NOWPAP POMRAC

Northwest Pacific Action Plan
Pollution Monitoring
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Development of NOWPAP Ecological Quality Objective targets aligned (where possible) with SDG indicators, phase 1
Regional synthesis report

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Regional synthesis report

Vladivostok, Russia
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Regional Seas

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List of acronyms

ASP - Amnesic Shellfish Poisoning
CEARAC - Special Monitoring and Coastal Environment Assessment Regional Activity Center
DDT - Dichlorodiphenyltrichloroethane
DIN - Dissolved Inorganic Nitrogen
DIP - Dissolved Inorganic Phosphorus
DO - Dissolved Oxygen
DSP - Diarrhetic Shellfish Poisoning
EMSA - Environmental Management Sea Area
EcoQO - Ecological Quality Objective
FPM - Focal Points Meeting
HAB - Harmful Algal Bloom
HCB - Hexachlorobenzene
HCH - Hexachlorocyclohexane
HELCOM - Helsinki Commission
IAEG-SDGs - Inter-Agency and Expert Group on Sustainable Development Goal Indicators
ICC - International Coastal Cleanup
ICEP - Index of Coastal Eutrophication Potential
ICM - Integrated Coastal Management
IOC UNESCO - Intergovernmental Oceanographic Commission of UNESCO
MAP - Mediterranean Action Plan
ML - Marine Litter
MSFD - Marine Strategy Framework Directive
NEAT - NOWPAP Eutrophication Assessment Tool
NOWPAP - Northwest Pacific Action Plan
OMB - Opportunistic Macroalgae Bloom
OSPAR - Oslo and Paris Conventions
PAH - Polynuclear Aromatic Hydrocarbons
PBDE - Polybrominated Diphenyl ether
PCB - Polychlorinated Biphenyl
PEL - Probable Effects level
PEMSEA - Partnerships in Environmental Management for the Seas of East Asia
PICES - North Pacific Marine Science Organization
POMRAC - Pollution Monitoring Regional Activity Center
PSP - Paralytic Shellfish Poisoning
PTS - Persistent Toxic Substances
RAC - Regional Activity Center
RAP MALI - Regional Action Plan on Marine Litter
SAP - Strategic Action Programme
SDGs - Sustainable Development Goals
SOMER - State of the Marine Environment Report
TEL - Threshold Effects Level
TN - Total Nitrogen
TP - Total Phosphorus
TPLC - Total Pollution Load Control
UNCLOS - United nations Convention of the Law of the Sea
UNEP - United Nations Environment Programme
WQI - Water Quality Index
YSLME - Yellow Sea Large Marine Ecosystem

Executive Summary

This Regional synthesis has been prepared based on national inputs provided by the nominated experts from NOWPAP member states: People's Republic of China, Japan, Republic of Korea and Russian Federation (hereinafter referred to as China, Japan, Korea and Russia). Results from the regional workshop held in March 2019 in Vladivostok (Russia) have been also taken into account (including views expressed by experts in their presentations).

For each of six Ecological Quality Objective (EcoQO) indicators agreed upon earlier, national experts considered their advantages and limitations; data availability; possibility of application; and existence of national numerical targets (standards). Experts' opinions, reflecting these criteria, are briefly summarized in this report. Based on the results of discussions at the March 2019 workshop, nominated national experts have agreed that EcoQO targets could be set up for the following four indicators:

- Nutrients concentration in the water column;
- *Chlorophyll a* concentration in the water column;
- Concentration of contaminants in water and sediments;
- Trends in the amount and composition of litter washed ashore.

At the same time, experts concluded that on two indicators related to eutrophication setting targets would be premature or unnecessary: nutrient ratios and harmful algal blooms (HABs). While discussing potential targets related to eutrophication (including *Chlorophyll a* and nutrients concentration), experience of NOWPAP CEARAC has been taken into account and further collaboration between POMRAC and CEARAC was encouraged.

Also at the March 2019 workshop, nominated national experts suggested specific "designated areas" where they will test those four NOWPAP EcoQO targets agreed upon during the second phase of this activity in 2020-2021 and beyond. These designated areas are:

- Jiaozhou bay in China;
- Toyama bay and/or Hakata bay in Japan;
- Masan bay and coastal area near Ulsan (for trace metals only) in Korea;
- Amursky bay in Russia.

Special attention at the workshop has been paid to definition of "baseline values" which could be used while setting the EcoQO targets. In the last part of this synthesis, the summary of agreed targets is given and the way forward is suggested, including possible alignment with SDG indicators which are still being developed and not yet finalized.

This Regional synthesis was prepared by Dr. Alexander TKALIN based on the national inputs provided by the following experts nominated by the NOWPAP member states (in alphabetical order): Dr. Yana BLINOVSKAYA (Russia), Dr. Wenlu LAN (China), Prof. Osamu MATSUDA (Japan), Dr. Tatiana ORLOVA (Russia), Dr. Jongseong RYU (Republic of Korea), Dr. Vladimir SHULKIN (Russia), Dr. Yuri ZUENKO (Russia).

1. Introduction

The Northwest pacific Action Plan (NOWPAP) has been adopted by four member states (China, Japan, Korea and Russia) in 1994. The overall goal of NOWPAP is "the wise use, development and management of the coastal and marine environment so as to obtain the utmost long-term benefits for the human populations of the region, while protecting human health, ecological integrity and the region's sustainability for future generations", i.e. sustainable development of the region (www.nowpap.org). Pollution Monitoring Regional Activity Center (POMRAC) of NOWPAP is involved in the implementation of several major elements of the sustainable management strategy for the NW Pacific adopted by the member states:

- Monitoring and assessment of the environmental conditions;
- Integrated coastal area planning;
- Integrated coastal area management;
- Establishment of a collaborative and cooperative network.

During the last decade, POMRAC has compiled and published several technical reports on atmospheric deposition of contaminants, on pollutants input with rivers, integrated coastal planning and management, and other issues. General assessments of the marine environment situation were prepared in the form of the "State of Marine Environment Report" (SOMER). The first SOMER was published in 2007 and the second one in 2014 (POMRAC, 2014).
Based on the analysis of regional marine environmental problems, POMRAC has started working on the development of regional Ecological Quality Objectives (EcoQOs). During the initial stage (2014-2015), similar experience of other Regional Seas programmes (such as HELCOM, MAP and OSPAR) has been analyzed. As a result, a preliminary set of five EcoQOs has been formulated and circulated among experts of NOWPAP member states and partner organizations (PEMSEA, PICES, YSLME and others). At the workshop held in 2014 in Busan (Korea), facilitated by a representative of OSPAR, experts from NOWPAP member states and partner organizations have agreed on the following EcoQOs for the NOWPAP region:

- Biological and habitat diversity are not changed significantly due to anthropogenic pressure;
- Alien species are at levels that do not adversely alter the ecosystems;
- Eutrophication adverse effects (such as loss of biodiversity, ecosystem degradation, harmful algal blooms, and oxygen deficiency in bottom waters) are absent;
- Contaminants cause no significant impact on coastal and marine ecosystems and human health;
- Marine litter does not adversely affect coastal and marine environments.

In 2016, POMRAC has developed a preliminary list of 24 possible indicators to be used to monitor the status of achieving the "Good Environmental Status" (the term from the Marine Strategy Framework Directive of the European Union, MSFD) along with the EcoQOs formulated earlier. In addition to experience from HELCOM, MAP and OSPAR, MSFD has been also taken into account. The list of possible indicators has been circulated among experts of NOWPAP member states and partner organizations and discussed at the workshop held in Vladivostok in 2016. After the workshop, national inputs were prepared by experts from member states describing national legislative and institutional arrangements, monitoring systems, and how the suggested indicators could be applied in their respective countries.
National experts have agreed that six NOWPAP EcoQO indicators (out of 24 initially suggested) could be applied in their countries. Agreed indicators are as follows (POMRAC, 2017):

- Nutrients concentration in the water column (possible SDG indicator 14.1.1)
- Nutrient ratios (silica, nitrogen and phosphorus)
- *Chlorophyll a* concentration in the water column (possible SDG indicator 14.1.1)

- Harmful algal blooms (HABs)
- Concentration of contaminants in water, sediments and organisms
- Trends in the amount and composition of litter washed ashore (possible SDG indicator 14.1.1)

The 22nd NOWPAP Intergovernmental Meeting (IGM) has approved the Programme of Work for 2018-2019 biennium, including the first phase of the POMRAC activity "Development of regional EcoQO targets aligned (where possible) with SDG indicators." Three of six indicators agreed by NOWPAP experts could be aligned in the future with indicators related to the Sustainable Development Goal 14.1: "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution." The goal of the first phase of this POMRAC activity is ***to analyze the national numerical targets (where they exist) related to NOWPAP EcoQO indicators and suggest (and then discuss) possible regional EcoQO targets aligned to the extent possible with the SDG-14 indicators***. At this stage, only two proxy indicators have been suggested by UNEP and IOC UNESCO for the SDG 14.1: *Chlorophyll a* concentration and the amount of marine debris washed ashore.

From the experience of other Regional Seas programmes (such as MAP, HELCOM and OSPAR) as well as the MSFD, the logical steps to achieving the Good Environmental Status of the Regional Seas are as follows. First, countries agree on common regional Ecological Quality Objectives (EcoQOs). Second, they agree on operational criteria (more detailed than EcoQOs). Third, countries agree on common indicators to be applied (taking into account geographical differences). Finally, numerical targets are set (taking into account geographical differences and other factors). After several years, the whole system of EcoQOs, operational criteria, indicators and targets is reviewed and necessary adjustments are made.

This synthesis is the result of compilation of the four national inputs submitted by experts nominated by NOWPAP member states as well as the results of discussions at the regional workshop held in March 2019 in Vladivostok, Russia.

2. Setting NOWPAP Ecological Quality Objective targets

The goal of the workshop held in March 2019 was to discuss possible NOWPAP EcoQO targets. Four of six above mentioned EcoQOs indicators are related to coastal eutrophication. Therefore, while preparing suggestions on the NOWPAP EcoQO targets, relevant achievements of NOWPAP CEARAC in the eutrophication assessment have been used, including reference values presented in several CEARAC reports (for example, http://www.cearac-project.org/cearac-project/integrated-report/eut_2013.pdf). Experience of other Regional Seas programmes (HELCOM, MAP and OSPAR) and some NOWPAP partners (such as YSLME) also has been taken into account, including the following reports (as well as working documents used for preparing those reports):

- Updated State of the Baltic Sea report (2018) available at http://stateofthebalticsea.helcom.fi/;
- Mediterranean 2017 Quality Status Report (available at https://www.medqsr.org/);
- OSPAR Intermediate Assessment 2017 (available at https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/).

While each of NOWPAP member states has well-developed national standards used to monitor and manage marine environmental quality, there are several major problems with setting NOWPAP EcoQO targets. First of all, unlike e.g. the European Union, NOWPAP member states do not have any common legislation which would allow prescribing what standards should be used in any particular country. Some leading Regional Seas programmes, such as HELCOM, MAP and OSPAR, have legally-binding conventions (which were ratified by each participating country), while NOWPAP member states only have adopted Action Plan (i.e. no legally-binding convention).

Second major problem (though similar problems also exist in sea areas covered by HELCOM, MAP, OSPAR and some other similar programmes) is: there are significant differences in geographic and socio-economic conditions in NOWPAP member states and in different areas of NOWPAP sea area. For example, in the northern (sub-arctic) regions of the Russian Far East (part of the NOWPAP sea area), population density could be as low as 1.2 persons per square kilometer and therefore anthropogenic pressure on the marine environment is negligible. At the same time, in coastal provinces of China facing the NOWPAP sea area population density could be as high as 268 persons per square kilometer. Population density in Korea in 2015 was 505 persons per square kilometer. Industry, agriculture and mariculture in coastal areas of China, Japan and Korea are much more developed than in the Russian Far East. At the same time, some coastal regions of China, Japan and Korea within the NOWPAP sea area are sub-tropical (i.e. in sharp contrast with the sub-arctic areas of the Russian Far East).

Different levels of economic development (including industry, agriculture, fisheries and aquaculture) result in different levels of anthropogenic pressure on the marine and coastal environment. River discharge of nutrients and other chemical substances, location of port facilities and offshore installations, density of shipping lanes, as well as coastal geomorphology and hydrography, also affect the marine environmental conditions in NOWPAP member states.

Due to these major problems, it was suggested that during the first phase of this POMRAC activity, each NOWPAP member state choses a “designated area” where monitoring data for several years are available (e.g. Masan Bay in Korea or Amursky Bay in Russia). In that case, the reference values suggested for selected sea areas by the CEARAC experts on eutrophication assessment could be taken into account. Possible EcoQO targets for each designated area could be set up using common and coordinated approach while taking into account national legislation, data availability, experience from other regions, etc. Using the designated areas allows to overcome the problem of incompatible data: NOWPAP member states are using slightly different parameters (for example, total nitrogen and phosphorus versus dissolved inorganic forms of nitrogen and phosphorus). Within the designated area, each member state could apply their standard national methodologies (used to analyze contaminants, marine litter, etc.).

On the following pages, possible NOWPAP EcoQO targets are presented based on submitted national inputs and the results of discussions held at the March 2019 workshop in Vladivostok, Russia. Each part (2.1 – 2.6) is concluded by a short summary shown in the blue box.

2.1. Nutrients concentration in the water column

This EcoQO indicator (and suggested target) is closely related to eutrophication because excess input of nutrients is considered as a major cause of coastal eutrophication. The importance of this target is also underlined by its close association with the SDG 14.1: "*By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution*". Experts from all four NOWPAP member states agreed that it is indeed possible to use nutrients concentration in the water column (DIN and DIP or TN and TP in case of Japan) as an EcoQO target. These parameters are included in routine monitoring in all NOWPAP member states and the data on nutrient concentrations are available from both scientific publications and official bulletins issued by the government agencies at different levels (in the latter case, with some limitations in China and Russia). In China and Korea, nutrient concentrations are also used to calculate the "Integrated Eutrophication Index" and "Water Quality Index" respectively.

All four NOWPAP member states have national standards for nutrients applicable to different types (or classes) of water areas. In most cases, these standards are being applied to water areas used for aquaculture and fisheries as well as for bathing and tourism, with less strict standards for harbors and industrial areas. In China, Japan and Russia, there are four classes of coastal waters. In Korea, until 2011, there were five classes of coastal waters distinguished based on TN, TP and four other parameters. After 2011, according to Water Quality Index (WQI) mentioned above, there are five classes of coastal waters distinguished according to the WQI values (calculated using DIN, DIP, DO and two other parameters). As an example, Tables 1 and 2 below show national standards of Japan and China for nutrient concentrations.

Table 1. Environmental quality standards of Japan for TN and TP (mg/L)

Indicator	Class I	Class II	Class III	Class IV
TN	≤0.2	≤0.3	≤0.6	≤1.0
TP	≤0.02	≤0.03	≤0.05	≤0.09

Class I - Conservation area
Class II - Bathing, good catch of wide variety of fish species
Class III - Good catch of most fish species except some demersal fish species
Class IV - Industrial water, catch of fishes tolerant to pollution

Table 2. National standards of China for DIN and DIP
(maximum permissible concentration, mg/L)

Indicator	First level	Second level	Third level	Fourth level
DIN	≤0.20	$0.20 < x \le 0.30$	$0.30 < x \le 0.40$	$0.40 < x \le 0.50$
DIP	≤0.015	$0.015 < x \le 0.030$		$0.030 < x \le 0.045$

In Korea, until 2011, national standards for TN and TP have been used which were similar to standards presented in Table 1 above (for water classes II-IV). Since 2011, WQI is being used (based on five parameters).

In the national report of Korea (and in expert presentation at the workshop), the term "baseline values" (or baseline levels, baseline concentrations, baseline conditions) has been introduced. It was originally applied only to five parameters (dissolved oxygen, *Chlorophyll a*, DIN, DIP and Secci depth). Since the 1980s, the Korean government has designated several environmental management sea areas (EMSAs). The location of nine EMSAs is shown on Figure 1.

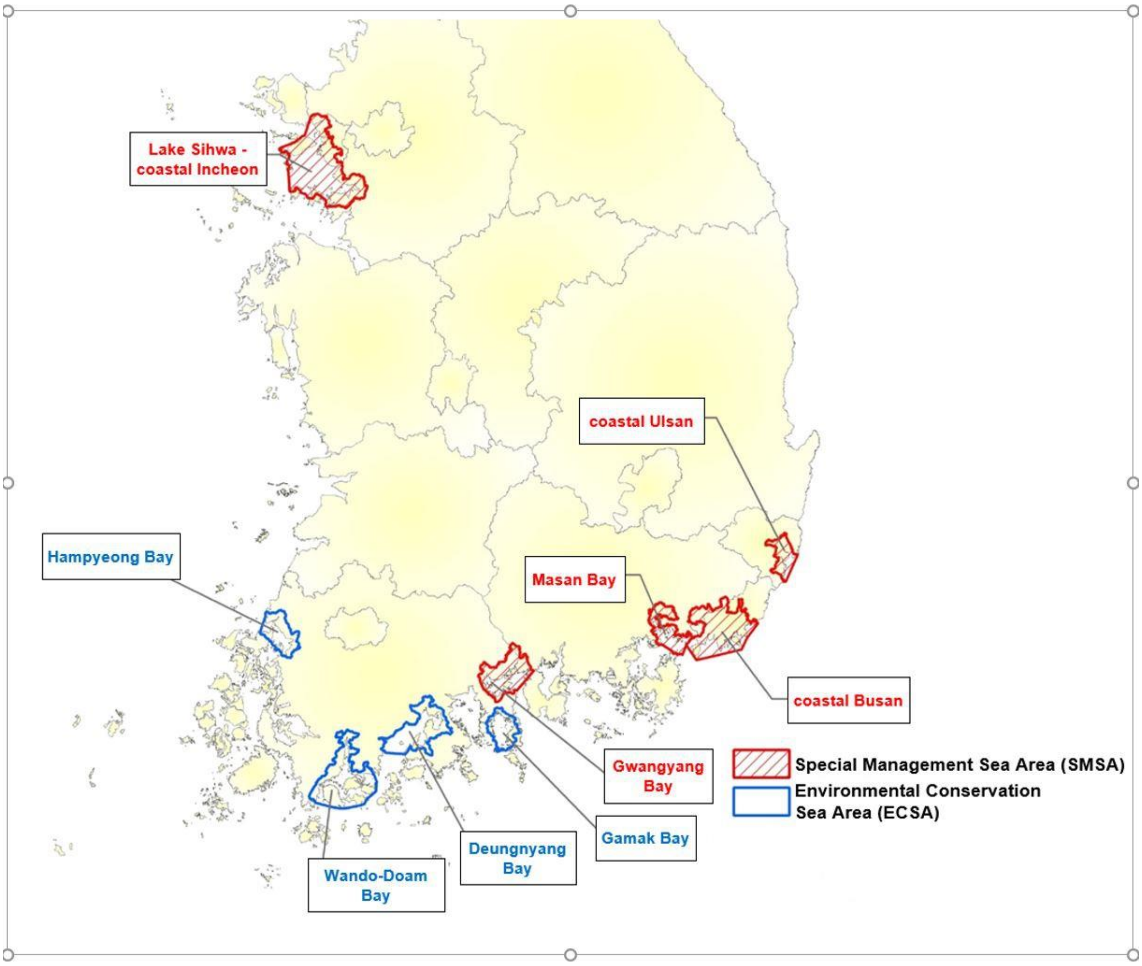

Figure 1. Locations of Environment Management Sea Areas (EMSAs) in Korea (as of 2018)

This concept of "baseline values" (to be applied to some other EcoQO targets as well) was discussed in some detail at the March 2019 workshop. As an example, Tables 3 and 4 below show baseline values of DIP and TP for several EMSAs in Korea. Using baseline values for setting EcoQO targets in relation to nutrients concentration might be advisable especially in case of Russia where national standard for DIN is very high: about 9 mg/L even for oligotrophic waters (standard for DIN is more realistic: 0.05 mg/L).

Table 3. Area-specific baseline conditions (median values) listed for each season (average of 2004-2017) for dissolved inorganic phosphorus (mg/L) in surface water of some Environmental Management Sea Areas (EMSAs) of Korea

EMSAs	Feb	May	Aug	Nov	Median	Range
Coastal Ulsan	0.027	0.014	0.009	0.023	0.020	0.034
Coastal Busan	0.015	0.013	0.009	0.022	0.015	0.022
Masan Bay	0.006	0.010	0.010	0.026	0.013	0.049
Gwangyang Bay	0.007	0.011	0.016	0.029	0.013	0.031
Gamak Bay	0.006	0.005	0.006	0.014	0.006	0.021

Table 4. Area-specific baseline conditions (median values) listed for each season (average of 2004-2017) for total phosphorus (mg/L) in surface water of some Environmental Management Sea Areas (EMSAs) of Korea

EMSAs	Feb	May	Aug	Nov	Median	Range
Masan Bay	0.032	0.054	0.058	0.057	0.051	0.073
Gwangyang Bay	0.026	0.029	0.050	0.043	0.035	0.191
Coastal Ulsan	0.034	0.032	0.040	0.032	0.034	0.042
Coastal Busan	0.027	0.029	0.032	0.033	0.029	0.027
Gamak Bay	0.023	0.023	0.027	0.030	0.026	0.083

●●● Summary ●●●

At the workshop held in Vladivostok in March 2019, nominated experts from NOWPAP member states have agreed on the following NOWPAP EcoQO target: **Nutrient concentrations in the water column within the designated area do not exceed the baseline values or existing national standards**.

Note: Baseline values could be decided by each country and will be confirmed by correspondence, taking into account past CEARAC studies on this issue to avoid unnecessary work.

2.2. Nutrient ratios

As mentioned in part 2.1 above, nutrient concentrations are being routinely monitored by all four NOWPAP member states. As an example, Figure 1 below shows monitoring network in Korea (425 stations in total). According to the Korean government decisions, there are nine Environmental Management Sea Areas (EMSAs), including Masan bay and coastal areas near Ulsan (suggested as designated areas in Korea for testing NOWPAP EcoQO targets). In China, monitoring of coastal water quality is being carried out three times a year and the results are summarized in annual bulletins issued by the Ministry of Ecology and Environment. In Japan, there are a few thousand monitoring points around the country where coastal water quality is being checked regularly according to the existing national standards. Regular monitoring of coastal water quality in Russia is being done by ROSHYDROMET.

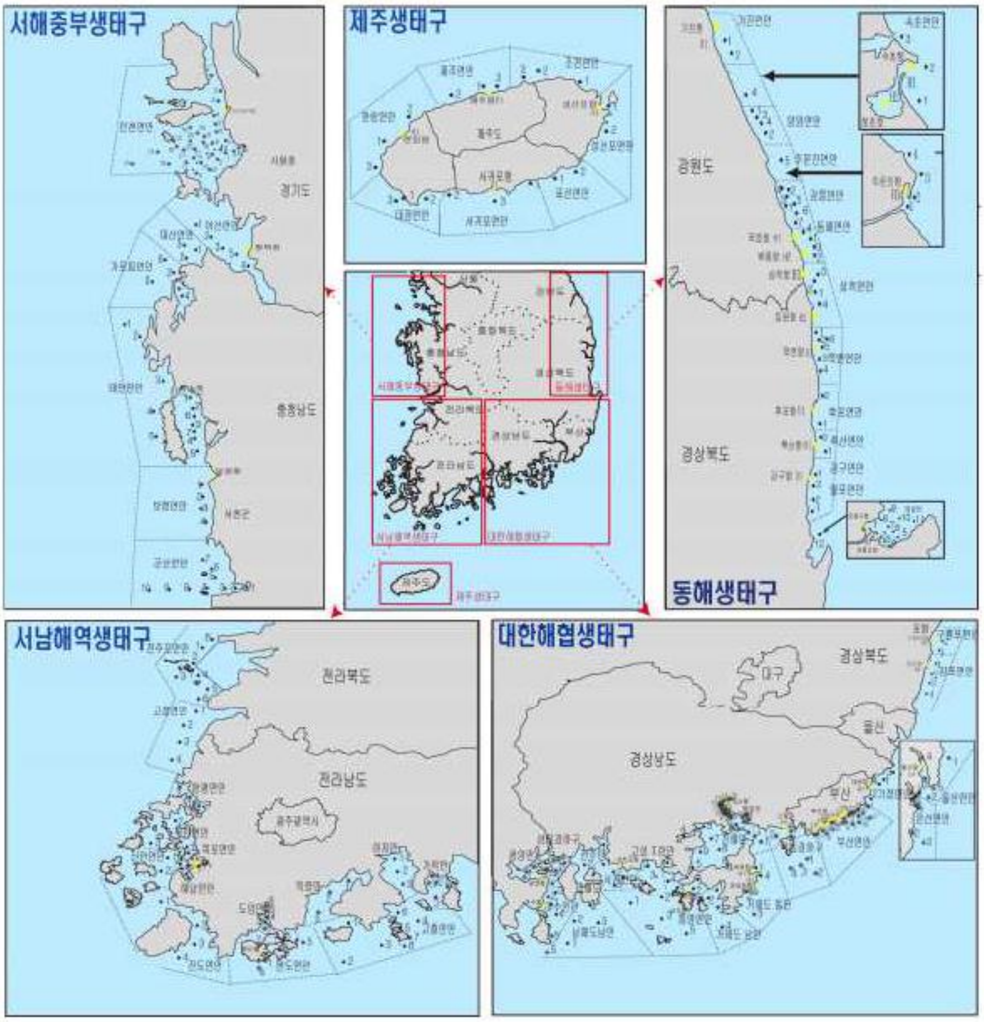

Figure 2. Map showing the stations of national monitoring network in Korea (as of 2017)

Therefore, theoretically there is no problem to calculate nutrient ratios (at least N/P ratio, as Si is not measured routinely in Japan). However, there are no national standards on N/P ratio in any NOWPAP member state. Even if N/P ratio is different from the Redfield ratio (16:1), it is difficult to interpret such deviation as a direct result of eutrophication.

In China, there were numerous studies regarding the relationship between nutrient ratios and phytoplankton growth (e.g., Huang et al., 2007; Ou et al., 2007; Zhu et al., 2018). It was concluded that nutrient ratios alone could not be a reliable indicator of eutrophication. As the nutrient ratios are not included in the current monitoring system in China, there are no such data in official bulletins and no national standards.

In Japan, during the rapid industrialization after the World War II, loads of N and P to the sea have dramatically increased (especially compared to the load of Si) which resulted in serious eutrophication. Diatom-dominated phytoplankton has been gradually replaced by dinoflagellate-dominated community. In recent decades, however, due to introduction of the Total Pollution Load Control (TPLC) in some restricted areas, the situation has improved significantly. However, national standards in Japan are available for TN and TP (not for Si) rather than for any nutrient ratio. Therefore, Japanese experts considered not appropriate setting a target for nutrient ratios.

Korean and Russian experts also concluded that in spite of obvious effects of changing nutrient ratios on phytoplankton communities in coastal areas of their respective countries (e.g., Baek et al., 2015; Zuenko, 2008), they cannot be used as direct indicator of eutrophication and therefore there are no national standards on nutrient ratios in both countries (as well as in Japan and China).

●●● Summary ●●●

As a result, at the workshop held in Vladivostok in March 2019, nominated experts from NOWPAP member states have agreed that **nutrient ratios could not be used as an indicator related to eutrophication in the NOWPAP sea area.**

2.3. *Chlorophyll a* concentration in the water column

Chlorophyll a is a good indicator of the phytoplankton biomass and could be used to estimate the status of eutrophication in coastal waters. Advantages of this indicator are: possibility to use remote sensing data covering large sea areas and availability of numerous data in both scientific publications and government bulletins (with some limitations in China and Russia). Experts of NOWPAP CEARAC have been using remotely sensed *Chlorophyll a* data while developing the "NOWPAP Common Procedure for Eutrophication Assessment" (see http://cearac.nowpap.org/publications/technical-report/eutrophication.html) and, more recently, the "NOWPAP Eutrophication Assessment Tool" (NEAT). The importance of using *Chlorophyll a* as an indicator (and target) is underscored by the possibility to align NOWPAP EcoQO targets with the SDG proxy indicator 14.1.1 (at this stage, *Chlorophyll a* concentration is still considered as proxy SDG indicator, at least till 2021).

Figures 3 and 4 below illustrate spatial and temporal distribution of *Chlorophyll a* in coastal areas of China and Russia respectively (using remote sensing data), while Figure 5 shows how *in situ* data could be used to analyze vertical distribution of *Chlorophyll a*.

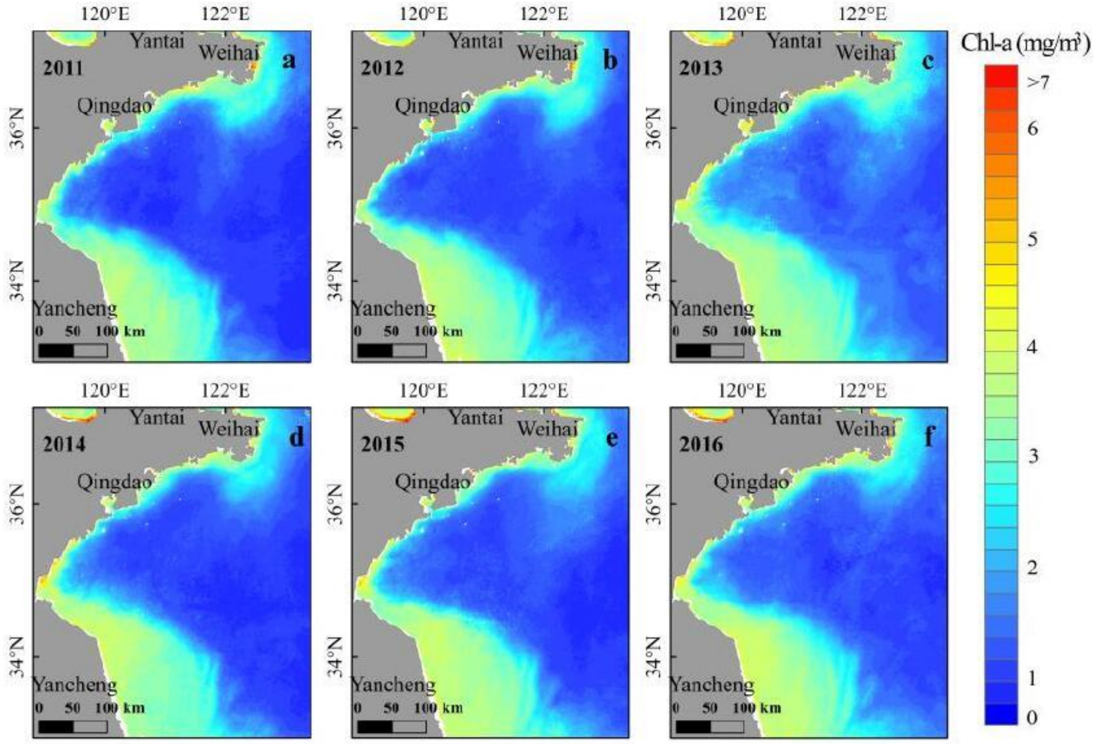

Figure 3. The horizontal distribution of *Chlorophyll a* in the Yellow Sea: remote sensing data from 2011 to 2016 (Sun, 2018)

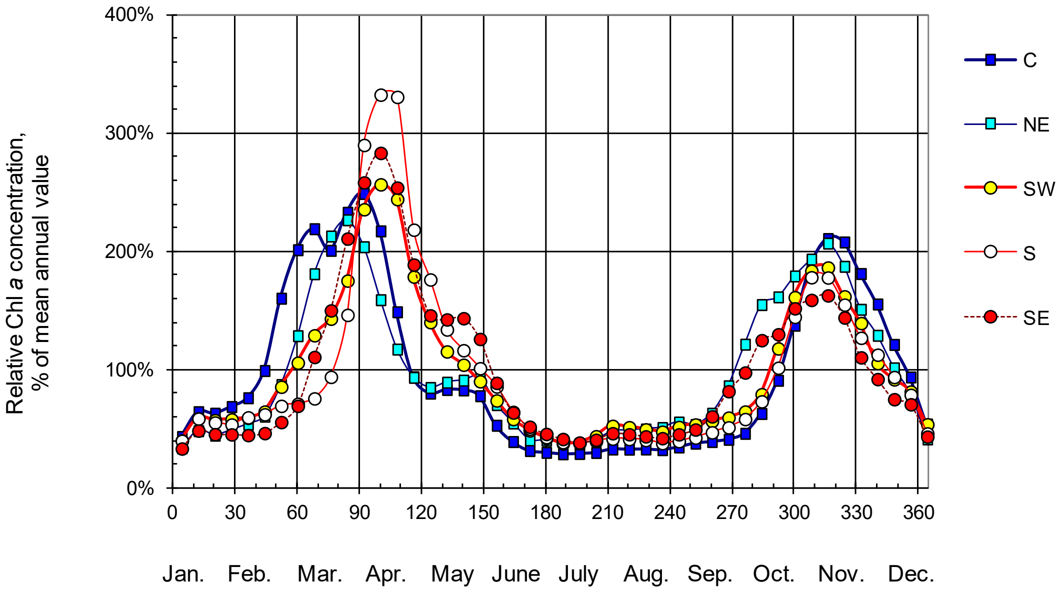

Figure 4. Seasonal changes of mean *Chlorophyll a* concentrations (for 1998-2008) at the sea surface measured by satellite color scanners in different areas of Peter the Great Bay (relative to the mean annual values for each area): C – central, NE – northeastern, SW – southwestern, S – southern, SE - southeastern (Zuenko, 2012)

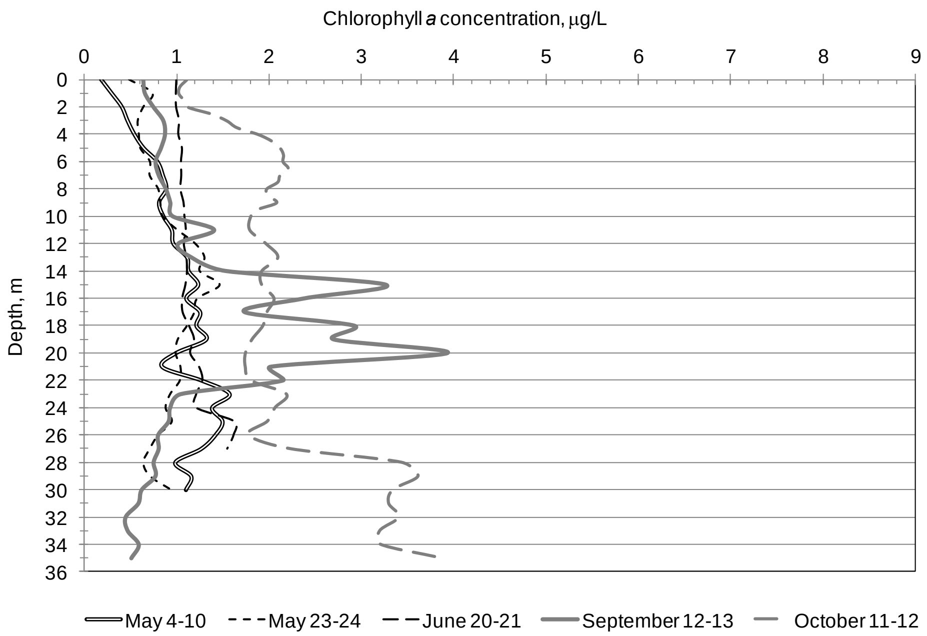

Figure 5. Vertical *Chlorophyll a* profiles averaged for the southern Amursky Bay in May-October 2017 (Zharova, Zuenko, 2018)

While developing the NOWPAP "Common Procedure for Eutrophication Assessment", CEARAC experts used both levels and trends of several parameters (see Figure 6 below as applied to *Chlorophyll a* data).

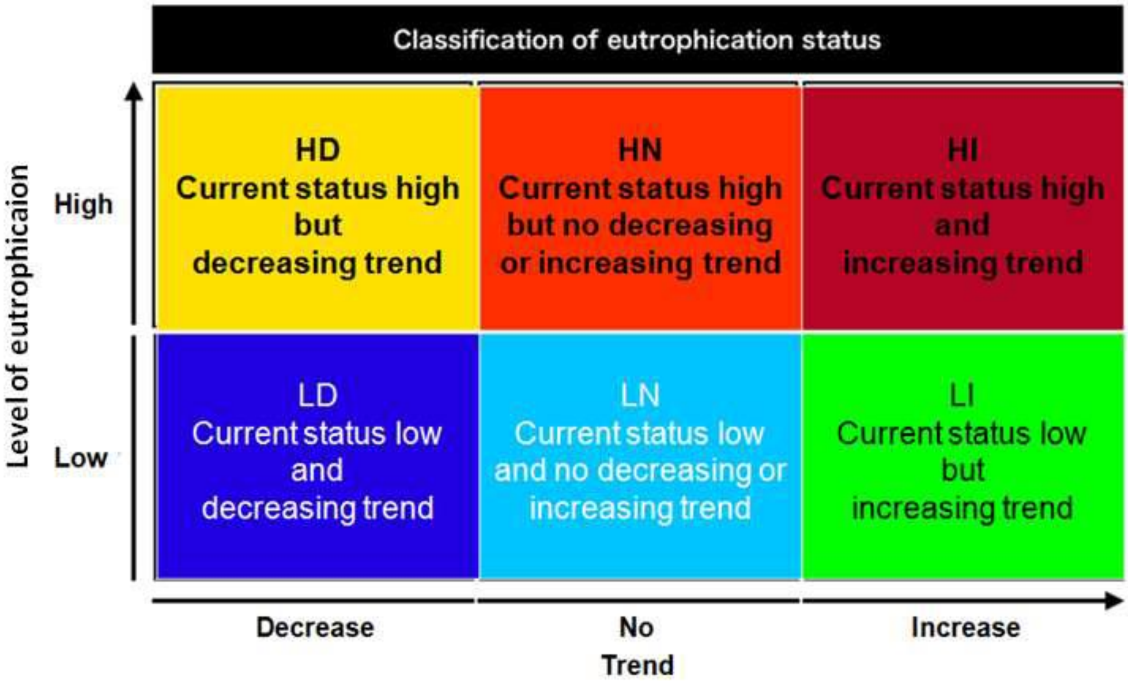

Figure 6. Classification of eutrophication status using both levels and trends of remotely sensed *Chlorophyll a* data

As a result of their extensive work (see, for example, CEARAC, 2011; Zvalinsky et al., 2013; CEARAC, 2014), it was possible to define "reference values" of several parameters for the well-studied designated areas in China, Japan, Korea and Russia. At the workshop held in Vladivostok, Russia, in March 2019, nominated national experts have agreed that CEARAC experience in defining reference values of nutrients, *Chlorophyll a*, and other parameters related to eutrophication should be used in the future work on EcoQO targets. In some cases, CEARAC reference values could be considered as baseline values when setting the EcoQO targets. As an example, Table 5 below shows baseline values of *Chlorophyll a* for several EMSAs in Korea.

Table 5. Area-specific baseline conditions (median values) listed for each season (average of 2004-2017) for *Chlorophyll a* (μg/L) in surface water of some Environmental Management Sea Areas of Korea

EMSAs	Feb	May	Aug	Nov	Median	Range
Masan Bay	9.079	11.401	10.038	7.780	9.982	28.127
Gwangyang Bay	5.264	4.174	6.583	2.401	4.262	14.467
Gamak Bay	2.748	2.485	3.712	2.367	2.802	12.032
Coastal Busan	1.827	4.394	7.308	1.914	2.551	10.942
Coastal Ulsan	0.936	6.313	9.159	1.762	2.504	22.559

●●● Summary ●●●

While there are no official government standards for *Chlorophyll a* concentrations in NOWPAP member states, it is possible to use baseline values as a benchmark. Therefore, at the workshop held in Vladivostok in March 2019, nominated experts from NOWPAP member states have agreed on the following NOWPAP EcoQO target: ***Chlorophyll a* concentrations within the designated areas do not exceed the baseline values.**

Note: Baseline values will be decided by each country and will be confirmed by correspondence, taking into account past CEARAC studies on this issue. For this particular target, *in situ* data will be used.

2.4. Harmful algal blooms

Harmful algal blooms (HABs) are observed in coastal areas of all NOWPAP member states, and NOWPAP CEARAC has prepared several reports and guidelines related to HABs (see for example the following link: http://cearac.nowpap.org/publications/technical-report/hab.html). In China, in addition to phytoplankton blooms, blooms of macroalgae are being observed, covering large sea areas (Table 6). These events are sometimes called "green tides" (see, for example, Wang et al., 2018). After 2015, the total area covered by the "green tides" in the Yellow Sea has been decreasing (Table 7).

Table 6. Harmful microalgae blooms (HABs) and opportunistic macroalgae blooms (OMBs) in the Yellow Sea from 2009 to 2015

Year	Frequency of HABs	Area of HABs (km^2)	Area of OMBs (km^2)
2009	13	1,878	
2010	9	735	530
2011	8	4,242	560
2012	11	1,333	267
2013	2	450	790
2014	2	19	540
2015	1	48	594

Table 7. Scale of green tides in the Yellow Sea from 2013 to 2017

Year	Maximum area of coverage (km^2)
2013	790
2014	540
2015	594
2016	554
2017	281

As for red tides in China, their frequency is not yet decreasing in recent years and they mostly happen in May-June (Figure 7).

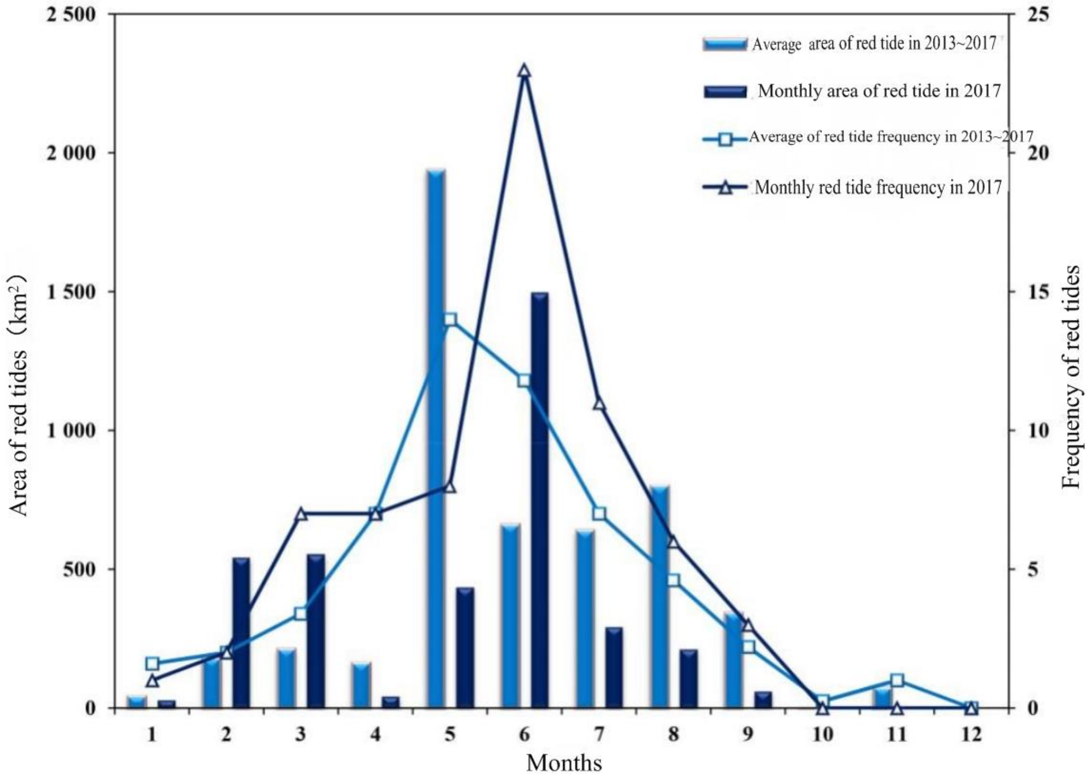

Figure 7. Monthly variation of red tide frequency and area in China from 2013 to 2017

In Japan, HABs have caused significant negative impact on coastal fisheries and aquaculture in the past. In recent years, due to government countermeasures and better mariculture techniques, situation has improved. Both in China and in Japan, there are national standards related to paralytic shellfish poisoning (PSP), diarrhetic shellfish poisoning (DSP), and amnesic shellfish poisoning (ASP).

In Korea, monitoring of HABs is being carried out on a monthly basis. The warning system is operational in order to issue forecasts to fisheries and aquaculture. Table 8 shows annual frequency of HABs in coastal waters around Korea from 2012 to 2017. Korean experts concluded that the occurrence of HABs does not necessarily indicate eutrophication in the coastal waters. Sometimes the initial occurrence of harmful phytoplankton happened offshore and only then moved into coastal areas (Lee et al., 2013).

Table 8. Annual frequency of HAB occurrence in some Environmental Management Sea Areas (EMSAs) of Korea during 2012-2017

EMSAs	Year					
	2012	2013	2014	2015	2016	2017
Gwangyang Bay	17	26	1	18	0	0
Masan Bay	2	1	2	5	2	0
Coastal Busan	1	1	4	5	5	5
Coastal Ulsan	0	18	15	22	0	0
Gamak Bay	18	40	14	17	9	1

In the Russian Far East, coastal aquaculture is less developed comparing with other NOWPAP member states. However, observations of "red tides" and toxin-producing phytoplankton blooms are being carried out (mostly by research institutions, see for example www.imb.dvo.ru/misc/toxicalgae) and certain amount of data is available. Data are submitted to the Harmful Algae Event Database (HAEDAT, http://haedat.iode.org). Food safety standards for PSP, ASP and DSP have been also introduced. Russian experts also concluded that possibility to applying red tide events as the indicator of eutrophication is rather low because there are many natural factors affecting phytoplankton communities.

●●● Summary ●●●

In spite of obvious negative impacts of green tides, red tides, and toxin-producing algae, experts agreed that it is difficult to use HABs as an indicator of eutrophication (and as an EcoQO target). For example, some HABs could be caused by natural factors. Therefore, at the workshop held in Vladivostok in March 2019, nominated experts from NOWPAP member states have agreed that **HAB frequency could not be used as an indicator related to eutrophication in the NOWPAP sea area.**

2.5. Concentration of contaminants in water and sediments

Contaminants in seawater, bottom sediments and marine organisms are being measured in all NOWPAP member states. For example, in China, contaminants in seawater are measured three times a year and once a year in bottom sediments. In Korea, trace metals in seawater, sediments and biota are measured at 198 stations (as of 2019) while persistent organic pollutants are being monitored at about 100 stations.

However, national standards for contaminants in NOWPAP member states are not yet established for all media (Table 9): standards were mostly established for contaminant concentrations in seawater and in some organisms (used for human consumption). Table 10 shows comparison of maximum permissible concentrations in seawater; more detailed information on national standards for seawater, sediments and biota is compiled in Annex 1.

Table 9. Availability of national standards on contaminants in different media in NOWPAP member states

Media	China	Japan	Korea	Russia
Seawater	Available	Available	Available	Available
Bottom sediments	Available	Not available	Partly available[a]	Not available
Biota	Available	Not available	Partly available[b]	Available

[a]For trace metals only, not yet for PTS

[b]Food safety standards only, not yet for marine organisms

Table 10. Comparison of national standards for some contaminants in seawater (μg/L)

Contaminants	China (second level)	Japan (public waters)	Korea (acute toxicity)	Russia (fishery areas)
Hg	0.2	0.5	1.8	0.1
Cd	5	3	19	10
Pb	5	10	7.6	10
Cu	10	---	3.0	5
Ni	10	---	11	10
Zn	50	---	34	50
DDTs	0.1	---	---	0.01
HCHs	2	---	---	0.01

Data on contaminants in coastal areas (in seawater, bottom sediments and biota) are available from scientific publications and to some extent from government bulletins (with some restrictions in China and Russia).

●●● Summary ●●●

At the workshop held in Vladivostok in March 2019, nominated experts from NOWPAP member states have agreed on the following NOWPAP EcoQO target: **During the last 5 years, contaminant concentrations in water and surface sediments within the designated area do not exceed the existing national standards or baseline values.**

Note: Spatial variability in surface sediments should be taken into account. If stations of different classes exist within the designated area, certain stations could be selected for testing this particular EcoQO target.

2.6. Trends in the amount and composition of litter washed ashore

NOWPAP member states have adopted the "Regional Action Plan on Marine Litter" (RAP MALI) in 2008. Each member state is implementing numerous actions against marine litter (ML), including observations of marine litter washed ashore (in some countries, monitoring of marine litter on the sea surface and on the bottom is also carried out). This EcoQO indicator (and target) is important as it might be possible to align it with the SDG 14.1.1 indicator (at this stage, beach litter is being used as proxy indicator, at least till 2021).

In Japan, in recent years, monitoring of seabed marine litter, floating marine litter and microplastics has been intensified with five research vessels involved (from four different universities) along with observations on beaches.

In Korea, national beach litter surveys have been carried out since 2008 at 20 beaches. Since 2014, 20 more monitoring sites were added. Monitoring data are open to the public (www.malic.or.kr) and show decreasing trend from 2008 to 2017 (Figure 8).

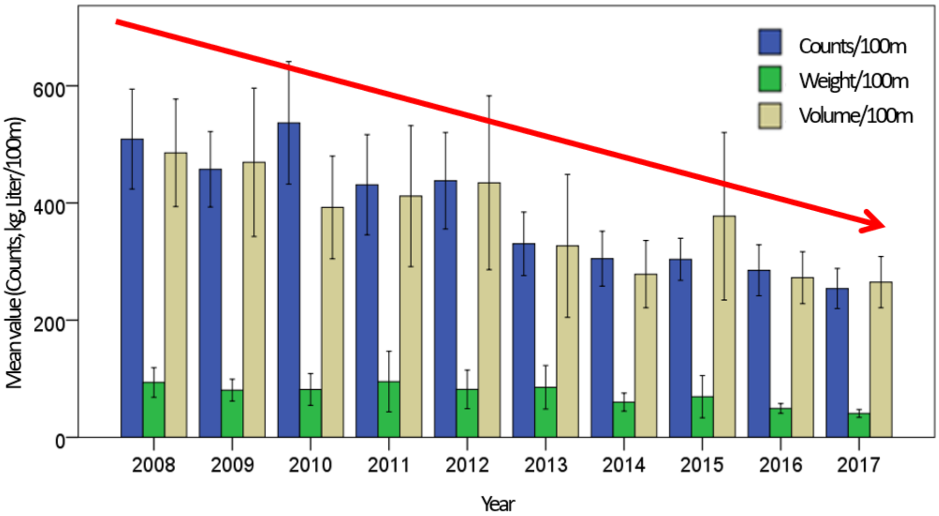

Figure 8. Interannual trend of marine litter washed ashore in Korea

In China, monitoring of floating litter, litter on seabed and on beaches was carried out in 49 regions around the country in 2016 (Figure 9). The results were published in the Marine Environment Quality Bulletin. Not surprisingly, 76% of marine litter on beaches was plastic. On the seabed, plastic represented 74% of marine litter. In 2018, some functions of the former State Oceanic Administration of China have been transferred to the "upgraded" Ministry of Ecology and Environment. Hopefully, after some transition period, data of marine litter monitoring will continue to be available through the government bulletins.

In the Russian Far East, unlike in Japan or Korea (where litter washed ashore is coming from other countries or regions with sea currents), "land-originated" litter is prevailing. So far, there is no national monitoring programme for marine litter. Therefore, most data are available due to annual International Coastal Cleanup (ICC) campaigns, originally introduced to the Russian Far East by the NOWPAP. Figure 10 shows, as an example, the sites of beach cleanup campaigns in Primorsky Kray of Russia in 2014. Table 11 shows the results of beach cleanup campaigns from 2007 to 2018 in Primorsky Kray of Russia.

Figure 9. The distribution of marine litter in the coastal areas of China within NOWPAP region in 2016

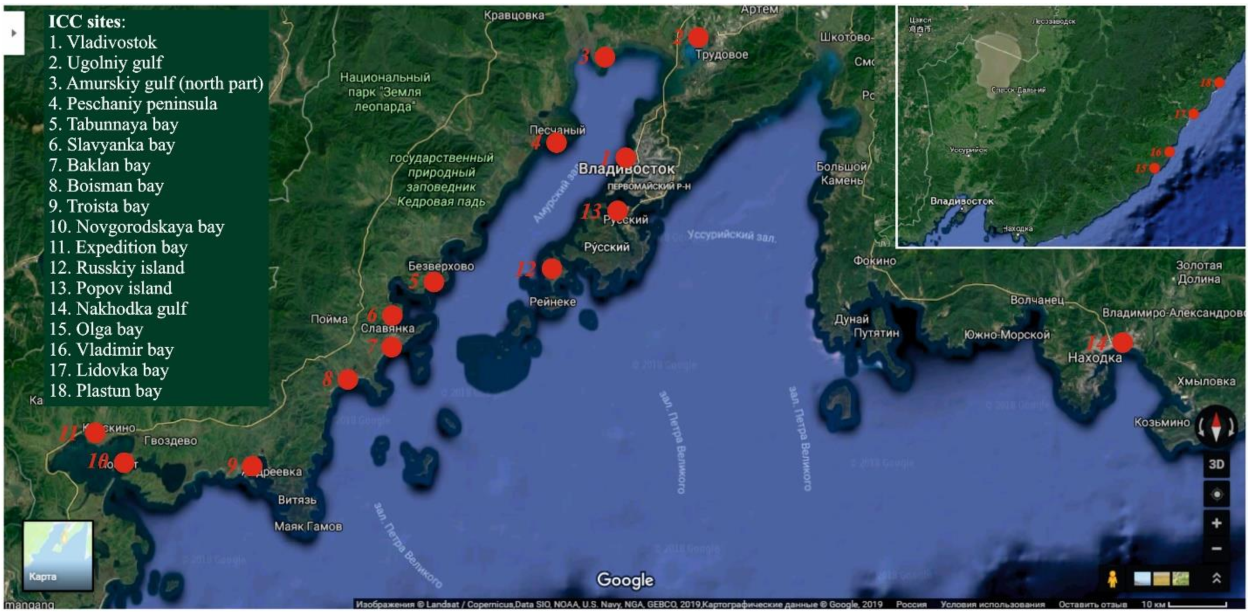

Figure 10. Beach cleanup sites in Primorsky Kray in 2014

Table 11. Marine litter data from beach cleanup campaigns, 2007 – 2018

Year	**Area, m^2**	**Collected marine litter, kg**				
		Total	Plastic	Metal	Glass	Other
2007	1,800	44.3	14	4.4	5.7	20.2
2008	6,000	27.7	14.9	2.4	0.9	9.5
2009	8,500	408.25	65.25	23	116.3	203.7
2010	1,590	188.5	54.5	65	55	14
2011	23,107	108.1	42.3	12.1	23.7	30
2012	23,510	518.3	146	58.8	193.4	120.1
2013	9,187	234.9	124	47.1	32.7	31.1
2014	1,525	22.7	4.7	2	4.5	11.5
2015	7,661	43.3	9.7	7.1	16	10.5
2016	1,856	66.5	22.4	19.4	13.9	10.8
2017	470	22.2	2.3	0.7	1.4	17.8
2018	3,200	373	141	50.5	116	65.5

●●● Summary ●●●

After careful consideration (especially regarding the lack of data on floating and seabed litter in some countries), at the workshop held in Vladivostok in March 2019, nominated experts from NOWPAP member states have agreed on the following NOWPAP EcoQO target: **During the last 5 years, there is a decreasing trend (statistically significant) in the amount of marine litter washed ashore.**

Note: In addition to regular monitoring results, data from annual International Coastal Cleanup (ICC) campaigns (held in the same area every year) might be used at the initial stage. Units might differ in different countries, i.e. it could be weight/volume/number of items per square meter or per 100 meters of shore length. Decreasing trend should be confirmed by common statistical tests.

3. Conclusions and possible way forward

Table 12 below is a summary of discussions at the March 2019 workshop in Vladivostok, Russia. It is interesting to note that NOWPAP EcoQO targets agreed upon by experts nominated by NOWPAP member states are in line with similar decisions of HELCOM, MAP, OSPAR and YSLME. For example, similar "reference concentrations" are being used by MAP (equivalent to "baseline values" in case of NOWPAP), while "threshold values" are being used by HELCOM for their "assessment units" (equivalent to "baseline values" in the "designated areas" in case of NOWPAP). Regarding marine litter, YSLME is aiming at "reduced standing stock" of ML and MAP is aiming at "decreasing trend" of ML. Perhaps it is not surprising, as NOWPAP experts tried to take into account best experiences from other Regional Seas programmes around the world. It is also worth noting that HELCOM, MAP and OSPAR do not use nutrient ratios and HAB occurrence frequency as targets.

Table 12. Summary of discussions at the March 2019 workshop in Vladivostok, Russia

Indicators	NOWPAP EcoQO targets
Nutrients concentration in the water column	**Nutrient concentrations in the water column within the designated area do not exceed the baseline values or existing national standards.** **Note:** Baseline values could be decided by each country and will be confirmed by correspondence, taking into account past CEARAC studies on this issue to avoid unnecessary work.
Nutrient ratios	National experts agreed that nutrient ratios could not be used as an indicator related to eutrophication in the NOWPAP sea area.
Chlorophyll a concentration in the water column	***Chlorophyll a* concentrations within the designated areas do not exceed the baseline values.** **Note:** Baseline values will be decided by each country and will be confirmed by correspondence, taking into account past CEARAC studies on this issue. For this particular target, *in situ* data will be used.
Harmful Algal Blooms (HABs)	National experts agreed that HAB frequency could not be used as an indicator related to eutrophication in the NOWPAP sea area.
Concentration of contaminants in water and sediments	**During the last 5 years, contaminant concentrations in water and surface sediments within the designated area do not exceed the existing national standards or baseline values.** **Note:** Spatial variability in surface sediments should be taken into account. If stations of different classes exist within the designated area, certain stations could be selected for testing this particular EcoQO target.
Trends in the amount and composition of litter washed ashore	**During the last 5 years, there is a decreasing trend (statistically significant) in the amount of marine litter washed ashore.** **Note:** In addition to regular monitoring results, data from annual International Coastal Cleanup (ICC) campaigns (held in the same area every year) might be used at the initial stage. Units might differ in different countries, i.e. it could be weight/volume/number of items per square meter or per 100 meters of shore length. Decreasing trend should be confirmed by common statistical tests.

Regarding the target on marine litter washed ashore, Japan has expressed their concern as follows. While the efforts to monitor and remove marine litter from the beaches are intensified, it is possible that survey results might show increase of marine litter washed ashore. However, such increase might be the result of more thorough monitoring rather than actual increase of marine litter accumulated on beaches. This consideration should be kept in mind while organizing regular surveys in NOWPAP member states.

3.1. Possible alignment with SDG indicators

Among four NOWPAP EcoQO targets agreed upon by experts (see Table 12 above), three might be theoretically aligned with the following SDG 14.1.1 indicator: Index of Coastal Eutrophication Potential (ICEP) and Floating plastic debris density. However, according to the decisions of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs), until approximately 2021, proxy indicators will be used instead: *Chlorophyll a* and beach litter. As the majority of Regional Seas programmes (and their participating countries) around the world also use *Chlorophyll a* and beach litter data (only limited number of countries have data about floating debris and in many countries there is not enough data and modeling experience to calculate ICEP), there is a strong possibility that these parameters will become core indicators (rather than proxy ones). Therefore, the process of alignment will have to wait till approximately 2021.

3.2. Possible way forward for NOWPAP RACs

The following way forward regarding NOWPAP EcoQO targets is suggested for the next biennium (2020-2021) and beyond (2022-2023).

- Nominated experts from each NOWPAP member state decide on baseline values for their designated areas to be used for testing agreed EcoQO targets and share their decisions with experts from all other member states (via POMRAC). CEARAC will be invited to participate actively in the elaboration of baseline values for the targets related to eutrophication.
- Nominated national experts test the four agreed EcoQO targets using monitoring data within their designated areas, checking if monitoring data in their designated areas are within the agreed targets or not and if agreed EcoQO targets are feasible and easily applicable in practice.
- In 2021 (tentatively), a joint regional POMRAC-CEARAC workshop is held where nominated experts discuss the EcoQO targets agreed upon earlier (together with recent national monitoring data within the designated areas) and consider if any changes in regional EcoQO targets are needed. Close cooperation between POMRAC and CEARAC in relation to EcoQO targets is strongly recommended.

Later on (in 2022-2023), while discussing the EcoQO targets agreed upon earlier, nominated national experts might take into account the following:

- Recent developments in SDG-14 indicators (e.g. if *Chlorophyll a* and beach litter proxy indicators are still being used or new indicators have been developed and approved).
- Recent developments in HELCOM, MAP and OSPAR (since publication of their integrated assessment reports in 2017-2018); in the UNEP Working Group on indicators; and working groups on eutrophication and floating plastic debris density.
- Recent developments in the YSLME-II project (to be completed in 2019) where similar targets on nutrients and marine litter were suggested and might be tested in some “pilot sites” in China and Korea.

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Annex 1. National standards of NOWPAP member states for some contaminants

Table A1. National standards of China for some contaminants in seawater (maximum permissible concentration, μg/L)

Contaminant	First level	Second level	Third level	Fourth level
Hg	0.05	0.2		45
Cd	1	5	10	
Pb	1	5	10	50
Cr^{6+}	5	10	20	50
Total Cr	50	100	200	500
As	20	30	50	
Cu	5	10	50	
Zn	20	50	100	500
Se	10	20	50	
Ni	5	10	20	50
HCHs	1	2	3	5
DDTs	0.05	0.1		

Table A2. National standards of China for some contaminants in marine sediments (maximum permissible concentration, mg/kg)

Indicator	First level	Second level	Third level
Hg	0.20	0.50	1.00
Cd	0.50	1.50	5.00
Pb	60.0	130.0	250.0
Cu	35.0	100.0	200.0
Zn	150.0	350.0	600.0
Cr	80.0	150.0	270.0
As	20.0	65.0	93.0
HCHs	0.50	1.00	1.50
DDTs	0.02	0.05	0.10
PCBs	0.02	0.20	0.60

Table A3. National standards of China for some contaminants in marine organisms (maximum permissible concentration, mg/kg)

Indicator	First level	Second level	Third level
Total Hg	0.05	0.10	0.30
Cd	0.2	2.0	5.0
Pb	0.1	2.0	6.0
Cu	10	25	50 (100 for oysters)
Zn	20	50	100 (500 for oysters)
Cr	0.5	2.0	6.0
As	1.0	5.0	8.0
PHCs	15	50	80
DDTs	0.01	0.10	0.50
HCHs	0.02	0.15	0.50

Table A4. National standards of Japan (µg/L) for some contaminants for human health protection (public water areas)

Chemical	Maximum permissible concentrations
Cd	3
Pb	10
As	10
Total Hg	0.5
Cr^{+6}	50

Table A5. National standards of Korea for some contaminants in seawater (µg/L) for ecosystem protection

Toxicity	Cu	Pb	Zn	As	Cd	Cr^{6+}	Hg	Ni
Acute	3.0	7.6	34	9.4	19	200	1.8	11
Chronic	1.2	1.6	11	3.4	2.2	2.8	1.0	1.8

Table A6. National standards of Korea for some contaminants in bottom sediments (mg/kg, dry weight)

Toxicity	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
TEL[a]	14.5	0.75	116	20.6	0.11	47.2	44.0	68.4
PEL[b]	75.5	2.72	181	64.4	0.62	80.5	119	157

[a]TEL: Threshold Effects Level

[b]PEL: Probable Effects Level

Table A7. Food safety standards (mg/kg) of Korea for heavy metals in some marine organisms

Heavy metals	Fish	Mollusk	Crustacean
Pb	0.5	2.0[a]	0.5[b]
Cd	2.0	2.0[c]	1.0[d]
Hg	0.5[e]	0.5	-

[a]1.0 for squids, 2.0 for octopus with intestine

[b]2.0 for blue crabs with intestine

[c]3.0 for octopus with intestine

[d]5.0 for blue crabs with intestine

[e]1.0 for fish eggs, 2.0 for cephalopods

Table A8. National standards of Russia for some contaminants in seawater (maximum permissible concentration, mg/L)

Parameter	Public water areas	Waters for fishery purpose
Cd	0.001	0.01
Ni	0.1	0.01
Cu	1.0	0.005
As	0.05	0.01
Hg	0.0005	0.0001
Cr^{+6}	0.05	0.02
Zn	1.0	0.05
Pb	0.03	0.01
HCHs	0.02	<0.00001
DDTs	0.1	<0.00001
PCBs	0.001	0.0001

Table A9. National food safety standards of Russia for some contaminants in aquatic organisms (maximum permissible concentration, mg/kg wet weight)

Contaminant	Fish	Mollusks and other invertebrates
As	5.0	5
Pb	1.0	10
Pb (tuna, swordfish, sturgeons)	2.0	---
Cd	0.2	2.0
Hg	0.5	0.2
Hg (tuna, swordfish, sturgeons)	1.0	---
Cu	10	30
Zn	40	200
HCHs	0.2	---
DDTs	0.2 (fresh meat), 3.0 (liver)	---
DDTs (sturgeons, salmon, herring and other fat fish)	2.0	---