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INVENTORY AND ASSESSMENT OF FLOWERING PLANTS IN THE SANOBHARYANG AREA OF KATHMANDU, NEPAL

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ABSTRACT

Documentation of flowering plants was carried out in the Sanobharyang area of Kathmandu, Nepal by direct observation method. Altogether 158 species of flowering plants with 138 genera and 60 families were recorded. Among these families Asteraceae had the highest number of species while 29 families had only one species each. Out of the total, 84 (52%) species were native and 74 (48%) species were non native including 10 (6%) invasive alien plant species. This study shows that a significant number of flowering plants can be conserved by maintaining the open spaces in the public places, roadsides and home gardens even in the densely populated part of the city.

Key words: *Documentation, Family Asteraceae, Invasive Alien Plant Species, Homegarden*

Introduction

The flora of a particular geographical area represents the patterns and structure of taxa that are unique for that particular area (Cloete, 2004). There are a variety of patterns along the environmental gradient as a result of the resources availability and variability having a significant impact on the pattern and structure of species diversity (Pausas *et al.*, 2001). Nepal is a Himalayan nation with a diverse range of climate and physiography as well as a rich biodiversity. The lowland to alpine region has different plant diversity due to its great diversity: Nepal's plant life accounts for about 3.2% of all known plant life of the world (GoN/MoFSC, 2014). Nepal is a tiny nation that covers just about 0.1% of the world's land surface area and Nepal ranks 10th in terms of richest flowering plant diversity in Asia and 31st in the world (Shrestha, 2016). About 118 different types of ecosystems have been found in different physiographic zones of Nepal including 52 and 53 in the mid hills and high lands respectively (GoN/MoFSC, 2002). The latest data shows that in Nepal at least 6973 species of flowering plants are recorded (Groombridge and Jenkins, 2002). When collections of herbarium specimens were made at the start of the 19th century, botanical exploration of Nepal was launched within a constrained

area in the most diverse physiographic region of the world. In 1802-1803, Buchanan-Hamilton became the first botanist to investigate the variety of plants from Makawanpur to Kathmandu, including Thankot, Nagarjun and Swyambhu. Wallich, 1820–1821 and Hooker, 1848 followed in his footsteps. The first flora of Nepal, known as Prodromus florae Nepalensis, was published in 1825 by D. Don and included 766 species. Following Nepal's opening of its borders to foreign explorers and mountaineers in the early 1950s, botanical explorations became more widespread and intense. As a result of hundreds of botanical expeditions conducted throughout the country and thousands of plant specimens are being housed in a number of international herbaria in UK, Japan, USA, France, Switzerland and India and so on (Rajbhandari, 1976). Plant systematic study is accomplished by acquiring, analyzing and synthesizing information about plants and their parts. Such could contribute fundamental information to the flora and also adds more knowledge on the status of studied taxa of any country. Making conservation strategies and policies is greatly aided by knowledge of the floral diversity of a given area, which can reflect the total resources, their use, and their conservation status. Documenting every species of plant in a specific geographic area is known as a floral study (Simpson, 2010). The nation is home to a rich diversity of flora and fauna that can be found anywhere from the dense tropical monsoon forest of the Terai to the deciduous and coniferous forests of the subtropical and temperate regions and finally to the subalpine and alpine pastures and snow-covered Himalayan peaks (Chaudhary, 1998). Therefore this research work was conducted with the aim of documenting the flowering plant species in the public places, roadsides and home gardens of core urban areas.

Material and Methods

Study area

We conducted this study in Nagarjun Municipality of Kathmandu districts located to the Northwest of Kathmandu Metropolitan city which was formed in 2014 consisting of ten wards. Geographically this Municipality ranges from 85.12° N to 85.17° N latitude and 27.40° E to 27.44° E longitude as well as altitude ranges from 1300 m to 2500 m asl. (Nagarjun Municipality) (Figure 1). Out of ten wards one no. ward was selected for the study area which is near to the ring road and includes some popular places such as: Radhkrishna Temple, Nepalese Army Institute of Health Sciences, Sanobharang, and some Buddhist Monastery.

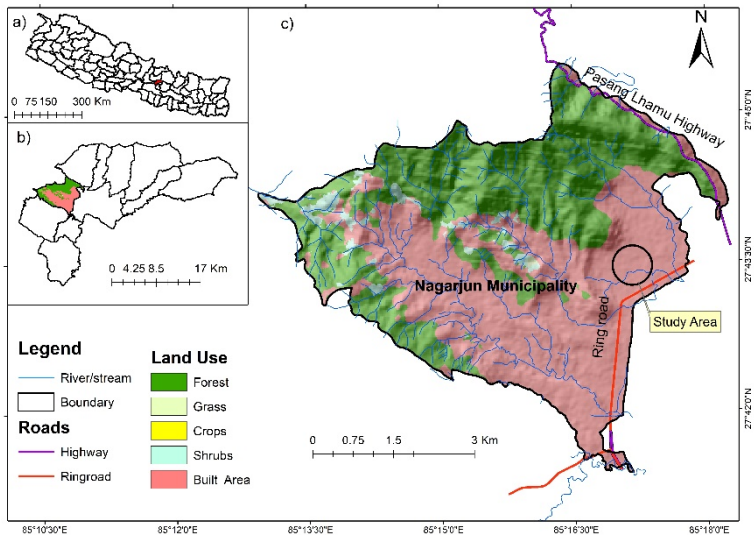

Figure 1. Map of the study area showing the sampling location within the Nagarjun Municipality, Sanobharyang, encompassing the Kathmandu district in central Nepal.

Plant collection and identification

The flowering plants of the study area were enumerated in the different seasons of the year 2023 through frequent field visit by direct observation. The plant species were photographed and herbarium was collected. The plant specimens were identified with the help of different relevant literatures (such as Polunin and Stainton, 1984; Stainton, 1988; Malla *et al.*, 1986; Shrestha, 1998; Press *et al.*, 2000). Plant status was categorized into native, non native and on the basis of geographical distribution through (Press *et al.*, 2000; Shrestha *et al.*, 2022; www.powo.science.kew.org). For the nomenclature of plant species APG III www.theplantlist.org was followed.

Data management and Data analysis

The collected vegetation data was managed in Microsoft excel. Confirmed plant species were categorized based on the family, distribution range and origin. All calculations and creation of graphs and diagrams such as pie charts and bar graphs were done in Microsoft Excel version 2010.

Result and Discussion

A total of 158 species of flowering plants were recorded in the study area, representing 136 genera and 60 families. In terms of life forms, herbaceous species were the most abundant, with 93 species (59%) (Annex 1). They were followed by trees with 30 species (19%), shrubs with 29 species (18%), and climbers with 6 species (4%) (Figure 2.).

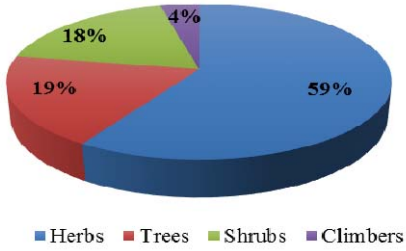

Figure 2. Percentage contribution of different life forms of flowering plants in the study area.

In accordance with families, the Asteraceae family had the highest number of species with 20 spp. which is followed by Poaceae with 14 spp., Fabaceae with 11 spp., Euphorbiaceae, Lamiaceae and Rutaceae with 5 spp. (Figure 3). Similarly, 5 families had 4 spp., 9 families had 3 spp., 11 families had 2 spp. and 29 families had 1 spp. The study area is rich in non-native ornamental and fruit plants such as *Psidium guajava, Persea americana, Punica granatum, Magnifera indica* and some medicinal plants like *Centella asiatica, Aloe vera, Azadirachta indica, Cassia fistula, Cinnamum tamala.*

In the similar study Bhattari, (2019) reported 229 species in Singha Durbar premises of Kathmandu Nepal. The slightly low number of species found in our study might be due to the population density, smaller open spaces. This study suggests that urban climatic conditions and population density highly affects the plant diversity of local areas. Garden management system and preference of plants and their availability also affects the plant diversity of the home gardens and other human managed public places (Bhattari and Pun, 2022).

Table 1

Total Families representing the number of plant species

S.N	Families	No. of species	S.N	Families	No. of species	S.N	Families	No. of species
1	Acanthaceae	3	21	Crassulaceae	1	41	Onagraceae	1
2	Adoxaceae	1	22	Cupressaceae	1	42	Oxalidaceae	2
3	Amaranthaceae	3	23	Cycadaceae	1	43	Passifloraceae	1
4	Amarylldaceae	2	24	Cyperaceae	2	44	Phyllanthaceae	2
5	Anacardiaceae	1	25	Elaeocarpaceae	1	45	Pinaceae	1
6	Apiaceae	1	26	**Euphorbiaceae**	**5**	46	Plantaginaceae	3
7	Apocynaceae	3	27	**Fabaceae**	**11**	47	**Poaceae**	**14**
8	Araucariaceae	1	28	Geraniaceae	1	48	Polygonaceae	4
9	Asparagaceae	2	29	**Lamiaceae**	**5**	49	Primulaceae	1
10	Asphodelaceae	1	30	Lauraceae	3	50	Ranunculaceae	2
11	**Asteraceae**	**20**	31	Linaceae	1	51	Rosaceae	3
12	Balsaminaceae	1	32	Lythraceae	2	52	Rubiaceae	1
13	Bigoniaceae	1	33	Magnoliaceae	1	53	**Rutaceae**	**5**
14	Boraginaceae	1	34	Malvaceae	1	54	Salicaceae	1
15	Brassicaceae	4	35	Mazaceae	1	55	Sapindaceae	1
16	Cactaceae	1	36	Meliaceae	2	56	Scrophulariaceae	2
17	Cannabaceae	2	37	Moraceae	3	57	Solanaceae	4
18	Cannaceae	1	38	Myrtaceae	3	58	Strelitziaceae	1
19	Commelinaceae	4	39	Nyctaginaceae	3	59	Urticaeae	1
20	Convolvulaceae	4	40	Oleaceae	1	60	Verbenaceae	2

Among the non native species: 20 species were recorded as native to North America, 20 species from South America. Similarly 9 from Asia except Nepal, 9 species from Africa, 4 from Europe and the rest of them 12 were recorded as other regions because they were cultivated worldwide (Figure 3). Due to globalization plant species are introduced from different parts of the world, the common mode of their introduction are transportation, tourism, ornamentation and international trade (Karki and Paudel, 2013). Among the land use types, residential areas, roadside and agroecosytems are the mostly affected areas by non-native (invasive alien) plant species (McDougall *et al.*, 2011). The most common invasive alien plants of the study area are *Ageratina adenophora, Alternanthera philoxeroides, Bidens pilosa, Lantana camara, Oxalis latifolia*. In their study Bajracharya *et al.*, (1997) reported that 90% were non native and only 10 % were native in different gardens of Kathmandu valley.

Table 2. Invasive alien plant species found in the study area

SN.	Name of species	Habit	Families	Distribution range
1	*Ageratum houstonianum* Mill.	H	Asteraceae	Native to Mexico and Pantropical weed.
2	*Ageratina adenophora* (Spreng) King & H.Rob.	H	Asteraceae	Native to Mexico
3	*Alternanthera philoxeroid es* (Mart.) Griseb.	H	Amaranthaceae	Native of Brazil, introduced in many tropical countries
4	*Bidens pilosa* L.	H	Asteraceae	Native to America and exotic to Asia, Europe, Eurasia, Africa, Australia.
5	*Erigeron karvinskianus* Dc.	H	Asteraceae	Native to Mexico, Central America, Columbia, Venezuela.
6	*Galinsoga quadriradiata* Ruiz & Pav.	H	Asteraceae	A cosmopolitan weed, native of Mexico.
7	*Lantana camara* L.	S	Verbenaceae	Native of America, widely naturalized in Nepal, India and other parts of Asia.
8	*Oxalis latifolia* Kunths	H	Oxalidaceae	Native to C. & S. America; naturalized in S. Europe, India, Malaysia.
9	*Parthenium hysterophorus* L.	H	Asteraceae	A pantropical weed, native of America
10	*Senna occidentalis* (L.) Link	S	Fabaceae	Native to the southern United States of America, Mexico and South America.

H = Herbs and S = Shrubs

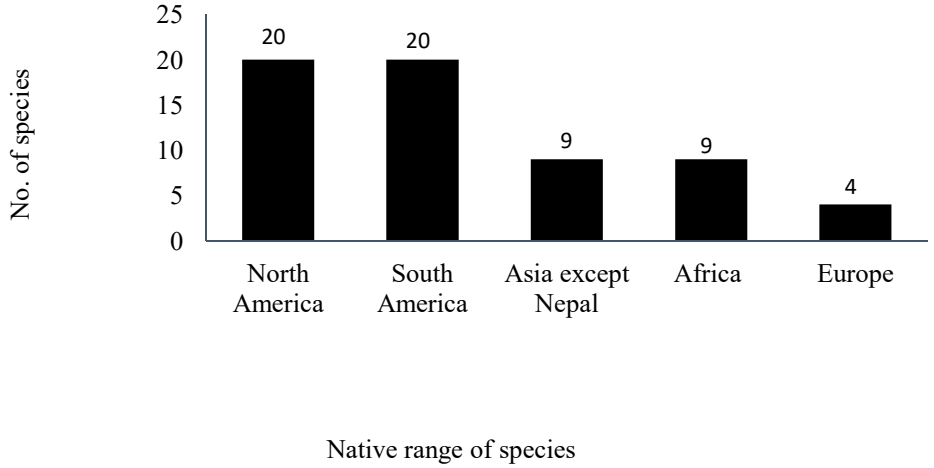

Figure 3 Origin and native range of non native plant species.

Conclusions

The Sanobharyang area of the Kathmandu district is rich in both native and non-native plant species. Home gardens and managed public places are abundant in non-native garden plants particularly ornamental and fruit varieties whereas natural habitats such as forest patches and meadows are rich in native plant species. However, these natural habitats are also being invaded by invasive alien plant species.

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Annex 1. Checklist of the flowering plants of the study area.

Name of species	Habitats	Families	Plant status
Achyranthes bidentata Bl.	H	Amaranthaceae	Native
Acmella uliginosa (Sw.) Cass.	H	Asteraceae	Non native
Ageratina adenophora (Spreng) King & H.Rob.	H	Asteraceae	Non native*
Ageratum houstonianum Mill.	H	Asteraceae	Non native*
Albizia lucidior (Steud.) I. C. Nielsen	T	Fabaceae	Native
Aloe vera (L.) Burm. fil.	H	Asphodelaceae	Non native
Alternanthera philoxeroides (Mart.) Griseb.	H	Amaranthaceae	Non native*
Amaranthus lividus L.	H	Amaranthaceae	Non native
Anagallis arvensis L.	H	Primulaceae	Native
Antirrhinum majus L.	H	Plantaginaceae	Non native
Araucaria columnaris (J. R. Forst.) Hook.	S	Araucariaceae	Non native
Artemisia indica Willd.	S	Asteraceae	Native
Axonopus compressus (Sw.) P. Beauv.	H	Poaceae	Non native
Azadirachta indica A. Juss.	T	Meliaceae	Native
Bidens pilosa L.	H	Asteraceae	Non native*
Blumea aromatica Wall. ex DC.	H	Asteraceae	Native
Boehmeria virgata var. macrostachya (Wight) Friis & Wilmot-Dear	S	Urticaeae	Native
Boerhavia diffusa L.	H	Nyctaginaceae	Native
Bougainvillea glabra Choisy	S	Nyctaginaceae	Non native
Brassica oleracea L.	H	Brassicaceae	Non native
Brassica rapa subsp. *oleifera* (DC.) Metzg.	H	Brassicaceae	Non native
Buddleja asiatica Lour.	S	Scrophulariaceae	Native
Caesalpinia decapetala (Roth) Alston	S	Fabaceae	Native
Calendula officinalis L.	H	Asteraceae	Non native
Callistemon citrinus var. citrinus Skeels	T	Myrtaceae	Non native
Calotropis gigantea (L.) W. T. Aiton	S	Apocynaceae	Native
Canna indica L.	H	Cannaceae	Native
Cannabis sativa L.	S	Cannabaceae	Non native
Capillipedium assimile (Steud.) A. Camus	H	Poaceae	Native
Cassia fistula L.	T	Fabaceae	Native
Catharanthus roseus (L.) G. Don	S	Apocynaceae	Non native
Cedrus deodara (Lamb.) G. Don	T	Pinaceae	Native
Celtis australis L.	T	Cannabaceae	Native
Cenchrus americanus (L.) Morrone	H	Poaceae	Non native
Centella asiatica (L.) Urb.	H	Apiaceae	Native
Crassocephalum crepidioides (Benth.) S.Moore	H	Asteraceae	Non native
Cinnamomum camphora (L.) J. Presl	T	Lauraceae	Non native
Cinnamomum tamala (Buch.-Ham.) T. Nees & Nees	T	Lauraceae	Native
Citrus aurantiifolia (Christm.) Swingle	T	Rutaceae	Native
Citrus grandis (L.) Osbeck	T	Rutaceae	Native
Citrus limon (L.) Burm. fil.	T	Rutaceae	Native
Citrus reticulata Blanco	T	Rutaceae	Native
Clematis acuminata DC.	C	Ranunculaceae	Native
Clematis buchananiana DC.	C	Ranunculaceae	Native
Coleus scutellarioides (L.) Benth.	H	Lamiaceae	Native
Commelina benghalensis L.	H	Commelinaceae	Native
Crotalaria prostrata Willd.	H	Fabaceae	Native
Cuscuta reflexa Roxb.	C	Convolvulaceae	Native
Cyanthillium cinereum (L.) H. Rob.	H	Asteraceae	Native
Cycas revoluta Thunb.	H	Cycadaceae	Native
Cymbopogon winterianus Jowitt ex Bor	H	Poaceae	Native
Cynodon dactylon (L.) Pers.	H	Poaceae	Native
Cynoglossum lanceolatum Forskál	H	Boraginaceae	Native

Cyperus rotundus L.	H	Cyperaceae	Native
Dalbergia sissoo DC.	T	Fabaceae	Native
Datura stramonium L.	S	Solanaceae	Non native
Desmodium laxiflorum DC.	H	Fabaceae	Native
Desmodium heterocarpon (L.) DC.	H	Fabaceae	Native
Duranta erecta L.	S	Verbenaceae	Non native
Eclipta prostrata (L.) L.	H	Asteraceae	Non native
Erigeron karvinskianus Dc.	H	Asteraceae	Non native*
Elaeocarpus angustifolius Bl.	T	Elaeocarpaceae	Native
Eleusine indica (L.) Gaertn.	H	Poaceae	Native
Emilia sonchifolia (L.) DC.	H	Asteraceae	Native
Eragrostis amabilis (L.) Wight & Arn.	H	Poaceae	Native
Eschenbachia japonica (Thunb.) J. Kost.	H	Asteraceae	Native
Euphorbia hirta L.	H	Euphorbiaceae	Non native
Euphorbia milii Des Moul.	S	Euphorbiaceae	Non native
Euphorbia heterophylla L.	H	Euphorbiaceae	Non native
Euphorbia pulcherrima Willd. ex Klotzsch	S	Euphorbiaceae	Non native
Evolvulus nummularius (L.) L.	H	Convolvulaceae	Non native
Fagopyrum acutatum (Lehm.) Mansf. ex K. Hammer	H	Polygonaceae	Native
Ficus benghalensis L.	T	Moraceae	Native
Ficus benjamina L.	T	Moraceae	Native
Fimbristylis fimbristyloides (F. Muell.) Druce	H	Cyperaceae	Native
Galinsoga quadriradiata Ruiz & Pav.	H	Asteraceae	Non native*
Gardenia jasminoides J. Ellis	S	Rubiaceae	Non native
Gazania rigens (L.) Gaertn.	H	Asteraceae	Non native
Geranium nepalense Sweet	H	Geraniaceae	Native
Glebionis coronaria (L.) N. N. Tzvel.	H	Asteraceae	Non native
Gomphrena globosa L.	H	Asteraceae	Non native
Hippeastrum vittatum (L'Hér.) Herb.	H	Amarylldaceae	Non native
Holmskioldia sanguinea Retz.	S	Lamiaceae	Native
Impatiens walleriana Hook. fil.	H	Balsaminaceae	Non native
Imperata cylindrica (L.) P. Beauv.	H	Poaceae	Native
Ipomoea purpurea (L.) Roth	C	Convolvulaceae	Non native
Ipomoea quamoclit L.	C	Convolvulaceae	Non native
Jacaranda mimosifolia D. Don	T	Bigoniaceae	Non native
Juniperus chinensis L.	S	Cupressaceae	Native
Justicia carnea Lindl.	H	Acanthaceae	Native
Justicia pectinata L.	H	Acanthaceae	Native
Justicia procumbens L.	H	Acanthaceae	Native
Kalanchoe pinnata (Lam.) Pers.	H	Crassulaceae	Non native
Lagerstroemia parviflora Roxb.	T	Lythraceae	Native
Lantana camara L.	S	Verbenaceae	Non native*
Lindernia ciliata (Colsm.) Pennell	H	Scrophulariaceae	Native
Liriope muscari (Decne.) L. H. Bailey	H	Asparagaceae	Non native
Litchi chinensis (Gaertn.) Sonn.	T	Sapindaceae	Non native
Magnolia grandiflora L.	T	Magnoliaceae	Non native
Mangifera indica L.	T	Anacardiaceae	Non native
Matthiola incana (L.) W. T. Aiton	H	Brassicaceae	Non native
Mazus pumilus (Burm. fil.) Steenis	H	Mazaceae	Native
Melia azedarach L.	T	Meliaceae	Native
Mirabilis jalapa L.	H	Nyctaginaceae	Non native
Mimosa rubicaulis Lam.	H	Fabaceae	Native
Morus alba L.	T	Moraceae	Native
Murdannia nudiflora (L.) Brenan	H	Commelinaceae	Native
Murraya koenigii (L.) Spreng.	S	Rutaceae	Native
Nerium indicum Mill.	S	Apocynaceae	Non native
Nyctanthes arbor-tristis L.	S	Oleaceae	Native

Ocimum tenuiflorum L.	H	Lamiaceae	Native
Oenothera grandiflora L'Her	H	Onagraceae	Non native
Oplismenus burmannii (Retz.) P. Beauv.	H	Poaceae	Native
Opuntia monacantha (Willd.) Haw.	S	Cactaceae	Non native
Oxalis corniculata L.	H	Oxalidaceae	Non native
Oxalis latifolia Kunths	H	Oxalidaceae	Non native*
Parthenium hysterophorus L.	H	Asteraceae	Non native*
Passiflora caerulea L.	C	Passifloraceae	Non native
Paspalum distichum L.	H	Poaceae	Non native
Persea americana Mill.	T	Lauraceae	Non native
Prunus persica (L.) Batsch.	T	Rosaceae	Native
Persicaria capitata (Buch.-Ham. ex D. Don) H. Gross	H	Polygonaceae	Native
Persicaria minor (Hudson) Opiz	H	Polygonaceae	Native
Phyllanthus emblica L.	T	Phyllanthaceae	Native
Phyllanthus niruri L.	H	Phyllanthaceae	Native
Plantago major L.	H	Plantaginaceae	Native
Petunia atkinsiana (L.) Franco	H	Solanaceae	Non native
Poa annua L.	H	Poaceae	Native
Prunus cerasoides D. Don	T	Rosaceae	Native
Psidium guajava L.	T	Myrtaceae	Non native
Punica granatum L.	S	Lythraceae	Non native
Reinwardtia indica Dumort.	S	Linaceae	Native
Ricinus communis L.	S	Euphorbiaceae	Non native
Rorippa dubia (Pers.) H. Hara	H	Brassicaceae	Native
Rosa chinensis Jacquin	S	Malvaceae	Non native
Rubus ellipticus Smith	S	Rosaceae	Native
Rumex nepalensis Spreng.	H	Polygonaceae	Native
Salix babylonica L.	T	Salicaceae	Native
Salvia coccinea Buc'hoz ex Etl.	H	Lamiaceae	Non native
Salvia splendens Sellow ex Nees	H	Lamiaceae	Non native
Sambucus chinensis Lindl.	S	Adoxaceae	Native
Senna occidentalis (L.) Link	S	Fabaceae	Non native*
Solanum nigrum L.	H	Solanaceae	Native
Strelitzia reginae Banks	H	Strelitziaceae	Non native
Syzygium cumini (L.) Skeels	T	Myrtaceae	Native
Tagetes erecta L.	H	Asteraceae	Non native
Thysanolaena latifolia (Roxb. ex Hornem.) Honda	H	Poaceae	Native
Tradescantia pallida (Rose) D. R. Hunt	H	Commelinaceae	Non native
Tradescantia zebrina (Schinz) D. R. Hunt	H	Commelinaceae	Non native
Tridax procumbens L.	H	Asteraceae	Non native
Trifolium repens L.	H	Fabaceae	Non native
Triticum aestivum L.	H	Poaceae	Non native
Vernonia cinerea (L.) Less.	H	Asteraceae	Native
Veronica javanica Bl.	H	Plantaginaceae	Native
Yucca gloriosa L.	S	Asparagaceae	Non native
Zephyranthes candida (Lindl.) Herb.	H	Amarylldaceae	Non native
Zinnia elegans Jacq.	H	Asteraceae	Non native
Zornia gibbosa Span.	H	Fabaceae	Native

H = Herbs, S = Shrubs T = Tree, C = Climber, Non native* = Invasive alien plant species.