

## **Impact of worming on survival of released fish**

The practice of catch and release in inland fisheries worldwide has encouraged studies into the factors affecting subsequent survival of released fish. There is a particular emphasis on North American fisheries and this review is primarily based on North American salmonids, which includes not only Atlantic salmon (*Salmo salar*) but also Pacific salmon and trout (*Oncorhynchus* spp and *Salvelinus* spp).

### *Factors affecting post-release survival*

Studies of factors influencing mortality of salmonids after being caught and released find that location of hooking is the most important factor in determining subsequent mortality. It is consistently shown that deep hooking in the gills or oesophagus (gullet), and any hooking location resulting in severe bleeding, causes high mortality (Bendock & Alexandersdottir 1993, Pauley & Thomas 1993, Savitz et al 1995, Schisler & Bergersen 1996).

It is also shown that high water temperature and low oxygen content of water can influence the survival of released salmonids (Lee & Bergersen 1996, Muoneke & Childress 1994, Schisler & Bergersen 1996), although these effects are species and habitat dependent.

The location of hooking, and hence the largest factor in mortality, can be affected by the use of natural bait or artificial lures.

### *Studies on worming*

A study on mortality of cutthroat trout (*Oncorhynchus clarki*) after being hooked and released (Pauley & Thomas 1993) found that mortality rates were greater after being caught on worm-baited hooks than spinners. The main factor affecting whether mortality occurred was the anatomical location of hooking, with hooking in the gill, tongue, oesophagus and eye causing high mortality (96, 67, 66 and 54% mortalities, respectively) and occurring more frequently with worm-baited hooks.

A study on hatchery-reared Atlantic salmon in Maine (Warner 1976) found that mortality of salmon caught on the worm (5.7% mortality) was not significantly different to salmon caught by fly (4.6%). Again, the main factor determining mortality was hooking location - mortality caused by hooking with worms was primarily from fish hooked in the eye (76%) and gill or gill arch (12%). Fly-caught mortalities had been hooked mainly in the isthmus (back of throat) or tongue (42%), oesophagus or stomach (25%), and eye (25%). It was noted in this study that few salmon were deep-hooked using worm bait as strikes were carried out immediately.

### *Reducing post-release mortality*

Schill (1996) showed that survival of rainbow trout that had deep-hooked by worm-baited hooks could be increased by cutting the line; this reduced post-release mortality by 58% in the wild. Of the fish that were deep-hooked and the line was cut, 60% shed the hooks within 34 days. It was also reported that the frequency of deep hooking was significantly higher for catches on a "slack line" (deeper water) than a "tight line" (faster water). Similarly, Schisler & Bergersen (1996) also found that cutting the line on critically hooked fish reduced mortality rates by more than one half, probably as a result of reduced bleeding.

There is evidence that the use of circle hooks over the traditional “J” hooks (Fig. 1) reduces mortality (reviewed by Cooke & Suski 2004). Circle hooks, because of their re-curved point, are unlikely to penetrate a fish until they lodge in the corner of the jaw, thus greatly increasing the likelihood of safe, shallow hooking and resulting in significantly less deep hooking than J hooks (Cooke & Suski 2004).

The downside of circle hooks is that they are considered to have significantly lower capture efficiency than J hooks (Cooke & Suski 2004), although efficiency is quite variable between studies and species. In addition, circle hooks are considered more difficult to remove than J hooks (resulting in longer handling time) and there is an issue of eye damage associated with circle hooks (Cooke & Suski 2004). Preliminary data suggests that circle hooks may not be effective for fly fishing (Cooke & Suski 2004).

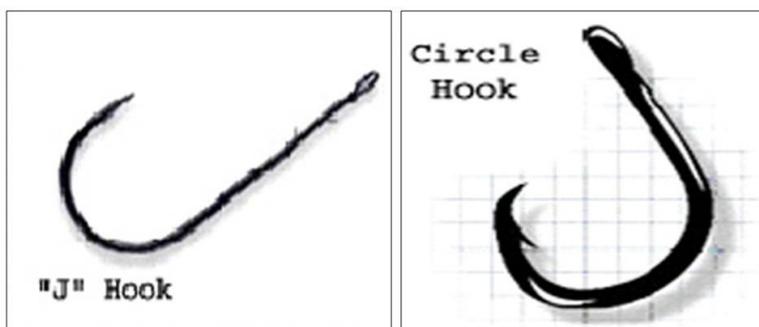


Figure 1. Types of hook

### *Conclusions*

Scientific studies show that the anatomical location of the hooking site (and therefore factors that influence this) is the greatest determinant of mortality of hooked and released fish. Whilst worm-baited hooks resulted in a significantly greater mortality rate than the use of spinners, owing to hooking location, wormed hooks resulted in similar levels of mortality to fishing flies. Based on this literature review, the following recommendations are made to reduce post-release mortality of hooked salmon and sea trout:

1. For deep-hooked fish, cut the line and do not attempt to remove the hook
2. Consider the use of circle hooks when using bait that is likely to be deep-hooked

## References

- Bendock T & Alexandersdottir M (1993). Hooking mortality of Chinook salmon released in the Kenai River, Alaska. *North American Journal of Fisheries Management* **13**, 540-549.
- Cooke SJ & Suski CD (2004). Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? *Aquatic Conservation: Marine and Freshwater Ecosystems* **14**, 299-326.
- Lee WC & Bergersen EP (1996). Influence of thermal and oxygen stratification on lake trout hooking mortality. *North American Journal of Fisheries Management* **16**, 175-181.
- Muoneke MI & Childress WM (1994). Hooking mortality: A review for recreational fisheries. *Reviews in Fisheries Science* **2**, 123-156.
- Pauley GB & Thomas GL (1993). Mortality of anadromous coastal cutthroat trout caught with artificial lures and natural bait. *North American Journal of Fisheries Management* **13**, 337-345.
- Savitz J, Bardygula-Nonn LG, Simpson A & Funk G (1995). Survival of smaller sport caught chinook, *Oncorhynchus tshawytscha* (Walbaum), and coho, *Oncorhynchus kisutch* (Walbaum), salmon from Lake Michigan and its management implications." *Fisheries Management and Ecology* **2**, 11-16.
- Schill DJ (1996). Hooking mortality of bait-caught rainbow trout in an Idaho trout stream and a hatchery: Implications for special-regulation management *North American Journal of Fisheries Management* **16**, 348-356.
- Schisler GJ & Bergersen EP (1996). Postrelease hooking mortality of rainbow trout caught on scented artificial baits. *North American Journal of Fisheries Management* **16**, 570-578.
- Warner K (1976). Hooking mortality of landlocked Atlantic salmon, *Salmo salar*, in a hatchery environment. *Transactions of the American Fisheries Society* **105**, 365-369.