The effect of removing invasive *Ranunculus* on juvenile salmonids and freshwater pearl mussels in the River Spey: one year after *Ranunculus* removal

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SUMMARY

Three survey areas encompassing six paired survey sites were examined to determine the effect of hand removal of *Ranunculus* on populations of freshwater pearl mussels (M*argaritifera margaritifera*), juvenile Atlantic salmon *(Salmo salar)* and juvenile trout *(Salmo trutta)* during 2002. Two survey areas (four paired survey sites) were re-examined in August 2003, one year after *Ranunculus* removal, using standard visual survey methodology for freshwater pearl mussels and electro-fishing for juvenile salmonids.

In the sites where *Ranunculus* was removed re-growth within the initial four-month study period in 2002 was negligible and little re-growth was recorded after one year in August 2003. Hand removal may be effective for short to medium term control. However, *Ranunculus* growth at the control sites was also low in 2003. This may have resulted from the prevailing low summer flows.

The extensive sand deposits recorded near the *Ranunculus* clumps during 2002 at the one of the survey sites were absent in 2003 indicating that removal can lead to an improvement in habitat. This may have contributed to a recorded increase in salmon fry densities.

The hand removal of *Ranunculus* had no significant impact on either the freshwater pearl mussel or the salmon and trout populations. The observed differences for both populations after one year are more likely to result from other factors, in particular, the long dry summer and prevailing low flows.

Further monitoring of the survey areas is not recommended. Future work should assess the overall distribution of the *Ranunculus* within the Spey, and identify factors promoting and/or limiting its spread and growth. Data of this kind could then be linked with pearl mussel and salmon distribution data to determine the effect of *Ranuculus* on these SAC species.

1. OBJECTIVES

This report was commissioned by Scottish Natural Heritage to:-

1. Examine *Ranunculus* re-colonisation one year after hand removal at main stem survey sites.
2. Re-examine fish and mussel populations within the survey sites after one year.

2. INTRODUCTION

Floating *Ranunculus* occurs in the main stem of the River Spey and in many other UK rivers, but in the River Spey it is believed to be a recently introduced species. In many other UK rivers where *Ranunculus* species are native, the aquatic plant community can be of considerable conservation value and 'watercourses characterised by *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation' is a habitat listed in Annex 1 of the European Commission (EC) Habitats and Species Directive. Lambert and Little (1988) indicate that *Ranunculus fluitans* appeared in the Spey main stem below Grantown in 1979 and spread rapidly due to cutting, so that by 1982 it was present from Grantown to the sea. They indicate that the likely source of the *Ranunculus* was the Auchernack Burn approximately 2km upstream from Grantown, but the reason for its appearance in this burn remains unclear.

The plant creates a number of problems for fishing proprietors, for example fishing pools can become choked, making it difficult for anglers to land salmon or sea trout. In addition as *Ranunculus* becomes more prevalent changes in the main stem habitat may occur. For example good salmon fry habitat and freshwater mussel habitat may be affected

Over the last few decades control of the *Ranunculus* has generally focused on two methods, hand removal or the application of a herbicide, typically Midstream (Lambert and Little, 1988). Both methods can be effective but each has drawbacks. However, the active part of Midstream is the chemical Diquat and recent EC legislation prevents this being used in watercourses. Thus chemical control is no longer available to river and fishery managers.

The main stem of the River Spey is at present a Site of Special Scientific Interest (SSSI) and a candidate Special Area of Conservation (cSAC) for four species: Atlantic salmon (*Salmo salar)*, otter (*Lutra lutra*), sea lamprey (*Petromyzon marinus*) and the freshwater pearl mussel (*Margaritifera margaritifera*).

The growth of *Ranunculus* and management actions, such as hand removal, could potentially have an impact on both the salmon and freshwater pearl mussel populations in the Spey. For example, during hand pulling mussels could be dislodged or crushed. Juvenile salmon may use the weed as refuges and removal could render them more vulnerable to predation.

Laughton *et al*. (in press) studied the effect of removing invasive *Ranunculus* by hand on the fish and mussel populations within the Spey during 2002. They indicate that the presence of *Ranunculus* clumps may provide some benefits for older salmon parr and trout and that the hand removal of the plant had little direct effect on salmon and trout fry and pearl mussel populations.

Extensive sand deposits were recorded near *Ranunculus* clumps and the numerous dead mussels collected provided clear evidence that such deposits are detrimental to freshwater pearl mussel populations (Laughton *et al*., in press). This depositional activity could also be detrimental to salmon and trout fry by choking the interstitial spaces in the substrate that they require during the early stage of their development. The root structure of the *Ranunculus* was also found to bind the substrate together possibly rendering it difficult for fish to spawn.

This report provides detailed data from revisits to two survey areas to assess salmonid and mussel populations one year after the initial study.

An additional survey of the distribution of *Ranunculus* in the Spey from Grantown to the mouth was also completed and the results are presented in Redgewell and Laughton (*in prep*).

3. METHODOLOGY

3.1 Site re-visits

A full description of site details can be found in Laughton *et al.* (in press).

Due to the continued threat from pearl fishing the precise locations of the study sites have been removed from this report and the sites are referred to by letter codes. Two sites on the Spey main stem (sites B and K) were re-visited in August 2003. A third survey site that formed part of the 2002 study was also inspected but not re-surveyed. The third site is located downstream from a sewage works outfall. Due to low flows throughout summer 2003 the site had accumulated a considerable amount of debris and organic material. . A noticeable sewage odour was also noted. The area was not re-surveyed, due to potential risks to staff, and the matter reported to SEPA.

3.2 Fish survey

Electro-fishing was carried out using Scottish Fisheries Co-ordination Centre methodology (SFCC, 1998) which is fully described in (Laughton *et al., in press*).

3.3 Freshwater pearl mussel survey

The following investigation was carried out with appropriate Animal Conservation Licence issued by Scottish Natural Heritage under the terms and conditions of the Wildlife and Countryside Act 1981.

A team of two fully trained freshwater pearl mussel fieldworkers carried out the survey to optimise search efficiency and for health and safety reasons. As in the 2002 surveys, the standard freshwater pearl mussel survey protocols, as described in Young *et al*. (2001a), were followed and adapted to cover four 100m^2 search areas with significant numbers of pearl mussels (two sites, each with an experimental treatment area, where *Ranunculus* was removed in 2002 and a control area, which was left undisturbed in 2002). The 2003 surveys were carried out approximately one year after *Ranunculus* removal. The searches followed the standardised methodology in order to ensure that information gained from this study was directly comparable to data collected in the original 2002 freshwater pearl mussel *Ranunculus* survey (Laughton *et al. in press*).

- Searches were made using a glass bottomed viewing bucket.
- Viewing was conducted under favourable conditions, i.e. bright light, clear water and a low flow regime.
- Searches were made in water sufficiently shallow for safe wading.
- The search was made in an upstream direction, checking all possible and favourable areas (e.g. in the shelter of cobbles or other obstructions). Loose debris and trailing weed were moved gently aside but no disturbance of fixed substrate was undertaken.
- Searches were conducted so as to traverse all the area of habitat within each 100m^2 area. All mussels were counted and a specific note was made of any juvenile mussel encountered (here taken to be all mussels at or below 65mm in length; Cosgrove, *et al.,* 2000) in the transect. In the general transect, weed and debris were moved aside but the substrate was not moved to search for hidden, buried mussels.

A series of 1m^2 quadrat searches were undertaken within the 100m^2 *Ranunculus* removal areas with the highest mussel densities (i.e. only at site B). Within these quadrats all visible *M. margaritifera* were counted, removed and measured using dial

callipers. All loose stones and debris were then displaced, so as to reveal any hidden *M. margaritifera* and, in particular, to search for any juvenile *M. margaritifera*. The number of visible mussels counted in each quadrat was expressed as a proportion of the total number of mussels present, including hidden mussels, in the quadrat. For example, 6/10 refers to six visible mussels out of a total of ten mussels found for the 1x1m quadrat (with four hidden mussels). The mussels were measured to provide information on the population structure of the mussels present in the area. All live mussels were returned to the river in the approximate locations where they were found.

For conservation purposes, standard criteria are used for describing the relative abundance of *M. margaritifera* populations, and these are usually based on visible transect counts of mussels (Cosgrove *et al.* 2000). The relative abundance and status terms used in this report (Table 1) are therefore based on the recommended terminology and importantly, are directly comparable to those used on all other Scottish mussel populations surveyed recently, e.g. the River Spey survey report (Young *et al.* 2001b) and the River Dee cSAC survey report (Cosgrove *et al.* 2004).

Table 1. Standard relative abundance and status terms for freshwater pearl mussels based on visual transect counts (adapted from Cosgrove et al. 2000)

Number of live visible mussels per 50 x 1m transect	Mussel density per m^2	Abundance code
1000+	>21	A
500-999	11-20	B
50-499	2-10	C
1-49	1	D
0	0	E

4. RESULTS

4.1 *Ranunculus* distribution and site structure

Details of the physical characteristics of each site were recorded in 2002 and 2003. The key difference between the two sampling years was water depth. The summer of 2002 was fairly wet while 2003 was very dry leading to much lower river levels in 2003. Indeed at both sites B and K some parts were dry and the substrate exposed.

Both areas were assessed visually for *Ranunculus* and the percentage cover for each site estimated. The 2002 and 2003 pre-removal and post-removal data for both sites are compared in Figure 1.

Figure 1: Percentage of* Ranunculus *at each site pre-removal, post removal and after one year.

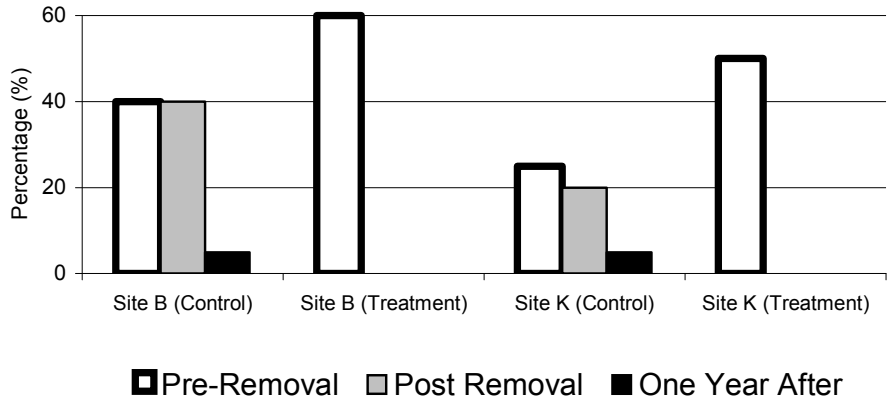


Figure 1 indicates that site B and K study areas initially contained *Ranunculus* cover of between 25% and 60%. After initial surveys of pearl mussels and juvenile salmonids were completed in July 2002 *Ranunculus* was completely removed by hand pulling at treatment areas of sites B and K. The plant was left in place at control areas of sites B and K (Laughton *et al, in press*).

Re-visits to the sites in August 2002 indicated that very little re-growth of the *Ranunculus* had occurred after removal from the treatment areas (Laughton *et al, in press*). Percentage cover at the control sites remained much the same. Assessments of the treatment sites in August 2003 indicated that small quantities of *Ranunculus* were present but no substantial re-growth had established. However, the percentage cover observed at the control sites was also low in August 2003, with only 5% at the control areas of sites B and K (Figure 1).

Figure 2a: Percentage of smaller substrates (silt, sand, gravel) present at each site in 2002 and 2003.

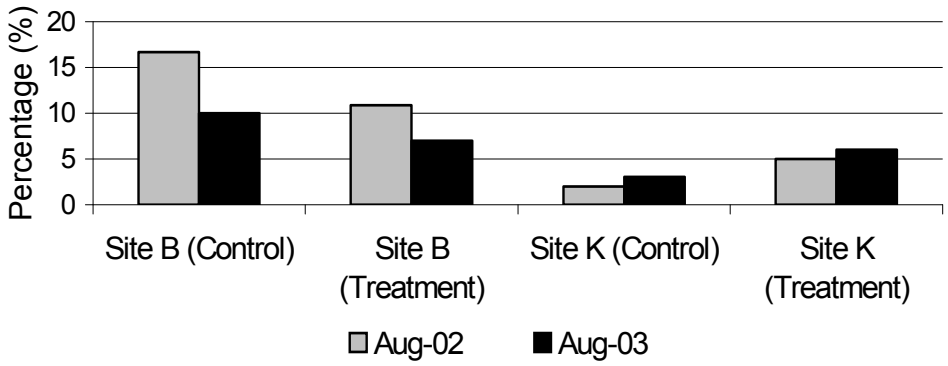
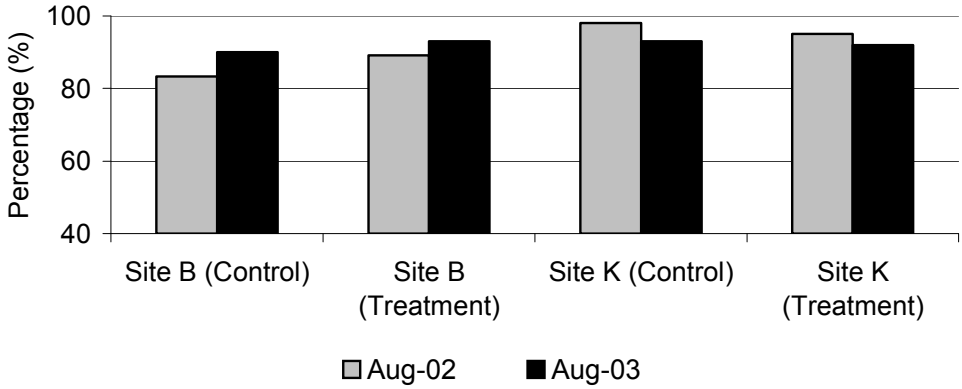


Figure 2b: Percentage of larger substrate (pebble, cobble, boulder) at each survey site in 2002 and 2003.



Figures 2a and 2b illustrate the percentage of different substrate present within each site. To allow comparison between years the smaller substrate types, silt through to gravel, are combined. Similarly the larger fractions, pebble through to boulder, are combined.

During 2002 the accumulations of sand and gravel within site B were relatively high, contributing 17% and 11% of the substrate at the control and treatment areas of site B (Figure 2a). This percentage had dropped during 2003 and an increase in the larger substrate types was recorded (Figure 2b). At site K similar amounts of smaller substrates were recorded in both years(Figure 2a).

4.2 Freshwater pearl mussels

The two study sites from the 2002 survey with significant numbers of mussels (sites B and K) were re-surveyed in 2003. Mussels were still found at both sites and numbers of mussels were recorded and compared to similar data sets collected in 2002 (Table 2). Although the absolute number of mussels varied slightly between the two surveys at site K, the relative abundance of mussels present did not change significantly between 2002 and 2003 (Table 2). There was a large decrease in the number of mussels present at the control area of site B over the same period with numbers at the control site dropping from 1309 in 2002 to 317 in 2003 (Table 2), representing a decrease of ca. 76%. The corresponding relative abundance categories changed from 'B' to 'C' at site B. A similar decline was also recorded in the site B treatment transect with numbers decreasing from 505 in 2002 to 218 in 2003 (Table 2), representing a decrease of ca. 57%. Despite this decrease the relative abundance category remained 'C'.

Table 2. The number and relative abundance of freshwater pearl mussels in four 100m^2 Ranunculus study sites in July –and August 2002 and August 2003.

Site	No. of mussels pre-treatment in 2002	No. of mussels post-treatment in 2002	Relative abundance pre- and post-treatment in 2002	No. of mussels post-treatment in 2003	Relative abundance post-treatment in 2003
Site B (treatment)	607	505	C	218	C
Site B (control)	1440	1309	B	317	C
Site K (treatment)	61	62	D	65	D
Site K (control)	258	234	C	295	C

Table 3. Summary statistics of site B mussel shell lengths (mm) pre and post *Ranunculus* treatment in July and August 2002 and August 2003.

Sample	Mean	Median	Standard deviation	Standard error	Range
Pre-treatment, 2002 (n = 389)	77.45	80	15.83	0.80	19-110
Post-treatment 2002 (n = 166)	72.11	78	18.89	1.47	18-104
Post-treatment					

Figure 3: Site B freshwater pearl mussel shell length frequencies prior to Ranunculus removal in 2002.

Figure 4: Site B freshwater pearl mussel shell length frequencies after Ranunculus removal in 2003.

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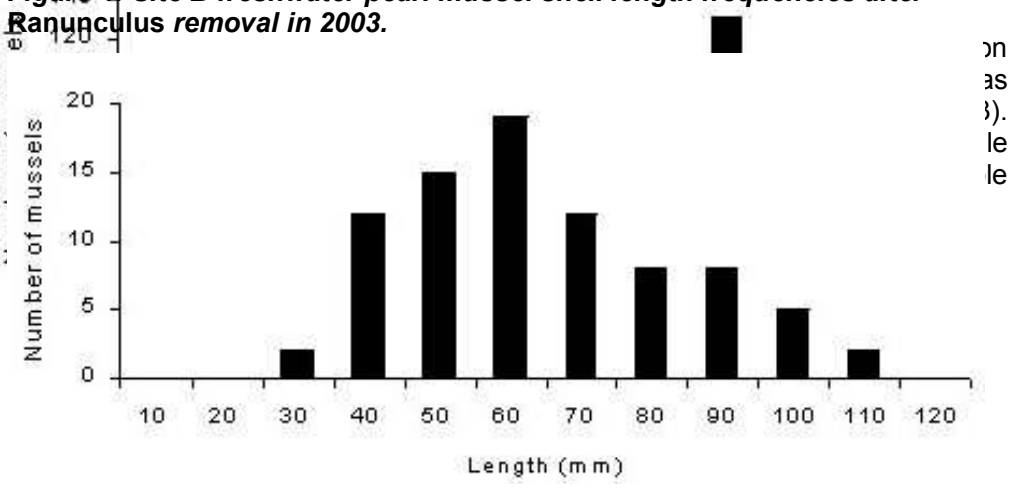

Table 4. Proportion of juvenile mussels at site B pre and post* Ranunculus *treatment in July and August 2002 and August 2003.

Shell length (mm)	Pre treatment 2002	Post treatment 2002	Post treatment 2003
<30mm	6/389 = 1.5%	6/166 = 3.6%	0/83 = 0%
<65mm	73/389 = 18.8%	54/166 = 32.5%	52/83 = 62.6%

There was also a significant change in mean and median sizes of mussels recorded between 2002 and 2003 (Table 3). The now smaller 2003 population was dominated by juvenile mussels (Table 4) and many fewer mussels were visible during quadrat searches (Table 5), meaning a greater proportion of the mussel population was buried in the substrate.

Table 5. Quadrat searches carried out prior to and after* Ranunculus *removal work at site B in July and August 2002 and August 2003.

Pre-treatment July 2002	Post treatment August 2002	Post treatment August 2003
Q1 = 36/45	Q1 = 8/9	Q1 = 4/21
Q2 = 69/100	Q2 = 28/41	Q2 = 0/16
Q3 = 52/77	Q3 = 8/21	Q3 = 0/16
Q4 = 87/167	Q4 = 8/15	Q4 = 17/30
	Q5 =10/17	
	Q6 = 30/44	
	Q7 = 17/19	

Note: See Section 3.3 for explanation of numbers,

4.3 Fish populations

The two study areas at site B and site K were re-fished on the 27th and 28th of August 2003 approximately one year after *Ranunculus* removal.

Table 6 indicates that the two study areas produced a similar range of fish species in 2003 when compared with the previous year. Salmon, trout, eel, and lamprey (*Lampetra sp.)* were all captured in 2003. In addition minnows were present at site K in 2003. All lamprey ammocoetes were identified as *Lampetra* species.

Table 6: Fish species captured at sites B and K during 2002 and 2003.

Species	Site K		Site B	
	2002	2003	2002	2003
Salmon	Yes	Yes	Yes	Yes
Trout	Yes	Yes	Yes	Yes
Eel	Yes	Yes	Yes	Yes
Lamprey (*Lampetra sp.)*	Yes	Yes	Yes	No
Minnow	No	Yes	No	No

Revisiting a survey site allows an age class of salmonids to be followed from 0+ to 1+. Figure 5 illustrates this for juvenile salmon at all the experimental areas of both sites. All four locations contained initial high densities of 0+ salmon fry in 2002 followed by a decline in 1+ salmon parr the following year. This reduction was greater

at both areas of site B than at site K. This may reflect the available habitat at the sites; larger cobble and boulder substrate was predominant at site K (Figure 2b).

Figure 6a shows the density of 0+ salmon at each of all the treatment areas of both sites during 2002 and 2003. 0+ salmon densities increased at both the control and treatment areas at site B while at site K, densities decreased.

Figure 6b shows that no clear pattern was evident for the older 1+ salmon parr. At the site B control area an increase in salmon parr was observed but in the area where *Ranunculus* had been removed a decline was recorded. The opposite pattern was observed at site K, with a decrease in salmon parr at the control area and an increase at the treatment area.

Figure 5: Salmon 2002 cohort at sites B and K.

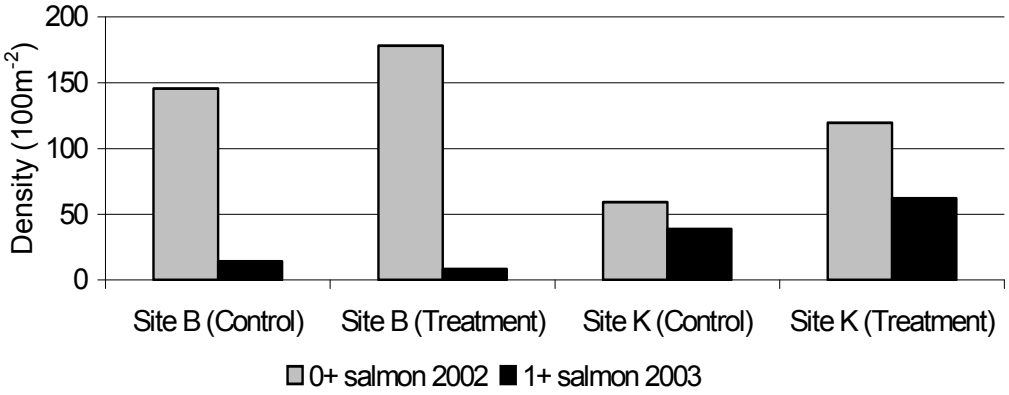

Figure 6a: 0+ salmon densities at sites B and K in 2002 and 2003.

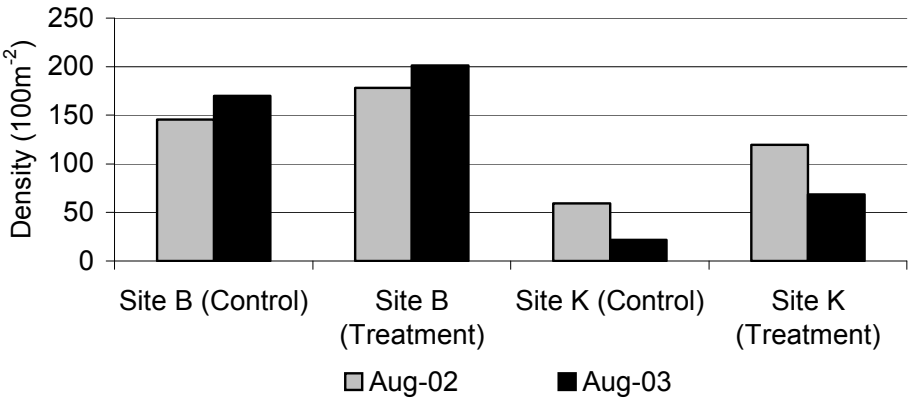

Figure 6b: 1+ salmon densities at sites B and K in 2002 and 2003.

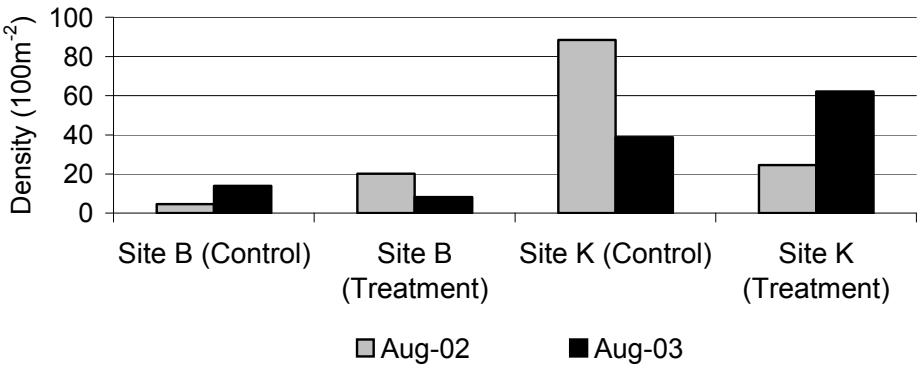

Figure 7: Trout 2002 cohort at sites B and K.

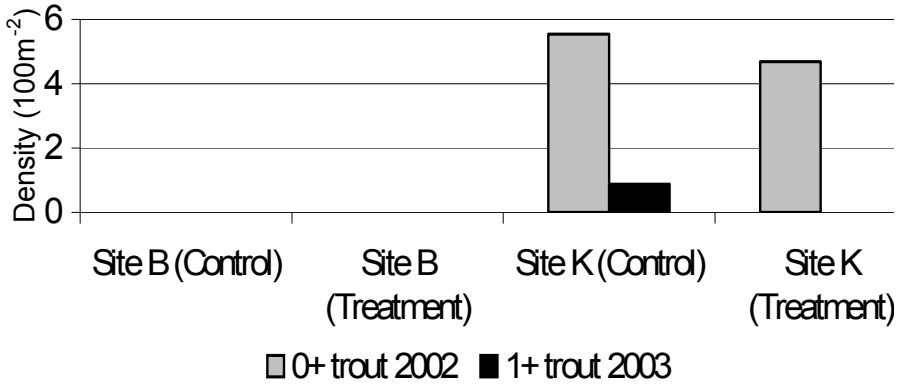

Figure 8a: 0+ trout densities at sites B and K in 2002 and 2003.

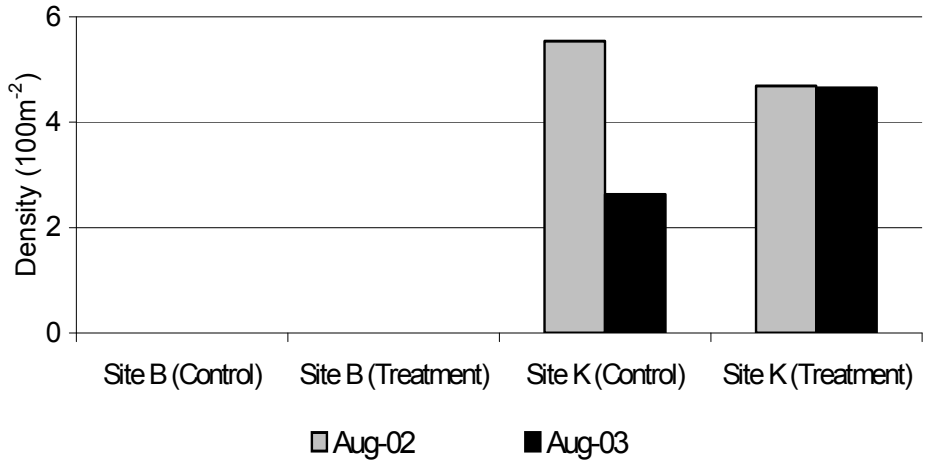

Figure 8b: 1+ trout densities at sites B and K in 2002 and 2003.

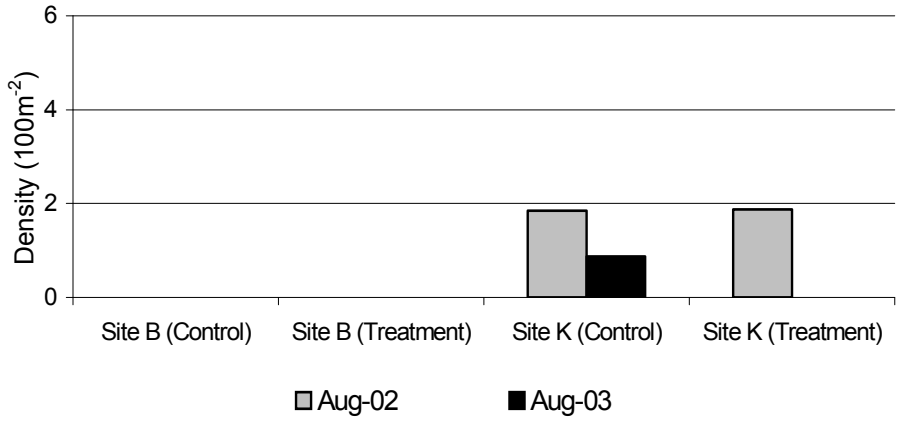

Figure 7 and Figures 8a and 8b indicate that trout were present only at site K. Densities of 0+ trout were lower than for 0+ salmon but, as with salmon, the densities of 1+ trout in 2003 were less than the initial 0+ densities.

Densities of 0+ trout were lower in 2003 than in 2002 although only a small decrease in density was observed at the treatment area of site K (Figure 8a). A small number of 1+ trout were present at both the areas of site K in 2002 but only the control area of site K produced 1+ trout in 2003 (Figure 8b). Densities at this site were less in 2003 than 2002.

5. DISCUSSION

5.1 *Ranunculus* Removal

Re-visits to the sites in August 2002 indicated that very little re-growth of the *Ranunculus* had occurred a month after hand removal from the treatment areas (Figure 1). Percentage cover at the control areas remained much the same. Assessments of the treatment sites in August 2003 indicated that small quantities of *Ranunculus* were present but that no substantial re-growth had established. However, the percentage cover observed at the control sites was also low in August 2003 suggesting that *Ranunculus* growth generally may have been less overall.

Currently it is not clear what limits or promotes growth of *Ranunculus* in the Spey. It is possible that the long dry summer leading to low river flows in 2003 may have limited the growth at the two study areas.

The reduced level of *Ranunculus* particularly at site B seems to have led to the most notable physical difference between the two years, a decline in sand and gravel deposits (Figure 2a).

Removal of the plant by hand appears to be successful in the short term with little re-growth observed at the treatment sites after July 2002. In addition the removal of the *Ranunculus* leads to the sand and gravel deposits being dispersed, so improving the suitability of the substrate for both pearl mussels and juvenile salmon.

5.2 Freshwater pearl mussels

The results from the 2003 monitoring differ dramatically between the two *Ranunculus* study sites. There were no significant changes in the numbers of relative abundance of mussels at both the control and treatment areas of site K. In contrast, numbers of mussels at both the control and treatment of site B declined significantly. The cause of this decline was immediately obvious when carrying out the fieldwork. The summer of 2003 was exceptionally dry and the River Spey water levels were extremely low, even by normal summer standards. Site B was very shallow, with significant parts of the $100m^2$ study plots dry or almost dry (e.g. 1-2cm deep). This affected both the control and treatment areas. There was not really enough water to support adult mussels at the surface of the substrate, hence the very low proportion of visible mussels in the quadrats. However, enough water was clearly present to allow juveniles hidden in the substrate to survive.

It is not known what happened to the many visible adult mussels that were present in the $100m^2$ study plots at the site B mussel bed in 2002. They might have died *in situ*, or been vulnerable to predation from otters and birds (e.g. oystercatchers) or moved into deeper water. There were several reports in summer 2003 of large flocks of oystercatchers feeding on exposed and drying freshwater pearl mussel beds on the River Spey (James Butler, *pers. comm.*). In addition some dead mussel shells collected during surveying displayed damage that could be attributed to oystercatcher predation. This appears to be the first time that such predation on *M. margaritifera* has been recorded.

Site K had much deeper water than site B, although even this site was shallower than in 2002. However, the mussel bed at site K did not dry out or become shallow enough for predators like oystercatchers to cause significant losses. Thus, the control and treatment sites both maintained their mussel populations. For the purpose of the *Ranunculus* removal monitoring, there is no evidence that hand removal caused any decline in the mussel populations monitored. This corroborates

the finding of the 2002 study that hand removal of *Ranunculus* appeared to have no direct impact on *M. margaritifera* (Laughton *et al,. in press*).

In terms of the conservation of the internationally important River Spey *M. margaritifera* population, the most important finding was that dry summers with low water levels have a significant impact on shallow water mussel beds. If planning long-term mussel monitoring, areas sufficiently deep to be permanently covered in water should be selected. Monitoring sites located in shallow water will become unsuitable if the drier summers predicted as a result of climate change occur more regularly.

5.3 Fish Populations

The range of fish species present was similar to the previous season with the only change being the addition of minnows (Table 6).

Similar to the 2002 survey (Laughton *et al., in press*) densities of salmon 0+ were also high in 2003. The increase in 0+ salmon densities at site B further indicates the importance of this area as a main stem spawning and fry rearing area. The lack of *Ranunculus* growth and reduction in sand deposits in the area may have contributed to this rise. The opposite occurred at site K with 0+ salmon densities declining at both experimental areas and a similar pattern was noted for 0+ trout. No clear pattern for older salmon and trout parr is evident. Site K is clearly an important rearing area for salmon parr and it is recommended that every effort should be made to maintain the substrate in favourable condition.

Juvenile salmon and trout densities can vary widely from year to year at any given monitoring site. Many factors can affect the densities of 0+ and 1+ fish including spawning and egg deposition levels, hatching success, water flow, water quality, substrate availability, predation and migration to and from an area. All of these factors will have influenced the 2003 results. However there is no evidence that the hand removal of *Ranunculus* significantly affected the distribution and density of the juvenile salmon within the study sites.

5.4 Monitoring programme

The current study builds on previous work by Laughton *et al*. (*in press*). However, there is a need to examine some issues over a longer timescale to fully inform future casework and conservation management concerns on the River Spey. The re-visits to the two survey areas indicated that the removal of *Ranunculus* at these locations had not significantly affected two of the cSAC species, freshwater pearl mussel and salmon.

Further monitoring of the study areas specifically to assess *Ranunculus* removal is not recommended although these established sites will be incorporated into the Spey Fishery Board's routine juvenile salmonid survey programme.

A useful addition to current knowledge would be to fully assess *Ranunculus* distribution in the Spey. To this end, a walk survey and limited aerial survey of the Spey to map *Ranunculus* distribution in the main stem was completed in 2003 and a report is in preparation (Redgewell and Laughton, *in prep)*. Thereafter the data could be linked to existing salmon and pearl mussel data to determine the overall effect the *Ranunculus* is having on these SAC species. This is considered particularly important if *Ranunculus* growth continues to increase.

Hand removal of the *Ranunculus* was effected on a small scale for the short and medium term. However, it is time consuming and presents a range of Health and Safety concerns for staff employed to remove it. Guidelines to assist estate staff and ghillies assess the risks involved in hand removal were prepared as part of this study and circulated to all Speyside fishing beats (Appendix 1). However, the need to develop better control and management of the *Ranunculus* remains a priority to safeguard the status of the freshwater pearl mussel and salmon in the Spey.

6. ACKNOWLEDGEMENTS

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Hand removal of *Ranunculus* from the River Spey

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Background

Ranunculus is widely spread throughout the River Spey from Grantown downstream to Fochabers. Control of the plant has generally taken two forms, spraying with a suitable weedkiller usually 'Midstream' or physical removal by hand. Recent EU legislation now prevents the use of 'Diquat' the active part of 'Midstream' leaving hand removal as the only viable means of control.

During 2002, studies on the River Spey revealed that *Ranunculus* can be damaging to populations of freshwater pearl mussels and juvenile salmon and trout. Large accumulations of sandy material can collect on the downstream side of a *Ranunculus* clump and this is detrimental to freshwater pearl mussel populations with numerous dead mussels trapped underneath. Similarly, this can create problems for salmon and trout fry by choking the interstitial spaces within the substrate that they require during their early development stage. The *Ranunculus* root structure was also found to bind the substrate together and may render it difficult for fish to spawn.

Hand removal of the plant was not found to be damaging to either mussel or salmonid populations, however it is time consuming, costly and a number of Health and Safety considerations need to be addressed. It can be effective with re-growth in the two months after removal negligible and re-visits to the sites in 2003 have also indicated that growth is much less than the areas left unchecked.

These findings indicate that if left unchecked *Ranunculus* may compromise the conservation status of freshwater pearl mussels and juvenile salmonids by affecting their habitat. A river wide strategy for management of the plant is being considered but meantime there is a need for guidelines to facilitate localised removal from fishing pools, spawning areas and mussel beds for example.

This document provides a basic guideline on the current best practice for localised removal and disposal of the plant and on Health and Safety issues. This is very much a first draft developed from experience gained in 2002 and comments on further improvements will be welcomed after testing the protocol this summer.

These guidelines are aimed at ghillies, estate workers and any other personnel who may be contracted or employed to remove *Ranunculus* from the Spey.

Any comments on these guidelines should be addressed to:-
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Guideline for the hand removal of *Ranunculus*

Risk Assessment

Full assessment of the area earmarked for *Ranunculus* removal should be completed before commencing work, and consider an assessment of depth, disposal points, entry and exit points from river, potential disturbance to other river users, communications, measures to avoid Weils disease (from contaminated rats urine), Lymes disease (from ticks in riparian vegetation), contact with sewage effluent, etc.

IN NO WAY DOES THIS GUIDANCE NOTE CONSTITUTE A FULL RISK ASSESSMENT. THIS MUST BE UNDERTAKEN BY THE PERSONNEL INVOLVED IN *RANUNCULUS* REMOVAL AND BE SITE SPECIFIC.

Timing of Removal

Ranunculus is usually noticeable by May and early removal when the plant is small is recommended.

Any time during daylight hours is suitable although removal when anglers are fishing nearby should be avoided. Workers should have clear guidance on when removal is discontinued due to rising water levels.

Personnel

Removal of the plant should be conducted with a minimum team of two people. Both should be competent swimmers and have experience working in riverine situations. In general only one worker should be in the water at any time with a safety rope should be attached. The second worker should remain on the river bank in close proximity and manage the safety rope.

Clothing and Protective Equipment

Neoprene waders are recommended since they provide good knee protection and are buoyant and warmer in cold water. However, in warmer conditions PVC or other waders may be used. In water greater than thigh depth a dry suit should be considered. Lifejackets must be worn by all workers and the wearer familiar with its operation.

Safety throw ropes should be available and placed within ready access of the working area. Safety helmets similar to those used by canoeists should also be considered.

Debris including fishing tackle, glass, etc., can accumulate within the *Ranunculus* clump so workers should be vigilant and wear suitable gloves, Neoprene or industrial rubber gloves are suitable.

In addition sewage can collect in the *Ranunculus* clumps so a means for cleaning hands is necessary, anti bacterial wipes and/or a supply of soap and water is recommended.

First aid kit suitable for field work is required. Polaroid sunglasses, sunscreen and insect repellent should also be available.

Communications

Mobile phones or radios should be carried at all times and workers should ensure they operate a 'buddy system' e.g. be in close contact with estate office throughout the removal operation.

Should workers enter an area where phone or radio communication is not possible the nearest point where this can be achieved or the nearest BT public phone should be determined before commencing work.

Removal Equipment

Ranunculus is relatively easy to remove and on many occasions pulling the plant in an upstream direction will suffice. Additional tools such as a gardening trowel and fork are also useful.

Hand Removal Procedure

Working in pairs and start at the downstream end of a selected area. Place the landing net over the end of *Ranunculus* clump then either use a trowel to loosen root/holdfast or simply pull in upstream direction. The landing net helps to limit the dispersal of the plant downstream.

Disposal

After removal, dispose of weed by spreading thinly in vegetation above the high water mark on river bank. Where large quantities are removed or removal takes place in a public area, dispose to an alternative location such as Local Authority dump.

Documentation

Workers should record the area where the plant is removed the date of removal and time taken. Details of any potential hazards to the operation, ie., deep water, etc should also be recorded.

Notes on the amount and distribution of the *Ranunculus* present before removal are also useful.

Hand Removal of *Ranunculus*: Site Report

Date:				
Site Location				
Staff				
Potential Hazards (Note hazards such as deep, fast flowing water)				
Communications	Mobile Phone		Radio	
	Yes	No	Yes	No
Notes (Include details of abundance (High, Medium, Light) and distribution, disposal point)				
Disposal method/site				