Forest site types of the Saint-Petersburg area

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Abstract. The goal of the study was to classify the forest sites of St. Petersburg area. The urban forest typology based on a set of 630 sample plots of 20×20 m each, located in the parks, gardens, urban forests, and natural reserves was elaborated. The 25 forest site types were distinguished.

1. Introduction
Despite the presence of several publications devoted to the study of forest vegetation of the city of Saint Petersburg [1, 2] it remains insufficiently studied until nowadays. The typology of urban forests, based on the principles of modern dynamical forest typology remains actual and useful for the practice of urban vegetation management [2]. It is known that urban vegetation with a predominance of trees differs significantly from natural forests by species composition of tree layer (TL), herb (HL), moss (ML) layers, and some other components of ecosystems [2]. Despite this, we believe that the terms forest, forest growth conditions (syn.: forest site type, (FST), forest type defined in the State All-Union Standard [3] are quite applicable to the urban ecosystems with the predominance of trees.

The goal of the article is to give a brief definition and description of FST and main forest types of the city of St. Petersburg.

2. Material and methods

2.1. Study area
The city of St. Petersburg (Russian Federation) adjoins the urban area and natural forests of the Gulf of Finland coast. The territory of the city extended from the point 25 km to the North of Zelenogorsk town in the North-West, to the towns Kolpino, Lomonosov, Pushkin, Pavlovsk and their environs in the South.

St. Petersburg is located in the temperate climatic zone, transitional from oceanic to continental climate, with mild winters and moderately warm summers. The average annual sum of precipitation is about 636 mm; the most of it (67%) falls during the warm period. The average annual temperature in St. Petersburg is +5 °C, the coldest month is February with the average temperature 8.0–8.5 °C; the warmest month is July with the average temperature +17.4–18.0 °C [4].

According to the geobotanical subdivision, the most part of the territory of St. Petersburg belongs to the Baltic-Leningrad district of Southern taiga forests characterized by the presence of typical boreal spruce and pine forests, alternated with broad-leaved forests (oak, maple, and lime) and coastal
black alder (Alnus glutinosa) groves [5]. The southwestern part of St. Petersburg area is located at the edge of the Ordovik limestone Plateau and belongs to the extra-zonal geobotanical district of the Ordovik Plateau with rendzin soils on limestone [5]. Oak, maple, lime, ash, and tall-forbs indicating high soil fertility and occurring mainly in the zone of broadleaved deciduous forests predominate in the forests of the Plateau [6].

Parks, gardens, arable lands, meadows, small-leaved secondary birch, and aspen and grey alder (Alnus incana) forests replaced natural vegetation of the city and for some extent of its surroundings. In total, 30 species of coniferous and 84 species of deciduous tree species forming closed stands were found in the city [7]. According to the data of the ecological service report for the period 2013–2016 [8] annual deposition of nitrogen in the city was 190–200 kg/ha per year, while the nitrogen deposition outside the city was only 5 kg/ha per year [9]. Nitrogen oxides deposition led to anthropogenic fertilization of soils and caused the plant succession (boreal dwarf-shrubs were replaced by herbs) [2].

2.2. Data collecting

The new urban forest typology was based on a set of 630 sample plots (SP) of 20×20 m each, located in 10 parks and gardens, 3 urban forests and 15 forests of natural reserves. The SP covered the all landscape diversity of the city; they were divided into: 1) parks of the 18–19th centuries, where cultivated vegetation was maintained; 2) the same without any care; 3) Second World War Victory parks founded after 1945; 4) parks and squares of the second half of 20th century and the beginning of the 21st century; 5) urban forests; and 6) natural and semi-natural forests. Urban forests are derivative forest stands formed after natural forests. When planning the research and estimating the soil types and soil moisture and fertility, we used the landscape zoning of the city [10]. When describing the tree layer (TL) the total layer density and the density of each species, average and maximum height and diameter of trunks were registered, the age trees was estimated according to the annual rings on cores and stumps or using the historical (archival) data. For the shrub layer (SL) the coverage and height were determined for every species and totally for the layer. The percentage coverage and height for each species of herb layer (HL) and moss-lichen layer (ML) and the total coverage for the layer were estimated. The thickness of humus and organic horizons and soil-forming substrate were determined on the SP.

2.3. Data processing

The first stage of the typological analysis included subdivision of SP to the land types firstly distinguished by O G Chertov [9]. We took into account granulomere composition of soil-forming substrate, presence of calcium carbonates, and degree of drainage and soil transformation by cultivation, drainage, or adding the artificial quasi-soil layers. For further ordination of SP we used ecological scales of L. G Ramensky’s, estimating soil moisture (M) and soil richness-salinity (RS) [11]. On the next step, we compiled cross-tables uniting SP of similar land types with species in rows and SP in columns and sorted rows and columns, in order to obtain the groups of SP similar in floristic composition, dominant species, soil moisture and fertility. For sorting the rows and columns in the tables, we used the computer program of Reciprocal averaging method by M O Hill [12]. The final sorting procedure took into account life forms of dominant species, the Ramenskiy’s coenotic types [13] (life strategy types), and the total coverage of HL and ML. As the result, the diagnostic groups of species (DGS) differentiating the units of SP were distinguished. The units of SP were interpreted as forest site types (FST) on the base of dynamical forest typological approach [14, 15]. FST were subdivided into subordinate units: series and variants.

Finally, we joined FST into the upper level classification units: divisions and classes, taking into account their ecological properties determining the possibilities of tree species regeneration, productivity of stands, and predominance of certain tree species. For the estimation of productivity, we used the M M Orlov tree bonitet classes (site indexes) depending of average height and age of tree stands, and the type of regeneration (seed or vegetative) [16].

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3. Results and discussion

3.1. Land types
We distinguished 14 land types: 1) extremely drained sands of tops and slopes of the hills with the depth of ground waters more than 2 m (S1); 2) normally drained sands (S2); 3) normally drained loams and sandy loams free of carbonates (L2); 3a) natural soils; 3b) soils transformed by plowing, cultivation, fertilization, drainage, adding of artificial quasi-soil layers; 4) normally drained loams and sandy loams rich with calcium carbonate (LC2); 5) semi-hydromorphic (peat thickness 10–30 cm) sands (S3); 6) semi-hydromorphic loams and sandy loams with stagnate waters (L3); 7) semi-hydromorphic peatlands, sandy loams, sands with flowing waters (F3); 8) coastal (maritime) sands periodically flooded by tides (CS); 9) oligotrophic peatlands (OP); 10) mesotrophic peatlands (MP); 11) eutrophic drained peatlands (EP); 12) oligotrophic drained peatlands (ODP); 13) mesotrophic drained peatlands (MDP); 14) eutrophic drained peatlands (EDP).

3.2. Division of nemoral forest site types
3.2.1. Class of nemoral normally drained potentially broad-leaved forest site types. Diagnostic species: weed–subnemoral Group (Aegopodium podagraria, Anthriscus sylvestris, Geum urbanum, Poa nemoralis, Ranunculus cassinicus, Veronica chamaedrys), and/or meadow-grass Group (Agrostis alba, A. capillaris, A. tenuis, Dactylis glomerata, Festuca gigantea, F. pratensis, Phleum pratense, Poa pratensis) and/or Group of large perennial or biannual weeds, indicators of soil surface disturbance and fertile soils (Arctium tomentosum, Artemisia absinthium, A. vulgaris, Chamomer angustifolium, Cirsium arvense, Equisetum arvense, Rumex obtusifolius, Tussilago farfara, Urtica dioica, Vicia cracca, V. sepium). This class unites normally drained sites (M: 68–76), with fertile soils (RS: 7–13). Land types are S2, L2, LC2; in the urban territories predominates L2b. The thickness of dark humus horizon is usually 8–15 cm. Sometimes humus layer was added artificially and its thickness can be up to 60 cm. Tree species regeneration is low, except maple. Pinus sylvestris occurs only on sandy soils and derivative from previous forest stand of Myrtilloza on S2 type. Due anthropogenic eutrophication by nitrogen the change towards more fertile soils occurred [2]. Nowadays the succession from pine stands to birch ones takes place. Pine stands in the urban forests are of II–III classes of bonitet; and in natural forests without urban impact pine spruce stands are of Ia–II classes of bonitet; aspen, birch, larch, poplar stands are of I–Ia classes, lime stands are of I–II; maple and oak stands are of II–III classes of bonitet.

This class unites the three forest site types: Nemoriherbosa on S2, Nemoriherbosa on L2, and Nemoriherbosa on CS2:

FST Nemoriherbosa on S2 includes three series: Aegopodioidso–Nemoriherbosa on S2, Graminosa–Nemoriherbosa on S2, Ruderaliherbosa–Nemoriherbosa on S2.

Series Aegopodioidso–Nemoriherbosa on S2 is characterized by predominance of Aegopodium podagraria. Series Graminosio–Nemoriherbosa on S2 is distinguished by the abundance of meadow–grass species group. Series Ruderaliherbosa–Nemoriherbosa on S2 is distinguished by the presence of weeds; the total coverage of them is higher than the coverage of any other group. We identified three groups of ruderal species. Group 1 includes species of trampled areas, tolerant to trampling: Lepidothece suaveolens, Plantago major, Poa annua, Polygonum aviculare, Potentilla anserina, Taraxacum officinale, Trifolium repens. Group 2 includes tall perennial or biannual ruderals, indicators of soil surface disturbance. Group 3 includes annual weeds: Capsella bursa- pastoris, Chenopodium album, Thlaspi arvense. We identified the corresponding variants of series according to the prevalence of the certain group of ruderals and weeds.

FST Nemoriherbosa on L2 includes three series; by floristic composition, they are similar to series on S2: Aegopodioidso–Nemoriherbosa on L2, Graminosio–Nemoriherbosa on L2, Ruderaliherbosa–Nemoriherbosa on L2. The difference between Nemoriherbosa on S2 and on L2 is the presence of pine stands on S2,
The diagnostic species of the FST *Nemoriferbosa on CS* are the species of nemoral species group (Actaea spicata, Asarum europaeum, Lathyrus vernus Mercurialis perennis, Pulmonaria obscura, Stellaria holostea, Viola mirabilis) and subnemoral species group (Carex digitata, Melica nutans, Milium effusum, Paris quadrifolia). Within St. Petersburg area, the sites of this type occur only in the Nature reserve “Duderhof Hills”, where maple, lime, oak, aspen, and willow (*Salix caprea*) are the dominants of tree layer [6].

### 3.3. Division of boreal forest site types

#### 3.3.1. Class of the boreal normally drained (potentially spruce) forest site types

Diagnostic species of the class occurring on S2 or L2a in coniferous natural and semi-natural forests are the species of boreal low herb group (*Linnaea borealis, Luzula pilosa, Lycopodium annotinum, Maianthemum bifolium, Melampyrum sylvaticum, Orthilia secunda, Oxalis acerosella, Platanthera bifolia, Rubus saxatilis, Trisetalis europaea*). In the ML species group of mesic boreal mosses (*Pleurozium schreberi, Hylomciurn splendens, Dicranum sp.* sp.) is abundant. In the urban forests the urban variants of the class occur, where boreal low herbs were replaced by other species. Among them were: reed (*Calamagrostis arundinacea*), the groups of oligotrophic grasses (*Festuca ovina, Deschampsia flexuosa*), of meadow grasses (*Festuca pratensis, F. rubra, Phleum pratens, Poa pratensis, Poa trivialis, Agrostis tenuis*) and meadow herbs (*Achillea millifolium, Alhemilla vulgaris, Geranium pratense*).

The coverage of meadow species is less than 10%. The class unites normally drained sites (M: 68–76), with rather poor or moderately fertile (for the boreal zone) soils (RS: 4–7) suitable for spruce. The thickness of humus horizon is less than 8 cm.

**FST Myrtillosa on S2,** and **FST Myrtillosa on L2.** In HL of the *Typical* series *Vaccinium myrtillus* usually prevails, *V. vitis-idaea* is abundant. Soil profile contain podzol horizon, and is rather poor with nutrients (RS: 4–6). The thickness of light grey humus horizon is 2–5 cm.

Derivative from *Myrtillosa typical* are series *Calamagrostidoso–Myrtillosa on L2* (with *Calamagrostis arundinacea* as the dominant), *Festuco-ovinae–Myrtillosa on S2,* *Deschampsio flexuosae–Myrtillosa on L2.* *Graminono–Myrtillosa on L2* (with *Festuca pratensis, F. rubra, Phleum pratens, Poa pratensis, Poa trivialis, Agrostis tenuis*), and *Prata herbosoa–Myrtillosa on S2* and *Prata herbosoa–Myrtillosa on L2* (with *Achillea millefolium, Alhemilla vulgaris, Geranium pratense*).

Bonitet classes for pine: II–III, for aspen: I–II, for birch, spruce: II–III, for oak: III–IV.

Pine and birch forests of *Myrtillosa* types occur in the city suburbs and in the urban forests. Spruce forests occur only on the areas free of urban impact.

**FST Oxalidoso on S2,** and **FST Oxalidoso on L2.** Diagnostic features of *Typical* series on S2 and L2a (usually with spruce stands) are the predominance of *Oxalis acerosella* and the presence of subnemoral species group (listed in 2.2.2) [15]. The most common derivatives of *Oxalidoso* types are birch, aspen, alder forests with high abundance of *Calamagrostis arundinacea* (series *Calamagrostidoso–Oxalidoso on L2*) or meadow grasses: *Festuca pratensis, Poa pratensis* (*Graminono–Oxalidoso on L2* series) and bryophytes *Brachythecium* sp. sp., *Mniaceae, Sanionia uncinata, Sciruhynnum* sp. sp. (*Bryoso–Oxalidoso on L2* series). The main diagnostic feature of the derivate series occurring in urban environment is the presence of ruderal-subnemoral species group *Anthricus sylvestris, Geum urbanum, Poa nemoralis, Ranunculus cassubicus*, and *Veronica chamaedrys*. The total coverage of ruderal-subnemoral group and meadow herbs and grasses does not exceed 10%. Derivative stands usually form on L2b. In some cases, they appear on the place of natural forests of *Myrtillosa* site types due to the anthropogenic eutrophication by nitrogen oxides.

We distinguished two wet variants (W: 75–76) of *Oxalidoso on L2** FST: Oxalidoso–Deschampsios series, differing by high abundance of *Deschampsia caespitosa and Oxalidoso–Pteridoso series* (with *Athyrium filix-femina* and/or *Dryopteris expansa* as dominants).

#### 3.3.2. Class of the boreal bog-moss pine and birch forest site types

Diagnostic species are the species of forest-bog species group (*Andromeda polifolia, Chamaedaphne calyculata, Eriophorum vaginatum, Ledum palustre, Oxycocus palustris, Vaccinium uliginosum*) and bog-moss group (*Sphagnum angustifolium, S. fallax, S. flexuosum, S. magellanicum*) as dominants. On burnt areas, *Polytrichum*
commune can replace bog mosses. Sometimes  Calluna vulgaris  is dominant in HL. Some forests of this class formed in the city and its surroundings due to drainage of bogs. The class unites wet sites (M: 77–90), with poor soils (RS: 2–4).

FST  Sphagnosa on OP.  Pine stands of V–Va classes of bonitet. In the HL there are 1–3 species of bog-dwarf-shrub group (Betula nana, Empetrum nigrum, Oxycoccus microcarpus) and/or of the group of oligotrophic herbs (Carex pauciflora, Drosera rotundifolia), in the ML the presence of  Sphagnum fuscum  is possible. The thickness of slightly decomposed  Sphagnum  peat layer is more than 50 cm. Only pine can regenerate on these sites.

FST  Ledosa on OP.  Pine stands of VI–V classes of bonitet, often with birch (0–30%). Species of the forest-bog dwarf-shrub group (Ledum palustre, Vaccinium uliginosum) predominate in the HL. Species of the forest-dwarf-shrub group ( Vaccinium myrtillus,  V. vitis-idaea) occur in the HL and can be dominant; species of bog-dwarf-shrubs group, oligotrophic herb group, and  Sphagnum fuscum  are absent. The thickness of the slightly decomposed Sphagnum peat layer is less than 50 cm. Pine predominates in young generation, birch also occurs among young growth.

FST  Herboso-Sphagnosa on MP.  The tree stands are with pine or birch of V–Va classes of bonitet. Species of the fen herb group ( Calla palustris, Comarum palustre, Equisetum fluviatile, E. palustre, Eriophorum polystachyon,  Juncus filiformis, Menyanthes trifoliata, Phragmites australis) or the fen sedge group (Carex acuta, C. lasiocarpa, C. rostrata, C. vesicaria) predominate in the HL. We distinguished the variant of the FST with the predominance of  Polytrichum commune  in ML occurring on the burnt areas. Pine or birch regenerate in these sites.

FST  Caricoso-Eriophorosa on OP.  The FST is transitive between Ledosa and Herboso-Sphagnosa FSTs. The tree stands are with pine or birch of V–Va bonitet classes. In the HL  Eriophorum vaginatum  or species of the forest-bog dwarf-shrub group predominate. There are 1–3 species from the fen herb group or fen sedge group. Pine predominates in young generation, birch also occurs.

FST  Myrtilloso-Ledosa on S3.  Diagnostic features are: participation of the forest-bog dwarf-shrub group and the forest-dwarf-shrub group ( Vaccinium myrtillus,  V. vitis-idaea) in the HL, the coverage of  Sphagnum  species or  Polytrichum commune  is more than 10%; forest mesic mosses ( Pleuroziun schreberi,  Dicranum sp. sp.) also can be dominants in ML. The tree stands are with pine or birch of III–IV bonitet classes. Pine predominates in young generation, birch also occurs among young growth.

3.3.3.  Class of boreal bog-moss (potentially spruce) forest site types. Diagnostic features are: species of the forest-bog dwarf-shrub group are absent or occur rarely; Carex globularis, Dryopteris carthusiana, D. expansa, Equisetum sylvaticum, Rubus chamaemorus, Vaccinium myrtillus, V. vitis-idaea predominate in HL; Sphagnum species (usually S. girgensohnii) or  Polytrichum commune  (on the burnt areas) predominate in ML. In natural or semi-natural forests, spruce predominates in the tree layer and among young growth. In the urban territories, it occurs rarely because of cutting or due to the fires. Birch and pine are common in these sites in urban forests. The class unites wet sites (M: 77–86), with moderately fertile soils (RS: 4–7) suitable for spruce. Spruce regenerates under the tree canopy in natural forests.

FST  Pteridoso-Sphagnosa on MP.  Diagnostic species are ferns ( Dryopteris carthusiana, D. expansa, Gymnogcrum dryopteris), and the species of boreal small herb group. Spruce, pine, and birch stands are of III–IV classes of bonitet.

FST  Myrtilloso-Sphagnosa on MP.  Carex globularis, Equisetum sylvaticum, Rubus chamaemorus, Vaccinium myrtillus, V. vitis-idaea dominate in the HL. No species of boreal small herb and fen herbs groups occur. Spruce and birch stands of IV–V bonitet classes, pine stands of III–IV bonitet classes.

FST  Myrtilloso-Polytrichosa on S3, L3. Characteristics of the HL are the same as in the Pteridoso-Sphagnosa. In the ML,  Sphagnum spp. coverage is 10% or even more,  Polytrichum commune , forest mesic mosses ( Pleuroziun schreberi, Hylocomium splendens, Rhytidiaepblus triquetrus,  Dicranum sp. sp.) can predominate. Spruce, aspen, and birch stands of III–IV bonitet classes, pine stands are of III bonitet class.
3.3.4. Class of boreal wet herb–rich (potentially spruce and black alder) forest site types. Diagnostic species are of the hydrophyte herb group (Filipendula ulmaria, Viola epipsila, Galium palustre, Ranunculus auricomus, R. fallax R. repens, Geum rivale, Crepis paludosa, Cirsium oleraceum, Scutellaria galericulata, Lycoreus europaeus). The coverage of ML is less than 50%; In the ML Climacium dendroides, Plagiomnium ellipticum, P. medium, Pseudobryum cinclidioides, Rhytidiadelphus triquetrus, Rhyzoziumn pseudopunctatum, R. punctatum, Sphagnum girgensohnii, S. squarrosum are common. On the hummocks species of subnemoral and fern groups occur. The class unites wet sites (M: 77–92) with fertile soils (RS: 7–13).

FST Filipendulosa on EP. Black alder, birch, spruce forests with Filipendula ulmaria or Athyrium filix-femina predominating in HL. Bonitet classes are II–III for black alder and III–IV for birch and spruce. Tree regeneration is low. For alder, sprouting is common.

FST Paludiherbosa on EP. The HL is characterized by mosaic structure: on hummocks, it consists of hygrophilous herbs, ferns, or subnemoral herbs and boreal small herbs. In moist hollows tall sedges are abundant (Carex acuta, C. cespitosa, C. vesicaria, Scirpus sylvestris); ten forbs and grasses (Calamagrostis canescens, Calla palustris, Caltha palustris, Cardamine amara, Comarum palustre, Equisetum palustre, Eriophorum paustachyon, Juncus filiformis, Mentanthes trifoliata, Naumburgia thrysiflora, Solanum dulcicamara, Thyselium palustre) and helophytes (Equisetum fluviatile, Glyceria fluitans, G. maxima, Iris pseudacorus, Phalaroides arundinacea, Phragmites australis,Polygonum hydropiper, Typha latifolia) are common. Bonitet classes for black alder are III–IV and for birch and spruce are V–II. The tree regeneration is low. Sprouting of alder predominates.

FST Oxalidosa–Filipendulosa on F3 is the intermediate type between FST Oxalidosa on L2 and FST Filipendulosa on EP. The characteristic features of the HL are similar or analogous to the ones of Filipendulosa on EP type, though spruce forests with Oxalis predominance occur. The bonitet classes for black alder are I–II and for birch and spruce are II–III. Yong growth of spruce and sprouting alder growth represent tree regeneration.

3.3.5. Class of pyrophyte forest sites on intensively drained sands. The sites of this class occur on sandy hills with the groundwater level deeper than 2 m. Diagnostic features are the absence of hygrophytes and species of subnemoral and boreal small herb groups, ferns, ruderals, and meadow grasses. Periodic forest fires induced the sites. As a result, fire tolerant pine predominates; forests of the class are impulsively stable communities. The class unites extremely drained sands (M: 58–67), with poor soils (RS: 1–4). Humus horizon is absent or very thin (less than 2 cm).

FST Cladinosa on S1. In the sites induced by forest fires more than 20 years ago and in the case of moderate recreation, without pollution by nitrogen oxides, in the ML lichens of Cladonia spp. or Cetraria islandica predominate. Arctostaphylos uva-ursi, Carex ericetorum in the HL are differential species of the FST. Lichen-rich pine forests occur in the surroundings of the town of Sestroretsk. In case of strong recreational digression, open sand with rare Calamagrostis epigeios around pine trees was met. In 1925 in the pine forest “Sosnovka” were vast areas with abundant Calluna vulgaris and lichens (Vasilyev, Gae, 1928). Nowadays low grasses (FST Festuco ovinae on S1) form the HL cover there.

FST Vaccinioea on S1. In forest areas slightly transformed by human activities or urban environment, cowberry (Vaccinium vitis-idaea), or heather (Calluna vulgaris) predominate in the HL and the forest mesic mosses (Pleuroziunm schreberi, Dicranum spp.) predominate in ML. In 1925, this type prevailed on sandy soils of “Sosnovka” forestry (Vasiliev, Gae, 1928). We found this type only on sand dunes in the surroundings of Sestroretsk town. It prevailed on the lacustrine-glacial deposits in the surroundings of Suldalskiye Lakes (“Ozerki”) up to 1950. Nowadays in “Sosnovka” and “Ozerki” areas, this type was replaced by Festuco ovinae FST and in a case of strong recreational digression; it was replaced by open sand with sparse herbs and grasses (mainly Calamagrostis epigeios).

FST Festuco ovinae on sand S1. The diagnostic species are low grasses (Agrostis capillaris, Anthoxanthum odoratum, Festuca ovina) that predominate in HL. In admixture, species of dry-herb group are met (Achillea millefolium, Antennaria dioica, Hieracium umbellatum, Leontodon autumnalis, Pilosella officinarum).
3.3.6. Class of drained peatlands. The class includes the four FST differing in peat fertility and similar in moisture (W: 72–78) maintained by artificial drainage.

FST Fruticoloso-turfosa on ODP includes extremely oligotrophic sites (RS: 2–3) with pine forests of IV–V bonitet classes with Empetrum nigrum, Ledum palustre, Vaccinium vitis-idaea as dominants in HL and Pleurozium schreberi, Dicranum sp.sp. predominating in ML.

FST Vaccinioso-turfosa on ODP unites oligotrophic sites (RS: 3–4) with pine forests of II–III bonitet classes where Vaccinium myrtillus and V. vitis-idaea predominate and Ledum palustre, Pleurozium schreberi are common in HL.

FST Myrtilloso-turfosa on MDP includes oligo-mesotrophic sites (RS: 4–5) where spruce of II–III bonitet classes can predominate potentially. In HL Vaccinium myrtillus predominates. Dryopteris carthusiana, Equisetum sylvaticum, Gymnocarpium dryopteris, Lycopodium annotinum, Vaccinium vitis-idaea are constant. In ML Hylocomium splendens, Pleurozium schreberi are abundant. Pine and birch forests with tree stands of II bonitet class are common.

FST Oxalidoso-turfosa on MDP unites mesotrophic sites (RS: 6–7) where spruce of I–II bonitet classes can predominate potentially. Dominants of HL are Dryopteris expansa and/or Oxalis acetosella. Pine and birch forests with tree stands of I–II bonitet classes are common.

FST Herbosso-turfosa on EDP unites black alder, birch, and potentially spruce forests of I–Ia bonitet classes on fertile peat soils (RS 8–13) with Aegopodium podagraria, Athyrium filix-femina, Filipendula ulmaria, and Urtica dioica as dominants in HL. Angelica sylvestris, Anthriscus sylvestris, Dryopteris expansa, Cirsium oleraceum, C. heterophyllum, Impatiens noli-tangere are constant.

3.3.7. Class of maritime psammophyte forest sites. FST Leymosa arenaria on CS. Forests of this type occur on the coastal sands of the Neva Bay including the Kotlin Island. They are induced by storm waves, tides and flooding due to Atlantic cyclonic winds in autumn. Periodic sediments of sand bury the existing HL and ML, and sand transportation by wind and waves are common for these sites. The diagnostic species are maritime psammophytes: Calamagrostis epigeios subsp. meiushausenii, Cackile baltica, Honckenia peploides, Lathyrus maritimus, Leymus arenarius. Tree stands are of IV–V bonitet classes with the predominance of Alnus glutinosa, Padus avium, Populus tremula, Salix fragilis, S. triandra, S. pentandra. Soils are sandy multilayered with buried organic horizons poor with humus and slightly saline. The salinity of Neva Bay waters is low and (0.10 g/L).

4. Conclusions
The fourteen forestland types, united into 2 divisions, 9 classes, and 25 FST were distinguished. Their diagnostic features were established using the indicator groups of species and soil properties. FST unite forests and open sites (cuttings, burned areas, lawns, and open stands) that have similar ecological properties controlling productivity, sustainability, and tree regeneration of the certain tree species. FST we subdivided into series using the dominant species of HL. Series of sites indicate growing conditions of arboreal vegetation, species diversity, anthropogenic impact, and aesthetic properties. Urban forest typology can be used for management of urban vegetation, selection of tree species composition for the certain sites, for melioration projects, and tree regeneration monitoring. Natural and semi–natural forest site types usually correspond to the forest types that were distinguished early [15].

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