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Economic Value Analysis of Naka River Recreational Ayu Fishing Using the Travel Cost Method: Truncated Negative Binomial Analyses

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【abstract】
Policies for promoting Tochigi Prefecture's recreational ayu fishing industry are considered very important in the inland fisheries sector. The prefecture has only used total licensing fees to assess the economic value of recreational ayu fishing for the making policies regarding economic matters. Accurate assessment of the economic scale of the fishing industry by the prefecture has important implications for implementing measures for the development of fisheries. To analyze economic value, we distributed survey questionnaires among Naka River ayu anglers in Tochigi Prefecture and received 455 valid responses. We applied truncated negative binomial regression (TNBR) and the individual travel cost method (ITCM) to analyze recreational ayu fishing. The results showed that the coefficients of interaction variables with travel cost and respondents' residential regions were statistically significant. Furthermore, the coefficients of respondents' years of fishing experience and their loyalty to the Naka River were also significant in the models. The annual benefit (consumer surplus) of recreational ayu fishing was 1,368 million yen for all anglers, 640 million yen for anglers living in Tochigi, 405 million yen for anglers living in prefectures adjacent to Tochigi, and 323 million yen for those residing outside these prefectures (Akita, Iwate, Miyagi, Chiba Saitama, Tokyo, Kanagawa, Yamanashi, and Nagano). The results clarified that the benefit for anglers living in Tochigi was several times larger than the total licensing fees. Thus, the prefecture will be able to expand the scale of projects in the prefectural master plan of fishery development or in a future master plan.

【keywords】
baseline survey before implementing fishery policy, evaluation of non-market goods, inland fisheries, regional developments

1. Introduction

Inland Japanese fisheries mainly target the following species for stock enhancement: chum salmon *Oncorhynchus keta*; rainbow trout *Oncorhynchus mykiss*; red-spotted masu salmon *Oncorhynchus masou ishikawae*, cherry trout *Oncorhynchus masou masou*, whitespotted char *Salvelinus leucomaenis*; ayu *Plecoglossus altivelis altiveautlis*; carp *Cyprinus carpio*; crucian carp *Carassius spp.*; freshwater eel *Anguilla japonica*; and Japanese smelt *Hypomesus nipponensis*. These species are released as juvenile fishes or eggs for propagation based on inland fishery rights. Excluding artificial eggs and shellfish, the total number released for each species in 2013 amounted to 304 million chum salmon, the highest number; 115 million of ayu, the second highest; and 12 million cherry trout, the third highest (1). Catching chum salmon in a river is prohibited according to fishery law in Japan. Therefore, the number of released juvenile ayu has tended to be the largest among these species in Japan's inland fisheries. The total number of released juvenile ayu was 185 million in 2003, 137 million in 2008, and 115 million in 2013 (1). Thus, the number of released ayu has been decreasing. Ayu catch amount has also been dropping from 84 hundred tons in 2003 to 34 hundred tons in 2008 and then to 23 hundred tons in 2013 (2).

To clarify the object of our research, we first illustrate the current situation of recreational ayu fishing. With respect to annual and fixed-term licenses for ayu fishing, 302 thousand were issued in 2008; this number dropped to 240 thousand in 2013, a decrease of 21% compared to the 2008 number (1). The number of licenses issued in each prefecture in 2013, ordered from the highest to lowest, was 30 thousand in Kanagawa, 23 thousand in Gifu, 18 thousand in Shizuoka, 17 thousand in Tochigi, and 12 thousand in Toyama (1). We chose to conduct our survey of recreational ayu fishing in Japan's fourth largest prefecture, Tochigi.

The development of recreational ayu fishing is a major policy issue in Tochigi Prefecture (3). In Articles 4 and 5 of the National Law on the Promotion of Inland Fisheries (National Law No. 103 of June 2014), it is specified that the national government and prefectures implement policies for the promotion of inland fisheries. Cost-effectiveness is an important factor in determining the implementation of a prefectural political measure (Hirano and Taniguchi (2010)). The prefecture has only used total licensing fees to assess the economic value (effectiveness) of recreational ayu fishing for making policies regarding economic matters. Thus, one of the priorities of the prefecture has been to shed further light on the economic value of the ayu fishing industry, including its potential value. Accurate assessment of the economic scale of the fishing industry by prefecture has important implications for implementing measures for fishery development. Additionally, the prefecture can understand the baseline economic value of fishing to clarify how to create value in fishing promotion projects under the policies of Tochigi's master plan for fishery development.

Many previous studies on economic value have used the travel cost method (TCM) to assess recreational fishing abroad (McConnell (1979), Vaughan and Russell (1982), Samples and Bishop (1985), Ward and Loomis (1986), Shrestha *et al.* (2002), Bergstrom *et al.* (2004), Prayaga *et al.* (2010), Grilli *et al.* (2017)). These have increased since the 1980s, when TCM research was developed. The TCM was invented by Hotelling (1947). The aforementioned studies estimated economic value using regression. An advantage of the individual travel cost method (ITCM) is that not only is it able to estimate an economic value for recreational fishing, but also it can also analyze the effects of respondents' demographic information on economic value (Shrestha *et al.* (2002), Bergstrom *et al.* (2004), Prayaga *et al.* (2010), Grilli *et al.* (2017)).

Several previous studies has focused on the economic value of Japan's recreational fisheries and fishing (Tamaki (1999), Nakahara (2002), Nakahara and Lou (2002), Tamaki (2007), Miyata (2010)). Recently, the number of papers on the economic value of inland Japanese fisheries has increased (Ueshima *et al.* (2018), Suzuki and Suzuki (2018), Yoshiyama *et al.* (2018)). This recent increase may imply growing interest in this field of research. However, these previous studies on the economic value of Japan's recreational fisheries and fishing activities employ the TCM using four arithmetic operations or the zone travel cost method (ZTCM) using simple regression, excluding the effects of respondents' demographic information.

In Article 5, the first chapter, National Law on the Promotion of Inland Fisheries, clearly states that the roles for the promotion of inland fisheries are to be shared between the national government and a prefecture. Tochigi Prefecture expects to increase the benefit of anglers living in the prefecture by implementing the promotion measures of fisheries via Tochigi's master plan; therefore, it makes sense to separate the anglers living in the prefecture from those living in other prefectures when conducting analysis using the TCM. Furthermore, there are economic relations between Tochigi and its adjacent prefectures as well as somewhat weak relations between Tochigi and outside prefectures beyond the adjacent prefectures. Additionally, Tochigi's fishery promotion projects are expected to differ between the anglers living in Tochigi and those in each other region. For example, these projects are designed to improve and/or expand ayu angling lectures for Tochigi residents, fresh fish products as a souvenir to anglers living in adjacent prefectures, and angler lodges for anglers living in outside prefectures. It also makes sense to separate the anglers living in Tochigi, those living in the adjacent prefectures, and those living in outside prefectures when conducting analysis using TCM.

In our study, we employ more modern methods: truncated negative binomial regression (TNBR), which is based on econometrics theory, to estimate the travel cost while including demographic variables.

2. Materials and methods

The Naka River Fisheries Cooperative Association of the Tochigi Prefecture federation supported our survey, distributing the ITCM questionnaires to Naka River ayu anglers from the 1st of June to the end of November 2017.

Half of the total ITCM questionnaires were placed at ayu decoy shops (which sell adult ayu as decoys, fishing license, fishing gear, etc.) around the Naka River. The other questionnaires were handed out to anglers by the staff and observers of four fishery cooperative associations under the Tochigi Prefecture Naka River fisheries Cooperative Federation at major fishing points, as shown in Figure 1, and recreational ayu fishing event sites during the same period. Almost all ayu anglers visit ayu decoy shops such as fishing shops before they begin fishing; thus, we covered five major ayu decoy shops for the survey. Recreational ayu fishing is a unique type of fishing in that ayu exhibit territorial behavior and tend to attack interlopers; therefore, anglers deploy decoy ayu as interlopers near the target ayu. Thus, almost all anglers buy lively ayu at the shops each time they fish.

In total, 2,500 questionnaires were distributed to ayu anglers at the shops, the points and the sites. The incentive for respondents to complete and return the questionnaires was entry into a random drawing, the prize for which was a gift of local food. A total of 584 responses were received by postal mail, and 68 questionnaires were duplicates submitted by the same respondents (the same names and addresses); ultimately, the valid number of responses for the regression analysis was 455, accounting for all questionnaires in which the respondents fully responded to all items.

We employed the ITCM as the travel cost method. The trip distance of a respondent was calculated with the starting point as the city hall in the town where the respondent lived. The ayu fishing destination was the first fishing point of the day, where was 11 points along the mainstream and tributaries of the Naka River. The red points in Figure

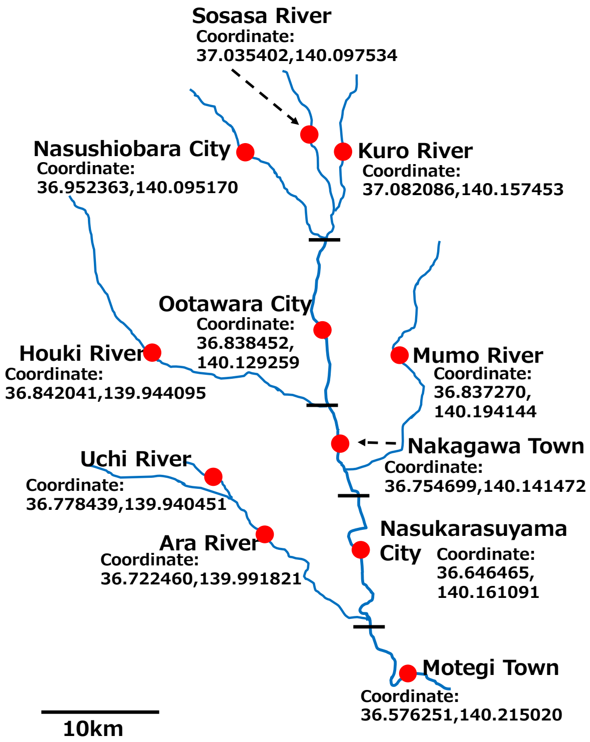

Figure 1　First fishing point of the day

1 represent the first fishing points that mark the middle points of each tributary or the center of the mainstream.

The Naka River is more than 5 km away from other rivers, but it is possible to reach those rivers from tributaries of the Naka River within a few kilometers. Therefore, we assumed that there would be an equal number of anglers who would move from the Naka River to other rivers and who would come to the Naka River from other rivers on the same day. Therefore, we did not consider this potential transfer situation in the model of this study.

Respondents provided their address, mode of transportation to the fishing point, highway information, and income. We estimated the trip distance using Google Maps. The travel cost for a respondent i is calculated with the following formula (1). We asked the respondents what type of license they obtained, since different licenses have different fees. Additionally, the index "i" of dependent variables in formulas (1) and (2) were taken from data collected via the questionnaires.

$$TC_i=((transD_i \times fuel\ /effic) \times dist_i+express_i) \times 0.85+pub_i+time_i \times oppo_i+liceD_i \times lice_i \qquad (1)$$

$$oppo_i=(income_i/\text{average annual labor time}) \times 1/3 \qquad (2)$$

where transD is the dummy for transportation; fuel is the unit price of gasoline (130yen/l); effic is the fuel economy (11.59km/L) (Kudoh *et al.* (2008)); dist is the round-trip distance; express is the round-trip expressway fees; the factor of 0.85 is the inverse average headcount in a car (1.17 heads/car) (Kubota (2017)); pub is the round-trip public transportation fees; time is the round-trip time, excluding fishing time; oppo is the opportunity cost of the trip; liceD is the dummy for license type; lice is the value of a one-time license (the annual license fee divided by fishing days in one year); income is the respondent's annual income; average annual labor time is 1,781 hours per year [(4)]; and the factor of 1/3 is the opportunity cost of recreation (Cesario (1976)).

For our models, the utility of consumer i from the general framework of utility maximization is represented by formula (3) (Shrestha *et al.* (2002)):

$$\max_{y_i, z_i} u_i(y_i, z_i|g_i) \quad \text{subject to} \quad TC_i y_i + q_i z_i = \text{income}_i \tag{3}$$

where y_i is the total number of fishing trips in a year, z_i is the consumption of other goods (vector), TC_i is the travel cost of one trip, q_i is the price of other goods (vector), $TC_i y_i$ is the total travel cost in a year, and $q_i z_i$ is the total other goods cost per year. $TC_i y_i + q_i z_i$ is constrained by income_i, and y_i is influenced by g_i (vector) as a demographic condition.

Shaw (1988) indicated that ITCM data had problems as (a) non-negative integers, (b) truncation, and (c) endogenous stratification. Therefore, we employed truncated negative binomial regression for (a) and (b), and we excluded questionnaires from duplicate respondents to address endogenous stratification for (c), through which we could identify names and addresses of respondents to send the incentive (local food) to winners.

Then, if consumer i accepts ϵ the total number of fishing trips, the expected y_i can be defined by formula (4). In addition, angler non-appearance is truncated because this is an onsite survey wherein the possibility of y_i on the condition of $y>0$ is formulated as a truncated negative binomial distribution of formula (5) (Shrestha *et al.* (2002)).

The Poisson regression model is indicated by previous studies to have a defect in terms of overdispersion (Lindén and Mäntyniemi (2011)). The negative binomial regression model compensates for the defect of the Poisson regression model by adding α, which reflects unobserved heterogeneity. Moreover, y_i is the total number of recreational ayu fishing trips per year, x_i is TC_i and the vector of g_i, and $\gamma()$ is a gamma function.

$$\epsilon_i = E(y_i|x_i) = \exp(bx_i) \tag{4}$$

$$\Pr(y_i = k | y_i > 0, x_i) = \frac{\frac{\gamma(y_i + \alpha^{-1})}{\gamma(\alpha^{-1})\gamma(y_i + 1)}\left(\frac{\alpha^{-1}}{\alpha^{-1} + \epsilon_i}\right)^{\alpha^{-1}}\left(\frac{\epsilon_i}{\alpha^{-1} + \epsilon_i}\right)^{y_i}}{1 - (1 + \alpha\epsilon_i)^{-1/\alpha}} \quad (5)$$

Then, the log likelihood functions of formula (5) are the following functions in formula (6):

$$\begin{aligned} \log L(b, \alpha) = \sum y_i \log(\alpha^2 \exp(bx_i)) - \left(y_i + \frac{1}{\alpha^2}\right)\log(1 + \alpha^2 \exp(bx_i)) \\ + \log\gamma\left(y_i + \frac{1}{\alpha^2}\right) - \log(\gamma(y_i + 1)) - \log\gamma\left(\frac{1}{\alpha^2}\right) \end{aligned} \quad (6)$$

where α in formula (6) is estimated by maximizing the functions.

The Naka River is famous as a recreational ayu fishing river and as a site for the migration of wild ayu in Japan (Kitada (1999)). Some ayu anglers living in outside prefectures seek the wild ayu of the Naka River. According to one of the largest fishing tackle retail company in Japan, the Naka River is the most famous river for ayu fishing in Kitakanto (Ibaraki, Tochigi, and Gunma Prefectures) [(5)].

Some ayu anglers come to the Naka River from afar because of the different opening days for the recreational ayu fishing season. Opening days in the Tohoku region (Fukushima, Miyagi, Iwate, Yamagata, Akita, and Aomori Prefectures) and in the prefectures of the Koushin region (Nagano and Yamanashi Prefectures) are approximately one month later than the opening day for the Naka River, when is June 1st. The opening days of the recreational ayu fishing season are based on river rules [(6)]. In addition, a month's delay can make a big difference in growth because the species is an annual fish (fish with a lifespan of one year). Consequently, some anglers living in these regions travel to the Naka River to be able to fish ayu earlier in the season before the opening days in regions in which they live and to fish ayu larger than those in the rivers closer to their residences. Thus, the utility of these anglers differs from that of anglers living in Tochigi.

In addition, some anglers living in metropolitan regions go to the Naka River to seek a good catch. There are metropolises in Chiba, Saitama, Tokyo, and Kanagawa in a southward direction from Tochigi. Clear rivers for fishing ayu in the region are limited, while the number of ayu anglers living in the region is sizable. Therefore, the catch of recreational ayu fishing in nearby rivers is generally poor. The utility of these anglers thus also differs from that of anglers living in Tochigi.

Against this background, it is necessary for a model to include interactional variables between travel cost and anglers' residences. However, the sampling numbers of ayu anglers from adjacent and outside prefectures were not adequate to allow for these analyses (Table 1). Consequently, we constructed a function with interactional variables between travel cost and residence in an adjacent prefecture seeking wild ayu or residence in an outside prefecture seeking early ayu and/or good catch and/or wild ayu (Figure 2). The function is shown by formula (7):

$$x_i = (\delta + \varepsilon \times adjacence_i + \theta \times outside_i)\, TC_i + \mu g_i \quad (7)$$

where adjacence is the interaction dummy for prefectures adjacent to Tochigi; outside is the interaction dummy for prefectures outside the adjacent prefectures; δ, ε, and θ are coefficients; and g_i (vector) represents demographic variables for respondent i. Additionally, the effect of income in formula (3) is included in the opportunity cost of TC.

The average benefit (consumer surplus) per trip is calculated as follows: $-1/\delta$ for anglers living in Tochigi, $-1/(\delta+\varepsilon)$ for anglers living in adjacent prefectures; and $-1/(\delta+\theta)$ for anglers living in outside prefectures, respectively.

Previous studies have indicated a problem with heteroskedasticity of regression using cross-sectional data (White (1980)). Therefore, we employ a robust standard error bootstrapped by 1000 replications. All estimations were calculated using STATA, version 16.

Table 1 Respondents' residences

Location*1	Prefecture	Freq.	Percent
△	Iwate	10	2.20
△	Miyagi	3	0.66
△	Akita	2	0.44
○	Fukushima	15	3.30
○	Ibaraki	41	9.01
◎	Tochigi	306	67.25
○	Gunma	20	4.40
○	Saitama	29	6.37
△	Chiba	12	2.64
△	Tokyo	13	2.86
△	Kanagawa	1	0.22
△	Yamanashi	1	0.22
△	Nagano	2	0.44
	Total	455	100

Note: *1; ◎ is the target research area; ○ is adjacent to the research area; △ is outside of the adjacent areas.

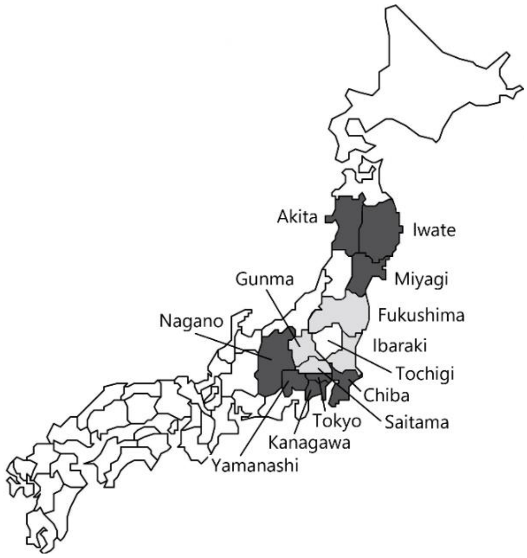

Figure 2 Residence prefecture of respondents

Note: the gray-colored prefectures are adjacent to the research prefecture, and the dark gray-colored prefectures are outside of the adjacent ones; this map excludes the islands of northern and southern Japan.

3. Results

3-1. Results of descriptive statistical analysis

There were 306 respondents living in Tochigi (Table 1) and 15-41 respondents living in each of the prefectures adjacent to Tochigi. Respondents living in outside prefectures came from Iwate, Akita, and Miyagi in northern Japan and from Chiba, Tokyo, Kanagawa, Yamanashi, and Nagano in the Minamikanto and Koushin regions. There were 1-13 respondents living in each of these outside prefectures (Table 1).

The demographic data of all respondents were as follows: males accounted for 99% of respondents; the average age was 60; the average income was 4.20 million yen/year; the percentage of lodgers was 5.05%; the average number of years of recreational fishing experience was 5.54; the average number of recreational ayu fishing trips per year was 20.23, and the percentage of loyalty to the Naka River was 56.70%. Loyalty was assessed with a question asking respondents if they would continue fishing in the Naka River regardless of fishing results (Table 2). Transportation to the fishing point on the

Table 2 Respondents' characteristics

	Total	Freq.	Average/percent
Male	455	451	99.03%
Age*1	454		60.00 years old
Income*2	455		4.20 million yen
Lodger	455	23	5.05%
Years of fishing experience	455		5.54 years
Naka River ayu fishing trips per year	455		20.23 times
Loyalty to the Naka River*3	455		56.70%

Note: *1 Answer choices were divided into 10 age groups; *2 Answer choices were: under 3 million, 3-5, 5-7, 7-9, 9-11, 11-13, 13-15, 15-17, and over 17 million, and the income of respondent was defined as the average of each income group and 1.5 million when it was under 3 million and 19 million when it was over 17 million; *3 The respondents answered that they would continue ayu fishing in the Naka River even if they could not catch a satisfactory number of ayu.

Naka River was by car (96.04%), by train (1.10%), or by another mode including by foot and bicycle (2.86%).

As mentioned above, the average income per respondent was 4.20 million yen under the conditions of 99% male and average 60 years old (Table 2). The average income of Japanese males in the age range of 55-59 years old according to the national statistics was between 4.12 and 4.24 million yen (7). The average income of respondents was similar to the values of these statistics. The average number of Naka River ayu fishing trips per year was 20.2 times for all respondents, 23.5 times for respondents living in Tochigi, 14.2 times for respondents living in adjacent prefectures, and 11.9 times for respondents living in outside prefectures.

3-2. Results of regression analysis

For the results of TNBR, the Akaike information criterion (AIC) and Bayesian information criterion (BIC) of models with/without interaction variables for TC (formula (7)) were 3,374 and 3,402, respectively, for the model with the adjacence and outside variables; 3,415 and 3,440, respectively, for the model with the adjacence variable; 3,392 and 3,417, respectively, for the model with outside variable; and 3,421 and 3,442, respectively, for the model without adjacence and outside variables. Therefore, we selected the model with adjacence and outside variables.

The coefficient of TC was estimated to be -0.000144 (Table 3), and the average benefit for respondents living in Tochigi was estimated to be 6,944 yen/trip (5,650-9,091 yen/trip; 95% confidence intervals). The average benefit for respondents living in prefectures adjacent to Tochigi was estimated to be 12,821 yen/trip (9,512-19,656 yen/trip; 95% confidence intervals), and the average benefit for respondents living in outside prefectures was estimated to be 24,390 yen/trip (18,142-37,202 yen/trip; 95% confidence intervals). The average benefit for all respondents was 10,078 yen/trip as estimated from the coefficients of TNBR.

The coefficient of fishing experience was estimated to be 0.084. This indicates that the number of fishing trips increased 0.14 trips/year with an increase of one year of fishing experience, which is a marginal effect under a condition of other coefficients fixed at means (8). The coefficient of loyalty was estimated to be 0.153. This indicates that the number of trips for respondents answering yes to the loyalty question is 2.8 trips/year more than the number of respondents who answered no, which is also a marginal effect under a condition of other coefficients fixed at means.

The alpha in Table 3 is α reflected unobserved heterogeneity in formula (5), and the LR test rejected the null hypothesis, alpha=0.

To address endogenous stratification, the above analyses excluded questionnaires from duplicate respondents. To make assurance double sure, we followed the methodology of Grilli *et al.* (2017), and conducted regression analysis using the generalized negative binomial model with endogenous stratification corrected for truncation. The results were almost the same as those in Table 3 (9), in which the coefficients as well as AIC and BIC were similar. Therefore, we concluded that endogenous stratification was addressed by excluding questionnaires from duplicate respondents.

4. Discussion

The utility of anglers from adjacent and outside prefectures differed from that of anglers living in Tochigi, since in the regressions, the coefficients of interaction for estimating benefits were significant and different (Table 3). This is the originality of our study, as previous studies (described in the introduction) do not discuss this.

The cumulative number of ayu anglers coming to the Naka River in 2017 was 137 thousand (10). Thus, the estimated number of anglers from each residence group was as follows: 92 thousand from Tochigi, 32 thousand from adjacent prefectures, and 13 thousand from outside prefectures (Table 4). These were estimated from the 137 thousand cumulative ayu anglers multiplied by the quotient of the number of anglers

Table 3 Results of truncated negative binomial regression

No. of obs.	455			
Replications	1,000			
Wald chi2(5)	115		Prob>chi2	0.000
Log pseudolikelihood	-1680			
Pseudo R2	0.053			
AIC	3,374		BIC	3,402
LR test of alpha=0: chibar2(01) = 1,625 Prob >= chibar2 = 0.000				

	Coef.	*1	[95% Conf. Interval]	
TC	-0.000144	***	-0.000177	-0.000110
Interaction variables for TC				
Adjacence	0.000066	***	0.000035	0.000096
Outside	0.000103	***	0.000071	0.000135
Experience	0.083667	***	0.033417	0.133916
Loyalty	0.153350	**	0.038716	0.267983
Constant	2.870018	***	2.574931	3.165104
lnalpha	-1.251685	***	-1.421074	-1.082297
alpha	0.286022	***	0.241455	0.338816

Note: *1 Significance levels: *** 1 %, ** 5 %, and *10%; based on the bootstrapped standard error.

Table 4 Annual benefit for ayu fishing at the Naka River

	Cumulative number of ayu anglers (thousand)		benefit (million yen)	
Tochigi	92	67%	640	47%
Adjacence	32	23%	405	30%
Outside	13	10%	323	24%
Total	137	100%	1,368	100%

Note: The total number of anglers as 137 thousand was taken from Sakai (2018) [10].

from our survey in each residence group.

The benefit of each residence group was estimated by TNBR as follows: 640 million yen for residents from Tochigi, 405 million yen for residents from adjacent prefectures, and 323 million yen for residents from the outside prefectures (Table 4). The total benefit of these anglers was estimated to be 1,368 million yen (Table 4).

The total licensing fees for the Naka River was recently calculated as 80-100 million yen/year (Kubota (2017)). The total benefit, as mentioned above, was 1,368 million yen, 14-17 times higher than the total licensing fees. If Tochigi Prefecture were to focus on prefectural inhabitants, the benefit of anglers living in Tochigi, at 640 million yen, was

6.4-8 times higher than the total licensing fees.

As mentioned above, the prefecture has only used total licensing fees to assess the economic value of recreational ayu fishing for policymaking. Tochigi's master plan for fishery development (2016) enumerates improvement of the sales channels of license tickets, promotion of recreational fishing, increasing the number of juvenile ayu released, etc. Thus, the prefecture will be able to expand a scale of projects in the master plan or in future master plans by up to 6.4 or possibly even 8 times. Moreover, the prefecture will request governmental subsidies several times larger than the current subsidy scale because the Ayu anglers living outside Tochigi are provided the utility from recreational ayu fishing in the Naka River.

This model is based on the following assumption. When recreational ayu fishing in the Naka River is not available, the anglers will move to other rivers to fish ayu or other fish species, the number of anglers in the rivers will increase, and the rivers will become crowded, making it difficult to catch enough ayu or other species. Consequently, the utility of the anglers will be reduced. In this model, the reduced utility is the same as the utility of ayu fishing anglers in the Nakagawa River.

In the questionnaire, we also asked about alternative relations between the Naka River and other rivers. Of the respondents, 56.7% answered that they would continue ayu fishing in the Naka River even if they could not catch a satisfactory number of ayu. A total of 16.0% of the respondents answered that they would move to other rivers in Tochigi if they could not catch a satisfactory catch, while 22.6% answered that they would move to other rivers in other prefectures if they could not catch a satisfactory catch, and 4.6% gave other answers. It is recommended that Tochigi Prefecture adjust the estimated benefits to take these results into account and that the adjustment be decided based on the Tochigi fishing policy and the national fishing policy, in which the promotion of inland fisheries is to be shared between the national government and a prefecture (National Law on the Promotion of Inland Fisheries).

The reputational damage from radioactive contamination after the Great East Japan Earthquake might be still remained, when we conducted this survey in 2017. However, the annual number of anglers recovered by 2014, and the number since 2014 has been decreasing at a rate similar to that before the earthquake [(11)]. Kubota points out that the decline of ayu anglers is caused by aging of the anglers and a significant decrease in newcomers (Kubota (2017)). Thus, countermeasures against the decline of anglers and aging are also important for the policy.

Previous studies on the travel cost method of recreational ayu fishing in Japan have been rare, excepting the paper of Suzuki and Suzuki in 2018. Thus, we compare our results with those of that study. The previous study neglected the number of passengers in a car as well as the mode of transportation, and it estimated the ZTCM. Furthermore, the study did not consider the opportunity cost for recreation but instead used a common labor cost (2,406 yen/hour). Thus, it may have overestimated, even in the presence of guidelines for economic evaluation in non-market reports to avoid overestimation (Arrow *et al.* (1993)). Therefore, we used the one-third common labor cost as in formula (2) for curbing an overestimation of benefit using the TCM (Cesario (1976)). However, the benefit per trip in the previous study was estimated at 8,711 yen/trip (2011) to 10,158 yen/trip (2012). Our result was 10,078 yen/trip. That is, the estimated benefits were similar. Therefore, it was difficult to explain the comparative results of the ITCM in this study and the ZTCM in the previous study for recreational ayu fishing and regarding the overestimation of the TCM.

Further study is needed to clarify differences among the utilities of ayu anglers living not in adjacent and outside prefectures but in the Tohoku and Koushin regions (regions with late opening days) and the Minamikanto region (metropolises) by increasing the number of anglers sampled.

Notes

(1) Ministry of Agriculture, Forestry and Fisheries (2013) The 2013 Census of Fisheries.

(2) Annual Statistical Report of the Fisheries and Aquaculture Production: http://www.maff.go.jp/j/tokei/ kouhyou/kaimen_gyosei/, “Accessed 14 April 2020”.

(3) Tochigi’s Master Plan of Fisheries Development: http://www.pref.tochigi.lg.jp/g02/suisan/suisansinkokeikaku1.html, “Accessed 14 April 2020”.

(4) Ministry of Health, Labour and Welfare (2017) Monthly Labour Survey.

(5) One of the largest fishing tackle retail company in Japan, “Johshuya,” said that the Naka River was truly a kingdom for recreational ayu fishing in Kitakanto (Johshuya news on 27 April 2019: http://www.johshuya.co.jp/news/detail.php?no=156854 “Accessed 14 September 2020”.

(6) List of opening days: http://www.naisuimen.or.jp/fising/ayu.html, National Federation of Inland Fisheries Cooperative Association, “Accessed 18 April 2020”.

(7) Ministry of Health, Labour and Welfare (2017) Basic Survey on Wage Structure.

(8) The choices were 1.under 1 year, 2. 2-5 years, 3. 6-10 years, 4. 11-20 years, 5. 21-30 years, 6. 31-50 years, and 7. over 50 years, and the fishing experience year of respondent was defined as the average of each year group, 0.5 years when it was under

1 year, and 55 years when it was over 50 years. The marginal effect estimated by ordinary least squares was 0.14 (Figure (8)).

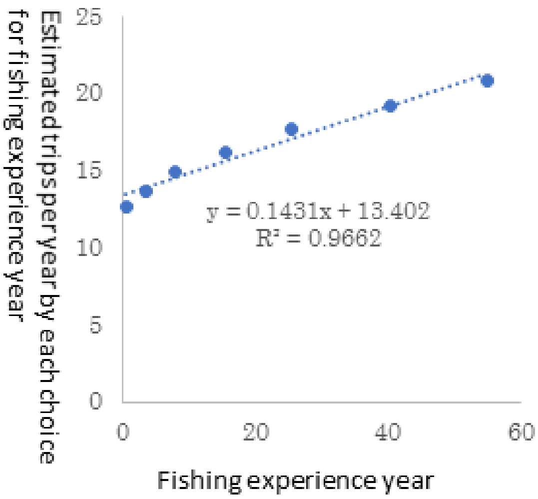

Figure (8) Regression for estimating marginal effect of fishing experience year

Note: Trips per year by each choice are estimated under a condition of other coefficients fixed at means.

(9) Table (9) shows the results of generalized negative binomial regression with endogenous stratification corrected for truncation.

Table (9) Results of regression of "Generalized Negative Binomial with Endogenous Stratification"

AIC	3,374	BIC	3,403	
	Coef.	*1	[95% Conf. Interval]	
TC	-0.000152	***	-0.000187	-0.000116
Interaction variables for TC				
Adjacence	0.000070	***	0.000037	0.000102
Outside	0.000109	***	0.000074	0.000144
Experience	0.087433	***	0.034685	0.140180
Loyalty	0.160231	**	0.033317	0.287145
Constant	2.415180	***	2.085126	2.745233
lnalpha	-0.711364	***	-0.956859	-0.465869
alpha	0.490974	***	0.384097	0.627590

Note: *1 Significance levels: *** 1 %, ** 5 %, and *10%; based on the bootstrapped standard error

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