Environment Agency

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Factors affecting the dispersal of coarse fish

Science Report – SC030215

The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

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Science at the Environment Agency

Science underpins the work of the Environment Agency. It provides an up-to-date understanding of the world about us and helps us to develop monitoring tools and techniques to manage our environment as efficiently and effectively as possible.

The work of the Environment Agency's Science Department is a key ingredient in the partnership between research, policy and operations that enables the Environment Agency to protect and restore our environment.

The science programme focuses on five main areas of activity:

- **Setting the agenda**, by identifying where strategic science can inform our evidence-based policies, advisory and regulatory roles;
- **Funding science**, by supporting programmes, projects and people in response to long-term strategic needs, medium-term policy priorities and shorter-term operational requirements;
- **Managing science**, by ensuring that our programmes and projects are fit for purpose and executed according to international scientific standards;
- **Carrying out science**, by undertaking research – either by contracting it out to research organisations and consultancies or by doing it ourselves;
- **Delivering information, advice, tools and techniques**, by making appropriate products available to our policy and operations staff.

Steve Killeen

Head of Science

Executive summary

Habitats for fish in lowland rivers in England and Wales have been extensively modified for flow regulation purposes, including milling, navigation, land drainage and flood prevention. These modifications have degraded fish habitats and restricted the ability of fish to move between them, leading to changes in fish communities. These fish habitats will require mitigation and restoration in order to meet environmental objectives, notably the Good Ecological Status required under the European Commission's Water Framework Directive. Legislation also requires that new schemes avoid adverse effects on biota, including fish. However, our understanding of the factors causing these changes and how best to rehabilitate rivers remains poor. In addition, future challenges, notably climate change and the consequent changes in flow and temperature regimes, may exacerbate these problems.

Stocking of fish is one possible approach to rehabilitating fisheries, particularly after pollution events. However, the dispersal of stocked fish and how this dispersal relates to the physical habitat in the river is poorly understood. This project investigated the patterns of movement of stocked fish before, during and after flow events, in relation to physical habitat, temperature and season, and in comparison with wild fish.

Rehabilitating the physical environment in rivers is another measure advocated for restoring Good Ecological Status. Such rehabilitation requires an understanding of the responses of wild fish populations to floods and high flows. This project describes patterns of lateral and longitudinal movement and the utilisation of various habitats by fish in relation to flow, temperature and season. It also examines losses of fish as a result of their becoming stranded in floodplains following overtopping of floodbanks and the subsequent isolation.

Field studies were condcuted on three English rivers: the River Ouse in Yorkshire; the River Trent near Nottingham; and the River Roding, a small tributary of the Thames in Essex. These field studies employed a variety of techniques, including some new technologies. There was therefore a need to demonstrate that the effects of these techniques on fish mortality and behaviour would not significantly influence the results. Trials of tagging methods on small coarse fish were thus undertaken under controlled conditions.

Both the benefits and the harmful consequences of high flows and floods for fish have been widely reported in the scientific literature. However, much of this work has been undertaken on large continental river systems with distinct seasonal flow regimes, and this is also the case with many documented lowland river rehabilitation projects. The aseasonal nature of the flow and flooding characteristics of UK rivers may present different challenges, which this study addresses.

On the Yorkshire Ouse, vast numbers of under-yearling coarse fish were found in temporary floodplain water-bodies following summer floods. Many fish became stranded in waterbodies created by over-topping of floodbanks, being unable to return to the main channel as floodwaters subsided. These young fish were mainly eurytopic species such as roach and bleak, but also included rheophilic species such as chub and dace. Very few fish were found in these habitats during the larger and more frequent winter floods. In summer and winter, backwaters also held large numbers of young fish and thus were also vital habitats for their survival.

Studies of the utilisation of man-made floodplain water bodies on the River Trent and a marina on the Yorkshire Ouse by adult and juvenile fish demonstrated that such water bodies are extensively used by a wide range of coarse fish species. The overall diversity of fish species using these water bodies was enhanced by the fact that they had varying degrees of connectivity to the main river channel according to flow stage.

The predicted effects of climate change on the frequency and magnitude of floods needs to be accounted for when designing and managing man-made waterbodies to ensure the optimum frequency and timing of connections to the river.

Studies conducted in controlled conditions showed that tagging and marking techniques for small coarse fish, employing full- and half-duplex PIT (Passive Internal Transponder) tags, had negligible effects on the survival of hatchery chub and roach and only limited and temporary impacts on their growth. The survival and growth of dace after PIT tagging was poorer, perhaps because of their smaller initial body size.

Studies of the movements of hatchery-reared and wild coarse fish on the River Roding demonstrated good survival of stocked fish: up to 70% of the fish remained after a five-month winter period with numerous high flow events. Movements of both wild and stocked fish were highly correlated with both flow and temperature, but varied between years. Generally, newly-stocked fish moved greater distances than wild fish and these movements were less clearly linked to the locations of favourable habitat. The movements diminished over time, suggesting an initial post-stocking exploratory phase followed by increasing site fidelity. This exploratory phase may bring greater danger of predation and displacement, and may explain the poor persistence of stocked fish observed in other studies.

Further research is required on a number of aspects in order to confirm the details of these findings. The DIDSON methodology described in Chapter 5 shows particular promise for future studies of fish behaviour in relation to physical structures.

This project has demonstrated the links between flows and habitat in lowland rivers and both the lateral and longitudinal movements of coarse fish. It also makes a number of key recommendations for future research and for management action to support Good Ecological Status in English and Welsh lowland rivers.

The design of Flood Risk Management schemes, and habitat restoration and mitigation schemes should incorporate the provision of lateral and longitudinal connectivity between different fish habitats relevant to the species present and local conditions, along the following lines.

- Fish require shelter areas during periods of high flow, especially during summer when the swimming capabilities of small juveniles are limited. Wherever possible, flood levees should be set back as far as possible from the main river to allow connectivity between the river and the floodplain. Where high flow velocities result in fish being displaced over levees, outlet channels should be designed to allow water to drain back into the river smoothly as the floods recede, so that the fish can to return to the river. Alternatively, permanent water bodies should be provided in the floodplain.
- Backwater areas are valuable for fish survival in high flows and should be constructed in channelised rivers as part of rehabilitation.
- Man-made floodplain waterbodies with variable connectivity to the main river channel at different discharge stages should be constructed where anthropogenic activities have reduced floodplain habitats.

Natural flow regimes and longitudinal connectivity should be protected and restored.

Restocking programmes can produce good results if account is taken of the availability of suitable habitats and the ability of stocked fish to move between them.

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