

Analysis on Awareness of Fishermen in Lake Biwa and their Desired Fishery Promotion Projects

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【abstract】

This study focused on the relationship between expected fishery promotion projects and personal attributes. A questionnaire survey was given to the fishermen belonging to the fishery cooperatives implementing the Multifaceted Fishery Measures at Lake Biwa. Among the seven fishery projects, fishermen tended to select the project regarding the improvement of water quality and removal of anomalously grown aquatic plants the most, followed by fishing ground maintenance, juvenile fish stock, harmful foreign fish extermination, fishery products promotion, nurturing successors, and Great Cormorants extermination. The result of the regression analysis revealed the following points. Fishermen in the southern Lake Biwa and those who achieved higher catch placed importance on the water quality project. The older fishermen showed higher preference to the foreign fish extermination project. Whereas, fishermen in the northern Lake Biwa and younger fishermen tended to consider the fisheries-product promoting project the most important. In addition, the Multifaceted Fishery Measures did not significantly affect the selection of fishery promotion projects. We conclusively show the quantitative relationship between desired fishery projects and different positions.

【keywords】

Lake Biwa, ordered logit model, questionnaire survey, fishery promotion project

1. Introduction

Currently, fisheries and the fishing villages in Japan have various problems. According to Japanese Fisheries Agency (2013), the total production of fisheries and

aquaculture industries has been decreasing from 12.82 million tons at the peak in 1984 to 4.86 million tons in 2012. In addition, the production amount was 2,977.2 billion yen at the peak in 1982 and decreased to 1,417.8 billion yen in 2012. The number of workers in fisheries in 2012 (excluding workers in Iwate, Miyagi, and Fukushima) decreased by 2.4% from the previous year to 174,000. The number of workers aged 65 and older increased by 0.8 % which makes a 36.9 % increase compared to the previous year. These data show that the number of workers in fisheries is decreasing and aging increasing. In addition, the price of fuel has risen sharply in the past decade due to various factors such as increased demand in emerging countries, conditions in oil producing countries, and fluctuation in exchange rates. These changes affect the fisheries because fuel accounts for the majority of their cost.

Fishing villages are known not only to be places of food production but also to have multifaceted functions. Industries of agriculture, forestry and fishery have important roles other than supplying food products, such as preservation of environment, protection of landscapes and prevention of disasters. Multifaceted preservation measures have been carried out by direct payment, mainly to the regions which have conditional disadvantages. Measures to preserve multifaceted functions of the fishery have already been implemented because of the importance of their roles, several studies have been conducted (e.g., Furuya *et al.* (2006), Shima (2009)). Under the circumstances mentioned, in order to support fisheries, Multifaceted Fishery Measures began from 2013 to 2015 in Japan. These conducted fishery projects which have been supporting activities for local initiatives, were aimed at demonstrating ‘original multifaceted functions’ of fisheries and fishing villages.

In Lake Biwa, which is the largest lake in Japan, fisheries have been operated by traditional methods (Azuma (2013)). In addition, some traditional food cultures using endemic fish of Lake Biwa such as *Funazushi*, a rare type of fermented sushi of carp, still exist (Tsukamoto (2013)). Lake Biwa is known for the production of *Ayu* (*Plecoglossus altivelis*) cultivation seedlings, and revenue from *Ayu* hauls is one of the largest incomes for fishermen in Lake Biwa. However, the amount of catch is decreasing due to the development of the lake-shore after the period of rapid economic growth, declining water quality by eutrophication, feeding damages by invasive foreign fish and Great Cormorant, and anomalous growth of aquatic plants. Particularly feeding damage by foreign fish has become a serious problem since 1980s. Extermination of foreign fish is important not only for fisheries but also for the aspect of environmental preservation. Therefore, studies on foreign fish extermination in various aspects are

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conducted (e.g., Nakao *et al.* (2006)). Currently, the Shiga Prefecture Office conducts projects regarding the extermination of invasive foreign fish (Yoshioka *et al.* (2012)). They also established a system that affiliated fishery cooperatives buy those captured fish. The effectiveness of this project has been pointed out in previous studies (e.g., Yamada *et al.* (2013)).

Lake Biwa is mainly comprised of two basins. The part of the lake to the north of the 'Biwako Ohashi' Bridge, which was built at the narrowest point, is called the Northern Lake, while the part to the south is called the Southern Lake. The Southern Lake is small (about 51.6km²) and shallow (mean depth of about 4m). The urban area such as Otsu city exists around there. In addition, it is reported that submerged macrophytes in the Southern Lake are increasing excessively (Haga (2008)). The Northern Lake has a larger (about 11 times of the Southern Lake) and deeper (mean depth of about 43m) water body than the Southern Lake. Therefore, the characteristics of the fishery in the Northern Lake is different from that in the Southern Lake.

In addition to the change of the environment of fisheries mentioned, there are various problems such as a decrease of the lake's fish product consumption because of dietary diversification, distribution of cheap imported marine products, and aging of workers in fisheries. Maintenance of the fishing ground and juvenile fish stock also were carried out in Lake Biwa. Fujiwara *et al.* (2012) evaluated the validity of labeled *Nigorobuna* (*Carassius auratus grandoculis*) stock. Furthermore, the economic effect of juvenile fish stock by the cost-benefit ratio was clarified. As a result, it was revealed that the discharge into reed belt is effective and it is more effective when released into the larger reed band. Although previous studies determined the effect of each project on fishery promotion in Lake Biwa, comprehensive assessment of the fishery promotion has not been found. When considering fishery promotion, it is clear that the opinions from each fisherman are important. However, it is difficult to analyze the differences in each position from the interview with the representatives of the fishery cooperatives. Therefore, the differences of projects which each fisherman desires by different standpoints are not clarified.

In this study, a questionnaire survey is given to fishermen in Lake Biwa to clarify the sequence of fishery promotion projects that fishermen expect, showing their satisfaction and anxiety for fisheries in Lake Biwa. In particular, the quantitative relationship between different positions by fishermen and actual fishery promotion projects implemented are described. Considering the difference in their positions, fishery promotion projects are discussed and suggested according to the result of the analysis.

2. Methods

As a preliminary survey, interviews were conducted on the Fishery Division of the Shiga Prefecture Office on December 10, 2013 and Shiga Federation of Fisheries Cooperatives (Shiga FFC) on June 18, 2014. At the interview at Fishery Division of Shiga Prefecture Office, projects on fisheries at Lake Biwa and the current extermination situation of harmful invasive foreign fish were asked. At Lake Biwa, 'New Strategy Plan of Agriculture and Fishery of Shiga' was set up, and variety of projects were conducted: including improvement of natural productivity by maintaining and conserving the fishing and breeding ground, increase production of fishery resources, preservation through extermination of foreign fish, and sustainable development of the fishery industry. In addition, it was found that there are several Fishery Cooperatives which conduct projects under the Multifaceted Fishery Measure which is a Project responding to fulfillment of multifunctional roles for fisheries supported by the Government of Japan. The fishery projects which have been supporting activities for local initiatives, aimed at demonstrating "original multifaceted functions" of fisheries and fishing villages.

Meanwhile, an interview was held with Shiga FFC on the characteristics of the Fishery Cooperative and the status of efforts toward the Fishery Projects at Lake Biwa. The interview survey revealed that feeding damage by foreign fish used to be a major issue in Lake Biwa, however currently, the project on foreign fish extermination has been carried out smoothly. This project was started in 1985 and established a system to use foreign fish (extermination, collection, processing and/or fish powderization). In addition, 22 out of 36 fishery cooperatives in Lake Biwa took part in the Multifaceted Fishery Projects, and it was found that the activities differed depending on each fishery cooperative. It can be assumed that they have high motivation in the fishery, since they conduct and apply the activities by themselves. The survey was conducted on eight fishery cooperatives among 22 according to their geographical distribution as follows: Isoda Fishery Cooperative (Isoda FC); Imazu Fishery Cooperative (Imazu FC); Okishima Fishery Cooperative (Okishima FC); Katada Fishery Cooperative (Katada FC); Kosei Fishery Cooperative (Kosei FC); Seta-cho Fishery Cooperative (Seta FC) Notogawa Fishery Cooperative (Notogawa FC); and Moriyama Fishery Cooperative (Moriyama FC). Their locations are shown in figure 1.

The survey in this study was an interview of representatives of each cooperative and a questionnaire for fishermen belonging to the target fishery cooperatives distributed

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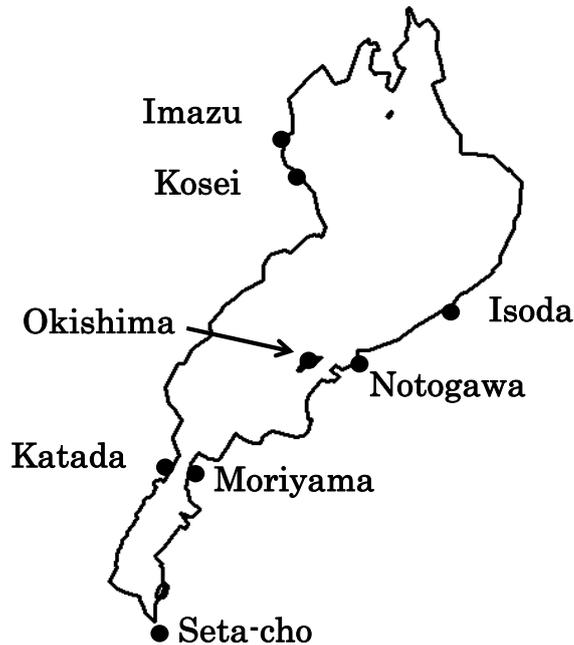


Figure 1 Location of Survey

in October and December of 2014. The contents of interviews are the current situation and problems of fishery at each fishery cooperative, and the activities carried out under the Multifaceted Fishery Projects. The questionnaire forms were given to the fishery cooperatives at the interview and the forms were collected by mail later. A total of 106 questionnaire forms were distributed, and the number of valid responses excluding unanswered and incorrect answers was 80. The questionnaire survey included age, sex, name of affiliated fishery cooperatives, membership (regular or non-regular)⁽¹⁾, employment status (full-time or part-time)⁽²⁾, personal attributes of catch and satisfaction for fishery, anxiety on continuing fishery, and desired fishery projects. The amount of catch is evaluated as follows: less than one million yen; between one million and two million yen; between two million and three million yen; between three million and four million yen, and four million yen and more. Satisfaction for fishery and anxiety for continuing fishery are evaluated with a five-point method as follows: strongly disagree; disagree; neutral; agree; strongly agree. In the questionnaire, seven projects were presented based on actual projects which have been conducted in Lake Biwa, and the full rank of their preference for the project was asked. As noted previously, in Lake Biwa, under the plan of the New Strategy of Agriculture and Fisheries Industry, four goals were set such as improvement of natural productivity by maintaining and conserving the fishing and breeding ground, increasing fish production, preserving

fishing ground by extermination of harmful invasive species, and sustainable development of fishery industry. Although alternatives were set based on these four plans, the alternative of preserving fishing ground by extermination is further separated into harmful invasive foreign fish extermination and Great Cormorant extermination. Specifically, alternatives were projects on improvement of fishing ground (FG Improvement), project on stock of juvenile fish (Fish Stock), project of foreign fish extermination (Fish Extermination), project on Great Cormorant extermination (GC Extermination), and project on nurturing successors who lead the fishery (Nurturing Successors). In addition, “PR project on fishery products” (Product PR) was added as one of the alternatives because there were some promotion seminars, promotion activities of the conventional foreign fish, and Funazushi cooking classes. Furthermore, one other alternative which was “water improvement project including removal of aquatic plants (WQ Improvement)” was added because they follow the area-wide water pollutant regulation to preserve the water quality against eutrophication, and aquatic plants has been actively removed under the Multifaceted Fishery Project. Thus, the total number of alternatives was seven. Data collected in the questionnaire survey were analyzed using regression analysis. The relationship between satisfaction to fishery and the personal attributes was estimated using the Ordered Logit Model (OLM). Similarly, the relationship between anxiety to continuing fishery and the personal attributes was presumed. Satisfaction and anxiety were calculated according to the explanatory variables 1 to 5 (‘strongly disagree’ to ‘strongly agree’). Regarding the affiliated fishery cooperatives, dummy variables were set to ‘0’ for the Northern Lake (north part of Lake Biwa) and ‘1’ for the Southern Lake (south part of Lake Biwa), and employment status were set to 0 for full-time and 1 for part-time. The catch (1,000 yen) gave the class mark for each class, and 4 million yen or more was considered as 4.5 million yen. Similarly, the relationship between ranking data of the Fishery Projects which fishermen desire and the personal attributes were examined, and they were measured by the use of OLM and the Rank-Ordered Logit Model (ROLM). The affiliated fishery cooperatives and their employment status are assumed to be similar dummy variables, with low catch (less than 3 million yen) as 0, high catch (3 million yen or more) as 1. The reason for using 3 million yen as a standard value was that the frequency distribution became bi-modal with 3 million yen as the boundary which will be described later. We used the polr function implemented in the MASS library of the R package in OLM and mlogit function implemented in the mlogit package in ROLM.

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Table 1 Result of interview survey to the fishery cooperatives

Name	Location	Problems	Projects under Multifaceted Fishery Project
Imazu	Takashima [N]	shortage of successors	conservation of bottom of lake, cleaning of lake shore, removal of aquatic plants
Kosei	Takashima [N]	continuation of fishery cooperatives	cleaning of lake-shore, monitoring, harvesting of reed, and transmission of traditional food culture
Isoda	Hikone [N]	weak consumer preference for freshwater fish and shortage of successors	appointing preservation, cleaning of lake-shore, and providing <i>Funazushi</i> class
Notogawa	Higashi-omi [N]	aging of fishermen and small size of fishing ground	appointing preservation, cleaning of lake-shore, offering opportunities for education and enlightenment
Okishima	Omi-hachiman [N]	shortage of successors, anomalous growth of aquatic plants and difficulties of male fishermen in getting married	conservation of bottom of lake, cleaning of lake shore, removal of aquatic plants, protection of reed band, and providing <i>Funazushi</i> Classes
Moriyama	Moriyama [S]	low in catch	conservation of bottom of lake, removal of aquatic plants, and offering fishery experience
Katada	Otsu [S]	shortage of successors, fishing environment (aquatic plants, invasive foreign fish)	offering fishery experience, extermination of foreign fish, and removal of aquatic plants
Seta-cho	Otsu [S]	anomalous growth of aquatic plants	removal of aquatic plants, and offering fishery experience

Note: N and S in parentheses mean that it is located in the Northern Lake and in the Southern Lake, respectively.

3. Results

Firstly, the results of the interview survey to the representatives of eight fishery cooperatives are shown in Table 1. In the problems the fishery cooperatives faced, the successor shortage was the most commonly mentioned. In addition, some fishery cooperatives consider the aging of the workers as a problem as it is difficult for them to continue organizing fishery cooperatives. Thus, they are assumed as critical issues. Furthermore, it is pointed out that Isoda FC and Moriyama FC are concerned with the decline in catch and lowered income. Katada FC, Seta FC and Okishima FC are dealing with serious anomalous growth of aquatic plants; therefore, it is suggested that the deterioration of the fishery is also a problem in the fishery. Various activities such as cleaning, conservation of fishing grounds, enlightenment activities of the environment and fishery were carried out in the Multifaceted Fishery Project. Five fishery cooperatives are working on the cleaning of lake-shore and removal of aquatic plants. Some fishery cooperatives listed enormous growth in aquatic plants, thus it is inferred that there are efforts utilizing the fishery project to solve these problems. The fishery experience activity was mainly targeted at local elementary school students. In the fishery experience activities, besides learning about fishery, tasting local fish products (e.g., miso soup using Seta Shijimi, freshwater clam domestically grown in this area) were also exhibited as promotion of fishery.

To understand opinions of individual fisherman, a questionnaire was given on awareness for fishery in Lake Biwa and fishery promotion projects which fishermen desire. Responded numbers of each attribute were shown in Table 2. The majority of respondents were men and regular members. The ages of respondents were mainly

Table 2 Responded numbers of each attribute

Sex	Male	79	Fishery Cooperative	Imazu	9
	Female	1		Kosei	5
Membership	Regular	78	Fishery Cooperative	Isoda	11
	Non-regular	2		Notogawa	5
Employment Status	Full-time	46	Fishery Cooperative	Okishima	10
	Part-time	34		Moriyama	9
Participation in the Multifaceted Fishery Project	Yes	70	Fishery Cooperative	Katada	8
	No	10		Seta-cho	23
Age	30s and 40s	5	Fish catch revenue	<¥1M	43
	50s	12		¥1M - ¥2M	11
	60s	31		¥2M - ¥3M	5
	70s	26		¥3M - ¥4M	9
	80s	6		>¥4M	12

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comprised in their 60s and 70s and the average was 66.5 years old. Focusing on the amount of catch revenue of respondents, fishermen with a fishing catch of less than 1 million yen accounted for the majority. Although there were differences in the number of responses among fishery cooperatives, there were 40 respondents in the Southern Lake and the Northern Lake respectively. In addition, 70 of the 80 responses were involved in the Multifaceted Fishery Project, therefore the participation ratio of the fishery projects became 87.5%.

Table 3 shows the frequency of alternatives for two questions (the satisfaction for fishery and anxiety about continuation of fishery). Regarding satisfaction, there were 46 fishermen which were more than half of all the respondents who answered “strongly

Table 3 Results of satisfaction and anxiety to fishery

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Satisfaction to fishery	5	8	21	32	14
Anxiety to continuing fishery	3	3	7	39	28

Table 4 Result of OLM for satisfaction to fishery

	Coefficient	Std. Error
Age	-1.67×10^{-2}	0.023
Catch (1,000yen)	5.26×10^{-4} ***	0.002
Employment Status	-0.151	0.473
Area	-0.089	0.417
Number of data		80
Likelihood ratio test statistic		14.801
P-value		0.00513

Note: * shows $p < 0.05$, ** shows $p < 0.01$, and *** shows $p < 0.001$.

Table 5 Result of OLM for anxiety to continuing fishery

	Coefficient	Std. Error
Age	-4.06×10^{-3}	0.023
Catch (1,000yen)	-6.70×10^{-6}	0.002
Employment Status	1.013 *	0.506
Area	0.828	0.455
Number of data		80
Likelihood ratio test statistic		8.050
P-value		0.0898

Note: * shows $p < 0.05$, ** shows $p < 0.01$, and *** shows $p < 0.001$.

agree” or “agree”. However, there were 34 fishermen whose responses differed from that. Regarding their anxiety, 67 answered “strongly agree” or “agree” which accounted for about 83.8% of the total. In other words, although the fishermen were satisfied with the fishery, but not entirely leading to many fishermen tending to feel uneasy about the continuation of the fishery. In order to see who is satisfied with the fishery and feel uneasy about the fishery’s continuation, we examined the relationship between individual attributes (age, affiliated fishery cooperatives, employment status, and fishing catch) and the satisfaction and anxiety using an OLM. Table 4 shows the results of the OLM for satisfaction of the fishery. First, as a result of performing a likelihood ratio test on this model, the p-value was 0.0051, which was found out to be a statistically significant model. Focusing on the regression coefficients, the amount of catch showed positive and the other variables showed negative. The amount of catch showed 0.1% which was statistically significant. It was found that fishermen tend to be satisfied for fishery more when the amount of catch is high. Similarly, anxiety for the continuation of the fishery was measured using an OLM (Table 5). The regression coefficient for the employment status was statistically significant (5%). However, the p-value for this model was not significant (0.0898).

In the question of anxiety for the fishery’s continuation, over 80% of the fishermen responded either “strongly agree” or “agree,” it seems that many fishermen feel some uneasiness. The result of the interview showed that at the Southern Lake, many fishery cooperatives tended to have inadequate environmental conditions such as anomalous growth of aquatic plants. At the Northern Lake, many of the fishery cooperatives tended to have problems with the decrease of fishery including the lack of successors. Based on these facts, many fishermen feel some anxiety about fisheries at Lake Biwa. The content of such uncertainty is likely to differ depending on the personal position.

Table 6 Result of ranking for desired fishery projects

	Ranking						
	1st	2nd	3rd	4th	5th	6th	7th
WQ Improvement	30	11	15	8	8	5	3
FG Improvement	11	21	16	13	10	5	4
Fish Stock	8	15	14	18	11	9	5
Fish Extermination	3	10	10	18	23	13	3
Product PR	10	7	14	8	10	10	21
Nurturing Successors	15	9	4	10	5	10	27
GC Extermination	3	7	7	5	13	28	17

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Table 7 Average score of desired project by overall and by every personal attribute

Project Attributes (n: No of data)	Total (n=80)	Area		Employment Status		Age (n=80)	Catch (n=80)
		Northern Lake (n=40)	Southern Lake (n=40)	Full- time (n=46)	Part- time (n=34)		
WQ Improvement	5.25	4.23	6.28	5.15	5.38	5.24	5.15
FG Improvement	4.74	4.58	4.90	4.78	4.68	4.72	4.73
Fish Stock	4.30	4.25	4.35	4.30	4.29	4.32	4.15
Fish Extermination	3.76	3.80	3.73	3.74	3.79	3.81	3.68
Product PR	3.56	4.00	3.13	3.70	3.38	3.49	3.85
Nurturing Successors	3.51	3.90	3.13	3.61	3.38	3.57	3.61
GC Extermination	2.88	3.25	2.50	2.72	3.09	2.85	2.82

Note: Age and Catch are showed by weighted average⁽³⁾.

Considering that the anxiety felt by fishermen will influence the choice of the fishery projects, the desired fishery projects are different depending on one's position of individual fishermen. Therefore, we need to consider how they relate to each other. Thus, in order to understand what differences exist between the fishery projects which fishermen desired to participate in, we asked about the seven alternatives mentioned above by ranking method. The simple totaling result is shown in Table 6. "WQ Improvement" is the most frequently answered, with 70% of respondents wishing to have the project at third place or higher. In the "FG Improvement," "Fish Stock" and "Fish Extermination," responses were frequently placed at second, fourth, and fifth, showing a uni-modal distribution. The "Product PR" was most frequently ranked at seventh and then third place. At the same time, "Nurturing Successors" was most frequently ranked at seventh and then again first place. These projects were resulted in a bi-modal distribution.

"Product PR" and "Nurturing Successors" showed a bi-modal distribution in the ranking because some of the fishermen supported them and others did not. If these differences are attributed to differences in individual positions, it is necessary to understand the relationship between personal attributes and the fishery projects. Ranking data was scored by the average for the whole and personal attributes were summarized in Table 7. Here, seventh place was given 1 point and 1 point was added

Table 8 Regression coefficient for OLM of desired projects and personal attributes

	WQ Improvement (n=80)		FG Improvement (n=80)		Fish Stock (n=80)		Fish Extermination (n=80)		Product PR (n=80)		Nurturing Successors (n=80)		GC Extermination (n=80)			
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.		
Age	0.003	0.022	-0.020	0.020	-0.017	0.019	0.063	**	0.020	-0.071	***	0.022	0.037	0.021	0.002	0.021
Employment status	-0.622	0.467	0.246	0.427	0.112	0.422	-0.192		0.435	0.254		0.423	0.170	0.444	-0.566	0.443
Area	2.975	***	0.199	0.397	-0.008	0.406	0.163		0.404	-1.117	**	0.418	-0.595	0.409	-0.592	0.414
Catch	1.285	*	-0.145	0.464	-0.343	0.509	0.023		0.500	0.510		0.467	-0.703	0.525	0.488	0.475
LR stat.	40.847		1.704		1.462		10.200		15.656		7.028		4.101			
P-value	2.89×10^{-8}		0.790		0.833		0.0372		0.00352		0.134		0.392			

Note: * shows $p < 0.05$, ** shows $p < 0.01$, and *** shows $p < 0.001$.

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as the rank goes up. Regarding the region and employment status, averages were calculated for each of the two categories, and a weighted average was calculated for age and catch. In terms of the overall average score, “WQ Improvement,” “FG Improvement,” “Fish Stock,” “Fish Extermination,” “Product PR,” “Nurturing Successors,” “GC Extermination” were ordered highest to lowest. Focusing on regional differences, “WQ Improvement” showed a significantly high score at the Southern Lake, while scores at the Northern Lake tended to be higher regarding the “Product PR” and “Nurturing Successors” project. In the employment status, there was not a clear difference in score between full-time and part-time fishermen. Regarding the age, there was a reversal of ranking between “Product PR” and “Nurturing Successors”. Reversal of ranking was shown in the fishing catch of “Fish Extermination” and “Product PR”.

As there was a difference between the average scores of each project by the personal attributes, it is necessary to investigate the relationship with the fishery projects including all four personal attributes. OLM was used in order to investigate the relationship between ranking of the fishery project and personal attributes. Table 8 shows the regression coefficients of OLMs. Statistically significant coefficients were shown in the “WQ Improvement,” “Fish Extermination,” and “Product PR” projects. In the “WQ Improvement,” the area variable was significantly positive at 0.1% (2.975), and the catch was significantly positive at 5% (1.285). Fishermen who belong to the fishery cooperatives at the Southern Lake and who have larger amount of catch tended to lean toward “WQ Improvement.” The age variable in “Fish Extermination” has a significantly positive coefficient at 1%, and older fishermen tend to desire this project. In the “Product PR,” the regression coefficients were negative in age and area variables, with statistically significant values (0.1%) at 1%, respectively. In other words, this

Table 9 Agreement of the fishery projects with the Multifaceted Fishery Project

	Imazu	Kosei	Isoda	Notogawa	Okishima	Moriyama	Katada	Seta-cho
Product PR	×	○	○	○	○	○	○	○
FG Improvement	○	○	○	○	○	○	○	○
WQ Improvement	○	×	×	×	○	○	○	○
Fish Extermination	×	×	×	×	○	×	○	×
GC Extermination	×	×	×	×	×	×	×	×
Fish Stock	×	×	×	×	×	×	×	×
Nurturing Successors	×	×	×	×	×	×	×	×

Note: Dummy variables x means 0 and o means 1.

result shows that the fishermen in the Northern Lake and younger have higher evaluations of the project. On the other hand, activity contents of the Multifaceted Fishery Project may give a large influence to preference of the projects in the questionnaire form. Therefore, we created a dummy variable (Table 9) showing the agreement of the project contents and examined the ROLM added, as an explanatory variable as a co-variate to estimate its effect. The coefficient of the dummy variable was not statistically significant and we obtained the similar results of the OLM.

4. Discussion

In this study, a questionnaire survey was given to fishermen at Lake Biwa to clarify the sequence of fishery promotion projects that fishermen desired to participate in, showing their satisfaction and anxiety for fishery in Lake Biwa. Major results are described below. From the survey results, it was found that there was a statistically significant relationship between the improvement of satisfaction to fishery and the amount of catch, and increasing the catch is important for improving satisfaction. In contrast, the result showed that about 40% of fishermen with fishing catch less than 1 million yen were satisfied with the fishery, and it is inferred that the reasons other than income give satisfaction to the fishermen. Though more than 80% of fishermen felt anxiety over the continuation of the fishery, we could not find a clear relation with the personal attributes from the results of the regression analysis. In the interview survey, the environmental deterioration such as anomalous growth of aquatic plants at the Southern Lake was the largest issue, whereas at the Northern Lake, the decrease of fishermen including the lack of successors was pointed out as the most important issue. Considering these results, anxiety they feel may be varied depending on their position. According to the questionnaire survey which respondents choose from the seven specified fishery projects, “WQ Improvement” was selected the most and then, “FG Improvement,” “Fish Stock,” “Fish Extermination,” “Product PR,” “Nurturing Successors,” and “GC Extermination” in order of priority. Focusing on the relationship between selection of these fishery projects, fishermen at the Southern Lake and fishermen with amount of higher catch tend to consider “WQ Improvement” to be important. Older fishermen considered “Fish Extermination” important. Fishermen at the Northern Lake and younger fishermen considered “Product PR” to be important. The other four fishery projects did not have clear relationships with personal attributes. In addition, it was revealed that the contents of the Multifaceted Fishery Projects do

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not have a large influence on the choice of the fishery projects that fishermen desire to participate in.

Based on the results, we consider the fishery projects of Lake Biwa take on many priorities. First, considering the fishery projects from the viewpoint of fishery management, the fishery projects are divided into three categories: the projects to increase the amount of catch; projects for improving the price and consumption of fisheries products, and projects to increase the number of successors in fishery. Focusing on the project to increase the amount of catch, it was ranked highly except for the “GC Extermination.” Also, since the three projects other than the “WQ Improvement” and “Fish Extermination,” the relation to personal attributes is not significant. It is suggested that the projects related to the increase in catch and resource are basically important projects that fishermen generally desire. Specially, fishermen at the Southern Lake and those who have a large amount of catch tend to consider “WQ Improvement” to be important, which was placed first in ranking overall. The reason for this is presumed that eutrophication is progressing in the Southern Lake as compared with the Northern Lake and the anomalous growth of aquatic plants affect fishery operation. The “Fish Extermination” project had a relatively lower rank, and older fishermen tended to place importance on it. Since it was clarified that the current “Fish Extermination” project is carried out relatively smooth in the interview survey, the importance of “Fish Extermination” may be lowered. Considering the trend of elderly people’s dependence on catching foreign fish pointed out in the previous study (Yamada *et al.* (2013)), the results of this study are compatible. The “Product PR” project related to consumption and price increase tended to be placed as important by fishermen at the Northern Lake and fishermen with lower age. It is considered that the native fish catch at the Northern Lake is larger than that at the Southern Lake and higher income is not usually necessary for the older fishermen. In the interview survey, there were many fishery cooperatives who responded that the successor shortage is a problem. However, the project on “Nurturing Successors” has a low ranking and the relationship with the personal attributes tends to be low as well.

The “FG Improvement” and the “Fish Stock” projects, which are the cores of the current fishery promotion projects, also showed a high ranking as a result of this research, and it was found that they are evaluated as desired projects as a whole. However, the “WQ Improvement” project has placed the most importance on the Southern Lake, while it was also an important project which is desired by many fishermen. Currently, the eutrophication countermeasure by the Ministry of the

Environment is practically limited only to regulate nutrient load from point sources. If the aquatic plants without a great impact on the environment can be removed, it will possibly become an effective project both from the viewpoint of eutrophication and fishery promotion. Furthermore, if we are to create unit requirements such as COD, nitrogen, and phosphorus of aquatic plants to be removed, we can estimate the reduction load. Tamaki and Sajiki (2014) propose a system for buying aquatic plants removed by fishermen, and it may be one of the effective ways to consider when actually dealing with the aquatic plants removal project. Also young fishermen wanted the “Product PR” project. Improvement of fishing catch by expanding consumption is considered important not only to stabilize fishery management but also to promote new business entry into fishery.

The aging population and the decrease of the workers are advancing at Lake Biwa. In the interview survey, there were many fishery cooperatives who replied that the successor shortage was a problem, whereas the questionnaire resulted in a low ranking for the project on “Nurturing Successors.” Although the contradiction result was obtained, several reasons can be inferred as causes. One reason may be the difference in the position of respondents. Interviews were conducted with representatives of the fishery cooperatives; therefore, it is possible that they responded to issues related to the continuation and development of fishery cooperatives as representatives. Whereas, the questionnaire survey was conducted to individual fishermen, it makes sense to lower the ranking of the “Nurturing Successors” project that does not contribute to the increase in individual fishery catch. Another is the effectiveness and uncertainty of projects. As mentioned above, a large number of fishermen participated in this study attained lower catches. Promoting new business entry could be difficult even when support is given. Therefore, it is possible that the fishermen preferred projects which could lead to effective results.

5. Conclusions

In this research, we analyzed how the fishermen of Lake Biwa feel about their fishery, and what fishery promotion projects fishermen wanted. As a result, we clarified the difference of the fishermen in the different positions and their relationships. From the previous studies, it was pointed out that fishermen at Lake Biwa are important not only from the fishery production prospective but also from the environmental preservation aspect as well (e.g. Yamada *et al.* (2013)). Moreover, fostering and

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nurturing successors for fishery to maintain the number of workers in fishery is important for the future. In this study, the interviews and the questionnaire survey resulted in the opposite; therefore, it was impossible to position the importance of the “Nurturing Successors” projects. Though the budget is limited in the actual projects, opinions of fishermen about the projects with limited budgets were not mentioned in this study. I would like to discuss these issues in the future.

Notes

- (1) Membership of fisheries cooperatives is regulated by the fisheries cooperatives act. The membership can be classified into regular membership and associate membership. Regular membership is given to fishermen who live in an area established by fisheries cooperatives and work more than the days determined by fisheries cooperatives. Associate members, who don't have a voting right and the right to elect, are members except for regular.
- (2) Some fishermen work not only in fishing but also in other jobs. Fishermen who only work in the fishery are shown "full-time", and "part-time" means those who also work other than fishery.
- (3) The weighted average for catch were calculated by use of class values. However, class value of four million yen and more was set at 4.5 million yen.

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