

Reference Values for Soil Carbon Stocks

Presented here are reference values for soil carbon stocks in Icelandic vegetation communities (Table 1), habitat types (Table 2), and habitat type classes (Table 3). The classification of land by vegetation communities is an important component of land mapping for afforestation and evaluation of site potential (Snorrason, 2015). Carbon projects operating under the **Skógarkolefni Carbon Code** (<https://www.skogarkolefni.is/>), are required to assess carbon stocks at the outset of project activities. Until now, however, reference values to support such assessments have not been readily available. The values presented here are intended to address this need.

In recent years, the Natural Science Institute of Iceland (NSII) has used habitat type classification as a framework for data collection (Ottósson et al., 2016). This classification is based on the European **EUNIS habitat type classification** (Chytrý et al., 2020). For Iceland, information on soil parameters associated with individual habitat types is published in *Habitat types in Iceland* (Ottósson et al., 2016), and the current calculations are based on this data. A key for identifying Icelandic habitat types is available on the NSII website (Natural Science Institute of Iceland, 2019). The Institute has also produced a map of habitat types (Natural Science Institute of Iceland, 2026), although its accuracy is insufficient for land mapping purposes.

Soil carbon stocks are normally assessed to a depth of at least 30 cm. The publication *Habitat types in Iceland* (Ottósson et al., 2016) contains information on soil carbon content (C%) in the topsoil (0-10 cm) for most terrestrial habitat types, together with information on stoniness, soil depth and soil type. However, information on soil parameters for habitat types below 10 cm depth is not presented, along with several other important parameters, most notably measurements of soil bulk density.

To estimate soil bulk density in the present calculations, information on the relationship between bulk density and carbon content in Icelandic soils was primarily drawn from a recent study by Sanchez et al. (2024). Additional soil references (Óskarsson et al., 2004; Arnalds, 2024) were also used to estimate the distribution of soil carbon content and bulk density with depth for different soil types.

The published data from the Natural Science Institute of Iceland, together with estimated additional values for soil carbon content and bulk density, were then used to estimate soil carbon stocks in habitat types to a depth of 30 cm. Surface stoniness was assumed to reflect the stone content of the upper soil profile, and stone volume was excluded from soil volume calculations when estimating carbon stocks. Adjustments were also made where the average soil depth of a habitat type was less than 30 cm. Estimated soil carbon stocks for habitat types are presented in Table 2, while additional information on the span of soil parameters used for the present calculations is provided in Table 3.

Likely matches between habitat types and vegetation communities were then used to transfer habitat-based carbon stock estimates to corresponding map units based on vegetation communities (Table 1). Uncertainty associated with this transfer reduces the confidence of the reference values in some cases. The soil data published by Ottósson et al. (2016) do not cover cultivated land or lupin-dominated areas. Vegetation communities associated with those land types are therefore omitted in the present version.

The primary purpose of these calculations is to provide reference values for the map units used in afforestation planning, as presented in Table 1. Moreover, the breakdown of soil

carbon stocks by habitat types and habitat type classes in Tables 2 and 3 may also be useful for carbon project developers and others.

Table 1. Reference values for soil carbon stocks in most vegetation communities listed in Mógilsá Report No. 33/2015, used in land classification for afforestation.

Vegetation mapping categories (Rit-Mógilsár 33-2015)*	Mean estimated soil carbon stocks in the top 30 cm (t C ha ⁻¹)
A Moss heath	28
B Ericaceous shrubs heath	31
BB <i>Vaccinium</i> heath	86
C <i>Betula nana</i> heath	76
DL <i>Salix lanata</i> heath	21
DGu <i>Salix phylicifolia</i> heath	77
E <i>Carex myosuroides</i> and <i>Juncus trifidus</i> heathland	67
G <i>Carex</i> spp. heath	78
J Lichens and dwarf shrub heath	50
HG Grassland	86
HT Rich grassland	83
HS Dwarf-shrub grassland	65
HM Dune grassland	3
L Forb meadows	71
T Moist land	66
UM <i>Carex nigra</i> sloping fen	114
UR Shrub sloping fen	107
VB <i>Eriophorum</i> spp level fen	108
VG <i>Carex lyngbyei</i> level fen	116
VT <i>Carex rostrata</i> level fen	121
O Sparsely or non-vegetated land	5

*Snorrason 2015; Natural Science Institute of Iceland, 2018

Table 2. Estimated reference values for carbon stocks of terrestrial habitat types. Vegetation mapping categories, compatible to selected habitat types, are added to the appropriate rows. Some vegetation mapping categories, notably sparsely or non-vegetated land and moss heath, occur in more than one row.

Habitat type classes	Habitat types		Vegetation mapping categories (Rit-Mógilsár 33-2015)*		Mean estimated soil carbon stock in the top 30 cm (t C ha ⁻¹)
Fell fields, moraines and sands	L1.1	Sparsely- or un-vegetated habitats on mineral substrates not resulting from recent ice activity	O	Sparsely or non-vegetated land	9.3
	L1.2	Sparsely- or un-vegetated habitats on mineral substrates not resulting from recent ice activity	O	Sparsely or non-vegetated land	17.7
	L1.3	Oroboreal <i>Carex bigelowii-Racomitrium</i> moss-heaths	A	Moss heath	31.4
	L1.4	Glacial moraines with very sparse or no vegetation			22.5
	L1.5	Volcanic ash and lapilli fields	O	Sparsely or non-vegetated land	2.2
	L1.6	Icelandic inland dunes		Dune grassland	3.3
Exposed aeolian soils	L2.1	Icelandic exposed andic soils			46.4
Screes and cliffs	L3.1	Icelandic talus slopes			18.0
	L3.2	Icelandic <i>Salix herbacea</i> screes			14.9
	L3.3	Icelandic <i>Alchemilla</i> screes	O	Sparsely or non-vegetated land	3.1
River plains	L4.1	Unvegetated or sparsely vegetated shores	O	Sparsely or non-vegetated land	0.0
	L4.2	Icelandic braided river plains			11.4
Moss lands	L5.1	Boreal moss snowbed communities	A	Moss heath	13.2
	L5.2	Icelandic <i>Racomitrium ericoides</i> heaths	A	Moss heath	13.0
	L5.3	Moss and lichen fjell fields	A	Moss heath	40.5
Lava fields	L6.1	Barren Icelandic lava fields	O	Sparsely or non-vegetated land	3.1
	L6.2	Icelandic lava field lichen heaths	A	Moss heath	14.9
	L6.3	Icelandic lava field moss heaths	A	Moss heath	42.6
	L6.4	Icelandic lava field shrub heaths	A	Moss heath	25.6
Coastal land	L7.1	Icelandic sand beach perennial communities			2.7
	L7.2	Upper shingle beaches with open vegetation	O	Sparsely or non-vegetated land	
	L7.3	Atlantic embryonic dunes	MH	Dune grassland	1.4
	L7.4	Northern fixed grey dunes			26.2
	L7.5	Atlantic lower shore communities			68.9
	L7.6	Icelandic <i>Carex lyngbyei</i> salt meadows			118.4
	L7.7	Atlantic sea-cliff communities			94.5
Wetlands	L8.1	<i>Philonotis-Saxifraga stellaris</i> springs	T	Moist land	112.4

	L8.2	Icelandic stiff sedge fens	T	Moist land	45.9
	L8.3	Cottonsedge marsh-fens			36.0
	L8.4	<i>Juncus arcticus</i> meadows	T	Moist land	39.6
	L8.5	Boreal black sedge-brown moss fens			115.5
	L8.6	Boreal black sedge-brown moss fens	UR	Shrub sloping fen	107.4
	L8.7	Aapa mires			108.0
	L8.8	Palsa mires			122.4
	L8.9	Icelandic black sedge-brown moss fens	UM	Carex nigra sloping fen	114.2
	L8.10	Icelandic <i>Carex rariflora</i> alpine fens			102.0
	L8.11	Common cotton-grass fens	VB	Eriophorum spp level fen	108.3
	L8.12	Icelandic black sedge-brown moss fens			94.5
	L8.13	Basicline bottle sedge quaking mires	VT	Carex rostrata level fen	121.2
	L8.14	Icelandic <i>Carex lyngbyei</i> fens	VG	Carex lyngbyei level fen	116.4
Grasslands	L9.1	Icelandic <i>Carex bigelowii</i> grasslands	G	Carex spp. heath	86.5
	L9.2	Insular <i>Nardus-Galium</i> grasslands	HG	Grassland	91.1
	L9.3	Wavy hair-grass grasslands	HG	Grassland	96.4
	L9.4	Boreal tufted hairgrass meadows	HT	Rich grassland	89.9
	L9.5	Icelandic <i>Festuca</i> grasslands	HS	Dwarf-shrub grassland	65.4
	L9.6	Boreo-subalpine <i>Agrostis</i> grasslands	HT	Rich grassland	76.0
	L9.7	Northern boreal <i>Festuca</i> grasslands	L	Forb meadows	70.8
Heathlands	L10.1	Icelandic <i>Racomitrium</i> grass heaths	A	Moss heath	42.5
	L10.2	Arctic <i>Dryas</i> heaths	E	Carex myosuroides and <i>Juncus trifidus</i> heathland	67.2
	L10.3	Icelandic <i>Carex bigelowii</i> heaths	G	Carex spp. heath	68.6
	L10.4	Icelandic <i>Empetrum Thymus</i> grasslands	HG	Grassland	70.5
	L10.5	Icelandic lichen <i>Racomitrium</i> heaths	J	Lichens and dwarf shrub heath	49.7
	L10.6	North Atlantic boreo-alpine heaths	C	<i>Betula nana</i> heath	76.0
	L10.7	Oroboreal moss-dwarf willow snowbed communities	B	Ericaceous shrubs heath	30.7
	L10.8	North Atlantic <i>Vaccinium-Empetrum-Racomitrium</i> heaths	BB	Vaccinium heath	85.6
	L10.9	Icelandic <i>Salix lanata/S. phylicifolia</i> scrub	DL	<i>Salix lanata</i> heath	20.8
	L10.10	Oroboreal willow scrub	DGu	<i>Salix phylicifolia</i> heath	77.4
Woodlands	L11.1	Boreo-Atlantic crowberry-bog bilberry birch woods			68.5
	L11.2	Icelandic bog bilberry-hairgrass birch woods			84.7
	L11.3	Icelandic cranesbill birch woods			91.5

*Snorrason 2015; Natural Science Institute of Iceland, 2018

Table 3. Estimated soil carbon stocks in different habitat type classes. Soil carbon content, bulk density and carbon stocks are shown as ranges of maximum and minimum values where applicable.

Habitat type classes	Soil carbon content, 0-10 cm depth* (C %)	Estimated soil bulk density, 0-10 cm depth (g cm ⁻³)	Estimated soil carbon content, 10-30 cm depth (C%)	Estimated soil bulk density, 10-30 cm depth (g cm ⁻³)	Calculated soil carbon stocks in the top 30 cm	
					Range (t C ha ⁻¹)	Average (t C ha ⁻¹)
Fell fields, moraines and sands	0.2-2.9	0.8-1.2	0.0 -1.0	1.1-1.5	2.2-31.4	14.4
Exposed aeolian soils	1.7	1	1.5	1		46.4
Screes and cliffs	0.5-13.9	0.3-1.2	0.0 -1.0	1.0-1.5	3.1-18.0	9.0
River plains	0.0-0.8	1.2-1.8	0.0-0.1	1.5	0.0-11.4	5.7
Moss lands	1.1-6.2	0.5-1.1	0.1-1.5	1.3-1.5	13.0-40.5	22.2
Lava fields	0.3-13.5	0.3-1.4	0.1-1.5	1.0-1.5	3.1-42.6	21.6
Coastal land	0.1-24.6	0.1-1.4	0.0-10.0	0.4-1.5	1.4-118.4	52.0
Wetlands	1.4-28.3	0.1-1.0	1.0-20.2	0.2-1.1	36.0-122.4	96.0
Grasslands	4.2-14.7	0.3-0.7	2.0-3.0	0.8-0.9	65.4-96.4	82.3
Heathlands	0.8-9.9	0.4-1.2	0.4-2.5	0.8-1.4	20.8-85.6	58.9
Woodlands	5.9-8.7	0.5-0.6	2.5-3.0	0.8	68.5-91.5	81.6

*Ottósson o.fl. 2016.

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