Damasonium alisma Miller

Starfruit, Thrumwort, Serffrwyth
ALISMATACEAE
SYN.: ***Actinocarpus europaeus*** **Spreng,** ***Alisma damasonium*** **L.,** ***Alisma stellatum*** **Lam.,** ***D. dalechampii*** **S.F. Gray,** ***D. damasonium*** **Ascher. & Graebn.,** ***D. stellatum*** **Pers.,** ***D. stellatum*** **Thuill.,** ***D. vulgare*** **Coss. & Germ.**

Status

Endangered
Schedule 8 Wildlife and Countryside Act (1981)
Status in Europe – Not Threatened
UK BAP priority species
Lead Partner: Plantlife International
5/33 10km squares post 1987 (native)

UK Biodiversity Action Plan

The following are the current targets following the 2001 Targets Review:

T1 - Maintain populations at all extant sites.

T2 - Establish a further ten populations by 2004.

Progress on targets as reported in the UKBAP 20002 reporting round can be viewed online at: http://www.ukbap.org.uk/2002OnlineReport/mainframe.htm.

The full Action Plan for *Damasonium alisma* can be viewed on the following web page: http://www.ukbap.org.uk/UKPlans.aspx?ID=256

Work on *Damasonium alisma* is supported by:

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1 Morphology, Identification, Taxonomy & Genetics

1.1 Morphology & Identification

Damasonium alisma Miller (Alismataceae, Monocotyledon) is an annual, or occasionally perennial, aquatic herb (see Figures 1-3). Leaves are all basal, long petiolate, submerged, floating or emergent, ovate-oblong with cordate base. Stems erect, to 30(60)cm; leaves 3-6(8)cm, flowers in whorls, bisexual, petals 3, white, with basal yellow blotch; 5-9mm across; stamens 6; carpels 6 in 1 whorl, with terminal style, each with 2 ovules; follicles 5-14mm with long beak (2n=42), (Stace, 1997).

Figure 1 – Close up *Damasonium alisma* flower. (Photograph by Belinda Wheeler, 2001).

There are three additional British genera in the family Alismataceae - *Baldellia*, *Alisma* and *Sagittaria*. *Damasonium alisma* can be distinguished from these by the following characters: the leaved are rounded at the apex, they are not as acute as in the other three genera, and the carpels are few (6) and beaked. Whilst difficult to identify at the vegetative stage, the fruit is easily distinguished from all other species by the 'star' shaped infructescence composed of six follicles (see Figure 4).

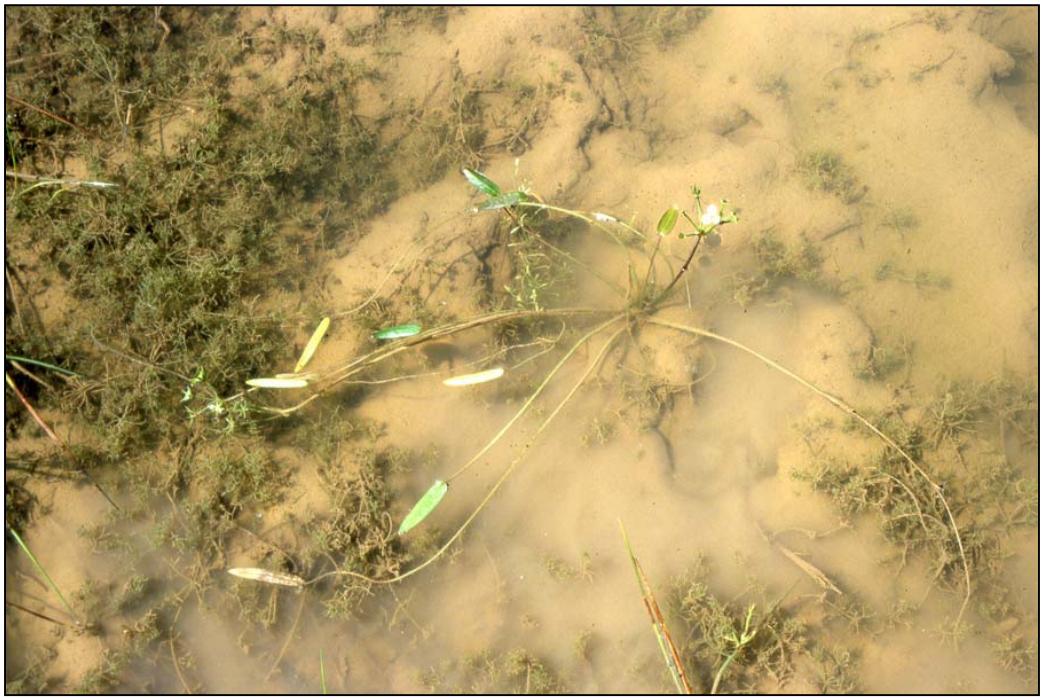

Figure 2 - *Damasonium alisma*, floating leaved aquatic stage. (Photograph by Belinda Wheeler, 2001).

Figure 3 - *Damasonium alisma*, semi-aquatic emergent on damp mud. (Photograph by Belinda Wheeler, 2001).

Figure 4 - *Damasonium alisma*, distinctive star-shaped fruits. (Photograph by Belinda Wheeler, 2001).

1.2 TAXONOMIC CONSIDERATIONS

The taxonomy of *Damasonium alisma* has been questioned in the past, some authors recognising more taxa than others. Dandy, in Flora Europaea (Tutin *et al*, 1980), included *D. polyspermum* and *D. bourgeai* as variables within *Damasonium alisma sensu lato*. All three species are native to Europe. Vuille (1987), Birkinshaw (1990) and Rich & Nicholls-Vuille (2001) treat *Damasonium alisma*, *D. bourgeai* and *D. polyspermum* as separate species, giving a total of five species in the genus *Damasonium*: *Damasonium alisma*, *D*

polyspermum, *D. bourgeai*, *D. californicum* and *D. minus* (the latter two being native to N. America and Australia respectively). The taxonomic treatment of the species by Vuille (1987) and Rich & Nicholls-Vuilles (2001) is accepted here and *D. alisma sensu stricto* is the subject of this dossier.

1.3 Genetic Implications

Genetic Fingerprinting Study

Dr. Michael Fay and colleagues of the Royal Botanic Gardens, Kew undertook a genetic fingerprinting study of *Damasonium alisma* using leaf material harvested from plants cultivated at Wakehurst Place, West Sussex (see Section 7.2). The study is described in full in Fay *et al* (2002). The main points are summarised here:

- Leaf samples were taken from plants from each seed lot. DNA was extracted and genetic fingerprinting using the technique of Amplified Fragment Length Polymorphisms (AFLP) undertaken.

- The level of variability found was remarkably low - individuals within and between populations had a high overall level of genetic similarity.

- The genome size measurement (the DNA C-value) was determined by flow cytometry. The 1C value of *Damasonium alisma* was shown to be 23.62 pg. This represents a large genome. The AFLP technique is less effective for species with a large genome. Examples of small genomes are rice *Oryza sativa* at 0.18 pg, and barley *Hordeum vulgare* at 5.55 pg.

- The conclusion drawn was that either the *Damasonium alisma* plants sampled are indeed genetically very similar whether they belong to the same or different populations; or the method used (AFLP) to determine genetic variability did not accurately show the genetic variability within *Damasonium alisma* because of the species' large genome.

Dr Fay and his colleagues are to use nuclear microsatellites to assess the genetic variability of *Damasonium alisma* in the hope that the resulting data will allow them to make an independent assessment of the accuracy of the AFLP results.

The results of such studies are of particular relevance when selecting an appropriate source of native seed for the translocation programme (see Section 7.2). If the AFLP results are accurate for *Damasonium alisma* then there is an absence of local genotypes.

2 Distribution & Current Status

2.1 World

Rich & Nicholls-Vuille (2001) traced records for *Damasonium alisma sensu stricto* in the countries of England, France, Italy, Portugal, Sicily, Russia and Ukraine. The majority of the records were from France. In addition, further records for the *Damasonium* aggregate (species unclear) were traced for Cyprus, Egypt, Greece, India, Iraq, Iran, Libya, Malta, Malta – Gozo, Palestine, Sardinia, Spain and Turkey. Whilst the addition of the *Damasonium* aggregate increases the area in which *Damasonium alisma sensu stricto* may have been recorded, it is clear from Rich & Nicholls-Vuille's (2001) distribution maps for this species that *Damasonium alisma* s.s. is predominantly recorded in western Europe with scattered

records from southern and eastern Europe. It is the most widespread of the three species. Its abundance in Eastern Europe is likely to be harder to determine from herbarium records due to the likelihood of less intensive recording in these countries.

2.2 EUROPE

Clarification of the distribution of the old world *Damasonium* species recognised by Rich and Nicholls-Vuille (2001) has provoked some questions. Their data suggest reliable records of *D. alisma sensu stricto* from England, France, Portugal, the western coast of Italy (including Sicily) and the Crimean Peninsula and southern Russia. However, all specimens from Spain and the Balearic Islands that they reviewed were *D. bourgeai*. This either means that *Damasonium alisma s.s.* has a disjunct distribution, or more simply that specimens from Spain have yet to be confirmed. In the eastern part of its range there is a significant gap in records between Italy and the Crimea. The majority of confirmed records are from central France and the Aquitaine region in the southwest. In some areas, such as the Brenne, it is common. However, it is generally regarded as rare and vulnerable throughout much of France and is protected under the "Arrêté du 31 août 1995" (and amendments) (Danton & Baffray, 1995). Whilst *Damasonium alisma* is included on the Liste Nationale, Annex 1, Appendix 1 (Conservatoire Botanique du Bassin Parisien, 1998) it is not protected under international legislation. Its official status in Europe is Not Threatened - Probably Endemic (Wigginton, 1999). However, it may well be worth revising this perhaps overly optimistic view considering its limited distribution within Europe and the apparent paucity of sites for *Damasonium alisma* s.s..

Table 1 gives the status of *Damasonium alisma sensu lato* in those countries in Europe considered in Flora Europaea (Tutin *et al,* 1980) to support *Damasonium alisma s.l.*. The likelihood of this record being *Damasonium alisma sensu stricto* is noted in the table.

Table 1 – Country by country status of *Damasonium alisma* across Europe. (*Country codes are taken from Flora Europaea as of 1964 with red data book listings where available).

COUNTRY*	IUCN LISTING	STATUS NOTES	SOURCE(S)
BI ISLAS BALEARES	None	Rich and Nicholls-Vuille determined all the Spanish herbarium specimens they located as *D. bourgeai*. The Universitat de les Illes Balears 'herbari virtual' lists *Damasonium alisma subsp. bourgeai* as a species of temporary ponds.	Rich & Nicholls-Vuille (2001); www.uib.es.
Br BRITAIN INCL ORKNEY, ZETLAND & ISLE OF MAN.;EXCL. CHANNEL ISLANDS & NORTHERN IRELAND	**EN**	Endangered. Historically recorded from over 100 sites in 17 vice-counties, since 1985 it has been recorded from 10 ponds in Buckinghamshire and Surrey.	Wigginton (1999).
Ga FRANCE	None	Locally common, particularly in the Brenne, but has apparently disappeared from some regions. Included on the Liste Nationale, Annex 1, Appendix 1 (Olivier Nawrot, Conservatoire Botanique du Bassin Parisien, 2001).	Danton & Baffray,1995; Pinet & Curtet, pers. comm. to R.V. Lansdown.

COUNTRY*	IUCN LISTING	STATUS NOTES	SOURCE(S)
Gr GREECE EXCLUDING KRITI & ISLANDS OUTSIDE EUROPE	None	*Damasonium alisma s.l.* considered rare by Raus but records for this country are attributed to *D. bourgeai* by Rich & Nicholls-Vuille.	Raus (1991) in Phitos *et al* (1995); Rich & Nicholls-Vuille (2001).
Hs SPAIN WITH GIBRALTAR & ANDORA, EXCLUDING BL	None	Rich & Nicholls-Vuille determined all the Spanish herbarium specimens they located as *D. bourgeai*.	Rich & Nicholls-Vuille (2001).
It ITALY INCL. ARCHIPELAGO TOSCANO, EXCL. SARDEGNA & SI		Rich & Nicholls-Vuille traced records for *Damasonium alisma* s.s..	Rich & Nicholls-Vuille (2001).
Lu PORTUGAL		All three taxa may have been recorded together in the same area of Portugal if Rich and Nicholls-Vuille's taxonomic treatment is accepted.	Rich & Nicholls-Vuille (2001).
Rs (W) WESTERN DIVISION		Rich & Nicholls-Vuille traced records for *Damasonium alisma* s.s..	Rich & Nicholls-Vuille (2001).
Rs (E) SOUTH-EASTERN DIVISION		Rich & Nicholls-Vuille traced records for *Damasonium alisma* s.s..	Rich & Nicholls-Vuille (2001).
Si SICILIA WITH PANTELLERIA, ISOLE PELAGIE, ISOLE LIPARI & USTICA; ALSO THE MALTA ARCHIPELAGO		Only one of the herbarium specimens uncovered by Rich and Nicholls-Vuille is attributed to *Damasonium alisma* s.s.; all the others were *D. bourgeai*.	Rich & Nicholls-Vuille (2001).

2.3 UNITED KINGDOM

OVERVIEW

Damasonium alisma is restricted to England in the United Kingdom – there are no known records from Scotland, Wales or Northern Ireland. Historically recorded from over 100 sites in 50 hectads across 17 vice-counties in England, the distribution of the species has contracted and population size declined drastically (Wheeler, 2000a). Figure 5 shows the past and current distribution of the species in Britain.

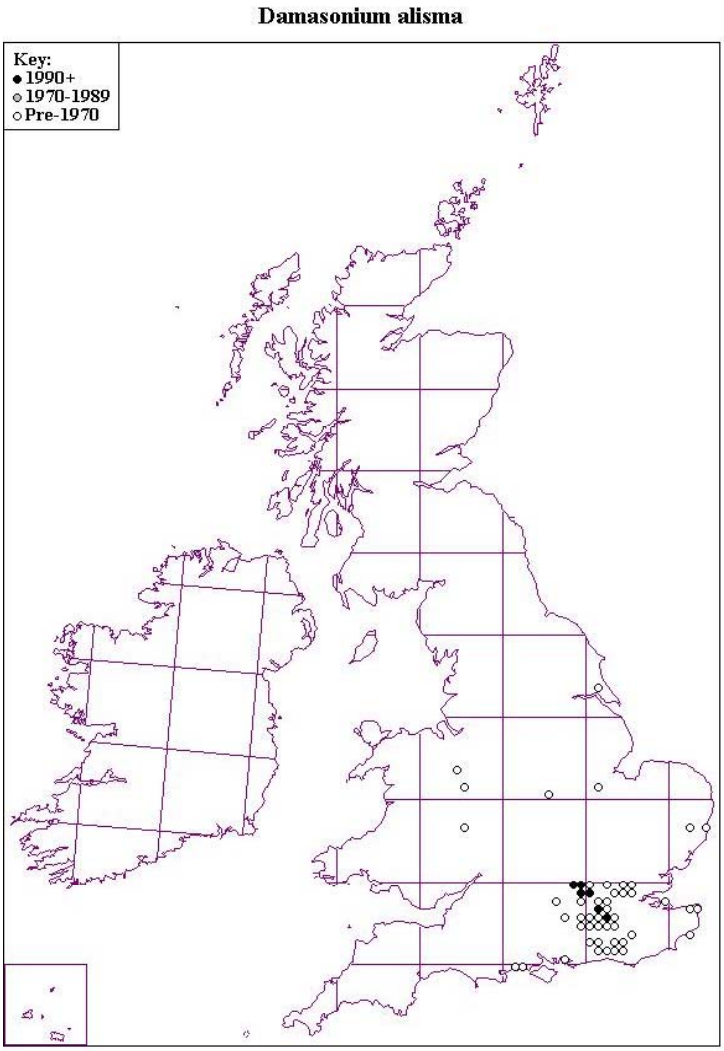

Fig. 5 – UK distribution map for *Damasonium alisma*

Historically the distribution of *Damasonium alisma* was centred on the south and southeast of England. There have only been isolated records outside these geographic regions. Although it was never common, the stronghold of the species centred on Surrey, Buckinghamshire, Sussex and adjoining counties. Before 1900, *Damasonium alisma* had died out from 11 of the 17 vice-counties in England in which it had previously been recorded (see Table 2). Since 1985 *Damasonium alisma* has been recorded from only six sites in two counties – Buckinghamshire and Surrey (Wheeler, 2000a), and several of these are as a direct result of translocation programmes.

Table 2 - Watsonian vice-counties (Dandy, 1969) in which *Damasonium alisma* has been recorded.

VICE-COUNTY	NUMBER OF RECORDS	DATE OF LAST RECORD
24 **Buckinghamshire**	16	2005
17 **Surrey**	36	2005
25 East Suffolk	2	1958
14 East Sussex	7	1955
20 Hertfordshire	3	1928
12 North Hants	1	1910
15 East Kent	5	1899
18 Essex	9	1890
55 Leicestershire	3	1890
13 West Sussex	10	1889
11 South Hants	2	1876
61 East Yorkshire	1	1870
37 Worcestershire	1	1867
21 Middlesex	4	1864
22 Berkshire	2	1843
40 Shropshire	1	1841
53 South Lincolnshire	1	1836

Counties in which the species is still considered extant are shown in bold in the above table. Records are for individual ponds that may be located very close to other ponds with a record.

2.3.1 ENGLAND

Since records are sparse for many of the 17 vice-counties across England, the species was clearly either only a casual, or already subject to decline by the nineteenth century when botanical recording gained greater popularity. The species was lost from 11 of these 17 vice-counties before 1900 and, there are few records within these 11, with the exception of West Sussex, (see Table 2). Post 1900 records show a further contraction in the range of the species in England over the last century. Those counties with post-1900 records (Kent, Hampshire, Sussex, Suffolk, Surrey and Buckinghamshire) are clustered in the southeast. Only the neighbouring counties of Surrey and Buckinghamshire in the Natural England **London Basin** and **Chilterns** **Natural Areas** have post-1960 records.

The historical stronghold of the species centred on the commons of Buckinghamshire, Surrey, East Sussex and West Sussex. Further records for the neighbouring counties of Middlesex, Hertfordshire and Essex indicate that these counties also probably once supported greater numbers, but it is likely that these areas – which have been drastically altered by the urban expansion of London – lost many of their populations before the botanical recording fervour began. These counties all provide or provided large tracts of the grazed common land with numerous ephemeral pools that the species favours. The herbarium records amount to a list of the last expanses of 'open space' in London and the Home Counties, such as Wimbledon Common, Holmwood Common, Epping Forest and Burnham Beeches.

During the last 20 years (1985-2004) *Damasonium alisma* has appeared as a naturally occurring native at six sites, four in Buckinghamshire and two in Surrey. Some of the sites contain more than one pond supporting Starfruit. Additionally, seed or plants have been reintroduced to one or more specially created ponds in two non-native sites in

Buckinghamshire that offered suitable habitat (Birkinshaw, 1990; Rich *et al*, 1994 & 1995; Wheeler, 1998, 2000a, 2002). Table 3 gives details of sites where *Damasonium alisma* is extant with an indication of whether the population present is naturally occurring or results from the artificial introduction of seed. Table 4 shows current and past population data for these ponds.

Table 3 – Sites where *Damasonium alisma* is extant / recently extant including an indication of whether plants occur naturally, or as the result of a translocation programme.

Vice-County	Site	Sub-Site / Pond	Status	Year of Last Record
17 Surrey	Headley Heath	Heath House Pond Brimmer Pond	Naturally occurring Naturally occurring, re-introduced	1999 1998
17 Surrey	West End Common	Half Penny Pond Chequers Pond	Naturally occurring Naturally occurring	2005 2004
24 Bucks	Gerrards Cross Common	New Pond Latchmoor Pond	Naturally occurring Naturally occurring	1998 1993
24 Bucks	Littleworth Common	Quaves Pond	Naturally occurring	2004
24 Bucks	Naphill & Downley Commons	Daisy Pond Mannings Pond	Naturally occurring Naturally occurring	1994 1994
24 Bucks	Coleshill	Coleshill Pond	Naturally occurring	1992
24 Bucks	Black Park Country Park	Black Park Pond	Introduced	2005
24 Bucks	Stoke Common	Penny Pond Jeremy Pond	Introduced Introduced	2004 2004

Table 4 – Current and past population data for ponds where *Damasonium alisma* is extant / recently extant.

Sub-site / Pond	♣ Last < 1988	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Headley Heath																			
Heath House Pond		×	16	c30	?	3	9	0	0	14	0	4	1	0	0	0	0	0	
Brimmer Pond	1863	*	0	17	?	1	3	0	0	8	3	5	0	0	0	0	0	0	
West End Common																			
Half Penny Pond	1966		*13	0	?	0	0	0	0	20	0	0	12	0	0	0	0	130	8
Chequers Pond	1966	*2	2	9	?	0	0	0	0	0	0	0	0	0	0	0	0	9	
Gerrards Cross Common																			
New Pond	1966	?	0	?	?	0	0	0	0	6	0	1	0	0	0	0	0	0	
Latchmoor Pond	1971	?	0	1	?	0	2	0	0	0	0	0	0	0	0	0	0	0	
Littleworth Common																			
Quaves Pond	1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
Naphill & Downley Commons																			

SUB-SITE / POND	♣ LAST < 1988	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Daisy Pond	↑1904	?	0	?	?	300	66	12	0	0	0	0	0	0	0	0	0	0	
Mannings Pond	↑1904	?	3	21	?	30	9	3	0	0	0	0	0	0	0	0	0	0	
COLESHILL																			
Coleshill Pond	1976	?	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0		
BLACK PARK COUNTRY PARK																			
Black Park Pond	none							*40	149	19	2	3	1	35	90		?	48	13
STOKE COMMON																			
Penny Pond	none														*	1	?	1	
Jeremy Pond	none														*	9	?	4	

Sources: Birkinshaw (1990); Rich *et al* (1992, 1994, 1995, 1996); Wheeler (1999, 2000, 2001); Andy McVeigh (pers. comm.); Dave Page (pers. comm.).

♣ Last pre 1988 Records from BRC, ITE unless stated.

* Year in which reintroduction of *D. alisma* seed took place.

? Data not available.

↑ Unspecified pond in vicinity.

2.3.2 NORTHERN IRELAND

There are no historical or current records for *Damasonium alisma* in Northern Ireland.

2.3.3 SCOTLAND

There are no historical or current records for *Damasonium alisma* in Scotland.

2.3.4 WALES

There are no historical or current records for *Damasonium alisma* in Wales.

3 Ecology & Life Cycle

Damasonium alisma Miller, a rare annual (occasionally perennial) member of the Alismataceae, is confined to freshwater aquatic habitats. These aquatic habitats are generally small to large ponds in heathland or rough pasture within lowland habitats. Ponds in which *Damasonium alisma* occurs have seasonal fluctuations in the water level that expose shallow muddy margins of largely clayey mineral soil with gravels. The plant germinates and grows initially as a submerged 'aquatic' within the water body and later develops into either a floating or emergent aquatic plant or a 'terrestrial' plant on the muddy margins exposed by the draw down in the water level. Plants can flower and fruit either in aquatic or terrestrial form. In shallow ponds, plants are found across the water body but in deeper ponds the plant is generally restricted to the margins.

Although populations of *Damasonium alisma* are generally confined to a single pond at most of their UK sites, this is likely to be a result of fragmentation and loss of habitat. Most of the UK sites that historically supported the species tended to be commons with a number of small ephemeral pools and ponds – several of which were likely to support the species at any given time. Research on similar species (e.g. *Luronium natans* – Alismataceae, Lansdown, 2004; *Ranunculus nodiflorus* – Ranunculaceae, Kirchner *et al*, 2003) and observations of the species on the continent suggests that populations of *D. alisma* would

naturally be dynamic, behaving as a metapopulation within a site. Colonisation of neighbouring sites and gene flow between populations (or 'subpopulations') is likely to occur through dispersal of seed. Large herbivores and, in more recent history, livestock are likely to transfer seed between any pools they visit in the mud on their hooves and legs. A second possibility is that, like *Ranunculus nodiflorus*, it colonises neighbouring pools along temporarily flooded corridors during periods of heavy inundation. The habitual retention of one seed in a floating follicle (see comments on Fruiting below) would facilitate this method of dispersal.

GERMINATION

Germination of *Damasonium alisma* seed takes place in autumn or spring whilst water levels are still high. Birkinshaw (1990) found that fresh seed germinates whilst submerged but dormant seed will only germinate if subjected to a cycle of submergence - emergence - submergence. Germination rates in dormant seed exposed to such a regime were higher than for fresh seed. A prolonged absence of seasonally fluctuating water levels would therefore have a detrimental effect on the germination success of this species. There is strong evidence to suggest that the presence of livestock also serves to stimulate germination of *Damasonium alisma* seed by poaching and turning over the exposed mud. Birkinshaw (1990) showed that seed buried 4cm deep can germinate but fails to reach the soil surface, and that germination is more than 50% higher in seed buried at 1cm, compared to that at a depth of 2cm.

SEEDLING STAGE

Seedlings have several short linear leaves appearing as small tufted plants rooted to the substrate, fully submerged in a shallow pond. Autumn-germinated seedlings tend to be subject to harsher conditions than spring-germinated seedlings, including freezing of the water body and litter deposition from any deciduous species located near the water's edge. The losses of seedlings from freezing, or the effect on the health of seedlings which survive, has not been measured but a plant that is native to Europe, including the more northerly countries, should be adapted to withstand such conditions. Birkinshaw (1990) has observed young plants that have recovered following a period of freezing. However, the effect of leaf-litter deposition may be more detrimental to the survival of the plant at this stage.

ADULT VEGETATIVE PLANT

Floating leaves are produced on long petioles from spring onwards. Initially the blades are almost linear but leaves produced by more mature plants are oblong to ovate-oblong and are more clearly visible on the surface of the pond. The form of both the leaf and petiole changes with time, reflecting changes in the water body. As the season progresses the water levels become lower and the leaves and petioles become stouter and more robust. Once the water level has subsided completely or to just a few centimetres – leaving the plant growing in damp mud – the floating leaves die and aerial leaves with short petioles are produced. These leaves are robust, often more ovate than oblong, and the plants are sub-terrestrial or terrestrial.

FLOWERING AND FLORAL BIOLOGY

Flowering may occur in either the aquatic or terrestrial phase of the life cycle. If flowering occurs whilst the plant is still submerged the flowers are borne on long peduncles that hold the flowers above the surface of the pond. Terrestrial plants are much shorter. Birkinshaw (1994) observes that the drier the substrate the shorter in stature and the shorter-lived the plant. Thus, terrestrial plants are most fecund when the exposed mud remains damp and longer-living plants are able to produce flowers over a longer period. At its native sites in England, most flowering occurs on terrestrial plants since ponds have usually dried up or are much reduced in area by the time flowering commences. The umbel-like 1-4 whorled inflorescences of flowers are produced in succession from [May] June to August if conditions

remain suitable. An individual plant can produce a good numbers of flowers, sometimes up to 150 per plant (Birkinshaw, 1990). Individual flowers are short-lived, opening several hours after dawn and lasting for only that day. The stamens are spread at the start of anthesis exposing the stigma (Vuille, 1987). Flowers are therefore generally allogamous, being cross-pollinated by insects. Birkenshaw (1990) lists a number of flies, beetles and hoverflies caught visiting the flowers. However, flowers are facultatively autogamous facilitated by the occasional occurrence of pollen sticking to the stigma before stamen expansion (Vuille, 1987). Vuille reported that this method of cleistogamy rarely occurred under experimental conditions. It is likely however that geitonogamy frequently occurs, particularly in the UK populations, since here populations are very small, often with only a few individuals flowering - each plant often producing several flowers on the same day. The floral movement and pollination of *Damasonium alisma sensu stricto* is different from that of both *D. bourgeai* and *D. polyspermum*, which are autogamous, one of the characters, used by Vuille (1987) to separate the species.

FRUITING

Following fertilization, the plant usually produces six two-seeded follicles arranged in the shape of a star (hence the name Starfruit). The fruits persist on the plant until water levels rise again in late summer or early autumn and the fruit becomes submerged, at which point the follicle releases one seed and retains the second generally much larger seed. Birkinshaw (1990) has observed that the seed remaining within the follicle often floats to the surface when it germinates and suggests that this may be a mechanism for dispersal during high water periods – facilitating movement from one water body to another whilst they are temporarily linked. Seeds that do not germinate in the autumn or the spring enter a period of dormancy. The longevity of the seed bank is unknown but dormancy is a necessary function in such ephemeral habitat where conditions suitable for germination and growth may only be met every few years. *Damasonium alisma* has certainly reappeared in ponds in which it has not been recorded for a prolonged period, for example Mannings Pond and Daisy Pond in Buckinghamshire (Showler, 1994), although, since plants and particularly flowers can be ephemeral too, it is not certain whether plants were absent or simply short-lived and unrecorded.

4 Habitat Requirements

4.1 THE LANDSCAPE PERSPECTIVE

Damasonium alisma colonises the muddy, seasonally exposed margins of ephemeral pools or ponds with fluctuating water levels. All remaining English sites are ponds on lowland heathland commons.

The historical records for *Damasonium alisma* in the UK refer specifically to pools, ponds and ditches, often described as “gravelly” (Leighton, 1841; Hooker, 1878; Arnold, 1907; Wolley-Dod 1937; & Lousley 1976). Hanbury and Marshall, in their Flora of Kent (1899), also refer to the species’ occurrence in marshes. Most records are for ponds on commons, which supported grazed heathland or rough pasture, or village ponds that were used whilst moving stock. The livestock on these commons would have grazed on the emergent and marginal vegetation and poached the muddy margins of the ponds. Poaching would have exposed dormant seed (see Section 3), and facilitated the spread of the species as stock moved from one pond to another carrying mud on their hooves. Grazing would have controlled other emergent aquatic species and reduced competition for *Damasonium alisma* within the water body. The regular presence of livestock would also have served to control the growth of trees around a pond, which cast shade and deposit leaf litter - two factors which would be detrimental to the survival of *Damasonium alisma*. The presence of

livestock, or large herbivores, is therefore considered to be an essential factor of suitable habitat.

The loss of grazed commons, and therefore *Damasonium alisma*, in England has been due to a number of factors. A decline in traditional grazing practices and the enclosure of commons led to loss of grazing and succession to woodland. Many commons in the southeast were subject to agricultural improvement or improved for recreational purposes and many, particularly in London and the Home Counties, were lost to urbanisation. In recent decades many ponds on the remaining commons have lost their shallow muddy margins through the construction of concrete edges, or have lost their draw down zone through measures to top-up water levels during the summer months.

In France, *Damasonium alisma* appears most abundant in areas where reasonably large numbers of suitable water bodies enable the survival of metapopulations. In the Brenne, some populations of hundreds of plants may grow for only a short period when conditions become suitable, but other sites more or less continually support the species. As with *Luronium natans*, not only do dispersal by wild boar (*Sus scrofa*) and human activities probably account for some of the recolonisation, but also recruitment from the seed-bank (Lansdown, 2004). The importance of the seed-bank recently became clear in north-western France, south of Brest, where a large number of plants appeared at a site with no recent records, following soil disturbance by farm machinery (S. Magnanon pers. comm. to R.V. Lansdown, 2003). Recent research by Beatriz Decenciere Ferrandiere (2001) of the Conservatoire Botanique National du Bassin Parissien (CBNBP) has provided useful information on some of the habitat types in which the species occurs in the Hurepoix Plateau (Paris Basin). Here the species grows in temporary pools in ploughed, cultivated fields (see Annex 1).

4.2 COMMUNITIES & VEGETATION

Aquatic plant communities are notoriously difficult to classify and short-lived communities of ephemeral pond edge habitats are no exception. Much quadrat data was collected during detailed surveys of the margins of ephemeral pools where the species is or has recently been extant (Wheeler 1999, 2000a, 2000b; Wheeler & Pond Action, 2001). This data was analysed using MATCH, which provides (%) correlation with National Vegetation Classification (NVC) community types (Rodwell, 1991-2000, 1992, 1995). Each site showed very poor correlation with a diverse range community types including open vegetation, mesotrophic grassland, swamp and aquatic communities. Those communities with which the quadrat data showed the strongest correlation, albeit generally only 20-30%, were:

- **OV28 Agrostis stolonifera–Ranunculus repens** community.
- **OV30 Bidens tripartita–Polygonum amphibian** community.
- **OV35 *Lythrum portula–Ranunculus flammula*** community (Rodwell, 2000).
- **MG13 *Agrostis stolonifera–Alopecurus geniculatus* grassland** (Rodwell, 1992).
- **S12 *Typha latifolia* swamp**.
- **S14 *Sparganium erectum* swamp**.
- **S19 *Eleocharis palustris* swamp**.
- **S22 *Glyceria fluitans* water-margin vegetation** (Rodwell, 1995).

- **A2 *Lemna minor*** community.
- **A9 *Potamogeton natans*** community.
- **A24 *Juncus bulbosus*** community (Rodwell, 1995).

Communities in which *Damasonium alisma* appears to be most successful are those characterized by a high percentage cover of bare mud. Drier sites that are subject to prolonged exposure on a regular basis are similar to the communities of open vegetation (OV). Associates frequently include Creeping Bent *Agrostis stolonifera*, Lesser Marshwort *Apium inundatum*, Trifid Bur-marigold *Bidens tripartita*, Common Water-starwort *Callitriche stagnalis*, Water-purslane *Lythrum portula*, Soft-rush *Juncus effusus* and Lesser Spearwort *Ranunculus flammula*. Where *Agrostis stolonifera* is very abundant, the community resembles poor **MG13**. Damper sites where the draw down zone is less pronounced or generally occurs for a shorter period resemble swamp communities (**S**); here Floating Sweet-grass *Glyceria fluitans*, Small sweet-grass *G. declinata*, Common Spike-rush *Eleocharis palustris*, Branched Bur-reed *Sparganium erectum* and Bulrush *Typha latifolia* are more common with a variety of Rush *Juncus* species. However, tall, dense stands of *Typha latifolia* tend to exclude *Damasonium alisma*, as does abundant growth of Sweet-grass *Glyceria* sp.. Water-plantain *Alisma plantago-aquatica*, Common Duckweed *Lemna minor*, Yellow Iris *Iris pseudacorus*, Broad-leaved Pondweed *Potamogeton natans* and Alternate Water-milfoil *Myriophyllum alternifolium* are also often present in quadrats recorded in open water (**A**). Additional species recorded with *Damasonium alisma* often reflect the particular habitat surrounding the pools, thus Purple Moor-grass *Molinia caerulea*, Common Marsh-bedstraw *Galium palustre*, Willows and Sallows *Salix* spp. and Marsh Pennywort *Hydrocotyle vulgaris* are often recorded in heathland sites for the species. Unfortunately, the alien New Zealand Pigmyweed *Crassula helmsii* also performs extremely well in the above community and in short periods of time will replace the above species with 100% cover.

Low species diversity in ephemeral pool margins is partly responsible for the poor correlation found with NVC community types, but local variation within sites also plays a part. Different communities or small-scale mosaics of transitory communities are often in juxtaposition at *Damasonium alisma* sites. Birkinshaw (1994) also acknowledges the difficulty in attributing community types to the aquatic habitats in which the species occurs and uses Ellenberg's (1988) community definitions for the five sites that he studied. Birkinshaw attributes the communities variously to Littorelletea, Isoeto-Nanojuncetea, Plantaginetea, Phragmitetea and Potamogetonetea.

Details of communities in which *Damasonium alisma* grows in the Hurepoix Plateau (Paris Basin) are briefly summarised in Annex 1, summarised from research presented in Decencière Ferrandière (2001).

4.3 Summary of Habitat Requirements

A number of habitat features are important to *Damasonium alisma*, and these have been summarised in Table 5.

Table 5 – Habitat features important to *Damasonium alisma* in Britain.

TYPE	DESCRIPTION
Physical and topographical	Lowland habitat. Draw down zone of seasonally fluctuating pools. Flat bottoms and gently sloping pond margins. Poorly drained clay or clay-enriched soils, often stony, with little organic build up. Relatively unshaded sites.
Vegetational and structural	In **OV open vegetation**, **MG mesotrophic grassland**, **S swamp** and **A aquatic** NVC communities (Rodwell, 1992-1995) in and on the margins of pools with seasonally fluctuating water levels. Very open vegetation, often with cover of bare mud of <75%. Low vegetation, typically less than 10cm tall.
Processes	Seasonally fluctuating water levels to expose – submerge – expose seeds and plant. Poaching by cattle or horses/ponies to expose dormant seed and to maintain open conditions. Ideally, grazing by cattle or horses/ponies to prevent successional changes to margins of pond and surrounding vegetation. Transfer of seed between sites by large herbivores.
Chemical	Water chemistry data collected by the Environment Agency and reviewed by the Ponds Conservation Trust (2001) from ponds which support or recently supported populations of the species indicate that it is "tolerant of a fairly wide range of natural, unpolluted, chemical conditions, with recent sites ranging from moderately acid, base-poor to base-rich and moderately alkaline".

5 Threats / Factors Leading to Loss or Decline or Limiting Recovery

HABITAT DESTRUCTION

Damasonium alisma has been lost from many sites due to changes in land use. Grazed heathlands and old commons have largely developed into woodlands (for example Naphill and Downley Commons), amenity grasslands, or even lost entirely to urbanisation – such as historic sites in London and the surrounding counties.

HABITAT DEGRADATION

Loss of grazing and succession Many sites have lost their traditional grazing regimes (see Figure 6) and in the absence of grazing or similar management heathland can quickly revert to scrub and eventually woodland. Many of those ponds that remain in historic sites have therefore been so degraded through neglect that they have become overgrown with scrub and the margins dominated by trees. Scrub and trees around ponds cast shade and deposit leaf litter, to the detriment of the species, and eventually fill and destroy the pond.

Figure 6 – Cattle-grazed heathland. (Photograph by Belinda Wheeler).

Loss of grazing stock may also have affected germination success in populations of *Damasonium alisma*. The action of hooves poaches the mud in and around the margins of the pond. This is essential in exposing buried seed, which is a requirement for germination and establishment of the species (see Section 3).

Leaf deposition and decomposition of aquatic flora and fauna can result in the build up of a deep layer of organic soil and litter. This provides an inhospitable substrate for the establishment of *Damasonium alisma* seedlings. Changes in the water chemistry, for example raised nitrate levels, can also affect *Damasonium alisma* - *Lemna minor* may increase in abundance in response to high nutrient levels, suppressing the growth and establishment of *Damasonium alisma*.

PUBLIC PERCEPTION

On occasion public perception of what a village pond should look like has resulted in measures to prevent the lowering of the water levels in summer (for example Latchmoor Pond and Coleshill Pond) and neatening of the margins through the construction of retaining walls (for example Brittens Pond – historic site in Surrey). In some sites, such as Latchmoor Pond, a modern desire to encourage wildfowl (i.e. ducks and geese) has resulted in eutrophication of the pond through faeces and uneaten bread scraps.

POLLUTION

The data analysed by the Ponds Conservation Trust (2001) indicates that typical *Damasonium alisma* habitat is in a natural, unpolluted chemical condition. Pollutants may enter ponds through road run-off or agricultural fertilizers. It is likely that as urban areas have encroached on historic sites for *Damasonium alisma* pollutants have entered the water body, perhaps resulting in unsuitable conditions for the species.

COMPETITION AND ALIEN WEEDS

The most recent threat has been from the introduction to many sites of two aggressively competitive non-native aquatic plants, New Zealand Pigmyweed *Crassula helmsii* and Parrot's-feather *Myriophyllum aquaticum*, which outcompete not just *Damasonium alisma* but also many other species associated with this habitat. *Crassula helmsii*, also known as Australian Swamp Stonecrop, is a common plant of garden ponds and has been introduced to natural ponds via this route. It is an extremely vigorous species that can achieve 100% cover of a shallow water body in a short period of time. It can either grow as an aquatic or as an emergent when the water levels become low. It is also tolerant of shade and has no dormant period. It excludes competitors by depleting oxygen levels beneath dense stands, casting dense shade and occupying niches that would otherwise be available for all stages of the life-cycle of *Damasonium alisma*.

Factors that have lead to loss or decline of sites for *Damasonium alisma*, and threats to current sites, are summarised in Table 6.

Table 6 – Threats to the survival of *Damasonium alisma* in Britain, and factors responsible for sites already lost.

TYPE	THREAT / FACTOR
Habitat destruction	In-filling. Agricultural reclamation. Afforestation. Industrial/urban development. Loss of water body complexes precluding function of metapopulation. Isolation of all known UK sites.
Habitat degradation	Loss of grazing leading to development of scrub and eventually woodland around margins. Loss of grazing leading to dominance in pond of floating and emergent plants. Competitive exclusion of plants through introduction of invasive and aggressive non-native species of water plant. Litter accumulation in pond producing deep organic soil. Infilling of pond due to succession to woodland. Artificial control of water levels reducing seasonal fluctuations. Pollutants.
Dispersal	Loss of grazing livestock on-site facilitating movement within sites. Loss of visiting grazing livestock through abandonment of drove roads to move stock facilitating movement between sites.

DISPERSAL

There is reason to conclude that the loss of traditional grazing from heathland and rough pasture, and the cessation of stock along historic drove roads, has impacted on dispersal of this species. It is known that seed of species such as *Luronium natans* may be transported

to neighbouring sites in the mud adhering to the hooves and hides of watering livestock (Lansdown, in press). It is likely that seed of *Damasonium alisma* was also once spread in this manner, although no direct evidence exists from the UK due to the paucity of existing sites.

6 Management Implications

Active management is required in the long term to maintain suitable habitat for *Damasonium alisma*. In the absence of a long-term commitment to active management by site managers, the species is unlikely to survive in the UK. Management that promotes self-sustaining systems is ideal but short-term solutions to providing suitable habitat should be considered whilst tackling the more complex issues of establishing these long-term self-sustaining systems.

Management required for this species is therefore as follows:

ESTABLISHMENT OF A COMPLEX OF SUITABLE WATERBODIES

A self-sustaining metapopulation would require a number of suitable waterbodies in reasonably close proximity. In some sites, such as Headley Heath in Surrey, there are already numerous ponds that simply require management to bring them into suitable condition. At sites with single or few ponds, such as Littleworth Common or Black Park, additional ponds should be created.

GRAZING

The incorporation of ponds into grazing compartments is an ideal form of management for the species. This can be achieved either by introducing grazing to a site, increasing existing grazing compartments to encompass existing ponds, or creating ponds within grazing compartments in suitable habitat. This latter option would obviously require translocation of seed or plants from a nearby population. The effect of grazing is three-fold.

- Livestock, particularly cattle, are an effective tool in preventing successional changes in the vegetation surrounding ponds.
- Livestock also play a role in reducing, through grazing, the marginal and emergent vegetation associated with the pond that may, if left, exclude *Damasonium alisma*.
- Cattle will use ponds if not provided with water troughs. The action of their hooves promotes poaching of the mud in and around the margins of the pond.
- The presence of livestock may facilitate dispersal of the species to other ponds, or promote functioning as dynamic metapopulations.

VEGETATION CONTROL

In the absence of or sometimes in addition to grazing, manual control of vegetation may be required to prevent successional changes and control competitors as detailed above. Recent programmes of control have targeted such species as Reedmace *Typha latifolia*, Reed Sweet-grass *Glyceria maxima*, Willow and Sallow *Salix* sp. and a number of aggressive alien species (see below).

Eradication or control of aggressive alien plant species New Zealand Pigmyweed *Crassula helmsii* and Parrot's-feather *Myriophyllum aquaticum* have both colonized native sites for *Damasonium alisma*. The detrimental effect of both these species on populations of *Damasonium alisma* is discussed in Section 5.

Mechanical methods of control are not effective for *Crassula helmsii* since the species fragments easily and the resulting plant fragments act as propagules to produce new plants. Chemical control with glyphosate or diquat-alginate is more effective. There has been some recent success at (near) eradication of *Crassula helmsii* from historic *Damasonium alisma* ponds on West End Common in Surrey. At this site Starfruit returned as a native to the site after a gap of many years following chemical control of *Crassula helmsii* (Dave Page, pers. comm.).

However, since *Myriophyllum aquaticum* does not produce propagules from vegetative fragments both mechanical and chemical methods of control can be used. These are described in a document produced by Rothamstead Research, Centre for Aquatic Plant Management. This document can be viewed on the following web pages:

DISTURBANCE

If there are no grazing livestock to poach the pond, mechanical disturbance may be required to keep conditions open and the substrate regularly turned. Methods employed have included the use of tractors (Gerrards Cross Common) and turning of sods with spades (Headley Heath). In practice these methods have limited success but are preferable to no disturbance at all.

Periodic dredging to remove organic build up and reveal the mineral soil below can benefit *Damasonium alisma*. Without grazing or dredging ponds can disappear altogether. Restoration of ponds through dredging has had remarkable success in re-establishing populations of *Damasonium alisma* in the past, for example at Naphill and Downley Commons (Showler, 1994), although there has been less success recently.

CONTROL OF POLLUTANTS

Ponds must be kept free of pollutants through the operation of exclusion zones around the ponds in the case of fertilizer application, or preventing road drains from emptying into ponds.

Table 7 shows which methods of management site managers at extant *Damasonium alisma* sites currently employ.

Table 7 – Current management at extant *Damasonium alisma* sites.

SITE	SUB-SITE / POND	CURRENT MANAGEMENT
Headley Heath	Heath House Pond Brimmer Pond	Disturbance of substrate and vegetation control. Cattle grazed.
West End Common	HalfPenny Pond Chequers Pond	Disturbance of substrate and vegetation control, including *Crassula* control. Disturbance of substrate and vegetation control, including *Crassula* control.
Gerrards Cross Common	New Pond Latchmoor Pond	Disturbance of substrate and vegetation control, including *Crassula* control. Disturbance of substrate and vegetation control.
Littleworth Common	Quaves Pond	Disturbance of substrate and vegetation control, particularly trees on margins; dredging to reduce organic build up; establishing grazing.

Site	Sub-Site / Pond	Current Management
Naphill & Downley Commons	Daisy Pond Mannings Pond	Disturbance of substrate; vegetation control; dredging to reduce organic build up and *Lemna* cover. Disturbance of substrate and vegetation control; dredging to reduce organic build up.
Coleshill	Coleshill Pond	None.
Black Park Country Park	Black Park Pond	Vegetation control including *Crassula* control.
Stoke Common	Penny Pond Jeremy Pond	Cattle grazed. Cattle grazed.

7 Current Conservation Measures

7.1 *In Situ* Measures

Overview

Damsonium alisma has been listed under Schedule 8 of Part I of the Wildlife and Countryside Act, 1981 (as amended) since 1981.

Table 8 lists extant (or recently extant) sites for *Damasonium alisma* indicating whether they receive protection as Sites of Special Scientific Interest (SSSIs). Nine of the 12 ponds that have supported naturally occurring, reintroduced or introduced populations of the species since 1985 are formally notified.

Table 8 – Protection of *Damasonium alisma* sites.

Site	Sub-Site / Pond	Protection
Headley Heath	Heath House Pond Brimmer Pond	SSSI SSSI
West End Common	HalfPenny Pond Chequers Pond	SSSI SSSI
Gerrards Cross Common	New Pond Latchmoor Pond	None None
Littleworth Common	Quaves Pond	SSSI
Naphill & Downley Commons	Daisy Pond Mannings Pond	SSSI SSSI
Coleshill	Coleshill Pond	None
Black Park Country Park	Black Park Pond	None
Stoke Common	Penny Pond Jeremy Pond	SSSI SSSI

Current Conservation Schemes

A number of countryside conservation schemes offer assistance to land managers conserving heathland and commons currently or formerly supporting populations of *Damasonium alisma*. Amongst the most appropriate are:

- Environmental Stewardship This is a new agri-environment scheme, which provides funding to farmers and other land managers in England who deliver effective environmental management on their land. The scheme is intended to build on the recognised success of the Environmental Sensitive Areas scheme and the Countryside Stewardship Scheme. It is administered by DEFRA.

- Countryside Stewardship The Countryside Stewardship scheme was the Government's principal scheme for the sustainable management of valued areas in the wider countryside, through the payment of grants to enhance, restore and recreate targeted landscapes and sites. It operates outside Environmentally Sensitive Areas. Through the scheme, farmers and land managers have entered 10-year agreements to manage land in an environmentally sensitive manner in return for annual payments. Like the ESA programme, this scheme is administered by DEFRA, and both are now closed to new applicants.

- Tomorrow's Heathland Heritage This is a £25 million-plus, ten-year programme that seeks to restore and recreate lowland heathland in local communities around the United Kingdom. The programme includes up to 26 separate site-based heathland projects, where scrub/tree clearance, heathland recreation, and reinstatement of traditional management practices is helping to make a significant contribution to the Government's heathland biodiversity action plan. Natural England leads the project with the support of over 140 partner organisations. The Heritage Lottery Fund provides financial support for the project.

7.2 *Ex Situ* Measures

Seed Banks

The Millennium Seed Bank, at the Royal Botanic Gardens, Kew, holds seed from Headley Heath (Heath House Pond), Gerrards Cross Common (New Pond) and Naphill and Downley Commons (Mannings Pond and Daisy Pond).

Translocation Programme

One of the targets of the UK Biodiversity Action Plan and Plantlife International's Back from the Brink programme for *Damasonium alisma* is to establish further populations of the species. Wheeler (1998, 1999 & 2000) has identified four suitable host sites for translocated seed:

- Brimmer Pond, Headley Heath, Surrey.
- Greenham Common, Berkshire.
- Whitmoor Common, Surrey.
- Stoke Common, Buckinghamshire.

Sites selected include those with pond complexes supporting an extant population of *Damasonium alisma* (Brimmer Pond), those with ponds that have historical records of *D. alisma* (Whitmoor Common) or those that fall within the historic range of *D. alisma* and offer suitable ponds and sustainable management (Stoke Common and Greenham Common).

Two major factors hindered the translocation programme: the Millennium Seed Bank (MSB) held insufficient seed to provide the programme with large quantities and there was no information available as to whether any detectable levels of genetic variation exist within and between populations of this species in the UK, which needed to be considered when designing a new population. Accordingly, Royal Botanic Gardens, Kew (at Kew Gardens, Surrey and Wakehurst Place, West Sussex) and Plantlife commenced a collaborative project in 2000. The Millennium Seed Bank kindly released some seed to Wakehurst Place to germinate and grow-on stock plants from which larger quantities of seed could be harvested. The plants produced would also provide leaf material for Royal Botanic Gardens, Kew to undertake genetic fingerprinting studies of the species to determine levels of variation within and between populations (see Section 1.3).

Seed was germinated from each of the four collections and plants were grown on throughout 2001. Germination and cultivation methodology is outlined in Wheeler (2000b) and in Foster (2001). In August 2001 seed was harvested from these plants and put into the care of the Millennium Seed Bank, which kindly provided Plantlife with 10,000 of these seeds in September 2001 and retained the remaining 19,000 harvested seeds to bulk up the existing collections.

The seeds provided by the Millennium Seed Bank were used in a translocation exercise at Stoke Common in September 2001 – the first site from the list of proposed sites to receive seed in this programme. Seeds were sown into each of two ponds created specifically as reception sites in 2000, Jeremy Pond and Penny Pond. In 2002 nine plants of *Damasonium alisma* appeared in Jeremy Pond and a further plant in Penny Pond. For further details and methodology see Wheeler (2001). The ponds will be monitored to determine the long-term success of the translocation.

It is hoped that further ponds will receive seed when site conditions are considered favourable and long-term management can be assured.

7.3 MONITORING *DAMASONIUM ALISMA* & THE COMMON MONITORING STANDARD

Due to the paucity of sites and the small populations concerned, censuses of *Damasonium alisma* have generally involved counts of the total number of plants observed on a particular day – i.e. a 'snap-shot' count. In the past such surveys have been carried out by volunteers, site managers or by Plantlife Project Officers. Counts have generally been of adult vegetative, flowering or fruiting individuals observed during the summer period when individual plants are most obvious in the shallow water or exposed damp mud of the draw down zone. Data on seedling establishment and numbers prior to the adult stage in the life cycle is lacking due to the difficulty in locating the fully submerged seedlings during the inundation period, and indeed recognising the plant in its early life-stages. At the most 'reliable' sites, such as Black Park, population counts of plants over time have been possible showing the increase in the number of plants as the season progresses. This data is useful in determining longevity of individual plants and recognising the peak period for flowering and fruiting.

However, with annual species such as *Damasonium alisma*, plant counts alone are not considered by many researchers to be a meaningful measure of the health of the population. This is particularly so when they are carried out directly following conservation management activity, when often large numbers of dormant seed are stimulated to produce a 'flush' of plants. What is meaningful though, is whether these plants set seed, and the fates of these seeds in subsequent years without repeat management. In his research on the mud plant Floating Water-plantain *Luronium natans*, Lansdown (2004) recommends

waiting for a period corresponding to the minimum expected seed dormancy period of the species to pass before assessing the size of the population. Furthermore, Lansdown (pers. comm.) considers that more useful measures of the condition of populations of annual species are whether plants have set seed and the approximate quantity of seed set.

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9 Acknowledgements

Thanks to Corinne Woodall and Graham Stevens (English Nature); Alan Showler; Ian Burgess, Andrew Fowler and Andy McVeigh (Buckinghamshire County Council); Lyn Trigwell (South Bucks District Council); Elspeth Gaylard, Diane Hepburn, Ian Gordon, Michael Sharp (Gerrards Cross Parish Council); Mike Fay, Clive Foster, Steve Alton, Andy Jackson (Royal Botanic Gardens, Kew); Jeremy Biggs and Penny Williams (Ponds Conservation Trust); Dave Page and Steve Delahunt (Elmbridge Borough Council); Nick Owen (Lower Mole Countryside Project); Peter Creasey and Gordon Flower (National Trust); Mark Havler (Surrey County Council), Mark Hampton (Imperial College, London University); Jean Yves Lesouëf and Claudine Fortune (Conservatoire Botanique National du Brest); Beatriz Decencière Ferrandière Fortune (Conservatoire Botanique National du Bassin Parisien); Councillor

Bowater; Richard Lansdown and Ruth Davis; and to Plantlife International volunteer Sarah Garnett for her editorial work on this dossier.

Particular thanks to Richard Lansdown for assistance with data and for comments on the distribution and ecology of continental populations.

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11 Links

- ARKive species web page for *Damasonium alisma*: http://www.arkive.org/species/ARK/plants_and_algae/Damasonium_alisma.

Plantlife International wishes to acknowledge the financial support of Natural England, Scottish Natural Heritage and the Countryside Council for Wales for the Back from the Brink *(species recovery)* programme.

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Edited by Plantlife International
First draft dated May 2004
Last revised 13 February 2007

ISBN: 1 904749-08-9

12 Annex 1

In July 2001 Plantlife was contacted by Beatriz Decencière Ferrandière of the Conservatoire Botanique Nationale du Bassin Parisien (CBNBP) who was carrying out a study of temporary ponds on cultivated land in the Hurepoix Plateau, Ile-de-France region (the Essonne and the Yvelines). 15 of the 50 ponds studied contained *Damasonium alisma*. Correspondence between Belinda Wheeler and Beatriz Decencière Ferrandière has allowed an exchange of information on the species and its habitat in England compared to France. Beatriz Decencière Ferrandière made some very interesting comments on the French sites she studied and has since forwarded a copy of her report on the study to Plantlife (Decencière Ferrandière, 2001).

Beatriz Decencière Ferrandière made the following comments (edited, pers. comm.) on the ponds containing *Damasonium alisma* in the ponds of the Hurepoix Plateau:

- *D. alisma* grows in different sizes of pond, from large to small.
- Pond banks are normally soft and muddy.
- All ponds are located in cultivated fields.
- All ponds are ephemeral with seasonal fluctuations in the water level.
- The ponds in which *D. alisma* grows are filled with water for 9 – 10 months of the year.
- The water is an acidic rain water (pH = 4,5 – 6).
- The depth of the ponds varies from 5cm up to 50cm more or less.
- When the pond is dry the farmer ploughs the pond along with the field in order to sow the crop.
- Most of the cultivated fields are drained.
- *D. alisma* starts its development when the pond is filled with water. The flowers and fruits, however, form when the soil is dry.
- Populations can be large, *D. alisma* invades all available habitat, which can mean more than 10,000 plants per pond.
- Sometimes, the population is small, 20-100.
- *D. alisma* doesn't appear every year in these ponds. For example, one of the temporary ponds visited has been studied before, in 1994, 1995 and 1996, and *D.*

alisma was present in the first two years and not in 1996. In France this kind of plant is called a “plant with eclipses”.

The management is simple: when the temporary pond is dry enough for agricultural machinery to cross, it is ploughed. Ploughing rejuvenates the habitat by destroying perennials, enabling the annual plants to survive. Since all the ponds studied are located in temporary ponds in open fields where wheat, barley or rape are grown, there is no grazing. The Paris basin is an area of intensive agriculture so the management of the ponds is closely linked to the normal cultivation of the land.

Decencière Ferrandièr (2001) describes the phytosociological group (according to Bournèrias, 1979) in which *D. alisma* was recorded. *D. alisma* was assigned to the 6th group – the alluvial banks with *Bidens* (alliance Bidens tripartii). This group characterizes eutrophic banks, saturated with nitrates and a temporarily flooded environment with changeable water level (Decencière Ferrandière, 2001). Plant species are mainly annual and helophyte (herbs with perennating buds lying in mud – Raunkiaer’s life forms, Raunkiaer, 1934) and include *D. alisma*, *Pulicaria vulgaris*, *Bidens radiata*, *Plantago major intermedia*, *Polygonum lapathifolium* [*Persicaria lapathifolia*], *Polygonum amphibian* [*Persicaria amphibia*] and *Ranunculus sceleratus*. Under the CORINE biotope classification (Bissardon *et al,* 1997) Decencière Ferrandière puts *D. alisma* in the *Bidens tripartitus* group (Bidention tripartitae) – annual community plants that colonize the nitrous muds of ponds – *Bidens radiata*, *Rorippa palustris*, *Chenopodium* spp., *Polygonum* spp., *Rumex maritimus* and *Ranunculus sceleratus*. However, Decencière Ferrandière’s analysis shows *D. alisma* as most closely associated with *Ranunculus sardous*, *Lythrum portula*, *Alisma lanceolatum*, *Juncus tenageia*, *Limosella aquatica*, *Pulicaria vulgaris* and *Elatine alsinastrum*. Decencière Ferrandière considers that there is a divide between those ponds supporting *D. alisma* and *Pulicaria vulgaris* and those supporting *Bidens radiata*.

Ranunculus sardous, *Lythrum portula*, *Alisma lanceolatum, Limosella aquatica*, and *Pulicaria vulgaris* all occur in Britain. Of these only *Lythrum portula* is a commonly recorded associate of *D. alisma* at extant (post 1990) sites.

The suite of species recorded by Decencière Ferrandière differs from those recorded in Lansdown, 2000 for a lake site supporting *D. alisma* in Sologne, Department of Loire et Cher. When empty (the lakes are drained over varying timescales) the mud supports *D. alisma*, *Alopecurus aequlis, Cyperus fuscus, C. michellanius, Elatine hexandra, E. hydropiper, Mentha pulegium, Persicaria minor* and *Rumex maritimus*.