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Ministry of the Environment

FY2025 Ecosystem Impact Assessment on Microplastics Study Results (Aquatic organisms)

Office of Policies Against Marine Plastics Pollution, Marine Environment Division

Secretariat: Mizuho Research & Technologies, Ltd.

Contents

1. Project Overview

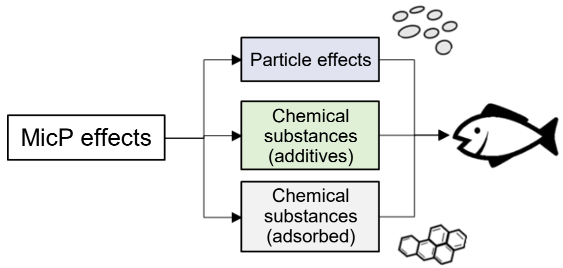
Project Overview

- Background: There is concern about the impact of microplastics (MicP) on organisms and ecosystems. <u>There is a need for quantitative data that sheds light on hazards and risk as much as possible.</u>
- Objective: After collecting scientific knowledge on the MicP exposure and environmental fate, hazards to aquatic organisms, among others, the project <u>aims to establish a preliminary risk assessment method</u> to quantitatively assess the impact on organisms and ecosystems and thereby <u>estimate the risk so as to inform government decision-making in the future.</u>
(Although there are concerns regarding the impact of MicP particles and chemicals on organisms and ecosystems, this study focused on the effects of particles on aquatic organisms.*

Trial risk assessment

[Risk Assessment Committee]

- ☐ Trial and study of the risk assessment methodology for MicP using exposure and hazard results



*Primarily anticipate the impact of particles on aquatic organisms (e.g., fish)

Cross-sectional study for trial risk assessment

[Expanded Subcommittee (2024) / Joint Subcommittee (2023, 2025)]

- ☐ Improvement of the risk assessment methodology for MicP using exposure and hazard results
- ☐ Summary of the respective tasks towards improving exposure and hazards

Exposure / Physicochemical properties

[Exposure Assessment Subcommittee]

- ☐ Up to FY2024: Compilation of estimation approaches for fine MicP (<330 µm) in marine surface layer and identification of associated issues
- ☐ Up to FY2024: Examination of conversion methods among hazard-relevant parameters (particle number, mass, volume, surface area, etc.) and identification of key issues for refinement
- ☐ FY2025: Compilation of current monitoring data for sediments and identification of issues in exposure assessment

Hazards

[Hazard Assessment Subcommittee]

- ☐ Up to FY2025: Refinement of evaluation criteria for literature review and identification of issues related to data screening
- ☐ Up to FY2025: Compilation of effect concentrations of MicP for aquatic organisms (fish, crustacean, and shellfish)
- ☐ FY2025: Examination of effects involving sorbed chemicals and additives.

Main Updates for FY2025

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■ Exposure Assessment

In the exposure assessment for FY2025, information on the occurrence, behavior, and estimation of microplastics (MicP) in sediments was compiled.

In addition, current challenges in the exposure assessment for sediments and knowledge gap was considered (see “6. Exposure Assessment (Sediment) ”). The slides in 3. Exposure Assessment (Marine Surface Layer) are the same as those published for FY 2024

■ Hazard Assessment

Regarding particle effects on aquatic organisms, the evaluation of data through literature review of toxicity test data was continued from FY 2024, and the provisional compilation of toxicity test data was updated (see “4. Hazard Assessment (Particle Effects of Microplastics)”).

At the same time, with respect to effects involving plastics associated chemicals (sorbed chemicals and additives) on aquatic organisms, three relevant review articles were examined to find out the latest assessment and knowledge gap to be explored in the future (see “7. Hazard Assessment (Including Effects of Sorbed Chemicals and Additives)”).

2. Committee Members

FY2025 Committee List (Exposure Assessment Subcommittee)

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Name (alphabetical order)	Affiliation
Atsuhiko ISOBE (Chair)	Distinguished Professor, Research Institute for Applied Mechanics, Kyushu University
Yutaka KAMEDA	Professor, Department of Civil and Environmental Engineering, Faculty of Creative Engineering, Chiba Institute of Technology
Go SUZUKI (Vice Chair)	Head, Material Cycles Science and Engineering Research Section, Material Cycles Division, National Institute for Environmental Studies
Kazutaka TAKAHASHI	Professor, Graduate School of Agricultural and Life Sciences, The University of Tokyo
Kosuke TANAKA	Researcher, Material Cycles Science and Engineering Research Section, Material Cycles Division, National Institute for Environmental Studies
Shuhei TANAKA	Associate Professor, Graduate School of Global Environmental Studies, Kyoto University
Hisayuki NAKATANI	Professor, Graduate School of Integrated Science and Technology, Nagasaki University
Haruhiko NAKATA	Associate Professor, Faculty of Advanced Science and Technology, Kumamoto University
Rei YAMASHITA	Project Researcher, Biology of Fisheries Resources, Department of Living Marine Resources, Atmosphere and Ocean Research Institute, The University of Tokyo

FY2025 Committee List (Hazard Assessment Subcommittee)

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Name (alphabetical order)	Affiliation
Yuichi IWASAKI	Senior Researcher, Risk Assessment Strategy Group, Research Institute of Science for Safety and Sustainability, National Institute of Advanced Industrial Science and Technology
Nobuyuki OHKUBO	Principal Researcher, Environmental Conservation Division, Fisheries Technology Institute, National Research and Development Agency, Japan Fisheries Research and Education Agency
Yuji OSHIMA (Chair)	Professor Emeritus, Kyushu University
Norihisa TATARAZAKO	Professor, Graduate School of Agriculture, Department of Science and Technology for Biological Resources and Environment, Ehime University
Takeshi HANO	Head, Environmental Chemistry and Ecotoxicology Group, Environmental Conservation Division, Fisheries Technology Institute, National Research and Development Agency, Japan Fisheries Research and Education Agency
Hiroshi YAMAMOTO (Vice Chair)	Director, Health and Environmental Risk Division, National Institute for Environmental Studies
Haruna WATANABE	Senior Researcher, Ecotoxicity Research Section, Health and Environmental Risk Division, National Institute for Environmental Studies

FY2025 Committee List (Joint Subcommittee)

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Atsuhiko ISOBE (Chair)	Distinguished Professor, Research Institute for Applied Mechanics, Kyushu University
Yuichi IWASAKI	Senior Researcher, Risk Assessment Strategy Group, Research Institute of Science for Safety and Sustainability, National Institute of Advanced Industrial Science and Technology
Yuji OSHIMA (Chair)	Professor Emeritus, Kyushu University
Go SUZUKI (Vice Chair)	Head, Material Cycles Science and Engineering Research Section, Material Cycles Division, National Institute for Environmental Studies
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Haruhiko NAKATA	Associate Professor, Faculty of Advanced Science and Technology, Kumamoto University
Hisayuki NAKATANI	Professor, Graduate School of Integrated Science and Technology, Nagasaki University
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Haruna WATANABE	Senior Researcher, Ecotoxicity Research Section, Health and Environmental Risk Division, National Institute for Environmental Studies

FY2025 Committee List (Risk Assessment Committee)

環境省

Name (alphabetical order)	Affiliation
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Atsuhiko ISOBE	Distinguished Professor, Research Institute for Applied Mechanics, Kyushu University
Yuji OSHIMA	Professor Emeritus, Kyushu University
Yoshihisa SHIRAYAMA (Chair)	Professor Emeritus, Kyoto University
Go SUZUKI	Head, Material Cycles Science and Engineering Research Section, Material Cycles Division, National Institute for Environmental Studies
Hideshige TAKADA	Visiting Professor, Faculty of Agriculture, Tokyo University of Agriculture and Technology
Norihisa TATARAZAKO	Professor, Graduate School of Agriculture, Department of Science and Technology for Biological Resources and Environment, Ehime University
Wataru NAITO	Research Team Leader, Integrated Research Center for Nature Positive Technology, National Institute of Advanced Industrial Science and Technology
Hiroshi YAMAMOTO	Director, Health and Environmental Risk Division, National Institute for Environmental Studies
Haruna WATANABE	Senior Researcher, Ecotoxicity Research Section, Health and Environmental Risk Division, National Institute for Environmental Studies

3. Exposure Assessment (Marine Surface Layer)

(~p.17: Results of the FY2024 considerations (shown again for reference))

For exposure assessment (sediment), newly initiated in FY2025, see Section 6.

Implemented Items and Results in Exposure Assessment

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[I. Added and updated estimation formulae for particle number concentrations]

- In FY2023, the methods used to estimate MicP concentrations in the marine surface layer were: 1) Cozar model and 2) the Kaandorp model. In FY2024, two models were added: 3) the Aoki model and 4) the sugar lump model, to conduct the study.
- Ministry of the Environment measurement data for MicP of particle size 330 μm or above was used for estimates after correcting for MicP leaked from nets (up to about 150 μm)using the Tokai et al. (2021) correction formula.
- These methods have limitations and challenges (summarized in P15), making it difficult to determine the most appropriate method, so multiple methods are included for each particle size category. Estimation results varied significantly depending on the estimation formula used and the degree in the power-law distribution.

[II. Conversion to mass concentrations using relational formulae based on environmental measurement data]

- In FY2023, we converted to mass concentrations using hypothetical shapes and densities, while in FY2024 we used relational formulae to convert to mass concentrations based on environmental measurement data. Specifically, we used the relational formula between MicP major axis and projected area (Tokai et al., 2021) and the relational formula between the projected area and mass (Kataoka et al., 2024). (Hereinafter, these two relational formulae will be collectively referred to as the "empirical formulae") The applicable range of the empirical formulae was set to a particle diameter of 10 μm or larger, as the relationship equation between projected area and weight (Kataoka et al. (2024)) is applicable to particles with a diameter of 10 μm or larger.
- The Cozar model assumes that mass is conserved for each particle size, so mass is expected to be fixed regardless of particle size. However, conversions using the empirical formulae found that total mass would vary by particle size if three-dimensional fragmentation (3D fragmentation) was assumed. This contradicts the assumption of mass conservation, so it is thought unlikely to see three-dimensional fragmentation (3D fragmentation) alone in the actual environment. In this study, the discussions in the subcommittees and interviews were condensed into the assumption of two-dimensional fragmentation mainly for particle sizes of 10 μm and larger, which fall within the applicable range of the empirical formula, with a progression into three-dimensional fragmentation for particle sizes of 10 μm and smaller.
- These methods have limitations and challenges (summarized in P15), making it difficult to set a specific method, so multiple methods are included for each particle size category. Estimation results varied significantly depending on the estimation formula used and the degree in the power-law distribution.

I. Added and Updated Estimation Formulae for Particle Number Concentrations

Four Types of Estimation Methods

- In FY2023, the methods used to estimate MicP concentrations in the environment were: 1) Cozar model and 2) the Kaandorp model.
- In FY2024, two models were added: 3) the Aoki model and 4) the sugar lump model, to conduct study.
- In models 1 and 2, as particle size decreases, the particle number concentration increases monotonically. In models 3 and 4, it is assumed that as particle size decreases, more energy is required for fragmentation, and so fragmentation itself is less likely to occur.

Estimation methods for microplastics with fine particle sizes

Estimation model	Developed by	Characteristics
1) Cozar model*1	Spain - University of Cádiz Cozar et al. (2014)	Generic formula in which particle number concentration changes exponentially relative to particle size.It was assumed that the total mass summed across all particle sizes remains constant regardless of particle size variation.
2) Kaandorp model*2	Netherlands - Utrecht University Kaandorp et al. (2021)	Model in which particles fragment in a fractal (self-similar) manner when subject to shocks. Fragmentation probability after a shock depends only on the material (fragmentation probability does not depend on particle size).
3) Aoki model*3	Meteorological Research Institute Kunihiro Aoki et al. (2021)	Model that applies statistical mechanics to fracture energy occurrence probability. Smaller fragment shapes require larger fracture energy (i.e. fragmentation probability is dependent on particle size).
4) Sugar lump model*4	France - University of Montpellier George et al. (2024)	Model in which there is threshold set for particle size such that fragmentation probability varies around that threshold (i.e., fragmentation probability is dependent on particle size) This allows for the amount of plastic entering the ocean to be changed depending on the year.

*1 Cózar, A., Echevarría, F., González-Gordillo, J.I., Irigoien, X., Úbeda, B., Hernández-León, S., Palma, Á.T., Navarro, S., García-de-Lomas, J., Ruiz, A., Fernández-de-Puelles, M.L., Duarte, C.M., 2014. Plastic debris in the open ocean. Proceedings of the National Academy of Sciences 111, 10239–10244.
*2 Kaandorp, M.L.A., Dijkstra, H.A., Sebille, E. van, 2021. Modelling size distributions of marine plastics under the influence of continuous cascading fragmentation. Environ. Res. Lett. 16, 054075.
*3 Aoki, K., Furue, R., 2021, A model for the size distribution of marine microplastics: A statistical mechanics approach, PloS one, Vol.16 (11), e0259781-e0259781.
*4 George, M., Nallet, F., Fabre, P., 2024, A threshold model of plastic waste fragmentation: New insights into the distribution of microplastics in the ocean and its evolution over time, Marine Pollution Bulletin, Vol.199, 116012.

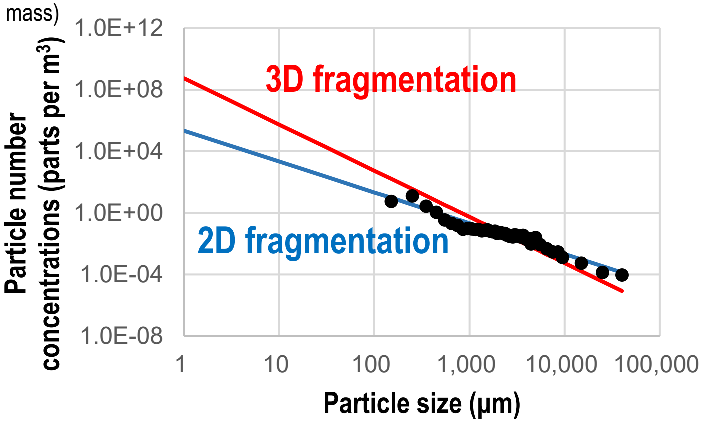
I. Added and Updated Estimation Formulae for Particle Number Concentrations

Results of Estimations of Particle Number Concentrations

■ For each model, the results below are MOE measurement data in FY2021 survey projects fitted by the least squares method.

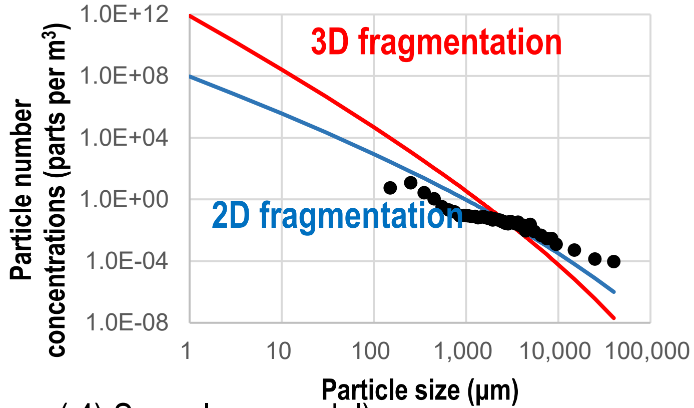
1) Cozar model

[Characteristics] Model in which particle number concentration changes exponentially relative to particle size based on the assumption of MicP equilibrium on the ocean surface. It is assumed that even if particle size changes, the total combined mass of all particles is fixed (conservation of mass)



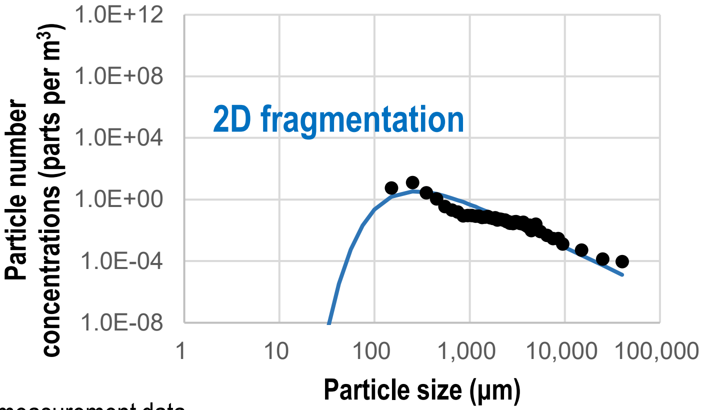
2) Kaandorp model

[Characteristics] Model in which particles fragment in a fractal (self-similar) manner when subject to shocks. Fragmentation probability after a shock depends only on the material (fragmentation probability does not depend on particle size). The analysis focuses on the ocean surface layer, assuming mass conservation within a closed system.



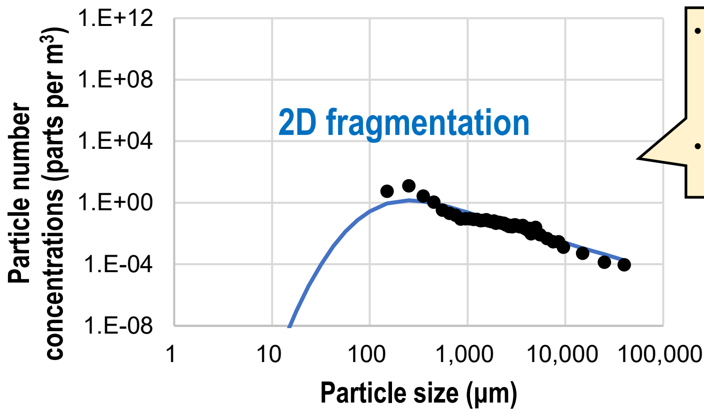
3) Aoki model

[Characteristics] Model that applies statistical mechanics to fracture energy occurrence probability. Smaller fragment shapes require larger fracture energy (i.e. fragmentation probability is dependent on particle size). This means there will be a peak at a certain particle size after which concentration will drop off for smaller parts. The paper assumes only 2D fragmentation



(4) Sugar lump model)

[Characteristics] Model in which there is threshold set for particle size such that fragmentation probability varies around that threshold (i.e. fragmentation probability is dependent on particle size) This means there will be a peak at a certain particle size after which concentration will drop off for smaller parts



- Large number of variables such that fitting is difficult as long as the peak is unknown.
- Excluded from estimation this time

●: Corrected 2021 MOE measurement data

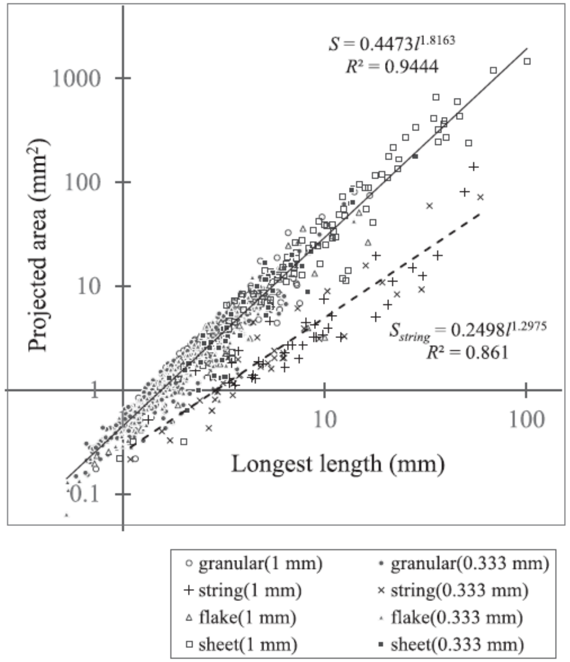
II. Conversion to Mass Concentrations Using Relational Formulae Based on Environmental Measurement Data

Conversion Method (major axis → area → mass)

- Calculated mass concentration based on MicP major axis data. Specifically, we used the relational formula between MicP major axis and projected area*1 to convert from the major axis to projected area, then used the relational formula between MicP projected area and mass*2 to convert from the projected area to mass.
- Referenced the relational formula between the major axis and projected area (Tokai et al., 2021) and the relational formula between the projected area and mass (Kataoka et al., 2024).

Relational formula between major axis and projected area

Major axis: X mm

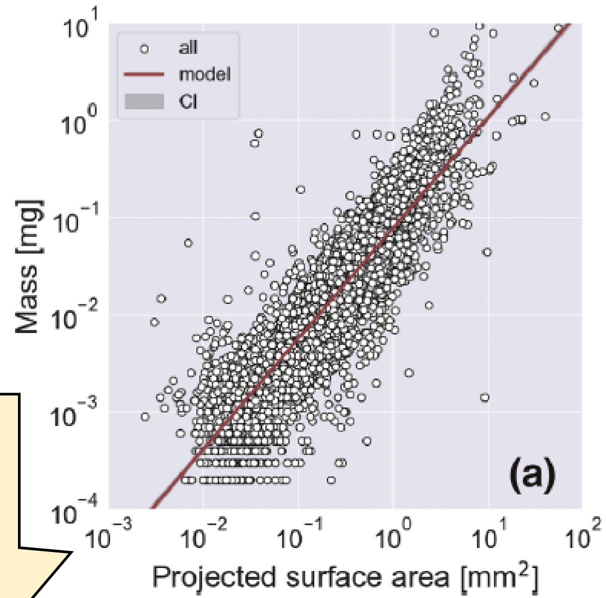


Relational formula derived from particles (333 μm mesh: 354 particles, 1 mm mesh: 188 particles) collected using Neuston Nets (mesh sizes 333 μm and 1 mm) in Tokyo Bay in October 2016

[Relational formulae]
Non-fiber particles: Projected area (mm^2) = 0.4473 x Major axis (mm)$^{1.8163}$
Fiber particles: Projected area (mm^2) = 0.2498 x Major axis (mm)$^{1.2975}$

[Range of application]
Particle sizes of 10 μm or less (10^{-4} mm^2) are expected to exceed the upper limit for mass when converted, so they are excluded. (Based on interviews)

Relational formula between projected area and mass



Mass: Y mg

Relational formula derived from particles (4,390 particles) collected using plankton nets (mesh size 335 μm) in 17 rivers in Japan from May 2019 to October 2022

[Relational formulae]
All particles: Mass (mg) = 10$^{-1.12}$ x Projected area (mm^2)$^{1.14}$
Spherical particles: Mass (mg) = 10$^{-0.49}$ x Projected area (mm^2)$^{1.17}$
Fiber particles: Mass (mg) = 10$^{-1.62}$ x Projected area (mm^2)$^{0.82}$
Fragment particles: Mass (mg) = 10$^{-1.05}$ x Projected area (mm^2)$^{1.13}$
Sheet particles: Mass (mg) = 10$^{-1.31}$ x Projected area (mm^2)$^{1.10}$

[Formula selection]
If there is no shape-specific detailed data, a conversion formula should be applied that incorporates various particle shapes across the whole. (Based on interviews)

*1 Tokai, T., Uchida, K., Kuroda, M., & Isobe, A. (2021). Mesh selectivity of neuston nets for microplastics. Marine Pollution Bulletin, 165, 112111.
*2 Kataoka, T., Iga, Y., R. A. Baihaqi, H. Hadiyanto, Nihei, Y. (2024). Geometric relationship between the projected surface area and mass of a plastic particle. Water Research, 261, 122061.

Exposure (FY2024, repeated for reference)

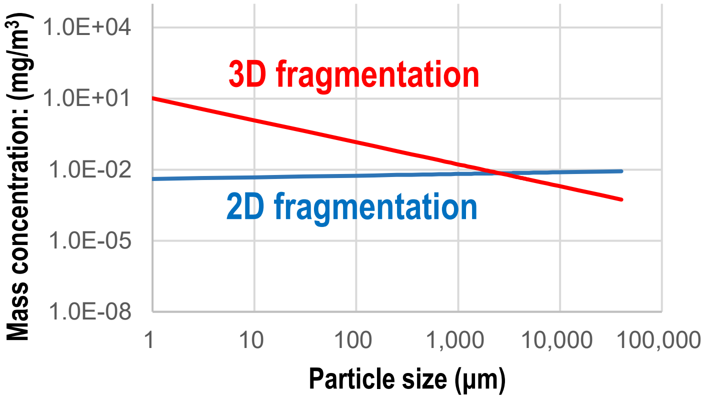
II. Conversion to Mass Concentrations Using Relational Formulae Based on Environmental Measurement Data

Results of Estimations of Mass Concentrations

■ For each model, the results below are conversions to mass concentrations using empirical formulae.

1) Cozar model

[Characteristics] Mass was largely constant regardless of particle size in two-dimensional fragmentation, but in three-dimensional fragmentation, mass concentration increased as particle size decreased.
In the Cozar model, since mass is conserved for each particle size, mass is expected to be fixed regardless of particle size. Since three-dimensional fragmentation is not included in this assumption, it is thought unlikely to see three-dimensional fragmentation alone.

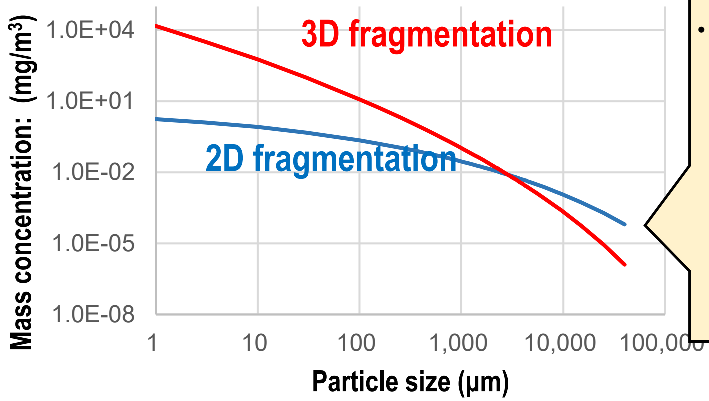


Supplement comment by expert interviews.:

- 3D fragmentation and 2D fragmentation are shown. Many marine MicP are flake- or sheet-shaped. In general, the most common process (flat 2D fragmentation) is for thin sheets to break apart, with steric 3D fragmentation occurring in some particle sizes

2) Kaandorp model

[Characteristics] In both two-dimensional and three-dimensional fragmentation, mass concentration increases as particle size decreases

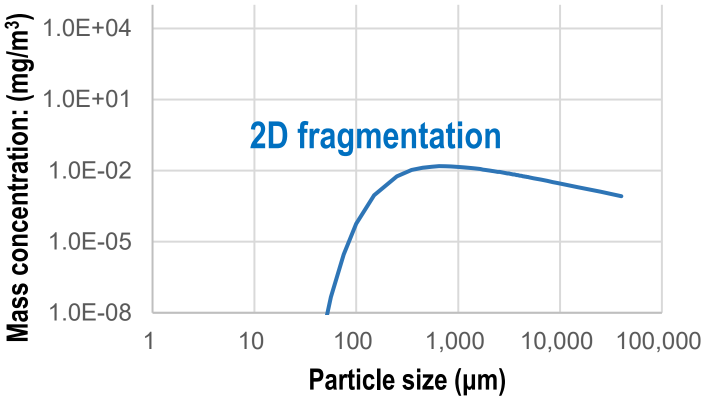


Supplement comment by expert interviews.:

- How microplastics actually fragment depends on particle size. Precipitation behavior from the ocean surface is also decided by particle size, so the assumption that "fragmentation probability is fixed independent of particle size" is a bit of a stretch

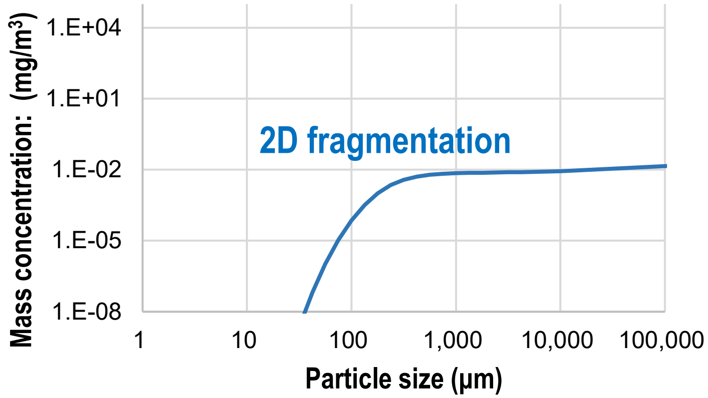
3) Aoki model

[Characteristics] As with particle number concentration, mass concentration decreases as particle size decreases



(4) Sugar lump model)

[Characteristics] As with particle number concentration, mass concentration decreases as particle size decreases



Current Understanding in Exposure Assessment

Estimates of particle number concentrations in the marine surface layer

- Estimates of particle number concentrations in the marine surface layer are calculated from values obtained by fitting particle number concentrations of MicP (adjusted) in the marine surface layer to the model formula curves using MOE measurement data in FY2021 survey projects (89 locations off the coast of Japan), then by extrapolating to fine particle sizes. Differences in estimate values from differing models are large, and the finer the particle sizes are, the greater the uncertainty in the estimates. The 5th and 95th percentile values indicate variance in particle number concentrations among MOE measurement sites.
- MicP in the marine surface layer can move in or out of the system through transfer to sediments and air (aggregation, settling, dispersion) or inflow from rivers and air. However, the Cozar model and the Kaandorp model used for estimations **assume a closed system on the marine surface layer (that fragmented MicP remain on the surface layer) as a prerequisite for their estimations**.
- Still, MicP on the marine surface layer may settle due to the influence of attached organisms and other factors, so **especially for smaller particle sizes, actual particle number concentrations on the marine surface layer are likely to be lower than estimated**. Since the Cozar model and the Kaandorp model also assume that volume and surface area are conserved, particle number concentration increases monotonically as particle size decreases. However, due to the physical limitations on fragmentation in the environment, it is unlikely that particle number concentrations increase monotonically at single- and double-digit μm range. **As such, it is possible that the estimate results are close to the maximum limit or even overestimated.** At the same time, concentrations may be even higher in hotspots in marine surface layer, such as boundaries between surface currents, and the possibility of underestimation cannot be excluded.
- In terms of fragmentation shape, many marine MicP are flake- or sheet-shaped. The most common process (2D fragmentation) is for thin sheets to break apart, with 3D fragmentation occurring as the aspect ratio approaches 1. Particle sizes at the boundary between two-dimensional and three-dimensional fragmentation are being examined by current research. **Based on the determination of experts in the subcommittees, this study assumed that two-dimensional fragmentation was most common for particle sizes of 10 μm and larger, with a progression into three-dimensional fragmentation for particle sizes of 10 μm and smaller. For that reason, in the graph on P56, a quadratic formula is used for particle sizes of 10 μm and larger, and the space between quadratic and cubic formulae is used for particle sizes of 10 μm and smaller.**
- In the Aoki model and the sugar lump model, fragmentation probability depends on particle size, and as particle size decreases, fragmentation is less likely to occur. This means there will be a peak at a certain particle size after which concentration will drop off for smaller parts. Challenges to be addressed include verifying applicability by collecting more measurement data on fine particle sizes.
- In the Aoki model, as particle size decreases, particle number concentration also decreases and exceeds numeric limits, so the graph on P56 omits particle sizes in the range of 1 to 10 μm. In addition, in the sugar lump model, the fragmentation threshold particle size can be set freely. If peak particle size is unknown, fitting is difficult, so it was omitted from the graph on P56.
- Careful attention is required to the scope of this estimation: it addresses marine surface layer only, and **other compartments in the marine environment, such as the water column and sediments, are outside the scope**. In addition, the estimation covers particle sizes ≥1 μm; **nanoscale particles are not included**. Finally, although the comparison was made using discrete particle-size ranges, particle sizes in the environment span a continuous range, and exposure scenarios involving a broad mixture of sizes can also be envisaged.

Conversion to mass concentration

- Since the Cozar model assumes that mass is conserved for each particle size, mass is expected to be fixed regardless of particle size. However, conversions using the empirical formulae (relational formulae between the major axis and projected area, and between the projected area and mass, derived from measurement data) found that total mass would vary by particle size if three-dimensional fragmentation (3D fragmentation) was assumed. This contradicts the assumption of mass conservation, so **it is unlikely that three-dimensional fragmentation (3D fragmentation) alone happens in the actual environment.**
- Mass concentrations for particle sizes between 1-10 μm are outside the applicable range of the current empirical formulae, so it **must be noted that mass concentrations are overestimated.**

Note: Revisions made in FY2025 are shown in red.

Draft: Current Issues and Future Directions for Data on Microplastic Exposure in Surface Marine Waters (as of the End of FY2024)

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Category	Current Issues	Directions for Future Study (Draft) (*Items possibly discussed in the committees in coming years)
measurement data*	**① Unknown how much MicP with fine particle sizes is in the actual environment** ➢ With current measurement technology, it is difficult to accurately measure MicP particle number concentrations with fine particle sizes (single-digit μm order) in the marine surface layer.	➢ Development of sampling and analysis techniques to determine how much MicP with fine particle sizes is in the environment
	② MicP mass concentration in the actual environment is unknown ➢ Current measurement data on MicP in the marine surface layer generally only contains particle number concentrations	➢ Measurement of mass concentrations by expert survey of measurement data ➢ Accumulation of mass concentrations by MOE survey of measurement data [*]
	③ Limited information on uneven distributions (horizontal and vertical directions) of MicP in the actual environment ➢ Although it is known that there is uneven distribution on coasts near MicP sources, high-concentration sites have not been identified ➢ Limited information on MicP concentration distributions in oceans in the vertical direction (e.g., water columns, sediment)	➢ More measurement data for the horizontal (geographical spread) and vertical (depth-wise distribution) directions in the ocean [*]
estimations and conversions	**④ Insufficient verification of the validity of application of the Cozar model, the Kaandorp model, the Aoki model, and the sugar lump model estimation formulae** ➢ The Cozar model and Kaandorp model assume a closed system on the marine surface layer (i.e. MicP fragments stay on the surface) , so they may overestimate ➢ For the Aoki model and sugar lump model, a future issue includes verifying applicability by collecting more measurement data on fine particle sizes ➢ States of degradation and fragmentation in the actual environment are unknown, so there is limited data on fragmentation type (2D/3D fragmentation) per particle size	➢ Collecting more literature on environmental concentration estimates for MicP with fine particle sizes [*] ➢ Explaining MicP behavior and fragmentation mechanisms in the water environment ➢ Measurement data for MicP with fine particle sizes (especially particle sizes from 1 to 100 μm)
	⑤ Unclear how valid the conversion formula from particle number to mass is for fine particle sizes ➢ Mass concentrations for particle sizes between 1-10 μm are outside the applicable range of the empirical formulae, so mass concentrations may be overestimated	➢ Measurement of mass concentrations by expert survey of measurement data, targeting fine particle sizes ➢ Accumulation of mass concentrations by MOE survey of measurement data, targeting fine particle sizes [*]

*Measurement data issues include some from the last fiscal year as well

4. Hazard Assessment
(Particle Effects of Microplastics)

For hazard assessment (including effects of sorbed chemicals and additives, newly initiated in FY2025), see Section 7.

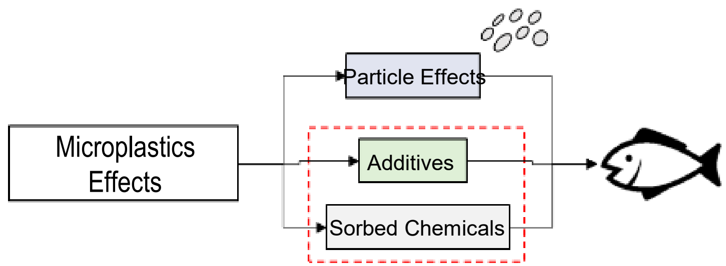
Implemented Items and Results in Hazard Assessment

[Particle Effects of Microplastics]

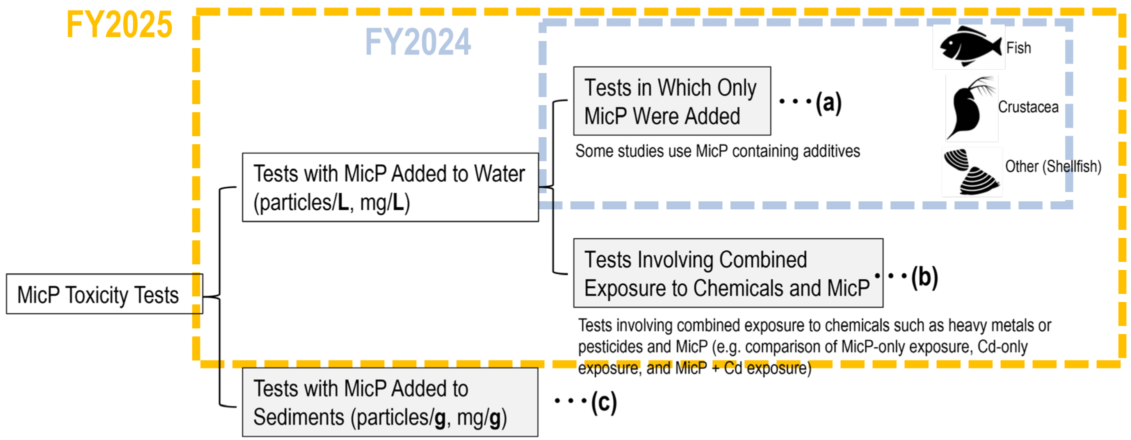
- **Development of criteria for literature review:** In the literature relevant to MicP hazard, the endpoints and test conditions addressed vary widely from study to study. By FY2023, the basic principles for selecting endpoints to be adopted in hazard assessment had been organized, and the basic approach for determining whether test data should be accepted was summarised in the form of *Key Considerations for Literature Review*. By FY2025, this had been updated, and *Evaluation Perspectives Focused on Long-Term Effects* and *Perspectives on Decision Making Related to Key Considerations* were added.
- **Data quality classification:** In the toxicity studies reported in each paper, not only the endpoints and test conditions but also the quality of the test data varied. From FY2024 onward, test data have been classified by quality in order to enable interpretation without misunderstanding. Specifically, **data judged to be of sufficient quality and to demonstrate a confirmed effect level were distinguished from other data**.
- **Literature search and review:** Alongside fish and crustacean, for which toxicity test methods for chemicals are well established, priority in literature review was given to studies using shellfish as test organisms, particularly as filter feeders. The review results were organized by particle number concentration / mass concentration, LOEC / NOEC, and chronic / subacute–subchronic / acute categories. In FY2025, based on the data collected to date, Provisional Summary of Test Data was compiled.

[Effects of Sorbed Chemicals and Additives]

- **Basic information gathering:** From FY2025, **effects including sorbed chemicals and additives were added to the scope of assessment**, and basic information was compiled primarily from highly cited review articles.



Classification of MicP Impacts



Scope considered in FY2024 and the expanded scope in FY2025

[Particle Effects of Microplastics] Test Data Compilation
Basic Policy (Category of data quality level)

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- Utilize hazard assessment perspectives used in ecological risk assessment for chemical substances by the Ministry of the Environment in the past, as well as other experience and expertise including review of findings and confirmation of reliability.
- However, in the MicP field,
  - ☐ there is no established standard test methodology for ecological toxicity using particulate matter
  - ☐ Most findings at the current point in time are from academic research, there are some cases where the reliability cannot be fully confirmed due to reasons such as a lack of sufficient descriptions of experimental conditions to consider some kind of standard.
  - ☐ In this context, new data is being collected all the time

  For reasons such as the above, it is not reasonable to conduct reliability assessments on the same level as ecological risk assessments for chemical substances performed by the Ministry of the Environment in the past, at this stage.
- Therefore, for hazard assessment (in this project), we propose separating test data into the following three categories <u>in order to understand impact level when taking an overarching view of a larger pool of data.</u>
  - ☐ In existing ecological risk assessments conducted under a risk-controlled system, strict reliability testing is not conducted in order to pull in a larger pool of findings. Specifically...

    1. Data that can be judged to be of sufficient quality and to demonstrate a confirmed effect level **<u>can be used for hazard assessment, and possibly used for estimating the ecological risk.</u>** [<u>quality level: Acceptable (A)</u>]

Note: test data categorized as "A" cannot necessarily be used for ecological risk assessment immediately. Even if the goal is to <u>utilize a piece of data for ecological risk monitoring</u> in the future, <u>it should be noted that it is classified from a mere hazard assessment perspective for the time being.</u>

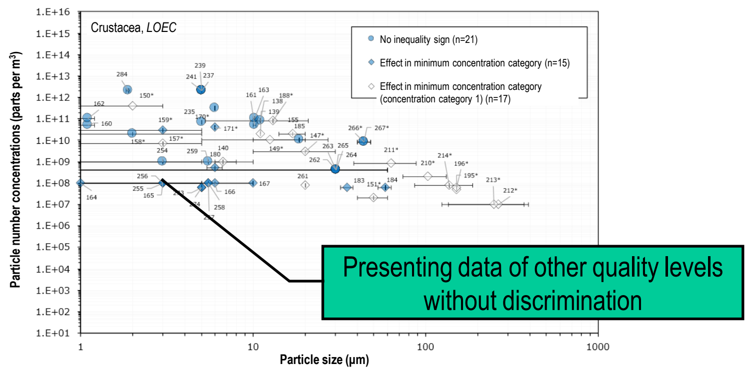
2. Even if data cannot be judged to be of sufficiently assured quality due to reasons such as being unable to confirm testing conditions in connection with the broader pool of findings collected, data that can be interpreted as indicating an effect level **<u>shall be used for reference purposes.</u>** [<u>quality level: Supplemental (S)</u>]
3. Data that is clearly deficient or cannot be said to be indicating an effect level **<u>shall not be included, as in the past.</u>** [<u>quality level: Unacceptable (U)</u>]

Note: Revisions made in FY2025 are shown in red.

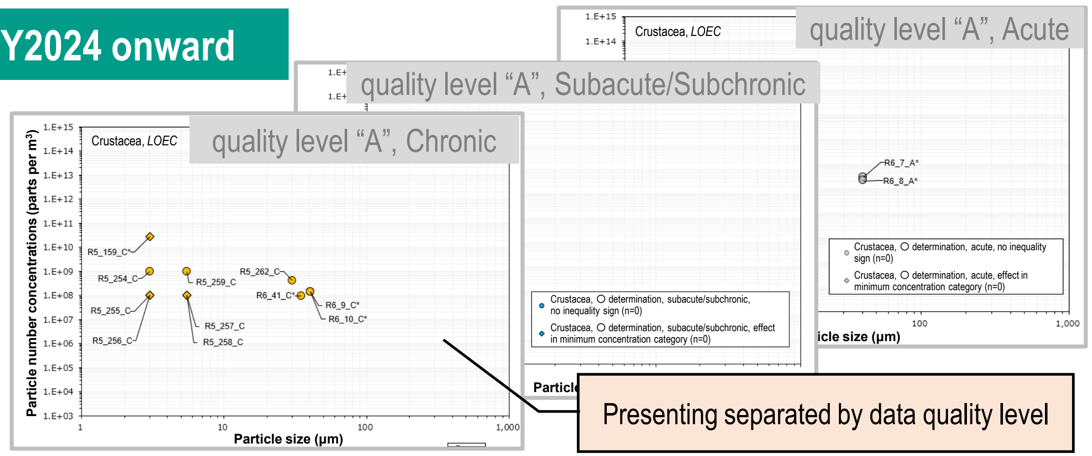
Summarizing 2024 hazard assessment
Basic Policy (Presentation of qualified data)

- In FY2023, test data for end points corresponding to Category I (harmful effects related to population maintenance; details on the next page) were illustrated. However, Category I covers various test parameters. Specifically, data of varying quality were mixed together, including cases where “actual concentrations were not measured or reported,” “particle pre-processing was not described,” and “findings addressed only acute effects,” but these differences were not indicated in the presentation.
- Given the above issues, in FY2024 and FY2025 the quality levels of test data will be distinguished in the presentation to ensure plots are not misinterpreted.
- Using the **fundamental approach to review of test data** described in the following pages, data that can be judged to be of sufficient quality and to demonstrate a confirmed effect level (quality level “A”) was so discriminated and extracted, after which it was then further categorized and presented as chronic, subacute/subchronic, or acute.

FY2023



From FY2024 onward



Previous presentation method: No distinction between quality levels “A” and “S”
(Quality level "U" was already omitted from plots)

- **Extract data confirmed to have a quantitative effect level (quality level “A”).**
- **Separate for presentation into chronic, subacute/subchronic, or acute**

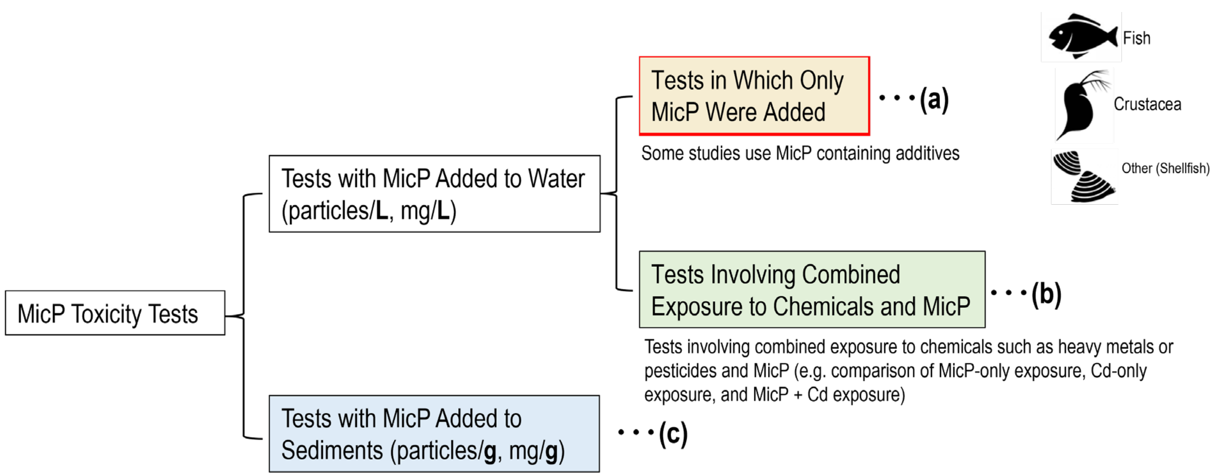
(Quality level “S” is displayed on a separate chart as reference information)

[Particle Effects of Microplastics] Literature Search, Screening, and Review
Scoping Literature to Review

■ We found literature for review by comprehensively searching using multiple literature search services to search for academic papers related to MicP published after 2000 (however, the portion done this year is the portion from FY2023).

- Scoping Step (1): Making a determination on a scope taken from a population of some 23,000 titles and abstracts, we selected three categories (a: experiments with MicP only added in water, b: experiments with MicP and chemical substances added in water simultaneously, and c: experiments with MicP added to sediment).
- Scoping Step (2): In relation to the literature categorized in a (some 700 papers), we selected literature determined featuring “using micro size particles,” “targeting fish, crustacea and shellfish and “harmful effects on maintenance of population” in the title or abstract and performed a review.

Scoping Step (1)



Scoping Step (2)

▼Literature categorized under “a” (some 700 papers)

↓

▼Of these, selecting papers using micro size particles

↓

▼Of these, selecting papers targeting fish, crustacea and shellfish

↓

▼Of these, selecting papers that can be read as having found effects on population maintenance end points
(114 papers on fish, 89 papers on crustacea, 30 papers on shellfish)

↓

We excluded papers reviewed up to FY2024 and papers not in Japanese or English
(For papers reviewed in FY2024, see the FY2024 report)

↓

▼In FY2025, we reviewed 14 papers on fish, 20 papers on crustacea, and 6 papers on shellfish.

[Particle Effects of Microplastics] Development of Criteria for Test Data Review
(1) Categorizing End Points

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- The basic approaches to end points that should be used in MicP hazard assessments are as follows.
  - ✓ [I: Adverse effects related to population maintenance] → Set as end points used
  - ✓ [II: Effects not covered by I or III] → Reference data (continues to be targeted for examination)
  - ✓ [III: Effects at the molecular and genetic levels] → Not covered by this review

I: Adverse effects related to population maintenance
✧ Maturity, reproduction, growth, and lethality effects (Specific examples: Decreased survival rate, growth inhibition, reduced body weight, decreased number of offspring, lower hatching rate, increased rate of abnormal appearance, etc.)

II: Effects not covered by I or III
✧ Effects on the individual sample level, but not directly on population maintenance / effects with unknown relevance (Specific examples: Behavioral abnormalities, reduced swimming speed, decreased swimming distance, etc.) ✧ No effect on the individual sample level (cellular or tissue level) (Specific examples: Intestinal, liver, and kidney lesions; tissue damage; reduced muscle mass; decreased gonad weight, etc.)

III: Effects at the molecular and genetic levels
✧ No effect on the individual sample level (molecular or genetic level) (Specific examples: Changes in stress markers, gene expression, etc.)

[Particle Effects of Microplastics] Development of Criteria for Test Data Review
(2) Key Considerations for Literature Review

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- We continued to examine and update the "Key Considerations for Literature Review" compiled in FY2023.
- Currently, there are no test guidelines based on established consensus for evaluating the hazard of MicP. The following serves only as a non-exhaustive reference and will need to be updated as necessary in the future.

Key Considerations for Literature Review Pertaining to MicP test data

- [1], [2]: **Experimental conditions not related to MicP**
- [1] Is compliance with domestic and international test guidelines ("TG") clearly stated?
- [2] Are the following conditions appropriate in cases where TG compliance is not clearly stated or where there are some deviations from TG ?
  - [2-1] Has a control group been established?
  - [2-2] Are there no effects observed in the control group?
  - [2-3] Has statistical processing of the results been conducted appropriately?
  - [2-4] Is the experiment conducted with multiple concentrations?
  - [2-5] Is the experiment reproducible (e.g., is the number of repetitions sufficient)?
  - [2-6] Are the test species common?
  - [2-7] Is the exposure period appropriate for the life stage of the test organisms?
  - [2-8] Is the result measurement methodology clearly described (i.e., is the experiment replicable)?
  - [2-9] Is the dose-response relationship observed?

[3] Experimental conditions related to MicP

- [3-1] Is the measured concentration of particles reported?
- [3-2] Are there statements about pre-processing of particles (if purchased, were dispersants, surfactants, preservatives, etc., in the dispersion liquid removed?)
- [3-3] Are the dispersal and agitation methods of particles stated?
- [3-4] Is the particle size reported? (including range, median particle size, distribution)?
- [3-5] Is the particle shape reported?
- [3-6] Is the particle material reported?
- [3-7] Is the source of particles reported? (Is reacquisition or re-preparation possible? Were they sampled from the actual environment?)
- [3-8] Were chemically surface-treated particles used? Etc.

[Particle Effects of Microplastics] Development of Criteria for Test Data Review

(3) Key Considerations for Literature Review, Appendix: Perspectives on Decision Making Related to Key Considerations

- The “Key Considerations for Literature Review” on the previous page are an important outcome in this work, and we expect to continue to update this going forward. In addition to this, discussions and views in the Hazard Assessment Subcommittee organized and written up as the appendix, “Perspectives on Decision Making Related to Key Considerations.”
- By summarizing the insights and decisions of experts, we aim to reduce “decision variance” in reviews and show the decision-making process in an easier-to-understand manner. The appendix must be updated from time to time.

Key considerations			Perspectives related to determinations
[1][2] Experimental conditions not related to MicP	[1]Is compliance with domestic and international test guidelines (“TG”) clearly stated?		There are cases where experiments depart partially from TG, even if TG compliance is clearly stated. These cases will be individually discussed.
	[2] Are the following conditions appropriate in cases where TG compliance is not clearly stated or where the experiment partially departs from this?	[2-1] Has a control group been established?	If dispersants are used in the test solution, we treat this as follows. ・ If dispersants are used The use of dispersants is permitted in acute toxicity tests for chemical substances, and they will, in principle, be treated the same for MicP. In addition, in order to acquire broader knowledge, the use of dispersants is also permitted for subchronic and chronic tests of MicP, if there is no effect in the solvent control group. ・ If antibiotic substances are used For algae, there may be cases where adding an antibiotic substance is necessary. However, for fish, crustacea and shellfish, this may affect intestinal florae, so we will determine that it will be difficult to adopt.
		[2-2] Are there no effects observed in the control group?	・Even where no effects are observed in the control group, careful judgement is needed when deciding whether the study should be accepted if the test conditions (e.g. feeding regime or stocking density) are considered problematic.
		[2-4] Is the experiment conducted at multiple concentrations?	We assign priority in literature for review and approach multiple concentrations as follows. ・ Before determining quality level “A”, “S” or "U," we select classifications of quality levels work targets from all previous literature and assign them an order of priority using the following standards Standard 1: The targets of quality screening work are “not difficult to adopt, and End Point classification 1, and multiple concentrations” Standard 2: quality level “A” may also be assigned where inequalities are attached (effect present at minimum concentration or no effect at maximum concentration), but it will be treated as having a lower priority
			The spacing ratio between concentrations (geometric ratio) is handled as follows. ・A ratio of 3.2 or less is desirable; however, it is not treated as an essential condition for ‘A’ and should instead be discussed on a case-by-case basis. Where the ratio is extremely large, for example around 100, the possibility of classification as S or U should also be considered.

Note: Revisions made in FY2025 are shown in red.

[Particle Effects of Microplastics] Development of Criteria for Test Data Review

(3) Key Considerations for Literature Review, Appendix: Perspectives on Decision Making Related to Key Considerations

Key considerations				Perspectives related to determinations
	[1][2] Experimental conditions not related to MicP	[2] Are the following conditions appropriate in cases where TG compliance is not clearly stated or where the experiment partially departs from this?	[2-9]Is a dose-response relationship observed?	We approach the presence or absence of a dose-response relationship as follows. ・ In general, where a toxicity effect occurs, it is desirable for there to be a dose-response relationship. However, in the case of MicP, because there may be variance in absorption based on the individual organism, toxicity effects may not necessarily affect exposure concentration. For this reason, dose-response relationships are desirable but not a necessary criterion for MicP hazard assessment.
		Other	Treatment of unusual exposure conditions	In the event of exposure conditions that differ significantly from usual (e.g., heavy fat meal), we will determine that it will be difficult to adopt.
			Approach to short/long-term effects	Reference: "Perspectives on Evaluations Focused on Long-term Effects "
			Aqueous concentration/ absorption concentration	We organize the display of toxicity values (NOEC, NOAEL) for MicP as follows. As it is possible that MicP could be ingested then produce effects, it is our approach that it is desirable to use intake volume (NOAEL, etc.). At the same time, as it is exceptionally difficult to measure actual intake volume, we use exposure concentration in test solution. ・ In addition, where particle diameter is large, for example, it is desirable to show particle number concentration, so we also take into consideration the interrelationship of size and concentration.

[Particle Effects of Microplastics] Development of Criteria for Test Data Review

(3) Key Considerations for Literature Review, Appendix: Perspectives on Decision Making Related to Key Considerations

Key considerations		Perspectives related to determinations
[3] Experimental conditions related to MicP	[3-1]Is the measured concentration of particles reported?	We organize our approach to the presence or absence of measurement of exposure concentration and quality level "A" candidates (reference: P30 “Collecting and Reviewing Literature”) as follows. • In general, it is desirable for exposure concentration to be consistent throughout the experimental system. MicP are substances that tend to localize, so measurement of exposure concentration are important, and we have come to organize literature that “measured” as having a higher priority. • However, as MicP localization will necessarily occur, even if measurements are performed, there remains the possibility that these will not show the real exposure concentration. • In addition, there are concerns overlooking if we select articles as quality level “A” candidates in discrimination of quality levels just because they “measured,” Even in cases of “not measured,” we focus on the existence of MicP of a nominal concentration in the experiment system, expand the scope of quality level “A” candidates to include “not measured,” and avoid making “measured” a necessary condition.
	[3-2] Are there statements about pre-processing of particles (if purchased, were dispersants, surfactants, preservatives, etc., in the dispersion liquid removed?)	Removing residue including additive agents, plasticizing agents and monomers, as agents originally included in plastics, can be difficult to remove, so the effects are evaluated including these. However, we will determine that it will be difficult to adopt literature where there are clear concerns that the effects come from other than the particles.
	[3-3] Are the dispersal and agitation methods of particles stated?	We organize our approach to dispersal and agitation methods of test solution and quality level “A” candidates as follows. ・ While it is desirable for mention to be made of dispersal, dispersal may be treated as an obvious task and thus not stated in the literature. ・ As it is specific characteristics* of MicP, there is likely to be inconsistent exposure. (*For fish and crustacea, if their food and particle sizes are near, they might actively ingest MicP. And shellfish may be subject to uneven exposure, as they ingest MicP together with sediment, regardless of the particle size.) ・ For these reasons, we do not make stating dispersal or agitation method a necessary condition for quality level “A” candidates.

[Particle Effects of Microplastics] Development of Criteria for Test Data Review

(3) Key Considerations for Literature Review, Appendix: Perspectives on Decision Making Related to Key Considerations

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Key considerations		Perspectives related to determinations
[3] Experimental conditions related to MicP	[3-4] Is the particle size reported (including range, median particle size, distribution)?	If a particle size is "clearly not possible to ingest," this will be treated as follows. ・ While the relationship between particle size and ingestion was not taken into account so far, even MicP that are large enough not to be ingested may still interfere with swimming by attaching to the surface of water fleas. For this reason, just because a MicP is of a size that cannot be ingested, this will not make it difficult to adopt.
		If there is a lack of particle size information, we will treat this as follows. ・ While it is desirable to state detailed information such as particle size distribution, only particle size range is reported in some literatures. ・ Even in such cases, this does not affect the conversion from mass concentration to particle number concentration itself (because conversion is done based on the mean or median value between the maximum and minimum particle sizes). ・ In addition, because there is little data which is acceptable for the hazard assessment, it will be accepted with quotation of the final determination in screening of quality levels.
		Where multiple particle size values are reported in a publication, the value considered more appropriate is used for plotting. For example, where both an upper limit and a median are available, the particle size used for plotting is determined in consideration of factors such as the size range that can be ingested by the test organism.
	[3-6] Is the particle material reported?	If the material of particles has specific characteristics, this is treated as follows. ・ We have seen some experiments using aged MicP or biodegradable plastic. ・ While there is room for discussion over how to make determinations, because the presence of aging has not, to now, been an axis of evaluation, at present, such literature was accepted with notes in the final determination in discrimination of quality levels. ・ Biodegradable plastic varies in speed and size depending on variety, and it is believed it can turn into MicP during degradation. Literature will not be deemed difficult to adopt for reason of biodegradable plastics, even to "see more data comprehensively." Discussion will also continue going forward, including the necessity of considering the particular characteristics of biodegradable plastics. ・Mixtures containing multiple polymer types need to be handled with care from the perspective of reproducibility; where such studies are used, the fact that they involve mixtures is explicitly stated in an annotation.
	[3-7] Is the method of acquisition of particles reported? (Is reacquisition or re-preparation possible? Were they sampled from the actual environment?)	If plastics sampled from the environment are used, we treat this as follows. ・ For toxicity experiments, it is generally desirable to secure reproducibility and traceability. There is thus a need for caution in case of use of MicP that are not commercial products, particularly MicP sampled from the environment. ・ On the other hand, various chemical substances attach themselves to MicP in the actual environment, so performing toxicity experiments using MicP sampled from the environment may yield results closer to reality. ・ For this reason, even if reproducibility is not secured, such literature will not be treated as uniformly hard to adopt. This will be treated as toxicity effects including the effects of attached chemical substances.

Note: Revisions made in FY2025 are shown in red.

[Particle Effects of Microplastics] Development of Criteria for Test Data Review

(4)-1 Perspectives on Evaluations Focused on Long-term Effects -Evaluating Existing Hazards

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- The effects of chemicals over the long term in the environment are evaluated by long-term exposure. Under short-term exposure, the effects that should be ascertained may not be captured sufficiently.(Specific examples: Substances that will not produce effects if they are not of high enough concentration; a suitable endpoint cannot be captured under short-term exposure, etc.).
- When evaluating the effects of aquatic organisms, as knowledge capturing chronic effects is limited, knowledge capturing acute effects has also come to be used. Knowledge capturing subacute and subchronic effects has also come into limited use.
- The basic approach*1 to acute and chronic toxicity is as follows in risk assessments of chemicals based on the above.

Chronic/ acute	Existing basic approach in hazard assessments	Examples of experimental guidelines this addresses
Chronic	■ Selection criteria*2: (1) Details of effects: Effects that cause inhibitions on survival and growth in fish in the embryonic, fry and early developmental stages are chronic effects (2) Attached period (trial period): Period of over 20 days including period from embryonic to early-larval stage (3) Details of main end points and impacts: LOEC, NOEC and MATC on impacts ■ Used in preference to acute effects	• OECD TG 210: Toxicity trial in early life stages of fish (End points: Hatching rate, survival rate, etc. Exposure period: 40 days)
Acute	■ Selection criteria*2: (1) Details of effects: Effects that cause inhibitions on survival in the short term in fish are acute effects (2) Attached period (trial period): Trial (requiring attached period) within four days (96 hours) (3) Details of main end points and impacts: LC50 (Median Lethal Concentration)	• OECD TG 203: Fish acute toxicity trial (End points: Death, Exposure period: 96 hours)

*1 Stated extracting fish from among organisms related to ecological effects

*2 2nd Health Science Council Subcommittee on Revising the Chemical Substances System Expert Committee on the Revision of the Regulatory System for Evaluating Chemical Substances, 9th Industrial Structure Council Chemicals and Biomass Subcommittee Panel on Planning for Management of Chemical Substances and 2nd Central Environmental Council Health Subcommittee Panel on the Regulatory System for Evaluating Chemical Substances Joint Meeting, Reference Materials 2, Comparison of Acute Toxicity Values and Chronic Toxicity Values in Ecotoxicity

[Particle Effects of Microplastics] Development of Criteria for Test Data Review

(4)-2 Perspectives on Evaluations Focused on Long-term Effects -Evaluating MicP Hazards

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- As stated above, the MicP toxicity data gathered so far includes a variety of experimental conditions. In addition to there being variety of settings around exposure periods, life stages and end points, different toxicity indicators such as E(L)C50 and N(L)OEC were mixed together. Acute effects/chronic effects have not been organized.
- There was some level of knowledge capturing or chronic effects or acute effects in MicP. Most of the tests showed results that "these tests look at long-term effects even more than general acute experiments, but not decisive whether they captured chronic effects." This knowledge were considered to be "subacute" of "subchronic" effects. Given that standard toxicity testing methods have also not been developed for MicP, in this study, we have organized "subacute" and "subchronic" data collectively as "subacute/subchronic."
- Based on the state of existing hazard assessments and MicP test data, in this study too, we advance assessment assuming the use of knowledge capturing subacute/subchronic effects and acute effects, while **making assessment focused on chronic effects the basis**. The perspectives are also related to point [2-7] of the Key Considerations for Literature Review.

Chronic/ acute	MicP basic approach in hazard assessments	Examples of experimental guidelines this addresses
Chronic	■ Knowledge capturing chronic effects, in line with TG handling chronic effects. Used in preference to acute effects ■ NOEC and LOEC are mainly used, but we will also consider the use of E(L)C50 where it has been calculated and where experts have determined that the use of E(L)C50 is appropriate	• Fish: OECD TG 210 • Crustacea: OECD TG 211 • shellfish: OECD TG 242* *:TG242 is for snails
Acute	■ Knowledge capturing acute effects, in line with TG handling acute effects. ■ EC50 and LC50 are mainly used, but we will also consider the use of NOEC or LOEC where individual experts have determined that their use is appropriate ■ E(L)C50 is displayed as is, without being converted, having been made identifiable	• Fish: OECD TG 203 • Crustacea: OECD TG 202
Subacute/ subchronic	■ While these look at long-term effects even more than acute effects, data that cannot make determinations capturing chronic effects overall are categorized as subacute/subchronic ■ Appropriate toxicity indicators are selected and indicated for each individual piece of data	-

[Particle Effects of Microplastics] Literature Search, Screening, and Review
Performing Review (Discriminate of Quality Levels)

- In determining the quality levels of test data, we performed work prioritizing the screening and selection of literature with quality level "A". Specifically, from FY2022 to FY2024 (until the second subcommittee), we made literature that did non-single concentration experiments the targets of quality classification work, excluding those that would be difficult to adopt, and discriminated as quality level "A" those that had relatively acceptable and useful [for the hazard assessment (in this project)].

Classification of test data related to quality levels (reprinted excerpt from p. 20)
- Data that can be judged to have a confirmed quantitative effect level shall be used to grasp ecological risk. [quality level: Acceptable (A)]
- Even if data cannot be determined to have a quantitative effect due to reasons such as being unable to confirm testing conditions in connection with the broader pool of findings collected, data that can be interpreted as indicating an effect level shall be used for reference purposes. [quality level: Supplemental (S)]
- Data that is clearly deficient or cannot be said to be indicating an effect level shall not be included, as in the past. [quality level: Unacceptable (U)]

- The work procedure was as follows.
  - ✓ To streamline the work, the secretariat organized the applicability of experiment conditions and selected quality level "A" candidates.
  - ✓ Multiple members of the Hazard Assessment Subcommittee made primary determinations of whether the quality level "A" candidates were "A", "S" or "U".
  - ✓ Based on the primary determinations, the Hazard Assessment Subcommittee held discussions, then decided a final determination.

Breakdown of the Test Data Reviewed from FY2022 to FY2025 *Only the final results for "A" from the Breakdown on page 44 are shown.

	Pool of candidates for literature review		Candidates for data quality classification		Candidates for A (Measured values / dispersion procedure described or TG-compliant)		Final classification 'A'		
	Publications (a)	Records	Publications	Records	Publications	Records	Publications (b)	Records	Percentage (b/a)
Fish	131	613	20	44	10	24	6	12 (Chronic 0,Subacute–subchronic 6,Acute 6)	5%
Crustacean	98	633	44	186	25	104	13	30 (Chronic 14,Subacute–subchronic 4,Acute 12)	13%
Shellfish	36	240	8	23	6	18	4	7 (Chronic 0,Subacute–subchronic 7,Acute 0)	11%
Total	265	1486	72	253	41	146	23	49	9%

From Pool of candidates for literature review **the top 9% with relatively high data reliability were extracted**.

[Particle Effects of Microplastics] Literature Search, Screening, and Review

Provisional Summary of Test Data

- In FY2025, the test data accumulated to date were reviewed from an overall perspective, and a provisional summary of the test data was organized as follows. Detailed tables of the individual test data are provided in the appendix. This draft summarises the test data collected up to February 2026 and will need to be updated as additional data become available.

Provisional Summary Test Data related to Particle Effects of Microplastics — Overall

There were 49 data points classified as 'A'. By taxonomic group, these comprised fish (12), crustacean (30), and shellfish (7), indicating that data were lacking for shellfish. In addition, while a certain number of TG-compliant data were identified for crustacean, almost none were identified for fish or shellfish. For these data gaps, further collection of data or additional testing will be desirable in the future.

Effect concentrations varied considerably depending on taxonomic group, particle size, and exposure duration, with ranges of 1 to 10^6-fold observed for effect concentrations at the same particle size, both on a mass-concentration basis and on a particle-number concentration basis. The minimum, maximum, mean, median, and related values of effect concentrations for data classified as 'A' and 'S' are shown in the table below. In addition, for shape, the collection target covered spherical and fragment-shaped particles, excluding fibres, and no clear difference in effect concentrations was identified between spherical and fragment-shaped particles. For polymer type, PS (77), PE (46), and PLA (24) accounted for the majority, while a small number of experiments were conducted using a variety of other polymer types (PP (10), PVC (7), and PET (5)); no clear trend or difference was identified among these polymer types.

Hazards

Draft: Current Issues and Future Directions for Test Data on Particle Effects of Microplastics in Marine Surface Layer

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Current issues	Directions for future study (draft) (*Items possibly discussed in the committees in coming years)
(1) There is a small number sets of test data that can be used for hazard assessments ➢ While the number of research examples so far has increased, the number of sets of data that contribute to hazard assessments is low. ➢ Lack of funds, facilities and personnel needed for experiments (e.g., some of the chronic effects experiments for fish are recommended to be performed in running water, so they will require specialized facilities, which would also cost a lot. It would be impractical to run these at university laboratories) ➢ Discrepancies between the research aims of researchers and government needs	**(1) Continuous collection of test data and research experiments by administration** ➢ <u>Further storing test data (continuing literature review) and analyzing and investigating reviewed test data [*]</u> ➢ Providing information from the government to research institutions, experimental facilities and international bodies, requesting cooperation or ordering ➢ <u>Identification and consolidation of current issues; external communication of administrative needs related to data gaps; dissemination of outcomes through publications and related outputs [*]</u>
(2) Biases in the quality levels of test data ➢ Lack of standardised test methods and sufficiently validated alternatives leads to inconsistent data quality across experiments.	**(2) Standardizing test data and discriminating quality levels** ➢ Establishment of standardised test methods for MicP effect ➢ <u>Continued data quality classification using the test data review criteria, together with updates to the literature review criteria.</u> [*]
(3) Discrepancies in toxicity experiment conditions and exposure conditions in the actual environment ➢ Many toxicity experiments use spherical polystyrene, but not only do various shapes and materials exist in the actual environment, but there are also cases where they have absorbed chemical substances. ➢ Since the concentration of substances in the actual environment is not consistent, there are locations where localized high concentrations exist (discrete sources on coasts or sediments, etc.) ➢ To date, evidence has mainly been compiled for suspended particles in the water column; however, environmental exposure pathways are diverse, and organisms with different feeding modes and lifestyles (including benthic organisms) also need to be considered.	**(3) Investigating matters that should be taken into account when applying test data to the actual environment** ➢ <u>Consideration of uncertainties in assessing impacts in actual environments based on laboratory test results, and a comparative review of existing methods for determining hazard assessment values for chemical substances (including thresholds and safety factors).[*]</u> ➢ <u>Collection of information on the effects of MicP with sorbed chemicals, including whether harmful effects are enhanced, and basic information collection on the effects of MicP containing additives</u> [*] ➢ Comparison between the shapes and polymer types of MicP used in toxicity tests and those found in real environmental conditions, as well as comparison between test conditions and real environmental conditions (e.g. concentration changes). Consideration of the development of test methods that better reflect real environmental conditions, or of conversion methods for applying test results to real environmental conditions. ➢ <u>Expansion of target organisms with consideration of feeding behaviour and habitat (including information collection on benthic organisms in addition to aquatic organisms)</u> [*]

5. Summary of Results

(Summary of Estimated Environmental Concentrations in Marine Surface Layer and Test Data)

Particle Number Concentration and Mass Concentration Estimates in the Marine Surface Layer (Per 1-10μm, 10-100μm, 100-1,000μm Segments)

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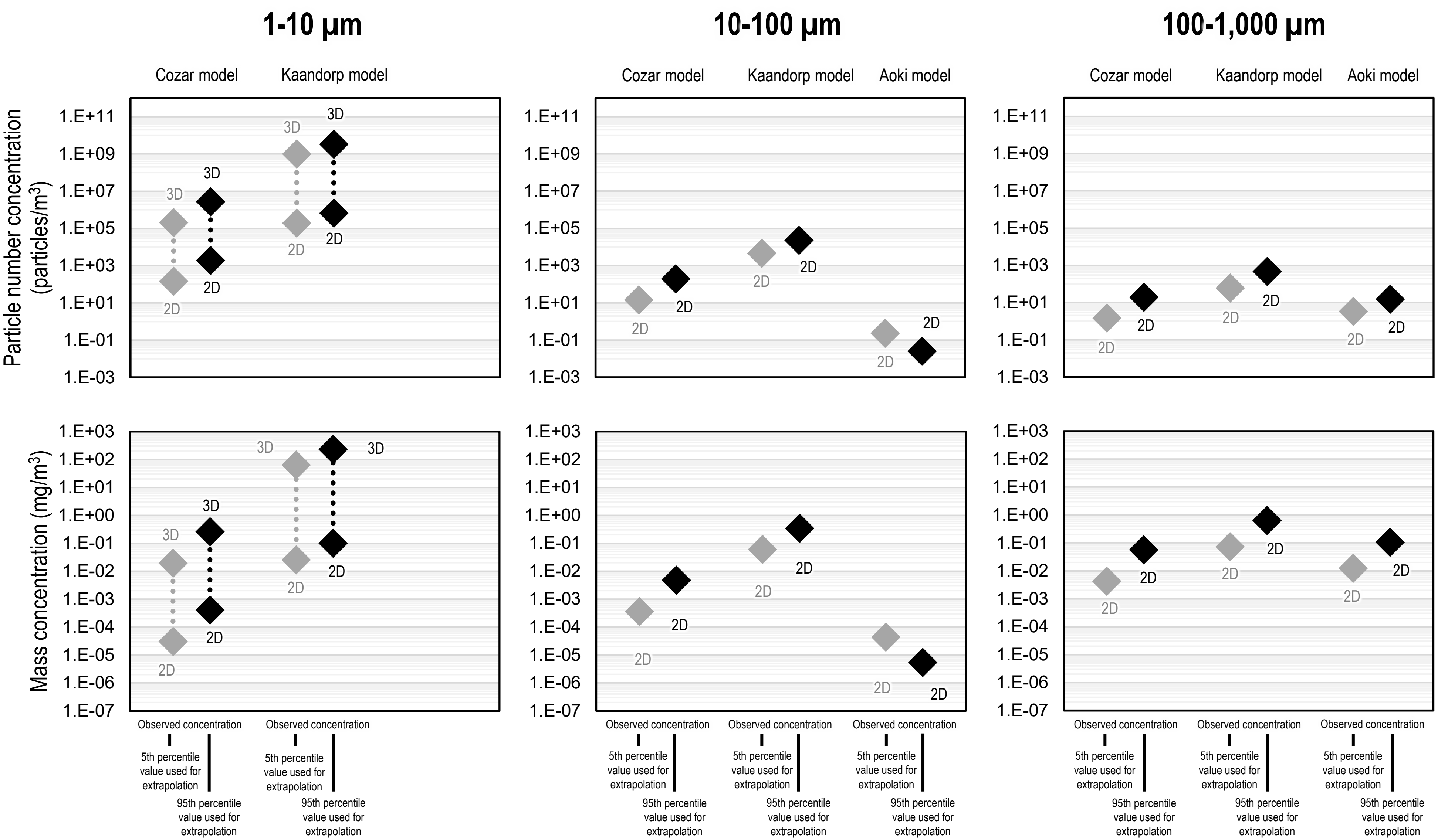
- Particle number concentration and mass concentration estimates in the marine surface layer are as follows.
- Please be sure to refer to the current understanding on p.15 and the key considerations pertaining to comparisons on p.42 when interpreting the chart.



Test Data for the 1–10 µm Size Range (Particle Number Concentration)

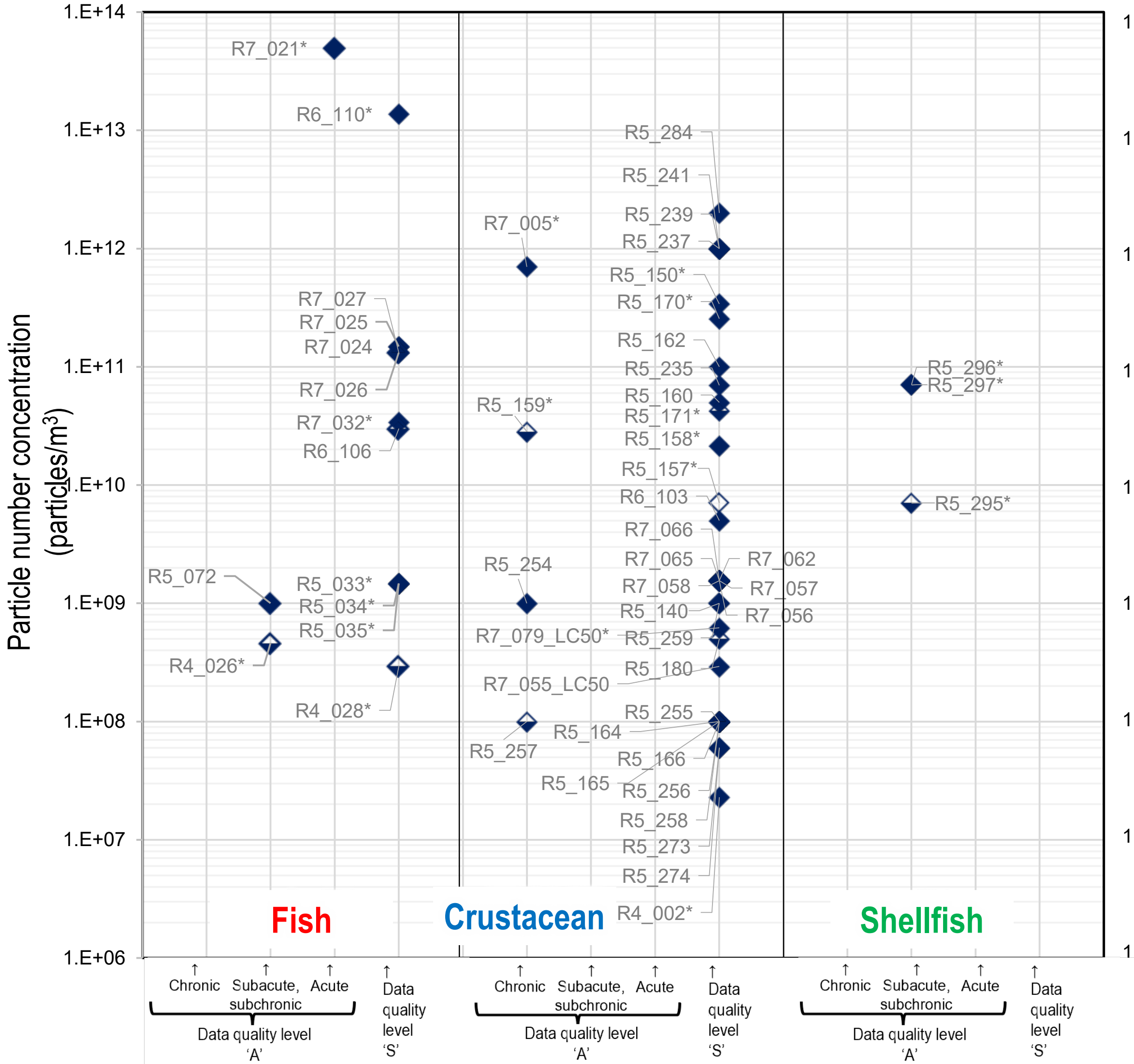
- The test data for the 1–10 µm particle-size class (particle number concentration) is shown below.
- To interpret the figures and tables, please refer to p. 43 (Key Considerations).

Left panel (LOEC) :
◆No inequality sign
◆Effect observed at the lowest concentration tested
◇Effect observed at the lowest concentration tested (single concentration level)

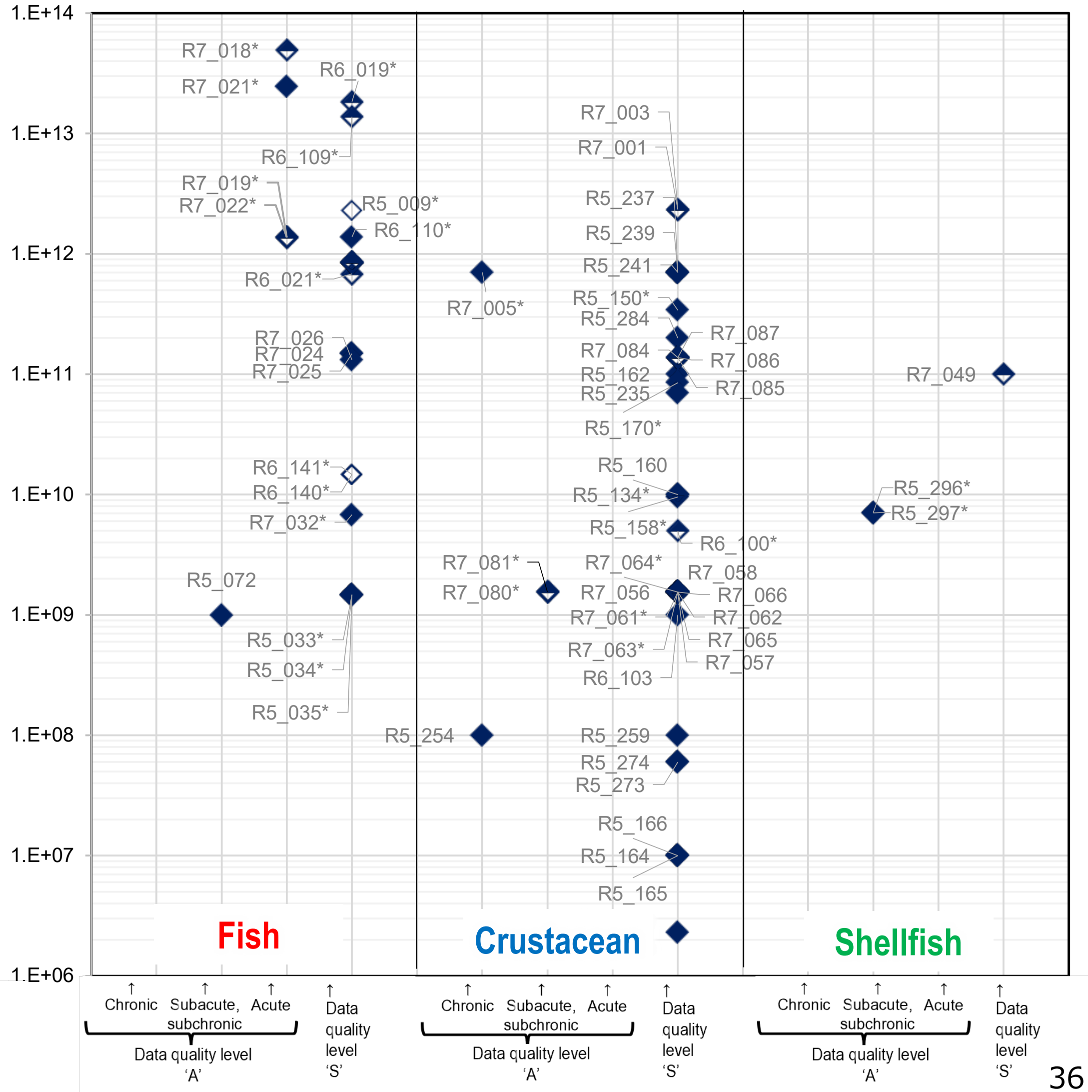
Right panel (NOEC) :
◆No inequality sign
◆No effect observed at the highest concentration tested
◇No effect observed at the highest concentration tested (single concentration level)

Data labels are shown as 'FY_Record ID'. An asterisk (*) indicates a value converted by the Secretariat.

LOEC Values for Aquatic Organisms Exposed to MicP (Literature Review)



NOEC Values for Aquatic Organisms Exposed to MicP (Literature Review)



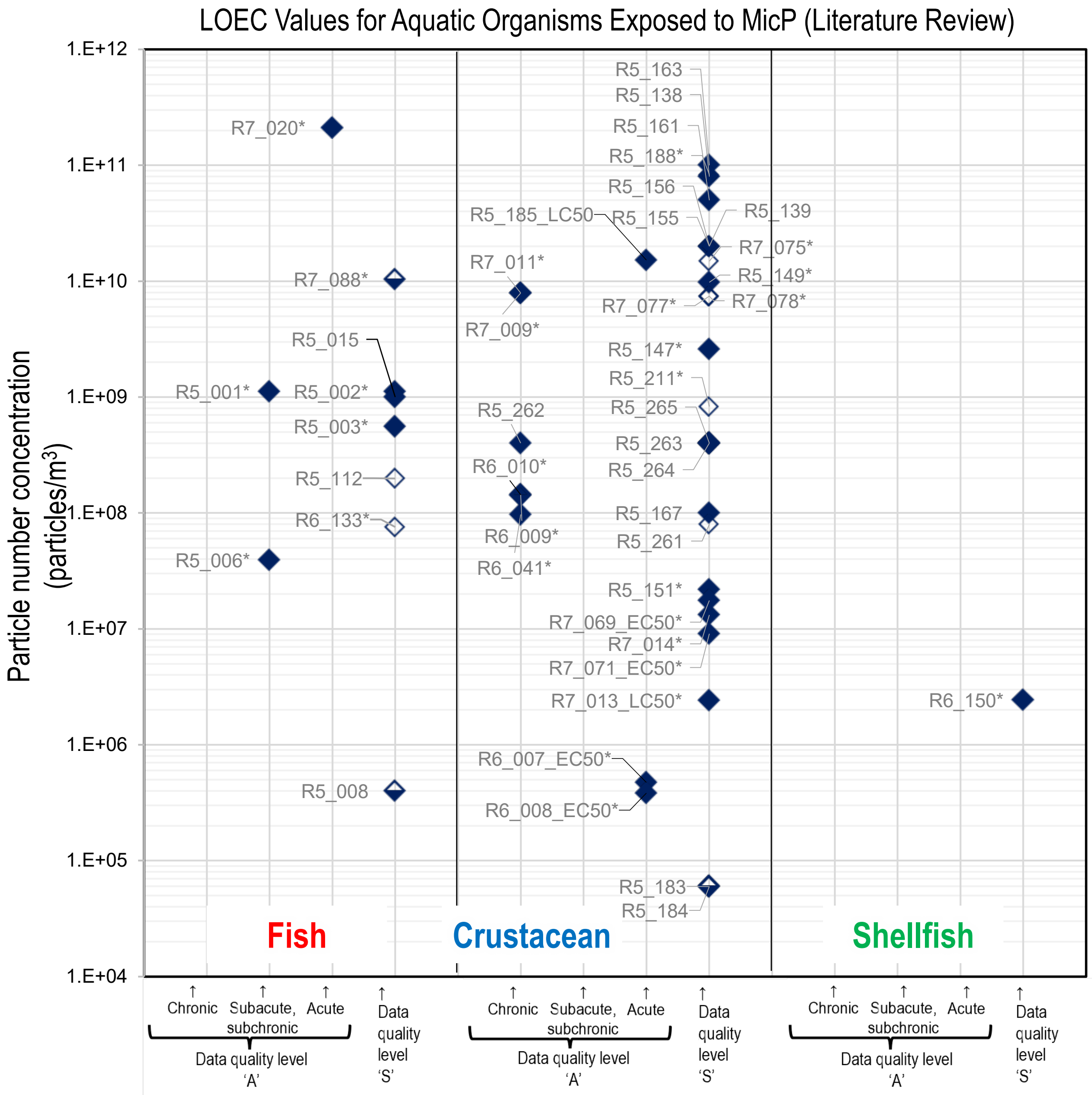
Test Data for the 10–100 µm Size Range (Particle Number Concentration)

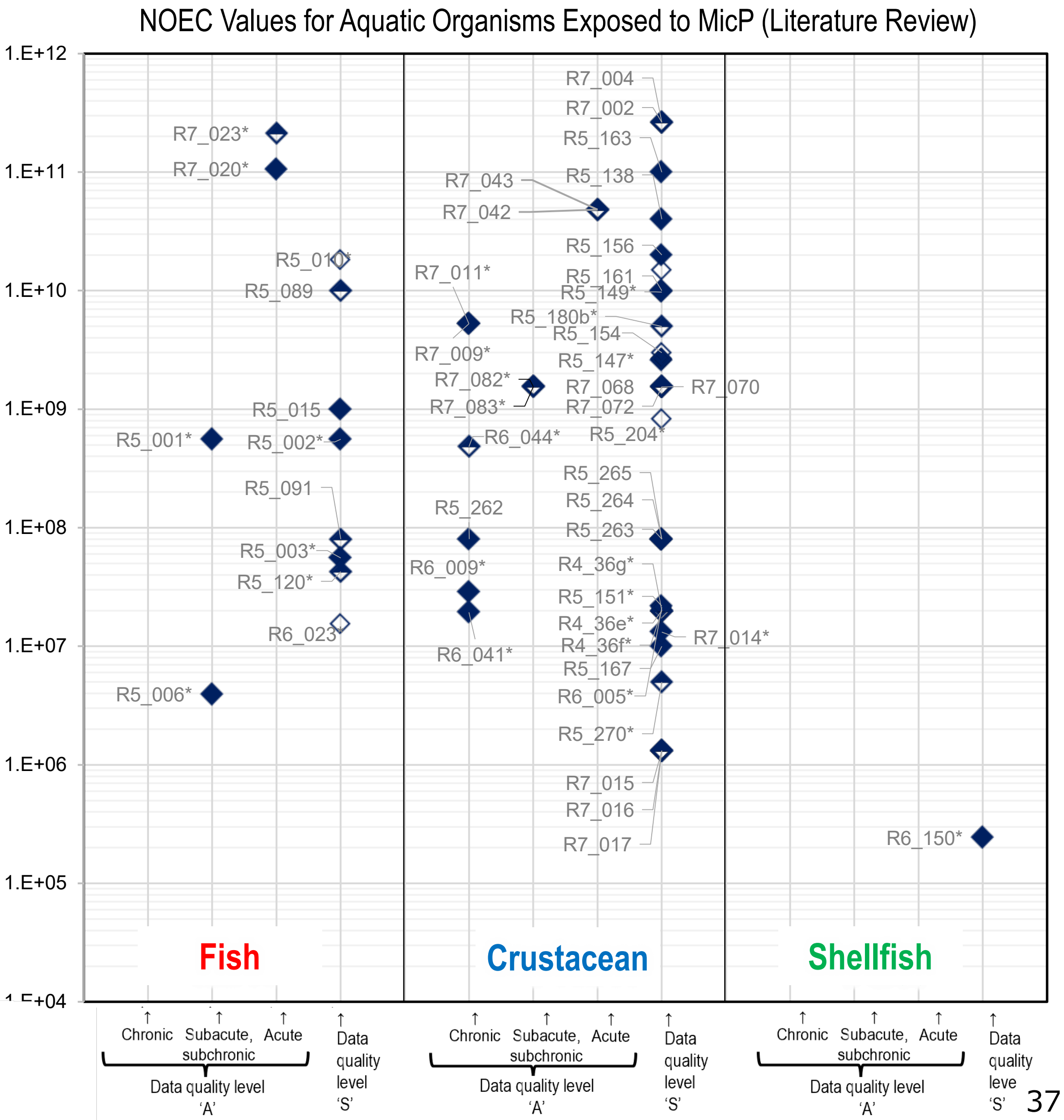
Left panel (LOEC) :
◆No inequality sign
◆Effect observed at the lowest concentration tested
◇Effect observed at the lowest concentration tested (single concentration level)

Right panel (NOEC) :
◆No inequality sign
◆No effect observed at the highest concentration tested
◇No effect observed at the highest concentration tested (single concentration level)

Data labels are shown as 'FY_Record ID'. An asterisk (*) indicates a value converted by the Secretariat.

- The test data for the 10–100 µm particle-size class (particle number concentration) is shown below.
- To interpret the figures and tables, please refer to p. 43 (Key Considerations).





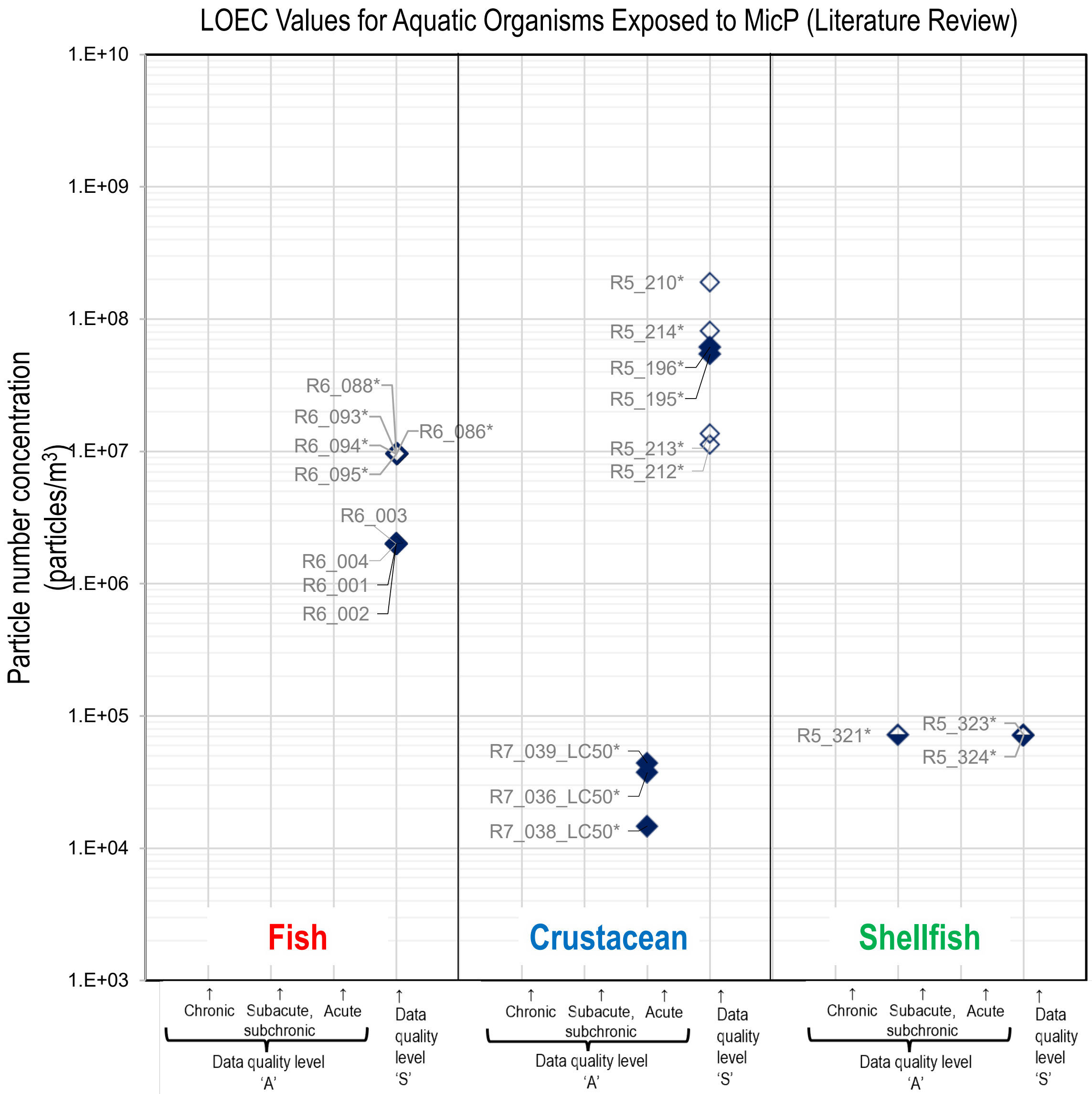
Test Data for the 100–1,000 μm Size Range (Particle Number Concentration)

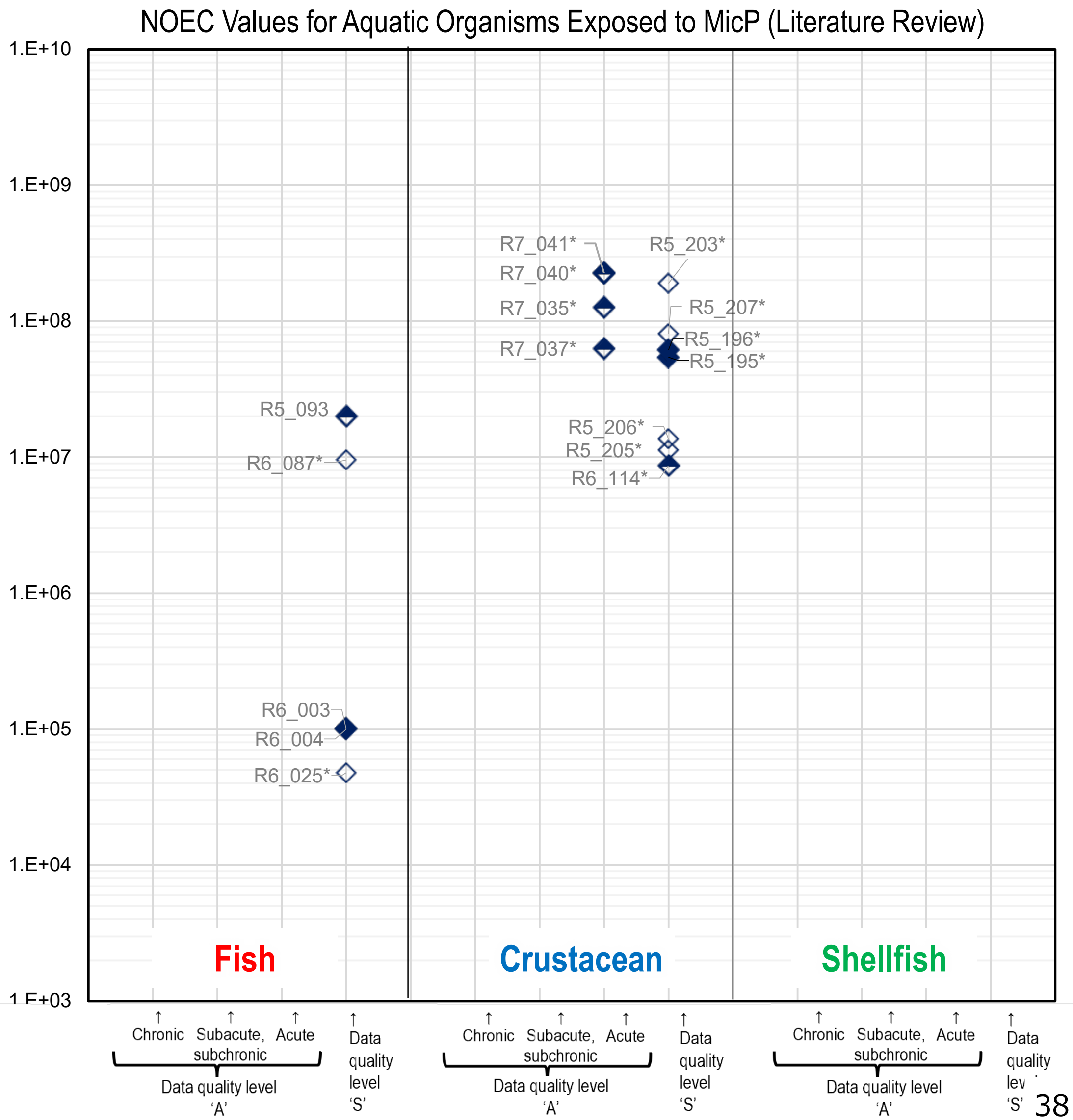
- The test data for the 100–1,000 μm particle-size class (particle number concentration) is shown below.
- To interpret the figures and tables, please refer to p. 43 (Key Considerations).

Left panel (LOEC) :
◆ No inequality sign
◆ Effect observed at the lowest concentration tested
◇ Effect observed at the lowest concentration tested (single concentration level)

Right panel (NOEC) :
◆ No inequality sign
◆ No effect observed at the highest concentration tested
◇ No effect observed at the highest concentration tested (single concentration level)

Data labels are shown as 'FY_Record ID'. An asterisk (*) indicates a value converted by the Secretariat.





Test Data for the 1–10 μm Size Range (Mass Concentration)

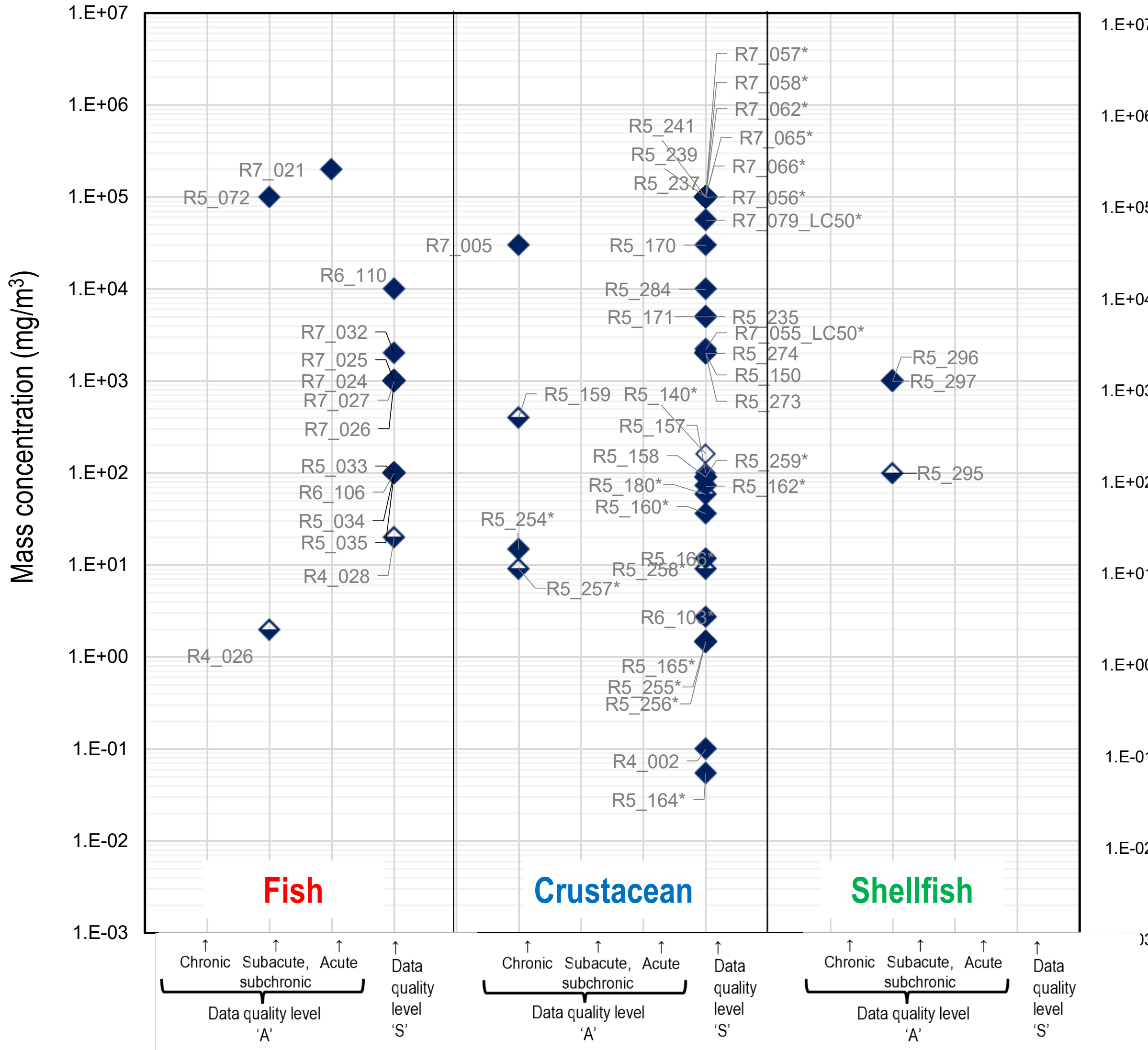
Left panel (LOEC) :
◆No inequality sign
◆Effect observed at the lowest concentration tested
◇Effect observed at the lowest concentration tested (single concentration level)

Right panel (NOEC) :
◆No inequality sign
◆No effect observed at the highest concentration tested
◇No effect observed at the highest concentration tested (single concentration level)

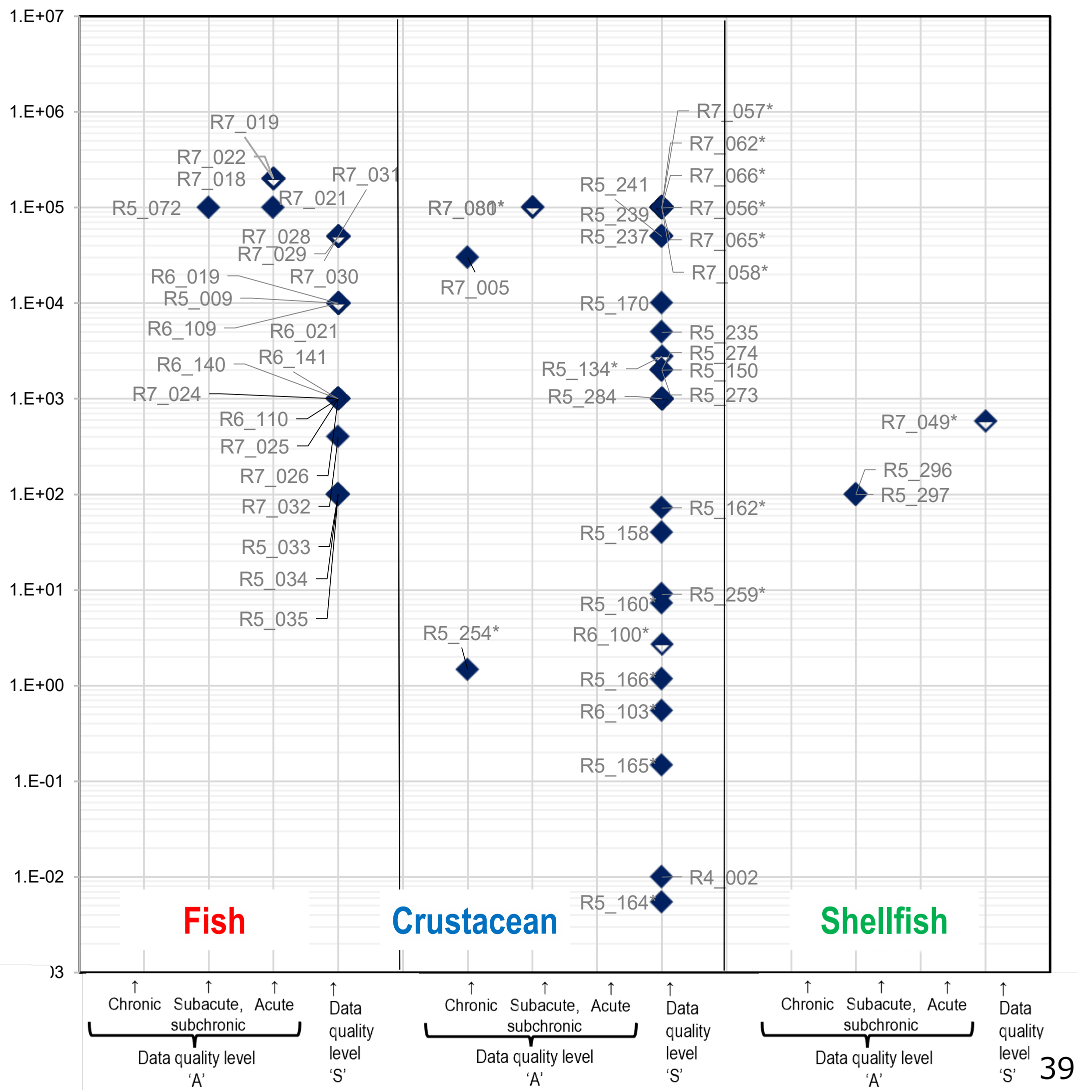
Data labels are shown as 'FY_Record ID'. An asterisk (*) indicates a value converted by the Secretariat.

- The test data for the 1–10 μm particle-size class (mass concentration) is shown below.
- To interpret the figures and tables, please refer to p. 43 (Key Considerations).

LOEC Values for Aquatic Organisms Exposed to MicP (Literature Review)



NOEC Values for Aquatic Organisms Exposed to MicP (Literature Review)



Test Data for the 10–100 µm Size Range (Mass Concentration)

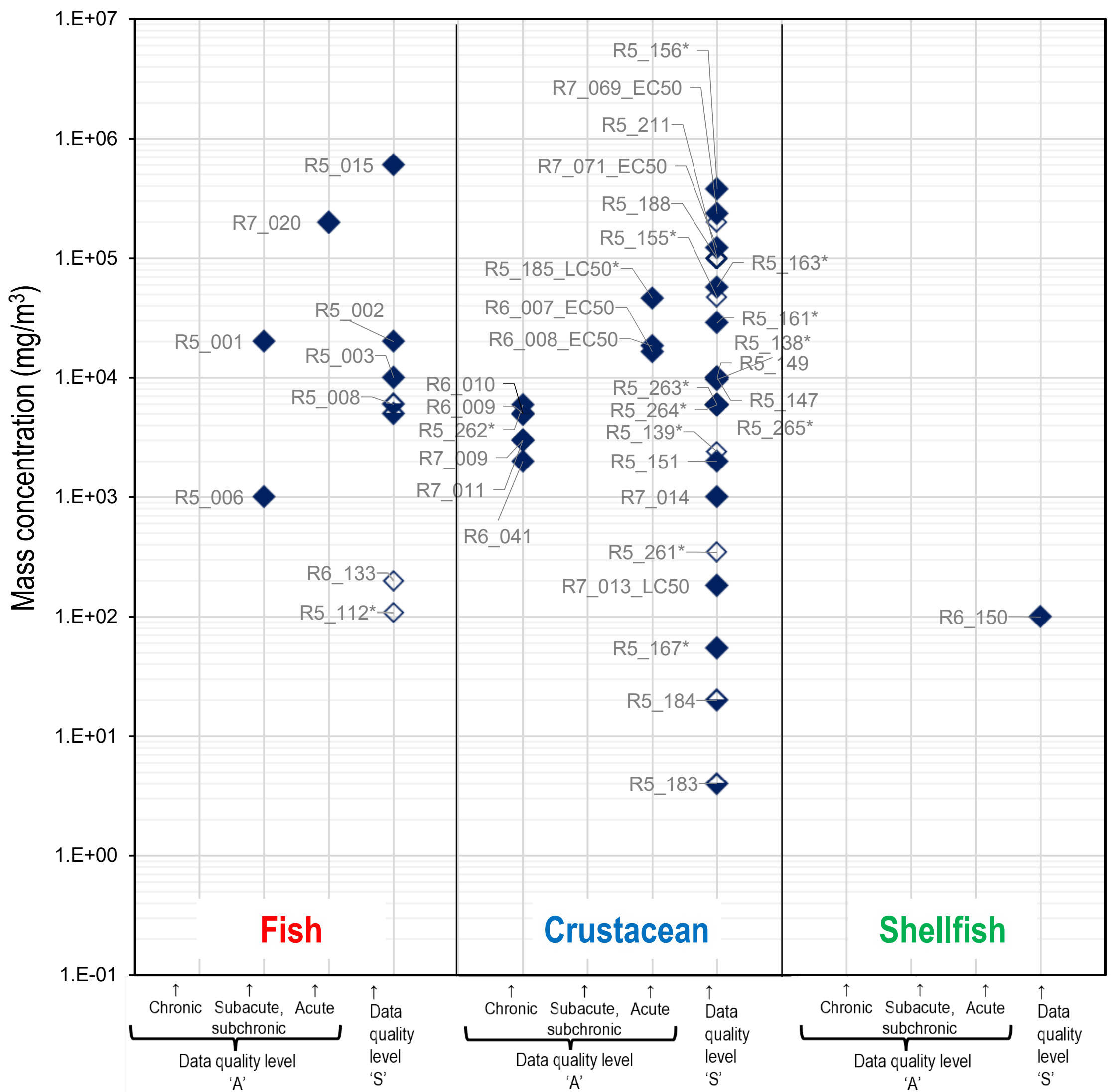
- The test data for the 10–100 µm particle-size class (mass concentration) is shown below.
- To interpret the figures and tables, please refer to p. 43 (Key Considerations).

Left panel (LOEC) :
◆No inequality sign
◆Effect observed at the lowest concentration tested
◇Effect observed at the lowest concentration tested (single concentration level)

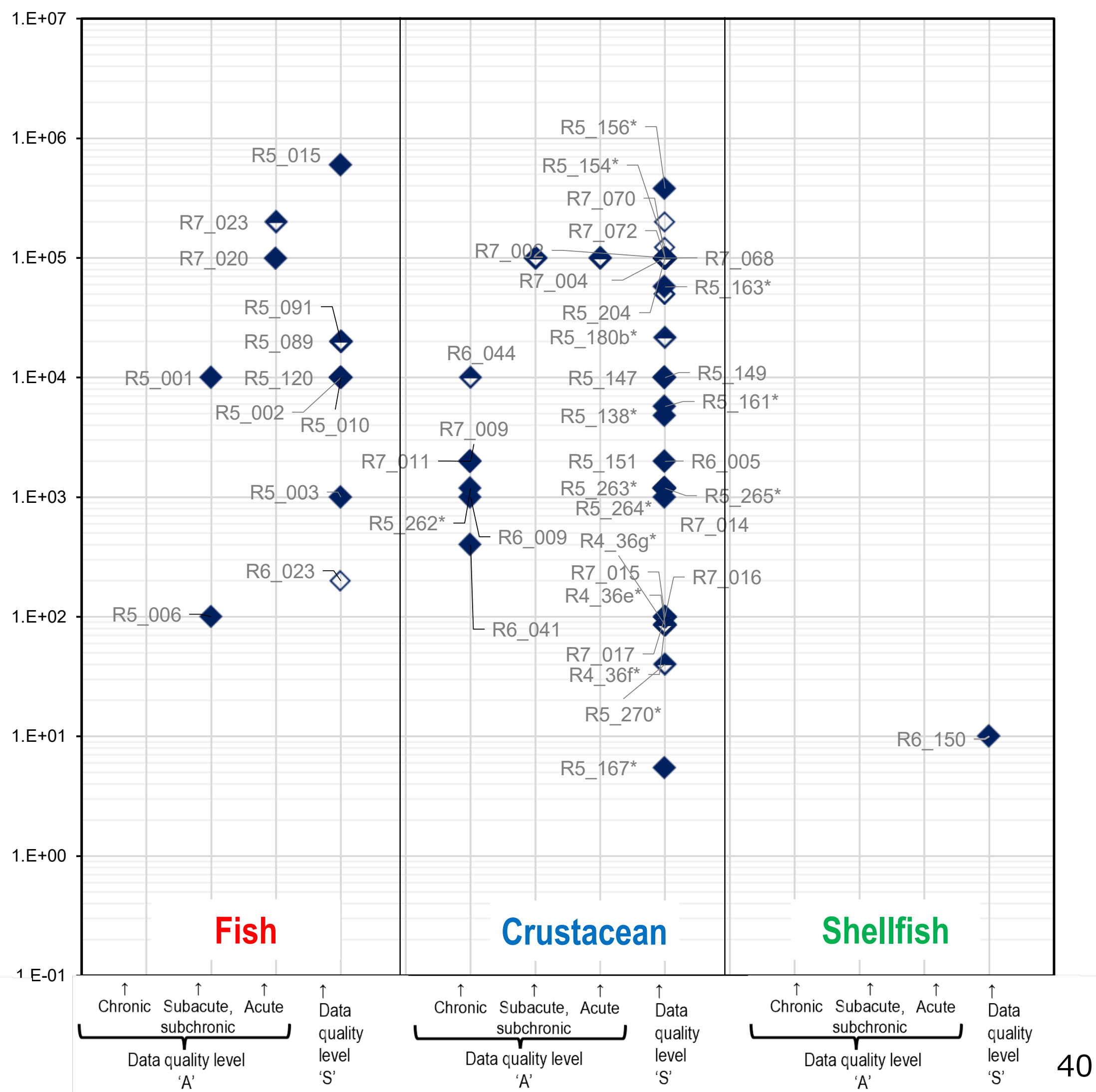
Right panel (NOEC) :
◆No inequality sign
◆No effect observed at the highest concentration tested
◇No effect observed at the highest concentration tested (single concentration level)

Data labels are shown as 'FY_Record ID'. An asterisk (*) indicates a value converted by the Secretariat.

LOEC Values for Aquatic Organisms Exposed to MicP (Literature Review)



NOEC Values for Aquatic Organisms Exposed to MicP (Literature Review)



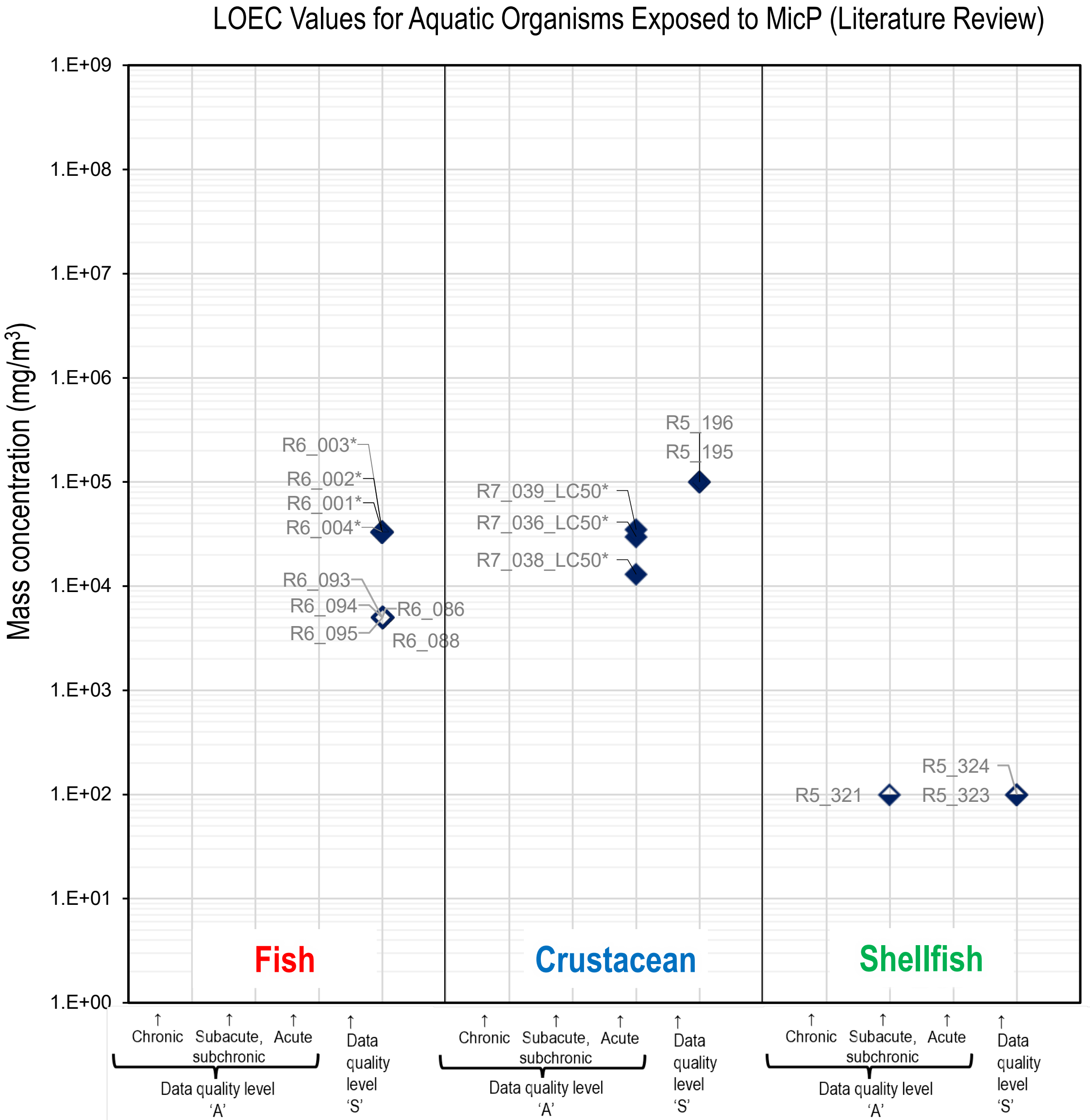
Test Data for the 100–1,000 μm Size Range (Mass Concentration)

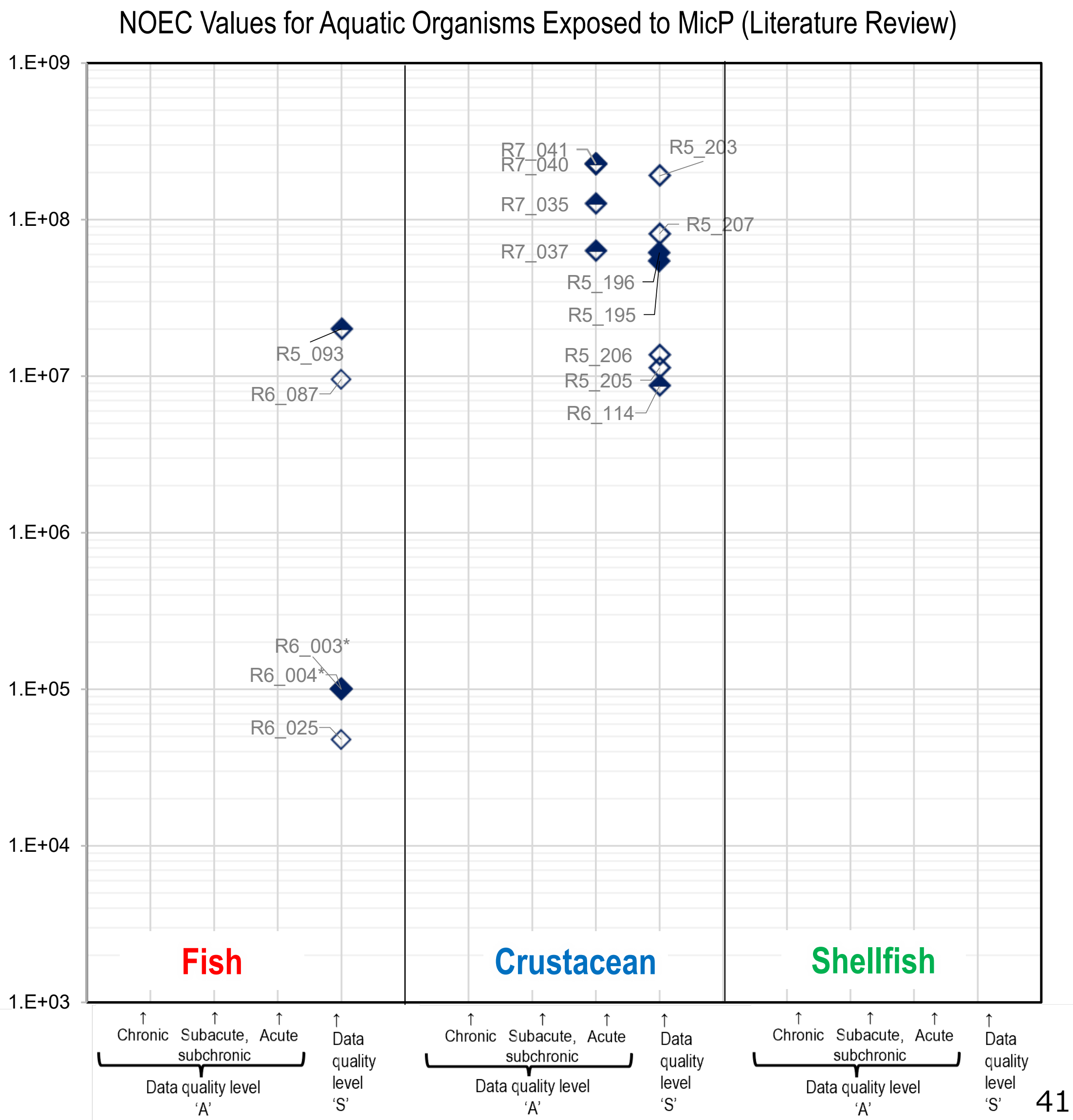
Left panel (LOEC) :
◆No inequality sign
◆Effect observed at the lowest concentration tested
◇Effect observed at the lowest concentration tested (single concentration level)

Right panel (NOEC) :
◆No inequality sign
◆No effect observed at the highest concentration tested
◇No effect observed at the highest concentration tested (single concentration level)

Data labels are shown as 'FY_Record ID'. An asterisk (*) indicates a value converted by the Secretariat.

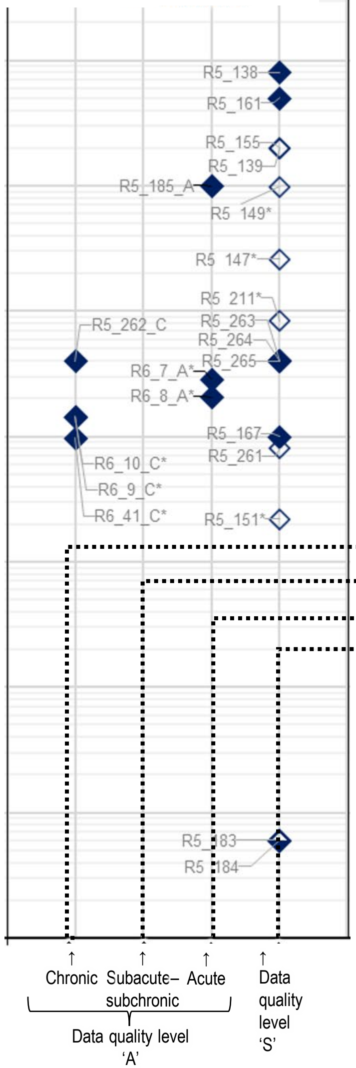
- The test data for the 100–1,000 μm particle-size class (mass concentration) is shown below.
- To interpret the figures and tables, please refer to p. 43 (Key Considerations).





- The breakdown of the test data on p. 36–41 (data quality level ‘A’: chronic/subacute–subchronic/acute, and data quality level ‘S’; see the appendix for details) is as follows.

Example: **Crustacean**



Breakdown of the Test Data Reviewed from FY2022 to FY2025

	Pool of candidates for literature review		Candidates for data quality classification		Candidates for A (Measured values / dispersion procedure described or TG-compliant)		Final classification ‘A’			Final classification ‘S’	
	Publications(a)	Records	Publications	Records	Publications	Records	Publications(b)	Records	Percentage (b/a)	Publications	Records
Fish	131	613	20	44	10	24	6	12 (Chronic 0,Subacute–subchronic 6,Acute 6)	5%	23	53
Crustacean	98	633	44	186	25	104	13	30 (Chronic 14, Subacute–subchronic 4, Acute 12)	13%	37	95
Shellfish	36	240	8	23	6	18	4	7 (Chronic 0,Subacute–subchronic 7,Acute 0)	11%	4	5
Total	265	1486	72	253	41	146	23	49	9%	64	153

Key Considerations for Comparing Estimated Environmental Concentrations in Marine Surface Layer with Test Data

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- At this point, a direct comparison between estimated environmental concentrations (exposure data) and toxicity data has not been conducted. As previously mentioned, there are challenges in both exposure assessment and toxicity evaluation, and further consideration must be given to the points outlined below.
- Matters beyond these applicable scopes (fibrous MicP outside the scope of estimates, assessments of vector effects, etc.) are issues for future study. Further investigation is needed.

■ for the Comparison of Exposure and Hazard Assessments

— Exposure assessments: Concentrations are estimated based not on measurement data from the actual environment but on measurement data from the marine surface layer off the coast of Japan. It is necessary to be aware of differences in assumed values and other assumptions across all models. The target for the estimates of this study was the marine surface layer, so it is also necessary to be sufficiently aware that other spots in the ocean such as water columns and sediments are out of scope. In addition, the estimation covers particle sizes ≥1 μm; nanoscale particles are not included. Finally, although the comparison was made using discrete particle-size ranges, particle sizes in the environment span a continuous range, and exposure scenarios involving a broad mixture of sizes can also be envisaged.

— Hazard assessments: Out of approximately 670 peer-reviewed articles screened from a total of around 18,000 reports, 13 articles were classified as quality level "A", indicating a limited number of test data available. Data on the chronic effects on fish and shellfish in particular remains limited, and there are biases in the quality of test data for reasons such as the lack of standard experimentation methods. These are organized by set concentrations, so there may be differences in actual exposure concentration in test systems (there may be inconsistencies due to settling, aggregation or variance in absorption). Regarding the effects of MicP on organisms and ecosystems, concerns have been raised over the effects of particles and chemical substances, but it is necessary to sufficiently understand that, in this study, the effects of particles mainly on aquatic organisms are the subject of study.

■ Discrepancies between the actual environment and the conditions of toxicity experiments

- Differences in particle characteristics:
  - Particle size: MicP with a wide distribution of particle sizes exist in the marine surface layer, but toxicity experiments, in principle, use a single particle size.
  - Form: Most MicP detected in the marine surface layer are fragmentary or fibrous, but those used in toxicity experiments are often spherical.
  - Materials: Relatively light MicP have been detected in the marine surface layer, but research fluorescent beads are often used in toxicity experiments, so materials differ to those in the actual environment.
  - Deterioration: It is likely that MicP in the actual environment deteriorate, but the degree of that is not consistent. The MicP used in toxicity experiments are often of a kind that is not made to deteriorate.
  - Chemical substances: It is possible that MicP absorb chemical substances in the water in the actual environment, but this study has, in principle, targeted the effects of particles in hazard assessments.

— Differences in concentration (consistency, etc.)
  - Actual environment: In the actual environment, there are a variety of concentration distributions across horizontal and vertical directions, and those concentrations vary with each passing moment. Localized high concentrations also occur at, for example, the lines where two currents meet or along coasts, so their hotspots may form. Concentrations may be even higher in hotspots in surface marine waters, such as boundaries between surface currents.
  - Toxicity experiments: Depending on aggregation, settling or variance in absorption, it may not be possible to maintain the nominal concentration consistently.

— Differences in organisms
  - In exposure assessments, estimates are performed targeting the marine surface layer, but MicP toxicity experiments are often done using freshwater organisms such as fish and crustacea in particular.
  - At present, we have not been able to identify organism groups that survive in high exposure concentration environments, so there may be differences between test organisms and organisms that survive in high concentration areas.
  - The susceptibility to MicP of toxicity experiment test organisms and organisms exposed to MicP in the actual environment may differ based on their life-stages and feeding habits.

Note: Revisions made in FY2025 are shown in red.

6. Exposure Assessment (Sediment)
(Newly Initiated Activities in FY2025)

Exposure Assessment (Sediment)

Activities and Outcomes in Exposure Assessment

- MicP enter the ocean via rivers and coastal areas and may be distributed temporarily in surface marine waters; however, over time they are influenced by processes such as degradation, fragmentation into smaller sizes, biofouling and aggregation, and are **ultimately thought to settle to the seafloor and accumulate in sediments**. Sediments are therefore considered the ultimate accumulation zone for MicP. Such particles, once accumulated in sediments, may also affect ecosystems through contact with benthic organisms. In the FY2025 exposure assessment, **information on the occurrence, behaviour and estimation of MicP in sediments was compiled, and current issues and future directions for sediment exposure assessment were summarised.**
- Specifically, **key differences in the exposure-assessment approach between surface marine waters and sediments were summarised**, including differences in sampling methods and in how the lower detectable particle-size limit is determined.
- **Measured data for sediments were also compiled**, summarising current practices and findings on sampling methods, pre-treatment, analysis, concentrations, target particle-size ranges and spatial variability across sites. In addition, **information was gathered on the behaviour of MicP in sediments and on approaches for estimation**.

Exposure Assessment (Sediment)

Key Differences in Exposure Assessment Between Surface Marine Waters and Sediments

Category	Topic	Surface marine waters	Sediments
(1) Measurement practices	Monitoring guidelines	✓ MoE monitoring guidelines for microplastics are available ✓ Measured data for waters around Japan are available, collected in accordance with the guidelines (particle size ≥ 330 μm)	✓ No MoE monitoring guidelines are available for sediments (no established criteria for judging which measured data are reliable) ✓ Measured data for sediments are fewer than those for surface marine waters, even in the academic literature; data for waters around Japan, coastal areas and inland waters are particularly limited
	Sampling methods	✓ Typically, MicP are collected by filtering seawater using a 330 μm mesh net (particles ≤ 330 μm may not be retained at this stage)	✓ Typically, sediments are collected using an Ekman–Birge grab sampler (small MicP are retained at this stage)
	Pre-treatment and analysis	✓ After filtration, MicP are identified using FT-IR, Raman spectroscopy and microscopic observation (with minimal interference from co-occurring materials)	✓ After density separation and removal of organic matter, MicP are identified using FT-IR, Raman spectroscopy and microscopic observation (with substantial interference from co-occurring materials)
	Spatial variability in concentrations	✓ Spatial variability is smaller than in sediments ✓ Surface marine waters are dynamic; measured concentrations represent instantaneous snapshots	✓ Spatial variability is large (driven by differences in geomorphology and flow velocity, the ease of mixing and settling, and the density of human activities) ✓ Measured concentrations reflect long-term accumulation history
	Detected polymer types	✓ Polymers with a specific gravity lower than water are typically detected	✓ Polymers with a specific gravity higher than water are typically detected (biofilm attachment can increase the apparent specific gravity, allowing low-specific-gravity polymers to settle)
	Units	✓ Typically reported as counts per unit water volume (particles/m^3)	✓ Typically reported as counts per unit dry sediment mass (particles/kg-dry sediment)
(2) Behaviour and estimation	Concentration estimation	✓ Estimation methods using existing fragmentation models are available (e.g. the Cozar, Kaandorp, Aoki and Sugar Lump models)	✓ Behaviour is more complex than in surface marine waters, making it difficult at present to represent it with simple models
	Key Environmental fate processes	✓ Suspension and transport/dispersal driven by wind, waves and currents	✓ Settling, resuspension and bioturbation, with accumulation through deposition
	Purpose of estimation	✓ Predicting concentrations for fine size ranges where measured data are limited	✓ Predicting concentrations for fine size ranges where measured data are limited
	Particle-size range required for estimation	✓ Typically, MicP are collected by filtering seawater using a 330 μm mesh net; therefore, <u>particles ≤ 330 μm are not captured and must be estimated (the net mesh size limits the detectable particle size range)</u>	✓ Typically, sediments are collected using an Ekman–Birge grab sampler, with pre-treatment and analysis conducted in the laboratory ✓ As a result, the measurable MicP particle-size range depends primarily on the analytical detection limit (the literature review suggests it is on the order of several tens of μm)

- Surface marine waters are dynamic environments characterised by movement, dispersion and drift, whereas sediments are depositional environments involving settling, deposition and resuspension, and long-term accumulation history is therefore reflected.
- Due to differences in sampling methods between the two, the way the lower detectable particle-size limit is determined also differs.

Exposure Assessment (Sediment)

Occurrence of MicP in Sediments

- To examine the occurrence of MicP in sediments, the literature on measured field data was compiled (see next slide). Using a literature search service, relatively recent studies were screened on the basis of their titles and abstracts, and those judged to report measured MicP concentrations in sediments were selected.
- Information was summarised with a focus on sampling (location, sampling devices), analytical methods (organic matter digestion, density separation, recovery rates, analytical instruments), and results (particle size, concentration, shape, polymer type).
- Sampling in many studies was conducted using an **Ekman–Birge grab sampler**, suggesting that the likelihood of excluding small MicP at the sampling stage is low. As a result, the measurable MicP particle-size range **depends primarily on the analytical detection limit**, which was interpreted from the literature review to be **on the order of several tens of μm when micro FT-IR was used**.
- Particle number concentrations **showed large variability across sites, ranging from 10 to 10,000 particles/kg-dry sediment**. This variability appears to be influenced by differences in geomorphology and flow velocity, the ease of mixing and settling, and the density of human activities, suggesting the presence of high-concentration areas (hotspots).
- With regard to polymer types, a wider variety is detected in sediments than in surface marine waters. **Polymers with a specific gravity higher than water are typically detected**; however, if biofilm attaches to MicP, even low-specific-gravity polymers are thought to settle.
- The presence or absence of recovery tests, contamination control measures, and consideration of fragmentation during sampling and analysis were also examined. Of the 22 studies reviewed, five conducted recovery tests during the analytical process and corrected MicP particle number concentrations accordingly (recovery: 55–100%). Many studies paid attention to contamination control, including pre-cleaning of analytical equipment and efforts to prevent contamination during analysis. None of the studies referred to fragmentation during sampling and analysis (i.e. changes in particle number concentrations caused by breakage of MicP during these processes), indicating that this is an important issue for future measurement studies.

Exposure Assessment (Sediment)

Concentration Variability Across Depositional Settings (Nine Major Sedimentary Environments)

■ MicP concentrations in sediments **tend to show greater spatial variability than those in surface marine waters**. A literature review was therefore conducted to characterise site-to-site differences, identify geomorphic settings with potential hotspots, and understand approaches for classifying sites.

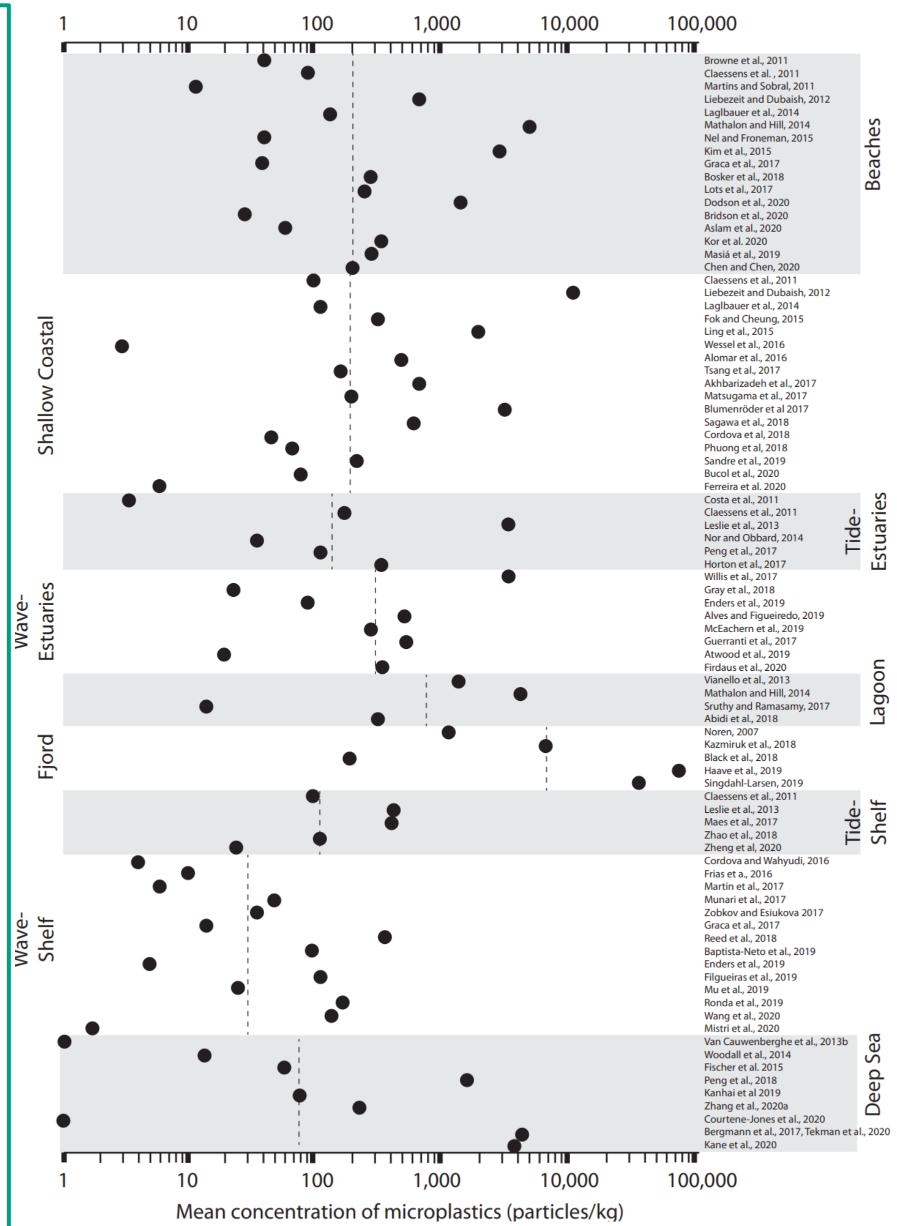
■ Peter T. Harris at GRID-Arendal (an environmental organisation established by UNEP and the Norwegian Government) reviewed MicP concentrations in sediments in *The fate of microplastic in marine sedimentary environments: A review and synthesis (2020).*

■ Peter T. Harris reviewed 80 studies and **classified sampling sites into nine major depositional settings**—Beaches, Shallow Coastal, Tide-dominated Estuaries and Deltas, Wave-dominated Estuaries and Deltas, Lagoons and Coastal Lakes, Fjords, Tide-dominated Continental Shelves, Wave-dominated Continental Shelves, and Deep-sea Environments—and compared MicP concentrations across these settings (see table on the right).

No.	Depositional setting	Description	No. of studies reviewed	Median MicP concentration (particles/kg)
1	Beaches	Shoreline and sandy beaches. Highly dynamic environments with strong wave action and frequent turnover of sediment grains.	17	~200
2	Shallow coastal	Coastal environments such as shallow areas within bays and tidal flats, with moderate influence from waves and tidal currents.	18	~200
3	Tide-dominated estuaries and deltas	Environments where flow reverses with the tidal cycle. High transport capacity, with sediment grains readily mobilised and transported.	6	~150
4	Wave-dominated estuaries and deltas	Environments where sediment grains are deposited and dispersed primarily by wave action; mud tends to accumulate in central areas.	8	~300
5	Lagoons and coastal lakes	Semi-enclosed environments that are partly isolated from the open sea, with limited water exchange.	4	~800
6	Fjords	Deep, glacially carved inlets. Deposition hotspots with very high deposition efficiency.	5	~7,000
7	Tide-dominated continental shelves	Seafloor environments with strong tidal currents, where mud is readily transported.	5	~120
8	Wave-dominated continental shelves	Environments where wave action promotes dispersal of sediment grains along the seafloor.	14	~30
9	Deep sea environments	Deep seafloor at ≥1,000 m water depth. Sediment grains settles slowly via marine snow.	9	~80

Concentration Variability Across Depositional Settings

- MicP concentrations in sediments across depositional settings are shown in the figure on the right. **Clear patterns and differences among depositional settings were observed, likely associated with differences in the physical and geomorphological characteristics of the environment and in depositional processes**.
- Most notably, MicP concentrations were particularly high in fjords. Among all environments reviewed, fjords showed the highest mean and maximum concentrations, with a median of approximately 7,000 particles/kg, and cases reaching up to 200,000 particles/kg have also been reported. One possible reason is that **fjords are structurally highly enclosed and have limited water exchange with the open sea, giving them geomorphological conditions that favour the deposition of suspended material**.
- After fjords, environments showing an overall tendency towards high MicP concentrations included lagoons and wave-dominated estuaries. In these environments, structural enclosure and particle deposition driven by wave transport are presumed to be the main contributing factors. Lagoons, in particular, are characterised by limited water exchange with the open sea and long water residence times, which are thought to inhibit the dispersion of MicP and promote deposition.
- Environments showing intermediate MicP concentrations included beaches, shallow coastal areas, and tide-dominated estuaries. These environments are all characterised by active water movement, which facilitates the resuspension and redistribution of deposited MicP and makes them less likely to be retained as stable sediment.
- In contrast, the lowest MicP concentrations were observed on continental shelves and in deep-sea environments. In wave-dominated continental shelves, the mean concentration was approximately 30 particles/kg, markedly lower than those in other environments, and high wave energy is thought to prevent MicP from being retained, leading instead to dispersal. A similar tendency was also observed in tide-dominated continental shelves. In deep sea environments, particles are generally less likely to reach the seafloor, and deposition rates are extremely low; concentrations are therefore low, with gradual accumulation over long periods.
- Taken together, these results suggest that the settling of MicP to the seafloor is controlled by multiple physical and chemical factors, including water depth, transport capacity, the degree of geomorphological enclosure, deposition rate, and the tendency to co-settle with organic matter. In particular, **distinguishing between environments that function as depositional hotspots for MicP (e.g. fjords and lagoons) and those dominated by dispersal and re-transport (e.g. continental shelves and deep-sea environments) is highly useful as a guide for site selection in marine environmental monitoring**.



Dry-weight concentrations of MicP in sediments reported in the literature reviewed (extracted from Fig. 4 of Peter T. Harris (2020))

Exposure Assessment (Sediment)

Information Gathering on MicP Behaviour and Estimation in Sediments

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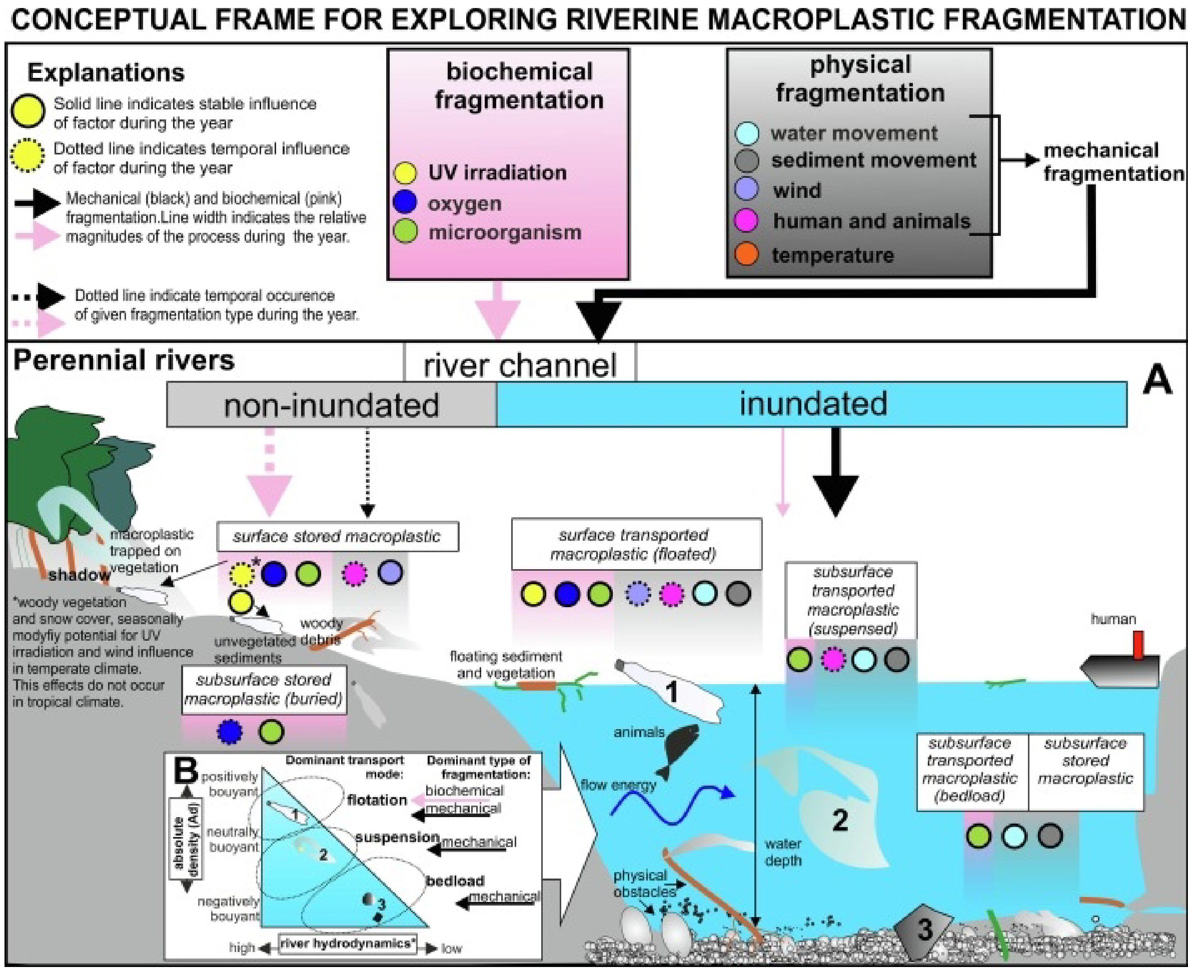
- No previous studies estimating MicP concentrations in sediments were identified. Nevertheless, information was compiled on MicP behaviour that should be taken into account in future estimation.
- Specifically, information was collected from previous studies on factors contributing to degradation and fragmentation, site-specific particle size characteristics, biofouling attachment, and settling and resurfacing. The results are shown below.

(1) Factors Contributing to Fragmentation

- According to Maciej Liro et al. (2023)[1], factors contributing to MicP fragmentation differ between surface waters and riverbeds.
- Fragmentation can be broadly classified into biochemical fragmentation and physical fragmentation. Factors associated with biochemical fragmentation include UV irradiation, oxygen, and microorganisms, whereas those associated with physical fragmentation include water movement, sediment movement, wind, humans and animals, and temperature.
- In riverbeds, the influence of UV irradiation is absent, and fragmentation is instead driven by microorganisms, water movement, and sediment movement.



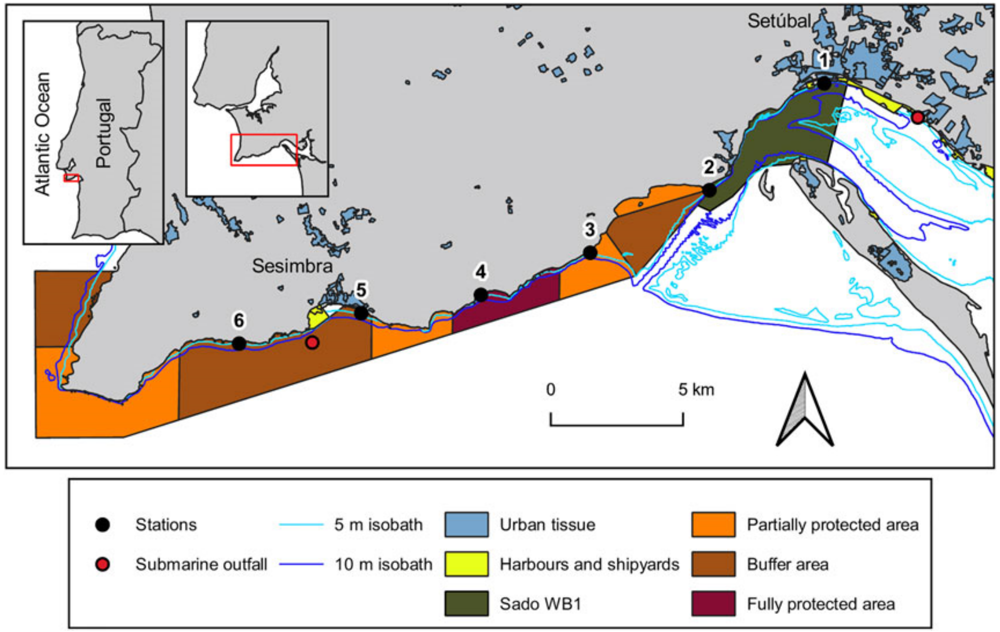
Extract from Fig. 4A of Maciej Liro et al. (2023), which illustrates the conceptual framework of biochemical and physical forces governing macroplastic fragmentation in perennial rivers.

1 : Maciej Liro et al. (2023), “Macroplastic fragmentation in rivers”

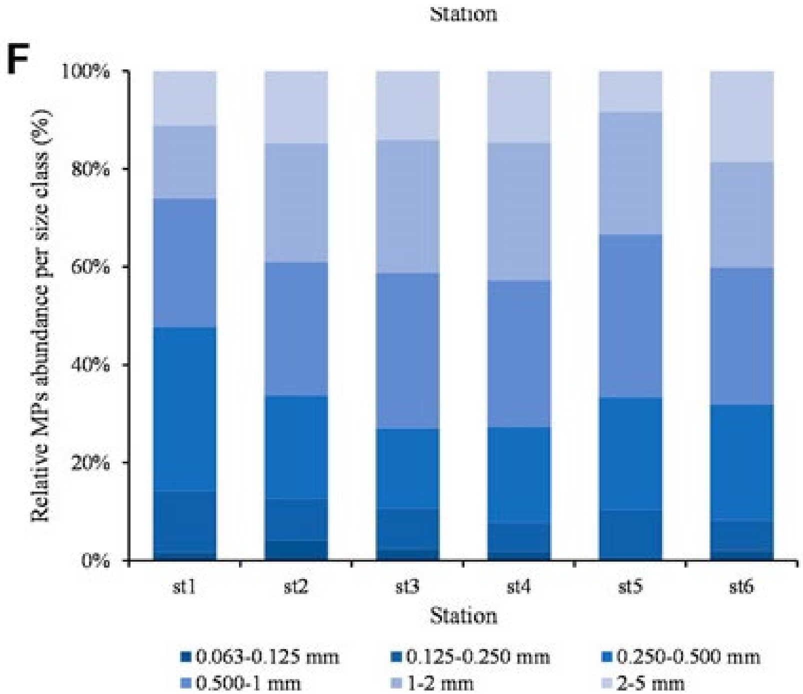
Exposure Assessment (Sediment)
Information Gathering on MicP Behaviour and Estimation in Sediments

(2) Site Characteristics

- According to Diana Rodrigues et al. (2020,2022)[2,3], the particle size distribution of MicP present in sediments may vary among sites due to environmental factors and other conditions.
- Most MicP accumulated in estuaries were in the 0.250–0.500 mm and 0.500–1 mm size ranges, whereas at sites closer to marine waters, most MicP were in the 0.500–1 mm and 1–2 mm size ranges.



Location of sampling stations
Extract from Fig. 1 of Diana Rodrigues et al. (2020).



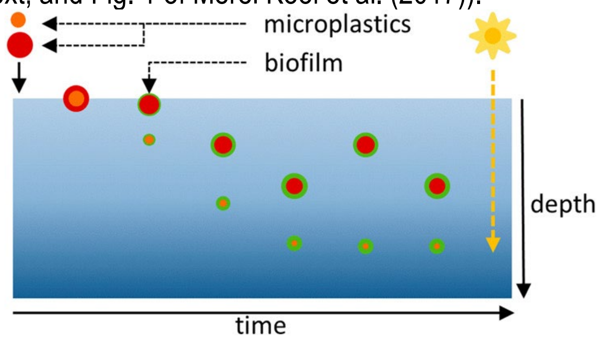
Relative distribution of particles size class, per station
Extract from Fig. 6(F) of Diana Rodrigues et al. (2022).

2: Diana Rodrigues et al. (2020), "Distribution Patterns of Microplastics in Seawater Surface at a Portuguese Estuary and Marine Park"
3: Diana Rodrigues et al. (2022), "Distribution patterns of microplastics in subtidal sediments from the Sado river estuary and the Arrábida marine park, Portugal"

Exposure Assessment (Sediment)
Information Gathering on MicP Behaviour and Estimation in Sediments

(3) Settling and Resurfacing Driven by Biofouling

- According to Merel Kooi et al. (2017)[4], a model was presented to describe vertical settling and resurfacing driven by biofouling on MicP surfaces (i.e. attachment and growth of biofilms).
- As algal biofilms attach to and grow on MicP, the particles begin to settle. Changes in MicP density caused by algal growth, mortality and respiration result in behaviours described as ‘floating’, ‘sinking’ and ‘oscillating’. The period and amplitude of oscillation depend on MicP size, with smaller MicP being less likely to resurface. The conceptual model, settling velocity equation, and size-dependent differences in behaviour are shown below (extracted respectively from the abstract, main text, and Fig. 1 of Merel Kooi et al. (2017)).

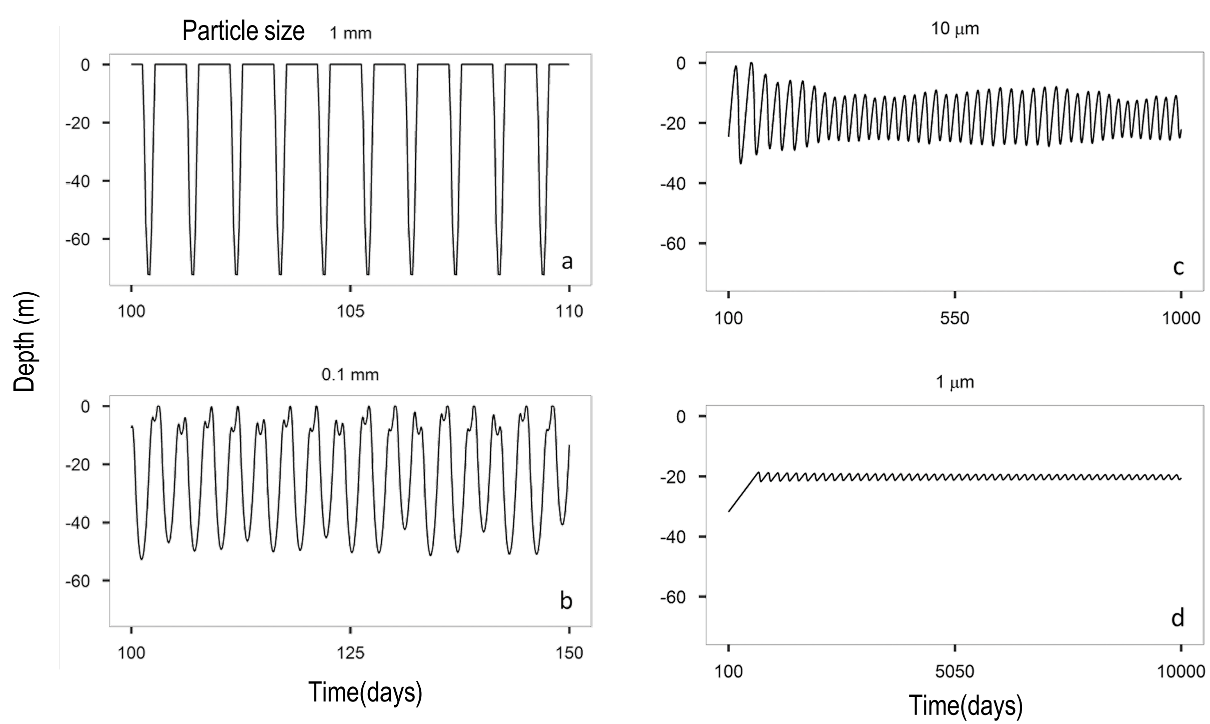


●Settling Velocity Equation (Modified Stokes’ Equation)

$$V_s(z,t) = -\left(\frac{\rho_{tot} - \rho_{sw,z}}{\rho_{sw,z}} g\omega_* \nu_{sw,z}\right)^{1/3}$$

V_s : settling velocity
ρ_{tot} : density of the plastic particle with biofilm
$\rho_{sw,z}$: seawater density at depth z
g : gravitational acceleration
ω_*: dimensionless settling velocity
$\nu_{sw,z}$: kinematic viscosity of seawater at depth z

● Size-Dependent Differences in Settling and Resurfacing Behaviour



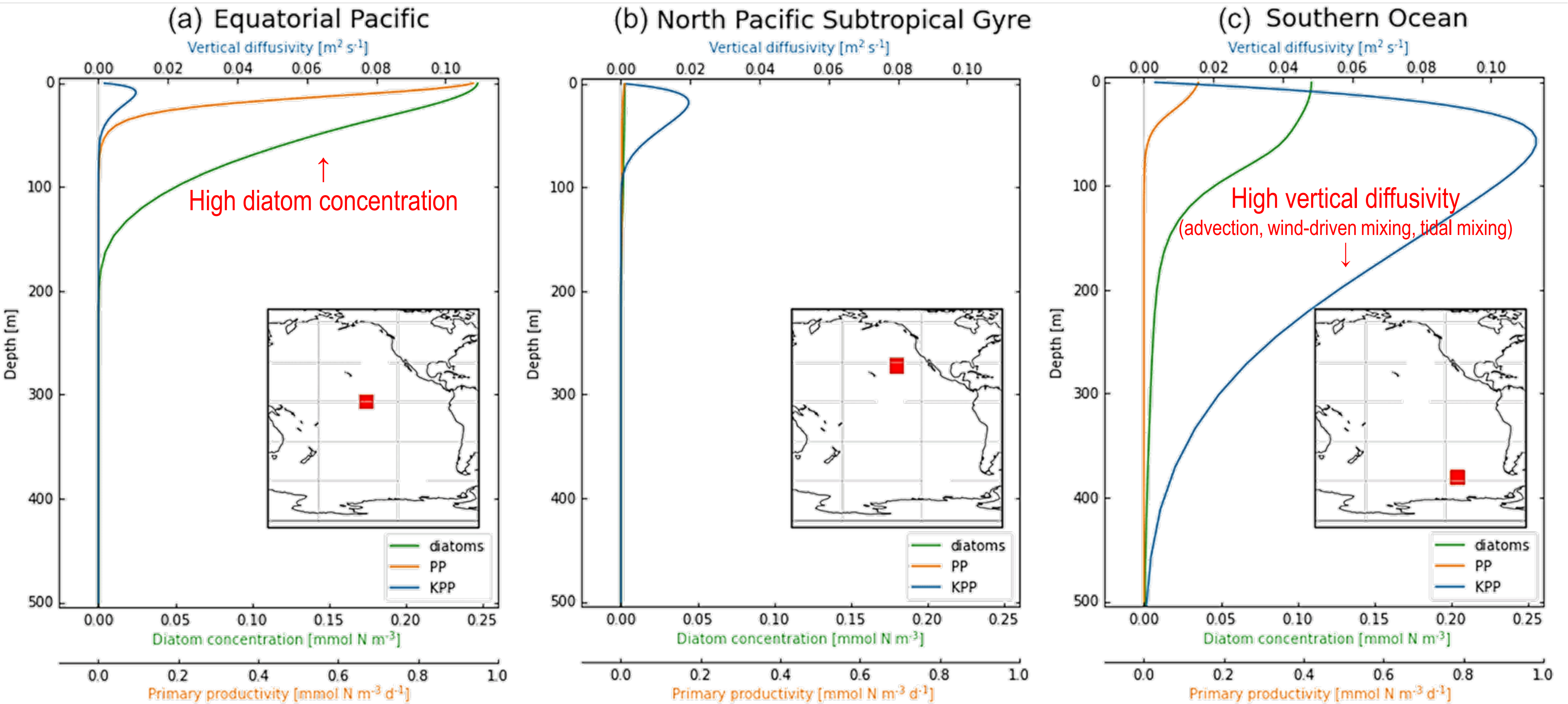
4: Merel Kooi et al. (2017), “Ups and Downs in the Ocean: Effects of Biofouling on Vertical Transport of Microplastics”

Exposure Assessment (Sediment)

Information Gathering on MicP Behaviour and Estimation in Sediments

(4) Simulation of Settling and Resurfacing

- Reint Fischer et al. (2022)[5] reported simulation results for the settling and resurfacing behaviour of MicP in three representative marine regions.
- Advection, wind-driven mixing, tidal mixing, and biofouling were assumed to be the main factors governing MicP settling and resurfacing.
- The calculations were based on the biofouling model developed by Lobelle et al. (2021), which is an improved version of the model proposed by Kooi et al. (2017).



Regions Included in the Calculation (extracted from Fig. 1 of Reint Fischer et al. (2022))

5: Reint Fischer et al. (2022), "Modelling submerged biofouled microplastics and their vertical trajectries"

Summary of Issues Related to Measured Data

■ Data Gaps and Spatial Variability in Sediment MicP Concentrations

— Unlike surface marine waters, hardly any measured data on MicP in sediments have been generated . Even in the academic literature, measured data for sediments are fewer than those for surface marine waters. Data for waters around Japan, coastal areas and inland waters are particularly limited.

— MicP concentrations in sediments show large spatial variability, and **priority should be given to environments where accumulation is likely to occur (hotspots), such as rivers, tidal flats, lakes and areas near sources**.

■ Issues and Considerations Related to Particle Size

— When an Ekman–Birge grab sampler and micro FT-IR are used, the lower size limit that can generally be regarded as reliable in measured data is **approximately 20 µm**; accurate measurement below this size is currently difficult. The mesh size used in pre-treatment (particularly the diagonal mesh opening) determines the particle-size range that can actually be recovered and detected.

— Recovery rates may decrease as particle size becomes smaller, which may reduce data reliability; therefore, **the size of the MicP used in recovery tests should be confirmed**.

■ Issues Related to the Reliability of Measured Data

— When reviewing measured-data studies, it is necessary to establish **minimum requirements**, including at least the following conditions.

— In particular, when comparing measured data with toxicity tests for benthic organisms, information on sediments is required; therefore, studies that include **sediment information in addition to MicP** should be prioritised. Because the organisms present vary with sediment depth, **depth information** should likewise be collected where available.

- Oxidative treatment in pre-treatment, and density separation methods (with the possibility that high-density polymers may not have been separated adequately)
- Mesh size used in pre-treatment (relevant to the reliable particle-size range)
- Contamination control measures
- Whether polymer identification was performed using FT-IR or similar methods
- Whether recovery tests were conducted, and the particle sizes used in those tests
- Number of MicP detected (reliability may be low if the number is extremely small)
- Measurement of sediment properties other than MicP (e.g. particle size distribution, organic matter content [loss on ignition], water content), etc.

Exposure Assessment (Sediment)

Summary of Behaviour and Estimation

Estimation

- Various types of MicP behaviour in sediments need to be taken into account, as outlined below. However, **because these processes occur simultaneously and interdependently, it is currently difficult to represent them using a simple model**. In practice, **the use of measured sediment data is considered the most realistic approach for comparison with test data**.
- On the other hand, **because the lower size limit that can generally be regarded as reliable in measured data is approximately 20 µm, estimation is needed for smaller size ranges**. In parallel with the above, preliminary estimation of sediment concentrations will be examined by incorporating settling processes into the estimated concentrations for surface marine waters. Behaviours that can and cannot be taken into account will be explicitly stated, and the current limitations will also be made clear. The validity of the model will be examined by checking the consistency between estimated and measured concentrations.

(Behaviours to be Considered in Estimation)

Settling and Fragmentation Processes

- The distribution of MicP in sediments is formed through a two-stage process involving particle fragmentation and settling. Because these processes proceed simultaneously and interdependently, it is difficult to reproduce them using a simple particle-size-distribution model.
- Settling velocity varies greatly with particle size, and particles in the single-digit micrometre range can remain suspended in the water for long periods. Environmental conditions such as currents, tides and turbulence strongly influence settling and dispersal behaviour. When conducting estimation, it is necessary to clarify which part of the real environment is being represented.

Resurfacing and Vertical Transport

- It has been suggested that MicP settled onto sediments may resurface and move through the water column again. In particular, in areas where swirling flow and disturbance occur, vertical movement involving repeated settling and resurfacing (the yo-yo effect) may occur.
- However, resurfacing is difficult to verify, and incorporating it into quantitative models involves substantial uncertainty. At present, **rather than attempting to quantify such detailed behaviour, it is more appropriate to state explicitly as an assumption that such processes may occur**.

Aggregation and Biofouling

- In the real environment, MicP are often present not as individual particles but as aggregates formed with algae and organic matter. This aggregated state has a major influence on settling velocity, distribution and bioavailability.
- **Results from environmental analysis are likely to reflect MicP in a state closer to individual particles after aggregates have been broken apart, and are therefore unlikely to directly reflect the state in which organisms actually ingest them. This point should be noted.**

Exposure

Draft: Current Issues and Future Directions for Exposure Assessment in Sediments

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Category	Current issues	Proposed future directions
Measurement-related issues	**(1) Limited understanding of fine-sized MicP occurrence in sediments** ➢ Current measurement techniques have a detection limit of around 20 μm, making it difficult to accurately determine MicP with particle sizes ≤ 20 μm ➢ Data for the seas around Japan, coastal areas, and inland waters remain limited, even compared with surface marine waters	➢ Development of analytical techniques to determine the occurrence of fine-sized MicP in the environment ➢ Accumulation of data in MOE field studies †
	(2) Limited information on hotspots ➢ MicP concentrations in sediments show large spatial variability, and although environments where accumulation is likely to occur (hotspots), such as rivers, tidal flats, lakes and areas near sources, are known to exist, information on concentration distribution remains limited	➢ Expansion of measured site-specific data in sediments †
Behaviour and estimation-related issues	**(3) Limitations of simple models for estimating MicP concentrations in sediments** ➢ Processes that should be taken into account in the estimation include settling and fragmentation, resurfacing and vertical transport, and aggregation and biofouling. However, because these processes occur simultaneously and interdependently, it is currently difficult to perform the estimation using a simple model	➢ Ongoing collection of information on the estimation of environmental concentrations and behaviour of fine-sized MicP † ➢ Preliminary estimation of sediment concentrations by incorporating a settling model into estimated concentrations in surface marine waters
Assessment-related issues ‡	**(4) Harmonisation of concentration metrics for comparison with test data** ➢ For field measurements in sediments, particle number per dry weight of sediment (particles/kg-dry sediment) and particle number per unit area (particles/m²) are often used ➢ In addition, sediment-mediated toxicity tests are often controlled using particle number per dry weight of sediment (particles/kg-dry sediment) or particle number per unit water volume (particles/m³), indicating that a range of concentration metrics are currently in use	➢ Review of concentration metrics used in previous literature (including, where necessary, conversion between dry-weight, wet-weight and volume-based units) †
	(5) Exposure scenarios (feeding behaviour and habitat) ➢ Exposure scenarios differ between organisms that burrow into sediments (e.g. polychaetes) and those that feed at the sediment surface (e.g. shrimp and crabs). When comparing MicP concentrations in sediments collected using an Ekman–Birge grab sampler with test data, it is necessary to consider to what extent organisms' feeding behaviour and habitat should be taken into account.	➢ Review of benthic-organism risk assessment methods used in previous literature † ➢ Close collaboration with the Hazard Assessment Subcommittee †

‡ Hazard-related issues are also included.

† Indicates items that could be addressed under the Ministry of the Environment's programme in future fiscal years.

７． Hazard Assessment (Including Effects of Sorbed Chemicals and Additives) (Newly Initiated Activities in FY2025) (Aquatic organisms)

Schematic of Uptake and Excretion Pathways

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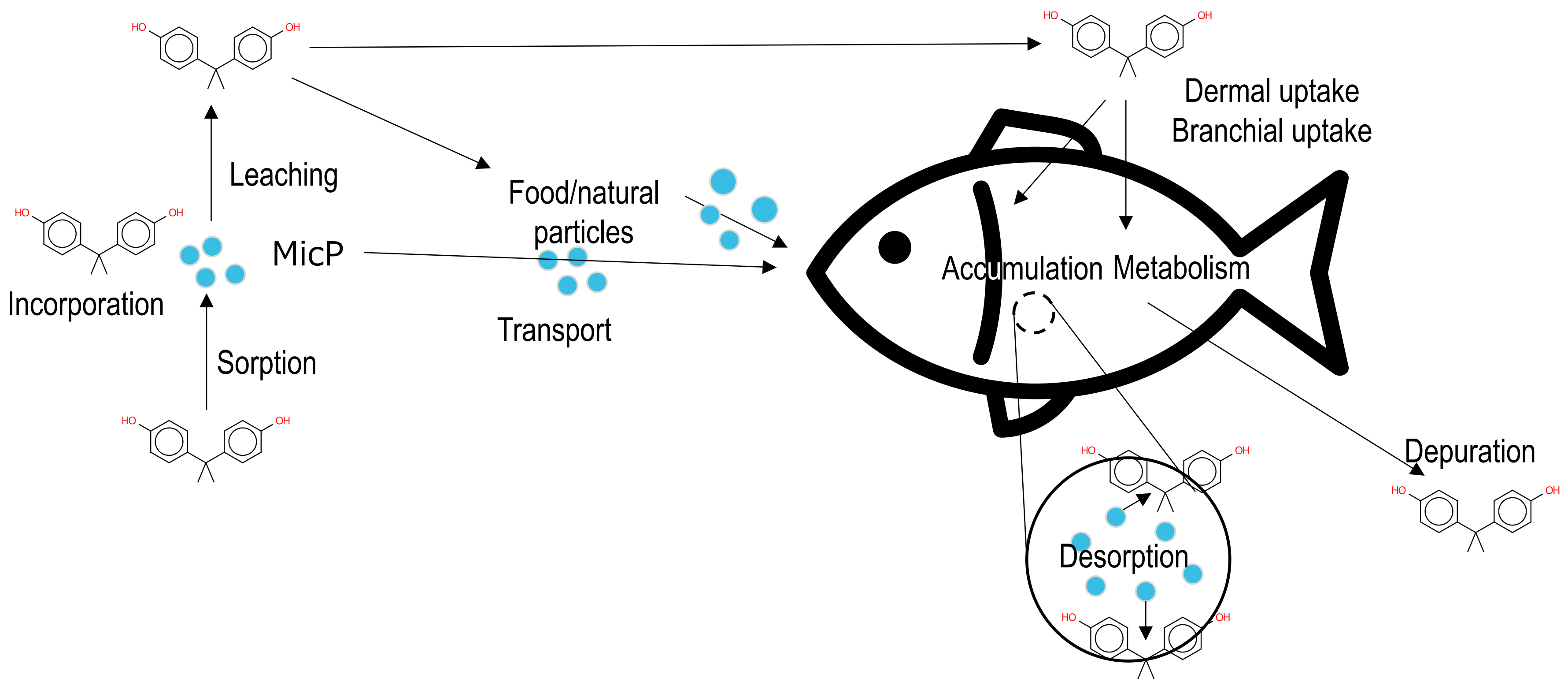
- Objective: To organise the findings identified to date and clarify the issues that should be addressed in the future.
- With regard to the so-called 'vector effect' of microplastics, the scope of this term varies among researchers and publications. Therefore, no formal definition is adopted here, and the term is not used; instead, consideration is given to 'impacts involving sorbed chemicals and additives'.
- The uptake and elimination pathways of sorbed chemicals and additives associated with microplastics in aquatic organisms were organised as follows.



Hazard Assessment (Including Effects of Sorbed Chemicals and Additives)

Findings from Existing Review Papers

- Three review papers on the effects of sorbed chemicals and additives on aquatic organisms were examined, and the current findings were summarised.

Menéndez-Pedriza et al. (2020) 'Interaction of Environmental Pollutants with Microplastics: A Critical Review of Sorption Factors, Bioaccumulation and Ecotoxicological Effects'

- This review was conducted by the research group of Menéndez-Pedriza et al. at an institute of the Spanish National Research Council. The authors identify the following three scenarios in which sorbed chemicals may affect organisms. They emphasise that 'the influence of MicP on the bioavailability of sorbed chemicals and additives should not be underestimated' and that 'the lack of studies on the bioaccumulation and biomagnification of pollutants due to desorption from MicP should be urgently addressed'.
  - Scenario 1: 'Contaminated biota exposed to clean MicP' — Ingestion of MicP may lead to a reduction in contaminants within the organism (cleaning effect).
  - Scenario 2: 'Clean biota exposed to contaminated MicP' — This scenario applies to many toxicity tests. It is also relevant to the transport of plastic additives and may increase their bioavailability. As several studies have shown different accumulation patterns of sorbed chemicals and additives among tissues, the importance of tissue-specific analysis is pointed out.
  - Scenario 3: 'Contaminated biota exposed to contaminated MicP' — This scenario assumes the most common interaction between organisms and MicP, which is considered closest to real environmental conditions. Many studies have reported that, because of sorption equilibrium, ingestion of MicP present within the same ecosystem does not increase contaminant bioaccumulation in marine animals.
- In addition, the review summarises ten studies in which chemicals were administered together with MicP — compared with test groups exposed to clean MicP, some studies reported enhanced effects in groups exposed to chemical-containing MicP, whereas others found no significant difference.

Koelmans et al. (2021) 'Weight of Evidence for the Microplastic Vector Effect in the Context of Chemical Risk Assessment'

- This review was conducted by the research group of Koelmans et al. at Wageningen University in the Netherlands. It provides a comprehensive and systematic overview of the current scientific knowledge on MicP, including their behaviour and cycling in the environment, their effects on the environment and ecosystems, their relationship with climate change, food safety, human exposure, and policy responses.
- In their review of sorbed chemicals, the authors classified a total of 63 publications into four categories: 30 laboratory studies (in vivo), 13 laboratory studies (in vitro), 6 field studies, and 14 model studies. Each publication was further evaluated and categorised as 'Demonstrated', 'Inconclusive', or 'Not Supported'. As a result, no publication was classified as 'Demonstrated'. Of the 63 publications, 42 (67%) were classified as 'Inconclusive' and 21 (33%) as 'Not Supported'. From a perspective-based analysis, references to exposure pathways were particularly common. The authors point out that assessment of pathways other than MicP, such as water and food, remains insufficient, and suggest that the contribution of MicP may be low relative to other pathways.

Findings from Existing Review Papers

Al-Emran et al. (2025) 'Vector effects of microplastics on organic pollutants: sorption-desorption and bioaccumulation kinetics'

- This review was conducted by the research group of Al-Emran et al. at Bangladesh Agricultural University. It is one of the most recent review papers providing a comprehensive overview of the existing literature on sorbed chemicals. The review focuses on the phenomenon whereby microplastics sorb and transport organic pollutants in the environment and subsequently desorb them within organisms, thereby increasing pollutant bioaccumulation. In this context, it addresses the full sequence of Sorption → Transport → Desorption → Bioaccumulation.
- The authors analysed previous studies from the perspectives of polymer type, particle size and concentration, and reported that strong effects of sorbed chemicals were observed under certain conditions.
  - Conditions under which strong effects of sorbed chemicals were observed
    - Polymer type: Many effects were observed for PE and PS, which are widely detected in aquatic environments and are frequently used as test materials in toxicity studies.
    - Particle size: Effects were particularly evident for particles with sizes of 1–10 μm or smaller.
    - Concentration: Regardless of particle size, effects were observed under high-concentration conditions (>10,000 μg/L).
- The review also suggests that an effective response is to break the sequence of Sorption → Transport → Desorption → Bioaccumulation, and identifies intervention at the following three key stages.
  - (1) Upstream prevention of releases of pollutants and microplastics to the environment
    - Regulation of industrial effluent and product-derived additives, including substitution where appropriate
    - Prevention of pellet loss through measures such as pellet spill prevention and mandatory reporting
    - Phase-out of persistent additives
  - (2) Suppression of sorption and desorption in the environment and in the digestive tracts of organisms
    - Strengthening the removal of fine particles < 10 μm through the introduction of tertiary treatment in sewage and urban wastewater systems
    - Reducing inputs to marine environments through urban runoff control measures, such as biofiltration and sedimentation ponds
  - (3) Reduction of exposure at the food chain and seafood supply stages
    - Mandatory depuration of shellfish
    - Analysis and reporting of microplastics and organic pollutants in commercial seafood lots
    - Development of consumption advisories for high-risk fish species and fishing grounds

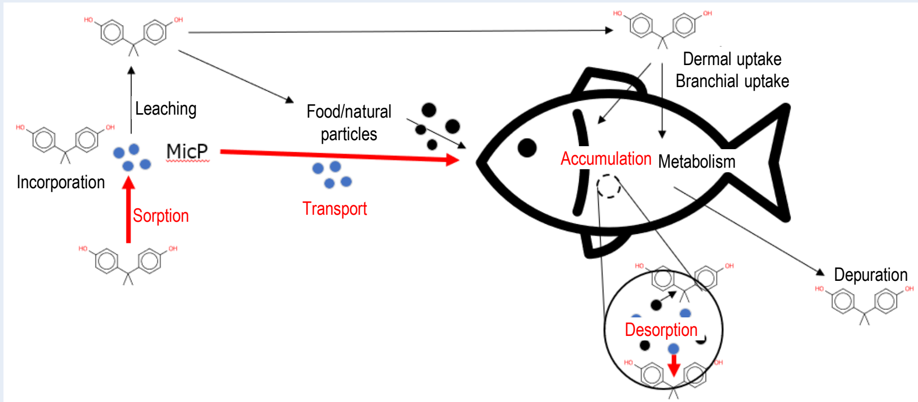
Hazard Assessment (Including Effects of Sorbed Chemicals and Additives)

Findings from Existing Review Papers

■ Three review papers on the effects of sorbed chemicals and additives on aquatic organisms were examined, and the current findings were summarised.

[Summary of Findings from Existing Review Papers]

- The three review papers mainly address the current understanding of sorbed chemicals that accumulate in organisms through ingestion (as indicated in red in the figure on the right). In contrast, there is little discussion of the effects of additives incorporated into plastics during manufacture or of exposure via water following the leaching of additives into the aquatic environment. One possible reason is that information available for assessment remains limited at present.



Effects mainly addressed in each review paper (indicated in red)

- Although some toxicity studies in which microplastics were loaded with high concentrations of chemicals have reported enhanced effects, the prevailing view is that, at environmentally relevant concentrations, the contribution of MicP to exposure to sorbed chemicals is limited.
- At the same time, it cannot be ruled out that strong effects of sorbed chemicals may occur under specific scenarios or conditions. Such effects have been reported to be more likely for PE and PS, which are widely detected in the environment, for particle sizes of 1–10 μm, and in microplastic hotspots.

Appendix

List of test data

Note1:For the source documents of each test data, see the Annex List of peer-reviewed publications.
Note 2 In cases where the literature only provides values for number or weight, shape is spherical, density is the density of the material (PE: 0.92, PET: 1.38, PP: 0.9, PS: 1.04, PVC: 1.4, others: 1), and particle size is the average of the upper and lower limits, and both are converted (converted values are in italics).
Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

■ Summary tables of test data by quality level and biological taxonomy is provided.

Table: Test data for quality level “A” in fish

Literature Information			Experimental design								Results							Chronic, subchronic/subacute, acute
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μ	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m³)			
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC	
R5_015	R5_001	Zhang et al. (2022)	Purchased	5～50	Polyamide	Fragment	*Danio rerio*	0,1.0E+03,1.0E+04,2.0E+04	–	10d	standardized body weight	–	1.E+04	2.E+04	–	*6.E+08*	*1.E+09*	Subacute/subchronic
R5_018	R5_006	Liu et al. (2022)	Purchased	32～40	PS	Sphere	*Ctenopharyngodon idella*	0,1.0E+02,1.0E+03	–	21d	body weight	–	1.E+02	1.E+03	–	*4.E+06*	*4.E+07*	Subacute/subchronic
R5_053	R5_072	Chen et al. (2022)	Purchased	6	PS	Sphere	*Oryzias melastigma*	0,1.1E+00,1.1E+03,1.1E+05	0,1.0E+05,1.0E+07,1.0E+09	14d	body length	–	1.E+05	1.E+05	–	1.E+09	1.E+09	Subacute/subchronic
R4_017	R4_026	Wang J et al. (2021)	Purchased	2	PS	Sphere	*Oryzias melastigma*	0,2.0E+00,2.0E+01,2.0E+02	–	150d	body length、body weight	<	2.E+00	2.E+00	<	*5.E+08*	*5.E+08*	Subacute/subchronic
R7_F07	R7_018	Levesque, Bailey et al. (2025)	Purchased	1.7～2.2	PS	Sphere	*Danio rerio*	0,5.0E+02,1.0E+03,2.0E+04,5.0E+04,7.0E+04,1.0E+05,2.0E+05	–	114h(6～120 hpf)	abnormal appearance、mortality	>	2.E+05	2.E+05	>	*5.E+13*	*5.E+13*	Acute
R7_F07	R7_019	Levesque, Bailey et al. (2025)	Purchased	5～7.9	PS	Sphere	*Danio rerio*	0,5.0E+02,1.0E+03,2.0E+04,5.0E+04,7.0E+04,1.0E+05,2.0E+05	–	114h(6～120 hpf)	abnormal appearance、mortality	>	2.E+05	2.E+05	>	*1.E+12*	*1.E+12*	Acute
R7_F07	R7_020	Levesque, Bailey et al. (2025)	Purchased	10～14	PS	Sphere	*Danio rerio*	0,5.0E+02,1.0E+03,2.0E+04,5.0E+04,7.0E+04,1.0E+05,2.0E+05	–	114h(6～120 hpf)	abnormal appearance、mortality	–	1.E+05	2.E+05	–	*1.E+11*	*2.E+11*	Acute
R7_F07	R7_021	Levesque, Bailey et al. (2025)	Purchased	1.7～2.2	PS	Sphere	*Danio rerio*	0,5.0E+02,1.0E+03,2.0E+04,5.0E+04,7.0E+04,1.0E+05,2.0E+05	–	114h(6～120 hpf)	abnormal appearance、mortality	–	1.E+05	2.E+05	–	*2.E+13*	*5.E+13*	Acute
R7_F07	R7_022	Levesque, Bailey et al. (2025)	Purchased	5～7.9	PS	Sphere	*Danio rerio*	0,5.0E+02,1.0E+03,2.0E+04,5.0E+04,7.0E+04,1.0E+05,2.0E+05	–	114h(6～120 hpf)	abnormal appearance、mortality	>	2.E+05	2.E+05	>	*1.E+12*	*1.E+12*	Acute
R7_F07	R7_023	Levesque, Bailey et al. (2025)	Purchased	10～14	PS	Sphere	*Danio rerio*	0,5.0E+02,1.0E+03,2.0E+04,5.0E+04,7.0E+04,1.0E+05,2.0E+05	–	114h(6～120 hpf)	abnormal appearance、mortality	>	2.E+05	2.E+05	>	*2.E+11*	*2.E+11*	Acute
R7_F080	R7_045	Karami A et al. (2017)	Purchased	17.6	PE	Fragment	*Danio rerio*	0,5.0E+00,5.0E+01,5.0E+02	0,1.0E+06,1.0E+07,1.0E+08	10, 20d	body length	>	5.E+02	5.E+02	>	1.E+08	1.E+08	Subacute/subchronic
R7_F080	R7_046	Karami A et al. (2017)	Purchased	17.6	PE	Fragment	*Danio rerio*	0,5.0E+00,5.0E+01,5.0E+02	0,1.0E+06,1.0E+07,1.0E+08	10, 20d	body weight	>	5.E+02	5.E+02	>	1.E+08	1.E+08	Subacute/subchronic

List of test data

Note1:For the source documents of each test data, see the Annex List of peer-reviewed publications.
Note 2 In cases where the literature only provides values for number or weight, shape is spherical, density is the density of the material (PE: 0.92, PET: 1.38, PP: 0.9, PS: 1.04, PVC: 1.4, others: 1), and particle size is the average of the upper and lower limits, and both are converted (converted values are in italics).
Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

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Table: Test data for quality level "A" in crustacean (1/2)

Literature Information			Experimental design								Results								Chronic, subchronic/subacute, acute
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration: Mass concentration (μg/L)	Nominal concentration: Particle number concentration (particles/m3)	Exposure time	Endpoints	Mass concentration (μg/L): Inequality Sign	Mass concentration (μg/L): NOEC	Mass concentration (μg/L): LOEC	Particle number concentration (particles/m^3): Inequality Sign	Particle number concentration (particles/m^3): NOEC	Particle number concentration (particles/m^3): LOEC	Notes	
P-1220	R6_007	An G et al. (2024)	Purchased	1～80	PLA	Fragment	*Daphnia magna*	0,1.3E+03,2.0E+03,5.0E+03,1.0E+04,2.0E+04	–	48h	immobilization or death	–	–	2.E+04	–	–	*5.E+05*	EC50	Acute
P-1220	R6_008	An G et al. (2024)	Purchased	1～80	PET	Fragment	*Daphnia magna*	0,1.3E+03,2.0E+03,5.0E+03,1.0E+04,2.0E+04	–	48h	immobilization or death	–	–	2.E+04	–	–	*4.E+05*	EC50	Acute
P-1220	R6_009	An G et al. (2024)	Purchased	1～80	PLA	Fragment	*Daphnia magna*	0,1.0E+03,5.0E+03	–	21d	survival	–	1.E+03	5.E+03	–	*3.E+07*	*1.E+08*		Chronic
P-1220	R6_010	An G et al. (2024)	Purchased	1～80	PLA	Fragment	*Daphnia magna*	0,1.0E+03,5.0E+03	–	21d	total number of offsprings	<	1.E+03	5.E+03	<	*3.E+07*	*1.E+08*		Chronic
P-0471	R6_041	Yin J et al. (2024)	Purchased	32～38	PE	–	*Daphnia magna*	0,4.0E+02,2.0E+03,1.0E+04	–	21d	number of offsprings	–	4.E+02	2.E+03	–	*2.E+07*	*1.E+08*		Chronic
P-0471	R6_044	Yin J et al. (2024)	Purchased	32～38	PE	–	*Scapholeberis kingi*	0,4.0E+02,2.0E+03,1.0E+04	–	21d	number of offsprings	>	1.E+04	1.E+04	>	*5.E+08*	*5.E+08*		Chronic
R5_006	R5_159	Peixoto et al. (2019)	Purchased	1～5	Thermoset amino formaldehyde polymer	Sphere	*Artemia franciscana*	0,4.0E+02,8.0E+02,1.6E+03	–	44d	total number of offsprings	<	4.E+02	4.E+02	<	*3.E+10*	*3.E+10*		Chronic
R5_035	R5_185	Au et al. (2015)	Purchased	10～27	PE	Sphere	*Hyalella azteca*	–	0,1.0E+07,1.0E+08,1.0E+09,1.0E+10,1.0E+11	10d	mortality	–	–	*5.E+04*	–	–	2.E+10	LC50	Acute
R5_007	R5_254	Jaikumar et al. (2019)	Purchased	1～5	PS	Sphere	*Daphnia magna*	–	0,1.0E+08,1.0E+09,1.0E+10,1.0E+11	21d	number of offsprings	–	*1.E+00*	*1.E+01*	–	1.E+08	1.E+09		Chronic
R5_007	R5_257	Jaikumar et al. (2019)	Prepared	1～10	PS	Fragment	*Daphnia magna*	–	0,1.0E+08,1.0E+09,1.0E+10,1.0E+11	21d	number of offsprings up to 3rd blood, total number of offsprings	<	*9.E+00*	*9.E+00*	<	1.E+08	1.E+08		Chronic
R5_036	R5_262	Schür et al. (2022)	Prepared	0.2～60	PS	Fragment	*Daphnia magna*	–	0,8.0E+07,4.0E+08,2.0E+09,1.0E+10	21d	mortality、reproduction(F0)	–	*1.E+03*	*6.E+03*	–	8.E+07	4.E+08		Chronic
R7_C01	R7_005	Procházková, Petra et al. (2024)	Purchased	8.68	Biodegradable polyester	Sphere	*Daphnia magna*	0,1.6E+03,3.1E+03,6.3E+03,1.3E+04,2.5E+04	–	21d	number of offsprings	–	3.E+04	3.E+04	–	*7.E+11*	*7.E+11*		Chronic
R7_C01	R7_007	Procházková, Petra et al. (2024)	Purchased	8.68	Biodegradable polyester	Sphere	*Daphnia magna*	0,1.6E+03,3.1E+03,6.3E+03,1.3E+04,2.5E+04	–	21d	mortality	<	2.E+03	3.E+03	<	*5.E+10*	*7.E+10*		Chronic
R7_C01	R7_009	Procházková, Petra et al. (2024)	Purchased	18	Biodegradable polyester	Sphere	*Daphnia magna*	0,1.6E+03,3.1E+03,6.3E+03,1.3E+04,2.5E+04	–	21d	number of offsprings	–	2.E+03	3.E+03	–	*5.E+09*	*8.E+09*		Chronic
R7_C01	R7_011	Procházková, Petra et al. (2024)	Purchased	18	Biodegradable polyester	Sphere	*Daphnia magna*	0,1.6E+03,3.1E+03,6.3E+03,1.3E+04,2.5E+04	–	21d	mortality	–	2.E+03	3.E+03	–	*5.E+09*	*8.E+09*		Chronic

List of test data

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Note 2 In cases where the literature only provides values for number or weight, shape is spherical, density is the density of the material (PE: 0.92, PET: 1.38, PP: 0.9, PS: 1.04, PVC: 1.4, others: 1), and particle size is the average of the upper and lower limits, and both are converted (converted values are in italics).
Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

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Table: Test data for quality level "A" in crustacean (2/2)

Literature Information			Experimental design								Results								
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration: Mass concentration (μg/L)	Nominal concentration: Particle number concentration (particles/m3)	Exposure time	Endpoints	Mass concentration (μg/L): Inequality Sign	Mass concentration (μg/L): NOEC	Mass concentration (μg/L): LOEC	Particle number concentration (particles/m^3): Inequality Sign	Particle number concentration (particles/m^3): NOEC	Particle number concentration (particles/m^3): LOEC	Notes	Chronic, subchronic/subacute, acute
R7_C14	R7_035	Manfra, Loredana et al. (2025)	Prepared	38～200	PP	Fragment	*Tigriopus fulvus*	0,1.0E+03,5.0E+03,1.0E+04,1.3E+04,2.5E+04,5.0E+04,1.0E+05	–	96h	mortality	＞	1.E+05	1.E+05	＞	*1.E+08*	*1.E+08*		Acute
R7_C14	R7_036	Manfra, Loredana et al. (2025)	Prepared	38～200	PP	Fragment	*Gammarus aequicauda*	0,1.0E+03,5.0E+03,1.0E+04,1.3E+04,2.5E+04,5.0E+04,1.0E+05	–	96h	mortality	–	–	3.E+04	–	–	*4.E+04*	LC50	Acute
R7_C14	R7_037	Manfra, Loredana et al. (2025)	Prepared	38～200	PP	Fragment	*Artemia franciscana*	0,1.0E+03,5.0E+03,1.0E+04,1.3E+04,2.5E+04,5.0E+04,	–	48h	mortality	＞	5.E+04	5.E+04	＞	*6.E+07*	*6.E+07*		Acute
R7_C14	R7_038	Manfra, Loredana et al. (2025)	Prepared	38～200	PLA	Fragment	*Artemia franciscana*	0,1.0E+03,5.0E+03,1.0E+04,1.3E+04,2.5E+04,5.0E+04,	–	48h	mortality	–	–	1.E+04	–	–	*1.E+04*	LC50	Acute
R7_C14	R7_039	Manfra, Loredana et al. (2025)	Prepared	38～200	PP	Fragment	*Artemia franciscana*	0,1.0E+03,5.0E+03,1.0E+04,1.3E+04,2.5E+04,5.0E+04,	–	48h	mortality	–	–	4.E+04	–	–	*4.E+04*	LC50	Acute
R7_C24	R7_040	Parolini, Marco et al. (2024)	Prepared	150	Plasmix (主にポリオレフィン(PE, PP) 60–70%, PET 4–5%, PS 2–4%の混合物)	Fragment	*Daphnia magna*	0,5.0E+01,1.0E+02,5.0E+02,1.0E+03,2.0E+03,5.0E+03,7.0E+03, 1.0E+04, 1.5E+04, 3.0E+04, 5.0E+04	–	48h	immobilization	＞	5.E+04	5.E+04	＞	*2.E+08*	*2.E+08*		Acute
R7_C24	R7_041	Parolini, Marco et al. (2024)	Prepared	500	Plasmix (主にポリオレフィン(PE, PP), PET, PSの混合物)にVibatan peroxideを添加。	Fragment	*Daphnia magna*	0,5.0E+01,1.0E+02,5.0E+02,1.0E+03,2.0E+03,5.0E+03,7.0E+03, 1.0E+04, 1.5E+04, 3.0E+04, 5.0E+04	–	48h	immobilization	＞	5.E+04	5.E+04	＞	*2.E+08*	*2.E+08*		Acute
R7_C59	R7_042	Kwak, Jin Il et al. (2024)	Supplied	15.8±7.6	HDPE	Fragment	*Artemia franciscana*	0,2.0E+04,1.0E+05	–	48h	immobilization	＞	1.E+05	1.E+05	＞	*5.E+10*	*5.E+10*		Acute
R7_C59	R7_043	Kwak, Jin Il et al. (2024)	Supplied	15.8±7.6	HDPE	Fragment	*Artemia franciscana*	0,2.0E+04,1.0E+05	–	48h	mortality	＞	1.E+05	1.E+05	＞	*5.E+10*	*5.E+10*		Acute
R7_C075	R7_044	Weber A et al. (2018)	Prepared	36	PET	Fragment	*Gammarus pulex*	–	0,8.0E+05,7.0E+06,4.0E+07,4.0E+08,4.0E+09	48d	mortality	＞	*2.E+04*	*2.E+04*	＞	4.E+09	4.E+09	・The particle size (36 μm) is calculated as the average particle size from the data in the paper.	Chronic
R7_C070	R7_058	Ziajahromi S et al. (2017)	Purchased	1～4	PE	Sphere	*Ceriodaphnia dubia*	–	2.1E+03,4.2E+06,8.4E+06,1.6E+07,3.3E+07,6.7E+07	8d	number of offsprings	–	*5.E+02*	*1.E+03*	–	3.E+07	7.E+07		Chronic
R7_C119	R7_080	Yu SP et al. (2020)	Purchased	1.7	PS	Sphere	*Amphibalanus amphitrite*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	5–6d	mortality	＞	*1.E+05*	*1.E+05*	＞	2.E+09	2.E+09		Subchronic/subacute
R7_C119	R7_081	Yu SP et al. (2020)	Purchased	6.8	PS	Sphere	*Amphibalanus amphitrite*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	5–6d	mortality	＞	*1.E+05*	*1.E+05*	＞	2.E+09	2.E+09		Subchronic/subacute
R7_C119	R7_082	Yu SP et al. (2020)	Purchased	10.4	PS	Sphere	*Amphibalanus amphitrite*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	5–6d	mortality	＞	*1.E+05*	*1.E+05*	＞	2.E+09	2.E+09		Subchronic/subacute
R7_C119	R7_083	Yu SP et al. (2020)	Purchased	19	PS	Sphere	*Amphibalanus amphitrite*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	5–6d	mortality	＞	*1.E+05*	*1.E+05*	＞	2.E+09	2.E+09		Subchronic/subacute

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Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

Table: Test data for quality level "A" in shellfish

Literature Information			Experimental design								Results							Chronic, subchronic/subacute, acute
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m^3)			
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC	
R5_001	R5_295	Bringer et al. (2020)	Purchased	1～5	Proprietary Polymer	Sphere	*Crassostrea gigas*	0,1.0E+02,1.0E+03,1.0E+04	–	24h	body length	<	1.E+02	1.E+02	<	*7.E+09*	*7.E+09*	Subchronic/subacute
R5_001	R5_296	Bringer et al. (2020)	Purchased	1～5	Proprietary Polymer	Sphere	*Crassostrea gigas*	0,1.0E+02,1.0E+03,1.0E+04	–	24h	abnormal appearance	–	1.E+02	1.E+03	–	*7.E+09*	*7.E+10*	Subchronic/subacute
R5_001	R5_297	Bringer et al. (2020)	Purchased	1～5	Proprietary Polymer	Sphere	*Crassostrea gigas*	0,1.0E+02,1.0E+03,1.0E+04	–	24h	growth	–	1.E+02	1.E+03	–	*7.E+09*	*7.E+10*	Subchronic/subacute
R5_005	R5_321	Bringer et al. (2022)	Prepared	138.6	MPs cocktail from oyster farming (28% HDPE, 40% PP and 32% PVC)	Fragment	*Crassostrea gigas*	0,1.0E+02,1.0E+04	–	2m	mortality	<	1.E+02	1.E+02	<	*7.E+04*	*7.E+04*	Subchronic/subacute
R7_S107	R7_050	Capolupo M et al. (2018)	Purchased	3	PS	Sphere	*Mytilus galloprovincialis*	–	0,5.0E+07,1.0E+08,5.0E+08,1.0E+09,5.0E+09	48h	abnormal appearance	>	*1.E+02*	*1.E+02*	>	1.E+10	1.E+10	Subchronic/subacute
R7_S109	R7_059	Tallec K et al. (2018)	Purchased	2	PS	Sphere	*Crassostrea gigas*	0,1.0E+02,1.0E+03,1.0E+04,2.5E+04	–	36h	Embryo development、abnormal appearance	>	3.E+04	3.E+04	>	*7.E+12*	*7.E+12*	Subchronic/subacute
R7_S109	R7_060	Tallec K et al. (2018)	Purchased	2	PS	Sphere	*Crassostrea gigas*	0,1.0E+02,1.0E+03,1.0E+04,2.5E+04	–	24h		>	3.E+04	3.E+04	>	*7.E+12*	*7.E+12*	Subchronic/subacute

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Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

Table: Test data for quality level “S” in fish (1/3)

Literature Information			Experimental design								Results						
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m^3)		
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC
P-0492	R6_001	Bucci K et al. (2024)	Purchased	150～500	PE	Fragment	*Pimephales promelas*	–	0,1.0E+05,2.0E+06	6m	body length	<	*2.E+03*	*3.E+04*	<	1.E+05	2.E+06
P-0492	R6_002	Bucci K et al. (2024)	Collected	150～500	PE	Fragment	*Pimephales promelas*	–	0,1.0E+05,2.0E+06	6m	abnormal appearance	<	*2.E+03*	*3.E+04*	<	1.E+05	2.E+06
P-0492	R6_003	Bucci K et al. (2024)	Collected	150～500	PE	Fragment	*Pimephales promelas*	–	0,1.0E+05,2.0E+06	6m	body length	–	*2.E+03*	*3.E+04*	–	1.E+05	2.E+06
P-0492	R6_004	Bucci K et al. (2024)	Collected	150～500	PE	Fragment	*Pimephales promelas*	–	0,1.0E+05,2.0E+06	6m	maturity	–	*2.E+03*	*3.E+04*	–	1.E+05	2.E+06
P-2065	R6_019	La Pietra A et al. (2024)	Purchased	1	PS	Sphere	*Danio rerio*	0,1.0E+01,1.0E+02,1.0E+03, 1.0E+04	–	72h	survival rate	>	1.E+04	1.E+04	>	*2.E+13*	*2.E+13*
P-2065	R6_021	La Pietra A et al. (2024)	Purchased	3	PS	Sphere	*Danio rerio*	0,1.0E+01,1.0E+02,1.0E+03, 1.0E+04	–	72h	survival	>	1.E+04	1.E+04	>	*7.E+11*	*7.E+11*
P-2196	R6_023	Wen S et al. (2024)	Purchased	10～50	PE	Fragment	*Oryzias melastigma*	0,2.0E+02	–	60d	body length、body weight、mortality	>	2.E+02	2.E+02	>	*2.E+07*	*2.E+07*
P-2196	R6_025	Wen S et al. (2024)	Purchased	100～300	PLA	Fragment	*Oryzias melastigma*	0,2.0E+02	–	60d	body length、body weight、mortality	>	2.E+02	2.E+02	>	*5.E+04*	*5.E+04*
P-3426	R6_028	Zhang D et al. (2024)	Purchased	50～100	PLA-PBAT (1:1 ratio)	–	*Danio rerio*	0,1.0E+03,2.0E+03,4.0E+03, 8.0E+03,1.6E+04	–	21d	mortality	–	–	1.E+04	–	–	*6.E+04*
P-1911	R6_086	Zhang L et al. (2024)	Purchased	100	PLA	Fragment	*Danio rerio*	0,5.0E+03	–	5w	mortality	<	5.E+03	5.E+03	<	*1.E+07*	*1.E+07*
P-1911	R6_087	Zhang L et al. (2024)	Purchased	100	PLA	Fragment	*Danio rerio*	0,5.0E+03	–	5w	hatching rate	>	5.E+03	5.E+03	>	*1.E+07*	*1.E+07*
P-1911	R6_088	Zhang L et al. (2024)	Purchased	100	PLA	Fragment	*Danio rerio*	0,5.0E+03	–	5w	body length	<	5.E+03	5.E+03	<	*1.E+07*	*1.E+07*
P-1911	R6_093	Zhang L et al. (2024)	Purchased	100	PLA (aged)	Fragment	*Danio rerio*	0,5.0E+03	–	5w	mortality	<	5.E+03	5.E+03	<	*1.E+07*	*1.E+07*
P-1911	R6_094	Zhang L et al. (2024)	Purchased	100	PLA (aged)	Fragment	*Danio rerio*	0,5.0E+03	–	5w	hatching rate	<	5.E+03	5.E+03	<	*1.E+07*	*1.E+07*
P-1911	R6_095	Zhang L et al. (2024)	Purchased	100	PLA (aged)	Fragment	*Danio rerio*	0,5.0E+03	–	5w	body length	<	5.E+03	5.E+03	<	*1.E+07*	*1.E+07*

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Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

Table: Test data for quality level “S” in fish (2/3)

Literature Information			Experimental design								Results						
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m^3)		
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC
P-1215	R6_106	Tamura Y et al. (2024)	Purchased	2	PS	Sphere	*Oryzias latipes*	0,1.0E+02	0,2.5E+10	28d	survival	<	1.E+02	1.E+02	<	3.E+10	3.E+10
P-2659	R6_109	Chu T et al. (2024)	Purchased	1.1	PS	Sphere	*Gobiocypris rarus*	0,1.0E+03,1.0E+04	–	14d	mortality	>	1.E+04	1.E+04	>	*1.E+13*	*1.E+13*
P-2659	R6_110	Chu T et al. (2024)	Purchased	1.1	PS	Sphere	*Gobiocypris rarus*	0,1.0E+03,1.0E+04	–	14d	body length、body weight	–	1.E+03	1.E+04	–	*1.E+12*	*1.E+13*
P-3575	R6_133	Sun X et al. (2023)	Purchased	16.94	PS	Sphere	*Sebastes schlegelii*	0,2.3E+02	–	15d	weight gain	<	2.E+02	2.E+02	<	*8.E+07*	*8.E+07*
P-3730	R6_140	Yang H et al. (2024)	Purchased	5	PS	Sphere	*Danio rerio*	0,1.0E+03	–	7その他	hatching rate	>	1.E+03	1.E+03	>	*1.E+10*	*1.E+10*
P-3730	R6_141	Yang H et al. (2024)	Purchased	5	PS	Sphere	*Danio rerio*	0,1.0E+03	–	7その他	body length	>	1.E+03	1.E+03	>	*1.E+10*	*1.E+10*
R5_15	R5_002	Zhang et al. (2022)	Purchased	5～50	Polyamide	Fragment	*Danio rerio*	0,1.0E+03,1.0E+04,2.0E+04	–	10d	body length、standardized body weight 、hatching rate	–	1.E+04	2.E+04	–	*6.E+08*	*1.E+09*
R5_15	R5_003	Zhang et al. (2022)	Purchased	5～50	Polyamide	Fragment	*Danio rerio*	0,1.0E+03,1.0E+04,2.0E+04	–	10d	standardized body weight	–	1.E+03	1.E+04	–	*6.E+07*	*6.E+08*
R5_20	R5_008	Malafaia et al. (2020)	Purchased	38.26	PE	Fragment	*Danio rerio*	0,6.2E+03,1.3E+04,2.5E+04, 5.0E+04,1.0E+05	0,4.4E+05,8.8E+05,1.8E+06,3.5E+06,7.1E+06	144h	survival rate of juveniles	<	6.E+03	6.E+03	<	4.E+05	4.E+05
R5_28	R5_009	Zhang et al. (2021)	Purchased	2	PS	–	*Oryzias melastigma*	0,1.0E+04	–	60d	body weight、body length、number of offsprings	>	1.E+04	1.E+04	>	*2.E+12*	*2.E+12*
R5_28	R5_010	Zhang et al. (2021)	Purchased	10	PS	–	*Oryzias melastigma*	0,1.0E+04	–	60d	body weight、body length、number of offsprings	>	1.E+04	1.E+04	>	*2.E+10*	*2.E+10*
R5_26	R5_015	Xia et al. (2022)	Purchased	53～106	PVC	–	*Oryzias melastigma*	0,5.9E+02,5.9E+05	0,1.0E+06,1.0E+09	25d	abnormal appearance	–	6.E+05	6.E+05	–	1.E+09	1.E+09
R5_2	R5_033	Wang et al. (2022)	Purchased	5	PS	Sphere	*Paramisgurnus dabryanus*	0,1.0E+02,1.0E+03	–	21d	mortality	–	1.E+02	1.E+02	–	*1.E+09*	*1.E+09*
R5_2	R5_034	Wang et al. (2022)	Purchased	5	PS	Sphere	*Paramisgurnus dabryanus*	0,1.0E+02,1.0E+03	–	21d	Weight gain	–	1.E+02	1.E+02	–	*1.E+09*	*1.E+09*
R5_2	R5_035	Wang et al. (2022)	Purchased	5	PS	Sphere	*Paramisgurnus dabryanus*	0,1.0E+02,1.0E+03	–	21d	Speific weight gain	–	1.E+02	1.E+02	–	*1.E+09*	*1.E+09*
R5_52	R5_089	Kim et al. (2022)	Purchased	14.12	HDPE	Fragment	*Danio rerio*	0,2.0E+04	0,1.4E+10	96h	mortality	>	2.E+04	2.E+04	>	1.E+10	1.E+10
R5_52	R5_091	Kim et al. (2022)	Purchased	80.32	HDPE	Fragment	*Danio rerio*	0,2.0E+04	0,7.8E+07	96h	mortality	>	2.E+04	2.E+04	>	8.E+07	8.E+07
R5_52	R5_093	Kim et al. (2022)	Purchased	120.97	HDPE	Fragment	*Danio rerio*	0,2.0E+04	0,2.3E+07	96h	mortality	>	2.E+04	2.E+04	>	2.E+07	2.E+07
R5_9	R5_112	De Marco et al. (2022)	Purchased	10	PS	Sphere	*Danio rerio*	–	0,2.0E+08	120h	hatching day, sub-lethal effects	<	*1.E+02*	*1.E+02*	<	2.E+08	2.E+08
R5_56	R5_120	Cormier et al. (2022)	Collected	53～100	PE+PP	Fragment	*Danio rerio*	0,1.0E+03,1.0E+04	–	93h	mortality	>	1.E+04	1.E+04	>	*4.E+07*	*4.E+07*

List of test data

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Note 2 In cases where the literature only provides values for number or weight, shape is spherical, density is the density of the material (PE: 0.92, PET: 1.38, PP: 0.9, PS: 1.04, PVC: 1.4, others: 1), and particle size is the average of the upper and lower limits, and both are converted (converted values are in italics).
Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

Table: Test data for quality level "S" in fish (3/3)

Literature Information			Experimental design								Results						
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m3)		
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC
R4_19	R4_028	Yao Zhao et al. (2020)	Purchased	5	PS	Sphere	*Danio rerio*	0,2.0E+01,1.0E+02	–	21d	body weight	<	2.E+01	2.E+01	<	*3.E+08*	*3.E+08*
R7_F36	R7_024	Wen, Liang et al. (2024)	Purchased	0.472～4.213	PGA	–	*Danio rerio*	0,1.0E+03,1.0E+05	–	96h	mortality	–	1.E+03	1.E+03	–	1.E+11	1.E+11
R7_F36	R7_025	Wen, Liang et al. (2024)	Purchased	0.472～4.213	PGA	–	*Danio rerio*	0,1.0E+03,1.0E+05	–	96h	body length	–	1.E+03	1.E+03	–	1.E+11	1.E+11
R7_F36	R7_026	Wen, Liang et al. (2024)	Purchased	0.6675～4.2135	PLA	–	*Danio rerio*	0,1.0E+03,1.0E+05	–	96h	mortality	–	1.E+03	1.E+03	–	1.E+11	1.E+11
R7_F36	R7_027	Wen, Liang et al. (2024)	Purchased	0.6675～4.2135	PLA	–	*Danio rerio*	0,1.0E+03,1.0E+05	–	96h	body length	<	1.E+03	1.E+03	<	1.E+11	1.E+11
R7_F37	R7_028	Hua, Jianghuan et al. (2024)	Purchased	5	PP	Fragment	*Danio rerio*	0,8.0E+01,4.0E+02,2.0E+03,1.0E+04,5.0E+04	–	48hpf	hatching rate	>	5.E+04	5.E+04	>	*8.E+11*	*8.E+11*
R7_F37	R7_029	Hua, Jianghuan et al. (2024)	Purchased	5	PP	Fragment	*Danio rerio*	0,8.0E+01,4.0E+02,2.0E+03,1.0E+04,5.0E+04	–	72hpf	abnormal appearance	>	5.E+04	5.E+04	>	*8.E+11*	*8.E+11*
R7_F37	R7_030	Hua, Jianghuan et al. (2024)	Purchased	5	PP	Fragment	*Danio rerio*	0,8.0E+01,4.0E+02,2.0E+03,1.0E+04,5.0E+04	–	120hpf	mortality	>	5.E+04	5.E+04	>	*8.E+11*	*8.E+11*
R7_F37	R7_031	Hua, Jianghuan et al. (2024)	Purchased	5	PP	Fragment	*Danio rerio*	0,8.0E+01,4.0E+02,2.0E+03,1.0E+04,5.0E+04	–	120hpf	body length	>	5.E+04	5.E+04	>	*8.E+11*	*8.E+11*
R7_F37	R7_032	Hua, Jianghuan et al. (2024)	Purchased	5	PP	Fragment	*Danio rerio*	0,8.0E+01,4.0E+02,2.0E+03,1.0E+04,5.0E+04	–	120hpf	body weight	–	4.E+02	2.E+03	–	*7.E+09*	*3.E+10*
R7_F139	R7_051	Yang H et al. (2020)	Purchased	5	PS	Sphere	*Carassius auratus*	0,1.0E+04,1.0E+05,1.0E+06	–	7d	body length	–	1.E+05	1.E+06	–	*1.E+12*	*1.E+13*
R7_F065	R7_088	Xiaohua, Xia et al. (2024)	Purchased	8～12	PE	Fragment	*Paramisgurnus dabryanus*	0,1.0E+03,5.0E+03,1.0E+04	–	21d	mortality	<	1.E+03	5.E+03	<	*2.E+09*	*1.E+10*

List of test data

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Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

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Table: Test data for quality level "S" in crustacean (1/5)

Literature Information			Experimental design								Results						
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration: Mass concentration (μg/L)	Nominal concentration: Particle number concentration (particles/m3)	Exposure time	Endpoints	Mass concentration (μg/L): Inequality Sign	Mass concentration (μg/L): NOEC	Mass concentration (μg/L): LOEC	Particle number concentration (particles/m^3): Inequality Sign	Particle number concentration (particles/m^3): NOEC	Particle number concentration (particles/m^3): LOEC
P-0909	R6_005	Pichardo-Casales B et al. (2024)	Purchased	53～63	PE	Sphere	*Minuca rapax*	0,2.0E+03	－	56d	mortality、body weight	＞	2.E+03	2.E+03	＞	*2.E+07*	*2.E+07*
P-1935	R6_100	Silveyra GR et al. (2023)	Purchased	1	PS	Sphere	*Procambarus clarkii*	－	0,1.0E+09,5.0E+09	30d	weight gain	＞	*3.E+00*	*3.E+00*	＞	5.E+09	5.E+09
P-1935	R6_103	Silveyra GR et al. (2023)	Purchased	1	PS	Sphere	*Leptuca pugilator*	－	0,1.0E+09,5.0E+09	30d	weight gain	－	*5.E-01*	*3.E+00*	－	1.E+09	5.E+09
P-3052	R6_114	De Felice B et al. (2024)	Prepared	164	PLA	Fragment	*Daphnia magna*	0,5.0E+01,1.0E+02,1.0E+03,5.0E+03,1.5E+04	－	48h	immobilization	＞	2.E+04	2.E+04	＞	*9.E+06*	*9.E+06*
R5_13	R5_134	Watts et al. (2016)	Purchased	8	PS	Sphere	*Carcinus maenas*	－	0,1.0E+09,1.0E+10	24h	mortality	＞	*3.E+03*	*3.E+03*	＞	1.E+10	1.E+10
R5_17	R5_138	Heindler et al. (2017)	Prepared	11	PET	Fragment	*Parvocalanus crassirostris*	－	0,1.0E+10,2.0E+10,4.0E+10,8.0E+10	5d	number of eggs	－	*5.E+03*	*1.E+04*	－	4.E+10	8.E+10
R5_17	R5_139	Heindler et al. (2017)	Prepared	11	PET	Fragment	*Parvocalanus crassirostris*	－	0,2.0E+10	24d	population size	＜	*2.E+03*	*2.E+03*	＜	2.E+10	2.E+10
R5_11	R5_140	Shore et al. (2021)	Purchased	6～8	PS	－	*Acartia tonsa*	－	0,1.2E+09	5 or 7d	Copepodid: survival、body length Parent Shrimp: number of eggs	＜	*2.E+02*	*2.E+02*	＜	1.E+09	1.E+09
R5_26	R5_147	Yu et al. (2020)	Purchased	10～30	PE	－	*Tigriopus japonicus*	0,1.3E+04	－	14d	number of eggs、survival	－	1.E+04	1.E+04	－	*3.E+09*	*3.E+09*
R5_26	R5_149	Yu et al. (2020)	Purchased	5～20	PA6	－	*Tigriopus japonicus*	0,1.3E+04	－	14d	number of eggs、survival	－	1.E+04	1.E+04	－	*1.E+10*	*1.E+10*
R5_27	R5_150	Liu et al. (2022)	Purchased	2	PVC	－	*Daphnia magna*	0,2.1E+03	－	21d	number of offsprings	－	2.E+03	2.E+03	－	*3.E+11*	*3.E+11*
R5_27	R5_151	Liu et al. (2022)	Purchased	50	PVC	－	*Daphnia magna*	0,2.1E+03	－	21d	1st number of offsprings	－	2.E+03	2.E+03	－	*2.E+07*	*2.E+07*
R5_30	R5_154	An et al. (2021)	Purchased	40～48	PE	Sphere	*Daphnia magna*	－	0,3.4E+09	21d	growth、number of offsprings	＞	*1.E+05*	*1.E+05*	＞	3.E+09	3.E+09
R5_30	R5_155	An et al. (2021)	Prepared	17	PE	Fragment	*Daphnia magna*	－	0,2.1E+10	21d	mortality、growth、number of offsprings	＜	*5.E+04*	*5.E+04*	＜	2.E+10	2.E+10
R5_30	R5_156	An et al. (2021)	Prepared	34	PE	Fragment	*Daphnia magna*	－	0,1.7E+10	21d	mortality	－	*4.E+05*	*4.E+05*	－	2.E+10	2.E+10
R5_4	R5_157	Martins et al. (2018)	Purchased	1～5	Thermoset amino formaldehyde polymer	Sphere	*Daphnia magna*	0,1.0E+02	－	F0 to F2	mortality, growth (F0, F1) number of offsprings, first hatcing day(F1)	＜	1.E+02	1.E+02	＜	*7.E+09*	*7.E+09*
R5_5	R5_158	Guilhermino et al. (2021)	Purchased	1～5	Thermoset amino formaldehyde polymer	Sphere	*Daphnia magna*	0,4.0E+01,9.0E+01,1.9E+02	－	21d	growth、number of offsprings, survival of offsprings	－	4.E+01	9.E+01	－	*1.E+10*	*2.E+10*
R5_8	R5_160	Lee et al. (2021)	Purchased	1～1.2	PS	Sphere	*Neomysis awatschensis*	－	0,1.0E+09,5.0E+09,1.0E+10,5.0E+10,1.0E+11	40d	mortality	－	*7.E+00*	*4.E+01*	－	1.E+10	5.E+10
R5_8	R5_161	Lee et al. (2021)	Purchased	10～10.35	PS	Sphere	*Neomysis awatschensis*	－	0,1.0E+09,5.0E+09,1.0E+10,5.0E+10,1.0E+11	40d	mortality	－	*6.E+03*	*3.E+04*	－	1.E+10	5.E+10
R5_8	R5_162	Lee et al. (2021)	Purchased	1～1.2	PS	Sphere	*Neomysis awatschensis*	－	0,5.0E+10,1.0E+11	40d	Number of newborn juvenil female	－	*7.E+01*	*7.E+01*	－	1.E+11	1.E+11
R5_8	R5_163	Lee et al. (2021)	Purchased	10～10.35	PS	Sphere	*Neomysis awatschensis*	－	0,5.0E+10,1.0E+11	40d	Number of newborn juvenil female	－	*6.E+04*	*6.E+04*	－	1.E+11	1.E+11

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Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

Table: Test data for quality level "S" in crustacean (2/5)

Literature Information			Experimental design								Results						
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m³)		
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC
R5_9	R5_164	Eom et al. (2020)	Purchased	1	PS	Sphere	*Artemia franciscana*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	30d	mortality	–	*5.E-03*	*5.E-02*	–	1.E+07	1.E+08
R5_9	R5_165	Eom et al. (2020)	Purchased	3	PS	Sphere	*Artemia franciscana*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	30d	mortality	–	*1.E-01*	*1.E+00*	–	1.E+07	1.E+08
R5_9	R5_166	Eom et al. (2020)	Purchased	6	PS	Sphere	*Artemia franciscana*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	30d	mortality	–	*1.E+00*	*1.E+01*	–	1.E+07	1.E+08
R5_9	R5_167	Eom et al. (2020)	Purchased	10	PS	Sphere	*Artemia franciscana*	–	0,1.0E+06,1.0E+07,1.0E+08,1.0E+09	30d	mortality	–	*5.E+00*	*5.E+01*	–	1.E+07	1.E+08
R5_10	R5_170	Eltemsah et al. (2019)	Purchased	6	PS	Sphere	*Daphnia magna*	0,5.0E+03,1.0E+04,3.0E+04,5.0E+04,1.0E+05	–	15d	Body length	–	1.E+04	3.E+04	–	*9.E+10*	*3.E+11*
R5_10	R5_171	Eltemsah et al. (2019)	Purchased	6	PS	Sphere	*Daphnia magna*	0,5.0E+03,3.0E+04,1.0E+05	–	21d	Body length	<	5.E+03	5.E+03	<	*4.E+10*	*4.E+10*
R5_33	R5_180	Schwarzer et al. (2022)	Purchased	5.4～6.6	PS	Sphere	*Daphnia magna*	–	0,5.0E+08,5.0E+09	21d	body length	<	*6.E+01*	*6.E+01*	<	5.E+08	5.E+08
R5_33	R5_180b	Schwarzer et al. (2022)	Purchased	18～22	PS	Sphere	*Daphnia magna*	–	0,5.0E+08,5.0E+09	21d	body length	>	*2.E+04*	*2.E+04*	>	5.E+09	5.E+09
R5_34	R5_183	Gray et al. (2022)	Purchased	32～38	PE	Sphere	*Palaemon pugio*	0,3.8E+00,3.8E+01,3.8E+02	0,6.3E+04,6.3E+05,6.3E+06	23d	mortality	<	4.E+00	4.E+00	<	6.E+04	6.E+04
R5_34	R5_184	Gray et al. (2022)	Purchased	53～63	PE	Sphere	*Palaemonetes pugio*	0,2.0E+01,2.0E+02,2.0E+03	0,6.3E+04,6.3E+05,6.3E+06	23d	mortality	<	2.E+01	2.E+01	<	6.E+04	6.E+04
R5_18	R5_188	Trotter et al. (2021)	Supplied	13.03	PS	Sphere	*Daphnia magna*	0,1.0E+05	–	19d	mortality、body length、number of second offspring	<	1.E+05	1.E+05	<	*8.E+10*	*8.E+10*
R5_40	R5_195	Li, et al. (2021)	Purchased	150	PS	Sphere	*Artemia parthenogenetica*	0,1.0E+05	–	45d	growth	–	1.E+05	1.E+05	–	*5.E+07*	*5.E+07*
R5_40	R5_196	Li, et al. (2021)	Purchased	150	PE	Sphere	*Artemia parthenogenetica*	0,1.0E+05	–	45d	growth	–	1.E+05	1.E+05	–	*6.E+07*	*6.E+07*
R5_43	R5_203	Kokalj et al. (2018)	Purchased	102.9	PE	Fragment	*Daphnia magna*	0,1.0E+05	–	48h	survival、body length	>	1.E+05	1.E+05	>	*2.E+08*	*2.E+08*
R5_43	R5_204	Kokalj et al. (2018)	Collected	63.05	PE	Fragment	*Daphnia magna*	0,1.0E+05	–	48h	survival、body length	>	1.E+05	1.E+05	>	*8.E+08*	*8.E+08*
R5_43	R5_205	Kokalj et al. (2018)	Collected	264	PE	Fragment	*Daphnia magna*	0,1.0E+05	–	48h	survival、body length	>	1.E+05	1.E+05	>	*1.E+07*	*1.E+07*
R5_43	R5_206	Kokalj et al. (2018)	Collected	247.9	PE	Fragment	*Daphnia magna*	0,1.0E+05	–	48h	survival、body length	>	1.E+05	1.E+05	>	*1.E+07*	*1.E+07*
R5_43	R5_207	Kokalj et al. (2018)	Collected	136.8	PE	Fragment	*Daphnia magna*	0,1.0E+05	–	48h	survival、body length	>	1.E+05	1.E+05	>	*8.E+07*	*8.E+07*
R5_43	R5_210	Kokalj et al. (2018)	Collected	102.9	PE	Fragment	*Artemia franciscana*	0,1.0E+05	–	48h	growth	<	1.E+05	1.E+05	<	*2.E+08*	*2.E+08*
R5_43	R5_211	Kokalj et al. (2018)	Collected	63.05	PE	Fragment	*Artemia franciscana*	0,1.0E+05	–	48h	growth	<	1.E+05	1.E+05	<	*8.E+08*	*8.E+08*
R5_43	R5_212	Kokalj et al. (2018)	Collected	264	PE	Fragment	*Artemia franciscana*	0,1.0E+05	–	48h	growth	<	1.E+05	1.E+05	<	*1.E+07*	*1.E+07*
R5_43	R5_213	Kokalj et al. (2018)	Collected	247.9	PE	Fragment	*Artemia franciscana*	0,1.0E+05	–	48h	growth	<	1.E+05	1.E+05	<	*1.E+07*	*1.E+07*
R5_43	R5_214	Kokalj et al. (2018)	Prepared	136.8	PE	Fragment	*Artemia franciscana*	0,1.0E+05	–	48h	growth	<	1.E+05	1.E+05	<	*8.E+07*	*8.E+07*
R5_47	R5_235	Wang et al. (2021)	Purchased	5	PE	Sphere	*Litopenaeus vannamei*	0,5.0E+01,5.0E+02,5.0E+03	0,7.3E+08,7.3E+09,7.3E+10	48h	survival	–	5.E+03	5.E+03	–	7.E+10	7.E+10

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Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

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Table: Test data for quality level "S" in crustacean (3/5)

Literature Information			Experimental design								Results							
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration: Mass concentration (μg/L)	Nominal concentration: Particle number concentration (particles/m3)	Exposure time	Endpoints	Mass concentration (μg/L): Inequality Sign	Mass concentration (μg/L): NOEC	Mass concentration (μg/L): LOEC	Particle number concentration (particles/m^3): Inequality Sign	Particle number concentration (particles/m^3): NOEC	Particle number concentration (particles/m^3): LOEC	Notes
R5_48	R5_237	Wang et al. (2021)	Purchased	5	PE	Sphere	*Penaeus monodon*	0,2.5E+04,5.0E+04,1.0E+05,2.0E+05,3.0E+05	0,3.6E+11,7.3E+11,1.5E+12,2.9E+12,4.4E+12	48h	mortality	–	5.E+04	1.E+05	–	7.E+11	1.E+12	
R5_48	R5_239	Wang et al. (2021)	Purchased	5	PE	Sphere	*Marsupenaeus japonicus*	0,2.5E+04,5.0E+04,1.0E+05,2.0E+05,3.0E+05	0,3.6E+11,7.3E+11,1.5E+12,2.9E+12,4.4E+12	48h	mortality	–	5.E+04	1.E+05	–	7.E+11	1.E+12	
R5_48	R5_241	Wang et al. (2021)	Purchased	5	PE	Sphere	*Lipopenaeus vanamei*	0,2.5E+04,5.0E+04,1.0E+05,2.0E+05,3.0E+05	0,3.6E+11,7.3E+11,1.5E+12,2.9E+12,4.4E+12	48h	mortality	–	5.E+04	1.E+05	–	7.E+11	1.E+12	
R5_7	R5_255	Jaikumar et al. (2019)	Purchased	1～5	PS	Sphere	*Daphnia pulex*	–	0,1.0E+08,1.0E+09,1.0E+10,1.0E+11	21d	number of offsprings up to 3rd blood	<	*1.E+00*	*1.E+00*	<	1.E+08	1.E+08	
R5_7	R5_256	Jaikumar et al. (2019)	Purchased	1～5	PS	Sphere	*Ceriodaphnia dubia*	–	0,1.0E+08,1.0E+09,1.0E+10,1.0E+11	7d	number of offsprings up to 3rd blood	<	*1.E+00*	*1.E+00*	<	1.E+08	1.E+08	
R5_7	R5_258	Jaikumar et al. (2019)	Prepared	1～10	PS	Fragment	*Daphnia pulex*	–	0,1.0E+08,1.0E+09,1.0E+10,1.0E+11	21d	number of offsprings up to 3rd blood	<	*9.E+00*	*9.E+00*	<	1.E+08	1.E+08	
R5_7	R5_259	Jaikumar et al. (2019)	Prepared	1～10	PS	Fragment	*Ceriodaphnia dubia*	–	0,1.0E+08,1.0E+09,1.0E+10,1.0E+11	7d	number of offsprings up to 3rd blood, total number of	–	*9.E+00*	*9.E+01*	–	1.E+08	1.E+09	
R5_24	R5_261	Cole et al. (2015)	Purchased	20	PS	Sphere	*Calanus helgolandicus*	–	0,7.5E+07	2d	hatching rate	<	*3.E+02*	*3.E+02*	<	8.E+07	8.E+07	
R5_36	R5_263	Schür et al. (2022)	Prepared	0.2～60	PS	Fragment	*Daphnia magna*	–	0,8.0E+07,4.0E+08,2.0E+09,1.0E+10	21d	mortality、reproduction(F1)	–	*1.E+03*	*6.E+03*	–	8.E+07	4.E+08	
R5_36	R5_264	Schür et al. (2022)	Prepared	0.2～60	PS	Fragment	*Daphnia magna*	–	0,8.0E+07,4.0E+08,2.0E+09,1.0E+10	21d	mortality、reproduction(F2)	–	*1.E+03*	*6.E+03*	–	8.E+07	4.E+08	
R5_36	R5_265	Schür et al. (2022)	Prepared	0.2～60	PS	Fragment	*Daphnia magna*	–	0,8.0E+07,4.0E+08,2.0E+09,1.0E+10	21d	mortality、reproduction(F3)	–	*1.E+03*	*6.E+03*	–	8.E+07	4.E+08	
R5_51	R5_270	Rani-Borges et al. (2023)	Purchased	24.5	PS	Sphere	*Hyalella azteca*	–	0,5.4E+05,2.7E+06,5.4E+06	7d	survival	>	*4.E+01*	*4.E+01*	>	5.E+06	5.E+06	
R5_53	R5_273	Sun et al. (2022)	Purchased	5	PS	Sphere	*Macrobrachium nipponense*	0,2.0E+03,2.0E+04	0,5.6E+07,5.8E+08	4w	body weight	–	2.E+03	2.E+03	–	6.E+07	6.E+07	
R5_53	R5_274	Sun et al. (2022)	Purchased	5	PS	Sphere	*Macrobrachium nipponense*	0,2.0E+03,2.0E+04	0,5.6E+07,5.8E+08	4w	abnormal appearance、hatching rate、mortality	–	2.E+03	2.E+03	–	6.E+07	6.E+07	
R5_54	R5_284	Kim et al. (2022)	Purchased	1.88	PS	Sphere	*Tigriopus japonicus*	0,5.0E+00,1.0E+02,1.0E+03,1.0E+04,1.0E+05	0,1.2E+08,2.3E+10,2.3E+11,2.3E+12,2.3E+13	40d	reproduction	–	1.E+03	1.E+04	–	2.E+11	2.E+12	
R4_1	R4_001	Jaehee Kim et al. (2021)	Purchased	2	PS	Sphere	*Moina macrocopa*	0,1.0E-03,1.0E-02,1.0E-01,1.0E+00,1.0E+01,5.0E+0	–	14d	mortality	–	1.E-02	1.E-01	–	*2.E+06*	*2.E+07*	
R4_3	R4_006	Gayathri Jaikumar et al. (2018)	Purchased	1～5	–	Sphere	*Daphnia magna*	–	0,1.0E+09,1.0E+10,1.0E+11,1.0E+12,1.0E+13	96h	mortality	–	–	*3.E+01*	–	–	2.E+09	LC50
R4_3	R4_008	Rodríguez-Torres R et al. (2020)	Purchased	1～5	–	Sphere	*Daphnia magna*	–	0,1.0E+09,1.0E+10,1.0E+11,1.0E+12,1.0E+13	96h	mortality	–	–	*8.E+00*	–	–	6.E+08	LC50
R4_7	R4_36e	Rodríguez-Torres R et al. (2020)	Purchased	13.9～30.3	PE	Sphere	*Calanus finmarchicus*	–	0,2.0E+05,2.0E+07	6d	mortality	>	*9.E+01*	*9.E+01*	>	2.E+07	2.E+07	
R4_7	R4_36f	Rodríguez-Torres R et al. (2020)	Purchased	13.9～30.3	PE	Sphere	*Calanus glacialis*	–	0,2.0E+05,2.0E+07	6d	mortality	>	*9.E+01*	*9.E+01*	>	2.E+07	2.E+07	
R4_7	R4_36g	Rodríguez-Torres R et al. (2020)	Purchased	13.9～30.3	PE	Sphere	*Calanus hyperboreus*	–	0,2.0E+05,2.0E+07	6d	mortality	>	*9.E+01*	*9.E+01*	>	2.E+07	2.E+07	
R7_C01	R7_001	Procházková, Petra et al. (2024)	Purchased	8.68	Biodegradable polyester	Sphere	*Daphnia magna*	0,6.3E+03,1.3E+04,2.5E+04,5.0E+04,1.0E+05	–	96h	immobilization	>	1.E+05	1.E+05	>	*2.E+12*	*2.E+12*	
R7_C01	R7_002	Procházková, Petra et al. (2024)	Purchased	17.96	Biodegradable polyester	Sphere	*Daphnia magna*	0,6.3E+03,1.3E+04,2.5E+04,5.0E+04,1.0E+05	–	96h	immobilization	>	1.E+05	1.E+05	>	*3.E+11*	*3.E+11*	
R7_C01	R7_003	Procházková, Petra et al. (2024)	Purchased	8.68	Biodegradable polyester	Sphere	*Daphnia magna*	0,6.3E+03,1.3E+04,2.5E+04,5.0E+04,1.0E+05	–	96h	immobilization	>	1.E+05	1.E+05	>	*2.E+12*	*2.E+12*	
R7_C01	R7_004	Procházková, Petra et al. (2024)	Purchased	17.96	Biodegradable polyester	Sphere	*Daphnia magna*	0,6.3E+03,1.3E+04,2.5E+04,5.0E+04,1.0E+05	–	96h	immobilization	>	1.E+05	1.E+05	>	*3.E+11*	*3.E+11*	

List of test data

Note1:For the source documents of each test data, see the Annex List of peer-reviewed publications.
Note 2 In cases where the literature only provides values for number or weight, shape is spherical, density is the density of the material (PE: 0.92, PET: 1.38, PP: 0.9, PS: 1.04, PVC: 1.4, others: 1), and particle size is the average of the upper and lower limits, and both are converted (converted values are in italics).
Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

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Table: Test data for quality level “S” in crustacean (4/5)

Literature Information			Experimental design								Results							
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration: Mass concentration (μg/L)	Nominal concentration: Particle number concentration (particles/m3)	Exposure time	Endpoints	Mass concentration (μg/L): Inequality Sign	Mass concentration (μg/L): NOEC	Mass concentration (μg/L): LOEC	Particle number concentration (particles/m^3): Inequality Sign	Particle number concentration (particles/m^3): NOEC	Particle number concentration (particles/m^3): LOEC	Notes
R7_C04	R7_013	Botterell, Zara L. R. et al. (2025)	Prepared	5～100	LDPE, PP, PA-6, polycaproamide	Fragment	*Acartia tonsa*	0,4.0E+01,8.0E+01,1.2E+02,1.6E+02,2.0E+02,4.0E+02,	－	72h	mortality	－	－	2.E+02	－	－	*2.E+06*	LC50
R7_C04	R7_014	Botterell, Zara L. R. et al. (2025)	Prepared	5～100	LDPE, PP, PA-6, polycaproamide	Fragment	*Acartia tonsa*	0,1.0E+01,1.0E+02,1.0E+03	－	5d	mortality	－	1.E+03	1.E+03	－	*1.E+07*	*1.E+07*	
R7_C04	R7_015	Botterell, Zara L. R. et al. (2025)	Prepared	5～100	LDPE, PP, PA-6, polycaproamide	Fragment	*Acartia tonsa*	0,1.0E+01,1.0E+02	－	14d		＞	1.E+02	1.E+02	＞	*1.E+06*	*1.E+06*	
R7_C04	R7_016	Botterell, Zara L. R. et al. (2025)	Prepared	5～100	LDPE, PP, PA-6, polycaproamide	Fragment	*Acartia tonsa*	0,1.0E+01,1.0E+02	－	14d	Growth	＞	1.E+02	1.E+02	＞	*1.E+06*	*1.E+06*	
R7_C04	R7_017	Botterell, Zara L. R. et al. (2025)	Prepared	5～100	LDPE, PP, PA-6, polycaproamide	Fragment	*Acartia tonsa*	0,1.0E+01,1.0E+02	－	14d	mortality	＞	1.E+02	1.E+02	＞	*1.E+06*	*1.E+06*	
R7_C081	R7_047	Canniff PM et al. (2018)	Purchased	63～75	PE	Sphere	*Daphnia magna*	0,2.5E+04,5.0E+04,1.0E+05	0,1.9E+09,3.8E+09,7.6E+09	21d	number of offsprings	－	1.E+05	1.E+05	－	8.E+09	8.E+09	
R7_C026	R7_052	Nik Mut, Nik Nurhidayu et al.	Prepared	25～53	PLA	Fragment	*Daphnia magna*	0,2.5E+03,5.0E+03	－	17d	number of offsprings	－	3.E+03	5.E+03	－	*2.E+08*	*4.E+08*	
R7_C089	R7_061	Yu P et al. (2018)	Purchased	5	PS	Sphere	*Eriocheir sinensis*	0,4.0E+01,4.0E+02,4.0E+03,4.0E+04	0,5.4E+08,5.4E+09,5.4E+10,5.4E+11	21d	mortality	＞	4.E+04	4.E+04	＞	5.E+11	5.E+11	
R7_C089	R7_062	Yu P et al. (2018)	Purchased	5	PS	Sphere	*Eriocheir sinensis*	0,4.0E+01,4.0E+02,4.0E+03,4.0E+04	0,5.4E+08,5.4E+09,5.4E+10,5.4E+11	21d	body weight	－	4.E+03	4.E+04	－	5.E+10	5.E+11	
R7_C097	R7_067	Zimmermann L et al. (2020)	Purchased and prepared	59	PVC	Fragment	*Daphnia magna*	0,1.0E+04,5.0E+04,1.0E+05,5.0E+05	－	21d	number of offsprings	NA	－	5.E+04	NA	－	*2.E+06*	EC50
R7_C097	R7_068	Zimmermann L et al. (2020)	Purchased and prepared	59	PVC	Fragment	*Daphnia magna*	0,1.0E+04,5.0E+04,1.0E+05,5.0E+05	－	21d	mortality	＞	1.E+05	1.E+05	＞	*2.E+09*	*2.E+09*	
R7_C097	R7_069	Zimmermann L et al. (2020)	Purchased and prepared	59	PUR	Fragment	*Daphnia magna*	0,1.0E+04,5.0E+04,1.0E+05,5.0E+05	－	21d	number of offsprings	－	－	2.E+05	－	－	*2.E+07*	EC50
R7_C097	R7_070	Zimmermann L et al. (2020)	Purchased and prepared	59	PUR	Fragment	*Daphnia magna*	0,1.0E+04,5.0E+04,1.0E+05,5.0E+05	－	21d	mortality	＞	1.E+05	1.E+05	＞	*2.E+09*	*2.E+09*	
R7_C097	R7_071	Zimmermann L et al. (2020)	Purchased and prepared	59	PLA	Fragment	*Daphnia magna*	0,1.0E+04,5.0E+04,1.0E+05,5.0E+05	－	21d	number of offsprings	－	－	1.E+05	－	－	*9.E+06*	EC50
R7_C097	R7_072	Zimmermann L et al. (2020)	Purchased and prepared	59	PLA	Fragment	*Daphnia magna*	0,1.0E+04,5.0E+04,1.0E+05,5.0E+05	－	21d	mortality	＞	1.E+05	1.E+05	＞	*2.E+09*	*2.E+09*	
R7_C097	R7_073	Zimmermann L et al. (2020)	Purchased and prepared	59	PVC	Fragment	*Daphnia magna*	0,4.6E+04	－	21d	number of offsprings	＞	5.E+04	5.E+04	＞	*3.E+09*	*3.E+09*	
R7_C097	R7_074	Zimmermann L et al. (2020)	Purchased and prepared	59	PVC	Fragment	*Daphnia magna*	0,4.6E+04	－	21d	mortality	＞	5.E+04	5.E+04	＞	*3.E+09*	*3.E+09*	
R7_C097	R7_075	Zimmermann L et al. (2020)	Purchased and prepared	59	PUR	Fragment	*Daphnia magna*	0,2.4E+05	－	21d	number of offsprings	＜	2.E+05	2.E+05	＜	*1.E+10*	*1.E+10*	
R7_C097	R7_076	Zimmermann L et al. (2020)	Purchased and prepared	59	PUR	Fragment	*Daphnia magna*	0,2.4E+05	－	21d	mortality	＞	2.E+05	2.E+05	＞	*1.E+10*	*1.E+10*	
R7_C097	R7_077	Zimmermann L et al. (2020)	Purchased and prepared	59	PLA	Fragment	*Daphnia magna*	0,1.2E+05	－	21d	number of offsprings	＜	1.E+05	1.E+05	＜	*7.E+09*	*7.E+09*	
R7_C097	R7_078	Zimmermann L et al. (2020)	Purchased and prepared	59	PLA	Fragment	*Daphnia magna*	0,1.2E+05	－	21d	mortality	＜	1.E+05	1.E+05	＜	*7.E+09*	*7.E+09*	

List of test data

Note1:For the source documents of each test data, see the Annex List of peer-reviewed publications.
Note 2 In cases where the literature only provides values for number or weight, shape is spherical, density is the density of the material (PE: 0.92, PET: 1.38, PP: 0.9, PS: 1.04, PVC: 1.4, others: 1), and particle size is the average of the upper and lower limits, and both are converted (converted values are in italics).
Note 3: If a significant effect was observed in the lowest concentration group, an inequality sign "<" is used, and if no significant effect was observed in the highest concentration group, an inequality sign ">" is used.

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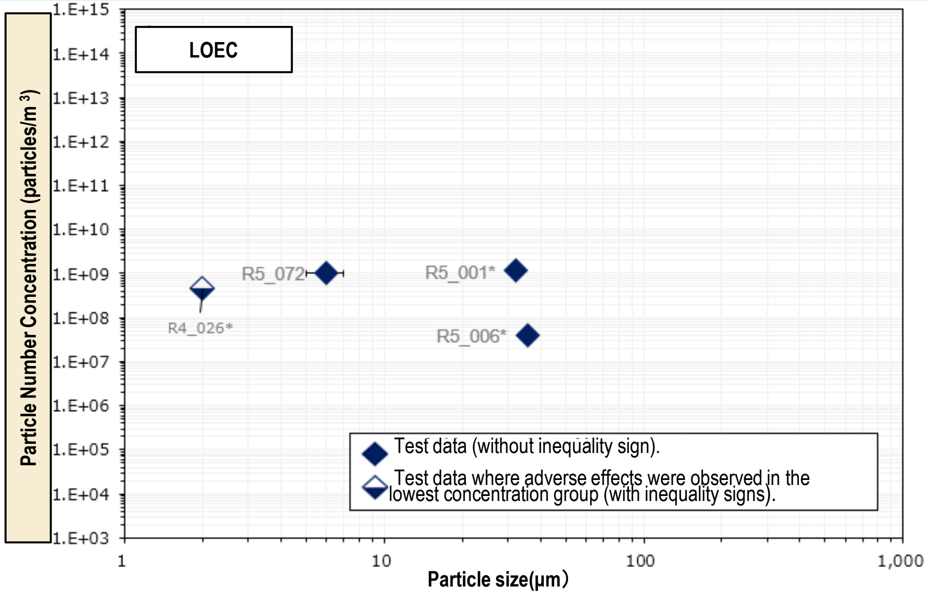
Table: Test data for quality level “S” in crustacean (5/5)

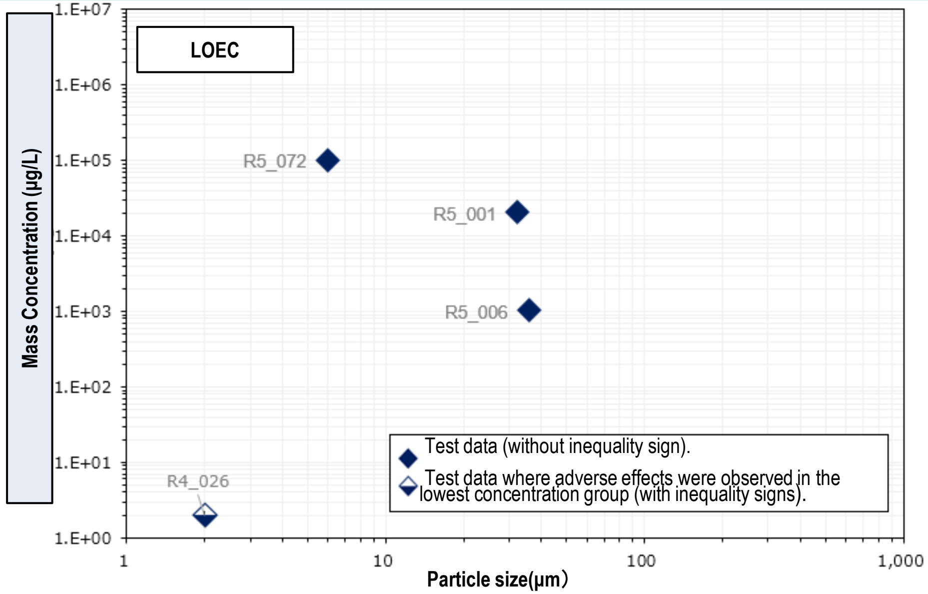
Literature Information			Experimental design								Results							
Literature No.	Record No.	Author(s)	Source of MicP	Particle size (μm)	Polymer type	Particle shape	Test organism	Nominal concentration		Exposure time	Endpoints	Mass concentration (μg/L)			Particle number concentration (particles/m^3)			Notes
								Mass concentration (μg/L)	Particle number concentration (particles/m3)			Inequality Sign	NOEC	LOEC	Inequality Sign	NOEC	LOEC	
R7_C100	R7_079	Gerdes Z et al. (2019)	Purchased and prepared	5	PET	Fragment	*Daphnia magna*	0,1.0E+02,1.0E+03,1.0E+04,1.0E+05,1.0E+06,1.0E+07	–	96h	immobilization	–	–	6.E+04	–	–	*6.E+08*	LC50
R7_C124	R7_084	Rist S et al. (2017)	Purchased	2.37	PS	Sphere	*Daphnia magna*	0,1.0E+02,5.0E+02,1.0E+03	–	21d	number of offsprings	>	1.E+03	1.E+03	>	*1.E+11*	*1.E+11*	
R7_C124	R7_085	Rist S et al. (2017)	Purchased	2.37	PS	Sphere	*Daphnia magna*	0,1.0E+02,5.0E+02,1.0E+03	–	21d		>	1.E+03	1.E+03	>	*1.E+11*	*1.E+11*	
R7_C124	R7_086	Rist S et al. (2017)	Purchased	2.37	PS	Sphere	*Daphnia magna*	0,1.0E+02,5.0E+02,1.0E+03	–	21d		>	1.E+03	1.E+03	>	*1.E+11*	*1.E+11*	

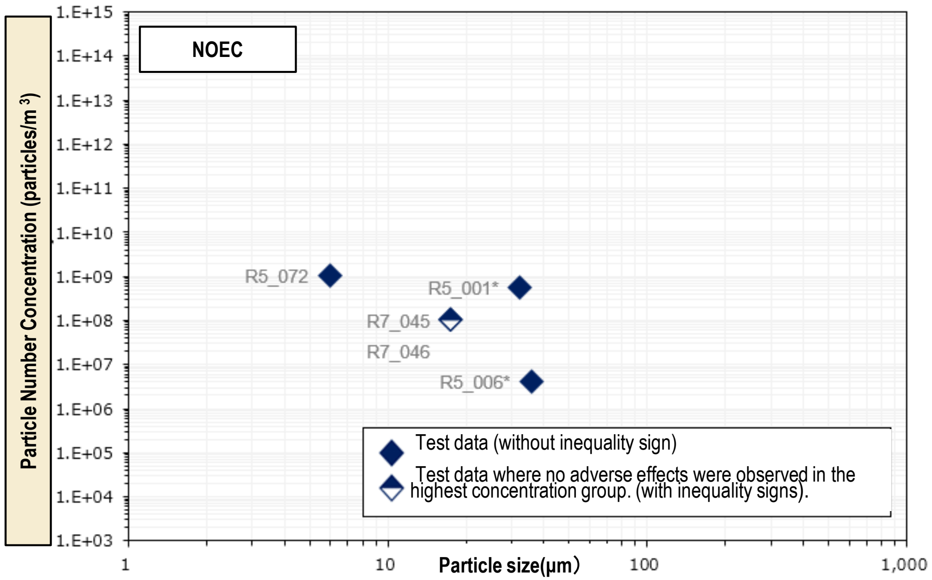
*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

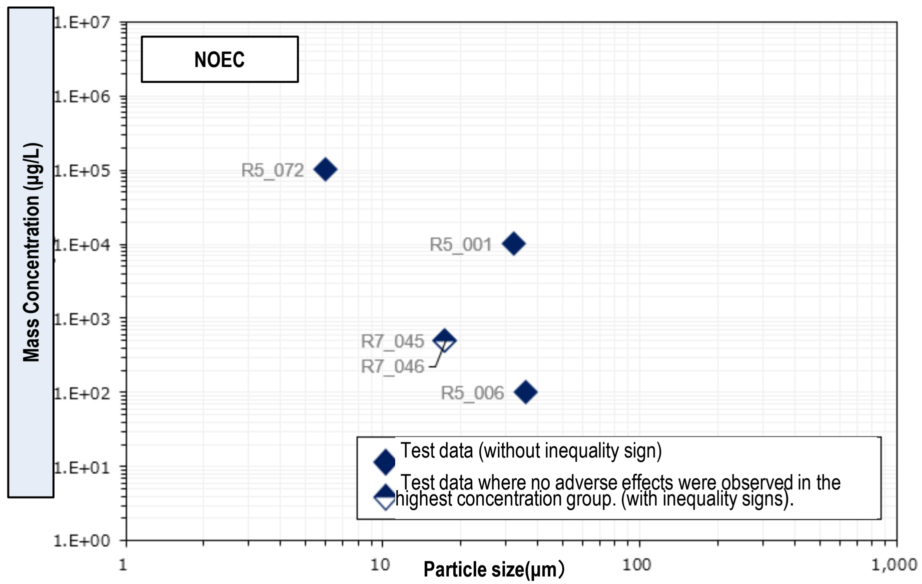
List of test data (correspondence between effect concentration and particle size)

- Correspondence between effect concentration and particle size for test data is shown below (Fish, quality level “A" and subchronic/subacute).





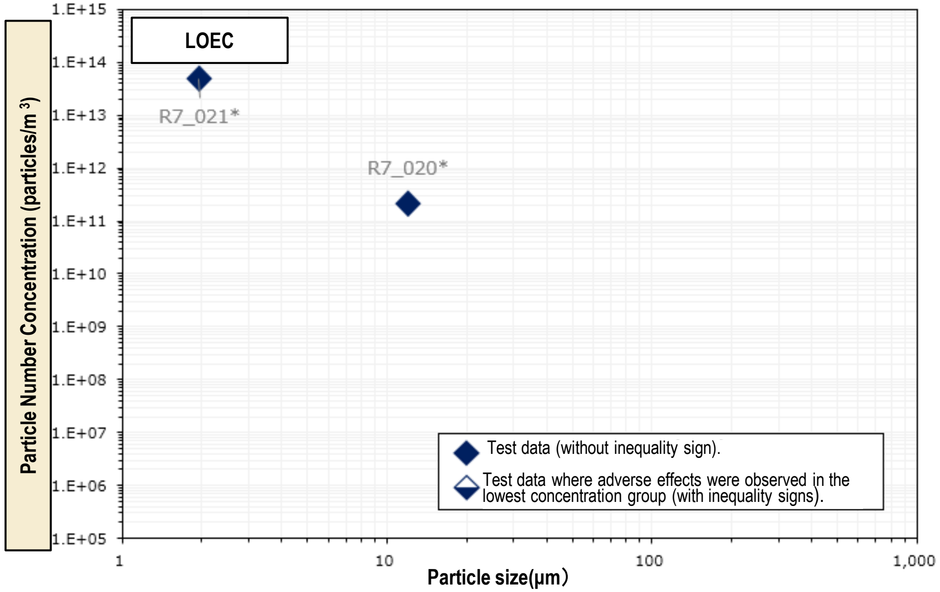


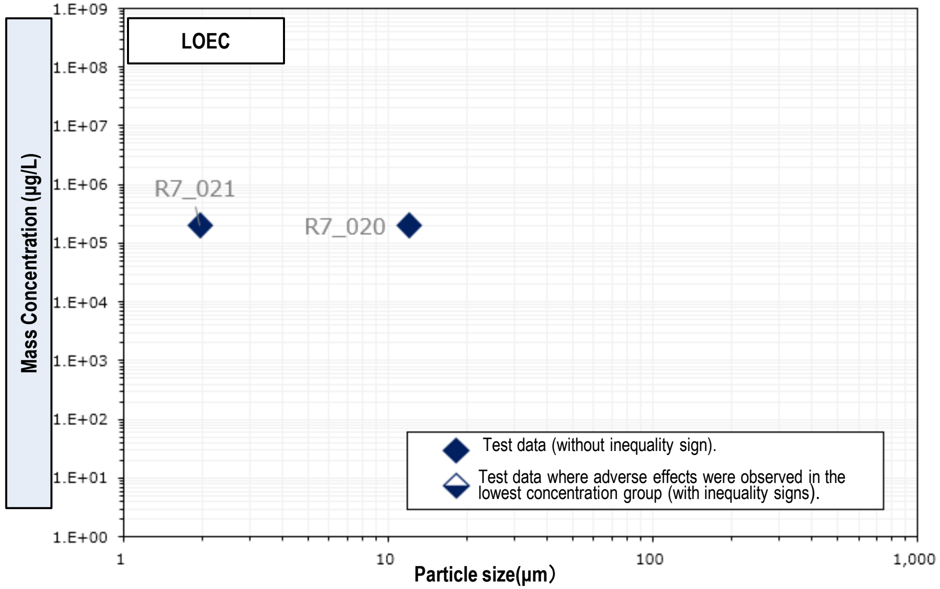


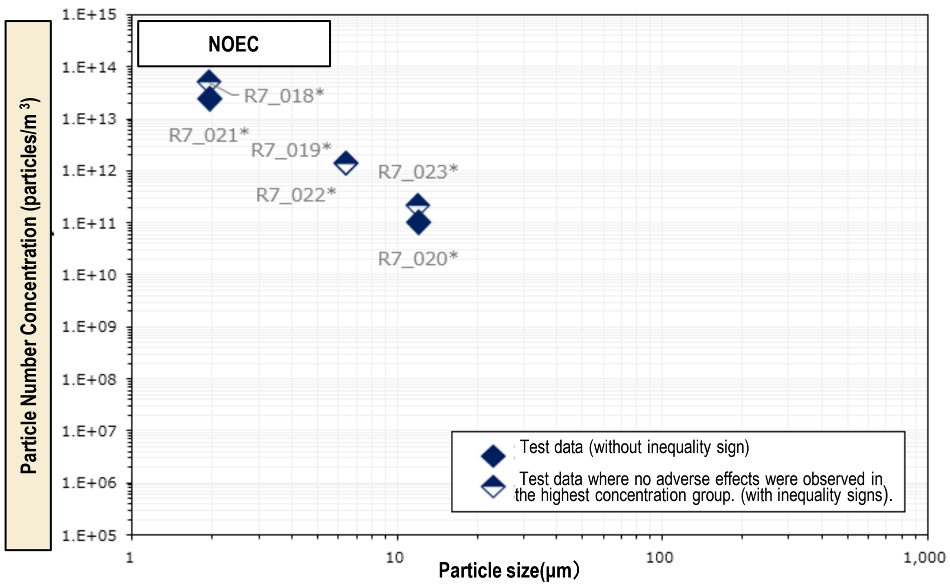
*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

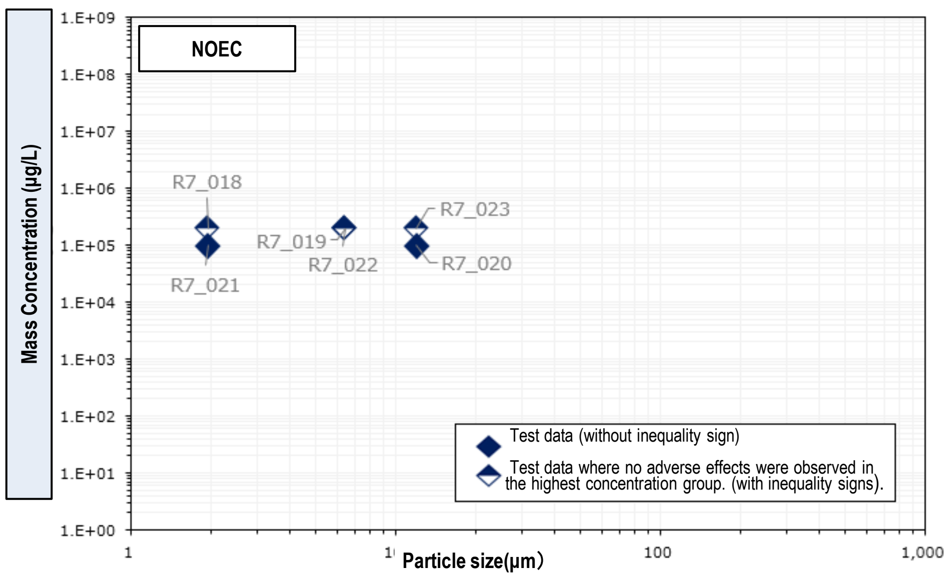
List of test data (correspondence between effect concentration and particle size)

- Correspondence between effect concentration and particle size for test data is shown below (Fish, quality level “A" and acute).







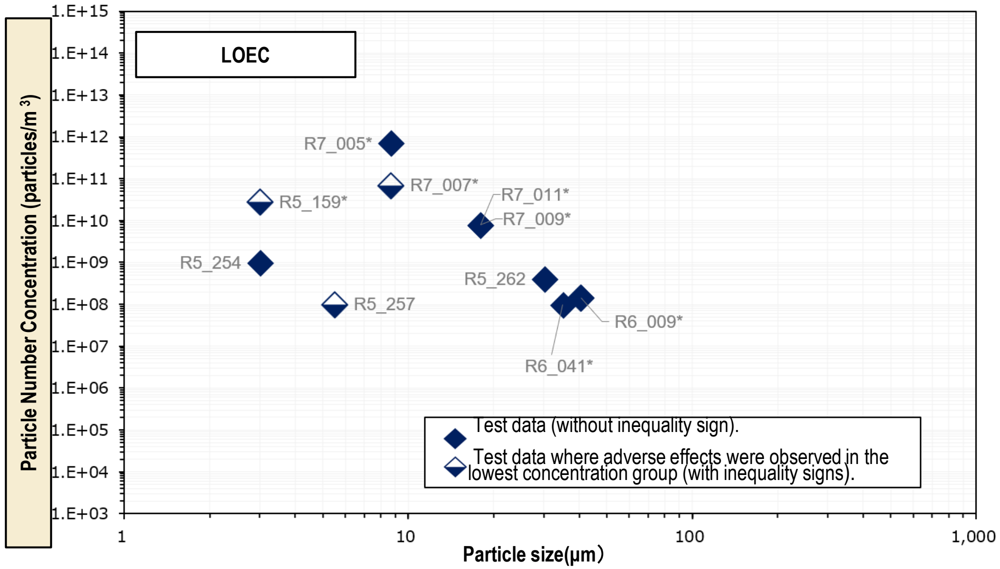


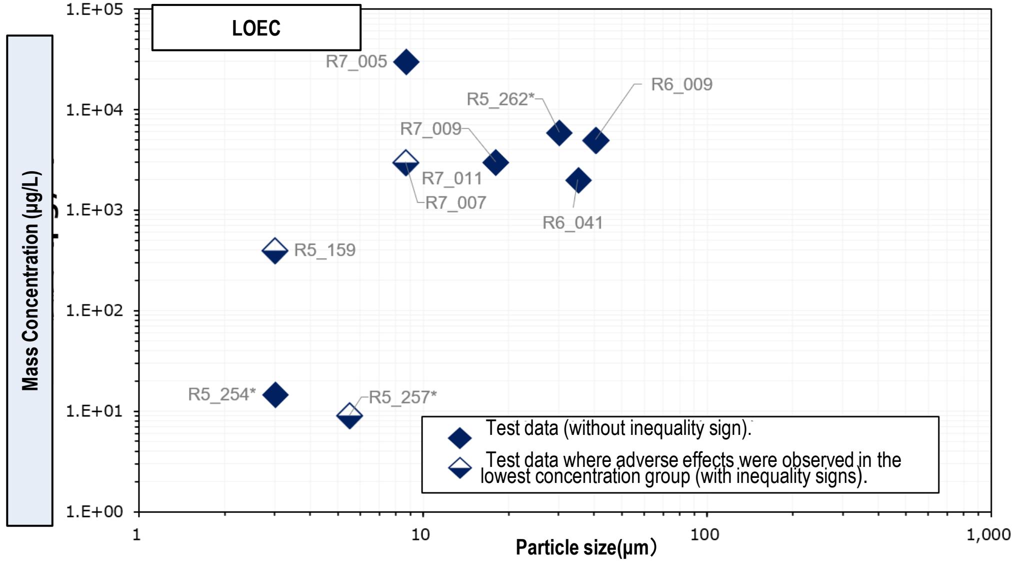
*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

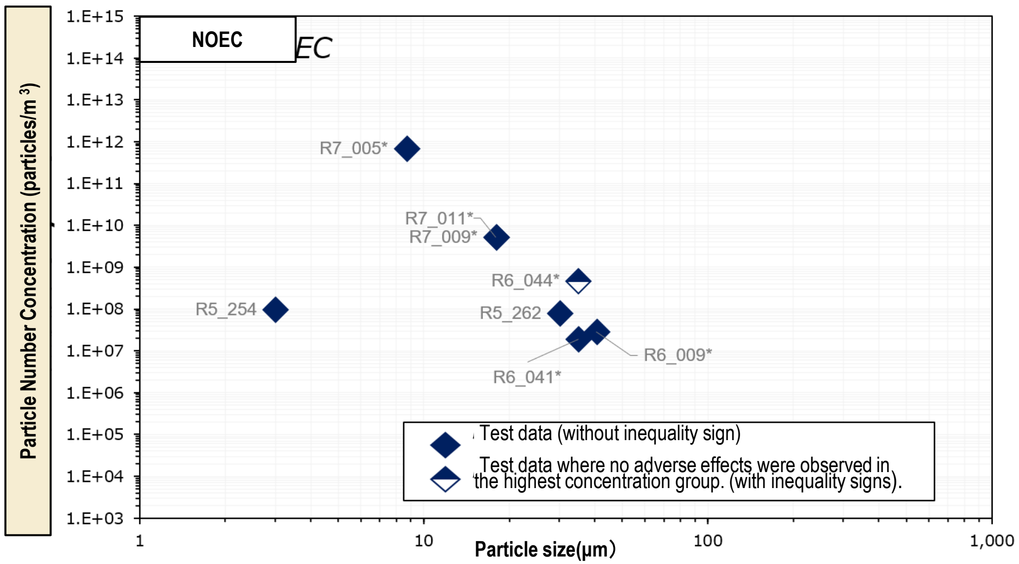
Hazard

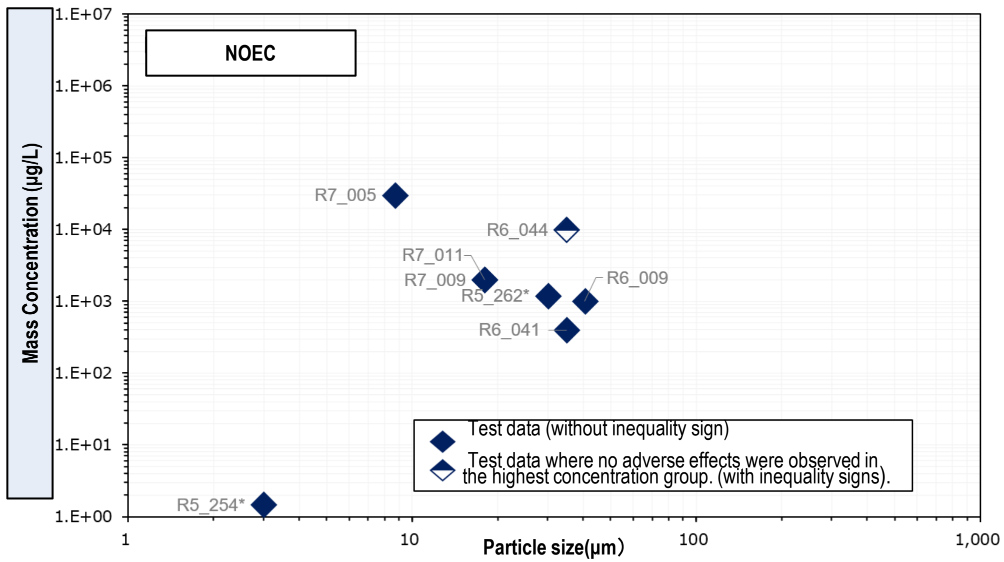
List of test data (correspondence between effect concentration and particle size)

■ Correspondence between effect concentration and particle size for test data is shown below (Crustacean, quality level “A" and chronic).





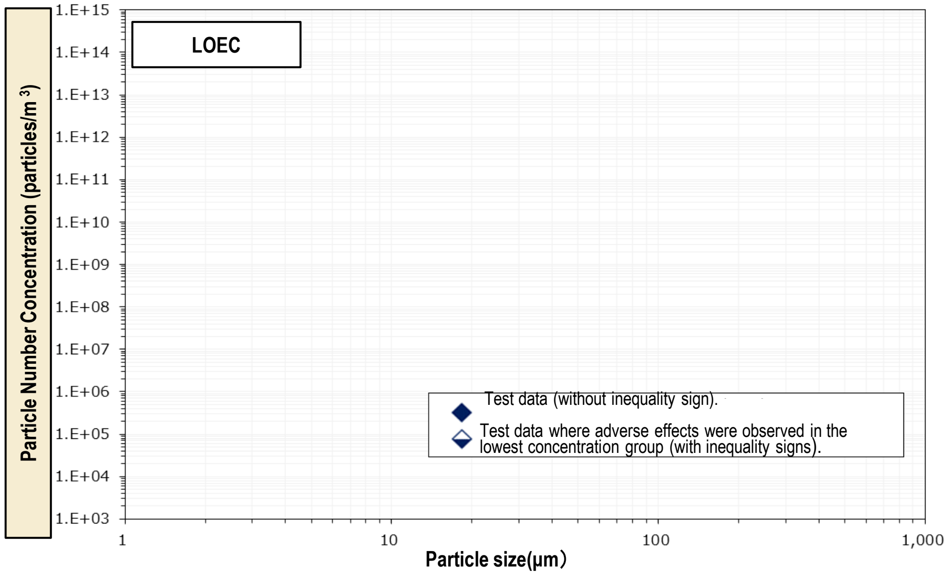


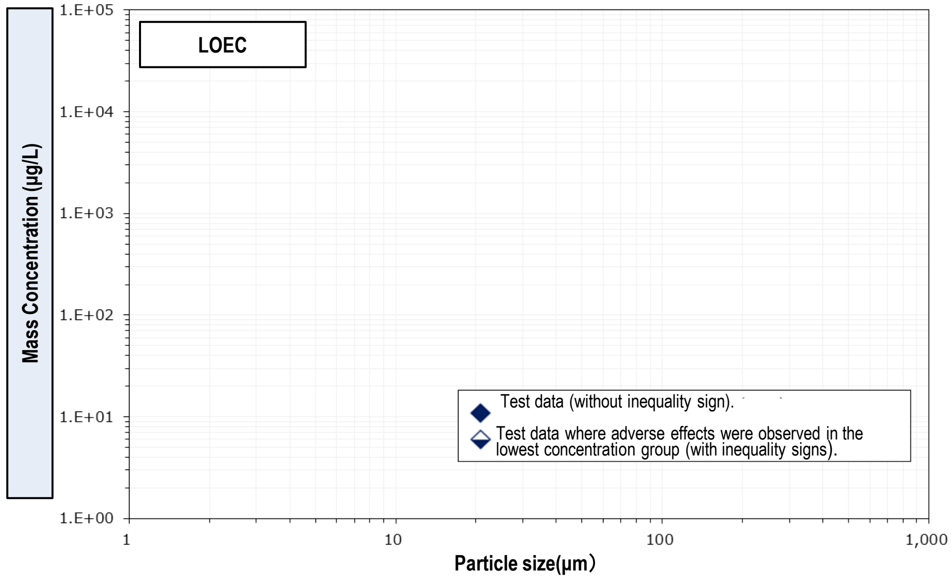


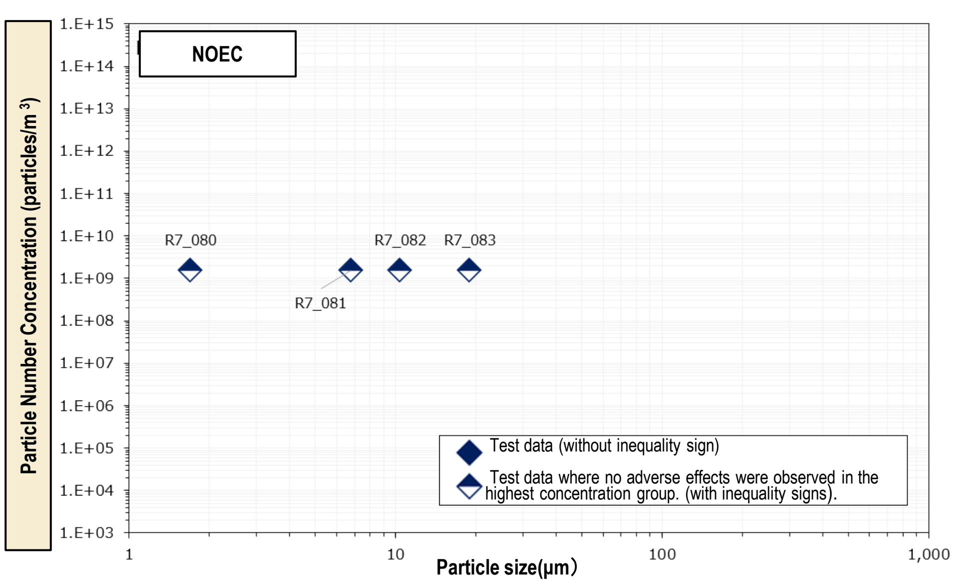
*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

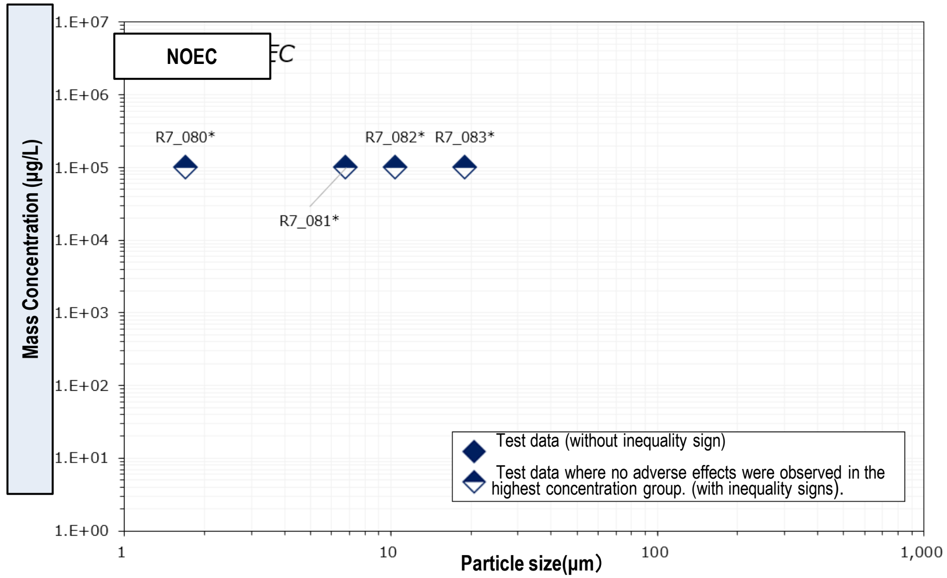
List of test data (correspondence between effect concentration and particle size)

- Correspondence between effect concentration and particle size for test data is shown below (Crustacean, quality level “A" and subchronic/subacute).





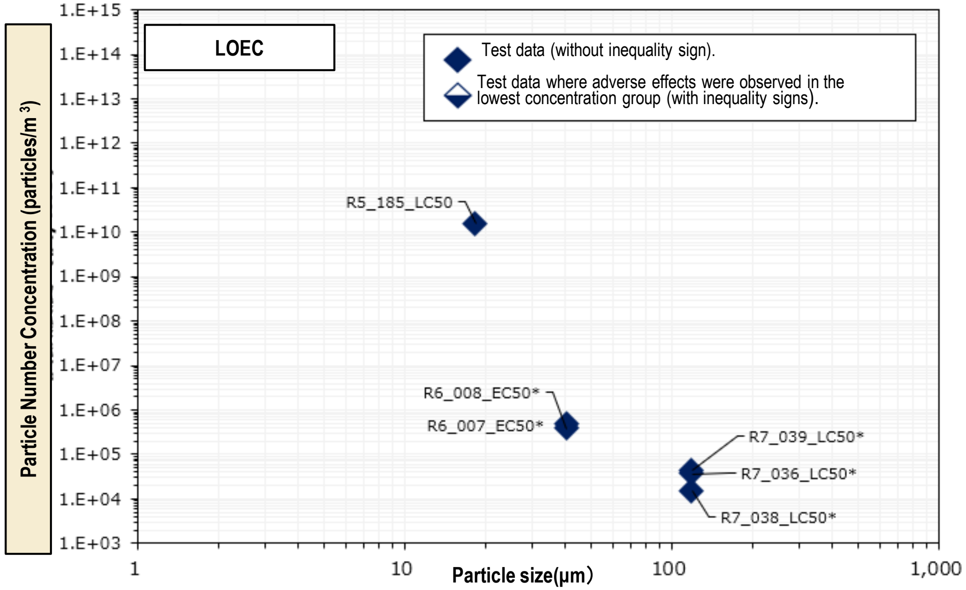


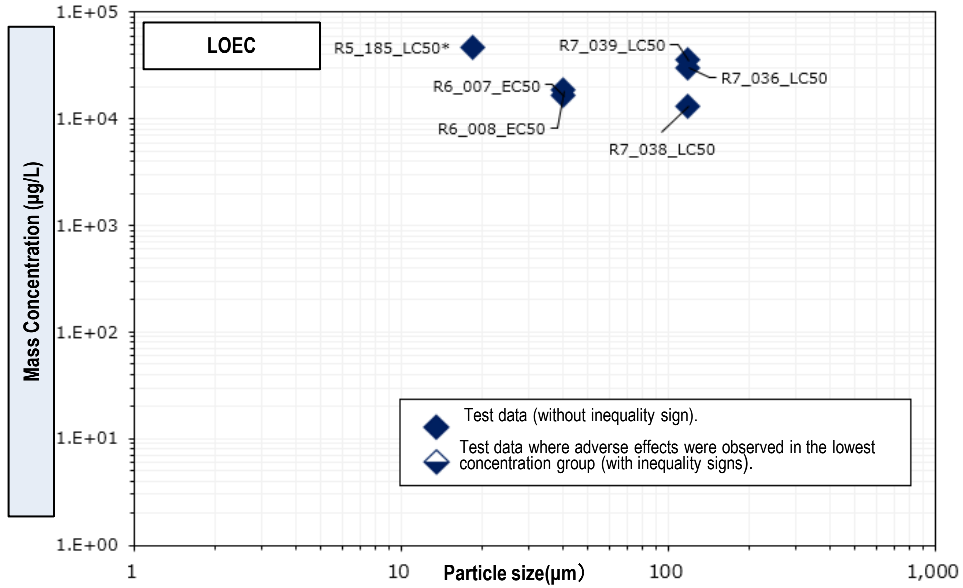


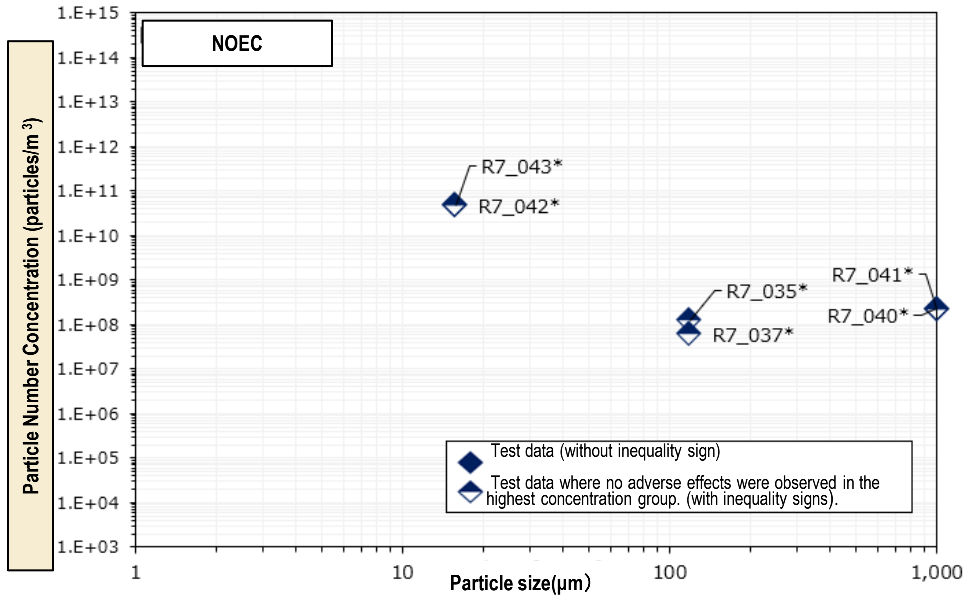
*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

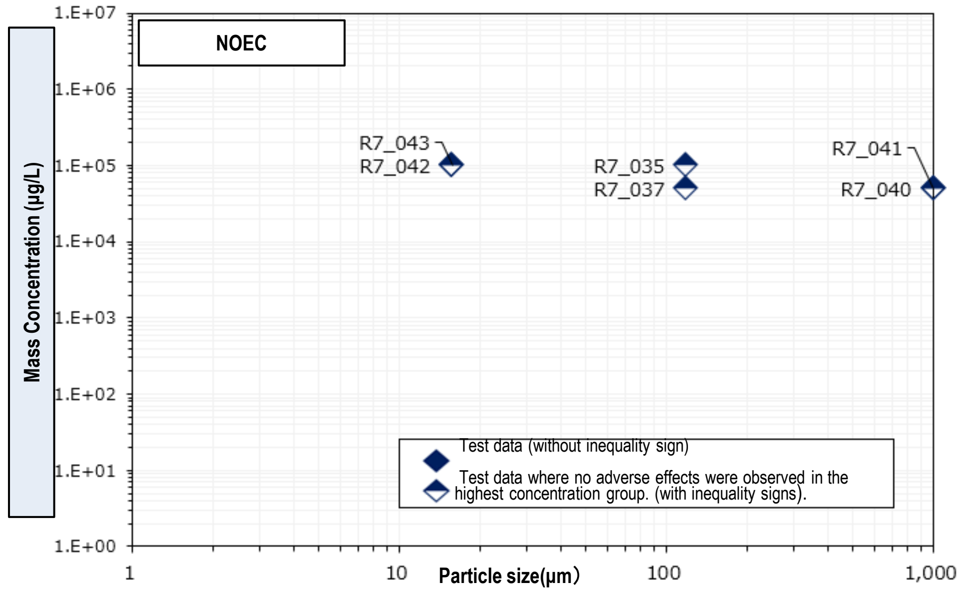
List of test data (correspondence between effect concentration and particle size)

■ Correspondence between effect concentration and particle size for test data is shown below (Crustacean, quality level “A" and acute).









*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

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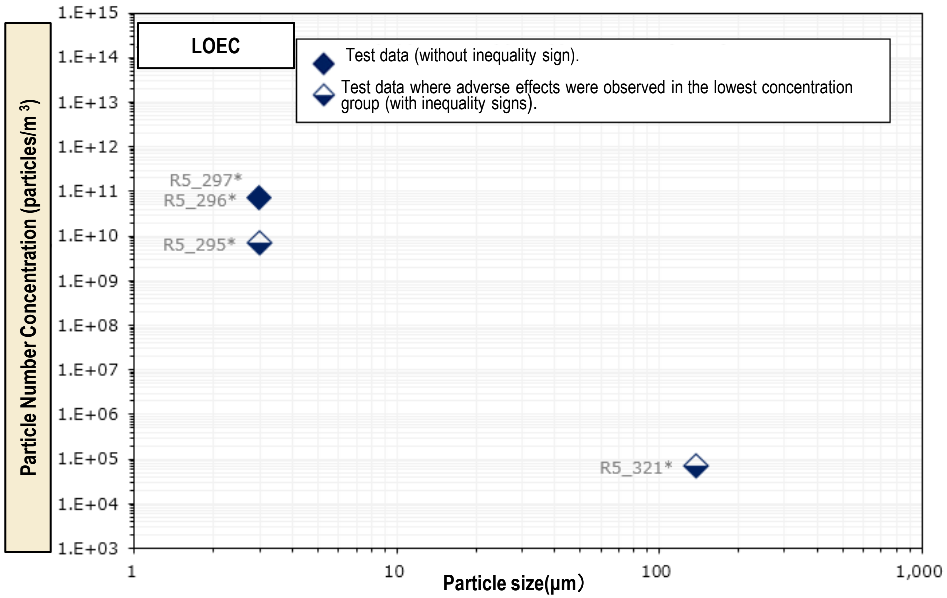
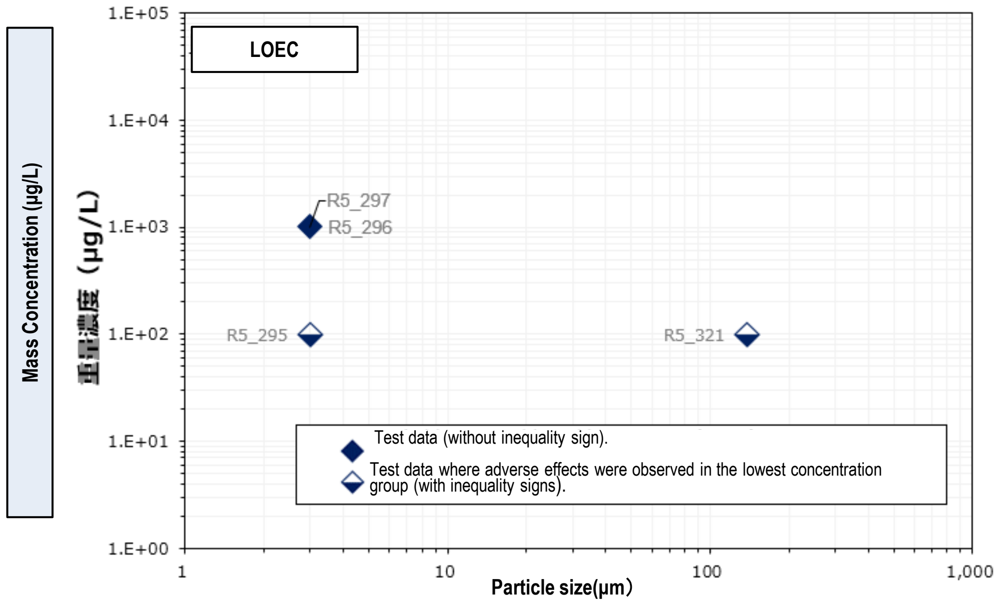
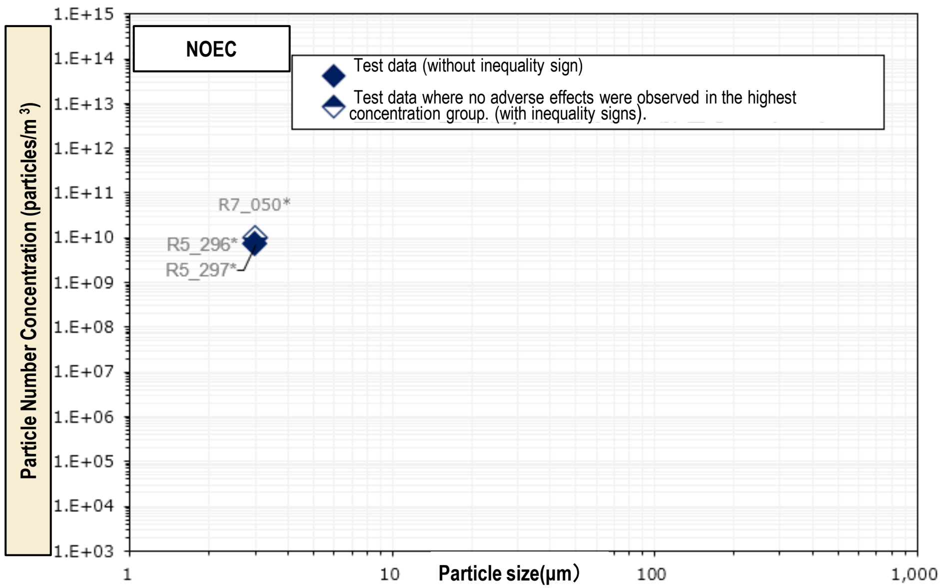
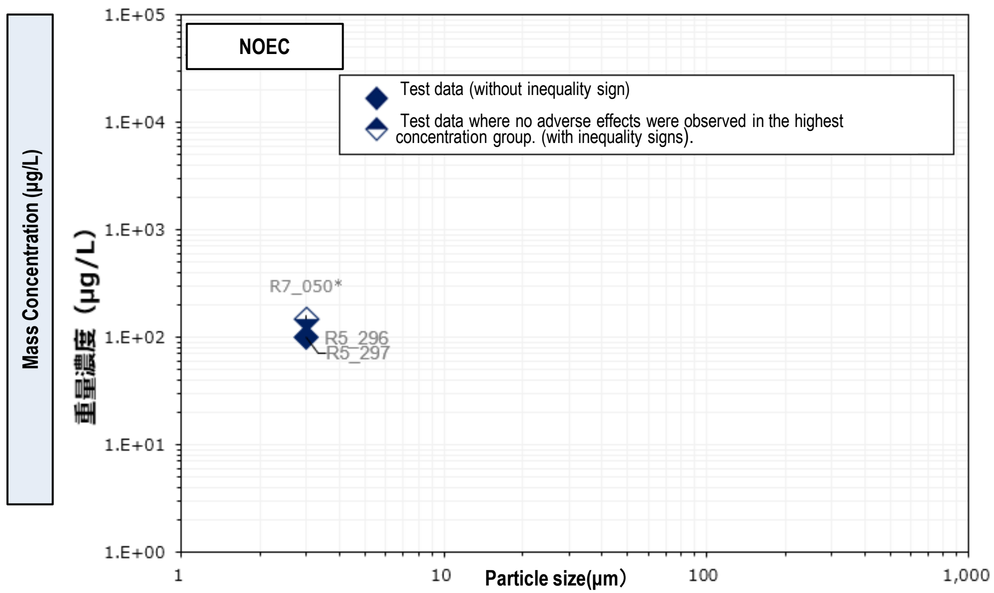
List of test data (correspondence between effect concentration and particle size)

- Correspondence between effect concentration and particle size for test data is shown below (Shellfish, quality level “A" and subchronic/subacute).









*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

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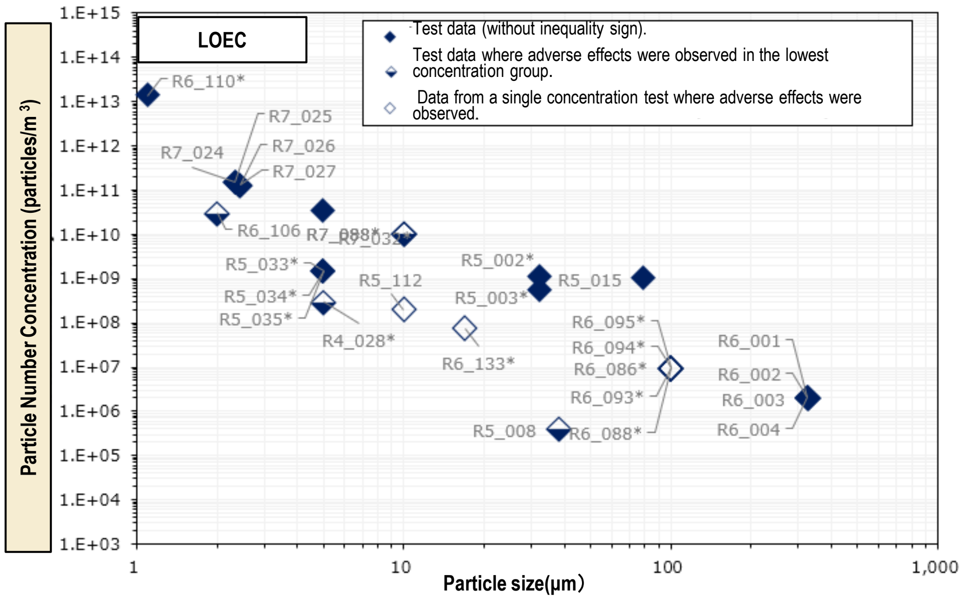
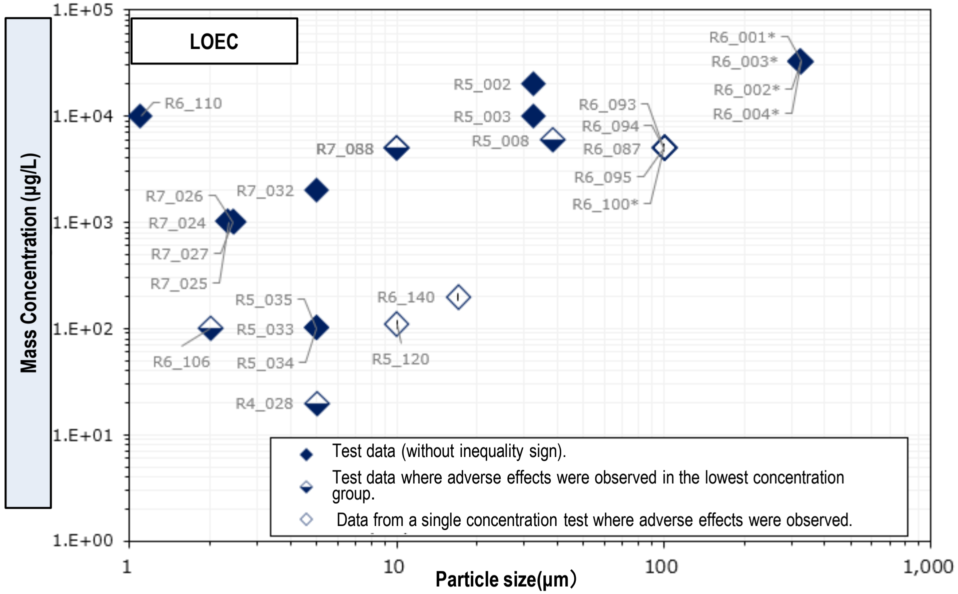
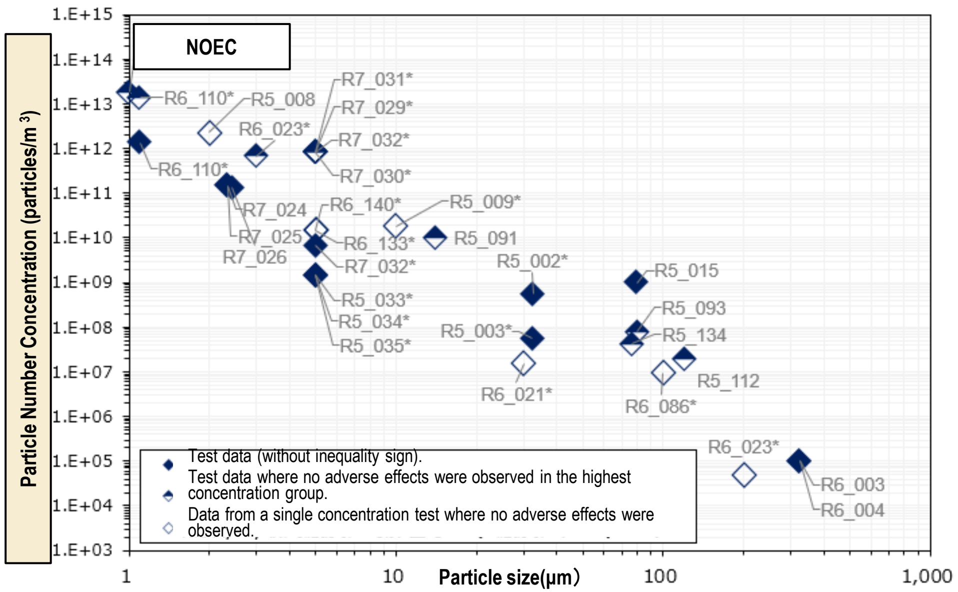
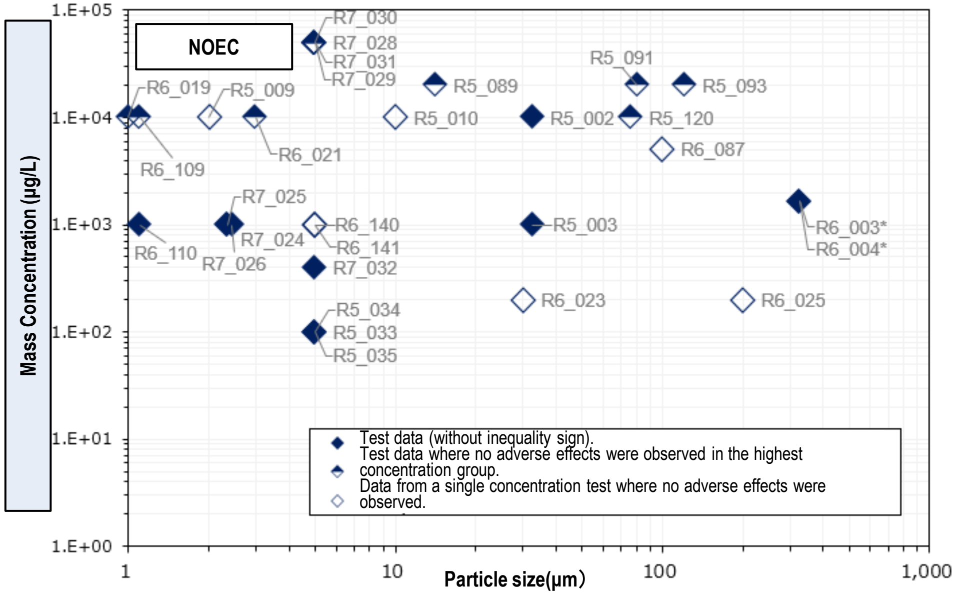
List of test data (correspondence between effect concentration and particle size)

■ Correspondence between effect concentration and particle size for test data is shown below (Fish and quality level “S").





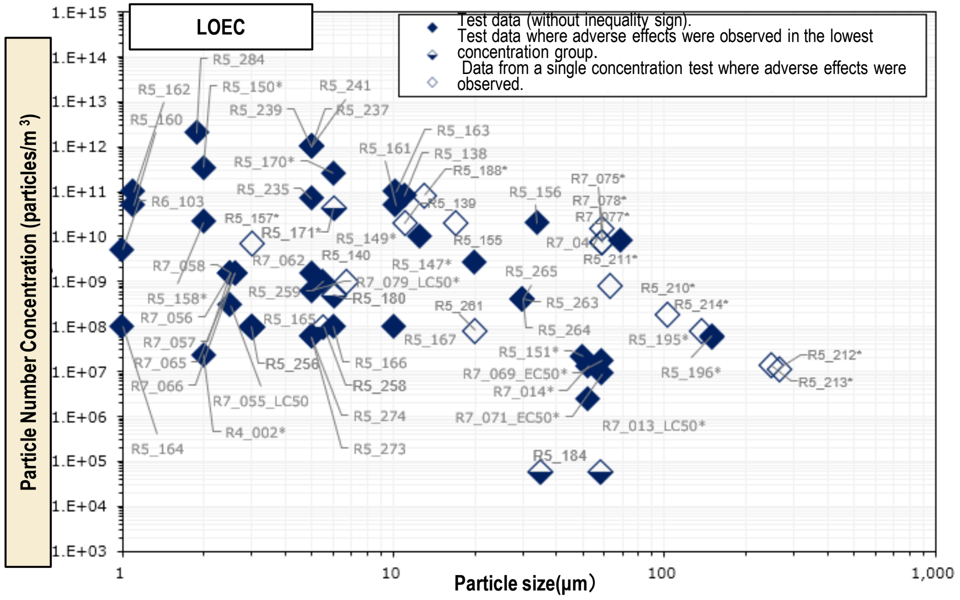


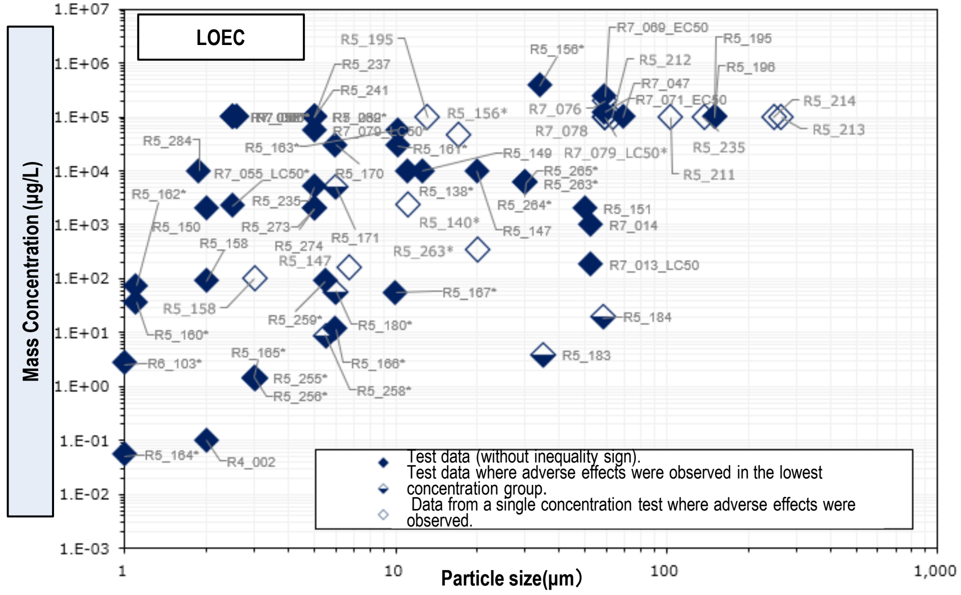


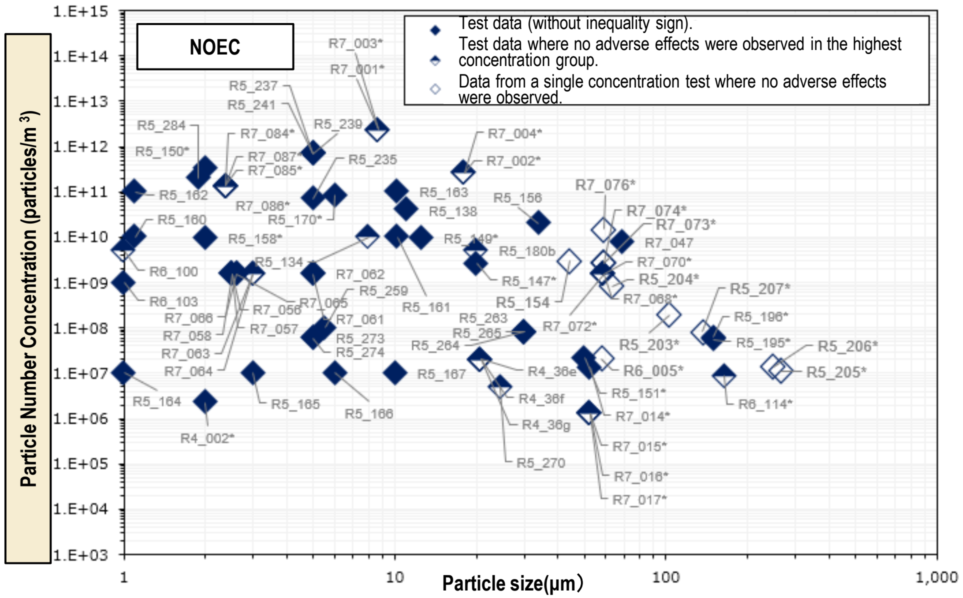
*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

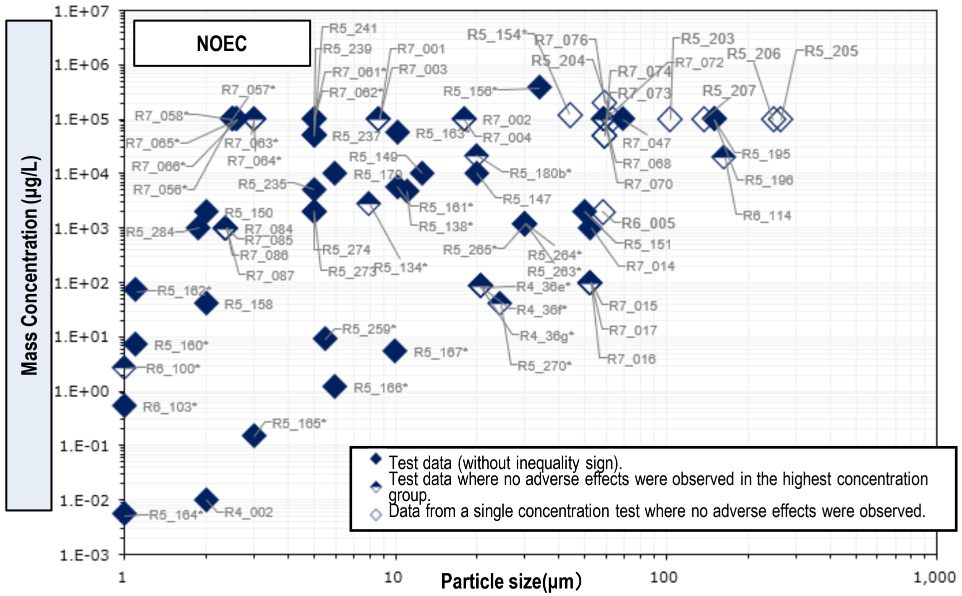
List of test data (correspondence between effect concentration and particle size)

- Correspondence between effect concentration and particle size for test data is shown below (Crustacean and quality level “S").









*The numbers in the plots correspond to record number of test data. For an overview of each data, see the overview of the test data on the previous page.

List of test data (correspondence between effect concentration and particle size)

■ Correspondence between effect concentration and particle size for test data is shown below (Shellfish and quality level “S").