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HE, Yufeng
College of Economics and Management, Shanghai Ocean University

CHEN, Tinggui
College of Economics and Management, Shanghai Ocean University

TAKAHASHI, Yoshifumi
Laboratory of Environmental Economics, Division of Agricultural and Resource Economics,
Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University

YABE, Mitsuyasu
Laboratory of Environmental Economics, Division of Agricultural and Resource Economics,
Department of Agricultural and Resource Economics, Faculty of Agriculture, Kyushu University

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The Livelihood Strategy Transformation of Retired Fishing Households under the Background of the Fishing Ban Policy in the Yangtze River, China

Yufeng HE¹, Tinggui CHEN^{1,2}, Yoshifumi TAKAHASHI and Mitsuyasu YABE*

Laboratory of Environmental Economics, Department of Agricultural and Resource Economics,
Faculty of Agriculture, Kyushu University, Fukuoka 812–8581, Japan
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The fishing ban policy in the Yangtze River Basin is an important measure to implement the concept of prioritizing ecological conservation and boosting green development. The resulting problem in the livelihood of retired fishermen has become a new challenge to consolidate the achievements of poverty alleviation and to construct an overall well-off society. Based on the sustainable livelihood approach framework, this study constructs the livelihood capital evaluation index system of Ma'anshan City's retired fishing households, calculates their sustainable livelihood capital index, and identifies the effect factors of livelihood strategy choice and transformation of fishing households. The results show that: In the four types of household livelihood strategies, the Short Term Employment household has the lowest livelihood capital index and the Self Employment type has the highest. Human capital has a significant negative effect on the choice of Short Term Employment and Single Long Term Employment strategies, and a significant positive effect on the households' choice of Couple Long Term employment and Self Employment strategies; Financial capital has a significant positive effect on the choice of Self Employment strategy of households. Education level, professional skills, annual household income, residential area and loans are the key factors for the strategy transformation from Short Term Employment strategy to others. Strengthening the construction of human capital, promoting the development of financial capital and scientifically planning the industrial structure of the fishing ban area are effective measures to protect the livelihood of retired fishing households and promote the households' strategy transformation to high level of livelihood strategies.

Key words: Fishing ban policy, Livelihood capital, Livelihood strategy, The Yangtze River, Transformation

INTRODUCTION

Ecological compensation, as one of the internationally recognized measures of resource and ecological environment management, has been widely practiced around the world (Westman, 1977; Costanza *et al.*, 1987; Seema *et al.*, 2017). In the past decade, with the rapid development of the Chinese social economy, the Chinese government has begun to focus more attention on national ecological security and resource protection, and has introduced a series of ecological compensation measures, such as the project of returning farmland to forest and forbidding grazing. In order to protect the ecological security and repair the ecological environment of the Yangtze River Basin, the Chinese ministry of agriculture, finance and human resources jointly issued the implementation plan for a fishing ban and the establishment of a compensation system in the key waters of the Yangtze River Basin in 2019, which clearly pointed out that in the future, productive fishing will be banned in the aquatic nature reserve, and fishing will be banned in the main stream and in important tributaries for 10 years. With the implementation of the fishing ban policy in the Yangtze River, nearly 300,000 fishermen around the Yangtze River Basin have lost their original livelihood. The resulting problem in livelihood of retired fish-

ermen have become a new challenge to consolidate the achievements of poverty alleviation and to construct the overall well-off society.

As a policy measure to promote the protection of ecological resources and the environment, the fishing ban compensation policy is used to solve the externality of fishery resources and of the ecological environment. The “Pigou tax” provides a theoretical basis for it; it is understood that the compensation standard should be the difference between social cost and private cost. When the marginal external cost is equal to the marginal external benefit, the external benefit could be maximized (Pang, 2020). The compensation method for the fishing ban in the Yangtze Rivers is mainly cash compensation for disposable or installment, and the opportunity cost method is often used for calculation (Chen *et al.*, 2018; Liu and Yu, 2018). However, cash compensation may not be able to meet the livelihood needs of retired fishermen, and with the marginal decline of the effectiveness of compensation, it is likely that an “involution” of fishing household livelihoods will form (Ge and Chen, 2021). Affected by the individual characteristics of traditional fishermen, hard livelihoods and re-employment have become serious problems faced by retired fishermen (Lin *et al.*, 2019). Livelihood is a way for living based on capital, abilities and activities, and livelihood strategies is the behavioral presentation to maintain and improve farmers' livelihood level and achieve the livelihood goal (Eills, 1998; Li and Li, 2007; Wang *et al.*, 2014). Previous studies indicate that livelihood capital is an essential factor influencing the choice of farmers' livelihood strategies, and identify the impact mechanism of

¹ College of Economics and Management, Shanghai Ocean University, Shanghai 201306, China

² Yangtze River Ecological Protection Strategy Research Center, Shanghai 201306, China;

* Corresponding author (E-mail: yabe@agr.kyushu-u.ac.jp)

livelihood strategy choice of farmers effectively is the key to instruct farmers to transform into sustainable livelihoods (Mushongah and Scoones, 2012; Dao, 2014; Zhao *et al.*, 2016). Moreover, the livelihood capital factors affecting farmers' livelihood strategies under different policy backgrounds are quite different (Tai and Zan, 2019; Yuan *et al.*, 2019; Zhao *et al.*, 2020). Therefore, mastering the current situation of livelihood capital of different fishing households types is conducive to accurately identify the characteristics of retired fishermen with different vulnerability levels and the advantages and disadvantages of their livelihood capital. Exploring the mechanism behind the choice of livelihood strategies for retired fishermen, analyzing the key effect factors on the transformation of fishermen livelihood strategies could provide micro evidence for policy optimization, and it has great significance to maintain regional social-economic stability and protect ecological strategic security.

Based on the sustainable livelihood approach framework, this paper takes the retired fishermen in Ma'anshan City as research objects and the household as a unit, constructs the livelihood capital evaluation index system and calculates the sustainable livelihood capital index of retired fishing households, discusses the decision mechanism of livelihood capital on households' livelihood strategies choices, and identifies the influencing factors of livelihood strategies transformation of fishermen further. The academic marginal contribution and characteristics of this paper are reflected in the following two aspects: first, in the division of fishing households livelihood strategies, combined with their actual situation, and based on employer's stability, this paper further deepens and expands the division standard of non-agricultural livelihood strategies. Second, from the perspective of fishery ecological compensation, this paper constructs a sustainable livelihood analysis framework suitable for retired fishing households. On the basis of evaluating the households livelihood capital level with different types of livelihood strategies, this paper analyzes the influencing factors of the choice of households in terms of livelihood strategies, and discriminates the key factors of the transformation from low to high level livelihood strategies, further enriches the research field and content of ecological compensation. This study is helpful for the management department to actively instruct the retired fishermen to complete reemployment, and provides a theoretical basis for the government to formulate scientific ecological environment governance policies and optimize the industrial structure of the fishing ban area.

ANALYSIS FRAMEWORK

The Sustainable Livelihoods Approach (SLA) proposed by the Department for International Development (DFID) in 2000 focuses on vulnerable people, clarifies the interaction between vulnerability background, livelihood capital, livelihood strategy and livelihood outcome, and analyzes what kind of livelihood strategy will be pro-

duced by different organizations of livelihood capital under specific background or impact, and explains the livelihood outcomes caused by different strategies (Scoones, 2009). In SLA, livelihood strategy is considered to be the best behavior combinations that farmers make through their own livelihood capital (Waleign, 2016; Milad and Ali, 2018; Kopytko and Natalie, 2018). Many scholars have discussed the influence of livelihood capital on livelihood strategies based on the SLA, involving many fields such as fields such as resettlement, animal husbandry, urbanization, and land transfer (Hu, 2016; Yu and Cai, 2016; Huang and Liu, 2017; Ma *et al.*, 2018). The widespread application of the SLA has gradually made it a mainstream paradigm for studying farmers' livelihood issues.

The SLA shows that when farmers face changes in the external environment, they will choose appropriate livelihood strategies based on the changes of livelihood capital, so as to achieve sustainable livelihood, and highlight the impact of various livelihood capital on livelihood strategies in vulnerable environments. The natural capital owned by farmers is the basis for their agricultural activities, and the choice of initial livelihood often shows a strong dependence on it. In vulnerable environments, environmental changes, policy impacts and natural disasters will lead to drastic changes in farmers' livelihood capital. In order to avoid the possible livelihood risk caused by the change of capital, farmers' livelihood strategies tend to transfer to being diversified and non-agricultural (Zhang and Zhao, 2015). Human capital, social capital, financial capital, physical capital and natural capital have become the main factors of the livelihood strategies transformation. For example, human capital is the main subject of livelihood strategy selection and implementation. The health, education and working skills of farmers would make a great impact on livelihood strategy transformation; Social capital is the window for farmers to obtain external assistance and information, which affects the transformation direction of the livelihood strategy; Physical capital, financial capital and natural capital become the conditional support for farmers' livelihood strategy transformation, and they are the driving force affecting the transformation, and determine farmers' willingness to transform their livelihood strategy, to a certain extent (Zhao *et al.* 2020).

Based on SLA and taking households as units, we construct an analysis framework for the sustainable livelihood of retired fishermen in the Yangtze River Basin (Fig. 1). According to the framework, the livelihood dynamics of retired fishermen follow the logic of "policy impact-change of livelihood capital-adjustment of livelihood strategy": the compensation policy for the fishing ban includes recovery of fishing rights, production equipment scrapping, social insurance, temporary living subsidies and employment training. The retired fishermen choose the optimal household strategy based on the existing livelihood capital to produce the expected livelihood results, including enhanced livelihood sustainability, improved vulnerability and reduced risk. The livelihood results will react to the livelihood capital and make

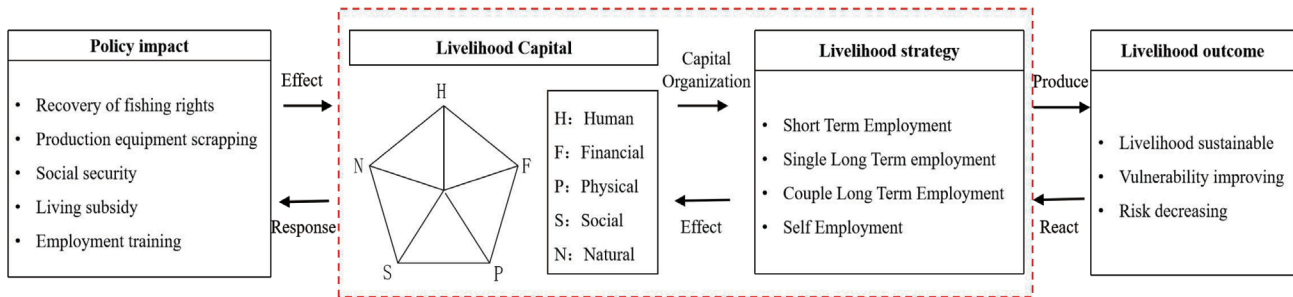


Fig. 1. The SLA framework of retired fishing households.

the fishermen livelihood enter the next cycle until this transmission mechanism enters a relatively stable state, that is, livelihood sustainability (Xie *et al.*, 2018; Zhou *et al.*, 2020). This study focuses on the impact mechanism of retired fishermen livelihood capital on the livelihood strategy under the implementation of the compensation policy, exploring the influencing factors of the transformation of the livelihood strategy of retired fishermen.

METHODOLOGY

Data collection

The steel industry is developed in Ma'anshan city of Anhui Province, and a large number of chemical industries are densely distributed along the Yangtze River, making Ma'anshan a serious pollution disaster area in the Yangtze River Basin. The contradiction between economic development and environmental protection has become the main problem restricting urban development. In response to national policies to restore the ecological environment of the Yangtze River, the Ma'anshan government has comprehensively rectified illegal docks, polluting enterprises, solid waste dumps and breeding farms along the Yangtze River, and took the lead in implementing the fishing ban policy in May 2019. The city only took three months to complete all parts of the process of implementing the fishing ban, who set a better example in the fishing ban policy implementation of the whole Yangtze River Basin with its high work efficiency. Most of fishermen in Ma'anshan are traditional fishermen in the Yangtze River Basin, who have been living on boats and fishing for a living for generations, and their working areas are mainly in upper Yangtze River and Shijiu Lake. In this paper, Ma'anshan City is taken as the research area, and semi-structured interview survey and questionnaire survey are used to investigate the retired fishermen in the resettlement communities of Bowang district and Dangtu County in December 2020. The questionnaire survey mainly includes the livelihood capital and livelihood activities of fishermen in 2018 and 2020, and the interview content involves the implementation status of the fishing ban policy and the changes of fishermen livelihood activities. A total of 219 questionnaires were sent out, 7 of which were excluded because of data missing, and 212 valid questionnaires were obtained, and the effective rate was 96.8%.

Research methods

Evaluation system of livelihood capital index

The livelihood capital index is a quantitative reflection of livelihood sustainability. The evaluation of livelihood capital mainly focus on five aspects: natural, financial, physical, human and social capital. According to the differences and particularity of different regions, it is necessary to adjust the specific evaluation index according to the actual situation (Su *et al.*, 2009). Natural capital generally refers to the natural resource owned or possibly owned by farmers, which is the basis for farmers to choose the agricultural livelihood strategy. Most retired fishermen in Ma'anshan are traditional fishermen, and their natural capitals are mainly fishery resources in the Yangtze River Basin, which differs from farmers. The fishing ban policy recovers their fishing rights, and few of them have cultivated land, forest land and water area, and the retired fishermen have basically transferred to the non-agricultural livelihood strategy. Therefore, this paper does not include natural capital in the analysis. Combined with previous evaluation methods of livelihood capital index (Li and Li, 2007; Wang *et al.*, 2014), we select human capital, physical capital and financial capital, social capital as main indexes to establish the livelihood capital evaluation index system of retired fishermen (Table 1). Education level, health, labor force and professional skills are selected as the measurement indicators of human capital; Physical capital includes residential area, durable consumer goods and transportation; Financial capital is measured by annual income, deposit, medical insurance, and loans; Social capital measures include the closeness value with relatives and friends, cadres and communities.

In the calculation of each livelihood capital index, in order to avoid the impact of subjective factors on the evaluation results and make the setting of index weight more objective and reasonable, entropy method is used to weight each index of livelihood capital (Table 1). In order to eliminate the influence of different dimensions, the min-max standardization method is used to standardize the index values before using the entropy method, and the standardized values are increased by 0.001 unit as a whole to ensure the effectiveness of the entropy method.

Then, various livelihood capital indexes are calculated according to the standardized index values and corresponding weights (Sophie and Juliana, 2018). The

Table 1. Evaluation index system of livelihood capital of retired fishing households

Capital	Indicator	Indicator description and score assignment	Weight	Standardized average
Human Capital (H)	Education Level (H_1)	The average educational years of fishing couples: $F_1 < 1(1)$; $1 \leq F_1 < 5(2)$; $5 \leq F_1 < 8(3)$; $8 \leq F_1 < 11(4)$; $F_1 \geq 11(5)$	0.561	0.161
	Health (H_2)	Healthy of fishing couples: Long illness=1; Frequent illness=2; Occasional illness =3; Rarely illness=4; No illness=5	0.067	0.088
	Labor Force (H_3)	Labor force population aged 16 ~ 65	0.244	0.046
	Professional Skills (H_4)	Participation in vocational skills training: Never=1; Rarely =2; Occasionally=3; Frequent=4; Always=5	0.128	0.075
Physical Capital (P)	Residential Area (P_1)	Housing construction area (m^2)	0.161	0.037
	Durable Consumer Goods (P_2)	The numbers of family durable consumer goods	0.059	0.126
	Transportation (P_3)	Whether the household has cars: Yes=1, No=0	0.780	0.028
Financial Capital (F)	Income (F_1)	Annual household income (thousand yuan) $F_1 < 10(1)$; $10 \leq F_1 < 30(2)$; $30 \leq F_1 < 50(3)$; $50 \leq F_1 < 80(4)$; $F_1 \geq 80(5)$	0.041	0.026
	Deposit (F_2)	Household Deposit (thousand yuan): $F_2 < 10(1)$; $10 \leq F_2 < 50(2)$; $50 \leq F_2 < 100(3)$; $100 \leq F_2 < 150(4)$; $F_2 \geq 150(5)$	0.155	0.059
	Medical Insurance (F_3)	Whether to attend medical insurance: Yes = 1; No = 0	0.101	0.082
	Loans (F_4)	Whether the household has loans: Yes=1; No=0	0.703	0.163
Social Capital (S)	Relatives And Friends Closeness (S_1)	Visiting relatives and friends: Never=1; Rarely =2; Occasionally=3; Frequent=4; Always=5	0.281	0.177
	Cadres Closeness (S_2)	Communicate with cadres: Never=1; Rarely =2; Occasionally=3; Frequent=4; Always=5	0.324	0.201
	Communities Closeness (S_3)	Participation in community activities: Never=1; Rarely =2; Occasionally=3; Frequent=4; Always=5	0.395	0.234

Source: Household survey, $n=212$

various livelihood capital indexes of fishermen are the average value of the sample households. The formula is as follows:

$$T_i = \sum_j^n (W_{ij} I_{ij}) \quad (1)$$

In formula 1, T_i is i th capital index of fishermen, and W_{ij} is the weight of j th evaluation index of i th capital; I_{ij} is the standardized value of the j th evaluation index of i th capital.

Livelihood strategy

Previous studies have divided farmers' livelihood strategies according to the three aspects of livelihood diversification, income source, income structure and household development direction (Jiao *et al.*, 2017; Mubaya and Mafongoya, 2017; Munkhnasan *et al.*, 2018). The common point is that they all expand based on the degree of agriculturalization of livelihood strategies, and

generally divide farmers into agricultural and non-agricultural types (Liu *et al.*, 2018). However, we did a survey and found that the livelihood strategies of retired fishermen in Ma'anshan are all transfer to non-agricultural, and the specific work types include odd jobs, stable jobs (local and migrant), individual transport, individual business activities and unemployment. According to this, based on previous studies and the employer stability, taking the household as unit and the work types of fishing couples as research objects, we have reclassified livelihood strategy types of retired fishing households as Short Term Employment (STE), Single Long Term employment (SLTE), Couple Long Term Employment (CLTE) and Self Employment (SE) (Table2).

Logistic Regression Analysis

The binary logistic regression model was used to analyze the relationship between livelihood capital and livelihood strategy choice. Binary logistic regression is

Table 2. Types and basis of livelihood strategies for retired fishing households

Livelihood Strategy	Division basis	Number	Proportion/%
Short Term Employment (STE)	No stable employer for both husband and wife, and work types of work include odd jobs and unemployment	32	15.1
Single Long Term employment (SLTE)	One of the fishing couple have stable employer with stable jobs (local and migrant), and the work types of another include odd jobs and unemployment	51	24.1
Couple Long Term Employment (CLTE)	Both sides of the fishing couple have stable employers with stable jobs (local and migrant)	95	44.8
Self Employment (SE)	The fishing couple are engaged in individual transport or individual business activities	34	16.0

Source: Household survey, $n=212$

to compare the probability of occurrence of dependent variables with their probability of non-occurrence, and carry out logarithmic operations through the comparison of value results to find the key factors affecting the occurrence of events. Taking four types of livelihood strategies as dependent variables, human capital, financial capital, physical capital and social capital as independent variables, constructing a binary logistic regression analysis model:

$$\ln(P_y/1-P_y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \quad (2)$$

Where, P_y represents the probability of households choosing y livelihood strategy, $1-P_y$ represents the probability of households not choosing this livelihood strategy, and $X_1 \sim X_4$ represent human, physical, financial and social livelihood capital index respectively.

In order to further reveal the transformation law between different livelihood strategies, the strategies STE, SLTE, CLTE and SE are assigned as 1, 2, 3 and 4 respectively. Taking STE strategy as reference group, the ratio of occurrence of the probability of the other three strategies to the occurrence probability of STE as a dependent variable, and the specific indicators contained in each livelihood capital as independent variables, a disordered multiple logistic regression model is constructed to analyze the key factors affecting the transformation of fishermen livelihood strategy, as shown in formulas (3) ~ (5):

$$\ln(P_{y2}/P_{y1}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_{14} X_{14} \quad (3)$$

$$\ln(P_{y3}/P_{y1}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_{14} X_{14} \quad (4)$$

$$\ln(P_{y4}/P_{y1}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_{14} X_{14} \quad (5)$$

In the formulas, $P_{y1} \sim P_{y4}$ are the probability of STE, SLTE, CLTE and SE strategies respectively, and $X_1 \sim X_{14}$ are specific indicators of each livelihood capital.

RESULTS AND DISCUSSIONS

Livelihood capital index analysis

Through the standardized processing of original data and the entropy method, livelihood capital indexes are calculated, which can directly reflect current livelihood capitals level of retired fishing households and determine livelihood vulnerability of households with different livelihood strategies. The higher livelihood capital indexes, the stronger sustainable livelihood ability households have (Li *et al.*, 2007).

According to Figure 2, the order of households' capital index from high to low has the following sequence: social capital (0.612) > human capital (0.370) > financial capital (0.331) > physical capital (0.191). The social capital index of retired households is the highest, which is due to the centralized community management of retired fishermen by Ma'anshan government. Through the establishment of resettlement communities and assistance stations, the relationship between fishermen

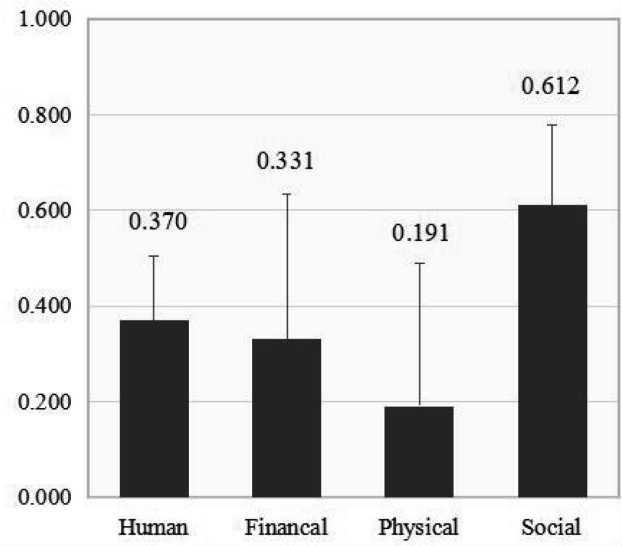


Fig. 2. Livelihood capital index of retired fishing households.
Source: Household survey, $n=212$

and government cadres has been strengthened, and social capital owned by retired fishing households has been improved. The homogeneity of fishermen social relations has increased the number of visits with relatives and friends, and further improved their social capital. In addition, most of the survey subjects are traditional professional fishermen who live by boat and fish for a living. During the transition period after retirement, they live in government resettlement houses and low rent houses, with limited housing area and physical conditions, and the main forms of transportation are bicycles and battery cars, which have caused the lowest physical capital index.

The livelihood capital indexes are different among each of households with different strategies (Figure 3), and the order of capital index from high to low consists of the following sequence: SE (1.865) > SLTE (1.499) > CLTE (1.422) > STE (1.376). As for various livelihood capital, human capital indexes of STE and SLTE households are 0.293 and 0.302 respectively, which are at a low level, but the physical capital indexes are higher than the other two types, which are 0.202 and 0.253 respectively, indicating that these two types households have a certain physical capital accumulation. In contrast, human capital index of households with CLTE and SE strategies are higher than the two others, which are 0.408 and 0.439 respectively, but the financial capital

Table 3. Livelihood capital index of fishing households with different livelihood strategies

Livelihood strategy	Human capital	Financial capital	Physical capital	Social capital	Livelihood capital
STE	0.293	0.315	0.202	0.566	1.376
SLTE	0.302	0.342	0.253	0.602	1.499
CLTE	0.408	0.231	0.153	0.630	1.422
SE	0.439	0.608	0.197	0.621	1.865

Source: Household survey, $n=212$

and physical capital indexes of CLTE households are the lowest, only 0.231 and 0.153. The financial capital index of SE households is 0.608, which is much higher than the other three types of households.

The effect of livelihood capital on the choice of strategies

Analysis on effect factors of livelihood strategies

Binary logistic regression was used to analyze the different effects of livelihood capital differences on the choice of livelihood strategies of households (Table 4). The results show that livelihood capital has significant effects on the choice of households' livelihood strategies: human capital has significant negative effects on the choice of STE and SLTE strategies, indicating that the richer human capital the have, the less likely they are to choose STE and SLE strategies. Besides, human capital and financial capital have significant effects on households' choice of CLTE strategies. Specifically, human capital has a positive effect and financial capital is negative, indicating that the richer human capital households have, the more likely they are to choose CLTE strategy, and households with high financial capital are less likely to choose CLTE strategy. As for SE strategy, human and financial capitals have significant positive effects on the choice for SE strategy.

Generally speaking, human capital and financial capital are important efficacious factors for retired households to choose as livelihood strategies. Significantly, human capital is always the key effect affecting the livelihood strategy choice. The higher human capital fishing households have, the more reemployment opportunities they will obtain, which is consistent with the previous study results (Guo *et al.*, 2017; Ren *et al.*, 2020). Human capital is a kind of personal knowledge and skills; people with high levels of human capital means high quality labor skills and strong information processing abilities. Fishermen with high human capital usually occupy an advantage in the labor market and are more favored by employers (Wang and Wang, 2016), and the reason is that human capital has a significant negative effect on households' choice of STE and SLTE strategies. Table 3 shows that human capital index of households with STE strategy is the lowest (0.293), which is reflected in higher household labor force age and lower education level. Fishermen with low human capital are

in a disadvantaged position in the labor market, as most of them have no reliable job or are jobless, and their family has no stable income making their livelihood capital index the lowest and the ability of sustainable livelihood the worst. Most households who choose SLTE strategy are Chinese traditional household models, that is, "men outside and women inside": males are the main labor force with stable jobs (local and migrant), while females focus on housework due to the restrictions of human capital such as education level, work skills and age. Although this type of household has certain amounts of financial and physical capital accumulation, the income source is reduced to a single individual and the income stability is poor.

The households which chooses CLTE strategy are younger with a high human capital index (0.408) and more employment opportunities, but their financial capital index is the lowest (0.153) (Table 3). With the assumption of a rational economic man, individuals will follow the principle of seeking advantages and avoiding disadvantages to optimize the opportunities they face and the measures to achieve their goals under certain constraints, so as to maximize utility. Limited by the lack of financial capital, young households tend to choose livelihood activities with stable income sources for financial capital accumulation based on their own human capital advantages to improve their ability to resist risks and livelihood sustainability. Therefore, human capital has a significant positive effect on the choice of CLTE strategy, and the lower financial capital, the more households tend to choose the CLTE strategy.

Most of the households who choose SE strategy have the highest human and financial capital indexes (0.439 and 0.608) (Table 3). This is because individual business activities put forward higher requirements for participants' anti-risk ability and education level. In addition, since there is a capital threshold for initial funds of individual business activities, the households rich in financial capital have strong financing access to cross the capital constraints, further increasing the possibility of households starting a business (Zhou, 2020). Therefore, human capital and financial capital have significant positive effects on households' choice of SE strategy, and these households also have the strongest sustainable livelihood ability.

Table 4. Binary logistic regression analysis of livelihood strategy choice

Capital	STE			SLTE			CLTE			SE		
	B	Wald	Exp (B)	B	Wald	Exp (B)	B	Wald	Exp (B)	B	Wald	Exp (B)
H	-5.495**	9.649	0.004	-5.873**	15.593	0.003	4.575**	13.859	97.008	5.706**	11.232	300.733
F	-0.230	0.114	0.795	0.191	0.117	1.210	-2.487**	17.311	0.083	3.508**	28.499	33.388
P	-0.074	0.013	0.929	0.700	1.755	2.014	-0.758	1.989	0.469	0.255	0.129	1.290
S	-0.978	0.644	0.376	0.813	0.600	2.255	-0.530	0.286	0.588	1.297	0.855	3.658
H-L Test	$\chi^2=9.987$			$\chi^2=11.086$			$\chi^2=9.137$			$\chi^2=3.983$		
	df=8 Sig=0.266			df=8 Sig=0.197			df=8 Sig=0.331			df=8 Sig=0.859		

Source: Household survey, n=212

Note: * $p<0.05$, ** $p<0.01$

Analysis on effect factors of livelihood strategies transformation

Disordered multiple logistic regression was used to analyze the effect factors of transformation of retired fishing households from STE to the other three strategies (Table 5). The results show that the annual household income and residential area are the key factors with significant positive effects for the transformation of STE to SLTE strategy. In the factors of the transformation from STE to CLTE strategy, education level, employment training, residential area and annual household income will promote the transfer significantly. More specifically, under the condition that other indicators remain unchanged, each standardized unit of these indicators increased, the possibility of the transformation increases by 21.329, 44.238, 276.419 and 38.107 times respectively. In the effect factors of the transformation from STE to SE strategy, loans also have a positive significant effect on it. For each increase in the standardized index value of loans, the possibility of the households' transformation from STE to SE strategy increases by 8.826 times.

Observing the effect factors of strategies transformation, it is found that residential area and annual household income have significant positive effects on the transformation from STE to other strategies, and have the greatest effects on the transformation from STE to SE. The housing area reflects the economic strength of households, and SE households with strong economic strength often have a large housing area. Liu *et al.* (2019) indicates that farmers with strong sustainable livelihood ability have greater demand for physical capital such as housing area, and this point has been further verified in our study. In addition, traditional fishing activities have the characteristics of high degree of freedom and flexibility, and traditional fishermen are hard to adapt to the regular and mandatory work rhythm within the duration of a short term. This leads to a phenome-

non, that is, with the increase of income, fishing households tend to choose SE strategies similar to the original livelihood characteristics.

Education level and professional skills are the concrete manifestation of effect of human capital on the transformation from STE to CLTE strategy. According to the survey, we found that most livelihood activities of CLTE households are concentrated in the secondary industries of technology intensive such as smelting, ship-building and welding. After the implementation of the fishing ban policy, Ma'anshan government provided a series of vocational skills training opportunities for the secondary industry for the retired households. The households with high education level are more willing to participate in training and have higher efficiency in learning vocational skills, and are easier to transform to CLTE strategy. Besides, a small number of fishermen have participated in selective government public welfare positions, which also put forward higher requirements on the educational background. Therefore, the level of education and professional skills have become the key factors influencing the strategy transformation of the households from STE to CLTE.

Loans have a significant positive effect on the strategy transformation of fishing households from STE to SE. The survey found that the livelihood activities of SE households include fishing tourism, aquaculture, ship transportation and individual business, and often have a sufficient income. In order to pursue more economic benefits, these households have more possibility to increase investment with loans to expand a business scale driven by survival rationality (Wen *et al.*, 2020).

CONCLUSIONS AND RECOMMENDATIONS

The implementation of the fishing ban compensation policy in the Yangtze River is an important measure to

Table 5. Multinomial logistic regression analysis of livelihood strategy transformation

Capital	Indicator	SLTE			CLTE			SE		
		B	Wald	Exp (B)	B	Wald	Exp (B)	B	Wald	Exp (B)
H	H ₁	-1.907	1.468	0.149	3.060*	4.648	21.329	4.649**	7.358	104.528
	H ₂	-1.508	0.927	0.221	-1.601	1.260	0.202	-3.367	2.791	0.034
	H ₃	-0.195	0.020	0.823	0.819	0.360	2.268	-1.120	0.360	0.326
	H ₄	2.442	2.818	11.497	3.790**	7.962	44.238	2.081	1.378	8.015
P	P ₁	1.164	0.721	3.204	-1.399	1.258	0.247	-2.871	3.106	0.057
	P ₂	-0.733	1.092	0.480	-1.107	2.372	0.331	-0.072	0.006	0.930
	P ₃	4.462*	4.075	86.701	5.622**	6.818	276.419	5.750*	4.994	314.124
F	F ₁	3.381*	6.228	29.401	3.640**	7.437	38.107	8.623**	20.496	5556.631
	F ₂	1.588	1.326	4.894	-0.388	0.084	0.679	1.387	0.712	4.002
	F ₃	-1.544	2.251	0.214	-0.521	0.286	0.594	0.960	0.549	2.611
	F ₄	0.315	0.183	1.370	-0.847	1.267	0.429	2.178*	5.493	8.826
S	S ₁	-1.463	1.049	0.232	-0.743	0.271	0.475	1.221	0.455	3.391
	S ₂	-0.020	0.000	0.980	-2.435	2.762	0.088	-0.793	0.173	0.452
	S ₃	-1.256	0.903	0.285	-0.250	0.037	0.779	-0.397	0.061	0.672
	Intercept	-0.673	0.130	0.510	-0.743	0.162	0.475	-7.403**	7.617	0.001

Source: Household survey, n=212

Note: *p<0.05, **p<0.01

maintain ecological security and ensure the green development of the Yangtze River economic belt. The study on the influencing factors of the livelihood strategy choice of retired fishing households is not only conducive to helping retired fishermen successfully complete the dual-transform to improve the sustainable livelihood ability, but also can effectively prevent retired fishermen from “picking up their old career” and curb the occurrence trend of illegal fishing, so as to alleviate the damage to the ecological environment caused by fishery activities and reduce the ecological pressure (Li *et al.*, 2009). Based on the survey data of retired fishermen in Ma’anshan City, this paper analyzes the livelihood capital status of retired fishermen and explores the key effect factors of their livelihood strategy choice and transformation. The conclusions are as follows:

(1) The retired fishing households in Ma’anshan city are engaged in non-agricultural production activities. Based on previous studies, we have divided the livelihood strategies of households into Short Term Employment (STE), Single Long Term employment (SLTE), Couple Long Term Employment (CLTE) and Self Employment (SE). The livelihood capital index of different types of households are different, from high to low, which is SE (1.865) > SLTE (1.499) > CLTE (1.422) > STE (1.376).

(2) Different types of livelihood capital have different effects on the choice of fishing household strategies: Human capital is always the key factor affecting the choice of households’ livelihood strategies. It has a significant negative effect on the choice of STE and SLTE, and a significant positive effect on the choice of CLTE and SE. Financial capital has a significant negative effect on the choice of CLTE and a significant positive effect on the choice of SE.

(3) Residential area and annual household income have significant positive effects on the transformation of STE to other three livelihood strategies. In addition, education level and professional skills have a significant positive effect on the strategy transformation from STE to CLTE, and education level and loans have significant positive effects on the transformation from STE to SE strategy.

According to the results, we found that the livelihood capital index of STE households is the lowest, and these households are also the group that needs more attention in protecting the livelihood of fishermen. Limited livelihood capital is not conducive to the transformation of retired fishermen to have optimal livelihood strategies, which would also become a stumbling block to achieve regional economic sustainable development. In the process of dual-transform for retired fishermen, the leading role of the government should be brought into full play, and the difference of retired fishing households’ livelihood capital should be identified exactly to formulate targeted livelihood assistance policies to instruct retired fishermen to develop scientific livelihood strategies. The following recommendations are made:

First of all, strengthen the construction of human capital of retired fishermen in two aspects of cultural

education and vocational skills training. Focus on strengthening the investment in basic education facilities construction of township to provide a favorable educational environment and resources for the children of retired fishing households to solve the children schooling problems. Build the retired fishermen assistance stations to provide targeted re-employment skills training for retired fishermen according to their livelihood capital characteristics and social development needs, so as to improve their employment competitiveness and adaptability.

Secondly, promote the development of financial capital in fishing ban areas, improve the availability of loans for retired fishermen. The government should improve the credit mechanism and entrepreneurship subsidy policies in fishing ban areas constantly, encouraging the development of multi-level township financial institutions and non-financial institutions. Develop targeted diversified credit supply mode and provide small, low interest and discount loans for retired fishermen with weak livelihood ability to reduce fishermen credit constraints. Enrich reasonable lending channels is also the possible effective method to increase opportunities for transformation of strategies.

Finally, scientifically planning the industrial structure of the resettlement area is a feasible method to promote retired fishing households strategy transformation. The government could provide policy assistance and skill guidance for retired fishermen to start their own businesses. Taking high-quality and characteristic fishery service industry as the starting point and promoting the development of tertiary industry in fishing ban areas may create more and better local jobs for the surplus labor force of retired fishing households.

AUTHOR CONTRIBUTIONS

Yufeng He designed the study questionnaire, collected and analyzed the data, and drafted the manuscript (the contributions account for 30%). Tinggui Chen collected the data, supervised the research and made critical revisions to the manuscript (the contributions account for 30%). Yoshifumi Takahashi assisted in editing of the manuscript and approved the final version (the contributions account for 10%). Mitsuyasu Yabe participated in the design of the study and supervised the work (the contributions account for 30%).

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