Economic Analysis of Bag Limits for the Recreational Spiny Lobster Fishery In the Florida Keys National Marine Sanctuary: Technical Appendix

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December 2005

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Introduction

Beginning with a pilot study in 1991, the Florida Marine Research Institute (FMRI), now the Florida Fish and Wildlife Research Institute (FWRI), has conducted annual mail surveys of recreational spiny lobster (crawfish) license holders. These surveys support the estimation of recreational lobster landings and fishing effort statewide and regionally during the Special Two-Day Sport Season and during the first month of the regular lobster fishing season, when the majority of recreational lobster fishing occurs. The surveys also provide details about fisher demographics and their opinions about lobster fishery management.

In 1992 and in 2001, Dr. J. Walter Milon (formerly at the University of Florida and now at the University of Central Florida) designed socioeconomic add-ons to the annual survey, which included questions on changing the bag limits for the recreational spiny lobster seasons.

In 2001, the Socioeconomic Research and Monitoring Program for the Florida Keys National Marine Sanctuary (FKNMS) funded a socioeconomic add-on to the annual survey to support estimation of the local economic impact of the two recreational spiny lobster seasons on Monroe County, Florida and estimate the economic value of changes in the bag limits. The 1992 data was archived and was available to include in the analyses. NOAA's Coastal and Ocean Resource Economics (CORE) Program, which runs the Socioeconomic Research and Monitoring Program for the FKNMS, contracted with Dr. Milon to analyze the 1992 and 2001 data on the economic value of changes in the bag limits.

Facts sheets summarizing catch and effort, the economic impact of the recreational spiny lobster seasons on Monroe County, Florida, and the economic value of bag limit changes can be found on the CORE web site: http://marineeconomics.noaa.gov/SocmonFK/lobster.html.

This report documents the analysis of the economic value of the bag limit changes for the recreational spiny lobster conducted by Dr. Milon and therefore serves as a Technical Appendix. The report includes: 1) the Final Report submitted to NOAA, which includes the final estimates for the economic value of changes in the bag limits; 2) the Interim Report, which includes preliminary models tested; and 3) the first contract Progress Report, which includes some basic summaries of the data.

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STATISTICAL ANALYSIS TO SUPPORT THE SOCIOECONOMIC RESEARCH AND MONITORING PROGRAM FOR THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Final Report
Summary Econometric Models and Economic Valuation of Alternative Recreational Bag Limits for Spiny Lobster

Econometric Modeling

Several econometric modeling issues for the 1992 and 2001 lobster survey data were discussed and evaluated in Interim Report 2. A brief recap of these issues and the results of alternative econometric treatments is as follows. First, the large number of $0.00 responses to the willingness to pay (WTP) questions in all three surveys resulted in a skewed distribution that could not be modeled using ordinary least squares (OLS) regression. Several alternative econometric models using integer data approaches (i.e. Poisson, negative binomial and zero-inflated Poisson (ZIP)) provided much better statistical fit for the survey data. These models, however, were not appropriate for econometric modeling of the combined data sets because an inflation adjustment for the 1992 survey data produces WTP values that were not integer values. The alternative tested was a Tobit model (with censoring in both tails of the WTP distribution) that provided good statistical results for both scenarios presented to survey respondents – proposed decreases and increases in the bag limits. The models were also evaluated using different approaches to sample definition in which a) all survey respondents were included, and b) respondents who indicated they were 'not in the market' for the bag limit changes were excluded.

Second, the payment card format provides only discrete integer responses that also violate the standard distributional assumptions for OLS. Given the relatively small gap, typically $1 increments, between the response intervals in all three surveys, this was not a major problem. The data were transformed using the midpoints of the intervals for econometric estimation. The Tobit model also addresses the non-normal distribution problems with the payment card format.

Finally, the protocol used in all three surveys was a proposed decrease in recreational lobster bag limits (2 lobsters in each survey) followed by proposed increases (8 lobster in the 1992 survey, 2 lobster in the 2001 regular season survey, and 6 lobster in the 2001 sport season survey). The potential for an "endowment effect" resulting from different WTP responses to a loss of the bag limit *vs* a gain in the bag limit was evaluated. Results from several alternative tests indicated that these were not considered to be symmetric changes by respondents. A complete model for the two WTP responses must also address this fundamental difference.

Turnbull Lower Bound Estimates of WTP per Lobster

Any econometric model imposes certain distributional restrictions on the parameter estimates and predicted values. To provide initial estimates of WTP for changes in spiny lobster bag limits, the Turnbull distribution-free estimator for a lower bound estimate of mean WTP (Haab and McConnell, 2002, pp. 59 – 83) was calculated for each set of responses in the three surveys. Results are presented in Tables 1 to 3 for the two WTP questions in each survey. The tables also provide the corresponding WTP per lobster for each question along with a t-test of the null hypothesis that the WTP to avoid a decrease in the bag limit was equal to the WTP for an increase in the bag limit. Results are presented for the full sample.

The results in Tables 1 to 3 demonstrate the difference in responses to the two WTP questions. With the exception of the 2001 regular season survey data, the mean WTP per lobster to avoid a decrease in the bag limit is greater than the mean WTP for an increase. This result is confirmed by the t-statistic for the 1992 and 2001 special season data. The lower bound WTP per lobster to avoid a decrease ranges from $0.69 to $1.20. The comparable range in WTP per lobster for an increase is $0.35 to $1.03. Due to the large number of $0.00 WTPs and the narrow range of responses between $0.00 and $16.00 (the maximum value if a respondent indicated WTP "more than $14.00"), the variance for each mean is very small.

Final Econometric Models

To address the different econometric issues described above and provide a model that could be used to evaluate the determinants of WTP, it was decided to treat the two WTP responses from each respondent as a 'panel' so that both responses would be included in a single model. The final model specification is a "pooled Tobit" that can be specified as:

$$WTP_{it} = \max(0, \beta x_{it} + u_{it}), \quad t = 1,2$$

where x is a vector of explanatory variables for the ith respondent to each WTP question. The explanatory variables include indicators for each survey period and for each WTP question. The lower bound limit is $0.00 and the upper bound can be fixed according to the distribution of the dependent variable. The estimate of u is conditional on x with the assumption that:

$$u \sim \text{Normal}(0,\sigma^2)$$

which is the censored normal distribution. More details on the pooled Tobit estimator are available in Wooldridge (2002, pp. 538 – 539). The complete model is specified as:

$$WTP_{it} = \alpha + \beta_1 \text{Experience} + \beta_2 \text{Catch} + \beta_3 01\text{Regular} + \beta_4 01\text{Sport} + \beta_5 \text{Bag Decrease} + u_{it}$$

where the variables are as defined in Report 2. Bag Decrease is a dummy variable to indicate if the response is a WTP to avoid a decrease in the bag limit.

Estimation results for the pooled Tobit model with both WTP responses for the full sample is provided in the first column of Table 4. The dependent variable is specified as the "WTP per lobster" due to the lack of variation in the bag limit change within a specific survey. This lack of variation would result in perfect collinearity if the bag limit change was included along with dummy variables for each of the surveys. Comparable results for a restricted sample in which respondents that were 'not in the market' for the bag limit changes were deleted are presented in the second column of Table 4.

In general, the two columns are qualitatively similar but with some important differences. The intercept for the full sample is negative whereas the intercept is positive, and highly significant, for the restricted sample. This reflects an important shift of the distribution resulting from the deletion of some portion of the $0.00 responses. The two individual specific explanatory variables, Experience and Catch, are not statistically significant in the restricted sample estimation results but Catch is positive and significant with the full sample. This is not unexpected since many of the $0.00 WTP respondents who were deleted from the full sample had no prior catch of spiny lobster.

The dummy variables for the 2001 regular and sport season surveys (1992 is the base) are similar in sign for both samples but the regular season dummy is not statistically significant with the full sample. The coefficients indicate important differences in the WTP per lobster across the three surveys that were not accounted for by other explanatory variables in the model. The result that bag changes in the sport season survey had a lower value is not surprising given that this season is so short relative to the regular season. Other factors such as differences in the availability of lobster or economic conditions between 1992 and 2001 may also account for some of these differences but they cannot be directly evaluated in the model.

The Bag Decrease dummy variable is positive and statistically significant with both the full and restricted samples. This result confirms the presence of an "endowment effect" that was discussed in more detail in Report 2. Finally, the dispersion parameter, sigma, is highly significant for both samples indicating the density of the WTP distribution around $0.00.

Mean Estimates of WTP per Lobster and Effects of Covariates

Using the model parameters presented in Table 4, estimates of the conditional mean WTP per lobster were developed and are presented in Table 5. Mean WTP per lobster for the restricted sample ($2.31) is nearly twice the mean for the full sample ($1.23) due to the larger intercept for the restricted sample model and the smaller number of $0.00 WTP responses. Note that the mean WTP per lobster values for all survey years in Table 5 are higher than the lower bound estimates in Tables 1 to 3 reflecting the differences in interval point estimates (lower bounds *vs* midpoints) used in the two mean estimation procedures.

The effects of covariates on the mean WTP are also presented in Table 5 along with the standard errors in parentheses. The largest change in both means is for the WTP to avoid a decrease in bag limits. The value per lobster increases by $0.44 for the full sample and $0.50 for the restricted sample. The change in means is also relatively large for the regular and sport season variables for the restricted sample. The other covariates have relatively little influence on the overall WTP values. These results suggest that unobserved factors had a significant influence on responses to the 1992 and 2001 surveys. Therefore, these mean estimates should be considered in the context of each survey and time period.

References

Haab, T. and K. McConnell. 2002. *Valuing Environmental and Natural Resources*. Edward Elgar.

Wooldridge, J. 2002. *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

Final ReportTable 1: Lower Bound Estimates of Willingness to Pay per Lobster - 1992 Survey

Lower Bound for Interval	Upper Bound for Interval	Probability of Payment at Upper Bound	Change in Density of Distribution	Willingness to Pay (Use Value $) (1) * (4)
		WTP to Avoid a Decrease in BAG Limit		
0	1	0.576	0.576	0.000
1	2	0.699	0.123	0.123
2	3	0.713	0.014	0.028
3	4	0.778	0.066	0.197
4	5	0.871	0.092	0.370
5	6	0.890	0.019	0.094
6	7	0.891	0.001	0.006
7	8	0.901	0.010	0.070
8	10	0.963	0.063	0.501
10	12	0.970	0.007	0.070
12	14	0.972	0.002	0.024
14	16	1.000	0.028	0.390
		Total Use Value (Sum Column 5)		$1.87
			WTP per Lobster	$0.94
			Variance	0.008
			WTP in 2001$	$1.20
		WTP for an Increase in BAG Limit		
0	1	0.548	0.548	0.000
1	2	0.611	0.064	0.064
2	3	0.621	0.010	0.020
3	4	0.672	0.051	0.152
4	5	0.741	0.069	0.274
5	6	0.760	0.020	0.099
6	7	0.763	0.003	0.018
7	8	0.791	0.028	0.195
8	10	0.903	0.111	0.891
10	12	0.920	0.018	0.179
12	14	0.929	0.009	0.107
14	16	1.000	0.071	0.988
		Total Use Value (Sum Column 5)		$2.99
			WTP per Lobster	$0.37
			Variance	0.0139
			WTP in 2001$	$0.48
			H_0: $WTP_1 = WTP_2$	3.80
			Reject H_0: 3.80 > 1.96	

Final Report Table 2: Lower Bound Estimates of Willingness to Pay per Lobster - Special Season 2001 Survey

Lower Bound for Interval	Upper Bound for Interval	Probability of Payment at Upper Bound	Change in Density of Distribution	Willingness to Pay (Use Value $) (1) * (4)
		WTP to Avoid a Decrease in BAG Limit		
0	1	0.651	0.651	0.000
1	2	0.789	0.137	0.137
2	3	0.799	0.010	0.021
3	4	0.852	0.053	0.159
4	5	0.908	0.056	0.224
5	6	0.915	0.007	0.037
6	7	0.915	0.000	0.000
7	8	0.923	0.008	0.055
8	10	0.974	0.051	0.405
10	12	0.977	0.004	0.037
12	14	0.984	0.006	0.073
14	16	1.000	0.016	0.230
		Total Use Value (Sum Column 5)		$1.38
			WTP per Lobster	$0.69
			Variance	0.006
		WTP for an Increase in BAG Limit		
0	1	0.612	0.612	0.000
1	2	0.699	0.087	0.087
2	3	0.711	0.012	0.024
3	4	0.761	0.050	0.150
4	5	0.815	0.054	0.215
5	6	0.843	0.028	0.140
6	7	0.844	0.001	0.007
7	8	0.858	0.014	0.098
8	10	0.944	0.086	0.687
10	12	0.954	0.010	0.104
12	14	0.969	0.015	0.176
14	16	1.000	0.031	0.435
		Total Use Value (Sum Column 5)		$2.12
			WTP per Lobster	$0.35
			Variance	0.011160
			H_0: $WTP_1 = WTP_2$	2.59
			Reject H_0: 2.59 > 1.96	

Final Report Table 3: Lower Bound Estimates of Willingness to Pay per Lobster - Regular Season 2001 Survey

Lower Bound for Interval	Upper Bound for Interval	Probability of Payment at Upper Bound	Change in Density of Distribution	Willingness to Pay (Use Value $) (1) * (4)
		WTP to Avoid a Decrease in BAG Limit		
0	1	0.570	0.570	0.000
1	2	0.707	0.138	0.138
2	3	0.721	0.014	0.027
3	4	0.779	0.058	0.174
4	5	0.846	0.067	0.267
5	6	0.854	0.008	0.041
6	7	0.854	0.000	0.000
7	8	0.871	0.017	0.116
8	10	0.947	0.077	0.615
10	12	0.952	0.004	0.041
12	14	0.960	0.009	0.106
14	16	1.000	0.040	0.554
		Total Use Value (Sum Column 5)		$2.08
			WTP per Lobster	$1.04
			Variance	0.005
		WTP for an Increase in BAG Limit		
0	1	0.608	0.608	0.000
1	2	0.720	0.113	0.113
2	3	0.729	0.009	0.018
3	4	0.783	0.053	0.160
4	5	0.838	0.056	0.222
5	6	0.848	0.010	0.050
6	7	0.849	0.001	0.007
7	8	0.868	0.018	0.128
8	10	0.940	0.073	0.582
10	12	0.947	0.007	0.071
12	14	0.959	0.012	0.142
14	16	1.000	0.041	0.571
		Total Use Value (Sum Column 5)		$2.06
			WTP per Lobster	$1.03
			Variance	0.008259
			H_0: $WTP_1 = WTP_2$	0.07
			Do not Reject H_0	

Final Report Table 4: Final Pooled Tobit Model Specifications for the WTP for Changes in Spiny Lobster Bag Limits

Variable	Model	
	Full Sample	Restricted Sample
Intercept	-0.2983**	1.796**
	(-2.684)	(18.55)
Experience	0.0105	-0.01206
	(0.955)	(-1.241)
Catch	0.0968**	0.010548
	(9.104)	(1.194)
01 Regular	0.07877	0.6948**
	(0.810)	(8.163)
01 Sport	-0.7295**	-0.5518**
	(-7.499)	(-6.494)
Bag Decrease	0.8601**	0.5808**
	(12.310)	(9.353)
Sigma	2.97**	2.13**
	(89.91)	(97.41)
n	8678	4744
Log-likelihood	-14607	-10320
Log-likelihood (restricted)	-18135	-10514

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parenthesis.

Final Report Table 5: Estimated Mean Willingness to Pay per Lobster for Full and Restricted Samples-All Years

	Full Sample	Restricted Sample
Conditional Mean	$1.23	$2.31
Marginal Values		
Decrease in BAG	$0.44	$0.50
	(0.04)	(0.05)
Regular 2001	$0.04	$0.59
	(0.05)	(0.07)
Sport 2001	-$0.37	-$0.46
	(0.05)	(0.07)
Experience	$0.01	-$0.01
	(0.01)	(0.01)
Catch	$0.05	$0.01
	(0.01)	(0.01)

STATISTICAL ANALYSIS TO SUPPORT THE SOCIOECONOMIC RESEARCH AND MONITORING PROGRAM FOR THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Interim Report 2
Econometric Models for the 1992 and 2001 Recreational Lobster Survey Data

Modeling Issues

As discussed in Interim Report 1, the willingness to pay (WTP) responses for the three surveys were characterized by a large proportion of zero responses. In addition, the elicitation format used in the surveys was a payment card with 11 values ranging from $1 to $14 and a 'more than $14' value. Both of these features of the data require special treatment to estimate econometric models for the WTP responses.

The large proportion of $0 responses to the WTP questions creates an asymmetrical distribution that violates the standard assumption of a normal distribution in econometric modeling. In this case, the clustering of WTP responses at $0 can be treated as: 1) a censoring effect or 2) the outcome of a discrete decision whether to give a value for the proposed bag limit changes and, if yes, how much to value the change. If the responses are treated as a form of censoring, the reasons for $0 responses are not very important. One the other hand, the discrete decision can be considered as a selection problem and the model should attempt to explain both parts of the decision.

The recent literature on 'spike models' suggests some alternative models to deal with these different interpretations of the data (e.g. Clinch and Murphy, 2001; Haab and McConnell, 2002; Nahuelhual-Munoz, Loureiro and Loomis, 2004; Strazzera et al., 2003). The choice of alternatives depends on the information available about the decision to give a $0 WTP response. Fortunately, the 1992 and 2001 surveys contain follow-up questions if respondents gave a $0 response. This information can be used to partition respondents into those who were: 1) indifferent to the proposed changes so this group is 'not in the market' and 2) interested in the proposed change but they did not give a positive WTP because they protest making a payment or the lowest response amount is greater than their true WTP. Haab and McConnell (2002, p. 135) emphasize the importance of properly accounting for these distinctions in model estimation. Many of the recent empirical studies have found considerable sensitivity due to model specification.

The payment card format also introduces aspects of the data that violate the assumption of a normal distribution. Cameron and Huppert (1989) were the first to raise concerns about this format and the potential bias caused by ordinary least squares estimation. The problem is that responses only occur in discrete interval values so it is necessary to select a midpoint between these intervals to measure the true WTP. An alternative is to use an "interval regression" method when the payment intervals are sufficiently 'coarse.' More recent literature has focused on the fact that interval data share many of the same characteristics of count data and may also have some truncation of responses in one or both tails of the distribution. Greene (pp. 919 – 926) discusses how these problems can be treated econometrically using count data models.

Due to the nature of the data and the alternative approaches to model estimation, no single econometric specification can be selected as the "correct" one without empirical analysis. In the following, various alternative definitions of the sample and model results are presented. Several alternative models to evaluate differences in the WTP response for the two valuation questions in each survey are also presented. These models consider whether an 'endowment effect' may influence responses. This report concludes with a discussion of a strategy for estimating the value of changes in the recreational bag limit for spiny lobster.

Variables for the Analysis

The WTP data described in Interim Report 1 provide the dependent variables for the econometric models. Variables from the three surveys that were used in the econometric models are presented in Table 1 along with basic statistics for each variable. The original values for the WTP questions as coded from the surveys are listed as 'WTP1 – Coded' and 'WTP2 – Coded.' WTP1 is the willingness to pay to avoid a decrease in bag limits – an equivalent variation (EV) measure of the change in welfare. WTP2 is the willingness to pay for an increase in bag limits – a compensating variation (CV) measure of welfare.

For each WTP measure, the 'Count Value' and 'Interval Value' are presented. The Count Value is the transformed value of the original coding into a dollar value but not with an inflation adjustment for the 1992 survey data. The Interval value is the transformed value with inflation. This distinction is important because count data models such as Poisson and Negative Binomial regression must be estimated with only whole integer values. The inflation adjustment for the 1992 data does not produce integer values. The WTP per lobster is also shown in Table 1 and was derived by dividing the Interval value of each WTP by the specified change in bag limit in the survey.

The dummy variables Y1 and Y2 indicate respondents who gave a WTP response greater than $0.00 for the proposed bag limit changes. For both responses, the percentage of positive values was less than 50 percent. The dummy variables I1 and I2 indicate respondents who gave a $0.00 WTP but who indicated in the reasons they provided for the response was that they were 'in the market' for the proposed changes. This distinction is intended to separate "indifferent" respondents from those in the market. This indifference was indicated by reasons such as "they would not catch the limit," "they did not want to keep more than the limit," or "bag limits are not enforced." Respondents who were in the market gave reasons such as "they did not know what a stamp would be worth" or "they did not want to pay more than they currently pay."

The selection of independent variables was very limited, however, because of the large number of missing values for the socioeconomic characteristics of respondents in the 2001 Regular and Sport Season surveys. To provide some variables for the models, zip code information was formatted to identify respondents according to four geographic regions for their residence. Table 1 shows the dummy variables used and the percentage of the sample who were residents living in North Florida, Central Florida and a Non-Resident. Residence in South Florida was the omitted category. The number of years respondents indicated they had fished for spiny lobster was labeled 'Experience' and provides another independent variable. Information in each survey on the individual respondent's harvest during the specific time period identified in that survey was also converted into a daily 'Catch' measure.

Other dummy variables were added to indicate the 2001 Regular and Special season surveys with the 1992 survey as the omitted category. Finally, Table 1 shows the proposed bag limit changes for WTP1 and WTP2 in terms of the number of lobster. Note that the proposed reduction for WTP1 is always 2 lobsters but the amount varies for WTP2. This variation, however, only occurs with each survey. Therefore, these bag limit changes are perfectly correlated with the survey dummy variables so they cannot be used together with the survey dummy variables in model estimation.

Interim Report Table 1: Summary Statistics for Econometric Model Variables

	Mean	*Std Deviation*	*Skewness*	*Minimum*	*Maximum*
WTP1 - Coded	2.11	3.23	1.62	0.00	12.00
WTP1 - Count Value	2.31	3.82	2.02	0.00	16.00
WTP1 - Interval Value	2.85	4.40	2.00	0.00	21.86
WTP1 - Value per Lobster	1.42	2.20	2.00	0.00	10.93
Y1 = 1 if WTP1 > 0	0.44	0.50	0.23	0.00	1.00
I1 = 1 if 'in the market'	0.15	0.36	1.91	0.00	1.00
WTP2 - Coded	2.56	3.75	1.27	0.00	12.00
WTP2 - Count Value	2.88	4.51	1.59	0.00	16.00
WTP2 - Interval Value	3.49	5.34	1.64	0.00	21.86
WTP2 - Value per Lobster	0.91	1.64	2.70	0.00	8.50
Y2 = 1 if WTP1 > 0	0.43	0.49	0.29	0.00	1.00
I2 = 1 if 'in the market'	0.08	0.27	3.14	0.00	1.00
Difference in WTPs	0.64	4.16	0.58	-21.86	21.86
Difference in WTPs/Lobster	-0.51	1.80	-1.46	-10.93	8.50
North Florida Resident	0.07	0.26	3.23	0.00	1.00
Central Florida Resident	0.26	0.44	1.09	0.00	1.00
Non-Resident	0.12	0.33	2.33	0.00	1.00
Experience	4.71	3.48	1.00	0.00	14.00
Catch	1.56	3.26	3.26	0.00	24.00
D1 = 1 if '01 Regular Survey	0.39	0.49	0.45	0.00	1.00
D2 = 1 if '01 Special Survey	0.38	0.48	0.50	0.00	1.00
F1 - Limit Change for WTP1	2.00	0.00		2.00	2.00
F2 - Limit Change for WTP2	4.90	2.44	-0.15	2.00	8.00

Econometric Models and Results

WTP1 – Table 2: Count Data Models

The first set of models for WTP1 using the variable as count data is presented in Table 2. These models are estimated with all observations for WTP1 (4,505) from the 3 surveys. Column 1 is a Poisson regression. Column 2 is a negative binomial regression. Column 3 is a ZIP model with a negative binomial distribution. Column 4 is a selection model with the second stage for the WTP1 specified as a ZIP model with a negative binomial distribution. Finally, column 5 is a hurdle selection model specified as a negative binomial regression for WTP1 in the second stage.

The results across the columns 1 – 3 indicate that the Poisson specification does not perform well due to overdispersion from the large number of $0.00 values. The statistical significance of the dispersion parameter, sigma, for the negative binomial and ZIP models confirms the overdispersion problem. The lack of significance for the extra dispersion parameter, rho, for the ZIP model suggests that this additional correction adds little to the negative binomial's performance.

The results in Columns 4 and 5 for the selection models indicate that the hurdle specification in Column 5 performs better with 4 variables significant at the .05 level or higher in the first level hurdle equation. This suggests that the decision whether to state an amount, the first hurdle, is not purely random.

Aside from the Catch variable, few of the other variables in the models are statistically significant. The notable exceptions are the survey dummy variables; negative signs for the '01 Sport season survey dummy variable were the most consistent results.

WTP1 – Table 3: Tobit Models

The second set of models for WTP1 using the interval value of the variable is presented in Table 3. Column 1 is an OLS regression which is included as a basis for comparison. Column 2 is a Tobit model and Column 3 is a Tobit with selectivity. Only 3 variables are included for the 1st stage selection model because specifications with other variables would not converge. Also, other variations of the Tobit specification with different selectivity rules did not produce useful results.

While a number of variables in the OLS specification in Table 3 are significant, the very high statistical significance for the dispersion parameter, sigma, in the Tobit model indicates that the latter specification is superior. Similarly, the selectivity model performed well but the selection part of the model did not reveal much information about the decision whether to state a value or not.

Interim Report Table 2: Alternative Model Specifications for the WTP to Avoid a Decrease in Spiny Lobster Bag Limits - Count Models, All Observations

Variable	Model				
	1	2	3	4	5
Intercept	0.823**	0.820**	0.831**	0.887**	0.627**
	(25.51)	(10.37)	(9.96)	(10.53)	(4.51)
Non-Resident	0.095*	0.097	0.085	0.133	0.139
	(3.07)	(1.26)	(1.11)	(1.58)	(1.16)
Central Florida Resident	0.098*	0.094	0.096	0.089	0.026
	(4.36)	(1.67)	(1.68)	(1.51)	(0.34)
North Florida Resident	0.013	0.016	0.017	-0.011	0.043
	(0.34)	(0.17)	(0.20)	(0.09)	(0.31)
Experience	0.005	0.006	0.007	0.002	0.001
	(1.72)	(0.845)	(0.92)	(0.26)	(0.11)
Catch	0.028**	0.026**	0.027**	0.025**	0.003
	(10.95)	(3.60)	(3.19)	(2.76)	(0.30)
01 Regular	0.087**	0.084	0.071	0.079	0.218**
	(3.23)	(1.23)	(1.01)	(1.09)	(2.18)
01 Sport	-0.201**	-0.196**	-0.184**	-0.196**	-0.146
	(7.14)	(2.89)	(2.61)	(2.81)	(1.56)
Selection					
Constant				-0.061	0.279
				(0.07)	(2.69)
Non-Resident				1.47**	0.017
				(2.56)	(0.16)
Central Florida Resident				-0.423	0.186**
				(0.65)	(2.54)
North Florida Resident				-84.22	-0.036
				(0.00)	(0.31)
Experience				-91.03	0.015
				(0.00)	(1.53)
Catch				-16.39	0.076**
				(0.00)	(7.01)
01 Regular				-1.41	-0.158*
				(1.58)	(1.76)
01 Sport				-0.93	-0.255**
				(1.03)	(2.86)
Sigma		2.068**	2.024**	1.98**	3.00**
		(32.46)	(15.24)	(17.74)	(6.23)
Rho			-5.213		
			(1.67)		
Log-likelihood	-14046.27	-9044.30	-9044.05	-9020.53	-9008.37
Pseudo R^2	0.017				

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 3: Alternative Model Specifications for the WTP to Avoid a Decrease in Spiny Lobster Bag Limits - Tobit Models, All Observations

Variable	Model		
	1	2	3
Intercept	3.27**	1.19**	0.03**
	(14.81)	(3.37)	(4.67)
Non-Resident	0.28	0.34	0.10**
	(1.32)	(0.99)	(2.64)
Central Florida Resident	0.31*	0.61*	0.08**
	-1.98	(2.43)	(3.57)
North Florida Resident	0.02	-0.03	0.04
	(0.04)	(0.07)	(1.67)
Experience	0.008	0.03	0.0001**
	(0.38)	(0.92)	(83.78)
Catch	0.09**	0.18**	0.0001**
	(4.33)	(5.69)	(178.82)
01 Regular	-0.53**	-0.81**	-0.06**
	(2.82)	(2.69)	(14.72)
01 Sport	-1.31**	-1.85**	-0.06**
	(6.92)	(6.14)	(16.68)
Selection			
Constant			-0.24**
			(7.86)
Non-Resident			0.09
			(1.69)
Central Florida Resident			0.08**
			(2.12)
North Florida Resident			0.04
			(0.36)
Sigma		6.48**	0.139**
		(67.35)	(55.56)
Rho			0.707**
			(60.10)
Log-likelihood	-13022.00	-10042.15	-8263.05
Adjusted R^2	0.019		
Pseudo R^2		0.182	

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

WTP2 – Table 4: Count Data Models
The first set of models for WTP2 using the variable as count data is presented in Table 4. These models are also estimated with all observations for WTP2 (4,407) from the 3 surveys. Column 1 is a Poisson regression. Column 2 is a negative binomial regression. Column 3 is a ZIP model with a negative binomial distribution. Column 4 is a selection model with the second stage for the WTP1 specified as a ZIP model with a negative binomial distribution. Finally, column 5 is a hurdle selection model specified as a negative binomial regression for WTP1 in the second stage.

The results here are similar to those for WTP1. The results in columns 1 – 3 indicate that the Poisson specification does not perform well due to overdispersion from the large number of $0.00 values. The statistical significance of the dispersion parameter, sigma, for the negative binomial and ZIP models confirms the overdispersion problem. In this case, the extra dispersion parameter, rho, for the ZIP model is significant suggesting that this additional correction does improve the negative binomial's performance.

The results in Columns 4 and 5 for the selection models indicate little difference between the two specifications. The selection equations tend to reduce the statistical significance of the same variables in the valuation portion of the models suggesting that the predictive power of these variables in each stage of the model is not very strong.

The main difference from the results for WTP1 is that the survey dummy variables are both negative and statistically significant in all models. This may be attributable to the difference in the proposed increase in bag limits in each survey with the largest increase (8 lobsters) occurring in the 1992 survey. Other factors, however, that may have influenced respondents across the 3 surveys cannot be ruled out.

WTP2 - Table 5: Tobit Models
The second set of models for WTP2 uses the interval value of the variable and is presented in Table 3. Column 1 is an OLS regression; Column 2 is a Tobit model and Column 3 is a Tobit with selectivity. As with WTP1 only 3 variables are included for the 1st stage selection model because specifications with other variables would not converge. Also, other variations of the Tobit specification with different selectivity rules did not produce useful results.

The very high statistical significance for the dispersion parameter, sigma, in the Tobit model indicates once again that the underlying distribution is not normal so that the tobit specification is superior. Similarly, the selectivity model performed well but the selection part of the model did not reveal much information about the decision whether to state a value or not. The very high t-statistics for several of the variables and the dispersion parameters in the selectivity model suggests, however, that the results are not very stable.

WTP1 – Table 6: Count Spike Models
For the three surveys, some respondents did not provide responses to both WTP questions. Because this creates unequal sample sizes for the WTP1 and WTP2 responses and a potential inconsistency between the valuation information, all

observations with incomplete responses were deleted from the data. To estimate the spike models, it was necessary to also exclude respondents who indicated they were indifferent to the proposed bag limit changes. This was done based on the variables I1 and I2 described earlier in Table 1. Excluding these respondents reduces the data set to 2,562 observations.

Table 6 presents the spike models using the same count data models that were estimated initially with all observations (Table 2). Despite the elimination of indifferent respondents and the reduced sample size, the qualitative results of the Table 6 count models are fairly similar to the comparable models in Table 2. Models 2 and 3 that correct for overdispersion around $0.00 WTP outperform the basic Poisson model 1. The only major difference is the catch variable is no longer significant in the Table 6 models. The selection models 4 and 5 in Table 6 are also qualitatively similar to those in Table 2 with the exception of the experience variable that is significant in the selection equation in Table 6.

WTP1 – Table 7: Tobit Spike Models
Using a Tobit estimation for the spike models with the inflated WTP responses also led to qualitatively similar results as in Table 3. The dummy variables for each survey are statistically significant but the catch variable, which was significant in the Table 3 models, is not significant in the Table 7 models. Also, the selectivity model with the spike model did not converge. Thus, the main difference in results between Tables 3 and 7 is an increase in the intercept value.

WTP2 – Table 8: Count Spike Models
A comparison of spike models in Table 8 with the earlier results in Table 4 also reveals relatively few differences in the qualitative results. Models 2 and 3 that correct for overdispersion are preferred. The survey dummy variables are negative in sign and significant in both tables although some of the other explanatory variables such as the dummy variables for residence are not significant in Table 8. The sample selection models 4 and 5 also produce qualitatively similar results as their counterparts in Table 4. The selection equations for these models perform relatively well although some of the coefficients, such as for the survey dummy variables, are inconsistent in sign in the two models.

WTP2 – Table 9: Tobit Spike Models
As with the earlier comparisons between the spike models and models with all observations, the results in Table 9 for Tobit spike models are qualitatively similar to those in Table 5. The Tobit specification (Model 2) is clearly preferred to OLS (Model 1) as the former corrects for the large number of $0.00 that still remain even in the spike model. Most of the variables have the same sign and significance in Tables 9 and 5 with the exception of the dummy for Central Florida resident. Again, the main effect of the spike model specification is to increase the absolute value of the intercept term. Various specifications of a Tobit selection model did not converge suggesting that a selection equation component may do little to enhance the overall explanatory power of a model.

Interim Report Table 4: Alternative Model Specifications for the WTP for an Increase in Spiny Lobster Bag Limits - Count Models

Variable	Model				
	1	2	3	4	5
Intercept	1.1399**	1.1316**	1.5864**	1.653**	1.656**
	(40.439)	(12.128)	(19.492)	(18.686)	(18.891)
Non-Resident	0.07648**	0.06734	0.05543	0.04624	0.0417
	(2.665)	(0.723)	(0.683)	(0.496)	(454)
Central Florida Resident	0.1918**	0.2042**	0.1603**	0.0952	0.09734
	(9.374)	(3.058)	(2.789)	(1.503)	(1.546)
North Florida Resident	0.1428**	0.16266	0.13	0.09052	0.08787
	(4.205)	(1.484)	(1.403)	(0.861)	(0.844)
Experience	0.008384**	0.0091965	0.005953	0.000529	-0.0004245
	(3.148)	(1.033)	(0.786)	(0.064)	(-0.052)
Catch	0.371**	0.04016**	0.02739**	0.00384	0.006823
	(15.994)	(4.488)	(3.319)	(0.562)	(0.937)
01 Regular	-0.353**	-0.3585**	-0.2857**	-0.1905*	-0.1882*
	(-14.365)	(-4.421)	(-4.037)	(-2.464)	(-2.456)
01 Sport	-0.2665**	-0.2742**	-0.2181**	-0.1516*	-0.1478
	(-11.035)	(-3.419)	(-3.119)	(-1.976)	(-1.945)
Selection					
Constant				-0.3937**	0.00389
				(-2.677)	(0.038)
Non-Resident				-0.0824	0.08364
				(-0.608)	(0.818)
Central Florida Resident				-0.2719**	0.2373**
				(-2.725)	(3.254)
North Florida Resident				-0.1664	0.1617
				(-1.047)	(1.356)
Experience				-0.02039	0.01908
				(-1.488)	(1.924)
Catch				-0.1423**	0.08348**
				(-6.310)	(8.310)
01 Regular				0.4593**	-0.4214**
				(3.771)	(-4.733)
01 Sport				0.3319**	-0.3138**
				(2.723)	(-3.540)
Sigma		3.091**	1.12**	1.0225**	1.004**
		33.05	(11.545)	(11.770)	(11.75)
Rho			-0.3717**		
			(-7.565)		
Log-likelihood	-16473	-9076	-8995	-8953	-8955
Adjusted R^2	0.02				

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 5: Alternative Model Specifications for the WTP for an Increase in Spiny Lobster Bag Limits - Tobit Models, All Observations

Variable	Model		
	1	2	3
Intercept	4.578**	1.209*	-0.0287*
	(17.154)	(2.444)	(-2.400)
Non-Resident	0.289	0.503	0.1163*
	(1.102)	(1.033)	(2.128)
Central Florida Resident	0.67**	1.318**	0.124**
	(3.557)	(3.781)	(2.799)
North Florida Resident	0.4233	0.889	0.07738
	(1.366)	(1.547)	(1.600)
Experience	0.03	0.0739	-0.0000000047**
	(1.179)	(1.582)	(-154.897)
Catch	0.1477**	0.323**	-0.0000000043**
	(5.905)	(7.220)	(-102.524)
01 Regular	-2.311**	-3.617**	-0.0474**
	(-10.051)	(-8.552)	(-2.575)
01 Sport	-2.061**	-3.072**	-0.0474*
	(-9.011)	(-7.318)	(-2.552)
Selection			
Constant			-0.242**
			(-8.077)
Non-Resident			0.1163*
			(2.242)
Central Florida Resident			0.124**
			(3.149)
North Florida Resident			0.0773
			(1.083)
Sigma		8.788**	0.1106**
		(60.334)	(43.585)
Rho			0.707**
			(99.99)
Log-likelihood	-13546	-9468	-8419
Adjusted R^2	0.04		
Pseudo R^2		0.03	

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 6: Alternative Model Specifications for the WTP to avoid a decrease in Spiny Lobster Bag Limits - Count Spike Models

Variable	Model				
	1	2	3	4	5
Intercept	1.3499**	1.347**	1.501**	1.414**	1.57**
	(40.307)	(17.397)	(22.752)	(18.813)	(84.641)
Non-Resident	0.064	0.07396	0.0623	0.0526	0.0422*
	(1.938)	(0.959)	(0.945)	(0.652)	(2.195)
Central Florida Resident	0.0429	0.03948	0.0354	0.00743	0.007829
	(1.818)	(0.720)	(0.801)	(0.143)	(0.614)
North Florida Resident	0.07369	0.07059	0.0635	-0.0218	-0.02247
	(1.894)	(0.764)	(0.804)	(-0.256)	(-1.065)
Experience	-0.00539	-0.004702	-0.00459	0.01	0.00745**
	(-1.656)	(-0.633)	(-0.780)	(1.401)	(4.263)
Catch	0.00553*	0.00343	0.00319	0.00558	0.00653**
	(2.001)	(0.534)	(0.664)	(0.968)	(5.053)
01 Regular	0.1386**	0.143*	0.122*	0.152*	0.1172**
	(4.975)	(2.164)	(2.218)	(2.353)	(7.456)
01 Sport	-0.1617**	-0.159*	-0.1366*	-0.0853	-0.0839**
	(-5.461)	(-2.389)	(-2.532)	(-1.333)	(-5.088)
Selection					
Constant				-2.585**	1.349**
				(-6.233)	(8.702)
Non-Resident				-0.113	0.1048
				(-0.374)	(0.678)
Central Florida Resident				-0.2305	0.14
				(-1.127)	(1.289)
North Florida Resident				-0.9099	0.422*
				(-1.598)	(2.093)
Experience				0.1087**	-0.0485**
				(3.468)	(-3.349)
Catch				0.0105	-0.005
				(0.5)	(-0.380)
01 Regular				0.1709	0.1055
				(0.601)	(0.805)
01 Sport				0.6264*	-0.32*
				(2.213)	(-2.475)
Sigma		1.1175**	0.6873**	0.6821**	
		(24.715)	(11.464)	(11.46)	
Rho			-1.2138**		
			(-11.88)		
Log-likelihood	-8812.357	-6336.708	-6305.8	-6294.74	-7374.627

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 7: Alternative Model Specifications for the WTP to avoid a decrease in Spiny Lobster Bag Limits - Tobit Spike Models

Variable	Model	
	1	2
Intercept	5.717**	5.717**
	(18.103)	(18.131)
Non-Resident	0.2945	0.2945
	(0.934)	(0.935)
Central Florida Resident	0.1968	0.1968
	(0.885)	(0.886)
North Florida Resident	0.2516	0.2516
	(0.668)	(0.669)
Experience	-0.0226	-0.0226
	(-0.742)	(-0.743)
Catch	0.0186	0.0186
	(0.684)	(0.685)
01 Regular	-0.6473*	-0.6473*
	(-2.415)	(-2.419)
01 Sport	-1.8619**	-1.8619**
	(-6.881)	(-6.892)
Selection		
Sigma		4.75**
		(71.58)
Log-likelihood	-7661.4	-7629.3
Adjusted R^2	0.022	

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 8: Alternative Model Specifications for the WTP for an increase in Spiny Lobster Bag Limits - Count Spike Models

Variable	Model				
	1	2	3	4	5
Intercept	1.622**	1.626**	1.9558**	1.9377**	1.982**
	(54.043)	(17.599)	(29.265)	(28.010)	(117.922)
Non-Resident	0.03876	0.0312	0.0002958	-0.01993	-0.0151
	(1.249)	(0.335)	(0.004)	(-0.274)	(-0.822)
Central Florida Resident	0.09465**	0.0976	0.06261	0.0444	0.0415**
	(4.272)	(1.476)	(1.341)	(0.909)	(3.352)
North Florida Resident	0.17**	0.184	0.09514	0.04806	0.0398
	(4.706)	(1.653)	(1.214)	(0.606)	(1.952)
Experience	-0.006591	-0.00662	0.000615	0.00526	0.00465**
	(-2.24)	(-0.749)	(0.097)	(0.790)	(2.865)
Catch	0.01495**	0.0152	0.00835	0.00462	0.00424**
	(5.795)	(1.909)	(1.526)	(0.835)	(3.075)
01 Regular	-0.2788**	-0.284**	-0.2216**	-0.1995**	-0.183**
	(-10.722)	(-3.556)	(-3.819)	(-3.301)	(-12.484)
01 Sport	-0.2043**	-0.212**	-0.1619**	-0.1427*	-0.131**
	(-7.865)	(-2.663)	(-2.764)	(-2.324)	(-8.807)
Selection					
Constant				-1.0238**	0.8629**
				(-6.352)	(6.109)
Non-Resident				-0.1627	0.1389
				(-1.019)	(0.987)
Central Florida Resident				-0.16	0.154
				(-1.456)	(1.569)
North Florida Resident				-0.456*	0.417*
				(-2.259)	(2.394)
Experience				0.0409**	-0.0359**
				(2.696)	(-2.642)
Catch				-0.03709**	0.03382**
				(-2.585)	(2.726)
01 Regular				0.2836**	-0.3*
				(2.125)	(-2.532)
01 Sport				0.2301	-0.2377*
				(1.702)	(-1.974)
Sigma		1.77**	0.458**	0.456**	
		(26.58)	(12.39)	(12.38)	
Rho			-0.427**		
			(15.34)		
Log-likelihood	-10362	-6502	-6315	-6306	-7216
Adjusted R^2	0.011				

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 9: Alternative Model Specifications for the WTP for an increase in Spiny Lobster Bag Limits - Tobit Spike Models

Variable	Model	
	1	2
Intercept	7.327**	6.693**
	(19.401)	(14.034)
Non-Resident	0.2212	0.2644
	(0.586)	(0.552)
Central Florida Resident	0.465	0.595
	(1.749)	(1.759)
North Florida Resident	0.777	1.091
	(1.726)	(1.914)
Experience	-0.03712	-0.0504
	(-1.018)	(-1.096)
Catch	0.0766*	0.1106**
	(2.351)	(2.685)
01 Regular	-3.038**	-3.78**
	(-9.48)	(-9.298)
01 Sport	-2.688**	-3.19**
	(-8.308)	(-7.798)
Sigma		7.02**
		(59.55)
Log-likelihood	-8087	-7134
Adjusted R^2	0.04	

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Difference in WTP1 and WTP2 – Table 10

The analytical approach used in the prior models was that WTP1 and WTP2 were independent observations. This is not correct since each respondent was asked to respond to a pair of scenarios – a decrease (WTP1) and an increase (WTP2) in bag limits that varied across the 3 surveys. Because the WTP1 response would be a reduction from the existing bag limit at the time of each survey, the WTP to avoid the decrease is an equivalent variation (EV). WTP2, on the other hand, is a compensating variation (CV) because the proposed change is an increase from the current limit.

Several theoretical papers (e.g. Willig, Randall and Stoll, Hanemann) have demonstrated that if the environmental good is easily substitutable with other goods and the value of the good is low in proportion to income, EV and CV measures of WTP are symmetric so there should be no difference. On the other hand, Thaler (1980), Knetsch (1989), and Kahneman et al. (1991) suggest that there may be an "endowment effect" caused by individual's attachment to a good. Experimental work by these authors and others (e.g. List, 2003; 2004) using everyday goods such as coffee mugs, chocolate bars, and sports cards do indeed find evidence of an endowment effect. In the context of a license to harvest spiny lobster, past experience and catch may create an endowment effect in that individuals feel they are entitled to be able to continue harvesting at existing bag limits. This is more likely if the individual purchases the license solely for their own utilization and cannot sell or buy a license from another individual (Kahneman et al., 1991). If such an effect were to occur, EV would be expected to exceed CV (i.e. WTP1 > WTP2) for equivalent changes in the bag limit.

To model the responses from the pairs of WTP responses, the difference in WTPs was created by subtracting WTP1 from WTP2 using the interval value for each response. This corrects for inflation between the different survey periods. In addition, to adjust for the fact that WTP2 applies to different changes in bag limits across the 3 surveys, a second variable was created to measure the difference in WTPs per lobster. Summary statistics for both of these variables are provided in the middle portion of Table 1. It is interesting to note that the difference in WTPs is positive but the WTP per lobster is negative. This result suggests that the treatment of the number of lobster in a formal econometric model may be an important aspect of determining the true value.

The results in Column 1 of Table 10 use the full set of observations (with respondents who had a missing value for either WTP1 or WTP2 deleted) with the difference in WTPs as the dependent variable. Because the dependent variable is continuous and normally distributed around $0.00, the estimation uses OLS. The positive and significant intercept indicates that WTP2 exceeds WTP1; this is inconsistent with an endowment effect. Catch is positive and significant indicating that respondents with higher catch were more willing to pay for increases in the bag limit. The survey dummy variables, on the other hand, were both negative and significant indicating that respondents in both 2001 surveys were not willing to pay as much for an increase in the bag limit as those in the 1992 survey. This may reflect the larger increase in the bag limit that was proposed in the 1992 survey. The results in Column 2 use the same dependent variable but observations in which the respondent indicated they were indifferent to the proposed changes were deleted. The parameter estimates with this restricted sample are qualitatively the same as for Column 1.

To adjust for the differences in the increased bag limit used for WTP2 across the 3 surveys, Columns 3 and 4 use the difference in WTP per lobster. Column 3 includes all observations while Column 4 uses the restricted sample with indifferent respondents deleted. Both models are estimated with OLS. The negative, and highly significant, intercepts

for both models indicate that WTP1 per lobster exceeds WTP2 per lobster. These results are clearly consistent with an endowment effect. None of the other coefficients are significant with the exception of the survey dummy variables that are both positive. The positive sign indicates that, after correcting for the differences in proposed bag limits across the 3 surveys, respondents in both of the 2001 surveys were willing to pay more for an increase in bag limits than in 1992. Given that inflation has already been accounted for in the WTP values, it is not clear why the 2001 respondents would express a higher WTP.

An alternative approach to modeling differences between WTP1 and WTP2 is evaluated in Table 11. These models are similar to Models 1 and 2 in Table 10 except that the *difference in bag limits* between WTP2 and WTP1 in each survey is used as an independent variable. This approach provides a more direct test for an endowment effect since the difference in the outcome (i.e. the bag limit change) does not distort the dependent variable. Because the proposed bag limit for WTP2 was always greater than for WTP1, the intercept measures the endowment effect due to a bag limit reduction of 2 lobster relative to a bag limit increase of 2 lobster. The difference in bag limits variable measures the marginal WTP for a 1 lobster increase in the bag limit.

Both the full and restricted sets of observations were used; estimation is via OLS. The results in Table 11 for both models indicate a negative, statistically significant intercept that is consistent with an endowment effect. The catch variable is positive and significant indicating an increased WTP for a higher bag limit for respondents who had more success harvesting lobsters. The positive and highly significant coefficient for the difference in bag limits indicates that respondents were willing to pay for higher bag limits. Note that this coefficient, however, is approximately one-half the value of the intercept indicating that the endowment effect due to a potential decrease in the bag limit is large relative to the marginal value of an additional lobster.

Future Tasks

The results from this portion of the project illustrate some of the alternatives for modeling the WTP for changes in spiny lobster bag limits. While it is possible to model the WTP1 and WTP2 responses as independent, the results in Tables 10 and 11 indicate that gains and losses in bag limits are not viewed as symmetric changes. These results will be considered in estimating the marginal values for bag limit changes in the final report.

Interim Report Table 10: Alternative Model Specifications using the Difference in WTP's

Variable	Model			
	1	2	3	4
Intercept	1.266**	1.6096**	-1.1628**	-1.896**
	(6.028)	(5.146)	(-12.958)	(-14.149)
Non-Resident	0.07	-0.07332	-0.0843	-0.2146
	(0.338)	(-0.235)	(-0.954)	(-1.604)
Central Florida Resident	0.3418**	0.2684	0.00287	-0.004314
	(2.298)	(1.218)	(0.045)	(-0.046)
North Florida Resident	0.4189	0.5255	0.1541	0.174
	(1.721)	(1.409)	(1.482)	(1.089)
Experience	0.0256	-0.01449	0.002599	-0.00218
	(1.28)	(-0.480)	(0.304)	(-0.169)
Catch	0.05303**	0.05798**	0.003388	0.0149
	(2.685)	(2.148)	(0.402)	(1.291)
01 Regular	-1.73**	-2.3907**	1.077**	1.5806**
	(-9.575)	(-9.007)	(13.954)	(13.9)
01 Sport	-0.747**	-0.8261**	0.555**	0.746**
	(-4.144)	(-3.082)	(7.211)	(6.501)
Log-likelihood	-12274	-7605	-8584	-5433
Adjusted R^2	0.03	0.04	0.05	0.09
n	4,339	2,562	4,339	2,562

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

Interim Report Table 11: Alternative Model Specifications for the Difference in WTP's as a Function of the Change in Bag Limits

Variable	Model	
	1	2
Intercept	-0.523**	-0.791**
	(3.85)	(3.81)
Non-Resident	0.121	0.064
	(0.60)	(0.21)
Central Florida Resident	0.341**	0.268
	(2.29)	(1.22)
North Florida Resident	0.432	0.526
	(1.78)	(1.41)
Experience	0.032	-0.013
	(1.69)	(0.46)
Catch	0.053**	0.058**
	(2.68)	(2.15)
Difference in Bag Limits	0.273**	0.396**
	(10.07)	(9.83)
Log-likelihood	-12275	-7604
Adjusted R^2	0.03	0.04
n	4,339	2,562

*,** indicate significance at the 0.05 and 0.01 level, respectively; t-statistic(two-tailed test) in parentheses.

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STATISTICAL ANALYSIS TO SUPPORT THE SOCIOECONOMIC RESEARCH AND MONITORING PROGRAM FOR THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Progress Report 1
Statistical Analysis of 1992 and 2001 Recreational Lobster Survey Data

1992 Sport Season Survey

The accompanying Table 1 provides a frequency distribution of responses to the contingent valuation questions that were included in the 1992 recreational sport season spiny lobster fishery survey conducted by the Florida Marine Research Institute (FMRI). The upper portion of Table 1 provides a frequency distribution of the willingness to pay (WTP) responses to purchase a special permit (stamp) to avoid a decrease in the bag limit from *6 to 4 lobsters per day* in Monroe county and from *8 to 6* elsewhere in Florida. The lower portion of Table 1 provides a distribution of WTP responses for an increase in the bag limit from 4 to 14 lobster per day in Monroe county and from 6 to 16 elsewhere. This special permit was described in the survey as an *additional* stamp that would be purchased along with the existing license stamp that was required to harvest spiny lobster. The survey question did not distinguish whether the lobsters were harvested during the sport season or during the regular season.

The data in Table 1 show the majority of respondents indicated a $0.00 WTP response for either increases or decreases in the bag limit. For respondents with a positive WTP, there was some degree of clustering around specific amounts. In the upper portion of Table 1, the most frequent response was $2.00 and the second most frequent was $5.00. The required fee for a lobster (crawfish) permit in 1992 was $2.00. In the lower portion of Table 1, however, the most frequent response was $10.00 followed by $16.00 which was the maximum WTP amount a respondent could indicate on the survey form. These differences in the response frequencies suggest that the existing $2.00 stamp did not have a strong 'anchoring' effect on responses to the WTP questions.

Table 2 provides a frequency distribution of the reasons given by respondents who indicated a $0.00 WTP for the bag limit scenarios described in Table 1. The reasons for not paying to avoid a decrease in the bag are shown in the upper portion of Table 2. The most frequent reason given was that the respondent "did not want to pay any more than he/she currently pay." These could be considered 'protest' responses since the respondents rejected the WTP elicitation process. The second most frequent reason for a $0.00 WTP was "the limit or fewer lobsters was all he/she wanted to keep." This is a legitimate reason for a $0.00 response if the respondent is indifferent to a lower bag limit. This same logic would apply to respondents who believed they were "not likely to catch the limit." The 'Other' category in the upper portion of Table 2 reflects the alternative responses that respondents provided in written form on the survey. In some cases respondents marked one of the reasons provided on the survey and then wrote in an additional response. This is the reason why the number of responses to this question (1061) is greater than the total number of responses to the WTP questions (1006) reported in Table 1. A review of these written responses indicates that the majority did not want to pay *any* additional fees regardless of the proposed change. Thus, many of the respondents in this Other category could also be considered protest responses.

The lower portion of Table 2 gives the reasons given for not paying to increase the bag limit. The most common responses were that respondents "did not want more that the limit" or they were "not likely to catch the limit." These are credible reasons for a $0.00 WTP. The protest response that the respondent did not want to pay more than the current fees was also a frequent response. The 'Other' category with written responses for an increase in the bag limits also contained a large number of entries that could be considered protest responses.

2001 Sport Season Survey

The accompanying Table 3 provides a frequency distribution of responses to the contingent valuation questions that were included in the 2001 recreational sport season spiny lobster fishery survey conducted by the Florida Marine Research Institute (FMRI). The upper portion of Table 3 provides a frequency distribution of the willingness to pay (WTP) responses to purchase a special permit (stamp) to avoid a decrease in the bag limit from *6 to 4 lobsters per day* in Monroe county and from *12 to 10* elsewhere in Florida during the sport season. The lower portion of Table 1 provides a distribution of WTP responses for an increase in the bag limit from *6 to 12 lobsters per day* in Monroe county and from *12 to 18* elsewhere. Unlike the 1992 survey, these WTP questions applied only to the sport season. The differences in the baseline and proposed bag limits outside Monroe county reflect differences in spiny lobster harvesting regulations that were enacted after 1992.

Both the upper and lower portions of Table 3 show a higher percentage of $0.00 WTP responses than the 1992 survey responses. In the upper portion of Table 3, there is again a clustering of responses around $2 and around $4, $5, and $10. Similarly, the lower portion shows a clustering around $2, $4, $5 and $10.

Table 4 presents the reasons given by respondents who indicated a $0.00 WTP for the bag limit scenarios described in Table 3. The reasons for not paying to avoid a decrease in the bag limit and not paying to increase the bag limit are shown in the upper and lower portions of Table 4, respectively. As with the 1992 survey, the most common reasons cited for a $0.00 WTP to avoid a bag limit decrease were an unwillingness to pay more and he/she did not want more than the limit. The 'Other' category with written responses included a large percentage of written comments that could again be considered protest responses. The most common reasons for a $0.00 WTP for a bag limit increase were he/she did not want more than the limit or it was not likely he/she would catch the limit. The next most frequent response was he/she was not willing to pay more. This response also was a common response in the written 'Other' category.

Progress Report Table 1: Frequency Distribution of Willingness to Pay (WTP) for Changes in Spiny Lobster Bag Limits in the 1992 Sport Season Survey

$ Value	Frequency	Percent	Cumulative Frequency
	WTP to Avoid a Decrease in BAG Limit		
$0.00	534	53.08	534
$1.00	45	4.47	579
$2.00	124	12.33	703
$3.00	14	1.39	717
$4.00	66	6.56	783
$5.00	93	9.24	876
$6.00	19	1.89	895
$7.00	1	0.10	896
$8.00	10	0.99	906
$10.00	63	6.26	969
$12.00	7	0.70	976
$14.00	2	0.20	978
$16.00	28	2.78	1006
	WTP for an Increase in BAG Limit		
$0.00	528	52.49	528
$1.00	23	2.29	551
$2.00	64	6.36	615
$3.00	10	0.99	625
$4.00	51	5.07	676
$5.00	69	6.86	745
$6.00	20	1.99	765
$7.00	3	0.30	768
$8.00	28	2.78	796
$10.00	112	11.13	908
$12.00	18	1.79	926
$14.00	9	0.89	935
$16.00	71	7.06	1006

Progress Report Table 2: Frequency Distribution of Reasons for $0.00 Willingness to Pay (WTP) in the 1992 Regular Season Survey

$ Value	Frequency	Percent	Cumulative Frequency
	WTP to Avoid a Decrease in BAG Limit		
Not Applicable	516	48.63	516
Not likely to catch limit	92	8.67	608
Don’t want more than limit	107	10.08	715
Limits not enforced	14	1.32	729
Won't pay more	166	15.65	895
Not sure about value	5	0.47	900
No Opinion	6	0.57	906
Other	155	14.61	1061
	WTP for an Increase in BAG Limit		
Not Applicable	535	50.42	535
Not likely to catch limit	107	10.08	642
Don’t want more than limit	128	12.06	770
Limits not enforced	15	1.41	785
Won't pay more	107	10.08	892
Not sure about value	10	0.94	902
No Opinion	4	0.38	906
Other	155	14.61	1061

Progress Report Table 3: Frequency Distribution of Willingness to Pay (WTP) for Changes in Spiny Lobster Bag Limits in the 2001 Sport Season Survey

$ Value	Frequency	Percent	Cumulative Frequency
	WTP to Avoid a Decrease in BAG Limit		
$0.00	989	60.27	989
$1.00	80	4.88	1069
$2.00	225	13.71	1294
$3.00	17	1.04	1311
$4.00	87	5.30	1398
$5.00	92	5.61	1490
$6.00	12	0.73	1502
$8.00	13	0.79	1515
$10.00	83	5.06	1598
$12.00	6	0.37	1604
$14.00	10	0.61	1614
$16.00	27	1.65	1641
	WTP for an Increase in BAG Limit		
$0.00	970	59.11	970
$1.00	35	2.13	1005
$2.00	142	8.65	1147
$3.00	20	1.22	1167
$4.00	82	5.00	1249
$5.00	88	5.36	1337
$6.00	46	2.80	1383
$7.00	2	0.12	1385
$8.00	23	1.40	1408
$10.00	141	8.59	1549
$12.00	17	1.04	1566
$14.00	24	1.46	1590
$16.00	51	3.11	1641

Progress Report Table 4: Frequency Distribution of Reasons for $0.00 Willingness to Pay (WTP) in the 2001 Sport Season Survey

$ Value	Frequency	Percent	Cumulative Frequency
	WTP to Avoid a Decrease in BAG Limit		
Not Applicable	588	35.83	588
Not likely to catch limit	151	9.20	784
Don’t want more than limit	197	12.00	981
Limits not enforced	24	1.46	1005
Won't pay more	281	17.12	1286
Not sure about value	26	1.58	1312
No Opinion	45	2.74	633
Other	329	20.05	1641
	WTP for an Increase in BAG Limit		
Not Applicable	661	40.28	661
Not likely to catch limit	179	10.91	893
Don’t want more than limit	226	13.77	1119
Limits not enforced	35	2.13	1154
Won't pay more	130	7.92	1284
Not sure about value	17	1.04	1301
No Opinion	53	3.23	714
Other	340	20.72	1641

2001 Regular Season Survey

The accompanying Table 5 provides a frequency distribution of responses to the contingent valuation questions that were included in the 2001 recreational regular season spiny lobster fishery survey conducted by the Florida Marine Research Institute (FMRI). The upper portion of Table 5 provides a frequency distribution of the willingness to pay (WTP) responses to purchase a special permit (stamp) to avoid a decrease in the bag limit from *6 to 4 lobsters per day* anywhere in Florida during the regular season. The lower portion of Table 5 provides a distribution of WTP responses for an increase in the bag limit from *6 to 8 lobsters per day* anywhere in Florida during the regular season. These WTP questions applied only to the regular season. The differences in the baseline and proposed bag limits from the 1992 survey reflect differences in spiny lobster harvesting regulations that were enacted after 1992.

The results in the upper and lower portions of Table 5 once again show a high percentage of $0.00 WTP responses although the percentage is lower than for the 2001 sport season survey. A similar patter of clustering at the $2, $4, $5, and $10 responses is also apparent in both portions of the table.

Table 6 presents the reasons given by respondents who indicated a $0.00 WTP for the bag limit scenarios described in Table 5. The reasons for not paying to avoid a decrease in the bag limit and not paying to increase the bag limit are shown in the upper and lower portions of Table 6, respectively. The frequency of responses for both the bag limit decrease and increase were similar to the 1992 and 2001 sport season surveys.

Means Test for Equivalence Between the 1992 and 2001 Surveys

Table 7 provides the results of a test of equivalence of the mean WTP response in the 1992 and 2001 sport and regular season surveys. This procedure used a Tukey pairwise test of the null hypothesis: H_0: $\mu_i = \mu_j$ where μ denotes the mean, the subscripts denote the three surveys, and the significance level (α) equals .05. Equivalence tests are only conducted between comparable bag limit change scenarios (decreases or increases). The results in the upper portion of Table 7 provide tests for WTP to avoid bag limit decreases and the lower portion is WTP for bag limit increases.

The test results in the upper portion of Table 7 show that the means of the 1992 and 2001 regular season survey WTP responses to avoid a decrease in bag limits were not statistically different. The mean WTP response in the 2001 sport season survey was significantly different than the 1992 and 2001 regular season survey. This result is somewhat surprising since the marginal decreases in bag limits in the three surveys were the same -- a reduction of 2 lobsters per day.

The test results in the lower portion of Table 7 show that the means of the 2001 sport and regular season surveys for bag limit increases were not statistically different. The 1992 survey mean was statistically different from both of the 2001 surveys. This latter result is expected since the marginal change in bag limit in the 1992 survey was an increase of 8 lobsters per day. The equivalence of the 2001 surveys is surprising because the marginal change in the bag limit in the sport survey was an increase of 6 lobsters per day while the increase in the regular season survey was only 2 lobsters per day. This result, combined with the difference in WTP to avoid a bag limit decrease, suggests that respondents in the 2001 surveys may not have been responsive to the size of the proposed change in bag limits.

To account for differences in the price level between the 1992 and 2001 surveys, an inflation adjustment was added to the analysis to restate the 1992 WTP responses in 2001 dollars. These inflation adjusted results are displayed in Table 8 using the same format as in Table 7. The results in the upper portion of Table 8 now show no equivalence between any of the survey WTP means for a comparable (2 lobsters per day) decrease in bag limit. The results in the lower portion of the Table 8 have the same implication as the lower portion of Table 7 -- the WTP in 1992 for an increase of 8 lobsters per day was statistically greater than the WTP in both of the 2001 surveys. The 2001 WTP means were not statistically significant even though each survey proposed different marginal changes in the daily bag limit.

Progress Report Table 5: Frequency Distribution of Willingness to Pay (WTP) for Changes in Spiny Lobster Bag Limits in the 2001 Regular Season Survey

$ Value	Frequency	Percent	Cumulative Frequency
	WTP to Avoid a Decrease in BAG Limit		
$0.00	898	53.07	898
$1.00	66	3.90	964
$2.00	233	13.77	1197
$3.00	23	1.36	1220
$4.00	98	5.79	1318
$5.00	113	6.68	1431
$6.00	14	0.83	1445
$8.00	28	1.65	1473
$10.00	130	7.68	1603
$12.00	7	0.41	1610
$14.00	15	0.89	1625
$16.00	67	3.96	1692
	WTP for an Increase in BAG Limit		
$0.00	981	57.98	981
$1.00	47	2.78	1028
$2.00	191	11.29	1219
$3.00	15	0.89	1234
$4.00	90	5.32	1324
$5.00	94	5.56	1418
$6.00	17	1.00	1435
$7.00	2	0.12	1437
$8.00	31	1.83	1468
$10.00	123	7.27	1591
$12.00	12	0.71	1603
$14.00	20	1.18	1623
$16.00	69	4.08	1692

Progress Report Table 6: Frequency Distribution of Reasons for $0.00 Willingness to Pay (WTP) in the 2001 Regular Season Survey

$ Value	Frequency	Percent	Cumulative Frequency
	WTP to Avoid a Decrease in BAG Limit		
Not Applicable	718	42.43	718
Not likely to catch limit	222	13.12	986
Don’t want more than limit	209	12.35	1195
Limits not enforced	25	1.48	1220
Won't pay more	227	13.42	1447
Not sure about value	23	1.36	1470
No Opinion	46	2.72	764
Other	222	13.12	1692
	WTP for an Increase in BAG Limit		
Not Applicable	689	40.72	689
Not likely to catch limit	285	16.84	1022
Don’t want more than limit	299	17.67	1321
Limits not enforced	17	1.00	1338
Won't pay more	102	6.03	1440
Not sure about value	18	1.06	1458
No Opinion	48	2.84	737
Other	234	13.83	1692

Progress Report Table 7: Means Test for Equivalence of Willingness to Pay (WTP) for Changes in Spiny Lobster Bag Limits in the 1992 and 2001 Surveys

Survey	Mean	Std. Dev.
	WTP to Avoid a Decrease in BAG Limit	
1992	$2.44[A]	$3.77
2001 Sport	$1.85	$3.36
2001 Regular	$2.68[A]	$4.20
	WTP for an Increase in BAG Limit	
1992	$3.67	$5.06
2001 Sport	$2.67[B]	$4.28
2001 Regular	$2.62[B]	$4.31

Note: The superscripts A, B denote pairs of means that are not statistically different.

Progress Report Table 8: Means Test for Equivalence of Willingness to Pay (WTP) for Changes in Spiny Lobster Bag Limits in the 1992 and 2001 Surveys with Inflation Adjustment

Survey	Mean	Std. Dev.
	WTP to Avoid a Decrease in BAG Limit	
1992	$3.13	$4.85
2001 Sport	$1.85	$3.36
2001 Regular	$2.68	$4.20
	WTP for an Increase in BAG Limit	
1992	$4.72	$5.06
2001 Sport	$2.67[A]	$4.28
2001 Regular	$2.62[A]	$4.31

Note: The superscript A denotes pairs of means that are not statistically different.