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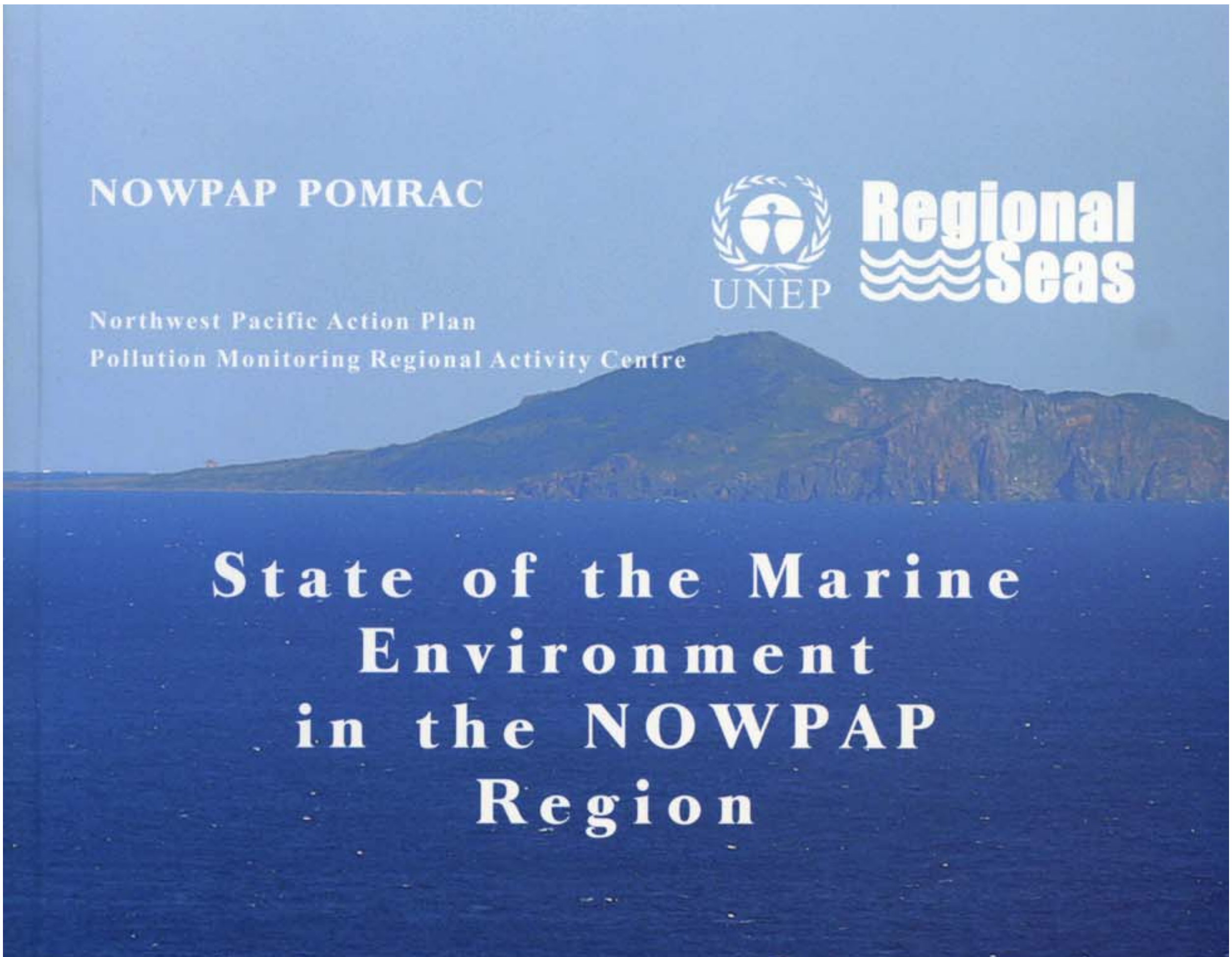
Northwest Pacific Action Plan
Pollution Monitoring Regional Activity Centre

State of the Marine Environment in the NOWPAP Region



2007

Note:
This document was prepared by the NOWPAP POMRAC in collaboration with other NOWPAP RACs.
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NOWPAP POMRAC

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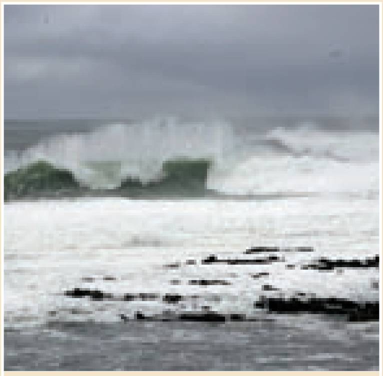
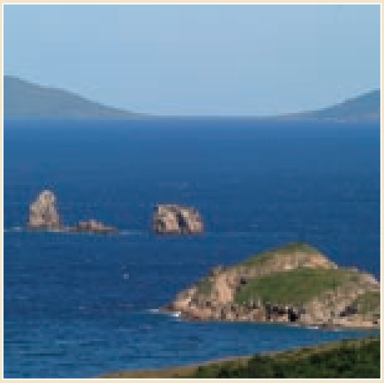


List of Acronyms

BOD	Biological Oxygen Demand
CEARAC	Special Monitoring and Coastal Environmental Assessment Regional Activity Centre
CHCls	Chlordane Ccompounds
COD	Chemical Oxygen Demand
DDTs	Dichloro-Diphenyl-Trichloroethane
DO	Dissolved Oxygen
DSP	Diarethic Shellfish Poison
EDC	Endocrine Desruptive Compounds
FPM	FFocal Points Meeting
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIWA	Global International Waters Assessment
GPA	Global Program of Action for the Protection of the Marine Environment from Land-Based Activities
HAB	Harmful Algal Bloom

HCHs	Hexachlorcyclohexane Ccompounds
HNS	Hazardous Noxious Substances
ICARM	Integrated Coastal Area and River Basin Management
IGM	Intergovernmental Meeting
IMO	International Maritime Organization
JMA	Japan Meteorological Agency
KEI	Korea Environment Institute
KORDI	Korea Ocean Research and Development Institute
LOICZ	Land-Ocean Interaction in the Coastal Zone
MALITA	Marine Litter Activity
MAP	Mediterranean Action Plan
MTS	MAP Technical Report Series
NEAR-GOOS	North East Asian Regional Global Ocean Observingation System
NGOs	Nongovernmental Organizations
NIES	National Institute for Environmental Studies, Japan
NOWPAP	Northwest Pacific Action Plan
OSPAR	OSPAR Commission established by the Convention for the
Protection of the	Marine Environment of the North East Atlantic
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyles
PICES	North Pacific Marine Science Organization
POMRAC	PPollution Monitoring Regional Activity Centre
POPs	Persistent Organic Pollutants
PSP	Paralytic Shellfish Poison
PTS	Persistent Toxic Substances
RACs	Regional Activity Centers
ROK	Republic of Korea
SOMER	State of Marine Environment Report
SPM	Suspended Particulate Matter
SS	Suspended Solids
TBT	Tri-Butyl Tin
TDA	Transboundary Diagnostic Analysis
TN,TP	Total Nitrogen, Total Phosphorus
TOC	Total Organic Carbon
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WWF	World Wide Fund for Nature
YSLME	Yellow Sea Large Marine Ecosystem



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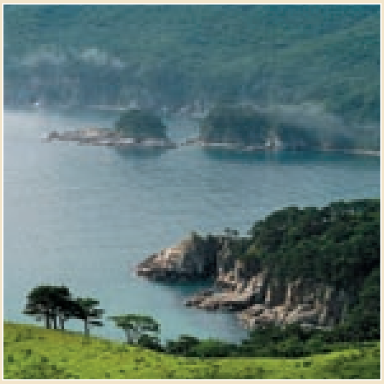


Executive Summary

This document – State of the Marine Environment Report (SOMER) for the NOWPAP Region – was prepared based on suggestions proposed at the Intersessional Workshop held in Seoul in July 2005 and following a decision of the 10th Intergovernmental Meeting (Toyama, 24-26 November 2005). The contents and structure of this report were discussed and adopted at the 3rd POMRAC Focal Points Meeting (Vladivostok, 10-11 October 2005). This report, based on data from the Regional Overviews prepared by NOWPAP RACs and on materials in other published sources, summarizes the current status of the marine environment in the NOWPAP region, describes major existing and emerging environmental problems, highlights knowledge gaps, and presents approaches on how to move forward to solve these problems.

A brief description of the key natural and socio-economical features of the different areas in the NOWPAP region is provided at the beginning of the report; this is followed by a description of current environmental issues. To rank the environmental problems found in the NOWPAP marine area is a difficult, if not impossible, task to undertake given the variety of problems encountered in different countries. According to the GPA Overview (UNEP/GPA, 2006) coastal and marine water pollution has generally increased throughout East Asia during 1995-2005, including the southern part of the NOWPAP region. This is largely a consequence of land-based domestic and industrial effluent discharges, air pollution, oil spills, and input of wastes and contaminants from shipping.

The major sources of air, river and marine pollution in the NOWPAP region are evaluated and compared. There is clear evidence that atmospheric input of pollutants (suspended particles, N, P, Cd, and Pb containing substances) is predominant in the eastern portion of the region. In the western portion, the role of atmospheric deposition ranges from 26% to 42% of the total input to the sea.

Analysis of air and river pollution problems demonstrates a need to take action on the following key issues:

1. Harmonize monitoring parameters, methodologies and technical standards/criteria used in NOWPAP member country studies. The lack of unified standards limits the possibility to jointly address atmospheric deposition and contaminated river inputs in the NOWPAP region;

2. Conduct additional joint research and develop an integrated regional monitoring network that tracks dust/sand storms and that looks for ways to reduce pollution delivered by rivers and trans-boundary movement of pollutants such as dust and sand storms in the NOWPAP region; and

3. Expand the efforts to obtain reliable data on trace pollutants (dissolved forms of some metals and persistent organic pollutants at µg and ng level) in the air, rivers and coastal waters.

Harmful algal blooms, including red tides and toxin producing plankton, are a very serious environmental problem, especially in China, Japan and Korea which have highly developed coastal aquaculture. The report presents information on the features and peculiarities of red tide events as a phenomenon of accelerated plankton growth in the region. Anthropogenic eutrophication and countermeasures to prevent HABs are also discussed. Toxin-producing plankton is a natural phenomenon and a threat to humans is associated with the consumption of poisoned shellfish.

Suggestions for future activities to address regional HABs, based on the analysis of NOWPAP CEARAC experts, include:

1. Facilitate research and study of *Cochlodinium* induced red tides;

2. Establish a common approach to HAB issues by creating a database and information network, and by establishing a collaborative framework for HAB monitoring;

3. Develop policy to control land-based nutrient discharge by studying the causal links between eutrophication and HABs; and

4. Share information on effective countermeasures to reduce HABs.

Oil and hazardous/noxious spills, given increasing oil and HNS tanker traffic, are recognized as one of the most potentially dangerous environmental problems in the NOWPAP marine area. The risk of an oil spill in the NOWPAP region is moderately high and risks are on par with the Mediterranean Sea and the Northeast Atlantic. However, regional preparedness to deal with an oil spill is relatively low. MERRAC has been building a strong partnership among NOWPAP members and has carried out activities to enhance regional cooperation in the field of oil spill preparedness and response in the region. This has been done within the framework of NOWPAP and with the professional support from UNEP, IMO and NOWPAP RCU.

The Regional Oil Spill Contingency Plan (Plan) and the Memorandum of Understanding

(MoU) on Regional Cooperation Regarding Preparedness and Response to Oil Spills adopted by NOWPAP countries are major MERRAC achiviments. Published Technical Reports on sensitivity mapping, shoreline clean-up, and the use of dispersants are other impotant results.

Shifts in biodiversity and/or the structure of hydrobiological communities have arisen as regional issue in part as a result of a natural shift in water characteristics: temperatue, salinity and nutrient levels. But the main reasons for the shifts are human induced changes: overexploitation of the most valuable fish and shelfish species, bioinvasions, and physical alteration of coastal habitats. There is a concern that this could lead to significant economic losses in the fishery and aquaculture sectors. However, loss of biodiversity and of habitats is also causing serious damage to regional ecosystems.

Given the importance of the marine litter issue, the Marine Litter Activity (MALITA) project was developed in the NOWPAP region; implementation began in November 2005. The first step in this project is a collection and review of existing data and information on marine litter in each NOWPAP country. The goal of this activity is to prepare a NOWPAP Regional Action Plan on marine litter to prevent and reduce marine litter problems in the Northwest Pacific region.

Persistent Toxic Substances (PTS) were segregated from other potentially harmful chemical substances because of their specific features: toxicity, resistance to degradation and a capacity to bioaccumulate. Current PTS distribution in the NOWPAP region and a description of knowledge gaps are presented in this report. The key gaps are inadequate information on the sources of regionally significant PTS affecting marine and coastal environments and on the mechanisms of PTS bioaccumulation. Disposal of obsolete PTS and of hazardous waste remains a serious concern.

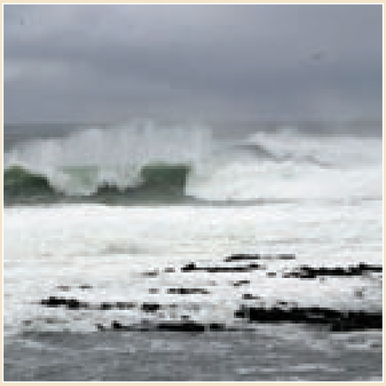
Japan and Korea are the regional leaders in studying and collaborating on PTS issues. Given the transboundary nature of many PTS issues, international and regional cooperation should be enhanced. The East Asian POPs Monitoring Network project recently undertaken by NIES (National Institute for Environmental Studies, Japan) could become a platform for cooperating on PTS issues.

Another opportunity to improve international cooperation is a NOWPAP GEF Project entitled "Addressing Land-Based Activities that Affect Marine and Coastal Environments of the Northwest Pacific Region" (GEF Project Database, GEF Project ID 2961). The aim of the project is to create a model for regional collaboration by effectively addressing Land Based Activities (LBA) and Land-Based Sources (LBS), focusing on PTS sources that adversely affect regional marine and coastal environments.

Other emerging environmental issues in the NOWPAP region are described in this SOMER and include physical alteration and destruction of coastal habitats, marine invasive species, environmentally harmful disposal of old computers and mobile phones (e-waste), alteration of natural cycles with dam construction, excessive aquaculture pressure on coastal areas, microbiological pollution, and the need to enlarge the regional network of wildlife protected areas.

Global climate change could have a major impact on all aspects of the marine and coastal environment by raising sea levels and by causing more frequent and severe typhoons, floods and droughts. The triggers, causal links and options for influencing global climate change remain very poorly understood.

A summary statement with recommendations presented by the NOWPAP RACs and other international organizations (GPA, GIWA, YSLME and PICES) is presented in the final section of this report. Two issues have been identified as key to improving environmental conditions in the NOWPAP region: 1) coordinating with other international efforts to develop a common set of indicators that can be used to assess changes in environmental conditions; and 2) developing integrated management approaches.



1. Introduction

The NOWPAP region, which includes parts of northeast China, Japan, Korea and southeast Russia, is one of the most densely populated areas of the world, with a total population around 355 million (excluding North Korea). This means there is significant anthropogenic impact on the regional environment. The NOWPAP marine area contains resources that are extremely valuable for all countries in the region and this area is experiencing a range of negative impacts.

A suggestion was made at the Intersessional Workshop in Seoul in July 2005 to prepare a State of the Marine Environment Report (SOMER) for the NOWPAP region as a new activity that the POMRAC would undertake in collaboration with other RACs. The 10th Intergovernmental Meeting (Toyama, 24-26 November 2005) approved this new study, while the contents and structure of the report were developed during discussions held at the 3rd POMRAC Focal Points Meeting (Vladivostok, 10-11 October 2005).

Social and economic development levels in NOWPAP countries vary. Anthropogenic impacts on the regional environment also vary significantly. The types and character of regional environmental problems are extremely diverse and comparing certain features of these problems is often difficult. At the same time, a holistic approach is needed to better understand conditions and to develop and implement practical actions that address and solve these problems. The preparation and publication of this SOMER is intended to assist in this process.

This report presents an analysis, overview and holistic description of environmental problems in the NOWPAP marine area. The major threat to marine environment is human activity in both coastal and inland areas, 80% of the marine pollution is a result of atmospheric, river borne and direct inputs of contaminants from land-based sources. This report thoroughly reviews the inputs originating from these sources, including municipal, industrial and agricultural run-off, as well as atmospheric deposition. Marine based problems that include harmful algal blooms (HABs), changes in algae and animal communities, oil and HNS spills, are also reviewed. The anthropogenic cause of an oil spill can be identified; HABs and changes in the biologic communities are problems with more complicated causal links. The marine litter issue and ballast waters that introduce invasive species are presented as emerging environmental problems. NOWPAP experts and concerned organizations describe current information gaps and offer approaches on how to close these gaps. They also provide recommendations on ways to modify environmental conditions in the coastal areas.

This SOMER is prepared based on data and information available in the National Reports and Regional Overviews published by NOWPAP RACs. Publications from other regional and international programs / projects, as well as information from the scientific literature, are also used. This report makes every effort to present reliable, up-to-date data on environmental quality and is a comprehensive collection of information from various sources. Expert recommendations are also included.

This SOMER also attempts to analyze results presented in other reports and publications. When possible, important trends, issues and future scenarios for the NOWPAP marine area are provided. SOMER will prove useful to different audiences: decision makers, researchers, NGOs, and school teachers. SOMER is structured as a reference work for individuals and institutions dealing with marine and coastal environment issues in the NOWPAP region.

The specific objectives of this State of the Marine Environment Report are:

- Assess the current state of the marine environment in the NOWPAP area, with attention focused on recent changes in environmental conditions and on human impacts on the marine environment and coastal areas;

- Identify regional concerns and emerging issues;

- Present actions and measures suggested for different programs / projects in a way that assists decision makers meet the challenge of addressing environmental concerns and issues at both the national and regional levels.

2. Geographical Features of the NOWPAP region

According to an agreement between China, Japan, Korea and Russia (1994), the NOWPAP region represents marine, coastal and offshore basins at 33^{O}-52^{O}N and 121^{O}-143^{O}E (Figure 1). Formally, the western part of this area, namely the Bohai Sea, was not included in the NOWPAP region. However, the Bohai Sea is a natural part of the Yellow Sea, is linked to it in various ways and it shares common environmental problems. For this reason, and for this report, we consider the entire basin of the Yellow Sea, including the Bohai Sea.

Given the region's 2,500 km stretch from north to south, its climate ranges from temperate to subtropical. The main climatic feature of the NOWPAP region, however, is monsoon circulation with prevailing winds from the land (from the northwest) in winter and from the sea (from the southeast) in summer. Most precipitation occurs in summer. Northern Japan and Sakhalin are an exception, with high snow cover from winter monsoons and heavy rains during summer monsoons. Typhoons that bring strong winds and heavy rains hit coastal areas, especially in Korea, China and Japan, in the summer and fall.

Average annual precipitation varies from about 800 mm in Primorsky Krai and northeastern Provinces (Jilin, Heilongjiang) of China to the 1,000-1,100 mm on Sakhalin

Figure 1. Main marine currents in the NOWPAP Region (within dashed line).

Island and in Liaoning and Jiangsu Provinces, with Korea getting 1,300-1,400 mm and western prefectures in Japan getting 1,200-2,100 mm.

The Chinese part of NOWPAP occupies the lowland west coast of the Bohai Sea and the Yellow Sea where the mouths of the Yangtze, Huaihe, Huanhe, Haihe and Liaohe rivers are situated. Two large hilly peninsulas, Liaodong and Shandong, with an average elevation of 500 m, are located between the Bohai Sea and the Yellow Sea. Land use in eastern China is very intensive. The percentage of land surface covered by forests, bush and grassland, that is not used as arable lands and farms, in Liaoning, Heilongjiang and Jilin Provinces are 28.7%, 41.9% and 42.4%, respectively. In contrast to these provinces, non-agriculture vegetation coverage rates in Shandong and Jiangsu Provinces are much lower: 21.5% and 10.6%, respectively. The region's major river basins include the Songhua, Liaohe, Haihe, Yellow, Huaihe and Yangtze Rivers; in 2002 the total river flow in the NOWPAP marine area from China was 1,193 km^3. The Yangtze River provides 80% of the region's river flow. If the Yangtze and Songhua Rivers (a tributary of the Amur River) are excluded, annual river flow is about 177 km^3. All rivers have peak runoff in summer and minimum flow in winter.

Western Japan is somewhat mountainous, with elevations up to 3,000 m in central Honshu Island and up to 1,800 m in the south of Kyushu Island. Despite relatively high population and intensive agriculture, forests cover 34.7% of the prefectures facing the NOWPAP marine region. This figure does not include privately held forests. Total forest cover in this part of Japan exceeds 50%. There are eight large rivers on the west coast of Japan: Teshio, Ishikari, Yoneshiro, Omono, Mogami, Agano, Shinano, Jintsu; their total annual (2002) flow is around 83 km^3, whereas total flow for all west coast Japanese first class rivers is 125 km^3.

The southern part of the Korean peninsula is mostly rugged, mountainous terrain and only the western one-fifth of the land base is covered in plains. The highest mountain is Halla (1,950 m) which is situated on the Jeju Island. 75% of the Korea is covered by mixed, mostly hand planted forests. Southern and western coast of Korean peninsula has a highly indented coastline characterized by high tidal ranges. Eastern coastline is generally unindented. There are five key rivers: Han, Guem, Yongsan, Somjin and Nakdong with a total annual flow around 46 km^3.

The Russian part of NOWPAP includes Primorsky Krai, parts of southeast Khabarovsky Krai, and parts of southwest Sakhalin Island. Massive mountain ridges belonging to the Sikhote Alin mountain system make up about 80% of Primorsky Krai and the adjoining part of Khabarovsky Krai. Average elevation is 600 meters, with the highest peaks reaching 1,855 meters. Southwest Sakhalin Island has low mountains and hills. Almost 80% of the territory is covered by forest and an additional 8.1% is occupied by wildlife reserves. The main rivers are the Tumannaya (Tumen), Razdolnaya (Suifun), Suchan, Samarga, Koppi, Botchi, Tumnin with total annual flow is around 27 km^3; total annual flow of all rivers from Russia within the NOWPAP area is around 43 km^3.

Just beyond the northern border of the NOWPAP area is the mouth of the Amur River whose annual flow is around 344 km^3. The Amur River does not directly flow into the NOWPAP area and so is not featured in this report. However, from a scientific perspective, the material load from the Amur River does influence water quality in the NOWPAP area, at least in the northern part of the Tartar Strait where the Amur's discharge rate is significant and some fresh water flows south in winter. In summer, when most of the Amur's water flows north, the river's flow increases water temperature along the northeast Sakhalin coast and affects other water characteristics.

Climatic characteristics and morphological features divide the NOWPAP marine area into two sub regions (Figure 1, Table 1). The integrated measure of climatic differences within NOWPAP marine area can be expressed in seasonal changes in sea surface water temperature (Figure 2). The multi-year water circulation pattern is similar (Figure 1) although current speed and location have significant seasonal variations.

Marine Area (sub region) A is located between the Japanese Islands and Sakhalin Island on the east and the Russia mainland and the Korean peninsula on the west. It is the biggest, deepest (Table 1) and coldest basin. This area's seasonal differences are the most extreme (Figure 2). In winter the northern part of the basin is covered by ice and even in May more than half of the area has a water temperature below 8°C. Water circulation (Figure 1) is characterized by a warm Tsushima current that flows from the

Table 1. Basic characteristics of key NOWPAP marine areas

	Marine Area A	Marine Area B
Surface area (km^2)	1,008,000	420,000
Volume (km^3)	1,360,080	17,731
Average depth (m)	1,350	44
Maximum depth (m)	3,796	100

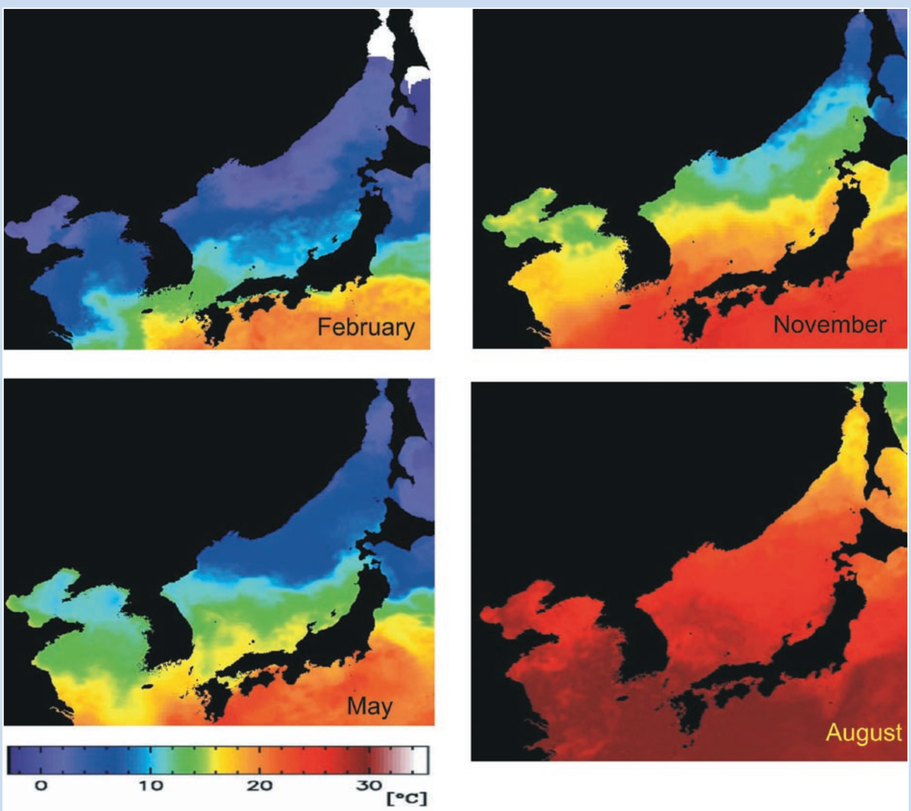


Figure 2. Seasonal changes in the surface temperature in NOWPAP marine areas
Sequence: February, May, August, November
Source: www.ocean.caos.tohoku.ac.jp

south through the straight between Korea and Japan. This current is then divided into several branches, leaving all southern parts of marine area A warmer than the northern part, with a distinct thermal front oriented from the middle of the Korean peninsula to the Tsugaru Straight (Figures 1 and 2). With the exception of the one or two warmest months, this is a permanent thermal front (Figure 2). A branch of this warm current runs along the west coast of Hokkaido and comes out through the La Perouse (Soya) Strait. The northward current moving along the west coast of Sakhalin reverses at the Tartar Straight and moves south as a cold Primorsky (Liman) current.

Marine Area (sub region) B is situated west and south of the Korea peninsula. Surface water temperature in January varies dramatically, from 3-4°C in the northwestern part to 17°C near Jeju Island. Summer temperatures are much more even: 28-30°C in July-August. Water circulation is characterized by the Kuroshio branch: a northward Yellow Sea current with two crosswind currents running along the coasts of the Korean and Shangdong peninsulas (Figure 1). Significant tidal currents are typical for the west coast of Korea. A key feature of the western part of this sub region is the pronounced direct influence of large Chinese rivers: Huaihe, Huanhe, Haihe and Liaohe.

3. Human Pressure within NOWPAP region

Two key factors determine the human impact on environment quality: 1) population and population density, and 2) character and intensity of human economic activity. A crucial, third factor is social organization that in this case expresses itself as the capacity to properly treat waste and sewage. Experience in highly developed countries shows that effective nature conservation and sustainable land use are possible even where there is very intensive industrial activity and a high population density.

The population in the northeast Chinese provinces facing the NOWPAP marine area is the highest among NOWPAP countries. The population is 272,600,000, with an average population density of 373 person/km^2. Korea has the highest population density – 478 person/km^2. The lowest population in absolute terms is the Russian area facing the NOWPAP marine area (Table 2). The number of people determines the volume of municipal sewage that can possibly influence river and coastal water quality, though one must also account for the level of waste treatment.

All NOWPAP countries are classified as industrial. There are, however, huge differences in their industrial sectors. Industry in Japan, Korea, and recently in China, has undergone gradual and sometimes drastic changes to maintain economic competitiveness. Japan and Korea have applied modern technological advances to comply with progressively stricter environmental standards. In contrast, many industries in Russia and China continue to use technologies installed when the plants

Table 2. Main socio-economic features of countries facing the NOWPAP marine area in 2002

	Population (million)	Population density (per/km^2)	GDP, 10^6 USD	GDP per capita, USD/person
China*	272.6	373	473,048	1,641
Japan**	34.4	303	527,435	15,340
Korea	46.1	478	457,200	9,446
Russia***	1.44	14	1,611	1,118

* – *Heilongjiang, Jilin, Liaoning, Shandong, and Jiangsu Provinces;*

** – *Hokkaido and Prefectures of the west coast of Honshu and Kyushu;*

*** – *coastal districts of Primorsky Krai, Khabarovsky Krai, and Sakhalin*

were originally built. Industry in these countries began to change rapidly in the 1990s. Industrial production in Russia has declined, many old industries have been closed or renovated and this process is resulting in new, profitable and more environmentally friendly operations. Industrial decline in China ended earlier and economic growth is now more pronounced than in Russia. There have been significant changes in the region's economics in the last 15 years. Japan has maintained its position as the world's second-largest economy, but Korea and China have also demonstrated major growth (Table 2).

Regional economic activity is reflected in gross domestic product (GDP) and GDP per capita. China, Japan and Korea have very similar absolute GDPs, though GDP per capita varies by 6-10 times. Russian regions in the NOWPAP area have lower GDPs and consequently have less human pressure on the environment.

Each NOWPAP country has a full spectrum of industrial, service and agricultural enterprises. At the same time, there are distinct differences in the structure of manufacturing sectors of these countries. In Japan most workers (69%) are employed in tertiary industries (service, trade). The number of service workers is about 30%. The same is true for Korea, with 59% in tertiary and 40% in secondary industries. In both Japan and Korea only 1% of workers are employed in a primary industry (agriculture, fishing, forestry). In 2002 the GDP in Chinese tertiary industries was about 37%, in secondary – 50%. The GDP in primary industries, including agriculture and fishing, was about 13% of total GDP in northeastern Chinese provinces. In 2002 most workers (54.8%) in Russia were employed in secondary industries, though tertiary industry employment is about 41.5%, with only 3.7% of workers employed in primary industries (agriculture, fishing and forestry).

Anti-pollution measures can make human economic activity environmentally friendly and can significantly decrease harmful impacts on environment quality. Measures should include full treatment of municipal and industrial sewage, exclusion of most dangerous substances from technological processes, and innovations that minimize resource consumption.

In Japan 58% of the population had sewage treatment in 1998; this figure in 2001 was 63%. Human sewage or night soils is 100% treated. 78% of the gray water (sewage from kitchens, laundries, etc.) discharge in Japan was treated in 2003. In Korea there were 114 sewage treatment plants in 1998 having a treatment capacity of 16.6 million tons/day (66% of daily production). In 2002 the percentage of Korea's population with sewage treatment systems rose to 79% nationwide, varying from 41 to 98.9%, depending on the province. The most common treatment method is secondary treatment using activated sludge. Even so, many rural areas in Korea still have treatment rates less than 11%. China's wastewater treatment rate is currently only 25.8%. Domestic wastewater treatment in Russia's Primorsky Krai covers only 27% of all sewage.

4. Current Marine Environmental Issues

4.1 Atmospheric Pollution

According to the National Reports on Atmospheric Deposition (NOWPAP POMRAC), national monitoring efforts in NOWPAP countries are focused primarily on air pollutant concentrations and secondly on land-based acid deposition. This reflects a reality that air quality affects what we breath. But the quantity and quality of air pollutants can influence the quality of surface water (rivers, lake, ponds) and can exert an impact on forests, fish and other living creatures. The obvious example is acid rain, a product of sulfur and nitrogen oxides that are generated by the combustion of fossil fuels. Some NOWPAP countries face serious air pollution problems because they depend on sulfur rich coal to fuel the rapid economic growth witnessed in recent years. The creation and successful activities of the Acid Deposition Monitoring Network in East Asia (EANET) is clear evidence of the regional concern with air quality.

Recent air quality monitoring results for major cities in the NOWPAP region are presented in the Table 3. Based on annual average air pollution concentrations, the major Japanese cities in the NOWPAP region met environmental standards in 2002. Concentrations for each pollutant in Japan appears to be gradually decreasing or leveling-off in the last 15 years . Air quality in major Korean cities is also slowly improving. This is expressed in a decrease in annual averaged concentrations of SO_2 in the last decade, from 0.018-0.045 to 0.003-0.005 ppm. A decrease in CO and SPM (dust) are also registered, although NO_2 and ozone concentrations show an increasing trend.

In China air pollution in large, metropolitan areas is more serious than in small ones. The assessment showed that 33.8% of 116 cities met the National Ambient Air Quality Standard (NAQAS) for Grade II. And 35% (120 cities) met a "softer" Grade III. The current level of air quality in Russian cities in NOWPAP area is comparable with Chinese cities for dust, but concentrations of SO_2 are lower and NO_2 levels are higher (Table 3).

Thus, air pollution in the NOWPAP Region remains a serious environmental problem. However, the situation is improving in most of the region's countries as major efforts are made at the national, regional and international levels.

There are two cases where air pollution can be the cause of an environmental problem for marine and coastal areas. The first is acid rain and the second is an excessive input of chemical substances (nutrients and/or toxic compounds). Concentrations of the main ions (SO_4, Cl, Na, Ca) in atmospheric precipitates are important and interesting as a characteristic of rain or snow, but the role of atmospheric input in the balance of the main ions in marine water appears negligible because, with the exception of nitrogen compounds, the concentrations in the precipitations are very low compared to sea water.

Annual average pH rates for precipitation in the Chinese portion of NOWPAP range from 5.1 to 7.15. In Japan the overall, 20-year average pH level is 4.77, with a range from pH 4.49 to pH 5.85. Precipitation with a pH of less than 3, a level at which plants suffer, is not observed. However, precipitation samples that showed a pH less than 4 accounted for about 5% of all samples collected in Japan and precipitation, in comparison with Europe, is acidic. In Korea the annually averaged pH rates for precipitation range from 5.2 to 6.3 and some trend toward an increase has been observed during the last decade (Fig. 3). In rain collected in Primorsky Krai (Russia), annually averaged pH is 5.3-6.2.

Table 3. Air pollution in major NOWPAP cities

Country	SPM (dust), mg/m^3	SO_2, ppm	NO_2, ppm
China	0.077-0.173	0.009-0.064	0.021-0.048
Japan	0.012-0.031	0.001-0.004	0.011-0.048
Korea	0.055-0.075	0.003-0.005	0.020-0.036
Russia	0.030-0.140	0.001-0.019	0.040-0.100

Source: National Reports on Atmospheric Deposition (NOWPAP POMRAC)

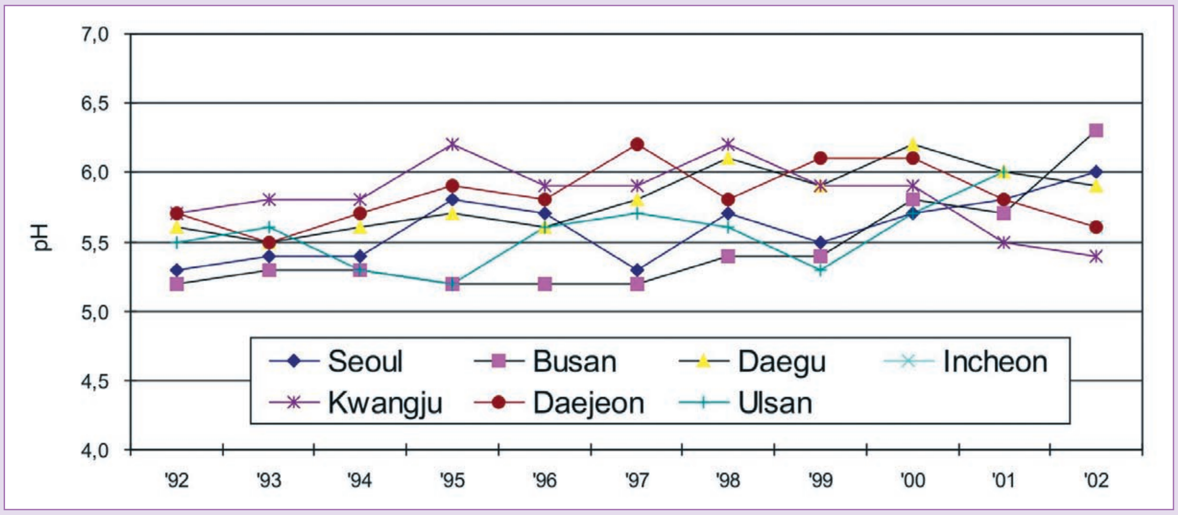


Figure 3. Annual average trend for precipitation pH in the major Korean cities

Acid rain does not appear to be a serious problem for the NOWPAP marine area at the moment. However, the impact of acid deposition is hard to evaluate without long-term monitoring. In the case of small lakes and soil with little buffering capacity in coastal areas, the long-term affects of acid deposition can appear suddenly. Long-term, continuous monitoring program for acid deposition is necessary.

The assessment of the impact of atmospheric pollution on the land is based on data from precipitation monitoring stations and can be made directly (empirically). Data on rainfall and the chemical composition of precipitation in marine areas are much rarer, so models and extrapolation are necessary. Fortunately, recent data from a year-long sampling program in the North Sea suggest that the results of on-board aerosol trace element concentrations are comparable to those in samples collected at the coast (Chester et al., 1993). The wet atmospheric deposition fluxes (Fw) are calculated from the annual amount of precipitation (P) and the volume-weighted mean concentration (C) of the substance of interest:

$$Fw = C \times P$$

The dry atmospheric deposition fluxes (Fd) are calculated by multiplying the geometric mean particulate concentration in air of the element of interest Ci by the elemental dry settling velocity (Vd):

$$Fd = Ci \times Vd$$

The velocity Vd varies with particle size, from gravitational settling of large particles to impaction and diffusion of small particles (submicrometer), and is dependent on conditions in the troposphere, especially in coastal environments (Duce et al. 1991). For some elements (Cd, Pb, Zn, Cu and Cr) which are found primarily associated with submicrometer particles a mean value of 0.1 cm s^{-1} was applied, and for others (Al, Fe, Mn) which are present primarily in the coarse fraction a mean value of 2 cm s^{-1} was adopted.

These values fall close to the Vd range given in other studies (Migon et al., 1997). It should be emphasized, however, that the flux calculations might vary by approximately an order of magnitude due to the uncertainties in Vd.

Table 4 shows an assessment of annual deposition of certain associated atmospheric substances to marine areas A and B in the NOWPAP region. Data on dust deposition (Uematsu et al., 2003) present a sum of wet and dry precipitation. The evaluation of the dry dust deposition based on a calculation of the aerosol concentration of Al above the sea area B (Hong et al., 1998) results in a range of 1,500,000 – 14,000,000 tons/year. Unfortunately, data on the concentration of other pollutants (like trace organics) in atmospheric precipitation are too rare to assess atmospheric flux to NOWPAP marine areas.

The key feature of atmospheric input is its non-point nature, that is, precipitation is spatially more or less evenly distributed. Atmospheric input differs in principle from river input in that it is non source point. One can correctly compare the amount of substances entering an entire basin via rivers and the atmosphere but this assessment, from the point of view of its influence on a specific portion of a basin will be, by definition, relative. Variants depend on the size of the area assessed: the smaller the area the less precise the assessment.

Table 4. Assessment of annual atmospheric input of chemical substances into NOWPAP marine areas

	Marine Area A	Marine Area B
Water, km^3	1,390	460
Dust (SS), t/y	6,400,000	6,000,000
NO_3, NH_4 , t N/y	568,512	335,160
PO_4 , t P/y	15,290	5,208
Pb, t/y	645	1,056
Cd, t/y	24	20

Sources: Leonov, 1960; Uematsu et al., 2003; Liu et al., 1998

A comparison between atmospheric and river inputs at the basin level (Table 4 and 5, Figure 4) clearly indicate that for marine area A atmospheric sources dominate for all components, including the water itself. In marine area B the situation is different and atmospheric input dominates for water and lead only. For nutrients, dust (suspended solids) and cadmium the fluxes through atmospheric input to the sea area B vary from 26 to 42% of total input (Figure 4).

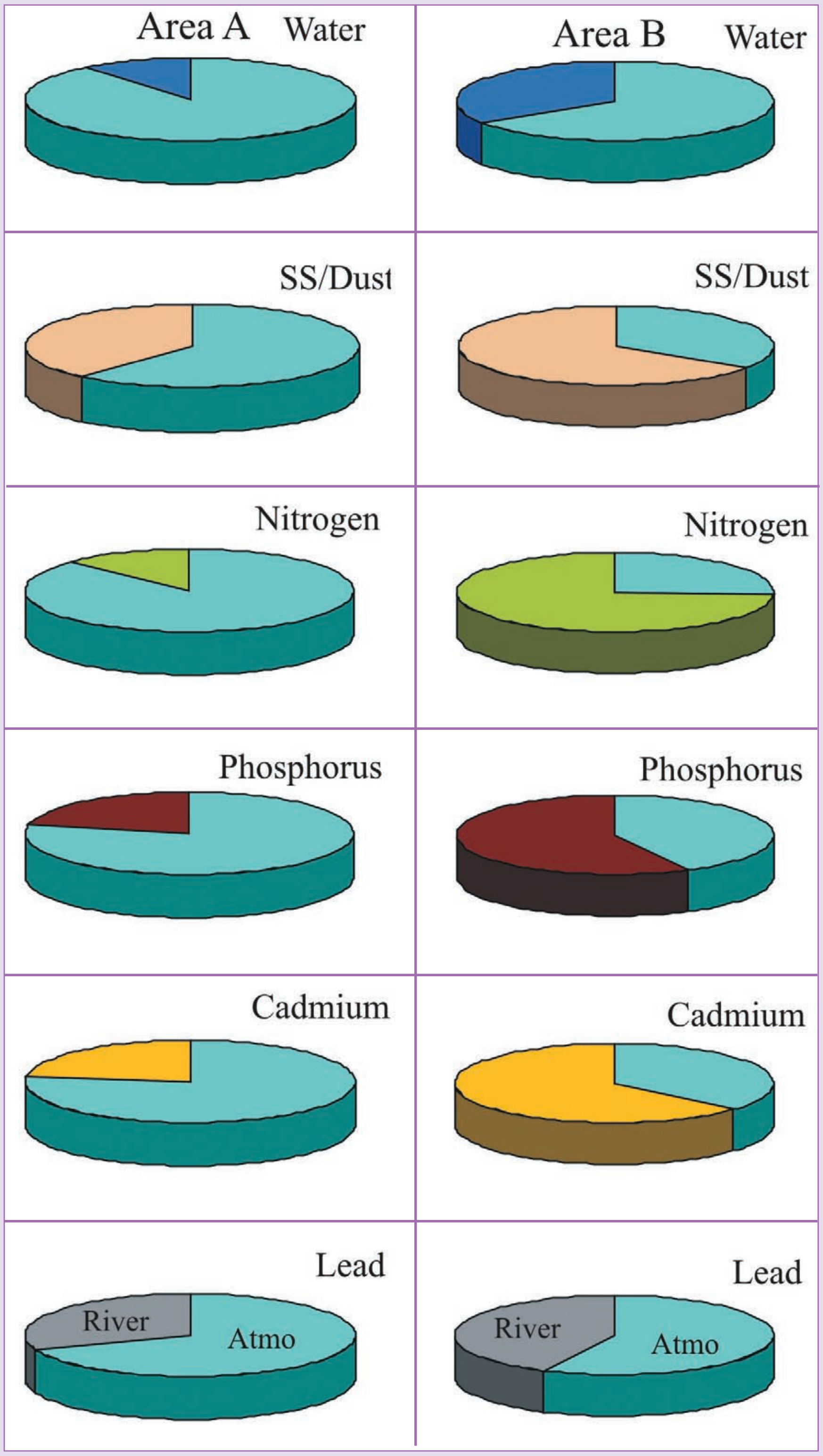


Figure 4. Relative role of atmospheric input (green) and river input (other colors) of different substances to NOWPAP marine area "A" (left) and NOWPAP marine area "B" (right)

Thus, atmospheric input of nutrients and some metals is a significant source for these substances in the marine ecosystems of NOWPAP areas. In offshore regions and for entire basins, atmospheric inputs are dominant and additional attention is needed for any potentially dangerous substances migrating via atmosphere fluxes. The role of atmospheric inputs for coastal marine areas will be determined by the ratio of concentrations of these substances in the rain/snow and in river water as well as by the ratio of river run-off and the amount of precipitation.

The current features of atmospheric pollutants monitoring, as analyzed in National Reports and Regional Overview (NOWPAP POMRAC), reveal the following issues:

- Monitoring parameters, methodologies and technical standards/criteria based on studies from member NOWPAP countries need coordination. The lack of coordinated methods limits joint efforts to address atmospheric deposition of contaminants in the NOWPAP region;

- Each NOWPAP country currently conducts its own air pollution monitoring. However, for some pollutants, especially trans-boundary pollutants, identifying their sinks and sources, as well as their environmental impacts, is difficult without an integrated, regional monitoring network that is staffed with trained technical personnel;

- Trans-boundary movement of air pollutants such as dust and sand storms, especially in China, Korea and Japan, is a critical issue in the NOWPAP region. Additional joint research is needed to prevent dust and sand storms;

- The environmental impacts of acid deposition require long-term monitoring and observation that should be based on regional initiatives;

- National reports and other information sources and data on atmospheric deposition of contaminants into marine and coastal environments in the NOWPAP region are very limited. National reports focus mainly on general information about air pollution in each country. Regional research is necessary on atmospheric deposition of contaminants into marine and coastal environments.

4.2. Pollutant Inputs with Rivers and Waste Waters

Table 5. Annual river water discharge (km^3/year), suspended solids (SS, tons/year) and flows of some chemical substances (tons/year) from countries facing the NOWPAP marine area (2002 data)

	China*	Korea	Input to the sea area B	Japan	Russia*	Input to the sea area A
Water	193	45.9	238.9	124.66	42.35	167.0
SS	nd	662,567	11,403,586	1,717,108	2,287,300	4,004,408
BOD_5	582,874	129,137	712,011	126,197	84,410	210,607
COD_{Mn}	1,012,665	272,683	1,285,348	364,187**	38,821***	803,008
NH_4	477,522	50,434	527,956	4,224**	3,830	8,054
NO_2	9,077	nd	>9,077	750**	245	995
NO_3	328,467	101,762	430,229	71,905**	3,543	75,448
TN	nd	240,557	>240,557	97,168**	nd	>97,168
PO_4	nd	6,087	>6,087	3,805**	469	4,274
TP	nd	7,976	>7,976	nd	nd	nd
oils	72,950	nd	>72,950	nd	847	>847
phenols	228.5	nd	>228.5	nd	67.3	>67.3
Pb	791.7	nd	>791.7	nd	3.3+281.4****	>3.3+281.4
Cd	34.5	nd	>34.5	nd	1.1+6.1****	>1.1+6.1
Hg	13.5	nd	>13.5	nd	nd	nd

* – *without Yangtze River for China and without Amur River for Russia,*
** – *data recalculated for the whole river discharge;*
*** – *COD_{Cr};* **** – *flux of dissolved forms plus flux in suspended solids;*
nd – no data

River flow is a major natural source of chemical substances in coastal marine areas. Anthropogenic pressure on coastal watersheds influences the concentration and fluxes of different chemical substances, including river pollutants. It is difficult, however, to distinguish anthropogenic impact from natural variability.

With respect to river water quality, chemical substance concentrations are an issue. In discussing river input into and river influence on the marine environment, the load (flux) of substances carried by rivers becomes more important. The possible impact of tides and estuarine processes on real fluxes should be kept in mind, but the first level of estimating river fluxes to the sea is a product of water discharge by the chemical substance concentrations in river water. Such estimates, based on monitoring data from the NOWPAP POMRAC Regional Overview (2006), are presented in Table 5 for Chinese, Japanese, Korean and Russian regions facing the NOWPAP marine area.

Natural features in the NOWPAP marine area (Figure 1, Table 1) mean that Chinese and most Korean rivers discharge into marine area B. The rivers on the east coast of the Korean peninsula are small compared with western and southern coasts. The Japanese and Russian rivers discharge into marine area A. One can thus evaluate river input into different marine areas (Table 5). This is a rough estimate because the parameters measured are partially incompatible and for some rivers there are no data on some parameters. There are also significant differences in the shape and length of coastlines. Normalization procedures can be recommended to facilitate comparisons. One procedure is a traditional watershed area normalization (specific discharge in $l/s.km^2$ or tons/year km^2) that shows the intensity of the processes occurring in watersheds. A different measure was recently suggested (Shulkin, 2005) to assess the intensity of land based inputs into marine environments: coastal specific discharge, which is the input of any substances divided by the length of the coastline. This method may prove useful at the regional and sub-regional level for first stage comparisons. Comparative assessment examples of river water and suspended matter input from NOWPAP countries on a coastline basis are presented in Table 6. It is obvious that in the example of water run-off, traditional specific discharge (normalized on watershed square, Q/S) is inadequate to assess a river's impact on a marine environment, e.g. it is lowest for China, which is not a reflection of actual conditions. For this reason, normalization per shore length or coastal specific discharge (F/L, where F – input of any substances, tons/year, L – length of coast line) is used (Table 6). This, of course, results in a rough estimate, especially when taking into account the shortage of available data. Nevertheless, the values calculated in Table 6 are reasonable enough to see the differences between countries with respect to the possible impact that river input has on coastal waters.

A more detailed study should be undertaken using this approach to evaluate river input impact from the different sub-regions of countries.

A comprehensive comparative assessment of the impact from river runoff for such chemical contaminants as metals, phenols, petroleum hydrocarbons (PHC), PCBs, pesticides, including chlorinated ones, polycyclic aromatic hydrocarbons (PAHs) for all NOWPAP countries is impossible because the necessary data are incomplete or entirely lacking. For example,

Table 6. Normalized parameters of river inputs for water, suspended solids, and some chemical substances for NOWPAP countries

Country	S $10^3 km^2$	L, km	Q, km^3	Q/S, l/s*km^2	Q/L, l/s*km	SS/L, t/y.km	BOD/L t/y.km	COD/L t/y.km	NH^4/L t/y.km	NO_3/L t/y.km
China*	1634,0	10,054	193,0	3.7	609	***	58	100.7	47.5	31.9
Japan	89.5	11,610	124.7	44.2	341	147.9	11	31.4	0.4	6.2
Korea	68.1	6,050	45.9	21.4	241	109.4	21	45.1	8.3	16.8
Russia**	133.4	3,095	43.3	9.9	428	738.9	27	141.8	1.2	1.1

Watershed Size (S), coast line length (L), annual water discharge (Q), specific discharges for water (Q/S), and parameters normalized per shore length (Q/L, SS/L, BOD/L etc.)

* - *without Yangtze and Songhua Rivers;*

** - *including Tumen River, but without Amur River; COD determined by $K^2Cr_2O_7$ method;*

*** - *not evaluated due to lack of data*

the scarcity of concentration data means the evaluation of the input of dissolved metals with river run-off into the sea is a rough estimate at best, with an error factor of one order of magnitude.

Nevertheless, Hong (Hong et. al., 1997) assessed the inputs into the Yellow Sea and results are presented in the beginning of Table 7. Other assessments in the Table 7 were made based on a recently published study (Gaillardet et al., 2003) of world average river concentrations of dissolved forms of Zn (0.6 µg/l), Mn (34 µg/l), Cu (1.48 µg/l), Pb (0.050 µg/l), and Cd (0.017 µg/l). The discrepancy in the results of Hong (1997) might be explained by the different volumes of water run-off used for the evaluation. The assessments for Russian rivers given in Table 5 and Table 7 are rather close.

In discussing metals input with river runoff it is important to remember that most metals are not dissolved but are adsorbed on the surface of suspended particles. This is why the particulate phase is the dominant transport form for heavy metals in rivers. Monitoring programs in China, Japan and Korea measure total metals only, without filtering the sample, so these data strongly depend on the suspended solids content and have limited value for pollution monitoring. Spatial and temporal inter-comparison of data requires a sampling strategy that is representative of total suspended sediment transport. This is almost impossible with the sampling frequency normally applied by national monitoring agencies because including one highly turbid sample or not in a data set may completely change the resulting average assessment.

Reliable data is very limited on persistent organic pollutants (POPs) in NOWPAP region rivers (Table 8), even though POPs are very important from a water quality point of view. It should be noted that these data are scarce even for rivers in regions with a long history of river water

Table 7. Assessment of dissolved metal input (tons/year) via rivers in NOWPAP marine areas

Marine area	Fe	Mn	Zn	Cu	Pb	Cd
Yellow Sea (by Hong et al., 1997)	2,756	1,395	136.8	136	24.3	0.62
Marine area B (sum)	15,767	8,123	143.3	353.6	11.9	4.06
Marine area B – Chinese* rivers	12,738	6,562	115.8	285.6	9.7	3.28
Marine area B – Korean* rivers	3,029	1,561	27.5	67.9	2.3	0.78
Sea Area A (sum)	11,088	5,712	100.8	248.7	8.4	2.86
Marine area A - Japanese* rivers	8,230	4,240	74.8	184.6	6.2	2.12
Marine area A - Russian* rivers	2,858	1,472	26.0	64.1	2.2	0.74

** – by water discharge from Table 5 and world averaged concentrations with minor changes;*

quality monitoring. PCBs concentrations in the Ishikari River correlate well with the lower range of PCBs concentrations in European rivers, though PCBs concentrations as high as 8.4 ng/l have been published for other Japanese rivers (UNEP/GEF Chemicals…, 2002). Chlororganic pesticides in the Ishikari River were determined to be at the low end of the scale when compared with European rivers.

Table 8. Comparison of POP_S concentrations in the Ishikari River with recent data for other rivers

POPs	Ishikari	Ebro **	Rhone **	Seine **	Nile**	German rivers***
PCBs	0.32	76±23	nd	nd	17-1000	0.2-2.6
Cyclodiene POPs*	0.085	0.4-1.6	0.2-0.6	0.2-0.6	0.004-0.008	nd
Total DDTs	0.54	0.3-0.9	3.6	0.2-0.8	26-103	nd
Chlordane	0.050	Nd	nd	nd	nd	nd
HCHs	1.29	0.7-2.7	5.6	7.0	0.05-0.5	0.2- 1.5

**– sum of Endrin, Dieldrin, Aldrin, Heptachlor;*
*** – data from UNEP/MAP/MTS 141, 2003;*
**** – data from OSPAR Commission, 2005; nd - no data.*

The lack of current data makes it unrealistic to estimate river input of POPs into the NOWPAP marine environment at regional or sub-regional levels. The use of data on POPs concentrations in bottom sediments and in mollusks might be an alternative way to assess the impact of land based sources on coastal marine areas since contaminated coastal sediments are mainly a result of freshwater discharge.

The available data on temporal trends in river water quality from 1995 to 2002-2003 that are presented in the National Reports and the Regional Overview (NOWPAP POMRAC, 2006) show some improvement in terms of BOD/COD parameters in Japanese and Korean rivers, though in Chinese and Russian rivers the trend is unclear.

Data on direct inputs of contaminants into the NOWPAP marine area are based on available national statistics on the volume and composition of wastewater discharge and waste dumping (NOWPAP POMRAC, 2006). A comparison of wastewater inputs and river inputs of BOD and COD to the sea (Table 9) shows that despite a negligible (less 1-2%) volume of wastewaters, the percentage in BOD and COD inputs is much higher and reaches 10-20% of river inputs from Chinese and Russian territories. In Japan the role of direct input of BOD does not exceed 2% (Table 9).

A comprehensive analysis for each contaminant is impossible due to lack of complete data, varied data collection formats and the different schemes used to evaluate wastewater discharge. Nevertheless, China and Russia could possibly assess the significance of direct input of some chemical substances by comparing with input via rivers (Figure 5). The wastewater generated in the coastal zone accounts for 20% of the BOD_5 and phenols that reach the sea from Russia in the NOWPAP area. These figures reach 40% for ammonia and petroleum hydrocarbons and 80% for phosphate (Figure 5). Most Chinese pollutants enter via rivers, but the elevated levels of ammonia and petroleum hydrocarbons in some Chinese rivers means a significant volume of the

Table 9. Generalized data on direct input of wastewater and dumping into the sea in NOWPAP countries in comparison with river inputs of some substances

	River water km^3	River BOD, tons/year	River COD, tons/year	River SS, 10^6 tons/year	Waste-waters, km^3	Waste-water BOD, tons/year	Waste–water COD, tons/year	Dumping to sea, 10^6 tons/year
China*	193	582,874	1,012,665	nd	0.388	nd	161,883	nd
Japan**	124.7	126,197	364,187	1.72	nd	3,024	5,656	3.2
Korea**	45.9	129,137	272,683	0.66	0.891	12,410	nd	8.9
Russia**	43.3	84,410	438,821	2.29	0.558	17,101	nd	nd

* – *Wastewater discharged directly to the coast besides rivers;*

** – *wastewater discharged directly and partly through the rivers; nd – no data*

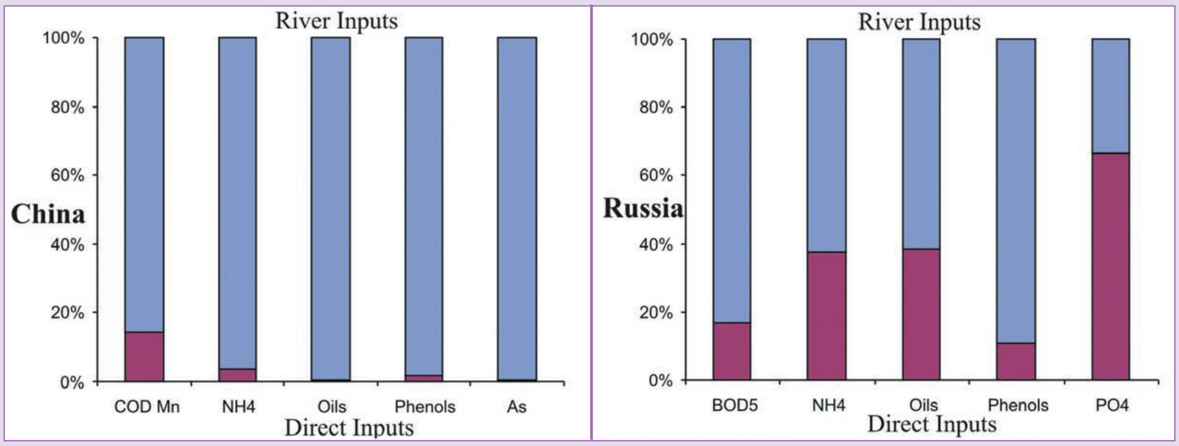


Figure 5. The relative role of river (blue) and direct (purple) inputs in the fluxes of some substances to the sea in Russian and Chinese coastal areas in the NOWPAP region.

industrial wastewater entering the sea from China comes via river discharge.

The significance of solid waste dumped into the sea can be assessed by comparing suspended solids (SS) discharge into rivers. In Japan and Korea dumping exceeds the amount of river SS (Table 9). Despite Korea's intent to reduce the amount of material dumped by 5 million tons/year in 2011, the impact of solid waste dumping on the river flux of suspended solids will continue to be a issue.

Analysis of current pollution inputs via river and direct inputs (National Reports and Regional Overview) reveals obvious gaps and a need for further research:

- Harmonize methodologies and procedures for monitoring water quality by studying the relationships between now inconsistent parameters: COD_{Mn}/ COD_{Cr}/TOC, TN/NO_3, TP/PO_4, and the influence of filtered / unfiltered samples. Research can be improved by training courses and analysis of existing data. Significant in this work would be access to data gathered at automated stations in China and Korea.

- Enhance efforts to obtain reliable data on trace pollutants (dissolved forms of some metals and persistent organic pollutants at µg and ng levels) in river and coastal water at the national and regional levels.

- Initiate joint research projects on the use of trace pollutants as indicators of early stage anthropogenic impact on water quality and on the influence of their flux via big rivers on coastal waters.

Successful implementation of points 1-3 can be achieved by taking into account data obtained in other regions (MAP, OSPAR, US EPA) for POMRAC activities.

4.3. Harmful Algal Blooms

4.3.1. Red Tides and Eutrophication

Red tides are an event characterized by vastly increased phytoplankton growth that causes water discoloration, deterioration of water quality and occasionally fisheries damage. Red tides are observed in all countries of the NOWPAP region, but they are concentrated along the coast of northern Kyushu (Japan) and the southern coast of Korea (Figure 6). Red tides are often registered along the entire Korean coast with the exception of the northeast. In China red tides are concentrated mostly along the coast of the Bohai Sea but coastal waters around the Liaodong and Shandong peninsulas also suffer from red tides. In Russian part of NOWPAP sea area, red tides were registered only in Peter the Great Bay. This is not a specific feature of the bay but the consequence of population density in this coastal area.

Red tides in the NOWPAP marine area usually extend across an area less than 100 km^2. The Chinese coastal area, namely the Bohai Sea, is the exception: 23% of red tide events are larger than 1,000 km^2. Different observation methods – aircraft in China and ships in other countries – might explain such significant differences (Table 10).

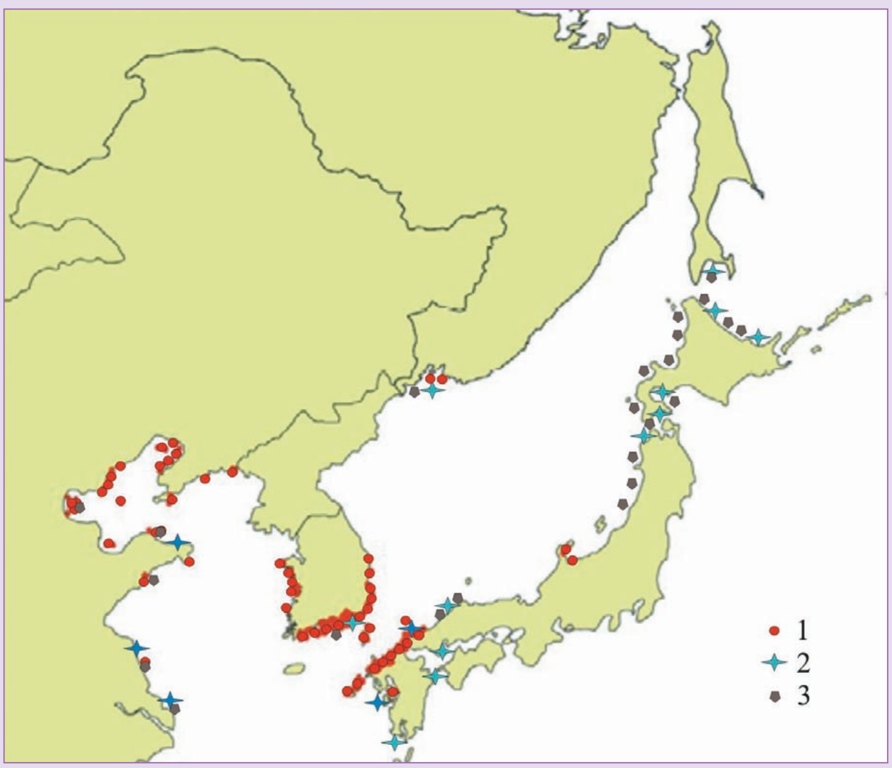


Figure 6. Red tide occurrence (1); PSP-producing plankton species (2), DSP-producing plankton species (3). Source: Integrated Report on Harmful Algal Blooms (HABs) for the NOWPAP Region (NOWPAP CEARAC, 2005)

Table 10. Summary of Red Tide Events in the NOWPAP region

	China (Bohai and Yellow Sea)	Japan (Data from Kyushu region unless stated (1998-2002))	Korea (1999-2003 unless otherwise stated)	Russia (1992-2003 unless otherwise stated)*
Number of Events	84 red tide events from 1990-2004.	150 red tide events recorded. 19 events were harmful.	304 red tide events recorded.	23 red tide events recorded. All events were harmless and caused no damage.
Causative Species	See Table 11	See Table 11 (includes Honshu region)	See Table 11	See Table 11
Cell Density	Maximum cell density recorded for the following major red tide species: *Noctiluca scintillans* (49,000 cells/ml) *Skeletonema costatum* (72,000 cells/ml) *Ceratium furca* (1,250 cells/ml) *Gymnodinium* sp. (300,000 cells/ml)	*Gymnodinium mikimotoi* recorded the highest density at 117,980 cells/ml.	Each year *Cochlodinium polykrikoides* recorded the highest cell density. Maximum cell density was recorded in 2003 at 48,000 cells/ml.	*Eutreptiella gymnastica* recorded the highest density at 30,900 cells/ml.
Location of occurrence	Mainly along the coast of B Sea Area (Figure 6)	Mainly along the coast of northern Kyushu (Refer to Figure 6: includes Honshu region)	Along the entire coast except the northeast coast (Refer to Figure 6)	Some areas in Peter the Great Bay (Refer to Figure 6)
Size of bloom	Data from 1990-2004 <10km^2: •18% 10-100km^2: •29% 100-1,000km^2: •30% >1,000km^2: •23% Affected area generally larger in northern part of Sea Area B compared to southern part of Sea Area B.**	<1km^2: •51% 1-100km^2: •48% >100km^2: •1%	<1km^2: •56% 1-100km^2: •19% >100km^2: •24% Large blooms were mostly by *C. polykrikoides*.	*Noctiluca scintillans* and *Prorocentrum minimum* blooms exceeded 1km^2.
Duration	Most red tides lasted less than a week. However, *Ceratium furca* bloom lasted for 40 days in 1998, and *Eucampia zodiacus* and *Chaetoceros socialie* bloom lasted for 20 d.	Although there were some variations, red tide events tended to last around 1 week. 18 out of 150 events lasted over 20 days.	Most red tide lasted for less than 10 days except for *C. polykrikoides*, which continued for 1 – 2 months.	*N. scintillans* and *Oxyrrhis marina* blooms lasted more than 20 days.

**: There are no regular red tide monitoring programs in Russia. The data presented refer to ad hoc monitoring or scientific research conducted by the IMB FEB RAS, 1992 – 2002.*
***: Observations were mainly conducted through aerial surveys.*

Source: Integrated Report on Harmful Algal Blooms (HABs) for the NOWPAP Region (NOWPAP CEARAC, 2005)

Table 11 Red Tide Species Recorded in the NOWPAP Region

Class	Genus and Species	China	Japan	Korea	Russia
Bacillariophyceae	*Asterionella sp.*		•		
	Chaetoceros curvisetum		•		
	Chaetoceros socialie	•			
	Chaetoceros sp.		•	•	
	Coscinodiscus asteromphalus	•			
	Coscinodiscus gigas			•	
	Coscinodiscus sp.			•	
	Ditylum brightwellii				•
	Eucampia zodiacus	•		•	
	Eucampia sp.			•	
	Leptocylindrus danicus	•	•	•	
	Leptocylindrus sp.		•		
	Navicula sp.	•			
	Neodelphineis pelagica		•		
	Nitzschia sp.		•	•	
	Pseudo-nitzschia calliantha				•
	Pseudo-nitzschia multiseries				•
	Pseudo-nitzschia pseudodelicatissima				•
	*Pseudo-nitzschia pungens**			•	•
	Pseudo-nitzschia sp.		•		
	Rhizosolenia delicatula		•		
	Rhizosolenia fragilissima			•	
	Rhizosolenia setigera			•	
	Rhizosolenia sp.	•	•	•	
	Skeletonema costatum	•	•	•	•
	Skeletonema sp.			•	
	Thalassiosira decipiens			•	
	Thalassiosira rotula			•	
	Thalassiosira sp.		•	•	
Cyanophyceae	*Microcystis virdis*			•	
Dinophyceae	*Alexandrium catenella*	•	•		
	Alexandrium fraterculus		•		
	Alexandrium sp.			•	
	Ceratium furca	•	•		
	Ceratium fusus			•	
	Ceratium sp.			•	
	Cochlodinium polykrikoides		•	•	
	Cochlodinium sp.		•		
	Exuviaella cordata	•			
	Exuviaella marina	•			
	Dinophysis ovata	•			

Class	Genus and Species	China	Japan	Korea	Russia
Dinophyceae	*Gonyaulax spinifera*	•			
	Gymnodinium mikimotoi	•	•	•	
	Gymnodinium sanguineum	•	•	•	
	Gymnodinium sp.			•	
	Gyrodinium sp.	•	•		
	Heterocapsa circularisquama		•		
	Heterocapsa sp.			•	
	Heterocapsa triquetra			•	
	*Noctiluca scintillans***	•	•	•	•
	Oxyrrhis marina				•
	Prorocentrum balticum		•		
	Prorocentrum dentatum		•	•	
	Prorocentrum micans	•	•	•	
	Prorocentrum minimum	•	•	•	•
	Prorocentrum sigmoides		•		
	Prorocentrum triestinum		•	•	
	Prorocentrum sp.			•	
Raphidophyceae	*Chattonella antiqua*	•	•		
	Chattonella globosa				•
	Chattonella marina	•	•		
	Fibrocapsa japonica		•		
	*Heterosigma akashiwo****	•	•	•	•
Chrysophyceae	*Dictyocha fibula*			•	
Eugrenophyceae	*Eutreptia lanowii*				•
	Eutreptiella gymnastica		•	•	•
	Eutreptiella sp.			•	
Haptophyceae	*Phaeocystis* sp.	•			
Cryptophyceae	*Chroomonas marina*			•	
	Chroomonas salina			•	
	Cryptomonas acuta			•	
	Cryptomonas sp.			•	
Prasinophyceae	*Pyramimonas* sp.		•		
Ciliate	*Mesodinium rubrum*	•	•	•	
	Tontonia sp.		•		

Source: Integrated Report on Harmful Algal Blooms (HABs) for the NOWPAP Region (NOWPAP CEARAC, 2005)

*: *Nitzschia pungens* is the synonym of *Pseudo-nitzschia pungens, N. pungens* is referred to as *P. pungens*

**: *Noctiluca scintillans* is the sole species of the genus. *Therefore, Noctiluca* sp. is included into *N. scintillans.*

***: *Heterosigma akashiwo* is the sole species of the genus and *Heterosigma* sp. is included into *H. akashiwo.*

Red tides are recorded in the NOWPAP region from May to September, with additional peaks occurring in Japan in April. Dominant red-tide species include flagellates *Noctiluca scintillans* (China, June-July, Japan, April, Russia, June), *Cochlodinium polykrikoides* (Korea, August-September), raphidophyte *Heterosigma akashiwo* (Japan, June, Russia, June), and diatom *Skeletonema costatum* (Russia, July), although in total 75 red-tide producing plankton species have been recorded (Table 11).

Most red-tides events last 7 to 10 days, although some have lasted from 1 to 2 mouths. Long lasting red-tides occur in Korea during the bloom of *C. polykrikoides.*

The damage caused by red tides depends on what coastal resources are being used. In Russia no serious damage from red tides is recorded due to a relatively low level of aquaculture development. In China, in the Bohai Sea, with its many aquaculture farms, red tide blooms consisting of the flagellate *Gymnodinium sp*. in 1989 caused massive shellfish kills and resulted in an economic loss of 38 million USD. In Korea the damage to fisheries from *C. polykrikoides* blooms have been registered almost every year since 1993, causing from 95 million USD damage in 1995 to 19 million USD in 2003. In Japan the economic loss from flagellates was 7 million USD in 1999.

Red tide trends over the last 25-30 years are distinct for different NOWPAP countries and they even show regional differences within a country (PICES Scientific Report #23, 2002). The number of red tides in Japan's Seto Inland Sea, a direct result of sewage discharge, was highest in the 1970s; the number of events dropped by 300% following a series of waste treatment measures. The number of red tide events on Japan's west coast has varied over the last 20-25 years without any clear trend, this despite taking similar waste treatment measures. The number of red tide events in Korea has risen steadily since the end of the 1970s, with an increase in the areas affected, with the duration of events and bloom density increasing as well. By the mid 1990s, however, the frequency of red tides had stabilized. The number of red tides in China has risen significantly, especially in the East China and South China Seas, although the number of red tides in coastal areas in the NOWPAP region has increased from sporadic events in the 1960s to 40 to 45 events per year in the 1990s.

Enhanced plankton production occurs when there is an ample supply of nutrients and so red tides are connected with eutrophication and the nutrient enrichment of waters. The total population in the NOWPAP region is approximately 355 million, approximately 77% of which lives in China. Domestic wastewater discharge into NOWPAP region marine areas is one reason for increased nutrient input into marine areas. And there is concern that the volume of nutrient input will increase with rapid industrialization in these areas.

The NOWPAP region has various forms of aquaculture: cultivating fish, shellfish and seaweeds. Aquaculture is wide spread along the coasts of China, Japan and Korea. Nutrient flow in these aquaculture areas raises concerns with eutrophication in the NOWPAP region. But direct links between changes in nutrient concentrations in coastal waters and red tide events are rarely observed. Phosphorus concentrations in the coastal waters of NOWPAP marine area A rarely exceed 0.01 mgP/l in the surface layer, especially in summer, despite observations of red tides along the coast (Figure 6).

Spatial and temporal variability in nutrient concentrations in coastal areas is very significant as are changes in plankton productivity (chlorophyll "a" content). It is very difficult to regionally assess temporal trends in trophic status changes in coastal areas with respect to changes in nutrient concentration. Clearer evidence of eutrophication is gained from time-series observations in the offshore parts of marine areas.

Increased phosphate concentrations were registered in the 1990s in the central part of NOWPAP marine area A (Chen et al., 1999). Nitrogen compound (sum of nitrate and nitrite) content increased as well. This trend was observed at all water depths, with the averaged rate set at 0.00025±0.00006 mgP/l/year and 0.0015±0.0011 mgN/l/year (Tishshenko et al., 2002); from a geological perspective, this is very rapid. One possible reason is warming that leads to increased stagnation (Chen et al., 1999, Minami et al., 1999). Another possible explanation is additional inputs of organic matter via water currents through the Tsushima/Korean Straight and subsequent mineralization of this material with the release of nutrients (Tishshenko et al., 2002). Eutrophication in the northern part of the NOWPAP marine area appears to be partially a consequence of processes occurring in the southern part of the region. The concentration of red tide events on the boundary between marine area A and marine area B (Figure 6) does not contradict this observation.

Eutrophication processes were observed in NOWPAP marine area B throughout the last 25 years of the 20th century. In contrast to the North Sea or Baltic Sea, where eutrophication is accompanied by an increase in all nutrients, eutrophication in NOWPAP area B is expressed as an increase in nitrogen and a decrease in phosphorus and silica. The spatial-temporal and seasonal variability of the coastal areas is too high to determine long-term trends in changes in hydrochemical characteristics. A clearer trend is observed in offshore areas, along transect at 36.8N. The annual mean of DIN (sum of nitrite, nitrate and ammonia) from 1976 until 2000 increased by 0.041 mgN/l with a temperature increase of 1.7^{O}C. At the same time, annual mean contents of phosphorus (phosphate forms) and dissolved silica decreased by 0.003 mg P/l and 0.1 mg Si/l accordingly (Lin et al., 2005). Thus, the averaged rate of nitrogen increase was 0.0017 mg N/l/year, and phosphorus decrease was 0.00012 mg P/l/year. Reduction of dissolved oxygen was also observed.

Temperature increase was consistent with recent climate warming in northern China and in adjacent seas: Bohai and East China. The reduction of dissolved oxygen is probably attributable to the warming of water and to diminished phytoplankton production in the off shore area. The positive trend of nitrogen concentration is attributable to atmospheric precipitation and partly to river discharge (Zhang et al., 2005). The negative concentration trends of P and Si were due to decreases in their concentrations in the seawater that flowed into this area from the Bohai Sea, which in turn probably was induced by a decrease in river discharge due to freshwater use in the upstream regions (Lin et al., 2005).

4.3.2 Toxin-Producing Plankton

Toxin-producing plankton is another phenomenon that should be included in the "harmful algal bloom" definition. These are phytoplankton species that produce toxins within their cells and that have a negative impact on fish and shellfish throughout the food chain. In the NOWPAP region toxin-producing species are separated into three groups based on the type of poisoning: paralytic shellfish poisoning (PSP), diarrhetic shellfish poisoning (DSP), and amnesic shellfish poisoning (ASP).

PSP-inducing plankton (6 species) belong to the flagellate group. DSP-inducing plankton (10 species) are also flagellate. ASP toxicity has not been registered so far in the NOWPAP region, but ASP-producing diatoms (4 species) were observed in Russia and Korea (Table 12).

Toxin-producing species are a natural phenomenon that threaten humans when they consume shellfish. Anthropogenic derived change in the plankton community is made possible when potentially more toxic species (e.g. flagellates) are induced. Additional research, however, is needed to establishment causal links.

The species affected in Japan include scallops, mussels and oysters. In the Chinese part of the NOWPAP region and for Korea as a whole, shellfish are affected but species are not given.

PSP affected areas include the Shandong and northern Jiangsu coastal waters in China, southwest (Kyushu and Chugoku)

Table 12. Toxin-producing plankton species recorded in the NOWPAP region

	Species name	China	Japan	Korea	Russia
PSP	*Alexandrium acatenella*				●
	Alexandrium tamarense		●	●	●
	Alexandrium catenella	●	●		
	Alexandrium pseudogonyaulax				●
	Alexandrium tamiyavanichii		●		
	Gymnodinium catenatum		●		
DSP	*Dinophysis fortii*	●	●	●	●
	Dinophysis acuminata	●	●	●	●
	Dinophysis acuta				●
	Dinophysis caudata		●		
	Dinophysis infundibrus		●		
	Dinophysis mitra		●		
	Dinophysis ovata	●			
	Dinophysis rotundata		●	●	●
	Exuviaella marina	●			
ASP	*Pseudo-nitzschia calliantha*				●
	Pseudo-nitzschia multiseries				●
	Pseudo-nitzschia pseudodelicatissima				●
	Pseudo-nitzschia pungens			●	●

and northwest (Tohoku) coasts in Japan, and southeast coast in Korea. DSP affected areas include the Shandong, Lianyungang and Bohai Sea coastal waters in China, the southwest and northwest parts of Honshu and the entire Hokkaido coast in Japan, and the southeast coast in Korea. PSP and DSP affected areas thus coincide (Figure 6). The areas affected by toxic plankton in Russia have not been identified because there is a low level of shellfish consumption and limited aquaculture.

Toxin-producing plankton is a human health hazard. More than 600 people in China have suffered from consuming poisoned shellfish since 1967, including 30 fatalities from PSP. In Japan approximately 900 people have fallen ill since 1976, including several deaths from PSP. In truth, the number of people suffering from poisoned shellfish is much greater because many DSP cases are not properly identified. An additional impact is the economic loss from bans on the harvest of shellfish.

4.3.3. Countermeasures and Suggestions on HABs

Countermeasure that include monitoring and direct and indirect interventions are necessary to prevent or reduce the damage from red tide and toxin-producing plankton.

The best countermeasures against *C. polykrikoides* red tides include monitoring / alarm systems (Korea, China, Japan) and clay dispersion to sink plankton cells (Korea, Japan). Controlling and reducing nutrient flow into coastal waters is an indirect method used against red tides in Japan. Numerous methods to fight micro algal blooms are being investigated and researched in China, Japan, Korea and Russia. These methods include using flocculants, hydroxide radicals produced by ionization in high electric fields, chemical control with algaecides, and biological control through the bacterial and allelopathic action of seaweeds (Ulvacea). Certain methods are effective, but the indirect ecological impacts are not entirely clear and this is the main restraint in applying these methods.

The NOWPAP CEARAC WG3 *Cochlodinium* pamphlet and its website (http://www.cearac-project.org/wg3/cochlo-entrance/) are part of the attempt to fight *Cochlodinium* in the NOWPAP region. This pamphlet and the website describe the biology and damage caused by *Cochlodinium* and offer countermeasures for countries in the NOWPAP region.

China, Japan and Korea have implemented a range of countermeasures to fight toxin-producing plankton. First is monitoring of the toxicity level of shellfish at harvest areas. When toxicity exceeds the threshold level established by government authorities, shipping and trading are banned, and shellfish harvest ceases until the toxin concentration in mollusks falls below acceptable levels. Most cases of PSP quarantine in Japan last 2-4 months, but the duration of DSP quarantines are longer and can, in some cases, last up to 5 months. Monitoring of toxin-producing species is carried out in addition to toxicity tests for harvested shellfish. The State Oceanic Administration and local fishery laboratories in China are responsible for monitoring. Japan also monitors key toxin-producing species. NFRDI (National

Fisheries Research Development Institute) laboratories in Korea regularly monitor flagellate *Alexandrium sp.*

Suggestions for future regional actions on HABs, based on the analysis of NOWPAP CEARAC experts, include:

- Conduct research and study of *Cochlodinium* induced red tides;
- Establish common understandings of HABs by developing a database and information network;
- Create policy to control land-based nutrient discharge by studying casual links between eutrophication and HABs;
- Develop a collaborative approach to HAB monitoring for the NOWPAP region;
- Share information on effective countermeasures against HABs; and
- Cooperate with other international organizations studying HAB issues.

4.4. Oil Spills

The volume of tanker shipped oil in the NOWPAP region is rapidly increasing as the region continues its economic growth. The increasing dependency on large tankers to ship oil means an accident at sea could cause the region enormous environmental and economic damage. The risk of an oil spill is increasing with oil exploration off Sakhalin Island and in the upper Yellow Sea. Figure 7 shows that the NOWPAP region is threatened by heavy tanker traffic moving oil to China, Japan, Korea and Russia.

According to a survey conducted by the International Tanker Owners Pollution Federation (ITOPF) that assessed the risk of oil spills and the state of preparedness in the region (Moller, 2002), the NOWPAP marine area, along with the Mediterranean, Black Sea, Northeast Atlantic and East Asian Seas, is classified as a high risk oil spill region. Between 1990-2005 the NOWPAP region experienced major oil spills (greater than 1,000 tonnes), 132 intermediate spills (50-1,000 tonnes), and numerous small spills (less than 50 tonnes). Major oil spills in the region are listed in Table 13. These data indicate that the NOWAP marine area must prepare a plan to respond to potential oil spills. However, the region has a relatively low level of oil spill response (Moller, 2002).

The catastrophic Sea Prince (1995, Figure 8) and Nakhodka (1997, Figure 9) accidents indicate that NOWPAP countries must develop national oil spill response plans. In accordance with the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC ’90), cooperative measures on marine pollution preparedness and response were advance at the regional and international level as a major NOWPAP priority.

MERRAC was established on 22 March 2000 at the Maritime and Ocean Engineering Research Institute / Korea Ocean Research and

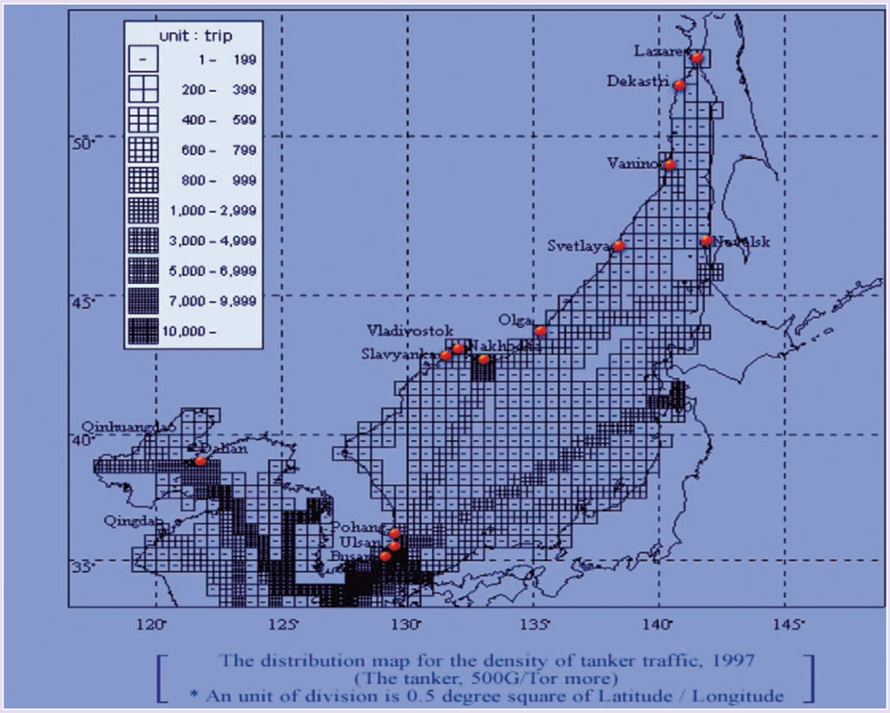


Figure 7. Oil Tanker Traffic Density in the NOWPAP Region (1997), source: http://merrac.nowpap.org

Development Institute (MOERI/KORDI) aiming to build strong relationships among NOWPAP members and to carry out specific activities to develop regional measures that address oil spill response in the Northwest Pacific region. This work is being carried out within the framework of NOWPAP, with professional support from the United Nations Environment Program (UNEP), the International Maritime Organization (IMO), and the NOWPAP Regional Coordinating Unit (RCU).

The NOWPAP Regional Oil Spill Contingency Plan and Memorandum of Understanding (MoU) on Regional Cooperation Regarding Preparedness and Response to Oil Spills in the Marine Environment of the Northwest Pacific Region were adopted at NOWPAP's 8th Intergovernmental Meeting (IGM) (Sanya, People's Republic of China, November 2003). These measures were developed within the framework of NOWPAP MERRAC. The Plan provides an official framework and technical guidelines for regional cooperation and an operational mechanism to assist in coordinating and organizing a prompt and effective response to major oil spill in the NOWPAP region. The MoU signed at the ministerial level by all NOWPAP members was presented to MERRAC. NOWPAP members are now better prepared to respond to oil spills as each country can request assistance from the other NOWPAP members in the event of a large oil spill. Prompt and effective action within the framework of the Plan will minimize the damage that could result from a major oil spill.

MERRAC also published *Technical Reports on Sensitivity Mapping, Guideline for Shoreline Clean-up, and Guideline for* *the Use of Dispersants* to provide appropriate technical measures and/or tools that are needed to implement regional cooperation on marine pollution preparedness and response.

Despite the efforts of NOWPAP members, marine oil spills continue to occur and range in size from several to thousands of tonnes. Preparing a timely and coordinated

Table 13. Oil Spills Greater than 1,000 tonnes in the NOWPAP Marine Area, 1990 – 2005.

No.	Date	Location	Name of Ship	Nationality	Type of Ship	Quantity (Ton)	Type of Oil	Cause
1	93.10.01	37° 00'N, 127° 45'E	Frountier express	Panama	Tanker	8,320	Naphtha	Grounding
2	97.01.02	37° 10'N, 130° 06'E	Nakhodka	Russia	Oil tanker	6,240	Cargo oil	Hull Broken
3	95.12.22	35° 24'N, 129° 25'E	Danita	Panama	Tanker	4,970	Kerosene	Collision
4	93.06.16	37° 13'N, 126° 24'E	Korea venus	Panama	Tanker	4,280	Fuel oil	Fog
5	95.07.23	34° 24'N 127° 48'E	Sea prince	Cyprus	Tanker	4,150	Crude oil	Grounding
6	95.09.21	34° 54'N, 128° 58'E	No.1 yuil	R. Korea	Tanker	2,900	Fuel oil	Grounding
7	01.01.16	25° 30'N, 119° 50'E	Long bo 6	China	Oil tanker	2,000	Diesel oil	Striking to the rocks
8	04.09.11	36° 45'N, 122° 31'E	JINDA 266	China	Chemical Tanker	2,000	Hydrochloric Acid	Overturn and sunk
9	98.01.20	37° 40'N, 119° 10'E	Bin hai219	China	Oil tanker	1,703	Heavy oil	Sinking
10	97.04.04	34° 36'N, 128° 34'E	No.3 ohsung	R. Korea	Tanker	1,700	Fuel oil	Sinking
11	92.05.10	34° 53'N, 128° 57'E	Stainless princess	Greece	Non-Tanker	1,600	MFP/MDO	Grounding
12	97.07.02	35° 21'N, 139° 43'E	Diamond grace	Panama	Oil tanker	1,550	Cargo oil	Grounding
13	90.07.15	37° 28'N, 126° 36'E	Korea hope	R. Korea	Tanker	1,500	Fuel oil	Collision
14	95.11.17	34° 51'N, 127° 16'E	Honam sapphir	Panama	Tanker	1,400	Crude oil	Collision
15	02.10.01	34° 41'N 139° 27'E	Hual Europe	Bahama	Car carrier	1,300	Fuel oil	Grounding
16	93.09.27	34° 52'N, 127° 45'E	No.5 Kumdong	R. Korea	Tanker	1,220	Fuel oil	Collision
17	04.05.26	34° 39'N, 127° 57'E	Mornong Express	Panama	Tanker	1,200	Naphtha	Collision
18	04.12.07	22° 06'N, 114° 27'E	MSC ILONA	Germany	Container ship	1,200	Fuel oil	Collision
19	97.06.03	32° 00'N, 118° 30'E	Da qing 243	China	Oil tanker	1,000	Crude oil	Explosion Fire

Figure 8. Sea Prince Accident, 1995

response for an event that can occur anywhere requires multilateral cooperation based on improved implementation and regulation. The effort also requires education campaigns for the general public, industry, municipal authorities, and local communities. The Plan should be tested during joint response activities and should be updated regularly to provide the framework for cooperation during large oil spills.

Figure 9. Nakhodka Accident, 1997

4.5. Coastal Environment Hot Spots

Coastal environmental hot spots have different characteristics, intensity and ecosystem impacts. Current and potential coastal hot spots are presented in Table 14. It should be noted in a discussion of the environmental consequences of hot spots that coastal environments are easily modified even without human activity. So natural hot spots are possible. Any estuary undergoing significant change in chemical and physical properties and where biological characteristics shift can also be called a hot spot. Areas with geothermal activity are another good example. In this report we discuss anthropogenic hot spots only, that is, events that arise and exist due to human activity.

A short list of environmental hot spots in Russian coastal area is presented in Table 15. A similar list could be developed for each NOWPAP country. An analysis of the hot spots would help to more clearly define national priorities and would reveal issues of mutual interest. In Russia, for example, high priorities are effective treatment of municipal wastewaters, improved management of coastal land-use and port activities, and measures against over exploitation of some biologic resources.

Chemical pollution in the Chinese coastal areas of the NOWPAP region is localized. Current concentration levels of industrial PCBs in bottom sediments are lower than in the Baltic Sea, but DDT concentrations are higher. PAH concentrations in coastal bottom sediments are elevated near oilfields and power stations (Wu et al., 1999). All persistent organic pollutants in bottom sediments are lower ER-L and ER-M (Long et al., 1995), DDT is the only exception where ER-L was exceeded near residential areas (Yuan et al., 2001).

Chinese aquaculture industry grew dramatically in the last decade and in 2002 accounted for almost 60% of world total production. Polluted Chinese fish ponds and shellfish farms resulting in lost natural habitat is a very serious issue. Areas suffering from red tides are also hot spots.

Habitat loss in Korean coastal areas is a serious problem. Land reclamation in estuaries and shallow bays is the main cause. Reclamation has reduced coastal habitats by 25% in recent decades.

Chemical pollution in Korean coastal waters is restricted to Masan Bay and Nakdong Estuary (Choi et al., 2001) where there are elevated concentrations of heavy

Table 14. Types of Coastal Environmental Hot Spots in NOWPAP Marine Area

Issues	Type of Problems	Causes of Problems
River input to estuarine zones	- Elevated concentrations of harmful substances in water, including suspended solids, bottom sediments and organisms due to additional input with river flux	Wastewater inputs and river pollution
Dumping and sewage discharges	- Elevated concentrations of harmful substances in water, bottom sediments and organisms due to sewage inputs and dumping of solids - Physical disturbance of benthos habitats	Liquid and solid wastes inputs to the sea without proper treatment;
Port activities	- Pollution of coastal waters during port operations, and wastes from the ships; - Loss of habitats and biodiversity.	Inefficient management of port activities; Conflict between water users
Aquaculture activities	- Pollution of coastal waters within aquaculture farm by nutrients and some other chemical substances; - Deterioration of the aquaculture resources	Excessive high density of aquaculture for given water body; Inefficient feeding, improper management
Mineral resources exploration and exploitation	- Pollution by industrial wastes, sewages, leakages; - Accidental spills; - Destruction of benthos and sea mammals habitats	Inefficient management of exploration and exploitation; Conflict between water users

Table 15. Environmental Hot Spots in Russian Coastal Waters in the NOWPAP Region

Location	Problems	Causes of problems
Some localities of the Amursky Bay near Vladivostok City and Nakhodka Bay near Nakhodka City	Elevated concentration of POPs, metals, nutrients in coastal waters, plankton, bottom sediments and organisms. Depletion of oxygen content. Deterioration of benthic and plankton communities. Marine litter and oil sleeks.	Water contamination by industrial and municipal sewage due to lack of treatment. Weak port management of pollution from ships and/or port facilities.
Coastal area adjoining the coastal landfill at the Ussuriysky Bay	High concentration of metals and POPs in coastal bottom sediments and organisms. Deterioration of mollusk (oysters) quality due to high concentration of some metals	Contamination by leakage from the city landfill situated near the coastline.
Rudnaya Pristan Bay in the middle Primorsky Krai	High concentration of metals in bottom sediments, water and organisms. Deterioration of benthic communities.	Contamination by river discharge and atmospheric deposition from the adjoining watershed with mining and ore processing industries.
Small bights within south part of Peter The Great Bay	Seasonal eutrophication and marine litter	Contamination due to unorganized recreation activity during summer season.
Coastal waters of Primorsky Krai	Elimination of high valuable species (sea cucumber, sea urchin, some crabs)	Poaching or irrational over exploitation of resources.

metals and some organic pollutants in bottom sediments and biota. An extensive sub-regional survey conducted in 2000 shows typical heavy metal levels in mussels for Korea’s coastal areas. At the same time, trace organic pollutant levels (PCBs, DDTs, HCHs, CHCs) in mussels near urban and/or industrial areas were often extremely high and spatial distribution of DDTs and CHLs were correlated with PCBs, indicating terrestrial pathways. HCHs distribution suggests a possible atmospheric input pathway for these chemicals (Kim et al., 2002).

In many areas along Korean south and southeast coast, aquaculture farms operate under a periodic threat of serious damage from red tides. All these localities can also be classified as environmental hot spots.

Environmental hot spots in Japanese coastal waters are also associated with damage from red tides. In the second half of the 20th century serious problems were observed in some coastal waters of Japan due to excessive Cd and Hg in the environment. Strict, comprehensive efforts by the Japanese government, officials and business have helped to resolve these problems.

4.6. Biodiversity and Changes in Biological Communities

Specialists in the different research fields note changes in coastal and offshore areas and these are discussed separately. In both areas changes in biodiversity are associated with significant changes in environmental conditions and follow a shift in the structure of biological communities. Environmental changes in offshore areas are initiated by regional changes in physical-chemical parameters and/or bio-invasions (discussed below). Local changes in coastal water and the high variability of physico-chemical conditions are caused by land based impacts. The main reason for environmental changes in the coastal area, however, is a physical transformation of habitats due to land reclamation, coastline reconstruction, and dredging. A second reason for changes in algae and animal communities in both coastal and offshore areas is overexploitation of some species.

Rapid changes in the species composition of fish communities and fish resource abundance have been observed in NOWPAP sea area B over the last four decades. Scientific fishing surveys in 1967 and in 1981 show a 62% reduction in the number of demersal abundant species (Zhang, Kim, 1999). Species diversity continued to decline in the 1980s to late 1990s (Marine Ecosystems…, 2004), with a clear trend toward replacement of demersal by pelagic species. Yield for various species shows different trends, but fisheries resources in NOWPAP sea area B have generally declined. The annual CPUE (Catch Per Unit Effort) in the Yellow Sea, a parameter characterizing fishing efficiency, fell from 3.46 t/hp (tons per horse power) in 1962 to 0.03 t/hp in 2001. The decline in resource quality can be expressed in a significant decline of the trophic level of organisms in catches (Figure 10). This means that high trophic level demersal species, at times the most valuable species, have gradually decreased and small pelagic species like anchovy have increased.

Changes in species composition at the lower trophic levels are also recorded. Before 1997-1999 the copepods were the major zooplankton group, with an increasing annual biomass trend. Jellyfish blooms begun in 2000 in the East China Sea and have moved northward to the NOWPAP marine area, causing problems for fisheries (Proceedings…, 2004).

Biological diversity of Korean coastal waters has decreased due to a loss of coastal area habitats (because of land reclamation). 29 marine species in Korea are registered as extinct, endangered and protected, including 2 mollusks, 23 waterfowls and 4 mammals. For mammals, there is mainly a decrease in large seal populations as a result f heavy catch and habitat loss.

In NOWPAP marine area A the general shift toward a warmer period in the late 1980s has caused a significant increase in zooplankton, an increase in the relative abundance of amphipods and euphausiids, and a rise in common squid. The species composition of this marine area's fish communities changed dramatically during

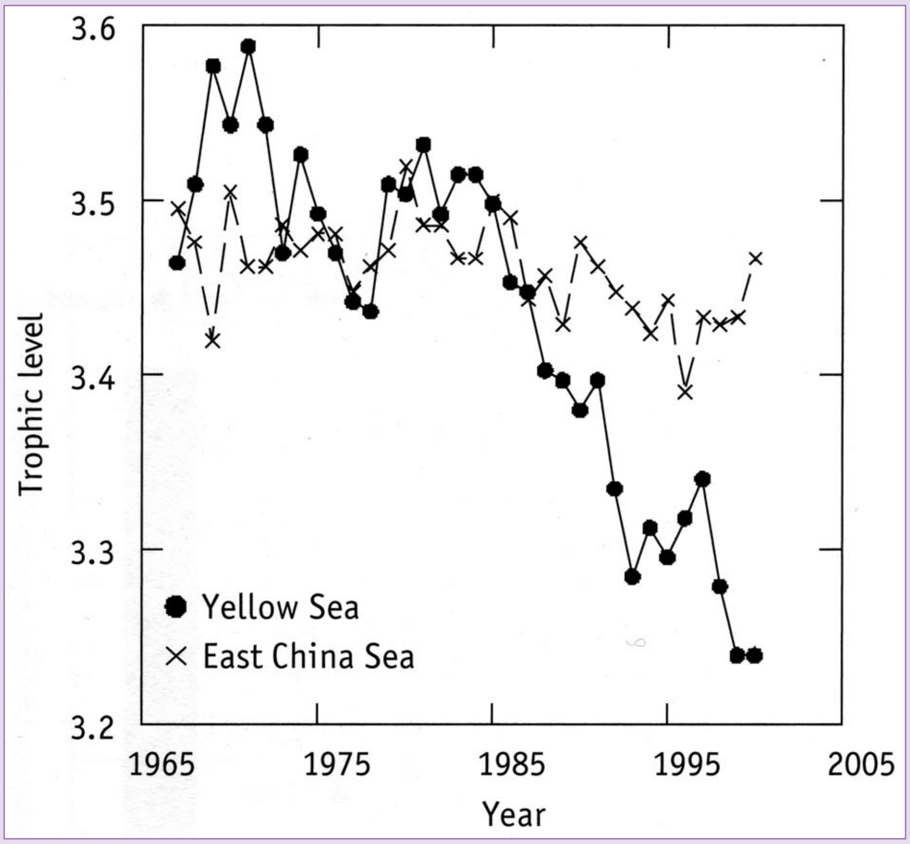


Figure 10. Trophic level of resource organisms in the catches of the Yellow Sea and East China Sea. (Source: Marine Ecosystems of the North Pacific, 2004).

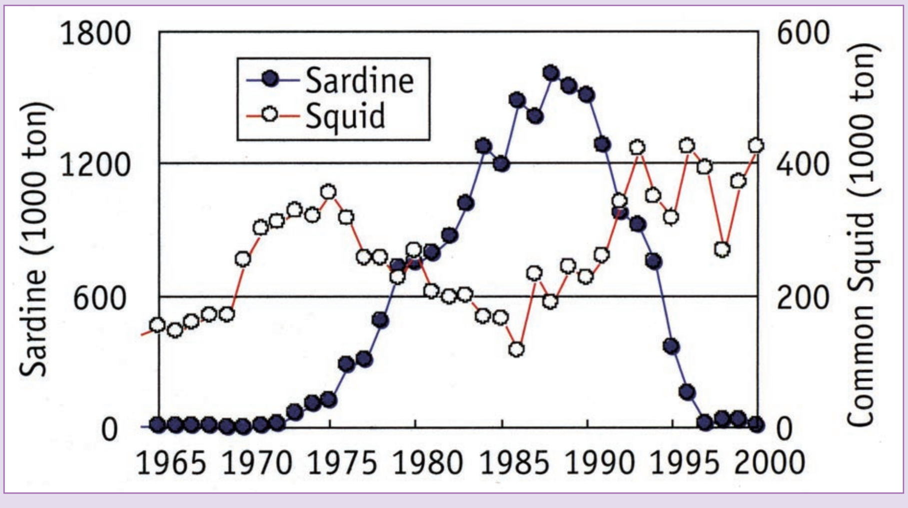


Figure 11. Change in harvest of two key fish species in the NOWPAP marine area A. (Source: Marine Ecosystems of the North Pacific, 2004).

the last four decades, exhibited in a rapid change in Japanese sardine volumes. The total catch of Japanese sardines rose sharply, to 1,600,000 t/year in the 1980s, and declined to 20,000 t/year in the mid 1990s (Figure 11). Natural oscillations appear to be the main reason for such variation and not over harvest or any other anthropogenic influence. Changes in the biodiversity of coastal waters in NOWPAP marine area A are expressed in a declining abundance of some valuable species from over harvest. Examples are sea urchin in Japan. In Russia it is sea cucumber and in some places, sea urchins. Decreasing excessive pressure on populations could result in resource recovery. In some cases, however, ecological niches have already been occupied by other species. The substitution of grey sea urchin by the less valuable black sea urchin following over harvest of the former is an example of a change in benthos population structure.

5. Emerging Environmental Issues

5.1. Marine Litter

Marine litter, any artificial, solid material that is discarded, disposed of or abandoned in coastal and marine environment, became a serious problem in the second half of 20th century. The growing volume of man-made materials, including extremely persistent plastics, is becoming a serious threat to marine environments. The threats are 1) hazards to marine animals and birds (entanglement and suffocation in abandoned fishnets); 2) economic impact on commercial fisheries; 3) lost aesthetic value of beaches and coastal areas (reduced tourism); 4) vectors for invasive marine species; 5) threats to human health from medical and sanitary wastes; 6) navigational hazards for ships; and 7) damage to vessel and power station cooling systems.

Plastic, rubber, polystyrene, paper, cloth, glass, ceramic and metal are the common types of litter observed in the marine environment. Litter is visible on beaches and shores, on the water surface, in the water column and on the sea floor, and litter can also be invisible to the eye. This makes addressing marine litter a complex problem to deal with.

The sources of marine litter are both sea- and land-based. Sea-based sources include merchant and cruise ships, navy vessels, fishing vessels and fish farms. Offshore oil and gas platforms are also a source of marine litter. Land-based sources include waste from coastal landfills, discharge of untreated storm water, garbage transported by rivers and litter left on beaches. Faris & Hart (1994) report that nearly 80% of the world's marine litter starts on land. Marine litter takes various forms, but 90-95% are non-degradable varieties of plastic, metal and glass that persist for decades and longer. For example, a plastic bottle takes 450 years to biodegrade (UNEP, 1990). Ultraviolet light and abrasion break these materials down into small pieces, making them difficult to collect. Mobility is another important feature of marine litter: it travels great distances in ocean currents and winds. There have been a number of attempts to use satellite information and simulation models to interpret marine litter transportation pathways (Kubota, 2005) as well as using a disposable lighter as the tracking device (Fujieda, 2005). These studies show that marine litter is a problem not only for the source regions, it also causes problems for remote areas as well.

Sea currents appear to be a key factor in the distribution and concentration of marine litter along certain parts of the coastline. The root cause of the marine litter problem is poor management of human activities and a lack of human awareness of the consequences of their behavior and actions. The misguided notion that the sea is unlimited and a lack of public information about the dangers represented by litter are the main reasons for peoples' poor behavior.

Enforcement of international agreements (MARPOL), providing adequate disposal facilities for ship-generated waste, improving waste management and organizing human activities (shipping, wastes treatment, fishing) are key to controlling marine litter. Influencing human behavior is difficult but can be achieved through measures that include information, education and public awareness campaigns, and the organization and support for cleanup activities. Additional economical investments to renovate fishing fleets, to reprocess old fish nets and gear are also needed.

The NOWPAP region is one of the most densely populated areas in the world, an area with very intensive fishing and shipping activities, thus marine litter is a serious concern. One consequence is that the volume of floating plastic, even in offshore areas, reaches 20-50 pieces/100 km, twice what is observed in other seas (Ida, 2006). The plastic created from decomposing fishing gear accounts for as much as 50% of the litter.

Marine litter on beaches is also a serious issue. A survey conducted in 2003 for 48 coastal sites in NOWPAP countries demonstrates this fact (Adachi, 2006): average litter volumes varied from 1673 pieces/100 m^2 on the northwest Kyusyu Island to the 36-53 pieces/100m^2 along the Russian coast and northeast coast of the Korean peninsula. A slightly different distribution pattern is observed for marine litter weight (Figure 12). But again, the area of northwest Kyusyu Island and some locations along west Honshu Island are the most contaminated (Figure 12). Plastic is the most numerous type of marine litter. The conclusion is that numerous small and light-weight plastic pieces are floating in the sea. At the same time there are sites on the west side of Japanese Islands that have rather small amounts of marine litter.

There are no long-term observations of marine litter distribution for some parts of the NOWPAP region. The most advanced surveys of the JMA (Japan) run since 1977

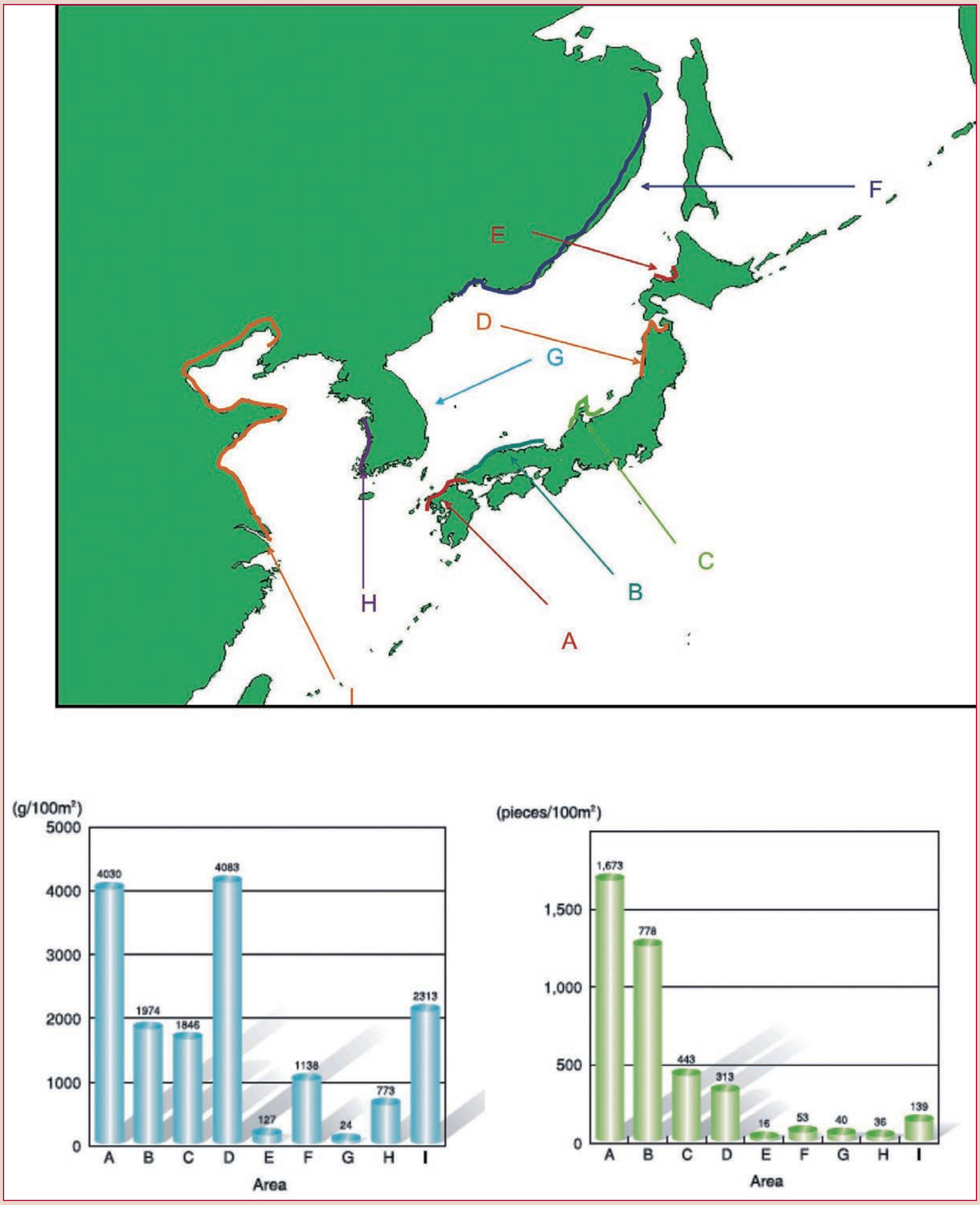


Figure 12. Distribution of marine litter on beaches in different parts of the NOWPAP region as measured by weight (left, g/100 m^2), and by quantity (right, pieces/100m^2). Source: Adachi, 2006.

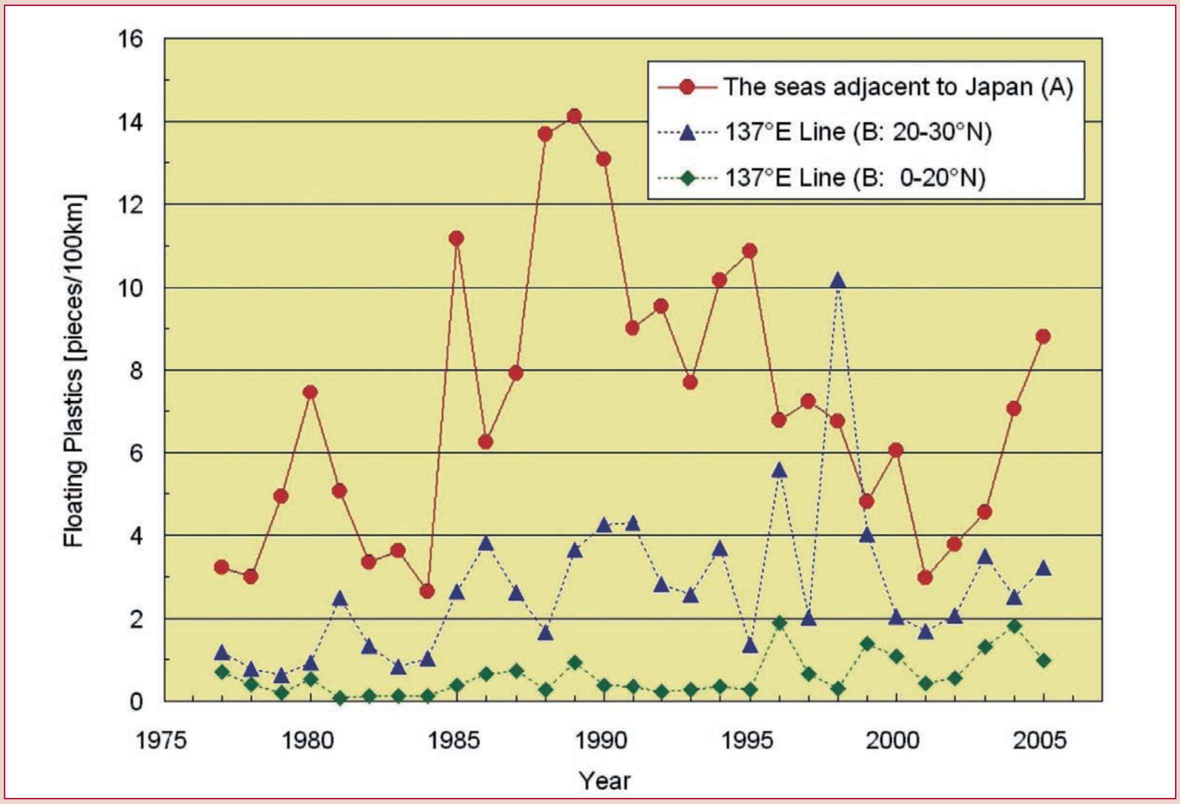


Figure 13. Trends in the amount of plastic litter observed by JMA Surveys. Source: Ida, 2006

and show a peak volume for floating plastic near Japan to the be the late 1980s, followed by some decrease (Figure 13).

Marine litter activities in NOWPAP countries are divided into four areas: 1) monitoring activity; 2) public awareness and information; 3) development and implementation of economic and policy measures to manage litter; 4) cleanup activities. Prevention of ship-based pollution is a separate measure that is comprehensively defined by the MARPOL Convention and is described in a separate set of documents.

Floating marine litter monitoring in Japan is carried out by the government agency (JMA) and marine litter monitoring on beaches is carried out by numerous agencies and NGOs (Yamaguchi, 2005, Fujii, 2005, Fujitani, 2005). In Korea marine litter monitoring began recently and is carried out by NGOs on beaches and in coastal waters. Marine litter monitoring in China and Russia is a voluntary action (Blinovskaya, 2005). Beach clean up is not a major feature of marine litter monitoring, but it is a good start to expand information dissemination and public awareness.

Public relations play a very important role in mitigating marine litter problems. Development of educational materials for children and students, participation in training exercises and workshops, questionnaires, brochures, videos are all examples of activities in this field. Crucial to the success of these actions is cooperation between officials, mass media, social scientists, NGO leaders and teachers.

Development and implementation of economic and policy measures to properly manage marine litter is very important. Emphasis in China is on fishing fleet renovation, equipping it with waste recycling gear and providing port facilities to deal with fishing nets, floats and ropes. Parallel to these efforts are attempts to strengthen control and management of fishing ships.

Prefectural governments administer coastal management in Japan. A local "Coastal Management Tax" was established in 2002 for prefectural governments; this tax is spent to manage washed-up litter. The Waste Management Law requires any person who supervises beaches, ports and other public places to make an effort to keep them clean. Swimming beaches, sightseeing spots, harbors and fishing areas are targets for cleanup efforts. Local governments, port managers, local associations and volunteers carry out cleanup activities. In some cases, there is national / local government financial support for the activities. In most cases, the local government moves marine litter to a disposal plant.

The emphasis in Korea is on projects to collect waste deposited in harbors and fishing ports. The first stage was completed in 2003 and the project, with an annually increasing budget, was expanded to costal seas in 2004. The central government and neighboring autonomous entities are developing new approaches to minimize waste production and new approaches are needed to process waste. Korea had a 1.5 million dollar budget in 2005 to purchase marine litter collected by local fishers. The purchase project is more effective (cost per ton purchased) than the collection project, but the purchase project does not address the source of litter and does not provide incentive to reduce the amount of litter thrown to sea.

Korea has used an integrated waste processing system since 1999. The system consists of a styrofoam volume reducer, ocean waste pre-processing system, multipurpose ocean waste collection boat, ocean waste incinerator and equipment to survey garbage on sea bottom at depth down to 1,000 m. Environmentally friendly fishing gear such as bio-decomposition weirs and nets is being developed.

Russia manages its marine litter problem through policy and practical measures. Use of marine areas is only possible with a license. Moreover, the contract to use marine areas is signed with the local government. This contract stipulates the procedure for keeping the marine area clean. A project of fitting sewage water outlets and mouths of rivers that flow into the sea with fine filter grating has begun. All river beds have been inspected. Measures are being taken to remove unauthorized dump sites. Some companies, based on inspections, are required to correct violations of environmental protection laws. Penalties can reach several thousand US dollars.

In addition, the following actions are planned within the framework of the Primorsky Krai Waste Program for 2005-2011:

- Water supply and sewage facilities reconstruction and development in Vladivostok;
- Construction of rain-storm run-off treatment plants in Vladivostok

- Construction of new municipal landfill in Vladivostok;
- Removal of the municipal solid waste landfill in Vladivostok (Gornostai Bay);
- Removal of sunken ships and scrapping of decommissioned ships.

Cleanup activities include actions to collect and remove marine litter from beaches. Aside from the obvious effect of cleaning a specific beach, these campaigns also play a certain public awareness role.

In noting the importance of marine litter problems, NOWPAP IGMs in 2004 and 2005 decided to begin regional marine litter activities. A new project on Marine Litter Activity (MALITA) in the NOWPAP region was developed and began in November 2005. The collection and review of existing data and information relevant to marine litter in each NOWPAP country were first steps in implementing this project which resulted in the creation of a marine litter database. Another activity was to collect information on relevant legal instruments and programs on marine litter in each of the NOWPAP members in order to identify gaps and needs in managing marine litter among member states. Based on these initial activities, the following future actions were proposed:

- Develop regional and national strategies on integrated management of marine litter;
- Develop and implement a long-tern regional and national monitoring program;
- Develop sectoral guidelines for management of marine litter;
- Develop and improve port reception facilities and services;
- Develop public education and awareness raising campaigns; and
- Develop of Regional Action Plan on marine litter.

The MALITA project will raise public awareness about marine litter as a key factor in regional marine and coastal environment degradation. This project will support the development of integrated waste management policies and systems at national and regional levels. The NOWPAP Regional Action Plan on Marine Litter, a project output, will aid in the prevention and reduction of marine litter in the Northwest Pacific region.

5.2. Persistent Toxic Substances (PTS)

5.2.1. Current PTS Issues

A list of POPs that includes aldrin, endrin, dieldrin, chlordane, DDTs, toxaphene, mirex, heptachlor, hexachlorobenzene, PCBs, dioxins and furans, resulted from decisions made by the Stockholm Convention (2001). All these substances have the following specific properties: persistence in the environment; resistance to degradation; toxicity; capacity to bioaccumulate and to move long distances in the environment. Beside these twelve substances, many other substances satisfy these criteria. For example, PAHs, organic mercury compounds, organic tin compounds, HCHs, and brominated flame retardants (PBDE) have been proposed as PTS in the Regional Assessment for Central and North Asia (UNEP Chemicals/GEF, 2002). As noted in these documents, DDT, HCH, dioxins, furans, PCBs and PAHs are high priority chemicals among other PTS for the eastern part of Asia. PTS can be divided into four main groups: 1) pesticides – DDTs, HCHs, aldrin, endrin, dieldrin, toxaphene, mirex, 2) industrial compounds – PCBs and hexachlorobenzene, 3) unintentionally produced substances - dioxins and furans, and 4) metal containing pollutants – organic mercury and organic tin compounds, lead and cadmium.

PTS, and especially persistent organic pollutants (POPs), are of major concern because they can bioaccumulate due to lipophilic properties in the organisms of higher trophic level and they are toxic to wildlife and humans. The harmful effects of these chemicals are associated with the occurrence of immunologic and teratogenic dysfunction, reproductive impairments and endocrine disruption at low and high trophic levels. It is widely accepted that PTS can concentrate in living organisms, including humans, at levels that can potentially cause injury to human health and/or the environment even when the initial release is far away due to the semivolatile nature and high mobility of some PTS through the atmosphere.

A special feature of the NOWPAP region with respect to PTS is the combination of highly industrialized countries like Japan and Korea that used PCBs extensively in the 1970s and 1980s and China's rapid growth where, until 1983, DDT and HCH were widely applied as pesticides. Temporary and limited application of DDT to fight malarial insects is still allowed.

Persistent toxic substances are used as pesticides or produced as a byproduct of industrial processes. PAHs and dioxins/furans are unintentional byproducts of combustion in incinerators and engines. Dioxins are also generated when chlorine is used for the disinfection of drinking water with high contents of dissolved organic substances. This diverse range of PTS sources causes various environmental problems. Outdated equipment and technological processes is most common source of problems. Technologies to deal with PTS vary greatly but in all cases this process is very expensive. A lack of funds to update technology is often the main barrier to reducing

PTS input to the environment. Another problem is the absence of reliable methods to eliminate PTS from the environment, so obsolete pesticides for example remain buried or stockpiled. In some cases, there have been no adequate alternatives so far. For example, although pyrethroids are considered as an alternative to DDT, they are less effective in fighting malaria carrying insects and are much more expensive.

Contamination of the environment with PTS may come from point sources (industrial discharges and wastewater treatment plant effluents) or, more frequently, from diffuse sources (atmospheric transport and deposition), the major pathway for transfer of persistent organic pollutants to remote sites.

Japan has put together a relatively diverse database on PTS in the past three decades. Korea is also relatively advanced in developing PTS source inventories. China and Russia have some shortage of reliable monitoring data on the PTS, programs on emission control, and adequate quality control, but the awareness of PTS issues is growing in all NOWPAP countries.

There is some deficiency in the reliable monitoring data on the of dissolved forms of PTS in the river and sea waters of NOWPAP area. Main reasons are the necessity in rather sophisticated equipment and methods, and shortage of trained personnel for the routine determination of dissolved substances at very low concentrations (ng/l, and less). Data on PTS concentrations in sediments and aquatic biota are more readily available. Elevated POPs concentrations have been detected in a wide range of environmental media and aquatic biota (Iwata et al., 1994; Monirith et al., 2003).

The results of monitoring marine pollution in Asian coastal waters using mussels as bioindicators (Monirith et al., 2003) clearly show the level of regional contamination by POPs. This suggests serious DDT contamination in China, Hong Kong and Vietnamese coastal waters, HCH contamination in Indian and Chinese marine environments, and PCB and CHCl contamination in Philippine, Malaysian and Singaporean marine waters. The occurrence of POPs residues in mussels creates a serious human health concern as mussels are the region's single largest and most commercially valuable aquaculture industry. Continuous monitoring of residues, including studies on ecotoxiclological risk assessment, is proposed to identify contamination trends and toxic impact.

Study of coastal sediments in the Bohai Sea and Yellow Sea (Ma et al., 2001) shows PCBs levels comparable to basins with pronounced anthropogenic impact like the Baltic Sea, Gulf of Main and New York's Bight. At the same time, DDT levels are very high compared to the Baltic Sea. Despite a ban on using DDT, bottom sediment contamination from these substances continues to occur. Oil pollution, a main source of PAHs, affects their concentrations in sediments. Extremely polluted areas like Jiaozhou Bay (near Qingdao) have very high concentration of all POPs (DDTs, PCBs, PAHs) in sediments.

Elevated POPs levels were detected in mollusks taken from coastal waters of Korea near urban and industrial areas. The area's varying congener patterns of PCBs indicate different PCB mixtures. Spatial distribution of DDTs and CHLs is well correlated with that of PCBs while HCHs are evenly distributed along the entire coast. No significant temporal decline of POPs for each of the bivalve groups has been observed in the past five years (Kim et al., 2002). Contamination levels were lower in Korea than in the US while higher than in some developing countries in Asia.

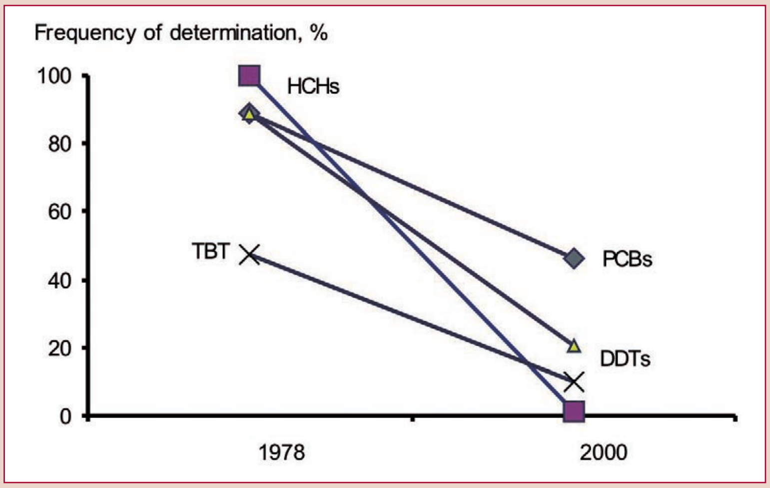


Figure 14. Change in the frequency of determination (% of non-zero results) of different PTS in fish and shellfish analysis during monitoring surveys in Japan. Source: UNEP Chemicals/GEF, 2002.

Japan has been conducting environmental monitoring of major organochlorines for nearly three decades and of organotins for more than a decade. Many compounds are less frequently detected, including PCBs, DDT, HCHs (lindane) and TBTs in fish and shellfish (Figure 14), suggesting that in recent decades contamination has generally decreased. It is difficult to calculate a time trend due to the proportional increase of data labeled "not detected" (UNEP/GEF, 2002).

Several reports have analyzed sediment core samples in order to obtain a time trend for PCBs, PCDD/PCDFs and other pollutants in Japan (Araki, et al., 2000; Okuda et al., 2000). Many show that PCBs concentrations were highest in the 1960s followed by a decline that has now slacked.

Distribution in sediment cores obtained from an estuary in southern China near Macau shows that DDTs peaked at 79 ng/g in 1993 while the level was lower, between "not detected" and 28.9 ng/g, after 1960. Total HCHs peaked at 82.3 ng/g in 1993 and then decreased to less than detectable levels (Zhang, et al., 1999).

NOWPAP countries have different economic levels and different potentials for the proper monitoring and management of PTS. Japan has a comparatively comprehensive scientific and legal system to manage PTS and has amassed significant data and relevant information. Japan is also developing advanced waste disposal techniques. Korea has established a risk/hazard evaluation system, accident prevention and response, risk reduction and chemical information management. Specialists are also developing national action plans. Korea currently has a 10-year national research program that includes compiling a PCB and PCDD/PCDF inventory. A joint project with Japan on EDCs (including PCBs and PCDD/PCDF) is also in progress.

China's environmental management of chemicals began in 1994 with environmental management controls on the import and export of toxic chemicals. The move is to have chemical management follow routine government procedures. Certain research institutes have carried out scientific studies of PTS. The Chinese government is now conducting an inventory of POPs pesticides and is implementing the PDF-B national implementation plan (NIP) as called for by the Stockholm Convention.

In Russia, environmental management of chemicals and relevant research began some time ago. Russia has established numerous environmental standards to cover PTS. Studies of PTS concentrations in the environment and in human populations have been carried out periodically.

Key information gaps on PTS issues in the NOWPAP region include:

- Inadequate information to determine the significance of other regional chemicals identified by experts: Polybrominated Diphenyl Ether (PBDE), Pentachlorophenol (PCP), Organic Mercury Compounds, and Organic Tin Compounds;

- Inadequate information on PTS accumulation mechanisms in the biota and their effects on biota. There is also a concern with the stability of some PTS in the marine environment given the very slow degradation rate of such PTS (PCBs for example) in marine ecosystems;

- Poor understanding of the sources of regionally significant PTS affecting marine and coastal environments. The regional assessment report (UNEP Chemicals/GEF, 2002) concluded that data are inadequate to monitor and/or model results or to identify specific source locations and PTS transport pathways.

Although the use of certain pesticides like DDT and HCH has been officially banned for decades in many countries, published papers and reports show detectable concentrations of these POPs in soils, bottom sediments and biota. One reason for their presence may be a lack of a generally approved technique to dispose of obsolete PTS. Regional hazardous waste disposal methods include composting, open dumping, landfills and incineration. Open dumping is the most widespread practice and waste is dumped along the coastline and into the sea in coastal cities in the region.

Within the region, Japan and Republic of Korea have some advantage in research and collaboration projects on PTS. Therefore due to transboundary nature of many PTS issues, the international cooperation should be enhanced. For the time being there is no solid regional collaboration activity in the NOWPAP region. The project East Asian POPs Monitoring Network initiated recently by NIES (National Institute for Environmental Studies, Japan) could be one of the platforms for the cooperation on the PTS issues. NOWPAP initiative related to PTS is described below.

5.2.2. NOWPAP GEF Project

NOWPAP considers the land-based activities that affect the marine environment as the major threats to marine and coastal ecosystems. A recent regional assessment (UNEP/GEF, 2002) on persistent toxic substances in the region states that specific PTS of concern, including POPs, are: Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF), Polychlorinated biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs), Dichlorodiphenyltrichloroethane (DDT) and Hexachlorocyclohexanes (HCH). The report highlights a problem with high PTS concentrations, for example PAHs in sediments in the marine areas of China, Japan and Korea. The report also indicates a shortage of data to determine the significance of other regional chemicals identified by experts: Polybrominated Diphenyl Ether (PBDE), Pentachlorophenol (PCP), Organic Mercury Compounds, and Organic Tin Compounds.

This assessment also stresses that inadequate regional data are available to identify hot spots with high contaminant concentrations; however, in general, agricultural areas with high pesticide use, urban areas with their automobiles and municipal sewage, and industrialized areas with chemical use, metallurgy, and the heavy combustions of fossil fuels and solid waste are noted as areas requiring further study. It is commonly claimed that land-based activities cause up to 80% of the damage to the marine and coastal environment. These activities include mobilization of contaminants that are transported into marine environment by continental runoff and atmospheric deposition. The impact of pollutants entering marine and coastal environments from far distant land based sources is also highlighted in the report.

The NOWPAP countries are committed to addressing land-based activities in a coherent and fully consultative manner because damage and threats to the marine ecosystem caused by land-based economic development whose impacts have been transported through by river and air are considered the key contributors to the degradation of the region's marine environment.

One of the possibilities to mitigate PTS problems is a NOWPAP regional project submitted to the Global Environment Facility (GEF) and entitled "Addressing Land-Based Activities that Affect the Marine and Coastal Environment of the Northwest Pacific Region." (GEF Project Database, GEF Project ID 2961)

This project will be a model for regional collaboration in effectively addressing Land Based Activities (LBA) and Land-Based Sources (LBS), with a focus on the sources of PTS that adversely affect the region's marine and coastal environments. More specifically, the project's expected outcomes are: 1) create a basis, in terms of a political agreement based on scientific information, for regional collaboration to address LBA/LBS affecting transboundary water bodies, 2) improved regional and national capacity to address LBA/LBS affecting the transboundary water bodies, and 3) demonstration of innovative measures and methods to address priority LBA/LBS issues/sites on land.

Implementation of the project will provide three outcomes:

1) Completion and multilateral adoption

of a set of preventive actions in a form of the Regional Action Programme on LBA/LBS Environmental Hotspots to address existing environmental degradation of and threats to international waters posed by land-based activities with focus on interventions to PTS sources.

It is essential to obtain scientific information on the LBA/LBS PTS sources and to identify regionally-agreed and prioritized environmental hotspots that adversely affect and/or potentially threaten the overall function of the marine ecosystem in the Northwest Pacific region. First will be an analysis of LBA/LBS PTS sources, a so-called Regional LBA/LBS Environmental Hotspots Analysis, to provide scientific background information leading to regionally adoption of the analysis. The analysis includes an identification of geographically characterized LBA/LBS environmental hotspots, with focus on PTS of regional concern, affecting the marine and coastal environment in the region, an estimate of discharges and transportation pathways of PTS from the LBA/LBS environmental hotspots and an estimate of their impacts on marine and coastal environments. The preliminary analysis completed during the PDF-B phase will be updated during the full-project phase.

This project will develop and establish a set of regionally agreed upon actions in the form of a Regional Action Programme on LBA/LBS Environmental Hotspots that will focus on the sources of PTS in the Northwest Pacific region. The project includes time targets to reduce/eliminate contaminants discharged from major sources affecting the marine and coastal environment and it will address the environmental issues and problems identified in the Northwest Pacific region. Approaches and technologies used as preventive measures will hopefully prove cost-effective in achieving regionally agreed upon actions.

The Regional Action Programme will focus on preventive actions, inter alia, to address regional PTS that are currently not covered by the Stockholm Convention, the so called PTS-beyond-POPs. Development and implementation of this Regional Action Programme will complement other national, regional and international initiatives on and/or relevant to POPs and LBA/LBS. These programmes include the Strategic Action Programme being developed by the UNDP/GEF YSLME Project and Sustainable Development Strategy for the Sea of East Asia lead by UNDP/GEF PEMSEA Project. The new programme will enhance and sustain regional collaborative actions to reduce/eliminate the LBA/LBS affecting the NOWPAP marine area. A draft Regional Action Programme prepared during the PDF-B phase will be elaborated, taking the results of updated Regional LBA/LBS Environmental Hotspots Analysis and the lessons learnt from demonstration projects during the full-size project.

2) Institutional strengthening and capacity building to ensure efficiency in environmental management and requisite national institutions, and the mechanisms and equipment to sustain marine environmental protection policies and measures.

The project proposes to further develop, at a regional level, institutional, financial and, wherever appropriate, policy and legal mechanisms necessary to implement a set of regionally-agreed upon actions highlighted in the Regional Action Programme on LBA/LBS Environmental Hotspots for addressing priority

LBA/LBS related marine environmental issues and problems. It is also proposed to develop capacity, including monitoring and assessment of PTS capacity, modeling of their transfer and knowledge and skills for effectively addressing these chemicals within national and regional institutions to implement the identified actions in the Northwest Pacific region.

The project also proposes to further develop coordination and implementation mechanisms to address LBA/LBS issues at a national level. Issues to be further developed will be identified during the PDF-B phase; however, provisional issues include ensuring linkage between regionally agreed actions and national action plans through introducing/updating relevant policies, strengthening inter-ministerial coordination, establishing/strengthening requisite national institutes for monitoring and assessment, development of effective measures and methods, development of on-the-ground management capacity, securing financial sources, and ensuring stakeholder involvement and awareness raising.

3) Replicable on-the-ground preventive actions that address the sources of priority damage and threats to the marine environment that stem from land-based activities.

The project proposes to design and implement 7-10 national and regional demonstration projects at selected regionally prioritized LBA/LBS Environmental Hotspots, and in particular, at sources of PTS. These pilot projects will provide proven data on efficiency and cost-effectiveness of different approaches and technologies. Lessons learnt will be exchanged not only among the participating countries, but also made available for stakeholders beyond the region. They will be also utilized for the update of the Regional Action Programme.

It is anticipated that the demonstration projects developed and implemented as a part of the project will focus on selected regionally significant PTS not covered by the Stockholm Convention. On-the-ground interventions to the twelve POPs currently covered by the Convention will be addressed through by implementing National Implementation Plans on POPs developed by each country.

In concert with the development of a Regional Action Programme on LBA/LBS Environmental Hotspots for the Northwest Pacific Region, this GEF project will promote regional mechanism. These include mechanisms for sustainable financing, full stakeholder involvement and institutional arrangement. By establishing regional mechanisms, the agreed up actions will be supported through national and international financing and be provided adequate technical support. Mechanisms will be incorporated into the overall NOWPAO institutional framework, thus ensuring that existing regional mechanisms serve as the mechanism for sustainable implementation of the Regional Action Programme.

The project results will be distributed not only through GEF IW Learn but also through the UNEP Regional Seas mechanism so that other UNEP Regional Seas Programmes may benefit from the lessons learnt during this project. With the existing NOWPAP mechanism as the baseline, this proposed GEF intervention will establish a strategic regional mechanism and framework to address identified environmental issues and concerns regarding this marine area. This regional mechanism will be incorporated into the NOWPAP framework and coupled to a sustainable financing mechanism.

5.3. Hazardous and Noxious Substances (HNS) Spills

A Hazardous and Noxious Substance (HNS) is defined as any substance other than oil which, if introduced into the marine environment, is likely to create a human health hazard, to harm living resources and marine life, and to damage amenities or to interfere with other legitimate uses of the sea (definition from International Maritime Organization (IMO) website for Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous & Noxious Substances, OPRC-HNS Protocol). HNS include any liquid substances defined as noxious or dangerous, liquefied gases, liquid substances with a flashpoint not exceeding 60°C; dangerous, hazardous and harmful materials and substances carried in packaged form, and solid bulk materials defined as possessing chemical hazards. The need to distinguish these substances from oil is the increase at sea transport of HNS, the increasing risk of accidents given volumes hauled, and the serious or catastrophic pollution consequence from an acceded at sea.

The abbreviation HNS is used in the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances (HNS) by sea. This Convention provides for liability and compensation for incidents involving these substances. IMO adopted the Convention in 1996, but it has not yet entered into force. The HNS Convention will ensure that ships carrying hazardous and noxious liquid substances are covered by preparedness and response regimes similar to those already in existence for oil incidents.

HNS spills have recently increased in frequency given increased high-sea transport of petrochemical and/or chemical industry products. A HNS spill can result in fire, explosion, suffocation, toxic ingredient, and corrosion. Unlike oil or oily mixtures, HNS demand special prevention methods that depend on their physical and chemical characteristics. Governments, local and international organizations are trying to create an efficient control system to prevent, and be ready to respond to HNS accidents. Internationally, IMO adopted the OPRC-HNS Protocol in 2000 and it will enter into force in June 2007.

The list of incidents presented by IMO in 2002 (Session of Legal Committee IMO, 2002) shows that shipping incidents involving HNS are occurring on a regular basis. Some of the incidents had serious consequences, others passed by with little or no effect. Nevertheless this list points out the importance of implementation of the HNS Convention on an international basis.

58 serious accidents were recorded worldwide between 1995 and 2002. 21 involved gasoline, jet fuel and diesel oil. Others accidents involved ships carrying gas (4 cases), mineral acids (nitric, sulfuric, phosphoric - 9 cases), chemical products (styrene, chlorophorm, xylene alkilnitrile - 6 cases), ammonia salts (5 cases), benzene and phenols (5 cases), naphtha and vegetable oil (6 cases), chlorates and hypochlorites (2 cases), ore products (2 cases).

NOWPAP countries are also exposed to a high risk of HNS and oil spills given large transport volumes. There is, however, a generally low level of preparedness for HNS incidents. China, for example, recorded a total of 52 incidents involving HNS between 1991-2004 year, of which 14 incidents were spills greater than 100 tones. Korea reported 22 HNS spills between 2000-2005, with 1,435 tones spilled. Japan reports several HNS incidents every year.

As HNS accident risk increases in the NOWPAP region, NOWPAP countries are trying to increase their national/regional HNS preparedness and response protocols and propose ratifying measures necessary for an OPRC-HNS Protocol. In 2004 China developed an oil and HNS national contingency plan to prevent and respond to HNS accidents, and expanded its emergency response resources for an eventual HNS accident. The Chinese government has moved to expand professional capacity, improve monitoring of ships carrying bulk HNS, improve the management of cargo handling operations in ports and terminals to prevent HNS spills.

The Japanese government is establishing a national system to develop a national HNS contingency plan. The system sets measures to be taken by parties responsible for HNS incidents by revising national laws on the prevention of marine pollution and maritime accidents, by promoting training, research and development, and international cooperation related to HNS issue, and by improving the Japanese Coast Guard's capacity to deal with HNS incidents.

The Korean government is also setting up detailed actions against HNS spills by establishing national and local HNS contingency plans that include an HNS accident response information system to provide technical data and/or advice services during a HNS spill response operation, development of a HNS accident response manual, execution of response training and education on HNS, and setting up of a coordinated system on HNS spills among governmental authorities and private sectors.

Recognizing that NOWPAP countries must respond jointly to HNS issues at the regional level, its members recently began development of a regional, cooperative system on HNS spill preparedness and response in the NOWPAP region, working within the framework of NOWPAP and MERRAC and with the support of the IMO and the United Nations Environment Program (UNEP). At the 10th NOWPAP Intergovernmental Meeting (December 2005), NOWPAP countries agreed to expand scope of the MERRAC activity to include HNS issues.

Based upon a decision made at the 9th MERRAC Focal Points Meeting, National Reports on HNS will include a general overview of national situations being developed by NOWPAP countries. These reports will be used as background for future cooperative activities of MERRAC on HNS issues. The 2006 Expert Meeting (Yuzhno-Sakhalinsk, Russian Federation, November 2006) was also organized to develop draft texts for a HNS regional contingency plan and its Memorandum of Understanding (MoU) is applicable to the NOWPAP region. An agreement was reached at this meeting to develop a combined Oil and HNS spill contingency plan by adding HNS specific issues to the existing NOWPAP Regional Oil Spill Contingency Plan instead of developing an independent regional HNS spill contingency plan. The texts of the revised draft "NOWPAP Regional Oil and HNS Spill Contingency Plan and its Associated MoU" were developed at the meeting and drafts will be submitted for further consideration at the 10th NOWPAP MERRAC Focal Points Meeting in May 2007. NOWPAP countries will in the future jointly establish effective regional cooperative measures on marine pollution to prepare and be ready to respond to HNS spills by establishing the HNS NOWPAP Regional Contingency Plan.

Increased regional capacity to deal with HNS spills in the NOWPAP region requires 1) increasing the national response capacities of NOWPAP countries, 2) finalizing the NOWPAP Regional Oil and HNS Spill Contingency Plan and its MoU, 3) carrying out technical cooperation, 4) launching a regional HNS related education and training, and 5) increasing the capability of MERRAC to implement regional cooperative activities on HNS spill preparedness and response in the NOWPAP region. IMO, UNEP and other international organizations need to support this initiative.

5.4. Marine Invasive Species

Today more than 80% of all commodities are shipped by sea. Modern maritime practices require ballast regulation to balance and stabilize empty ships and to safely and efficiently sail. Up to 1010 tons of ballast water is annually produced. It is estimated that ballast tanks move at least 7,000 different species around the world (Zvyagintsev, Guk, 2006). Although less than 3% of these aquatic organisms survive in new environments upon discharge, introduced survived organisms have the capacity to destroy the habitat of native species and the marine environment and they raise economic and ecological concerns.

The IMO has identified the introduction of invasive marine species into new environments via ballast water or on ship hulls as one of the four greatest threats to the world's oceans. The other three threats are land-based sources of marine pollution, over harvest of biologic marine resources and physical alteration / destruction of marine habitat.

The United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, in its Agenda 21, recognized the seriousness of the problem and called on the IMO and other international bodies to take action to address the transfer of harmful ship transported organisms. The World Summit on Sustainable Development in Johannesburg in 2002 affirmed its commitment to Agenda 21 and called for accelerating the finalization and introduction of the IMO Ballast Convention. The WHO is also paying attention to ballast water as a possible way for harmful diseases to spread.

The harmful effect of introduced species is very difficult to predict ("ecological roulette" - Carlton and Geller, 1993). Most marine species carried in ballast water do not survive the journey. For those species that do survive the voyage, dealing with predation by and/or competition from native species further reduces survival in new environments. When introduced species are reproductively successful in a new environment, however, they may out compete native species and become dominant.

Most introductions are harmless. However, there are well known problems, such as *Dreissena polymorpha* introduced into the Great Lakes from the Dnipro-Bug estuary; it annually causes 500 million USD in economic losses by clogging cooling systems. The introduction in the 1980s of the North-

American species *Mnemiopsis leidyi* into the Black Sea causes 240 million USD in economic losses to fisheries. Another example is the crash of shellfish aquaculture in New Zealand following a bloom of introduced plankton species. These cases demonstrate how serious is the invasive specie issue. Unlike other forms of marine pollution such as oil spills, where there are actions that can be taken to restore the environment, the impacts of invasive marine species are most often irreversible. World wide annual economic loss from bioinvasions and introduced species is estimated at 10 billion USD (IMO Bulletin, 1998).

The semi-enclosed seas of the NOWPAP region face serious ballast water pollution problems. Damage from invasive species in the NOWPAP region is not well documented. Though sources are unidentified, ballast water discharge could become a leading source of aquatic bioinvasion. Invasive species in the NOWPAP marine area might increase as tanker traffic and ballast water volume increase. The UNEP/GEF/IMO project GloBallast has a demonstration project in Dalian China where four alien species have been registered. Russian research has identified 17 introduced species in Peter the Great Bay in the northwestern part of NOWPAP marine area A (Zvyagintsev, Guk, 2006).

The dramatic increase in marine vessel traffic using large tonnage ships is the main reason for the region's bioinvasions. All introduced species in Peter the Great Bay were first registered as invasive species in Japan (Zvyagintsev, Guk, 2006). Large ascidia *Molgula manhattensis* recently entered ports in Vladivostok and possibly pose a future threat to aquaculture. A related species, ascidia *Ciona intestinalis*, was introduced and has seriously disrupted shellfish aquaculture in Canada (Carver et al., 2003). Recently this species was discovered in Peter the Great Bay. Barnacles and polychaete worms are other species that could possibly enter the NOWPAP marine area (Zvyagintsev, Guk, 2006). Barnacles are resistant to antifouling coatings and poisons and can seriously affect vessels. Some polychaete worms can adapt and reach very high population densities, completely changing benthos community structure.

There are several approaches to reducing ballast water bioinvasions. The most practical and widely used method is to dump ballast water off shore (50-200 miles at depth beyond 2000 m) and to treat ballast water onboard. The former method is not entirely safe. The latter method is expensive, although the IMO has developed several treatment methods, including physical (heating, ultrasonication, UV-irradiation), mechanical (filtration, special coating of tanks), chemical (ozonizing, chlorination, biocides), and biological (adding parasites or predators) treatment. Each treatment method has its limitations and disadvantages, some are very serious, and all are in a testing phase. For the time being, offshore discharge of ballast water continues to be the favored alternative.

There is a biological basis for off shore dumping. Off shore waters have fewer ecotopes and the chance of survival for an introduced species is less than in coastal areas. Ballast water should be dumped in the daytime since at night surface water has more plankters. Eutrophication and decreased salinity are factors enhancing the risk of bioinvasions.

Besides possible damage to the population structure of indigenous species, disturbance of aquaculture and fisheries and shipping hazards, an additional significant feature of invasive species is the fouling the hydro equipment cooling systems. The volume of sea water used to cool land-based enterprises and power plants is very significant and amounts to thousands and millions cubic meters per minute. In such situation even minor obstacle for the water flow from mollusk, ascidian and other colonial species fouling causes significant economic loss. Japanese specialists have proposed various methods to address this problem (Kiyono, 2003). Russia has also suggested methods to address the fouling of power station cooling systems by mussels, including hot water pipe processing (40-45^{O}C). Given proper time and regime choices, this is a very effective procedure against mussel fouling. Environmental effects should also be considered. Thermal pollution can damage phyto- and zooplankton, and juvenile fish. The use of chemicals to clean pipes increases the risk of damage. The warming of coastal waters near outputs of cooling systems assists invasive species from the subtropics to acclimatize (Zvyagintsev, Guk, 2006).

IMO is the main driver of measures to fight marine invasive species. NOWPAP should join this activity, at least by collecting and exchanging information. This is an urgent priority given increasing oil tanker traffic between NOWPAP countries and the construction of new, large volume oil ports in the northwestern part of NOWPAP marine area A.

NOWPAP members have been developing response techniques that implement the IMO Ballast Convention. Relating regulations within the framework of the Convention's guidelines are under consideration. China has reported the seriousness of invasive species and pathogens by ship's ballast water to the Global Ballast Water Management Programmes (IMO GloBallast Programme). China has improved communication, education and awareness of ballast water problems through the Program. The Chinese government is developing programs such as new ship design for ballast water management, ballast water controlling techniques, pre-ballast load measures, management plan for specific types of ballast water, and information services on harmful algal bloom. China is examining domestic laws and regulations on ship ballast water and sediments to update and approve them at ministerial levels.

The Japanese government has also been developing ballast water treatment techniques to meet IMO Ballast Convention conditions. Japan has enforced relevant laws to prevent invasive species since 2005. Scientific research on domestic and international routes of invasive species at sea has been conducted to raise general public awareness.

The Korean government has developed measures to control ballast discharge and is collecting information on port characteristics: environment, organisms, ship arrival and departure. The Korean government introduced legislation to comply with international conventions relevant to ballast water discharge and has developed scientific programs to implement the conventions. The aim is to manage exotic species and evaluate systems to render them harmless and to monitor port activities.

It is necessary to develop detailed regional management in cooperation with all NOWPAP members: ballast water exchange, risk assessment, specific requirements, technical assistance and information exchange to control the amount of aquatic organisms in ballast water, this to comply with the convention. The IMO Convention, for instance, requires that ballast water be released at least 200 nautical miles from the nearest land and in water at least 200 m deep (Regulation B-4). It might be difficult to find such an area within NOWPAP region given regional geographic condition.

So designated ballast water release areas should be designated in consultation with the NOWPAP members.

The Convention also grants exemptions to ballast water exchange or treatment requirements (Regulation A-4) when, for instance, it is assessed that a regional sea has the same ecological environment and the migrating species pose no threat. This, however, is a matter that should be implemented based upon IMO risk assessment guidelines. Based on results of the ballast water risk assessment carried out in Dalian, the Globallast demonstration site is replicating an exotic species test for the NOWPAP region. Given that the 10th NOWPAP Intergovernmental Meeting (Toyama, Japan, November 2005) agreed to expand the MERRAC activities to cover ballast water issues as well as other ship related pollution, further regional cooperative efforts against ballast water can be jointly and efficiently developed within the framework of the NOWPAP MERRAC.

5.5. Other Issues related to Land-Based Pollution Sources

The UNEP Global Programme of Action for the Protection of the Marine Environment from Land-Based activities (GPA) has been in place since 1995. The Programme's key objective is to prevent and reduce marine degradation from land-based sources. GPA initially defines nine land-based threats to the marine environment: 1) sewage, 2) persistent organic pollutants (POPs), 3) radioactive substances, 4) heavy metals, 5) oils, 6) nutrients, 7) sediment mobilization, 8) marine litter and 9) the physical alteration and destruction of habitats. Many of these issues have already been discussed in this review.

Nuclear power plants in Japan and Korea serve as the basis for concern with radioactive substances in the NOWPAP region. Another concern is with accidents in the Russian nuclear fleet. Available data are limited, but joint research cruises with Japanese and Russian scientists demonstrate that NOWPAP marine area A does have normal background levels of radioactive substances. Recently additional concern is arisen connected with nuclear activities of DPRK.

Physical alteration and destruction of coastal habitats (PADH) is a serious issue in all NOWPAP countries. The key threats to important habitats are different in each NOWPAP country. In Russia there are fires, poaching, poor infrastructure and unplanned recreation. In China it is farming (loss of wetlands), timber harvest (limited since 1998), reforestation in single species, monoculture plantations, urbanization and suburbanization. In Korea and Japan the concerns are with coastal land reclamation and landfilling for industrial purposes and construction.

Both marine and freshwater habitats in China and Korea are under serious pressure from human activities such as urbanization and agricultural expansion. Demographic and development pressures are obviously the common drivers.

New and emerging environmental issues

have recently been recognized in the NOWAP region. These include climate change and electronic waste (e-waste).

Climate change impacts on the coastal zones include accelerated sea level rise and more frequent typhoons with more severe damage due to loss of the coastal ecosystems buffering wave impact. Some coastal cities like Tianjin, Shanghai and Tokyo could be affected by a rise in sea levels, changes in hydrographic regimes, salt-water intrusion and land loss. Temperature increases could also lead to increased eutrophication in wetlands and freshwater supplies, and in the coastal sea waters as well.

In 2004, the number of obsolete computers was estimated at 100 million (Hilty, 2005). Each computer contains valuable materials, including up to 4 g of gold that can be recycled. In some NOWPAP countries, namely China and Russia, e-waste is disposed of or recycled without proper controls. E-waste contains more than 1,000 of different substances, many of which are toxic, such as Pb, Hg, As, Cd, Se, hexavalent chromium, and flame retardants that emit dioxins when burned. So hand-made recycling of old computers and mobile phones in the some places in China will have predictable negative impacts on the environment and human health. The uncontrolled disposal of e-waste in Russia is not environmentally friendly also.

An important issue not directly mentioned in the GPA is dams influencing the marine environment. The most obvious consequence of dam construction is a reduction in the discharge of suspended solids. In many cases water discharge also decreases. The complex links between man made dams and marine ecosystems and the resultant hydraulic alterations and eutrophication have been studied (Ittekot et al., 2000). Stagnant water bodies generated by dams let freshwater plankton take up dissolved silicate and sink to the sediment. Consequently, the flow of dissolved silica to the seas decreases and non-diatom algal species (non-siliceous and potentially harmful dinoflagellates, first of all) increase in place of diatoms (siliceous and forming the basis of the healthy marine ecosystem) in the coastal seas downstream. The anthropogenic additional input of nitrogen aggravates the situation.

5.6. Aquaculture, Microbiological Pollution, Biodiversity, Protected Areas

The distribution of aquaculture enterprises in the NOWPAP region is very uneven. In Russia aquaculture is less developed compared with other NOWPAP countries due to relatively low population and small demand of seafood, though operations are expanding. Environmental issues associated with aquaculture are divided into two groups: 1) impact on aquaculture, and 2) impact of aquaculture enterprises on coastal habitats. In Russia, and partly in Japan, the former is the key aquaculture / environmental issue: typhoons, HABs, and diseases cause the damage to the aquaculture. In Korea and especially in China the influence on aquaculture also occurs, but due to the high level of activity, it is aquaculture that has an equally serious environmental impact. This is habitat loss, damage to indigenous species, risk of bioinvasion, contamination of water and bottom sediments by nutriment/excreta, and finally damage to the aquaculture species themselves.

Microbiological pollution is mainly associated with summer swimming and limited to local summer swimming areas. Korea's rivers are reported to have microbiological problems (UNEP GIWA, 2002). Microbiological pollution is closely related to wastewater discharge via rivers or directly.

The biodiversity conservation concern is related to the continued loss of coastal habitats due to land reclamation for construction. Unlike pollution problems, which can be resolved through legislation and funding, habitat loss is irreversible as the population and economy grows. Creation and support of a broad network of protected areas is a key to protecting biodiversity in such heavily populated region as NOWPAP.

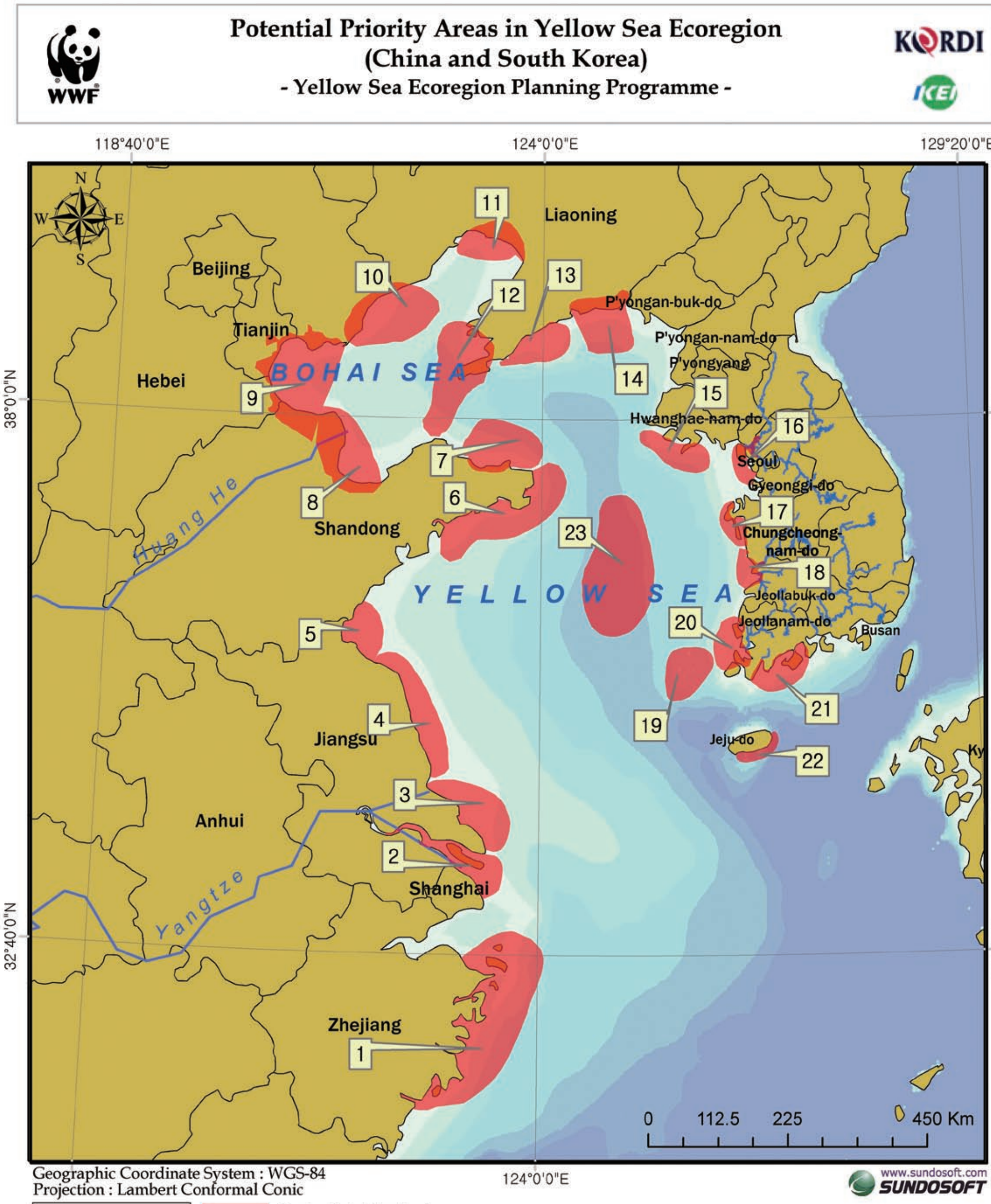
The percentage of wildlife protected areas in the NOWPAP region is as follows: China from 5.1 to 9.7% in different provinces; Japan – 14.9%; Korea – 7%; Russia – 8.1%. A number of national parks have been established along the coast, including: Peter the Great Bay Marine National Park (Russia); Rishiri-Rebun-Sarobetsu National Park, Daisen-Oki National Park and Sanin-Kaigan National Park (Japan); and Tadohae Marine National Park, Taean Seashore National Park and Hallyo-Haesang National Park (Korea).

Recently WWF in cooperation with Korean researchers from KORDI and KEI made valuable attempt to define list of 23 areas (Fig 15) within Yellow Sea region (NOWPAP marine area B) for the primary protection of endangered species of birds, fish, mollusks, plants and algae (WWF et al., 2006). Each area has own list of endangered species for the future protection.

This list could be a basis for discussion about support of existing and establishment of additional protected areas in the future, because for the time being the coverage of proposed protected areas looks too wide and their boundaries too undefined (Table 16, Fig. 15).

Table 16. Priority area for the biodiversity protection in the Yellow Sea and Bohai Sea (WWF et al., 2006)

#	Name of Area	#	Name of Area	#	Name of Area	#	Name of Area
1	Zhoushan Archipelago	7	Yanwei	13	Changshandao Island	19	Huksando Island Island
2	Yangtse Estuary Wetland	8	Huanghe-Leizhouwan	14	Yalujiang Estuary	20	Yeongsangang Estuary
3	S. Jiangsu Coast	9	Bohaiwan	15	Baengnyeong – Yeonpyeong Is.	21	Boseong-Yeoja Bays
4	N Jiangsu Coast	10	Qinghuangdao	16	Gyeonggi Bay	22	Jeju Island
5	Haizhou Bay	11	Liaohe Estuary	17	Cheonsu Bay	23	Yellow Sea Cold Water
6	Qing-Shi	12	Haiyangdao – Changxing Is.	18	Geum-Mangyeon Dongjun Estuaries		



Bathymetry

- Under 200m
- 200m - 100m
- 100m - 90m
- 90m - 70m
- 70m - 50m
- 50m - 30m
- 30m - 10m
- 10m - 0m

Potential Priority Area

No	Area Name of PPAs	No	Area Name of PPAs	No	Area Name of PPAs	No	Area Name of PPAs
1	Zhoushan Archipelago	7	Yanwei	13	Changshandao Islands	19	Huksando Island
2	Wetland in Yangzte Estuary	8	Huanghe-Laizhouwan	14	Yalujiang Estuary	20	Yeongsangang Estuary
3	Southern Jiangsu Coast	9	Bohaiwan	15	Baengnyeongdo-Yeonpyeongdo Islands	21	Boseong-Yeoja Bays
4	Northern Jiangsu Coast	10	Qinghuangdao	16	Gyeonggi Bay	22	Jejudo Island
5	Haizhou Bay	11	Liaohe River Estuary	17	Cheonsu Bay	23	Yellow Sea Cold Water Mass
6	Qing-Shi	12	Haiyangdao - Changxing Islands	18	Geumgang-Mangyeongang-Dongjingang Estuaries		

Fig 15

6. Assessment and Recommendations

6.1. Summary of Current Conditions

A summary of environmental conditions across the entire NOWPAP marine area is very difficult to compile given the varied nature of the countries and their environmental problems. According to the GPA Overview (UNEP/GPA, 2006), coastal and marine water pollution has generally increased in East Asia, including the southern part of the NOWPAP region, throughout the 1995-2005 period. The main causes are domestic and industrial effluent discharges, atmospheric deposition, oil spills, wastes and contaminants from shipping. Sand/silt, nutrients, toxic chemicals, and oil also come from land-based sources.

Key environmental impacts affecting marine and coastal areas in the NOWPAP region include land-based sources (LBS) of pollution, oil spills, coastal modification, including land reclamation, and over exploitation of biologic resources. LBS include direct discharge of domestic sewage and industrial effluents from major cities and industrial complexes into marine environments as well as river and atmospheric inputs.

Coastal water eutrophication and the occurrence of harmful algal blooms are geographically limited but are most frequently reported in the southern part of the NOWPAP marine area: off the southern coast of the Korean Peninsula, and particularly in Chinhae and Masan Bays. Eutrophication has declined in coastal waters where there have been substantial reductions in nutrient inputs (UNEP GIWA, 2002).

Oil spills of varying magnitude have been reported in most countries in the region, both land-based and tanker spills. Increased tanker traffic creates substantial risk that accidental spills will occur and so an oil spill preparedness and response are essential. There have also been chemical spills in the region, and specialized preparedness and response plan on the HNS issue is needed.

Marine and coastal waters along the eastern Korean Peninsula are subject to wastewater discharge from coastal settlements and industries (UNEP GIWA 2002). The Nakdong delta, which is experiencing habitat degradation and severe pollution, is an important bird resting and feeding area. Russian Peter the Great Bay suffers from severe contamination originating from sewage discharges from Vladivostok. Beside local but contrasting pollution by the mining waste waters is observed at the some coastal areas of Primorsky Krai. Pollution sources in the western Yellow Sea include industrial wastewater from Qingdao, Dalian, and Lianyungang port cities, oil discharged from vessels and ports, and oil and oily mixtures from oil exploration. The eastern Yellow Sea is badly polluted in the shallow inlets of its southern coastline where the many islands prevent mixing with open ocean water. There are also regular red tides (NOWPAP CEARAC, 2005).

Four priority problems were recently identified by the GPA (www.unep.gpa. IGR2006): 1) sewage and management of municipal wastewater, 2) nutrient over-enrichment, 3) marine litter and 4) physical alteration and destruction of habitats. These problems have been designated as an area for priority attention in most regions and are the subject of novel approaches.

Six emerging challenges deserve special attention, according to the GPA (UNEP/GPA, 2006): 1) over-enriched nutrients in coastal dead zones, 2) depleted freshwater flow, 3) importance of coastal and freshwater wetlands, 4) abundant stream of new chemicals, 5) importance of resilient coastal habitats for coastal protection, and 6) sea level rise.

6.2. Recommendations on Emerging Issues

6.2.1. Integrated Coastal Area and River Management (ICARM)

There is a clear contradiction between population growth and intensifying resource use in coastal zones and the need to protect these valuable areas for future generations. The complexity of the link between natural and socio-economic processes have been appreciated for more than 15 years, with Integrated Coastal Area Management (ICAM) proposed as an appropriate managerial strategy to account for population growth, urbanization trends, consumption patterns, waste generation and the use of available resources. Managers realize that freshwater flow into coastal areas exerts heavy impacts on coastal environments and on the welfare of the people living in those areas. The physical and socio-economic relationship between river basins and their corresponding coastal areas also forms the basis for an integrated approach to sustainable development. This new approach is called Integrated Coastal Area and River Basin Management (ICARM). The priorities in this management approach are capacity building, coastal land-use planning, river basin development and resource management, legislation, enforcement, coastal and shoreline protection and conservation.

River basin management has traditionally focused on water supply only. Now it is evident that river basins must be managed in an integrated way. Unlike river basins, coastal management has long combined two features: marine resource management and land-use planning. But numerous conflicts arise given intensive use of coasts. As with river basins, it is now recognized that sustainable development relies upon integrated coastal management. Changes in upstream land and resource use have impacts on downstream areas. Conflicting demands on natural resources and on land uses require a comprehensive approach that accounts for a wide range of interests.

ICARM requires establishment of governance mechanisms that recognize the links between sustainable use and environmental protection and socio-economic development. ICARM follows a sustainable development paradigm in which environmental protection is as equally important as economic efficiency and social equity.

A pro-active approach is necessary when establishing an integrated management system for river basins and coastal zones. Planning takes on a special role in establishing a process of governance and a strategic framework of goals, policies and actions. Strategy formulation within the context of ICARM depends on case study parameters and on broader regional and national conditions. Strategy formulation often needs to address issues that have an impact on the management of a river basin or coastal area but that fall outside the authority of those who are participating in the process.

There are two prerequisites in implementing plans based on ICARM:

- Plans need to have a legal status that will assure successful implementation; and
- Plans must be realistic.

This means having sensible policies and actions that address the problem, local government capacity, necessary human and financial resources, and adequate technical support.

The expected outcome of the ICARM approach is an optimization of human activities to reduce potential environmental conflicts. This can be achieved by recognizing key links between coastal areas and river basin systems (both natural processes and human activities), and by identifying proper decision-making processes.

These or similar approaches will be used by NOWPAP POMRAC when the ICARM activities will be started in late 2007.

6.6.2. Data and Information Management

Timely data and information exchange plays an extremely important role in regional environmental issues. All national, regional and international initiatives and programs contain parts describing data and information management needs and they recognize information exchange as a key program objective. NOWPAP is no exception. One of key objective of NOWPAP POMRAC is to «create an efficient information base". The creation and support of reference data base on the published materials on HAB issues is a significant and undoubtedly useful outcome of NOWPAP CEARAC. Other RACs also note similar information related issues. The Data and Informational Network Activity Center (DINRAC) is a specialized RAC that deals with information management issues.

NOWPAP has developed the following data and information management resources:

- Data bases created by DINRAC (http://dinrac.nowpap.org)
- HAB reference data base (*http://cearac.nowpap.org*)
- Remote sensing portal site (*http://cearac.nowpap.org*)
- Data bases created by MERRAC (http://merrac.nowpap.org)

POMRAC also compiled a reference data base on river input and atmospheric deposition for the DINRAC website.

Other international programs to collect and manage data include the Global Ocean Observation System (GOOS). Its regional component for the Northeast Asia (NEAR-GOOS) shares oceanographic data and ocean health information.

Efforts to improve data and information exchange should be continued by NOWPAP RACs and the RCU in close cooperation with relevant regional organizations and projects.

6.2.3. Policy and Legislation

Environmentally sound policy actions should be a final goal of such result-oriented program as NOWPAP. It is clear also that consistent actions are possible within the proper legislation framework only. Therefore legislative aspects should be taken into account both at the initial stage of projects/programs during analysis of problems and especially at the final stage during development of policy action plan.

Each NOWPAP country has its own laws to deal with environmental problems. Some of these laws are presented in the National Reports as well as in the Regional Overviews which have been published by NOWPAP POMRAC. The updated "Overview of National Environmental Legislation, Objectives, Strategies and Policies" is under publication by NOWPAP DINRAC in 2007. This overview is a necessary precursor to any suggestion on the amendments and harmonization of legislative issues.

The public relations issue is another aspect of environmentally sound policy actions. This is very diverse activity including public awareness, educational campaigns the proper and timely informing of local communities, NGOs and general public on the different aspects of environmental problems. The necessity and importance of this activity is obvious, because inappropriate behavior of people in their everyday life is a key reason of many environmental issues, for example marine litter. The protection of biodiversity is also impossible without appreciation of the majority of local population.

The future activities of NOWPAP RACs in this field might include the further analysis of the features of environmental legislation in the NOWPAP countries for the subsequent discussion of possible harmonization. The different public oriented actions like public awareness through brochures, newspapers or newsletters, web-sites, clean-up campaigns (within MALITA) should be also in the focus of attention of NOWPAP RACs and RCU.

6.2.4. Biodiversity Conservation

Despite a rather well developed network of wildlife protected areas, the number of endangered species continues to increase and the reasons of this deterioration are not fully understood. The following actions should be taken:

- Determine routes of migratory species, primarily in border seawater areas;
- Develop the environmental and economic rationale for a framework to ensure conservation and recovery of native biodiversity in coastal ecosystems;
- Identify and analyze undesirable environmental management systems;
- Optimize the structure and management of national protected areas;
- Discuss the possibility to establish additional protected areas;
- Improve environmental laws/ regulations.

6.2.5. Invasive Species

The appearance and acclimatization of invasive species in NOWPAP marine areas is unavoidable given the increase in shipping with associated ballast water and fouling issues. Projects to transport oil from the northern part of NOWPAP sea area A through the Pacific will not improve the situation. The activities which could be recommended for the NOWPAP region to deal with this problem are as follows:

- Support and enforce the implementation of the GloBallast Convention including the establishment of additional demonstration sites in the place (places) of large port construction in near future;
- Develop the comprehensive monitoring system of invasive plankton and especially fouling communities in the “risk” areas;

- Support development and implementation of the effective and environmentally safe methods of the ballast waters treatment;

- Support the exchange of information on the situation at the ballast water release areas, and on the achievements in the environmentally friendly treatment of ballast and antifouling methods.

6.2.6. Additional Recommendations (from GIWA, GPA, YSLME, and PICES)

NOWPAP is not the only regional organization in the northwestern Pacific dealing with environmental issues. The following are the conclusions and recommendations from several related projects and organizations. These outcomes might be taken into account while planning and implementing future NOWPAP activities in order to protect the marine and coastal environment in the Northwest Pacific Ocean.

The goal of **GIWA** (Global International Water Assessment) project is to assess all major water basins in the world using a unified ranking system. A unified ranking system is based on five key water concerns: 1) water shortage; 2) pollution; 3) habitat and community modification; 4) unsustainable exploitation of fisheries and other living resources; and 5) global changes. Each concern has subsections. For example, global changes include changes in hydrological cycles and ocean circulation, sea level change, increased UV-B radiation, changes in ocean CO2 source/sink functions. Pollution concerns include air pollution, water pollution, eutrophication, microbiological pollution, chemical pollution, oil spills, thermal pollution. The GIWA procedure consists of expert evaluation of each concern followed by a ranking, root-cause analysis and policy option analysis.

Unfortunately, a GIWA analysis for all NOWPAP areas was not conducted in full. Some preliminary assessments were done for NOWPAP marine area A. The GIWA assessment for NOWPAP marine area B (Yellow Sea and Bohai Sea) is published already (http://www.giwa.net).

GIWA experts identified the following problems in NOWPAP marine area A: pollution, namely local eutrophication, and unsustainable harvesting of living resources, namely over-exploitation and destructive fishing practices. The immediate causes of pollution (eutrophication) were given as an increased input of nutrients, growth of aquaculture pressure, reduction in the reproduction level and changes in the population structure.

The main root causes are the following:

- Economic (rush for super-profits and population growth);

- Technologic (inefficient waste treatment); and

- Legislative (ineffective policy at the regional, national and international levels).

The immediate causes for over harvesting are intensified fishing, reduction in reproduction levels, changes in the population structure, and excess fishing fleets. The root causes of overexploitation of fishing resources are divided into economic, legislative, managerial, technological and educational. Economic causes are connected with a rush for high profits, poor taxation and customs systems. Policy concerns are failure to comply with national regulatory systems and ineffective international cooperation. Managerial concerns include 1) an absence of effective management and control for fishing in national economic zones and 2) illegal fisheries. Poor public environmental awareness and ineffective monitoring of marine resource conditions are educational concerns.

GIWA experts describe the Yellow Sea, NOWPAP marine area B, separately.

The following concerns are given for the Yellow Sea: 1) regional freshwater shortages, 2) habitat and community modification, and 3) over harvesting and destructive fishing practices.

The immediate causes of freshwater shortage are increased irrigation, industrial and domestic water use as well as upstream damming and draining for flood control and increased agricultural activities. Another cause is river pollution by industrial, agriculture and domestic waste. The main threat to regional coastal habitats is intensive coastal development and land reclamation, especially in estuaries and shallow bays.

Root causes are demographic (rapid population growth), technologic (inefficient irrigation), economic (rapid industrial growth resulting in increased water use and waste release), educational (excessive use of fertilizers and pesticides) and legislative (inadequate regulation of waste discharge and fertilizer/pesticides use).

The policy options for freshwater shortage include:

- Integrate development and management of agricultural irrigation systems with integrated river basin management programs;
- Adopt and promote water-saving technologies;
- Promote market systems to encourage the use of green technologies in the industry;
- Enhance laws and enforcement mechanisms related to pollution prevention;
- Adopt laws and enforce mechanisms to control the use and disposal of fertilizers and pesticides; Adopt educational and public awareness campaigns for good agricultural practices and improving soil fertility.

The policy options for habitat and community modification include:

- Adopt laws and enforcement mechanisms to restrict the population migration;
- Develop small, rural-oriented urban centers; and

- Adopt laws and enforcement mechanisms to promote good practices in agriculture that decrease the discharge of agricultural run-off high of harmful pollutants.

A third key concern for the Yellow Sea is the unsustainable harvesting of biologic resources, specifically, overexploitation and destructive fishing practices. Immediate causes include: 1) introduction of new, improved and more efficient fishing technologies and larger fishing fleets resulting in over harvest, 2) bottom trawling along coastal waters, and 3) use of pesticides and dynamite for fishing.

Demographic issues are population growth and food demand. Economic root causes include the profit motive in fishing, disregarding environmental consequences, market demand for seafood. Technological roots are easy access to improved fishing technologies and affordable fishing boast. The education root cause is a lack of public awareness of the consequences of destructive practices.

Policy options to stem overexploitation and destructive fishing practices include:

- Enhance laws and enforcement mechanisms to limit the size of fishing fleets;

- Adopt alternative livelihood programs for fishermen and other fisheries operators;

- Adopt public awareness and education programs on the environmental and social consequences of overexploitation.

- Adopt sustainable production practices to enhance fisheries and aquaculture production; and

- Enhance law enforcement mechanisms to restrict destructive fishing practices, including public campaigns on environmental and the social consequences of overexploitation.

* * * * *

The **GPA** assessment recommends a holistic and comprehensive approach to marine pollution management. The approach should define practical technologies for different users and integrate waste minimization and recycling to control water pollution. This should be supported by improved institutional, legal, and regulatory frameworks that promote a division of labor among stakeholders, including different levels of government and the private sector. The initiative should enhance capacities, find effective and viable investment and cost recovery instruments, and create political and public support for urban pollution management. There is, however, a need to intensify efforts to develop regional capacities in terms of expertise, equipment manufacture, processing technology guidelines, design, construction, installation, operation, and maintenance of waste treatment, disposal and pollution reducing facilities.

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YSMLE is UNDP/GEF project entitled "Reducing Environmental Stress in the Yellow Sea Marine Large Ecosystem Sea Marine Large Ecosystem" has been started in

2005. The geographical scope of this project is practically equal to the NOWPAP sea area “B”. Transboundary Diagnostic Analysis (TDA) has been prepared within this project during 2006, and has been published in 2007 (UNDP/GEF, 2007). According to this TDA, there are two recommendations for national authorities:

- Need to improve the legislation and associated regulations aimed to enhance marine and coastal environment protection. The discussion of bilateral (China – Korea) agreement to cooperate in the enhancement of environmental legislation is proposed for this purpose;
- Discuss and consider the agreement to improve the compliance with laws and regulations, because non-compliance with legal provisions is a root cause of many environmental problems in the marine fisheries sectors and in other sectors as well.

Recommendations which could be to local authorities include:

- Introduce steadily additional buffer zones between agriculture enterprises and water bodies, because considerable amount of nutrients, pesticides, animal sewage are derived from agriculture activities, and prevention of this run-off will reduce the pollution significantly;
- Apply the procedure of environmental impact assessments (EIA) as obligatory stage before the endorsement of any new developments in coastal areas.

Beside these recommendations YSLME TDA has outlined several “technical” actions which could help to decrease the stress on the Yellow Sea:

- To make a stronger commitment to improving solid waste management as a way to reduce the input of submerged and floating solids into the marine environment;
- To harmonize the marine biological resource management through the harmonization of fish stock assessment techniques;
- To apply more wider the polyculture approach taking into account local hydrodynamic features to the mariculture enterprises for the minimization of adverse effects such as siltation of bottom sediments and cultivated organisms deceases;
- To carry out the assessment of assimilative capacity of the different coastal areas and Yellow Sea as a whole for the proper determination of additional input of potentially harmful substance leading to the serious adverse effects. The knowledge of assimilative capacity will allow to define the locations and rates of contaminants discharge and the restrictions on the scale of mariculture activities;
- To adopt the already compiled list of areas, animals and plants worthy to protect from the biodiversity point of view, and to develop the practical ways for such protection.

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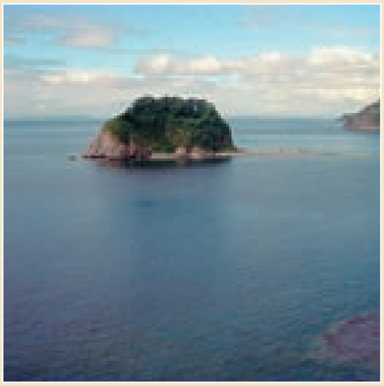
PICES is another large, multidisciplinary intergovernmental organization that covers, in addition to the NOWPAP region, the west coast of North America, the Bering Sea and the Sea of Okhotsk.

The following priority issues for NOWPAP marine area "A" were reported in a 2004 PICES overview entitled the "Marine Ecosystem of the North Pacific":

- Need to continue monitoring the physical and chemical features of this very seasonally changeable basin to better understand major variables;
- Need to expand research on the synthesis of remote sensing of chlorophyll with information on the plankton communities; and
- Increase in harmful red tides events, and in particular, Cochlodinium polykricoides events.

PICES identified the following priority issues for the NOWPAP marine area "B" (Yellow Sea):

- Need to establish an observation system for continuous, time-series ecosystem evaluation;
- Need to comprehensively assess the impact of aquaculture on marine ecosystems;
- Serious damage to the biodiversity of coastal habitats as a result of land reclamation; and
- Harmonize monitoring activity, including methodological aspects, to achieve basin-wide assessments.



References

Adachi Y. (2006). Overview of marine litter problems and measures in Japan. Proceedings of The 1st NOWPAP Workshop on Marine Litter. Incheon, Korea, p.129-140.

Araki, S., Kurono, K., Kanai, M., Sakurai, T., Doi, T., Tanaka, A., Ishiwatari, R., Suzuki, N., Sakai, S., Nakasugi, O., Morita, M (2000) Time trends of dioxins in aquatic sediment cores in Japan// Organohalogen Comp., 46: 330-333.

Blinovskaya Y. Y. (2005) Primorsky Kray Shoreline Pollution Monitoring Methods and Results. Abstracts of First International Workshop on Marine Litter in the Northwest Pacific Region, p. 98-104.

Carlton J.T., Geller J.B. (1993). Ecological roulette: the global transport of nonindigenous marine organisms // Science. N 261: 78-82.

Carver C., Chisholm A., and Mallet L. (2003). Strategies to mitigate the impact of Ciona intestinalis (L.) biofouling on shellfish production. J. of Shellfish Res. V. 22, N 3: 621-631.

Chen C.T.A., Bychkov A.S., Wang S.L., Pavlova G.Yu. (1999) An anoxic Sea of Japan by the year 2200? // Mar.Chem. V.67: 249-265

Chester, R., Bradshaw, G.F., Ottley, C.J., Harrison, R.M., Merrett, J., Preston, M.R., Rendell, A.R., Kane, M.M., Jickells, T.D., (1993). The atmospheric distribution of trace metals, trace organics and nitrogen over the North Sea. Philosophical Transactions of the Royal Society A 343,

Choi, J.W., Matsuda, M., Kawano, M., Wakimoto, T., Min, B.Y. (2001). Contamination of PCBs in Nakdong river estuary, Korea.// Toxicol. Environ. Chem. 72, 233–243.

Duce R. A., Liss P. S., Merril J. T., et al. (1991) The atmospheric input of trace species to the world ocean. Global Biogeochemical Cycles. 5, 193-259.

Faris, J and Hart, K. (1994) Seas of Debris: A Summary of the Third International Conference on Marine Debris. Alaska Fisheries Science Center, Seattle. 54 p.

Fujieda S. (2005) Use of disposable lighter as an indicator item to monitor marine debris. Abstracts of First International Workshop on Marine Litter in the Northwest Pacific Region, p. 71-75.

Fujii N. (2005) Activities for Litter Washed Ashore by Japan Coast Guard. Abstracts of First International Workshop on Marine Litter in the Northwest Pacific Region, p. 91-93.

Fujitani R. (2005) Research on Washed-up Driftage on the Coasts of the Northwest Pacific Region. Abstracts of First International Workshop on Marine Litter in the Northwest Pacific Region, p. 145-147.

Gaillardet J., Viers J., Dupre B. (2003). Trace elements in river waters, 225-268. In Surface and Ground Water, Weathering and Soils (ed. J.I.Drever). Vol.5. Treatise on Geochemistry. Elsevier Pergamon, Oxford.

Hilty, L.M. (2005). Electronic waste - an emerging risk? // Environmental Impact Assessment Review, 25: 431-435

Hong G. H., Kim S.-H., Yang D.-B., Lim G. H. (1998). Atmospheric Input of Trace Metals Over the Yellow Sea: Shipboard Results, April 1995. In. (Eds. G.H. Hong, J. Zhang, B.-K. Park). Health of the Yellow Sea. Seoul, p.211-235.

Hong G. H., S. H. Kim, and C. S. Chung (1997). Contamination in the Yellow Sea Proper: a Review.// Ocean Research, Vol. 19, # 1: 55-62.

http://www.giwa.net

http://www.globallst.imo.org

http://www.unep.gpa

Ida M. (2006). Observation for floating plastics in the seas adjacent to Japan and to the western north Pacific by Japan Meteorological Agency. Proceedings of The 1st NOWPAP Workshop on Marine Litter. Incheon, Korea, p.85-90.

IMO Bulletin. (1998). To put an end to invasion of alien organisms as a result of their transportation with ballast water. October 1998. 21 pp.

Ittekot, V., Humborg, C. & Schafer, P. (2000). Hydrological alterations and marine biogeochemistry: a silicate issue, BioScience, 50: 776-782.

Iwata, H., Tanabe, S., Sakai, N., Nishimura, A., Tatsukawa, R. (1994). Geographical distribution of persistent organochlorines in air, water and sediments from Asia and Oceania, and their implications for global redistribution from lower latitudes. // Environmental Pollution, 85:15-33

Kado R. (2003). Invasion of Japanese shores by the NE Pacific barnacle Balanus glandula and its ecological and biogeographical impact // Marine ecology progress series. V. 249: 199-206.

Kim, S.-K. , J.R. Oh, W.J. Shim, D.H. Lee, U.H. Yim, S.H. Hong,Y.B. Shin, D.S. Lee. (2002). Geographical distribution and accumulation features of organochlorine residues in bivalves from coastal areas of South Korea.// Marine Poll. Bull., 45: 268-279.

Kiyono M. (2003).Control of biofouling in power plant cooling water systems – Discussion of practical research targets from a user’s view // Sessile Organisms. V. 20, № 1:11-13.

Kubota M. (2005) Movement and accumulation of floating marine debris simulated by surface currents derived from satellite data. Abstracts of First International Workshop on Marine Litter in the Northwest Pacific Region, p. 57-60.

Leonov A.K. (1960).Regional Oceanography, part I. Gidrometeoizdat.L. 767 p.

Lin C., X. Ning, J. Su, Y. Lin, B. Xu. (2005) Environmental changes and the responses of the ecosystems of the Yellow Sea during 1976–2000.// J. Marine Systems 55: 223– 234

Liu C., Zhang J., Yu Z., Shen Z. (1998) Atmospheric Transport of Heavy Metal to the Yellow Sea. In. (Eds. G.H. Hong, J. Zhang, B.-K. Park). Health of the Yellow Sea. Seoul . p. 193-209

Long E.R., MacDonald D.D., Smith S.L. and Calder F.D. (1995). Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments.// Environ. Management. 19: 81-97.

Ma.M, Feng Z., Guan C., Ma Y., Xu H., Li H. (2001). DDT, PAH and PSB in Sediments from the intertidal zone of the Bohai Sea and Yellow Sea.// Mar.Poll.Bull. 42, 2: 132-136.

Marine Ecosystems of the North Pacific. (2004). PICES Special Publication 1, 280 p.

Migon C., Journel B., Nicolas E. (1997). Measurement of trace metal wet, dry and total atmospheric fluxes over the Ligurian Sea. // Atmos. Environ., 31(6): 889-896.

Minami H., Kano. Y., Ogawa K. (1999). Long-term variations of potential temperature and dissolved oxygen of the Japan Sea proper water.// J.Oceanogr., V. 55: 197-205.

Moller, T.H. (2002), Assessment of the risk of oil spills and the state of preparedness in the regional seas areas, In: IMO/UNEP Forum on regional arrangements for co-operation in combating marine pollution incidents, London, 30 September-2 October, IMO & UNEP, 31-35.

Monirith I., D.Ueno, S.Takahashi, H.Nakata, A.Sudaryanto, A.Subramanian, A.Ismail, M. Muchtar, J.Zheng, B.J. Richardson, M.Prudente, N.D.Hue, T.S.Tana, A.V. Tkalin, S.Tanabe. (2003). Asia-Pacific mussel watch: monitoring contamination of persistent organochlorine compounds in coastal waters of Asian countries.// Mar.Poll.Bull. 46: 281-300.

NOWPAP CEARAC (2005) Integrated Report on Harmful Algal Blooms (HABs) for the NOWPAP Region.

NOWPAP POMRAC (2006). Regional Overview on River and Direct Inputs of Contaminants into the Marine and Coastal Environment in NOWPAP Region. 60 p.

Okuda, K., Nakada, N., Isobe, T., Nishimura, H., Sanada, Y., Sato, T., Takada, H. (2000) Endocrine disruptors in a sediment core collected from Tokyo Bay – The historical trends during the past 50 years. Bull. Coastal Oceanogr., 37, 97-106.

OSPAR Commission. (2005). Data Report on the Comprehensive Study of Riverine inputs and Direct discharge (RID) in 2003. 201 p.

PICES (2002). Scientific Report # 23. Harmful Algal Blooms in North Pacific.

Proceedings of "International Workshop on Jellyfish Bloom: China, Japan and Korea", Yokohama, Japan, 24 February, 2004.

Shulkin V.M. (2005). Normalization of Estimation of the Influence of River Runoff on Coastal Areas. Doklady Akademii Nauk, 405, 3: 1-4 (in Russian).

Tishchenko P.Ya., L.D.Talley, A.P.Nedashkovsky, S.G.Sagalaev, V.I.Zvolinsky. (2002).Temporal variability of Hydrochemical properties in the Japan Sea.// Okeanologia, 42, #6: 837-847 (in Russian).

Uematsu M., Wang Z., Uno I. (2003). Atmospheric input of mineral dust to the western North Pacific region based direct measurements and a regional chemical transport model.// Geophysical Research Letters, vol. 30, No 6, 1342, doi: 10.1029/2002GL016645.

UNDP/GEF Project **YSLME:** Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem. (2007).Transboundary Diagnostic Analysis. 98 p.

UNEP (1990) **GESAMP**: The state of the marine environment. GESAMP Reports and Studies, No. 39. United Nations Environmental Programme, Nairobi, Kenya.

UNEP (2005).**Teng S.K., Yu H., Tang Y.** et al. Yellow Sea. GIWA Regional assessment 34. Kalmar, Sweden.

UNEP Chemicals/GEF (2002). Regionally based assessment of persistent toxic substances. Switzerland. 112 p.

UNEP/GPA (2006). The State of the Marine Environment: Trends and processes. UNEP/GPA, The Hague.

Wu, Y., Zhang, J., Zhou, Q. (1999). Persistent organochlorine residues in sediments from Chinese river/estuary systems.// Environ. Pollut. 96: 217–226.

WWF, KORDI, KEI. (2006). Potential priority areas for biodiversity conservation of the Yellow Sea ecoregion. March 2006. 4 p. Mimeo.

Yamaguchi H. (2005) A serious Problem of Coastal Contamination by Drifted Garbage in Japan Islands. Abstracts of First International Workshop on Marine Litter in the Northwest Pacific Region, p. 76-90.

Yuan D., D.Yang, T.L.Wade, Y.Qian. (2001). Status of persistent organic pollutants in the sediments from several estuaries in China.// Environ.Poll. 114:101-111.

Zhang C.I. and S.Kim. (1999). Living marine resources of the Yellow Sea ecosystem in Korean waters: status and perspectives. In K.Sherman and Q.Tang (eds.) Large Marine Ecosystems of the Pacific Rim: assessment, sustainability, and management. Blackwell Science. 465 p.

Zhang J., G. S. Zhang, and S. M. Liu. (2005) Dissolved silicate in coastal marine rainwaters: Comparison between the Yellow Sea and the East China Sea on the impact and potential link with primary production.// J. Geophys. Res. V.110, D16304, doi:10.1029/2004JD005411.

Zhang, G., Min, Y.S., Mai,B.X., Sheng G.Y., Fu, J.M., Wang, Z.S. (1999) Time trend of PHCs and DDTs in a sedimentary core in Macao estuary, Southern China.// Mar. Pollut. Bull. 39, 326-330.

Zviagintsev A.Yu., Guk Yu.G. (2006). Estimation of ecological risks arising from bioinvasions in sea coastal ecosystems of Primorsky Krai (with sea fouling and ballast waters as an example).// Izvestia TINRO. 145: c. 3-38 (in Russian).

State of the Marine Environment in the NOWPAP Region

Состояние морской среды в регионе северо-западной Пацифики (NOWPAP)
(на английском языке)

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Ответственный редактор Качур Анатолий Николаевич

Отпечатано с оригинал-макета, подготовленного
Центром защиты дикой природы «Зов тайги»,
минуя редподготовку
Компьютерный дизайн, верстка Л. М. Кабалик
Фото О. О. Кабалика, В.А. Солкина, Г.Н. Шаликова, В.А.Арамилева, А.М.Паничева