Rapport 2018:2

Länsstyrelsen
Stockholm

Action programme for the conservation of Baltic water-plantain *(Alisma wahlenbergii)*

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Tfn: 010-223 10 00

Foto omslag: Anders Jacobson

Utgivningsår: 2018
ISBN: 978-91-7281-793-7

Du hittar rapporten på vår webbplats www.lansstyrelsen.se/stockholm

Preface to the revised English edition

The following action programme is an English translation of Environmental Protection Agency report 5499 “Action programme for the conservation of Baltic water-plantain”, which was published in 2005. A new authority, the Swedish Agency for Marine and Water Management, has been formed in Sweden since then. This authority has taken over responsibility for action programmes for endangered species in freshwater and marine environments.

Appendix 1 in the original programme has been revised. The appendix describes proposed actions to promote and conserve the species and its growth sites. The appendix was revised according to a decision made by the Swedish Agency for Marine and Water Management on 9 September 2016. At that time, a decision was also made to extend the term of the action programme to 2020.

The programme has been translated in order to make it more accessible to English speakers, and in particular to increase the exchange of action work experience between countries where Baltic water-plantain can be found. Funding has been received from the Swedish Agency for Marine and Water Management for this work.

Stockholm, February 2018

Mats Thuresson
National coordinator, Action program for the conservation of Baltic water-plantain
County Administrative Board of Stockholm

Preface

The Swedish Environmental Protection Agency has emphasised the importance of devising and implementing action programmes for endangered species and biotopes in a number of contexts, including in “Aktionsplan för biologisk mångfald” (1995) [Action plan for biodiversity]. Producing and initiating action programmes for species in need are also explicit targets of the environmental objectives adopted by the Riksdag (Swedish Parliament), *Flourishing Lakes and Streams, A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos, Thriving Wetlands, A Varied Agricultural Landscape, Sustainable Forests and A Magnificent Mountain Landscape (Government Bill 2000/01:130 Sweden's environmental objectives – targets and action strategies).* The action programmes are also central to environmental efforts in order to stem the loss of biodiversity by 2010 – an objective established at the EU summit in Gothenburg in 2001 and the world summit held in Johannesburg in 2002.

Action programmes are devised for species or biotopes that cannot be preserved by means of general nature conservation measures and are in need of specific initiatives if they are to survive. These programmes are for guidance and are not legally binding documents. They include a brief information review and a presentation of the actions required to improve the conservation status of the species/biotope in Sweden. These actions are coordinated among various stakeholders, thereby increasing information and understanding of the species or biotope. Support is garnered for the actions through consultation and a referral process in which authorities, experts, interest groups and – in some cases – individuals have the opportunity to submit opinions and so contribute to their formulation.

The action programme for the conservation of Baltic water-plantain *(Alisma wahlenbergii)* has been compiled by Anders Jacobson, Lund University on behalf of the Swedish Environmental Protection Agency. This programme provides guidance for relevant stakeholders' coordinated initiatives for conservation of the species between 2006 and 2010. The Swedish Environmental Protection Agency is responsible for the final content of the action programme and would hereby like to thank everyone who has contributed to the process.

The establishment of the action programme is one element in our ambition to improve information on conservation efforts for the species. The Swedish Environmental Protection Agency hopes that this programme will encourage involvement and specific activities at various levels, and that this will lead to the Baltic water-plantain regaining a favourable conservation status in Sweden.

Stockholm, July 2005

Björn Risinger
Director, National Resources Department

Establishment, validity and reassessment

The Swedish Environmental Protection Agency made a decision on 7 July 2005, according to departmental protocol N 89/05, section 3, to establish the action programme for Baltic water-plantain (Alisma wahlenbergii). This action programme is valid for the period 2006–2010.

The coordinating county (AB County) should compile actions undertaken each year in the form of a brief annual report which is submitted to the Swedish Environmental Protection Agency by the end of the year at the latest. This report should also include a summary of the actions planned for the coming season.

The action programme should be reassessed as soon as possible after the end of the period, but by the end of 2010 at the latest. The action programme may be reassessed earlier if the need arises.

Contents

Sammanfattning

Småsvalting *(Alisma wahlenbergii)* är en sällsynt vattenväxt som är endemisk för Östersjöområdet. Det är förmodligen en ung art som uppstått i Östersjöområdet efter den senaste istiden. Arten förekommer främst på grunda, sandiga bottnar i brackvatten eller i naturligt mesotrofa-eutrofa sötvatten med förhållandevis hög konduktivitet. Den har höga krav på vattenkvaliteten och förekommer bara i relativt klara vatten. Småsvalting tål inte konkurrens från vass och andra storvuxna vattenväxter. Arten förekommer i tre separata regioner inom Östersjöområdet: Mälaren, Finska viken och Bottenviken. Den största regionala populationen, som förmodligen består av flera hundratusen individ, finns i Bottenviken där arten är känd från ett 70-tal lokaler varav de flesta på den finska sidan. På den svenska sidan finns omkring 10 000 individ fördelade på ca 13 lokaler. I Mälaren finns strax över 40 000 individ fördelade på ett tiotal lokaler. I Finska viken har småsvalting hittats på ett antal lokaler mellan S:t Petersburg och Viipuri men artens aktuella status i regionen är dåligt känd.

Småsvalting har under det senaste halvseklet minskat dramatiskt i de södra delarna av utbredningsområdet. Den har till exempel helt försvunnit från Nyköpingstrakten och Ekolns fjärdsystem i Mälaren där den tidigare var relativt vanlig. Numera anses småsvalting vara hotad i hela utbredningsområdet. I Finland anses arten vara sårbar, i Ryssland akut hotad och i Sverige starkt hotad. I Bottenviken är situationen för arten relativt bra och där finns inga kända hot i nuläget utom lokalt i vissa områden på den finska sidan där eutrofiering är ett problem. I Mälaren är arten dock akut hotad på grund av eutrofieringsproblem, igenväxning, konkurrens från introducerade arter (till exempel jättegröe, smal vattenpest och vandringsmussla), exploatering och utbyggnad vid stränderna och erosion från båtars vågsvall.

Följande åtgärder förslås för att bevara småsvalting i Sverige:

- Sprida information om arten via informationsblad och informationsskyltar till dem som bor och verkar vid och i närheten av småsvaltingslokaler.
- Genom biotopvårdande insatser och restaureringar öka antalet lämpliga växtplatser för småsvalting inom dess utbredningsområde.
- Öka antalet populationer genom utplantering vid lämpliga lokaler. I första hand bör utplantering ske på lokaler där arten tidigare funnits.
- Tre lokaler i Mälaren (Herrmete, Gräsholmen och Asknäsviken) bör skyddas formellt som naturreservat.
- Botaniska trädgårdar bör kunna fungera som genbanker genom att odla småsvalting från hela dess utbredningsområde. Det vore värdefullt om

detta arbete kunde genomföras i samarbete med Finland och Ryssland.

- En begränsning av båttrafiken i närheten av småsvaltingslokaler bör införas.
- Biotopvårdande insatser såsom vassröjning och återupptaget strandbete bör vid behov genomföras vid artens befintliga lokaler.
- Åtgärder bör vidtas för att minska eutrofieringen i de regioner där småsvalting förekommer.
- Ökade kunskaper om artens ekologi. Om möjligt bör dessa studier genomföras i samarbete med Finland och Ryssland.

Åtgärdsprogrammet gäller under fem år, mellan åren 2006 och 2010. De totala kostnaderna under giltighetstiden beräknas till ca 1 393 000 SEK.

Summary

Alisma wahlenbergii is a rare water plant that is endemic to the Baltic Sea area. The species is the smallest member of the genus *Alisma* and is quite similar in appearance to the closely related species *Alisma gramineum*, which has a much wider distribution throughout the northern hemisphere. *Alisma wahlenbergii* is probably a young species which has evolved after the last ice age from local populations of *Alisma graminuem* in the Baltic Sea region. Nowadays, *Alisma gramineum* is extinct from Sweden.

Alisma wahlenbergii is normally self-fertilized and flowers underneath the water with cleistogamous (closed) flowers. It occurs on sandy bottoms in shallow brackish waters (salinity of no more than 3–4 ‰) or naturally meostrophic-eutrophic waters with relatively high conductivity (more than 150 ÌS/cm). The species is a poor competitor that only thrives at localities where reeds and other large water plants do not occur.

Alisma wahlenbergii occurs in three separated regions of the Baltic Sea area (Fig. 3.): Lake Mälaren (Sweden), the Gulf of Bothnia (Sweden and Finland) and the Gulf of Finland (Russia). The population in the Gulf of Bothnia is by far the largest with probably several hundred thousand individuals distributed among more than 70 populations. However, only a few, relatively small populations (about 13) occur on the Swedish side of the Gulf of Bothnia and the total population in this area is about 10 000 individuals. In Lake Mälaren the species occurs with a total of a little more than 40 000 individuals distributed among about 10 populations. The species' distribution in the Gulf of Finland is poorly known but a handful of relatively small populations occur at the coast between St. Petersburg and the city of Vyborg.

Alisma wahlenbergii has declined dramatically in the southern parts of its distribution area during the last half century (Fig. 3.). It has disappeared from the area of Nyköping in Sweden since the late 1960s as well as from most of its former distribution area in Lake Mälaren. Moreover, the species has disappeared from the only known site in the Finnish part of the Gulf of Finland and from the vicinity of St. Petersburg where it occurred frequently before the dike across the Neva Bay was built. No dramatic decline has been detected in the Gulf of Bothnia, but the species has disappeared from the southernmost site in the region, which was located in the Vaasa archipelago, as well as from some smaller sites in the Oulu area. Today, *Alisma wahlenbergii* is considered to be endangered in its entire distribution area, even though there are considerable differences between the regions. In Finland, which hosts most of the total population, the species is listed as vulnerable, while it is considered to be critically endangered in Russia and endangered in Sweden. In Sweden, there seems to be relatively few threats to the populations in the Gulf of Bothnia, where it occurs in areas with little human impact. However, more

information on the species distribution and population dynamics in the Swedish part of the Gulf of Bothnia is needed. The better-known population in Lake Mälaren is critically endangered because of eutrophication, expanding reeds, competition from introduced species (e.g. *Glyceria maxima, Elo- dea nuttallii* and *Dreissena polymorpha*), urbanization, erosion caused by back wash from boats and changed land use. Studies performed during the former action plan for the species shows that back wash from fast-travelling boats can severely damage the localities for *Alisma wahlenbergii* and make the species decline dramatically.

Earlier experiences show that the *Alisma wahlenbergii* from Lake Mälaren is relatively easy to cultivate on a nutrient rich substrate in 20–50 cm deep water. Individuals from the Gulf of Finland, however, seem to be much harder to cultivate. The reason for this is not clear, but there might be too few hours of daylight in southern Sweden – where these observations were made – during the growing season. If the species is to be replanted at new sites, this should be performed as early as possible in the growing season since well-established plants have a much better survival rate during the following winter.

The following actions are suggested to preserve *Alisma wahlenbergii* in Sweden:

- Information about the species and how to protect it should be available to all people that work, live or spend their leisure time in the vicinity of the sites where the species occur.
- Increase the number of suitable sites by restoring old localities and other areas with supposedly suitable environments.
- Introduce the species at suitable sites, preferably in areas where it has formerly occurred.
- Three sites in Lake Mälaren (Herrmete, Gräsholmen and Asknäsviken) should be protected as nature reserves.
- Botanical gardens should act as gene banks by cultivating the species from its entire distribution area. If possible, this should be done in cooperation between Sweden, Finland and Russia.
- Limit the boat traffic in the vicinity of sites where the species occurs.
- Clear reeds and resume cattle grazing at the shores at sites where this is needed.
- Take measures to reduce the eutrophication in areas where the species occur.
- Increase the knowledge of the species by studying its ecology in the whole distribution area. If possible, these studies should be performed in cooperation between Sweden, Finland and Russia.

This action plan will run during a period of five years between 2005 and 2009. The total cost for carrying out these actions amounts to ca 155 500 Eur

Facts on the species

General morphological description

Description of the species

Baltic water-plantain *(Alisma wahlenbergii)* is a perennial underwater plant belonging to the family *Alismataceae*, water-plantain. This species is the smallest member of the genus and grows to a height of 10–45 cm, normally with a rosette of up to around 15 narrow, band-shaped leaves (cover photo, Figure 1). The underwater leaves are normally 1–3 mm wide, flat in section and longer than the inflorescence. In rare cases, Baltic water-plantain can form stunted land forms with short, lanceolate leaves with a clearly defined lamina. The flowers are stalked and arranged in a circular cluster with 1-3 flowers. The species flowers almost exclusively underwater and has cleistogamous (closed) flowers that are self-fertilised. Open flowers have been observed in cultivation (Jacobson 2003), and in rare cases in nature as well, when the plant flowered above the surface when the water level was low (herbarium sheet at the Nordic Herbarium at the Swedish Museum of Natural History: personal comment, Mats Thulin). Open flowers are small (approx. 5–7 mm in diameter) and quite modest, with three narrow, white petals that are just slightly longer than the sepals. Each individual flower produces 12–15 thin-shelled seeds (nuts). Björkqvist 1967 and 1968, Mossberg & Stenberg 2003, Martinsson & Jacobson 1998

Fig 1. Picture of Baltic water-plantain from one of the sites in Rånefjärden in the Gulf of Bothnia. Photo: Peter Erixon.

The origin of Baltic water-plantain shrouded in mystery, but genetic surveys indicate that it is a relatively young species that probably evolved in the Baltic Sea area after the last ice age from an easterly form of the related species ribbon-leaved water-plantain *(Alisma gramineum)*, which reached the Baltic Sea via the Gulf of Finland (Jacobson 2003).

Species causing confusion

Baltic water-plantain is very similar to the closely related ribbon-leaved water-plantain *(Alisma gramineum)*, although all parts of this are larger and normally flower above the surface of the water, with an inflorescence longer than the leaves. In Sweden, narrowleaf water-plantain has only been found in one location, situated in an Ätran inlet at Falkenberg. However, it disappeared from there more than a century ago when the site was destroyed and is now considered to be extinct in our country (Georgson et al. 1997). The nearest current sites are in the Baltic States, the St Petersburg area in Russia, Northern Germany and Poland. Narrowleaf water-plantain has previously been found in Denmark, but it has not been seen over the last few years and is now assumed to be extinct there (Stoltze & Pihl 1998).

Flowering Baltic water-plantain can hardly be confused with any other plants, apart from narrowleaf water-plantain. However, when the species is not flowering there is a slight risk of confusion with seedlings of lakeshore bulrush *(Schoenoplectus lacustris)* and flowering rush *(Butomus umbellatus)*. However, small lakeshore bulrush seedlings are bluish-green in colour with a two-sided rosette of leaves, unlike Baltic water-plantain, which has yellowish-green leaves and an all-round rosette of leaves. Flowering rush is easiest to recognise from its fairly rigid leaves that are clearly triangular in section. In areas where there are large quantities of adherent algae or lime incrustation (common in Stora Ullfjärden), slender-leaved pondweed *(Potamogeton filiformis)* may sometimes resemble Baltic water-plantain, but on close inspection it differs in that it has no rosettes of leaves and instead has a stalk from which narrow, filiform leaves emerge.

Genetics relevant to conservation

Genetic variation

Baltic water-plantain is diploid, with a chromosome number of 2n=14. Genetic variation in the species is generally low, which is to be anticipated from a young species that is largely self-fertilised. Studies have shown that the variation is extremely small on individual sites, but there appear to be genetic differences between different populations within Lake Mälaren and the Gulf of Finland. Within the Gulf of Bothnia, however, the species is almost genetically homogeneous despite the fact that this region is by far the largest in terms of area, the number of populations and the number of individuals. The greatest genetic differences have been noted between the

three regional populations, all of which differ from one another. The population in the Gulf of Finland is most different and to an extent resembles narrowleaf water-plantain in the same area (Jacobson 2003).

The genetic differences between the regional populations in the Gulf of Bothnia, Lake Mälaren and the Gulf of Finland mean that it is very inappropriate to collect material from one region to plant in another. Such intermixing of the genetic material should definitely be avoided as in a worst-case scenario, this may lead to local genotypes being outcompeted or failure of planting due to the plant material not being adapted to the prevailing environment.

Genetic problems

Baltic water-plantain is probably not susceptible to inbreeding as it is largely self-fertilised and is therefore probably capable of surviving for long periods in populations with small numbers of individuals. However, small populations are very vulnerable and the low genetic variation of the species means that the opportunity for adaptation is limited, which increases the risk of extinction if there are changes in its habitat. The lack of genetic variation in the populations of the species means that even large populations may rapidly disappear if there are changes – even apparently insignificant changes – in the environment as all individuals in the population are equally sensitive to the change in question. Genetic variation is a basic prerequisite for the option of adapting to changes in habitat, such as climate changes (Falk & Holsingen 1991), and hence it is important to preserve as much as possible of the small variation found in Baltic water-plantain. As most of the genetic variation in Baltic water-plantain within the regions appears to occur between different populations, it is particularly important to conserve as many populations as possible. In this regard, it may be important to preserve very small populations just as much as large ones, which is particularly true of the populations in Lake Mälaren and the Gulf of Finland, where the most genetic variation appears to be.

Biology and ecology

Propagation and dispersal methods

Baltic water-plantain flowers in July–August and the seeds mature one to several weeks after flowering, depending on temperature. The seeds probably grow mainly in the spring of the following year, but in cultivation they have also been observed to grow in the autumn just after the seeds have come away from the parent plant (Jacobson, unpublished). Whether this also takes place in nature, and if so to what extent, is unknown. The leaves and inflorescences wilt quite early in the autumn (as early as early to mid-September) and the plant survives the winter with a small rhizome (less than 5 mm thick) in the bottom sediment. Common water-plantain (A. plantago-aquatica) has a long-

lived seed bank on its growth sites, but whether this is also true of Baltic water-plantain is unknown. The seeds of Baltic water-plantain have a considerably thinner shell, which could indicate that they are more sensitive than the seeds of common water-plantain and have a shorter life.

Baltic water-plantain appears to have a good ability to reproduce on its sites and frequently occurs in dense populations in appropriate environments. Propagation mainly takes place via seeds that are distributed primarily in the vicinity of the parent plant. There is a certain amount of vegetative propagation, only at very short distances due to shoot formation from the rhizome (at most a few centimetres from the parent plant). The rarity of the species and its absence from many apparently appropriate sites within the distribution area may indicate that it has difficulties with distribution over longer distances. Baltic water-plantain is frequently distributed very unevenly, even on its sites. Some sites have very dense populations, while the species is entirely absent from apparently equivalent sites just a few metres away (Martinsson & Jacobson 1998). However, in the Gulf of Bothnia it is obvious that despite everything, Baltic water-plantain must have fairly good dispersal potential even over longer distances as appropriate sites are frequently separated by quite large distances and rarely last a particularly long time on account of the rapid land elevation. Seeds of Baltic water-plantain that have matured underwater are unable to float and rapidly sink to the bottom when they are released from the parent plant, which is probably why there is very little direct seed dispersal over any longer distance with water currents. It can be assumed that long-distance dispersal of seeds is primarily effected with the assistance of sea birds and/or by means of dislodged, seed-bearing seedlings or inflorescences which, unlike the seeds, float and can travel long distances on currents. Germinating seedlings have primarily been observed in the Gulf of Bothnia but also occur in Lake Mälaren; albeit to a considerably lesser extent, which may be assumed to be due to a more stable environment with deeper water and smaller numbers of feeding seabirds that tear up seedlings on the Lake Mälaren sites.

Habitat

Baltic water-plantain occurs in brackish waters (maximum salinity approx. 3-4 ‰) or in naturally mesotrophic to eutrophic freshwater with relatively high conductivity (at least approx. 150 ÌS/cm). It has stringent demands in terms of water quality and occurs only in relatively clear waters. This species is unable to withstand competition from large water plants and frequently occurs together with other small species susceptible to competition, such as small pondweed *(Potamogeton pusillus)*, slender-leaved pondweed *(Potamogeton filiformis)*, autumnal water-starwort *(Callitriche hermaphroditica)*, eight-stamened waterwort *(Elatine hydropiper)* and horned pondweed *(Zannichellia palustris)*. Baltic water-plantain refers sandy

bottoms, but it can also occur in areas where the sand is fairly strongly intermixed with clay. However, it is almost never found on pure clay or mud. In Lake Mälaren, Baltic water-plantain normally grows at depths of 0.5–2 metres (Figure 2A), but in exceptional cases it may occur at depths down to 4 metres in areas where the waters are clear. However, the species does not seem to be able to propagate at depths greater than approx. 2 m. In the Gulf of Bothnia, Baltic water-plantain grows in shallower waters and can be found at depths of 0.3–1 metre (depths of 1.5–2 metres in exceptional cases) in areas protected from powerful wave erosion and ice heave and that are not drained entirely during periods of persistent low water. Lagoons and inlets formed recently by the rapid land elevation in the area are common growth sites in the Gulf of Bothnia (Figure 2B). At low water, these sites may be entirely cut off from the sea. Field observations indicate that Baltic water-plantain typically occurs at an intermediate stage of the succession from open, exposed seashores to entirely cut off inlets at the land elevation shores of the Gulf of Bothnia. It is not one of the very first pioneer species to arrive when there is periodic significant erosion due to winds, currents and ice, but nor does it occur in inlets that are entirely cut off. According to Finnish information from the Gulf of Bothnia, the number of individuals on individual sites may vary widely from year to year. It is likely that the relatively unstable environment in the Gulf of Bothnia contributes to the wide variation in the population sizes there from year to year. In Lake Mälaren, where the habitat is considerably more stable, no rapid fluctuations in population sizes have been observed; no fluctuations due to natural causes, in any case.

Baltic water-plantain is probably most susceptible to erosion (waves, being trodden on, etc.) and changing water levels in spring and early summer when the seedlings grown that year are still small and poorly rooted.

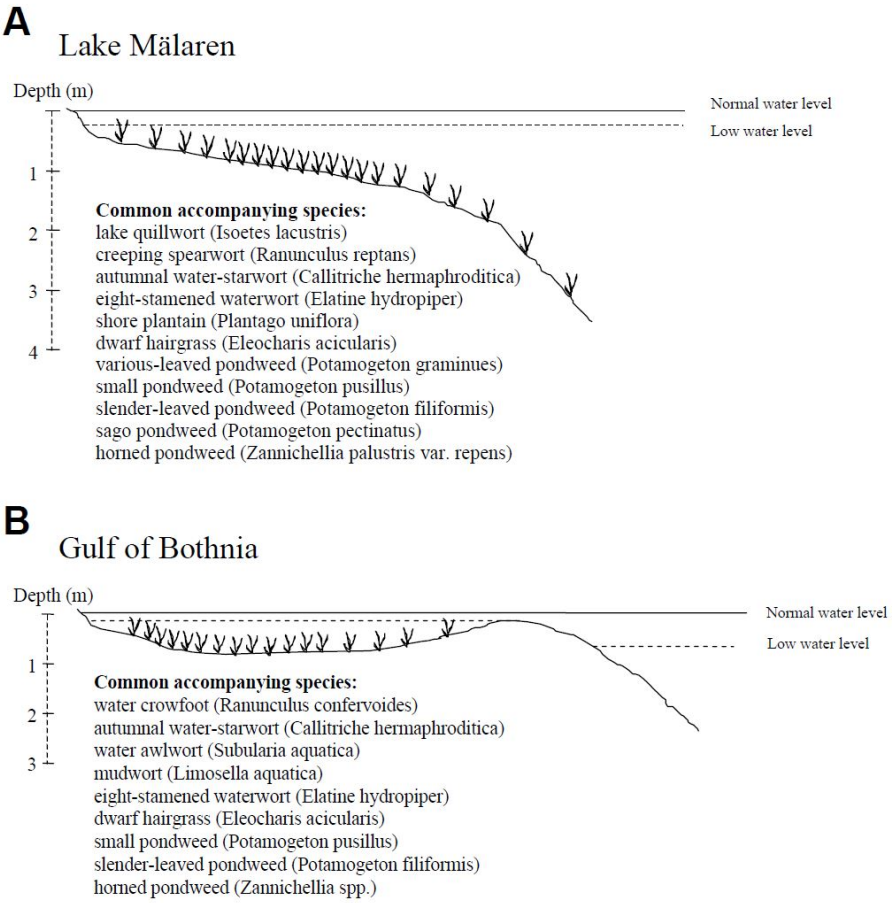

Fig 2. Cross-section of a typical growth site for Baltic water-plantain in Lake Mälaren (A) and the Gulf of Bothnia (B). In Lake Mälaren it frequently grows on relatively shallow sandy bottoms at depths of 0.5-2 metres, but in rare cases it may occur at depths of almost 4 metres adjacent to larger populations. It grows in shallower waters in the Gulf of Bothnia, and the sites are frequently made up of lagoons and inlets of a shape similar to that pictured. Picture Anders Jacobson.

Baltic water-plantain and habitats in Natura 2000

The Natura 2000 habitats that most closely match the environment in the brackish water populations of Baltic water-plantain are 1150 (Coastal lagoons), 1160 (Large shallow inlets and bays) and 1630 (Boreal Baltic coastal meadows). However, no habitat according to Natura 2000 fully matches the growth sites for the species in Lake Mälaren. The nearest one is 3130 (Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*), but in the case of in Lake Mälaren this is not strictly correct as the lake is mesotrophic to eutrophic, rather. Another habitat similar to the one in Lake Mälaren is 1610 (Baltic esker islands with sandy, rocky and shingle short vegetation and sublittoral vegetation). However, Lake Mälaren is a freshwater lake, so this habitat is not completely correct either.

Important interspecies conditions

Baltic water-plantain sensitive to competition from larger water plants and disappears rapidly when reed vegetation spreads. Common reed *(Phragmites australis)*, lakeshore bulrush *(Scheonoplectus lacustris)* and narrow leaf cattail *(Typha angustifolia)* are known to be harsh competitors, but other large species such as great manna grass *(Glyceria maxima)*, water lilies *(Nuphar and Nymphaea)*, longroot smartweed *(Persicaria amphibia)*, some pondweeds *(Potamogeton)* and milfoils *(Myriophyllum)* may also outcompete Baltic water-plantain. Western waterweed *(Elodea nuttallii)* propagates strongly in parts of Lake Mälaren in certain years and would probably be capable of outcompeting Baltic water-plantain and other smaller water plants locally by stealing available light. However, it has not been possible to note serious problems with waterweed at the relevant Baltic water-plantain sites to date.

In parts of Lake Mälaren, primarily the Ekoln bay system, zebra mussel *(Dreissena polymorpha)* have propagated strongly since being introduced in 1926 and may form dense populations down to depths of 10–15 metres (Willén et al. 1990). There is not much space for water plants in areas where the populations are at their densest, and it is possible that the zebra mussel has contributed to the disappearance of the Baltic water-plantain, primarily in the Ekoln bay system. It is worth noting that the zebra mussel is by no means as profuse in parts of Lake Mälaren where Baltic water-plantain still remains (this is also applicable to Stora Ullfjärden, which belongs to the Ekoln bay system).

There are no known problems with diseases, parasites or animals predating on Baltic water-plantain, but it may be assumed that seabirds may feed on the species to a certain extent, particularly on the shallow bottoms in the Gulf of Bothnia during the autumn migration period. However, at the same time seabirds may be assumed to be important to the dispersal of the species, particularly in the Gulf of Bothnia, and a reduction in the number of resting birds during the autumn migration period could have an adverse impact on the dispersal capability of the species.

"Species status"

In the Gulf of Bothnia, Baltic water-plantain indicates a unique, dynamic brackish water environment adjacent to shores with rapid land elevation. Outside the Baltic Sea area, this environment exists hardly anywhere else in the world and thus accommodates one of Sweden's most species-rich water plant communities, with large populations of species that are more or less rare in other parts of the country. Many of these water plants are small and unable to withstand competition and are benefited by the environment created by land elevation, ice erosion and large, irregular variations in water levels. Small pondweed *(Potamogeton pusillus)*, horned pondweed

(Zannichellia palustris), water awlwort, *(Subularia aquatica)*, mudwort *(Limosella aquatica)*, water crowfoot *(Ranunculus confervoides)*, autumnal water-starwort (*Callitriche hermaphroditica)* and various types of waterworts *(Elatine spp.)* are examples of such species.

In Lake Mälaren, Baltic water-plantain is an indicator of very valuable, species-rich environments in naturally mesotrophic to eutrophic freshwater where there is relatively low competition between species due to the absence of reedbeds and other large water plants. Such environments have largely disappeared in Sweden, as in large areas of the rest of Europe, over the past century due to eutrophication, lowering of water levels, storage capacity regulations, reduced shore grazing, cessation of reed harvesting, construction and development. Naturally mesotrophic to eutrophic lakes have frequently been affected particularly severely by eutrophication as they are normally situated in lowland, densely populated clay flatlands where intensive agriculture has taken place for a long time. In Lake Mälaren, now water environments with low interspecies competition, primarily at reed-free shore sections adjacent to eskers. The plant communities at these shores have – for Swedish freshwater conditions – an unusually rich and very rare composition of species, including a mix of eutrophic water plants (such as autumnal water-starwort, *Callitriche hermaphroditica*, sago pondweed, *Potamogeton pectinatus*, small pondweed, *P. pusillus*, horned pondweed, *Zannichellia palustris* var. repens and fan-leaved water crowfoot, *Ranunculus circinatus*) and oligotrophic water plants (such as lake quillwort, *Isoetes lacustris*, spiny quillwort, *I. echinospora*, shore plantain, *Plantago uniflora*, water lobelia, *Lobelia dortmanna* and water awlwort, *Subularia aquatica*). Freshwater environments with plant communities similar to those occurring on Lake Mälaren's reed-free esker shores are probably rare from a European perspective as well.

Due to its rarity, Baltic water-plantain can hardly be used as a signal species despite the fact that it indicates valuable environments. However, due to its rarity and the fact that the species is endemic to our area, it may possibly be of value as a flagship species. Baltic water-plantain may be viewed as a representative of the unusual environments on the esker shores of Lake Mälaren and the land elevation shores of the Gulf of Bothnia.

Further information

For further information on the biology, ecology, genetics and distribution of the Baltic water-plantain, the following are recommended: Björkqvist 1967 and 1968, Savela 1994, Jacobson 1996, Ecke 1997, Tzvelev 2000, Martinsson & Jacobson 1998, Jacobson 1999, Jacobson 2003, Kautsky 2003 and Anderberg & Anderberg 2004.

Distribution and population status

Current distribution

Baltic water-plantain is endemic to the Baltic Sea area and its distribution is split into three regions: Lake Mälaren, the Gulf of Bothnia and the Gulf of Finland (Figure 3). The species is not known in any other area in the world. All relevant sites in Sweden are listed in Appendix 2.

Population facts

It is difficult to make a reasonably safe estimate of the size of the overall world population of Baltic water-plantain as the data is very poor on occasion. However, with what we know at present, it can be assumed that there are several hundred thousand individuals over around a hundred sites (however, the number of sites varies depending on how one chooses to define them).

In **the Gulf of Finland** , Baltic water-plantain is known from a small number of sites between St Petersburg and Viipuri, and a now extinct site in Pyhtää in Finland (Tzvelev 2000). However, not much is known about the current distribution of the species in the Gulf of Finland. In the area around Primorsk, the species was noted in 2001 as a handful of relatively sparsely populated sites (at most a few hundreds of individuals per site), of which a number of occurrences were previously unknown (Jacobson unpublished).

In **Lake Mälaren** , the species is known from around ten sites in three separate subareas: Stora Ullfjärden, Norra Björkfjärden and Kyrkfjärden-Rödstensfjärden. Most of these populations are small and accommodate less than 500 individuals, but at the largest site (Asknäsviken in Kyrkfjärden) the population in 2001 was estimated by Dahlgren to amount to at least 17,000 individuals (Solander & Stenlund 2001). According to the latest reports, the population in Lake Mälaren totals approximately 33,000 individuals (77% of the Swedish population), of which 81% are located in the Sandudden area (including the large population at Asknäsviken) on southern Ekerö. Kyrkfjärden-Rödstensfjärden appears to be the hub for the distribution of the species in Lake Mälaren and Accommodates more than half of the Lake Mälaren sites and 89% of the total population for the lake.

In **the Gulf of Bothnia**, Baltic water-plantain is present on a relatively large number of sites (at least 70 or so), of which some on the Finnish side are very large and probably accommodate several hundred thousand individuals. Quite a lot is known about the distribution of the species on the Finnish side of the Gulf of Bothnia, while considerably less is known about the distribution on the Swedish side. According to the latest reports, the total population of the species on the Swedish side of the Gulf of Bothnia amounts to just over 10,000 individuals (23% of the Swedish population), divided over approx. 13 sites into limited areas: Rånefjärden (13% of the Swedish population in the Gulf of Bothnia) and the outer parts of the

Haparanda archipelago (87% of the Swedish population in the Gulf of Bothnia). The largest known Swedish site in the Gulf of Bothnia can be found at Seskar-Furö in the Haparanda archipelago, which accommodates around 4000 individuals (Hammarsjö & Zethraeus 1998). Other sites on the Swedish side of the Gulf of Bothnia generally accommodate considerably lower numbers of individuals (see Appendix 2). More information about Baltic water-plantain in the Gulf of Bothnia can be found in Ecke & Zethraeus 1997, Hammarsjö & Zethraeus 2000, Zethraeus 2000 and Zethraeus 2003.

Fig. 3. Distribution of Baltic water-plantain (Alisma wahlenbergii). Areas where Baltic water-plantain can be found are marked with dashes. The crosses represent extinct sites, and the question mark indicates uncertain information. 1 = Gulf of Bothnia, 2 = Lake Mälaren, 3 = Gulf of Finland.

Current threat status

Baltic water-plantain is considered to be endangered throughout its entire distribution area, but the threat status differs between the three regions in which it occurs. In Russia (the Gulf of Finland), the species is considered to be acutely endangered (Kotiranta et al. 1998), while in Finland – where most of the known sites are located – it is considered to be vulnerable (VU) On the basis of IUCN criteria A1ac, B2c+3cd (Rassi et al 2001). In Sweden, new Baltic water-plantain finds Over the past decade mean that situation for the species is considerably brighter than it appeared to be when the previous action programme was compiled in 1996. There is hardly any immediate threat to the populations in the Gulf of Bothnia, which is why the species as a whole can no longer be considered to be acutely endangered in Sweden. In the latest Red List (Gärdenfors 2000), Baltic water-plantain is placed in threats category EN (endangered) on the basis of IUCN criteria B1 and 2cd (B1 means that the species has a small distribution area and occurs in fragmented populations, while 2cd means anticipated future decline due to reduced area of occupancy, reduced distribution area, deterioration in habitat quality and actual or potential exploitation of the species). However, the situation in Lake Mälaren is troubling – here, the species is still acutely endangered and is at risk of dying out in the not too distant future if nothing is done, even though a number of new sites have been discovered over the past few years.

History and trends

In **Lake Mälaren** , Baltic water-plantain was first found on many sites in the 19th century and the first half of the 20th century, primarily in the Ekoln bay system upstream of Stäket, where the species appears to have been relatively common (Appendix 2). After that, the species appears to have disappeared from all sites in the Ekoln bay system except for Stora Ullfjärden, probably due mainly to deterioration in water quality and cessation of cultivation on the coastal meadows in the area (Martinsson & Jacobson 1998). The species has also disappeared from a site at Kungsberga on Färingsö, probably due to cessation of agriculture and reed overgrowth. All current sites in Lake Mälaren, except for the one at Stora Ullfjärden, we discovered in 1995 or later and are situated in eastern Lake Mälaren, where the water quality is better than in the Ekoln bay system (Figure 3, Appendix 2). Moreover, eastern Lake Mälaren was not impacted as severely when the problems with eutrophication were at their worst in the 1960s (Persson et al. 1989).

In **the Nyköping district** (Mellanfjärden and Sjösafjärden), Baltic water-plantain was observed up to the late 1960s, but despite repeated attempts it has not been possible to find it again in this area. In the Nyköping area, its disappearance was probably due to deterioration in water quality and overgrowth (Martinsson & Jacobson 1998).

In **the Gulf of Finland**, it is known that Baltic water-plantain has disappeared recently from the area nearest to St Petersburg, where the species was previously present in large numbers at a number of sites. It disappeared from a number of these sites at the time of the construction of the large dam that blocks off the inner part of the Gulf of Finland and protects St Petersburg against extremely high sea levels. Deterioration in water quality within the dam and development of the shores are the likely causes of the disappearance of the species in this area (Tzvelev 2000). Baltic water-plantain has also disappeared from a site at Pyhtää in Finland (Savela 1994). Information on the current status of the species in the Gulf of Finland in general is otherwise so poor that it is difficult to make any definite statements on more general trends in the development of the population.

In **the Gulf of Bothnia**, many new sites have been found over the past decade on both the Finnish and the Swedish sides (all the Swedish sites have been discovered in 1999 or later). It can be assumed that this is mainly due to previous major shortcomings in awareness of the distribution of the species, but nor is it possible to rule out the actual occurrence of a certain increase. On the Finnish side, however, the species is considered to be endangered by eutrophication and overgrowth, at least in certain areas (Rassi et al. 2001). Baltic water-plantain was previously also known at a site in the Vaasa archipelago, but this site is now overgrown and the species has probably disappeared (Savela 1994). The Swedish sites in the Gulf of Bothnia have been not been known long enough for it to be possible to draw conclusions on any population changes. More information about the distribution of Baltic water-plantain on the Swedish side of the Gulf of Bothnia would be desirable. Appropriate growth sites are primarily found at shallow, sandy shores with many lagoons and inlets. Sandgrönnorna in the Luleå archipelago is one example of an interesting area.

There are three unverified reports of Baltic water-plantain from other areas in Sweden. A collection from the mouth of the Svartån river in Roxen made by Cnattingus in 1917 is of particular interest as the coastal meadows in this area may well have been an appropriate environment for Baltic water-plantain at the time the collection was made. This area is also grazed nowadays and could still be home to the species. However, eutrophication has increased enormously in Roxen since the find was made, which reduces the chances of Baltic water-plantain still being in the area. On the other hand, the two other collections – one from Fredriksnäs in the parish of Gryt in Östergötland and one from Lummelunda on Gotland – are highly likely to be incorrect (Samuelsson 1922).

Community status

Regulations for protection of species/general biotope protection

Baltic water-plantain is protected according to section 1 c of the Species Protection Ordinance (1998:179) and NFS 1999:12, which means that picking, digging up or otherwise harming wild, living specimens of the species is prohibited in Sweden. Removing or harming seeds or other parts of Baltic water-plantain is also prohibited. The Species Protection Ordinance (1998:179) prohibits the importation, exportation and storage of living specimens and the sale of living and dead specimens of Baltic water-plantain (there are certain exemptions).

Baltic water-plantain is protected in both Finland and the St Petersburg area in Russia (Kotiranta et al 1998). There is no general biotope protection for Baltic water-plantain growth sites.

The Habitats Directive and the Birds Directive.

Baltic water-plantain is listed as a priority species and species in need of strict protection in Annexes II and IV of the Habitats Directive.

Two of the Natura 2000 habitats in which Baltic water-plantain is found are listed as priority habitats (1150, Coastal lagoons and 1630, Boreal Baltic coastal meadows). According to chapter 7, section 28 a of the Environmental Code, permits are required in order to conduct business or implement actions that may significantly impact on the environment in a natural area designated as a Natura 2000 area in accordance with chapter 7, section 27.

International conventions

Baltic water-plantain is included in Annex I to the Bern Convention, which covers strictly protected plant species.

Existing international action plans

Baltic water-plantain is not covered by any international action programme within the EU or the Bern Convention.

Causes of decline and current threats

Known causes of decline

Eutrophication and overgrowth are likely to be the main causes of the decline in Baltic water-plantain, but dredging, construction and other development of shores and wave erosion from boat traffic have probably been of significance.

- **Eutrophication** leads to increased volumes of plankton and adherent algae, which impairs the light climate for underwater plants.

Eutrophication also accelerates overgrowth of common reed and other large water plants, suppressing Baltic water-plantain and other species that are unable to withstand competition. In Lake Mälaren, eutrophiccation has been a major problem since the mid-20th century, particularly in the Ekoln bay system upstream of the sound at Stäket (with the exception of the relatively isolated Ullfjärden areas, which have been able to maintain better water quality) and in the bays to the west of the line between Enköping and Strängnäs. The eastern parts of Lake Mälaren itself have coped better with the eutrophication problems, and the waters here are considerably clearer (Persson et al. 1989). Increasing eutrophication is also a problem in the Baltic Sea, particularly in the archipelago areas, and it is assumed to have contributed to the disappearance of Baltic water-plantain in the Nyköping district in Sweden (Martinsson & Jacobson 1998), and Vaasa and Pyhtää in Finland (Savela 1994). It is also possible that eutrophication has contributed to its disappearance from a number of smaller sites in the district around Oulu.

- **Overgrowth** of shallow shores at Lake Mälaren and in the Baltic Sea have in many instances become a serious problem over the last 50 years as regards water plants such as Baltic water-plantain that are unable to withstand competition. This is due to increasing eutrophiccation in combination with reduced shore grazing and cessation of reed harvesting. In Lake Mälaren, land elevation has ceased and the water level amplitude has fallen significantly following regulation of the lake in 1943, which has also accelerated overgrowth along the shores. Varying water levels place reed-forming plants at a disadvantage due to the fact that they are raised and worn away by the ice (Alexandersson et al. 1986). Experiences from sites such as Gräsholmen in Lake Mälaren indicate that Baltic water-plantain disappears quickly when reeds propagate. Nor does Baltic water-plantain appear to thrive in the shadows beneath dense, projecting trees and bushes close to shore. However, this is mostly no major problem; but in areas where the zone with an appropriate water depth is narrow – in Stora Ullfjärden, for example – this may potentially limit the habitat of the species to a more obvious extent.
- **Dredging** on and in the vicinity of Baltic water-plantain sites may be harmful in that population is dug out, and probably also because large amounts of settling sludge may suffocate the seedlings nearby. Long-term turbidity of the water following dredging work may also present a problem for Baltic water-plantain as the light climate is then impaired.
- **Construction and other development** of the shores, such as gravel pits, backfilling, marinas, jetties, docking areas for boats and swimming areas, may directly destroy Baltic water-plantain sites, but they may also have an adverse impact on these due to eutrophication and increased

wear and tear. Increased population pressure in the vicinity of Baltic water-plantain sites may have an adverse impact on the plant population due to a general increase in wear and tear at the sites and an increased risk of intervention and emissions of harmful substances.

- **Wave erosion** from larger, fast boats can massively decimate populations of Baltic water-plantain, according to experiences from Gräsholmen in Lake Mälaren (see below). In the longer term, this type of disruption could potentially be devastating for Baltic water-plantain. The backwash from boats probably poses one of the greatest threats to the species throughout much of Lake Mälaren, unless boat traffic is regulated. However, there are exceptions to this. At Fantholmen, no negative trend has been noted despite dense boat traffic in the nearby waters for a long time. This indicates that the species is capable of withstanding erosion in certain environments, perhaps depending on the type of bottom.

Boat traffic a serious threat

Monitoring of the populations at Gräsholmen in Lake Mälaren has shown that Baltic water-plantain is susceptible to erosion caused by powerful backwash from boats. Fast passenger ferries on the Kungsängen–Birka route in the sound between Gräsholmen and Malmhuvud between 1997 and 2001 can be correlated to a dramatic reduction in the population of Baltic water-plantain at Gräsholmen (Figure 4). Other water vegetation also changed on the test routes at Gräsholmen over the same period. During years in which wave erosion was at its most powerful, robust, well rooted species such as various-leaved pondweed and shore plantain accounted for a larger proportion of water plants on the test routes that was previously the case, while the percentage of more sensitive species such as Baltic water-plantain, horned pondweed and small pondweed was reduced. Stoneworts disappeared from the test routes entirely during the same period. The stoneworts returned only when the fast passenger boats stopped operating. The backwash from these boats was very powerful and caused visible damage to the shores of the island. A certain delay to the effects on Baltic water-plantain can be noted in the diagram in Figure 4. The greatest reduction appeared a couple of years after boats had begun to operate there. This is probably because the relatively slow boat M/S Birka Express (nowadays known as M/S Hebbe lille), with a maximum speed of 15 knots (SWEREF 2004), operated on the route for the first two years. The considerably faster M/S Eskil (maximum speed 26 knots) operated on the route in 1999 and 2000, and the even faster but smaller, waterjet-driven boat M/S Speedo 1 (maximum speed 30 knots) operated on the route in 2001. The backwash from these two fast ships probably caused significantly greater damage than the backwash from M/S Birka Express. The delay may also be due in part to the fact that seedlings,

and hence new recruitment of Baltic water-plantain seedlings, were primarily affected by wave erosion initially, while the older seedlings were able to withstand the situation for longer. It is worth noting that M/S Eskil only operated return journeys on the route three or four times a week in the 1999 season when the decline in Baltic water-plantain was at its peak, but that the damage to the site rapidly became very extensive despite its relatively moderate operation. The most intensive boat traffic took place in 2001 (the year before the route was discontinued), when the fast M/S Speedo 1 operated on the route every day between 30 June and 19 August. Pleasingly, it was possible to discern a tendency towards the recovery of the vegetation at Gräsholmen in the 2003 inventory: in other words, as early as the second year with no scheduled boat services in the sound. It is to be hoped that this means the site will recover within a few years, provided that the harmful shipping traffic is not resumed and the site is not permitted to overgrow.

Backwash from standard letter about traffic does not appear to affect Baltic water-plantain populations as dramatically as leisure boats operated in the sound between Malmhuvud and Gräsholmen long before the erosion damage and reduction in Baltic water-plantain numbers began.

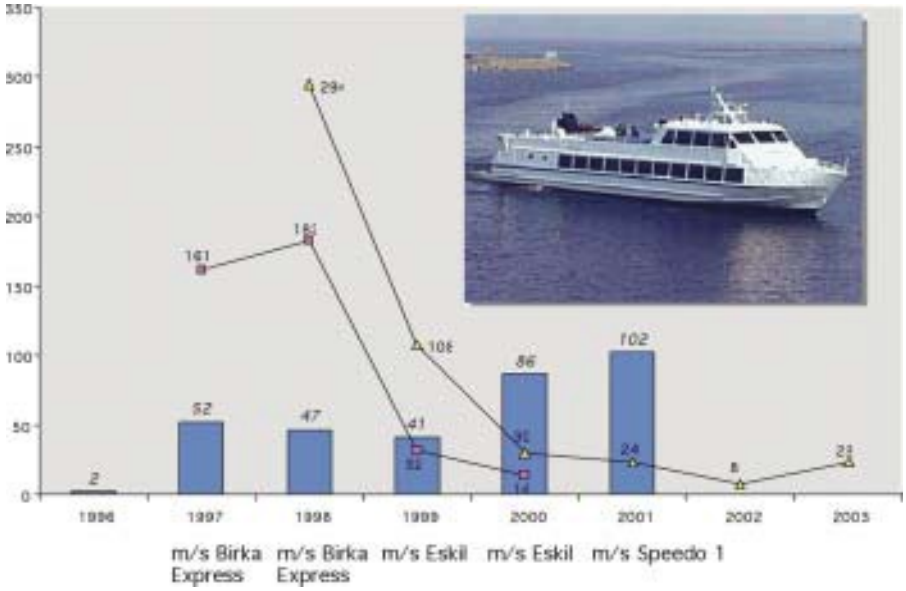

Fig. 4. The lines show the total number of Baltic water-plantain within the fixed test routes in area 3 at Gräsholmen. The top line shows the number in the three outermost routes in transect 2, i.e. the routes in this transect that are not affected by the expanding numbers of reeds in the area. The bottom line shows the number in transect 1. Measurements in this transect were taken between 1997 and 2000. The height of the columns corresponds to the total number of times fast passenger boats of the type pictured passed the area, according to timetables for scheduled trips in each season. The figures in the diagram shows the number of Baltic water-plantain (lines) and the number of passengers (columns) per season. The boat pictured is the fast M/S Eskil, which operated on the Kungsängen-Birka route in 1999 and 2000. This picture is on loan from SWEREF 2004. Information on timings for scheduled services and which boats operated on the route has been obtained from Strömma Kanalbolaget.

Similar effects on macrophytic vegetation from the backwash of boats as those observed at Gräsholmen have also been noted in the Stockholm archipelago (Eriksson et al. 2004), as well as in several other parts of the world such as the Danube Delta (Sarbu 2003), the Nile (Ali, Murphy & Langendorff 1999) and Tallinn Bay (Soomere & Kask 2003). If the water plant communities in the shore zones of Lake Mälaren are destroyed due to boat traffic, this may also have far-reaching effects on areas other than the conservation of Baltic water-plantain, as rich water plant vegetation is very important in the reproduction of invertebrates and fish (Orth et al. 1984, Lubbers et al. 1990, Grenouillet & Pont 2001). In shallower areas, the macrophytes represent a not inconsiderable element of primary production, and a reduction in macrophytic vegetation may shift the equilibrium and lead to an increase in planktonic algae, which will result in more powerful algal blooms and more turbid waters. Moreover, studies have shown that water plants stabilise the sediments and can act as a buffer to prevent the leakage of nutrients from land (Duarte 2000).

Unconfirmed suspected causes of decline

In Stora Ullfjärden, Baltic water-plantain has been declining for some unknown reason since the mid-1990s. There appears to have been no apparent change in the water quality in the bay throughout this period, according to water samples taken by the municipality of Håbo, nor have there been any interventions in the shore areas. It is possible that a change in groundwater currents caused by the current gravel pit in the ridge on the west side of the bay has had an adverse impact on Baltic water-plantain. However, this is merely speculation and more information is needed on the effect of groundwater currents on Baltic water-plantain. Furthermore, it is not known whether the observed decline is due to natural variations in the size of the Baltic water-plantain populations in Stora Ullfjärden.

Current threat

As things stand at present, the Swedish populations of Baltic water-plantain in the Gulf of Bothnia appear to be relatively unthreatened and all sites are located in either the Rånefjärden Natura 2000 area or the Haparanda Archipelago National Park. On the Finnish side of the Gulf of Bothnia, the species is reported to be declining in some areas due to overgrowth caused by eutrophication. Eutrophication is probably less of a problem on the Swedish side of the Gulf of Bothnia as the population density is lower and there is less agricultural land within the water catchment than on the Finnish side. There are signs indicating that Baltic water-plantain has increased in certain areas of the Gulf of Bothnia over the past few years, which could be due to the beneficial effects of moderate eutrophication. In its normal condition, the Gulf of Bothnia is so low on nutrients that a certain amount of eutrophication may perhaps benefit the species (Tupona Kovanen, personal

comment). No surveys relating to this have been published, and it must be borne in mind that any positive effects of eutrophication in the Gulf of Bothnia may at any time be overshadowed by accelerated overgrowth which will threaten Baltic water-plantain in the longer term. In this context, it is important to point out that further eutrophication in Lake Mälaren and the Gulf of Finland would definitely not be beneficial for Baltic water-plantain as these areas are considerably richer in nutrients than the Gulf of Bothnia.

In Lake Mälaren, the situation as regards Baltic water-plantain is troubling. As things stand at present, all sites must be considered to be endangered in one way or another, and if no action is taken there is a risk of the species disappearing from the lake in the not too distant future. Although the situation has improved considerably since the 1960s, problems with eutrophication persist throughout much of Lake Mälaren. The water quality in Ekoln and adjacent bays is probably still too poor for Baltic water-plantain to thrive, and attempts to plant the species in Ekoln have failed (Martinsson & Wetterin 1996). Large parts of the shores of Lake Mälaren have become overgrown with common reed due to eutrophication, reduced shore grazing, cessation of reed harvesting and reduced water level amplitude due to regulation of the lake's outlets. Growth in the Stockholm area threatens Baltic water-plantain in the long-term due to the fact that an increasing proportion of the shores of Lake Mälaren are being incorporated in the urban environment, which increases demands for development of coastal areas by construction of housing and facilities for leisure activities of various kinds, for example. In addition to this, there are problems with the harmful effects of backwash from boat traffic, which is probably a limiting factor as regards the distribution of Baltic water-plantain and several other more or less rare plants that are unable to withstand competition in Lake Mälaren at present. Problems with erosion caused by the backwash from boats can be expected to increase as the population in the Stockholm area grows.

Current threat at currently known Baltic water-plantain sites in Sweden:

Lake Mälaren, Stora Ullfjärden – Decline since the mid-1990s, for unknown reasons. However, the decline appears to have diminished over the past few years. No known, acute threats, but common reed (particularly along the west shore of the bay), wear and tear caused by swimmers, overshadowing trees and bushes and periodically recurring, moderately powerful algal bloom probably limit the habitat for Baltic water-plantain. Powerful lime incrustation of Baltic water-plantain leaves in late summer occurs regularly in Stora Ullfjärden and may possibly impact adversely on the species. *The population will be endangered in the longer term if the observed decline continues.*

Lake Mälaren, Herrmete – The Baltic water-plantain population at the site is endangered due to a massive decline since the late 1990s, probably

caused by wave erosion from fast boats that cause powerful backwashes. No other threats known. *Acutely endangered population.*

Lake Mälaren, Gräsholmen – Large population, although it has undergone a massive decline since the late 1990s, which is highly likely to be due to erosion caused by the backwash from fast passenger ferries. A certain amount of recovery in the populations has been observed since 2001 when the boat services in question stopped operating, and the most acute threat to the populations of Baltic water-plantain appears therefore to have been eliminated, but reed overgrowth still presents a major problem on the shallow west side of the island. Emissions of eutrophying substances via drains from the summer cottages on the island may potentially present a problem. However, this needs to be investigated in greater depth. There has been some dredging in order to make the waters deeper at approaches to private jetties on the island, and this may constitute a problem on a local level. Wear and tear from swimmers on the shallow sandbank at the southern tip of the island may potentially impact adversely on Baltic water-plantain, at least in the places where people swim most frequently. *Provided that the harmful boat traffic is not resumed, there is currently hardly any immediate threat to the populations at Gräsholmen, except in the area on the west side of the island where reeds are propagating.*

Lake Mälaren, Asknäsviken-Sandudden – Lake Mälaren's biggest population of Baltic water-plantain can be found at these relatively recently discovered sites, when nothing is known about the development of the populations. Constant impact of wave erosion from fairways Stockholm-Södertälje in the bay outside the area is probably impacting adversely on the populations as Baltic water-plantain is present in considerably smaller numbers than anticipated, given the water depth at the point where wave erosion is at its most powerful, i.e. less than one metre deep. However, the small island of Narven probably provides a certain amount of protection against wave erosion for the populations in Asknäsviken. Reeds are fairly widespread in the area, particularly in Asknäsviken, and this is probably limiting the distribution of Baltic water-plantain, but at the same time they may provide a certain amount of protection against wave erosion in certain sections. However, the reeds are advancing and will probably threaten the populations in the longer term. Extensive construction work is planned at the now abandoned gravel pit in Uppsalaåsen just inside the shore, along with a large dam to be connected to Lake Mälaren via a canal. Despite a great deal of consideration being shown for Baltic water-plantain populations in the construction plans, it is not possible to disregard the risk of adverse impact from this project, primarily due to a massive increase in population pressure in the area and subsequent risk of increased wear and tear on the shore area, increased eutrophication and the risk of accidents resulting in emissions of pollutants. There is also a risk that starting to develop the area may lead to future demands for more extensive expansion and remodelling of the

landscape, including the shore sections. Asknäsviken and parts of the site at Sandudden are Natura 2000 areas, and a nature reserve is planned for Asknäsviken. *All in all, the populations at Asknäsviken-Sandudden are not considered to be under threat at present, but this may change in the event of future extensive construction of housing in the area. Overgrowth may also constitute a threat in the longer term.*

Lake Mälaren, Fantholmen – A newly discovered small population (around 30 specimens) Is located on the west side of the island, and there is a larger population (approx. 350 specimens) at the southern tip of the island. Both populations are very vulnerable to wave erosion from the fairway just south of the area, and there is major erosion damage to the shore (Dahlgren 2004). An increase in wave erosion due to larger numbers of fast boats in Lake Mälaren may present a serious threat to the populations in the long term. Studying the populations in this area with more emphasis on the effects of erosion would be a valuable exercise. *The populations at Fantholmen are deemed to be endangered due to the powerful wave erosion and the fact that the populations are located outside private shore plots where it is not possible to rule out future intervention in the shore zone.*

Lake Mälaren, Södran – A small population (around 50 specimens) at the north end of the swimming area at Södran. When this site was discovered in the late 1990s, there was a smaller population (some 50 individuals) at the south end of the beach as well. However, this population was not noted in the inventory 2004 (Dahlgren 2004), and it is assumed no longer to exist. The beach at Södran is heavily frequented by swimmers and is also relatively open to wave erosion. If the construction of housing in the nearby Sandudden area continues, the number of swimmers at Södran is likely to increase, resulting in greater wear and tear on the lake beds in the area, which will probably place Baltic water-plantain under threat in the long term. It is possible that the disappearance of the population south of the beach may be due to the increase in the number of swimmers visiting following phase 1 of the construction of housing at Sandudden. *All in all, the populations at Södran are deemed to be acutely endangered.*

Lake Mälaren, Lundhagen – There are two nearby populations of Baltic water-plantain in this area. The larger population, which was discovered in the late 1990s, is located at Lundhagsbadet and, according to an estimate carried out in 2004, comprises around 1900 individuals. The other population, which is considerably smaller (around 50 individuals), is located a couple of hundred metres west of Lundhagsbadet (Dahlgren 2004). No direct, acute threats to these populations are known, but they are situated within areas involving strong human influence, which in itself constitutes a risk for interventions of various kinds (dredging operations, clearing of vegetation, emissions, wear and tear, construction of jetties, etc.). Reeds may potentially cause a problem in the future unless they are kept in check. Both the populations, particularly the one at Lundhagsbadet, are protected against

wave erosion by the island of Röskär, which is located just south of the area. A number of individual specimens of Baltic water-plantain have been found along the entire section between Fantholmen to the west and Rödsten to the east, but no larger populations have been noted (Dahlgren 2004). *All in all, the threat to the populations at Lundhagen is deemed to be fairly small at present, but in future overgrowth, as well as other types of intervention, may constitute a threat as the sites are situated in an area involving strong human influence.*

Lake Mälaren, Slagstabadet – A small population of around 50 individual Baltic water-plantain plants at the beach. This site has not been revisited since the population was discovered in the late 1990s, and its current status is unclear. Extensive wear and tear caused by swimmers and wave erosion from the fairway north of the swimming area probably limiting factors as regards the distribution of the species within the area. *Acutely endangered population.*

Gulf of Bothnia, Haparanda archipelago – A number of fairly large populations within the Haparanda Archipelago National Park. *There is more or less no human influence in the area, and no threats to Baltic water-plantain are known.*

Gulf of Bothnia, Rånefjärden – A number of smaller and a few larger populations. Most of them have been discovered recently and the population development is unknown. Overgrowth may potentially be a problem at some of the sites in the long term. However, this will probably be due not to human influence, but to completely natural causes, primarily land elevation. Untreated sewage discharges from coastal leisure properties may potentially cause local eutrophiccation in inlets with poor water circulation. However, this needs to be investigated in greater depth. Otherwise, there is possibly a risk of intervention at the sites located close to the leisure properties (dredging operations, construction of jetties, motorboats, etc.). *All in all, the threat to the sites in Rånefjärden is deemed to be small but the threat situation should be examined in greater detail.*

Suspected susceptibility to climate change

Baltic water-plantain has a northern distribution and could potentially be directly adversely impacted if the average temperature rises. It is possible to predict with greater certainty that there will be an indirect impact on the species due to changes in plant communities at the sites if the climate changes in future. If the climate becomes warmer, overgrowth may accelerate and volumes of plankton and adherent algae may increase due to elevated water temperature, a longer growth season and increased leakage of nutrients into lakes and seas. Reduced ice erosion, primarily on the shores of the Gulf of Bothnia and the Gulf of Finland, due to shorter ice seasons could also lead to accelerated overgrowth and deterioration of the habitat for Baltic water-plantain.

Other facts

Experiences from previous actions that may affect conservation work

Baltic water-plantain has been cultivated at the University of Uppsala Botanical Garden since the late 1990s, where at least the Lake Mälaren variety appears to be easy to cultivate on sand in water-filled concrete pipes outdoors.

Baltic water-plantain have also been cultivated in unheated greenhouses at the Department of Ecology at Lund University. Experiences from there show that Baltic water-plantain from Lake Mälaren is easy to cultivate on a nutrient-rich substrate in water approximately 30 centimetres deep. Specimens from the Gulf of Bothnia, on the other hand, appear to be considerably more difficult to cultivate, which may be due to the fact that they require a different light climate during the growth season than that offered in southern Sweden. For the best germination, Baltic water-plantain seeds should be sown fresh beneath the water and then cold stratified for several months, ideally over the winter. The germination rate is reduced considerably if the seeds are stored dry for any length of time.

Attempts were made to plant Baltic water-plantain in Stora Ullfjärden and Ekoln in the early 1990s, but the results were poor (Martinsson & Wetterin
1996). During these attempts, seedlings we move directly from natural populations to the planting sites. Experiences from cultivation in green-houses indicate that planting should take place as early as possible in the season as the species must have time to establish itself well before the winter resting period begins in September if it is to survive over winter. Planting early in the season is probably particularly important if seedlings are dug up and moved directly from existing sites as the roots are then damaged more than if plants cultivated in pots are planted.

Advice on handling local information

A number of threatened species are of interest for illegal hunting, picking, etc. Recommendations from the Swedish Environmental Protection Agency and the Swedish Species Information Centre on how to handle information on where the species can be found.

Baltic water-plantain leads an anonymous existence in fairly inaccessible environments at water depths of a few decimetres and is of little value from an aesthetic standpoint, which is why it is possible to assume that illegal gathering of the species is not a major problem. However, it is possible to assume that there will be a certain amount of gathering by plant collectors as the species is so rare. However, no problems with this have been noted in Sweden over the past decades, and all in all there is deemed to be no need to classify Baltic water-plantain sites as confidential as things stand at present.

However, this assessment may be altered if confidentiality becomes necessary in future. In some cases, there may be special reasons to classify individual sites as confidential, but this should be assessed in each individual case.

All site information, regardless of source, should be reported to the Swedish Species Information Centre. Otherwise, relevant county administrative boards and municipalities should also be notified of Baltic water-plantain populations.

Visions and targets

Vision

Favourable conservation status for Baltic water-plantain should be achieved by 2025. In the case of favourable conservation status, vital populations of Baltic water-plantain must occur in all larger regions in which the species was previously known, i.e. in the Gulf of Bothnia, Lake Mälaren, the Nyköping district and the Gulf of Finland. At this time, any obstacles to dispersal and establishment must have been eliminated to such an extent and the water quality must be good enough to give the species opportunities for natural establishment at appropriate sites within the region in question.

Distribution area:

- Baltic water-plantain must be present in the Gulf of Bothnia, Lake Mälaren and the Nyköping district.
- In the Gulf of Bothnia, the present distribution area must be maintained or extended, and there must have been no deterioration of the habitat for the species.
- In the Nyköping district, the water quality and other conditions should be good enough to allow Baltic water-plantain to grow, flower and seed on at least five sites.
- In Lake Mälaren, the water quality must have improved enough to allow Baltic water-plantain to grow, flower and seed in all areas where the plant could be found previously, and at least 20 populations of at least 100 individuals each must be present at various locations within the lake.

Sufficiently large habitat:

- The water quality at sites where the species established must have good ecological status according to the definitions of the Water Framework Directive.
- Every population must have access to at least 100 m2 of sandy bottom.

Population development:

- The number of individuals in every population must be stable (compared with the estimates in Appendix 2) or increase, and every population must comprise at least 100 individuals.

Gap analysis

Outside the Gulf of Bothnia, Baltic water-plantain is currently found in far too few populations that are far too isolated for the future of the species to be assured. The habitat in Lake Mälaren is unsatisfactory due to poor water

quality, overgrowth and threats from development. In the case of favourable conservation status, the habitat in Lake Mälaren will have been improved to the extent that the distribution of the species will not be limited by these factors to any major extent. Planting Baltic water-plantain on new sites in Lake Mälaren and the Nyköping district will create more populations and a wider distribution area, which will reduce the risk of extinction due to unforeseen deterioration of the habitat in any area (e.g. accidents involving emissions of chemicals, intervention at sites, extreme weather over a number of years, etc.). In the Gulf of Bothnia, the habitat for Baltic water-plantain is better as things stand at present, but it is important to ensure that the environment does not deteriorate in future; and furthermore, there is a need for more information on the situation for the species, particularly on the Swedish side of the Gulf of Bothnia. Protection may also be needed against intervention in shore areas where a lot of leisure accommodation is constructed. This problem is particularly extensive on the Finnish side.

Short-term targets

Short-term targets that should be attained during the term of this action programme are listed below.

- By 2007, 15 appropriate planting sites for Baltic water-plantain should be identified in Lake Mälaren and necessary restoration measures should be investigated at each planting site.
- By 2008, planting attempts should have begun at no fewer than three of the above sites.
- By 2008, there should have been further investigation into whether any of the sites in Rånefjärden Is in need of more far-reaching site protection than can be offered by the present Natura 2000 area.
- By 2010, the habitat requirements and ecology for the species should be so well known that it is possible to undertake relevant measures in order to ensure its survival and genetic diversity.
- By 2008, the causes of the decline of the species at all Lake Mälaren sites should be investigated and measures should be undertaken to prevent further decline.
- By 2010, all currently known local threats against individual populations of Baltic water-plantain in Sweden should be eliminated (overgrowth, site eutrophication, wave erosion, damage from construction and development, etc.). This should be coordinated with action programmes in accordance with the Water Framework Directive.
- By 2010, the following Baltic water-plantain sites in Lake Mälaren should have obtained site protection in the form of nature reserves, with special regulations on maintenance in order to benefit the species (reed clearance, grazing, etc. if necessary): Asknäsviken, Sandudden, Gräsholmen and Herrmete.
- By 2010, restrictions to boat traffic should have been introduced in Lake

Mälaren at the fairways in Kyrkfjärden and in the sound between Gräsholmen and Malmhuvud in Norra Björkfjärden (speed limits, ban on boats above a certain size class/speed class and/or amended route for the fairways).

- By 2010, there should be good awareness of the total distribution of the species in Sweden. In order to achieve this, all environments that could accommodate Baltic water-plantain in eastern Lake Mälaren (including the Ekoln bay system), the bays outside Nyköping (the area inside Skanssundet) and the mouth of the Svartån river in Roxen should have been searched in order to find any occurrences of the species. In the Gulf of Bothnia, appropriate sites at shallow, sandy shores should have been searched along the entire coast and in the archipelagos to the south, at least as far as Bjuröklubb.
- By 2010, any trends in the population development of the species at all relevant sites in Sweden should be known. This should take place by means of annual inventories in accordance with the monitoring protocol in Appendix 3. At Gräsholmen, Fantholmen, Asknäsviken, Stora Ullfjärden and any of the sites in the Gulf of Bothnia (ideally in both the Haparanda archipelago and Råneфjärden), this inventory should be supplemented with fixed test routes.

Long-term targets

By 2015, the targets for the number of populations of Baltic water-plantain in the event of favourable conservation status should have been achieved in the Gulf of Bothnia and in the parts of Lake Mälaren that accommodate Baltic water-plantain at present, i.e. Stora Ullfjärden, Norra Björkfjärden and Rödstensfjärden-Kyrkfjärden.

By 2015, Baltic water-plantain should be distributed in Lake Mälaren as follows (every population must accommodate at least 100 individuals, most of which regularly flower and seed – the figures in brackets indicate the number of populations within each area that currently meet this criterion):

- Rödstensfjärden-Kyrkfjärden – at least 7 populations (4).
- Norra Björkfjärden – at least 5 populations (1).
- Stora Ullfjärden – at least 3 populations (2).

For other areas, the following should have been achieved by 2015:

- In the Gulf of Bothnia, all current sites should be intact and information on the total distribution of the species should be satisfactory.
- The water quality in the Ekoln bay system north of Stäket, in Lilla Ullfjärden and in the bays outside Nyköping should have improved sufficiently to allow larger-scale planting of Baltic water-plantain to commence in these areas.

Actions, recommendations

Description of priority actions

This section provides a general description of the actions proposed for implementation during the term of the action programme. Appendix 1 includes a table containing detailed information on the planned actions. The proposals for actions have been devised on the basis of existing information and the conservation actions proposed in the Species and Habitat Guidance for Natura 2000.

New information

Information on the spatial structure of the genetic variation within and between populations is very important as a basis for future decisions on conservation biology issues concerning Baltic water-plantain. Investigations have indicated that Baltic water-plantain in Lake Mälaren accommodates more genetic variation than in the Gulf of Bothnia despite the fact that the Gulf of Bothnia population is many times larger in terms of area, the number of individuals and the number of sub-populations (Jacobson 2003). However, the investigation on which these indications are based was not designed specifically to map the genetic variation in Lake Mälaren, and so further investigations are necessary if it is to be possible with certainty to investigate the distribution of the genetic variation within and between Baltic water-plantain populations in the lake.

Little is known about the natural population dynamics, habitat requirements and dispersal and establishment capability of the species, and these factors should be investigated in greater detail. One issue of relevance in connection with the observed decline in Baltic water-plantain in Stora Ullfjärden, and also in connection with plans to construct housing in the Sandudden area on Ekerö, is whether Baltic water-plantain is favoured by outflowing groundwater on the beds where it grows. Therefore, investigation of this would be desirable.

It is important to investigate whether a long-lived seed bank, similar to that of the common water-plantain *(Alisma plantago-aquatica)*, exists in Baltic water-plantain. One way of testing whether there are fertile seeds in the sediments is to gather sediment samples in late autumn or early spring (as soon as the ice has worked loose) from sites of interest, and then to spread the samples out in containers of water and see what grows. Samples that have been collected in autumn may have to be left until the spring so that germination can begin, as investigations have shown that germination follows a clear annual cycle that is difficult to influence with heat and artificial light (Björkqvist 1967). If there is a long-lived seed bank in Baltic

water-plantain as well, it is hoped that appropriate actions could awaken slumbering seeds on sites where the species has been extinct for a long time.

The effects of competition from other water plants and zebra mussel should be investigated as it is important to know this when repopulating old sites, as well as when assessing the threat to Baltic water-plantain at existing sites.

Nothing is known about how Baltic water-plantain would be affected directly and indirectly by a warmer climate in future, and a study of this would be valuable.

Inventory

There is a lack of information on the distribution of Baltic water-plantain on the Swedish side of the Gulf of Bothnia, and the species should be searched for in more locations, particularly on sandy islands in the Luleå archipelago, such as Sandgrönnorna. Attempts should also be made to seek the species further to the south in the Gulf of Bothnia, at least as far as Bjuröklubb, in order – if possible – to establish the southern boundary for the species on the Swedish side of the Gulf of Bothnia. The distribution of the species in Lake Mälaren is considerably better known than in the Gulf of Bothnia, but despite this there may be unknown populations in the lake: this justifies further searching. New attempts should be made to find Baltic water-plantain in the bays outside Nyköping, and the mouth of the Svartån river in Roxen, where the species was found in the early 20th century, should also be searched.

Information

Information signs should be put up, or existing signs should be supplemented, in areas where Baltic water-plantain is located and where lots of people can be found. The main relevant areas for Lake Mälaren are Gräsholmen, Herrmete, the swimming areas at Södran and Lundhagsbadet on Ekerö, and Slagstabadet in Botkyrka. In the Gulf of Bothnia, signs are mainly relevant in the Haparanda archipelago. Information sheets should be sent out to residents in areas near to Baltic water-plantain populations. The main relevant areas for this are the Sandudden area and the area at Lundhagen on Ekerö, Gräsholmen-Alholmen in Upplands-Bro and Jämtöavan at Rånefjärden.

The action programme should be translated into English and/or Finnish and Russian if possible and distributed to responsible authorities in Finland and the St Petersburg area in Russia.

Prevention of illegal activities

Supervision should be exercised by means of annual inventories of all relevant Baltic water-plantain sites. Sites located near to areas with strong population pressure should be monitored particularly carefully as the risk of

wear and tear, emissions and other adverse impact is greater there than at more inaccessible sites.

Reassessment of applicable regulations

Restricting boat traffic in the sound between Malmhuvud and Gräsholmen is of the utmost importance. Only leisure boats below a certain size class should be allowed to operate in the sound, and a speed limit should be introduced. It is very important to ban fast ships of the M/S Eskil and M/S Speedo 1 type (see "Causes of decline and current threats" above) in the fairways around Gräsholmen and the island world of Norra Björkfjärden. a speed limit should also be introduced in the waters outside Baltic water-plantain populations in Kyrkfjärden-Rödstensfjärden-Vårbyfjärden, at least for ships that cause powerful backwash. An investigation should also be carried out to find out whether it would be possible at all to redirect boat traffic in order to reduce erosion at Baltic water-plantain sites.

Site protection

All currently known populations of Baltic water-plantain in Sweden should be included in Natura 2000 areas. The populations at Gräsholmen and Asknäsviken-Sandudden should be protected in nature reserves. These reserves should also include surrounding water areas (down to depths of at least four metres at Gräsholmen and Asknäsviken-Sandudden). Specific maintenance plans should be devised for each reserve.

The maintenance plan for Gräsholmen – which should be formulated in consultation with the island's association of cottage owners – should include regular reed clearance and monitoring of the Baltic water-plantain populations, as well as restriction of boat traffic in the sound between Gräsholmen and Malmhuvud.

At Asknäsviken-Sandudden, parts of the area should also be cleared of reeds regularly, and a speed limit in the fairway passing the area is desirable.

At Stora Ullfjärden, an investigation should be carried out into whether the maintenance plan for both the existing nature reserve at Ekillaåsen and a potential future reserve on the west side of the bay should include regular reed clearance and clearance of dense, coastal vegetation that projects out over the water in some areas.

An investigation should be carried out into whether it is necessary to form nature reserves at the Baltic water-plantain sites in Rånefjärden in the Gulf of Bothnia. This area is currently in a Natura 2000 area, but further protection may be necessary.

Monitoring

In the national guidelines for conservation actions in Natura 2000 areas, it is proposed that annual inventories of all populations of Baltic water-plantain

in Sweden should be carried out and that the base inventory should include a population estimate at all sites in Lake Mälaren. Inventories and monitoring should be carried out according to the protocol in Appendix 3. Where possible, the total size of the populations should be counted directly. However, in the case of the largest populations this method is less appropriate for purely practical reasons, and here the size of the populations may be estimated instead by counting the number of Baltic water-plantain in randomly positioned sample squares on the site. Counting can be carried out using waders and aquascopes at the sites in the Gulf of Bothnia and Stora Ullfjärden. However, it will be necessary to dive for the inventory at the sites in other parts of Lake Mälaren as the species there grows to a depth of four metres. Regardless of which inventory method is selected, it is very important always to use the same method at a specific site as different inventory methods may give very different results.

Monitoring should also take place using permanent sample squares. The number of permanent sample squares at Gräsholmen in Lake Mälaren should be increased, and new sample squares should be positioned in another of the populations at the island. More permanent sample squares should be laid out in Stora Ullfjärden as well. Monitoring using permanent sample squares should also take place at Asknäsviken-Sandudden. In this area, such monitoring is urgent given the plans to construct extensive housing in the local area. Permanent sample squares should be laid out before more extensive development of the area begins.

In Stora Ullfjärden, water samples should be taken three times a year (in May, July and September) adjacent to any of the Baltic water-plantain populations in order to monitor the water quality during the growth season. These tests should include nutritional salts (total nitrogen and total phosphorus), pH, conductivity, chlorophyll, water colour and water transparency, as well as any other appropriate parameters. An investigation should also be carried out into whether leakage of chemicals – such as herbicides from surrounding farmland – affects Baltic water-plantain in the bay. Water quality in other parts of Lake Mälaren will be monitored by means of regular surveys under the auspices of Mälarens vattenvårdsförbund [the Lake Mälaren water management association], but these should be supplemented with samples taken directly adjacent to the populations at Gräsholmen, Herrmete, Asknäsviken and Lundhagsbadet. These samples should cover the same parameters and be taken at the same times as the samples from Stora Ullfjärden. Similar samples should also be taken at a site in the Haparanda archipelago and a site in Råneфjärden. Here, too, it is important for the samples to be taken using the same method as in Lake Mälaren. Water samples should also be taken according to the same method at two now extinct sites in the Ekoln water system and two extinct sites in the bays outside Nyköping so that these areas can be compared with sites which still have Baltic water-plantain populations.

Creation of appropriate habitats outside the protected areas

It is hoped that the water quality in Lake Mälaren will improve in future, and in this regard it is important to identify potentially appropriate growth sites in areas where Baltic water-plantain could be found previously and protect these even if they are not home to any interesting flora at present. Such environments are primarily coastal meadows and shallow, sandy shores that are not too exposed to waves – ideally adjacent to eskers, but this is probably not a requirement. Appropriate habitats should primarily be sought in areas with little urban impact so as to avoid conflicts with other interests as far as possible. If necessary, these environments can be restored by resuming/increasing shore grazing and/or reed clearance and regular reed harvesting. Actions of this type may also be useful to other endangered plant and animal species that are benefited by coastal cultivation.

In the Gulf of Bothnia, most of the Baltic water-plantain sites occur in naturally open environments, but shore grazing is probably positive for the species here as well, so it is important to protect the grazed coastal meadows remaining in the region. However, shore grazing has never been significant in the Gulf of Bothnia, and the influence of the ice on the areas in question is instead beneficial for the conservation of the species. There are a number of examples of Baltic water-plantain sites on the Finnish side of the Gulf of Bothnia where shore grazing occurs, such as Ulkokarvo on Hailuoto. These sites would probably become partly overgrown if grazing were to cease, which would most probably make them less appropriate for Baltic water-plantain.

Biotope conservation initiatives on a regional level

On a regional level, it is important to improve the water quality in areas which accommodate or have accommodated Baltic water-plantain. This can be achieved by reducing leaching of nutrients from agricultural land, improving the treatment of sewage and reducing nitrogen deposition from the air. Actions to improve water quality are particularly important in Lake Mälaren (especially in the Ekoln bay system) and in the bays outside Nyköping.

In Lake Mälaren, changing the regulation of the water level in the lake could be beneficial to Baltic water-plantain. If greater variation in the water level were to be permitted, with high water directly before the thaw and low water in summer and winter, Baltic water-plantain and other water plants that are unable to withstand competition would be benefited, while reed vegetation would be placed at a disadvantage as it would be raised up and worn away by the ice.

Biotope conservation initiatives at relevant sites

Biotope conservation initiatives are most urgent at the Baltic water-plantain sites in Lake Mälaren. Reduction of the nutritional salt levels in Lake Mälaren as a whole must be regarded as the most important general objective, but local initiatives should also be implemented at each respective growth site as required, such as preventing overgrowth and excessive wear and tear from human activities.

In practice, the biotope conservation actions at the relevant sites for Baltic water-plantain mainly involve regular clearing of reeds. In some cases, clearing overshadowing trees and bushes may be beneficial to Baltic water-plantain as the species appears to be placed at a disadvantage by dense vegetation projecting out over the water. Resumed or extended shore grazing could be beneficial at Asknäsviken in Lake Mälaren, but it is not really of relevance at other currently known Swedish Baltic water-plantain sites.

Below is a list of Baltic water-plantain sites in Sweden where local biotope conservation initiatives should be implemented:

Mälaren, Stora Ullfjärden

- Reed clearance may be necessary in some areas, primarily on the west side of the bay where the reeds are distributed more widely than on the spit between Stora Ullfjärden and Lilla Ullfjärden.
- Clearing of trees and bushes that project out over the water and over-shadow the bottom may be relevant in some sections. Baltic water-plantain does not appear to thrive in the shadow of other vegetation, and as the zone with an appropriate water depth for the species is relatively narrow in Stora Ullfjärden (often less than five metres wide), dense vegetation projecting out over the water may be a limiting factor for the distribution of the species along certain shores. The greatest problem with overshadowing vegetation is probably encountered along the west shore of the bay, but this should be investigated before implementing any clearing operations.

Lake Mälaren, Gräsholmen

- Reed clearance is very important on the west side of the south tip of Gräsholmen. This shallow, sandy area was previously used as a beach by summer visitors to the island, but since the beach was abandoned the area has rapidly become overgrown (at least since the early 1990s), and it is important for the reeds to be cleared as soon as possible. Baltic water-plantain occurs in smaller numbers in a number of areas around Gräsholmen, even outside the larger populations, and reduction of the distribution of reeds around the island, primarily on the west and north sides, would probably benefit the establishment of more large populations of Baltic water-plantain.
- Limiting the size and speed of boats in the waters around Gräsholmen

would reduce the risk of adverse wave erosion in the area.
- Any eutrophying emissions via individual drains from summer cottages on the island should be reduced.

Lake Mälaren, Sandudden-Asknäsviken
- Comparisons with old aerial photos show that over the last few decades, reeds have propagated in this area and reed clearance would probably be beneficial to Baltic water-plantain. In any case, the reeds must not be permitted to propagate more than is already the case. Reed clearance is most urgent in Asknäsviken, where broad reed beds can be found. However, an investigation should be carried out to find out whether the reeds in parts of Asknäsviken provide a certain amount of protection against wave erosion from the fairway in the bay outside, and in this case they should be retained.
- Resuming/increasing shore grazing at Asknäsviken could perhaps benefit Baltic water-plantain, but this should be investigated first as the shore area is currently inaccessible and therefore less attractive as a location for potentially harmful human activities such as swimming and motorboats.
- Speed limits in the fairway south of the area could reduce harmful wave erosion.

Lake Mälaren, Fantholmen
- The backwash from boats in the fairway just south of the site should be reduced by defining a speed limit in the fairway or moving the fairway further away from Fantholmen.

Lake Mälaren, Södran
- Baltic water-plantain is only present in the area north of the beach itself (it was previously present south of the shore as well). Clearing of reeds in the area north and south of the beach could benefit Baltic water-plantain as long as these areas are not utilised intensively by swimmers.
- Appropriate actions should be used to steer swimming activities away from the areas at the northernmost and southernmost parts of the beach where Baltic water-plantain grows.

Lake Mälaren, Lundhagen
- Common reed and other large water plants should be cleared as required, including from areas where there is no Baltic water-plantain at present. This will create appropriate new growth sites in the area to which the species can spread.
- Excessive impact from boats, swimmers and other activities in the shore area should be avoided near to the Baltic water-plantain sites.
- The area at the beach should be "cleaned" using gentle methods. Staff who maintain the beach facilities should be notified of where Baltic

water-plantain can be found and what it looks like, and they should be told to respect the species when performing cleaning operations and other work at the site.

Lake Mälaren, Slagstabadet

- A speed limit should be introduced in the fairway north of the site.
- Responsible staff should be notified that Baltic water-plantain is present in the area and that it should be respected when performing cleaning operations and other work at the site.

Actions to reinforce the population

The number of Baltic water-plantain sites in Sweden must be increased in order to achieve a favourable conservation status for the species. In Lake Mälaren, the number of viable sites with at least 100 individuals per site should be increased to at least 20 by 2025. As the species appears to find it difficult to spread over long distances, planting on new growth sites will probably be necessary in order to attain this objective. Planting should primarily take place on sites where the species grew previously. If these sites are no longer appropriate for Baltic water-plantain and it is deemed impossible to restore them, other appropriate growth sites should also be sought. In many cases, the planting sites will probably have to be restored in some way; by means of reed clearance and/or resumed/intensified shore grazing, for example. Planting should also be tested in the Ekoln bay system north of Stäket. Previous planting attempts in this area have failed, which was considered to be due to the fact that the water quality in the area is still too poor for Baltic water-plantain to thrive. However, these planting attempts were made to a fairly limited extent, and it would be valuable to implement more extensive planting operations on appropriate sites in this area so that the results can be evaluated more effectively.

If possible, Baltic water-plantain should be reintroduced to the bays outside Nyköping. However, the number of appropriate sites here is limited due to occasionally vigorous reed overgrowth and generally poor water quality. The more or less reed-free coastal meadows east of Linudden, which could have constituted appropriate environments, are unfortunately severely impacted by wave erosion from a nearby fairway, and the water is very cloudy and probably not appropriate for Baltic water-plantain. If these problems can be remedied, or if other sites offering more appropriate environments be found, attempts should be made to plant Baltic water-plantain as soon as possible. However, it should be borne in mind that the water quality in these bays will probably still have to be improved if Baltic water-plantain is to have the opportunity to survive there in the longer term. Systematic planting attempts may provide an indicator of how poor the situation is with the habitat in these bays.

Material for planting should primarily be obtained from any seed banks at the relevant planting sites. If there is no fertile seed bank available, material for planting should be gathered from sites that are as local as possible. It is hoped that genetic surveys will be able to provide more details information on which populations would be appropriate to use as sources of material for planting operations. However, it is already clear that material should not be taken from one region (Lake Mälaren, the Gulf of Bothnia and the Gulf of Finland) for planting in another as there are genetic differences between the regions (Jacobson 2003).

Further genetic surveys may provide answers as to whether there are any small, endangered populations with unusual genotypes in each region. It is particularly valuable to conserve such populations, and biotope conservation initiatives and initiatives to reinforce the population may be particularly urgent there.

Unusual genotypes should be given priority during planting operations in order to reduce the risk of loss of genetic diversity within the species. Note that material from unusual genotypes should primarily be planted on new sites in the vicinity of the original site and not directly adjacent to sites that are home to other genotypes.

When planting at both new and existing sites, it is very important to perform a thorough follow-up and evaluation. Newly introduced populations should be studied carefully for a number of years so that a relevant evaluation can be carried out. Planting should take placed systematically, and each individual planted should be marked separately so that its future fate can be monitored. For a planting operation to be considered successful the site should accommodate a population of at least 100 reproducing individuals for at least five consecutive years and it must be possible to observe good rejuvenation.

Gene bank and cooperation across national borders

Cooperation with Finland and Russia for the conservation of Baltic water-plantain would be valuable. Such cooperation could, for example, include joint research projects and exchanging information and experiences. Botanical gardens and/or other appropriate institutions in Sweden, Finland and Russia could act as gene banks for Baltic water-plantain by continuing to cultivate material from the various regional populations (Lake Mälaren, the Gulf of Bothnia and the Gulf of Finland). A gene bank of this kind could preserve the genetic variation in the species in the event of any of the regional populations dying out. It may also be stated that the species is very unfamiliar in the Gulf of Finland and funding, perhaps from the EU, should be set aside in order to search for Baltic water-plantain in both the Russian and Finnish parts of the Gulf of Finland.

General recommendations to various stakeholders

Actions that may harm the species

Reed clearance and all types of clearance should use gentle methods at sites where Baltic water-plantain is present. If excessive amounts of sludge and sand are disturbed, this may harm the species by impairing the right climate and suffocating the seedlings due to sedimentation of agitated material. Jetties, swimming areas, swimming areas for dogs and docking areas for boats should not be constructed at or in the vicinity of Baltic water-plantain growth sites. Initiatives that may cause an increase in the outflow of sediment, nutrients and chemicals should not be implemented in the vicinity of Baltic water-plantain growth sites, nor should actions be implemented that increase the risk of erosion in the shore zone (increased boat traffic, excavation work in the shore zone, dredging operations, removal of stabilising vegetation in the shore zone, etc.). In general, all actions and initiatives in the vicinity of Baltic water-plantain populations should be assessed in each individual case as the effects may vary widely depending on differences in the local conditions at each site.

How different stakeholders can benefit the species

Landowners and other occupiers of shore areas within Baltic water-plantain distribution areas can benefit the species by:

- keeping down reeds and other large water plants, particularly along sandy sections of shore.
- maintaining or resuming grazing, primarily with cattle, on coastal meadows (including on sites where the species is not currently present).
- taking Baltic water-plantain into account when cleaning swimming areas where the species can be found.
- avoiding disruptive water activities in the vicinity of the Baltic water-plantain population (fast boats, dredging operations, frequent swimming, etc.).
- not using chemicals and toxins such as herbicides in coastal areas.
- reviewing and minimising emissions from drains.
- minimising emissions of fertilisers and chemicals from agricultural land, – particularly in areas where water runs off to known Baltic water-plantain sites.

Assistance with funding for actions

Stakeholders wishing to implement actions that will benefit Baltic water-plantain can receive information via their county administrative boards on where assistance with funding can be applied for. Assistance with funding available via municipalities' local nature conservation initiatives.

Consequences and validity

Impact statement

Effects of the action programme on other endangered species

The actions in the programme directly benefit a number of small water plants that are unable to withstand competition and stoneworts that are present in the same environment as Baltic water-plantain. A number of these species have now become more or less rare in freshwater, particularly in southern Sweden. These species are: autumnal water-starwort *(Callitriche hermaphroditica)*, waterwort *(Elatine spp)*, mudwort *(Limosella aquatica)*, small pondweed *(Potamogeton pusillus)*, slender-leaved pondweed *(Potamogeton filiformis)*, horned pondweed *(Zannichellia palustris)* and several stonewort species.

A number of other underwater plants will benefit indirectly from the actions. This is also applicable to species that do not grow directly next to current Baltic water-plantain growth sites. Endangered and/or more or less rare species that will probably benefit from the actions to promote Baltic water-plantain are: water crowfoot *(Ranunculus confervoides)*, fan-leaved water crowfoot *(Ranunculus circinatus)*, grass-wrack pondweed *(Potamogeton compressus)*, flat-stalked pondweed *(Potamogeton friesii)*, sheathed pondweed (*Potamogeton vaginatus)* and long-stalked pondweed *(Potamogeton praelongus)*. Grass-wrack pondweed and flat-stalked pondweed are classified as vulnerable (threat category VU), while sheathed pondweed is classified as near threatened (threat category NT).

Improved water quality, rich underwater vegetation, reduced reed numbers, shore grazing and reduced wave erosion from boats will also benefit various waders, fish species and lower animals.

Resumed/intensified shore grazing will benefit all terrestrial organisms linked with open, well-managed coastal meadows. Many of these organisms have declined over the past century. Examples of less common species in well grazed coastal meadows are strawberry clover *(Trifolium fragiferum)*, adder's-tongue *(Ophioglossum vulgatum)*, fen violet *(Viola persicifolia)*, early marsh-orchid *(Dactylorhiza incarnata)*, marsh pea *(Lathyrus palustris)*, water-purslane (*Lythrum portula)*, western yellow wagtail *(Motacilla flava)* and a range of waders.

Certain bird species that nest in lakes rich in reeds are the primary organisms that may be assumed to be disadvantaged by the proposed actions for the conservation of Baltic water-plantain. It may be assumed this will be disadvantaged in that the actions of the programme aim partly to reduce reed numbers.

Effects of the action programme on various habitats

Natural environments that will benefit from the actions in the programme are grazed coastal meadows, shallow bottoms with short vegetation, esker shores, lagoons and mesotrophic to eutrophic lakes. Natural environments that will be disadvantaged are reed beds, shore thickets and overgrown land in previously managed coastal meadows.

Natura 2000 habitats that will benefit from the action programme are 1150* (Coastal lagoons), 1160 (Large shallow inlets and bays) and 1630 (Boreal Baltic coastal meadows). Habitat 3130 (Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea) will also be favoured if it can currently be considered not to occur at all within the distribution area for Baltic water-plantain. Habitat 3150 (Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation) will benefit from the actions that aim to reduce eutrophication and heavy overgrowth, but they may also be disadvantaged by the fact that the actions of the programme aim to reduce floating aquatic vegetation, large underwater plants and reeds on Baltic water-plantain growth sites. Otherwise, no Natura 2000 habitats be disadvantaged by the actions proposed in this action programme.

**Priority habitat*

Conflicts of interest in general

The greatest risk of conflict between Baltic water-plantain conservation work and other interests occurs in the densely populated areas near Stockholm. Demands for construction work and other types of development of coastal areas and conflicts concerning the right to use the shores for various leisure activity types are potential conflicts of interest. The right to sail boats in the areas is another likely source of conflicts. There is a risk of conflicts as regards both commercial boats and leisure boats.

Proposals for minimisation of conflicts of interest

When planting Baltic water-plantain on new sites, densely populated areas where there is a risk of potential future conflicts of interest should be avoided. Affected municipalities also have a major responsibility in the planning work to steer expansion work and development away from areas near to Baltic water-plantain populations.

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Action table for Baltic water-plantain 2016-2020, according to decision 9 September 2016, ref. no. 2299-2016

Action¤	County	Area/site	Stakeholder	Funded by	Estimated cost	Priority	To be implemented by
Biotope maintenance: clearing of reeds and other competing above-water vegetation	AB, C	Stora Ullfjärden, Gräsholmen, Asknäsviken and elsewhere if necessary	CAB AB, C	Swedish Agency for Marine and Water Management (allocation 1:12)/NV (allocation 1:3)	200 000	1	2020
Biotope maintenance: resumed/intensified short grazing at relevant Baltic water-plantain sites	AB	Asknäsviken (however, the effects should be investigated first)	CAB AB	NV (allocation 1:3)	Not included	2	2020
Information: review the information on Baltic water-plantain on signs at Baltic water-plantain sites	AB, C, BD	All sites	CAB AB, C, BD and relevant municipalities	Swedish Agency for Marine and Water Management (allocation 1:12)	30 000	1	2017
Information: targeted information for specific target groups; landowners, farmers, etc.	AB, C, BD	Sites in acute need of action	CAB AB, C, BD	CAB/Swedish Agency for Marine and Water Management (allocation 1:12)	?	1	2020
Information: update fact sheet on Baltic water-plantain	AB, C, BD	All sites	CAB AB, C, BD/ Swedish Species Information Centre/ Floraväkteriet	Swedish Agency for Marine and Water Management (allocation 1:12) /Swedish Species Information Centre	30 000	3	2020
Information: set up viewing premises for Baltic water-plantain using a snorkel line, for example	AB	Suggestion: Södran or Lundhagsbadet	CAB/municipality of Ekerö	Swedish Agency for Marine and Water Management (allocation 1:12)/WWF?	30 000	3	2020
Information: translation of the action programme into English	AB, C, BD	Relates to all sites	CAB AB	Swedish Agency for Marine and Water Management (allocation 1:12)/Swedish Species Information Centre	15 000	3	2018
Inventory: counting of all known Baltic water-plantain populations with reasonable accuracy once every 6 years, coordinated with the biogeographical follow-up	AB	Lake Mälaren – sites in county of Stockholm	CAB AB	Swedish Agency for Marine and Water Management (biogeographical follow-up)/Swedish Agency for Marine and Water Management (allocation 1:12)	150 000	1	2017
Inventory: counting of all known Baltic water-plantain populations with reasonable accuracy once every 6 years, coordinated with the biogeographical follow-up	C	Lake Mälaren – sites in county of Uppsala	CAB C	Swedish Agency for Marine and Water Management (biogeographical follow-up)/Swedish Agency for Marine and Water Management (allocation 1:12)	20 000	1	2017

Inventory: counting of all known Baltic water-plantain populations with reasonable accuracy once every 6 years, coordinated with the biogeographical follow-up	BD	Gulf of Bothnia	CAB BD	Swedish Agency for Marine and Water Management (biogeographical follow-up)/Swedish Agency for Marine and Water Management (allocation 1:12)	40 000	1	2017
Inventory: searching for Baltic water-plantain in appropriate habitats	BD	Gulf of Bothnia	CAB BD	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	75 000	2	2016
Inventory: annual general inspection of population status	AB	Lake Mälaren – sites in county of Stockholm	CAB AB	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	200 000	2	annually
Inventory: annual general inspection of population status	C	Lake Mälaren – sites in county of Uppsala	CAB C	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	60 000	2	annually
Inventory: annual general inspection of population status	BD	Gulf of Bothnia	CAB BD	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	75 000	2	annually
Inventory: annual counting of population/populations in order to get a better perception of population dynamics and/or to follow up on actions	AB, C	Lake Mälaren: (suggested) Asknäsviken or Sandudden	CAB AB, C	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	150 000	2	annually
Inventory: annual counting of population/populations in order to get a better perception of population dynamics and/or to follow up on actions	BD	Rånefjärden	CAB BD	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	30 000	2	annually
Inventory: searching for Baltic water-plantain in appropriate habitats	AB, C	Lake Mälaren	CAB AB, C, D	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	50 000	2	2016
Inventory: searching for Baltic water-plantain in appropriate habitats	D, E	Other historical sites		Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	25 000	3	2020
Data management: all inventories to be processed in Artportalen, including estimated distribution area	AB, C, BD	All sites	CAB/inventory personnel	Swedish Agency for Marine and Water Management (allocation 1:12) /responsible for biogeographical follow-up	?	1	Ongoing
Quality assurance/skills development: workshop on Baltic water-plantain for inventory personnel, etc. with the opportunity to visit national sites and possibly sites in Finland/Russia	AB, C, BD			Swedish Agency for Marine and Water Management (allocation 1:12)	30 000	2	2020

Protection: investigate the conditions and the need for protection of unprotected sites	AB, C, BD	Gräsholmen, Fantholmen, Södran, Lundhagen, Slagstabadet, Stora Ullfjärden 2 and 3, new site in Gulf of Bothnia	CAB AB, C, BD	Affected CAB	Not included	1	2020
Protection: investigate the conditions and the need for enhanced protection	AB	Asknäsviken	CAB AB	CAB AB	Not included	2	2020
Protection: regulation of boat traffic (speed and size limits)	AB	Herrmete, Gräsholmen, Asknäsviken, Sandudden, Fantholmen, Södran, Lundhagen and Slagstabadet	CAB AB	CAB AB	Not included	3	2020
Planting: investigate the conditions for planting of Baltic water-plantain at previous sites in Lake Mälaren	AB, C	Ekoln area, etc.	CAB C	Swedish Agency for Marine and Water Management (allocation 1:12)	30 000	1	2017
Planting: follow-up of previous planting attempts	C	Sandviksåsen		Swedish Agency for Marine and Water Management (allocation 1:12)	20 000	1	Ongoing
Planting: planting attempts, including follow-up and evaluation	C	adjacent to historical sites in Lake Mälaren	AB C	Swedish Agency for Marine and Water Management (allocation 1:12)	75 000	1	2020
Planting: restoration of planting sites by clearing reeds and resuming short grazing, for example	C	Lake Mälaren	CAB C	Swedish Agency for Marine and Water Management (allocation 1:12)	100 000	2	2020
Planting: investigate whether there is any fertile seed bank at old sites	AB, C	Lake Mälaren	CAB AB, C	Swedish Agency for Marine and Water Management (allocation 1:12)	25 000	2	2020
Investigation: summary of inventory results 2003-2015 plus processing of the sites in Artportalen	BD	Rånefjärden	CAB BD	Swedish Agency for Marine and Water Management (allocation 1:12)/Swedish Species Information Centre	20 000	1	2016
Investigation: investigation of the nutrient load	C	Stora Ullfjärden, etc. Ekillabäcken's contribution	CAB C	Swedish Agency for Marine and Water Management/CAB	50 000	1	2017
Investigation: provide suggestions for appropriate areas for searching using GIS analysis and expert knowledge	BD	The entire northerly distribution area	Swedish Species Information Centre	Swedish Species Information Centre	?	2	2016
Investigation/research: investigate the significance of outflowing groundwater	AB, C, BD	Entire distribution area. Ideally in cooperation with Finland and Russia	AB/Swedish Species Information Centre/Swedish Agency for Marine and Water Management	Swedish Agency for Marine and Water Management/Swedish Species Information Centre/universities	?	3	2020

Investigation: investigate positive and negative effects of wear and tear from swimming and the effects of boat traffic	AB, C, BD	Entire distribution area. Ideally in cooperation with Finland and Russia	CAB/Swedish Species Information Centre/Swedish Agency for Marine and Water Management	Swedish Agency for Marine and Water Management/Swedish Species Information Centre/universities	?	3	020
Investigation/research: investigate the population dynamics of the species	AB, C, BD	Entire distribution area. Ideally in cooperation with Finland and Russia	CAB/Swedish Species Information Centre/Swedish Agency for Marine and Water Management	Swedish Agency for Marine and Water Management/Swedish Species Information Centre/universities	?	3	2020
Other actions: work to achieve Good Ecological status on the basis of the Vattenmyndigheterna Action Programme	AB, C	Stora Ullfjärden, Rödstensfjärden	Relevant municipalities/CAB	Swedish Agency for Marine and Water Management/CAB/municipalities	100 000	2	Ongoing
Other actions: gene bank (cultivation of Baltic water-plantain from the entire distribution area at botanical gardens, for example)		All areas. Ideally in cooperation with Finland and Russia	CAB AB	Swedish Agency for Marine and Water Management (allocation 1:12)	?	3	2020
Total estimated cost					***1 630 000***		

Table showing current Baltic water-plantain (Alisma wahlenbergii) sites in Sweden.
Compiled by Anders Jacobson on 10 February 2005.

* = information from Peter Erixon, Luleå

Site, year	Lake Mälaren	Discovered in	Area, latest	Number	Counted	Development	Threat	Protection	Other	Source
1	Slagstabadet	1998	small	50	1998	?	swimming, backwash from boats	none	endangered site	Anders Jacobson, Göran Odelvik
2a	Lundhagen 1 (Lundhagsbadet)	1998	small	1 875	2004	stable ?	swimming, close proximity to jetty	none	possibly slightly skewed age distribution in population	Anders Jacobson
2b	Lundhagen 2	2004	small	52	2004	?	close proximity to jetty	none	risky location between jetties	Stefan Dahlgren
3	Södran	1998	small	50	2004	?	swimming, planned marina	none	endangered site	Anders Jacobson
4a	Fantholmen 1	1999	small	350	2004	?	backwash from boats, private beach plot with docking area for boat	none	endangered site	Anders Jacobson
4b	Fantholmen 2	2004	small	26	2004	?	backwash from boats, private beach plot	none	endangered site	Stefan Dahlgren
5	Sandudden	1998	moderate	9 000	2000	stable ?	nearby marina, planned housing construction in local area, backwash from boats	Natura 2000	seems vigorous	Anders Jacobson
6	Asknäsviken	2000	large	17 000	2000	stable ?	planned housing construction in local area, backwash from boats, overgrowth	Natura 2000	seems vigorous	Nanna Malmros, Anders Jacobson
7	Gräsholmen	1995	moderate	3000	2000	catastrophic decline since 1998	backwash from boats, overgrowth, dredging operations	none	endangered, formerly the largest site and very vigorous at that time	Anders Jacobson

Site, year	Lake Mälaren	Discovered in	Area, latest	Number	Counted	Development	Threat	Protection	Other	Source
8	Herrmete	1997	small	25	2000	Severely declining since 1997	possibly impaired	Natura 2000	acutely endangered site	Stefan Dahlgren, Anders Jacobson.
9	Stora Ullfjärden 1	1850	large	450	2003	since mid-1990s	possibly impaired water quality (?), gravel pit	nature reserve and Natura 2000	endangered if decline continues	A. Fls.(Erik Almquist's notes at University Library, Uppsala)
10	Stora Ullfjärden 2	1987	large	27	2000	declining since mid-1990s	impaired water quality (?), gravel pit	Natura 2000	acutely endangered if decline continues	Karin Martinsson
11	Stora Ullfjärden 3	1993	large	220	2000	declining since mid-1990s	impaired water quality (?), gravel pit	Natura 2000	endangered if decline continues	Karin Martinsson
	Gulf of Bothnia									
12	Haparanda Sandskär 1	2000	large	3000	2000	?	none	Natura 2000 Haparanda Archipelago National Park		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Linda Johansson, Staffan Svanberg, Ulf Zethraeus
13a	Haparanda Sandskär 2a	2000	moderate	100	2000	?	none	Natura 2000, Haparanda Archipelago National Park		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Linda Johansson, Staffan Svanberg, Ulf Zethraeus
13b	Haparanda Sandskär 2b	2000	moderate	500	2000	?	none	Natura 2000, Haparanda Archipelago National Park		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Linda Johansson, Staffan Svanberg, Ulf Zethraeus

Site	Gulf of Bothnia	Discovered in	Area	Number	Counted	Development	Threat	Protection	Other	Source
14a	Haparanda Sandskär 3a	2000	moderate	1000	2000	?	none	Natura 2000, Haparanda Archipelago National Park		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Linda Johansson, Staffan Svanberg, Ulf Zethraeus
14b	Haparanda Sandskär 3b	2000	moderate	20	2000	?	none	Natura 2000, Haparanda Archipelago National Park		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Linda Johansson, Staffan Svanberg, Ulf Zethraeus
15	Seskar-Furö 1	1998	large	4000	1998	?	none	Natura 2000, Haparanda Archipelago National Park		Anders Jacobson, Jan Ahlm, Märta Fredriksson, Claes Hammarsjö, Svante Pekkari, Staffan Svanberg, Ulf Zethraeus
16	Seskar-Furö 2	1998	moderate	100	1998	?	none	Natura 2000, Haparanda Archipelago National Park		Svante Pekkari, Anders Jacobson, Jan Ahlm, Märta Fredriksson, Claes Hammarsjö, Staffan Svanberg, Ulf Zethraeus

Site	Gulf of Bothnia	Discovered in	Area	Number	Last counted	Development	Threat	Protection	Other	Source
17	Seskar-Furö 3	1998	moderate	200	1998	?	none	Natura 2000, Haparanda Archipelago National Park		Ulf Zethraeus, Anders Jacobson, Jan Ahlm, Märta Fredriksson, Claes Hammarsjö, Svante Pekkari, Staffan Svanberg
18	Rånefjärden 1	2003	moderate	100-120*	2003	?	none known	Natura 2000		Peter Erixon
19a	Rånefjärden 2a	2003	small	10-20*	2003	?	none known	Natura 2000		Peter Erixon
19b	Rånefjärden 2b	2000	large	>1000*	2003	?	none known	Natura 2000		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Svante Pekkari, Ulf Zethraeus
20	Rånefjärden 3	2003	large	30-40*	2003	?	none known	Natura 2000		Peter Erixon
21	Rånefjärden 4	2003	moderate	>100*	2003	?	none known	Natura 2000		Peter Erixon
22	Rånefjärden 5	2000	small	7	2000	?	none known	Natura 2000		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Svante Pekkari, Ulf Zethraeus
23	Rånefjärden 6	2000	small	1	2000	?	none known	Natura 2000		Anders Jacobson, Jan Ahlm, Claes Hammarsjö, Svante Pekkari, Ulf Zethraeus
24	Rånefjärden 7	2000	small	1	2000	?	none known	Natura 2000		Ulf Zethraeus, Jan Ahlm, Claes Hammarsjö, Anders Jacobson, Svante Pekkari

Appendix 3:

Protocol for monitoring Baltic water-plantain (Alisma wahlenbergii).

If the presence of vegetation is to be stated, a scale of 1 to 4 is used: 0 = not present, 1 = sparse (<5 %), 2 = intermediär (5-50 %) och 3 = riklig (>50%). For the inventory, a total inventory must be used in the first instance in the number of Baltic water-plantain. If this is not possible (at very large sites, for example), the number is estimated using randomly positioned sample squares on the site. Note that it is very important always to use the same method at each individual site as different methods may give different results.

Inventory carried out by: Inventory date:

County: Municipality: Site:

Coordinates:

Bottom substrate (stone, gravel, sand, clay, etc.):

Water quality (turbidity, algal bloom, adherent algae, water transparency, etc.):

Reed vegetation (species, populations of each individual species and totals are specified according to the above scale):

Other water vegetation (species, populations of each individual species and totals are specified according to the above scale):

Number of Baltic water-plantain on site (if possible, also state the percentage of flowering specimens): Change since previous inventory (also state date of previous inventory):

Growth depth for Baltic water-plantain on site (depth at which the densest populations grow and the depth to which the species grows):

Inventory method (aquascope or diving):

Method for estimating the total number of individuals (e.g. total inventory or estimate using randomly positioned sample squares):

Any threats to the site:

Other:

General map of the site showing the boundaries of the Baltic water-plantain populations (also state the density of Baltic water-plantain populations in various parts of the site as per the above scale, and also add the distribution of reed vegetation):

”

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