



What Salmon Smell : the Importance of Clean Rivers

Introduction

Chemicals in water provide an essential source of information for salmon (*Salmo salar*) and many other fish species. The olfactory sense (sense of smell) is very well developed in salmon and plays a crucial role in many aspects of their lives, including their remarkable homing behaviour. The 'smells' that salmon detect are the chemicals present in the water. These include derivatives from the soil, rocks and plants surrounding the river, and chemical products (odour cues) of other animals. This ability to remember smells enables salmon to recognise specific localities and other fish species that they have previously encountered.

How do salmon use smell?

Early Life

The offspring of different parents have different odours. Newly hatched salmon learn their own 'family smells' whilst living in the gravel among their siblings.



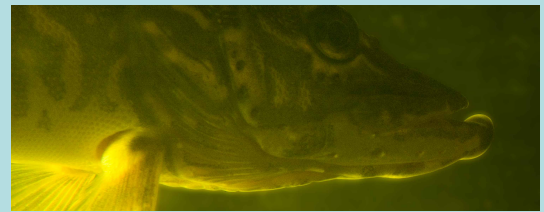
Homing

At some stage in life, young, or juvenile, salmon 'imprint on' (memorise) the chemical cues specific to their home stream. These may be chemicals derived from the local soil and vegetation, and perhaps also from local fish. This memory enables the salmon return to the same place to spawn.



Predators

Salmon are able to recognise odours of predator fish. The strength of the odour warns how close the predator is. Salmon can even distinguish between odours of predators that have recently fed on salmon, and those which have eaten other animals.



A second means of predator recognition uses a chemical alarm signalling system. When a predator's teeth puncture the skin of a salmon, chemicals released from the skin act as a warning for other nearby salmon.

Marking Territory

The area of river substrate that a salmon occupies becomes chemically labelled with its fish odour. This can be detected by other salmon, and may warn of the risk of aggression from the territory holder. In summer, salmon tend to tolerate siblings, but not fish from other families in their territory.



Individual Recognition

Population-specific odours may help returning adults to recognise members of their own population, thereby reducing population mixing and loss of genetic adaptations. Species-specific odours are probably of great importance in reducing the likelihood of salmon hybridizing with their closest relative, the brown trout (*Salmo trutta*). Their retained memory of their siblings' odour may also reduce inbreeding. Between potential mates, specific chemical odours (pheromones) released from males and females are essential for synchronizing the readiness of the sexes to spawn.





Effects of pollution

The sophisticated olfactory sense of the salmon is key to its survival. River pollutants threaten to interrupt the functioning of this vital sense. The consequences of this interrupted functioning are discussed below:

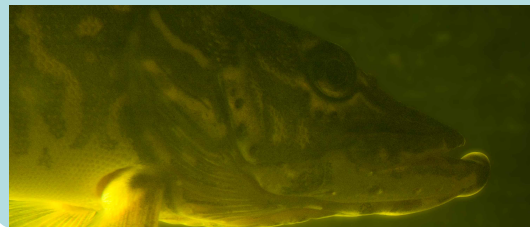
Homing

In the presence of pollutants (for example, diazinon), fewer adult salmon return to their spawning ground. Trace metals in water (for example, copper) can prevent trout from recognising their home stream water, suggesting that similar effects on salmon could be responsible for a lower return rate of adults. Other potential effects of pollutants on olfaction give rise to concern. For example, long-lasting pollutants in the rivers may impinge on, or prevent, successful imprinting in juvenile salmon, by inhibiting their ability to detect the unique chemical cues of their home stream.



Predators

Pollutants can prevent salmon from detecting the alarm chemical released from an individual attacked by a predator. In addition, pollutants may reduce the ability of salmon to detect predatory odours and assess the associated predation risk.



Marking Territory

Pollutants may reduce the ability of salmon to detect one another. This has implications for territory formation and sibling relationships, and may affect, for example, the extent of aggression between territory holders.



Individual Recognition

Olfactory communication between the sexes at the spawning grounds is disrupted, because the pollutants prevent the males from detecting the female pheromones which signals that the female is ripe. Therefore males do not respond, and their reproductive physiology is desynchronized.

