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Effect of Thermal Discharge from Semiconductor Factory into Stream on Freshwater Fish

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Abstract

The study was conducted in Manu-stream, located in Paju, Gyeonggi-do, from January 2021 to December 2021. The survey points were selected in the upper and lower streams based on where thermal discharged to investigate water temperature and fish species and biological community analysis and growth rate were analyzed. The average annual water temperature difference between the upper and lower stream is about 11.0℃, and in the case of the lower stream area, the water temperature is maintained at 20.0℃ or more per year. Fish that appeared during the survey period decreased lower stream compared to the upper stream, which is believed to be the result of a decrease in temperature-sensitive species as the simple riverbed structure and water temperature increased compared to the upper stream. As a result of biological community analysis, it showed a relatively stable community state at the upper stream. The growth rate of fish has a high regression coefficient b value in lower streams throughout the four seasons. It showed relatively good growth lower stream, with a high water temperature. However, the results of each survey point are similar from season to season. The indicator species is a resistant intermediate species, and the range of resistance to water temperature is wide, so it is judged that water temperature's effect on the indicator species' growth is low.

Keywords*: Freshwater Fish, Thermal discharge, Stream*

1. INTRODUCTION

During the recent industrialization process, a large amount of hot drainage has been discharged into streams and oceans. Hot drainage refers to discharged water discharged to nearby streams and lakes at a temperature higher than natural water used in cooling water, hot springs, and wastewater treatment plants used in power plants. Hot drainage is described as artificial discharge water with an excessively higher temperature than natural water, damage to the ecosystem, or potential for risk, and the impact can be further increased by relatively increasing disruption in small streams with low flow rates[1,2,3]. Due to the discharge of hot drainage in winter, when the water temperature is seasonally low, environmental problems such as interference with stream freezing, mass death of fish, fog generation, and disturbance of aquatic ecosystems continue to occur[4,5].

Water temperature is one of the most important components in the environment, determining physical

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properties and interacting with the relationship between aquatic ecosystems and physiology and ecology, and biological and chemical fluctuations[2,6,7,8,9,10]. The effect of water temperature on streams was found to decrease as stream order increased due to various environmental variables involved[10,11]. In addition, fish are physiologically affected by water temperature as a representative temperature-changing animal, and when it exceeds each resistant temperature range, it moves or disappears to other parts of the stream, and species composition in the stream is simplified[12].

Hot drainage discharged into streams can cause changes in the aquatic ecosystem and have a lot of effects, so it is necessary to analyze the degree of impact through this study and actively respond to changes in the ecosystem.

2. SUBJECTS AND METHODS OF STUDY

2.1 Study Area and Survey Period

Manu-Stream, located in Paju, Gyeonggi-do, was selected and investigated among streams where Hot drainage is discharged from domestic semiconductor factory complexes. The on-site survey period was conducted four times, once per season, for about a year in 2021, The water temperature measurement period was measured on an hourly basis from January 2021 to December 2021. Among the collected data, only the data excluding some abnormal values were used in this paper.

2.2 Method of Study

The survey point was selected from the discharge port to the upper and lower streams, and HOBO was installed to investigate the water temperature, During the survey period, data recorded periodically were collected by automatically measuring every hour. Also, seasonal surveys of fish were collected using nets(7x7mm) and skimming nets(5x5mm), the collected fish were identified and classified at the site, species and populations were identified, and then released.

The biological community analysis was calculated based on the species and populations that appeared through the survey, and the population growth rate was calculated using the body length-weight correlation to analyze the effect of high-temperature hot drainage through a comparison of growth conditions for indicator species collected at the survey site. The fish's growth can determine the fish's health status and is used as an indicator of various information.

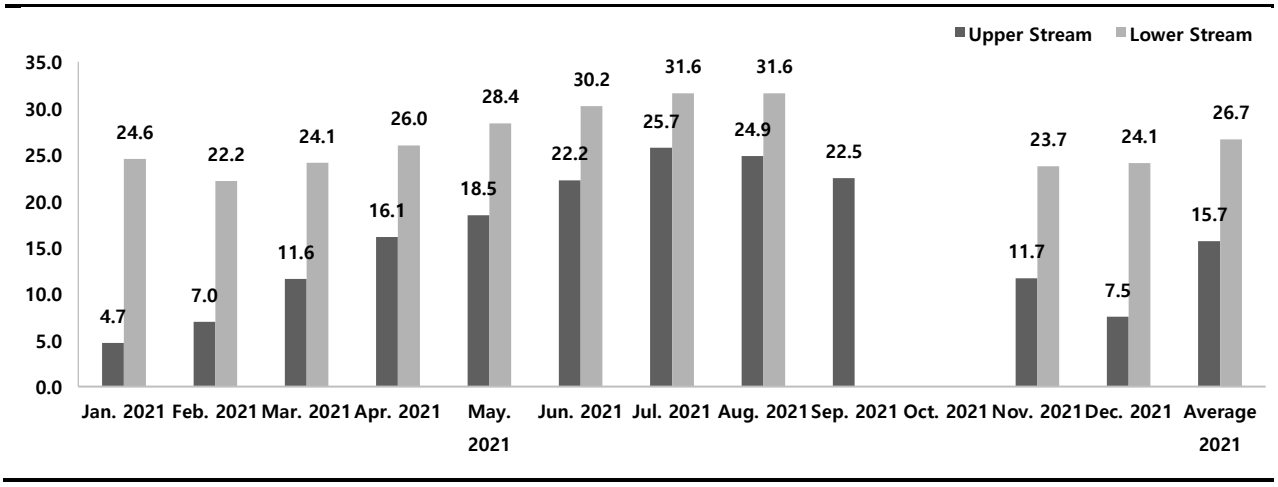
3. RESULTS

3.1 Water temperature distribution status

As shown in Figure 1, the average monthly water temperature upper stream is distributed from a maximum of 25.7℃ in July 2021 to a minimum of 4.7℃ in January 2021, with an annual average of 15.7℃. The average monthly water temperature lower stream is distributed from a maximum of 31.6℃ in August 2021 to a minimum of 22.2℃ in February 2021, and an annual average of 26.7℃. The average annual water temperature difference between the upper and lower stream is about 11.0℃, and in the case of the lower stream area, the

water temperature is maintained at 20.0℃ or more per year.

Figure 1. Water temperature distribution status



3.2 Freshwater fish appearance status and biological community analysis results

During the survey period, there were 4 to 8 species of fish that appeared upper stream, A total of 146 populations of 4 families 10 species appeared. During the survey period, there were 4 to 5 species of fish that appeared lower stream, A total of 155 populations of 3 families 7 species appeared. In both upper and lower streams, minnows accounted for the majority of the population, The number of species decreased in the lower stream area. Compared to the upper stream, the riverbed structure in the lower stream is mostly composed of sand, so various habitats have been reduced, It is judged to be the result of a decrease in temperature-sensitive species as the water temperature increases lower stream.

As shown in Table 1, as a result of biological community analysis, the dominant index was analyzed as 0.78 in the upper stream and 0.86 in the lower stream. The diversity index was analyzed as 1.17 in the upper stream and 0.90 in the lower stream. The richness index was analyzed as 1.81 in the upper stream and 1.19 in the lower stream. It shows a relatively stable community structure in the upper stream than the lower stream, It was analyzed that the lower stream showed an unstable community structure with high dominance index and low diversity index, and richness index.

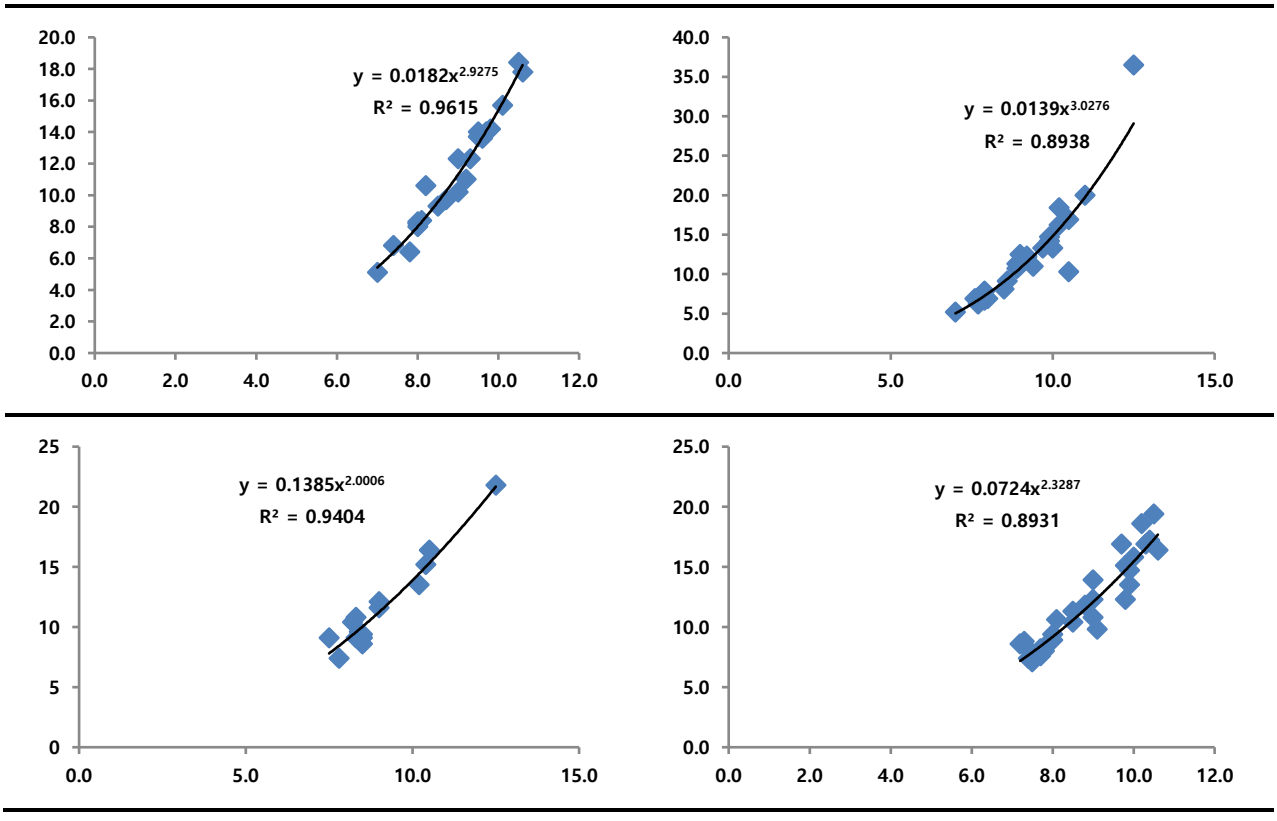
Table 1. Freshwater fish appearance status and biological community analysis results

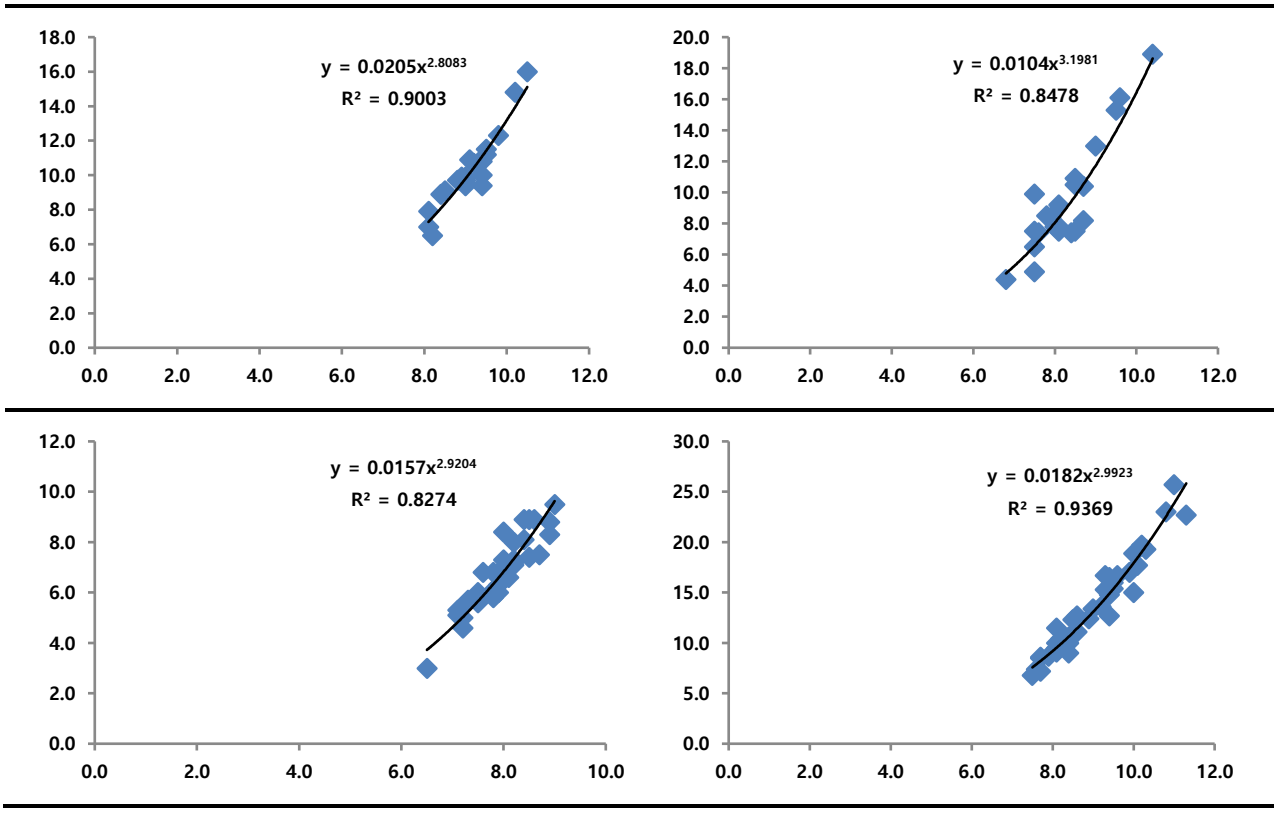
	Upper stream	Lower stream
The number of species	10	7
population	146	155
Dominance Index	0.78	0.86
Diversity Index	1.17	0.90
Richness Index	1.81	1.19

3.3 Freshwater fish growth rate

As shown in Figure 2, The degree of growth of freshwater fish is determined based on the regression coefficient b value 3.0 to determine whether it is obese or not compared to the length of the fish. As a result of analyzing the total length-weight correlation by survey point, the regression coefficient b value was 2.9275 (spring), 2.0006 (summer), 2.8083 (autumn), and 2.9204 (winter) upper stream, the lower stream was 3.0276 (spring), 2.3287 (summer), 3.1981 (autumn), and 2.9923 (winter). Except for summer, it was analyzed at a value close to 3.0 in the remaining three seasons, showing good growth conditions, In all seasons, the regression coefficient b value was higher lower stream than the upper stream, showing relatively good growth conditions in the lower stream where the water temperature was high. However, considering that the analysis results by survey point are similar by season, *Zacco platypus* are resistant intermediates and have a wide range of resistance to water temperature, so it is judged that the effect of water temperature on the growth of *Zacco platypus* is low.

Figure 2. The growth rate of Zacco platypus





4. CONCLUSIONS

In this study, we investigated the effect of thermal discharge on freshwater fish through y. Through this, it is possible to see changes in fish according to water temperature and analyze the degree of disturbance of the river ecosystem to set more accurate goals such as river restoration and biodiversity improvement. In the future, it is expected that clearer goals can be set through continuous and complex surveys on the aquatic environment and aquatic ecosystem.

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