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SHORT COMMUNICATION

Does electrofishing harm freshwater pearl mussels?

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ABSTRACT

1. Two experiments were carried out in a Scottish river to test the effects of electrofishing on endangered freshwater pearl mussels (*Margaritifera margaritifera*).
2. In the first experiment, two areas of mussel bed were marked out as treatment and control sites and the former was electrofished using standard equipment. The mussels were examined 10 min, 24 h and 35 days after treatment and their shell valve closure responses, burrowing capabilities and gravidities were recorded as signs of normal 'functioning'.
3. In the second experiment, individual mussels were marked as treatments and controls and the former were electrofished. These mussels were examined as before.
4. No mortalities occurred and no significant differences in 'functioning' between treatments and controls were observed in either experiment.
5. Since no measurable treatment effect could be demonstrated, it appears that electrofishing did not adversely affect the short-term survival of *M. margaritifera*.

KEY WORDS: conservation; electrofishing; pearl mussels

INTRODUCTION

Electrofishing—the application of an electrical current to water in order to capture fish—is a standard, cost-effective sampling technique that has been widely used by fishery biologists for almost 50 years (Snyder, 1995). It was developed primarily for stock assessments and ecological studies of freshwater fish, particularly salmonids (Bohlin *et al.*, 1989), but has now also been used successfully to sample populations of freshwater shrimps (Penczak and Rodriguez, 1990), crayfish (Rabeni *et al.*, 1997) and other aquatic invertebrates (Nagel, 1993). Although electrofishing has long been considered to be the ideal non-destructive fish-sampling tool, there is now growing concern about the injurious effects of the technique, particularly on endangered fish populations, and a number of studies have recently been undertaken (e.g. Barrett and Grossman, 1988; Snyder, 1995; McMichael *et al.*, 1998; Nielsen, 1998; Habera *et al.*, 1999). By contrast, very little is known about the effects of electrofishing on aquatic invertebrates, other than the fact that certain groups (e.g. arthropods) can be successfully sampled using this method (Penczak and Rodriguez, 1990; Nagel, 1993; Rabeni *et al.*, 1997). Since many aquatic invertebrate species around the world are now threatened, it is important that studies of the effects of electrofishing on different invertebrate groups (e.g. arthropods, molluscs) are also carried out.

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The freshwater mussels (Unionacea) are a highly threatened group of aquatic invertebrates (Bauer and Wachtler, 2001). In Scotland, the endangered freshwater pearl mussel (*Margaritifera margaritifera*) is found in several important salmon and trout rivers which have been extensively electrofished for many years (Hastie, 1999). Freshwater mussels use different fish species as larval hosts. For example, *M. margaritifera* larvae (glochidia) can only complete their development on the fry and parr of commercially important Atlantic salmon (*Salmo salar*) or brown trout (*Salmo trutta*), and large numbers of these young fish are often found within or near mussel beds (personal observation). Given this type of association, it is likely that a large number of threatened mussel beds in different rivers around the world have been exposed to the effects of electrofishing. Therefore, in the interests of conservation, studies to determine whether or not electrofishing has any damaging effects on freshwater mussels would be worthwhile. The following investigation was carried out to assess the effects of electrofishing on a population of *M. margaritifera* in a river in northern Scotland.

MATERIALS AND METHODS

The study was carried out during June–August 2000 at two sites (*A* and *B*) on a river in northern Scotland, supporting a large, viable *M. margaritifera* population. It is necessary to keep the specific site details confidential because of the present threat of illegal pearl fishing (Hastie *et al.*, 2000). Site *A* is a natural mussel bed in the river (*ca* 50–100 m^2 of river bed). Site *B*, located *ca* 2 km further upstream, is an old disused mill lade (*ca* 100 m long) with running water, which usually contains several hundred live mussels washed in during floods.

Site *A*

Two 10 m^2 areas of mussel bed (10 m apart) were marked out as treatment and control areas. Standard electrofishing equipment (250 V, 100 Hz DC, 25% duty cycle) was used and the entire treatment area was 'swept' three times. A number of fish in the treatment area were temporarily immobilized, indicating that the equipment was functioning properly, but no immobilized fish were seen in the control area during treatment. The control area was also 'swept' (with no electrofishing) by wading over the mussel bed three times in order to produce a similar level of physical disturbance in both areas. The mussels in the treatment and control areas were then checked and compared 10 min, 24 h and 35 days after treatment.

The shell valve closure responses of the mussels to prodding (10 min, 24 h, 35 days), burying capabilities (24 h, 35 days) and gravidities (35 days only—during annual spawning event) were checked as signs of normal functioning. Mussels were checked for gravidity by carefully opening the shell valves with special tongs, and checking for the presence of glochidia in the modified gill structures (marsupia) of the female mussels (Young and Williams, 1983). Since the sex of *M. margaritifera* cannot be determined in the field, gravidity was recorded as an overall proportion of examined mussels containing glochidia (Hastie, 1999).

Site *B*

A random sample of 100 adult mussels (shell length L range 70–120 mm) was taken from the upper lade where mussels collect during floods. The samples were divided into two and the mussels were marked by scoring either an 'E' (treatment) or an 'X' (control) on their shells ($n = 2 \times 50$). The mussels were transported in an insulated plastic container of water to the lower lade (*ca* 100 m downstream, no mussels) where the treatment mussels were placed in the water and electrofished as described previously (the control mussels were simply disturbed and then returned to the container). A number of fish in the lower lade were immobilized during treatment. The treated mussels were put in the container with the control mussels and were then returned to the upper lade. These were also checked 10 min, 24 h and 35 days after treatment.

RESULTS

Site *A*

Most of the mussels in both the treatment and the control areas closed their shell valves during the 'sweeps', probably as a result of physical disturbance. Even when the power was on and the fish were affected, the mussels in the treatment area appeared to react (by withdrawing their siphons and closing their shell valves) only when they were physically disturbed. Within 10 min after electrofishing, several mussels in both areas began to open their shell valves again and filter feed normally (indicated by protruding siphons). Mussels of all sizes (*ca* 10–120 mm *L*) appeared to be unaffected by the treatment. By 24 h, all visible mussels in both areas appeared to be filter feeding normally and they exhibited a normal shell valve closing response to prodding. After 35 days, the mussels continued to react normally. They had already commenced spawning by this time, but there were still a number of gravid mussels in both areas. The proportions of gravid mussels observed were 6/50 (12%) and 9/50 (18%) in the treatment and control areas, respectively.

Site *B*

The treated mussels again reacted only to physical disturbance, even when the power was on. Within 10 min after they were returned to the lade, some of the treated and control mussels began to open up and filter feed normally again. By 24 h, most of the mussels had re-buried themselves in the sandy bottom of the lade so that only a third of their shells remained visible above the surface. As before, all mussels appeared to react normally to prodding. After 35 days, only 47 treated and 48 control mussels were recovered, but these continued to react normally. The mussels had already commenced spawning by this time, but a number of treated and control mussels were still gravid. The proportions of gravid mussels observed were 14/47 (30%) and 16/48 (33%) in the treatment and control areas, respectively.

DISCUSSION

Electrofishing had no observed effect on the mussels, and the conclusion from this work is that it does not adversely affect the short-term survival of *M. margaritifera*. The only significant difference observed was between the proportions of gravid mussels in the lade and those in the river. It appears that the mussels in the river had commenced spawning 1–2 days earlier. Since the lade is very shaded and has a much slower flow of water, this may be due to slight differences in water temperature and/or dissolved oxygen content (which can influence the timing of spawning in this species; Hastie, 1999). Whatever the reasons, it is clear that electrofishing was not a factor. However, these results do not rule out entirely the possibility that the mussels might have suffered some undetected injury. Since *M. margaritifera* is a highly endangered species (Young *et al.*, 2001), it would certainly be worthwhile to carry out further research to confirm or refute the findings of this study. For example, the control and treated mussels could be examined during the next annual spawning episode in 2001 to check for any longer-term effects. Various types of electrofishing gear (and different gear settings) are widely used by fisheries biologists (Tillma, 1996) and the possible adverse effects of these on the mussels should be tested. Sampling protocol may be important (P. Maitland, personal communication). A small number of detailed histological examinations and comparisons of the tissues of treated and control mussels would also be worthwhile.

The possible indirect effects of electrofishing on mussels should also be investigated. For example, it has been demonstrated that electrofishing can harm host fish (including significant egg mortality and spinal injuries), although how this translates into population effects has not been adequately studied (Nielsen, 1998). According to Ziuganov *et al.* (1994), a low host fish density may be a limiting factor in some *M. margaritifera* populations. In Scotland, stocks of wild salmonids are declining (Walker, 1993) and there is now concern that host fish densities may be sub-critical in some mussel rivers (Hastie, 1999). A number of small streams have mussel populations which do not appear to be recruiting adequately, as shown by a lack of juveniles (Hastie *et al.*, 2000). Perhaps, as a precaution, repeated electrofishing over mussel beds in these streams should be avoided, if at all possible, until further research is carried out.

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