DAIMON Toolbox Fact Sheets:

Methods to Study the Impact of Dumped Munitions on Marine Biota

Assessment category 3: Biological effects

Toolbox component: Fitness

Fact Sheet 3.6: Condition Index (CI) in bivalves

Author: Matthias Brenner, Alfred Wegener Institute (AWI)

What is it?

Mathematical relationship between weight of entire softbody (wet weight) and weight of mussel shell:

$$CI = (Weight\ Softbody(g)/Weight\ Shell)*100$$

The condition index based on wet weights (Milroy, 1909) is often used in studies were also biomarker are investigated. Although, less precise than CIs based on dry- or ash free dry weights it can be applied using the same cohort or individuals further investigated with biomarkers (Brenner et al., 2012).

What does it tell you?

CI is in first instance an indicator of nutritional status/growth of mussels. However, CI is also considered as a generic non-specific indicator of habitat quality and environmental stress, reflecting the well-being and fitness of mussels and is, thus, often recorded as supporting variable for measurements of biological effects of contaminants in mussels. High values indicate a good status; low CI values a poor status. A decrease in CI may be caused by a variety of natural and anthropogenic stressors, including exposure to hazardous substances.

Since CI is a generic stress indicator, it is applicable in a screening or detailed study on effects of conventional or chemical munitions and warfare agents only in concert with other more specific biological indicators (biomarkers). Because of the non-specificity of the index, it is not recommended to use it in isolation.

Further, CI may vary substantially according to seasons and reproduction status of blue mussels. Also habitat condition can influence shell structure and like this also the weight of shells. The basic CI version presented here is intended to be used for linear growing mussels, like Mytilidae. For mussels growing in more oval forms, CI e.g. based on volume comparisons are recommended (see Crosby and Gale, 1989).

Type of Indicator (tick box)

☒ non-specific stress indicator
☐ specific for groups of contaminants incl. CWA or explosives

☐ CWA-specific indicator
☐ specific for substances related to explosives (e.g. TNT)

How to measure it?

***Species*:** CI presented here can be used in all mussel species having a pronounced linear growth.

***Matrix*:** whole mussel

***Equipment*:** For measurement of weight and length, a balance and a Vernier caliper are needed. For weight measurements at sea on unstable platforms (e.g., onboard research vessels), special balances (scales) are required (e.g. https://marel.com/fish-processing/systems-and-equipment/on-board/surimi/receiving--handling/weighing/marine-https://marel.com/fish-processing/systems-and-equipment/on-board/surimi/receiving--handling/weighing/marine-scales/303?prdct=1) which are able to integrate over fluctuating values.

***Measurements and units*:** Each mussel is carefully opened with a knife by cutting the posterior adductor muscle. The remaining respiratory water is briefly drained in order to gain the drained net weight of each mussel (in g). Then mussels are dissected for further biomarker analysis. The remaining shell is carefully cleaned from tissue remains before shell weight (in g) is determined. Weight of softbody is calculated by subtracting the shell weight from total wet weight. Shell length is measured as total length and recorded to the nearest mm.

***Sample size*:** The sampling size depends on the study purpose. Comparisons between different mussel populations require higher numbers of investigated mussels, than e.g. field or lab experiments with restricted numbers of candidates.

How to analyse and assess the data?

From the individual CI values, mean values per sampling site or treatment (filed /lab experiments) can be calculated; e.g., arithmetic means and standard deviation or arithmetic means and 95 % confidence intervals. Depending on the distribution of the data and the form of the mathematical relationship, medians with percentiles are also applicable.

For the assessment of effects on the CI, two commonly applied approaches can be used:

(1) Statistical comparison of mean CI values obtained from exposure scenarios (e.g. a munitions dumpsite in the field or a lab exposure treatment with a certain concentration of warfare agent) and from un-impacted reference areas or control treatments.

(2) The use of assessment criteria (BAC: background assessment criteria; EAC: environmental assessment criteria) reflecting a good, medium or bad fitness status.

So far, no generally applicable assessment criteria for CI in mussels have been established.

References

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Crosby, M.P., Gale, L.D. (1989). A review and evaluation of bivalve condition index methodologies with a suggested standard method, Journal of Shellfish Research, 9(1), 233-237

Milroy. I. A 1909. Seasonal variations in the quantity of glycogen present in samples of oysters. Scientific investigations, London, Set. 2, 17(6)