

GUIDELINES FOR METAPLANTING AND RESTITUTION OF THE FRINGED WATER LILY *Nymphoides peltata* (S.G. GMELIN) O. KUNTZE = *Limnanthemum nymphoides* LINK

I. Methodology of metaplanting and restitution of plants in new sites

The final effect of the work is conditioned primarily by the following important conditions:

- a) ecological requirements of the metaplanting site;
- b) deadline for the works;
- c) the accuracy of replanting;

II. Choosing the site for metaplanting

Due to ecological requirements and technical conditions for metaplanting, the site where the population of transferred plants will be introduced must meet the following conditions:

1. Ecological requirements:

- a) the sites should be located in the downstream part of the river – fringed water lily formations are very sensitive to rapid currents which hinder the growth of its shoots;
- b) sites cannot be located in the zone of rush vegetation formation, which is one of the reasons of the disappearance of fringed water lily patches. It is advisable to place the sites in a way which ensures that they are shielded by rushes against strong winds which cause intense water ripples;
- c) the bottom of the site should be sandy with a small proportion of gravel fractions and a layer of organic sediments of moderate thickness. The stable nature of the bottom is conducive to the permanent rooting of plants.

2. Deadline for the works:

- a) the process of adaptation to the conditions of the new site requires mainly a proper rooting of plants in the soil. Damage to some parts of the root system is unavoidable in the process of harvesting plants for replanting. Metaplantation should be carried out in a time that will allow for a sufficiently long period of rooting and growth of the transferred plants in new conditions – the optimal time for implementation is the turn of June and July. These works should not be carried out later, and any delay diminishes the final effect of the procedure. However, the time may depend on ecological conditions. The development of shoots from underground organs hibernating in the substrate of the ecosystem depends on atmospheric factors in a given year and does not always occur at the same time.

3. Technical conditions:

- a) due to the necessity to precisely execute the work when reintroducing plants into the soil, the ecosystem waters should not be too deep, as it will significantly impede the correct placement of plants in the soil. The optimum water depth at selected sites should be around 0.7-

0.8 m (1.0-1.2m), i.e. such that it allows for manual operations during replanting. Too shallow water in the formed site causes the rooting shoots to rise in the event of strong rippling. Therefore, placement on slightly deeper sites is more favourable, but it will require properly selected anchors to secure plant shoots in the soil;

b) if possible, work should be carried out when water levels are low, to allow for proper implementation.

4. Selection of material to be replanted

The procedure should be as follows:

a) select well-developed plant shoots with good phytosanitary status. It is important to remember that leaving some of the existing plant population allows it to rebuild after the reconstruction work is completed. Important factors here include the extent of interference in the existing site, the size of patches, and the number of plants in the population, as well as the change in ecological conditions. Hence, the scope of work and interference in the area of existing sites should be limited to the necessary technical minimum;

b) in order to intensify the rooting process, removing most inflorescences from the replanted shoots is recommended. Their formation and development require plants to expend energy, which limits its adaptability and rooting. The replanted shoots will be weakened anyway, and it is likely that they will not enter the final phase of generative development, and the formation of a new plant population at the site will depend primarily on vegetative development.

5. Reintroduction system and technique:

a) during the reintroduction works, floating equipment should be used – a pontoon or a boat on which the replanted shoot material will be deposited, as well as equipment necessary during the implementation of the task;

b) reintroduction shall be carried out on a 1.5 x 1.5 m square, with individual organs distributed evenly on the surface;

c) avoid placement of rhizome organs in the soil, avoiding changes of their natural position;

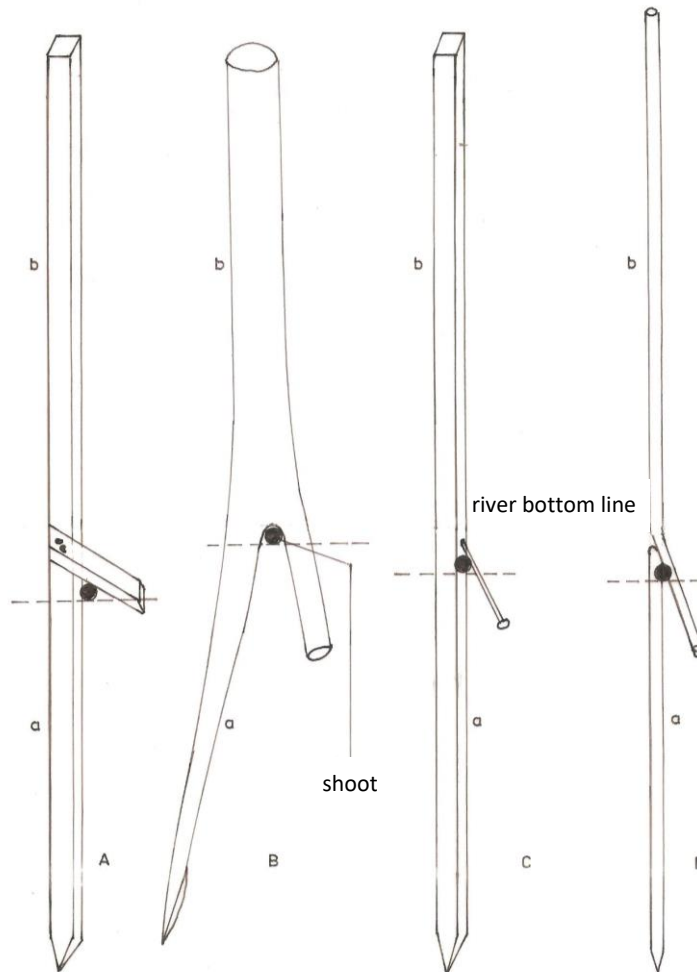
d) it is necessary to permanently secure replanted organs in the surface layer of the bottom with anchors. If possible, additional covering of rhizome with bottom formations is recommended, especially in the zone of nodes with adventitious roots of shoots.

6. Types of anchors securing the organs in the soil at the site:

a) anchors which will be fixed in the soil of replanted organs must not permanently interfere with the ecological conditions of the ecosystem. The most advantageous solution is to construct them from natural materials that will degrade over time. They can be wooden or, in the worst case, metal anchors; the following anchor types are recommended:

- wooden anchors from natural branches of woody plant shoots. The anchors must be debarked and free from covering tissues - cork and phloem, so that they will not root;
- artificially formed wooden anchors;

- metal anchors made of wire.



A - slat anchor with 1x1cm cross-section and a 5-6 cm long slat attached; B - wooden anchor made of a branching branch: a wooden anchor with a cross-section of 1x1cm with a thin nail or wire 5-6 cm long; D - metal anchor made of bent wire with a cross-section of 3-4mm

Fig.6. Types of anchors for securing replanted fringed water lily shoots in new sites

The schematic drawing shows the proposed forms of anchors marked with capital letters A, B, C, D. All proposed forms of anchors have similar shape. The length of section **a**, which will be inserted in the bottom, is important. Depending on its nature, it should be 15 cm long for a mineral bottom, up to approx. 20 cm for a bottom covered with a layer of organic sediments. The location of the lily shoot relative to the bottom is marked with a black dot.

The length of section **b**, located above the plant shoot secured to the bottom, depends on the depth of water on the site. At a water depth of about 1.00-1.30 m, the entire anchor should have a length of up to 0.70 m. This means that after attaching the shoot to the bottom of the site, it will not protrude above the water surface, and its upper end section will be submerged about 30 to 60 cm, which allows for performing replanting operations manually and will not pose difficulties.

III. MATERIAL AND PREPARATION OF MATERIAL FOR METAPLANTATION AND RESTITUTION AT NEW SITES

1. Origin and health of the material

The material for restoring the population of species at the new designated sites will consist of plants from local populations.

2. Collection of shoots for metaplanting and restitution

Material for metaplanting should be collected in accordance with the following principles:

- a) material for replanting should be collected on the edges of patches. Collecting material clusters inside the patches is allowed. Material obtained in this way will be in good condition without mechanical damage;
- b) large numbers of plant organs should not be collected in one place. Leaving small, scattered patches will increase the likelihood of a reconstruction of the taxon population at existing sites;
- c) the collected metaplantation material should be immediately placed in flat containers in which it will be transported to the new replanting site;
- d) plant shoots should not be packed too densely in containers. The number of plants located in the transport container should be chosen according to the size of the container, so that it corresponds more or less to their natural density;
- e) rhizomes should be carefully removed from the bottom sediment. This can be done, for example, with a rake or a pole with a lifting hook.
- f) the best part for replanting will be the tops of collected rhizomes. The middle parts of shoots can also be used for this purpose.
- g) approx. 4-5 nodes with adventitious roots and floating leaves should be cut off from the shoot extracted from the bottom to the surface;
- h) organs should be cut off with a very sharp tool;
- i) mechanically damaged shoots should not be used for replanting.

3. Rules for collecting and transporting material

During the collection of material for metaplantation and restoration of the fringed water lily population in a new site the procedure should be as follows:

- a) material should be collected in the shallowest part of the basin, so that it is possible to control the manual actions performed;
- b) while collecting material, there should be as little damage to adjacent plants as possible;
- c) specimens of plants with shoots that are not broken, crushed, or entangled should be collected for metaplanting;
- d) the collected material should be transported in flat containers filled with water from the site;
- e) to avoid breakage or other mechanical damage, the material in the container must not be too densely packed;

- f) Containers for transport should have a lid. This will protect the shoots against drying out, while also preventing water from spilling;
- g) There should be enough water in containers for the transported shoots to be submerged.

4. The number of specimens necessary to restore the population in new sites

It is difficult to precisely determine the necessary number of specimens to be reintroduced in each of the newly selected sites. The effect of metaplanting and restitution works will largely depend not only on the choice of site, material quality, but also on the technique. Ecological parameters of the metaplantation habitat may also be significant.

So far, metaplantation works and species restitution in Pomorze show that the universal method is to transfer appropriately selected plant shoots and then deposit them in the soil. Work carried out using other vegetative and generative organs did not give the expected result.

In the case of metaplanting and restitution with shoots, or rhizomes, 10-15 fragments of organs should be introduced at each site. The most favourable solution would be for each fragment of the rhizome intended for restitution to cover a section with 4-5 nodes.

Table 1 The number of fringed water lily shoots needed for metaplanting and restitution at one site in a 1.5m x 1.5m square

number of patches formed at 1 restitution site	number of organs for metaplanting in one patch sites	total number of organs at the selected site
6-10	10-15	60-150
total		number of sites x 60-150

5. Date of collection and reintroduction of the species

Material collection and reintroduction should take place when the rhizomes begin to form floating leaves. The organs introduced to new sites will then have sufficient time to adapt in new conditions, to achieve the appropriate development phase which will allow them to survive the winter and rebuild the population in the following years. It should be assumed that rhizomes should be obtained from the second decade to the end of July. A later date, starting from the beginning of August, does not guarantee achieving the intended effect, as indicated by experience gained from the metaplanting and restitution works carried out so far.

6. Transport of material to be replanted

During transport of the collected material for restitution, the following conditions must be observed:

- a) material has to be transported immediately after it has been collected;
- b) it is possible to keep the material overnight, until the next day, in a cool place with little sunlight, in which case the containers should be left slightly, but not fully, open;
- c) the water level should be checked and if necessary, more water from the material collection site should be added.

IV. METHODOLOGY AND STRATEGY FOR RESTORATION OF THE POPULATION OF FRINGED WATER LILY *NYMPHOIDES PELTATA* (S.G. GEMELIN)

1. Place of reintroduction and method of site preparation

Material for restitution is reintroduced to previously selected and marked sites.

Sites must meet the following requirements:

- a) water depth of approx. 1.0-1.3 m;
- b) bottom covered with an organic-mineral layer;
- c) site with limited water ripples, protected against the effects of intense air currents, bays in front of rushes, oxbows, bank zone;
- d) the location of the site should allow easy access, as well as observation;
- e) the location of the site should prevent intrusion by members of the public;
- f) selected metaplanting sites that meet ecological requirements should be marked with wooden stakes placed in the bottom with tops protruding slightly above the water surface. The tops may be painted with light-coloured paint. This will make it easier to find the selected site for restitution patches and facilitate any subsequent control and monitoring observations;
- g) it is advisable to define the position of the site with GPS coordinates, and to compile other tabular information about its characteristics, e.g. water depth, distance from the bank, bottom type, etc.;
- h) replanted shoots should be evenly distributed on an approx. 1.5m x 1.5.m square area. It is possible to enclose the surface of the patch with a frame made of wooden slats or plastic pipes, which will limit any water rippling in the initial phase of patch formation. The frames must have buoyancy and be anchored to the bottom of the site.

2. Spread of metaplanting sites

Positive effects on each of the new created sites are generally not achieved in 100%. The effect depends on the selection of the place and the local ecological conditions. The metaplanting and restitution works carried out so far show that the positive results are at the level of about 80%. It depends to a large extent on the quality of works. Hence, new patches should be grouped and located in close proximity to each other – approx. 3 m. In one selected new ecosystem site there should be about 6-10 patches next to each other. Such formation will, in the following years, allow the population to spread and form compact phytocoenoses covering the entire water surface. Individual sites formed from 6-10 metaplantation patches should be at a distance of approx. 10-15 m from each other. The total number of individual sites depends not only on the ecological conditions of the ecosystem, but also on formal and administrative requirements. This means that they do not have to be in one place or aquatic ecosystem.

3. The number of specimens in the patch

The number of reintroduced specimens in the patch must be selected in such a way as to guarantee the success of the procedure. Hence, the plant density cannot be too high or too low. From the results obtained so far, it is known that not all plants introduced to a site adapt to the new

conditions and begin to grow to form a new population. So far, 15 specimens of plant shoots/1 patch has been replanted.

4. Anchoring shoots in the soil

Each of the replanted shoots should be anchored with 3 anchors, one in the middle of its length and one near each end. Anchors should be located in the node zone. This will allow the forming adventitious root system to penetrate the soil.

5. Time coordination of restitution

Time coordination is extremely important for the success of the procedure. Transported material cannot be stored for more than 1 day. Later, decomposition processes may occur, which will reduce its value and the strength of biological adaptation to new conditions. That is why material should be transported in a timely fashion.

V. PLANNED ACTIONS AFTER SPECIES REINTRODUCTION

1. Monitoring of species in sites

The sites of fringed water lily restitution should be subject to a monitoring program concerning not only the process of plant adaptation and developmental biology, but also the further formation of its phytocoenosis, plant life, flowering, fruiting, etc. In the first and second year, monitoring must be detailed and performed for various plant development phases, i.e. the formation of floating leaves, their number on the surface of the patch, the formation of flowers and fruit. Later, an inspection of plant population behaviour can be carried out, depending on formal and legal requirements defined by the environmental protection authority, or the purposes of obtaining results. The collected information can be developed using scientific method and made available as a publication. It will constitute valuable material for similar tasks in the future.

VI. GENERAL RULES FOR WATER VEGETATION PROTECTION

The vegetation of aquatic ecosystems is characterised by a set of specific adaptation features known as hydromorphism, which is a manifestation of unique adaptation to the conditions of the aquatic habitat.

An important factor determining the durability of phytocoenoses is the durability and stability of the ecosystem. Hence, substantial fluctuations in the water level, which are accompanied by a change in a number of ecological factors of the habitat, are an adverse phenomenon. A lowering of the water level causes dynamic vegetation succession processes, generally leading to the formation of aquatic or terrestrial rush phytocoenoses in later stages and, as a result, to the disappearance of nymphoides patches, including fringed water lily patches.

Changes in nature are not only a natural process of vegetation succession, but also the effect of interference with the natural environment and anthropogenic transformations. Adverse processes resulting from various investments often require interference that allows humans to stop adverse changes in natural ecosystems that constitute refugia for rare and endangered species of flora and

fauna. Such stabilisation activities will be indispensable also for the task of metaplanting the fringed water lily.