SAFE REPORT APPENDIX 1

Description of price model used for economic cost benefit analysis

Estimation of annual ex-vessel prices

Fish prices constitute one of the important channels through which fishery management actions affect fishing revenues, vessel profits, consumer surplus, and net economic benefits for the nation. The degree of change in ex-vessel price in response to a change in variables affected by management, i.e., scallop landings and size composition of landed scallops, is estimated by a price model, which also takes into account other important determinants of price, such as disposable income of consumers and price of imports.

Given that there could be many variables that could affect the price of scallops, it is important to identify the objectives in price model selection for the purposes of cost-benefit analyses. These objectives (in addition to developing a price model with sound statistical properties) are as follows:

- To develop a price model that uses inputs of the biological model and available data. Since the biological model projects annual (rather than monthly) landings, the corresponding price model should be estimated in terms of annual values.
- To select a price model that will predict prices within a reasonable range without depending on too many assumptions about the exogenous variables. For example, the import price of scallops from Japan could impact domestic prices differently than the price of Chinese imports, but making this separation in a price model would require prediction about the future import prices from these countries. This in turn would complicate the model and increase the uncertainty regarding the future estimates of domestic scallop prices.

In addition to the changes in size composition and landings of scallops, other determinants of ex-vessel price include level of imports, import price of scallops, disposable income of seafood consumers, and the demand for U.S. scallops by other countries. The main substitutes of sea scallops are the imports from Canada, which are almost identical to the domestic product, and imports from other countries, which are generally smaller in size and less expensive than the domestic scallops. An exception is the Japanese imports, which have a price close to the Canadian imports and could be a close substitute for the domestic scallops as well.

The ex-vessel price model estimated below includes the price, rather than the quantity of imports as an explanatory variable, based on the assumption that the prices of imports are, in general, determined exogenously to the changes in domestic supply. This is equivalent to assuming that the U.S. market conditions have little impact on the import prices. An alternative model would estimate the price of imports according to world supply and demand for scallops, separating the impacts of Canadian and Japanese imports from other imports since U.S. and Canadian markets for scallops, being in proximity, are highly connected and Japanese scallops tend to be larger and closer in quality to the domestic scallops. The usefulness of such a simultaneous equation model is limited for our present purposes, however, since it would be almost impossible to predict how

the landings, market demand, and other factors such as fishing costs or regulations in Canada or Japan and in other exporting countries to the U.S. would change in future years.

Since the average import price is equivalent to a weighted average of import prices from all countries weighted by their respective quantities, the import price variable takes into account the change in composition of imports from Canadian scallops to less expensive smaller scallops imported from other countries. This specification also prevents the problem of multi-colinearity among the explanatory variables, i.e., prices of imports from individual countries and domestic landings. In terms of prediction of future ex-vessel prices, this model only requires assignment of a value for the average price of imports, without assuming anything about the composition of imports, or the prices and the level of imports from individual countries. The economic impact analyses of the fishery management actions usually evaluate the impact on ex-vessel prices by holding the average price of imports constant. The sensitivity of the results affected by declining or increasing import prices could also be examined, however, using the price model presented in this section.

The price model presented below estimates annual average scallop ex-vessel price by market category (PEXMRKT) as a function of

- Meat count (MCOUNT)
- Average price of all scallop imports (PIMPORT)
- Per capita personal disposable income (PCDPI)
- Total annual landings of scallops (SCLAND)
- Percent share of landings by market category in total landings (PCTLAND)
- A dummy variable as a proxy for price premium for Under 10 count scallops (PP10).
- Dummy variables for 2005 (D05) and 2010 (D10) to take into account the problems with the Japanese aquaculture in those years that reduced the supply of large scallops from this country and increased the demand for US sea scallops.
- Ratio exported pounds to the landings of domestic scallops (REXPLAN)

Because the data on scallop landings and revenue by meat count categories were mainly collected since 1998 through the dealers' database, this analysis included the 1998-2013 fishing years. All the price variables were corrected for inflation and expressed in 2013 prices by deflating current levels by the consumer price index (CPI).

The ex-vessel prices are estimated in semi-log form to restrict the estimated price to positive values only as follows:

> Log (PEXMRKT) = f (MCOUNT, PIMPORT, PCDPI, SCLAND, PCTLAND, DU10, D2005, D2010, REXPLAN)

The market categories above 30-count are grouped together since landings of scallops over 40-, 50- or 60-count were almost nonexistent since 1998 and also to be consistent with the grouping

in the biological model which estimates composition of scallop landings in terms of four market categories. The data for the regression analysis did not include the landings of scallops with unclassified market category.

The estimation of the price model using the Nonlinear GMM method produced robust estimates of the coefficient of variation and the parameter as shown in **Table 1** and **Table 2**. Adjusted R^2 indicates that changes in meat count, composition of landings by size of scallops, domestic landings, average price of all imports, disposable income, price premium on under 10 count scallops, 2005 and 2010 dummy variables and ratio of exports to domestic landings explain over 87 percent of the variation in ex-vessel prices by market category.

Table 1 - Estimation results for price model

Observations Processed
Read 64
Solved 64
GMM with HCCME=1

The MODEL Procedure

Nonlinear GMM Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
Log (PEXMRKT)	10	54	0.4019	0.00744	0.0863	0.8959	0.8785

Table 2 - Coefficients of the Price Model

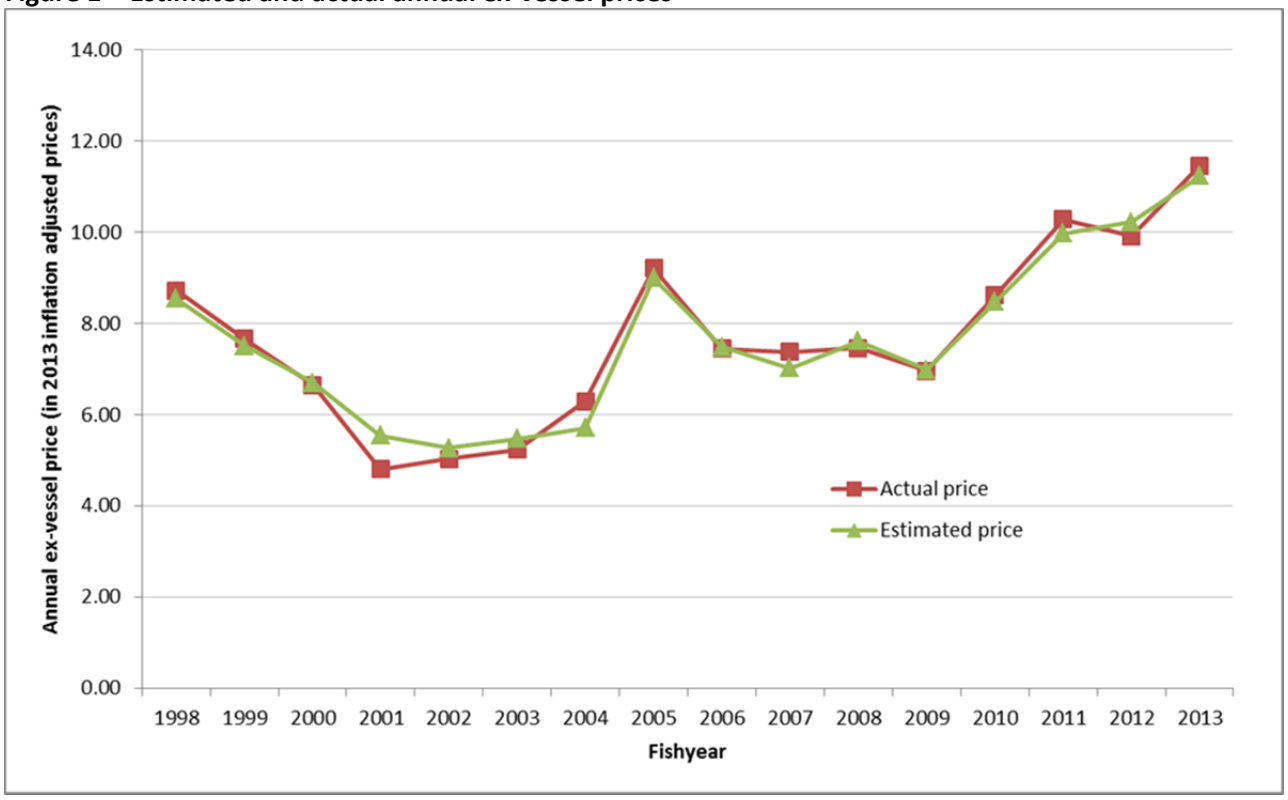
Nonlinear GMM Parameter Estimates

Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
INTERCEPT	0.51439	0.4824	1.07	0.2910
MCOUNT	-0.00512	0.00198	-2.58	0.0125
PIMPORT	0.086544	0.0270	3.21	0.0023
PP10	0.046582	0.0528	0.88	0.3814
PCTLAND	-0.20172	0.0554	-3.64	0.0006
SCLAND	-0.00596	0.00159	-3.75	0.0004
D10	0.161308	0.0457	3.53	0.0009
D5	0.169627	0.0410	4.14	0.0001
DPICPC	0.033619	0.0133	2.52	0.0147
REXPLAN	0.681612	0.1909	3.57	0.0008

The coefficients of the model are used first to estimate the prices by market category and then a weighted (by share in total landings) average of the estimated prices is calculated to estimate the annual average price.

Figure 1 shows that this model provides a very good fit to the actual values of ex-vessel prices especially given that data is imperfect and there are possibly several other factors that affect prices in some small degree that cannot be practically included in the model. In terms of data, a percentage of landings remain unclassified in terms of market category (**Table 3**). Average annual prices were estimated assuming that composition of the unclassified landings is similar to the composition of the landings by classified market categories, it likely that actual distribution were different from what was assumed. Another data issue is that dealer data combines U12 scallops with usually demand a higher premium with scallops up to 20-count scallops. Because of that, the price model cannot take into account the proportion of U12's in landings.

Figure 1 – Estimated and actual annual ex-vessel prices



In addition to these data issues the changes in import price of scallops coming from different countries, or changes in the seasonal composition of landings are among other factors that could affect annual average ex-vessel prices. However, as mentioned above, the goal was to develop a price model that uses inputs of the biological model, which projects annual rather than seasonal landings. Another important goal was to select a price model that will predict prices within a reasonable range without depending on too many assumptions about the exogenous variables, including the composition of imports from different countries. Although numerical results should be interpreted with caution, since the analysis covers about 16 years of annual data from a period during which the scallop fishery underwent major changes in management policy including area closures, controlled access, and rotational area management, overall, the above price model has the proper statistical properties and provides a robust estimate of average annual prices. In 14 out of 16 years, the difference in estimated price from the actual price was less than

5% and in the last 6 years with better data compared to the previous years, this difference was at most was 3% (**Table 4**).

Table 3 - Composition of scallop landings by market category

Fishyear	Unclassified	Under 10 count	10 to 20 count	20 to 30 count	>30 count	Grand Total
1998	24%	2%	17%	21%	35%	100%
1999	12%	16%	12%	28%	33%	100%
2000	10%	7%	20%	42%	21%	100%
2001	13%	3%	23%	52%	10%	100%
2002	11%	5%	14%	66%	4%	100%
2003	13%	6%	21%	56%	3%	100%
2004	8%	8%	45%	39%	1%	100%
2005	7%	13%	58%	21%	2%	100%
2006	7%	23%	50%	19%	1%	100%
2007	7%	24%	52%	12%	4%	100%
2008	4%	23%	52%	19%	1%	100%
2009	3%	15%	62%	21%	0%	100%
2010	2%	15%	63%	19%	0%	100%
2011	2%	15%	77%	6%	1%	100%
2012	2%	18%	73%	6%	0%	100%
2013	3%	21%	61%	14%	0%	100%
Period average	**7%**	**14%**	**48%**	**27%**	**4%**	**100%**

Table 4 - Percentage difference of estimated annual ex-vessel price from the actual price

Fishyear	Percent difference of estimated price from actual prices
1998	-2.0%
1999	-2.0%
2000	0.7%
2001	15.2%
2002	4.6%
2003	4.6%
2004	-9.2%
2005	-2.3%
2006	0.5%
2007	-4.8%
2008	2.1%
2009	0.4%
2010	-1.7%
2011	-2.9%
2012	3.1%
2013	-2.0%
Period average	**0%**