resulted in missing and lost quantities (Deliberation Committee on PCB Waste Treatment Project, 2003), and there is concern over the likely discharge of such missing or lost PCB into the environment.

Partly because signatory nations will be obliged to complete the appropriate treatment of PCBs by 2028 under the POPs Treaty, the "Law Concerning Special Measures for Promotion of Proper Treatment of PCB Waste" was established in 2001 and detoxification by chemical processing methods has been gradually implemented in Japan since December 2004 with the objective of completing the treatment of PCB wastes by July 2016. Because PCBs are slow to decompose in the environment (low degradability) and are apt to be concentrated/accumulated within the bodies of organisms through the food chain (high bioaccumulation), the reduction of outflow of PCBs into the environment associated with the treatment of PCB wastes has not taken effect yet in the form of decreases in the concentration levels within sediments or marine organisms.

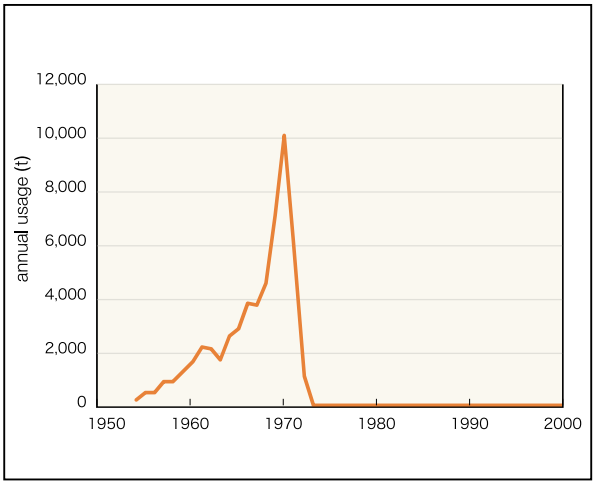

Figure 3.7 Changes in PCB Consumption
(Prepared from data based on Isono, 1975)

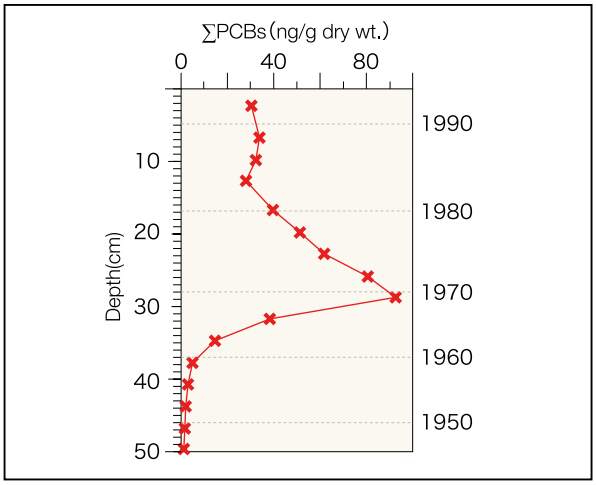

Figure 3.8 PCB Vertical Distribution in Core Sediment of Tokyo Bay
(Data from Okuda et al., 2000)

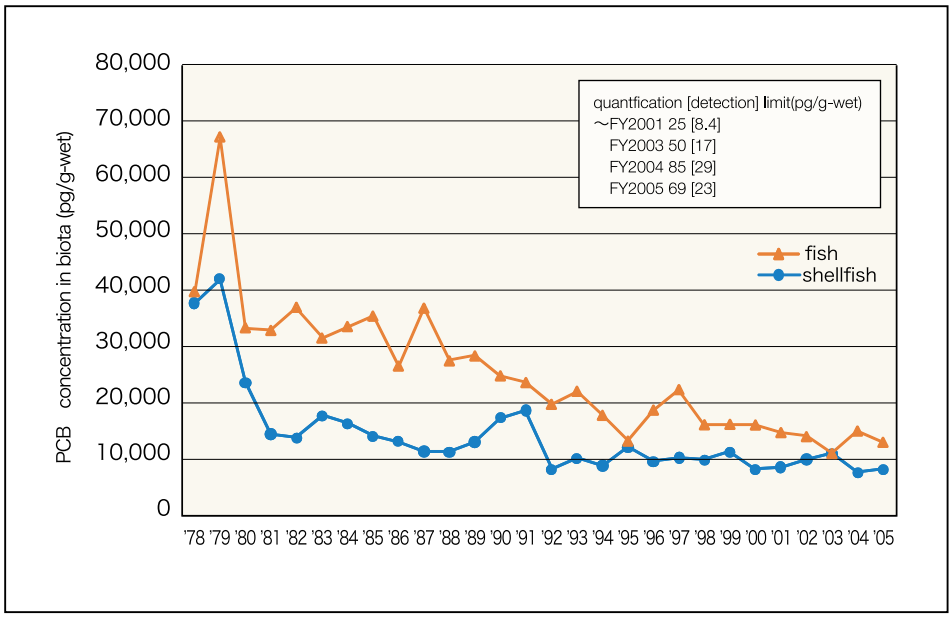

Figure 3.9 Long-term Changes in PCB Concentration within Bodies of Organisms
(Prepared from data via Ministry of the Environment, 2007)

(4)Butyltin compounds

1) Results of the Marine Environment Monitoring Survey

According to the Marine Environment Monitoring Survey, butyltin compounds within sediments show higher concentrations in inner bays/coastal areas located in metropolitan areas and lower concentrations in offshore areas (Figure 3.10). Given that butyltin compounds are chiefly used in antifouling paints, the contamination is likely to be derived from the heavy traffic of vessels rather than from terrestrial origins. In addition, given that the use of antifouling paints containing butyltin compounds has already been prohibited in Japan as discussed below, a chief ongoing loading source may be due to the navigation of foreign vessels.

Butyltin compounds within marine organisms showed a statistically significant downward trend ($P<0.05$) in some sea areas and some marine organisms (mussel (soft parts) in Sendai Bay and Toyama Bay, and in benthic sharks (liver) in Tokyo Bay and the Sea of Ariake) but not in a general and definite manner (Figure 3.11).

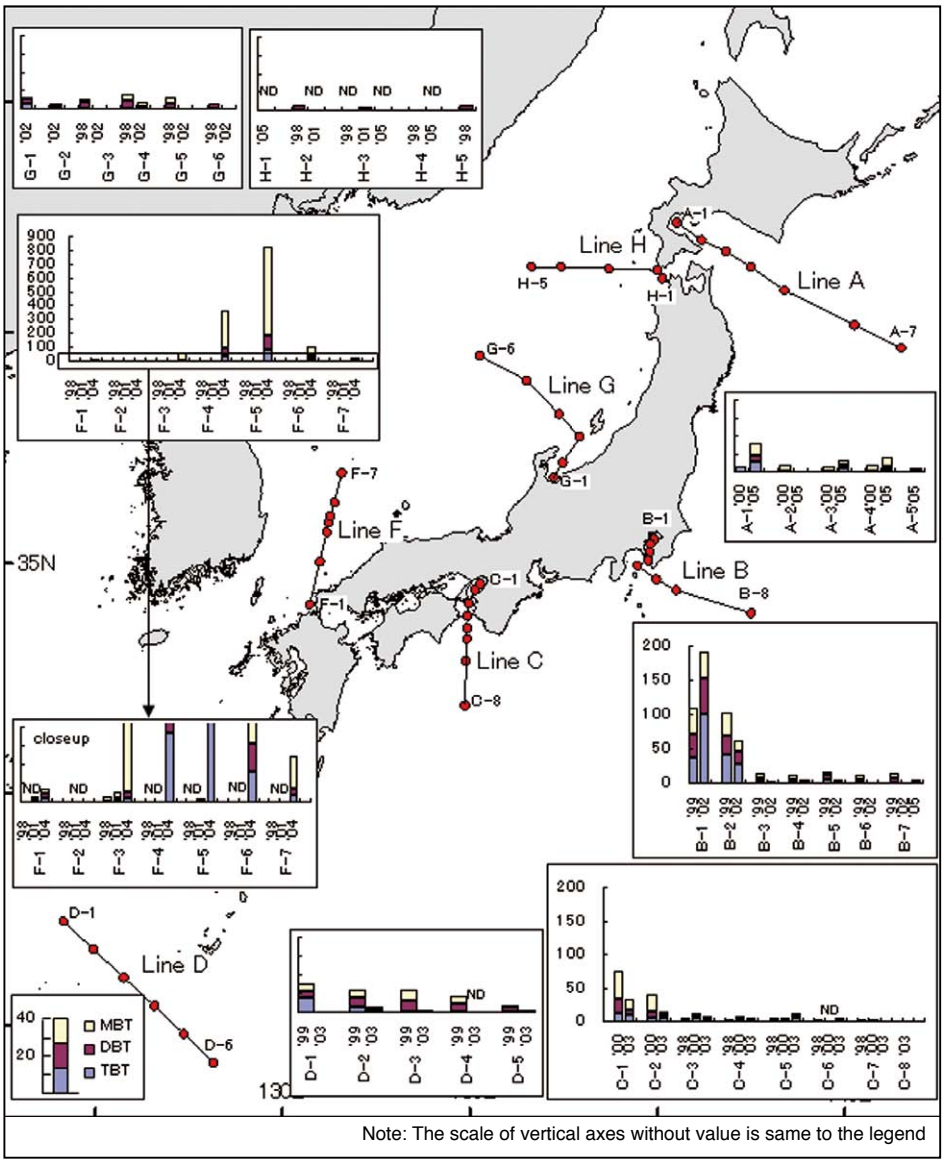

Figure 3.10 Geographical Distribution of Butyltin Compound Concentration within Surface Sediments (ng/g dry wt)

2) Evaluation of previous control measures

Since the 1960s, butyltin compounds have been widely used in antifouling coatings (for ship bottom paints or fish net antifouling paints). In the mid 1980s, however, marine pollution from organotin compounds became a social issue in Japan. In association with the issue, one of the most important members of this pollutant group, tributyltin oxide (TBTO) was designated as a class I specified chemical substance under the Law Concerning the Examination and Regulation of Manufacture, etc. of Chemical Substances in January 1990 in Japan and was prohibited from being manufactured, used, or imported. In September of the same year, other tributyltin (TBT) compounds, were designated as a class II specified chemical substance that requires prior notification of production or importation, with the quantities the production or import restricted accordingly. Prior to these regulations, the production and use of antifouling paints was voluntarily controlled by the various relevant industries involved. Shipment amounts of TBT for open system use have been decreasing rapidly after peaking at the end of 1980s (Figure 3.12), probably due to the effect of the above restrictions.

TBT concentrations within fishes and shellfishes show a long-term downward trend since 1985 when the environmental survey for the status of chemical

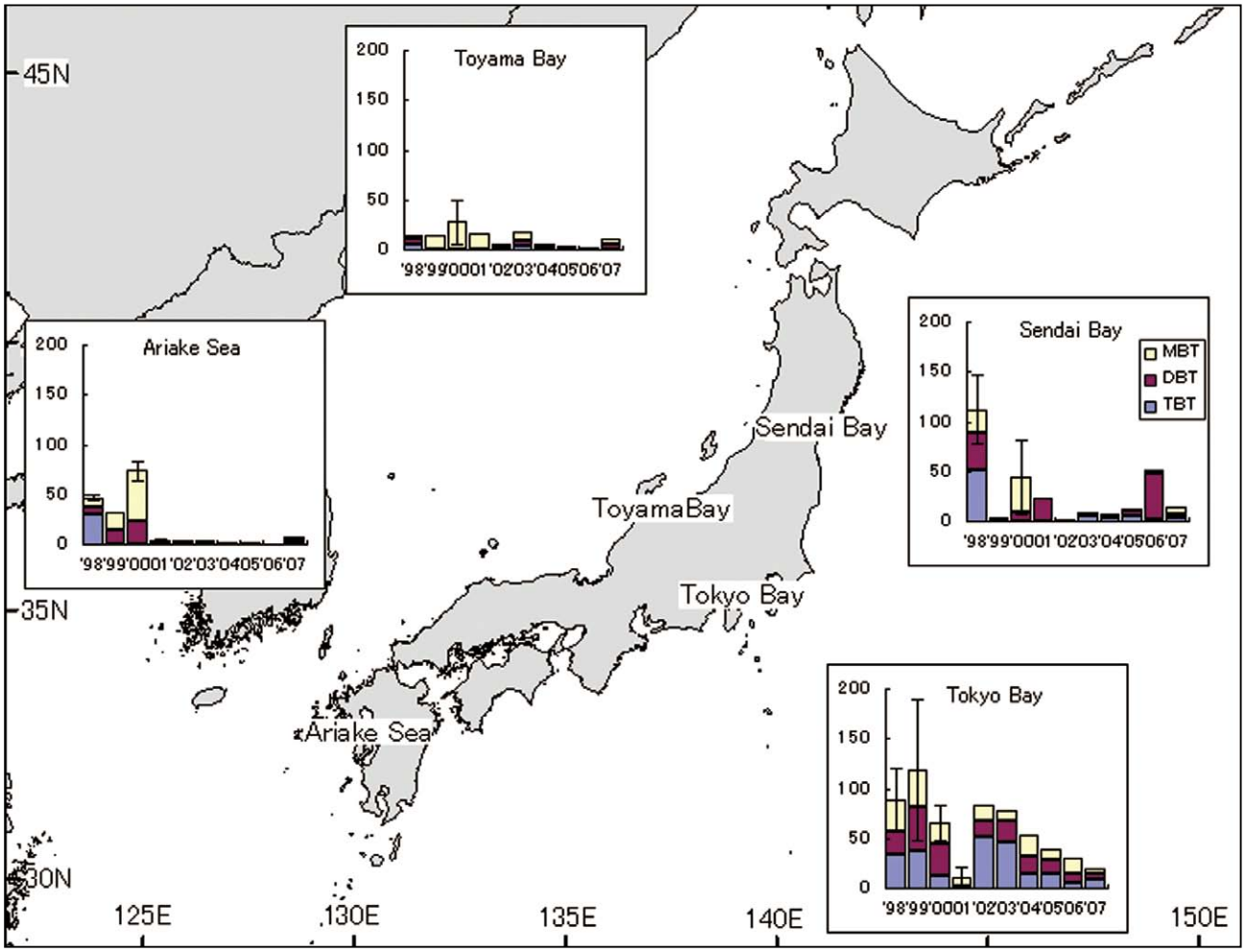

Figure 3.11 Chronological Changes in Butyltin Compound Concentration within Benthic Sharks (Liver) (ng/g wet wt)

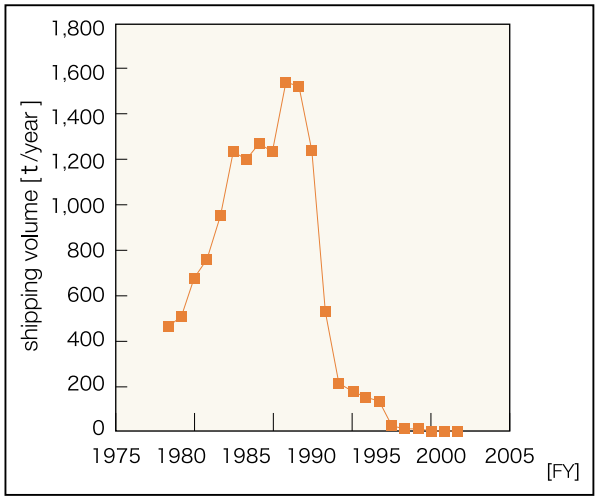

Figure 3.12 Estimated Shipment Amounts of TBT for Open System Use
(Except for shipment amounts for chemical raw materials; TBT-base equivalent value)
(Nakanishi and Horiguchi, 2006)

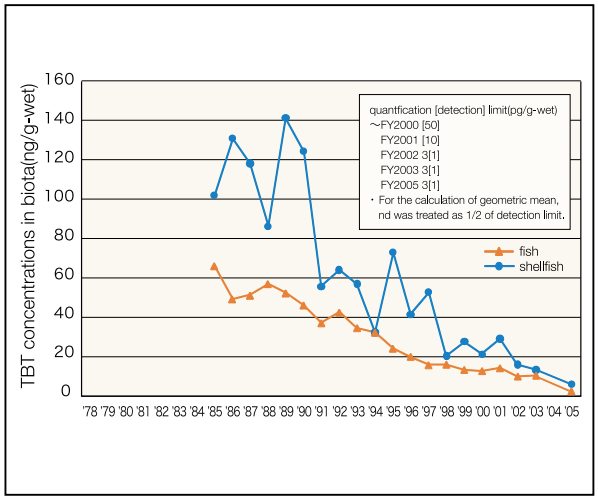

Figure 3.13 Long-term Changes in TBT Concentrations within Bodies of Organisms
(Prepared via data from Ministry of the Environment, 2007)

substances by the Ministry of Environment started (Figure 3.13; Ministry of Environment, 2007), probably due to the effect of the various above-mentioned control measures. On the other hand, the downward trend has slowed down since 1998. In addition, as stated above, in terms of the Marine Environment Monitoring Survey, TBT concentrations within the bodies of marine organisms show a significant downward trend in some sea areas and some kind of marine organisms but not in a general and definite manner. Taking these findings together, the residues of tributyltin compounds within the bodies of marine organisms may remain uneliminated for the time being.

The International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention) went into effect in 2008. As outlined under this convention, foreign vessels sailing into Japanese ports are prohibited from using ship bottom antifouling paints which contain organotin compounds. Therefore, loading of butyltin compounds in sea areas around Japan is expected to decrease.

3.1.2 Impacts of hazardous substances on benthic communities

The impacts of various human activities on the marine environment appear to be becoming more evident in the form of changes in the marine ecosystem. In the Marine Environment Monitoring program, a survey on meiobenthos communities was performed in an attempt to better assess this perspective. In this study, data were accumulated from various sea areas up to a water depth of approximately 5,000 m (Figure 3.14).

In some inner bay areas, a change was observed in the composition of the meiobenthos community, which was most likely due to hypoxic environmental conditions. On the other hand, no obvious relationships were observed between pollution by hazardous chemical substances and observable changes in population or composition of meiobenthos communities.

At this point in time, baseline monitoring data that will form the basis for future such assessments have only recently been obtained. Further data accumulation of this nature will hopefully enable a more complete and thorough evaluation of impacts on the environment.

3.1.3 Nutrients

In major water bodies like Tokyo Bay and Osaka Bay, under high levels of nutrient loading from terrestrial

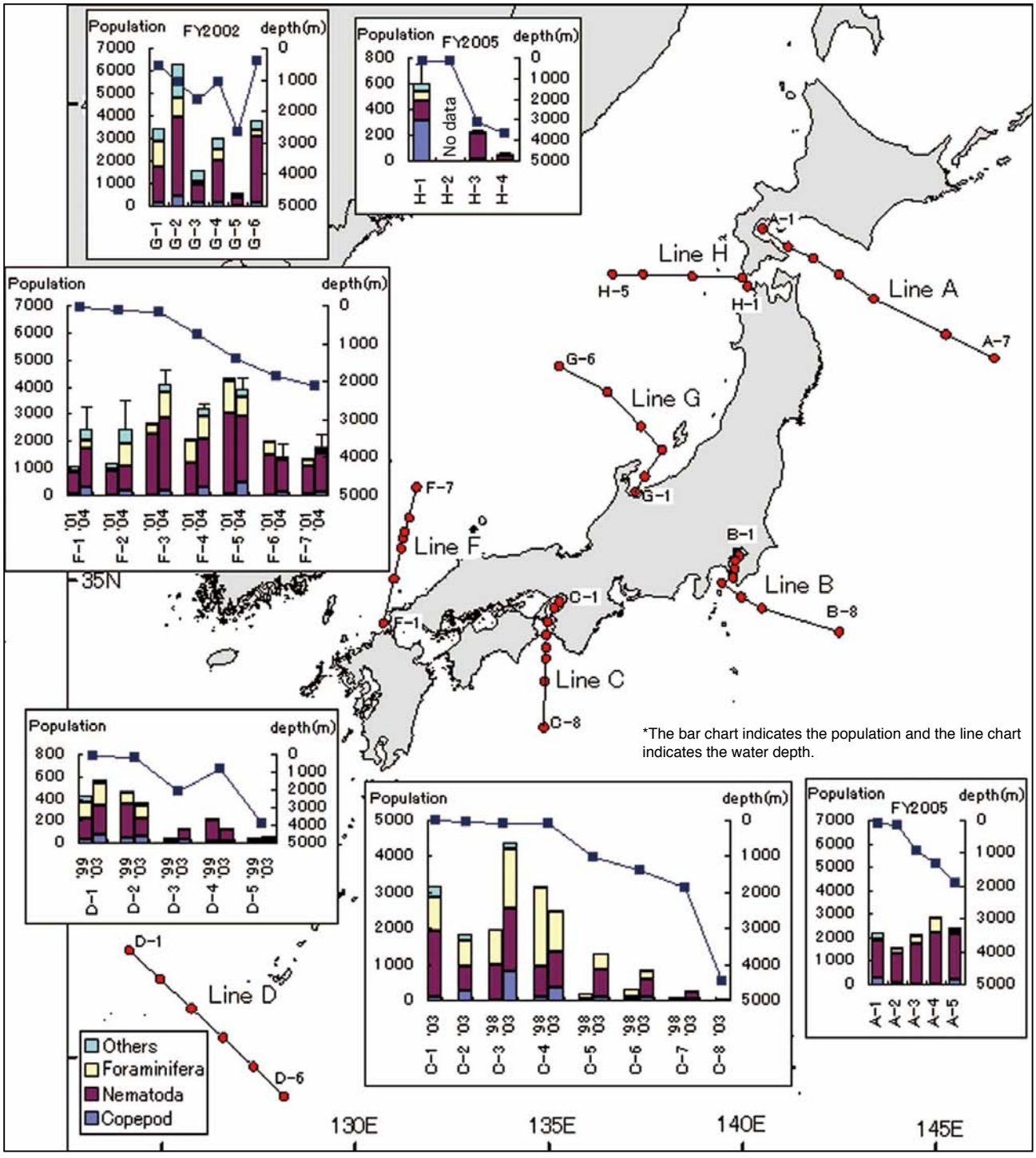

Figure 3.14 Distribution of Meiobenthos Population (Population/10cm^2)

origin, surface water of inner bay showed high level of nutrients, and anthropogenic loading from land area to the sea water was observed. On the other hand, in the offshore area, nutrient level showed vertical trend with peak in the mid depth and low level in the surface. Since this trend was similar to which was shown in the existing study (Saino, 1995), it was verified that the impact in the coastal areas did not appear to have extended out to the offshore region (Figure 3.15).

3.1.4 Floating Litter

1) Results of the "Marine Environment Monitoring Survey"

The results of the Marine Environment Monitoring Survey revealed that floating plastic wastes have distributed not only in the coastal waters but also in offshore areas (Figure 3.16). Some sea areas showed a higher concentration of plastic wastes in the coastal waters, with a lower concentration in offshore areas. However, little data show such trends in a definite manner. In addition, the data were highly nonuniform in spatial-temporal terms. The distributed quantity varied significantly, both locally and/or among survey years.

2) Existing knowledge and international efforts, with respect to Floating Litter:

It is known that resin pellets and plastic fragments are

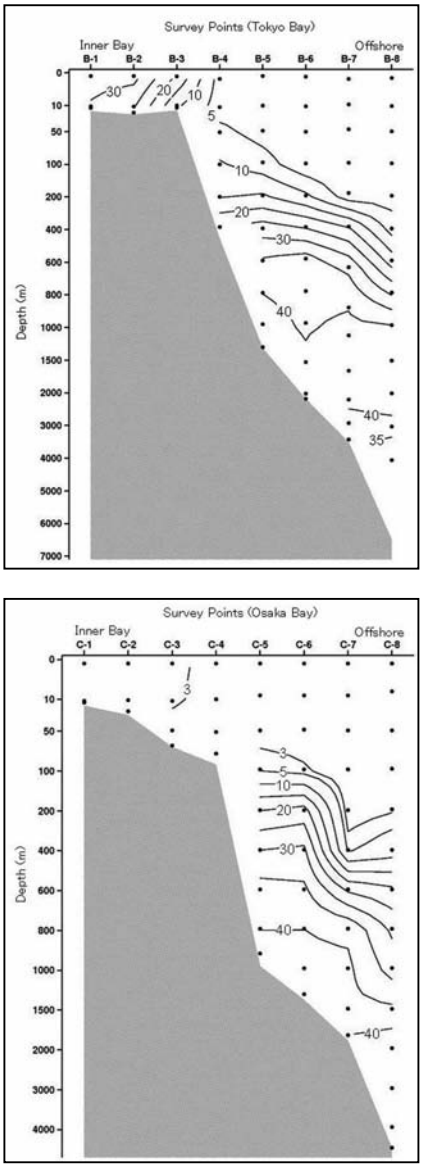

Figure 3.15 Vertical Distribution of Nitrate (μM) in Tokyo Bay (December 2002) and in Osaka Bay (December 2003)

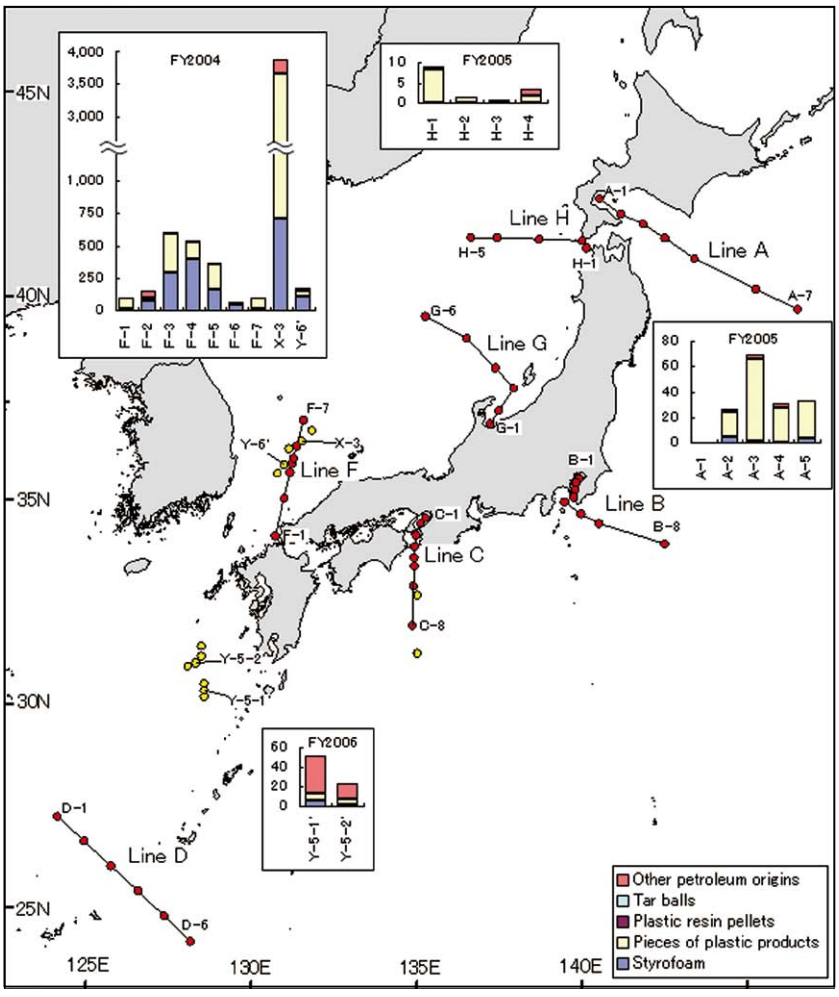

Figure 3.16 Distribution of Floating Plastic Wastes from Fiscal 2004 to 2006 (thousand pieces/km^2)

accidentally swallowed by marine organisms such as sea birds. It has been also reported that there is a significantly increasing concentration of various hazardous chemical substances inside the bodies of such organisms, as a result of materials such as ingested resin pellets being subjected to natural biological and digestive processes, which could likely serve to facilitate the breakdown and elution of some of the component materials, thus increasing their potential for bioavailability (Teuten et al., 2009). Given that plastic wastes once discharged into the environment are slow to decompose and plastics are distributed across a wide stretch of ocean around Japan, these materials definitely pose future concerns regarding their potential longterm influence on marine organisms.

Ogi and Fukumoto (2000) reported that 490 thousand pieces/km2 of plastic particles on average (with a range of 0 to 9,890 thousand pieces/km2) had been distributed in the coastal waters off Southeast Hokkaido during the period from 1994 to 1995. However, since the distribution quantity varied greatly among survey years at the same survey point shown in the results of the Marine Environment Monitoring Survey, it is difficult to determine from the data whether the observed quantities are following an upward or a downward trend.

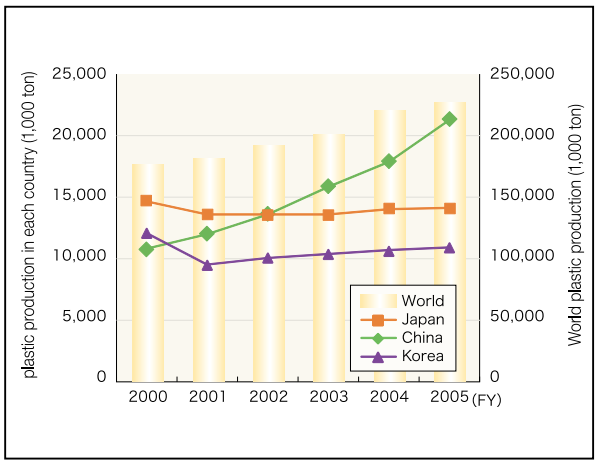

Figure 3.17 Changes in Annual Production of Plastics
(Prepared from data furnished via the website of the Japan Plastics Industry Federation)

In recent years, in addition to studying possible measures for more effectively reducing ocean wastes in Japan, action plans for discharge prevention, as well as for the monitoring, removal, and disposal of ocean wastes (RAP MALI) are being planned by Japan, China, South Korea, and Russia under NOWPAP. However, with the production of plastics in the world showing an upward trend (Figure 3.17), the environmental loading of plastic wastes is likely to increase in the future, despite these positive and unified efforts by cooperating nations to more effectively quantify and manage the problem.

3.2 Impacts of Pollution Derived from Ocean Dumping

Ocean dumping of wastes in Japan is regulated by the Law Relating to the Prevention of Marine Pollution and Maritime Disasters and the Waste Disposal Law as an effort to ensure the requirements specified in the London Convention, which is an international treaty, and its "Protocol of 1996".

Prior to April 2007, Sea Areas A, B, C, and F had been specified as sea areas where ocean dumping was permitted. (Figure 3.18 ; Sea Area B includes Sea Area A, Sea Area C includes Sea Area B, and Sea Area F includes substantially all seas).

The following wastes were specified for the respective sea areas, and identified as wastes permitted to be dumped for disposal:

Sea Area A (present Sea Area I (not established)) had been a sea area prior to 2007, where dumping and disposal were permitted for solidified wastes with high harmful effects. The ocean dumping of such highly hazardous wastes, however, has not been practically implemented in Japan since 1981, and it has been prohibited after the Law Relating to the Prevention of Marine Pollution and Maritime Disasters was revised in 2007. The waste dumped for disposal into Sea Area B (present Sea Area II) was chiefly water-insoluble

inorganic sludge, including bauxite residue and construction sludge. In Sea Area C (present Sea Area III), organic wastes had been permitted to be dumped for disposal. Various other types of specific waste items dumped in Sea Area C included sludge from facilities of human waste treatment, organic sludge and waste water, animal and plant residues, and cattle manure. In Sea Area F (present Sea Area IV), ocean dumping of dredged soil had been permitted.

In the ocean dumping process, action criteria are established for wastes and other matter likely to be contaminated by hazardous chemical substances, and wastes meeting those criteria are permitted to be dumped for disposal. Under the old Law Relating to the Prevention of Marine Pollution and Maritime Disasters, the national government defined the waste permitted for ocean dumping and designated appropriate sea areas of discharge by performing a comprehensive environmental impact assessment. Whereas, the current Law Relating to the Prevention of Marine Pollution and Maritime Disasters obligates the individual waste-generating companies to select specific places of discharge within the sea area of discharge designated by the national govemment and to perform an environmental impact assessment prior to the dumping. These companies are also required to do monitoring after the dumping has taken place.

According to the results of the past Marine Environment Monitoring Survey, no impact of ocean dumping has been detected in Sea Area I. With regard to Sea Areas II and III, an environmental impact on the meiobenthos community was observed, with a substance derived from bauxite residue detected at a survey point in Sea Area II located off Boso and Izu. However, the observed impact was within the range of the assumptions put forth in the prior environmental assessment for these areas. No impact of legal ocean dumping was detected in most of the other sea areas. On the other hand, pollution from unknown origins has been detected in some sea dumping areas. Given the possible impacts of illegal waste dumping, further identification of the pollution source(s) is required (see 3.3).

After April 1, 2007, an approval system for the ocean dumping of wastes was established

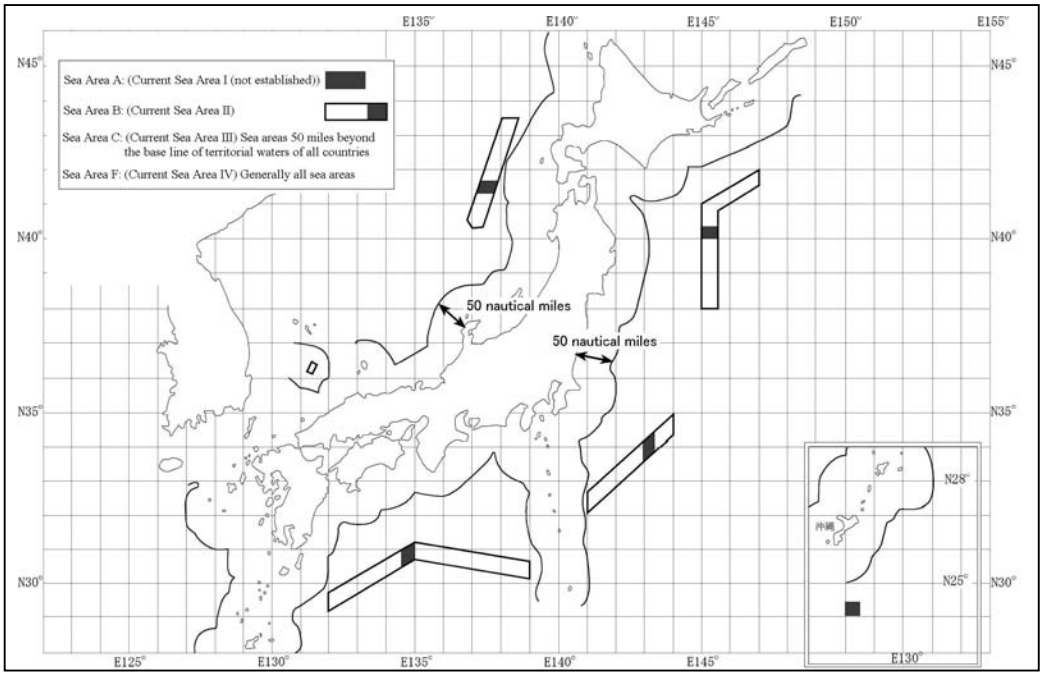

Figure 3.18 Waste Disposal Sea Area Map (Prepared based on data from Environment Law Association of Japan, 2004)

in association with the partial revision of the Law Relating to the Prevention of Marine Pollution and Maritime Disasters in response to the Protocol of 1996. Associated with the above system, it was decided that waste-generating companies was obligated to perform a prior assessment of the impact of ocean dumping on the marine environment. Although -- given the above approval system for ocean dumping-- it is less likely that significant pollution will arise in the future, it is important to continuously check the legitimacy of the ocean dumping based on the law.

3.3 Detection of Specific Polluted Sea Areas (Hot Spots)

The Marine Environment Monitoring Survey detected high concentrations of pollution, rarely seen in the other sea areas for sediments in offshore areas in the following three sea areas.

(1) Sea areas around the Kii Channel

Higher-than-background levels of PCBs were detected within sediment in a sea area around the Kii Channel. The investigation indicated continuous loading of PCBs since about 1970 to recent years with a PCB loading source present near the sea bottom. In addition, the investigation indicated that it is highly possible that the loading source is not likely to be a simple point source.

(2) Off Kii/Shikoku

High concentrations of butyltin and phenyltin compounds were detected in sediments located in Sea Area II and Sea Area III (at a water depth of approximately 4,000 m to 4,500 m) off Kii/Shikoku.

(3) Western part of the Sea of Japan

A high concentration of butyltin compounds was detected within sediment in a wide-scale sea area around the Sea Area III located in the western part of the Sea of Japan.

None of the above sea area cases was determined to have reached a level affecting human health. Those cases, however, nonetheless indicate that these human-caused environmental impacts have extended to the offshore areas. Accordingly, continuous monitoring is necessary from the perspective of conserving the marine environment and ecosystem.

In view of the findings of pollution in such deep sea floor areas, as evidenced in the past monitoring survey, an extensive and comprehensive monitoring program needs to be continuously performed, including sea areas that have not yet been surveyed, in order to go forward with effectively identifying and mitigating these pollution sources and issues in the future.

3.4 Toward Future Countermeasures

As previously mentioned, as a result of the laws and regulations, emissions of dioxins over the last decade have decreased to 1/10 or less of prior levels. Atmospheric concentrations of dioxins have likewise rapidly decreased, in close association with the decrease in the emissions. On the other hand, although dioxins showed a partial downward trend in terms of the concentrations within the bodies of marine organisms, this downward trend is not definite or clearly characterized at this time.

Thus, restrictions on these sorts of persistent pollutants already discharged into the marine environment will not readily have observable effects. In order to effectively prevent marine pollution, conservation measures and prevention measures need to be taken in light of the various specific characteristics of the seas. Including such perspectives, the issues to be addressed in the Marine Environment Monitoring Survey in the future are summarized below:

(1) Monitoring of substances likely to become new pollutants

With respect to persistent organic pollutants (POPs) such as PCBs and dioxins, preventive measures are

promoted at a global level including the elimination of production/use, emission reduction, and proper disposal under the POPs Treaty that came into effect in May 2004. On the other hand, there are various additional chemical substance groups currently distributed and used, which have similar physicochemical properties as existing POPs and which likewise pose a concern over global spread and impacts of pollution (candidate substances for POPs). Of the candidate substances for POPs, such substances as PBDEs (tetra to hepta-brominated diphenyl ethers) and PFOS were added as new controlled materials at the fourth session of the conference of the POPs Treaty held in May 2009. The POPs Treaty will re-evaluate the validity of its requirements every six years, based on the global environmental monitoring data. In order to accumulate data conducive to the validity evaluation, these controlled materials need to be monitored on a long-term basis.

(2) Implementation of surveys associated with transboundary pollution

With the increasing economic growth and development in neighboring countries, there is a concern over a concomitant increase in transboundary pollution from those countries via the seas. To cope with the situation, it is necessary to obtain monitoring data in the respective countries for comparative studies, via the framework of international cooperation as well as implementing surveys that will be conducive to the early detection of inflow of pollutants from neighboring countries.

(3) Implementation of surveys meeting the changes in the regulatory framework for ocean dumping

The approval system for ocean dumping of wastes was newly established associated with a partial revision of the Law Relating to the Prevention of Marine Pollution and Maritime Disasters. Accordingly, it has now become more possible to accurately predict in advance the types, quantities, and positions of materials being dumped for disposal. In addition, with the monitoring report obligations now required for waste-generating companies, a field survey by the waste-generating company is expected to be performed for wastes being dumped for disposal in large quantities. In the future, a monitoring system needs to be constructed to check the relevance of the monitoring report being performed by the waste-generating company, and to prevent additional pollution-borne impacts on the marine environment for the sea areas where continuous ocean dumping will be implemented in the future.

(4) Monitoring of impacts on the marine environment of carbon dioxide (CO2) sequestration in sub-seabed geological formations

With the adoption of the proposal for revision of Annex I of the London Protocol of 1996, CO2 sequestration in sub-seabed geological formations became regulated under a permitting process. In Japan, a verification test is now required to be performed in sub-seabed regions in the future, as a means of implementing this CO2 sequestration policy. A license issuance framework similar to that of ocean dumping of wastes has been constructed to prevent and minimize the impacts of CO2 sequestration on the marine environment, in accordance with the Law Relating to the Prevention of Marine Pollution and Maritime Disasters. From now on,, at the stage of an actual project implementation, the national government must verify the relevance and accuracy of the monitoring report performed by the company concerned, and whether it presents plausible information indicating that the proposed project will not pose any significant impacts on the marine environment.

(5) Continuous monitoring of specific polluted sea areas (hot spots)

Based on the findings of past surveys, continuous monitoring needs to be performed for PCBs within

the sediment in the sea area around the Kii Channel, as well as for the organotin compounds within the sediment off Kii/Shikoku, and for the butyltin compounds within the sediment in the western part of Sea of Japan. In addition, monitoring should be performed as needed, in the various sea areas that have not yet been surveyed, in order to better characterize and evaluate the possible extent of artificial pollution that may be impacting these regions.

(6) Assessment of the marine environment to be implemented by the all Japan system

In recent years, the assessment of the marine environment from the perspective of an ecosystem approach has been shifting toward the direction of implementing an integrated assessment. In the UK, for example, a national report (Defra, 2005) has been prepared by the joint efforts of relevant ministries and agencies.

In Japan, with the Basic Act on Ocean Policy enforced in July 2007, the Headquarters for Ocean Policy was established within the Cabinet with the Prime Minister as the Administrative Chief. The Basic Plan on Ocean Policy was developed in order to extend and expand scientific knowledge with respect to ecosystems and pollutants concerning the marine environment, and to promote ocean surveys designed to obtain this sort of information.

This recent assessment of marine pollution around Japan described in this report, was performed taking into account the results of the Marine Environment Monitoring Survey implemented by the Ministry of the Environment, together with other existing knowledge. In the future, it is desired that joint efforts will be made by relevant ministries and agencies toward the realization of a comprehensive assessment of the marine environment around Japan. Ideally, this should also include risk assessments of impacts on marine organisms and habitats, as well as impact assessments of overfishing etc. on the fishery resources, as well as an environmental assessment of the impacts on marine ecosystems associated with the climate changes.

(7) Implementation of the periodic assessment of the marine environment

The Marine Environment Monitoring Survey, which began Phase III of its operational plan in Fiscal 2008, is anticipated to complete its basic investigation of sea areas around Japan in five to eight years. In this monitoring program, a periodic evaluation is expected to be performed for the respective phases on the present status of the marine environment, the effects of the various enforcement and control measures that have been set in place, and so forth. This will be augmented by the use of ,additional domestic and overseas monitoring data, in addition to the data obtained thus far under this particular survey program.

The evaluation results will be shared and utilized for regional assessment as part of the NOWPAP and Global Marine Assessment (GMA) programs, as well as being used for the planning and reassessment of continuing measures for the conservation of the marine environment of Japan.

There is a widening recognition that, given the continuity of the sea and the extensive spread of pollution via air, it is insufficient for each country to continue to attempt to independently perform conservation of the marine environment. The spread of marine pollution does not limit itself to geopolitical boundaries , and cooperative and concerted efforts to address these problems should be thus be taken together collectively by several countries. It is desired that Japan will further enhance the Marine Environment Monitoring Survey by fully utilizing the international cooperation frameworks for marine environment conservation such as the NOWPAP, the POPs Treaty, and the GMA, and make a significant contribution to the conservation of the marine environment including the sea areas around Japan.

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- The data on Marine Environmental Monitoring Survey can be downloaded from following (only in Japanese)
  : http://www-gis4.nies.go.jp/kaiyo/

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