These cool water masses are the water draining from the river system, since river water at this season is cooler than sea water. Salmon stopped their vertical movement for minutes in such cool water masses.

As described above, chum salmon reduce their metabolic energy consumption by making deep dives in thermally stratified water. We closely analyzed the diving behavior of salmon with newly developed loggers which can record swimming speed, depth, temperature, and acceleration in two directions, parallel and perpendicular to the body axis. Acceleration parallel to the body axis is a good indicator of an angle of fish body and the other is that of swimming activity. Our study revealed that chum salmon swam much more actively when they were ascending than descending, whereas swimming speed was similar. The angle of fish body was more acute when they were descending. These data suggest that the density of the salmon is equivalent to that of sea water in the surface layer, but becomes larger in the deeper layer.

Application of data logger tagging to the salmon made us possible to know their minute to minute behavior. The detailed data on the response of homing chum salmon against the "hot" water masses are now accumulating. However, the study site is restricted to the coastal area and the study subject to homing adults at present. Further studies on the salmon at different life stages, at more broader area, and in the different sea water condition are indispensable.

How do we know salmon behavior? II. A mesoscale study: Behavior of salmon schools estimated from fish market statistics and routine marine meteorological data.

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Behavior of salmon *Oncorhynchus keta* schools estimated from fish market statistics and routine marine meteorological data will be introduced as an example for a mesoscale study of salmon behavior. Here, mesoscale means order of 10 km to 100 km in spatial scale and that of day to hour in temporal scale, such as the spatial and temporal scale in homing behavior of salmon from Sanriku Coast, the Pacific side in northern Japan, to rivers.

The fishermen's proverb in Sanriku Coast says, "the large salmon catch occurs just after dropping down of seawater temperature." It may be true since the salmon return from the northern sea where seawater temperature is lower than that of Sanriku Coast. They also say, "the large salmon catch occurs just after rainfall or blowing of westerly strong wind." Rainfall increases the amount of river water. The westerly wind is the monsoon in salmon fishery season. This strong wind carries the river water widely and rapidly off the bays of Sanriku Coast, because bay mouths are open to the east. These two phenomena, increase of the river water and the wider spread of river water to the open sea, may help salmon to identify their natal rivers by means of detecting the smell of the river water (Hasler and Wisby, 1950). Thus, it is possible that the fishermen's proverbs are scientifically true.

However, there are poor reports on the relationship between salmon catch and sea condition and/or weather condition. Then we tried to prove the fishermen's proverbs and to estimate the mesoscale behavior of salmon schools returning to Sanriku Coast by using fish market statistics and routine marine meteorological data.

We performed it in Otsuchi Bay as a model of Sanriku Coast because we have been obtaining the marine meteorological data by our system. The axis of the Otsuchi Bay leis in the direction of east and west, and the mouth is open to east, the North Pacific side. The length and width are about 7 km and 3 km, respectively. The depth at the bay mouth is about 80 m and becomes shallower toward the bay head linearly. Three natal rivers, Otsuchi River, Kozuchi River and Unosumai River, flow into the bay head.

Marine meteorological observation system has been operating since 1978 by OMRC of the University of Tokyo at the center and the north side in Otsuchi Bay. The parameters included seawater temperature in 5 layers of 1, 5, 10, and 15 m and meteorological components as wind velocity, precipitation, *etc* are monitored at 10 min interval on real time at the entrance hole of OMRC. Hourly mean or daily mean of 5 m-seawater temperature, wind speed and wind direction are used for analysis except daily-integrated precipitation.

Otsuchi Bay was divided into three areas; the bay mouth, the bay head and the river mouth. Then daily salmon catch of each area, which was calculated from the market statistics of stationary trap-nets, was discussed with marine meteorological conditions in 1996 and 1997.

The salmon catch in every area reached a peak of the fishing season when the seawater temperature became 13°C level in both years. The peak in the river delayed a few days compared with that in the bay moth in 1996 but it did not delayed in 1997. In 80% cases, the salmon catch at the day after the rainfall (>5 mm) or strong westerly wind (>10 m/s) became over 1.5 times larger than the previous day. The largest salmon catch in each year was observed at the day after the largest rainfall occurred, or the day after westerly wind (>10 m/s) blew for the longest period. These data suggest that the homing behavior of chum salmon was affected significantly by seawater temperature, rainfall, and westerly wind in Sanriku Coast.

Surprisingly, more than ten years before Hasler and Wisby (1950), Kubo (1938) has already reported the relationship between salmon catch and the weather condition in the Miomote

River, Niigata prefecture northern Japan, which located symmetrically against Otsuchi Bay in the river mouth direction. Miomete River flows into Japan sea and Otsuchi Bay is open toward the Pacific Ocean. Kubo (1938) concluded that the catch was influenced by snowfall and wind; a significant positive correlation between the catch and the amount of snow and "easterly" wind.

We can say that the fishermen's proverbs are worth believing.

Contamination and toxic impact of organochlorines and butyltins in mammals

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The present paper overviews the global contamination by persistent organochlorines and organotins, a representative group of endocrine disrupters, and their ecotoxicological implications on marine mammals.

The recent pattern of contamination by organochlorine residues in the coastal environment is prominent in tropical regions due to continuous usage in the low-latitude developing countries. The major emission source of organochlorines is probably located in the tropical belt and large quantities of volatilized contaminants are dispersed through the atmosphere of global terms. Reflecting this, a considerable contamination was observed in open ocean tropical waters as well as in the Arctic and nearby waters. The study of the mass transfer of organochlorines at the air-water interface suggests that the oceanic water bodies, particularly Arctic waters, act as a sink for persistent contaminants.

In this regard, the marine mammals, particularly cetaceans, are one of the animal groups receiving high concentrations of persistent organochlorines arising out of a worldwide contamination. They can amplify much greater amounts of toxic contaminants through feeding and also pass them in large quantities from one generation to the next through lactation. Unfortunately, these animals have a smaller capacity for degradation of these contaminants due to the specific mode of cytochrome P-450 enzyme systems. These drug-metabolizing enzyme systems may be related to the possible effects of persistent organochlorines, particularly coplanar PCBs. Furthermore, the residue levels of these contaminants in marine mammals are unlikely to decline in the near future.

Regarding organotin pollution, both cetaceans and pinnipeds showed the highest concentrations of butyltins (BTs) in the liver among various tissues and organs. In addition, noticeable high concentrations were found in the hair of pinnipeds, indicating possible excretion of BTs through shedding. BTs composition in mammals and their prey organisms suggested that pinnipeds have a stronger capacity to degrade BTs rather than cetacean. No age trend of BTs concentrations was observed in pinnipeds, while cetaceans showed increasing levels in immature growth stage. Comparing butyltin concentrations on various marine mammals, cetaceans retained higher butyltin concentrations than pinnipeds. The above specific accumulation patterns found in marine mammals are probably attributable to the lower breakdown capacity of BTs in cetaceans and the significant excretion of BTs through shedding in pinnipeds. Unlike organochlorines, comparable residue levels of butyltins were found in male and female of marine mammals. Such a trend suggested that butyltins are less transferable through gestation and lactation from mother to fetus/pup. On a global perspective of butyltin contamination in marine mammals, residue levels were found to be prominent in the coastal water of developed nations. The present contamination by BTs may pose a toxic threat to some coastal species of cetaceans.

Considering all these facts, it may be concluded that marine mammals are one of the most vulnerable and possible target organisms with regard to long-term toxicity of hazardous man made chemicals in the future.

Distribution, fates and effects of man-made organics in the aquatic environment

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I. *Distribution of selected man-made organics in the aquatic environments.*

We are surrounded by more than hundred thousands of man-made organics. Various species of wild animals as well as human are exposed to these chemicals. Field observations have been conducted about some organochlorine and organophosphorous compounds in the water of Western part of Japan including Lake Biwa, Yodo River basin, rivers in Osaka City and the harbor area of Osaka Port during these 20 years. The levels of organochlorines such as PCBs and HCHs in river water are decreasing year and year after the prohibition of application and use of these chemicals since 1972 in Japan. The concentration of PCBs and HCHs are less than 100 ng/L, generally. In place of these organochlorines,