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Regional overview of possible Ecological Quality Objective indicators for the NOWPAP region

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Vladivostok, Russia

2017

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List of acronyms

BOD	- Biological Oxygen Demand
BSAP	- Baltic Sea Action Plan
CBD	- Convention on Biological Diversity
CEARAC	- Special Monitoring and Coastal Environment Assessment Regional Activity Center
COD	- Chemical Oxygen Demand
CoMMA	- Conservation and Management of Marine Ecosystems Act
DDT	- Dichlorodiphenyltrichloroethane
DIN	- Dissolved Inorganic Nitrogen
DINRAC	- Data and Information Network Regional Activity Center
DIP	- Dissolved Inorganic Phosphorus
DO	- Dissolved Oxygen
DON	- Dissolved Organic Nitrogen
DOP	- Dissolved Organic Phosphorus
EBM	- Ecosystem Based Management
EBSA	- Ecologically or Biologically Significant Area
EC	- European Commission
EU	- European Union
EcoQO	- Ecological Quality Objective
GDP	- Gross Domestic Product
GES	- Good Environmental Status
GN	- Hygienic Norm (transliteration of the Russian acronym)
HAB	- Harmful Algal Bloom
HCB	- Hexachlorobenzene

HCH	- Hexachlorocyclohexane
HELCOM	- Helsinki Commission
IA2017	- Interim Assessment 2017
IAEG-SDGs	- Inter-Agency Expert Group on Sustainable Development Goals
ICM	- Integrated Coastal Management
I-MEM	- Integrated Marine Ecosystem Monitoring
JAMSTEC	- Japan Agency for Marine-Earth Science and Technology
JFRCA	- Japan Fisheries Resource Conservation Association
JODC	- Japan Oceanographic Data Center
KOEM	- Korea Ocean Environment Management Corporation
MAP	- Mediterranean Action Plan
MEMA	- Marine Environment Management Act
MEP	- Ministry of Environmental Protection
MERRAC	- Marine Environmental Emergency Preparedness Regional Activity Center
MNR	- Ministry of Natural Resources
MPA	- Marine Protected Area
MPC	- Maximum Permissible Concentration
MPD	- Maximum Permissible Discharge
MSFD	- Marine Strategy Framework Directive
NPEC	- Northwest Pacific Region Environmental Cooperation Center
NFRDI (NIFS)	- National Fisheries Research and Development Institute (now National Institute of Fisheries Science)
NOWPAP	- Northwest Pacific Action Plan
OPRF (OPRI)	- Ocean Policy Research Foundation (now Ocean Policy Research Institute)
OSPAR	- Oslo and Paris Conventions
PCB	- Polychlorinated Biphenyl

PEMSEA	- Partnerships in Environmental Management for the Seas of East Asia
PHCs	- Petroleum hydrocarbons
PICES	- North Pacific Marine Science Organization
POMRAC	- Pollution Monitoring Regional Activity Center
POPs	- Persistent Organic Pollutants
RAC	- Regional Activity Center
ROK	- Republic of Korea
SanPIN	- Sanitary Norms and Regulations (transliteration of the Russian acronym)
SDGs	- Sustainable Development Goals
SOA	- State Oceanic Administration
SOI	- State Oceanographic Institute
SOMER	- State of the Marine Environment Report
SS	- Suspended Solids
TINRO-Center	- Pacific Institute of Fisheries and Oceanography (transliteration of the Russian acronym)
TL	- Toxicity Level
TN	- Total Nitrogen
TP	- Total Phosphorus
TPLC	- Total Pollutant Load Control
TPLMS	- Total Pollution Load Management System
UNEA	- United Nations Environment Assembly
UNEP	- United Nations Environment Programme
YSLME	- Yellow Sea Large Marine Ecosystem

Executive Summary

This Regional Overview 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).

After the brief introduction describing the history of NOWPAP approach to the Ecological Quality Objectives (EcoQOs) and its relevance to the Sustainable Development Goals (SDGs), part 2 provides examples of similar approaches in other Regional Seas programmes: Mediterranean Action Plan (Barcelona Convention), Oslo and Paris Conventions (OSPAR) and Helsinki Commission (HELCOM). Similarities in NOWPAP approach with these three individual programmes as well as with the Marine Strategy Framework Directive (MSFD) of the European Union are shown.

Part 3 describes national approaches of the NOWPAP member states to the suggested five NOWPAP EcoQOs while also highlighting differences in natural and socio-economic conditions (population density, level of aquaculture development, etc.).

Part 4 is dedicated to the analysis of how suggested EcoQOs could be used in the NOWPAP member states. It is concluded that only a few suggested EcoQO indicators could be easily applicable in all NOWPAP member states.

The final part contains several suggestions regarding the possible way forward (to be discussed and decided by the NOWPAP member states). First of all, alignment of NOWPAP EcoQO indicators with the SDG indicators (some of them are still being developed) is suggested. NOWPAP member states could contribute to the development of several SDG 14 indicators related to pollution, eutrophication, fish stocks, and marine protected areas.

Second, enhancement of certain activities of the NOWPAP Regional Activity Centers (RACs) is suggested, including possible creation of several *ad hoc* working groups.

Finally, further work on comparing, analyzing and harmonizing national monitoring approaches (including existing standards and indicators) is recommended.

1. Introduction

The overall goal of the Northwest pacific Action Plan (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. Major 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.

Based on the analysis of regional marine environmental problems, POMRAC has started working on the development of regional Ecological Quality Objectives (EcoQOs). During the first stage, 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 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. The information from national inputs (submitted by the end of 2016) is summarized in parts 3 and 4 of this Regional Overview.

The final list of suggested indicators is shown below. It should be noted however that terminology used in MSFD and in some individual Regional Seas programmes (such as HELCOM, MAP and OSPAR, described in part 2 below) is quite different which might cause some confusion.

Ecological Quality Objectives	Operational Criteria	Indicators
1. Biological and habitat diversity are not changed significantly due to anthropogenic pressure	1.1. Species diversity of marine mammals and waterbirds	1.1.1. Abundance, distribution and population growth rates of marine mammals 1.1.2. Abundance and productivity of key waterbird species
	1.2.Species, age and size structure of fish stocks	1.2.1. Catch/biomass ratio 1.2.2. Spawning Stock Biomass (SSB) 1.2.3. Proportion of large fish (for selected species at the top of food webs)
	1.3.Distribution of benthic and pelagic communities and their status	1.3.1. Distribution 1.3.2. Condition of the typical species and communities 1.3.3. Hydrological and chemical conditions
2. Alien species are at levels that do not adversely alter the ecosystems	2.1. Abundance and state characterization of alien species	2.1.1. Trends in spatial distribution and biomass of alien species
	2.2. Environmental impact of alien species	2.2.1. Ratio between alien species and native species and their interaction at the level of ecosystem, habitats and species

3. Eutrophication adverse effects (such as loss of biodiversity, ecosystem degradation, harmful algal blooms, and oxygen deficiency in bottom waters) are absent	3.1. Nutrients concentration	3.1.1. Nutrients concentration in the water column 3.1.2. Nutrient ratios (silica, nitrogen and phosphorus)
	3.2. Direct effects of nutrient enrichment	3.2.1. *Chlorophyll a* concentration in the water column 3.2.2. Species composition and abundance of toxic microalgae 3.2.3. Harmful algal blooms (HABs) 3.2.4. Abundance of opportunistic macroalgae
	3.3. Indirect effects of nutrient enrichment	3.3.1. Seasonal hypoxia, dissolved oxygen changes and size of the area concerned
4. Contaminants cause no significant impact on coastal and marine ecosystems and human health	4.1. Concentration of contaminants	4.1.1. Concentration of the contaminants in sediments, water and hydrobionts 4.1.2. Exceeding of Maximum Permissible Concentration (MPC) in aquatic organisms and frequency of such cases
	4.2. Effects of contaminants	4.2.1. Levels of pollution effects on the ecosystem components concerned, where a cause/effect relationship has been established
5. Marine litter does not adversely affect coastal and marine environments	5.1. Characteristics of litter in the marine and coastal environment	5.1.1. Trends in the amount and composition of litter washed ashore 5.1.2. Trends in the amount of litter in the water column and deposited on the seafloor 5.1.3. Trends in the amount, distribution and composition of micro-particles
	5.2. Impacts of litter on marine life	5.2.1. Trends in the amount and composition of litter ingested by marine animals

After the adoption of the Sustainable Development Goals (SDGs) in 2015, the work on Ecological Quality Objectives has become even more important and relevant for the NOWPAP member states. Achieving Good Environmental Status along with the five EcoQOs described above will contribute to the achievement of several goals of the SDG 14 on Oceans ("Conserve and sustainably use the oceans, seas and marine resources for sustainable development"):

> 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 (EcoQOs 3, 4, 5).
>
> 14.2. By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans (EcoQOs 1 and 2).
>
> 14.5. By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information (EcoQOs 1 and 2).

Efforts of NOWPAP member states focused on Ecological Quality Objectives, in particular on biodiversity conservation and on combatting marine litter, will also contribute to achieving SDG 12 ("Ensure sustainable consumption and production patterns") and SDG 13 ("Take urgent action to combat climate change and its impacts").

The implementation of activities related to EcoQOs 1-5 will also contribute significantly to achieving CBD Aichi Biodiversity Targets.

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2. Approach to EcoQO indicators in other regions

2.1. Marine Strategy Framework Directive (MSFD) of the European Union

In 2008, the European Commission (EC) has adopted the Marine Strategy Framework Directive (MSFD) requesting member states to achieve before 2020 Good Environmental Status (GES) in their marine areas. The process of achieving GES is shown in Fig. 2.1 below. However, an interim assessment undertaken in 2014 has shown that the development of indicators and targets by the EU member states took longer than expected and many shortcomings have been revealed. More information could be found on the web: http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

Fig. 2.1. What does a Marine Strategy include?

Annex I of the MSFD contains 11 descriptors defining the Good Environmental Status (GES):

- **Descriptor 1**. Biodiversity is maintained
- **Descriptor 2**. Non-indigenous species do not adversely alter the ecosystem
- **Descriptor 3**. The population of commercial fish species is healthy
- **Descriptor 4**. Elements of food webs ensure long-term abundance and reproduction
- **Descriptor 5**. Eutrophication is minimized
- **Descriptor 6**. The sea floor integrity ensures functioning of the ecosystem

- **Descriptor 7.** Permanent alteration of hydrographical conditions does not adversely affect the ecosystem
- **Descriptor 8.** Concentrations of contaminants give no effects
- **Descriptor 9.** Contaminants in seafood are below safe levels
- **Descriptor 10.** Marine litter does not cause harm
- **Descriptor 11.** Introduction of energy (including underwater noise) does not adversely affect the ecosystem

In 2010, the European Commission has also produced a set of "criteria and methodological standards" to measure the progress in achieving GES along the 11 descriptors shown above (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0477(01)). It was clearly mentioned that geographical differences should be taken into account when developing region-specific indicators and targets related to achieving GES. Therefore, each member state could develop its own indicators and targets while following general criteria set in the MSFD.

Even before the MSFD has been issued in 2008, several individual programmes around the world were developing their own approaches to ecological objectives. In three sub-chapters below, such approaches taken in the Mediterranean Sea, North East Atlantic and the Baltic Sea are described in more detail.

2.2. Mediterranean Action Plan (MAP) / Barcelona Convention

Within the area covered by the Mediterranean Action Plan (MAP), joint monitoring of the marine environment has been implemented for many years and therefore there is plenty of good quality data which could be used for setting up ecological objectives, choosing appropriate indicators and finally setting up targets which will indicate the progress towards the Good Environmental Status (GES) as prescribed by the Marine Strategy Framework Directive (MSFD) of the European Union (EU).

Fig 2.2 below is a compilation of several Ecological Objectives (most relevant for NOWPAP, out of 11 in total) adopted by the MAP member states as well as corresponding indicators. More details could be found on the MAP website, on the page dedicated to the Ecosystem Approach and Integrated Monitoring and Assessment Programme (IMAP): http://web.unep.org/unepmap/who-we-are/ecosystem-approach. It should be noted that some of indicators are not yet agreed upon (two "candidate indicators" in Fig. 2.2).

EO 1 Biodiversity
Common Indicator 1: Habitat distributional range (to also consider habitat extent as a relevant attribute);
Common Indicator 2: Condition of the habitat's typical species and communities;
Common Indicator 3: Species distributional range (related to marine mammals, seabirds, marine reptiles);
Common Indicator 4: Population abundance of selected species (related to marine mammals, seabirds, marine reptiles);
Common indicator 5: Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles)

EO 3 Harvest of commercially exploited fish and shellfish
Common Indicator 7: Spawning stock Biomass;
Common Indicator 8: Total landings;
Common Indicator 9: Fishing Mortality;
Common Indicator 10: Fishing effort;
Common Indicator 11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy;
Common Indicator 12: Bycatch of vulnerable and non-target species

EO 10 Marine litter
Common Indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines;
Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor;
Candidate Indicator 24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles

EO 2 Non-indigenous species
Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (in relation to the main vectors and pathways of spreading of such species)

EO 5 Eutrophication
Common Indicator 13: Concentration of key nutrients in water column;
Common Indicator 14: Chlorophyll-a concentration in water column

EO 8 Coastal ecosystems and landscapes
Common Indicator 16: Length of coastline subject to physical disturbance due to the influence of man-made structures;
Candidate Indicator 25: Land use change

EO 9 Pollution
Common Indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (related to biota, sediment, seawater);
Common Indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established;
Common Indicator 19: Occurrence, origin (where possible), extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances), and their impact on biota affected by this pollution;
Common Indicator 20: Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood;
Common Indicator 21: Percentage of intestinal enterococci concentration measurements within established standards

Fig. 2.2. Some Ecological Objectives and associated indicators adopted by the MAP member states

2.3. Oslo and Paris Conventions (OSPAR)

Oslo and Paris Convention (covering the Northeast Atlantic) was among the first regions that developed Ecological Quality Objectives (EcoQOs). After the adoption of the Marine Strategy Framework Directive (MSFD), OSPAR countries had to align their environmental objectives and indicators with those stipulated in the MSFD. Table 2.1 below shows detailed information about common and candidate indicators being developed and tested within OSPAR (for several sub-regions of the NE Atlantic). The list is rather long and complicated and is still work in progress. Color shading is explained in the Table 2.2 as well as a division into sub-regions I – V; D1 – D11 refer to the MSFD descriptors. These indicators will be tested while preparing the 2017 OSPAR Intermediate Assessment (IA2017). More details could be found on the OSPAR website (http://www.ospar.org/work-areas/cross-cutting-issues/intermediate-assessment-2017-resources).

Table 2.1. Common and candidate indicators for the different sub-regions of the OSPAR sea area

Indicator	Explanation / title	Region I	Region II	Region III	Region IV	Region V
D1 Mammals 3	Seal abundance and distribution					
D1 Mammals 4	Cetacean abundance and distribution					
D1 Mammals 5	Grey seal pup production					
D1 Mammals 6	Marine mammal bycatch					
D1 Birds 1	Marine bird abundance					
D1 Birds 2	Breeding success of kittiwake					
D1 Birds 3	Breeding status of marine birds					
D1 Birds 4	Non-native/invasive mammal presence on island seabird colonies					
D1 Birds 5	Marine bird bycatch					
D1 Birds 6	Distribution marine birds					
D1 Fish Ceph 1	Fish abundance					
D1 Fish Ceph 2	OSPAR EcoQO proportion of large fish (LFI)					
D1 Fish Ceph 3	Mean maximum length of demersal fish and elasmobranchs					
D1 Fish Ceph 4	By-catch rates of Chondrichthyes					
D1 Fish Ceph 5	Conservation status of elasmobranch and demersal bony-fish species (IUCN)					
D1 Fish Ceph 6	Proportion of mature fish					
D1 Fish Ceph 7	Distributional range					

Indicator	Explanation / title	Region I	Region II	Region III	Region IV	Region V
D1 Fish Ceph 8	Fish distributional pattern					
D1/6 BentHab1	Typical species composition					
D1/6 BentHab2	Condition of benthic habitat defining communities. (Multi-metric indices)					
D1/6 BentHab3	Physical damage of predominant and special habitats					
D1/6 BentHab4	Area of habitat loss					
D1/6 BentHab5	Size-frequency distribution of bivalve or other sensitive/indicator species					
D1 PelHab 1	Changes of plankton functional types (life form) index Ratio					
D1 PelHab 2	Plankton biomass and/or abundance					
D1 PelHab 3	Changes in biodiversity index (s)					
D2 NIS	Rate of new introductions of NIS					
D4 FoodWeb 1	Reproductive success of marine birds in relation to food availability					
D4 FoodWeb 2	Production of phytoplankton					
D4 FoodWeb 3	Size composition in fish communities (LFI)					
D4 FoodWeb 4	Changes in average trophic level of marine predators (cf MTI)					
D4 FoodWeb 6	Biomass, species composition and spatial distribution of zooplankton					
D4 FoodWeb 7	Fish biomass and abundance of dietary functional groups					
D4 FoodWeb 8	Biomass trophic Spectrum					
D4 FoodWeb 9	Ecological Network Analysis diversity					
D5 Nutrient inputs	Nutrient inputs in water and air					
D5 Nutrient conc.	Winter nutrient concentrations					
D5 Chlorophyll	Chlorophyll concentration					
D5 *Phaeocystis*	Species shift/indicator species: Nuisance species *Phaeocystis*					
D5 Oxygen	Oxygen					
D7 Area affect	Extent of area affected – physical					
D7 Habit affect	Spatial extent of habitats affected					
D7 Habit functions	Changes in habitat functions					

Indicator	Explanation / title	Region I	Region II	Region III	Region IV	Region V
D8 Input metal	Inputs of Hg, Cd and Pb via water and air					
D8 Metals (biota)	Metal (Hg, Cd, Pb) concentrations in biota					
D8 Metals (sediment)	Metal (Hg, Cd, Pb) concentrations in sediments					
D8 PCBs (biota)	PCB concentrations in biota					
D8 PCBs (sediments)	PCB concentrations in sediments					
D8 PAHs (biota excluding fish)	PAHs concentrations in biota					
D8 PAHs (sediment)	PAHs concentrations in sediments					
D8 Organotin (biota)	Organotin concentrations in biota					
D8 Organotin (sedim)	Organotin concentrations in sediments					
D8 PBDE (biota)	PBDE concentrations in biota					
D8 PBDE (sedim.)	PBDE concentrations in sediments					
D8 HCB (biota)	HCB (hexachlorobenzene) concentrations in biota					
D8 HCBD (biota)	HCBD (hexachlorobutadiene) concentrations in biota					
D8 HCBD (sedim)	HCBD (hexachlorobutadiene) concentrations in sediments					
D8 Imposex	Imposex/intersex					
D8 Fish disease	Externally visible fish diseases					
D8 LMS	Lysosomal stability (LMS)					
D8 Bile metab	Bile metabolites (of PAHs)					
D8 Micronuclei	Micronuclei (MN)					
D8 EROD	EROD					
D10 On beach	Beach litter					
D10 On seabed	Litter on the sea floor					
D10 In Fulmar	Fulmar litter ingestion (impact and floating litter)					
D10 Microplastic	Microplastics					
D11 Impulsive	Impulsive noise					
D11 Ambient	Ambient noise					

(Source: http://www.ospar.org/work-areas/cross-cutting-issues/intermediate-assessment-2017-resources).

Table 2.2. Explanations of color shading and sub-regions shown in Table 2.1

(IA2017 – Intermediate Assessment to be prepared in 2017)

(blue)	Common indicator contributing to the IA2017, as agreed by OSPAR Commission
(green)	Candidate indicator delivering a case study to the IA2017
(yellow)	Priority candidate indicators (in Regions other than where it is already common)
	Candidate indicator not prioritised
Region I	Arctic Waters
Region II	Greater North Sea
Region III	Celtic Seas
Region IV	Bay of Biscay and Iberian Coast
Region V	Wider Atlantic

(Source: http://www.ospar.org/work-areas/cross-cutting-issues/intermediate-assessment-2017-resources).

2.4. Helsinki Commission (HELCOM)

Countries surrounding the Baltic Sea (and participating in the Helsinki Commission, HELCOM), have adopted the Baltic Sea Action Plan (BSAP) in 2007 with four main issues being addressed: biodiversity, eutrophication, hazardous substances, and maritime activities affecting the marine environment. Table 2.3 below shows indicators for these four major groups and also their relations to the MSFD descriptors as many of the Baltic Sea countries are members of the European Union. More details could be found on the HELCOM website, on the page dedicated to indicators (http://www.helcom.fi/baltic-sea-trends/indicators/). Indicators shown in red color are not yet agreed by member states. As of December 2016, five out of 10 HELCOM countries had some reservations related to certain indicators.

Table 2.3. Indicators suggested to monitor the progress of the implementation of the Baltic Sea Action Plan

Biodiversity (MSFD descriptor D1):		Eutrophication (MSFD descriptor D5):
Abundance of coastal fish key functional groups		Chlorophyll-a
Abundance of key coastal fish species		Inputs of nitrogen and phosphorus to the basins
Abundance of salmon spawners and smalt		Nitrogen/DIN
Abundance of sea trout spawners and parr		Oxygen
Abundance of waterbirds in the breeding season		Phosphorus/DIP

Abundance of waterbirds in the wintering season		Water clarity
Distribution of Baltic Seals		
Number of drowned mammals and waterbirds in fishing gears		
Nutritional status of marine mammals		**Hazardous substances (MSFD descriptor D8)**
Population trends and abundance of seals		*Hexabromocyclodocecane (HBCDD)*
Reproductive status of marine mammals		*Metals (lead, cadmium and mercury)*
		Polybrominated biphenyl ethers (PBDE)
Maritime activities		*Perfluorooctane sulphonate (PFOS)*
Oil spills affecting the marine environment		*Radioactive substances: Cs-137 in fish and surface waters*
Trends in arrival of non-indigenous species		*White-tailed eagle productivity*

(Source: http://www.ospar.org/work-areas/cross-cutting-issues/intermediate-assessment-2017-resources).

2.5. Commonalities and differences in approaches applied in other regions

Comparing approaches applied in three different regions described above (MAP/Barcelona Convention, OSPAR and HELCOM), it is obvious that there are some commonalities (even before the MSFD has been adopted by the European Union). Mostly, this is because major pressures on the marine environment around the world are similar: pollutants from land- and sea-based sources, destruction of coastal habitats, overfishing, loss of biological diversity, etc. From the NOWPAP perspective, where five major Ecological Quality Objectives (EcoQOs) were suggested by experts from member states in 2014 (and then farther elaborated in 2016), it is important to mention that these five EcoQOs are addressed by all three Regional Seas programmes described above (MAP, OSPAR and HELCOM). Table 2.4 below illustrates these commonalities.

Table 2.4. Marine environmental issues included in EcoQOs suggested for the NOWPAP region which are similar to the MAP, OSPAR and HELCOM sea areas

EcoQOs suggested for the NOWPAP region	Similar EcoQOs in other regions (YES or NO)		
	MAP	**OSPAR**	**HELCOM**
EcoQO 1: Biological and habitat diversity are not changed significantly due to anthropogenic pressure	YES	YES	YES
EcoQO 2: Alien species are at levels that do not adversely alter the ecosystems	YES	YES	YES
EcoQO 3: Eutrophication adverse effects are absent	YES	YES	YES
EcoQO 4: Contaminants cause no significant impact on coastal and marine ecosystems and human health	YES	YES	YES
EcoQO 5: Marine litter does not adversely affect coastal and marine environments	YES	YES	YES

However, in spite of the fact that many countries participating in MAP/Barcelona Convention, OSPAR and HELCOM are members of the European Union (and therefore have to comply with the MSFD requirements), there are also some differences in EcoQOs and related indicators adopted by these three programmes. First of all, these differences could be explained by geographical differences between such regions as the Mediterranean, the Baltic or the North Sea (and wider NE Atlantic). But the main reason behind different approaches applied in MAP/Barcelona Convention, OSPAR and HELCOM is related to major differences in monitoring programmes carried out in these regions for many years. As a result, there are major differences between countries in parameters measured and hence the data accumulated and being available that have to be accounted for when developing indicators of the marine environmental quality. Such differences also exist among the NOWPAP member states and will be described in the following chapters.

3. National approaches in NOWPAP member states related to the suggested Ecological Quality Objectives

Before comparing national approached of the NOWPAP member states to marine environmental issues, it is worth considering briefly peculiarities of their geographic and socio-economic conditions. Unlike Korea and Japan, only parts of China and Russia are within the NOWPAP geographic scope. In China, NOWPAP covers Liaoning, Shandong and Jiangsu Provinces, which are maritime provinces facing the Yellow Sea with the total coastline length of about 6,054 km, and Heilongjiang and Jilin Provinces. The total area of these five provinces is about 1,004,000 km^2. In Russia, coastal areas covered by the NOWPAP scope include Primorsky Kray and parts of Sakhalin Island and Khabarovsky Kray with the total land area of 121,000 km^2 and coastline length of about 3,092 km. For comparison, the total coastline length of the Republic of Korea is about 14,963 km and of Japan is about 29,000 km (all data are taken from national inputs submitted by the nominated experts).

The areas of China, Japan, Korea and Russia covered by NOWPAP differ not only in the length of the coastline, but also in population density and Gross Domestic Product (GDP, as an approximate indicator of economic development). As a result, the anthropogenic pressure on the marine environment (influenced indirectly by these two factors) is also different. For example, population density in the Russian Far East administrative districts covered by NOWPAP in 2014 was between 1.2 and 77.7 persons per square kilometer (for different Far East administrative districts) while in Korea the population density in 2015 was 505 persons per square kilometer (more than 10 times the global average). In China, population density in five provinces concerned in 2015 was 268.3 persons per square kilometer. GDP of the same Russian administrative districts in 2014 varied from 332.4 million to 11.9 billion USD while the GDP of five Chinese provinces covered by NOWPAP in 2015 was about 3 trillion USD. The intensity of coastal aquaculture in the Russian Far East is negligible compared with the aquaculture development in China, Japan and Korea. Hence, the severity of such events as the incidence of harmful algal blooms or introduction of invasive species (often a side effect of large-scale intensive aquaculture) is much less in the Russian Far East compared with the other NOWPAP member states.

3.1. China

In China, coastal marine environmental monitoring (including sea water quality, pollution of sediments, and biota) is carried out by the Ministry of Environmental Protection (MEP) and the State Oceanic Administration (SOA). However, integrated assessment of the ecological quality of the marine environment has just started and is still in the development stage. A lot of research is being carried out on ecological quality assessments locally (e.g., Dalian Bay, Jinzhou Bay and Yangtze River estuary).

"The Guidelines for the Assessment of Coastal Marine Ecosystem Health" (HY/T 087-2005) have been published in 2005, including the health status of coral reefs, mangroves, seagrass beds, estuaries and bays. There are several categories of indicators used in the Guidelines, including water, sediment and biota.

Chinese government has published a series of biological diversity assessment standards during the last three decades. In September 2011, MEP has published “Standard for the assessment of regional biodiversity HJ 623—2011”. In the same year (2011), MEP has also published “Technical guideline for assessment on environmental risk of alien species HJ 624—2011”. In addition to this guideline, an industry standard of regulation for invasive alien species management in nature reserves was published in 2014 by the State Forestry Administration.

For the purpose of evaluation of water quality and eutrophication status, dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) concentrations are usually considered (along with dissolved oxygen and *Chlorophyll a* concentrations). However, dissolved silica is not considered as an indicator for eutrophication in China. Indicators of DIN and DIP are included in almost all standards in China which are related to coastal or marine water quality, eutrophication as well as ecosystem health. Beside these two indicators, chemical oxygen demand (COD) is also considered as one of indicators for eutrophication evaluation in China.

Compared with nutrients concentration, nutrient ratios (silica, nitrogen and phosphorus) have received little attention at the national level. At the current stage, nutrient ratios have not been included in national standards related to marine environment assessment in China.

In China, standards on concentrations of contaminants in the environment as well as maximum acceptable emissions were established and approved at the early stage of the environmental protection. However, environmental and ecological quality standards for coastal and marine environment are lagging behind those for fresh water and atmosphere. Around 2000, several standards for quality assessment of sea water, sediments and marine organisms as well as standards for safety qualification on agricultural products have been established and approved in China.

Comparing with dissolved contaminants, marine litter pollution is easily detected visually. However, marine litter has not been included in pollution monitoring by the Government of China for a long time. SOA has begun some experimental work on marine litter monitoring and assessment from 2007 and in 2015 it has approved technical regulations for the marine litter monitoring and assessment. Regular marine litter monitoring and assessment is now being carried out along the coastal regions of China by SOA. Since 2007, annual SOA bulletins, which include marine litter data, are available online (in Chinese) at http://www.coi.gov.cn/gongbao/.

3.2. Japan

The system of the coastal environmental management in Japan initially made emphasis on water pollution control. However, recently the approach has shifted gradually from pollution control to more holistic approach such as integrated coastal management (ICM), ecosystem based management (EBM), restoration of habitats and management of nutrient cycle. The basic legal framework of environmental management in Japan has changed dramatically since the beginning of the 21st century. The basic acts such as the Basic Act for Establishing a Sound Material Cycle Society (entered into force in 2001), Basic

Fisheries Act (2001), Basic Ocean Act (2007), Basic Biodiversity Act (2008) and Basic Act on Water Cycle (2014) were newly established legal instruments reflecting the new concepts and the requirements of international conventions. These Basic Acts (or national laws) are usually implemented through the respective national basic plans which are developed addressing specific provisions of the laws. Further detailed programs and measures at the sub-national level such as the ones at the prefecture level are adopted based on the national basic plans. Therefore, legal framework in Japan relevant to the proposed NOWPAP EcoQOs generally includes obligations under the multilateral environmental agreements, national laws, national basic plans and sub-national regulations.

Among various basic plans mentioned above, Basic Act for Establishing a Sound Material Cycle Society based on the Basic Environment Law is very important for EcoQOs partly because Marine Litter Law (2009) was established under this Basic Act in order to promote proper treatment of waste and recycling. Proper treatment of waste is guaranteed by the Waste Management and Public Cleaning Law, and promotion of recycling is guaranteed by the Law for the Promotion of Effective Utilization of Resources.

Legal system based on Basic Ocean Act (2007) and Basic Biodiversity Act (2008) was also newly established. The first National Basic Ocean Plan based on Basic Ocean Act was proposed by the Cabinet in 2008 and then the second one in 2013. Following almost the same process, the first National Strategy for Biodiversity based on the Basic Biodiversity Act was adopted in 2010, and additionally National Strategy for Marine Biodiversity was adopted in 2011. Invasive Alien Species Act was enacted in 2004. Legal system on marine litter management was first established in 2009 through the Marine Litter Law.

However, the entire implementation system including legislative, administrative and nongovernmental activities with the use of appropriate indicators and criteria has not been fully developed yet.

In general, national legal system for conservation of marine environment in Japan has a two-stage management structure. The first is the Basic Environmental Act (the objective law, effective in 1993) and the second is Water Pollution Control Law (the practical law, effective in 1970).

The Basic Environmental Act defines “Environmental Standards” which are the environmental quality targets. Environmental standards for water quality are composed of 1) standards concerning the protection of human health (Health Items); and 2) standards concerning the conservation of the living environment (Living Environmental Items). Class designation on Living Environmental Items has been done by the national government for 47 water areas including both fresh water areas and sea areas that span a number of prefectures such as Tokyo Bay and Ise Bay, while class designation for other water areas has been done by prefectural governments. In this system marine areas are generally classified into 3 classes (A, B and C) but from the viewpoint of TN and TP marine areas are classified into four classes: I, II, III and IV (see Table A2 in Annex 2).

Water Pollution Control Law sets the “Effluent Standards” for controlling discharges flowing into public waters. “Effluent Standards” consist of 1) Health Items; and 2) Living Environmental Items, similar to the case of water quality standards. In this legal framework, penalty will be charged for violators of the regulation.

Total Pollution Load Control (TPLC) which was introduced for the designated enclosed coastal seas in Japan aims to reduce the overall amount of pollutant loads (for COD, TN and TP). Around the large enclosed coastal seas, the density of population and industries is so high that the effluent concentration standard alone cannot effectively achieve the Environmental Quality Standard for water pollution. The TPLCs designated areas are Tokyo Bay, Ise Bay and Seto Inland Sea with their watershed areas due to extremely high pollutant load based on the high population and industry level. These semi-enclosed marine areas in Japan were designated as especially important nationally.

In addition to the legal system described above, there are two additional institutional frameworks in Japan. One is "Standards for Fisheries Waters" (2012) developed by Japan Fisheries Resource Conservation Association (JFRCA) which are environmental criteria for living aquatic life referring mainly to water quality and to some extent to sediment quality. The other is the "Health Examination of the Sea" which was developed by the Ocean Policy Research Foundation (OPRF, presently Ocean Policy Research Institute, OPRI).

Standards for Fisheries Waters. Among the established legal water quality standards in Japan, there are two kinds of standards: "Health Items" (such as toxic substances harmful for human health) and "Living Environment Items" (such as general environmental conditions relevant for human beings). Because both standards were established for the human population, there were no legal water quality standards for fish and aquatic animals in Japan. Standards for Fisheries Waters were then developed by JFRCA mainly as criteria for fish and fisheries in rivers, lakes and the sea. Major indicators are pH, BOD, COD, suspended solid (SS), dissolved oxygen (DO), *coli*-form bacteria, total nitrogen (TN), total phosphorus (TP) and toxic substances. Standards of some indicators are set for fish species such as salmon, trout, smelt, carp and oyster. Water quality criteria for laver seaweeds (Nori) culture are also established.

Health Examination of the Sea. Concept and scheme of the "Health Examination of the Sea" has been developed as one of the holistic environmental assessment and monitoring systems by Ocean Policy Research Foundation (presently Ocean Policy Research Institute) from the year of 2000. Major categories of "Health Examination of the Sea" are: 1) Stability of ecosystem; and 2) Smoothness of material circulation.

"Health Examination of the Sea" has been applied so far in order to provide basic information for Integrated Coastal Management (ICM) plans of local governments in Japan. "Health Examination of the Sea" consists of 2 stages of examination which are preliminary examination (simple and easy) and advanced examination (specialized and detailed). Results of preliminary examination are classified into the following three classes: A (healthy), B (warning - need further inspection), and C (unhealthy, deteriorated). Preliminary examination of the 88 enclosed coastal seas in Japan was made in 2004 and the "Report of health examination of the enclosed seas all over Japan" (71 sea areas) was published in 2008.

The above mentioned "Health Examination of the Sea" was afterward developed into the Normalization of Marine Material Circulation Plan ("Healthy Sea Plan") prepared by the Ministry of the Environment during 2010-2014. Management processes to realize effective nutrient cycle in both land and marine environment were examined in three model sites and finally the "Manual for Healthy Marine Material Circulation" (in Japanese) was published in 2013 by the Ministry of the Environment.

Water quality monitoring. The objective of water quality monitoring is to acquire a full understanding of the status of water pollution in public waters and underground water as well as to implement control measures for the prevention of water pollution in appropriate ways. In 2013, the number of total (and coastal in parenthesis) monitoring sites for "Health Items" and "Living Environment Items" (described above) were 5409 (1057) and 7088 (2044), respectively. Regular monitoring of the marine environment in Japan is being conducted by prefectures.

In addition, Japan Meteorological Agency and Japan Agency for Marine-Earth Science and Technology (JAMSTEC) provide data (available online) on basic oceanographic conditions. Hydrographic and Oceanographic Department, Japan Coast Guard (https://www1.kaiho.mlit.go.jp/jhd-E.html) and Japan Oceanographic Data Center, JODC (http://www.jodc.go.jp/) also provide oceanographic data to the public. Ministry of the Environment conducts marine environment monitoring at some selected areas on sediment quality, biological communities, marine litter, etc. from the view point of effects of land–based pollutants (http://www.env.go.jp/water/kaiyo/monitoring.html). On this website, "Present Status of Marine Pollution in the Sea around Japan" (Ministry of the Environment, 2009) is cited which provides valuable information related to the biodiversity, eutrophication and marine litter issues of the proposed NOWPAP EcoQO indicators.

Regular monitoring of fisheries environment in the coastal and offshore areas has long been conducted by the Fisheries Agency. These surveys collected data on salinity, transparency, plankton, DO, COD, DIN (nitrate-N, nitrite-N and ammonium-N), DIP and silicate (Si) in the coastal seas of Japan. Along with other kinds of oceanographic information, these data are available at Japan Oceanographic Data Center (JODC) website: http://www.jodc.go.jp/jodcweb/.

3.3. Korea

In Korea, two major laws, namely Marine Environment Management Act (MEMA) and Conservation and Management of Marine Ecosystems Act (CoMMA) provide legal basis for the protection and management of marine ecosystems. Two long-term (about 10 years) plans of environment and ecosystem management that cover several issues such as land-based pollution, sea-based pollution, ecosystem health, and climate change, have been developed since the late 2000s. Specific government plans cover the Total Pollution Load Management System (TPLMS), clean-up of coastal garbage, oil spill management, conservation of fishing grounds, marine protected areas, and mitigation/adaptation strategy for climate change. The national level management plans collectively support the local coastal action plans targeting the same issues at the metropolitan and provincial levels.

Among the five suggested EcoQOs, two objectives (related to biodiversity and invasive species control) are supported by CoMMA. Biological and habitat diversity includes mammals, waterbirds, fish stocks, plankton, and benthos. CoMMA key objectives for invasive species management focus on the population structure and their changes in the natural environment as well as their environmental impact on local ecosystems. Pollution issues (including eutrophication, pollutants, and marine litter) are covered by the MEMA, where pollution status and/or pollution adverse effects on ecosystems are taken into account. MEMA key objectives related to eutrophication include nutrient concentrations and their direct and/or indirect effects on the environment. Concentration of pollutants, including trace metals and organic pollutants, and their adverse effects on ecosystems are considered as well. Marine litter issues are addressed in terms of characteristics, including source and distribution of various kinds of garbage, and their impacts on ecosystems.

Various marine environment monitoring systems have been developed and introduced during the past 20 years both at the local and national levels. One representative national monitoring system is the Integrated Marine Ecosystem Monitoring (I-MEM) operated by the Korea Environment Management Corporation (KOEM) and the National Fisheries Research and Development Institute (NFRDI) since 2006 (Fig. 3.1).

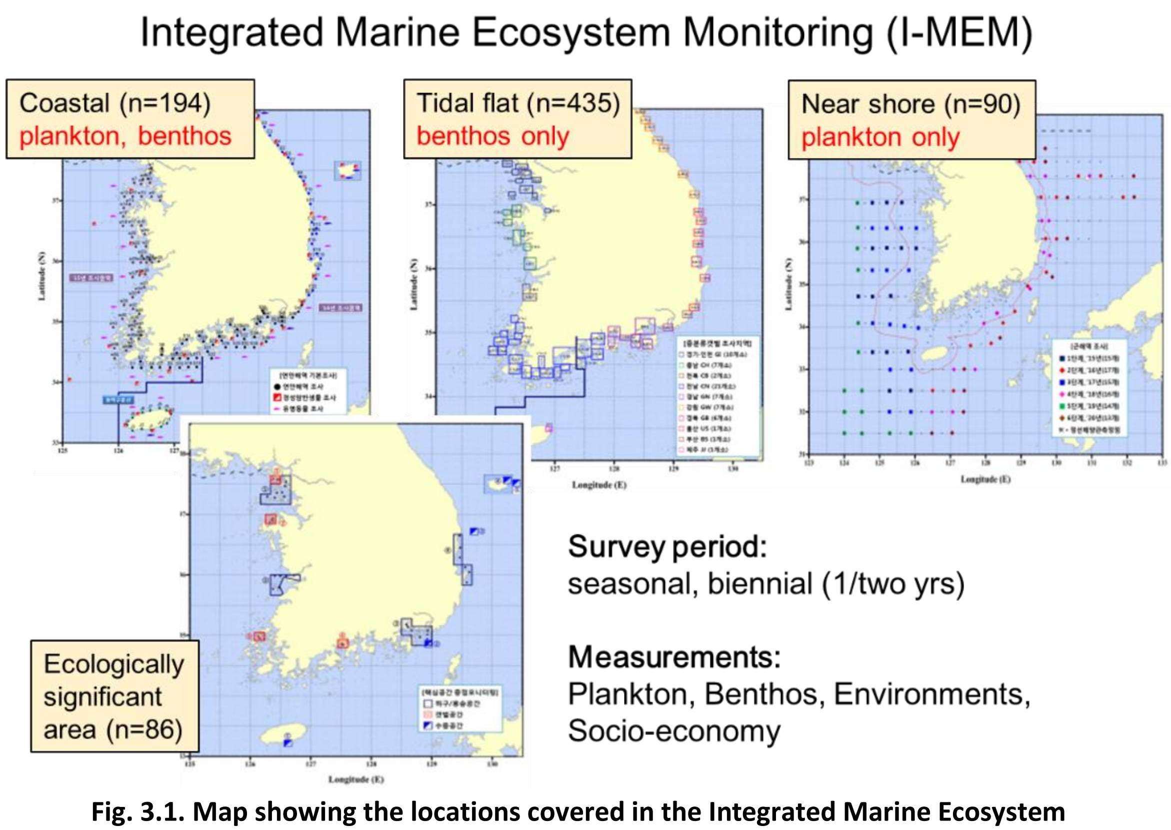

Fig. 3.1. Map showing the locations covered in the Integrated Marine Ecosystem Monitoring (I-MEM) program in Korea ("n" indicates the number of stations)

The I-MEM surveys include various parameters such as plankton, benthos, general environmental conditions, and even socio-economy aspects, and cover the entire coast of Korea from the intertidal to the offshore areas. As for the monitoring of four major groups of marine organisms (Table 3.1), the corresponding measurements slightly vary depending on the target animals, but generally cover the species composition, abundance and biomass. However, survey period and monitoring frequency vary depending on the targets or areas, thus there could be certain limitations, for example availability of time-series or possibility of cross comparison between targets or areas in the given period of time.

Table 3.1. Biological measurements of I-MEM

Category	Biota	Substratum	Measurements
Plankton	Microbial	water	total abundance
	Phytoplankton	water	species, abundance, biomass
	Zooplankton	water	species, abundance, biomass
	Fish eggs/larvae	water	species, abundance, biomass
Benthos	Meiofauna	sub/intertidal	species, abundance, biomass
	Macrofauna	sub/intertidal	species, abundance, biomass
	Algae	subtidal	species, coverage, biomass
	Seagrass	subtidal	species, coverage, biomass
	Halophyte	intertidal	species, coverage, biomass
Nekton	Finfish	subtidal	species, abundance, biomass, gut content
	Crustaceans	subtidal	species, abundance, biomass
	Molluscs	subtidal	species, abundance, biomass
Waterbirds		intertidal	species, counting

It should be noted that two government-sponsored agencies, NFRDI (now National Institute of Fisheries Sciences, NFIS) and KOEM, also perform the water quality monitoring from 1997 to the present time, which covers more than 400 locations in coastal and offshore areas along the entire coast of the Republic of Korea (Fig. 3.2). These surveys provide long-term environmental data targeting the water quality parameters, including nutrients and pollutants such as heavy metals. The survey period varies depending on the targets or area, but generally covers four seasons in the coastal zone. The resulting data could be very valuable for interpreting the ecosystem changes and for planning an adaptive coastal management.

No. of stations: 417

Survey period
manual: 1~4 times/yr
automatic: 5 seconds interval

Measurements (manual type)

Medium	Water column	Sediment
Physical	T, S, pH, DO, SS	Grain size, organic, AVS, COD
Nutrients	COD, DIN, DIP, Si	COD
Pollutants	Heavy metals	Heavy metals
Biological	Chl-a, *E. Coli*	-

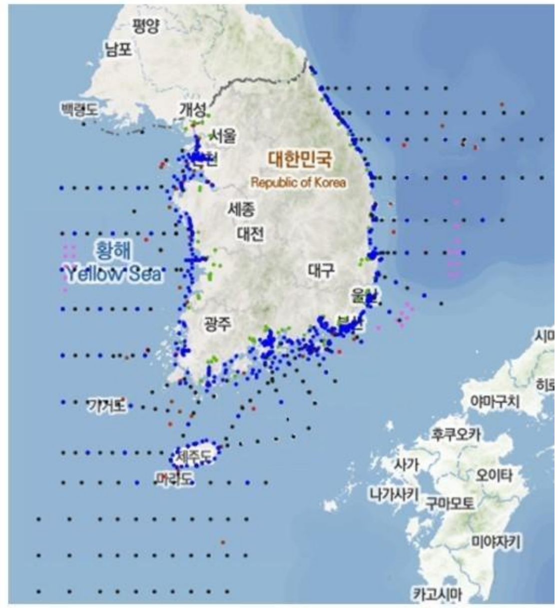

Fig. 3.2. Map showing the locations covered by the Korea Marine Environmental Monitoring Network (MEM-Net)

3.4. Russia

National legislation. The ecosystem management in Russia is regulated by several key laws. The first of them – “Russian Federation Law on Environmental Protection” (Federal Law 7-FZ of 2002 with amendments from 2004-2011) defines the relationships between society and environment and the impacts of economic activities on the environment within the territory of the Russian Federation, its coastal areas and exclusive economic zone. The Law sets the background of environmental management, responsibilities at different levels (from federal/central government to citizens), including financial aspects (payments and fines). Environmental quality standards are covered by the Federal Law 7-FZ as well, e.g. standards of environmental quality expressed by the chemical, physical and biological parameters including the list of maximum permissible concentrations as well as norms of allowable discharge of chemical substances and norms of the allowable withholding of natural mineral and biogenic resources.

Separate part of Federal Law 7-FZ prescribes the rationale, structure and main features of the state ecological monitoring in Russia, including state monitoring of main ecosystem components (air, water, soil, biota, etc.). In addition, it defines the establishment and maintenance of the state database (archive) of ecological monitoring results. There is a special regulation Act of the Russian Government #219 of 10.04.2007 on the implementation of state monitoring of water bodies describing the structure of work and responsibility of different federal agencies carrying out water monitoring: Federal Agency for Water Resources, Federal Service for Hydrometeorology and Environmental Monitoring, Federal Agency for Mineral Resources.

National policies for the management of water pollution and water quality are based on the sets of Maximum Permissible Concentrations (MPCs) elaborated by the Federal Agency for Fisheries for fisheries related water bodies, and by the Federal Service for the Oversight of Consumer Protection and Welfare for drinking, bathing and washing waters. These water quality standards are elaborated and used in accordance with the Federal Law 52-FZ "On Sanitary Epidemiological Welfare of Population" (1999 with amendments 2004-2015). Information about the Russian water quality standards is available online (in Russian) at www.dioxin.ru/doc/gn2.1.5.1315-03.htm.

The calculation of the Maximum Permissible Discharge (MPD) is a main tool to manage the discharge of municipal and industrial wastewaters. The MPD values are calculated by scientific and engineering organizations for different water users and should be approved by the Federal Service for Environmental, Technological and Nuclear Supervision and the Ministry of Natural Resources (MNR). There is a special methodology approved by the MNR order #333 (17.12.2007) for the elaboration and calculation of maximum permissible discharge to the water bodies. The amount and quality of all types of wastewaters are controlled by the subdivisions of Federal Service for the Oversight of Consumer Protection and Welfare (ROSPOTREBNADZOR) and Federal Service for Environmental, Technological and Nuclear Supervision (ROSTECHNADZOR). The Federal Service on Hydrometeorology and Environmental Monitoring (ROSHYDROMET) is responsible for the monitoring of ambient water quality.

The provision of biological resources for human consumption is an important ecosystem service due to a vital role of seafood as a protein source for humankind. All coastal and offshore sea waters with biological resources are federal property in Russia. Federal Law 166-FZ "On Fishing and Biological Resources Protection" (2004 with amendments from 2005-2014) prescribes the rules of quotations, seasonal restrictions, determination of the permissible catch of different species, and the rules of distribution of permits among users and stakeholders. Protection of biological/fish resources and their environment is also defined by the 166-FZ Law. A special Federal Law 148-FZ "On Aquaculture" (2013) regulates the use of water bodies for the cultivation of the biological aquatic resources by different users.

The quality of seafood in terms of concentration of contaminants is regulated by the set of chemical and microbiological maximum permissible concentrations (SanPIN 2.3.2.1078-01) elaborated under the supervision and approval of the Federal Service for the Oversight of Consumer Protection and Welfare, and in accordance with Federal Law 52-FZ about sanitary welfare.

The legal framework of the ecological problems connected with biodiversity issues consists of some articles in the Water Code, Land Code, Federal Law 7-FZ (Nature Protection), and Federal Law 166-FZ (Fishing). Moreover, there is a special Federal Law 33-FZ "On Specially Protected Natural Areas" (1995 with amendments from 2001-2014). The 33-FZ prescribes several types of protected areas in the Russian Federation, including:

- State and biosphere natural reserves
- National parks
- Natural parks
- State natural sanctuaries
- Natural monuments
- Arboretums and botanic gardens

The protected areas are divided into the federal, regional and local levels according to their significance.

To avoid the unfavorable anthropogenic influence, the exclusion zones are established around the protected areas of federal significance. Federal Law 33-FZ determines possible economic activities within the protected areas at different levels.

Based on the above mentioned Federal Laws providing legal framework, the State Program "Environmental Protection 2012-2020" has been elaborated and approved in 2014. However, water ecosystems are not specifically described in that Program.

National monitoring programme. The Federal Service on Hydrometeorology and Environmental Monitoring (ROSHYDROMET) is responsible for routine monitoring in Russia. In Primorsky Kray, monitoring of contamination of air, rivers, soil and marine environment is implemented by the Primorsky Office on Hydrometeorology and Environmental Monitoring according to the State Monitoring Program.

The general objectives of the State Monitoring Programme are: 1) monitoring of water quality at the background (pristine) sites, and near the possible sources of contamination due to human activities; 2) assessments and forecast of water quality changes under the influence of natural and human factors; 3) provision of the reliable information about ambient water conditions and their changes to the government and other stakeholders.

The water quality monitoring plan at different monitoring sites is established according to the several criteria, including population on the watershed and significance of the biological resources. Several classes of monitoring sites are established and monitoring plans depend on the site class.

The water quality assessment in Russia is based on the compliance of the observed characteristics with the so-called maximum permissible concentrations (MPCs). There are three sets of MPCs in ambient waters: 1) for the drinking water; 2) for the water for domestic and cultural uses – "public waters" (both according to former SanPIN 2.1.4.559-96; from July 2003 – GN 2.1.2.1315-03); and 3) for water used for fisheries purposes. All substances are divided into four classes of toxicity (toxicity level - TL) for people and/or fish, cumulative and prolonged effects, etc.: 1st class – extremely dangerous, 2nd class – highly dangerous, 3rd class – dangerous, 4th class – moderately dangerous.

The MPCs for the most common potentially hazardous chemical substances in the marine waters used for fisheries are presented in Annex 2. That list covers only small portion of substances with the established MPCs. Besides, the maximum permissible concentrations are established for more than 600 organic chemical substances in drinking water and more than 1,000 chemical substances in "public" waters.

The quantitative criteria based on the observed concentrations are established for the classification of contamination events in ambient waters: exceeding MPC, highly polluted, and extremely highly polluted. State Office for Supervision on the Protection of Consumer's Rights and Human Welfare (subdivision of the Ministry of Health and Social Development) is an executive authority responsible for the establishment of sanitary-hygienic MPCs. State Fishery Service (subdivision of the Ministry of Agriculture) is responsible for establishing MPCs for waters used for fisheries purposes.

4. Possibility of using suggested EcoQOs indicators in NOWPAP member states

4.1. Biodiversity

All NOWPAP member states are parties to the Convention of Biological Diversity (CBD) and therefore are committed to preserving biological and habitat diversity, including diversity of marine and coastal organisms. The relevant information from national inputs submitted by nominated experts from the NOWPAP member states is briefly summarized below.

4.1.1. China

Chinese government has published a series of biological diversity assessment standards during the last three decades. In October 2014, the Ministry of Environmental Protection (MEP) has published a national environmental protection standard of technical guidelines for biodiversity monitoring of birds, which was the first standard related to biodiversity of birds in China. The standard specified the primary coverage, technical requirements as well as methods for birds' biodiversity monitoring. It is used for birds' diversity monitoring all over the country, including waterbirds.

In China, marine fishery resources surveys and assessments were usually conducted by the Ministry of Agriculture. Fish diversity monitoring is also guided by the Ministry of Environmental Protection. The MEP has published technical guidelines for biodiversity monitoring - inland water fish (HJ 710.7–2014) in 2014. In December 2012, the Ministry of Agriculture has published a national standard on technical specification for marine fishery resources surveys. Therefore, surveys of marine fish diversity as well as fish stock assessments are following the fishery resources survey standard while taking into account the freshwater fish diversity standard for reference. However, in the technical specification for marine fishery resources surveys, indicators for biodiversity assessment were not included.

Considering several standards mentioned above (as well as availability of data from scientific studies conducted in China), it seems possible to use three (out of eight) suggested EcoQO 1 indicators in the Chinese part of the NOWPAP sea area (see Table 4.1 below).

Table 4.1. Possibility of using suggested EcoQO 1 indicators in China

Operational criteria	**Possibility of using suggested EcoQO 1 indicators in China**
1.1. Species diversity of marine mammals and waterbirds	1.1.1. Abundance, distribution and population growth rates of marine mammals – no available data 1.1.2. Abundance and productivity of key waterbird species – possible (abundance only, mostly data from scientific research)
1.2.Species, age and size structure of fish stocks	1.2.1. Catch/biomass ratio – not enough data 1.2.2. Spawning Stock Biomass (SSB) – not enough data 1.2.3. Proportion of large fish (for selected species at the top of food webs) – not enough data
1.3.Distribution of benthic and pelagic communities and their status	1.3.1. Distribution – possible 1.3.2. Condition of the typical species and communities – possible 1.3.3. Hydrological and chemical conditions – not enough data

4.1.2. Japan

In Japan, fish catch statistics (by species as well as by area) have long been collected based on the Law on Statistics. Fisheries Protected Areas which include important spawning and nursery grounds for fisheries resources have been designated by Governors of prefectures or the Minister of Agriculture, Forestry and Fisheries based on the Fisheries Resources Protection Act. Approximately 3,000 ha of Fisheries Protected Areas (55 sites) have been already established, mainly in the coastal areas.

Natural Park system based on the Natural Park Law (which includes National Parks, Quasi-national Parks and Prefectural Natural Parks) contributed to the conservation of biological and habitat diversity (http://www.env.go.jp/en/laws/nature/index.html). Revision of the Nature Park Law was made in 2009 in order to maintain ecosystems in the parks appropriately through the new category of Coastal Park which includes both marine and land areas instead of previous Sea Park category which included only marine areas.

Ecologically or Biologically Significant Marine Areas (EBSAs) were selected by the Ministry of the Environment during the period of 2011-2014 in order to promote conservation and sustainable utilization of marine biodiversity. EBSAs identified in Japan include coastal, offshore surface, and offshore bottom areas. Number of the selected EBSAs are 270, 20 and 31, respectively, corresponding to coastal, offshore surface and offshore bottom areas. As a result of this selection, the EBSAs within the NOWPAP region occupy wide range of the north-western coast of Japan. This means that recently identified EBSAs in the Japanese part of the NOWPAP region can play an important role in the conservation of biodiversity and setting marine Protected Areas (MPAs) in the future.

Unfortunately, according to the information contained in the Japanese national input, none of the suggested EcoQO 1 indicators (with the exception of one fish stock indicator related to catch/biomass ratio) could be readily available in Japan (see Table 4.2 below). However, some data might be available as a result of scientific studies conducted at the local and sometimes at the national level.

Table 4.2. Possibility of using suggested EcoQO 1 indicators in Japan

Operational criteria	Possibility of using suggested EcoQO 1 indicators in Japan
1.1. Species diversity of marine mammals and waterbirds	1.1.1. Abundance, distribution and population growth rates of marine mammals - not enough data (mostly scientific research) 1.1.2. Abundance and productivity of key waterbird species - not enough data (mostly scientific research)
1.2.Species, age and size structure of fish stocks	1.2.1. Catch/biomass ratio – possible 1.2.2. Spawning Stock Biomass (SSB) - not enough data 1.2.3. Proportion of large fish (for selected species at the top of food webs) - not enough data
1.3.Distribution of benthic and pelagic communities and their status	1.3.1. Distribution - not at this moment (some national/local scientific data might be available) 1.3.2. Condition of the typical species and communities - not at this moment (some national/local scientific data might be available) 1.3.3. Hydrological and chemical conditions - not at this moment (some national/local scientific data might be available)

4.1.3. Korea

Suggested EcoQO 1 indicators include all the major marine organisms such as marine mammals, waterbirds, fish, benthos, and plankton. In Korea, these major groups of marine organisms are used for nation-wide monitoring, but protected and/or endangered species are of primary concern. It should be noted however that most of marine mammals around Korean coastal waters are designated as protected species anyway. As for waterbirds, the regular monitoring surveys are being conducted in the intertidal areas and habitat mapping is included for the protected species in ROK. Population and community level monitoring for fish, benthos, and plankton was also included in the Integrated Marine Ecosystem

Monitoring (I-MEM) program in Korea. In addition, the development of ecological health indices for the benthos and plankton communities is ongoing.

Using the data of regular monitoring surveys and scientific research conducted in Korea, it is possible to apply all suggested EcoQO 1 indicators (see Table 4.3 below).

Table 4.3. Possibility of using suggested EcoQO 1 indicators in Korea

Operational criteria	Possibility of using suggested EcoQO 1 indicators in Korea
1.1. Species diversity of marine mammals and waterbirds	1.1.1. Abundance, distribution and population growth rates of marine mammals – possible (protected species only) 1.1.2. Abundance and productivity of key waterbird species – possible (endangered species only)
1.2.Species, age and size structure of fish stocks	1.2.1. Catch/biomass ratio – possible 1.2.2. Spawning Stock Biomass (SSB) – possible 1.2.3. Proportion of large fish (for selected species at the top of food webs) - possible
1.3.Distribution of benthic and pelagic communities and their status	1.3.1. Distribution – possible 1.3.2. Condition of the typical species and communities – possible 1.3.3. Hydrological and chemical conditions – possible

4.1.4. Russia

Information on the abundance, distribution and species composition of marine mammals in the Russian part of the NOWPAP region is very fragmented and based mainly on scientific sources (mostly visual observation data). The number of species of seabirds which reproduce along the shores in the Russian part of the NOWPAP region (18-19) is considerably less than in the Sea of Okhotsk (32 species) or the Bering Sea (39 species).

Marine fish fauna of the Russian part of the NOWPAP region is comprised of 304 species. Trawl surveys are being conducted more or less regularly by the TINRO-Center.

Regular surveys of coastal benthic invertebrates to study their species composition, biological indicators, and stock status in the coastal waters of Primorye are available only for the last 10-15 years. A number of counting methods have been used, including diving (for echinoderms and mollusks), trawling (for crustaceans, mollusks, and echinoderms), and bottom grabbing and dredging (for bivalve mollusks).

According to the information provided in the Russian national input, it looks like most of the suggested EcoQO 1 indicators could be used in the Russian part of the NOWPAP sea area with the two exceptions (see Table 4.4 below).

Table 4.4. Possibility of using suggested EcoQO 1 indicators in Russia

Operational criteria	Possibility of using suggested EcoQO 1 indicators in Russia
1.1. Species diversity of marine mammals and waterbirds	1.1.1. Abundance, distribution and population growth rates of marine mammals – no reliable data 1.1.2. Abundance and productivity of key waterbird species – possible
1.2.Species, age and size structure of fish stocks	1.2.1. Catch/biomass ratio – possible (at least for some species) 1.2.2. Spawning Stock Biomass (SSB) – possible (though terminology in Russia might be slightly different) 1.2.3. Proportion of large fish (for selected species at the top of food webs) – data available only for sturgeons
1.3.Distribution of benthic and pelagic communities and their status	1.3.1. Distribution – possible 1.3.2. Condition of the typical species and communities – possible 1.3.3. Hydrological and chemical conditions – possible

4.2. Alien species

Although every member state of NOWPAP is concerned about invasive species and significant amount of scientific research is dedicated to this issue, suggested indicators related to alien species and their impact (listed in the Table 4.5 below) cannot be easily applied at this time. However, most member states consider this issue as an important one for future sustainable management of the marine and coastal environment (partly due to potential impact of climate change on invasive species introduction).

Table 4.5. Possibility of using suggested EcoQO 2 (alien species are at levels that do not adversely alter the ecosystems) indicators in the NOWPAP member states

Operational criteria	Suggested EcoQO 2 indicators	China	Japan	Korea	Russia
2.1. Abundance and state characterization of alien species	Trends in spatial distribution and biomass of alien species	Data are limited	Not at this moment (some national/local scientific data might be available)	Under development	Data are limited
2.2. Environmental impact of alien species	Ratio between alien species and native species and their interaction at the level of ecosystem, habitats and species	Data are limited	Not at this moment (some national/local scientific data might be available)	Under development	Data are limited

4.3. Eutrophication

4.3.1. China

Eutrophication is serious in some estuaries and coastal areas of China, e.g. in the Yangtze River estuary (which is close, but outside the NOWPAP sea area). For the coastal areas of China within the NOWPAP sea area, eutrophication is not severe, but some effects of nutrient enrichment have occurred in coastal waters.

Nutrients concentration. Regular monitoring of marine and coastal waters in China usually includes measuring concentrations of dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP). However, dissolved silica is not considered as an indicator of eutrophication in China. Beside DIN and DIP, chemical oxygen demand (COD), dissolved oxygen (DO) and *Chlorophyll a* are also considered as possible indicators for eutrophication evaluation in China.

Compared with nutrients concentration, nutrient ratios (silica, nitrogen and phosphorus) have received little attention in China and mostly are studied by scientists. The observed ratios of DIN/DIP in the Yellow Sea were quite high (about 30-38 during the period of 2009-2015), much higher than the Redfield ratio of 16, which might indicate excessive nitrogen input.

Direct effects of nutrient enrichment. Since 1990s, serious attention in China had been given to the monitoring of harmful algal blooms (HABs). In the last 7 years, the area affected by the HABs in the Yellow Sea ranged from 19 to 4,242 km^2. In 2003, the State Oceanic Administration (SOA) of China has published an industry standard on technical guidelines for marine harmful algal blooms monitoring. Then, in 2005, the SOA has published another industry standard on technical specification for red tide monitoring to replace the former standard. Many indicators were included in the standard of technical specification for red tide monitoring, such as indicators of environment conditions, nutrient concentrations, biological patterns of algal blooms, and some effects of the blooms. Toxic algal blooms received much more attention due to their effects on human health. The ratio of dinoflagellates to total algal biomass has been also analyzed.

Macroalgae. In China, the problem of macoralgae blooms (as a direct consequence of nutrient enrichment in the region) has become very serious since 2007. Therefore, characteristics of opportunistic macroalgae were included in the standards for the assessment of regional biodiversity in China.

Indirect effects of nutrient enrichment. Among different indirect effects of nutrient enrichment (such as changes in the community structure of plankton and benthos), changes in the dissolved oxygen (DO) concentrations and hypoxia are most profound. Hypoxia can be detected using very simple indicator of DO (between 1 and 30% of dissolved oxygen saturation), which is a basic parameter for water quality evaluation and has been listed in all national and industry standards in China. Seasonal hypoxia in China is usually observed only in the areas with high eutrophication (such as the estuary of the Yangtze River, which is outside the NOWPAP sea area).

From the data included in the national input of China (briefly summarized above), it is obvious that all suggested EcoQO 3 indicators could be applied in China (see Table 4.6 below).

Table 4.6. Possibility of using suggested EcoQO 3 indicators in China

Operational criteria	Possibility of using suggested EcoQO 3 indicators in China
3.1. Nutrients concentration	3.1.1. Nutrients concentration in the water column - possible 3.1.2. Nutrient ratios (silica, nitrogen and phosphorus) – possible (though data are limited, mostly from scientific studies)
3.2. Direct effects of nutrient enrichment	3.2.1. Chlorophyll concentration in the water column – possible 3.2.2. Species composition and abundance of toxic microalgae – data are limited 3.2.3. Harmful algal blooms (HABs) – possible 3.2.4. Abundance of opportunistic macroalgae – possible (though data are limited)
3.3. Indirect effects of nutrient enrichment	Seasonal hypoxia, dissolved oxygen changes and size of the area concerned – data are limited

4.3.2. Japan

In Japan, Environmental Quality Standards for Water Pollution are set under the Basic Environmental Act. TP and TN are routinely measured as the legally defined water quality parameters, while Si and other forms of nutrients (such as DIP, DOP, DIN, and DON) are additionally monitored by local governments and other organizations. As a result, it is possible to calculate e.g. winter mean, annual mean, monthly and seasonal means, seasonal or annual maxima, etc. Spatial and temporal data related to nutrient ratios (such as DIN:DIP and Si:N:P) are available for many coastal areas.

Chlorophyll a concentration and species composition of microalgae are not included in legal standards but are widely monitored by regular surveys of local governments. HABs are identified as a result of such surveys. However, opportunistic macroalgae are not regularly monitored. Data on spatial and temporal variations of *Chlorophyll a* concentrations are available including annual maximum and annual mean. Ratio between diatoms, flagellates and cyanobacteria is regularly assessed. Toxic microalgae are also monitored, especially at the aquaculture areas.

DO in the bottom water layer has been long monitored although it was not included in the legal standards until quite recently (new standard values of DO in bottom layer were set only in March 2016). Data on spatial and temporal variations of DO concentration are available for many enclosed coastal seas.

Therefore, all suggested EcoQO 3 indicators are easily available in Japan (with the exception of opportunistic macroalgae): see Table 4.7 below.

Table 4.7. Possibility of using suggested EcoQO 3 indicators in Japan

Operational criteria	**Possibility of using suggested EcoQO 3 indicators in Japan**
3.1. Nutrients concentration	3.1.1. Nutrients concentration in the water column- possible 3.1.2. Nutrient ratios (silica, nitrogen and phosphorus) – possible (mostly from scientific studies)
3.2. Direct effects of nutrient enrichment	3.2.1. Chlorophyll concentration in the water column – possible 3.2.2. Species composition and abundance of toxic microalgae – possible 3.2.3. Harmful algal blooms (HABs) – possible 3.2.4. Abundance of opportunistic macroalgae – data not available
3.3. Indirect effects of nutrient enrichment	Seasonal hypoxia, dissolved oxygen changes and size of the area concerned – possible

4.3.3. Korea

As mentioned earlier, nationwide monitoring for the water quality in coastal areas of ROK has been conducted by the NFRDI and KOEM since late 1990s. The program includes the *in situ* measurement of major nutrients, including nitrogen and phosphorous targeting eutrophication, in more than 400 locations around the Korean coast (Fig. 3.2). The occurrence of red tides and hypoxia in surface and bottom waters are also being monitored on a regular basis, as direct and indirect indicators of coastal eutrophication. In 15 locations (being suspected to be severely polluted coastal areas), a real-time automated measurement of water quality has been undertaken since 2005. The monitoring parameters include water temperature, salinity, *Chlorophyll a*, pH, COD, TN, and TP.

In Korea, water quality index (WQI) was developed and utilized for the water quality management in coastal areas, which includes such parameters as dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorous (DIP), *Chlorophyll-a*, dissolved oxygen (DO), and Secchi disc depth (transparency). The WQI is further utilized for the selection of Special Management Areas (SMAs). Until now, five coastal areas have been designated as SMAs: Masan Bay, the Sihwa-Incheon Coastal Area, the Busan Coastal Area, the Ulsan Coastal Area, and Gwangyang Bay. Once designated as SMA, Total Pollution Load Management System (TPLMS) would be applied to improve the water quality in a stepwise manner.

Table 4.8 shows that most of the suggested EcoQO 3 indicators could be easily applied in Korea. Some data might be not readily available mainly because the relevant issues are not of high concern in Korea (e.g. opportunistic macroalgae).

Table 4.8. Possibility of using suggested EcoQO 3 indicators in Korea

Operational criteria	Possibility of using suggested EcoQO 3 indicators in Korea
3.1. Nutrients concentration	3.1.1. Nutrients concentration in the water column – possible 3.1.2. Nutrient ratios (silica, nitrogen and phosphorus) – possible
3.2. Direct effects of nutrient enrichment	3.2.1. Chlorophyll concentration in the water column – possible (though data are limited) 3.2.2. Species composition and abundance of toxic microalgae – possible (though data are limited) 3.2.3. Harmful algal blooms (HABs) – possible (though data are limited) 3.2.4. Abundance of opportunistic macroalgae – data not available
3.3. Indirect effects of nutrient enrichment	Seasonal hypoxia, dissolved oxygen changes and size of the area concerned – possible (though data are limited)

4.3.4. Russia

There are several government organizations responsible for environmental monitoring in the Russian part of the NOWPAP sea area: 1) Prymorsky Center on Hydrometeorology and Environmental Monitoring (PCHEM); 2) Sakhalin Hydrometeorological Service (with main goal to carry out environmental monitoring of atmosphere, hydrosphere and soils in Primorsky Krai and Sakhalin, respectively); and 3) Far Eastern Regional Hydrometeorological Research Institute (FERHRI, with main goals to develop monitoring methods and to model and forecast environmental changes). These organizations also ensure the storage of the observed data. Besides, many relevant scientific studies are carried out by the institutes of the Russian Academy of Sciences, TINRO-Center, and Far Eastern Federal University. The Annual Reports of the State Oceanographic Institute (SOI), Moscow, which are available from 2004, provide only general information such as annual averages and sometimes maximum concentrations of contaminants as well as general information about ecological status of the coastal waters around Russia. Despite obvious limitations of these averaged data, they could be used to describe the general chemical characteristics of different localities within coastal waters, and to assess the inter-annual trends.

The network of the state seawater quality monitoring stations within the Russian part of the NOWPAP sea area is not dense (Fig. 4.1) due to a low population density and modest level of economic development of the territory.

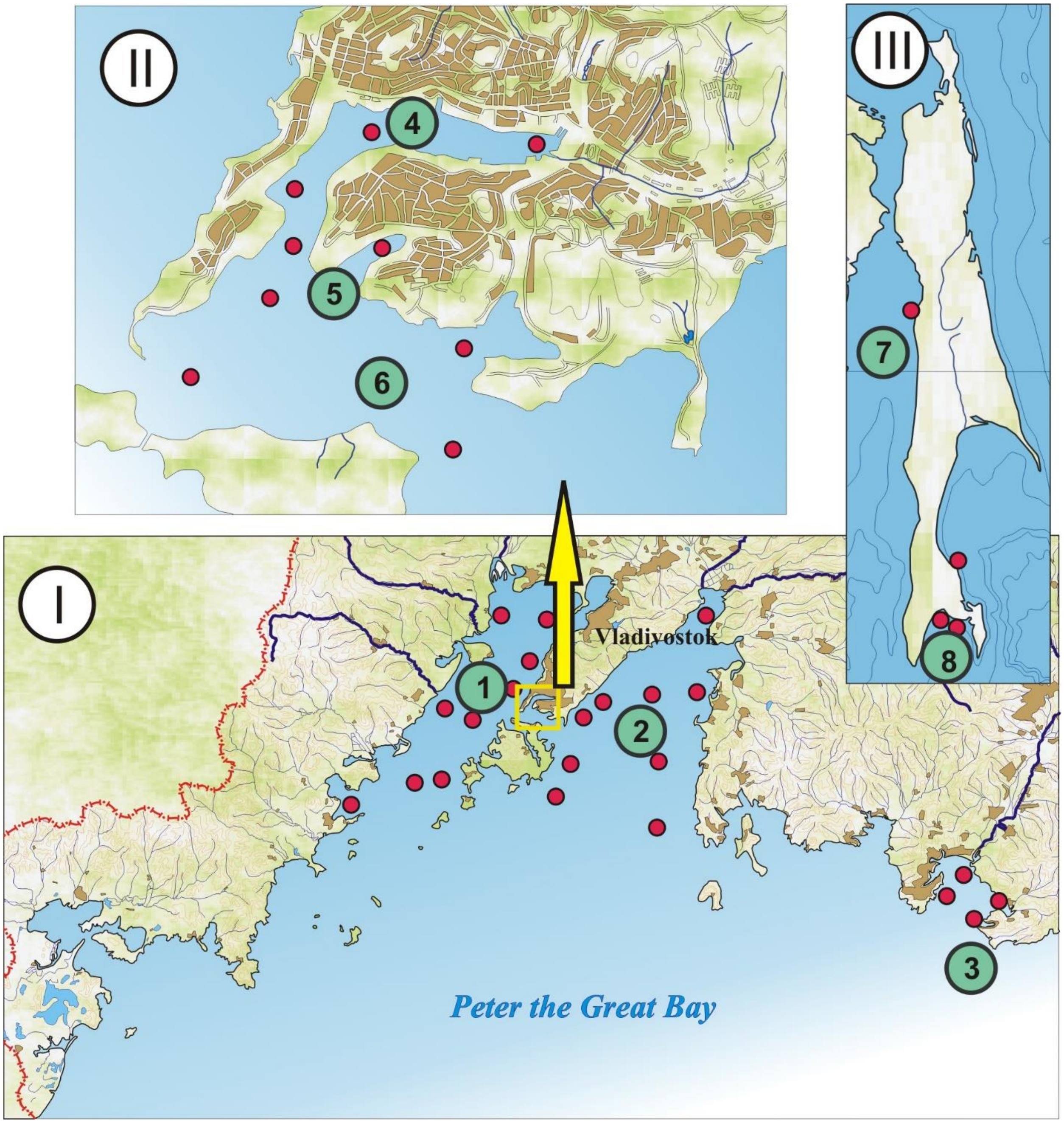

Fig. 4.1. Monitoring stations of State Observation Network in the Russian part of the NOWPAP region. 1 - Amursky Bay, 2 - Ussuriisky Bay, 3 - Nakhodka Bay, 4 - Golden Horn Bay, 5 - Diomid Bay, 6 - Bosphorus Vostochny Strait (Primorsky Kray); 7 - Tatar Strait, 8 - Aniva Bay (Sakhalin Island).

Nutrient concentrations that are observed during the late autumn (November) can be recommended as an indicator of eutrophication in the Russian coastal waters within the NOWPAP region.

The molar ratio Si:N:P as an indicator of eutrophication is often used in the scientific research, but not in the state monitoring in Russia. Based on the results of published scientific research, the variability of Si:N:P ratio in the coastal waters of Russia within NOWPAP sea area depends mostly on the natural causes (due to the absence of significant enrichment of river waters by nitrogen).

For the time being Chlorophyll-a is not included in the routine monitoring of seawater quality in Russia. Fortunately, there is a continuous interest to the phytoplankton composition and distribution studies from the scientific and fishery communities. Both the Institute of Marine Biology and the Pacific Oceanological Institute of the Russian Academy of Sciences and TINRO-Center are actively involved in the research projects related to phytoplankton studies. As a result, numerous *Chlorophyll a* data are available in the scientific publications.

Besides changes in biomass, measured by *Chlorophyll a* abundance, eutrophication could be accompanied by the change of the phytoplankton community composition, including the appearance of toxic algal species. Observation and study of phytoplankton abundance and composition in the Russian Far East are carried out by the academic and research institutes and universities. Peter the Great Bay is the only area in the Russian Far East where spatial and temporal variability of phytoplankton community (including toxin-producing species) is assessed due to efforts of the Harmful Algal Monitoring Center (based in the Institute of Marine Biology). Due to the importance of HAB events from the economic and ecological points of view, the use of information on HAB events as indicators of eutrophication is highly recommended.

Characteristics of macroalgae community are not included in the routine monitoring of seawater quality. Therefore, the results of scientific studies by the institutes of the Russian Academy of Sciences, TINRO-Center, and universities is the only source of information on macroalgae.

Existing annually averaged data on the dissolved oxygen obtained from the ROSHYDROMET Annual Reports (SOI, 2004-2014) provide enough information about seasonal concentrations of dissolved oxygen (DO). Such areas as Amursky Bay and Golden Horn Bay are often characterized by seasonal hypoxia. However, exact size of the areas with diminished DO concentration cannot be determined by the data of state monitoring network because of the limited number of stations (Fig. 4.1). For the time being the existence and degree of seasonal hypoxia observed and measured as time series at the typical characteristic sites could be recommended as an indicator of indirect effect of eutrophication. Detailed surveys for the precise determination of location and extent of hypoxic zones might be needed in the future.

From the analysis of information included in the Russian national input (briefly summarized above), it could be concluded that all suggested EcoQO 3 indicators could be applied in Russia (with some limitations due to the lack of data).

Table 4.9. Possibility of using suggested EcoQO 3 indicators in Russia

Operational criteria	Possibility of using suggested EcoQO 3 indicators in Russia
3.1. Nutrients concentration	3.1.1. Nutrients concentration in the water column – possible 3.1.2. Nutrient ratios (silica, nitrogen and phosphorus) – possible (though data are limited)
3.2. Direct effects of nutrient enrichment	3.2.1. Chlorophyll concentration in the water column – possible (though data are limited) 3.2.2. Species composition and abundance of toxic microalgae – possible (though data are limited) 3.2.3. Harmful algal blooms (HABs) – possible (though data are limited) 3.2.4. Abundance of opportunistic macroalgae – possible (though data are limited)
3.3. Indirect effects of nutrient enrichment	Seasonal hypoxia, dissolved oxygen changes and size of the area concerned – possible (though data are limited)

4.4. Contaminants

4.4.1. China

Concentrations of major contaminants in China are included (as environmental quality indicators) in relevant national standards for marine water, sediment and marine organisms. These contaminants include heavy metals, persistent organic pollutants and other toxic contaminants. Environmental quality is classified into different levels (classes): four levels for marine waters and three levels for both sediments and marine organisms.

According to the information included in the national input prepared by Chinese experts, it is possible to use suggested EcoQO 4 indicators related to contaminant concentrations in sea water, sediments and marine organisms as well as cases of exceeding maximum permissible concentrations in aquatic organisms. However, at this moment it is not possible to use suggested indicators related to the effects of contaminants (see Table 4.10 below). Pollution effects on the marine ecosystem components is now a subject of scientific studies in China, but no biochemical indicators have been used for the routine environmental quality assessment in China yet.

Table 4.10. Possibility of using suggested EcoQO 4 indicators in China

Operational criteria	Possibility of using suggested EcoQO 4 indicators in China
4.1. Concentration of contaminants	4.1.1. Concentration of the contaminants in sediments, water and organisms – possible (in sediments and water only) 4.1.2. Exceeding of MPC in aquatic organisms and frequency of such cases – not at this moment (some national/local scientific data might be available)
4.2. Effects of contaminants	Levels of pollution effects on the ecosystem components concerned, where a cause/effect relationship has been established – not at this moment

4.4.2. Japan

In Japan, standards for contaminant concentrations in sea water, sediments and marine organisms are well established and regularly monitored (see part 3.2 above). Therefore, suggested EcoQO 4 indicators related to contaminant concentrations could be easily applied in Japan. However, data on exceeding maximum permissible concentrations in aquatic organisms as well as data on harmful effects of contaminants on marine life are generated as a result of scientific studies and might be not readily available. Hence, using such indicators might be difficult in Japan at this moment (Table 4.11 below).

Table 4.11. Possibility of using suggested EcoQO 4 indicators in Japan

Operational criteria	Possibility of using suggested EcoQO 4 indicators in Japan
4.1. Concentration of contaminants	4.1.1. Concentration of the contaminants in sediments, water and organisms – possible 4.1.2. Exceeding of MPC in aquatic organisms and frequency of such cases – not at this moment (some national/local scientific data might be available)
4.2. Effects of contaminants	Levels of pollution effects on the ecosystem components concerned, where a cause/effect relationship has been established – not at this moment (some national/local scientific data might be available)

4.4.3. Korea

The occurrence and distribution of environmental contaminants including heavy metals and persistent organic pollutants (POPs) have been well studied during the past 20 years in Korea. While monitoring of heavy metals has been conducted by the government agencies, POPs monitoring has been done by the *ad hoc* monitoring surveys or through individual research projects. The monitoring of contaminants generally covers both the concentrations of target contaminants and their toxic effects which allowed to formulate the environmental guidelines for sea water and sediment for selected contaminants in Korea. Therefore, it is possible to use all suggested EcoQO 4 indicators in Korea (see Table 4.12 below).

Table 4.12. Possibility of using suggested EcoQO 4 indicators in Korea

Operational criteria	Possibility of using suggested EcoQO 4 indicators in Korea
4.1. Concentration of contaminants	4.1.1. Concentration of the contaminants in sediments, water and organisms – possible (in sediments and organisms) 4.1.2. Exceeding of MPC in aquatic organisms and frequency of such cases – possible
4.2. Effects of contaminants	Levels of pollution effects on the ecosystem components concerned, where a cause/effect relationship has been established – possible

4.4.4. Russia

Data on concentrations of heavy metals and organochlorine pesticides in sea water, sediments and biota in the Russian Far East are available from both routine monitoring and scientific studies. There are also well established standards of maximum permissible concentrations of contaminants in sea water and marine organisms (intended for human consumption). Therefore, it is possible to use relevant EcoQO 4 indicators in Russia.

However, data on harmful effects of contaminants on marine ecosystems and their components (and possible indicators of such effects) are the subject of continuous scientific research and therefore suggested EcoQO4 indicators related to pollution effects could not be used in Russia at this moment (Table 4.13 below).

Table 4.13. Possibility of using suggested EcoQO 4 indicators in Russia

Operational criteria	Possibility of using suggested EcoQO 4 indicators in Russia
4.1. Concentration of contaminants	4.1.1. Concentration of the contaminants in sediments, water and organisms – possible (in sediments and organisms) 4.1.2. Exceeding of MPC in aquatic organisms and frequency of such cases – possible
4.2. Effects of contaminants	Levels of pollution effects on the ecosystem components concerned, where a cause/effect relationship has been established – not at this moment

4.5. Marine litter

Among two indicators suggested for the EcoQO 5 (marine litter), data on marine litter washed ashore are available in all four NOWPAP member states. However, data on marine litter in water column and on sea bed as well as data on microplastics are very limited, especially information on temporal trends (see Table 4.14 below). Research on microplastics has started in all NOWPAP member states, but some countries have more experience than others at this time.

Even less information is available on the negative impacts of marine litter on biota (though some reports were published e.g. in Korea).

Therefore, it might take some time before some common indicators for the EcoQO 5 could be agreed upon by the NOWPAP member states (except for marine litter concentrations on the beaches).

Table 4.14. Possibility of using suggested EcoQO 5 (marine litter does not adversely affect coastal and marine environments) indicators in the NOWPAP member states

Operational criteria	Suggested EcoQO 5 indicators	China	Japan	Korea	Russia
5.1. Characteristics of litter in the marine and coastal environment	5.1.1. Trends in the amount and composition of litter washed ashore 5.1.2. Trends in the amount of litter in the water column and deposited on the seafloor 5.1.3. Trends in the amount, distribution and composition of micro-particles	5.1.1. Possible 5.1.2. Data are very limited 5.1.3. Under development	5.1.1. – 5.1.3: Possible (using data from national/local surveys)	5.1.1. – 5.1.3: Possible	5.1.1. Possible 5.1.2. Data are very limited 5.1.3. Data are very limited
5.2. Impacts of litter on marine life	Trends in the amount and composition of litter ingested by marine animals	Not at this moment	Data not available	Not at this moment, under development	Not at this moment

5. Conclusions and possible way forward

Annex 1 shows the compilation of information presented in part 4 about the possibility of applying suggested EcoQO indicators in the NOWPAP member states. Comparison of the information presented in national inputs allowed to conclude that there are only a few indicators which could be easily applied in all NOWPAP member states at this moment. These indicators are related to fish stocks (biodiversity), nutrient concentrations and their effects (eutrophication), and concentrations of contaminants and marine litter (mostly washed ashore).

Sections 5.1 – 5.3 below provide some suggestions regarding the possible way forward within the NOWPAP framework: aligning NOWPAP EcoQO indicators with the SDG indicators, enhancing relevant activities of NOWPAP Regional Activity Centers, and harmonizing national approaches (including existing numerical targets for certain indicators).

5.1. Aligning with SDG indicators

The Sustainable Development Goals (SDGs) have been adopted by the UN General Assembly in December 2015 and their practical implementation has started since then. Goal 14 is dedicated to the oceans: "Conserve and sustainably use the oceans, seas and marine resources for sustainable development". The global indicator network was developed by the Inter-Agency Expert Group on SDG indicators (IAEG-SDGs): http://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-IAEG-SDGs-Rev1-E.pdf. All indicators are classified into three tiers:

Tier 1: Indicator conceptually clear, established methodology and standards available and data regularly produced by countries.

Tier 2: Indicator conceptually clear, established methodology and standards available but data are not regularly produced by countries.

Tier 3: Indicator for which there are no established methodology and standards or methodology/standards are being developed/tested.

Unfortunately, most indicators suggested for the SDG 14 on oceans belong to Tier 3 and therefore further work is needed to agree on methodology for such indicators and even then data might be not easily available in some countries. Only two indicators of SDG 14 belong to Tier 1: 14.4.1 ("Proportion of fish stocks within biologically sustainable levels") and 14.5.1 ("Coverage of protected areas in relation to marine areas").

United Nations Statistical Commission maintains the global database on SDG indicators: http://unstats.un.org/sdgs/indicators/database/. At this moment, only these two indicators (14.4.1 and 14.5.1) are included in the database. There are two more indicators under consideration at this stage relevant to NOWPAP EcoQOs: eutrophication index (which will be most probably based on the concentrations of *Chlorophyll a*) and indicator related to floating marine litter (currently, marine litter concentrations on the beaches are being considered as the first proxy). UNEP is the custodian agency for these two indicators.

The second session of the United Nations Environment Assembly (UNEA-2), in the resolution 2/10, invited "*member states and regional seas conventions and action plans, in cooperation, as appropriate, with other regional organizations and fora, such as regional fisheries management organizations, to work towards the implementation of, and reporting on, the different ocean-related Sustainable Development Goals and associated targets, the Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets*".

NOWPAP, as an integral part of the UNEP Regional Seas Programme, can play a certain role in achieving SDG 14 (and other relevant SDGs) in the NW Pacific region, including through applying relevant SDG indicators (i.e. aligning the indicators suggested by experts from NOWPAP member states in 2014-2016 with the global SDG indicators which are now under development). It is also worth participating actively in the Working Group on indicators established in 2013 within the Regional Seas Programme. NOWPAP will also provide inputs to the development of two SDG 14 indicators through the two established by the UNEP working groups: on eutrophication and on floating plastic debris density. During this process, NOWPAP member states could align the regional goals/objectives/indicators/targets with the relevant SDGs and associated indicators.

Among the NOWPAP EcoQO indicators, only two indicators for EcoQO 3 and EcoQO 5 (on eutrophication and marine litter) are matching directly with the proposed SDG 14 indicators (see tables in Annex 1). NOWPAP member states could also consider collecting data for two more SDG indicators: 14.2.1 "Proportion of national exclusive economic zones managed using ecosystem-based approaches" (Tier 3 indicator without established methodology, UNEP is a custodian agency) and 14.5.1 "Coverage of protected areas in relation to marine areas" (Tier 1 indicator). One additional indicator 14.4.1 ("Proportion of fish stocks within biologically sustainable levels") could be also derived from the information available in some NOWPAP countries.

5.2. Enhancing relevant activities of NOWPAP RACs

Since 2014, all NOWPAP Regional Activity Centers (RACs) are actively involved in the development of Ecological Quality Objectives (EcoQOs) for the NOWPAP region and, more recently, in the discussion of possible indicators to be applied along with those five EcoQOs agreed upon in 2014. Below is what each RAC could do to enhance their relevant activities.

CEARAC. In recent years, CEARAC is working on several issues relevant to the EcoQOs agreed upon in 2014: biodiversity conservation (including the regional report on MPAs, the assessment of major negative impacts on biodiversity and the assessment of seagrass and seaweed distribution), harmful algal blooms (including several integrated reports on HABs as well as report on HAB countermeasures), and eutrophication (including the development of common methodology, regional eutrophication assessment, the development of interactive map of eutrophic zones, and the report on remote sensing applications along with several regional training courses). Obviously, the outcomes of all these CEARAC activities will contribute to the agreement on possible indicators to be applied under EcoQOs 1, 2 and 3 (biodiversity, alien species, and eutrophication). CEARAC work on marine litter washed ashore (as well as the work of their host organization, Northwest Pacific Region Environment Cooperation Center, NPEC), will contribute to the development of possible indicators for the EcoQO 5 on marine litter. Therefore, such activities contributing to the achievement of regional EcoQOs (and relevant global SDG indicators) should be continued and enhanced.

DINRAC. By definition, the role of DINRAC is to serve as a regional depository of all the data produced within the NOWPAP. Therefore, the data for the EcoQO indicators to be agreed upon by the member states should be available (and to be provided free of charge) at DINRAC website in the future (http://dinrac.nowpap.org).

MERRAC. Among several other marine environmental issues, MERRAC is working on floating marine litter. This work is in line with the expected SDG 14 indicator on marine litter and therefore the outcomes of MERRAC activities might be very useful. Another area not yet explored by MERRAC is the introduction of alien species with ballast water. MERRAC activities should contribute at least to the development of indicator(s) related to marine litter and potentially the indicator on invasive species introductions.

POMRAC. Although all RACs were involved in recent work on EcoQOs and suggested indicators, POMRAC was leading this process. In particular, POMRAC has organized two regional workshops where experts from member states and from NOWPAP partner organizations (OSPAR, PEMSEA, PICES, and others) have discussed and agreed upon five Ecological Quality Objectives and then the suggested indicators. POMRAC has compiled four national inputs on EcoQO indicators and initiated this present regional overview. POMRAC activities are also closely related to contaminant (and other marine environment parameters) monitoring. Therefore, the outcomes of POMRAC activities will be relevant for the development of indicators on EcoQOs 3, 4 and 5 (eutrophication, contaminants, and marine litter, including microplastics) and should be enhanced.

Recommendations for further work on EcoQO indicators. Taking into account that further development of suggested EcoQO indicators will require specific scientific knowledge, it might be worth considering to establish Working Groups (or Expert Groups) working by correspondence on specific indicators (or groups of similar indicators), perhaps under the oversight of the RAC Focal Points. For example, within HELCOM, there are more than 10 such groups working on very specific issues (e.g., AGRI, FISH, MARITIME, PRESSURE, RESPONSE, SHORE, etc.). Similar arrangements exist in the European Union (dealing with MSFD implementation) as well as in MAP and OSPAR. It would be desirable to establish such ad-hoc working group for EcoQO 1 (biodiversity,) EcoQO 2 (alien species), and EcoQO 3 (eutrophication) under the framework of CEARAC. Working group on EcoQO 4 (contaminants) indicators could be established under POMRAC. Working group on EcoQO 5 (marine litter) could be established under RAP MALI Focal Points. It is recommended that POMRAC will continue playing leading coordinating role in further development of EcoQO indicators among all NOWPAP RACs by organizing regular synthesis meetings.

5.3. Harmonizing national monitoring approaches

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 adjustment are made (see Fig. 2.1 as an illustration).

Though at a regional level the work on EcoQOs and related indicators has started just recently, each NOWPAP member state has already in place the routine marine environment monitoring system (or systems) and applicable national standards. To illustrate the differences in these national approaches, Annex 2 contains several tables with existing national standards of China, Japan, Korea and Russia related to eutrophication and contaminants.

It is unrealistic to expect that all NOWPAP member states will decide to change their national standards and agree on one set of regional standards. However, further careful work on comparison of national standards and indicators between NOWPAP countries and with the SDGs indicators (where applicable) is necessary and NOWPAP RACs could play an active role in this process in accordance with their relevant mandates.

Possibility of applying suggested EcoQO indicators in the NOWPAP member states

EcoQO 1: Biological and habitat diversity are not changed significantly due to anthropogenic pressure						
Operational criteria	**Suggested indicators**	**Relevant SDG Indicators**	**China**	**Japan**	**Korea**	**Russia**
1.1. Species diversity of marine mammals and waterbirds	1.1.1. Abundance, distribution and population growth rates of marine mammals 1.1.2. Abundance and productivity of key waterbird species		1.1.1. No available data **1.1.2. Possible (abundance only, mostly data from scientific research)**	1.1.1. Not enough data (mostly scientific research) 1.1.2. Not enough data (mostly scientific research)	**1.1.1. Possible (protected species only)** **1.1.2. Possible (endangered species only)**	1.1.1. No reliable data **1.1.2. Possible**
1.2.Species, age and size structure of fish stocks	1.2.1. Catch/biomass ratio 1.2.2. Spawning Stock Biomass (SSB) 1.2.3. Proportion of large fish (for selected species at the top of food webs)	14.4.1. Proportion of fish stocks within biologically sustainable levels (measures the % of the assessed stocks are within biologically sustainable levels)[1]	1.2.1. Not enough data 1.2.2. Not enough data 1.2.3. Not enough data	**1.2.1. Possible** 1.2.2. Not enough data 1.2.3. Not enough data	**1.2.1. Possible** **1.2.2. Possible** **1.2.3. Possible**	**1.2.1. Possible** **1.2.2. Possible** **1.2.3. Possible (for sturgeon only)**
1.3.Distribution of benthic and pelagic communities and their status	1.3.1. Distribution 1.3.2. Condition of the typical species and communities 1.3.3. Hydrological and chemical conditions		**1.3.1. Possible** **1.3.2. Possible** 1.3.3. Not enough data	Not at this moment (some national/local scientific data might be available)	**1.3.1. Possible** **1.3.2. Possible** **1.3.3. Possible**	**1.3.1. Possible** **1.3.2. Possible** **1.3.3. Possible**

[1] Stocks are at the sustainable level if abundance ≥ 80% of the abundance at the maximum sustainable yield, with the exception of rebuilding stocks, which must be at 100%. Percentage of stocks at sustainable level is calculated by dividing the total number of stocks at the sustainable level by the total number of Fish Stock Sustainability Index (FSSI) stocks with known stock status / abundance levels.

EcoQO 2: Alien species are at levels that do not adversely alter the ecosystems						
Operational criteria	**Suggested indicators**	**Relevant SDG Indicators**	**China**	**Japan**	**Korea**	**Russia**
2.1. Abundance and state characterization of alien species	Trends in spatial distribution and biomass of alien species	Indicator is proposed only for alien species on land and water ecosystems and could be applied only for coastal river systems: 15.8.1: Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species	Data are limited	Not at this moment (some national/local scientific data might be available)	Under development	Data are limited
2.2. Environmental impact of alien species	Ratio between alien species and native species and their interaction at the level of ecosystem, habitats and species		Data are limited	Not at this moment (some national/local scientific data might be available)	Under development	Data are limited

EcoQO 3: Eutrophication adverse effects are absent

Operational criteria	Suggested indicators	Relevant SDG Indicators	China	Japan	Korea	Russia
3.1. Nutrients concentration	3.1.1. Nutrients concentration in the water column 3.1.2. Nutrient ratios (silica, nitrogen and phosphorus)	14.1.1. Index of coastal eutrophication (indicator with established methodology and standards is absent, but initial proposal is to focus on *Chlorophyll a* as a core parameter with progressive identification of additional parameters)	**3.1.1. Possible** **3.1.2. Possible (though data are limited, mostly from scientific studies)**	**3.1.1. Possible** **3.1.2. Possible (mostly from scientific studies)**	**3.1.1. Possible** **3.1.2. Possible**	**3.1.1. Possible** **3.1.2. Possible (though data are limited)**
3.2. Direct effects of nutrient enrichment	3.2.1. *Chlorophyll a* concentration in the water column 3.2.2. Species composition and abundance of toxic microalgae 3.2.3. Harmful algal blooms (HABs) 3.2.4. Abundance of opportunistic macroalgae		**3.2.1. Possible** 3.2.2. Data are limited **3.2.3. Possible** **3.2.4. Possible (though data are limited)**	**3.2.1. Possible** **3.2.2. Possible** **3.2.3. Possible** 3.2.4. Data not available	**3.2.1. Possible (though data are limited)** **3.2.2. Possible (though data are limited)** **3.2.3. Possible (though data are limited)** 3.2.4. Data not available	**3.2.1. Possible (though data are limited)** **3.2.2. Possible (though data are limited)** **3.2.3. Possible (though data are limited)** **3.2.4. Possible (though data are limited)**
3.3. Indirect effects of nutrient enrichment	Seasonal hypoxia, dissolved oxygen changes and size of the area concerned		Data are limited	**Possible**	**Possible (though data are limited)**	**Possible (though data are limited)**

EcoQO 4: Contaminants cause no significant impact on coastal and marine ecosystems and human health						
Operational criteria	**Suggested indicators**	**Relevant SDG Indicators**	**China**	**Japan**	**Korea**	**Russia**
4.1. Concentration of contaminants	4.1.1. Concentration of the contaminants in sediments, water and organisms 4.1.2. Exceeding of MPC in aquatic organisms and frequency of such cases	None at this moment	**4.1.1. Possible (in sediments and water only)** 4.1.2. Not at this moment (some national/local scientific data might be available)	**4.1.1. Possible** 4.1.2. Not at this moment (some national/local scientific data might be available)	**4.1.1. Possible (in sediments and organisms)** **4.1.2. Possible**	**4.1.1. Possible (in sediments and organisms)** **4.1.2. Possible**
4.2. Effects of contaminants	Levels of pollution effects on the ecosystem components concerned, where a cause/effect relationship has been established		Not at this moment	Not at this moment (some national/local scientific data might be available)	**Possible**	Not at this moment

EcoQO 5: Marine litter does not adversely affect coastal and marine environments						
Operational criteria	**Suggested indicators**	**Relevant SDG Indicators**	**China**	**Japan**	**Korea**	**Russia**
5.1. Characteristics of litter in the marine and coastal environment	5.1.1. Trends in the amount and composition of litter washed ashore 5.1.2. Trends in the amount of litter in the water column and deposited on the seafloor 5.1.3. Trends in the amount, distribution and composition of micro-particles	14.1.1. Floating plastic debris density (indicator with established methodology and standards is absent, but initial proposal is to focus on beach litter as a proxy indicator)	**5.1.1. Possible** 5.1.2. Data are very limited 5.1.3. Under development	**Possible (using data from national/local surveys)**	**5.1.1. Possible** **5.1.2. Possible** **5.1.3. Possible**	**5.1.1. Possible** 5.1.2. Data are very limited 5.1.3. Data are very limited
5.2. Impacts of litter on marine life	Trends in the amount and composition of litter ingested by marine animals		Not at this moment	Data not available	Not at this moment, under development	Not at this moment

Annex 2

Existing national standards related to eutrophication and contaminants in NOWPAP member states

Only a few examples (related to eutrophication and contaminants) are presented here to demonstrate what national standards already exist in NOWPAP member states at this moment. Obviously, these standards are quite different.

Table A.1. National standards of China for nutrient and COD concentrations in sea water (maximum permissible concentration, mg/L)

Indicator	First level	Second level	Third level	Fourth level
DIN	≤0.20	＞0.20, ≤0.30	＞0.30, ≤0.40	＞0.40, ≤0.50
DIP	≤0.015	＞0.015, ≤0.030		＞0.030, ≤0.045
COD	≤2	＞2, ≤3	＞3, ≤4	＞4, ≤5

Table A.2. National standards of Japan for nutrient concentrations in sea water (maximum permissible annual average, 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 A.3. National standards of Russia for nutrient and PHCs concentrations in sea water (maximum permissible concentration, mg/L)

Water types:	Waters for fishery purposes			Bathing waters
Indicator	Oligotrophic waters	Mesotrophic waters	Eutrophic waters	
DIN	<9.42	<9.42	<9.42	<12.7
DIP	≤0.050	< 0.150	<0.200	<1.14
PHCs	<0.05	<0.05	<0.05	<0.30

Table A.4. National standards of China for contaminants in sea water (maximum permissible concentration, µg/L)

<table>
<tr><th>Contaminant</th><th>First level</th><th>Second level</th><th>Third level</th><th>Fourth level</th></tr>
<tr><td>Hg</td><td>0.05</td><td colspan="2">0.2</td><td>45</td></tr>
<tr><td>Cd</td><td>1</td><td>5</td><td colspan="2">10</td></tr>
<tr><td>Pb</td><td>1</td><td>5</td><td>10</td><td>50</td></tr>
<tr><td>Cr^{6+}</td><td>5</td><td>10</td><td>20</td><td>50</td></tr>
<tr><td>Total Cr</td><td>50</td><td>100</td><td>200</td><td>500</td></tr>
<tr><td>As</td><td>20</td><td>30</td><td colspan="2">50</td></tr>
<tr><td>Cu</td><td>5</td><td>10</td><td colspan="2">50</td></tr>
<tr><td>Zn</td><td>20</td><td>50</td><td>100</td><td>500</td></tr>
<tr><td>Se</td><td>10</td><td>20</td><td colspan="2">50</td></tr>
<tr><td>Ni</td><td>5</td><td>10</td><td>20</td><td>50</td></tr>
<tr><td>Cyanide</td><td colspan="2">5</td><td>100</td><td>250</td></tr>
<tr><td>Sulfide</td><td>20</td><td>50</td><td>100</td><td>250</td></tr>
<tr><td>Volatile phenol</td><td colspan="2">5</td><td>10</td><td>50</td></tr>
<tr><td>Petroleum</td><td colspan="2">50</td><td>300</td><td>500</td></tr>
<tr><td>Hexachlorocyclohexane</td><td>1</td><td>2</td><td>3</td><td>5</td></tr>
<tr><td>DDTs</td><td>0.05</td><td colspan="3">0.1</td></tr>
<tr><td>Benzopyrene</td><td colspan="4">2.5</td></tr>
</table>

Table A.5. National standards of Korea for contaminants in sea water (maximum permissible concentration, µg/L)

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

Table A.6. National standards of Japan (human health-related) for contaminants in sea water (maximum permissible concentration, mg/L)

Contaminant	Standard
Se	0.01
Pb	0.01
As	0.01
Cd	0.003
Cr^{6+}	0.05
Total mercury	0.0005
Alkylmercury	Undetected
Dichloromethane	0.02
PCB	Undetected
1,2-Dichloroethane	0.004
Cis-1,2-Dichloroethylene	0.04
1,1,2-Trichloroethane	0.006
Tetrachloroethylene	0.01
Carbon tetrachloride	0.002
1-1-Dichloroethylene	0.02
1,1,1-Trichloroethane	1.0
Trichloroethylene	0.01
1,3-Dichloropropene	0.002
Total cyanide	Undetected
Benzene	0.01

Table A.7. National standards of Russia for contaminants in sea water (maximum permissible concentration, μg/L)

Water types:	Waters for fishery purposes		Bathing waters
Contaminant	Sea water	Fresh water	
As	10	50	10
Cu	5	1	1,000
Pb	10	6	10
Ni	10	10	20
Zn	50	10	1,000
Cd	10	5	1
Cr^{6+}	20	20	50
Hg	0.1	<0.01	<0.01
Cyanide	50	50	35
DDTs	0.01	0.01	2
HCHs	0.01	0.01	20

Table A.8. National food safety standards of China for contaminants in aquatic organisms (maximum permissible concentration, mg/kg wet weight)

Contaminant	Fish	Crustacean	Molluscs	Other animals	Algae
Pb	0.5	0.5	1.5	1.0	1.0 (dry weight)
Cd	0.1	0.5	2.0 (muscle)	2.0 (muscle)	—
Hg (methyl mercury)	1.0 (carnivorous fish)	0.5	0.5	0.5	0.5
As (inorganic arsenic)	0.1	0.5	0.5	0.5	1.5 (dry weight)
Cr	2.0	2.0	2.0	2.0	—
PCBs	0.5	0.5	0.5	0.5	2.0 (dry weight)
HCBs	0.1	0.1	0.1	0.1	0.1
DDTs	0.5	0.5	0.5	0.5	0.5

Table A.9. National food safety standards of Russia for contaminants in aquatic organisms (maximum permissible concentration, mg/kg wet weight)

Contaminant	Fish	Mollusks and other invertebrates
As	1.0*-5.0	5
Pb	1.0	10
Pb (tuna, swordfish, sturgeons)	2.0	
Cd	0.2	2.0
Hg	0.3*-0.5	0.2
Hg (tuna, swordfish, sturgeons)	1.0	
Cu	10	30
Zn	40	200
HCHs	0.03*-0.2	
DDTs	0.2 (fresh meat), 3.0 (liver)	
DDTs (sturgeons, salmon, herring and other fat fish)	2.0	

*freshwater fish species