

Dumped ammunition - an environmental problem for sediment management?

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Introduction: In many countries dumping of ammunition in aquatic environments was widespread in the period from WWII and until the 1970s. Ammunition contains toxic compounds which can contaminate the sediments and harm the environment. The question which is often raised today is whether the dumped ammunition should be taken up (risk for explosion) or left in place (risk for contamination). To illustrate the complexity of the problem, two cases of dumped ammunition are presented; the lake of Mjøsa, Norway and the lake of Thun, Switzerland.

Dumped ammunition in the lake of Mjøsa, Norway: Ammunition was dumped in the lake of Mjøsa from the early 1940s until 1971. The ammunition was dumped in three different areas of the lake at great depths varying from 160 m to 400 m. It was mainly grenade components and ammunition remnants of explosives which were dumped. The lake of Mjøsa is Norway's largest lake and an important drinking water source for the surrounding Lillehammer region. In 2001 a detailed survey [1] was done to find out if the dumped ammunition was influencing the drinking water quality. The survey showed that none of the components in the explosives could be found in the sediments or in the water. An assessment was also done for the state of the explosives in the future when they would be in direct contact with water due to corrosion of the protective casing (after several hundred years):

- The explosives will be fully or partly degraded.
- The explosives will be covered by sediment due to sedimentation.
- A large part of the explosives will be bound to the sediments.
- Explosives that are spread to the water column will be relatively limited.

The recommendation from the Norwegian Defence Authorities was to leave the ammunition in place. This was accepted by the Norwegian Pollution Control Authority, but they ordered the Norwegian Defence to monitor the dumping areas with respect to spreading of components of explosives. Monitoring showed remnants of picric acid above the detection level in the pore water of the sediments in 2004 while

in 2007 there was no picric acid in the pore water. This indicates that small amounts of explosives are in the sediments which can result in concentrations above the detection limit in sporadic cases.

Dumped ammunition in the lake of Thun, Switzerland: Ammunition has been dumped in the lake of Thun from 1945 until 1964. The lake is frequently used by hobby fishermen and when deformities were found on fish caught from the lake it was claimed that this could have been caused by the explosives in the dumped ammunition. A thorough investigation was done in 2005 to find out if there was a connection between the dumped ammunition and the deformities on the fish. Laboratory tests combined with modelling [2] showed that the sedimentation in the lake was going much faster than the spreading of the buried explosives towards the sediment surface. The investigation concluded that there was not going to be any (or very limited) spreading of explosives to the water column and thus no impact on the fish population. Later investigations have instead been looking at other possibilities for the deformities on the fish, among these are the brominated flame retardants [3]. The Swiss authorities have decided that the explosives should be left in place because this poses fewer risks than taking them up.

Conclusions: The cases show that dumped ammunition causes very limited or no impact on the aquatic environment. Even in the future when the protective casings have corroded and the explosives are in direct contact with the water, the impact on the aquatic environment is expected to be low.

References: [1] Forsvarets bygningstjeneste (2001), *Dumped ammunition in Mjøsa, Sediment survey and assessment of spreading of dumped ammunition in Mjøsa*, DNV report 2001-0478 (in Norwegian). [2] Agroscope FAW and Swiss Federal Institute for Environmental Science and Technology (2005), *Aquatic load of explosives in the lake of Thun*, Final report, Contract no. 4500312638 (in German). [3] EMPA (2006), *Flame retardants with unknown consequences*. Press release to PhD by C. Bogdal.