

New records of the invasive alien *Rosa rugosa* (Rosaceae) in the Archipelago Sea National Park, SW Finland

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Rosa rugosa Thunb. is an invasive alien species in Europe with negative ecological effects on biodiversity. In Finland it occurs especially in the coast and in the archipelagos of the Baltic Sea, where it replaces native plant species and causes overgrown of rare and threatened habitats, like sand beaches and seashore meadows. This study contributes new records of *Rosa rugosa* stands within the Archipelago Sea National Park and its surroundings in SW Finland. In total, the shores of 665 islands or skerries were inventoried systematically during the field studies in 2017 and 2018. We found 96 new occurrences of *R. rugosa*. The median size of new stands was 4 m² and total they covered 698 m² area. The most common habitat was stone shore (48 stands), but also shore meadows were also typical habitats (22 stands). Altogether 301 stands are now found from the study area. Distribution, stand sizes and habitats of naturalized *R. rugosa* are essential information for performing the control work of this invasive species. It is likely that dozens of stands are still undiscovered from the National Park area.

Introduction

The origin of *Rosa rugosa* Thunb. is in East Asia, where it occurs along sand and gravel coasts of the Pacific Ocean. The species was introduced to gardens in Europe and it started to naturalize during the 19th century (Bruun 2005). Nowadays it has become widely naturalized especially in North and Northwest Europe including the Baltic Sea (Bruun 2005, Hill et al. 2010, Kelager et al. 2013). *R. rugosa* has invaded in coastal habitats, like sand dunes, but also vegetated shingle, grassland, low scrub and verges also in inland habitats (Isermann 2008, Kollmann et al. 2009, Thiele et al. 2009). *R. rugosa* is a great threat to coastal ecosystems because it replaces native plant species and changes the composition of habitat types and suppresses natural vegetation of high conser-

vation value (Kollmann et al. 2009, Thiele et al. 2010, 2011). Therefore, *R. rugosa* is among the 100 worst alien species in Europe (Essl 2006).

In Finland *Rosa rugosa* started spreading effectively into nature in the 1930's (Erkamo 1949). *R. rugosa* occurs throughout in the coastal area and the archipelagos of Finland until Bothnian Bay, including Åland Islands. On the southern coast, in the archipelago of the Gulf of Finland and in the Archipelago Sea it is most common (Kunttu et al. 2016).

In Finland *Rosa rugosa* is established on the shore, often in threatened habitat types like sand beaches, dunes, shrub heaths and seashore meadows (Ryttäri et al. 2014, Kontula & Raunio 2018). Consequently, overgrown leads to reduced diversity of native species, while shores support a specialized biodiversity and several red-listed spe-

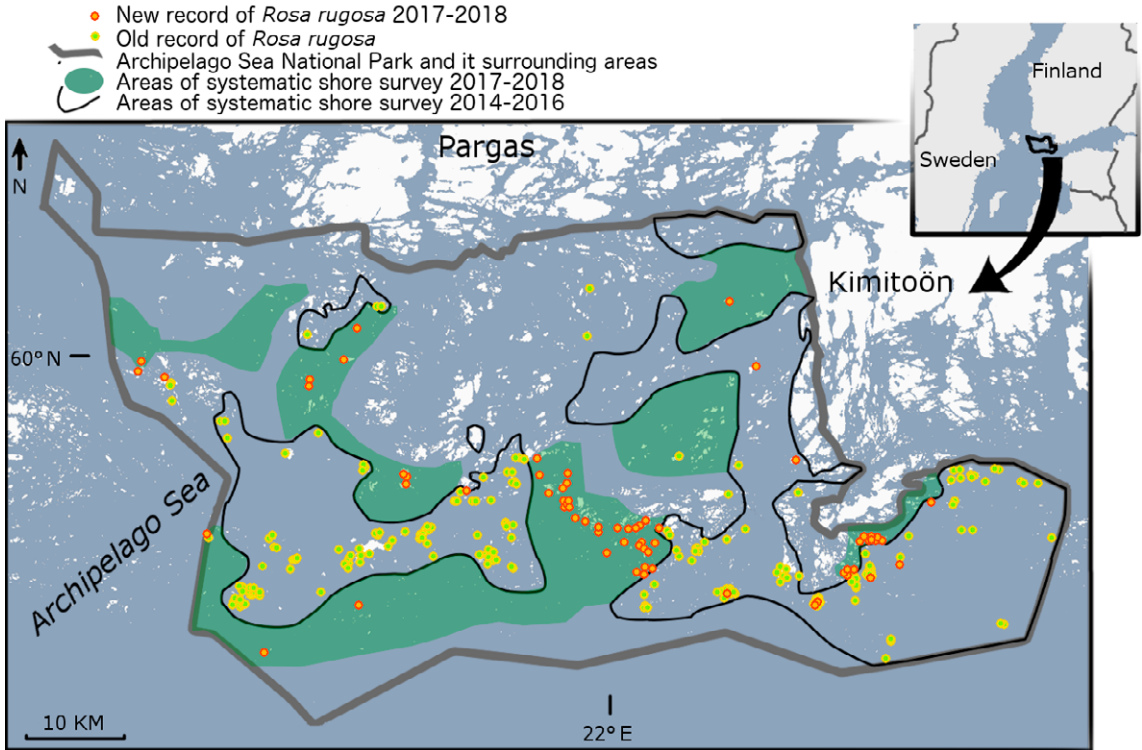


Figure 1. Study area in SW Finland, areas of systematic shore survey and the distribution of stands of the invasive alien *Rosa rugosa* Thunb.

cies (e.g. Skytén 1978, Ryttäri et al. 2006, Aspelund & Ryttäri 2010, Rassi et al. 2010). In Finland it has been classified as a very harmful invasive plant because of its negative effects on native species and natural habitat types (Niemi-Lahhti 2012).

The purpose of this study is to complete the knowledge of *Rosa rugosa* distribution, habitats and stand sizes in the Archipelago Sea National Park, SW Finland. The first review was published in 2017 (Kunttu & Kunttu 2017), but a lot of new information has accumulated after that.

Study area

The Archipelago Sea National Park and its surrounding area is a part of the Baltic Sea and it is situated in southwestern Finland (approx. 60°N, 22°E; Fig. 1). The area is located in the hemiboreal zone (Ahti et al. 1968) and it belongs to the municipalities Kimitoön and Pargas. The National Park and its unprotected surroundings contain

8384 islands or skerries (size at least one are). In total, the area covers 151 km² of land and 2896 km² of sea. Nevertheless, only 23% of land area is protected, and the rest, inside of the boundary shown in fig. 1, is unprotected privately owned land.

The length of the growing season is on average 191 days and the temperature sum 1250–1300 (Kersalo & Pirinen 2009). The mean annual temperature is +6.5°C, and the annual precipitation 549 mm. The prevailing winds blow from southwest (20 %), and the average wind speed is 7.1 m/s (Pirinen et al. 2012). The islands consist mainly of gneiss and granite bedrock with soil layers of moraine, sand or gravel deposition (<http://en.gtk.fi>). The highest point of the study area is 42 m a.s.l.

The Archipelago Sea National Park is unique in the world due to its geology affected by glacial periods, a mosaic-like landscape and historical agriculture land use. Nowhere else can be found a similar density of islands, and the number of species and habitat types is the highest in Finland.

For example, 45 habitat types of the Natura 2000 programme have been found in this area (Lindgren 2000). The number of red-list species is exceptionally high with 467 species (Kunttu et al. 2014). Many habitat types are small in size, and therefore invasive species can have fatal impacts on their biodiversity.

Material and methods

We carried out systematic inventories of shores on 665 islands and skerries (with perennial vegetation) during 2017–2018 (Fig. 1). All islands and skerries were went around by the shore line and if the inner parts of the island appeared potential habitat for *Rosa rugosa*, they were also checked. Nevertheless, according our previous field experience (Kunttu & Kunttu 2017) stands are strongly concentrated near the shores. Yards and gardens were excluded from this study.

All records contain size of the stand, the habitat type and the location of growing site, which is given with coordinates of World Geodetic System (WGS84). The habitat types (according to Kontula & Raunio 2018) used in this study were: sand beach, stone shore (including also gravel, shingle and boulder shores), seashore meadows and dry meadows, rock outcrops, and dwarf shrub heaths.

Results

We found 96 new stands of *Rosa rugosa* in the surveyed area within the Archipelago Sea National Park and its surroundings (Fig. 1 & Appendix). The number of the stands and their sizes according to habitat types are shown in table 1. The median size of stands was 4 m² and total they cov-

ered 698 m² area (Table 1). The largest stand in this study was 42 m². The most common habitat was stone shore (48 stands), but also shore meadows were also typical (22 stands). No stands on sand beaches were found in this study. Altogether, 23 % of the stands were situated in the protected areas. Typical habitats of *R. rugosa* found in this study are presented in fig. 2.

Discussion

In total, 301 stands are now found in the Archipelago Sea National Park and its surroundings (Kunttu & Kunttu 2017). Their total area at this moment after eradication work is 3459 m² (originally 8062 m²). When we combine these new records and those records which were published in Kunttu & Kunttu (2017): a median size of each separate stand is 5 m² with range from 0.5 m² to 304 m², when we exclude the largest, but almost eradicated stands on Öro island. *Rosa rugosa* occurs in many different habitats in the National Park. The most common habitat type is stone shore (incl. boulder, gravel and shingle shores) where 48 % (142) of stands were found, and then, seashore meadow and dry meadow 25 % (74), and rock outcrops 15 % (44), sand beach 6 % (19), and dwarf shrub heath 6 % (18), respectively. Nevertheless, most of the colonized area were on meadows, whereas the largest stands were on sand beaches. The seven largest still existing stands amount to 25 % of the total area covered by *R. rugosa* in the study area.

In total, 112 stands were spotted in the National Park, 28 stands in privately-owned nature reserves, and 161 stands from unprotected private land. Thus 47 % of the stands were found from the protected areas, although approximately 30 %

Table 1. The number of stands and their size according to habitat types based on the new records of *Rosa rugosa* from the field studies in 2017 and 2018.

Habitat type	Number of stands	Total area (m ²)	Median size (m ²)	Range (m ²)
Sand beach	–	–	–	–
Stone shore	48	370	4	0.5–42
Seashore meadow and dry meadow	22	214	6	0.5–35
Dwarf shrub heath	9	64	5	0.5–22
Rock outcrops	17	51	1	0.5–16
Total	96	698	4	0.5–42

of all land area is protected. One explanatory factor for this is that the islands of the National Park are situated in the outer part of the archipelago, which seems to be the most potential area of *R. rugosa* to occur due to its habitats.

Control measures and removal actions have been performed – at least started – at 63 sites (21 % of all sites), but we can assume only 11 stands to be eradicated. Additionally, four old stands are not found again despite carefully inventories. Several control measures have been

used: manual uprooting, machinery uprooting, herbicide treatment, covering with a tarpaulin and shrivelling of shrubs by ripping leaves away frequently. All these control measures need work of many years. Making prioritization when considering the control measures is essential to avoid severe problems for biodiversity in shore habitats.

The number of *Rosa rugosa* stands is high – but mainly still rather small stands – and they occur throughout the study area, while the highest

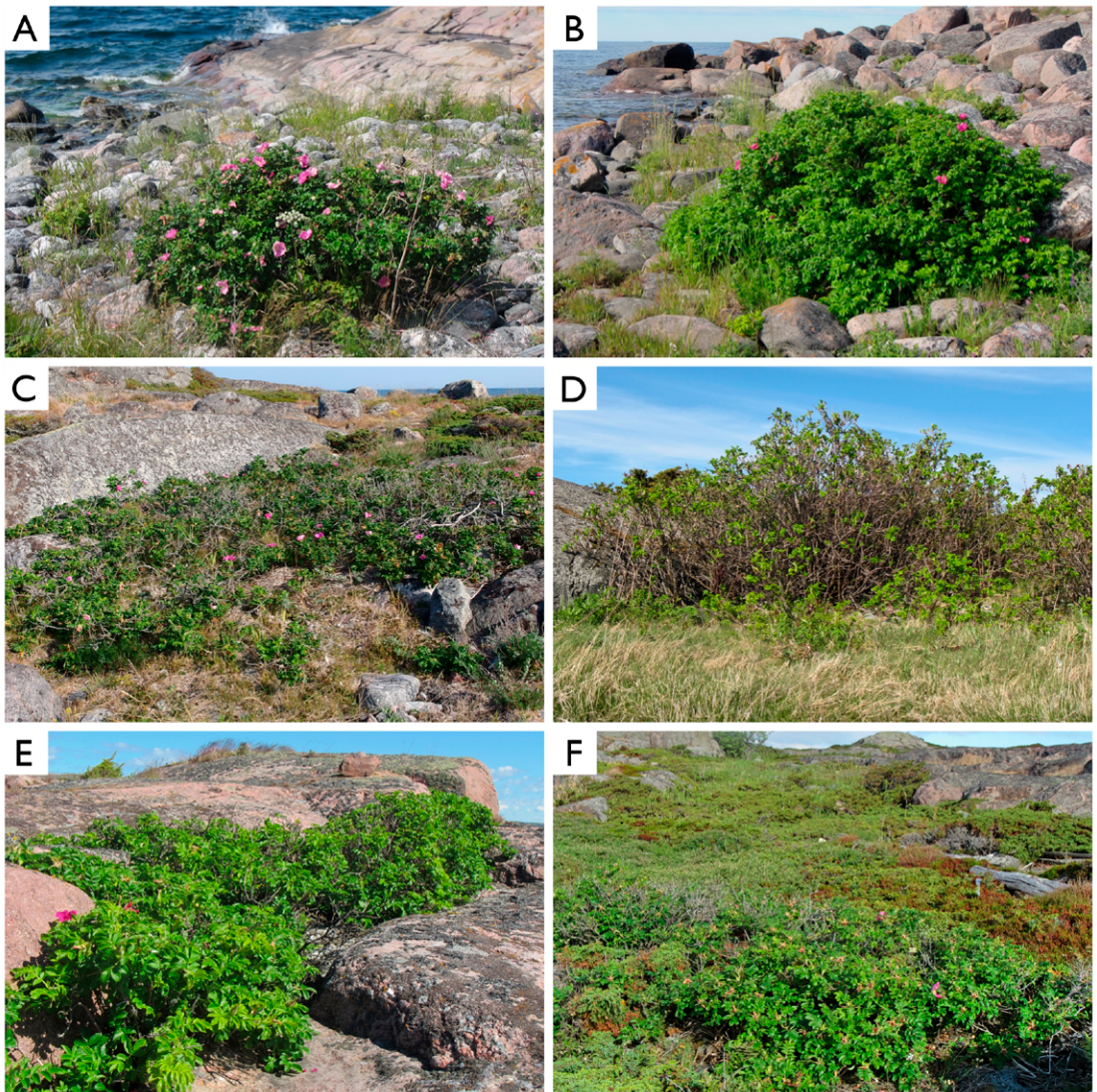


Figure 2. Typical habitats of the invasive alien *Rosa rugosa* Thunb. in the Archipelago Sea National Park and its surroundings: **A** – stone shore (middle-sizes stones), **B** – stone shore (boulders), **C** – dry meadow, **D** – seashore meadow, **E** – rock outcrop on seashore, and **F** – dwarf shrub heath. Photos: Panu Kunttu and Sanna-Mari Kunttu.

density of stands can be found through the outermost part of the study area. Due to the high number of stands, the dispersal potential is remarkable. In addition to naturalized stands, *R. rugosa* is still used in gardens on many inhabited islands.

Remarkable proportion of the most important area of potential occurrence of *Rosa rugosa* is now surveyed, but it is likely that there are at least tens of undiscovered stands in the National Park and its surroundings. Furthermore, new stands will be formed also in future, which makes control work very challenging.

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Appendix. Stands of *Rosa rugosa* Thunb. in the Archipelago Sea National Park and its surroundings recorded in 2017–2018. Abbreviations: NP – national park, PNR – private nature reserve.

Locality	Site	Coordinates	Cons. area	Size m ²	Main habitat type	Note
Aspö	Diskan, W-skerry	59° 58' 04,0" N 21° 29' 27,4" E	NP	18	Stone shore	
Aspö	Tvisingskär	59° 59' 29,4" N 21° 32' 46,3" E	NP	9	Meadow	
Aspö	Vällingskär, E-skerry	59° 58' 24,058" N 21° 29' 40,733" E	PNR	12	Dwarf shrub heath	
Björkö	Lotan	59° 53' 31,5" N 21° 39' 29,3" E	-	2	Stone shore	
Björkö	Mossalandet	59° 53' 15,8" N 21° 40' 06,3" E	-	2	Stone shore	
Björkö	Prackkläppen	59° 52' 52,8" N 21° 39' 35,6" E	-	8	Stone shore	
Borstö	Bäcklandet	59° 51' 38,6" N 21° 56' 19,1" E	NP	14	Stone shore	
Borstö	Bäcklandet	59° 51' 39,7" N 21° 56' 10,7" E	NP	18	Meadow	
Borstö	Bäcklandet	59° 51' 39,4" N 21° 56' 12,0" E	NP	2	Rock outcrops	
Borstö	Bäcklandet	59° 51' 39,1" N 21° 56' 14" E	NP	2	Stone shore	
Borstö	Bäcklandet	59° 51' 39,5" N 21° 56' 11,9" E	NP	4	Meadow	
Borstö	Delekobbarna, easternmost skerry	59° 52' 02,4" N 21° 56' 02,7" E	-	3	Meadow	
Borstö	Delekobbarna, northernmost skerry	59° 52' 6,048" N 21° 55' 52,224" E	-	6	Rock outcrops	
Borstö	Edokläppen, WW-skerry	59° 51' 52,446" N 21° 55' 51,529" E	-	33	Stone shore	
Borstö	Edokläppen, WW-skerry	59° 51' 53,157" N 21° 55' 51,254" E	-	5	Meadow	
Borstö	Fiskjaskären, W-island	59° 52' 26,5" N 21° 54' 18,8" E	NP	3	Stone shore	
Borstö	Höglandet	59° 51' 35,9" N 21° 56' 38,2" E	-	1	Meadow	
Borstö	Höglandet	59° 51' 35,1" N 21° 56' 38,0" E	-	42	Stone shore	
Borstö	Skavaskär	59° 52' 6,931" N 21° 56' 20,543" E	-	4	Stone shore	
Borstö	Sundskären, westernmost island	59° 52' 46,939" N 21° 56' 24,777" E	-	16	Rock outcrops	
Borstö	Sundskären, westernmost island	59° 52' 46,4" N 21° 56' 31,7" E	-	35	Meadow	
Borstö	Äggeskären, northernmost island	59° 53' 28,7" N 21° 54' 02,8" E	-	5	Meadow	White-flowered form
Borstö	Pryss	59° 49' 16,530" N 22° 0' 46,468" E	-	7	Stone shore	
Borstö	Rudharun	59° 51' 6,713" N 21° 57' 12,385" E	NP	2	Stone shore	
Borstö	Sillskär	59° 50' 58,742" N 22° 0' 13,445" E	-	2	Stone shore	
Borstö	Sommarö harun, W-skerry	59° 50' 51,427" N 21° 58' 9,655" E	-	22	Dwarf shrub heath	

Locality	Site	Coordinates	Cons. area	Size m ²	Main habitat type	Note
Borstö	Ytterskär	59° 50' 30,899" N 21° 59' 43,661" E	-	0,5	Stone shore	Grew under black alder
Borstö	Ytterskär	59° 50' 32,425" N 21° 59' 35,261" E	-	3	Dwarf shrub heath	
Borstö	Bredskär	59° 52' 41,3" N 21° 56' 02,0" E	-	2	Stone shore	
Brunskär	Södra Rönharun	60° 01' 08,0" N 21° 34' 39,8" E	NP	4	Stone shore	
Gullkrona	Västra Dömmaskär	60° 2' 33,630" N 22° 13' 10,160" E	-	0,5	Rock outcrops	
Hitis	Tärnsgrundet	59° 52' 3,815" N 22° 34' 37,582" E	-	4	Meadow	
Holma	Gräskär	59° 54' 12,521" N 22° 20' 28,800" E	-	11	Stone shore	
Högsåra	Skogskärs kläppen	59° 59' 5,396" N 22° 16' 23,733" E	-	10	Stone shore	
Jurmo	Stora Hamnskär	59° 46' 33,808" N 21° 34' 49,335" E	PNR	0,5	Stone shore	
Lökholm	Djäkenskär	59° 53' 28,2" N 21° 56' 37,9" E	-	6	Meadow	
Lökholm	Hästkläppen	59° 54' 13,0" N 21° 53' 21,0" E	-	11	Meadow	
Lökholm	Hästkläppen	59° 54' 12,2" N 21° 53' 25,6" E	-	13	Stone shore	White-flowered form
Rosala	Buskskåret	59° 47' 53,408" N 22° 26' 42,638" E	-	2	Stone shore	
Rosala	Kuggskär	59° 46' 42,419" N 22° 22' 38,308" E	PNR	0,5	Dwarf shrub heath	Uprooted 2018
Rosala	Kuggskär	59° 46' 42,478" N 22° 22' 37,426" E	PNR	0,5	Dwarf shrub heath	
Rosala	Kuggskär	59° 46' 47,797" N 22° 22' 34,377" E	PNR	6	Dwarf shrub heath	
Rosala	Ljusskär (Flasskären)	59° 47' 59,7" N 22° 24' 47,6" E	-	12	Meadow	
Rosala	Ljusskär (Flasskären), NE-skerry	59° 48' 02,9" N 22° 24' 51,6" E	-	1	Rock outcrops	
Rosala	Ljusskär (Flasskären), NE-skerry	59° 48' 2,935" N 22° 24' 54,167" E	-	3	Rock outcrops	White-flowered form
Rosala	Ljusskär (Flasskären), NE-skerry	59° 48' 02,9" N 22° 24' 55,9" E	-	4	Rock outcrops	
Rosala	Storskären, southernmost island	59° 48' 13,0" N 22° 25' 46,2" E	-	10	Stone shore	
Rosala	Storskären, W-skerry	59° 48' 16,360" N 22° 25' 31,076" E	-	2	Stone shore	
Rosala	Allandet	59° 50' 4,191" N 22° 29' 22,888" E	-	5	Stone shore	
Rosala	Bomarsklobben	59° 50' 6,935" N 22° 27' 57,131" E	-	7	Rock outcrops	
Rosala	Bomarsklobben	59° 50' 7,016" N 22° 27' 56,670" E	-	1	Rock outcrops	
Rosala	Bomarsklobben	59° 50' 6,871" N 22° 27' 56,239" E	-	2	Stone shore	
Rosala	Bomarsklobben	59° 50' 6,693" N 22° 27' 55,749" E	-	4	Stone shore	
Rosala	Bomarsklobben	59° 50' 6,702" N 22° 27' 56,005" E	-	0,5	Stone shore	
Rosala	Dömmaskär	59° 44' 43,764" N 22° 30' 16,526" E	-	1	Rock outcrops	
Rosala	Ekeskåret	59° 50' 1,562" N 22° 28' 38,432" E	-	11	Stone shore	
Rosala	Ekeskåret	59° 50' 2,610" N 22° 28' 28,453" E	-	12	Stone shore	
Rosala	Flasskären, N-island	59° 47' 55,1" N 22° 25' 06,4" E	-	3	Meadow	
Rosala	Lammgrundet, southernmost skerry	59° 48' 18,972" N 22° 27' 34,974" E	-	1	Rock outcrops	Uprooted 2017
Rosala	Ljusskåret (northern one)	59° 50' 17,543" N 22° 28' 45,777" E	-	5	Dwarf shrub heath	
Rosala	Nordanvädergrundet	59° 49' 21,989" N 22° 31' 27,164" E	-	2	Rock outcrops	
Rosala	Rönnlandet	59° 50' 0,034" N 22° 29' 21,523" E	-	3	Stone shore	

Locality	Site	Coordinates	Cons. area	Size m ²	Main habitat type	Note
Rosala	Rönlandet	59° 49' 59,728" N 22° 29' 25,807" E	-	30	Meadow	
Rosala	Rönlandet	59° 49' 58,357" N 22° 29' 28,308" E	-	0,5	Rock outcrops	
Rosala	Rönlandet, NE-island	59° 50' 4,050" N 22° 29' 43,513" E	-	12	Meadow	
Rosala	Stora Gallbyskäret	59° 47' 25,417" N 22° 26' 41,628" E	-	0,5	Rock outcrops	Uprooted 2017
Rosala	Stora Gallbyskäret	59° 47' 25,803" N 22° 26' 35,105" E	-	0,5	Rock outcrops	Uprooted 2017
Rosala	Uddskären, northernmost skerries, E-skerry	59° 50' 13,987" N 22° 29' 37,700" E	-	16	Stone shore	
Trunsö	Gömskär	59° 52' 36,0" N 21° 46' 11,2" E	-	11	Dwarf shrub heath	
Utö	Alu	59° 44' 08,1" N 21° 24' 55,4" E	-	2	Meadow	
Utö	Slevharu	59° 49' 47,3" N 21° 18' 26,4" E	-	0,5	Rock outcrops	Uprooted 2018
Vänö	Örs ören	59° 47' 23,7" N 22° 13' 26,8" E	NP	0,5	Meadow	
Vänö	Örskär (Ejrsräsen)	59° 47' 18,494" N 22° 13' 10,033" E	NP	6	Meadow	
Vänö	Gåsharu	59° 48' 15,818" N 22° 4' 9,227" E	-	4	Dwarf shrub heath	
Vänö	Gåsharu, E-skerry	59° 48' 14,610" N 22° 4' 14,996" E	-	4	Rock outcrops	
Vänö	Gärskär	59° 49' 57,734" N 22° 2' 32,260" E	NP	1	Stone shore	
Vänö	Hamns Bosskär, N-island	59° 49' 52,107" N 22° 5' 44,668" E	NP	12	Stone shore	
Vänö	Hamnskär	59° 49,48" N 22° 4,98" E	-	2	Meadow	
Vänö	Hamnskär	59° 49,47" N 22° 4,85" E	-	5	Stone shore	
Vänö	Hamnskär	59° 49' 25,855" N 22° 5' 14,397" E	-	1	Stone shore	
Vänö	Höga Sundskär	59° 49' 45,152" N 22° 3' 44,740" E	-	4	Stone shore	Grew partly under black alder and rowan
Vänö	Linharu	59° 49' 24,642" N 22° 6' 14,458" E	-	1	Stone shore	
Vänö	Manskär, W-island	59° 50' 44,978" N 22° 6' 9,168" E	-	5	Stone shore	
Vänö	Odonskärs kläpparna, easternmost island	59° 50' 45,338" N 22° 4' 40,076" E	-	3	Stone shore	
Vänö	Odonskärs kläpparna, westernmost island	59° 50,83" N 22° 4,35" E	-	1	Stone shore	
Vänö	Rödharu, W-side, southernmost skerry	59° 48' 51,137" N 22° 5' 6,215" E	-	9	Stone shore	
Vänö	Stockhamn, SE-skerry	59° 50' 43,935" N 22° 3' 9,314" E	NP	21	Stone shore	
Vänö	Stockhamns harun	59° 50' 38,024" N 22° 2' 1,036" E	-	6	Stone shore	
Vänö	Stora Smörskär	59° 49' 59,591" N 22° 4' 3,692" E	-	2	Stone shore	
Vänö	Sundskär, westernmost island	59° 49' 40,955" N 22° 4' 0,538" E	-	6	Meadow	
Vänö	Södra Blekungen	59° 51' 6,853" N 22° 5' 10,866" E	-	26	Stone shore	
Österskär	Hättskärs kobben	59° 58' 45,7" N 21° 13' 49,4" E	-	15	Stone shore	
Österskär	Långkläppen	59° 58' 29,7" N 21° 12' 00,9" E	NP	30	Meadow	
Österskär	Långkläppen	59° 58' 28,6" N 21° 11' 52,4" E	NP	9	Meadow	
Österskär	Sundkläpparna	59° 59' 00,6" N 21° 12' 03,9" E	-	0,5	Stone shore	
Österskär	Sundkläpparna	59° 59' 00,0" N 21° 12' 04,5" E	-	10	Stone shore	