Pick your golf balls up!

- Lots of golf balls disappear into lakes and fall outside the golf course, but because of the lack of test standards (among other things), it is difficult to say how much of an environmental problem this is

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Golf balls should not be left lying around in nature, and a damaged golf ball should be thrown away with the regular waste, as it would otherwise take between 100 and 1,000 years for it to decompose naturally. This fact is impossible to disagree with, but nevertheless it is still a fact that golf balls get lost or land in a water hazard on a golf course. So the question is whether this can be regarded as a significant environmental problem, which golf as a sport ought to deal with differently in the future.

As part of our consulting work in the Danish Golf Union, the question has been put to us several times about the environmental impact lost golf balls have on nature. Water hazards especially are affected by a large number of balls, so we thought it was relevant to investigate whether the chemicals that golf balls give off when in water constitute a threat to the environment..

We quickly find out that the answer was not as easy to obtain as we thought. We got in touch with our networks abroad in the USA and in England, where we would have expected that this question had been raised and looked into already. But surprisingly, the answer was that they didn't know of any such investigations which would help us. So we therefore found ourselves in a situation where answering the question meant that we were pioneers.

A smashed golf ball contains large amounts of zinc

Earlier this year, we heard about an analysis of a damaged golf ball which showed high concentrations of, in particular, zinc and other damaging heavy metals. The result of the test only shows what is in the ball, but not what environmental impact it may have.

A completely smashed golf ball will in practice never be found on a golf course. A lawnmower or an agricultural machine will at worst cut the ball into 2 or 3 pieces, but never completely pulverise it. Analysing a smashed golf ball will therefore not give any information about the potential environmental impact from golf balls. In addition, it is generally difficult to evaluate the potential for pollution from golf balls, as the extent and location are of course two significant factors to take into account.

Even though it is difficult to determine the potential pollution threat from golf balls, caution dictates that damaged golf balls should in principle always be collected and disposed of properly.

No standards for the test

There are no standards for testing golf balls, and as it was not possible to find any tests abroad which could enlighten us about the subject, we had to construct a scenario which we ourselves felt was representative. The choice of analysis was not made easier by the fact that the different analysis institutes we contacted had different attitudes to how the analysis should be undertaken.

In order to be able to compare the results to something, we eventually chose to have a standard analysis undertaken - as is used for classifying waste. A number of used balls recovered from a lake were used. We thought it was more realistic to use used balls because finding them in a water hazard is the most likely scenario.

Figure 1. 63 balls used in the experiment. As can be seen, a broad range of manufacturers is represented.

Figure 2. The setup of the experiment where polluting chemicals are washed out in two tests partly for non-organic and partly for organic materials.

The result

Finally, we chose to have a so-called centrifuge test done (EN-12547-3), which is prescribed by the environmental agency for classifying waste. The analysis is not carried out on the actual ball but on the liquid it has been in for a period of time which matches the conditions when a ball lands in water. The analysis gave the following results.

Parameter	**Analysis**	**Government notice 921, 1996 regarding quality requirements for water areas (obsolete)**
	µg/l	µg/l
Pb (lead)	< 0,6	3,2
Cd (cadmium)	< 0,05	5
Cr (chromium)	< 0,9	10
Cu (copper)	2	12
Ni (nickel)	1	160
Zn (zinc)	38	110
As (arsenic)	< 1	4
Hydrocarbons	< 5	
Benzene	< 0,020	2
Toluene	1,8	10
Ethyl Benzene	0,086	10
Xylenes	0,17	10

We decided to compare the results of the analysis to a prior government notice about quality requirements for water areas, in order to obtain a feeling for whether the values would constitute a problem in relation to the requirements. The government notice has been deleted and no replacement has been drawn up, which is why it is often still used, for lack of a better test.

With this analysis method, 2 litres of liquid are used for each kilogram of golf balls. That means that the concentration in the liquid may be expected to be much larger than in for a example a lake, where the quantity of water is much larger compared to the golf balls in the experiment. It may also therefore be expected that equivalent concentrations to those found in this experiment will not be found in nature. As can be seen, all the values in this analysis lie below the requirements in the notices with a good margin of safety.

Even though the requirements are met, there is still the question of inappropriate materials being emitted into the natural water environment. Below, there is a short summary of the potential environmental risk with the materials found.

Hydrocarbons
Hydrocarbons in the chemical world are an organic material consisting of carbon and hydrogen. In an analysis of a smashed golf ball referred to earlier, hydrocarbons were found, and in the above centrifuge test a very limited amount was also seen.

Hydrocarbons are not normally considered to be a big environmental problem for water environments. The reason is that the omission of hydrocarbons under water occurs in an environment containing bacteria, where the material mentioned will be broken down by those bacteria.

BTEX
BTEX is an acronym for benzene, toluene, ethylbenzene and xylene. BTEX occurs in benzene and other oil products. The problem with these materials is that they are very soluble, which gives a significant risk of groundwater pollution. They are therefore chemicals one does not wish to find in an analysis, but the level in this analysis is fortunately very low and well below the quality requirements for water environment.

Breakdown of BTEXs occurs most easily under oxygen rich conditions. A healthy, oxygen-rich water hazard will therefore give the best conditions for breakdown to occur, which is also the case for hydrocarbons.

Heavy metals (zinc)
Today, synthetic rubber is used in solid core golf balls. Over the past 30 years, materials used in the rubber have included zinc diacrylate. That is why such large amounts of zinc were found in the analysis of the smashed golf ball.

The washing out of heavy metals has an effect on the bottom vegetation in lakes and waterholes on golf courses. Experience with lead and other heavy metals from earlier experiments in small lakes adversely affected by run-off water from roads and other paved areas shows that heavy metals sink quickly to the bottom because of their density, and bind to the sediment in the lake.

The heavy metals given off by golf balls will therefore also sink to the bottom. A certain amount will therefore be absorbed by plants, subsequently entering into the food chain, something which is not appropriate.

Zinc is problematic because it is mobile. That means that it is soluble in water and can be absorbed by both flora and fauna. All living organisms need zinc in appropriate amounts, but if the concentration is too high it can lead to poisoning.

Trawling the lake can be more damaging
Unless a lake is completely carpeted with golf balls, trawling for balls will possibly be more damaging for the lake's bottom vegetation than leaving the balls where they are. That is because mechanical trawling destroys the plants. In addition, the damaging chemicals which have sunk to the bottom are recirculated and can thus enter into the food chain and have an adverse effect on it.

Proportions
When evaluating the pollution risk from a golf ball, the amount of balls is of course crucial for determining whether there is a problem or not. In addition, when evaluating how damaging the golf balls are for the environment, an evaluation of the sensitivity of the area where the balls land should also be taken into account. The issue is therefore very different depending on whether the affected area is used for agriculture, is not farmed or has another use such as a lake.

In addition, care must always be taken to keep actions in proportion to the problem and clarify the actual environmental risk from the disturbance which, for example, would be caused by removing the balls from the bottom of the lake.

In soil, waste that for example is discarded or blown on to fields can potentially constitute a much larger problem in certain areas. At the present time, we do not however know the proportions of the various different influences.

Alternatives to traditional golf balls
One alternative to the environmentally-damaging washout process is to find alternative materials for manufacturing golf balls. There are companies who have begun to produce golf balls without zinc, and some companies advertise golf balls without heavy metals and which are manufactured with 100% recyclable materials, including the packaging.

The product development is thus moving in an environmentally friendly direction, and hopefully this will result in our not having to consider the environmental impact of golf balls in the future.

More knowledge desired
The pollution potential of golf balls is unfortunately not answered fully by this article. We therefore hope that next year we can start an actual research experiment to illustrate the problem further so that golf sport can handle the issue as well as possible in future.

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