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Ministry for Primary Industries
Manatū Ahu Matua

Evaluation of Fish and Game food chain exposure pathway for human consumption of trout from within a 1080 treatment area.

Summary

MPI was contacted by the Department of Conservation (DOC) in September 2016 to undertake an update to a 2014 risk assessment of 1080 residues in trout following the consumption of poisoned mice.

Based upon an exposure model, composed by Fish and Game, of trout directly consuming a 1080 bait pellet there is possibly a small food safety risk to trout consumers. However, the MPI risk assessment model illustrates that this possibility is highly unlikely to eventuate in trout in the wild.

MPI is of the opinion that any food safety risks can be mitigated if anglers are advised to avoid consuming trout from waterways in a 1080 drop area within seven days of the baiting operation.

Background

Fish and Game have undertaken a human health exposure modelling exercise for the possibility of trout having consumed sodium monofluoroacetate (1080) bait pellets in waterways. The model calculates the full transfer of the concentration of 1080 in a 12 g pellet to a 1 kg trout and the consumption of 500 g fillets from the fish. The calculated exposure dose in this model is 0.13 mg/kg bw/day for a 70 kg adult and 0.45 mg/kg bw/day for a 20 kg child. Both values are calculated to exceed the Lowest Observable Adverse Effect Level (LOAEL) reported in a reproductive toxicity trial in mink and are therefore flagged as a potential toxicity concern.

Exposure modelling considerations

The Fish and Game pathway model follows standard practice for considering exposure to residues and accurately represents the transfer of the concentration of 1080 in a consumed pellet to the dose received by a consumer.

One change to standardise with MPI current practice would be that the exposure is compared against the No Observable Adverse Effect Level (NOAEL) from the rat 90-day toxicity study (0.075 mg/kg bw/day; Eason & Turck, 2002) as the most appropriate value to protect human health rather than the LOAEL from the mink study.

The exposure model presents a “worst case” scenario in several aspects and a “most likely” risk model would use different input parameters when estimating risk.

Firstly the tissue transfer calculation is based on 100% absorption of the concentration of 1080 in the pellet bait to the fillet. However, the Cawthron Institute study shows this maximum tissue concentration (C-max) reaches its highest value at only 70% of the consumed dose at the 24 hour time point after dosing (Champeau et al., 2014). Using the raw data in Appendix 3. of the Cawthron Institute report, fish number 14 received a body weight adjusted dose of 5.68 mg/kg resulting in a fillet concentration of 4 mg/kg being reported. The concentration value then reduces to a maximum of 66% of the consumed dose in fish harvested at 48 hours after dosing (fish number 19). Then at 84 hours down to a maximum of 39% of the consumed dose (fish number 22). This indicates that a proportion of the dose may not get absorbed, or is rapidly excreted, and so complete transfer to the edible tissue of the full pellet bait concentration is unlikely. As the trout in the Cawthron Institute study were fasted for 2 days prior to dosing the experimental C-max could also be expected to be higher than in a wild fish where other gut contents may reduce the rate of gut absorption.

Secondly for the child model it is considered that consumption of a full 500 g fillet is highly unlikely. MPI bases its consumer risk models for children on the Ministry of Health 2002 Child Nutrition Survey (MOH, 2003). In the values for reported consumers of diadromous fish the 97.5th percentile consumption amount is only 283 g/day. The mean consumption value for reported child consumers was at 82 g/day.

Amended exposure model

By retaining the original exposure model but updating it with the parameters suggested above the following calculation is obtained.

Consumption by a 1 kg trout of a 12 g bait containing 18 mg 1080 (0.15%) would result in a maximum tissue transfer residue of 12.6 mg/kg at 24 hours after consumption, equivalent to 6.3 mg in a 500 g fillet. The maximum residue at 84 hours after consumption would be 7.02 mg/kg, equivalent to 3.51 mg in a 500 g fillet.

Consumption by a 70 kg adult of the entire 500 g fillet would lead to an exposure of 0.09 mg/kg bw if the fish is caught 24 hours after bait consumption and 0.05 mg/kg bw if the fish is caught at 84 hours.

Consumption of a large 283 g portion by a 5-6 year old child of 23 kg (standard weight from the New Zealand Total Diet Study) would lead to an exposure of 0.16 mg/kg bw at 24 hours after bait consumption and 0.09 mg/kg bw after 84 hours. A more typical fish consumption for this age group of 82 g leads to an exposure of 0.05 mg/kg bw at 24 hours after bait consumption and 0.03 mg/kg bw after 84 hours.

It is important to consider that this model is only run for a 1 kg trout, with larger fish there is greater dilution of dose to body weight. Assuming the consumed portion sizes remain the same, the consumption of fillet from a trout weighing greater than 1.2 kg will not lead to a dose exceeding the NOAEL for adults at 24 hours after bait consumption. For children a fish of greater than 2.1 kg will not lead to a NOAEL exceedance at 24 hours after dosing, or a fish of greater than 1.2 kg at 84 hours, based on a single bait being consumed.

Comparison against the NOAEL of 0.075 mg/kg bw/day indicates that the exposure to a large portion size of a fillet from a trout <1.2 kg in weight consuming one 12 g 1080 bait in the previous 84 hours would potentially represent an unacceptable exposure for adults. For children consuming a large portion the exposure may remain a concern even at 84 hours after fish consumption of the bait. A child with more typical consumption patterns of diadromous fish would not be exposed to a dose above the NOAEL.

Discussion

The exposure pathway model is accurate in recording that a scenario could exist where trout consumers may be at risk from 1080 exposure. However a full risk assessment model using "most likely" exposure pathway input parameters would provide a more realistic, and considerably lower, estimate of risk.

The model involves a number of assumptions regarding the exposure pathway. Whilst the model has identified that there is a degree of risk if a bait is consumed by a trout, to put this risk in context it is appropriate to test the assumptions made and consider if these are mitigated or can be considered sufficiently improbable by other data.

1. Is the bait consumed by trout?

A definite assessment of whether a trout would consume a bait is not available. An important indication that this is rare in occurrence may be that MPI has received no direct reports or sighted no anecdotal reports on trout being caught with intact 1080 pellets in their guts.

Gut emptying time in trout varies with temperature and the digestibility of the food. A study of brown trout maintained at 14 ^{o}C reported a gut emptying rate of 10% per hour with total emptying taking ~ 24 hours (He & Wurtsbaugh, 1993). As a result intact pellets are likely to be identifiable during fish gutting for potentially up to a day after being consumed. That in the many years of pellet bait use there have been no reports of pellets being found intact in trout indicates it is uncommon. In contrast concern was raised in 2014 over the potential secondary exposure through trout

consuming mice as a result of it being commonly reported that trout had been caught with large numbers of mice in their guts.

The Department of Conservation have reported that 1-3 kg rainbow trout at the Tongariro National Trout Centre offered non-toxic 6g RS5 pellets did not ingest them within the first hour of the pellets entering the water. The fish were observed to consume other forms of feed prior to and after this hour however. As a result it is unlikely that trout will consume the 6g or the larger 12g pellets in the wild. Additionally in the situations where 1080 is being used rodent numbers are likely to be very high as such competing interest for consuming mice may further reduce the probability that trout will take pellets.

Consumption of multiple bait pellets is further unlikely but also largely mitigated by the potential toxicity of the 1080 to the trout. 50% mortality has been reported in rainbow trout after 96 hours at a water concentration of 53 mg/L 1080 and 10% mortality was also reported to occur at 23 mg/L (EPA Reassessment, Appendix C). Whilst not directly equivalent to an ingestion route it would suggest that the 1080 concentration in three 12 g baits may be lethal for a 1 kg trout and the 1080 in little more than a single 12 g bait may cause some toxicity. Significant trout mortality following 1080 baiting operations has not been reported which suggests ingestion of multiple pellets is limited in trout stocks.

2. Does the bait contain the maximum concentration of 1080?

In submerged bait pellets 1080 is rapidly leached into the surrounding water. A leaching half-life of 5 hours has been established and 90% loss of 1080 in a bait occurs in 24 hours (Suren, 2006). This leaching occurs much more rapidly than the dye loss or bait fragmentation. As a result to obtain the maximum doses a fish would have to consume the pellet reasonably quickly after it enters the water. Consumption of a bait that has leached out 50% of its 1080 would result in a reduced exposure to a consumer.

3. Will a trout that has consumed a bait be caught within the timeframe for tissue residue to remain toxic?

While the Cawthron institute study was unable to calculate a tissue half-life it is likely based on the data that the C-max had peaked at 24 hours after dosing and residues deplete consistently after that (Champeau et al., 2014). As a result there is a short timeframe following the consumption of the bait by a fish where tissue residue may remain a concern. This is unlikely to be longer than 7 days after consumption for a child, double the 84 hour period where residues remain a concern in tissues, and shorter for an adult. The probability of an angler catching such a fish within this period has to be

rated as low. Additionally as pellets may still remain discernible in the gut for the first 12-24 hours it is probable that the fish will be rejected during gutting if caught immediately after bait consumption.

Food safety advice

Based on consideration of the discussion points it is highly unlikely that the exposure pathway model for trout consuming 1080 baits would be eventuate in the environment.

Analysis of the tissue data for 1080 from the Cawthron Institute report indicates that there is a clear depletion in 1080 concentrations from 24-84 hours, which if forecasted linearly forward to 168 hours (7 days) indicates residues will have fully depleted in tissue of a 1 kg trout (Champeau et al., 2014). However, two fish sampled at 120 hours display higher tissue concentrations than any of the four sampled at 84 hours. Because of the reduced sample size it is difficult to interpret the implications of this to actual tissue decay. Linear forecasting suggests the worst case residue transfer achieved at 168 hours, if the lower 84 hours residue data is omitted, is 31% the original dose. Recalculating the high child consumer exposure with this tissue transfer provides a dose of 0.07 mg/kg bw/day, equivalent to the NOAEL. Forecasting with all four timepoints induced indicates a residue transfer of 23% the original dose at 168 hours, equivalent to an exposure of 0.05 mg/kg bw/day. Exposure would therefore in the worst case depletion be equivalent to the NOAEL, with it being more realistic that tissue transfer will lead to residues below this level.

Considering the tissue depletion data in addition to the considerations on probabilities of trout consuming baits, baits retaining the full 1080 concentration and a child needing to consume a large portion of the affected fish, it is highly unlikely that any food safety risk would eventuate with a seven day precautionary period

Given the low probabilities of bait being consumed and the assessed tissue depletion data a seven day precautionary period for consumption of trout after a 1080 baiting operation would mitigate any food safety concerns.

References

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