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Research Proposal for Investigation and Assessment of the Fishing Ban Effect on Songjiang Perch in the Fuyang Section of the Qiantang River Based on Broadband Acoustic Technology

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ABSTRACT

Songjiang perch (Trachidermus fasciatus) is a catadromous fish with important ecological and conservation value in the Qiantang River, and it is also a national Class II protected wild animal. To evaluate the protection effect of the fishing ban period on Songjiang perch in the Fuyang section of the Qiantang River, this study intends to use a broadband scientific echosounder to measure the acoustic characteristics of Songjiang perch by the controlled method and the modeling method, and to conduct two acoustic surveys at night in May and July in the Fuyang section of the Qiantang River. Based on the broadband acoustic characteristics of Songjiang perch, fish targets in the survey data will be screened, and their quantity distribution will be analyzed. The target strength–body length and body mass relationships will be used to evaluate the individual mass of Songjiang perch and analyze its mass distribution, thereby estimating its resource abundance and evaluating the protection effect of the fishing ban period on the Songjiang perch population. This study can provide technical support for resource monitoring, habitat protection, and fishing ban management of the Songjiang perch in the Fuyang section of the Qiantang River.

KEYWORDS

Songjiang perch; Fuyang section of the Qiantang River; fishing ban effect; broadband acoustics; target strength; resource assessment

1. INTRODUCTION

Songjiang perch (Trachidermus fasciatus Heckel), also known as the four-gill perch, belongs to the genus Trachidermus, family Cottidae, order Scorpaeniformes. It is a cold-temperate, estuarine, benthic, marine–freshwater migratory fish. It has high nutritional value and is reputed to rank first among China's "four famous freshwater fishes." The Songjiang perch lives a benthic life and is habituated to nocturnal activity, mainly feeding on crustaceans, small fish, and shrimp. Its common body length is 50–170 mm. Songjiang perch grows and fattens in freshwater, inhabiting the bottom layer of clear flowing water. It hides at the bottom during the day and becomes active at night. Its lifespan is only one year, and the spawning population depends entirely on recruitment from juveniles, making it highly susceptible to natural environmental and anthropogenic disturbances and causing large fluctuations in population size. At present, Songjiang perch has been listed as one of the ten first-class species in the "List of Priority Fish Species for Protection" in the China Biodiversity Conservation Action Plan, and it is protected as a national Class II protected wild animal.

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The Fuyang section of the Qiantang River is one of the important distribution areas of the Songjiang perch. In recent years, to protect the population of Songjiang perch in the Fuyang section of the Qiantang River, Fuyang District of Hangzhou has established a provincial aquatic germplasm resources conservation area for triangular bream and Songjiang perch, and has carried out stock enhancement and release of Songjiang perch every year, with an average annual release of more than 10,000 individuals. According to the relevant regulations of the Department of Agriculture and Rural Affairs of Zhejiang Province on fishing bans in eight major river basins, since March 1 each year, the Qiantang River, Oujiang River, Jiaojiang River, Yongjiang River, Feiyun River, and Aojiang River basins enter the fishing ban period; the Tiaoxi and Yunhe River basins have a year-round fishing ban. During the fishing ban period from March to June 2024, fisheries law enforcement agencies at all levels carried out large-scale fishing ban enforcement inspections, confiscated illegal catches, cleaned up illegal fishing gear, banned illegal "three-no" fishing vessels, handled administrative cases, and apprehended 1,923 persons involved, with administrative fines of 1.462 million yuan and 142 persons transferred for judicial handling. These management measures have a potential role in the recovery of rare fish resources such as the Songjiang perch, but their ecological effects still require scientific assessment.

Traditional fish resource survey methods usually rely on large-scale biological sampling, which is obviously not feasible for endangered species. Acoustic surveys have the advantages of comprehensive coverage, no damage to biological populations, and strong spatiotemporal continuity, making them particularly suitable for abundance surveys of the Songjiang perch population in the Fuyang section of the Qiantang River. In recent years, broadband acoustic technology has developed rapidly. With the new-generation scientific echosounder (SIMRAD, EK80, Norway), acoustic surveys have developed from "black-and-white photographs" in the past to “color photographs,” enabling the acquisition of the acoustic frequency spectrum of every fish covered in the survey and greatly improving target identification ability. Therefore, this study intends to combine the controlled method and the modeling method to study the acoustic characteristics of Songjiang perch and to conduct nighttime acoustic surveys to evaluate the protection effect of the fishing ban period on Songjiang perch in the Fuyang section of the Qiantang River.

2. MATERIALS AND METHODS

2.1. Study Area and Target Species

The study area is the Fuyang section of the Qiantang River. This river section is located in Fuyang District, Hangzhou, and is an important ecological node in the Qiantang River basin, as well as the location of the provincial aquatic germplasm resources conservation area for Songjiang perch. The target species is Songjiang perch. Songjiang perch is a small, benthic, catadromous fish that is active at night, has no swim bladder, and has a relatively small acoustic target strength. Its parent fish begin to migrate back to the estuary in November each year, reproduce in the nearshore area of the estuary, and then move from the estuary to shallow sea to spawn. The peak spawning period is from late February to early March. From late April, juveniles begin to migrate upstream from nearshore waters into freshwater. The nearshore abundance of juvenile Songjiang perch peaks in May and ends in June.

2.2. Measurement of Acoustic Characteristics of Songjiang Perch

This project uses a combination of the controlled method and the modeling method to measure the broadband acoustic characteristics of Songjiang perch.

Controlled method: After being anesthetized, Songjiang perch is fixed in the acoustic beam with a thin line, and its acoustic characteristics are measured using a broadband scientific echosounder. This method can directly obtain the backscattering signal of live fish under controlled conditions.

Modeling method: According to acoustic scattering theory and the biological characteristics of Songjiang perch, an individual fish is approximated as a spatial regular model, and its acoustic characteristics are simulated and calculated on a computer. Commonly used scattering models include exact analytical models, accurate numerical models, and approximate analytical models. Among them, KRM (Kirchhoff Ray Mode) is widely used. The KRM model was first conceived by Clay and Horne (1992) to describe the backscattering of Atlantic cod (Gadus morhua) and has since been further developed and applied to many fish species. The KRM model calculates the backscattering of the whole fish as the sum of the backscattering of a group of gas-filled or liquid-filled cylinders that together represent the whole fish. It considers the reflection coefficients at the front and rear interfaces between cylinders and requires relatively little computational work. By performing X-ray scans on the dorsal and lateral sides of the fish, 3D morphometric measurements of the fish and fish body can be constructed respectively and used as input for the KRM model.

This study will combine the measured results of the controlled method with the simulation results of the modeling method to verify each other and ensure the reliability of the acoustic characteristic parameters of the Songjiang perch.

2.3. Acoustic Survey Design

The acoustic surveys in this project are arranged at night in May and July. May is the period when the nearshore abundance of juvenile Songjiang perch peaks, and July can further supplement the investigation of the growth and distribution of Songjiang perch in freshwater. A broadband scientific echosounder (SIMRAD EK80, Norway) will be used in the survey, and field surveys can be completed by chartering local vessels. No biological sampling of Songjiang perch will be conducted during the survey to avoid harming the protected species.

2.4. Data Processing and Resource Assessment

Acoustic data will be post-processed using the Echoview software. The project team has purchased ECHOVIEW software and completed two upgrades, ensuring that the latest software version and data modules can be used. The data processing steps include:

Using the broadband acoustic characteristics of Songjiang perch as the basis to screen Songjiang perch fish targets in the acoustic data;

Counting the number of individual Songjiang perch and studying their quantity distribution;

Using the relationship between target strength and body length and body mass to evaluate the individual mass of Songjiang perch;

Analyzing the mass distribution of Songjiang perch;

Estimating the fishery resource abundance of Songjiang perch in the Fuyang section of the Qiantang River;

Combining the background of fishing ban management to evaluate the protection effect of the fishing ban on Songjiang perch.

The technical route can be summarized as follows: controlled method + modeling method → measurement experiment of broadband acoustic characteristics of Songjiang perch; acoustic survey of fishery resources in the Fuyang section of the Qiantang River (night survey in May and night survey in July) → screening of Songjiang perch targets in acoustic data → individual quantity and body length assessment by target strength → fishery resource abundance of Songjiang perch → acoustic investigation and assessment of the fishing ban effect on Songjiang perch in the Fuyang section of the Qiantang River.

3. EXPECTED RESULTS

Obtain broadband acoustic characteristic parameters of Songjiang perch and verify them mutually through the controlled method and the KRM modeling method;

Establish a method for screening Songjiang perch targets based on broadband acoustic characteristics;

Obtain the quantity distribution characteristics of Songjiang perch at night in May and July in the Fuyang section of the Qiantang River;

Use target strength to evaluate the individual body length and body mass of Songjiang perch and obtain their mass distribution;

Preliminarily evaluate the protection effect of the fishing ban period on the resource abundance of Songjiang perch in the Fuyang section of the Qiantang River.

4. DISCUSSION

4.1. Advantages of Acoustic Surveys in Monitoring Endangered Fish

The Songjiang perch is a national Class II protected wild animal, and traditional sampling methods may harm its population. Acoustic surveys have the advantages of not damaging organisms, wide coverage, and strong repeatability, making them suitable for resource monitoring of endangered fish such as the Songjiang perch. In particular, broadband acoustic technology can provide frequency information and improve target identification ability, providing a new technical means for screening Songjiang perch targets.

4.2. Difficulties in Studying the Acoustic Characteristics of Songjiang Perch

Songjiang perch is relatively small and has no swim bladder, and its acoustic target strength is weak, which brings certain difficulties to acoustic detection and target identification. However, existing broadband scientific echosounders have high sensitivity. In previous studies, good results have been obtained for weak scattering targets such as Acetes shrimp and jellyfish. Therefore, the acoustic characteristics of Songjiang perch can be measured and studied. Obtaining measured data through the controlled method and verifying it with the KRM model can improve the reliability of acoustic characteristic parameters.

4.3. Ecological Significance of Evaluating the Fishing Ban Effect

The Fuyang section of the Qiantang River has established a provincial aquatic germplasm resources conservation area for Songjiang perch and continues to carry out stock enhancement and release. The fishing ban system can reduce fishing pressure and provide a window period for juvenile Songjiang perch to migrate upstream and grow. Through two acoustic surveys in May and July, the changes in the quantity and mass distribution of Songjiang perch after the fishing ban period can be preliminarily understood, providing baseline data for subsequent long-term monitoring and optimization of protection measures.

4.4. Limitations and Prospects

Conducting only two acoustic surveys in May and July makes it difficult to fully reflect the annual dynamics of Songjiang perch. In the future, multi-year monitoring, environmental DNA, traditional fishery resource surveys, and habitat assessment should be combined to build a comprehensive monitoring system for Songjiang perch, providing a more comprehensive scientific basis for

population recovery and fishing ban management of Songjiang perch in the Fuyang section of the Qiantang River.

5. CONCLUSION

This project intends to take the Songjiang perch in the Fuyang section of the Qiantang River as the research object, and use the controlled method and modeling method to measure its broadband acoustic characteristics, conduct acoustic surveys at night in May and July, screen Songjiang perch targets, analyze their quantity distribution and mass distribution, and thereby evaluate the protection effect of the fishing ban period on Songjiang perch. This study can provide technical support for resource monitoring, formulation of protection measures, and assessment of fishing ban effects for Songjiang perch in the Fuyang section of the Qiantang River, and is of great significance for the conservation of rare and endangered fish.

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