

Kimhwa-gun, entering South Korea after it crosses the Military Demarcation Line. Sediment carried by the river accumulates upstream of Yongyang Weir, which is believed to have led to the formation of lacustrine wetlands (National Institute of Ecology (NIE), 2019).

Several survey studies on forests have focused on the distribution of plants throughout the DMZ, starting with a study on the distribution of *Pinus densiflora* Siebold & Zucc. (Lee, 1968; Moon, 2019). Recent studies have been conducted in Gwangchiryeong, Yang-gu (Heo *et al.*, 2017) and Daedeukbong Peak, Cheolwon-gun (An *et al.*, 2018). In terms of wetland studies, some studies have been conducted on the flora in the Hak Reservoir, which is connected to the Hantangang River water system in the region bordering the DMZ (Shin *et al.*, 2015).

In this study, we performed a floristic survey of Yongyangbo Wetlands in the CCZ under circumstances that ecological surveys, including floristic surveys, were limited by restricted access to the region. This is necessary for military reasons. It is also necessary due to local characteristics such as the presence of mines scattered around the area (Oh *et al.*, 2009). Through this survey, we ascertained the distribution of endangered wild plant habitats and the distribution of naturalized plants that might threaten the ecosystem. Results of our survey can be used as basic data to support the conservation of wetland ecosystems in the CCZ and for the management of Yongyangbo Wetlands, which have been designated as wetland protected areas.

Materials and Methods

Survey area

In terms of administrative districts, Yongyangbo Wetlands bridge Yongyang-ri and Amjeong-ri in Kimhwa-eup, Cheolwon-gun, Gangwon-do, and South Korea. Specifically, it is a region between 37°12'08"N and 37°14'00"N, 127°42'48"E, and 127°44'22"E (Fig. 1). The survey area was about 0.77 km² with an average altitude of 227.7m and an average slope of 2.8°. According to data from the Cheolwon Weather Station, over the last 30 years (1989–2018), the mean annual air temperature was 10.25°C and the mean annual precipitation was 1,381.14 mm in the Yongyangbo Wetlands as a whole, which was similar to the mean annual precipitation across South Korea. Approximately 72.5% of the total annual precipitation occurs in summer (June to September), showing typical rainfall characteristics of a temperate monsoon region, with large differences in precipitation between seasons (NIE, 2019).

Survey method

A field survey of five sessions was conducted between April and August 2019 in accordance with the National Wetland Survey Protocol (ME, 2011). The survey was conducted on foot, covering the entire Yongyangbo Wetlands. Identification and classification were performed as described by Lee (1996a), Lee (1999), and Park (2009). Scientific and Korean names were assigned in accordance with the National List of Species of Korea (National Institute of Biological Resources (NIBR), 2020). Plant lists



Fig. 1. Map of the survey area in Yongyangbo Wetlands.

were grouped by taxonomic ranks of family and below and arranged in alphabetical order. Based on plants identified in the survey, life-forms (Lee, 1996b), endemic plants (Chung *et al.*, 2017), floristic target species (NIE, 2018), and rare plants (Korea National Arboretum (KNA), 2008) were summarized. Naturalized plants were investigated as described by Lee *et al.* (2011) and Ryu *et al.* (2017). Floristic richness (Kim & Lee, 2006) was analyzed to investigate the biodiversity of plants in the survey. To ascertain the degree of wetland disturbance, disturbance index (Benabdelmoumene *et al.*, 2014) and naturalization index (Numata, 1975) were calculated.

Results and Discussion

Flora of vascular plants

The flora observed at Yongyangbo Wetlands consisted of a total of 248 taxa, 72 families, 163 genera, 230 species, 4 subspecies, and 14 varieties. There were 4 taxa of Pteridophyta (4 families, 4 genera, 4 species), 1 taxon of Pinophyta (1 family, 1 genus, 1 species), and 243 taxa of Magnoliophyta (67 families, 158 genera, 164 species, 4 subspecies, 14 varieties; Table 1, Supplementary Table 1), corresponding to approximately 5.4% of 4,596 vascular plant taxa found in the Korean Peninsula (NIBR, 2020). The most commonly observed families in order of descending richness were Poaceae (26 taxa, 10.5%), Asteraceae (25 taxa, 10.1%), Cyperaceae (17 taxa, 6.9%), and Fabaceae (17 taxa, 6.9%; Table 2). The floristic diversity of Yongyangbo Wetlands was 1.52, higher than that of Hak Reservoir near the DMZ in Cheolwon (1.38, Shin *et al.*, 2015) but lower than that of Daedeukbong Peak (1.59, An *et al.*, 2018). Floristic diversity was calculated as the species-to-genera ratio, with a larger value indicating more diverse genera containing a broader spectrum of species (Kim & Lee, 2006).

Table 1. Number of vascular plants in Yongyangbo Wetlands

Taxa	Fam.	Gen.	Sp.	Subsp.	Var.	For.	Total
Pteridophyta	4	4	4	-	-	-	4
(Polypodiopsida)	(3)	(3)	(3)	-	-	-	(3)
(Equisetopsida)	(1)	(1)	(1)	-	-	-	(1)
Pinophyta	1	1	1	-	-	-	1
(Pinopsida)	(1)	(1)	(1)	-	-	-	(1)
Magnoliophyta	67	158	225	4	14	-	243
(Magnoliopsida)	(55)	(124)	(164)	(4)	(13)	-	(181)
(Liliopsida)	(12)	(34)	(61)	-	(1)	-	(62)
Total	72	163	230	4	14	-	248

Table 2. Family compositions of vascular plants in Yongyangbo Wetlands

Family	No. of taxa	Ratio (%)
Poaceae	26	10.5
Asteraceae	25	10.1
Cyperaceae	17	6.9
Fabaceae	17	6.9
Polygonaceae	12	4.9
Brassicaceae	12	4.9
Rosaceae	11	4.5
Apiaceae	10	4.1
Caryophyllaceae	7	2.8
Lamiaceae	6	2.4
Liliaceae	6	2.4
Salicaceae	6	2.4
Others (60 families)	93	37.2
Total	248	100.0

Life-forms

Raunkiaer dormancy forms of the 248 taxa in the survey area were analyzed. The dormancy form with the highest richness was therophytes (Th) in 73 taxa (29.4%), followed by hemicryptophytes (H) in 64 taxa (25.8%), geophytes (G) in 35 taxa (14.1%), and helophytes (HH) and nanophanerophytes (N) in 17 taxa (6.9%; Table 3). Montane wetlands tend to show a high abundance of hemicryptophytes (Kim *et al.*, 2011; Ko *et al.*, 2014), while riverine wetlands such as Yongyangbo Wetlands are at low altitudes and surrounded by farmland, roads, and other facilities, resulting in the appearance of a large number of therophytes, including naturalized plants. The disturbance index at Yongyangbo Wetlands was 33.8%, indicating a more stable habitat than orchards (47.0%, Kim *et al.*, 2019) or fields (55.0%, Kim *et al.*, 2015) known to undergo continual human management. It is also a more stable habitat than Hak Reservoir, which is a lacustrine wetland in the DMZ (38.2%, Shin *et al.*, 2015).

The most commonly observed radicle form was R_5 (147 taxa, 59.3%) (a non-clonal form, such as *Erigeron annuus* (L.) Pers., *Setaria pumila* (Poir.) Roem. & Schult., or *Inula britannica* var. *japonica* (Thunb.) Franch. & Sav), followed by R_3 (49 taxa, 19.7%) that showed short-branching rhizomes and clonal growth over a narrow range, such as *Eragrostis ferruginea* (Thunb.) P. Beauv. or *Aster incisus* Fisch. (Table 4). Among disseminule forms, clitochores (D_4 , 129 taxa, 52.0%) was the most common, followed by anemochore or hydrochore (D_1 , 44 taxa, 17.8%) (for which seeds

are carried on wind or water) and zoochore (D_3 , 24 taxa, 9.7%) (for which seeds are carried by sticking to animals or humans) (Table 5). Among growth forms as a way to categorize the state of growth and morphology of aerial parts, the erect form (73 taxa, 29.4%) was the most common, followed by the tussock form (t, 40 taxa, 16.1%)

and the pseudo-rosette form (ps, 27 taxa, 10.9%; Table 6). Thus, life forms of plants in Yongyangbo Wetlands could be Th-R₅-D₄-e. This is a life-form composition similar to that of plants in orchards and fields, but different from the life-form composition of H-R₅-D₄-e generally observed for forest plants (Kang *et al.*, 2006).

Table 3. Dormancy form of vascular plants in Yongyangbo Wetlands

Dormancy form*	Perennial							Annual			
	Ch	E	G	H	HH	M	MM	N	HH _(Th, Thw)	Th	Th _(w)
No. of taxa	11	1	35	64	17	16	14	17	6	32	35
Ratio (%)	4.4	0.4	14.1	25.8	6.9	6.5	5.6	6.9	2.4	12.9	14.1

*Ch, chamaephyte; G, geophyte; H, hemicryptophyte; HH, hydatophyte; M, microphanerophyte; MM, megaphanerophyte; N, nanophanerophyte; Th, therophyte (summer annual); Th(w): therophyte (winter annual).

Table 4. Radicoid form of vascular plants in Yongyangbo Wetlands

Radicoid form*	R ₁₋₂	R ₂₋₃	R _{2-3(b)}	R ₃	R _{3(b)}	R _{3(o)}	R _{3(s)}	R _{3(v)}	R ₄	R ₅	R _{5(b)}	R _{5(o)}	R _{5(s)}	R ₅	R _(v)
No. of taxa	1	29	1	38	2	1	2	6	18	141	1	1	4	2	1
Ratio (%)	0.4	11.7	0.4	15.3	0.8	0.4	0.8	2.4	7.3	56.9	0.4	0.4	1.6	0.8	0.4

*R₁ : widest extent of rhizomatous growth; R₂ : moderate extent of rhizomatous growth; R₃ : narrowest extent of rhizomatous growth; R₄ : clonal growth by stolons and struck roots; R₅ : non-clonal growth; R₁₋₂ : plants with rhizomatous mutation of R₁ and R₂ ; R₂₋₃ : plants with rhizomatous mutation of R₂ and R₃ , R_(b) : Bulb, R_(c) : Corm, R_(o) , oblique type, R_(s) : succulent type, R_(v) : vertical type.

Table 5. Disseminule form of vascular plants in Yongyangbo Wetlands

Disseminule form*	D ₁	D _{1,4}	D ₂	D _{2,4}	D ₃	D _{3,2}	D ₄	D _{4,1}	D _{4,2}	D _{5,4}
No. of taxa	44	9	24	10	24	1	129	4	1	2
Ratio (%)	17.8	3.6	9.7	4.0	9.7	0.4	52.0	1.6	0.4	0.8

*D₁: widely disseminated by wind or water; D₂: disseminated attachment with or eaten by animals and humans; D₃: disseminated by mechanical propulsion of dehiscence of fruits; D₄: no special modification for dissemination; D₅: not producing seeds; D_{1,4}: plants with D₁ and D₄ , D_{2,4}: plants with D₂ and D₄ , D_{3,2}: plants with D₃ and D₂ , D_{4,1}: plants with D₄ and D₁ , D_{4,2}: plants with D₄ and D₂ , D_{5,4}: plants with D₅ and D₄.

Table 6. Growth form of vascular plants in Yongyangbo Wetlands

Growth form*	b	b,e	b-l	b-p	b-ps	e	e,b	l	l-b	p	p-b	p-e	p-l	p-ps	pr	ps	ps-b	r	t	t-p
No. of taxa	16	1	6	4	3	73	12	21	3	2	1	1	1	4	15	27	2	13	40	3
Ratio (%)	6.5	0.4	2.4	1.6	1.2	29.4	4.8	8.5	1.2	0.8	0.4	0.4	0.4	1.6	6.1	10.9	0.8	5.3	16.1	1.2

*b: branched form; e: erect form; l: liana form; p: procumbent form; pr: partial-rosette form; ps: pseudo-rosette form; r: rosette form; t: tussock form, b,e: b form and/or e form, b-l: b form with liana stem, b-p: b form with procumbent stem, b-ps: b form with pseudo-rosette, e,b: e form and/or b form, l-b: l form with branched form, p-b: p form with branched form, p-e: p form with e form, p-l: p form with liana form, p-ps: p form with pseudo-rosette, ps-b: ps form with branched form, t-p: t form with procumbent stem.



Fig. 2. Rare plants in Yongyangbo Wetlands. A. *Silene capitata* Kom., endangered species Class II; B. *Polygonatum stenophyllum* Maxim., endangered species; C. *Aristolochia contorta* Bunge, least concern.

Rare and endemic plants

Rare plants are native plants that require special protection because of their decreasing population sizes or habitats. Three taxa of rare plants were observed in Yongyangbo Wetlands: *Silene capitata* Kom., *Polygonatum stenophyllum* Maxim. (both of which are classified as endangered species), and *Aristolochia contorta* Bunge (Classified as a species of least concern) (Fig. 2). Of these, *S. capitata* has been designated by the Ministry of Environment as a Class II endangered wildlife. Forty individuals were observed on roadside cliffs at three points. A relatively large distribution of *A. contorta* was observed near the farmland and edges of the wetlands.

Because Yongyangbo Wetlands are located in the CCZ, it is not a region that can be freely accessed by civilians. However, it can be accessed by tourists who submit an application. The endangered plant *S. capitata* is located on rocks behind an exploration zone made of wooden decking. Therefore, there is a risk of destruction due to the approach of tourists. To protect *S. capitata*, it is necessary to take active measures to prevent its destruction, such as installing signposts or a fence to restrict access.

Endemic plants are native plants that are only found in South Korea. *Salix koriyanagi* Kimura ex Goerz was the only endemic plant taxon observed in the survey area. This species was observed on flat sands of the river terrace where waterways meet upstream of Yongyangbo Wetlands. *Salix purpurea* var. *smithiana* Trautv. and *S. koriyanagi* were co-dominant. They formed a unique vegetative landscape that characterized Yongyangbo Wetlands.

Floristic target species and naturalized plants

A total of 17 taxa of floristic target species were identified in Yongyangbo Wetlands. There was one Class V taxon (*S. capitata*), one Class IV taxon (*P. stenophyllum*), three Class III taxa (*Sinomenium acutum* (Thunb.) Rehder & E. H. Wilson, *Thalictrum rochebrunianum* Franch. & Sav., *S. purpurea* var. *smithiana*), five Class II taxa (*Alisma orientale*

(Sam.) Juz., *Alisma canaliculatum* A. Braun & C. D. Bouché, *Carex planiculmis* Kom., *Weigela florida* (Bunge) A. DC., *Mukdenia rossii* (Oliv.) Koidz.), and seven Class I taxa (*Adoxa moschatellina* L., *A. contorta*, *Impatiens nolitangere* L., *Deutzia uniflora* Shirai, *Salix chaenomeloides* Kimura, *Hemiptelea davidii*(Hance) Planch., *Ulmus davidiana* var. *japonica* (Rehder) Nakai; Table 7).

There were 26 taxa of naturalized plants observed in the survey area, including *Fallopia dumetorum* (L.) Holub, *Rumex crispus* L., *Chenopodium album* var. *spicatum* W. D. J. Koch, *Lepidium virginicum* L., *Thlaspi arvense* L., and *Potentilla supina* L. The naturalization index was 10.5%. Annual herbaceous plants (16 taxa) constituted the largest proportion of these, followed by perennial herbaceous plants (eight taxa) and woody plants (two taxa; Table 8). Most naturalized plants were observed near roads, where there were frequent human interferences. Three invasive alien species were observed: *Ambrosia trifida* L., *Ambrosia artemisiifolia* L., and *Humulus japonicus* Siebold & Zucc. Although only a small number of scattered individuals were observed owing to regular weeding, given that they must have entered from adjacent areas, changes in population sizes for these species need to be monitored continuously.

Conclusion and Suggestions

According to results of this study, a total of 248 taxa were identified in the Yongyangbo Wetlands during the survey, including 72 families and 163 genera. The most commonly observed families, in order of descending richness, were Poaceae, Asteraceae, Cyperaceae, and Fabaceae. Their life-forms were characterized by Th-R₅-D₄-e, a life-form composition similar to that of plants in orchards and fields. Three taxa of rare plants were observed, including *S. capitata* (a Class II endangered wildlife), 26 taxa of naturalized plants, and 3 taxa of invasive alien species. The disturbance index was 33.8%, indicating that the habitat

Table 7. Growth form of vascular plants in Yongyangbo Wetlands

Grade	Family	Scientific name
V	Caryophyllaceae	<i>Silene capitata</i> Kom.
IV	Liliaceae	<i>Polygonatum stenophyllum</i> Maxim.
III	Menispermaceae	<i>Sinomenium acutum</i> (Thunb.) Rehder & E. H. Wilson
	Ranunculaceae	<i>Thalictrum rochebrunianum</i> Franch. & Sav.
II	Salicaceae	<i>Salix purpurea</i> var. <i>smithiana</i> Trautv.
	Alismataceae	<i>Alisma orientale</i> (Sam.) Juz.
	Cyperaceae	<i>Alisma canaliculatum</i> A. Braun & C. D. Bouché
I	Diervillaceae	<i>Carex planiculmis</i> Kom.
	Saxifragaceae	<i>Weigela florida</i> (Bunge) A. DC.
	Adoxaceae	<i>Mukdenia rossii</i> (Oliv.) Koidz.
	Aristolochiaceae	<i>Adoxa moschatellina</i> L.
	Balsaminaceae	<i>Aristolochia contorta</i> Bunge
	Hydrangeaceae	<i>Impatiens nolitangere</i> L.
	Salicaceae	<i>Deutzia uniflora</i> Shirai
	Ulmaceae	<i>Salix chaenomeloides</i> Kimura
		<i>Hemiptelea davidii</i> (Hance) Planch.
		<i>Ulmus davidiana</i> var. <i>japonica</i> (Rehder) Nakai

Table 8. Naturalized plants in Yongyangbo Wetlands

Family	Scientific name	Dormancy form
Asteraceae	<i>Ambrosia trifida</i> L.*	Th
	<i>Ambrosia artemisiifolia</i> L.*	Th
	<i>Carduus crispus</i> L.	Th _(w)
	<i>Conyza canadensis</i> (L.) Cronquist	Th _(w)
	<i>Erigeron annuus</i> (L.) Pers.	Th _(w)
	<i>Galinsoga quadriradiata</i> Ruiz & Pav.	Th
	<i>Taraxacum officinale</i> F. H. Wigg.	H
Brassicaceae	<i>Lepidium virginicum</i> L.	Th _(w)
	<i>Thlaspi arvense</i> L.	Th _(w)
Chenopodiaceae	<i>Chenopodium album</i> var. <i>spicatum</i> W. D. J. Koch	Th
Convolvulaceae	<i>Ipomoea purpurea</i> (L.) Roth	Th
Euphorbiaceae	<i>Euphorbia maculata</i> L.	Th
Fabaceae	<i>Amorpha fruticosa</i> L.	N
	<i>Melilotus suaveolens</i> Ledeb.	Th _(w)
	<i>Robinia pseudoacacia</i> L.	MM
	<i>Trifolium pratense</i> L.	H
	<i>Trifolium repens</i> L.	Ch
Iridaceae	<i>Iris pseudacorus</i> L.	G
Onagraceae	<i>Oenothera biennis</i> L.	Th _(w)
Poaceae	<i>Bromus tectorum</i> L.	Th
	<i>Festuca arundinacea</i> Schreb.	H
	<i>Poa pratensis</i> L.	H
Polygonaceae	<i>Fallopia dumetorum</i> (L.) Holub	Th
	<i>Rumex crispus</i> L.	H
Rosaceae	<i>Potentilla supina</i> L.	CH
Scrophulariaceae	<i>Veronica americana</i> Schwein. ex Benth.	Th _(w)

* Invasive alien species. Abbreviations for dormancy forms are shown in Table 3.

was more stable than that of orchards or fields.

The Yongyangbo Wetlands have been designated as a protected wetland area because of their excellent natural-ity and integrity obtained through long-time preservation with high biodiversity based on various habitat environments. In particular, it is an area where genetic exchange with wildlife populations is possible as it is an ecological linkage channel with the northern area. The activation of eco-tourism will introduce economic vitality to the depressed local economy in the DMZ area. In order to maintain its functions and roles, systematic management of these wetlands is necessary because there is concern of threats to habitats of indigenous species and the distribution of alien species caused by disturbances to the environment from military units, farmers, visitors, and river facility management, *inter alia*.

Conflict of Interest

The authors declare that they have no competing interests.

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Supplementary Table 1. Vascular plants in Yongyangbo Wetlands

Family	Scientific name	A	B	C	D	E	F
Equisetaceae	<i>Equisetum arvense</i> L.	G	R ₂₋₃	D ₁	e		
Athyriaceae	<i>Athyrium niponicum</i> (Mett.) Hance	G	R ₂₋₃	D ₁	t		
Dryopteridaceae	<i>Polystichum tripterum</i> (Kunze) C. Presl	H	R _(w)	D ₁	t		
Thelypteridaceae	<i>Thelypteris palustris</i> (A. Gray) Schott	G	R ₂₋₃	D ₁	e		
Cupressaceae	<i>Metasequoia glyptostroboides</i> Hu & W. C. Cheng	MM	R ₅	D ₁	e		
Salicaceae	<i>Salix chaenomeloides</i> Kimura	MM	R ₅	D ₁	e		I
	<i>Salix gracilistyla</i> Miq.	N	R ₅	D ₁	b		
	<i>Salix pierotii</i> Miq.	MM	R ₅	D ₁	e		
	<i>Salix koriyanagi</i> Kimura ex Goerz***	N	R ₄	D ₁	b		
	<i>Salix purpurea</i> var. <i>smithiana</i> Trautv.	N	R ₅	D ₁	b		III
	<i>Salix triandra</i> subsp. <i>nipponica</i> (Franch. & Sav.) A.K. Skvortsov	M	R ₅	D ₁	e		
Fagaceae	<i>Castanea crenata</i> Siebold & Zucc.	MM	R ₅	D ₄	e		
	<i>Quercus mongolica</i> Fisch. ex Ledeb.	MM	R ₅	D ₄	e		
	<i>Quercus variabilis</i> Blume	MM	R ₅	D ₄	e		
Ulmaceae	<i>Hemiptelea davidii</i> (Hance) Planch.	MM	R ₅	D ₁	e		I
	<i>Ulmus davidiana</i> var. <i>japonica</i> (Rehder) Nakai	MM	R ₅	D ₁	e		I
	<i>Zelkova serrata</i> (Thunb.) Makino	MM	R ₅	D ₁	e		
Cannabaceae	<i>Humulus japonicus</i> Siebold & Zucc.	Th	R ₅	D ₄	l		
Moraceae	<i>Morus alba</i> L.	MM	R ₅	D ₂	e		
	<i>Morus bombycis</i> Koidz.	MM	R ₅	D ₂	e		
Urticaceae	<i>Pilea mongolica</i> Wedd.	Th	R ₅	D ₄	e		
Polygonaceae	<i>Aconogonon alpinum</i> (All.) Schkuhr	H	R ₂₋₃	D ₄	e		
Polygonaceae	<i>Fallopia dumetorum</i> (L.) Holub	TH	R ₅	D ₄	l	○	
	<i>Persicaria hastatosagittata</i> (Makino) Nakai ex T. Mori	HH _(Th)	R ₄	D _{4,1}	b-l		
	<i>Persicaria hydropiper</i> (L.) Delarbre	HH _(Th)	R ₄	D _{4,1}	e,b		
	<i>Persicaria lapathifolia</i> (L.) Delarbre	Th	R ₅	D ₄	e,b		
	<i>Persicaria perfoliata</i> (L.) H. Gross	Th	R ₅	D ₄	b-l		
	<i>Persicaria senticosa</i> (Meisn.) H. Gross ex Nakai	Th	R ₅	D ₄	b-l		
	<i>Persicaria thunbergii</i> (Siebold & Zucc.) H. Gross	HH _(Th)	R ₄	D _{4,1}	b-p		
	<i>Polygonum aviculare</i> L.	Th	R ₅	D ₄	b,e		
	<i>Rumex acetosa</i> L.	H	R ₅	D ₄	ps		
	<i>Rumex conglomeratus</i> Murray	H	R ₅	D ₄	ps		
	<i>Rumex crispus</i> L.	H	R ₅	D ₄	ps	○	
Caryophyllaceae	<i>Arenaria serpyllifolia</i> L.	Th _(w)	R ₅	D ₄	b		
	<i>Cerastium fontanum</i> subsp. <i>vulgare</i> (Hartm.) Greuter & Burdet	H	R ₅	D ₄	b		
	<i>Pseudostellaria heterophylla</i> (Miq.) Pax	H	R _(s)	D ₄	b		
	<i>Sagina japonica</i> (Sw.) Ohwi EN	Th _(w)	R ₅	D ₄	b		
	<i>Silene capitata</i> Kom. ** EN	H	R ₅	D ₄	b		V
	<i>Stellaria alsine</i> var. <i>undulata</i> (Thunb.) Ohwi	Th _(w)	R ₅	D ₄	b		
	<i>Stellaria aquatica</i> (L.) Scop.	Th _(w)	R ₅	D ₄	b		
Chenopodiaceae	<i>Chenopodium album</i> var. <i>spicatum</i> W. D. J. Koch	Th	R ₅	D ₄	e,b	○	
	<i>Chenopodium album</i> L.	Th	R ₅	D ₄	e		
Amaranthaceae	<i>Achyranthes bidentata</i> var. <i>japonica</i> Miq.	H	R ₅	D ₂	e		
Lauraceae	<i>Lindera obtusiloba</i> Blume	N	R ₅	D ₂	e		
Ranunculaceae	<i>Clematis apiifolia</i> DC.	N	R ₄	D ₁	l		
	<i>Ranunculus japonicus</i> Thunb.	H	R ₅	D ₄	ps		
	<i>Thalictrum aquilegifolium</i> var. <i>sibiricum</i> Regel & Tiling	G	R ₅	D ₄	ps		
	<i>Thalictrum minus</i> var. <i>hypoleucum</i> (Siebold & Zucc.) Miq.	G	R ₅	D ₄	e		
	<i>Thalictrum rochebrunianum</i> Franch. & Sav.	G	R ₅	D ₄	e		III
Menispermaceae	<i>Menispermum dauricum</i> DC.	N	R ₂₋₃	D ₁	l		
	<i>Sinomenium acutum</i> (Thunb.) Rehder & E. H. WilsonLC	N	R ₂₋₃	D ₁	l		III
Aristolochiaceae	<i>Aristolochia contorta</i> Bunge	H	R ₅	D ₁	l		I
Actinidiaceae	<i>Actinidia arguta</i> (Siebold & Zucc.) Planch. ex Miq.	M	R ₅	D ₁	l		
Clusiaceae	<i>Hypericum ascyron</i> L.	H	R ₅	D ₃	e		
	<i>Hypericum erectum</i> Thunb.	H	R ₃	D ₄	e		

Family	Scientific name	A	B	C	D	E	F
Papaveraceae	<i>Chelidonium majus</i> var. <i>asiaticum</i> (H. Hara) Ohwi	Th _(w)	R ₅	D _{4,2}	e		
Fumariaceae	<i>Corydalis speciosa</i> Maxim.	Th _(w)	R ₅	D ₃	b		
	<i>Corydalis remota</i> Fisch. ex Maxim.	G	R _(s)	D ₃	ps		
Brassicaceae	<i>Arabis glabra</i> (L.) Bernh.	Th _(w)	R ₅	D ₄	pr		
	<i>Barbarea orthoceras</i> Ledeb.	HH _(Thw)	R ₅	D ₄	pr		
	<i>Capsella bursa-pastoris</i> (L.) Medik.	TH _(w)	R ₅	D ₄	ps		
	<i>Cardamine flexuosa</i> With.	TH _(w)	R ₅	D ₃	ps		
	<i>Cardamine fallax</i> (O. E. Schulz) Nakai	TH _(w)	R ₅	D ₃	ps		
	<i>Cardamine impatiens</i> L.	HH _(Thw)	R ₆	D ₄	ps		
	<i>Cardamine leucantha</i> (Tausch) O. E. Schulz	H	R ₃	D ₄	e		
	<i>Draba nemorosa</i> L.	Th _(w)	R ₅	D ₄	ps		
	<i>Lepidium virginicum</i> L.	Th _(w)	R ₅	D ₄	ps	○	
	<i>Rorippa indica</i> (L.) Hiern	Th _(w)	R ₅	D ₄	pr		
	<i>Rorippa palustris</i> (L.) Besser	Th _(w)	R ₅	D ₄	ps		
	<i>Thlaspi arvense</i> L.	Th _(w)	R ₅	D ₄	pr	○	
Crassulaceae	<i>Sedum kamschaticum</i> Fisch. & C. A. Mey.	H	R ₃	D ₄	b		
	<i>Sedum sarmentosum</i> Bunge	H	R ₄	D ₄	b-p		
Hydrangeaceae	<i>Deutzia uniflora</i> Shirai	N	R ₃	D ₄	e,b		I
Saxifragaceae	<i>Mukdenia rossii</i> (Oliv.) Koidz.	E	R ₄	D ₄	r		II
Rosaceae	<i>Crataegus pinnatifida</i> Bunge	M	R ₅	D ₂	e		
	<i>Duchesnea indica</i> (Andr.) Focke	Ch	R ₄	D ₂	p-ps		
	<i>Potentilla kleiniana</i> Wight & Arn.	Ch	R ₅	D ₄	p-ps		
	<i>Potentilla supina</i> L.	Ch	R ₅	D ₄	b-ps	○	
	<i>Prunus japonica</i> var. <i>nakaii</i> (H. Lev.) Rehder	N	R ₅	D ₂	e,b		
	<i>Prunus padus</i> L.	MM	R ₅	D ₂	e		
	<i>Prunus persica</i> (L.) Batsch	M	R ₅	D ₂	e		
	<i>Rosa multiflora</i> Thunb.	N	R ₃	D ₂	e		
	<i>Rubus crataegifolius</i> Bunge	N	R ₅	D ₂	e		
	<i>Rubus parvifolius</i> L.	N	R ₅	D ₂	p-l		
	<i>Spiraea prunifolia</i> var. <i>simpliciflora</i> (Nakai) Nakai	N	R ₅	D ₄	e,b		
Fabaceae	<i>Amorpha fruticosa</i> L.	N	R ₅	D ₄	e	○	
	<i>Amphicarpea bracteata</i> subsp. <i>edgeworthii</i> (Benth.) H. Ohashi	Th	R ₅	D ₃	l-b		
	<i>Kummerowia stipulacea</i> (Maxim.) Makino	Th	R ₅	D ₃	e,b		
	<i>Kummerowia striata</i> (Thunb.) Schindl.	Th	R ₅	D ₄	e,b		
	<i>Lathyrus davidii</i> Hance	G	R ₅	D ₃	e,b		
	<i>Lespedeza bicolor</i> Turcz.	N	R ₅	D ₄	e		
	<i>Lespedeza cuneata</i> (Dum. Cours.) G. Don.	H	R ₅	D ₄	b		
	<i>Melilotus suaveolens</i> Ledeb.	Th _(w)	R ₅	D ₄	b	○	
	<i>Pueraria lobata</i> (Willd.) Ohwi	Ch	R ₅	D ₄	l-b		
	<i>Robinia pseudoacacia</i> L.	MM	R ₅	D ₃	e	○	
	<i>Sophora flavescens</i> Aiton	G	R ₃	D ₄	e,b		
	<i>Trifolium pratense</i> L.	H	R ₅	D ₄	e,b	○	
	<i>Trifolium repens</i> L.	Ch	R ₄	D ₄	p	○	
	<i>Vicia amoena</i> Fisch. ex Ser.	G	R _{2,3}	D ₃	l		
	<i>Vicia amurensis</i> Oett.	G	R ₅	D ₃	l		
	<i>Vicia unijuga</i> A. Braun	G	R ₃	D ₃	e		
	<i>Vigna angularis</i> var. <i>nipponensis</i> (Ohwi) Ohwi & H. Ohashi	Th	R ₅	D ₃	l		
Oxalidaceae	<i>Oxalis corniculata</i> L.	Ch	R ₄	D _{3,2}	p-b		
Geraniaceae	<i>Geranium sibiricum</i> L.	H	R ₅	D ₃	psb		
	<i>Geranium thunbergii</i> Siebold ex Lindl. & Paxton	H	R ₅	D ₃	psb		
Euphorbiaceae	<i>Acalypha australis</i> L.	Th	R ₅	D ₃	e		
	<i>Euphorbia maculata</i> L.	Th	R ₅	D ₃	b-p	○	
	<i>Flueggea suffruticosa</i> (Pall.) Baill.	M	R ₅	D ₄	e		
Anacardiaceae	<i>Rhus javanica</i> L.	M	R ₅	D ₄	e		

Family	Scientific name	A	B	C	D	E	F
Aceraceae	<i>Acer tataricum</i> subsp. <i>ginnala</i> (Maxim.) Wesm.	M	R ₅	D ₁	e		
Balsaminaceae	<i>Impatiens nolitangere</i> L.	Th	R ₄	D ₃	e		I
	<i>Impatiens textori</i> Miq.	Th	R ₄	D ₃	e		
Celastraceae	<i>Celastrus flagellaris</i> Rupr.	M	R ₅	D _{2,4}	l		
	<i>Celastrus orbiculatus</i> Thunb.	M	R ₅	D _{2,4}	l		
Staphyleaceae	<i>Staphylea bumalda</i> DC.	M	R ₅	D ₄	e		
Vitaceae	<i>Parthenocissus tricuspidata</i> (Siebold & Zucc.) Planch.	M	R ₅	D _{2,4}	l		
Onagraceae	<i>Oenothera biennis</i> L.	Th _(w)	R ₅	D _{4,1}	pr	○	
Haloragaceae	<i>Myriophyllum spicatum</i> L.	HH	R _{2,3}	D ₁	e		
Violaceae	<i>Viola lactiflora</i> Nakai	H	R _{3(v)}	D ₃	r		
	<i>Viola mandshurica</i> W. Becker	H	R _{3(v)}	D ₃	r		
	<i>Viola verecunda</i> A. Gray	H	R _{3(v)}	D ₃	b-ps		
Cucurbitaceae	<i>Trichosanthes kirilowii</i> Maxim.	G	R _{5(o)}	D _{2,4}	l		
Cornaceae	<i>Cornus controversa</i> Hemsl.	MM	R ₅	D _{2,4}	e		
	<i>Cornus kousa</i> F. Buerger ex Miq.	M	R ₅	D _{2,4}	e		
Araliaceae	<i>Aralia elata</i> (Miq.) Seem.	M	R ₅	D _{2,4}	e		
Apiaceae	<i>Angelica cartilaginosmarginata</i> (Makino ex Y. Yabe) Nakai	G	R _{3(s)}	D ₄	ps		
	<i>Angelica dahurica</i> (Fisch. ex Hoffm.) Benth. & Hook. f. ex Franch. & Sav.	G	R _{5(s)}	D ₄	ps		
	<i>Angelica amurensis</i> Schischk.	G	R ₃	D ₄	ps		
	<i>Anthriscus sylvestris</i> (L.) Hoffm.	H	R _{5(s)}	D ₄	ps		
	<i>Oenanthe javanica</i> (Blume) DC.	HH	R ₄	D _{1,4}	p-ps		
	<i>Ostericum grosseserratum</i> (Maxim.) Kitag.	H	R ₃	D ₄	ps		
	<i>Peucedanum terebinthaceum</i> (Fisch. ex Trevir.) Ledeb.	H	R ₅	D ₄	ps		
	<i>Pimpinella brachycarpa</i> (Kom.) Nakai	G	R ₃	D ₄	ps		
	<i>Sium suave</i> Walter	HH	R ₅	D ₄	ps		
	<i>Torilis japonica</i> (Houtt.) DC.	Th _(w)	R ₅	D ₂	ps		
Oleaceae	<i>Ligustrum obtusifolium</i> Siebold & Zucc.	M	R ₅	D ₂	e		
Asclepiadaceae	<i>Metaplexis japonica</i> (Thunb.) Makino	G	R _{2,3}	D ₁	l		
Rubiaceae	<i>Galium maximowiczii</i> (Kom.) Pobed.	H	R ₅	D ₂	e		
	<i>Galium spurium</i> L.	Th _(w)	R ₅	D ₂	b-l		
	<i>Rubia argyi</i> (H. Lev. & Vaniot) H. Hara ex Lauener & D.K. Ferguson	G	R ₃	D ₂	b-l		
	<i>Rubia cordifolia</i> L.	G	R ₃	D ₂	b-l		
Polemoniaceae	<i>Phlox subulata</i> L.	H	R _{2,3}	D ₄	e,b		
Convolvulaceae	<i>Calystegia hederacea</i> Wall.	G	R _{2,3}	D _{5,4}	l		
	<i>Calystegia pubescens</i> Lindl.	G	R _{2,3}	D _{5,4}	l		
	<i>Ipomoea purpurea</i> (L.) Roth	Th	R ₅	D ₄	l	○	
Boraginaceae	<i>Trigonotis peduncularis</i> (Trevir.) Steven ex Palib.	Th _(w)	R ₅	D ₄	b		
Lamiaceae	<i>Clinopodium micranthum</i> (Regel) H. Hara	H	R ₅	D ₄	b		
	<i>Isodon inflexus</i> (Thunb.) Kud	G	R ₃	D ₄	e		
	<i>Leonurus japonicus</i> Houtt.	Th _(w)	R ₅	D ₄	pr		
	<i>Lycopus lucidus</i> Turcz. ex Benth.	HH	R _{2,3}	D ₄	e		
	<i>Salvia plebeia</i> R. Br.	Th _(w)	R ₅	D ₄	ps		
	<i>Teucrium japonicum</i> Houtt.	H	R _{2,3}	D ₄	e		
Scrophulariaceae	<i>Mazus pumilus</i> (Burm. f.) Steenis	Th _(w)	R ₅	D ₄	b-ps		
	<i>Veronica americana</i> Schwein. ex Benth.	Th _(w)	R ₅	D ₄	e	○	
Phrymaceae	<i>Phryma leptostachya</i> var. <i>oblongifolia</i> (Koidz.) Honda	G	R ₃	D ₂	e		
Plantaginaceae	<i>Plantago asiatica</i> L.	H	R _{3(o)}	D _{2,4}	r		
Caprifoliaceae	<i>Lonicera japonica</i> Thunb.	M	R ₃	D _{2,4}	l-b		
Adoxaceae	<i>Adoxa moschatellina</i> L.	H	R ₃	D ₄	ps		I
	<i>Sambucus williamsii</i> Hance	M	R ₅	D ₂	e		
Diervillaceae	<i>Weigela florida</i> (Bunge) A. DC.	N	R ₅	D ₄	e		II
Campanulaceae	<i>Lobelia chinensis</i> Lour.	H	R ₄	D ₄	p-e		
Asteraceae	<i>Ambrosia artemisiifolia</i> L.*	Th	R ₅	D ₄	e	○	

Family	Scientific name	A	B	C	D	E	F
	<i>Ambrosia trifida</i> L.*	Th	R ₅	D ₄	e	○	
	<i>Artemisia annua</i> L.	Th	R ₅	D ₄	e		
	<i>Artemisia capillaris</i> Thunb.	H	R ₃	D ₄	e		
	<i>Artemisia codonocephala</i> Diels	H	R _{2,3}	D ₄	e		
	<i>Artemisia lancea</i> Vaniot	H	R _{2,3}	D ₄	e		
	<i>Artemisia montana</i> (Nakai) Pamp.	Ch	R _{2,3}	D ₄	pr		
	<i>Artemisia indica</i> Willd.	Ch	R _{2,3}	D ₄	pr		
	<i>Artemisia selengensis</i> Turcz. ex Besser	H	R _{2,3}	D ₄	e		
	<i>Aster tataricus</i> L. f.	H	R ₃	D ₁	e		
	<i>Aster incisus</i> Fisch.	Ch	R ₃	D ₄	pr		
	<i>Aster yomena</i> (Kitam.) Honda	Ch	R ₃	D ₄	pr		
	<i>Carduus crispus</i> L.	Th _(w)	R ₅	D ₁	pr	○	
	<i>Conyza canadensis</i> (L.) Cronquist	Th _(w)	R ₅	D ₁	pr	○	
	<i>Crepidiastrum sonchifolium</i> (Bunge) Pak & Kawano	Th _(w)	R ₅	D ₁	ps		
	<i>Erigeron annuus</i> (L.) Pers.	Th _(w)	R ₅	D ₁	pr	○	
	<i>Galinsoga quadriradiata</i> Ruiz & Pav.	Th	R ₅	D ₄	e	○	
	<i>Hemistepta lyrata</i> Bunge	Th _(w)	R ₅	D ₁	pr		
	<i>Inula britannica</i> var. <i>japonica</i> (Thunb.) Franch. & Sav.	G	R ₅	D ₁	e		
	<i>Ixeris polycephala</i> Cass.	H	R ₅	D ₁	e		
	<i>Ixeris stolonifera</i> A. Gray	CH	R ₄	D ₁	p-ps		
	<i>Lactuca indica</i> L.	Th, Th _(w)	R ₅	D ₁	pr		
	<i>Taraxacum coreanum</i> Nakai	H	R _{3(v)}	D ₁	r		
	<i>Taraxacum officinale</i> F. H. Wigg.	H	R _{3(v)}	D ₁	r	○	
	<i>Taraxacum platycarpum</i> Dahlst.	H	R _{3(v)}	D ₁	r		
Alismataceae	<i>Alisma canaliculatum</i> A. Braun & C. D. Bouché	HH	R ₅	D ₁	r		II
	<i>Alisma orientale</i> (Sam.) Juz.	HH	R ₅	D ₁	r		II
Hydrocharitaceae	<i>Hydrilla verticillata</i> (L. f.) Royle	HH	R ₅	D ₁	e		
Potamogetonaceae	<i>Potamogeton pusillus</i> L.	HH	R ₅	D ₁	e		
Liliaceae	<i>Allium macrostemon</i> Bunge	G	R _{3(b)}	D ₄	r		
	<i>Allium monanthum</i> Maxim.	G	R _{2-3(b)}	D ₄	r		
	<i>Allium sacculiferum</i> Maxim.	G	R _{3(b)}	D ₄	r		
	<i>Hosta longipes</i> (Franch. & Sav.) Matsum.	H	R ₅	D ₄	r		
	<i>Polygonatum stenophyllum</i> Maxim.	G	R ₃	D _{2,4}	e		IV
	<i>Barnardia japonica</i> (Thunb.) Schult. & Schult. f.	G	R _{5(b)}	D ₄	t		
Smilacaceae	<i>Smilax nipponica</i> Miq.	G	R ₅	D ₂	e		
	<i>Smilax sieboldii</i> Miq.	N	R ₅	D ₂	l		
Dioscoreaceae	<i>Dioscorea polystachya</i> Turcz.	G	R _{5(s)}	D ₁	l		
	<i>Dioscorea nipponica</i> Makino	G	R _{3(s)}	D ₁	l		
Iridaceae	<i>Iris pseudacorus</i> L.	G	R ₃	D ₃	ps	○	
	<i>Iris sanguinea</i> Donn ex Hornem.	G	R ₃	D ₃	ps		
Juncaceae	<i>Juncus decipiens</i> (Buchenau) Nakai	HH	R ₃	D _{1,4}	t		
Commelinaceae	<i>Commelina communis</i> L.	Th	R ₅	D ₄	b-p		
Poaceae	<i>Elymus ciliaris</i> (Trin.) Tzvelev	Th _(w)	R ₅	D ₄	t		
	<i>Elymus tsukushiensis</i> Honda	Th _(w)	R ₅	D ₄	t		
	<i>Alopecurus aequalis</i> Sobol.	Th _(w)	R ₅	D _{1,4}	t		
	<i>Bromus japonicus</i> Thunb.	Th	R ₅	D ₄	t		
	<i>Bromus tectorum</i> L.	Th	R ₅	D ₄	t	○	
	<i>Digitaria ciliaris</i> (Retz.) Koeler	Th	R ₄	D ₄	t-p		
	<i>Spodiopogon cotulifer</i> (Thunb.) Hack.	H	R ₃	D _{1,4}	t		
	<i>Echinochloa crus-galli</i> (L.) P. Beauv.	HH _(Th)	R ₅	D ₄	t-p		
	<i>Eleusine indica</i> (L.) Gaertn.	Th	R ₅	D ₄	t		
	<i>Eragrostis ferruginea</i> (Thunb.) P. Beauv.	H	R ₃	D ₄	t		
	<i>Festuca arundinacea</i> Schreb.	H	R ₅	D ₁	t	○	
	<i>Miscanthus sacchariflorus</i> (Maxim.) Hack.	H	R ₂₋₃	D ₄	t		
	<i>Muhlenbergia huegelii</i> Trin.	H	R ₃	D ₁	t-p		
	<i>Oplismenus undulatifolius</i> (Ard.) Roem. & Schult.	H	R ₄	D ₄	p		
	<i>Phalaris arundinacea</i> L.	HH	R ₂₋₃	D ₂	e		

Family	Scientific name	A	B	C	D	E	F
	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	HH	R _{1,2}	D ₁	e		
	<i>Phragmites japonica</i> Steud.	HH	R ₄	D ₁	e		
	<i>Poa annua</i> L.	Th _(w)	R ₅	D ₄	t		
	<i>Poa hisauchii</i> Honda	Th _(w)	R ₅	D ₄	t		
	<i>Poa pratensis</i> L.	H	R _{2,3}	D ₄	t	○	
	<i>Poa sphondyloides</i> Trin.	H	R ₅	D ₄	t		
	<i>Setaria faberi</i> R. A. W. Herrm.	Th	R ₅	D ₄	t		
	<i>Setaria pumila</i> (Poir.) Roem. & Schult.	Th	R ₅	D ₄	t		
	<i>Setaria viridis</i> (L.) P. Beauv.	Th	R ₅	D ₄	t		
	<i>Spodipogon sibiricus</i> Trin.	H	R ₃	D ₄	e		
	<i>Trisetum bifidum</i> (Thunb.) Ohwi	H	R ₃	D ₄	t		
Typhaceae	<i>Typha orientalis</i> C. Presl.	HH	R _{2,3}	D _{1,4}	t		
Cyperaceae	<i>Carex breviculmis</i> R. Br.	H	R ₃	D ₄	t		
	<i>Carex dimorpholepis</i> Steud.	H	R ₃	D ₄	t		
	<i>Carex forficula</i> Franch. & Sav.	H	R ₃	D ₄	t		
	<i>Carex heterolepis</i> Bunge	H	R _{2,3}	D ₄	t		
	<i>Carex japonica</i> Thunb.	H	R _{2,3}	D ₄	t		
	<i>Carex laevissima</i> Nakai	H	R ₃	D ₄	t		
	<i>Carex lanceolata</i> Boott	H	R ₃	D ₄	t		
	<i>Carex leiorhyncha</i> C. A. Mey.	H	R ₃	D ₄	t		
	<i>Carex maackii</i> Maxim.	H	R ₃	D ₄	t		
	<i>Carex miyabei</i> Franch.	HH	R _{2,3}	D ₄	t		
	<i>Carex neurocarpa</i> Maxim.	H	R ₃	D ₄	t		
	<i>Carex planiculmis</i> Kom.	H	R _{2,3}	D ₄	t		II
	<i>Cyperus amuricus</i> Maxim.	Th	R ₅	D ₄	t		
	<i>Cyperus iria</i> L.	Th	R ₅	D ₄	t		
	<i>Eleocharis valleculosa</i> var. <i>setosa</i> Ohwi	HH	R ₅	D _{1,4}	t		
	<i>Eleocharis ussuriensis</i> G. Zinserl.	HH	R _{2,3}	D _{1,4}	t		
	<i>Scirpus radicans</i> Schkuhr	HH	R _{2,3}	D _{1,4}	t		

* Invasive alien species, ** endangered species Class II, ***endemic plant, EN: rare plants classified as endangered species, LC: rare plants classified as least concern, A: dormancy form, B: radicaid form, C: disseminule form, D: growth form, E: naturalized plant, F: grade of floristic target species. Abbreviations for life forms (A~D) are shown in Tables 3~6.