# PROTECTION OF OCEANS AND THEIR LIVING RESOURCES - JAPAN

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## Contents



## Summary

Japan is surrounded by the sea. Its coast is quite diversified, with every feature except fjords. Japan is washed by both warm (Kuroshio) and cold (Oyashio) currents, which

brings about biotic enrichment. The Japanese people have enjoyed this richness of living resources since antiquity.

On the other hand, Japan's world-famous economic growth, particularly its postwar achievement, has also resulted in environmental degradation and worsening of the coastal environment, especially in bays and inland seas. These environmental changes have caused severe damage to living resources and fisheries. The worst period is considered to have occurred around 1970, with some slight recovery in the ensuing years. There are many waters, however, still retaining the past damage.

These processes of environmental degradation are traced in more detail in case studies of Tokyo Bay and the Seto Inland Sea, and the effects of such environmental changes on biota and fisheries are also examined.

Finally, future needs in protection of the marine environment are considered. Different viewpoints are shown, as well as the need to consider environmental protection on the basis of specific characteristics of each sea. The necessity of implementing full environmental impact assessments is underlined in the protection of the marine environment, and the importance of marine environmental monitoring is also stressed. Further, the importance of international cooperation is pointed out.



## 1. Introduction

After World War II, Japan made a great effort to restore the economy and succeeded not only in recovering to the prewar level but also in attaining higher economic growth. This miraculous recovery and growth, however, resulted in environmental degradation including Minamata disease and various other *Kogai* * diseases caused by environmental pollutants. *Kogai* is a Japanese word, which literally means 'public nuisance' and it is used to describe environmental degradation. Environmental degradation in Japan reached its peak around 1970. Since the 1970s, regulations have been largely strengthened. As a result, *Kogai* was overcome, although the environmental stresses of the past are still observed in many places. (Words with an asterisk are explained in the glossary.) (See also *Protection and Promotion of Human Health in Japan*).

As for the marine environment, pollution was experienced locally in Japan even before World War II. The main cause was mining waste, particularly heavy metals. Another major cause was domestic and industrial wastes around big cities. Waters such as Tokyo Bay already had serious pollution problems in the mid 1930s due to the development of the Keihin Industrial Zone, which is the largest industrial area in Japan; it is situated along the coasts of Tokyo, Kawasaki, and Yokohama. With the onset and aftermath of the world war, industrial activities were reduced and the population also decreased as a result of movement to suburban or local areas. This tended to help reduce the environmental loads and hasten the recovery of the environment. Postwar economic restoration and further higher economic growth, however, greatly increased the loads to the marine environment and brought about serious *Kogai* problems, particularly in the waters close to industrial and population centers. In 1971 the Environment Agency of Japan was established and environmental regulations were strengthened and

implemented. In this article, the history and current state of the marine environment around Japan will be described, especially after World War II. As background information, some original pictures of the marine environment and its living resources around Japan are described. (This chapter is primarily concerned with Japan and the ministries and agencies mentioned hereinafter are those of Japan, unless specified otherwise.)

## 2. The Marine Environment around Japan

Japan is entirely surrounded by the sea and has a long shoreline of 33 000 km. The Kuroshio* and Oyashio*, warm and cold currents respectively, flow on its Pacific side. Japan has climate zones ranging from subpolar to subtropical. There are various kinds of coastlines including rias, sand, rock, and coral, which means that in Japan, virtually all types of coasts except fjords can be seen. Japan therefore boasts a very diversified environment, and its marine biota is rich.

Such richness is evident in the fishery catches around Japan. The Fisheries Agency has prepared catch statistics*, i.e. catches by species, by fishing methods and by prefecture together with production by aquaculture. Japan's marine waters are divided into eight regions, and the catches of major species are shown in Figure 1.

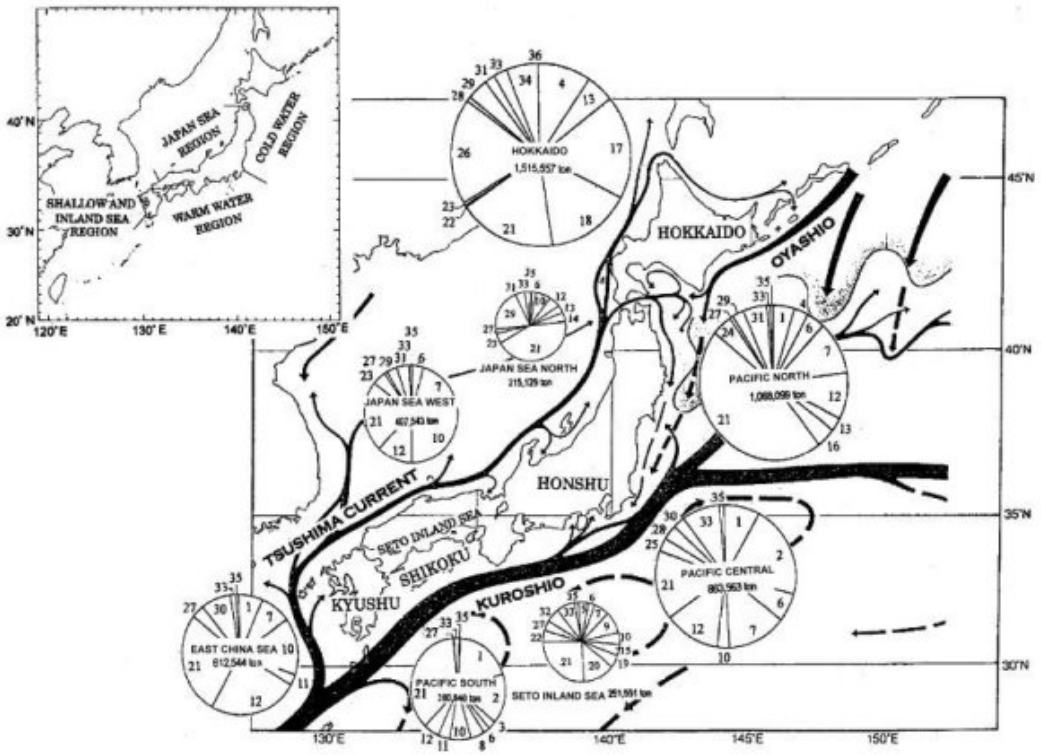


Figure 1. Ocean currents and marine communities around Japan

Based on species composition of these catches together with other information, marine biota around Japan can be largely grouped into four regional communities. The first is the community in waters affected by the Oyashio from Hokkaido to Tohoku. This

community is characterized by cold current species such as Pacific cod (*Gadus macrocephalus*), Alaska Pollock (*Theragra chalcogramma*), Atka mackerel (*Pleurogrammus azonus*), King crab (*Paralithodes camtschaticus*), doflein octopus (*Paroctopus dofleini dofleini*), etc. (The English names of fishes and shellfishes used here are those used in FAO Fishery Statistics.) The second community is found in the waters south from Kanto and affected by the Kuroshio. Organisms characteristic to these waters are those carried from the south by the so-called "Kuroshio belt conveyor." Those include many species such as skipjack tuna (*Katsuwonus pelamis*), Japanese amberjack (*Seriola quinqueradiata*), chub mackerel (*Scomber japonicus*), Japanese horse mackerel (*Trachurus japonicus*), Japanese spiny lobster (*Panulirus japonicus*), common octopus (*Octopus vulgaris*), etc. Essentially these "Kuroshio species" characterize the majority of the biota of Japanese seas. The boundary between the Kuroshio and Oyashio fluctuates seasonally between Sanriku and Choshi. The boundaries in the sea between sub-polar and temperate and between temperate and sub-tropical are much farther north than the corresponding boundaries on land, which indicates a strong effect of the Kuroshio. The third regional community is the community of the Japan Sea. This water body is strongly enclosed and has a unique environment and characteristic biota. In the Japan Sea warm currents such as the Tsushima current, a branch of the Kuroshio, and cold currents such as the Liman current, intermingle at the surface. The flow pattern is quite complex and yet completely understood. An important characteristic of the Japan Sea is its unclear boundary between warm and cold currents. Here cold current species extend farther south and warm current species migrate farther north than they do in the open Pacific Ocean. Due to such factors as low water temperatures in winter, small tidal differences, and low surface salinity, coastal biota are diminished and oceanic species such as skipjack tuna are not abundant. Beneath the surface layer, deeper than 300-400m, there are cold water masses, which are called the "Japan Sea Proper Water" and which occupy about 85% of the total volume of the Japan Sea. The temperatures (0.0 to 0.5 ) and salinity (34.0 to 34.1) are constant throughout these water masses and these uniform environmental conditions enable the organisms to distribute in wider depth ranges than in the Pacific. Also, primary deep-sea fishes* are lacking; this may be related to the origin of the deep basin of the Japan Sea and the rather short history since its creation.

The three communities mentioned above are all largely comprised of species which prefer waters nourished under oceanic conditions. On the other hand, in bays and inland seas, communities are quite different from their oceanic counterparts. Around Japan, continental shelves are usually narrow. Coastal waters affected by river runoff have not developed fully, except in the East China Sea. In enclosed or semi-enclosed bays and inland seas, however, coastal waters develop and establish unique communities. In these waters many common species are seen from south to north. Representatives of such coastal ecosystems are clams, observed in inner bays such as Japanese carpet shell (*Ruditapes philippinarum*) etc, most of which have been continuously represented since ancient times.

The Japanese people have utilized these rich marine living resources since antiquity. Recently, however, changes have been observed in these resources; there has been a decline and other ecological changes in the marine environment. One major change is a decrease in traditional marine resources. Other change to the ecosystem have been

caused by invasion of exotic species*. Although no large scale or drastic ecosystem changes have yet been observed in the marine environment, many native species are in crisis and may not survive. The Fisheries Agency summarized the status of aquatic organisms of Japan in a report entitled “Databook on Rare Wild Aquatic Organisms in and around Japan”, in 1998. According to the report, among the examined 67 species of marine fish, the number of species which are endangered*, threatened, or rare are 7, 8, and 14, respectively. In addition, populations of a further 26 species have decreased.

This chapter will now examine temporal changes in the marine environment and living resources in coastal and offshore waters around Japan. Also, the responses of biota to environmental changes will be considered using case studies of Tokyo Bay and the Seto Inland Sea. Finally, mechanisms to protect the marine environment and its living resources will be discussed.

## 3. Changes in the Marine Environment

### 3.1.Topographic changes: increases in reclaimed land and artificially altered coastlines

Japan is a small country in area and more than 60% of its land is covered by mountains. Thus, plains, and similar lowlands easy to use, are scarce, and reclamation has long been utilized to create land. Land reclamation accelerated significantly after World War II, particularly in the 1960s, and shallow coastal waters were reclaimed rapidly to create cheap land for factories, urban development, ports, etc. The development of the Keihin Industrial Zone, covering Tokyo, Kawasaki and Yokohama, was a pioneering effort, first begun in the Meiji era. Although the areas of reclaimed land differ somewhat according to the surveys of the Ministry of Transportation (areas in ports) and the Ministry of Agriculture, Forestry and Fishery (MAFF) (lost areas of fishing grounds), both surveys indicate acceleration of land reclamation in the 1960s and 1970s. Development during this period started at Tokyo Bay, Ise Bay, and the Seto Inland Sea including Osaka Bay, and then shifted to the coasts of local cities. Changes in the total area of fishing grounds lost surveyed by MAFF (see Figure 2) show that in the Pacific Central region (including Tokyo Bay and Ise Bay) and Seto Inland Sea region, the reclamation was greatest in the 5-year period from 1963 to 1967, and second highest was 1968 to 1972.

| 埋立 | 瀬戸内海区 SETO INLAND SEA | 東シナ海区 EAST CHINA SEA | 日本海西区 JAPAN SEA, WEST | 日本海北区 JAPAN SEA, NORTH | 太平洋南区 PACIFIC, SOUTH | 太平洋中区 PACIFIC, CENTRAL | 太平洋北区 PACIFIC, NORTH | 北海道区 HOKKAIDO | 全国 |
|---|---|---|---|---|---|---|---|---|---|
| 63-67 | 114.9 | 23.5 | 4 | 0.7 | 14.3 | 54.1 | 3.2 | 1.1 | 72.7 |
| 68-72 | 48.8 | 15.3 | 2.4 | 0.8 | 2.3 | 49.6 | 1.9 | 2.1 | 55.9 |
| 73-77 | 44.2 | 28.4 | 6.5 | 3 | 2.2 | 38.3 | 4.1 | 3.8 | 48.4 |
| 78-82 | 18.1 | 13.9 | 4.1 | 1.8 | 2.2 | 32.6 | 5 | 2.4 | 42.2 |
| 83-87 | 22.1 | 22 | 4.8 | 3.2 | 1.2 | 14.3 | 1.6 | 1.3 | 18.4 |
| 88-92 | 25.8 | 13.8 | 8.4 | 0.9 | 1.3 | 8.2 | 2.1 | 1.8 | 13.4 |
| 93-97 | 10.3 | 5.8 | 1.4 | 2.2 | 0.7 | 9.4 | 4.2 | 0.9 | 34.8 |

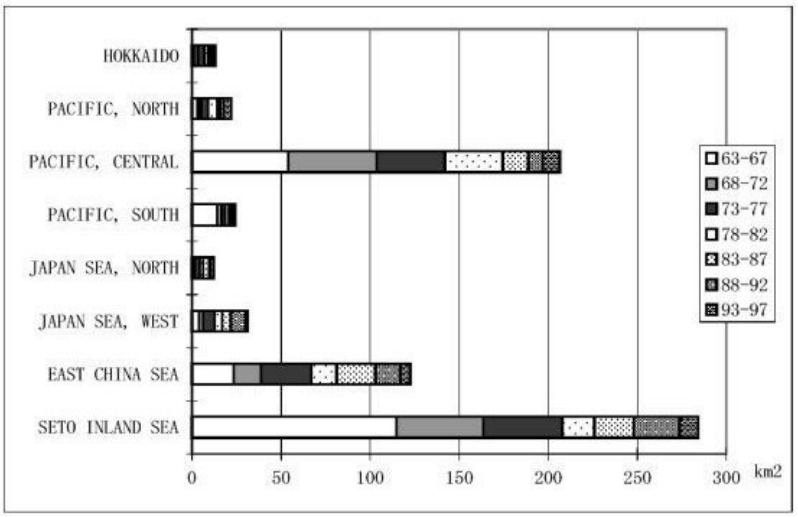


Figure 2. Progress of land reclamation (loss of fishing grounds)

Meanwhile, in other regions, the peak of land reclamation activity occurred mostly after these periods. Thus these data tell us that land reclamation shifted from large central cities to local small cities as time went by. Around 20% of the total area of Tokyo Bay has been reclaimed. The situations in Tokyo Bay and the Seto Inland Sea will be examined in more detail later in the case studies.

Together with land reclamation, shorelines of the Japanese coast have been altered artificially, partially because of the protection of coasts from erosion. (Severe erosion is observed along the Japan Sea coasts, and also the Pacific coasts of central parts of Honshu.) A survey by the Environment Agency in 1995 showed that, of the 33 000 km of total shoreline, 55% remains as natural, 14% semi-natural, and 30% artificially altered (see Figure 3). Natural coasts are generally better preserved on smaller islands. If the island regions are excluded, the ratio occupied by the natural coast decreases to 45% and that of the artificially altered increases to 38%. Erosion of beaches is considered to have some relationship to the reduction of the supply of riverine sand resulting from the widespread construction of dams. At present, Japan has almost no river that is without dams.

| | 全国 | 本土域 | 島嶼域 | | Islands | Whole area | Main land |
|---|---|---|---|---|---|---|---|
| 自然海岸 | 18109.22 | 8543.4 | 9565.82 | Natural | 9565.82 | 18109.22 | 8543.4 |
| 半自然海岸 | 4470.01 | 3071.62 | 1398.39 | Semi-natural | 1398.39 | 4470.01 | 3071.62 |
| 人工海岸 | 9974.05 | 7278.92 | 2695.13 | Artificially altered | 2695.13 | 9974.05 | 7278.92 |
| 河口部 | 263.96 | 239.57 | 24.39 | Estuary | 24.39 | 263.96 | 239.57 |

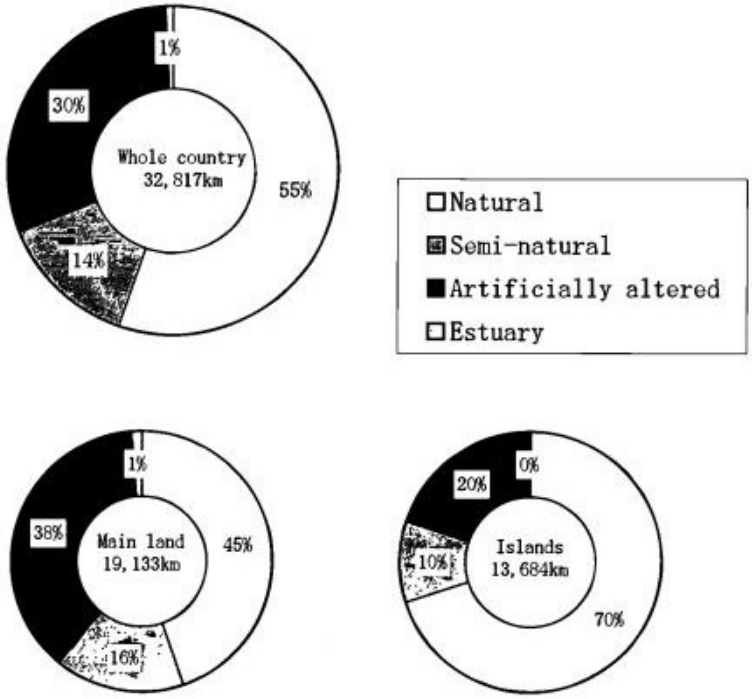


Figure 3. The present status of shorelines around Japan

Thus, the coasts and/or shorelines of Japan have been considerably changed. These topographic changes have brought about not only physical influences but have also resulted in the expansion of industrial activities and the concentration of population. This has led to an increase of wastes discharged to the sea. In the next section, the situation regarding marine pollution in the waters around Japan will be considered.

### 3.2 Marine pollution

Currently there are several systems in place that monitor the marine environment around Japan. Details will be given later in another section but several national and local governmental networks exist. One such activity is by the Maritime Safety Agency for "the confirmation of occurrence of marine pollution." This is observation of marine pollution by cause, (namely oil, other chemicals, and red tides), and has been carried out since 1968. Occurrences of marine pollution rapidly increased nation-wide in total in the initial five years of this survey, began to decline after a peak of 2460 cases in 1973, and then reduced to about half of the peak level in the first half of the 1980s (see Figure 4).

Then, with some fluctuation, this decreasing tendency continued with only 589 cases reported in 1999, which is less than a quarter of the peak. The main cause was oil, which occupied most of the cases during the initial phase of the survey. The ratio of oil pollution, however, decreased gradually after the latter half of the 1970s, and is currently about 50%. Red tides* also showed a peak in the mid 1970s and then steadily decreased. Cases involving other chemicals tended to increase after the late 1980s and, it consequently became necessary to investigate these cases more carefully. This survey is carried out to confirm reported pollution events and, therefore, only cases confirmed visibly are recorded, which means that invisible cases such as mercury pollution at Minamata are not included.

When examining the temporal changes by region, in Tokyo Bay, Ise Bay, Osaka Bay, and the Seto Inland Sea the occurrences reached a peak around 1973 and decreased afterwards in a pattern quite similar to that observed nationwide. In the 1970s the cases in these three big bays and Seto Inland Sea comprised about 2/3 of the total but the ratio decreased gradually to about half in the 1980s and to less than half in more recent years. In the other regions the occurrences reached a peak mostly in the latter half of the 1970s. Although pollution tended to decrease generally after the peak, there are some regions that experienced a second peak at some period after the first peak. In addition, in the 1990s, some regions such as coastal waters off Kyushu had a second peak larger than the first peak of the 1970s. These phenomena indicate that coastal development started at the three big bays and Seto Inland Sea and dispersed gradually to the coasts of local cities, which corresponds with the patterns for development and land reclamation previously mentioned.

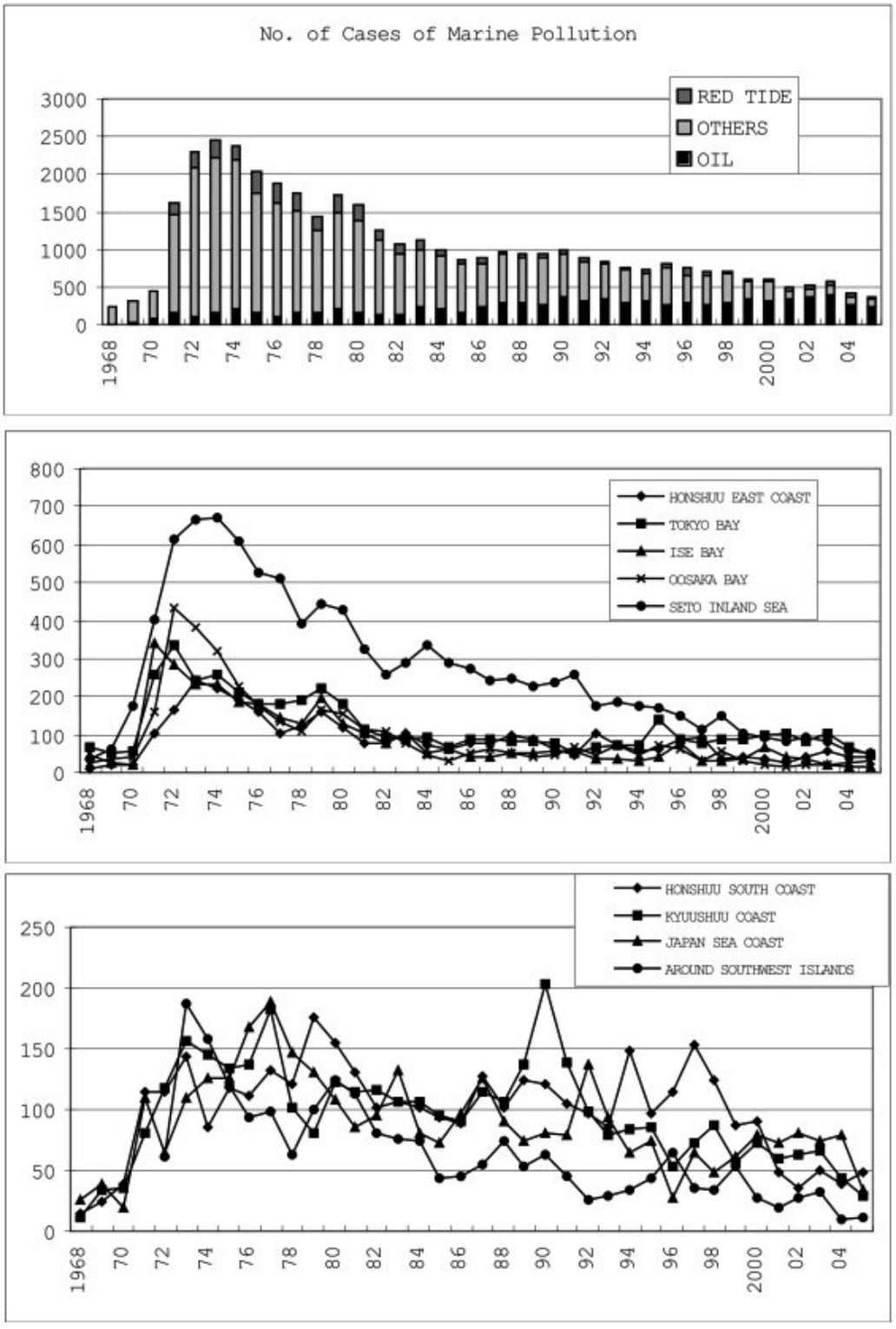


Figure 4. Occurrences of marine pollution

The causes of marine pollution are largely divided into hazardous chemicals (including oil) and organic substances and/or nutrients which bring about eutrophication*/red tide (as grouped in the survey of the Maritime Safety Agency). Hazardous chemicals include

heavy metals such as mercury, (the causative agent of Minamata disease), chlorinated hydrocarbons (such as PCBs, DDT* and more recently the notorious dioxins*), oil, and various agricultural chemicals including pesticides. These substances are usually released as a result of industrial activities. Eutrophicating substances, however, are contained largely in domestic effluent, together with industrial wastes. Eutrophication brings about red tides and further threatens the survival of benthos* through deprivation of dissolved oxygen via decomposing organic materials accumulated at the bottom.

Pollution by each substance, examining details respectively, peak at a different time period. Macroscopically, however, their progress was quite similar. From the late 1960s and through the 1970s the problem was made clear to the public, and necessitated the establishment of counter-measures. In 1971, the Environment Agency was established, after which regulations were strengthened and various countermeasures were taken in earnest. A countermeasure is considered to be effective only when it leads to the reduction of stresses and/or loads on the environment. In the case of Japan, establishment of environmental standards and regulation of effluent to achieve the environmental standards were quite effective in controlling pollution, particularly from hazardous chemicals. In Japan, environmental standards in the aquatic environment are established using two criteria, namely protection of human health (so-called health items) and conservation of the living environment (so-called daily life items). Simply speaking, the former is for hazardous chemicals and the latter for eutrophication, etc. Compliance rates of environmental standards are observed each year by the monitoring of public waters. For ‘health items,’ the compliance rate has rapidly improved and the ratio of cases exceeding the standards is currently quite low. On the other hand, for ‘daily life items,’ no dramatic improvement has been attained. Compliance rates for COD* in the marine environment as a whole indicated a slight improvement in the 1970s but in the 1980s and thereafter, they leveled off, without any further improvement. This is especially true in the three big bays, Tokyo Bay, Ise Bay, and Osaka Bay, and Seto Inland Sea, where noticeable change in the compliance rate is not evident (see Figure 5).

In the three big bays and many other coastal waters, absolute values of COD are gradually decreasing but they have not yet dropped enoughl to satisfy the environmental standard. The difference in improvement between ‘health items’ and ‘daily life items’ is considered to reflect the likely differences in the routes of entry of each pollutant. In the following, temporal changes are described for hazardous chemicals and eutrophicating substances, respectively, in waters around Japan.

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**Biographical Sketch**

**M. Shimizu** started his research work in the Fisheries course of the Biological Division of the Postgraduate School of University of Tokyo, in the field of marine radioecology, particularly on the uptake, accumulation and loss of radionuclides in marine organisms. After finishing the course in 1963, he obtained a position in the Faculty of Agriculture, University of Tokyo, first as Assistant Professor, then Associate Professor and finally Professor (he retired in 1996). In his research, the target was gradually expanded to include not only radionuclides but also heavy metals and chlorinated hydrocarbons such as PCBs. Meanwhile from around 1970, he started a study on pollution of Tokyo Bay and pursued the relationship between environmental changes and fisheries resources. Analyses of fisheries statistics and field survey were carried out, including experimental trawls, to obtain information on the distribution of bay organisms.

Shimizu has attended many international scientific meetings. He was a member of CRESP (Co-ordinate Research and Environmental Surveillance Programme related to Sea Disposal of Radioactive Wastes) of OECD/NEA from 1986 to 1996, as the representative of Japan and the leader of the Biology Task Group from 1987 to 1991. He also joined the Committee of Marine Environmental Quality of North Pacific Marine Science Organization (PICES) and was a member for seven years since 1993 as a Japanese delegate.

At present he is a member of the Central Environment Council (Ministry of Environment) and also of many other committees on marine environmental issues of national and local governments.