http://dx.doi.org/10.15576/GLL/2016.2.77

GLL

Geomatics, Landmanagement and Landscape No. 2 • 2016, 77–89

CONDITIONS FOR THE OCCURRENCE OF SELECTED AQUATIC PLANT SPECIES IN THE WATER BODIES OF THE MUNICIPAL PARK IN SKAWINA

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Summary

The study was 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 location and the conditions of the occurrence of selected species were characterized, by means of describing their positions and plotting them on the land survey and height map in the scale of 1 : 500 [Czarnota 1997]. The pH and salinity of the water were examined, the percentage of light reaching the plants was determined, and the organic matter content in the soil was measured. Understanding these conditions will make it possible to select the right species and varieties of plants, having the requirements compliant with the conditions existing in the tested water basin, which will enable their further development and maintaining attractive appearance.

Keywords

aquatic plants • salinity • organic matter • sunlight exposure

1. Introduction

In a unique way, water enlivens and enriches each environment in which it occurs, either natural or artificial.

Wanting to make his environment more varied and attractive, man often attempts to create enclaves of water, introducing selected accompanying species of fauna and flora, examples of which are found in park and garden design. In urban parks and gardens, large bodies of water not only add to the landscape, but they also provide a place for recreation and relaxation, where beautiful aquatic plants and animals living in an aqueous environment are no doubt the biggest attraction for visitors.

Aquatic plants and marshland plants demonstrate numerous morphological, anatomical and physiological adaptation traits to the specific physical and chemical properties of the aquatic environment. Water is about 775 times denser than air and nearly 100 times more viscous, thus the mechanical action of the mass of water in motion is more powerful than that of air (wind) in an aerial and terrestrial environment. Furthermore, the water has large specific heat, and therefore a high thermal capacity, whereby thermal changes occur slowly, while large bodies of water have a soothing effect on the microclimate. Compared to other liquids, water exhibits anomalous density changes due to temperature – it has the highest density at 4°C, and when passing into the solid state (ice), it becomes less dense, lighter and increases in volume. This phenomenon is the cause of thermal stratification of stagnant water, mostly in deeper reservoirs.

As stated by Kłosowski and Kłosowski [2001], the properties of a given aquatic environment have a huge impact on the plants living therein. Surrounding of a plant organism with water gives it the ability to receive the nutrients with the whole surface of its body. In many aquatic species, therefore, we observe an increase of the absorption and assimilation surface of the leaves located underwater, by their fragmentation into a number of small sections (for instance, in thread-leaved water-crowfoot – *Ranunculus trichophyllus*; whorl-leaf water-milfoil – *Myriophylletum verticillatum*; and hornwort – *Ceratophyllum demersum*); formation of long, ribbon-like leaves (for instance, arrowhead – *Sagittaria sagittifolia* (Figure 1); European water-plantain – *Alisma plantago-aquatica* (Figure 2); reduction of the ground tissue and its lack of differentiation [Broda and Mowszowicz 1979] (for example, in waterweed Canadian pondweed - *Elodea canadensis Michx.*; blue water-speedwell – *Veronica anagalis-aquatica*); as well as loss of cuticle and wax on the skin (mostly in the case of submerged plants). In floating species, common features include the reduction or absence of root system (for example, spotless watermeal - *Wolffia arrhiza* L.; hornwort – *Ceratophyllum demersum* L.), as well as the disappearance of the system for conducting water and mineral salts.

Photo by Z. Koziara

Fig. 1. Arrowhead (*Sagittaria sagittifolia* L.)

Photo by Z. Koziara

Fig. 2. European water-plantain (*Alisma plantago-aquatica*)

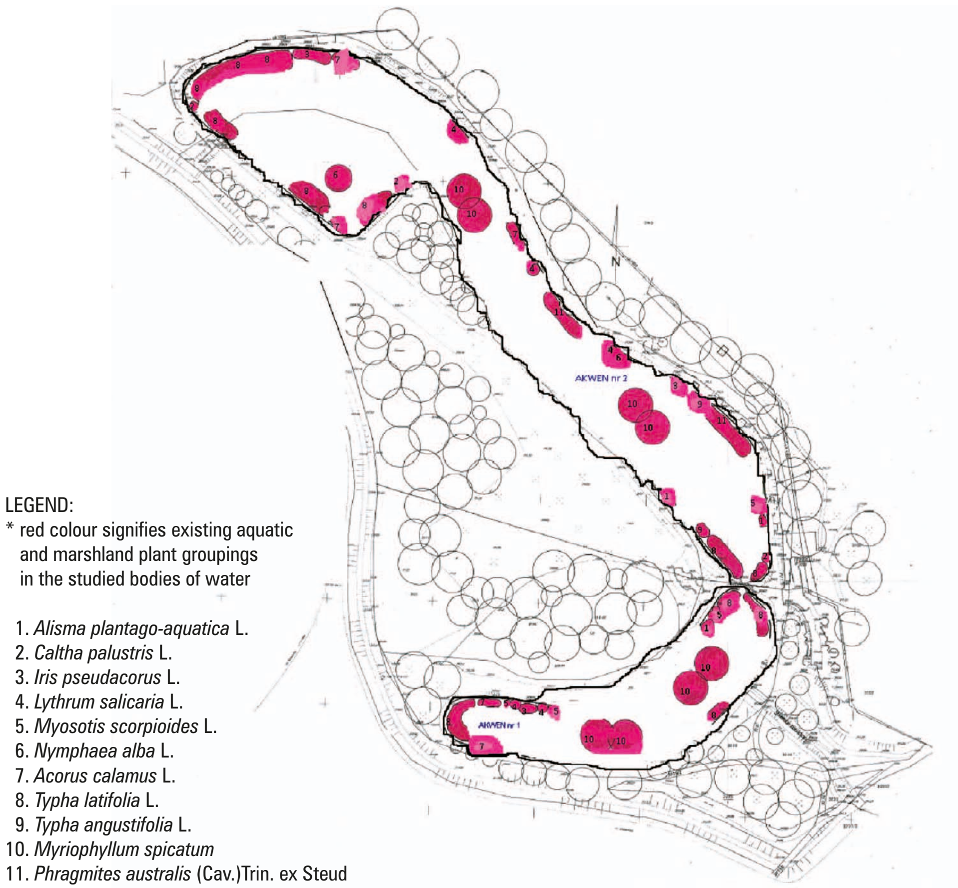
Appropriate selection of plants for water planting will depend primarily on the location of the given body of water, its sunlight exposure and the soil type. When knowing the requirements of individual plant species, we can create favourable conditions for the healthy growth of aquatic plants.

2. Materials and methods

The aim of this study was to locate the positions of the groupings of aquatic plants, and to describe the characteristics of selected species in the artificial body of water within the municipal leisure park in Skawina, as well as to learn about the conditions for their occurrence.

These studies will allow the development of methods for the cultivation of various species, and they will show the current status of the aquatic biological environment in question.

The fen consists of two separate bodies of water (the smaller one, with an area of about 1,700 square meters, and the larger one, with an area of over 2,600 square meters), connected by a narrow lock, and fed by streams flowing thereto (Figure 3). Excess water flows via an artificial canal into the nearby Skawinka river.



Source: registered land surveyor Marek Czarnota. Existing groupings of aquatic and marshland plant species are marked (May 2004)

Fig. 3. 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. 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

Studies have been carried out in the period from January 2003 to November 2003. During the studies, locations were determined and the species, which occurred there, were labelled. Measurements of light intensity, water pH level and water salinity were conducted, as well as the measurement of the organic matter content in the soil. To identify individual species and their characteristics, we have benefited from the guides – keys to the plants identification by eminent Polish botanists, including: Rostafiński and Seidel [1967], Mowszowicz [1979], Szafer et al. [1988], as well as the atlas of aquatic and wetland plants, developed by Kłosowski and Kłosowski [2001].

Samples of water (about 50 ml each) were obtained from the selected locations of the tested bodies of water, and subsequently analysed in the laboratory at the Department of Biochemistry, University of Silesia, where pH was determined using the electric pH meter type CP-401 produced by Elmetron, and salinity was measured using resistivity meter CC-401, also by Elmetron. The results obtained were summarized in Table 1, in the format of arithmetic means.

Organic matter was identified using thermal method, in the laboratory of the Agrochemical Station in Poznań. The results in the form of arithmetic means are summarized in Table 2.

The intensity of light exposure was measured with a Sonopan light meter type L-100.

The study was conducted twice, in June 2003, and in August 2003, during cloudless weather, in the afternoon. Having selected multiple locations, we determined illumination levels at the height of the lamina of the studied plants, and these were compared with the light intensity in the open, while our control (100%) was provided by the illumination conditions in the particular location in the given day of measurement. This served to determine the degree of shading of selected plants (%) relative to open space. The results of the arithmetic means of the measurements are summarized in Table 3.

3. The results

In the area covered by the study, several interesting groupings of aquatic and marshland vegetation were found. Among these plants, only those were selected and described, which possessed special decorative qualities, while the others, as common and typical for natural bodies of water, have not been covered by this study.

The reservoir No. 1 (Figure 2) 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*, Figure 4) and narrowleaf cattail (*Typha angustifolia* L)., sweet flag (*Acorus calamus* L., Figure 5), and common reed (*Phragmites australis*, Figure 6). There were isolated cases of true forget-me-not (*Myosotis palustris*, Figure 7), purple loosestrife (*Lythrum salicaria*) and marsh-marigold (*Caltha palustris*, Figure 9). The reservoir also features, in a well-lit position, a group of European white water-lily (*Nymphaea alba*, Figure 8) and yellow iris (*Iris pseudacorus*, Figure 10). Similarly as in the reservoir No. 2, 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 1) 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*).

Photo by Z. Koziara

Fig. 4. Broadleaf cattail (*Typha latifolia*)

Photo by Z. Koziara

Fig. 5. Sweet flag (*Acorus calamus* L.)

Photo by Z. Koziara

Fig. 6. Common reed (*Phragmites australis*)

Photo by Z. Koziara

Fig. 7. True forget-me-not (*Myosotis palustris*)

3.1. Description of the characteristics of studied species

European white water-lily (*Nymphaea alba*), family: *Nymphaeaceae*

Photo by Z. Koziara

Fig. 8. European white water-lily (*Nymphaea alba*)

This species was observed only in the reservoir No. 2, in locations at the depth of up to 170 cm. The plants were concentrated in a small clump, not yet spread. Perennial plant with thick, branching rhizome of 1 to 3 meters long, it sunk into the mud bottom. Leaf blades are mounted on long, cylindrical stalks. The floating leaves are circular or oval, nearly half indented at the root (double folding), from 8 to 25 cm long (Figure 8). Underwater leaves (occurring only in the initial phase of the plant's development) are ovate, smaller than the floating ones, and curled under the water. The dark green leaves have a distinctive maroon tint. The flowers are dioicous, white in colour. The fruit is a berry with a circular or angular thimble. The plant blooms from June to September [Szafer et al. 1988].

Marsh marigold (*Caltha palustris*), family: *Ranunculaceae*

This species occurs in two places in the reservoir No. 2. We have found just small tufts, clearly of a species that was only a recent arrival.

The leaves are dark green, kidney shaped (Figure 9); smaller at the time of flowering, and later enlarging to a width of 12–15 cm [Rostafinski and Seidl 1967]. The height of flowering plants ranged from 14 to 27 cm.

Flowers appeared at the beginning of April, and the full flowering lasted for a half of that month. The plants were blooming profusely, although briefly, because two weeks later, the complex seed heads began forming, in the shape of star-shaped follicles.

Photo by Z. Koziara

Fig. 9. Marsh marigold *(Caltha palustris)*

Yellow iris (*Irys pseudacorus*), family: *Iridaceae*

The species appeared in small tufts on the banks of reservoirs No. 1 and 2. It is a perennial plant with thick, strongly branching rhizome and multiflorous stems up to 1 m [Koziara 2015] (Figure 10). The leaves are green (width 3 cm), sword-shaped. The flowers are dioicous, with long pedicles, and they turn yellow. The fruit is a capsule. The plant blooms from May to July [Mowszowicz 1979].

Photo by Z. Koziara

Fig. 10. Yellow iris (*Irys pseudacorus*)

Purple loosestrife (*Lythrum salicaria*), family: *Lythraceae*

Single plants growing in a group of rushes were located in reservoirs No. 1 and 2. This robust perennial plant grows up to 1 m in height. The rhizome is woody, well developed. The stem is straight and poorly branched, in green-brown colour. Dark green leaves, lanceolate, alternate, are gathered in whorls, 3 each. Pink and violet flowers are dioicous, dorsiventral, gathered in a spiked inflorescence. The fruit is a capsule, which cracks open into two flaps. The plant blooms from July to August [Mowszowicz 1979].

Spiked water-milfoil (*Myriophyllum spicatum)*, family: *Halorrhagidaceae*

This species was encountered in the reservoirs No. 1 and 2, creating a dense, though fragile, underwater carpets. The stems, submerged or floating-branched, were about 100 cm long. Underwater leaves, pinnatisectum, with almost thread-like sections, are gathered in whorls, 4 to 6 each. Inflorescences usually grow above the water surface. Flowers are collected in a clear, peaking ear of several centimetres, monoicous and dioicous,and they are usually gathered by 4 in one whorl. In the bottom of the inflorescence, female flowers are placed, and above, there are male flowers [Szafer et al. 1988]. Reddish – pink ears appeared above the water surface at the beginning of July, and they remained on the plants until the end of August.

3.2. Characteristics of the conditions for the occurrence of the studied species

The pH and salinity of the water

Table 1. The pH and salinity in the locations of the studied plants

No.	Species	pH	Salinity mS · cm^{-1}
1	European white water-lily	6.8–6.9	0.20
2	Marsh-marigold	6.8	0.18
3	Yellow iris (reservoir no. 1)	6.4–6.8	0.18
4	Yellow iris (reservoir no. 2)	6.3–6.9	0.16–0.20
5	Purple loosestrife	6.8	0.18
6	Spiked water-milfoil	6.8–6.9	0.2

Source: author’s study

From the measurements, it follows that these plants occupied positions in the slightly acidic environment (pH 6.3–6.9). Differences arising from the determined pH range are not high, and nowhere was a strongly acidic or alkaline environment determined.

The lowest pH results were found in the location of the yellow iris, and the highest, in the location of European white water-lily, spiked water-milfoil, and yellow iris.

As is apparent from Table 1, most of the plants selected for the study grew in an environment with an average salinity in the range of 0.16–0.20 mS · cm^{-1}.

Content of organic matter in the substrate, in the locations of the studied plants

The content of organic matter in locations of the studied plants ranged from 64.2 to 85.9% (Table 2).

Table 2. Organic matter content in the locations of the studied plants

No.	Species	[%]
1	European white water-lily	85.9
2	Marsh-marigold	71.4
3	Yellow iris (reservoir no. 1)	71.9
4	Yellow iris (reservoir no. 2)	73.8
5	Purple loosestrife	64.2
6	Spiked water-milfoil	66.2

Source: author's study

These values indicate that the tested environment, in most cases, contained a small amount of nutrients. Purple loosestrife grew on slightly more sandy soil, which is characterized by a lower organic matter content. The content of organic matter in the remaining locations ranged from 66.2 to 85.9%. The highest value was found in the European white water-lily environment.

Intensity of sunlight

Table 3. Percentage of sunlight reaching the studied plants

No.	Species	Amount of sunlight reaching the plant [%]		
		Measurement 1	Measurement 2	Average
		20 June	15 August	
1	European white water-lily	90	100	95
2	Marsh-marigold	88	89	88.5
3	Yellow iris (reservoir no. 1)	65	75	70
4	Yellow iris (reservoir no. 2)	82	92	87
5	Purple loosestrife	86	73	79.5
6	Spiked water-milfoil	100	100	100

Source: author's study

Based on the data presented in Table 3, we can draw conclusions as to the requirements of individual species in terms of sunlight, which in the future will facilitate making the selection of species with a similar demand for light. Plants living on the border between aquatic and terrestrial environments have a high demand for solar radiation. Very high light requirements (up to 100% of the incoming light) is typical for aquatic species with leaves floating on the surface (for example, European white water-lily), or near the water surface (for example, spiked water-milfoil), with inflorescences rising above the water surface. These plants grow abundantly in shallow, sunny and well-heated bodies of water.

Although about 100% of the light in fact reached the plants whose leaves float on the water surface, the species that were submerged in water received much less light than it would result from measurements made above the water surface. Less demand for light (at the level of 70–90%) is typical for species such as marsh marigold or purple loosestrife. These plants grow in positions with good sunlight exposure, but in mixed species clusters, with plants, which shadow each other.

Yellow iris is presented in the table twice, because the conditions in which it occurred in the two reservoirs were slightly different. In reservoir No. 2, where more light reached the plants, the latter were more compact, they had darker leaves, and bloomed much more intensively than in reservoir 1.

The area under study is located in the periphery of Skawina town. This is a park where town residents often spend their free time, walking along the paths and observing the surrounding nature. Farming in the immediate vicinity of the park and the studied reservoirs is not intense, and the presence of modernized factories also should not directly interfere with or disrupt of hydrophytes' growth in the basin in question.

4. Conclusions

Within the body of water, we have found locations of plants, which are protected by law (European white water-lily).

The pH in the studied location was in the range of 6.3 to 6.9, therefore, most of the studied plants grew under the conditions of slightly acidic pH.

Salinity of the water reservoirs showed no extreme values, oscillating around the average of 0.20 $mS \cdot cm^{-1}$.

The highest light intensity (specified in %) arrived to aquatic plants with large leaf blades floating on the surface of the water, and inflorescences, which were raised about the water surface (for example, white water-lily).

Lower light intensity (in %) fell on partially shaded species, e.g. marsh marigold and purple loosestrife, while specimens of yellow iris growing in intensely lit locations developed more luxuriantly, and the flowers were larger.

A Summary of all the measurements and observations is a guideline to making the appropriate selection of vegetation for the studied area, while it also provides valuable guidance on how to cultivate these plants.

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