

Re-introduction of Triangular Club-rush

R&D Technical Summary W1-045/TS

Introduction

The Environment Agency is the lead partner for protection and positive management actions, identified through the United Kingdom (UK) Biodiversity Group within the Species Action Plan (SAP), for triangular club-rush *Scirpus triqueter*. The rarity and vulnerability of triangular club-rush has led to detailed research on the existing native populations in Ireland and England. This Summary outlines the approach and findings of this work, commissioned by the Environment Agency in collaboration with English Nature, providing a case study that may have a broader application for Agency staff dealing with the management of rare and endangered species.

Background

Triangular club-rush is an aquatic perennial plant restricted to brackish environments along the lower reaches of tidal rivers. It forms part of the *Cyperaceae* family containing 110 genera and is classified within the *Scirpus* genus, which worldwide contains about twenty species, mostly aquatic perennials. There are four native species within Britain and Ireland, the common *S. tabernaemontani* and *S. lacustris*, and the rare *S. pungens* and *S. triqueter*.

Triangular club-rush is a widely distributed Eurasian club-rush. It is most abundant in West Asia but extends its range to Africa, Southern and Central Europe and is naturalised in North America. In Britain, Ireland and Holland it reaches its northern geographical limit *S. triqueter* was historically recorded from five localities in Britain and Ireland. Its stronghold is now in Ireland, on the Shannon Estuary where the population is stable if not increasing.

The only remaining location in Britain was thought to be on the Tamar Estuary on the Devon/Cornwall border where, in 1998, the population was restricted to two small clumps.

Hybridisation between triangular club-rush *S. triqueter* and other *Scirpus* species (*S. tabernaemontani* and *S. lacustris*) exist where their populations overlap. This has created problems with field identification and possible errors in past records.

Prior to the development of the Species Action Plan (SAP) some significant work had taken place on the status of *S. triqueter* in Britain by English Nature, Plymouth City Council and Plantlife. Historical distribution records have been collated and this has provided an appreciation of its decline and local extinction from a number of British sites. Plant rhizomes had been removed as a precautionary measure from native stock on the Tamar to be cultivated in a secure environment at the Royal Botanical Gardens (RBG) Field Station at Wakehurst Place.

In recognition of the plant's vulnerability a SAP was developed to identify matters requiring clarification to enable future management and the lead partners to implement these tasks. The latter was based on statutory responsibilities and local enthusiasm. This placed the Environment Agency as the key player since all the historic sites for the plant in Britain were on main rivers where the some regulatory responsibility. The SAP was produced by English Nature, the Agency and the Plymouth City Council's Ecologist and was subsequently refined as a result of wider consultation.



Key Aims within the action plan were:

- A comprehensive survey of the distribution and abundance of the British and Irish population of triangular club-rush and the hybrid populations to determine their current status and describe their habitat requirements and local availability;
- Genetic study to establish the appropriateness of reintroduction of triangular club-rush to areas that contain its hybrids.
- An autoecological assessment of the Irish population to allow refinement of proposed conservation actions;
- To maintain nursery stock to allow future propagation of triangular club-rush from native stock at Royal Botanical Gardens Wakehurst Place;
- To monitor the last remaining population on the Tamar; and
- To restore a viable population on the Tamar with a possible extension to other historic sites and beyond.

On adoption of the action plan these key aims were progressed by a number of workers in parallel and co-ordinated by the Environment Agency under the R&D Project W1-045. The Agency and English Nature provided funding in terms of staff time, equipment and resources for consultant support. The following section summarises the approach and findings of the various studies designed to achieve the key aims of the action plan as identified above.

Tamar Survey 1997. R.FitzGerald *et al.*

The survey aimed to map the distribution of the *Scirpus* species on the upper Tamar and collect voucher material for DNA analysis. Survey methods incorporated both boat and bank surveys and confirmed that *S. triqueter* and hybrid forms of *S. x kuekenthalianus* were restricted to the tidal banks of the Tamar estuary. Hybrid plants were found at five locations with the native population of *S. triqueter*. Both the extent and distribution of hybrid and pure forms were reduced from earlier surveys.

Upper Shannon Estuary below Limerick City. B. 1998-1999 B.M.Deegan

This survey formed part of a larger study and repeated earlier surveys of the area increasing the known range of *S. triqueter* within the main stem of the River Shannon and its tributaries on the River Ratty, Maigue and the Cratloe, Meelick and Ballincurra Creeks. The population was regarded as abundant and stable if not increasing and was found in three habitat types i.e. creek banks, the outer zone of mud banks and within lagoons. *Scirpus* species were restricted to *S. triqueter* and *S. tabernaemontani* no hybrid forms were recorded.

Arun and Medway Survey 2000. P.A.Nicholson.

The survey repeated the methods applied to the Tamar by FitzGerald for approximately 34 kilometres of the upper estuarine reaches and the adjoining open water and wetland areas of the Arun and Medway Estuaries. *Scirpus* species and hybrids were identified,

their location and field characteristics recorded and specimens collected for later laboratory examination and genetic studies. Field notes were taken of the general distribution of all *Scirpus* species and associated plants within the channel and banks. The physical form and historic management of the channel were also noted. The findings of the survey confirmed that *Scirpus triqueter* had become extinct from its former range on both estuaries. *S. tabernaemontani* was present on both the Arun and Medway as were plants showing the hybrid features of *S. x kuekenthalianus*. No other *Scirpus* species were recorded and on the Arun, the hybrid form was dominant throughout the survey area.

Genetic Studies of the *Scirpus* species *S. lacustris*, *S. tabernaemontani*, *S. triqueter* and their hybrids. 1998 & 2001 M.F.Fay *et al.*

Voucher material collected between 1997 and 2000 were subject to a number of analyses by the RBG at Kew and presented in two reports in 1998 and 2001. The voucher material collected from selected plants at the four historic sites of *S. triqueter*, one other site in Britain and from the Shannon was subjected to a technique called amplified fragment length polymorphisms (AFLPs). This genetic fingerprinting technique is the most sensitive method currently available and suitable for use with rare and endangered species. The findings concluded that *S. lacustris*, *S. tabernaemontani* were so genetically distinct that they should be considered as a separate species and not as two subspecies of *S. lacustris*, as recommended by some authorities. The close relationship between the English and Irish material of *S. triqueter* indicates a narrow genetic diversity for this species at least in the British Isles. Hybrid forms based on phenotypic characteristics collected from a wide range of sites on the Arun and Tamar all proved to be genotypically *S. x kuekenthalianus*. Other voucher material collected on field characteristics as *S. tabernaemontani* (Thames and Arun) proved to be genotype *S. x kuekenthalianus*. Conversely voucher material collected on field characteristics as *S. x kuekenthalianus* (from the Medway) proved to be genotype *S. tabernaemontani*. It is apparent that phenotypic plasticity (variable physical taxonomic features) makes positive field identification problematic. This has significant implications for the project when trying to establish its former range and the subsequent suitability of sites for reintroduction.

Ecology of triangular club-rush *S. triqueter* in the Shannon Estuary an MSc. Thesis University of Limerick B.M.Deegan 2000.

A wide ranging study on the ecology of *S. triqueter* on the Shannon. The thesis identifies the current population status of *S. triqueter* in Ireland (see left) and investigates its phytosociology and environmental tolerances. The experimental studies quantify the limiting levels of soil salinity, anoxic sediments, sulphide concentrations, temperature and daily inundation periods on the plants growth rate and fertility. Comparisons were made with other hydrophytic and halophytic species and consideration given to the implications to the interspecific competitive

advantage of these environmental factors and their influence on the current distribution of *S. triqueter* on the Shannon.

S. triqueter growth was found to be stimulated by low salinity levels below 2ppt and suppressed by levels of 0 and >5ppt. The plants were also shown to have a tolerance for tidal immersion in terms of biomass production and tolerant of a wide range of soil types but was less tolerant of anoxic conditions >200 µM than *Bolboschoenus maritimus* but greater than *S. tabernaemontani*. No seed production was recorded for the native population but cultivated plants proved to be fertile with germination of seed requiring an incubation temperature of 20°C.

All the quantified laboratory investigation results favouring optimum growing conditions for *S. triqueter* reflected the environmental conditions present within habitats that supported the native populations of *S. triqueter* on the Shannon.

Monitoring and Re-introduction Programme 1997 - 2001. Environment Agency.

A series of internal reports have been produced by Agency staff documenting the process for site selection and planting methods applied to the re-introduction of *S. triqueter* on the Tamar. The reports cover the period 1997-2001 and cover four planting sessions and the interim monitoring operations.

Plant Propagation

S. triqueter plant material from the native population on the Tamar was taken to Wakehurst Place under license from English Nature, when the plant's vulnerability was first recognised. The nursery crop now established at the RBG Field Station at Wakehurst Place is grown in an unheated greenhouse in a damp freshwater environment where it flourishes and freely produces fertile seed. Propagation for transplants is by rhizome fragments placed in 2.5 inch pots in a potting medium covered with sand. The plants are then grown in the greenhouse, to the transplant stage, without re-potting. The plants at transplant stage have strong rhizome and root growth with 3-8 shoots per pot with an average height of 0.7 metre. Plants are transported to site by road and the entire propagation exercise is undertaken by staff of the Royal Botanic Gardens and is funded by English Nature. Voucher material is stored here so that it can be used to react to future declines.

Site selection

Site selection for re-introduction to the Tamar was within the plant's historic stronghold. The habitat in this zone conforms to that recognised in the Irish studies as providing the best growing conditions available for *S. triqueter* when free from interspecific competition. Initially five sites were selected based on low salinity levels; freedom from competition with *Phragmites australis* or other *Scirpus* species; avoidance of anoxic substrates; stable bank or slope structure and close to the shoreline to reduce the

extent of tidal inundation. This was repeated at other sites for the second planting operation with subsequent plantings concentrating on those previously successful sites to expand their area and density.

Planting Methods and Frequency

Plants were transported to the suitable sites by boat. The plants were removed from the pots but retained their potting medium and established within the mud at 0.5 metre centres with the potting medium 0.1-0.2 metre below the surface mud level. The nature of the environment encouraged a strict adherence to good health and safety practice, which became more comprehensive with successive plantings.

Planting took place on four occasions:

Date	No. of sites	No. of pots
28/6/1997	5	58
24/6/1998	3	101
4/8/1998	3	65
1999	3	663
TOTAL		887

Monitoring

The Tamar estuary is a fairly isolated area so monitoring of the planting sites was only achievable by boat and then strongly constrained by tidal conditions. Monitoring frequency was understandably low only once or, at best, twice each year from 1997-2001 and often coupled with the next re-introduction session. Monitoring was largely restricted to observation on the presence or absence of plants with no quantitative data available for individual surveys after 1998. Losses were related largely to the unsuitability of the chosen re-introduction sites or gross changes in the physical habitat, although the monitoring was not designed to specifically identify factors such as flooding that coincided with these losses. However at the end of the 2001 season the population had expanded to an established and thriving population covering approximately 8.5m² by the introduction of plants. The original native clump had declined by half from its 1998 size to less than 0.5m².

Conclusion

The survey of *Scirpus* species in the UK and Ireland has shown that the *S. triqueter* is no longer present within the survey areas of either the Arun or the Medway Estuaries. The stronghold for the species remains on the Shannon where the population is stable. Following re-introduction experiments on the Tamar the population has increased significantly but is still considered to be threatened and therefore needs to be carefully monitored.

Specimens exhibiting hybrid features either by phenotype or genotype were present at all the historic sites of *S. triqueter* in England but absent from Ireland. Phenotypic plasticity was described from *Scirpus* species present on the Arun and Medway and Thames. * Specimens collected as pure forms of *S. tabernaemontani* on the Arun and Thames were

found to be genotypically *S. x kuekenthalianus*. Specimens collected as *S. x kuekenthalianus* from the Medway were found to be genotypically *S. tabernaemontani*. This discovery makes confidently identifying hybrid forms using taxonomic keys difficult and provides a significant obstacle for trying to establish the former range.

Suitable sites for re-introduction of the now locally extinct *S. triqueter* were located on both estuaries. These suitable areas were more extensive on the Medway than the Arun.

The value of the extension of the current re-introduction programme of *S. triqueter* to the other historic sites on the Arun, Medway and Thames poses problems in terms of effort and the potential impact on the hybrid forms that have been shown to replace *S. triqueter* at these sites. This is particularly significant on the Arun where the hybrid population is extensive and habitat availability restricted.

The Tamar re-introduction programme has had considerable success and the potential to establish other populations on historic sites particularly the Medway would be both feasible and a valuable conservation achievement.

Future Development

- 1 Broad consultation of the findings and recommendations contained in the technical reports.
- 2 Ongoing monitoring and re-introduction of plants from nursery stock within the Tamar to a determined stable level.
- 3 A trial re-introduction programme for the Medway with ongoing monitoring.
- 4 Transplantation of stock from the Shannon to Wakehurst Place to increase the genetic diversity of the stock and subsequent re-introductions.

Broader Implications

This work on *Scirpus* species may provide an example of an approach to the investigation and management of rare and endangered species that may benefit subsequent studies by the Environment Agency.

The strengths of the research were shown to be:

- A sound foundation based on a structured and simple set of aims and objectives set out in the SAP with wide consultation and formal agreement;
- The identification of a costed programme, adequate funding and the allocation of tasks to organisations with the appropriate time and expertise;
- Genetics support to establish the suitability of reintroduction proposals and to establish the relationship between triangular clubrush and its hybrids.
- An R&D framework that determined a clear reporting structure on the products of the research; and
- The early safeguarding of the native genetic stock and its cultivation in a protected environment that

allowed a bold approach to re-introduction experiments on the Tamar.

The weaknesses of the study were shown to be:

- Problems with field identification of hybrid forms of closely related *Scirpus* species;
- Monitoring of the fate of transplants was not designed to access the cause of losses to the re-introduced plants;
- The lack of conservation values placed on the hybrid forms of *Scirpus* species;
- The absence of a clearly defined population size and distribution range for re-introductions of *S. triqueter*; and
- The absence of a procedure to allow the future funding and long-term management of *S. triqueter* and its habitat.

The weaknesses within the study relate more to the future elements of the species management rather than the R&D undertaken. It is important however that such work gives comprehensive guidance to any future management of the endangered species being studied.

The project supported the Agency Key Theme on "Enhancing Biodiversity".

This R&D Technical Summary relates to information from R&D Project W1-045 reported in detail in the aforementioned outputs.

Internal Status: Limited release to Agency Regions
External Status: Restricted

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Copies of the reports will be available internally from your Regional Libraries or the National Information Centre in Bristol. Externally, this Summary and other outputs are available from the Environment Agency's R&D Dissemination Centre, c/o WRc Information Resources, Frankland Road, Blagrove, Swindon, Wiltshire SN5 8YF, Tel: 01793 865138, Fax: 01793 514562. Website URL: www.eareports.com

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