Ranunculus and Chalk rivers

Environment Agency

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Classic Chalk River – River Itchen showing stable flow and diverse natural riparian vegetation.

The Environment Agency is the lead organisation responsible for delivering obligations under the UK Chalk Stream Biodiversity Action Plan. A significant part of that obligation is the maintenance of the characteristic macrophyte community dominated by water crowfoot – *Ranunculus*. Under the Habitats and Species Directive some chalk rivers have been selected by English Nature as Special Areas of Conservation (SACs), a component interest of which includes the *Ranunculus* community.

Many Chalk rivers are renowned fisheries, where for centuries *Ranunculus* has been managed to provide the most favourable conditions for angling as well as to control water levels and reduce flood risks. Thus the future well-being of the community is inextricably linked with, and often dependent on, other interests associated with Chalk rivers.

In the last decade considerable concern has been expressed about the deteriorating condition of Chalk rivers and in particular an apparent decline in *Ranunculus*. This resulted in many interested organisations and individuals getting together in 1998 to form the '*Ranunculus* Forum'. Possible reasons for concern included increased levels of phosphates, variable flows resulting from fluctuations in rainfall or over-abstraction, competition from other macrophytes, smothering by algae, and physical changes to the river environment.

For the reasons given above, *Ranunculus* and Chalk rivers have been the subject of much research. However in the past, most research has been carried out in isolation and few projects have been collaborative to maximise the value of pooling existing knowledge.

Small Chalk rivers: Lambourn, pictured left, and Piddle, pictured right.

To fulfil its responsibilities the Environment Agency needs to understand what governs the success and failure of *Ranunculus* in Chalk rivers. In 1999-2000 an R&D project was carried out with the aim of drawing together the current state of knowledge on what affects its growth most.

The project was undertaken in two phases. Phase 1 involved the gathering of data – literature, anecdotal observations and, most importantly, the views of people with a long association of living and working on Chalk rivers. Phase 2 required a detailed appraisal of that data, including a review of all relevant published papers and reports that were to hand.

This short leaflet gives a brief summary of the key findings of the project, especially those that have implications for managing and protecting the interests of Chalk rivers today, and in the future.

Key findings

Teasing out controlling influences

An essential element of the project was to identify if any literature existed to give clear evidence of the cause and effect of various environmental and man's influences on the growth and distribution of *Ranunculus* in Chalk rivers

The project review separated influences into '*Factors*' and '*Drivers*'. *Factors* are primarily measurable variables considered to affect *Ranunculus* growth, and the *Drivers* are natural and man-induced influences that change the character of the *Factors*. The most important of these are:

R. Hull – high water levels sustain adjacent wetlands.

Bere Stream – an unmanaged, tree-lined, reach.

Ranunculus pseudofluitans, the species typical of perennial Chalk rivers.

Factors

- Discharge – Seasonal/Annual Changes
- Velocity, Depth, Levels
- Substrate & Siltation
- Physical Channel Characteristics
- Competition – Interaction/Life Cycle/ Colonization
- Water Quality, Enrichment, Suspended Solids
- Grazing, Light, Shade, Temperature.

Drivers

- Natural Climate Cycles
- Abstraction and Catchment water use
- Channel Management
- Vegetation Management
- Enrichment from Point Sources
- Shading by algae
- Land use & Diffuse Enrichment
- Rehabilitation, Augmentation etc.

Thus Water Velocity is a *Factor*, which can be affected by *Drivers* such as climate, abstraction, channel management etc. Thus how management is carried out, or what licenses/consents are given, can alter many *Drivers*. By linking *Factors* to *Drivers* it is possible to identify ways in which the Environment Agency, and others, could be assisted in their management of Chalk rivers for the benefit of the *Ranunculus* community.

Prime Factors highlighted by the project

The greatest number of citations within the documents reviewed was the *Factor* 'Velocity', and this was universally regarded as of prime importance to the growth and distribution of *Ranunculus*. 'Discharge' and 'Substrate and Siltation' had the next highest number of citations with 'Light, Shade and Temperature' having the next highest. The lowest number of citations were for 'Grazing (by swans etc.) and 'Physical Channel Dimensions'. The latter is particularly surprising since recent rehabilitation projects on many Chalk rivers often target artificially wide or over-deepened rivers to restore habitat more suitable for *Ranunculus,* trout and other characteristic Chalk river biota.

Sheer numbers of reports citing the importance of any given Factor therefore cannot be considered definitive; greatest confidence is placed on reports including quantitative (measured) information that has been rigorously collected and subject to statistical analysis. In this respect 'Velocity' was still the most important; however there were no quantitative data relating to the influence on *Ranunculus* of grazing or changes in channel dimensions.

The *Factors* 'Discharge' and 'Velocity' (including Seasonal Annual Changes) appear to operate in tandem. With sufficient discharge, high velocity is instrumental in stimulating healthy growth early in the year. It also clears away senesced plant material, silt and potential competitors at the end of the growing season, so preparing the substrate for re-growth or colonisation the following year.

Significant Drivers

'Natural Climate Cycles' was highlighted as the most important influence on *Ranunculus* through the related aspects influenced by discharge. Data, and personal observations, show the importance of the seasonal cycle of discharge rather than absolute values. Other *Drivers* that are also important in influencing velocity, and therefore the suitability of habitats and conditions for *Ranunculus* growth, include channel and vegetation management, abstraction and the physical dimensions of rivers.

Elevated nutrient levels are frequently mentioned as a contributor to the general ecological deterioration of many Chalk rivers and as a cause of either **increased or decreased** *Ranunculus* growth. However more documents report an inability to find strong correlations between *Ranunculus* growth and water quality parameters. Enrichment from point sources is associated in the literature most with fish farm effluent, sewage treatment works and Water-cress farms. A greater emphasis is placed on phosphate than nitrate in the literature and elevated phosphate levels are implicated with stimulating filamentous and epiphytic algae affecting *Ranunculus* through competition. Possible physiological effects, such as root structure changes, have been shown in some studies.

Based on Observations of the effects of swans on the Rivers Avon and Wylye, non-breeding birds have been identified as causing the most damage to *Ranunculus* by grazing. Birds show a preference for shallow areas. Here, and on the Kennet, river keepers report birds have greatest impact when water levels are low and plants are in poor condition.

A 'snapshot' on *Ranunculus* growth today in Chalk rivers

All contacts reported that the low flows of the late 1980s and early 1990s resulted in a reduction in *Ranunculus*, and sparked concern over its possible spiralling demise. Equally, all reported particularly successful years between 1998-2000. This has been almost entirely attributed, by those providing the information, to improved winter discharge following the negative effects of low flows. These impacts, however, were shown not to be new. Those with long associations with Chalk rivers reported similar problems during the drought of 1976; dramatic changes to the flora of the Kennet were also recorded in the dry years of the 1940s.

The reporting of poor growth in low-flow years in the early 1990s, and the especially good recovery in 1999/2000 (continued into 2001 too) is consistent with the conclusions drawn from the literature that climate is invariably the key *Driver*.

Database

For anyone interested in more details of the information contained within the reports, papers and statements reviewed through the project, information on over 350 documents are held on a database which is on a freely available CD. It is hoped that a network of interested personnel will feed information into this in the future.

Strip cutting on the Lambourn.

Management implications

Management for fisheries and flood defence

For centuries the vegetation of Chalk rivers has been managed by cutting to reduce risk of flooding and provide conditions favouring salmonid fishing. Getting the right balance of having sufficient *Ranunculus* and other aquatic vegetation for a healthy environment, but not too much to make fishing difficult or cause flood defence problems is tricky, and demands the Agency and river keepers to apply many skills and negotiate with all interests.

In terms of the impact of cutting on the competitive advantage of *Ranunculus*, there are strong suggestions that it is only regular cutting of the channel that allows *Ranunculus* to dominate. The extent to which *Ranunculus* in Chalk rivers reproduce by seed is still unknown, and could be rare. The common field observations regarding low seed production, germination and seedling production is echoed in the literature. Due to uncertainties, allowing a proportion of *Ranunculus* to flower and set seed is recommended, especially in years when growth is poor, and enhancing future establishment is desirable.

Natural shade from planting bankside trees has been recommended as a means of controlling *Ranunculus* growth on small Chalk rivers following work at the River Laboratory. in Dorset. Removal of major quantities of plant material from Chalk rivers is considered by some as a potentially damaging ecologically action due to large numbers of invertebrates possibly being removed from the system. This may include *Simulium* (blackfly) larvae that graze on algae and therefore affect competition with algae.

An assessment was made of the effect of bar cutting on the growth and recession of *Ranunculus* at sites on the Kennet and Lambourn. It was concluded that it was best to leave as much *Ranunculus* uncut as possible as it would begin to wash out naturally soon after flowering. A cut before flowering did not control growth and often increased the amount of *Ranunculus* during the following winter. The most effective way to control summer growth was cutting, but only the minimum necessary, at the time of flowering.

Whilst there is a wealth of data on the various impacts of cutting *Ranunculus* when it is thriving, there is a positive dearth of knowledge on how cutting effects *Ranunculus* under stressed conditions such as low flows or enrichment. The emphasis of the work in the past has been on controlling *Ranunculus* whereas in the future the emphasis in places will be on maintaining, promoting and re-instating *Ranunculus* communities.

Many documents cite the detrimental impact on *Ranunculus* growth of silt accumulation. Recent studies suggest that there is at least a perceived increase in the amount of silt entering Chalk rivers. There have been observations on the Test & Itchen that *Ranunculus* rooted in silt is more easily removed when flow recovers. On the Avon system, an experienced river keeper suggested that cutting plants growing in silt tends to uproot them, preventing re-growth.

Discrete silt deposits are important habitats for many Chalk stream animals, including lamprey. Some silt is therefore of value, but sluice management that reduces blankets of silt being formed benefits *Ranunculus,* and the majority of Chalk river invertebrates and fish.

Only cutting a narrow channel of vegetation maintains clean gravel through increasing velocity.

Water resources

The review process has shown that discharge, and many other *Factors* affected by this, are highly linked with climate, and abstraction of water from the aquifer can heighten impacts of low discharge. There have been many studies in Chalk catchments looking at abstraction and how this affects river flows; however there is a dearth of information on how this translates to affecting the *Ranunculus* community. Studies on the Allen going back more than 10 years showed that very low summer flows weakened the growth of *Ranunculus* making it vulnerable to removal by high winter flows. This occurred in 1989/90 and again in 1994/95, with recovery in intervening years. However good winter/spring flows need to be adequate to wash out accumulated silt and the previous years growth of Water-cress, otherwise *Ranunculus* will be retarded in the spring.

This illustrates the need to allow natural extremes and variations in seasonal and annual flow to be maintained. The Allen study was carried out over a sufficiently long period to enable provisional recommendations to be made for a minimum prescribed flow that from April to July is 50% greater than for August and September. In most rivers adequate data on *Ranunculus* do not exist over a sufficient time-scale to allow such prescriptions to be made.

Swans

There seems to be general agreement that a breeding pair of swans will keep most other swans away thereby reducing grazing impacts on *Ranunculus*. Outside the breeding season this control may not apply. Thus a family of swans need not be considered detrimental to the aquatic river community, but large herds are different. Efforts on the Wylye to encourage (by driving and some local fencing to reduce the availability of flight paths) large numbers of juveniles to congregate and feed in 'sacrificial' stretches is meeting with some success.

River rehabilitation

A prime consideration of many river rehabilitation projects is to change 'Channel Dimensions' to restore previous habitats. The majority have been carried out to redress deficiencies in some reaches due to elevated siltation, lack of discharge or inadequate velocities associated with past channel modification, such as over-deepening and over-widening. The guiding principles of many rehabilitation projects have been to increase velocity that has invariably led, at least in the short term, to the re-appearance of healthy *Ranunculus*. The exact reasons for this should be treated with caution, but some very significant improvements were achieved in the mid 1990s when *Ranunculus* was declining elsewhere.

Cattle have been implicated in some studies as a major contributory cause to changing natural channel dimensions and fencing has been employed locally with good effect to help in-stream vegetation recovery and bring about channel narrowing. Fencing entire catchments is not advocated in the interest of developing a patchwork of different habitats so that diversity is maintained to sustain a rich marginal invertebrate population.

Licensing and consenting implications

The implication made by the majority of the literature is that *Ranunculus* is maintained at un-naturally high levels by vegetation management and other practices that favoured it over its competitors. Management of *Ranunculus* and Chalk rivers has helped create the habitat and diversity recognised by the UK Chalk Stream Biodiversity Action Plan and Habitats Directive (SACs).

English Nature has produced draft generic targets for *Ranunculus* communities associated with the Chalk rivers BAP and the Avon and Itchen SACs which cover many aspects including desired flow regimes, substrate characteristics, make up of macro-phyte community assemblages, water quality standards etc. The Environment Agency, through its own permissive activities and consenting role, also has important responsibilities. By using the reviewed data from this project, and utilizing future follow-up work, it is hoped these activities and targets will be better supported by quantitative information to help river keepers, water companies and other river users meet their, and others, objectives.

Swans on a stretch of the R. Wylye.

Devill's Brook 2 years after fencing.

Devill's Brook unfenced (control).

Cattle poaching the R. Piddle.

Future priorities

Conclusions

Despite the considerable amount of field work undertaken on Chalk rivers in the last 30 years there are many aspects of *Ranunculus,* and the *Factors* and *Drivers* affecting its growth and distribution, which remain undetermined or only partially answered.

The decade of the late 1980s to 1990s raised concerns about the future status of *Ranunculus* in Chalk rivers, and the rivers themselves. The higher winter flows of recent years have, at least temporarily, assuaged fears about the ability of *Ranunculus* to recover from a series of low flow years. Under the BAP process the Environment Agency now has responsibilities towards the future conservation of Chalk rivers and the *Ranunculus* community.

The project has shown that *Ranunculus* is again thriving in many well known Chalk rivers following 2-3 years of higher flows. Little is known, however, about the status of *Ranunculus* even in some of these rivers prior to 1990. Worryingly, the project identified that the responsible authorities for Chalk river conservation have no data at all for even the present day status of the *Ranunculus* community in around half the UK resource of c150 Chalk rivers.

There is a lot of observational evidence on the preference of *Ranunculus* for clean gravel substrates and frequently an inferred negative impact resulting from siltation. By contrast there are no hard data to quantify amounts, sources, changes in quantity and absolute effects of siltation.

There is evidence showing enhanced physiological response of *Ranunculus* to fast flowing water and lots of observational links between velocity and *Ranunculus* performance. A figure of 10 cm/sec is often quoted as the point below which *Ranunculus* growth may be limited, but there are no absolute values to support this. Velocity is affected by a host of influences, especially natural climate cycles, channel dimensions and management, abstraction etc.

There is frequent inference to the problems associated with poor water quality and enrichment and its impact on *Ranunculus*. Water quality is invariably linked to point source enrichment inducing increases in epiphytic and filamentous algae and thereby threatening *Ranunculus* through competition and/or shading.

River narrowing by constructing a causeway.

Low-tech rehabilitation on the R. Avon using mattresses to concentrate low flows to the centre of the channel.

There is little published information concerning the influence of land use and diffuse enrichment on *Ranunculus* status, and literature is sparse on suspended solids. Impacts are reported on *Ranunculus* via siltation on leaves and of combined stress of siltation, nutrient enrichment, and low flows following poor winter re-charge.

Data gaps and priority needs

On the basis of this project review there are gaps in data that are considered very important to address to ensure adequate protection and appropriate management of all Chalk rivers in the future. The following are some of the key gaps.

- The status of *Ranunculus* distribution and abundance is poorly known in many Chalk rivers. There is an urgent need to establish the status in all Chalk rivers where these data are absent otherwise the Environment Agency and English Nature will not be able to fulfil their obligations under the Chalk Rivers BAP.
- As the most important *Factor* affecting *Ranunculus* is Discharge, and Natural Climate Cycle is the key *Driver*, there is a need to establish better relationships between discharge, physical dimensions, water quality and sediment loading, and *Ranunculus* growth.
- There is a need for clarification, and promotion, of vegetation management techniques that take full account of the needs of nature conservation (*Ranunculus* community) as well as flood defence and fisheries.
- Sediment dynamics are poorly documented or understood, yet it is important to know where sediments come from, how they change over time and their potential nutrient input. We also need to understand what benefits arise from more benign land use practices, such as countryside stewardship, re-use of water meadows, developed buffer strips etc.
- The effects of silt on rooting and colonization success of *Ranunculus* via vegetative and seeding means.
- The physical, biological and chemical effects of suspended solids (via turbidity) on *Ranunculus* growth, and the interaction with algae.
- The potential impacts/benefits arising from climate change, including regional scenarios, changes in season rainfall patterns/amounts and the implications for competing interests such as water resources.
- Including a fluvial geomorphological (working with natural processes) approach into rehabilitation projects to ensure sustainable solutions are produced.
- Scientific quantification of appropriate physical channel dimensions for good *Ranunculus* growth under given discharge scenarios in relation to water quality, sediment loadings and gradient.
- Monitoring of rehabilitation projects to quantify the effects on *Ranunculus*, other biota, and channel conveyance performance as well as ensuring schemes meet their objectives without compromising other interests.
- Establish and quantify the impact of swan grazing at catchment scale.
- Extend the consideration of issues relating to *Ranunculus* to other macrophytes which constitute the *Ranunculus* **community.**

Where to get more information

If you are interesting in receiving a copy of the R&D report, which contains a read-only CD of the database, please contact the Environment Agency's R&D Dissemination Centre, Water Research Centre plc, Frankland Road, Blagrove, Swindon, Wiltshire SN5 8YF.
Tel: 01793 865012 Fax: 01793 514562
email: publications@wrcplc.co.uk
website: www.wrcplc.co.uk/rdbookshop

Recommendations

On the basis of the conclusions drawn from the data review a number of recommendations for further works have been made. These have been listed into four categories:

- Research and Development;
- Field Trials;
- Monitoring & Survey;
- Dissemination, Advisory, Promotion of Good Practice.

Thirteen discrete elements have been proposed, but as yet the priorities for action have not been set. A meeting involving a mix of river keepers, researchers and river managers (*Ranunculus* Forum) will be held in November 2001 to debate these, and help shape any future work. Hopefully future activities will be undertaken in partnerships between agencies and river keepers, and on many different Chalk rivers. This leaflet is the first output produced as a result of the project.

Top: River Till – January 1994

Bottom: River Till – August 1994

Dramatic flow changes in the headwaters of Chalk rivers are natural.

Can you help with future work?

Following the Forum meeting it is hoped that a series of projects, database updates and field trials will be put in train for the coming years. If you would be willing to consider being part of this process, including field trials, please contact Allan Frake, Environment Agency, South Wessex Area, Rivers House, Sunrise Business Park, Higher Shaftesbury Road Blandford DT11 8ST.
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