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MARSHLAND AND AQUATIC PLANTS OF THE ARTIFICIAL WETLAND WITHIN THE MUNICIPAL PARK IN SKAWINA

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Summary

Observations of aquatic plants and marshland plants were conducted in an artificially formed fen, within the old basin of Skawinka river, in a municipal park located in the southwest part of Skawina town. The area selected for the study was determined based on the location of plant stands, representative for the whole body of water. Based on the analysis of the locations where the aquatic and marshland plants occurred, observations were made of selected species. When making the selection, we were guided by the criterion of the potential suitability of using these plants in garden plantings, planned subsequently. We have marked the locations of particular plant communities, and then applied them on the situational and altitude map, in the scale of 1 : 500 [Czarnota 1997], which is the basis for the design and planting in the area.

Keywords

town park • aquatic plants • design

1. Introduction

Water is not only the most important factor in the growth and development of organisms, but also – for thousands of years – it has provided a compositional element used by man to shape his environment and the constantly changing landscape around us. On the banks of reservoirs, trees of interesting shapes are planted, whose branches, reflecting in the water mirror, further enhance the effect intended by the designer. Currently, according to the prevailing fashion, more and more reservoirs are formed so as to mimic the natural environment. The selection of available plant species is very broad, both in terms of plant size and the colour and shape of leaves and flowers. However, they should be chosen carefully and skilfully, so that not only would they provide the undeniable embellishment, but also cause no major difficulties in their subsequent care. Therefore, when choosing plantings, we recommend domestic species and varieties. Exotic plants are not only troublesome to grow, but also cannot withstand the conditions of our climate, and often in spite of diligent care, they die from the frost.

The true beauty of the water garden does not lie in its fancy, sophisticated form, but in its simplicity and closeness to nature. Observation of nature and wildlife is a source of valuable tips and information on how to look after and skilfully take care of these plants.

Water is associated with garden composition from the earliest times. Bogusławska and Wilkaniec [2003] report that in ancient gardens, we encounter geometric pools in open residential interiors, we find wells, fountains and water channels. The authors also recall that in medieval rectangular cloisters, a centrally located well, fountain or pond served as lavabo-the place ritual washing in the pursuit of eternal purity, and that water often had a symbolic meaning. Water as a compositional element has acquired a distinctly poetic expression in medieval Arab gardens.

Included in the regular form of ponds, fountains and canals, water surface would reflect the colours of the sky and the surroundings, and its gentle movement under the influence of wind or water droplets falling from the fountain played a key part in the garden's compositional whole [Bogusławska and Wilkaniec 2003]. In the Italian Renaissance era, decorative forms of water flourished, fountains were decorated with complex sculptural elements, and framed in architectural compositions, often well over ten meters in height. "Water art" was characteristic of this period, consisting in systems or devices with an element of a surprise: fun but tricky, and sometimes even pernicious to the passer-by. In baroque gardens, water played an even greater role, becoming an essential element of the garden composition: canals, pools and water parterres marked its main axes.

The romantic garden abandoned geometric forms in an attempt to achieve the natural effect. There were stylized streams, springs, ponds and waterfalls referring to wild nature in their character. At the same time, the Far East perfected the art of shaping the gardens, where water symbolized freedom and harmony in nature. These elements were visible especially in the Japanese gardens. Recently, the style and symbolism of Japanese and Chinese gardens finds more and more supporters among plant lovers. Water in oriental gardens represents simplicity and naturalness, but what is most characteristic about it is the perfection in the selection of plants and decorative elements. Among them we find stone lanterns, bamboo compositions and furniture, stones of different shapes and colours, bridges, fancifully raked gravel and sand, and finally the beautiful specimens of koi and subtle vegetation, with only slightly moulded shapes.

Wide choice of various plans and shapes of water gardens makes it possible to create "mini water landscapes". There are two basic styles of reservoirs, and the right choice depends largely on the location. A formal reservoir has well-defined boundaries, and either a geometric (square, elongated, rectangular, round) or a gently curved shape. Usually it remains separated from the other elements of the garden, and is often the focal point. In the case of an informal reservoir, the outline is not strictly defined – it is possible to combine it with other elements of the garden, for example, a rock garden or a waterfall. The coastline is irregular because the reservoir is supposed to look like a natural watercourse. For the latter purpose, coastal plants are used, which mask the edges of the water basin.

Kłosowscy [2001] report that aquatic plants can be divided into three subgroups:

- Plants floating freely on the surface of the water or under the surface (for instance, lesser duckweed – *Lemna minor* L., common bladderwort – *Utricularia vulgaris* L. or floating fern – *Salvinia natans*);
- Rooted to the bottom and completely submerged, with only the flowers or inflorescences floating above the water surface (for instance some species of water-milfoil such as whorleaf water-millfoil – *Myriophylletum verticillatum*, some species of water-crowfoot such as thread-leaved water-crowfoot – *Ranunculus trichophyllus* and many kinds of pondweed, for instance perfoliate pondweed – *Potamogeton perfoliatus* L.);
- Rooted to the bottom and submerged in most part, but with some of their organs such as upper shoots and some leaves floating to or above the water surface, for instance nuphars (Figure 1), water lilies (*Nymphaea alba*) (Figure 2), floating-leaf pondweed – *Potamogeton natans* or water soldiers – *Stratiotes aloides* L.).

Photo by Z. Koziara

Fig. 1. Yellow water-lily (*Nuphar lutea*)

According to the aforementioned authors, the main characteristics of marshland or bog plants is that, most commonly, only the lower parts of their shoots are immersed in water or in a substrate permanently saturated with water. This group is a broad category; belonging therein are both the reeds proper (for instance, sweet flag – *Acorus calamus* L. (Figure 3), lakeshore bulrush – *Schoenoplectus lacustris* L., cattail: narrowleaf cattail – *Typha angustifolia* L. and broadleaf cattail – *Typha latifolia* L., reed manna grass – *Glyceria maxima* Hartm as well as the Carex genus (for example, swamp sawgrass – *Cladium mariscus* L. and other, numerous kinds

of sedges). Included are also quagmire (peatland) plants such as for instance soft rush (Figure 4), trifoliate bogbean – *Menyanthes trifoliata* L., purple marshlocks – *Comarum palustre* L., various species of sedges (*Carex*): *Carex canescens*, sleder sedge (*C. lasiocarpa* Ehrh.), bog-sedge (*C. limosa* L.), shrubs such as for example grey willow (*Salix cinerea*) or sallow (Figure 5), bay willow (*S. pentandra*), swamp willow (*S. myrtilloides* L.), downy willow (*S. lapponum*) and trees such as for example black alder (*Alnus glutinosa*) (Figure 6). Bryophytes (*Bryophyta*) occurring in bogs are also classified among marshland plants.

Photo by Z. Koziara

Fig. 2. European white water-lily (*Nymphaea alba*)

Photo by Z. Koziara

Fig. 3. Sweet flag (*Acorus calamus* L.)

Photo by Z. Koziara

Fig. 4. Soft rush (*Juncus effusus*)

Photo by Z. Koziara

Fig. 5. Goat willow (*Salix caprea*)

Photo by Z. Koziara

Fig. 6. Black alder (*Alnus glutinosa*)

Between water plants and marshland plants, there are various transitional forms – hence the demarcation of both groups is difficult and usually made intuitively. Many hydro-botanists classify them together as aquatic plants. A common feature of species belonging to these groups is their permanent attachment to the aquatic environment. This means that – being completely, for the most part, or only slightly submerged in water, they are able to develop freely, and therefore growth, reproduce and enhance their range using the substances contained in the water, in the bottom sediment, or in the substrate saturated with water.

Aquatic and wetland plants include species from different taxonomic groups, including representatives of green algae, mosses, ferns and angiosperms (bacteria, fungi and most algae are not currently included in the plant world, and some taxonomists exclude also green algae).

Settling of the water reservoir consists in introducing both plants and animals therein, in order to establish a balance between them.

A blueprint for creating the best conditions for plants in a water garden should be their natural habitat. We follow that blueprint, when making various garden arrangements, including the planning or designing a water garden.

Settling a pond with plants can be accomplished in several ways. Most often it is recommended that prior to the planting, the bottom of the pond should be lined with a properly prepared substrate; alternatively, plants can be placed in openwork baskets or jute bags, then covered with gravel.

In small ponds, the latter method is applicable. The water remains clean, plant growth is better controlled, and performing necessary tasks such as for example thinning the plants, does not threaten them with damage. In the case of diseases or pests, it is easier to use plant protection products.

2. Material and methods

The aim of this study was to locate the positions of aquatic plants in the basin of the Municipal Park in Skawina, and to conduct observations of selected species. This work will allow for the development of methods for the cultivation of particular species, which in turn will facilitate the appropriate selection of other plants that can grow in the wetland in question. Finally, our aim was to prepare a development project for the studied reservoirs.

The search of the locations of aquatic plants groups was conducted within an artificial body of water in the Municipal Recreation Park in Skawina.

The wetland consists of two separate bodies of water (smaller, with the area of about 1,700 square meters and larger, with the area of over 2,600 square meters), connected by a narrow lock, fed by streams (Figure 7). The excess water flows out by an artificial canal, and into the nearby Skawinka river.

The study was conducted in the period from January 2003 to November 2003, with the majority of observations falling in the months of May–August 2003, as this is the most abundant period: most of the selected species develop and flower at that time.

Plant stands were located through community interview and our own search. Locations where species of interest occurred were determined by sweeping the shores of the reservoirs. We also searched the open area of water, moving along the surface by boat.

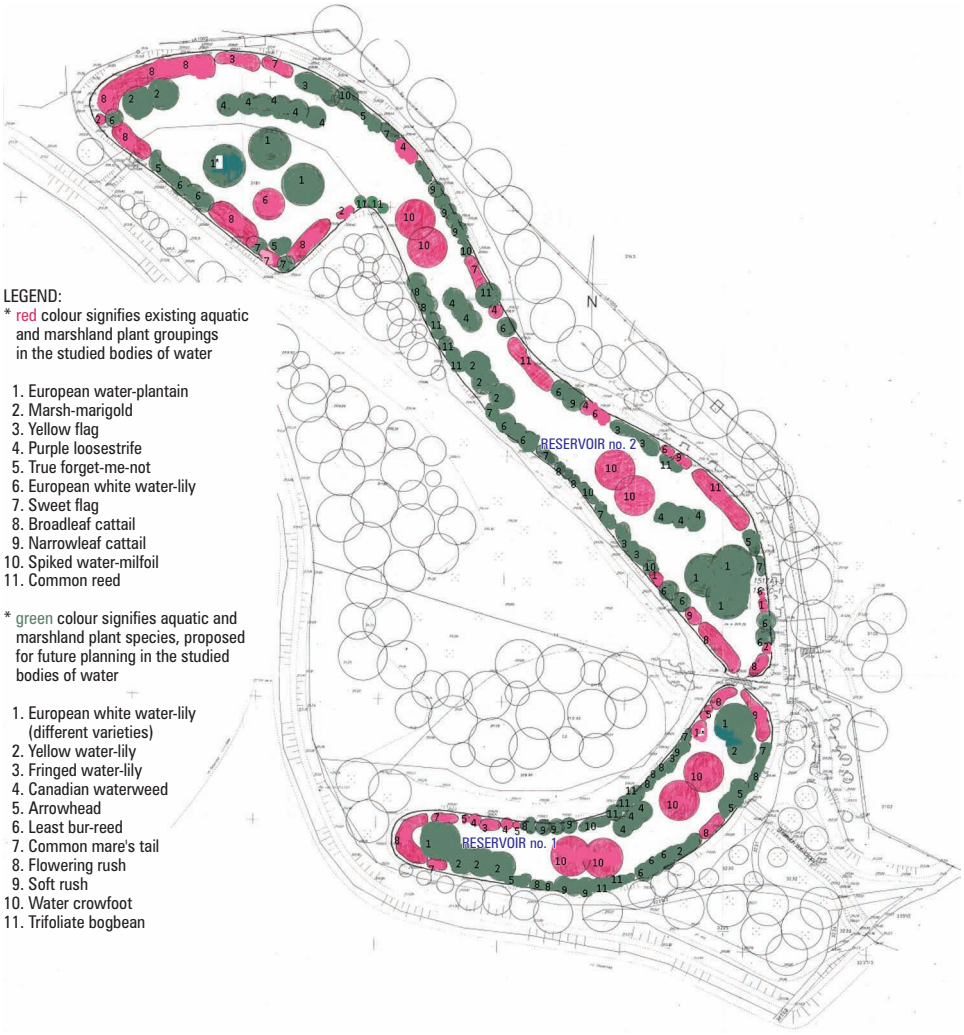
To identify individual species and their characteristics, we have benefited from the guides – keys to the identification of plants by eminent Polish botanists, including: Rostafiński and Seidel [1967] Mowszowicz [1979] Szafer et al. [1988] and the atlas of aquatic and marshland plants developed by Kłosowscy [2001].

3. The results

In the area covered by the study, we found some interesting groups of aquatic and marshland vegetation. Among these plants, we selected those of special decorative qualities, while others, despite the fact that they occurred in greater numbers and were typical for natural water bodies, are presented in less detail.

The reservoir No. 1 (Figure 7) is not very deep (about 1.5–2 m); it is smaller of the two, and it constitutes an artificial pond. From the south, it is partially shaded by several deciduous trees and a flood embankment, from the north, it adjoins a thick trees stand, and an extensive free space, which forms a meadow overgrown with various species of grasses. There is a pathway leading around the perimeter of the reservoir. The edges of the pond are not overgrown with lush marshland vegetation, however, we encountered tufts of broadleaf cattail (*Typha latifolia*) and narrowleaf cattail (*Typha angustifolia* L)., sweet flag (*Acorus calamus* L.), yellow iris (*Iris pseudacorus*), and common reed (*Phragmites australis*). There were much fewer cases of purple loosestrife (*Lythrum salicaria*) and European water-plantain (*Alisma plantago-aquatica*). A relatively large area of water surface was covered with spiked water-milfoil (*Myriophyllum spicatum*), which blooms with pink flowers during the flowering period.

The reservoir No. 2 (Figure 7) is a bigger, artificially shaped pond. From the north-east, it borders on the park with trees, while from the south, the bankside is partially exposed to the sun, and in some places sheltered by birch (*Betula*) and willow (*Salix*) trees. Here we found common reed (*Phragmites australis*), sweet flag (*Acorus calamus* L.), broadleaf cattail (*Typha latifolia*) and tufts of yellow iris (*Iris pseudacorus*).



Source: registered land surveyor Marek Czarnota. Existing groupings of aquatic and marshland plant species are marked in red, and plants proposed for introducing as a part of the developed project are marked in green [Maj 2004]

Fig. 7. Land survey and height map of the water bodies (reservoir No. 1 and reservoir No. 2) in the Municipal Park in Skawina, scale 1 : 500

There were isolated cases of true forget-me-not (*Myosotis palustris*, see Figure 8), purple loosestrife (*Lythrum salicaria*) and marsh-marigold (*Caltha palustris*). The reservoir also features, in a well-lit position, a group of a strictly protected species: European white water-lily (*Nymphaea alba*). Similarly as in the reservoir No. 1, spiked water-milfoil (*Myriophyllum spicatum*) also occurs here.

3.1. Observations of selected species

True forget-me-not (*Myosotis palustris*), family: *Boraginaceae*

This species is found in the waters of reservoirs number No. 1 and No. 2. It grew in the most swampy portion of the meadow, on the banks of the ponds. Perennial plant with a thin, creeping rhizome, with an angular, hairy stem, straight or raised, branching out in its upper part, the height of 20–80 cm. Oblong lanceolate leaves, 2–10 cm long and 0.5–2 cm wide, with short, coarse hair on both sides; lower leaves on short petioles, blunt; and higher leaves seated and sharpened. Dioicous flowers, collected in twists at the peak, blue-white in colour (Figure 8). The fruit is a schizocarp, splitting up into four mericarps. It blooms from May to July.

Photo by Z. Koziara

Fig. 8. True forget-me-not (*Myosotis palustris*)

Broadleaf cattail (*Typha latifolia*)

A fairly common species in the studied area; it has a thick, creeping rhizome. The leaves are very long, evenly narrow, arranged in two rows, with the width of 2.5 cm, and the height of 2.5 m. They grow above their inflorescence, which is shaped like a cob, male inflorescence on top, and female, on the bottom [Koziara 2015] (Figure 9).

Inflorescences are adjacent to each other. Mature inflorescence is light brown-blackish. The fruits are small nuts. It blooms from June to August.

Photo by Z. Koziara

Fig. 9. Broadleaf cattail (*Typha latifolia*)

Narrowleaf cattail (*Typha angustifolia*)

A less numerous group of narrowleaf cattail was found in basin No. 2, on the western shore of the pond. Perennial plant with rhizomes creeping along the ground, and a straight, raised cylindrical stem up to 160 cm in height. Leaves up to 190 cm, grassy, green with a shade of blue, are maximum 1 cm wide. The cob is thinner, red-brown in colour and with separate male and female parts. It blooms from July to August.

Sweet flag (*Acorus calamus*), family: *Araceae*

Sweet flag is one of the most common plants in the area under study. Many groups were located both in the basin 1 and 2, but always in places with good sun exposure. Perennial with a thick, cylindrical, aromatic rhizome, with triangular stem up to 1.5 m. The leaves are reddish at the base, and green, sword-shaped above (see Figure 3). They are 120 cm in height, and 2 cm wide, arranged in two rows. Inflorescence in the form of a cob reaches a length of 10 cm, the flowers are inconspicuous, greenish-yellow, dioicous. The fruit is a berry, of the red colour (in our climate fruits are not formed). It blooms from June to July.

Common reed (*Phragmites australis*), family: *Poaceae* (*Gramineae*)

This species has been observed in reservoir No. 2, where it forms dense thickets of attractive-looking panicles. It is the largest Central European grass, dwelling in the aquatic environment. Perennial with vertical stems of up to 4 meters in height (Figure 10), lance-

shaped leaves with very sharp edges, brown-purple flower shucks. Inflorescence is panicle-shaped. This plant flowered at the turn of July and August, keeping its flowers until September. It was found in the coastal part of the pond, on muddy ground, richer in nutrients. Its scrubs provide the perfect hiding place for many animals living around the wetland, especially for waterfowl.

Photo by Z. Koziara

Fig. 10. Common reed (*Phragmites australis*)

European water-plantain *(Alisma plantago-aquatica)*, family: *Alismataceae*

The species occurred in small quantities in reservoirs No. 1 and 2, between the clumps of sweet flag and reeds. The most impressive plants have measured up to 90 cm, but typically, they were about 60 cm in length. Leaves are of fresh green, with long petioles, broad-lancet-shaped; but their shape was dependent on the habitat the plants occupied. Namely, in plants submerged in the water, leaves were more elongated, narrow, with long petioles, and in plants that were not directly immersed, we observed wider leaf blades and shorter petioles (Figure 11).

Dioicous, white flowers, gathered in bunked, branched panicles, appeared already in early June [Koziara 2015]. Flowering lasted until the last days of September. Flowers of 6–9 mm in diameter are arranged individually on thin stalks, 2 cm long.

Other plant species occurring here include marsh marigold (*Caltha palustris*), yellow iris (*Iris pseudacorus*), purple loosestrife (*Lythrum salicaria*), European white water lily (*Nymphaea alba*), spiked water-milfoil (*Myriophyllum spicatum*). They were discussed by Koziara [2016] in the second issue of GLL in 2016.

Although the studied reservoirs are large in size, thanks to the implementation of the developed project for filling them with newly introduced species of aquatic plants, they are easier to maintain in a state of biological equilibrium.

Photo by Z. Koziara

Fig. 11. European water-plantain (*Alisma plantago-aquatica*)

Such reservoirs, both those large and natural, creating vast water areas of lush vegetation and characteristic fauna, and those smaller ones, often artificially established, with planted plants introduced by human activity, remain one of the most captivating elements of the landscape. In aquatic and wetland habitats, we encounter very valuable species, often threatened with extinction. Aquatic plants, as, indeed, all other organisms, do not only react to the environment and adapt themselves to the living conditions therein, but they also modify it to a greater or lesser extent, by their own life processes – sometimes the change they cause is not necessary to their advantage. For instance, they can cause changes in the chemical composition of water, reduce its transparency and contribute to the shallowing and overgrowing of water bodies, which in turn may lead to their pushing out by other plant groupings, better adapted to the already changed conditions [Pawłowski 1972].

In the studied aquatic environment, the existing plants are mostly acquired in a natural way and are self-sown (except plantings of the European white-water lily (*Nymphaea alba*). Water conditions in are reservoirs are similar to their natural habitats, and therefore the plants here located find good standing for proper development. Only the colonies of water milfoils caused shading and reduction in water clarity, but this did not have a significant impact on other plants, as the group of this species did not neighbour them directly.

Human activity also causes the reduction of hydrophytes' occurrence. Air and water pollution, wetland drainage, river regulation, all rapidly reduce the natural resources of clean water, and contribute to the disappearance of habitats of aquatic and wetland plants. As a result of these processes, some species are becoming extinct, and the only possibility of saving them from extinction seems to be in growing them at artificial

reservoirs. In addition, the need for contact with living nature causes more and more people to decide to create a water reservoir with accompanying vegetation in their immediate environment [Pawłowski 1972, Lewczuk 1998].

The area covered by the study was not very extensive. It contains two artificially created water reservoirs, connected by a narrow lock, and an inflowing stream. These reservoirs do not have rich marshland and aquatic vegetation, which is confirmed by the low number of species inhabiting the studied area. The reservoirs are covered with a small amount of typical marshland plants, forming small thickets of reed and rush. The most common species were broadleaf cattail (*Typha latifolia*), common reed (*Phragmites australis*) and yellow flag (*Iris pseudacorus*).

The area where the research was undertaken lies within the peripheral part of Skawina town. It is a park where residents often spend their free time, walking along the paths and observing the surrounding nature. There is no intensive farming activity in the vicinity of the reservoirs, and the presence of the modernized factories also should not directly interfere with or disrupt the hydrophytes' habitat.

Therefore, nothing stands in the way of developing the land use of the area, and introducing new species and varieties of plants into the reservoir, which will become an additional attraction of the place. It will be important to select such species for planting, that would easily settle in the current conditions, and at the same time would not be too demanding in cultivation and care.

Numerous species of aquatic plants found in the wild state have long been transferred to artificially planted gardens and successfully grown therein. This enables us to admire the resulting new, beautiful cultivars of these plants. We are talking about such species as for instance yellow flag (*Iris pseudacorus*), marsh-marigold (*Caltha palustris*), yellow water-lily (*Nuphar lutea*) (see Figure 1), European white water-lily (*Nymphaea alba*), or arrowhead (*Sagittaria sagittifolia* L., Figure 12). Garden varieties can also be selected from the natural environment, where many forms of the species can be found, differing in their shape, built, or colour of the flowers. An example may be yellow flags (*Iris pseudacorus*), which differ in morphology depending on the place of occurrence, or marsh-marigold (*Caltha palustris*), which differ in the construction inflorescences (single or full) and the time of flowering. But the most beautiful and admired of the plants are the water lilies, such as for instance European white water-lily (*Nymphaea alba*) in its wide range of varieties [Polakowska 1992, Lewczuk 1998].

Although our flora abounds in species with high decorative value, it is not admissible to acquire crops to be grown in the garden from the natural, wild environment. These plants may serve only as a starting material for further breeding. Digging them out on a mass scale, and moving them to the gardens is a threat to these plants' population, and may even lead to the extinction of the species. This phenomenon is most undesirable. It is not only keen amateur gardeners who are to blame for the destruction of natural vegetation. Many losses are also caused by improper development and deepening of reservoirs [Pawłowski 1972, Polakowska 1992].

In the studied area, there were few aquatic and hydrophilic species. Among plants having substantial importance in garden plantings, we should note, first of all, the

European white water-lily (*Nymphaea alba*), broadleaf cattail, European water-plantain, yellow iris, marsh marigold, and others. Some of them due to their strong growth, and others, vice versa – due to their small built (such as *Myriophyllum spicatum*) – reveal their decorative value only when growing in larger clusters, in natural conditions. Others can be successfully grown also in small ponds, or even in small containers (in barrels, buckets, ornamental tanks or troughs). Skilful combination of species and proper presentation of their properties create gardens that can be enjoyed from spring to late autumn, and even winter.

Photo by Z. Koziara

Fig. 12. Arrowhead (*Sagittaria sagitifolia*)

Reducing the population, or even the disappearance of habitats of some species is a disturbing phenomenon, because it has clearly intensified in recent years. Natural aquatic and marshland habitats throughout Europe (and even across the globe) have been undergoing rapid changes [Mikulski 1982]. An example of this may be the steady decrease in the number of water bodies due to their overgrowing with expansive vegetation, or the influence of human activities. The rapid shrinking of natural habitats of hydrophyte plants should be a warning sign, inspiring us to conduct large-scale action in order to protect vegetation associated with aquatic environment. "Nature conservation" should be understood not only as the protection of its natural resources, but also, and perhaps above all, as the rational use thereof.

An effective method used in the current studies, aimed at preventing the extinction of aquatic plants, is the establishment of artificial swamps, which not only provide a decorative function and serve as recreational areas, but also provide a kind of manual for extending the knowledge about plants and animals living in their habitat. When

observing such a reservoir on a daily basis, when watching the changes in the development of fauna and flora, we learn to respect and care for the world around us.

4. Conclusions

There were species of plants found in the studied area that can be successfully grown, or have already been grown in our gardens for many years.

Within the reservoir, there are locations of plants, which are protected by law – European white water-lily (*Nymphaea alba*).

The growing season in the studied site lasted almost 9 months. Flowering of the aquatic plants started in the first decade of May – in the case of the European white water-lily (*Nymphaea alba*), while marshland plants started flowering in late March and early April. The greatest intensity of flowering coincided with the summer months and lasted until mid-October.

Marshland and aquatic plant species in the studied area occurred in both single-species clusters, forming a rather small, not yet spread communities, and in groupings of mixed species, forming mixed thickets. In these cases, the zone of water and marshland intermingled, blurring the boundaries between aquatic and terrestrial environment.

After a thorough analysis of the conditions prevailing in the reservoirs, and guided by the decorative value of plants, we have designed a development plan for the area, drawn on a map on a scale of 1 : 500 [Czarnota 1997] based on the species and varieties of aquatic and marshland plants discussed in the present paper.

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