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NOWPAP Northwest Pacific Action Plan

O·S·E·A·N Our Sea of East Asia Network

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Cover picture: Artificial wave by Jung-A Kim

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ABBREVIATIONS AND ACRONYMS

CCRF	Code of Conduct for Responsible Fisheries
CEARAC	Special Monitoring and Coastal Environmental Assessment Regional Activity Center
COBSEA	Intergovernmental Meeting of the Coordinating Body on the Seas of East Asia
CRAES	Chinese Research Academy of Environmental Sciences
DINRAC	Data and Information Network Regional Activity Center
EAS	East Asian Seas
EcoQO(s)	Ecological Quality Objective(s)
FAO	Food and Agriculture Organization of the United Nations
FPs	Focal Points
FPM	Focal Points Meeting
FML	Floating marine litter
FRP	Fiber-reinforced plastic
FTIR	Fourier Transform Infrared Spectroscopy
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
GPML	Global Partnership on Marine Litter
KOEM	Korea Marine Environment Management Corporation
ICC	International Coastal Cleanup campaign
IGM	Intergovernmental Meeting
IMO	International Maritime Organization
IPW	International Pellet Watch
MALITA	Marine Litter plan, Marine Litter Activity
MARPOL	International Convention for the Prevention of Pollution from Ships
MEE	Ministry of Ecology and Environment
MERRAC	Marine Environmental Emergency Preparedness and Response Regional Activity Centre
MOF	Ministry of Oceans and Fisheries
MoU	Memorandum of Understanding
NOWPAP	Northwest Pacific Action Plan
NPEC	Northwest Pacific Region Environmental Cooperation Center
OPRC Convention	International Convention on Oil Pollution Preparedness, Response, and Cooperation
OSEAN	Our Sea of East Asian Network
PE	Polyethylene

PET	Polyethylene terephthalate
PP	Polypropylene
POMRAC	Pollution Monitoring Regional Activity Center
POPs	Persistent Organic Pollutants
RAC(s)	Regional Activity Center(s)
RAP MALI	Regional Action Plan on Marine Litter
RCU	Regional Coordinating Unit
SDG(s)	Sustainable Development Goal(s)
SOA	State Oceanic Administration
SOMER	State of the Marine Environment Report for the NOWPAP Region
TEMM	Tripartite Environment Ministers Meeting (China, Japan, Korea)
UNCLOS	United Nations Convention on the Law of the Sea
UNEA	UN Environment Assembly
UNEP	United Nations Environment Programme

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EXECUTIVE SUMMARY

The attention on marine litter, along with microplastics, has been growing rapidly in recent years. The plastic marine litter is presently found anywhere from the coast to the deep sea, from the equator to the polar region, and he Northwest Pacific (NOWPAP) region is not an exception.

Eleven years have passed since adopting the NOWAP Regional Action Plan on Marine Litter (RAP MALI) in 2008. In the meantime, the four Regional Activity Centers (RACs) of NOWPAP have collected and reviewed a vast amount of information and data on marine litter in the region. Many documents have been published to allow the NOWPAP Member States to be more active in managing and preventing marine litter. These promoted more stakeholders and the public to recognize the issue and bring about changes in their behavior. In 2011, the implementation evaluations of RAP MALI were carried out. Afterwards, the NOWPAP Member States' activities on addressing marine litter have increased noticeably. A comprehensive review report is needed to review the effectiveness of NOWPAP RAP MAL in the past decade. Against this backdrop, this review report is developed.

This report provides integrated information on marine litter ranging from mega to micro sizes according to the spatial existence. It reviews methodologies used for distribution surveys (target size, site number, sampling location, date, seasonality, interval, measuring units, citizen science, technical aspects, etc.), showing similarity and difference. It shows the abundance of marine litter and compares them among countries by figures or tables in three compartments like beaches, seawater, and sea bottom and tries to figure out temporal trends.

Overall, huge efforts have been made to understand the distribution of marine litter in the region. Especially when it comes to microplastics, there are notable research results around the world. The pollution level of marine litter in this region is similar to that of other regions. Still, the concentrations of microplastics and seafloor litter are relatively higher than those of other regions. Republic of Korea's long-term monitoring on beach litter has identified the major contributors and revealed the need for policy intervention. It can also be seen that the amount of beach litter per a certain period decreases statistically significantly with the implementation of preventive policies.

The report reviews the research results on marine litter impact on wildlife, tourism, fisheries,

navigation, and human health/food safety based on the published papers in scientific journals. It was noticed that various attempts are being made to investigate the impact of marine litter but very limited compared to those on the abundance and distribution. The enormous impacts of derelict fishing gear on navigation safety were quantified in the Korean seas. The impact of microplastic in seafood is being studied in China. Japanese researchers have widely studied the chemical contamination of pellets collected on the beaches.

The report provides an overview of the NOWPAP Member States' actions to address marine litter, including laws, regulations, action plans, and institutional arrangements. The information was collected from the nominated experts' reports and the previous reports and meeting documents. The progress in this aspect is clear in all member countries. Active responses to establish a new law targeting marine litter (Japan, Republic of Korea, and the Russia Federation) and to revise the existing legal framework (People's Republic of China) have been detected.

The report also assesses the implementation of RAP MALI in three aspects, including prevention, monitoring, and removal of marine litter. Overall, the implementation of RAP MALI in each Member State has been very active in the three fields.

It was found out through the review that the NOWPAP region is one of the most actively responsive regions to address marine litter issues, particularly microplastic issues. Governmental engagement, active research activities, and civil societies' contributions have been remarkably promoted. The extensive efforts to combat marine litter will lead to a cleaner and safer ocean in the region. Based on the review, six response measures are recommended to fill the gaps in knowledge and implementation of RAP MALI: 1. Studying macro and meso-sized plastics for source- and solution-oriented efforts, 2. Studying the impact of marine litter in various compartments, 3. Activating web database using a comparable data form, 4. Activating the participation of citizens and companies, 5. Integrating scientific results and policy measures for science-based management, and 6. Revision of RAP MALI.

The report was written by Dr. Sunwook Hong, Mrs. Jongsu Lee, and Dr. Jongmyoung Lee from Our Sea of East Asia Network. The information on the implementation of RAP MAIL in China and Russia was provided by Dr. Meng Qing Jia from the Chinese Research Academy of Environmental Sciences, and Dr. Mariia Vysotckaia from the Maritime State University,

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Chapter 1 . INTRODUCTION

Worldwide, marine litter has become a growing concern during the last decades as it has spread even to remote areas and affected all parts of the ocean (Barnes et al., 2010). Plastic litter accounts for most of the marine litter. Indeed, plastic was only invented over 100 years ago, its advantages have significantly improved the quality of life for people. However, many studies have shown that the damage caused by large amounts of plastic waste entering the ocean is serious at a global and local level. These include effects on marine biodiversity, ecosystems, fisheries, tourism, economies, societies, marine transport, recreation, and human health. Jambeck et al. (2015) concerned that a huge amount of mismanaged plastic waste from coastal areas keeps entering and exponentially increasing globally. This pattern won't change easily, nor is a breakthrough solution clear. Therefore, a great collective effort is required.

In 2015, the United Nations General Assembly adopted Sustainable Development Goal (SDG) 14 and its target 14.1, which seeks by 2025 to "prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution". The first report on the global-level assessment on the knowledge of marine litter and microplastics was published in 2016 by UNEP (UNEP, 2016). The fourth United Nations Environment Assembly (UNEA) of UNEP adopted the resolution stressing the importance of preventing and reducing marine litter from both land and sea-based sources for the SDG 14.1 on 15 March 2019. It also stressed the importance of strengthening the science-policy interface at all levels, including "improving understanding of the fate, distribution, and impact of marine litter and promoting local, national, regional and global action".

The Regional Action Plan on Marine Litter (RAP MALI) of the Northwest Pacific Action Plan (NOWPAP) has played an important role in reducing marine litter in the region. The first regional overview on marine litter in the NOWPAP region was produced in 2007 with national nominated experts' contributions. It described the strengths, gaps, and needs of marine litter management and proposed actions. RAP MALI in the region was established in 2008, which was the first case among UNEP regional sea programs (UNEP, 2018). The goal of RAP MALI is to improve the quality of the marine and coastal environment of the Northwest Pacific region. To achieve this goal, the following three objectives need to be realized: to prevent the

marine litter input into the marine and coastal environment, to monitor the quantities and distribution of marine litter, and to remove existing litter that was already discarded, disposed or abandoned. Under RAP MALI, each member state has been working together to address the region's marine litter problem. The 2nd regional overview was completed in 2011.

Over the last decade, there were many developments in the NOWPAP member states, including introducing new legal, institutional, and financial frameworks. There was an exponential increase in scientific studies and understanding of marine litter and microplastics distribution and impacts in the region. This report in nine years is designed to capture such an important achievement and to find the knowledge gaps for further progress to make our oceans cleaner and healthier.

The literature reviewed here is collected from the Web of Science's databases, papers drawn from keywords such as marine (plastic, anthropogenic) litter/debris, microplastics, the impact of marine litter/debris, navigation, and entanglement/ingestion. Over 150 papers were reviewed about the region and compared with other areas. Most of the results are presented in chapters 2 and 3. However, it has not been easy to sum up the marine litter data, which has been accumulating in the NOWPAP region, where other related activities have been very active in recent years. It wasn't easy to compare and analyze data posted on websites (DINRAC) or in various reports and meeting materials with data published in academic journals. Therefore, there are possibilities to miss some parts of the data from the grey reports or websites.

The overview of the legal aspects and implementation of RAP MALI in individual member states was based on the information provided by nominated experts in China and Russia, inputs provided by the Japanese government in the previous meeting, and the data collected by the experts in Korea. The progress in implementing RAP MALI was summarized in chapter 5 based on the nominated experts' reports and information from various sources.

The gaps in chapter 6 are from the authors' subjective evaluation based on extensive literature reviews. Constructive advice and additions from member states will make this gap analysis more sophisticated. The comparison among action/strategy plans in different organizations or programs in chapter 6 will help revise RAP MALI. The six recommendations in chapter 7 are targeting the NOWPAP region and should be revised with current global perspectives.

[This regional overview was developed following the approval of Programme of Work for 2018-2019 biennium (UNEP/NOWPAP IG.22/12/Ver.1) of the 22nd NOWPAP Intergovernmental Meeting.]

Chapter 2 . DISTRIBUTION, SOURCES, SPATIAL AND TEMPORAL TRENDS OF MARINE LITTER

Marine litter from various sources has been a major concern, particularly plastic marine litter, because its amount has increased exponentially due to mass production and the use of plastic products. To understand and evaluate marine litter's environmental impacts and establish policies and regulations for reduction, it is essential to elucidate the distribution of marine litter in various marine compartments.

This chapter presents the distribution, sources, and trends of marine litter on beaches, seawater, and sea bottom in the NOWPAP region. We reviewed the papers published in scientific journals and integrated information on marine litter ranging from macro to micro. We applied a broad perspective to our methodologies and reporting ways, gathering as many relevant papers and reports dating back to the 1990s as possible but included articles since 2000 to avoid too much heterogeneity. The review contained abundances and methodologies in terms of target sizes, locations, dates, seasonality, measuring units, and technical aspects. It shows similarities and differences between methodologies. Most marine litter pollution studies are carried out in a wide variety of ways organized, as shown in Table 2.1.

Size is the most frequently described component to categorize marine litter. There is no consensus for the nomenclature of marine litter sizes. Suggestions for it have been made in several marine litter monitoring guides (Cheshire et al., 2009; European Commission, 2013; Lippiatt et al., 2013). In this report, we reviewed published papers following the definition of GESAMP (2019) (Table 2.1).

Table 2.1 A conceptual overview of marine litter surveys for better understanding the following chapters

Category	Subcategory	Details
Pollution understanding	Quantity / amount / density / concentration / abundance	Measuring unit: gram, count, and volume per m, m^2, m^3
	Impact	Wild animal, ecosystem, fishing resources, tourism, economy, navigation safety, human health, disaster, chemical
Monitoring type at beach	Accumulation rate / load	Cleanup after periodical survey at fixed areas or sites (newly accumulated amount over time) (abundance per time, i.e. counts/m/month)
	Standing stock	Survey at a certain time (abundance, i.e., counts/m)
Size	Mega	1 m <
	Macro	25 mm – 1 m
	Meso	5 mm – 25 mm
	Micro	1 μm – 5 mm for the size range

		Primary and secondary for manufacturing point of view
	Nano	< 1 μm
Space position	Beach / coast	
	Floating / seawater	Sea surface, water column
	Sea bottom / seafloor	
Source / origin of macro marine litter	Land-based	Daily consumption, smoking, beach recreation, agriculture, medical and personal hygiene, dumping
	Ocean- / sea-based	Fisheries (capture fishing, aquaculture), recreational fishing (sport fishing), shipping (ferry, cruise, merchant vessels)
	Common / unknown	
	Foreign	Litters drifted ashore from overseas or vessels
Material / composition of macro marine litter	Plastic (+EPS)	60-90% of marine litter (number)
	Metal, glass, wood (timber), paper, rubber, cloth, others	Occasionally activities or sources-related categories (e.g., smoking, fishing, personal hygiene, or sanitary) are added.
Shape of microplastic	Hard plastic	Occasionally sphere is included
	Foamed	
	Film (sheet)	
	Fiber (fabric, textile)	
	Pellet	
Composition of microplastic	PE	Polyethylene (lighter than seawater)
	PP	Polypropylene (lighter than seawater)
	EPS	Expanded polystyrene (Styrofoam) (lighter than seawater)
	PS	Polystyrene (heavier than seawater)
	PVC	Polyvinylchloride (heavier than seawater)
	PET	Polyethylene terephthalate (heavier than seawater)

The abundance of marine litter on beaches has been widely monitored for the last two decades in the region. Relatively abundant data on abundance and distribution were collected from China and Korea. In Japan, researchers published results on developing transport models and new technologies to detect marine litter (Isobe et al., 2014; Iwasaki et al., 2017; Kako et al., 2011; Nakashima et al., 2012). Research on microplastics has dramatically increased in recent years in China, Korea, and Japan. In this review, almost 50 papers and reports were compiled, and more than half were based on China, followed by Korea, Japan, and Russia. Data posted online or in gray documents may not be thoroughly reviewed because it is rather challenging to compile them in an integrated way.

2.1. Beach litter

In this report, methodologies are reviewed of surveying beach marine litter and pollution level

in the NOWPAP region and then provide a summary and comparison with other regions.

2.1.1. Methodologies for quantification and identification

Numerous studies have used various methods, which hampers spatial and temporal comparison of survey results either from different or even the same locations. In this chapter, methodologies are reviewed applied in the NOWPAP region in terms of size, sampling at a site, survey period, reporting unit, etc.

Size classifications of the litter and reporting unit are not unified, with some reports labeling litter for pieces larger than 2.5 cm as macro-sized. In contrast, others label them as visible items. Intermediate-sized litter reported in Korea between macro and micro-sized litter was labeled ‘meso-sized litter’. The upper limit of microplastics, which caused controversy among sampling protocols worldwide, was defined < 5 mm in all NOWPAP region reports. However, the lower limit of litter was inconsistent. In some studies, microplastics were divided into large microplastics and small microplastics by 1 mm (Eo et al., 2018; Lee et al., 2013a; Lee et al., 2015).

Some studies sampled an entire designated zone (e.g., 100m) of the beach (Hong et al., 2014), and others surveyed a specific area in quadrats (Eo et al., 2018; Lee et al., 2013a; Lee et al., 2015; Yu et al., 2018). A representative of the sampling method is the Korea National Marine Debris Monitoring Program, which has been conducting sampling of designated beach areas for over ten years (Figure 2.1a). The program selected 20 beaches from 2008 to 2014 and added another 20 beaches from 2015, collecting macro-sized litter in a 100 m beach area. Trained citizen scientists have been involved in the survey program within the whole designated area.

Meso and micro-sized litter are usually sampled in reduced areas (i.e., in quadrats). Researchers usually divided several transects perpendicular to the coastline and placed quadrats in each transect, with the number of quadrats varying according to the research purposes. Sieving required a certain sieve size, such as 5 mm or 1 mm perforations, and samples larger than 5 mm could then be collected with the naked eye from the sieved material (Figure. 2.1b).

For microplastics, sieving with a suitable sieve should be preceded before identifying microplastics to obtain volume-reduced samples, which refer to a certain portion of the entire

sample volume for further processing. After that separation, filtration and digestion are required before identifying microplastics with special instruments such as the Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscope (Figure 2.1b). Several studies from Korea and China adopted this method for microplastics analysis (Eo et al., 2018; Kim et al., 2015; Peng et al., 2017; Wang et al., 2018; Zhao et al., 2018). For large microplastics (1~5 mm), picking them with the naked eye from volume-reduced samples can be applied.

A study in the NOWPAP region showed depth-related profiles by sampling different sand layers on beaches (Kusui and Noda, 2003). The results provide useful insight into how deep we should dig to get a representative sample from the sampling site.

One of the distinctive sampling techniques to assess the level of marine litter standing stock on the beach would be the “rapid assessment using a visual scoring indicator along the natural coastline of the Korean peninsula” implemented by the Ministry of Oceans and Fisheries (MOF) and Korea Marine Environment Management Corporation (KOEM) (2016~2018) (Lee et al., 2019). Extensive areas and numerous sites can be surveyed with this method in a short time. Citizen scientists are expected to contribute more to marine litter monitoring in this way.

The duration and repetitive periods of study on the same area over multiple years are important to check the spatial and temporal variation. Most reports in the NOWPAP region were based on one-off surveys and confined to limited areas. Only a few monitoring efforts revisited the same site and conducted comparisons of seasonal and yearly changes (Hong et al., 2014; Zhou et al., 2016).

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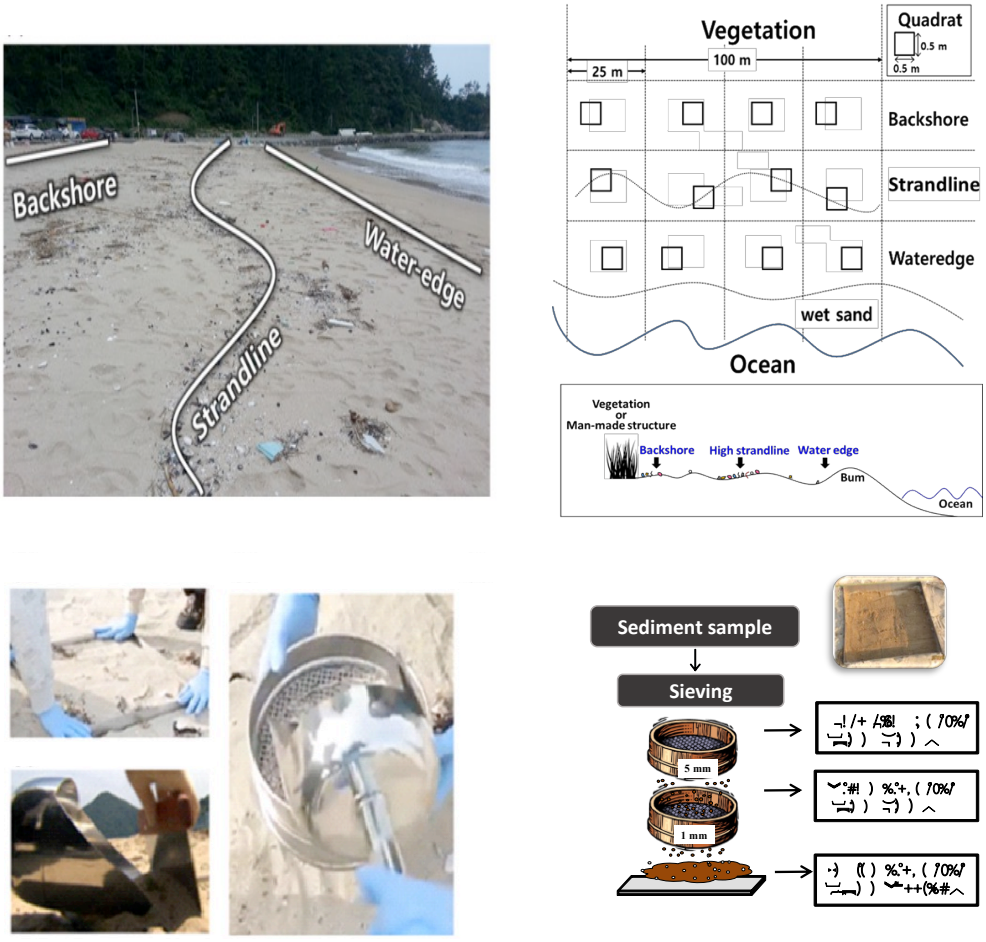
a)



b)

Figure 2.1 Sampling methods according to size of marine litter. a) macro-sized litter sampling on a beach, b) meso-sized litter and microplastics sampling in a quadrat (volume reduced sampling) (Figure 2.1. b) adapted from Eo et a., 2017)

2.1.2. Distribution of macro, meso, and micro-sized litter

In Korea, relatively balanced studies of marine litter were carried out in terms of marine compartments and litter sizes (Eo et al., 2018; Jang et al., 2014b; Lee et al., 2013a; Lee et al., 2015; Lee et al., 2017; Song et al., 2015). On the other hand, researchers in China have focused on macro-sized litter and microplastics (Yu et al., 2018; Zheng et al., 2019; Zhou et al., 2015, 2016), with nationwide monitoring on macro-sized litter being conducted once a year since 2007.

Most of the studies reported the abundances of macro-sized litter in items/m² (Table 2.2).

Within the region, the highest marine litter levels were observed at Heungnam Beach in Korea (Heo et al., 2013). Despite the different sizes and sampling depths, the abundances were in a similar range on beaches around Korea, China, the west coast of Japan, and Russia, except for one research from China (Zhou et al., 2016). Only a limited study of macro-sized litter on beaches of China was available in this review.

The numbers of macro-sized litter in the unit area (item/m^2) of the NOWPAP region were rather higher than those of other regions with some exceptions (Table 2.2 and Figure 2.2.). Considering the target size of the litter, the levels of macro-sized litter in Korea could be even higher than those of other regions because they were evaluated with a larger size of litter than those of other areas (Jang et al., 2014b; Lee et al., 2013a; Lee et al., 2015). The level of macro-sized litter expressed in number per unit length in Korea was similar to that in Norway and Bonaire in the Caribbean.

Table 2.2 The levels of macro-sized beach litter in the NOWPAP region and comparisons with other areas

Country	Location	Sampling depth	Target size	Abundance	Unit	References
Korea	Nakdong River Estuary	surface	>25 mm	0.97 (before rainy) 1.03 (after rainy)	items/m²	Lee et al. (2013b)
Korea	Heungnam Beach (Southeastern coast)	5 cm	> 10 mm	64 (high strandline) 13 (cross-section)	items/m²	Heo et al. (2013)
Korea	6 beaches around Korea	surface	>25 mm	0.5	items/m²	Jang et al. (2014b)
Korea	20 beaches around Korea	surface	>25 mm	4.8 ± 2.68	items/m	Hong et al. (2014)
Korea	12 coasts around Korea	surface	>25 mm	1.0 (strandline) 3.9 (strandline and backshore)	items/m²	Lee et al. (2015)
China	4 beaches in Rizhao City (Shandong Province)	surface	visible item	0.26	items/m²	Zhou et al. (2015)
China	East China Sea	surface	visible item	0.029	items/m²	Zhou et al. (2016)
Japan	Beaches along the East Sea/Sea of Japan	surface	visible	3.41	items/m²	Kusui and Noda (2003)
Japan	Awaji Island (inside Seto Inland Sea)			3.39	items/m²	Shimizu et al. (2008)
Russia	East coast of Russia	surface	visible	0.21	items/m²	Kusui and Noda (2003)
Oman	Gulf of Oman	surface	visible item	1.79 ± 1.04	items/m	Claereboudt et al. (2004)
Brazil	Island of Santa Catarina	surface	visible item	1.02	items/m²	Widmer and Hennemann (2010)
The Carribean	Bonaire	few centimeters	>5 cm and bottle cap (2cm)	291.0 (windward) 1.4 (leeward)	items/m	Debrot et al. (2013)
Slovenia	The Slovenian Coast	surface	> 20mm	1.51	items/m²	Laglbauer et al. (2014)

Brazil	Salvador and adjacent northern shore	surface	> 10mm	0.81	items/m²	Leite et al. (2014)
Pakistan	Clifton, Beach, Karachi	surface	> 20mm	8.9 ± 1.5	items/m	Qari and Shaffat. (2015)
South China Sea	South China Sea (outside the NOWPAP region)	surface	visible	0.022	items/m²	Zhou et al. (2016)
Norway	Along the Norwegian coast	surface	visible item	1.44 (OSPAR method) 4.02 (KNB method)	items/m	Falk-Andersson et al. (2019)

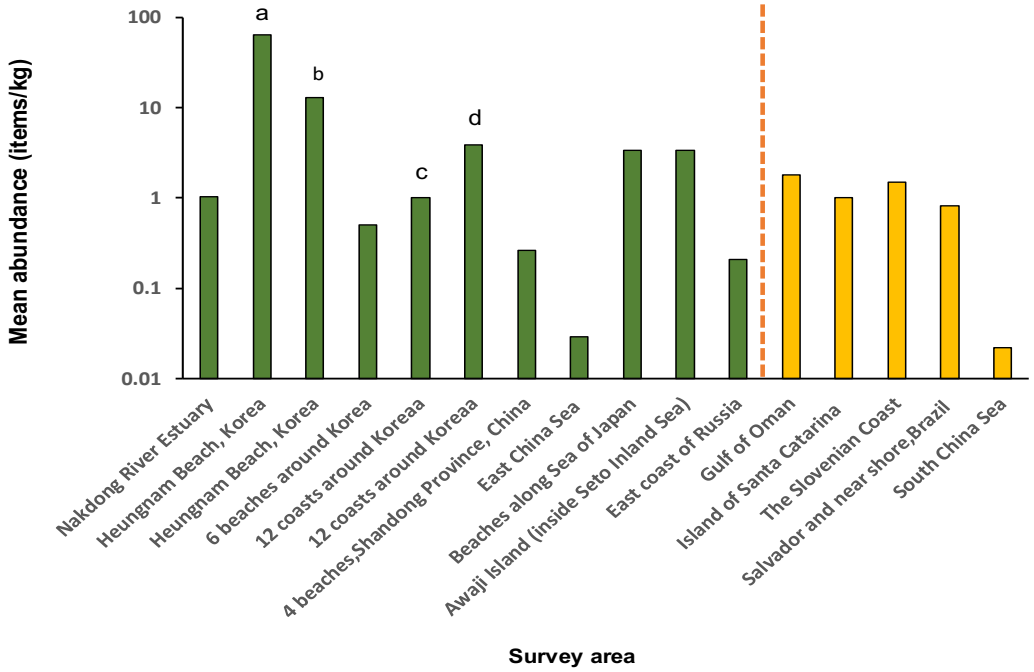


Figure 2.2 The levels of macro-sized beach litter in the NOWPAP region and comparisons with other areas. a: high strandline, b: cross-section, c: strandline, d: strandline and backshore.

Meso-sized litter has been less studied worldwide, and, as a result, there are gaps in the information on abundance, characteristics of accumulation, and impacts on marine organisms were reported. Studies on meso-sized litter were conducted in Korea (Heo et al., 2013; Lee et al., 2013b; Lee et al., 2015; Lee et al., 2017), finding that levels of meso-sized litter ranged from tens to hundreds of items/m^2, showing similar or slightly higher levels compared to those in other regions (Table 2.3 and Figure 2.3).

Table 2.3 Levels of meso-sized litter in the NOWPAP region compared to other areas

Country	Location	Sampling depth(cm)	Target size (mm)	Abundance	Unit	References
Korea	Nakdong River Estuary	5	5-25	238 (before rainy) 237 (after rainy)	items/m² m²	Lee et al. (2013b)
Korea	Heungnam beach (Southeastern coast of Korea)	5	2-10	913±388 (high strandline) 460±388 (cross-section)	items/m²	Heo et al. (2013)

Korea	12 coasts around Korea	2	5-25	37.7 (strandline) 897.3 (strandline and backshore)	items/m²	Lee et al. (2015)
Korea	20 coasts around Korea	2.5	5-25	13.2	items/m²	Lee et al. (2017)
U.S.A.	Hawaii	5.5	4.75-15	225.14[a]	items/m²	McDermid and McMullen (2004)
Brazil	the Archipelago of Fernando de Noronha	2	5-20	124.4[b]	items/m²	Ivar do Sul et al. (2009)
Portugal	Western coast of Portugal	2	5-20	51.8[c]	items/m²	Martin and Sobral (2011)
China	Guangdong	4	5-10	163± 154	items/m²	Fok et al. (2017)
The Maldives	Coral island of the Maldives	1	> 5	13.2 ± 17.7 (daily) 383 ± 417 (long term)[d]	items/m²	Imhof et al. (2017)

[a, b, c]: recalculated using figures from the original paper. [d]: 98% and 94% of the particles were larger than >5 mm meso-plastics for long term and daily abundance of plastics, respectively. Therefore, they were considered as meso-plastics in this review

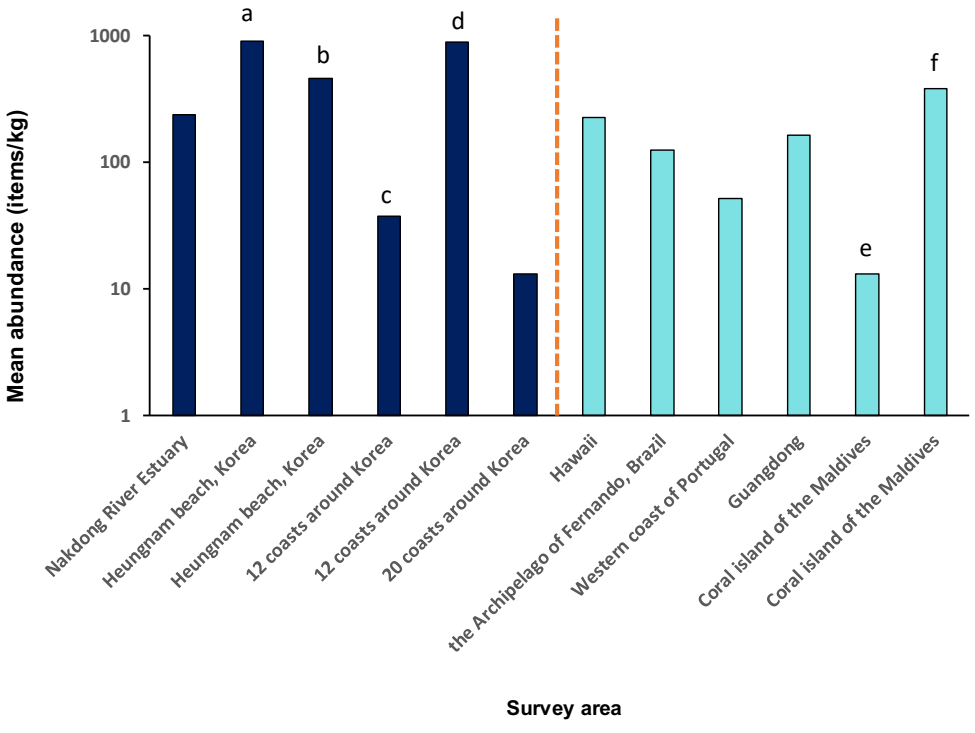


Figure 2.3 The levels of meso-sized beach litter in the NOWPAP region compared with other areas. a: high strandline, b: cross-section, c: strandline, d: strandline and backshore, e: daily, f: long term.

Microplastic research on beaches has actively been studied in Korea and China (Table 2.4). A few data were available for Japan, and no data were obtained for Russia in this review

(considering what was published in the scientific journals). Comparing the levels of microplastics in China with those in Korea was not available because of the different units expressed. The level of microplastics in the Oosumi Peninsula, Japan, was comparable to those in Heungnam beach, Korea (Heo et al., 2013; Majanga et al., 2015). Considering the size of the microplastics in both studies (1-5 mm and 1-8 mm, respectively), their levels were quite high. Both areas have been famous for aquaculture farms, and EPS (expanded polystyrene) buoys have been heavily used for the industry, which was likely to contribute to high levels of microplastics. Kim et al. (2015) recorded that the level was as high as 285,673 items/m² in Soya Island, which was the highest level globally.

A comparison of the levels of microplastics is shown in Figure 2.4. The levels were higher in Korea than those in other areas reviewed in this study. EPS particles would contribute to the high pollution of microplastics in Korean beaches. The levels of microplastics in China were similar to that of other regions (Dekiff et al., 2014) but lower than those of Italy, Slovenia, and Turkey (Blumenröder et al., 2017; Laglbauer et al., 2014; Vianello et al., 2013). Even in the sediment of a semi-enclosed bay like Jiaozhou Bay, where natural environment changes and human activities affect it all year round, the level of microplastics was 15 ± 6 items/kg (dry weight, D. W.). The big difference between the pollution levels of Korea and China needs to be explained through more research.

Table 2.4 The abundance of microplastics in the NOWPAP region and other areas [a]: sum of the fragments, EPS and fiber from paper. [b]: recalculated using original data from the paper,

Country	Location	Sampling depth	Target size	Abundance	Unit	References
Korea	Nakdong River Estuary	5 cm	1-5 mm	8,205 (before rainy) 27,606 (after rainy season)	items/m²	Lee et al. (2013b)
Korea	12 coasts around Korea	2 cm	1-5 mm	880.4 (strandline only) 27,165.8 (strandline and backshore)	items/m²	Lee et al. (2015)
Korea	Near- and off-shore of Geoje	5 cm	< 5 mm	2,726 (by FTIR) 812 (by microscope)[a]	items/L	Song et al. (2015)
Korea	Soya Island (mid-west of Korea)	2 cm	0.05-5 mm	46,334 ± 71,291	items/m²	Kim et al. (2015)
Korea	20 coasts around Korea	2.5 cm	< 5 mm	251.9 ± 405[b]	items/m²	Eo et al. (2018)
			< 1 mm	13,435 ± 18,072	items/m²	
China	Jiaozhou Bay	< 10 cm	< 5 mm	25 ± 13	items/kg (D.W.)	Zheng et al. (2019)
Japan	Kagoshima Bay	5 cm	1-8 mm	165,100	items/m²	Majanga et al. (2015)
China	Bohai Sea (outside the NOWPAP	2 cm	< 5 mm	102.9 ± 39.9 -163.3 ± 37.7	items/kg (D.W.)	Yu et al. (2016)

	region)					
Brazil	the Archipelago of Fernando de Noronha	2 cm	2-5 mm	60[b]	items/m²	Ivar do Sul et al. (2009)
Belgium	Along the Belgian Coast	-	-	92.8 ± 37.2	item/kg (D.W.)	Claessen et al. (2011)
Malta Island	Around Malta Island	surface	1.9 - 5.6 mm	0.7 - 167	items/m²	Tuner and Holmes (2011)
Hong Kong	Pearl River Estuary	4 cm	0.315 - 5 mm	5,595	items/m²	Fok and Cheung (2015)
Portugal	Western coast of Portugal	2 cm	0.1-5 mm	133.3[b]	items/m²	Martin and Sobral (2011)
Slovenia	The Slovenian Beach	5 cm	0.25-5 mm	133.3 (shoreline)/155.6 (infralittoral)	item/kg (D.W.)	Laglbauer et al. (2014)
Germany	Norderney	3 cm	0.1 < 1 mm	1.3 – 2.3 (without fiber)	item/kg (D.W.)	Dekiff et al. (2014)
China	South China Sea	5 cm	1-5 mm	24.3[b]	items/m²	Zhao et al. (2015)
China	Guangdong	4 cm	< 5 mm	6,675 ± 7021	items/m²	Fok et al. (2017)
Scotland	Orkney	3 cm	< 5 mm	3030 (particle + fiber)	item/kg (D.W.)	Blumenröder et al. (2017)

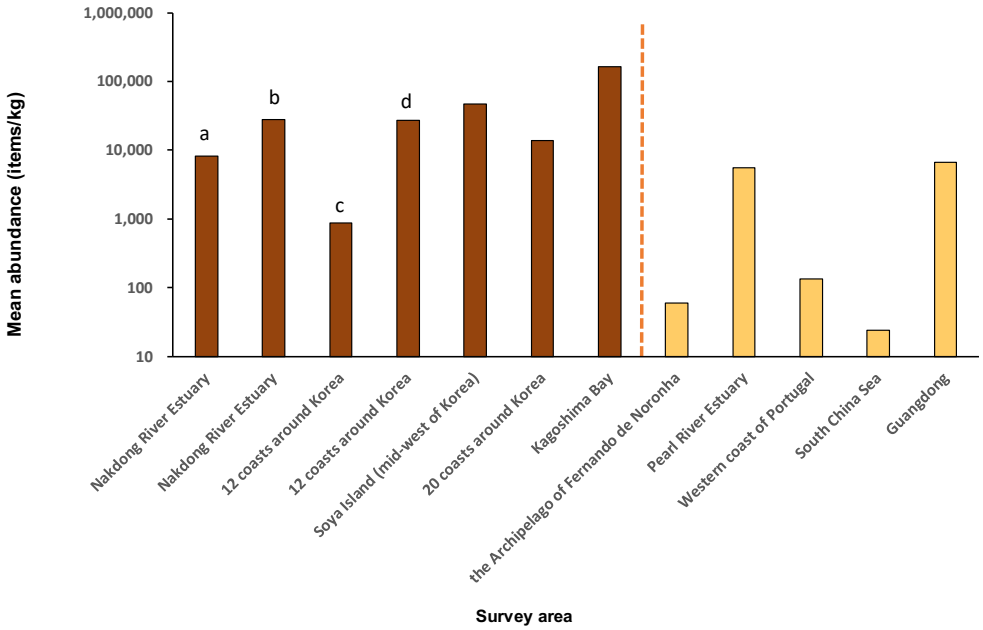


Figure 2.4 The levels of micro-sized beach litter in the NOWPAP region in comparison with other areas. a: before raining, b: after raining, c: strandline, d: strandline and backshore.

2.1.3. Composition and source

The macro-sized litter in Korea was mainly composed of fiber and EPS fragments in both studies (Jang et al., 2014b; Lee et al., 2015). Unlike the common belief that up to 80% of

marine litter consists of land-based items, Jang et al. (2014b) reported that macro-sized litter on Korean beaches were mainly composed of sea-based items, suggesting that ropes and nets produce a lot of fibers contributing to the marine litter in Korean beaches. Earlier surveys along the Korean coastline in 2008 and 2009 revealed the majority of the debris composition consisted of EPS buoys and ropes and that the main sources of marine litter were from fishing activities, including commercial fisheries and marine aquaculture (Hong et al., 2014).

The macro-sized litter in the Rizhao City of China was mainly composed of wood, plastics, and EPS, followed by paper, metal, rubber, fabric, fiber, glass, and other materials (Zhou et al., 2015). The authors suggested that land-based beach litter sources were the most representative, and beach users were also responsible for some debris in the area. Meanwhile, plastic was the main element, accounting for more than 48% of beach litter in the East China Sea (Zhou et al., 2016). Besides plastics (including EPS), other beach litter contained wood, glass, fabric/fiber, and metal (Zhou et al., 2016). The first source of litter was from coastal/recreation-related activities followed by other disposal sources such as navigation/fishing activities and smoking.

For the meso-sized litter, EPS was the dominant component on Korean beaches in all three studies reviewed, followed by hard plastics (Lee et al., 2013b; Lee et al., 2015; Lee et al., 2017). EPS buoys are intensively used to sustain buoyancy in aquaculture structures for oysters and laver. In particular, EPS buoys without covers for oyster farming are directly exposed to the environment and are very easily lost or broken down into smaller pieces. The extent of the pollution suggested that aquacultures were the major source of marine litter in Korean beaches.

For microplastics, EPS accounted for 95% of the number of large microplastics (L-MPs, 1mm – 5mm), whereas small microplastics (S-MPs, <1mm) were predominantly composed of fragments and fibers within 20 beaches around Korea (Eo et al., 2018). Another study elucidated that EPS was overwhelmingly dominant in Soya Island, located northwestern coast of Korea (Kim et al., 2015). A high EPS concentration occurred even in the area far from major aquaculture grounds, because EPS buoys can easily move to shore away, and even a single buoy can be split into countless microspheres or fragments. The difference between L-MPs and S-MPs proportions would come from different fragmentation processes and detection techniques (Eo et al., 2018). The microplastics were mainly fiber in all samples from sediments of Jiaozhou Bay, China (Zheng et al., 2019).

The most abundant microplastics in Korea were EPS for the range from 1mm to 5mm, whereas polyethylene (PE) and polypropylene (PP) were predominant for the smaller particles of fragments and fiber shape. Polyethylene terephthalate (PET) was the main type of microplastics, followed by PP and PE in Jiaozhou Bay, China (Zheng et al., 2019). Microplastic polymer types in the bay showed a close match to the polymer types found in estuaries, suggesting that riverine input is an important contributor to the microplastics in the area.

Finding marine litter sources is somewhat frustrating because one item, such as plastic bottles, can be entered the marine compartments either from household garbage or recreational activities on the beach and from ships. A few source identification methods were applied in the studies in the NOWPAP region. Hong et al. (2014) adopted ICC and the scoring methods of Whiting (1998) for identifying sources. The main sources of litter in their research were ocean/waterway (49.2% using ICC method, Figure 2.5a) and fishery-related marine litter (35.3% using the Whiting method, Figure 2.5b). This study reveals that management policy for marine litter in Korea should focus on fishery-related sources, especially given that the most abundant items were from EPS buoys and ropes from aquaculture activities such as oyster or laver farming. The result coincides with other research (Eo et al., 2018; Jang et al., 2014b; Lee et al., 2015). On the other hand, the primary source of marine litter on beaches in China was inferred from coastal/recreational activities, followed by other disposal sources (Zhou et al., 2015,2016). For Japan and Russia, more data should be provided to elucidate the source of marine litter.

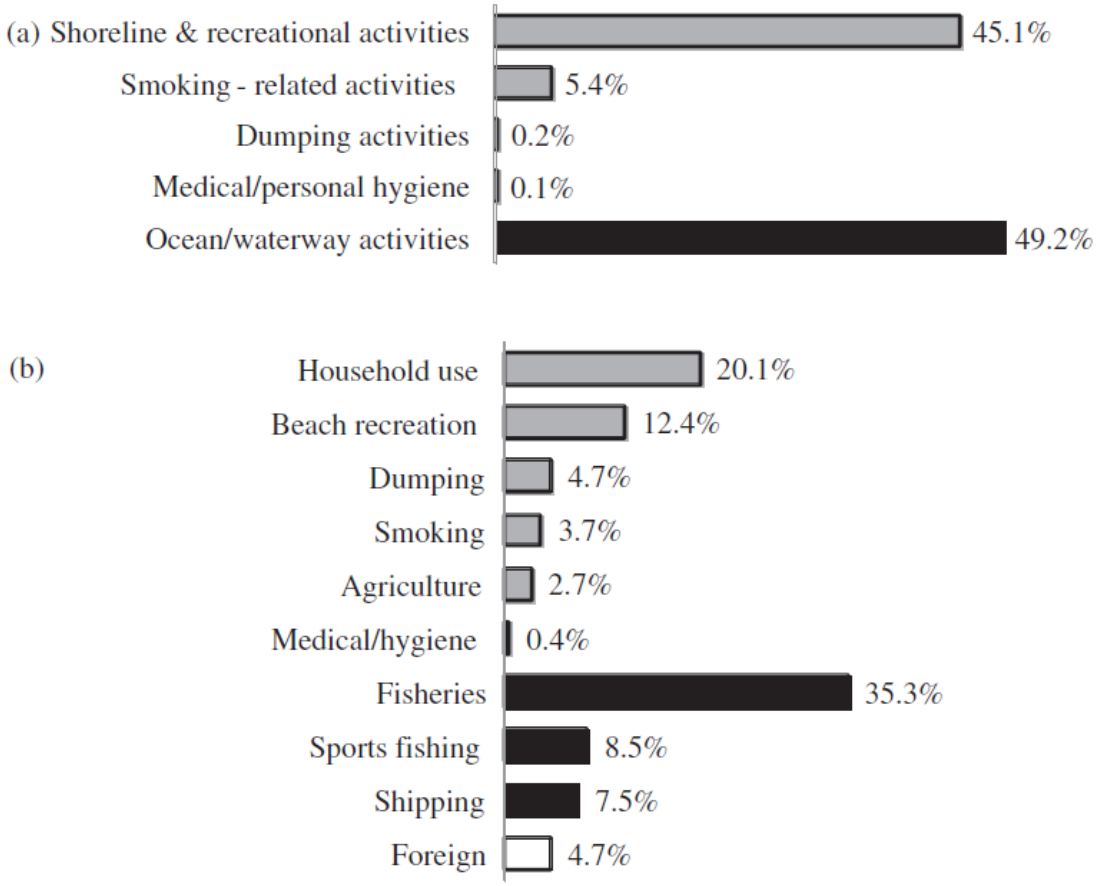


Figure 2.5 Sources of beach debris inferred by (a) the International Coastal Cleanup (ICC) method (Ocean Conservancy, 2007) and (b) the cross-tabulation probability scoring system (Whiting, 1998) using the marine litter item numbers surveyed at 20 sites. Gray bar: land-based sources, black bar: sea-based sources, and white bar: foreign (adapted from Hong et al., 2014) (Unit: counts/100m/2month).

2.1.4. Spatial and temporal trend

Although interest in marine litter has significantly increased in recent years, there are still many limitations in identifying long-term fluctuations in abundance except for in Korea. The result of a survey on 560 thousand items totaling 108 tons, quantities showed a statistically significant decrease over the years (Hong et al., 2018) (Figure 2.6). Among the 100 items surveyed, EPS buoy items used to show the highest numbers during the first four years have decreased significantly. The decrease is likely affected by governmental policy interventions such as the encouragement to replace EPS buoys for durable buoys since 2009.

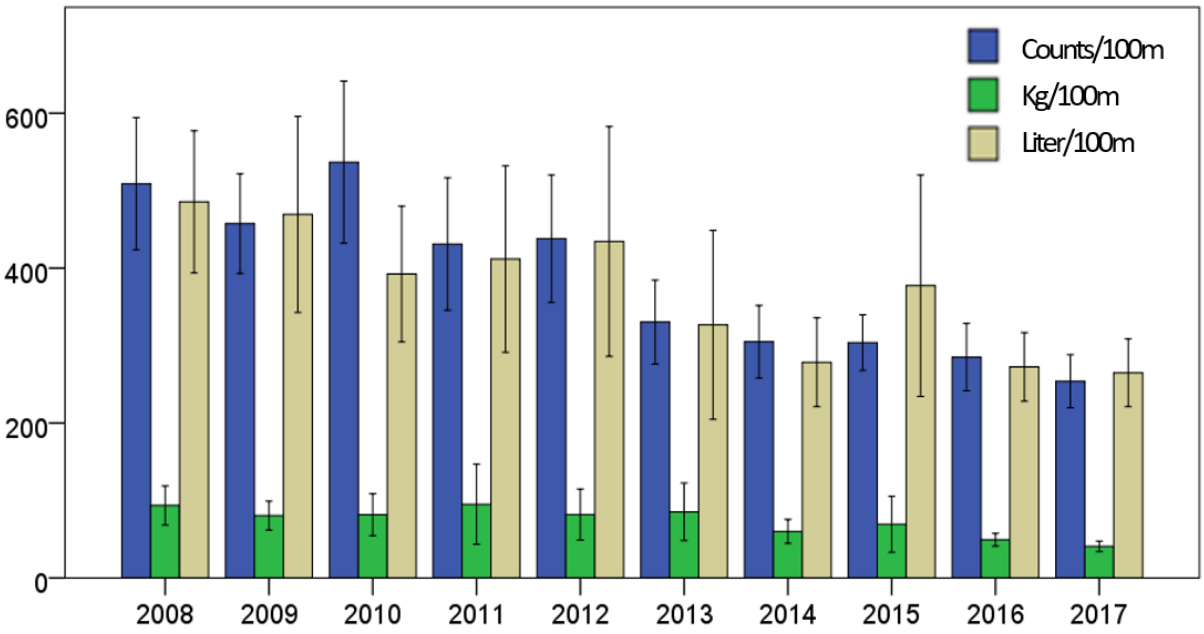


Figure 2.6 Temporal trend of macro-sized litter abundance at 20-40 sites in Korea (Hong et al., 2018). The number, weight, and volume of marine litter have significantly decreased over 10 years. (Note that the survey is conducted bimonthly at each site and all litter items within the designated area (100m with various width) are removed after the survey).

The China's monitoring of beach macro-sized litter appears to decrease in the recent years after increase in the early years of the survey (Figure 2.7).

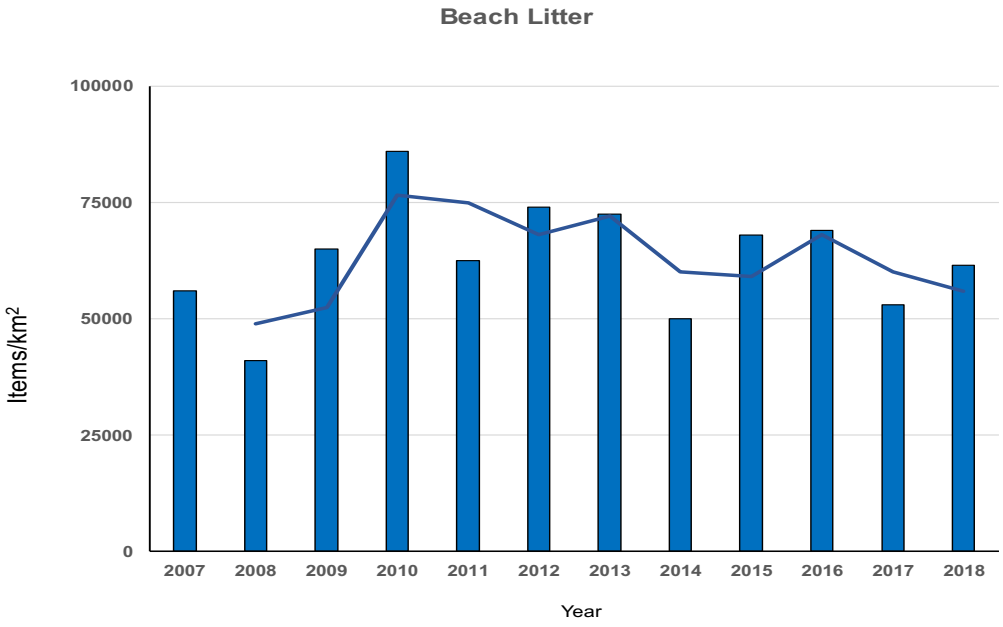


Figure 2.7 Long-term trend of beach macro-sized litter in China (adapted from Wang, 2019)

2.2. Marine litter in seawater

2.2.1. Methodologies for quantification and identification

The consistency or uniformity of the methods of monitoring marine litter cannot be overemphasized. Even though there are a lot of data on marine litter in seawater, it is challenging to compare them directly because different methodologies are used. For the consistency and comparison of data, it is urgent to develop guidelines monitoring methods such as 'Guidelines for harmonizing ocean surface microplastic monitoring methods' (Michida et al., 2019). In this review, methodologies for microplastic monitoring methods were compiled and compared with data using similar methods in the following session.

There are two main types of sampling methods for floating litter. The first method involves observers aboard a ship to visually detect large floating litter, and the second is to collect small-sized samples, especially microplastics using nets. Here we explain the latter methodology in detail.

The mesh size of the net to collect floating microplastics is important because it restricts the size and quantity of the samples. It is related to the sampling methods such as Manta trawl, neuston net, hand net, and pump (Table 2.5). The most commonly used nets to sample from surface water up to certain depths were Manta trawl and neuston (Chae et al., 2015; Kang et al., 2015; Song et al., 2015; Zhang, K. et al., 2017; Zhang, W. et al., 2017; Zhao et al., 2014). These are suitable for use on vessels for wide sampling. Sieves were used to sample from the surface microlayer (Chae et al., 2015; Song et al., 2014, 2015), and a Teflon pump was used to get samples from a certain depth (Zhao et al., 2014, 2015). Hand nets, Niskin hydrophore, and sight surveying were less used (Shiomoto and Kameda, 2005; Song et al., 2014, 2015). The majority of the studies in the NOWPAP region used 330 to 333μm meshes (Table 2.5). However, microplastic abundance increased with a decreased mesh size. The majority of microplastics were <300μm (Song et al., 2014), so using a bigger mesh size of more than 300 μm can underestimate the abundance of microplastics. The Ministry of Environment of Japan has issued a guideline recommending that the results for particles 1-5 mm should be reported separately from those of particles of under 1 mm in size if a net with a mesh opening of about 0.3 mm (Michida 2019).

Water depth for sampling ranged from 0-30 cm in the NOWPAP region, although many cases did not specify their depth (Table 2.5). According to Song et al. (2018), who investigated the

vertical distribution and composition of microplastics in the surface at different depths of the water column, a higher concentration of microplastics is observed in the surface water (shallower than 20 cm) than in the middle (at a certain depth of water column ranging from 3-27 m) and bottom (5-58 m) of the water column. However, the total number of microplastics in the middle of the water column was higher than that in the surface water because of the larger volume of water. The result indicates that the water column of the coastal zones retained a large proportion of microplastics.

Table 2.5 Different methods to collect samples at sea

Country	Location	Sampling method		Sampling depth	Target size	Mesh size	References
Korea	Kyeonggi and Asan Bays (western coast of Korea)	surface microlayer	sieving	<400 μm	50-5000 μm	0.75 μm	Chae et al. (2015)
		surface seawater	hand net	0-30 cm	50-5000 μm	20 μm	
			trawl net	0-20 cm	50-5000 μm	330 μm	
Korea	Geoje (Southeastern Sea of Korea)	hand net	net collection	0-20 cm	>50 μm	50 μm	Kang et al. (2015)
		manta trawl	net collection		>330 μm	330 μm	
Korea	Geoje (Southeastern Sea of Korea)	sieving		1 mm	<5 mm	0.75 μm	Song et al. (2015)
Korea	Geoje (Southeastern Sea of Korea)	surface microlayer	sieving	1 mm	<5 mm	0.75 μm	Song et al. (2014)
		bulk water	bucket collection	0-20 cm	<5 mm	50 μm	
		hand net	net collection	0-20 cm	<5 mm	50 μm	
		manta trawl	net collection	0-20 cm	<5 mm	330 μm	
Korea	Off coast of Korea	surface,	bucket collection	0-20 cm	20 μm-5000 μm	20 μm	Song et al. (2018)
		middle	pump	3~27 m	20 μm-5000 μm	20 μm	
		bottom	pump	5~58 m	20 μm-5000 μm	20 μm	
China	Yangtze Estuary	teflon pump		1 m	0.5-5 mm	32 μm	Zhao et al. (2014)
China	East China Sea	neuston net		-	<5 mm	333 μm	
China	Rudong offshore wind farm (Yellow Sea)	neuston net		-	<5 mm	333 μm	Wang et al. (2018)

China	Jiaojiang, Oujiang, and Minjiang Estuary (south-eastern China)	teflon pump	30 cm	<5 mm	333 μm	Zhao et al. (2015)
China	Bohai Sea	manta trawl	-	>0.3 mm	330 μm	Zhang et al. (2017)
China	Xiangxi Bay of three Gorges Reservoir	surface trawl net	-	<5 mm	112 μm for surface water	Zhang et al. (2017)
China	East China Sea	trawl net for small and medium size; Strip transect for large and out size	-	small (<2.5 cm), medium (2.5-10 cm), large (10-100 cm), out size (>100 cm)	-	Zhou et al. (2016)
Japan	Kuroshio Current area, western North Pacific Ocean	neuston net	-	1-11 mm	330 μm	Yamashita and Tanimura (2007)
Japan	East Asian seas around Japan	neuston net	-	<40 mm	350 μm	Isobe et al. (2015)
Japan	near-shore around Japan	(visual survey)	-	>5 cm	-	Shiomoto and Kameda (2005)

Water should be sieved to recover floating litter, and then visual sorting performed to separate marine litter from other materials. It is conducted with the naked eye or through a microscope and is usually carried out to separate litter larger than 1 mm from other organic materials. After sorting (separation, filtration, and digestion), microplastics less than 1 mm are analyzed with FTIR or the Raman-spectroscopic (Figure 2.8).

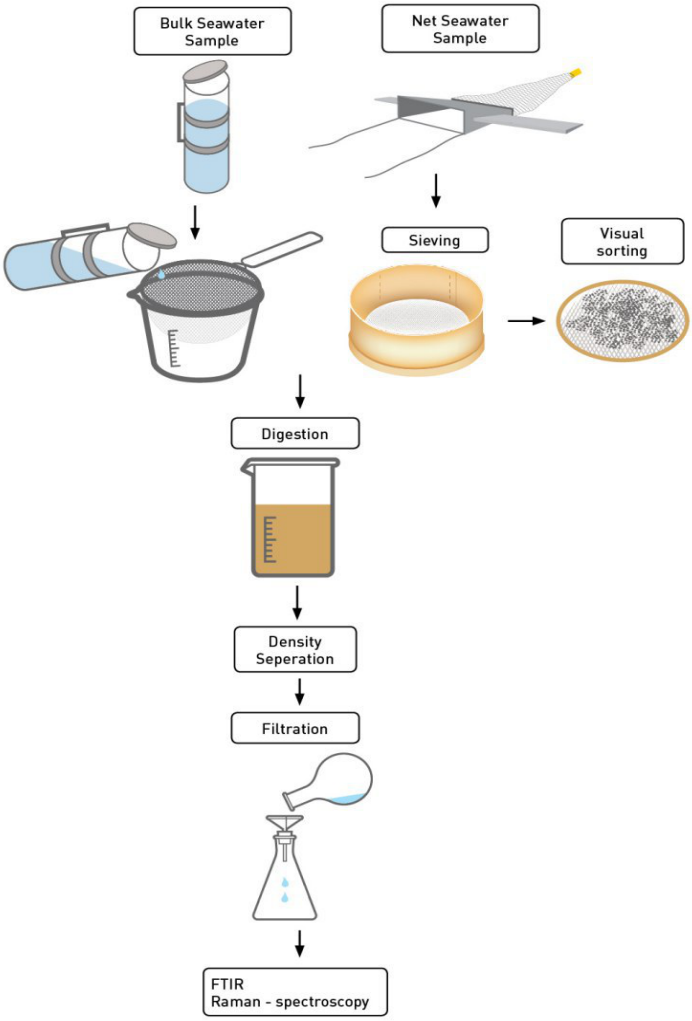


Figure 2.8 A schematic diagram of processing samples for chemical analysis

The majority of the studies reported the abundance of marine litter with particle numbers in a certain volume due to the water sample being mainly bulk or volume-reduced, in which a large volume of water is filtered with nets. Twelve papers reviewed herein reported the abundance expressed as a volume-based unit (particle numbers/m^3 or particle numbers/L). In comparison, three papers reported it as an area-based unit (particle numbers/m^2 or particle numbers/km^2). The measuring unit should be paid attention to and if possible, carefully replaced with a comparable one.

2.2.2. Distribution of macro-, meso-, and micro-sized litter

Marine litter, especially microplastics, is widely distributed in the seawaters of the NOWPAP region. According to the size groups, the levels of floating marine litter (FML) reviewed in this study are described according to the size groups (Table 2.6).

Table 2.6 Spatial distribution and abundance of floating marine litter in the NOWPAP region

Country	Location	Sampling method		Mesh size	Identification	Range	Mean abundance	References
Korea	Kyeonggi and Asan Bays (western coast of Korea)	surface microlayer	sieving	0.75 μm	FTIR	48,092-359,748 ea/m²	152,688±92,384 ea/m³	Chae et al. (2015)
		surface seawater	hand net	20 μm	FTIR	10-4,227 ea/m³,	1,602±1,274 ea/m³	
			trawl net	330 μm	FTIR	0.06-0.45 ea/m³	0.19±0.14 ea/m³	
Korea	Geoje (Southeastern Sea of Korea)	hand net	net collection	50 μm	microscope, FTIR	260-1,410 ea/m³, 210-15,560 ea/m³ (before and after raining season	-	Kang et al. (2015)
		manta trawl	net collection	330 μm	Visual, microscope, FTIR	0.62-57 ea/m³, 0.64-860 ea/m³ m³ (before and after raining season)	-	
Korea	Geoje (Southeastern Sea of Korea)	sieving		0.75 μm	stereomicroscope	-	fragment: 127±111 ea/L EPS: 0.1±0.2 ea/L fiber: 13±15 ea/L	Song et al. (2015)
				0.75 μm	FTIR	-	fragment: 206±117 ea/L EPS: 0.4±1.8 ea/L fiber: 4.5±4.1 ea/L	
Korea	Geoje (Southeastern Sea of Korea)	surface microlayer	sieving	0.75 μm	FTIR	-	16,272±13,457 ea/m³	Song et al. (2014)
		hand net	net collection	50 μm	FTIR	-	1,143±3,353 ea/m³	
		bulk water	bucket collection	50 μm	FTIR	-	213±141 ea/m³	
		manta trawl	net collection	330 μm	FTIR	-	47±192 ea/m³	

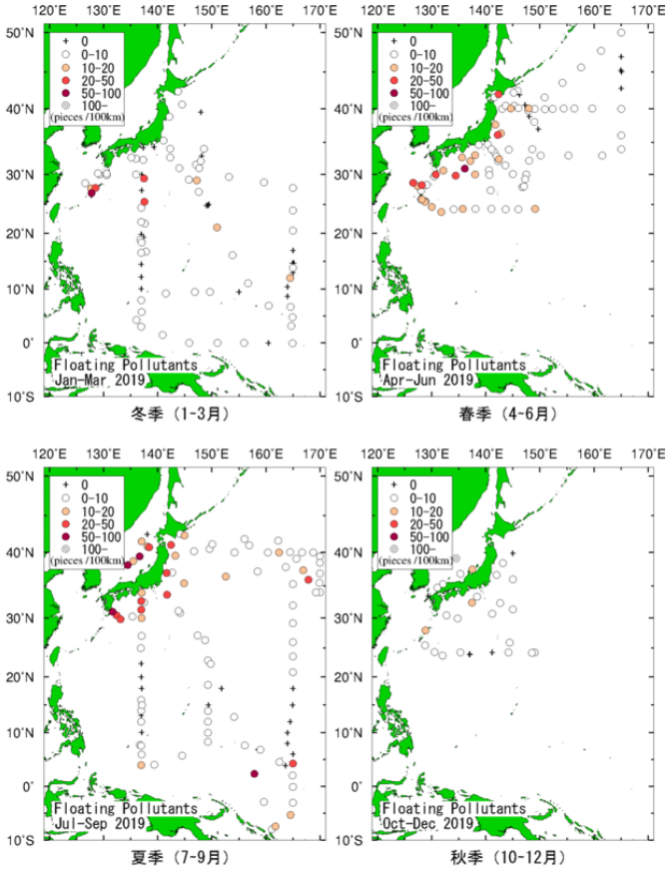
Korea	Off coast of Korea	surface,	bucket collection	20 μm	μ-FTIR	-	1736±1179 ea/m³	Song et al. (2018)
		middle	pump	20 μm	μ-FTIR	-	423±342 ea/m³	
		bottom	pump	20 μm	μ-FTIR	-	394±443 ea/m³	
China	Yangtze Estuary	teflon pump		32 μm	microscope	500-10,200 ea/m³	4,137.3 ± 2,461.5 ea/m³	Zhao et al. (2014)
China	East China Sea	neuston net		333 μm	microscope	0.03-0.455 ea/m³	0.167±0.138 ea/m³	
China	Rudong offshore wind farm (Yellow Sea)	neuston net		333μm	microscope, μ-FTIR	0.117-0.506 ea/m³	0.330±0.278 ea/m³	Wang et al. (2018)
China	Jiaojiang, Oujiang, and Minjiang Estuary (south-eastern China)	teflon pump		333μm	microscope, micro Raman spectroscopy	100.0-4,100 ea/m³	Jiaojiang: 955.6±848.7 ea/m³ Oujiang: 680.0± 284.6ea/m³ Minjiang:1245.8 ±531.5 ea/m³	Zhao et al. (2015)
China	Xiangxi Bay of three Gorges Reservoir	surface trawl net		112μm for surface water	Microscope, Raman microscope	55,000-34,200,000 ea/㎢		Zhang et al. (2017)
China	North China Sea	trawl net for small and medium size; Strip transect for large and out size		-	-	-	0.0035 ea/100m² for large and outsize,	Zhou et al. (2016)
	East China Sea			-	-	-	0.0014 ea/100m² for large and outsize, 0.20 ea/100m² for small and medium	
China	Yellow Sea	bongo net		500 μm	Stereoscope, μ-FTIR	0.00-0.81 ea/m³	0.13±0.20 ea/m³	Sun et al. (2018)
Japan	Kuroshio Current area, western North Pacific Ocean	neuston net		330μm	-	-	174,000±467,000 ea/㎢ (0.174±0.467 ea/m³)	Yamashita and Tanimura (2007)
Japan	East Asian seas around Japan	neuston net		350 μm	Microscope, FTIR	<5 mm:0.03-491.0 ea/m³	<5 mm 3.74±10.40 ea/m³	Isobe et al. (2015)
						>5mm: 0-70	>5mm:	

					ea/m³	0.38±1.06 ea/m³	
Japan	near-shore around Japan	sight survey	-	Naked eye	-	0.37±0.51 ea/㎢	Shiomoto and Kameda (2005)
Russia	Far East Russia	hand net for tidal zone	100 μm	Microscope, FTIR	1.5 – 56 ea/m³	-	Kozlovskii N.V. and Kachur A. N., 2018
		manta trawl for off coast	100 μm	Microscope, FTIR	0.13 – 1.13 ea/m³	-	

In some studies, large-scale FML was reported to be abundant. One research from China elucidated it in a wide spectrum of sizes: small (<2.5 cm), medium (2.5 cm<), large (10 cm<), and mega (1 m<) (Zhou et al., 2016). The research also determined their temporal trend over 7 years (2007~2014) in the NOWPAP region. The abundance of FML was two orders higher in a small and medium-sized litter (0.20 items/100m^2, 0.92 g/100m^2, respectively) than those of large and mega litter (0.0014 items/100m^2) in the East China Sea.

The abundance of FML larger than 5cm was reported in near-shore water around Japan through a visual survey (Shiomoto and Kameda, 2005). The level was high in the south and low in the north around Japan (average 0.37±0.51 ea/km2). On the other hand, The Meteorological Agency of Japan has reported floating plastic litter on the sea surface around Japan since the 1970s. It classifies plastic into styrofoam, fishing gear, thin-film plastics, and others (Figure 2.9). On average for 10 years, Styrofoam was the most abundant, exceeding 50%, followed by fishing gear, other plastics, and thin-film plastics. There was one big difference between years and sea areas (Fi 2.10):

(https://www.data.jma.go.jp/kaiyou/db/pollution/archive/d_1/floatpol/result_flp.html)



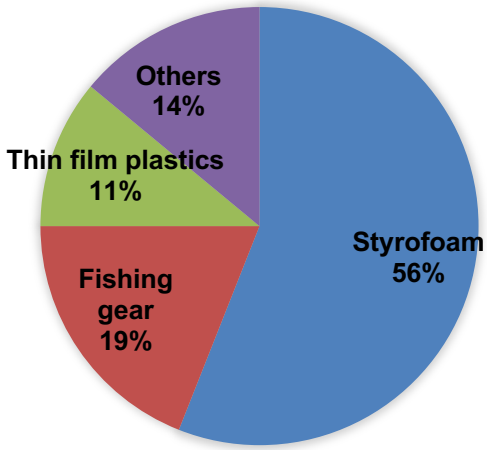


Figure 2.9 Top: Distribution of floating plastic litter in waters around Japan in 2019. Bottom: Composition of floating plastic litter in waters around Japan for ten years (2001-2010)
(https://www.data.jma.go.jp/kaiyou/db/pollution/archive/d_1/floatpol/result_flp.html)

Most of the studies reported microplastics in seawater. More than 90% of the floating litter was composed of plastics smaller than 5 mm (Zhao et al., 2014). Within the mesh size range of 330 to 350 μm, higher abundance was found in Jiaojiang, Oujiang, and Minjiang estuaries in southeastern China, showing 955.6 ± 848.7 ea/m^3, 680.0 ± 284.6 ea/m^3, and 1,245.8 ± 531.5 ea/m^3, respectively. The abundance was as low as two-orders in Geoje and much lower in Kyeonggi and Asan Bays in Korea, East China Sea, and East Asian Seas around Japan.

Microplastics taken from a hand net or bulk sampler with a 50 μm mesh (Figure 2.8) showed three or four orders higher in abundance than those taken from a 330-350 μm mesh except for Jiaojiang, Oujiang, and Minjiang estuaries (Kang et al., 2015; Song et al., 2014; Zhao et al., 2015) (Table 2.6).

Meanwhile, the quantity of mesoplastics and microplastics was relatively lower in Far East Russia (Kozlovskii N.V. and Kachur A. N., 2018). Twelve sites were surveyed with hand nets for tidal zones and Manta trawls used for off coast sites (100-300 m from the shoreline) between 2016 and 2017. The number of mesoplastics and microplastics was in the range of 1.5-56 ea/m^3 for tidal zone waters and 0.13-1.13 ea/m^3 for off coastal waters. Low industrial and urban activities in the area are thought to be the reason for the low levels (Kozlovskii N.V. and Kachur A. N., 2018)

To understand the status of FML contamination in the NOWPAP region, data from samples using 250-505 μm mesh and compared them with those of other studies that used similar sampling methods were selected in the report (Table 2.7 and Figure 2.10). Microplastics in the NOWPAP region showed comparable or lesser concentrations than these in the results from other regions except for Jiaojiang, Oujiang, and Minjiang estuaries in China (Zhao et al., 2015). Their location can explain the exceptionally high concentrations in the three estuaries above in the most densely populated and developed areas in China. As a result, the supporting estuaries have been hotspots for microplastic contamination (Wright et al., 2013).

Table 2.7 Comparison of abundance of microplastics collected with 250-350 μm mesh in seawaters with worldwide data

Region	Location	Mesh size (μm)	Abundance (n/m^3)	References
NOWPAP	Seto inland	335	0.39	Isobe et al. (2014)
	East Asian Sea	335	3.7	Isobe et al (2015)
	East China Sea	333	0.167	Zhao et al (2014)

	Southeastern Sea of Korea	330	1.92-5.51	Kang et al (2015)
	Kyeonggi and Asan Bays, Korea	330	0.19	Chae et al (2015)
	Geoje, southeastern Sea of Korea	330	47	Song et al (2014)
	Jiaojiang, Oujiang, and Minjiang Estuary (south-eastern China)	333	100-4100	Zhao et al (2015)
	Rudong offshore wind farm (Yellow Sea)	333	0.330	Wang et al (2018)
Outside NOWPAP	Bohai Sea, China	330	0.33	Zhang et al (2017)
	North Pacific Gyre	333	2.23	Moore et al. (2002)
	Southern California	333	37.25	Moore et al. (2002)
	Southern California-Santa Monica Bay	333	3.92	Lattin et al. (2004)
	South east Bering Sea	505	<0.1	Doyle et al. (2011)
	Northeast Pacific Ocean	505	0.004-0.19	Doyle et al. (2011)
	Portuguese Coastal waters	280	0.002-0.036	Frias et al., (2014)
	Central-Western Mediterranean Sea	500	0.15	de Lucia et al. (2014)
	Northeast Atlantic (Celtic Sea)	250	2.46	Lusher et al. (2014)

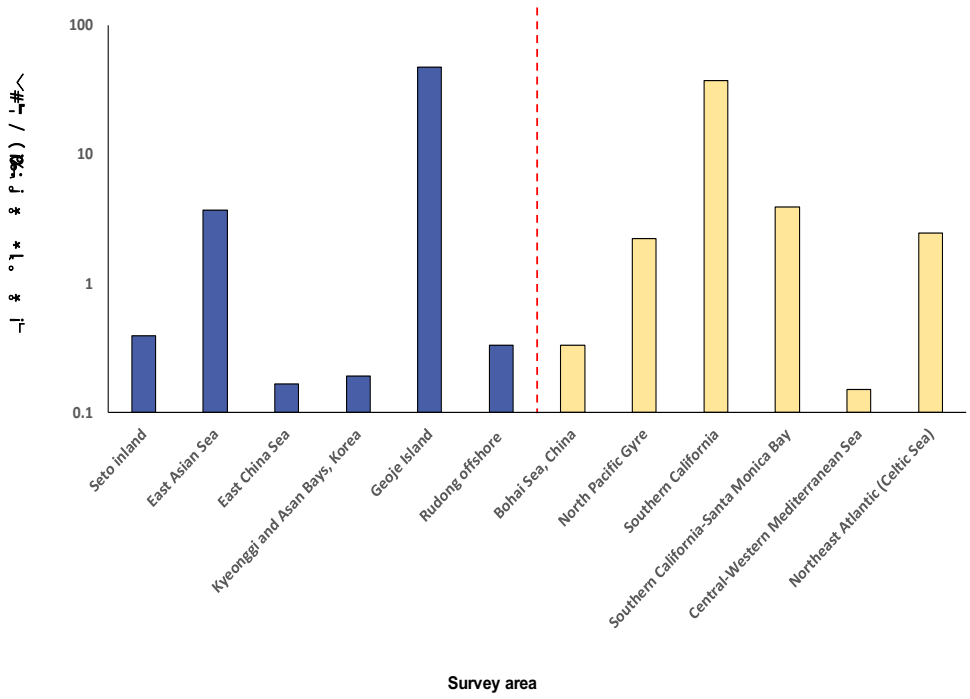


Figure 2.10 Comparison of floating microplastics (> 250 μm) in the NOWPAP region with those of other areas

2.2.3. Composition and source

Floating litter in the NOWPAP region was mainly composed of plastics, consistent with other studies worldwide (Eriksen et al., 2014; Thiel et al., 2013). Most of the research reviewed in this study elucidated the composition of microplastics in terms of shape (fragment, foam, film,

fiber, and pellet) and polymer type (PP, PE, PS, etc.).

Fibers were the most frequent shape of microplastics, followed by granules and films on the surface water of the Yangtze estuary (Zhao et al. 2014). The surface waters at Rudong Offshore wind farm area in the Yellow Sea mainly contained fibers (75.3%) (Wang et al., 2018). All research from China mentioned above points out that fibers were the most frequent or major component types of microplastics. One possible reason for the phenomenon is that sampling locations were near the densely populated areas of the Yangtze, Jiaojiang, Oujiang, and Minjiang Estuary, and municipal sewage has been considered a primary source of fibrous plastics resulting from clothes washing (Browne et al., 2011; Zhao et al., 2015).

The majority of the microplastics in the microlayer of the sea surface in Geoje, Republic of Korea, were composed of fragments and fibers (Song et al., 2015). Fishing ropes used for aquaculture, fishing nets, and ships in the neighboring seas around Korea are potential sources of microplastics in Korea.

PE and PP were the dominant polymers in the East China Sea and Yellow Sea (Zhang et al., 2017; Zhao et al., 2015) and PE at Rudong of the Yellow Sea in China (Wang et al., 2018). Heavy fisheries and anthropogenic activities are likely the main contributors to the polymers (Wang et al., 2018; Zhang et al., 2017).

In the south and west coastal waters of Korea, alkyds and polyacrylate/styrene were the most abundant polymers (Song et al.; 2014, Chae et al., 2015; Kang et al., 2015). These polymers are thought to originate from paints and the fiber-reinforced plastic (FRP) matrix used on ships (Song et al., 2014). Vigorous fishing and shipping activities can explain this phenomenon, although further study is required to evaluate the major input pathway of paint particles in these areas.

Pan et al. (2019) reported the major composition of microplastics near the mainland of China and Taiwan was PE (57.8%), followed by PP (36.0%) and nylon (3.4%), while near Japan was mainly PP. They tried to infer the source of microplastics using the differences among relative proportions of polymer types. Future discussions on this issue will be needed.

Trajectory studies on floating ML can also help understand the geographical source of FML. Movement by winds, waves, and ocean currents was studied by Kako et al. (2010) and Iwasaki et al. (2017).

2.2.4. Spatial and temporal trend

There are long-term monitoring cases on spatial and temporal trends of floating ML in China and Japan. Figure 2.11 shows a decreasing trend in macro floating litter around China but not in mega litter. More detailed information about this trend should be discussed.

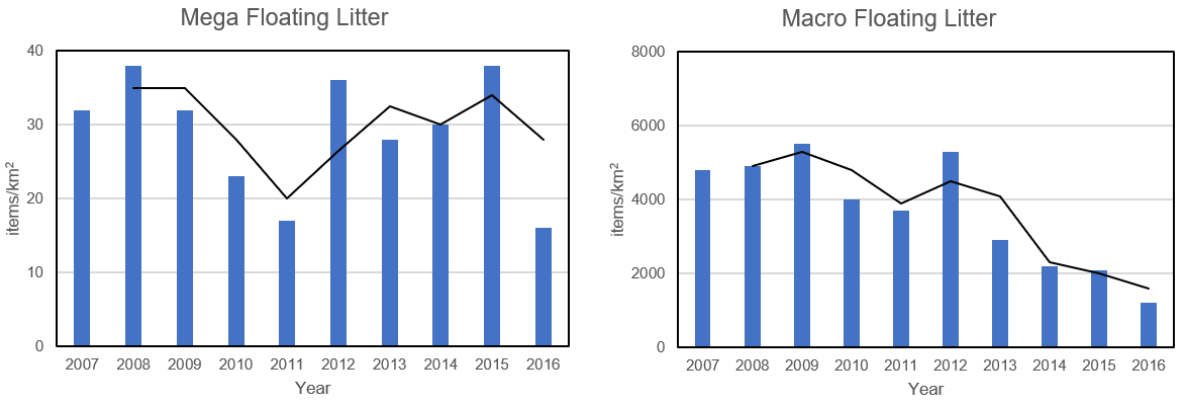


Figure 2.11 Macro floating litter decreases in the seas around China (adopted from Wang, 2019)

2.3. Marine litter deposited on the seafloor

2.3.1. Methodologies for quantification and identification

Marine litter on the seafloor in the NOWPAP region has different features according to countries. Side San Sonar (Kim and Kang, 2012; Park et al., 2016), trawl nets (Kim et al., 2006), and trap/gillnets (Kim et al., 2014) were used to elucidate the distribution and composition of submerged marine litter in Korea. Trawl nets were used to determine its abundance in Japan (Fujieda et al., 2009; Goto and Shibata, 2015; Kuriyama et al., 2003). These methods allowed them to determine mega and macro-sized litter on the seafloor, such as ropes, nets, pots, plastic bottles, and plastic bags. The reason why large litter was investigated in Korea was predefined by the research objectives to elucidate the influence of submerged litter on fisheries and estimate expenditure for collection and disposal of it on the fishing grounds (Kim and Kang, 2012). Water depth for the side-scan sonar ranged from 15m to 40m around the southwestern coast of Korea (Kim and Kang, 2012). However, the other studies from Korea didn't report the water depth. The surveyed seafloors in Japan were 80-220m (Fujieda et al., 2009) and 183-521m (Goto and Shibata, 2015).

On the other hand, monitoring efforts to determine the abundance and characteristics of microplastics on the seafloor were conducted in China (Peng et al., 2017; Wang et al., 2018; Zhao et al., 2018) and Russia (Zobkov and Esiukova, 2017). In their study, a box corer (Peng et al., 2017; Zhao et al., 2018), bottom grab sampler (Wang et al., 2018), and dredge (Zobkov and Esiukova, 2017) were used to obtain sediment samples. The sample sizes were less than 5 mm, and only one paper revealed lower sample sizes (Zhao et al., 2018). Therefore, the sea litter levels on the seafloor should be reviewed separately in response to the surveying method. The water depth of sediment sampling was 12-78 m in China (Zhao et al., 2018) and 3-30 m in Russia (Zobkov and Esiukova, 2017).

2.3.2. Distribution and composition

One research conducted by a side-scan sonar at Pohang Port in southeastern Korea estimated that submerged marine litter equated to 61,759 kg in 103.8 km^2, equivalent to 528.30 kg/km^2 after retrieval from the designated area (Park et al., 2016) (Table 2.8; Figure 2.12). It mainly consisted of nets, ropes, traps, anchors, woods, tires, and plastics. Nets and traps were predominantly abundant, occupying 88.1 % of the total sample. The predominance of fishery equipment can be explained by the sampling location, which was at a port where there are many fishery docks.

Another research surveyed submerged marine litter around five islands located in the southeast of Korea (Kim and Kang, 2012). Its abundance varied, ranging from 534 kg/ km^2 to 4,350 kg/km^2, composed of traps, anchors, ropes, nets, and wires. Meanwhile, a similar survey was performed in Busan Port, where plastics were the most predominant in number based on weight, fishing gear was ranked first, along with household items that came from the nearby municipality (Kim et al., 2006).

Lee et al. (2006) conducted surveys of marine litter on the seafloor in the South Sea of Korea and the East China Seas. Mean distribution densities ranged from 59.8 to 109.8 kg/km^2 and from 30.6 to 42.8 kg/km^2, respectively. The marine litter collected from the seafloor through bottom trawl nets were composed of fishing gear such as pots, nets, octopus jars, and fishing lines, occupying 37-62 % and 42-72% of the total in the East China Sea and the South Sea of Korea, respectively.

The densities of marine litter on the seafloor were higher in the Korean ports (Kim and Kang, 2012; Kim et al., 2006; Park et al., 2016) than those offshore (Lee et al., 2006). The high

abundance of fishing gear found indicates that active fishing operations are the major source.

Several studies have been conducted in Japan (Kuriyama et al., 2003; Fujieda et al., 2009; Goto and Shibata, 2015) and showed fishing gear was the dominant litter on the seafloor. The levels of litter were one to two orders lower than those of Korea. One possible reason for the difference is that the research on seafloor litter in Korea was conducted in fishery grounds and ports.

Monitoring efforts for the marine litter on the seafloor were conducted in the Bohai Sea/Yellow Sea and Changjiang Estuary in China (Peng et al., 2017; Zhao et al., 2018). The marine litter levels were 171.8 items/kg, 123.6 items/kg, 72 items/kg, and 121 items/kg in the Bohai Sea, Northern Yellow Sea, Southern Yellow Sea, and in the Changjiang Estuary, respectively. Both studies targeted microplastics in China and showed that marine litter on the seafloor was predominantly composed of fibers (93.9% in Bohai and the Yellow Sea and 93% in the Changjiang Estuary). Rayon was the most abundant among fibers, implying household sewage discharge was the major contributor to it.

The marine litter levels in China were higher than that in the Southern Portuguese shelf and similar to the Sublittoral zone of the Belgian coast. Regarding the major types of marine litter, they were consistent with other studies (Sanchez-Vidal et al., 2018; Woodall et al., 2014). In the Portuguese subtidal coastal sediments, most microplastics were identified as fibers (81%), and the remaining was polypropylene. Fibers were identified as rayon with FTIR, which is in accordance with other studies analyzing deep-sea sediments (Sanchez-vidal et al., 2018; Woodall et al., 2014). The fiber-dominant profile of microplastics was evident in pelagic fish and sediments in Europe (Browne et al., 2011; Claessens et al., 2011; Lusher et al., 2013). A large proportion of fibers may be derived from sewage due to washing clothes (Browne et al., 2011). Besides, denser fibers like cellulosic fibers and polyester are more likely to sink. They are found in high quantities in deep-sea sediments in European seas (Sanchez-vidal et al., 2018; Woodal et al., 2014).

There is insufficient understanding of marine litter on the seafloor in the NOWPAP region because research is costly and requires sophisticated equipment. In the case of Korea, the government has conducted extensive investigations before carrying out projects to clean up submerged marine litter, with the focus being to estimate the amount of marine litter to be cleaned.

Table 2.8 Distribution and abundance of marine litter on the seafloor

Country	Location	Sampling depth	Target size	Abundance	Unit	References
Korea	Pohang Port		Mainly fishing gear	528.30	kg/㎢	Park et al. (2016)
Korea	Wanndeung-do Younghung-do Jawol-do Saengil-do Heuksan-do	30 m 20 m 15 m 25 m 40 m	Mainly fishing gear	686 4,350 534 708 1,686	kg/㎢	Kim and Kang (2012)
Korea	Busan Port		Fishing gear, household item	355	kg/㎢	Kim et al. (2006)
Japan	Tokyo Bay		Fishing gear, household item	20.1 (1995) 10.4 (2000)	kg/㎢	Kuriyama et al. (2003)
Japan	Kagoshima Bay	80-220 m	Fishing gear, household item	30.0	kg/㎢	Fujieda et al. 2009)
Japan	Pacific coast of northern Japan	183-521	Fishing gear, household item	54-57 (2003) 89-94 (2004) 233-332 (2011)	items/㎢	Goto and Shibata (2015)
China	Yellow Sea	12-78 m	0.06 – 5 mm	123.6 (Northern Yellow Sea) 72 (Southern Yellow Sea)	items/kg (D.W.)	Zhao et al. (2018)
China	Changjiang Estuary	-	<5 mm	121 ± 9	items/kg (Dry weight)	Peng et al. (2017)
China	Rudong		<5 mm	2.58±1.14	items/g (Dry weight)	Wang et al. (2018)
China	North Yellow Sea (outside the NOWPAP region)		<5 mm	37.1±42.7	items/kg (Dry weight)	Zhu et. al. (2018)
Russia	Baltic Sea	3-30 m	0.175-5 mm	34 ± 10	items/kg (Dry weight)	Zobkov and Esiukova (2017)
Belgium	Sublittoral zone of Belgian coast	-	0.038 -1 mm	97.2 ± 18.6 (sublittoral zone) 166.7±92.1 (harbor)	items/kg (Dry weight)	Claessens et al. (2011)
Deep sea world wide	Porcupine Abyssal Plain Polar Front Distal lobe of Congo Canyon Nile Deep Sea Fan	4842-4844 m 2749 – 4881 m 4785 1176	0.035 – 1 mm	0.5	items/25cm^2	Cauwenbergh e et al. (2013)
Portugal	Southern Portuguese shelf	7.1–27.4 m		0.01 ± 0.001	items/g	Frias et al. (2016)
Regions – N/NE Atlantic, Mediterranean, SW	Mediterranean Sea Atlantic Ocean Indian Ocean	300-3500 m	0.032-5 mm	13.4 ± 3.5	Items/50ml	Woodall et al., (2014)

Indian						
France	Brest Bay		0.0016 mm	0.97 ± 2.08	items/kg (D.W.)	Frère et al. (2017)
Spain	Mediterranean Sea	1.5 10 m	0.063 – 5 mm	0.90 ± 0.10	items/g	Alomar et al. (2016)
Europe	Southern European deep sea	42 – 3500 m	0.032-5 mm	6,965± 3,669	Items/m²	Sanchez-vidal et al. (2018)

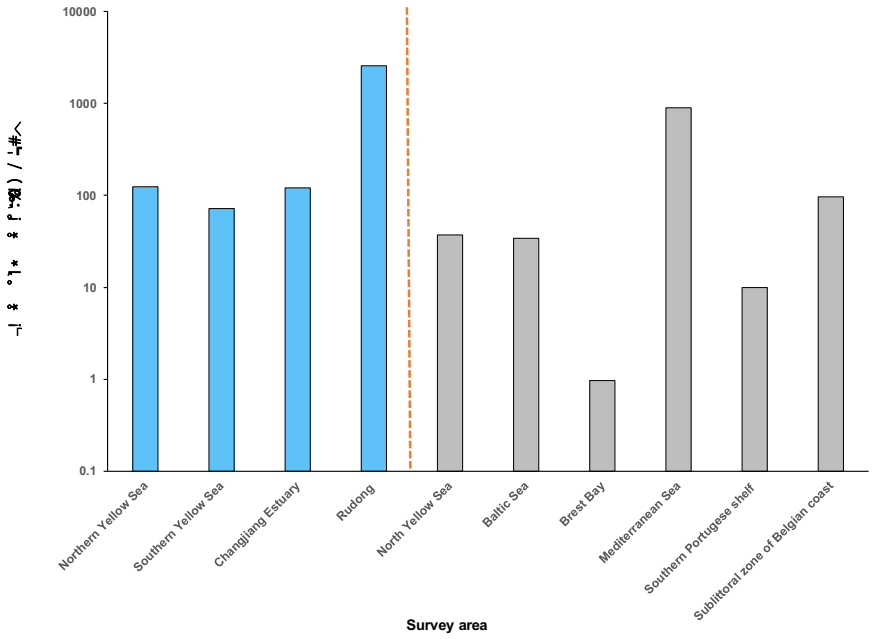


Figure 2.12 Levels of marine litter on the seafloor in the NOWPAP region and comparison of them with those of other areas

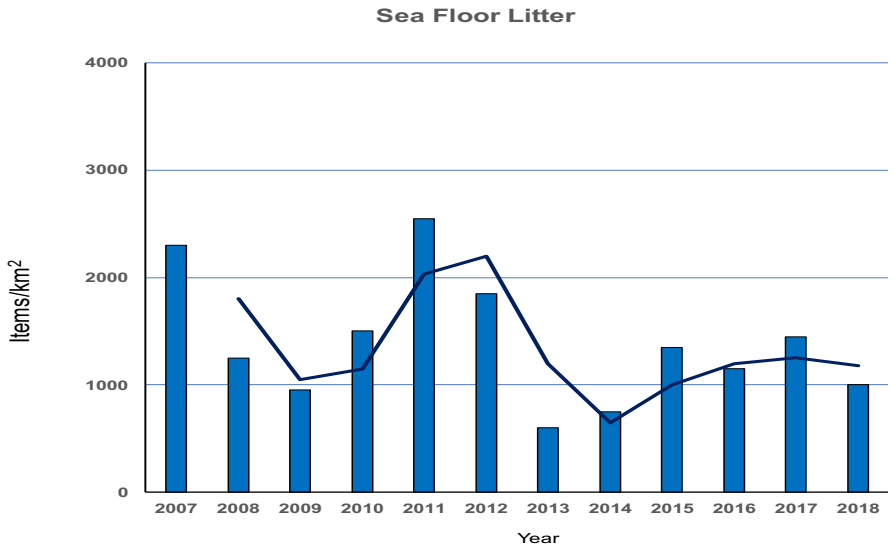


Figure 2.13 Sea floor litter in the seas around China (adopted from Wang, 2019)

Chapter 3 NEGATIVE IMPACTS ON MARINE ECOSYSTEMS AND SOCIO-ECONOMY

About 30 papers on the impact of marine litter have been published since 1990 in the region. Table 3.1 summarizes the search results using Google Scholar with the keywords of "impact, entanglement, ingestion, marine litter, debris, plastic". Except for Russia, the member states have studied the impact of marine litter on chemical characteristics by microplastic ingestion (CM), wildlife (W) and its microplastic ingestion (WM), disaster (D) and wildlife invasion by disaster (DW), fisheries resources and economy (F), human health (H), navigation (N), tourism (T) and a combination of chemical features, wildlife, and microplastic (CWM). Korea and China have been more active than other member states in recent years. Korea presented the impacts on tourism due to heavy rain and navigation safety due to propeller entanglement of floating derelict fishing nets and ropes. China demonstrated various seafood and salt-containing microplastics in several papers. Japan revealed anchovies' intestines, one of the most popular seafood in the region, containing microfiber. Studies on the impact on fisheries were only done in Japan 30 years ago.

Table 3.1 Studies on the negative impacts of marine litter (CM: chemical+ microplastic, W: wildlife, WM: wildlife+ microplastic, C: chemical, F: fisheries resources and economy, H: human health and food safety, N: navigation, T: tourism, WCM: wildlife+ chemical+ microplastic).

Country	Classification	Target	Characteristics	References
China	CM	POPs	Ingestion	Zhang et al. (2015)
	W	Terrestrial bird	Ingestion	Zhao et al. (2016)
	WM	Fish (seawater, freshwater)	Ingestion	Jabeen et al. (2017)
	H	9 bivalves, mussel, Scallop, Ark shell	Market, fiber	Li et al. (2016, 2015)
	H	Mussel	Coast (aquafarm), fiber	Jabeen et al. (2017), Li et al. (2016)
	H	Mussel	Coast (wild), fiber	Li et al. (2016), Qu et al. (2018)
	H	Salt (sea, lake, rock, well)	Market, fragment	Yang et al. (2015)
Japan	C	Toxic metal, fishing float		Nakashima et al. (2012)
	CM	Lead		Nakashima et al. (2016)
	F	Fishing vessels	Collision and propeller entanglement	Takehama (1990)
	W	Fur seal	Dermal tissue damage by net entanglement	Nakajima et al. (1990)
	W	Fur seal	Daily activity by net entanglement	Yoshida and Suzuki (1990)
	W	Sea turtle	Feeding behavior	Fukuoka et al. (2016)

	H	Fish (anchovy)	Coastal water (wild), fragments, microbead	Tanaka and Takada (2016)
Korea	CM	Additives	Ultraviolet stabilizers and antioxidants	Rani et al. (2017)
	N	Navy vessels	Propeller entanglement	Hong et al. (2017)
	T	Beach tourism	Economic loss	Jang et al. (2014a)
	W	Wild animals	Entanglement and ingestion	Hong et al. (2013)
	W	Endangered bird (black faced spoonbill)	Nest building	Lee et al. (2015)
	WCM	Mussel	Ingestion	Jang et al. (2016)
	WM	Polychaetas, EPS	Fragmentation	Jang et al. (2018)
	H	Oyster, mussel, Manila Clam, scallop	Market, fragment	Cho et al. (2019)

3.1. Wildlife and ecosystem

The impacts on wildlife were most frequently investigated (8 papers), including polychaeta, mussels, fish, birds, sea turtles, fur seals, and porpoises (Table 3.1). The first study on the impact of fishing nets on fur seals was carried out by Nakajima et al. (1990) and Yoshida et al. (1990). They reported net entanglement caused damage to the dermal tissue of fur seals and limited their daily movement and behavior. Sixteen years later, Fukuoka et al. (2016) analyzed incidentally captured sea turtles on the north-east coast of Japan and reported that green sea turtles significantly more often encountered artificial litter than loggerhead sea turtles.

Hong et al. (2013) analyzed 45 animal cases impacted by marine litter, which occurred over ten years from 2003 to 2012, and identified 21 species, including five threatened or protected species in Korea. The most dangerous litter items originated from recreational fishing activities. These include hooks, monofilament lines, and lead sinkers. One of the endangered species, the black-faced spoonbill in western Korea, had built its nests from a mixture of plastic package bands, fishing lines and ropes, plastic bag fragments, and natural tree branches/rice straws (Lee et al. 2015).

Plastic ingestion of terrestrial birds, freshwater/seawater fish, and mussels was reported in China and Korea (Jabeen et al., 2017; Jang et al., 2016; Zhao et al., 2016). Jang et al. (2018) observed that polychaetas inhabiting expended polystyrene buoys, which are very common for the maricultural area in Korea, contained micro-sized EPS fragments in their feces and could be an important contributor to fragmentation.

3.2. Tourism

As for the impact on tourism, there is only one study on the economic damage to the tourism industry in the downstream region of the Nakdong River in Korea (Jang et al., 2014a). The impact was caused by heavy rains in the watershed, which lasted only ten days in July 2011. Jang et al. (2014a) estimated the economic loss caused by a decrease in the number of visitors to the beach due to a large amount of litter flowing downstream from adjacent rivers during periods of high precipitation. Since the visitor count decreased 63% compared to the previous year's count, the tourism revenue loss of an island downstream was estimated to be US$29 – 37 million.

3.3. Fisheries

Only one study dealt with the impact of marine litter on fisheries. Takehama (1990) reports economic loss due to collisions of fishing vessels against floating artificial objects, propeller entanglement, and engine clogging nationwide. The study was carried out almost 30 years ago, and no more follow-up studies have been conducted on the fishing industry.

3.4. Threat to Navigation

Hong et al. (2017) reported a total of 2,386 cases of naval vessels caught in floating derelict fishing nets in Korean territorial seas from 2010 to 2015 (Figure 3.1). These facts correspond to about 400 incidents per year and 2.3 cases per vessel per year. Therefore, there were no vessels that experienced no disability each year. It means the persistent and ubiquitous threat of derelict fishing gear to the navigation of all kinds of ships. They also found that more than 1,000 people are required to work more than 100 hours each year to disentangle the propellers. They estimated an annual economic loss of $68.2 million when the survey results were extended to the total number of power ships, considering only divers' labor costs. They emphasized that this effect should potentially be reduced by preventing derelict floating gears in fishing areas rather than removing DFGs.

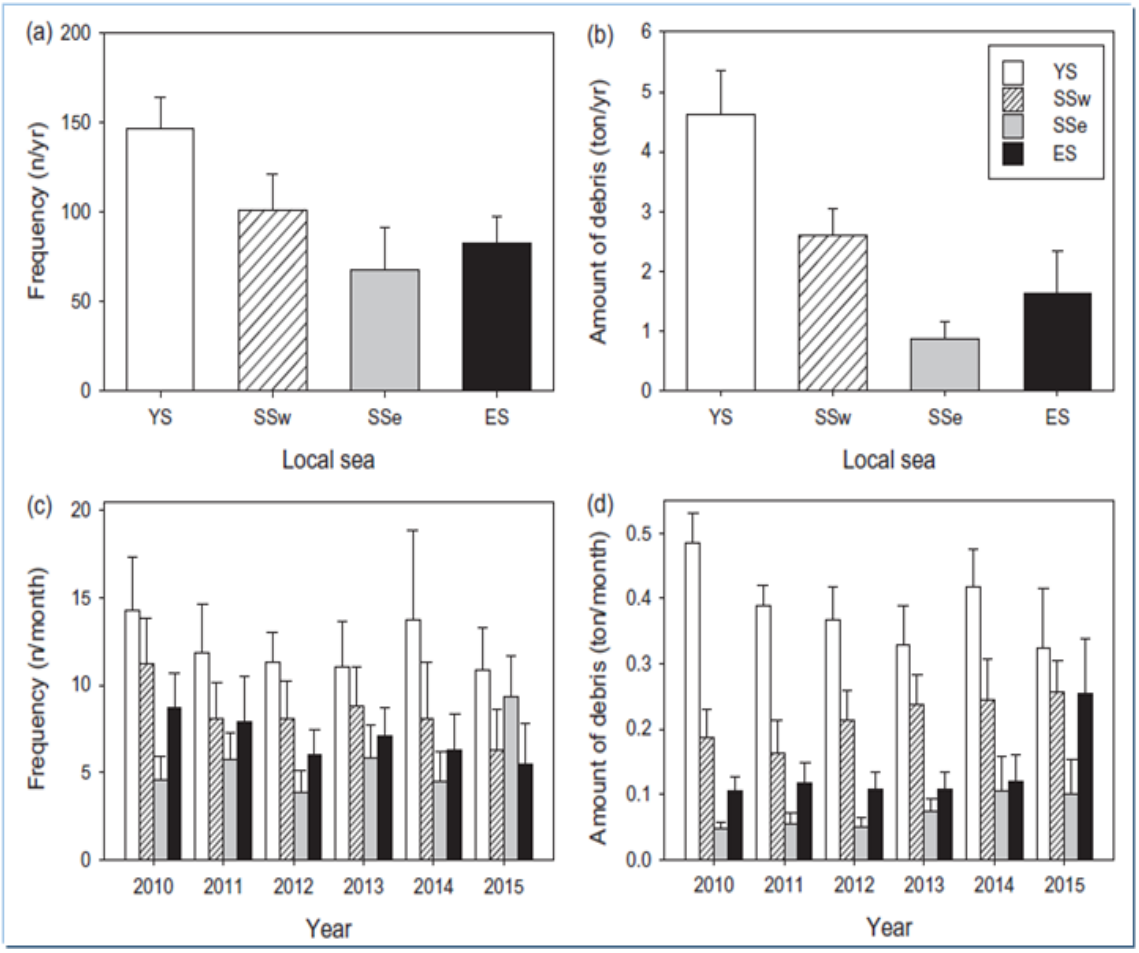


Figure 3.1 Regional and temporal trends of the vessels entangled by derelict fishing gears in Korean seas. ES: East Sea/Sea of Japan, YS: Yellow Sea, SSe: Eastern South Sea, SSw: Western South Sea (adapted from Hong et al., 2017).

3.5. Hazardous chemicals

Four papers reported chemical components of marine litter in the region. The elevated concentrations of Persistent Organic Pollutants (POPs) in resin pellets sampled from beaches in China were observed by Zhang et al. (2015). Nakashima et al. (2012, 2016) were concerned that toxic metal or lead components could be eluted to the marine environment from plastic buoys found on the coast of Japan. Ultraviolet stabilizers and antioxidants added in manufacturing plastics were detected on the plastic litters collected on the beaches in Japan and Korea (Rani et al., 2017).

International Pellet Watch (IPW) has reported plastic pellet pollution and the concentrations of persistent organic pollutants (POPs) such as PCBs, DDTs, and HCHs on the pellets. It was designed by Japanese researchers, and since its launching in 2005, IPW has monitored the

concentration of plastic pellets and POPs over 200 locations worldwide. The concentrations of PCBs on the pellets were high in the USA, India, and Japan, those of DDTs were high in Vietnam and the USA, and those of HCHs were high in southern Africa (Ogata et al., 2009) (Figure 3.2).

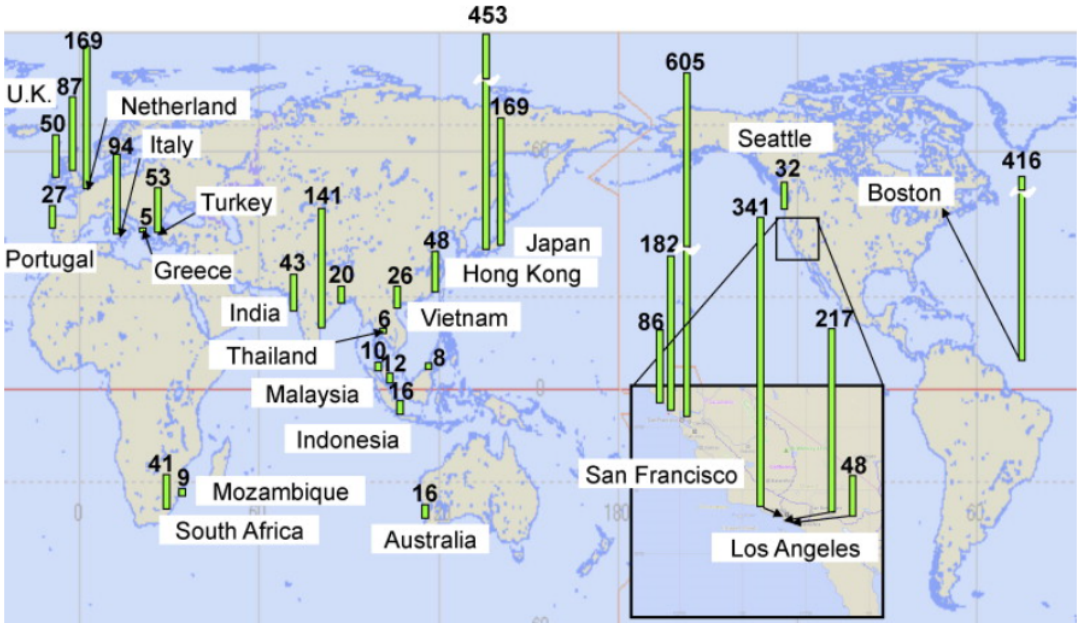


Figure 3.2 Median concentrations of ∑13 PCBs (ng/g-pellet) in beached plastic pellet (adapted from Ogata et al., 2009)

3.6. Human health and food safety

The negative effects of microplastics may include the presence of microplastics in seafood and the high intake of it, which raises concerns that it may eventually affect human health (Barboza et al., 2018). Six studies dealt with microplastic-containing shellfish, bivalves, fish, and salt (Table 3.1). The studies in China show that fibers were the most abundant type of detected microplastics, whereas hard plastic fragments were the most abundant in those in Korea. It is not yet known how microplastics in seafood affect human health, and studies on microplastics found in various media are expected to increase in the future.

Chapter 4 OVERVIEW OF MARINE LITTER RELATED LEGISLATURE, POLICIES, AND ACTION PLANS

The NOWPAP member states are already parties to the existing global marine-litter related legal framework such as the United Nations Convention on the Law of the Sea (UNCLOS), International Convention for the Prevention of Pollution from Ships (MARPOL Convention), the Convention for the Prevention of Marine Pollution from Dumping of Wastes (London Convention) and the Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention). And there are other international instruments related to marine litter, such as the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), the Code of Conduct for Responsible Fisheries (CCRF) by the Food and Agriculture Organization of the United Nations (FAO), The Honolulu Strategy by the United Nations Environment Programme and National Oceanic and Atmospheric Administration of the United States of America and the Sustainable Development Goals (SDGs), specifically goal14.1 of the United Nations General Assembly.

The G7 Summit agreed on the management of marine litter to protect the marine environment and announced the 'G7 Action Plan to Combat Marine Litter' as an annex. In July 2017, the G20, including China, Japan, the Republic of Korea, and Russia, agreed on the G20 Action Plan on Marine Litter, which includes seven policies and 41 tasks to be implemented to cope with the marine litter problem. The G20 Summit in Osaka, Japan, 2019, declared the vision to reduce additional pollution by marine plastic litter to zero by 2050 through a comprehensive life cycle approach and endorsed the “G20 Implementation Framework for Actions on Marine Plastic Litter”.

Complying with the international conventions and agreements on marine litter, the NOWPAP member states are encouraged to have national legal frameworks dedicated to the issue and strengthen the implementation of existing policies and measures. Each member state’s legislature, policies, and action plans were compiled based on information from the nominated experts in this review, the website (http://dinrac.nowpap.org/our-work/marine-litter/related-legal-instruments/), and the previous documents in NOWPAP’s activities. However, there are some discrepancies in the information from various sources, which should be integrated and amended in this report later. Each table in the subsections is originally based on the draft provided by the nominated experts in China and Russia and by the authors in Korea. Table 4.1 summarizes most of the national laws, regulations, and action plans related to marine litter. The bold highlighted ones represent key laws and regulations.

Laws, regulations, and action plans related to marine litter have been improved in four member states. China strengthened the regulations on the import of plastic waste and domestic waste separation. In particular, Japan has a law targeting beach litter, which has been expanded to encompass floating and sunken litter. Korea continues to implement its 5-year action plan targeting marine litter based on a rather general law covering the general marine environment and a new law on marine litter currently pending in the National Assembly. Russia has a new federal and regional law on solid waste (Table 4.1).

Table 4.1 National laws, regulations and action plans related to marine litter in member states

Classification	Laws	Regulations	Notice/Order	Action Plan
China	· **Environmental Protection Law** · **Marine Environmental Protection Law** · Prevention and Control of Environmental Pollution Caused by Solid Wastes · **Law on Prevention and Control of Water Pollution** · Law on Control of Ocean Waste Dumping	· Regulations on the Prevention of Marine Environmental Pollution by Marine Construction Projects · Regulations on Prevention of the Marine Environmental Pollution by the Coastal Construction · Regulations on Prevention of Pollution Damage to the Marine Environment by Land-based Pollutants · Regulations on Strengthening Management of Plastic Package Wastes along Main Roads, in River basins and at Tourist Attractions · Regulations on the Control of Environmental Pollution by Ship-based Wastes · Regulation on the Safety Management of Hazardous Chemicals · Regulations on the Management of Marine Dumping	· **Administrative Measures for the Import of Solid Waste** · **Administrative Measures for Examination and Approval of the Export of Hazardous Wastes**	· **Integrated Reform Plan for Promoting Ecological Progress** · **Water Pollution Control Action Plan** · Coastal Water Pollution Control Plan · Coastal Pollution Prevention and Control Plan · Soil Pollution Prevention and Control Action Plan · Urban Black and Odorous Water Management Battle Plan · Agricultural and Rural Pollution Control · Plan on Prevention and Control of Pollution from Ship and Ports · Yangtze River Protection and Reconstruction Battle Plan · Bohai Comprehensive Management Battle Plan
Japan	· Basic Environment Law (1993); · Basic Act on Ocean Policy (2007); · Waste Management and Public Cleansing	· Cabinet Order of Waste Management and Public Law (Effective date: 24 September 1971; revised on 31 March 2006),		· Basic Plan on Ocean Policy · Plastic Resource Circulation Strategy · Fourth Fundamental Plan

	Law (effective date: 25 December 1970; revised on 02 June 2006), · Law on the Prevention of Marine Pollution and Maritime Disaster (Effective date: 25 February 1970; revised on 19 May 2004 and 30 March 2007), · Seacoast Law (effective date: 12 May 1956; revised on 08 February 2004), · Port and Harbor Law (Effective date: 31 May 1950; revised on 07 June 2006); · **Law for the Promotion of Marine Litter Disposal since July 2009 (revised on 22 June 2018)** · Fundamental Law for Establishing a Sound Material-Cycle Society (2000)	·		for Establishing a Sound Material-Cycle Society (2018) · Basic Policy for the Comprehensively and Effectively Promoting Measures against Marine Litter (revised 2019) · **National Action Plan for Marine Plastic Litter (2019)**
Korea	· Environmental Policy Basic Law (1990), · **Marine Environment Management Act (MEMA) came into force in January 2008 after the revision of Marine Pollution Prevention+F83 Act. Since Jan 2009;** · Waste Management Act (1991); · Coastal Management Act (2000); · Marine and Fisheries Development Basic Law (2002); · Port Management Law (2008); · Act on Marine Environment Conservation and Utilization (enforced on 22 Sep 2017; enacted on 21 Mar 2017)	· **Regulation on the Use of Disposable Plastic Bags**		· **The 3rd National Marine Litter Management Plan (2019~2023)** · **The First Resource Recycling Basic Plan (2018~2027)** · **Comprehensive Plan for Marine Plastics Reduction (2019)** · **Comprehensive measures for Recycling Waste Management (5 Aug 2018)**

	· **Act on the Promotion of Saving and Recycling of Resources (enforced on 21 Jan 2016; enacted on 20 Jan 2015; partial amendment)** · **Resource Circulation Basic Law**			
Russia	· Federal Law on Production and Consumption Wastes (Approved on December 29, 2014); · Regional Law on Production and Consumption Wastes in Primorsky (Approved on June 29, 2009); · Federal Law on Fishery, Water and Biological Resources Preservation (Approved on June 29, 2015).	· Federal Government Regulation on Solid Consumption Waste Management · Federal Government Regulation on Development, Public Discussion, Approval, Correction of Territorial Schemes in the Field of Industry and Consumption Waste Management · Federal Government Regulation on Approval of the Rules of the Arrangement of Accumulation Places of Municipal Waste and Maintaining their Register · Compulsory Regulation on the seaports	· Order of Sakhalinskaya oblast Ministry of Natural Resources and Safety Environment	· Federal Standard of The Best Available Technologies for Resource-Saving, Hierarchical Procedure of the Waste Management

4.1. People's Republic of China

4.1.1. Laws and regulations

In China, several laws and regulations related to marine litter have been reported in the previous reviews (NOWPAP, 2011, 2007). According to the DINRAC website (https://dinrac.nowpap.org), 16 laws and regulations are relevant to marine litter management. Especially the Environmental Protection Law and the Marine Environment Protection Law guide the national practice for marine environmental protection. The Law of Prevention and Control of Environmental Pollution Caused by Solid Wastes is the major legal framework to prevent and control solid waste originated from land-based activities. However, no legislation

targeting marine litter has been developed yet (Table 4.2).

Since 2008, the 'Plastic Limit Order' has been applied to limit single-use plastic bags. The production, sale, and use of plastic bags with a thickness of less than 0.025 mm have been prohibited nationwide. In recent years, several governmental policies have been introduced, which are expected to positively affect the generation of plastic waste and reduce its input into the ocean (Bai et al., 2018). For example, in 2017, 'Banning Import of Foreign Garbage into China' was embodied to promote solid waste import management reform, and the 'Classification of Domestic Garbage in Key Cities' was issued to contribute to the rapid decrease of plastic waste generation.

Table 4.2 Laws and regulations related to marine litter adopted/enacted since 2008 in China

Name of Law and regulation	Main contents	Notes
Law of the People's Republic of China on the Prevention and Control of Environment Pollution Caused by Solid Wastes	The law is enacted to prevent solid waste from polluting the environment, safeguarding human health, maintaining ecological security and promoting sustainable economic and social development.	Revised on Nov.7, 2016
Administrative Measures for the Import of Solid Waste	To regulate the environmental administration of the import of solid waste and prevent environmental pollution caused by imported solid waste, these measures are formulated in accordance with the Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste and other relevant laws and administrative regulations.	Implemented on Aug. 1, 2011
Administrative Measures for Examination and Approval of the Export of Hazardous Wastes	These measures are enacted according to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (hereinafter referred to as the Basel Convention) and relevant laws and administrative regulations for the purpose of regulating the export administration of hazardous wastes and preventing environmental pollution.	Implemented on Mar. 1, 2008
Regulation on the Safety Management of Hazardous Chemicals	This regulation is formulated to strengthen the safety management of hazardous chemicals, prevent and reduce hazardous chemical accidents, guarantee the life and property safety of the general public and protect the environment.	Implemented on Dec. 1, 2011

4.1.2. Action plans

Several action plans are related to marine litter and solid waste management in China (Table 4.3). They are related with water and soil pollution, urban sewage, agricultural and rural pollution, and river/bay protection.

Table 4.3 Action plans related to marine litter and solid waste management in China

Name of action plans	Main contents	Notes
Water pollution control action plan	• Comprehensive control of pollutant emissions • Promote economic restructuring and upgrading • Focus on saving water resources • Strengthening scientific and technological support • Give full play to the role of the market mechanism • Strict environmental law enforcement supervision • Practically strengthen water environment management • Fully guarantee the safety of ecological environment of water • Identify and implement the responsibilities of all parties • Strengthen public participation and social supervision	The State Council issued it on Apr. 2, 2015.
Coastal water pollution control plan	• Promote industrial transformation and upgrading in coastal areas • Gradually reduce land-based pollution emissions • Strengthen the control of marine pollution sources • Protect marine ecology • Prevent environmental risks in coastal waters	The former Ministry of Environmental Protection and other 10 ministries and commissions of the State Council jointly issued it in Mar. 2017.
Soil Pollution Prevention and Control Action Plan	• Conduct soil pollution surveys to grasp the quality of soil environment • Promote legislation on soil pollution prevention and control, and establish a sound system of laws and regulations • Implement agricultural land classification management to ensure the safety of agricultural production environment • Implement construction land access management to prevent human settlement environmental risks • Strengthen the protection of uncontaminated soil and strictly control the newly added soil pollution • Strengthen the supervision of pollution sources and do a good job in soil pollution prevention • Carry out pollution control and restoration to improve the quality of regional soil environment • Increase scientific and technological research and development efforts to promote the development of environmental protection industry • Play the leading role of the government and build a soil environmental governance system • Strengthen target assessment and strict accountability	The State Council issued it on May 28, 2016.
Yangtze River Protection and Reconstruction Battle Plan	• Strengthen the ecological environment control and strictly observe the ecological protection red line • Investigate and rectify the sewage outfall and promote unified supervision of land and water • Strengthen industrial pollution control and effectively prevent ecological environmental risks • Continuously improve the rural living environment and curb agricultural non-point source pollution • Complement the short-term environmental infrastructure to ensure the safety of drinking water sources • Strengthen the prevention and control of shipping pollution and prevent environmental risks in ship ports • Optimize water resource allocation and effectively protect ecological water demand	

	• Strengthen the management and protection of ecosystems and crack down on ecological damage	
Urban black and odorous water management battle plan	• Control source interception • Internal pollution source management • Ecological restoration • Restoring ecological flow	
Agricultural and Rural Pollution Control	• Strengthening the protection of drinking water sources in rural areas • Accelerate the treatment of rural domestic wastewater • Focus on solving pollution in aquaculture • Effective prevention and control of agricultural pollution • Improve the supervision ability of agricultural and rural environment	

4.1.3. Institutional arrangements

The Ministry of Ecology and Environment (MEE) of the Chinese government takes responsibility for marine litter management from 2019, replacing the State Oceanic Administration (SOA) following a restructuring of the Chinese government in 2019. The Ministry of Natural Resources and the Ministry of Housing and Urban-Rural Development are also involved in this issue. The National Marine Environmental Monitoring Center supports marine litter monitoring nationwide (Table 4.4).

Table 4.4 Institutional arrangements (agencies and their roles) in China

Name of agency	Main roles	Notes
Department of Marine Ecology and Environment, Ministry of Ecology and Environment	Responsible for the supervision of the national marine ecological environment. Formulate and organize the implementation of marine and ecological environmental policies, plans, zoning, laws, administrative regulations, departmental rules, standards and norms in national and key sea areas. Responsible for the investigation and evaluation of marine ecological environment. Organize and carry out marine ecological protection and restoration supervision, supervise and coordinate the comprehensive management of key sea areas. Supervise the discharge of land-based pollutants, supervise and guide the installation of sewage outlets into the sea, and undertake the control of marine discharge permits and the total discharge of pollutants in key sea areas. Responsible for the prevention and control of coastal and marine engineering construction projects, marine oil and gas exploration and development and waste marine dumping for ecological pollution protection of marine pollution. Approve the environmental impact assessment documents for coastal and offshore engineering construction projects according to their authority. Manage the dumping area. Supervise and coordinate the national deep-sea ocean and polar ecological environmental protection work. Responsible for	There are 5 institutions: 1. General Office. 2. Marine Ecological Protection and Environmental Quality Management Office (referred to as the Ecological Quality Department). 3. Sea Area Integrated Management Supervision and Coordination Office (Bohai Integrated Management Supervision and Coordination Office) (referred to as the Marine Area Management Office, Bohai Office). 4. Marine pollution prevention and control supervision (referred to as one supervision). 5. Marine Pollution Prevention and

	the domestic implementation of relevant international conventions.	Control Regulation 2 (referred to as Supervision 2).
Department of Solid Wastes and Chemicals, Ministry of Ecology and Environment	Responsible for the supervision and management of pollution prevention and control of solid waste, chemicals and heavy metals nationwide. Formulate and organize the implementation of relevant policies, plans, laws, administrative regulations, departmental rules, standards and norms. In charge of hazardous waste management licenses and export approval, solid waste import licenses, import and export registration of toxic chemicals and environmental management registration of new chemical substances. Responsible for domestic implementation of relevant international conventions.	There are 3 divisions: 1. General Office. 2. Solid waste (referred to as solids). 3. Chemicals division.
Department of Marine Strategic Planning and Economics, Ministry of Natural Resources	Formulate major strategies for the development of marine powers such as marine development, deep sea and polar regions and supervise their implementation. Formulate and supervise the implementation of marine economic development, comprehensive protection and utilization of coastal zones, protection and utilization of sea areas, and integration of marine and civilian development. Undertake the development of marine emerging industries such as seawater desalination and comprehensive utilization, marine renewable energy. Carry out comprehensive monitoring, statistical accounting, investigation and evaluation and information release of marine economic operations.	
Sea Island Management Division, Ministry of Natural Resources	Formulate policies and technical specifications for the use of sea areas and island protection and supervise and manage the development and utilization of islands in the sea area. Organize the monitoring and evaluation of sea area island surveillance, and manage the unnamed islands, sea areas, seabed topographic names and submarine cable pipelines. Undertake the review and approval of the sea and island used for approval by the State Council. Organize and formulate special-purpose island protection management policies such as territorial sea points and supervise implementation.	
Urban Construction Department, Ministry of Housing and Urban-Rural Development	Formulate development strategies, medium and long-term plans, reform measures, and regulations for urban construction and municipal public utilities; guide urban water supply, water conservation, gas, heat, municipal facilities, gardens, city environment management, urban construction supervision, etc.; guide urban sewage treatment facilities Support construction with the pipeline network; guide the greening work in the urban planning area; undertake the work related to the national-level scenic spots, the World Natural Heritage Project and the World Natural and Cultural Double Heritage Project.	

4.2. Japan

4.2.1. Laws and regulations

In Japan, the national law on marine litter enacted in 2009 provides an overall national framework for addressing the issue (Table 4.5). Based on the law, the government provides financial support to local governments (prefectures) to remove marine litter along Japanese coasts. The total amount of the removed litter amounted to approximately 31 thousand tons in the fiscal year 2016. In June 2019, this law was strengthened, adding floating and seabed litter to the scope of the law, along with new measures for microplastic management, such as controlling the use of microplastics in products. The "Basic Policy for the Comprehensively and Effectively Promoting Measures against Marine Litter " based on the law was revised in May 2019. Moreover, 'National Action Plan for Marine Plastic Litter' was developed, and based on the 4th National Plan for a Sound Material-Cycle Society, a new 'Resource Circulation Strategy for Plastics' was developed.

Table 4.5 Laws and regulations related to marine litter adopted/enacted since 2008 in Japan

Name of Law and regulation	Main contents	Notes
Law on Promoting the Treatment of Marine Debris Affecting the Conservation of Good Coastal Landscapes and Environments to Protect Natural Beauty and Variety (Law for the Promotion of Marine Litter Disposal)	• The law was enacted to conserve good landscapes and environments, by promoting smooth removal action and effective reduction of marine litter generation. • To clarify the respective responsibilities of relevant organizations (national government, local government, coast administrator, etc). • To provide a basic policy for marine litter to make local government (prefectural level) regional plans for marine litter. • To organize the 'Promotion Council of Marine Litter Policy' within the government (secretariat: Ministry of Environment). • To provide a budget for subsidy projects for cleaning along the coast.	Enforced in 2009 and revised in June 2018 (efforts to suppress the use of microplastics in products and to curb the emission of plastic waste were made mandatory for businesses).

4.2.2. Action plans

The Japanese government developed an action plan to promote to reduce, reuse, recycle and renewable on plastic. "In addition, the "National Action Plan for Marine Plastic Litter" was developed focusing on preventing the discharge of plastic litter to the oceans (Table 4.6).

Table 4.6 Action plans related to marine litter and solid waste management in Japan

Name of policies	Main contents
Plastic resource circulation strategy	<Reduce> 1. Cumulative reduction of 25% of single-use plastics by 2030 <Reuse/Recycle> 2, Reusable/recyclable design by 2025 3. Reuse/recycle 60% of containers and packaging by 2030 4. 100% effective use of used plastics by 2035 <Recycling and Bio-Plastics> 5. Double the use of recycled amount by 2030 6. Introduce 2 million tons of bio-plastics by 203
National Action Plan for Marine Plastic Litter	Reduction of additional pollution by plastics 1. Promoting proper waste management systems 2. Preventing littering, illegal dumping and unintentional discharge of litter 3. Collecting scattered waste on land 4. Removing plastic litter from the ocean 5. Innovating through development and conversion of alternative materials 6. Collaborating with stakeholders 7. Cooperating internationally to promote measures in developing countries 8. Understanding actual conditions and accumulating scientific knowledge

4.2.3. Institutional arrangements

Ministry of Environment in Japan is the leading institution, and five other ministries and agencies are involved in marine litter management (Table 4.7).

Table 4.7 Institutional arrangements (agencies and their roles) in Japan

Name of agency	Main roles
Ministry of Environment	The Secretariat of the 'Promotion Council' in order to manage the affairs of the council • Responsibility for Management of Marine litter (excluding matters related to other ministries) • Responsibility for waste management (the Waste Management and Public Cleaning Act etc.) and establishment of a sound material-cycle society (including promotion of Recycling system etc.)
Ministry of Economy, Trade and Industry	Industrial activities
Ministry of Agriculture, Forestry and Fisheries	Fishery-based litters, shrubs from mountains
Ministry of Land, Infrastructure, Transport and Tourism	Riverside litter, debris in Port and Sea Route area
Japan Meteorological Agency	Research for plastic debris
Japan Coast Guard	Public awareness for marine environment conservation

4.3. Republic of Korea

4.3.1. Laws and regulations

In Korea, the Marine Environment Management Act is the major legal framework most closely involved with sea-based litter. The Act on the Promotion of Saving and Recycling of Resources is one of the most important legal frameworks regarding single-use plastic waste from land-based activities (Table 4.8).

Table 4.8 National laws and regulations adopted/enacted since 2008

Name of Law and regulation	Main contents	Notes
Environment Policy Basic Law (1990)	Providing the overall supervision of management of the environmental protection	
Act on the Promotion of Saving and Recycling of Resources	Promoting the use of recycled resources by means of controlling the generation of wastes and facilitating recycling.	[Enforcement Date 21. Jan 2016.] [Act No.13036, 20. Jan 2015., Partial Amendment]
Resource Circulation Basic Law (2018)	Providing the overall supervision of sustainable resource circulation	
Waste Management Act (1991)	Concerning the collection and treatment of industrial and household wastes	
Marine Environment Management Act	Aiming to prevent the marine and coastal environment from hazardous pollutants (mainly from ships) such as oil, sewage and garbage.	
Coastal Management Act (2000)	Aiming towards the sustainable use of the coastal environment, including beaches and public swimming areas, and regulates coastal construction.	
Marine and Fisheries Development Basic Law (2002)	Setting forth basic principles for the development of ocean-related industries including fisheries.	
Port Management Law (2008)	Prohibiting the discharge of waste in the port area for safe navigation and describing the development, maintenance and management of ports and their facilities	
Act on Marine Environment Conservation and Utilization (2017)	Providing the basic direction of the policy on the conservation and utilization of the marine environment and its establishment and implementation system.	[Enforcement Date 22. Sep 2017.] [Act No. 14746, 21. Mar 2017., Enacted]
Law on Marine Waste and Polluted Deposit Management (2019)	Prescribing matters necessary for the environment-friendly and systematic management of marine wastes and marine polluted deposits.	[Enforcement Date 4 Dec 2020] [Act No. 17110, 24 March 2020., Enacted]
Regulation on the Use of Disposable Plastic Bags	Prohibiting plastic bags at supermarkets (larger than 165 m^2) and bakeries	[Enforcement Date 1 April 2019 for plastic bags at supermarkets] [Enforcement Date 1 Jan 2019 for plastic bags at bakeries]

4.3.2. Action plans

In Korea, the 2nd National Marine Litter Management Plan (2014~2018) was the major plan to implement governmental actions. It is established every 5-years. The 3rd plan was established in 2018, which will be implemented from 2019 to 2023 (Table 4.9).

Table 4.9 Action plans related to marine litter and solid waste management in Korea.

Name of action plans	Main contents	Notes
The 3rd National Marine Litter Management Plan (2019~2023)	Strategies include 1) Prevention of generation, 2) Improvement of collection and transportation system, 3) Promotion of treatment and recycling, 4) Strengthening the management base and raising public awareness	
The first resource recycling basic plan (2018 ~ 2027)	Vision aims to realize a sustainable circular economy through a virtuous circle of resources. The goal is to reduce waste generation by 20% compared to GDP by 2027 and to increase the recycling rate (actual recycling rate) from 70% to 82%.	[Reported to the State Council 24. Sep. 2018]
Comprehensive Measures for Recycling Waste Management (5 Aug 2018)	Goals by 2030: 50% reduction of plastic waste generation; increase of plastic waste recycling from 34% to 70%	
Comprehensive Plan for Marine Plastics Reduction (May 2019)	Goals by 2030: 50% reduction of standing stock of marine litter through managing full lifecycle of marine plastics from generation to collection and treatment; Improving marine plastics management system and expand participation of the general public Major areas: reduction measures by source; improving marine plastics collection/transportation system; promoting treatment/recycling of marine plastics; improving legal basis for management and public awareness	

4.3.3. Institutional arrangements

The Ministry of Oceans and Fisheries and the Ministry of Environment in Korea are the leading institutions. The Korea Marine Environment Management Corporation, as a public company, is also an important agency to implement the governmental action plan. The Korea Maritime Institute also plays a key role in supporting policy development (Table 4.10).

Table 4.10 Institutional arrangements (agencies and their roles) in Korea

Name of agency	Main roles	Notes
Ministry of Oceans and Fisheries (MOF)	Leading ministry in marine litter management (enacting and establishing policies)	
Ministry of Environment (ME)	Leading ministry in waste management (enacting and establishing policies) / single-use plastic waste	
Korea Coast Guard (KCG)	Fishermen awareness / ship safety guide	
Korea Marine Environment Management Corporation (KOEM)	Implementing the marine litter management policies	Public company
Korea Fishing Infrastructure Public Agency (FIPA)	Implementing the marine litter management projects in fishing villages and ports	Public agency
Korea Maritime Institute (KMI)	Developing management and policies	Research institute
Korea Institute of Ocean Science and Technology (KIOST)	Research and development on microplastics	Research institute
National Institute of Fisheries Science (NIFS)	Developing biodegradable fishing gears	Supporting agencies

4.4. Russian Federation

4.4.1. Laws and regulations

In Russia, progress has been made in legislative areas, with federal laws such as the law on Production and Consumption Wastes being approved on December 29, 2014. The Fishery, Water and Biological Resources Preservation law was approved on June 29, 2015. The Regional Law on Production and Consumption of Wastes in Primorsky within the NOWPAP region was approved on June 29, 2009 (Table 4.11).

Table 4.11 Laws and regulations related to marine litter adopted/enacted since 2008 in the Russian Federation

Name of Law and regulation	Main contents	Notes
About modification in "Production and Consumption Wastes" Federal Law, certain statutes of the Russian Federation and declare certain statutes (position of statues) invalid, Federal Law No. 458-FZ, approved on December 29, 2014	The terminologies connected with waste are changed. For example, 'the waste processing' means their preparation for further utilization. The sorting, disassembly and cleaning of waste are included in a range of works on their processing. The 'waste neutralization' definition is introduced. It means the measures for decreasing the negative impact of waste on human health and the environment. The procedure of the waste accumulation is regulated. The term of the waste warehousing is established. Item concerning the waste separation is added. Licensing of all types of the activity concerning the	

	waste management is provided. The ecological fee for the manufacturers who do not provide their own recycling is introduced. The decreasing coefficients for the enterprises making packing and goods from secondary raw materials are introduced. The common regional operator according to the waste management in each territorial unit of the Russian Federation is organized. Each territorial unit of the Russian Federation is obliged to develop the program in the field of waste management and the territorial scheme.	
"Production and Consumption Wastes" Primorsky region law No. 447, approved on June 29, 2009	The document approves the Primorsky krai Administration authority in the field of waste management including the procedure of maintaining the regional waste inventory and the adoption of the solid municipal waste accumulation (including waste separation).	
About modification in "About fishery and water biological resources preservation" Federal Law No 208-FZ, approved on June 29, 2015	The document makes changes to the "About Fishery and Preservation of Water Biological Resources" Federal law No 166-FZ approved on December 20, 2004 concerning the ban on the drift net fishing in the Russian Federation sea waters.	
RF Government Regulation "About solid consumption waste management" No. 1156 dated November 12, 2016	The document approves rules for the handling of waste including procedures for the accumulation, collection, transportation, processing, utilization, neutralization and storage.	
National standard of the Russian Federation "The best available technologies. Resource-saving. A hierarchical procedure of the waste management" RF GOST (National Standard) R56828.31-2017	The document outlines provisions to use for the decision-making process for ecologically safe and economically acceptable industrial and consumption waste handling.	
RF Government Regulation "About the development, public discussion, approval, correction of territorial schemes in the field of industrial and consumption waste management, including with solid consumption waste and also about requirements to structure and contents of such schemes" No. 1130 dated September 22, 2018	The document presents the development, public discussion, approval and correction of territorial schemes in the field of industrial and consumption waste management, including solid consumption waste and also outlines requirements on the structure and contents of such schemes.	
RF Government Regulation "About the	The document defines the procedure for municipal waste accumulation sites/building including the rules of	

approval of the Rules of the arrangement of accumulation places (sites) of the municipal waste and maintaining their register" dated August 31, 2018 No. 1039	setting up the places (sites), the specifications of registration, and maintenance.	
RF President decree "About the creation of the on-the-record company 'The Russian ecological operator' on the formation of a municipal waste management complex system" dated January 14, 2018 No 8	"The Russian ecological operator" company is created for the purpose of the formation of a municipal waste management complex system, support of this system management, prevention of the harmful effects on human health and the environment, involvement of the waste products in economic circulation as raw materials and secondary raw materials for new products and energy production. The document defines the Operator functions and the authorities.	
Compulsory regulations for some seaports of Russian Far East. Approved by the orders of Ministry of Transport of the Russian Federation	The document contains the description of the seaport, the rule of vessel calls and vessels navigation and also the rules of environmental safety including the waste management on the 13 seaports of Far East Russia	Vostochiy, Nakhodka, Kholmsk, DeKastri, Posiet, Vanino, Shakhtersk, Zarubino, Korsakov, Vladivostok, Olga, Nevelsk, Sovetskaya Gavan.
The order of the Sakhalinskaya oblast, the Ministry of Natural Resources and Environment dated May 05, 2015 No. 22 "On approval of the procedure of maintaining regional cadastre of industrial and domestic waste in Sakhalinskaya oblast"	The document establishes procedures for collecting, processing, storage, systematization and providing information on the waste types included in the regional classification catalog. Data on the subjects of waste placement located in the region and subjects on the neutralization of the waste operated in the territory of the Sakhalin oblast.	

4.4.2. Action plans

The territorial scheme on the circulation of waste in Russia was approved in the three regions Primorsky, Khabarovsky and Sakhalinskaya which belong to the NOWPAP region (Table 4.12).

Table 4.12 Action plans related to marine litter and solid waste management in Russia

Name of action plans	Main contents	Notes
The territorial schemes of the circulation of waste in some regions of Russian	The documents approve the territorial schemes of the circulation of waste including solid domestic waste in Primorsky krai, Khabarovsky	In present time, materials of Primorsky krai are undergoing public discussion

Name of action plans	Main contents	Notes
Far East	krai and Sakhalinskaya oblast.	and aren't approved.

4.4.3. Institutional arrangements

The Ministry of Natural Resources and Environment and the Ministry of Transport in Russia are responsible for marine litter issues (Table 4.13).

Table 4.13 Institutional arrangements (agencies and their roles) in Russia (Adapted from NOWPAP (2011)

Name of agency	Main roles	Notes
Ministry of Natural Resources and Environment (MNRE)	Responsible for marine environmental protection issues including the management of biological resources.	
Ministry of Transport (MOT)	In charge of shipping-related issues including safe navigation of ships.	
Administrations of Sea Ports	Responsible for merchant shipping-related issues in subordination to MOT.	

Chapter 5 . OVERVIEW OF PROGRESS IN IMPLEMENTING RAP MALI PRIORITIES

At the national level, progress in the implementation of RAP MALI between 2012 and 2018 was discussed with the baseline assessment of the 2nd regional overview by NOWPAP RCU (NOWPAP, 2011). RAP MALI consists of three components:

1. Prevention of marine litter input to the marine and coastal environment
2. Monitoring of marine litter quantities and distribution
3. Removing existing marine litter and its disposal

The following tables describe how the four member countries have implemented RAP MALI in each country (Table 5.1).

Preventive actions in RAP MALI include improving waste management practices, supporting beach cleanup activities and public awareness programs. The member states have been more active in implementing various activities to prevent marine litter than ever.

In the context of monitoring, macro-sized beach litter has been monitored for a long time in China and Korea along the coastline nationwide. Korea is an excellent example of prioritizing its policy on marine litter from beach litter monitoring results. The clear decreasing trend in the number, weight, and beach litter volume was shown in the 10-year result analysis (Hong et al., 2018). In the case of Japan, monitoring has started relatively recently, and surveys are being conducted at a rather small number of sites compared to its coastline. Russia somewhat lacks in the survey of beach litter. As for the floating litter, China and Japan are conducting extensive surveys on large-scale marine litter, while there is little data in Korea and Russia. As for microplastics, all member states are actively conducting research, Korea and China are more active than other states. Sea bottom litter has also been monitored for a long time in China and Korea.

Removal is the most common way to reduce existing marine litter in each country. Beach and sea bottom cleanups are most active in Korea. Supporting beach and sea bottom cleanups of local governments is also active in Japan.

Table 5.1 Identification of priorities of RAP MALI by the authors in this study to find gaps for improvement of RAP MALI implementation (A: actively on going, O: on going, P: in preparation, -: not known)

Category	Subcatego-ries	China	Japan	Korea	Russia	Notes
1. Prevention of ML input to marine and coastal environment	1.1. Legal and administrative instrument	A	A	A	A	
	1.2. Wise management of ML	A (Mainly land-based ML, classification of domestic solid waste)	A (Mainly land-based ML)	A (Mainly sea-based ML, Buyback of derelict fishing gear; subsidies to replace expanded polystyrene buoys into durable ones; floating reception barges to retrieve DFG by fishermen)	A (Mainly land-based ML, waste sorting)	
	1.3. Information, education, outreach and public awareness	O	A	A	O	
	1.4. Cooperation with civil society	O	A	A (Citizen science projects: national beach debris monitoring and rapid assessment of beach pollution)	A	
	1.5. Research activities	P	O	A (Research on biodegradable fishing nets, gear marking, impact on navigation safety, microplastic in seafood)	P	Technology to prevent booms, etc
2. Monitoring of ML quantities and distribution	2.1. ML monitoring using NOWPAP guideline	A (The second national survey of pollution sources, the first program started in 2007, focusing macro on beach, in seawater and on sea bottom)	A (Large-size litter on beach and seawater, floating microplastics)	A (Beach litter monitoring nationwide (2008~) at 40 sites, 6 times a year with trained citizen scientists	A (Beach litter monitoring (2014~) and river, floating, and beach microplastic surveys (2017~))	
	2.2. Maintenance of ML database	O	O	O	A (The latest data: 2015 (ICC results))	DINRAC database
	2.3. Compilation	O (Potential contributor:	O (Potential contributor:	O (Potential contributor: Marine	O (primorsky.ru)	Important but not

	of data from national monitoring program	National Marine Environmental Monitoring Center)	JMA (www.data.jma.go.jp, floating ML)	Litter Management Center: www.malic.or.kr)		implemented
	2.4. Regular assessment of current situation and trends of ML quantities and distribution	A (Long-term trend in beach, floating, and sea bottom ML) (mega and macro) Floating microplastic since 2016	A (Long-term trend of floating mega litter)	A (Annual report of beach macro litter monitoring since 2008 shows long-term decreasing trend.)	-	
3. Removing existing ML and its disposal	3.1. Beach cleanup campaigns	A (ICC campaigns; not posted data)	A (ICC campaigns; not posted data)	A (ICC campaigns; not posted data)	A (ICC campaigns; not posted data)	
	3.2. Removal of existing ML	P	A (Active removal of beach ML: The effects of the subsidy project were visualized using Web GIS) (www.msil.go.jp)	A (Active removal of beach, floating, and sea bottom ML: malic.or.kr)	P	
	3.3. Research activities related to ML	P	P	A	P	Research on treatment and disposal
4. Others		Microplastic research (distribution and impact)	Microplastic research (distribution and trajectory)	Microplastic research (distribution and impact)	Microplastic research (distribution)	

5.1. People's Republic of China

5.1.1. Prevention of marine litter input to the marine and coastal environment

In 2008, China began to regulate single-use plastic bags (thinner than 0.025mm), and in 2014 the government began strengthening regulations, such as the prohibition of fishing equipment and vessels that easily cause derelict fishing gears. Various voluntary marine litter reduction campaigns are underway (Table 5.2).

Table 5.2 Prevention of marine litter input in China

Name of program or action	Contents
Notice of the General Office of the State Council on restricting the production and sale of plastic shopping bags	From June 1, 2008, it is prohibited to produce, sell and use plastic shopping bags with a thickness of less than 0.025 mm nationwide. Since June 1, 2008, it is prohibited to provide free plastic shopping bags in all supermarkets, shopping malls, bazaars and other retail outlets
Notice on the Prohibition of the Use of Thirteen Fishing Gears, such as Double Ship Single-Piece Multi-Tag Trawl	Since Jan. 1, 2014, 13 fishing vessels such as double-ship single-chip poly-tank trawls have been banned in the Chinese sea areas of Bohai Sea, Yellow Sea, East China Sean and South China Sea.

5.1.2. Monitoring of marine litter quantities and distribution

The first survey of China's national marine litter was launched in 2007 including the beach, floating, and sea bottom litter. The second survey is being implemented in 2017. The China Environmental Statistics Yearbook, the coastal water quality bulletin board, etc., are also expected to produce marine litter information (Table 5.3).

Table 5.3 Programs and actions to prevent marine litter from entering seas (including microplastics) and sustainable waste management adopted/enacted since 2008 in China (draft provided by the nominated expert for this report).

Name of program or action	Contents
The first national survey of pollution sources	In order to implement the scientific development concept, strengthen environmental supervision and management, understand basic information about various enterprises and institutions related to the environment, establish and improve various key pollution source files and pollution source information databases at all levels, and provide evidence for economic and social policies, the State Council decided to carry out the first national survey of pollution sources. The standard time for the census is December 31, 2007, and the period is 2007. The census targets are industrial pollution sources (hereinafter referred to as “industrial sources”), agricultural pollution sources (hereinafter referred to as “agricultural sources”), domestic pollution sources (hereinafter referred to as “living sources”) and centralized pollution control facilities. The census includes the basic conditions of various types of pollution sources, the generation and discharge of major pollutants, pollution control, etc.

The second national survey of pollution sources	According to the "Regulations on the National Survey of Pollution Sources", the State Council decided to launch the second national survey of pollution sources in 2017. The census object was a unit with a source of pollution and an individual business owner within the territory of the People's Republic of China. The scope includes industrial pollution sources, agricultural pollution sources, domestic pollution sources, centralized pollution control facilities, mobile sources and other facilities that generate and discharge pollutants. The census included basic information of census objects, types and sources of pollutants, generation and discharge of pollutants, construction and operation of pollution control facilities. The census standard time was December 31, 2017, and the period is 2017. From the fourth quarter of 2016 to the end of 2017, it was the preparatory stage of the census, focusing on the preparation of census plans, the pilot of census work, and publicity and training. In 2018, during the comprehensive census phase, local organizations conducted censuses, formed a census database through step-by-step review, and completed the census at the end of the year. In 2019, it was the summary release stage, focusing on the work of census work acceptance, data aggregation and results release.
China Statistical Yearbook on Environment	It is an annual comprehensive statistical data compiled by the National Bureau of Statistics and the Ministry of Ecology and Environment and other relevant ministries and commissions to reflect the basic situation of various fields in China's environment. It contains basic data of various fields in the provinces, autonomous regions and municipalities directly under the Central Government, and major national environmental statistics in major years. The content is mainly divided into twelve parts, namely: 1. natural conditions; 2. water environment; 3. marine environment; 4. atmospheric environment; 5. solid waste; 6. natural ecology; 7. land use; 8. forestry; 9. natural disasters and emergencies; 10. environmental investment; 11. urban environment; 12. rural environment.

5.1.3. Removing existing marine litter and its disposal

Charity events to clean beach litter have been implemented in collaboration with various groups of people in the International Coastal Cleanup season (Table 5.4).

Table 5.4 Action for removing existing marine litter and its disposal in China

Name of program or action	Contents
Clean Beach nationwide, Care for the Blue -2015 Campaign	The Dalian Environmental Protection Volunteers Association launched an environmental public welfare campaign with the theme of “Clean Beach Nationwide, Care for the Blue”. More than 230 environmental volunteers and students from primary and secondary schools participated in the event.
Connecting with heart and care for the blue -2016 Campaign	On Sep. 17th, the International Beach Cleaning Day, the Dalian Environmental Protection Volunteers Association held a clean-up and investigation of coastline marine litter with the theme of “Connecting with Hearts and Protecting Blue” at Xinghai Bay Beach. More than 120 students from Dalian 24 Middle School and their parents, employees and their families from Shanghai Overseas Service, and environmental protection volunteers participated in the event.
Beautiful Ocean, Clean Beach – 2017 Campaign	Supported by the Department of Ecology and Environmental Protection of the State Oceanic Administration, sponsored by the China Ocean Development Foundation, the National Oceanic Administration Publicity and Education Center, the China Youth Volunteers Association, the National Marine Environmental Monitoring Center, the Liaoning Provincial Ocean and Fisheries Department, and the Dalian Environmental Protection Volunteers Association, the Dalian City Construction Bureau's Landscape Architecture Department organized this campaign.

Guarding the beautiful beaches · We act together – 2018 Campaign	Sept. 15th 2018 was the 33rd International Coastal Cleanup Day. A celebration event was organized by the Dalian Environmental Protection Volunteers Association, the China Ocean Development Foundation, and the China Ocean Development Volunteers Association to promote marine environmental protection, and raise awareness. The main event was held at the Fujiazhuang Park Beach. This is a three-dimensional salvage and environmental protection activity to collect waste on the beach, sea and seabed. More than 1,000 environmental volunteers and citizens from all walks of life witnessed the launch of the event.

5.1.4. Others (R&D, etc)

In China, research and development projects on microplastic distribution, accumulation, impact and management are underway (2016-2020) (Table 5.5).

Table 5.5 Research and development projects in China

Name of program or action	Contents	Notes
The National Key Research and Development Program of China: Research on Marine Microplastics Monitoring and Eco-Environmental Impact Assessment Technology	The typical estuary (Changjiang Estuary, Pearl River Estuary), Bohai Sea, Yellow Sea, East China Sea and China's coastal key beaches are selected as research areas, focusing on marine micro-plastic pollution monitoring, ecological risk assessment and source control technology. 1. Develop marine microplastic monitoring techniques, source tracing techniques and drift diffusion model; 2. Study the accumulation and transmission of micro-plastics and adsorbed pollutants in the food chain, the ecotoxic effects and mechanisms of micro-plastics, and the micro-plastic propagation of harmful attached organisms; 3. Establish marine microplastic ecological risk assessment techniques; 4. Develop and control marine micro-plastic pollution source control and management techniques.	From June 2016 to December 2020

5.2. Japan

5.2.1. Prevention of marine litter input to the marine and coastal environment

Various measures for outreach and education to reduce the generation of marine litter in Japan have been conducted. Establishing signboards, distribution of brochures and posters, seminars, campaigns and events, patrols, international exchange, web sites and SNS, education in schools, and cooperation with NPO/NGOs are included.

5.2.2. Monitoring of marine litter quantities and distribution

Japan (Ministry of Environment) continues supporting active monitoring program for beach litter, floating macro and microplastic litter and seabed litter (Table 5.6).

Table 5.6 Monitoring of marine litter in Japan

Name of program or action	Contents	Notes
Marine litter monitoring on the coasts	Marine litter monitoring is conducted on 28 coasts for 5 years. Information concerning the amount, items, composition and languages on the label (showing the origin), etc. of marine litter is collected and classified.	
Visual observation of floating marine litter	Floating marine litter is observed visually from vessels in coastal waters and open oceans. Density and amount of marine litter are estimated on each ocean.	
Seabed marine litter survey	Seabed marine litter is monitored with a trawl net in coastal waters and open oceans. Density and amount of marine litter are estimated.	
Floating microplastic survey	Microplastics survey is conducted to promote research on marine pollution. Distribution of microplastics around Japan, amount of hazardous chemical substances such as PCB adsorbed on microplastics are surveyed.	Researchers and 5 vessels from Tokyo University, Nagasaki University, Kagoshima University, and Hokkaido University

5.2.3. Removing existing marine litter and its disposal

Based on the law (2009), the central government has invested US$ 198 million from 2009 to 2016. The budget has been used for cleanups along the coasts and generation reduction efforts (Table 5.7). From 2015, the removal of drifting and seabed litter was added to the targets for subsidies. Local governments wishing to receive a portion of the central government's budget should establish and submit a plan for marine litter cleanup and generation reduction. The central government subsequently provides subsidies accordingly, and the local government reports the results to the central government after the distribution of the budget.

Table 5.7 Budget and amount of removed marine litter in Japan

Year	2009	2010	2011	2012	2013	2014	2015	2016
Budget (Thousand US$)	54,182				90,800		25,910	27,272
Amount of removed litter (ton)	11,760	17,584	43,058	6,617	34,610	43,259	30,611	31,141

*source: presentation in the NOWPAP workshop in 2018

The effects of the subsidy project for coastal cleanups were visualized using Web GIS (Figure 5.1). The input data is released on the web sites where users can see where the coast was cleaned, and how much litter was collected on the coast. The collected information is useful to make future cleanup plans.

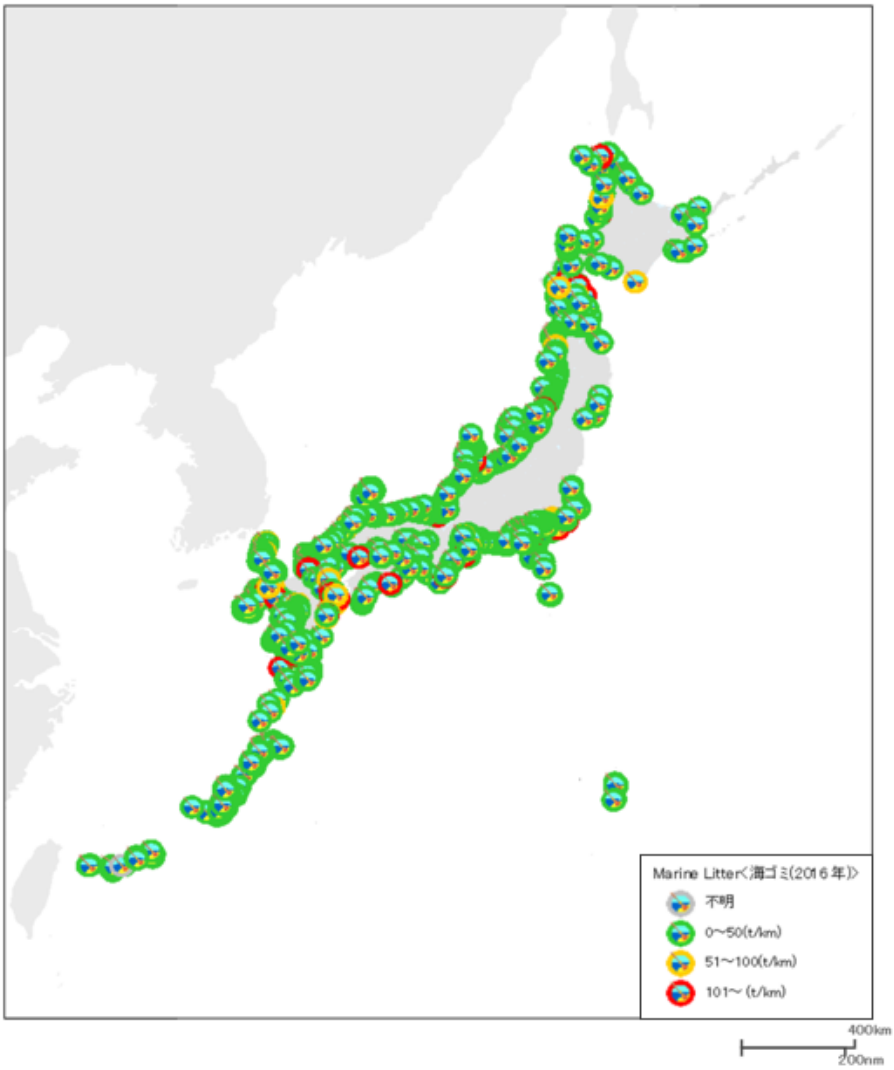


Figure 5.1 The map shows density of beach litter (ton/km) collected with the governmental subsidy (in 2016). Green: low, yellow: middle, and red: high density (https://www.msil.go.jp/ msil/Htm/main.html?Lang=1).

5.2.4. Others (R&D, etc)

Since 2016, the Ministry of Environment has supported an international project on harmonizing monitoring methodologies on marine microplastics, which focuses on comparisons of net

sampling in the ocean using various methodologies. The project goals are to identify harmonized technical parameters and to consider minimum requirements and specific needs for the analysis. In the fiscal year 2017, Japan conducted a joint analysis of standard samples with 12 institutions from 10 countries, including the NOWPAP member states. Recommendations and guidelines on monitoring microplastics in the ocean have been published in May 2019 and revised in June 2020.

5.3. Republic of Korea

5.3.1. Prevention of the marine litter input to the marine and coastal environment

The 2nd National Marine Litter Management Plan (2014~2018) consists of four management tasks: 1) to manage the sources of marine litter and solid waste, 2) to strengthen the capacity for collecting and treating marine litter, 3) to establish a basis for marine litter management and 4) to increase citizen participation in and strengthen international cooperation on reducing and managing marine litter. Tasks 1, 3, and 4 are closely related to the prevention of marine litter (Table 5.8).

Land-based marine litter was retrieved by the Ministry of Environment (ME), and local governments shared the cleanup cost. The regulation of single-use plastics has been strengthened by ME.

An integrated management system for derelict fishing gear, including EPS buoys, has been developed as a research project, and the replacement of EPS buoys into durable buoys is underway. Floating barges for the volunteer collection of ML by fishermen have been distributed by the Ministry of Oceans and Fisheries (MOF).

Table 5.8 Prevention of marine litter input in Korea

Name of program or action	Contents	Notes
Land-Based		
Prevention of marine litter through river and estuary	Cleanups around rivers and estuaries through collaboration among local agencies	ME with local governments
Regulations on single use plastics	Identifying the responsibilities of business operator's on controlling the use of disposable products and prohibit providing disposable products free of charge	ME
Regulation on Microbeads	Banning the use of Microbead in product types such as cosmetics (for rinse-off, scrub, etc.) and sanitary aids (gargle, toothpaste, and teeth whitening)	Ministry of Food and Drug Safety
Public awareness campaign on marine litter	Advertisements using mass media	MOF (KOEM)
Sea-Based		

Strengthen management of used styrofoam buoy	Establishing the integrated management system for styrofoam buoy	MOF
Dissemination of biodegradable fishing gears	Development of biodegradable fishing gears and supporting fishermen to purchase the gear with subsidies	MOF (NIFS)
Clean Fishery Communities Program	Voluntary bring-back and cleanup of marine litter by fishery villages	MOF (KCG)
Marine Litter Collection by Floating Receptacles	Installation of deck barges in fishery ports for collecting marine litter from fishing boats	MOF (Local government)
Developing education materials on marine litter	School teacher guides and lecturer manual for fishermen	MOF (KOEM)

5.3.2. Monitoring of marine litter quantities and distribution

Monitoring of marine litter along the coastline of Korea has been conducted since 2008. The Korea National Beach Litter Monitoring Program (hereafter, monitoring program) was completed at the end of 2017 as Phase I. The 2nd Phase started in 2018 with a slight modification of the survey protocol. The information collected by the monitoring program has been uploaded to the online database system (www.malic.or.kr), and all data is available to the public. The data analysis result is reported at the end of every year and is an example of the best practice of citizen science (Hong et al., 2018). Seafloor surveys on deposited marine litter have been implemented from 2012 to 2016.

Table 5.9 Monitoring of marine litter in Korea

Name of program or action	Contents	Notes
Korea National Beach Litter Monitoring Program	Survey of beach litter in 40 sites around Korea (every other month) (20 sites from 2008~2014; 40 sites since 2015)	MOF (KOEM, NGOs) Citizen science with quality control

5.3.3. Removing existing marine litter and its disposal

Removal of existing marine litter is most active in Korea (Table 5.10). The information on the amount of collected litter through various programs is open to the public (www.marlic.or.kr). The collected amount of marine litter through various removal programs in Korea is shown in Figure 5.2.

Table 5.10 Removing existing marine litter and its disposal in Korea

Name of program or action	Contents	Notes
Land-based		
Collection and disposal of disaster litter	Collection and disposal of marine litter after disasters (typhoon, flood, etc.)	MOF (KOEM)
Sea-based		

Sea-bed litter cleanup	Retrieval of sunken litter from ports and designated areas for marine conservation	MOF (KOEM)
Ports cleanup	Management of floating and sunken litter in port areas	MOF (KOEM, FIPA)
Coastal cleanup	Cleanups in beaches and seashores	MOF (Local government)
Fishing ground cleanup	Cleanups in fishing grounds including Buy Back program, retrieval of illegal fishing gears	MOF (FIPA)

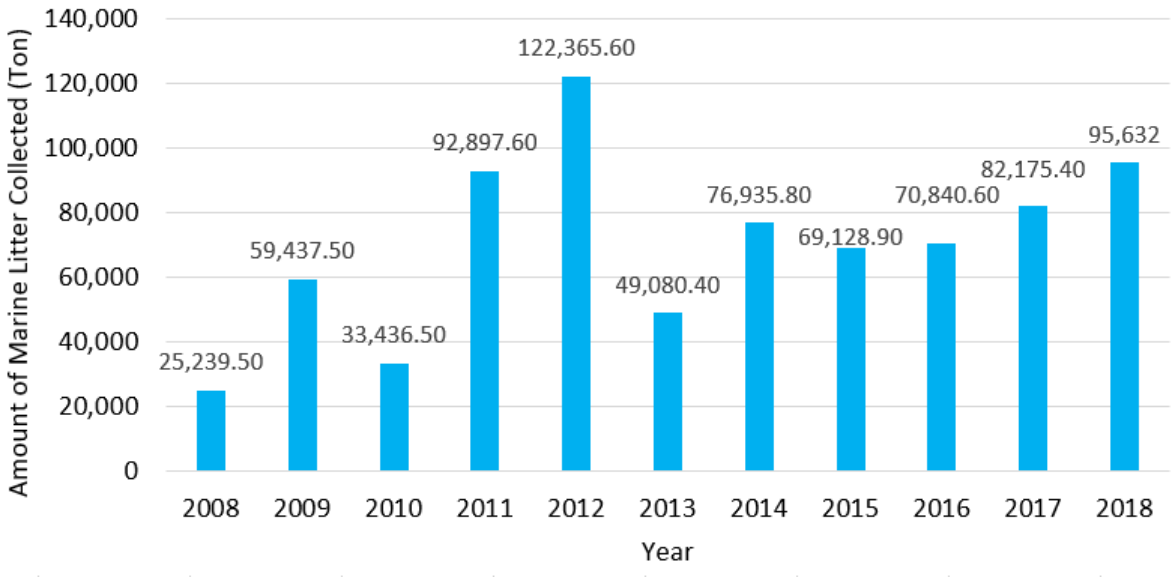


Figure 5.2 Collected amount of marine litter through various removal programs in Korea (www.malic.or.kr)

5.3.4. Others (R&D, etc)

Research and development projects on microplastics have been actively conducted in Korea (Table 5.11).

Table 5.11 Research and development projects on microplastics in Korea

Name of program or action	Contents	Notes
Environmental Risk Assessment of Microplastics in the Marine Environment	Research on generation and impacts of microplastics.	MOF (KIOST)

5.4. Russian Federation

5.4.1. Prevention of the marine litter input to the marine and coastal environment

Improvements have been made in waste treatment facilities and landfills, participation of industry, reduction of plastic waste, and promotion of coastal cleanup and awareness in the Far East Russia (Table 5.12).

Table 5.12 Prevention of marine litter input in Russia

Name of program or action	Contents	Notes
Land-Based		
Some ecological initiatives of the "Coca-cola" company	The Coca-Cola company carries out all-Russian "Green Teams" cleanup actions since 2004 where general public including school children take part. The interactive lessons of the "Divide with Us" series are developed for schoolchildren with the assistance of the company and fund "ERA". Main subjects of the lessons: reasons of the waste origin, the waste separate collecting and processing, innovative solutions to the waste problem. Projects are implemented in the Russian Federation including in the NOWPAP region.	http://xn--80aaleijfpli0as4p.xn--p1ai/
International Coastal Cleanup (ICC)	The students and staff of the Institute of Sea Protection and Shelf Development, Maritime State University named after adm. G.I. Nevelskoy take part in coastal area cleaning campaigns since 2007. The faculty members and students organize lectures for schoolchildren of Primorsky Krai about negative consequences of the marine litter. They carried out ICC according to the NOWPAP recommendations.	
ECO Show	The annual final event of the municipal program "The waste" (Vladivostok) is organized by administration of Vladivostok and devoted to ecological education and enlightenment. The presentations of the best results, rewarding of the winners, the competition of the hand-made articles from the waste and the competition "The Waste Fashion" where schoolchildren show the fashion created from the waste products are held at this show.	https://primamedia.ru/news/112323/ http://vlc.ru/city-environment/ecology/ecologicaleducation
'Ocean without borders'	Within the framework of project ecological actions in monitoring marine litter, coastal cleanup actions, studying of a coastal marine biodiversity, master classes in the production of hand-made art articles from marine litter, methodical seminars, the edition of information materials are carried out. The project has been implemented since 2014 till present with the assistance of Department of Natural Resources and Environmental Protection of Primorsky region, National Scientific Center of Marine Biology FEBRAS, Primorsky Aquarium, and the Northwest Pacific Region Environmental Cooperation Center (NPEC, Japan).	http://ekoinpro.ru/services/ocean_bez_gran/
Ecological project "The scrap-heap stop"	The project has been implemented by the "EcoStar Technology" LTD together with the administration of Vladivostok city since 2011. The project includes the gathering of car tires from tire mounting companies at low prices and transferring them to the processing enterprise for production of rubber crumbs.	http://primorye24.ru/news/post/60198-svalkam-net-vo-vladivostoke-rabotayut-punkty-priema-otrabotannyx-shin http://ecostar-tech.ru/nashi-proekty/ekologicheskiy-proekt-svalkam-net/

Ecological project “Utilize correctly”	The project has been implemented by the “PrimTekhnopolis” LTD together with the administration of Vladivostok city since 2011. The project includes the organization of the selective collecting and the ecologically safe utilization of mercury-containing waste, the batteries and plastic products for the minimization of negative impact of this waste to the environment. The map of Vladivostok with the addresses of waste collection points and locations of eco modules was developed within the project.	http://upvl.ru/
Vladivostok treatment plants	The reconstruction and the construction of the water supply system and sewerage system in Vladivostok during 2011-2018. 85% of city effluents are cleansed in present time.	
The domestic waste sorting and processing plant constructing on the Holmistaya Street (Vladivostok) in 2011	The waste sorting began in 2011. The paper, cardboard, PET-bottles, polyethylene, polymers, tin and aluminum packing, glass and rubber waste are sorted and transferred to specialized enterprises. Unsortable "tails" are briquetted and stored in landfills. The rated capacity of plant is 300000 tons per year.	https://www.newsvl.ru/vlad/2018/06/19/171197/#ixzz5aHpU7s51
The recultivation of the domestic waste landfill in Gornostay bay (Vladivostok)	The recultivation of the landfill of 2 million m^3 which functioned from 1967 to 2011 was carried out in 2010 – 2011.	http://capitel-vl.ru/?p=121
“Let's bring salmon back and keep the Sakhalin rivers clean” project	The project was carried out by Sakhalin fishing club “Sakhalin – Kurils” with assistance from the “Global Green Grants” fund in 2011. The Sakhalin schoolchildren took part in this action. 200 meters long Lutoga river coastline was cleaned and participants collected 3 tons of litter.	https://ecodelo.org/11061-sakhalintsy_ochistili_reki_ot_setei_i_musora-zashchita_rek_i_vodoemov
Bloggers are against garbage	In consideration of modern informatization and popularity of social networks, using Internet resources allows the prompt communication between various social groups. Since 2011 bloggers initiated this event. The action united people of different ages, occupations, and political sights through the common idea to make the coastal area cleaner.	
International project “Let’s Do It”	This project provides opportunity for better interaction among the public, business and national authorities at all levels to form a mutual understanding of the waste treatment problem and further search for efficient solutions. The project has been implemented since 2012 including conferences and ecological camps.	
The water of Russia	Within the Federal target program of the Russian Federation water management complex in 2012 — 2020 (the FTP "The water of Russia") all-Russian events on water reservoirs and their coastlines cleanup events take place. Materials for ecological lessons for schoolchildren and students are developed and provided for free access. Competitions of drawings and photo contests were held.	http://voda.org.ru/
Cooperation in rational productions on recycling with use of the advanced environmentally friendly and safe technologies	Waste management sphere reforming with implementation of the best available technologies. Alliance between the Department of Natural Resources and Environmental Protection of Primorsky region, “AVA-trade” Ltd and the prefecture of Tottori (Japan). The project has been implemented since 2016 till the present.	

with minimization of negative impact on the environment		
The landfill construction in Sovetskaya Gavan	The regional landfill for production and consumption waste envisages a storage capacity of 80000 m^3. The project started in 2019.	https://sovgavadm.khabkrai.ru/events/Novosti/122
Monitoring of microplastic by the coastal ground	Coastal ground monitoring is carried out at the 13 monitoring stations within the south part of Primorsky region, which includes recreational and industrial areas differing in hydrodynamic behavior. The project has been implemented since 2017 till present by Ecostart Ltd.	
Coastal cleanup	Regular cleanup campaigns are carried out by representatives of the business community with the involvement of authorities, the general public, schoolchildren and students.	http://rodnyeostrova.ru https://citysakh.ru/news/68380 http://primpress.ru/article/28106 https://lotosnews.ru/v-poselkah-slavyanka-i-primorskij-projdet-aktsiya-chistyj-bereg/
"Island of dream" project	For the purpose of Primorsky Krai island pollution prevention, the following events were held: unauthorized dumps and garbage burial grounds were liquidated; educational work with various groups was carried out; separate collection and processing of waste was popularized. The ecological actions, lectures of local historians, ecologists and travelers were carried out, master classes, photo exhibitions were organized, and ecological camps were held within the project. Volunteers have implemented the project with the assistance of the Vladivostok and Primorsky Krai administration since 2014.	http://old.vlc.ru/life_city/ecology/ekoproekt-ostrov-mechty/
The formation of the Russian ecological operator	Regional operators have participated in the creation of effective mechanisms of waste management, development of infrastructure of ecologically safe collecting, transportation, processing, utilization and placement of waste, formation of ecological culture of the population in the waste management field and the development of the separate waste collection system in the territory of the Russian Federation since 2019.	https://www.rbc.ru/business/12/10/2018/5bbf1ff49a7947f41673dfd2
The choice of the regional ecological operators	Regional operators in the Primorsky, Khabarovsky and the Sakhalin regions were selected following the competitive process in 2018. Regional operators participate in the creation of effective mechanisms of waste management, development of infrastructure of ecologically safe collecting, transportation, processing, utilization and placement of waste, formation of ecological culture of the population in the waste management field and the development of the separate collecting waste system in the territory of the Russian Federation/	http://spzv.ru/ https://sakhalin.gov.ru/index.php?id=105andtx_ttnews%5Btt_news%5D=12072 http://gkh27.ru/about/info/news/2369/
Marine community work day	In every June the general public, government and the business community organize and take part in the ecological action in the cleaning of the Ob'yasneniya river mouth and Gold Horn bay since 2014. Similar actions are carried out in other Primorsky krai cities.	https://www.newsvl.ru/vlad/2018/06/02/170800/
Sea-Based		

International day of reservoirs cleanup	Russian divers have also become very active. Every International Cleanup Day since 2007 divers join in picking up marine litter in the Vladivostok bays (Primorsky region) and Nevelsk bays (Sakhalin oblast).	

5.4.2. Monitoring of marine litter quantities and distribution

In Russia, a variety of micro-plastic research (including coastal, floating, and sediment-related marine spaces) are underway. Investigations are also underway through coastal cleanups (Table 5.13).

Table 5.13 Monitoring of marine litter in Russia

Name of program or action	Contents	Notes
Microplastic monitoring in the Peter the Great gulf	The first large-scale expedition to study microplastics in deep-sea waters has been undertaken on July 15-18, 2017 with financial support from Steward port LTD and JSC "Eastern Port". The Floating Lab of the Admiral Nevelskoy Maritime State University – the "Reef" yacht examined the subsurface layer of the Peter the Great Gulf on the route Vladivostok – Povorotniy cape – Vladivostok.	http://msun.ru/ru/news/id-5379%23
"Ocean without borders"	Primorsky region coastline marine litter monitoring. The project has been implemented in 2014 till the present in conjunction with "Ecoinvestproject" Ltd with the assistance of the Department of Natural Resources and Environmental Protection of the Primorsky region, National Scientific Center of Marine Biology FEBRAS and the Primorsky Aquarium, and the Northwest Pacific Region Environmental Cooperation Center (NPEC, Japan).	http://ekoinpro.ru/services/ocean_bez_gran/
International Coastal Cleanup (ICC)	Since 2007 the students and staff of the Institute of Sea Protection and Shelf Development and the Maritime State University named after adm. G.I. Nevelskoy have taken part in coastal area cleaning campaigns. They cover popular recreation sites in Vladivostok, Hasansky, Nadezhdinsky, Shkotovsky, Partizansky, Olginslky, Terneisky and other districts. Social organizations, and governmental agencies have involved in these activities as well.	
Microplastic monitoring in the coastal grounds	"Ecostart" LTD has been studying the content of microplastics in the coastal grounds since 2017. Studies were carried out on seven beaches of Vladivostok, two beaches in the top of the Amur Bay and three beaches of the Bay of Posiet.	
Microplastic pollution in the coastal waters	Assessment of the microplastic pollution has been implemented in the coastal waters of the NOWPAP Russian sector in 2016 – 2017 by NOWPAP POMRAC.	
Microplastic monitoring in the river basins	NOWPAP POMRAC has assessed microplastics abundance in river runoff and coastal waters of the NOWPAP region since 2018.	

5.4.3. Removing existing marine litter and its disposal

Various types of coastal cleanup activities involving stakeholders and students are actively conducted in the Russian Far East (Table 5.14). In particular, education programs for promoting marine environmental awareness are accompanied with coastal cleanups.

Table 5.14 Removal of existing marine litter and disposal in Russia

Name of program or action	Contents	Notes
Land-Based		
Coastlines, internal reservoirs and territories cleanup campaigns organized by Coca-Cola	The Coca-Cola company has carried out all-Russian "Green Teams" cleanup actions since 2004 where the general public including school children take part.	
International Coastal Cleanup (ICC)	Since 2007 the students and staff of the Institute of Sea Protection and Shelf Development, Maritime State University named after adm. G.I. Nevelskoy have taken part in coastal cleaning campaigns. They cover popular recreation sites in Vladivostok, Hasansky, Nadezhdinsky, Shkotovsky, Partizansky, Olginslky, Terneisky and other districts. Social organizations, and authorities are involved in these activities as well.	
“Ocean without borders”	Within the framework of project ecological actions in monitoring marine litter, coastal cleanup actions, studying of coastal marine biodiversity, master classes in the production of hand-made articles of art from marine litter and methodical seminars for the edition of information materials were carried out. The project has been implemented since 2014 till present with the assistance of the Department of Natural Resources and Environmental Protection of the Primorsky region, National Scientific Center of Marine Biology FEBRAS and Primorsky Aquarium, with the assistance of the Northwest Pacific Region Environmental Cooperation Center (NPEC, Japan).	https://www.primorsky.ru/upload/medialibrary/444/444fa69f481621fa643852c5e8415a97.pdf https://www.primorsky.ru/authorities/executive-agencies/departments/environment/report-on-the-environmental-situation-1.php http://ekoinpro.ru/services/ocean_bez_gran/
Bloggers are against garbage	In consideration of modern informatization and the popularity of social networks, using Internet resources allows prompt communication between various social groups. Since 2011 bloggers initiated this event. The action united people of different ages, occupations, and political sights because of the common idea to make the coastal area cleaner.	https://sdelaem.info/news/blogerov-protiv-musora-stalo-vdvoe-bolshe https://rosphoto.com/events/bloger_protiv_musora_2013-1694
“Let's bring salmon back and keep the Sakhalin rivers clean” project	The project was carried out by the Sakhalin fishing club Sakhalin - Kurils with the assistance of the Global Green Grants fund in 2011. The Sakhalin school children took part in this action. The Lutoga river coastline which is 200 meters long was cleaned and participants collected 3 tons of litter.	https://ecodelo.org/11061-sakhalintsy_ochistili_reki_ot_setei_i_musora-zashchita_rek_i_vodoemov
International project “Let’s Do It”	This project provides for better interaction amongst the public and business and national authorities at all levels to form a mutual understanding on the waste treatment problem and further search for efficient	https://sdelaem2018.ru/ https://sdelaem.info/

	solutions. The project has been implemented since 2012 including conferences and ecological camps.	
The water of Russia	Within the Federal target program of the Russian Federation water management complex of 2012 — 2020 (the FTP "The water of Russia") where all-Russian events on water reservoirs and their coastline cleanup events take place. Materials for ecological lessons for children, schoolchildren and students are developed and provided for free access. Competitions for drawings and photo contests were held.	
“Island of dream” project	For the purpose of Primorsky Krai island pollution prevention the following events were held: unauthorized dumps and garbage burial grounds were liquidated; educational work with various groups was carried out; separate collection and processing of waste was popularized. Ecological actions, lectures by local historians, ecologists and travelers are delivered, master classes, photo exhibitions were organized and ecological camps were conducted within the project. Volunteers implement the project with the assistance of Vladivostok and Primorsky Krai administration since 2014.	http://old.vlc.ru/life_city/ecology/ekoproekt-ostrov-mechty/
Coastal cleanup	Regular cleanup campaigns are carried out by representatives of the business community with the involvement of authorities and the general public including schoolchildren and students	http://rodnyeostrova.ru https://citysakh.ru/news/68380 http://primpress.ru/article/28106 https://lotosnews.ru/v-poselkah-slavyanka-i-primorskij-projdet-aktsiya-chistyj-bereg/
The formation of the Russian ecological operator	The Russian Ecological Operator company was set up in 2019 for the purpose of the formation of a waste management complex system, prevention of harmful effects of waste on human health and the environment, waste processing, treatment and obtaining energy.	https://www.rbc.ru/business/12/10/2018/5bbf1ff49a7947f41673dfd2
The selection of the regional ecological operators	Regional operators in the Primorsky, Khabarovsky and the Sakhalin regions were selected following the results of competitive process in 2018. Regional operators will participate in the creation of effective mechanisms of waste management, development of infrastructure of ecologically safe collecting, transportation, processing, utilization and placement of waste, formation of ecological culture in the waste management field and the development of a separate waste collection system in the territory of the Russian Federation.	http://spzv.ru/ https://sakhalin.gov.ru/index.php?id=105&ndtx_ttnews%5Btt_news%5D=12072 http://gkh27.ru/about/info/news/2369/
Marine community work day	In every early June the general public, government and the business community organize and take part in ecological actions in cleaning of the Ob’yasneniya river mouth and other cities seasides since 2014. Similar actions were carried out in other Primorski krai cities.	https://www.newsvl.ru/vlad/2018/06/02/170800/ http://old.vlc.ru/news/2017/185379/
Sea-Based		
International day of reservoirs cleanup	Russian divers are also very active. Every International Cleanup Day since 2007 divers join together to pick marine litter in the Vladivostok bays (Primorsky region) and Nevelsk bays (Sakhalin oblast).	

Marine community work day	In early June the general public, government and the business community organize and take part in the ecological action in cleaning of the Gold Horn bay of floating litter.	http://vestiprim.ru/2016/06/04/akvatoriyu-buhty-zolotoy-rog-vo-vladivostoke-ochistili-ot-musora-v-hode-subbotnika.html http://old.vlc.ru/news/2017/185379/

5.4.4. Others (R&D, etc)

A variety of microplastic studies are underway, especially the research on ghost fishing by abandoned fishing gear and the impacts on marine mammals (Table 5.15).

Table 5.15 Other marine litter-related activities in Russia

Name of program or action	Contents	Notes
"Ocean without borders"	Within the framework of project master classes in production of hand-made articles of art from marine litter, methodical seminars, and editing information materials were carried out. The project was implemented since 2014 till present with the assistance of the Department of Natural Resources and Environmental Protection of Primorsky region, National Scientific Center of Marine Biology FEBRAS, Primorsky Aquarium, and Northwest Pacific Region Environmental Cooperation Center (NPEC, Japan).	http://ekoinpro.ru/services/ocean_bez_gran/
Reclamation of tires, "EcoStar technology" Ltd	There is a unique technological line of car tire processing with a productivity of more than 3500 kg per hour. The rubber crumb, ferrous metals and textile fiber are reclaimed. . The rubber crumb is used for pavement. The waste tires polluted by oil products and paints are treated with thermal destruction in the pyrolysis module. This product can be used as fuel for burner. There is a joint patent with the Far Eastern Federal University.	http://ecostar-tech.ru/nashi-uslugi/pokryshki-avtomobilnye/ https://a-forester.livejournal.com/228313.html
Enterprise for biofuel production in the Primorsky Krai	"Ecoline" LTD under the agreement with JSC Corporation of Far East development utilizes waste products from the logging and wood processing since 2018. Waste products from this process are used for biofuel production such as fuel briquettes.	http://www.vl.aif.ru/society/v_primore_zapushcheno_proizvodstvo_biotopliva https://erdc.ru/stories/ooo-ekolayn/
Case study on the application of a "no special fee system" in Russian ports	Seaports are strategic objects of the state, which is why it is necessary to improve the methods and forms of ecological management of their development with a modern approach.	
Memorandum about the partnership between Ecostart Ltd and Dalrybvtuz-Nevod Ltd	Assessment of fishery impact on the marine environment, including "ghost fishing" and marine litter monitoring since 2018. "Eco-Net" research and production alliance is the result of the activity in the framework of memorandum.	
Memorandum about the partnership between	Marine litter monitoring and impact assessment on marine mammals since 2018. Development of a database on	

Ecostart Ltd and NGO "Friends of Ocean"	"Marine litter and marine mammals".	
Memorandum about the partnership between Ecostart Ltd and Far Eastern Federal University Ecology analytical center	Research of microplastics qualitative and quantitative structure in the coastal, underground water and sea water areas since 2017. Researching the coastal grounds of the South coastline of Primorsky region.	
Round table "Marine litter in the Arctic: problem analysis and recommendations development", "Econet" alliance	Round-table discussion organized by "Eco-Net" research and production alliance, was held in the frame of PAME (Protection of the Arctic Marine Environment) on October 1, 2018. The objective of the roundtable was: to encourage exchange of information between the experts engaged in the field, as well as to develop a program for joint activities and formulate proposals for administrative bodies conducting activities in the Arctic and along the Northern Sea Route. The discussion was conducted by the participants from the RF nonprofit, research and academic organizations representing all the constituent entities of the Arctic zone and the Northern Sea Route and the PAME participating nations.	https://pame.is/index.php/document-library/pame-reports-new/pame-working-group-meeting-reports/319-pame-ii-2018-meeting-report/file

5.5. NOWPAP RACs and ICC

The NOWPAP institutional infrastructure includes Regional Activity Centers in the four member states. Each RAC has conducted its own activities to implement specific parts of RAP MALI. The progress is introduced in the following section.

5.5.1. Marine Environmental Emergency Preparedness and Response Regional Activity Centre (MERRAC)

In response to growing concern about marine litter, the NOWPAP activities have been initiated since November 2005, when the project proposal was approved at the Tenth NOWPAP Intergovernmental Meeting. Since then, MERRAC has been in charge of the regional cooperation activities related to sea-based marine litter in the NOWPAP region to assist NOWPAP members in the environmental protection and sustainable development of the NOWPAP region. Under the two phases of the NOWPAP Marine Litter plan, Marine Litter Activity (MALITA) and RAP MALI, MERRAC has worked hard to reduce marine litter in this region by developing guidelines in various sectors and collecting the information and data from NOWPAP Members (Figure 5.3).

The first phase, called MALITA, was completed by the end of 2007. Based upon the approval of the 10th NOWPAP IGM, the 9th MERRAC FPM (5-7 June 2006) decided to implement MERRAC activities concerning the sea-based marine litter issues within the framework of

MALITA. Particularly, it was agreed that the term 'sea-based marine litter' would include 'garbage from ships' defined in Annex V of the MARPOL Convention. The Meeting agreed to implement the activities in close cooperation with UNEP, IMO, other RACs, and Marine Litter Focal Points under the overall management of NOWPAP RCU. Under the MALITA project, MERRAC, with the support of the NOWPAP members, published the following guidelines and documents:

- Guidelines for Monitoring Marine Litter on the Seabed in the Northwest Pacific Region;
- Guidelines for Providing and Improving Port Reception Facilities and Services for Ship-generated Marine Litter in the Northwest Pacific Region;
- Sectoral Guidelines for Marine Litter Management: Fishing;
- Sectoral Guidelines for Marine Litter Management: Commercial Shipping;
- Sectoral Guidelines for Marine Litter Management: Recreational Activities;
- Sectoral Guidelines for Marine Litter Management: Passenger Ships; and
- Brochure on Sea-based Marine Litter: Problem & Solution

Figure 5.3 Brochures developed by MERRAC

Noting the successful implementation of MALITA, the 12th NOWPAP IGM (Xiamen, China, 23-25 October 2007) approved the NOWPAP Regional Action Plan on Marine Litter (RAP MALI) for 2008/2009, as the next phase of NOWPAP MALITA (UNEP/NOWPAP IG. 12/7/2). Since 2008, under RAP MALI activities, MERRAC published the following technical reports (Figure 5.4):

- Regional Report on Sea-based Marine Litter (2008);
- Marine Litter Management: The approach of Incheon City, Republic of Korea (2008);

- Port reception facilities in the NOWPAP region (2012);
- Negative Impacts of Marine Litter in the NOWPAP Region: Case Studies (2013);
- Best Practices in dealing with Marine Litter in Fisheries, Aquaculture and Shipping Sectors in the NOWPAP Region (2015);
- Understanding on Floating Marine Litter Distribution in the NOWPAP Region (2017); and,
- Review and analysis of existing Floating Marine Litter prediction models in the NOWPAP region (2018)

Figure 5.4 Publications by MERRAC

Upon the approval by the 22nd NOWPAP IGM, MERRAC has also initiated the project on 'Understanding of Floating Marine Litter sources and flows in the NOWPAP region' as a MERRAC RAP MALI activity for 2018/2019 biennium. The technical report of the project was finalized and published by end of 2019, based upon the comments and/or feedbacks from UNEP, IMO, ML FPs and MERRAC FPs.

5.5.2. Special Monitoring and Coastal Environmental Assessment Regional Activity Centre (CERRAC)

For the objectives of RAP MALI, CEARAC has implemented activities on marine litter from land-based sources through understanding existing monitoring/survey activities, marine litter types/generators, countermeasures, and others.

When the marine litter activities were started in NOWPAP, regular monitoring of marine litter was not conducted in the member states. To understand the situation and the distribution of marine litter in the NOWPAP region, continuous regular monitoring was necessary. Thus, CEARAC developed "Guidelines for Monitoring Marine Litter on the Beaches and Shorelines

of the Northwest Pacific Region" in 2007. In RAP MALI, monitoring of marine litter is one of the main tasks of the member states. NOWPAP member states started regular monitoring using the guideline, and their monitoring results have been shared among the member states. Now, NOWPAP member states have their national monitoring and regular cleanup, and the understanding of quantities and distribution of marine litter in the NOWPAP region is enhanced through their efforts.

One of the dominant items of marine litter on beaches is plastic. To collect and treat plastic marine litter is the most effective countermeasure for reducing marine litter on beaches. However, plastic marine litter on beaches is a critical issue for treatment because it includes salt. Therefore, CEARAC collected information on treatment, especially focusing on recycling plastic litter on beaches and published a Booklet on Recycling of Plastic Marine Litter in 2007 to share information on best practices on recycling plastic marine litter.

A large amount of marine litter can be found on beaches, and some of them, such as plastic bottles and cigarette butts, are generated from visitors and tourists of beaches. To raise awareness among tourists and tour sectors against marine litter, CEARAC also developed Marine Litter Guidelines for Tourists and Tour Operators in Marine and Coastal Areas in 2007 and updated it in 2011. Also, CEARAC prepared several public awareness brochures.

Eighty percent of washed-up marine litter on beaches comes from the land through rivers except for specific areas and remote islands. To reduce marine litter on beaches, prevention of marine litter input from land-based sources is a high-priority action. Central governments, local governments, and various stakeholders of the NOWPAP member states take actions to prevent marine litter input from land-based sources. CEARAC collected information on best practices for prevention of marine litter input from land-based sources in the NOWPAP member states and published reports "Regional report on measures and best practices for prevention of marine litter input from land-based sources in the NOWPAP region" and "Best practices for prevention of marine litter input from land-based sources in the NOWPAP region" in 2013. The report on best practices was translated into the four NOWPAP member states' languages to disseminate information more widely. CEARAC also collected information on the actions of the central and local governments in Japan and published reports "Model Survey for Reduction of Marine Litter" and "Marine Litter Management within a River Basin: A case study of Oyabe river basin, Toyama Prefecture, Japan" in 2009 and 2015, respectively.

To enhance the awareness of marine litter prevention actions at the national, local, and grass-root levels as well as to exchange information on marine litter among the member states and with other regions, the Northwest Pacific Regional Node of the Global Partnership on Marine Litter was established by Northwest Pacific Region Environmental Cooperation Center (NPEC), the host organization of CEARAC, and NOWPAP RCU in 2014. Through this regional node, a website on marine litter in the NOWPAP region provides basic information on marine litter and information on surveys on marine litter in the NOWPAP member states and countermeasures by central and local governments are provided. Since 2018, the Northwest Pacific Regional Node has been operated by DINRAC, responsible for data and information of NOWPAP. CEARAC collected information on national actions on marine microplastics in the NOWPAP member states and published a report in April 2020.

5.5.3. Pollution Monitoring Regional Activity Centre (POMRAC)

NOWPAP POMRAC, located in Vladivostok, the Russian Federation, has the goal of coordination of activity and establishment of cooperation in regional monitoring of marine litter. The main functions and tasks include 1. to collect relevant information on the program and technologies of regional monitoring of atmospheric deposition and rivers and direct inputs, 2. to coordinate an exchange of monitoring results in the network of monitoring stations, 3. to provide the necessary methodical and, when possible, technical assistance for organizations of the NOWPAP countries in efforts and techniques of monitoring of sea, coastal and associated freshwaters and atmosphere, 4. to organize data inter-calibration in cooperation with other international and regional organizations concerned, especially IOC UNESCO, and 5. to promote harmonization of the approaches and techniques used in NOWPAP monitoring network.

POMRAC has prepared a report on applying the “no special fee” system used in the Russian ports in 2015. POMRAC surveyed floating microplastics in the Peter the Great Gulf and developed the distribution map (micro- and meso-sized plastic) and microplastic discharge directly into the marine water.

5.5.4. Data and Information Network Regional Activity Centre (DINRAC)

NOWPAP DINRAC has collected marine litter data on the abundance and distribution according to three spatial categories: shoreline (beach litter), sea surface (floating litter), and

seabed (sunken litter). The data is collected as follows: 1. Member States' publicly shared information on marine litter, relevant laws and regulations, marine litter monitoring information. The information is collected by national liaison officers and maintained by DINRAC with unified standards; 2. A database on marine litter by collecting information from relevant international organizations; 3. From research institutes and enterprises; 4. Results by using large data collection and analysis techniques.

Information on national and local governments' and NGOs' efforts in Japan, Korea, and Russia is available on the DINRAC website, and marine litter monitoring data on NOWPAP beaches is available until 2012. DINRAC completed the construction of the information platform for the Northwest Pacific Regional Node of the Global Partnership on Marine Litter in 2018.

5.5.5. International Coastal Cleanup in NOWPAP region

International Coastal Cleanup (ICC) is a global volunteer event for picking up and recording the litter in the environment. US NGO Ocean Conservancy has organized ICC with the help of country coordinators from all over the world for over 30 years.

NOWPAP RAP MALI recognizes ICC as an effective means of reducing marine litter and encouraging member states to participate. In fact, since 2007, ICC events have been held in all NOWPAP member states. In particular, the member states take turns organizing the NOWPAP ICC campaign and marine litter workshop every year. The number of people who participated in the ICC event in NOWPAP countries is about 40 thousand for recent years (2017 ~ 2019). They picked up more than 600 thousand litters from a 1,078 km (670 miles) length of coasts. The weight of the litter collected was 422 tons (930,616 pounds) (Table 5.16).

Table 5.16 International Coastal Cleanup in NOWPAP countries (2017 ~2019).

Country	Clean Up Summary	Land	Underwater	Total
China	People	21,251	61	21,312
	Pounds	404,815	544	405,359
	Miles	167	8	175
	Litter Items collected	107,099	1,819	108,918
Japan	People	9,472	235	9,707
	Pounds	111,575	2,140	113,715

	Miles	214	1	215
	Litter Items collected	275,890	3,762	279,652
Korea	People	9,068	216	9,284
	Pounds	405,369	2,215	407,584
	Miles	255	10	265
	Litter Items collected	213,541	1,596	215,137
Russia	People	314	67	381
	Pounds	3,954	5	3,959
	Miles	14	0	15
	Litter Items collected	16,712	1	16,713
Total	People	40,105	579	40,684
	Pounds	925,713	4,904	930,616
	Miles	651	19	670
	Litter Items collected	613,242	7,178	620,420

Source: Country reports for 3 years (2017 ~2019) downloaded from the ICC database (Trash Information for Education and Solution, TIDES)

The most important source of marine litter was single-use and take away plastics (72%), categorized as 'Most likely to find items' in ICC data. Fishing gear and Packaging materials were 9% and 8%, respectively. Tiny litter like plastic and foam pieces (less than 2.5 cm) were not considered in this analysis (Figure 5.5).

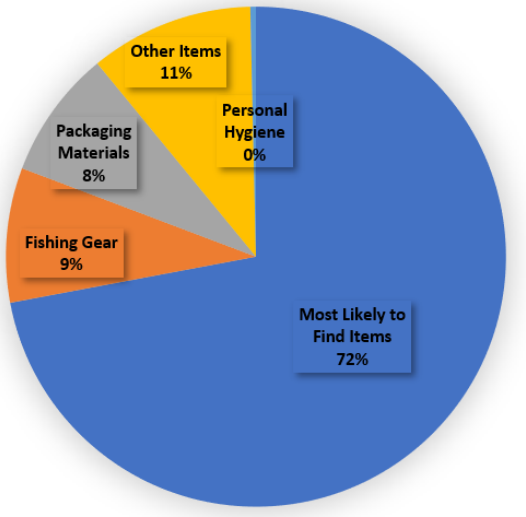


Figure 5.5 Sources of marine litter from ICC in NOWPAP countries (2017 ~2019).

The top ten items comprised 64.4% of the total number of marine litters collected in ICC of the NOWPAP countries (2017 ~ 2019). The number one litter item was Cigarette buttes (11.8%), followed by plastic beverage bottles (8.3%) and food wrappers (7.6%). Plastic bags (6.4%) and glass beverage bottles (6.0%), and fireworks (5.5%) were also included in the top ten items. Tiny litter items were also not included in this analysis (Table 5.17).

Table 5.17 Top 10 litter items of ICC in NOWPAP countries (2017 ~2019).

Rank	Litter item	Number of litter items	% of total litter items
1	Cigarette Butts	53,277	11.8%
2	Beverage Bottles (Plastic)	37,629	8.3%
3	Food Wrappers (candy, chips, etc.)	34,158	7.6%
4	Other Plastic Bags	28,818	6.4%
5	Beverage Bottles (Glass)	27,101	6.0%
6	Bottle Caps (Plastic)	27,067	6.0%
7	Fireworks	24,940	5.5%
8	Grocery Bags (Plastic)	19,805	4.4%
9	Beverage Cans	19,045	4.2%
10	Other Plastic/Foam Packaging	18,905	4.2%
Top 10 total litter item		290,745	64.4%
Total litter items		451,698	100.0%

Chapter 6 . KNOWLEDGE AND IMPLEMENTATION GAPS

This chapter provides summarized tables to show the available knowledge and implementation gaps in each section to aid understanding of the largest gaps, which will correspond to the recommendations and priorities for each member state in the following chapter. The assessments such as ‘actively ongoing - ongoing - in preparation’ in the following tables is made on the basis of authors’ opinions.

6.1. Understanding of distribution, sources and temporal trends of macro marine litter and microplastics

Over the past period, all members of NOWPAP have been working very hard to identify the distribution, composition, source, and temporal tendency of marine litter. Their efforts are summarized in Table 6.1-6.3.

Exceptionally active efforts have been invested in research of microplastics in Korea and China during the last decade. Most of them are on the abundance, composition, types, and distribution. Efforts to improve the methodologies in microplastic identification are also noteworthy. In the case of microplastic, it is not just the NOWPAP region's problem but also a phenomenon common worldwide, making comparison very difficult because of the many different methodologies used (GESAMP, 2019). To harmonize the methods will still be challenging despite the strong recommendations by experts (Cheshire et al., 2009; GESAMP, 2019). Guidelines for harmonizing ocean surface microplastics monitoring methods” has published in May 2019, contributed by NOWPAP members’ experts.

Table 6.1 Gaps in understanding of beach, seawater and seafloor pollution by marine litter (A: actively on going, O: on going, P: in preparation, -: not known)

Categories	China	Japan	Korea	Russia
Beach	A	A	A	A
Seawater	A	A	A	A
Seafloor	O	O	A	O

Table 6.2 Gaps in understanding of various size range of marine litter (A: actively on going, O: on going, P: in preparation, -: not known)

Categories	China	Japan	Korea	Russia
Mega	A	A	-	-
Macro	A	A	A	A
Meso	-	O	O	O
Micro	A	A	A	A

Table 6.3 Gaps in understanding of distribution, composition, source, and spatial and temporal trends of marine litter (A: actively on going, O: on going, P: in preparation, -: not known)

Categories	China	Japan	Korea	Russia
Distribution	A	A	A	A
Composition	A	A	A	A
Source	O	A	A	O
Temporal trend	A	A	A	-

6.2. Understanding of the negative impacts of macro and microplastic litter

Research on the impact of marine litter is weak compared to studies on the quantities, despite several studies conducted in Korea and Japan. Studies on the effects of microplastics on human health, such as those found in salt or seafood, are more active in China (Table 6.4).

Table 6.4 Gaps in understanding of negative impacts of macro and microplastic litter (A: actively on going, O: on going, P: in preparation, -: not known)

Categories	China	Japan	Korea	Russia
Wild animals and ecosystem	O	O (1990)	O	-
Tourism	-	-	O	-
Fisheries	-	O (1990)	O	-
Navigation	-	O (1990)	O	
Economy	-	O (1990)	O	
Chemical	O	A	A	-
Human health	A	O	O	-
Disaster	-	-	O	-

6.3. Status of legal instruments

All four members have made great progress in the legal and institutional sectors. All have

relevant laws, regulations and plans for the implementation of RAP MALI. Japan has enforced the law targeting marine litter since 2009 and a separate law targeting marine litter is being pursued in Korea (Table 6.5).

Table 6.5 Gaps in legal instruments (O: on going)

Categories	China	Japan	Korea	Russia
Law	O	O (Targeting ML)	O	O
Regulation	O	O	O	O
Action plan	O	O (Targeting ML)	O (Targeting ML)	-

6.4. Status of Implementation

Implementation of the action plan is active in all countries (Table 6.6). Prevention in each state has been recognized to be important for marine litter management in China, Japan and Russia has focused on land-based sources while Korea focuses on sea-based sources. Monitoring of marine litter has been implemented in a wide range of spatial positions and sizes in China, Japan and Korea. Reduction is relatively more active in Japan and Korea than other member states.

Table 6.6 Gaps in implementation of RAP MALI (A: actively on going, O: on going, P: in preparation, -: not known)

Categories	China	Japan	Korea	Russia
Prevention	A (plastic bag, import of plastic waste)	A	A (replacement of Styrofoam buoys, fishermen education)	A (solid waste)
Monitoring	A (beach, floating, sea bottom)	A (beach, floating litter)	A (beach)	O (beach, floating)
Reduction	O	A	A	O

6.5. Comparison among Regional Action Plans

Table 6.7 summarizes the cases for each organization which has action plans or strategies to combat marine litter to help improve RAP MALI in the NOWAP region (Table 6.7).

Table 6.7 Framework of RAP MALI and marine litter action plans of intergovernmental associations

Organization	Category	Subcategory
NOWPAP	Prevention of marine litter input to the marine and coastal environment	Legal and Administrative Instruments
		Wise Management of Marine Litter
		Information, Education, Outreach and Public Awareness
		Cooperation with Civil Society

		Research Activities
	Monitoring of marine litter quantities and distribution	Marine Litter Monitoring Using NOWPAP Guidelines
		Maintenance of Marine Litter Database
		Compilation of Data from National Monitoring Programmes
		Regular Assessments of Current Situation and Trends in Marine Litter Quantities and Distribution
		Collection of Marine Litter-related Research Outcomes
	Removing existing marine litter and its disposal	Beach Cleanup Campaigns
		Removal of Existing Marine Litter
		Research Activities Related to Marine Litter
COBSEA	Preventing and reducing marine litter from land-based sources	Legal and economic instruments
		Integrated waste management
		Removal of existing litter and its disposal
	Preventing and reducing marine litter from sea-based sources	Legal and economic instruments
		Removal of existing marine litter and its disposal
	Monitoring and assessment of marine litter	Expert Group
		Regional and National Marine Litter Monitoring Programmes
		Reports
		Regional Database
	Activities supporting the implementation of COBSEA RAP MALI	Regional and international cooperation and reporting
		National Action Plans on Marine Litter (NAP MALI)
		Research activities
		Information, education, outreach and Involvement of stakeholders
		Training and capacity building
HELCOM	Regional actions – HELCOM Collective Actions	Land-based sources of marine litter
		Sea-based sources of marine litter
		Education and outreach on marine litter
	Voluntary national actions	Land-based sources of marine litter
		Sea-based sources of marine litter
		Education and outreach on marine litter
OSPAR	Actions to combat sea-based source	Harmonized system for port reception facilities
		Enforcement of international legislation/regulation regarding all sectors
		Incentives for responsible behavior/disincentives for littering
		Develop best practice in relation to fishing industry Fines for Littering at Sea
	Actions to combat land-based sources	Improved waste prevention and management
		Reduction of sewage and storm water related waste
		Incentives for responsible behavior/ Disincentives for littering
		Elimination, change or adaptation of the products for environmental benefits
		Development of sustainable packaging
		Zero pellet loss
	Removal Actions	Application of Fishing for Litter activities
		Cleaning environmental compartments and keeping them clean
	Education and outreach	Education
		Outreach
G20 (Implementation Framework for	Facilitation of Effective Implementation of the Action Plan	Implementation of actions
		Information sharing and continued updating

Actions on Marine Plastic Litter)	Collaborative Actions and Outreach of Implementation of the Action Plan	Promotion of international cooperation
		Promotion of innovative solutions
		Sharing scientific information and knowledge
		Multi-stakeholder involvement and awareness raising
ASEAN (Framework of Action on Marine Debris)	Policy Support and Planning	Promote regional policy dialogue on prevention and reduction of marine debris from land- and sea-based activities by highlighting the issue, sharing information and knowledge and strengthening regional coordination
		Mainstream multi-sectoral policy measures to address marine debris in national and ASEAN's development agenda and priorities
		Encourage ASEAN Member States to implement relevant international laws and agreements related to waste management- such as MARPOL Annex V ship generated waste, Basel Convention, and UN Environment Assembly resolutions 3/7 on Marine Litter and Microplastics.
		Develop a regional action plan on combating marine debris in the ASEAN Region by applying integrated land-to sea policy approaches
	Research, Innovation and Capacity Building	Compile regional baseline on status and impacts of marine debris in the ASEAN Region
		Strengthen regional, national and local capacities to develop and implement national action plans/initiatives
		Enhance scientific knowledge, transfer marine technology and promote innovative solution to combat marine debris
		Promote integration and application of scientific knowledge to enhance science-based decisions and policies on marine debris prevention and management. "
	Public Awareness, Education and Outreach	Promote public awareness on status and impacts of marine debris and microplastics
		Accelerate advocacy strategy/programme to promote behavior change to combat marine debris, and to incorporate marine debris issue into ASEAN's Culture of Prevention Initiative
		Promote platforms for knowledge sharing, innovative solutions and best practices to combat marine debris
	Private Sector Engagement	Promote collaborative actions with private sector and industry associations to implement measures to address marine debris issues
		Encourage private sector investment in and contribution to combat marine debris

Chapter 7 CHAPTER 7. PROPOSED RESPONSE MEASURES BY NOWPAP MEMBERS

This chapter proposes 6 response measures corresponding each section of chapter 6. Proposed response measures have been prepared according to the opinions of the NOWPAP member states. (Table 7.1).

Table 7.1 Proposed response measures

1. Study macro and meso-sized plastics for source and solution-oriented efforts.
2. Study the impact of marine litter in various compartments.
3. Activate a web database using comparable data form.
4. Promote participation of citizens and companies.
5. Integrate scientific results and policy measures (science-based management).
6. Revise RAP MALI established in 2008.

7.1. Study macro and meso-sized plastics for source and solution-oriented efforts

The authors of the report suggest strengthening the search for human activities that may cause marine litter regardless of its size (macro, meso, and micro) or spatial location (beach, seawater, and seafloor). While many studies report the quantity and distribution of marine litter, they do not have enough information to develop policies and alternatives to reduce marine litter fundamentally. In particular, research on the abundance, type, and composition of microplastics has only become active in recent years, proving it difficult to collect source information to inform preventive measures. Therefore, while monitoring marine litter, more attention needs to be paid to macro and meso-sized litter to mitigate and prevent sources.

7.2. Study the impact of marine litter in various compartments

While studies of the amount (abundance) of marine litter are very active, studies of its impacts are very limited. Research progress on the negative impacts of marine litter will have to be made in the future. Research needs to focus on what efforts should be made to reduce the damage by enhancing understanding of the negative impacts of marine litter. Collecting the cases of impacts on wildlife, fishery, tourism and, navigation safety would be a good start.

7.3. Activate web database using comparable data form

Marine litter information is being collected within each country and is provided to DINRAC to create a database. However, the information is difficult to grasp comprehensively as it is obtained in different ways or provided in different raw data forms. If member states present data according to a specific type of data format (comparable reporting form) and post it in an infographic format on the Northwest Pacific Regional Node, data utilization will greatly increase.

7.4. Integrate scientific results and policy measures (science-based management)

The Korea Marine Debris Monitoring Program is the only program that has been used to find the sources of marine litter and reduce them (e.g., Styrofoam buoys). Even though many studies have been accumulated in the NOWPAP region, more efforts need to be made to link scientific data and policy development in an integrated manner.

7.5. Revise RAP MALI

RAP MALI needs to be revised. Since RAP MALI was established in 2008, there have been countless scientific discoveries and efforts to combat the problem of marine litter. Through the overview in this report, it is evident that there is much more interest in microplastics than in developing technical parts and the disposal process of retrieved litter from the sea. After the announcement of UN SDGs 14.1, there have been a wide variety of action/strategy plans to tackle the issue (Chapter 6). Based on gap analysis and comparison with action plans and strategies in other regions, it is proposed that the existing RAP MALI be revised, as shown in Table 7.2.

Table 7.2 Suggestion for revision of RAP MALI

Category	Main contents
Prevention of the quantity and impact of land-based marine litter	Clarification of the target types of marine litter (e.g. plastic packages) with top priorities and generating activities of them in terms of quantities and impacts using the results of ML monitoring and policy assessment in national or regional level
	Prevention of the generating activities through improvement of legal and policy instruments, active public awareness programs and education, and collaboration with various sectors including civil societies and companies
Prevention of the quantity and impact of sea-based marine litter	Clarification of the target types of marine litter (e.g. fishing gears) with top priorities and generating activities of them in terms of quantities and impacts using the results of monitoring ML and policy assessment in national or regional level

	Prevention of the generating activities through improvement of legal and policy instruments, active public awareness programs and education, and collaboration with various sectors including stakeholder communities (fishers, sea farers, etc.) and companies
Monitoring of quantities and impacts of marine litter	Monitoring of quantities in environmental compartments and impacts on various areas
	Compiling data in comparable form and regular assessment of current situation and trends in quantities and impacts
	Provision of results to identify policies and actions for prevention
Reduction of quantity and impact of existing marine litter	Removal of existing marine litter in a low-cost, high-efficiency way
	Removal of existing marine litter in consideration of damage and impact assessment.
Implementation of adaptive management	Regular assessment and modification of RAP MALI with feedback on implementation
	Supporting implementation of RAP MALI and research activities

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