated.

- 7.A.1. Woody Horticultural Crop (F042):

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

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Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.A. Woody Agricultural Vegetation

7.A.3. Woody Wetland Horticultural Crop (F049)

OVERVIEW

Database Code: 7.A.3 (F049)

Scientific Name: Woody Wetland Horticultural Crop Formation

Common Name (Translated Scientific Name): Woody Wetland Horticultural Crop Formation

Colloquial Name: Woody Wetland Horticultural Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.A. Woody Agricultural Vegetation (S22)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural crops dominated by woody wetland crops, such as cranberries.

Type Concept:

Classification Comments [optional]: There may be planted wetland tree crops that may also be placed here, though if they are intensive tree plantations, they may preferably be placed in 7.A.2 Intensive Forestry Plantation & Agroforestry Crop Formation (F043).

Similar NVC Types:

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.B. Herbaceous Agricultural Vegetation (S23)

OVERVIEW

Database Code: 7.B (S23)

Scientific Name: Herbaceous Agricultural Vegetation Subclass

Common Name (Translated Scientific Name): Herbaceous Agricultural Vegetation Subclass

Colloquial Name: Herbaceous Agricultural Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 7. Agricultural & Developed Vegetation (C07)

Lower Level Hierarchy Units:

- 7.B.1. Row & Close Grain Crop (F044)
- 7.B.2. Pasture - Hay Field & Crop (F045)
- 7.B.3. Herbaceous Horticultural Crop (F050)
- 7.B.4. Fallow Field & Weed Vegetation (F046)
- 7.B.5. Herbaceous Wetland Agricultural Crop (F058)

Type Concept Sentence: Agricultural vegetation, including row crops, planted grain crops, pastures, hayfields, horticultural crops (such as commercial flower operations), fallow fields and early-successional weed fields, and wetland rice and taro crop fields.

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

- 7.A. Woody Agricultural Vegetation (S22):
- 7.C. Herbaceous & Woody Developed Vegetation (S21): Residential vegetable gardens overlap with 7.B.

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

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Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

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Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.B. Herbaceous Agricultural Vegetation

7.B.1. Row & Close Grain Crop (F044)

OVERVIEW

Database Code: 7.B.1 (F044)

Scientific Name: Row & Close Grain Crop Formation

Common Name (Translated Scientific Name): Row & Close Grain Crop Formation

Colloquial Name: Row & Close Grain Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.B. Herbaceous Agricultural Vegetation (S23)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural vegetation, including row crops, such as corn, soybeans, cotton, tobacco, sunflowers, a wide variety of vegetables, and some planted grain crops (annual rye, wheat).

Type Concept:

Classification Comments [optional]: Some planted grain crops, such as annual rye or wheat are more akin to row crops than to hay or pasture and so they are placed here, rather than in 7.B.2 Pasture - Hay Field & Crop Formation (F045).

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.B. Herbaceous Agricultural Vegetation

7.B.2. Pasture - Hay Field & Crop (F045)

OVERVIEW

Database Code: 7.B.2 (F045)

Scientific Name: Pasture - Hay Field & Crop Formation

Common Name (Translated Scientific Name): Pasture - Hay Field & Crop Formation

Colloquial Name: Pasture - Hay Field & Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.B. Herbaceous Agricultural Vegetation (S23)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural vegetation, including pastures and hayfields, often regularly mowed, fertilized, intensively grazed, and/or manipulated to maintain a particular desirable structure and composition.

Type Concept:

[Classification Comments \[optional\]:](#) Agricultural pastures and hayfields differ from native or naturalized grasslands in the degree to which both structure and composition are manipulated through regular mowing, fertilization, intensive grazing, and other practices. These modifications to structure and composition provide distinctive vegetation characteristics as compared to native or natural grasslands. If agricultural practices are discontinued, native and exotic species from the surrounding landscape may establish and the field will become more "semi-natural." Where this occurs, the vegetation is reclassified as a native or naturalized "old-field" [see 2.A Tropical Grassland, Savanna & Shrubland Subclass (S01) or 2.B Temperate & Boreal Grassland & Shrubland Subclass (S18)].

Some planted grain crops, such as annual rye or wheat, are more akin to row crops than to hay or pasture and so they are placed in 7.B.1 Row & Close Grain Crop Formation (F044).

Similar NVC Types:

- 2.A.1. Tropical Lowland Grassland, Savanna & Shrubland (F019): Pastures may overlap in composition with native grasslands, particularly in grassland regions. And in regions where a pastoral tradition has existed from 100s to 1000s of years, recognition of native versus agricultural grasslands may be challenging.
- 2.B.2. Temperate Grassland, Meadow & Shrubland (F012): Pastures may overlap in composition with native grasslands, particularly in grassland regions. And in regions where a pastoral tradition has existed from 100s to 1000s of years, recognition of native versus agricultural grasslands may be challenging.

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.B. Herbaceous Agricultural Vegetation

7.B.3. Herbaceous Horticultural Crop (F050)

OVERVIEW

Database Code: 7.B.3 (F050)

Scientific Name: Herbaceous Horticultural Crop Formation

Common Name (Translated Scientific Name): Herbaceous Horticultural Crop Formation

Colloquial Name: Herbaceous Horticultural Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.B. Herbaceous Agricultural Vegetation (S23)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural vegetation, including horticultural crops (such as commercial flower operations).

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.B. Herbaceous Agricultural Vegetation

7.B.4. Fallow Field & Weed Vegetation (F046)

OVERVIEW

Database Code: 7.B.4 (F046)

Scientific Name: Fallow Field & Weed Vegetation Formation

Common Name (Translated Scientific Name): Fallow Field & Weed Vegetation Formation

Colloquial Name: Fallow Field & Weed Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.B. Herbaceous Agricultural Vegetation (S23)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural vegetation, fallow fields and early-successional weed fields.

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.B. Herbaceous Agricultural Vegetation

7.B.5. Herbaceous Wetland Agricultural Crop (F058)

OVERVIEW

Database Code: 7.B.5 (F058)

Scientific Name: Herbaceous Wetland Agricultural Crop Formation

Common Name (Translated Scientific Name): Herbaceous Wetland Agricultural Crop Formation

Colloquial Name: Herbaceous Wetland Agricultural Crop

Hierarchy Level: Formation

Placement in Hierarchy: 7.B. Herbaceous Agricultural Vegetation (S23)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Agricultural wetland vegetation, such as wetland rice and taro crop fields.

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:**Full Citation:**

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.C. Herbaceous & Woody Developed Vegetation (S21)

OVERVIEW

Database Code: 7.C (S21)

Scientific Name: Herbaceous & Woody Developed Vegetation Subclass

Common Name (Translated Scientific Name): Herbaceous & Woody Developed Vegetation Subclass

Colloquial Name: Herbaceous & Woody Developed Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 7. Agricultural & Developed Vegetation (C07)

Lower Level Hierarchy Units:

- 7.C.1. Lawn & Recreational Vegetation (F040)
- 7.C.2. Horticultural Garden Vegetation (F041)
- 7.C.3. Open Developed Vegetation (F051)
- 7.C.4. Developed Wetland Vegetation (F059)

Type Concept Sentence: Vegetation includes closely-cropped vegetation such as lawns, gardens, sports fields, and golf courses, as well as vegetation growing in urban materials, such as pavement, from dry lands to emergent wetlands. Tree canopy varies from 0 to 100% (e.g., open to shaded lawns and gardens).

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

- 5.B. Freshwater Aquatic Vegetation (S13):
- 7.A. Woody Agricultural Vegetation (S22):
- 7.B. Herbaceous Agricultural Vegetation (S23): Herbaceous & Woody Developed Vegetation (S21) contains residential vegetable gardens that overlap with Herbaceous Agricultural Vegetation (S23).

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.C. Herbaceous & Woody Developed Vegetation

7.C.1. Lawn & Recreational Vegetation (F040)

OVERVIEW

Database Code: 7.C.1 (F040)

Scientific Name: Lawn & Recreational Vegetation Formation

Common Name (Translated Scientific Name): Lawn & Recreational Vegetation Formation

Colloquial Name: Lawn & Recreational Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.C. Herbaceous & Woody Developed Vegetation (S21)

Lower Level Hierarchy Units [incomplete]:

- 7.C.1.a. Lawn (D188)

Type Concept Sentence: Vegetation includes closely-cropped vegetation such as lawns, sports fields, and golf courses. Tree canopy varies from 0 to 100% (e.g., open to shaded lawns).

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

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Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.C. Herbaceous & Woody Developed Vegetation

7.C.2. Horticultural Garden Vegetation (F041)

OVERVIEW

Database Code: 7.C.2 (F041)

Scientific Name: Horticultural Garden Vegetation Formation

Common Name (Translated Scientific Name): Horticultural Garden Vegetation Formation

Colloquial Name: Horticultural Garden Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.C. Herbaceous & Woody Developed Vegetation (S21)

Lower Level Hierarchy Units [incomplete]:

- 7.C.2.a. Other Urban / Built-Up Vegetation (D189)

Type Concept Sentence: Vegetation includes gardens. Tree canopy varies from 0 to 100% (e.g., open to shaded gardens).

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation
7.C. Herbaceous & Woody Developed Vegetation

7.C.3. Open Developed Vegetation (F051)

OVERVIEW

Database Code: 7.C.3 (F051)

Scientific Name: Open Developed Vegetation Formation

Common Name (Translated Scientific Name): Open Developed Vegetation Formation

Colloquial Name: Open Developed Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.C. Herbaceous & Woody Developed Vegetation (S21)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Vegetation includes vegetation growing in urban materials, such as pavement. Tree canopy varies from 0 to 100% (e.g., open to shaded weed vegetation in pavement cracks).

Type Concept:

[Classification Comments \[optional\]:](#)

Similar NVC Types:

Diagnostic Characteristics:

[Rationale for Nominal Species or Physiognomic Features \[optional\]:](#)

VEGETATION

[Physiognomy and Structure \[optional\]:](#)

[Floristics \[optional\]:](#)

ENVIRONMENT

[Environmental Description \[optional\]:](#)

DISCUSSION

[Discussion \[optional\]:](#)

[Animals \[optional\]:](#)

[Mapping Issues \[optional\]:](#)

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

[USFS Ecoregions \(2005\) \[optional\]:](#)

[Omernik Ecoregions \[optional\]:](#)

CONFIDENCE LEVEL

Confidence Level: Moderate

[Confidence Level Comments \[optional\]:](#)

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fuels, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation
7.C. Herbaceous & Woody Developed Vegetation

7.C.4. Developed Wetland Vegetation (F059)

OVERVIEW

Database Code: 7.C.4 (F059)

Scientific Name: Developed Wetland Vegetation Formation

Common Name (Translated Scientific Name): Developed Wetland Vegetation Formation

Colloquial Name: Developed Wetland Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.C. Herbaceous & Woody Developed Vegetation (S21)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: A very uncommon vegetation that includes urban, suburban and rural planted and managed emergent and woody wetlands, such as small urban ponds with emergent vegetation. Tree canopy can vary from 0 to 100% (e.g., open to shaded planted wetlands).

Type Concept:

Classification Comments [optional]: Type is very uncommon and concept needs review. Emergent and woody wetlands are typically natural to semi-natural.

Similar NVC Types:

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.D. Agricultural & Developed Aquatic Vegetation (S24)

OVERVIEW

Database Code: 7.D (S24)

Scientific Name: Agricultural & Developed Aquatic Vegetation Subclass

Common Name (Translated Scientific Name): Agricultural & Developed Aquatic Vegetation Subclass

Colloquial Name: Agricultural & Developed Aquatic Vegetation

Hierarchy Level: Subclass

Placement in Hierarchy: 7. Agricultural & Developed Vegetation (C07)

Lower Level Hierarchy Units:

- 7.D.1. Agricultural Aquatic Vegetation (F047)
- 7.D.2. Developed Aquatic Vegetation (F048)

Type Concept Sentence: Floating and submerged vegetation found in managed agricultural and developed sites, such as farm ponds, urban ponds, and other open water sites in urban, suburban and rural settings.

Type Concept:

Classification Comments [optional]: Agricultural and developed aquatic vegetation that is not regularly managed may contain a native or naturalized set of growth forms and species that places it in 5.B Freshwater Aquatic Vegetation Subclass (S13).

Similar NVC Types:

- 5.B. Freshwater Aquatic Vegetation (S13):
- 7.A. Woody Agricultural Vegetation (S22): Agricultural & Developed Aquatic Vegetation (S24) contains urban ponds with woody vegetation that may be similar to Woody Agricultural Vegetation (S22).

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.D. Agricultural & Developed Aquatic Vegetation

7.D.1. Agricultural Aquatic Vegetation (F047)

OVERVIEW

Database Code: 7.D.1 (F047)

Scientific Name: Agricultural Aquatic Vegetation Formation

Common Name (Translated Scientific Name): Agricultural Aquatic Vegetation Formation

Colloquial Name: Agricultural Aquatic Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.D. Agricultural & Developed Aquatic Vegetation (S24)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Floating and submerged vegetation found in managed agricultural sites, such as farm ponds.

Type Concept:

Classification Comments [optional]: Agricultural aquatic vegetation that is not regularly managed may contain a native or naturalized set of growth forms and species that places it in 5.B Freshwater Aquatic Vegetation Subclass (S13).

Similar NVC Types:

- 5.B.1. Tropical Freshwater Aquatic Vegetation (F056): Although in some cases there may be difficulty distinguishing natural from agricultural ponds, in the large majority of cases, they are distinct in ecological setting, edges, and in composition.
- 5.B.2. Temperate & Boreal Freshwater Aquatic Vegetation (F057): Although in some cases there may be difficulty distinguishing natural from agricultural ponds, in the large majority of cases, they are distinct in ecological setting, edges, and in composition.
- 7.D.2. Developed Aquatic Vegetation (F048):

Diagnostic Characteristics: Agricultural aquatic vegetation typically has a highly managed growth form composition, regulated water levels, and hardened, human-created shorelines.

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

7. Agricultural & Developed Vegetation

7.D. Agricultural & Developed Aquatic Vegetation

7.D.2. Developed Aquatic Vegetation (F048)

OVERVIEW

Database Code: 7.D.2 (F048)

Scientific Name: Developed Aquatic Vegetation Formation

Common Name (Translated Scientific Name): Developed Aquatic Vegetation Formation

Colloquial Name: Developed Aquatic Vegetation

Hierarchy Level: Formation

Placement in Hierarchy: 7.D. Agricultural & Developed Aquatic Vegetation (S24)

Lower Level Hierarchy Units [incomplete]:

Type Concept Sentence: Floating and submerged vegetation found in managed developed sites, such as urban ponds.

Type Concept:

Classification Comments [optional]: Developed aquatic vegetation sites that are not regularly managed may contain a native or naturalized set of growth forms and species that place them in 5.B Freshwater Aquatic Vegetation Subclass (S13).

Similar NVC Types:

- 5.B.1. Tropical Freshwater Aquatic Vegetation (F056): Although in some cases there may be difficulty distinguishing natural from urban ponds, in the large majority of cases, they are distinct in ecological setting, edges, and in composition.
- 5.B.2. Temperate & Boreal Freshwater Aquatic Vegetation (F057): Although in some cases there may be difficulty distinguishing natural from urban ponds, in the large majority of cases, they are distinct in ecological setting, edges, and in composition.
- 7.D.1. Agricultural Aquatic Vegetation (F047):

Diagnostic Characteristics:

Rationale for Nominal Species or Physiognomic Features [optional]:

VEGETATION

Physiognomy and Structure [optional]:

Floristics [optional]:

ENVIRONMENT

Environmental Description [optional]:

DISCUSSION

Discussion [optional]:

Animals [optional]:

Mapping Issues [optional]:

DISTRIBUTION

Geographic Range:

Nations [incomplete except for CA and US]: CA, US

USFS Ecoregions (2005) [optional]:

Omernik Ecoregions [optional]:

CONFIDENCE LEVEL

Confidence Level: Moderate

Confidence Level Comments [optional]:

CITATIONS

Synonymy:

Full Citation:

- *Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.-P. Saucier, G. Fults, E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Primary Concept Source: Hierarchy Revisions Working Group, Federal Geographic Data Committee (Faber-Langendoen et al. 2012)

Author of Description: D. Faber-Langendoen

Acknowledgments:

Version Date: 16 Jul 2012

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