

Biological Side Effects from Activated Carbon When Used in Contaminated Sediment Treatment: Trying to Put Things into Perspective

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Background/Objectives. Abundant data published over the last 10+ years clearly shows activated carbon (AC) is a highly effective sorbent of many organic sediment contaminants. As a result, AC's international use in in situ isolation capping and treatment has grown dramatically. Earlier in situ treatment projects involved mechanically mixing AC-bearing material into surface sediments (mechanical mode) while later projects instead involve placing thin AC-bearing layers overtop sediment and rely on natural bioturbation for mixing (thin-layer mode). While AC's international reputation as a highly effective sediment management tool has grown substantially, so too has the number of studies reporting biological side effects from AC when used in in situ treatment (both modes). Such results have prompted Norway's Miljødirektoratet to note (2014) "It is difficult to conclude if [AC] can be used in large contaminated areas", and a 2017 study by Scandinavian researchers to state "The promising remediation potential of AC has been brought into question based on the adverse effects of AC to certain benthic organisms". There also appears to be a common belief powdered AC (PAC) causes greater harm to benthic organisms than granular AC (GAC). While credible evidence of AC's biological side effects cannot be discounted, conclusions being drawn from available results need to be carefully scrutinized.

Approach/Activities. From 2005 to 2017, a total of 23 studies were published in international journals in which AC effects on benthic organisms were evaluated. Typically, the studies: were by American and/or Scandinavian researchers, were laboratory or field-based, involved either (but not both) AC treatment modes, used PAC or GAC at different dosages (often < 5%), evaluated responses of selected benthic species or communities, and focused on specific ecological endpoints or community level responses. A critical review of this published body of AC-effects research was performed and key findings will be presented.

Results/Lessons Learned. Given currently available published data, the goal was to determine what conclusions can defensibly be drawn – or not – on biological side effects from AC when used in in situ treatment of contaminated sediments. Questions to be addressed include:

- In general, are there enough results to conclude that biological side-effects from AC outweigh its clearly demonstrated treatment benefits – *especially* when endpoint-specific and community responses are nearly always mixed?
- For the thin-layer mode, are the relatively few (and mixed) results enough to question AC's use in the context of this popular treatment mode?
- Can results for the mechanical mode be used to adequately predict biological effects from AC when used in the thin-layer mode? Don't these two treatment modes represent entirely different levels of AC exposure, including over time?
- Are there enough results to conclude PAC is more damaging to organisms and/or communities than GAC?
- The issue of biological side-effects from AC appears to receive more attention and focus in Scandinavia than in the USA, perhaps to the point that AC's use in sediment treatment is being limited in Scandinavia. If so, why is that?
- Are there ways possible biological side effects from AC use in sediment treatment can be minimized while still benefiting from its positive treatment effects, e.g. intermittent applications of lower doses over time?