Anglers’ responses to bait certification regulations: the case of virus-free bait demand

Lindsay Vollmar\textsuperscript{a}, Christopher R. McIntosh\textsuperscript{b}\textasteriskcentered and Jonathan Bossenbroek\textsuperscript{a}

\textsuperscript{a}Department of Environmental Sciences & Lake Erie Center, University of Toledo, Toledo, OH, USA; \textsuperscript{b}Department of Economics, Labovitz School of Business and Economics, University of Minnesota Duluth, 1318 Kirby Drive, 330H LSBE, Duluth, MN 55812, USA

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The threat of viral haemorrhagic septicaemia (VHS) to the sport fish of the Great Lakes region has caused the state of Michigan to regulate some types of fishing bait that could spread the disease. Given large-scale fish kills from VHS are uncertain and regulation costly, it is important to consider the knowledge level of anglers and their estimated benefits from these regulations. About 75\% of anglers self-reported being at least somewhat familiar with VHS and VHS regulations, and agreeing that VHS is a serious threat to the health of Great Lakes’ fish populations. Demand for a popular baitfish susceptible to VHS, emerald shiners, was estimated using a contingent valuation method survey. The results suggest increased likelihood of purchase and mean willingness to pay point estimate premiums between 15\% and 29\% for certified bait. The inclusion of an educational piece on VHS and regulations in our survey did not lead to significant demand differences from those who did not receive the extra information. These results may help regulators efficiently allocate funding for the prevention of spreading VHS and allow bait shops to understand better the value of certified bait.

Keywords: viral haemorrhagic septicaemia; bait; invasive species; willingness to pay; contingent valuation method; environmental attribute

1. Introduction

Ecological changes have the potential to affect the economy by altering the resources we use in our everyday lives. One such change threatening the $4 billion annual sport and commercial fishing industries of the Great Lakes is the spread of the viral haemorrhagic septicaemia virus (VHS; Great Lakes Information Network 2003). This study aims to examine the demand of Michigan anglers for certified and uncertified VHS-free bait using the contingent valuation method (CVM). By analysing the results of stated preference surveys, the existence or absence of any value anglers give to protecting VHS-free areas from infestation and/or abiding by VHS regulations will be inferred.

VHS is considered one of the most important viral pathogens of finfish for many nations and international associations according to the World Organisation for Animal Health (OIE 2011). The virus is also one of the nine OIE-listed and reportable pathogens of fish, indicating it has been shown to negatively affect wild aquatic animal populations that are worth protecting for economic or environmental reasons (Hill 2010). While VHS poses no risk to human health, it has been known to cause mass fish kills of freshwater...
Economically, VHS can have substantial impacts, particularly relating to the sport and commercial fishing industries of the Great Lakes. One particular area of economic concern has been aquaculture facilities. Michigan has six fish hatcheries that produce fish, in part, to provide diverse fishing opportunities in both Michigan’s inland and Great Lakes waters. About 40% of all Michigan recreational fishing depends on stocked fish, including 70% of the Great Lakes’ trout and salmon populations (MI DNR 2013a). Fortunately, VHS has not been discovered in these facilities in the Great Lakes region (VHSV Expert Panel and Working Group 2010), although the disease did slow production of coolwater fish at the Wolf Lake State Fish Hatchery in 2008 (MI DNR 2013b). If infiltration were to occur, the over $76 million Great Lakes aquaculture industry could suffer huge losses (University of Wisconsin Aquatic Sciences Center 2012). When the virus infiltrated aquaculture operations in Denmark in the early 1990s, the rainbow trout industry suffered losses of $60 million US dollars annually (Hill 1992).

Regulations on fish species, including baitfish, susceptible to the virus have been implemented. A federal order prohibits the interstate movement of VHS susceptible fish between Great Lakes states and Canada (USDA 2008). The exception to this rule is that fish with the proper documentation stating that they have been tested to be free of VHS may cross borders. Thus, VHS-susceptible fish can either be certified, which means they have tested free of VHS, or uncertified, which means they have not been tested and could potentially be carrying the disease. The certification process is costly and has caused entities along the entire baitfish supply chain, such as bait farms, dealers, and shops, to struggle economically (Lauber, Connelly, and Knuth 2009).

In addition to the federal order, each Great Lakes state has its own regulations on VHS. The MI DNR has set up disease management areas that dictate where certified and uncertified VHS-free-listed baitfish can be used by anglers (MI DNR 2010). VHS-free management areas are those that have tested negative for VHS and are not likely to contain the disease anytime soon. VHS surveillance management areas are those that have not contained the disease but are at high risk of containing the disease in the near future. VHS positive management areas are those where VHS is known to be present. VHS-free bait or bait caught in any VHS-free waters is legal to use anywhere in the state. Bait caught in VHS surveillance areas can only be used in VHS positive or VHS surveillance waters. Bait testing positive for VHS or bait caught in any VHS positive management areas can only be used in VHS positive waters.

Despite the economic impact on the baitfish industry, there have not been any studies published regarding the demand for VHS certification of bait. This study focuses on a particular regulated baitfish species, emerald shiner, which is popular among Michigan anglers. In this study, the certification attribute of the baitfish product will be treated in the same manner as an environmental attribute of any consumer good. Several studies have demonstrated increased likelihoods of purchase and potential premiums from ecolabelling, while others have found negative effects based on the perception of the label (for ecolabelling, see, for example, Blend and van Ravenswaay [1999]; for an early study on the effects of the genetically modified organism (GMO) labelling, see Huffman et al. [2003]; for invasive species labelling, see Yue, Hurley, and Anderson [2011]).

VHS has the potential to have substantial ecological and economic impacts on the Great Lakes fishing community, thus warranting research to understand the view anglers have of VHS and the certification of baitfish. Anglers can influence the spread of this potentially fatal disease; thus, the value they place on the preservation of VHS-free areas...
is vital to government regulators. This value and the factors that influence it can also aid bait shops in understanding their customers’ behaviour. We assessed the importance of VHS certification of bait by addressing two specific null hypotheses: (1) certification neither influences the likelihood of shiner purchase nor the willingness to pay (WTP) for shiners; and (2) including educational information about VHS neither influences the likelihood of shiner purchase nor the WTP for shiners.

2. Methodology
A survey was designed to elicit anglers’ WTP for emerald shiners. An alternative would have been to use price and quantity data from bait shops. However, none of the bait shops sold both certified and uncertified shiners simultaneously; therefore, trying to create a field experiment that simultaneously sold shiners with controlled price differences was not possible. Initial calls also revealed a very small sample of bait shops selling uncertified shiners. Given the goal was to understand anglers’ perspectives and willingness to pay, it did not seem appropriate to use limited historical data with restrictions based on customer fishing locations and bait availability. Utilising a survey allowed more control to obtain appropriate data and sample sizes to test our hypotheses.

The goal of the willingness-to-pay questions was to maintain sufficient control to ensure that relative demand comparisons could be made across treatments. Since respondents varied in their experience and usage of the product, it was impractical to ask every respondent a sufficient number of questions to construct their individual demand curve for shiners. Therefore, asking one question to retrieve both price and quantity from individuals would have only generated one point on their individual demand function. Using those individual points to construct an aggregate demand curve would not have been wise since it would not represent an aggregate demand curve but a series of points all belonging to different curves. For example, a light user may be willing to pay $3 for the 1st dozen shiners and $1 for the 20th, whereas a heavy user may pay $10 for the 1st dozen and $5 for the 20th dozen. Therefore, imagine that the light user was asked about the 1st dozen with WTP = $3 and the heavy user was asked about the 20th dozen with WTP = $5. Aggregating the single points would lead to inconsistent results. An alternative is to provide a fixed quantity of the good into one basket that the respondent either purchases or does not. Since the quantity in the basket is fixed for all respondents in all treatments, only the total and average price per dozen changes in the offerings. This restriction led to fixing the annual quantity of shiners purchased in the hypothetical WTP question. An initial quantity of 20 dozen shiners per year was tested. While other fixed quantities could have been tested, the two hypotheses required splitting the total sample by the four versions; therefore, to keep each version sample size reasonable, further fixed quantities were not considered. However, an open-ended usage question was kept in the survey as well, such that stratifying the sample by low, average, and high usage to test for result differences was possible.

Four survey versions (i.e. treatments) were created to test the hypotheses based on two factors. The first factor was to ask the fisherman their WTP for either certified or uncertified bait (shiners). Thus, the four survey types were (1) inclusion of an educational piece and WTP question about certified shiners (EC), (2) no educational piece and inclusion of WTP question about certified shiners (NEC), (3) inclusion of an educational piece and WTP question about shiners that were not certified (ENC), and (4) no educational piece and WTP question about shiners that were not certified (NENC). The second factor was
whether or not surveys included education material about VHS and VHS regulations. Similar sample sizes for the four treatments were collected in both the pretest and final survey.

All survey versions contained an introduction and four sections of questions. Section 1 included questions regarding the respondents’ perceived prior familiarity and knowledge of VHS and regulations. As a knowledge check, they were asked which popular sport fish species were susceptible to VHS. Next, two of the four versions included an educational piece about VHS that included pictures. Gary Whelan, Fish Production Manager at the MI DNR, verified the accuracy of the information presented. Permissions for the photos used were obtained from Dr Paul Bowser, Cornell University, and Dr Mohamed Faisal, Michigan State University. Section 2 asked questions about the frequency and location of live emerald shiner use and perceptions about VHS regulations. Another knowledge check was employed, as subjects were asked how their primary fishing locations were classified regarding the presence of VHS; free, surveillance, or positive. Respondents indicated their usage of emerald shiners in dozens per year. Finally, five statements about the necessity and impacts of VHS were given, subjects indicated how strongly they agreed with each based on a Likert scale. Section 3 asked about household income and WTP for shiners, as income is often positively correlated with WTP for environmental goods. Section 4 included many demographic questions about variables that are sometimes correlated with WTP, including employment, education, memberships in fishing or environmental organisations, gender, marital status, and age.

2.1. Pretest survey

Pretest respondents were recruited at sporting shows (over 90%), bait shops, and yacht clubs, and completed printed survey versions in person immediately following recruitment. Seven $25 gift cards were awarded randomly to survey participants. One gift card was awarded to those filling out surveys at bait shops. The other six gift cards were awarded by random selection to survey participants at sporting shows.

An open-ended CVM question regarding their WTP for emerald shiners was asked to help create appropriate dichotomous choice bids in the final survey (see Boyle and Bishop 1988). As respondents were anglers who used emerald shiners, they were familiar with the good. This is a key determinant in the reliability of the CVM exercise (see Portney 1994). They were also asked to provide feedback on the understandability of the questions, which provided important insights into the final survey design. For example, they indicated that the WTP question should be framed as dollars per dozen rather than a total payment for a fixed quantity of shiners; this led to far fewer participants indicating question confusion. Prior to changing the WTP question to be framed as dollars per dozen, only 66% of survey respondents indicated that all questions were clear and understandable. After the change, there was an increase to 100%. Respondents were asked to consider their income to remind them of their budget constraint. Therefore, the WTP scenario was described as follows:

Please assume that you plan to buy and use a total of 20 dozen live emerald shiners throughout each year. What is the most you would be willing and able to pay, per dozen, for 20 dozen live emerald shiners that are certified VHS Free? Please keep in mind your annual income and budget.

$______._______ per dozen for 20 dozen VHS Free live emerald shiners per year
An open-ended question about shiner usage was also included and about 47% of the pretest sample used between 10 and 30 dozen shiners per year. Therefore, 20 dozen were considered about average and used in the final version. The four survey versions were pretested with 77 usable responses.

2.2 Final survey

The surveys were reformatted for online completion and hosted by the University of Toledo Urban Affairs Center from July to October 2012 (a text version of the survey is available as supplementary file at http://dx.doi.org/10.1080/21606544.2014.974677). A link was created for the online final survey and there were several methods through which the advertisement containing the link was distributed including fishing organisation websites, posts, and forums, Facebook pages, newsletters, etc. Also, the MI DNR sent out e-mail invitations to over 10,000 anglers inviting them to go to the link and take the survey. E-mails were sent to online respondents of the final survey asking them to share the link with others. Subjects who completed the survey had the option of entering a drawing to win one of the seven $25 American Express gift cards.

The final versions of the survey employed the double-bounded dichotomous choice (DBDC) question format. Hanemann, Loomis, and Kanninen (1991) demonstrated that the key benefit of double bounding is that it tends to create tighter WTP confidence intervals (aka statistical efficiency). This property is particularly appealing in comparative analysis. However, Carson and Groves (2007) discussed potential problems using double bounding including starting point bias and incentive compatibility. While these concerns are legitimate, the analysis is less focused on absolute WTP estimates and more focused on relative treatment comparisons. That is, unless the potential issues associated with starting point bias and incentive compatibility are for some reason expected to be different across treatments, the comparative results should not be affected since double bounding was used consistently in all treatments.

The open-ended WTP responses from the pretest survey were used only to create the DBDC bid vector for the final survey (Hanemann and Kanninen 1999). Following the general advice of Hanemann and Kanninen (1999), the bid vector should bound approximately 50%–75% of respondents’ WTP values, the final bid vector was chosen based on the pretest survey open-ended WTP responses and bounds approximately 55% of respondents’ expected WTP values. The second dichotomous choice bids were either increased (if ‘Yes’ to first) or decreased (if ‘No’ to first) by 50% of the initial bid. The final bid vector in dollars per dozen shiners is presented in Table 1. The four treatments and eight initial bids created 32 survey versions. The online system initially randomly selected survey versions. However, the random selection was not generating something reasonably close to a uniform number of respondents for each version. Therefore, versions with high response numbers were pulled out of the selection process to assist in obtaining more uniform sample sizes. While there was variation in the sample sizes by bid amounts (see Table 1), the sample sizes by treatment were very similar (see below).

The online survey generated 432 completed surveys from anglers using emerald shiners. The final version included a follow-up question for those choosing ‘No’ to both WTP questions (Portney 1994). Legitimate reasons for respondents choosing ‘No’ to both questions included that the shiners were not worth the amounts listed, that they were willing to use substitutes, or household income constraints. Those who chose a lack of understanding or ‘I don’t know how this survey will be used’ were treated as having rejected the market with five and four such responses, respectively. Those picking ‘Other’
were allowed an open-ended response to why they chose ‘No’ to both WTP questions, and all were judged legitimate reasons. The final data-set contained 423 observations with very similar treatment breakouts: EC (n = 103), NEC (n = 105), ENC (n = 106), and NENC (n = 109).

3. Analysis and results

Testing WTP and likelihood hypotheses from DBDC survey data typically uses two methods (see, recent example, Trenholm et al. 2013). First, econometric models with few independent variables are used to generate estimates of mean and median WTP by splitting the sample by treatment. Recall that the dependent variable is a yes/no response to purchasing 20 dozen shiners at various prices/dozen. Since this is a limited dependent variable, various probit and logit models were used. Bateman et al. (2002) recommends these models to have very few independent variables, often using only a constant and the bid amount. The point is to determine if the results are so strong across treatments that the unconditional mean and median WTP are statistically different. The coefficient estimates are then used to construct confidence intervals to test for these results.

The second part of the analysis focuses on generating a best-fit model of explaining the likelihood of choosing ‘Yes’ to the WTP questions. These models are sometimes referred to as ‘fully parameterised’ and typically consider many more independent variables. The coefficient estimates are used to analyse statistical significance of individual independent variable effect, if any, on purchase likelihood.

Both aspects were explored by considering multiple statistical models; probit and logit models were used to analyse the response to the first WTP answer (yes/no), while double-bound interval logit and bivariate probit models were used to consider both responses. All models were computed using Econometric Software Inc., NLogit 5 statistical program.

3.1. Mean WTP and confidence interval estimation

The goal of this section is to compute and compare 90% confidence intervals for mean and median WTPs across the treatments to initially test whether the unconditional mean and median are statistically different. Hanemann, Loomis, and Kanninen (1991) illustrated the procedure for determining the mean donation; using simplified models it has been shown that the mean and median WTPs, for our model specifications, are equal to the negative of the ratio of the constant over the bid coefficient. The standard errors and resulting confidence intervals were calculated using the delta method (Greene 2000).
The results are provided in Table 2. The logit and probit models, which only consider the response to the first WTP question (yes/no), do not indicate statistically significant differences across the treatments at the 10% significance level (i.e. the intervals overlap). The double-bound interval logit model considers both WTP bids (i.e. initial and follow-up) in its coefficient estimates; the EC interval is above the ENC interval, indicating that the EC treatment leads to statistically higher WTP estimates.

The bivariate probit model calculates separate coefficient estimates for each WTP question (i.e. initial and follow-up = '2nd Equ'), while allowing for correlated disturbances between the two (Greene 2000). The bivariate probit 2nd equation models indicate statistically higher intervals for EC compared to ENC and NENC (5% and 10%, respectively). The correlation coefficients (Rho) from the bivariate probit models above also indicated significant disturbance correlation between the equations.4

The correlation results suggest that the initial and follow-up responses should be considered simultaneously rather than separately. The results from the double-bound interval logit and bivariate probit models are emphasised with respect to the hypotheses tests since they incorporate both equations in the estimates. Recall the first null hypotheses: (1) certification neither influences the likelihood of shiner purchase nor the WTP for shiners.

Table 2. Ninety per cent confidence intervals for the simple and control models determined using the delta method (Greene 2000) for anglers’ mean WTP for baitfish ($/dozen shiners, 20 dozen annually).

| Statistical model     | Treatment | Interval ($Low, $High) |
|-----------------------|-----------|------------------------|
| Logit                 | EC ($n = 103$) | 3.29, 4.27             |
|                       | NEC ($n = 105$) | 3.33, 4.38             |
|                       | ENC ($n = 106$) | 2.56, 4.85             |
|                       | NENC ($n = 109$) | 2.89, 4.59             |
| Probit                | EC        | 3.29, 4.25             |
|                       | NEC       | 3.46, 4.41             |
|                       | ENC       | 2.51, 4.91             |
|                       | NENC      | 2.89, 4.59             |
| DB interval logit     | EC        | 3.50, 4.17             |
|                       | NEC       | 3.40, 3.98             |
|                       | ENC       | 2.55, 3.44*            |
|                       | NENC      | 2.72, 3.56             |
| Bivariate probit      | EC        | 3.29, 4.26             |
|                       | 2nd Equ   | 3.80, 7.14             |
|                       | NEC       | 3.46, 4.45             |
|                       | 2nd Equ   | 3.19, 5.51             |
|                       | ENC       | 2.61, 3.76             |
|                       | 2nd Equ   | 2.31, 3.27**b          |
|                       | NENC      | 2.91, 4.47             |
|                       | 2nd Equ   | 2.11, 3.79**a          |

**Statistically different than EC at 5% and 10%.

aRho sign 1%, bRho sign 10%.
Since the hypothesis focuses on certification, the emphasis was on making comparisons between the treatments that only differed by whether the shiners were certified or not. These models indicate some statistically significant results where the education and certified (EC) treatment has a higher mean interval than education and not certified (ENC) for both the double-bound interval logit and bivariate probit 2nd equation. Also, note that while not statistically different, the no education and certified (NEC) mean WTP intervals are considerably shifted up compared to the no education and not certified (NENC) treatment for the same models and equations. Overall, there is some evidence of statistical differences even in the unconditional mean and median estimates such that some certified intervals indicate higher WTP than intervals from not certified treatments. Therefore, there was some evidence to suggest that this null be rejected.

The second null hypothesis focuses on the effects of the educational materials provided, (2) including educational information about VHS neither influences the likelihood of shiner purchase nor the WTP for shiners. All the intervals from the double-bound logit model and bivariate probit model illustrate a great deal of overlap when comparing the education certified (EC) to the no education certified (NEC) and the education not certified (ENC) to the no education and not certified treatments (NENC). There was no evidence to suggest rejecting the second null from the WTP analysis.

3.2. Fully parameterised model

Next, consider how individual independent variables affect the probability of purchasing the 20 dozen shiner baskets. The dependent variables are the responses to the WTP purchase decisions where ‘yes’ was assigned a value of ‘1’ and ‘No’ was assigned a value of ‘0’. Due to assigning ‘1’ for ‘yes’, the model coefficients indicate the effect of a change in the independent variables on the probability of purchasing the 20 dozen shiner baskets. The statistical model chosen was the bivariate probit. Recall that some of the previous regressions indicated statistically significant disturbance correlation coefficients; after running several variations with alternative independent variables, it became clear that this correlation result would hold in the fully parameterised model and should be controlled for in the results (the final model suggests positive correlation with Rho = 0.353 and significant at the 1% level). The goal was to determine a model with the best overall goodness-of-fit measure. Therefore, Akaike information criteria (AIC) was used along with advice from Burnham and Anderson (2004) when small changes in AIC made it unclear regarding model improvement.

3.2.1. Variable selection

The following explanatory variables were considered in our models. It was expected that the higher the bid the lower the purchase likelihood; therefore, the Bid variable should have a negative sign. The education and certified (EC) treatment was intentionally chosen as the baseline. Binary treatment variables were created along with treatment interactions for bid slope and bid slope squared for each of the two WTP questions (e.g. NEC, BidNEC, and SBNEC). The treatment interactions allowed us to test for non-linear effects from changes in the bid amount. This could happen, for example, if fisherman will always pay at least $2 a dozen regardless of the type of shiner and education materials provided, but between $2 and $4 become somewhat less likely to buy uncertified, and at $4 and above become quickly increasingly less likely to buy uncertified. The initial predication
was that all the binary treatment variables and interactions would have negative signs, suggesting lower purchase probability than the EC treatment.

Given the dependent variable was a quantity purchase decision, McConnell’s (1990) advice to not include independent variables that approximate quantity demanded was followed. Therefore, the open-ended question regarding shiner usage could not be explicitly used in the regressions. However, in addition to the pooled sample analysis, the sample was split into low, average, and high uses to test for any result differences between these groups.5

While asking respondents about their familiarity with VHS and VHS regulations, those who indicated less than very familiar were allowed to indicate if they would like to learn more (regardless of treatment). Those who indicated they would not to either VHS or VHS regulations were given a value of “1” in the corresponding binary variable (WouldNot, 26%). It was predicted that not wanting to learn more would have a negative effect on the probability of purchase given the EC baseline.

The answers to the VHS regulation perception questions were combined to generate a binary variable for those indicating negative expected outcomes from any regulations (BadReg, 7%). It was anticipated that this variable would lead to lower probability of purchase given the EC baseline. Respondents who listed VHS-free fishing locations were also identified, and those who skipped this section were included separately (LocVHSF, 25%; LocMiss, 1%). The sign of the VHS-free location binary variable was unclear as those who fish VHS-free locations may be more likely to purchase VHS-free bait to keep their fishing lakes free of the virus while others may be frustrated by being legally forced to purchase VHS-free bait at potentially higher prices. However, since the BadReg variable was used to control for the later, LocVHSF was predicted to have a positive impact on purchase likelihood.

Many demographic variables were initially considered. The final model included income categories, belonging to a fishing or environmental organisation, and not being married as important. Three income variables were generated based on reported household income; under $25,000 (LowInc, 9%) and over $100,000 (HighInc, 22%), and do not know or missing (IncMiss, 5%). Since having an average income is the baseline, the variable LowInc was expected to create a negative effect while HighInc was expected to create a positive effect on the probability of purchase. Those who belonged to a fishing or environmental organisation were noted (Org, 34%) and thought to have a positive effect. Those not married were indicated and the sign of the effect was unclear but predicted to be positive since single anglers may be more freely able to spend on their hobby of choice (NotMar, 28%).

The model results must be interpreted from the baseline. Except where noted, the baseline was carefully chosen to include the EC treatment and modal choices of binary variables to reduce multicolinearity with the constant. The baseline included the following characteristics:

- EC treatment,
- very familiar with VHS or wanted to learn more,
- VHS positive or surveillance fishing locations,
- regulations not perceived negatively,
- average income,
- not a member of a fishing or environmental organisation,
- married.

The results of the bivariate probit model are presented in Table 3. Considering the signs of the coefficient estimates in Table 3, only the coefficient for the fishing or
environmental organisation membership variable (Org) is the opposite of what was predicted. It is unclear why this would be, but having the vast majority of coefficients matching expectations provides some model validity.

3.2.2. Tests of hypothesis (1): certification does not influence the likelihood of shiner purchase

The goal was to statistically analyse the sets of treatments that only differ based on whether the shiners are certified or not certified. Therefore, the emphasis is to compare (1) education and certified (EC) with education and not certified (ENC) and (2) no education and certified (NEC) with no education and not certified (NENC).

Based on the econometric model results in Table 3, with the education and certified (EC) treatment as the baseline, the comparison of EC to ENC is complicated due to the non-linear relationship. Note that if all the coefficients ($\beta_{ENC}$, $\beta_{ENC}^{2}$) were negative, it would be clear that EC leads to higher purchase likelihoods. However, since $\beta_{ENC}^{2}$ is positive, the overall effect is a negative quadratic for both equations.

Due to the complexity of the comparison of EC and ENC, the best model with the baseline changed to ENC was determined. In this model, only the treatment variable EC was significant rather than needing the complexity of the quadratic. The key result was that the single treatment variable for the education certified treatment (EC) leads to higher

| Variable | Description | Coefficient | SE | Coefficient | SE |
|----------|-------------|-------------|----|-------------|----|
| Constant |             | 1.8***      | .31| 1.6***      | .21|
| Bid      |             | -.48***     | .07| -.36**      | .05|
| ENC      | Dummy — educational material, non-certified bait | -1.6** | .70 | -1.49** | .64|
| BidENC   | Bid slope for ENC | 1.1** | .45 | .53 | .40 |
| SBENC    | Bid slope squared for ENC | -.18** | .08 | -.07 | .06 |
| NEC      | Dummy — no educational material, certified bait | .22 | .22 | -.14 | .22 |
| NENC     | Dummy — no educational material, non-certified bait | -.22 | .20 | -.67** | .20 |
| Would not | Not interested in more VHS info | -.43** | .17 | -.23 | .16 |
| LocVHSF  | Fishing in VHS-free locations | .11 | .17 | .27* | .16 |
| LocMiss  | Skipped location section of survey | -.40 | .97 | -.41 | .78 |
| BadReg   | Thinks negative outcomes from regulation | -.39 | .27 | -.42 | .27 |
| LowInc   | Income <$25,000 | -.30 | .25 | -.23 | .27 |
| HighInc  | Income >$100,000 | .66*** | .18 | .52*** | .18 |
| IncMiss  | Undeclared income | .44 | .35 | .08 | .32 |
| Org      | Fishing or environmental org member | -.20 | .15 | -.29* | .15 |
| NotMar   | Not married | .19 | .16 | .49*** | .17 |
| Rho(1,2) |             | .33***      | .13 |
purchase likelihood at the 1% significance level for the second equation. There is some statistical evidence to suggest that EC leads to higher purchase likelihood than ENC.

The comparison of NEC to NENC was much more straightforward and was analysed statistically by completing the following Wald test for each of the two estimated equations: $\beta_{\text{NEC}} = \beta_{\text{NENC}}$. These tests compare the purchase likelihood of the no education certified (NEC) and the no education not certified (NENC) treatments. Therefore, they directly compare the two no education treatments which only differ based on the certification attribute. Wald tests indicated statistically significant differences in the treatment variable coefficients for both the first (5% significance level) and second equations (1% significance level). There is a strong statistical evidence that the NEC treatment leads to a higher likelihood of purchase than NENC.

The results of the tests of hypothesis (1) from the fully parameterised models indicate a reasonable probability that the certified treatments lead to higher purchase likelihood than the not certified treatments. There is some statistical evidence that the EC treatment leads to higher likehoods than ENC. There is a strong statistical evidence that the NEC treatment leads to higher likelihoods than NENC.

3.2.3. Tests of hypothesis (2): including educational information about VHS neither influences the likelihood of shiner purchase nor the WTP for shiners

The goal was to statistically analyse the sets of treatments that only differ based on whether education materials were presented or not. Therefore, the emphasis is to compare (1) education and certified (EC) with no education and certified (NEC) and (2) education and not certified (ENC) with no education and not certified (NENC).

The comparison of EC to NEC was analysed statistically from the results presented in Table 3 by completing the following Wald test for each of the two estimated equations: $\beta_{\text{NEC}} = 0$. The sign of the coefficients of the NEC treatment variable changed from the first to second equation and neither were statistically significant. There was no evidence of likelihood of purchase differences between the two certified treatments (EC vs. NEC).

Given the complication of the non-linear relationship between EC and ENC, the model was adapted to have ENC as the new baseline to allow a more direct comparison between the uncertified treatments. The NENC treatment variable was insignificant for both the first and second equations. This suggested no statistical difference between the two uncertified treatments.

The results of the tests of hypothesis (2) from the fully parameterised models indicate that it is very improbable that the education treatments lead to higher purchase likelihood than those without education materials. There is a strong statistical evidence that the EC treatment does not lead to higher purchase likelihoods than NEC. There is some statistical evidence that the ENC treatment does not lead to higher purchase likelihoods than NENC. Overall, there is no evidence to suggest that receiving educational materials increased the probability of purchase.7

4. Discussion

The results of our survey show that certification of bait to be free of VHS is likely to influence both the probability of purchase and the WTP for shiners. Several statistical tests demonstrated that anglers were more likely to purchase certified shiners compared to uncertified shiners, and there is some evidence WTP was higher for certified bait. These results suggest that anglers are concerned about the movement of fish diseases in baitfish,
that they are likely familiar with VHS, and that they value the certification process and keeping their bait clean.

Anglers in Michigan show a willingness to pay a premium for shiners that are certified VHS-free. By comparing the education treatment point estimate means (EC vs. ENC) for our models incorporating both bids (double bound [DB] interval logit and bivariate probit), the range of implied mean premiums is [$0.60, $2.68] with median $1.01. Utilising a similar comparison of the treatments without the education piece (NEC vs. NENC), the range of implied mean premiums is [$0.01, $1.60] with median $0.49. Therefore, the relative premium of certification is about 29% for the education treatments and 15% for the treatments without the education piece. These results are similar to the Yue, Hurley, and Anderson’s (2011) findings that plants labelled as non-invasive and native received a 15% premium. Switching the baseline, one could view the results as also being similar to Huffman et al.’s (2003) relative results of 15% discounts for a perceived negative label (‘GMO’ or ‘not certified’). Interestingly, a simple analysis of very limited actual bait shop prices yielded an average premium within the 15%–29% range; approximately $0.50 or 23% (uncertified ≈ $2.20/dozen, certified ≈ $2.70/dozen).

Our inclusion of an education piece about the impacts of VHS did not influence either the likelihood of shiner purchase or the WTP for shiners. There are no statistically significant differences in either the fully parameterised models or the mean WTP estimates. There are likely several factors as to why the education piece did not have a significant influence on demand. First, Michigan VHS regulations were in place for over two years when the survey was conducted. Therefore, over 75% of those surveyed self-reported being at least somewhat familiar with VHS and the regulations. Additionally, over 75% either agreed or strongly agreed that VHS was a major threat to the health of fish populations in the Great Lakes region and that Michigan VHS regulations were needed to keep the virus from spreading. The piece was also intentionally accurate to not bias results by including the following statements:

- VHS does not affect humans. It is safe to eat fish that are VHS positive.
- This virus is a relatively new discovery in the Great Lakes region. Therefore, a lot of information is still being gathered about the nature of VHS and its effects on fish populations.

Finally, 47% of anglers that responded ‘No’ to both WTP questions in the uncertified treatments indicated that they only buy certified bait \((n = 24)\). Therefore, the education piece, or lack of, was unlikely to influence their WTP decisions.

### 5. Conclusion

Viral haemorrhagic septicaemia is an internationally recognised fish disease that has been found to cause substantial ecological and economic damages. Regulations on the disease, particularly the costly certification process, have impacted the Great Lakes fishing industry. The certification attribute of VHS susceptible baitfish products can be seen as an environmental attribute, similar to an ecolabel. The value consumers place on the certification attribute is indicative of the value they place on protecting the fish in VHS-free inland lakes in Michigan from becoming infested with VHS.

Using the CVM, this research found evidence that the certification of baitfish can increase the likelihood of purchase and the WTP for emerald shiners. Mean WTP point estimates imply the magnitude of the premium to be between 15% and 29%. While a
certification premium likely exists, there was statistically significant evidence of demand for uncertified bait as well. Only 11% of those responding to uncertified treatment surveys indicated that they would not buy uncertified bait; uncertified bait can be legally used in some water bodies (e.g. VHS positive). The addition, in some survey treatments, of a VHS education piece did not significantly change the likelihood or WTP for certified shiners.

Implications of these research results pertain mainly to government regulators and baitfish retailers. Government regulators are spending funds on maintaining VHS regulations and educating anglers on VHS. As per our findings, Michigan anglers are aware of the VHS issue and thus increasing educational efforts are not likely to significantly influence certified baitfish purchase. Baitfish retailers can use the conclusions of this research in evaluating aspects of their business models, including product offerings, location, and marketing. For example, a firm may consider whether the extra input costs of certification are outweighed by a potential WTP premium.

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Notes
1. The open-ended usage question was kept as well, such that stratifying the sample by low, average, and high usage to test for result differences was possible. See footnote 7 for results.
2. The data-set is available at http://doi.pangaea.de/10.1594/PANGAEA.827695.
3. Note for the statistical models considered the mean is always equal to the median.
4. Two key variables were determined and added to separate regressions to test for any affects, high-income respondents, and those who indicated they would not want to learn more about VHS and VHS regulations. Similar confidence interval results were obtained when adding them into the regressions to control for their affects.
5. Those results are briefly discussed in footnote 7.
6. There is a small loss in goodness of fit as measured by AIC by switching to this model. Therefore, the model with EC as the baseline is presented in Table 3.
7. Based on the open-ended usage question, it was determined that 20 dozen was the modal response, 24% of subjects used 20 dozen annually. Additionally, 50% of users purchased between 10 and 30 dozen per year. The goal of picking a fixed quantity that most anglers could relate to seems to have been met. As a robustness check, the sample was split three ways according to usage: less than 10 dozen, 10–30 dozen, and more than 30 dozen. The bivariate probit models were designed to compare to that presented in Table 3 with EC as the baseline. The average-use group (n = 214) had very similar results to the full sample (n = 423). The low-use group (n = 140) results indicated no treatment effects in the first equation and a constant negative effect from the ENC treatment in the second equation. Other significant variables included would not like to learn more (WouldNot), high income (HighInc), and VHS-free locations (LocVHSF) with the same signs as previous results. The high-use group (n = 64) had a small sample size, and only the constant and bid variables were significant.
8. Keep in mind that these changes and percentages are based on differences of the mean point estimates, not statistical differences from the confidence intervals.
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