Position statement

ENVIRONMENTAL FLOWS

ISSUE

Various aspects of river flow are known to be critical to different life stages of fishes. Elements of flow help to create and maintain channels, to sustain water quality, clean spawning gravel, induce migration and reproduction, and flood riparian areas and floodplains needed for spawning and refuge. Timing of flow peaks and troughs is often as critical to fish as is the overall flow in the river.

Relationships have been established between flow-related parameters and population and community dynamics of riverine fish, particularly salmonids and those living in large floodplain rivers. Understanding of the influence of flows on fish populations in small to medium sized middle and lowland river reaches is less well-developed. Extreme high- and low-flow events can have obvious and demonstrable effects on fish populations, however the significance of marginal changes in flow upon the population dynamics of these fishes is poorly understood.

Flows can interact with a variety of other anthropogenic impacts such as barriers to migration, poor water quality, riparian and in-stream management, and land-use effects such as siltation. Human activities are increasingly modifying natural flow regimes by damming for power generation and flood control, and through abstractions for domestic, agricultural and industrial use. As a result many rivers are perceived to be suffering from low flows whilst others are affected by artificially high flows due to water transfer schemes and reservoir releases.

Two main types of flow regulation can be distinguished: Restrictive management that involves limiting abstractions from a river; and active management that involves releasing water from a dam whose reservoir is not full, or augmenting river flows using pumped groundwater. Each of these may require different approaches to regulation and technical management.

The Environment Agency is responsible for regulating abstraction from rivers, lakes and groundwater, and for regulating the volumes of compensation water from reservoirs. Many abstractions and impoundments pre-date modern legislation and the Agency has limited powers to regulate these; this is also the case where water is drawn for navigation. The Environment Agency has a framework for managing and regulating modern abstraction licences and for assessing new applications for abstraction – the Catchment Abstraction Management System (CAMS). A key element in this system is the RAM (Resource Assessment Methodology) which seeks to identify the river flows needed to protect good ecological status of water bodies (ecological River Flow Objectives- RFO's) and to assess to what extent these objectives are currently being met. From this, it is possible to indicate whether, and how much, water is available for abstraction licensing. Fisheries interests have significant concerns about the effectiveness of RAM and CAMS in protecting fisheries ecology from insensitive water resources management. The first cycle of CAMS is almost complete (November 2006) and the Agency is busy reviewing the system, specifically the RAM process

POSITION

The Institute of Fisheries Management should promote and support science to develop our understanding of the relationship between fish ecology and rivers flows generally and of the effects of artificial manipulation of flow regimes in particular.

The Institute should press for regular review of the Agency's management and regulatory systems in the light of new understanding and of changing circumstances, notably climate change.

The Institute should continue to support and pressure the Agency to resolve issues of over-abstraction and rivers suffering from chronic low flows and insensitive water management.

The Institute should press for adoption of the precautionary principle in dealing with flow impacts where the science is less robust and in contentious cases the onus should be upon the abstractor/impounder to provide evidence that their scheme is having no significant impact on the ecosystem.

The Institute supports the principle of threshold flows below which no abstractions would be licensed or take place. In the case of impoundments there should be an agreed minimum release to ensure that the environment remains suitable for fish.

The Institute considers that the development of our understanding of the influence of flows and flow manipulation of fish ecology should not be compromised by the costs and political implications of more stringent water management regulation; i.e. in the CAMS system, the assessment of sensitivity and determination of River Flow Objectives should be a separate process from the application of regulations.

The Institute considers that flow should not be considered in isolation but should be linked to an understanding of the form, function and degree of modification of the river reaches in question (See position on River Habitat Improvement). Furthermore licensing, both of abstractions and of releases from reservoirs, should be linked to Water Quality. Minimum permissible flows should be established that maintain adequate quality throughout the year.

SUPPORTING INFORMATION

Flow regimes have varied and profound effects directly upon the fish and upon their habitat. The degree and nature of these effects depend upon the fish species concerned and the environment they inhabit.

RAIN-FED RIVERS

Upland river reaches. The uppermost reaches typically support populations of resident brown trout sometimes accompanied by juvenile migratory salmon, and sea – trout. Slightly lower down the system there may also be bullhead and brook lamprey, lower still there may be stoneloach and minnow. Under typical UK weather patterns such streams enjoy plentiful and regular rainfall with wetter conditions in autumn and winter than in summer. Spring may often be the driest time of year. Such streams are prone to the disruptive effects of extreme weather events because of their small catchment area, and small physical size which offers limited buffering capacity for fluctuations in flow volume. Extremely high rainfall in winter mobilises large quantities of bed material and destroys spawning redds and their contents. Lack of high bed-scouring flows in winter may result in increased sedimentation of spawning gravels and lower egg survival. Low flows in late spring and summer, can result in shrinkage of available habitat, and the concentration of fish in the remaining deeper pools, leading to increased competition, cannibalism, and predation by birds and mammals. Very dry conditions can result in complete disappearance of surface flow, resulting in total habitat loss for all but young-of the year fish, which may be able to persist in the interstices between cobbles. Low flows in autumn have the effect of restricting access to spawning areas for adult brown trout, migratory trout and salmon. The consequences of changes in uplands land management on both peak and base flows is currently poorly understood but it is important to be aware that anthropogenic influences may be having a profound impact on flows in our upland catchments.

The Middle Reaches – pool and riffle habitat. The upper-middle reaches contain similar fish assemblages to the upper reaches but hold a higher proportion of larger, older resident brown trout that may be accompanied by grayling and rheophilic cyprinids such as dace, chub, barbel and gudgeon, plus stoneloach and eel. Lower down these reaches, the proportion of resident salmonids tends to reduce and other coarse fish species such as pike and perch may appear. Middle reaches are larger and hence better buffered against localised extreme conditions, however there is potential for flow impacts similar in nature to those in true upland reaches. Extreme winter flows can result in major redistribution of bed material within the channel but salmonid spawning areas in these larger rivers are less likely to be damaged than those in headwaters. Conversely, low winter flows can deprive the river of the higher scouring flows needed to maintain good spawning gravels for both salmonids and coarse fish. Low flows in spring and early summer may impede access to upstream spawning areas for spring-spawning species, particularly where there are weirs or other man-made barriers. Conversely very high spring flows can result in wash-out of coarse fish larvae particularly in heavily modified channels. In mid to late summer, middle reaches of rivers can be affected by low flows in a number of ways. Total drying of the riverbed is unlikely, unless there are special geological conditions, however, low flows produce severe reductions in wetted channel width in the shallower, gravel/riffle areas, resulting in significant loss of habitat for riffle-dwelling species. Under low-flow conditions the deeper pools may become stagnant with significant development of filamentous algae and excessive macrophyte growth, sometimes resulting in localised low oxygen conditions. This is particularly evident in organic enriched rivers. Prolonged low flow conditions in the middle reaches of rain-fed rivers are often associated with changes in community composition, with slow-water cyprinid and percid species becoming more prevalent than salmonids and rheophilic species, due to subtle alteration of the competitive balance between the species at various life-stages. Low autumn flows are only important in the middle reaches for salmonid migration, very dry autumns often resulting in long delays for salmon waiting to enter freshwater or for fish waiting for sufficient water to pass weirs or other barriers.

Lowland Reaches. Lowland reaches of upland rivers and rivers whose entire course is in lowland regions are often considered to be less vulnerable to the effects of flow than middle and upper reaches However, this is not universally true, especially where modified flows interact with other anthropogenic impacts. Lowland rivers and the lower reaches of rivers rising in upland areas tend to have very similar fish communities, though in the latter there is usually a migratory salmonid component that passes through these reaches during certain periods. Typical lowland species are roach, bream, bleak, perch, pike with localised chub and barbel, plus “stillwater” species such as tench, rudd and carp. Many lowland reaches are heavily modified for flood defence, drainage, and navigation and such modifications interact with the impacts of flow regimes.

High winter flows in channelised rivers are often contained entirely within the river channel resulting in very high water velocities and mass downstream displacement of coarse fish fry and juveniles, because there is little riparian structure to offer refugia. The floodplain may offer a refuge from high flows but will not be accessible to river fish until extreme flow events result in the levees being overtopped or washlands being artificially flooded. Fish that are able to access the floodplains may be subsequently stranded due to rapid recession of water levels and their return to the river channel being impeded by floodbanks, flap-valves, culverts and other structures. In natural lowland rivers, high flow events in spring and summer are important for fish to access to off-river spawning areas but in most UK rivers such areas, if they exist at all, are disconnected from the river channel except during very high winter floods. Hence, high summer flows can result in similar problems to winter events but are potentially more serious because the very young life-stages of lowland species are present at this time and are especially vulnerable to displacement due to their limited mobility.

Low spring flows in lowland rivers reduce the success of downstream-migrating salmonid smolts and delay spring-running adults. In the summer, low flows impact upon fish communities, chiefly via lowering of water quality, especially in rivers with high nutrient loads due to diffuse pollution or point source discharges. Physical loss of habitat under low-flow conditions is negligible as the levels in nearly all lowland rivers are controlled by weirs or sluices, however in more natural systems, access to and egress from off-river habitats may be prevented as flows and levels fall.

Tidal reaches. Tidal reaches respond to flow in similar ways to lowland freshwater reaches but are also vulnerable to changes in salinity due to the interactions between freshwater flows, winds and tides. Many tidal reaches exhibit long residence times for the water in them, leading to exacerbation of water quality problems. Tidal rivers are hence vulnerable to low freshwater flows during several periods of the year. In summer the impacts are likely to be associated with water quality, typically the development of mobile zones of low oxygen and high ammonia that can be lethal to fish especially in summer when temperatures are also high. This is especially relevant to salmonids attempting to pass through these zones. In autumn, winter and early spring, low flows allow the ingress of seawater during spring tides, particularly when exacerbated by storm conditions. These can lead to fish kills especially where fish are unable to escape upstream into freshwater due to physical barriers, or where they become trapped in off-channel areas such as marinas or dykes. As with freshwater lowland reaches, tidal river reaches are commonly heavily modified and these modifications interact with the impacts of flow regimes to exacerbate problems for fisheries.

CHALK RIVERS.

Chalk-fed rivers are confined to the lowland areas of south and east Britain. In their natural condition these rivers have much more stable and predictable flows to which the biota inhabiting them are adapted. Consequently they are less able to cope with extreme situations than those in upland rain- fed systems. Spring-fed chalk rivers tend not to have defined upland reaches with high gradient and large substratum. As a consequence of this and their steadier flow, their headwaters and middle reaches are less prone to great changes in wetted width and to desiccation than are true upland rivers. Fish communities in chalk rivers generally show more gradual change along the length of the river than is the case with classic rain fed systems, often with some coarse fish present right up the main river stem and brown trout and grayling residents almost down to the tidal limit. Many have runs of migratory trout and salmon. The susceptibility of chalk rivers to extreme flow conditions varies less along their length than in the case of rivers with true upland sources. Chalk rivers are particularly prone to low flows in late autumn and early winter due to the time-lag between the onset of winter rain and full recharge of the springs. This may have consequences for migratory salmonids and also resident brown trout when attempting to access spawning grounds in headwater streams. Chalk rivers are often nutrient-enriched, even in their upper reaches, and support abundant plant growth, so autumn low flows can also result in poor spawning conditions due to die-back of plant growth and accumulation of debris. Chalk rivers may be affected by high winter flows if there is high rainfall run-off. Although the washout of redds by such flows in less likely here than in rain-fed rivers, high rainfall can introduce sediment which is mobilised by the high flows, which can harm developing salmonid eggs. In summer, the main impacts on chalk rivers due to low flows will be via lower water velocities and enrichment, leading to excessive development of plant growth, algal blooms and fluctuations in dissolved oxygen and pH, which can be particularly damaging for coarse fish larvae. In some chalk rivers, reduction of flows of cooling groundwater can result in elevated temperatures in summer, which can be harmful or even lethal for salmonids.

FURTHER READING

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CONTACTS

For further information on this topic or the position paper please contact:
Graeme.Peirson@environment-agency.gov.uk;
I.G.Cowx@Hull.ac.uk;
Welcomme@dsl.pipex.com