Why Information was requested on freshwater pearl mussels in the River Dee

Summary

There can be no doubt that freshwater pearl mussels are at risk. This charismatic species is threatened with extinction or is highly vulnerable in every part of its former range. Although the Aberdeenshire Dee is one of the few rivers with a healthy population of pearl mussels it is not clear if the Dee population is viable under current conditions.

The Habitats and Species Directive places clear responsibility for maintaining pearl mussel populations in a healthy state in the hands of the UK and Scottish Governments. In proposing to construct a new road across the River Dee Special Area of Conservation the Scottish Government itself is exposing the pearl mussel population to risk. However, a full analysis of those risks has not been carried out, and the need to adopt a precautionary approach to protecting pearl mussels has been ignored.

Road Sense wished to present a risk assessment for pearl mussels in the Dee at the Public Inquiry into the Aberdeen Western Peripheral Route (AWPR). That opportunity was denied to Road Sense by a refusal on the part of Scottish Natural Heritage, conservation advisers to the government, to release information on the locations and characteristics of the pearl mussel populations in the Dee.

The risk to pearl mussels comes from the release of sediment and contaminants into the river, and alteration of the flow conditions, from the construction of the AWPR and its associated bridge and construction site. Pearl mussels are not distributed evenly within the river. They are associated with particular river bed conditions, depths and flow rates. The individual mussels are gathered together within mussel beds. The location of those beds is important in assessing their exposure to damage. Pearl mussel beds within or below tributaries subject to engineering works, or those below the new bridge, or adjacent to the construction site are likely to be especially vulnerable to the release of sediments and contaminants. Pearl mussels further downstream will be less affected as sediment falls out and contaminants are progressively diluted.

Information on the condition of the pearl mussels within the mussel beds is also important for the risk analysis. Populations of pearl mussels with a high proportion of juveniles are more vulnerable to exposure and more important to the conservation status of mussels in the Dee than fragmented groups of old mussels.

Road Sense was denied access to information on the location and condition of the pearl mussel populations despite an offer to restrict the information to named individuals. As a result the actions proposed by the Scottish Government could not be assessed or commented upon at the Public Inquiry into the AWPR. There is now the wider question of whether the Scottish Government and its conservation advisers have neglected their

responsibilities for protecting freshwater pearl mussel populations by failing to carry out a full and rigorous risk assessment.

The request

The original request from Road Sense for information on freshwater pearl mussels in the Aberdeenshire Dee was submitted in June 2008 following sight of material to be submitted by Transport Scotland, its agents, and Scottish Natural Heritage (SNH), the government's nature conservation advisers, as evidence to the impending Public Local Inquiry (PLI) into the Aberdeen Western Peripheral Route (AWPR).

SNH's advice in several of the papers submitted to the PLI was that the AWPR was likely to have a significant effect on the qualifying interests of the site (freshwater pearl mussels, salmon and otters). In relation to pearl mussels, SNH expressed concerns about impacts on water quality deterioration, habitat deterioration, and impacts on the larval hosts (salmon).

Local Road Sense members (Professor Anthony Hawkins, an aquatic biologist; Henry Irvine Fortescue, landowner; and Nigel Astell, naturalist), were already aware that there were beds of freshwater pearl mussels in the vicinity of the new bridge proposed for the AWPR, and were concerned that these mussel beds would be especially vulnerable. Dr Hawkins was also aware that that state of the mussel populations in the Dee was so poor that experiments were being conducted to assess the feasibility of breeding mussels in captivity, in an attempt to restore their former abundant status within the Dee. Confirmation of the vulnerability of the mussels was provided in a Report to Inform Appropriate Assessment, one of the papers submitted by Jacobs (agents of Transport Scotland) to the PLI. This stated in section 5.1.1:

> *A recent assessment of freshwater pearl mussels within the River Dee (SNH 2005b) found that the species was in unfavourable condition. The total population of the Dee, estimated at about 1.3 million mussels, is greatly reduced compared to past levels and has been adversely affected by past pearl fishing and river engineering activity, resulting in a low density (<1 mussel/m) and fragmented mussel beds. Surveys conducted for the site condition monitoring (SNH, 2005b) indicated a low percentage of juveniles and lack of very young mussels (<30mm), suggesting that the population may be unable to sustain itself naturally. It is considered unlikely that the availability of juvenile salmonids as hosts is limiting the pearl mussels in the River Dee. The lack of juvenile mussels could be associated with problems such as depressed water quality.*

This statement invoked particular concern amongst Road Sense members. Freshwater pearl mussels tend to be found in mussel beds, where the condition of the river bed and river flow rate is suitable. Having general knowledge that there was at least one important mussel bed in the vicinity of the site caused Road Sense members to wonder whether the site chosen for the AWPR river crossing was appropriate, and whether other alternative crossing points might result in less damage to the mussels and other qualifying interests. It seemed that the crossing point had been chosen by Transport Scotland for engineering and social reasons and that in many respects it was the worst possible crossing point for the protection

of nature conservation. The crossing was just below the first major tributary of the Dee, the Crynoch Burn, and the road required extensive river engineering work on the burn and its tributaries. The road was also crossing the flood plain of the Dee, necessitating a longer bridge span, and a viaduct on the flood plain, potentially causing a higher risk of damage. A major construction site for the road and bridge, with further potential for the release of silt and contaminants, was to be built close to the river bank. There was potential for damage to the mussels from changes to the water flow regime, and entry of sediment and contaminants to the river and its adjacent tributaries and feeder burns associated with the construction of the road, the bridge and the drainage system.

Whilst the material submitted to the PLI by Transport Scotland and its agents acknowledged the risk to freshwater pearl mussels it proposed that these risks were to be dealt with by what Road Sense considered to be inadequate and generalised mitigation measures. It was said that pollution control would be more stringent than SEPA's criteria[1], that an ecological clerk of works would be present to ensure that risks to the mussels were minimised, and that temporary attenuation ponds to cope with a 1 in 100 year storm event would be used throughout the construction period to ensure that water released to the river met minimum water quality standards. Continuous monitoring of suspended solids with a warning trigger value would be undertaken at points where surface water was being discharged into the River Dee. Bubble curtains (?) might be used to prevent sediment settling on freshwater pearl mussel beds if there was a substantial sediment release. These measures were described in a 'Mitigation Vision Statement' submitted to the PLI by agents of Transport Scotland.

It seemed to Road Sense that these measures were likely to be insufficient to protect the mussels, which have strong protection in law. Although monitoring was to take place there was a great risk that damage to the mussels might occur before steps could be taken to halt the release of sediment and contaminants. The attenuation ponds would build up considerable quantities of sediment and contaminants and their inadvertent release would be a catastrophe for local mussel populations. It is also worth noting that there have been two 1 in 100 year floods on the Dee in the last 20 years. The most obvious solution to protecting the mussels was to choose an alternative crossing point for the AWPR, which was well away from any pearl mussel beds and was chosen to minimise the release of sediment and contaminants into the river in the vicinity of the mussels.

In preparing its own evidence for the PLI Road Sense sought information from SNH on the state of freshwater pearl mussel populations in the Dee. It was evident that a report had been prepared for SNH (referred to as SNH, 2005b), and it seemed likely that this report would provide information on:

> The general state of pearl mussel populations within the Dee, their conservation status, and the risks to which they were exposed
>
> The location of mussel beds, both in the vicinity of the proposed AWPR crossing and other potential crossing points

[1] SEPA is the agency responsible for protecting and improving water quality in Scotland

The condition of those mussel beds (in terms of the substrate, the local distribution of mussels and their population characteristics (in particular the proportion of juvenile mussels)

Whether a full risk analysis had been carried out as part of the report

This report was withheld.

Why is information on the location and condition of the mussels important?

Mussels show a patchy distribution. Some parts of the river have none, while others may have many. The state of each local 'bed' is also important in assessing risk to the Dee as a whole. A small fragmented population of old mussels is less important in conservation terms than a large healthy population with a spread of ages and including juveniles. Exposure of the latter to contaminants would be especially damaging. Moreover, the effects of releasing sediment and contaminants are most pronounced locally, in the immediate vicinity of the release. Sediment is gradually deposited as it is moved downstream, while contaminants are progressively diluted. Information on location and state of the local mussel beds would have been invaluable to Road Sense in preparing its case against crossing the River Dee at the point chosen by Transport Scotland.

It would be normal for such factors to be considered as part of the 'appropriate assessment' required under the EU Habitats & Species Directive. Accordingly, Professor Hawkins, on behalf of Road Sense, sent an email to SNH on 23rd June 2008, well before the PLI opened, asking whether an appropriate assessment had been performed, and seeking further information in relation to the crossing of the Dee by the AWPR. This request was repeated on the 14th July 2008, together with an undertaking not to communicate any portions of the appropriate assessment labelled confidential to other parties except by agreement with SNH.

In August 2008, Professor Hawkins received a reply from Finlay Bennett of SNH providing papers in relation to the Dee crossing. However, the information supplied did not include the SNH (2005b) report, even in a redacted form. The letter stated that SNH had determined that locational data on freshwater pearl mussel cannot be released, and that if SNH was to release this data to Professor Hawkins it would also be obliged to release it to any other person who asked for it.

By this time, the Public Local Inquiry was imminent, and there were strong pressures upon Professor Hawkins and others (who had day jobs) to prepare their evidence. It was considered unlikely that the appeal process would yield the required information before the end of the inquiry. Accordingly, no appeal was lodged. However, at the PLI Road Sense witnesses were berated by the barrister for Transport Scotland on the grounds that no evidence had been presented to demonstrate risk to mussels.

Subsequent to the PLI, Professor Hawkins submitted to SNH a further request for information on freshwater pearl mussels. A large quantity of information was provided, but papers dealing with freshwater pearl mussels were heavily redacted. The information

requested was not been provided. The request was then refused by SNH on appeal, and the case has now been submitted to the Scottish Information Commissioner.

Road Sense contends that the emphasis placed by SNH on preventing fishing on the pearl mussels in the Dee is misplaced. Pearls are only found in older mussels. In many of the mussel beds on the Dee it is the lack of very young mussels which is causing concern as it indicates that the mussels are failing to replace themselves. It is the high vulnerability of the larvae and young mussels to contaminants and sediments which should be the focus of concern.

That concern is now a more general one and it requires urgent resolution. Road Sense contends that SNH and the Scottish Government are failing to act to protect freshwater pearl mussel populations in the River Dee, although they are obliged by the Habitats and Species Directive to take active steps to do so. It is the presence of contaminants and sediment within the river which gives particular cause for concern. It creates the appearance that the Scottish Government has instructed SNH not to allow conservation and other potential constraints to create a barrier to development, and that SNH is being less vigorous than it should be in opposing developments which pose a strong risk to conservation interests. It is now important to call the Scottish Government and SNH to account for failing to protect freshwater pearl mussels at a very significant location of European standing.

Background Information on freshwater pearl mussels

General

Freshwater pearl mussels, *Margaritifera margaritifera,* are large, long-lived mussels that live in the bottom of clean, fast-flowing rivers. They favour cool, well-oxygenated, soft water, low in nutrients, and free from pollution or turbidity.They are now very rare, largely because there are so few unpolluted rivers remaining. Scotland is one of the global strongholds for the species and it is therefore especially important that Scottish populations are protected and conserved. Pearl mussels are especially vulnerable to disturbance from engineering work in rivers as well as the presence of sediment and contaminants in the water. Juvenile pearl mussels are more readily affected by adverse water conditions. Many rivers which once supported mussel populations do so no longer. The Aberdeenshire Dee has previously been relatively free from engineering works and sources of contaminants and until recently the mussel populations have remained in a relatively healthy state. However, recent surveys have shown a preponderance of older mussels and a lack of juveniles in some populations, suggesting that the mussels are not replacing themselves. In the past, fishing took place for the larger older mussels as they may contain pearls which have a commercial value. Fishing is now illegal.

Biology

Freshwater pearl mussels can grow to over 15cm long and live for more than a century. They feed by drawing in river water and filtering out fine organic food particles. An adult

mussel is able to filter about 50 litres of water a day. Many contaminants and especially hydrocarbons and other toxic organic chemicals attach themselves to particles and tend to be ingested by the mussels. The contaminants can remain and accumulate within the fatty tissues. Because of this tendency to concentrate pollutants freshwater mussels have been used as bio-monitors for organic industrial contaminants and pesticides at some locations.

The mussels have a complex lifecycle and in their first year they live on the gills of young salmon or trout. Scotland remains a stronghold for the species because of the cleanliness of the rivers and the strength of salmonid populations. However many Scottish rivers now show quite high levels of inorganic and organic contaminants, and these may threaten the very existence of the mussels. There is a critical period between fertilization of ova in the adult female mussel and attachment of viable larvae to a suitable fish host. Female mussels release the larvae (thousands to millions) into the water where they must attach to the gills or fins of fish and become encysted by fish epithelial tissue for several weeks before dropping off onto the substrate. Any chemical or physical stressor that limits survival of the released larvae in the water column, or affects the health of the newly settled juvenile mussels could adversely affect recruitment to the population.

Adult mussels live buried or partly buried in coarse sand and fine gravel, often between cobbles and stones. Their distribution within the river is patchy, as they are found only where the substrate is suitable and where flow conditions are appropriate. Optimum depth and velocity in Scottish rivers were found by Hastie *et al.* (2000a) to be 0.3–0.4 m deep and 0.25– 0.75 m s^{-1}. The larvae drop off their salmonid hosts in May and early June, and must land in clean sandy or gravelly substrates under appropriate flow conditions to settle and thrive. They grow only slowly. The life span and maximum size reached are highly variable between populations, depending on environmental conditions and particularly the hydrochemistry and water temperature (Zuiganov *et al.* 1994). Virtually all juveniles burrow completely into the substrate and under loose stones (Hastie *et al.* 2000a). The huge losses involved in their unusual life cycle make freshwater pearl mussels particularly vulnerable to exposure to adverse conditions.

The health of mussel populations is usually assessed by looking at their age structure. Theoretically, age structures in a viable population should reflect both active recruitment and longevity. Adequate recruitment may be indicated by 20% of the population being less than 20 years old (Hastie *et al.* 2000b).Very few rivers now show this level of recruitment (Cosgrove *et al.* 2000a, Young *et al.* 2000). Adult mortality of 10% per decade has been suggested as sustainable if recruitment is normal (Bauer 1992). There is still debate over the natural rate of recruitment and adult mortality in established populations.

Vulnerability

Pearl mussels are most vulnerable to human influences at the stage where the larvae leave the host fish and establish in the sediment. This stage will be affected adversely if even a slight degree of pollution is present. The juveniles are also far less tolerant than the adults, and persistent intermediate levels of eutrophication[2] may prevent long-term recruitment, resulting in aged stocks (Bauer 1988).

[2] The presence of excessive nutrients in a lake or other body of water, usually caused by runoff from the land

Even slight hydrological changes may result in serious degradation of habitat due to the very specific sediment requirements of the juvenile mussels (Bauer 1988, Buddensiek *et al.* 1993). Any alteration to river conditions and land drainage, and all work that has the potential to increase siltation or the speed of run-off, is likely to cause local problems. Siltation of suitable substrates is a severe problem for juvenile mussels and can be caused by increased sediment load. Bank erosion, flooding and land drainage can all affect sediment load and threaten adult mussel beds; even small quantities of sediment can alter the interstitial environment of the juveniles. If the interstitial spaces are clogged, the young mussels suffocate (Hastie *et al.* 2000a). River engineering may cause local extinctions (Young 1995). Activities such as dredging, canalisation, scouring and weir construction cause alteration or loss of suitable river bed substrata (Young & Williams 1983). Any such activities or proposals should therefore be subject to rigorous environmental assessment.

Chemical contaminants

Chemical contaminants have been identified among the many potential factors involved in the decline of freshwater mussel populations in North America. In contrast, little attention has been paid to pollution as a cause of decline in the UK. The October 2007 issue of the journal Environmental Toxicology and Chemistry has a special section on the pollutant sensitivity of freshwater mussels. It reports that mussels are sensitive to a range of pollutants, particularly copper, ammonia, fungicides, and some components of currently used pesticide mixtures. There are observations that mussels are more sensitive than the other animals used to develop water quality criteria for pollutants like ammonia, chlorine and copper. Ruessler *et al* (2009) have reported significant bioaccumulations of mercury, organochlorine pesticide residues and PCBs in freshwater mussels – including substances which adversely affect reproductive status and cause endocrine disruption.

Water running off roads and bridges may have particularly adverse effects upon freshwater pearl mussels. The run off transports mineral and organic materials to aquatic ecosystems which may provoke detrimental changes in the latter's chemical, physical and biological characteristics. The materials in the runoff come from rubber, metal-bearing vehicular wear particles, road salt, washer liquid and other sources and may contain aliphatic hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and phenols, all of which are toxic (Boxall and Maltby 2000). It may also contain de-icing salts, nutrients, and metals (especially zinc).

Assessing damage to mussel populations

As the freshwater pearl mussel does not reach reproductive maturity until at least 12 years old and may live for over 120 years (Bauer 1992; Beasley & Roberts 1999), population age-structure is crucially important when assessing viability. The presence of juveniles (a feature essential to the long-term sustainability of mussel populations) is a clear indicator of the structural and functional features of the habitat required for the survival and reproduction of the species. Where the pearl mussels consist only of scattered individuals, or small, fragmented groups, with few juvenile mussels present, then this is indicative of poor recruitment and survival of the juveniles on which healthy populations depend.

Current status in Europe

The pearl mussel is now 'on the brink', across Europe. Indeed, the pearl mussel is threatened with extinction or is highly vulnerable in every part of its former range. The current lack of recruitment in many rivers may be due to a number of factors, including increasing siltation and eutrophication of rivers (Bauer 1983, 1988). Recent declines in migratory salmonids upon which the larvae depend are also giving cause for concern. River engineering for hydro-schemes, flood defence purposes and fishery improvements continue to pose serious localised threats. Forestry operations, acidification, effluent from fish farms and chemical sheep dip are further threats to the declining populations (Young *et al.* 2000).

The freshwater pearl mussel is listed on Annexes II and V of the EU Habitats and Species Directive and Appendix III of the Bern Convention. It is included on the IUCN Invertebrate Red List, where its status is described as Vulnerable. It is classified as a priority species by the UK Biodiversity Steering Group and a national Species Action Plan has been prepared to encourage measures for its survival. Outside Britain and Ireland, recruiting populations of international importance survive in probably fewer than 50 rivers world-wide (Young *et al*. 2000). Only a few viable populations survive in mainland Europe, most remaining continental populations consisting of mussels at least 30 years old with few signs of recent recruitment. England and Wales are each now believed to support only a single recruiting population. In Northern Ireland the species formerly occurred widely in several catchments, but is now restricted to a few sites. Many rivers in the UK now contain only scattered individuals, with no juvenile mussels recorded; such populations may become extinct due to lack of recruitment. In Scotland there are now only a few populations in the South of the country. Pearl mussels are only abundant in those clean Highland rivers which have been kept free of development and pollution. However, it has been estimated that if the present rates of extinction continue, surviving Scottish populations may only persist for a further 25 years (Cosgrove & Young 1998). Up to half the world's known remaining populations with active recruitment now occur in Scotland (Young *et al.* 2000). However, even within Scotland, two-thirds (101) of the 155 rivers occupied 100 years ago now lack mussels or contain only a few fragmented groups, indicating that *M. margaritifera* is now extinct or is about to become extinct in these rivers. Furthermore, analysis indicates that the rate of mussel population extinction has accelerated since 1970, with a recent average of two mussel river extinctions per year. The pearl mussel is now a rare species whose conservation is giving rise to concern. Its increasing rarity in mainland Europe gives extra significance to Scottish populations. Actions taken within the UK have a direct consequence for the global survival of this species.

Pearl mussels in the Aberdeenshire Dee

The Aberdeenshire Dee is a major east coast Scottish river, which flows uninterrupted for some 130 km from its upland reaches in the high Cairngorms to the North Sea. It is an oligotrophic[3] river, with an alpine pattern of flow. Salmon stocks within the river remain

[3] Lacking in nutrients and having a high level of dissolved oxygen throughout

relatively healthy, although there has been a decline in the numbers of returning spring salmon. The river supports a good population of pearl mussels and small groups have been recorded from a location approximately 30 km from the river source to approximately 6-7 km upstream from the river mouth (within the busy city of Aberdeen). Juveniles make up approximately 30% of the recorded population, among the highest proportions recorded in Scotland. This indicates that the population is recruiting well. It is therefore one of the most important populations in the UK. The Aberdeenshire Dee has previously been relatively free from engineering works and sources of contaminants and that is why the mussel populations have remained in a relatively healthy state. However, recent surveys have shown a preponderance of older mussels at some sites and low densities and fragmented mussel beds at other sites. A report of the River Dee Catchment Partnership points out that though water quality is generally good parts of the lower catchment are now nutrient enriched. Although some mussel beds appear to be in a healthy recruiting condition it is unclear if the pearl mussel population is viable under current conditions. There are water quality concerns, including the effects of the cumulative impact of phosphorous within the catchment. The report proposes the following actions, amongst others:

- The reasons for population declines need to be investigated urgently.
- There are areas where more detailed surveys are required, in particular to record the location and extent of suitable habitat.
- To safeguard remaining populations, it is imperative that those undertaking river works are aware of the presence of mussels and the consequences of the legal protection afforded to them.
- The significance of these threats needs to be identified and action taken to address outstanding concerns.

Conclusion

As illustrated, the request to SNH for information on the pearl mussels was made to specifically assess the threat of construction and operation of the AWPR to the pearl mussel population in the River Dee. RoadSense' position is that the real threat to the pearl mussel population is pollution, not illegal fishing. RoadSense contest that the Scottish Government is failing in its duties to protect the species both generally, and specifically from this project.

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