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Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Economic valuation of Nile Tilapia (*Oreochromis niloticus*) in Lake Hawassa, Southern Ethiopia

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The purpose of this study is to investigate the economic value of fish (Nile Tilapia) in Lake Hawassa and determine the factors affecting the households' willingness to pay for a quality improved fish product. The survey was conducted through face-to-face interview of 467 households consuming fish caught from the lake. The respondents were aware on the poor quality of the fish due to domestic and industrial effluents discharged into the lake. The consumers stated their preferences on quality improved fish product with the mean value of Birr 57.76 per kilogram, which was equivalent to USD3.20 per kilogram during the survey period. The analysis on the determinants of willingness to participate in the fish quality improvement program shows that education, annual income, frequency of fish consumption, marital status and multiple use of the lake influence the participation on the quality improvement program positively while family-size, residential-land and employee negatively influence the participation on the quality improvement program. The valuation of quality improved fish product shows that households who are aware of the poor quality of the lake, residential-land owners and those who earn high annual income are more likely to attach higher monetary value for the quality improved fish product. Therefore, identification of such variables and their relative importance in the valuation helps to obtain households who are willing to pay maximum level for the fish quality improvement.

Key words: Contingent valuation, fish, Heckman model, Lake Hawassa, willingness to pay.

INTRODUCTION

Fish provide vital and unique nutritional benefits such as protein, vitamins, minerals and micro-nutrients. High per capita consumption of fish has a significant impact on food and nutrition security especially in the lake districts. World per capita fish consumption increased from an average of 14.4 kg in the 1990s to 20.1 kg in 2014 (FAO, 2016). However, the distribution of the increase in fish consumption has been unequal among countries and within countries. For example, the per capita fish consumption in East Africa is below 1 kg. The level of fish

consumption in Ethiopia varies among various income classes ranging from 22 g to 1.7 kg, with the average annual per capita consumption of 476 g (FAO, 2011). Since fish has not been integrated into the diet of most of the population, the demand for fish is small. The other factor for low per capita consumption of fish in Ethiopia is limited supply of the product.

The fish productions in major Ethiopian lakes are below the maximum sustainable yields except Lake Hawassa where 140% of its maximum sustainable yield is caught

from Lake Hawassa (Assefa, 2014). The annual per capita consumption of fish from Lake Hawassa is 1.56 kg. Among the major species of fish in Lake Hawassa, Tilapia (*Oreochromis niloticus*) accounts for more than 90 percent of the landed fish biomass in the lake. About 73% of fish caught from Lake Hawassa is sold in nearby market (FAO, 2011). The factors which trigger demand for fish in Hawassa district include the relatively low price of fish or the increasing prices of its substitutes and religious influences. For example, Coptic Orthodox Christians tend to resort to fish during lent when they abstain from meat and dairy products (FAO, 2016).

The domestic sewages, silts or sediments and industrial effluents have posed pressure on the aquatic lives of Lake Hawassa creating unfavorable environment due to some toxic substances in the effluents. Gebremariam and Desta (2002) observed that the effluents from the nearby factories were acutely toxic to fish, with a higher mortality rate within small wastewater solution within 24 h. The discharges of untreated effluents affect water transparency and gas solubility, which in turn cause damage to the aquatic biota. According to Birenesh (2007), the effluents discharged into the lake contain heavy metals like Mercury (Hg), Cromium (Cr), Lead (Pb), Cupper (Cu) and other metals.

Various combinations of metals and also metals with other substances in domestic and industrial waste waters present a real and potential hazard for aquatic ecosystems. Semenovich (2001) states that the heavy metals have a high degree of accumulation through the food chain and can intensify the toxic effects on humans eating fish products. Whether the resource users are aware of the poor quality of the lake and willing to pay for the improvement of fish quality are not well understood. The valuation of the benefits of the lake from the perception of users is a critical input for implementation of fish quality improvement program. Therefore, are the beneficiaries willing to pay for the improvement of fish quality? If yes, what are the determinants of their willingness to pay for the quality improved fish products? The objective of this study is to analyze the economic value of fish product and determine the factors that affect the consumers' willingness to pay for quality improved fish product with the hypothesis that consumers prefer clean water, which is not in need of purification, to treated water after polluted.

Unfortunately, integrated information about economic values of the water-resources which is important for its conservation has been limited in the region. Those who would estimate the benefit of controlling water pollution face a dilemma because the studies that have valued local water bodies such as lakes are of limited use in determining water quality policy changes due to unreliable data. Unreliable results on the economic value of the water bodies due to lack of quality and sufficient data needed for research have, therefore, contributed little value to the management of local water resources.

This study differs from previous studies on Lake Hawassa in quantifying the water-resource use in terms of fish value in monetary terms so as to reduce its degradation more effectively. Hence, it contributes to sustainable resource use providing the necessary economic information of the lake as a source of fish products to develop socially acceptable, environmentally sound and financially feasible water resource management. This study is limited to the use value of the lake as fish product. The other use values of the lake such as recreational value, irrigation water, and the non-use value such as the existence value and bequest value of the lake have not been considered in this study.

LITERATURE REVIEW

Fish production and valuation of fish product

Aquatic animals are sources of protein, minerals such as calcium, iron and phosphorous as well as trace elements and vitamins. Fish, the most important aquatic animals, are main source of protein, especially in the developing world. One billion people rely on fish as their primary protein source, and several hundred million people depend on fish as their main source of income (IFPRI, 2009). Globally, fish represents about 16.6% of animal protein supply and 6.5% of all protein for human consumption (FAO, 2012). In low-income food deficit countries fish account for 20% of animal-derived protein as compared to 13% in the industrialized countries (Delgado et al., 2003).

Fish is usually low in saturated fats, carbohydrates and cholesterol, and provides not only high-value protein but also a wide range of essential micronutrients, including various vitamins and minerals (FAO, 2012). Thus, even in small quantities, provision of fish can be effective in addressing food and nutritional security among the poor and vulnerable populations around the globe. While the global human population continues to increase rapidly, the world's fishing areas have reached their maximal potential for capture fisheries production (FAO, 2014). As a result demand for fish is much greater than the capture fishery can supply. The high demand and good price has therefore led to overfishing, which is environmentally damaging and economically inefficient (Peter, 2006). In Ethiopia, Nile perch and Tilapia show signs of over-fishing in Lake Hawassa and Lake Chamo, and Tilapia in Lake Ziway are probably at full exploitation (Assefa, 2014).

In the analysis of consumer preference and willingness to pay for fish farmed in treated waste water, Solomie et al. (2015) confirm that consumers with children are less likely to pay for fresh Tilapia farmed in treated waste water. This reflects that consumers prefer clean water, which is not in need of purification or other treatment, to water that has been polluted but treated to clean.

According to Solomie et al. (2015), bid negatively influence the households' willingness to pay for fish farmed in treated water. The negative sign for bid implies that the higher the amount requested to pay, the lower the probability a consumer would be willing to pay for the fish farmed in treated waste water. In addition, consumers with higher level of education are less likely to be willing to pay for fresh Tilapia farmed in treated waste water. Education increases consumers' consciousness towards food safety, which implies that postharvest processing of fish might be perceived as safer and thus increases the likelihood of consumers' willingness to pay for smoked fish.

The analysis of the factors that determine consumers' willingness to pay for a given quantity of safely prepared fish reflects a significant association between consumers' attitude and acceptance of food safety measures. The food safety measures include source of production labels and hygienically displaying unit for fish and other food stuff sold in the area (Ehirim et al., 2007). Household income and size of household are positively related with the changes in probability that a consumer will pay for safety than not having it at all. The economic implication of positive and significant influence of income is that consumers are ready to pay more for safety as this could offer a cheaper health care and health security than controlling the health problems due to unsafe food consumption.

Contingent valuation method (CVM)

Economic values are usually distinguished as use and non-use values. Use value is further classified into direct and indirect use values (Turner et al., 1994a). Direct use values of water resources can be extracted, consumed or directly enjoyed. It is therefore known as extractive or consumptive use value (Hawkins, 2003). Direct use values of water resources include the consumption of fish for food, water for drinking, cooking and washing, irrigation, recreation and tourism. Indirect use of water resource services includes energy production and nutrient recycling (Schuyt and Brander, 2004). Non-use values are often intangible and include the value of leaving opportunities for future generations (bequest value) and the value from knowing that the resources exist, which is known as existence value (Chandler and Suyanto, 2005).

For water resource goods and services that are traded in the market place and whose prices are not distorted, market prices can be used as indicators for economic values. Often, however, most of goods and services do not have a market price and shadow pricing techniques can be applied to determine their economic values (Schuyt and Brander, 2004). Among several shadow valuation methods that economic theory distinguishes, a well-known method is contingent valuation, which directly obtains consumers' willingness to pay for a change in the level of environmental good, based on a hypothetical market.

Contingent valuation is the most widely accepted stated preference method used for estimating total economic value, including all types of non-use values (Hajkowicz and Okotai, 2006). The purpose of the contingent valuation method is to elicit individuals' preferences, in monetary terms, for changes in the quantity or quality of nonmarket environmental resources, which have the characteristics of non-excludability and non-divisibility (Perman et al., 2003; Birol et al., 2006). In conducting the contingent valuation surveys acknowledgement of all stakeholders, careful survey design and administration, and post survey debriefings (particularly for examining the reasoning behind irrational responses) help improve the process of valuation of environmental resources (Duberstein and de Steiguer, 2004).

To conduct a CV survey, special attention needs to be paid to the design and implementation of the survey. Focus groups, consultations with relevant experts, and pretesting of the survey are important pre-requisites. Decisions need to be taken regarding how to conduct the interviews; what the most appropriate payment bid vehicle is e.g., an increase in annual taxes, a single-one-off payment, a contribution to a conservation fund, among others as well as the willingness to pay (WTP) elicitation format. The survey may be conducted through face-to-face interviews, telephone or mail surveys. In developing countries, face-to-face interviews are considered the most appropriate because of high rates of illiteracy and defective telephone networks. Fortunately, personal interview is the best approach for reducing sampling bias (McClelland et al., 1993; Turner et al., 2004b; Birol et al., 2006).

The advantage of using Contingent valuation technique over Travel Cost Method (TCM) in valuation of water resources is its ability to capture both use and non-use values. Perman et al. (2003) explains the advantages of CVM over TCM as its ability to deal with both use and non-use values and, in principle, its answers go directly to the theoretically correct monetary measures of utility changes. This technique is enormously flexible in that it can be used to estimate the economic value of virtually anything. For example, using other valuation methods like hedonic pricing and travel cost method will underestimate the benefits people obtain from improved water resources as they measure only use values. In practice, getting more information close to reality through revealed preferences derived from observed behavior is a difficult task in non-market resources.

In the valuation of improved water quality for recreation in East Lake, Yaping (1998) applies both contingent valuation and travel cost methods. The multivariate analysis of travel cost method reveals income and education are insignificant factors affecting demand. Furthermore, travel cost method shows that income is

inversely related to demand for East Lake, which implies that the lake is inferior good. However, the East Lake is still regarded as a luxury good (Yaping, 1998). Whereas, the contingent valuation method of the same lake shows that education and income are significant at 1% level. The comparison of the values from TCM and CVM shows that the net addition of consumer surplus due to quality improvement with TCM is RMB¥18.09/m^2 at swimming level while the total WTP in the recreational area with CVM is RMB¥21.41/m^2 if water becomes clean enough for swimming (Yaping, 1998). This finding reflects that CVM value is higher than that from TCM.

Despite the strengths of this technique over others regarding its ability to estimate both values (use and non-use) and evaluate irreversible changes, contingent valuation method is criticized for its limitations in addressing full services and functions of the environmental resources. The valuation of environmental resources benefits is imperfect and in need of improvement. For instance, CVM is criticized for its lack of validity and reliability (Mathews, 1999; Birol et al., 2006). As this technique is survey-based and all relevant stakeholders are not included in valuing resource for reaching effective resource management, outcomes of contingent valuation may, however, be less accurate (Duberstein and de Steiguer, 2004).

Since the contingent survey instrument is of a hypothetical market, the data is criticized for its bias, some of which are hypothetical bias and strategic bias (Birol et al., 2006; Krantzberg and de Boer, 2006). Hypothetical bias is caused by the hypothetical market nature of the contingent valuation. Hypothetical bias is created when respondents are not capable of knowing the environmental resource values without participating in a market in the first place in spite of their well preparation to reveal their true values (Turner et al., 2004b).

Strategic bias means that people purposively state a higher or a lower price than what they are willing to pay; in this way the resource will be either underestimated or overestimated and someone else will bear the over- or underestimated cost (Bulov and Lundgen, 2007). For instance, respondents may deliberately understate their WTP when they believe that the actual fees they will pay for provision of the environmental resources will be influenced by their response to the CV question. Conversely, realizing that payments expressed in a CV exercise are purely hypothetical, respondents may overstate their true WTP hoping that this may increase the likelihood of a policy being accepted (Birol et al., 2006).

In the social sciences, bias in the estimated effects from any given study is very difficult to rule out, no matter how intuitively appealing the methodology. There is, unfortunately, no statistical silver bullet. Sometimes the Heckman Model as an approach is applied to observational data for the purpose of estimating an unbiased causal effect (Briggs, 2004).

METHODOLOGY

Description of the study area

Lake Hawassa is located at 6°33' – 7°33'N and 38°22' – 39°29'E in the southern Ethiopia. The surface area of the lake on average is 93.5 km^2 with maximum depth of 32.2 m and the average depth of 13.6 m. The seasonal variation of the lake water level ranges from 0.09 to 1.57 m with an average of 0.66 m (Halcrow Group Limited and Generation Integrated Rural Development, 2009). Unlike other closed lakes with alkaline characteristics, Lake Hawassa is one of the few fresh closed lakes with its electrical conductivity of 802 µS/cm, and pH=8.6 (Tenalem et al., 2007). The freshness of the lake water could be justified as water from Lake Hawassa catchment can flow to lakes of lower altitude (Yemane, 2004).

Survey design and development

A contingent valuation survey instrument was designed as the scenario informs the change in the resource under valuation. It explains clearly how that change would come about; how it would be paid for; and the larger context that is relevant for considering the change. The question was phrased using the payment vehicle of price increment per kilogram for quality improved Nile tilapia (*Oreochromis niloticus*). Such payment form was assumed to empower the respondents to decide freely on the resource management. It was also assumed that the society might not accept other payment forms particularly 'tax' relating it with the actual tax increment without resource improvement. With the aim of contingent valuation survey to display the attitudes and perceptions of a study population, the design was made to ensure the values expressed by the respondents would be those held for the fish quality improvement.

According to Whittington (2002), the job of training enumerators on the administration of contingent valuation surveys includes two related but distinct tasks. The first is to ensure that the enumerators understand the objectives of the survey and the subject matter contained in the CV scenario. The second is to provide enumerators with the skills to conduct a high-quality in-person interview. Following this advice, the enumerators were carefully instructed about the objectives of the survey and the concept of CV scenario like the contextual concept of the survey, the resource condition and the need for management, the content of the survey and how to measure the respondents' annual income and others especially for those who would be interviewed in the rural areas, and other relevant concepts of the survey instrument. The questionnaires were administered using a face-to-face interview technique.

Based on stratified random sampling technique, 467 respondents were selected from fish consumers combining the formula: $n > 104+m$, where n = sample size, and m = the parameters that are expected to affect the willingness to pay for water quality improvement, and the advice that for regression equations using six or more predictors, an absolute minimum of 10 participants per predictor variable is appropriate. However, if the circumstances allow, a researcher would have better power to detect a small effect size with approximately 30 participants per variable (Van Voorhis and Morgan, 2007). To make the sample representative of the whole population, the sample size obtained using the above formula was critically examined in line with the proportionality of the sample to total population. The questionnaire was designed to consist three sections. The first section was about the respondents' knowledge, attitudes, and perception about the resource and its environmental problems, which provide an explanation of the environmental issue of interest together with information on the change in quality. The second section was about the contingent

valuation scenario created for the resource improvement program and the respondents' willingness to pay in support of the proposed improvement. The third section was about the respondents' socio-economic characteristics like information on the respondents' educational level, income, and other socio-economic and demographic characteristics, which enable analysis and verification of the validity of responses on willingness to pay given by respondents.

According to Bateman et al. (2002), protests are non-responses in which the genuine WTP are not provided. That means respondents either responded with a zero value or with an unrealistically high value instead. These responses do not represent the households' honest value of the nonmarket good as they are protesting to an aspect of the hypothetical scenario, such as mistrust for the institution that manages the funds, or the belief that protection of resource is a government responsibility. Hence, such respondents could also be termed as scenario rejecters. To critically examine whether the responses of the respondents who preferred to remain neutral in the proposed improvement program were protests or genuine responses, the CV survey instrument was designed to state why the respondents would not participate in the proposed program.

Empirical model specification

The Heckman's two step model was employed in the analysis of the survey data. When the population of the study area is quite large with no boundaries, sampling can only define the scope that is selected by the researchers. It is possible to insert irrelevant variables or not to include associated variables in the sample, which may cause sample selection bias. Heckman's two-step model explicitly resolves potential sample selection bias (Zhang et al., 2014). The Heckman two-step model examines the two steps leading to respondents' decisions in a single model while distinguishing the influence of different factors between these two steps. That means it investigates the factors influencing willingness to pay along with payment level in a single model. It also prevents the disturbance of respondents whose willingness to pay (WTP) is zero. It is a two equation model: the regression model and the selection model.

Selection equation

Participation = $Z_i\gamma + u_i$ (1)

Regression or observation equation

WTP = $\beta X_i + \varepsilon_i$ (2)

From the first stage (Participation), Mill's inverse ratio was constructed and then regressed by Ordinary Least Squares (OLS) as:

WTP = $\beta X + \rho_{\varepsilon u}\sigma_\varepsilon \lambda_i(-Z_i\gamma)$ (3)

Since the correlation between two disturbance terms was different from zero ($\rho_{\varepsilon u} \neq 0$), the OLS estimates were biased as it did not account for estimation of γ, which is an additional term that depends on the inverse Mill's ratio evaluated at $Z\gamma$. This omitted variable, $\lambda(z\gamma)$, was correlated with X (Wooldridge, 1999). Under the assumption that the error terms were jointly normal, we had

WTP = $\beta X + \rho_{\varepsilon u}\sigma_\varepsilon \lambda_i(-Z_i\gamma)$

Where, $\rho_{\varepsilon u}$ is the correlation between unobserved determinants of propensity to support (u) and unobserved determinants of WTP (ε),

σ_ε is the standard deviation of ε, and λ is the inverse Mills ratio evaluated at $-Z_i\gamma$.

The WTP equation was estimated by replacing γ with probit estimates from the first stage, constructing the λ term, and including it as an additional explanatory variable in linear regression estimation of the WTP equation. The Inverse Mill's ratio [$\lambda_i(-Z_i\gamma)$] was calculated using the formula:

$$\lambda_i(-Z_i\gamma) = \frac{\varphi(-Z_i\gamma)}{1-\phi(-Z_i\gamma)}$$

      (4)

Where, φ denotes the standard normal density function, and ϕ denotes the standard normal cumulative distribution function.

The Heckman model can help social work research by providing researchers with methods of detecting and correcting sample selection bias (Cuddeback et al., 2004). In other words, the application of Heckman's sample selection model shows efficiency and robustness of controlling for selection bias through a two-stage process (Gou, 2009). This model allows using information from non-supporting individuals to improve the estimates of the parameters in the regression model. Hence, the Heckman selection model provides consistent, asymptotically efficient estimates for all parameters in the model.

Generally, the selection equation is estimated by maximum likelihood as an independent probit model to determine whether to participate and pay using information from the whole sample of supporters and non-supporters. A vector of inverse Mills ratios (estimated expected error) can be generated from the parameter estimates. The WTP amount, *y*, is observed only when the selection equation equals 1 (that is, individuals support the quality improvement program) and is then regressed on the explanatory variables, *x*, and the vector of inverse Mills ratios from the selection equation by ordinary least squares. Therefore, the second stage reruns the regression with the estimated expected error included as an extra explanatory variable, removing the part of the error term correlated with the explanatory variable and avoiding the bias.

To estimate the economic value of the lake and the factors that determine the willingness to pay for fish consumption, the frequency of fish consumption, number of years that households consumed fish caught from the Lake Hawassa, awareness of the households on the poor quality of the lake, gender, age, marital status, family size, education, employment status, ownership of permanent asset (land) in the watershed, duration of the households in the watershed area, household's annual income, type of uses that households benefit from the lake, residential location, and distance from the resource were considered. Taking into account the factors that significantly affect the households' willingness to pay for the quality improved fish product, the equation for parametric mean WTP was derived as:

WTP = $\beta_o + \beta_1$frequency of fish consumption + $\beta_2$poor quality + $\beta_3$age + $\beta_4$marital status + $\beta_5$emplyee + $\beta_6$business man + $\beta_7$residential land + $\beta_8$duration + $\beta_9$income + β_{10}mills inverse

      (5)

Description of explanatory variables and expected impacts

(1) *Freqconfish*: It stands for the frequency of fish consumption. The sign for this variable is expected to be positive. The assumption is that the respondents who use fish more frequently express their willingness to pay for the quality improvement to keep on using the improved fish product. In addition, these people understand the change in quality and size of fish due to various activities in the watershed, and hence reflect their participation in the resource improvement program. Gempesaw et al. (1995) reflect positive correlation between frequency and willingness to pay for the resource improvement.

(2) *Fishconsdurn*: It refers to how long the households have used the fish caught from Lake Hawassa. The sign for this variable is expected to be positive because those who used the fish for many years would observe the trend of changes of fish products in terms of size and quality, and hence reveal their willingness to participate in the proposed improvement program, if other factors remain constant.

(3) **Poor-quality:** This stands for the perception of poor quality of the lake. It refers to the overall condition of the water resources in the watershed, that is, whether its quality has got worse or not, the small size and low quality of fish product. It is a dummy variable taking 1 for those who perceive the quality of the resource has got worsen; 0 otherwise. Generally the households who realized that the resource has degraded could pay much attention to its improvement, and they become more responsible to reduce its deterioration. Thus, its sign is expected to be positive (Mallios and Latinopoulos, 2001; Benson, 2006; Gupta and Mythili, 2007).

(4) **Sex:** This is a dummy variable taking 1 if the respondent is male and 0 for female. In the rural side of the lake, males are more dominant in decision making process since they have more access to resource control compared to females, in which case the sign is expected to be positive. This expectation is consistent with the finding of Tiwari (1998). On the other hand, women are more attentive than men to link between the environment and the things they value. Birol et al. (2006) also state that females are more likely to attach higher values to non-use values of wetlands. According to these arguments, the sign for sex is expected to be negative. For this study, the impact of sex on WTP is mixed, which is in line with the findings of Brown and Taylor (2000).

(5) **Age:** This refers to the age of the respondents. It is continuous variable. The sign of the coefficient on age variable is not possible to predict a priori. The hypothesis is that young generations are relatively more educated than older people, and they have better understanding on the resource improvement (Imandoust and Gadam, 2007). On the other hand, older people have indigenous knowledge and they are more sensitive to the environmental protection and natural resource management. In such a case, it is positively related to determine the willingness to pay for the resource management. This implies that as people get older, their experience with the benefits and services increases so that they support the improvement program, in which case the sign for age would be positive (Holmes et al., 2004; Benson, 2006).

(6) **Marital-status**: This refers to marital status of the respondent. It is a dummy variable taking 1 if the respondent is married; 0 otherwise, and it is expected to have positive sign. It is assumed that married respondents could help each other in contributing for the fish quality improvement program. It is also assumed that married people would be more responsible to keep their environment and natural resource in a sustainable way. This might be because they would attach the bequest and existence values to the resource in addition to their current benefits they derive from the resource. This expectation is similar to the findings of Solomon (2004).

(7) **Family-size:** This refers to family size of the respondents. It is a continuous variable. The sign for family size is expected to be negative. This is due to the fact that as the family size increases, the welfare distribution in the family members would be reduced. Therefore, their willingness to pay for the fish quality improvement program could relatively be lower (Tiwari, 1998; Tang et al., 2013). This implies that households with large family sizes allocate their limited income to their relatively large number of family members and hence face financial constraint to allocate for the fish quality improvement program as compared to households with smaller family sizes.

(8) **Education:** This stands for educational level of the respondent in years of education. It is continuous variable. The idea with education in determining the resource improvement program is that more years of education would, generally, give them better understanding on the values of the environmental resources. Therefore, educational level attained by the respondents is expected to have positive sign, indicating households with higher level of literacy have better chances of maximizing their utility and welfare from consuming and getting access to improved fish products. In addition, when people are more educated, their perception on non-marketed benefits of the environment and natural resources increases, and hence their willingness to pay for resource quality improvement plan becomes higher than those with lower educational levels (Holmes et al., 2004; Benson, 2006).

(9) **Employment-status:** This is the variable referring to the profession of the respondents. This includes farmer, employee (both governmental and non-governmental institutions), and businessman (self-employed and investors). In the estimation, the variable 'farmer' was taken as a reference category while others were included as dummy variables as follows:

(i) Employee: This refers to the occupation type of the respondents who work in governmental or non-governmental institutions. It is a dummy variable taking 1 for workers and 0 otherwise. The sign for employee is indeterminate. The hypothesis is that since the workers are expected to get better understanding on the resource quality improvement program including non-use value of the lake with reference to farmers, they attach higher monetary value for fish quality improvement program. In such a case, the sign is expected to be positive for employee. On the other hand, the positive sign for this variable can be explained with the ability to pay for the quality improved resources (Hite et al., 2002). So, if farmers earn high income as compared to employee, they would attach high monetary value for quality improved fish product, in which case, the sign for employee is expected to be negative.

(ii) Businessman: IT is a dummy variable taking a value of 1 for the respondents who get income running their own business, and 0 otherwise. Its sign is expected to be positive. The assumption for the variable to positively influence the resource improvement program is that businessmen can obtain more income as compared to other employment status. Since income has positive relationship with willingness to pay for normal goods, individuals who are engaged in such activities are expected to pay more money for the proposed improvement (Gupta and Mythili, 2007).

(iii) Land type: this refers to land type of the respondents owned in the watershed areas. This includes categories: agricultural land, residential land type, and no land owned in the area. This variable is represented with dummy variables, with the 'agricultural land' type serving as a reference for fish consumers. The first dummy variable taking 1 for agricultural land; 0 otherwise. Agricultural land includes houses and farms in the rural areas. Agricultural landowners, particularly riparian landowners benefit from the resource irrigating their farms in addition to fish products. This variable is expected to take positive sign in support of the improvement program. This implies that since 'agricultural land' is reference variable, the positive sign for 'agricultural-land' means the negative signs for 'no-land' and 'residential-land' in the proposed improvement program. The second dummy variable takes 1 for no land; 0 otherwise. The sign of this variable is expected to be negative reflecting the assumption that individuals with no landownership would place lower value for the resource management as compared to agricultural land owners. The general assumption in land type is that respondents with fixed assets will

support the resource improvement program because of their wide-ranges of benefits of the resources. Therefore, landowners are expected to be more responsible for the improvement program. However, for riparian restoration program, property owners along the lake might show negative sign for the improvement program associated with land use restrictions in riparian buffers (Holmes et al., 2004; Angella et al., 2014). In such a case, the sign for residential-land owners is expected to be negative.

(iv) Duration: this variable refers to the length of the respondents' stay in the watershed area. It is a dummy variable taking 1 for longer than 10 years, and 0 otherwise. The sign of the coefficient on variable 'duration' is not possible to predict a priori because the residents who stayed near the resource for longer period of time can give much attention for fish product and recreational value of the lake. This is because they have consumed fresh fish and visited the lake frequently for relatively longer period of time with minimum travel and other related costs to get into the fish market and recreational site of the lake. In addition, the households who stayed longer in the watershed areas can understand the trend of quality changes brought about by various activities in the watershed areas and therefore would be willing to participate in the restoration program of the resource (Angella et al., 2014). This implies that respondents who stayed longer period near by the lake resource might be willing to pay more money for the quality improvement program. In such a case, the sign for 'duration' would become positive. On the other hand, respondents who stayed longer in some other areas where there is no such beautiful natural resources that would have benefited them with fish products and other aesthetic services but have recently come to Hawassa city, which is endowed with its natural beauty, could give much attention to the management program of lake Hawassa as these respondents have practically experienced the impact of natural resource loss in their lives. Hence, these respondents might be willing to attach more monetary value to the resource management program. In this case, the sign for 'duration' would become negative.

(v) Income: This variable refers to the annual income of the households. The variable 'income' indicates the respondents' ability to pay. Economic theory reveals positive relationship between quantity demand and income for normal goods. Since fish product is normal good, it implies the positive relationship between income and demand for fish and related environmental quality improvement program. Therefore, the sign for this variable is expected to be positive (Holmes et al., 2004; Benson, 2006; Gupta and Mythili, 2007; Zakaria et al., 2013).

(vi) Distance: It is the variable that measures distance of the lake resource from homestead. It is a dummy variable taking 1 for the households near to the resource site, 0 otherwise. Its sign is expected to be positive (+). It is assumed that the households near to the resource would be more willing to pay for its improvement than those of the distant residents. This is because households who are in relatively farther distance from the resource are assumed to get less access to fish product as compared to the closer ones. This implies that as the distance of the households from the resource increases, they would be relatively less responsible for managing the resource, other things kept constant. This expectation is similar with the finding of Angella et al. (2014).

(vii) Use: This variable refers to the purpose that households benefit from the lake resource. It is a dummy variable taking 1 for the respondents who use the lake for multiple purposes; 0 otherwise. That means households with more access to use the resource for recreation, fishing, irrigation, exploring, and other purposes, are generally expected to pay high amount for the project ensuring the sustainable use of resource. Therefore, the sign is

expected to be positive (Benson, 2006; Gupta and Mythili, 2007).

(viii) Location: This stands for the residential area of the respondents. This is a dummy variable taking 1 for urban; 0 for rural area. Its sign is uncertain since the resource benefits both residents in various forms. That means the residents of urban areas are assumed to give higher value from the recreational benefits of the lake to fish consumption while those in rural areas are assumed to value the resource mainly in terms of irrigation and water supply for livestock as compared to fish product.

RESULTS AND DISCUSSION

Descriptive analysis of the respondents on fish consumption

The respondents were found to fall in the age range of 18 to 87 with the majority of them were in between 18 and 35 years. From the total respondents, about 79% were married and the family size was from 1 to 10 with the average size of 4.6. The gender composition of the respondents was 76.7% males and 23.3% females. The respondents were found to participate in various economic activities like farming, governmental and non-governmental works and private businesses. The educational background of the respondents shows that about 55% had attained secondary or tertiary level, and only 2.6% had no formal education. The majority of the respondents earned annual income ranging from Birr[1] 40,000 to Birr 80,000 (Table 1).

About 70% of total respondents had fixed assets like agricultural, residential or commercial land in Hawassa watershed. The majority of them had lived for more than 10 years in the watershed areas. Whereas the respondents who had no permanent assets in the watershed area revealed they stayed in the watershed areas for short period of time. The respondents explained that they had used the lake resource for various purposes like fishing, exploring, wildlife watching, and related benefits.

The households' valuation for fish consumption

From the total respondents, nearly 78% revealed their interests in participation for the resource improvement program. These respondents stated their WTP from Birr 20 to Birr 100 per kilogram of fish caught from Lake Hawassa. Birr 18 was equivalent to one USD during the survey period. The majority of the respondents stated their preferences to be Birr 50 for one kilogram of fish, which is similar to the average value of fish calculated from the respondents who voted in favor of the lake quality improvement program. About 33 percent stated the monetary value more than Birr 50 for one kilogram while nearly 35% preferred to pay less than the average

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[1] 1US$ = 18 Birr

Table 1. Socio-economic characteristics of fish consumers.

Variable		Absolute figure	Percentage
Gender	Male	358	76.7
	Female	109	23.3
	18 – 35	283	60.5
Age	36 – 50	164	35.2
	51 and above	20	4.3
Marital status	Married	370	79.2
	Not married	97	20.8
Family size	1 – 5	325	69.6
	6 – 10	142	30.4
	No formal education	12	2.6
Education level	Elementary school	199	42.6
	Secondary school	165	35.3
	Higher level	91	19.5
Occupation	Employee (GOV/NGO[2])	145	31.0
	Self-employed	137	29.4
	Farmer	185	39.6
	35,000 – 40,000	47	10.0
Household annual income (Birr)	40,001 – 60,000	184	39.4
	60,001 – 80,000	182	39
	> 80,000	54	11.6

Source: Summary of own data.

[2] GOV = Government; NGO = Non-Governmental Organization

value of the respondents voted in support of the proposed program (Figure 1).

The majority of the respondents who stated the higher value was found to be using the fish for more than ten years and realized the current and previous size and quality of fish in Lake Hawassa. They explained that the size and quality of fish decreased as compared to the previous years. These respondents stated that they use the lake for many purposes like fish consumption, wildlife watching and exploring. They were also found to frequently use the fish caught from Lake Hawassa. However, due to the low quality of the lake, they did not use the lake for swimming purpose. These respondents stated that the industrial and city sewages were the main problems that put pressure on the living organisms including the fish in the lake. Stating higher value for fish can be their interest to see the lake clean and yield fish free from any toxic substances. The respondents who preferred to remain neutral in the improvement program stated that they could not afford any contribution at the

time of survey period. These respondents were found to earn low annual income but administer large family size. Some of the respondents who preferred to remain neutral reflected their doubt on the implementation of the improvement program as stated in the scenario.

Econometric analysis of contingent valuation for the improved fish product

The coefficient on inverse Mill's ratio, which was bias. The Heckman two step estimates were therefore implemented to correct the selection bias. According to Heckman (1979), the sample selection model triggers both a rich theoretical discussion on modeling selection bias and the development of new statistical procedures that address the problem of selection bias. The likelihood ratio (LR) test indicated that the correlation was very significant. Thus the two-step selection model was appropriate for estimating the participation and valuation
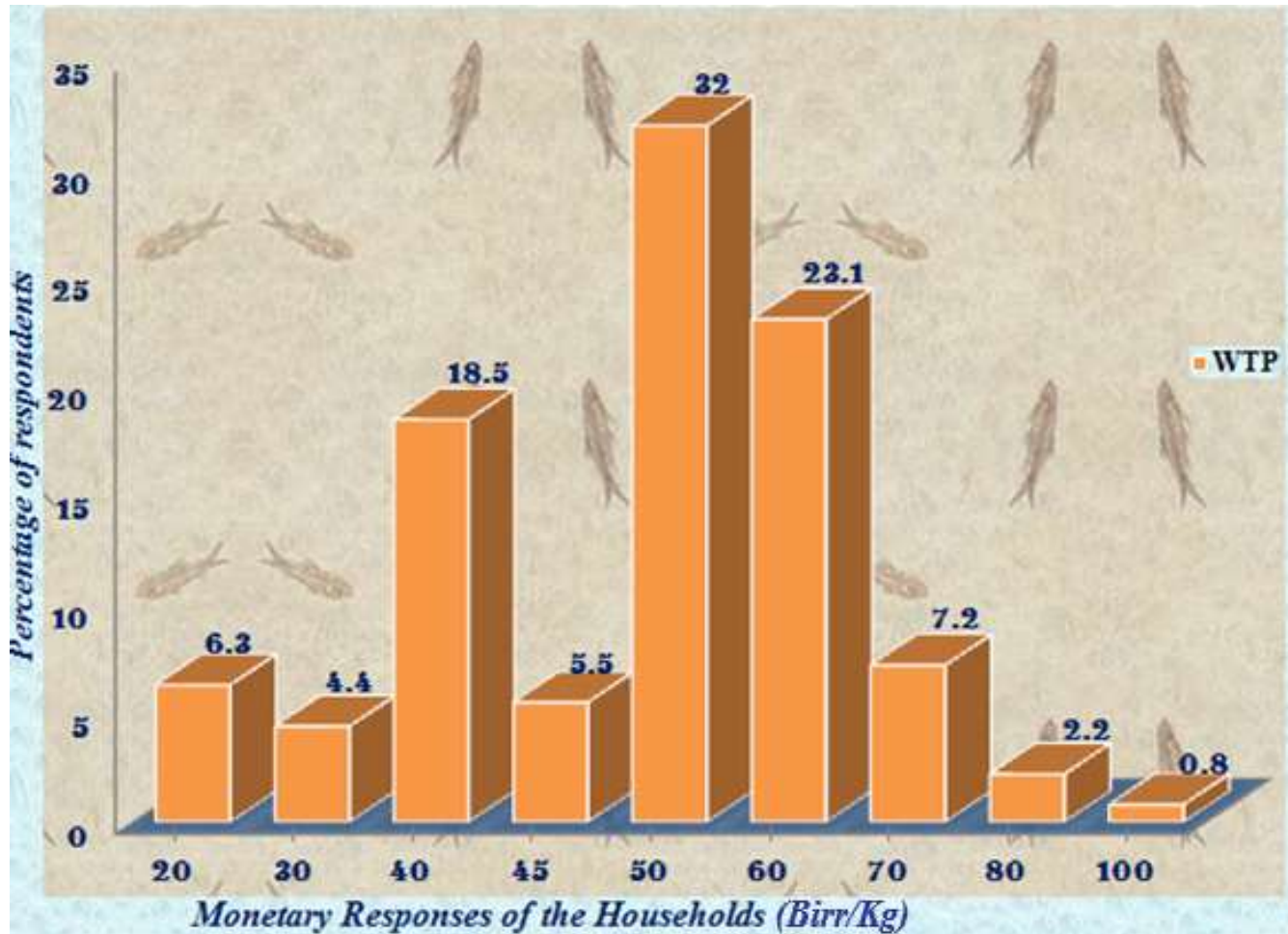
Figure 1. The monetary responses of the households for fish consumption.

for the quality improved fish product.

The LR chi square that measures the overall significance of the model with the null hypothesis that all coefficients were zero was rejected at 1% significance level to reflect that at least one of the coefficients was different from zero. The pseudo R^2 (0.6527) reveled 65.27% of the variation in the participation was explained by the variables included in the model. The regression result with the Mills' inverse ratio as additional explanatory variable indicated that 48.73% of the variation in WTP amount was explained by the variables incorporated in the model. The result of adjusted R^2 (46.05%), which had only small variation from R^2 (48.7%), revealed the relevance of the explanatory variables included in the regression.

The households who frequently consume fish, married individuals, those who earn high annual income, the households who use the lake for multiple purposes, and households with more years of education were found to participate in the lake quality improvement (Table 2). Whereas, the households with large family size, and those who were employed in governmental and non-governmental organizations were less likely to participate in the quality improvement as compared to the households with small family size and farmers, respectively. The households who have residential land type were less likely to participate in the proposed improvement as compared to those who have farmlands under irrigation using the lake.

The valuation of improved fish product reveals the households who realized the poor quality of the lake, older households, households with residential land (houses) in Hawassa city, and individuals with higher annual income were found to attach higher monetary value for quality improved fish per kilo gram. Whereas, the households who frequently consume fish, married individuals, employees and businessmen with reference to farmers, and households who stayed longer in the watershed areas were found to pay low amount for the improved fish products per kilogram.

Freqconfish: It stands for frequency of fish consumption.

Table 2. Heckman's two step estimates for fish consumption in Lake Hawassa.

Parameter	Participation model [coefficient (S.E)]	Valuation model [coefficient (S.E)]
	Heckman's two-step (Probit)	Heckman's two-step (OLS)
Freqconfish	1.2964*** (0.2593)	-0.1395* (0.0807)
Fishconsdurn	0.0239(0.0215)	-0.0014(0.0028)
Poor-quality	-0.4587(0.2502)	0.2289*** (0.0397)
Sex	-0.4926(0.3723)	0.0137(0.0336)
Age	0.0283(0.0184)	0.0048* (0.0026)
Marital-status	0.6244** (0.2838)	-0.0882* (0.0530)
Family-size	-0.3003*** (0.0788)	-0.0131(0.0184)
Head	0.8768(0.3507)	–
Education	0.2925*** (0.0489)	-0.0028(0.0172)
Employee	-0.7808** (0.3911)	-0.1757*** (0.0648)
Businessman	0.0981(0.3309)	-0.1782*** (0.0382)
Residential-land	-1.2972** (0.6165)	0.1871* (0.1100)
Noland	-0.9170(0.6728)	0.1506(0.1018)
Duration	0.2729(0.2302)	-0.0613* (0.0590)
Income	0.6417*** (0.1648)	0.0683* (0.0458)
Distance	0.1396(0.4209)	0.0803(0.0590)
Use	0.4894* (0.2974)	-0.0321(0.0458)
Location	0.8800(0.5479)	-0.0113(0.0947)
Millsinverse	–	3.8531* (2.2986)
Constant	-4.5572*** (0.9502)	3.5470*** (0.2570)
Sample size	467	363
Log likelihood	-85.9999	–
R^2	0.6527	0.4873
Adjusted-R^2	–	0.4605

***1% significance level, **5% significance level, *10% significance level with two tailed tests.

The positive sign and significant level for this variable reveal the households who frequently consume fish caught from Lake Hawassa are more likely to participate in the lake quality improvement. It is found to be significant at 1% of significance level. However, the valuation of households who are willing to participate in the lake quality improvement shows that households who frequently consume fish attach less monetary value for fish products per kilogram. The negative sign and significant level for frequent fish consumption can be explained by the fact that households who buy fish many times from the fish market might face financial shortage to attach higher value per kilogram.

Poor-quality: The households who realized the poor quality of the lake likely attach higher monetary value for the quality improvement of the lake in terms of increased fish price per kilogram. It is found to be positive and significant at 1% level. This can be explained by the fact that the households who perceived the poor quality of the lake are interested in restoring the lake quality and decide the higher price for one kilogram of fish when the proposed improvement comes to true. Understanding low

quality of the lake reflects significant effect on attaching monetary value for fish product per kilogram. Obiero et al. (2014) reflect that quality ensured fish provide balanced and nutritious diets, and prevent disease occurrence, which implies that households who perceived the poor quality of the lake are willing to pay for the resource quality improvement. In the study of consumers' willingness to pay for sustainable seafood made in Europe, Zander and Feucht (2018) find a positive attitude of participants toward sustainability in fisheries stating that protection of endangered species, no pollution, and absence of drugs and hormones in production and fishing are the most important issues from the consumer perspective. In the study of households' willingness to pay for fish product in Vietnam, Danso et al. (2017) find that households are willing to pay 65% (USD 1.42 per kg) above the prevailing market price for certified fish, which supports the notion of households' concern over the safety of consuming wastewater-raised fish.

Age: age has positive relationship with high value attachment for the improved fish per kilogram. It is significant at 10% level though it has no effect on

participation in the proposed improvement of the lake. Households with older age might compare the current low quality of the lake with the previous years of big size and good quality of fish caught from the lake. These households are therefore motivated to restore good quality of the lake expressing their willingness to pay high amount for quality improved fish product per kilogram. This result is in agreement with that of Salim (2014) who states age to positively influence the willingness to pay for quality improved fish product. In the study of WTP for fish farmed in treated waste water, Solomie et al. (2015) find that older households are less likely to prefer fish farmed in treated waste water. This supports the hypothesis that households prefer clean water, which is not in need of purification or other treatment, to water that has been polluted but treated to clean. In the analysis of factors affecting fish landing price around Lake Victoria, Tanzania, Sambuo et al. (2019) reveal age significantly influence the landing price of fish.

Marital-status: this factor is found to positively influence the participation for the lake quality improvement. It is significant at 5% level. The positive influence of marital status on the consumer preferences for the quality improved fish product is similar with the findings of Li et al. (2000). However, married individuals are less likely to pay high price for the improved fish per kilogram. This can be related to the family size where married individuals are responsible to administer their families. Hence, they may experience financial limitation to buy the fish at higher price. As a result, their monetary value for improved fish per kilogram is relatively lower as compared to unmarried respondents.

Family-size: households with large family size are less likely to participate in the resource quality improvement program as compared to households who administer small family size. It is found to be significant at 1% level. This finding is in agreement with that of Salim (2014) who explains that family size negatively influence willingness to pay for fish indicating that for every ten percent increase in the family size, the WTP decreases by 1.7% from the mean level, ceteris paribus.

Education: The sign for education is positive. It is significant at 1% level. The positive sign and significant level of education imply that educated households might give much attention to non-use value besides the use value of the lake. This finding is similar with that of Polanco et al. (2008) and Salim (2014). Solomie et al. (2015) find education to be negative and significant at 10% level for fish farmed in treated waste water. This implies that educated people prefer fish farmed in clean water, which is in need of other treatment. That means households with more years of education are willing to pay for the lake quality protection. Obiero et al. (2014) explain that education enlightens consumers about the

health and other benefits of fish consumption, hence positively influences the preference of consumers.

Employee: This variable is negatively influencing the participation in the resource quality improvement and the valuation of improved fish products as compared to farmer. Since farmers are benefited from the lake in terms of irrigation, watering animals, household consumption of the lake water after boiling, fish, and other related benefits, farmers are more likely to participate in the proposed improvement as compared to employees. Employee is significant at 5% significance level for participation and 1% significance level for the valuation of the improved fish product per kilogram with reference to farmer.

Businessman: This variable is found to negatively influence the valuation for the improved fish products with reference to farmer. It is significant at 1% implying that businessmen are likely to pay 17.82 percent less than the value that farmers pay for one kilogram of quality improved fish product. This variable is, however, insignificant in the participation of the lake quality improvement program.

Residential-land: It is found to negatively influence the participation for the lake quality improvement with reference to farm land. However, the comparison of the valuation among the respondents who were willing to participate in the proposed improvement shows that households who have residential land (house) in Hawassa city are found to pay higher monetary amount for the improved fish product per kilogram with reference to households who owned farm land in the watershed. This can be explained by the fact that households in urban areas have more knowledge on nutritional value of fish product and hence attach higher amount for one kilogram of quality improved fish as compared to the farmers.

Duration: The households who stayed for longer period in the watershed are likely to pay small amount for the improved fish product as compared to those who stayed for less than ten years. The valuation for the improved fish product shows that this variable is negative and significant at 10 percent. This might be due to the fact that the households who stayed for relatively short period in Hawassa watershed probably had lived in other areas with low natural resources before coming to Hawassa watershed, and hence appreciated the beautiful nature of the watershed (Lake Hawassa). As a result they attached high amount for improved fish per kilogram. However, this variable is found to be insignificant to influence the participation for the lake quality improvement.

Income: The positive sign and significant effect on both participation and valuation for the improved fish product

are as expected. Households with higher annual income are more likely to participate in the resource improvement and also attach higher value for the quality improved fish per kilogram. The participation result shows that this variable is significant at 1% level while on the valuation (WTP amount) it is significant at 10% level. This positive and significant effect of income reflects the households' ability to pay higher monetary value for the proposed improvement. In addition, it explains that fish product is normal good where for normal goods willingness to pay increases when the annual income of households increases. So, the higher annual income the higher value is attached for the improved fish product. This result is similar with the findings of Ehirim et al. (2007), Polanco et al. (2008), Salim (2014), Sharma et al. (2017) and Tohmo (2017).

Use: The households who are benefited from the lake in multiple uses like fish, recreations, irrigation and related valuable benefits of the lake are likely participate in the quality improvement program. It is found to be positive and significant at 10% level. However, it has no influential effect on determining the valuation for the improved fish product.

Parametric willingness to pay estimates for fish consumption

Unlike the non-parametric approach, the parametric WTP estimate is based on the determinants that affect the households' willingness to pay for the quality improved fish product. This approach provides more economic information considering the socio-economic characteristics in the calculation of mean willingness to pay for the proposed improvement. Taking into account the factors that significantly affect the households' willingness to pay for the quality improved fish product, the equation for parametric mean WTP is written as:

$$WTP = \beta_o + \beta_1 \text{frequency of fish consumption} + \beta_2 \text{poor quality} + \beta_3 \text{age} + \beta_4 \text{marital status} + \beta_5 \text{emplyee} + \beta_6 \text{businessman} + \beta_7 \text{residential land} + \beta_8 \text{duration} + \beta_9 \text{income} + \beta_{10} \text{mills inverse} \tag{6}$$

The parametric mean WTP is calculated to be Birr 57.76 per kilogram of fish caught from Lake Hawassa. This mean value is greater than the market price of fish in the status quo by 44.4%. As compared to non-parametric mean WTP (Birr 50), the parametric approach yielded relatively higher mean WTP. Since the parametric approach considers the socio-economic characteristics of respondents, which are common to the whole society of the study area, the parametric mean WTP is preferred to estimate the price of fish caught from quality improved lake. The Heckman selection model employed in parametric approach provides consistent, asymptotically efficient estimates for all parameters in the model. This model allows us to use information from non-participating households to improve the estimates of the parameters in the regression model. Mills inverse ratio was additional explanatory variable generated from the selection model that comprised information from non-participating households. Hence, the price for fish caught from Lake Hawassa is preferably estimated to be Birr 57.76 per kilo gram, which is equivalent to USD3.20.

Conclusion

The urban residents have better understanding on the nutritional value of the fish and therefore incorporate the fish product into their diets. These people are also aware of the low quality of the lake and hence support the quality improvement program. They express their willingness to pay for the resource improvement attaching higher monetary value for the quality improved fish per kilogram. The households are willing to pay on average

Birr 57.76 (USD3.20) per kilogram for the fish caught from the quality improved lake.

The households who frequently consume the fish, married individuals, educated households, those who earn high annual income and the households who use the lake for multiple purposes are more likely to participate in the lake quality improvement. The factors that determine households' willingness to attach high value for the quality improved fish product per kilogram are awareness of the poor quality of the fish caught from the lake, the households' age, residential land type with reference to agricultural land type and households' annual income. Whereas, the frequency of fish consumption per year, marital status, the employment status and duration in the watershed are the factors that influence households' willingness to pay amount for the quality improved fish product.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

REFERENCES

Angella N, Dick S, Fred B (2014). Willingness to pay for irrigation water and its determinants among rice farmers at Doho rice irrigation scheme (DRIS) in Uganda. Journal of Development and Agricultural Economics 6(8):345-355.

Assefa MJ (2014). Fish production, consumption and management in Ethiopia. Research Journal of Agriculture and Environmental Management 3(9).

Bateman IJ, Carson RT, Day B, Hanemann M, Hanley N, Hett T, Jones-Lee M, Loomes G, Mourato S, Ozdemigorlu E, Pearce DW, Sugden

R, Swanson J (2002). Economic Valuation with Stated Preference Techniques: A Manual. Edward Elgar Publishing, Inc. USA

Benson MC (2006). An Economic Valuation of Improved Water Quality in Opequon watershed. A Thesis submitted to Davis College of Agriculture, Forestry, and Consumer Sciences at West Virginia University, Morgantown. West Virginia.

Birenesh A (2007). Assessment of Downstream pollution Profiles of Awassa Textile Factory Effluent along Tikur Wuha River using Physico-chemical and Macroinvertebrate Indicators. A Thesis submitted to Environmental Science Programme, Addis Ababa University, Addis Ababa. Ethiopia.

Birol E, Karousakis K., Koundouri P (2006). Using economic valuation techniques to inform water resources management: A survey and critical appraisal of available techniques and an application. Science of the Total Environment 365:105-122.

Briggs DC (2004). Causal Inference and the Heckman Model. Journal of Educational and Behavioral Statistics 29(4):397-420.

Brown K., Taylor L (2000). Do as you say, say as you do: evidence on gender differences in actual and stated contributions to public goods. Journal of Economic Behavior Organ 43:127-139.

Bulov S, Lundgren T (2007). An Economic Valuation of Periyar National Park: A Travel Cost Approach. Economics C-UPPSATS. Lule University of Technology. Available at: www.epuble.ltu.se

Chandler J, Suyanto S (2005). Recgnizing and Rewarding the Provision of Watershed Services. World Agroforestry Centre (ICRAF Southeast Asia), Bogor, Indonesia.

Cuddeback G, Wilson E, Orme JG, Orme TC (2004). Detecting and Statistically Correcting Sample Selection Bias. Journal of Social Service Research 30(3):19-33.

Danso GK, Otoo M, Linh ND, Madurangi G (2017). Households' willingness to pay for fish product attributes and implications for market feasibility of wastewater-based aquaculture business in Hanoi, Vietnam. Journal of Resources 6(30). www.mdpi.com/journal/resources

Delgado CL, Wada N, Rosegrant MW, Meijer S, Ahmed M (2003). Fish to 2020 supply and demand in changing global markets. International Food Policy Research Institute and World Fish Center. https://www.fcrn.org.uk/sites/default/files/IFPRI_Fish_to_2020.pdf

Duberstein JN, de Steiguer JE (2004). Contingent Valuation and Watershed Management: A Review of Past Uses and Possible Future Applications. School of Renewable Natural Resources, University of Arizona. Tucson, USA.

Ehirim NC, Mark HO, Ogueri C, Adaka GS, Awoyemi TT (2007). Determinants of consumers' willingness to pay for fish safety in Bayelsa State of Nigeria. The Social Sciences 2(4):399-404.

Food and Agriculture Organization (FAO) (2011). Fishery and aquaculture country profiles Ethiopia. FAO, Rome. Available at: http://www.fao.org/fishery/countrysector/FI-CP_ET/en

Food and Agriculture Organization (FAO) (2012). The State of the World Fisheries and Aquaculture 2012. FAO, Rome.

Food and Agriculture Organization (FAO) (2014). The state of the world fisheries and aquaculture. FAO, Rome (In press)

Food and Agriculture Organization (FAO) (2016). The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome.

Gebremariam Z, Desta Z (2002). The chemical composition of the effluent from Awassa textile factory and its effects on aquatic biota. Ethiopian Journal of Science 25:263-274

Gempesaw CM, Bacon JR, Wessells CR, Manalo A (1995). Consumer perception of aquaculture products. American Journal of Agricultural Economics 77(5):1306-1312.

Gou S (2009). Heckman Sample Selection Model and Its Applications to Social Work Research. SSWR Society for Social Work and Research. Available at: www.sswr.org/ Heckman Sample Selection model

Gupta V, Mythili G (2007). Estimating intangible benefits of improving water quality of Powai Lake in India: A contingent valuation approach. National Institute of Industrial Engineering (NITIE), Mumbai, India.

Hajkowicz S, Okotai P (2006). An economic valuation of watershed pollution in Rarotonga, the Cook Islands. Marfleet Printing Co. Ltd., Apia, Samoa. Available at website: www.sprep.org

Halcrow Group Limited and Generation Integrated Rural Development

(GRID) (2009). Rift Valley Lakes Basin Integrated Resources Development Master Plan Study Project. Phase III. Addis Ababa, Ethiopia: The Federal Democratic Republic of Ethiopia Ministry of Water Resources.

Hawkins K (2003). Economic Valuation of Ecosystem Services. University of Minnesota. US state of Minnesota. USA.

Heckman JJ (1979). Sample selection bias as a specification error. Econometrica 47(1):153-161.

Hite D, Hudson D, Intrapapong W (2002). Willingness to pay for water quality improvements: The case of precision application technology. Journal of Agricultural and resource Economics 27(2):433-449.

HolmesT, Bergstrom J, Huszar E, Kask S, Orr F (2004). Analysis of Contingent valuation, net marginal benefits, and the scale of riparian ecosystem restoration. Ecological Economics 49:19-30.

IFPRI (2009). International Agricultural Research for Food Security, Poverty reduction, and the environment: what to expect from scaling up OGIAR Investments and "Best Bet" programs. The World Fish Center, Penang, Malaysia.

Imandoust SB, Gadam SN (2007). Are people willing to pay for river water quality, Contingent valuation. International Journal of Environmental Science and Technology 4(3):401-408.

Krantzberg G, de Boer C (2006). A Valuation of Ecological Services in the Great Lakes Basin Ecosystem to Sustain Healthy Communities and a Dynamic Economy. McMaster University.

Li HS, Houston JE, Wang, SM, Lee HJ (2000). Factors affecting consumer preferences for fish in Taiwan. Food Industry Research and Development Institute, Taiwan

Mallios Z, Latinopoulos P (2001). Willingness to pay for irrigation water: A case study in Chalkidiki, Greece. Aristotle University of Thessaloniki, Greece.

Mathews LG (1999). Estimating Water Quality Benefits by Combining Revealed and Stated Preference Methods: an application in the Minnesota River. Paper prepared for the 1999 AAEA Annual meeting Nashville, Tennesse. USA.

McClelland G, Schulze W, Lazo J (1993). Additional Explication of Methods for Measuring Non-Use Values: A Contingent Valuation Study of Groundwater Cleanup. Center for Economic Analysis, University of Colorado, Boulder, CO 80309.

Obiero KO, Opiyo MA, Munguti JM, Orina PS, Kyule D, Yongo E, Githukia CM, Karisa HC (2014). Consumer preference and marketing of farmed Nile Tilapia (Oreochromis niloticus) and African Catfish (Clarias gariepinus) in Kenya: Case study of Kirinyaga and Vihiga countries. International Journal of Fisheries and Aquatic Studies 1(5):67-76.

Perman R, Yue Ma, McGilvray J, Common M (2003). Natural Resource and Environmental Economics. 3rdedition. Pearson Higher Education, under the Addison Wesley imprint

Peter E (2006). Impacts of increased international demand on fisheries on local populations, with particular attention to local economic status and health. Caribbean Costal Area Management Foundation.

Polanco JF, Luna L, Sanchez JLF (2008). Factors affecting consumers' attitudes towards aquaculture. IIFET 2008 Vietnam proceedings. Available at: https://ir.library.oregonstate.edu

Salim SS (2014). Demand pattern and willingness to pay for high value fishes in India. Journal of the Marine Biological Association of India 55(2):48-54.

Sambuo D, Kirama S, Malamsha K (2019). Fish Price Determination around Lake Victoria, Tanzania: Analysis of Factors Affecting Fish Landing Price. Global Business Review. https://doi.org/10.1177/0972150917811509

Schuyt K., Brander L (2004). The economic values of the world's wetlands. The Swiss Agency for the environment, forests and landscape (SAEFL). Gland/Amsterdam, The Netherlands.

Semenovich SI (2001). Water pollution and its impact on fish and aquatic invertebrates. All-Russian Research Institute of freshwater fish culture, Russia. Available at: www.eolss.net/Eolss-sampleAllChapter.aspx

Sharma HR, Mugaonkar P, Mahida N, Gawa S (2017). Consumer's willingness to pay (WTP) more for preferred fish (Labeo rohita) in Manipur. International Journal of Pure and Applied Bioscience 5(6).

Solomie AG, Amewu S, Amoah P (2015). Consumer preference and willingness to pay for fish farmed in treated wastewater in Ghana.

International Water Management Institute. Accra, Ghana.

Solomon J (2004). Contingent valuation of multi-purpose tree resources: the case of Arsi zone, Ethiopia. A thesis submitted to the school of Graduate Studies of Addis Ababa University, Addis Ababa, Ethiopia.

Tang Z, Nan Z, Liu J (2013). The Willingness to pay for irrigation water: A case study in Northwest China. Global Nest Journal 15(1).

Tenalem A, Becht R, Leishout AV, Yemane G, Dagnachew L, Onyando J (2007). Hydrodynamics of topographically closed Lakes in the Ethio-Kenya Rift: The case of Lakes Awassa and Naivasha. Journal of Spatial Hydrology 7(1):81-100.

Tiwari DN (1998). Determining Economic Value of Irrigation Water, CSERGE Working Paper GEC 98-05.

Tohmo T (2017). Looking for determinants of willingness to pay for Sibelius Hall, Lahti. Cogent Arts and Humanities 4:1296343.

Turner RK, Pearce D, Bateman I (1994a). Environmental Economics – an Elementary Introduction, Pearson Education Limited, England.

Turner RK, Georgiou S, Clark R, Brouwer R, Burke J (2004b). Economic valuation of water resources in agriculture. FAO Water Reports 27, Food and agriculture organization of the United Nations. Rome.

Van Voorhis CRW, Morgan BL (2007). Understanding power and rules of thumb for detecting sample sizes. Tutorials in Quantitative Methods for Psychology 3(2):43-50.

Whittington D (2002). Improving the Performance of Contingent Valuation Studies in Developing Countries. Environmental and Resource Economics 22:323-367.

Wooldridge J (1999). Econometric Analysis of Cross Section and Panel Data. MA: MIT Press.

Yaping D (1998). The value of improved water quality for recreation in East Lake, Wuhan, China: Application of Contingent valuation and Travel cost methods. Economy and Environment Program for Southeast Asia. Available at: www.idrc.org.sg/eepsea

Yemane G (2004). Assessment of the Water Balance of Lake Awassa Catchment (Unpublished master's thesis). the International Institute for Geo-information Science and Earth Observation, ITC, Netherlands.

Zakaria H, Abujaja AM, Adam H, Nabila AY, Mohammed I (2013). Factors affecting farmers willingness to pay for improved irrigation service: A case study of Bontanga irrigation scheme in Northern Ghana. International Journal of Agricultural Economics and Extension 2(1).

Zander K, Feucht Y (2018). Consumers' Willingness to Pay for Sustainable Seafood Made in Europe, Journal of International Food and Agribusiness Marketing 30(3):251-275.

Zhang N, Kong F, Xiong K (2014). Determinants of farmers' willingness to pay and its level for ecological compensation of Poyang Lake wetland, China: A household-level survey. Sustainability ISSN 2071-1050. Available at: www. mdpi.com/journal/ sustainability.