Supplementary Material

Other factors potentially influencing MP uptake

Microplastic ingestion appears to be common across different life stages and species in varying intensities, with body size, feeding modes, and preferred habitat individually not explaining the variation observed to a sufficient extent. Several studies suggested other factors that could potentially drive MP ingestion in marine fish such as the body shape, mouth/gape size, and swimming ability (Vendel et al. 2017) or behavioral traits, i.e., migrating behavior (Romeo et al. 2015). Furthermore, assessing the following factors may be considered expedient in assessing relevant explanatory variables: life stage and associated shifts in diet of ELS and adult fish (Silva et al. 2018), sex (McGoran et al. 2018; Su et al. 2019b), and site of origin (i.e., distance to shore) rather than preferred habitat (Steer et al. 2017; Chan et al. 2019). As feeding modes, and, thus, preferred prey items may also vary among the same species, originating from different locations, species- and site-specific factors should also be taken into account (Silva et al. 2018).

Impacts on Early Life Stages of Fish

During the period of switching from yolk-sac to exogenous feeding, the majority of marine fish larvae are considered to be planktivorous, while more diverse feeding patterns (including species-specific prey preferences) are observed during the juvenile life stage (Nunn et al. 2012). Deriving from this, early life stages (ELS) may be particularly susceptible towards microplastic (MP) ingestion in relation to their feeding mode during the larval stage along with species-specific feeding habits at later ontogenetic phases. Knowledge about the feeding ecology of the respective taxa under investigation is, therefore, considered essential when evaluating the extent to which ELS are vulnerable to MP uptake and potential detrimental effects.

As the impact of ingestion is likely to differ, depending on the size relation of the organism affected and the particles ingested (Lusher 2015), ELS of fish may be considered particularly vulnerable to the impact of MP-sized particles (Mazurais et al. 2015). Digestive injuries and starvation may be among the conceivable consequences for ELS ingesting large amounts of MP (Ferreira et al. 2016). Studies assessing the impact on early life stages of fish should, thus, pay special attention to signs of malnutrition in MP-feeding fish. Regarding the potentially increased risk of mortality caused by MP uptake, Hoss and Settle (1990) came to the conclusion that the overall ingestion of inert MP by ELS presumably did not contribute towards an increased mortality, yet nowadays, the extent to which MP ingestion adds to mortality in these vital life stages still remains to be understood. Even though these first in-situ reports of MP ingestion included ELS of fish (Carpenter et al. 1972; Kartar et al. 1976; Hoss and Settle 1990), information on the impacts of ingestion remain insufficient, with field and laboratory studies commonly focusing on adult fish or giving no indication concerning the life stage investigated. To precisely appraise the vulnerability of ELS to MP pollution, future studies should, therefore, pay attention to recording the actual size and/or life stage of the organisms under examination. Moreover, the immediate as well as the long-term effects of MP ingestion are yet to be assessed. Due to the special vulnerability of ELS, priority consideration should be given to in-depth studies on larval and juvenile stages both in field and laboratory studies.

Condition indices based on fish morphometrics

Based on the assumption that heavier fish of a given length are in better shape or condition than equally-sized individuals of lighter weight, fishery ecologists frequently use external measures of fish size (e.g., standard length, height, body mass) and the thereof computed ratios as a proxy for individual or population fitness and well-being (Hayes and Shonkwiler 2001). The main advantages of morphometric-derived condition indices are the rapid and non-destructive collection of the required data along with its simplicity in roughly estimating the well-being of a fish. Apparent limitations may be caused by the various approaches to determine length (standard length, fork length, total length) or weight (wet weight or eviscerated wet weight), impeding comparisons across different studies and the apparent loss of information by reducing multi-dimensional relationships into a single factor (Cone 1989).

At the beginning of the 20th Century, Fulton proposed a condition factor *K*, which assumes isometric growth (i.e., growth with constant body proportions), based on the following formula:

$$K = \frac{weight}{length^3}$$

with wet weight in grams and length in centimeter (Fulton 1904).

Until today, Fulton's *K* is still one of the most frequently used indices (Nash et al. 2006). However, allometric growth is observed in most fish taxa (Le Cren 1951), which requires a species-specific adjustment of the slope of the length-weight relationship (LWR), as proposed by Ricker (1975) in the relative condition factor *K*', an extension of Fulton's *K*:

$$K' = \frac{weight}{length^b}$$

with wet weight in grams, length in centimeter and *b* as a species-specific constant.

To estimate the LWR of a fish (and, thus, the species-specific constant), the following linear regression of the log-transformed equation is used:

$$\log(Weight) = \log(a) + b\log(Length)$$

with the parameter *a* representing the intercept and the parameter *b* the slope of the relationship.

Derived from these two basic condition formulas, researchers have been applying various condition factors based on morphometrics, such as the Richardson condition factor:

$$CF = 100 \times \left(\frac{weight}{(length)^b}\right),$$

used in two of the studies under review. Other factors have been proposed which take into account not only the length and weight of a fish, but also its height (Jones et al. 1999). Within a given fish taxon, however, the relationship between body length and weight may vary considerably, depending on various factors such as the fish population itself (i.e., sex, maturation, or life stage), or on the annual variability of environmental conditions (Froese 2006). The usage of the relative condition factor after Le Cren (1951) may be, thus, advisable as it compensates for the variation in condition in relation to increasing body lengths:

$$K_{rel} = \frac{observed\ weight}{theoretically\ estimated\ weight}$$

Here, the observed wet weight (in grams) of an individual is compared to the calculated weight for that respective length in a given population (based on the calculation of the LWR).

A comprehensive overview on the different condition indices based on morphometrics, their strengths and potential limitations can be found, inter alia, in Bolger and Connolly (1989), Richter et al. (2000), and Froese (2006).

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