主論文の要約

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Study on the monitoring methods for early warning of harmful organisms such as jellyfish and macroalgae near the water intake of the nuclear power plant

（原子力発電所取水口の周辺海域におけるクラゲ類・海藻類等有害生物の早期警戒のためのモニタリング手法に関する研究）

Nuclear power plants in coastal facilities use large amounts of seawater for cooling purposes. The presence of marine organisms in seawater tends to clog the cooling intake system and affects normal water intake. This study developed the database of harmful marine organisms and summarizes the monitoring methods for early warning of cooling water intake through extensive investigations and experiments. We outlined the monitoring methods in onshore, offshore, and aerial scales and suggested appropriate monitoring methods for different marine organisms.

The database in the area near Hongyanhe Nuclear Power Plants (NPP) was compiled by combining the historical information and ecological conditions of this power plant and its surrounding waters, as well as the monitoring and salvage situation in 2018-2020. The biological species that might threaten the safety of cooling water intake are summarized based on their biomass, distribution, ecological characteristics, and potential risks of outbreaks. These are primarily phytoplankton, such as *Phaeocystis globosa* and *Noctiluca scintillans*, that cause red tide; macroalgae, such as *Enteromorpha linza* and *Ulva pertusa*, cause green tide; jellyfish species of zooplankton, such as *Aurelia coerulea* and *Nemopilema nomurai*, that causes white tide. And nekton, such as *Acetes chinensis*, *Oratosquilla oratoria*, *Ammodytes personatus*, and *Engraulis japonicus*; macrobenthos, such as *Obelia* sp., *Musculus senhousia*. It was clear that macroalgae and giant jellyfish, in particular, have a significant impact on the safety of cooling water intake.

We suggested constructing a biological monitoring system within a radius of 30 km with the water intake of coastal facilities as the center. The monitoring for macroalgae in the intertidal zone where the majority of onshore water was conducted. Then, the monitoring with netting gear was performed for giant jellyfish, floating seaweeds, small fish, and shrimp in offshore waters. Aerial monitoring was also conducted based mainly on satellite remote sensing. It was supplemented by the survey with unmanned aerial vehicles that was done mainly concentrated within a 5 km radius, focusing on red tide, green tide, white tide, oil spills, and other large-scale abnormalities in watercolor.

From these results, we recommended the optimal monitoring methods for early warning of harmful organisms. These methods allow us to know accurate information about the growth and distribution of marine organisms that affect the safety of cooling water systems. It also provides suggestions for improvement of the first protective measure of the cooling water intake system - trash-blocking nets installation. This study would be a pioneer in the field of biomonitoring for the safe operation of the nuclear power plant. In addition, the monitoring methods developed in this study could also be applicable to other coastal facilities, such as thermal power plants that require seawater for cooling purposes.