Supporting materials

Abbreviations of MPs:

ABS: Acrylonitrile butadiene styrene

AN: Acrylonitrile

CP: Cellophane

CPM: Copolymerization mixture

EA: Ethyl acrylate

EVA: Ethylene-vinyl acetate

PA: Polyamide/nylon

PAN: Polyacrylonitrile

PBT: Polybutylene terephthalate

PC: Polycarbonate

PE: Polyethylene

PEA: Polyethyl acrylate

PES: Polyester

PET: Polyethylene terephthalate

PMMA: Polymethyl methacrylate/Acrylic

POM: Polyoxymethylene

PP: Polypropylene

PPA: Polyphthalamide

PS: Polystyrene

PTFE: Polytetrafluoroethylene

PU: Polyurethane

PVA: polyvinyl alcohol

PVAc: Polyvinyl acetate

PVC: Polyvinyl chloride

PVS: polyvinyl sulfate

SAN: Styrene acrylonitrile

SBR: Styrene butadiene rubber

VC/VAC: Vinyl chloride-vinyl acetate copolymer

Abbreviations of PFASs:

ADONA: Ammonium 4,8-dioxa-3H-perfluorononanoate

Br-PFOS: Branched perfluorooctane sulfonate

Cl-PFESA: Chlorinated polyfluorinated ether sulfonate

9Cl-PFONS: Perfluoro-2-propoxypropanoic potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate

9Cl-PF3ONS/9Cl-PFONS: 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate

diPAP: Polyfluoroalkyl phosphate diester

di-SAmPAP: Perfluorooctane sulfonamidoethanol-based phosphate diester

DONA: 4,8-dioxa-3H-perfluorononanoic acid

F-53B: 6: 2 chlorinated polyfluorinated ether sulfonate

FBSA: Perfluoro-1-butane-sulfonamide

FHEA: Perfluorohexyl ethanoic acid

FOSA: Perfluorooctanesulfonamide

FTAA: Fluorotelomer sulfonamide alkylamine

FTAB: Fluorotelomer sulfonamide alkylbetaine

FTCA: Fluorotelomer carboxylic acid

FTOH: Fluorotelomer alcohol

FTSA: Fluorotelomer sulfonate

FTSAm: Fluorotelomer sulfonamide

FTUCA: Fluorotelomer unsaturated carboxylic acid

GenX/PFPrOPrA: Ammonium perfluoro-2-propoxypropionate

H-PFESA: Hydrogen-Substituted Polyfluorooctane Ether Sulfonate

HFPO-DA: Hexafluoropropylene oxide dimer

HFPO-TA/HFPO-TrA: Hexafluoropropylene oxide trimer acid

HFPO-TeA: Tetramer acid of hexafluoropropylene oxide

L-PFOS: Linear perfluorooctanesulfonate

MeFBSA: Methyl perfluorobutane sulfonamide

N-EtFOSAA/EtFOSAA: N-ethyl-perfluorooctane sulfonamidoacetic acid

N-EtFOSE/EtFOSE: N-ethylperfluorooctane sulfonamidoethanol

N-MeFOSA: N-methylperfluorooctane sulfonamide

N-MeFOSE/MeFOSE: N-methylperfluorooctane sulfonamidoethanol

N-MeFOSAA/MeFOSAA: N-methyl-perfluorooctane sulfonamidoacetic acid

NaDONA: Sodium dodecafluoro-3H-4,8-dioxanonanoate

OBS: sodium p-perfluorous nonenoxybenzenesulfonate

PFBA: perfluorobutanoic acid

PFBS: Perfluorobutanesulfonate

PFDA: Perfluorodecanoic acid

PFDeA: Perfluorodecanic acid

PFDoDA/PFDoA: Perfluorododecanoic acid

PFDS: Perfluorodecane sulfonate

PFECHS: Perfluoroethylcyclohexane sulfonate

PFHpA: Perfluoroheptanoic acid

PFHS: Perfluorohexane sulfonic acid

PFHxA: Perfluorohexanoic acid

PFHxDA: Perfluorohexadecanoic acid

PFHxPA: Perfluorohexaphosphonic acid

PFHxS: Perfluorohexanesulfonate

PFHxSi: Perfluoroalkylsulfinates

PFNA: Perfluorononanoic acid

PFOA: Perfluorooctanoic acid

PFODA/PFOcDA: Perfluorooctadecanoic acid

PFOS: Perfluorooctane sulfonate

PFOSA: Perfluorooctane sulfonamide

PFOSi: Perfluoroalkylsulfinates

PFOSK: potassium perfluorooctanesulfonate

PFPeA: Perfluoropentanoic acid

PFPeS: Perfluoropolyethers

PFPiA: Perfluoroalkyl phosphinic acids

PFPnA: Perfluoropentanoic acid

PFPrS: Perfluoropropanesulfonate

PFTeDA/PFTeA: Perfluorotetradecanoic acid

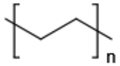
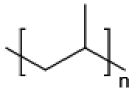
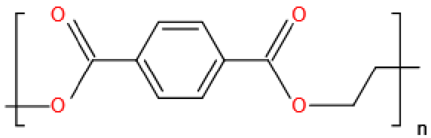
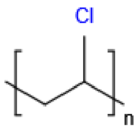
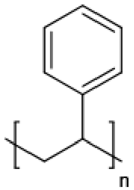
PFTrDA/PFTrA/PFTriDA: Perfluorotridecanoic acid

PFUnA: perfluoroundecanoic acid

PFUnDA/PFUdA: Perfluoroundecanoic acid

THPFOS: Tetrahydroperfluorooctanesulfonate

Table S1 Selected physicochemical properties of typical MPs (Stubbins et al., 2021; Min et al., 2020).

MPs	**Formula**	**Structure**	**Density (g/cm^3)**	**%Crystal**	**Glass transition temperature**	**Hydrophobicity**	**Log*P*(SA)$^{-1}$ (Å^{-2})**
PE	$(C_2H_4)_n$		0.92–0.97	69.0	−110℃	High	0.0236
PP	$(C_3H_6)_n$		0.88–0.91	56.0	−20℃	High	0.0237
PET	$(C_{10}H_8O_4)_n$		1.30–1.40	19.1	75℃	Medium	0.00807
PVC	$(C_2H_3Cl)_n$		1.35–1.50	–	60℃–100℃	High	0.0162
PS	$(C_8H_8)_n$		1.04–1.50	0.0	90℃	High	0.0229

Notes: "–": not available. Log*P*(SA)$^{-1}$: a predictor to quantify the hydrophobicity, the high the number, the high hydrophobicity of MPs.

Table S2 Selected physicochemical properties of typical PFASs (Gagliano et al., 2020).

PFAS type	Compound name	Acronym	Formula	$LogK_{ow}$	pK_a	Solubility in water (mg/L)
Perfluoroalkyl carboxylic acids (PFCAs)	Perfluorobutanoic acid	PFBA	C_3F_7COOH	2.31	1.07	2.14×10^5 (at 25℃)
	Perfluorohexanoic acid	PFHxA	$C_5F_{11}COOH$	3.48	–0.16	15700 (at 25℃)
	Perfluorooctanoic acid	PFOA	$C_7F_{15}COOH$	4.81	–0.5–4.2	2290 (at 24℃)
	Perfluorononanoic acid	PFNA	$C_8F_{17}COOH$	5.48	–0.21	–
	Perfluorodecanoic acid	PFDA	$C_9F_{19}COOH$	6.51	–5.2	–
Perfluoroalkyl sulfonic acids (PFSAs)	Perfluorobutane sulfonic acid	PFBS	$C_4F_9SO_3H$	1.82	–3.31	344 (at 25℃)
	Perfluorooctane sulfonic acid	PFOS	$C_8F_{17}SO_3H$	4.49	<1.0	3.2×10^3 (at 25℃)
	Perfluorononane sulfonic acid	PFNS	$C_9F_{19}SO_3H$	6.13	–3.24	–
	Perfluorodecane sulfonic acid	PFDS	$C_{10}F_{21}SO_3H$	6.83	–3.24	–
Perfluoroalkane sulfonamides (FASAs)	Perfluorooctane sulfonamide	FOSA	$C_8H_2F_{17}NO_2S$	5.8	3.37	8.04×10^{-3} (at 25℃)
	Potassium salt of 6:2 chlorinated polyfluorinated ether sulfonate	F–53B		4.84	<1	–

Note: "–" presents not available.

Table S3 Global distribution of MPs in water bodies of aquatic environments.

Water bodies	MP type	MP shape	MP size	MP concentration	Sampling location	Reference
Seawater	PP	Films, lines, fragments	0.35–4.76 mm	0.334271 items/m^2	North Pacific	(Moore et al., 2001)
	–	Fragments, fibers, pellets	≤ 10 mm, > 10 mm	0.004–0.19 items/m^3	Northeast Pacific Ocean	(Doyle et al., 2011)
	PS	Fragments, films	0.33–5 mm	0.116 items/m^2	North Western Mediterranean Sea	(Collignon et al., 2012)
	PET, Polyacrylate	Granules, fibers	< 1 mm	$1.52\times10^5 \pm 2.76\times10^5$ items/m^3	Southern North Sea	(Dubaish and Liebezeit, 2013)
	PE, PP, PS, EVA	Lines, pellets	0.4–82.6 mm	4.2564×10^{-3} items /m^2	Around Australia	(Reisser et al., 2013)
	–	Fibers, fragments	64.8–5810 μm	8–9200 items/m^3	Northeast Pacific Ocean	(Desforges et al., 2014)
	PE, PP, Polyacrylate, Alkyd resin	Fragments, films	–	0.036 items/m^3	Algarve, Portuguese	(Frias et al., 2014)
	PES, PA, Rayon fibers	Fibers, fragments, beads, foams	0.2–43.2 mm	2.46 items/m^3	Northeast Atlantic Ocean	(Lusher et al., 2014)
	–	Fibers, granules, films, spherules	0.5–12.46 mm	0.167 ± 0.138 items/m^3	East China Sea	(Zhao et al., 2014)
	PE, PP, PES, PS, Alkyds	Paint particles, foams, fibers	0.05–5 mm	260–1410 items/m^3 in May; 210–15560 items/m^3 in July	Southeastern Coast of Korea	(Kang et al., 2015)

PES, PA, PE, PMMA, PVC	Fibers, fragments, films	0.25–7.71 mm	2.68 items/m^3	Arctic polar waters	(Lusher et al., 2015)
–	Fragments	< 5 mm	3.74 items/m^3	East Asian seas, Japan	(Isobe et al., 2015)
PE, PP	Fragments, sheets, lines, pellets, foams	0.5–207 mm	1.69 items/m^3	North Atlantic Gyre	(Reisser et al., 2015)
PP, PE, PVC, PVA, PVS, PET, PS	Fragments, films	> 0.05 mm	4.8092×10^4–3.59748×10^5 items/m^3	Incheon/Kyeonggi Coastal Region, Republic of Korea	(Chae et al., 2015)
PS	Fibers, fragments	> 0.065 mm	257.9 ± 53.36 to 1215 ± 276.7 items/m^3	South Africa	(Nel and Froneman, 2015)
PS	Pellets, lines, films, fibers, fragments	≤ 5 mm	7.03 ± 11.93 items/m^3	Durban harbour of KwaZulu-Natal, South Africa	(Naidoo et al., 2015)
PP, PE, Phenoxy resin, PS, PES, Synthetic rubber	Spheres, fibers, sheet	< 2 mm	$8.8\times10^4 \pm 6.8\times10^4$ items/m^3	Jinhae Bay, Republic of Korea	(Song et al., 2015)
PE, PP, PS, PA, PMMA, PU, PVC	Spheres, fibres	≥ 7 μm	13–501 items/m^3	Atlantic Ocean	(Enders et al., 2015)
–	Fibers, films, fragments	0.2–5 mm	1100 ± 900 items/m^3	Southeastern Black Sea	(Aytan et al., 2016)
PP, PE, PS, PA, PMMA, ABS, CP	Granules, fibers	0.125–15.98 mm	0–3 items/m^3	Qatar's marine Exclusive Economic zone	(Castillo et al., 2016)
PS, PE, PP, PVC	Fibers, fragments,	< 5 mm	0.0031 items/m^3	Southern Ocean	(Isobe et al., 2017)
PP, PE, SAN	Fragments, lines, fibers, pellets	0.01–4.96 mm	0.61–270.9 items/m^3	Marine waters Hong Kong, China	(Tsang et al., 2017)
PE, PP	Fragments, fibers, pellets, films	< 5 mm, ≥ 5 mm	16.4 items/m^3	Jurujuba Cove, Niterói, RJ, Brazil	(Castro et al., 2016)

PE, PP, PS, PET, PVC, PU, AN	Fragments, lines, films	> 330 μm	0.33 ± 0.34 items/m^3	Bohai Sea, China	(Zhang et al., 2017b)
–	Fibers, fragments	< 5 mm	0.21 ± 0.15 items/m^3	Bornholm Basin, Baltic Sea	(Beer et al., 2018)
PES, PA, PP, PMMA, PVC, PS, PU	Fibers, fragments	0.25–5 mm	1.15 ± 1.45 items/m^3	Atlantic Ocean	(Kanhai et al., 2017)
PE, PP, PES, PTFE, PMMA, PA	Fibers, fragments	> 60 μm	0.0032–1.18 items/m^3	Ross Sea (Antarctica)	(Cincinelli et al., 2017)
PET, PMMA	Fibers	0.4–8.3 mm	70.8 items/m^3	Rockall Trough (North Atlantic Ocean)	(Courtene-Jones et al., 2017)
–	Fragments, pellets, lines, films, foams	0.355–4.749 mm	0–1.5 items/m^3	North West Europe	(Maes et al., 2017)
–	Fibers, fragments, beads	> 0.335 mm	4.8–8.2 items/m^3 from Bong samples, 5.0–18.4 items/m^3 from Neuston samples, 6.0×10^{-4} – 15.7×10^{-4} items/m^3 from Niskin bottles	Northern Gulf, Mexico	(Di Mauro et al., 2017)
–	Fragment, pellets, filaments	0.3–5 mm	7.68 ± 2.38 items/m^3	Mediterranean coastal waters	(van der Hal et al., 2017)
–	Fibers, fragments, paint flakes	0.5–5 mm	400 ± 580 items/m^3	Baltic Sea（Eastern Gotland basin）	(Bagaev et al., 2018)
PET, PVAs, PVC, PE, Alkyd resin	Fibers, granules, films	> 333 μm	0.330 ± 0.278 items/m^3	Yellow Sea, China	(Wang et al., 2018)

PP, PE, PS	Fragments, paint flakes, fibers	> 335 μm	0.42 items/m^2	Stockholm Archipelago, Baltic Sea	(Gewert et al., 2017)
PP, PE	Fragments, films, foams, fibers	0.35–44.99 mm	0.13 ± 0.20 items/m^3	Yellow Sea, China	(Sun et al., 2018)
PE, PP, PE-EA copolymer	Films, fibers, pellets, granules	0.001–5 mm	545 ± 282 items/m^3	North Yellow Sea, China	(Zhu et al., 2018)
PE, PP, PVC, PS, PU, PA, EVA	Fibers, fragments	≤ 5 mm, > 5 mm	2.4 ± 0.8 items/m^3	Northeast Greenland	(Morgana et al., 2018)
PES, PVC, PA, PAN	Fibers, fragments	0.25–5 mm	0.7 items/m^3	Arctic Central Basin	(Kanhai et al., 2018)
PE, PP, PS	Fragments，fibers, granules, films	0.1–5 mm	0.45 items/m^3	Small Islands of Bintan water, Indonesia	(Syakti et al., 2018)
PET, PP, PE, PA, PVAc	Fibers, fragments, granules	< 4 mm	20–120 items/m^3	Jiaozhou Bay, China	(Zheng et al., 2019)
Rayon, PES, PP, PE, PA, PS, PU, PBT, POM	Fibers, flakes, foams, fragments	< 5 mm	4500 ± 100 items/m^3	Qinzhou harbor (Maowei Sea), China	(Zhu et al., 2019)
PE, PP, PA, PS	Pellets, films, fragments, fibers, foam	0.3–4.75 mm	1.25 ± 0.88 items/m^3	Kerala coast, India	(Robin et al., 2020)
PE, PP, PS, PET, PA, PVC	Fibers, fragments, spherules, granules	0.05–5 mm	$6.36\times10^4 \pm 3.74\times10^4$ items/m^3	Sanggou Bay, China	(Wang et al., 2019a)
PP, PU, PA	–	0.011–5 mm	0.1–245.4 items/m^3	Southern North Sea	(Lorenz et al., 2019)
Rayon, PA, PMMA, PET, PP, PE	Fragments, films, fibers	< 5 mm	0.018–0.31 items/m^3	Northwest Pacific,	(Mu et al., 2019b)
PE, PP, PS, PVC PET, CPM	Fibers, fragments, foams, pellets	< 5 mm	1485.7 ± 819.9 items/m^3 in HaiHe Estuary;	Bohai Bay, China	(Wu et al., 2019b)

			788.0 ± 464.2 items/m^3 in Yongdingxinhe Estuary		
PP, PE, PS, PVC, PAN	Fragments, films, fibers, lines	0.3–10 mm, > 10 mm	0.013 ± 0.028 items/m^3 in the dry season, 0.044 ± 0.064 items/m^3 in the hurricane season	Banderas Bay, Mexico	(Pelamatti et al., 2019)
PS, PP, PE	Fibers, fragments, paint flake, pellets	0.1–5 mm	0.49 ± 0.43 items/m^3	Chabahar Bay, Gulf of Oman (Makran Coasts)	(Aliabad et al., 2019)
PE, PET, PA	Fibers, fragments, films, pellets	< 5 mm	$2.18\times10^5 \pm 1.7\times10^4$ items/m^3	Chabahar Bay, Iran	(Hosseini et al., 2020)
PE, PES, CPM, Rayon	Fibers, fragments, beads	> 0.33 mm	0.54 ± 0.2 items/m^3	Gulf of Maine, USA	(Lindeque et al., 2020)
PS, PES, PP	Fibers, fragments, paint particles	0.33–5 mm	1.12–4.74 items/m^3	Korean coastal waters	(Kwon et al., 2020)
PE, PP, PS, PA, PET	Fibers, lines, granules, films, fragments	0.05–5 mm	$6.5\times10^3 \pm 2.1\times10^3$ items/m^3	South Yellow Sea, China	(Jiang et al., 2020b)
PE	Fragments, fibers, lines, films	> 0.02 mm	$3.737\times10^4 \pm 2.978\times10^4$ items/m^3	Marmara Sea, Turkey	(Çullu et al., 2021)
PET, PET-PS, PA	Fibers, fragments	0.1–1 mm, > 1 mm	200–1500 items/m^3	South of Caspian Sea	(Nematollahi et al., 2020)
PE, PP, PS, PA, PMMA, PVAc	Lines, fibers, granules, films, fragments	0.1–5 mm	1190 ± 280 items/m^3	Nordic Seas	(Jiang et al., 2020a)
PE, PP	Fibers, fragments, films, pellets	0.335–5 mm	0–14.09 items/m^3	South of the Algarve Coast	(Lechthaler et al., 2020)

PP, PE, PA, PET, CP, Polyethylenepropylene-diene	Fibers, fragments	> 0.25 mm	0.01–0.70 items/m^3	Todos Santos Bay, Mexico	(Ramírez-Álvarez et al., 2020)
PES, PA, PE, PP	Fibers	> 0.01 mm	67–278 items/m^3	Fjord Nuup Kangerlua, Denmark	(Rist et al., 2020)
PP, PE, PAN, Polypropylenepolyethylene copolymer, Urethane alkyd	Fibers, fragments, films	< 5 mm	0.0556 ± 0.0355 items/m^3	Nansha Islands, South China Sea	(Tan et al., 2020)
PES, PP, PE, PA	Fibers, fragments, films, pellets	< 5 mm	60–2500 items/m^3	Greater Melbourne Area	(Su et al., 2020)
PE, PS, PP, PVAE	–	< 5 mm	0.09–0.57 items/m^3	South Pacific	(Bakir et al., 2020)
PP, PE, PMMA, PET, PS, PP-PE	Fibers, fragments, granules, films and foams	0.3-5 mm	6.03×10^{-3} – 9.53×10^{-2} items/m^2	Midwest Pacific Ocean	(Wang et al., 2020a)
PE, PS, PP, PC, Cellulose	Granules, fibers, films, pellets	< 5 mm	$2.0\times10^4 \pm 4.73\times10^3$ items/m^3	Sanggou Bay, China	(Xia et al., 2021)
PE, PP, PET, PS, PA	Fibers, fragments, films, cylinders, pellets	< 5 mm	0.246 ± 0.020 items/m^3	Southern Caspian Sea	(Manbohi et al., 2021)
PP, PE, PS, PES	Fibers, fragments, films	0.3–5 mm	1.37 ± 0.47 items/m^3	Southwest Coast of the Caspian Sea, Iran	(Rasta et al., 2021)
Rayon, PET, EVA	Fibers, pellets, foams, fragments	< 5 mm	8.50×10^5–3.50×10^6 items/m^3	Guangdong Coastal Areas, South China	(Li et al., 2021b)
PE, PP, Rayon, Cellulose, Polyisoprene	Fibers, fragments	> 0.355 mm	1.32 ± 0.70 items/m^3	Monterey Bay, California	(Kashiwabara et al., 2021)
PP, PE, PA	Fibers	0.299–57 mm	13.4–4903.7 items/m^3	Rio Formoso Estuary, Brazil	(Lins-Silva et al., 2021)

	–	Fibers, fragments, foams, films, granules	< 5 mm	0–0.12 items/m^3	Atlantic Ocean	(Silvestrova and Stepanova, 2021)
	PE, PP, PS, PET, PVC	Filaments, films, foams, granules, pellets, fragments	0.5–5 mm	0.01–8.96 items/m^3	Caribbean, Colombia, USA	(Garcés-Ordóñez et al., 2021)
	PE, PP, PET, PA, PS, ABS	Fibers, fragments	0.02–0.724 mm	0.92 ± 0.61 items/m^3	Baltic Sea	(Uurasjärvi et al., 2021)
Freshwater	–	Fibers, granules, films, spherules	0.5–12.46 mm	4137.3 ± 2461.5 items/m^3	Yangtze Estuary, China	(Zhao et al., 2014)
	–	Fragments, foams, pellets, fibers	> 0.33 mm	1.94 items/m^3 upstream, 17.93 items/m^3 downstream	North Shore Channel, USA	(McCormick et al., 2014)
	–	Soft plastic, paint chips, thread	< 5 mm	0.2606 items/ m^3	Goiana Estuary, Brazil	(Lima et al., 2014)
	–	pellets, flakes, spherules	> 0.5 mm	0.3168 ± 4.6646 items/m^3	Austrian Danube	(Lechner et al., 2014)
	PE, PS, PP, PVC, PES, PA	Fibers, sheets, pellets, fragments	≤ 5 mm, > 5 mm	0.028 items/m^3	Tamar Estuary, Southwest England	(Sadri and Thompson, 2014)
	PP, PE, PVC, PTFE	Pellets, films, fibers, granules	≤ 5 mm, > 5 mm	1245.8 ± 531.5 items/m^3	Minjiang estuary, China	(Zhao et al., 2015a)
	–	fibers	0.1–5 mm	3–106 items/m^3	Greater Paris	(Dris et al., 2015)
	PP, PE, PS	Fragments, pellets, cosmetic beads, lines, fibers, films, foams	0.3–5 mm	0.22 items/m^2	Lakes Geneva, Swiss	(Faure et al., 2015)
	PS	–	–	5.2297 items/m^2	Chilean rivers, Chile	(Rech et al., 2015)

PP	Fibers, fragments, films, pellets	0.005–5 mm	3.4×10^3–2.58×10^4 items/m^3	Taihu lake, China	(Su et al., 2016)
–	Fragments, fibers	0.3–5 mm	2.68–3.36 items/m^3	Lake Chiusi, Italy	(Fischer et al., 2016)
–	–	0.125–2 mm	71.7 items/m^3 downstream, 24 items/m^3 upstream	Raritan River, New Jersey, USA	(Estahbanati and Fahrenfeld, 2016)
–	Fibers, pellets, foams, films, fragments	> 0.355 mm	1.9 items/m^3	Great Lakes tributaries, USA	(Baldwin et al., 2016)
PP, PE, PS	Pellets, fibers, fragments	0.330–4.75 mm	2.355 ± 0.375 items/m^3 upstream, 5.733 ± 0.85 items/m^3 downstream	Rivers in Illinois, USA	(McCormick et al., 2016)
PET, PP, PE, PA, PS	Fibers, granules, pellets, films	< 5 mm	1660.0 ± 639.1 to 8925 ± 1591 items/m^3	Wuhan, China	(Wang et al., 2017)
PS, PP, PE, PC, PVC, VC/VAC	Fibers, fragments, pellets, films, foams	< 5 mm	1597–12611 items/m^3	Three Gorges Reservoir, China	(Di and Wang, 2018)
–	Fibers, foils, spheres	0.01–5 mm	4.8×10^4–1.87×10^5 items/m^3	Dutch river delta and Amsterdam canals	(Leslie et al., 2017)
PP, PET, PTFE	Fibers	0.33–3.59 mm	490 items/m^3	Hudson River, USA	(Miller et al., 2017)
PE, PP, PS, PET, PVAc, EVA, PTFE, PEA, SBR, PMMA	Fragments, pellets, films, Foams, fibers	< 5 mm	58–193 items/m^3 in March, 71–1265 items/m^3 in October	Antuã River, Portugal	(Rodrigues et al., 2018)
PE, PP, PET	Fibers, fragments	< 5 mm	1.72×10^5–5.19×10^5 items/m^3	Saigon River, Vietnam	(Lahens et al., 2018)

PS, PA, PES, PE, PP	Fibers, fragments, foams, spheres	> 0.063 mm	3×10^3–1.1×10^4 items/m^3	Charleston Harbor, USA	(Gray et al., 2018)
PE, PP, PET	Fibers, fragments, films	0.02–5 mm	379–7924 items/m^3	Pearl River along Guangzhou, China	(Lin et al., 2018)
PET, PP, PA, PE, PMMA, PVC, PS, PU, PC	Pellets, films, fragments, fibers	0.021–4.83 mm	500–3100 items/m^3	Middle-Lower Yangtze River Basin, China	(Su et al., 2018)
PE, PS, PET	Fibers, films, fragments, grains	< 5 mm	1760 ± 710 to 10120 ± 4090 items/m^3	Lake Ulansuhai, China	(Wang et al., 2019c)
PP, PE, PS, PVC, PET	Foams, films, fragments, fibers	0.112–5 mm	0.56 ± 0.45 items/m^3	Feilaixia Reservoir, China	(Tan et al., 2019)
PC, PS, PP, PE	Fibers, films, granules, fragments	0.02–2.535 mm	$1.353\times10^4 \pm 4.6\times10^3$ to $4.493\times10^4 \pm 9.41\times10^3$ items/m^3	Estuaries in Shanghai, China	(Zhang et al., 2019b)
PE, PVC, PS	Fibers, fragments, pellets, films, foams	≤ 5 mm, > 5 mm	3.67×10^3–1.07×10^4 items/m^3	Wei River, China	(Ding et al., 2019)
–	Fragments, pellets, lines, fibers, flakes, foams, foils	0.3–5 mm	0.9 ± 0.4 to 13 ± 5 items/m^3	Ofanto river, Italy	(Campanale et al., 2020)
PE, PP, PS, PTFE, PES, Polyacrylate	–	> 0.1 mm	3.52–32.05 items/m^3	Carpathian basin, Europe	(Bordós et al., 2019)
PE, PP, PET, PAN	–	> 0.333 mm	0.27 ± 0.18 items/m^3	Northern European Lake	(Uurasjärvi et al., 2020)
PP, PES, PE, PA, PS, PMMA, PU, PVC, Poly (ethylene-vinyl acetate), Poly (acrylatestyrene)	Fragments, fibers, spheres, films	0.02–5 mm	293 ± 83 to 4760 ± 5242 items/m^3	Nakdong River, Republic of Korea	(Eo et al., 2019)

PA, PES	Fragments, fibers	0.05–2 mm	$5.85\times10^3 \pm 3.28\times10^3$ items/m^3	Ciwalengke River, Majalaya district, Indonesia	(Alam et al., 2019)
PE	Fragments, fibers, lines, films	> 0.02 mm	$3.077\times10^4 \pm 3.059\times10^4$ items/m^3	Lake, Turkey	(Çullu et al., 2021)
PE, PP	Fragments, fibers, films, monofilament, foams	0.125–5 mm	0.0574 ± 0.025 items/m^3	Citarum River, Indonesia	(Sembiring et al., 2020)
PET, PE, PS, PP	Films, fragments, fibers, foams, pellets	0.3–5 mm	1.47–43.11 items/m^3 in surface, 0.76–12.56 items/m^3 in middle, 1.43–34.63 items/m^3 in bottom	Surabaya River, Indonesia	(Lestari et al., 2020)
PES, PMMA, PP, Rayon, PA, PE	Fibers, fragments, films, pellets	0.036–4.668 mm	400 ± 270 items/m^3	Goulburn River Catchment, Australia	(Nan et al., 2020)
–	Fibers, microbeads, fragments, films, foams	> 0.01 mm	120 ± 10 to 160 ± 20 items/m^3	St. Lawrence River, *Canada*	(Crew et al., 2020)
PE, PP, PS, PVAc, Urethane alkyd	Fragments, films, beads	< 3.499 mm	83 ± 100 items/m^3	River Leen, UK	(Stanton et al., 2020)
PP, PE, PS	Fragments, fibers, films, pellets	0.335–5 mm	200 items/m^3	Muthirappuzhayar River, India	(Lechthaler et al., 2021)
PE, PP, PS	Fibers	0.094–33.6 mm	$2.5\times10^3 \pm 1.3\times10^3$ items/m^3	Greater Paris region, France	(Treilles et al., 2021)
PA, PC, PE, PET, PP, PS, PU, PVC, PES	Fibers, fragments, pellets	–	1.7–2.0 items/m^3	SE Gulf of California, USA	(Rios-Mendoza et al., 2021)

Note: "–" not available.

Table S4 Global distribution of MPs in sediments.

Sediments	MP type	MP shape	MP size	MP concentration	Sampling location	Reference
Marine Sediments	PS	Fibers, fragments	> 0.065 mm	688.9 ± 348.2 to 3308 ± 1449 items/m^2	South-eastern coastline of South Africa	(Nel and Froneman, 2015)
	PS	Pellets, lines, films, fibers, fragments	> 0.02 mm	13.7 ± 5.6 to 159.9 ± 271.2 particles per 500 mL	KwaZulu-Natal, South Africa	(Naidoo et al., 2015)
	PP, PE, SAN	Fragments, lines, fibers, pellets	0.01–5mm	49–279 items/kg	Sediments of Hong Kong, China	(Tsang et al., 2017)
	–	Fragments, pellets, lines	0.355–5 mm	0–3146 items/kg d.w.	Sediments of North West Europe	(Maes et al., 2017)
	PET, PPA, PVC, PE	Fibers, granules, films	> 333 μm	2.58 ± 1.14 items/g d.w.	Yellow Sea, China	(Wang et al., 2018)
	PE, PP, PE-EA	Films, fibers, pellets, granules	0.001–5 mm	37.1 ± 42.7 items/kg d.w.	North Yellow Sea, China	(Zhu et al., 2018)
	PET, PP, PE, PA, PVAC	Fibers, fragments, granules	< 4 mm	7–25 items/kg d.w.	Jiaozhou Bay, China	(Zheng et al., 2019)
	PE, PP, PA, PS	Pellets, films, fragments, fibers, foams	0.3–5 mm	40.7 ± 33.2 items/m^2	India	(Robin et al., 2020)
	PP, PU, PA	–	0.011–5 mm	2.8–1188.8 items/kg	Southern North Sea	(Lorenz et al., 2019)

PE, PP, PS, PVC PET, CPM	Fibers, fragments, foams, pellets	< 5 mm	216.1 ± 92.1 items/kg d.w.	Haihe Estuary, China	(Wu et al., 2019b)
PE, PET, PA	Fibers, fragments, films, pellets	< 5 mm	112–468 items/kg	Chabahar Bay (Oman sea), Iran	(Hosseini et al., 2020)
PET, PS, PA	Fibers, fragments	0.1–1 mm, > 1 mm	0–48 items/kg	South of Caspian Sea	(Nematollahi et al., 2020)
PE, PP	Fibers, fragments, films, pellets	> 0.335 mm	0–0.29 items/g d.w.	South of the Algarve Coast, Portugal	(Lechthaler et al., 2020)
PP, PE, PVC, CP	Fibers, fragments	> 0.333 mm	850–24940 items/m^2	Todos Santos Bay, Mexico	(Ramírez-Álvarez et al., 2020)
PET, PP, PE, PA	Fibers, fragments, films, pellets	< 5 mm	0.9–298.1 items/kg	Greater Melbourne Area	(Su et al., 2020)
PE, PS, PP, PVAE	–	< 10 mm	333 ± 115 to 33,300 ± 7300 items/kg d.w.	South Pacific	(Bakir et al., 2020)
Rayon, PET, EVA	Fibers, pellets,	< 5 mm	433.3–4166.3 items/kg	Guangdong Coastal Areas, South China	(Li et al., 2021b)
PP, PET, Rayon	Fibers, films	0.1-4.86 mm	0–68.88 items/kg d.w.	Northern Bering and Chukchi Seas	(Mu et al., 2019a)
PE, PP, PA, Rayon, PVC	Fibers	–	106.7 items/kg	Black Sea	(Cincinelli et al., 2021)
ABS, PES, PAN, PA, PP, PS, PVC, Alkyd resin	Fibers, fragments, films	–	197 ± 129 items/kg d.w.	Rockall Trough	(Courtene-Jones et al., 2020)
PES, PP, PU, PVC, PS	Fibers, fragments, films	–	1300 ± 510 items/kg	Antarctic Peninsula	(Cunningham et al., 2020)
–	Spheres, fibers	–	0–3146 items/kg d.w.	North Sea	(Maes et al., 2017)

	PP, PE, PS, PVC, PAN, PA, PES, ABS	Fibers, fragments	< 1 mm	67 ± 76 items/kg d.w.	Atlantic coastal, France	(Phuong et al., 2018)
	PET, PP, PE, CP	Fibers, films, fragments	0.1–4.93 mm	240 items/kg d.w.	Western Pacific Ocean	(Zhang et al., 2020)
	PE, PP, PTFE, PA, PVC, Nitrile rubber	–	< 0.5 mm	42–6595 items/kg	Arctic	(Bergmann et al., 2017)
Freshwater Sediments	PET, PP, PE, PA, PVAC	Fibers, fragments, granules	< 4 mm	7–25 items/kg d.w.	Jiaozhou Bay, China	(Zheng et al., 2019)
	–	Fragments, fibers	< 5 mm	205–266 items/kg d.w.	Lake Chiusi, Italy	(Fischer et al., 2016)
	PS, PP, PE, PC, PVC, VC/VAC	Fibers, fragments, pellets, films, foams	< 5 mm	25–300 items/kg w.w.	Three Gorges Reservoir, China	(Di and Wang, 2018)
	–	Fibers, foils, spheres	0.01–5 mm	100–3600 items/kg d.w.	Dutch North Sea coast	(Leslie et al., 2017)
	PE, PP, PS, PET, PVAC, EVA, PTFE, PEA, SBR	Fragments, pellets, films, foams, fibers	< 5 mm	100–629 items/kg in March 18–514 items/kg in October	Antuã River, Portugal	(Rodrigues et al., 2018)
	PS, PA, PET, PE, PP	Fibers, fragments, foams, spheres	> 0.063 mm	42.2 ± 8.5 to 1195.7 ± 193.9 items/m^2	Charleston Harbor, USA	(Gray et al., 2018)
	–	Fibers, fragments, films	0.02–5 mm	80–9597 items/kg	Pearl River along Guangzhou City, China	(Lin et al., 2018)
	PET, PP, PA, PE, PMMA, PVC, PS, PU, PC	Pellets, films, fragments, fibers	0.02–4.83 mm	15–160 items/kg	Middle-Lower Yangtze River Basin, China	(Su et al., 2018)

PE, PVC, PS	Fibers, fragments, pellets, films, foams	< 5 mm, > 5 mm	360–1320 items/kg	Wei River, China	(Ding et al., 2019)
PE, PP, PS, PTFE, PAC, PET	–	> 0.3 mm	0.46–1.62 items/kg	Carpathian basin, Europe	(Bordós et al., 2019)
PP, PE, PES, PVC, PS, PMMA, PU, Polydimethylsiloxane, Poly (acrylate-styrene), Poly (lauryl acrylate)	Fragments, fibers, spheres, films	0.02–5 mm	1970 ± 62 items/kg	Nakdong River, Republic of Korea	(Eo et al., 2019)
PA, PES	Fragments, fibers	0.05–2 mm	30.3 ± 15.9 items/kg d.w.	Ciwalengke River, Indonesia	(Alam et al., 2019)
PE, PP	Fragments, fibers, films, monofilament, foams	0.125–5 mm	166.66 ± 5.77 items/kg	Citarum River, Indonesia	(Sembiring et al., 2020)
–	Fibers, microbeads, fragments, films, foams	> 0.01 mm	65–7562 items/kg d.w.	St. Lawrence River, *Canada*	(Crew et al., 2020)
PE, PP, PA, Rayon, PAN, SBR	Foams, fibers, fragments, films, pellets	< 5 mm	32.9–6229 items/kg d.w.	Milwaukee River Basin, USA	(Lenaker et al., 2019)

	PET, PES, PE, PP, PVC	Fragments, pellets, fibers, films, foams	> 0.355 mm	9.1–318 items/kg in Lake Michigan, 77.6–1680 items/kg in Lake Erie	USA	(Lenaker et al., 2021)
	PE, PS, PU, PP, PES, PMMA, PA	Fibers, fragments, fibers, films	> 0.125 mm	372 items/kg d.w.	Lake Simcoe, Canada	(Felismino et al., 2021)

Note: “–” indicate not available in the literature.

Table S5 The distribution of PFASs in freshwater and seawater.

Water bodies	PFAS type	PFAS concentration	Sampling location	Reference
Seawater	PFCAs (C4–14), PFSAs (C4, 6 and 8), 4:2, 6:2 and 8:2 FTSs, FOSA, 6:2, 8:2 Cl–PFESA, 6:2 Cl–PFESA, ADONA, 6:2 FTAB	61–1380 pg/L	Northwestern Pacific to Southern Ocean	(Shan et al., 2021)
	PFBS, PFHxS, PFOS, PFDS, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFHxDA, PFOcDA, PFOSA, N–MeFOSAA, N–EtFOSAA, 8:2 FTUCA, 8:2diPAP, 8:2 FTS, ADONA, HFPO–DA, Gen–X, 9Cl–PFONS, F–53B	0.39–22.9 ng/L	Coast, Republic of Korea	(Lee et al., 2020a)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoA, PFTrA, PFTeA, PFBS, PFHxS, PFOS, PFDS, 6:2 and 5:3 FTCA, 4:2, 6:2, 8:2 and 10:2 FTSA, 6:2 and 8:2 F–53B, ADONA, PFECHS, HFPO–DA, HFPO–TA	23–66 ng/L	South Yellow Sea, China	(Feng et al., 2020)
	PFBS, PFHxS, PFHpS, PFOS, PFHxA, PFHpA, PFOA, PFNA, PFDA, FOSA, N–MeFOSA	130–11000 pg/L	Global open ocean	(González-Gaya et al., 2019)
	11 PFCAs (C4–C14), 5 PFSAs (C4, C6, C7, C8, C10), the cyclic PFAS PFECHS, 6 PFECAs and PFESAs (e.g., HFPO–DA, HFPO–TrA, HFPO–TeA, DONA, 6:2 and 8:2 Cl-PFESA), 2 PFPiAs (e.g., 6:6 PFPiA, 6:8 PFPiA) and 4 precursors (e.g., FOSA; 4:2 FTSA, 6:2 FTSA, 8:2 FTSA)	1.6–7.4 ng/L	North and Baltic Seas	(Joerss et al., 2019)
	13 PFCAs, 4 PFSAs, HFPO–DA PFECHS and 2 Cl–PFESAs	20.5–684 ng/L	Bohai Bay, China	(Liu et al., 2019a)

PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, PFBS, PFHxS, PFOS, PFDS	346.9–3045.3 pg/L	North Pacific to Arctic Ocean	(Li et al., 2018)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, PFBS, PFHxS, PFOS, PFDS, 6:2 FTSA, FOSA, MeFOSA and EtFOSA, FOSAA, MeFOSAA, EtFOSAA, MeFOSE, EtFOSE	1.2–14 ng/L	Northern Europe	(Nguyen et al., 2017)
PFOA, FOSA, PFBS, PFHxS, PFPA, PFHxA, PFHpA	181–2658 pg/L in East China Sea, 62–494 pg/L in South China Sea	East and South China Sea	(Zheng et al., 2017)
PFOA, PFOS	1.7–3.9 ng/L	Tokyo Bay, Japan	(Sakurai et al., 2016)
PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFDoDA, PFTeDA, PFBS, PFHxS, PFHpS, PFOS, PFDS, FOSA, EtFOSE	246–515 pg/L	Western Mediterranean Sea	(Brumovský et al., 2016)
C4–12 PFCAs, C4, C6, C8 PFSAs, PFOSA	195–4925 pg/L	South China Sea	(Kwok et al., 2015)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFBS, PFHxS, PFOS, PFDS	1.2–130 ng/L	Coast, Republic of Korea	(Hong et al., 2015)
PFBS, PFHxS, PFHpS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFOA, PFNA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, FOSA	4.1–250 ng/L in Elbe River; 3.8–16 ng/L in Weser River; 0.13–10 ng/L in North Sea	North Sea, Elbe and lower Weser River in Germany	(Zhao et al., 2015b)
PFBS, PFHxS, PFHpS, PFOS, PFOA, PFNA, PFDA, PFOSA, N–MePFOSA	131–10900 pg/L in Atlantic Ocean; 344–2500 pg/L in Pacific Ocean; 176–1976 pg/L in Indian	Global Tropical and Subtropical Surface Oceans	(González-Gaya et al., 2014)
PFBS, PFOS, PFDS, PFHS, PFBA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA	1.5–41 ng/L	Puget Sound, USA; Barkley Sounds, Canada	(Dinglasan-Panlilio et al., 2014)

FTOHs (6:2, 8:2, 10:2, and 12:2 FTOH), FTACs (6:2 and 8:2 FTAC), Me– and EtFOSA, Me– and EtFOSE, MeFBSA, MeFBSE	3.7–160 pg/L	North Sea	(Xie et al., 2013)
6:2 diPAP, 8:2 diPAP, PFBS, PFHxS, PFOS, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA	0.988–6.051 ng/L	Hong Kong, China	(Loi et al., 2013)
PFOA, PFOS	1.6–95.9 ng/L	Effluent–receiving marine environments, China	(Chen et al., 2012)
PFBS, PFHxS, PFHpS, PFOS, PFDS, PFBA, PFPA, PFHpA, PFHxA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, FOSA	532–15284 pg/L	Fildes Peninsula and King George Island, Antarctica	(Cai et al., 2012a)
PFBS, PFHxS, PFHpS, PFOS, PFDS, PFBA, PFPA, PFHpA, PFHxA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, MeFBSA, EtFOSA, FOSA, MeFOSA, MeFOSE, EtFOSE	133–3320 pg/L	East to South China Sea	(Cai et al., 2012b)
16 PFCAs, 7 PFSAs, 6:2 FTS, PFSiAs, FASAs, FASEs, FTCAs, FTUCAs	0.35–621 ng/L	River Rhine, Europe	(Möller et al., 2010)
PFOA, PFOS	3.77–129 ng/L	Tokyo Bay, Japan	(Sakurai et al., 2010)
PFBS, PFHxS, PFOS, PFOA, PFNA	0.07–13 ng/L	Mediterranean coastal waters, Spain	(Sánchez-Avila et al., 2010)
13 PFCAs, 5 PFSAs, 3 PFPAs, FASEs, FTCAs, FTUCAs, 6:2 FTS	14.5–449 pg/L	Greenland Arctic Ocean	(Busch et al., 2010)
33 ionic PFCs (PFCAs, PFSAs, PFSiAs, FTCAs, FTUCAs, 7 neutral PFC precursor compounds	0–1115 pg/L	Atlantic Ocean	(Ahrens et al., 2009a)
PFOS, PFOA	0.17–39.8 ng/L	Dalian Coast, China	(Ju et al., 2008)

Freshwater	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUA, PFDoA, PFTrDA, PFBS, PFPeS, PFHxS, PFHpS, PFOS, PFNS, PFDS	441.7–2234.3 ng/L	Urban watersheds in Nevada, USA	(Bai and Son, 2021)
	11 PFCAs, 8 PFSA, 2 PFPA, 3 PFPiA, PFECA, 2 PFESA, PFECHS, 4 PFSA, 3 PFSOAA, disAmPAP, 4 FTSA, 2 diPAP	67–5500 ng/L	Stony Creek, Melbourne, Australia	(Marchiandi et al., 2021)
	PFBS, PFHxS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, FOSA, N–MeFOSA, N–EtFOSA	0.37–47 ng/L	Tagus River basin, Spain	(Navarro et al., 2020)
	PFBS, PFHxS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, FOSA, MeFOSA, EtFOSA, MeFOSE, EtFOSE, FOSAA, MeFOSAA, EtFOSAA, 6:2 FTSA	95–100 ng/L	Lake Sänksjön, Sweden	(Mussabek et al., 2020)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, L-PFBS, L–PFHxS, L–PFHpS, L–PFOS, L–PFDS, FOSA, MeFOSAA, EtFOSAA	17.7–467 ng/L	Asan Lake, Republic of Korea	(Lee et al., 2020b)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFBS, PFHxS, PFOS, PFOSA	22.9–279.5 ng/L	New Jersey, USA	(Goodrow et al., 2020)
	PFCAs (C4–C14, C16), PFSAs (C3–C10, C12), Cl–PFOS, PFEtCHxS, unsubstituted perfluoroalkyl sulfonamides (C4, C6, C8), MeFOSA, EtFOSA, FOSAA, MeFOSAA, EtFOSAA, x:2 telomer sulfonates (C4, C6, C8, C10), saturated telomer acids x:2 (C6, C8, C10), x:3 (C3, C5, C7); unsaturated telomer acids x:2 (C6, C8, C10), HFPO-DA, ADONA, F53-B, diPaps x:2 (C6, 8)	LOQ–203 ng/L	Freshwater Lake, USA	(Schwichtenberg et al., 2020)
	PFOA, PFOS, PFNA, PFHxS, PFBS, FOSA, MeFOSA, EtFOSA, MeFOSE, EtFOSE	<64 ng/L	Ireland	(Harrad et al., 2019)

C4–C14 PFCAs, PFBS, PFHxS, PFOS, HFPO–DA, ADONA, 4:2, 6:2, and 8:2 FTSAs, HFPO–TA, 4:2, 6:2, and 8:2 Cl–PFESAs, 6:2 H–PFESA	1.63–2182.48 ng/L	Rivers in China, USA, UK, Sweden, Germany, Netherlands and Republic of Korea	(Pan et al., 2018)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrA, PFTeA, PFBS, PFHxS, PFOS, PFDS	LOQ–38.5 ng/L	Vaal River, Africa	(Groffen et al., 2018)
PFOS, PFOA, PFHpA, PFBS, PFPeA, PFNA, PFDA, PFUnDA, PFDoDA	62.3–186.4 ng/L	Plankenburg River, Cape Town, South Africa	(Fagbayigbo et al., 2018)
PFBA, PFPeA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFBS, PFPeS, PFHxS, PFHpS, PFOS, PFNS, PFDS, PFDoDS, 6:2 FTS	0.03–74 ng/L	Melbourne, Australia	(Szabo et al., 2018)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, PFBS, PFHxS, PFOS, PFDS, 6:2 FTSA, FOSA, MeFOSA, EtFOSA, FOSAA, MeFOSAA, EtFOSAA, MeFOSE, EtFOSE	1.0–60 ng/L	Northern Europe	(Nguyen et al., 2017)
6:2 FTAA, 6:2 FTAB, 6:2 FTSAm	16.04–52 ng/L	Canadian Surface Waters	(D'Agostino and Mabury, 2017)
PFHpA, PFNA, PFDA, PFDoA, PFOA, PFHS, PFOS	15.45–1003 ng/L	Mississippi River, USA	(Newsted et al., 2017)
PFCAs, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFSAs, PFBS, PFHxS, PFOS, PFDS	<8.88 ng/L	Vietnam	(Lam et al., 2017)
PFHxS, PFOS, PFHxA, PFHpA, PFOA, PFNA, PFDA	0.89–35.02 ng/L	Maltese Islands	(Sammut et al., 2017)
PFBA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFOS, PFDS, PFHxS, PFPeA	280.8 ng/L in Kakum River; 397.63 ng/L in Pra River	Pra and Kakum River, Ghana	(Essumang et al., 2017)
14 PFCAs (C4–C18), 5 PFSs (C4, C6–C10), PFSA	0.04–83.1 ng/L	Jucar River, Spain	(Campo et al., 2016)

PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrA, PFTeA, PFHxDA, PFODA, PFBS, PFHxS, PFOS, PFDS, PFOSA	113.38–351.7 ng/L in Brazil; 191.49–327.2 ng/L in France; 114.6–458.1 ng/L in Spain	Brazil, France and Spain	(Schwanz et al., 2016)
PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFBS, PFHxS, PFOS, PFDS	0.22–73.9 ng/L	Industrialized bays, rivers and agricultural areas, Republic of Korea	(Lam et al., 2016)
PFOS, PFOA, PFBA, PFUdA, PFPnA, PFHpA, PFNA, PFBS, PFHxA, PFDA, PFDoA	44.7 ng/L–1.52 μg/L	Yellow River, China	(Zhao et al., 2016)
PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFOS, PFDS, PFOSA	1.3–15.9 ng/L	Ganges River, India	(Sharma et al., 2016)
PFBS, PFHxS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, FOSA, MeFOSA EtFOSA, MeFOSE, EtFOSE, FOSAA, MeFOSAA, EtFOSAA, 6:2 FTSA	0.073–5.6 ng/L	Lake Tana, Ethiopia	(Ahrens et al., 2016)
PFBA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFBS, PFHxS, PFOS, PFPrOPrA	<LOQ–4696 ng/L	Cape Fear River, North Carolina, USA	(Sun et al., 2016)
PFBS, PFHxS, PFOS, 6:2 FTS, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA	<LOQ–270.8 ng/L	Rhode Island and New York, USA	(Zhang et al., 2016)
14 PFCAs (C4–C18), 5 PFSs (C4–C10), PFSA	0.01–233 ng/L	Llobregat River, Spain	(Campo et al., 2015)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFBS, PFHxS, PFOS	<LOQ–137 ng/L	River Lambro, Italy	(Castiglioni et al., 2015)
PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFBS, PFHxS, PFOS	<LOD–8 μg/L	Italian river basins	(Valsecchi et al., 2015)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFTrDA, PFTeDA, PFBS, PFHxS, PFHpS, Br-PFOS,	<LOD–725 ng/L	France	(Munoz et al., 2015)

L–PFOS, PFDS, MeFOSAA, EtFOSAA, FOSA, MeFOSA, EtFOSA, 6:2 FTSA			
PFSAs (C4, C6–C8, and C10), PFCAs (C4–C14), FOSA	0.68–146 ng/L in Zhejiang Province; 39–212 ng/L in Shanghai and Kunshan	Eastern China	(Lu et al., 2015)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFBS, PFHxS, PFHpS, PFOS, PFDS	0.39–24.23 ng/L	Red River, Vietnam	(Duong et al., 2015)
PFOS	1.71–16.19 ng/L	Nigeria	(Ololade, 2014)
N–EtFOSA, N–EtFOSAA, FOSA, PFNA, PFOA, PFDS, PFOS, PFHxS, PFBS, 6:2 FTS, PFOcDA, PFHxDA, PFTeDA, PFDoDA, PFUnDA, PFDA, PFHpA, PFPeA, PFHxA, PFBA	<100 ng/L	Tianjin and Weifang, China	(Yao et al., 2014)
PFHxA, PFHpA, PFOA, PFNA, PFDA, PFBS, PFHxS, PFOS	0.83–40 ng/L	Brisbane River, Australia	(Gallen et al., 2014)
PFBA, PFPeA, PFHXA, PFOA, PFOS, PFHpA, PFNA, PFDA, PFDODA, PFTeDA, PFUnDA, PFTrDA, PFBS, PFHXS, PFHpS, PFDS, N–EtFOSAA	1.38–320.58 ng/L	Pearl River Delta, China	(Pan et al., 2014b)
PFBA, PFHXA, FOSA, PFOA, PFOS, PFHpA, PFNA, PFDA, PFDODA, PFTeDA, PFUnDA, PFTrDA, PFBS, PFHXS, PFHpS, PFDS, EtFOSAA	2.2–74.56 ng/L	Yangtze River, China	(Pan et al., 2014a)
di-SAmPAP, FOSA, 8:2 FTCA, PFDS, PFOS, PFHxS, PFBS, PFTeDA, PFTrDA, PFDoDA, PFUnDA, PFDA, PFNA, PFOA, PFHpA, PFHxA, PFPeA, PFBA	3.8–38 ng/L	Tama River, Japan	(Ye et al., 2014)
PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFHxS, PFOS, PFDS	1.17–40.63 ng/L	Korean rivers and lakes, Republic of Korea	(Lam et al., 2014)
PFOA, PFOS	169–496 ng/L	Western Cape, South Africa	(Mudumbi et al., 2014)
PFOS	<LOQ–20.7 ng/L	Aire and Calder rivers, UK	(Earnshaw et al., 2014)

PFHxS, PFOS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA	3511.91 pg/L in river water; 2495.57 pg/L in lake water	Svalbard Archipelago, Norway	(Kwok et al., 2013)
PFBS, PFHxS, PFHpS, PFOS, PFDS, PFBA, PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA	3.0–52 ng/L	Pearl River, China	(Zhang et al., 2013)
Br–PFOS, L–PFOS, PFHxS, PFDoDA, PFUnDA, PFDA, PFNA, PFOA, PFHpA, PFHxA, PFPeA, 7 PFOS isomers	11–79 ng/L	Huai River Basin and Taihu Lake, China	(Yu et al., 2013)
PFBS, PFHxS, PFOS, PFDS, PFBA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA	0.75–3.1 ng/L in Guanting Reservoir; 1.1–2.5 ng/L in Hohhot; 0.55–16 ng/L in Shanxi; 4.4–25 ng/L in Tianjin; 3.2–121 in Liaoning	Guanting Reservoir, Hohhot, Shanxi, Tianjin and Liaoning, China	(Wang et al., 2012)
PFBA, PFPeA, PFDoA, PFOS, PFHxA, PFHpA, PFUnA, PFOA, PFNA, PFDA	30.98 ng/L	Dianchi Lake, China	(Zhang et al., 2012)
PFHxS, PFOS, PFDS, FOSA, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA, PFTeDA	47.1 ng/L	Lake Ontario, Canada	(Myers et al., 2012)
PFOS, PFHpA, PFOA, PFNA, PFDA, PFUnA	27–754 pg/L	Meromictic Lakes, Canada	(Veillette et al., 2012)
PFOA, PFOS	0.91–49.44 ng/mL	Langat River, Malaysia	(Zainuddin et al., 2012)
PFHxA, PFHpA, PFNA, PFOA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFPeDA, PFHxDA, PFHpDA, PFOA isomer, PFNA isomer, PFDA isomer, PFUnDA isomer, PFHxS, PFHpS, PFOS, PFNS, PFDS, PFOS isomer, 8:2 FTUCA, 10:2 FTUCA, 8:2 FTCA, 10:2 FTCA, NMeFOSAA, NEtFOSAA, FOSAA, NMeFOSE, NEtFOSE, THPFOS, PFHxPA	32.6 ng/L	Tokyo Bay, Japan	(Zushi et al., 2011)
PFCAs (C5–C14), PFOSA, PFSAs (C4, C6–C8, C10)	0.35–621 ng/L	River Rhine, Europe	(Möller et al., 2010)
PFBA, PFOA, PFBS, PFOS	<828 ng/L	Mississippi River, USA	(Nakayama et al., 2010)

PFBS, PFHxS, PFOS, PFDS, PFBA, PFHxA, PFHpA, PFNA, PFDA, PFUnA, PFDoA	<LOQ–450 ng/L	Coast, Republic of Korea	(Naile et al., 2010)
PFBS, PFHxS, PFOS, PFOA, PFNA	2.24–21.9 ng/L	River along the Catalan coast	(Sánchez-Avila et al., 2010)
PFBS, PFPS, PFHxS, PFHpS, PFOS, PFHxSi, PFOSi, 6:2 FTS, PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFOSA, MeFBSA, MeFBSE, FHUEA	7.6–26.4 ng/L	River Elbe, Germany	(Ahrens et al., 2009b)
PFOA, PFOS	0.8–109.63 ng/L	Lake Victoria, Africa	(Orata et al., 2009)
PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFOS, PFDS, PFOSA, N–Et–PFOSA	12.1–54.9 ng/L	River Danube and two tributaries, Austria	(Clara et al., 2009)
PFBS, PFHxS, PFOS, FOSA, PFDS, PFDA, PFNA, PFOA, PFHpA, PFHxA, 6:2 FTS	69.6–85.4 ng/L	Glatt Valley, Switzerland	(Huset et al., 2008)
PFOS, PFOA	4.6–2723 ng/L	Yodo river, Japan	(Lein et al., 2008)
PFOS, PFHxS, PFBS, PFOSA, PFNA, PFOA, PFHxA, PFHpA, PFDA, PFUnDA, PFDoDA, PFTeDA, PFHxDA, PFOcDA	11.493–122.01 ng/L	Pearl River and Yangtze River, China	(So et al., 2007)
PFOA, PFDA	9.49–35.9 ng/L	Washington Park Lake and Rensselaer Lake, USA	(Kim and Kannan, 2007)
PFBA, PFHeA, PFOA, PFNA, PFDeA, PFOS	15.351 ng/L in Xiaoqing River; 17.442 ng/L in Gaobeidian effluent	Xiaoqing River and Jingmi Canal, China	(Zhao et al., 2007)
PFOA, PFOS, PFBS, PFHxS, PFOSA, PFDoA	<31.9–137.1 ng/L	Rivers in Kyoto, Japan	(Senthilkumar et al., 2007)

Table S6 Global distributionof PFASs in sediments of aquatic environments.

Sediments	**PFAS type**	**PFAS concentration (ng/g dry weight)**	**Sampling location**	**Reference**
Marine sediments	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFHxDA, PFBS, PFPeS, PFHxS, PFOS, PFNS, PFDS, PFDoS, HFPO–DA, ADONA, FHxSA, FBSA, FOSA, 4:2, 6:2, 8:2 and 10:2 FTS, 6:2 and 8:2 Cl–PFESA	0.209–4.74	East China Sea and Yellow Sea, China	(Zhong et al., 2021)
	PFBS, PFHxS, PFHpS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, F–53B, GenX, 6:2 FTSA, FBSA, FOSA	0.19–0.66	Beibu Gulf, China	(Xiao et al., 2021)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, PFPrS, PFBS, PFPeS, PFHxS, PFHpS, PFOS, 4:2, 8:2 and 10:2 FTS, FHEA, FOSA, N–MeFOSAA, N–EtFOSAA, PFECHS, 9Cl–PF3ONS	0.05–3.89	Pensacola and Perdido Bays, USA	(Ahmadireskety et al., 2021)
	PFBS, PFHxS, PFOS, PFDS, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFHxDA, PFOcDA, PFOSA, N–MeFOSAA, N–EtFOSAA, 8:2 FTUCA, 8:2diPAP, 8:2 FTS, ADONA, HFPO–DA, Gen–X, 9Cl–PFONS, F–53B	0.045–1.13	Coast, Republic of Korea	(Lee, et al., 2020a)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoA, PFTrA, PFTeA, PFBS, PFHxS, PFOS, PFDS, 6:2 and 5:3 FTCA, 4:2, 6:2, 8:2 and 10:2 FTSA, 6:2 and 8:2 F–53B, ADONA, PFECHS, HFPO–DA, HFPO–TA	0.198–3.295	South Yellow Sea, China	(Feng et al., 2020)
	PFBS, PFHxS, PFOS, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA	0.06–1.73	Bering Sea to the western Arctic	(Lin et al., 2020)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFBS, PFHxS, PFOS, PFDS, 4:2, 6:2, 8:2 and 10:2 FTSA, 3:3, 5:3, 7:3, 6:2 and 8:2 FTCA, 6:2 and 8:2	0.7–4.13	Bohai and Yellow Sea, China	(Zhao et al., 2020)

	FTUCA, 6:2 and 8:2 Cl–PFESA, 6:2 and 8:2 diPAP, HFPO–DA, ADONA, PFECHS, 6:2, 8:2 and 10:2 FTOH, N–MeFOSA, N–EtFOSA, N–EtFOSE, N–MeFOSE			
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTeDA, PFHxDA, PFOcDA, PFBS, PFHxS, PFOS, PFDS, HFPO–DA, ADONA, 6:2 Cl–PFESA, 8:2 Cl–PFESA	0.0075–0.0842	South China sea	(Wang et al., 2019b)
	11 PFCAs (C4–C14), 5 PFSAs (C4, C6–C8, C10), the cyclic PFAS PFECHS, 6 PFECAs and PFESAs, 2 PFPiAs and four precursors (e.g., FOSA, 4:2 FTSA, 6:2 FTSA, 8:2 FTSA)	0.4424–2.1584	North and Baltic Seas	(Joerss et al., 2019)
	13 PFCAs, 4 PFSAs, HFPO–DA PFECHS and 2 Cl–PFESAs	2.69–25.0	Bohai Bay, China	(Liu et al., 2019a)
	PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFHxDA, PFOcDA, PFBS, PFHS, PFOS, PFDS	0.00661–0.821	Jinhae Bay, Republic of Korea	(Shen et al., 2018)
	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFBS, PFHxS, PFOS, PFDS, FOSA, FOSAA, EtFOSA, EtFOSAA	0.007–0.198	Bahia, Brazil	(Nascimento et al., 2018)
	6:2 diPAP, 8:2 diPAP, PFBS, PFHxS, PFOS, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA	1.168	Hong Kong, China	(Loi et al., 2013)
	PFHxA, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA, PFTeDA, PFBS, PFHxS, PFOA, PFOS, FOSA, PFDS, FOSAA, MeFOSAA, EtFOSAA	0.61–3.4	False Creek, Canada	(Benskin et al., 2012)
	PFOA, PFOS	0.062–5	Tokyo Bay, Japan	(Sakurai et al., 2010)
Freshwater sediments	PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUA, PFDoA, PFTrDA, PFBS, PFPeS, PFHxS, PFHpS, PFOS, PFNS, PFDS	272.9	Truckee River, USA	(Bai and Son, 2021)
	PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, PFDS, C9–C14 PFCAs	0.24–1.93	Jiulong River, China	(Wang et al., 2022)
	PFBS, PFHxS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA,	3–61	Lake Sänksjön, Sweden	(Mussabek et al.,

PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, FOSA, MeFOSA, EtFOSA, MeFOSE, EtFOSE, FOSAA, MeFOSAA, EtFOSAA, 6:2 FTSA			2020)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFUdA, PFDoA, PFTrDA, PFTeDA, PFHxDA, PFODA, L–PFBS, L–PFHxS, L–PFHpS, L–PFOS, L–PFDS, MeFOSAA, EtFOSAA	0.04–15.0	Asan Lake, Republic of Korea	(Lee et al., 2020b)
PFBS, PFHxS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, FOSA, MeFOSA, EtFOSA, MeFOSE, EtFOSE, FOSAA, MeFOSAA, EtFOSAA, 6:2 FTSA	0–30.9	New Jersey, USA	(Goodrow et al., 2020)
PFOA, PFOS	1.3–20.7	Laurentian Great Lakes, North America	(Remucal, 2019)
PFOS, PFECHS, PFHxS, PFBS, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, FOSA	0.006–1.52	Lake Hazen, Canada	(MacInnis et al., 2019)
PFOS, PFOA, PFHpA, PFBS, PFPeA, PFNA, PFDA, PFUnDA, PFDoDA	1.47–2.12	Plankenburg River, Africa	(Fagbayigbo et al., 2018)
6:2 FTAA, 6:2 FTAB, 6:2 FTSAm	<LOD–0.44	Welland River, Canada	(D'Agostino and Mabury, 2017)
PFCAs, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFSAs, PFBS, PFHxS, PFOS, PFDS	0.18–23.4	Vietnam	(Lam et al., 2017)
PFOS, PFOA, PFBA, PFUdA, PFPnA, PFHpA, PFNA, PFBS, PFHxA, PFDA, PFDoA	8.19–17.4	Yellow River, China	(Zhao et al., 2016)
14 PFCAs (C4–C18), 5 PFSs (C4, C6–C10), PFSA	14.3–75.9	Jucar River, Spain	(Campo et al., 2016)
PFBS, PFHxS, PFOS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTriDA, PFTeDA, PFHxDA, PFOcDA, FOSA, MeFOSA EtFOSA, MeFOSE, EtFOSE, FOSAA, MeFOSAA, EtFOSAA, 6:2 FTSA	0.22–0.5	Lake Tana, Ethiopia	(Ahrens et al., 2016)
PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFTrDA, PFTeDA, PFBS, PFHxS, PFHpS, Br–PFOS, L–PFOS, PFDS, MeFOSAA, EtFOSAA,	<LOD–25	France	(Munoz et al., 2015)

FOSA, MeFOSA, EtFOSA, 6:2 FTSA			
PFOS	<1.64–10.29	Nigeria	(Ololade, 2014)
PFOA, PFOS, PFHxS, PFDS, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA	0.22–19.21	Charleston Harbor, USA	(White et al., 2015)
PFHpA, PFOA, PFNA, PFDA, PFHxS, PFDS, FOSA	0.19–64	Lakes in Cornwallis Island, Arctic Ocean	(Lescord et al., 2015)
PFBA, PFHxA, FOSA, PFOA, PFOS, PFHpA, PFNA, PFDA, PFDODA, PFTeDA, PFUnDA, PFTrDA, PFBS, PFHXS, PFHpS, PFDS, EtFOSAA	0.05–1.44	Yangtze River, China	(Pan et al., 2014a)
PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFHxS, PFOS, PFDS	0.03–1.09	Korean rivers and lakes	(Lam et al., 2014)
PFBA, PFPeA, PFDoA, PFOS, PFHxA, PFHpA, PFUnA, PFOA, PFNA, PFDA	0.21–2.45	Dianchi Lake, China	(Zhang et al., 2012)
PFHxS, PFOS, PFDS, FOSA, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA, PFTeDA	6.5–67	Lake Ontario, Canada	(Myers et al., 2012)
PFBS, PFHxS, PFOS, PFOA, PFNA	2.24–21.9	River water along the Catalan coast	(Sánchez-Avila et al., 2010)
PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFOS, PFDS, PFOSA, N-Et-PFOSA	1.95–12.68	River Danube and two tributaries, Austria	(Clara et al., 2009)
PFOA, PFOS, PFBS, PFHxS, PFOSA, PFDoA	3.01–14.17	Rivers in Kyoto, Japan	(Senthilkumar et al., 2007)

Table S7 Toxicity of MPs to aquatic organisms.

Organism	Species	MPs type	Shape, size, concentration	Exposure time	Toxic effects and related mechanisms	Reference
Algae	Marine microalgae (*Dunaliella salina*)	PE	Spheres, 180–212 μm, 50, 100, 150, 200, 250, 300, 350 mg/L	6 days	Promoted the growth and photosynthesis activity of microalgae.	(Chae et al., 2019)
	Microalgae (*Dunaliella tertiolecta*)	PS–COOH, $PS–NH_2$	40 nm, 50 nm 0.5, 1, 5, 10, 25, 50 μg/mL	72 h for growth inhibition test, 14 d for long-term toxicity test	PS–COOH formed micro–scale aggregates and did not inhibit the growth of microalgae. $PS–NH_2$ formed nano-scale aggregates and inhibited the growth of algae (EC_{50} = 12.97 μg/mL).	(Bergami et al., 2017)
	Freshwater microalgae (*Scenedesmus obliquus*)	PS, $PS–NH_2$	Beads, PS: 0.1, 0.5, 1, 2 μm, $PS–NH_2$: 0.1 μm, 75, 250 mg/L	250 h	Larger MPs inhibited the photosynthesis by blocking light transport, while smaller ones inhibited the growth by destroying the cell wall.	(Liu et al., 2020a)
	Marine green microalgae (*Platymonas helgolandica*)	PS	Spheres, 70 nm, 20, 200, 2000 μg/L	6 days	Caused growth inhibition, elevated heterocyst frequency, increased the membrane permeability and mitochondrial membrane potential, and decreases light energy.	(Wang et al., 2020b)

	Marine microalgae (*Skeletonema costatum*)	PVC	Spheres, 1 μm, 1 mm, 1, 5, 10, 50 mg/L	4 days	PVC with 1 μm led to growth inhibition, chlorophyll content and photosynthetic efficiency decreased.	(Zhang et al., 2017a)
Daphnia	*Daphnia magna*	PS	5.8 μm, 0–2 mg/L	48 h, 21 days	Reduced hatching rate, prolonged the time of first brood, limited the number of brood, and reduced the total number of neonates.	(Yin et al., 2020)
	Daphnia magna	PS	Spheres, < 5 μm, 2.1 to 8.4 mg/L	7 days	Reduced filtration capacity, and enhanced mortality.	(Colomer et al., 2019)
	Daphnia magna, *Artemia franciscana*	PE, PET	20–250 μm, 100 mg/L	48 h	Enter into daphnia gut, and inhibit the growth of *A. franciscana*.	(Kokalj et al., 2018)
	Daphnia magna, *Daphnia pulex*, *Ceriodaphnia dubia*	PE	1–5 μm, 1–10 μm 10^3, 10^4, 10^5, 10^6, 10^7 particles/mL	96 h	Increased mortality, and primary MPs were more toxic to *Ceriodaphnia dubia*.	(Jaikumar et al., 2018)
	Daphnia magna	PS, PS–NH_2, PS–COOH	50–100 nm, 10 mg/L	48 h	Oxidative damage to gut, caused damage on the thoracopods, and induced abnormalities.	(Zhang et al., 2019a)
	Daphnia magna	PVC	4–276 μm, particle concentration and algae cell numbers was set at 1:10	31 days	Increased body length, and reduced number of offspring.	(Schrank et al., 2019)
	Waterflea (*Daphnia pulex)*	PS	~ 75 nm, 0.1, 0.5, 1, 2 mg/L	21 days	Promoted the expression of DpCYP370B, CYP4AN1 and CYP4C34.	(Wu et al., 2019a)
	Freshwater flea *(Daphnia pulex)*	PS	Spheres, 75 nm, 10, 25 mg/mL	48 h, 21 days	Extended the time of first eggs, reduced the total number of offspring per female, first	(Liu et al., 2019b)

					induce and then inhibited the expression of SOD, GST, GPx, and CAT.	
	Daphnia magna	PET	Fibers, length range: 62–1400 μm, width: 31–528 μm, thickness: 1–21.5 μm, 12.5–100 mg/L	48 h	Increased mortality, and entered the gut.	(Jemec et al., 2016)
Shellfish	Marine mussels (*Mytilus spp*)	PS	Beads, mix of 2 and 6 μm, 32 μg/L	7 days	Increased hemocyte mortality, generated ROS in hemocyte, promoted the accumulation of fluoranthene in mussels, and induced histopathological damages.	(Paul-Pont et al., 2016)
	Mussels (*Mytilus galloprovincialis*)	PET	Fibres, 5–3000 μm, 0.1 g/L	7 days	Induced biochemical stress, and increased the production of lipid peroxidation (LPO) and glutathione peroxidase (GPX).	(Provenza et al., 2020)
	Bivalve mollusk (*Tegillarca granosa*)	PS	Beads, 500 nm, 30 μm, 0.29 mg/L	14 days	Induced apoptosis of haemocytes, inhibited phagocytosis, and hampered the detoxification of sertraline.	(Shi et al., 2020)
	C. fluminea	PS	80 nm, 0.1, 1, 5 mg/L	96 h	Accumulate in the mantle, visceral masses and gills, and induced oxidative stress, intestinal inflammation, neurotoxicity and liver damage.	(Li et al., 2020)
	Brown mussel *(Perna perna)*	PP	Irregular shape, total volume 10 mL: 0.5, 1, 2 mL of pellets	48 h	The toxicity of MP leachate was higher than that of original particles. MPs and its leachate hampered embryonic development.	(e Silva et al., 2016)
	Quagga mussels (*Dreissena bugensis*)	PE	10–45 μm, 0.1, 0.4, 0.8 g/L	24 h	Impaired feeding through decreasing filtration rates.	(Pedersen et al., 2020)

	Thick shell mussels (*Mytilus coruscus*)	PS	Spheres, 2 µm, 10, 10^4, 10^6 particles/L	14 days	Promoted the generation of catalase (CAT), glutathione (GSH) and lysozyme (LZM), and hampered the generation of pepsin (PES), trypsin (TRS), alpha-amylase (AMS) and lipase (LPS).	(Wang et al., 2020c)
	Mediterranean mussel (*Mytilus galloprovincialis*)	PS	Spheres, 1, 10, 90 µm, 66, 116 items/L	40 days	Small size MPs had a long retention time in vivo, while larger MPs were slowly excreted.	(Kinjo et al., 2019)
Fish	Marine demersal fish (*Sebastes schlegelii*)	PS	0.5 µm, 15 µm, 190 µg/L	14 days	Reduced the speed of swimming, induced respiration and metabolism stress, caused lower protein and lipid contents, reduced the growth and gross energy, and damaged bile, liver and intestine lumen.	(Yin et al., 2019)
	Fathead minnow (*Pimephales promelas*)	Tire particles	Squares, 3 ± 2 mm^2, leachates from 10 g/L tire particles	5 days	Caused a lack of eye pigmentation in fish embryos, hampered hatching success, and caused deformities.	(Kolomijeca et al., 2020)
	Yellow croaker (*Larimichthys crocea)*	PS	Spheres, 100 nm, 10, 10^4, 10^6 items/L	14 days	Inhibited digestion and absorption of juvenile fish, increased mortality, changed the proportion of the dominant bacterial phyla in the gut, reduced digestive enzyme, and reduced lysozyme activity.	(Gu et al., 2020)
	Epinephelus moara	PS	Fragments, 20–100 µm, leachates: 1.5, 15 mL/L, MPs: 2.0 and 20 mg/g dry feed	26 days	Inhibited the growth, induced lipidosis-driven hepatic lesions, oxidative stress-triggered mitochondrial depolarization, suppression of fatty acid oxidation and transport, and promotion of inflammation.	(Wang et al., 2020d)
	Sebastes schlegelii	PS	Spheres, 15 µm, 1 × 10^6 items/L	14 days	Reduced the feeding activity of fish, swimming speed and range of motion, and caused histopathological changes of gallbladder and liver.	(Yin et al., 2018)

Zebrafish (*Danio rerio*)	PS	5 and 20 μm, 70 nm, 20, 200, 2000 μg/L	7 days	Caused liver inflammation, induced oxidative stress, and disturbed the lipid and energy metabolism.	(Lu et al., 2016)
Zebrafish (*Danio rerio*)	PE	Irregular shape, 434.60 μm^2, 6.2, 12.5, 25, 50, 100 mg/L	24, 48, 72, 96, 120, 144 h	Reduced embryo hatching rate, and caused lower larval survival rate.	(Malafaia et al., 2020)
Japanese medaka	PE, PP, PS	0.01, 0.1 and 1% w/w in fish food	30 days	Increased mortality, reduced head body ratio, changed swimming behavior, and induced DNA breaks.	(Pannetier et al., 2020)
Poecilia reticulata	PS	32–40 μm, 100, 1000 μg/L	28 days	Induced oxidative stress in viscera, reduced Na+/K+-ATP activity and body molar ratio of C:N and $\delta^{13}C$ value.	(Huang et al., 2020)
Asian seabass (*Lateolabrax maculatus*)	PE, PP, PES	> 20 μm	–	Field sampling: 0.3 to 5.3 items/individual in the gut, 0.3 to 2.6 items/individual in the gill.	(Su et al., 2019)

Table S8 Toxic effects of PFASs on aquatic organisms.

Organism	Species	PFASs type	PFASs concentration	Exposure time	Toxic effects and related mechanisms	Reference
Algae	Green algae *(Chlorella pyrenoidosa*, *Selenastrum capricornutum*)	PFOA	0, 15, 30, 60, 90, 120, 150, 180 mg/L	192 h	Cell membrane permeability reduced, SOD and CAT activities increased at low concentration but inhibited at high concentration.	(Xu et al., 2013)
	Green algae (*Chlorella pyrenoidosa*)	PFOA	0.05, 0.2, 0.5 and 1.0 mg/L	10 d	Under N, P-limited and -starved conditions, algal growth and chlorophyll contents were decreased, and membrane integrity and morphology were damaged.	(Hu et al., 2020)
	Green algae (*Pseudokirchneriella subcapitata*)	PFBA, 5H 4:1 FTOH, PFOA, PFNA, PFDA, PFUnA, PFDoA	0–10 mM	4.5 h	Toxicity related to the carbon-chain length.	(Ding et al., 2012)
	Green algae (*Chlorella pyrenoidosa*)	PFOA, GenX	100 ng/L, 100 μg/L	12 d	Photosynthetic genes were down-regulated.	(Li et al., 2021a)
Daphnia	*Daphnia magna*	PFOS, PFOA, PFNA, PFDA, PFUnA, PFDoA	50 mg/L	21 d	Enhanced bioaccumulation of PFASs by HA and albumin at low level, but decreased at high level. Reduced uptake rates in the presence of DOM.	(Xia et al., 2015a)

Daphnia magna	PFOS	Acute toxicity: 0, 30, 44, 66, 100, 150 mg/L, Chronic toxicity: 0, 1, 2, 4, 8, 16 mg/L	Acute toxicity: 48 h, Chronic toxicity: 21 d	Stimulated the heartbeat, inhibition of the reproductive, antioxidant and neurological functions.	(Liang et al., 2017)
Daphnia magna	PFOS, PFOA, PFDA, PFNA, PFUnA, PFDoA	5 μg/L	72 h	Na^{+} and Ca^{2+} inhibited the bioaccumulation of PFASs.	(Xia et al., 2015b)
Daphnia magna	PFOS	1, 10, 100, 1000, 10,000 μg/L	25 d	Body weight, AChE and GST were changed, and the reproduction of F0 were inhibited.	(Jeong et al., 2016)
Daphnia magna	PFOS, PFOA, PFDA, PFNA, PFUnA, PFDoA	1, 5, 10 μg/L	25 d	Body surface sorption dominated the bioaccumulation of PFASs.	(Dai et al., 2013)
Daphnia carinata	PFOA, PFOS	Acute toxicity: 0–250 mg/L for PFOA, 0–50 mg/L for PFOS. Chronic toxicity: 0, 0.001, 0.01, 0.1, 1.0, 10 mg/L	Acute toxicity: 48 h, Chronic toxicity: 21 d	Induced mortality and reproductive defects, and damaged genetic makeup.	(Logeshwaran et al., 2021)

Shellfish	Pacific oysters (*Crassostrea gigas*)	PFOA, PFOS, PFDA, PFUnDA	10 μg/L	28 d	Salting-out effect, salinity contributed the bioaccumulation of PFCs.	(Jeon et al., 2010)
	Zebra mussels (*Dreissena polymorpha*)	PFOA, PFOS	1, 10, 1000 μg/L	10 d	Inhibited mussel MXR transporter activity.	(Fernández-Sanjuan et al., 2013)
	Green mussels (*Perna viridis*)	PFOA, PFOS, PFNA, PFDA	0.1, 1, 10, 100, 1000 μg/L	7 d for exposure and 7 d for depuration	DNA strand breaks, chromosomal breaks and apoptosis.	(Liu et al., 2014)
	Green mussels (*Perna viridis*)	PFOA, PFOS, PFNA, PFDA	0.1, 1, 10, 100, 1000 μg/L	7 d for exposure, 7 d for depuration	Reduced hemocyte cell viability, inhibited immune function.	(Liu and Gin, 2018)
	Green mussels (*Perna viridis*)	PFOA, PFOS, PFNA, PFDA	4, 40 μg/L	56 d, 48 d	Long-chain PFASs can lead to more bioaccumulation.	(Liu et al., 2011)
	Clam (*Corbicula fluminea*)	PFOSK	0, 10, 100, 1000 μg/L	7 d	Oxidative stress enhanced, gonads and digestive glands were lesioned with the combination of suspended sediment and high level PFOS.	(Liu et al., 2020b)
Fish	Zebrafish (*Danio rerio*)	PFOS, F–53B, OBS	PFOS: 0.025, 0.25, 2.5 mg/L, F-53B: 0.015, 0.15, 1.5 mg/L,	4 d	Increased Energy expenditure metabolism, decreased feed intake, and changed the expression of metabolic genes.	(Tu et al., 2019)

		OBS: 0.04, 0.4, 4 mg/L			
Zebrafish (*Danio rerio*)	PFBA, PFBS , PFPeA, PFHxA, PFHpA, PFOA, PFOS, PFNA, PFDA, PFUnA, PFDoA	10 μg/L	28 d	C-F number increased the bioconcentration of PFASs than protein content.	(Wen et al., 2019)
Zebrafish (*Danio rerio*)	PFBA, PFPeA, PFHpA, PFBS, PFHxA, PFOA, PFOS, PFNA, PFDA, PFUnA, PFDoA	10 μg/L	28 d	Long-chain PFASs inhibited the bioconcentration of short-chain PFASs by competing for transporters or binding sites of proteins.	(Wen et al., 2017)
Zebrafish (*Danio rerio*)	F–53B	0, 5, 50 μg/L	180 d	Hepatomegaly, decreased liver triglyceride level, disrupted PPAR signaling pathway, and bioaccumulation of PFASs was sex-dependent.	(Shi et al., 2019)
Zebrafish (*Danio rerio*)	F–53B	0, 5, 50, 500 μg/L	180 d	Altered sex hormone level and gene expression, and disrupted spermatogenesis in male fish.	(Shi et al., 2018)
Zebrafish (*Danio rerio*)	PFDoA	0, 0.24, 1.2, 6 mg/L	120 h	Decreased expression of neuron-specific GFP, and inhibited cholinergic system and neuronal development.	(Guo et al., 2018)

Atlantic cod (*Gadus morhua*)	PFNA, PFOA, PFOS, PFTrA	PFNA: 5.925, 118.5 μg/kg, PFOA: 3.825, 76.5 μg/kg, PFOS: 25, 500 μg/kg PFTrA: 16.95, 339 μg/kg	14 d	Changed feedback signaling processes of dopaminergic.	(Khan et al., 2019)
Marine medaka (*Oryzias melastigma*)	PFBS	0, 1, 3, 10 μg/L	120 d	Multigenerational disruption of the thyroid endocrine system.	(Chen et al., 2018)
Marine medaka (*Oryzias melastigma*)	PFBS	0, 1.0, 2.9, 9.5 μg/L	14 d	Sex ratio was skewed, and transgenerational reproduction was damaged.	(Chen et al., 2019)
Japanese medaka (*Oryzias latipes*)	PFOA, PFOS	PFOA: 10 mg/L, PFOS: 1 mg/L	21 d	Reduced fecundity and caused gene expression changes of vitellogenin and choriogenin.	(Kang et al., 2019)

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