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Metal contamination of *in situ* caged *Gammarus fossarum* as an indicator to predict ecological disturbance: a national scale case-study

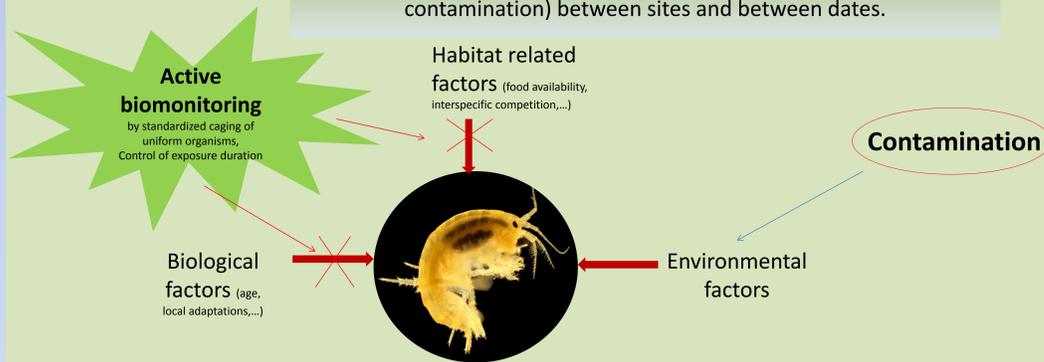


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Gammarus fossarum has been validated as a highly relevant tool for monitoring freshwater bioavailable contamination (Besse et al 2013)

Suppressing the factors which prevent comparability of accumulated concentrations (indicator of bioavailable contamination) between sites and between dates.



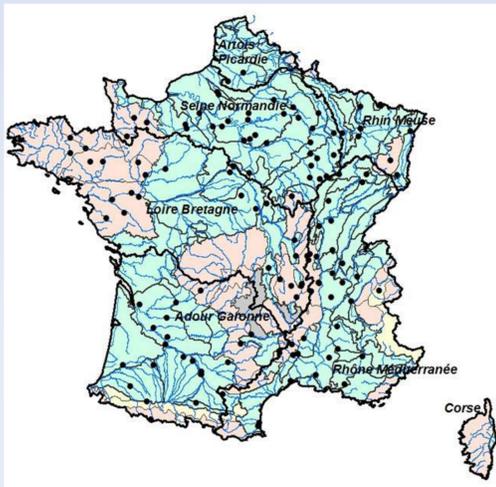
For chemical status characterization, threshold values of bioavailable contaminants in gammarids, named "Bioavailable Background Assessment Concentration" (BBAC) were derived from national deployment as values above which measured concentrations are expected to be representative of a bioavailable contamination at the sampling site. Accumulated concentrations under the threshold only reflect the national background level of contamination.

Objectives: Calibrate the *G. fossarum* indicator of bioavailable contamination towards ecological responses related to changes at community levels

Thorough standardisation of metal data acquisition which provides high robustness and repeatability, enabling temporal and spatial comparisons

Approach: a national investigation was performed, in order to establish relationships between contamination levels observed in caged *G. fossarum* and impacts on populations of macro-invertebrates, including gammarids (presented hereafter).

Methods



Study sites at the French national scale level: metal concentrations in *G. fossarum* and gammarid numbers were recorded on 117 sites representative of the different existing waterway profiles and taken from different national monitoring networks

Element quantification: 11 metals and metalloids were quantified by ICP-MS (Cd, Pb, Cr, Co, Ni, Cu, Zn, As, Se, Ag) or automated AAS (Hg).

Count of gammarid numbers: The number of gammarids on the same 117 sites were extracted from the national surveillance network database.

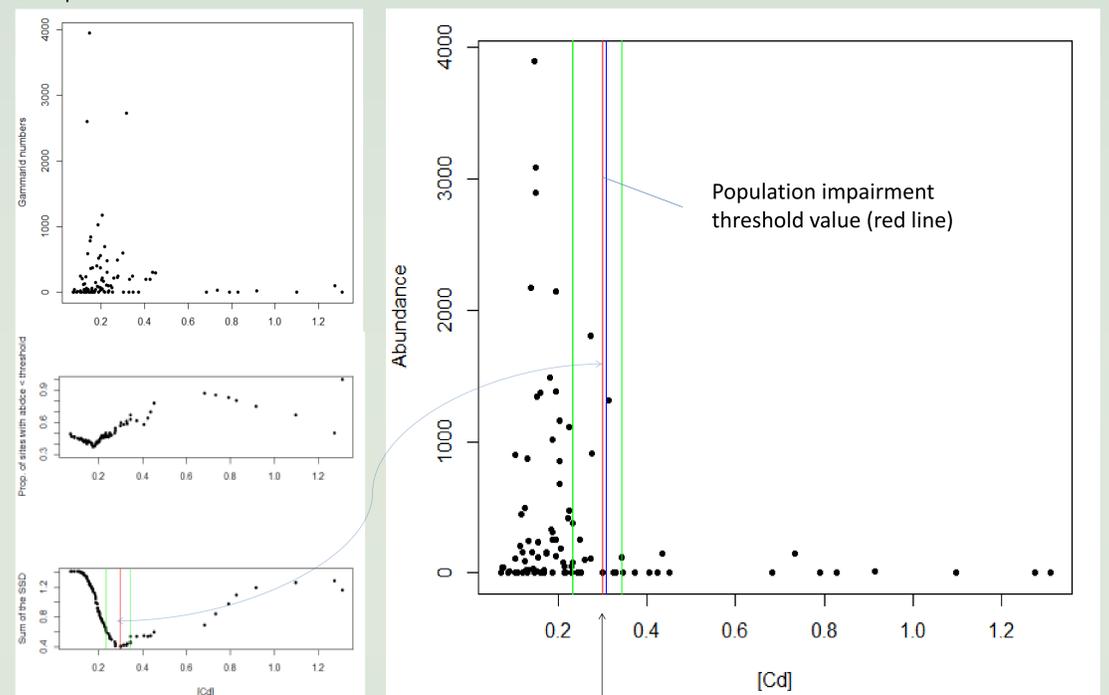
Correction factors: The French rivers are classified according to the "physicochemical typology" (based on physicochemical, hydromorphological and geographical parameters). Depending on the river type, the numbers of gammarids vary naturally. The initial gammarid numbers were then corrected so that they consider the profile of the river they were taken from.

Meaning of the corrected numbers: For each river type, the value of the 95th percentile of the number of gammarids were considered as the maximum carrying capacity. For each studied site, the corrected number is expressed as a percentage of this assumed maximum carrying capacity.

Statistical processing: For each site, the numbers of gammarids were plotted against the values of metal concentrations measured in caged *G. fossarum*. The median value of the gammarid numbers on reference sites for each typology were then arbitrarily introduced as internal thresholds, and the proportion of sites with numbers of gammarids below these thresholds were plotted against metal concentrations. Last, the sum of the SSD were determined and the lowest value was considered as the threshold value corresponding to the main cut in the distribution. Confidence intervals around these values were set by bootstrap (1000 runs).

Results and discussion

Example with Cadmium



- Cd ecological impairment threshold value = 0.3 µg/g
- Cd contamination is likely to strongly impact gammarid numbers as no substantial effectives are observed if Cd levels exceed the ecological impairment threshold value
- Ecological impairment threshold value is very close to BBAC (blue line).
- Similar results with Pb but no obvious results with essential elements (not shown here)
- Ongoing analyses with other macro-invertebrate taxa.

Conclusions: Our approach...

- Sets national thresholds of concentrations of several metals in *G. fossarum* above which the numbers of gammarids always remain low, suggesting strongly a situation of ecological impairment at populational level due to metal contamination
- Heads towards a prioritization of contaminants problematic for ecological status of each site.
- Is highly valuable for WFD: comparisons and exact trend measurements, improvement basis for metrics used to assess ecological status of water bodies.
- Will be used with toxicity data instead of concentration data so that the effects of all the contaminants present in a given environment can be integrated.