

Microplastic pollution of worldwide lakes

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This research received specific grants from the Agence de l'Eau Rhône Méditerranée Corse 8 (Agence de l'eau RMC) and the Fondation Université Savoie Mont-Blanc (Fondation USMB) 9 10 Abstract: Studies on microplastic (MP) pollution in lakes are recent, although the problem of MP particles in the oceans was first discovered in the 1970s. The first study on lakes was 11 published in 2011. Since then, to our knowledge, 98 lakes have been investigated worldwide. 12 13 In recent years, studies on this topic have increased worldwide, particularly those focusing on urbanised lakes. Most of the plastic waste in the seas and oceans originates from the terrestrial 14 15 environment and inland waters. Moreover, lakes are potential temporary or long-term MP accumulators, according to the residence time of water. They are also of high interest for 16 biodiversity, ecology, and the economy. Lacustrine ecosystems may suffer the same fate as 17 18 marine ecosystems, or even worse, owing to their greater exposure. With the significant focus on ocean and sea contamination, contamination of freshwater ecosystems and lakes is a new 19 20 and rising topic. However, as a new field of research, several methodological issues have been 21 raised. The team diversity worldwide has led to contrasting sampling techniques and 22 materials, sample treatments, analyses, and presentation of results. Consequently, it is

necessary to determine several consensuses between scientific teams in order to work together 23 with accuracy, produce comparable results, speed up knowledge sharing and reduce the 24 25 reproducibility crisis. This review focuses on (1) MP contamination in 98 worldwide lakes. We identify (2) the theoretical sources of MPs and provide (3) an estimate of MP pollution in 26 27 different compartments of the lakes based on current state-of-the-art methods. In addition, we also report (4) the predominant MP size classes and polymer types. Finally, we suggest (5) 28 several recommendations to build a consensus between all the working teams to facilitate 29 30 decision-making by public authorities.

- 31 Microplastic pollution has been investigated in 98 lakes around the world by using different
- 32 methods and materials which leads to incomparable data.

33 1. Introduction

34 Macroplastics, microplastics (MPs), and nanoplastics have been widely studied in the past few years, particularly in marine and oceanic environments. Plastic pollution in aquatic 35 environments was observed for the first time in the 1970s. In the Sargasso Sea, the plastic 36 concentration was close to 3,500 items/km², which was mainly comprised of cigarette holders 37 (Carpenter and Smith, 1972). Recently, many studies have focused on plastic pollution in 38 freshwater environments, especially rivers and lakes. In 2011, 80 % of the plastic pollution in 39 40 seas and oceans originated from the terrestrial environment (Andrady, 2011). In 2019, the MP contamination observed in the terrestrial environment was 4 to 23 times higher than that in 41 marine ecosystems (Horton et al., 2017). Freshwater is considered one of the sources of MPs 42 flowing into the seas, and rivers are considered the main transport vector of plastic debris 43 from terrestrial sources (Iannilli et al., 2020). It is of high importance to study freshwater 44 ecosystems and analyse the plastic pollution sources, dispersion dynamics, accumulation, and 45 46 fate of these pollutants. Lacustrine ecosystems are pollutant accumulators, and consequently, 47 indicators of catchment functioning. Climatic, geographical, and physical characteristics determine the residence time of water in lakes. Pollutant circulations depend on this duration; 48 a short retention time leads to quick contamination and cleaning, whereas a long retention 49 time leads to slower changes in the plastic contents and additional processes such as local 50 fragmentation (Montuelle et al., 2015). Therefore, lakes with long water retention times seem 51 52 to accumulate a greater amount of MPs, as observed in Mongolia (Free et al., 2014; Iannilli et al., 2020). Some plastic polymers are positively buoyant and float on the surface or strand on 53 54 the coast; some are negatively buoyant and will remain in the water column or sink to the benthic zone. The behaviour of polymers plays a crucial role and influences the subsequent 55 contamination of rivers, seas, and oceans. Furthermore, human societies are dependent on 56 57 these ecosystems. Lakes offer many resources to societies based on ecosystem services such

as control services (flooding and drought), provision services (drinking water; food 58 59 production via fisheries, aquaculture, and irrigation of agricultural lands; and energy production via hydropower dams), cultural services (recreation), and support for favourable 60 conditions for sustainable nutrient cycling. Lakes are essential to the function of the economy 61 and offer many ecosystem benefits. Halieutic resources allow the local development of 62 professional fishing spots, restaurants, and culinary businesses; sports and recreational 63 64 possibilities are key elements for tourism; and biodiversity contributes to good ecological functioning and reinforces tourism. In addition, MPs, which threaten fauna (Bellasi et al., 65 2020), could endanger humans through their diet (Cox et al., 2019; Koelmans et al., 2019; Q. 66 67 Zhang et al., 2020), and may be vectors of potentially pathogenic bacteria and viruses (Arias-Andres et al., 2018; Kirstein et al., 2016; Wu et al., 2019). Currently, MPs are ubiquitous in 68 urbanised and more isolated environments. In 2010, worldwide plastic production reached 69 70 265 million t (PlasticsEurope, 2011). In 2018, it reached 359 million t (PlasticsEurope, 2019). In the same year, European plastic production reached 62 million t (PlasticsEurope, 2019). 71 72 According to a recent study, the annual production of plastic fibres increased by more than 6 %/y, reaching 60 million t in 2016, or approximately 16 % of global plastic production 73 (Gasperi et al., 2018). In 2019, it was predicted that the proportion part of poorly managed 74 75 plastic waste could increase, from 60-99 million t in 2015 to 155-265 million t by 2060 (Lebreton and Andrady, 2019). If this estimation is correct, then lacustrine ecosystems will be 76 significantly affected by MP contamination. However, knowledge of plastic pollution in lakes 77 worldwide is still incomplete. In 2012, the mean publication rates on MP pollution were: 23, 78 79 5, and 2 papers for marine, freshwater, and estuarine ecosystems, respectively (Meng et al., 2020). Nevertheless, studies concerning MP pollution in lakes have recently increased. This 80 review examines all the studies concerning MP in lakes to date to collect available data and to 81 understand the types of plastic pollution in the lacustrine ecosystem. MP pollution has been 82

studied in 98 lakes worldwide (Tables S1-S2). The aim of this work was to compare the 83 84 worldwide MP contaminations in lakes. Unfortunately, in view of the high heterogeneity of the sampling protocols, result reports, and definitions used, comparisons among the obtained 85 results are laborious. Therefore, we carefully compared: (1) the methods to investigate MP in 86 lakes and we suggested a normalised protocol, (2) all the MP contaminations in the various 87 88 environmental compartments of each lake in regards with methodologies and sampling 89 protocols and, (3) MP contaminations sources according to demographic pressures (urban vs rural lakes). 90

91 2. Material and methods

92 2.1. Sampling methodologies

Among all the studies investigated MPs in lakes, three sampling methods have been used: net 93 94 was the most frequent (22 articles), pump (7 articles) and, sampler/jar/bucket are more occasionally employed (8 articles taken together). Few studies were using pump system 95 because of its cost and specific purpose (net is also used in plankton studies); however, it 96 97 allowed to easily filter different MP size classes compared to net system. Two major difficulties were related to pump sampling: i) to convert a precise measurement of the filtered 98 volume (m³) into a filtered surface to provide a density (MP/km²) for floating MP and ii) 99 100 avoid clogging of a limited filtration area while filtering large volume of water to insure the 101 sampling representativeness. The use of buckets, jars and samplers also led to volume limitation due to the necessity to take the samples back to the laboratory and consequently, 102 103 one could question the sample representativeness. However, filtration conditions in the laboratory would be better controlled. Net systems were most common (22 articles) because 104 105 they can also be used in plankton studies and usual mesh size (300 µm) were fairly low cost (nets < 300 µm are more expensive). Unlike pump methods, nets have a large filtration area 106

which limits clogging and allows larger and thus more representative samples. Nevertheless, a 107 108 major bias in MP investigation using nets lied in the difficulty to properly assess the filtered volume. Indeed, authors assumed that water velocity within the net equal the boat speed or the 109 110 flow velocity in the river which was incorrect and induced an overestimation of the filtered volume and a subsequent underestimation of the MP contamination. For instance, (Gateuille 111 112 et al., 2020) reported an averaged filtration velocity, three times lower than the boat speed 113 using a 50 µm net. Therefore, authors willing to use nets should be able to accurately measure the flow velocity in the net. The measurement of the instantaneous filtration velocity is also 114 an efficient tool to monitor the net clogging and to stop the sampling as soon as the net 115 116 clogging starts therefore preventing a surface water backflow that could lead to the loss of floating MPs. Differences in results were observed when using a net or pump (Uurasjärvi et 117 al., 2020). The MP concentrations in the surface water of Kallavesi Lake (Finland) greatly 118 119 differed according to the sampling strategy (even if stations were not similar between the net and pump samples), with 0.27 ± 0.18 particles/m³ obtained with a 333 µm Manta net and 1.80 120 121 ± 2.30 particles/m³ obtained with a 300 µm filtering pump (Uurasjärvi et al., 2020). However, 122 the pump and net samplings were not carried out exactly at the same places during this study and the differences in MP concentrations could be due to spatial heterogeneity rather than 123 124 sampling protocols. Therefore, further investigations are required to accurately compare these 125 two sampling methods (pump and net). As most of the published results were obtained using net sampling, and because of the ease of access of this device, we suggest the use of nets for 126 surface water sampling, with the measurement of water velocity in the net to obtain a precise 127 value of filtered water volume. Moreover, it is essential to reach an agreement on the mesh 128 size (Table S2). The 300 µm net is the most commonly used (particularly 300, 333, and 355 129 μ m). Approximately 80 % of 50 published aquatic surveys concerning MPs in aquatic 130 environments only accounted for plastics \geq 300 µm in diameter, whereas > 95 % of particles 131

in surveyed products were smaller than the 300 µm minimum diameter (Conkle et al., 2018). 132 133 The use of 50 μ m or at least \leq 100 μ m nets will reduce particle underestimation and fill the knowledge gap on the smallest plastic particles. Some researchers have already started 134 working on smaller particles in lake surface waters, such as 20 µm (Kaliszewicz et al., 2020), 135 20 µm (Bharath K et al., 2021), 38 µm (Alfonso et al., 2020b), 50 µm (Pastorino et al., 2020) 136 137 and, 60 µm (Bertoldi, 2020). In order to consider as many MPs as possible, the lowest mesh 138 size should be used to avoid underestimation. However, using thinner nets can be difficult if there is a large number of suspended solids in the water. We suggest using nets with a mesh 139 size between 50 μ m and 300 μ m to reach a compromise between the lowest amount of 140 141 clogging and the highest quantity of sampled MPs. The sampling depths for surface waters were very heterogeneous, namely 16 cm, 20 cm, 30 cm, 50 cm and, 100 cm below the surface. 142 The sampling depth was often not mentioned at all. The researchers working on MP in 143 144 freshwaters (lakes, tributaries) should mentioned it to help readers to understand the results. In order to standardise studies, we suggest to sample water between surface and ~ 50 cm at the 145 146 most and to use another system to sample the column water independently. Further studies 147 should focus on column water (from the bottom to surface water) sampling with a Niskin bottle or net lifting. This method would help to determine and understand the distribution of 148 149 particles throughout the water column and their transfer to sediments according to lake characteristics. Finally, we advise scientific community to be rigorous in writing and 150 explaining their sampling and laboratory techniques (e.g.: MP detection limit according to the 151 analysis system, class size studied according to sampling methods). In order to ease the 152 information research in a paper we suggest that authors provide with the main details of the 153 methods (sampling, treatment, analysis) rather than only refer to scientific studies which is 154 time consuming for the reader and sometimes refers to inaccessible publications. In addition, 155 we suggest to sample the largest possible volume for each water sample to be more 156

representative and ease comparison of future scientific studies. Concerning the sediment 157 158 compartment, it is important to describe the type (sandy, gravelly, or muddy) and the organic carbon content because of their influence on plastic bonds and mechanical pit capacities 159 160 (Zbyszewski et al., 2014). In addition, the sample depth and thickness should be mentioned each time. We also recommend that authors report contaminations either in MP/m³ or MP/kg 161 (dry weight: dw or, wet weight: ww) with the corresponding sediment density. The studied 162 163 samples should be precisely named following our suggestions (lake bottom sediments (LBoS), lakeshore sediments (LShS) or lake beach sediments (LBeS)) to help in cross 164 analysis. LBoS and LShS are both under water, whereas LBeS is mainly a temporary sink for 165 166 buoyant particles and can also be contaminated by direct discharge of MPs and macroplastics. Among the studies, different terminology was used, which led to misunderstandings. 167

168 2.2. Quantification methods, reporting of result, and definitions

First, we suggest using a shared format to report the MP concentrations in surface water, 169 170 sediment, and fauna to ease the comparison between studies. Further investigations should study the MP concentrations by volume (particles/ m^3), the average particle size (ideally the 171 volume or at least the minimum and maximum dimensions of the particle already provide a 172 good indication), mass (particles/kg), and individuals (particles/aquatic organism) for water, 173 sediment, and fauna, respectively. Moreover, it is essential to report at least the mean 174 concentration and standard deviation. In addition, the minimal and maximal values could be 175 176 provided. Further studies should always include the total and blank concentrations in parallel and not subtract the blank concentration to avoid the use of different subtraction methods. 177 Second, it is important to precisely quantify the types and forms of polymers (percentage of 178 the concentration) and avoid quantification ranking to better compare all the studies. 179 Concerning the polymer types, several acronyms have been used among studies, thereby 180

making the parallel comparison more complex. For example, polyacrylate can be named PAK 181 182 or PAC. We suggest naming polymers PE, PP, copolymer (CP), PS, nitrocellulose (NCE), PA, PET, PVC, EPS, PES, PAC (polyacrylate), polyurethane (PU), polycarbonate (PC), 183 polymethyl methacrylate (PMMA), polybutyl methacrylate (PBMA), acrylonitrile butadiene 184 styrene (ABS), styrene butadiene rubber (SBR), and others/unknowns (O/U). Copolymers can 185 include PU-PET, PVC-PSS (polystyrene sulfonate), PE-PP, PE-PET, PAC-PET, VC-VAC 186 187 (vinyl chloride/vinyl acetate), and ethylene-vinyl acetate (EVA). We suggest including natural and synthetic sources in cellulose given the complexity of discriminating between parental 188 and regenerated compounds through spectroscopic analyses (Binelli et al., 2020; Hartmann et 189 190 al., 2019; Stark, 2019). The main components of the tire particles (copolymers ABS and SBR) are not included given the complexity of identifying these particles by FT-IR spectroscopy. 191 192 However, they could be a major source of MPs in the lacustrine environment. It is necessary 193 to develop an efficient analytical methodology to precisely quantify these copolymers. Concerning the MP shapes, we suggest reporting them as follows to avoid ambiguous 194 195 communication and generation of incomparable data: fibres (which includes fibres, filaments 196 and lines), fragments, films/sheets, pellets (which includes granules, flakes, microbeads and, spheres) and, foams (which includes Styrofoam). Some studies differentiate fibres from 197 198 filaments, pellets from granules but as it is difficult to visually differentiate them, combining 199 them will avoid incorrect identification. Further studies should quantify the particle shapes by percentage (as polymer types) to expose differences among lakes worldwide and precise 200 percentage estimates (by mass and/or number). Ideally, the current technological tools allow 201 202 us to have the average size distribution of the particles which must be informed. If it is not possible, to easily compare the report of precedent and future results, we suggest using the 203 same four size classes in further studies as follows: $< 50 \,\mu$ m, $50 \,\mu$ m- $300 \,\mu$ m- $1 \,m$ m, 204 1 mm-5 mm. Moreover, the detection limit of FTIR is approximately 6.25 µm, we suggest to 205

set the limit at 8 times the measurement limit. We suggest a limit of 50 µm because studies 206 207 that worked on small plastic particles were at or below this size (Section 5.1), including 38 μm (Alfonso et al., 2020b), 45 μm (Jiang et al., 2018), 47 μm (Alfonso et al., 2020a), and 50 208 209 µm (Wang et al., 2017; Xia et al., 2020; Yuan et al., 2019), for surface water. Several studies worked at or above the 100 µm limit for surface water, namely 100 µm (Bordós et al., 2019), 210 106 µm (Cable et al., 2017), 112 µm (Xiong et al., 2018), 125 µm (Grbić et al., 2020), and 211 150 µm (Migwi et al., 2020). The 300 µm frontier corresponds to the size of a plankton net, 212 and so far, most studies have worked with 300 µm or 333 µm nets. Among studies concerning 213 MPs in lakes, several quantified particles up to 999 µm (Eriksen et al., 2013; Free et al., 2014; 214 215 Mason et al., 2020, 2016) or 1 mm (Alfonso et al., 2020b, 2020a; Di and Wang, 2018; Oni et al., 2020). We suggest a consensus of 1 mm because most of the studies were interested in 216 particles smaller than 1 mm and some define MP as particles below or equal to 1 mm. Finally, 217 218 we suggest a limit of 5 mm according to the initial MP definition (Arthur and Bamford, 2009). 219

220 2.3. Study sites

To our knowledge, MP contamination has been studied in 98 lakes to quantify the 221 222 concentration or identify the shape and polymeric composition of plastic debris. However, to better understand the fate of MPs in lakes, researchers should consider and highlight 223 numerous physical and environmental characteristics of freshwater ecosystems, especially the 224 length of the main tributary (km) and its flow (m^3/s) , the water retention time (year), the 225 surface area (km²), volume (km³), mean and maximum depth (m), watershed area (km²), lake 226 altitude (m), land uses (percentage of urban, agricultural and road areas), the waste and 227 wastewater treatment policy, population density (inhabitants/km²), and distance of inhabited 228 areas to the lake (km), as shown in a recent study in Table SI (Alfonso et al., 2020b). These 229

environmental parameters will allow readers to understand the place of the lake, its 230 231 environment, its watershed and the potential MPs sources that may be linked to it. Moreover, these provided characteristics will ease the comparisons between studies and the interpretation 232 233 of the differences among results. Currently, there is almost no available data for remote lakes (Tables S1- S2), which is defined as an ecosystem far from any city, town, village, or hamlet 234 235 that is only reachable through hiking and does not contain anthropogenic settlements (except 236 for mountain huts) in the catchment basin. Remote lakes could also be affected by MPs via atmospheric fallout on the water surface or on the soils in the watershed. Investigation of 237 these remote sites can help to quantify the flux of atmospheric deposition after mid-range or 238 239 long-range atmospheric transport of MPs. It will also help to identify the impacts on aquatic life because of the high sensitivity of these ecosystems to xenobiotic pressure. 240

241 3. Estimation of microplastic pollution in worldwide lakes

242 The concentrations of MPs and other anthropogenic particles in Lake Ontario streams were correlated with urbanisation in the region (Grbić et al., 2020). In order to better compare the 243 244 MP contamination between lakes subjected to various pollution pressures, we differentiated 245 the lakes according to the proximity of urbanised areas and the number of inhabitants. We presumed that lakes distant to urbanised areas were more affected by atmospheric fallout and 246 agricultural runoff than those close to densely inhabited areas, which were more affected by 247 248 macroplastic pollution, impermeable surface runoff, and high-volume wastewater discharge. We distinguish "rural" and "urban" lakes as defined in Sections 2.1 and 2.2, respectively. 249 250 MPs contamination on surface waters and sediments of rural and urban lakes were compared (Fig. 1-2) according to size range studied, units (MP/m³, MP/km², MP/kg and, MP/m²) and 251 252 available data. Concerning surface waters (Fig. 1), values were comprised between 0.27 MP/m³ and 34,000 MP/m³ with a median value around 1,442 MP/m³ and, between 10,900 253

MP/km² and about 4,700,000 MP/km² with a median value of 48,200 MP/km². We noticed the 254 lack of available data on MP pollution of rural lakes. Indeed, only three values were available 255 for rural lakes approximately 1 MP/m³, 4,000 MP/m³ and, 20,000 MP/km² confirming the 256 257 importance of investigating more rural and remote lakes. MPs in water showed larger size ranges for MP/m³ than MP/km², these differences in size ranges were linked to the sampling 258 259 (e.g.: net, pump) and laboratory techniques (e.g.: filtration mesh). In some cases, large size 260 ranges seemed to be in correlation with higher MP pollutions. However, differences in MP contaminations between lakes cannot be explained by methodologies variability only. 261 Identifying the MP sources and the watershed characteristics could explain these differences 262 263 as suggested in Section 1.3. Concerning sediments (Fig. 2), values were comprised between 0.7 MP/kg to 4,220 MP/kg with a median value around 385 MP/kg and, between 17 MP/m² 264 and 2,500 MP/m² with a median value around 290 MP/m². Sediments in rural lakes could be 265 266 less contaminated than urban ones. However, the variability of size ranges studied avoid an accurate comparison of the results. Most of MP contaminations in urban lakes were higher in 267 surface waters and sediments than rural lakes. However, the lack of available data on MP 268 pollution of rural lakes, the differences in methodologies and the lack of watershed data 269 prevented us suggesting conclusions. 270

271 3.1. Rural lakes

We define a rural lake as a lake close to a hamlet(s), village(s), or town(s) (total \leq 100,000 inhabitants) (\leq 10 km). In the current scientific literature, plastic contamination in different compartments has been studied for 20 rural lakes out of 98 lakes. For surface water, a mean concentration of 20,264 MP/km² with a size class of 333 µm - 4.75 mm was observed in Khövsgöl Lake (Mongolia) (Free et al., 2014). Another study on Khövsgöl Lake showed 0.3 MP/m³ (Karnaukhov et al., 2020). Nine lakes in the Pampean Region (Argentina) contained

278	0.3 MP/m ³ to 1.9 MP/m ³ with a mean of 0.9 \pm 0.6 MP/m ³ and a size class between of 38 μ m
279	to 1 mm (Alfonso et al., 2020b). Finally, Lake Sassolo (Switzerland) contained mean
280	concentrations of 2.6×10^3 MP/m ³ and 4.4×10^3 fibres/m ³ (natural and synthetic fibres were
281	excluded from MPs) (Negrete Velasco et al., 2020), 4.1 μ g of MP fibres/m ² was reported for
282	Majcz Lake (Poland) (Kaliszewicz et al., 2020) and, no MP were observed in the surface
283	water for Dimon Lake (Italy) (Table S2). The disparities in the MP concentration between
284	these lakes could be linked to their characteristics (e.g. volume, surface, and depth). Khövsgöl
285	Lake (0.3 MP/m ³) is almost 8 times deeper and 55,200 times larger (on the surface) than
286	Sassolo Lake (2.6×10^3 MP/m ³). A voluminous lake exposed to the same MP flux as a
287	smaller lake will have a lower concentration of MPs. The different sampling methodology
288	(e.g. net, pump, and mesh size and, surface water or epilimnion) could also explain the
289	disparities in the MP concentration between lakes. Bottom lake sediments were studied only
290	in the shallow lake Knudsenheia (Svalbard, Norway) with 400 microparticles of
291	anthropogenic litter per square meter including 93 MP < 5 mm and 19 MP > 5 mm in each of
292	the six sediments sampled at the rock surface, thereby leading to an average estimation of 90
293	\times 10 ⁶ MP/km ² (González-Pleiter et al., 2020). In Lake Sassolo (Switzerland), 514 fibres/kg
294	(dw) and 33 MP/kg (dw) were quantified in the bottom sediment. The MP concentration in
295	the lakeshore sediments was also variable from $8 \pm 14 \times 10^6$ to $563 \pm 1,220 \times 10^6$
296	particles/km ² for Siling Co, $42 \pm 47 \times 10^6$ particles/km ² for Geren Co, $117 \pm 126 \times 10^6$
297	particles/km ² for Wuru Co, and $17 \pm 20 \times 10^6$ particles/km ² for Mujiu Co (all Chinese lakes)
298	(Zhang et al., 2016). In addition, in Ziway Lake (Ethiopia), the 0-2 cm sediment layer of this
299	lake contained 33,282 particles/m ³ (from 5,333 particles/m ³ to 97,333 particles/m ³ in the 13
300	investigated shoreline sites). The MP contamination induced a concentration of a 4 MP/fish.
301	Benthic and benthopelagic fish species were found to contain a significantly higher number of
302	plastic particles than planktivorous fish species (Merga et al., 2020). The disparities could be

linked to the fish diet and MP concentrations in the lake water and sediment. Depending on
the study, different unit systems, sampling methods, and lake compartments were used,
thereby leading to difficulties in comparing the results. However, all 20 lakes are
contaminated with MPs, and there is a serious need to clearly identify the sources of this
pollution in rural areas.

308 3.2. Urban lakes

An urban lake is defined as a lake close to at least one town (> 100,000 inhabitants) or one 309 city (> 1 million inhabitants) (< 50 km). In the scientific literature, MP contamination has 310 been studied in various compartments of 78 urban lakes out of 98 lakes. Similar to those of 311 rural lakes, the surface waters of urban lakes are contaminated to various degrees from 10,900 312 MP/km² to 2,090,000 MP/km² or from 0.27 MP/m³ to 34,000 MP/m³ (Table S2). For 313 instance, concentrations of $180,900 \pm 229,533$ MP/km² with a size class ranging from $112 \,\mu\text{m}$ 314 to 5 mm were reported in Qinghai Lake (China), which was mainly due to plastic waste from 315 tourism (Xiong et al., 2018). Contamination of 3.1×10^3 MP/m³ and 11.3×10^3 MP/m³ with a 316 size class from 330 µm to 5 mm was reported for Ulansuhai Nur Lake (China) (Wang et al., 317 2019). In Lake Dziekanowskie and Kalwa Lake (Poland), 4.7 μ g of MP fibres/m³ and 4.4 μ g 318 of MP fibres/m³ were reported, respectively (Kaliszewicz et al., 2020). MP pollution in the 319 surface water of urban lakes showed the lowest concentrations in Zürich (Switzerland) with 320 10,900.00 MP/km² (Faure et al., 2015), Iseo (Italy) with 11,479.00 MP/km² (Binelli et al., 321 2020), Michigan (USA) with 15,698.00 MP/km² (Mason et al., 2016), and Kallavesi (Finland) 322 with 0.27 ± 0.18 MP/m³ (Uurasjärvi et al., 2020), Bolsena (Italy) with 2.51 MP/m³, Chiusi 323 (Italy) with 3.02 MP/m³ (Fischer et al., 2016) and, Simcoe (Canada) with 0.4 - 1.3 MP/m³ 324 (Felismino et al., 2020 In Press, Corrected Proof). Therefore, some rural lakes (such as 325 Khövsgöl with 20,264 MP/km² or Sassolo with 2.6×10^3 MP/m³) seem more contaminated 326

than some urban lakes. The urban Kallavesi Lake (Finland) contains 0.27 ± 0.18 MP/m³ 327 (Uurasjärvi et al., 2020), whereas nine rural lakes in Argentina contain 0.90 ± 0.60 MP/m³ 328 (Alfonso et al., 2020b). This could be explained by the lake characteristics (depth, surface 329 330 area, etc.) that influence the MP concentration. The larger surface area of Kallavesi Lake (473 km²), compared with that of Argentinean lakes (mean of 88 km²) could be a plausible 331 explanation for the MP concentration. The different sampling methodologies, with a mesh 332 333 size of 333 µm in Finland and 38 µm in Argentina could also lead to inaccurate result comparisons. Logically, some urban lakes are more contaminated than rural lakes. For 334 example, Qinghai Lake (China) showed 9 times more MPs in the surface water than Khövsgöl 335 336 Lake (Mongolia) with 180,900 particles/km² and 20,264 particles/km², respectively. However, these disparities could also be linked to the sampling methodology because 112 µm and 333 337 um meshes were used for Qinghai Lake and Khövsgöl Lake, respectively. It is of fundamental 338 339 interest to ease the parallel comparison of results by using a consistent methodology to sample the same size classes of MPs. In addition, quantification by particles/km² or particles/m³ or 340 341 use both is of importance. In lake bottom sediments, MP contamination also has different 342 magnitudes from 0.7 MP/kg to 7,593.0 MP/kg and from 0.8 MP/m² to 339.0 MP/m². The concentrations of lakeshore sediments vary less, from 104 MP/kg to 760 MP/kg. Dongting 343 Lake (Yueyang, China) contained 389 ± 66 particles/m³ to 501 ± 331 particles/m³ in the 344 lakeshore sediments (Jiang et al., 2018). The MP concentrations in sediments of Lake 345 Yenagoa (Nigeria) ranged from 1,000 particles/m³ to 8,330 particles/m³ during the dry season 346 and 201 particles/m³ to 8,370 particles/m³ during the raining season (Oni et al., 2020). Finally, 347 the lakeshore sediments of lakes Albano, Bracciano, and Vico (Italy) contained 3.4 g/m² of 348 MPs (Iannilli et al., 2020). The disparities in the MP concentration in sediments could be 349 350 linked to the lake depth and polymer density, which modify the fate of these particles in the water column. For example, Qinghai Lake (China) contained 180,900 particles/km² in the 351

surface water and 50 particles/km² to $1,290 \times 10^{6}$ particles/km² in lakeshore sediments, 352 353 thereby underlying the role of the sediment (at least temporarily) as a sink. Future studies should measure the MP sedimentation flux in the water column to better understand the 354 355 factors influencing MP accumulation in sediment. MP pollution of beach sediments was studied for some urban lakes (but not for rural lakes). Various methodologies have also been 356 used with different unit systems (particles/m³, particles/m², particles/g, and g/m²). Several 357 authors have also worked on the MP contamination in fauna. Three fishes out of forty and 358 eight birds out of nine contained plastic particles in their gut contents in several European and 359 Swiss lakes (Faure et al., 2015; Faure and De Alencastro, 2016). Amphipods (Cryptorchestia 360 361 garbinii) contained a mean of 2.0 particles/individual and 4.8 particles/individual in the Italian Lake Albano and Lake Bracciano, respectively (Iannilli et al., 2020). Yuan et al. 362 (2019) measured 0 particles/fish to 18 particles/fish in Poyang Lake (China). Twenty percent 363 364 of the collected fish in Lake Victoria (Uganda) contained MPs (Biginagwa et al., 2016). In the Lake Mead National Recreation Area (USA), the MP concentration in shellfish ranged from 365 2.7 particles/organism to 105.0 particles/organism, and the MP concentration in fish ranged 366 from 0.0 particles/organism to 19.0 particles/organism (Baldwin et al., 2020). Xiong et al. 367 (2018) detected 5.4 \pm 3.6 particles/fish in Qinghai Lake (China). Aquatic fauna is affected by 368 369 MP pollution of lakes. However more studies are urgently needed in rural lakes to determine the order of magnitude related to the different sources. Further studies should focus on MP 370 contamination in pelagic and benthic fauna to better understand the transfer pathways and 371 potential impacts on the ecosystems. Finally, snow and ice samples near the shore of a 372 lacustrine environment have been studied in Finland at Vesijärvi Lake (Scopetani et al., 373 2019). The MP concentrations were $117 \pm 18 \times 10^3$ particles/m³ melted snow and $8 \pm 1 \times 10^3$ 374 375 particles/m³ melted ice. The high porosity of the snow matrix could play an important role in trapping airborne synthetic fibres (Scopetani et al., 2019). Microplastics contamination in 376

lakes depends on many sources and the functioning of the hydrosystem. It is essential to
conduct studies to inventory all the MP sources and methods of transfer in a specific lake
ecosystem, including its watershed, to understand the mechanisms of MP contamination and
to deduce actions to preserve and/or restore the lacustrine environment. The impact and
transfer of MPs in lake ecosystems are also dependent on the particle size and polymer
composition. Therefore, it is important to identify the main types of MPs in lakes.

383 3.3. Predominant types of particles in lakes

384 3.3.1. Microplastic size classes

Most of the plastic particles were < 2 mm in all the studied lakes, except for lakes within the 385 Siling Co basin (northern Tibet), where most particles were between 1 mm and 5 mm (Zhang 386 et al., 2016). In most cases, the particles were < 1 mm in size (Alfonso et al., 2020a, 2020b; 387 Boucher et al., 2019; Cable et al., 2017; Di and Wang, 2018; Egessa et al., 2020; Eriksen et 388 389 al., 2013; Fischer et al., 2016; Free et al., 2014; González-Pleiter et al., 2020; Irfan et al., 2020; Mason et al., 2020, 2016; Su et al., 2016; Uurasjärvi et al., 2020), and even < 500 µm 390 (Boucher et al., 2019; Fischer et al., 2016; González-Pleiter et al., 2020; Jiang et al., 2018; 391 Uurasjärvi et al., 2020; Xiong et al., 2018; Yin et al., 2020; Yuan et al., 2019) (Table 1). In 392 the Great Lakes (Canada, and USA), the number of small plastic particles (106 µm–1.00 mm) 393 was 130 times higher than that of large particles (1.00–4.75 mm) (Cable et al., 2017). In 394 395 Kallavesi Lake (Finland), the particles were 20 µm to 300 µm in size (Uurasjärvi et al., 2020). Plastic particles on the rock surfaces from the bottom (0.75 m) of a shallow lake in Svalbard 396 (Norway) were divided as follows: $25 \% < 350 \mu m$, $50 \% < 670 \mu m$, and $75 \% < 1,400 \mu m$ 397 398 (González-Pleiter et al., 2020). Many parameters could affect the size distribution of MPs in lakes. In Poyang Lake (China), plastic particles in fish are larger (82.1 % > 500 µm) than 399 those in surface water and sediments (73.1 % and 57.1% < 500 μ m, respectively), thereby 400

suggesting a selective effect during the intake (Yuan et al., 2019). Shoreline sediments in 401 402 Lake Victoria (Uganda) contained more MPs of all sizes than in the lake sediments (at a distance of 250 m and 500 m from the shoreline). This could be due to the proximity of the 403 shoreline sediments to land-based sources (Egessa et al., 2020). In Lake Yenagoa (Nigeria), 404 74.9 % of the particles in water and sediment are 1.00-3.00 mm in the dry season and 89.1 % 405 of the particles are 0.51–1.00 mm in the rainy season (smaller MPs may originate from deep 406 fragmentation of large plastic debris) (Oni et al., 2020). Various sizes of MP particles could 407 also be caused by the significant variation in the sampling methodology. For instance, surface 408 waters are sampled with nets of different mesh sizes, namely 38, 47, 112, 300, 330, 333, and 409 410 355 µm or pumped through different filters: 20, 48, 50, 100, 300 µm. Further studies must be conducted using a unique sampling methodology, unit system (particles/km² or particles/m³), 411 and quantification of the different size classes (percentage of the total). Recommendations for 412 413 scientific community are provided in Section 1.

414 3.3.2. Polymer types

The most common types of polymers in lakes (surface water and sediment) were PE and PP 415 (Fig. 3). These results can be linked to the 2018 global demand for polymer, with 17.5 % 416 LDPE, 12.2 % HDPE and, 19.3 % PP (PlasticsEurope, 2019). The other polymeric materials 417 produced industrially at the international scale are polyvinyl chloride (PVC) (10 %), 418 419 polyurethane (PUR) (7.9 %), polyethylene terephthalate (PET) (7.7 %), polystyrene (PS) and 420 expanded polystyrene (EPS) (6.4 %) and others (19 %). The variation of MP composition 421 (polymer types) between lacustrine compartments (surface water, sediment, snow/ice) could be due to differences in the polymer densities, MP forms, potential MP sources, watershed 422 423 characteristics. Overall, PE and PP were predominant, other polymers (e.g.: PVC, PA, PET, etc.) were found in several lakes but to a lesser extent. The MP composition in the surface 424 water was similar in most lakes however in some areas, more specific signatures were 425

reported. Those particular signature were observed for one specific scientific paper or one 426 427 specific country suggesting a site-specific contamination. Despite the studies number, few data were available in all lakes, even less for snow and ice. In this last compartments, the 428 429 main polymer types were CE and, PA that were mostly found in the form of fibres which was consistent with an atmospheric origin. As for the particle size, the chemical compositions of 430 the MPs varied greatly among the lakes. In Lake Yenagoa (Nigeria), the polymer types of the 431 432 sampled MPs were related to the season. In surface water and sediment, 72.63 % PET and 10.90 % PVC were observed during the dry season compared with 81.50 % PVC and 4.20 % 433 LDPE during the rainy season. The high presence of PVC during the rainy season was 434 435 thought to originate from the erosion of water pipes of neighbouring communities. The significant presence of PET during the dry season could be attributed to the importation of 436 raw material from other regions by three plastic companies producing PET bottles for soft 437 438 drinks and water, which was located a few kilometres from the lake shore (Oni et al., 2020). The release of plastic in Lake Geneva (Switzerland) was estimated to have four main 439 440 contributors, namely tire abrasion, the construction sector, the textile industry, and the 441 packaging industry (Boucher et al., 2019). Tire wear particles (TWPs) are a recent research topic that requires further investigation to determine its importance in the MP contamination 442 of lakes. All MPs are first composed of polymers, but they also contain two components, 443 namely chemical additives (plasticiser, UV blocker, antioxidative compound, flame retardant, 444 etc.) and chemicals (polycyclic aromatic compounds, trace metallic elements, etc.) absorbed 445 from the surrounding environment. The leaching of these additives and pollutants from the 446 plastic surface to the surrounding waters can affect the ecosystem (Wong et al., 2020). In 447 addition to their chemical composition, the shape of MPs can also greatly determine their fate 448 and impacts. 449

450 3.3.3. Particle shapes

The most commonly identified polymer forms in lakes (surface water and sediment) were 451 452 fibres, and, fragments (Fig. 4). The MP fibres contamination in lakes could be linked to urban sources (wastewaters, washing machines). Indeed, urban network was supposed to be a major 453 454 MP source in lakes. Investigating MP fibres proportions in relation to watershed inhabitants could be of high interest, confirming the necessity of watershed characteristics reporting in 455 future studies (Section 1). Pellets and films were also frequently found compared to foams. 456 457 Given the results, not link could be established between the polymer forms and lacustrine compartments (surface water and sediment). Concerning fishes, only two polymer forms were 458 observed namely, fibres and fragments. However, very few studies investigated MP pollution 459 460 in lake fishes. Moreover, the probability of finding fibre and/or fragment in fish was highest than other polymer forms given the distribution of the particle forms in lake sediments and 461 surface waters. Even if the results in this figure were not conclusive, it allowed to present an 462 463 overview of polymer forms in all the investigated compartments of the lacustrine environments across the globe. This lack of data highlighted the importance of increase 464 studies on freshwater fishes. In Switzerland and Italy, the most represented forms are 465 fragments and films. However worldwide, fragments and fibres are strongly represented. In 466 nine lakes in the Pampean Region (Argentina), MP fibres ranged from 66.70 % to 96.40 % 467 (Alfonso et al., 2020b). Determining the particle shapes is essential to understanding the fate 468 of MPs in lake ecosystems (e.g. fibres and foams will probably float) and the impacts on biota 469 (e.g. coarse fragments may injure the digestive system in fish while nanoparticles may 470 translocate into organs). 471

472 4. Sources of microplastics in lakes

473 4.1. Introduction

The sources of MPs in lakes are numerous, and MPs can be transferred from various origins. 474 475 Plastic pollution has three origins, namely macroplastic fragmentation in the environment, wear and tear of products that contain plastic polymers (e.g. fragmentation of textile fibres 476 during washing, paints, and tires), and intentional origin (e.g. exfoliants, industrial abrasions, 477 and drug vectorisation) (INERIS, 2018). The principal top-down MP sources are tires, paint 478 479 markings, plastic resins, and clothing made of synthetic fibres (Hann et al., 2018). Moreover, 480 MP pollution is intensified by climatic conditions. According to previous research, there are several climate change impacts concerning MPs in aquatic ecosystems (Welden and Lusher, 481 2017; Zhang Yafei et al., 2020). MP emissions to the environment and transport increase 482 483 through precipitation, flooding, glacier melting, and runoff; plastic in the atmosphere intensifies with the increase in strong wind events; MP suspension from sediments increases 484 through wind and water currents as well as temperature changes in water; and plastic retention 485 486 increases through higher evaporation in lakes. (Boucher et al., 2019b) assumed "the potential role of big lakes as a barrier preventing more plastic from reaching the oceans". The previous 487 works point out the lack of integrated studies considering the whole ecosystem, which is 488 crucial for future investigations of MP pollution in lakes integrated at the catchment scale. 489 This should help to understand the involvement of each potential MP contamination source in 490 lakes, namely soil leaching and road runoff, wastewater treatment plant (WWTP) discharge, 491 atmospheric fallout, and in-situ macroplastic fragmentation. Indeed, these sources are 492 influenced by the population density (e.g. increase in single-use plastics), road density, 493 impermeable watershed area, industrial activity of plastic production/transformation, climatic 494 conditions, and lake characteristics. Public authorities require these elements to act on major 495 sources and implement new policies to reduce the plastic contamination in lakes. 496

497 4.2. Macroplastic fragmentation

Fragmentation of macroplastic waste could be one of the main sources of MPs in lakes. Most 498 499 of the knowledge on plastic fragmentation is based on in vitro experiments with ultraviolet (UV), thermal, or bio-degradation. Limited knowledge was acquired under real environmental 500 501 conditions in which degradation mechanisms occur simultaneously or successively. Environmental conditions (UV irradiation intensity, pH, and temperature) and chemical and 502 physical properties of plastic polymers (density, crystallinity, and the presence of additives) 503 504 play crucial roles in plastic fragmentation. Plastic polymers from oligotrophic lakes can break 505 up more easily with high UV penetration and weak biofouling, which reinforce the polymer durability (Andrady, 2011, 2003; Free et al., 2014). In lakes at high altitudes, low 506 507 temperatures and snow cover can better maintain the plastic particle integrity (Andrady, 2003; Free et al., 2014). However, macroplastic degradation is weaker in freshwater than in marine 508 509 ecosystems owing to weaker current and limited wave action (Vaughan et al., 2017). 510 However, littoral waves, especially in vast lakes, can cause higher fragmentation rates (Imhof et al., 2013). Low turbulence and wave action in some freshwater ecosystems lead to longer 511 512 pollution persistence. The estimations of plastic longevity range from hundreds to thousands 513 of years (Barnes et al., 2009). In 2016, plastic particles were found in each sediment sample from Lake Geneva (Switzerland), which mainly originated from macroplastic fragmentation 514 515 (Faure and De Alencastro, 2016). Plastic pollution in Lake Michigan (USA) also revealed a high concentration of secondary MPs (from the breakdown of larger plastics), especially 516 fragments (Mason et al., 2016). Near Dongting Lake (Yueyang, China) and Lake Victoria 517 (Uganda), synthetic fishing nets have a strong impact on plastic contamination and constitute 518 519 a major source of secondary MPs (Egessa et al., 2020; Yin et al., 2020). The predominance of coloured MP particles could reflect macroplastic fragmentation (Migwi et al., 2020). Finally, 520 521 a large amount of cellulose acetate, which is one of the main cigarette filter components, was reported in Lake Ontario (Canada/USA) (Grbić et al., 2020). The prevalence of small plastic 522

particles from fragmentation was also reported in Khövsgöl Lake (Mongolia) (Free et al., 523 524 2014) and Taigu and Poyang lakes (China) (Su et al., 2016; Yuan et al., 2019). Plastic degradation processes, namely cracking, splitting, and biofilm formation, seem globally 525 526 similar in freshwater and marine ecosystems (Imhof et al., 2013; Li et al., 2020; Zbyszewski and Corcoran, 2011). However, little is known about the kinetics of fragmentation in lakes. 527 528 After 25 weeks of accelerated weathering in water under xenon lamp irradiation, low-density 529 polyethylene (LDPE) films split into smaller fragments (62 % on average) corresponding to 530 the definition of MPs (< 5 mm), thereby suggesting that long residence times in water lead to MP fragmentation and contamination of the aquatic environment (Julienne et al., 2019). 531 532 Mechanical properties at the polymer surface play a major role in the fragmentation pathway whereas the fabrication process may influence the propagation direction of the cracks. The 533 534 size distribution of plastic fragments may be linked not only to the nature of the polymer, but 535 also to its manufacturing process (Julienne et al., 2019). The number of polymer particles fragmented by UV exposure and mechanical abrasion increased with decreasing size in all 536 537 polymer types. According to Song et al. (2017), mechanical abrasion by sand minimally fragmented polyethylene (PE) and polypropylene (PP) without UV photo-oxidation. 538 Moreover, the rate of fragmentation increased with UV exposure depending on the polymer 539 type. Twelve months of UV exposure and two months of mechanical abrasion of PP and PE 540 produced $6,084.0 \pm 1,061.0$ particles/pellet and 20.0 ± 8.3 particles/pellet (mean \pm SD), 541 respectively. To roughly quantify the fragmentation flux in the lake, we considered a mean 542 fragmentation rate of 3,052 MP/pellet (independent of the polymeric composition) and the 543 544 average weight of one pellet (Song et al., 2017) to 20 mg. As the concentration of macroplastics in the surface water of Lake Geneva was measured as 44,000 mg/km² (Grand 545 Lac) and 27,000 mg/km² (Petit Lac) (Faure et al., 2015) we estimated a fragmentation flux 546 from the surface as high as 1.1×10^8 MP/y (SI Calculations). We also estimated the 547

macroplastics concentration of surface waters in worldwide lakes with available data in 548 549 literature by calculating the mean MP concentration (mp/km²) in surface waters of lakes, namely 2,808.98 macroplastics/km² (based on Cable et al., 2017; Faure et al., 2015; Faure et 550 551 al., 2012; Mason et al., 2016). We linked this macroplastics concentration estimate to MP concentration in the corresponding lakes surface waters (based on Cable et al., 2017; Faure et 552 al., 2015; Faure et al., 2012; Mason et al., 2016), namely 133,741 mp/km². Additional studies 553 are however required to clearly comprehend the mechanisms, quantify the kinetics of 554 fragmentation within the environment, and determine the precise origins of macroplastics 555 waste from industrial, agricultural, and domestic use, among others. 556

557 4.3. Wastewater

WWTPs might be an important source of MPs in lacustrine environments depending on the 558 WWTP setup, population density, or discharge of wastewater into lakes (Bretas Alvim et al., 559 2020). Wastewater contains both types of MPs, namely primary (tiny particles designed for 560 561 commercial use, e.g. personal care products) and secondary (from the breakdown of larger plastics, e.g. textile fibres in domestic wastewater or tire particles in stormwater). For 562 instance, the influent of a Hong Kong WWTP contained 7.1 ± 6.0 particles/L to 12.8 ± 5.8 563 particles/L with intra-day variations of 6.6×10^8 particles/d and 1.2×10^9 particles/d (Cao et 564 al., 2020). Several experiments confirmed that textile fibres are an important component of 565 MPs in wastewater. One item of clothing produces more than 1,900 fibres per wash (Browne 566 et al., 2011); one fleece produces approximately 110,000 fibres (Carney Almroth et al., 2018), 567 and 5 kg of polyester (PES) cloth can release approximately 6,000,000 microfibres (De Falco 568 569 et al., 2019). Fibres represent 70 % of MPs in tributaries from WWTPs (Talvitie et al., 2016). The efficiency of MP removal in WWTPs varies between 88.0 and 99.9 % (Uddin et al., 570 571 2020). The average concentration of MPs and other anthropogenic particles (with a FourierTransform Infrared spectroscopy or Raman spectroscopy signal of an anthropogenic dye) found in wastewater effluent was 13.3 ± 15.5 particles/L near Lake Ontario (USA and Canada). Fibres were also the dominant category in WWTP effluent with 90 % relative abundance (Grbić et al., 2020). The disposal of treated effluents can add approximately $1.5 \times$ 10^{15} MP/y to the aquatic environment, whereas the discharge of untreated effluent is likely to add 3.9×10^{16} MP/y at the global scale (Uddin et al., 2020).

578 4.4. Stormwater, agricultural runoff, and tributaries

579 Surface runoff and lake tributaries could also be significant sources of MPs according to the lake catchment basin characteristics and climatic conditions. Rivers represent an important 580 581 source of MPs because they can collect WWTP effluents, untreated stormwater, road runoff, 582 and agricultural runoff. As an example, the MP abundance increased in the Cooks River estuary (Sydney, Australia) from 400 particles/m³ to 17,383 particles/m³ before 2 days of 583 heavy rain events (Hitchcock, 2020). Rain and storm events may be key moments of MP 584 585 contamination in lake ecosystems. In Lake Ontario (USA and Canada), MPs in sediment samples were mostly carried by nearby tributaries (Ballent et al., 2016). The average 586 concentrations of anthropogenic particles were 15.4 ± 7.9 particles/L in stormwater runoff 587 (sampling in urban rivers during wet weather) and 0.9 ± 1.3 particles/L in agricultural runoff 588 near Lake Ontario (USA and Canada) (Grbić et al., 2020). The most abundant particles in 589 stormwater samples were microfibres (41 %) and tire and road wear particles (TRWPs) (22 590 591 %) (Grbić et al., 2020). Sewer overflow systems and urban runoff are also major sources of MPs in different subalpine lakes (Faure and De Alencastro, 2016). For example, the plastic 592 inflow in Lake Geneva (Switzerland) was estimated to be between 34 t/y and 83 t/y (average 593 59 t/y) with strong inputs from road and urban runoff after precipitation (Boucher et al., 594 2019). The mass of TWPs ultimately entering the aquatic environment strongly depends on 595

the extent of collection and treatment of road runoff, which is highly variable (Wagner et al., 596 597 2018). Up to 11,000 t/y of TWPs from German highways can enter surface waters (Wagner et al., 2018). Agricultural runoff can also contaminate tributaries and the lacustrine environment 598 599 because of plastic mulching, WWTP sludge spreading or even irrigation with recycled wastewater (an approach used in a few countries). Plastic mulching is an agricultural 600 601 technique used to reduce evaporation, suppress weeds, conserve moisture and increase soil 602 temperature. In China, MP concentrations in agricultural soil increased over time with 5, 15, 603 and 24 y of continuous mulching with 80.3 ± 49.3 , 308.0 ± 138.1 , and $1,075.6 \pm 346.8$ particles/kg soil, respectively (Huang et al., 2020). The spreading of liquid or dewatered 604 605 WWTP sludge may also be a source of MP to lakes through agricultural soil leaching. There is still uncertainty about how the plastic debris interacts with the microorganisms constituting 606 607 the sludge during biological wastewater treatment processes. However, the MP concentrations 608 varied between 8.2 particles/g (dw) and 301.4 particles/g (dw) in sludge samples collected from a municipal WWTP based on the conventional activated sludge process in Finland 609 610 (Lares et al., 2018). In addition, play areas and sports fields can also generate large quantities 611 of MPs in stormwater systems: they are considered the fifth major source of MPs in Germany (Bertling et al., 2018). 612

613 4.5. Atmospheric fallout

Atmospheric fallout enriched in MPs has been observed in urban, industrial, and remote areas (Zhang et al., 2016, 2019; Yulan Zhang et al., 2020). Atmospheric transport constitutes a large flux of plastic particles in the environment, but it has been poorly studied (Horton and Dixon, 2017). In the Paris Metropolitan Area, 3.5×10^{10} and 7.6×10^{10} synthetic fibres could originate from the atmosphere per year, thereby leading to an atmospheric flux of 18×10^{6} synthetic fibres/(km²·d) to 37×10^{6} synthetic fibres/(km²·d) (Rachid Dris, 2016). Intense

precipitation (rain, storm and snow) probably increases MP atmospheric fallout via washout 620 621 of MPs (Allen et al., 2019; Dris et al., 2016a, 2016b). In the absence of wastewater discharge to the Hampstead No. 1 Lake near London, atmospheric fallout was considered the main 622 623 source of MPs as fibres were mostly observed in sediment samples (Turner et al., 2019). Synthetic textiles and TRWPs are considered the major sources of MPs in the atmosphere 624 with a majority of fibres and fragments (Yulan Zhang et al., 2020). To the best of our 625 knowledge, the mean fluxes of MPs in atmospheric fallout vary from 36×10^6 626 particles/(km²·d) to 770×10^6 particles/(km²·d) (Allen et al., 2019; Cai et al., 2017; Dris et al., 627 2016a, 2015; Klein and Fischer, 2019; Wright et al., 2020; Zhou et al., 2017) (Fig. 5). 628 Therefore, the mean flux of MPs in atmospheric fallout can be estimated as 287×10^6 629 particles/(km²·d). Even if data from atmospheric fallout are more detailed than data from 630 other MP sources to lakes worldwide, further studies should imperatively determine both the 631 632 atmospheric MP flux and MP concentration in surface water for one specific lake area to understand the real impact of atmospheric fallout. Future work is urgently needed to clearly 633 quantify the MP flux to lake water at the catchment basin scale, namely in-situ macroplastics 634 635 fragmentation, wastewater or stormwater discharge, agricultural soil runoff, and atmospheric fallout. 636

4.6. Estimates of source contributions to lake contamination by microplastics

Depending on the catchment features, the relative contribution of each source of MPs to a lake may considerably differ both in nature and intensity. As a recent example, Lake Ontario (USA and Canada) is exposed to various sources of MPs. Some of them have been quantified with MP (> 125 μ m) concentrations (Grbić et al., 2020), namely WWTP discharge, impermeable urban surface runoff, and agricultural runoff. The concentrations are highly variable with 15,400 ± 7,900 particles/m³ in stormwater runoff (relative abundances of fibres

of 41 %, and TRWPs of 22 %), $13,300 \pm 15,500$ particles/m³ in wastewater effluent (90 % 644 fibres), and $900 \pm 1,300$ particles/m³ in agricultural runoff (no dominant category). 645 Unfortunately, the intensity of these sources (as a flux of MPs to the lake) cannot be estimated 646 647 as the flow rates have not been measured. Boucher et al. (2019) estimated, for the first time to our best knowledge, the contributions of the different MP sources to a lake contamination. 648 The approach based on field measurement showed the following MP (> $300 \mu m$ to 5 mm) 649 contributions: 41.3 t/y river discharge (wet period), 8.9 t/y urban runoff, 5.6 t/y river 650 discharge (dry period), 2.6 t/y storm overflow, 0.05 t/y waste water effluent and, 0.03 t/y 651 atmospheric fallout. In Western Europe waste management systems are efficient (in Germany 652 653 MP retention of 97% (Mintenig et al., 2017)), these estimated fluxes could be higher in countries with less efficient waste management systems. However, the watershed 654 characteristics are essential to understand the MP contamination in a specific lake. In our 655 656 review, we estimated the MP contribution of macroplastics fragmentation to reach 1.1×10^8 MP/y corresponding to approximately 0.03 t/y which is similar the atmospheric fallouts 657 658 estimated by Boucher et al. (2019b) (0.03 t/y > $300 \mu m$). Our own estimations on fallout flux 659 was 0.2 t/y (MPs > 300μ m) (SI Calculations) which was of the same order of magnitude. However, these calculations were strongly dependent on size particle, volume particle and, 660 density. Therefore, reporting MP size distributions, watershed characteristics, polymer types 661 and forms are essential in future studies and to improve estimations (Section 1). Macroplastics 662 fragmentation and atmospheric fallouts could be weak MP sources in lakes. The main 663 limitation on atmospheric deposition fluxes is the lack of data on rural areas. Consequently, 664 the main sources of MP to lacustrine environment would be the leaching of MP from rural 665 areas or other sources such as road runoff which are not treated by WWTP. Given these 666 667 results it would be important for future studies to study the MP flux from urban and impermeabilized watershed which are a significant source of MPs in the environment and, on 668

atmospheric fallout which could be the main source of MP in more remote lakes. We also 669 670 suggest to investigate tributaries, from now on it is absolutely necessary to work on potential MP sources linked to the investigated lake as Hu et al. (2020) wrote "rivers became an 671 important source of MPs in lakes and studying surrounding rivers while working on a lake is 672 essential". The scientific community is aware of MP in freshwaters, now it is time to 673 understand where they come from and the MP quantities of each potential sources. Future 674 675 studies should focus on the different point sources and diffuse sources in contrasting watersheds (urbanised or rural) to precisely quantify the intensity and composition of each 676 source. This will help public authorities, local policies, or companies to guide best 677 678 management practices and future mitigation strategies for the reduction in MP pollution, which is highly variable from one lake to another. 679

680 5. Conclusion

MP pollution was reviewed in 98 lakes worldwide with a distinction between rural (20) and 681 urban (78) lakes, according to the supposed main influence of the nearby population density. 682 Remote lakes should be also studied to clearly quantify the fluxes of various MP sources. In 683 this review, we noticed MP pollution in each of the 98 investigated lakes. Some lakes showed 684 MP contamination in the surface water, sediments (lake, shoreline, and beach), tributaries, 685 aquatic fauna, ice and/or snow. The common MP size class studied was 300 µm to 1 mm. The 686 687 MP concentrations were sometimes higher in rural lakes than in urban lakes. We insist on the importance of identifying MPs sources (macroplastics fragmentation, wastewater or 688 stormwater discharge, agricultural and road runoff, tributaries, and atmospheric fallout) and 689 690 quantifying their respective flux to the lake to inform public authorities in order to take accurate actions for plastic pollution reduction. For example, input plastic flows in Lake 691 Geneva from land were estimated to be 55 t/y; the plastic stocks were 0.10 t on the surface, 692

10.00 t on the banks, and 580.00 t in the sediments, and the plastic out flows were 5 t/y in the 693 outflow of the Rhone river, 10 t/y in coastal clean-ups, and 40 t/y in sediments (Boucher et al., 694 2019). This study will allow public authorities to act on precise areas and set effective 695 systems, such as stormwater retention tanks to avoid WWTP bypass in tributaries, tertiary 696 697 treatment in WWTPs to selectively remove plastic fibres, stormwater retention ponds to intercept tire particles from road runoff, mainstream awareness campaigns, intensification of 698 the number of recycling and garbage bins (in urban but also rural areas), campaigns to raise 699 700 public awareness concerning remote pollution, bans on single-use plastic, use of reusable 701 packing and dishes in every sector; construction of new recycling centres and penalties for 702 non-reusable packaging.

703 References :	
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704	Alfonso et al., 2020a M.B. Alfonso, A.H. Arias, M.C. Piccolo
705	Microplastics integrating the zooplanktonic fraction in a saline lake of Argentina:
706	influence of water management
707	Environ. Monit. Assess., 192 (2020), pp. 117, 10.1007/s10661-020-8080-1
708	
709	Alfonso et al., 2020b M.B. Alfonso, F. Scordo, C. Seitz, G.M.M. Manstretta, A.C. Ronda,
/10	A.H. Arias, J.P. Tomba, L.I. Silva, G.M.E. Perillo, M.C. Piccolo
/11	First evidence of microplastics in nine lakes across Patagonia (South America)
712	Sci. 10tal Environ., 733 (2020), pp. 139385, 10.1016/j.scitotenv.2020.139385
713	Allen et al. 2010 S. Allen, D. Allen, V.B. Dhoeniy, C. Le Bouy, B. Duréntez Jiménez, A
714	Allell et al., 2019 S. Allell, D. Allell, V.K. Flioellix, G. Le Koux, F. Duralitez Jillellez, A.
715	Atmospheric transport and deposition of microplastics in a remote mountain
710	Atmospheric transport and deposition of microplastics in a remote mountain estebmont
718	Nat Geosci 12 (2019) pp $339-344$ 10 1038/s41561-019-0335-5
719	Nut. Geosei., 12 (2017), pp. 557-544, 10.1050/341501 017 0555-5
720	Anderson et al. 2017 P.I. Anderson, S. Warrack, V. Langen, I.K. Challis, M.L. Hanson, M.D.
721	Rennie
722	Microplastic contamination in Lake Winnipeg. Canada
723	Environ. Pollut., 225 (2017), pp. 223–231, 10.1016/i.envpol.2017.02.072
724	
725	Andrady, 2011 A. L. Andrady
726	Microplastics in the marine environment
727	Mar. Pollut. Bull., 62 (2011), pp. 1596–1605, 10.1016/j.marpolbul.2011.05.030
728	
729	Andrady, 2003 A.L. Andrady
730	Plastics and the environment
731	John Wiley & Sons publishing, pp. 1-747
732	
733	Arias-Andres et al., 2018 M. Arias-Andres, U. Klümper, K. Rojas-Jimenez, HP. Grossart
734	Microplastic pollution increases gene exchange in aquatic ecosystems
735	Environ. Pollut., 237 (2018), pp. 253–261, 10.1016/j.envpol.2018.02.058
736	
/3/	Artnur et al., 2009 C. Artnur, J. Baker, H. Bamford
/38	Proceedings of the international research workshop on the occurrence, effects,
739	and rate of microplastic marine debris
740	NOAA, Technical Memorandum
741	Baldwin et al. 2020 A K Baldwin A P. Spanier M.P. Bosen T. Thom
742	Microplastics in Laka Moad National Pacroation Area, USA: accurrance and
745	biological untaka
744	PLOS ONE 15 (2020) nn e 0228896 10 1371/journal none 0228896
746	1 200 0112, 15 (2020), pp. 00220090, 10.157 17journal.polic.0220090
747	Ballent et al., 2016 A. Ballent, P.L. Corcoran, O. Madden, P.A. Helm, F.I. Longstaffe
748	Sources and sinks of microplastics in Canadian Lake Ontario nearshore.
749	tributary and beach sediments
750	Mar. Pollut. Bull., 110 (2016), pp. 383–395, 10.1016/j.marpolbul.2016.06.037

751	Barnes et al., 2009 D.K.A Barnes, F. Galgani, R.C. Thompson, M. Barlaz
752	Accumulation and fragmentation of plastic debris in global environments
753	Phil. Trans. R. Soc. B, 364 (2009), pp. 1985–1998 10.1098/rstb.2008.0205
754	
755	Bellasi et al., 2020 A. Bellasi, G. Binda, A. Pozzi, S. Galafassi, P. Volta, R. Bettinetti
756	Microplastic contamination in freshwater environments: a review, focusing on
757	interactions with sediments and benthic organisms
758	Environments, 7 (2020), pp. 30, 10.3390/environments7040030
759	
760	Bertling et al., 2018 J. Bertling, R. Bertling, L. Hamman
761	Kunststoffe in der Umwelt: Mikro- und Makroplastik. Ursachen, Mengen,
762	Umweltschicksale, Wirkungen, Lösungsansätzen, Empfehlungen
763	Frauenhofer-Institut für Umwelt-, Sicherheits- und Energietechnik UMSICHT.
764	10.24406/umsicht-n-497117
765	
766	Bertoldi et al., 2020 C. Bertoldi, L.Z. Lara, F.A. de L. Mizushima, F.C.G. Martins, M.A.
767	Battisti, R. Hinrichs, A.N. Fernandes
768	First evidence of microplastic contamination in the freshwater of Lake Guaíba,
769	Porto Alegre, Brazil
770	Sci. Total Envir., 759 (2020), pp. 143503
771	
772	Bharath et al., 2021 K.M. Bharath, S. Srinivasalu, U. Natesan, R. Ayyamperumal, S.N.
773	Kalam, S. Anbalagan, K. Sujatha, C. Alagarasan
774	Microplastics as an emerging threat to the freshwater ecosystems of Veeranam
775	lake in south India: A multidimensional approach
776	Chemosphere, 264 (2021), pp. 128502, 10.1016/j.chemosphere.2020.128502
777	
778	Biginagwa et al., 2016 F.J. Biginagwa, B.S. Mayoma, Y. Shashoua, K. Syberg, F.R.
779	First evidence of microplastics in the African Great Lakes: recovery from Lake
780	Victoria Nile perch and Nile tilapia
781	J. of Great Lakes Res., 42 (2016), pp. 146–149, 10.1016/j.jglr.2015.10.012
782	
783	Binelli et al., 2020 A. Binelli, L. Pietrelli, S. Di Vito, L. Coscia, M. Sighicelli, C.D. Torre,
784	C.C. Parenti, S. Magni, S.
785	Hazard evaluation of plastic mixtures from four Italian subalpine great lakes on
786	the basis of laboratory exposures of zebra mussels
787	Sci. Total Envir., 699 (2020), pp. 134366, 10.1016/j.scitotenv.2019.134366
788	
789	Bordós et al., 2019 G. Bordós, B. Urbányi, A. Micsinai, B. Kriszt, Z. Palotai, I. Szabó, Z.
790	Hantosi, S. Szoboszlay
791	Identification of microplastics in fish ponds and natural freshwater environments
792	of the Carpathian basin, Europe
793	Chemosphere, 216 (2019), pp. 110-116, 10.1016/j.chemosphere.2018.10.110
794	
795	Boucher et al., 2019 J. Boucher, F. Faure, O. Pompini, Z. Plummer, O. Wieser, L. Felippe de
/96	Alencastro
797	(Micro) plastic fluxes and stocks in Lake Geneva basin
/98	Irends Anal. Chem., 112 (2019), pp. 66–74, 10.1016/j.trac.2018.11.037
/99	Destes Alsies et al. 2020 C. Destes Al. ' J.A.M. J. D. A.D. D''
800	Bretas Alvim et al., 2020 C. Bretas Alvim, J.A. Mendoza-Roca, A. Bes-Pia

801 802	Wastewater treatment plant as microplastics release source – Quantification and identification techniques
802	Identification techniques $255 (2020)$ and 100720 ± 101016 is a second 2010 100720
803 804	J. of Envir. Manag., 255 (2020), pp. 109739, 10.1016/j.jenvman.2019.109739
805	Browne et al., 2011 M.A. Browne, P. Crump, S.J. Niven, E. Teuten, A. Tonkin, T. Galloway,
806	R. Thompson
807	Accumulation of microplastic on shorelines worldwide: sources and sinks
808	Environ, Sci. Technol., 45 (2011), pp. 9175–9179, 10.1021/es201811s
809	
810	Cable et al., 2017 R.N. Cable, D. Beletsky, R. Beletsky, K. Wigginton, B.W. Locke, M.B.
811	Duhaime
812	Distribution and modeled transport of plastic pollution in the Great Lakes, the
813	world's largest freshwater resource
814	Front Environ Sci $5(2017)$ pp 45 10 3389/fenvs 2017 00045
815	110ht. Environ. Seil, 5 (2017), pp. 15, 10.5505/10ht0.2017.00015
816	Caietal 2017 L Cai I Wang I Peng Z Tan Z Zhan X Tan O Chen
817	Characteristic of micronlastics in the atmospheric fallout from Dongguan city
818	China: nreliminary research and first evidence
010 010	Environ Sci Pollut Res. $24 (2017)$ pp. $24028 - 24035 = 10.1007/s11356-017-0116-y$
820	Environ. Sei. Fondt. Res., 24 (2017), pp. 24920–24955, 10.1007/811550-017-0110-X
820 821	Cao et al. 2020 V. Cao, O. Wang, V. Ruan, R. Wu, J. Chen, K. Zhang, P.K.S. Lam
021	Intra-day microplastic variations in wastawatar: a case study of a sowage
022	treatment plant in Hong Kong
025	Mar Dollut Rull 160 (2020) pp 111525 10 1016/i marpollul 2020 111525
024 025	Mai. Fonut. Bun., 100 (2020), pp. 111555, 10.1010/J.maipoibul.2020.111555
825	Carney Almroth et al. 2018 B.M. Carney Almroth L. Åström S. Roslund H. Petersson M.
020 017	Johansson N K Dersson
027	Johansson, NK. 1 cisson Quantifying shadding of synthetic fibers from taxtiles: a source of microplastics
020 920	released into the environment
029	Envir Sci Dollut Dog $25 (2018)$ pp 1101 1100 10 1007/011256 017 0528 7
000	Elivii. Sci. Poliut. Res., 25 (2018), pp. 1191–1199, 10.1007/811550-017-0528-7
832	Carpenter & Smith 1972 F. I. Carpenter, K.I. Smith
032	Plastics on the Sargassa Saa Surface
022	Science 175 (1072) pp. 1240 1241
034 035	Science, 175 (1972), pp. 1240–1241
836	Conkle et al. 2018 LL Conkle, C.D. Báez Del Valle, L.W. Turner
020	Control et al., 2018 J.L. Control, C.D. Bacz Der Vanc, J.W. Turner A no we underestimating microplestic contamination in equatic environments?
03/	Envir Manage 61 (2018) pp. 1-8-10 1007/c00267 017 0047 8
030	Elivii. Manag., 01 (2018), pp. 1–6, 10.1007/800207-017-0947-6
839	Constal 2010 K D Constant UL During LE Dorres E Lourse CE Dude
840	Cox et al., 2019 K.D.Cox, G.A. Covernion, H.L. Davies, J.F. Dower, F. Juanes, S.E. Dudas
841	Human consumption of microplastics
842	Environ. Sci. Technol., 53 (2019), pp. 7068–7074, 10.1021/acs.est.9601517
843	
844	De Falco et al., 2019 F. De Falco, E. Di Pace, M. Cocca, M. Avella
845	I ne contribution of wasning processes of synthetic clothes to microplastic
846	pollution Sci. Kep., 9 (2019), pp. 6633, 10.1038/841598-019-43023-x
847	
848	Di & wang, 2018 M. Di, J. Wang
849	Microplastics in surface waters and sediments of the Three Gorges Reservoir,
850	China

851	Sci. Total Envir., 616-617 (2018), pp. 1620-1627, 10.1016/j.scitotenv.2017.10.150
852	
853	Dris, 2016 K. Dris
854	First assessement of sources and fate of macro and micro plastics in urban
855	hydrosystems: Case of Paris megacity
856	Hydrology, Université Paris-Est
857	
858	Dris et al., 2016a R. Dris, J. Gasperi, M. Saad, C. Mirande, B. Tassin
859	Synthetic fibers in atmospheric fallout: A source of microplastics in the
860	environment?
861	Mar. Pollut. Bull., 104 (2016), pp. 290–293, 10.1016/j.marpolbul.2016.01.006
862	
863	Dris et al., 2015 R. Dris, H. Imhof, W. Sanchez, J. Gasperi, F. Galgani, B. Tassin, C. Laforsch
864	Beyond the ocean: contamination of freshwater ecosystems with (micro-)plastic
865	narticles
866	Environ Chem Lett 12 (2015) pp 539-550 10 1071/EN14172
867	Environ. Chem. Lett., 12 (2015), pp. 555 556, 10.107 (1214) 11/2
868	Dris et al. 2016h R. Dris, I. Lahens, V. Rocher, I. Gasperi, B. Tassin
808	Dris et al., 20100 K. Dris, E. Lanchis, V. Köcher, J. Gasperi, D. Tassin Dramidras investigations sur los migranlastiques an Sain a
009	DIDEN Soine, phase VII
870	PIKEIN-Seine, pilase VII
8/1	Error et al. 2020 D. Errore A. Naulashirrar, D. Darasana, D. Naharina
872	Egessa et al., 2020 R. Egessa, A. Nankabirwa, K. Basooma, R. Nabwire
8/3	Occurrence, distribution and size relationships of plastic debris along shores and
874	sediment of northern Lake Victoria
875	Environ. Pollut., 257 (2020), pp. 113442, 10.1016/j.envpol.2019.113442
876	
877	Eriksen et al., 2013 M. Eriksen, S. Mason, S. Wilson, C. Box, A. Zellers, W. Edwards, H.
878	Farley, S. Amato
879	Microplastic pollution in the surface waters of the Laurentian Great Lakes
880	Mar. Pollut. Bull., 77 (2013), pp. 177–182, 10.1016/j.marpolbul.2013.10.007
881	
882	Faure et al., 2012 F. Faure, M. Corbaz, H. Baecher, L. Felippe
883	Pollution due to plastics and microplastics in Lake Geneva and in the
884	Mediterranean Sea
885	Arch. Sci., 65 (2012), pp. 157-164
886	
887	Faure & Alencastro, 2016 F. Faure, F. De Alencastro
888	Micronlastiques : situation dans les eaux de surface en Suisse
889	Fachartikel Aqua & Gas 4 (2016) np 72-77
800	i demartiker / kqua te Gas, 4 (2010), pp. 72 77
090 001	Fours et al. 2015 E Fours, C. Demors, O. Wieser, M. Kunz, I. E. de Alencastro
091	Diagtia pollution in Swigg surface waters: noture and concentrations, interaction
892	riasuc ponution in Swiss surface waters: nature and concentrations, interaction
893	with pollutants $E = \frac{1}{2} (2015) = 592.501 \pm 10.1071/E N114219$
894	Environ. Chem., 12 (2015), pp. 582-591, 10.10/1/EN14218
895	
896	Felismino et al., 2020 M.E.L. Felismino, P.A. Helm, C.M. Rochman
897	Microplastic and other anthropogenic microparticles in water and sediments of
898	Lake Simcoe
899	J. Great Lakes Res., 10.1016/j.jglr.2020.10.007
900	

901	Fischer et al., 2016 E.K. Fischer, L. Paglialonga, E. Czech, M. Tamminga
902	Microplastic pollution in lakes and lake shoreline sediments – A case study on
903	Lake Bolsena and Lake Chiusi (central Italy)
904	Environ. Pollut., 213 (2016), pp. 648–657, 10.1016/j.envpol.2016.03.012
905	
906	C.M. Free, O.P. Jensen, S.A. Mason, M. Eriksen, N.J. Williamson, B. Boldgiv
907	High-levels of microplastic pollution in a large, remote, mountain lake
908	Mar. Pollut. Bull., 85 (2014), pp. 156–163, 10.1016/j.marpolbul.2014.06.001
909	
910	Gasperi et al., 2018 J. Gasperi, S.L. Wright, R. Dris, F. Collard, C. Mandin, M. Guerrouache,
911	V. Langlois, F.J. Kelly, B. Tassin
912	Microplastics in air: Are we breathing it in?
913	Curr. Opin. Environ. Sci. Health, 1 (2018), pp. 1–5, 10.1016/j.coesh.2017.10.002
914	
915	Gateuille et al., 2020 D. Gateuille, J. Dusaucy, F. Gillet, J. Gasperi, R. Dris, G. Tourreau, E.
916	Naffrechoux
917	Microplastic contamination in remote alpine lakes
918	EGU General Assembly, Vienne, Austria, 10.5194/egusphere-egu2020-1292
919	
920	González-Pleiter et al., 2020 M. González-Pleiter, D. Velázquez, C. Edo, O. Carretero, J.
921	Gago, Á. Barón-Sola, L.E. Hernández, I. Yousef, A. Ouesada, F. Leganés, R. Rosal, F.
922	Fernández-Piñas
923	Fibers spreading worldwide: Microplastics and other anthropogenic litter in an
924	Arctic freshwater lake
925	Sci. Total Environ., 722 (2020), pp. 137904, 10.1016/j.scitoteny,2020,137904
926	Sen Tour Environ, 722 (2020), pp. 157901, Torroroj, Seneten (2020) (27901
927	Grbić et al., 2020 I. Grbić, P. Helm, S. Athey, C. Rochman
928	Microplastics entering northwestern Lake Ontario are diverse and linked to
929	urban sources
930	Water Res. 174 (2020) pp. 115623, 10 1016/i watres 2020 115623
931	(<i>actives</i>), <i>i</i> , <i>i</i> (2020), <i>p</i> : <i>i</i> 10020, <i>i</i> 011010, <i>ja c</i> 020, <i>i</i> 10020
932	Hann et al., 2018 S. Hann, C. Sherrington, O. Jamieson, M. Hickman, P. Kershaw, A.
933	Bapasola G Cole
934	Investigating options for reducing releases in the aquatic environment of
935	microplastics emitted by (but not intentionally added in) products
936	Eunomia ICF Final Report 335
937	
938	Hartmann et al. 2019 N B. Hartmann, T. Hüffer, R C. Thompson, M. Hassellöv, A.
939	Verschoor A E Daugaard S Rist T Karlsson N Brennholt M Cole M P
940	Herrling MC Hess NP Ivleya AL Lusher M Wagner
941	Are We Sneaking the Same Language? Recommendations for a Definition and
942	Categorization Framework for Plastic Debris
942	Environ Sci Technol 53 (2019) np $1039-1047$ 10 $1021/acs$ est 8b05297
943 944	Litvitoli. Sei. Teeniol., 55 (2017), pp. 1057 1047, 10.1021/des.est.0005277
0/5	Hitchcock 2020 IN Hitchcock
016	Storm events as key moments of micronlastic contamination in aquatic
040 0/17	ecosystems
947 Q/Q	Sci Total Envir
010	734 (2020) np. 139436 10 1016/i scitateny 2020 130436
949	757 (2020), pp. 157750, 10.1010(J.Settotelly.2020.157750)
220	

951	Horton & Dixon, 2018 A.A. Horton, S.J. Dixon
952	Microplastics: an introduction to environmental transport processes
953	WIREs WATER, 5 (2018), pp. e1268, 10.1002/wat2.1268
954	
955	Horton et al., 2017 A.A. Horton, A. Walton, D.J. Spurgeon, E. Lahive, C. Svendsen
956	Microplastics in freshwater and terrestrial environments: Evaluating the current
957	understanding to identify the knowledge gaps and future research priorities
958	Sci. Total Environ., 586 (2017), pp. 127–141, 10.1016/j.scitotenv.2017.01.190
959	
960	Hu et al., 2020 D. Hu, Y. Zhang, M. Shen
961	Investigation on microplastic pollution of Dongting Lake and its affiliated rivers
962	Mar. Pollut. Bull., 160 (2020), pp. 111555, 10.1016/i.marpolbul.2020.111555
963	
964	Huang et al. 2020 Y. Huang, O. Liu, W. Jia, C. Yan, J. Wang
965	Agricultural plastic mulching as a source of microplastics in the terrestrial
966	environment
967	Environ Pollut 260 (2020) pp 114096 10 1016/i envpol 2020 114096
968	Environ. 1 ond., 200 (2020), pp. 111050, 10.1010/j.en/p0.2020.111050
969	Hwang et al. 2019 I Hwang D. Choi S. Han, I. Choi, I. Hong
970	An assessment of the toxicity of nolynronylene micronlastics in human derived
970	cells
972	Sci Total Environ 684 (2019) pp 657–669 10 1016/i scitateny 2019 05 071
972	Sei. Total Environ., 004 (2019), pp. 037-009, 10.1010/j.seitotenv.2019.05.071
973	Jannilli et al. 2020 V. Jannilli, F. Corami, P. Grasso, F. Lecce, M. Buttinelli, A. Setini
075	Plastic abundance and seasonal variation on the shorelines of three volcanic lakes
975	in Control Italy: can amphinods boln datast contamination?
970 077	Environ Sci Pollut Res. 27 (2020) np. 1.4711 1.4722 10 1007/s11356-020-07054-7
078	Environ. Sei. Fondt. Res., 27 (2020), pp. 14711–14722, 10.1007/311550-020-07954-7
070	Imbofetal 2013 H.K. Imbof N.P. Iyleya I. Schmid R. Niessner, C. Laforsch
080	Contamination of basch sadiments of a subalning lake with microplastic particles
001	Curr Biol 23 (2013) pp PR867 R868 10 1016/i cub 2013 00 001
000	Cuii. Biol., 25 (2015), pp. 1 K807–K808, 10.1010/j.cub.2015.09.001
083	INERIS 2018
903	Données technico-économiques sur les substances chimiques en France :
005	micronlastiques
902	http://www.ineris.fr/substances/fr/ (last accessed: 01.13.2021)
007	http://www.inclis.ii/substances/ii/ (last accessed: 01.13.2021)
907	Irfan et al. 2020 T. Irfan S. Khalid M. Taneez, M.Z. Hashmi
900	Plastic driven pollution in Polyiston: the first evidence of environmental exposure
969	to microplostic in sodiments and water of Pawal I also
990	Environ Sci Dollut Dog 27 (2020) pp 15082 15002 10 1007/s11256 020 07822 1
991	Environ. Sci. Ponut. Res., 27 (2020), pp. 15085-15092, 10.1007/811550-020-07855-1
992	Liona et al. 2018 C. Liona, I. Vin, Y. Wan, C. Du, I. Wu, Y. Lona, Y. Liu, Y. Ma, O. Vin, Z.
993	Jiang et al., 2018 C. Jiang, L. Till, A. wen, C. Du, L. wu, T. Long, T. Liu, T. Ma, Q. Till, Z. Zhou, H. Don
994	LIIUU, FI. Fall Mianonlooting in Sodimont and Suufaan Water of West Departing Lake and Suuth
995	Micropiasues in Seument and Surface Water of West Dongting Lake and South Dongting Laket Abundance, Source and Composition
996	Jongung Lake: Adundance, Source and Composition
997	int. J. Environ. Res. Public realiti, 15 (2018), pp. 2104, 10.3390/1jerpn15102164
338	Julianna at al. 2010 E. Julianna, N. Dalarma, E. Lagarda
333	Junchine et al., 2019 F. Junchine, N. Deloffile, F. Lagarde

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 conventional activated sludge process and advanced MBR technology Water Res., 133 (2018), pp. 236–246, 10.1016/j.watres.2018.01.049 Water Res., 133 (2019 L. Lebreton, A. Andrady Lebreton & Andrady 2019 L. Lebreton, A. Andrady Future scenarios of global plastic waste generation and disposal Palgrave Communications, 5, 6, 10.1057/s41599-018-0212-7 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1034	Occurrence, identification and removal of microplastic particles and fibers in
 Water Res., 133 (2018), pp. 236–246, 10.1016/j.watres.2018.01.049 Water Res., 133 (2018), pp. 236–246, 10.1016/j.watres.2018.01.049 Lebreton & Andrady 2019 L. Lebreton, A. Andrady Future scenarios of global plastic waste generation and disposal Palgrave Communications, 5, 6, 10.1057/s41599-018-0212-7 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1035	conventional activated sludge process and advanced MBR technology
 Lebreton & Andrady 2019 L. Lebreton, A. Andrady Future scenarios of global plastic waste generation and disposal Palgrave Communications, 5, 6, 10.1057/s41599-018-0212-7 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1036	Water Res., 133 (2018), pp. 236–246, 10.1016/j.watres.2018.01.049
 Lebreton & Andrady 2019 L. Lebreton, A. Andrady Future scenarios of global plastic waste generation and disposal Palgrave Communications, 5, 6, 10.1057/s41599-018-0212-7 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1037	
 Future scenarios of global plastic waste generation and disposal Palgrave Communications, 5, 6, 10.1057/s41599-018-0212-7 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1038	Lebreton & Andrady 2019 L. Lebreton, A. Andrady
 Palgrave Communications, 5, 6, 10.1057/s41599-018-0212-7 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1039	Future scenarios of global plastic waste generation and disposal
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 Li et al., 2020 C. Li, R. Busquets, L.C. Campos Assessment of microplastics in freshwater systems: A review Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1041	
 1043 Assessment of microplastics in freshwater systems: A review 1044 Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 1045 1046 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. 1047 Knauff, W. Edwards, M.J. Hoffman 1048 High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1042	Liet al 2020 C Li R Busquets L C Campos
 Sci. Total Environ., 707 (2020), pp. 135578, 10.1016/j.scitotenv.2019.135578 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1043	Assessment of microplastics in freshwater systems. A review
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 Mason et al., 2020 S.A. Mason, J. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R. Knauff, W. Edwards, M.J. Hoffman High levels of pelagic plastic pollution within the surface waters of Lakes Erie 	1045	501. 10an Environ, 707 (2020), pp. 155570, 10.1010/J.senotenv.2017.155570
1047Knauff, W. Edwards, M.J. Hoffman1048High levels of pelagic plastic pollution within the surface waters of Lakes Erie	1046	Mason et al. 2020 S.A. Mason, I. Daily, G. Aleid, R. Ricotta, M. Smith, K. Donnelly, R.
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10 10 million levels of penagic plastic pollution within the sufface waters of Lakes Effe	1048	High levels of nelagic plastic pollution within the surface waters of Lakes Frie
1049 and Untario	1049	and Ontario

1050	J. Great Lakes Res., 46 (2020), pp. 277-288, 10.1016/j.jglr.2019.12.012
1051	
1052 1053	Mason et al., 2016 S.A. Mason, L. Kammin, M. Eriksen, G. Aleid, S. Wilson, C. Box, N. Williamson, A. Rilev
1054	Pelagic plastic pollution within the surface waters of Lake Michigan USA
1055	J. Great Lakes Res., 42 (2016), pp. 753–759, 10.1016/j.jglr.2016.05.009
1056	
1057	Meng et al., 2020 Y. Meng, F.J. Kelly, S.L. Wright
1058	Advances and challenges of microplastic pollution in freshwater ecosystems: A
1059	UK perspective
1060	Environ. Pollut., 256 (2020), pp. 113445, 10.1016/j.envpol.2019.113445
1061	
1062 1063	Merga et al., 2020 L.B. Merga, P.E. Redondo-Hasselerharm, P.J. Van den Brink, A.A. Koelmans
1064	Distribution of microplastic and small macroplastic particles across four fish
1065	species and sediment in an African lake
1005	Species and sequinent in an Arrican lake Sei Total Environ, 741 (2020) pp. 140527, 10 1016/j goitatony 2020 140527
1066	Sci. Total Environ., 741 (2020), pp. 140527, 10.1010/J.scholenv.2020.140527
1067	
1068	Migwi et al., 2020 F.K. Migwi, J.A. Ogunah, J.M. Kiratu
1069	Occurrence and Spatial Distribution of Microplastics in the surface Waters of
1070	Lake Naivasha, Kenya
1071	Environ. Chem., 39 (2020), pp. 765-774, 10.1002/etc.4677
1072	
1073	Mintenig et al., 2017 S.M. Mintenig, I. Int-Veen, M.G.J. Löder, S. Primpke, G. Gerdts, G.
1074	Identification of microplastic in effluents of waste water treatment plants using
1075	focal plane array-based micro-Fourier-transform infrared imaging
1076	Water Res., 108 (2017), pp. 365-372, 10.1016/j.watres.2016.11.015
1077	
1078	Montuelle & Clémens, 2015 B. Montuelle, A. Clémens
1079	Le tour des grands lacs alpins en 80 questions
1080	Graie publishing, pp. 4-205
1081	
1082	Negrete Velasco et al., 2020 A. de J. Negrete Velasco, L. Rard, W. Blois, D. Lebrun, F.
1083	Lebrun, F. Pothe, S. Stoll
1084	Microplastic and Fibre Contamination in a Remote Mountain Lake in
1085	Switzerland
1086	Water, 12 (2020), pp. 2410, 10 3390/w12092410
1087	(atol, 12 (2020), pp. 2110, 10.00000 (120)2110
1088	Oni et al. 2020 B.A. Oni. A.O. Aveni. O. Agboola, T. Oguntade, O. Obanla
1000	Comparing microalestics contaminants in (dry and raining) seasons for Ov- Row
1000	Laka in Vanagaa. Nigaria
1090	Eastaviaal Environ Saf 108 (2020) nn 110656 10 1016/j accony 2020 110656
1091	Ecoloxicol. Elivitoli. Sal., 198 (2020), pp. 110050, 10.1010/J.ecoeliv.2020.110050
1092	Destaring et al. 2020 D. Destaring E. Dizzul M. Destali S. Angelmi M. Kužća V. Mangani
1093	rasionno et al., 2020 P. Pasionno, E. Pizzui, M. Berton, S. Anseimi, M. Kusce, V. Menconi,
1094	IVI. Prearo, IVI. Kenzi
1095	First insights into plastic and microplastic occurrence in biotic and abiotic
1096	compartments, and snow from a high-mountain lake (Carnic Alps)
1097	Chemosphere, 265 (2020), pp. 129121, 10.1016/j.chemosphere.2020.129121
1098	

1099	Picó et al., 2020 Y. Picó, R. Alvarez-Ruiz, A.H. Alfarhan, M.A. El-Sheikh, H.O. Alshahrani,
1100	D. Barceló
1101	Pharmaceuticals, pesticides, personal care products and microplastics
1102	contamination assessment of Al-Hassa irrigation network (Saudi Arabia) and its
1103	shallow lakes
1104	Sci. Total Environ., 701 (2020), pp.135021, 10.1016/j.scitotenv.2019.135021
1105	
1106	PlasticsEurope, 2019
1107	Plastics - the Facts 2019: an analysis of European plastics production, demand
1108	and waste data
1109	https://www.plasticseurope.org/fr/resources/market-data (last accessed: 01.13.2021)
1110	
1111	PlasticsEurope, 2011
1112	Plastics - the Facts 2011: an analysis of European plastics production, demand
1113	and recovery for 2010
1114	https://www.plasticseurope.org/fr/resources/market-data (last accessed: 01.13.2021)
1115	
1116	Sarker et al., 2020 A. Sarker, D.M. Deepo, R. Nandi, J. Rana, S. Islam, S. Rahman, M.N.
1117	Hossain, Md.S. Islam, A. Baroi, JE. Kim
1118	A review of microplastics pollution in the soil and terrestrial ecosystems: A global
1119	and Bangladesh perspective
1120	Sci. Total Environ., 733 (2020), pp. 139296, 10.1016/j.scitotenv.2020.139296
1121	
1122	Scopetani et al., 2019 C. Scopetani, D. Chelazzi, A. Cincinelli, M. Esterhuizen-Londt
1123	Assessment of microplastic pollution: occurrence and characterisation in
1124	Vesijärvi lake and Pikku Vesijärvi pond, Finland
1125	Environ. Monitor. Assess., 191 (2019), pp. 652, 10.1007/s10661-019-7843-z
1126	
1127	Sighicelli et al., 2018 M. Sighicelli, L. Pietrelli, F. Lecce, V. Iannilli, M. Falconieri, L.
1128	Coscia, S. Di Vito, S. Nuglio, G. Zampetti
1129	Microplastic pollution in the surface waters of Italian Subalpine Lakes
1130	Environ. Pollut., 236 (2018), pp. 645–651, 10.1016/j.envpol.2018.02.008
1131	
1132	Song et al., 2017 Y.K. Song, S.H. Hong, M. Jang, G.M. Han, S.W. Jung, W.J. Shim
1133	Combined effects of UV exposure duration and mechanical abrasion on
1134	microplastic fragmentation by polymer type
1135	Environ. Sci. Technol., 51 (2017), pp. 4368–4376, 10.1021/acs.est.6b06155
1136	
1137	Stark, 2019 M. Stark
1138	Letter to the Editor Regarding "Are We Speaking the Same Language?
1139	Recommendations for a Definition and Categorization Framework for Plastic
1140	Debris"
1141	Environ. Sci. Technol., 53 (2019), pp. 4677–4677, 10.1021/acs.est.9b01360
1142	
1143	Su et al., 2016 L. Su, Y. Xue, L. Li, D. Yang, P. Kolandhasamy, D. Li, H. Shi
1144	Microplastics in Taihu Lake, China
1145	Environ. Pollut., 216 (2016), pp. 711–719, 10.1016/j.envpol.2016.06.036
1146	
1147	Talvitie et al., 2017 J. Talvitie, A. Mikola, O. Setälä, M. Heinonen, A. Koistinen

1148	How well is microlitter purified from wastewater? – A detailed study on the
1149	stepwise removal of microlitter in a tertiary level wastewater treatment plant
1150	Water Res., 109 (2017), pp. 164-172, 10.1016/j.watres.2016.11.046
1151	
1152	Turner et al., 2019 S. Turner, A.A. Horton, N.L. Rose, C. Hall
1153	A temporal sediment record of microplastics in an urban lake, London, UK
1154	J. Paleolimnol., 61 (2019), pp. 449–462, 10.1007/s10933-019-00071-7
1155	
1156	Uddin et al., 2020 S. Uddin, S. Fowler, M. Behbehani
1157	An Assessment of Microplastic Inputs into the Aquatic Environment from
1158	Wastewater Streams
1159	Mar. Pollut. Bull., 160 (2020), pp. 111538, 10.1016/i.marpolbul.2020.111538
1160	
1161	United Nations, 2020
1162	Sustainable Development Goals Knowledge Platform
1163	https://sustainabledevelopment.un.org/ (last accessed 4.29.20)
1164	
1165	Uurasjärvi et al. 2020 E. Uurasjärvi, S. Hartikainen, O. Setälä, M. Lehtiniemi, A. Koistinen
1166	Microplastic concentrations size distribution and polymer types in the surface
1167	waters of a northern Furonean lake
1168	Water Envir Res. 92 (2020) np. $149-156$ 10 1002/wer 1229
1169	Water Envir. Res., 92 (2020), pp. 149 150, 10.1002/wei.1229
1170	Vaughan et al. 2017 R. Vaughan, S.D. Turner, N.L. Rose
1171	Micronlastics in the sediments of a UK urban lake
1172	Environ Pollut 229 (2017) pp $10-18$ 10 1016/i envpol 2017 05 057
1173	Environ. 1 ond., 229 (2017), pp. 10-10, 10.1010/j.envp01.2017.05.057
1174	Wagner et al. 2018 S. Wagner, T. Hüffer, P. Klöckner, M. Wehrhahn, T. Hofmann, T.
1175	Reemtsma
1176	Tire wear particles in the aquatic environment - A review on generation analysis
1177	occurrence fate and effects
1178	Water Res. $139(2018)$ np. $83-100(10,1016/i)$ waters $2018(03,051)$
1179	water Res., 159 (2010), pp. 65 100, 10.1010/j.waters.2010.05.051
1180	Wang et al. 2017 W. Wang, A.W. Ndungu, Z. Li, I. Wang
1100	Microplastics pollution in inland freshwaters of China: A case study in urban
1182	surface waters of Wuhan China
1182	Sci Total Envir 575 (2017) pp 1369–1374 10 1016/i scitoteny 2016 09 213
118/	Sei. Total Elivin, 575 (2017), pp. 1509–1574, 10.1010/j.seitoteliv.2010.09.215
1185	Wang et al. 2019 7 Wang V Oin W Li W Yang O Meng I Yang
1105	Microplastic contamination in frashwatar: first absorvation in Laka Illansuhai
1100	Vollow Piyor Rosin, Chino
1107	Environ Chem Lett. 17 (2010) pp. 1821–1830, 10 1007/s10311,010,00888,8
1100	Elivitoli. Chem. Lett., 17 (2019), pp. 1821–1830, 10.1007/810511-019-00888-8
1109	Walden & Lusher 2017 N & Walden & L. Lusher
1101	Impacts of changing according on the distribution of marine microplastic
1102	littory abanging according of the and maxing microplastic littory
1102	Integr. Environ Assass Manag. 12 (2017) nr. 492, 497, 10 1002/joan 1011
1104	megi. Environ. Assess. Wanag., 15 (2017), pp. 465–467, 10.1002/leam.1911
1194	Wang at al. 2020 LV II Wang VV Lag VIID Targe D. S. Ver
1102	Wong et al., 2020 J.N.H. Wong, N.N. Lee, N.H.D. Tang, PS. Yap
1196	imposts and sustainable as left and terrestrial environments: prevalence, fates,
1197	impacts and sustainable solutions

1198 1199	Sci. Total Environ., 719 (2020), pp. 137512, 10.1016/j.scitotenv.2020.137512
1200	Wright et al. 2020 S.I. Wright I. Illke, A. Font, K.I. A. Chan, F.I. Kelly
1200	Atmospheric microplestic denosition in on urban anyironment and an avaluation
1201	of transport
1202	$ \begin{array}{c} \text{Or transport} \\ \text{Environ Int} 126 (2020) \text{nn} 105411 10 10164 \text{onvint} 2010 105411 \\ \end{array} $
1203	Environ. Int., 150 (2020), pp. 103411, 10.1010/J.envint.2019.103411
1204	We stal 2010 V We I Day M I' V I' M Dauthers V Wess
1205	wu et al., 2019 X. wu, J. Pan, M. Li, Y. Li, M. Bartiam, Y. wang
1206	Selective enrichment of bacterial pathogens by microplastic biofilm
1207	water Res., 165 (2019), pp. 114979, 10.1016/j.watres.2019.114979
1208	
1209	Xia et al., 2020 W. Xia, Q. Rao, X. Deng, J. Chen, P. Xie
1210	Rainfall is a significant environmental factor of microplastic pollution in inland
1211	waters
1212	Sci. Total Environ., 732 (2020), pp. 139065, 10.1016/j.scitotenv.2020.139065
1213	
1214	Xiong et al., 2018 X. Xiong, K. Zhang, X. Chen, H. Shi, Z. Luo, C. Wu
1215	Sources and distribution of microplastics in China's largest inland lake – Qinghai
1216	Lake
1217	Environ. Pollut., 235 (2018), pp. 899-906, 10.1016/j.envpol.2017.12.081
1218	
1219	Yin et al., 2020 L. Yin, X. Wen, C. Du, J. Jiang, L. Wu, Y. Zhang, Z. Hu, S. Hu, Z. Feng, Z.
1220	Zhou, Y. Long, Q. Gu
1221	Comparison of the abundance of microplastics between rural and urban areas: A
1222	case study from East Dongting Lake
1223	Chemosphere, 244 (2020), pp. 125486, 10.1016/j.chemosphere.2019.125486
1224	
1225	Yuan et al., 2019 W. Yuan, X. Liu, W. Wang, M. Di, J. Wang
1226	Microplastic abundance, distribution and composition in water, sediments, and
1227	wild fish from Poyang Lake, China
1228	Ecotoxicol. Environ. Safety, 170 (2019), pp. 180-187, 10.1016/j.ecoenv.2018.11.126
1229	
1230	Zbyszewski & Corcoran, 2011 M. Zbyszewski, P.L. Corcoran
1231	Distribution and Degradation of Fresh Water Plastic Particles Along the Beaches
1232	of Lake Huron, Canada
1233	Water Air Soil Pollut., 220 (2011), pp. 365–372, 10.1007/s11270-011-0760-6
1234	
1235	Zbyszewski et al., 2014 M. Zbyszewski, P.L. Corcoran, A. Hockin
1236	Comparison of the distribution and degradation of plastic debris along shorelines
1237	of the Great Lakes, North America
1238	J. Great Lakes Res., 40 (2014), pp. 288–299, 10.1016/j.jglr.2014.02.012
1239	
1240	Zhang et al., 2016 K. Zhang, J. Su, X. Xiong, X. Wu, C. Wu, J. Liu
1241	Microplastic pollution of lakeshore sediments from remote lakes in Tibet plateau.
1242	China
1243	Environ, Pollut., 219 (2016), pp. 450–455, 10.1016/i.envpol.2016.05.048
1244	, , , , , , , , , , , , , , , , , , ,
1245	Zhang et al., 2020 O. Zhang, E.G. Xu, J. Li, O. Chen, L. Ma, F.Y. Zeng, H. Shi
1246	A Review of Microplastics in Table Salt. Drinking Water, and Air: Direct Human
1247	Exposure

12/18	Environ Sci Technol 54 (2020) pp 3740-3751 10 1021/acs est 9b04535
1240	Environ. Ser. Technol., 54 (2020), pp. 5740-5751, 10.10217acs.est.9004555
1249	
1250	Zhang et al., 2019 Y. Zhang, T. Gao, S. Kang, M. Sillanpää
1251	Importance of atmospheric transport for microplastics deposited in remote areas
1252	Environ. Pollut., 254 (2019), pp. 112953, 10.1016/j.envpol.2019.07.121
1253	
1254	S. Zhang et al., 2020 S. Zhang, S. Yulan, S. Kang, S. Allen, D. Allen, T. Gao, M. Sillanpää
1255	Atmospheric microplastics: A review on current status and perspectives
1256	Earth Sci. Rev., 203 (2020), pp. 103118, 10.1016/j.earscirev.2020.103118
1257	
1258	Y. Zhang et al., 2020, Y. Zhang, J. Liang, G. Zeng, W. Tang, Y. Lu, Y. Luo, W. Xing, N.
1259	Tang, S. Ye, X. Li, W. Huang
1260	How climate change and eutrophication interact with microplastic pollution and
1261	sediment resuspension in shallow lakes: a review
1262	Sci. Total Environ., 705 (2020), pp. 135979, 10.1016/j.scitotenv.2019.135979
1263	
1264	Zhou et al., 2020 Q. Zhou, C. Tian, Y. Luo
1265	Various forms and deposition fluxes of microplastics identified in the coastal
1266	urban atmosphere
1267	Chin. Sci. Bull., 62 (2020), pp. 3902–3909, 10.1360/N972017-00956
1268	





Fig. 1. Microplastic concentrations on surface waters of worldwide lakes (MP/m³ or MP/km²) according to size
 range studied and anthropogenic pressure (rural, urban)









8 Fig. 3. Distribution of the polymer types in all the compartments of the lacustrine environments across the globe



10 Fig. 4. Distribution of the particle forms in all the compartments of the lacustrine environments across the globe



- 12 Fig. 5. Atmospheric fallout (wet and dry) of microplastics between different geographical localization
- 13 (particle/km²/day x 10⁶). For each localization, mean concentration is written and also the size class studied
- 14 (μm) . Numbers are rounded to the nearest unit.

Country	Mesh (µm)	Size (µm)	Concentration on surface water	References
Arcenting	38 (N)	70.7 % < 1,000	$9.0 \times 10^{-1} \pm 6.0 \times 10^{-1} \text{ mp/m}^3$	Alfonso et al., 2020
Algentina	47 (N)	62.8 % < 1,000	$1.4 \times 10^2 \pm 4.0 \times 10^1 \text{ mp/m}^3$	Alfonso et al., 2020
	48 (P)	79.8 % < 1,000	$4.7 \times 10^3 \pm 2.8 \times 10^3 \text{ mp/m}^3$	Di et Wang, 2018
China	50 (P)	80 % < 2,000	$1.7 \times 10^3 \pm 6.4 \times 10^2 \text{ mp/m}^3$	Wang et al., 2017
China	50 (P)	65 % < 2,000	$1.2 \times 10^2 \pm 2.3 \times 10^3 \text{ mp/m}^3$	Wang et al., 2018
	112 (N)	73.1 % < 500	$5.0 - 3.4 \times 10^1 \text{ mp/m}^3$	Yuan et al., 2019
Italy	300 (N)	< 500	2.5 and 3.0 mp/m ^{3} (two lakes)	Fischer et al., 2016
China	330 (N)	98.2 % < 2,000	$3.1 - 1.1 \times 10^1 \text{ mp/m}^3$	Mao et al., 2020
Finland	333 (N) and 20; 100; 300 (P)	20 - 300	0.27 ± 0.18 and $1.6 \times 10^2 \pm 73$; 12 ± 17 ; 1.8 ± 2.3 mp/m ³ respectively	Uurasjärvi et al., 2020
	355 (N)	81 % < 999	$4.3 \times 10^4 \pm 1.2 \times 10^5 \text{ mp/km}^2$	Eriksen et al., 2013
Canada, USA	355 (N)	59 % < 999	$1.7 \times 10^4 \text{ mp/km}^2$	Mason et al., 2016
	355 (N)	73 % < 999	2.3×10^5 and 4.5×10^4 mp/km ² (two lakes)	M ason et al., 2020
Mongolia	355 (N)	41 % < 999	$1.3 \times 10^4 \text{ mp/km}^2$	Free et al., 2014

2 Table 1: five-columns

Table 1. Distribution of the plastic particle sizes in worldwide lakes with their concentration on the surface water according to sampling
 methodology used. (N) means researches used net and (P) means researches used pump.

Colors should be used for the graphical abstract

Graphical abstract

